High-Speed Data Capture for Root-Cause Analysis and Data Management

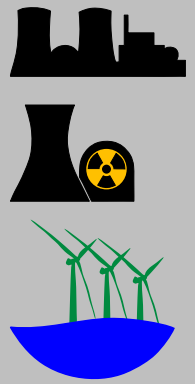
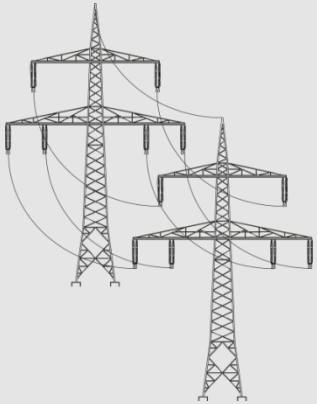
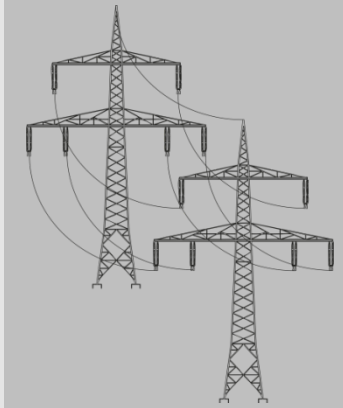
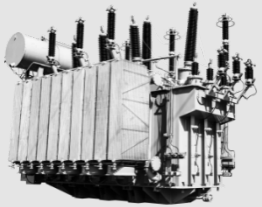
Apr-2022 | Manko Ho | iba America, LLC

Self-Intro

- Speaker: Manko Ho
- Company: iba America, LLC
  - iba is a global company with the headquarter located in Germany. iba offers software and hardware products to support high-speed industrial data acquisition applications with a wide range of connectivity options to collect data from PLCs, transducers, drives, etc. We also provide data visualization and analysis packages.
- Education:
  - MS in Mechanical Engineering from Georgia Tech
  - BS in Mechanical Engineering from the University of Florida

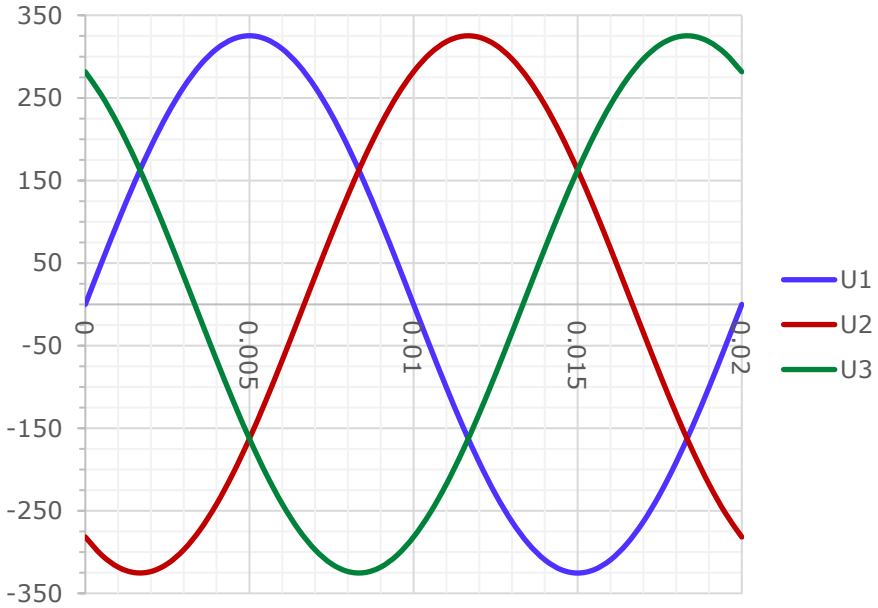
- Coauthors:
  - Dr. Jochen Fuchs (iba AG)
    - Sr. Application Engineer
  - Manuel Koenig (iba AG)
    - Product Manager/Technical Support

Motivation

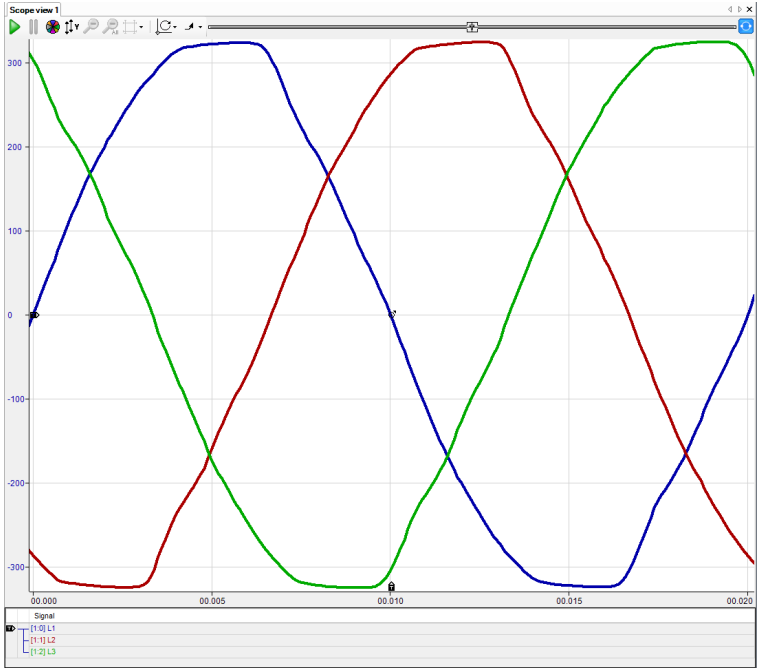
Generator	High voltage ≥220 kV	High voltage 110 kV	Medium voltage 10–35 kV	Low voltage 110–400 V
Power plants 				

