IEEE PES-TR74 Report Overview

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Presentation Agenda

Background

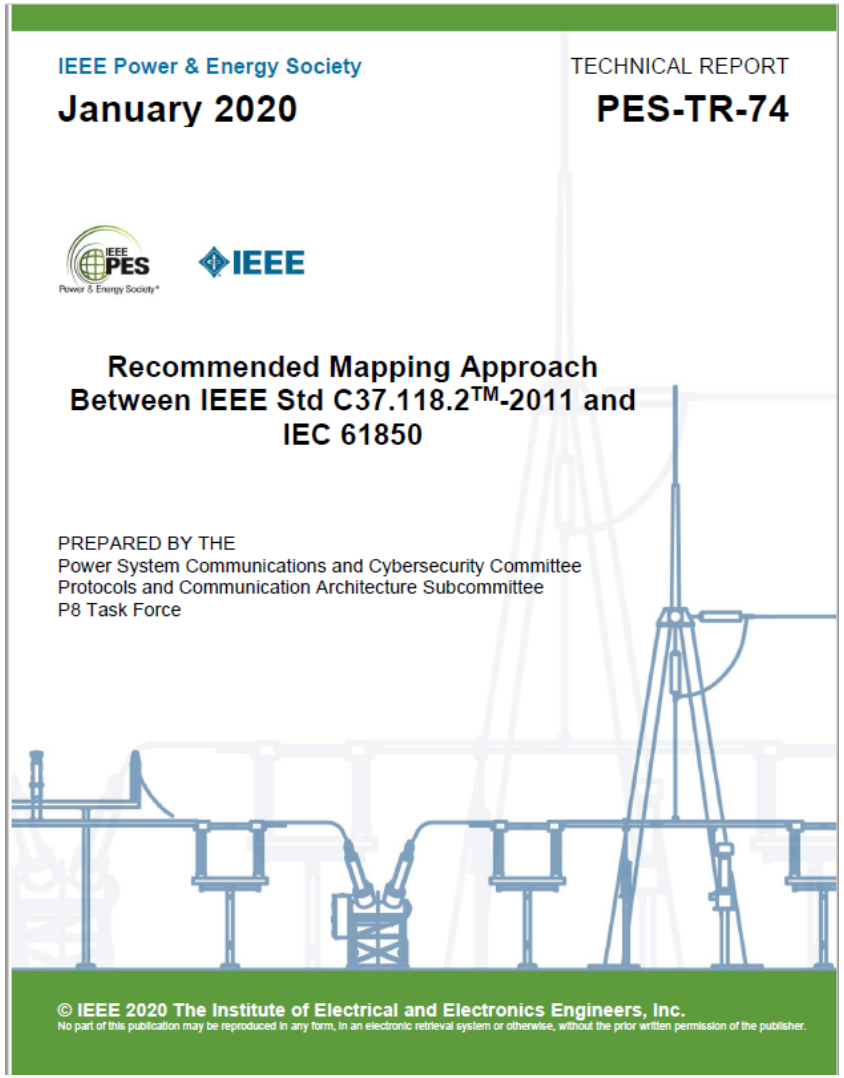
- IEEE Std C37.118.2™-2011
- IEC 61850-90-5

Report Overview

- Use cases, conceptual architecture, and data, configuration, and control message exchange
- Detailed mapping overview

