Simulation, Testing and Analysis of the IEC 61850-9-2LE Sampled Value Message

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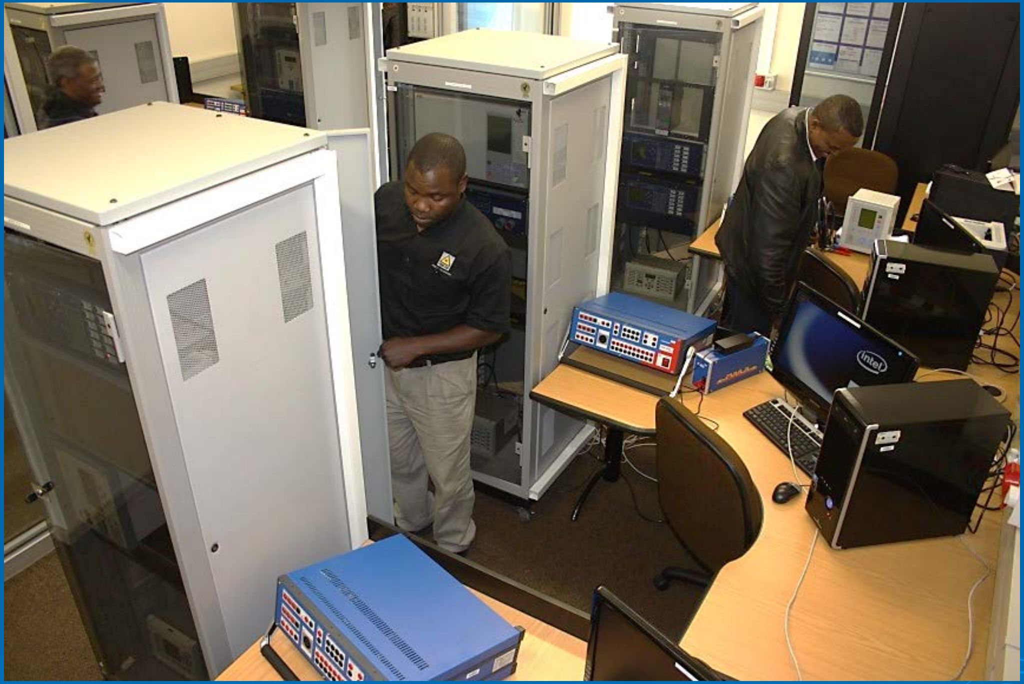
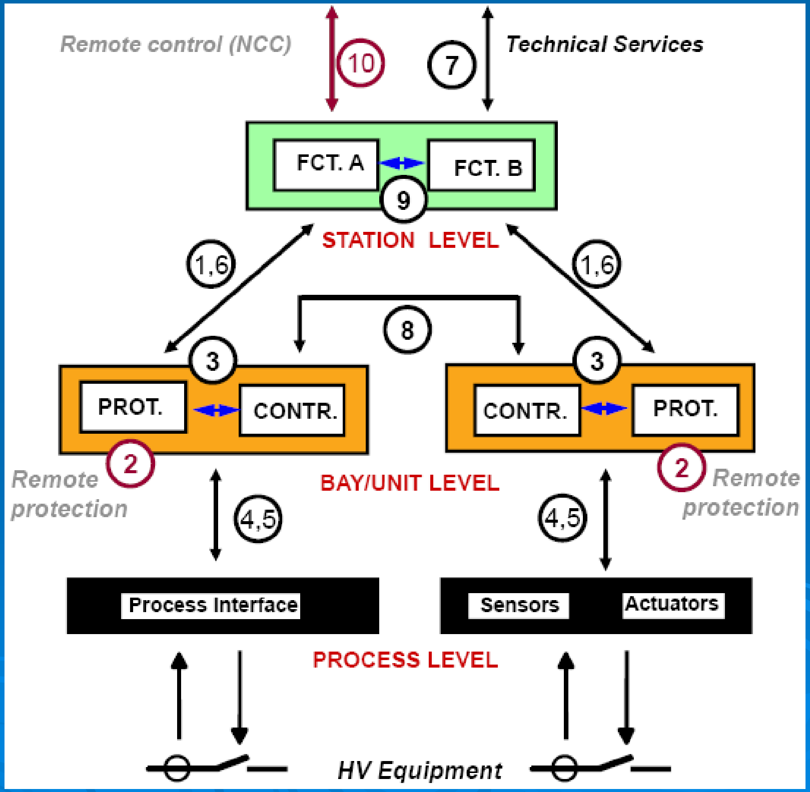
Presentation overview

- Introduction
- Objectives
- Methodology
- Case studies
- Conclusion



Introduction

- IEC 61850-9-2LE for Substation Automation Systems
- CT and VT outputs are digitized at the Process Level directly from the primary plant equipment using MUs
- Digital sampled value data is transmitted via Ethernet to IEDs, meters, etc.



Introduction

Benefits of IEC 61850-9-2 Process Bus

- Reduction in the amount of copper cabling
- Increased safety and reliability
- Based on Ethernet communication thus ensuring that it is easy to configure and reconfigure
- Standard-based detailing specific communication requirements to ensure interoperability
- One of the standards specified in the facilitation of the smart grid

Objectives

Motivation

- Fault diagnosis
- Developing hardware compliant with the IEC 61850 standard

Objectives

- Interpretation and understanding of relevant parts of IEC 61850-9-2 LE – CONFORMANCE testing
- Exchanging information between devices from different vendors – INTEROPERABILITY testing
- Verification of accuracy of information exchanged – PERFORMANCE testing

Methodology

Conformance

- RTDS simulated power model developed in RSCAD publishing IEC 61850-9-2LE sampled value messages
- Analysis of published sampled value message using network protocol analyzer software – Wireshark

Interoperability

- RTDS simulated power system model – publisher
- OMICRON CMC-850 – subscriber
- MUs from different vendors publisher/subscriber

