Extended FDSN source identifiers preamble

As of this writing, this specification should be considered a working, transitional definition of an identifier. If the FDSN adopts this or another source identifier that includes the enhancements defined here, it should be used instead.

Background and context

Adopted by the FDSN in 1987, the SEED format has become and still serves as the canonical format for passive source seismic (and other) data. This document contains a specification for a source identifier scheme to be used in next generation time series format and other FDSN formats.

A unique data source is identified in using a combination of network, station, location and channel codes. This specification describes the rules of how these identifiers are to be used.

Overview of significant changes between identifiers defined in SEED 2.4 and this specification

- Expand maximum length of each code as follows:
    - network: 2 => 8 characters
    - station: 5 => 8 characters
    - location: 2 => 8 characters

- Subdivide the channel code into individual codes, allowing expansion of each:
    - channel => "BAND_SOURCE_POSITION", where
        - BAND indicates the general sampling rate and response band of the data source
        - SOURCE is a code identifying an instrument or other data producer and
        - POSITION is a code identifying orientation or otherwise relative position
    - Single character versions of these individual codes are the same as SEED 2.4
        - Example: SEED 2.4 channel "BHZ" maps to "B_H_Z"

- Allow dash "-" character, ASCII 45, in station and location codes.

- Specify a Uniform Resource Name (URN) known as a "source identifier" (SID) constructed from a combination of the network, station, location and channel codes. This URN provides a convenient, flexible, single identifier for use in data formats, request mechanisms, etc. while allowing mapping back-and-forth between the URN and the separate codes as needed.

- Define rules for temporary network code: must end in a 4 digit year identifying the start year.

Examples of scenarios where further instruments or data source definitions are needed

- Synthetic time series
- Derived time series, e.g. conversion of geodetic measurements into a seismogram-like waveform
- Operational measurements such a "latency of a channel" and other state of health information that is otherwise well suited to be stored as a time series along with the recorded data

In many cases, the lack of a clear way to identify these data sources has forced manufacturers, operators and data centers to create, with little or no coordination, channel codes that do not conform to any convention agreed convention.

Extended FDSN source identifier specification

Version 2019-5-6

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Section 1: Overview

Purpose

The International Federation of Digital Seismograph Networks (FDSN)[1] defines a number of codes, that, when combined in a hierarchy, uniquely identify a data source in FDSN data formats. A source is identified using a combination of network, station, location and channel codes, where the channel code is further subdivided into band, source and position codes. This specification defines the meaning and rules for these codes and in addition to how they are to be combined into a Uniform Resource Name.

Background

The Standard for the Exchange of Earthquake Data (SEED)[2] was adopted by the FDSN in the 1980s and served as the dominant standard for seismological data archiving and exchange for decades. This specification defines a format to store both time series and a rich set of related metadata. This specification of identifiers is an expansion and enhancement of the identifiers defined in SEED version 2.4.

[1] The International Federation of Digital Seismograph Networks (FDSN): http://www.fdsn.org/
[2] FDSN SEED format: http://www.fdsn.org/publications/

Section 2: Definition of identifiers

Data sources are uniquely defined using a sequence of codes named network, station, location and channel, where the channel is further subdivided into band, source and position codes. Each of these codes must be composed of the following ASCII character sets:

- Uppercase [A-Z], ASCII 65 through 90
- Numeric [0-9], ASCII 48 through 57

The station and location codes may further be composed of the following ASCII character:

- Dash “-”, ASCII 45

The codes are further defined as follows:

Network code: Uniquely identifies the owner and network operator responsible for the data. This identifier is assigned by the FDSN. Must be between 1 and 8 characters.

Station code: Uniquely identifies a station within a network. Must be between 1 and 8 characters.

Location code: Uniquely identifies a group of channels within a station, for example from a specific sensor or sub-processor. Must not exceed 8 characters. The special value of “--” is forbidden as it conflicts with previous usage for designating empty locations.

Channel: A sequence of codes that identify the band, source and position. Values for each of these codes are defined in *Section 6: Definition of channel codes*.

Band: Indicates the general sampling rate and response band of the data source. May be empty.

Source: Identifies an instrument or data source. Cannot be empty.

Position: Identifies the orientation or otherwise relative position. May be empty.

