

Building a Transient Recorder System for the Large Hadron Collider

Bjarke Dahl-Madsen, Project Manager, CLA, CLED
CIM Industrial Systems A/S

National Instruments Gold Alliance Partner Denmark

Core Expertise

- System Design
- Software Development
- Project Management

Primary Markets

- Test Solutions
- Green Engineering
- Medico Solutions (GMP, CFR 21 Part 11)
- Vision Solutions (test and industrial)



Agenda

- Introduction
- The Project
- System Requirements
- Challenges
- Data Handling
- Logging Tool
- Summary



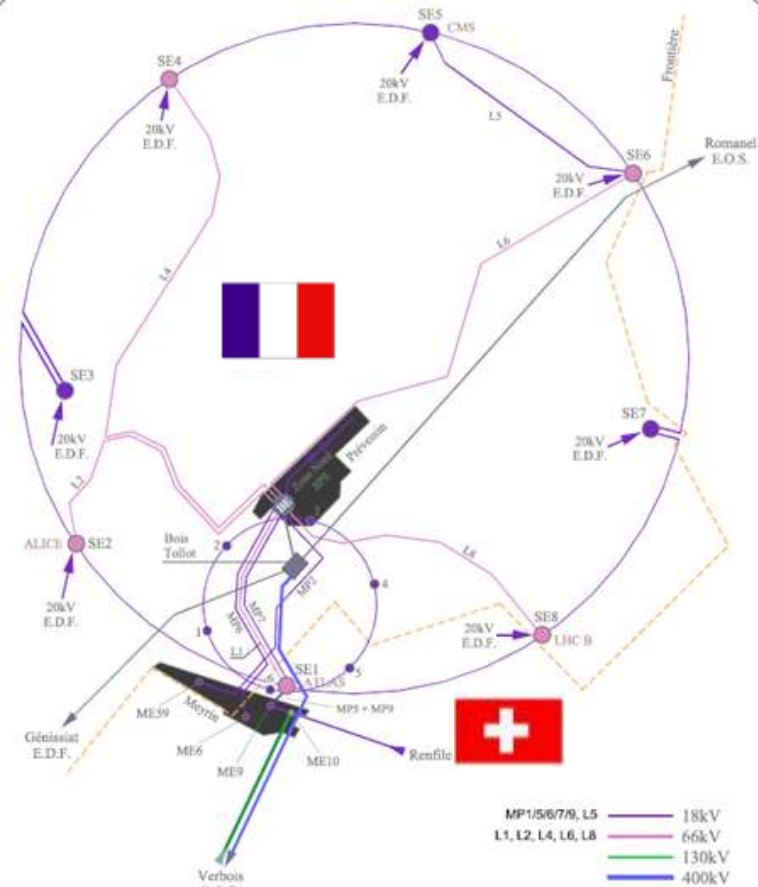
- European Organization for Nuclear Research
- Geneva (Swiss-French Border)
- Used by +10000 physicists WW
- Home of the Large Hadron Collider



The Large Hadron Collider

LHC TRIVIA

- 27 km Ring, Mean Depth 100m
- Two Particle Beams
- 9600 different Magnets
- -271,3 C using Liquid Helium
- 7 Power Stations
- 3 Billion Euro

