## Document Revision History

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Executive Summary

This document describes the concepts and design of the GÉANT2 E2E Monitoring System. Intended audience for this document are DANTE and NRENs involved in provisioning of E2E Links, as well as E2ECU and other operations staff and also other interested users.
1 Introduction

1.1 How to read this document

This document aims to support all groups involved in the set-up and operating of E2E Links. It describes the concepts behind E2E Monitoring and is also intended as a user guide describing how domains can provide monitoring data and how people involved in operations can make use of the E2E Monitoring System.

Section 2 explains the basic terms and concepts of E2E Monitoring. It should be read by the whole audience and gives the foundation for understanding the remainder of the document.

Section 3 concentrates on the tasks for the domains. It explains how measurement data can be reported to the E2E Monitoring System.

Section 4 is a User Guide to the central visualization component of E2E Monitoring. It helps people involved in E2E Link operations in understanding how to use the system and to understand its views and messages.

Section 5 shows how the E2E Monitoring System is integrated with other management tools like Nagios.

The Appendixes (Section 0) contain some more formal descriptions mainly used by E2E Monitoring System developers.

1.2 Further Information

Please note that this document is a design description.

For implementation and deployment related information please refer to the perfSONAR WIKI:

http://wiki.perfsonar.net/jra1-wiki/index.php/PerfSONAR_support_for_E2E_Link_Monitoring

This page is regularly updated and contains all necessary information for installing and setting up the various components of E2E Link Monitoring.
1.3 What are E2E Links - Introduction to the Terminology

_E2E Links_ are defined as optical connections realized using layer 1 and 2 technologies like Ethernet or SDH/SONET over fibre. E2E Links connect endpoints in organisations which may be located in different countries and cross networks of different network domains. In provisioning GÉANT2 E2E Links, both the National Research and Educational Networks (NREN) and DANTE act as providers.

**Figure 1** - E2E Links in multi-domain environment

Figure 1 shows a basic model of three E2E Links in a multi-domain environment. In this example E2E Link 1 is a link connecting two _End Points_ (EP) E1 and E2 within a single domain. Links 2 and 3 cross more than one domain.

**Figure 2** - Basic structure of E2E Links

The composition of E2E Links is shown Figure 2. An E2E Link is composed of several parts, sometimes even within a single domain. There may be also different fibre providers in one domain. The parts are connected by optical network equipment, e.g. repeater, amplifier or DWDM devices. Partial Links within a single domain are called _Domain Links_, the parts crossing the border between two domains are named _Interdomain Links_ (ID Links). The devices terminating an E2E Link are called _End Points_; the devices at the border of domains are called _Demarcation Points_. The term Monitored Link is used for referencing both Domain Links and Interdomain Links.

To realize and operate E2E Links the domains have to collaborate in the set-up, maintenance and management processes.
1.4 Principles of E2E Monitoring

The following principles show the main concepts of E2E Monitoring (see figure 3):

- E2E Links may be implemented using a range of technologies (SDH/Sonet, Ethernet, MPLS …). The Monitoring System is fully agnostic to the technologies used for realization of the links. Thus in E2E Monitoring all Monitored Links are *logical links* which completely hide the internal structure and physical makeup.

- Monitored Links share common abstract properties (for example a status “link up”, “link down” etc.) and hide hardware- and technology-specific information (e.g. optical-electrical, Ethernet-SONET/SDH).

- The E2E Monitoring System does not need direct access to physical devices. Instead, each domain provides information about its Monitored Links via a perfSONAR Web-Service.

- Status Data from Monitored Links are periodically polled by the E2E Monitoring System.

- To ensure the proper assembly of E2E Links in the Monitoring System, a commonly agreed naming schema for all parts of E2E Links has to be used by all involved co-operating parties.

- The E2E Monitoring System computes properties of an E2E link by aggregation of the properties of the involved Monitored Links.

- All involved participants (also from the domains) need access to the E2E Monitoring System.

*Figure 3 - Principles of E2E Link Monitoring*
2 Structure of E2E Links

This section gives more detail about the structure of E2E Links and the determination of their operational and administrative states, i.e. to describe their properties.

2.1 Terms and Definitions

The following terms are used for E2E Link Monitoring:

- An E2E Link is a logical connection between two Endpoints and consists of 1 or more Monitored Links. It has two state attributes State Oper and State Admin, representing the operational and administrative status of the whole connection. Every E2E_Link is owned by a Project. The link is identified by the E2E-LinkID attribute.

- A Project represents the “owner” of an E2E link. It has the attribute Project ID.

- A Monitored Link is either a Domain Link (within a single domain) or an ID Link (Interdomain Link, connecting two domains). It has three attributes. The State Oper and State Admin attributes reflect the operational and administrative states of the Monitored Link. The TimeStamp attribute shows the time of last state measurement for this particular link, performed by the domain either directly by polling state or asynchronously by receiving traps.

- A Monitored Link is delimited by two Topology Points. For a particular E2E link a Topology Point can either be a Demarcation Point (Demarc) or an Endpoint of the link (described by Topology Point Type).

- A Topology Point is a logical representation of either an Endpoint of an E2E link or a Demarc. It is identified by the attribute Topology Point ID. The attributes Name, Country, City, Institution, Latitude and Longitude provide additional information about the Topology Point. The Latitude and Longitude attributes are used for the graphical representation.

- Every Topology Point belongs to an Authoritative Domain (any of the domains). This is the domain which has the responsibility for operating the Topology Point.

- In the case of ID Links two scenarios of providing link status information are supported:
  1. One of the involved domains takes over the monitoring responsibility and provides the status information about the whole ID Link.
  2. Both involved domains provide only information given by their own equipment. In this case the status of a single ID Link is computed as aggregation of the status information from the two involved Domains (ID Link PartialInfo). The oldest of both TimeStamps will be used as a TimeStamp for the ID Link.

- A Monitoring Responsible is an organisation responsible for a domain which provides status information about links. Although the domains always act as Monitoring Responsibilities for their Domain Links, the Monitoring Responsible is not necessarily the “owner” of the monitored links, especially in the case of ID Links.

1 Complete description of required naming convention for all IDs is given in section 2.6.
2.2 Examples

In the following examples, domain names and Topology Point IDs where chosen as examples. The same rules and procedures are valid for all domains participating in E2E link monitoring (European NRENs, DANTE and non-European domains).

2.2.1 Example 1: Interdomain Link under Single Monitoring Responsibility

Figure 4 shows a possible E2E link between two Endpoints, situated in Munich (LRZ) and Amsterdam (SARA).

In this example we have the following three Monitored Links:

<table>
<thead>
<tr>
<th>Topology Point</th>
<th>Topology Point</th>
<th>Link Type</th>
<th>Monitored by</th>
</tr>
</thead>
<tbody>
<tr>
<td>DFN-LRZ (Endpoint)</td>
<td>DFN-MUE (Demarc)</td>
<td>Domain Link</td>
<td>DFN</td>
</tr>
<tr>
<td>DFN-MUE (Demarc)</td>
<td>SURFnet-MUE (Demarc)</td>
<td>ID Link</td>
<td>DFN</td>
</tr>
<tr>
<td>SURFnet-MUE (Demarc)</td>
<td>SURFnet-SARA (Endpoint)</td>
<td>Domain Link</td>
<td>SURFnet</td>
</tr>
</tbody>
</table>

The connection between the two demarcation points situated in MUE (one belongs to DFN, the other belongs to SURFnet) is an Interdomain Link (ID link). ID Links could be realised by a patch cable connecting two WDM devices.

This example presents the section provided by DFN. In this example DFN has monitoring responsibility for the complete ID Link between the demarcs DFN-MUE and SURFnet-MUE.

---

Figure 4 - Section of E2E link between LRZ and SARA reported by DFN
2.2.2 Example 2: Interdomain Link under Shared Monitoring Responsibility

In example 1 we have assumed that DFN has the monitoring responsibility over the ID Link in Münster (MUE). There are also cases where it is technically not possible for a single domain to take over the monitoring responsibility over an ID Link.

Figure 5 shows a possible E2E link between two Endpoints, situated in Poland and the Czech Republic.

In this example we have the following three Monitored Links:

<table>
<thead>
<tr>
<th>Topology Point</th>
<th>Topology Point</th>
<th>Link Type</th>
<th>Monitored by</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSNC-EP1 (Endpoint)</td>
<td>PSNC-CIE (Demarc)</td>
<td>Domain Link</td>
<td>PSNC</td>
</tr>
<tr>
<td>PSNC-CIE (Demarc)</td>
<td>CESnet-OST (Demarc)</td>
<td>ID Link Partial Info</td>
<td>PSNC, CESnet</td>
</tr>
<tr>
<td>CESnet-OST (Demarc)</td>
<td>CESnet-EP2 (Endpoint)</td>
<td>Domain Link</td>
<td>CESnet</td>
</tr>
</tbody>
</table>

In this example the link between PSNC-CIE (Cieszyn) and CESnet-OST (Ostrava) is monitored by both NRENs. In this case both involved domains provide just the status information available from their own equipment.

![Diagram of E2E link monitored by two involved domains](image)

**Figure 5 - Section of E2E link monitored by two involved domains**
2.3 State Information and Aggregation

2.3.1 State Values

An E2E Link and its Monitored Links have two state attributes:

- **Operational State**, derived from the operational state of the involved physical devices. Supported values are:

<table>
<thead>
<tr>
<th>Operational State Value</th>
<th>Description</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown</td>
<td>Domain could not acquire information about operational state</td>
<td>0</td>
</tr>
<tr>
<td>Up</td>
<td>Link is up</td>
<td>1</td>
</tr>
<tr>
<td>Degraded</td>
<td>Link is up, but has reduced performance</td>
<td>2</td>
</tr>
<tr>
<td>Down</td>
<td>Link is down</td>
<td>3</td>
</tr>
</tbody>
</table>

- **Administrative State**, reflects the management processes performed by the domains. Supported values are:

<table>
<thead>
<tr>
<th>Administrative State Value</th>
<th>Description</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown</td>
<td>Domain could not acquire information about administrative state</td>
<td>0</td>
</tr>
<tr>
<td>NormalOperation</td>
<td>No administrative work is performed</td>
<td>1</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Planned maintenance activity in progress</td>
<td>2</td>
</tr>
<tr>
<td>TroubleShooting</td>
<td>Trouble shooting is in progress</td>
<td>3</td>
</tr>
<tr>
<td>UnderRepair</td>
<td>Repair process is in progress</td>
<td>4</td>
</tr>
</tbody>
</table>

The domains have to provide both Operational and Administrative States of all Monitored Links of this domain to the E2E Monitoring System. The Monitoring System then aggregates the states of the Monitored Links to the State of the E2E Link.

