KTH ROYAL INSTITUTE
OF TECHNOLOGY

Distributed Signal Processing Units for CPC architectures

Nordic Workshop on Power System Protection
2017-05-23

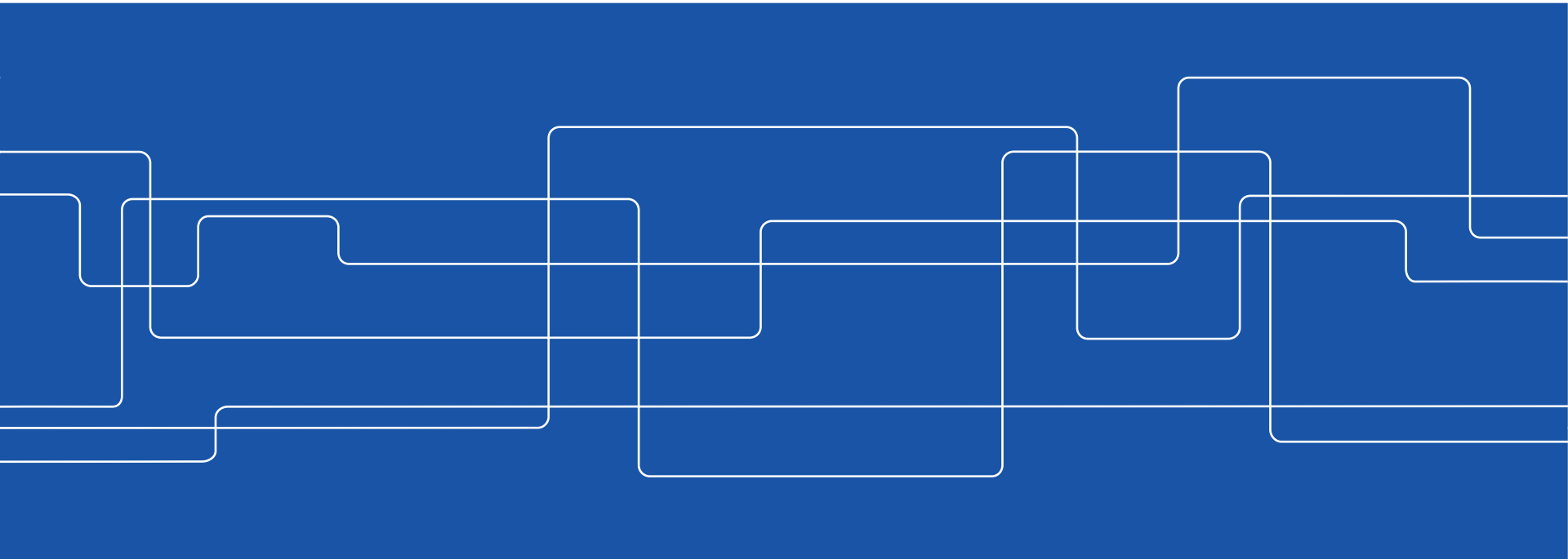


Table of Contents

Trends in Substation Automation Systems

- Functional Integration
- (Higher integration) of IEC 61850 at the process level
- Reliable and deterministic Ethernet Communication (e.g. HSR + PTP)

S. Brahma, “Advancements in Centralized Protection and Control Within a Substation,” in IEEE Transactions on Power Delivery, 2016

Trends in Substation Automation Systems

- Functional Integration
- (Higher integration) of IEC 61850 at the process level
- Reliable and deterministic Ethernet Communication (e.g. HSR + PTP)

Centralized Substation Protection and Control (CPC)

S. Brahma, “Advancements in Centralized Protection and Control Within a Substation,” in IEEE Transactions on Power Delivery, 2016

