# obsinfo

***Release 0.110***

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**Sep 14, 2023**

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# ONE

# OVERVIEW

## 1.1 Introduction

**obsinfo** is a Python standalone application for creating FDSN-standard (StationXML) data and metadata for ocean bottom seismometers using standardized, easy-to-read information files in YAML or JSON formats. The advantages of **obsinfo** are the following:

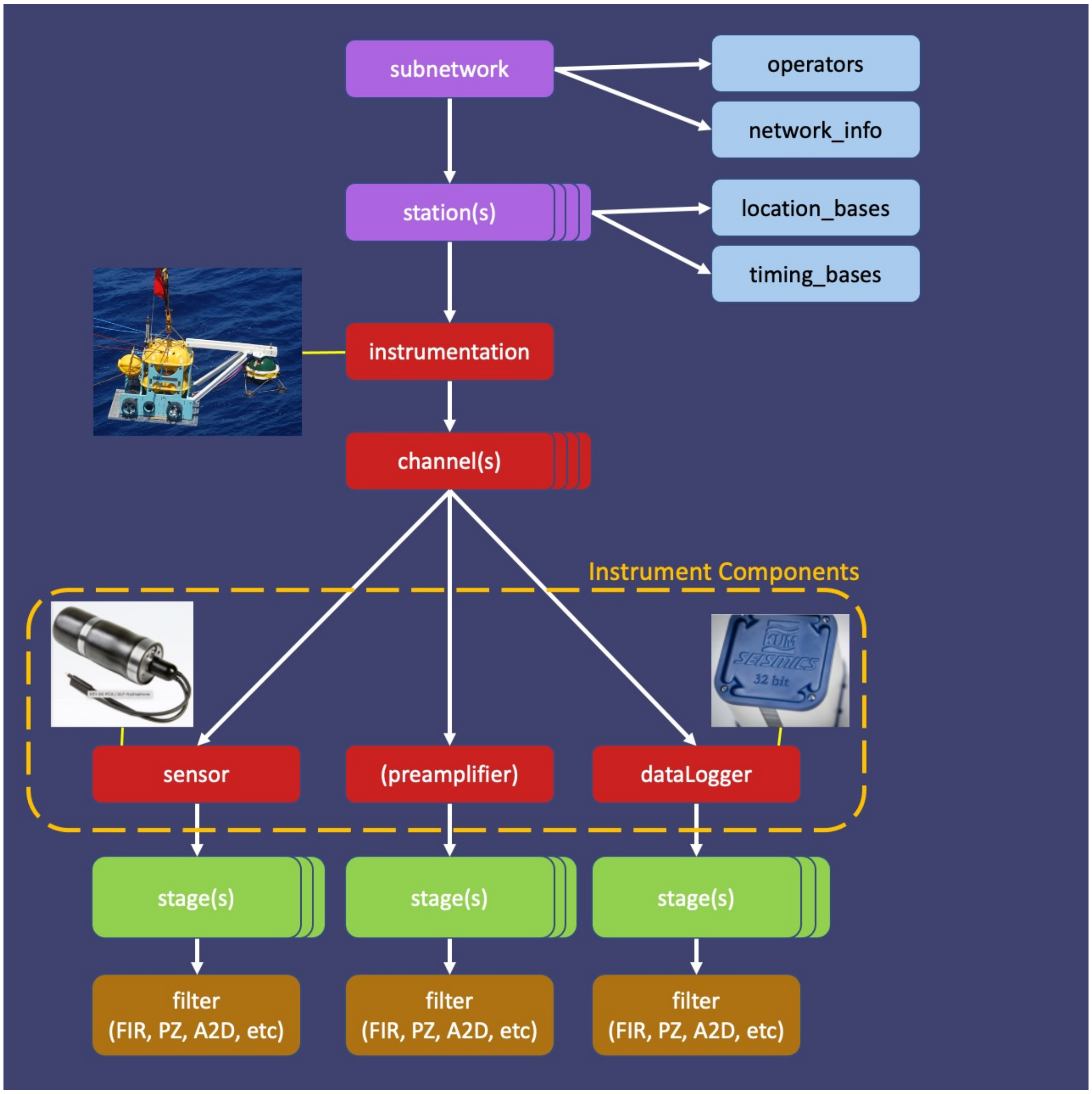
- Easier input user format, as YAML and JSON syntax is simpler than XML
- Avoiding redundancy (**`Don't Repeat Yourself`_**)
- Flexibility to change configurations avoiding rewriting or modifying a new StationXML file each time
- Autonomy of operation from Internet connections, being text-based
- Adapts StationXML to OBS-specific functionality
- Simple interface to other systems, such as Yasmine

Unlike general systems like Yasmine, **obsinfo** is designed to reflect the vast variability of OBS equipment and the fact that changes on the field are common and cannot be planned in advance. Emergency procedures such as changing an equipment component or a stage in the high seas need to accounted for. The fact that the editing of information needs to occur without connection to a central database is also a consideration. We have therefore chosen to avoid a GUI such as Yasmine and make **obsinfo** totally text-based using regular files. At the same time, every effort has been made to stay compatible with AROL, which is based on an earlier version of **obsinfo** itself, so AROL yaml files can be imported into **obsinfo**. However, as of this publication, some differences exist.

Reuseability and lack of redundancy ais achieved by creating a repository of instrumentations which is referenced time and again by different campaigns. Flexibility is achieved by permitting these instrumentations to have several selectable configurations, as well as the ability to make punctual changes to *any* field via channel modifications (see Advanced Topics).

**obsinfo** also manages two "parallel" information file types: *experiment* and *datacite*. These files are not needed for creating StationXML but are useful for validating data and metatdata and for creating DataCite files for DOI. The **datacite_** information file only contains fields that the lead scientist should provide to a data center.

## 1.2 Object Model



The reference manual is organized around the object model, in pages that describe each particular class. The object hierarchy starts in Class *Network*. You can navigate from one class to the other by using the **Relationships** section.

## 1.3 Information Files

The system is based on "*information files*" in JSON or YAML format as input, filled in by appropriate actors and broken down into different categories to remove redundancy and simplify input as much as possible. Information files are taken as input and converted first to an obsinfo object, which in turn gets converted to an ObsPy object and then is output as a StationXML file.

There are 6 main file types for StationXML and processing path creation:

| Name | Description | Filled by | When filled |
|---|---|---|---|
| **subnetwork** | Deployed stations, their instruments and parameters | OBS facility | after a campaign |
| **instrumentation** | Instrument description | OBS facility | new/changed instruments |
| ***instrument_components*** **sensors** **components** **dataloggers** | Description of basic components | OBS facility -or- component manufacturer | when there are new are new components or calibrations |
| **response_stage** | Description of stages digitizers, amplifiers/filters) | OBS facility -or- component manufacturer | when there are new components or calibrations |
| **filter** | Description of filters amplifiers and digitizers used in stages | OBS facility -or- component manufacturer | when there are new components or calibrations |

Only the **subnetwork** files are OBS-specific and for most data-collection campaigns they are all you'll need to fill out.

The **instrumentation** files and their subfiles could be replaced by existing standards such as RESP files or the NRL (Nominal Response Library), but obsinfo provides a simpler and more standards-compliant way to specify the components, and it automatically calculates response sensitivities based on gains and filter characteristics (using ObsPy). **obsinfo** instrumentation files could also be used to make RESP-files and NRL directories (not yet coded).

There are 2 other (optional) file types for quality control and Datacite creation:

| Name | Description | Filled by | When filled |
|---|---|---|---|
| **experiment** | Lists of stations facilities and participants, plus desired verification. NOT NEEDED FOR PROCESSING | Chief scientist | after a data collection campaign |
| **datacite** | Scientist-specific information for DOI datacite files | Chief scientist | after a data collection campaign |

### 1.3.1 File Hierarchy

It is recommended to arrange the information files in a file hierarchy such as this:

```
/authors (contains files used in headers of other information files)
/network
/instrumentation
/sensors
/preamplifiers
/dataloggers
```

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```
[/instrumentation_componenent]/stages
[instrumentation_componenent]/stages/filters
```

where [instrumentation_componenent] = sensors, preamplifiers or dataloggers.

**The hierarchy is completely up to the user**, including the names of the folders/directories. In fact, it is perfectly possible to put all the information in a single file, although it is not recommended as reusability of filters, stages or components depends on independent files.

To reference a file from within another file, use the *JREF* syntax:

```
authors: - {$ref: "../authors/Wayne_Crawford.author.yaml#author"}
```

The effect of this directive is at the core of the philosophy of *obsinfo*, as it is this mechanism which allows reuse: it substitutes the content of the key `author` within the file `../authors/Wayne_Crawford.author.yaml` as the value of the key `authors`. If you want to include the complete file, remove the `#author` anchor.

### 1.3.2 File Naming Convention

While there is flexibility about the folder hierarchy, information files **must** follow the following naming convention:

<descriptive file name>.<obsinfo file type>.<file format>

where

**<descriptive file name>** usually includes vendor and configuration shorthand to make the file easily identifiable by users,

**<obsinfo file type>** is one of `campaign`, `network`, `instrumentation`, `sensor`, `preamplifier`, `datalogger`, `stage`, `filter`

**<file format>** is one of `yml`, `yaml` or `json`.

Examples:

- `TI_ADS1281_FIR1.stage.yml` is a stage with a Texas Instruments FIR filter nested in it, in YAML format.
- `BBOBS.INSU-IPGP.network.json` is a network of broad-band stations deployed by INSU IPGP, in JSON format.

There are three resources to look up the exact syntax for each information file. One is the *Introduction* which takes you step by step building a typical hierarchy of information files. The different *Classes* pages have a complete explanation of all the attributes in the class. Unless otherwise noted, attributes in the file have the same syntax as attributes in the class. The third resource is the formal syntax of the file, which is a JSON schema, which is always referenced in the Class page.

### 1.3.3 File Metadata

All information files contain common metadata

- `format_version:` - This is a required field. It reflects the template version against which this file must be validated
- `revision:` - Revision information (date in particular) to keep change control of file.
  - `date:` - date of revision
  - `authors:` - authors of revision, usually a reference to an author file

- `notes:` - Optional extra information which will not be put in final metadata.
- `yaml_anchors:` - YAML anchors to avoid redundancy, for advanced YAML users. Here is a guide on how to use YAML anchors.

## 1.4 Resources

*Installation and Startup Guide <InstallStartup>*

*Tutorial <Tutorial1>*

*Class Reference Pages <class11>*

*Information File Templates <FILE>*

For the YAML specification, see YAML . For a tutorial, see YAML Tutorial

For the JSON specification, see JSON . For a tutorial, see JSON Tutorial

For the JREF notation, see JREF Notation

For the StationXML reference, see FDSN StationXML Reference

CHAPTER

TWO

# INSTALLATION AND STARTUP GUIDE

## 2.1 Prerequisites

*obsinfo* requires Python 3.9 or higher.

### 2.1.1 Linux

Most Linux installations have Python preinstalled. However, it might not be the latest version. Check the version and update to 3.9 at least.

To check your version, use any of the following commands:

```
$ python --version

$ python2 --version

$ python3 --version
```

### 2.1.2 Windows

We have not tested the current version of Windows and we don't expect that it will work without some modifications. You must have Windows 10 installed.

## 2.2 Python installation

The following link provides complete information on how to install Python in several platforms:

https://realpython.com/installing-python/#how-to-check-your-python-version-on-linux

The official installation guide for **UNIX** is here:

https://docs.python.org/3/using/unix.html

**Windows**:

https://docs.python.org/3/using/windows.html

**MacOS**:

https://docs.python.org/3/using/mac.html

## 2.3 Python packages

The following packages must be installed, preferably with a package manager, either using `pip` or `conda`.

Instructions to install a package using `pip`. If you don't have `pip` installed, this same link instructs you who to install it.

https://packaging.python.org/tutorials/installing-packages/

Instructions to install a package using `conda`

https://conda.io/projects/conda/en/latest/user-guide/tasks/manage-pkgs.html

**Packages**

*Standard library (no need to install)*

```
difflib
glob
inspect
json
math
pathlib
pprint
os
re
sys
unittest
warnings
```

*External libraries*

```
jsonschema
jsonref
gitlab
numpy
obspy
pyyaml
```

In particular *obsinfo* relies on `obspy` to create the objects needed to output a StationXML file.

## 2.4 Git installation

If you wish to install *obsinfo* using `git`, you have to install it first.

**Linux**:

```
$ sudo apt-get install git
```

In **Windows**, download from this site:

```
https://git-scm.com/download/win
```

## 2.5 Obsinfo installation

*obsinfo* is a published package in PyPI. Currently, version v0.111-beta.1 is available.

Make sure you have the latest pip version: .. code-block:: console

> $ python3 -m pip install –upgrade pip

or

```
$ python -m pip install --upgrade pip
```

depending on your Python configuration.

Next, use `pip` to install *obsinfo*:

```
$ python3 -m pip install obsinfo
```

or

```
$ python -m pip install obsinfo
```

depending on your Python configuration.

## 2.6 Description of obsinfo file structure

| | |
|---|---|
| data | YAML/JSON schemas |
| _examples | Example information files |
| instrumentation | Python code |
| main | Python code |
| misc | Python code |
| network | Python code |
| obsMetadata | Python code |

## 2.7 Obsinfo setup

**Linux**:

The *obsinfo* executables are:

- `obsinfo-makeStationXML` to create StationXML files
- `obsinfo-validate` to validate the syntax of information files
- `obsinfo-print` to print information files without creating the StationXML file. This may be useful as a test or to discover configurations

All executables are installed in `~/.local/bin`, which is usually in the PATH variable of the operating system. If this is not the case, add that directory:

```
$ PATH=$PATH:$HOME/.local/bin
$ export PATH
```

To avoid having to set up the variable in each session, store these instructions in your .bashrc file in your home directory.

Remember in **Windows** and **MacOS** you can setup the variable in the configuration panel. Follow the instructions to set environment variables.

After having installed *obsinfo* with pip or conda, you need to run a setup. This gives you an opportunity of creating a local directory where the existing examples of information files will be copied, instead of the arcane and standard ~/.local/lib/python3.x/site-packages/obsinfo/_examples/Information_Files.

To do so, simply run:

```
$ obsinfo-setup -d <directory name>
```

The program will copy the examples to the directory mentioned and will perform other administrative tasks.

**IMPORTANT**: EVEN if you don't want to create a new directory, you MUST run `obsinfo-setup`, as it performs several housekeeping tasks, notably creating the configuration file `.obsinforc` and the directory `.obsinfo` which is used for logging.

`obsinfo-setup` is very flexible. Through it you can reconfigure several variables that will tell *obsinfo* where to find your files. More on this in the next section.

## 2.8 File discovery

`obsinfo-setup` sets several variables specific to *obsinfo* and stores them in a configuration file called `.obsinforc` in your home directory called `.obsinforc`. Here they are with their default values:

```
gitlab_repository: www.gitlab.com
gitlab_project: resif/obsinfo
gitlab_path: _examples/Information_Files
datapath:  [https://www.gitlab.com/resif/obsinfo/obsinfo/_examples/Information_Files]
obsinfo_branch: master
```

The first, second and third variables are used to tell *obsinfo* where the remote repository for information files is. The fourth one needs more explanation. It works like the `PATH` variable in Linux: whenever a file in a `$ref` is found in an information file, *obsinfo* will **sequentally** look for the file in all the directories specified in `obsinfo_datapath`. In the default case, the only place where *obsinfo* will look is the remote directory. Observe this is the concatenation of the first three variables, the repository, the project and the path.

Finally, since the remote repository is assumet to be a gitlab repository, we must specify a gitlab branch, which by default is `master`.

All these defaults are achieved by simply running:

```
$ obsinfo-setup
```

with no parameters. But with options you can specify all the variables. `gitlab_repository` is specfied with -g, `gitlab_project` with -p, `gitlab_path` with -P and `obsinfo_branch` with -b.

Other options allow you to not copy the examples (`-x`) or modify the `datapath` variable. This is done so you don't have to manually edit `.obsinforc` **which is discouraged**. Three local directories are considered in `datapath`: a working directory, a local repository and an example directory. We have seen that the `-d` option creates (if non existing) the example directory. When specified, this directory takes precedence over the remote directory (unless `-x` is specified). The `datapath` variable will look like:

```
datapath:  [<local example directory>, https://www.gitlab.com/resif/obsinfo/obsinfo/_
↪examples/Information_Files]
```

where `<local example directory>` is the directory specified with `-d`. If you add the working directory (with `-w`) and the local repository (with `-l`), they will take precedence in this order:

```
datapath:  [<working directory>, <local repository>, <local example directory>, https://
↪www.gitlab.com/resif/obsinfo/obsinfo/_examples/Information_Files]
```

You can change the order putting the remote repository first by using the `-v` option. Of course, you change the order of the local directories by simply specifying one or the other as working, local repository or example.

All this is summarized here:

```
-x, --no_examples     Don't import examples, only templates, and remove
                      examples directory from the datapath
-c, --no_copy         Don't import anything at all, don't create dest
                      directory, which will be removed from datapath
-n, --no_remote       Install obsinfo without access to a gitlab repository.
                      May be needed in some operating systems for
                      compatibility issues
-v, --invert_datapath
                      Put remote gitlab repository first. All local
                      directories will keep their order
-b, --branch          Specifies the git branch to use, if not master
-d DEST, --dest DEST  Destination directory for templates and examples.
-g GITLAB, --gitlab GITLAB
                      Gitlab repository)
-p PROJECT, --project PROJECT
                      path to project and the directory where information
                      files lie within the Gitlab repository)
-l LOCAL_REPOSITORY, --local_repository LOCAL_REPOSITORY
                      Specify local repository for information files and
                      include it as first or second option in datapath
-w WORKING_DIRECTORY, --working_directory WORKING_DIRECTORY
                      Specify working directory for obsinfo and include it
                      as first option in datapath
-P REMOTE_PATH, --remote_path REMOTE_PATH
                      Specify remote directory under project
```

**IMPORTANT: In datapath, the remote directory is always the concatenation of `gitlab_repository`,**
`gitlab_project` and `gitlab_path` when created by `obsinfo-setup`. Therefore, if you manually change the `datapath` in the `.obsinforc` file you will not get the expected result. Always use `obsinfo-setup` to change that file.

Of course, you will create your own information files in a directory selected by you.

CHAPTER

THREE

# COMMAND-LINE TOOLS

**There are four main command-line tools:**

- obsinfo-setup
- obsinfo-makeStationXML
- obsinfo-validate
- obsinfo-print

## 3.1 obsinfo-setup

creates an *.obsinforc* file that indicates where obsinfo should look for the reference files. More details in the Installation and Startup Guide

## 3.2 obsinfo-makeStationXML

Now you're all set to run obsinfo. Type

```
$ obsinfo-makeStationXML -h
```

to display all the options of makeStationXML. Most are self-explanatory.

To create a StationXML file from a file called <filename>, type:

```
$ obsinfo-makeStationXML [options] filename
```

The output file, by default, will have the stem part of the network filename followed by "station.xml". That is, if the filename to be processed is `BBOBS.INSU-IPGP.network.yaml`, the resulting file will be called by default `BBOBS.INSU-IPGP.station.xml`. This can be changed with the `-o` option.

A single file is processed at a time. This is basically to simplify operation and avoid confusion with file discovery. However, a `for` statement in a shell script can be used to process several files at a time, as is customary.

The most important thing about the way *obsinfo-makeStationXML* operates is where it finds its information files. As a rule, the argument you pass to the application must have a non-ambiguous path to a network information file, such as:

..code-block:

```
BBOBS.INSU-IPGP.network.yaml

./BBOBS.INSU-IPGP.network.yaml

/home/arean/examples/BBOBS.INSU-IPGP.network.yaml

../../my_examples/BBOBS.INSU-IPGP.network.yaml
```

Standard POSIX notation is used. The first and second examples will look for the file in the current working directory. The third one is called an absolute path and will try to locate the file in the /home/arean/examples/ directory. The fourth one is a path relative to the working directory which will go up to levels and then down to /my_examples to find the file.

All other files (i.e. the files in `$ref` attributes, will operate in a different fashion. Examples two, three and four will work in the same way, but example one will be considered a file that needs discovery. This discovery is performed through the variable `obsinfo_datapath`, which is a list of directories separated by commas, in typical Python/YAML syntax. Every director is visited in sequence. When the file is found in one of the, the discovery stops. If not file is found in any of the directories, an error message is generated.

We can also make the filename passed as argument to *obsinfo-makeStationXML* behave in this way with the option `-r`. If we use this option, even the network file passed as an argument will be discovered in one of the directories in OBSINFO_DATAPATH.

The rest of the options are self-explanatory, and are explained by a message generated with:

```
$ obsinfo-makeStationXML -h

usage: obsinfo-makeStationXML [-h] [-r] [-l] [-v] [-q] [-d] [-t] [-V]
                                   [-o OUTPUT]
                                   input_filename

positional arguments:
  input_filename        is required and must be a single value

optional arguments:
  -h, --help            show this help message and exit
  -r, --remote          Assumes input filename is discovered through obsinfo_datapath.
                        Does not affect treatment of $ref in info files
  -l, --validate        Performs complete validation, equivalent to obsinfo-validate,␣
↪before processing
  -v, --verbose         Prints processing progression
  -q, --quiet           Silences a human-readable summary of processed information file
  -d, --debug           Turns on exception traceback
  -t, --test            Produces no output
  -V, --version         Print the version and exit
  -S, --station         Create a StationXML file with no instrumentation
  -o OUTPUT, --output OUTPUT
                       Names the output file. Default is <input-filename-stem>.station.
↪xml
```

## 3.3 obsinfo-validate

This executable will validate the specified file:

```
$ obsinfo-validate [options] filename
```

*obsinfo-validate* will identify the type of file from the filename and run the relevant validation.

Option `-r` works as in *obsinfo-makeStationXML*. The rest of the options are self-explanatory:

```
$ obsinfo-validate -h

usage: obsinfo-validate [-h] [-q] [-r] [-d] input_filename

positional arguments:
  input_filename  Information file to be validated.

optional arguments:
  -h, --help      show this help message and exit
  -q, --quiet     Quiet operation. Don't print informative messages
  -r, --remote    Search input_filename in the DATAPATH repositories
  -d, --debug     Print traceback for exceptions
```

As mentioned in Best Practices, it is always a good idea to validate files before trying to create a StationXML file. Use a bottom-up approach to avoid getting difficult-to-read error messages: start with filters, then stages, then components, then instrumentations, then networks.

All files in official central repositories are assumed to have been validated.

## 3.4 obsinfo-print

This executable will print the *obsinfo* objects generated out of the specified file:

```
$ obsinfo-print [options] filename
```

*obsinfo-print* will identify the type of file from the filename and run the relevant printing routine. When used with the `-l` option, it will print up to a certain level specified after the option according to the keywords below. For example, a sensor file with a `stage` level will not print the filter information, and a network file with a `station` level will not print the instrumentation information and down.

```
usage: obsinfo-print [-d] [-h] [-l LEVEL] input_filename

positional arguments:
  input_filename  Information file to be validated.

optional arguments:
     -l or --level: prints up to LEVEL, where LEVEL is:
                    all
                    stage
                    component
                    instrumentation
                    channel
                    station
```

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```
                   network
     -d or --debug: do not catch exceptions to show error trace.
     -h or --help: prints this message
```

CHAPTER

# FOUR

# TUTORIAL

## 4.1 Introduction

Information files are written in YAML or JSON, mostly YAML. YAML is a markup language (despite some claim its acronym means "yaml ain't a markup language" that permits users to encode data in a structured format which can be shared, written and read by many applications using text files (rather than binary ones), a process known as *serialization* of data. It is one of the standard tools for this purpose, others being JSON and XML, which tend to be more verbose and harder to read and write. This tutorial will center on YAML, but it is readily translatable to JSON for users fluent in the use of that markup language, which can, at any rate, be learned here. Keep in mind YAML is a superset of JSON, so some functionality is not readily implemented in the latter.

This is **not** a YAML tutorial. We freely mix required YAML syntax with best practices advocated for *obsinfo* and leave out many aspects of the language. For people wanting to get acquainted with YAML, a number of resources are available, such as this.

### 4.1.1 Basic YAML syntax

YAML files, as in the other markup languages mentioned, are structured hierarchically. The basic structure is the key-value pair, which permits to assign a value retrievable by key (and easily readable by a human user), such as:

```
last_name  : "Presley"
first_name : "Elvis"
```

Being hierarchical, these key-value pairs can be nested:

```
artist_name:
  last_name  : "Presley"
  first_name : "Elvis"
```

*Space* indentation is used in YAML to nest key-value pairs. NEVER use tabs. As a convention, two spaces are used and all key-value pairs at the same level must be equally indented.

YAML uses three dashes "—" to separate different streams of data. Always put as the first line in your file the three dashes as a best practice. All YAML files such have a `.yaml` extension.

### 4.1.2 YAML data types

There are other observations for the little piece of code above. First, the data types. Scalars can be either a `number`, a `boolean` (True or False as values) or a `string`, enclosed in double quotes. Numbers can be integers (without decimal point) or floating point (with decimal point).

Other data structures include lists and dictionaries. A list is simply an enumeration of elements which can be any data type, enclosed in brackets or listed in separate indented lines which start by dashes. The following are equivalent:

```
die_toss: [1,2,3,4,5,6]

die_toss:
 - 1
 - 2
 - 3
 - 4
 - 5
 - 6
```

Dictionaries are a collection of key-value pairs. They can either be indented, as above (`last_name`: “Presley” and `first_name`: “Elvis” are actually elements of a dictionary value associated with the key `artist_name`) or as enumerations enclosed in curly brackets, or, again, as dashes. As a side note, the curly brackets syntax makes YAML compatible with JSON. The following are equivalent:

```
artist_name:
  last_name  : "Presley"
  first_name : "Elvis"

artist_name: { last_name  : "Presley", first_name : "Elvis"}

artist_name:
  - last_name  : "Presley"
  - first_name : "Elvis"
```

### 4.1.3 YAML variables

YAML is case sensitive. In *obsinfo* we only use keys in lower case with words separated by underscores.

### 4.1.4 Code reuse

The $ref special variable, a JSON feature, is used in *obsinfo* to allow the inclusion of the content of another file in the current YAML file:

```
revision:
   date: "2018-06-01"
   authors:
       - $ref: "Wayne_Crawford.author.yaml#author"
```

In this example, only the part corresponding to the key `author` will be included. Note that a file can be totally included by omitting the `#author` anchor. $ref references will totally override all other keys at their level. For example, if we had another field at the `authors` level:

```
revision:
   date: "2018-06-01"
   authors:
       - $ref: "Alfred_Wegener.author.yaml#author"
       email: Alfred_Wegenerd@yahoo.de
```

the email field will disappear in the final result. Contrast this with YAML anchors, to be discussed next.

### 4.1.5 YAML anchors

YAML anchors are used to avoid repetition, according to the DRY ("don't repeat yourself") principle. In this real *obsinfo* example, an anchor is defined which has the value of a dictionary:

```
yaml_anchors:
   obs_clock_correction_linear_defaults: &LINEAR_CLOCK_DEFAULTS
       time_base: "Seascan MCXO, ~1e-8 nominal drift"
       reference: "GPS"
       start_sync_instrument: 0
```

Further down the information file the following appears in several places wiwth different values for the `start_sync_reference`, `end_sync_reference` and `end_sync_instrument` keys:

```
processing:
  - clock_correction_linear_drift:
      <<: *LINEAR_CLOCK_DEFAULTS
      start_sync_reference: "2015-04-21T21:06:00Z"
      end_sync_reference: "2016-05-28T20:59:00.32Z"
      end_sync_instrument: "2016-05-28T20:59:03Z"
```

When an anchor is referenced with a star (*) it's called an alias and has the effect of replacing the alias by the anchor definition. The effect will be:

```
processing:
  - clock_correction_linear_drift:
        time_base: "Seascan MCXO, ~1e-8 nominal drift"
        reference: "GPS"
        start_sync_instrument: 0
      start_sync_reference: "2015-04-21T21:06:00Z"
      end_sync_reference: "2016-05-28T20:59:00.32Z"
      end_sync_instrument: "2016-05-28T20:59:03Z"
```

Furthermore, the << label above indicates that this is a mapping. If no fields with the similar name appear under the alias, its effect is to simply replace the alias by the anchor, as mentioned earlier. But if there are fields such as `time_base` under the alias, like this:

```
- clock_correction_linear_drift:
                <<: *LINEAR_CLOCK_DEFAULTS
                    time_base: "unavailable"
```

those fields will be overriden, so the effect of the latter piece of code is the following:

```
- clock_correction_linear_drift:
                 time_base: "Seascan MCXO, ~1e-8 nominal drift"
```

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```
                    reference: "GPS"
                    start_sync_instrument: 0
```

overriding the value of `time_base`.

All this allows for code reuse without needing an external file as in `$ref`.

*Next page, Information File Structure*, discusses how to start creating *obsinfo* information files.

## 4.2 The general structure of information files

Information files are arranged in a hierarchy, with upper files referencing lower files. There are 5 main file types in *obsinfo*:

| Name | Description | Filled by | When filled |
|---|---|---|---|
| **subnetwork** | Deployed stations, their instruments and parameters | scientist or OBS facility | after a campaign |
| **instrumentation** | Instrument description | OBS facility | new/changed instruments |
| ***instrument_components*** **sensors** **components** **dataloggers** | Description of basic components | OBS facility -or- component manufacturer | when there are new are new components or calibrations |
| **stage** | Description of stages digitizers, amplifiers/filters) | OBS facility -or- component manufacturer | when there are new components or calibrations |
| **filter** | Description of filters amplifiers and digitizers used in stages | OBS facility -or- component manufacturer | when there are new components or calibrations |

The hierarchy is a best practice. In principle, all information contained in lower level files can be included in the network file. However, it is highly recommended that the “$ref” functionality to refer to other files is used.

### 4.2.1 File Hierarchy

It is recommended to arrange the information files in a file hierarchy such as this:

..code-block:

```
/persons (contains files used in headers of other information files)
/network
/instrumentations
/sensors
/preamplifiers
/dataloggers
[instrumentation_componenent]/stages/
[instrumentation_componenent]/stages/filters (filters can be substituted by a specific␣
↪kind of filter: FIR, PZ, etc.)
```

where [instrumentation_componenent] = sensors, preamplifiers or dataloggers.

Another possibility is to arrange instrument components under instrumentation, but that may cause extra typing while writing references (`$ref`)in information files. That would be something like this:

**..code-block::** /instrumentations/sensors

**The hierarchy is completely up to the user**, including the names of the folders/directories. In fact, it is perfectly possible to put all the information in a single file, although it is not recommended as reusability of filters, stages or components depends on independent files.

To reference a file from within another file, use the JsonRef syntax:

```
authors: - {$ref: "persons/Wayne_Crawford.person.yaml#person"}
```

The effect of this directive is at the core of the philosophy of *obsinfo*, as it is this mechanism which allows reuse: it substitutes the content of the key `author` within the file *authors/Wayne_Crawford.author.yaml* ` as the value of the key `authors`. If you want to include the complete file, remove the `#author` anchor.

How to express absolute and relative paths, and their meaning, are discussed later.

### 4.2.2 File Naming Convention

While there is flexibility about the folder hierarchy, information files **must** follow the following naming convention:

<descriptive file name>.<obsinfo file type>.<file format>

where

> **<descriptive file name>** usually includes vendor and configuration shorthand to make the file easily identifiable by users,
>
> **<obsinfo file type>** is one of `campaign`, `network`, `instrumentation`, `sensor`, `preamplifier`, `datalogger`, `stage`, `filter`
>
> **<file format>** is one of `yaml` or `json`.

Examples:

- `TI_ADS1281_FIR1.stage.yaml` is a stage with a Texas Instruments FIR filter nested in it, in YAML format.
- `BBOBS.INSU-IPGP.subnetwork.json` is a network of broad-band stations deployed by INSU IPGP, in JSON format.

There are two resources, other than this tutorial, to look up the exact syntax for each information file. The different pages have a complete explanation of all the attributes in the class. Unless otherwise noted, YAML keys or labels (also called fields or sections) in the file have the same exact name (case sensitive) as the attributes in the class. The other resource is the formal syntax of the file, which is a JSON schema, which is always referenced in the Class page.

### 4.2.3 File Metadata

All information files contain or may contain common metadata. `format_version` and `revision` are required.

- `format_version:` - This is a required field. It reflects the template version against which this file must be validated
- `revision:` - Revision information (date in particular) to keep change control of file.
  - `date:` - date of revision
  - `authors:` - authors of revision, usually a reference to an author file

- notes: - Optional extra information which will not be put in final metadata.
- yaml_anchors: - YAML anchors to avoid redundancy, for advanced YAML users. Here is a guide on how to use YAML anchors.
- *Next page: Building a simple network file*
- *Previous page*
- *Back to start*

## 4.3 A simple subnetwork file

### 4.3.1 Fundamentals of an information file

Under the folder which will contain all your information files, create a folder called `network`. Network information files can be part of or referenced by a campaign information file, but since we are not dealing with campaigns in *obsinfo* we will start with a network file.

Use your favourite text editor to create a network information file. Select as filename something meaningful, for example, single period OBS from INSU-IPGP would be SPOBS.INSU-IPGP. Then add the type of information file, `network` and the type of format, `yaml`:

```
SPOBS.INSU-IPGP.subnetwork.yaml
```

The file should start with the three dashes; the next line must specify the *obsinfo* version (required to know how to process the file). There are several optional fields which we will omit in this first exercise. It's a good idea, though, to include a revision with a date and an author.

```
---
format_version: "0.111"
revision:
   authors:
       - names: ["Wayne Crawford"]
         agencies: ["IPGP", "CNRS"]
         emails: ["crawford@ipgp.fr"]
         phones: ["+33 01 83 95 76 63"]
   date: "2017-10-04"
```

Note the dash in a lonely line which indicates `authors` is a list. Alternatively, since the author is probably an information that will be repeated several times, this information can be stored in another file. Let's say we create a folder named `persons` at the same level as `network` and then create a file inside that folder named `Wayne_Crawford.person.yaml`. We put the three fields previously under the `authors` key in that file, so the file will look like:

```
---
format_version: "0.111"
person:
    names: ["Wayne Crawford"]
    agencies: ["IPGP", "CNRS"]
    emails: ["crawford@ipgp.fr"]
    phones: ["+33 01 83 95 76 63"]
```

And then we reference the file with a `$ref` field in the original network file:

```
---
format_version: "0.110"
revision:
   authors:
       - $ref: 'persons/Wayne_Crawford.person.yaml'
   date: "2017-10-04"
```

The effect of this, from the point of view of *obsinfo*, is to insert said part of the Wayne_Crawford.person.yaml file instead of the $ref line. If you do this *all* of the contents will be inserted. This is undesirable as it will cause a syntax error; the system expects to see the fields names, emails, agencies and phones, not the three dashes, the version, etc. The solution is using an *anchor* or *fragment*, which will only insert the contents of the field referenced by the anchor. In this case, the anchor should be the field person, and so the final syntax is the following:

```
---
format_version: "0.111"
revision:
   authors:
       - $ref: 'persons/Wayne_Crawford.person.yaml#person'
   date: "2017-10-04"
```

### File discovery

Finding the information files is one of the most important features in *obsinfo*. Notice that the pathnames in the examples above are not absolute (i.e. they don't start at the base of the filesystem). In regular POSIX practice it is assumed that non-absolute paths are added to the directory where the application is executed (called the current working directory, or cwd). To allow the user to store instrumentation files in one standard spot, *obsinfo* will try to *discover* the file in one of several directories specified by the variable obsinfo_datapath, which is set by the obsinfo-setup application and found in the configuration file ~/.obsinforc (~ is your home directory). This works much in the same way that executables are found in Linux, MacOS or Windows using the variable PATH.

Whenever a file in a $ref is specified without an absolute path, *obsinfo* will **sequentally** look for the file in all the directories specified in obsinfo_datapath. A special keyword, GITLAB, specifies a remote Gitlab repository. Here's an example:

obsinfo_datapath, as specified above, will always look in a local directory where the current examples are installed (via pip or conda) and then, if not found, in the remote repository. This gives the user great flexibility, as (s)he can override an existing remote information file with a local one, change the order of discovery, etc.

In the end, you will create your own information files in a directory selected by you. Then you will have to edit the obsinfo_datapath variable to reflect the directory from which you want to access your information files.

It is possible, although not recommended, to use absolute paths.

Use of slashes (/) instead of Windows backslashes () is recommended for uniformity, so a file can be used on different operation systems. However, if you use backslashes, *obsinfo* will understand them.

### 4.3.2 subnetwork

The next field key, subnetwork, starts the actual information. You may specify several sub-elements which are listed in subnetwork, but let's stick to the fundamentals:

```
subnetwork:
   network:
       code: "4G" # Either an FDSN provided network code or "XX" if no such code exists.
       name: "Short period OBSs" # Use the FDSN name if applicable
       start_date: "2007-07-01"
       end_date: "2025-12-31"
       description: "Short period OBS network example"
       operators: [{$ref: "operators/EMSO-AZORES.operator.yaml#operator"}]
   operators:
       -   {$ref: "operators/INSU-IPGP.operator.yaml#operator"}
```

The network section describes the network, of which the subnetwork is a subset.

If the network has been declared to FDSN, the information in network should correspond to the values on the FDSN site. For information on how to request a network code or use a temporary code, see this link .

### 4.3.3 stations

Stations belonging to the network are specified next. They could, of coursem be put in a different file, but it is a best practice to put the station information, so that one file contains all of the essential deployment information.

The following attribute is, therefore, stations. One can specify as many stations as you want, but in this example we will only specify one. Stations are identified by a one to five character code. This code acts like a key, but be careful to surround it by quotes: otherwise it will be flagged as an error by the JSON syntax validator. The start_date and end_date should correspond to data start and end. The site is described as a text field, and a location code is specified too. More on locations later.

```
stations:
     "LSVW":
         site: "Lucky Strike Volcano West"
         start_date: "2015-04-22T12:00:00Z"
         end_date: "2016-05-28T21:01:00Z"
         location_code: "00"
         instrumentation:

             ...
```

### 4.3.4 instrumentation

Stations must have an instrumentation, which specifies the entire data recording system, from the sensor(s) to the datalogger. The best practice is to specify these in a separate file, as the same instrumentation (with different serial numbers and possibly different configurations) may be used at several stations and/or for several experiments . The way to reference an instrumentation is the following:

```
instrumentation:
    base: {$ref: "instrumentation/SPOBS2.instrumentation.yaml#instrumentation"}
    datalogger_configuration: "250 sps"
```

`$ref` is a different file in a folder called `instrumentation`. It is possible to specify several instrumentations in list format:

```
instrumentations:
        - $ref: "instrumentation/SPOBS2.instrumentation.yaml#instrumentation"
        - $ref: "instrumentation/BBOBS1_2012+.instrumentation.yaml#instrumentation"
```

Instrumentations can be configured in several ways. One almost always provides a `datalogger_configuration`, to specify the sample rate and possibly digital filters and/or gains. Here is an example using all the possible keys:

```
instrumentation:
    base: {$ref: "instrumentation/SPOBS2.instrumentation.yaml#instrumentation"}
    serial_number: "01"
    configuration: "low power"
    modifications:
        ...
    channel_modifications:
        ...
```

The `serial_number` key lets you specify the instrumentation's serial number The `configuration` key lets you select a configuration that has been pre-defined for the instrumentation. The `modifications` and `channel_modifications` keys let you modify individual elements within the instrumentation: we will discuss them later.

### 4.3.5 Locations

There must be at least one location in the file. This is the position in geographical coordinates of the station, usually referred as location "00". Locations are specified as follows:

```
locations:
    "00":
        base: {$ref: 'location_bases/INSU-IPGP.location_base.yaml#location_base'}
        configuration: "ACOUSTIC_SURVEY"
        position: {lon: -32.32504, lat: 37.29744, elev: -2030}
```

There is a base, which is again a referenced file in a different folder (as best practice). Again, there is a `configuration`, which lets us chose which method was used to locate the station (a default value is chosen if `configuration` is not provided).

Observe the difference between a list and a dictionary. List items are separated by dashes, dictionaries need a key/value pair. authors is a list. locations is a dictionary.

However, there can be several locations. That's the reason we have a `location_code` to specify the location corresponding to the station itself. Other locations can be used if different channels have different positions or if two channels have the same FDSN channel code, as will be seen shortly.

### 4.3.6 Channel modifications

`channel_modifications` allow you to apply modifications to certain channels in the instrumentation. For example, a change in an instrument_component configuration (more about this in the *Next page, Building a simple instrumentation file*). Higher-level specifications take priority, so if channel_modifications are specified both in the `subnetwork` file and in the `instrumentation` file, the one in the subnetwork file takes precedence.

Channel modifications are what makes *obsinfo* so flexible. We can specify several different configurations for the same components, and then select one of them. We can also directly change other attributes in the instrumentation. This allows components to be regarded almost as virtual descriptions which, when a particular configuration is selected, are instantiated into a specific, actual component. Thus instrumentation files can be authentic libraries with little changes, while the changes of configuration are specified for each station in a network in a specific campaign.

Furthermore, these libraries can reside in a central GitLab repository, which is updated by authorized users and, being public, is available for reuse by all users. A user can even clone the repository in the regular GitLab way (see here) in order to work offline with the latest version of the repository.

### 4.3.7 Complete example

*You can skip this section in a first reading.*

This is an actual subnetwork information file with the above information and some optional fields which we have not yet described. Note the additions:

1) A second station
2) Use of yaml_anchors to avoid repeating information *in the same file*
3) Comments field in `network`
4) a `processing` field in a `station`. For more information on this, see *Processing*

— format_version: “0.111” revision:

**authors:**

- {$ref: “persons/Wayne_Crawford.person.yaml#person”}

date: “2019-12-19”

**subnetwork:**

**network:** $ref: “networks/EMSO-AZORES.network.yaml#network”

**operators:**

- {$ref: “operators/INSU-IPGP.operator.yaml#operator”}

**stations:**

**“BB_1”:** site: “My favorite site” start_date: “2011-04-23T10:00:00” end_date: “2011-05-28T15:37:00” location_code: “00” locations:

**“00”:** base: {$ref: ‘location_bases/INSU-IPGP.location_base.yaml#location_base’} configuration: “BUC_DROP” position: {lon: -32.234, lat: 37.2806, elev: -1950}

**instrumentation:** base: {$ref: “instrumentations/BBOBS1_pre2012.instrumentation_base.yaml#instrumentation_base configuration: “SN07” modifications:

datalogger: {configuration: “62.5sps”}

**processing:**

- **clock_correction_linear:** base: {$ref: "timing_bases/Seascan_GNSS.timing_base.yaml#timing_base"} start_sync_reference: "2015-04-23T11:20:00" end_sync_reference: "2016-05-27T14:00:00.2450" end_sync_instrument: "2016-05-27T14:00:00"

**"BB_2":** site: "My other favorite site" start_date: "2015-04-23T10:00:00Z" end_date: "2016-05-28T15:37:00Z" location_code: "00" notes: ["example of deploying with a different sphere"] instrumentation:

base: {$ref: "instrumentations/BBOBS1_2012+.instrumentation_base.yaml#instrumentation_base"} serial_number: "06" modifications:

datalogger: {configuration: "62.5sps", equipment: {serial_number: "26"}} preamplifier: {equipment: {serial_number: "26"}}

**channel_modifications:** "1-*": {sensor: {configuration: "Sphere08"}} "2-*": {sensor: {configuration: "Sphere08"}} "Z-*": {sensor: {configuration: "Sphere08"}} "H-*": {sensor: {configuration: "5004"}}

**locations:**

**"00":** base: {$ref: 'location_bases/INSU-IPGP.location_base.yaml#location_base'} configuration: "BUC_DROP" position: {lon: -32.29756, lat: 37.26049, elev: -1887}

**processing:**

- **clock_correction_linear:** base: {$ref: "timing_bases/Seascan_GNSS.timing_base.yaml#timing_base"} start_sync_reference: "2015-04-22T12:24:00" end_sync_reference: "2016-05-28T15:35:00.3660" end_sync_instrument: "2016-05-28T15:35:02"

In all *obsinfo* information files, you can add `notes` as a list of strings. Notes are not put into the StationXML file, they only serve documentation purposes within the information file.

`comments`, on the other hand, `comments` are added to StationXML files, and can only be placed at levels which correspond to the levels in a StationXML file with a `Comment` field.

`extras` are key:value pairs for information that you wish to document/process but do not correspond to existing obsinfo elements. They are added as comments to the output StationXML file.

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## 4.4 Building a simple instrumentation file with channels

As seen in the last section, instrumentation are usually referred to with `$ref` from a network / station information file. This is a best practice, but it is not mandatory. It does allow for easier reuse.

The file starts as usual:

```yaml
---
format_version: "0.1101"
revision:
   date: "2019-12-19"
   authors:
       - {$ref: "persons/Wayne_Crawford.person.yaml#person"}
       - {$ref: "person/Romuald_Daniel.person.yaml#person"}
```

Observe that we have added an author to the list of authors, and that lists are separated by dashes.

## 4.4.1 Equipment

The main part of the file is the instrumentation section. First, we have the `equipment` section, which details the manufacturer, model and serial number of the instrumentation.