**Please note:** The administrative state is not mandatory in the current version. Please set this state to “Unknown” if it is not possible to fill in the correct administrative state.
2.3.2 How to use the State Values

Both state attributes are mandatory, i.e. values have to be provided for both states. The state values should be used as follows:

- **Operational State:**

  Each domain has the responsibility for mapping of the actual measured state of the domain’s own devices to the Operational State value of the corresponding Monitored Links. This mapping depends on the used technology and hardware. Therefore it is not possible to provide rules with general applicability.

  If the Operational State can not be determined by the domain – e.g. if a device could not be reached –, the state of the corresponding link should be set to Unknown. All other Operational State values should only be used if the state can actually be determined.

  **Please note:** The Degraded state is reserved for future use. For now, please only use the values Unknown, Up and Down.

  **Example:** To illustrate the mapping, we present a possible mapping for devices which support the standard SNMP IF-MIB (RFC 2233):

  The possible IF-MIB::ifOperStatus values are

  1 : up
  2 : down
  3 : testing
  4 : unknown
  5 : dormant
  6 : notPresent
  7 : lowerLayerDown

  so a possible mapping from IF-MIB (left) to E2E Mon. Oper. State (right) could be:

  up -> Up
  down -> Down
  testing -> Down
  unknown -> Unknown
  dormant -> Down
  notPresent -> Down
  lowerLayerDown -> Down

  Of course, other mappings are possible and valid.

- **Administrative State:**

  This state value has to be provided by the domains. Similar to the Operational State, the mapping of the actual administrative state to the state values of the Administrative State of E2E Monitoring is in responsibility of the individual domain.

  If the Administrative State can not be set by the domain, the state of the corresponding link should be set to Unknown. All other Administrative State values should only be used if the state can actually be determined.
Interrelationship between Operational and Administrative States

Generally speaking, Operational and Administrative States are complementary concepts, i.e. the Operational state should reflect the actual state of the devices which realize the links, and the Administrative state should reflect operational aspects. While Operational States usually can be derived automatically from the devices, the Administrative State has to be set manually; ideally, the Administrative State is maintained in a NMS and can be taken over from this system.

Here are some examples which help to understand the usage of these states:

**Examples:**

1. A domain has a planned maintenance window from 01:00 AM to 02:00 AM. The actual maintenance operation lasts only 5 min.

   In this case, it would be nice to set the Administrative Status to **Maintenance** during the whole maintenance window (not only for the 5 min. required for the work itself). The Operational State should continue to reflect the measured state. So it usually will be **Up**, except for the time the link is actually down due to maintenance work.

2. The maintenance operation doesn't end within the planned maintenance window, e.g. the link is down from 01:30 AM to 02:30 AM (planned maintenance window: 01:00 AM to 02:00 AM)

   In this case, the Administrative State should be set to **Maintenance** from 01:00 AM to 02:00 AM. It should be set to **NormalOperation** after the maintenance window, regardless of the Operational State of the link. The Operational State reflects the state of the devices, so in this example it will be **Down** from 01:30 AM to 02:30 AM and will change to **Up** after the work is done.
2.3.3 Aggregation Rule

The domains provide status information for Monitored Links. The E2E Monitoring System uses the following simple method for calculating the status of whole E2E Links:

To determine the status of an E2E Link, the worst state value (i.e. having the highest weight) of all Monitored Links for this particular E2E Link is used.

If one of the states is Unknown, the Monitoring System will show the user that some information is missing.

This rule applies for both Operational and Administrative States.

2.3.4 Examples for Status Aggregation

We refer to the examples from Section 2.2 to illustrate the aggregation rule with help of hypothetical state values.

E2E Link between DFN-LRZ and SURFnet-SARA:

<table>
<thead>
<tr>
<th>Monitored Link</th>
<th>Link Type</th>
<th>Monitored by</th>
<th>Operational State</th>
<th>Administrative State</th>
</tr>
</thead>
<tbody>
<tr>
<td>DFN-LRZ to DFN-MUE</td>
<td>Domain Link</td>
<td>DFN</td>
<td>Up</td>
<td>NormalOperation</td>
</tr>
<tr>
<td>DFN-MUE to SURFnet-MUE</td>
<td>ID Link</td>
<td>DFN</td>
<td>Unknown</td>
<td>Maintenance</td>
</tr>
<tr>
<td>SURFnet-MUE to SURFnet-SARA</td>
<td>Domain Link</td>
<td>SURFnet</td>
<td>Degraded</td>
<td>NormalOperation</td>
</tr>
</tbody>
</table>

Aggregated State: Degraded Maintenance

E2E Link between PSNC-EP1 and CESnet-EP2:

<table>
<thead>
<tr>
<th>Monitored Link</th>
<th>Link Type</th>
<th>Monitored by</th>
<th>Operational State</th>
<th>Administrative State</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSNC-EP1 to PSNC-CIE</td>
<td>Domain Link</td>
<td>PSNC</td>
<td>Degraded</td>
<td>NormalOperation</td>
</tr>
<tr>
<td>PSNC-CIE to CESnet-OST</td>
<td>ID Link Partial Info</td>
<td>PSNC</td>
<td>Up</td>
<td>NormalOperation</td>
</tr>
<tr>
<td>PSNC-CIE to CESnet-OST</td>
<td>ID Link Partial Info</td>
<td>CESnet</td>
<td>Down</td>
<td>TroubleShooting</td>
</tr>
<tr>
<td>CESnet-OST to CESnet-EP2</td>
<td>Domain Link</td>
<td>CESnet</td>
<td>Up</td>
<td>NormalOperation</td>
</tr>
</tbody>
</table>

Aggregated State: Down TroubleShooting
2.4 **E2E Link Reconstruction**

The E2E Monitoring System has no central repository where the configuration of E2E Links is stored. Thus, it has to reconstruct the E2E Links from the partial information provided by all involved domains.

To illustrate this process, Figure 6 shows a simple scenario of a single E2E Link crossing two domains. In Step 1, the two domains report their Monitored Links to the E2E Monitoring System. In Step 2, the E2E Monitoring System tries to concatenate these pieces. This is done by matching Topology Point names.

The resulting E2E Link is called *contiguous* if:

- It has exactly two End Points
- All Monitored Links of this E2E Link are connected like a pearl necklace
- There is a single path which connects the two End Points

![Figure 6 - Reconstruction of Contiguous E2E Link](image-url)
To illustrate the problems which can disturb the E2E Link reconstruction, Figure 7 shows an erroneous scenario where domain DFN uses a wrong Topology Point name.

Figure 7 - Name Mismatch: E2E Link is not Contiguous

The result of this error is that the E2E Link can not be reconstructed properly and breaks down into parts. Note the icon in the Figure 7 that symbolizes the gap between these parts. Such a link is not contiguous (see section 2.5 for a more detailed discussion).

The naming schema plays a crucial role in the reconstruction of E2E Links.
2.5 Non-contiguous E2E Links

As shown in the last section, it is not always possible for the Monitoring System to properly reconstruct an E2E Link from the parts reported by the domains.

An E2E Link is **non-contiguous** if at least one of the following conditions occurs:

- E2E Link does not have **exactly two** End Points (e.g. EP is missing or too many EPs are reported)
- E2E Link breaks down into parts and has one or more gaps (shown in the Monitoring System using the icon).

This could have several reasons:

- Data from the domain could not be queried (e.g. Measurement Point is not accessible due to firewall restrictions, XML with Measurement Data is not well-formed)
- The Monitored Links reported by the domains are erroneous (e.g. name mismatch like in Figure 7).

The Monitoring System reports status information for non-contiguous E2E Links, too. However, this status information is **not reliable**, because in this case not all parts are properly monitored. From the end user perspective, it is **not** possible to determine the operational and administrative state of a non-contiguous E2E Link.

Therefore non-contiguous E2E Links have to be resolved ASAP.
2.6 Naming Schema

As explained in the previous sections, the naming schema is crucial for the reconstruction of E2E Links.

All IDs are case-insensitive. They have to conform to the following conventions:

- **Domain ID**: a *globally unique* acronym of the domain name, e.g. DFN.
- **Topology Point ID** (Endpoint or Demarcation Point): composed of the Domain ID and a local part (unique within this domain) denoting the Topology Point. The parts are concatenated with a “minus” character, e.g. DFN–MUE. This composed ID is supposed to be *globally unique*.
- **Project ID**: a *globally unique* ID of a project, e.g. DEISA.
- **E2E Link ID**: a *globally unique* ID of an E2E Link. This ID is composed as a combination of the two globally unique acronyms of the organisations at the Endpoints in lexicographical order, the project ID and an additional numerical index (three digits with leading zeros) to distinguish between multiple E2E links of the same project. The properties are concatenated by a minus character, eg. LRZ–SARA–DEISA–001.
- **Monitored Link ID** (Local Name): a *locally unique* ID of a Monitored Link. This ID has the purpose to help the domain’s T-NOC in identifying the physical components which realise a particular Monitored Link.

**Globally unique IDs** (E2E Link ID, Domain ID, Project ID) are assigned by DANTE. They have to be unique between all participants.

**Locally unique IDs** (Topology Point ID and Monitored Link ID) are defined individually by each domain. As a rule of thumb, they are defined by the domain which has the administrative responsibility for it.

**Allowed characters**: only letters of the English alphabet (a-z, A-Z), numbers (0-9) and underscore (“_”). Spaces are not allowed as part of IDs (to avoid having IDs divided by spaces). Although there is no restriction about the length or combination of the allowed characters, the IDs should be kept as short as possible and should be chosen to be human readable and understandable.

**Correct usage of E2E Link- and Topology Point IDs**: to ensure proper reconstruction of E2E Links, all participants have to refer to the same objects by *exactly* the same IDs. This means that the E2E Link ID has to be equal for all Monitored Links of this particular E2E Link, and the participants have to agree upon which Topology Point IDs are used for providing an E2E Link.
2.7 Data Model

This section shows the Data Model design used for reporting of monitoring data to the E2E Monitoring System.

Figure 8 - Data Model used by E2E Monitoring System
3 The Domain Perspective - Data Provisioning

This chapter presents the general design of data provisioning to the E2E Monitoring System.

