4th generation
Specialized Synchrotron Radiation Source

SSRS-4 project

Control and diagnostic systems

Timur Kulevoy
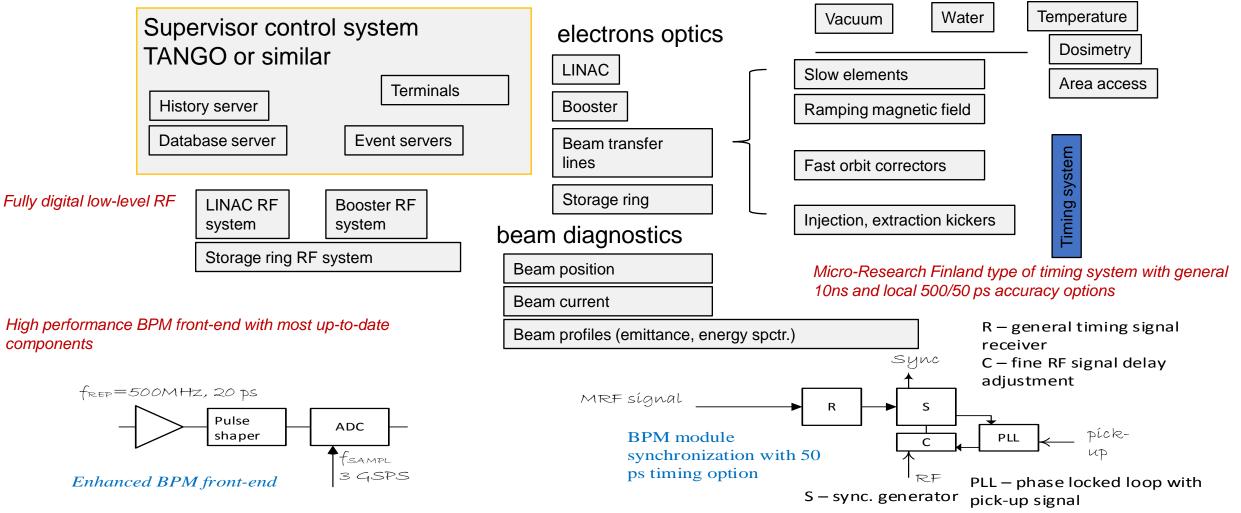
Bird's eye view at SSRS4 control and diagnostics

- *Classical SCADA architecture*
- *Uses mainly Ethernet network*
- *Dedicated network for BPMs*
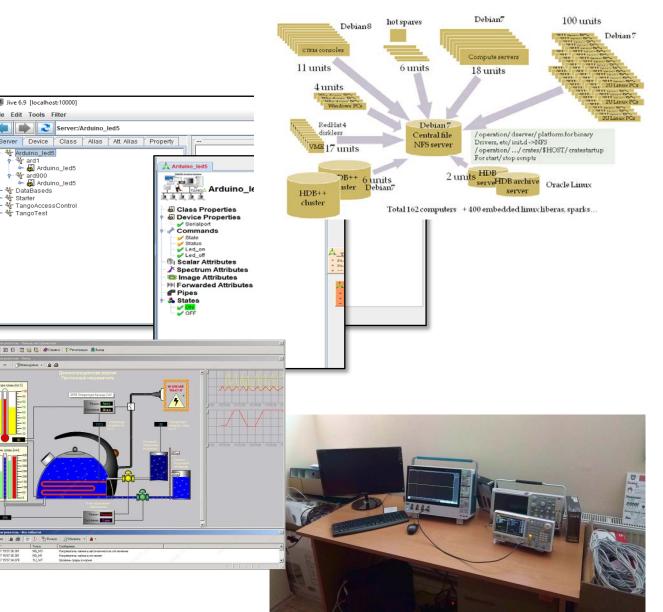- *Open source middleware solutions and so on*

Engineering systems

Vacuum Water Temperature

Dosimetry

Area access

Supervisor control system TANGO or similar

Terminals

History server

Database server

Event servers

electrons optics

LINAC

Booster

Beam transfer lines

Storage ring

Slow elements

Ramping magnetic field

Fast orbit correctors

Injection, extraction kickers

Timing system

Fully digital low-level RF

LINAC RF system

Booster RF system

Storage ring RF system

beam diagnostics

Beam position

Beam current

Beam profiles (emittance, energy spctr.)