Motivation

Ideal grid voltage

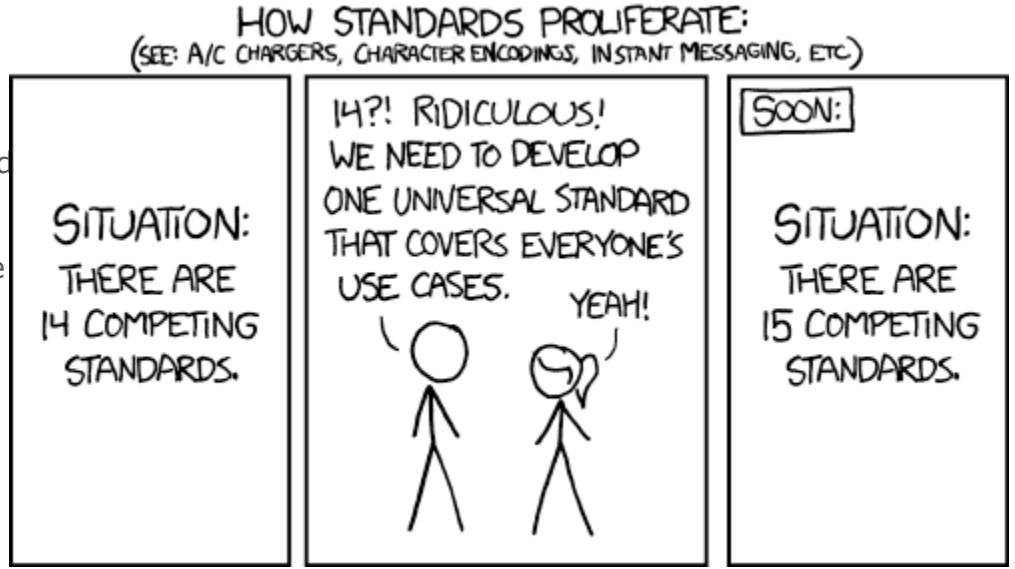


Real grid voltage



Motivation

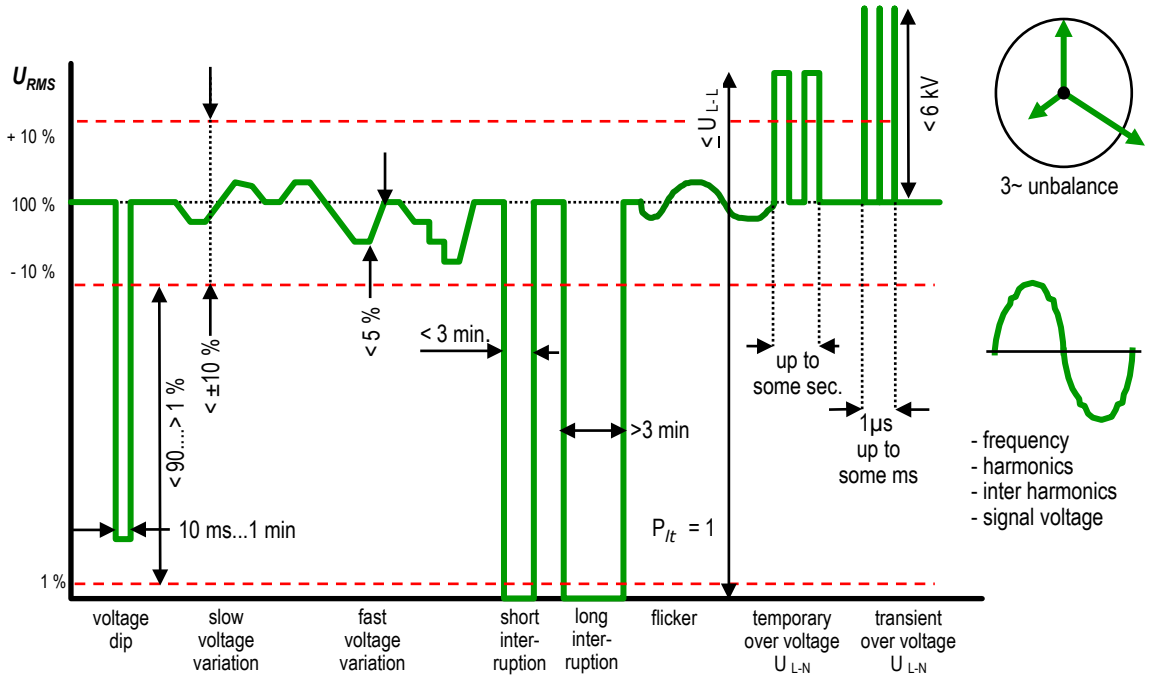
- EN 50160
  - Reporting standard
- IEC 61000-4-30
  - Power quality measurement and calculations
- IEC 61000-4-7
  - Harmonic and interharmonic measurement and
- IEEE 519
  - Relates to the calculation and limits on voltage
- IEC 61000-4-15
  - Flicker measurements
- IEEE C37.118-2005
  - Synchrophasor
- Etc…



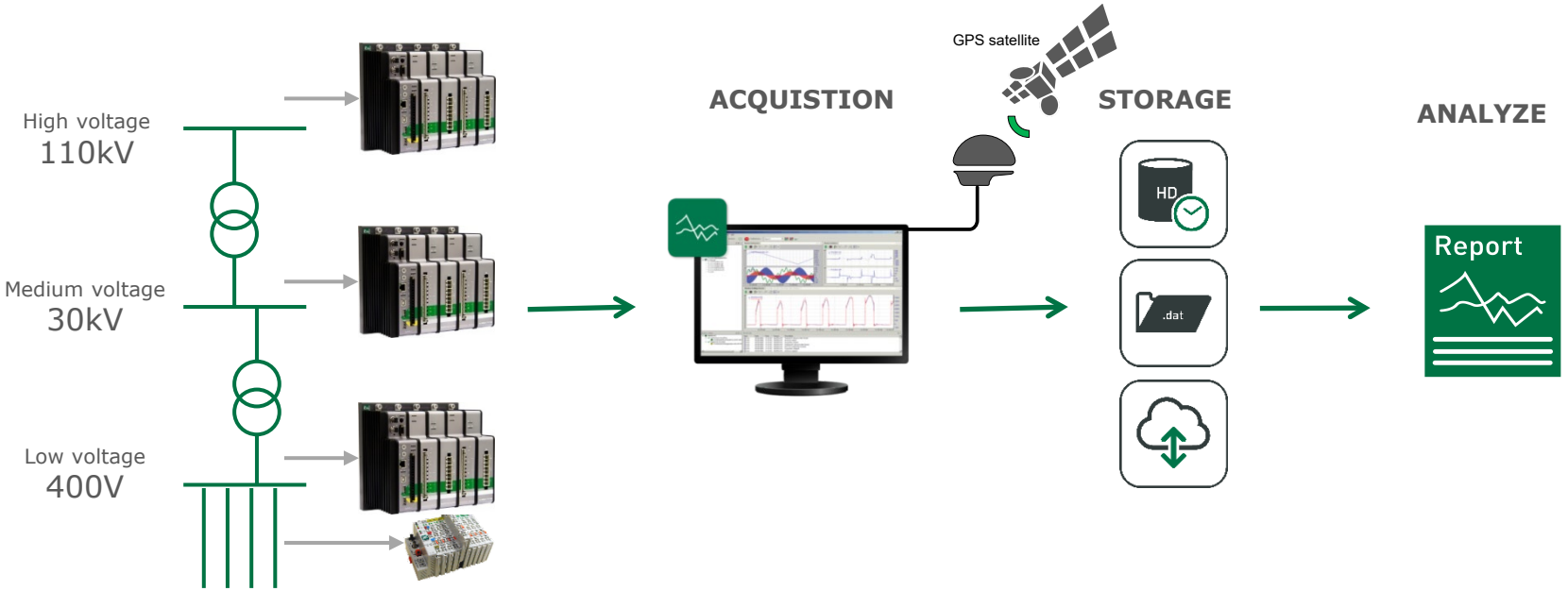
Src: https://imgs.xkcd.com/comics/standards.png

