Güralp Discovery

Software Manual

Document Number: MAN-DIS-0001

Issue A,

Designed and manufactured by
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Table of Contents

1 Preliminary Notes

1.1 Proprietary Notice

1.2 Cautions and Notes

Cautions and notes are displayed and defined as follows:

Caution: A yellow triangle indicates a chance of damage to or failure of the equipment if the caution is not heeded.

Note: A blue circle indicates a procedural or advisory note.

1.3 Conventions

Throughout this manual, examples are given of command-line interactions. In these examples, a fixed-width typeface will be used:

```
Example of the fixed-width typeface used.
```

Commands that you are required to type will be shown in bold:

`Example of the fixed-width, bold typeface.`

Where data that you type may vary depending on your individual configuration, such as parameters to commands, these data are additionally shown in italics:

`Example of the fixed-width, bold, italic typeface.`

Putting these together into a single example:

`System prompt:` **`user input with`** ***`variable parameters`***

Specific references to menu buttons or selections are depicted:

Menu Button

2 System Overview

Discovery is a graphical application that offers a common interface to a number of tools that are relevant to three areas of Seismic instrumentation:

1. Instrument connectivity, Network Address Discovery and State of Health Display
2. QA of a seismic instrument through data analysis
3. Management of data storage and archiving - The Güralp Data Centre (GDC)

Discovery is NOT an essential for managing Güralp Seismic instrumentation. However, it is designed with this in mind and offers a set of tools to make that process simple.

Much of the function of the application relates to Ethernet connectivity - either locally (LAN) or remotely via the internet (WAN). The system also supports the loading and analysis offline data files in the industry standard miniSEED format.

The applications name “Discovery” refers to its goal of ‘discovering’ an instruments IP address. This is done in a number of ways depending on the connectivity.

A wide range of ‘applets’ are built into the application to assist in verifying an instrument’s performance as well as an installation’s quality. This in turn offers the ability to diagnose potential problems.

The third area covered relates to recording and storing data from telemetered (Network connected) systems. This GDC function come with a set of tools to assist in the installation, managing and support of both small and large (100’s of devices) networked arrays of sensors.

2.1 Key features

- IP Address discovery on LAN
- Interface to Güralp Cloud Registry for IP Address and SOH Discovery on WAN
- Software update tools for Güralp sensors and Digitiser
- Analytic tools for sensor seismic data such as PSD, Coherence, Self-Noise, Correlation Functions, Filter tools
- MiniSEED Import
- Sensor Response plotting
- SOH display, email and text message on event and SOH transitions
- Graphical front end for GDC configuration and monitoring
- Sensor orientation and rotation calculation
- Sensor response and calibration verification

2.2 Typical applications

- Sensor performance verification
- Sensor/Digitiser management
- IP Address discovery
- GDC management
- Software update tools
- Digitiser System configuration

3 Network Connectivity

3.1 Operation on a LAN

In Scan Locally mode, Discovery will automatically find and list Güralp devices connected via the local network(s). Discovered devices are displayed in the Discovery Main Window, serving as the entry point for the majority of the functionality provided by Discovery. Below is an example of Discovery finding devices on the local ethernet and WiFi, including a statically set device outside the appropriate netmasks.

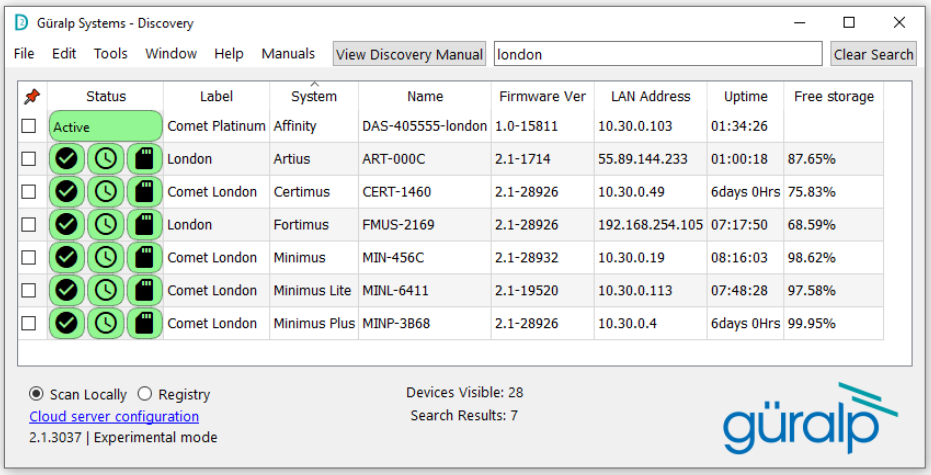


Figure 1 Discovery's splash screen, showing various devices

In addition, basic state of health information is presented in this screen, giving a convenient overview of the health of entire seismic networks in a single window.

A list of network interfaces detected and used by Discovery is shown in the Settings page under Device Discovery's Local Network section:

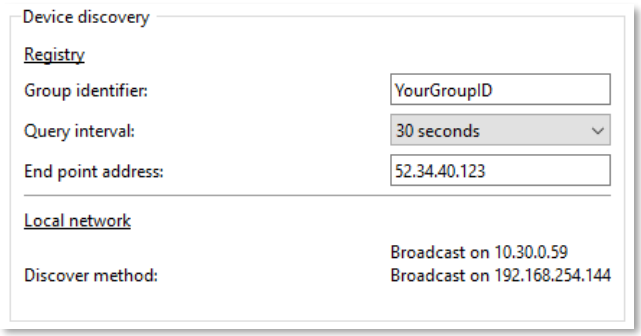


Figure 2 Discover methods (broadcast or direct broadcast) listed for each interface

3.1.1 To DHCP or not to DHCP

Güralp digitisers default to using DHCP. When coupled with Discovery this works seamlessly in locating device IPs. This is more often than not the best solution.

Static IP addresses often have hidden side effects and require both the netmask and default gateway to be set correctly.

3.1.2 Discovering Devices

Discovery makes use of broadcast packets to give the best chance of making contact with as many instruments as possible. A broadcast UDP packet is sent roughly every 10 seconds addressed to port 11788. Any Güralp device that receives this packet will respond with a single packet. This response is a Unicast packet if the device sees the Discovery packet as emanating from the same subnet. If the device sees the Discovery packet comes from another subnet, the response will be a broadcast.

This minimises the amount of local broadcast activity but still allows instruments to be "discovered" even if their IP address is on a different subnet. This would be the case if an instruments address was simply set wrongly on that connection.

This ability allows an instrument to be "discovered" and then configured even if its address is set arbitrarily.

From when Discovery is put into Scan Locally mode, regular attempts are made to probe the local network. This is both to find new devices and to refresh data for known devices with the latest state of health information.

In addition, Güralp devices will emit unsolicited network probes to promote detection with instances of Discovery running on their local network as quickly as possible. This typically occurs when a system starts up.

Not seeing an instrument respond when plugged directly into the LAN of a laptop can only be caused by firewall rules in the PC.

3.1.3 Changing IP addresses

Right-clicking the listed device and selecting Edit Network Address offers the option to set the IP Address. This is possible provided the system is on the same physical subnet as the computer running Discovery. A broadcast is used to send the new address so this will function even if the current address does not the computer's subnet.

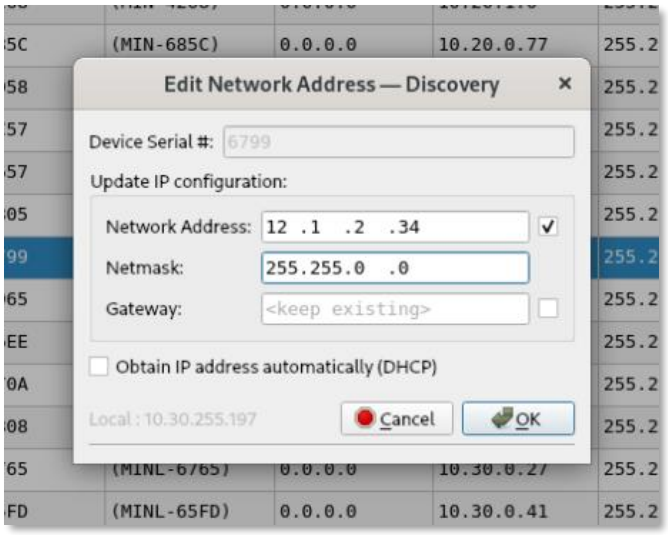


Figure 3 Change Network Address applet

3.1.4 Manually Adding Devices

In most cases it is *not* necessary to have prior knowledge of the network address of a device. However, different operating systems, subnet configurations, network topologies and networking hardware can affect the discovery of devices; in some cases not every device can be automatically found. In these situations it is possible to manually add a known device IP address to populate an entry in the Discovery main window.

Select the **Edit** menu option, followed by **Add Device**.

Manually adding a device's IP address can also be useful where direct communication is possible but outside of the local network, beyond the reach of broadcast packets; for example where a VPN has been used to connect to a remote device.

This is not a common use case.

3.2 Operation over a WAN

Where instruments are not located on the same local network as the instance of Discovery, the same automatic device detection as outlined for local devices is not possible. Moreover, network features such as firewalls and Network Address Translation often prevents direct communication between remotely located Güralp devices and Discovery instances completely, even if the device's IP address is already known.

3.2.1 Registry Server

Even in situations where direct network connectivity between Discovery and Güralp instruments is not feasible, device discovery and live instrument state of health updates are still possible. As long as both the Discovery instance and Güralp device are able to make outgoing connections to the same WAN (for example, the internet), a Güralp Registry Server may be used to facilitate communication between them.

A *Registry Server* is a publicly accessible server located on the WAN which is running Güralp's Responder software as a service.

A single outbound UDP packet is sent from the digitiser to the Registry Server every 10 seconds by default. The destination port number is 11788.

At deployment, instruments can be configured to make themselves known to one or more Registry Servers. In this fashion, a constantly updated list of instruments, with their state of health information, is maintained for a distributed network of seismic stations and devices.

Choosing Registry mode in the Discovery main window causes Discovery to poll the configured Registry Servers for their listed devices. The Main Window will be populated with these devices, displaying their identifying information, network addresses and state of health as if they had been discovered locally.

It comprises a simple binary that runs headless on a computer. A single UDP port 11788 must be open.

WAN Address reflects packet return address in packets received by registry from devices.

LAN Address reflects the instruments address on its ethernet interface.

3.2.1.1 Güralp Public Registry

To allow users to try this functionality before setting up their own Registry Server, Güralp hosts public Registry Servers for customer use. Only systems that have a matching "Group ID" are visible to a particular user. This service offers a simple way to discover the IP address of a system and to see the basic State of Health parameters of the system.

The default registry address shown below is programmed into all Güralp digitisers systems as a default.

52.34.40.123	*IP address of Güralp's Default Public Registry*

To set up your own Registry Server, contact Güralp Systems for further information.

3.2.1.2 Setting Up Güralp Registry

As mentioned previously, registered devices must be assigned to groups, each of which has a "Group Identifier". Instances of Discovery must also be configured with a Group ID and can only display registered devices from the matching group. This allows partitioning of large networks into smaller administrative domains. It also makes the simultaneous use of the Güralp shared Registry Server by multiple organisations possible.

Therefore, to use the Registry, you need to configure both the device and Discovery. Please follow these steps to set up your Registry.

- First, the address of the Registry Server and the chosen Group ID must be set individually for each participating device. To do this, first connect the device to the same network as a PC running Discovery. Then open the webpage and set Group ID and Registry address from the Network tab. To use the Güralp shared cloud server, enter **52.34.40.123.**
- Once you have set these values, the device must be rebooted before the changes will take effect.
- Last, open Discovery and click on Cloud server configuration at the bottom left of the main window. Enter the Group ID and server IP address in the relevant fields ("Group identifier" and "End point address", respectively). Click on Apply.

From Discovery's main window, click the Registry button and all devices configured with the same Registry server and Group ID will now appear in the main list.

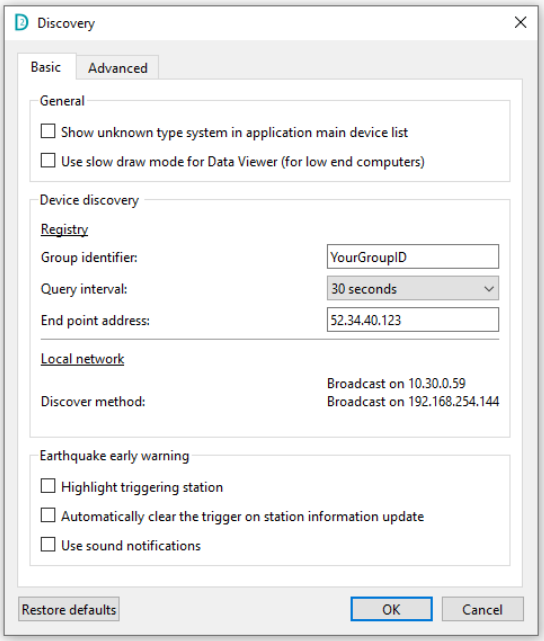


Figure 4 Cloud Server Configuration window

3.2.1.3 Setting Up Your Own Registry

Administrators can create their own registry servers by installing a simple program on a server. The server itself must have a static IP address and be accessible to all connected devices, as well as the PCs running Discovery.

In order to create your own registry, Please follow these steps to set up your Registry.

- Contact Güralp technical support (support@guralp.com) to receive a copy of the program;
- Download the file attached to your email;
- Run the binary guralp_responder on a Linux machine with a -d switch using the command:

  ```
  ./guralp_responder  -d
  ```

- Open the instrument's webpage and change the Registry IP address on the Network tab to be the one of the PC where the responder is running. Set a Group ID using the key you prefer. Repeat for all the instruments you want to add to the Registry;
- Open Discovery and change the IP address from Cloud Server Configuration on bottom-left of the window with the one of the PC running the responder;
- From the same window, set the same Group ID you used in the instrument's webpage;
- Click on Registry button in Discovery.

You should now see the configured devices appearing in Discovery main window when you click on Registry button.

In order to make it work, the following network ports need to be open:

UDP 11788
UDP 11789
TCP 11789

Note: The PC with the responder and the PC with Discovery cannot be the same machine because the same port 11788 cannot be used for different purposes.

If the instruments and the machine running the responder are in different networks you have to make sure that the ports in Table 1 below are also open/forwarded.

3.2.2 Interacting with WAN Instruments

Beyond the information transmitted via Registry Servers, as outlined above, the functionality available for each instrument in Discovery depends upon network connectivity between the Discovery instance and the device.

In terms of configuring firewalls, the product manual provided for each Güralp device will outline the required open network ports for given functionality.

The most common are:

Table 1 List of the main required open network ports

Port	Layer 4 Protocol	Description
80	TCP	HTTP server
1565	TCP	GDI transmission protocol
1567	TCP/UDP	GCF transmission protocol
4242	TCP	File exchange protocol
4244	TCP	Remote console
11788	UDP	Remote procedure calls
18000	TCP	SEEDlink transmission protocol

The most common and significant hurdle to communicating with remote devices is Network Address Translation. A number of solutions are here presented.

Right-clicking on the instrument row (on any column BUT the LAN address one) offers various functions that will all use the WAN address to communicate with the instrument. So all will function as expected as long as ports are open.

Right-clicking on the LAN address column forces the use of the LAN IP address to communicate with the device instead.

3.2.2.1 Port Forwarding

In some cases, depending on networking equipment and topology, it may be possible to arrange the relevant device network ports to be forwarded by the WAN router. This allows direct connections to the remote device.

If a device is made available via port forwarding, users should initiate Discovery functionalities using the WAN address of the instrument. Where multiple network addresses are available for an instrument, it is possible to force Discovery to use the WAN address by selecting the WAN Address column of the device entry. Subsequent invocations either via the **Edit** menu or the right-click context menu will then utilise the WAN address. The WAN address is used by default when in Registry Mode

It is common when port forwarding to remap port numbers away from the default internal device ports when presented to the WAN. Discovery allows for this by

allowing for per device custom port numbers. Right-clicking on the instrument and selecting **Device Port Configuration** opens a window to change forwarding ports for an individual instrument.

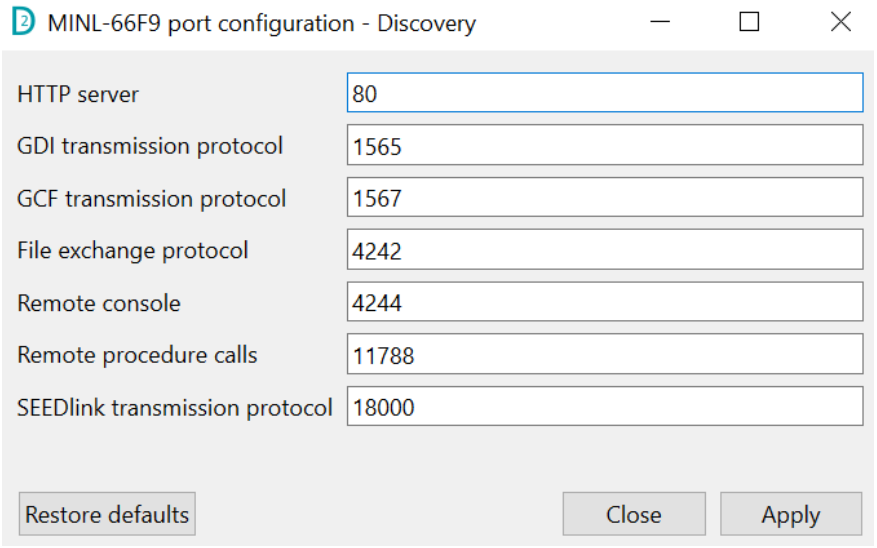


Figure 5 Port configuration window for an individual device

3.2.2.2 Router/Gateway VPN

Some WAN routers include a VPN client feature which may allow remotely located instruments to appear as if they are on the same local network as the Discovery instance. Setting up a VPN is beyond the scope of this manual.

In some cases it is necessary to manually add devices which are accessible via a VPN, by selecting **Edit → Add Device**.

3.2.2.3 Güralp Discovery Tunnel

The easiest way to overcome firewall and NAT networking challenges with remote instruments is to use the Güralp Discovery Tunnel. By combining a Güralp device running Dig firmware with a Registry Server and Discovery, it is possible to maintain full connectivity with remote WAN connected instruments without any extra network configuration (beyond connecting the instrument to the WAN).

This feature allows all network traffic between a Discovery instance and instrument to be routed via a Registry Server, using only outgoing TCP connections from each end point (device and Discovery instance). In this way, full communication is possible through firewalls and NAT routers without special configurations or degrading network security.

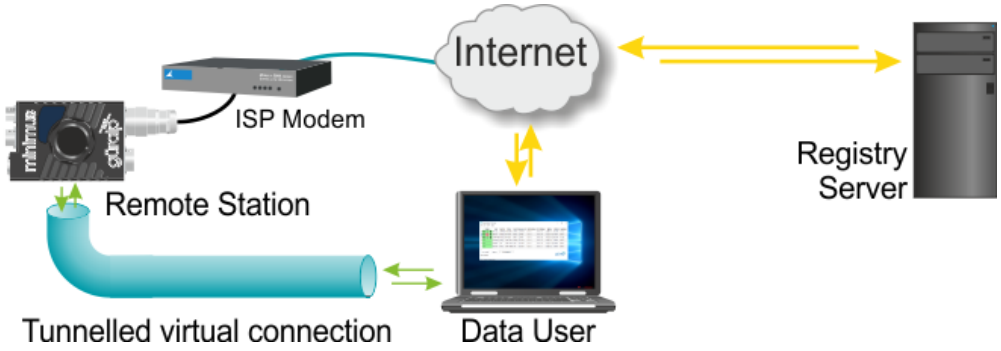


Figure 6 Discovery Tunnel

To enable this feature, relevant Güralp devices should be assigned to a Registry server and the **Tunnel Auto Connect** setting should be enabled. Where multiple Registry servers can be configured, the first Registry server slot should contain the tunnel enabled Registry server. For more details refer to the device manual.

To allow connectivity via a Registry server, the tunnel option must also be enabled when starting the Responder service. For more details refer to the help information for Responder. Port 8190 TCP is used to make the connection to the remote registry server from the digitiser – so this outbound port must be permitted in any firewall rules.

Generally, all that is required is the enable of the tunnel connection within the instrument by ticking the **Tunnel Auto Connect** box from the webpage, under the **Network** tab.

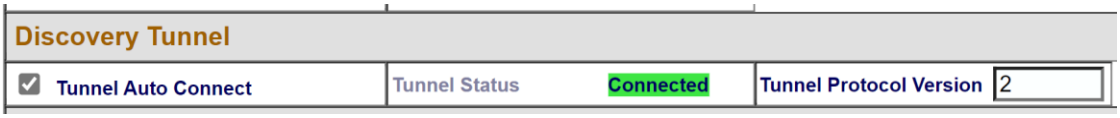
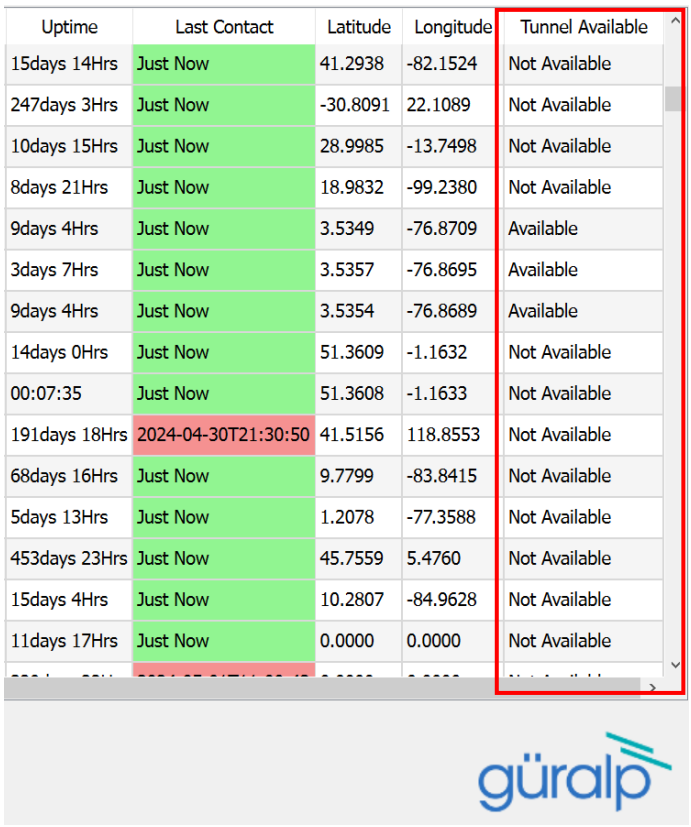


Figure 7 Discovery tunnel option available from the Network tab of the instrument webpage

In **Registry** mode, the Discovery Main Window will display the tunnel availability of listed devices. If this column is not displayed, it can be enabled by selecting **Window → Show → Tunnel Available**. Devices connected to a tunnel enabled Registry server

(and with tunnel connection enabled) will be indicated with “Available” in the Tunnel Available column.



Uptime	Last Contact	Latitude	Longitude	Tunnel Available
15days 14Hrs	Just Now	41.2938	-82.1524	Not Available
247days 3Hrs	Just Now	-30.8091	22.1089	Not Available
10days 15Hrs	Just Now	28.9985	-13.7498	Not Available
8days 21Hrs	Just Now	18.9832	-99.2380	Not Available
9days 4Hrs	Just Now	3.5349	-76.8709	Available
3days 7Hrs	Just Now	3.5357	-76.8695	Available
9days 4Hrs	Just Now	3.5354	-76.8689	Available
14days 0Hrs	Just Now	51.3609	-1.1632	Not Available
00:07:35	Just Now	51.3608	-1.1633	Not Available
191days 18Hrs	2024-04-30T21:30:50	41.5156	118.8553	Not Available
68days 16Hrs	Just Now	9.7799	-83.8415	Not Available
5days 13Hrs	Just Now	1.2078	-77.3588	Not Available
453days 23Hrs	Just Now	45.7559	5.4760	Not Available
15days 4Hrs	Just Now	10.2807	-84.9628	Not Available
11days 17Hrs	Just Now	0.0000	0.0000	Not Available

Figure 8 Tunnel status shown in main device list

To utilise the tunnel connection, simply invoke a Discovery applet with the chosen device selected in Registry mode. Discovery will automatically default to using the tunnel network address for all communications with the instrument (unless the user specifically selects the WAN or LAN fields).

More information regarding the tunnel’s operation is shown in the Tunnel Status applet available by right-clicking on the entry of a device whose tunnel is enabled. This provides detailed status and connection information for each tunnel connected device.

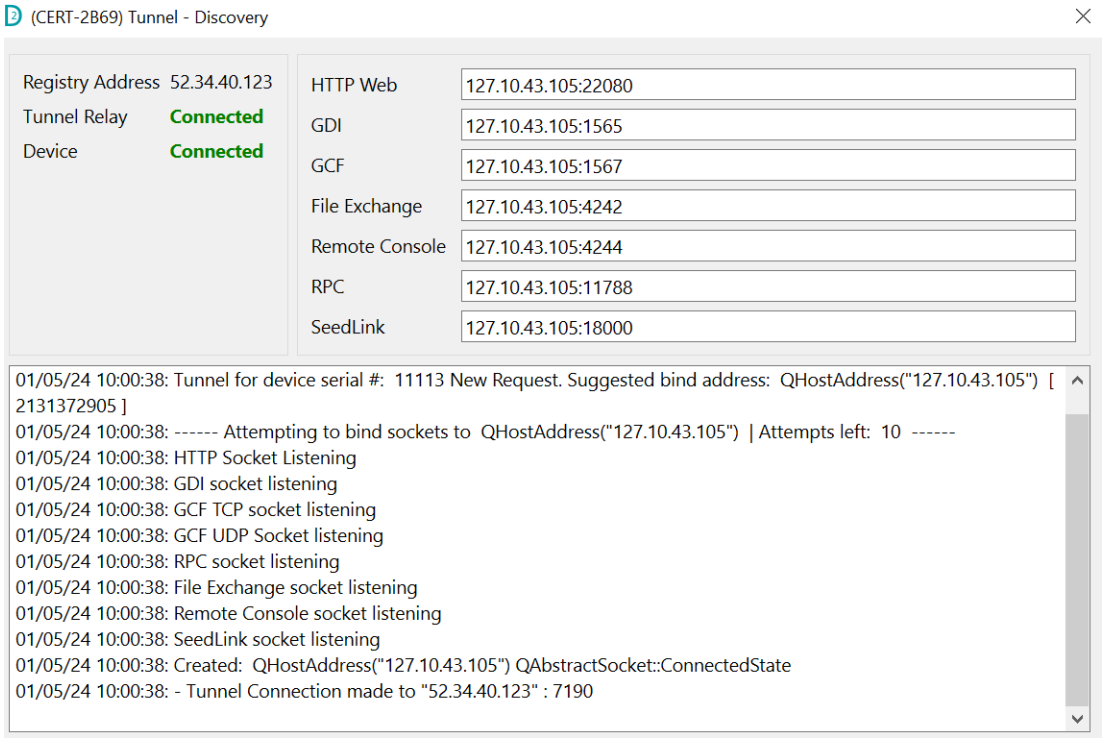


Figure 9 Tunnel status applet

4 Main Device List Window Overview

4.1 Instrument State of Health Information

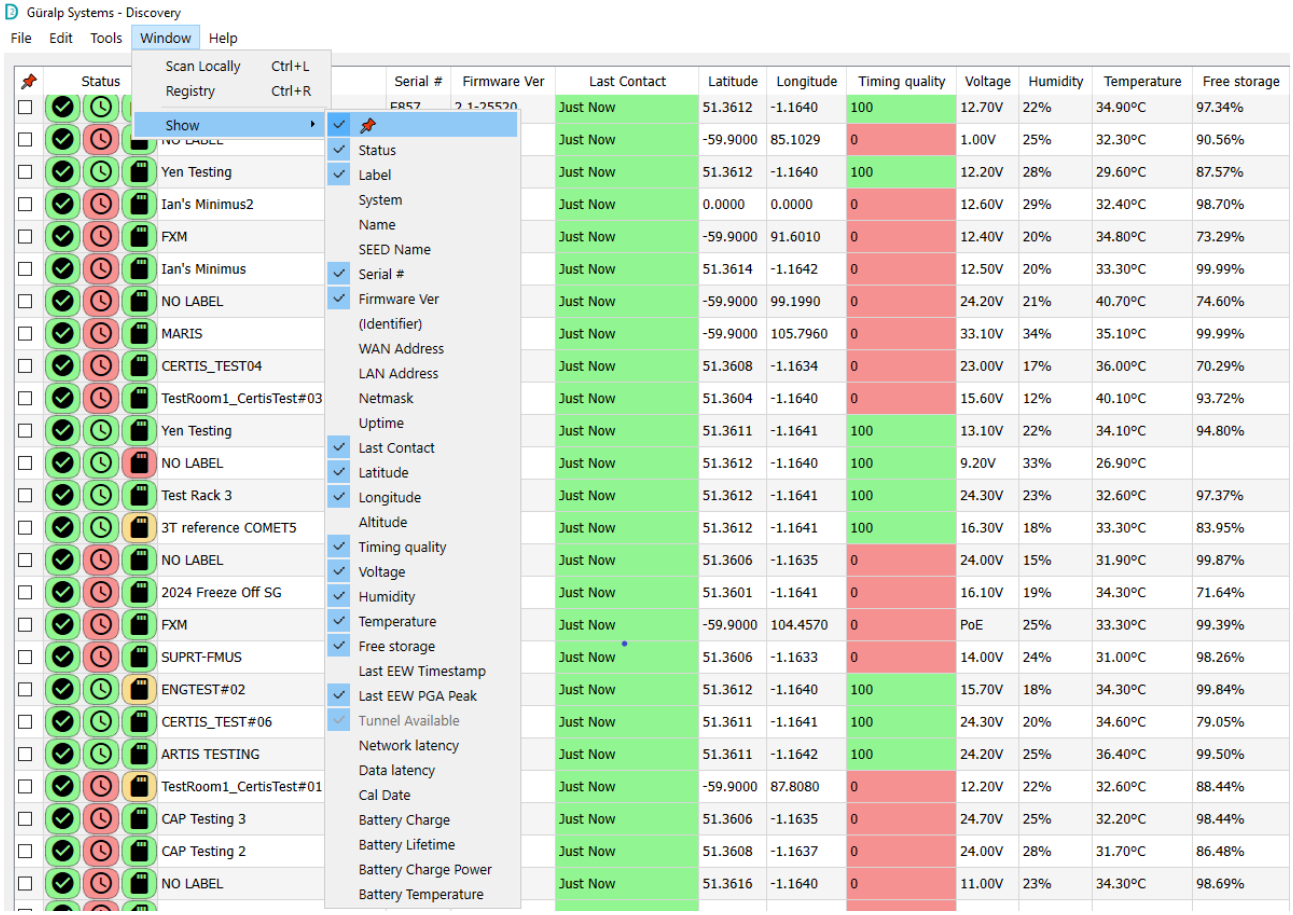
4.1.1 SOH on LAN

The instruments response to the Broadcast discovery packet on the LAN contains a range of state of health (SOH) information. The instrument's serial number, software version, supply voltage, temperature, event trigger status are all included.

To choose which parameters to display on the main window, click on **Window → Show** and tick the boxes of the desired parameter.

The displayed values are typically shown with a latency of about 10 seconds. The time of last contact is remembered so an instrument that stops working or becomes disconnected from the network will be shown with its last (old) contact time.

Manually clicking the **Scan Locally** button, or the shortcut key **F5**, will clear the display of old instruments, losing the knowledge of the last contact times.



Status	Serial #	Firmware Ver	Last Contact	Latitude	Longitude	Timing quality	Voltage	Humidity	Temperature	Free storage
	F857	2.1-25520	Just Now	51.3612	-1.1640	100	12.70V	22%	34.90°C	97.34%
			Just Now	-59.9000	85.1029	0	1.00V	25%	32.30°C	90.56%
Yen Testing			Just Now	51.3612	-1.1640	100	12.20V	28%	29.60°C	87.57%
Ian's Minimus2			Just Now	0.0000	0.0000	0	12.60V	29%	32.40°C	98.70%
FXM			Just Now	-59.9000	91.6010	0	12.40V	20%	34.80°C	73.29%
Ian's Minimus			Just Now	51.3614	-1.1642	0	12.50V	20%	33.30°C	99.99%
NO LABEL			Just Now	-59.9000	99.1990	0	24.20V	21%	40.70°C	74.60%
MARIS			Just Now	-59.9000	105.7960	0	33.10V	34%	35.10°C	99.99%
CERTIS_TEST04			Just Now	51.3608	-1.1634	0	23.00V	17%	36.00°C	70.29%
TestRoom1_CertisTest#03			Just Now	51.3604	-1.1640	0	15.60V	12%	40.10°C	93.72%
Yen Testing			Just Now	51.3611	-1.1641	100	13.10V	22%	34.10°C	94.80%
NO LABEL			Just Now	51.3612	-1.1640	100	9.20V	33%	26.90°C	
Test Rack 3			Just Now	51.3612	-1.1641	100	24.30V	23%	32.60°C	97.37%
3T reference COMET5			Just Now	51.3612	-1.1641	100	16.30V	18%	33.30°C	83.95%
NO LABEL			Just Now	51.3606	-1.1635	0	24.00V	15%	31.90°C	99.87%
2024 Freeze Off SG			Just Now	51.3601	-1.1641	0	16.10V	19%	34.30°C	71.64%
FXM			Just Now	-59.9000	104.4570	0	PoE	25%	33.30°C	99.39%
SUPRT-FMUS			Just Now	51.3606	-1.1633	0	14.00V	24%	31.00°C	98.26%
ENGTEST#02			Just Now	51.3612	-1.1640	100	15.70V	18%	34.30°C	99.84%
CERTIS_TEST#06			Just Now	51.3611	-1.1641	100	24.30V	20%	34.60°C	79.05%
ARTIS TESTING			Just Now	51.3611	-1.1642	100	24.20V	25%	36.40°C	99.50%
TestRoom1_CertisTest#01			Just Now	-59.9000	87.8080	0	12.20V	22%	32.60°C	88.44%
CAP Testing 3			Just Now	51.3606	-1.1635	0	24.70V	25%	32.20°C	98.44%
CAP Testing 2			Just Now	51.3608	-1.1637	0	24.00V	28%	31.70°C	86.48%
NO LABEL			Just Now	51.3616	-1.1640	0	11.00V	23%	34.30°C	98.69%

Figure 10 Example of some of the available parameters showing instrument's state of health

4.1.2 SOH via registry on WAN

Operationally, the available SOH parameters for devices on a WAN are much the same as above. The information latency is between 10-20 seconds as the data must be fetched from the Registry server rather than directly from the device. The information remains on the Registry server for 24 hours (configurable). Restarting the local Discovery or pressing the Registry button simple re-fetches this SOH information.

The registry server can be configured to send emails or text messages when some changes happen in the systems in the Registry, such as:

- a system (which was not in the network) appears into the network
- a system disappears from the network (lost contact for more than 2 minutes)
- a system re-appears into the network
- the Status of a system changes
- an event is detected.

This functionality makes the monitoring of medium-large network easy and efficient.

4.1.3 Options for emailing SOH changes

HOW TO CONFIGURE FOR EMAILS – Work in progress....

4.1.4 Options for SMS message updates

HOW TO CONFIG FOR TEXT – Work in progress....

4.1.5 Additional SOH direct from instruments

Work in progress....

