CERN General Machine Timing System: a proposal for the evolution of hardware

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Outline

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  - Types of CERN timing systems.
- The General Machine Timing System: Hardware and topology.
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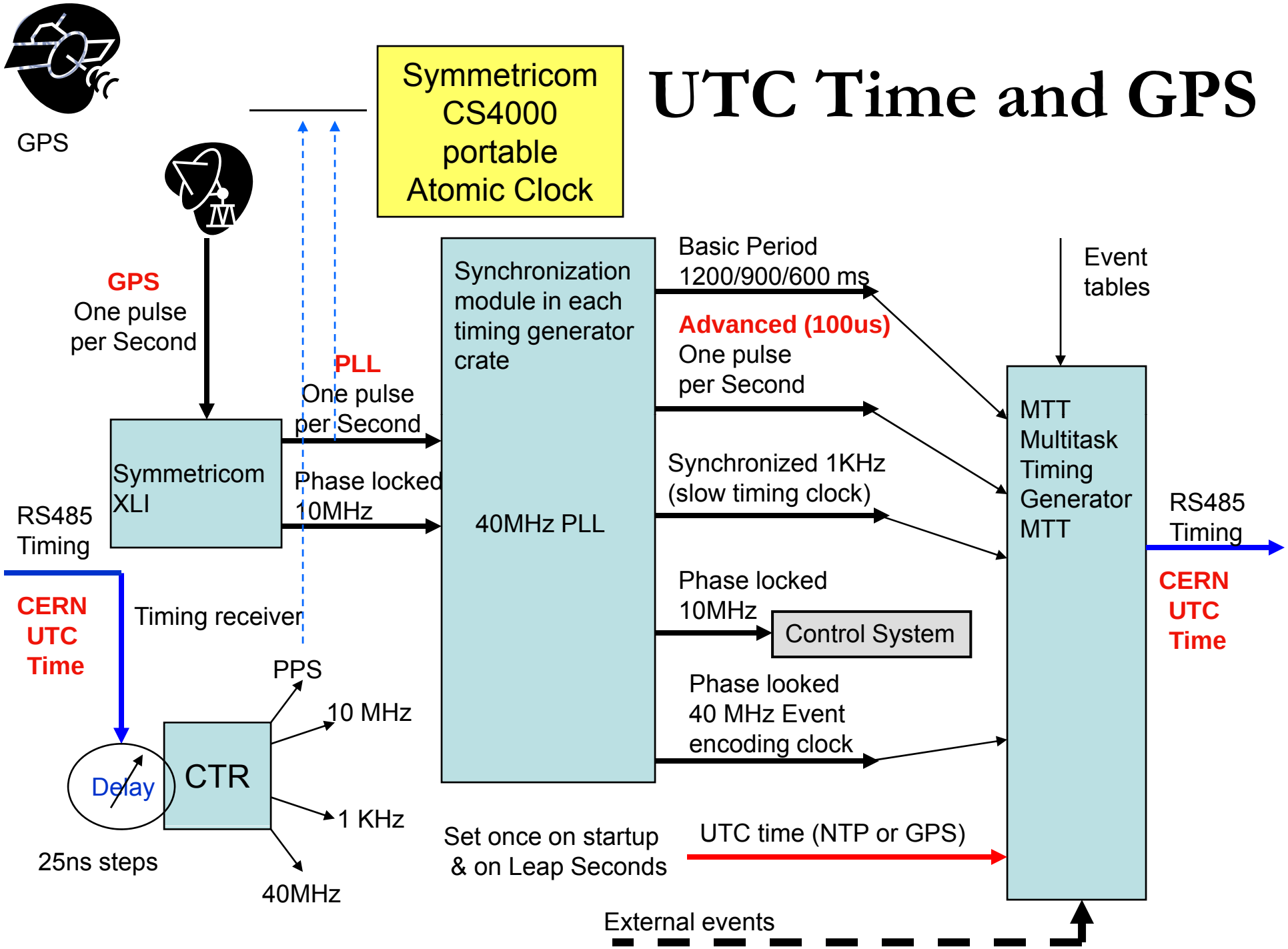
Why GMT?

- CERN is like a factory: its end products are BEAMS.
- Manufacturing a beam requires a series of sequential “cycles” in cascaded accelerators.
- Orchestrating this process we have the Central Beam and Cycle Manager, sending messages out.
- Receivers react on these messages by producing interrupts/front panel pulses.

Types of CERN timing systems

- General Machine Timing (GMT)
  - Based on UTC-synchronous 40.000 MHz.
  - 500 kbit/s over fiber and twisted pair (RS-422).
  - Granularity: 1 ms.
  - Jitter < 1 ns.
- Timing Trigger and Control (TTC)
  - Technology to multiplex Revolution tick and data in a single stream.
  - Experiments use it without data to have better clock recovery.
- Beam Synchronous Timing (BST)
  - Based on TTC technology.
  - Encodes messages in TTC data channel using bunch crossing frequency for LHC (40.079 MHz). Fiber-based.
  - Granularity: 1 LHC revolution (89 μs).
  - Jitter < 1ns.

UTC Time and GPS



The timing HW renovation project: why?

- Lack of bi-directionality in GMT:
  - Forces us to have a parallel data path (technical network) for control and diagnostics → forces us to support only platforms with an embedded computing engine.
  - Cabling delay compensation cannot be done automatically → need for costly/unreliable measurement campaigns.
- Lack of bandwidth in GMT
  - 500 kb/s current rate was chosen for backwards compatibility.
  - Forces us to have different networks for different accelerators → cabling and software hassle.

The timing HW renovation project: how?

- Identify commonalities with other projects, then launch collaborative effort.
- Promising enabling technologies:
  - Synchronous Ethernet and PTP.
  - Bidirectional optical links, with active or passive fan-outs.
- Boundary conditions:
  - Be as standard as reasonably possible.
  - End up with a completely open source product (NB. This is open hardware, we're talking about).
- Open points:
  - Fiber vs. copper.
  - Potential synergies with WorldFIP insourcing project.
  - How to mix companies and open hardware? How to fund this?
  - Smooth migration scenarios for injectors.

The CERN Timing HW Workshop

- Held on 15 February 2008 at CERN (http://indico.cern.ch/conferenceDisplay.py?confId=28233).
- Convergence on Synchronous Ethernet + PTP solution.
- Work Packages for phase 1 distributed to the different actors (https://espace.cern.ch/ab-co-timing/hw-project/default.aspx):
  - CERN: project management, final overall specification, reliability studies.
  - Austrian Academy of Sciences: fiber vs. copper, scalability system-level simulation.
  - Cosylab: user requirements gathering (from CERN, GSI and IN2P3).
  - InES Winterthur + ITER: standards compliance.
  - Oregano Systems + IN2P3 Lyon: scalability studies and switch design.
  - GSI will kick in in phase 2.
  - Micro Research interested in following up effort and might participate in the future.

Conclusions

- Very promising start of a collaboration to develop the next generation of GMT hardware.

- Main open points to be dealt with in the short term:
  - Migration scenarios.
  - Synergy with ScientiFIP.
  - Open hardware strategy.
  - Funding.

In collaboration with Injectors Renovation Project