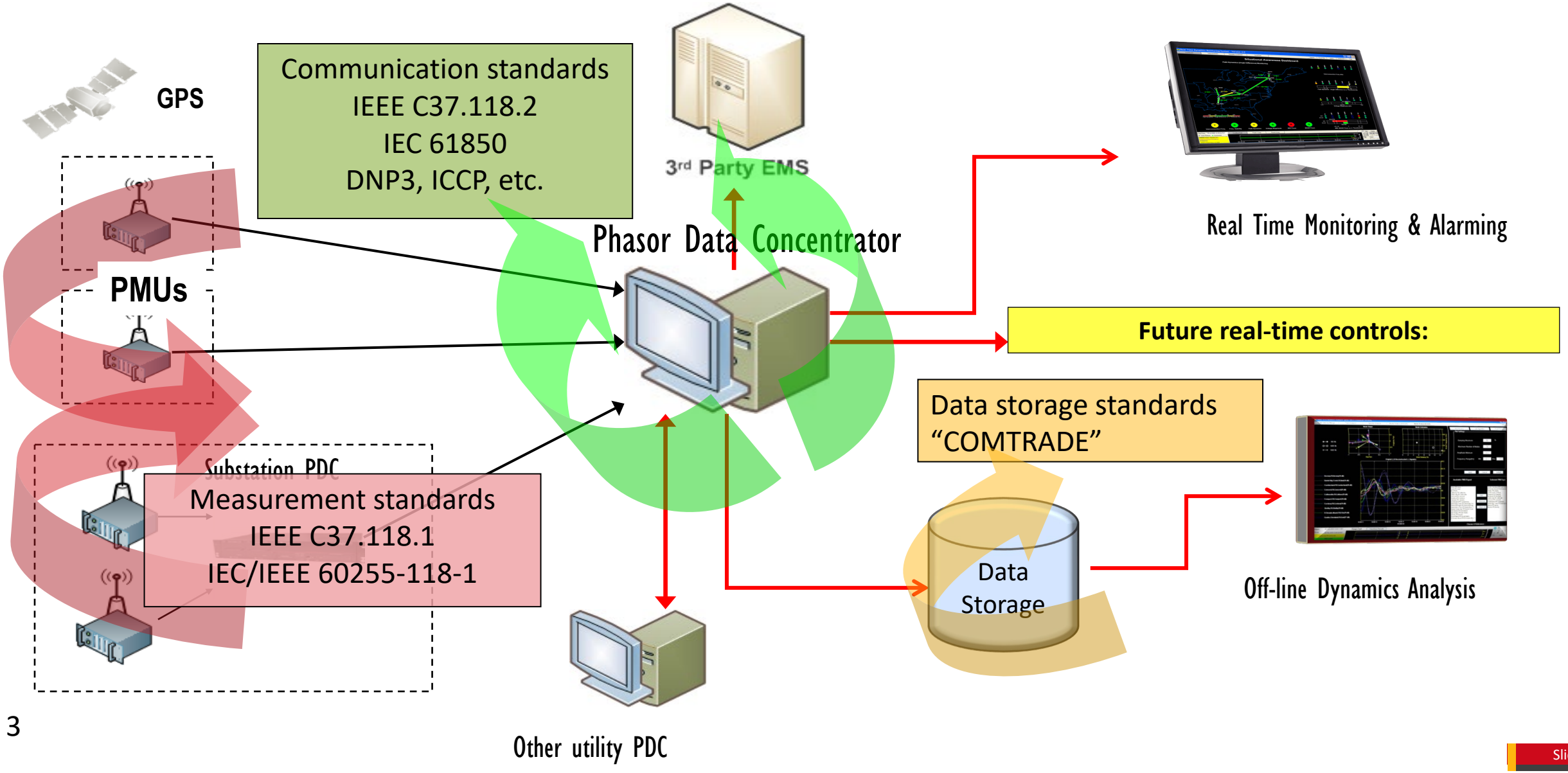
Takeaways & Outlook

- Key takeaways
- Current synchrophasor data transfer protocol related standardization activities



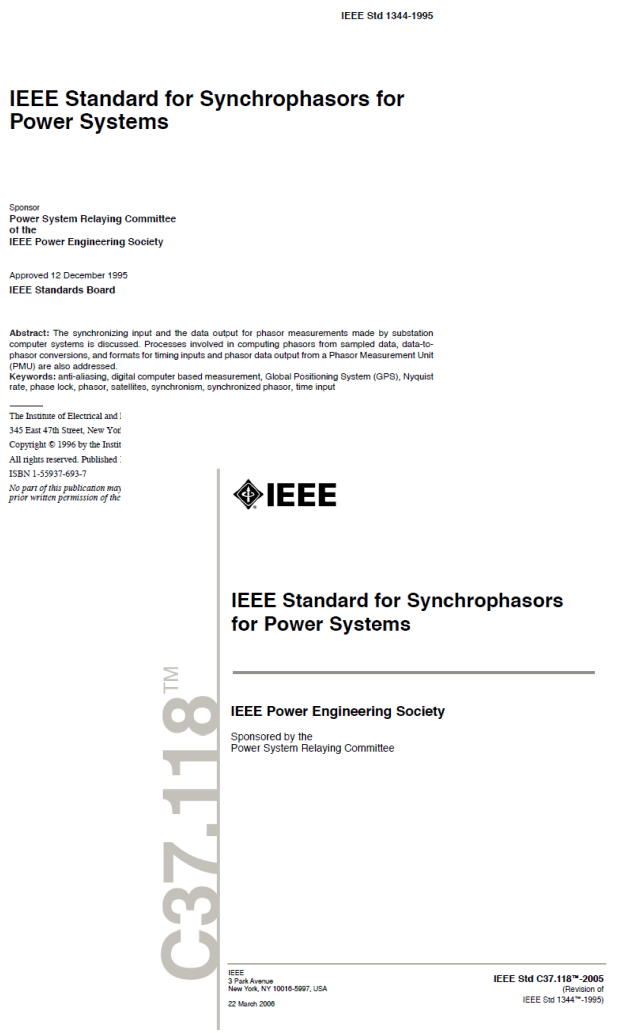
Source: https://resourcecenter.ieee-pes.org/publications/technical-reports/PES_TP_TR74_PSCC_012020.html