Motivation

- Frequency of voltage events
  - Dip / Swell
  - Drop (Interruption)
- Violation of harmonic limits
  - Limits of individual harmonics
  - THD
- Grid frequency
- Flicker
- Voltage unbalance
- …



Data Capture Architecture



Using the Data

- Application Example 1: M2 Voltage Feedback

The Background

- The cycloconverter drive for propulsion Motor 2 faulted on a shipping vessel

The Data

- A recording of the motor voltage and current feedback signals for was taken.
- An analysis of the recording shows that even though the drive tripped on a Phase C fault the problem was caused by a loss of voltage feedback on Phase B.

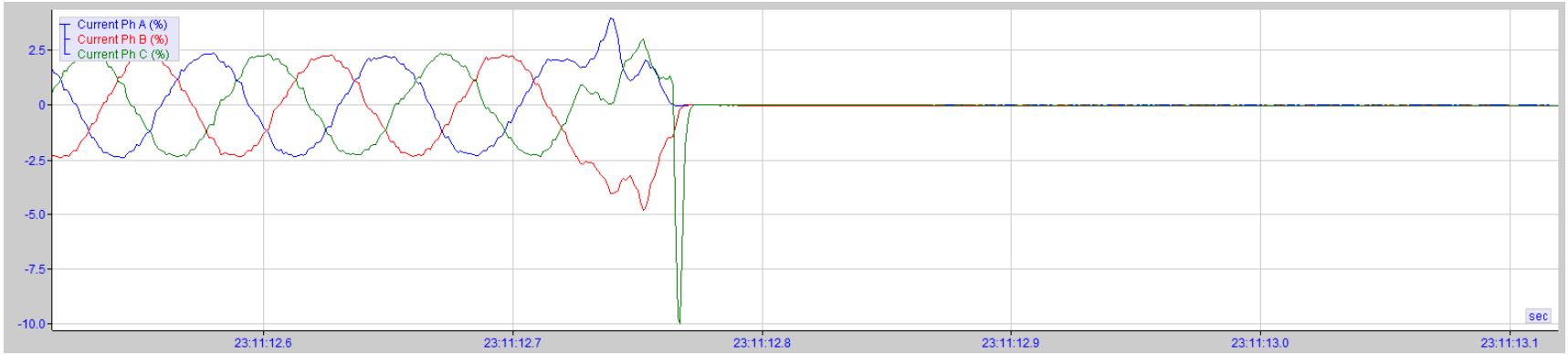
The Issue

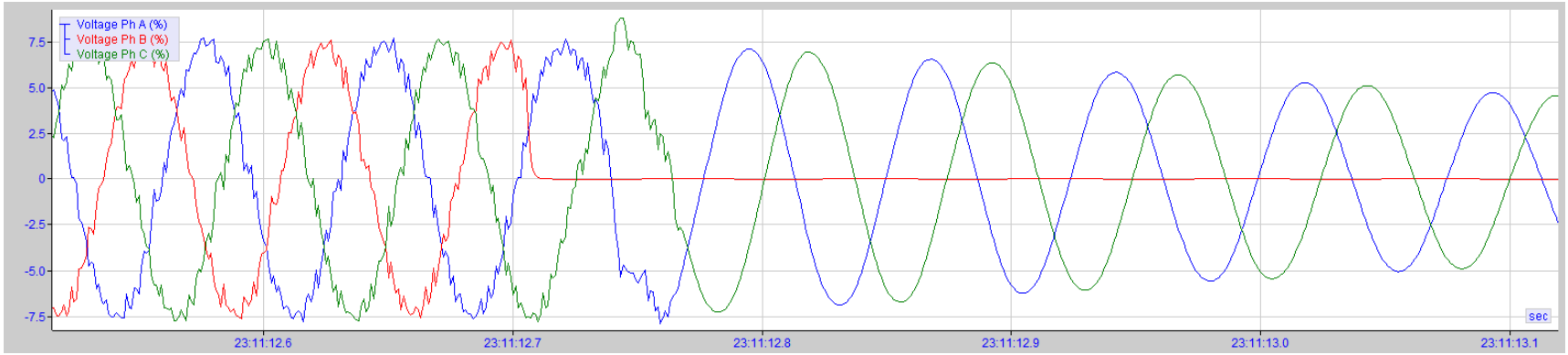
- The fault occurred due to an invalid current calculation in the motor Phase C

The Solution

- The voltage feedback transducer for Phase B was replaced to resolve the problem.

Using the Data





Using the Data

- Application Example 2: 110 kV Transmission Line

The Background

- Fault in the 110kV transmission line in Fürth leading to computer issues at the iba AG office

