LHC Optical Private Network Operational Handbook

Revision 1.14.1, 2008/03/06

Contents

1 Introduction

This handbook is designed to document the operational procedures followed by the Routers Operators (R-Op), the Grid Operations Managers (Grid-OM), and the LHCOPN Coordination Unit (LCU) to operate the IP service delivered by the LHCOPN. These terms are described in the following sections. Operations of the links composing the optical backbone, are co-ordinated by the End-to-End Co-ordination Unit (E2ECU) which are described in a sister document
[FIXME: find a placeholder for the E2ECU Operations Handbook].

This handbook was elaborated by many involved entities. The working group could be contacted about these procedures at this e-mail addresse.

2 Introduction to the LHCOPN

The LHCOPN is the network that interconnects the Tier-0 site (CERN) and the eleven Tier-1 sites across Europe, North America, and Asia. This network will carry the multi-gigabit streams of data produced at CERN by the LHC experiments in order to transfer them out of the temporary storage at CERN to the permanent storage at the Tier-1 sites.

Transferring data from the Tier-0 to the Tier-1s is the primary goal of the LHCOPN. Therefore resiliency is included in order to prevent a site from isolation by single link failure. All LHCOPN links can be used for Tier-1 to Tier-1 traffic as long as the primary goal stated above is not jeopardized. The LHCOPN is mission-critical in supporting the LHC experiment analysis. As such the network is designed for 24×7 operations wherever possible with rapid problem diagnosis and restoration, supporting high speed data transport between the Tier-0 and Tier-1 sites.

This network consists of dedicated point-to-point links between twelve sites (their names are listed in section 6.1). Links between Tier-1 and Tier-2 sites are not part of the LHCOPN hence this document does not cover them. The majority of the LHCOPN links has a 10 Gbit/s capacity and is supported by the NRENs' infrastructure in Europe, North America and Asia. For a detailed technical description of the LHCOPN, the reader shall consult the LHCOPN Wiki.

3 LCG Service Quality and Requirements

Some basic assumptions about the service quality of LCG are documented in the LCG MoU[1] agreed by the Tier-0 and the Tier-1s sites. The constraints put on the networking part in this document are the following:

Tier-0 Networking service to Tier-1 Centres during accelerator operation (Annex 3.1, p. A3.2):

- Maximum delay in responding to operational problems:
  - Service interruption : 6 hours
  - Degradation of the capacity of the service by more than 50% : 6 hours
  - Degradation of the capacity of the service by more than 20% : 12 hours
- Average availability (= time running/scheduled up-time) measured on an annual basis:
  - During accelerator operation: 99%
  - At all other times: n/a

Tier-1 Networking service to the Tier-0 Centre during accelerator operation (Annex 3.2, p. A3.4):

- Maximum delay in responding to operational problems:
  - Service interruption : 12 hours
  - Degradation of the capacity of the service by more than 50% : 24 hours
  - Degradation of the capacity of the service by more than 20% : 48 hours
- Average availability (= time running/scheduled up-time) measured on an annual basis:
  - During accelerator operation: 98%
  - At all other times: n/a

Delays hereby specified certainly need to be better defined. We currently assumed that these are delays to acknowledge the trouble, do some first investigations and initiate the first actions (they will be further defined in the sections below). Concerning the level of service degradation, we shall assume that this means a degradation in the transfer performance (fraction of the average achievable bandwidth under normal conditions over the same link). Concerning availability, the metrics and how they will be gathered will be further defined in section 7.

4 Operational Model and Roles

4.1 Operational Model

In the LHCOPN Operational Model, the following entities have been identified:

- E2E Coordination Unit (E2ECU)
- LHCOPN Coordination Unit (LCU)
- Routers Operators (R-Ops)
- Grid Operations Managers (Grid-OMs).