Phasor Measurement System



IEEE Synchrophasor Standards

- IEEE1344-1995, first standard
  - Focus on sampling & timing
- IEEE C37.118 – 2005, second standard
  - Measurement requirements--
    - Test method & error limits specified
    - Steady-state phasor only
  - Data transmission format--
    - Comprehensive status and error indications
    - Allows transmitting data aggregated from multiple PMUs
    - Adaptable for network communication



IEEE Std 1344-1995

IEEE Standard for Synchrophasors for Power Systems

Sponsor
Power System Relaying Committee
of the
IEEE Power Engineering Society

Approved 12 December 1995
IEEE Standards Board

Abstract: The synchronizing input and the data output for phasor measurements made by substation computer systems is discussed. Processes involved in computing phasors from sampled data, data-to-phasor conversions, and formats for timing inputs and phasor data output from a Phasor Measurement Unit (PMU) are also addressed.
Keywords: anti-aliasing, digital computer based measurement, Global Positioning System (GPS), Nyquist rate, phase lock, phasor, satellites, synchronism, synchronized phasor, time input

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IEEE

IEEE Standard for Synchrophasors for Power Systems

C37.118™

IEEE Power Engineering Society

Sponsored by the
Power System Relaying Committee

IEEE
3 Park Avenue
New York, NY 10016-5997, USA

22 March 2006

IEEE Std C37.118™-2005
(Revision of
IEEE Std 1344™-1995)

Synchrophasor System Growth

- Large growth in phasor measurements after 2003 blackout in N. America & others around world
  - IEEE & IEC interested in harmonization of standards for synchrophasor applications
- IEC considered adoption of C37.118
  - C37.118 includes measurements and communications
  - IEC separates communication and measurement into separate technical committees and thereby has separate standards
  - Therefore adoption or direct harmonization were not possible
- In 2008 IEEE split C37.118-2005 split into two standards to facilitate joint development or adoption