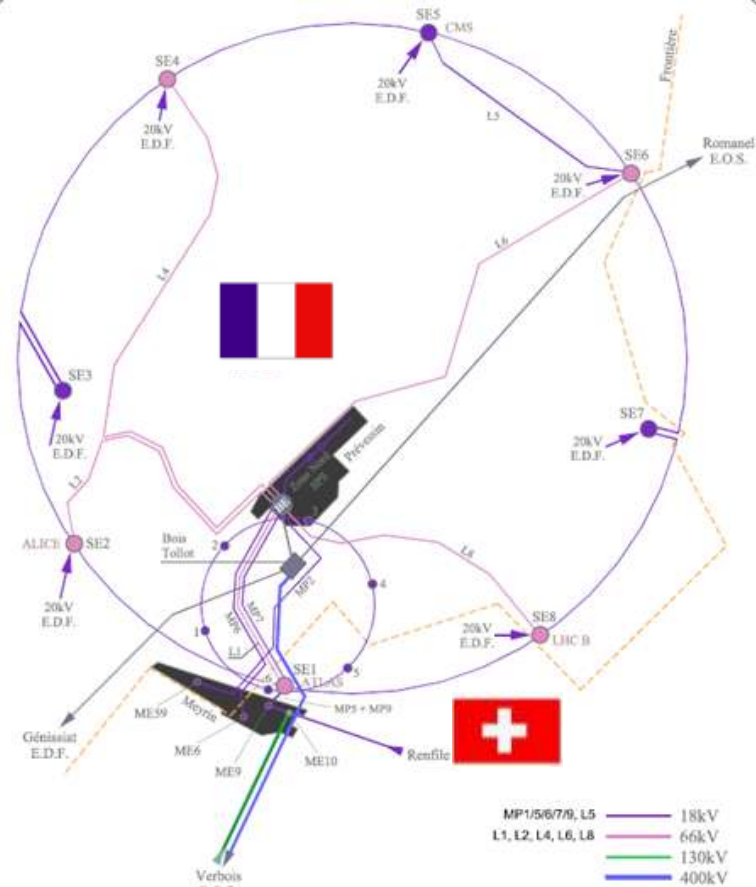


Geographical overview of the CERN power supply network

- A Greater Understanding of How the Universe evolved

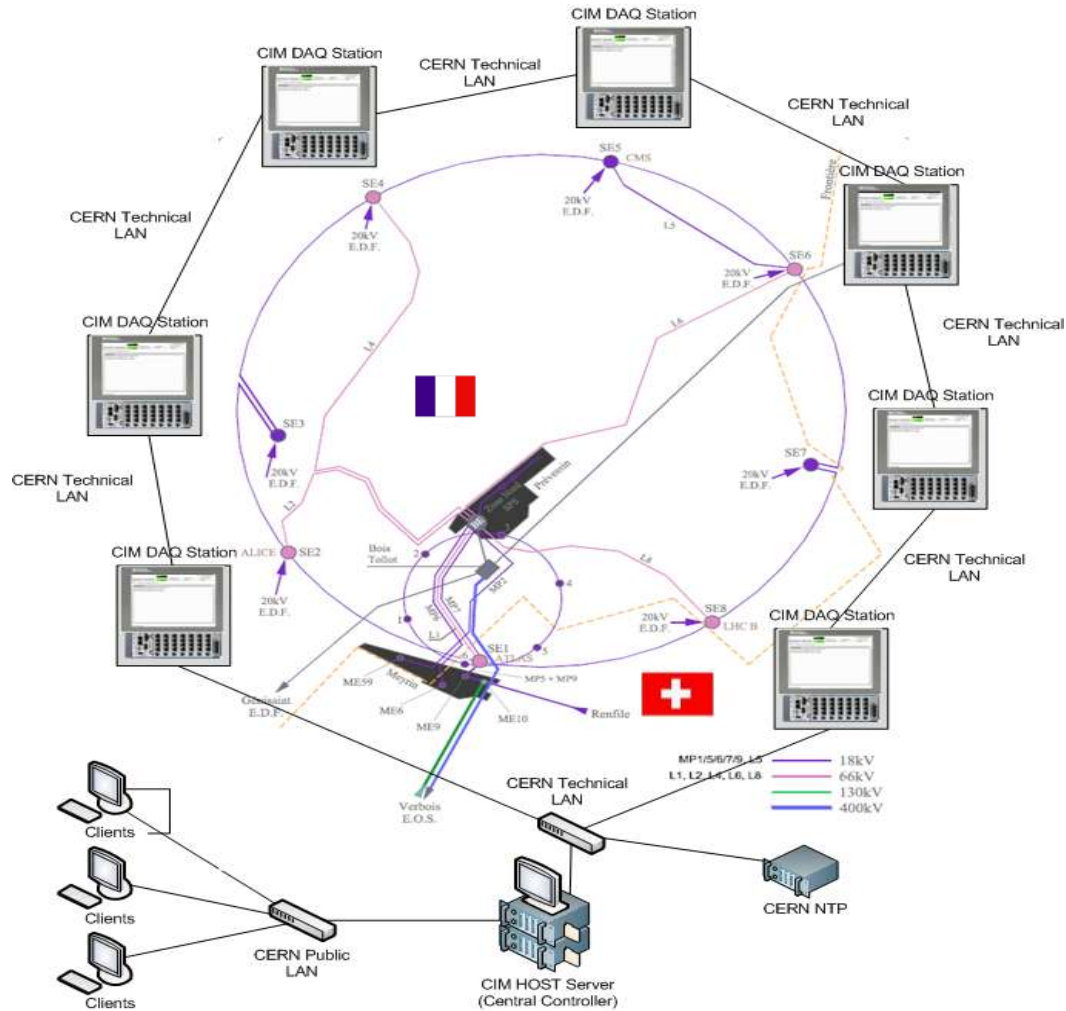
What is Transient Recorder?

- Oscilloperturbography
- Power supply from surrounding Power stations
- Is the fidelity of the power supply good enough?
- What happens when things go wrong?
- Can transients be mitigated?