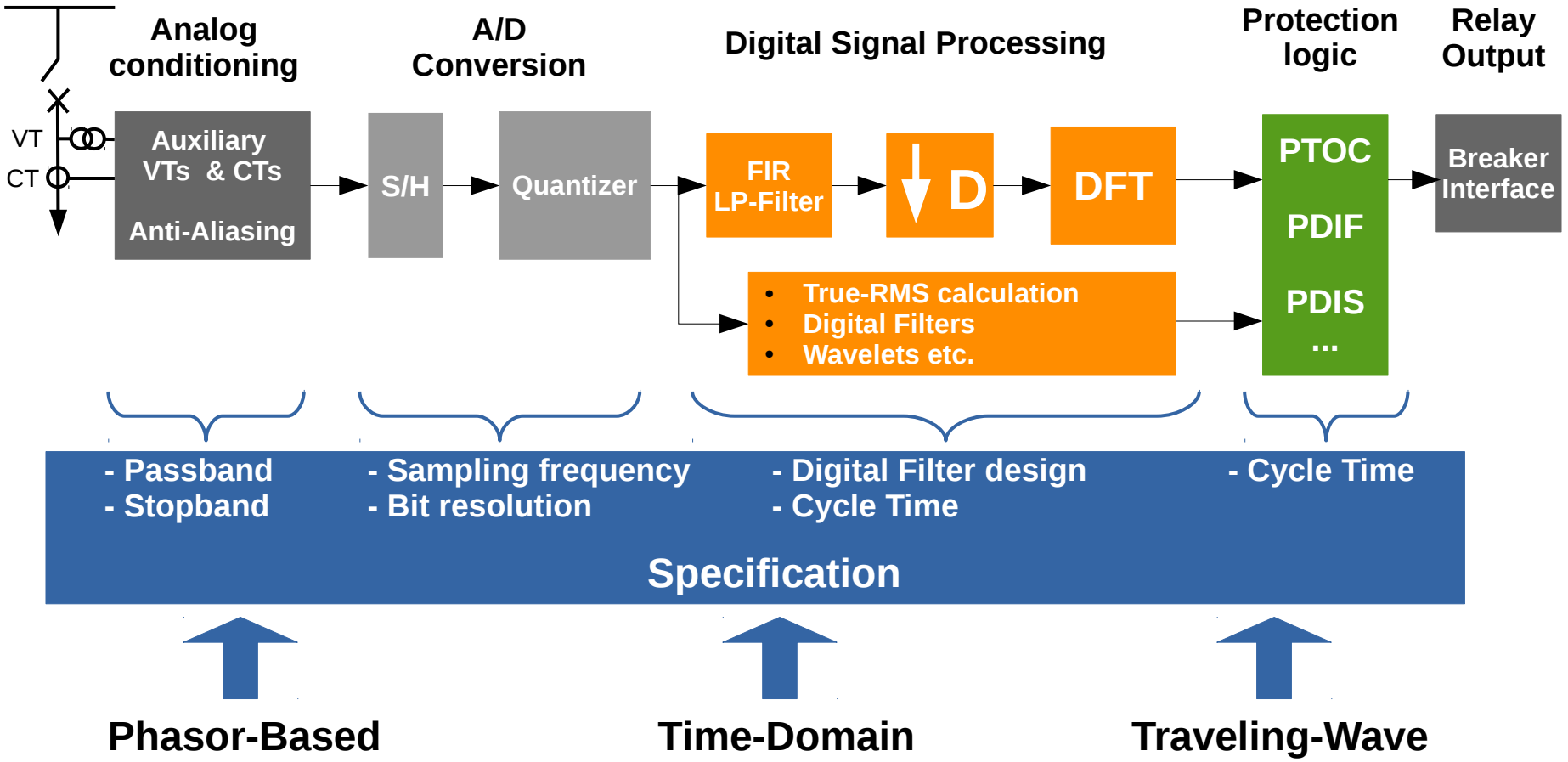
Trends in Power System Protection

Phasor-Based

Time-Domain (incremental)

Traveling-Wave

Signal Processing for Protection Systems



Determinism (Real-time)

"A deterministic system can be mathematically verified, in contrast to a non-deterministic system, for which only a probability of success can be given"

H. Kirrmann and I. Sotiropoulos, "Determinism in Substation Automation with IEC 61850 (HSR/PTP)," in *PAC World – Protection, Automation & Control World, Volume 39,* March 2017

Determinism (Real-time)