Functions	Operation	Centralisation
Data movements applications	Grid-OM	
IP service	R-Ops	LCU
E2E links	Research networks	E2ECU

Table 1: Operational entities and associated functions

With regard to the associated functions, the situation is summarized on table 1:

The roles and functions of these different entities are elaborated in the following sections. The possible communications between them are depicted in figure 1 below. For the sake of completeness, the NRENs NOCs and the other organization responsible for the monitoring of the physical network of the LHCOPN are also shown on this figure although the procedures for this monitoring are out of the scope of this document. The interactions between those and the E2ECU are detailed in the E2ECU Operations Handbook [FIXME: find a placeholder for the E2ECU Operations Handbook] .

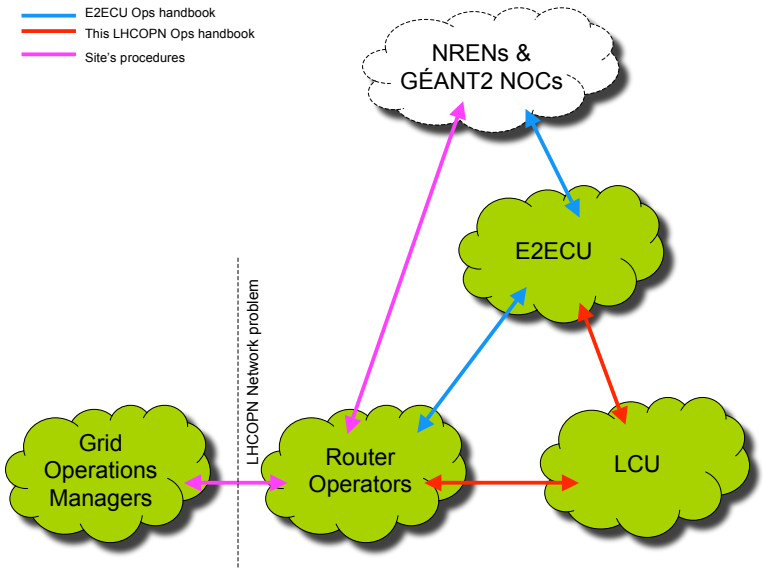

Figure 1: Entities involved in the LHCOPN operations

4.2 Grid Operations Managers

The Grid users must nominate persons who act in the role of Grid Operation Managers (for instance the data manager of the experiment). In the operational model, the Grid Operations Managers (Grid-OM) play the role of the LHCOPN users. The Grid-OMs are considered to be one seamless user community without differentiating between specific groups. As a group they represent the interests of all the Grid users. A Grid-OM is under the responsibility of a particular T1.

The functions of the Grid Operations Managers assumed in this paper in respect to LHCOPN are the following:

- Separate applicative problems from networks problems
  [FIXME: Step done by Grid-OMs?, R-Ops, both ?]
- Report networks problems to Router Operators on its site
- Act as the sole contact point for LHCOPN related issues
- Receive updates about network problems and broadcast impact to Grid community

[1] Version of the 2nd of August 2007

The interface used by the Grid-OM is expected to be GGUS[2] (Global Grid User Support) as the Trouble Ticketing System (TTS). It implies that the interactions with other entities take place in GGUS. It would also seem practical that the logging of incident resolutions and maintenance notices are done in GGUS

4.3 Router Operators

Router Operators (R-Op) are responsible for the network equipments connecting T0/T1 to the LHCOPN. They are the ones able to modify the router configurations. They are also responsible for the part of the monitoring framework at their site required for the operations of the whole service.

The "Router Operator" role is often implemented in the T0/T1 NOCs. Exceptions exist however where the responsible entity of the router lies also in another domain. Their functions are:

- Receive incident/maintenance reports from Grid-OM, E2ECU or LCU and perform impact assessment
- State if problem is under their responsibility or not
- Act in case they are responsible (even partially) in the causes, following the agreed procedures
- Notify the LCU and/or E2ECU of any likely incident they detect (under their responsibility or not) or maintenance they schedule to carry out on the LHCOPN
- Maintain parts of the monitoring framework they are responsible for (located at their sites)

4.4 End-to-End Coordination Unit (E2ECU)

From the perspective of the LHCOPN, the physical layer[3] is handled by the E2ECU whose functions are:

