ESRF'S NEW BEAM POSITION SYSTEM FOR THE STORAGE RING USING LIBERA BRILLIANCE DEVICES.

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The ESRF has entirely refurbished its control of the Storage Ring Beam Position Monitors with 224 intelligent controllers (Libera Brilliance) which have replaced the former system working for 17 years.

The orbit feedback software reads the orbit parameters from these devices via a set of hierarchical TANGO device servers.

This challenging upgrade has been done progressively over 3 months without interrupting the operation of the ESRF. This poster describes the architecture of both Slow and Fast Orbit Feedback control systems with a particular focus on the challenges linked to data flow generated by this high number of devices. It makes a point on the tools developed for installation and maintenance.

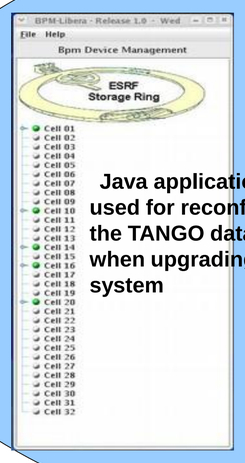
This fast and efficient result was possible thanks to a collaborative development at several levels. The Synchrotron SOLEIL developed the TANGO device server for the Libera which was then re-used and improved by the other Institutes within the collaboration: ELETTRA, ALBA and the ESRF. The FPGA firmware for the Communication Controller of the Fast Orbit Feedback was initially developed at the DIAMOND Light Source and also used by SOLEIL and the ESRF and has now become a standard option of the Libera.

OPERATIONAL CONSTRAINTS

One important constraint was to upgrade the system gradually during the normal operation and only a few shifts of 8 hours can have been dedicated for the commissioning.

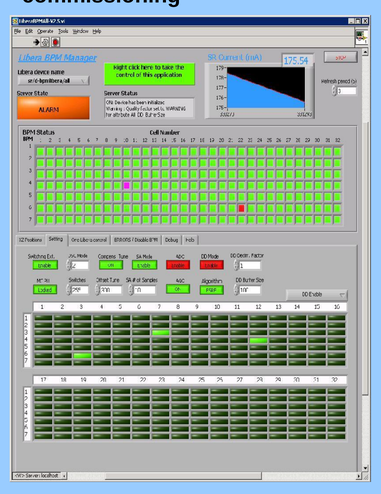
Also the Libera Brilliance was not fully adapted for our needs and we have requested some modifications or improvements and had therefore to suffer of the several firmwares and TANGO device server releases to install.

To achieve these requirements some tools for the smooth upgrade from the old system to the new system, but also from one release to another had to be developed.

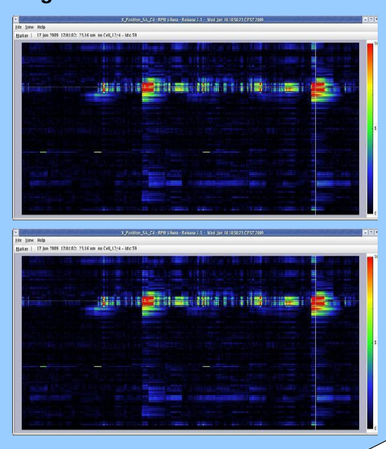


Java application used for reconfiguring the TANGO database when upgrading the system

LABView application used for BPM system commissioning



Java application displaying the X and Z positions changes over 15 minutes.