```
instrumentation:

   equipment:
       model: "BBOBS1"
       type: "Broadband Ocean Bottom Seismometer"
       description: "LCHEAPO 2000 BBOBS 2012-present"
       manufacturer: "Scripps Inst. Oceanography - INSU"
       vendor: "Scripps Inst. Oceanography - UNSU"
```

As most OBS are assembled with parts from different manufacturers, the only required fields of the equipment section are the type (a free-form text field) and the description.

## 4.4.2 channels and channel default

Next, we have channels. A channel is the combination of an instrument (sensor + optional preamplifier + datalogger) and an orientation. Orientation codes are explained here in the *Geographic orientation subsource codes* section. They are dictated by FDSN standards.

The `channels` are the actual channels in the instrumentation. They all have string labels, which are usually numbers giving their sequence/code within the data acquistion system (not the FDSN channel name). These must be in quotes as they are not keys in the *obsinfo* syntax.

To minimize duplication, a `default` channel declares common elements to all channels. This is not an actual channel, it's just a place to specify default attributes. If an attribute is not specified in an actual channel but exists in the default channel then it will be added to the final configuration of the channel.

Let's see an example:

```
channels:
    default:
        sensor: {base: {$ref: "sensors/NANOMETRICS_T240_SINGLESIDED.sensor.yaml#sensor"}}
        preamplifier:
            base: {$ref: "preamplifiers/LCHEAPO_BBOBS.preamplifier.yaml#preamplifier"}
        datalogger: {base: {$ref: "dataloggers/LC2000.datalogger.yaml#datalogger"}}
    "1": {orientation: {"2": {azimuth.deg: {value: 90},  dip.deg: {value: 0}}}}
    "2":
        orientation:
                "1":
                    azimuth.deg: {value: 0, uncertainty: 9}
                    dip.deg: {value: 0}
```

This code specifies two channels as a dictionary. Each channel specifies the two or three instrument components and the `orientation_code`. The orientation key will become the third character in the SEED code identification (see *SeedCodes*, and thus must follow FDSN standards.

Again, these are real, physical channels. `default`` specifies three instrument components: `sensor`, `preamplifier` and `datalogger` These will be applied to all channels that do not specify these values themselves All three files reference an information file in separate directory, which, in the example, are just under the DATAPATH directory. So the above could also be typed:

```
channels:
       "1":
           sensor: {base: {$ref: "sensors/NANOMETRICS_T240_SINGLESIDED.sensor.yaml#sensor
↪"}}
           preamplifier: {base: {$ref: "preamplifiers/LCHEAPO_BBOBS.preamplifier.yaml
↪#preamplifier"}}
           datalogger: {base: {$ref: "dataloggers/LC2000.datalogger.yaml#datalogger"}}
           orientation: {"2": {azimuth.deg: {value: 90},  dip.deg: {value: 0}}}
       "2":
           sensor: {base: {$ref: "sensors/NANOMETRICS_T240_SINGLESIDED.sensor.yaml#sensor
↪"}}
           preamplifier: {base: {$ref: "preamplifiers/LCHEAPO_BBOBS.preamplifier.yaml
↪#preamplifier"}}
           datalogger: {base: {$ref: "dataloggers/LC2000.datalogger.yaml#datalogger"}}
           orientation:
                    "1":
                        azimuth.deg: {value: 0, uncertainty: 9}
                        dip.deg: {value: 0}
```

Observe that in this case we have used curly parentheses to specify elements in a dictionary. They can be left out, letting simple indentation do the job of determining the items.

If a channel specifies any field that is also in the default, it will override that field. Let's assume we have a 4th channel 4 with a hydrophone:

```
"4":
    sensor: {base: {$ref: "sensors/SIO_DPG.sensor.yaml#sensor"}}
    preamplifier: {base: {$ref: "preamplifiers/LCHEAPO_DPG.preamplifier.yaml#preamplifier
↪"}}
    orientation: {"H": {{azimuth.deg: {value: 0},  dip.deg: {value: 90}}}
```

Then, assuming the same `default`` field as above, the result of channel 4 would be:

```
"4":
    sensor: {base: {$ref: "sensors/SIO_DPG.sensor.yaml#sensor"}}
    preamplifier: {base: {$ref: "preamplifiers/LCHEAPO_DPG.preamplifier.yaml#preamplifier
↪"}}
    datalogger: {base: {$ref: "dataloggers/LC2000.datalogger.yaml#datalogger"}}
    orientation: {"H": {azimuth.deg: [0, 0],  dip.deg: [90, 0]}}
```

Only `datalogger` retaints the default value. The other components are overriden with the values specified in channel 4.

### 4.4.3 Orientation Codes

Orientation codes are a FDSN standard. By convention, if the orientation code is **N**, **E** or **Z**, these represent the regular coordinates in space , within five degrees of the actual directions. So **N** corresponds to an azimuth of 0º and a dip of 0º, **E** corresponds to an azimuth of 90º and a dip of 0º, and **Z** corresponds to an azimuth of 0º and a dip of -90º (the positive **Z** direction is upwards). However, if **1**, **2** or **3** are specified, these represent three orthogonal directions but not necessarily coincidental with the regular coordinates, so an azimuth and a dip *must* be specified, depending on the type of code. The same is true of the **H** (hydrophone) code. See reference above for details.

Note also how we freely mix the two syntactic ways of specifying a dictionary in YAML, either with curly parentheses or with indentation. You can use whatever syntax you prefer.

The order that you enter the keys `sensor`. `preamplifier` and `datalogger` is arbitrary, but their stages will always be processed from input (physical) to the output (stored): that is, first sensor, then preamplifier, then datalogger. You should specify stages within each of these instrument components in the same order, from top to bottom. For example, a sensor with an internal amplifier should have the sensor as the top stage and the amplifier below. **obsinfo** will check that the `output_units` of each stage match the `input_units` of the stage below.

### 4.4.4 Configurations

We have learned how to specify default components through the default and how to override them. This is pretty flexible, but we can get more flexible still. This is done through *configurations*. Every element that specifies a `base` element (instrumentation, location_base, instrument_components and `stage`) can also specify `configurations` that modify this base element. `configuration`` definitions can take any field at the `base` level and either overriding it or add to it. This is by *selecting* a configuration at the channel level. A configuration selection field can specify a configuration for each of the three instrument components in a channel: sensor, preamplifier and datalogger. The configuration **must** be defined. Below, we add two things to the previous example: a `default` preamplifier configuration and a channel 3 that overrides this configuration.

```yaml
channels:
    default:
        sensor: {base: {$ref: "sensors/NANOMETRICS_T240_SINGLESIDED.sensor.yaml#sensor"}
↪}
        preamplifier:
            base: {$ref: "preamplifiers/LCHEAPO_BBOBS.preamplifier.yaml#preamplifier"}
            configuration: "0.225x"
        datalogger: {base: {$ref: "dataloggers/LC2000.datalogger.yaml#datalogger"}}
    "1": {orientation: {"2": {azimuth.deg: {value: 90},  dip.deg: {value: 0}}}}
    "2":
         orientation:
                 "1":
                     azimuth.deg: {value: 0, uncertainty: 9}
                     dip.deg: {value: 0}
    "3":
        orientation: {"Z": {azimuth.deg: 0, dip.deg: -90}}
        preamplifier: {configuration: "1x"}
    "4":
        sensor: {base: {$ref: "sensors/SIO_DPG.sensor.yaml#sensor"}}
        preamplifier: {base: {$ref: "preamplifiers/LCHEAPO_DPG.preamplifier.yaml
↪#preamplifier"}}
        orientation: {"H": {{azimuth.deg: {value: 0},  dip.deg: {value: 90}}}
```

This code specifies configurations, which can be for sensor, preamplifier or datalogger; in this case, simply for the preamplifier. The configuration selected is called “0.225x” and is a gain multiplier, as will be seen shortly. This value will be used in all channels, except channel 3, where it will be changed to “1x”. In the end, the four channels specified above will be the same as typing this:

```
channels:
    "1":
        sensor: {base: {$ref: "sensors/NANOMETRICS_T240_SINGLESIDED.sensor.yaml#sensor"}}
        preamplifier:
            base: {$ref: "preamplifiers/LCHEAPO_BBOBS.preamplifier.yaml#preamplifier"}
            configuration: "0.225x"
        datalogger: {base: {$ref: "dataloggers/LC2000.datalogger.yaml#datalogger"}}
        orientation: {"2": {azimuth.deg: {value: 90},  dip.deg: {value: 0}}}
    "2":
        sensor: {base: {$ref: "sensors/NANOMETRICS_T240_SINGLESIDED.sensor.yaml#sensor"}}
        preamplifier:
            base: {$ref: "preamplifiers/LCHEAPO_BBOBS.preamplifier.yaml#preamplifier"}
            configuration: "0.225x"
        datalogger: {base: {$ref: "dataloggers/LC2000.datalogger.yaml#datalogger"}}
        orientation:
             "1":
                 azimuth.deg: {value: 0, uncertainty: 9}
                 dip.deg: {value: 0}
    "3":
        sensor: {base: {$ref: "sensors/NANOMETRICS_T240_SINGLESIDED.sensor.yaml#sensor"}}
        preamplifier:
            base: {$ref: "preamplifiers/LCHEAPO_BBOBS.preamplifier.yaml#preamplifier"}
            configuration: "1x"
        datalogger: {base: {$ref: "dataloggers/LC2000.datalogger.yaml#datalogger"}}
        orientation: {"Z": {azimuth.deg: 0, dip.deg: -90}}
    "4":
        sensor: {base: {$ref: "sensors/SIO_DPG.sensor.yaml#sensor"}}
        preamplifier: {base: {$ref: "preamplifiers/LCHEAPO_DPG.preamplifier.yaml
↪#preamplifier"}}
        datalogger: {base: {$ref: "dataloggers/LC2000.datalogger.yaml#datalogger"}}
        orientation_code: {"H": {azimuth.deg: [0, 0],  dip.deg: [90, 0]}}
```

### Channel modifications

As seen in the last chapter, channel configurations can also be modified. The rationale behind this feature is that the user has a stable database of instruments which may occasionally undergo last-minute or one-time modifications, for example, when a malfunctioning sensor is replaced by another. *obsinfo* is conceived to reflect this malleability. Channel modifications are indicated at the `station` level but can potentially change *any* field from instrumentation level down. This is a more complex topic that falls outside of this beginner’s tutorial. It will be treated in the Advanced Topics documentation.

### 4.4.5 Notes and extras

This file is complex, so it's a good place to talk about `notes` and `extras`. These are optional fields. Notes can occur in any information file. They are documentation that can be used to remind users of the specifics of the information file. They will **not** be put into the StationXML to avoid clutter.

Extras are key:value pairs that document attributes that do not exist in the information file specification. They **are** put into StationXML comments. For this reason and to avoid clutter, they are only available at three levels: network, station and channel.

As an example, let's assume we have an "octopus" sensor where the serial number of the sensor is not specified. This is because we have actually several sensors with different serial numbers, enclosed in spheres. How do we convey that information? There are two ways. One is in a list of notes at the end of the *sensor* file:

```
notes:
   - "INSU-IPGP OBS park sphere sensor pairs are: Sphere01-133, Sphere02-132,"
   - "Sphere03-134, Sphere04-138, Sphere05-137, Sphere06-830, Sphere07-136,"
   - "Sphere08-829, Sphere09-826"
```

The other YAML syntax for lists is possible too:

**notes: ["INSU-IPGP OBS park sphere sensor pairs are: Sphere01-133, Sphere02-132,",** "Sphere03-134, Sphere04-138, Sphere05-137, Sphere06-830, Sphere07-136,", "Sphere08-829, Sphere09-826"]

This associates serial numbers to the spheres. However, this will not be reflected in the StationXML file. Alternatively, we can use the `extras` dictionary, not in the sensor file but in the instrumentation one:

```
extras:
   "Description": "Serial numbers for sensors"
   "Sphere03": "134"
   "Sphere04": "138"
   "Sphere05": "137"
   "Sphere06": "830"
   "Sphere07": "136"
   "Sphere08": "829"
   "Sphere09": "826"
```

#### Complete example

This is a real file. The order of the fields may be different than the examples above. As previoiusly mentioned, this is immaterial.

— format_version: "0.111" revision:

**authors:**

- {$ref: "persons/Wayne_Crawford.person.yaml#person"}

date: "2019-12-19"

**subnetwork:**

**operators:**

- {$ref: “operators/INSU-IPGP.operator.yaml#operator”}

**network:** $ref: “networks/EMSO-AZORES.network.yaml#network”

**stations:**

**“BB_1”:** site: “My favorite site” start_date: “2011-04-23T10:00:00” end_date: “2011-05-28T15:37:00” location_code: “00” locations:

**“00”:** base: {$ref: ‘location_bases/INSU-IPGP.location_base.yaml#location_base’} configuration: “BUC_DROP” position: {lon: -32.234, lat: 37.2806, elev: -1950}

**instrumentation:** base: {$ref: “instrumentations/BBOBS1_pre2012.instrumentation_base.yaml#instrumentation_base configuration: “SN07” modifications:

datalogger: {configuration: “62.5sps”}

**processing:**

- **clock_correction_linear:** base: {$ref: “timing_bases/Seascan_GNSS.timing_base.yaml#timing_base”} start_sync_reference: “2015-04-23T11:20:00” end_sync_reference: “2016-05-27T14:00:00.2450” end_sync_instrument: “2016-05-27T14:00:00”

**“BB_2”:** site: “My other favorite site” start_date: “2015-04-23T10:00:00Z” end_date: “2016-05-28T15:37:00Z” location_code: “00” notes: [“example of deploying with a different sphere”] instrumentation:

base: {$ref: “instrumentations/BBOBS1_2012+.instrumentation_base.yaml#instrumentation_base”} serial_number: “06” modifications:

datalogger: {configuration: “62.5sps”, equipment: {serial_number: “26”}} preamplifier: {equipment: {serial_number: “26”}}

**channel_modifications:** “1-*”: {sensor: {configuration: “Sphere08”}}* “2-”: {sensor: {configuration: “Sphere08”}} “Z-*”: {sensor: {configuration: “Sphere08”}} “H-*”: {sensor: {configuration: “5004”}}

**locations:**

**“00”:** base: {$ref: ‘location_bases/INSU-IPGP.location_base.yaml#location_base’} configuration: “BUC_DROP” position: {lon: -32.29756, lat: 37.26049, elev: -1887}

**processing:**

- **clock_correction_linear:** base: {$ref: “timing_bases/Seascan_GNSS.timing_base.yaml#timing_base”} start_sync_reference: “2015-04-22T12:24:00” end_sync_reference: “2016-05-28T15:35:00.3660” end_sync_instrument: “2016-05-28T15:35:02”

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## 4.5 Building instrument component files with response stages: sensors and preamplifiers

Sensor, preamplifier and datalogger are all instrument components. While InstrumentComponent is not a key in information files, it is a class in Python used to inherit attributes and methods to all three component classes. All instrument components share the same attributes and sensor and datalogger add one each on their own. Components in an instrument are always understood to come in the same order, and are processed in that order: first the sensor, then possibly a preamplifier, usually analog, and then the datalogger.

What characterizes all components is that they have an ordered list of response stages. While the order of the components themselves is predetermined, the order of the stages *must* be specified. The order of all stages is then determined as sensor stage 1, sensor state 2,. . . , preamplifier stage 1, preamplifier stage 2,. . . , datalogger stage 1, datalogger stage 2,. . .

### 4.5.1 A simple sensor component

A sensor is, as it is well-known, any kind of transducer that senses a seismic signal and transduces it to an electrical signal, typically an analog one.

Let's see an example of a sensor component.

```
---
format_version: "0.110"
revision:
   date: "2017-11-30"
   authors:
       - {$ref: "authors/Wayne_Crawford.author.yaml#author"}
sensor:
   equipment:
       model: "Trillium T240"
       type: "Broadband seismometer"
       description: "Trillium T240 seismometer, single-sided connection"
       manufacturer: "Nanometrics, Inc"
       vendor: "Nanometrics, Inc"
```

We have an equipment section, just as the instrumentation level, as sensors can have different manufacturers from the rest of the equipment. The description allows to add enough detail so we can identify this sensor. Then we have the seed codes section. Seed codes are coded descriptions of such elements as the band base, the instrument type and the orientation. The codes of the first two follow the FDSN standard, as explained here .

```
seed_codes:
    band_base: "B"
    instrument: "H"
```

Seed codes are only present in sensors. No other component has them. Seed codes are based on an FDSN standard and consist of three characters. The first specifies the band_base, the second the instrument type. A third one, orientation, with azimuth and dip, is specified at the channel level, although in the StationXML file it will part of the seed code.

The value of `polarity` should be "+" if an upward motion or a pressure increase results in a positive voltage, and "-" otherwise.

### 4.5.2 Stages

Now, let's take a look at the next section, response stages. As is readily seen in the example, `stages` are a list of stages. Being a list, individual stages have no label or key, which would make them dictionary items rather than list items. As they are (usually) not referenced elsewhere (the glaring exception being channel modifications), this simplifies the syntax. In this case, we only include a single stage, as a reference to a stage file, which is the recommended best practice. Stages are found in a stage folder.

```
stages
     - $ref: "stages/Trillium_T240_SN1-399-singlesided_theoretical.stage.yaml#stage"
```

Response stages are used in all three components. While StationXML lists all stages separately from the components, *obsinfo* associates conceptually stages to components by way of their functionality. In the end, however, stages will be grouped together and numbered from the sensor stages to the datalogger ones, all in sequence.

This ends the presentation of a simple sensor file. But the important part of components, their flexibility, lies ahead.

### 4.5.3 Configuration definitions

This is the place where the full power of *obsinfo* manifests itself. The application allows several configuration definitions to coexist in any component file. This means that we can have a virtual sensor or datalogger which can potentially have any number of configurations, so we can form a library of component files. Only when they are added to an instrument (or, if you like to think it that way, to a channel), will one particular configuration be "instantiated" and a real component will be described by the file. This occurs with the field `configuration_selections` in the instrumentation file. That value selects one configuration among all the configuration definitions. But we also allow a default configuration, so if no configuration is selected at the channel level, this will be the actual configuration selected. Let's modify our simple sensor file adding configurations:

```
---
format_version: "0.110"
revision:
  date: "2017-11-30"
  authors:
      - {$ref: "authors/Wayne_Crawford.author.yaml#author"}
sensor:
  equipment:
      model: "Trillium T240"
      type: "Broadband seismometer"
      description: "Trillium T240 seismometer, negative shorted to ground"
      manufacturer: "Nanometrics, Inc"
      vendor: "Nanometrics, Inc"

  seed_codes:
      band_base: "B"
      instrument: "H"

  configuration_default: "SINGLE-SIDED_SN1-399"

  configuration_definitions:
      "SINGLE-SIDED_SN1-399" :
          configuration_description: "serial numbers 1-399"
          stages:
              -$ref: "responses/Trillium_T240_SN1-399-singlesided_theoretical.stage.yaml
↪#stage"
```

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```
      "SINGLE-SIDED_SN400plus" :
          configuration_description: "serial numbers 400+"
          stages:
              -$ref: "responses/Trillium_T240_SN400-singlesided_theoretical.stage.yaml
↪#stage"
```

This file requires a lot of commentary. Let's start with the resulting configuration. Note that we have added two configuration definitions, which are specified as a dictionary (i.e. they have labels, key/value pairs),"SINGLE-SIDED_SN1-399" and "SINGLE-SIDED_SN400plus". This is a real example in which a component has different behaviour depending on its serial number (below or above 400), which calls for two differently configured stages. If no sensor configuration is selected in the instrumentation file, the result would be to use the default configuration, so the file above would be the same as this:

```
---
 format_version: "0.110"
 revision:
   date: "2017-11-30"
   authors:
       - {$ref: "authors/Wayne_Crawford.author.yaml#author"}

 sensor:
   equipment:
       model: "Trillium T240"
       type: "Broadband seismometer"
       description: "Trillium T240 seismometer, negative shorted to ground [config:␣
↪serial numbers 1-399]"
       manufacturer: "Nanometrics, Inc"
       vendor: "Nanometrics, Inc"

   seed_codes:
       band_base: "B"
       instrument: "H"

   stages:
       -$ref: "responses/Trillium_T240_SN1-399-singlesided_theoretical.stage.yaml#stage"
```

`stages` is added from the default configuration definition. No surprises here. But look at what happened in `description`. We didn't override the existing description, we *concatenated* the new one to the old one. This is an exception to the way all other fields behave. The idea is to be more specific about the description according to the configuration. This could possibly be achieved with YAML anchors, but unfortunately YAML does not concatenate strings, so we need to do it this way, with an exception to the general overriding rule.

Now, if we had selected configuration "SINGLE-SIDED_SN400plus" in the instrumentation file (in the `config_selections` section), the result would be:

```
---
 format_version: "0.110"
 revision:
   date: "2017-11-30"
   authors:
       - {$ref: "authors/Wayne_Crawford.author.yaml#author"}

 sensor:
```

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```
  equipment:
      model: "Trillium T240"
      type: "Broadband seismometer"
      description: "Trillium T240 seismometer, negative shorted to ground [config:␣
↪serial numbers 400+]"
      manufacturer: "Nanometrics, Inc"
      vendor: "Nanometrics, Inc"

  seed_codes:
      band_base: "B"
      instrument: "H"

  stages:
      - $ref: "responses/Trillium_T240_SN400-singlesided_theoretical.stage.yaml#stage"
```

At any rate, the philosophy is to have all these configurations added to the component file from the start, so we don't change the file much; but, of course, if needs be, you can add more configurations anytime.

### 4.5.4 Complete example sensor file

```
---
format_version: "0.110"
revision:
  date: "2017-11-30"
  authors:
      - {$ref: "authors/Wayne_Crawford.author.yaml#author"}
sensor:
  equipment:
      model: "Trillium T240"
      type: "Broadband seismometer"
      description: "Trillium T240 seismometer, negative shorted to ground"
      manufacturer: "Nanometrics, Inc"
      vendor: "Nanometrics, Inc"

  seed_codes:
      band_base: "B"
      instrument: "H"

  configuration_default: "SINGLE-SIDED_SN1-399"

  configuration_definitions:
      "SINGLE-SIDED_SN1-399" :
          configuration_description: "serial numbers 1-399"
          stages:
              -$ref: "responses/Trillium_T240_SN1-399-singlesided_theoretical.stage.yaml
↪#stage"
      "SINGLE-SIDED_SN400plus" :
          configuration_description: "serial numbers 400+"
          stages:
              -$ref: "responses/Trillium_T240_SN400-singlesided_theoretical.stage.yaml
↪#stage"
```

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```
notes:
   - "INSU-IPGP OBS park sphere sensor pairs are: Sphere01-133, Sphere02-132,"
   - "Sphere03-134, Sphere04-138, Sphere05-137, Sphere06-830, Sphere07-136,"
   - "Sphere08-829, Sphere09-826"
```

### 4.5.5 Preamplifier configuration definitions

Preamplifiers are, in fact, the simplest components. They only have `equipment`, `stages`, `configuration_default` and `configuration_definitions`, already explained above. Thus, we limit ourselves to showing an example, noting the the configuration definitions are based on gain, not serial number as in the sensor example before. Remember that labels for configuration definitions are totally arbitrary, so you can make your own choice as to how to characterize the configurations.

```
---
format_version: "0.110"
revision:
   date: "2017-11-30"
   authors:
       -   $ref: "authors/Wayne_Crawford.author.yaml#author"

preamplifier:
   equipment:
       model: "BBOBS-GAIN"
       type: "Analog gain card"
       description: "INSU BBOBS gain card"
       manufacturer: "SIO or IPGP"
       vendor: ~

   configuration_default: "1x"

   configuration_definitions:
       "0.225x":
           configuration_description: "0.225x gain"
           stages:
               - $ref: "responses/INSU_BBOBS_gain0.225_theoretical.stage.yaml#stage"
       "1x":
           configuration_description: "1x gain"
           stages:
               - $ref: "responses/INSU_BBOBS_gain1.0_theoretical.stage.yaml#stage"
```

In the next section we will see how to configure a datalogger information file.

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## 4.6 Building a datalogger information file

Dataloggers are the components used to record the data treated by the instrument stages before. Their configuration files might get quite complex due to the number of necessary stages.

Dataloggers have the same common fields of any other instrument component, with two extra fields: `correction` and `sample_rate`, which is the overall sample rate of the complete instrument.

**correction**

All stages can have nominal delays, but these delays sometimes need to be corrected. The `correction` field accomplishes this. In StationXML **correction** is an attribute of each stage. However, as most delays come from the datalogger's digital filters, where they are in samples which can only be converted to time once the stages sampling rates are known, **obsinfo** requires you to specify the correction at the `datalogger` level. Two processes are allowed:

1. Set the correction equal to the delay in every stage. This is the most common case used by commercial dataloggers but it seems false if the datalogger doesn't REALLY correct time at every stage.
2. Set the correction equal to zero in all stages but the last, where the correction is set equal to a value provided by the user. This corresponds to what most non-commercial dataloggers do.

The first case is activated by **NOT** specifying the `correction` in the datalogger information file. In other words, **obsinfo** assumes by default a "perfect" delay correction. Note that this will also be applied to the non-datalogger stages, which should probably be changed (either have a separate correction field for each instrument_component, or specify `correction` at the channel level)

The second case is activated by specifying a `correction` in the datalogger information file. Note that, if your datalogger does not correct for the digital delay, specifying `correction:  0` does the right thing, which is to set `correction=0` in each stage.`

### 4.6.1 Datalogger configuration definitions

The following paragraph requires the reader to have a minimal knowledge of signal treatment.

The code below is a real datalogger configuration file. We see that this example has several response stages in each configuration, based this time on the sample rate. This is due to the fact that each stage with the FIR2 amd FIR3 filters has a decimation factor of 2: each one divides the sample rate by two. FIR1 is actually an ADC, an analog to digital converter, all previous stages in this instrument being analog, in particular the one in the previous component, the preamplifier. FIR1 outputs a 32000 sps sample rate. Thus, to get to a final 1000 sps sample rate we need four FIR2 and one FIR3, each halving the sample rate. FIR2 and FIR3 have different coefficients and thus both are necessary. This means we need at least one FIR1, one FIR2 and one FIR3. To keep halving the sample rate we simply add more FIR2. So it's simple now to see now the difference in configurations: it's simply adding an extra FIR2 each time.

```yaml
---
format_version: "0.110"
revision:
   date: "2019-12-20"
   authors:
       - $ref: 'authors/Wayne_Crawford.author.yaml#author'
notes:
   - "Delay correction is hard-coded to 29 samples in LCHEAPO software"

datalogger:
   equipment:
       model: "CS5321/22"
       type: "delta-sigma A/D converter + digital filter"
```

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```
        description: "CS5321/22 delta-sigma A/D converter + FIR digital filter"
        manufacturer: "Cirrus Logic"
        vendor: "various"

    configuration_default: "125 sps"

    configuration_definitions:
        "62.5sps":
            sample_rate: 62.5
            correction: 0.464
            stages:
                - $ref: "responses/CS5321_FIR1.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR3.stage.yaml#stage"
        "125sps":
            sample_rate: 125
            correction: 0.232
            stages:
                - $ref: "responses/CS5321_FIR1.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR3.stage.yaml#stage"
        "250sps":
            sample_rate: 250
            correction: 0.116
            stages:
                - $ref: "responses/CS5321_FIR1.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR3.stage.yaml#stage"
        "500sps":
            sample_rate: 500
            correction: 0.058
            stages:
                - $ref: "responses/CS5321_FIR1.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
```

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```
            - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
            - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
            - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
            - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
            - $ref: "responses/CS5322_FIR3.stage.yaml#stage"
    "1000sps":
        sample_rate: 1000
        correction: 0.029
        stages:
            - $ref: "responses/CS5321_FIR1.stage.yaml#stage"
            - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
            - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
            - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
            - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
            - $ref: "responses/CS5322_FIR3.stage.yaml#stage"
```

As can be seen, configuration definition labels are flexible and can suit any purpose imagined by the user. The best practice is to keep them short, explicit and consistent among different selectable configurations in the same group.

Next we will see stages and filters in more detail.

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## 4.7 Building a stage information file with different filters

Conceptually, stages are each of an electronic block diagram “boxes”. They are usually implemented as a single printed circuit connected to the instrument bus. An instrument component has an ordered list of stages. Each stage has certain signal treatment characteristics.

It is important to note that, since stages are chained,

- Output units of stage and input units of the next stage must match.
- In digital stages, the output sample rate of one stage must match the input sample rate of the next one.
- Declared sample rate of the instrument as a whole must match calculated sample rate of the response ensemble.

To allow flexible use of stages, as exemplified in the datalogger information file above, it is a good idea *not* to specificy input sample rates (output sample rates cannot be specified, see below) for all but the first stage. For example, the FIR2 stages in the datalogger example above only specify decimation factor. This means that, irrespective of input sample rate, the will have the output sample rate specified by the decimation factor.

Both conditions are checked by *obsinfo*.

In the current implementation, all stages have one, and exactly one filter associated. This may seem a little strange, as some stages are not properly filters, but rather analog and digital amplifiers (they only increment gain) or ADCs, analog-digital converters. This is idiosyncratic. It seems StationXML does not allow stages that are not some sort of filter. Therefore, as will be seen, these stages are implemented as filters in *obsinfo*.

Let’s profit from this to see what a stage with a very simple “filter” in the above sense looks like. This is a stage for a preamplifier. It is analog and only has a gain. with no other processing. We have a specification of input and output units and a gain, composed of a value and a frequency where that gain value is measured. It has an associated “filter” of type ANALOG. All these are required fields. We also have an optional description, which is nonetheless recommended.

```
---
format_version: "0.110"
stage:
   description : "PREAMPLIFIER: BBOBS 0.225x"
   input_units : {name: "V", description: "VOLTS"}
   output_units : {name: "V", description: "VOLTS"}
   gain : {value : 0.225, frequency: 0}
   filter :
       type : "ANALOG"
  polarity: "+"
```

Next we can see another pseudo-filter, an analog to digital converter used as the first stage of a datalogger:

```
---
format_version: "0.110"
revision:
   date: "2017-11-30"
   authors:
       -   $ref: "authors/Wayne_Crawford.author.yaml#author"

notes:
   - "From CS5321-22_F3.pdf"

stage:
   description : "DIGITIZER - CS5321 Delta-Sigma A/D converter" #  optional
   input_units : { name : "V", description: "Volts"}
   output_units : { name : "counts", description: "Digital Counts"}
   input_sample_rate : 256000
   decimation_factor : 8
   gain :
       frequency: 0
       value: 1165084 #  counts/V
   filter:
       type : "AD_CONVERSION"
       input_full_scale : 9 #  9 V pp
       output_full_scale : 10485760 #  4FFFFF@Vref and B00000@-Vref
```

Although it is obvious that the input is analog, we specify an `input_sample_rate` in agreement with StationXML specifications. The output rate, as mentioned above, is never specified, but can easily be obtained from this and the `decimation_factor` by division. In the example, the output sample rate will be 32000 sps. For the time being, we will ignore the other fields in `filter`, which will be discussed in the next section.

Note the use of the `notes` attribute, which will **not** be processed as comments in StationXML. Other optional attributes don't appear here to keep the discussion simple but can be readily consulted in the corresponding *Stage*. However, there are three attributes that should be noticed.

### 4.7.1 delay, offset and correction attributes

Digital filters can have an `offset`, which specifies how samples the peak of an impulse will be offset by the filter. This is specified at the filter level.

The stage level has an attribute called `delay`. If `delay` is not specified but `offset` is in the associated filter, `delay` is calculated by dividing `offset` by the input sample rate. If both `delay` and ``offset``are specified, their specified values are kept untouched.

`correction` is an attribute in StationXML which is calculated, as mentioned in the previous section, using the datalogger field `correction`. It should **not** be specified by the user.

We see in this example a stage without `input_sample_rate` but with `decimation_rate` of 2, which divide the `output_sample_rate` of the previous stage by 2, as mentioned in the introduction to this section. This is precisely the stage FIR3 that was used in the previous page as a datalogger stage example. The other thing worth noting is the reference to a filter file in the folder `filters/`.

```
---
format_version: "0.110"
revision:
   date: "2017-11-30"
   authors:
       -   $ref: "authors/Wayne_Crawford.author.yaml#author"

notes: ["From CS5322_Filter.pdf"]

stage:
   decimation_factor : 2
   gain :         {value: 1, frequency: 0}
   input_units :  { name : "counts", description: "Digital Counts"}
   offset: 50

   description : "DECIMATION - CS5322 FIR3 (linear phase)"
   filter:
       $ref: "filters/CirrusLogic_CS5322_FIR3.filter.yaml#filter"
   extras:
       DBIRD_response_type : "THEORETICAL"
```

### 4.7.2 Polarity

Each stage can have a polarity: if omitted it is assumed to be "+". A "+" polarity means:

- For a seismometer, a postitive voltage corresponds to a movement **UP**.
- For a hydrophone, a positive voltage corresponds to an **INCREASE** in pressure
- For a non-sensor stage, the passband output has the **SAME** polarity as the input in the passband

**A "-" polarity means:**

- For a seismometer, a postitive voltage corresponds to a movement **DOWN**.
- For a hydrophone, a positive voltage corresponds to a **DECREASE** in pressure
- For a non-sensor stage, the passband output has the **OPPOSITE** polarity as the input in the passband

By multiplying the polarities in a channel's stages we get the channel's polarity. For seismometer and hydrophone channels, a positive polarity corresponds to dip = -90º and a negative polarity to dip = 90º

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## 4.8 Building a filter information file for different filters

As pointed out in the last section, all stages have an associated filter, even if we can't properly call it a filter, due to the ideosyncretic behavior of StationXML. Some of the normal filters are familiar:

- *PolesZeros* - Any kind of digital filter specified by its poles and its zeros. Use this for Laplace transforms and IIR filters.
- *FIR* - Finite Input Response digital filter
- *Coefficients* - A FIR expressed with coefficients of transfer function
- *ResponseList* - A digital filter with all responses expressed as frequency, amplitude and phase.

Others are not properly filters:

- *ADConversion* - Analog to digital conversion stage
- *Analog* - gain only analog stage-
- *Digital* gain only digital stage

For more details on each one go to their corresponding Class pages. Here are some examples on how to express different filters (for examples of Analog and ADConversion, see last section).

All filters have a type, which is specified in the list above, and digital ones have an `offset`, which is the number of pulses to be skipped at the start of the signal input. `offset` is used to calculate delay, as explained in the last section.

### 4.8.1 PolesZeros

A PolesZeros digital filter (as defined in the field `type`) specifies a transfer function type, a normalization factor and frequency, and the respective poles and zeros:

```yaml
---
format_version: "0.110"
revision:
   date: "2017-11-30"
   authors:
       -   $ref: "authors/Wayne_Crawford.author.yaml#author"

filter:
   type: "PolesZeros"
   transfer_function_type: "LAPLACE (RADIANS/SECOND)"
   normalization_factor : 1
   normalization_frequency : 0
   zeros :
       -     [0.0,  0.0]
       -     [0.0,  0.0]
       -   [-72.5,  0.0]
       -  [-159.3,  0.0]
       -  [-251,    0.0]
```

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```
        - [-3270.0,  0.0]
   poles :
        -    [-0.017699,    0.017604]
        -    [-0.017699,   -0.017604]
        -   [-85.3,         0.0]
        -  [-155.4,       210.8]
        -  [-155.4,      -210.8]
        -  [-713,           0]
        - [-1140,          -0]
        - [-4300,          -0]
        - [-5800,          -0]
        - [-4300,        4400]
        - [-4300,       -4400]
   offset: 0

notes:
   - poles et zeros d'un Trillium T240 no de serie 400+
   - d'apres le fichier Trillium240_UserGuide_15672R7.pdf de Nanometrics.
```

### 4.8.2 FIR

A FIR filter can be specified by a symmetry and a set of numerator coefficients of the transfer function. The symmetry specification permits to specify the filter without having to repeat values. But a FIR filter can also be specified by the numerator *and* denominator coefficients of the transfer function, in which case the type "Coefficients" is used. For more information, see the corresponding class. Finally, the specification can take the form of a list of responses, which uses the type "ResponseList". Again, this is straightforward. The syntax can be looked up in the corresponding class.

```
---
format_version: "0.110"
revision:
   date: "2017-11-30"
   authors:
        -   $ref: "authors/Wayne_Crawford.author.yaml#author"

filter:
   type: "FIR"
   symmetry: "NONE"
   offset: 6
   coefficients:
        - 2.44141E-4
        - 0.00292969
        - 0.0161133
        - 0.0537109
        - 0.12085
        - 0.193359
        - 0.225586
        - 0.193359
        - 0.12085
        - 0.0537109
        - 0.0161133
        - 0.00292969
```

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```
        - 2.44141E-4
```

### 4.8.3 Analog and Digital

Analog and digital "filters" are stages that basically amplify the signal, whether analog or digital, with the gain specified, as usual, at the stage level. Analog filters can invert the polarity, so this needs to be specified with a `polarity` attribute.

```
---
format_version: "0.110"
revision:
   date: "2017-11-30"
   authors:
       -   $ref: "authors/Wayne_Crawford.author.yaml#author"

filter:
   type: "Analog"
   polarity: "-"
```

### 4.8.4 ANALOG to DIGITAL Converter

This is another type of pseudo-filter which has the input voltage range and the output voltage range as attributes:

```
---
format_version: "0.110"
revision:
   date: "2017-11-30"
   authors:
       -   $ref: "authors/Wayne_Crawford.author.yaml#author"

filter:
   type: "ADConversion"
   input_full_scale : 9 #  9 V pp
   output_full_scale : 10485760 #  4FFFFF@Vref and B00000@-Vref
```

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## 4.9 Summary

As a summary, remember *obsinfo* strives for reuse and flexibility.

1. Try to use the hierarchy referencing files as much as possible. This allows reuse across files and different campaigns.
2. Use `yaml_anchors` for reuse in the *same file*
3. Start from simple files with only required fields and build up from that

4. You can add notes at any level. You can add extras only in network, station and instrumentation files. Only extras and comments will be reflected as comments in StationXML.
5. Make extensive use of the `*` default channel to avoid repeating redundant information in different channels.
6. Make extensive use of configuration_definitions to avoid duplicating the same components with little variations
7. Remember: `*` channel default preferably for complete substitutions of a component or of a default configuration. `config_selection` for changing the list of stages, filter parameters, equipment fields.

File templates are available to help you start writing your information files.

## 4.9.1 Conclusion

This finishes our tutorial. For more detailed information please review the *Classes* hierarchy where attributes are described in detail and some optional attributes that were not discussed here for the sake of brevity are explained. Have fun using *obsinfo*!

If you find any issues or have any questions please use the Issues functionality of gitlab: https://www.gitlab.com/resif/obsinfo/issues

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CHAPTER

FIVE

# INFORMATION FILES

Here are examples of information files, from the most basic to the most complete. You can also see the schemas at . . .

## 5.1 Overview

Information files are the core units of the obsinfo system. We present here the most important concepts, the hierarchy of information files and some examples.

### 5.1.1 Concepts

- The basic hierarchy is *subnetwork* -> *stations* -> *instrumentation* -> *channels* -> {*datalogger*, *preamplifier*, *sensor*} -> *stages* -> *filter*
- ***datalogger*, *preamplifier* and *sensor* objects:**
  - are at the same level and all have *stages* subobjects.
  - Are refered to collectively as`instrument_compoents`
  - Their *stages* are put into StationXML from top (stage N) to bottom (stage N+M). The ordering is *sensor* -> *preamplifier* -> *datalogger*, so the top *sensor* stage will be the instrument's stage 0.
  - *preamplifier* is optional.
- information is generally divided into "atomic" files which are referenced using the *$ref:* operator (inherited from JSONref).
- The paths in the $ref operator are added to the *datapath* specified in the *.obsinforc* file (often the current directory, a local instrumentation database and possibly an online database)
- **base objects and configuration (Details)**
  - allow partial (pre-configured) customization of *station*, *instrumentation* and *instrument_component* objects
  - are specified using a *base* and (optional) *config* object at each of these levels in the information files.
  - Use *configuration_definitions* (and a *configuration_default* object in case *config* is not specified) subobjects specified within the *base* configurable object
- **channel modifications (Details)**
  - allow full customization of all objects
  - provide a "base" customization for all channels, then a specification/customization of differences between individual channels

- The order of evaluation for customization is *base* < *config* < *channel_modifications*. Within *channel_modifications*, the most specific channel specifiers override the more general ones.