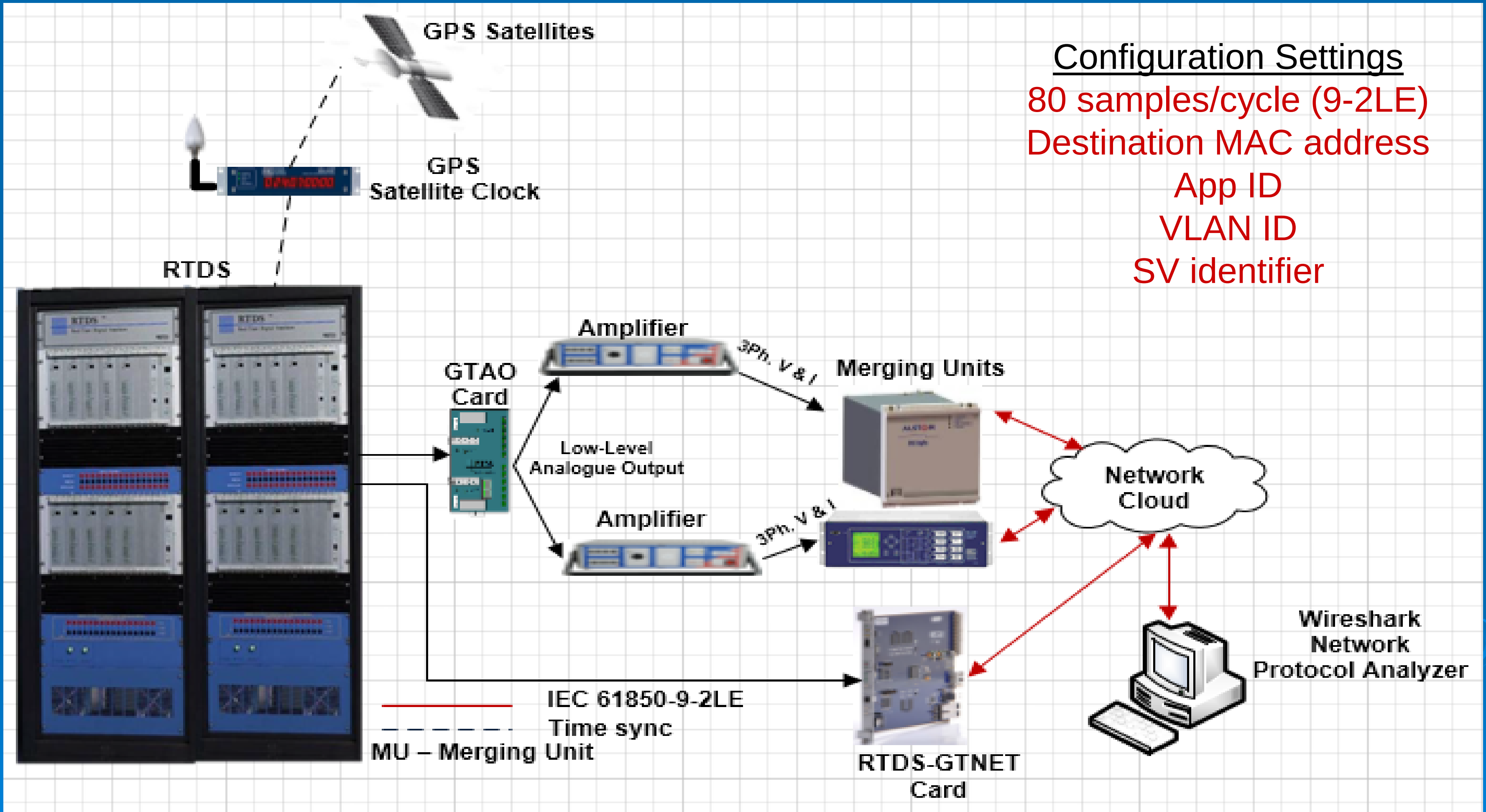
Performance

- Accuracy of measurement

Methodology

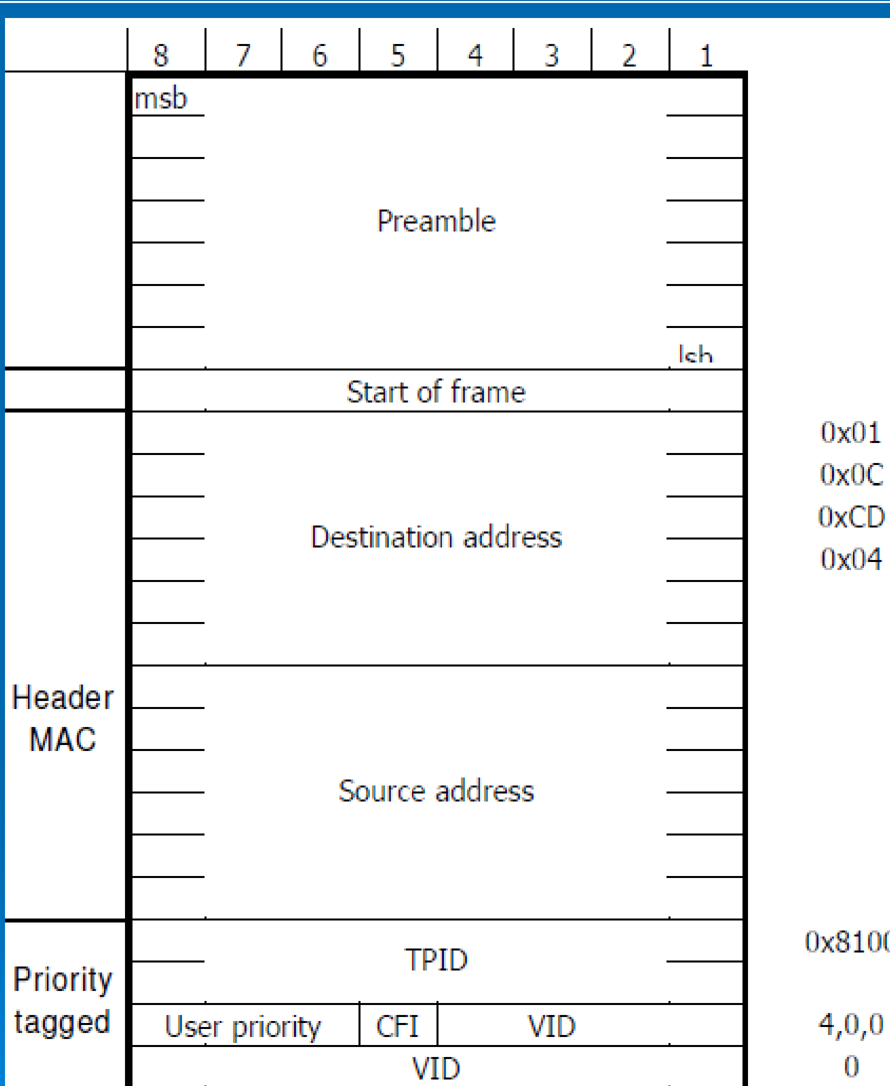
Laboratory system setup

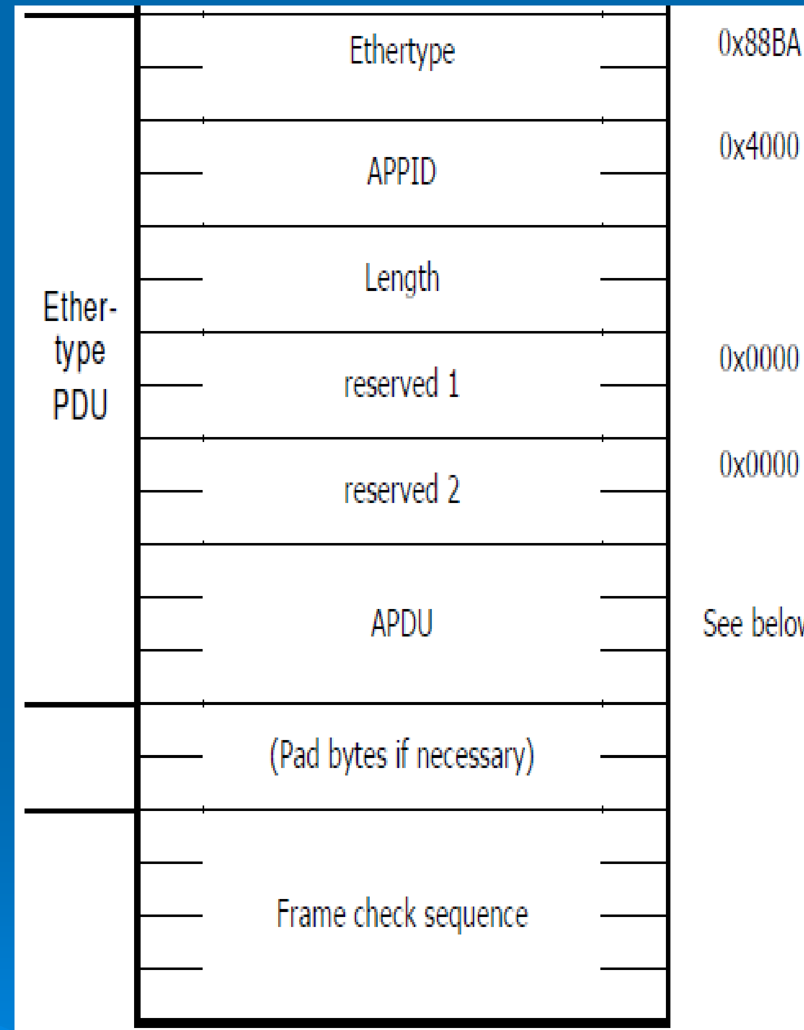
Case study 1 - Conformance