4.2 Connectivity

The IP addresses listed can be used to make connection with the digitiser devices.

slinktool -S DG_05656 -v -p min-5656

slinkttool -Q 192.168.1.2

telnet 10.20.1.2 -P 11789

Ping 10.20.1.1

Example of connection to a seedlink server:

telnet min-5656 18000

Trying 10.30.0.7...

Connected to min-5656.

Escape character is '^]'.

HELLO

SeedLink v3.0 (MIN-5656 CAP Testing 3) :: SLPROTO:3.0

DG.05656

4.3 Main Window Applets

Right-clicking on a system offers a number of operations that depend on the recognised instrument type and potentially software version. Some of the available applets are introduced in the following Sections.

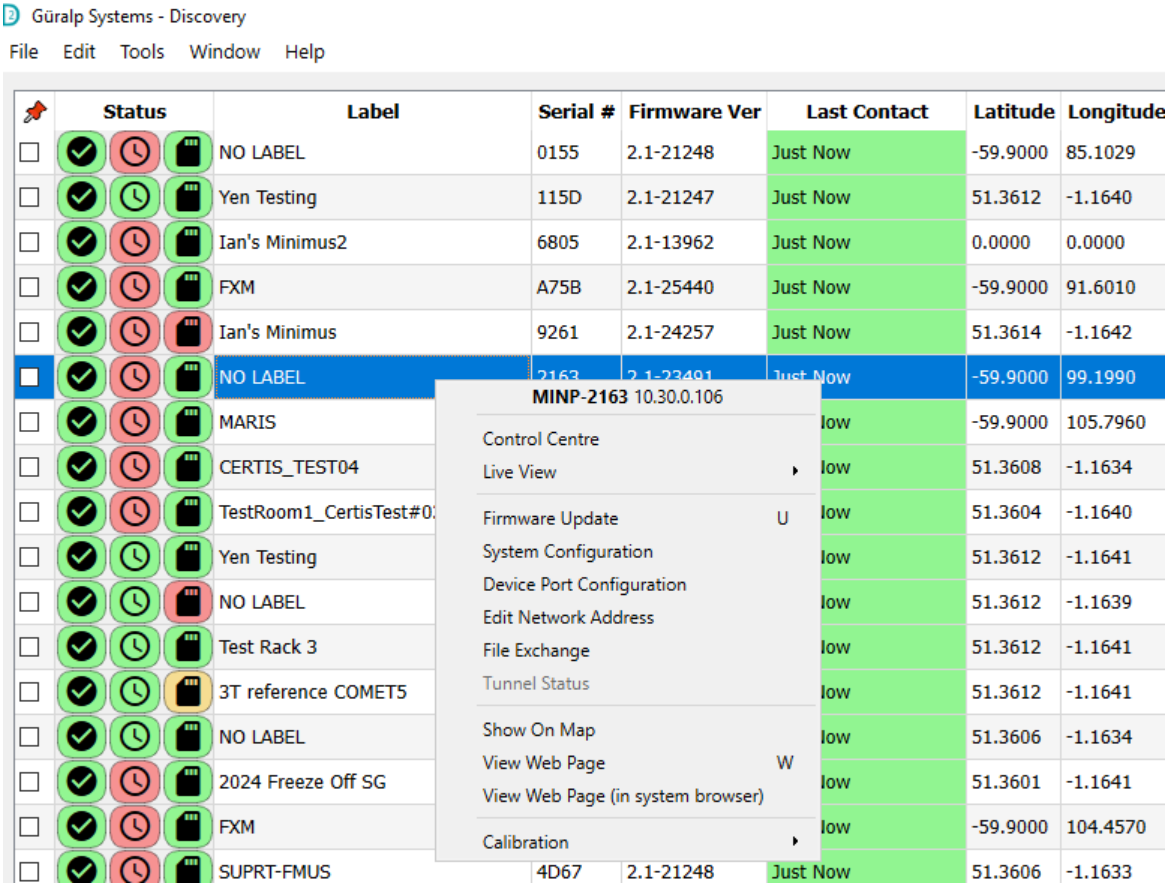


Figure 11 Right-click menu

4.3.1 Firmware Update

Caution: Do **NOT** follow these instructions to update the firmware of Minimus$_2$, Minimus Lite and Artius. To update the firmware of Minimus$_2$, Minimus Lite and Artius units, follow the procedure in Section 4.3.4.1.

The Firmware Update applet offers automatic download of appropriate versions for Minimus, Minimus+, Fortimus and Certimus units. The software is then sent to the instrument where it is verified and stored before installation begins. Network problems during the upgrade process are therefore NOT an issue. The update is only performed at the instrument when all information is on the instrument. The update will continue even if the network disconnects at that point.

System updates do not affect the network settings such as IP address. Other parameters are typically reset to defaults when the new software starts up for the first time. Older system settings can be automatically re-applied after the update completes if the suitable options are ticked in the applet.

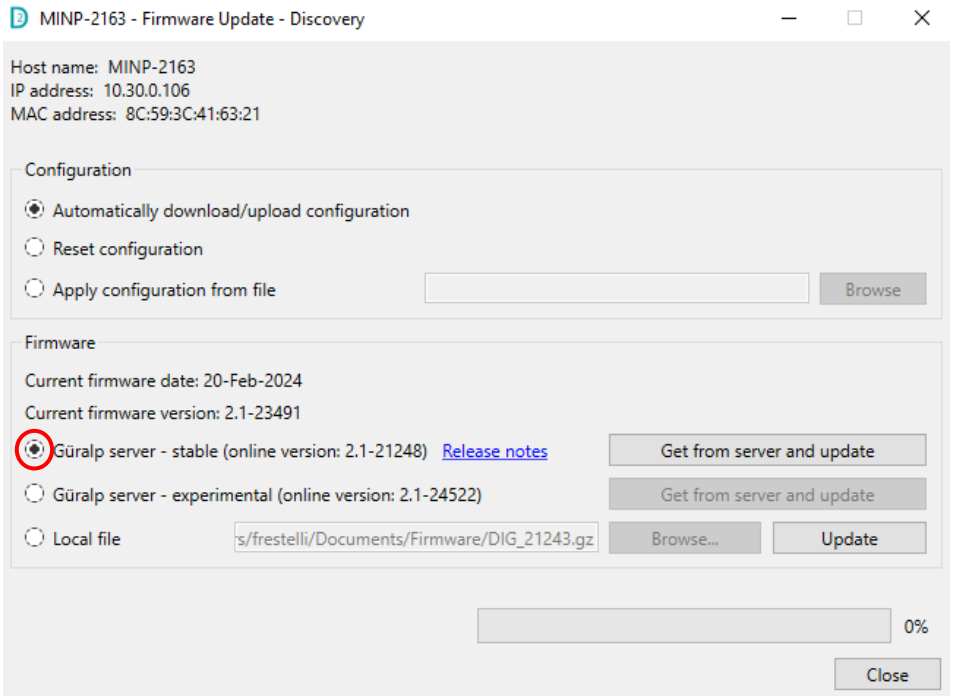


Figure 12 Firmware Update applet for firmware update of Minimus, Minimus+, Fortimus and Certimus

Much of the applet is concerned with where the firmware file should be downloaded from. Typically, this will be from the Güralp webserver. There are always 2 versions available: the current qualified stable release and an experimental (Beta) build.

The experimental build is typically based on the last stable build but with additional bug fixes and features. It is generally not recommended to use the experimental version for active deployments unless directed by Güralp support.

Once an update has completed successfully from a local file path, it is then possible to perform multiple updates on other systems in one operation. Simply select a group of instruments in the devices list and right-click the Firmware Update option. This will launch multiple update applets that will run in parallel. Each will close as it completes.

4.3.2 Live View -GDI/GCF

The Live View applet launches the live seismic data viewer and a stream of data is initiated. The GCF protocol is offered for older systems. Newer systems all support the GDI protocol (and SeedLink). GDI (Güralp Data Interchange) runs over a TCP connection. It supports the concept of additional metadata on each stream as well as multiple streams on the same TCP connection at potentially differing sample rates. The protocol generally has a lower latency than GCF or SeedLink as samples are sent when ready rather than waiting for a full packet. When several channels are used (Z, N, E, Mass etc) this results in efficient packets being sent with a mix of the channels depending on sample rates. This differs to SeedLink where a packet contains only one channels data and must be filled with that channel alone before transmission.

The addition of metadata in the connection also ensures that instrument response and calibration parameters are inseparable from the seismic data. When a connection is made the calibration and response and SI Units etc all come automatically.

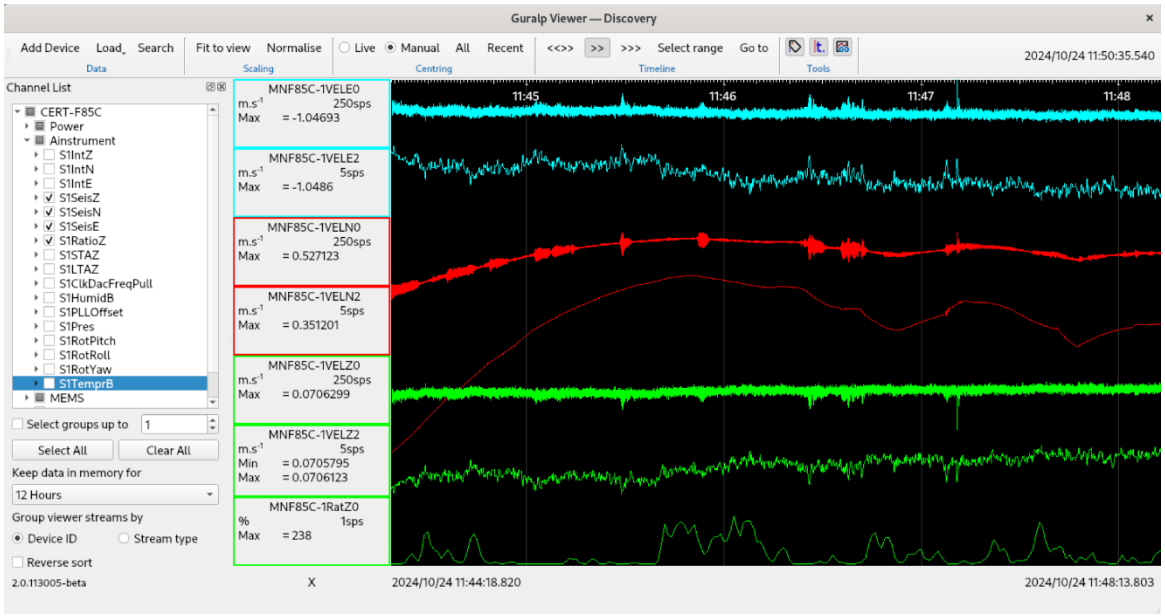


Figure 13 Waveform viewer main window

The left hand list of channels can be used to enable the display of the data in right hand viewer by using the tick boxes. Hovering over the name in the Channel List or the Channel name box in the viewer will display a hover help list of the channel's metadata as shown below:

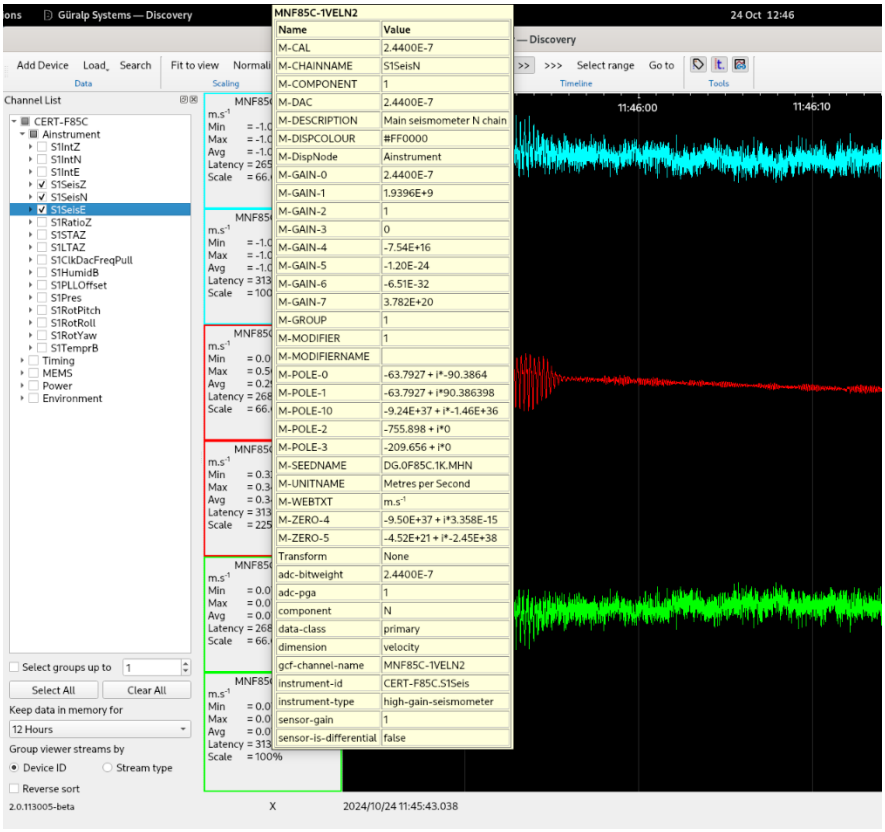
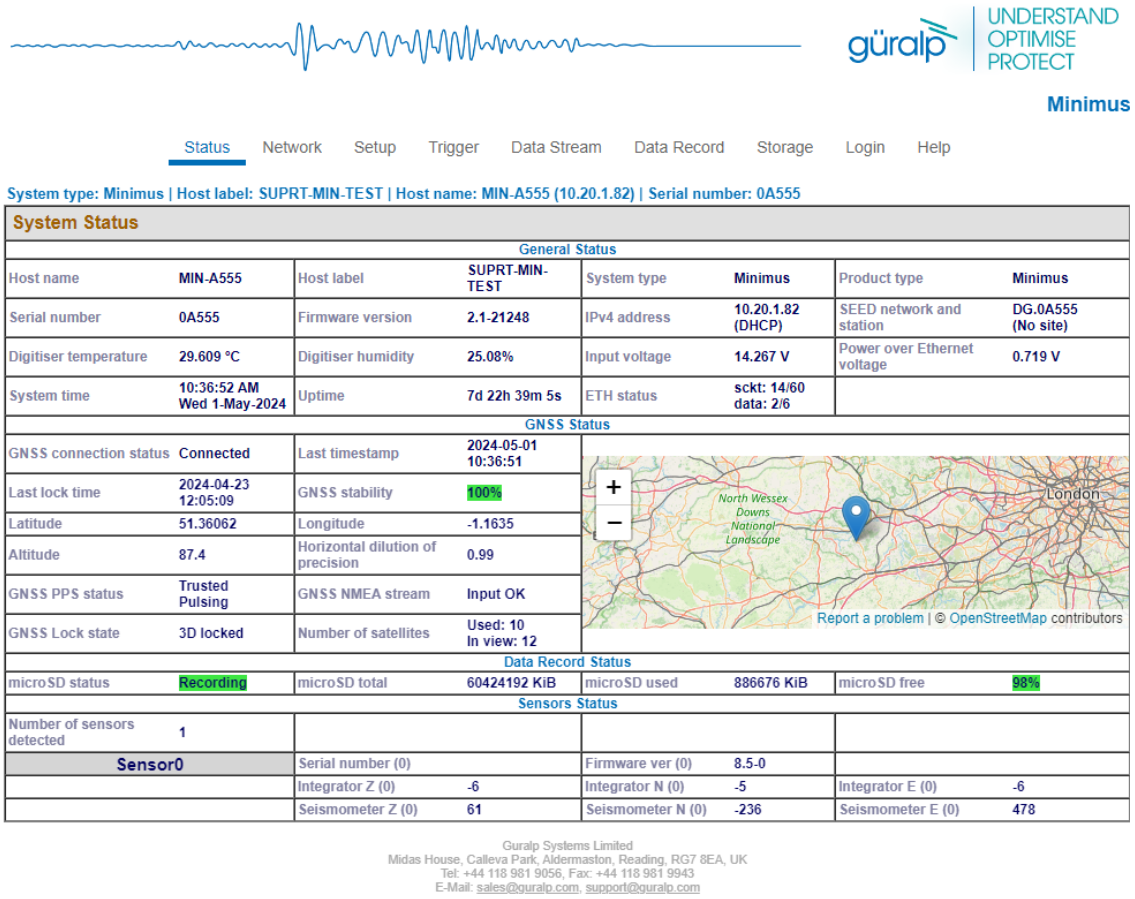


Figure 14 Channel associated metadata

4.3.3 Web Page (System Browser)



Minimus

Status Network Setup Trigger Data Stream Data Record Storage Login Help

System type: Minimus | Host label: SUPRT-MIN-TEST | Host name: MIN-A555 (10.20.1.82) | Serial number: 0A555

System Status

General Status

Host name	MIN-A555	Host label	SUPRT-MIN-TEST	System type	Minimus	Product type	Minimus
Serial number	0A555	Firmware version	2.1-21248	IPv4 address	10.20.1.82 (DHCP)	SEED network and station	DG.0A555 (No site)
Digitiser temperature	29.609 °C	Digitiser humidity	25.08%	Input voltage	14.267 V	Power over Ethernet voltage	0.719 V
System time	10:36:52 AM Wed 1-May-2024	Uptime	7d 22h 39m 5s	ETH status	sckt: 14/60 data: 2/6		

GNSS Status

GNSS connection status	Connected	Last timestamp	2024-05-01 10:36:51		
Last lock time	2024-04-23 12:05:09	GNSS stability	100%		
Latitude	51.36062	Longitude	-1.1635		
Altitude	87.4	Horizontal dilution of precision	0.99		
GNSS PPS status	Trusted Pulsing	GNSS NMEA stream	Input OK		
GNSS Lock state	3D locked	Number of satellites	Used: 10 In view: 12		

Data Record Status

microSD status	Recording	microSD total	60424192 KiB	microSD used	886676 KiB	microSD free	98%

Sensors Status

Number of sensors detected	1						
Sensor0		Serial number (0)		Firmware ver (0)	8.5-0		
		Integrator Z (0)	-6	Integrator N (0)	-5	Integrator E (0)	-6
		Seismometer Z (0)	61	Seismometer N (0)	-236	Seismometer E (0)	478

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Figure 15 An instrument's WEB page

Most Güralp product's configuration can be viewed and modified via a Web page, which can be accessed by selecting the applet View Web Page. This is served by a HTTP Server within the instrument or Digitiser. This option launches a WEB viewer from within the Discovery software. This has limited functionality but is more than sufficient for most operations. The system browser can be launched if an alternative browser is required for say download management.

An instrument's webpage can also be accessed by typing the instrument's IP address in a web browser.

4.3.4 File Exchange

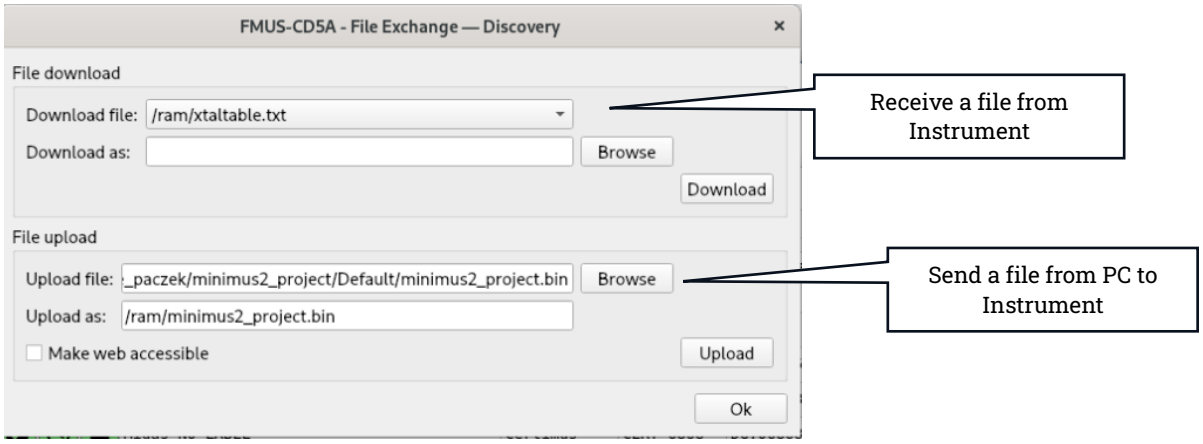


Figure 16 File exchange window

File exchange enables files to be sent to a digitiser or received from a digitiser. This can be used for log files, station XML etc and software updates of certain systems and sub-systems.

When sending a file to a digitiser the 'Upload as' field specifies the name of the file as written in the digitiser. This is typically of importance as a number of specific filenames are known to the receiving systems and are used as the cue to decide what to do with the new file.

Some examples below:

'certis.bin' – software for the Certis instrument

'femtomus.bin' – software for Aquarius and Certimus ultralow power internal digitiser

battery_project.bin – Power Pack Module firmware update

Once the filename paths are set up in the applet, multiple systems can be updated in one hit. Simply select a group of instruments in the device list and right-click the File Exchange selection. This will launch multiple applets that run in parallel. The popup will close automatically as it completes the transfer.

Note: This does not mean that an update is fully complete – only the file transfer. Watch the LEDs on the instrument or the device list to reflect the new version etc. *before* repowering anything.

The file exchange window can also be used to run a script file that contains a list of commands to be executed at specific dates and time. This can be used for operations such as scheduled instrument calibration. For more details, see Section.

4.3.4.1 Minimus$_2$, Minimus Lite and Artius Firmware Update

File Exchange, specifically the bottom section called File Upload, is also used for updating the firmware of the Minimus$_2$ and Minimus Lite units. The Prepare Firmware Update option automatically downloads the most recent stable or experimental build from the web and fills in the columns above, ready for the upload.

Caution: When using the Stable and Experimental buttons next to Prepare Firmware Update for the update process, it is vital that the name next to "Upload as" remains unchanged. Any alterations will result in issues after uploading this new firmware.

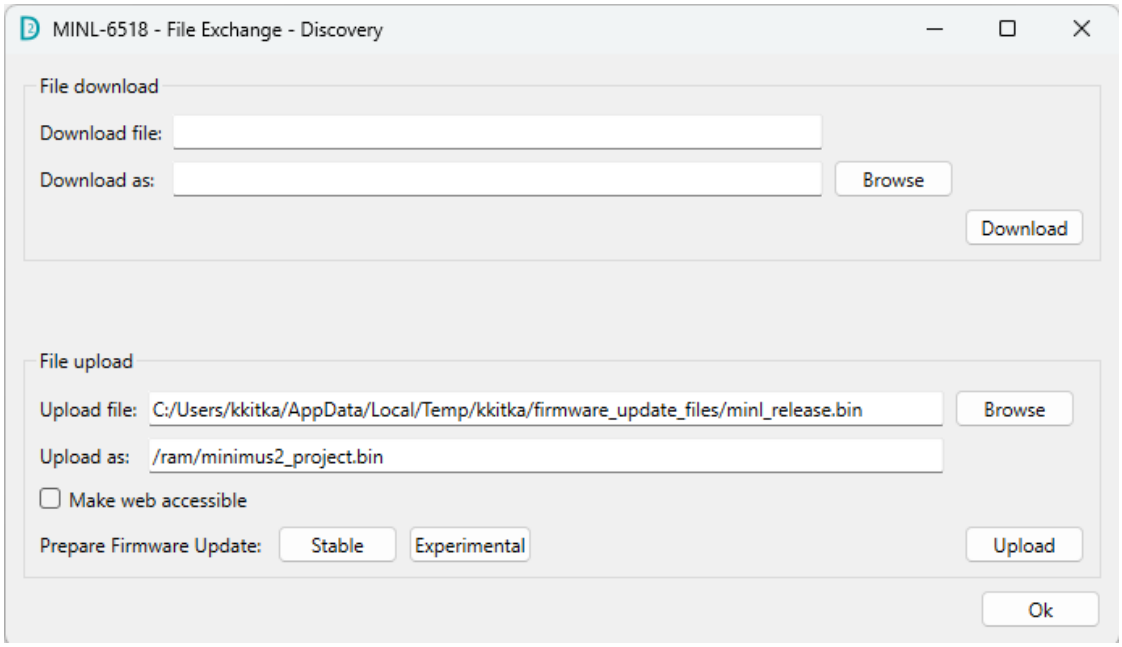


Figure 11 File Exchange applet for firmware update of Minimus$_2$ and Minimus Lite

4.3.5 System Configuration

A Configuration Import/Export tool can be access by selecting System Configuration. All Güralp digital sensors and digitisers have the idea of configuration files. These allow the entire system configuration to be copied from a system and reapplied to another system (or systems).

The config file is in text readable format. It comprises name/value pairs. The names are the same as they appear on the instrument's web page. Text values appear as they do on the web page. Pulldown menus appear as enumerations (index into the list).

The config files can be manually edited if desired. It is also possible to remove items from a config file. This has the effect of those parameters remaining unchanged when the settings are applied. This may be useful when a group of instruments with unique system and station names require all their channel sample rates changing without affecting other parameters such as the names, or you can make a file with

perhaps just one parameter that can be sent to a group of systems to change just that singular setting.

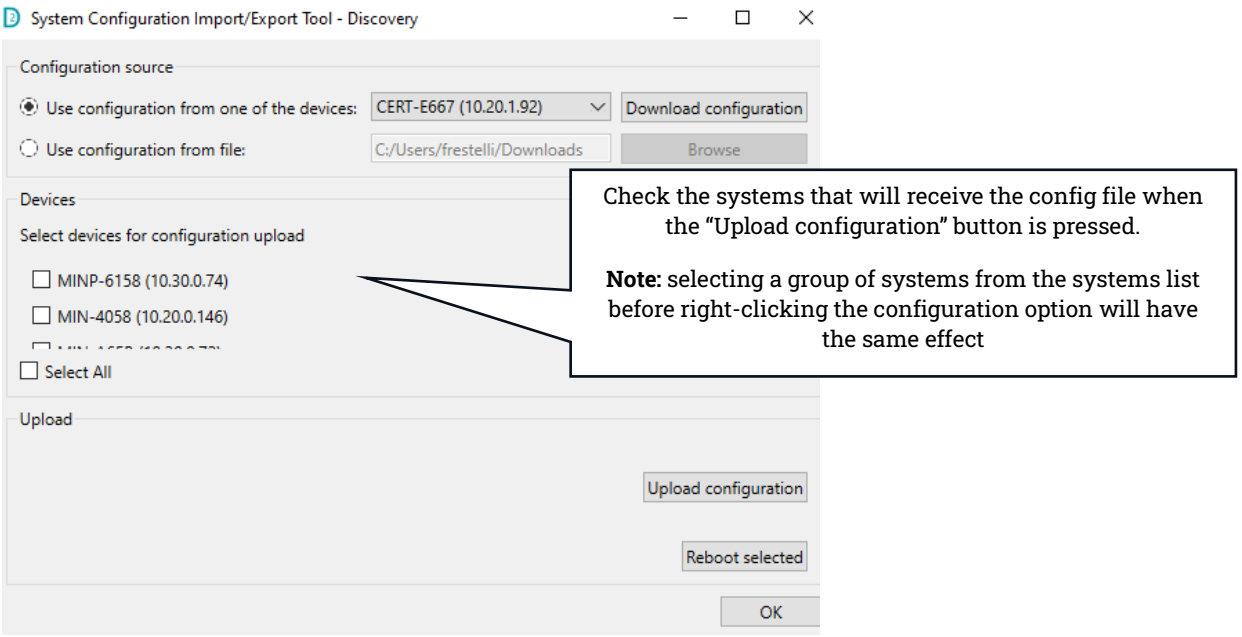


Figure 17 System configuration window

To perform mass configuration, preselect a group of instrument in the Discovery device list, right-click and select System Configuration. The applet below appears with the instruments preselected (ticked). Further selection of additional instruments can be performed before uploading a chosen file to all the selected systems in parallel. Once the Upload is complete, the Reboot Selected button can be used to restart all the instruments in one button press.

Loading an old .config file onto a system with newer software is perfectly acceptable. Any new parameters added in the newer version will simply not be modified by the upload.

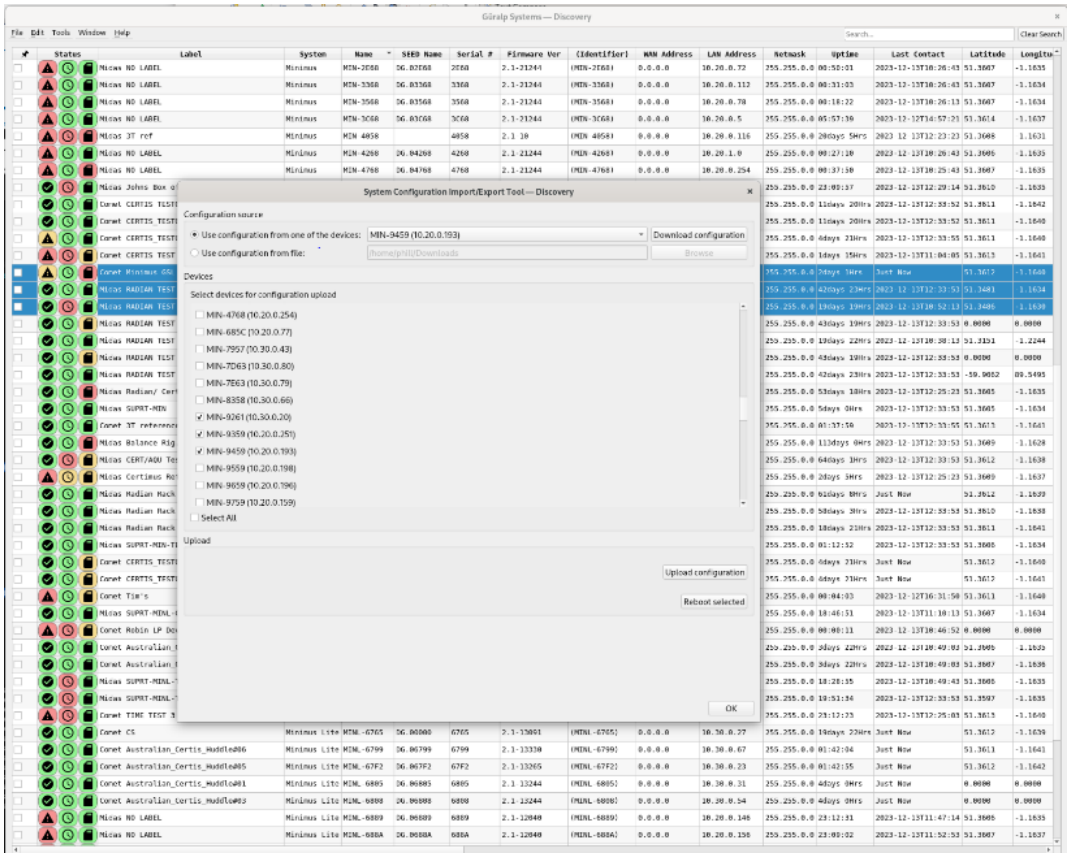


Figure 18 System configuration import/export tool

4.3.6 Running Scripts

A shell script can be run directly from Discovery. The script receives the instruments Hostname and IP Address as the first two parameters.

Both Linux and Windows builds of Discovery support this operation. With Windows it is necessary to install the Linux shell functions of Windows 11 onwards.

Bash or Python or any shell scripts can be run in this manner.

Group selection of multiple systems results in multiple shells being launched to run each script. An example of this would be to instigate a data download from the instrument's web server. These downloads will all operate in parallel for maximum speed. This is an effective way of offloading systems after a deployment.

In order to run scripts, first configure the folder that contains the script files by editing the config2.ini file (see Section 9.1 to find out the location of this file). Add the tag ScriptFilePath= to the folder that contains the script files. Files must be named "discovery_xxxx" They will appear in the right-click context menu under **Scripts**:

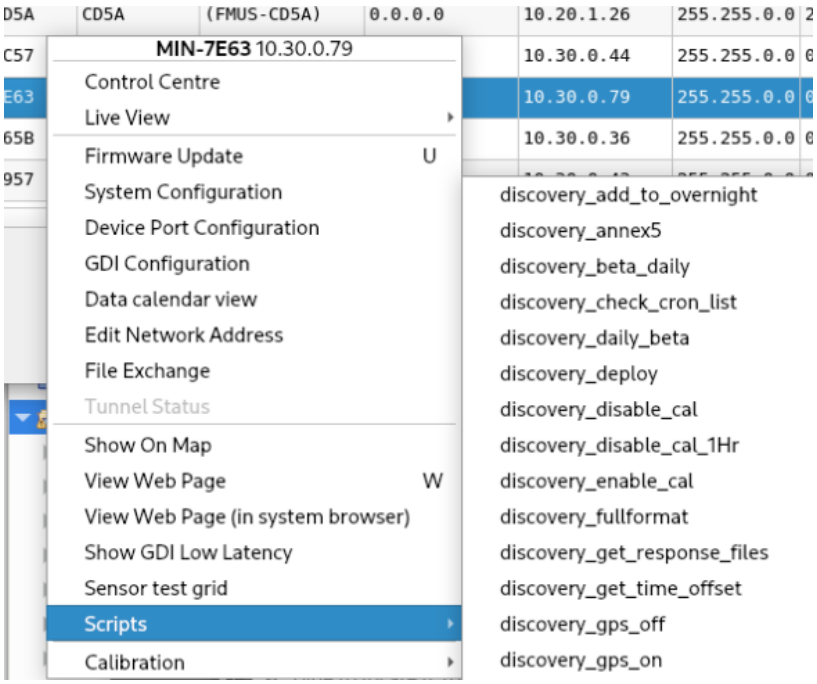


Figure 19 Script files are listed automatically

The example below fetches all the data files from the digitiser. This is using the HTTP (WEB Page) protocol to download all the files shown on the file list page of the instrument. Scripts are only supported on the Linux version of Discovery.

```
#!/bin/bash
set -x
foo=$(date +%Y-%m-%d)
mkdir $foo
cd $foo
mkdir $1
cd $1
wget -rnp http://$2/tab9.html
cd ..
```

4.3.7 Calibration

Calibration is a procedure used to verify or measure the frequency response and sensitivity of a sensor. It establishes the relationship between actual ground motion and the corresponding output voltage. Calibration values, or response parameters, are the results of such procedures.

Response parameters typically consist of a sensitivity or "gain", measured at some specified frequency, and a set of poles and zeros for the transfer function that expresses the frequency response of the sensor. A full discussion of poles and zeros is beyond the scope of this manual. The gain for a seismometer is traditionally expressed in Volts per

ms^{-1} and, for an accelerometer, in Volts per ms^{-2}. Other instruments may use different units: an electronic thermometer might characterise its output in mV per °C.

A calibration procedure is also used to establish the relationship between the input voltage that a digitiser sees and the output, in counts, that it produces. The results are traditionally expressed in Volts per count. Güralp digitisers (Minimus, Minimus+, $Minimus_2$ and Minimus Lite) are programmed at the factory so that they know their own calibration values. However, when an analogue sensor (*e.g.* Güralp Fortis, 3T, etc.) is connected to a digitiser of the Minimus family you are required to manually input the sensor's calibration values.

To enter the calibration values for your analogue instruments, right-click the digitiser's entry in Discovery's main window and select Calibration → Edit Poles & Zeros. This actions opens the Calibration Editor window.

