



VTT



# COMBINED PROTECTION CHIL WITH WIRELESS 5G COMMUNICATION PERFORMANCE VALIDATION

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2023 EUROPEAN  
**RTDS** TECHNOLOGIES INC.  
USER'S GROUP MEETING 2023



2023 EUROPEAN USER'S GROUP MEETING

**RTDS**  
Technologies  
AMETEK



# CONTENT

- VTT in brief
- CHIL
- Communication testbed
- Use cases
- Advancements with RTDS
- Selected results
- Future work

# VTT – BEYOND THE OBVIOUS

VTT is a visionary research, development and innovation partner for companies and the society.

We bring together people, business, science and technology to solve the biggest challenges of our time. This is how we create sustainable growth, jobs and wellbeing and bring exponential hope.

**261 M€**

turnover and other  
operating income

**2,213**

employees

**43%**

of the net turnover  
from abroad

**32%**

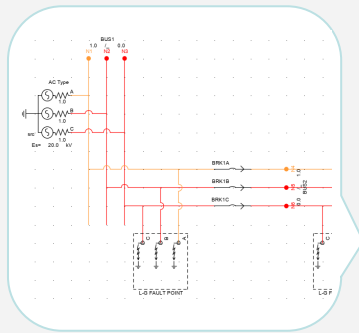