Micro-Research Finland type of timing system with general 10ns and local 500/50 ps accuracy options

High performance BPM front-end with most up-to-date components

f_{REP}=500MHz, 20 ps

Pulse shaper

ADC

f_{SAMPL} 3 GSPS

Enhanced BPM front-end

MRF signal → R → S → Sync

PLL ← pick-up

C ← RF

BPM module synchronization with 50 ps timing option

R – general timing signal receiver
C – fine RF signal delay adjustment

S – sync. generator

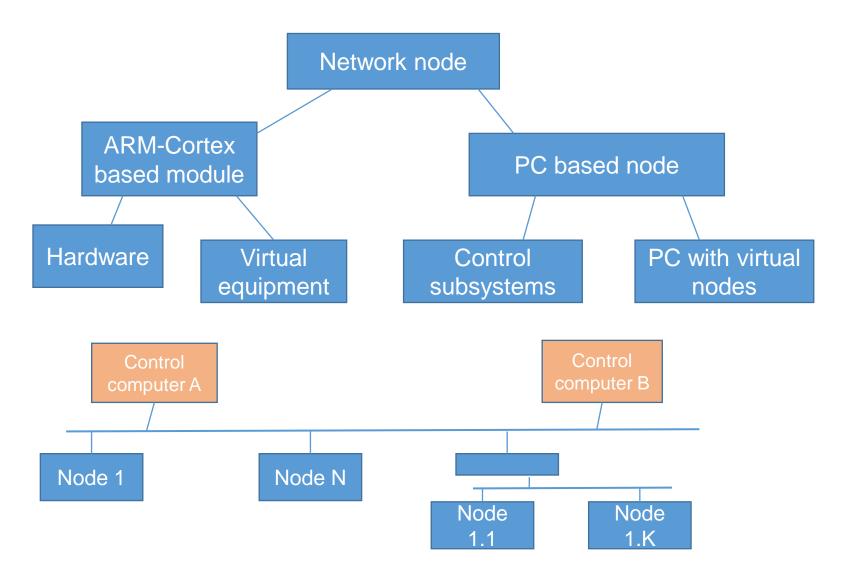PLL – phase locked loop with pick-up signal

Control system

- We have carefully investigated documentation for some well-known control systems such as TANGO and EPICS.

- To fill more familiar to TANGO a small plant of Arduino controllers and few applications under TANGO control had been developed.

- For the moment there is a intermediate decision to develop SSRS-4 control system and define overall design rules on the base of common SCADA standards and experience of numerous TANGO-based systems

Special thanks to Jean-Michel Chaize, Andy Goetz (ESRF).
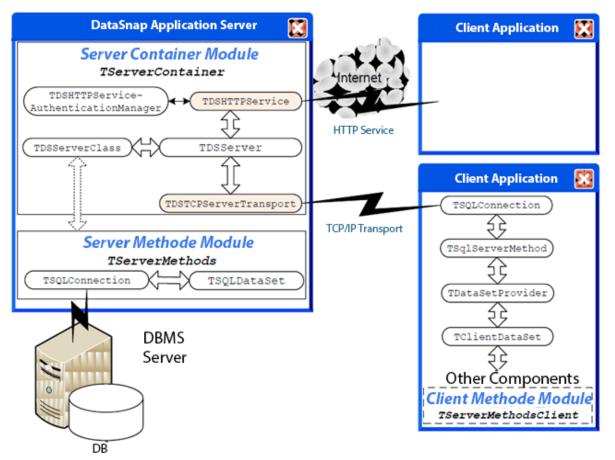
Distributed equipment

- A network node model is under development
- The Ethernet and the correspondent protocols are considered as a main data transport
- We are developing templates, rules and code examples for desktop computers and ARM-based controllers

