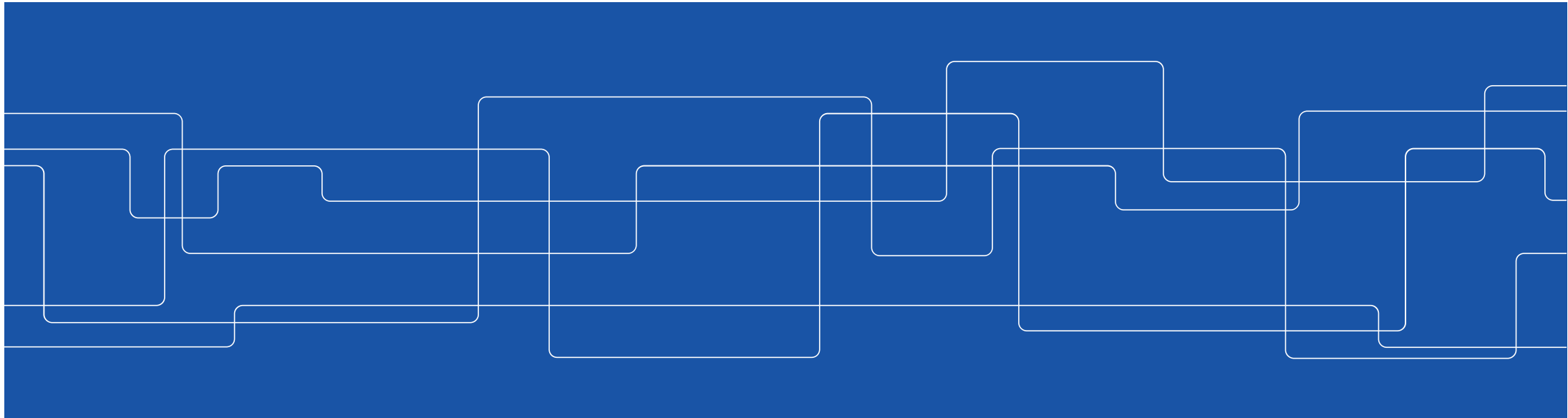




# Distributed signal processing units (DSPU) for centralized protection and control (CPC)

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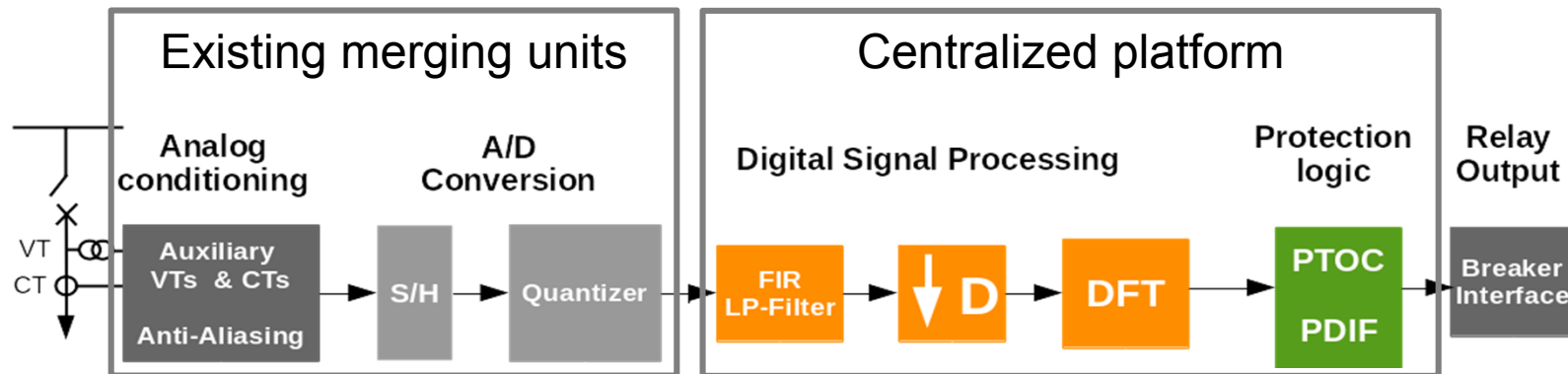
# Problem statement