3.1 General Steps for Data Exchange

The general steps required for data provisioning are shown in Figure 9.

![Diagram of data provisioning steps]

**Figure 9 - Scenarios of Data Provisioning**
These steps are:

- **Measurement Data Acquisition**: Extract the information from the equipment. We assume that a domain has knowledge about all the hardware equipment (HW) involved in providing their Monitored Links and has access to status information of this HW. Because of the heterogeneity of the used HW no assumption about this step is made.

- **Data Transformation and Aggregation**:
  - **Data Transformation**: The acquired data measurements may not be directly usable by the E2E Monitoring System, which requires that data comply with the data model. Therefore the data have to be analysed and transformed into logical status information.
  - **Data Aggregation**: The status information required for E2E Monitoring System is given not for single devices but instead for the Monitored Links.

- **Data Population**: The domain has to populate a data structure of the perfSONAR web-service. The naming of E2E Links is coordinated by DANTE.

- **Data Provisioning**: Aggregated data from Monitored Links are provided for the E2E Monitoring System via a perfSONAR Web Service. Two alternative scenarios are supported: using a Measurement Point (MP) or a Measurement Archive (MA). The scenarios are described below in this document.


---

3.2 Web Service Interface

The web services used for data provisioning have to support the following request/response model:

**SOAP Request (generated by E2E Monitoring System):**

```xml
<nmwg:message type="SetupDataRequest"
   xmlns:nmwg="http://ggf.org/ns/nmwg/base/2.0/">
  <nmwg:metadata id="meta1">
    <nmwg:eventType>Path.Status</nmwg:eventType>
  </nmwg:metadata>

  <nmwg:metadata id="meta2">
    <select:parameters>
      <select:parameter name="time">now</select:parameter>
    </select:parameters>
  </nmwg:metadata>
</nmwg:message>
```

**SOAP Response (generated by MA/MP Web Service):**

The XML schema of the SOAP Response is described in section 3.4.

**Note:** The SOAP envelope is not described in this document. The perfSONAR framework proposes to use SOAP messages using a *document literal* payload encoding format, i.e. the message is not encoded additionally. Please refer to the perfSONAR documentation for more information.
3.3 Scenarios for Data Provisioning

There are currently two types of perfSONAR web-services: Measurement Point (MP) and Measurement Archive (MA). In Figure 9 the two alternative scenarios are depicted.

Web-Service Selection: The NRENs can choose which of the supported Web Services they want to use for Data Provisioning:

- **Measurement Point (MP):** A lightweight perfSONAR web-service which provides the latest status information made available in an XML registry file.
- **Measurement Archive (MA):** A perfSONAR web-service which can provide both the latest status as well as historical information of the links.

Both methods have their own data structure that contains the status information. The data structures are respectively an XML file or SQL database. The NRENs need to populate the data structure with the aggregated status information they are retrieving from their equipments. Both type of web-services receive the same requests and export the data in the same way (as expected by the E2E Monitoring System).

3.3.1 Measurement Point (MP)

A Measurement Point provides actual status information. A stand alone MP is sufficient for providing the measurement data required for basic functionality of the E2E Monitoring System. In this scenario the NREN provides an XML Registry File which is transferred to the E2E Monitoring System by the MP Web Service.

3.3.1.1 XML Registry File

The XML Registry File is almost identical to the schema of the NMWG Message described in section 3.4. However, it is a store, thus the main element has to be `nmwg:store` instead of `nmwg:message`. The remaining elements are identical.

```xml
<nmwg:store type="SetupDataResponse"
xmlns:nmwg="http://ggf.org/ns/nmwg/base/2.0/"
xmlns:nmtm="http://ggf.org/ns/nmwg/time/2.0/"
xmlns:nmwgtopo3="http://ggf.org/ns/nmwg/topology/base/3.0/"
...
</nmwg:store>
```

3.3.2 Measurement Archive (MA)

An MA also provides historical data and uses a database for data storage. The development of the MA is independent from the E2E Monitoring System. Please refer to perfSONAR WIKI for more information.
3.4 Introduction to the NMWG XML Schema for E2E Link Monitoring

The XML schema is compliant to the NMWG schema used in the perfSONAR framework (see [3] for more information). Using this schema, a single domain provides configuration and status information for Topology Points and Monitored Links of this domain. The schema definition using RELAX-NG format is given in section 5.3.

The NMWG message consists of three types of elements:

- **nmwgtopo3:node**: contain metadata information about a single Topology Point (a logical representation of either an end point of an E2E link or a demarcation point). Only the domain which has the administrative responsibility for a topology point may provide this information. Other domains can refer to foreign Topology Points using only the Topology Point ID.

  **Main elements:**

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nmwgtopo3:node, Attribute</td>
<td><strong>id</strong> This element is a container element providing information about Topology Point. The <strong>id</strong> attribute contains the Topology Point ID.</td>
</tr>
<tr>
<td>nmwgtopo3:type</td>
<td>Fixed value: TopologyPoint</td>
</tr>
<tr>
<td>nmwgtopo3:name</td>
<td>Long name of the Topology Point</td>
</tr>
<tr>
<td>nmwgtopo3:country</td>
<td>Country of Topology Point location</td>
</tr>
<tr>
<td>nmwgtopo3:city</td>
<td>City of Topology Point location</td>
</tr>
<tr>
<td>nmwgtopo3:latitude</td>
<td>Specifies the geographical location of Topology Point. Expected in format similar to RFC1876, but only latitude, e.g. 50° 00.01 N</td>
</tr>
<tr>
<td>nmwgtopo3:longitude</td>
<td>Specifies the geographical location of Topology Point. Expected in format similar to RFC1876, but only longitude, e.g. 8° 27.47.94 E</td>
</tr>
</tbody>
</table>

- **nmtl2:link**: this element provides metadata information about a single Monitored Link the domain has the monitoring responsibility for.

  **Main elements:**

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nmwg:metadata, Attribute</td>
<td><strong>id</strong> This element is a container element. The <strong>id</strong> attribute is referenced by <strong>nmwg:data</strong> section (see below).</td>
</tr>
</tbody>
</table>

...
**E2E Link Monitoring System**  
*System Design and Documentation*

**Document Code:** <GN2-JRA4-06-010v230>

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nmtl2:link</td>
<td>This element is a container element providing information about a Monitored Link.</td>
</tr>
<tr>
<td>nmtl2:name</td>
<td>Locally unique Monitored Link ID (local name)</td>
</tr>
<tr>
<td>nmtl2:globalName</td>
<td>Globally unique E2E Link ID</td>
</tr>
<tr>
<td>nmtl2:type</td>
<td>Specifies the type of monitored link. Supported values are: Domain_Link, ID_Link, ID_LinkPartialInfo</td>
</tr>
<tr>
<td>nmwgtopo3:node, Attribute nodeIdRef</td>
<td>Specifies the Topology Point delimiting the monitored link. Two of these elements have to be provided for each Monitored Link. The attribute nodeIdRef contains the Topology Point ID.</td>
</tr>
<tr>
<td>nmwgtopo3:role</td>
<td>Specifies the role of Topology Point for the Monitored Link. Supported values are EndPoint und DemarcPoint</td>
</tr>
</tbody>
</table>

- **nmwg: data**: this element contains **status information** for a single Monitored Link.

**Main elements:**

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nmwg: data, Attribute metadataIdRef</td>
<td>This element is a container element. metadataIdRef identifies the corresponding metadata element, which contains the description of a Monitored Link.</td>
</tr>
<tr>
<td>ifevt:datum, Attributes timeType and timeValue</td>
<td>This element is a container element. It contains the actual operational and administrative states of the corresponding Monitored Link. Attribute timeType specifies format of the timeValue attribute, supported values are: “ISO”, “Unix”. Attribute timeValue provides the time of last state measurement performed either directly by polling state or asynchronously by receiving traps. Values are expected either in ISO format “yyyy-mm-ddThh:mm:ss+hh:mm” (e.g. “2006-04-06T13:06:02+1:00”) or UNIX format (e.g. “1166193342”)</td>
</tr>
<tr>
<td>ifevt:stateOper</td>
<td>This element contains the operational State of the Monitored Link. Supported values are: Up, Degraded, Down, Unknown</td>
</tr>
<tr>
<td>ifevt:stateAdmin</td>
<td>This element contains the operational State of the Monitored Link. Supported values are: NormalOperation, Maintenance, TroubleShooting, UnderRepair, Unknown</td>
</tr>
</tbody>
</table>

For the naming schema of IDs used in the NMWG XML schema for E2E Link Monitoring, please refer to section 2.6.
3.5 Examples

We refer to the same examples as in section 2.2.

3.5.1 Example 1

This example presents the section of the XML message provided by DFN, covering from the E2E link between LRZ and SARA that part between DFN-LRZ and DFN-MUE. In this example DFN has the monitoring responsibility for the complete ID link between the demarcs DFN-MUE and SURFnet-MUE.