IEEE Synchrophasor Standard Changes

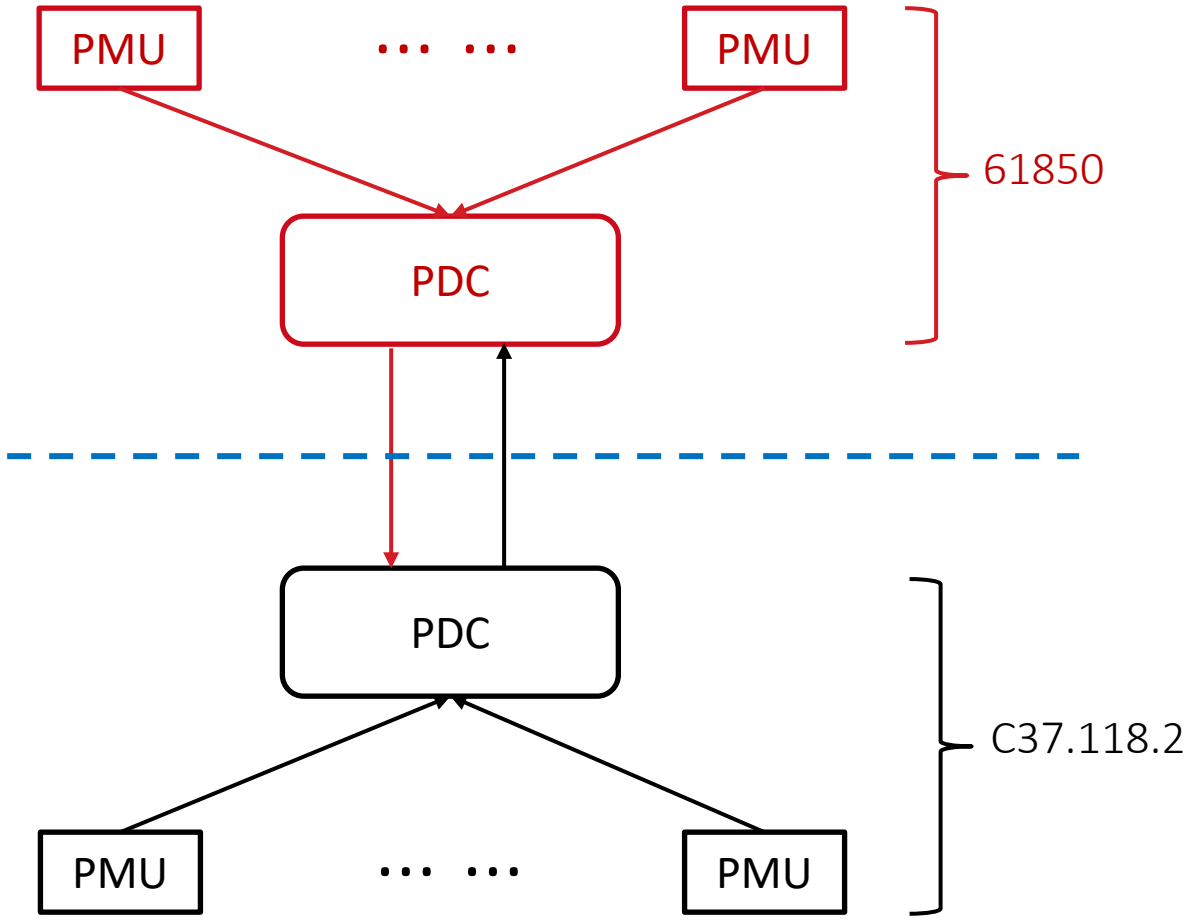
- IEEE C37.118-2005 split into 2 standards:
- C37.118.1 – 2011 (& 2014 amendment)
  - Measurements only
  - Dynamic operation qualifications added
  - Frequency & ROCOF included in qualification tests
- C37.118.2 – 2011
  - Preserved existing data exchange
  - Added needed improvements (flags & configuration)
- Note: C37.118.1 is now superseded by IEC/IEEE 60255-118-1

IEC Synchrophasor Communication

- WG10 (IEC TC57) developed TR 61850-90-5
  - Based on use cases of established synchrophasor uses and applications
  - Changes included --
    - Routable mapping of SV
    - New models for logical node & PDC function
    - New A & T profiles
    - New data classes & object types
    - Advanced security features
- Completed October 2011, published May 2012

Data Exchange Challenges

- When one protocol is used, data exchange is a simple send-receive process
- When exchanged data between systems/devices using different protocols
  - Some “Translation”(or “Mapping”) will be needed



Report TOC

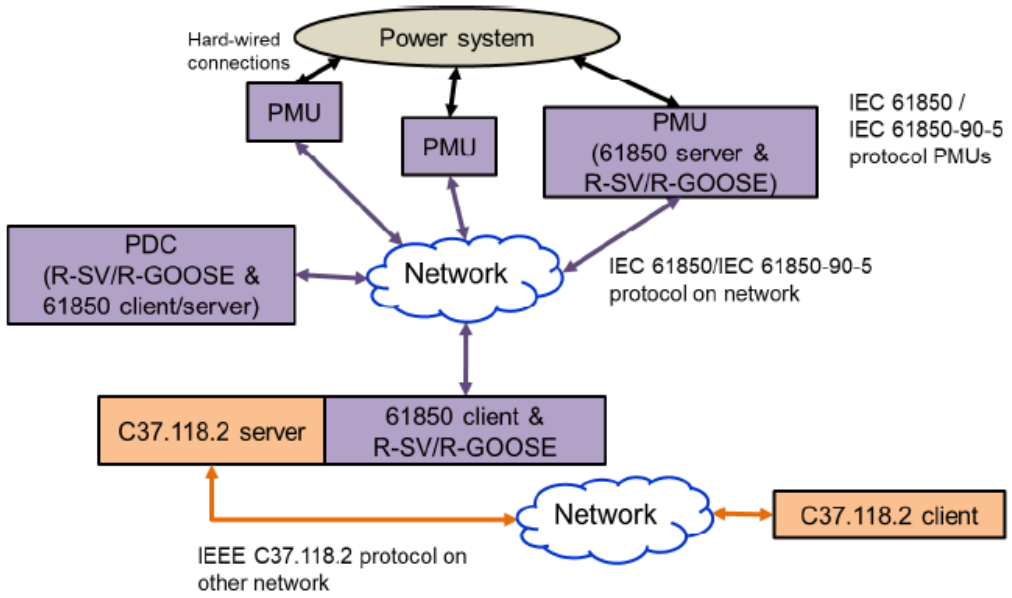
- Work started in 2013 to develop a report with an intention to potentially develop it into a standard
  - IEEE C37.118.2 ←→IEC 61850-90-5
- During the development, some changes to the two standards occurred
  - IEC integrated key components of TR 61850-90-5 into main parts of 61850 Ed.2.1
  - IEEE C37.118.2-2011 update has started
- Decision was made to keep it as a report but make some adjustment to take changes in IEC 61850 into account