SSRS-4 Control System Databases
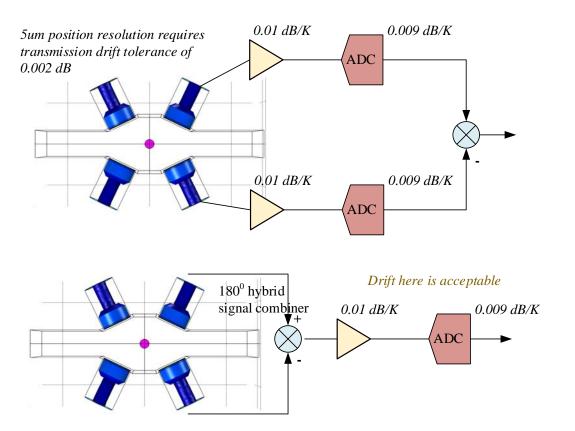## *Expected SSRS-4 SCADA implementation*

- It is supposed to use the architecture of a multi-tiered client/server application in which an additional middle tiers between the client application and database server is added. This middle tier is frequently named application server. This allows different client applications to use the same data, while ensuring consistent data logic. It also allows for smaller client applications, because much of the processing is off-loaded onto the middle tier.

- A standard tool for building multi-user applications in RAD Studio is the DataSnap package, which allows clients to remotely invoke server methods and is optimized for server operation with many clients.

- That tool use JSON form of messages. JSON is a text string with a hierarchical dataset of key / value.
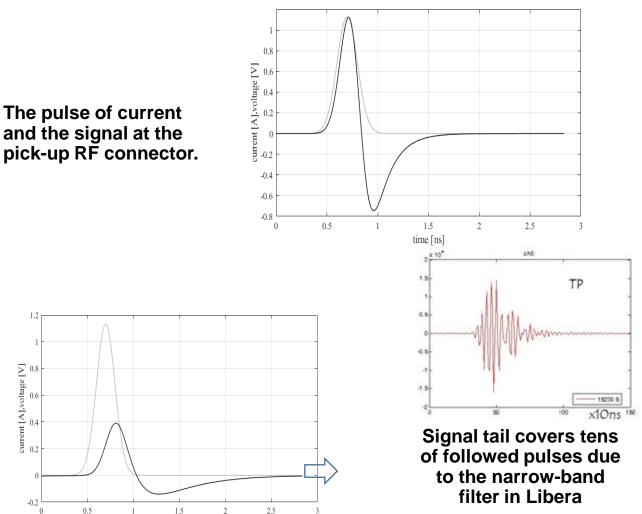
BPM for 4-th generation accelerators

- Specific requirement for low-emittance accelerators is a long-term stability of the BPM measurements. The requirements are 5 um position accuracy in the axial region.

- We are not warrying too much about mechanical tolerances.

- The thermal drift and aging of amplifiers and ADCs lead unacceptable measurement errors.

- Signal to noise ratio allows signal manipulation before amplification stage.

- Therefore we are going to test a scheme with passive wide band signal combiner (see figure on the right)

5um position resolution requires transmission drift tolerance of 0.002 dB

0.01 dB/K *0.009 dB/K*

ADC

0.01 dB/K *0.009 dB/K*

ADC

-

Drift here is acceptable

180^0 hybrid signal combiner

+

-

0.01 dB/K *0.009 dB/K*

ADC

BPM electronics

- **BPM functionality depends on the budget!**

- **From functionality point of view an RF sampling (6GSPS) ADC embedded into FPGA package is able to solve most of BPM tasks.**

- **But such module as well as 14 bit, 3GSPS ADCs probably make the electronic too expensive.**

- **We could formulate a minimal requirements for electronics. Bunch by bunch operation requires 500 MHz bandwidth to separate adjacent bunches from each other(see figure on the right). It also needs ADC with sampling rate 500 MSPS or higher.**

- **Affordable solution will be 1.5 GSPS ADC with 2 GHz analog bandwidth.**

The pulse of current and the signal at the pick-up RF connector.

Signal tail covers tens of followed pulses due to the narrow-band filter in Libera

The same signal as at top but after a low-pass filter. Small portion of power of the signal leaks to the next bunch. Therefore we demand for processing a frequency band at least 500 MHz

BPM. Prototyping of electronics

- As a first step we choose a semicommercial solutions for proving hardware and software solutions.

- There are numerous evaluation boards which allows combining high performance ADCs and FPGA. We chose Abaco systems ADC board as a companion of Xilinx KC705 Evaluation board.

- Analog electronics is under construction in the lab

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