a doctorate or a  
licentiate's degree

Established in

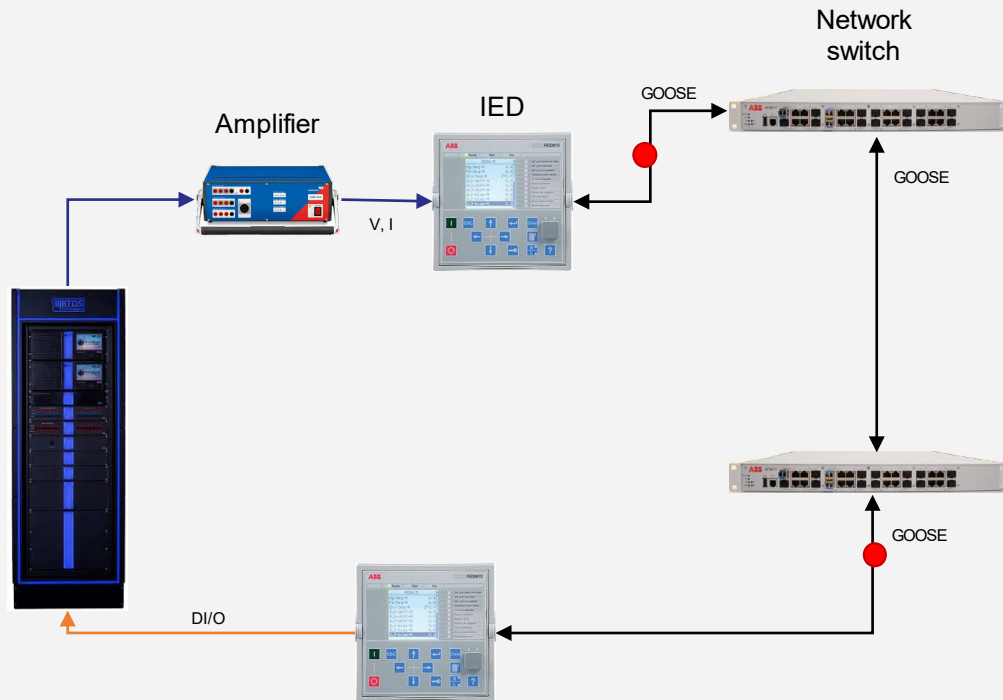
**1942**

Owned by Ministry  
of Economic Affairs  
and Employment

# CHIL

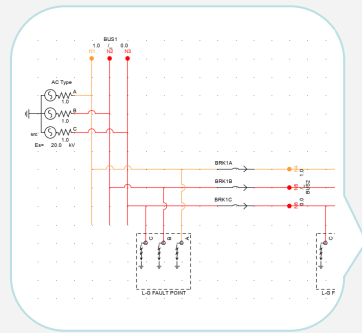


RTS

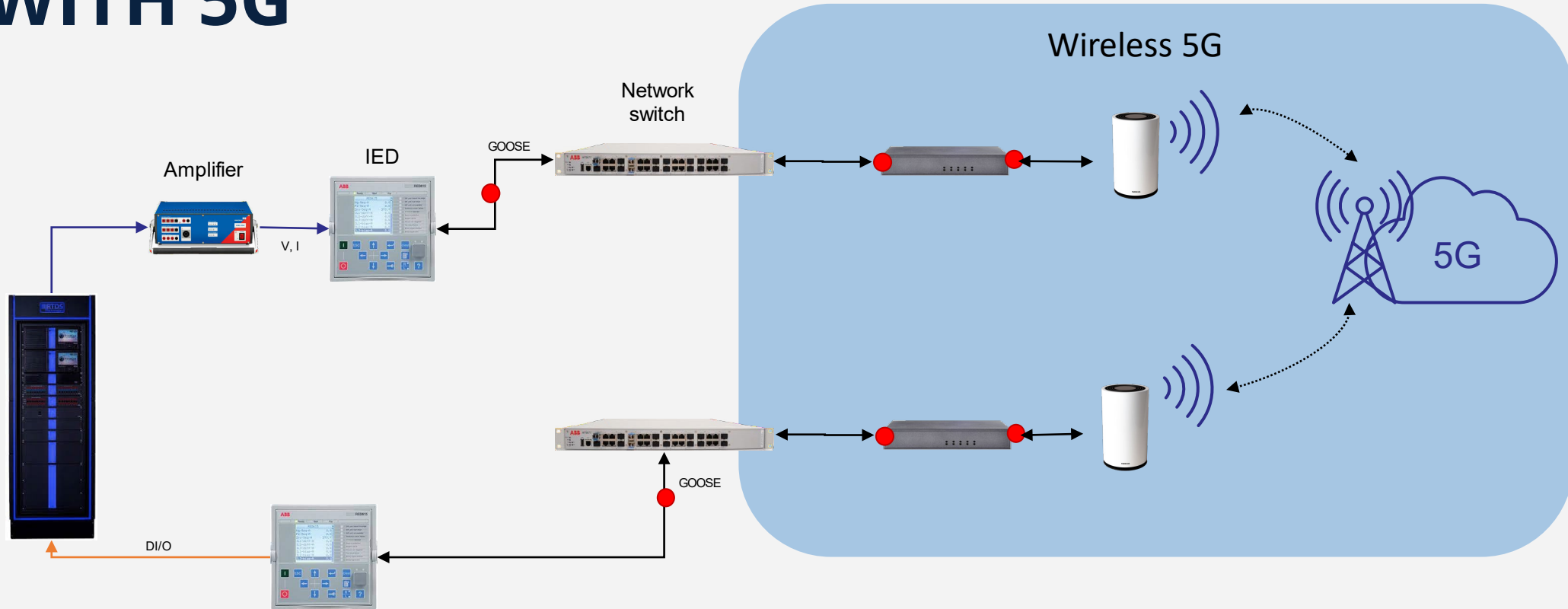


— Ethernet or fiber connection  
— Electrical signals  
— Digital signals

# CHIL WITH 5G



RTS



— Ethernet or fiber connection  
 — Electrical signals  
 — Digital signals

# COMMUNICATION TESTBED

- Supported by commercial and test 5G network infrastructures enabling, e.g. large-scale trials, pre-commercial deployments, and testing beyond 5G products and services.
- Testing with different types of traffic using real devices, recorded data, traffic generators, and traffic emulation and shaping functions.
- Effects of different technologies, services, configurations, and routing solutions are investigated.