CONTENTS

Source: IEEE PES-TR74 Report

Use Cases for Mapping

Use Case A
61850 ➔ C37.118.2

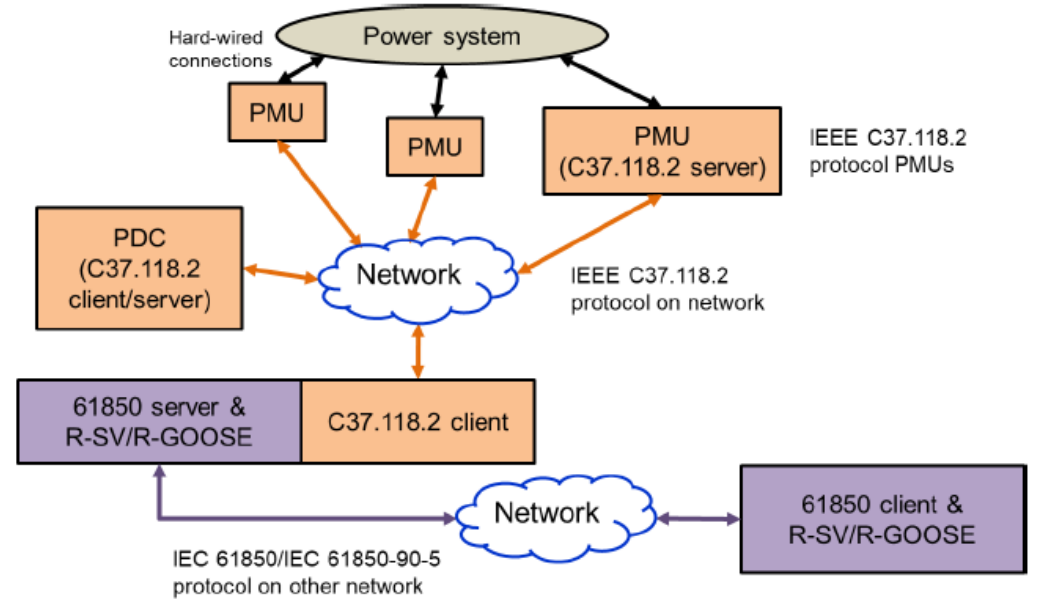


Use case A: An IEEE C37.118.2 system receiving PMU data from an IEC 61850/90-5 system, i.e. IEC 61850/90-5 ➔ IEEE C37.118.2

Note: Required cyber security measures such as firewalls are not illustrated for simplicity.

Source: IEEE PES-TR74 Report

Use Case B
C37.118.2 ➔ 61850



Use case B: An IEC 61850/90-5 system receiving PMU data from an IEEE C37.118.2 system, i.e. IEEE C37.118.2 ➔ IEC 61850/90-5