This form has one tab for each seismic component, mass position and a calibration channel. The instrument's response values should be entered in here. These are:

- The **Digitiser Volts per Count (VPC) –** the ratio between the input voltage and the digitised output value ("counts"). This field will be populated automatically with the correct value for this input channel of the Minimus.
- **Analogue Instrument Gain –** this specifies the output voltage of the analogue seismometer per unit of ground motion, as measured at 1 Hertz. This information is normally provided on the calibration document that is shipped with the instrument. In the calibration document, this parameter is often referred to as "Velocity Output V/m/s" or "Acceleration Response $V/m/s^2$" depending on the analogue instrument. This value can vary slightly across the three components.
- The **ADC offset** is the quiescent output seen when digitiser input is zero. This field will be populated automatically with the correct value for this input channel of the Minimus.
- The **Coil constant** is the coil constant for the component being calibrated, in A/ms^{-2}, as given on the analogue sensor calibration sheet. This value is the same across all three components. This value is not relevant when Minimus is used with a Güralp Fortis accelerometer or Güralp Certis broad-band seismometer.
- The **Calibration resistor** is the value of the calibration resistor, in Ω, as given on the sensor calibration sheet. This value is the same across all three components. This value is not relevant when Minimus is used with a Güralp Fortis accelerometer or Güralp Certis broad-band seismometer.
- The **Normalising factor** specifies the value that the transfer function (as specified by the poles and zeros) must be multiplied by in order to provide unity gain at 1 Hz. This value is the same across all three components.
- The **Poles** and **Zeros** describe the frequency and phase response of the component. *They must be specified in Hertz.* This information is normally provided on a calibration document that is shipped with the instrument. If poles and zeros are not included in your calibration document, nominal values can be found here:

https://www.guralp.com/apps/paz/. This value is the same across all three components.

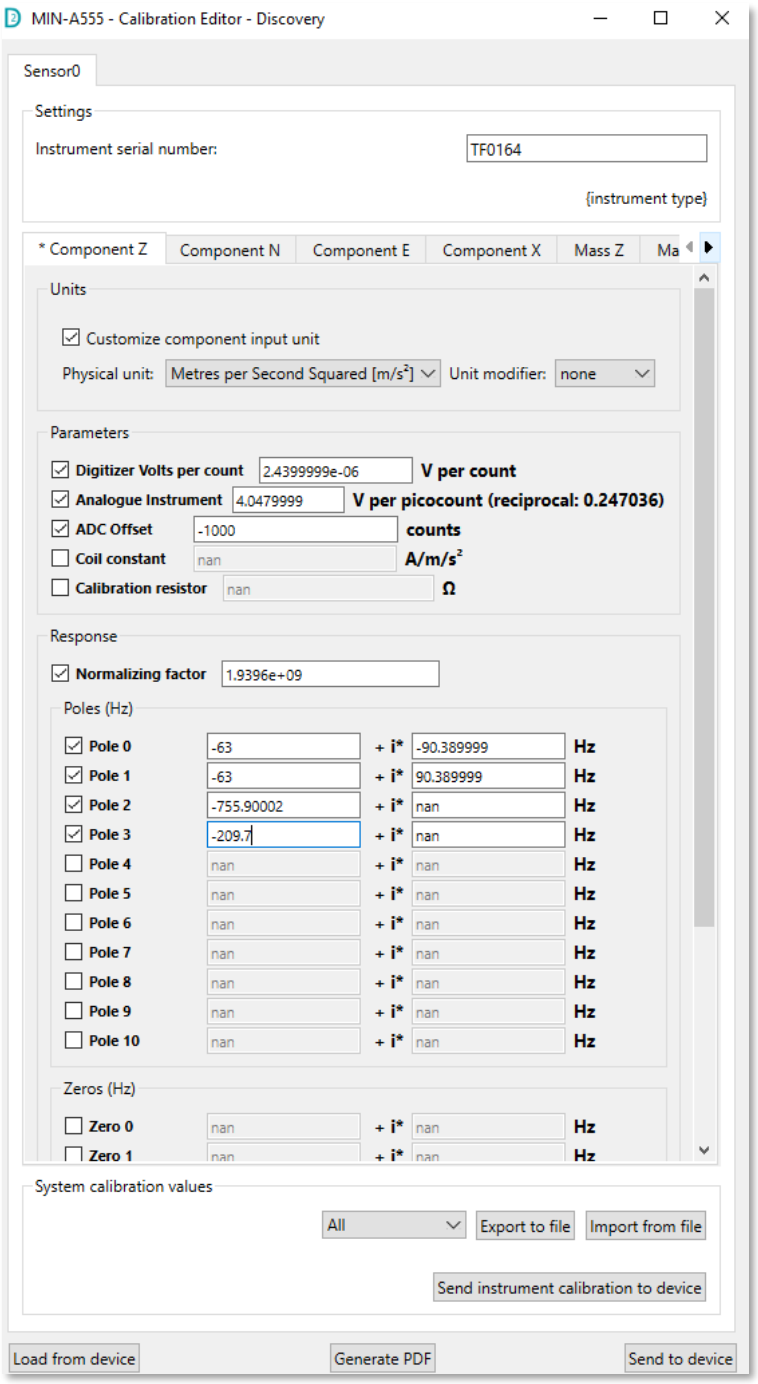


Figure 20 Calibration Editor window

Note: If the calibration document is lost, please visit the website to learn how to request a copy (https://www.guralp.com/customer-support).

The calibration parameters for one component can be copied to any other component of the same instrument, or other instruments. This is especially useful for poles and zeros because they are typically identical for all three components of all instruments in a class.

Within the "Component configuration" section, the "Copy:" drop-down box allows the selection of what to copy: poles and zeros, parameters, or All(tab dependant). The destination sensor can be set in the "to sensor" box and takes the numeric identity of the sensor as detected by the Minimus. Finally the specific components can be selected in the "to component" drop-down box. Click on the Copy button to copy and paste the selected values. Finally click on Send axis Z button to send the calibration values to the digitiser and save them permanently. Repeat this last step for the other axis. Note that Send axis Z only sends the calibration of the selected axis.

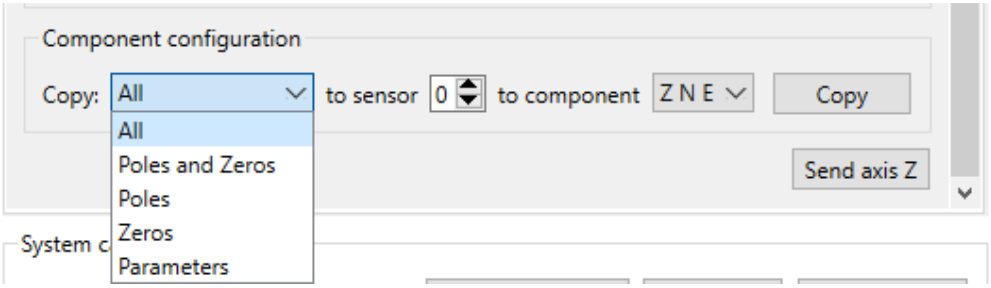


Figure 21 How to copy parameters to various components.

The overall system calibration parameters can be exported and saved in a file for future use by clicking on the Export to file button under "System calibration values".

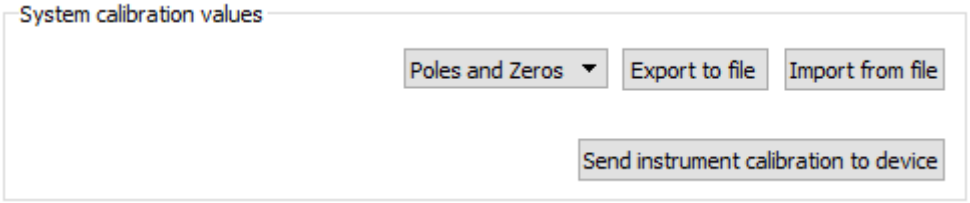


Figure 22 How to apply instrument calibration values.

The resulting filename will have the extension ".conf". Values from an existing calibration file can be imported using the Import from file button. The associated drop-down menu allows specification of what to import: poles and zeros, gains, or everything. Click on Send sensor0 calibration to device to send the calibration values to the digitiser and save them permanently.

Note: When using Minimus+, this action will only send the calibration of the selected sensor. Click on the Send to device button to send the complete calibration to the digitiser.

5 Tools Menu

There are a number of tools and applets available which perform functions that are not specific to devices. These are available in the Tools menu

5.1 MiniSEED to Directory Structure

Güralp instruments record data in miniSEED format. These files can be offloaded from the SD cards. The directory structure on the SD cards is flat and comprises 128Mbyte files.

These file are pre-created and stretched to 128Mbytes. The key reason for this is to prevent the File Allocation Table (FAT) being constantly updated as the system records. In fact, a loss of power during the update of the FAT would result in a loss of most or all data on the card. The pre-stretched files are never extended during normal operation so a loss of power during a write would result in just one corrupt block in the middle of a miniSEED file, which is typically skipped over by any reader.

This tool allows you to chop a large miniSEED file in smaller miniSEED files with a fixed length of 1 hour. It will process the miniSEED files to create a folder structure of month/day/hour with the hour-long miniSEED files in each folder.

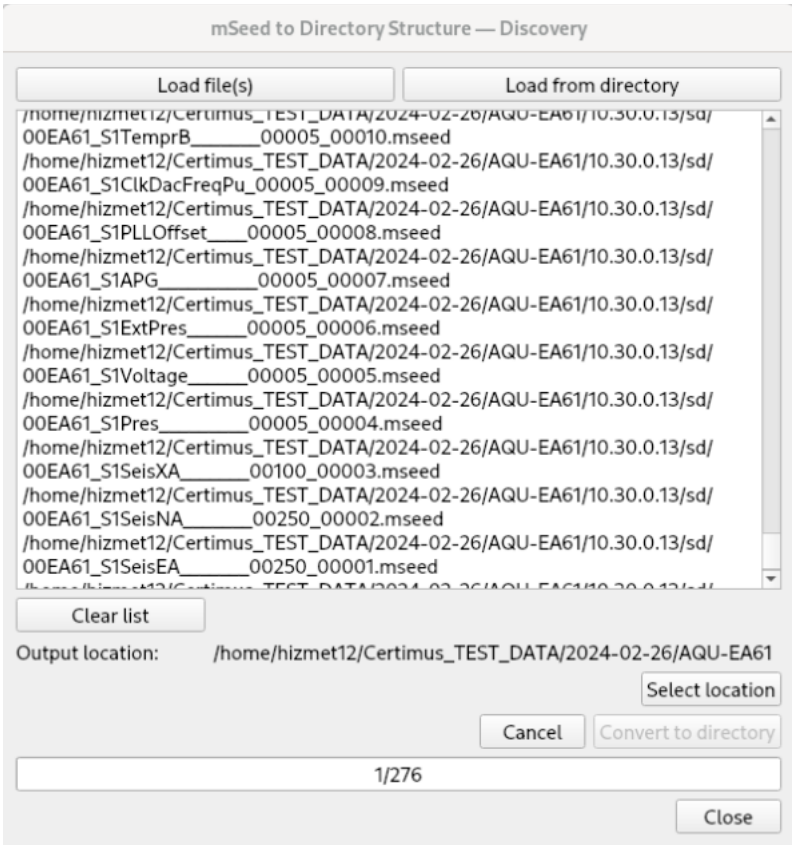


Figure 23 mSeed to Directory Structure *window*

Figure 24 Resulting file hierarchy

5.2 CAP Receiver

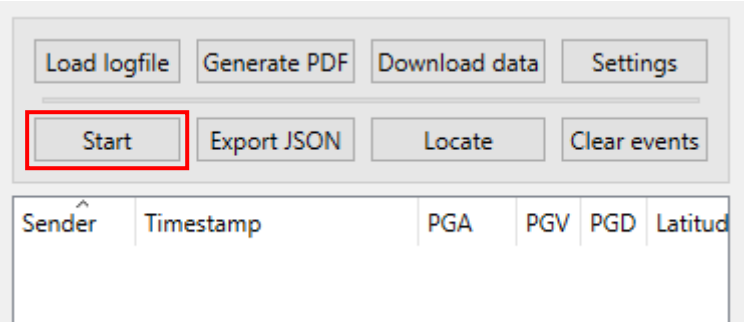
Instruments can detect local events using a number of algorithms. Typically, an STA/LTA trigger is used. This is relatively immune to slow changes in background noise such as day to night.

A trigger can be configured to send a message (CAP – Common Alert Protocol). Güralp Discovery includes a CAP receiver. It listens on a specified UDP port for incoming CAP messages. When one arrives, it can be displayed on a map alongside a table of information. Furthermore, there is a user defined *event window* where Discovery's CAP receiver will receive multiple event messages and evaluate them producing:

- An event log containing all the raw CAP messages received during the event
- An Event Report PDF listing crucial details from the event messages
- An epicentre based on trigger times of the event messages
- A GeoJSON file for importing the results to third-parties

On generating the above the CAP Receiver will stop listening for CAP messages and open a new instance that will continue listening for new events. This allows the user to review the data inside the CAP Receiver if needed whilst still actively listening.

Note: In order to receive CAP messages, please make sure that the CAP receiver has been started by clicking on the Start button. If you see instead a Stop button, it means that the CAP receiver is already listening.



5.2.1 Network Settings

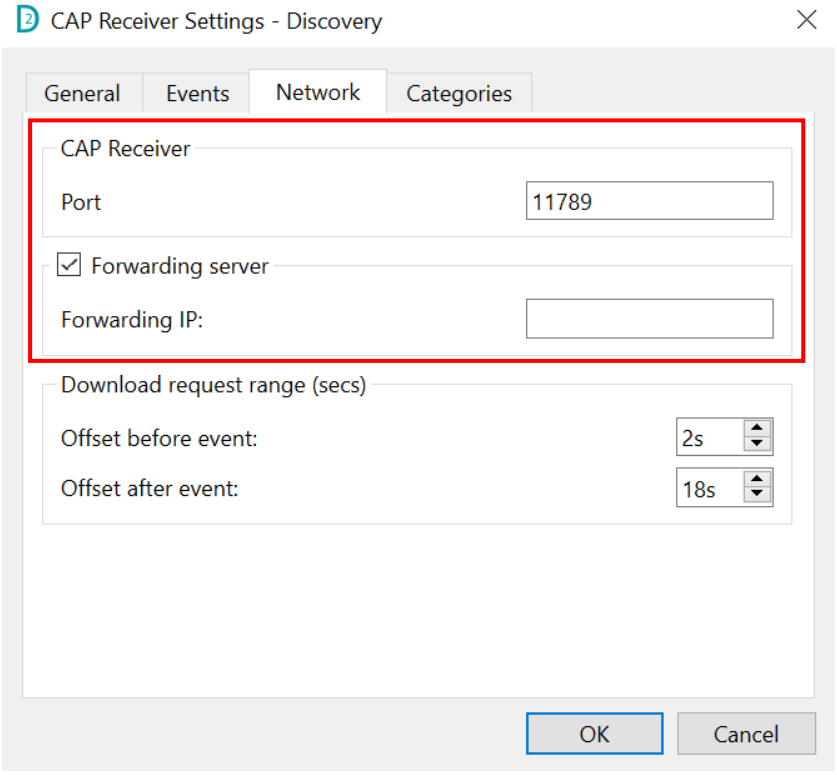


Figure 25 CAP receiver network settings

The CAP receiver window allows specification of the listening port. This is available by clicking on Settings and then on the Network tab. Each device from which messages should be received must have this value specified as the "CAP Port" in its triggering settings (from the Trigger tab of the webpage). The value should be between 1025 and 65535. You should avoid numbers in the list at https://en.wikipedia.org/wiki/List_of_TCP_and_UDP_port_numbers.

Note: For full instructions about how to configure triggers using instruments that run the DIG firmware (i.e. Minimus, Minimus+, Fortimus and Certimus) see DIG firmware's manual (**MAN-DIG-0001**).

If you wish to forward the CAP messages to a server, type its I.P. address into the field and tick the check-box named "Forwarding server". An error message is displayed if the entered I.P. address is not valid.

5.2.2 Map & Table View

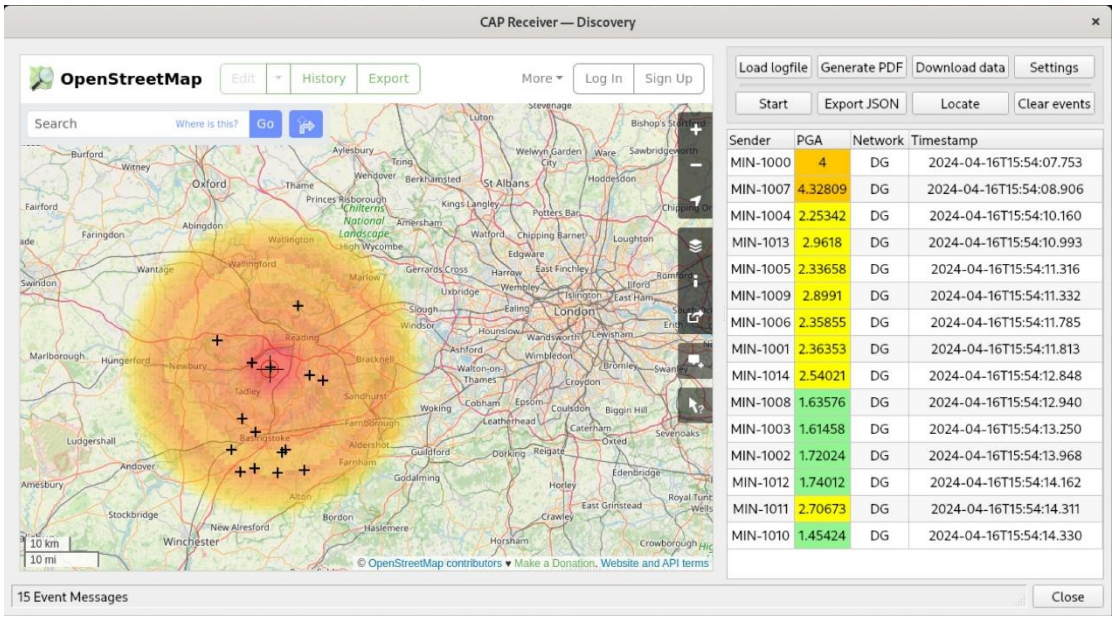


Figure 26 Discovery's shake map

Each row of the table contains information from a CAP message, such if you have three devices trigger you will see three rows in the table. If the device is setup to send Peak Ground data or remote triggers, these will merge with the initial trigger they relate to. This means after the initial trigger is received the PGA column may be empty but it will populate when the Peak Ground data comes through later on.

Note: PGA, PGV and PGD are available only for instruments running the DIG firmware (Minimus, Minimus+, Fortimus and Certimus. **NOT** Minimus2/Minimus Lite). To receive PGA, PGV and PGD information, the EEW parameters have to be enabled. See DIG firmware's manual (**MAN-DIG-0001**) for more details.

The column headers in the table are configurable in Settings, giving a range of useful information from the CAP messages. Colour coding schemes are used for the PGA column and optionally for the Sender column if Site Fragility is enabled. is used to show individual station's PGA values in the list. The list can be sorted by clicking on the column header.

Clicking on entries in the list will highlight the location on the map – and vice versa.

Each device that has triggered is displayed on the map as a black cross. Red crosses on the map reflect sensors that have some form of compromised performance – possible timing inaccuracies or poor connectivity

5.2.3 Colour Categories – Site Fragility

There is a default colour category for PGA values which will colour the PGA column of the CAP message table in either green, yellow, orange, or red (for most severe).

An advanced colouring option called Site Fragility can be used to colour the Sender Name column and optionally be used to colour the PGA column as well.

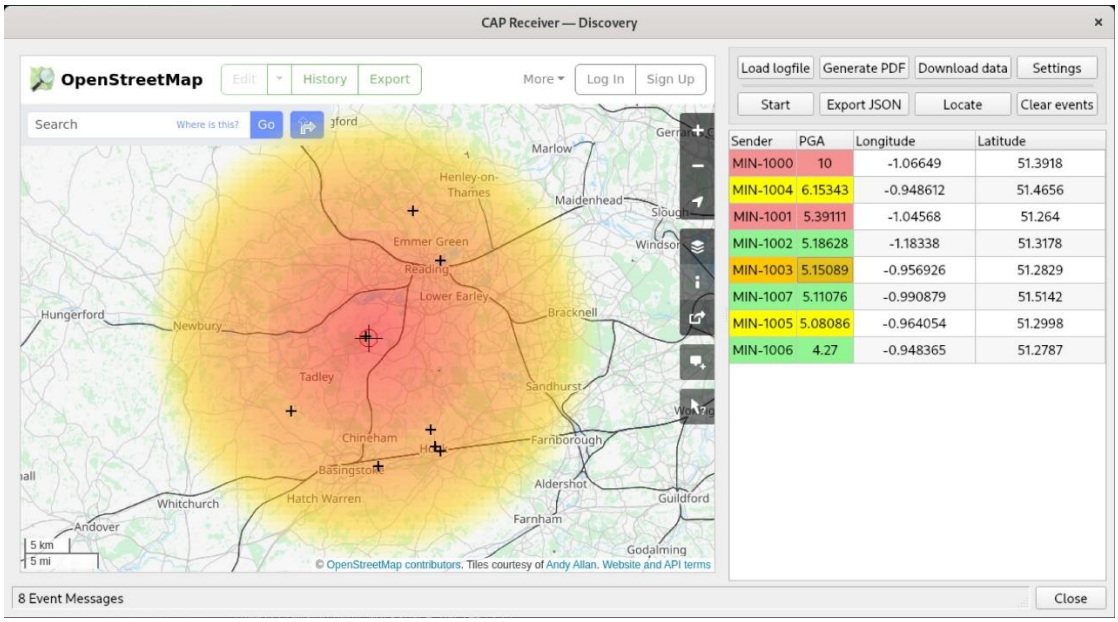


Figure 27 – An example of Site Fragility categories overriding PGA categories

In the above example the event table has been ordered by PGA and we can see the colouring is no longer dependant entirely on PGA but is different per site. Each site has PGA limits set for it. This can be found in Settings on the Categories tab:

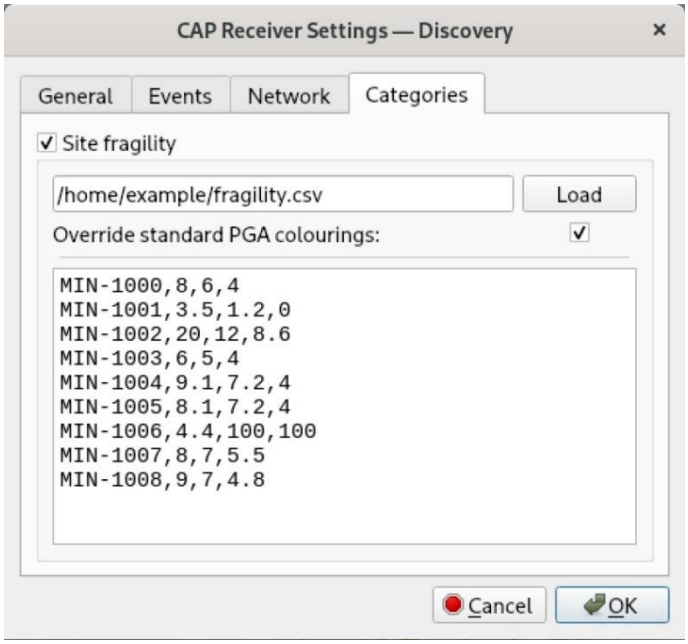
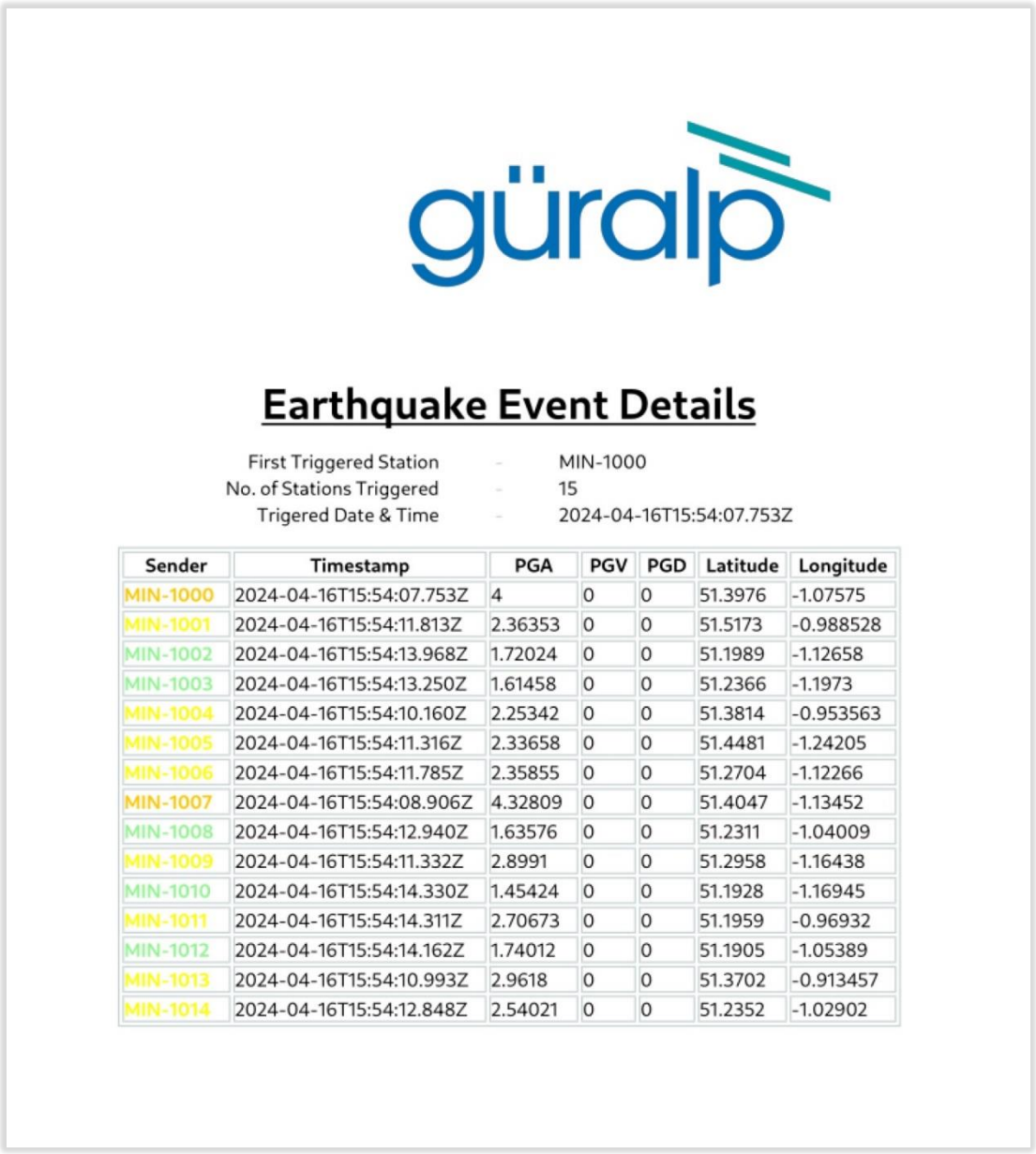


Figure 28 – Settings, Categories tab

The format of the CSV file is <sender-name>, <red>, <orange>, <yellow>, <green>. Where the colours relate to a PGA value (it turns red after the PGA reaches <red>).

5.2.4 Event Report & GeoJSON

When an event window closes, or when the user presses Generate PDF, a PDF is built from the information in the current event's CAP messages. This displays the sender information, timestamps, Peak Ground data, and latitude/longitude. The example below uses faked data which is why there are no PGV or PGD values.



Earthquake Event Details

First Triggered Station	MIN-1000
No. of Stations Triggered	15
Trigered Date & Time	2024-04-16T15:54:07.753Z

Sender	Timestamp	PGA	PGV	PGD	Latitude	Longitude
MIN-1000	2024-04-16T15:54:07.753Z	4	0	0	51.3976	-1.07575
MIN-1001	2024-04-16T15:54:11.813Z	2.36353	0	0	51.5173	-0.988528
MIN-1002	2024-04-16T15:54:13.968Z	1.72024	0	0	51.1989	-1.12658
MIN-1003	2024-04-16T15:54:13.250Z	1.61458	0	0	51.2366	-1.1973
MIN-1004	2024-04-16T15:54:10.160Z	2.25342	0	0	51.3814	-0.953563
MIN-1005	2024-04-16T15:54:11.316Z	2.33658	0	0	51.4481	-1.24205
MIN-1006	2024-04-16T15:54:11.785Z	2.35855	0	0	51.2704	-1.12266
MIN-1007	2024-04-16T15:54:08.906Z	4.32809	0	0	51.4047	-1.13452
MIN-1008	2024-04-16T15:54:12.940Z	1.63576	0	0	51.2311	-1.04009
MIN-1009	2024-04-16T15:54:11.332Z	2.8991	0	0	51.2958	-1.16438
MIN-1010	2024-04-16T15:54:14.330Z	1.45424	0	0	51.1928	-1.16945
MIN-1011	2024-04-16T15:54:14.311Z	2.70673	0	0	51.1959	-0.96932
MIN-1012	2024-04-16T15:54:14.162Z	1.74012	0	0	51.1905	-1.05389
MIN-1013	2024-04-16T15:54:10.993Z	2.9618	0	0	51.3702	-0.913457
MIN-1014	2024-04-16T15:54:12.848Z	2.54021	0	0	51.2352	-1.02902

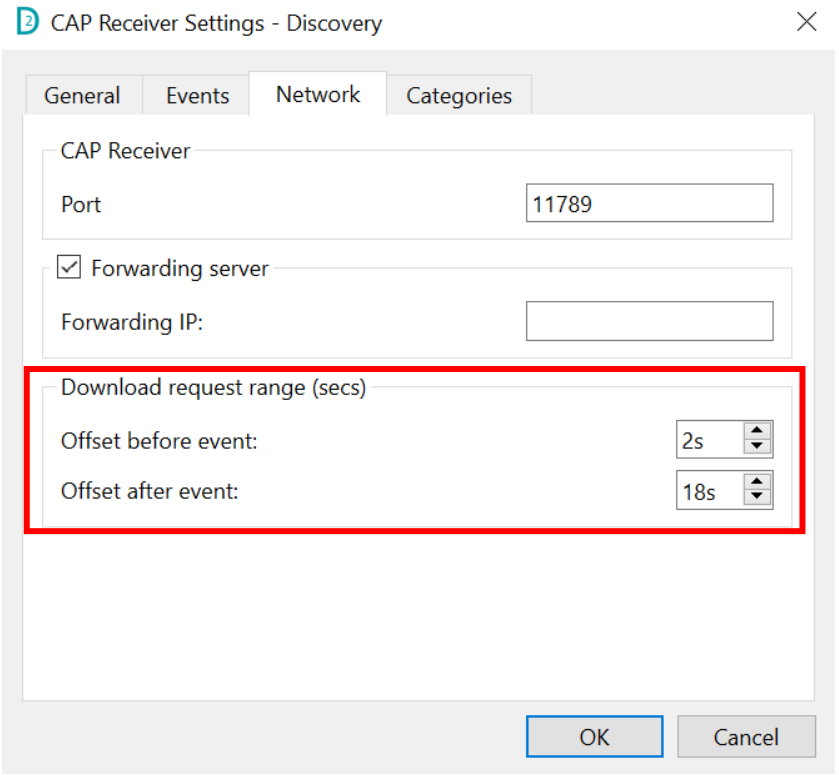
Figure 29 - Example of an Event Report PDF

When an event window closes, or when the user presses Export JSON, a JSON file is built from the sender name, PGA, and latitude/longitude for all current CAP messages.

5.2.5 Download Data

Stream data can be download from the selected instruments by selecting them either in the table or on the map view and pressing the Download data button.

The time range to download is configurable in Settings allowing a range before the event and a range after.

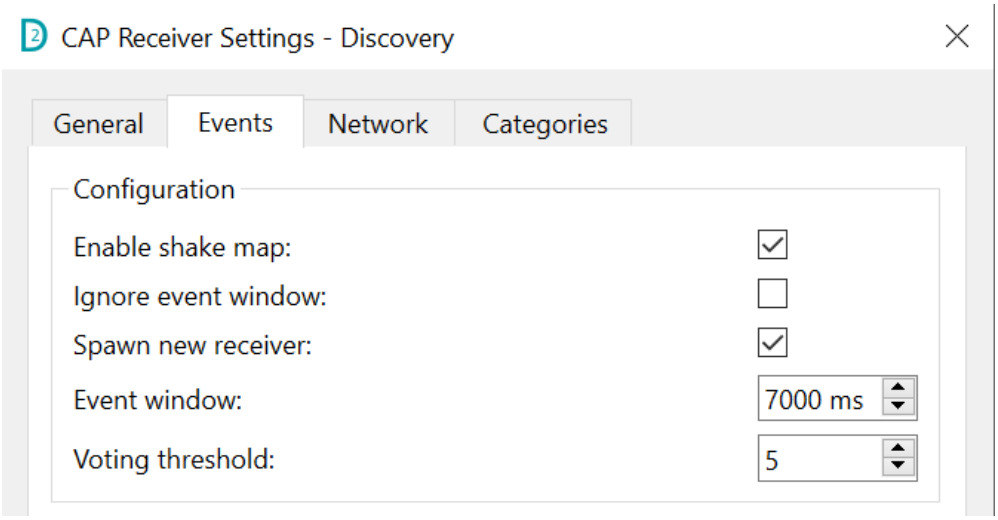


Note: Immediately after an event occurs the device will not have copied the data across so requesting data with Download data will not be successful until some time afterwards.

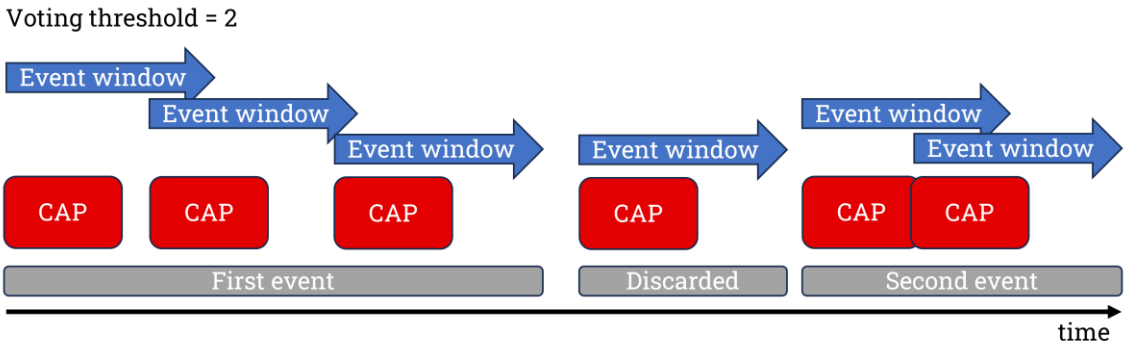
5.2.6 Triggers – Voting

When multiple instruments are deployed within a network, a voting scheme is typically used to reduce false triggers. Local voting among sensors helps filter out spurious events, as simultaneous triggers from widely spaced sensors are highly improbable in the absence of a genuine seismic event.

The voting scheme in Discovery's CAP receiver is characterised by two parameters: the voting threshold and the event window. These two parameter can be set from the Events tab of the CAP receiver Settings.



The voting threshold defines the minimum number of CAP messages that must be received within a specified time frame (event window) to confirm an actual event. When a new CAP message is received, the event window is initiated. If another CAP message arrives within the event window, the timer resets, and the full duration of the window begins again from that point. If the threshold is not met before the event window expires (i.e., no new messages extend it further), Discovery's CAP receiver terminates the instance, discards all collected messages and takes no further action.