Conformance testing system setup

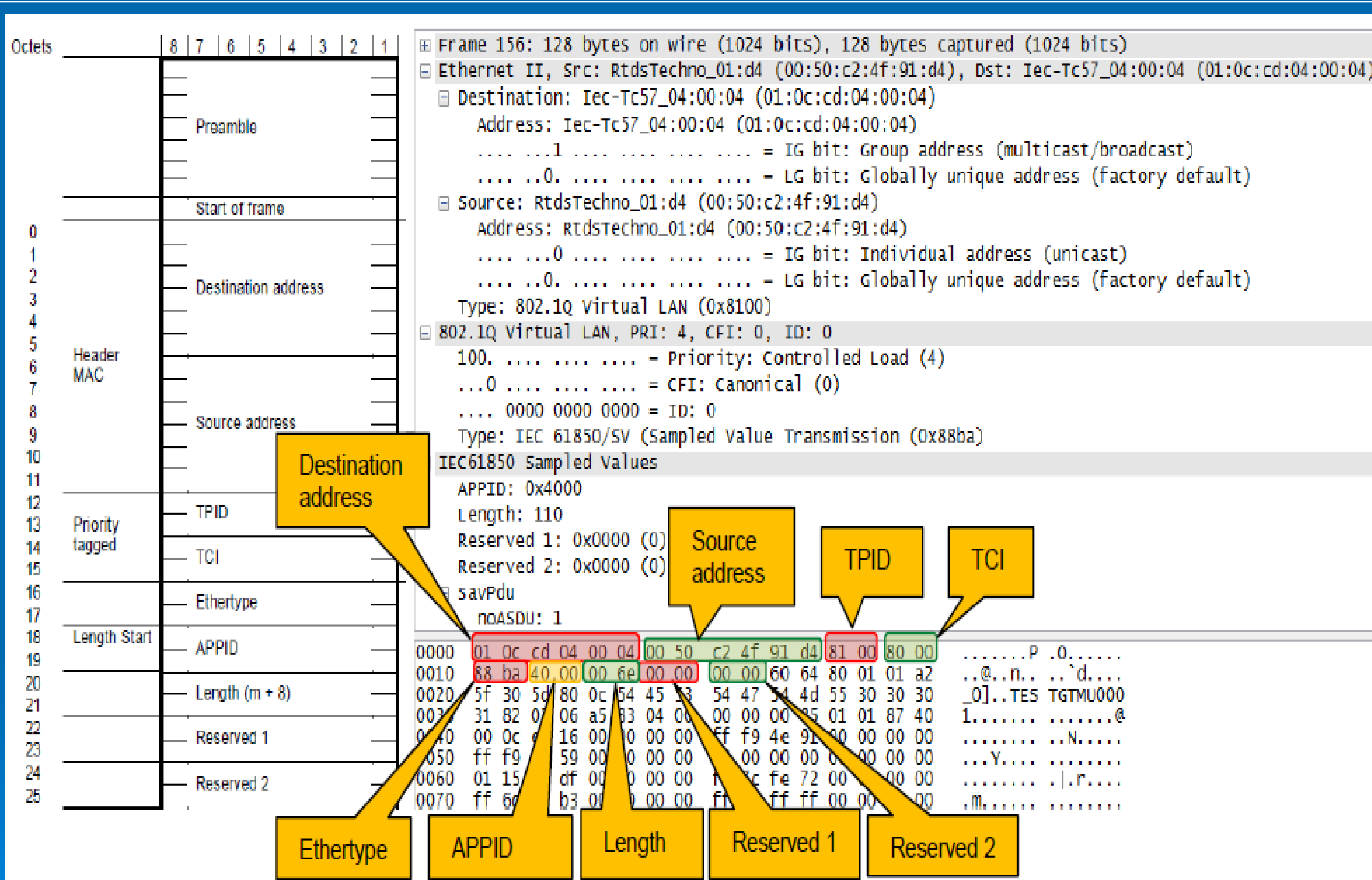
Case study 1 - Conformance





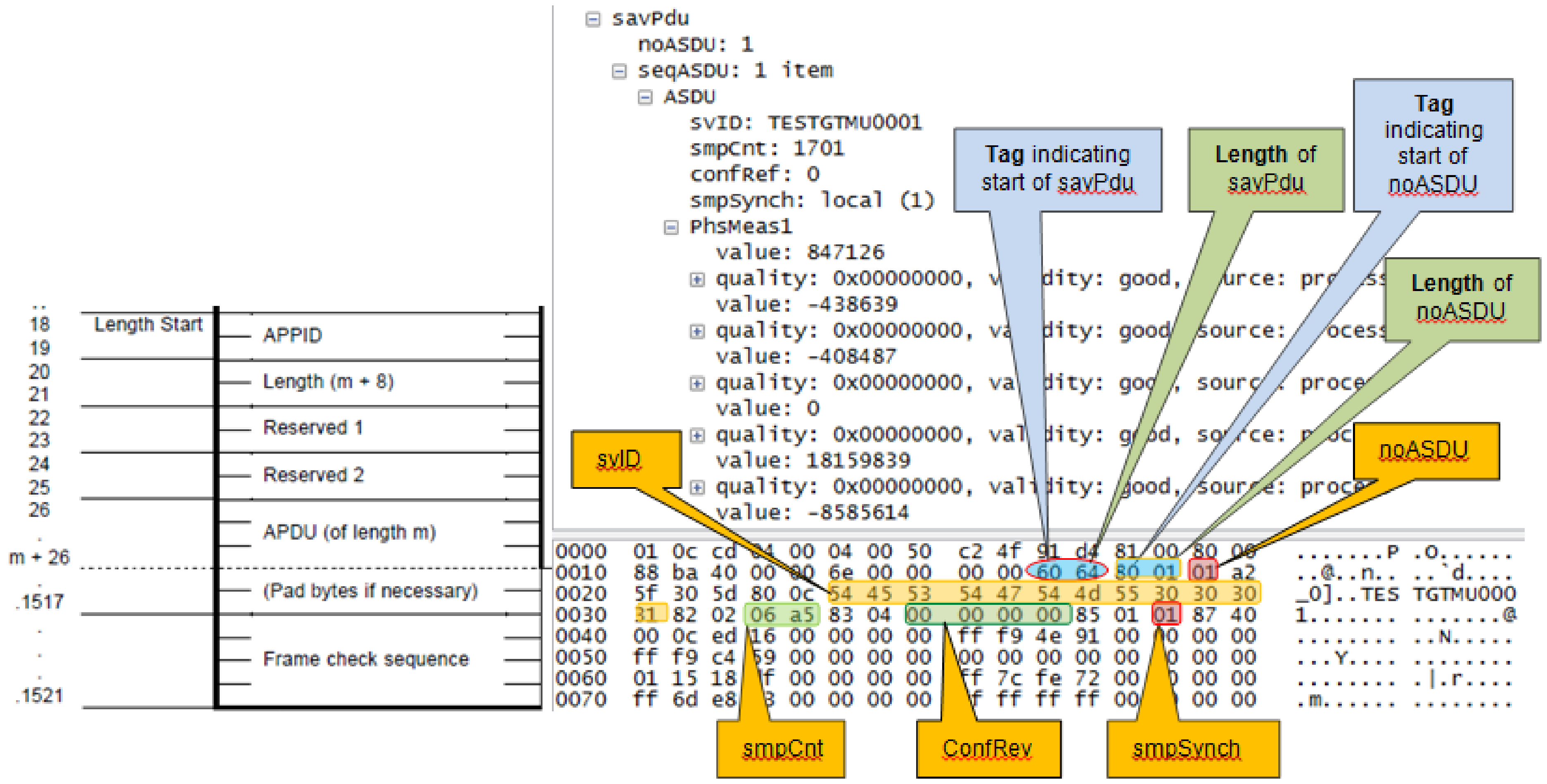
Complete Sampled value message frame as defined in IEC 61850-9-2LE