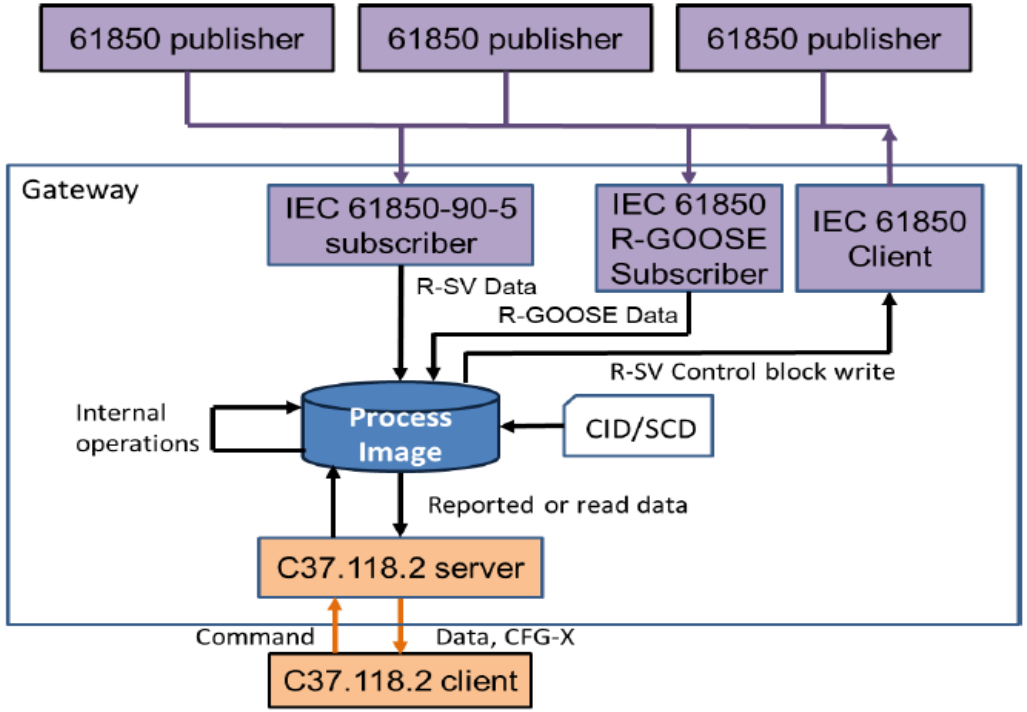
Note: Required cyber security measures such as firewalls are not illustrated for simplicity.