The Data

- High-speed data and derived values were captured to trend the transient event

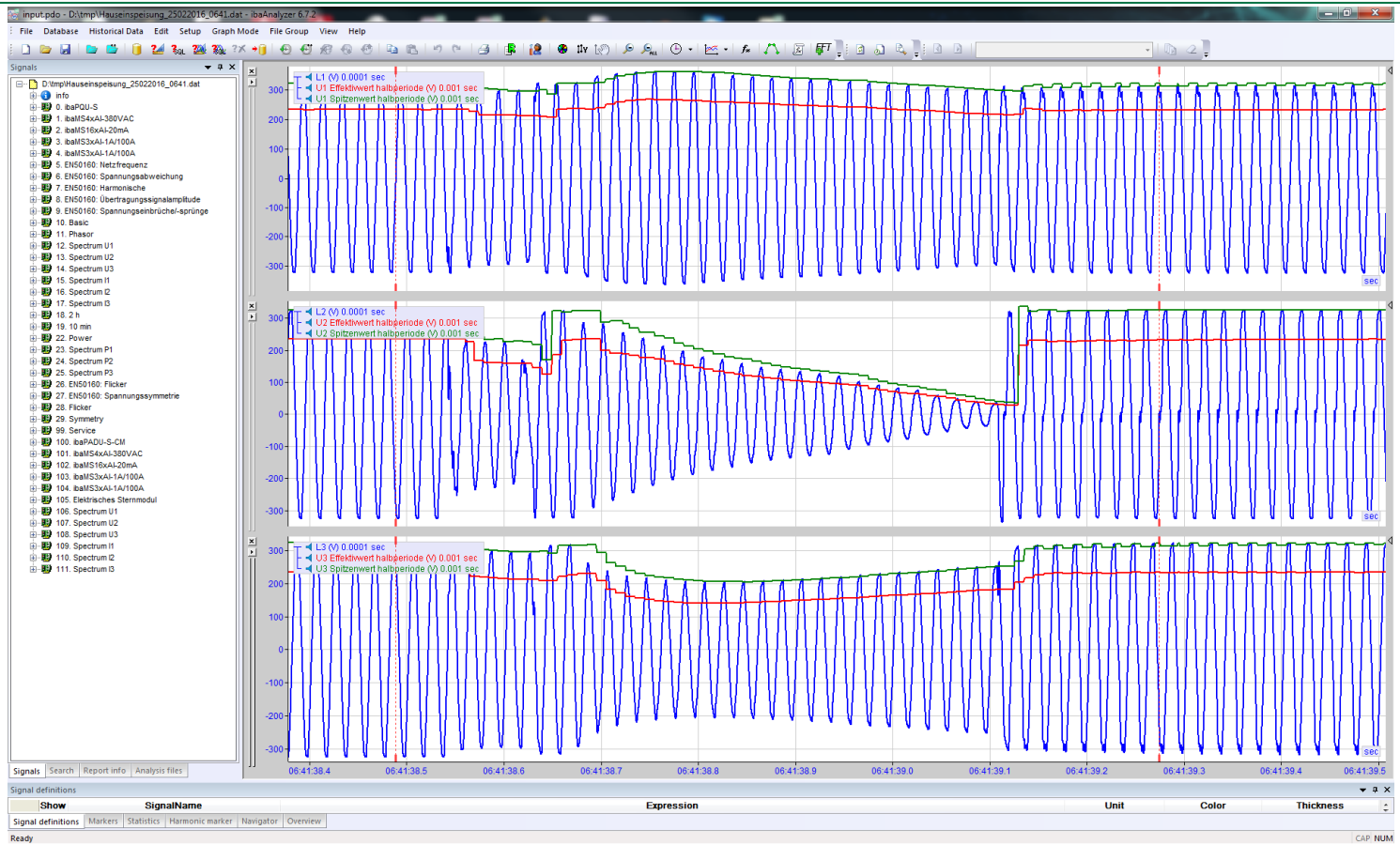
The Issue

- Prolonged low voltage on phase L2 led to issues for the power supplies

The Solution

- Confirmed with the local power company that they had an issue with the transmission line

Using the Data



Using the Data

- Application Example 3: Significant Frequency Deviation
  - Below information are from: Link

The Background

- "On Jan. 10th, 2019 at 21:02 CET, the Continental Europe Power System registered for 9 seconds the largest absolute deviation since 2006."

The Data

- Data collected at the iba head quarter in Germany captured the deviation.
- The power frequency can be observed to drop at the indicated time

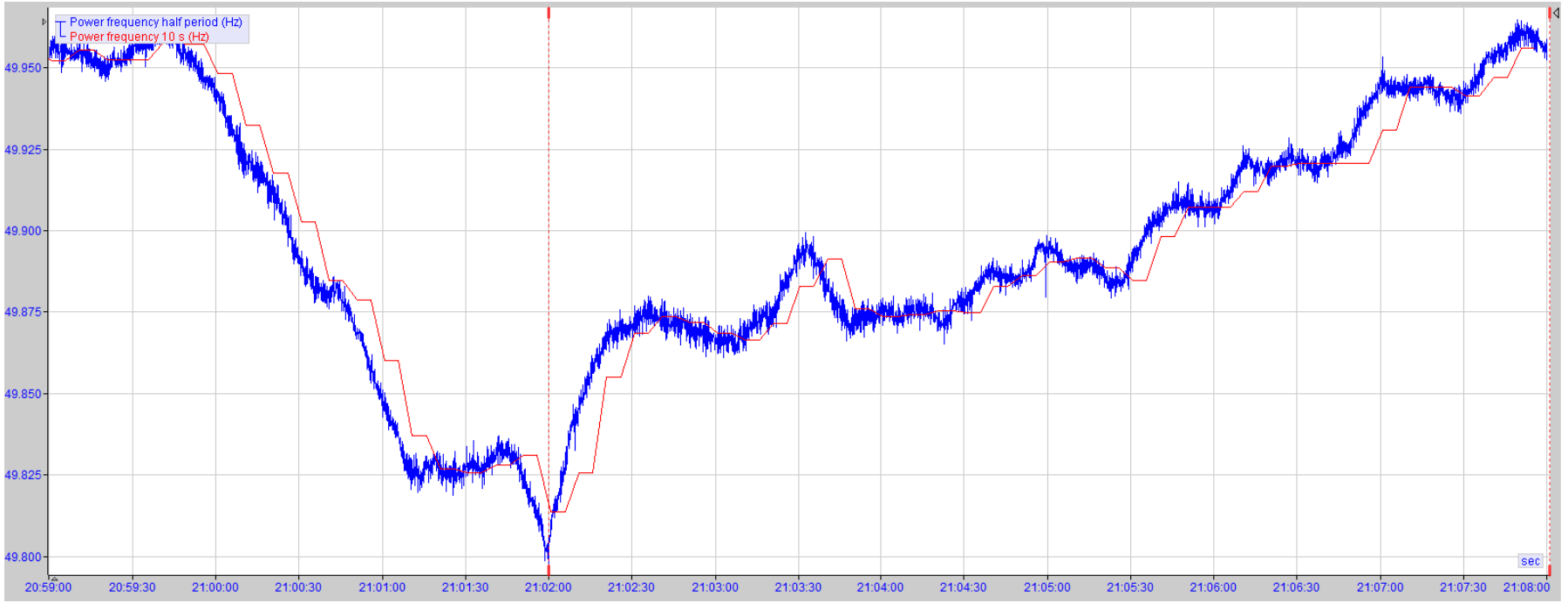
The Issue

- "After a detailed technical analysis by the TSOs of Continental Europe, it appears the drop was caused by the superposition of a large deterministic frequency deviation on one hand, and another frequency deviation, due to a frozen measurement on four interconnection lines between Germany and Austria that lasted between 9 and 11 January, on the other hand."

The Solution

- Immediate fix: "Activation of reserves across Continental Europe and of interruptible contracts with industrial consumers in France quickly brought the frequency back to normal range."
- Further investigations/studies were launched by ENTSO-E to offer solutions for the future

Using the Data



Using the Data

- Application Example 4: French-Spanish Interconnection
  - Below information are from: Link

The Background

- "On Saturday, 24 July 2021, due to a major incident originated in France, France and Spain were disconnected at 16:36 CEST and were brought back into normal operation by the responsible TSOs of Spain and France at 17:09 CEST."

The Data

- Data collected at the iba head quarter in Germany captured the influence of this event happening a few countries away.