Source identifiers as a URN

The source identifier is a combination of the network, station, location, band, source and position codes into a Uniform Resource Name (URN) as defined by RFC 3986. The pattern of the source identifier URN is as follows:

XFDSN:<network>_<station>_<location>_<band>_<source>_<position>

where the network, station and source codes are required to be non-empty. The underscore (ASCII 95) delimiters must always be present.

Example identifiers:
XFDSN:IU_COLA_00_B_H_Z (where network=IU, station=COLA, location=00 and channel=B_H_Z)
XFDSN:NL_HGN__L_H_Z (where network=NL, station=HGN, location is empty and channel=L_H_Z)

The “XFDSN:” portion is a namespace identifier reserved to identify this specification.

The formal “urn:” prefix is not included in the source identifiers as they are already identified as URNs.

Temporary network codes convention

As a convenience, network codes for deployments that are known to be temporary may include the 4-digit start year of the deployment at the end of the code with the following pattern:

<1-4 characters><4-digit start year>

For example, "SEIS2018" would be a valid network code and imply that the initial deployment was in the year 2018 and is temporary.

Transitional mapping of previously allocated temporary network codes

Historical temporary network codes were allocated as two-character codes, with the first character being a digit or the letters X, Y or Z. Many of these codes have been reused for different deployments in different years and are therefore not globally unique. A data owner or delegate data center may wish to convert, or provide an alias, for data using the older, 2-character codes. The mapping from the 2-character codes is strongly recommended to follow this pattern:

<2-character code><4-digit start year>

For example, a network deployment allocated a network code of "XA" operating in the years 2002 and 2003 could be mapped to "XA2002".

A temporary network operator may wish to request a 6 character network code in the transitional mapping pattern above in order have a globally unique code that is also usable with miniSEED 2.4 through the mapping.

Location code usage

Location codes are used to logically group channels within a single station deployment. This can be for channels produced by the same sensor, channels produced in a sub-processor, many sensors deployed in a grid or an array, etc.

When used to designate sensors deployed in an array, operators may choose to identify a series of sensors using ordered or otherwise meaningful location code values.

Section 3: Definition of channel: band, source and position codes

A sequence of three codes describes one aspect of the instrumentation and its digitization as follows:

Band: Indicates the general sampling rate and response band of the data source. May be empty.

Source: Identifies an instrument or other general data source. Cannot be empty.

Position: Identifies the orientation or otherwise relative position. The position codes are specific to sources. May be empty.

Two sequences are reserved for special channels: “L_O_G” for the console log and the (deprecated) “S_O_H” for general state of health.

Band Code

The band code specifies the general sampling rate and the approximate response band of the instrument (when applicable to the data source).

Band code	Band type	Sample rate (Hz)	Lower bound (sec)
F	...	≥ 1000 to < 5000	≥ 10 sec
G	...	≥ 1000 to < 5000	< 10 sec
D	...	≥ 250 to < 1000	< 10 sec
C	...	≥ 250 to < 1000	≥ 10 sec
E	Extremely Short Period	≥ 80 to < 250	< 10 sec
S	Short Period	≥ 10 to < 80	< 10 sec
H	High Broadband	≥ 80 to < 250	≥ 10 sec
B	Broadband	≥ 10 to < 80	≥ 10 sec
M	Mid Period	> 1 to < 10	
L	Long Period	≈ 1	
V	Very Long Period	≈ 0.1	
U	Ultra Long Period	≈ 0.01	
R	Extremely Long Period	≥ 0.0001 to < 0.001	
P	On the order of 0.1 to 1 day[1]	≥ 0.00001 to < 0.0001	
T	On the order of 1 to 10 days[1]	≥ 0.000001 to < 0.00001	
Q	Greater than 10 days[1]	< 0.000001	
A	Administrative Instrument Channel	variable	
O	Opaque Instrument Channel	variable	

Source and Position Codes

The source code specifies the family to which the sensor belongs or otherwise a general data source. In essence, this identifies what is being measured or simulated. Each of these source types are detailed in this section.

The position code provides a way to indicate the directionality of the sensor measurement (orientation) or the relative location of the sensor. Position codes are source-specific. When orthogonal directions are used, there are traditional orientations of North (N), East (E), and Vertical (Z), as well as other orientations that can be converted to traditional ones. These options are detailed with each source type. Only use N or E for the orientation when it is within 5 degrees of north or east. Use 1 or 2 when orientations are more than 5 degrees from north or east or to avoid any assumptions about the orientation and ensure that the metadata is consulted.