## CPC architecture

Utilising process bus communication based on IEC 61850-9-2 and IEC 61869-9

## High sampling rates

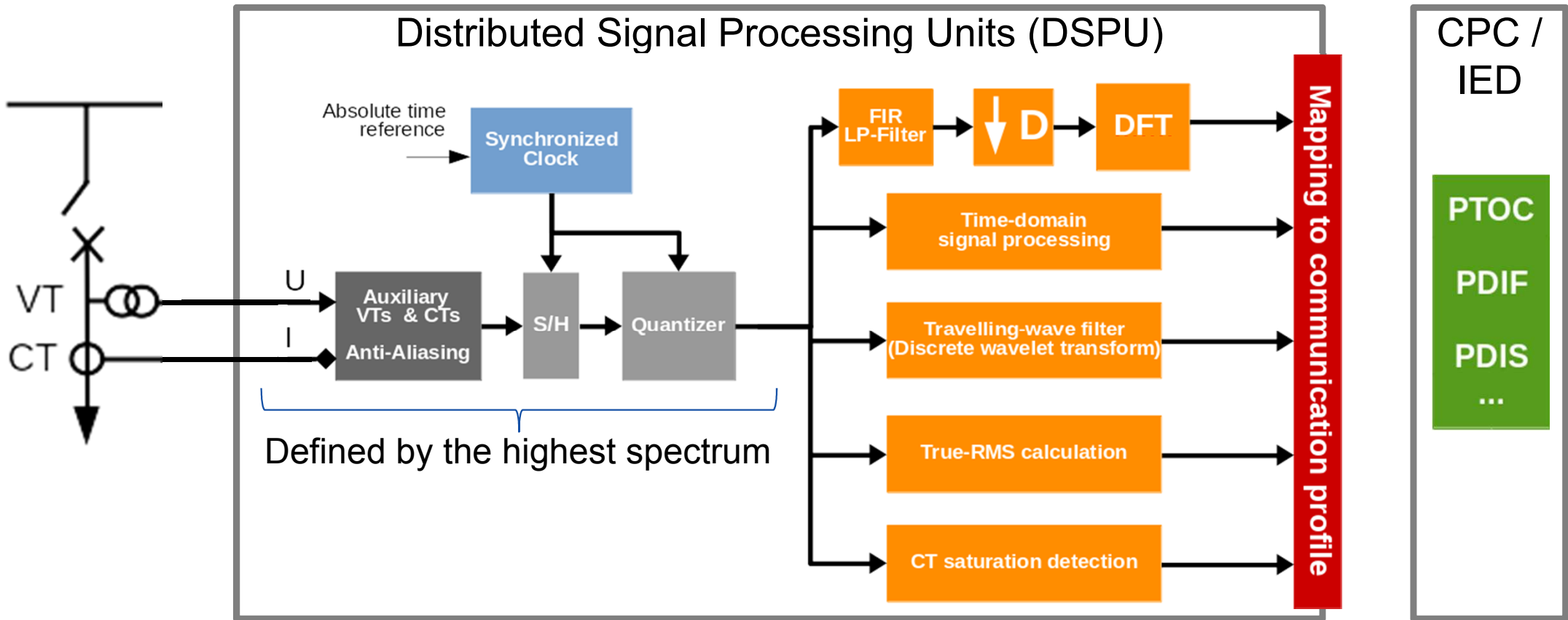
Integrating applications with high sampling rates in CPC architecture



High communication load on process bus due to high sampling rate based application demands  
High computational burden on centralized platform due to digital signal processing algorithms