Case study 1 - Conformance



Fixed Portion of the Sampled value message frame published by the RTDS MU

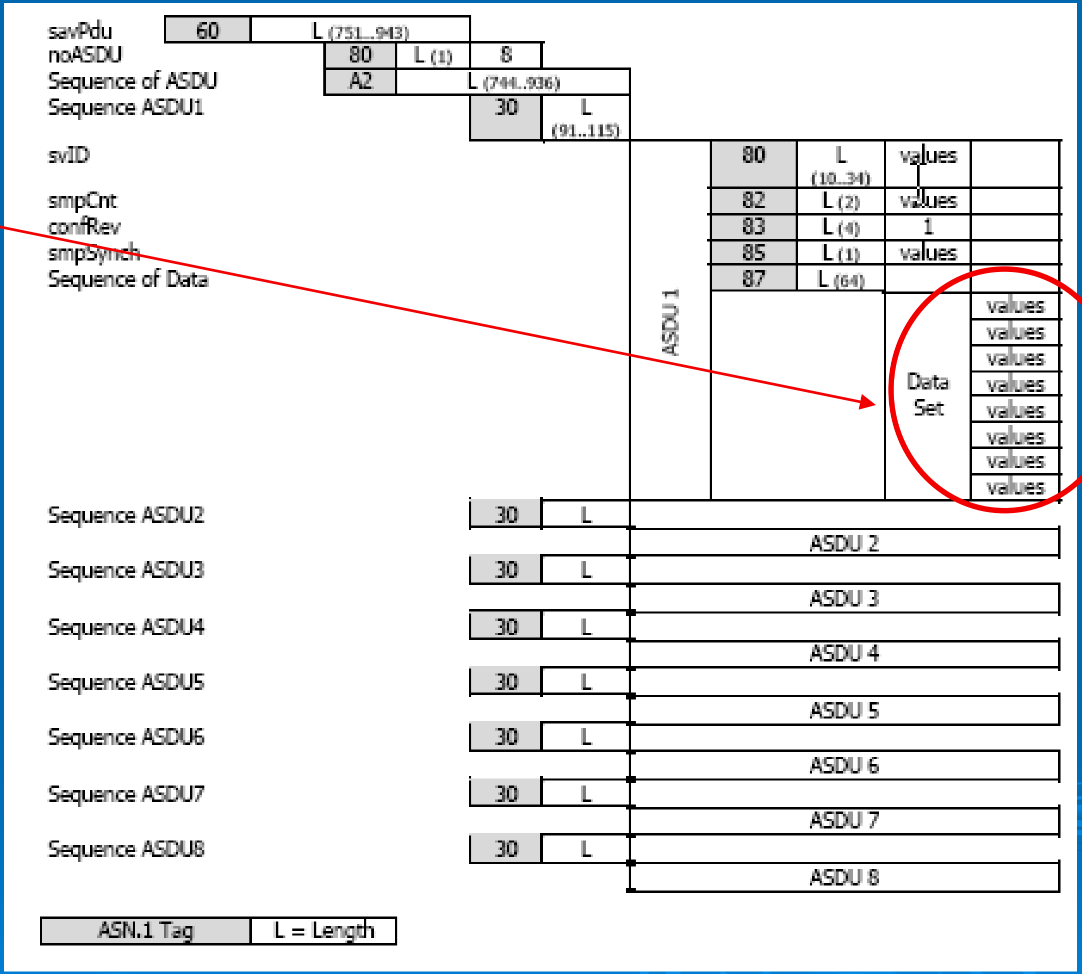
Case study 1 - Conformance



Variable Portion of the Sampled value message frame published by the RTDS MU

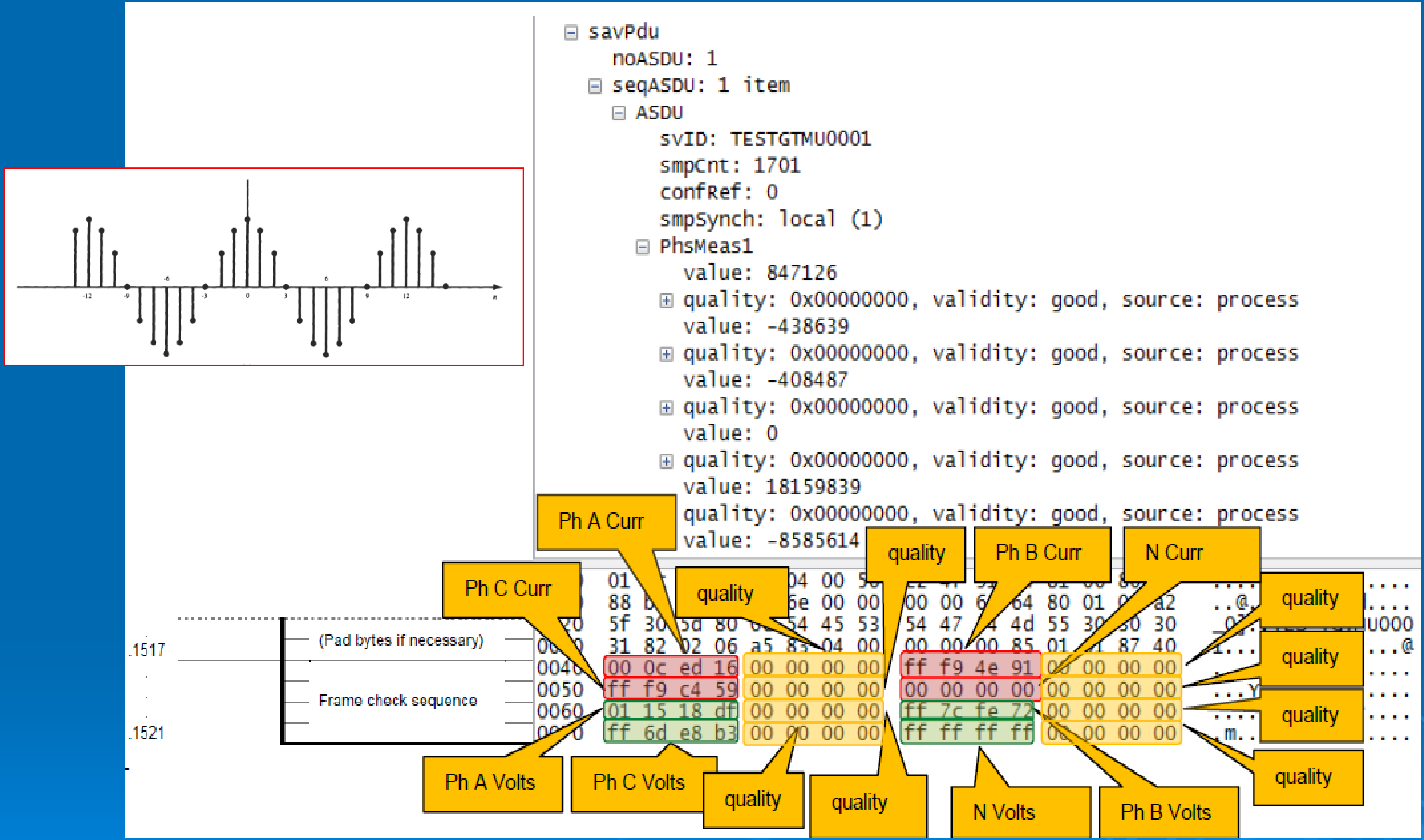