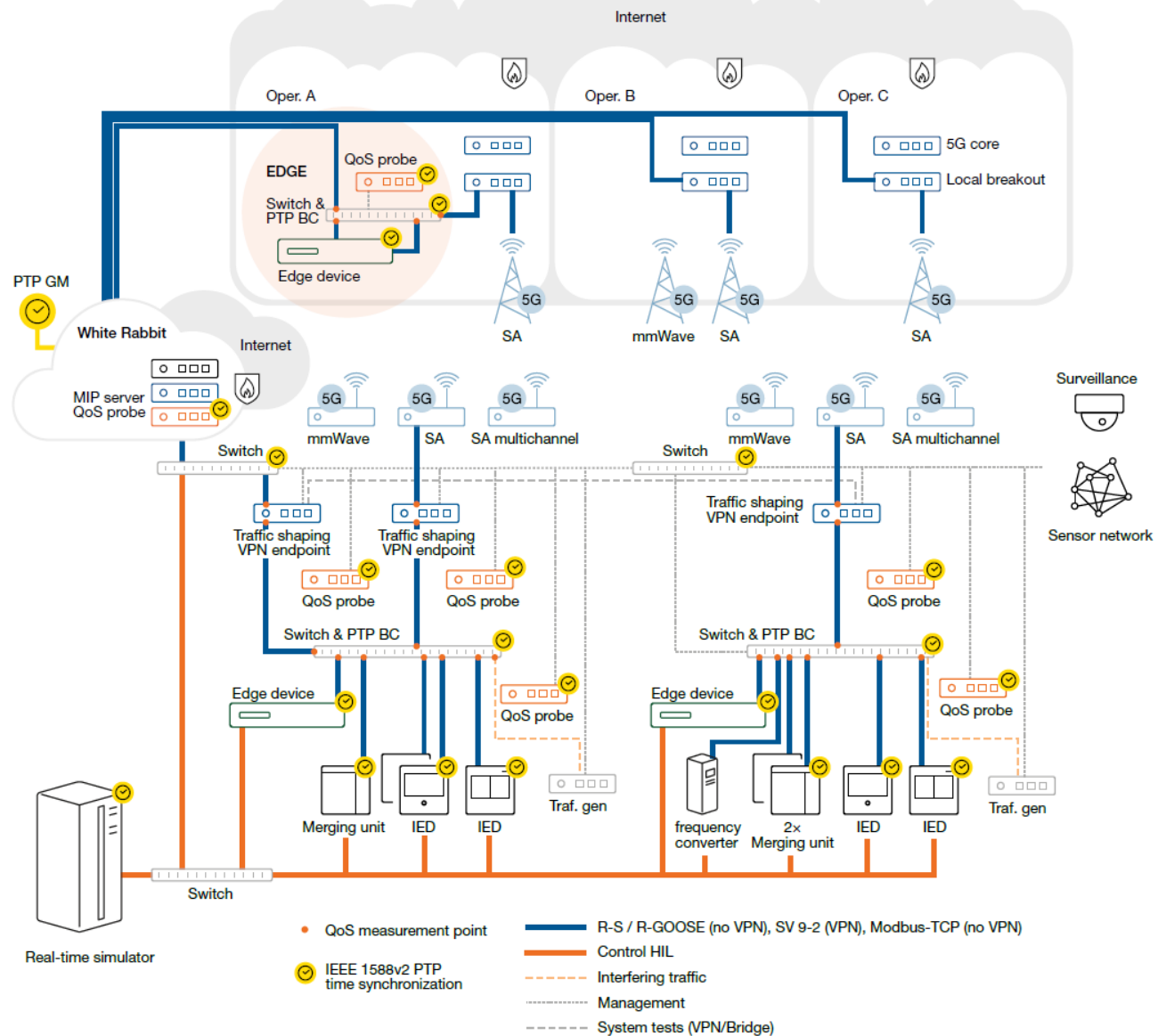
*5G networks available in Otaniemi Campus, Espoo, Finland.*

# KPI METRICS FOR COMMUNICATION

- Fixed and wireless communications, e.g.:
  - Maximum throughput
  - Load
  - Latency and jitter
  - Lost and malformed packets
  - Connection breaks, and downtime
  - Cell id, signal level, and quality
- Timing and synchronisation
  - Clock bias
  - Clock drift
  - Time accuracy