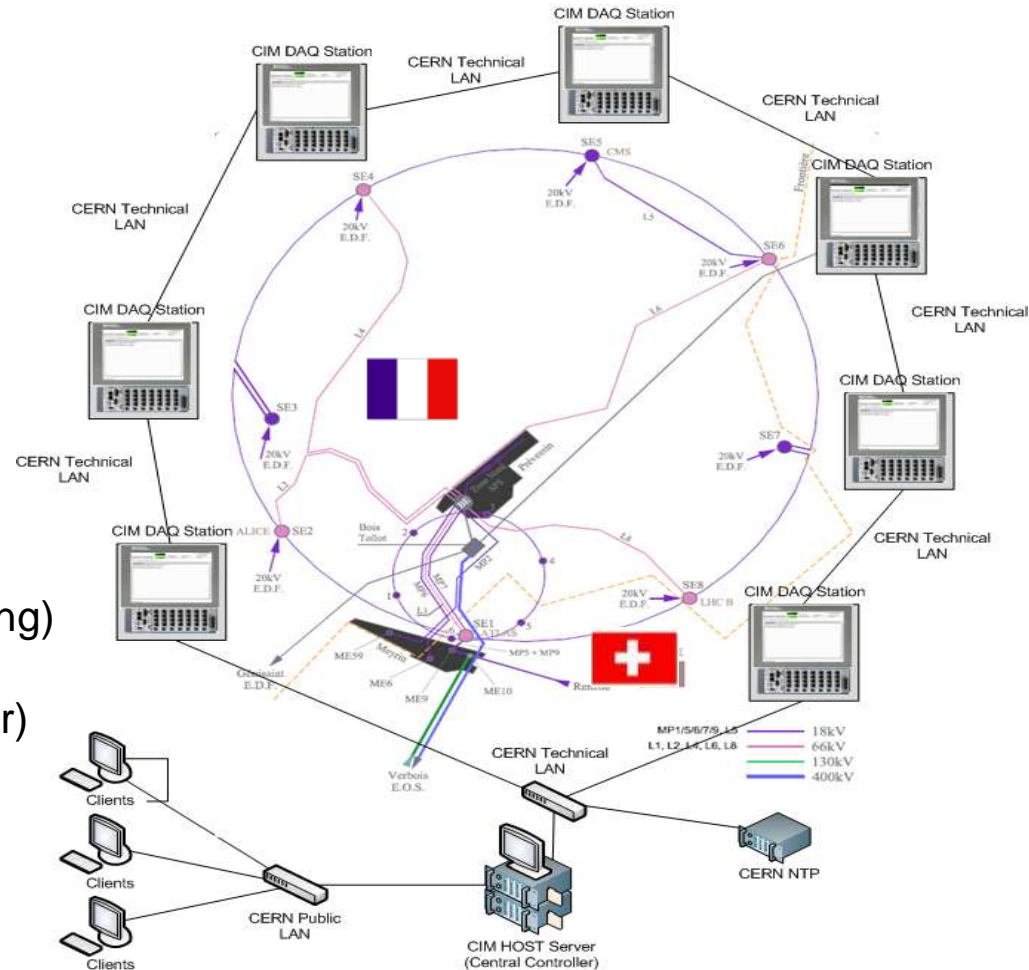
Geographical overview of the CERN power supply network

