

## Operational Model for E2E links in the NREN/GÉANT2 and NREN/Cross-Border-Fibre supplied optical platform

### 0 Background

In the GÉANT2 project plan it is foreseen that end-to-end (E2E) links (essentially circuits) built on the basis of NREN/GÉANT2 fibre and respective equipment (with dedicated interfaces to terminate the links) can be ordered by institutions through their NRENs. The most prominent usage examples are links for the LCG network (see /1/) or for the DEISA network. LCG has (or will soon have) its own Operations Centre and its own User Help Desk, called the GGUS. Basic concepts and definitions of the terminology are specified in /2/. Within LCG it is envisaged that it is possible to implement another entity, which is the operational interface of the GGUS to the data networks. For the implementation of this entity, which will be called the E2E coordination unit (E2ECU), the NRENs and GÉANT2 must each make available status and/or performance information of their respective portion of an E2E link for the LCG network they provide.

In case of problems (including network problems) end users will always call the entity within the LCG operations structure, the GGUS. They will in general call the GGUS and not the E2ECU. This means that such problem taken up by the GGUS must be communicated (via the E2ECU) to the NRENs or GÉANT2.

As a complement to these NREN/GÉANT2 links other kinds of link will be established on top of so called Cross Border Fibre (CBF). CBF is fibre between two neighbouring NRENs which may also be concatenated with NREN links and/or other CBF. Through this mechanism it is possible for NRENs to collectively access a wide area optical network infrastructure that will, for the most part, be physically diverse from the GÉANT2 fibre footprint and over which E2E links can be provisioned.

**Both types of links are called E2E links in the following paper** as they happen to be logically the same.

It is expected that several hundred such E2E links have to be supplied from the GÉANT2 consortium. It is therefore obvious that there is a strong necessity for an operational model for that specific usage of the NREN/GÉANT2 and NREN/CBF supplied (optical) platform.

The following paper deals with operational problems of such constructs and it is restricted to links built directly from that optical platform, i.e. it does not cover E2E links provided through the IP platform. As mentioned, the operational model has to be integrated into concepts for GRID operations as GRID operations demand certain information about network operations.

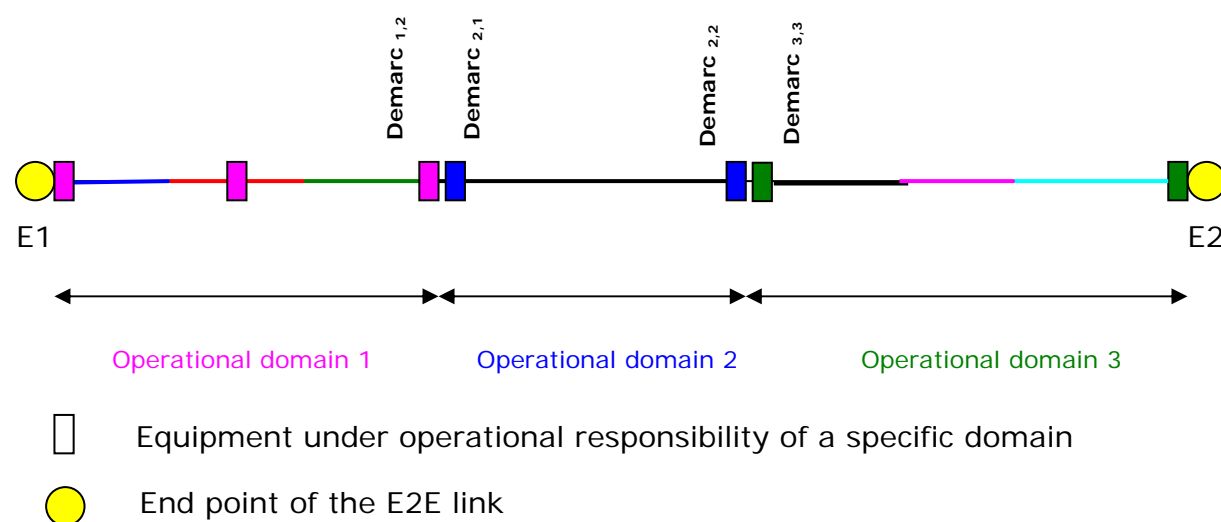
### 1 Problem Definition

The general structure of an E2E link from an endpoint (E1) to another endpoint (E2) is shown in figure 1, where the domains indicate the operational responsibility for the optical equipment. Each domain is delimited by a well defined number of demarcation points in the following text called demarc(s). A demarc labels (in general) the location where the WDM equipment of two domains are placed (back-to-back) and has two indices. These labels describe in a unique way the

domain (1st index) and the demarc location within the domain (2<sup>nd</sup> index). The link between these two demarcs (labelled as an Interdomain Link) may in most cases be a patch cable between DWDM equipment, but it could be a router-router or switch-switch link as well. The responsibility for the status monitoring of this Interdomain Link will be assigned to one of the involved NRENs. This responsible NREN will then be expected to deliver the status of the Interdomain Link to the E2ECU in a commonly agreed way.