![Diagram of E2E link between LRZ and SARA](image)

**Figure 10 - Section of E2E link between LRZ and SARA reported by DFN**

XML message provided by DFN (extract related to Example 1):

```xml
<nmwg:message
    type="E2E_Link_status_information"
    xmlns:nmwg="http://ggf.org/ns/nmwg/base/2.0/"
    xmlns:nmtm="http://ggf.org/ns/nmwg/time/2.0/"
    xmlns:nmwgtopo3="http://ggf.org/ns/nmwg/topology/base/3.0/
    xmlns:nmtl2="http://ggf.org/ns/nmwg/topology/l2/3.0/"
    xmlns:nmtl3="http://ggf.org/ns/nmwg/topology/l3/3.0/"
    xmlns:nmtl4="http://ggf.org/ns/nmwg/topology/l4/3.0/"
    xmlns:ifevt="http://ggf.org/ns/nmwg/event/status/base/2.0/">

    <nmwg:parameters id="storeId"
        >DFN</nmwg:parameter>
        </nmwg:parameters>

    <nmwg:metadata id="md1"
        >DFN</nmwg:metadata>
        </nmwg:parameters>

    <nmwg:subject id="sub-DFN-LRZ"
        >DFN</nmwg:subject>
        </nmwg:subject>

    <nmwgtopo3:node id="DFN-LRZ"
        >DFN</nmwg:node>
        </nmwg:node>

</nmwg:message>
```
<nmwgtopo3:node nodeRef="SURFnet-MUE">
  <nmwgtopo3:role>DemarcPoint</nmwgtopo3:role>
</nmwgtopo3:node>

</nmtl2:link>
</nmwg:subject>
</nmwg:metadata>

<nmwg:data id="d1" metadataIdRef="md3">
  <ifevt:datum timeType="ISO" timeValue="2006-04-20T17:20:00.0+1:00">
    <ifevt:stateOper>Up</ifevt:stateOper>
    <ifevt:stateAdmin>NormalOperation</ifevt:stateAdmin>
  </ifevt:datum>
</nmwg:data>

<nmwg:data id="d2" metadataIdRef="md4">
  <ifevt:datum timeType="ISO" timeValue="2006-04-20T17:20:00.0+1:00">
    <ifevt:stateOper>Down</ifevt:stateOper>
    <ifevt:stateAdmin>Maintenance</ifevt:stateAdmin>
  </ifevt:datum>
</nmwg:data>

</nmwg:message>
3.5.2 Example 2

In example 1 we assume that DFN has the monitoring responsibility over the ID Link in Münster (MUE). There are also cases where it is not possible for a single domain to take over the monitoring responsibility over an ID Link, for example the Cieszyn – Ostrava connection. In this case both involved domains provide just the status information available from their own equipment. In the following we show extracts of two XML messages, one of them provided by PSNC and the other by CESnet. Both XML sections cover the ID link shown in Figure 11. Note that the link type has to be set to ID_LinkPartialInfo in this case.

Figure 11 - Section of E2E link reported by two involved domains

XML message provided by PSNC (extract related to Example 2):

```xml
<nmwg:message
type="E2E_Link_status_information"
xmlns:nmwg="http://ggf.org/ns/nmwg/base/2.0/"
xmlns:nmtm="http://ggf.org/ns/nmwg/time/2.0/"
xmlns:nmwgtopo3="http://ggf.org/ns/nmwg/topology/base/3.0/"
xmlns:nmtl2="http://ggf.org/ns/nmwg/topology/l2/3.0/"
xmlns:nmtl3="http://ggf.org/ns/nmwg/topology/l3/3.0/"
xmlns:nmtl4="http://ggf.org/ns/nmwg/topology/l4/3.0/"
xmlns:ifevt="http://ggf.org/ns/nmwg/event/status/base/2.0/">
    <nmwg:parameters id="storeId">
        <nmwg:parameter name="DomainName">PSNC</nmwg:parameter>
    </nmwg:parameters>
    ...
</nmwg:message>
```
XML message provided by CESnet (extract related to Example 2):

```xml
<nmwg:message
 type="E2E_Link_status_information"
 xmlns:nmwg="http://ggf.org/ns/nmwg/base/2.0/"
 xmlns:nmtm="http://ggf.org/ns/nmwg/time/2.0/"
 xmlns:nmgtopo3="http://ggf.org/ns/nmwg/topology/base/3.0/"
 xmlns:nmtl2="http://ggf.org/ns/nmwg/topology/l2/3.0/"
 xmlns:nmtl3="http://ggf.org/ns/nmwg/topology/l3/3.0/"
 xmlns:nmtl4="http://ggf.org/ns/nmwg/topology/l4/3.0/"
 xmlns:ifevt="http://ggf.org/ns/nmwg/event/status/base/2.0/">
  <nmwg:parameters id="storeId">
    <nmwg:parameter name="DomainName">CESnet</nmwg:parameter>
  </nmwg:parameters>

  <nmwg:metadata id="md3">
    <nmwg:subject id="sub1">
      <nmtl2:link>
        <nmtl2:name type="logical">CESnet-link-XY5w</nmtl2:name>
        <nmtl2:globalName type="logical">EP1-EP2-PrjID-004</nmtl2:globalName>
        <nmtl2:type>ID_LinkPartialInfo</nmtl2:type>
      </nmtl2:link>
    </nmwg:subject>
  </nmwg:metadata>

  ...<nmwg:datum
    timeType="ISO" timeValue="2006-04-20T17:18:30.0+1:00">
    <ifevt:stateOper>Down</ifevt:stateOper>
    <ifevt:stateAdmin>TroubleShooting</ifevt:stateAdmin>
  </nmwg:datum>

  ...
</nmwg:message>
```
<nmtl2:globalName type="logical"> EP1-EP2-PrjID-004</nmtl2:globalName>
<nmtl2:type>ID_LinkPartialInfo</nmtl2:type>

<nmwtopo3:node nodeIdRef="CESnet-OST">
  <nmwtopo3:role>DemarcPoint</nmwtopo3:role>
</nmwtopo3:node>

<nmwtopo3:node nodeIdRef="PSNC-CIE">
  <nmwtopo3:role>DemarcPoint</nmwtopo3:role>
</nmwtopo3:node>

...</nmtl2:link>
</nmwg:subject>
</nmwg:metadata>

<nmwg:data id="d1" metadataIdRef="md3">
  <ifevt:datum timeType="ISO" timeValue="2006-04-20T17:20:00.0+1:00">
    <ifevt:stateOper>Down</ifevt:stateOper>
    <ifevt:stateAdmin>Unknown</ifevt:stateAdmin>
  </ifevt:datum>
</nmwg:data>

...</nmwg:message>
4 The User Perspective: The E2E Link Monitoring System

This chapter is intended for the users of the E2E Monitoring System. It provides all necessary information required for understanding the User Interface. It assumes knowledge of information presented in chapters 1 and 2.

4.1 Overview

The User Interface (UI) of the E2E Monitoring System is HTML based. It presents several views, showing different aspects of E2E Links:

<table>
<thead>
<tr>
<th>View</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E2ECU view</td>
<td>This view with its four sub-views gives some comprehensive overview of all E2E Links currently deployed.</td>
</tr>
<tr>
<td>Domain view</td>
<td>This view shows the domains involved in E2E Link Monitoring. For each domain, a list of all Monitored Links provided by this domain is given.</td>
</tr>
<tr>
<td>Project view</td>
<td>This view gives an overview about the projects. For each project a list of E2E Links provided for this project is given.</td>
</tr>
<tr>
<td>Availability Statistics</td>
<td>This view presents E2E Link related availability.</td>
</tr>
<tr>
<td>Alarms</td>
<td>This view shows a history of alarms generated by the E2E Link Monitoring System. All available information about alarms and SNMP traps can be investigated</td>
</tr>
</tbody>
</table>

Additionally, E2E Links can be filtered to distinguish links being in production from other links (see section 4.2).

The start page of the UI of the E2E Monitoring System is shown in Figure 12. Generally, the UI is divided into two parts. On the left hand side you see the navigation bar containing a list of all views and sub-views. Using the navigation bar, it is easy to find the necessary information needed for a particular task in operations. At the right hand side, the content of the currently selected view is shown. Please note that all views that contain time-related data, e.g. status information, are updated automatically.

In the following sections, screenshots of the UI are shown without browser elements and navigation bar, i.e. only the content part of the view.

Supported browsers are: Microsoft Internet Explorer 6 (and higher) and Firefox 2.0 (and higher).
Figure 12 - User Interface of E2E Link Monitoring System
4.2 E2E Link Filtering

The E2E Monitoring System uses an auto learning approach trying to get to know about new E2E Links as soon as they appear in the information collected from the Domains. Although this concept proved to be very powerful, it is necessary to distinguish between E2E Links actually being in production – and needing particular attention by operations – from links which are still in the provisioning phase or are de-provisioned.

E2E Links can be marked as being in production by adding the corresponding E2E Links IDs in the configuration file `/etc/G2_E2E_MonSystem_ProdLinks.txt`. All E2E Links listed in this file are considered as being in production. This file can either be edited manually, or via the AdminGUI (see Figure 13).

**Toggle productive/non-productive E2E Links**

- CSC-FRA-DEISA-001
- DFN-PSNC-CBFA-001
- EPCC-FRA-DEISA-001
- FERM-IN2P3-IGTMD-001
- FZJ-FRA-DEISA-001
- GARR-SURFNET-EXPRESS-001
- GRIDKA-FZU-LHCT1T2-001
- GRIDKA-IN2P3-LHCPN-001
- HLRS-FRA-DEISA-001
- IDRIS-FRA-DEISA-001
- RZG-FRA-DEISA-001
- SARA-FRA-DEISA-001

E2E Links being in production are treated differently by the E2E Monitoring System. The following features are only applicable on productive links:

- **Alarm Handling:** Alarms (i.e. SNMP Traps) are only sent for Links being in production. For other links, errors and warning are displayed in the UI, but not propagated as alarms.

- **Statistics:** Only links being in production are included in the Statistics pages. For other links, no Statistics are available.

Via buttons in the navigation page, it can be selected which E2E Links are shown:

**Figure 13 - AdminGui - Toggle Prod/Non Prod Links**

The filtering buttons have the following meaning:

<table>
<thead>
<tr>
<th>Prod.</th>
<th>Non Prod.</th>
<th>All Links</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Only E2E Links being in Production are shown.</td>
<td></td>
</tr>
</tbody>
</table>
Non Prod. | Only E2E Links not being in Production are shown.
---|---
All Links | All E2E Links which are known to the system are shown.

The active filtering button is shown in blue. The selection affects all views of the E2E Monitoring System. If an E2E Link is missing in a view, please check that the correct filtering is active.

**Please note:**

- The filtering is only available if the switch `PRODSWITCH` is turned on in the general configuration file.
- It is crucial that the configuration file is always up-to-date to ensure that Alarm Handling and Statistics is activated properly.

### 4.3 Presentation of E2E Links

#### 4.3.1 Contents

![E2E Link ID](image)

<table>
<thead>
<tr>
<th>Domain</th>
<th>GEANT2-AMS</th>
<th>SURFNET</th>
<th>CERN-TO</th>
<th>GEANT2-GEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Link Structure</td>
<td><strong>EP</strong></td>
<td><strong>DP</strong></td>
<td><strong>EP</strong></td>
<td><strong>EP</strong></td>
</tr>
<tr>
<td>Type</td>
<td>EndPoint</td>
<td>ID Part.Info</td>
<td>ID Part.Info</td>
<td>Demarc</td>
</tr>
<tr>
<td>Local Name</td>
<td>GEANT2-AMS</td>
<td>SURFNET-NL-CERN-SARA</td>
<td>SURFNET-SARA</td>
<td>CERN-T0</td>
</tr>
<tr>
<td>State Oper.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>State Admin.</td>
<td>-</td>
<td>-</td>
<td>Normal Oper.</td>
<td>-</td>
</tr>
<tr>
<td>Timestamp</td>
<td>2007-01-31</td>
<td>T08:45:02.0+0100</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

![Attributes for the whole E2E Link](image)

**Figure 15 - E2E Link Presentation**
The presentation of an E2E Link is reachable from different views and is shown in Figure 15. Logically it is divided into three parts:

- **E2E Link ID:** The ID of the presented E2E Link is shown on the top of the view. This ID is used throughout the whole system to identify a particular E2E Link. Everywhere an E2E Link ID is shown in a view of the UI, it is linked to this E2E Link Presentation.