The total number of CAP messages sent by an individual instrument varies depending on its settings.

When a trigger is configured on individual channels, a CAP message is immediately issued upon trigger activation. If the EEW (Earthquake Early Warning) transform is applied to that channel, a second CAP message is sent a few seconds later containing the calculated PGA (Peak Ground Acceleration), PGV (Peak Ground Velocity) and PGD (Peak Ground Displacement) values.

Triggers can also be configured on seismic triplets. In this case, triggering can be based on the 3D resultant of the Z, N and E components together, or the Z component and the 2D resultant of the N and E components separately. In this case, a CAP message is issued upon trigger activation, and additional CAP messages are sent if the EEW transform is enabled.

The table below provides some examples of trigger configurations and the corresponding number of CAP messages generated.

Source	EEW transform	Triplet options	Triggered channels	N° CAP messages
Single tap	Disabled			1
Single tap	Enabled			2
3 × Single tap	Disabled			3
3 × Single tap	Enabled			6
Triplet	Disabled	3D		1
Triplet	Enabled	3D		2
Triplet	Disabled	Z & NE	Z *or* NE	1
Triplet	Disabled	Z & NE	Z *and* NE	2
Triplet	Enabled	Z & NE	Z *or* NE	4
Triplet	Enabled	Z & NE	Z *and* NE	5

Note: EEW transform is only available for Minimus, Minimus Plus, Certimus and Fortimus, **NOT** for Minimus2 and Minimus Lite. Therefore, for Minimus2 and Minimus Lite only the rows with EEW transform disabled are relevant.

5.2.7 Triggering Test Tool

In order to see the event locator and logging operate without the need for a real event, Güralp has written a test tool that generates fake trigger events and sends CAP messages. with an 'epicentre' within the geographic region specified.

The test tool is installed in the Program Files folder under Guralp Systems / Discovery2. Simply double click 'thing.exe'

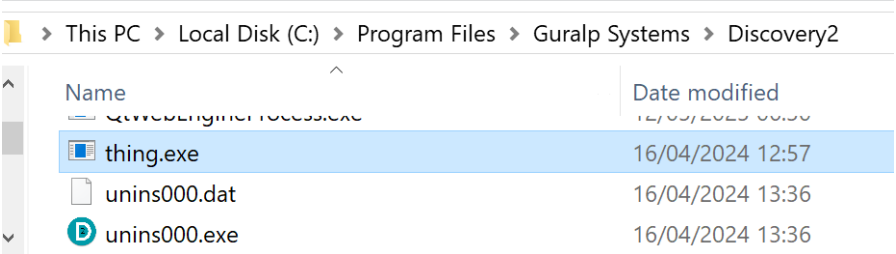


Figure 30 Discovery's test tool

First, enter the IP address of the CAP receiver (the computer running Discovery), in the Destination IP field. To find out the IP address of a Windows computer, key Windows + R to open the "Run" dialogue, enter `cmd` and press the Enter key. Type `ipconfig` in the terminal. Look for the right network adapter (e.g. Wi-Fi or Ethernet). The IP address will show next to the IPv4 Address entry.

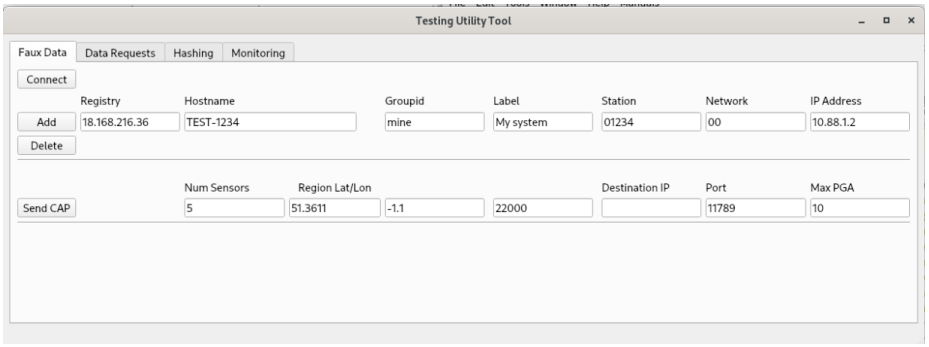


Figure 31 CAP sender Test Tool

The number of instruments can be specified under Num Sensor, such that triggers are randomly generated from these instruments and create arrival times consistent with a simulated 'epicentre' within the geographic region specified. The maximum PGA can also be specified.

5.3 MiniSEED Extractor

The miniSEED extractor serves two purposes:

- When an SD card is quick-formatted, each file is marked as unused but previously recorded data can still remain in them. Subsequent recordings overwrite these files from the beginning but, if the previous recording had a longer duration, old data will remain in the files. When the files are copied from the SD card to a PC, these older data can cause problems.

- The format used on the SD cards consists of fixed-length, 128 MiB files. Some recordings might not use all of this space. When the files are copied from the SD card to a PC, this can cause wasted disk space.

The miniSEED extractor reads miniSEED files on the PC and copies them to a selected Destination folder, keeping track of the latest block time-stamp as it goes. If it encounters either an unused block or a time-stamp which is earlier than the previous one, it stops copying, truncating the output file at that point. This guarantees that each output file contains only blocks in time order and contains no wasted space.

To use the tool, select "miniSEED Extractor" from the **Edit** menu. Click the first Browse button to select which files you wish to process and then the second Browse button to select the folder into which you wish the output files to be written.

Finally, click the Trim Files button to extract the valid data from the selected files into new files in the selected destination folder. When the process reaches 100% the window can be closed and the trimmed miniSEED files can be found in the chosen folder.

5.4 MiniSEED Gap Reporter

This tool can generate a report of any gaps in the data from the input files. To use, upload the desired input and then click Gap Report to view the report of all files or just selected files.

5.5 Command Scheduler

6 Data Visualisation

6.1 Streaming data into Discovery

6.1.1 Streaming protocols

Discovery offers a versatile live waveform/data viewer. To open the Waveform Viewer, in Discovery's main window, select an instrument, right-click on it and select Live View. The menu will then present options for data streaming, either GDI or Seedlink.

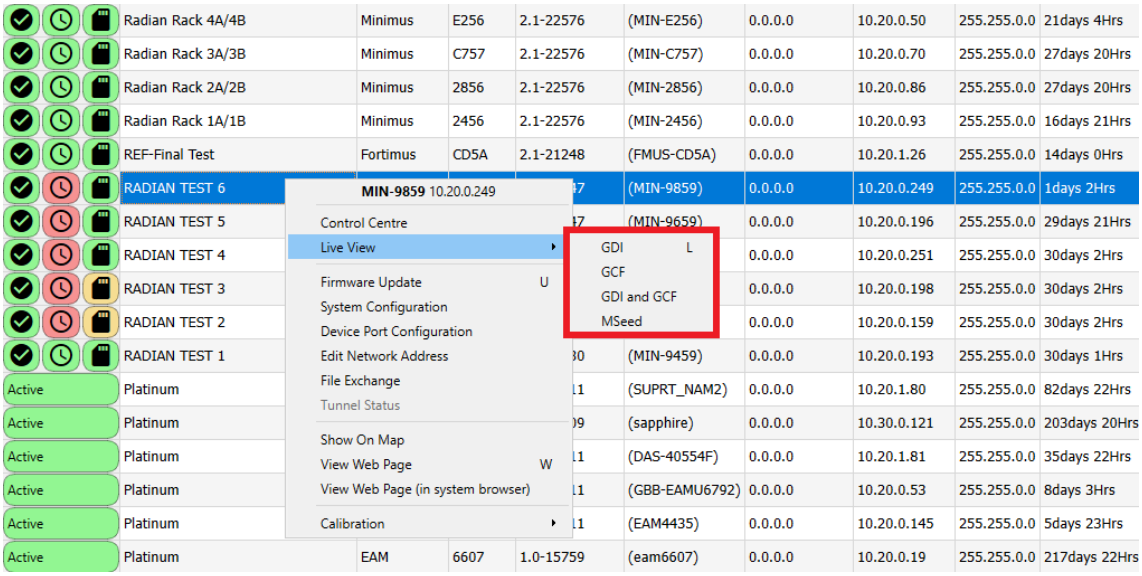


Figure 32 Discovery main window and Live View options

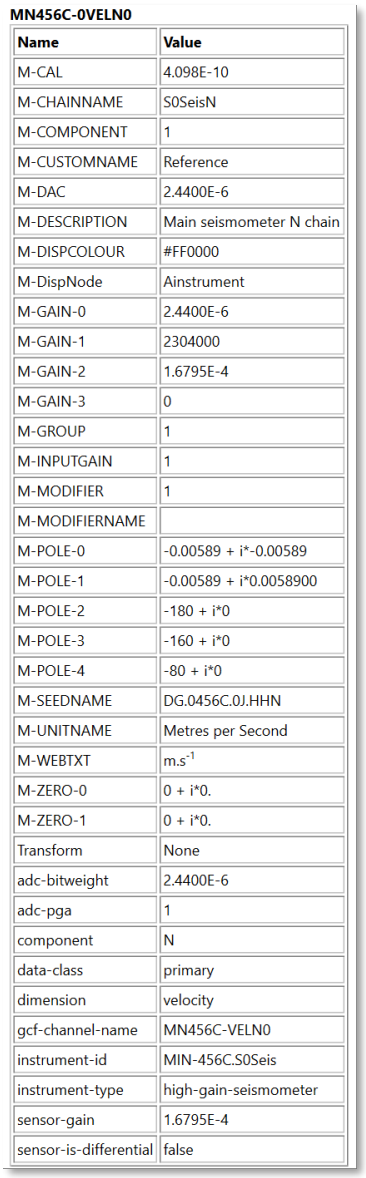
The Seedlink option utilises the industry standard SEED protocol, allowing the user to stream data from a single instrument or an instance of the Güralp Data Centre (GDC). For more information on GDC and Seedlink archive, see Section 8.6.4.

All newer systems support the GDI protocol. The GDI protocol streams data sample-by-sample and provides a low-latency data link for seismic data, both time-series (sample) and state-of-health information. These much smaller packets of samples allowing for a faster time-to-receive and a smoother feeling live stream.

The GDI protocol also allows the sending of each instrument's calibration parameters so that data can be expressed in terms of physical units rather than digitiser counts. This is discussed in more details in Section 6.1.2.

The main features and controls of the Live View window are introduced in Section 6.1.3.

6.1.2 Metadata



MN456C-0VELN0

Name	Value
M-CAL	4.098E-10
M-CHAINNAME	S0SeisN
M-COMPONENT	1
M-CUSTOMNAME	Reference
M-DAC	2.4400E-6
M-DESCRIPTION	Main seismometer N chain
M-DISPCOLOUR	#FF0000
M-DispNode	Ainstrument
M-GAIN-0	2.4400E-6
M-GAIN-1	2304000
M-GAIN-2	1.6795E-4
M-GAIN-3	0
M-GROUP	1
M-INPUTGAIN	1
M-MODIFIER	1
M-MODIFIERNAME	
M-POLE-0	-0.00589 + i*-0.00589
M-POLE-1	-0.00589 + i*0.0058900
M-POLE-2	-180 + i*0
M-POLE-3	-160 + i*0
M-POLE-4	-80 + i*0
M-SEEDNAME	DG.0456C.0J.HHN
M-UNITNAME	Metres per Second
M-WEBTXT	$m.s^{-1}$
M-ZERO-0	0 + i*0.
M-ZERO-1	0 + i*0.
Transform	None
adc-bitweight	2.4400E-6
adc-pga	1
component	N
data-class	primary
dimension	velocity
gcf-channel-name	MN456C-VELN0
instrument-id	MIN-456C.S0Seis
instrument-type	high-gain-seismometer
sensor-gain	1.6795E-4
sensor-is-differential	false

Figure 33 Example of metadata available by hovering over GDI channel

GDI metadata consists of name/value pairs of text. The above list shows a typical set of metadata from a digitiser seismic channel, which appears when hovering on the GDI channel. Most of the metadata is sent only once on the connection of the channel.

Metadata can be edited using the View/Edit Metadata function, accessible by right-clicking on the waveforms. Gain and response parameters can be manually overwritten, but this is lost when a new connection is made. This can be used as a quick diagnostic tool. The metadata can be modified in a permanent way through the Calibration Editor.

M-CAL represents the scaling factor used for the conversion from digital counts to physical units. M-CAL is the product between M-GAIN0 (the digitiser's sensitivity expressed in V/counts) and M-GAIN2 (the sensor's sensitivity expressed in m/s/V for a velocity instrument and $m/s^2/V$ for an acceleration sensor).

Changing the value of M-DISPCOLOUR will result in the stream being drawn with a different colour.

A Seedlink stream to a Guralp device will automatically request the dataless file. This file is the SEED protocol for metadata. On receiving the dataless file the stream will populate the metadata with units, gains, poles, zeros, etc.

6.1.3 Waveform Viewer

To open the waveform viewer, right-click on an instrument in Discovery's main window and select Live View.

More than one instruments can be selected by clicking on their entries while holding down the Shift key (to select a range of instruments) or the Ctrl key (to select each instrument individually).

6.1.3.1 Waveform Visibility

The left tree display (Channel List) allows individual streams of data to be made visible or hidden from view. The Clear All and Select All buttons remove everything from view and display all the streams, respectively.

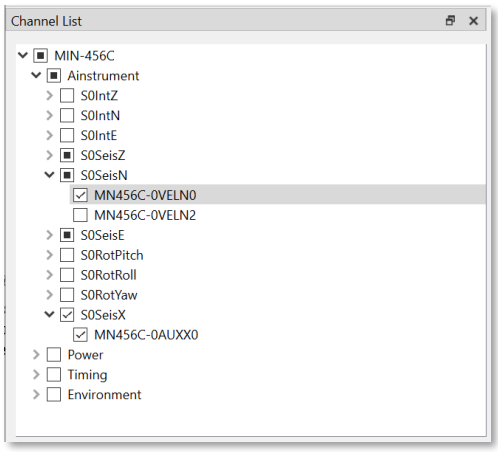


Figure 34 Channel List check boxes control waveform visibility

Right-clicking on one of the channels offers access to filters to apply visibility over all available channels (also across different instruments). There are three different filter options presented:

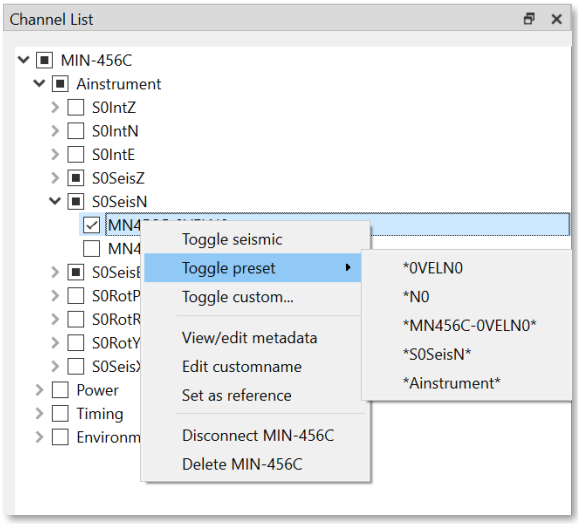


Figure 35 Context menu offers filters

- **Toggle Seismic** – A quick and simple way to toggle on or off all the seismic channels (ending Z/N/E). The selection choice is set in a config option 'SeismicToggleBands' which can be set in the advanced settings. It is a list of the acceptable seedname values for the first character in the channel code:

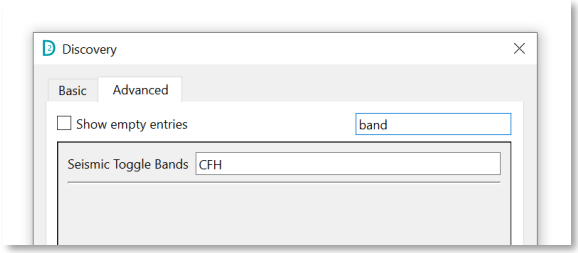


Figure 36 Searching the advanced settings for 'band' to edit 'SeismicToggleBands'

- **Toggle Preset** – Automatically generated possible searches based on the hierarchy of the Channel List
- **Toggle Custom** - A simplified expression search filter where "*" is used as wildcard and "," is used to add more filters.

  Some filter examples:
  - *Z → select all channels with names ending in 'Z'
  - *ACCN2, *ACCE2 → select all acceleration channels (tap 2) for horizontal components
  - *Timing* → select all channels with timing information

6.1.3.2 Channel metadata

As mentioned previously, GDI channels and Seedlink with dataless carry metadata in addition to the sample stream. This can be displayed by right-clicking on a channel and select View/Edit.

For GDI, the values can be modified such that other applets use the new values. The modifications remain until restarting the application.

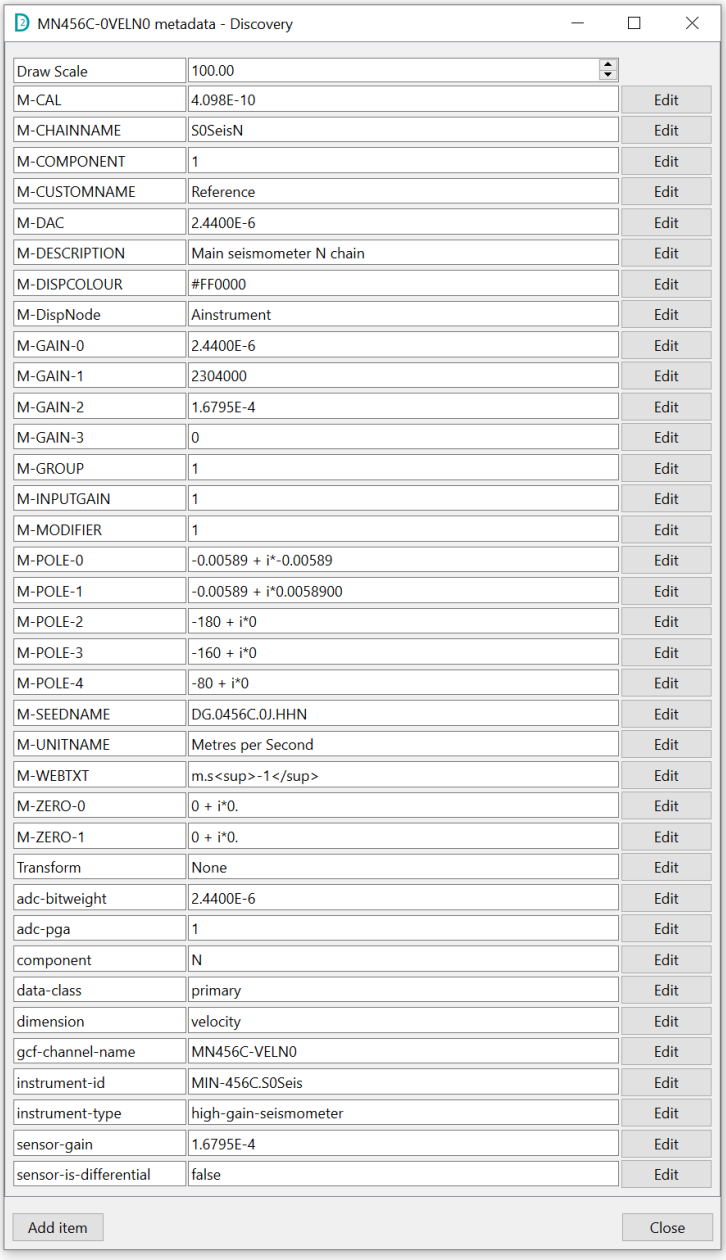


Figure 37 Metadata access from Channel List context menu

6.1.3.3 Selection mechanism

Dragging the mouse with left-click extends the selection. Once a temporal selection has been made, the channel makeup of the selection can be altered.

Use Ctrl + left-click on other individual channels within the selected region to toggle their inclusion.

Use Shift + left-click to extend the selection across multiple channels.

When no key modifier is used, dragging the mouse with left-click over a waveform shows the maximum, minimum and average (in terms of mean and RMS) values for the selection. These values are typically expressed in physical units, with the counts shown in brackets.

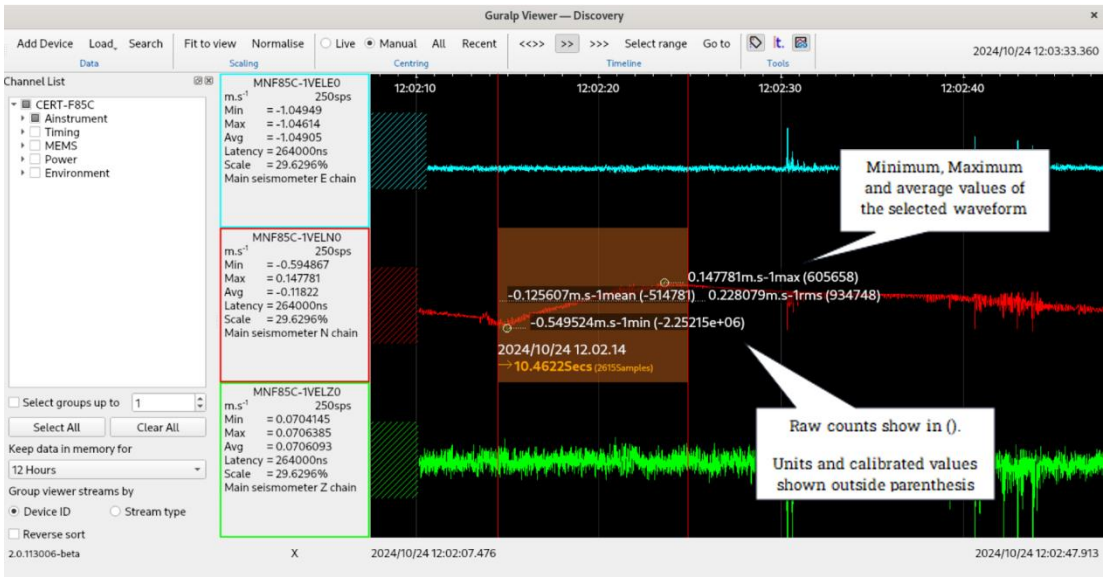


Figure 38 Left-click and drag selection of waveform

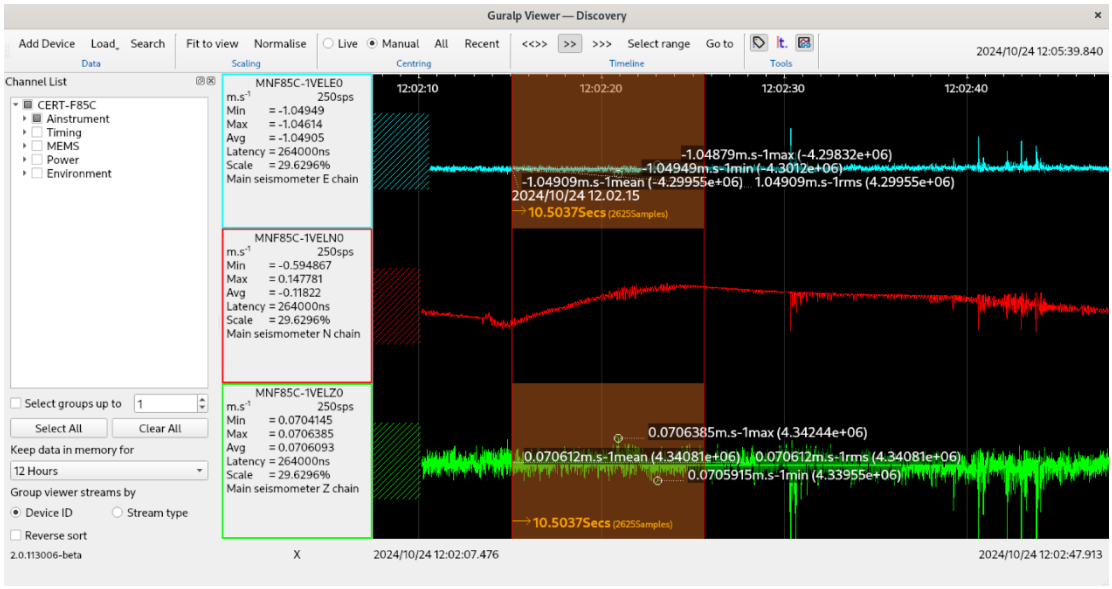


Figure 39 Use Ctrl + left-click to select two channels not close to each other

Key modifiers (*Shift, Alt*) changes the annotated text to depict different signal statistics.

- Shift → The mean of the selected waveform if subtracted from the min and max. The range (difference between min and max) is also shown.
- Alt → The integral (area between signal and mean), the time in seconds between min and max and the ratio of min/max are displayed.

Using the Alt key changes the numerical annotation of the selected waveform as shown below. Using this feature to analyse a seismic instrument's step response will display damping factor and estimated long period corner in seconds.

Note: This approach to instrument verification is relatively quick to achieve an estimate of the instruments frequency response but it is highly broadband noise calibration is performed for a better, more accurate measurement.

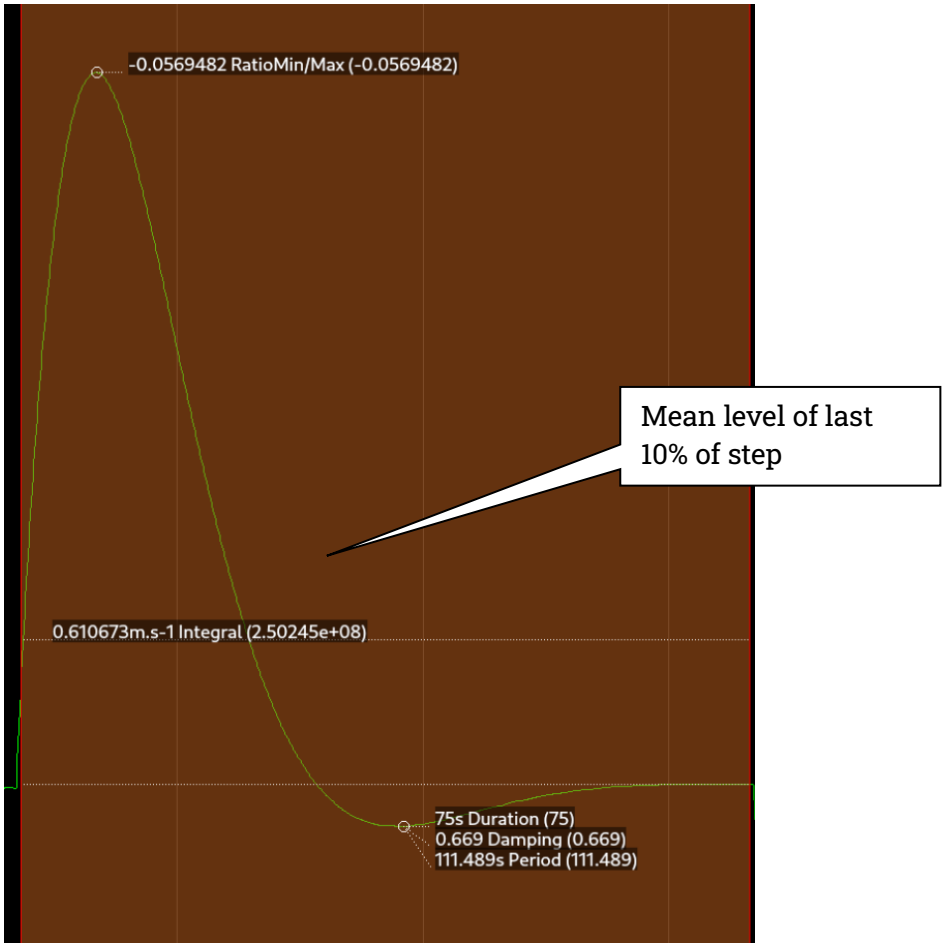


Figure 40 Step response analysis with Alt Key

6.1.3.4 Saving Files

Portions of waveforms displayed in the Live View window can be saved to your PC in miniSEED format. In order to do this, highlight the section of waveform you want to save, right-click on it, and select Save as mseed. Multiple waveforms can also be selected as described in Section 6.1.3.3.

Various files are saved in the chosen directory, specifically:

- One file in miniSEED format for each channel selected, named after the channel name, which contains the highlighted portion of waveform
- One dataless file
- One file called all.mseed in miniSEED format, which contains multiple traces from all the channels selected.

If channels from more than one instruments are selected, the files from the different instruments are saved in folders named after the serial number of the devices. Each folder contains the same files as specified above.

6.1.3.5 Window Control Short-Cuts and controls

You can change the display of the waveforms with based on a combination of key-strokes and mouse wheel and menu buttons. These commands are shown in the tables below:

Table 2 List of commands to change waveform display

Command	Window control
<<>>	Extend view over all available data
>>	Show most recent minute or so of data
>>>	Show most recent few seconds of data
Ctrl + mouse wheel	Pan time-scale right/left
Shift + mouse wheel	Zoom time-scale in/out
Mouse wheel	Scale amplitude of all traces
Mouse wheel – over trace label	Scale amplitude of that individual trace
Right Click Context menu – Zoom in	Re-zoom whole display to show the selected region only
Right Click Context menu – ReZero	Remove mean from the selected portion of the waveform
Double left-click over Channel Stats	Magnify that channel
R Key When in Waveform Context	Re-scale and re-zero channels individually to be visible
+ Key When in Waveform Context	Change offset to bring last 10% into view
Mouse Wheel Over Channel Info Text	Zoom that one stream independently
Mouse Wheel Over Channel Info Text +Shift	Move that one stream's offset
Mouse Wheel Over Channel Info Text +Control	Fine move that one stream's offset

The overall waveform window scaling and offset of channels is controlled by the buttons above the waveforms. These change all the channel's zoom and offset values in one 'hit'.

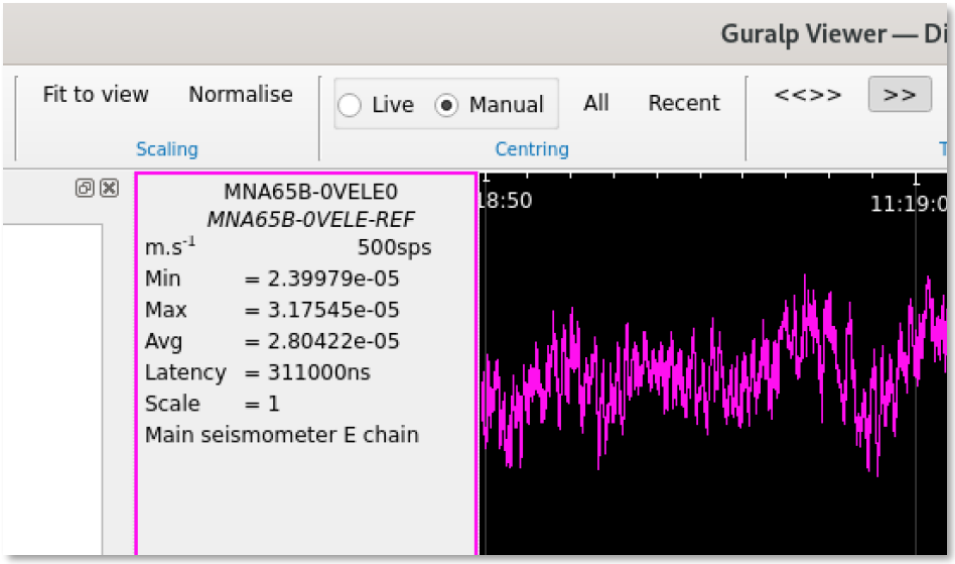


Figure 41 Scale, Offset and Zoom controls in Live View window

Table 3 Summary of waveform zoom and offset controls

Button	Scale	Offset	Comments
Fit to view (formally Reset)	Each channel scaled to fit	Set to the channel's mean	A quick way to guarantee actually seeing something irrespective of any channel offset or signal size
Normalise	Reset Zoom to fit the biggest waveform. Other channels given the same zoom	Set to the channel's mean	Useful to compare relative size of multiple instrument's response to an event.
Live	No Effect	Dynamically set to the mean of the channel's recent data.	Toggles Live mode.
Manual (formally Centre Streams)	No Effect	Call All once.	Toggles Manual mode.

All	No Effect	Set to Channel's Mean	Manual mode only.
Recent	No Effect	Set to the mean of the channel's recent data.	Manual mode only.

6.1.3.6 Window Tools

There are 3 tools available within the waveform window to assist in analysing the trace data.

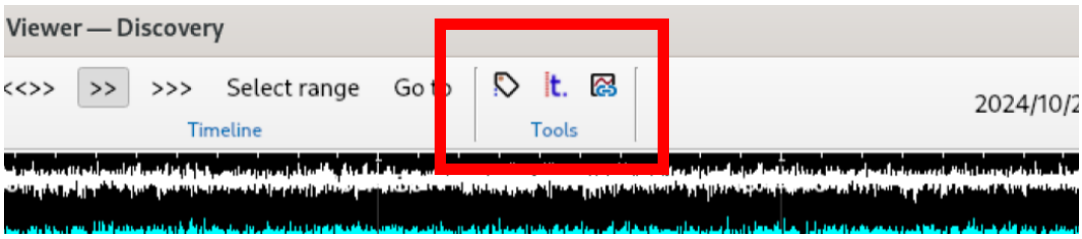


Figure 42 Waveview Tools

From left to right these tools do the following:

1 – Stream Marker Labels - Used to highlight any gaps or overlaps.

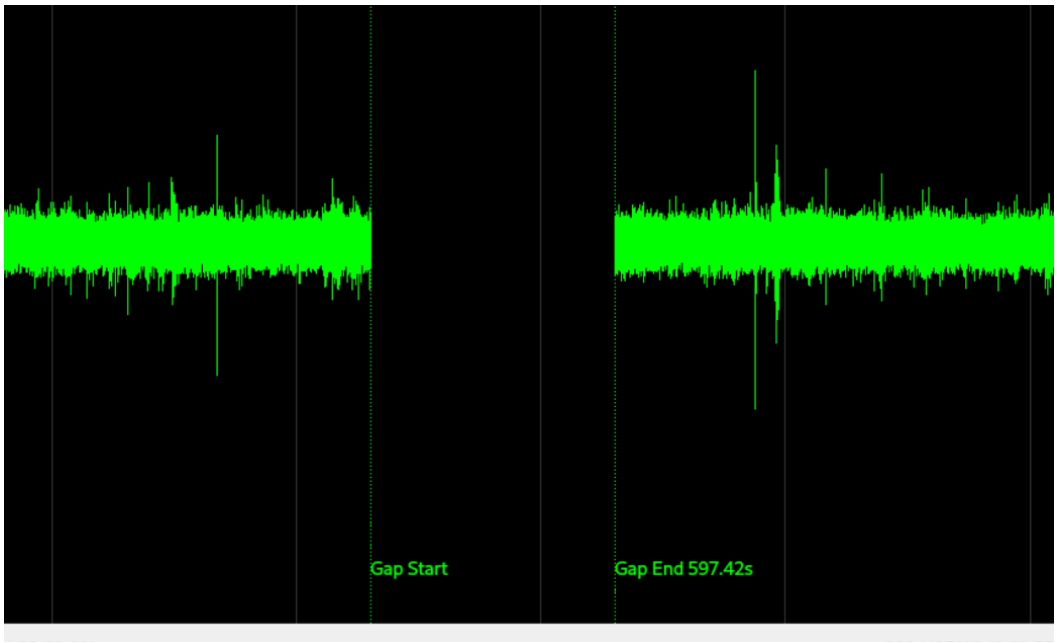


Figure 43 Stream Marker Labels showing gap in data

2 – Vertical Time Bar – Allows user to pinpoint the time of a specific event in the stream data.