Source: IEEE PES-TR74 Report

Recommend to address both use cases using gateway functions

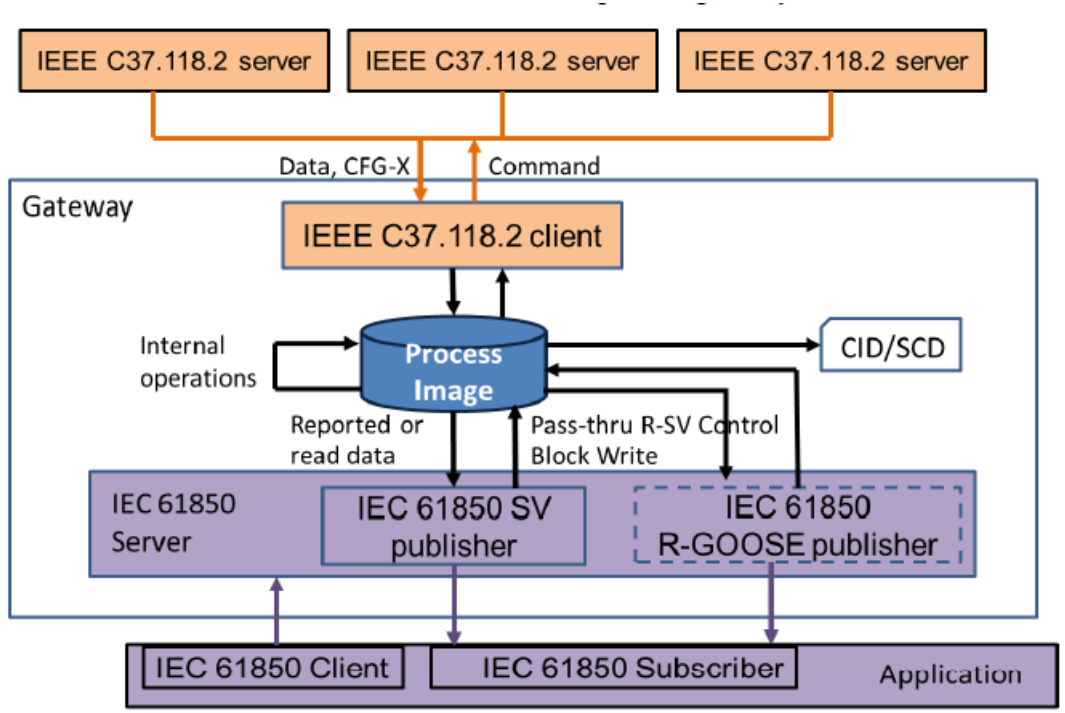
Use Case Conceptual Architecture

Use Case A
61850 ➔ C37.118.2



Source: IEEE PES-TR74 Report

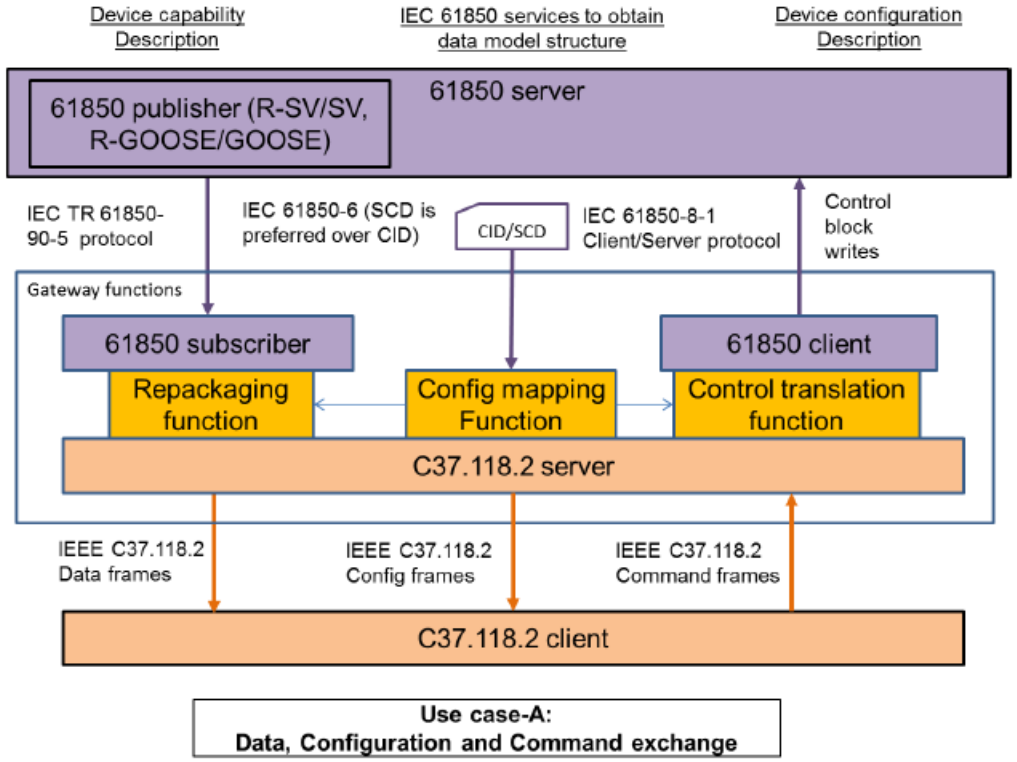
Use Case B
C37.118.2 ➔ 61850



Source: IEEE PES-TR74 Report

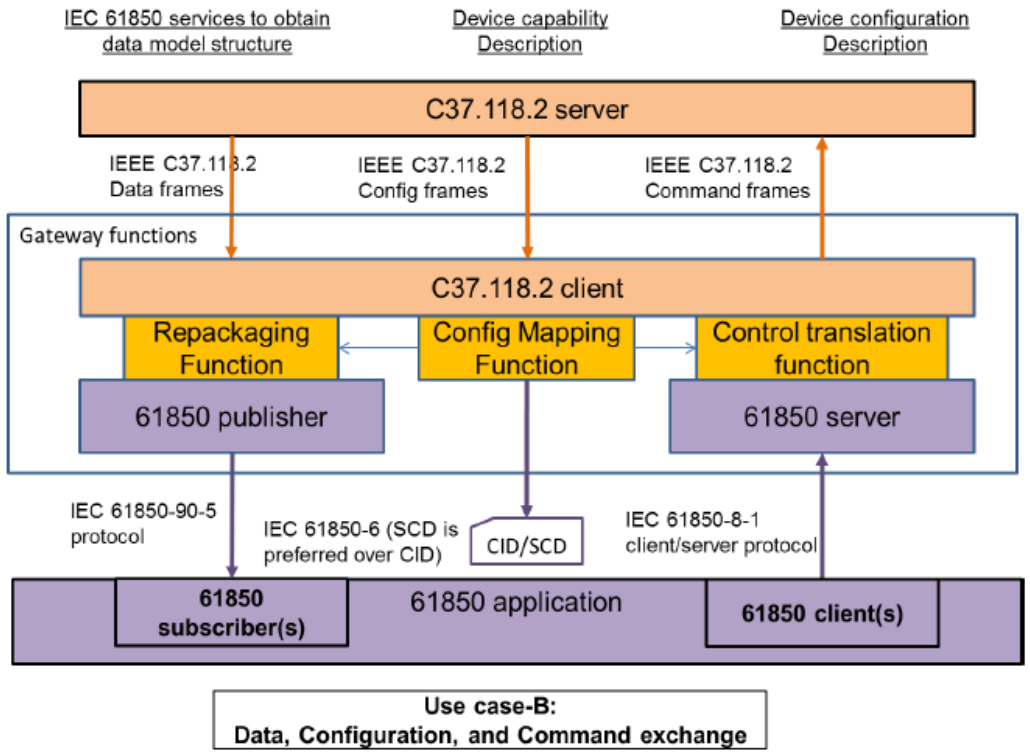
Data, Configuration, and Command Exchange for Each Use Case