Seismometer

Measures displacement/velocity/acceleration along a line defined by the the dip and azimuth.

Source Code

```
H    High Gain Seismometer
L    Low Gain Seismometer
G    Gravimeter
M    Mass Position Seismometer
N    Accelerometer*
```

* Historically some channels from accelerometers have used instrumentation codes of L and G. The FDSN defined the N code for accelerometers in August 2000.

Position Code

```
Z N E  Traditional (Vertical, North-South, East-West), when with 5 degrees of true directions
A B C  Triaxial (Along the edges of a cube turned up on a corner)
T R    For formed beams or rotated components (Transverse, Radial)
1 2 3  Orthogonal components but non traditional orientations
U V W  Optional components
```

Dip/Azimuth: Ground motion vector
Signal Units: M, M/S, M/S**2, (for G & M) M/S**2 (usually)

Tilt Meter

Measures tilt from the horizontal plane. Azimuth is typically N/S or E/W.

Source Code

A

Position Code

N E Traditional

Dip/Azimuth: Ground motion vector
Signal Units: Radians

Creep Meter

Measures the absolute movement between two sides of a fault. Traditionally this has been done by means of fixing a metal beam on one side of the fault and measuring its position on the other side, but can also done with light beams, triangulation wires and other techniques.

The orientation and therefore the dip and azimuth would be perpendicular to the measuring beam, which would be along the average travel vector for the fault. Position/negative travel would be arbitrary, but would be noted in the dip/azimuth.

Source Code

B

Position Code

Unkonwn

Dip/Azimuth: Along the fault or wire vector
Signal Units: M

Calibration Input

Usually only used for seismometers or other magnetic coil instruments. This signal monitors the input signal to the coil to be used in response evaluation. Usually tied to a specific instrument. Sometimes all instruments are calibrated together, sometimes horizontals are calibrated separately from verticals.

Source Code

C

Position Code

A B C D For when there are only a few cal sources for many devices.
Blank if there is only one calibrator at a time or, Match Calibrated Channel (is. Z, N or E).

Pressure

A barometer, or microbarometer that measures pressure. Used to measure the atmospheric pressure or sometimes for state of health monitoring down hole. This includes infrasonic and hydrophone measurements.

Source Code

D

Position Code

O Outside
I Inside
D Down Hole
F Infrasound
H Hydrophone
U Underground

Dip/Azimuth: Not applicable
Signal Units: Pa (Pascals)

Electronic Test Point

Used to monitor circuitry inside recording system, local power or seismometer. Usually for power supply voltages, or line voltages.

Source Code
E

Position Code
Designate as desired, make mnemonic as possible, use numbers for test points, etc.

Dip/Azimuth: Not applicable
Signal Units: V, A, Hz, Etc.

Magnetometer

Measures the magnetic field at the sensor location. They measure the part of the field vector that is aligned with the measurement coil. Many magnetometers are three axis. The instrument will typically be oriented to local magnetic north. The dip and azimuth should describe this in terms of the geographic north.

Example: Local magnetic north is 13 degrees east of north in Albuquerque. So if the magnetometer is pointed to magnetic north, the azimuth would be + 103 for the E channel. Some magnetometers do not record any vector quantity associated with the signal, but record the total intensity. So, these would not have any dip/ azimuth.

Source Code
F

Position Code
Z N E   Magnetic

Dip/Azimuth: Not applicable
Signal Units: T (Teslas)

Humidity

Absolute/relative measurements of humidity. Temperature recordings may also be needed for meaningful results.

Source Code
I

Position Code
O   Outside environment
I   Inside building
D   Down hole
1 2 3 4 Cabinet sources
All other letters for mnemonic source types.

Dip/Azimuth: Not applicable
Signal Units: %

Rotational Sensor

Measures solid-body rotations about an axis, commonly given in “displacement” (radians), velocity (radians/second) or acceleration (radians/second**2).