### 5.1.2 Hierarchy

We will present:

1) A basic level diagram of the entire structure (missing many sub-fields)
2) A full decription of each atomic-level object
3) A full level diagram of the entire structure, including all sub-fields

The definition (JSON Schemas) for the information files are found in *obsinfo/data/schemas*

#### 1) Basic level diagram

Only required fields are shown, except a few very commonly-used fields, which are prefixed by "*". Atomic objects described below are surrounded by <>

```
subnetwork:
    operators:
        - <operator>
    network: <network>
    stations:
        {STATIONNAME1}: <station>
            site: <string>
            start_date: <string>
            end_date: <string>
            location_code: <string>
            locations:
                {LOCATION_1}: <location>
                {LOCATION_2}: <location>
                ...
            instrumentation: <instrumentation>
                base: <instrumentation_base>
                    equipment: <equipment>
                    channels:
                        default: <channel>
                            datalogger:
                                base: <datalogger_base>
                                    equipment: <equipment>
                                    sample_rate: <number>
                                    stages:
                                        -
                                            base: <stage_base>
                                                input_units:
                                                    name: <string>
                                                    description: <string>
                                                output_units:
                                                    name: <string>
                                                    description: <string>
                                                gain:
                                                    value: <number>
```

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```
                                                filter: <filter>
                                                    type: <string>
                                        - base: <stage>
                                        - ...
                            *preamplifier: <preamplifier>
                                base:
                                    equipment:
                                        <equipment>
                                    stages:
                                        - base: <stage>
                                        - base: <stage>
                                        - ...
                            sensor: <sensor>
                                base:
                                    equipment:
                                        <equipment>
                                    seed_codes:
                                        band_base: "B" or "S"
                                        instrument: <single character>
                                    stages:
                                        - base: <stage>
                                        - base: <stage>
                                        - ...
                        {SPECIFIC-CHANNEL1}: subset of <channel>
                        {SPECIFIC-CHANNEL2}: subset of <channel>
                        ...
        {STATIONNAME2}:
            ...
```

### 2) Atomic level diagram with comments

Starred fields are optional. If you put a level in a separate file, it is good practice to use the following file structure:

```
format_version: <format_version>
*revision: <revision>
*notes: <list of strings>
level: <level>
```

#### Major objects

##### subnetwork

```
network: <network>
operators: <list of operator>
stations:
    <STATIONNAME1>:
        <station>
    <STATIONNAME2>:
        <station>
```

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```
    ...
*reference_names:
    campaign: <string>
    operator: <string>
*comments: list of strings
*extras: <free-form object>
```

### network

```
code: <string>
name: <string>
start_date: <date-formatted string>
end_date: <date-formatted string>
description: <string>
*operators: <list of operator>
*comments: <list of <string> and/or <stationxml_comment>>
*restricted_status: 'open', 'closed', or 'partial'
*source_id: <uri-formatted string>
*identifiers: <list of uri-formatted string, must have prefix>
```

### station

```
site: <string>
start_date: <string>
end_date: <string>
location_code: <string>
locations: object list of <location>
instrumentation:
    base: <instrumentation_base>
    *configuration: <string>
    *modifications: <modifications>
    *channel_modifications: {}
    *serial_number: <string>
    *notes: <list of strings>
*operators: <operators>
*comments: list of strings or <stationxml_comment>
*extras: <free-form object>
*processing:
    - *clock_correction_linear: {}
    - *clock_correction_leapsecond: {}
*restricted_status: ['open', 'closed', 'partial', or 'unknown']
*source_id: <string in uri format>
*external_references:
    - uri: <string in uri format>
      description: <string>
*identifiers:
    - <string in uri format>
*water_level: <number>
*notes: <list of strings>
```

instrumentation_base

```
equipment: {}
channels:
    default:
        <channel>
   <SPECIFIC-CHANNEL1>:
        subset of <channel>
   <SPECIFIC-CHANNEL2>:
        subset of <channel>
   ...
*configuration_default: <string>
*configurations:
    {CONFIGURATION_1}: <subset of instrumentation>
    {CONFIGURATION_2}: <subset of instrumentation>
    ...
```

channel

```
datalogger:
    base: <datalogger>
    *configuration: <string>
sensor:
    base: <sensor>
    *configuration: string
*preamplifier:*
    base: <preamplifier>
    *configuration: <string>
*orientation: <orientation>
*location_code: <string>   # if not specified, inherits from station
*comments: <list of string>
*restricted_status": 'open', 'closed'
*source_id": <uri-formatted string>
*identifiers": <list of uri-formatted strings, must have scheme>
*external_references": <list of {uri: description}>
*extras: <free-format object>
```

### datalogger_base

```
<GENERIC_COMPONENT>
sample_rate: number
*correction: number
```

### preamplifier_base

```
<GENERIC_COMPONENT>
```

### sensor_base

```
<GENERIC_COMPONENT>
 seed_codes:
```

### GENERIC_COMPONENT

```
equipment:  <equipment>
*stage_modifications: {}
*notes: <list of string>
*stages:
    - base: <stage>
      *configuration: <string>
    - base: <stage>
      *configuration: <string>
    - ...
*configuration_default: <string>
*configurations:
    {CONFIGURATION_1}: <subset of datalogger, sensor, or preamplifier>
    {CONFIGURATION_2}: <subset of datalogger, sensor, or preamplifier>
    ...
```

### stage_base

```
input_units: <string>
output_units: <string>
gain: <float>
*name: <string>
*description: <string>
*decimation_factor: <integer>
*delay: <number>
*calibration_date: <string>
*polarity: '+' or '-'     # default is '+'
*input_sample_rate: <number>
*resource_id: <string>
```

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```
*filter:
    <filter>
*configuration_default: <string>
*configurations:
    {CONFIGURATION_1}: <subset of stage>
    {CONFIGURATION_2}: <subset of stage>
    ...
```

### filter

fields depend on type:

```
type: "PoleZeros"
poles: <list of string>
zeros: <list of string>
*delay.samples: <float>
*transfer_function_type:  "LAPLACE (RADIANS/SECOND)", "LAPLACE (HERTZ)", or "DIGITAL (Z-
↪TRANSFORM)"
*normalization_frequency: <number>
*normalization_factor: <number>
*resource_id: <string>
```

```
type: "FIR"
symmetry:  "EVEN", "ODD" or "NONE"
coefficients:  <list>
coefficient_divisor: <number>
*delay.samples: <number>
*resource_id: <string>
```

```
type: "Coefficients"
numerator_coefficients: <list>
denominator_coefficients": <list>
*delay.samples: <number>
*transfer_function_type: "ANALOG (RADIANS/SECOND)", "ANALOG (HERTZ)" or "DIGITAL"*
*offset: <number>
*resource_id: <string>
```

```
type: "ResponseList"
elements: <list>
*delay.samples: <number>
*resource_id: <string>
```

```
type: "Polynomial"
frequency_lower_bound: <number>
frequency_upper_bound: <number>
approximation_lower_bound: <number>
approximation_upper_bound: <number>
maximum_error: <number>
coefficients: <list of number>
```

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```
*approximation_type: "MACLAURIN"
*resource_id: <string>
```

```
type: "ADConversion"
input_full_scale: <number>
output_full_scale: <number>
*delay.samples: <number>
*resource_id: <string>
```

```
type: "Analog"
*delay.seconds: <number>
*resource_id: <string>
```

```
type: "Digital"
*delay.samples: <number>
*resource_id: <string>
```

### Minor objects

**person_**, **operator_**, **location_base_** and *network* are often in separate files.

**equipment_** is widespread enough that it should probably have its own schema file

```
names: <list of string>
*agencies: <list of string>
*emails: <list of string>
*phones: <list of string>
```

```
type: <string>
description: <string>
manufacturer: <string>
model: <string>
*vendor: <string>
*serial_number: <string>
*installation_date: <date-formatted string>
*removal_date: <date-formatted string>
*calibration_dates: <list of date_formatted strings>
*resource_id: <'GENERATOR:Meaningful ID' str>
```

```
base:
    uncertainties.m:
        lat: <number> (in meters)
        lon: <number> (in meters)
        elev: <number> (in meters)
    depth.m: <number>
    geology: <string>
    vault: <string>
    *localisation_method: <string>
position:
    lat: <number> (in degrees)
```

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```
    lon: <number> (in degrees)
    elev: <number> (in meters)
```

```
agency: <string>
*contacts: <list of person>
*website: <string>
```

```
date: <string>
authors: <list of person>
```

```
value: <string>
*begin_effective_time: <date-formatted string>
*end_effective_time: <date-formatted string>
*authors: <list of person>
```

### 3) Full level diagram

#### Structural units

A full obsinfo subnetwork description consists of the following fields (starred fields are optional):

```
format_version: {}
*revision: {}
*notes: []
subnetwork:
    network: <network>
    operators: <list of operator>
    *restricted_state: {}
    *comments: <list of string>
    *extras: <free-form object>
    *reference_names:
        campaign: <string>
        operator: <string>
    stations:
        <STATIONNAME1>:
            site: <string>
            start_date: <string>
            end_date: <string>
            location_code: <string>
            *serial_number: <string>
            *operators: <list of operator>
            instrumentation:
                base:
                    equipment: <equipment>
                    channels:
                        default:
                            *orientation: <orientation>
                            datalogger:
                                base:
                                    << GENERIC_COMPONENT
```

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```
                                    sample_rate: <number>
                                    *correction: <number>
                                *configuration: <string>
                                *modifications: <subset of base>
                                *stage_modifications: <stage_modifications>
                                *serial_number: <string>
                                *notes: <list of string>
                            *preamplifier:*
                                base:
                                    << GENERIC_COMPONENT
                                *configuration: <string>
                                *modifications: <subset of base>
                                *stage_modifications: <stage_modifications>
                                *serial_number: <string>
                                *notes: <list of string>
                            sensor:
                                base:
                                    << GENERIC_COMPONENT
                                    seed_codes:
                                        band_base: 'B' or 'S'
                                        instrument: <character>
                                *configuration: <string>
                                *modifications: <subset of base>
                                *stage_modifications: <stage_modifications>
                                *serial_number: <string>
                                *notes: <list of string>
                            *location_code: <string>
                            *restricted_status: 'open', 'closed', or 'partial'
                            *source_id: <uri-formatted string>
                            *identifiers: <list of uri-formatted strings>
                            *external_references:
                                - uri: <uri-formatted string>
                                  description: <string>
                            *comments: <list of string or stationxml_comment>
                            *extras: <free-form object>
                       <SPECIFIC-CHANNEL1>: {}
                       <SPECIFIC-CHANNEL2>: {}
                       ...
                *channel_modifications: {}
                *serial_number: <string>
            locations: {}
            *notes: <list of string>
            *comments: <list of string or stationxml_comment>
            *extras: <free-form object>
            *processing:
                - *clock_correction_linear: {}
                - *clock_correction_leapsecond: {}
            *water_level.m: <number>
            *restricted_status: 'open', 'closed', or 'partial'
            *source_id: <uri-formatted string>
            *identifiers: <list of uri-formatted strings>
            *external_references:
```

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```
                - uri: <uri-formatted string>
                  description: <string>
        <STATIONNAME2>:
            ...
```

## 5.2 base-configuration-modification

Several elements in information files are expressed using "base-configuration-modification". This allows easy specification or modification of values with minimum repetition.

The base and configurations are defined in an element named `<field>:base` and are implemented and modified in an element just above named `<field>`, where `field` could be `instrumentation`, `location`, `sensor`, `datalogger`, `preamplifier` or `stage`. For example:

```
datalogger:
    base:
        equipment: ...
        stages: ...
        sample_rate: 125
        correction: 0.232
        configuration_default: "125sps"
        configurations:
            "62.5sps":
                configuration_description: "62.5 sps"
                sample_rate: 62.5
                correction: 0.464
                stages: ...
            "125sps":
                configuration_description: "125 sps"
            "250sps":
                configuration_description: "250 sps"
                sample_rate: 250
                correction: 0.116
                stages: ...
    configuration: "250sps"
    modification:
        correction: 1.0
        equipment:
            serial_number: "F05"
    <shortcuts>
    <non-base_elements>
    <specific_modifications>
```

If the datalogger base were specified and no `configuration` was specified, then the "125sps" configuration would be used. The `configuration_description` is appended to the equipment `description`.

In this example the "250sps" `configuration` is specified, so the values in the "250sps" configuration will replace the values with the same names in the `base` definition.

The `modifications` field allows one to further modify the values. The values specified in `modifications` overwrite corresponding values in both the `base` and the `configuration`.

If no `configuration_default` is specified and `configurations` is specified, the level above MUST specify the configuration. This will not be caught by `obsinfo-validate`: only by `obsinfo_print` or `obsinfo_makeStationXML`.

The `base` element must include all required fields for the element (needed for `obsinfo-validate`). In our example, since this base configuration specifies the values corresponding to a 125 sps sampling rate, the "125sps" configuration is nearly empty.

`configurations` are optional, so if you only have one configuration you don't have to add additional elements. Some elements (such as `timing_bases`) may nneed a configuration but the base-configuration-modification system provides a consistent interface that allows us to easily add in information, in this case sync times.

In almost all cases, the element definition should be in a separate file: for example the datalogger definition file would contain:

```
datalogger_base:
    equipment: ...
    stages: ...
    sample_rate: 125
    correction: 0.232
    configuration_default: "125sps"
    configurations:
        "62.5sps":
            configuration_description: "62.5 sps"
            sample_rate: 62.5
            correction: 0.464
            stages: ...
        "125sps":
            configuration_description: "125 sps"
        "250sps":
            configuration_description: "250 sps"
            sample_rate: 250
            correction: 0.116
            stages: ...
```

and the call to it would look like:

```
datalogger:
    base: {$ref: 'dataloggers/LC2000.datalogger_base.yaml#datalogger_base'}
    configuration: "250sps"
    modifications:
        correction: 1.0
        equipment:
            serial_number: "F05"
```

### 5.2.1 Shortcuts

Shortcuts allow you to quickly enter common modifications. For example, the `datalogger` element has a shortcut called `serial_number` that duplicates `datalogger: {equipment: {serial_number:}}`, allowing you to write the above code as:

```
datalogger:
    base: {$ref: 'dataloggers/LC2000.datalogger_base.yaml#datalogger_base'}
    configuration: "250sps"
    serial_number: "F05"
```

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```
    modifications:
        correction: 1.0
```

Shortcuts override equivalent entries at the modifications level. They are:

| Shortcut | Replaces |
|---|---|
| instrumentation: {datalogger_configuration:} | instrumentation: {channel_modifications: {'*-*': {datalogger: {configuration:}}}} |
| instrumentation: {serial_number:} | instrumentation: {modifications: {equipment: {serial_number:}}} |
| datalogger: {serial_number:} | datalogger: {modifications: {equipment: {serial_number:}}} |
| sensor: {serial_number:} | sensor: {modifications: {equipment: {serial_number:}}} |
| preamplifier: {serial_number:} | preamplifier: {modifications: {equipment: {serial_number:}}} |

### 5.2.2 Non-base elements

Non-base elements are not specified in the base element, because they are expected to be different for each deployment. They are:

#### location:

```
position: {lat: <number>, lon: <number>, elev: <number>}
```

#### clock_correction_linear:

```
start_sync_reference: <date-time>
end_sync_reference: <date-time>
end_sync_instrument: <date-time>
```

### 5.2.3 Specific modifications

Specific modifications apply only to certain channels or even certain stages of a given channel. They are specified using the channel_modifications and stage_modifications elements at the instrumentation, datalogger, sensor or preamplifier level. Details are provided in channel_modifications and in *stage_modifications*.

## 5.3 Comparison with StationXML

obsinfo information fields are as close to StationXML as feasible, but the need to reduce duplicated information requires some changes.

### 5.3.1 Summmary of differences

#### YAML_ instead of XML

Files are easier to read (as long as they are kept small) and we can take advantage of the **JSONref_** standard for importing files

#### arrays instead of multiply-used fields:

XML allows the same field name to be used repeatedly, **YAML_** does not. So multiply-used fields in StationXML are replaced with arrays, usually with an "s" tacked onto the field name. Some examples (noted as they are in the following tables) are:

| StationXML field | obsinfo array |
|---|---|
| Comment: (0+) | comments: [] |
| CalibrationDate: (0+) | calibration_dates: [] |

#### Use of `$ref` s to insert other files

Inherited from **JSONref_** and is the key to reducing information to atomic components

#### Use of *base* channels and specific modifiers

Many channels have much the same information (position, start and enddates, even sensors). obsinfo therefore allows a *base* channel definition, which is then modified by values placed in the specfic modifiers fields

#### Default inheritance of some fields

In many cases, the *operator*, *location_code*, *start_date* and *end_date* values are the same at the *network*, *station* and *channel* levels. In StationXML they must be redefined in each level. In obsinfo, if they are not defined at a level, they are inherited from the level above.

#### No *sensitivity* stage in obsinfo

The StationXML sensitivity stage is supposed to correspond to the sum of the sensitivities of the underlying stages. *obsinfo* therefore simply calculates this value from the provided stages

### Handling of InstrumentComponents

StationXML **Channel/Datalogger**, **Channel/Sensor** and **Channel/Preamplifier** elements are actually **Equipment** objects. These elements' response stages are mixed into the **Channel/Stages** list.

**obsinfo_** `datalogger`, `sensor` and (optional) `preamplifier` elements contain `equipment` definitions, `response_stage` lists and elements specific to each InstrumentComponent (`sensor` : seed_code, azimuth, dip. `datalogger`: sampling_rate) which are given flatly in the StationXML **Channel** level

The StationXML **InstrumentSensitivity** stage should equal the sum of the sensitivities of the underlying stages at the given frequency. **obsinfo_** therefore does not ask for this value, but calculates it from the provided stages

### Handling of positions

StationXML 1.2 specifies Station and Channel positions using the elements **Latitude**, **Longitude** and **Elevation**, each of which is based on the **FloatType_** which includes **units**, **plusError**, **minusError** and **measurementMethod**

Latitudes and Longitudes are generally given in degrees and Elevation in meters, but most most OBS (and land station) positions have an uncertainty that is approximately constant (in meters), depending on the measurementMethod.

For this reason, **obsinfo_** expresses positions and their uncertainties using three elements: - position: {lat:, lon:, elev.m:} - positition_uncertainty: {lat.m, lon.m, elev.m} - position_measurement_method: string

This allows the position_uncertainty values to be associated with a measurement method and entered separately from the actual instrument position. **obsinfo_** then translates these values into StationXML FloatTypes with the appropriate units arc-degrees, arc-degrees and meters), with the arc-degrees value depending on the station latitude.

## 5.3.2 Line-by-line comparison of differences

Below is a line by line naming of StationXML 1.2 fields and their equivalent name in obsinfo information files:

| StationXML *FDSNStationXML* | obsinfo |
|---|---|
| Source | *None* |
| Sender | *None* |
| Module | *None* |
| ModuleURI | *None* |
| Created | *Automatically calculated* |
| Network | *See Network_ level* |

| StationXML *Network* | obsinfo `network` |
|---|---|
| code (*attribute*) | code |
| *startDate* (*attribute*) | start_date: |
| *endDate* (*attribute*) | end_date: |
| *sourceID (attribute)* | source_id |
| *restrictedStatus (attribute)* | restricted_status |
| *Description* | description |
| *Comment* (0+) | comments |
| *Operator* | operator |
| *Identifier* | identifiers |
| *SelectedNumberStations* | *number of stations specified* |
| Station (0+) | stations *see **station_** * |
| *DataAvailability | *None* |
| *alternateCode (attribute)* | *None* |
| *historicalCode (attribute)* | *None* |

| StationXML *Equipment* | obsinfo `equipment` |
|---|---|
| Description | description |
| Type | type |
| Manufacturer | manufacturer |
| Model | model |
| Vendor | vendor |
| SerialNumber | serial_number |
| InstallationDate | installation_date |
| RemovalDate | removal_date |
| resourceId | resource_id |
| CalibrationDate: (0+) | calibration_dates: [] |

The StationXML **Response** level is replaced in **obsinfo_** by the `datalogger` `preamplifier` and `sensor` levels

| StationXML *Response* | obsinfo `channel` | Notes |
|---|---|---|
| resourceId (*attribute*) | | |
| InstrumentSensitivity | *calculated from Stages* | |
| *InstrumentPolynomial* | *None* | StationXML allows either InstrumentSensitivity or InstrumentPolynomial |
| Stage (0+) | **datalogger_** *preamplifier_* **sensor_** | |

| StationXML *Stage* | obsinfo `stage` | Notes |
|---|---|---|
| number (attribute) | *calculated by obsinfo* | |
| resourceId (attribute) | | |
| {Type} | filter/type: | Can be PolesZeros, Coefficients, ResponseList, FIR or Polynomial |
| Decimation | | *DecimationType_*, Not in "Polynomials" |
| StageGain | | *GainType*: Value, Frequency. Not in "Polynomials" |

| StationXML *DecimationType* | obsinfo `stage` | Notes |
|---|---|---|
| InputSampleRate | | |
| Factor | | |
| Offset | | |
| Delay | | |
| Correction | | |

| StationXML *PolesZeros* | obsinfo `filter` | Notes |
|---|---|---|
| name (attribute) | | |
| resourceId (*attribute*) | | |
| *Description* | | |
| InputUnits | | |
| OutputUnits | | |
| PzTransferFunctionType | | |
| NormalizationFactor | | |
| NormalizationFrequency | | |
| Zero: (0+) | | |
| Pole: (0+) | | |

| StationXML *Coefficients* | obsinfo `filter` | Notes |
|---|---|---|
| name (attribute) | | |
| resourceId (*attribute*) | | |
| *Description* | | |
| InputUnits | | |
| OutputUnits | | |
| CfTransferFunctionType | | |
| Numerator: (0+) | | |
| Denominator: (0+) | | |

| StationXML *ResponseList* | obsinfo `filter` | Notes |
|---|---|---|
| name (attribute) | | |
| resourceId (*attribute*) | | |
| *Description* | | |
| InputUnits | | |
| OutputUnits | | |
| ResponseListElement: (0+) | | StationXML: Frequency, Amplitude, Phase |

| StationXML *FIR* | obsinfo `filter` | Notes |
|---|---|---|
| name (attribute) | | |
| resourceId (*attribute*) | | |
| *Description* | | |
| InputUnits | | |
| OutputUnits | | |
| Symmetry | | NONE, EVEN or ODD |
| NumeratorCoefficient: (0+) | | |

| StationXML *Polynomial* | obsinfo `filter` | Notes |
|---|---|---|
| name (*attribute*) | | |
| resourceId (*attribute*) | | |
| *Description* | | |
| InputUnits | | |
| OutputUnits | | |
| ApproximationType | | default="MACLAURIN"> |
| FrequencyLowerBound | | |
| FrequencyUpperBound | | |
| ApproximationLowerBound | | |
| ApproximationUpperBound | | |
| MaximumError | | |
| Coefficient: (0+) | | |

| StationXML *Operator* | obsinfo `operator` |
|---|---|
| Agency: string | agency: string |
| Contact: [] | contacts: [] |
| WebSite: URI | website: uri |

| StationXML *PersonType* | obsinfo `person` |
|---|---|
| Name: (0+) | name: |
| Agency: (0+) | agencies: [] |
| Email: (0+) | emails: [] |
| Phone: (0+) | phones: [**PhoneNumberType_**] |

| StationXML *PhoneNumberType* | obsinfo |
|---|---|
| CountryCode | |
| AreaCode | |
| PhoneNumber | |
| *name* | |

| StationXML *uncertaintyDouble* | obsinfo |
|---|---|
| *plusError* (attribute) | uncertainty: float |
| *minusError* (attribute) | |
| *measurementMethod* (attribute) | measurement_method: string |

```
FDSNStationXML:
  Network:
      Station:
          Channel:
            - *Description: string*
              *Identifier:*
                - string
              *Comment:*
                - Value: string
                  BeginEffectiveTime: '2017-08-25T05:02:50.47'
                  EndEffectiveTime: '2016-03-07T01:49:19.16'
```

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```
                  Author: ''
                    - ''
                  - Value: string
                *DataAvailability:*
                  Extent: ''
                  Span:
                    - ''
                ExternalReference:
                  URI: <URI>
                  Description: string
                Latitude: number
                Longitude: number
                Elevation: number
                Depth: number
                *Azimuth: number*
                Dip: number
                Type:
                  - [CONTINUOUS, HEALTH, SYNTHESIZED, GEOPHYSICAL, TRIGGERED, or WEATHER]
                SampleRate: number
                SampleRateRatio:
                  NumberSamples: number
                  NumberSeconds: number
                ClockDrift: number
                *CalibrationUnits:*
                  Name: string
                  Description: string
                Sensor:
                  <equipment>
                *PreAmplifier:*
                  <equipment>
                DataLogger:
                  <equipment>
                Equipment:
                  <equipment>
                Response:
                  AnyElementYouLike: Some Data Or Other Elements
              - Identifier: string
    - ''
    - ''
```

```
<DecimationType
    InputSampleRate
    Factor
    Offset
    Delay
    Correction
```

```
   <BaseNodeType>
       code *(attribute)*
       *startDate *(attribute)*
       *endDate* *(attribute)*
```

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```
        *sourceID* *(attribute)*
        *restrictedStatus* *(attribute)*
        *alternateCode* *(attribute)*
        *historicalCode* *(attribute)*
        *Description:*
        *Identifier (0+)*
        *Comment (0+)*
        *DataAvailability*

.. code-block:: yaml

   <BaseFilterType>
       name (attribute)
       resourceId (*attribute*)
       *Description*
       InputUnits
       OutputUnits
```

# stationxml 1.2 schema, with <annotations> and their contained <documentation>s removed

```
    <xs:element name="FDSNStationXML" type="fsx:RootType"/>
    <xs:complexType name="RootType">
            <xs:sequence>
                    <xs:element name="Source" type="xs:string">
                    <xs:element name="Sender" type="xs:string" minOccurs="0">
                    <xs:element name="Module" type="xs:string" minOccurs="0">
                    <xs:element name="ModuleURI" type="xs:anyURI" minOccurs="0">
                    <xs:element name="Created" type="xs:dateTime">
                    <xs:element name="Network" type="fsx:NetworkType" maxOccurs=
↪"unbounded"/>
                    <xs:any namespace="##other" processContents="lax" minOccurs="0"␣
↪maxOccurs="unbounded"/>
            </xs:sequence>
            <xs:attribute name="schemaVersion" type="xs:decimal" use="required">
            <xs:anyAttribute namespace="##other" processContents="lax"/>
    </xs:complexType>
    <xs:complexType name="NetworkType">
            <xs:complexContent>
                    <xs:extension base="fsx:BaseNodeType">
                            <xs:sequence>
                                    <xs:element name="Operator" type="fsx:OperatorType"␣
↪minOccurs="0"

                                            maxOccurs="unbounded">
                                    <xs:element name="TotalNumberStations" type=
↪"fsx:CounterType" minOccurs="0">
                                    <xs:element name="SelectedNumberStations" type=
↪"fsx:CounterType" minOccurs="0">
                                    <xs:element name="Station" type="fsx:StationType"␣
↪minOccurs="0"

                                            maxOccurs="unbounded"/>
                            </xs:sequence>
                    </xs:extension>
```

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```
            </xs:complexContent>
        </xs:complexType>
<xs:complexType name="StationType">
    <xs:complexContent>
        <xs:extension base="fsx:BaseNodeType">
            <xs:sequence>
                <xs:element name="Latitude" type="fsx:LatitudeType">
                <xs:element name="Longitude" type="fsx:LongitudeType">
                <xs:element name="Elevation" type="fsx:DistanceType">
                <xs:element name="Site" type="fsx:SiteType">
                <xs:element name="WaterLevel" type="fsx:FloatType" minOccurs="0">
                <xs:element name="Vault" type="xs:string" minOccurs="0">
                <xs:element name="Geology" type="xs:string" minOccurs="0">
                <xs:element name="Equipment" type="fsx:EquipmentType" minOccurs="0"
                    maxOccurs="unbounded">
                </xs:element>
                <xs:element name="Operator" type="fsx:OperatorType" minOccurs="0"
                    maxOccurs="unbounded">
                </xs:element>
                <xs:element name="CreationDate" type="xs:dateTime" minOccurs="0">
                <xs:element name="TerminationDate" type="xs:dateTime" minOccurs="0">
                <xs:element name="TotalNumberChannels" type="fsx:CounterType" minOccurs=
↪"0">
                <xs:element name="SelectedNumberChannels" type="fsx:CounterType"␣
↪minOccurs="0">
                <xs:element name="ExternalReference" type="fsx:ExternalReferenceType"
                    minOccurs="0" maxOccurs="unbounded">
                <xs:element name="Channel" type="fsx:ChannelType" minOccurs="0"
                    maxOccurs="unbounded"/>
            </xs:sequence>
        </xs:extension>
    </xs:complexContent>
</xs:complexType>
<!-- End StationType-->
<xs:complexType name="ChannelType">
    <xs:complexContent>
        <xs:extension base="fsx:BaseNodeType">
            <xs:sequence>
                <xs:element name="ExternalReference" type="fsx:ExternalReferenceType"
                    minOccurs="0" maxOccurs="unbounded">
                </xs:element>
                <xs:element name="Latitude" type="fsx:LatitudeType">
                <xs:element name="Longitude" type="fsx:LongitudeType">
                <xs:element name="Elevation" type="fsx:DistanceType">
                <xs:element name="Depth" type="fsx:DistanceType">
                <xs:element name="Azimuth" type="fsx:AzimuthType" minOccurs="0">
                <xs:element name="Dip" type="fsx:DipType" minOccurs="0">
                <xs:element name="WaterLevel" type="fsx:FloatType" minOccurs="0">
                <xs:element name="Type" minOccurs="0" maxOccurs="unbounded">
                    <xs:simpleType>
                        <xs:restriction base="xs:NMTOKEN">
                            <xs:enumeration value="TRIGGERED"/>
```

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```
                            <xs:enumeration value="CONTINUOUS"/>
                            <xs:enumeration value="HEALTH"/>
                            <xs:enumeration value="GEOPHYSICAL"/>
                            <xs:enumeration value="WEATHER"/>
                            <xs:enumeration value="FLAG"/>
                            <xs:enumeration value="SYNTHESIZED"/>
                            <xs:enumeration value="INPUT"/>
                            <xs:enumeration value="EXPERIMENTAL"/>
                            <xs:enumeration value="MAINTENANCE"/>
                            <xs:enumeration value="BEAM"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:group ref="fsx:SampleRateGroup" minOccurs="0"/>
                <xs:element name="ClockDrift" minOccurs="0">
                    <xs:complexType>
                        <xs:simpleContent>
                            <xs:restriction base="fsx:FloatType">
                                <xs:minInclusive value="0"/>
                                <xs:attribute name="unit" type="xs:string" use="optional
↪" fixed="SECONDS/SAMPLE">
                                    </xs:attribute>
                            </xs:restriction>
                        </xs:simpleContent>
                    </xs:complexType>
                </xs:element>
                <xs:element name="CalibrationUnits" type="fsx:UnitsType" minOccurs="0">
                <xs:element name="Sensor" type="fsx:EquipmentType" minOccurs="0">
                <xs:element name="PreAmplifier" type="fsx:EquipmentType" minOccurs="0">
                <xs:element name="DataLogger" type="fsx:EquipmentType" minOccurs="0">
                <xs:element name="Equipment" type="fsx:EquipmentType" minOccurs="0"␣
↪maxOccurs="unbounded">
                <xs:element name="Response" type="fsx:ResponseType" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="locationCode" type="xs:string" use="required">
        </xs:extension>
    </xs:complexContent>
</xs:complexType>
<!-- End ChannelType -->
<xs:complexType name="GainType">
    <xs:sequence>
        <xs:element name="Value" type="xs:double">
        <xs:element name="Frequency" type="xs:double">
    </xs:sequence>
</xs:complexType>
<xs:group name="FrequencyRangeGroup">
    <xs:sequence>
        <xs:element name="FrequencyStart" type="xs:double">
        <xs:element name="FrequencyEnd" type="xs:double">
        <xs:element name="FrequencyDBVariation" type="xs:double">
    </xs:sequence>
</xs:group>
```

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```
<xs:complexType name="SensitivityType">
    <xs:complexContent>
        <xs:extension base="fsx:GainType">
            <xs:sequence>
                <xs:element name="InputUnits" type="fsx:UnitsType">
                <xs:element name="OutputUnits" type="fsx:UnitsType">
                <xs:group ref="fsx:FrequencyRangeGroup" minOccurs="0">
            </xs:sequence>
        </xs:extension>
    </xs:complexContent>
</xs:complexType>
<xs:complexType name="EquipmentType">
    <xs:sequence>
        <xs:element name="Type" type="xs:string" minOccurs="0">
        <xs:element name="Description" type="xs:string" minOccurs="0">
        <xs:element name="Manufacturer" type="xs:string" minOccurs="0">
        <xs:element name="Vendor" type="xs:string" minOccurs="0">
        <xs:element name="Model" type="xs:string" minOccurs="0">
        <xs:element name="SerialNumber" type="xs:string" minOccurs="0">
        <xs:element name="InstallationDate" type="xs:dateTime" minOccurs="0">
        <xs:element name="RemovalDate" type="xs:dateTime" minOccurs="0">
        <xs:element name="CalibrationDate" type="xs:dateTime" minOccurs="0" maxOccurs=
↪"unbounded">
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs=
↪"unbounded"/>
    </xs:sequence>
    <xs:attribute name="resourceId" type="xs:string" use="optional">
    </xs:attribute>
    <xs:anyAttribute namespace="##other" processContents="lax"/>
</xs:complexType>
<xs:complexType name="ResponseStageType">
    <xs:sequence>
        <xs:choice>
            <xs:sequence>
                <xs:choice>
                    <xs:element name="PolesZeros" type="fsx:PolesZerosType" minOccurs="0
↪">
                    <xs:element name="Coefficients" type="fsx:CoefficientsType"␣
↪minOccurs="0"/>
                    <xs:element name="ResponseList" type="fsx:ResponseListType"␣
↪minOccurs="0"/>
                    <xs:element name="FIR" type="fsx:FIRType" minOccurs="0">
                </xs:choice>
                <xs:element name="Decimation" type="fsx:DecimationType" minOccurs="0"/>
                <xs:element name="StageGain" type="fsx:GainType">
            </xs:sequence>
            <xs:element name="Polynomial" type="fsx:PolynomialType">
        </xs:choice>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs=
↪"unbounded"/>
    </xs:sequence>
    <xs:attribute name="number" type="fsx:CounterType" use="required">
```

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```
    <xs:attribute name="resourceId" type="xs:string">
    <xs:anyAttribute namespace="##other" processContents="lax"/>
</xs:complexType>
<xs:complexType name="CommentType">
    <xs:sequence>
        <xs:element name="Value" type="xs:string">
        <xs:element name="BeginEffectiveTime" type="xs:dateTime" minOccurs="0">
        <xs:element name="EndEffectiveTime" type="xs:dateTime" minOccurs="0">
        <xs:element name="Author" type="fsx:PersonType" minOccurs="0" maxOccurs=
↪"unbounded">
    </xs:sequence>
    <xs:attribute name="id" type="fsx:CounterType" use="optional">
    <xs:attribute name="subject" type="xs:string" use="optional">
</xs:complexType>
<xs:complexType name="PolesZerosType">
    <xs:complexContent>
        <xs:extension base="fsx:BaseFilterType">
            <xs:sequence>
                <xs:element name="PzTransferFunctionType">
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:enumeration value="LAPLACE (RADIANS/SECOND)"/>
                            <xs:enumeration value="LAPLACE (HERTZ)"/>
                            <xs:enumeration value="DIGITAL (Z-TRANSFORM)"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="NormalizationFactor" type="xs:double" default="1.0">
                <xs:element name="NormalizationFrequency" type="fsx:FrequencyType">
                <xs:element name="Zero" type="fsx:PoleZeroType" minOccurs="0" maxOccurs=
↪"unbounded">
                <xs:element name="Pole" type="fsx:PoleZeroType" minOccurs="0" maxOccurs=
↪"unbounded">
            </xs:sequence>
        </xs:extension>
    </xs:complexContent>
</xs:complexType>
<xs:complexType name="FIRType">
    <xs:complexContent>
        <xs:extension base="fsx:BaseFilterType">
            <xs:sequence>
                <xs:element name="Symmetry">
                    <xs:simpleType>
                        <xs:restriction base="xs:NMTOKEN">
                            <xs:enumeration value="NONE"/>
                            <xs:enumeration value="EVEN"/>
                            <xs:enumeration value="ODD"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="NumeratorCoefficient" minOccurs="0" maxOccurs=
↪"unbounded">
```

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```
                    <xs:complexType>
                        <xs:simpleContent>
                            <xs:extension base="xs:double">
                                <xs:attribute name="i" type="xs:integer"/>
                            </xs:extension>
                        </xs:simpleContent>
                    </xs:complexType>
                </xs:element>
            </xs:sequence>
        </xs:extension>
    </xs:complexContent>
</xs:complexType>
<xs:complexType name="CoefficientsType">
    <xs:complexContent>
        <xs:extension base="fsx:BaseFilterType">
            <xs:sequence>
                <xs:element name="CfTransferFunctionType">
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:enumeration value="ANALOG (RADIANS/SECOND)"/>
                            <xs:enumeration value="ANALOG (HERTZ)"/>
                            <xs:enumeration value="DIGITAL"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="Numerator" minOccurs="0" maxOccurs="unbounded">
                    <xs:complexType>
                        <xs:simpleContent>
                            <xs:extension base="fsx:FloatNoUnitType">
                                <xs:attribute name="number" type="fsx:CounterType"/>
                            </xs:extension>
                        </xs:simpleContent>
                    </xs:complexType>
                </xs:element>
                <xs:element name="Denominator" minOccurs="0" maxOccurs="unbounded">
                    <xs:complexType>
                        <xs:simpleContent>
                            <xs:extension base="fsx:FloatNoUnitType">
                                <xs:attribute name="number" type="fsx:CounterType"/>
                            </xs:extension>
                        </xs:simpleContent>
                    </xs:complexType>
                </xs:element>
            </xs:sequence>
        </xs:extension>
    </xs:complexContent>
</xs:complexType>
<xs:complexType name="ResponseListElementType">
    <xs:sequence>
        <xs:element name="Frequency" type="fsx:FrequencyType"/>
        <xs:element name="Amplitude" type="fsx:FloatType"/>
        <xs:element name="Phase" type="fsx:AngleType"/>
```

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```
    </xs:sequence>
</xs:complexType>
<xs:complexType name="ResponseListType">
    <xs:complexContent>
        <xs:extension base="fsx:BaseFilterType">
            <xs:sequence>
                <xs:element name="ResponseListElement" type="fsx:ResponseListElementType"
                    minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
        </xs:extension>
    </xs:complexContent>
</xs:complexType>
<xs:complexType name="PolynomialType">
    <xs:complexContent>
        <xs:extension base="fsx:BaseFilterType">
            <xs:sequence>
                <xs:element name="ApproximationType" default="MACLAURIN">
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:enumeration value="MACLAURIN"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="FrequencyLowerBound" type="fsx:FrequencyType">
                <xs:element name="FrequencyUpperBound" type="fsx:FrequencyType">
                <xs:element name="ApproximationLowerBound" type="xs:double">
                <xs:element name="ApproximationUpperBound" type="xs:double">
                <xs:element name="MaximumError" type="xs:double">
                <xs:element name="Coefficient" maxOccurs="unbounded">
                    <xs:complexType>
                        <xs:simpleContent>
                            <xs:extension base="fsx:FloatNoUnitType">
                                <xs:attribute name="number" type="fsx:CounterType"/>
                            </xs:extension>
                        </xs:simpleContent>
                    </xs:complexType>
                </xs:element>
            </xs:sequence>
        </xs:extension>
    </xs:complexContent>
</xs:complexType>
<xs:complexType name="DecimationType">
    <xs:sequence>
        <xs:element name="InputSampleRate" type="fsx:FrequencyType"/>
        <xs:element name="Factor" type="xs:integer">
        <xs:element name="Offset" type="xs:integer">
        <xs:element name="Delay" type="fsx:FloatType">
        <xs:element name="Correction" type="fsx:FloatType">
    </xs:sequence>
</xs:complexType>
<!-- The following elements represent numbers. -->
<xs:attributeGroup name="uncertaintyDouble">
```

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```
    <xs:attribute name="plusError" type="xs:double" use="optional">
    <xs:attribute name="minusError" type="xs:double" use="optional">
    <xs:attribute name="measurementMethod" type="xs:string" use="optional"/>
</xs:attributeGroup>
<xs:complexType name="FloatNoUnitType">
    <xs:simpleContent>
        <xs:extension base="xs:double">
            <xs:attributeGroup ref="fsx:uncertaintyDouble"/>
        </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:complexType name="FloatType">
    <xs:simpleContent>
        <xs:extension base="xs:double">
            <xs:attribute name="unit" type="xs:string" use="optional">
            <xs:attributeGroup ref="fsx:uncertaintyDouble"/>
        </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<!-- Derived from FloatType. -->
<xs:complexType name="SecondType">
    <xs:simpleContent>
        <xs:restriction base="fsx:FloatType">
            <xs:attribute name="unit" type="xs:string" fixed="SECONDS">
            <xs:attributeGroup ref="fsx:uncertaintyDouble"/>
        </xs:restriction>
    </xs:simpleContent>
</xs:complexType>
<xs:complexType name="VoltageType">
    <xs:simpleContent>
        <xs:restriction base="fsx:FloatType">
            <xs:attribute name="unit" type="xs:string" fixed="VOLTS">
            <xs:attributeGroup ref="fsx:uncertaintyDouble"/>
        </xs:restriction>
    </xs:simpleContent>
</xs:complexType>
<xs:complexType name="AngleType">
    <xs:simpleContent>
        <xs:restriction base="fsx:FloatType">
            <xs:minInclusive value="-360"/>
            <xs:maxInclusive value="360"/>
            <xs:attribute name="unit" type="xs:string" use="optional" fixed="DEGREES">
            <xs:attributeGroup ref="fsx:uncertaintyDouble"/>
        </xs:restriction>
    </xs:simpleContent>
</xs:complexType>
<xs:complexType name="LatitudeBaseType">
    <xs:simpleContent>
        <xs:restriction base="fsx:FloatType">
            <xs:minInclusive value="-90"/>
            <xs:maxExclusive value="90"/>
            <xs:attribute name="unit" type="xs:string" use="optional" fixed="DEGREES">
```

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```
            <xs:attributeGroup ref="fsx:uncertaintyDouble"/>
        </xs:restriction>
    </xs:simpleContent>
</xs:complexType>
<xs:complexType name="LatitudeType">
    <xs:simpleContent>
        <xs:extension base="fsx:LatitudeBaseType">
            <xs:attribute name="datum" type="xs:NMTOKEN" use="optional" default="WGS84"/>
        </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:complexType name="LongitudeBaseType">
    <xs:simpleContent>
        <xs:restriction base="fsx:FloatType">
            <xs:minInclusive value="-180"/>
            <xs:maxInclusive value="180"/>
            <xs:attribute name="unit" type="xs:string" use="optional" fixed="DEGREES">
            <xs:attributeGroup ref="fsx:uncertaintyDouble"/>
        </xs:restriction>
    </xs:simpleContent>
</xs:complexType>
<xs:complexType name="LongitudeType">
    <xs:simpleContent>
        <xs:extension base="fsx:LongitudeBaseType">
            <xs:attribute name="datum" type="xs:NMTOKEN" use="optional" default="WGS84"/>
        </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:complexType name="AzimuthType">
    <xs:simpleContent>
        <xs:restriction base="fsx:FloatType">
            <xs:minInclusive value="0"/>
            <xs:maxExclusive value="360"/>
            <xs:attribute name="unit" type="xs:string" use="optional" fixed="DEGREES">
            <xs:attributeGroup ref="fsx:uncertaintyDouble"/>
        </xs:restriction>
    </xs:simpleContent>
</xs:complexType>
<xs:complexType name="DipType">
    <xs:simpleContent>
        <xs:restriction base="fsx:FloatType">
            <xs:minInclusive value="-90"/>
            <xs:maxInclusive value="90"/>
            <xs:attribute name="unit" type="xs:string" use="optional" fixed="DEGREES">
            <xs:attributeGroup ref="fsx:uncertaintyDouble"/>
        </xs:restriction>
    </xs:simpleContent>
</xs:complexType>
<xs:complexType name="DistanceType">
    <xs:simpleContent>
        <xs:restriction base="fsx:FloatType">
            <xs:attribute name="unit" type="xs:string" use="optional" default="METERS">
```

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```
            <xs:attributeGroup ref="fsx:uncertaintyDouble"/>
        </xs:restriction>
    </xs:simpleContent>
</xs:complexType>
<xs:complexType name="FrequencyType">
    <xs:simpleContent>
        <xs:restriction base="fsx:FloatType">
            <xs:attribute name="unit" type="xs:string" use="optional" fixed="HERTZ">
        </xs:restriction>
    </xs:simpleContent>
</xs:complexType>
<xs:group name="SampleRateGroup">
    <xs:sequence>
        <xs:element name="SampleRate" type="fsx:SampleRateType">
        <xs:element name="SampleRateRatio" type="fsx:SampleRateRatioType" minOccurs="0">
    </xs:sequence>
</xs:group>
<xs:complexType name="SampleRateType">
    <xs:simpleContent>
        <xs:restriction base="fsx:FloatType">
            <xs:attribute name="unit" type="xs:string" use="optional" fixed="SAMPLES/S">
        </xs:restriction>
    </xs:simpleContent>
</xs:complexType>
<xs:complexType name="SampleRateRatioType">
    <xs:sequence>
        <xs:element name="NumberSamples" type="xs:integer">
        <xs:element name="NumberSeconds" type="xs:integer">
    </xs:sequence>
</xs:complexType>
<xs:complexType name="PoleZeroType">
    <xs:sequence>
        <xs:element name="Real" type="fsx:FloatNoUnitType">
        <xs:element name="Imaginary" type="fsx:FloatNoUnitType">
    </xs:sequence>
    <xs:attribute name="number" type="xs:integer">
</xs:complexType>
<xs:simpleType name="CounterType">
    <xs:restriction base="xs:integer">
        <xs:minInclusive value="0"/>
    </xs:restriction>
</xs:simpleType>
<xs:complexType name="OperatorType">
    <xs:sequence>
        <xs:element name="Agency" type="xs:string">
        <xs:element name="Contact" type="fsx:PersonType" minOccurs="0" maxOccurs=
↪"unbounded"/>
        <xs:element name="WebSite" type="xs:anyURI" minOccurs="0">
    </xs:sequence>
</xs:complexType>
<xs:complexType name="PersonType">
    <xs:sequence>
```

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```
        <xs:element name="Name" type="xs:string" minOccurs="0" maxOccurs="unbounded">
        <xs:element name="Agency" type="xs:string" minOccurs="0" maxOccurs="unbounded">
        <xs:element name="Email" type="fsx:EmailType" minOccurs="0" maxOccurs="unbounded
↪">
        <xs:element name="Phone" type="fsx:PhoneNumberType" minOccurs="0" maxOccurs=
↪"unbounded">
    </xs:sequence>
</xs:complexType>
<xs:complexType name="SiteType">
    <xs:sequence>
        <xs:element name="Name" type="xs:string">
        <xs:element name="Description" type="xs:string" minOccurs="0">
        <xs:element name="Town" type="xs:string" minOccurs="0">
        <xs:element name="County" type="xs:string" minOccurs="0">
        <xs:element name="Region" type="xs:string" minOccurs="0">
        <xs:element name="Country" type="xs:string" minOccurs="0">
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs=
↪"unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##other" processContents="lax"/>
</xs:complexType>
<xs:complexType name="ExternalReferenceType">
    <xs:sequence>
        <xs:element name="URI" type="xs:anyURI">
        <xs:element name="Description" type="xs:string">
    </xs:sequence>
</xs:complexType>
<!-- Simple types -->
<xs:simpleType name="NominalType">
    <xs:restriction base="xs:NMTOKEN">
        <xs:enumeration value="NOMINAL"/>
        <xs:enumeration value="CALCULATED"/>
    </xs:restriction>
</xs:simpleType>
<xs:simpleType name="EmailType">
    <xs:restriction base="xs:string">
        <xs:pattern value="[\w\.\-_]+@[\w\.\-_]+"/>
    </xs:restriction>
</xs:simpleType>
<xs:complexType name="PhoneNumberType">
    <xs:sequence>
        <xs:element name="CountryCode" type="xs:integer" minOccurs="0">
        <xs:element name="AreaCode" type="xs:integer">
        <xs:element name="PhoneNumber">
            <xs:simpleType>
                <xs:restriction base="xs:string">
                    <xs:pattern value="[0-9]+-[0-9]+"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:element>
    </xs:sequence>
    <xs:attribute name="description" type="xs:string" use="optional"/>
```

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```
</xs:complexType>
<xs:simpleType name="RestrictedStatusType">
    <xs:restriction base="xs:NMTOKEN">
        <xs:enumeration value="open"/>
        <xs:enumeration value="closed"/>
        <xs:enumeration value="partial"/>
    </xs:restriction>
</xs:simpleType>
<xs:complexType name="UnitsType">
    <xs:sequence>
        <xs:element name="Name" type="xs:string">
        <xs:element name="Description" type="xs:string" minOccurs="0">
    </xs:sequence>
</xs:complexType>
<xs:complexType name="IdentifierType">
    <xs:simpleContent>
        <xs:extension base="xs:string">
            <xs:attribute name="type" type="xs:string">
            </xs:attribute>
        </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:complexType name="BaseFilterType">
    <xs:sequence>
        <xs:element name="Description" type="xs:string" minOccurs="0">
        <xs:element name="InputUnits" type="fsx:UnitsType">
        <xs:element name="OutputUnits" type="fsx:UnitsType">
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs=
↪"unbounded"/>
    </xs:sequence>
    <xs:attribute name="resourceId" type="xs:string">
    <xs:attribute name="name" type="xs:string">
    <xs:anyAttribute namespace="##other" processContents="lax"/>
</xs:complexType>
<xs:complexType name="ResponseType">
    <xs:sequence>
        <xs:choice minOccurs="0">
            <xs:element name="InstrumentSensitivity" type="fsx:SensitivityType"␣
↪minOccurs="0">
            <xs:element name="InstrumentPolynomial" type="fsx:PolynomialType" minOccurs=
↪"0">
        </xs:choice>
        <xs:element name="Stage" type="fsx:ResponseStageType" minOccurs="0"
            maxOccurs="unbounded">
        </xs:element>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs=
↪"unbounded"/>
    </xs:sequence>
    <xs:attribute name="resourceId" type="xs:string">
    <xs:anyAttribute namespace="##other" processContents="lax"/>
</xs:complexType>
<xs:complexType name="DataAvailabilityExtentType">
```

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```
    <xs:attribute name="start" type="xs:dateTime" use="required">
    <xs:attribute name="end" type="xs:dateTime" use="required">
    <xs:anyAttribute namespace="##other" processContents="lax"/>
</xs:complexType>
<xs:complexType name="DataAvailabilitySpanType">
    <xs:attribute name="start" type="xs:dateTime" use="required">
    <xs:attribute name="end" type="xs:dateTime" use="required">
    <xs:attribute name="numberSegments" type="xs:integer" use="required">
    <xs:attribute name="maximumTimeTear" type="xs:decimal" use="optional">
    <xs:anyAttribute namespace="##other" processContents="lax"/>
</xs:complexType>
<xs:complexType name="DataAvailabilityType">
    <xs:sequence>
        <xs:element name="Extent" type="fsx:DataAvailabilityExtentType" minOccurs="0"/>
        <xs:element name="Span" type="fsx:DataAvailabilitySpanType" minOccurs="0"␣
↪maxOccurs="unbounded"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs=
↪"unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##other" processContents="lax"/>
</xs:complexType>
```

## 5.4 Comparison with AROL/YASMINE

The goals and technologies of obsinfo are similar to those found in YASMINE and the format of the Atomic Response Object Library (AROL) files used by YASMINE is the very similar to that of the Datalogger, Sensor and Preamplifier files (and underlying `filter` files) used by obsinfo. The major differences are: - obsinfo is a completely file-based solution, designed for processing large

> sets of similar instruments. Yasmine is a GUI (YASMINE_EDITOR) or a command-line interface (YASMINE_CLI) to modify existing StationXML files. obsinfo is thus best compared with a combination of YASMINE_EDITOR (to create a base StationXML file for a given configuration), followed by YASMINE_CLI (to enter station-specific modifications to this configuration)

- obsinfo holds its configuration information inside the instrument component (DataLogger, PreAmplifier, Sensor) files, whereas AROL has a file for each configuration and uses an accompanying configuration file to choose between them
- obsinfo adds processing and ocean-bottom seismology specific fields, to facilitate the notation and correction for clock problems such as drift and leap-seconds.
- obsinfo uses `instrumentation`` files to represent specific OBSs
- obsinfo uses `network` files to control all this

The YASMINE Commmand-line interface (_YASMINE_CLI)

### 5.4.1 Nomenclature

We use the term “InstrumentComponent” for Dataloggers, Preamplifiers and Sensors.

