Relay testing - Application note

The standard IEC 61850 describes the communication of devices in substations. GOOSE messages describe binary status signals over the substation network and are also used for relays tripping. For relay testing in IEC 61850 substations it is necessary to access to these data. This new feature is performed by ISA Automatic relay test set DRTS-6 and the new software TDMS rev. 5.01.

By means of a dedicated software module, ISA DRTS-6 can expand his testing capabilities by handling IEC61850 messages. One such message coming from a device connected to the substation network (such a relay) is also called Goose.

The IEC61850 Interface option for DRTS-6 is required for relay testing with Ethernet-based substation communication protocol. The IEC61850 Interface is mounted directly on the front panel of the DRTS-6. It is possible to upgrade old DRTS-6 units.

TDMS 5.01 Software upgrade.

To control the IEC61850 board press the relative button in the Timer and Input Contacts frame of the Test Page of Distance 21.

When the button is pressed the window Goose Explorer is opened.

By means of the Goose Explorer it is possible to explore the IEC61850 messages on the network. The window shows a File menu, a main area divided in two pages (Exploring Goose and Virtual Contacts) and an optional side that shows the Activity Log.

File Menu

A simple and basic menu is provided in order to handle the data that is captured by the Goose Explorer window.

• Open: opens a database file (.gse extension) containing the result of a session of exploring of the IEC61850 network
• Save: saves a database file (.gse extension) containing the result of a session of exploring of the IEC61850 network
Main Area
As it can be seen, the main Area is divided in two main pages:

- Exploring Goose
  This page controls the Exploring Options, displays the Goose List and the Goose details and also handles the Filters.

- Virtual Contacts
  This page displays and sets the Virtual Contacts.

Exploring Goose
The first action to perform in order to use effectively the Goose Explorer is to catch the messages on the network. To this extent there are two Exploring options: Explore at START and Explore Now.

Explore at START
When the Explore at Start option is selected, it is not possible to Start the exploring in this window. The Exploring will be automatically performed during the execution of a Shot type test.

Explore Now
When the Explore now option is selected it is possible to execute the exploring by pressing the Start Exploring button. Choose appropriately the Exploring time by setting the relative box. Upon pressing the button, the IEC61850 board mounted in the ISA Instrument starts to capture the messages and these are immediately displayed in the Goose list frame. The Start Exploring button turns Red and its caption is changed into Stop Exploring. The exploring can thus be stopped at any moment by pressing the button. The grid displays for each Goose:
- Source Mac Address: physical address of the generator of the message
- Destination Mac Address: physical address of the destination of the message
- Goose ID: Identifier of the Message
- Data Set Reference: Identifier of the type of message created by the IED
- Event TimeStamp: Universal Time that identifies the Goose Data in this grid can be ordered in various ways included in the Order Goose List by menu.

You can select this menu at any time, even during the download of gooses. It is possible to Order data according to:
- Number: the actual sequence in which the goose has been captured. (not necessarily they are received by Time Stamp)
- Time Stamp: the UTCTime identifier of the goose
- Goose ID
- Source Mac Address

By selecting a row of the Goose List, it is possible to see the details of the Data Structure handled by the selected Data Set Reference. The Goose Details grid is loaded accordingly.

Explore at START
When the Explore at Start option is selected, it is not possible to Start the exploring in this window. The Exploring will be automatically performed during the execution of a Shot type test.

Filters
The amount of messages that can travel on a IEC61850 network can be burdening due to the amount of objects connected to it. In order to select a portion of the messages, especially only the meaningful one, related to the device undergoing the test, it is possible to set Filters.

In particular, by selecting one message from the Goose List and by right-clicking with the mouse, a menu is opened:

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Relating to Filters, it is possible:

- add filter as **IED**: extracts the IED of the selected Goose and use it as a Filter, in order to capture only the messages with that same Dataset Reference.

The filter cannot be changed. A name can be given to the filter by selecting the Name column and writing an appropriate name. Click on the En column in order to Enable the Filter.

- add filter as **TIMESTAMP**: extracts the timestamp of the selected Goose and use it as a basis for a Filter. The Time can be edited.

The filter can be changed: click on the Value column and a box appears in order to edit the time of the filter.

After selecting a goose from the Goose List in the Exploring Goose page, the Goose details frame is loaded with the details of the selected Dataset data structure. Each of the parameters in this data structure can be set in order to define a virtual contact.

Right-click with the mouse on a parameter and a menu appears.

<table>
<thead>
<tr>
<th>#</th>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BOOLEAN</td>
<td>False</td>
</tr>
<tr>
<td>2</td>
<td>BOOLEAN</td>
<td>False</td>
</tr>
<tr>
<td>3</td>
<td>BOOLEAN</td>
<td>False</td>
</tr>
<tr>
<td>4</td>
<td>BOOLEAN</td>
<td>False</td>
</tr>
</tbody>
</table>

It is possible to set the parameter as a basis for a virtual contact. By choosing the menu item, a new virtual contact will be added to the Virtual Contacts page. It is possible to add up to 8 virtual contacts.

This will represent the minimum time after which messages will be sensed and captured by the IEC61850 board. Any message with UTC Time prior to the Filter time will be discarded.

A name can be given to the filter by selecting the Name column and writing an appropriate name. Click on the En column in order to Enable the Filter.

It is possible to set up to 8 filters, although only one at a time can be enabled.

At the start of an Exploring session, if the filters have been changed, a message box will appear to let the user choose whether to use the new filters or leave the previous filter condition.

**Virtual Contacts**

Once the user has performed an Exploring of the messages, be it with or without Filters, it is possible to set Virtual contacts. As the name describes, this is not a physical contact of the ISA Instrument, but is a 'virtual' contact or a condition that becomes true for a device on the network. This condition is verified by means of the occurrence of a very specific goose.

A virtual contact is identified by:

- **Name**: it can be given by the user by editing the relative box in the grid. The same name will appear in the lower frame that represent the Trip condition for the Virtual contact.
- **Dataset Reference**: it represents the exact goose that serves as the basis for the virtual contact. The same device can and does produce more than one Goose ID, so in order to set the virtual contact it is not enough to define the Goose ID, but the selection has to be made on the Dataset Reference.
- **Type**: it can be Boolean, BitString, Unsigned, Signed, Float or UTC Time.
- **Condition**: depending on the type of the data it can be: Equal to, Less than, Greater than or Not Equal to. It is set by default to Equal to, but it can be changed according to the data type. Select the appropriate condition form the menu that appears when clicking on the condition column.
- **Value**: together with the condition field, it defines the actual condition of the Virtual Contact. In case of data type Boolean, it can only assume value True or False.
Time: represents the actual ‘trip time’ of the virtual contact, or the time interpreted from the goose that the device produces when the condition is verified. It cannot be modified, it is automatically set by the software when a test is performed and a virtual contact has tripped.

In the lower part of the page, it is possible to set the Virtual Contacts trip conditions.

<table>
<thead>
<tr>
<th>#</th>
<th>Name</th>
<th>AND #1</th>
<th>AND #2</th>
<th>AND #3</th>
<th>AND #4</th>
<th>OR #1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VC1</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>VC2</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>VC3</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>VC4</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>VC5</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>VC6</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>7</td>
<td>VC7</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>8</td>
<td>VC8</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
</tr>
</tbody>
</table>

In the situation here pictured, the test will trip, apart from the Trip contact conditions set in the main page of the software in this conditions:

- trip of virtual contacts 1 and 2
- trip of virtual contacts 3 and 4
- trip of virtual contacts 5, 6, and 8
- trip of the only contact 7