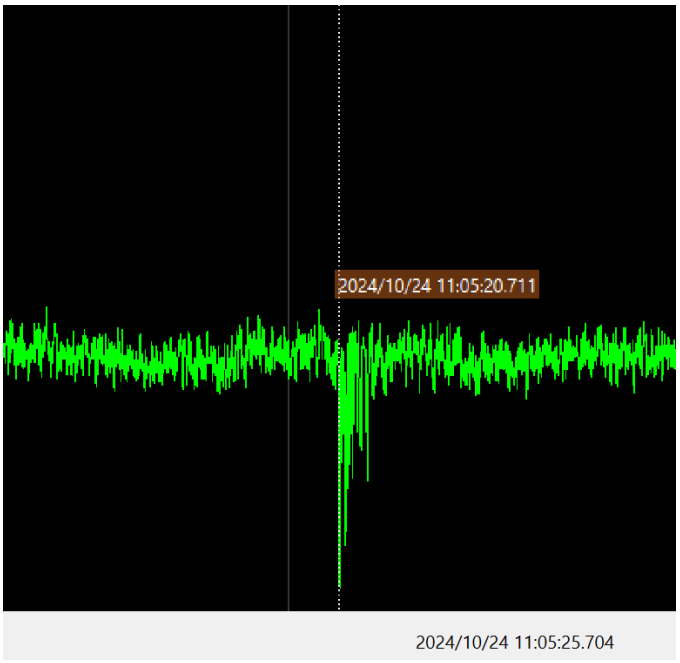


Figure 44 Vertical time bar being used to analyse a specific seismic event

3 – Connection Events –A live list of connection events. Useful for gaining understand of what is happening in terms of device connection, disconnection and re-connection.

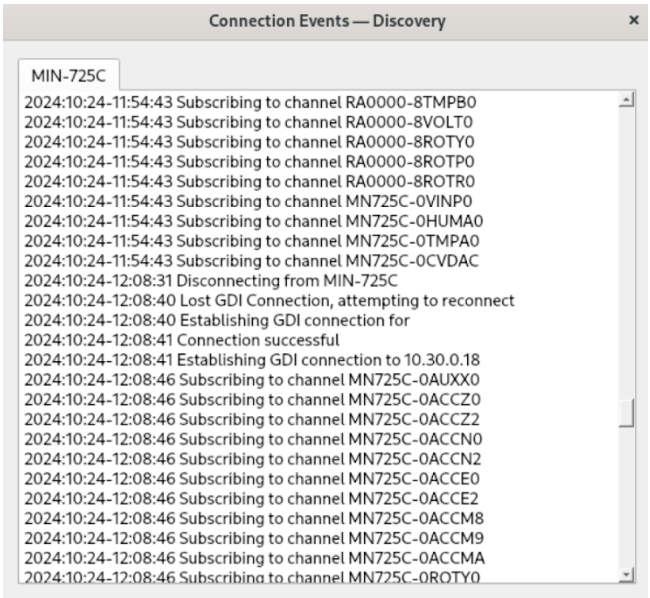


Figure 45 Connection Events Widget

All tools can be enabled/disabled easily via the Wave View page.

6.2 Offline Data

MiniSEED data can be loaded directly into the viewer from files. Open the data viewer from the Tools menu. Clicking on the Load data option from the top of the viewer screen opens the file dialog for this purpose.

MiniSEED data can either be loaded from file(s) or from directory. This second option will be explored in Section 6.2.2. MiniSEED files can also be loaded by dragging them into the Viewer.

A miniSEED file stores time series data with very limited metadata (time series identification and simple SOH flags). Therefore, when a miniSEED file is uploaded alone, the time series is displayed in counts.

The metadata, including the instrument response, is contained in the dataless SEED volume. To visualise the time series in physical units the dataless SEED volume is needed.

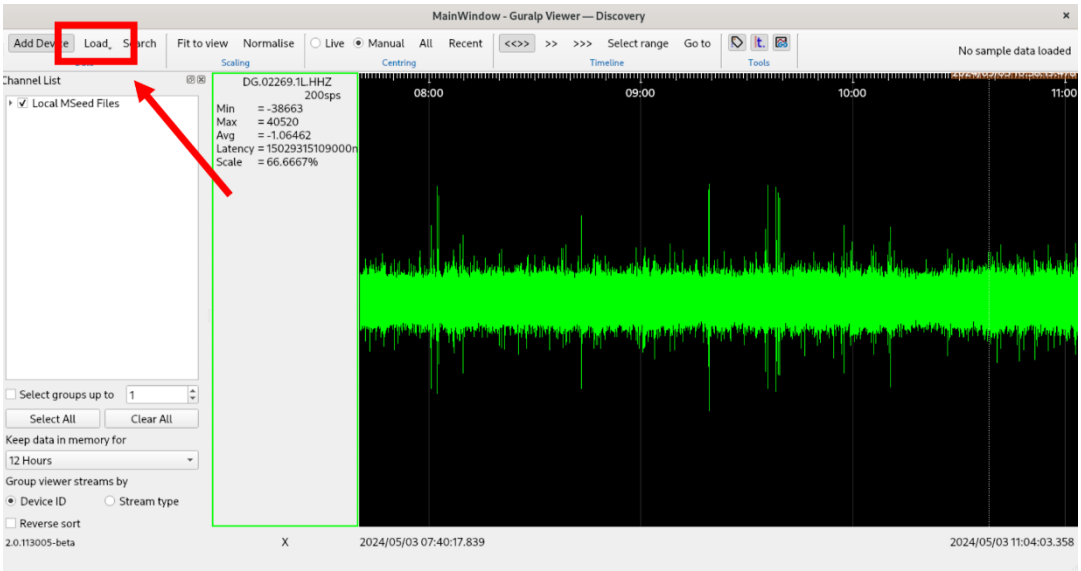


Figure 46 Load data option from the Live View window

6.2.1 Upload Metadata

Metadata (calibration, gains etc) is loaded from a .dataless file. Choose a file of this extension and any matching seed channels will display gains, units etc in their respective metadata from then onwards.

First, drag into the Data Viewer or upload the dataless file. Then, drag or upload the correspondent miniSEED file(s). Alternatively, load miniSEED and dataless file together. Now your waveforms will be displayed in physical units.

The dataless file can be offloaded from any Güralp digitisers from the Storage tab of the webpage.

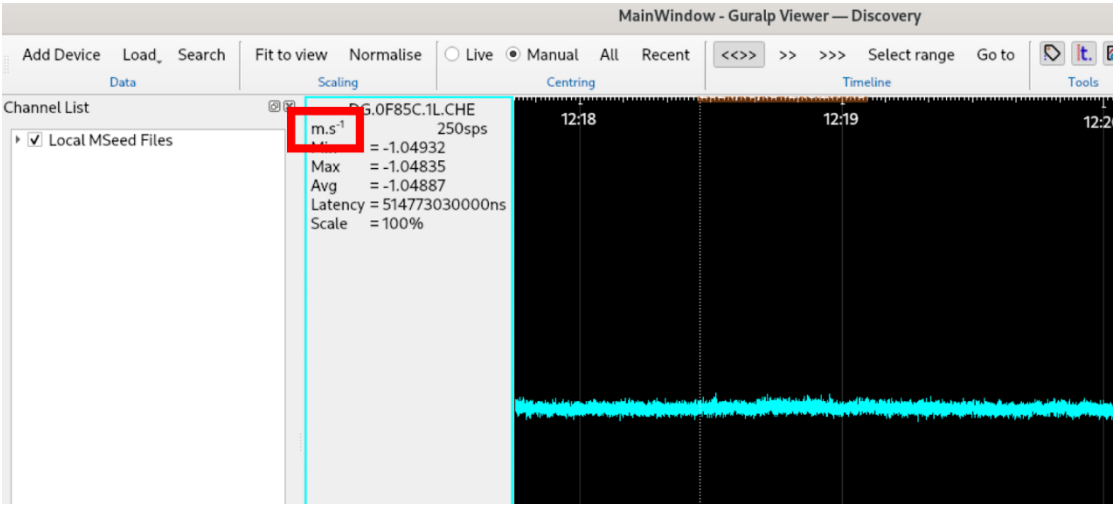


Figure 47 Upload the dataless SEED file together with the miniSEED file to display the waveforms in physical units

6.2.2 Directories and Filters

As mentioned previously, there is an option for loading files from a directory (folder). If this option is chosen, a later dialog will ask if you want to filter the loaded files depending on the filenames by using the wildcard *.

Some examples:

* → load all the files in the directory

SeisZ → load all the Z channel data

EVENT* → load all the files generated as a result of triggers

Rot → load all the files with rotation information (yaw, pitch and roll)

DG* → load all the files with network code DG (including dataless file if available)

This feature is based on the matching of the filenames, so the expressions may vary depending on the instrument.

7 Data Analysis Tools

Data analysis tools are available for both real-time data (Live Viewer) and offline data (Data Viewer).

Note: When offline miniSEED files are uploaded to the Data Viewer tool, remember to upload also the dataless file before performing data analysis (see Section 6.2.1).

Once the waveform viewer is opened and the desired streams are displayed, selecting a portion of waveform and right-clicking on it gives the user access to various processing applets. These generally accept a block of samples from the selected region and perform a function that may then lead to a graph or dialog. Most of the applets either accept multiple channels and would overlay results or launch one instance of the applet per stream, as applicable.

The following sections describe the main applets available.

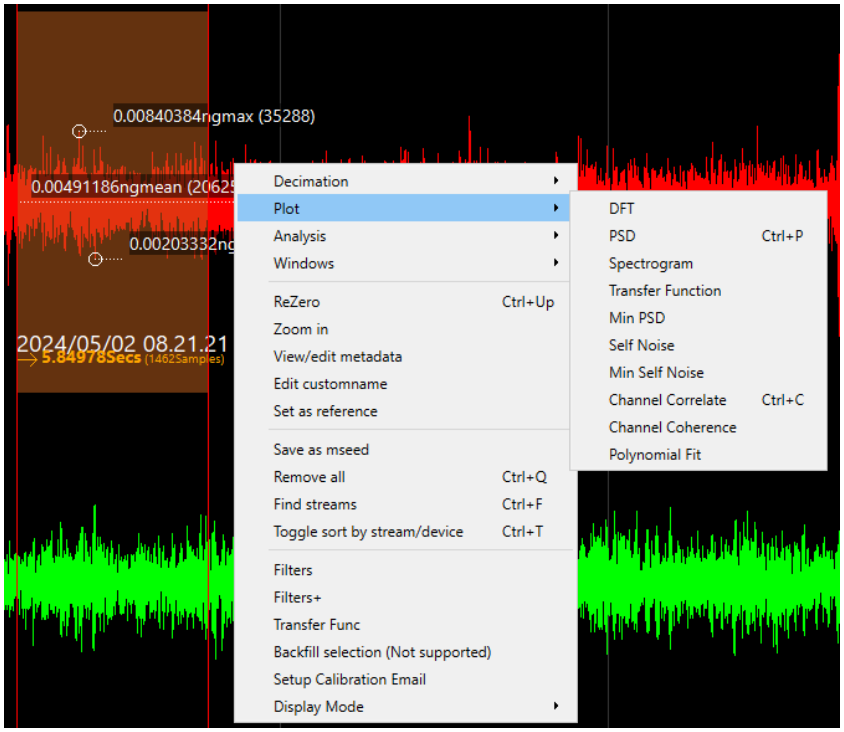


Figure 48 Right-click context menus

7.1 Plots

7.1.1 PSD

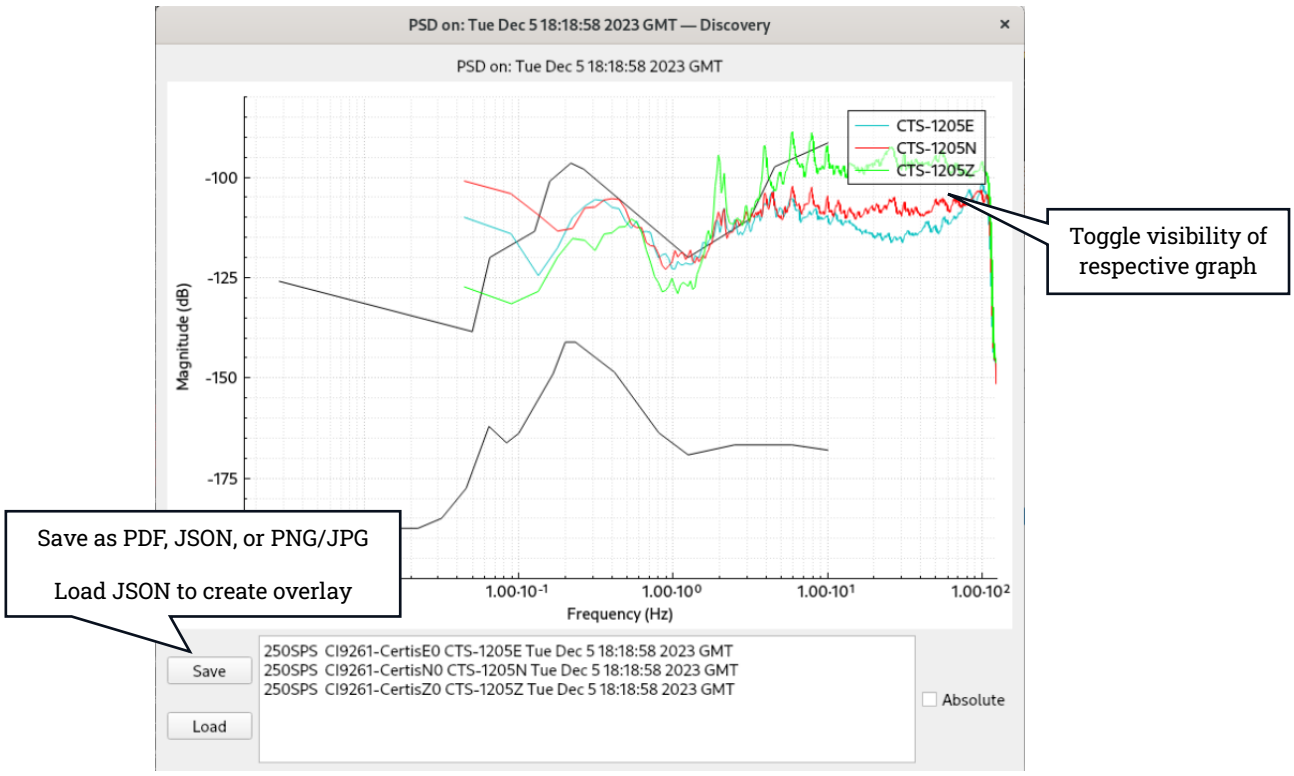


Figure 49 Example of PSD of 3 components of an instrument

Clicking on **Plot → PSD** allows you to plot of the Power Spectral Density (PSD) of selected data. More than one streams can be selected simultaneously to overlay the results. The PSDs of your data will overlay the new high- and low-noise models (NHNM and NLNM, respectively).

This operation deconvolves the instruments response with the poles, zeros and gain extracted from the channels metadata. The PSD is calculated from the signal in various, overlapping, finite-length windows within the data selection. The window function, overlap and step can be set by right-clicking on the selection of data, and selecting **Windows**.

The plot can be zoomed in/out by using the mouse and modifier keys as follows:

Mouse Wheel – Change overall zoom
Shift + Mouse Wheel – Horizontal zoom only
Ctrl + Mouse Wheel – Vertical zoom only.

Clicking on the entry of a specific channel in the legend box will remove that line from the graph. Click on it again to re-add the line.

PSDs can be saved in different formats, including PDF, JSON and JPG. JSON files can be loaded into your graph to create overlay.

7.1.2 Min PSD

In order to show the instrument's best performance over a period of time, the user should compute the Min PSD, which can be done by clicking on Plot → Min PDS.

For the calculation of the Min PSD, the PSD is computed multiple times at increasing time offsets. The power measured in each frequency bin is then minimised across all the PSDs that have been calculated, so that the effect of local impulse noise is removed. This presumes that a large amount of source data is selected, typically 12 or 24 hours. This is an intensive operation that takes advantage of multi core hardware.

The statistical spread of the instruments output is represented as is the mode.

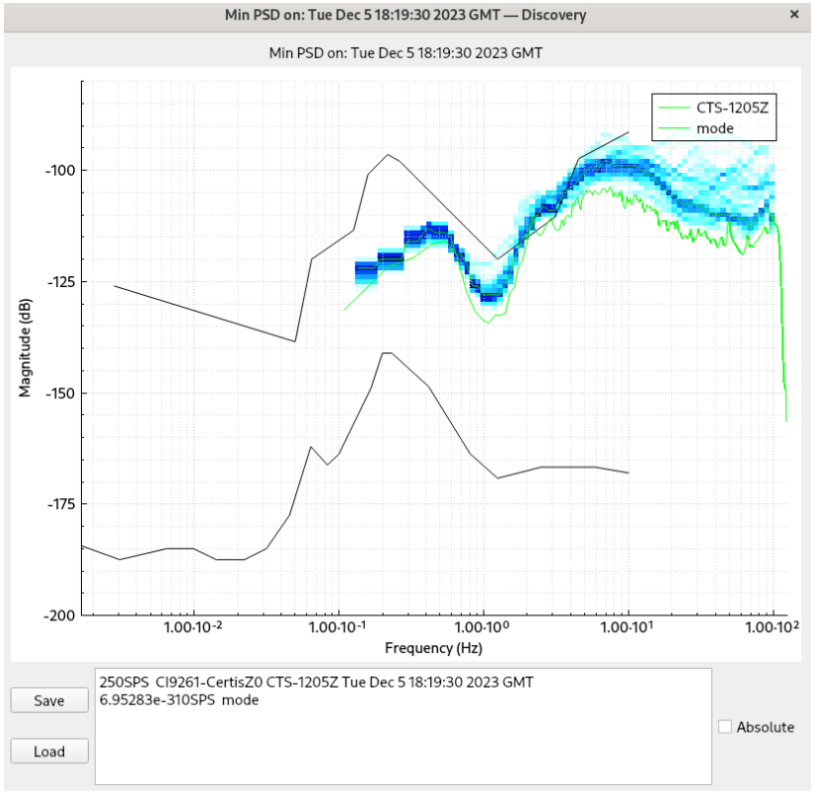


Figure 50 Example of Min PSD

7.1.3 Self Noise

The measurement of an instrument's self-noise requires a second instrument which is used as a reference. The reference instrument must be precisely aligned with the

instrument under test. During the computation of the self-noise, the common signal between the two instruments is eliminated, leaving only the non-coherent signal. The residual noise is plotted as indication of an instrument's performance.

To generate a self-noise plot, at least two streams must be selected. The first stream serves as a reference and corresponds to data from the reference instrument. Subsequent streams represent the instruments for which the self-noise is being calculated. Once the data is selected, right-click on the selection and choose **Plot → Self Noise.**

7.1.4 Min Self Noise

7.1.5 Spectrogram

A spectrogram is a visual representation of how the frequency content of a seismic signal changes over time. The Spectrogram function thus generates a spectral plot over time. It is designed to spot typically anthropomorphic noise picked up by a sensor such as vibration from motors, engines, vehicles etc.

The horizontal axis represents the time duration of the selected seismic recording. The vertical axis shows the frequency content of the signal in Hz. This axis of the spectrogram is linear, with the maximum corresponding to the Nyquist frequency. The colouring represents the energy at each frequency over time, and it follows a logarithmic scale.

The plot can be zoomed in/out and modified by using the mouse and modifier keys as follows:

Mouse Wheel – Change overall zoom
Shift + Mouse Wheel – Horizontal zoom only
Ctrl + Mouse Wheel – Change colour palette
Left Mouse drag – Move X,Y

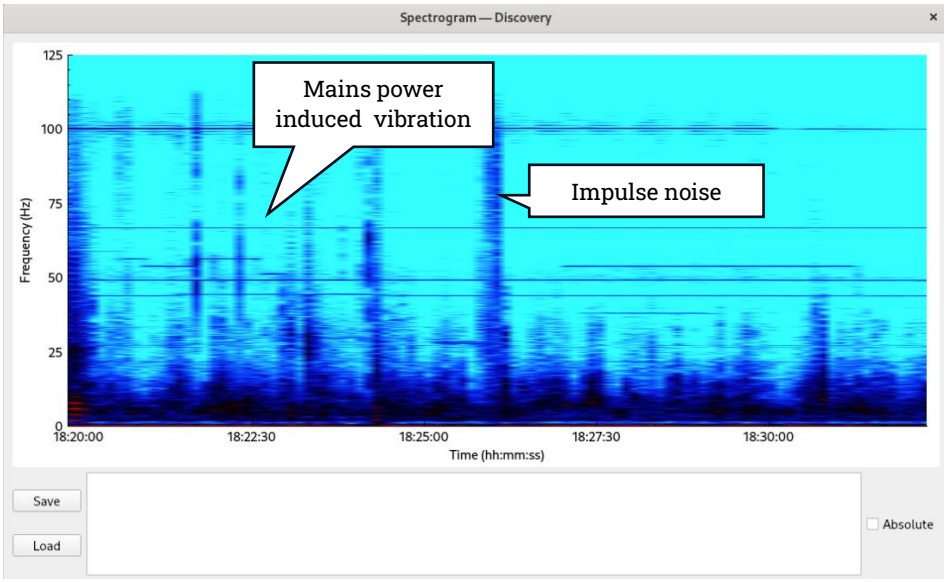


Figure 51 Example of a spectrogram for a 250sps channel

7.1.6 Transfer Function

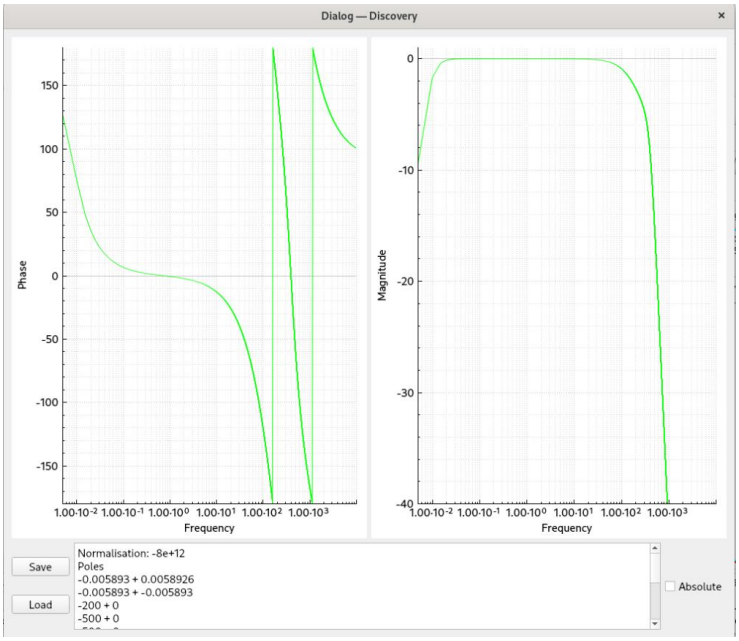


Figure 52 Plot of the transfer function based on metadata poles/zeros

The poles and zeros from the selected channel are plotted as a Bode plot giving phase and magnitude response of the instrument. Note that this applet does not compute the poles and zeros, but only plots the transfer function based on the poles and zeros already supplied.

7.1.7 Channel coherence

This tool measures the similarity between seismic signals recorded at two different stations or channels as a function of frequency. Amongst various uses, coherence results can help to identify common signals (high coherence means that signals are part of the same seismic event), to assess stations performance (low coherence may indicate sensor issues or poor site conditions), to assess site amplification effects (coherence between vertical and horizontal components).

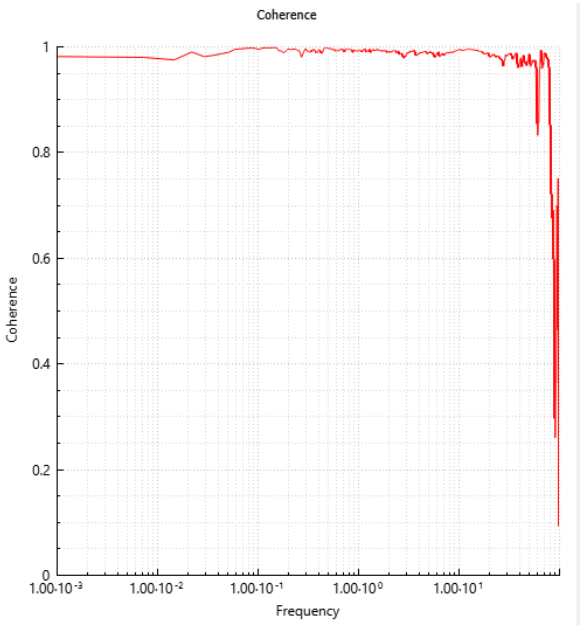


Figure 53 Example of coherence plots between the East channels of two co-located seismometers

7.1.8 Channel correlation

This tool performs a time domain correlation between selected channels. To plot the correlation between two desired channel, select a portion of data from one stream (which will be deemed the reference) and then Ctrl + Click on the second stream. Right-click and select Plot → Channel correlation.

The data is windowed (using the Hanning function) before the correlation is computed. For the computation of the correlation one signal is shifted continuously towards the reference, and for each time-shift the value of the correlation is calculated. A peak at the mid-point (marked zero on the output) shows how similar (correlated) the channels are.

This tool can be used to calculate the time offset between channels even if the data is not identical. For example, it can be useful in order to measure the time delay between two seismometer channels. The numerical time offset is displayed in the text region below the graph.

Performing this on a single channel plots the autocorrelation function of the data.

The left hand graph shows the same data as the right hand but at an oversampled (x100) rate. This allows a more accurate, sub-sample time period to be measured.

The graphs can be panned and zoomed with the mouse wheel and control and shift keys as follows:

Mouse Wheel – Change overall zoom
Shift + Mouse Wheel – Horizontal zoom only
Ctrl + Mouse Wheel – Vertical zoom only
Left Mouse drag – Move X,Y

This applet can be also used to correlate a calibration signal (for example, a sine wave) and the instrument's output. The values reported in the text box below the graphs can be used for gain calculation and phase analysis. For more information, the reader is referred to Section 7.2 .

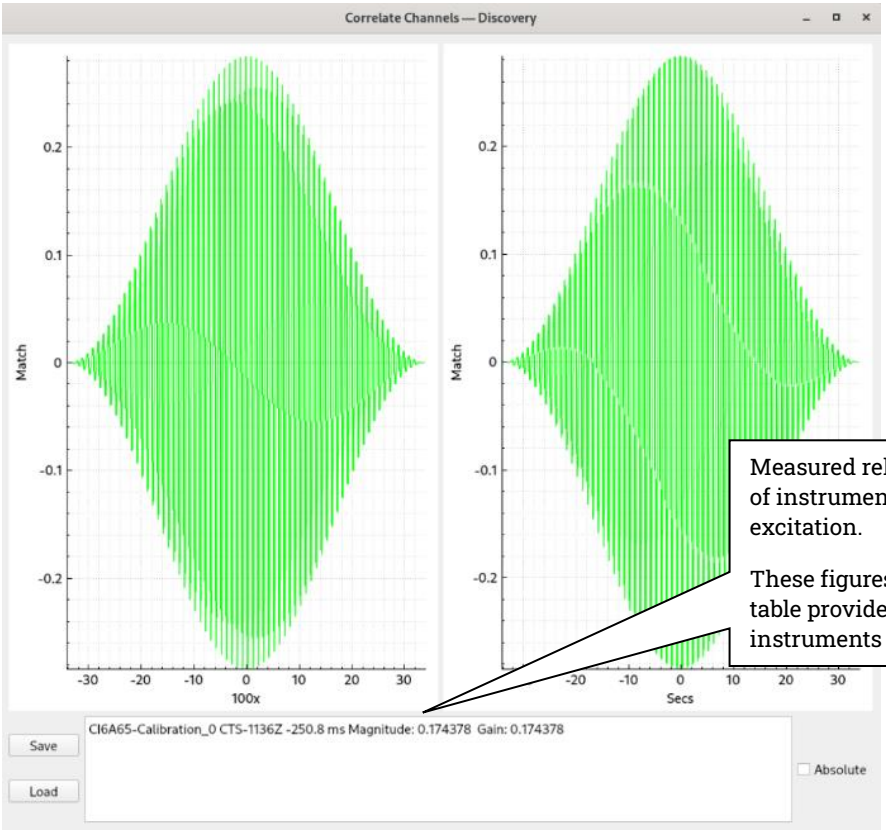


Figure 47 Correlation between calibration signal and instrument output

7.1.9 Alignment

This function attempts to align a subject sensor to a reference by rotating the subject data through a series of angles and comparing it to the reference via their coherence,

over the specified frequency range. The angle between the sensors is determined by finding the highest coherence, the mean squared error is used to check for a 180° offset (coherence is a function of power and therefore will give the same result whether or not the subject is inverted).

The alignment plot is used primarily to find the yaw (clockwise rotation around the vertical axis) of the subject. In its most basic form one horizontal channel is needed as a reference, while all subjects will need both their N/S and E/W channels. With channels selected in this manner the reference drop down in the dialog will contain only one possible option and the "Subject Starting Orientation" controls are disabled.

If the both the horizontal channels are selected for the reference the subject will be evaluated against each in turn, with the final result being the sum of the N/S and E/W coherences. If all three channels are provided for the subject, you can specify starting roll and pitch angles (can be taken from the sensors MEMS accelerometer channels if it has them).

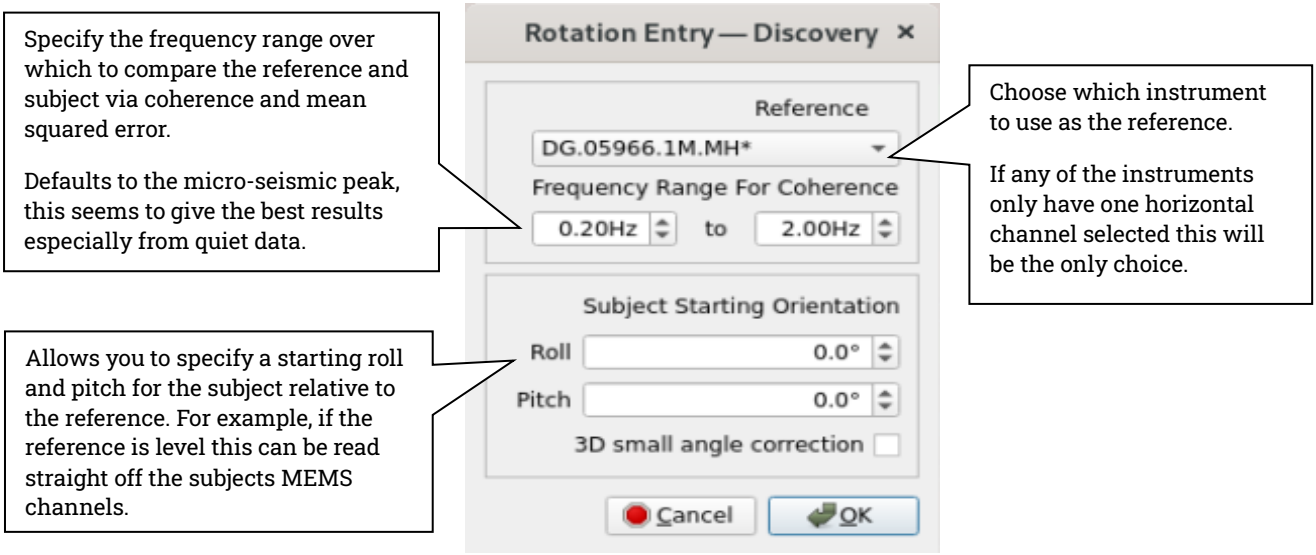


Figure 54 Alignment Dialog

Finally if all three axes for both the reference and subjects are selected, the option to apply a "3D small angle correction" will appear. This searches for the best total coherence while rotating the subject around all three axes (roll, pitch and yaw) over a ±4° range.

The reference and subject steams need to have the same sample rates and should have the same response (poles and zeros) although this is not essential if they have a good match over the specified frequency range. Comparing sensors with different unit types (e.g. acceleration against velocity) is not advised as it can give odd results.

Once Discovery finishes processing you will get an alignment plot for each subject. This shows the coherence and mean squared error versus yaw angle and replots the selected reference timeseries data against the newly rotated subject.

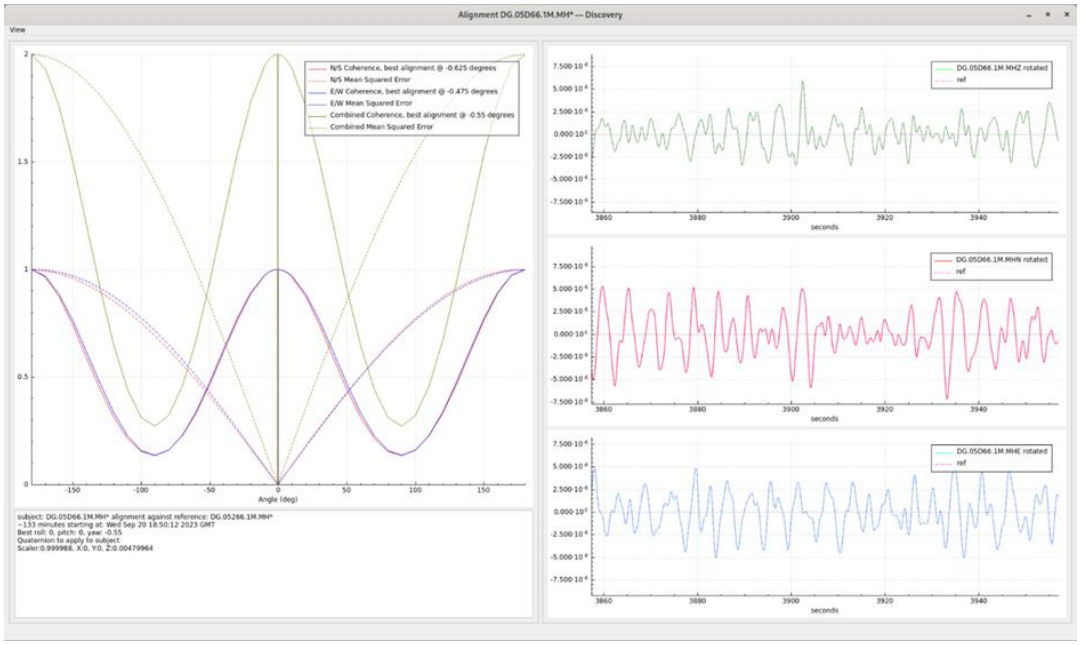


Figure 55 Alignment plot

The notes section will give you the angle with best coherence found and provide a quaternion equivalent to this rotation which can be applied directly to the subject sensor via the transforms tab of its digitizer webpage.

7.2 Setup Calibration Emails

This function can be performed as a superset of the Correlation function above (Section 7.1.8).

An instrument can be 'excited' with a test signal – typically a sine wave.

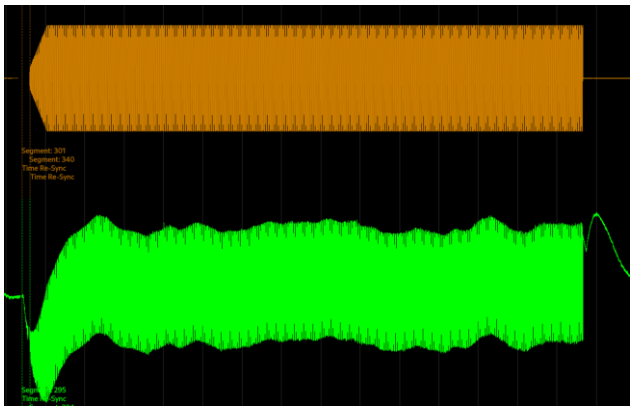


Figure 56 Typical output during calibration with a Sine Wave

The output of the instrument can be correlated with the excitation signal and then the results tested between limits to decide whether the instrument is working as expected.