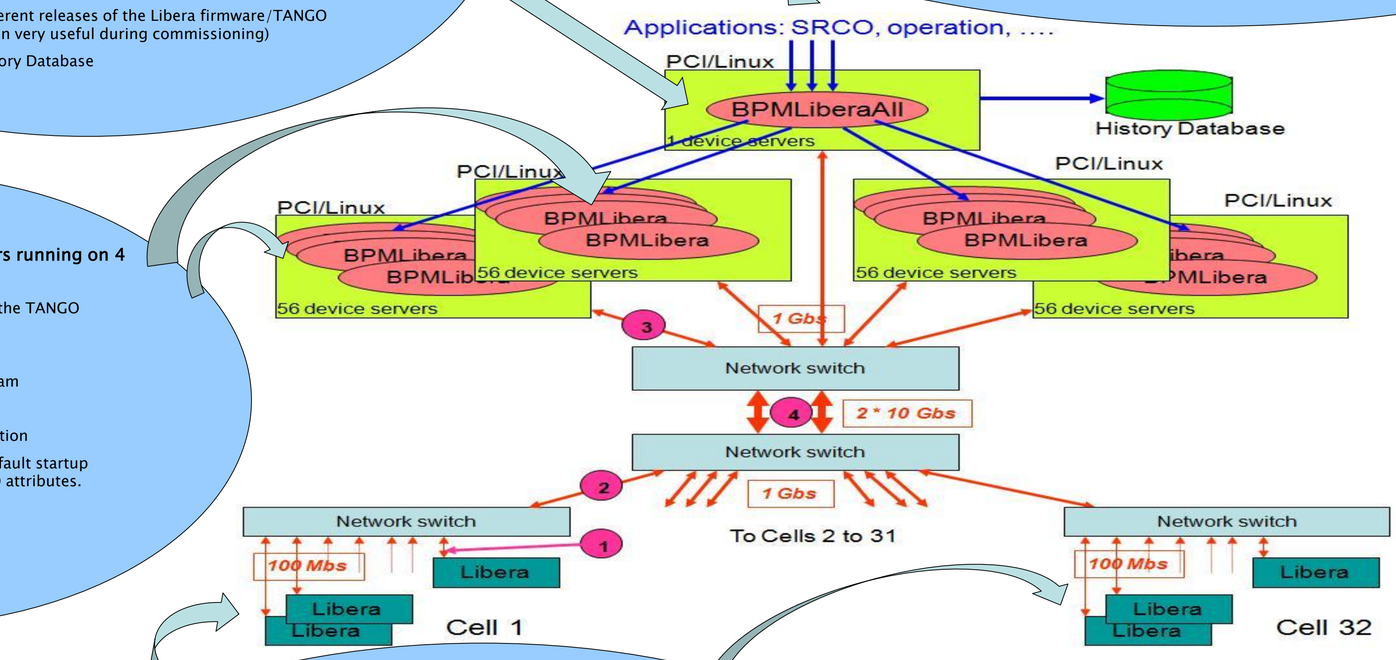


1 TANGO **BPMLiberaAll** device server running on its own PCI/Linux rackable PC

- Collects: data Positions, Electrodes Sum and Status on all the 224 Libera device servers using Group call (15milli-seconds to read one TANGO attribute) at 2 Hz. Generates TANGO events for the connected clients.
- Build an History
- Performs positions corrections according to the SR current.
- Manages lower device server and Libera error: Incoherency, Libera or server not responding, Libera frozen, …
- Checks regularly the coherent setting of all the Liberas: DSC, AGC, Compensate Tune, PLL Locked, …
- Manages up to three different releases of the Libera firmware/TANGO device server (This has been very useful during commissioning)
- Archives to the ESRF History Database

224 TANGO **BPMLibera** device servers running on 4 PCI/Linux rackable PC

- Originally developed by SOLEIL and used over the TANGO collaboration (ELETTRA, ALBA and ESRF)
- Extended by the ESRF to add our own needs:
  - X and Z global offsets measured with beam
  - ESRF positions algorithm using arctan
  - Electrodes drifts to disable faulty BPM station
  - Usage of "Free" (global) property for default startup configuration instead of memorized TANGO attributes.
  - Others: RMS on SA and DD, ….



224 **Libera Brilliance** devices (7 per cell, 32 cells)

The Libera embed an ARM microprocessor running Linux to control the internal resources of the device and to transmit data using a TCP/IP socket based Ethernet connection hidden by a library named CSPI (Control System Programming Interface).

The 5 possible data stream are:

- SA (Slow Acquisition): Data coming at 10 Hz: X and Z positions, Electrodes values, …
- Turn by Turn (also called DD mode): Data buffer coming at the Machine Trigger Frequency (Up to 10 Hz at the ESRF) and synchronised with the Kickers
- ADC: Data buffer also triggered at the Machine Trigger Frequency
- Post Mortem: Data buffer triggered by an external hardware signal coming from the Machine Interlock system.
- FA (Fast Acquisition): Continuous X and Z positions data stream at 10 KHz but using a dedicated 1 Gbs Ethernet link.