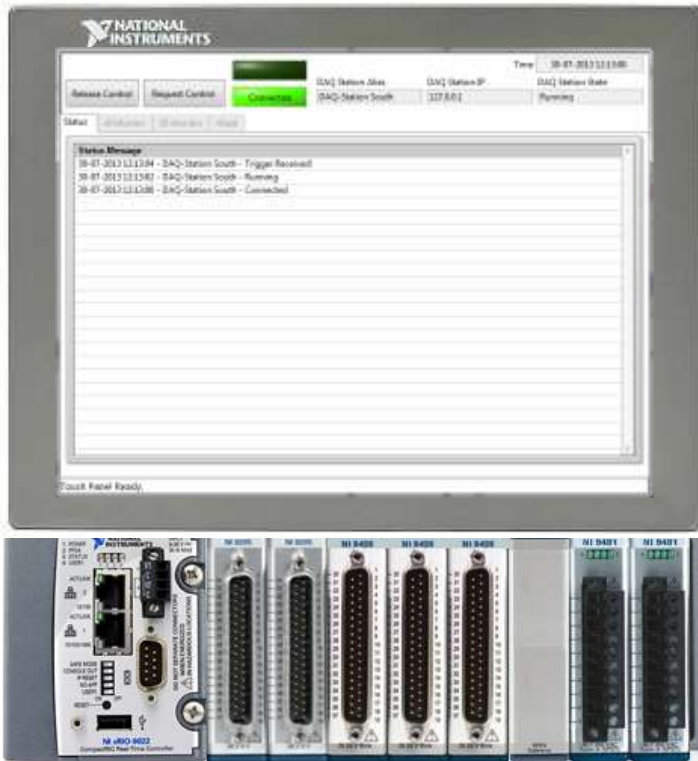
The Project



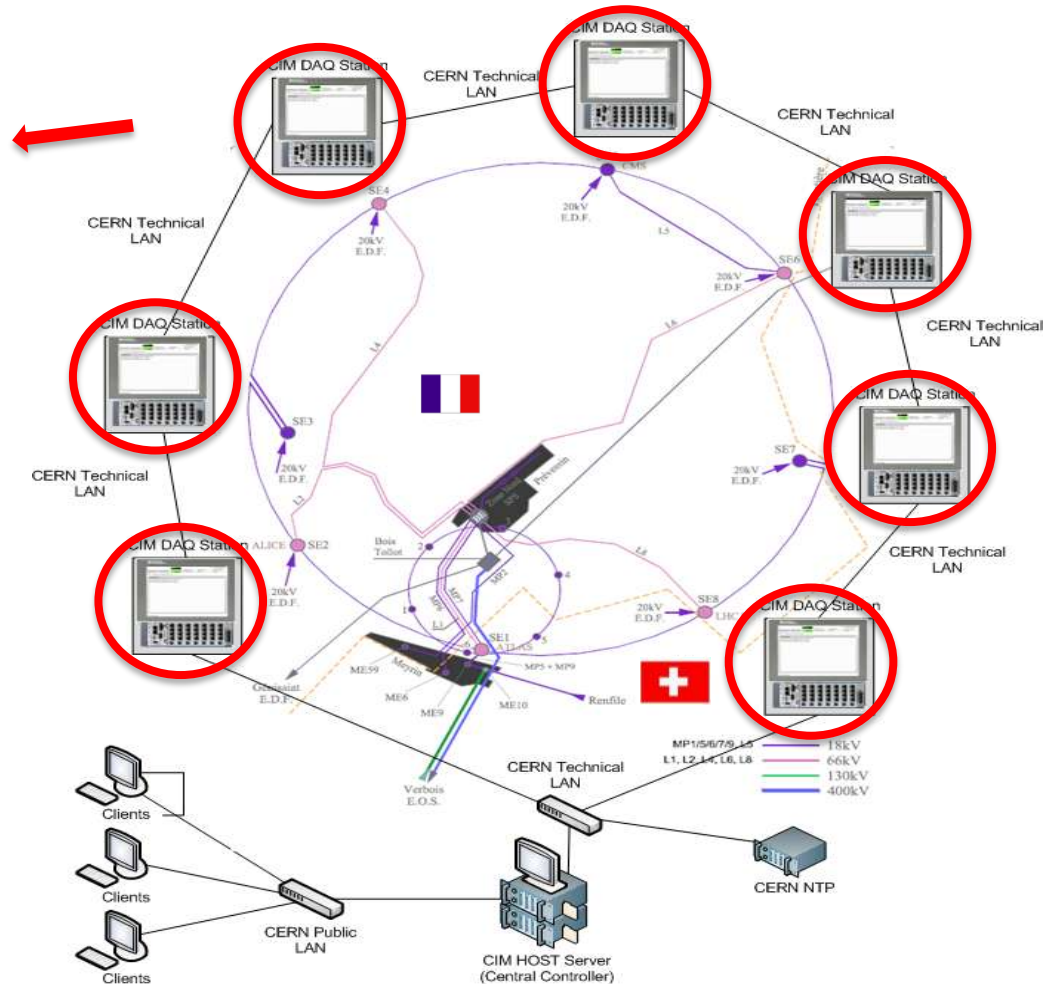
cRIO Based Transient Recorder

- Distributed Continuous Measurements
- 64 AI, 96 DI per DAQStation
- Sub Millisecond Synchronization
- Triggered Data Collection
- Redundancy (System Disconnect Handling)
- Data Stored on Server (Central Controller)
- Clients for Configuration and Analysis

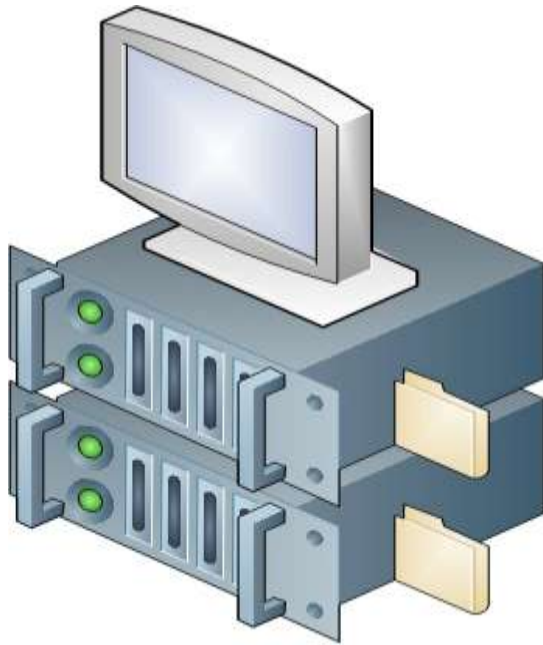




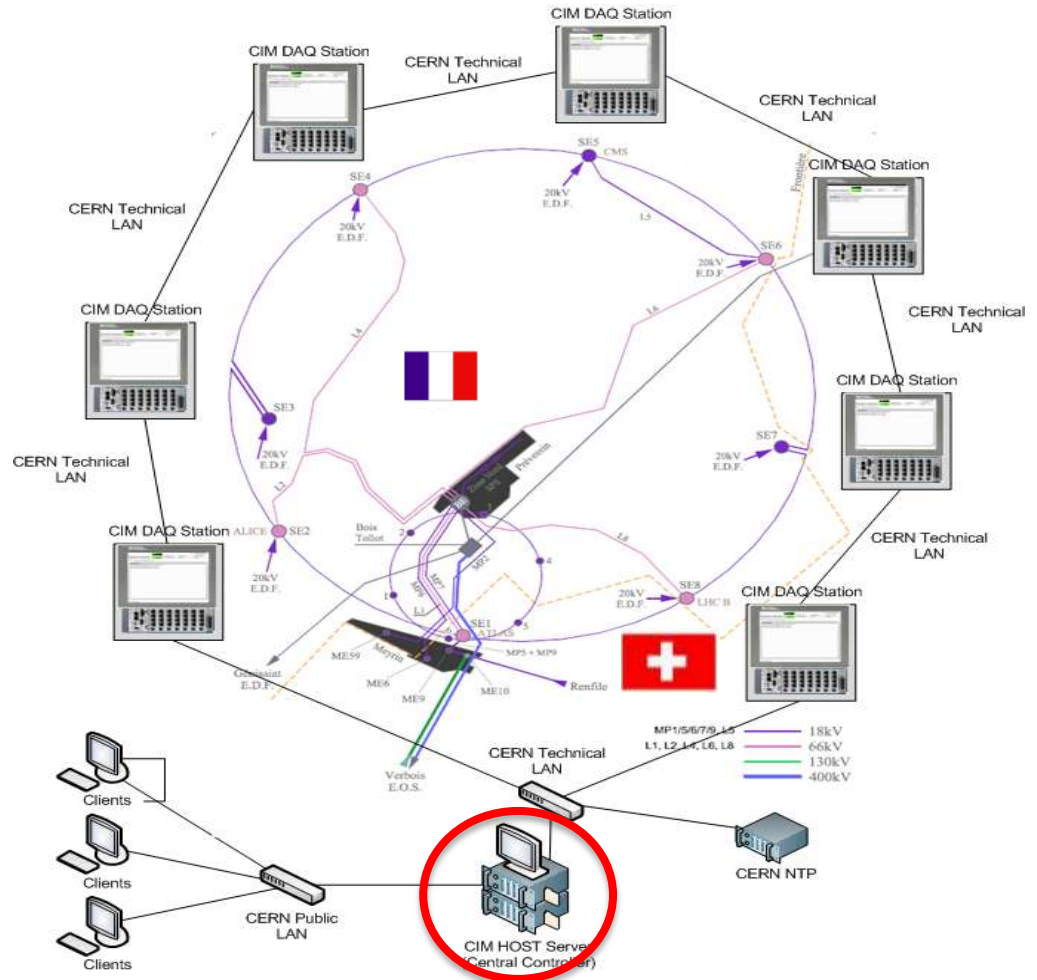
- Transient Recorder Acquisition System
 - Analysis, Triggers, Communication
- Touch Panel IO, Trigger Masking



