TTC backbone real-time monitoring

A facility and a web application for a real time monitoring of the TTC backbone status.

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Project summary

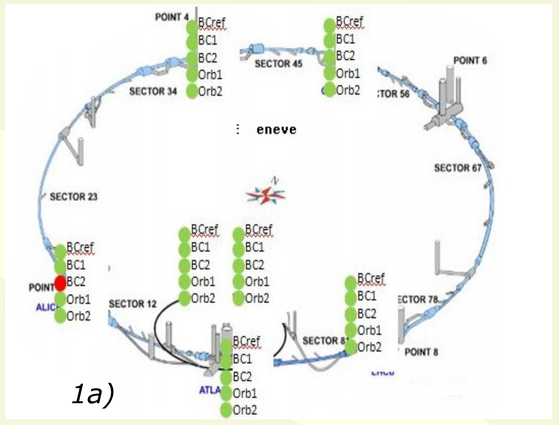
As the reliability of the distribution of the LHC timing signals to the experiments is of great importance, there has been a need for a global monitoring system with a real time and post-mortem analysis facility. This system will have to gather qualitative data describing the status of the timing signals all over the accelerator and make them available anytime to the TTC (Timing, Trigger and Control) support team.

The deployed system is mostly based on an equipment (consisting of a server PC (called TTCpage1 server), a VMEbus processor and a number of custom designed VME slave cards) installed in the Rack zone of the CERN Control Center (CCR) at the Prevessin site. However, as the RF timing signals have to reach different destinations, it is necessary that they are monitored all the way from their sources, through CCR, where they are retransmitted, and down to all the four experiments.

Among the measured and monitored values, the monitoring system is focusing on bunch clock and orbit frequency and synchronization, as well as jitter and phase shift due to temperature drift. These values are complemented with the Beam Mode of the LHC, distributed by the BST system (Beam Synchronous Timing).

A dedicated web based application will provide fast data visualization means to the LHC experiments, in order to monitor the status of timing signals in real time. This application will be available to the users and will help them to quickly detect unexpected conditions and cross correlate them with other events. As all the data will be time-stamped and stored in a database, real-time and post-mortem data analysis will be simplified.

TTC backbone



1a)

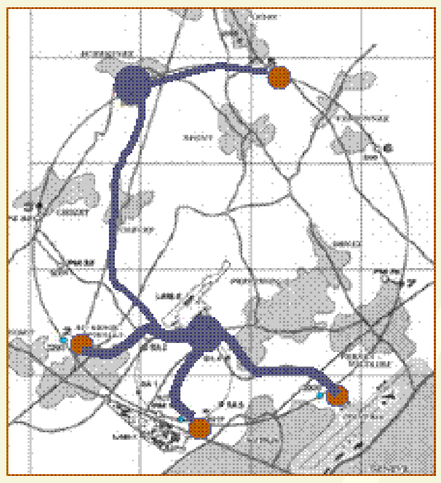


Figure 1:
a) LHC complex,
b) RF/TTC distribution backbone

AB/RF optical links
TTC equipment

1b)

The distribution of timing signals from the LHC Radio Frequency (RF) source in Echenevex to the four experiments (ATLAS, ALICE, CMS and LHCb) is part of the TTC system (Timing, Trigger and Control), common to all the experiments. A copy of these signals is also transmitted to the monitoring system, installed in the Control Center in Prevessin by the TTC team, which provides continuous measurement of parameters such as Bunch Clock (BC) jitter and frequency, Orbit period in BC counts and transmission delay over fiber versus temperature.

System architecture

The heart of the system responsible for gathering measurement data consists of a computer server (TTCpage1 server). The server has been equipped with two network adapters, one connected to the CERN Technical Network (TN) and the other one to the local TTCpage1 private network (PN).

The purpose of designing PN is to ensure stability of data transmission between the server and the measurement devices (oscilloscopes, VP110 VMEbus crate controller and frequency meters). The location of the server within TN is imposed by a need for Data Interchange Protocol accessibility, which is unachievable within CERN General Public Network (GPN).

Once all the measurement data is gathered it is sent to a database provided by CERN ORACLE database services. While this database is used for data storage it also act as a "gateway" between the TN and GPN.
The provided service enables the system to store all the data during the whole LHC lifetime without the need for data reduction (the system is mostly based on 10s interval refresh rate, which is equivalent to ~1GB during a year).

A web server provided by CERN Web Services will be used for data visualization.
The web page will be implemented in PHP for rendering graphs and producing final HTML output refreshed every 10s.