- **Attributes for the whole E2E Link:**
  - **Time of State Aggregation:** this line reflects the time the status information was collected and aggregated by the E2E Monitoring System. The time shown in this line has to be used in communication with the domains about a particular error situation.
  - **Aggregated Status Information for E2E Link:** This section shows the aggregated Operational and Administrative State of the complete E2E Link. Definition of the states is given in section 2.3.1.

In addition, Warnings and Errors are displayed as follows:

<table>
<thead>
<tr>
<th>Type</th>
<th>UI Message</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error</td>
<td>E2E Link is not contiguous (End Point missing or gap found)</td>
<td>A detailed discussion about this error and recommended actions can be found in chapter 2.5. If this error occurs, the shown status information of E2E Link is incomplete and not reliable from a user point of view.</td>
</tr>
<tr>
<td>Warning</td>
<td>Operational state is not known for all involved links</td>
<td>Operational state is unknown for at least one Monitored Link.</td>
</tr>
<tr>
<td>Warning</td>
<td>Administrative state is not known for all involved links</td>
<td>Administrative state is unknown for at least one Monitored Link.</td>
</tr>
</tbody>
</table>

All these errors and warnings are related to the Monitored Links of the domains. In all the cases it is recommended to contact the respective domain(s) to clear this situation.

- **Structure of E2E Link:** This section shows the Topology Points and Monitored Links the E2E Link is composed of.

The first line shows the assignment of E2E Link elements to the domains. This allows an easy identification of the domain(s) which have to be contacted in case of an erroneous situation.

The link structure is shown in a semi-graphical fashion using the following icons:

<table>
<thead>
<tr>
<th>Icon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EP</td>
<td>End Point of E2E Link</td>
</tr>
</tbody>
</table>
### Icons for Monitored Links:

Icons for Monitored Links can appear in three colours depending on the Operational State of the Monitored Link: **Green** for Up, **Orange** for Degraded, **Red** for Down.

The **Type** field shows the type of information displayed in a particular column.

For Topology Points, only the Topology Point ID is shown. More detailed information (name, domain, country, city, institution) is shown in a Tool Tip when the mouse is placed on the Topology Point ID.

For Monitored Links, the following data is displayed:

- **Local Name**: The locally unique ID of the Monitored Link.
- **State Oper, State Admin**: The state information for this Monitored Link.
- **Timestamp**: The time of last state measurement performed by the domain.

### 4.3.2 Dealing with Errors

**Case 1: ID Partial Info missing**
In Figure 16, the blue question mark indicates that the corresponding ID Link Partial Info is missing, in this example, the ID Link Partial Info between CERN-T0 and GEANT2-GEN.

The reason for the error in this example could be:

- GEANT2 does not deliver monitoring data at all, because the GEANT2 Measurement Point or Archive couldn’t be reached by the Monitoring System. Please check the Domain View for GEANT2 if there are errors at domain level (see section 4.5.2, p. 44).

- One of the neighbouring domains uses a wrong configuration for this ID Link. In this example, either CERN uses a wrong Topology Point Name, or GEANT2 does not provide information for this ID Link. It is necessary to contact both domains to figure out how to solve the problem.

Case 2: Gap

In Figure 17 the red gap sign indicates that the E2E Monitoring System could not put together all Monitored Links to a single contiguous link (see 2.5 for a discussion about non-contiguous links).
Please note: The position of the gap symbol does not necessarily indicate the responsible domains which cause the gap.

The reason for the error could be:

- One or more domains do not deliver monitoring data at all, because their Measurement Point or Archive couldn’t be reached by the Monitoring System. Please check the Domain View if there are errors at domain level (see section 4.5.2, p. 44).

- Not all Monitored Links are reported by the domain, even if the MA/MP of these domains are reachable.

- One or more domains use wrong Topology Point IDs.

In the latter two cases, it is necessary to contact all domains which are involved in providing this link to figure out the reason for the gap.

4.3.3 Links to Open Alarms

If there are errors present, alarms are generated. In the Open Alarms section links to the detailed alarm info are shown to enable further investigation (see Figure 18). Multiple alarms can be present for the same E2E Link.

Open Alarms:

Alarms #097
Alarms #709
Alarms #728

Figure 18 - Open Alarms for E2E Link

4.4 E2ECU View

The E2ECU View can be seen in Figure 19. In this view, at a glance one can see all E2E Links together with their current Operational and Administrative States as well as Additional Information about the state of a particular link (i.e. errors and warnings, see also section 4.2). Definition of the states is given in section 2.3.1.
All E2E Links

<table>
<thead>
<tr>
<th>E2E Link ID</th>
<th>State Oper</th>
<th>State Admin</th>
<th>Additional Info</th>
</tr>
</thead>
<tbody>
<tr>
<td>CERN:BNL-LHCOPN-001</td>
<td>Up</td>
<td>Normal Oper.</td>
<td>Error: E2E Link is not contiguous (End Point missing or gap found)</td>
</tr>
<tr>
<td>CERN:BNL-LHCOPN-002</td>
<td>Up</td>
<td>Normal Oper.</td>
<td>Warning: Operational state is not known for all involved links</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Warning: Administrative state is not known for all involved links</td>
</tr>
<tr>
<td>CERN:CNAF-LHCOPN-001</td>
<td>Up</td>
<td>Normal Oper.</td>
<td></td>
</tr>
<tr>
<td>CERN:FERMILHCOPN-001</td>
<td>Up</td>
<td>Normal Oper.</td>
<td></td>
</tr>
<tr>
<td>CERN:FERMILHCOPN-002</td>
<td>Up</td>
<td>Normal Oper.</td>
<td>Error: E2E Link is not contiguous (End Point missing or gap found)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Warning: Operational state is not known for all involved links</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Warning: Administrative state is not known for all involved links</td>
</tr>
<tr>
<td>CERN:GRIDKALHCOPN-001</td>
<td>Up</td>
<td>Normal Oper.</td>
<td></td>
</tr>
<tr>
<td>CERN:IN2P3-LHCOPN-001</td>
<td>Up</td>
<td>Normal Oper.</td>
<td></td>
</tr>
</tbody>
</table>

By clicking on the E2E Link ID the user navigates to the Presentation of E2E Link described in details in section 4.2.

The E2ECU view has four sub-views:

- **All E2E Links**: List of all E2E Links reported by the domains.
- **Mon. Links**: List of all Monitored Links reported by the domains
- **Problem E2E Links**: This view shows only E2E Links which suffer from Errors and/or Warnings.
- **Problem Mon. Links**: This view shows only Monitored Links which suffer from Errors and/or Warnings.
4.5 Domain View

4.5.1 Contents

In the navigation bar, all domains involved in E2E Link Monitoring are listed. Figure 20 shows the content of the Domain View for a single domain. This view lists all Monitored Links this particular domain reports to the E2E Monitoring System.

The view can be used by the domains to check the Monitored Links they actually operate and report.

Monitored Links for Domain GARR

<table>
<thead>
<tr>
<th>Mon. Link Local Name</th>
<th>E2E Link ID</th>
<th>Topology Point A</th>
<th>Role</th>
<th>Topology Point B</th>
<th>Role</th>
<th>Link Type</th>
<th>Oper. Status</th>
<th>Admin. Status</th>
<th>Time Stamp</th>
</tr>
</thead>
</table>

Figure 20 - Domain View

For each Monitored Link provided by this domain, the following data is displayed in a single line:

- **Mon. Link Local Name**: The locally unique ID of the Monitored Link.

- **E2E Link ID**: ID of the E2E Link this Monitored Link belongs to. By clicking on the E2E Link ID the user navigates to the Presentation of E2E Link described in details in section 4.2.

- **Topology Point A/B**: IDs of the delimiting Topology Points.

- **Role**: Role of this Topology Point in the E2E Link (E: End Point, D: Demarcation Point)

- **Link Type**: Type of the Monitored Link.

- **Oper. State, Admin. State**: The state information for this Monitored Link.

- **Time Stamp**: The time of last state measurement performed by the domain.
4.5.2 Dealing with Errors

Figure 21 shows how error messages at domain level are shown in the Monitoring System:

- In the navigation bar, errors at domain level are indicated by a (?) sign. If this sign is shown next to a Domain ID, please go to the domain view to check the errors.

- In the domain view, errors are shown below the “Errors Occurred” line. If an error message is shown, there is a problem in accessing the Measurement Point or Measurement Archive of this domain. Please contact the domain to figure out how to resolve the problem.

If an error occurs in retrieving data from the domain, one of the following error messages will be displayed. In the rightmost column, hints are given about possible reasons for the individual errors:

Errors Occurred:
- MP/MA not reachable

Open Alarms:
- Alarm #720
## System Message| Description| Possible Reasons
---|---|---
MA/MP not reachable| Measurement Point or Measurement Archive installed by the domain could not be reached at all.| MA/MP not running, Firewall restriction, Wrong configuration of E2E Monitoring System (wrong IP address, port)
An error was reported by the MA/MP| MA/MP could be reached. However, severe error reported by the MA/MP.| Internal error or misconfiguration in MA/MP.
The MA/MP has sent malformed XML data| MA/MP delivers XML data. However, the data is not compliant to the specification of section 3.4.| Misconfiguration of MA/MP.
Topology Point roles of the same ID-Link are reported different| A Topology Point or Monitored Link was reported inconsistently.| Two domains report the same object in an inconsistent way. Usually, this error is caused by a mismatch of Topology Point roles. To resolve this situation, both domains reporting this object have to be contacted to clear the configuration. The error description gives detailed information about the data reported by both domains; the error is shown for both domains.
The MA/MP has sent malformed XML data (unexpected keyword used)| MA/MP delivers XML data. However, the data is not compliant to the specification of section 3.4. An Unexpected keyword value is used.| For example IDLink is used as link type instead of ID_Link
Undefined domain ID| Undefined Domain ID is used in XML file.| Misconfiguration of MA/MP.
Unexpected domain ID (MA/MP may only report data for their own domain)| Domain ID specified in XML file does not match with ID expected by the E2E Monitoring System| Misconfiguration of MA/MP or E2E Monitoring System.
Unexpected Topology Point description (only descriptions of Topology Points owned by the current domain are allowed)| The domain tries to define a "foreign" Topology Point.| To resolve this situation, inform the affected domain to omit the definition of foreign Topology Point.
Internal System Error| A system error has occurred.| Several reasons possible. Please report the complete output to the developers.