These limits can be set through Discovery, according to the frequency and type of excitation.

Two measurements are made on the correlation. The first is the time offset between the excitation signal and the instrument output. This measures the phase response of the instrument. The second is the relative amplitude of the instrument's output as compared to the excitation amplitude. This relates to the instrument's gain.

Numerical values of the phase and magnitude are calculated and saved to a log file.

This function is enabled in the digitiser by performing a Sine Wave Calibration. The action of turning off the calibration triggers the analysis automatically.

Note: the Calibration channel needs to be enabled on the digitiser.

Emails can be configured to be set out when the sine wave calibration signal is sent. To do this, right-click on the Wave Viewer and select Setup Calibration Emails.

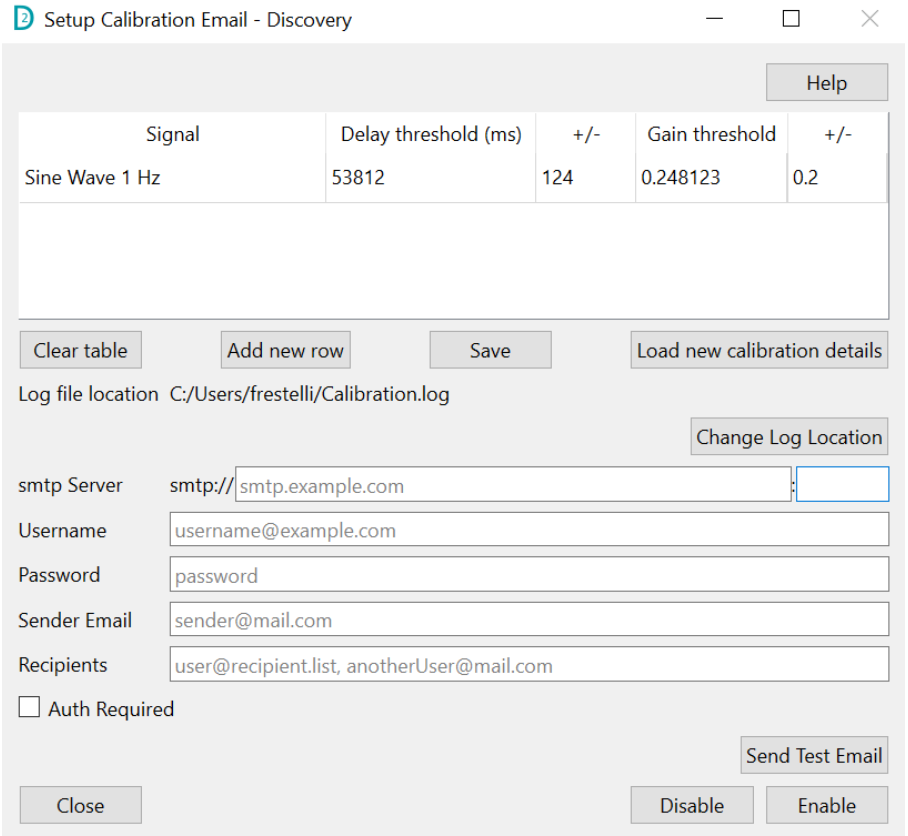


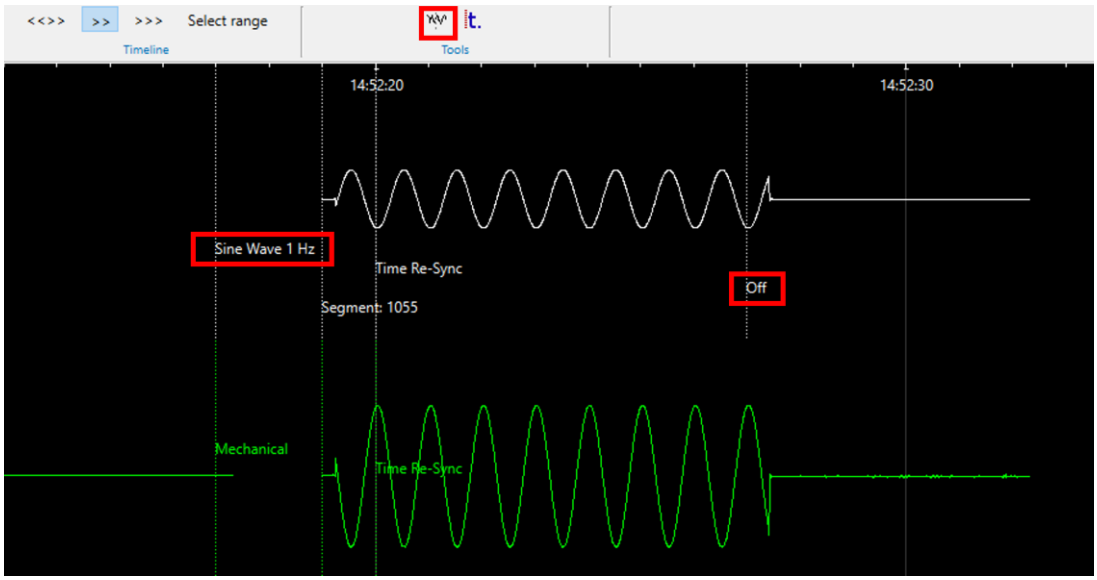
Figure 57 Setup calibration email window

This window will assist with setting up emails to notify the success or failure of correlating calibration data of ZNE streams, based on the thresholds indicated in the table.

The required threshold can be inserted into the table either manually or by loading a *.csv file with 5 columns. These columns will contain:

- The type and frequency of the excitation as it appears on the instrument's webpage ("Signal")
- The threshold for the time offset between the excitation signal and the instrument output in ms ("Delay threshold")
- The tolerance of the time offset ("+/-")
- The threshold for the relative amplitude of the instrument's output as compared to the excitation amplitude ("Gain threshold")
- The tolerance of the relative amplitude ("+/-")

Note: the type and frequency of the excitation in the "Signal" column has to be written exactly as it appears in the label of the calibration channel in Discovery's Live View (i.e. "Sine Wave 1 Hz"). If you do not see any labels, click on the icon with the symbol in the figure below (under the Tools section). If you do not see the label at the beginning of the calibration signal, you may need to upgrade the instrument's firmware.



The 2 lines below represent an example of valid entries for the csv file:

Sine Wave 2 s	64522	845	0.248123	0.03
Sine Wave 1 Hz	53812	124	0.248123	0.02

Any lines in the csv file that do not contain 5 items will be discarded. Blank data is accepted. However, these rows will not be read when reading calibration data.

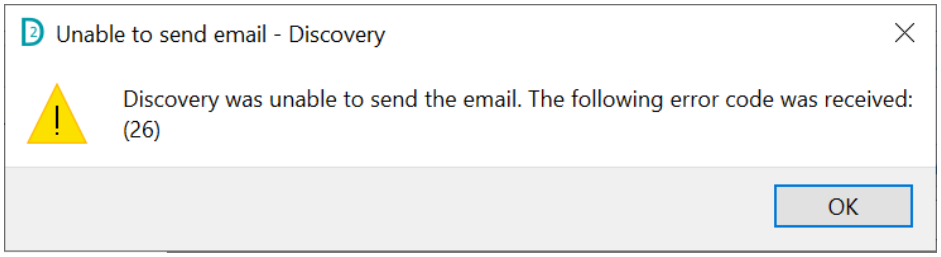
If your smtp server requires authentication, tick the “Auth required” box and fill in the “Username” and “Password” fields. If authentication is not required, do not leave the box un-ticked and the “Username” and “Password” fields empty.

When adding emails to the recipients list, separate them with a comma (','):

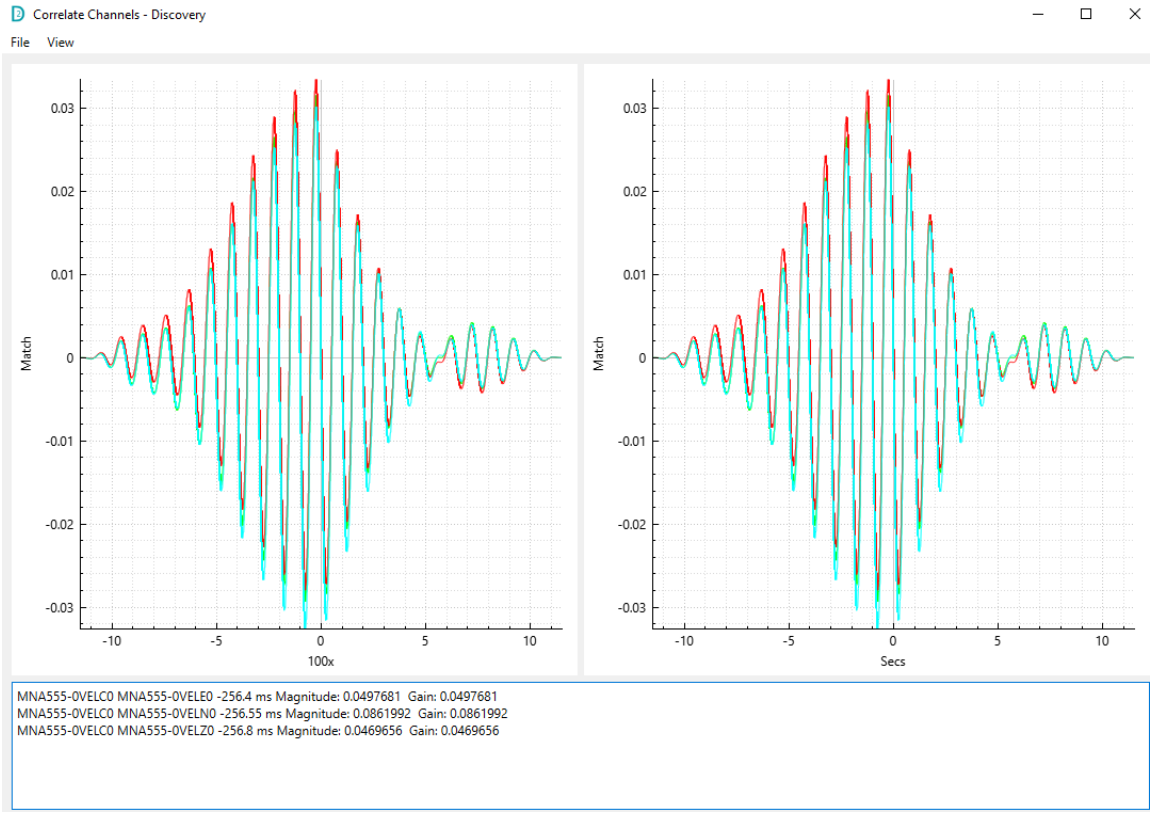
someone@example.com, someoneelse@example.com

Once the email settings have been filled in, send a test email by clicking on Send Test Email. If the test email was successful, click Enable to complete the setup. Your password will not be stored, so this feature will need to be reenabled if Discovery is restarted.

Note: If this error message appears when trying to send the test email on a Windows machine, try to run Discovery as administrator.



The action of turning on and off the calibration signal basically triggers the Channel Correlation applet, which performs the correlation between the excitation and each one of the three seismic channels. The results of the three correlations will appear on the same plot as in the figure below.



The success/fail email will be sent once a calibration signal that matches a row in the table is started *and then switched off*.

If there are fewer than 10,000 samples the email will not be sent as the data set will be insufficient.

Below is an example of the curl script used to send the email:

```
curl --url 'smtp://mymailhost.com:25' --mail-from
me@mymailhost.com' --mail-rcpt 'whoever@mymailhost.com' -vv --
upload-file
```

Note: To send emails, `curl` must be installed on your system

Success and failures will also be logged to the location specified in this window to a fie called “Calibration.log”. The location of the log file can be changed using the button Change Log Location.

7.3 Filters

Filters are an essential tool in seismic data processing. The main types of filters are:

- Low-pass filters: they allow lower frequencies to pass through while attenuating higher frequencies

- High-pass filters: they allow higher frequencies to pass through while attenuating lower frequencies
- Band-pass filters: they allow only a specific range of frequencies to pass through while filtering out the others. A combination of low-pass and high-pass filter can be used to create a band-pass filter.

Filters are typically used for the following purposes:

- Remove unwanted noise from various sources, such as ocean waves or human activity
- Enhance signals of interest or different seismic phases
- Spectral analysis to study earthquake source properties and site effects
- Instrument response removal, along with deconvolution techniques.

Discovery offers both real-time filters and non-real-time filters, as detailed below.

7.3.1 Real-Time Filtering – Inbound Filters

Filter can be applied in real-time to data coming into Discovery (inbound). Either a low-pass, high-pass, or combination of both can be used. Since these filters are performed in real time, they are *causal* in nature. In short, causal filters are filter where the output at any given time depends only on the past and present inputs, and not future inputs. This makes them suitable for real-rime processing applications. All inbound filters will be remembered and applied the next time a stream is opened.

To add a filter to data streamed to the Discovery Live Viewer, right-click on the channel summary and select Inbound Filters.

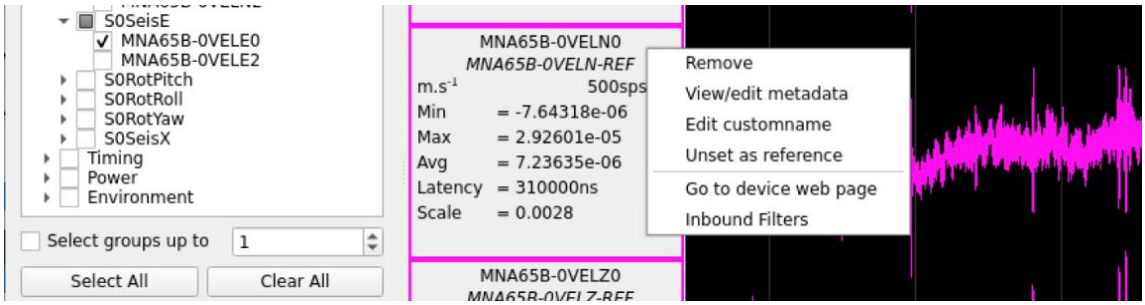


Figure 58 Right-click to apply real-time filters

This action opens the “Inbound Filters” widget.

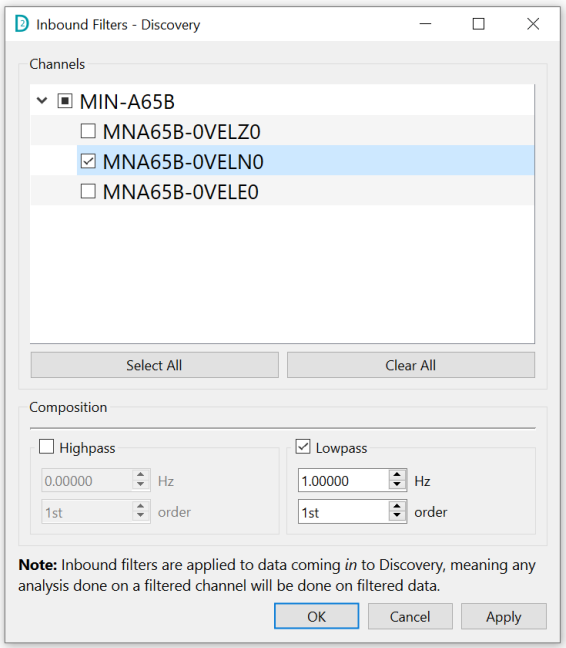


Figure 59 Inbound filters widget

All channels visible in the Data Viewer will be listed and the one used to open the widget will be automatically selected and checked. Multiple channels can be selected by ticking the relative boxes. The Composition section of the widget allows the user to choose which type and order of filters to apply to the selected channels. A combination of high-pass and low-pass filters can be used to achieve a band-pass filter. When Apply or OK are pressed, the current composition will be applied to all channels in the list that are checked. After setting a filter on a channel it will show up on the channel summary:

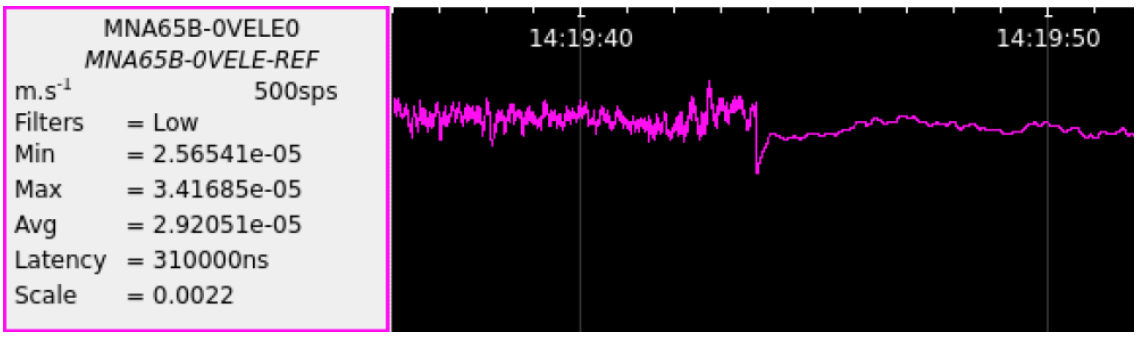


Figure 60 Channel with filter applied

Note: Inbound filters are applied to data coming *into* Discovery. This means that any analysis done on a filtered channel will be done on filtered data.

7.3.2 Non Real-Time Filtering – Filter+

The Filter+ applet allows you to apply filters to non-real-time data. These data can be either miniSEED files loaded into the Discovery's Data Viewer (together with the relative dataless file – see Section **Error! Reference source not found.**), or a selection of data streamed to the Live Viewer.

To select a section of time-domain signals on one channel, right-click on the waveform and drag to make a selection. To then select multiple channels, click on them while holding the Ctrl or Shift key. Once the desired data have been selected, right-click and choose Filter+. This action opens the "Filter+" widget. The Replot button is used to re-plot the data after any filter or other options have been selected. Click on the Replot button also to visualise the data upon opening the Filter+ widget (otherwise, no data is displayed).

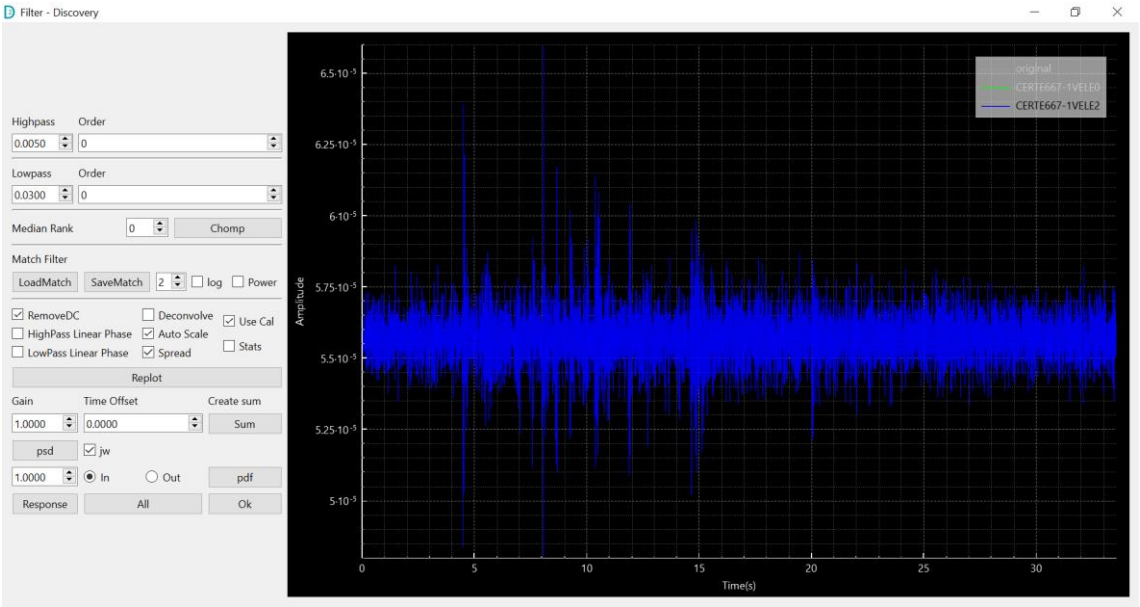


Figure 61 Filter+ widget

Tick the Use Cal box to visualise the data in physical units rather than digital counts. When this box is ticked, the data is scaled using the scaling factor represented by M-CAL (see Section 6.1.2). Tick the Auto Scale box to automatically optimise the view. Tick the Remove DC box if you want to plot the data centred around zero. If multiple streams have been selected they may overlap, making it difficult to distinguish the features of each waveform. Tick the Spread box to centre the data from each channel around different values, ensuring all waveforms are visible simultaneously. Note that when this box is ticked the vertical label loses its meaning.

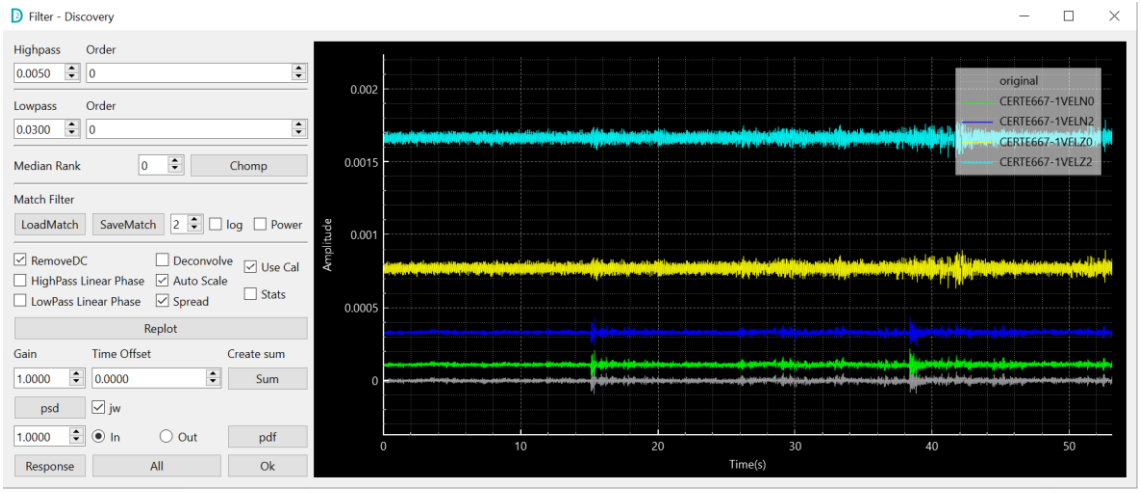


*Figure 62 Ticking the **Spread** box allows you to visualise multiple waveforms simultaneously without overlaps*

At the top-left of the Filter+ window, low-pass and high-pass filter options (hence band-pass filters) are implemented. The order of the filter can also be set. The Linear Phase check boxes are used to perform symmetrical (forwards and backwards, or acausal) filtering, which ensures that the timing of edges for picking remain the same.

Both the original input and filtered output can be displayed as shown below. Individual traces can be hidden or revealed by clicking the names in the legend on the top-right.

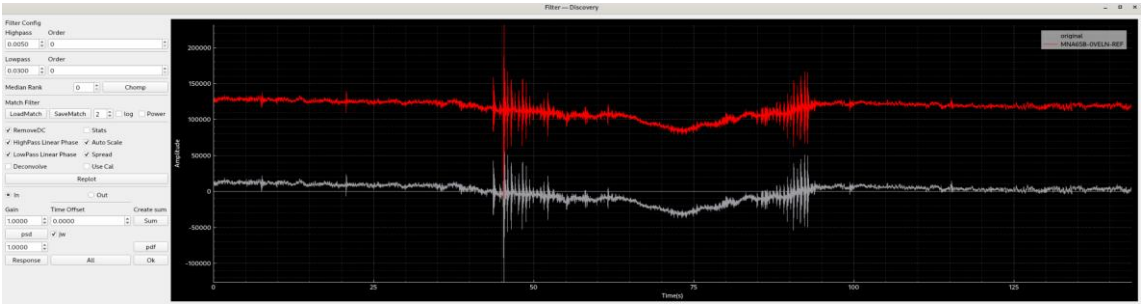


Figure 63 Filter+ Applet displaying original and filtered traces

The Deconvolve check box performs a deconvolution of the time-domain data using the instrument's response (poles and zeros). Typically, for a seismometer this is a bandpass response. This results in a boost for the low and high frequencies as the plot below demonstrates.

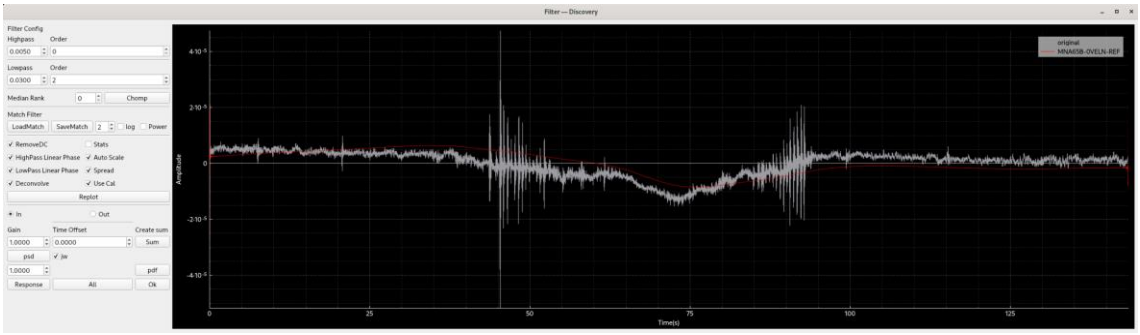


Figure 64 Low-pass filter and Deconvolution with cursors

Waveform statistics can be displayed by ticking the Stats box. To view true peak ground motion, use the **Cal** option and the **Deconvolve** option. Typically, also the **Remove DC** option is used to eliminate instrument drift when looking at the PGA of an event.

See below for an example.

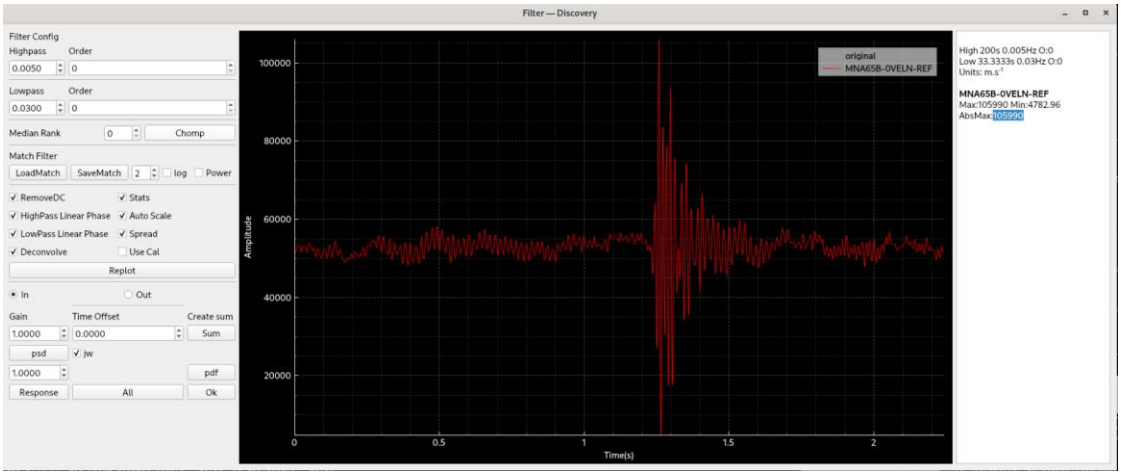
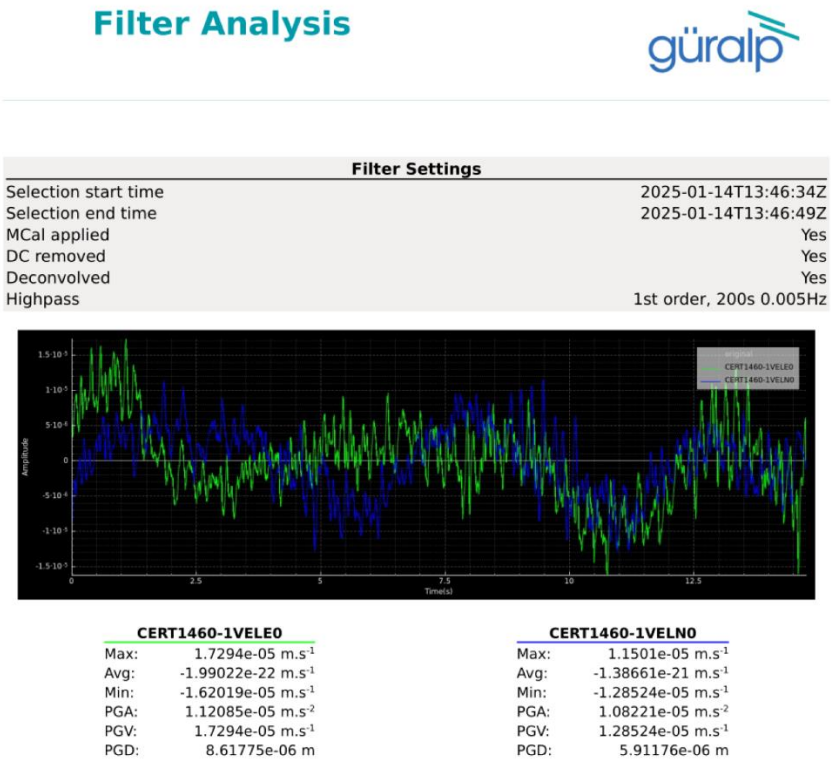


Figure 65 Stats display to the right of the waveforms

A PDF report can be generated for Filters+ with the pdf button. This will catalogue the filter options used, including: timestamps, deconvolution, and any pass filters applied. It also displays the plot of waveforms followed by a table for each waveform detailing the min/avg/max and, if they are from seismic channels, the PGA/PGV/PGD. An example output follows.



Filter Analysis

güralp

Filter Settings	
Selection start time	2025-01-14T13:46:34Z
Selection end time	2025-01-14T13:46:49Z
MCal applied	Yes
DC removed	Yes
Deconvolved	Yes
Highpass	1st order, 200s 0.005Hz

CERT1460-1VELE0	
Max:	1.7294e-05 $m.s^{-1}$
Avg:	-1.99022e-22 $m.s^{-1}$
Min:	-1.62019e-05 $m.s^{-1}$
PGA:	1.12085e-05 $m.s^{-2}$
PGV:	1.7294e-05 $m.s^{-1}$
PGD:	8.61775e-06 m

CERT1460-1VELN0	
Max:	1.1501e-05 $m.s^{-1}$
Avg:	-1.38661e-21 $m.s^{-1}$
Min:	-1.28524e-05 $m.s^{-1}$
PGA:	1.08221e-05 $m.s^{-2}$
PGV:	1.28524e-05 $m.s^{-1}$
PGD:	5.91176e-06 m

Figure 66: PDF report for applying M-CAL, DC removal, deconvolution, and a first order high pass filter to a selection of two streams.

Filter+ also allows you to select a time window within the Filter+ widget and automatically highlight the corresponding data segment in the Data Viewer. To do this:

- Hold down the Ctrl key and left-click at the desired start time. A red line will mark the selection start.
- While still holding the Ctrl key, right-click at the desired end time. A yellow line will mark the selection end.
- The same time window will automatically be highlighted in the Data Viewer as shown in the image below.

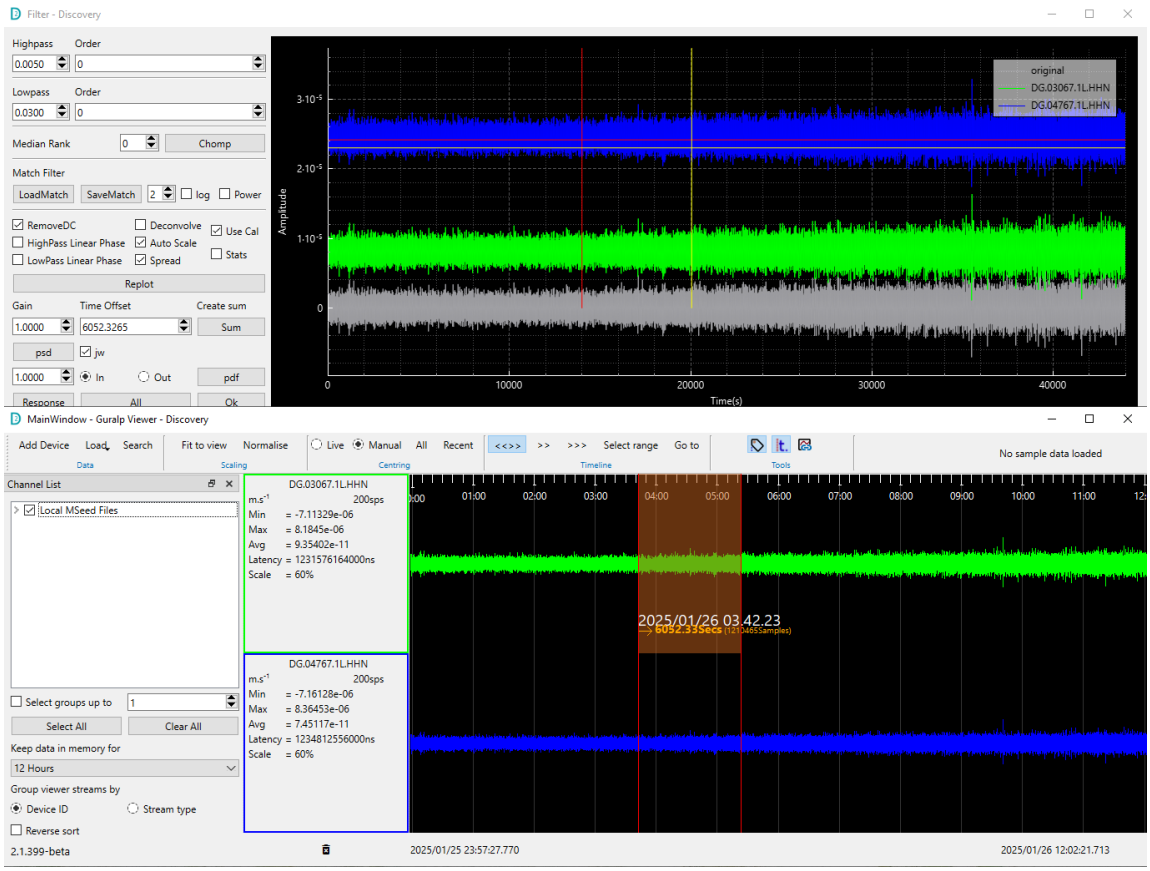


Figure 67 Time selection of data in the Filter+ widget and corresponding data in the Data Viewer

A possible application of this feature is related to the computation of an instrument's PSD (see Section 7.1.1) for performance assessment. For an optimal performance evaluation of the instrument, data should be selected from quiet periods. Usually, nighttime data are used, when human activity is at its minimum. Applying filters before computing a PSD can help in selecting the best data. In fact, filtering the data

can emphasise transient events (e.g. spikes and glitches) that would otherwise not be visible.

The figure below shows an example of how filtered data (green) can reveal spikes that are not visible in the original waveform (grey).