Measurement devices and signal sources

A set of applications written in C/C++ has been developed for collecting the data from different measurement devices and signal sources.

As a part of their functions the applications provide a remote control of two LECROY manufactured oscilloscopes accessed via TCP/IP connection and Versatile Instrument Control Protocol (VICP). The application makes use of General Public License (GPL) based library for controlling VICP devices.

As the DIP protocol is used as a source of some of the monitored signals (statuses of TTC receivers, Beam mode and temperature value), the applications have been extended with DIP libraries and some interface classes providing ability to act as both dip-publisher and dip-subscriber.

Three high precise frequency meters based on XILINK Microblaze design and 10MHz GMT clocks have been developed at CERN to provide high accurate frequency tracking (precision up to 1 Hz, BC ~ 40 MHz). The server communicates with the meters through RS232 interface.

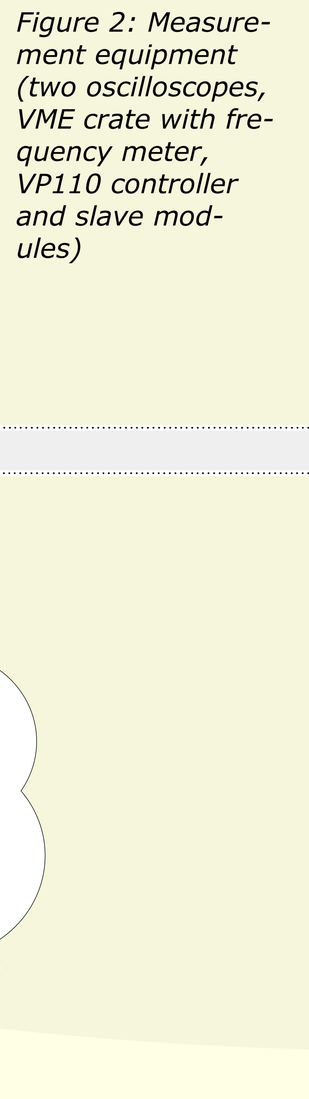


Figure 2: Measurement equipment (two oscilloscopes, VME crate with frequency meter, VP110 controller and slave modules)

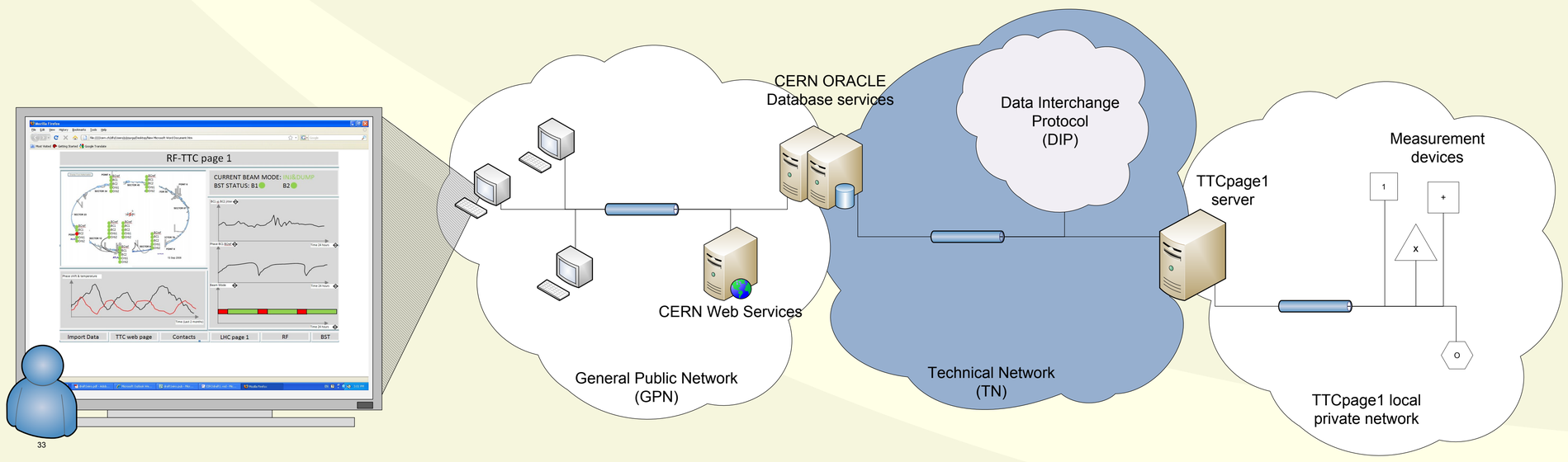


Figure 3: System architecture