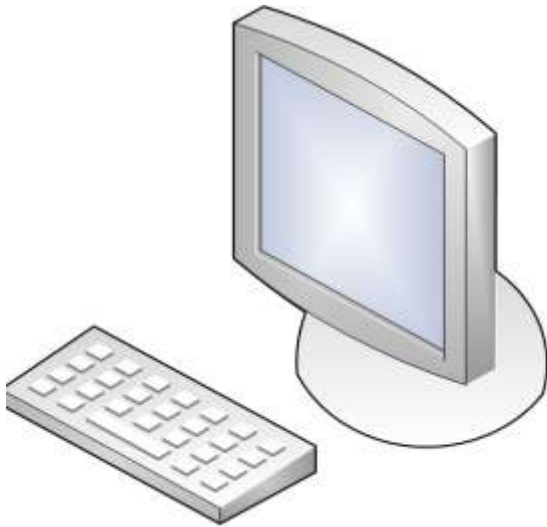
Central Controller



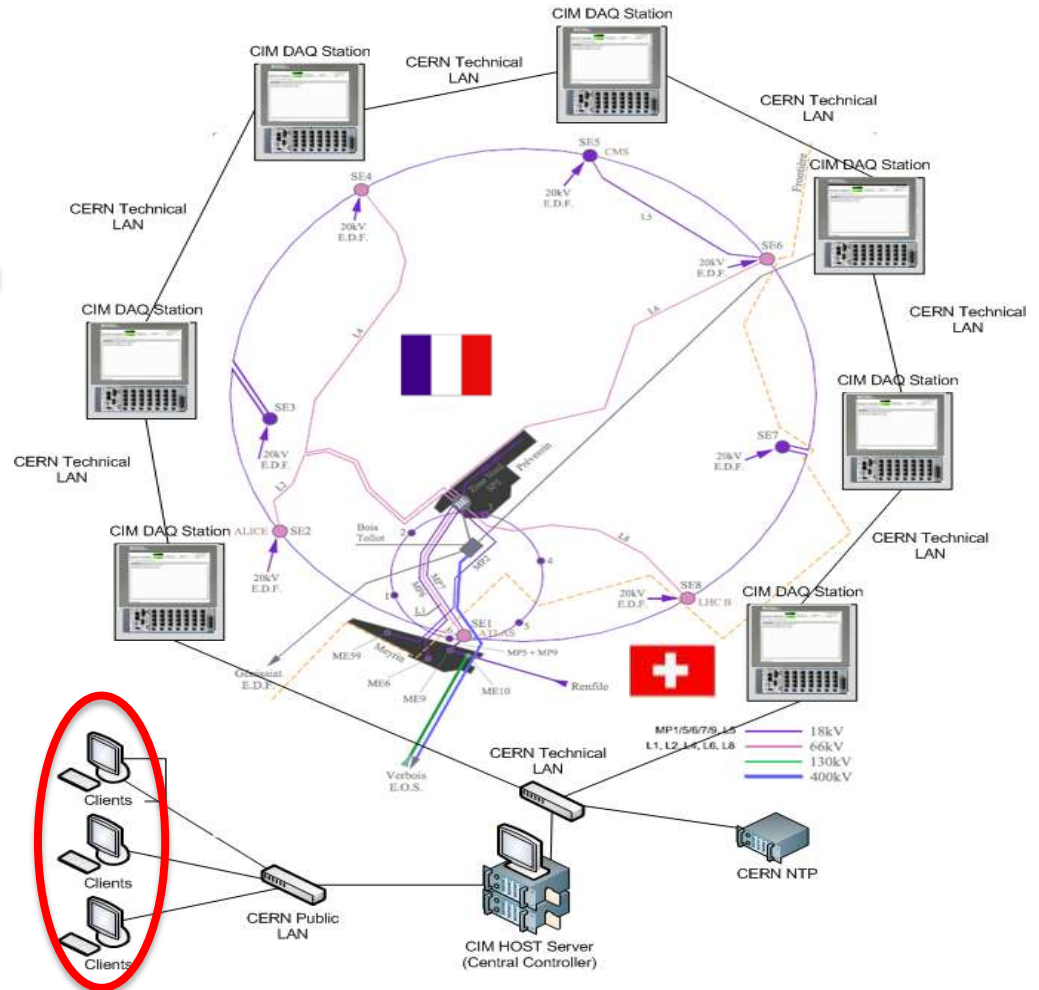
- Data Traffic Controller Manager
- Settings, Monitoring, Data Retrieval