7 Liberas Brilliance on one Cell

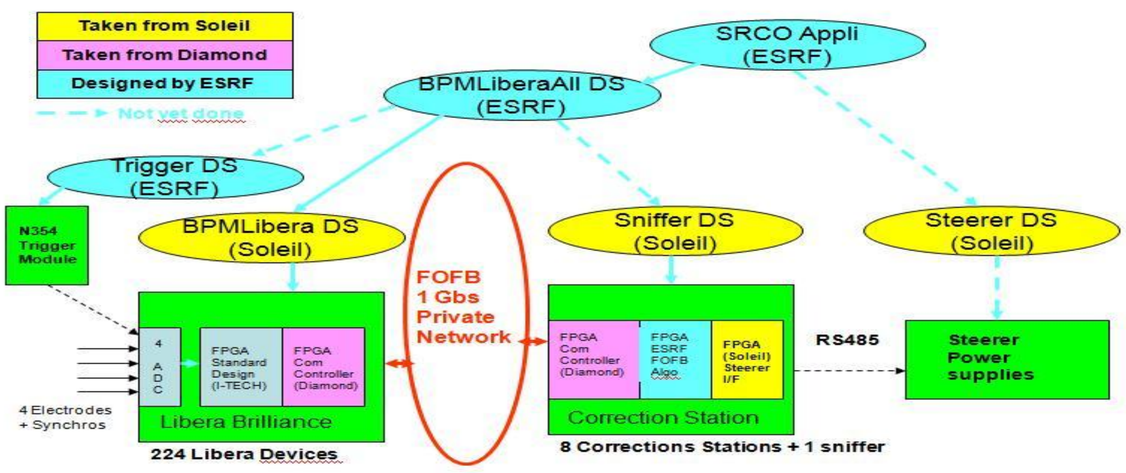
Acknowledgment:
- To Nicolas Leclercq and Nicolas Hubert of the SOLEIL synchrotron
- To Guenther Rehm and Michael Abbott of DIAMOND light source
- To the ESRF's Diagnostics Group
- To the ESRF's Software Engineering Group

Table1: Network bandwidth measured at several points of the network (see figure above)

MODE	Network points 1, 2, 3 ,4
SA (10Hz)	0.1 / 0.1 / 1.5 / 0.1 %
SA + TbT@1Hz (50 samples)	0.2 / 0.1 / 1.5 / 0.1 %
SA + TbT@1Hz (1K samples)	0.5 / 0.2 / 3.0 / 0.3 %
SA + TbT@1Hz (5.5 Ksamples)	1.8 / 0.6 / 11 / 0.9 %
SA + TbT@10Hz (5.5 K samples)	9.0 / 2.5 / 48 / 4 %

Software re-use: The rapid deployment of this system could not have been possible without re-using software already developed by other Institutes. The figure below describes the different pieces of software re-used for the project:

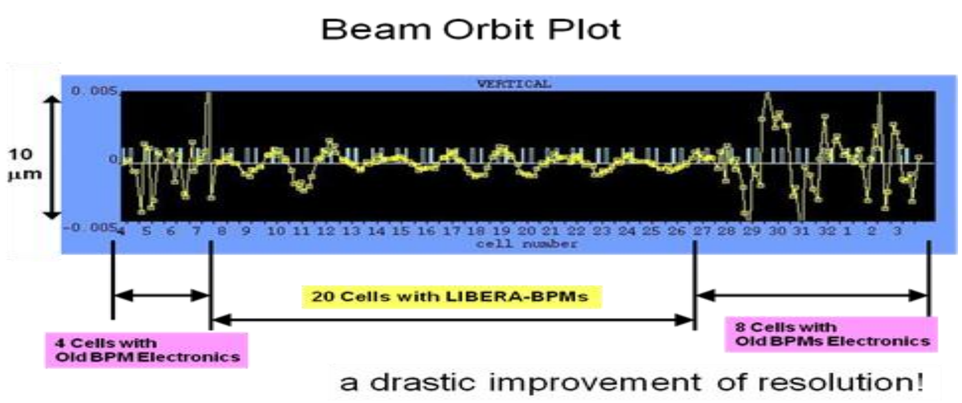
- The TANGO device servers for the Libera BPM, the FOFB sniffer and possibly the Steerer power supplies and also the FPGA program for the communication with the steerers power supplies have been written by SOLEIL
- The FPGA program for the Communication Controller has been originally written by DIAMOND.



Conclusion: Presently, mainly the SA mode is daily used for the Slow Orbit Feedback correction and performances of the BPM system has been drastically improved in term of resolution (see figure below) but also in term of data acquisition speed.

We are currently working on the improvement of the Beam Position Interlock system, the Turn by Turn mode and the development of the Fast Orbit Feedback.

Also, some new ideas as the calculation of the Transfer Efficiencies, the Lifetime and the Tune measurements are already in mind for future improvements of the Accelerators Diagnostics.



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