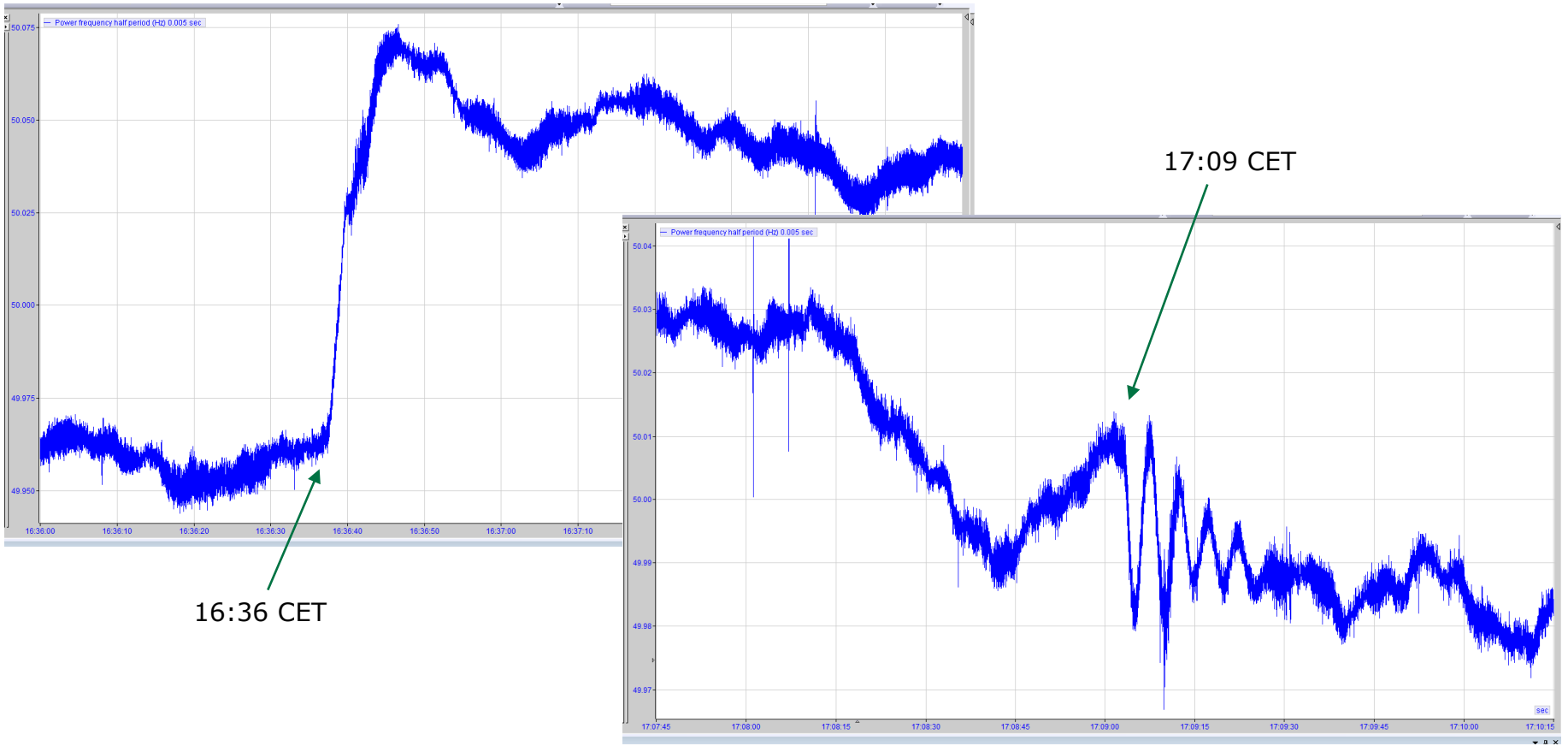
The Issue

- "During the disturbance, the frequency deviation of the large part of the Continental Europe was kept within a narrow margin between 49.96 and 50.07 Hz, whereas in the Iberian Peninsula the deviation was more substantial and involved further emergency measures according to the predefined plans. The load and customers which were disconnected in the Iberian Peninsula after 16:36 CEST, were again connected and re-supplied after 17:09 CEST."

The Solution

- TSOs executed predefined plans to minimize frequency deviations.
- "Investigation and verification are currently ongoing on whether the forest fire along the line route was the root cause of the event."

Using the Data



Using the Data

- Application Example 5: G2 Power Surge

The Background

- The crew heard the main engines surge for a few seconds

The Data

- Analysis of data files shows that Generator 2 momentarily sped up causing it to take more load.
- The other two generators reduced load in order to keep the bus frequency at 60 Hz.