### 5.4.2 AROL verus obsinfo configuration methods

Let’s compare the AROL implementation of a Nanometrics Taurus datalogger with that of obsinfo. My AROL example comes from gitlab/RESIF/AROL/sources/Dataloggers.

The AROL configuration file is called *nanometrics.yaml* and includes Centaur, Taurus and .. dataloggers. For brevity, I only include the Taurus loggers:

```
mandatory_filters: [digitizer_manufacturer, digitizer_model, sampling_rate]

filters:
  - name: Digitizer manufacturer
    code: digitizer_manufacturer
    help: Select the manufacturer of your digitizer

  - name: Digitizer model
    code: digitizer_model
    help: Select the model of your digitizer

  - name: Version
    code: digitizer_version
    help: Select the version of digitizer you have

  - name: DC removal on/off
    code: dc_removal
    help: Is DC removal filter activated or not

  - name: Samples per seconds
    code: sampling_rate
    help: Select the sampling rate for this channel

  - name: Frontend gain
    code: preamplifier_gain
    help: Select the preamplifier gain (frontend)

responses:
  - path: nanometrics/TAURUS-G-1.response.yaml
    applicable_filters:
      digitizer_manufacturer: Nanometrics
      digitizer_model:  Taurus
      preamplifier_gain: Gain 1 (1x - 0dB - 16Vpp)

  - path: nanometrics/TAURUS-G-04.response.yaml
    applicable_filters:
      digitizer_manufacturer: Nanometrics
      digitizer_model:  Taurus
      preamplifier_gain: Gain 0.4 (0.4x - 0dB - 40Vpp)

  - path: nanometrics/TAURUS-G-2.response.yaml
```

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```
    applicable_filters:
      digitizer_manufacturer: Nanometrics
      digitizer_model:  Taurus
      preamplifier_gain: Gain 2 (1x - 0dB - 8Vpp)

  - path: nanometrics/TAURUS.10.response.yaml
    applicable_filters:
      digitizer_manufacturer: Nanometrics
      digitizer_model: Taurus
      sampling_rate: 10 sps

  - path: nanometrics/TAURUS.40.response.yaml
    applicable_filters:
      digitizer_manufacturer: Nanometrics
      digitizer_model: Taurus
      sampling_rate: 40 sps

  - path: nanometrics/TAURUS.50.response.yaml
    applicable_filters:
      digitizer_manufacturer: Nanometrics
      digitizer_model: Taurus
      sampling_rate: 50 sps

  - path: nanometrics/TAURUS.100.response.yaml
    applicable_filters:
      digitizer_manufacturer: Nanometrics
      digitizer_model: Taurus
      sampling_rate: 100 sps

  - path: nanometrics/TAURUS.200.response.yaml
    applicable_filters:
      digitizer_manufacturer: Nanometrics
      digitizer_model: Taurus
      sampling_rate: 200 sps

  - path: nanometrics/TAURUS.250.response.yaml
    applicable_filters:
      digitizer_manufacturer: Nanometrics
      digitizer_model: Taurus
      sampling_rate: 250 sps
```

and a few examples of the AROL response files are:

### nanometrics/TAURUS-G-1.response.yaml

```
---
format_version: '0.106'
response:
  decimation_info:
    correction: true
  stages:
    - input_units:
        name: V
        description: Volts
      output_units:
        name: V
        description: Volts
      gain:
        value: 1.0
        frequency: 0.0
      filter:
        type: ANALOG
      name: ' AMPLIFIER_FILTER'
      delay: 0.0
extras:
  DBIRD_response_type: THEORETICAL
  Number_of_zeroes: '0'
  Number_of_poles: '0'
notes:
  - '#   Diviseur par 1 en preampli'
  - 'Response_type                      : THEORETICAL   # optionel'
  - 'Input_unit                         : V             # optionel'
  - 'Output_unit                        : V             # optionel'
  - 'Transfer_normalization_frequency   : 0             # optionel'
```

### nanometrics/TAURUS-G-2.response.yaml

```
---
format_version: '0.106'
response:
  decimation_info:
    correction: true
  stages:
    - input_units:
        name: V
        description: Volts
      output_units:
        name: V
        description: Volts
      gain:
        value: 2.0
        frequency: 0.0
      filter:
        type: ANALOG
```

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```
      name: ' AMPLIFIER_FILTER'
      delay: 0.0
extras:
  DBIRD_response_type: THEORETICAL
  Number_of_zeroes: '0'
  Number_of_poles: '0'
notes:
  - '#   Diviseur par 1 en preampli'
  - 'Response_type                        : THEORETICAL   # optionel'
  - 'Input_unit                           : V             # optionel'
  - 'Output_unit                          : V             # optionel'
  - 'Transfer_normalization_frequency     : 0             # optionel'
```

### nanometrics/TAURUS-G-04.response.yaml

```
---
format_version: '0.106'
response:
  decimation_info:
    correction: true
  stages:
    - input_units:
        name: V
        description: Volts
      output_units:
        name: V
        description: Volts
      gain:
        value: 0.4
        frequency: 0.0
      filter:
        type: ANALOG
      name: ' AMPLIFIER_FILTER'
      delay: 0.0
extras:
  DBIRD_response_type: THEORETICAL
  Number_of_zeroes: '0'
  Number_of_poles: '0'
notes:
  - '#   Diviseur par 1 en preampli'
  - 'Response_type                        : THEORETICAL   # optionel'
  - 'Input_unit                           : V             # optionel'
  - 'Output_unit                          : V             # optionel'
  - 'Transfer_normalization_frequency     : 0             # optionel'
```

### nanometrics/TAURUS.100.response.yaml

```
---
format_version: '0.106'
response:
  decimation_info:
    correction: true
  stages:
    - input_units: &id001
        name: V
        description: Volts
      output_units: &id002
        name: counts
        description: Digital Counts
      gain:
        value: 1000012.875
        frequency: 0.0
      filter:
        type: AD_CONVERSION
        input_full_scale: "16.777"
        output_full_scale: "16777216.000000"
      name: ' DIGITIZER'
      input_sample_rate: 0.0
      output_sample_rate: 30000.000300000003
      delay: 0.0
    - input_units: *id002
      output_units: *id002
      filter:
        $ref: include/tau_FirSym2_s1_100.filter.yaml#filter
      name: ' DECIMATION'
      input_sample_rate: 30000.000300000003
      output_sample_rate: 2000.0
      delay: 0.0
      decimation_factor: 15
    - input_units: *id002
      output_units: *id002
      filter:
        $ref: include/tau_FirSym2_s2_100.filter.yaml#filter
      name: ' DECIMATION'
      input_sample_rate: 2000.0
      output_sample_rate: 200.0
      delay: 0.0
      decimation_factor: 10
    - input_units: *id002
      output_units: *id002
      filter:
        $ref: include/tau_FirSym2_s3_100.filter.yaml#filter
      name: ' DECIMATION'
      input_sample_rate: 200.0
      output_sample_rate: 100.0
      delay: 0.0
      decimation_factor: 2
extras:
```

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```
  DBIRD_response_type: "THEORETICAL"
  Output_sampling_interval: '1.0000000e-02'
notes:
  - '# Generated by G. Cougoulat LGIT '
  - '# On: 10/25/2010'
  - "Response_name                          : DIGITIZER# optionnel"
  - "Response_type                          : THEORETICAL# optionnel"
  - "Input_sampling_interval                : 0# optionnel "
  - "Output_sampling_interval               : 3.3333333e-05# (= 5.10^-4 / 15)  "
  - "Input_full_scale                       : 16.777# 16.777 Vpp , gain = 1"
  - "Output_full_scale                      : 16777216.000000# 2^24 "
  - "Sensitivity                            : 1000012.875# 1\xB5v"
  - '# stage 1 decimation par 15'
  - "Response_name                          : DECIMATION# optionnel"
  - "Response_type                          : THEORETICAL# optionnel"
  - "Input_sampling_interval                : 3.3333333e-05# 3.0000000e-04# ~ 30000\
    \ / 15 = "
  - "Output_sampling_interval               : 5.0000000e-04# 2.0000000e-03# optionnel"
  - '# stage 2 decimation par 10'
  - "Response_name                          : DECIMATION# optionnel"
  - "Response_type                          : THEORETICAL# optionnel"
  - "Input_sampling_interval                : 5.0000000e-04# 2.0000000e-03"
  - "Output_sampling_interval               : 5.0000000e-03# 2.0000000e-02# optionnel"
  - '# stage 3 decimation par 2'
  - "Response_name                          : DECIMATION# optionnel"
  - "Response_type                          : THEORETICAL# optionnel"
  - "Input_sampling_interval                : 5.0000000e-03#2.0000000e-02"
  - "Output_sampling_interval               : 1.0000000e-02# optionnel"
```

### nanometrics/TAURUS.200.response.yaml

```
---
format_version: '0.106'
response:
  decimation_info:
    correction: true
  stages:
    - input_units: &id001
        name: V
        description: Volts
      output_units: &id002
        name: counts
        description: Digital Counts
      gain:
        value: 1048576.0
        frequency: 0.0
      filter:
        type: AD_CONVERSION
        input_full_scale: "16.0"
        output_full_scale: "16777216.000000"
```

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```
      name: ' DIGITIZER'
      input_sample_rate: 0.0
      output_sample_rate: 30000.000300000003
      delay: 0.0
    - input_units: *id002
      output_units: *id002
      filter:
        $ref: include/tau_FirSym2_s1_200.filter.yaml#filter
      name: ' DECIMATION'
      input_sample_rate: 30000.000300000003
      output_sample_rate: 2000.0
      delay: 0.0
      decimation_factor: 15
    - input_units: *id002
      output_units: *id002
      filter:
        $ref: include/tau_FirSym2_s2_200.filter.yaml#filter
      name: ' DECIMATION'
      input_sample_rate: 2000.0
      output_sample_rate: 400.0
      delay: 0.0
      decimation_factor: 5
    - input_units: *id002
      output_units: *id002
      filter:
        $ref: include/tau_FirSym2_s3_200.filter.yaml#filter
      name: ' DECIMATION'
      input_sample_rate: 400.0
      output_sample_rate: 200.0
      delay: 0.0
      decimation_factor: 2
extras:
  DBIRD_response_type: "THEORETICAL"
  Output_sampling_interval: '5.0000000e-03'
notes:
  - '# Generated by G. Cougoulat LGIT '
  - '# On: 10/25/2010'
  - "Response_name                       : DIGITIZER# optionnel"
  - "Response_type                       : THEORETICAL# optionnel"
  - "Input_sampling_interval             : 0# optionnel "
  - "Output_sampling_interval            : 3.3333333e-05# (= 5.10^-4 / 15)  "
  - "Input_full_scale                    : 16.0# 16 Vpp , gain = 1"
  - "Output_full_scale                   : 16777216.000000# 2^24 "
  - "Sensitivity                         : 1048576.0# 1\xB5v"
  - '# stage 1 decimation par 15'
  - "Response_name                       : DECIMATION# optionnel"
  - "Response_type                       : THEORETICAL# optionnel"
  - "Input_sampling_interval             : 3.3333333e-05# 3.0000000e-04# ~ 30000\
    \ / 15 = "
  - "Output_sampling_interval            : 5.0000000e-04# 2.0000000e-03# optionnel"
  - '# stage 2 decimation par 5'
  - "Response_name                       : DECIMATION# optionnel"
```

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```
- "Response_type                      : THEORETICAL# optionnel"
- "Input_sampling_interval            : 5.0000000e-04# 2.0000000e-03"
- "Output_sampling_interval           : 2.5000000e-03# 2.0000000e-02# optionnel"
- '# stage 3 decimation par 2'
- "Response_name                      : DECIMATION# optionnel"
- "Response_type                      : THEORETICAL# optionnel"
- "Input_sampling_interval            : 2.5000000e-03#2.0000000e-02"
- "Output_sampling_interval           : 5.0000000e-03# optionnel"
```

In `obsinfo`, we would have 2 choices for implementing the two choices here: sampling rate and gain: 1) put the gain into a "preamplifier" file and the "sampling rate" into a

`datalogger` file

2) put both in a `datalogger` file

The second is more complicated but also easier to directly translate from AROL and expandable to other configuration dimensions such as the choice between minimum phase and linear phase filtering, or the implementation of a DC removal filter. We show this option below.

First, we would break the different `stages` into their own files:

tau_DIGITIZER.100.stage.yaml .. code-block:: yaml

— format_version: '0.110' stage:

- **input_units: &id001** name: V description: Volts

  **output_units: &id002** name: counts description: Digital Counts

  **gain:** value: 1000012.875 frequency: 0.0

  **filter:** type: AD_CONVERSION input_full_scale: "16.777" output_full_scale: "16777216.000000"

  name: ' DIGITIZER' input_sample_rate: 0.0 output_sample_rate: 30000.000300000003 delay: 0.0

tau_DIGITIZER.200.stage.yaml .. code-block:: yaml

— format_version: '0.110' stage:

- **input_units: &id001** name: V description: Volts

  **output_units: &id002** name: counts description: Digital Counts

  **gain:** value: 1000012.875 frequency: 0.0

  **filter:** type: AD_CONVERSION input_full_scale: "16.777" output_full_scale: "16777216.000000"

  name: ' DIGITIZER' input_sample_rate: 0.0 output_sample_rate: 30000.000300000003 delay: 0.0

tau_FirSym2_s1_100.stage.yaml .. code-block:: yaml

— format_version: '0.110' stage:

- **input_units: *id002** name: counts description: Digital Counts

  **output_units: *id002** name: counts description: Digital Counts

  **filter:** $ref: include/tau_FirSym2_s1_100.filter.yaml#filter

  name: ' DECIMATION' delay: 0.0 decimation_factor: 15

tau_FirSym2_s2_100.stage.yaml .. code-block:: yaml

— format_version: '0.110' stage:

- **input_units: *id002** name: counts description: Digital Counts

  **output_units: *id002** name: counts description: Digital Counts

  **filter:** $ref: include/tau_FirSym2_s2_100.filter.yaml#filter

  name: ' DECIMATION' delay: 0.0 decimation_factor: 10

tau_FirSym2_s3_100.stage.yaml .. code-block:: yaml

— format_version: '0.110' stage:

- **input_units: *id002** name: counts description: Digital Counts

  **output_units: *id002** name: counts description: Digital Counts

  **filter:** $ref: include/tau_FirSym2_s3_100.filter.yaml#filter

  name: ' DECIMATION' delay: 0.0 decimation_factor: 2

Notice that we lost the sampling rates and had to specify the units in each file rather than using YAML anchors. Here is the modified 100 sps datalogger file:

```yaml
---
format_version: '0.110'
datalogger:
  sample_rate: 100
  correction: true
  stages:
    - {$ref: 'tau_DIGITIZER.stage.yaml#stage'}
    - {$ref: 'tau_FirSym2_s1.stage.yaml#stage'}
    - {$ref: 'tau_FirSym2_s2.stage.yaml#stage'}
    - {$ref: 'tau_FirSym2_s3.stage.yaml#stage'}
```

This file is ALMOST AROL-compatible, except that

- the output `sample_rate` is specified
- *response* is renamed `datalogger` and can include `equipment` (where is this in AROL?)
- *stages* is renamed *stages* (change in v0.111?).
- *correction* is not under *decimation_info* (change in v0.111?)

Many of these differences come from our "flattening" of the StationXML *Response*, should we move back for compatibility?

We can add one of the gains as well, here before the digitizer:

```yaml
---
format_version: '0.110'
datalogger:
  sample_rate: 100
  correction: true
  stages:
    - {$ref: "TAURUS-G-1.response.yaml#response/stage"}
    - {$ref: 'tau_DIGITIZER.stage.yaml#stage'}
    - {$ref: 'tau_DIGITIZER.stage.yaml#stage'}
    - {$ref: 'tau_FirSym2_s1.stage.yaml#stage'}
```

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```
    - {$ref: 'tau_FirSym2_s2.stage.yaml#stage'}
    - {$ref: 'tau_FirSym2_s3.stage.yaml#stage'}
```

Now, putting configurations inside the `Datalogger` file we have:

```
---
format_version: '0.110'
datalogger:
  sample_rate: 100
  correction: true
  stages:
    - {$ref: "TAURUS-G-1.response.yaml#response/stage"}
    - {$ref: 'tau_DIGITIZER.stage.yaml#stage'}
    - {$ref: 'tau_DIGITIZER.stage.yaml#stage'}
    - {$ref: 'tau_FirSym2_s1.stage.yaml#stage'}
    - {$ref: 'tau_FirSym2_s2.stage.yaml#stage'}
    - {$ref: 'tau_FirSym2_s3.stage.yaml#stage'}
  configuration_default: '100sps_G1'
  configuration_definitions:
    "100sps_G1":
        configuration_description: "100 sps, gain=1"
    "100sps_G2":
        configuration_description: "100 sps, gain=2"
        stages:
          - {$ref: "TAURUS-G-2.response.yaml#response/stage"}
          - {$ref: 'tau_DIGITIZER.100.stage.yaml#stage'}
          - {$ref: 'tau_FirSym2_s1_100.stage.yaml#stage'}
          - {$ref: 'tau_FirSym2_s2_100.stage.yaml#stage'}
          - {$ref: 'tau_FirSym2_s3_100.stage.yaml#stage'}
    "100sps_G04":
         configuration_description: "100 sps, gain=0.4"
         stages:
          - {$ref: "TAURUS-G-04.response.yaml#response/stage"}
          - {$ref: 'tau_DIGITIZER.100.stage.yaml#stage'}
          - {$ref: 'tau_FirSym2_s1_100.stage.yaml#stage'}
          - {$ref: 'tau_FirSym2_s2_100.stage.yaml#stage'}
          - {$ref: 'tau_FirSym2_s3_100.stage.yaml#stage'}
    "200sps_G1":
        sample_rate: 200
        configuration_description: "200 sps, gain=1"
         stages:
          - {$ref: "TAURUS-G-1.response.yaml#response/stage"}
          - {$ref: 'tau_DIGITIZER.200.stage.yaml#stage'}
          - {$ref: 'tau_FirSym2_s1_200.stage.yaml#stage'}
          - {$ref: 'tau_FirSym2_s2_200.stage.yaml#stage'}
          - {$ref: 'tau_FirSym2_s3_200.stage.yaml#stage'}
    "200sps_G2":
        sample_rate: 200
        configuration_description: "200 sps, gain=2"
         stages:
          - {$ref: "TAURUS-G-2.response.yaml#response/stage"}
          - {$ref: 'tau_DIGITIZER.200.stage.yaml#stage'}
```

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```
            - {$ref: 'tau_FirSym2_s1_200.stage.yaml#stage'}
            - {$ref: 'tau_FirSym2_s2_200.stage.yaml#stage'}
            - {$ref: 'tau_FirSym2_s3_200.stage.yaml#stage'}
      "200sps_G04":
          sample_rate: 200
          configuration_description: "200 sps, gain=0.4"
           stages:
            - {$ref: "TAURUS-G-04.response.yaml#response/stage"}
            - {$ref: 'tau_DIGITIZER.200.stage.yaml#stage'}
            - {$ref: 'tau_FirSym2_s1_200.stage.yaml#stage'}
            - {$ref: 'tau_FirSym2_s2_200.stage.yaml#stage'}
            - {$ref: 'tau_FirSym2_s3_200.stage.yaml#stage'}
extras:
   DBIRD_response_type: "THEORETICAL"
   Output_sampling_interval: '1.0000000e-02'
```

This is not the best example, as the Taurus appears to use different FIRs for each sampling rate: in many cases we can further reduce repetion by giving the same FIRs for different sampling rates, simply adding FIRs to account for the different sampling rates (e.g. CS5321 converters) or having a different sampling rate for the first stage (e.g. AD128* converters). One of the advantages is that we only specify a given FIR (or IIR) sequence once in the hierarchy

### 5.4.3 Converting obsinfo files to AROL

This should be fairly straightforward via a program that "explodes" an InstrumentCompoennt file into individual files and an AROL-style configuration file.

### 5.4.4 Converting AROL files to obsinfo

It may be possible to write a routine that combines a given set of files into an obsinfo file with different configurations, although there would be much repetition in this file.

### 5.4.5 Directly using AROL files in obsinfo

For now, this is not directly possible because of the lack of configuration information in the AROL InstrumentComponent files. See below for converting AROL files to obsinfo

Another, more complicated option would be to allow obsinfo to read AROL-style configuration files (`$arol` operator instead of `$ref`?), but the top-level configuration would have to allow several fields for the configuration

## 5.5 Examples

Examples of information files, from the most basic to the most complete.

### 5.5.1 Basic - two channel

Here is an example of a valid information file containing only required fields, all in one file. To save space, this is a two-channel instrument. Generally, to save space and avoid repetition, information files are split into parts connected by JSON references: in the next secton you will find the same information as below, but spit into "atomic" files.

The file below can be found in obsinfo/_examples/Information_Files/subnetworks/EXAMPLE_essential_noRefs.subnetwork.yaml

```yaml
---
format_version: "0.111"
revision:
    authors:
        - names: ["Wayne Crawford"]
          agencies: ["IPGP", "CNRS"]
          emails: ["crawford@ipgp.fr"]
          phones:  ["+33 01 83 95 76 63"]
          date: "2019-12-19"
subnetwork:
    operators:
        - agency: "INSU-IPGP OBS operator"
          contacts:
              -
                  names: ["Wayne Crawford"]
                  emails: ["crawford@ipgp.fr", "parc-obs@services.cnrs.fr"]
                  phones: ["+33 (0)6 51 51 10 54"]
              -
                  names: ["Romuald Daniel"]
          website: "http://parc-obs.insu.cnrs.fr"
    network:
        code: "4G"
        name: "EMSO-AZORES"
        start_date: "2007-07-01"
        end_date: "2025-12-31"
        description: "Local seismological network around the summit of Lucky Strike␣
↪volcano"
        comments:
            - "Lucky Strike Volcano, North Mid-Atlantic Ridge"
    stations:
        "BB_1":
            site: "My favorite site"
            start_date: "2011-04-23T10:00:00"
            end_date: "2011-05-28T15:37:00"
            location_code: "00"
            locations:
                "00":
                    base:
                        depth.m: 0
                        geology: "unknown"
                        vault: "Sea floor"
                        uncertainties.m: {lon: 20, lat: 20, elev: 20}
                        measurement_method: "Short baseline transponder, near-seafloor␣
↪release"
                    position: {lon: -32.234, lat: 37.2806, elev: -1950}
            instrumentation:
```

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```
                base: "INSU_BBOBS"
                configuration: "SN07"
                modifications:
                    datalogger: {configuration: "62.5sps"}
            processing:
                - clock_correction_linear:
                        base:
                            instrument: "Seascan MCXO, ~1e-8 nominal drift"
                            reference: "GNSS"
                            start_sync_instrument: 0
                        start_sync_reference: "2015-04-23T11:20:00"
                        end_sync_reference: "2016-05-27T14:00:00.2450"
                        end_sync_instrument: "2016-05-27T14:00:00"
```

### 5.5.2 Basic atomic - two channel

Here is an example of a the same information as in basic_flat, divided across the standard obsinfo file structure. You can see that there are many fewer lines and less repetition.

The file below can be found in obsinfo/_examples/Information_Files/subnetworks/EXAMPLE_essential.subnetwork.yaml, , with configuration definitions removed for simplicity. To see what configuration definitions can do, see the basic_configuration document. The referenced files are found below obsinfo/_examples/Information_Files/.

```
---
format_version: "0.111"
revision:
    authors:
        - {$ref: "persons/Wayne_Crawford.person.yaml#person"}
    date: "2019-12-19"
subnetwork:
    operators:
        -   {$ref: "operators/INSU-IPGP.operator.yaml#operator"}
    network:
        $ref: "networks/EMSO-AZORES.network.yaml#network"
    stations:
        "BB_1":
            site: "My favorite site"
            start_date: "2011-04-23T10:00:00"
            end_date: "2011-05-28T15:37:00"
            location_code: "00"
            locations:
                "00":
                    base: {$ref: 'location_bases/INSU-IPGP.location_base.yaml#location_
↪base'}
                    configuration: "BUC_DROP"
                    position: {lon: -32.234, lat: 37.2806, elev: -1950}
            instrumentation:
                base: {$ref: "instrumentations/BBOBS1_pre2012.instrumentation_base.yaml
↪#instrumentation_base"}
                configuration: "SN07"
                modifications:
```

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```
                    datalogger: {configuration: "62.5sps"}
            processing:
                - clock_correction_linear:
                      base: {$ref: "timing_bases/Seascan_GNSS.timing_base.yaml#timing_
↪base"}
                      start_sync_reference: "2015-04-23T11:20:00"
                      end_sync_reference: "2016-05-27T14:00:00.2450"
                      end_sync_instrument: "2016-05-27T14:00:00"
```

### 5.5.3 Basic atomic + configuration - two channel

Using the same basic instrumentation as above, here is an example of configuration, which allows us to:

- change instrument components from the default (sensors, preamplifiers, dataloggers)
- modify parameters of one or more instrument components (serial numbers, response stage, datalogger sampling frequency and/or digital filter)

The subnetwork file shown below is found in `Information_Files/subnetwork/EXAMPLE_essential.subnetwork.yaml` and the other information files are found in the `Information_Files` hierarchy

```
---
format_version: "0.111"
revision:
    authors:
        - {$ref: "persons/Wayne_Crawford.person.yaml#person"}
    date: "2019-12-19"
subnetwork:
    operators:
        -   {$ref: "operators/INSU-IPGP.operator.yaml#operator"}
    network:
        $ref: "networks/EMSO-AZORES.network.yaml#network"
    stations:
        "BB_1":
            site: "My favorite site"
            start_date: "2011-04-23T10:00:00"
            end_date: "2011-05-28T15:37:00"
            location_code: "00"
            locations:
                "00":
                    base: {$ref: 'location_bases/INSU-IPGP.location_base.yaml#location_
↪base'}
                    configuration: "BUC_DROP"
                    position: {lon: -32.234, lat: 37.2806, elev: -1950}
            instrumentation:
                base: {$ref: "instrumentation_bases/BBOBS1_pre2012.instrumentation_base.
↪yaml#instrumentation_base"}
                configuration: "SN03"
                datalogger_configuration: "250sps"
            processing:
                - clock_correction_linear:
                      base: {$ref: "timing_bases/Seascan_GNSS.timing_base.yaml#timing_
↪base"}
```

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```
                        start_sync_reference: "2015-04-23T11:20:00"
                        end_sync_reference: "2016-05-27T14:00:00.2450"
                        end_sync_instrument: "2016-05-27T14:00:00"
        "BB_2":
            notes: ["example of deploying with a different sphere"]
            site: "My other favorite site"
            start_date: "2015-04-23T10:00:00Z"
            end_date: "2016-05-28T15:37:00Z"
            location_code: "00"
            locations:
                "00":
                    base: {$ref: 'location_bases/INSU-IPGP.location_base.yaml#location_
↪base'}
                    configuration: "ACOUSTIC_SURVEY"
                    position: {lon: -32.29756, lat: 37.26049, elev: -1887}
            instrumentation:
                base: {$ref: "instrumentation_bases/BBOBS1_2012+.instrumentation_base.
↪yaml#instrumentation_base"}
                configuration: "SN06"
                datalogger_configuration: "125sps"
                channel_modifications:
                    "1-*": {sensor: {configuration: "Sphere08"}}
                    "2-*": {sensor: {configuration: "Sphere08"}}
                    "Z-*": {sensor: {configuration: "Sphere08"}}
                    "H-*": {sensor: {configuration: "5004"}}
            processing:
                - clock_correction_linear:
                        base: {$ref: "timing_bases/Seascan_GNSS.timing_base.yaml#timing_
↪base"}
                        start_sync_reference: "2015-04-22T12:24:00"
                        end_sync_reference: "2016-05-28T15:35:00.3660"
                        end_sync_instrument: "2016-05-28T15:35:02"
```

CHAPTER

SIX

# DATACITE INFORMATION FILES

## 6.1 Introduction

datacite information files are used to allow the principal scientist to provide information for DOI datacite files. The DataCite standard is described at https://schema.datacite.org/meta/kernel-4.3/ and there are some tools for directly creating Datacite files, such as https://github.com/claudiodsf/datacite-metadata-generator

The datacite information files simplify entering values for principal scientists, by proposing a limited but usually sufficient list of fields and values for these fields, as shown below.

One of the simplifications is that only a few identifier schemes are proposed: ORCID for people and ROR or GRID for organizations. To find the ROR URI for your organization, you can go to https://ror.org and search for your organization, or just do a web search on "{your institution} ROR"

The fields provided are:

| Name | # | Type | Description |
|---|---|---|---|
| *title* | 1 | string | Title for the experiment |
| *description* | 1 | string | Description of the experiment |
| *creators* | 1 | list of *Entity* | List of authors (Entity objets), in publication order |
| *subjects* | 1 | list of string | Keywords \| |
| *contributors* | 1 | object | |
| ` data_collectors` | 1 | list of *Entity* | Data collectors not in *creators* (engineers, scientists) |
| ` project_leader` | 0-1 | *Entity* | use only if not the same as the first creator |
| ` project_members` | 0-1 | list of *Entity* | Participants not in *creators* or *data_collectors* |
| *related_identifiers* | 0-1 | list of *RelIdent* | Things like articles, other DOIs, etc |
| *place* | 1 | string | The experiment location |
| *funders* | 0-1 | list of *Funder* | Experiment funders |

### 6.1.1 Entity

describes people or organizations in the lists of creators or contributors:

| Name | # | Type | Description |
|---|---|---|---|
| *name* | 1 | string | "family, given" if Personal name |
| *type* | 0-1 | string | 'Organization', if not a Personal name |
| *identifier* | 0-1 | string | affiliation unique identifier (i.e. 'https://orcid.org/0000-0002-3260-1826') \| |
| *scheme* | 1 | string | identifier scheme, required if *identifier* provided (i.e. 'ORCID') |
| *affiliations* | 0-1 | list | list of affiliations |
| ` name` | 1 | string | affiliation name (i.e 'IPGP') |
| ` identifier` | 0-1 | string | affiliation unique identifier (i.e. 'https:/ror.org/004gzgz66') |
| ` scheme` | 1 | string | identifier scheme, required if *identifier* provided (i.e. 'ROR') |

## 6.1.2 RelIdent

describes related identifiers, such as DOIs and articles

| Name | # | Type | Description |
|---|---|---|---|
| *identifier* | 1 | string | affiliation unique identifier (i.e. 'https://orcid.org/0000-0002-3260-1826') \| |
| *scheme* | 1 | **sc_string_** | identifier scheme |
| *relation* | 1 | **rel_string_** | relation between the identifier and the current datacite: |

An *sc_string* is a string chosen from: ARK arXiv bibcode DOI EAN13 EISSN Handle IGSN ISBN ISSN ISTC LISSN LSID PMID PURL UPC URL URN w3id

A *rel_string* is a string chosen from: IsCitedBy Cites IsSupplementTo IsSupplementedBy IsContinuedBy Continues IsDescribedBy Describes HasMetadata IsMetadataFor HasVersion IsVersionOf IsNewVersionOf IsPreviousVersionOf IsPartOf HasPart IsPublishedIn IsReferencedBy References IsDocumentedBy Documents IsCompiledBy Compiles IsVariantFormOf IsOriginalFormOf IsIdenticalTo IsReviewedBy Reviews IsDerivedFrom IsSourceOf IsRequiredBy Requires IsObsoletedBy Obsoletes

## 6.1.3 Funder

describes funders

Below is an example datacite information file from *_examples/datacite/EMSO-MOMAR_OBS.datacite.yaml*

```
---
format_version: "0.110"
datacite:
    title : EMSO-MOMAR
    description : "Seismology component of a multi-year multidisciplinary
                  geophysical observatory on Lucky Strike volcano,
                  Mid-Atlantic Ridge (37°N, 32°W)"
    creators:
        -   name : Cannat, Mathilde
            identifier: https://orcid.org/0000-0002-5157-8473
            scheme: ORCID
        -   name : Crawford, Wayne
            identifier: https://orcid.org/0000-0002-3260-1826
            scheme: ORCID
        -   name : IPGP Marine Geosciences Team
            type : Organization
            affiliations :
```

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```
                - name: IPGP
                  identifier: https://ror.org/004gzqz66
                  scheme : ROR
    subjects :
        - Mid-ocean ridge volcanos
        - Hydrothermal fields
    dates_collected:  2007-07-18/2022-08-24
    contributors:
        data_collectors:
            -   name: Daniel, Romuald
                affiliations:
                    - name: INSU-IPGP OBS Facility
            -   name: Besancon, Simon
                affiliations:
                    - name: INSU-IPGP OBS Facility
            -   name: INSU-IPGP OBS Facility
                type: Organization
                identifier: "Need to make an ROR for the facility"
                scheme: ROR
        project_members:
            -   name: Bohidar, Soumya
                affiliations:
                -   name: IPGP
    related_identifiers:
        -   identifier: www.doi.org/1234567
            scheme: DOI
            relation: HasMetadata
    place: Lucky Strike volcano, Mid-Atlantic Ridge
    funders:
        -   name: ANR
            identifier: https://ror.org/00rbzpz17
            scheme: ROR
            award_URI: https://anr.fr/Project-ANR-14-CE02-0008
            award_title: "Magma chamber to micro-habitats : dynamics of deep sea
                         hydrothermal ecosystems - LuckyScales"
```

CHAPTER

# SEVEN

# ADVANCED

## 7.1 Base-configuration-modifications

### 7.1.1 Base-configuration-modifications

#### Overview

The full power of **obsinfo** is achieved using the **base-configuration-modifications** protocol. OBS are subject to many variations in configuration, including changes of components in the field. The aim of *obsinfo* is to have a relatively stable database of information files for instrumentation, but also to account for reassembling the in the field instrumentation, substituting stages and even whole components. This must be reflected in the metadata without compromising the stability of the instrumentation database. The way to do this is through the **base-configuration-modifications** nomenclature, which can change *any* attribute in the configuration, down to serial numbers or pole/zeros of filters at the channel level.

The `configuration` element allows pre-configured customization of instrumentation. It is also used to reduce repetition when specifying station locations and clock drifts.

**instrument_components:** `datalogger`, `sensor` and `preamplifier` elements all have the same structure and are specified at the same level. In the following, we refer to them collectively as `instrument_components`

#### Structure

#### Basic

All base-configuration-modifications elements can have these elements:

```
base: <file reference>
configuration: <string>
modifications: <element>
```

Only `base` is required

### Max structure

Here are all the possible elements (you'll never get them all together):

```
base: <file reference>
configuration: <string>
modifications: <element>
channel-modifications: <element>
response-modifications: <element>
<shortcut1>:
...
<shortcutN>:
<non-base1>:
...
<non-baseN>:
```

The order of priority is: `non-base` > `stage_modifications` > `channel-modifications` > `shortcuts` > `modifications` > `configuration` > `base`

only `base` and the <`non-base`> elements (if they exist) are required

### Each element explained

#### base

The `base` element defines the default parameters and optional configurations. It is generally located in another file and has the following structure:

```
<base-element1>: <element>
<base-element2>: <element>
...
configuration_default: <string>
configurations:
    "<CONFIG1>":
        <base-elementX>:
        <base-elementY>:
        ...
        configuration_description: <string>
    "<CONFIG2>":
        ...
    ...
```

The values under the chose configuration will update the same elements in the base definition. This is a safe update: if, for example, a dictionary is entered, but not all of its elements, only the specified elements will be changed. Similarly, if an array is specified, only the corresponding indices will be changed, and only the specified elements within these corresponding indices. This gives a lot of flexibility: for example, if you have a 5-element `stages` array and you specify a 1-element `stages` array in the specified configuration, only the first element will be changed and only those specified subelements will be changed (this is useful for changing gains). Also, if you specify a 7-element `stages` array then two stages will be added, which is useful for dataloggers which have a different number of stages depending on the sampling rate. But, if you are intending to completely wipe out the existing stage information you have to provide a complete stage description, as anything left over will be retained. Also, there is no way to reduce the number of stages, so your default configuration should have the least number of stages possible.

*It would be nice to allow the user to wipe out an existing set of stages, but I don't know how to and keep the possibility of just changing a few values. Also, as there are no ``stage_modifications`` in ``configurations`` (and it would be complicated to add them) I don't know how else to change a single value like "gain" in a single stage*

### `configuration`

Allows you to chose one of the configurations specified in the `base` element

"[config: `configuration_description`]" is appended to the end of:

- `equipment:description` (for `instrumentation`, `sensor`, `preamplifier` and `datalogger`)
- `stage:name`

### `modifications`

The elements in `modifications` override elements specified in `base` . Under `modifications` the user can specify a complete hierarchy down to the lowest level. In general, only the value(s) specified will be modified. So if a "leaf" value is changed, such as gain value, only the gain value for a particular stage will be changed. If you want to replace the entire element, precede the key the character "^". This is useful if you want to swap out a sensor, for example, without risking retaining some of the original sensor's values/configurations. This only works with `channel` sub-elements: `^datalogger`, `^sensor`, `^orientation`, `^preamplifier`, `^identifiers`, `^external_references`, `^comments`, `^extras`

### `<non-base>`

<`non-base`> elements are only specified at the top level, not in the `base`. These are values that we will ALWAYS want to specify in the subnetwork file. They are:

- `location:position`
- `clock_correction_linear:start_sync_reference`
- `clock_correction_linear:end_sync_reference`
- `clock_correction_linear:end_sync_instrument`

### `<shortcut>`

Shortcuts to commonly-changed parameters. Existing shortcuts are:

| Shortcut | Standard |
|---|---|
| `instrumentation:serial_number` | `instrumentation:modifications:equipment:serial_number` |
| `instrumentation:datalogger_configuration` | `instrumentation:modifications:datalogger:configuration` |
| `datalogger:serial_number` | `datalogger:modifications:equipment:serial_number` |
| `sensor:serial_number` | `sensor:modifications:equipment:serial_number` |
| `preamplifier:serial_number` | `preamplifier:modifications:equipment:serial_number` |

### `channel-modifications`

Limit modifications to selected channels. See *channel_modifications* for details.

### `response-modifications`

Limit modifications to selected response stages. See *stage_modifications* for details.

## elements using base-configuration-modifications

Here is a list of each element using the **base-configuration-modifications** structure, each with its required or particular top-level elements (the always-available but optional `configuration` and `modification` elements are not shown):

- `instrumentation`

```
instrumentation:
    base: <instrumentation_base file>
    serial_number: <str>            # shortcut
    datalogger_configuration: <str>  # shortcut
    channel-modifications: <element>
```

- instrument_component (`datalogger`, `sensor`, or `preamplifier`)

```
instrument_component:
    base: <instrument_component_base file>
    serial_number: <str>           # shortcut
    response-modifications: <element>
```

- `stage`

```
stage:
    base: <stage_base file>
```

- `locations`

```
locations:
    <location_code>:
        base: <location_base file>
        position: {lat: <float>, lon: <float>, elev: <float>} # <non-base>
    <location_code>:
        ...
```

- `clock_correction_linear``

```
clock_correction_linear:
    base: <timing_base file>
    start_sync_reference: <ISOtime string>     # <non-base>
    end_sync_reference: <ISOtime string>       # <non-base>
    end_sync_instrument: <ISOtime string>      # <non-base>
```

### Multi-level, multi-stage elements

#### Level-based priority

The `instrumentation` element has `instrument_components` as sub-elements, which themselves have `stages` as sub-elements. Elements specified at a higher level override those at a lower level (`instrumentation` > `instrument_components` > `stage`). A higher-level `configuration` will not override lower-level `modifications`, so be sparing in the use of modifications at the `instrument_components` and `stage` levels. A higher-level `base` will cancel all lower-level `configuration` and `modifications`, as those were set for another `base`

#### Channel_modifications

The element `channel_modifications` is used to select a channel or channels upon which to apply modificiations.

#### Specifying the channel to change

Channel identification is performed by an orientation-location code of the form:

```
"<orientation code>-<location code>"
```

For example,

```
"Z-02"
```

The orientation codes are defined as in the FDSN standard. If the location code is omitted, a location code of “00” is assumed. You can select all channels using “*” (although you could simply use `modifications` for this):

| Code | Result |
|---|---|
| `*` or `*-*` | All channels |
| `*-00` | All orientations with location “00” |
| `H-*` | Channel with orientation code H and all locations |
| `H` | Channel with orientation code H and location “00” |
| `1-01` | Channel with orientation code 1 and location “01” |

Orientation-location codes have priorities. The more specific code takes precedence over the less specific code, and the orientation code specification takes precedence over the location code specification. For example, if `*-*` and `1-01` are specified, `1-01` takes precedence for channels with orientation code `1` and location code `01`. And if `*-00` and `H-*` are specified, `H-*` takes precedence for channels with orientation code `H`.

#### Specifying an element to change

The elements under a given **orientation-location code** can be:

- `datalogger`
- `sensor`
- `preamplifier`
- `orientation`

The first three allow you to change elements of one of these instrument components, and/or the entire instrument component, while `orientation` lets you change the orientation.

The first three can be filled with any valid entities of their parent entity, plus any of following keywords:

- `base`: replaces the instrument component before applying the other entities.
- `configuration`: applies the configuration specified in the instrument component's `configurations` field
- `modifications`, within which you can speficy a change to any subelement
- `serial_number`, a shortcut for `{modifications:  equipment:  {serial_number:  }}`.
- `stage_modifications`, which allow you to change parameters in individual stages

For example, if you want to specify the sensor's serial number you could enter:

```
sensor:
    modifications:
        equipment: {serial_number: 'A1542'}
```

or

```
sensor:
    serial_number: 'A1542'
```

If you do both, the shortcut will overwrite the long version and you should get a warning.

If you want to change the type of sensor, specify its serial number and use a custom configuration, you could enter:

```
sensor:
    base: {$ref: 'sensors/T240.nanometrics.sensor.yaml#sensor'}
    configuration: "SINGLE-SIDED"
    serial_number: '235'
```

### stage_modifications

Since stages have no name, they are referenced by their number, which specifies the order of the stage (starting at 1) within a given instrument component (`sensor`, `preamplifier`` or `datalogger`). Modifications to stages are specified using the keyword `stage_modifications`.

If we want to change the gain the third stage of the sensor, the hierarchy would look like this:

```
channel_modifications:
   "H-00":
        sensor:
            stage_modifications:
              "2": {gain: {value: 17}}
```

If we wanted to replace all of the response stages, the file would look like this:

```
channel_modifications:
   "H-00":
        datalogger:
            stages:
               - $ref: "responses/CS5321_FIR1.stage.yaml#stage"
               - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
```

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```
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR3.stage.yaml#stage"
```

Response modifications are very flexible. The label can be any of several regular expressions. Either a single number, as above, a list, a range or the wildcard "*". Again, you could just use `modifications` instead of `stage_modifications:"*"`, although the `stage_modifications` version is higher priority.

| Stage Number | Result |
|---|---|
| * | All stages |
| [1,3] | Stages 1 and 3 |
| [1-4] | Stages 1, 2, 3 and 4 |

### 7.1.2 Abstract examples

The following examples don't use real _obsinfo_ structures, but their simplicity may help you to understand the basic concepts.