### 4.5.3 Links to Open Alarms

If there are errors present, alarms are generated. In the Open Alarms section links to the detailed alarm info are shown to enable further investigation.
4.6 Project View

All projects having commissioned E2E Links are listed in the navigation bar. Figure 22 shows the content of the Project View for a single project. This view lists all E2E Links provided for this project.

The view can be used by authorized project people to check the status of “their” E2E Links.

### E2E Links for Project LHCOPN

<table>
<thead>
<tr>
<th>E2E Link ID</th>
<th>State Oper</th>
<th>State Admin</th>
<th>Additional Info</th>
</tr>
</thead>
<tbody>
<tr>
<td>CERN-FERMILHCOPN-001</td>
<td>Up</td>
<td>Normal Oper.</td>
<td>Error: E2E Link is not contiguous (End Point missing or gap found)</td>
</tr>
<tr>
<td>GRIDKA-SARALHCOPN-001</td>
<td>Up</td>
<td>Normal Oper.</td>
<td>Warning: Operational state is not known for all involved links</td>
</tr>
<tr>
<td>GRIDKA-IN2P3-LHCOPN-001</td>
<td>Down</td>
<td>Normal Oper.</td>
<td>Error: E2E Link is not contiguous (End Point missing or gap found)</td>
</tr>
<tr>
<td>CERN-BNL-LHCOPN-001</td>
<td>Up</td>
<td>Normal Oper.</td>
<td>Warning: Operational state is not known for all involved links</td>
</tr>
<tr>
<td>CERN-SARALHCOPN-001</td>
<td>Up</td>
<td>Normal Oper.</td>
<td>Warning: Administrative state is not known for all involved links</td>
</tr>
<tr>
<td>CERN-GRIDKA-LHCOPN-001</td>
<td>Up</td>
<td>Normal Oper.</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 22 - Project View**

The fields shown in this view are identical to those shown in the E2ECU view (see section 4.4).
4.7 Availability Statistics

This view presents the availability statistics data for all monitored E2E Links. These statistics are available for the current and for the previous month. The statistics for the current month are periodically updated. The links are grouped by projects (see Figure 23).


**Project: EXPRES**

<table>
<thead>
<tr>
<th>E2E Link ID</th>
<th>Endpoint A</th>
<th>Endpoint B</th>
<th>Monitored Domains</th>
<th>Availability (%)</th>
<th>Monitored Time (min)</th>
<th>Up-Time (min)</th>
<th>Degraded-Time (min)</th>
<th>Down-Time (min)</th>
<th>Uncertain-Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GARR-SURFNET-EXPRES-001</td>
<td>GARR-MEDICONA</td>
<td>SURFNET-SARA</td>
<td>GARR2 GARR2</td>
<td>46.34</td>
<td>36667</td>
<td>16991</td>
<td>0</td>
<td>0</td>
<td>19676</td>
</tr>
</tbody>
</table>

**Project: LHCOPN**

<table>
<thead>
<tr>
<th>E2E Link ID</th>
<th>Endpoint A</th>
<th>Endpoint B</th>
<th>Monitored Domains</th>
<th>Availability (%)</th>
<th>Monitored Time (min)</th>
<th>Up-Time (min)</th>
<th>Degraded-Time (min)</th>
<th>Down-Time (min)</th>
<th>Uncertain-Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CERN-FERMILHCOPN-001</td>
<td>CERN-T0</td>
<td>FERMI-T1</td>
<td>CERN USRL-CHIC <code>Fermi</code></td>
<td>85.49</td>
<td>36667</td>
<td>31345</td>
<td>0</td>
<td>1007</td>
<td>3515</td>
</tr>
<tr>
<td>CEINET-GRIDKA-LHCOPN-001</td>
<td>CEINET-PRA</td>
<td>GEANT2</td>
<td>CERN USRL-Chic</td>
<td>0.00</td>
<td>16991</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>16991</td>
</tr>
<tr>
<td>GRIDKA-SARA-LHCOPN-001</td>
<td>DFN-FZK25</td>
<td>DFN</td>
<td>CERN USRL-Chic</td>
<td>0.00</td>
<td>36667</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>36667</td>
</tr>
<tr>
<td>CERN-ENL-LHCOPN-001</td>
<td>ESIET-ENL</td>
<td>CERN-T0</td>
<td>CERN USRL Ch Snet</td>
<td>74.78</td>
<td>36667</td>
<td>27421</td>
<td>0</td>
<td>6731</td>
<td>3515</td>
</tr>
<tr>
<td>GRIDKA-INFS-LHCOPN-001</td>
<td>INFS-GRIDKA1</td>
<td>INFS-LHCOPN</td>
<td>RENATER</td>
<td>0.00</td>
<td>36667</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>36667</td>
</tr>
<tr>
<td>CERN-SARA-LHCOPN-001</td>
<td>SURFNET-SARA</td>
<td>CERN-T0</td>
<td>GEANT2 CERN SURFNET</td>
<td>46.34</td>
<td>36667</td>
<td>16991</td>
<td>0</td>
<td>0</td>
<td>19676</td>
</tr>
<tr>
<td>CERN-FERMILHCOPN-002</td>
<td>CERN-T0</td>
<td>FERMI-T1</td>
<td>CERN USRL-Chic</td>
<td>51.02</td>
<td>36667</td>
<td>18725</td>
<td>0</td>
<td>0</td>
<td>17932</td>
</tr>
<tr>
<td>CERN-GRIDKA-LHCOPN-001</td>
<td>DFN-FZK25</td>
<td>CERN-T0</td>
<td>GEANT2 CERN</td>
<td>46.34</td>
<td>36667</td>
<td>16991</td>
<td>0</td>
<td>0</td>
<td>19676</td>
</tr>
</tbody>
</table>

**Figure 23 - E2E Link Statistics**

The following fields are displayed for each E2E Link:

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E2E Link ID</td>
<td>E2E Link ID</td>
</tr>
<tr>
<td>Endpoint A/B</td>
<td>Topology Point IDs of End Points of this E2E Link</td>
</tr>
<tr>
<td>Monitored Domains</td>
<td>Domains involved in Monitoring this E2E Link</td>
</tr>
<tr>
<td>Availability (%)</td>
<td>Up-Time/Monitored Time</td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Monitored Time (min)</td>
<td>The total amount of time when the E2E Monitoring System was able to gather data for this E2E Link from at least one MP or MA. It is equal to the total sum of Up-, Degraded-, Down- and Uncertain-Time.</td>
</tr>
<tr>
<td>Up-Time (min)</td>
<td>The amount of time when the aggregated Operational Status of the E2E Link was Up.</td>
</tr>
<tr>
<td>Degraded-Time (min)</td>
<td>The amount of time when the aggregated Operational Status of the E2E Link was Degraded.</td>
</tr>
<tr>
<td>Down-Time (min)</td>
<td>The amount of time when the aggregated Operational Status of the E2E Link was Down.</td>
</tr>
</tbody>
</table>
| Uncertain-Time (min)       | The amount of time when one of the following cases occurred:  
  1) E2E Link is not contiguous (e.g. MP is not reachable, see section 2.5)  
  2) E2E Link status is Unknown. |

Please note:

- Although the time is given in minutes, the granularity of the statistics depends on the polling interval of the E2E Monitoring System.

- The availability shown might be astonishingly low, even down to 0%. This can have several reasons:
  1. The E2E Link was not contiguous all the time (see 2.5 for an explanation about possible reasons). In this case, only the statistics counter Uncertain-Time is increased.
  2. If the status of all Monitored Links of a given E2E Link is Unknown, only the statistics counter Uncertain-Time is increased for this E2E Link.
  3. The statistics-counter Up-Time is increased only if the whole E2E Link is contiguous and has the operational status Up.

### 4.7.1 Links to CSV Export File

The Statistics data is provided also as CSV Export Files. For each project, the CSV Export File is accessible by the Link “CSV Export” under the project name (see Figure 23). The CSV Export File is structured as follows:

```
Project, E2E Link, Endpoint A, Endpoint B, Monitored Domains, Availability (%), Monitored Time (min), Up-Time (min), Degraded-Time (min), Down-Time (min), Uncertain-Time (min)
```

The field contents are the same as in the HTML output (see above). The list of Monitored Domains is Space-separated.
4.8 Alarm History

For E2E Links being in production, the E2E Link monitoring system generated alarms if errors occur, for example if a Monitored Link is down. These alarms are propagated via SNMP Traps to other management applications (see section 5.1).

Please note: The complete information the system has about an error situation is collected in the Alarm History. There is no need to look into log files to research about alarms, because the data shown in the log files is a subset of the information show in the Alarm History.

Each alarm is identified by an AlarmID. The Alarm History gives an overview about all alarms (see Figure 1). Cleared alarms are shown in green, alarms that are still open are shown in red color.