"A deterministic system can be mathematically verified, in contrast to a non-deterministic system, for which only a probability of success can be given"

$$t_p + t_{A/D} < T_s$$

$$f_{MAX} \leq \frac{f_s}{2} < \frac{1}{2\left(t_p + t_{A/D}\right)}$$

$T_s - Sampling\ Time$

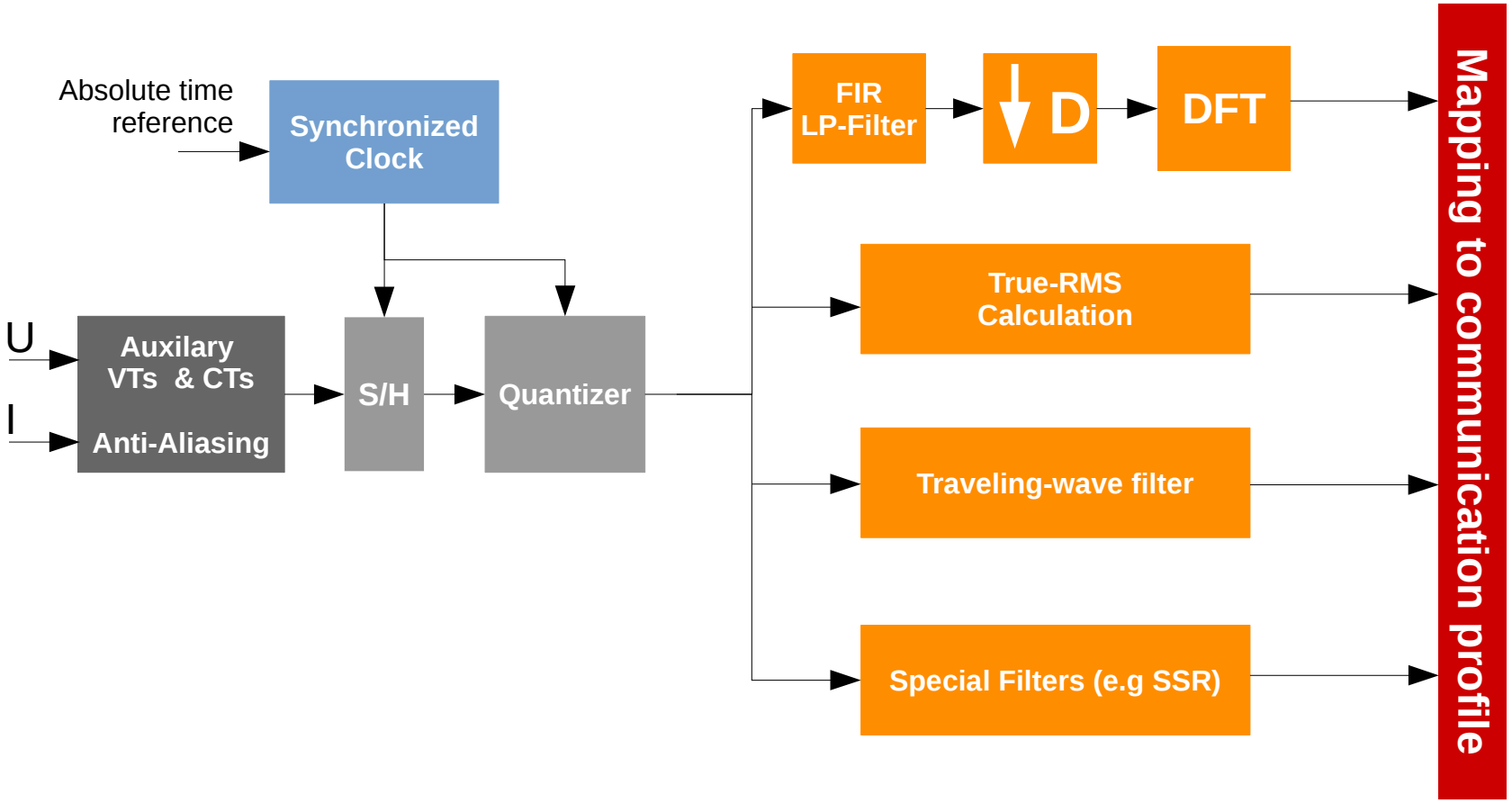
$t_p - Processing\ Time$

$t_{A/D} - Time\ for\ A/D\ conversion$