#### Priority levels

```
base:
    param1: 'A'
    param2: 'A'
    param3: 'A'
    param4: 'A'
    param5: 'A'
    configuration_default: 'CONFIGA'
    configuration_definitions:
        'CONFIGA':
            configuration-description: "The standard configuration"
        'CONFIGB':
            configuration-description: "The B definition"
            param1: 'B'
            param2: 'B'
configuration: "CONFIGB"
modifications:
    param2: 'C'
    param3: 'C'
```

will return :

```
param1: 'B'
param2: 'C'
param3: 'C'
param4: 'A'
param5: 'A'
```

because the configuration `CONFIGB` overrides the base values of `param1` and `param2`, then the modifications `param2` and `param3` override the result.

### Only specified sub-elements are changed

```
base:
    param1:
        sub-param1: 'A'
        sub-param2: 'A'
modifications:
    param1: {sub_param1: 'C'}
```

will return:

```
param1:
    sub-param1: 'C'
    sub-param2: 'A'
```

and so on for deeper levels.

### Multi-level priorities

#### Modifications > configuration > base priority

```
base:
    paramA1:
        base:
            paramB1: 'A'
            paramB2: 'A'
            configuration_default: 'CONFIGX'
            configuration_definitions:
                'CONFIGX':
                    configuration-description: "The standard configuration"
                'CONFIGY':
                    configuration-description: "The Y definition"
                    paramB1: 'D'
                    paramB2: 'D'
                'CONFIGZ':
                    configuration-description: "The Z definition"
                    paramB1: 'E'
                    paramB2: 'E'
        configuration: "CONFIGY"
        modifications:
            paramB2: 'C'
    paramA2: 'A'
    configuration_default: 'CONFIGA'
    configuration_definitions:
        'CONFIGA':
            configuration-description: "The standard configuration"
        'CONFIGB':
            configuration-description: "The B definition"
            paramA1:
                paramB1: 'B'
            paramA2: 'B'
configuration: "CONFIGB"
```

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```
modifications:
    paramA1:
        configuration: 'CONFIGZ'
        paramB2: 'F'
    paramA2: 'C'
```

will return :

```
paramA1:
    paramB1: 'E'
    paramB2: 'F'
paramA2: 'C'
```

because the top-level configuration of paramA1 ("CONFIGZ") overrides the lower level configuration ('CONFIGY')a nd in turn overriden by the modification of paramB2 at the same level. This looks complicated, but it is much clearer in a typical information file, since each base definition is in a seperate file.:

```
base:  {$ref: "higher_level_base.yaml#higher_level_base"}
configuration: "CONFIGB"
modifications:
    paramA1:
        configuration: 'CONFIGZ'
        paramB2: 'F'
    paramA2: 'C'
```

and so we immediately see what is changed from the values in the base specification files

#### stage_modifications > channel_modifications > modifications

#### As complicated as it gets

Here should be multi-level example with channel-modifications and response-modifications.

Point out that this is much more complicated than anyone will see because the lower levels are in separate files.

### 7.1.3 Concrete examples

#### Specifying a datalogger's sampling rate

base configuration in the datalogger_base file

```
datalogger_base:
    equipment:
        model: "CS5321/22"
        type: "delta-sigma A/D converter + digital filter"
        description: "CS5321/22 A/D converter + digital filter"
        manufacturer: "Cirrus Logic"
        vendor: "various"
    configuration_default: "125sps"
    stages:
        - {base: {$ref: "dataloggers/stages/CS5321_FIR1.stage_base.yaml#stage_base"}}
```

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```
        - {base: {$ref: "dataloggers/stages/CS5322_FIR2.stage_base.yaml#stage_base"}}
        - {base: {$ref: "dataloggers/stages/CS5322_FIR2.stage_base.yaml#stage_base"}}
        - {base: {$ref: "dataloggers/stages/CS5322_FIR2.stage_base.yaml#stage_base"}}
        - {base: {$ref: "dataloggers/stages/CS5322_FIR2.stage_base.yaml#stage_base"}}
        - {base: {$ref: "dataloggers/stages/CS5322_FIR2.stage_base.yaml#stage_base"}}
        - {base: {$ref: "dataloggers/stages/CS5322_FIR2.stage_base.yaml#stage_base"}}
        - {base: {$ref: "dataloggers/stages/CS5322_FIR2.stage_base.yaml#stage_base"}}
        - {base: {$ref: "dataloggers/stages/CS5322_FIR3.stage_base.yaml#stage_base"}}
    sample_rate: 125
    correction: 0.232
    configurations:
        "125sps":
            configuration_description: "125 sps"
        "250sps":
            configuration_description: "250 sps"
            sample_rate: 250
            correction: 0.116
            stages:
                - {base: {$ref: "dataloggers/stages/CS5321_FIR1.stage_base.yaml#stage_
↪base"}}
                - {base: {$ref: "dataloggers/stages/CS5322_FIR2.stage_base.yaml#stage_
↪base"}}
                - {base: {$ref: "dataloggers/stages/CS5322_FIR2.stage_base.yaml#stage_
↪base"}}
                - {base: {$ref: "dataloggers/stages/CS5322_FIR2.stage_base.yaml#stage_
↪base"}}
                - {base: {$ref: "dataloggers/stages/CS5322_FIR2.stage_base.yaml#stage_
↪base"}}
                - {base: {$ref: "dataloggers/stages/CS5322_FIR2.stage_base.yaml#stage_
↪base"}}
                - {base: {$ref: "dataloggers/stages/CS5322_FIR2.stage_base.yaml#stage_
↪base"}}
                - {base: {$ref: "dataloggers/stages/CS5322_FIR3.stage_base.yaml#stage_
↪base"}}
        "500sps":
            configuration_description: "500 sps"
            sample_rate: 500
            correction: 0.058
            stages:
                - {base: {$ref: "dataloggers/stages/CS5321_FIR1.stage_base.yaml#stage_
↪base"}}
                - {base: {$ref: "dataloggers/stages/CS5322_FIR2.stage_base.yaml#stage_
↪base"}}
                - {base: {$ref: "dataloggers/stages/CS5322_FIR2.stage_base.yaml#stage_
↪base"}}
                - {base: {$ref: "dataloggers/stages/CS5322_FIR2.stage_base.yaml#stage_
↪base"}}
                - {base: {$ref: "dataloggers/stages/CS5322_FIR2.stage_base.yaml#stage_
↪base"}}
                - {base: {$ref: "dataloggers/stages/CS5322_FIR2.stage_base.yaml#stage_
↪base"}}
                - {base: {$ref: "dataloggers/stages/CS5322_FIR3.stage_base.yaml#stage_
↪base"}}
```

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```
```

Instantiation in the `subnetwork` file, (drilling through the `instrumentation` to the `datalogger`):

```
...
stations:
    <STATION1>:
        ...
        instrumentation:
            base: {$ref: "my_instrumentation.instrumentation.yaml"}
            datalogger_configuration: "500sps"
```

**Note 1:** There is almost nothing specified for the “125sps” configuration because it is the default. For schema testing purposes, the base_level description must include all required parameters, so there’s no point repeating them in the configuration definition.

**Note 2:** The text in the configuration description will be added to the `equipment:description` field, which will become (for the default configuration): “CS5321/22 A/D converter + digital filter [config: 125 sps]”

**Note 3:** If no “configuration_description” is provided, the configuration name will be added to the `equipment:description`

### Locations

base configuration in a `location_base` file

```
---
...
location_base:
    depth.m: 0
    geology: "unknown"
    vault: "Sea floor"
    uncertainties.m: {lon: 200, lat: 200, elev: 20}
    measurement_method: "Sea surface release point"
    configuration_default: "SEA_SURFACE"
    configurations:
        "SEA_SURFACE":
            configuration_description: "Standard sea-surface deployment"
        "MAYOBS_SEA_SURFACE":
            configuration_description: "Sea-surface deployment offshore Mayotte"
            measurement_method: "Sea surface release point"
            uncertainties.m: {lon: 300, lat: 300, elev: 20}
        "ACOUSTIC_SURVEY":
            uncertainties.m: {lon: 5, lat: 5, elev: 10}
            measurement_method: "Acoustic survey"
        "AIRGUN_SURVEY":
            uncertainties.m: {lon: 40, lat: 40, elev: 40}
            measurement_method: "Airgun survey"
            notes: ["Uncertainty will generally be least along-line"]
        "BUC_DIRECT":
            uncertainties.m: {lon: 5, lat: 5, elev: 10}
            measurement_method: "Short baseline transponder, seafloor release"
        "BUC_DROP":
```

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```
            uncertainties.m: {lon: 20, lat: 20, elev: 20}
            measurement_method: "Short baseline transponder, near-seafloor release"`
```

Instantiation in the subnetwork file

```
---
...
subnetwork:
    ...
    stations:
        "LSVW":
            ...
            locations:
                "00":
                    base: {$ref: 'location_bases/INSU-IPGP.location_base.yaml#location_
↪base'}
                    configuration: "SURFACE_DROP"
                    position: {lon: -32.32504, lat: 37.29744, elev: -2030}
        "LSVE":
            ...
            locations:
                "00":
                    base: {$ref: 'location_bases/INSU-IPGP.location_base.yaml#location_
↪base'}
                    configuration: "ACOUSTIC_SURVEY"
                    position: {lon: -32.02504, lat: 37.25744, elev: -2130}
```

### Clock drift

base configuration in a timing_base file named Seascan_GNSS.timing_base.yaml

```
---
...
timing_base:
    instrument: "Seascan MCXO, ~1e-8 nominal drift"
    reference: "GNSS"
    start_sync_instrument: 0
```

Instantiation in a subnetwork file

```
---
...
subnetwork:
    ...
    stations:
        "LSVW":
            ...
            processing:
                - clock_correction_linear:
                    base: {$ref: "timing_bases/Seascan_GNSS.timing_base.yaml#timing_base
↪"}
```

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```
                    start_sync_reference: "2015-04-21T21:06:00Z"
                    end_sync_reference: "2016-05-28T20:59:00.32Z"
                    end_sync_instrument: "2016-05-28T20:59:03Z"
        "LSVE":
            ...
            processing:
                - clock_correction_linear:
                    base: {$ref: "timing_bases/Seascan_GNSS.timing_base.yaml#timing_base
↪"}
                    start_sync_reference: "2015-04-21T22:00:00Z"
                    end_sync_reference: "2016-05-29T20:59:59.32Z"
                    end_sync_instrument: "2016-05-30T21:00:00Z"
```

### Changing a sensor

using `channel_modifications` to change the type of hydrophone on the '*H' channel:

```
...
stations:
    <STATION1>:
        ...
        instrumentation:
            base: {$ref: "my_instrumentation.instrumentation.yaml"}
            channel-modifications:
                '*H':
                    sensor:
                        base: {$ref: "my_other_sensor.sensor_base.yaml"}
                        serial_number: "H424B"
```

### Chained configurations

In this example, the preamplifier `configurations` affect the `configuration` of the stages beneath them

The preamplifier_base definition:

```
...
preamplifier_base:
    equipment:
        model: "HYDRO-GAIN"
        type: "Analog gain/filter card"
        description: "SIO gain/filter card, hydro channel"
        manufacturer: "SIO or IPGP"
        vendor: ""
    configuration_default: "64x gain"
    stages:
        - {base: {$ref: "preamplifiers/stages/Scripps_SPOBS_HydroL22_theoretical.stage_
↪base.yaml#stage_base"}}
    configurations:
        "16x gain":
            stages: [{configuration: "16x"}]
```

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```
        "32x gain":
            stages: [{configuration: "32x"}]
        "64x gain":
            stages: [{configuration: "64x"}]
        "128x gain":
            stages: [{configuration: "128x"}]
```

the stage_base definition `Scripps_SPOBS_HydroL22_theoretical.stage.yaml`

```
---
...
stage_base:
    description : "PREAMPLIFIER: SPOBS hydrophone or L22"
    input_units : {name: "V", description: "VOLTS"}
    output_units : {name: "V", description: "VOLTS"}
    gain: {value: 64, frequency: 10}
    filter :
        type : "PolesZeros"
        transfer_function_type: "LAPLACE (RADIANS/SECOND)"
        zeros : ['0 + 0j']
        poles : ['-6.667 + 0j']
    delay: 0
    configuration_default: "64x"
    configurations:
        "64x":
            gain: {value: 64, frequency: 10}
        "32x":
            gain: {value: 32, frequency: 10}
        "16x":
            gain: {value: 16, frequency: 10}
        "128x":
            gain: {value: 128, frequency: 10}
```

Instantiation in the `subnetwork file` configuring the preamplifier to “64x gain”:

```
---
...
stations:
    <STATION1>:
        ...
        instrumentation:
            base: {$ref: "my_instrumentation.instrumentation.yaml"}
            datalogger_configuration: "500sps"
            channel_modifications:
                '*-*': {datalogger: {serial_number: "0145"}}
                'H-*': {preamplifier: {configuration: "64x gain"}}
```

### Setting a custom value from the `subnetwork` file

You could force the gain of one stage to a non-configured value (1000 in this example), as follows:

```
---
...
stations:
    <STATION1>:
        ...
        instrumentation:
            base: {$ref: "my_instrumentation.instrumentation.yaml"}
            datalogger_configuration: "500sps"
            channel_modifications:
                '*-*': {datalogger: {serial_number: "0145"}}
                '*H':
                    preamplifier:
                        stage_modifications:
                            "0": {gain: {value: 1000}}}
```

### A complete network file with channel_modifications:

```
---
format_version: "0.111"
revision:
   authors:
       - {$ref: "authors/Wayne_Crawford.author.yaml#author"}
   date: "2019-12-19"
subnetwork:
   network:
       $ref: "network/EMSO-MOMAR.network.yaml#network"
   operators:
       -
           agency: "INSU-IPGP OBS Park"
           contacts:
               -
                   names: ["Wayne Crawford"]
                   emails:  ["crawford@ipgp.fr"]
           website:  "http://ipgp.fr"
   reference_names:
       operator: "INSU-IPGP"
       campaign: "MYCAMPAIGN"
   stations:
       "BB_1":
           site: "My favorite site"
           start_date: "2015-04-23T10:00:00"
           end_date: "2016-05-28T15:37:00"
           location_code: "00"
           instrumentation:
               base: {$ref: "instrumentation/BBOBS1_2012+.instrumentation_base.yaml
↪#instrumentation_base"}
               channel_modifications:
                   "*-*": {datalogger: {configuration: "62.5sps"}}
```

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```
            locations:
                "00":
                    base: {$ref: 'location_bases/INSU-IPGP.location_base.yaml#location_
↪base'}
                    configuration: "BUC_DROP"
                    position: {lon: -32.234, lat: 37.2806, elev: -1950}
            processing:
                - clock_correct_linear_drift:
                    base: {$ref: 'timing_bases/SEASCAN_GNSS.timing_base.yaml#timing_base'}
                    start_sync_reference: "2015-04-23T11:20:00"
                    end_sync_reference: "2016-05-27T14:00:00.2450"
                    end_sync_instrument: "22016-05-27T14:00:00"
        "BB_2":
            notes: ["An example of changing the sensor"]
            site: "My other favorite site"
            start_date: "2015-04-23T10:00:00Z"
            end_date: "2016-05-28T15:37:00Z"
            location_code: "00"
            instrumentation:
                base: {$ref: "instrumentation/BBOBS1_2012+.instrumentation_base.yaml
↪#instrumentation_base"}
                channel_modifications:
                   "*-*":
                    sensor: {configuration: "Sphere06"}
                    datalogger: {configuration: "62.5sps"}
                   "H-*":
                      sensor:
                        serial_number: "IP007"
                        stage_modifications:
                          "3": {gain: {value: 15}}
            locations:
                "00":
                    base: {$ref: 'location_bases/INSU-IPGP.location_base.yaml#location_
↪base'}
                    configuration: "ACOUSTIC_SURVEY"
                    position: {lon: -32.29756, lat: 37.26049, elev: -1887}
            processing:
                - clock_correct_linear_drift:
                    base: {$ref: 'timing_bases/SEASCAN_GNSS.timing_base.yaml#timing_base'}
                    start_sync_reference: "2015-04-22T12:24:00"
                    end_sync_reference: "2016-05-28T15:35:00.3660"
                    end_sync_instrument: "2016-05-28T15:35:02"
                    modifications:
                        start_sync_instrument: "2015-04-22T12:24:01"
                    notes: "The instrument clock was incorrectly synced at the start"
```

## 7.2 AROL compatibility

One of the objectives of *obsinfo* is to be compatible with the AROL instrumentation database. AROL is a yaml-based instrumentation database which can be explored through the Yasmine application. Its syntax is heavily based on version v0.106 of *obsinfo*. Efforts are underway to make the syntax of the current version of *obsinfo* and of AROL be as close as possible. However, since the philosophy is somewhat different, some discrepancies will be inevitable. AROL builds a configuration out of user choices made with the Yasmine tool. *obsinfo* lists all available configurations and lets the user choose using the configuration fields (`sensor_configuration`, `preamplifier_configuration`, `datalogger_configuration`) in a station or network information file.

The current effort is to make AROL yaml files readable by *obsinfo*. However, there are some outstanding issues:

1. AROL does not have an offset field in its filter information files. It has a field called `delay.samples` which fulfills the same function. Proposed solution: let AROL change name. If not possible, read the AROL file and change within the *obsinfo* application.
2. AROL uses `units` instead of `transfer_function_type` in Pole/Zero filters. Their value is directly translatable, via a table, to the `transfer_function_type` enumeration used by StationXML (see table below). Proposed solution: let AROL change names. If not possible, read the AROL file and change within the *obsinfo* application.

| AROL unit | obsinfo/StationXML equivalent |
|---|---|
| “rad/s” | “LAPLACE (RADIANS/SECOND)” |
| “hz” | “LAPLACE (HERTZ)” |
| “z-transform” | “DIGITAL (Z-TRANSFORM)” |

3. AROL names of “fake” filters ANALOG, DIGITAL and AD_CONVERSION are in CamelCase in *obsinfo*: Analog, Digital, ADConversion to be consistent with StationXML. **Proposed solution**: let AROL change name. If not possible, read the AROL file and change within the *obsinfo* application.
4. AROL specifies both `input_sample_rate` and `output_sample_rate` for all stages. *obsinfo* only specifies the input sample rate for the first stage in the whole instrument. It calculates all the other values out of decimation factors. This gives more flexibility to the definition of each individual stage in the `stages` field of an information file. **Proposed solution**: read the AROL file and ignore these fields within the *obsinfo* application.
5. AROL specifies response stages thus:

```
response:
  decimation_info:
    correction: true
  stages:
```

   *obsinfo* simply specifies `stages` and the `correction` attribute is specified at the `datalogger` level, as it is the only place where it makes sense for the global instrument. Also, `correction` is specified as either boolean in AROL or as a real number. In *obsinfo* a value of `None` is equivalent to AROL `False` and a numeric value is equivalent to AROL `True`. **Proposed solution**: make *obsinfo* read the AROL file and interpret this attribute. If found in a response other than the datalogger, give a warning and ignore.

## 7.3 Best practices

### 7.3.1 Place instrumentation information files in a central repository

One of the main pillars of *obsinfo* philosophy is reuse and the DRY (don't repeat yourself) principle. In order to achieve this every effort has been made to ensure reusability, but the ultimate responsibiity for this lies with the user. It is strongly recommended to create a central repository of instrumentation information files which can then be reused by several campaigns. Instrumentations should be flexible enough, with several typical configurations, so the need to make modifications through `channel_modifications` is minimized.

The use of a central repository will also permit information to be protected assigning modification writes only to the responsible parties.

Campaign, network and station files can then be placed in different directories according to users and teams.

### 7.3.2 Use a file hierarchy for different objects

Although *obsinfo* gives you total flexibility to organize your files as you see fit, it is recommended to use a hierarchy of directories and the `obsinfo_datapath` variable setup with the `obsinfo-setup` application, whose used is explained in the *Installation and Startup Guide*.

### 7.3.3 Validate all information files bottom up

Before trying to create a Station XML file, all information files should be validated individually. The best way to do this is to proceed bottom up: first validate filters, then stages, then components, then instrumentations, then networks. This way one can avoid very large output messages which are difficult to parse.

Files in central repositories should never be uploaded unless they're previously validated. Conversely, users can assume they don't have any need to validate central repositories.

### 7.3.4 Verification of `stages` in information file

All files in central repositories must be validated before being uploaded. It is good practice to validate your files from the bottom up. That is, validate filter files first, stage next, and so on to network, unless you're using (already verified) central repository files. This is to avoid long and unreadable messages from the validator.

### 7.3.5 Reuse information files

Either create a repository of your own or use one of the central repository. If you plan on working offline, you can clone the GitLab repository locally.

### 7.3.6 Document information files with notes, extras and comments

A choice of documentation options are available in information files. Aside of the "#" comment mechanism of the YAML language, `notes` are used for *obsinfo* documentation that will **not** be reflected in the resulting StationXML file. On the other hand, `comments` can be used at the `network`, `station` and `channel` levels which will be incorporated into the StationXML file. The reason to not extend this to `stage` and `filter` is that the resulting StationXML file would be cluttered with repeated comments. Similarly, at the same levels, `extras` can be specified. These take the form of key/value pairs to simulate attributes which are not actually present in StationXML but can be used for documentation. A typical example is:

```
DBIRD_response_type : "CALIBRATED"
```

which is used in several filters. It should be specified at the channel level, though, perhaps specifying to which filters it applies.

### 7.3.7 Placement of `stages` in information file

Although `stages` can be specified outside the `configuration_definitions`, this is discouraged unless there is a single configuration. If there are several configurations, `stages` should be specified in the `configuration_definitions`. Nevertheless, if `stages` is specified outside and there are several `configuration_definitions`, the one selected will overwrite the `stages`. If no configuration is specified, the `stages` outside will be used.

In the following example, "responses/INSU_BBOBS_gain0.225_theoretical.stage.yaml" will *always* be overwritten by "responses/INSU_SPOBS_L28x128_theoretical.stage.yaml#stage", as there is a configuration default which corresponds to the configuration definition "128x gain".

```
preamplifier:
    equipment:
        model: "GEOPHONE-GAIN"
        type: "Analog gain/filter card"
        description: "SIO gain/filter card, seismo channel"
        manufacturer: "SIO or IPGP"
        vendor: ""
    configuration_default: "128x gain"
    stages:
        - $ref: "responses/INSU_BBOBS_gain0.225_theoretical.stage.yaml#stage" # THIS␣
↪WILL BE OVERWRITTEN
    configuration_definitions:
        "128x gain":
            stages:
               - $ref: "responses/INSU_SPOBS_L28x128_theoretical.stage.yaml#stage"
```

Due to this, the best practice dictates that, in the presence of `configuration_definitions`, the `stages` in bold should be omitted. If `configuration_default` were not present and no configuration is selected at the channel/instrument level, a warning will be issued and the `stages` in bold will be used. If no response stages can be selected then an exception will be raised and the program will exit with error.

```

```

The following example, though, is perfectly OK, as there is a single configuration and no need to specify `configuration_definitions`:

**preamplifier:**

**equipment:** model: "GEOPHONE-GAIN" type: "Analog gain/filter card" description: "SIO gain/filter card, seismo channel" manufacturer: "SIO or IPGP" vendor: ""

**stages:**

- $ref: "responses/INSU_BBOBS_gain0.225_theoretical.stage.yaml#stage"

### 7.3.8 How to modify individual stages

Individual stage modification must always be specified in `stage_modifications` at the instrument component level. This will NOT work:

```
preamplifier:
   {$ref: "preamplifiers/LCHEAPO_BBOBS.preamplifier.yaml#preamplifier"}
   gain:
      value: 34
```

This will:

```
preamplifier:
   {$ref: "preamplifiers/LCHEAPO_BBOBS.preamplifier.yaml#preamplifier"}
   stage_modifications:
      "*": gain:
             value: 34
```

### 7.3.9 Use of channel modifications

It should be the aim to create a large and flexible instrumentation database with lots of possible configurations. This way, channel modifications will be rarely used. In fact, it is recommended to use channel modifications sparingly. If they must be used, remember to **always** use the adequate syntax. No shortcuts are allowed. All the hierarchical syntax must be used. For example, to change the gain of a sensor stage you need to write:

```
channel_modifications:
   sensor:
       {$ref: "sensors/SIO_DPG.sensor.yaml#sensor"}
       stage_modifications:
         "*": gain:
                value: 34
```

and not a shortcut such as:

```
channel_modifications:
   gain:
     value: 34
```

as there is no way *obsinfo* can determine to which stage of which component to apply the modification in gain.

### 7.3.10 How to use notes

There is a single `notes` attribute in JSON/YAML files, which contains a list of notes, in order to make documentation more systematic. However, sometimes a user may want to comment a piece of the file (for example, a single station in a network file). To do so we recommend using the YAML notation for comments, "#" followed by the comment text. Currently there is no way to do this in JSON files.

### 7.3.11 Base your info files in templates

While syntax may be a challenge, we recommend strongly that, when starting a new information file, you use a template. That way at least you can guarantee that the indentation and spelling of attributes is right.

## 7.4 Notes

### 7.4.1 Date formats

Dates can be entered in regular "dd/mm/yyyy" format or in UTC format, either "yyyy-mm-dd" or "yyyy-mm-ddThh:mm:ss" or "yyyy-mm-ddThh:mm:ssZ", according to norm ISO 8601. The difference between the latter two formats is that the first represents local time and the second UTC time. The norm allows you to specify hours respective to UTC by adding or subtracting. This particular format is not allowed in *obsinfo*. Separators can be either "/" or "-".

Dates in other formats will result in an exception.

No effort is made to validate if dates are legal, i.e., to reject dates such as "31/02/2021".

## 7.5 Caveats

### 7.5.1 Caveat: Effect of `$ref`

In every case, the use of `$ref` is to totally substitute that line by the content referenced in the file path (under the "#" tag). It is completely equivalent to write the content of referenced file instead of the `$ref` line. This should be taken into account for syntax purposes. If syntax is not validated, a very good chance is that the `$ref` file syntax is either wrong or in the wrong place. Not finding the file also causes problems which are not evident at first glance; if you keep getting errors, check if the file is in the right place.

### 7.5.2 Caveat: Cryptic syntax messages

Unfortunately, the JSON/YAML parser is very terse reporting syntax errors such as unmatched parentheses, brackets or curly brackets, single items instead of lists, etc., usually result in an exception with a cryptic message. It is *strongly* recommended that YAML files are edited in a suitable editor which can check at least basic syntax errors. See also the Troubleshooting section below.

### 7.5.3 Caveat: Use of response stages

Although response stages are specified at the component (sensor, preamplifier and datalogger) level, in the end they are considered as a single response for the whole instrument. Response stages are taken in this order: sensor stages, preamplifier stages and datalogger stages, irrespective of the order in which components appear in the information file. Within a component, they are taken in the order specified in the information file. In the end, they are numbered from one to *n* for the whole response.

### 7.5.4 Caveat: Treatment of sample rates in response stages

Only the input sample rate should be specified for a response, starting in the ADConversion stage. All other input and output rate are calculated using the decimation factor of each digital stage. Therefore, `input_sample_rate` and `output_sample_rate` should never be specified for later digital stages, and decimation factor should *always* be specified for them.

Total sample rate is calculated for the whole response and checked against the sample rate specified in the datalogger. A warning will be issued if they are different.

### 7.5.5 Caveat: ALWAYS follow the syntax and beware of $ref overwriting your attributes

A naïve approach to syntax might think that we can add fields, for example, to a $ref information file. For example, the file could be an instrumentation file and we could decide to add a datalogger configuration which is not present in the file:

..block-code:: yaml

> **instrumentation:** "$ref" : "instrumentations/BBOBS1_2012+.instrumentation.yaml" datalogger_config: "62.5sps"

This is wrong. First, it is the wrong syntax: what channel with the configuration be applied to? There is no indication of that. Remember: modifications should always follow the same syntax. If `datalogger_config` belongs under a channel, it should always be applied to a channel.

But there is another problem. "$ref" will substitute all attributes at the same level, thus erasing the attribute `datalogger_config`. If this happens it will be a silent error, since substitution occurs before validation and the application will never know `datalogger_config` was there. The correct way of applying `datalogger_config` is through `channel_modifications` at the station level.

## 7.6 Troubleshooting

Sometimes it is a challenge to understand where an error lies in an information file. Messages are sometimes cryptic. We recommend you use the best practice above of using templates to avoid indentation errors. Also, if you can, use the best practice of working with an editor which recognizes elementary YAML errors such as indentation or wrong parentheses balancing. Let's review the most common sources of error:

1) `JSONEncodeError/EOF`. An error which raises a JSONEncodeError exception and/or `EOF (end of file) reached prematurely`. This is the most serious error, as it stops processing of the information file and exits the program. It is usually due to:

a) Indentation

b) Unmatched double or single quotes, parentheses, brackets, curly brackets

c) Extra commas or not enough commas

Check for these, if possible, with an editor which shows matching signs. Use templates if possible. If everything else fails, try to reduce the information file to a bare bones version, see if the error persists. If it doesn't, add new attributes gradually. For example, a network file might have this kind of problem. Temporarily eliminate attributes such as `channel_modifications` and reduce the network to a single station.

2) `File not found: <filename>`. <filename> has not been found. Either the directory where the file exists is not correctly specified in the path of the argument or in OBSINFO-DATAPATH, or the <filename> is misspelled or the file does not exist. This is typical for files referenced in `$ref`.

3) Validation error: `<YAML expression> is not valid under any of the given schemas`. This means that the information file is recognized and correctly parsed, but the portion <YAML expression> is not recognized. This may be due to illegal values, illegal value type (e.g. a string instead of a number, or a string pattern which does not correspond to valid patterns. An example is the wrong version:

```
['format_version']: '0.107' is not valid under any of the given schemas
```

or a phone number with letters:

```
['revision']: {'date': '2017-11-30', 'authors': [{'first_name': 'Wayne', 'last_name':
↪'Crawford', 'institution': 'IPGP', 'email': 'crawford@ipgp.fr', 'phones': ['+33A 01 83␣
↪95 76 63'}]]} is not valid under any of the given schemas.
```

or a string instead of a list (in the phones attribute):

```
['revision']: {'date': '2017-11-30', 'authors': [{'first_name': 'Wayne', 'last_name':
↪'Crawford', 'institution': 'IPGP', 'email': 'crawford@ipgp.fr', 'phones': '+33A 01 83␣
↪95 76 63'}]} is not valid under any of the given schemas
```

One possibility with validation errors is that the output of the message may be too long and difficult to parse, as it shows the whole produced information files with all its subfiles. The way to avoid this is to apply the best practice of validation bottom-up: first validate filters, then stages, then components, then instrumentations, then networks. This way the output is manageable.

4) Validation error: `Additional properties are not allowed (<attribute name> was unexpected)` An attribute name was not recognized, either because it was misspelled or because it does not exist in the specification.

```
['network']['operator']: Additional properties are not allowed ('fulsdl_name' was␣
↪unexpected)
```

5) Validation error: `<attribute name> is a required property` A required attribute name was not included.

```
['network']['operator']: 'reference_name' is a required property
```

## 7.7 Addons

If you want to add codes allowing you to make scripts according to your needs, use the *obsinfo/addons/* directory. Existing classes/executables in this directory are:

- LCHEAPO: Go from SIO LC2000 data files to basic miniSEED.
- SDPCHAIN: Go from basic miniSEED to datacenter-ready data
- LC2SDS: Generate basic clock-corrected SDS data archives.
- OCA:

### 7.7.1 LCHEAPO

Creates scripts to generate miniSEED data from SIO LC2000 data files. miniSEED files are deliberately NOT drift corrected so that that step can be done at a data/metadata preparation 'A-node'

Run through the executable *obsinfo-makescripts-LCHEAPO*

the generated scripts need the *sdpchain* module (not publically available)

### 7.7.2 SDPCHAIN

Makes scripts to to go from basic miniSEED to data center ready

Run through the executable *obsinfo-makescripts-SDPCHAIN*

the generated scripts need the *sdpchain* module (not publically available)

### 7.7.3 LC2SDS

Makes scripts to generate SDS data archives directly from SIO LC2000 data files, including basic clock corrections. To furnish facility users, NOT FDSN/EIDA-level data centers

Runs through the executable *obsinfo-makescripts-LC2SDS*

The generated scripts need the pip-available *lcheapo* module

### 7.7.4 OCA

Just a stub for metadata conversion between *obsinfo* and *OCA* protocols. Never finished.

CHAPTER

# EIGHT

# NOMENCLATURE

Terms that have specific meanings in the **obsinfo** universe

**experiment** the highest level of the experiment-campaign-expedition sequence, it represents all data collected at one region (something like an FDSN network)

**campaign** A data collection campaign, which may consist of one or more expeditions. Each campaign generally represents one group of data that will be sent to a data center

**expedition** One data-collection mission, generally a ship leg for OBS deployments

**element** Anything written as a key in a `key: value` pair in an information file

**key** Must be a string

attribute

parameter

CHAPTER

NINE

# TRAINING COURSE

## 9.1 Introducing obsinfo

### 9.1.1 Philosophy and comparison to other systems

`obsinfo` is a system to create standard seismological metadata files (currently StationXML), as well as processing flows specific to ocean bottom seismometer (OBS) data. It's basic philosophy is:

1) break down every component of the system into "atomic", non-repetitive units.
2) Follow StationXML structure where possible, but:
    a) Add entities missing from StationXML where necessary
    b) Use appropriate units for each component (for example, specifying the `offset` for a digital filter, not the `delay`, which depends on the sampling rate)
3) Allow full specification of a deployment using text files, for repeatability and provenance

#### File formats

#### Compared to StationXML files

- Minimizes repeated information
    - for example, in StationXML
        - Each channel could have the same datalogger but all of the datalogger specifications are repeated for each channel.
        - Within a channel's response itself, several of the stages may be identical (except for the `offset`).
- Eliminate fields that can be calculated from other fields, such as:
    - The `<InstrumentSensitivity>` field, which depends on the `Stage` s that follow
    - The `<Delay>` for a digital filter stage, which can be calculated from `<Offset> * <Factor> / <InputSampleRate>`

#### Compared to RESP files

RESP files (mostly used in the Nominal Reference Library) are just text representations of the Dataless SEED files that preceded the StationXML standard, so they share the repetitive nature of StationXML files and add the complexity of a non-standard text format.

#### Compared to AROL

The Atomic Response Objects Library (AROL) replaces the RESP-based Nominal Response Library in the new YASMINE system. Files use the same atomic concept and YAML structure as `obsinfo`, in fact the AROL format was based on a previous version of obsinfo and we try to keep the two compatible.

AROL lacks the `subnetwork`, `station` and `instrumentation` levels as these are assembled by YASMINE.

#### Metadata creation systems

#### Compared to PDCC

PDCC is a graphical user interface allowing one to assemble different components (sensors, dataloggers, amplifiers) and then add in deployment information. Components can be added from the Nominal Response Library (NRL), which combines RESP files with textual configuration files which allow the user to select the exact component and configuration they used. *obsinfo* uses a fully textual description of instruments and deployments rather than a graphical user interface.

#### Compared to IRIS DMC IRISWS

I don't know much about this, it looks like a webservice to obtain component responses but I'm not sure how you're supposed to assemble them. It might just be a more modern way to access the NRL components that is supposed to be used by newer systems.

#### Compared to YASMINE

YASMINE is a new StationXML metadata creation tool. It's major difference from PDCC is its use of atomic response files, which should be compatible with obsinfo files. It provides a graphical user interface (YASMINE-EDITOR) and a command-line interface (YASMINE-CLI). The major differences from `obsinfo` are the lack of `instrumentation`, `station` and `subnetwork` levels, as well as processing information such as instrument clock drift

### 9.1.2 File formats

All information files can be written in YAML or JSON format. Use whichever you prefer. `YAML` is generally easier to write and read by humans, whereas `JSON` is easier for computers. The tutorial includes a section describing `YAML` files as used in `obsinfo` (tutorial:tutorial-1). There are many sites for converting from one format to the other and for validating either format: including this json-to-yaml-convertor and this yaml-validator.

### 9.1.3 The Tutorial

This training course is meant to accompany an instructor. The tutorial provides a more detailed step-by-step explanation and we refer to sections of the Tutorial throughout this training course.

### 9.1.4 Structural units

A full `obsinfo` subnetwork description consists of the following entities (starred fields are optional):

```
format_version: {}
*revision: {}
*notes: []
subnetwork:
    network: {}
    operators: []
    *restricted_status: <string>
    *comments: []*
    *extras: {}*
    *reference_names: {}
    stations:
        <STATIONNAME1>:
            site: <string>
            start_date: <string>
            end_date: <string>
            locations: {}
            location_code: <string>
            instrumentation:
                base:
                    equipment: {}
                    channels:
                        default:
                            *orientation: <string or {}>
                            datalogger:
                                << GENERIC_COMPONENT
                                *configuration: <string>
                                sample_rate: <number>
                                *correction: <number>
                            *preamplifier:*
                                *<< GENERIC_COMPONENT*
                                *configuration: <string>
                            sensor:
                                << GENERIC_COMPONENT
                                 seed_codes:
                                *configuration: <string>
                            *location_code: <string> # otherwise inherits from station
                            *comments: []
                            *extras: {}
                       <SPECIFIC-CHANNEL1>: {}
                       <SPECIFIC-CHANNEL2>: {}
                       ...
                *serial_number: <string>
                *modifications: {}
```

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```
                *channel_modifications: {}
            *notes: []
            *comments: []
            *operators: []
            *extras: {}
            *processing:
                - *clock_correction_linear: {}
                - *clock_correction_leapsecond: {}
        <STATIONNAME2>:
            ...
```

Where GENERIC_COMPONENT is:

```
equipment: {}
*configuration_default: <string>
*configurations: {}
*stage_modifications: {}
*notes: []
*stages:*
    - stage:
        base:
            input_units: <string>
            output_units <string>
            gain: <number>
            *name: <string>
            *description: <string>
            *decimation_factor: <integer>
            *delay: <number>
            *calibration_date: <string>
            *polarity: '+' or '-'     # default is '+'
            *input_sample_rate: <number>
            *filter:
                type: <string>
                <fields depending on type>
        *configuration: <string>
        *modifications: {}
    - stage:
    - ...
```

And FILTER is:

```
type: <string>  # one of "PolesZeros", "FIR", "Coefficients",
                # "ResponseList", "Polynomial", "ADConversion",
                # "Analog", "Digital"
*description: <string>
*delay.samples: <number>  # for all except "Analog" and "PolesZeros"
*delay.seconds: <number>  # for "Analog" and "PolesZeros"
# other parameters specific to the specified type
```

This could all be in one file, in which case there would be little benefit over StationXML. The power of obsinfo comes from the ability to put any sub-entity into a separate file, which is called from the parent file using the $ref field.