- Supervision and Fault detection on end-to-end links
- Manage a ticket system to easily share information between involved entities
- Fault/maintenance announcement via Trouble Ticket distribution to R-Op and LCU
- Interact with all parties to ensure resolution of network incidents
- Provision of monthly reports to NREN NOCs, E2E links providers and LCU

The E2ECU already exists (implemented by DANTE) and is shared between various projects (DEISA, IGTMD, LHCOPN, USCMS...) using e2e links. For more information, see the E2ECU Operational Handbook [FIXME: find a placeholder for the E2ECU Operations Handbook] .

4.5 LHCOPN Coordination Unit (LCU)

The LCU serves as a concentration point. Its functions are:

- Receive and summarize LHCOPN status from monitoring information
- Centralize information about LHCOPN incidents and maintenances tracking
- Send incident reports to R-Op and E2ECU if problem is not yet reported
- [FIXME: Follow-up LHCOPN tickets resolution? How light will be LCU's role?]
- Produce metrics and periodic reports
- Broadcast maintenance to E2ECU and to R-Op

The LCU is the central point where all the LHCOPN operational information is gathered. As such, any action taken during an incident or maintenance should be reported to the LCU so that it is able to log them and produce further metrics. It is also mandatory in case of post-mortem analysis where the gathered information should help in the understanding of a malfunction.

[2] http://www.ggus.org/

[3] Currently this is restricted to Tier-0/Tier-1 links and Tier-1/Tier-1. Tier-1/Tier-2 links, where they exist, are not monitored by the E2ECU

4.6 Classification of Incidents and Maintenances

Below are described the different possible problems classified by their primary sources.

- Incident reported by a Grid-OM
- Incidents reported by an R-Op
- Scheduled maintenance planned by an R-Op
- Incident reported by the E2ECU
- Scheduled maintenance reported by the E2ECU
- Incident detected by the LCU e.g. by means of monitoring tools

5 Procedures of Incidents and Maintenances handling

We elaborate here the procedures a given entity must follow for every classes of troubles relevant to it.

5.1 Grid Operations Managers

The Grid-OMs are a particular case since they are part of procedures as a troubles notices source. As such, they have no detailed procedure to follow. When a problem is supposed to involve the LHCOPN they will contact its local R-Op giving at least following information:

- The location of the incident (name of the end-sites and hosts involved - see section 6.1 for official sitenames)
- The date and time the incident was detected
- The date and time the incident is supposed to have begun
- The kind of impact (absence of connectivity, minor performance issue, severe performance issue)
- A detailed description of the problem

Grid-OMs should always be kept informed of the impact of incidents on the service (this is the responsibility of the R-Ops). They must also be prepared to interact in a timely manner with R-Ops for problem confirmation, analysis, and for solution confirmation.

5.2 The Routers Operators

[FIXME: All Grid-OMs should be warned by R-Op or only the local?]

5.2.1 Incident reported by Grid-OMs

In case of an incident reported by Grid-OM the **local R-Op** will first check problem is LHCOPN related. If confirmed, the procedure to follow is similar to those described in section 5.2.2 below.

5.2.2 Incident detected by the R-Op

In case of an incident detected by a R-Op, the R-Op must open a ticket in the TTS describing as much as possible the incident. Incident can concern routers and all the equipments participating in the running and operations of the IP service (for instance the monitoring framework). The necessary information to be sent is the following:

```
Type: Incident
Status: ['Opened', 'Updated', 'Closed']
Location: [Name of the end-sites and/or Links]
Ticket_Opened_Date: [AAAA-MM-DD HH:MM:SS ZZ]
Problem_Start: [AAAA-MM-DD HH:MM:SS ZZ]
Problem_End: [AAAA-MM-DD HH:MM:SS ZZ]
Ticket_Closed_date: [AAAA-MM-DD HH:MM:SS ZZ]
Impact: [List of impacted link IDs/sites]
Priority: ['Low', 'Medium', 'High']
```

```
Kind_of_Impact: ['None', 'Connectivity', 'Perf', 'Severe Perf',
 'Minor Perf', 'Unknown']
Description : [Free text]
```

The list of official link IDs and sitenames could be found in section 6.2.