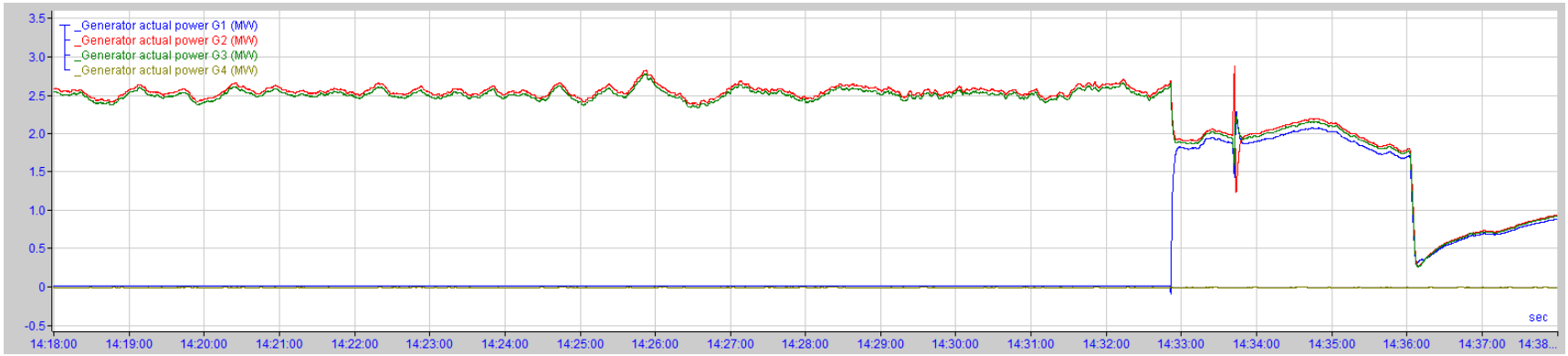
The Issue

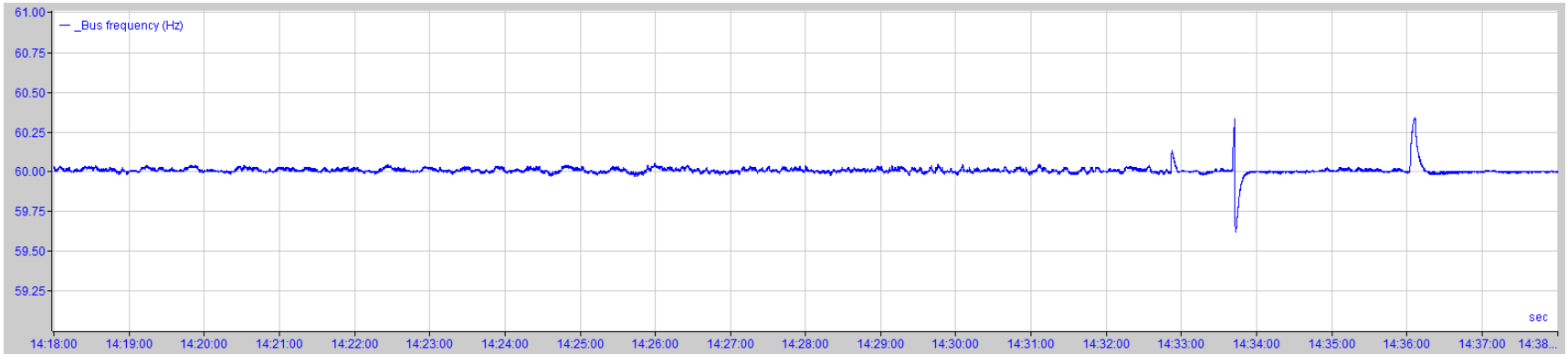
- The event was too fast to observe meter readings.

The Solution

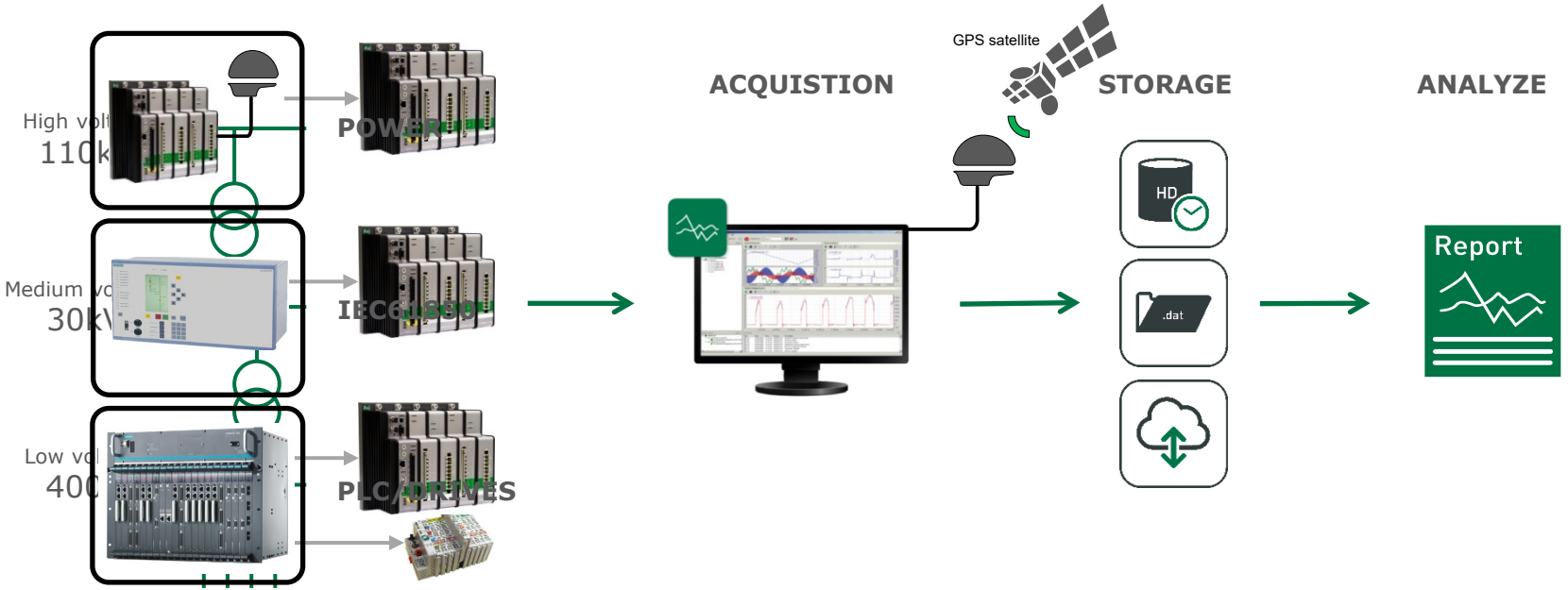
- A problem was found in the Generator 2 mechanical governor.