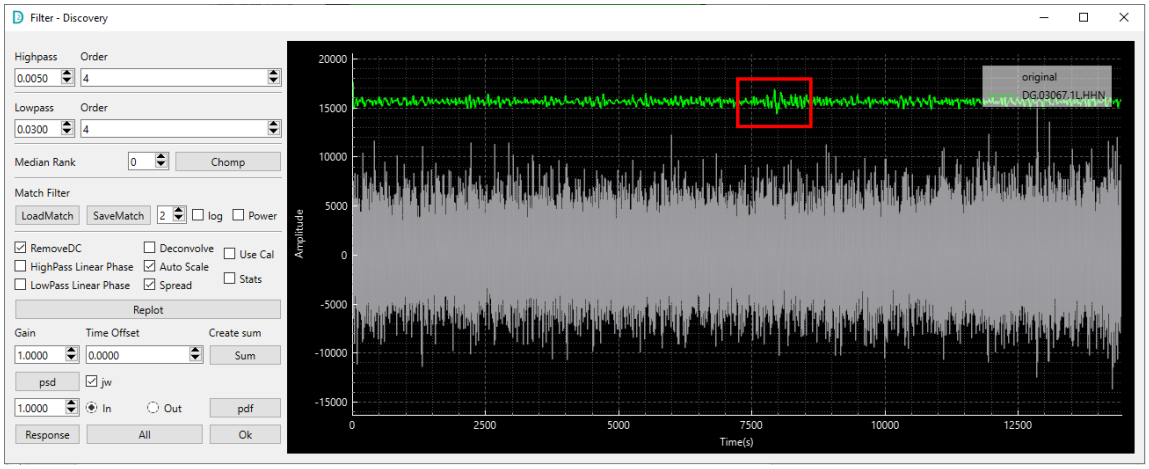


Figure 68 Example of filtered data revealing spikes not visible in the original waveform

For the computation of a PSD for performance analysis, a time window which excludes the spikes should be selected. This can be done in the Filter+ widget as explained above. This action will highlight the corresponding time selection in the Data Viewer, which can then be used to compute the PSD.

8 Güralp Data Centre (GDC)

8.1 Concept & Purpose

Güralp Systems Data Centre software package (acquisition software package) consists of several applications with the primary purpose of acquiring, saving and re-distribute miniSEED data. It also provides system state of health monitoring and distribution, with remote configuration capabilities.

8.2 Software Components

- IRIS ringserver

- slinktool

- slink2dali

- Güralp Data Centre controller service

- Güralp Data Centre monitor service

- Güralp responder service

- Güralp Discovery application (NOT Deployed on GDC server)

Optional components:

    - Earthworm client

    - SeiscomP3 client

8.3 Operating System Compatibility

Güralp Systems Data Centre software package has been tested on the following x86_64 platforms:

- Red Hat Enterprise Linux 8 (or equivalent, e.g. Rocky Linux 8 or AlmaLinux 8)

- Amazon Linux 2

8.4 Open Ports

The GDC requires access to the network to operate correctly. Please make sure that the system security settings allow the network traffic to and from the machine on ports specified in the table below. It also might be needed to configure SELinux features in relation to the mentioned requirements.

Table 4 Ports that have to be open for GDC

Port	Protocol	Description
11788	UDP	Used for sending and requesting state of health information by system components and Discovery desktop application.
11788	TCP	Configuration exchange protocol used by Discovery desktop application to configure data streaming connections.
16000	TCP	DataLink data transmission protocol connection to IRIS ringserver.
18000	TCP	SeedLink data transmission protocol connection to IRIS ringserver for both incoming and outgoing data streams.

8.5 GDC Configuration

8.5.1 IRIS ringserver

IRIS ringserver does not require any specific configuration unless change in either default storage location (/var/cache/guralp/miniseed/) or time for which the data is kept on the hard drive is required. Application runs as an operating system service and listens for SeedLink connections on TCP port 18000. If required listening port is different to 18000 please contact support@guralp.com for instructions.

8.5.2 Ringserver miniSEED files storage location configuration

IRIS ringserver storage location is configured by the home directory of ringserver user and if required can be changed by system administrator by editing the user properties. This can be done via SSH into data centre. Newly selected directory should have sufficient permission and ownership. The steps below show how to modify the home directory of the ringserver user in Red Hat Linux environment (please note that commands may require elevated permissions).

a. Copy tmpfiles.d guralp-miniseed.conf file to /etc system location

```
cp /usr/lib/tmpfiles.d/guralp-miniseed.conf/etc/tmpfiles.d/guralp-miniseed.conf
```

b. Edit the copied configuration file and append a new line specifying the new storage location:

```
 d  /run/guralp/etc                          0755 root    root
 F  /run/guralp/etc/iris-ringserver.conf     0640 root    ringserver   -
MSeedWrite %%n_%%s_%%l_%%c_%%Y_%%j.mseed
 d  /var/cache/guralp/miniseed               0775 root    ringserver       3d
 d  /mnt/new/storage/directory               0775 root    ringserver       3d
```

c. Save the changes made to the file

d. Modify the ringserver user home directory

```
usermod -d /mnt/new/storage/directory ringserver
```

e. Reboot the system to apply the changes.
Please note that only the following top directories can be used: /home /media /mnt /opt /srv /var

8.5.3 Ringserver miniSEED files storage auto-clean configuration

IRIS ringserver storage is controlled by system tmpfiles clean timer and can be configured by editing guralp-miniseed.conf file. To change the configuration of time that historical data is kept in the system please follow the steps below.

a. Copy tmpfiles.d guralp-miniseed.conf file to /etc system location

```
cp /usr/lib/tmpfiles.d/guralp-miniseed.conf/etc/tmpfiles.d/guralp-miniseed.conf
```

b. Edit the copied configuration file and change the age of storage location to the required value.

```
d  /run/guralp/etc                          0755 root      root
F  /run/guralp/etc/iris-ringserver.conf     0640 root      ringserver       -
MSeedWrite %%n_%%s_%%l_%%c_%%Y_%%j.mseed
d  /var/cache/guralp/miniseed               0775 root      ringserver       3d
```

where `3d` is the age of temporary files (read more: https://www.freedesktop.org/software/systemd/man/tmpfiles.d.html).

c. Save and reboot the system.

8.5.4 Slinktool

Slinktool process runs as a service with parameters provided through the service name in a form of a '@' separated list of values. Under normal operation there is no requirement to manually configure (enable/disable or start/stop) the service, this task is performed by the Data Centre controller on remote request from the Discovery desktop application.

Manual service configuration can be performed but it is not recommended. To do that, please log in to the Data Centre computer and use systemctl command to enable/disable and/or start/stop the Slinktool service. Slinktool service is run with a set of parameters:

slinktool@NN@ST@LLCHA@CONNECTION@PORT.service

where:

- NN is the SEED network code.
- ST is the SEED station code.
- LLCHA, is SEED location and channel codes.
- CONNECTION, is the connection IP address or hostname, for latency monitoring in the Data Centre this is set to 127.0.0.1 (localhost)
- PORT is the connection port of the Seedlink data.

Wildcard character for SEED location and channel name can be used and is represented by '_' character. Also, a list of location and channel names can be provided to a given service and should be separated with '-'character.

Example:

slinktool@DG@0585A@_____@127.0.0.1@18000.service, will connect to station 0585A of DG network, subscribing to any channel (wildcard selector of 5x '_' character).

slinktool@DG@0585A@0NHHZ-0NHHN-0NHHE@127.0.0.1@18000.service, will connect to station 0585A of DG network, subscribing to 0N.HHZ, 0N.HHN and 0N.HHE channels.

8.5.5 Slink2dali

Slink2dali process runs as a service with parameters provided through the service name in a form of a '@' separated list of values. Under normal operation there is no requirement to manually configure (enable/disable or start/stop) the service, this task is performed by the Data Centre controller on remote request from the Discovery desktop application.

To configure the required connection (slink2dali and Slinktool services) use the Discovery desktop application described below.

8.6 GDC Discovery Interface

After primary installation and configuration, the GDC is intended to run as a headless server. Further configuration, maintenance and SOH monitoring can be accomplished though Discovery. The purpose of GDC is to record data streams from multiple

sensors. This archive of miniSEED files is then available to applications on the Linux environment.

The system also runs a SeedLink server that is capable of re-streaming any of the streams that are being recorded. Any SeedLink client can connect to this server to retrieve data.

Discovery can be used as a SeedLink client also. In this mode, data can be viewed live without the need to pull a second stream directly from the device.

8.6.1 Configuration - Adding a Station

- Open Discovery desktop application and change the view to “Registry” mode.
- Right-click on the Data Centre instance.
- Select Configuration option.
- In the configuration widget, if not preloaded with configuration, click on “Restore” button to retrieve the Data Centre configuration.

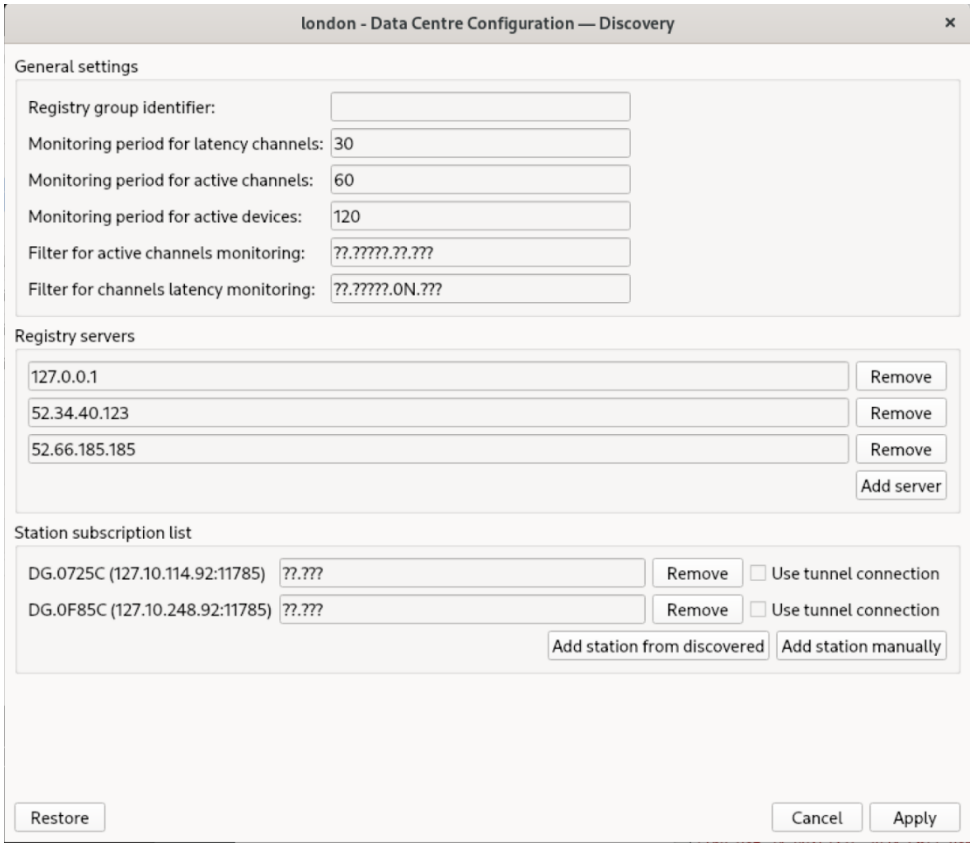


Figure 69 Data Centre Configuration Controller

- From here Devices on the same registry server can be added from ‘Add station from discovered.

- To apply configuration changes to device, choose ‘Apply’. Ensure that when adding devices that ‘Use tunnel connection’ is selected.

8.6.2 State of Health

The Data Centre state of health can be monitored in the real time either in the Discovery desktop application main window by checking the status indication icons, and/or by accessing the dedicated Data Centre state of health widget.

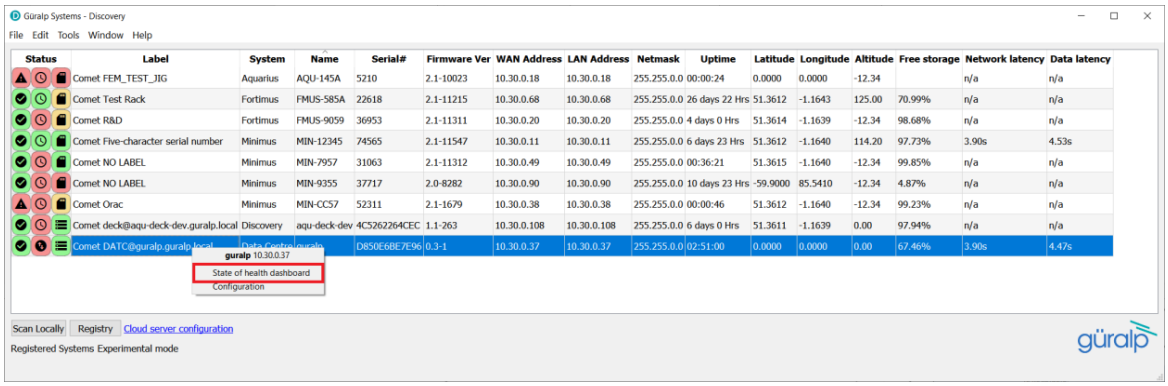


Figure 70 Access to GDC state of health from Discovery's window

The state of health dashboard widget is divided into 4 main parts as shown and described in the following Figures.

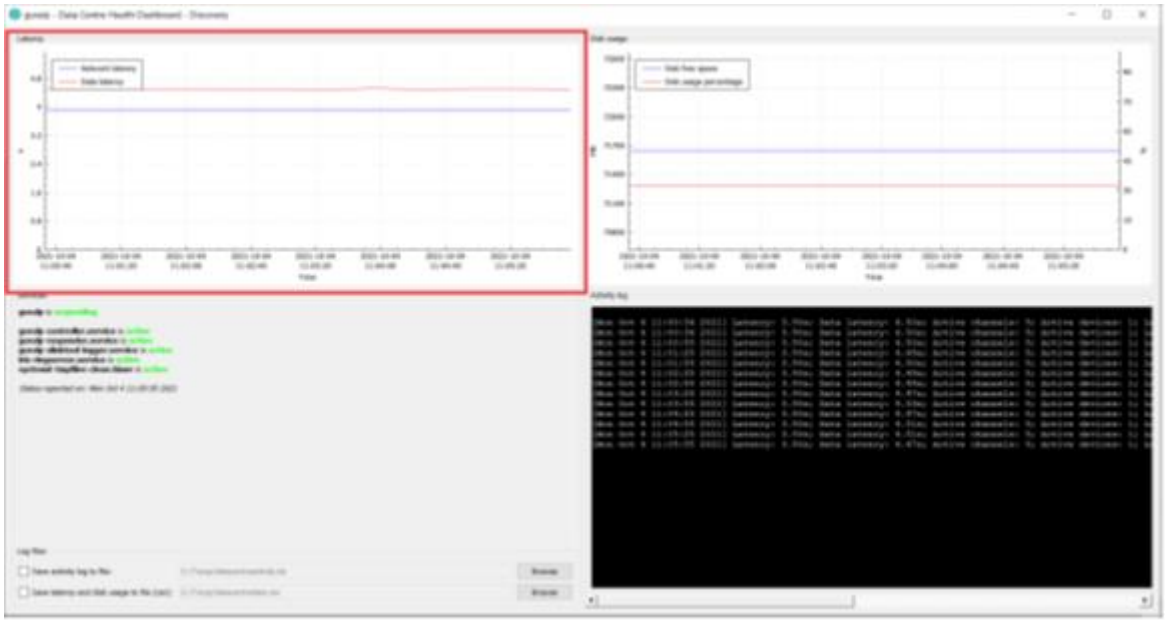


Figure 71 Top-left widget is a latency graph displaying the highest historical latency value for up to last 30 minutes.

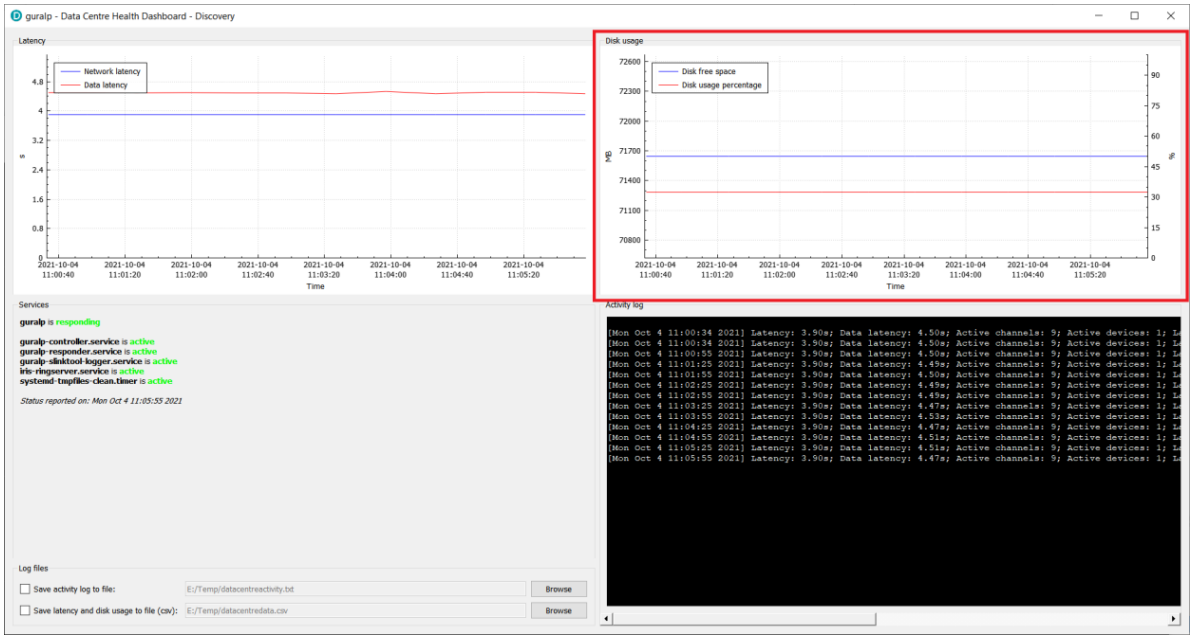


Figure 72 Top-right widget is a disk usage graph displaying the disk free space in MB (blue graph, left y axis) and disk used space percentage (red graph, right y axis)

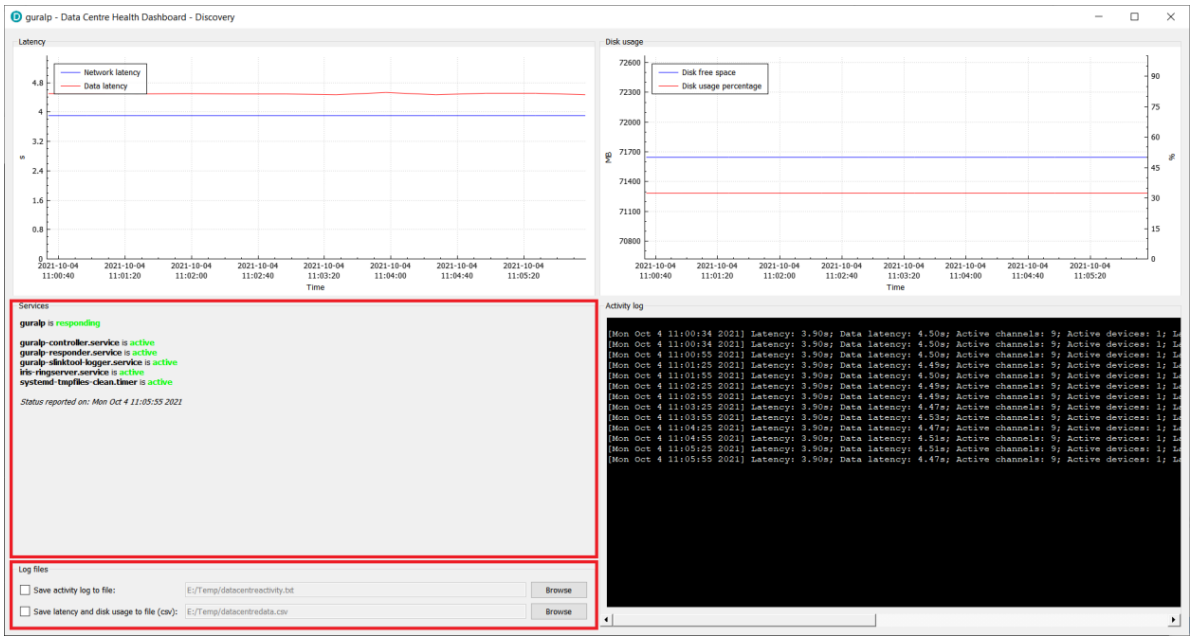


Figure 73 Bottom-left widget displays the state of services running on the Data Centre and allows to configure the logfile and output data file for activity log and latency/disk usage data respectively.

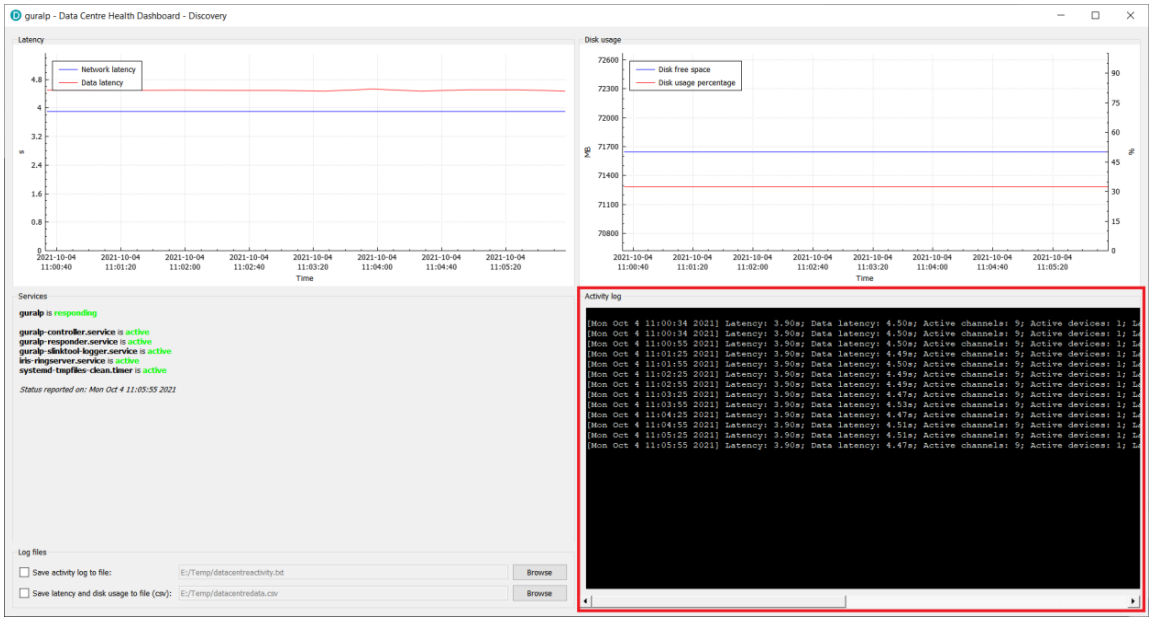


Figure 74 Bottom-right widget displays the activity log based on state of health information packets received.

Log line contains the following information:

- Timestamp
- Latency value
- Sample latency value
- Number of active channels
- Number of active devices
- Latest sample timestamp
- Available disk space in KB
- Disk used space in KB
- Percentage value of free disk space

And is logged as single line in the following format:

```
{[Timestamp]} Latency: {Latency value}s; Sample latency: {Sample latency
value}s; Active channels: {Number of active channels}; Active devices:
{Number of active devices}; Latest sample timestamp: {Latest sample
timestamp}; Disk available: {Available disk space in KB}; Disk used: {Disk
used space in KB}; Disk free: {Percentage value of free disk space}%;
```

Example:

```
[Fri Jul 9 13:50:34 2021] Latency: 1.50s; Sample latency: 1.81s; Active channels: 26; Active
devices: 2; Latest sample timestamp: Fri Jul 9 13:49:43 2021; Disk available: 73364480; Disk
used: 54698232; Disk free: 25.44%
```

8.6.3 Advanced redundancy configuration

It is possible to have two data centre servers running concurrently. For advice on this more advanced configuration please contact Güralp at support@guralp.com

8.6.4 GDC Restreaming

Discovery can fetch live data directly from the GDC ring buffers.

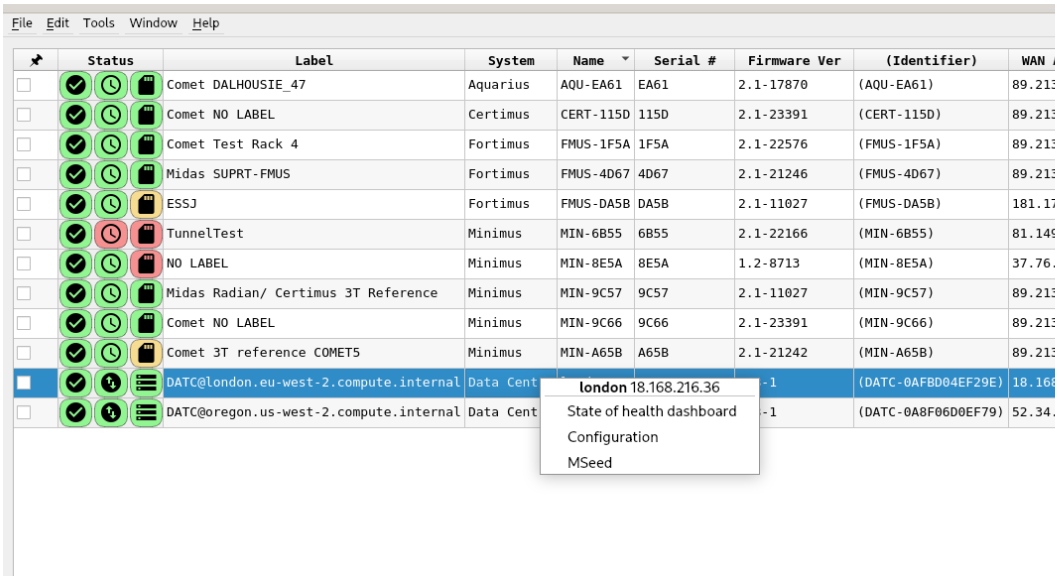


Figure 75 Context menu when selecting a GDC server

Selecting the Mseed option will connect to the SeedLink server at the GDC instance and start live streaming of data into the Discovery Viewer.

Dataless files for instruments re-streamed from the GDC can be placed in a folder:

Linux:

```
~config/Guralp Systems/Discovery/dataless/
```

Windows:

```
C:\Users\<username>\AppData\Local\Guralp Systems\Discovery\dataless
```

These files are read when a stream is first created.

Alternatively, manually loading a dataless file using the Load Data button in the viewer has the same effect. The units and calibration should then appear in the viewer. Hover over the stream status to view the metadata associated with that channel.

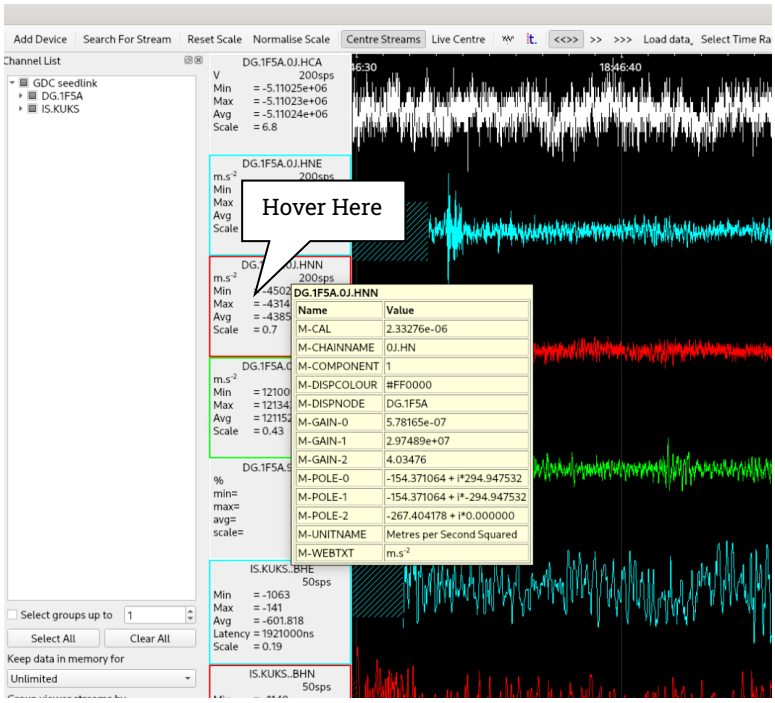


Figure 76 Channel metadata originating from dataless file

8.6.5 Viewing Instrument/Digitiser WEB configuration via GDC

Typically, digitisers are connected to the GDC via a tunnel. This circumvents NATs and makes the connection more secure. Güralp digitisers have an inbuilt tunnel that can be enabled in the Network tab of the instrument.

When such tunnels are implemented, the GDC retrieves Seed data using the SeedLink protocol. This travels via the tunnel.

Access to the instrument's web config page and other services can also be made via the same tunnel connection.

When running Discovery as a local client, the tunnel is not terminated locally. Accesses to the WEB pages need to be forwarded through the GDC server. This is handled automatically. Right-clicking on the Tunnel column forces the local Discovery to access the instrument via the GDC. This avoids to need for separate port forwarding or additional

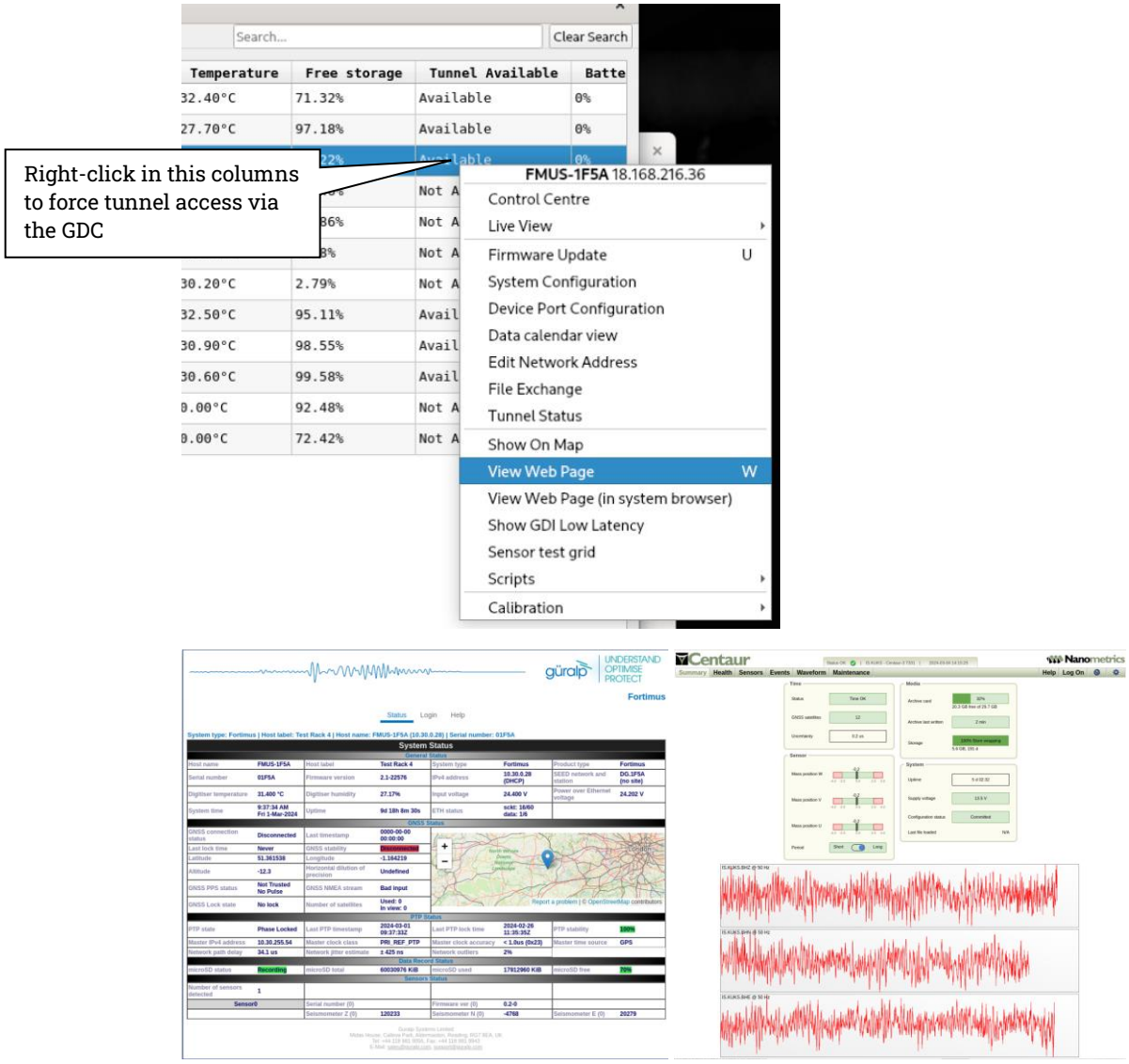


Figure 77 Instrument Access

9 Discovery Configuration

9.1 Config file

Discovery reads a config file on startup. There are a number of options and parameters that can be changed in this file. The file is written when parameters change or when Discovery is closed. For this reason, editing of this file should be done *after* Discovery is closed.

Linux:

```
~/.config/Guralp Systems/Discovery/config2.ini
```

Note: The space in "Guralp Systems" may need to be escaped with a backslash when using some shell command lines:

```
~/.config/Guralp\ Systems/Discovery/config2.ini
```

Windows:

```
C:\Users\<username>\AppData\Local\Guralp Systems\Discovery\config2.ini
```

9.2 Data locations

10 Appendix 1 - Güralp Discovery Installation

Güralp Discovery is a software package for Microsoft Windows, MAC and Linux, which facilitates the identification, configuration and management of Güralp digitisers and instruments.

Güralp Discovery has a conventional `.msi` -based installer. Once installed, the software can check whether it is the current version and can update itself using a button on the Help→About menu.

10.1 Installation in Linux

The Linux version of Discovery 64-bit is delivered in a self-contained package.

To install Güralp Discovery:

1. Open the terminal
2. Visit www.guralp.com/sw/download-discovery.shtml to download the appropriate installation script or use the command

   `wget http://www.guralp.com/download/discovery/Discovery.run`
3. Make the downloaded file executable using the command

   `chmod +x Discovery.run`
4. Run the script with the `-h` option to see the installer's help message:

   `./Discovery.run -h`

   ```
   Online installer for Guralp Systems Discovery application

   Usage: ./Discovery.run [parameters]

   Parameters:

   -h : this message

   -i : perform installation

   -o <directory> : output directory (default
   /opt/guralp/discovery)
   ```
5. Execute the script, either accepting the default installation directory

   `./Discovery.run -i`

   or providing your own, alternative location

   `./Discovery.run -i -o /usr/lib/discovery`

The script proceeds through the following installation stages:

1. A confirmation prompt:

   ```
   Guralp Discovery will be installed in:
   /opt/guralp/discovery. [C]ontinue/[A]bort
   ```

   Type C to continue installation in listed directory, or A to abort and change directory using the `-o` execution parameter

2. Downloading. The following message is printed:

   ```
   Downloading Discovery from Guralp Systems server
   [Downloading]
   ```

   This step downloads the discovery package from the Güralp server. It is around 50 MiB in size so downloading may take a long time if you have a slow Internet connection.