The difference between `Ticket_Opened_Date` and `Problem_Start` is that the `Ticket_Opened_Date` is the date when the incident was detected (should be automaticaly linked to the opening date of the ticket by the TTS) while the `Problem_Start` is the moment when the impact starts (beginning of the service disruption). The same distinction applies for `Ticket_Closed_Date` and `Problem_End`.

The ticket will then be assigned by LCU to the relevant R-Ops. The LCU and maybe the E2ECU will be added to the recipients list.

5.2.3 Scheduled maintenance reported by the R-Op

To schedule a maintenance or update an already scheduled one, the R-Op must create a ticket assigned to the LCU. Maintenance creation or update must happen five working days before `Ticket_Opened_Date`. Maintenance can concern routers and all the equipments participating in the running and operations of the IP service (for instance the monitoring framework). The necessary information to be sent is the following:

```
Type: Maintenance
Status: ['Opened', 'Updated', 'Closed']
Location: [Name of the end-sites]
Ticket_Opened_Date: [AAAA-MM-DD HH:MM:SS ZZ]
Problem_Start: [AAAA-MM-DD HH:MM:SS ZZ]
Ticket_Closed_Date: [AAAA-MM-DD HH:MM:SS ZZ]
Problem_End: [AAAA-MM-DD HH:MM:SS ZZ]
Impact: [List of impacted link IDs/sites]
Priority: ['Low', 'Medium', 'High']
Kind_of_Impact: ['None', 'Connectivity', 'Perf', 'Severe Perf',
                 'Minor Perf', 'Unknown']
Description : [Free text]
```

The list of official link IDs and sitenames could be found in section 6.2.

The same comments as those in end of previous section applie for theses field.

The LCU will then broadcast the maintenance to E2ECU if the maintenance has an impact on L2 and to all T1s R-Ops.

Thus E2ECU could mute alarms on element involved, an R-Ops could warn local Grid-OMs if needed.

5.2.4 Incident reported by the E2ECU

[FIXME: Should R-Ops receive incidents directly from E2ECU or should LCU forwards relevant to it ?]

Incident are send from the E2ECU to all R-Ops to warn then, particularly to help them understanding some alarms that could be raised and to give them a planned resolution time with the supposed impacted path.

When an incident having an impact is reported, the R-Ops will notify the Grid-OMs.

5.2.5 Scheduled maintenance reported by the E2ECU

The R-Ops should not receive directly maintenance from the E2ECU, but through the LCU.

5.2.6 Incident reported by the LCU

R-Ops could also be directly contacted by the E2ECU as discussed in previous section 5.2.4.

1. The R-Op receives a ticket from the LCU regarding an incident involving the equipment under its responsibility.
2. The R-Op checks if he can confirm the incident lies under its responsibility:

- If no, the R-Op replies to the LCU that it is not involved and the process stops here, provided that further investigations are not required by the LCU. The ticket will be re-assigned by the LCU.
- If yes, the process goes on with the next step ;

3. The R-Op starts its own internal resolution process and keep the LCU, Grid-OMs (and maybe E2ECU) informed as soon as some progresses are made with regards to the incident and in any case not after four hours after the last notice on the incident. The E2ECU should be included in the process only if the trouble has a L2 impact.

4. As soon as the incident is solved, the R-Op informs the LCU, Grid-OMs (and maybe E2ECU).

5.2.7 Scheduled maintenance received from the LCU

When the R-Op receives a scheduled maintenance from LCU it will perform impact analysis and warn Grid-OM about service consequences.

5.3 The End-to-End Coordination Unit

From the point of view of this document, it is seen as a source of incident and maintenance notices. In that respect, necessary procedures are described in the E2ECU Operational Handbook.
[FIXME: find a placeholder for the E2ECU Operations Handbook] .