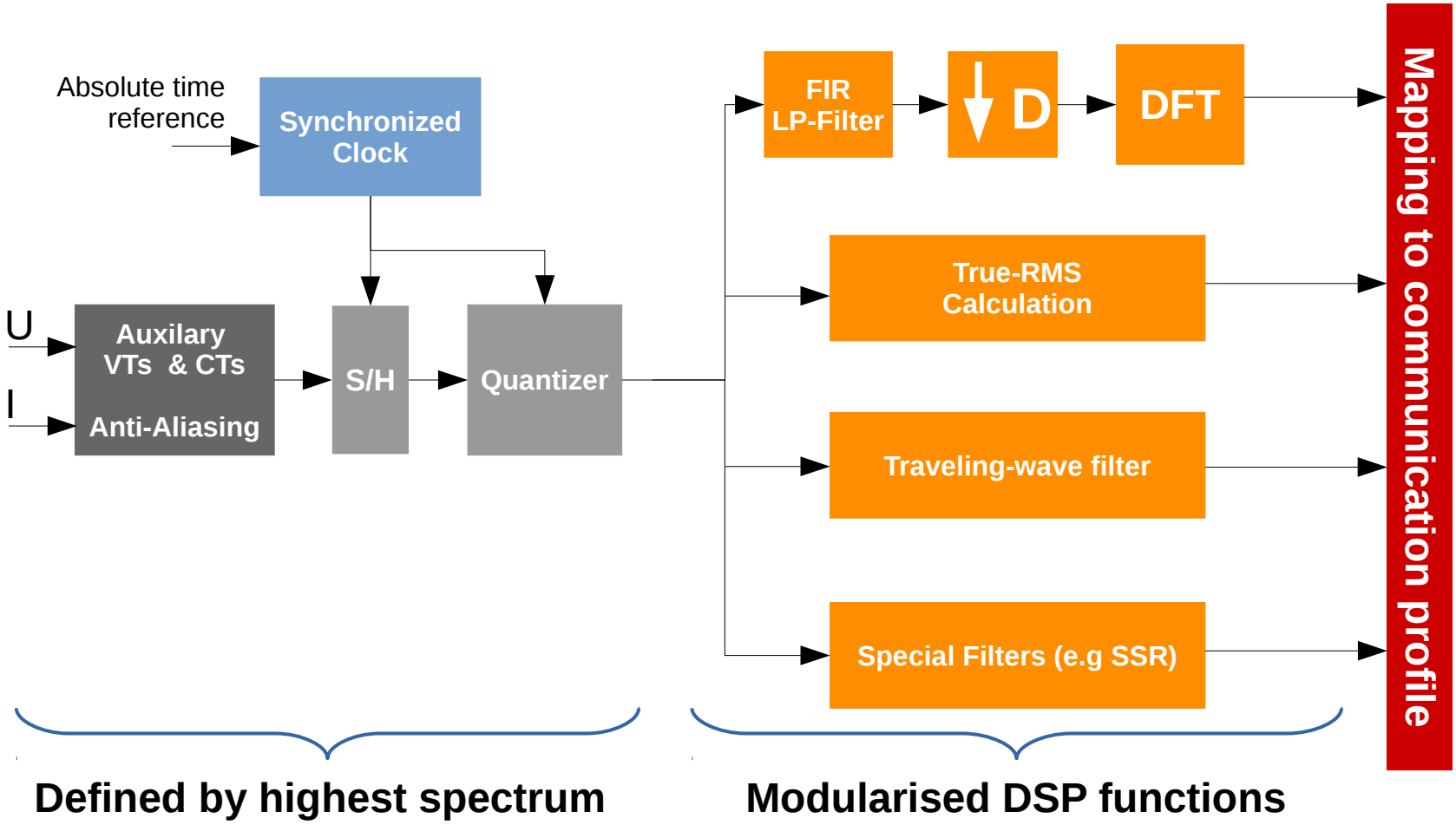
$f_{MAX} - Max\ frequency\ of\ signal$

H. Kirrmann and I. Sotiropoulos, "Determinism in Substation Automation with IEC 61850 (HSR/PTP) ," in *PAC World – Protection, Automation & Control World, Volume 39,* March 2017

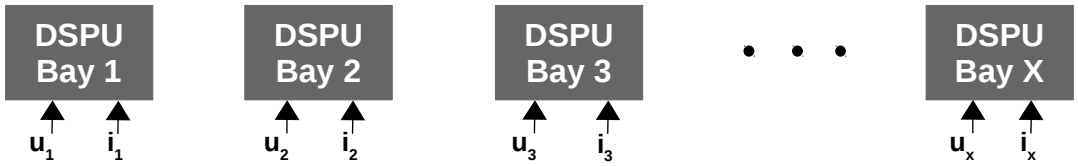
Distributed Signal Processing Unit (DSPU)