Use Case A
61850 ➔ C37.118.2



Source: IEEE PES-TR74 Report

Use Case B
C37.118.2 ➔ 61850



Source: IEEE PES-TR74 Report

Recommended Detailed Mapping

Dataset **mapping**

- (Stream or Source or PDC) ID code
- Number of PMUs in the data stream
- A Time Stamp that includes
  - Second of Century
  - Fraction of Second
  - **Time quality indicator**
- A 16-bit Status WORD
- Synchrophasors
- Frequency
- ROCOF
- Analog values
- Digitals

Configuration **mapping between CFG-2 (and CFG-3) and the IEC 61850 SCL:Stream ID code**

- Stream ID Code (single PMU or PDC)
- Number of PMUs in the stream
- Time base
- **Station name of a PMU dataset**
- Source ID code of a PMU dataset
- Global PMU ID of a PMU dataset (a CFG3 data item – Needs to be added to 61850)
- Data format of a PMU dataset (Note: all data in a 61850 SV frame is to be in Float format)
- Number of phasors in a PMU dataset
- Number of analog values in a PMU dataset
- Number of digital status words in a PMU dataset
- **Signal channel names (Note: 61850 has standard names for the Synchrophasor Data Objects; names from C37.118.2 should be mapped into the Description fields of these standard Data Objects)**
- Phasor conversion factors with flags (only used when mapping Integer data from C37.118.2)
- Analog signal conversion factors (Note: CFG2 ANunit is ambiguous)
- Mask words for digital status words
- PMU location – Latitude (CFG3 only)
- PMU location – Longitude (CFG3 only)
- PMU location – Elevation (CFG3 only)
- PMU service class – Note: this data is not available in a CFG2 message. It is proposed that Service Class be incorporated in the STN.
- Phasor measurement window length
- Phasor measurement group delay
- Nominal frequency (Should be part of LLN0)
- Configuration count
- Data rate

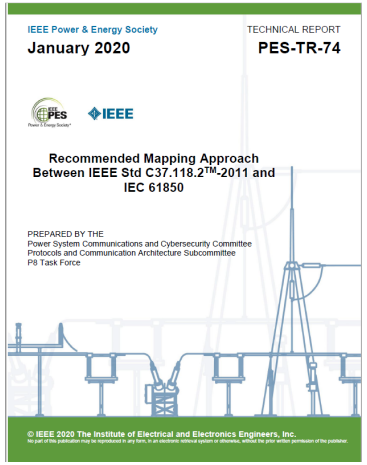
"Global PMU ID", "Window Length (in μsec)", and "Group Delay (in μsec)" are not mapped

Control messaging and *security requirements* are not mapped!

Key Takeaways

When systems and communication capabilities expand

- Protocol update and extension
- Discontinue obsolete methods
- Develop new protocols



Reference

Increased need for standardized protocol “Translation” or “Mapping”

Synchrophasor Data Transfer Protocol Standardization Outlook

- Development of systems and methods continues to meet user needs
- C37.118.2 revision
  - Clear up ambiguities such as status indications
  - Add new features including discrete event frame, more status indications, measurement quality, remote configuration, & missing data retrieval
- P2664 standard (STTP)
  - Publisher-Subscriber operation
    - Easier to manage data exchanges
  - Measurement value oriented rather than PMU
    - Reduced data loss & simplifies data set management
  - Easier to integrate multiple data rates & types
  - Uses standard IT managed network systems and methods (TCP & UDP/IP protocols)

Thank You!

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