# CPC architectures with DSPUs





# Application demands for higher sampling rates

## Protection functions based on:

- Time-domain quantities
- Travelling-wave quantities

## Sampling rate

10 kHz  
up to 100 kHz

## Travelling-wave based fault locator:

- Overhead lines
- Cables

1 MHz  
3-5 MHz



# Comparison between DSPU and Merging units

## Merging unit output according to IEC 61869-9

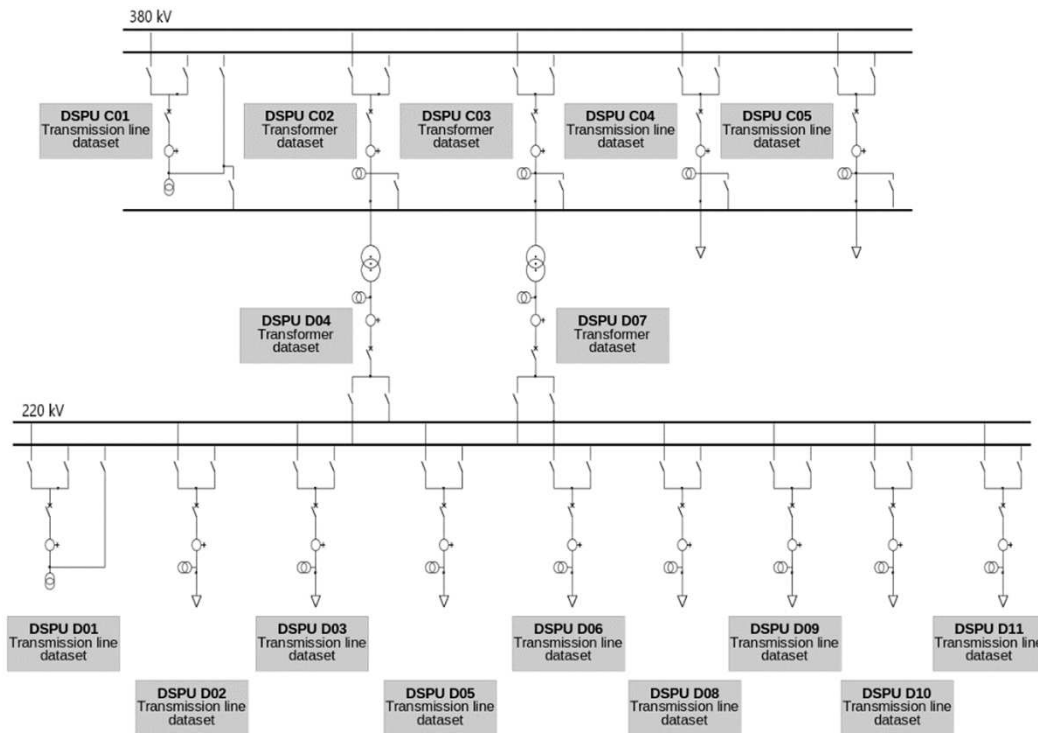
- Preferred sampling rate for protective applications is 4 800 Hz
- Limits spectrum to 2 400 Hz (Nyquist-Shannon sampling theorem)
- If the sampling rate is increased, the communication burden increases a lot

## Distributed signal processing units (DSPU)

- Digital signal processing is performed within the DSPU
- DSPU publishes the results of the DSP algorithms, such as fundamental and harmonic components as well as travelling wave quantities
- Publishing rate does not directly depend on sampling rate



# Case study: Substation topology



## Goal:

Analysis of the communication load on the process bus of the proposed CPC architecture