Distributed Signal Processing Unit (DSPU)

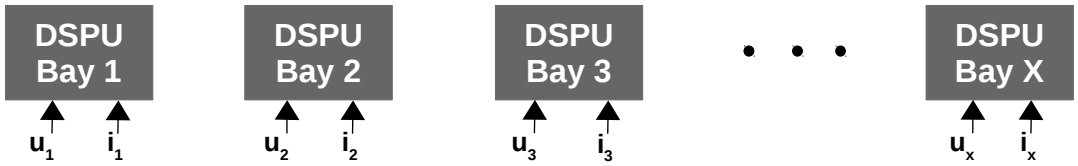


Proposed CPC architecture

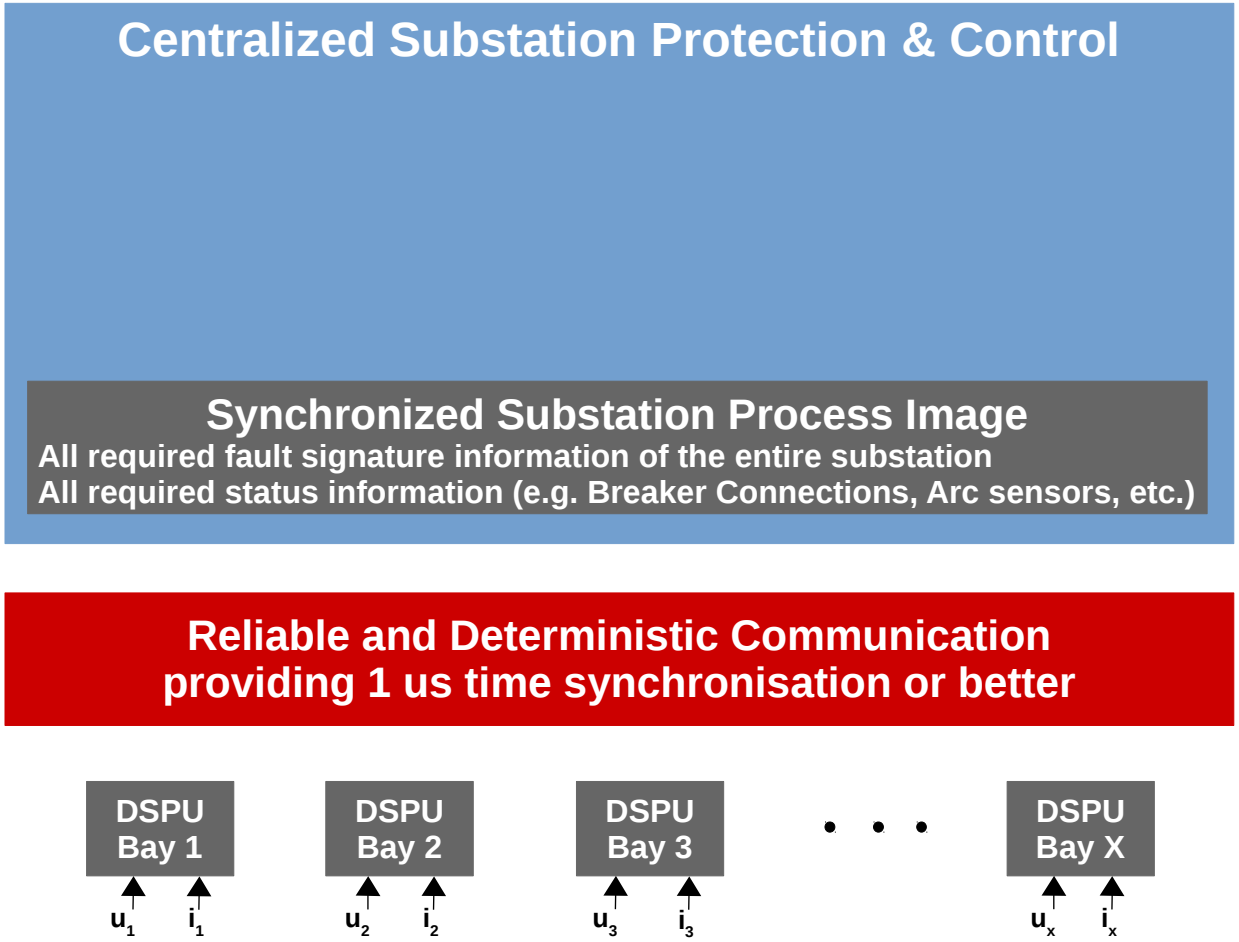


