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Blacknest Data System (BDS)

Instrument Response handling – 2.0.11 - 2013-12-03

1. Introduction

The BDS system stores, manages and retrieves instrument responses from its internal database. This document briefly describes this process and the external formats supported.

2. Internal Storage

The BDS stores responses in the Responses table of its internal Mysql database. The following information is stored:

Name	Type	Attributes	Description
id	Integer	unique, not_null, auto_increment	Unique ID for this entry
startTime	String	Primary	The Start time
endTime	String	Primary	The End time
network	String	Primary	The Network name
station	String	Primary	The Station/Array name
channel	String	Primary	The Channels primary identifier
source	String	Primary	The Source of the data this metadata is for
stage	Integer	Primary	The stage number of the response. 0 is for Overall response
stageType	String		The stage type: A - Analog (rad/sec), B - Analog (Hz), C - Composite, D - Digital.
name	String	Primary	The responses name (Overall,instrument,digitiser,anti-aliasing filter, post filter etc)
type	String		The type of response (PoleZero, FAP or FIR)
data	Blob		PoleZero, FAP or FIR Coefficient data. This is stored in an encoded HEX/ASCII format. We could store as a more reabable ASCII)
gain	Double		Overall gain at gain frequency. (For information)
gainFrequency	Double		Frequency that gain is valid for. (For information)
stageType	String		The stage type: A - Analog (rad/sec), B - Analog (Hz), C - Composite, D - Digital
decimation	Double		Decimation performed post filter. (For information)
symmetry	String		Symmetry for FIR coefficients (A = asymmetric, B = symmetric[odd], C = symmetric[even])
description	String		General description
measured	Boolean		Set if response was a measured response.

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sampleRate	Double		The stage's sample rate if set. generally for Digitiser FIR filters. set to 0.00 if not used.
lastUpdate	Timestamp	default CURRENT_TIMESTAMP on update CURRENT_TIMESTAMP,	DateTime this record was last updated

Each BDS channel can have multiple responses stored. There can be multiple responses due to changes based on time (such as Sensor or Digitiser changes) and due to the different stages in the Sensor and Digitiser processing pipelines.

The network:stations:channel:source fields are used to link the response to a particular BDS channel. The startTime and endTime fields are used for time related response changes. The multiple processing stages are defined using the stage and name fields.

The type field defines the type of response. At the moment PoleZero, FAP and FIR types are supported. The actual response data is stored in the data blob using the BOAP data serialising scheme.

Overall gain is store in the gain field and the other fields are for extra information.

3. Response Types

The BDS supports the following response types:

- **PoleZero:** This consists of a set of poles and a set of zeros each represented as complex numbers.

- **FAP:** This consists of a set of frequency, amplitude and phase values.

- **FIR:** This consists of a set of "b" (numerator) coefficients and a set of "a" denominator coefficients with an error value for each.

4. Response Stages

The BDS can store the response of each stage of processing in the Sensor through Digitiser processing chain. Most station channels simply have a single overall PoleZero response, but some make use of this feature. The stage and name fields are used for this. It is expected that imported multiple stage sets have the core instrument response as stage 1 and is named "instrument" as per the standard IDC naming scheme. following this can be any number of named stages. Typically these will be named "digitizer" and numbered 3 onwards. The BDS uses the response stage 0 named "Overall" as its primary overall response. When importing just a single response for a channel this is stored as stage 0 and named "Overall". If a set of multiple stage responses are imported, these are imported as is and a stage 0 named "Overall" entry is added based on the stage 1 "instrument" one imported.

5. External Data Formats

There doesn't appear to be any well named and documented response file formats. The BDS supports the following external representations of responses:

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Type	Description
RESPONSE	Generic for import of any of the supported formats. Scans the file to determine the format.
RESPONSE-SAC-POLEZERO	This is a simple ASCII format for PoleZero response import and export. It looks like: ZEROS 5 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 -3030.0000 0.0000 POLES 4 -0.3950 0.0000 -3.8330 4.9790 -3.8330 -4.9790 -42.6800 0.0000 CONSTANT 360.992094
RESPONSE-RAW-FAP	This is a simple ASCII format for FAP response import and export. It looks like: 5.000000E-02 9.651473E+08 1.303462E+01 6.147467E-02 9.735240E+08 1.026658E+01 7.558270E-02 9.790335E+08 7.895283E+00 9.292844E-02 9.824989E+08 5.838499E+00 1.142549E-01 9.844650E+08 4.018842E+00 1.404756E-01 9.852573E+08 2.364227E+00 1.727139E-01 9.850285E+08 8.069217E-01 2.123506E-01 9.837949E+08 -7.181713E-01 2.610836E-01 9.814743E+08 -2.275690E+00

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Type	Description
RESPONSE-IDC	Generic IDC ASCII response for import/export. this is of the form: theoretical 2 instrument paz description 1.40568e+12 3 -9904.8 3786 0 0 -9904.8 -3786 0 0 -12507 0 0 0 0 theoretical 4 digitizer fir 30000 5 3.788775e-05 0 1.997269e-04 0 5.912768e-04 0 1.198337e-03 0 1.677196e-03 0
RESPONSE-IDC-POLEZERO RESPONSE-IDC-FAP	These are the specific PoleZero and FAP formats for export choice. If response is stored in PoleZero format will be converted and exported as FAP if RESPONSE-IDC-FAP is chosen. These will only export the first overall instrument response (stage 0, "Overall"). When used for import, only the first response in a multi-stage file will be imported.

As well as these ASCII formats the BDS will support the following:

Type	Description
SEED-METADATA SEED	SEED files supported for export of responses.
IMS-RESPONSE IMS-POLEZERO IMS-FAP IMS	IMS files supported for export.

6. Import of Responses

The bdsAdminGui, bdsuserGui and bdsMetadata programs all support the import of responses from ASCII type response only files. There is no program to import from SEED files as yet, perhaps bdsImportData could be extended or a new simple bdsImportResponse could be created.

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7. Export of Responses

The bdsAdminGui, bdsuserGui, bdsDataAccess and bdsMetadata programs all support the export of responses. The user supplied format defines the export format. Responses can be exported on their own or with the data in certain formats such as SEED and IMS.

There may need to be a flag to export all of the response stages rather than just the primary stage 0 "Overall" response.

8. Further Information

For further information please look at the BDS system documentation at:
https://portal.beam.ltd.uk/support/blacknest.