Using the Data





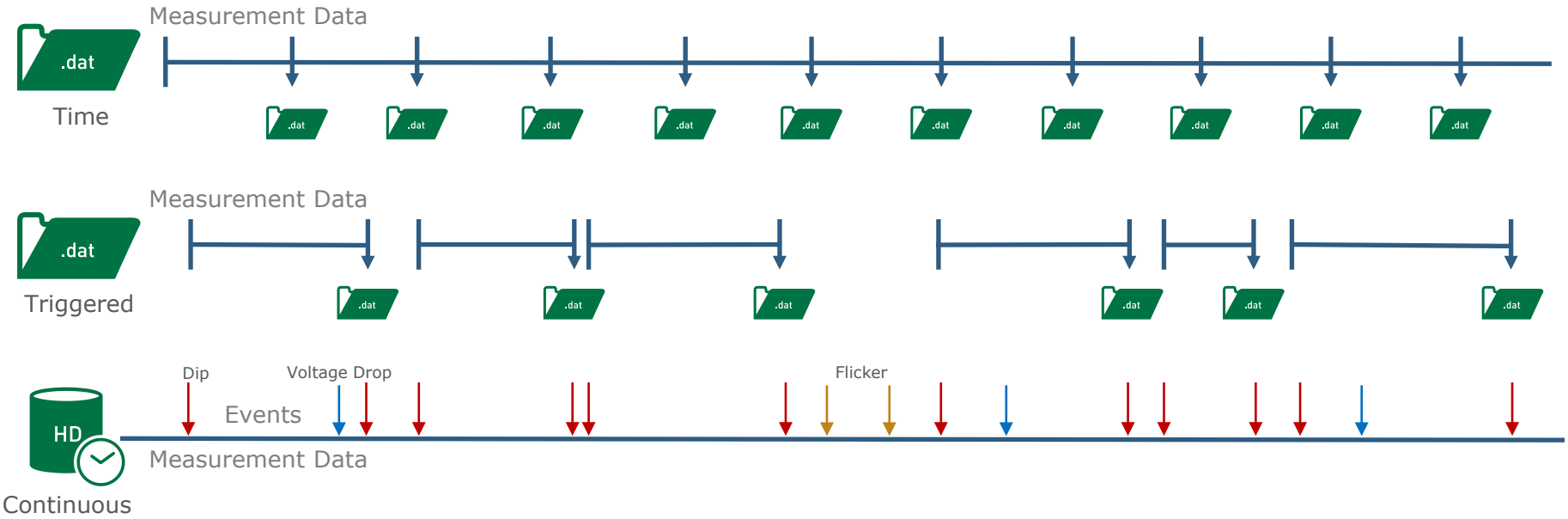
Other Types of Data



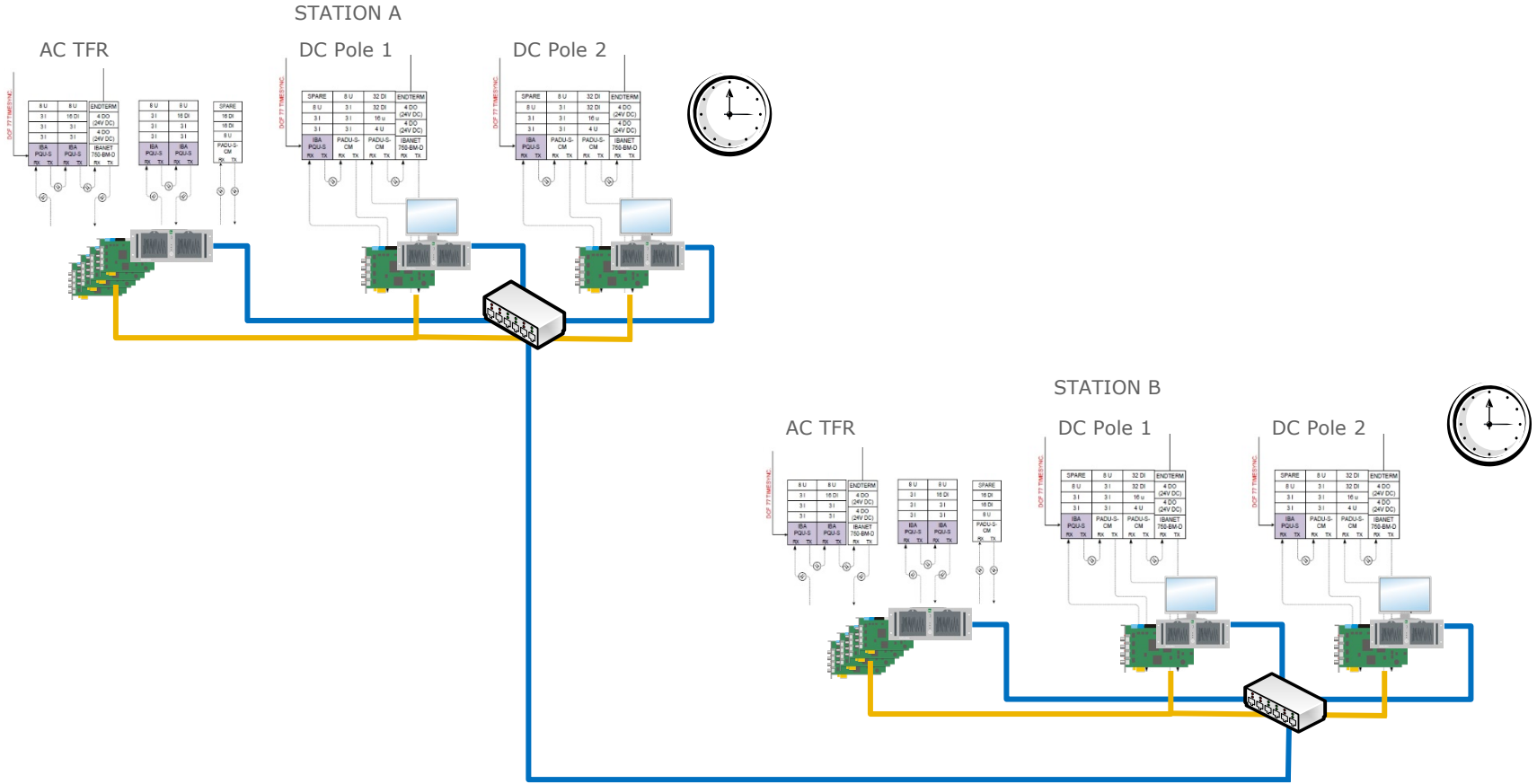
Data Storage

Events

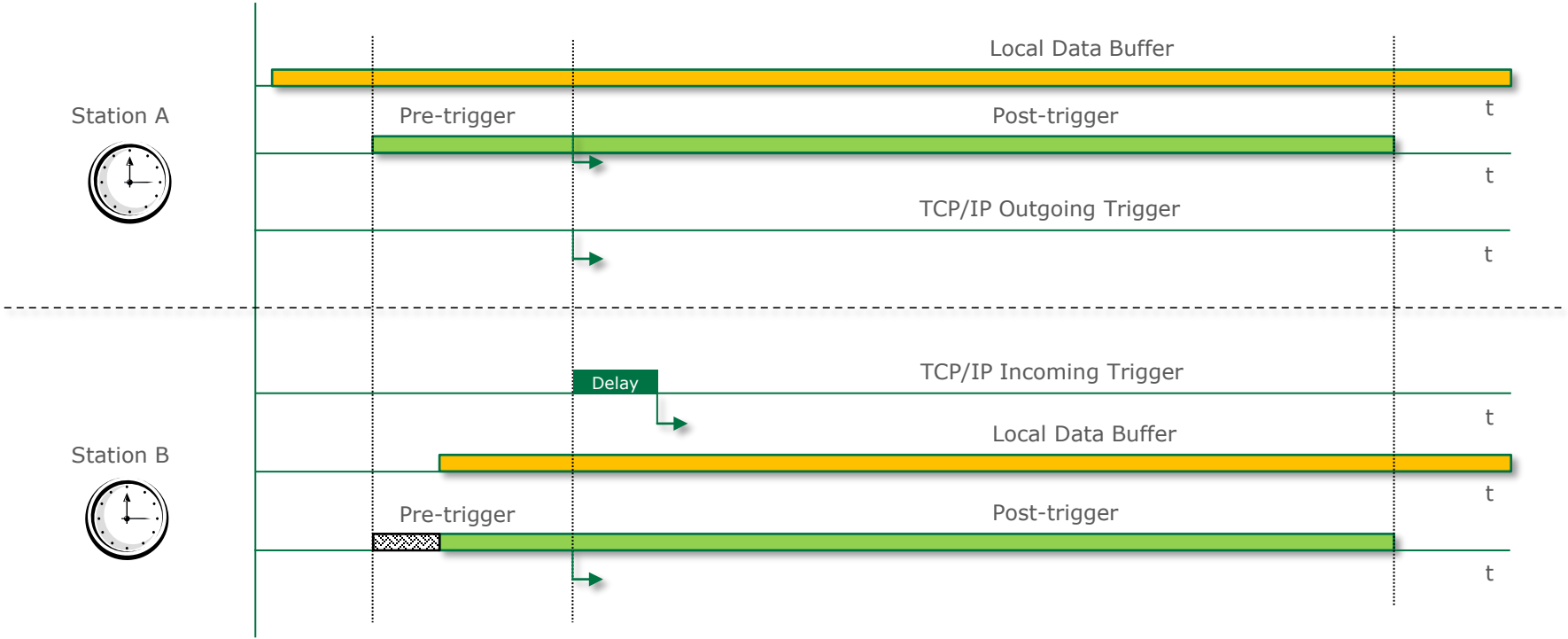
Data Acquisition



Topology with n stations

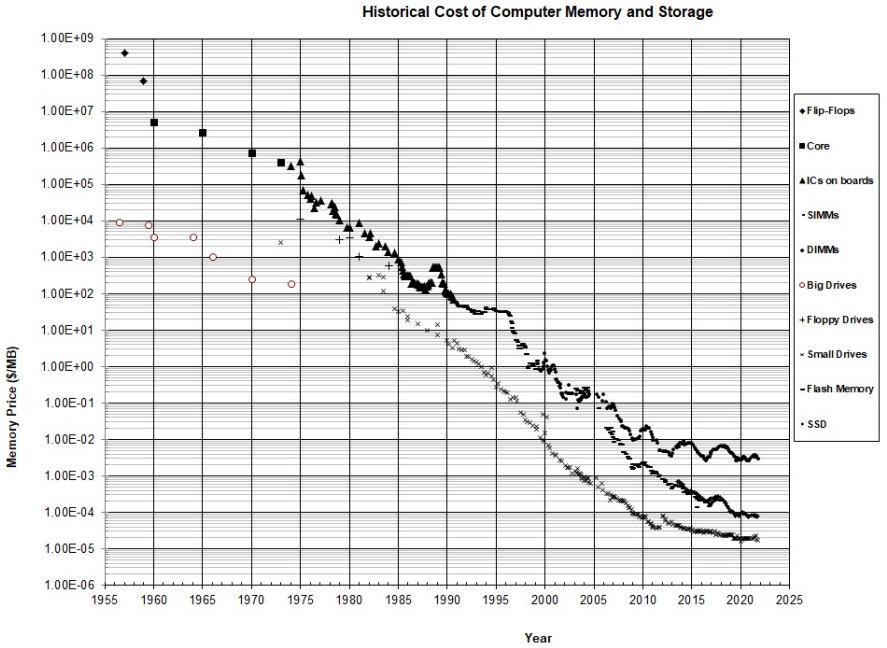


Delay Incoming Trigger



Data Storage

- Raw data storage may get expensive!
- Imagine a typical 3 phase power scenario
  - 8kHz * 6 channels (3 voltages + 3 currents) = 48 kSamples/sec
  - 48 kSamples/sec * 4 bytes/sample = 192 kB/sec