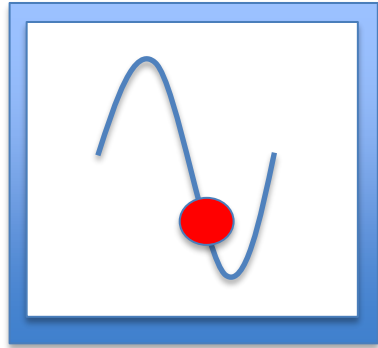
Configuration Clients



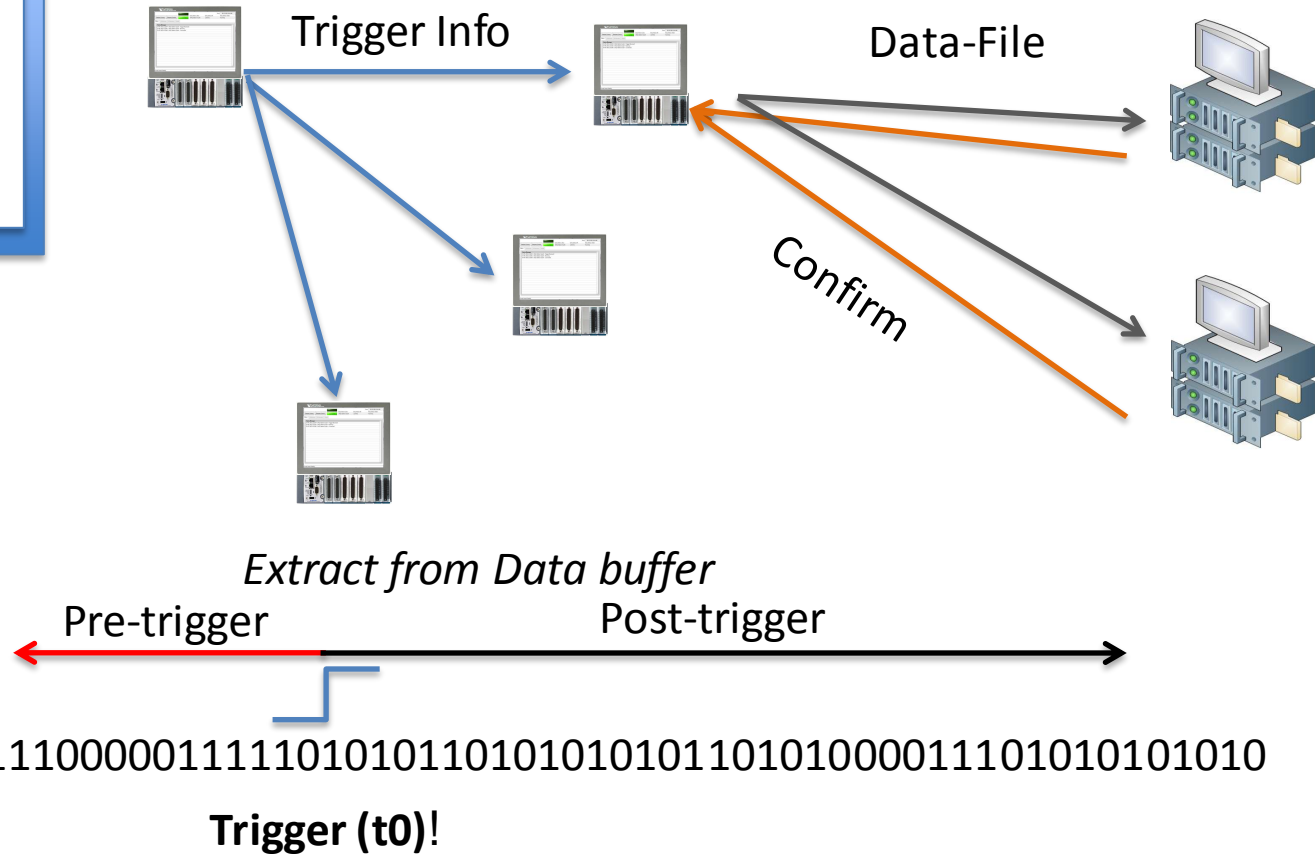
- Systems Configuration Tool
- Data View and Analysis



The Flow



Trigger (t0)!



Challenges

- Distributed Systems
- Multiple Platforms (Linux, Windows, RT, FPGA)
- Synchronization
- High Load Application
 - 7800 Hz Measurement and Realtime Analysis on 160 Channels Per DaqStation
- Bookkeeping (Redundancy)