E2ECU will send incident and maintenance notices to LCU. The LCU is responsible to broadcast maintenances and incident to involved entities, regarding if outages are L2 or L3 and what should be the impact.
[FIXME: should every R-Ops being also receiving all E2ECU's tickets?]

5.4 The LHCOPN Coordination Unit

5.4.1 Scheduled maintenance reported by a Router Operator

1. The R-Op opens a ticket with the "Type of problem" set to "LHCOPN", specifying the maintenance time window (start and end date), the impacted sites and the likely impact on the service. The ticket is then automaticaly assigned to the LCU;

2. The LCU checks that there is not an already planned maintenance conflicting with the new maintenance (for instance, two concurrent maintenances affecting both the primary and the backup links of a site):

   - If the time window is correct, the process goes on with the next step;
   - If there is a conflict, the LCU updates the ticket to warn the R-Op about the likely conflict.

3. The LCU will broadcast maintenance to all R-Ops and to E2ECU if it impacts L2. It is then up to the R-Op to warn the local Grid-OM.

4. A reminder is sent by the LCU before the maintenance starts and it reassign the ticket to the R-Op.

5. The R-Op closes the ticket as soon as the maintenance ends and updates it to summarize the outcome of the maintenance.

The same procedure applies when a maintenance window is changed, except that the existing ticket is updated with the new information rather than opened at step 1. In order to simplify this procedure, the LCU shall maintain an agenda of all the announced maintenances in order for the R-Ops to better planned their own changes and for the Grid-OMs to have a better view of the planned work on the LHCOPN.

5.4.2 Incident reported by an R-Op

1. The R-Op requests a Trouble Ticket is opened describing the problem and with the "Type of problem" set to "LHCOPN" ;

2. The ticket is automaticaly assigned to the LCU;

3. The LCU checks if the incident is a new problem or a known error:

- If it is a known error (for instance, a scheduled maintenance), the LCU replies with the reference to the existing ticket in the ticketing system, or gives a short solution or the reference to an existing documentation giving a solution, and then closes the ticket (status set to "solved"). The process stops here as the ticket is closed. However, the requester can ask for further investigations if is not satisfied with the solution. In that case, the process restart at the beginning ;
- If it's a new problem, the process goes on with the next step ;

4. The LCU assigns the ticket to the R-Op involved in the incident who now owns the responsibility of the incident. The ticket could also be assigned or linked to one of the E2ECU if problems is not under R-Ops responsibility.

5. The LCU monitors the ticket in the TTS while the R-Op updates the ticket regularly according to the resolution progress. The LCU might ask periodically for updates if the ticket remains unmodified during a defined period ([FIXME: 4 hours]).

6. A final notice is send to the initial requester as soon as the incident is solved.

5.4.3 Incident detected by the LCU

1. The LCU detects an incident, for instance by receiving an alarm from the alarm system or by detecting an unexpected behavior on the monitoring tools ;

2. The LCU checks if the incident is a new problem or a known error:

   - If it is a known error (for instance, a scheduled maintenance), the process stops here ;
   - If it's a new problem, the LCU creates a ticket ;

3. The process goes on like previously starting step 4 in section 5.4.2.

If the incident is supposed to lie at the link layer, it might be more efficient the LCU contacts directly the E2ECU rather than going through the R-Ops of the involved sites: if this is seen as an optimization in the near future, it might be implemented.

This procedure also applies when a ticket created in the TTS is wrongly assigned to a support entity. In that case, the LCU should be seen as the default "catch-all" entity for tickets related to the LHCOPN and the ticket will be assigned to the LCU for investigations and re-assignment to the right entity.

5.4.4 Scheduled maintenance reported by the E2ECU

1. The E2ECU sends a notice about a scheduled maintenance to the LCU. The notice contains at least the start and end date of the maintenance window, the name of the domain performing the maintenance, the impacted Monitored Link (Domain or Inter-Domain Link), and the global end-to-end link name itself. The type of impact will be stated but it is usually a loss of connectivity. The notice will include the E2ECU (and any other known) ticket number.