Standard file levels are: subnetwork, instrumentation_base, datalogger_base, preamplifier_base, sensor_base, stage_base and filter. The schema files are defined at these same levels, allowing the command-line tool `obsinfo-validate`` to validate any file ending with {one of the above}.{yaml,json}. Other elements often put into separate files are `author`, `location_base`, `network_info` and `operator`.

A common file structure is then (this time showing only the required fields):

- a subnetwork file:

```
format_version: <string>
subnetwork:
    operators: []
    network: {$ref: networks/xxx.network.yaml#network}
    stations:
        <STATIONNAME1>:
            site: string
            start_date: string
            end_date: string
            location_code: string
            instrumentation:
                base: {$ref: instrumentations/xxx.instrumentation_base.yaml
↪#instrumentation_base}
            locations: {}
       <STATIONNAME2>:
            ...
       <STATIONNAME3>:
            ...
        ...
```

- instrumentation_base files:

```
format_version: <string>
instrumentation_base:
    equipment: {}
    channels:
        default:
            datalogger:  {base: {$ref: dataloggers/xxx.datalogger_base.yaml
↪#datalogger_base}}
            sensor: {base: {$ref: sensors/xxx.sensor.yaml#sensor}}
       <SPECIFIC-CHANNEL1>: {}
       <SPECIFIC-CHANNEL2>: {}
       ...
```

- datalogger_base files:

```
format_version: <string>
datalogger_base:
    << GENERIC_COMPONENT
    sample_rate: float
```

- sensor_base files:

```
format_version: <string>
sensor_base:
    << GENERIC_COMPONENT
    seed_codes:
```

- stage_base files:

```
format_version: <string>
stage_base:
    input_units : {}
    output_units : {}
    gain : {}
    filter :
        type : <string>
```

- filter files:

  There are 5 filter types corresponding directly to their StationXML analogues: `PoleZeros`, `FIR`, `Coefficients`, `ResponseList` and `Polynomials`. 3 other types allow simpler information entry:

  - `Analog`: An analog stage with no filtering (translated to StationXML PoleZero without any poles or zeros)
  - `Digital`: A digital stage with no filtering (translated to StationXML Coefficients stage without any coefficients)
  - `ADConversion`: like an analog stage, plus information about input voltage and output counts limits

  For examples, see `Information_Files/{datalogger, preamplifier, sensor}/stages/filters` `PoleZero` example:

```
---
format_version: "0.111"
filter:
    type: "PolesZeros"
    transfer_function_type: "LAPLACE (RADIANS/SECOND)"
    zeros:
       - '0.0 + 0.0j'
       - '0.0 + 0.0j'
    poles:
       - '19.99 + 19.99j'
       - '19.99 - 19.99j'
```

You don't actually need to put the information in each file under a field with the filetype name: in fact if you didn't you would save a little typing, as you could specify, for example,

```
{$ref: xxx.datalogger_base.yaml}
```

instead of:

```
{$ref: xxx.datalogger_base.yaml#datalogger_base}
```

But the second style is preferred as it allows the files to contain useful provenance and version information at the base level. To incite you to use the second style, `obsinfo-validate` only accepts this style.

### 9.1.5 Comments, notes and extras

Comments and notes are both lists of text.

`comments` will be transformed in to StationXML comments. They can be entered at the `subnetwork`, `station` and `channel` level and will be transformed into StationXML comments at the same level.

`notes` will not go into the StationXML file, they are for your information only. They can be entered at the `base`, `station`, and `component` levels.

`extras` is a free object-based field. It can be used to add fields that may be useful in a future version of obsinfo. Nothing there is put into the StationXML code unless the obsinfo software is specifically updated to do so ( which allows new fields without breaking compatibilty or schema rules). They can be entered at the `subnetwork`, `station` or `channel` level

### 9.1.6 Configurations, channel modifications and shortcuts

**components** can have pre-defined **configurations** and their internal values can be **modified** from higher levels.

The simplest and most common example is specifying each station's sampling rate, which is done as follows:

```
modifications:
    datalogger: {configuration: "125sps"}
```

#### Configurations

**Configurations** modify parameters in a given **component** according to an existing `configuration_definition` in the component's information file.

Allowed fields are:

- `datalogger_configuration`
- `sensor_configuration`
- `preamplifier_configuration`

Configurations can be specified at the following levels, in order of priority:

1) `station:channel_modifications`
2) `instrumentation:channels:{CHNAME}`
3) `instrumentation:channels:default`

Configurations are defined in the the component information files under the `configuration_definition` field.

#### Channel Modifications

`channel_modifications` directly modify one or more parameters in a given element. This gives complete control to the user but assumes knowledge of the obsinfo hierarchy.

Details of `channel_modifications` are provided in the Advanced Topics section advanced/chan_mods

#### Shortcuts

`datalogger_configuration`, `preamplifier_configuration` and `sensor_configuration` are actually **shortcuts** for common `channel_modifications`. **Shortcuts** are hard-coded into obsinfo to allow simpler representation of common configurations or modifications. Other ones may be added, including `XX_serial_number`, where **XX** could be `datalogger`, `sensor`, `preamplifier` or `instrumentation`

#### Other sources

- Channel modifications are described briefly in /tutorial/tutorial-3:channel modifications and in detail in /advanced/chan_mods
- Component configurations are described in /tutorial/tutorial-4:configurations and /tutorial/tutorial-5:configuration definitions and /tutorial/tutorial-6:datalogger configuration definitions

### 9.1.7 Details

- Referenced files referenced are searched for starting at the paths given in the `~/.obsinforc` file

### 9.1.8 delay, offset, and correction

One area where obsinfo differs from StationXML is in its handling of delays in digital filters. StationXML (and RESP) have three parameters in each stage, relating to the time delay created by the stage, in each Stage's Decimation section:

**offset** Sample offset chosen for use. If the first sample is used, set this field to zero. If the second sample, set it to 1, and so forth.

**delay** The estimated pure delay for the stage (in seconds). This value will almost always be positive to indicate a delayed signal.

**correction** The time shift, if any, applied to correct for the delay at this stage. The sign convention used is opposite the <Delay> value; a positive sign here indicates that the trace was corrected to an earlier time to cancel the delay caused by the stage and indicated in the <Delay> element.

StationXML specifies the **delay** for each stage, leaving the offset equal to zero. A digital filter's true delay is in samples, not seconds, meaning that the **delay** will depend on the sampling rate.

obsinfo's atomic philosphy does not allow a variable delay (in seconds) when there is a constant delay (in samples). obsinfo puts `delay` in the `stage` level but `offset` in the filter level. For digital filters, `` offset` should be filled with the delay samples and ``delay `` should not be provided.

### 9.1.9 Details

- Referenced files referenced are searched for starting at the paths given in the `~/.obsinforc` file

### 9.1.10 Command-line files

all of the command line files start with **obsinfo-**, so if you have a decent shell you should be able to see them by typing obsinfo<TAB>

- `obsinfo-makeStationXML` makes stationXML files from an obsinfo subnetwork file and its dependencies
- `obsinfo-validate` validates subnetwork, instrumentation, datalogger, sensor, preamplifier, stage and filter files
- `obsinfo-print`
- `obsinfo-print_version`
- `obsinfo-setup` creates the .obsinforc file and can also create an example database.
- `obsinfo-test` runs a series of validation tests

The different `obsinfo-makescripts-*` command-line scripts are used for making IPGP-specific data processing flows, as described below. They could be used as a basis for creating your own data processing flows.

The directory `obsinfo/obsinfo/addons/` contains programs to create processing scripts using the information in the subnetwork files.

This is addressed in more detail in the training_course/4_advanced module

## 9.2 Setting up

The following are basic steps to install and confirm that everything is working

### 9.2.1 Installation

Note: DOES NOT (YET) WORK IN WINDOWS: use a Mac or Linux computer

- Install obspy using their Conda Installation instructions
- In your obspy environment, install obsinfo by typing `pip install obsinfo`
- type `pip list` to confirm that your version is up-to-date (0.111.1.post5 at least)

More detailed instructions are in the *Installation and Startup Guide*

### 9.2.2 Copy an example database into your own folder

- Create a working directory
- Go in there and run `obsinfo-setup -d DATABASE`

A subfolder named `DATABASE` will be created. Inside is a directory named `Information_Files` and under that are lots of subdirectories with obsinfo information files.

### 9.2.3 Create a StationXML file

Copy one of the network files from the `DATABASE/` directory into your working directory:

```
cp DATABASE/Information_Files/subnetworks/EXAMPLE_essential.subnetwork.yaml .
```

Then run `obsinfo-makeStationXML` on it:

```
obsinfo-makeStationXML EXAMPLE_essential.subnetwork.yaml .
```

A file named "EXAMPLE_essential.station.xml" should be created

### 9.2.4 Test the other command-line codes

Try the following two lines, to make sure that the other command-line codes work:

```
obsinfo-validate EXAMPLE_essential.subnetwork.yaml
obsinfo-print EXAMPLE_essential.subnetwork.yaml
```

## 9.3 Creating a StationXML file using your own instruments and deployments

In each case, use:

- associated example and schema files to help you create the file(s)
- `obsinfo-validate` to validate your file(s)
- `obsinfo-print` for something?
- `obsinfo-makeStationXML` to verify that you can create a StationXML file

### 9.3.1 Creating a network file (using the example instruments)

Create your own network file, using existing instruments in the example_directory.

First-level associated files: `network` Second-level associated files: `author`, `network-info`, `operators`,

`location_bases`

### 9.3.2 Adding your own sensor/datalogger/analog filter

Add and validate sensor, datalogger and/or preamplifier(s) in the example_directory. Modify an example instrumentation file to reference the new compoent(s) and create a StationXML file

**First-level associated files: `datalogger`, `sensor`, `preamplifier`,** `stage`, `filter`

Second-level associated files: `author`

### 9.3.3 Adding your own instrumentation

Create a new instrumentation (OBS), using your newly created components and any other specific information

First-level associated files: `instrumentation` Second-level associated files: `author`, `operators`

### 9.3.4 Putting it all together

Create a network file corresponding to a deployment of your own instruments.

## 9.4 Advanced issues

### 9.4.1 Creating a processing pathway

The directory `obsinfo/obsinfo/addons/` contains programs to create processing scripts using the information in the network files. These scripts depend on the external programs used: `obsinfo` currently has programs for:

| Transformation | file | command line |
|---|---|---|
| LCHEAPO OBS data to miniSEED using the SDPCHAIN tools | LCHEAPO.py | `obsinfo-makescripts_LCHEAPO` |
| uncorrected to corrected miniSEED using the SDPCHAIN tools | SD-PCHAIN.py | `obsinfo-makescripts_SDPCHAIN` |
| LCHEAPO OBS data to (poorly) corrected SDS structure | LS2SDS.py | `obsinfo-makescripts_LC2SDS` |

These probably aren't directly applicable to other OBS facilities, but the files can serve as a basis for your own codes. The command line programs are created using the `console_scripts` parameter in `obsinfo/setup.py`

### 9.4.2 Storing and accessing your instrument database online

I have never done this, Luis discusses it in tutorial/tutorial-3:file-discovery

## 9.5 Future plans

### 9.5.1 obsinfo v0.111

All of this are "issues" on the gitlab site. All will require changes to input files (major change)

#### Replace "network" with "subnetwork"

Avoid confusion with FDSN network, more compatible with concept of multiple facilities/deployments possibly composing an FDSN network

### Bring instrument modifiers under *station:instrumentation*

And allow instrumentation-level configuration by adding `modifications` and `config` fields.

- This could also just be `equipment_modifications` as I think equipment is all that is modified
- `serial_number` is shorthand for ` (`serial_number` is in `equipment`), or maybe keep it as a shorthand for `equipment_modifications {serial_number:  }`: declaring both should be considered an error (can it be done in the schema file?)

**v0.110**

```
instrumentation:
     {$ref: "xxx.instrumentation.yaml"}
serial_number: string
channel_modifications: object
```

**0.111**

```
instrumentation:
    base: {$ref: "xxx.instrumentation.yaml"}
    serial_number: string
    config: string
    modifications: {equipment: object of equipment parameters to change}
    channel_modifications: object
```

or

```
instrumentation:
    base: {$ref: "xxx.instrumentation.yaml"}
    serial_number: string
    config: string
    equipment_modifications: object of equipment parameters to change
    channel_modifications: object
```

### Make "person" fields compatible with StationXML Person

Currently "author", change to "person"

**v0.110**

```
first_name: string
last_name: string
institution: string
email: string
phones: array of strings or [country_code, area_code, phone_number] objects
```

**0.111**

```
name: string
agency: string
email: string
phone: string or [country_code, area_code, phone_number] objects
```

### Make uncertainties into objects with measurement_method

Currently, azimuth.deg and dip.deg are 2-element arrays of number or null, with the first value being the value and the second the uncertainty, e.g.:

```
azimuth.deg: [90, 5]
dip.deg: [0, 1]
```

Change them to be objects with the possible attributes specifed in the **`StationXML Documetation<http://docs.fdsn.org/projects/stationxml/en/latest/reference.html#azimuth>`_**:

```
azimuth: {value.deg: 90, uncert.deg: 5, measurement_method: "Ppol"}
dip: {value.deg: 0, uncert.deg: 1, measurement_method: "Ppol"}
```

only *value.deg* should be required.

Should probably enable this for all fields that are defined as "FloatType" in the 1.1 XML schema:

- *WaterLevel* (units=m)
- *ClockDrift* (units=s?)
- *Response:Amplitude* (no units, specifed elsewhere?)
- *Response:Phase* (units=deg)
- *Response:Frequency* (units=Hz)
- *Decimation:InputSampleRate* (units=Hz)
- *PzTransferFunctionType:NormalizationFrequency* (units=Hz)
- *ApproximationType:FrequencyLowerBound* (units=Hz)
- *ApproximationType:FrequencyUpperBound* (units=Hz)
- *Decimation:Delay* (units=s)
- *Decimation:Correction* (units=s)
- *DipType* (units=deg)
- *Depth* (units=m)
- *SampleRate* (units=sps)

But allow value-only shortcut definitions, in which case *uncert* and *measurement_method* will be set to *null*, for exampe *WaterLevel.m: 0*, *ClockDrift.s: 1e-10* and so on…

*Latitude.deg Longitude.deg* and *Elevation.m* are special cases for which the uncertainties and measurement method can be separately specified, as is currently the case.

Or should I allow a separate _uncert variable for each field, in case they are the same for all instances (would only be inserted if the value was otherwise null)?

Perhaps have special *uncertainties* and *measurement_methods* objects that defined default uncertainties:

```
uncertainties: {lat.m: 100, lon.m: 100, elevation.m: 10}
measurement_methods: {lat: "acoustic survey", lon: "acoustic survey", elevation:
↪"acoustic survey", azimuth: "Ppol"}
```

for which I should probably keep the separation of uncertainties, measurement method and values

### Remove intrumentation:operator field from schema

Already does nothing, but I kept it there to avoid breaking existing files

### Make "operator" conform to StationXML standard

Currently flat:

```
operator:
    reference_name:  # Just for link with campaign file, not StationXML
    full_name:   # Change to "agency"
    contact:    # Currently just a person's name
    phone_number:
    email:
    website:
```

Should be

```
operator:
    reference_name:  # Just for link with campaign file, not StationXML
    agency:
    contact:
        name:
        agency:
        phone_number:
        email:
    website:
```

The contact is a Person type and so can just be loaded from an "author" file (change "authors" to "persons")

### StationXML errors to fix in new version 0.111

The following errors, originally 6.3, 6.4, 8, 9, 10 and 12 in issue #3, will be addressed in v0.111. Most require a new version, because we will need to add a *base* field to the *instrumentation* object in order to bring station serial number and channel_modifications into this object:

1. No Serial Number shown for Station/Equipment
2. **LS5a is listed as 125 sps even though the network file says 62.5 sps**

And the following (possibly derived) errors:

1. Channel

    a) Sensor serial number is given as "32793N" (direct from instrumentation files, doesn't take into account OBS serial number)

2. Preamp/Datalogger/Equipment have no Serial Number

Moreover, I have to decide how to specify instrumentation-level serial numbers and configurations. Should I imitate *channel_modifications* with and *instrumentation_modifications* (or just *modifications*?) field, or should I allow specific common fields such as *serial_number* and *instrumentation_configuration* (or *configuration*)?

Other bugs that I didn't fix in v0.110.12:

1. Channel

    1. Sensor

        1. Has installation date, removal date and three calibration dates, all after expt (Trillium T240)

    2. PreAmplifier

        1. BBOBS gain card description is not specific enough (1x? 0.225x?)

2. No Comment (or field) saying how the station was located
3. Equipment description does not include configuration-specific information (need *configuration_description* field?)

**Should also make all tests work and maybe put my own tests back in**

### Generalize base-configuration-modification

schema files currently have no means to be configured (or modified?).

One solution would be to add to this level.

Another would to allow base, configuration and modification fields at any level: if "base" is specified, then configuration and or modification can be put at the same level.

CHAPTER

TEN

# DEVELOPER'S CORNER

## 10.1 Introduction

### 10.1.1 Python architecture

#### Executables

The following command-line executables perform the main tasks:

- `makeSTATIONXML`: generates StationXML files from a network + instrumentation information files

```
$ python3 makeStationXML -h
```

displays all the options of makeStationXML.

To create a StationXML file from a file called <filename>, type:

```
$ python3 makeStationXML.py [options] filename
```

- `obsinfo-validate`: validates an information file against its schema
- `obsinfo-print`: prints a summary of an information file

The following command-line executables make scripts to run specific data conversion software:

- `obsinfo-make_LCHEAPO_scripts`: Makes scripts to convert LCHEAPO data to miniSEED
- `obsinfo-make_SDPCHAIN_scripts`: Makes scripts to drift correct miniSEED data and package them for FDSN-compatible data centers

#### Package and Modules

The package name is `obsinfo`

`obsinfo.main` contains code to initialize the main obsinfo routine, to read and potentially validate main (network) information file and to write StationXML file

`obsinfo.network` and `obsinfo.instrumentation` contain the main code to process the corresponding information files.

`obsinfo.OBSMetadata` contains code to read and validate information files in either YAML or JSON formats.

`obsinfo.misc` contains miscellaneous code, currently deprecated and unsupported, which is not used anymore in the application

`obspy.addons` contains modules specific to proprietary systems:

- `obspy.addons.LCHEAPO` creates scripts to convert LCHEAPO OBS data to miniSEED using the `lc2ms` software
- `obspy.addons.SDPCHAIN` creates scripts to convert basic miniSEED data to OBS-aware miniSEED using the `SDPCHAIN` software suite
- `obspy.addons.OCA` creates JSON metadata in a format used by the Observatoire de la Cote d'Azur to create StationXML

## Auxiliary subdirectories

### *obsinfo/data/schema*

`data/schema` contains JSON Schema for each file type.

### *obsinfo/_examples/*

Contains example information files and scripts:

- `_examples/Information_Files` contains a complete set of information files
  - `_examples/Information_Files/network` contains **network** files
  - `_examples/Information_Files/instrumentation` contains **instrumentation**, **instrument_components**, **response** and **filter** files.
- `_examples/scripts` contains bash scripts to look at and manipulate these files using the executables. Running these scripts is a good way to make sure your installation works, looking at the files they work on is a good way to start making your own information files.

### *obsinfo/tests/*

Contains test cases and code using `unittest.py`. The tests are performed either on the information files under `test/data` or on `_examples`.

## Comments on versioning

We use standard MAJOR.MINOR.MAINTENANCE version numbering but, while the system is in prerelease:

- MAJOR==0
- MINOR increments every time the information file structure changes in a **non-backwards-compatible** way
- MAINTENANCE increments when the code changes or the file structure changes in a **backwards-compatible** way

## 10.2 Classes

### 10.2.1 Information File Tree

**network |** ***Network***

- network | *FDSNNetwork*
- operator | *Operator*
- **station |** ***Station***
  - **processing |** ***Processing***
    - clock_correct_leap_second | *LeapSecond*
    - clock_correct_linear_drift | *LinearDrift*
  - **location |** ***Location***
    - location_base | *LocationBase*
  - **instrumentation(s) |** ***Instrumentation***
    - equipment | *Equipment*
    - **channel |** ***Channel***
      - ***No label* |** ***Instrument***
        - ***No label* |** ***InstrumentComponent***
          - **sensor |** ***Sensor***
            - seed_codes | *SeedCodes*
          - preamplifier | *Preamplifier*
          - datalogger | *Datalogger*
          - **stages |** ***Stages***
            - stage | *Stage*
            - filter | *Filter*
            - ADConversion | *ADConversion*
            - Analog | *Analog*
            - Coefficients | *Coefficients*
            - Digital | *Digital*
            - FIR | *FIR*
            - PolesZeros | *PolesZeros*
            - ResponseList | *ResponseList*

Names left of the | symbol are as they appear in information files as labels/keys. Names right of the | are the corresponding classes in the object model and the Python implementation of that model. An empty label means the label does not exist in information files but exists as an object model / Python class.

### 10.2.2 Filter Types

- type="ADConversion" | *ADConversion*
- type="Analog" | *Analog*
- type="Coefficients" | *Coefficients*
- type="Digital" | *Digital*
- type="FIR" | *FIR*
- type="PolesZeros" | *PolesZeros*
- type="ResponseList" | *ResponseList*

#### Network

#### Description

An OBS network is a seismological network of stations as part of a campaign *stations* in a given campaign.

#### Python class:

Network

#### YAML / JSON label:

**network** Contained in a network file.

#### Corresponding StationXML structure

Network

#### Object Hierarchy

#### Superclass

*None*

#### Subclasses

*None*

### Relationships

- Gathers one or more *Stations*
- Is part of a Campaign (not implemented in *obsinfo* as a class).

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| network | *FDSNNetwork* | Y | *None* | *None* | |
| operator | *Operator* | Y | *None* | OperatorFDSN | Not required in StationXML |
| stations | Array of *Station* | Y | *None* | StationFDSN | |
| restricted_state | List of values: "open", "closed", "partial", "unknown" | N | *None* | *None* | |

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/network.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

- Part of the network information file https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/network/SPOBS.INSU-IPGP.network.yaml with `station` content elided:

```
---
format_version: "0.107"

 ...

revision:
   authors:
       - $ref: 'authors/Wayne_Crawford.author.yaml#author'
   date: "2017-10-04"
```

**subnetwork:**

**network:** code: "4G" name: "Short period OBSs" start_date: "2007-07-01" end_date: "2025-12-31" description: "Short period OBS network example" comments: ["Lucky Strike Volcano, North Mid-Atlantic Ridge"]

**reference_names:** operator: "INSU-IPGP" campaign: "SPOBS"

operators: [{agency: "INSU-IPGP OBS Park"}] stations:

"LSVW":

…

"LSVE":

...

- Another example: https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/network/BBOBS.INSU-IPGP.network.yaml

### Class Navigation

==> *Station*

==> *FDSNNetwork*

==> *Operator*

### FDSNNetwork

### Description

FDSN network contains specifications compatible with the FDSN standards to describe the *Network*. This class is not actually implemented as such in the Python code, its attributes are assigned in the __init__() method of the Network class.

### Python class:

***None*** These attributes are treated in *Network*.

### YAML / JSON label:

network

### Corresponding StationXML structure

***None*** Individual attributes in this class belong to the Network attribute.

### Object Hierarchy

### Superclass

*None*

### Subclasses

*None*

### Relationships

- Is part of the specification of a *Network*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| code | string | Y | *None* | code | Codes are assigned by FDSN according to this process |
| name | string | Y | *None* | *None* | Will be added as a Comment |
| description | string | Y | *None* | Description | Not required in StationXML |
| comment | string | N | *None* | Comment | |
| start_date | date | Y | *None* | startDate | Not required in StationXML |
| end_date | date | Y | *None* | endDate | Not required in StationXML |

### JSON schema

https://www.gitlab.com/obsinfo/obsinfo/data/schemas/network.schema.json

https://www.gitlab.com/obsinfo/obsinfo/obsinfo/data/schemas/definitions.schema.json

### Example

FDSN Network_info section referred in network information file.

```
network:
       code: "4G"
       name: "Short period OBSs"
       start_date: "2007-07-01"
       end_date: "2025-12-31"
       description: "Short period OBS network example"
       comments: ["Lucky Strike Volcano, North Mid-Atlantic Ridge"]
```

### Class Navigation

*Network* <==

### Operator

#### Description

Operator specifies the operator of the network, corresponding to the operator field in StationXML. It is also copied to the operator field in station in StationXML.

#### Python class:

Operator

#### YAML / JSON label:

operator

#### Corresponding StationXML structure

**Operator** Both in Network and Station.

#### Object Hierarchy

#### Superclass

*None*

#### Subclasses

*None*

#### Relationships

- Is part of a *Network*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| reference_name | string | Y | *None* | Operator. Agency | Operating agency abbreviation |
| full_name | number | Y | *None* | Operator.Contact. Name | Operating agency full name, used in contact name |
| contact_name | number | Y | *None* | Operator.Contact. Name | |
| email | email | Y | *None* | Operator.Contact. Email | Not required in StationXML |
| phone_number | string | N | *None* | Operator.Contact. Phone | |
| website | URL | N | *None* | Operator. WebSite | |

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/network.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

Operator section in network information file https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/network/SPOBS.INSU-IPGP.network.yaml

```
operator:
        reference_name: "INSU-IPGP"
        full_name: "INSU-IPGP OBS Park"
```

### Class Navigation

*Network* <==

*Instrumentation* <==

### Station

classes/

## Description

An OBS station is an actual implementation of one or several *instrumentation* in a given campaign and *network*.

## Python class:

Station

## YAML / JSON label:

**stations** Pertaining to Network Information File

## Corresponding StationXML structure

Station

## Object Hierarchy

### Superclass

*None*

### Subclasses

*None*

### Relationships

- Implements one or several *Instrumentations*
- Is part of a *Network*
- Is in one or several *Locations*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| *code* | string | Y | *None* | Station. code | Code does not appear as a YAML/JSON attribute. It's simply the key of the station. |
| site | string | Y | *None* | Site | |
| location_code | string | Y | *None* | alternate-Code | See class *Location* for details |
| locations | Array of *Location* | Y | *None* | *Operator* | The use of locations is not simple. See class *Location* for details |
| instrumentation | *Instrumentation* | Y | *None* | *None* | This is mostly contained in attribute Channel in StationXML |
| processing | *Processing* | N | *None* | Description | Will appear appended to Description in StationXML |
| restricted_state | List of values: "open", "closed", "partial", "unknown" | N | "unknown" | *None* | |
| comments | string | N | *None* | Comment | |
| start_date | date | N | *None* | startDate | All three instrument components have these dates. They're the same for all the station. |
| end_date | date | N | *None* | endDate | All three instrument components have these dates. They're the same for all the station. |

### JSON schema

https://gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/station.schema.json

### Example

- Part of network information file https://gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/network/SPOBS.INSU-IPGP.network.yaml corresponding to the stations, with an example of use of the anchor &LINEAR_CLOCK_DEFAULT. The `instrumentations` parts are explained under *Instrumentation*.

```
yaml_anchors:
   obs_clock_correction_linear_defaults: &LINEAR_CLOCK_DEFAULTS #Definition of the␣
↪anchor as the next three attributes.
      time_base: "Seascan MCXO, ~1e-8 nominal drift"
      reference: "GPS"
      start_sync_instrument: 0

  ...

   stations:
      "LSVW":
```

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```
          site: "Lucky Strike Volcano West"
          start_date: "2015-04-22T12:00:00Z"
          end_date: "2016-05-28T21:01:00Z"
          location_code: "00"
          instrumentations:
              -
                  base:
                      $ref: "instrumentation/SPOBS2.instrumentation.yaml#instrumentation"
                  datalogger_config: "125sps"
          locations:
              "00":
                  base: {$ref: 'location_bases/SURFACE_DROP.location_base.yaml#location_
↪base'}
                  position: {lon: -32.32504, lat: 37.29744, elev: -2030}
          processing:
              - clock_correction_linear_drift:
                  <<: *LINEAR_CLOCK_DEFAULTS
                  start_sync_reference: "2015-04-21T21:06:00Z"
                  end_sync_reference: "2016-05-28T20:59:00.32Z"
                  end_sync_instrument: "2016-05-28T20:59:03Z"

      "LSVE":
          site: "Lucky Strike Volcano East"
          start_date: "2015-04-22T12:00:00Z"
          end_date: "2016-05-28T21:01:00Z"
          location_code: "00"
          instruments:
              -
                  base:
                      $ref: "instrumentation/SPOBS2.instrumentation.yaml#instrumentation"
                  datalogger_config: "125sps"
          locations:
              "00":
                  base: {$ref: 'location_bases/ACOUSTIC_SURVEY.location_base.yaml
↪#location_base'}
                  position: {lon: -32.02504, lat: 37.25744, elev: -2130}
          processing:
              - clock_correct_linear_drift:
                  <<: *LINEAR_CLOCK_DEFAULTS
                  start_sync_reference: "2015-04-21T21:06:00Z"
                  end_sync_reference: "2016-05-28T20:59:00.32Z"
                  end_sync_instrument: "2016-05-28T20:59:01Z"
```

### Class Navigation

*Network* <==> *Instrumentation*

==> *Location*

==> *Processing*

### Instrumentation

### Description

An OBS instrumentation is an ensemble of instruments associated with specific channels constitute a physical unity that will be launched and recovered as a unit. While *obsinfo* is concerned only with the signal processing aspects of the instrumentation, an OBS instrumentation also includes the physical parts of the OBS frame, ballast elements, recovery devices, communication and power supply.

Channels in the instrumentation all have string labels, which are usually channel numbers. They must specify an orientation. Default chann properties can be specified with a label `default`. These properties are common to all channels *unless* overridden by attributes present in specific channels. For example, if a sensor **X** appears under the label `default` but a sensor **Y** appears under the label "2" then for channel 2 the selected sensor will be **Y**. If a preamplifier **Z** is specified under the label `default` and no preamplifier is specified under the label "2", then channel 2 will have preamplifier **Z**. All attributes can be specified under the default label.

### Python class:

Instrumentation

### YAML / JSON label:

**instrumentation** Contained in an instrumentation file

### Corresponding StationXML structure

***None*** At the Station level StationXML documents the total number of channels and the selected number of channels. Both are equal in OBS and are calculated implicitly.

### Object Hierarchy

### Superclass

*None*

### Subclasses

*None*

### Relationships

- Is used in a *Station*
- Has one or several *Channels*
- Has one or specifications defined in *Equipment*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| equipment | *Equipment* | Y | *None* | *None* | |
| channels | Array of *Channel* | Y | *None* | Channel | |
| channel_modifications | Array of *Channel* | Y | *None* | Channel | See AdvancedTopics for details |

The attribute channel_modifications is used to modify the attributes of a channel. In particular, instruments are supposed to be a rather static database of components and their configurations, but occasionally it is necessary to change some of the attributes for particular campaigns.

Under this keyword the user can specify a complete hierarchy down to the filter level. Only the value(s) specified will be modified. So if a "leaf" value is changed, such as gain value, only the gain value for a particular stage will be changed. But if a complete sensor is specified, the whole component along with its stages and filters will be modified. For more details, see AdvancedTopics.

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/instrumentation.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

YAML code for instrumentation information file https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/instrumentation/BBOBS1_2012%2B.instrumentation.yaml with the `channel_template` and `das_channels` parts elided.

```
---
format_version: "0.110"
revision:
   date: "2019-12-19"
   authors:
       - {$ref: "authors/Wayne_Crawford.author.yaml#author"}
       - {$ref: "authors/Romuald_Daniel.author.yaml#author"}
```

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```
instrumentation:
   operator: {$ref: "operators/INSU-IPGP.operator_info.yaml#operator_info"}
   equipment:
       model: "BBOBS1"
       type: "Broadband Ocean Bottom Seismometer"
       description: "LCHEAPO 2000 BBOBS 2012-present"
       manufacturer: "Scripps Inst. Oceanography - INSU"
       vendor: "Scripps Inst. Oceanography - UNSU"

   channels:
       default:
             ...

       "1":
             ...

       "2":
             ...

       "3":
             ...

       "4":
              ...
```

### Class Navigation

*Station* <==> *Channel*

### Equipment

### Description

Equipment class describes the characteristics of a particular instrumentation or instrument component, such as the vendor, model, serial number and calibration dates.

### Python class:

Equipment

### YAML / JSON label:

equipment

### Corresponding StationXML structure

- Equipment
- Datalogger
- Sensor
- Preamplifier

All of these classes have the same attributes as the *obsinfo* class, which are populated from the `Equipment` subclass of `Instrumentation`, `Sensor`, `Preamplifier` and `Datalogger` in *obsinfo*

### Object Hierarchy

### Superclass

*None*

### Subclasses

*None*

### Relationships

Belongs to:

- Instrumentation
- Datalogger
- Sensor
- Preamplifier

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| type | string | Y | *None* | type | Not required in StationXML |
| description | string | Y | *None* | Description | Not required in StationXML |
| manufacturer | string | Y | *None* | manufacturer | Not required in StationXML |
| model | string | Y | *None* | model | Not required in StationXML |
| vendor | string | N | *None* | vendor | Not required in StationXML |
| serial_number | string | N | *None* | serial_number | Not required in StationXML |
| installation_date | date | N | *None* | startDate | Not required in StationXML |
| remove_date | date | N | *None* | endDate | Not required in StationXML |
| calibration_date | date | N | *None* | calibDate | Not required in StationXML |

- (str):
  - vendor (str):
  - serial_number (str):
  - resource_id (str):
  - obspy_equipment (object of class Equipment from *obspy.core.inventory.equipment*

### JSON schema

https://www.gitlab.com/obsinfo/obsinfo/data/schemas/network.schema.json

https://www.gitlab.com/obsinfo/obsinfo/obsinfo/data/schemas/definitions.schema.json

### Example

FDSN Network_info section referred in network information file.

```
network:
    code: "4G"
    name: "Short period OBSs"
    start_date: "2007-07-01"
    end_date: "2025-12-31"
    description: "Short period OBS network example"
    comments: ["Lucky Strike Volcano, North Mid-Atlantic Ridge"]
```

### Class Navigation

*Network* <==

### Channel

#### Description

An OBS channel is an *Instrument* plus an orientation. An *Instrumentation* complex consists of one or several channels, each one implementing the signal processing of an instrument.

Actual channels all have string labels, which are usually channel numbers. They must specify an orientation. Default chann properties can be specified with a label `default`. This is not an actual channel. These properties are common to all channels *unless* overridden by attributes present in specific channels. For example, if a sensor **X** appears under the label `default` but a sensor **Y** appears under the label "2" then for channel 2 the selected sensor will be **Y**. If a preamplifier **Z** is specified under the label `default` and no preamplifier is specified under the label "2", then channel 2 will have preamplifier **Z**. All attributes can be specified under the `default` label.

Configurations are defined at the instrument component level, but are selected at the channel level. A configuration selection attribute specifies a configuration for each of the three instrument components in a channel: sensor, preamplifier and datalogger. They are the attributes sensor_configuration, preamplifier_configuration and datalogger_configuration, respectively.

#### Python class:

Channel

#### YAML / JSON label:

- channels
- default
- Particular string labels for each channel

Channels are part of the instrumentation information file.

#### Corresponding StationXML structure

Channel

#### Object Hierarchy

#### Superclass

*None*

### Subclasses

*None*

### Relationships

- Implements the signal of an *Instrument*
- Is part of an *Instrumentation*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| instrument | *Instrument* | Y | *None* | *None* | Attributes of instrument in Channel in StationXML |
| orientation: | Orientation | Y | *None* | *None* | |
| • orientation_code | List of values: X,Y,Z,1,2,3,H | Y | *None* | *None* | If orientation code is 1,2,3 or H it must include as a dictionary azimuth and dip. See example. |
| • azimuth | number | Y | *None* | Channel. Azimuth | 0.0 Azimuth < 360.0 in degrees |
| • dip | number | Y | *None* | Channel. Dip | -90.0 Dip 90.0 in degrees |
| location_code | string | Y | *None* | locationCode | See *Location-Base* for details of how location codes are used. |
| sensor_configuration | string | N | *None* | *None* | For *obsinfo* use only. This selects one of the configurations defined in the instrument components. |
| preamplifier_configuration | string | N | *None* | *None* | For *obsinfo* use only. This selects one of the configurations defined in the instrument components. |
| datalogger_configuration | string | N | *None* | *None* | For *obsinfo* use only. This selects one of the configurations defined in the instrument components. |

Orientation codes are a FDSN standard. By convention, if the orientation code is **X**, **Y** or **Z**, these represent the regular coordinates in space following the right-hand rule, within five degrees of the actual directions. So **X** corresponds to an azimuth of 0º and a dip of 0º, **Y** corresponds to an azimuth of 90º and a dip of 0º, and **Z** corresponds to an azimuth of 0º and a dip of -90º (the positive **Z** direction is towards the bottom). However, if **1**, **2** or **3** are specified, these represent three linearly independent directions but not necessarily coincidental with the regular coordinates, so an azimuth and a dip _must_ be specified. The same is true of the **H** (hydrophone) code.

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/instrumentation.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

Channels part of instrumentation information file https://gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/instrumentation/BBOBS1_2012%2B.instrumentation.yaml

```
channels:
    default:
        datalogger: {$ref: "dataloggers/LC2000.datalogger.yaml#datalogger"}
        preamplifier:
            {$ref: "preamplifiers/LCHEAPO_BBOBS.preamplifier.yaml#preamplifier"}
        sensor: {$ref: "sensors/NANOMETRICS_T240_SINGLESIDED.sensor.yaml#sensor"}

        preamplifier_configuration: "0.225x"

    "1": {orientation_code: {"2": {azimuth.deg: [90, 0]}}}
    "2": {orientation_code: {"1": {azimuth.deg: [0, 0]}}}
    "3":
        orientation_code: "Z"
        preamplifier_configuration: "1x"
    "4":
        orientation_code : {"H": {azimuth.deg: [0,0], dip.deg: [90,0]}}
        preamplifier: {$ref: "preamplifiers/LCHEAPO_DPG.preamplifier.yaml#preamplifier"}
        sensor: {$ref: "sensors/SIO_DPG.sensor.yaml#sensor"}
```

### Class Navigation

*Instrumentation* <==> *Instrument*

### Instrument

### Description

An OBS instrument (measurement instrument) records one physical parameter. It is composed of a *Sensor*, an optional *Preamplifier* and a *Datalogger*.

### Python class:

Instrument

### YAML / JSON label:

***None*** Conceptually, the three instrument components are gathered under an instrument, which has a class in Python. However, as shorthand, we **omit** the instrument label in information files and list the `sensor`, `preamplifier` and `datalogger` components directly under `channel`.

### Corresponding StationXML structure

***None*** Atributes of an instrument are assigned to a Channel.

### Object Hierarchy

### Superclass

*None*

### Subclasses

*None*

### Relationships

- Is assigned to a *Channel*
- Composed of a *Sensor*, an optional *Preamplifier* and a *Datalogger*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| sensor | *Sensor* | Y | *None* | Sensor | |
| preamprlifier | *Preamplifier* | N | *None* | Preamplifier | |
| datalogger | *Datalogger* | Y | *None* | Datalogger | |

### JSON schema

*None*

### Example

*None*

### Class Navigation

*Channel* <==> *InstrumentComponent*

## InstrumentComponent

### Description

An *Instrument* in *obsinfo* is broken down into three components: *Sensor*, an optional *Preamplifier* and a *Datalogger*. All of them are subclasses of this class, with some specialized attributes.

What characterizes all components is that they have an *ordered* list of response stages, along with different configuration definitions. The idea is to specify all regularly used configurations (you can always add more later). These different configuration override selected default attributes at the stage and filter level, or add new attributes to them. In turn, the information files at the instrumentation level select one particular configuration definition, and thus, one set of overrides and additions. Configurations are usually labeled with a code which specifies the main characteristic that changes in a particular set of configurations, such as sample rate or gain; in general, We present examples for three different ways to characterize configuration definitions.

On the other hand, it is very important to realize that stages must be specified in order. The top level order is sensor - preamplifier - datalogger, but within these three components it is up to the user to make sure the stages are in the correct order, starting with the one closer to the sensor.

The class InstrumentComponents does not appear explicitly in YAML or JASON files but it's part of the object model.

### Python class:

InstrumentComponents

### YAML / JSON label:

*None*

### Corresponding StationXML structure

*None*

There are structures in StationXML for *Sensor*, *Preamplifier* and a *Datalogger*.

### Object Hierarchy

### Superclass

*None*

### Subclasses

- *Sensor*
- *Preamplifier*
- *Datalogger*

### Relationships

- Contains *Stages*
- Specs are described in *Equipment*
- Is part of an *Instrument*

### Attributes

### JSON schema

*None*

### Example

*None*

### Navigation

*Instrument* <==

==> *Sensor*

==> *Preamplifier*

==> *Datalogger*

### Sensor

#### Description

A sensor is an *InstrumentComponent* belonging to an *Instrument*. It models an OBS sensor and so is the generator of the signal being processed. Inheriting from InstrumentComponent, it has all its attributes plus the ones below.