Case study 1 - Conformance

- SAVPdu;
- Data set (payload) contains analog 3-phase voltages plus the neutral and 3-phase currents plus the neutral;



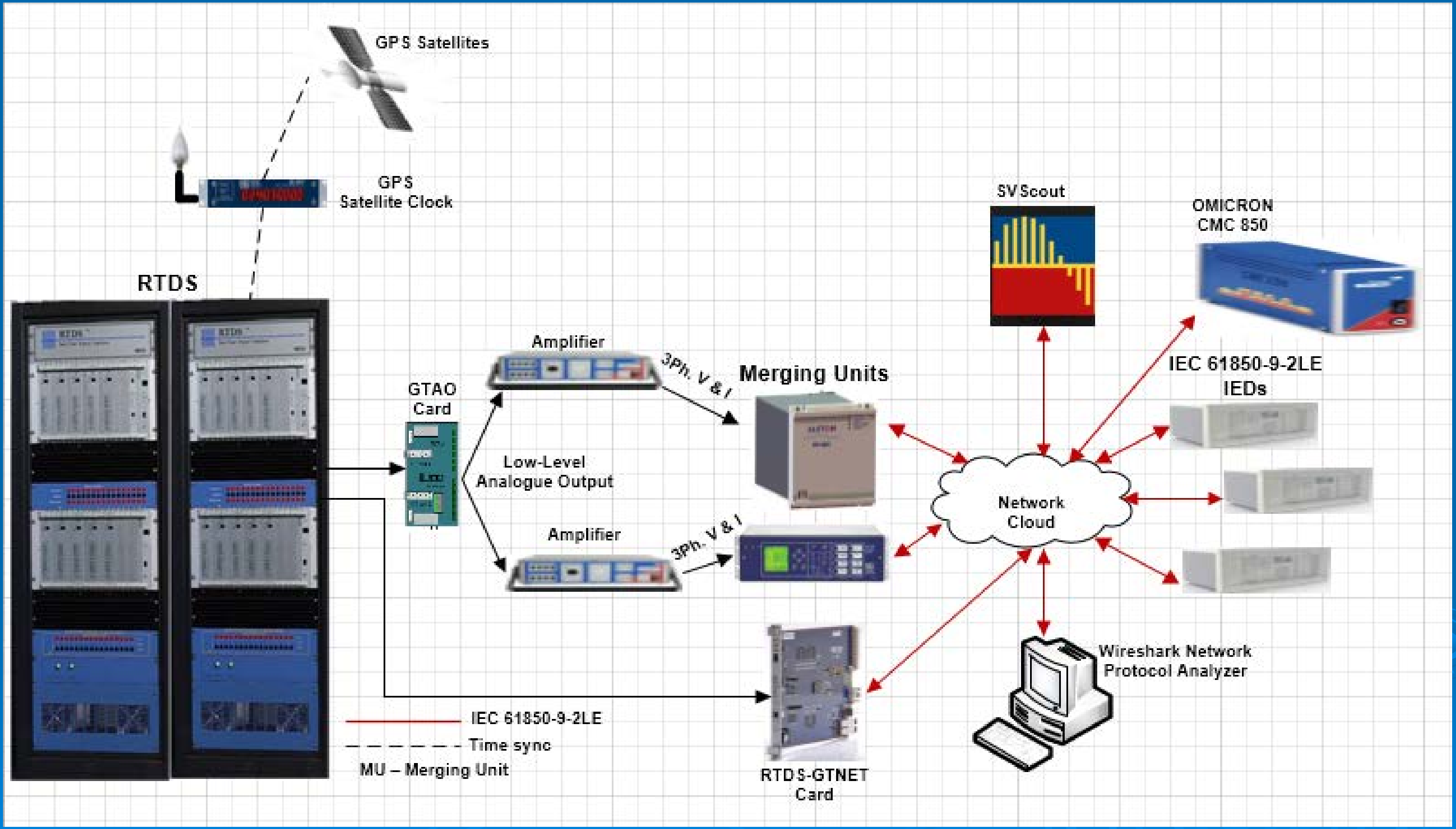
Dataset (payload) of the Sampled value message frame published by the RTDS MU