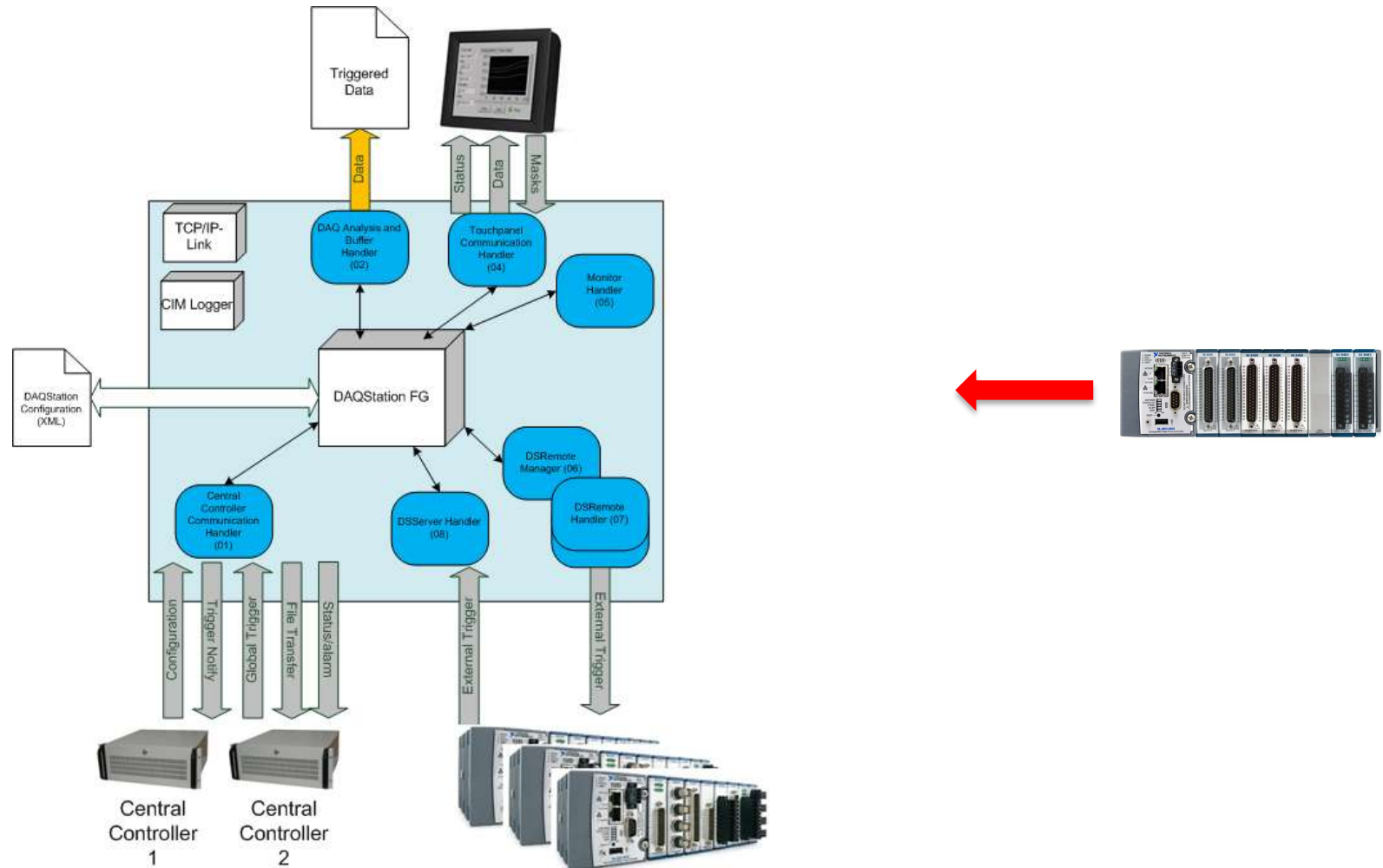


Design, Design and more Design!

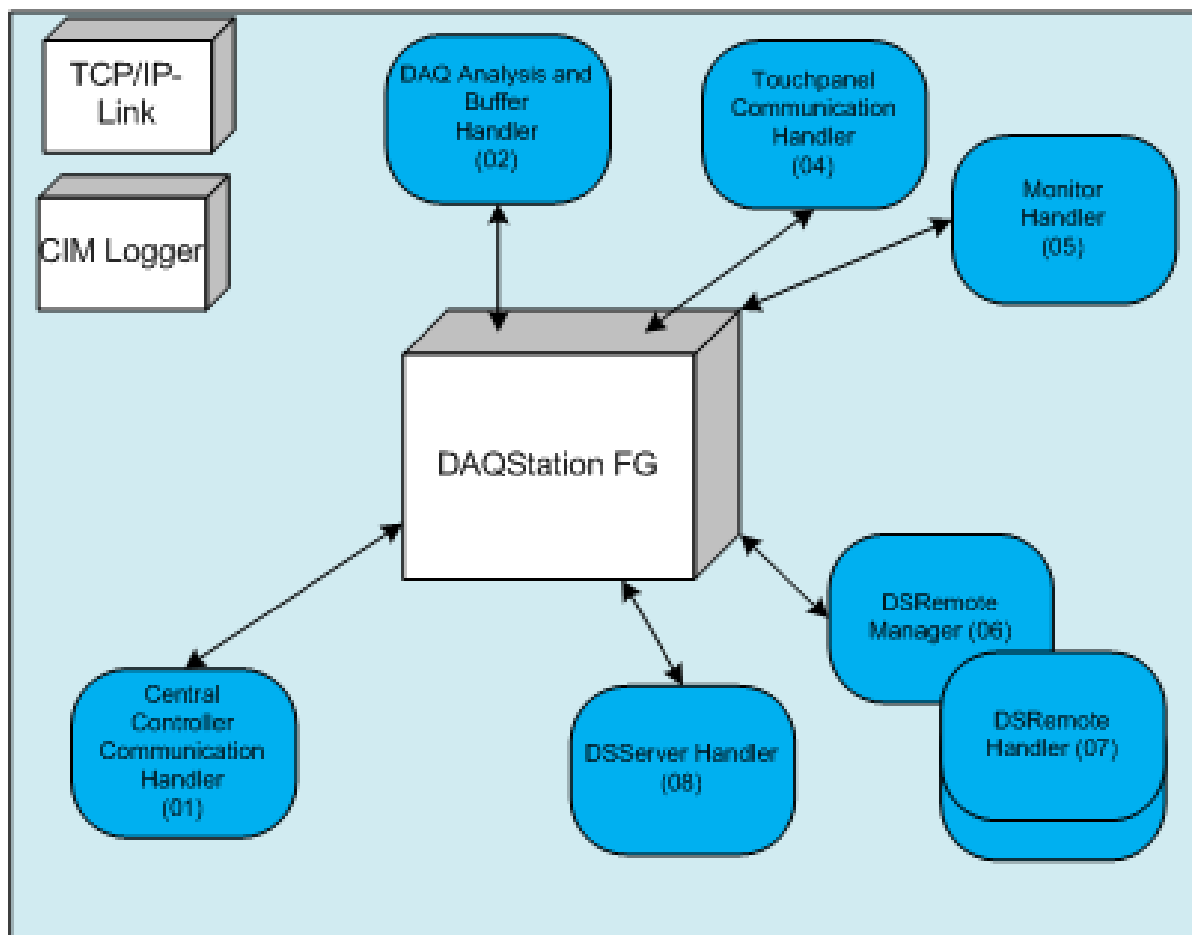
- Event-based frame-work
- Modular – atomic
- Several Developers
- Scalable/Versatile/Flexible
- Templates and code standard.
- 65% of project time used on design before first VI dropped!
- Pseudocode (VISIO) – breaking everything down in to small steps