Proposed CPC architecture

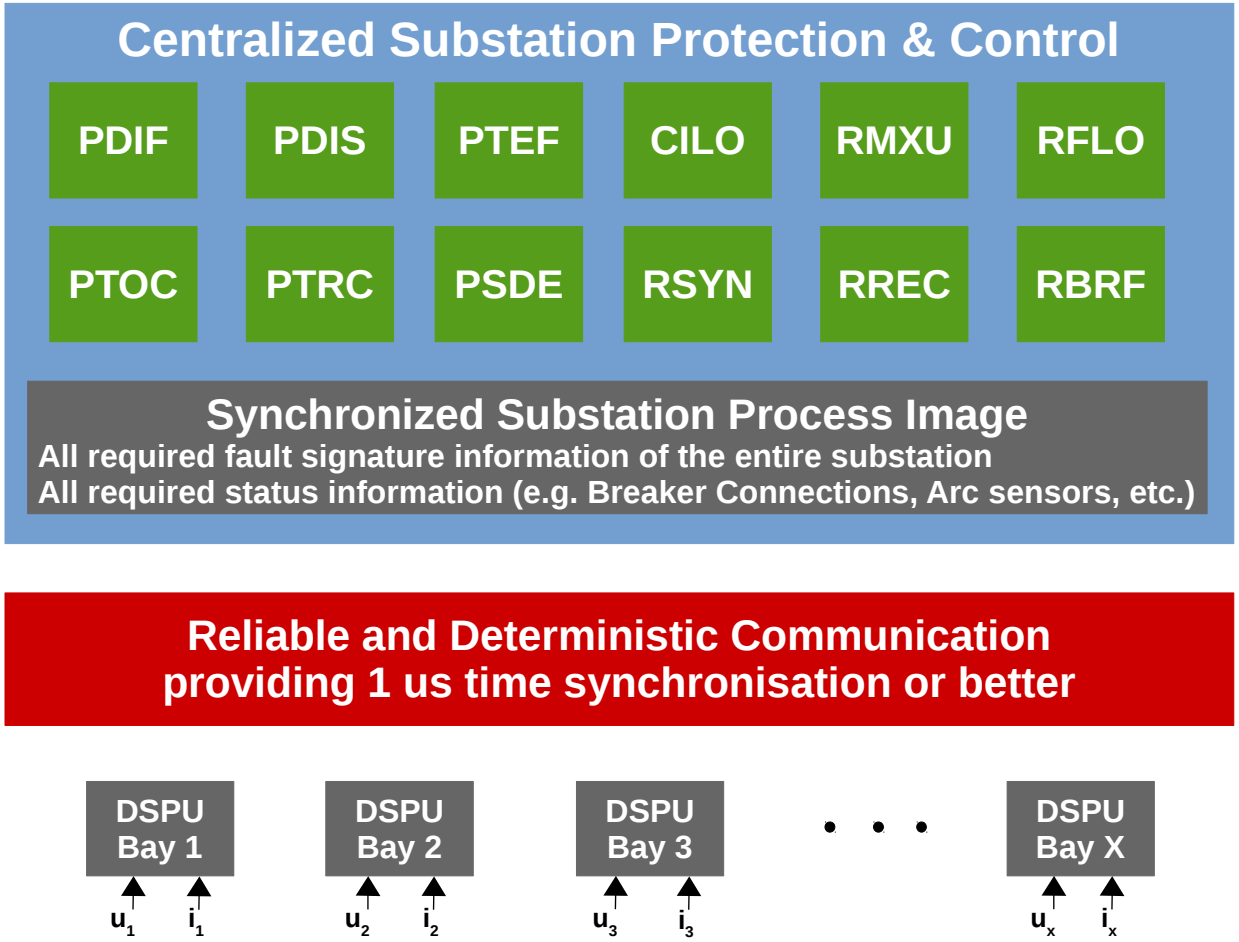
Reliable and Deterministic Communication providing 1 us time synchronisation or better