E2E Monitoring System - Alarm History

<table>
<thead>
<tr>
<th>Alarm</th>
<th>Log File Location</th>
<th>Alarm</th>
<th>Log File Location</th>
<th>Alarm</th>
<th>Log File Location</th>
<th>Alarm</th>
<th>Log File Location</th>
<th>Alarm</th>
<th>Log File Location</th>
<th>Alarm</th>
<th>Log File Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>#000730</td>
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<td>#000735</td>
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<td>#000907</td>
<td>#000908</td>
<td>#000909</td>
</tr>
<tr>
<td>#000910</td>
<td>#000911</td>
<td>#000912</td>
<td>#000913</td>
<td>#000914</td>
<td>#000915</td>
<td>#000916</td>
<td>#000917</td>
<td>#000918</td>
<td>#000919</td>
<td>#000920</td>
<td>#000921</td>
</tr>
</tbody>
</table>

Figure 24 - Alarm History

Detailed information about a particular alarm can be shown by clicking on the corresponding link (see Figure 25).
Information for E2E Monitoring Alarm #835

Detailed Alarm Info:
- Alarm ID: 835
- Mon. Entry Name: RENATER-LYO-GRIDKA-IN2P3
- Mon. Entry Type: PartIDLink
- State Oper: Degraded
- Additional Info: e2aLinkID=GRIDKA-IN2P3-LHCOPN-001
- Mon. Domain: RENATER

E2E Link Info (at time of alarm raise):
- Operational State: Degraded
- Administrative State: Normal Oper.
- Error: E2E Link is not contiguous (End Point missing or gap found)
- Warning: Operational state is not known for all involved links
- Warning: Administrative state is not known for all involved links

<table>
<thead>
<tr>
<th>Domain</th>
<th>IN2P3 (?)</th>
<th>RENATER (?)</th>
<th>Link Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>EndPoint</td>
<td>ID Part Info</td>
<td>ID Part Info</td>
</tr>
<tr>
<td>Local Name</td>
<td>IN2P3-GRIDKA</td>
<td>RENATER-LYO</td>
<td>IN2P3</td>
</tr>
<tr>
<td>State Oper</td>
<td>-</td>
<td>Up</td>
<td>-</td>
</tr>
<tr>
<td>State Admin</td>
<td>-</td>
<td>Normal Oper.</td>
<td>-</td>
</tr>
<tr>
<td>Timestamp</td>
<td>2007-07-24</td>
<td>11:08:01-0-000</td>
<td></td>
</tr>
</tbody>
</table>

Associated XML Registry Files:

The view is divided into three parts:

- Detailed Alarm Info: This section shows the complete information which is contained also in the SNMP Traps. The root cause for the alarm can be identified by the Mon. Domain and Mon. Entry Name. The timestamps show the time of alarm raise and clearance (if available).

- E2E Link Info: The Alarm Info is focused on the root cause of the Alarm. To give a broader view, the complete context of the E2E Links is shown in the E2E Link Info section. Please note, that this view shows a snapshot of the link at the time of alarm raise.

- Associated XML Registry Files: The E2E Monitoring System generates alarms according to the information received by the Domains. This section gives access to a copy of the NMWG XML data as received by the domains (only the domains affected by the particular alarm are included in this section).
4.9 Configuration

4.9.1 Configuration Files

The central component of E2E Monitoring can be configured via configuration files, usually located in
./G2_E2E_MonitoringSystem/etc:

<table>
<thead>
<tr>
<th>File Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>./G2_E2E_MonSystem_General.conf</td>
<td>This file contain general Mon. System settings.</td>
</tr>
<tr>
<td>./G2_E2E_MonSystem_Domains.conf</td>
<td>This file contain Domain-Specific information (URLs of MPs/MAs).</td>
</tr>
<tr>
<td>./G2_E2E_MonSystem_DomainIDs.txt</td>
<td>This file lists all IDs of known domains. Only the doamin IDs listed in this file are valid.</td>
</tr>
<tr>
<td>./G2_E2E_MonSystem_ProdLinks.txt</td>
<td>This file lists all IDs of E2E Links which are in production.</td>
</tr>
</tbody>
</table>

All files are ASCII text files. A complete specification of the format and the contents is included in the header of the files. Please refer to the files for details.

Changes in the configuration files are automatically reflected in the running system. There is no need to restart the system after changes in configuration files.

4.9.2 AdminGUI

The AdminGUI provides a more comfortable way to editing some configuration settings. In the current release, the AdminGUI provides functionality for:

- Configuration of MPs/MAs (see 4.9.4)
- Configuration of Prod/Non-Prod Links (see 4.2)

The AdminGUI is accessible via URL “AdminGUI.html” in the HTML root directory of E2Emon (please ask your E2Emon administrator for complete path).
4.9.3 Main Settings

In addition to the complete specification in the configuration files, the main settings of the general configuration file (./G2_E2E_MonSystem_General.conf) are explained in the table below. This list is not complete, it is only intended to give an overview:

<table>
<thead>
<tr>
<th>Entry Key</th>
<th>Possible Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOMAINIDS</td>
<td>&lt;&lt;File with Path Specifier (absolute or relative)&gt;&gt;</td>
<td>Filename for list of all valid Domain IDs. If not specified, default value: ../etc/G2_E2E_MonSystem_DomainIDs.txt</td>
</tr>
<tr>
<td>PRODSWITCH</td>
<td>&lt;&lt;TRUE</td>
<td>FALSE&gt;&gt;</td>
</tr>
<tr>
<td>PRODLINKS</td>
<td>&lt;&lt;File with Path Specifier (absolute or relative)&gt;&gt;</td>
<td>Filename for list of E2E Links in production (only relevant if PRODSWITCH=TRUE). If not specified, default value: ../etc/G2_E2E_MonSystem_ProdLinks.txt</td>
</tr>
<tr>
<td>SILOROOT</td>
<td>&lt;&lt;Path (absolute or relative)&gt;&gt;</td>
<td>Automatically generated files for storage of system state will be placed in this directory. If not specified, default value: ..\silo</td>
</tr>
<tr>
<td>REFRESHTIME</td>
<td>&lt;&lt;Time (sec.)&gt;&gt;</td>
<td>Define the interval for polling the MPs/MAs. If not defined, default value: 300 sec. Please ensure that the polling interval is not too short, this could corrupt the statistics.</td>
</tr>
<tr>
<td>HTMLROOT</td>
<td>&lt;&lt;Path (absolute or relative)&gt;&gt;</td>
<td>Generated HTML pages will be stored in HTMLROOT directory. If not specified, default value: ..\html</td>
</tr>
<tr>
<td>TIMESTAMP</td>
<td>&lt;&lt;SHOW</td>
<td>HIDE&gt;&gt;</td>
</tr>
<tr>
<td>ADMINSTATE</td>
<td>&lt;&lt;SHOW</td>
<td>HIDE&gt;&gt;</td>
</tr>
<tr>
<td>STATISTICS</td>
<td>&lt;&lt;SHOW</td>
<td>HIDE&gt;&gt;</td>
</tr>
</tbody>
</table>
### DEMO

| DEMO          | <<TRUE|FALSE>> | If value=TRUE: |
|---------------|---------|---------------|
|               |         | • the installation is marked as a demo or test installation |
|               |         | • the following text is displayed in the start page: “This is just a test box. It is for non-operative purposes only” |

If not specified, default value: FALSE

### LOGFILE

<table>
<thead>
<tr>
<th>LOGFILE</th>
<th>&lt;&lt;File with Path Specifier (absolute or relative)&gt;&gt;</th>
<th>Filename for the log of E2E Monitoring System. If not specified, default value:../G2_E2E_MonitoringSystem.log</th>
</tr>
</thead>
</table>

### MAILSERVER, MAILTO, MAILCC, MAILBCC, MAILFROM, MAILSUBJ

<table>
<thead>
<tr>
<th>MAILSERVER, MAILTO, MAILCC, MAILBCC, MAILFROM, MAILSUBJ</th>
<th>&lt;&lt;Address[:port]&gt;&gt;, &lt;&lt;e-Mail Addr.&gt;&gt;, &lt;&lt;e-Mail Addr.&gt;&gt;, &lt;&lt;e-Mail Addr.&gt;&gt;, &lt;&lt;e-Mail Addr.&gt;&gt;, &lt;&lt;Subject&gt;&gt;</th>
<th>E2E Monitoring System generates e-Mail notifications if a domain's MP/MA is not accessible. If MAILSERVER is not specified, no e-Mail notifications will be sent</th>
</tr>
</thead>
</table>

### SNMPTRAPDEST

<table>
<thead>
<tr>
<th>SNMPTRAPDEST</th>
<th>&lt;&lt;Address[:port]&gt;&gt;</th>
<th>E2E Monitoring System generates a SNMPv2 Trap in the following cases:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>• a change of the operational status of a MonitoredLink is recognized</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• a domain’s MP/MA is not accessible</td>
</tr>
</tbody>
</table>

If SNMPTRAPDEST is not specified, no SNMP traps will be generated. For the generated traps E2EMONNOTIFICATION-MIB is used.

### 4.9.4 Configuration of MPs/MAs

The configuration of the URLs of the MPs and MAs polled by E2Emon can be done in two ways:
- The file \\G2\_E2E\_MonSystem\_Domains.conf can be edited manually. See inline comments in the file for description of the fields. Please note, that the file is overwritten if changes are made via the AdminGUI.

- Via the AdminGUI, which provides user-friendly interactive interface to add, modify or delete the access configuration for MPs/MA(s) (see Figure 26).

### Edit MP/MA List for E2Emon

<table>
<thead>
<tr>
<th>Action</th>
<th>Domain ID</th>
<th>Proxy</th>
<th>URI</th>
<th>Callmode Mail to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delete</td>
<td>CANARIE</td>
<td><a href="http://iack-bar.cern.ch:8081">http://iack-bar.cern.ch:8081</a></td>
<td>G2_E2E_MP</td>
<td>soaplite</td>
</tr>
<tr>
<td>Edit</td>
<td>CERN</td>
<td><a href="http://hec-prdmon.cern.ch:8081">http://hec-prdmon.cern.ch:8081</a></td>
<td>MeasurementArchiveService</td>
<td>doclit</td>
</tr>
<tr>
<td>Delete</td>
<td>CESNET</td>
<td><a href="http://portmon.cesnet.cz:8081">http://portmon.cesnet.cz:8081</a></td>
<td>G2_E2E_MP</td>
<td>soaplite, <a href="mailto:nejman@netflow.cesnet.cz">nejman@netflow.cesnet.cz</a></td>
</tr>
<tr>
<td>Edit</td>
<td>DESY</td>
<td><a href="http://deisa.mp.fz-juelich.de:8081">http://deisa.mp.fz-juelich.de:8081</a></td>
<td>G2_E2E_MP</td>
<td>doclit</td>
</tr>
</tbody>
</table>

**Figure 26 - AdminGUI - Configure MPs/MA(s)**

Please note: To access a E2Emon MP up to release 1.0, please enter URI=G2\_E2E\_MP, Callmode=soaplite.
For newer releases, enter URI=G2\_E2E\_MP, Callmode=doclit.
For SQL MA, enter URI=MeasurementArchiveService, Callmode=doclit.
5 Integration with other Management Tools

This chapter describes how the E2E Monitoring System can be integrated with other System and Network Management Tools like NAGIOS.