The maintenance responsibility of an Interdomain Link is likely to be arranged in a different manner. Typically each of the NRENs will be responsible for the patching up to a pre-defined optical patch panel. There would then be a short optical patch between the bulkhead connectors in the optical patch panels. (This patching may actually be longer than a few metres (and traverse a number of intervening bulkhead connectors) if it has to be done in a “meet me” room within a collocation facility. In such a setup the responsibility for this patching may lie with the collocation provider. Even then, the collocation provider is unlikely to be actively monitoring such patches so it will be the responsibility of one (or both) of the NRENs to instigate corrective action should a break occur in this patching.

Different colours for the fibre within an operational domain indicate possibly concatenated fibres which may be provided by different fibre providers within that domain.



**Figure 1:** Structure of E2E links

A domain is an area of operational responsibility with a homogenous operational concept. Operational functions of that kind are described in GÉANT2 as a so called “Thin NOC” (TNOc). TNOcs have to ensure that the parameters which are described in /4/, especially in paragraph 4 “Maintenance agreements”, are met. GÉANT2 has its own TNOc.

A multi-domain environment means that an E2E-link is implemented within concatenated domains. Because of the multiplicity of operational responsibilities there is a need to have a coordination function on top of all domains which is in addition able to give a view on the operational status of the entire E2E-link and is

able to give special views of all those links, which belong to a special project (or VPN) like the LCG network or the DEISA network.

The concept can be extended to environments with more than three domains, scenarios which may come up in the international context.

## **2 Related Work**

There is partially ongoing work in several projects on similar topics:

- DJ.1.2.1 GÉANT2 General Monitoring Framework /5/, which is dealing among other things with the problem how to monitor performance data of links and how to efficiently store and retrieve such monitoring data.
- EGEE ENOC concept /3/, which describes an IP based NOC-like concept for the EGEE infrastructure and how to embed this ENOC within Grid Operations Concept, i.e. GGUS.
- LCG GGUS /3/, which is under construction and describes an operational concept especially for the LCG-network in collaboration with the GGUS.
- TEN-155 External Operational Procedures for the TEN-155 Managed Bandwidth Service OPS-99-071, 2 August 1999, DANTE. This paper describes the workflows for the management of E2E links in an ATM multi domain environment. However the concepts documented in this paper must be considered with care as a different problem is described. Unlike in the GÉANT2/CBF environment the TEN-155 multi domain problem always assumed that a specific domain (the TEN-155 domain) used by any E2E-link. Furthermore the set-up times for the TEN-155 links were quite different from the GÉANT2/CBF based links. While in TEN-155 the set-up times were in the order of hours, this is not true for the problem to be dealt with – in the case discussed here it is in the order of several weeks. Finally within the TEN-155 environment it was necessary to check the bandwidth available for the E2E link(s) at a quite low level (20% of total bandwidth available). In the case to be dealt with, the equipment limits available number of wavelengths over a fibre.

The results of these pieces of work have to be taken into account for the concept of an operational model for E2E links within the GÉANT2 programme.

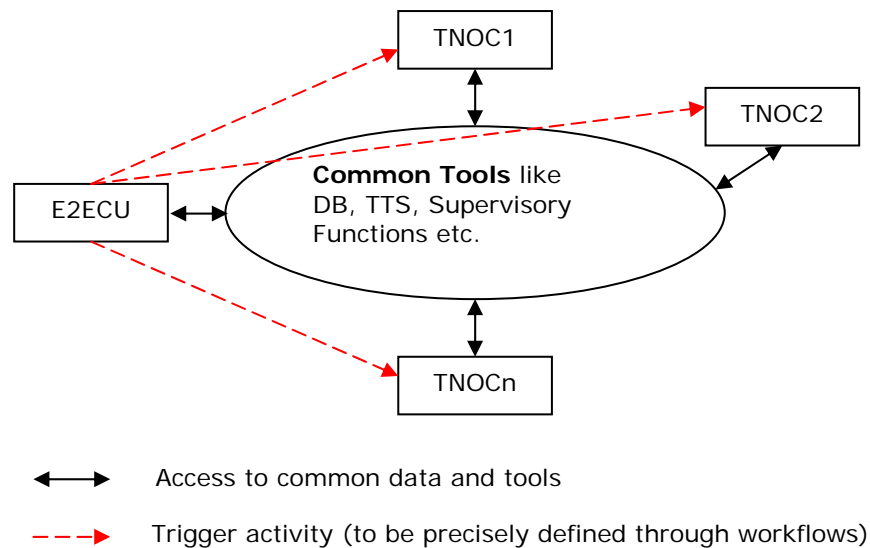
## **3 Basic functions for E2E link operation**