Source Code

J   High Gain Seismometer

Position Code

Z N E   Traditional (Vertical, North-South, East-West)
A B C   Triaxial (Along the edges of a cube turned up on a corner)
T R   For formed beams (Transverse, Radial)
Z 1 2   Orthogonal components, but non traditional horizontal orientations
1 2 3   Orthogonal components, but non traditional orientations
U V W   Optional components

Dip/Azimuth: Axis about which rotation is measured following right-handed rule.
Signal Units: rad, rad/s, rad/s**2 – following right-handed rule

Temperature

Measurement of the temperature at some location. Typically used for measuring:

1. Weather   - Outside temperature
2. State of Health - Inside recording building
                    - Down hole
                    - Inside electronics

Source Code

K

Position Code

O   Outside environment
I   Inside building
D   Down hole
1 2 3 4 Cabinet sources
All other letters available for mnemonic types.

Signal Units: degrees C or degrees K

Water Current

Measurement of the velocity of water in a given direction. The measurement may be at depth, within a borehole or a variety of other locations.

Source Code

O

Position Code

Unknown

Dip/Azimuth: Along current direction
Signal Units: M/S

NOTE: The special, administrative codes of “SOH” and “LOG” do <u>not</u> denote water current and should be avoided when using the “O” Source Code.

Geophone

Very short period seismometer, with natural frequency 5 - 10 Hz or higher.

Source Code
P

Position Code
Z N E Traditional

Dip/Azimuth: Ground Motion Vector
Signal Units: M, M/S, M/S**2

Electric Potential

Measures the Electric Potential between two points. This is normally done using a high impedance voltmeter connected to two electrodes driven into the ground. In the case of magnetotelleuric work, this is one parameter that must be measured.

Source Code
Q

Position Code
Unknown

Dip/Azimuth: Not applicable
Signal Units: V - Volts

Rainfall

Measures total rainfall, or an amount per sampling interval

Source Code
R

Position Code
Z N E Traditional

Dip/Azimuth: Not applicable
Signal Units:

Linear Strain

Dip/Azimuth are the line of the movement being measured. Positive values are obtained when stress/distance increases and negative when they decrease.

Source Code
S

Position Code
Z N E   Vertical, North-South, East-West

Dip/Azimuth: Along axis of measurement
Signal Units: M/M

Tide

Measurement of depth of water at monitoring site. Not to be confused with lunar tidal filters or gravimeter output.

Source Code
T

Position Code
Z   Always vertical

Dip/Azimuth: Always vertical
Signal Units: M - Relative to sea level or local ocean depth

Bolometer

Infrared instrument used to evaluate average cloud cover. Used in astronomy to determine observability of the sky.

Source Code
U

Position Code
Unknown

Dip/Azimuth: Not applicable
Signal Units:

Volumetric Strain

Source Code
V

Position Code
Unknown

Dip/Azimuth: Not applicable
Signal Units: M**3/M**3

Wind

Measures the wind vector or velocity. Normal notion of dip and azimuth does not apply.

Source Code
W

Position Code
S   Windspeed
D   Wind direction vector, relative to geographic north

Dip/Azimuth: Not applicable
Signal Units:

Derived or generated channel

Time series derived from observational data or entirely generated by a computer.

Source Code

X

Position Code

Similar to the observable data that was modified or the observable equivalent for generated time series (synthetics). See Position Codes for the corresponding observed channel.

Further Usage

In order to document the provenance of the data, information must be available in the metadata for this channel that documents the algorithms, processes, or systems that modified or generated the time series. A channel comment, providing a Uniform Resource Locator (URL), must be included in the metadata. The information available at the URL must identify the processes that were applied to modify or generate the time series. This information must reference the FDSN web site (http://www.fdsn.org/x-instrument/).

Non-specific instruments

For instruments not specifically covered by an existing Source Code the Y Source Code can be used.

Source Code

Y

Position Code

Instrument specific.

Further Usage

In order to document the instrument type and provenance of the data, information must be available in the metadata for this channel that documents the instrument that was used to generate the time series. A channel comment, providing a short description of the instrument, the type of measurement it makes and a Uniform Resource Locator (URL) referencing the FDSN web site (http://www.fdsn.org/y-instrument) that fully describes the instrumentation.

Synthesized Beams

This is used when forming beams from individual elements of an array.

Source Code

Z

Position Code

I   Incoherent beam
C   Coherent beam
F   FK beam
O   Origin beam
D   Wind direction vector, relative to geographic north

Dip/Azimuth: Ground motion vector
Signal Units: M, M/S, M/S**2