Case study 1 - Conformance



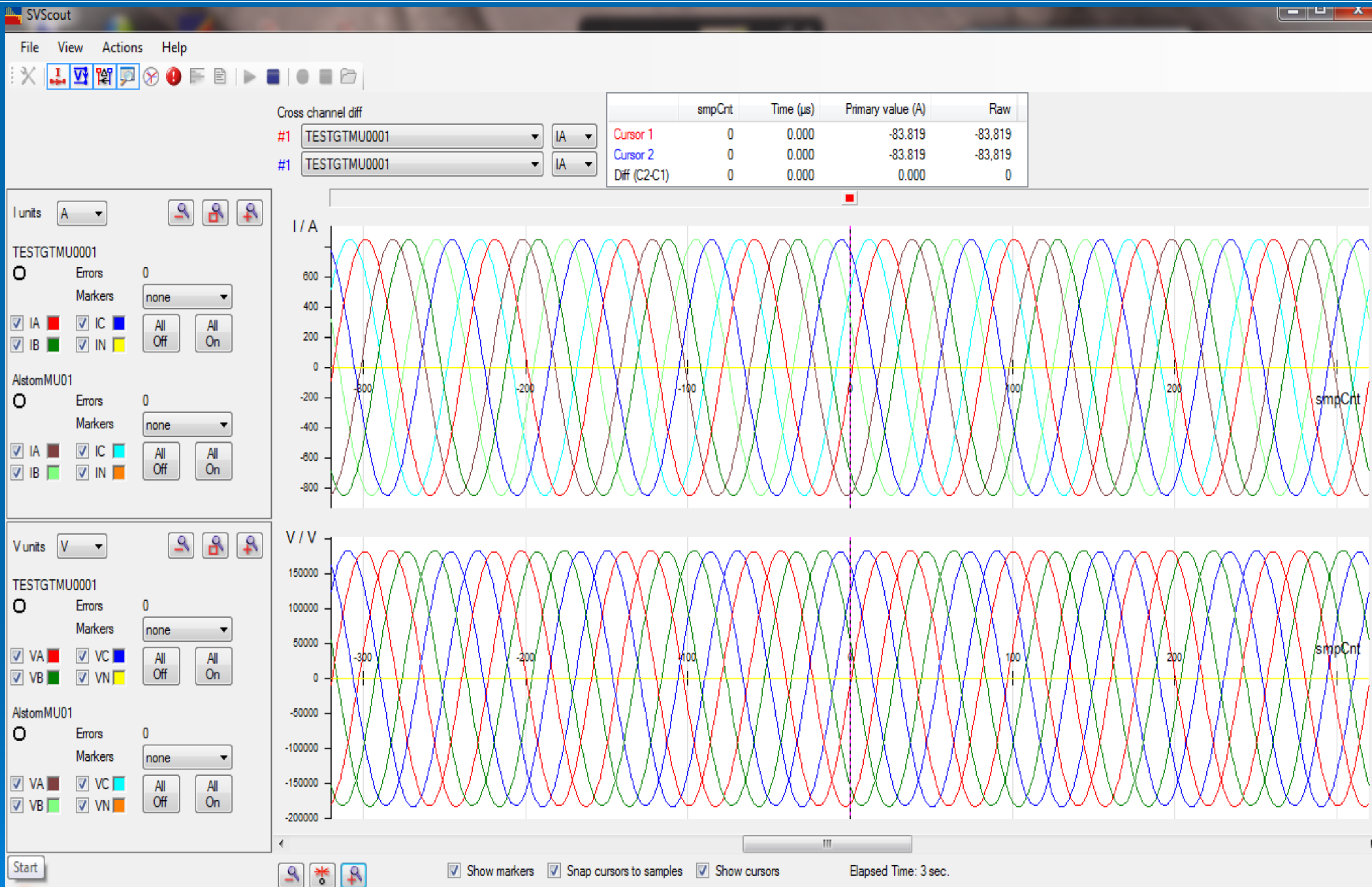
Dataset (payload) of the Sampled value message frame published by the RTDS MU