3. Next, the following message is printed:

   ```
   Creating installation directory: /opt/guralp/discovery [OK]
   ```

   This step creates the installation directory. If an error occurs at this stage, please make sure that the user running the installation script has permission to create the specified directory.

4. The downloaded archive is now unpacked into the specified installation directory. The following message is printed:

   ```
   Unpacking Discovery to /opt/guralp/discovery [OK]
   ```

5. The next step removes the downloaded file from the disk.

   ```
   Removing downloaded Discovery archive [OK]
   ```

6. A this point, the installation is complete. The message

   ```
   Discovery is now installed in:
   /opt/guralp/discovery/discovery
   ```

   is displayed and the application is available in the specified directory.

10.2 Installation in Windows

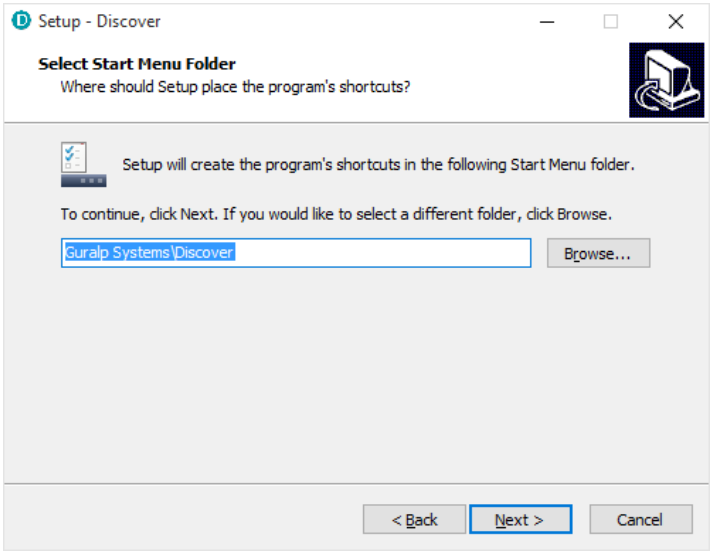
To install Güralp Discovery on a Windows machine:

1. Download the appropriate installer – 32-bit or 64-bit – from

   https://www.guralp.com/sw/download-discovery/

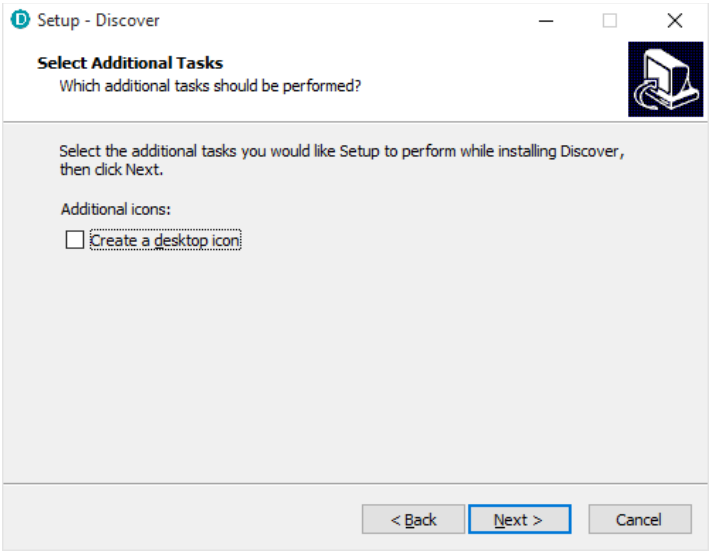
2. Double-click the downloaded file. You may be asked whether you wish to continue: answer yes.

3. The following screen asks where, in the Start Menu, you would like to place the Discovery short-cut. The default location is normally satisfactory but you can change it from here if you wish.



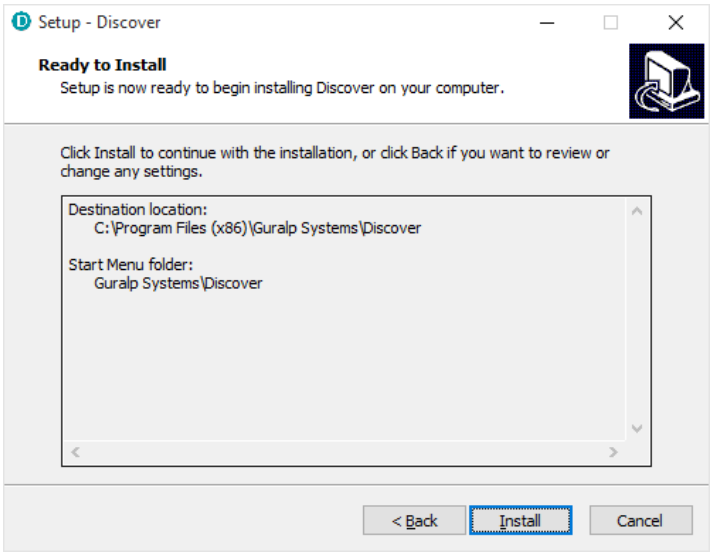
Click Next >, key ↵ or key Alt + N to continue.

4. The next screen asks whether you would like to place an icon for Discovery on the desktop:



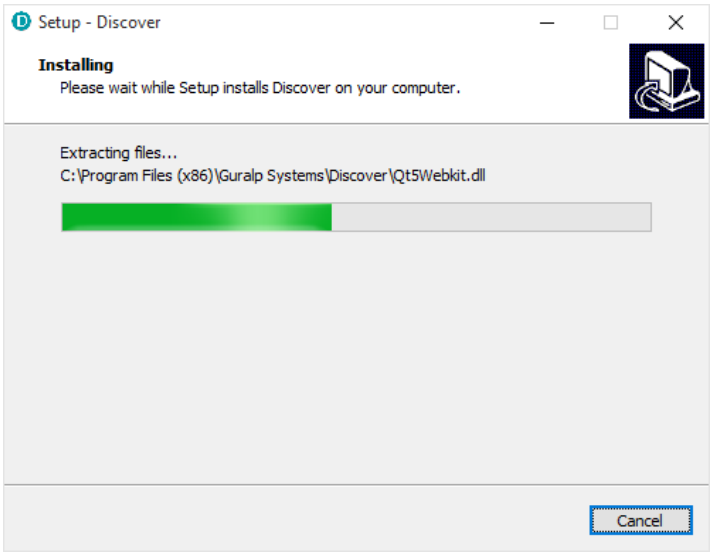
Tick the check-box if you wish and then click Next >, key ↵ or key Alt + N to continue.

5. The installer then offers a last chance to change any of your decisions:



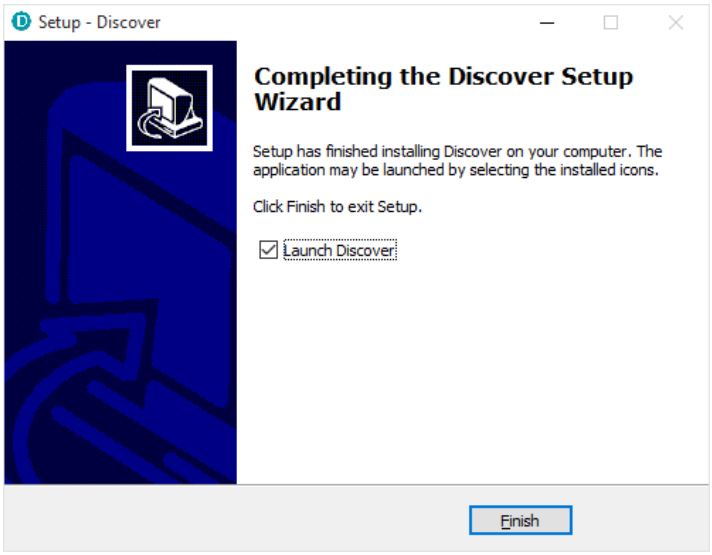
Click Install, key ↵ or key Alt+I if you are happy with your choices or click < Back (or key Alt+B) if you wish to revisit any of them.

6. Once you have clicked Install, the installation begins and a progress screen is displayed:



Pressing Cancel or keying Esc now will remove all of the installed files (except the installer itself) and reverse any changes made so far.

7. Once installation is complete, the following screen is displayed:



Press Finish, key ↵ or key Alt + F to close the installer and launch Discovery.

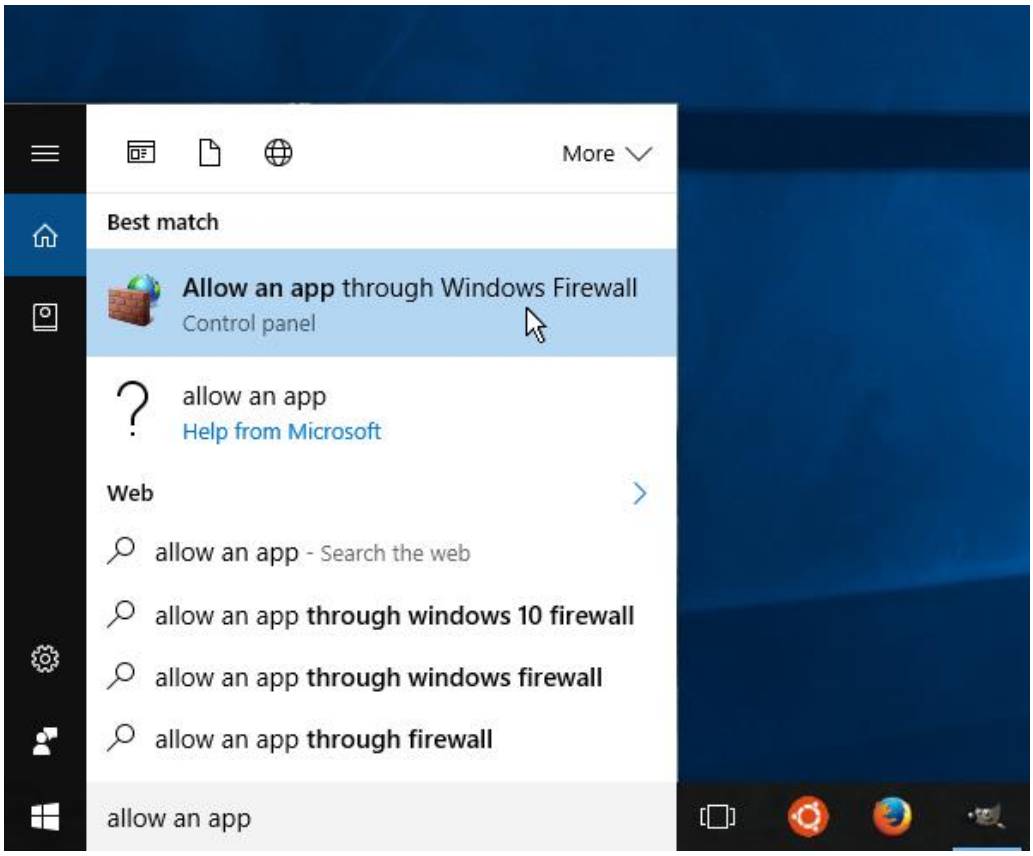
Note: Discovery for Windows 64-bit requires Microsoft Visual C++ 2015. Discovery may ask to install it if it is not installed yet.

10.3 Configuring Windows Firewall

Windows Firewall can interfere with Discovery's ability to send information to instruments and/or receive information from instruments over the network. If you use Windows Firewall, you should make special provision for allowing Discovery to communicate, as described in this section.

1. Click in the "Ask me anything" search box at the bottom left of your Windows screen:

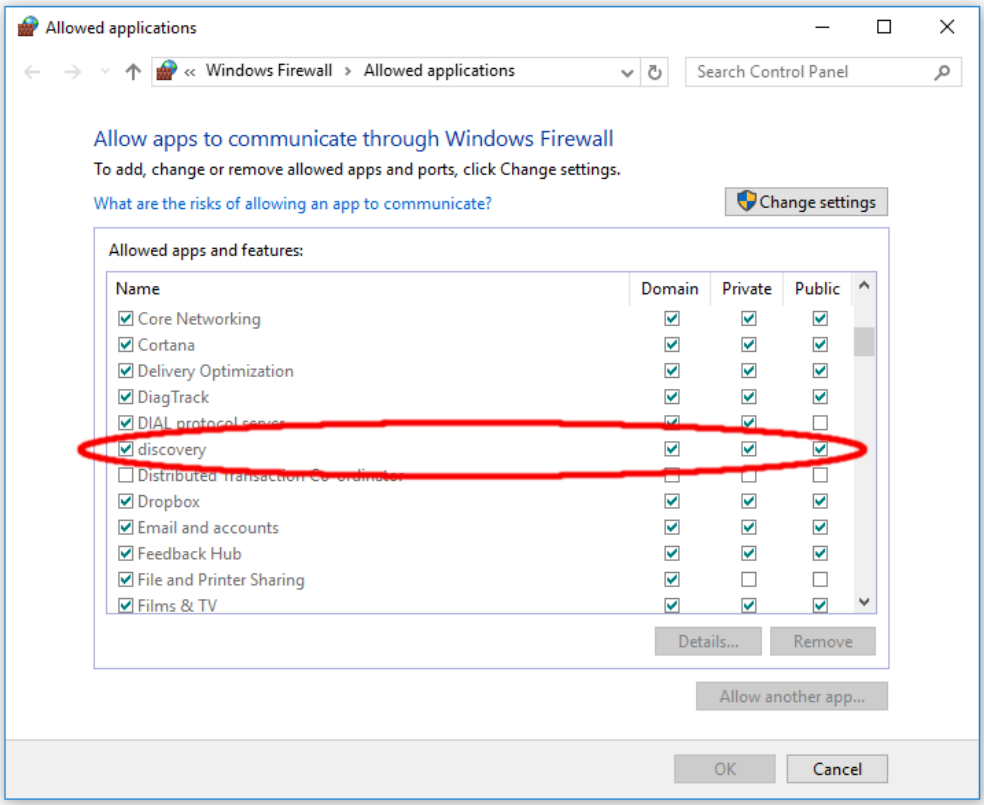
2. Type “allow an app”



3. Select “Allow an app through Windows Firewall” from the search results.

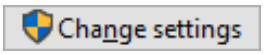
4. Windows will display the “Windows Firewall Allowed Applications” screen.

   This displays a list of applications in alphabetical order. Each application is provided with three check-boxes which indicate whether the application can communicate with networked devices in the “Domain” profile, the “Private” profile or the “Public” profile. (Profiles are also known as “network locations”.)



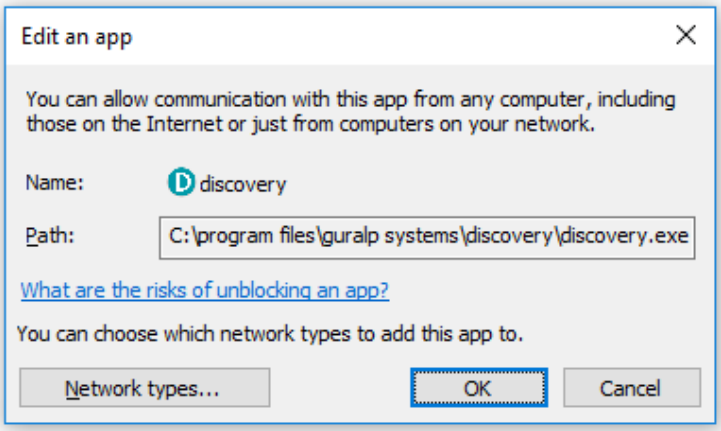
The “Domain” profile applies to networks where the host system can authenticate to a domain controller. The “Private” profile is a user-assigned profile and is used to designate private or home networks. The default profile is the “Public” profile, which is used to designate public networks such as Wi-Fi hotspots at coffee shops, airports, and other locations.

For a more complete discussion of this topic, please see http://www.tenforums.com/tutorials/6815-network-location-set-private-public-windows-10-a.html or your Windows documentation.

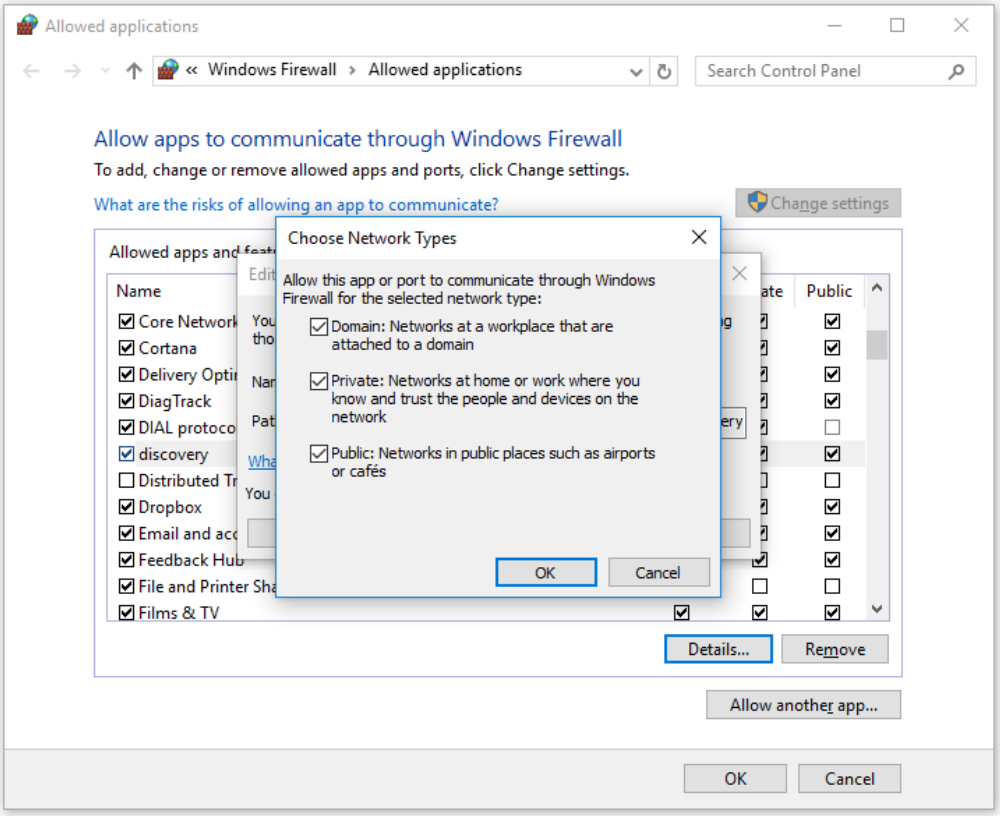
5. First click the 

buttons to activate the interface.

6. Highlight the "discovery" line and then click the Details... button. The "Edit an app" window is shown:



7. Click the Network types... button. The "Choose network types" window is shown:

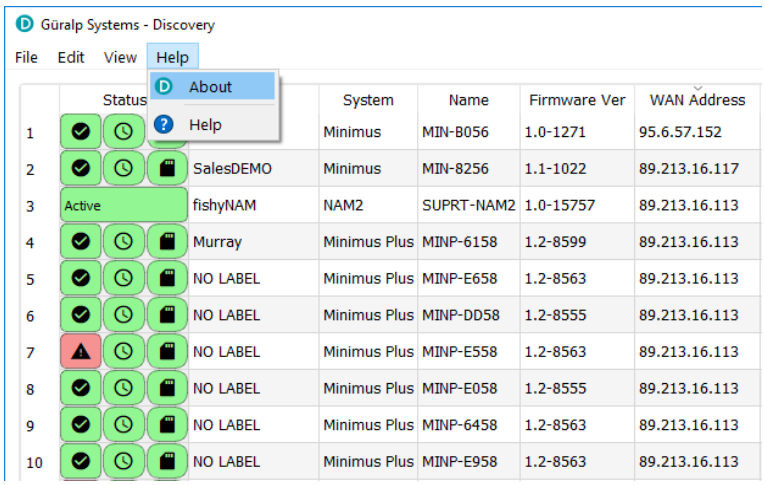


8. After making appropriate changes, click OK first in the "Choose network types" window, then in the "Edit an app" window, then in the "Windows

Firewall Allowed Applications". This closes the Windows Firewall "Allowed Applications" tool and saves the changes that you have made.

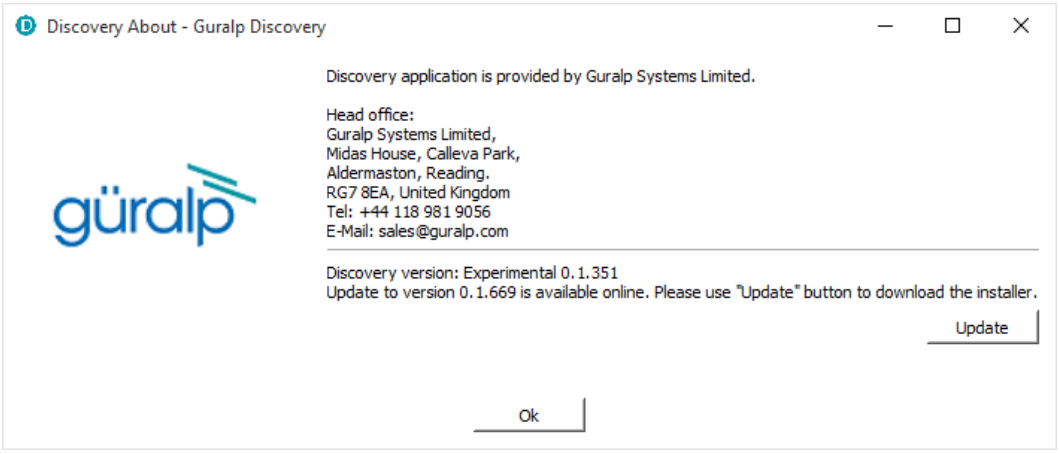
10.4 Update

If a PC running Güralp Discovery has an Internet connection, Discovery can check whether an update is available. To initiate this, click About from the Help menu or type Alt + H followed by A:



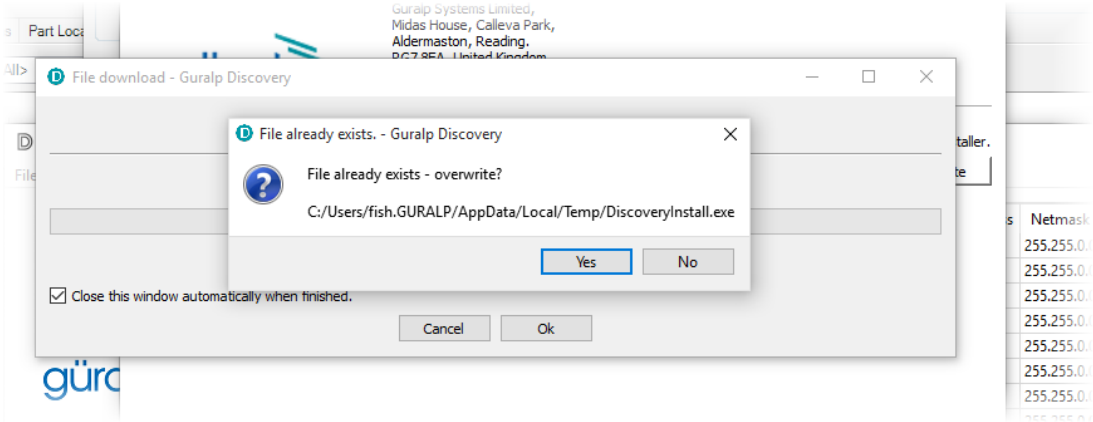
A screen like the following is displayed:

The currently installed version is shown. If this is the most recent version available, the screen will say `Up to date` and the Update button will be disabled, as shown above. If a newer version is available, the screen will look like this:



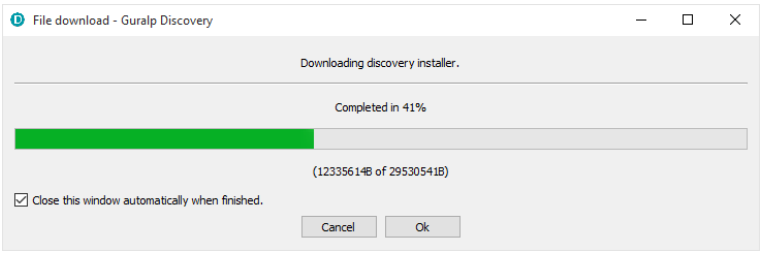
If you wish to proceed with downloading the newer version, click the Update button. This does not commit to an immediate upgrade: it just downloads the installer. If you do not wish to download the installer, click Ok to close the "Discovery About" dialogue.

If you clicked Update, you may see the following warning if the previous installer is still in your download folder:

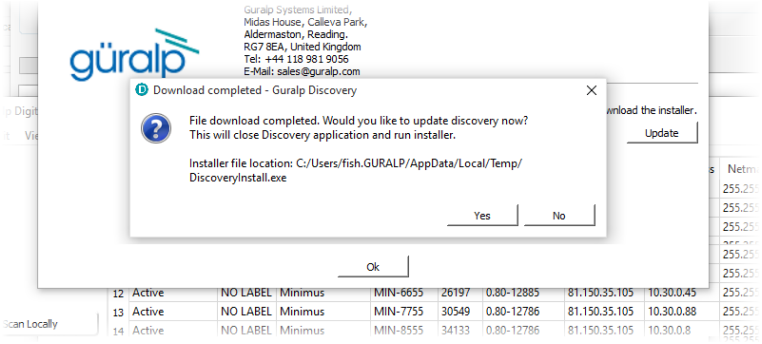


Simply click Yes or key  to continue: the download will start immediately.

While the download is in progress, the following indicator will be displayed:



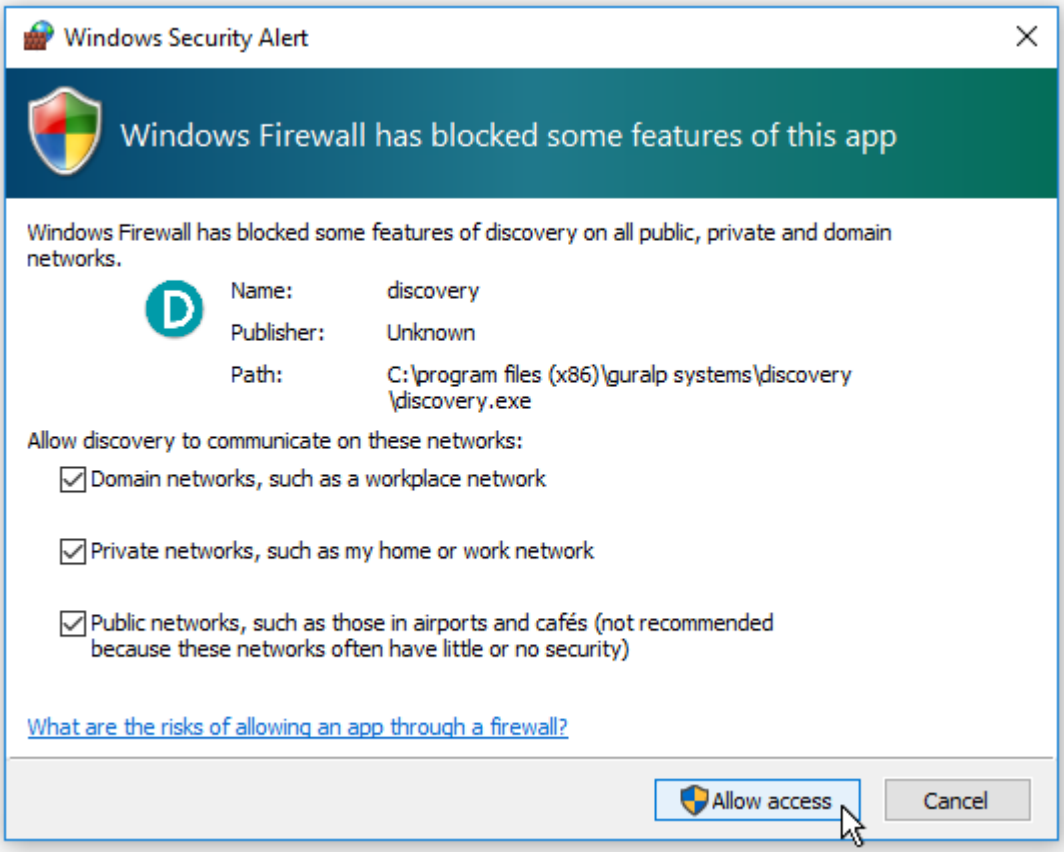
When the download is complete, the following screen is displayed:



If you wish to complete the installation immediately, click Yes. If you would rather defer the installation, click No and run the installer at a more convenient time.

Once the upgrade is complete, start Discovery in the usual way. Windows, recognising that the program has changed, may ask you to specify how you wish Discovery to interact with the Windows Firewall. Because Discovery requires network communication in order to function, it is important that you understand the options available.

The following screen is displayed:



The screen provides three check-boxes which indicate whether Discovery can communicate with networked devices in the “Domain” profile, the “Private” profile or the “Public” profile. (Profiles are also known as “network locations”.)

The “Domain” profile applies to networks where the host system can authenticate to a domain controller. The “Private” profile is a user-assigned profile and is used to designate private or home networks. The default profile is the “Public” profile, which is used to designate public networks such as Wi-Fi hotspots at coffee shops, airports, and other locations.

For a more complete discussion of this topic, please see www.tenforums.com/tutorials/6815-network-location-set-private-public-windows-10-a.html or your Windows documentation.

11 Appendix 2 – I.P. Address Configuration on PC or Laptop

With APIPA (Automatic Private I.P. Addressing), a laptop or PC can automatically configure itself with an I.P. address in the range `169.254.0.1` to `169.254.255.254`. The default subnet mask is `255.255.0.0`.

Connect you Güralp device to the laptop or PC using the blue Ethernet cable and power it up.

11.1 On Linux

On your Linux computer, open the terminal and type the command

`sudo bash`

Key  and provide the appropriate password. Then, enter the command

`ifconfig`

to identify the Ethernet network interface to which your device is connected. Once you have identified the correct interface, connect the device, power it up and enter the commands

`ifconfig` *`wlp2s0`* `down`

`ifconfig` *`wlp2s0`* `up`

replacing ***`wlp2s0`*** with the name of the appropriate interface on your PC.

Enter the command **`ifconfig`** again to verify that the IPv4 address of the Ethernet adapter is now included in the network `169.254.0.0/16` - *i.e.* the address begins `169.154.`...

```
wlp2s0  flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 169.254.139.29  netmask 255.255.0.0  broadcast 169.254.255.255
        ether 94:65:9c:ab:3c:9a  txqueuelen 1000  (Ethernet)
        RX packets 556837  bytes 722823565 (689.3 MiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 320424  bytes 42811910 (40.8 MiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

In the example above, the interface has been allocated address `169.254.139.29`, which is in the correct network.

11.2 On Windows

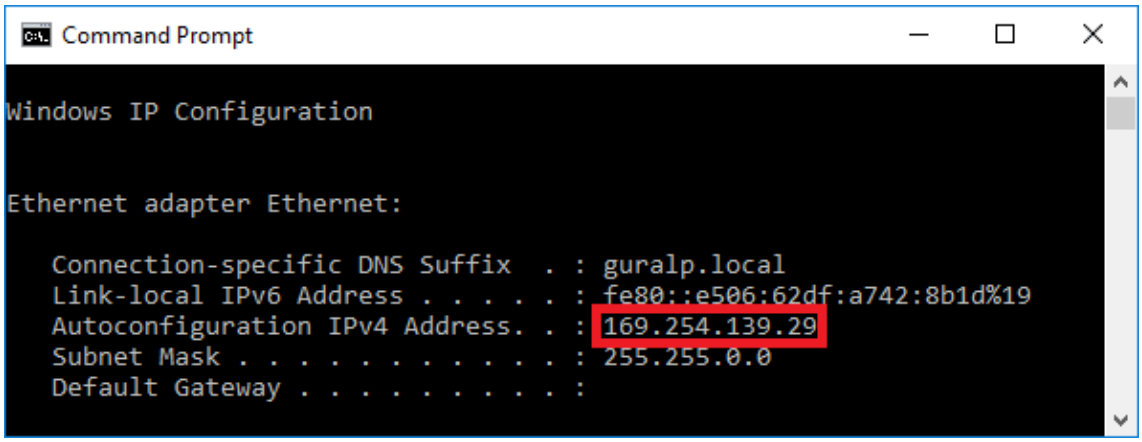
On a Windows computer, key 

to open the "Run" dialogue, enter **`ncpa.cpl`** and key  .

Right-click on the network adapter which is connected to the device and select “Disable” from the context menu. Right-click on the same adapter again and select “Enable”. Close the network settings window.

Key 

and type **`cmd.`**, then  . This opens a command window. Type the command **`ipconfig`** and verify that the IPv4 address of the Ethernet adapter is included in network *`169.254.*.*`*.



In the example above, the interface has been allocated address `169.254.139.29`, which is in the correct network.

12 Appendix 3 - Operation with 3rd Party Products

Discovery and GDC supports systems that source data using SeedLink protocol. This is a well-defined 'Industry Standard' protocol that is supported by many manufacturers.

The streaming protocols are standard yet typically the mechanism of discovering and finding the IP address of a device is manufacturer specific.

In order to allow Discovery and GDC to access data from 3rd party devices, Güralp has added a mechanism to add an entry for that device in the Devices list in Discovery.

Once we have made the Discovery aware of the existence of the device, we can perform a number of operations on the device – such as viewing the WEB page or streaming data.

There are two mechanisms of adding a 'fixed' device to the device list:

1. For Local devices (ordinarily found by Scan Local) we can Edit/Add Device.

   This should largely be used to test a connection. Using this to add a Güralp product is NOT recommended as the normal automated discovery mechanism should work. If not, other problems will likely follow!

   These manually 'added' devices are not saved as their use is only transitory.

2. For Remote devices an entry can be added to the Cloud registry. This is a permanent addition as the details are saved on the registry server. They can also be individually deleted.

   This operation is performed from the Güralp "Test Facility" application. This is available from the Start menu/Guralp Systems on Windows systems. On Linux the executable 'Thing' should be run.

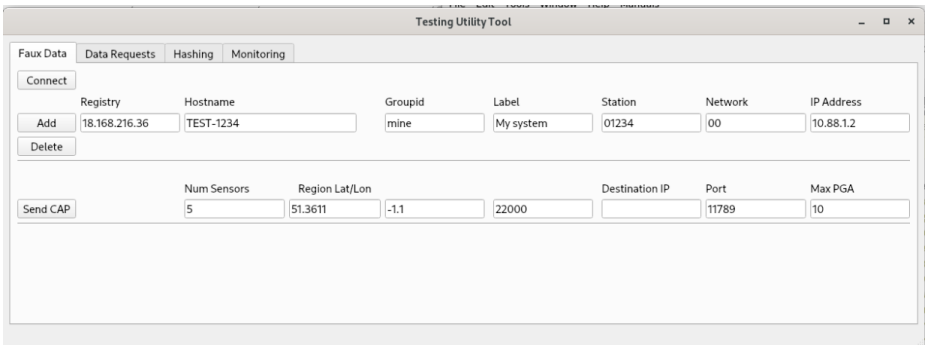


Figure 78 Test Utility

Use the Add button to send a packet to the Registry (IP Address specified) thus registering the present of such an instrument.

Assuming that the device is a SeedLink server, specifying Station and Network code and the devices IP Address, will give Discovery sufficient information for it to request SeedLink data or instruct a GDC to request SeedLink data.

Leaving the Station and Network blank will cause Discovery to probe the system for a list of Stations when a GDC connection is requested.

13 Revision History

A	2022-03-11	Initial release