## Approach:

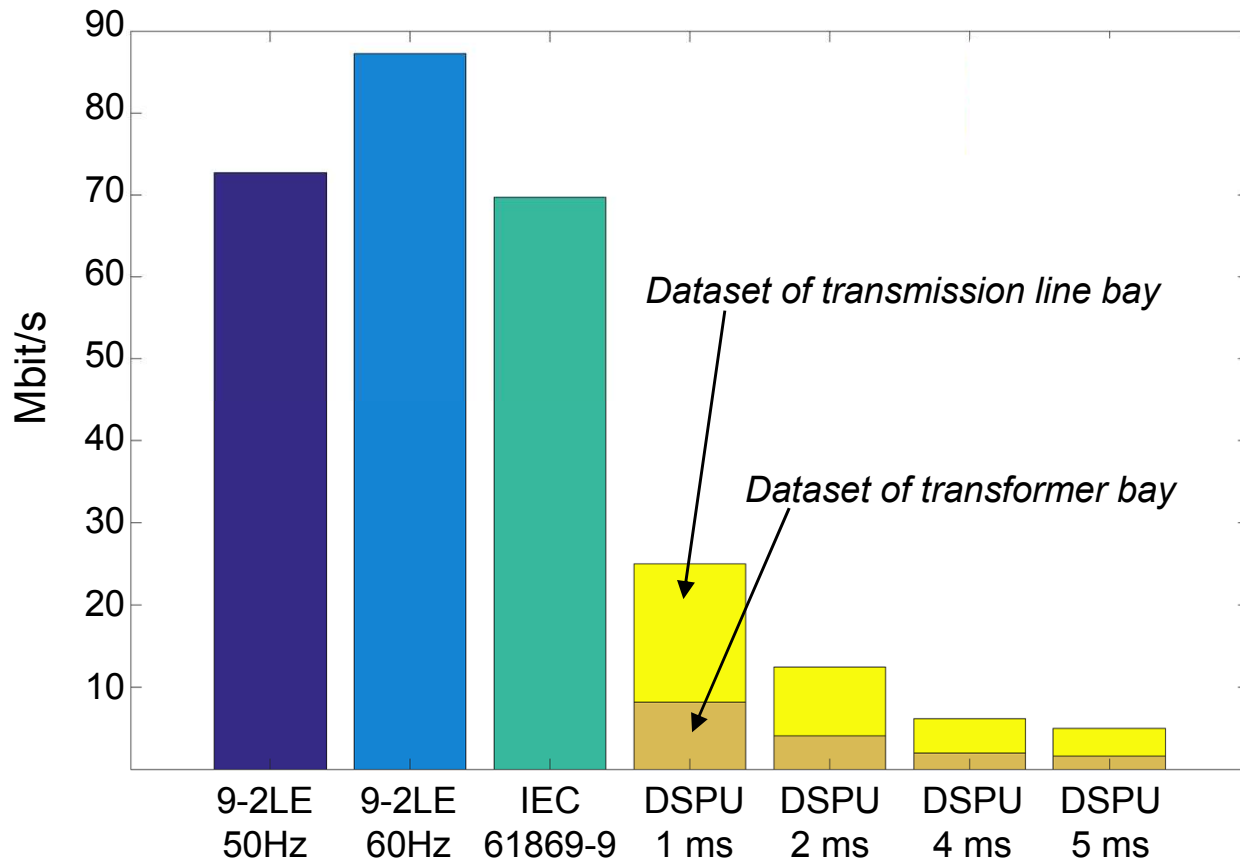
- Usage of the reference transmission substation topology from IEC 61850-5
- Modelling of DSPU datasets for each protection object according to IEC 61850-7-3
- Mapping dataset to the application-layer protocol Sampled-Value (IEC 61850-9-2)

Substation topology adopted from:

IEC TC 57, "IEC 61850-5 Communication networks and system for power utility automation – Part 5: Communication requirements for functions and device models", 2013



# Case study: Communication load on process bus



## Calculation basis:

Ethernet overhead +  
Application layer overhead +  
Dataset

## IEC 61869-9 variants/datasets:

- F4000S1I4U4
- F4800S1I4U4
- F4800S2I4U4

## DSPU datasets:

Transmission line bay dataset +  
Transformer bay datasets for  
1ms, 2ms, 4ms and 5ms cycle times





# Case study: Findings

## Problem statement

- High communication load on process bus due to high sampling rate based application demands

## Findings



The communication load of the process bus can be reduced by the concept of distributed signal processing units (DSPU)