#### Python class:

Sensor

#### YAML / JSON label:

**sensor** Sensor usually has its own information file (best practice)

#### Corresponding StationXML structure

Channel.Sensor

#### Object Hierarchy

#### Superclass

*InstrumentComponent*

#### Subclasses

*None*

#### Relationships

- Contains *Stages*
- Is part of an *Instrument*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| seed_codes | *SeedCodes* | Y | *None* | Channel. code | See explanation in class *SeedCodes* Only first two codes set here. Orientation set at channel level. |

*For the rest of attributes, see superclass :ref:`InstrumentComponent <InstrumentComponent>`*

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/sensor.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

From sensor information file https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/sensors/NANOMETRICS_T240_SINGLESIDED.sensor.yaml (complete file).

```yaml
---
format_version: "0.110"
revision:
   date: "2017-11-30"
   authors:
       - {$ref: "authors/Wayne_Crawford.author.yaml#author"}
sensor:
   equipment:
       model: "Trillium T240"
       type: "Broadband seismometer"
       description: "Trillium T240 seismometer, single-sided connection"
       manufacturer: "Nanometrics, Inc"
       vendor: "Nanometrics, Inc"

   seed_codes:
       band_base: "B"
       instrument: "H"

   configuration_default: "SINGLE-SIDED_SN1-399"
```

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```
    configuration_definitions:
        "SINGLE-SIDED_SN1-399" :
            equipment:
                description: "negative shorted to ground, serial numbers 1-399"
            stages:
                -$ref: "responses/Trillium_T240_SN1-399-singlesided_theoretical.stage.yaml
↪#stage"
        "SINGLE-SIDED_SN400plus" :
            equipment:
                description: "negative shorted to ground, serial numbers 400+"
            stages:
                -$ref: "responses/Trillium_T240_SN400-singlesided_theoretical.stage.yaml
↪#stage"

notes:
    - "INSU-IPGP OBS park sphere sensor pairs are: Sphere01-133, Sphere02-132,"
    - "Sphere03-134, Sphere04-138, Sphere05-137, Sphere06-830, Sphere07-136,"
    - "Sphere08-829, Sphere09-826"
```

### Class Navigation

*InstrumentComponent* <==> *Stages*

### SeedCodes

### Description

Seed Codes are defined by the FDSN to characterize *channels* according to their data sources and signal treatment characteristics.

### Python class:

SeedCodes

### YAML / JSON label:

seed_codes

### Corresponding StationXML structure

*Channel.code*

### Object Hierarchy

### Superclass

*None*

### Subclasses

*None*

### Relationships

- Belongs to an *Sensor*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| band_base | string with restrictions (1 char) | Y | *None* | *None* | For a complete explanation of codes, click on band-code . Called band code in the new FDSN nomenclature. |
| instrument_code | string with restrictions (1 char) | Y | *None* | *None* | For a complete explanation of codes, click on instrument-code . Called source code in the new FDSN nomenclature. |
| orientation_code | string with restrictions (1 char) | N | *None* | *None* | For a complete explanation of codes, click orientation-code . See subsection *Geographic orientation subsource codes*. This code is assigned at the channel level. Called subsource orientation code in the new FDSN nomenclature. While part of the seed code, it is assigned at the channel level. |

#### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/sensor.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

#### Example

#### Class Navigation

*Sensor* <==

### Preamplifier

#### Description

An optional preamplifier may be part of an OBS instrument. It is an *InstrumentComponent* with response stages and no particular attributes of its own.

#### Python class:

Preamplifier

#### YAML / JSON label:

preamplifier

#### Corresponding StationXML structure

Preamplifier

#### Object Hierarchy

#### Superclass

*InstrumentComponent*

#### Subclasses

- *Filter*

### Relationships

- Is element of *Equipment*
- Contains *Response Stages*

### Attributes

*None*

*For the rest of attributes, see superclass :ref:`InstrumentComponent <InstrumentComponent>`*

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/preamplifier.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

Preamplifier information file https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/preamplifiers/LCHEAPO_BBOBS.preamplifier.yaml (complete file)

```
---
format_version: "0.110"
revision:
   date: "2017-11-30"
   authors:
       -   $ref: "authors/Wayne_Crawford.author.yaml#author"

preamplifier:
   equipment:
       model: "BBOBS-GAIN"
       type: "Analog gain card"
       description: "INSU BBOBS gain card"
       manufacturer: "SIO or IPGP"
       vendor: ~

   configuration_default: "1x"

   configuration_definitions:
       "0.225x":
           config_description: "0.225x gain"
           stages:
               - $ref: "responses/INSU_BBOBS_gain0.225_theoretical.stage.yaml#stage"
       "1x":
           config_description: "1x gain"
           stages:
               - $ref: "responses/INSU_BBOBS_gain1.0_theoretical.stage.yaml#stage"
```

### Class Navigation

*InstrumentComponent* <==> *Stages*

## Datalogger

### Description

A datalogger is the part of an OBS instrument which records the signal after processing. It is an *InstrumentComponent* with response stages and attributes such as the global delay correction and the overall sample rate of the instrument.

### Python class:

Datalogger

### YAML / JSON label:

datalogger

### Corresponding StationXML structure

Datalogger

### Object Hierarchy

#### Superclass

*InstrumentComponent*

#### Subclasses

*None*

#### Relationships

- Is element of *Equipment*
- Contains *Stages*

### Attributes

*For the rest of attributes, see superclass :ref:`InstrumentComponent <InstrumentComponent>`*

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/datalogger.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

Datalogger information file https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/dataloggers/LC2000.datalogger.yaml :

```
--
format_version: "0.110"
revision:
   date: "2019-12-20"
   authors:
       - $ref: 'authors/Wayne_Crawford.author.yaml#author'
notes:
   - "Delay correction is hard-coded to 29 samples in LCHEAPO software"

datalogger:
   equipment:
       model: "CS5321/22"
       type: "delta-sigma A/D converter + digital filter"
       description: "CS5321/22 delta-sigma A/D converter + FIR digital filter"
       manufacturer: "Cirrus Logic"
       vendor: "various"
   configuration_default: "125 sps"

   configuration_definitions:
       "62.5sps":
           config_description: "62.5 sps"
           sample_rate: 62.5
           correction: 0.464
           stages:
               - $ref: "responses/CS5321_FIR1.stage.yaml#stage"
               - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
               - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
               - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
               - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
               - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
               - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
               - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
               - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
               - $ref: "responses/CS5322_FIR3.stage.yaml#stage"
       "125sps":
           config_description: "125 sps"
           sample_rate: 125
```

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```
            correction: 0.232
            stages:
                - $ref: "responses/CS5321_FIR1.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR3.stage.yaml#stage"
        "250sps":
            config_description: "250 sps"
            sample_rate: 250
            correction: 0.116
            stages:
                - $ref: "responses/CS5321_FIR1.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR3.stage.yaml#stage"
        "500sps":
            config_description: "500 sps"
            sample_rate: 500
            correction: 0.058
            stages:
                - $ref: "responses/CS5321_FIR1.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR3.stage.yaml#stage"
        "1000sps":
            config_description: "1000 sps"
            sample_rate: 1000
            correction: 0.029
            stages:
                - $ref: "responses/CS5321_FIR1.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
                - $ref: "responses/CS5322_FIR3.stage.yaml#stage"
```

### Class Navigation

*InstrumentComponent* <==> *Stages*

## Stages

### Description

Stages are discrete units in the block diagram of an electronic circuit which perform a specific function and is usually physically circumscribed to a printed board. An instrument component in *obsinfo* is usually composed of several chained stages which connect the output of one stage to the input of the next one. This class implements the change of individual stages.

It is important that contiguous stages are consistent in two ways:

1. Output units of a stage must be equal to input units of the next stage
2. Output sample rate of a stage must match the input sample rate of the next stage

### Python class:

Stages

### YAML / JSON label:

stages

### Corresponding StationXML structure

Response

### Object Hierarchy

#### Superclass

*None*

#### Subclasses

*None*

### Relationships

- Contains one or several *Stages*
- Belongs to an *Instrument Component*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| Stage | Array of *Stage* | N | *None* | StageFDSN | |

### Calculated Attributes

These attributes do not exist in the YAML/JSON file. They are or may be calculated programmatically to feed corresponding values in the StationXML file or for other purposes.

| Name | Type | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|
| number | number | *None* | Stage. Number | Calculated depending on position |
| sensitivity | number | *None* | InstrumentSensitivity | Calculated with obspy.obspy_Sensitivity using gain.frequency of first stage as reference frequency and then recalculated with frequency out of sensitivity calculation. |
| total_sample_rate | number | *None* | *None* | Calculated as sum of stage sample rates in order to validate against declared sample_rate. |

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/stages.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

Response stages part of a datalogger information file https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/dataloggers/LC2000.datalogger.yaml

```
stages:
              - $ref: "responses/CS5321_FIR1.stage.yaml#stage"
              - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
              - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
              - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
              - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
              - $ref: "responses/CS5322_FIR2.stage.yaml#stage"
              - $ref: "responses/CS5322_FIR3.stage.yaml#stage"
```

### Class Navigation

*InstrumentComponent* <==> *Stage*

## ResponseList

### Description

A *filter* can be characterised by the list of impulse responses it yields, instead of its transfer function. These responses are triples of [frequency (in Hz), amplitude, phase (in degrees)], expressed in a list.

### Python class:

ResponseList

### YAML / JSON label:

ResponseList

### Corresponding StationXML structure

ResponseList

### Object Hierarchy

### Superclass

*Filter*

### Subclasses

*None*

### Relationships

- Is nested in *Stage*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| elements | **Array of Values:** [number, number, number] where **first element =** frequency (in Hz) **second elmenet =** amplitude **third element =:** phase (in degrees) | Y | *None* | ResponseListElement: `Frequency` `Amplitude` `Phase` | |

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/filter.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

No available example.

### Class Navigation

*Filter* <==

## Stage

### Description

Stages are discrete units in the block diagram of an electronic circuit which perform a specific function and is usually physically circumscribed to a printed board. An instrument component in *obsinfo* is usually composed of several chained stages which connect the output of one stage to the input of the next one.

### Python class:

Stage

### YAML / JSON label:

Unnamed element of stages array. The array itself has a label `stages`

### Corresponding StationXML structure

Stage

### Object Hierarchy

### Superclass

*None*

### Subclasses

*None*

### Relationships

- Is element of *Stages*
- Nests one *Filter*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| name | string | N | *None* | e.g. FIR. name | In StationXML this attribute is at the filter (PZ, Coeff, FIR, etc.) level. |
| description | string | N | *None* | e.g. FIR. Description | In StationXML this attribute is in the filter (PolesZeros, Coefficients, FIR, etc.) |
| input_units | IRISUnits | Y | *None* | e.g. FIR. InputUnits | In StationXML this attribute is at the filter (PZ, Coeff, FIR, etc.) level. |
| output_units | IRISUnits | Y | *None* | e.g. FIR. OutputUnits | In StationXML this attribute is at the filter (PZ, Coeff, FIR, etc.) level. |
| gain: | | Y | *None* | StageGain | |
| • frequency | number | Y | *None* | Frequency | In Hertz |
| • value | number | Y | *None* | Value | |
| filter | *Filter* | Y | *None* | *None* | No filter attribute in StationXML. Individual filters are subsumed in Stage. |
| calibration_date | date | N | *None* | *None* | In StationXML this attribute is only found at the equipment level. |
| decimation_factor | number | N | 1.0 | Decimation. Factor | |
| input_sample_rate | number | Y | *None* | Decimation. InputSampleRate | |
| delay | number | N | 0.0 | Decimation. Delay | If not set, will be calculated as filter.offset / input_sample_rate |
| polarity | string with values "+" and "-" | Y | *None* | *None* | "+" = counts increase when the input voltage increase, "-" otherwise. |

### Calculated Attributes

These attributes do not exist in the YAML/JSON file. They are or may be calculated programmatically to feed corresponding values in the StationXML file or for other purposes.

| Name | Type | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|
| stage_sequence_number | integer | 0 | number | |
| correction | number | 0.0 | Decimation.Correction | This value is calculated as a function of correction in class Datalogger. If delay.correction exists correction=0 for all stages but the last, which has value = delay.correction. If it does not exist, correction = delay. |
| output_sample_rate | number | 0.0 | *None* | |

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/stage.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

Stage information file https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/instrumentation/dataloggers/responses/CS5321_FIR3.stage.yaml .

```
---
format_version: "0.110"
revision:
   date: "2017-11-30"
   authors:
       -   $ref: "authors/Wayne_Crawford.author.yaml#author"

notes: ["From CS5322_Filter.pdf"]
stage:
   decimation_factor : 2
   gain :         {value: 1, frequency: 0}
   input_units :  { name : "counts", description: "Digital Counts"}

   description : "DECIMATION - CS5322 FIR3 (linear phase)"
   filter:
       $ref: "FIR/CirrusLogic_CS5322_FIR3.filter.yaml#filter"
   extras:
       DBIRD_response_type : "THEORETICAL"
```

## Class Navigation

*Stages* <==> *Filter*

## Filter

### Description

The class Filter describes the different types of filters that process the signal in the stages of the instrument components of an OBS.

### Superclass

*None*

### Subclasses

- *PolesZeros*
- *FIR*
  - *Analog*
- *Coefficients*
  - *ADConversion*
  - *Digital*
- *Response List*

### Relationships

Is nested in a *Stage*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| type | string | Y | *None* | N/A | Possible values: "PolesZeros", "FIR", "Coefficients", "Analog", "Digital", "ADConversion" |
| offset | number | Y | *None* | Decimation.Offset | If delay is not present in the corresponding Stage, it will be set to offset/input_sample_rate |

Depending on the *type*, other attributes will be required

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/filter.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

This is the filter information file https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/instrumentation/dataloggers/responses/FIR/CirrusLogic_CS5322_FIR3.filter.yaml , which specifies a “FIR”-type filter.

```
---
format_version: "0.110"
revision:
   date: "2017-11-30"
   authors:
       -   $ref: "authors/Wayne_Crawford.author.yaml#author"

notes: ["101 coefficients, linear phase filter"]

filter:
   type: "FIR"
   symmetry: "NONE"
   offset: 50
   coefficients:
       - -3.09982E-6
       - -2.94483E-5
       - -9.8002E-5
       - -1.62383E-4
       - -1.00029E-4
       - 1.20655E-4
       - 2.61935E-4
       - 2.52755E-5
       - -4.10488E-4
       - -3.66852E-4
       - 3.7627E-4
       - 8.54597E-4
       - -3.05213E-5
       - -0.00127677
         ...
       - 1.20655E-4
       - -1.00029E-4
       - -1.62383E-4
       - -9.8002E-5
       - -2.94483E-5
       - -3.09982E-6
```

### Class Navigation

*Stage* <==

==> *PolesZeros*

==> *FIR*

==> *Coefficients*

==> *ResponseList*

==> *ADConversion*

==> *Digital*

==> *Analog*

### ADConversion

### Description

StationXML does not specify analog to digital stages. We implement them as a Coefficients filter with one numerator coefficient, which is equal to one.

#### Python class:

ADConversion

#### YAML / JSON label:

ADConversion

#### Corresponding StationXML structure

Coefficients (with no coefficients except one numerator equal to one)

### Object Hierarchy

#### Superclass

*Coefficients*

### Subclasses

*None*

### Relationships

- Is nested in *Stage*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| input_full_scale | number | N | *None* | *None* | |
| output_full_scale | number | N | *None* | *None* | |

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/filter.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

Filter section in stage information file https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/instrumentation/dataloggers/responses/CS5321_FIR1.stage.yaml

```
filter:
        type : "AD_CONVERSION"
        input_full_scale : 9 #  9 V pp
        output_full_scale : 10485760 #  4FFFFF@Vref and B00000@-Vref
```

### Class Navigation

*Filter* <==

## Analog

### Description

StationXML does not specify Analog stages which do not have filters. They are implemented here as a PZ filter without poles or zeroes.

### Python class:

Analog

### YAML / JSON label:

Analog

### Corresponding StationXML structure

PolesZeros (with no poles or zeros))

### Object Hierarchy

### Superclass

*PolesZeros*

### Subclasses

*None*

### Relationships

- Is nested in *Stage*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| | | | | | |

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/filter.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

In stage information file https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/instrumentation/preamplifiers/responses/INSU_BBOBS_gain0.225_theoretical.stage.yaml

```
filter :
       type : "Analog"
```

### Class Navigation

*Filter* <==

## Coefficients

### Description

The Coeffcients class is a reprentation of a finite impulse response (FIR) filter, which is a *filter* whose impulse response (or response to any finite length input) is of finite duration, because it settles to zero in finite time. It is used mainly for FIR filters which are not symmetric. A symmetric FIR filter should use the FIR class.

The impulse response (that is, the output in response to a Kronecker delta input) of an Nth-order discrete-time FIR filter lasts exactly N + 1 samples (from first nonzero element through last nonzero element) before it then settles to zero. FIR filters can be discrete-time or continuous-time, and digital or analog.

For a more detailed discussion, click here.

### Python class:

Coefficients

### YAML / JSON label:

Coefficients

### Corresponding StationXML structure

Coefficients

### Object Hierarchy

### Superclass

*Filter*

### Subclasses

- *Digital*
- *ADConversion*

### Relationships

- Is nested in *Stage*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| transfer_function_type | **List of values:** LAPLACE (RADIANS/SECOND), LAPLACE (HERTZ), DIGITAL (Z-TRANFORM) | N | LAPLACE (RADIANS/SECOND) | PzTransferFunctionType | More info… |
| numerator_coefficients | List of numbers | Y | *None* | Numerator | |
| denominator_coefficients | List of numbers | Y | *None* | Denominator | |

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/filter.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

```
---
format_version: "0.110"
filter:
    type: "Coefficients"
    numerator_coefficients:
         [1, 0.1, -0.3, 0.6]
    denominator_coefficients:
         [-0.2, 0.8, 0.4, -0.3]
```

### Class Navigation

*Filter* <==

## Digital

### Description

StationXML does not have a class for digital stages which are not filters. They are therefore implemented as a Coefficients filter with one numerator coefficient, equal to 1.

### Python class:

Digital

### YAML / JSON label:

DIGITAL

### Corresponding StationXML structure

Coefficients (with no coefficients)

### Object Hierarchy

#### Superclass

*Coefficients*

#### Subclasses

*None*

#### Relationships

- Is nested in *Stage*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| *None* | | | | | |

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/filter.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

No existing file for this example.

```
filter:
   type: "Digital"
```

### Class Navigation

*Filter* <==

## FIR

### Description

A finite impulse response (FIR) filter is a *filter* whose impulse response (or response to any finite length input) is of finite duration, because it settles to zero in finite time.

The impulse response (that is, the output in response to a Kronecker delta input) of an Nth-order discrete-time FIR filter lasts exactly N + 1 samples (from first nonzero element through last nonzero element) before it then settles to zero. FIR filters can be discrete-time or continuous-time, and digital or analog.

Alternatively, FIR filters in *obsinfo* are also commonly documented using the Coefficients class, though FIR has the advantage of allowing representation of symmetric FIR coefficients without repeating them.

For a more detailed discussion, click here.

### Python class:

FIR

### YAML / JSON label:

FIR

### Corresponding StationXML structure

FIR

### Object Hierarchy

### Superclass

*Filter*

### Subclasses

*None*

### Relationships

- Is nested in *Stage*

### Attributes

| **Name** | **Type** | **Required** | **Default** | **Equivalent StationXML** | **Remarks** |
|---|---|---|---|---|---|
| symmetry | **List of values:** ODD, EVEN, NONE | Y | *None* | Symmetry | |
| coefficients | List of numbers | N | *None* | NumeratorCoefficient | |
| coefficient_divisor | number | N | 1.0 | *NOT USED* | |

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/filter.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

In filter information file https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/instrumentation/dataloggers/responses/FIR/TexasInstruments_ADS1281_FIR1.filter.yaml

```
--
format_version: "0.107"
filter:
   type: "FIR"
   symmetry: "NONE"
   delay.samples: 5
   coefficient_divisor: 512
   coefficients:
       - 3
       - 0
       - -25
       - 0
       - 150
       - 256
       - 150
       - 0
       - -25
       - 0
       - 3
```

### Class Navigation

*Filter* <==

## PolesZeros

### Description

A Pole-Zero *filter*. Every digital filter can be specified by its poles and zeros (together with a gain factor). Poles and zeros give useful insights into a filter's response. For a more detailed discussion, click here.

### Python class:

- PolesZeros

### YAML / JSON label:

- PolesZeros

### Corresponding StationXML structure

No direct correspondence. Mapped into subattribute PolesZeros of attribute Stage.

### Object Hierarchy

### Superclass

*Filter*

### Subclasses

- *Analog*

### Relationships

- Is nested in *Stage*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| transfer_function_type | **List of Values:** LAPLACE (RADIANS/SECOND), LAPLACE (HERTZ), DIGITAL (Z-TRANFORM) | N | LAPLACE (RADIANS/SECOND) | PzTransferFunctionType | More info… |
| zeros | List of numbers | Y | *None* | Zero | |
| poles | List of numbers | Y | *None* | Pole | |
| normalization_frequency | number | N | *None* | NormalizationFrequency | |
| normalization_factor | number | N | *None* | NormalizationFactor | Frequency at which the NormalizationFactor is valid. This should be the same for all stages and within the passband, if any. |

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/filter.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

In the filter information file https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/instrumentation/sensors/responses/PolesZeros/Trillium_T240_SN400-_generic.filter.yaml .

```
---
format_version: "0.110"
revision:
   date: "2018-06-01"
   authors:
       - {$ref: "authors/Wayne_Crawford.author.yaml#author"}

filter:
   type: "PolesZeros"
   transfer_function_type: "LAPLACE (RADIANS/SECOND)"
   zeros :
       -     [0.0,  0.0]
       -     [0.0,  0.0]
       -   [-72.5,  0.0]
       -  [-159.3,  0.0]
       -  [-251,    0.0]
       - [-3270.0,  0.0]
   poles :
       -    [-0.017699,    0.017604]
       -    [-0.017699,   -0.017604]
       -   [-85.3,         0.0]
       -  [-155.4,       210.8]
       -  [-155.4,      -210.8]
       -  [-713,           0]
       - [-1140,          -0]
       - [-4300,          -0]
       - [-5800,          -0]
       - [-4300,        4400]
       - [-4300,       -4400]
   offset: 0

notes:
   - poles et zeros d'un Trillium T240 no de serie 400+
   - d'apres le fichier Trillium240_UserGuide_15672R7.pdf de Nanometrics.

extras: None
```

### Class Navigation

*Filter* <==

## Processing

### Description

This class has no correlate in StationXML, but it is used for important documentation purposes in *obsinfo*, and thus is included as a comment in StationXML. It documents the addition or subtraction of leap seconds to the signal data, and any kind of clock drift. As is well known, OBS equipment does not have a GPS connection and its clock must be manually synchronized.

### Python class:

Processing

### YAML / JSON label:

processing

### Corresponding StationXML structure

*None*

### Object Hierarchy

#### Superclass

*None*

#### Subclasses

*None*

#### Relationships

- Is element of *Station*
- Is composed of *LeapSecond*
- Is composed of *LinearDrift*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| linear_drift | *LinearDrift* | N | *None* | *None* | |
| leap_second | *LeapSecond* | N | *None* | *None* | |

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/network.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

Processing section of network information file https://gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/network/BBOBS.INSU-IPGP.network.yaml .

```
processing:
              - clock_corrections:
                  linear_drift:
                      time_base: "Seascan MCXO, ~1e-8 nominal drift"
                      reference: "GPS"
                      start_sync_instrument: 0
                      start_sync_reference: "2015-04-23T11:20:00"
                      end_sync_reference: "2016-05-27T14:00:00.2450"
                      end_sync_instrument: "22016-05-27T14:00:00"
```

*Station* <==

==> *LinearDrift*

==> *LeapSecond*

## LinearDrift

### Description

This class has no correlate in StationXML, but it is used for important documentation purposes in *obsinfo*, and thus is included as a comment in StationXML. It documents the clock drift. As is well known, OBS equipment does not have a GPS connection and its clock must be manually synchronized.

### Python class:

Processing

The subclass LinearDrift is not implemented in Python but directly as attributes of class Processing

### YAML / JSON label:

processing: clock_correct_linear_drift

### Corresponding StationXML structure

*None*

### Object Hierarchy

*None*

### Superclass

*None*

### Subclasses

*None*

### Relationships

- Is element of *ProcessingClockCorrections*

### Attributes

| **Name** | **Type** | **Required** | **Default** | **Equivalent StationXML** | **Remarks** |
|---|---|---|---|---|---|
| time_base | string | Y | *None* | *None* | Time base of OBS |
| reference | string | Y | *None* | *None* | Reference used |
| start_sync_instrument | timestamp | Y | *None* | *None* | If set to zero or absent, see below in Calculated Attributes. |
| start_sync_reference | timestamp | Y | *None* | *None* | |
| end_sync_instrument | timestamp | Y | *None* | *None* | |
| end_sync_reference | timestamp | Y | *None* | *None* | |

### Calculated Attributes

| Name | Type | Default | StationXML | Remarks |
|---|---|---|---|---|
| start_sync_instrument | timestamp | *None* | *None* | If set to 0 or absent in the file, it is set equal to the start_sync_reference |

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/network.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

Processing section of network information file https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/network/BBOBS.INSU-IPGP.network.yaml .

```
clock_correct_linear_drift:
    time_base: "Seascan MCXO, ~1e-8 nominal drift"
    reference: "GPS"
    start_sync_reference: "2015-04-23T11:20:00"
    end_sync_reference: "2016-05-27T14:00:00.2450"
    end_sync_instrument: "22016-05-27T14:00:00"
```

*Processing* <==

### LeapSecond

### Description

This class has no correlate in StationXML, but it is used for important documentation purposes in *obsinfo*, and thus is included as a comment in StationXML. It documents the addition or subtraction of leap seconds to the signal data. As is well known, OBS equipment does not have a GPS connection and its clock must be manually synchronized.

### Python class:

Processing

The subclass LeapSecond is not implemented in Python but directly as attributes of class Processing

#### YAML / JSON label:

clock_correct_leap_second

#### Corresponding StationXML structure

*None*

#### Object Hierarchy

#### Superclass

*None*

#### Subclasses

*None*

#### Relationships

- Is element of *ProcessingClockCorrections*

#### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| time | timestamp | Y | *None* | *None* | |
| type | string (1 char, + or -) | Y | *None* | | A positive leapsecond is a 61 second minute, a negative one, a 59 sec. |
| corrected_in_end_sync | boolean | Y | *None* | *None* | |
| corrected_in_end_data | boolean | Y | *None* | | |

#### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/stage.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

Section in network information file https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/campaign/LEAP_SECOND.INSU-IPGP.network.yaml .

```
- clock_correct_leapsecond:
                   time: "2016-12-31T23:59:60"
                   type: "+"
                   corrected_in_end_sync: True
```

### Class Navigation

*Processing* <==

### Location

### Description

This class serves two purposes. If a single location is specified or if the location code "00" is specified, this will be geographic location of the corresponding *Station* in StationXML. The rest of locations serve to group channels that treat the signal of a single sensor. They can be physically in other geographic locations or not.

### Python class:

Location

### YAML / JSON label:

location:

### Corresponding StationXML structure

*None*

Location codes appear in channels of a given instrumentation. All locations corresponding to these codes are specified as individual attributes in the channel section of StationXML.

### Object Hierarchy

### Superclass

*None*

### Subclasses

*None*

### Relationships

- Is assigned, as a code, to a *Channel*
- Is assigned to a *Station*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| *code* | string | Y | *None* | location_code | |
| base | *LocationBase* | N | *None* | *None* | Individual fields of base in Station attribute. See *LocationBase* for details. |
| position: | Position | Y | *None* | *None* | |
| • lat | number | Y | *None* | Latitude | Expressed in degrees/min/sec/fractions of sec. |
| • lon | number | Y | *None* | Longitude | Expressed in degrees/min/sec/fractions of sec. |
| • elev | number | Y | *None* | Elevation | Expressed in meters |

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/network.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

Facility section in network information file https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/network/SPOBS.INSU-IPGP.network.yaml

```
locations:
                "00":
                    base: {$ref: 'location_bases/SURFACE_DROP.location_base.yaml#location_
↪base'}
                    position: {lon: -32.32504, lat: 37.29744, elev: -2030}
```

### Class Navigation

*Station* <==> *Instrumentation*

==> *LocationBase*

## LocationBase

### Description

LocationBase specifies parameters specific to a type of location.

### Python class:

LocationBase

### YAML / JSON label:

location_base

### Corresponding StationXML structure

***None*** Individual attributes in this class belong to the Station attributes.

### Object Hierarchy

### Superclass

*None*

### Subclasses

*None*

### Relationships

- Is part of a *Location*

### Attributes

| Name | Type | Required | Default | Equivalent StationXML | Remarks |
|---|---|---|---|---|---|
| uncertainties | dictionary of {lat: number, lon:number, elev: number} | Y | *None* | Included in latitude, longitude and elevation (see Class Location) | In meters. As uncertainties.m in YANL / JSON |
| depth | number | Y | *None* | *None* | In meters. As depth.m in YANL / JSON |
| geology | string | Y | *None* | Geology | |
| vault | string | Y | *None* | Vault | |
| localisation_method | string | Y | *None* | *None* | Added in Comment in StationXML |

### JSON schema

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/network.schema.json

https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/data/schemas/definitions.schema.json

### Example

LocationBase information file **`https://www.gitlab.com/resif/obsinfo/-/tree/master/obsinfo/_examples/Information_Files/location_b**

```
---
format_version: "0.107"
revision:
   date: "2018-06-01"
   authors:
       - $ref: "Wayne_Crawford.author.yaml#author"
location_base:
   depth.m: 0
   geology: "unknown"
   vault: "Sea floor"
   uncertainties.m: {lon: 200, lat: 200, elev: 20}
   localisation_method: "Sea surface release point"
```

### Class Navigation

*Location* <==

## 10.3 Fundamentals

This is a stub.

**Explain here the fundamentals of obsinfo coding:**

- **Need to follow StationXML as much as possible**
  - But to add other fields
  - And to eliminate redundancy
- Correlation and non-correlation of classes to StationXML objects and why
- **How an obsinfo file is parsed to obtain an obspy Network object**
  - Including non-standard field stuffing into comments.

### 10.3.1 __str__()

*explain how to write __str__(self, indent=0, n_subclasses=0)*

### 10.3.2 Verify reading of attributes_dict

values in attributes_dicts should be "popped" and the final attributes_dict verified empty to be sure that all inputs are processed (mostly a debugging process).

For now I'm just doing so on a class-by-class basis, should I write a helper function to do it everywhere (might have to be able to say where it was called from in case of error).

Wrote a helper function to verify that a dictionary is empty and, if not, to state in which calling function it was not.

For example:

```python
    def __init__(self, attributes_dict, higher_modifs={}): self.equipment = Equip-
        ment(base_dict.pop('equipment', None)) self.configuration = base_dict.pop('configuration', None)
        self.configuration_description = base_dict.pop('configuration_description', self.configuration) seed_dict
        = self.base_dict.pop('seed_codes', {}) self.seed_band_base_code = seed_dict.get('band_base', None)
        self.seed_instrument_code = seed_dict.get('instrument', None) self._clear_base_dict()
```

```python
    def _clear_base_dict(self):
        if len(self.base_dict) > 0:
            raise ValueError('base_dict has remaining keys: {}' .format(list(self.base_dict.keys())))
        del self.base_dict
```

## 10.4 Delay correction

As written in the tutorial, stage-level `correction` s are calculated by OBSINFO using the filter-level `offset`, stage-level `delay` and datalogger-level `correction` fields:

- `offset` can be set at the Filter level. If not, it is set to zero. It is a required field for `FIR` filters (why not the other digital filters?)
- `delay` can be set at the Stage level. If it is not specified, it is set to the Stage Filter's `offset` divided by the Stage's ‘`input_sample rate`. This cannot be done when the Stage is first read, because the Stage's `input_sample_rate` usually depends on the preceding Stages.
- `correction` depends on the value of `datalogger.correction`:
  - if `datalogger.correction` is `None` (i.e., not specified in the information file, `correction` = `delay` in every stage
  - otherwise, `correction = datalogger.correction` in the last stage and `correction = 0` in every other stage.

  this calculation can only be made after `delay` is calculated

The process for calculating `delay` and `correction` is as follows:

1. An attribute dictionary is passed to `Instrument._init()`, which
   1. creates `Sensor`, `Datalogger`, and `PreAmplifier` properties using their constructors
      - each one creates/contains a Stages() property, but only the `Datalogger` object gets a `correction`` value
      - The `Stages` constructor creates a list of `Stage` s. Each `Stage`:
        - contains a `delay` (usually not specfied in the information file, in which case `delay = None`)`
        - contains a `Filter`` that contains an `offset` (set to `0` if not specified)
   2. calls `self.combine_stages()`, which combines the Sensor, PreAmplifier and DataLogger stages into a single, ordered list (Sensor stages, then Preamplifier and finally Datalogger)
   3. calls `self.integrate_stages()`, which loops through each stage, checking/creating continuity, calculating `delay` (in `Stage.calculate_delay()`) and setting `correction = delay` if `correction` is `None`
   4. creates a list of `obspy` stages and incorporates them into an obspy `Response` object (including calculating Sensitivity)

## 10.5 Base-Configuration-Modifications

The base-configuration-modifications nomenclature is at the core of customizing instrumentation in obsinfo.

### 10.5.1 Classes using base-configure-modification:

- Stage (in obsinfo/instrumentation/stage.py)
- Datalogger (in obsinfo/instrumentation/instrument_component.py)
- Sensor (in obsinfo/instrumentation/instrument_component.py)
- Preamplifier (in obsinfo/instrumentation/instrument_component.py)
- Instrumentation (in obsinfo/instrumentation/instrumentation.py)
- Location (in obsinfo/helper_classes/location.py)
- Timing changes (not sure it's enabled yet!)

### 10.5.2 YAML structure:

```
{element}:
    base:
        {element}_property1
        {element}_property2
        {element}_property3
        ...
        configuration_default: <str>
        configuration_definitions:
            {CONFIG_NAME1}:
                (configuration_description): <str>
                {element}_propertyN
                ...
            {CONFIG_NAME2}:
                (configuration_description): <str>
                {element}_propertyM
                ...
            ...
    configuration: <str>
    modifications:
        {element}_propertyY
        ...
        {element_specific_modifier1}
        ...
    *channel_modifications:
        <CH-IDENTIFIER>:
            *base*: <file reference>
            *configuration: <str>
            modifications:
                {element}_property
                ...
        <CH-IDENTIFIER>:
            ...
        ...
    **stage_modifications:
        <STAGE-NUMBER-CODE>:
            *base*: <file reference>
            *configuration: <str>
```

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```
            {element}_property
            ...
        <STAGE-NUMBER-CODE>:
            ...
        ...
```

'*' `channel_modifications` only exist in `instrumentation` elements

'**' `stage_modifications` only exist in `instrument_component` and `instrumentation:channel_modifications` elements`

### 10.5.3 ORDER OF PRIORITY

`stage_modifications` > `channel_modifications` > `modifications` > `configuration` > `base`

#### Multi-level priorities

`instrumentation` elements contain `instrument_component` elements, which contain `stage` elemetns. Each of these can have `configurations` and `modifications`. The order of priority is

I THINK THE ORDER SHOULD BE:

instrumentation_level_declaration > instrument_component_level_declaration > stage_level_declaration

The highest-level configuration is chosen, then all of the modifications are evaluated, from highest to lowest level.

This means that a modification introduced at a lower level will override a higher-level configuration. We do this so that the high-level user gets out what they put in, but a consequence is that unseen lower-level modifications can override what the user expected from his-her configuration.

WE RECOMMEND AGAINST USING MODIFICATIONS AT THE LOWER LEVELS, UNLESS IT IS ABSOLUTELY SOMETHING THAT SHOULD IMPLEMENTED FOR THE GIVEN ELEMENT.

### 10.5.4 Specification in schemas

Every element that uses the base-config nomenclature has the following element declarations in it's JSON schema file:

| Name | properties | required |
|---|---|---|
| `{element}` | • `base`<br>• `configuration`<br>• `modifications`<br>• `notes` | `base` |
| `base` | • *{properties}*<br>• `configuration_default`<br>• `configurations` | specified properties |
| `modifications` | • `base`<br>• `configuration`<br>• *{properties}* | none |
| `configurations_map` | map of configuration names (=> `configuration_definition`) | NA |
| `configuration_definition` | • *{properties}*<br>• `configuration_description` | none |

There is also a `base_properties` element that lists all of the properties in a base element. Originally this was used with `allOf` to avoid repetition, but `allOf` validation errors are impossible to read so we now explicitly state properties in each element. In each of the other elements, I separate the base_properties from the element-specific properties by a blank line, for clarity. The `base_properties` element is now just a reference.

### 10.5.5 Implementation in the code

When a class has a base-configuration-modification nomenclature, calls to `ObsMetaData.get_super()` are replaced by calls to `ObsMetaData.base_configured_element()`. The latter evaluates the `base: configuration: modification:` structure and replaces values as appropriate before handing off to `ObsMetaData.get_super()`

**`base_configured_element()` should, in order:**

1. Check if the configuration has been updated
2. return the given configuration
3. Apply local (base-config) changes to the configuration
4. Apply higher-level (channel-mods?) changes to the configuration

Here is an explanation of the philosophy, the codes involved and the potential bugs.

Most of the modifications are handled by the `ObsMetaData` class defined in `obsmetadata.py`. I'll start by outlining what is done in `obsmetadata.py` before going on to specific implementations in the element classes.

### obsmetadata.py

#### get_super()

Essentially a "super" *dict.get()*, adding the possibility to override the returned value by one in modifs_list dicts. With `safe_update()` and `get_configured_modified_base()`, I don't think I need it anymore

#### get_configured_modified_base()

**def get_configured_modified_base(self, higher_modifs={}):** """ Return a fully configured and modified base_dict

Values in higher-modifs outrank those in self. Modifications outrank configurations. Uses safe_update() to only change specified elements.

**Args:**

**self (`ObsMetadata`): base-configuration-modification** dictionary. Must have "base", can have "configuration" and "modification" AND NOTHING ELSE.

**higher_modifs (dict or `ObsMetadata`): modifications** dictionary. Can have "base", "configuration" and/or "modification" AND NOTHING ELSE

**Returns:**

**base_dict (:class:`ObsMetadata): fully configured and modified** attribute dictionary

**Raises:**

**ValueError: if self or higher_modifs contain keys other than "base",** "configuration" and/or "modification"

"""

#### safe_update()

Simplifies combining base elements and their modifications.

```
def safe_update(self, update_dict, allow_overwrite=True):
    """
    Update that only changes explicitly specfied fields

    Drills recursively through dicts inside the dict, only changing fields
    which are specified in update_dict

    Args:
        update_dict (dict or :class:`ObsMetadata`): dictionary containing
            fields to update
        allow_overwrite (bool): allow a field that was originally a dict
            to be overwritten by a field that is not a dict
    ...
```

### Files/classes involved

If possible, only involve the classes that directly have the base-channel-modification structure:

- locations.py: Locations class
- instrumentation.py: `Instrumentation` class
- instrument_component.py: `InstrumentComponent` superclass and `Datalogger`, `Preamplifier` and `Sensor` subclasses
- stage.py: `Stage` class
- processing.py?: `Processing` class? or `Timing` class? (not yet done)

For `Locations` and `Timing` the implementation should be fairly easy because at one level. We write here the philosophy/implementation for the ``**Instrumentation**`` -> `channel` -> `Instrument` -> ``**Instrument_Component**`` -> `Stages` -> ``**Stage**`` -> `Filter` chain:

### `Instrumentation` class

1. input attributes dict is split into `base_dict`, `modifications`, `channel_modifications` and the shortcut `serial_number`
2. The shortcut is inserted into `modifications`
3. `modifications` is split into `ic_modifs` (keys = `datalogger`, `sensor` and `preamplifier`) and `modifications` (the rest).
4. if `modifications['base']` exists, replace ``base_dict`.
5. if `modifications['configuration']` exists, set `base_dict["configuration"]`
6. Safe_update `base_dict` with given configuration
7. Safe_update result with `modifications`
8. Create `equipment` attribute.
9. **Create `channels` attribute in a loop for each channel:**

    a. Get channel_specific attributes from the updated base_dict.
    b. Extract `channel_modifications` corresponding to the given channel
    c. Split the selected `channel_modifications`` into InstrumentComponent-related and other
    e. Safe_update the channel_specific attributes with the non-ic channel-specific modifications

   e. Safe_update ic_modifs with ic-related channel modifications. g. Pass attributes and ic_modifs down to `Channel()`

### `Channel` class

1. Combine `attributes` and `channel_default` into `new_attributes_dict`

2. Create several attributes 2. Create `instrument` attribute (`Instrument` class), passing down

   `new_attributes_dict` and `ic_modifications`

### `Instrument` class

1. **Loop through ic_types: `datalogger`, `sensor`, `preamplifier`**

   a. Pass `attributes_dict[ic_type]` and `ic_modifications[ic_type]` to InstrumentComponent.construct(attributes_dict, modifs, ic_type)

2. Combine the response stages from the 3 ic_types

3. Calculate overall sensitivity

### `InstrumentComponent` class

**base-configuration-modification** module

1. **Split `attributes_dict` into**

   a. creates `ic_base_dict`, `ic_modifs`, and `ic_response_modifs` from `attributes_dict[ic_type]`

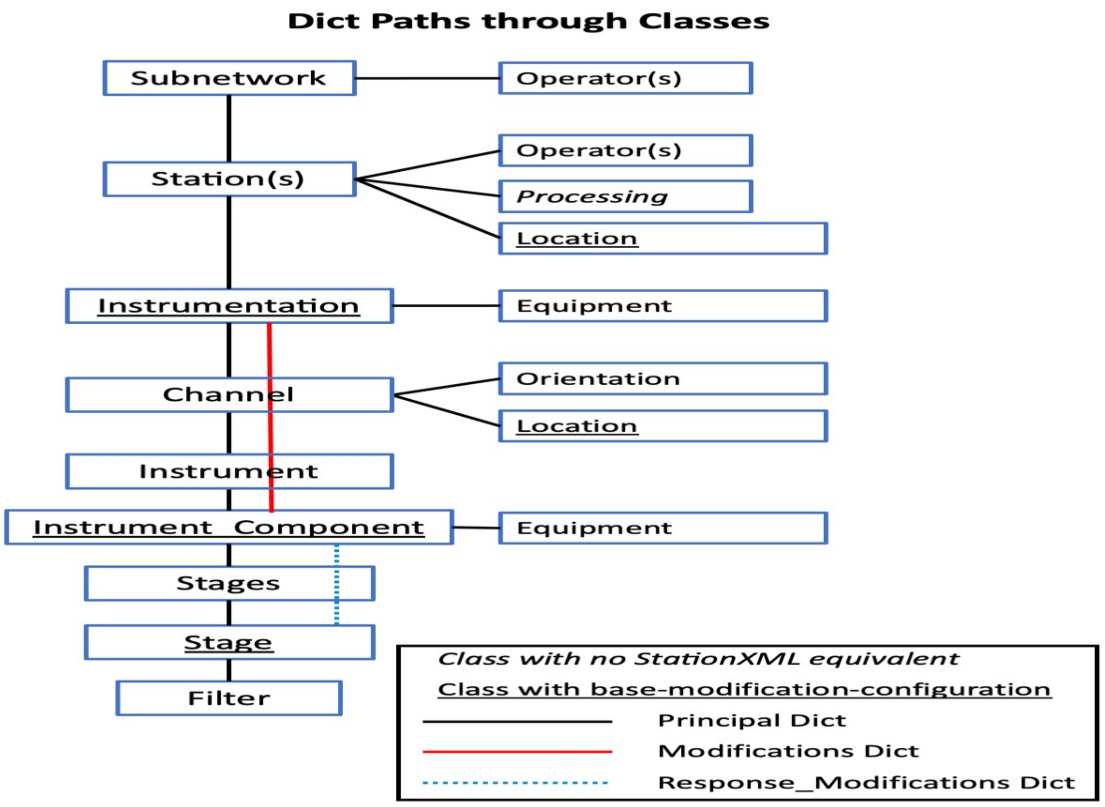
   b. creates `higher_modifs` from `modifs[ic_type]`, then `higher_base`, `higher_config` and `serial_number` (shortcut) from higher_modifs

2. Creates `instrument` attribute as an `Instrument`, passing down `new_attributes_dict`, `ic_modifications` and `channel_modifications`

### Handling `channel_modifications` and `stage_modifications`

`channel_modifications` and `stage_modifications` are handled in the `Channel` and `Stage` classes, respectively. These classes update the `modifications` dictionary with the qualifying dictionaries.

Here is a plot of how dictionaries are passed through the classes, followed by extracts of the actual codes:



`subnetwork/subnetwork.py`:

**def __init__(self, attributes_dict=None, station_only=False):** # … self.stations = Stations(attributes_dict.get("stations", None),

station_only, self.stations_operators)

## `subnetwork/station.py`:

Passes `channel_modifications` down to Instrumentation

```
def __init__(self, code, attributes_dict, station_only=False,
             stations_operators=None):
# ...
    instr_dict = attributes_dict.get('instrumentation', None)
    channel_modifs = attributes_dict.get('channel_modifications', {})
    if instr_dict:
        self.instrumentation = Instrumentation(
            instr_dict, self.locations, start_date, end_date,
            channel_modifs, self.serial_number)
```

#### instrumentation/instrumentation.py:

Passes channel_modifications down to Channel

```
def __init__(self, attributes_dict_or_list, locations,
             start_date, end_date, channel_modifs={},
             serial_number=None):
    # ...
    self.channels = [Channel(label, attributes, locations,
                             start_date, end_date,
                             self.equipment.obspy_equipment,
                             channel_default, channel_modifs)
                     for label, attributes in das_channels.items()]
```

where das_channels comes from instr_dict['channels'] and channel_default comes from das_channels['default']

#### channel.py:

Selects the channel modifications to pass down to Instrument

Initializing a Channel class calls

```
def __init__(self, label, attributes, locations,
             start_date, end_date, equipment, channel_default={},
             channel_modifs={}):
    # ...
    selected_channel_modifs = self.get_selected_channel_modifs(
        self.channel_id_code, channel_modifs)
    self.instrument = Instrument(self.das_channel, selected_channel_modifs)
    # ...
```

and Channel.get_selected_channel_modifs() is:

**Modify this to take ``modifications`` as well?**

#### instrument.py:

```
def __init__(self, attributes, channel_modifs={}):
    # ...
    for ic_name in ('datalogger', 'sensor', 'preamplifier'):
        key = ic_name + '_configuration'
        config_selector = attributes.get_configured_element(key, channel_modifs)
        ic_obj = InstrumentComponent.dynamic_class_constructor(
            component, attributes_dict, channel_modifs, config_selector)
        setattr(self, ic_name, ic_obj)  # equivalent to self.ic_name = ic_obj
    # ...
```

which I changed to

```
for ic_type in ('datalogger', 'sensor', 'preamplifier'):
    ic_config_key = ic_type + '_configuration'
```

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```
    if ic_type in channel_modifs:
        ic_modifs = channel_modifs[ic_type]
        # Pop out keywords
        config = ic_modifs.pop('configuration', None)
        sn = ic_modifs.pop('serial_number', None)
        base = ic_modifs.pop('base', None)
        # replace ic by channel_modifs[ic_type][]'base'] if it exists
        if base is not None:
            logger.info('Replacing {ic_type}')
            attributes[ic_type] = base
        if sn is not None:
            if 'equipment' in ic_modifs:
                if 'serial_number' in ic_modifs['equipment']:
                    logger.warning('equipment:serial_number and serial_number specified,␣
↪equipment:serial_number overrides')
                else:
                    ic_modifs['equipment']['serial_number'] = sn
            else:
                ic_modifs['equipment'] = {'serial_number': sn}
        if config is not None:
            # For now, just replace v0.110 "*_configuration" keyword
            if ic_config_key in attributes:
                msg = 'attributes[{}]={} replaced by {{"{}": {{"configuration": {}}}}}'.
↪format(
                    ic_config_key, attributes[ic_config_key], ic_type, config)
                warnings.warn(msg)
                logger.warning(msg)
            attributes[ic_config_key] = config
    config_selector = attributes.get_configured_element(ic_config_key,
                                                         channel_modifs)
    ic_obj = InstrumentComponent.dynamic_class_constructor(
        ic_type, attributes, channel_modifs, config_selector)
    setattr(self, ic_type, ic_obj)  # equivalent to self.ic_type = ic_obj
```

in order to handle configurations, serial_numbers and the `base`` element: For each of the `instrument_component` s found in the dictionary, it

- defines a config_key ("datalogger_configuration", for example)
- checks if the instrument_component is named in the channel_modifs dict, if so: - pops out keywords ('configuration', 'serial_number' and 'base')

    (shouldn't need to pop any more, now that modifications are separated)

    - if there is a 'base' keyword, replace attributes[instrument_component]['base'] by this one
    - if there is a 'serial_number' keyword, sets channel_modif[instrument_component]['equipment']['serial_number']
    - if there is a 'configuration' keyword, set attributes[config_key] to the given value
- uses ObsMetadata.get_configured_element() to choose the configuration between channel_modifs[config_key] and attributes[config_key]
- creates the instrument component using InstrumentComponent.dynamic_class_constructor(ic_type, attributes, channel_modifs, config_selector)

where `channel_modifs` is the `selected_channel_modifs` in `Channel.__init()__`

But I think it can be simplified now

The handling of the configuration names looks confused to me.