Case study 2 - Interoperability



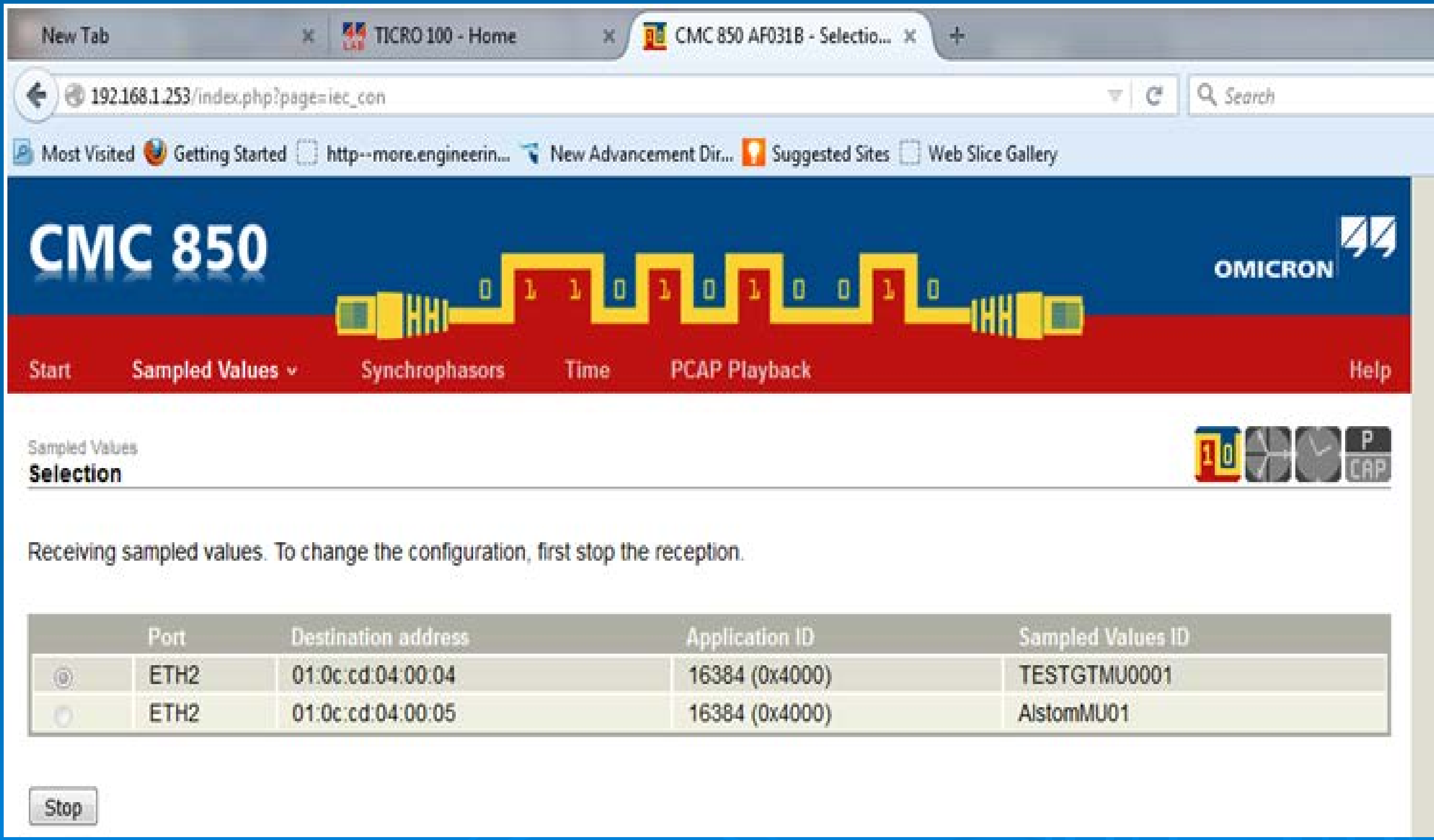
Interoperability testing system setup

Case study 2 - Interoperability



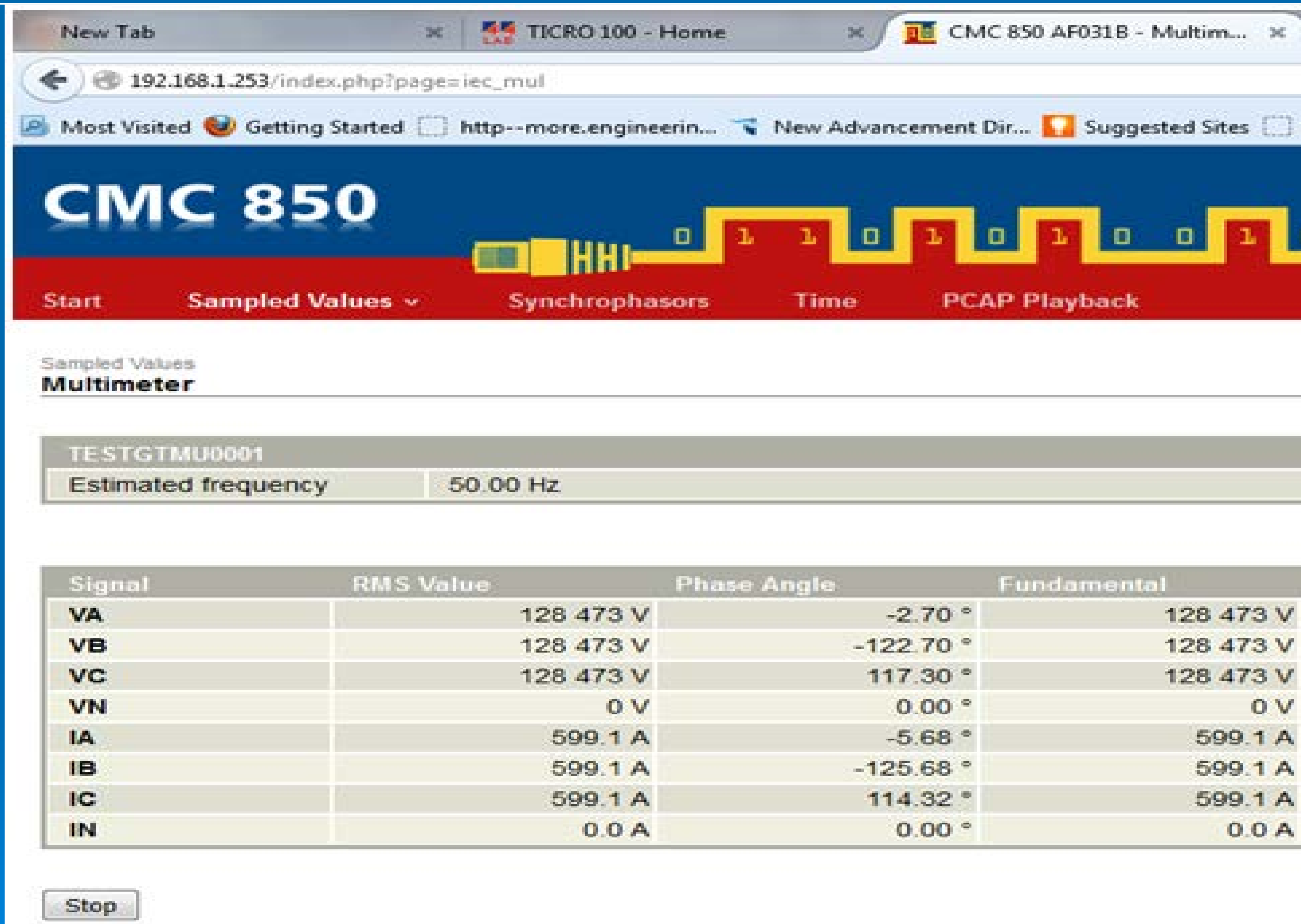
SVScout capture of the sampled value message published by RTDS