  - 1 hour = 691200 kB = 0.691GB
  - 24 hours = 16.7 GB
  - 365 days = 6.05 TB

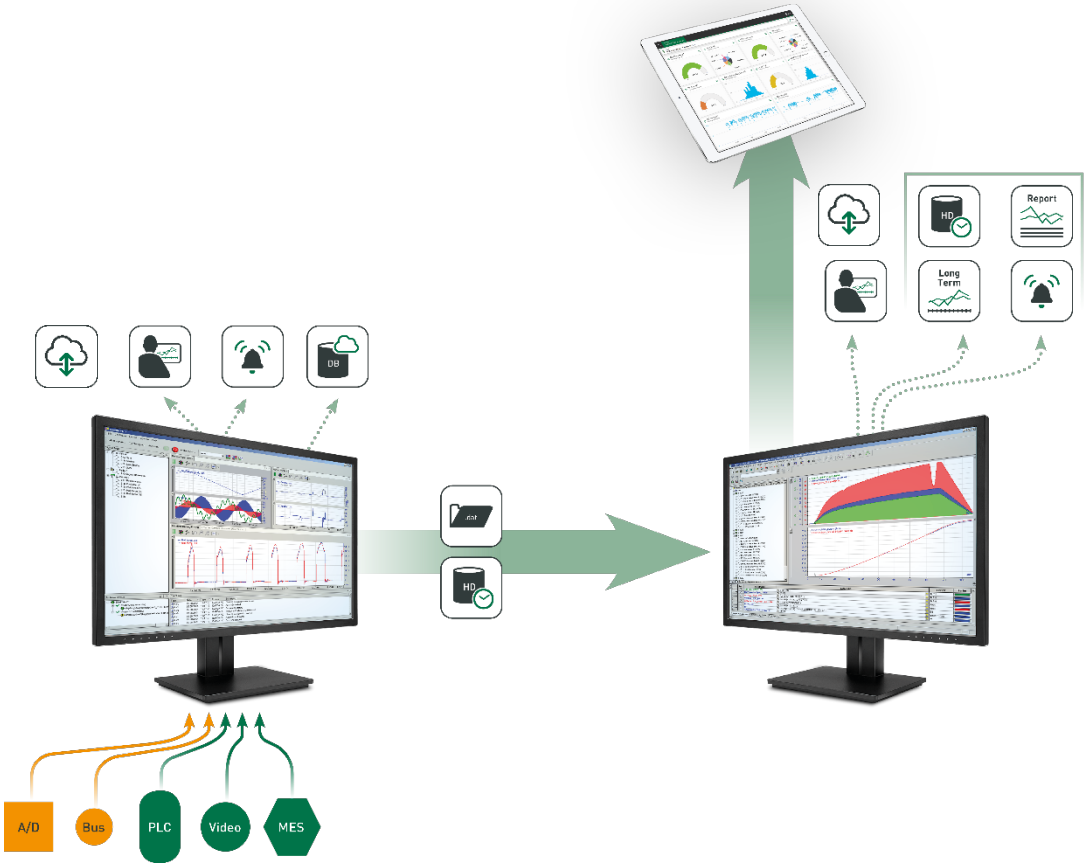


Src: Disk Drive Storage Price Decreasing with Time (jcmit.net)

Stake Holders

Data

- Operation Data
- Production Data
- Process Data
- PLC Data
- Machine Data
- Energy Data
- Vibration Data



Stake Holders

- Maintenance
- Quality Management
- Production
- Process Technology
- R&D / Engineering
- Plant Builders

Questions?

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