Currently, the integration of the E2E Monitoring System with other tools is realized by SNMP and e-Mail notifications. Other interfaces, like a perfSONAR compliant Measurement Archive interface, are planned for the future, but not implemented yet.

5.1 SNMP Notifications

The E2E Monitoring System sends Notifications using SNMP Traps to registered recipients if the Operational State of a Monitored Link changes or a problem with data collection from a domain occurs or is resolved. The complete workflow can be seen in the Figure 27.
The SNMP MIB used is defined in 5.4.

5.2 e-Mail Notifications

The E2E Monitoring System sends an e-Mail Notification to registered recipients if a problem with data collection from a domain occurs. The recipients can be configured individually for each domain as well as for all domains.

Please note: An e-Mail is sent immediately whenever the E2Emon System can not reach a domain MA/MP. Only one e-Mail is sent for every period of unattainability of the MA/MP.
Appendixes

5.3 NMWG Schema for E2E Link Monitoring

See NMWG Schema Developers Guide (URL: http://stout.pc.cis.udel.edu/NMWG/devguide.pdf) for a reference to the syntax used in this chapter.

```xml
# File:    XML_Schema_v03_final.rnc - Schema to describe
#          topological features for DFN.
# Version: $Id$
# Purpose: This file lays out the requirements for the DFN
#          schema.
# Reference: http://books.xmlschemata.org/relaxng/page2.html
#
# ###################################################################
# # The nmwg:message is the first element
# # ###################################################################
start = element nmwg:message {
    MessageContent
}
# ###################################################################
# # Inside of the message, we have a set type
# # a single set of parameters, and then
# # multiple metadata and data blocks.
# # ###################################################################
MessageContent =
    Identifier? &
    attribute type { "E2E_Link_status_information" } &
    MessageParameters &
    MessageMetadata* &
    MessageData*
# ###################################################################
# # The parameters are well known.
```
# MessageParameters =
  element nmwg:parameters {
    attribute id ( "messageId" ) &
    element nmwg:parameter {
      attribute name ( "DomainName" ) &
      xsd:string
    }
  }

# The metadata consists of a single subject
# that contains either a node, or a link
# structure.
#
# MessageMetadata =
  element nmwg:metadata {
    Identifier &
    MetadataIdentifierRef? &
    element nmwg:subject {
      Identifier &
      SubjectIdRef? &
      (MessageNode | MessageLink)
    }
  }

# The node is a lesser version of the
# nmwg version 3 topology node.
#
# MessageNode =
  element nmwgtopo3:node {
    Identifier? &
    NodeIdRef? &
    MessageRole? &
    element nmwgtopo3:name {
      attribute type ( "logical" ) &
      xsd:string
    } &
    element nmwgtopo3:type { xsd:string } &
    element nmwgtopo3:country { xsd:string } &
    element nmwgtopo3:city { xsd:string } &
    element nmwgtopo3:institution { xsd:string } &
    element nmwgtopo3:latitude { xsd:string } &
    element nmwgtopo3:longitude { xsd:string }
  }

```xml
# MessageParameters =
  element nmwg:parameters {
    attribute id ( "messageId" ) &
    element nmwg:parameter {
      attribute name ( "DomainName" ) &
      xsd:string
    }
  }

# The metadata consists of a single subject
# that contains either a node, or a link
# structure.
#
# MessageMetadata =
  element nmwg:metadata {
    Identifier &
    MetadataIdentifierRef? &
    element nmwg:subject {
      Identifier &
      SubjectIdRef? &
      (MessageNode | MessageLink)
    }
  }

# The node is a lesser version of the
# nmwg version 3 topology node.
#
# MessageNode =
  element nmwgtopo3:node {
    Identifier? &
    NodeIdRef? &
    MessageRole? &
    element nmwgtopo3:name {
      attribute type ( "logical" ) &
      xsd:string
    } &
    element nmwgtopo3:type { xsd:string } &
    element nmwgtopo3:country { xsd:string } &
    element nmwgtopo3:city { xsd:string } &
    element nmwgtopo3:institution { xsd:string } &
    element nmwgtopo3:latitude { xsd:string } &
    element nmwgtopo3:longitude { xsd:string }
  }
```
# The link is a lesser version of the
# nmwg version 3, layer 2 link.
#
# MessageLink =
# element nmtl2:link {
#    Identifier? &
#    LinkIdRef? &
#    element nmtl2:type { "DOMAIN_Link" | "ID_Link" | "ID_LinkPartialInfo"} &
#        element nmtl2:name {
#            attribute type { "logical" }? &
#            xsd:string
#        } &
#        element nmtl2:globalName {
#            attribute type { "logical" }? &
#            xsd:string
#        } &
#        (element nmwgtopo3:node {
#            NodeIdRef &
#            (attribute role { "EndPoint" | "DemarcPoint" } |
#            element nmwgtopo3:role { "EndPoint" | "DemarcPoint" })
#        )
#     } &
#     element nmwgtopo3:node {
#        NodeIdRef &
#        (attribute role { "EndPoint" | "DemarcPoint" } |
#        element nmwgtopo3:role { "EndPoint" | "DemarcPoint" })
#     }
# }
#
# The data consists of information wrapped
# in result namespace datums.
#
# MessageData =
# element nmwg:data {
#    Identifier &
#    MetadataIdentifierRef &
#    element ifevt:datum {
#        attribute timeType { "ISO" | "unix" } &
#        attribute timeValue { xsd:string } &
#        element ifevt:stateOper { "Up" | " Degraded" | " Down" | " Unknown" } &
#        element ifevt:stateAdmin { "NormalOperation" | "Maintenance" | "TroubleShooting" | "UnderRepair" | "Unknown" }
#    }
# }
#
# Misc. elements
#
# ####################################

Identifier =
  attribute id { xsd:string }

MetadataIdentifierRef =
  attribute metadataIdRef { xsd:string }

SubjectIdRef =
  attribute subjectIdRef { xsd:string }

LinkIdRef =
  attribute linkIdRef { xsd:string }

NodeIdRef =
  attribute nodeIdRef { xsd:string }

MessageRole =
  ( attribute role { xsd:string } |
    element nmwgtopo3:role { xsd:string } )
5.4 E2E Monitoring SNMP MIB

```markdown
E2EMONNOTIFICATION-MIB DEFINITIONS ::= BEGIN

IMPORTS
   MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE, enterprises,
   Counter32
      FROM SNMPv2-SMI
   TruthValue, DisplayString
      FROM SNMPv2-TC;

DANTE OBJECT IDENTIFIER ::= { enterprises 27262 }

geant2 OBJECT IDENTIFIER ::= { DANTE 1 }

e2eLinkMon OBJECT IDENTIFIER ::= { geant2 1 }

alarmHandoff MODULE-IDENTITY
   LAST-UPDATED "0610240000Z"
   ORGANIZATION "GEANT2 JRA-4 E2E Link Monitoring Development"
   CONTACT-INFO "gn2-jra4@DANTE.org.uk"
   DESCRIPTION "The MIB module for E2E Link Monitoring alarm handoff"
   ::= { e2eLinkMon 1 }

alarmHandoffObjects OBJECT IDENTIFIER ::= { alarmHandoff 1 }

alarmTable OBJECT-TYPE
   SYNTAX  SEQUENCE OF AlarmEntry
   MAX-ACCESS not-accessible
   STATUS current
   DESCRIPTION "The list of currently raised alarms"
   ::= { alarmHandoffObjects 1 }

alarmEntry OBJECT-TYPE
   SYNTAX AlarmEntry
   MAX-ACCESS not-accessible
   STATUS current
   DESCRIPTION "Each entry contains 1 alarm description"
   INDEX { currentAlarmId }
   ::= { alarmTable 1 }

AlarmEntry ::= SEQUENCE {
   AlarmId AlarmId,
   monEntityName DisplayString,
   monEntityType DisplayString,
   eventTime
}```
DisplayString,
stateOper  DisplayString,
additionalInfo  DisplayString,
monDomain  DisplayString
}

AlarmId  OBJECT-TYPE
SYNTAX  AlarmId
MAX-ACCESS  read-only
STATUS  current
DESCRIPTION  "A unique identifier for an alarm"
::= { alarmEntry 1 }

AlarmId ::= Counter32 (1..4294967295)

monEntityName  OBJECT-TYPE
SYNTAX  DisplayString
MAX-ACCESS  read-only
STATUS  current
DESCRIPTION  "The name of the entity in a human readable form"
::= { alarmEntry 2 }

monEntityType  OBJECT-TYPE
SYNTAX  DisplayString
MAX-ACCESS  read-only
STATUS  current
DESCRIPTION  "The type of the failed entity. The perceived types can be:  
Domain,  
DomainLink,  
IDLink,  
PartIDLink"
::= { alarmEntry 3 }

eventTime  OBJECT-TYPE
SYNTAX  DisplayString
MAX-ACCESS  read-only
STATUS  current
DESCRIPTION  "The time the alarm event occurred"
::= { alarmEntry 4 }

stateOper  OBJECT-TYPE
SYNTAX  DisplayString
MAX-ACCESS  read-only
STATUS  current
DESCRIPTION  "The perceived State of the alarm can be one of:  
Down,  
Degraded,  
Unknown,  
Up"
::= { alarmEntry 5 }
additionalInfo OBJECT-TYPE
SYNTAX DisplayString
MAX-ACCESS read-only
STATUS current
DESCRIPTION "Will contain if applicable the e2eLinkID affected by the alarm in the following format e2eLinkID=XXX"
 ::= { alarmEntry 6 }

monDomain OBJECT-TYPE
SYNTAX DisplayString
MAX-ACCESS read-only
STATUS current
DESCRIPTION "Will contain the domain ID where the failure occurred"
 ::= { alarmEntry 7 }

alarmHandoffTraps OBJECT IDENTIFIER ::= { alarmHandoff 2 }

alarmRaise NOTIFICATION-TYPE
OBJECTS { AlarmId, monEntityName, monEntityType, eventTime, stateOper, additionalInfo, monDomain }
STATUS current
DESCRIPTION "Notification that an alarm is currently active"
 ::= { alarmHandoffTraps 1 }

alarmClear NOTIFICATION-TYPE
OBJECTS { AlarmId, monEntityName, monEntityType, eventTime }
STATUS current
DESCRIPTION "Notification that an alarm has been cleared"
 ::= { alarmHandoffTraps 2 }