Case study 2 - Interoperability



RTDS subscription to OMICRON CMC-850 sampled value message

Case study 3 - Performance

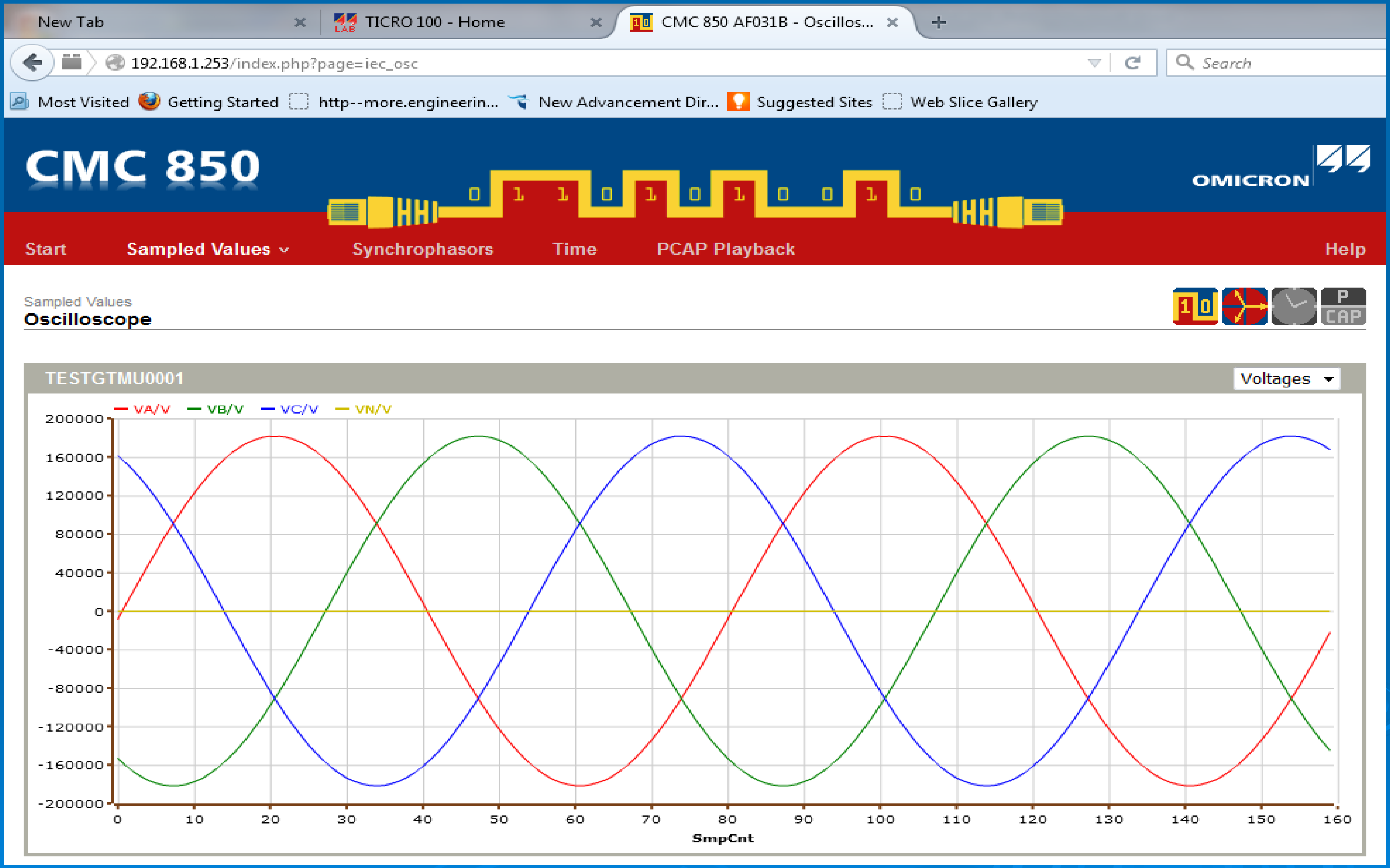


TESTGTMU0001	
Estimated frequency	50.00 Hz

Signal	RMS Value	Phase Angle	Fundamental
VA	128 473 V	-2.70 °	128 473 V
VB	128 473 V	-122.70 °	128 473 V
VC	128 473 V	117.30 °	128 473 V
VN	0 V	0.00 °	0 V
IA	599.1 A	-5.68 °	599.1 A
IB	599.1 A	-125.68 °	599.1 A
IC	599.1 A	114.32 °	599.1 A
IN	0.0 A	0.00 °	0.0 A

RTDS SV measurements subscribed to by OMICRON CMC-850

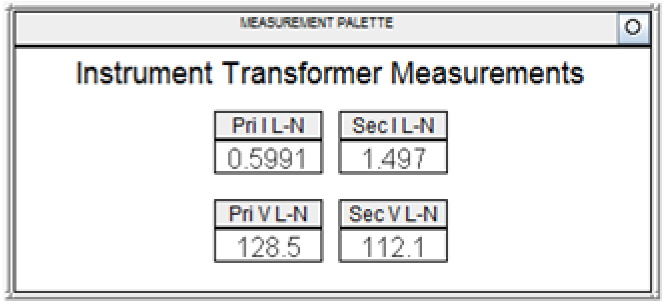
Case study 3 - Performance



3-phase voltages subscribed to by OMICRON CMC-850

Case study 3 - Performance

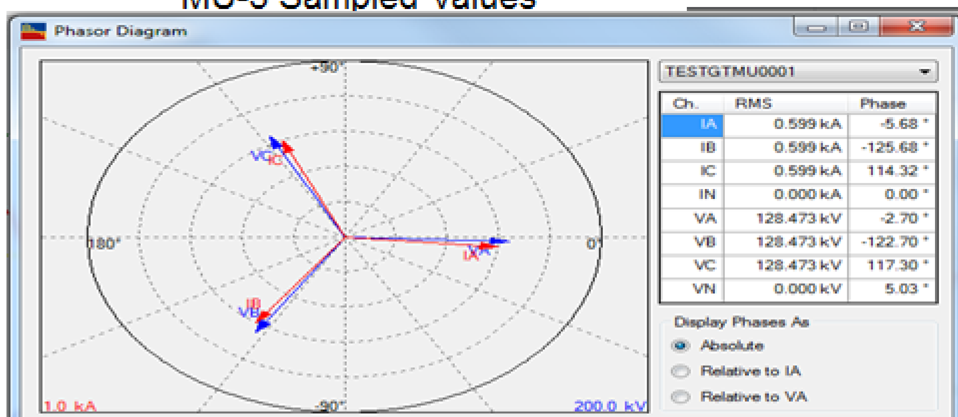
Reference Values from the RTDS



RMS Current deviation 0.00017%

RMS Voltage deviation 0.021%

MU-3 Sampled Values



Conclusion and Future work

- RTDS Sampled value message structure confirmed
- Interoperability between RTDS and MU
- Measurement accuracy confirmed

Future work

- Embedded systems development
- Foundation for developing hardware and systems compliant with the IEC 61850 standard