2. The LCU checks if the notice is the first one about this maintenance or if it is an update of an existing one:

   - If it is a unknown maintenance, the LCU creates a ticket into the TTS;
   - If the maintenance has already been reported, the existing ticket will be used ;

3. The LCU checks the impact of the maintenance (or its update) on the service (impacted sites, usage of a backup path, service degradation...) and fill in its diagnosis in the ticket ;

4. R-Ops and Grid-OMs are added to the recipients list of the ticket.

In order to simplify this procedure, the LCU shall maintain an agenda of all the announced maintenances in order for the R-Ops to better planned their own changes and for the Grid-OMs to have a better view of the planned work on the LHCOPN. An automatic reminder shall also be sent to the relevant recipients sometime before the maintenance starts, if found useful.

5.4.5 Incident reported by the E2ECU

1. The E2ECU sends a notice about an incident to the LCU. The notice contains at least the start date the incident was detected, the name of the domain(s) where the fault lies, the impacted Monitored Link (Domain or Inter-Domain Link), and the global end-to-end link name itself. The type of impact will be stated but it is usually a loss of connectivity. The notice will include the E2ECU (and any other known) ticket number.
2. The LCU checks if the notice is the first one about this incident or if it is an update of an existing one:
   - If it is a unknown incident, the LCU creates a ticket into the TTS. All R-Ops will then be warned of the outage.
   - If the incident has already been reported, the existing ticket will be used ;
3. The LCU checks the impact of the incident (or its update) on the service (impacted sites, usage of a backup path, service degradation...) and fill in its diagnosis in the ticket ;
4. All affected R-Ops are added to the recipients list. It is then up to the R-Ops to warn Grid-OMs.

6 Naming conventions

It is very important to have every entity using the same naming conventions, this leverages possiblities for automation of some tasks (ticket assignement ...).

The up to date main list could be be found here, relevant content for this handbook is summarized below.

6.1 Sitenames

The official sitename list is following:

CH-CERN	CA-TRIUMF	DE-KIT
ES-PIC	FR-CCIN2P3	IT-INFN-CNAF
NDGF	NL-T1	TW-ASGC
UK-T1-RAL	US-FNAL-CMS	US-T1-BNL

Table 2: Official names for T0/T1 sites

6.2 Links IDs

The official end to end link IDs for links composing the LHCOPN are shown below:

CERN-CNAF-LHCOPN-001	CERN-SARA-LHCOPN-001	CERN-GRIDKA-LHCOPN-001
CERN-RAL-LHCOPN-001	CNAF-GRIDKA-LHCOPN-001	CERN-FERMI-LHCOPN-001
CERN-FERMI-LHCOPN-002	CERN-BNL-LHCOPN-001	CERN-BNL-LHCOPN-002
GRIDKA-SARA-LHCOPN-001	BNL-FERMI-LHCOPN-001	BNL-FERMI-LHCOPN-002
CERN-IN2P3-LHCOPN-001	GRIDKA-IN2P3-LHCOPN-001	CERN-SARA-LHCOPN-002
CERN-SARA-LHCOPN-003	CERN-SARA-LHCOPN-004	CERN-PIC-LHCOPN-001
CERN-TRIUMF-LHCOPN-001	CERN-TRIUMF-LHCOPN-002	CERN-ASGC-LHCOPN-001
CERN-ASGC-LHCOPN-002		

Table 3: Official IDs for links part of the LHCOPN

7 Measurements & Metrics

We define here a few measurements and metrics. The LCU is responsible to produce those metrics. However the analysis and follow-up is out of the scope of the LCU. Every indicator will be produced for the whole LHCOPN and per link constituting the LHCOPN. This list of metrics will be further elaborated according to requirements and further availability of measurements.