The basic functions for operating E2E links are:

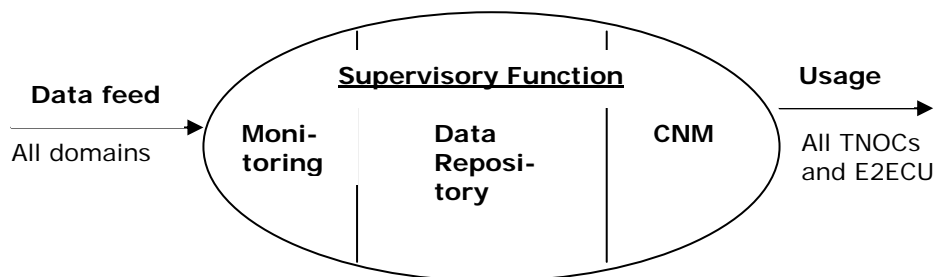
- Establishment and shut-down of E2E links
- Supervision of any E2E link by monitoring and archiving operational data from the link at all demarcs and end points of the E2E-link on a 24/7 basis (monitoring and archiving function)
- Trigger necessary activities for example repair, filling the trouble ticket systems (TTS) with information etc. (activity trigger function) based on the information taken from the monitoring data
- Giving necessary feedback to GRID operational structures if an E2E link is provided for that purpose

These functions have to be drawn from and integrated into the multi-domain environment.

The interaction between different entities involved in the operation of E2E links are given in figures 2a and 2b.



**Figure 2a:** Basic Building Blocks for E2E operations



**Figure 2b:** Data feed and usage of the supervisory function

#### 4 The Concept

In order to design the operational model for the operation of E2E links the following assumptions are made:

- Rights and duties will be acknowledged by all NRENS and DANTE supplying E2E-links by appropriate means (MoU...)
- Every domain is able to deliver through a TNOc like system semantically consistent monitoring information about the operational status (e.g. up/down) of the domain specific part of an E2E link to the coordinating operational entity, called E2ECU. See also /4/, specifically the paragraph on monitoring.

- Through workflow definitions every TNOc can be triggered by the E2ECU to perform necessary activities, like repair of broken equipment etc.
- All workflows between the different operational entities have to be defined and documented.

The first step is the installation of an E2ECU, which operates an own Trouble Ticket System (TTS). This TTS is NOT coupled with any other TTS of the TNOcs. This is justified if a certain number of Trouble Tickets per link and year is assumed. The E2ECU "owns" Trouble Tickets reported by either GGUS or TNOcs until they have been resolved within the domains. The E2ECU will access status information from the domains the E2E links are implemented on.

To give all necessary information on E2E links to the E2ECU, a data model for E2E links has to be defined. A database (DB) of all parts of all active E2E links or all E2E links which are in the establishment / shut-down phase with their technical and administrative data has to be put in place. This is described in more detail in /6/.

A precise definition of workflows between the E2ECU and the TNOcs has to be put in place to get this information and to trigger necessary activities to be performed in case of network failures.

For progressing repairs, procedures for escalation, feedback procedures from the TNOcs have to be established.

The E2ECU has to deliver information about the E2E-links to the application specific user support units (like GGUS).

## 5 Terminology and Background Papers

**LCG:** LHC Computing Grid

**TNOc:** A Network Operation Center, specifically designed for the provision of an optical platform within one (single) domain.

**GGUS:** Global Grid User Support, the concept for LCG operations support as documented in /2/

**ENOC:** Network Co-ordination Centre as documented in the EGEE document /3/. It is the provision of a function or service for the co-ordination of the activities of a set of NOCs involved in the implementation and operation of an Optical Private Network (OPN). The reference paper describes a service which has to be upgraded for OPNs as it provides at present only IP related functions. In this context it is called end-to-end coordination unit (E2ECU).

/1/ "LHC high-level network architecture" document  
(Version 1.9, 17 June 2005)

/2/ „LHC Computing Grid – Technical Design Report“  
(Version 1.04, 20 June 2005)

<http://cern.ch/lcg/tdr>

- /3/ „EGEE: Operational Interface between EGEE and GÉANT/NRENs“, 21.04.05  
<http://edms.cern.ch/document/565449>
- /4/ „Engineering Requirements and Rules for Cross-Border Implementations“  
<http://wiki.geant2.net/bin/view/JRA4/DmsDocCBFEngReqsRules>
- /5/ DJ.1.2.1 GÉANT2 General Monitoring Framework,  
<http://monstera.man.poznan.pl/jra1-wiki/images/9/95/GN2-05-057v5.pdf>
- /6/ End-to-end link Data Model  
<http://wiki.geant2.net/bin/view/JRA4/DmsDocGN2JRA406017>  
<http://wiki.geant2.net/bin/view/JRA4/DmsDocE2ELinkDataModel>