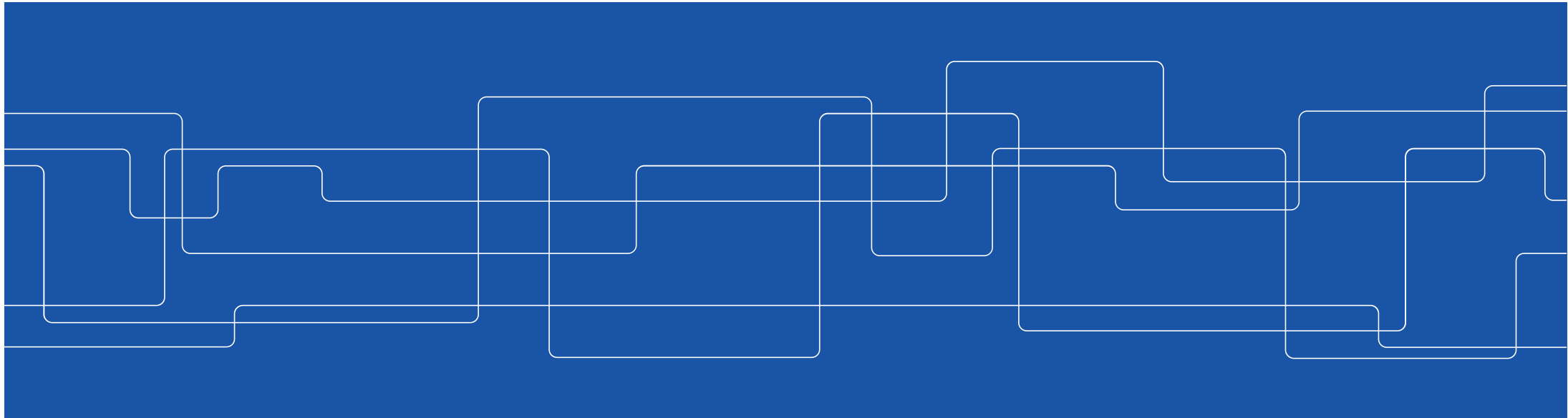
## Conclusion and Future work

- Integration of applications with high sampling rates in a CPC architecture becomes feasible by using DSPUs
- Reduction of the communication load of the process bus through the concept of distributed signal processing units has been provided
- Detail application related reduction of the computational burden on the centralized platform will be shown in future work



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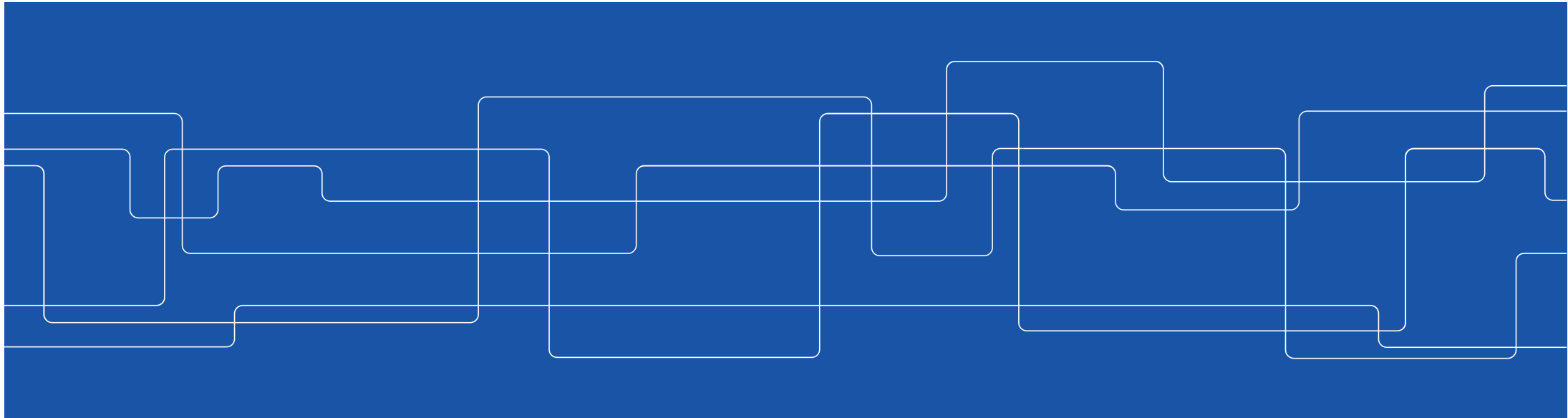
**Thank you!**





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# Backup





# Challenges

- IEC 61850 does not consider the separation of the signal processing algorithms from the protection logic
- Transient behaviour of signal processing algorithms might differ due to different implementations by manufactures
- Reliable standalone methods for CT saturation detection based on local bay measurements only