THE COMMUNICATIONS INFRASTRUCTURE FOR THE LHC

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Abstract

The communications infrastructure which was put into place for the LEP collider is now well over 10 years old, and will, in some cases, soon need replacement. Moreover, the communications needs for the LHC collider, experiments, and associated services are different from those of LEP. The time is now ripe to examine these requirements, and evaluate the possible ways in which they can be met. A Communications Infrastructure Working Group was put into place to identify the needs for communications services during the construction, commissioning, and initial operation of the LHC. The services to be considered include transmission of voice, video, and data. This paper will report on the progress of this group, and will also outline some technical options for the communications infrastructure.
1 INTRODUCTION

At the time of the construction of the LEP collider significant changes were taking shape in the fields of telecommunications and data networking.

2 USER REQUIREMENTS

2.1 Voice communications

2.1.1 Emergency telephones

At present the emergency ('red') telephones are connected to SR1 through dedicated cabling in the tunnel. The planned civil engineering work will effectively cut all connections in the tunnel. In order to maintain an emergency telephone service during the period of the civil engineering it is planned to reroute these connections, passing instead to the nearest point where there is a telephone switching node (in general, the SR buildings).

In parallel with the audio connection for the emergency telephones there is an alarm connection which is routed to synoptic panels at each site. It will be necessary to revise these panels and the associated cabling.

2.1.2 Fixed telephones

The need for fixed telephones in the underground areas is still being debated. The surface areas will be equipped, as other surface buildings of CERN, with a limited number of fixed telephones for general use.

2.1.3 Radio telephone service

During the LEP dismantling period the 'leaky feeder' radio system will be cut in several places. This will result in the loss of underground GSM communication capability, as well as the fire brigade service. These services will be progressively restored as soon as possible after the tunnel sections have been handed back to CERN’s responsibility.

2.2 Data communications

2.2.1 Technical services

Several technical service systems require data communications:

- alarm level 3 information transport,
- the site and machine access control system,
- the electrical distribution system,
- cooling and ventilation,
- cryogenics,
- vacuum,
- other miscellaneous systems.

By the time LHC commissioning starts, a completely redundant transmission system will be required, with no common points of failure. However, in the interim period it is probably acceptable to have a single, albeit reliable, transmission system.

2.2.2 Accelerator control

The current network in place for control of the LEP collider will, with possible upgrades due to technological evolution, be generally adequate for the LHC. Some specific systems which might need special attention are currently being studied.
2.2.3 **General purpose network**

The CERN general purpose (office) network will be required in all LHC buildings. It is expected that the backbone for this network will be based on Gigabit and 10 Gigabit Ethernet rather than ATM as had been previously supposed.

2.2.4 **Experimental data**

The data communications needs for the LHC experiments differ enormously, owing to the special characteristics of each experiment. However, it is clear that these requirements will dwarf all other data communications requirements across the CERN site (and beyond). For example, the CMS experiment expects the following data rates:

- From the pit to the surface
  - 1 Gbit/s for controls
  - 1000 Gbit/s for event data.

- From the surface to the CERN computer centre
  - 1 Gbit/s for controls
  - 10 Gbit/s for event data.

- From the CERN computer centre to other regional centres
  - 622 Mbit/s for event data.

2.3 **Video transmission**

Video transmission needs for the LHC are expected to be rather similar to those for LEP, with the bulk of the images being for site and machine access control, and for beam observation. In total this means that well over 100 television signals will have to be transported across the site.

3 **EXISTING INFRASTRUCTURE**

The current communications infrastructure was installed at the time of the construction of the LEP collider. The equipment is now 15 years old: even without the advent of the LHC it would soon be necessary to replace it.

The infrastructure consists of various systems:
- an optical fibre network installed in surface trenches and interconnecting the Meyrin and Prevessin sites as well as PA1, 2, 3, 4, 6, and 8,
- a fibre optic cable installed in the drain under the floor of the LEP tunnel,
- a coaxial cable network installed in the LEP tunnel,
- a 'leaky feeder' cable installed in the LEP tunnel to facilitate radio communications,
- various 'hard wired' systems, for example for emergency telephones.

This physical infrastructure transports a wide variety of information, the principal ones being:
- video signals,
- the Time-Division Multiplex (TDM) system, which is now mainly used to interconnect the nodes of the PABX,
- the data networks for office networking, accelerator control, and technical services,
- links for the transfer of data from experiments,
- radio communication including GSM and fire brigade channels.
4 INFRASTRUCTURE FOR THE LHC

It is clear that the basic infrastructure for the LHC will be based on optical fibres. The two access points (5 and 7) which were not originally connected by surface optical fibre links are currently being connected.

It is also evident that the infrastructure has to support redundant connections so that communications can continue in the event of a failure. Several approaches are possible.

One attractive possibility is to use a 'self-healing' ring topology. This can be at the physical level of the fibre optic links, or using a new TDM technology known as Synchronous Digital Hierarchy (SDH). The principle is the same in both cases. In the event of a failure (even a total cut at a point in the ring) the ring automatically wraps back upon itself. The system is well tried, and is used by telecommunications network operators worldwide.

Another possibility is to use networks based on Internet Protocol (IP). IP networks were designed to be resilient and to survive breakdowns in specific connections by using alternate routing. Although IP networks hitherto have been principally used for data transport, recently standards have been defined to allow voice and video communication over them.

5 CONCLUDING REMARKS

The decision as to the basis for the communications infrastructure for the LHC has not yet been taken, although it will certainly be based on optical fibre technology. Self-healing ring topologies and IP networks are both attractive propositions, and the two could co-exist.

The first report of the Communications Infrastructure Working Group, which is planned to be published soon, will elaborate on this.