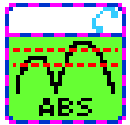
DAQ Station Overview



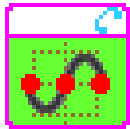
DAQ Station Overview



Trigger Types



Absolute



Zerocrossing



Delta-Peak



Peak-to-Peak



FFT – Requires Co-processor on FPGA

DAQ and
Trigger analysis
Handler
(02)

Very busy application!

Lots of memory-use, CPU-optimization and looking at load distribution

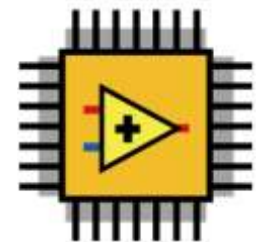
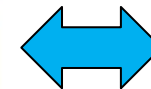
- Measure 64 Analog and 96 Digital Channels at 7800 Hz
- Data to FPGA Co-Processor
- Pipelining
- Optimization

DAQ and
Trigger analysis
Handler
(02)

DAQStation/cRIO



RT exe



FPGA

Keeping Tabs on the Entire Application

- 7 DAQStations
- 7 Touch Panels
- 2 Central Controllers
- N Configuration tools

Challenge! – Who does WHAT? WHEN? WHERE?

Solution - Distributed logging tool

- Syslog-standard with UDP-Multicast




Syslog Tool/Server

CIM Syslog Server (Syslog: 127.0.0.1:60514 Multicast: 234.5.6.7:58432)

DS CCI CC2 DS2 CT Setup Flood Alert Build: 1.0.2.3

Filter: IP Severity

Date	Time	Priority	Host	Message
29-07-2013	13:14:38	Debug	192.168.64.105	11:14:38,444 CT_CcComHandler_ConnectionManagement.vi Link CTClient192.168.1.141, IP: 192.168.64.122, Log: Warning code: 63, Source: TCP Open Connection in CCM - ConnectionManager.vi:1->CCM - Main.vi:3
29-07-2013	13:14:32	Debug	192.168.64.105	11:14:31,226 CT_CcComHandler_ConnectionManagement.vi Link CTClient192.168.1.141, IP: 192.168.64.122, Log: Old state: Enabling, New state: Enabled
29-07-2013	13:14:31	Debug	192.168.64.105	11:14:31,226 CT_CcComHandler_ConnectionManagement.vi Link CTClient192.168.1.141, IP: 192.168.64.122, Log: Old state: Disabled, New state: Enabling
29-07-2013	13:14:31	Debug	192.168.64.105	11:14:31,226 CT_CcComHandler_ConnectionManagement.vi Link: CTClient192.168.1.141 Re/Started, Port: 60001, IP: 192.168.64.122
29-07-2013	13:14:31	Debug	192.168.64.105	11:14:28,688 CT_CcComHandler_ConnectionManagement.vi Connection Manager Parallel Loop Started
29-07-2013	13:14:28	Debug	192.168.64.105	11:14:28,686 CT_CcComHandler_WriteCcMessage.vi Write CC parallel loop Started
29-07-2013	13:14:28	Debug	192.168.64.105	11:14:28,185 CT_GUIModule_Main.vi Module Started
29-07-2013	13:14:28	Debug	192.168.64.105	11:14:28,185 CT_SimulationModule_Main.vi Module Started
29-07-2013	13:14:27	Debug	192.168.64.105	11:14:27,800 CT_CcComHandler_Main.vi Module Started
29-07-2013	13:14:26	Info	192.168.64.105	11:14:26,948 CT_Main.vi =====CT_Main.vi Application Starting=====Build 1.0.0.4=====
29-07-2013	13:14:26	Info	192.168.64.105	11:14:26,688 Log DAEMON -o-o-o-o-o-o-o-o-o-o-DAEMON Started-o-o-o-o-o-o-o-o-o-o-
29-07-2013	13:14:26	Debug	192.168.64.105	Init log from BDM-LAPTOP2.cim.local

LOG  Init  Log  Close

Questions



Contact Info

Bjarke Dahl-Madsen - bdm@cim.as

Learn more about CIM Industrial Systems A/S at

www.cim.as

Thank You!