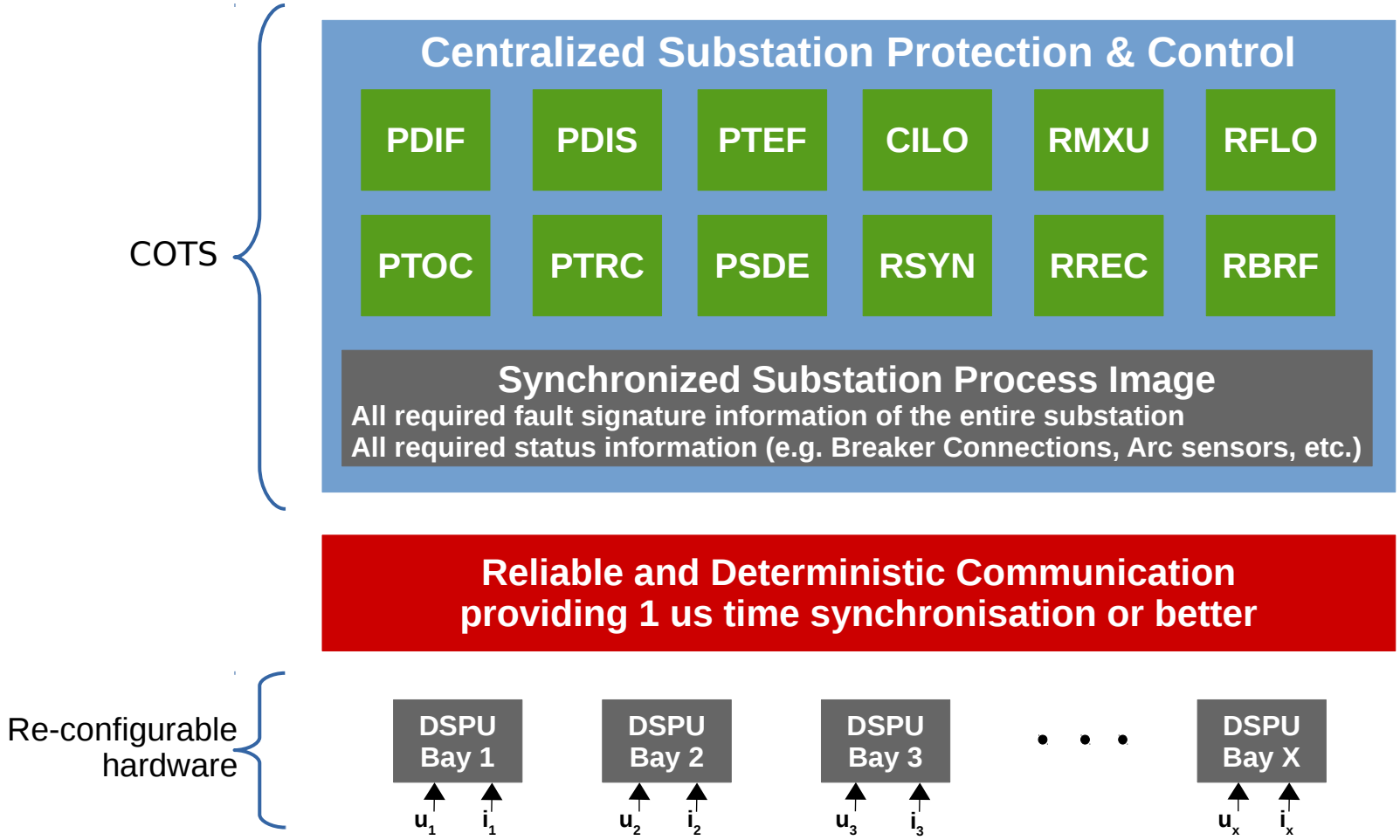
Proposed CPC architecture



Proposed CPC architecture



Proposed CPC architecture



Future plans

1. Build a prototype of a DSPU

2. Show proof of concept with a centralized platform

3. Application development in phasor- and time-domain

Questions ?