The following ticket metrics are aimed at assessing the quality of the LHCOPN operations. The measurements are based on the data filled in the tickets and are relevant for any single ticket. We are also using fields that are automatically gathered by the ticketing system, such as `Ticket_Opened_Date`, `Ticket_Closed_Date`, and `Requester` (obtained via the certificate DN for instance). For each metric, the LCU will produce a range of indicators, like the average, maximum or minimum (depending on the relevance), over a particular period $\mathscr{P}$(one month, 3 month, 1 year, *etc.*) and per support entity (when relevant). Indicators are computed over the set of tickets that have a `Problem_Start` **and** `Problem_End` **and** that are closed in the considered period $\mathscr{P}$.

TimeToDetect In case of incident, this is the difference between `Ticket_Opened_Date` and `Problem_Start`. It reflects the time needed to detect the Incident

AdvancedNotice In case of maintenance, this is the difference between `Ticket_Opened_Date` and `Problem_Start`. It reflects the delay between the maintenance notice and the maintenance start.

TimeToRepair In case of incident, this is the difference between `Problem_Start` and `Problem_End`. This is the time to fix the incident. The ticket might remained opened longer, for instance to monitor the affected components after resolution.

ChangeDuration In case of maintenance, this is the difference between `Problem_Start` and `Problem_End`. It reflects the duration of maintenance window.

TimeToRespond In case of incident, this is the difference between `Ticket_Opened_Date` and the date of the first update of the ticket. It reflects the time the first contacted entity takes to respond to a request.

TicketOpeningTime This is the difference between `Ticket_Opened_Date` and `Ticket_Closed_Date`. This is an indicator for how long a ticket remains opened.

The following set of metrics are required to measure LHCOPN availability according to LCG MoU (see section 3). They are derived from the previously defined metrics. The coherence of the results will be checked against the monitoring framework.

TotalTime It is the total time of the considered period.

Runtime It is the total time the LHCOPN was foreseen to run over the considered period.. It consists of the TotalTime minus the duration of scheduled maintenances as reported to the LCU.

$$\mathsf{Runtime} = \mathsf{TotalTime} - \sum_{\text{tickets} \in \mathscr{P}} \mathsf{ChangeDuration}$$

Uptime It is the total time the LHCOPN run over the considered period. It consists of the Runtime minus the duration of the incidents as reported to the LCU.

$$\mathsf{UpTime} = \mathsf{RunTime} - \sum_{\text{tickets} \in \mathscr{P}} \mathsf{TimeToRepair}$$

Availability The Availability is the fraction of the Runtime the LHCOPN was up over the considered period. This matches with the availability definition in the LCG MoU (see section 3).

$$\mathsf{Availability} = \frac{\mathsf{Uptime}}{\mathsf{Runtime}}$$

The LCU will also produced the following set of metrics over different periods of time:

- Number of incidents per link constituting the LHCOPN;
- Number of maintenances per link constituting the LHCOPN;
- Number of maintenances announced after the time limit per source (E2ECU and R-Ops);
- Number of reported incidents per source (E2ECU, R-Ops, Grid-OMs, LCU);
- Average and maximum load per link. Measurements will be taken from the monitoring framework.

8 Requirements

8.1 Trouble Ticketing System

The Trouble Ticketing System (TTS) should meet the following requirements:

- Provide a web interface for the aforementioned entities to request tickets to be opened
- Every change to a ticket should be logged with date & time and user
- Provide a dashboard showing the tickets related to the LHCOPN
- Provide either a mean to produce the defined ticket metrics (see section 7), or a mean to extract raw tickets data in a pre-defined format in order to be processed
- Provide some reminders on pending tickets
- Provide authentication
- Ability to have automatic ticket assignements using rules on some fields

While some of these requirements are already satisfied by GGUS, some developments are certainly required. If these developments are not feasible within GGUS, external tools will be developed to cope with these limitations.

8.2 Monitoring framework

The monitoring framework must be able to provide reliably and accurately the load on every LHCOPN link at [FIXME: a reasonable fine grain]. If the monitoring framework is not able to produce directly the previously defined indicators (see section 7), a mean to extract the raw data must be available. It should also provide a mean to verify the Uptime measured via ticket data is coherent with the observed runtime.