`config_selector` won't need `ic_name + 'configuration'` in v0.111, as the congfiguration will use the same keyword (`configuration`) for each InstrumentComponent field.

### `instrument_component.py`:

`InstrumentComponent.dynamic_class_constructor(ic_type, attributes, channel_modifs, config_selector)` selects the appropriate component from the `attributes` dict and passes it on to the specific component's `dynamic_class_constructor` method:

We use this static method rather than __init__()`` in order to directly create and pass back one of the subclasses (`Sensor`, `Datalogger` or `Preamplifier`)

```
@staticmethod
def dynamic_class_constructor(component_type, attributes_dict,
                              channel_modif={}, config_selector=''):
    # ...
    selected_config = InstrumentComponent.retrieve_configuration(
        component_type, attributes_dict[component_type], config_selector)

    if component_type == 'datalogger':
        theclass = Datalogger
    elif component_type == 'sensor':
        theclass = Sensor
    elif component_type == 'preamplifier':
        theclass = Preamplifier
    # ...
    obj = theclass.dynamic_class_constructor(
        ObsMetadata(attributes_dict[component_type]),
        channel_modif.get(component_type, {}),
        selected_config)
    return obj
```

Here is the meat of the dynamic_class_constructor for each compoent (Datalogger, Sensor, or Preamplifier) class

```
def dynamic_class_constructor(cls, attributes_dict, channel_modif={},
                              selected_config={}):

    # ...
    stages_list = attributes_dict.get_configured_element(
        'stages', {}, selected_config, None)
    config_description = attributes_dict.get_configured_element(
        'configuration_description', channel_modif, selected_config, '')

    stages = Stages(stages_list,
                    channel_modif.get('stage_modifications', {}),
                    selected_config.get('stage_modifications', {}),
                    None)

    obj = cls(Equipment(ObsMetadata(attributes_dict.get('equipment', None)),
                        channel_modif.get('equipment', {}),
```

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```
                    selected_config.get('equipment', {})),
                stages,
                config_description)

    return obj
```

`stages.py`:

Passes `stage_modifications` (now in `channel_modif` and `selected_config` down to `Stage`

```
def __init__(self, attribute_list, channel_modif={}, selected_config={},
             correction=None, ext_config_name=None):
    # ...
        self.stages = []
        for s, i in zip(attribute_list, range(0, len(attribute_list))):
            # Assign correction value
            if correction is None:
                correction = None
            elif i == len(attribute_list)-1:
                correction = correction
            else:
                correction = 0
            self.stages.append(Stage(ObsMetadata(s),
                                     channel_modif,
                                     selected_config,
                                     correction,
                                     i+1,
                                     ext_config_name))
            # ...
```

`stage.py`:

Handles the `stage_modifications`, passing on any values that match the stage_sequence_number:

```
def __init__(self, attributes_dict, channel_modif_list={},
             selected_config={}, correction=None,
             sequence_number=-1, ext_config_name=None):
    stage_modif = self.get_stage_modifications(
        channel_modif_list, str(sequence_number - 1))
    self.configuration = od.base_get_configuration_name(ext_config_name)
    kwargs = {'channel_modification': stage_modif,
              'selected_configuration': selected_config,
              'ext_config_name': ext_config_name}
    name = od.base_configured_element('name', default='', **kwargs)

    # ...
```

## 10.6 File discovery

information files can import other information files using the *$ref* operator. This is based on the *jsonref* standard, but we have expanded it to also work on **YAML_** files and to allow several directories in which to search for the given filepaths. This is called the *datapath* and includes the files and urls specified in the ~/.obsinfo file.

The .obsinforc file is created in *main/setupObsinfo.py* and is read by *Datapath* objects through a call to *ObsinfoConfiguration.datapath*

I would also like to be able to search in the current file's directory, but haven't yet been able to figure out how, although this was probably the origina jsonRef default.

I think that the subfiles are read through the recursive *JsonRef.replace_refs()* classmethod, which is called by *yamlref.load()*, *yamlref.loads()* and *yamlref.load_uri()*.

Searching for *datapath* in *yamlref.py* suggests that its methods are only called in the derived property *JsonRef.full_uri* (see below), which is called by the *callback* method. The *callback* method appears to be intrinsic to the "proxytypes" superclass, but I don't understand it. According to python documents, it is called when its object is garbage collected???

One could possibly be inspired by the *jsonschema is True* case, because jsonschema always reads from the same directory. On the other hand, perhaps this directory is passed in the *base_uri* argument for jsonschema and not for the others?

```**python** @property def full_uri(self):

"""" This method/property returns the full uri to reference a `$ref` object. It's the heart of how a datapath is used to either access a local or remote (gitlab) file. All schema files are supposed to be local, part of the obsinfo distribution

**returns** updated full uri

**raises** ValueError

""""

kwargs = self._ref_kwargs

**if kwargs['jsonschema']:** return urlparse.urljoin(self.base_uri, self.__reference__["$ref"])

**else:** dp = kwargs["datapath"] if not dp:

msg = f'Error in datapath in full_uri, reference: {self.__reference__["$ref"]}' logger.error(msg) raise ValueError(msg)

base_uri = Path(dp.build_datapath(self.__reference__["$ref"]))

tupl = urlparse.urlsplit(str(base_uri)) path = unquote(tupl.path) frag = tupl.fragment new_uri = Datapath.add_frag(path, frag) # define the uri depending on whether it is remote or not self.base_uri = new_uri if gitLabFile.isRemote(str(base_uri))

else unquote(base_uri.as_uri())

return(self.base_uri)

```

I don't like that (the file *discoveryfiles.py* only contains the class *Datapath*, should rename to *datapath.py*)

## 10.7 ObsMetadata

`ObsMetadata` is a dict subclass that allows some advanced operations useful for **obsinfo_**. It has the additional methods:

- get_configured_element(): substitutes elements with selected or modification values
- get_information_file_format(): determines if an information file is in JSON or YAML format
- get_information_file_type(): determines the information file type ('network', etc)
- list_valid_types()
- read_json_yaml()
- read_json_yaml_ref()
- read_json_yaml_ref_datapath()
- validate()
- validate_date()
- validate_dates()

All but the first method seem like they should be in another class. I'm guessing Luis but them together to make sure that the output of any read was an ObsMetatdata object, but that should be just as easy to do with another class. . . .

This file is a stub.

## 10.8 Filters

**All of the following classes are subclsses of FilterTemplate:**

- Coefficients
- FIR
- PolesZeros
- ResponseList
- Polynomial
- ADConversion
- Analog
- Digital

They are NOT subclasses of Filter, which exists only to return one of the FilterTemplate subclasses. I therfore use Filter.construct() rather than Filter()

Filter.construct figures out which filter subclass to create, creates it and returns it.

The different filter types can be created using Filter.construct(). I think I do this to that we get back an object of one of the Filter subclasses (PoleZeros, )

## 10.9 Schema files

- Each file corresponds to a possible information file (with 1-2 exceptions)
- Do not use *allOf* or *anyOf* in schema files, unless the things they are comparing/combining are very short. Any failure just prints out everything downstream and says that couldn't find a match to *allOf* or *anyOf*, which is about useless for validating information files.

## 10.10 Logging

Logging is initiated at the top of each file using

```
import logging
logger = logging.getlogger('obsinfo')
```

This activates the logger that is initiated by each console script and which writes, by default, INFO level and above to a file in ~/.obsinfo/ and WARNING level and above to the console.

Each console script should have the following at the top:

```
from ..helpers import init_logging
logger = init_logging(name)
```

where `name` is the script name. File logs will be written to ~/.obsinfo/obsinfolog-{name}.

Here are the arguments for init_logging:

## 10.11 Testing

Testing is very important to minimize bugs, but also to show how routines should be called. Proper testing avoids the all-to-frequent case of a code modification breaking previously working parts, if there are enough tests covering these parts. In general, every method of a class should have a test and, if you discover a bug that is not covered by a test, you should add a test for it.

We implement testing using the unittest Unit testing framework (https://docs.python.org/3/library/unittest.html). Ideally, every submodule should have a `tests` directory with a `test.py` file. This allows you to concentrate on local tests when you are modifying code, and should keep the `test.py` codes from being too huge.

A good practice when you modify a function is to see if that function has a test code that will see what you are changing and, if not, to add it and run the test before and after your modifications.

To run all tests, go into the `obsinfo` top directory and run

The basic structure of the `test.py` files is:

..code-block:: python

> #!/usr/bin/env python # -- *coding: utf-8* -- “”” Test network and station classes “”” import warnings from pathlib import Path import unittest import difflib
>
> # Third party imports
>
> # obsinfo modules from obsinfo.network import (Station, Network)
>
> warnings.simplefilter(“once”) warnings.filterwarnings(“ignore”, category=DeprecationWarning) verbose = False

**class NetworkTest(unittest.TestCase):** “”” Class of test methods for network and station objects

**Attributes:**

**testing_path (str): path to datafiles to be tested aside from the** examples

level (str): level to be printed test (boolean): determines if this is test mode print_output (boolean): determines if this is print mode. Both can

coexist.

“””

**def setUp(self, test=True, print_output=False, level=None):** “”” Set up default values and paths “”” self.testing_path = Path(__file__).parent.joinpath(“data”)

self.level = level self.test = test self.print_output = print_output

**def assertTextFilesEqual(self, first, second, msg=None):**

**with open(first) as f:** str_a = f.read()

**with open(second) as f:** str_b = f.read()

**if str_a != str_b:** first_lines = str_a.splitlines(True) second_lines = str_b.splitlines(True) delta = difflib.unified_diff(

first_lines, second_lines, fromfile=first, tofile=second)

message = ‘’.join(delta) if msg:

message += ” : ” + msg

self.fail(“Multi-line strings are unequal:n” + message)

**def test_A(self):** “””Test of one method””” …

**def test_B(self):** “””Test of another method””” …

**def test_C(self):** “””Test of yet another method””” …

**def suite():** return unittest.makeSuite(NetworkTest, ‘test’)

**if __name__ == ‘__main__’:** unittest.main(defaultTest=’suite’)

CHAPTER

# ELEVEN

# TECHNICAL DOCUMENTATION

## 11.1 Code Documentation: obsinfo package

### 11.1.1 Subpackages

#### obsinfo.network package

Contains the main classes from Network to Station

#### obsinfo.network module

#### obsinfo.network.network module

#### obsinfo.network.Network class

#### obsinfo.network.Station class

#### obsinfo.network.Station class

#### obsinfo.network.station module

#### obsinfo.network.processing module

#### obsinfo.instrumentation package

#### obsinfo.instrumentation.instrumentation module

Instrumentation class

**class** `obsinfo.instrumentation.instrumentation.`**`Instrumentation`**(*attributes_dict*, *station_locations*, *station_location_code*, *station_start_date*, *station_end_date*)

Bases: `object`

One or more Instrument Channels. Part of an obspy/StationXML Station

Methods convert info files to an instance of this class. No equivalent obspy/StationXML class

A more detailed description the class and its attributes is found in XXX

**`equipment`**

**Type** `Equipment`

**`channels`**

list of channels (`Channel`)

**Type** list

**`__init__`**(*attributes_dict*, *station_locations*, *station_location_code*, *station_start_date*, *station_end_date*)

Constructor

attributes_dict may contain a configuration_selection for the instrumentation and the corresponding configs for the components: datalogger, preamplifier and sensor

**Parameters**

- **`attributes_dict`** (dict or `ObsMetadata`) – instrumentation attributes
- **`station_locations`** (`Locations`) – list of Locations
- **`station_location_code`** (*`str`*) – station's location code
- **`station_start_date`** (*`str`*) – station start date
- **`station_end_date`** (*`str`*) – station end date

It is assumed an instrumentation's default location, start date and end_date are the same as its station's.

**`class`** `obsinfo.instrumentation.instrumentation.`**`Instrumentations`**(*instrumentations_list*)

Bases: `obsinfo.helpers.obsinfo_class_list.ObsinfoClassList`

A list of Instrumentation objects

**`__init__`**(*instrumentations_list*)

**Parameters** **`instrumentations_list`** – (list of *`Instrumentations`*):

## obsinfo.instrumentation.channel module

Channel, Instrument and Operator classes

**`class`** `obsinfo.instrumentation.channel.`**`Channel`**(*attributes_dict*, *ic_modifs: dict*, *location*, *equipment*)

Bases: `object`

Corresponds to StationXML/obspy Channel plus channel code

**`das_channel`**

represents a channel with defaults incorporated

**Type** `ObsMetadata`

**`location`**

location for this channel

**Type** `Location`

**`start_date`**

inherited from Station

**Type** str

**`end_date`**

inherited from Station

**Type** str

**`instrument`**

a sensor, a datalogger and an optional preamplifier

**Type** `Instrument`

**orientation**
: **Type** `Orientation`

**comments**
: **Type** list of str

**`__init__`**(*attributes_dict*, *ic_modifs: dict*, *location*, *equipment*)
Constructor

**Parameters**
- **attributes_dict** (dict or `ObsMetadata`) – channel attributes
- **ic_modifs** (dict or `ObsMetadata`) – modifications to pass through to InstrumentComponents
- **location** (`Location`) – channel location
- **equipment** (`Equipment`) – channel equipment

**channel_code**(*sample_rate*)
Return channel code for a given sample rate.

Validates instrument and orientation codes according to FDSN specifications (for instruments, just the length). Channel codes specified by user are indicative and are refined using actual sample rate.

**Parameters** **sample_rate** (*float*) – instrumentation sampling rate (sps)

**property seed_code**
This is equivalent to channel code for self.instrument.sample_rate

**to_obspy**()
Create obspy Channel object

**Returns** *obspy.core.inventory.channel.Channel*)

**Return type** (~class

**class** `obsinfo.instrumentation.channel.`**Channels**(*channels_list=None*)
Bases: `obsinfo.helpers.obsinfo_class_list.ObsinfoClassList`

A list of Channel objects

**`__init__`**(*channels_list=None*)

**Parameters** **channels_list** – (list of `Instrumentations`):

## obsinfo.instrumentation.instrument_component module

InstrumentComponent class and subclasses Sensor, Preamplifier, Datalogger. Equipment class

**class** `obsinfo.instrumentation.instrument_component.`**Datalogger**(*attributes_dict*, *higher_modifs={}*)
Bases: *`obsinfo.instrumentation.instrument_component.InstrumentComponent`*

Datalogger Instrument Component.

Obspy ``Datalogger` only contains elements of `Equipment`, rest is in Response

**equipment**
equipment attributes

**Type** `Equipment`

**stages**
channel modifications inherited from station

**Type** `Stages`

**sample_rate**
sample rate of given configuration. Checked against actual sample rate

**Type** float

`correction`
the delay correction of the component. If a float, it is applied to the last stage and the other stage corrections are set to 0. If None, each stage's correction is set equal to its delay
**Type** float or None

**`__init__`**(*attributes_dict*, *higher_modifs={}*)

**Parameters**
- **`attributes_dict`** (dict or `ObsMetadata`) – InstrumentComponent attributes
- **`higher_modifs`** (dict or `ObsMetadata`) – modifications inherited from instrumentation

**Returns** (*`Datalogger`*)

`class obsinfo.instrumentation.instrument_component.`**`InstrumentComponent`**(*attributes_dict*, *higher_modifs={}*)
Bases: `object`

InstrumentComponent class. Superclass of all component classes. No obspy/StationXML equivalent, because they only specify the whole sensor+amplifier+datalogger system

`equipment`
**Type** `Equipment`

`stages`
**Type** `Stages`

`obspy_equipment`
**Type** `obspy_Equipment`

`configuration_description`
description of configuration to be added to equipment description
**Type** str

**`__init__`**(*attributes_dict*, *higher_modifs={}*)
Creator.
**Parameters**
- **`attributes_dict`** (dict or `ObsMetadata`) – InstrumentComponent attributes
- **`higher_modifs`** (dict or `ObsMetadata`) – modifications inherited from instrumentation

`class obsinfo.instrumentation.instrument_component.`**`Preamplifier`**(*attributes_dict*, *higher_modifs={}*)
Bases: *`obsinfo.instrumentation.instrument_component.InstrumentComponent`*

Preamplifier Instrument Component. No obspy equivalent
**Attributes:** equipment (`Equipment`): Equipment information stages (`Stages`): channel modifications inherited from station configuration_description (str): the configuration description that was
selected, added to equipment description

**`__init__`**(*attributes_dict*, *higher_modifs={}*)

**Parameters**
- **`attributes_dict`** (dict or `ObsMetadata`) – InstrumentComponent attributes
- **`higher_modifs`** (dict or `ObsMetadata`) – modifications inherited from instrumentation

`class obsinfo.instrumentation.instrument_component.`**`Sensor`**(*attributes_dict*, *higher_modifs={}*)
Bases: *`obsinfo.instrumentation.instrument_component.InstrumentComponent`*

Sensor Instrument Component. No obspy equivalent

**`equipment`**
Equipment information
**Type** *`Equipment`*

**`seed_band_base_code`**
SEED base code ("B" or "S") indicating instrument band. Must be modified by obsinfo to correspond to output sample rate. Actual SEED base code is determined by FDSN standard <http://docs.fdsn.org/projects/source-identifiers/en/v1.0/channel-codes.html>`
**Type** str (len 1)

**`seed_instrument code`**
SEED instrument code, determined by *FDSN standard <http://docs.fdsn.org/projects/source-identifiers/en/v1.0/channel-codes.html>*
**Type** str (len 1)

**`stages`**
channel modifications inherited from station
**Type** `Stages`

**`__init__`**(*attributes_dict*, *higher_modifs={}*)
Create Sensor instance from an attributes_dict
**Parameters**
- **`attributes_dict`** (dict or `ObsMetadata`) – InstrumentComponent attributes
- **`higher_modifs`** (dict or `ObsMetadata`) – modifications inherited from instrumentation

## obsinfo.instrumentation.response_stages module

Stages and Stage classes

**`class`** `obsinfo.instrumentation.stages.`**`Stages`**(*attribute_list=None*, *higher_modifications={}*, *correction=None*)
Bases: `obsinfo.helpers.obsinfo_class_list.ObsinfoClassList`

Ordered list of `Stage`.

Has a custom constructor using a list of attribute_dicts, and custom input_units(), output_units and to_obspy() methods

**`stages`**
**Type** list of objects of `Stage`

**`__init__`**(*attribute_list=None*, *higher_modifications={}*, *correction=None*)
Constructor
**Parameters**
- **`attribute_list`** (*`list of dicts`*) – information file dictionaries for each stage
- **`higher_modifications`** (dict or `ObsMetadata`) – modifications to pass down to Stage
- **`correction`** (*`float`*) – used only for datalogger: the delay correction for the entire instrument

**`property calibration_dates`**

**`property input_units`**

**`property output_units`**

### obsinfo.instrumentation.filter module

Filter classes: - Coefficients - FIR - PolesZeros - ResponseList - Polynomial (never tested) - ADConversion (subclass of PolesZeros) - Analog (subclass of PolesZeros) - Digital (subclass of Coefficients)

### obsinfo.instrumentation.equipment module

InstrumentComponent class and subclasses Sensor, Preamplifier, Datalogger. Equipment class

`class obsinfo.instrumentation.equipment.`**`Equipment`**(*attributes_dict*)

Bases: `obspy.core.inventory.util.Equipment`

Equipment.

Equivalent to :class: obspy.core.inventory.util.Equipment

**`type`**

**Type** str

**`channel_modif`**

**Type** str

**`selected_config`**

**Type** str

**`description`**

**Type** str

**`manufacturer`**

**Type** str

**`model`**

**Type** str

**`vendor`**

**Type** str

**`serial_number`**

**Type** str

**`installation_date`**

**Type** str in date format

**`removal_date`**

**Type** str in date format

**`calibration_dates`**

**Type** str in date format

**`resource_id`**

**Type** str

**`obspy_equipment`**

**Type** class *obspy.core.inventory.equipmentEquipment*

**`__init__`**(*attributes_dict*)

Constructor

**Parameters** **`attributes_dict`** (dict or `ObsMetadata`) – attributes of component

**`to_obspy`**()

Convert an equipment (including the equipment description in components) to its obspy object

**Returns** (`obspy.core.invertory.util.Equipment`)

### obsinfo.instrumentation.location module

### obsinfo.instrumentation.orientation module

Orientation class

**class** `obsinfo.instrumentation.orientation.`**`Orientation`**(*attributes_dict*)

Bases: `object`

Class for sensor orientations. No channel modifs. Cannot change orientation as it is part of the channel identifiers. Azimuth and dip can be changed Orientation is coded by *FDSN standard <http://docs.fdsn.org/projects/ source-identifiers/en/v1.0/channel-codes.html>*

**These are the dips to give for vertical/hydrophone channels:**

**-90°:**

- vertical seismometer with positive voltage corresponding to upward motion (typical seismometer)
- hydrophone with positive voltage corresponding to increase in pressure (compression)

**90°: vertical seismometer with positive voltage corresponding to**
downward motion (typical geophone),

- hydrophone with positive voltage corresponding to decrease in pressure (dilatation)

**`code`**

Single-letter orientation code

**Type** str

**`azimuth`**

azimuth in degrees, clockwise from north

**Type** `FloatWithUncert`

**`dip`**

dip in degrees, -90 to 90, positive=down, negative=up

**Type** `FloatWithUncert`

**`__init__`**(*attributes_dict*)

Constructor

**Parameters** **`attributes_dict`** (dict or `ObsMetadata`) – Orientation dictionary with key = orientation code

### obsinfo.obsMetadata package

### obsinfo.obsMetadata.obsmetadata module

### obsinfo.main package

### obsinfo.main.makeStationXML module

### obsinfo.main.print module

### obsinfo.main.setupObsinfo module

### obsinfo.main.validate module

### obsinfo.misc package

### obsinfo.misc.configuration module

`class obsinfo.misc.configuration.`**`Singleton`**`(`*cls*`)`

Bases: `object`

Class to implement singleton pattern design in Python

**`Instance`**`()`

### obsinfo.misc.const module

Exit values as constants as per UNIX BSD standard

### obsinfo.misc.discoveryfiles module

`class obsinfo.misc.discoveryfiles.`**`Datapath`**`(`*datapath=None*`)`

Bases: `object`

Class to discover where information files are stored.

**`datapath_list`**

directories where information files will be searched, in sequence

**Type** list of str

**`infofiles_path`**

same as datapath_list, used by validate, kept for compatibility

**Type** list of str

**`validate_path`**

one unique path to validation schemas

**Type** str

`static` **`add_frag`**`(`*path*, *frag*`)`

Add the path and the frag to restore a partial or complete uri

**Parameters**

- **`path`** (*`str`*) – path portion of uri, possibly with other elements but without frag
- **`frag`** (*`str`*) – fragment portion of uri

**Returns** (str)L path with frag

**`build_datapath`**`(`*file*`)`

Create list of directories which may have data or schemas

1) If the file path is absolute, return the file itself.
2) If path starts by ./ or ../ complete to an absolute path using working directory
3) If the file has no prefix discover whether file exists in the datapath list. Use the first found file.

**Parameters** **`file`** (*`str or path`*) – filename of file to be found

**Returns** found file as string

**Raises** **`FileNotFoundError`** –

### obsinfo.misc.printobs module

Functions to print obsinfo objects

**class** `obsinfo.misc.printobs.`**`PrintObs`**

Bases: `object`

Collection of methods to print obsinfo objects at different levels of depth. All methods are static.

**`\*None*`**

**static** **`print_component`**(*obj*, *level='all'*)

Prints comoponent information and continues if level is not "component" or "channel".

If level is not "channel" detailed equipment information is not printed.

**Parameters** **`level`** (*`str`*) – determines to which level the *obsinfo* object will be printed

**static** **`print_instrumentation`**(*obj*, *level='all'*)

Prints instrumentation information and continues if level is not "instrumentation".

If level is "response" or "all" response stages information will be printed (if it exists). Recall at this point all the response is gathered in `instrument.stages.sgates` If level is "all" or "filter" (i.e. not "response") all information will be printed (only filter is left at this point…)

**Parameters** **`level`** (*`str`*) – determines to which level the *obsinfo* object will be printed

**static** **`print_network`**(*obj*, *level='all'*)

Prints network information and continues if level is not "network".

**Parameters** **`level`** (*`str`*) – determines to which level the *obsinfo* object will be printed

**static** **`print_station`**(*obj*, *level='all'*)

Prints station information and continues if level is not "station".

**Parameters** **`level`** (*`str`*) – determines to which level the *obsinfo* object will be printed

### obsinfo.misc.remoteGitLab module

**class** `obsinfo.misc.remoteGitLab.`**`gitLabFile`**

Bases: `object`

Provide the methods to use the gitlab API to read a remote file and decode it

**`\*None*`**

**static** **`get_gitlab_file`**(*uri*, *read_file=True*)

Get the file content pointed at by uri and decode it.

Uses b64 first to get the remote file and convert to a byte string, and then utf-8 to convert to regular string.

**Parameters**

- **`uri`** (*`string or path-like`*) – uri to read
- **`(bool)`** (*`read_file`*) – If true, reads the content. If not, simply checks if the file exists

**Returns** read content

**Return type** (str)

Raises: FileNotFoundError, ValueError

**static** **`isRemote`**(*file*)

Checks if scheme means file is remote.

**Parameters** **`file`** (*`str`*) – filename to be checked, with complete uri

**Returns** boolean. True if remote, False otherwise

## obsinfo.misc.yamlref module

Module to read and parse YAML or JSON files, locally or remotely (gitlab only)

jsonref with YAML reading added.

copied directly from jsonref v0.2, with added routines _yaml_load and _yaml_loads replacing json.load and json.loads Added/modified lines are marked “# WCC”

class obsinfo.misc.yamlref.**JsonLoader**(*store=()*, *cache_results=True*)

Bases: `object`

Provides a callable which takes a URI, and returns the loaded JSON referred to by that URI. Uses `requests` if available for HTTP URIs, and falls back to `urllib`. By default it keeps a cache of previously loaded documents.

**Attributes:**

- **store: pre-populated dictionary matching URIs to loaded JSON** documents used as cache
- cache_results (boolean): if this is set to false, the internal cache of
- loaded JSON documents is not used

**__init__**(*store=()*, *cache_results=True*)

**get_json_or_yaml**(*uri*, ***kwargs*)

Open either a local file, if uri scheme is `file` or a remote one, calling a gitlab method which implements the gitlab API (version 4)

**Parameters**

- **uri** (*path-like object, string or byte string*) – The URI of the JSON or YAML document to load
- **kwargs** (*dict*) – Keyword arguments passed to `json.loads()`

**Returns** dictionary of parsed YAML or JSON formats

**Raises** FileNotFoundError, IOError, OSError

class obsinfo.misc.yamlref.**JsonRef**(*refobj*, *base_uri=''*, *loader=None*, *jsonschema=False*, *load_on_repr=True*, *_path=()*, *_store=None*, *datapath=None*)

Bases: `proxytypes.LazyProxy`

A lazy loading proxy to the dereferenced data pointed to by a JSON Reference object.

**Attributes:**

- __reference__: dictionary object referenced to by a `$ref`
- base_uri: object of type `Path` which is used to build the full uri
- loader: a loader object (a callable) such as *JsonLoader*, to load a JSON or YAML file/string
- jsonschema = Flag to turn on `JSON Schema` mode
- **load_on_repr = If set to `False`, `repr()` call on a** *JsonRef* object will not cause the reference to be loaded if it hasn’t already. (defaults to `True`)
- path = list of string keywords: keywords of different $ref in lists or dictionaries
- store = dictionary of cached objects used to prevent reading files over again
- datapath = object of `Datapath`, stores directories to search for files

**__init__**(*refobj*, *base_uri=''*, *loader=None*, *jsonschema=False*, *load_on_repr=True*, *_path=()*, *_store=None*, *datapath=None*)

**callback**()

Callback from proxytypes, `LazyProxy`.

Resolves the pointer (part of the dictionary read from the info file) that is incorporated instead of `$ref`. Updates `base_uri`

**Returns**

**the fragment portion of the base_doc, which has already had its** `$ref` replaced.

property **full_uri**

This method/property returns the full uri to reference a `$ref` object. It’s the heart of how a datapath is used to either access a local or remote (gitlab) file. All schema files are supposed to be local, part of the obsinfo distribution

**Returns** updated full uri

**Raises** ValueError

**classmethod replace_refs**(*obj*, *_recursive=False*, ***kwargs*)

Returns a deep copy of `obj` with all contained JSON reference objects replaced with *JsonRef* instances.

**Parameters**

- **obj** (*JSONRef* or *collection`*) – If a JSON reference object, a *JsonRef* instance will be created. If not, a deep copy of it will be created with all contained JSON reference objects replaced by *JsonRef* instances
- **recursive** (*bool*) – Process `$ref` recursively
- **kwargs** (*dict*) – Keyword arguments passed to `json.loads()`

**Returns** the information in `$ref` file

**Return type** obj ():class:*JsonRef*)

**Raises TypeError, ValueError through JsonRef object creation** –

**kwargs include:**

**base_uri (Path): URI to resolve relative references** against. Can be remote (https://) or local(file://) This is how datapath is implemented

**datapath (Datapath): object to implement file** discovery in a list of directories

**loader (loader object such as *JsonLoader*): Callable that** takes a URI and returns the parsed JSON (defaults to global `jsonloader`, a *JsonLoader* instance)

**jsonschema (bool): Flag to turn on JSON Schema mode,** which means the file is a schema file. This makes 'id' keyword to change the `base_uri` for references contained within the object, such as $ref: '#/definitions'

**load_on_repr (bool): If set to False, repr() call on a** *JsonRef* object will not cause the reference to be loaded if it hasn't already. (defaults to `True`)

**resolve_pointer**(*document*, *pointer*)

Resolve a json pointer `pointer` within the referenced `document`.

**Parameters**

- **document** – the referent document
- **pointer** (*str*) – a json pointer URI fragment to resolve within it

**Returns** part of document dictionary pointed at by pointer

**exception** obsinfo.misc.yamlref.**JsonRefError**(*message*, *reference*, *uri=''*, *base_uri=''*, *path=()*, *cause=None*)

Bases: `Exception`

Create exception for JSONRef

**Attributes:**

- message (str): message to print with exception
- reference (str): reference where exception occurred
- uri (str or path-like): uri of file being processed
- base_uri: (str or path-like): base_uri (complement) of file being processed
- path = list of string keywords: keywords of different $ref in lists or dictionaries
- cause (str): cause of exception

**__init__**(*message*, *reference*, *uri=''*, *base_uri=''*, *path=()*, *cause=None*)

obsinfo.misc.yamlref.**dump**(*obj*, *fp*, ***kwargs*)

Serialize `obj` as a JSON formatted stream to file-like `fp`

`JsonRef` objects will be dumped as the original reference object they were created from.

**Parameters**

- **obj** – Object to serialize
- **fp** (*File-like object*) –

- **kwargs** (*dict*) – Keyword arguments for `json.dumps()`

`obsinfo.misc.yamlref.`**`dumps`**`(`*obj*, ***kwargs*`)`

Serialize `obj`, which may contain *JsonRef* objects, to a JSON formatted string. `JsonRef` objects will be dumped as the original reference object they were created from.

**Parameters**

- **obj** – Object to serialize
- **kwargs** (*dict*) – Keyword arguments for `json.dumps()`

**Returns** dumped string

`obsinfo.misc.yamlref.`**`load`**`(`*fp*, *base_uri=''*, *loader=None*, *jsonschema=False*, *load_on_repr=True*, *datapath=None*, ***kwargs*`)`

Drop in replacement for `json.load()`, where JSON references are proxied to their referent data.

The difference between load and loads is that the first uses a file-like object and the second a string.

**Parameters**

- **fp** (*File-like object*) – File-like object containing JSON document
- **base_uri** (object of type `Path`) – URI to resolve relative references against. Can be remote (https://) or local(file://) This is how datapath is implemented
- **datapath** (object of type `Datapath`) – object to implement file discovery in a list of directories
- **loader** (a loader object such as *JsonLoader*) – Callable that takes a URI and returns the parsed JSON (defaults to global `jsonloader`, a *JsonLoader* instance)
- **jsonschema** (*boolean*) – Flag to turn on JSON Schema mode, which means the file is a schema file. This makes 'id' keyword to change the `base_uri` for references contained within the object, such as $ref: '#/definitions'
- **load_on_repr** (*boolean*) – If set to `False`, `repr()` call on a:class:*JsonRef* object will not cause the reference to be loaded if it hasn't already. (defaults to `True`)
- **kwargs** (*dict*) – This function takes any of the keyword arguments from *JsonRef.replace_refs()*. Any other keyword arguments will be passed to `_yaml_load()`

**Returns** dictionary of parsed YAML or JSON formats

`obsinfo.misc.yamlref.`**`load_uri`**`(`*uri*, *base_uri=None*, *datapath=None*, *loader=None*, *jsonschema=False*, *load_on_repr=True*`)`

**Load JSON data from `uri` instead of file-like object or string.** with JSON references proxied to their referent data. Not used in obsinfo.

**Parameters**

- **uri** (*string or path-like object*) – URI to fetch the JSON from
- **base_uri** (`Path`) – URI to resolve relative references against. Can be remote (https://) or local(file://) This is how datapath is implemented
- **datapath** (`Datapath`) – object to implement file discovery in a list of directories
- **loader** (loader object such as *JsonLoader*) – Callable that takes a URI and returns the parsed JSON (defaults to global `jsonloader`, a *JsonLoader* instance)
- **jsonschema** (*bool*) – Flag to turn on JSON Schema mode, which means the file is a schema file. This makes 'id' keyword to change the `base_uri` for references contained within the object, such as $ref: '#/definitions'
- **load_on_repr** (*bool*) – If set to `False`, `repr()` call on a class:*JsonRef* object will not cause the reference to be loaded if it hasn't already. (defaults to `True`)

**Returns** parsed YAML or JSON formats

**Return type** newref (dict)

`obsinfo.misc.yamlref.`**`loads`**`(`*s*, *base_uri=''*, *loader=None*, *jsonschema=False*, *load_on_repr=True*, *datapath=None*, *recursive=True*, ***kwargs*`)`

Drop in replacement for `json.loads()`, where JSON references are proxied to their referent data.

The difference between load and loads is that the first uses a file-like object and the second a string.

**Parameters**

- **s** (*str*) – Input JSON document
- **base_uri** (Path) – URI to resolve relative references against. Can be remote (https://) or local(file://) This is how datapath is implemented
- **datapath** (Datapath) – object to implement file discovery in a list of directories
- **loader** (loader object such as *JsonLoader*) – Callable that takes a URI and returns the parsed JSON (defaults to global `jsonloader`, a *JsonLoader* instance)
- **jsonschema** (*bool*) – Flag to turn on JSON Schema mode, which means the file is a schema file. This makes 'id' keyword to change the `base_uri` for references contained within the object, such as $ref: '#/definitions'
- **load_on_repr** (*bool*) – If set to `False`, `repr()` call on a *JsonRef* object will not cause the reference to be loaded if it hasn't already. (defaults to `True`)
- **kwargs** (*dict*) – Any of the keyword arguments from *JsonRef.replace_refs()*. Any other keyword arguments will be passed to `_yaml_load()`

**Returns** decoded JSON or YAML

**Return type** dic (dict)

## obsinfo.tests package

### obsinfo.tests.remoteGithub module

`obsinfo.tests.remoteGithub.`**`constructURL`**(*user='404'*, *repo_name='404'*, *path_to_file='404'*, *url='404'*)

### obsinfo.tests.test module

### obsinfo.tests.testmain module

## obsinfo.addons package

### obsinfo.addons.LCHEAPO module

Write extraction script for LCHEAPO instruments (proprietary to miniseed)

`obsinfo.addons.LCHEAPO.`**`process_script`**(*network_code*, *station*, *station_dir*, *distrib_dir*, *input_dir='.'*, *output_dir='miniseed_basic'*, *include_header=True*)

Writes script to transform raw OBS data to miniSEED

**Parameters**

- **network_code** (*str*) – FDSN network_code
- **(** (*station*) – class: ~obsinfo.Station): the station to process
- **station_dir** (*str*) – the base directory for the station data
- **distrib_dir** (*str*) – directory where the lcheapo executables and property files are found
- **input_dir** (*str*) – directory beneath station_dir for LCHEAPO data
- **output_dir** (*str*) – directory beneath station_dir for basic miniseed]
- **include_header** (*bool*) – include the header that sets up paths (should be done once)

### obsinfo.addons.SDPCHAIN module

Generate scripts needed to go from basic miniSEED to data center ready

`obsinfo.addons.SDPCHAIN.`**`process_script`**`(`*station*, *station_dir*, *distrib_dir='/opt/sdpchain'*, *input_dir='miniseed_basic'*, *corrected_dir='miniseed_corrected'*, *extra_commands=None*, *include_header=True*, *SDS_uncorr_dir='SDS_uncorrected'*, *SDS_corr_dir='SDS_corrected'*, *SDS_combined_dir='SDS_combined'*`)`

Writes OBS data processing script using SDPCHAIN software

**Parameters**

- **`station`** – an obsinfo.station object
- **`station_dir`** – base directory for the station data
- **`input_dir`** – directory beneath station_dir for input (basic) miniseed data ['miniseed_basic']
- **`corrected_dir`** – directory beneath station_dir for output (corrected) miniseed data ['miniseed_corrected']
- **`SDS_corr_dir`** – directory beneath station_dir in which to write SDS structure of corrected data (ideally ../SOMETHING if ms2sds could write all to the same directory)
- **`SDS_uncorr_dir`** – directory beneath station_dir in which to write SDS structure of uncorrected data (ideally ../SOMETHING if ms2sds could write all to the same directory)
- **`include_header`** – whether or not to include the bash script header ('#!/bin/bash') at the top of the script [True]
- **`distrib_dir`** – Base directory of sdpchain distribution ['/opt/sdpchain']

**The sequence of commands is:**

1. optional proprietary format steps (proprietary format -> basic miniseed, separate)
2. optional extra_steps (any cleanup needed for the basic miniseed data, should either overwrite the existing data or remove the original files so that subsequent steps only see the cleaned data)
3. ms2sds on basic miniseed data
4. leap-second corrections, if necessary
5. msdrift (creates drift-corrected miniseed)

### obsinfo.addons.LC2SDS module

Write a script to convert LCHEAPO data to SDS* using the lcheapo** python package

Includes clock drift and leap-second correction Script is a BASH shell script *SDS = SeisComp Data Structure **THIS PROGRAM DOES NOT CREATE DATA-CENTER QUALITY DATA:

- drift correction is calculated for each day, not each record
- does not set drift correction record header flags
- does not fill in record header time_correction field

`obsinfo.addons.LC2SDS.`**`process_script`**`(`*network_code*, *stations*, *station_data_path*, *input_dir='.'*, *output_dir='../'*, *include_header=True*, *no_drift_correct=False*`)`

Writes script to transform raw OBS data to SeisComp Data Structure

**Parameters**

- **`network_code`** (`str`) – FDSN network_code
- **`stations`** (list of `Station`) – the stations to process
- **`station_data_path`** (`str`) – the base directory beneath the station data dirs
- **`input_dir`** (`str`) – directory beneath station_dir for LCHEAPO data

- **output_dir** (*str*) – directory beneath station_dir for SDS directory
- **include_header** (*bool*) – include the header that sets up paths (should be done once)
- **no_drift_correct** (*bool*) – Do NOT drift correct

### 11.1.2 obsinfo.print_version module

### 11.1.3 obsinfo.version module

CHAPTER

TWELVE

# CHANGELOG

- **0.110.11:**
  - Added obsinfo-makescripts-LC2SDS
- **0.110.12:**
  - Fixed bug in clock correction reading (leapsecond and drift)
  - Made obsinfo-makescripts-LC2SDS write to campaign directory by default
  - **Fixed some (not all) StationXML bugs:**
    * Made clock correction Comments using JSON
    * Removed *restrictedStatus='unknown'* (invalid) from StationXML
    * Fixed bugs in Decimation filters and stage #s
    * Standardized uncertainties in Poles, Zeros, Elevation, Dip, Azimuths
  - **Bugs that will probably have to wait for version 0.111:**
    * instrumentation serial number and configurations not accounted for
- **0.110.13:**
  - Made all obsinfo-test cases work
  - Added "serial_number" to station level (temporary fix before v 0.111)
  - Updated JSON schema to draft07, allowing more precise/compact information on mutiple-choice errors (e.g., different types of filter)
- **0.110.14:**
  - Added StationXML test case and made it work
  - made `python -m unittest discover` work
- **0.110.15:**
  - corrected JSON validation schema for `orientation_code`
  - improved azimuth.deg and dip.deg schema definitions
  - Fixed a bug in reporting schema validation errors (in *obsmetadata.py*) introduced when shifting to draft07
  - Reduced a bug when a jsonref points to an inexistent pointer within a file
  - Uses Python 3.8-dependent syntax despite only requiring Python 3!
- **0.110.16:**

  - Clean up information file validation, removing many redundancies in main/validate.py and hopefully fixing bug where schema files lacking ".schema.yaml" are searched for
  - Requires Python 3.7 syntax and only uses 3.7-dependent syntax
  - *post2*: streamlines *obsinfo-makescripts_LC2SDS*'s output
- **0.110.17:**
  - **Improvements to channel_modifications:**
    - Make reading a new sensor, datalogger or preamplifier work
    - Enable shortcuts for entering serial number
    - Updated documentation
  - Added developer and information_file documentation in channel_modifications/
  - Moved tests up to united top-level directory
  - *offset* can be a non-integer
- **0.110.18:**
  - Added datacite information file
  - Added schema and validation of datacite, author, location_base, network_info and operator information files
  - Cleaned up some information file validation glitches

CHAPTER

THIRTEEN

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# PYTHON MODULE INDEX

# INDEX