# CHIL



BUSINESS  
FINLAND

ABB

NOKIA

Telia

DNA

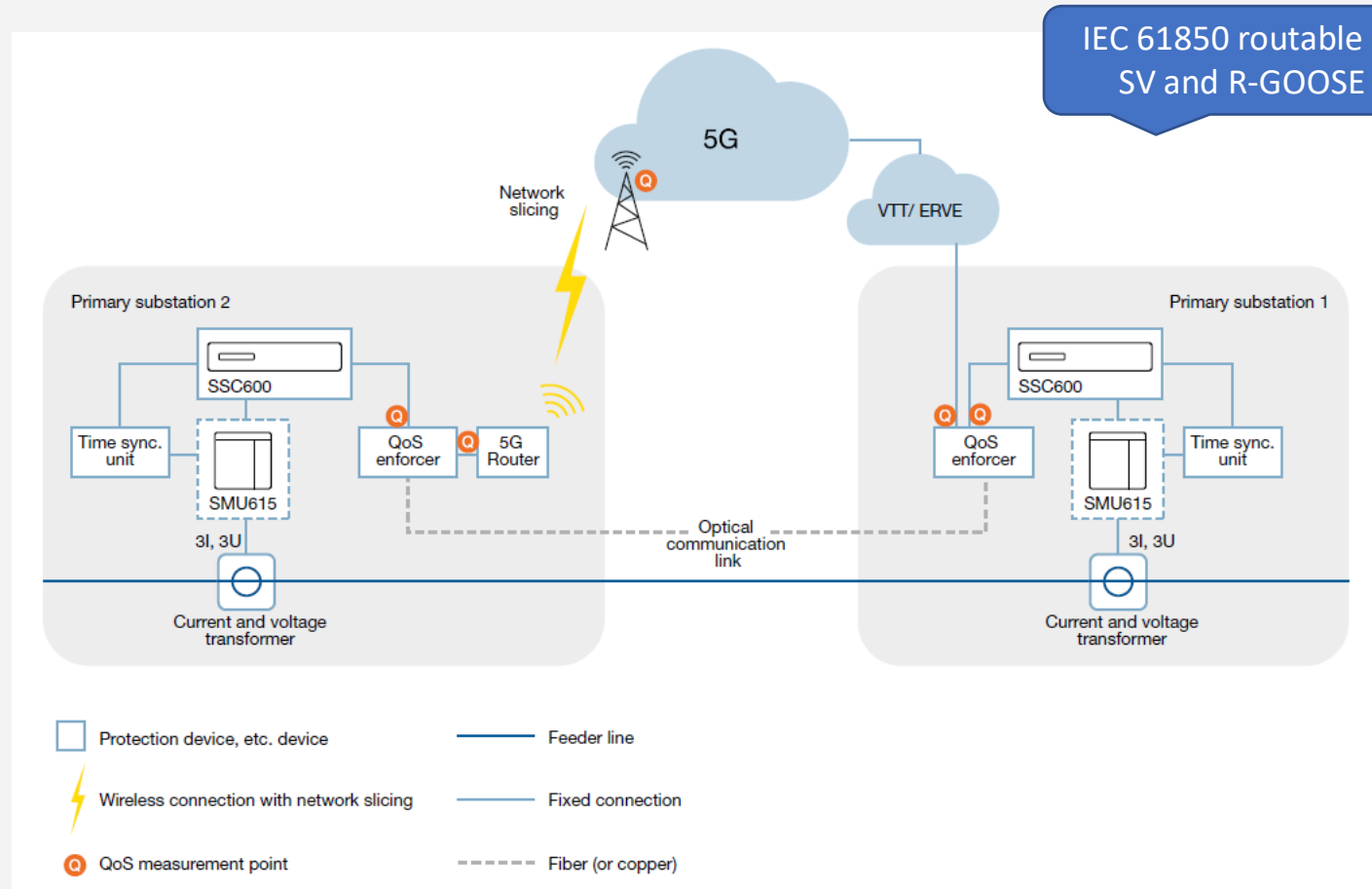
GOODMILL  
Always online

åea  
Ålands Elandslag

FINGRID  
CARUNA

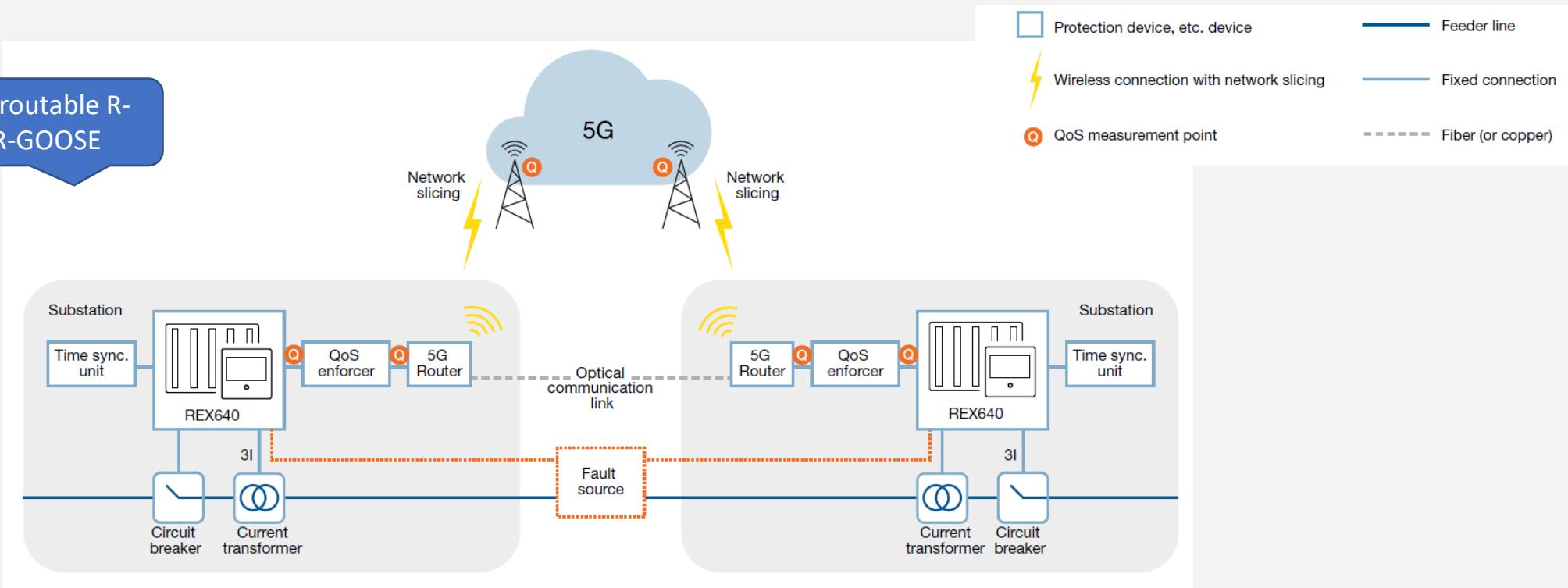


# INTERTRIP PROTECTION



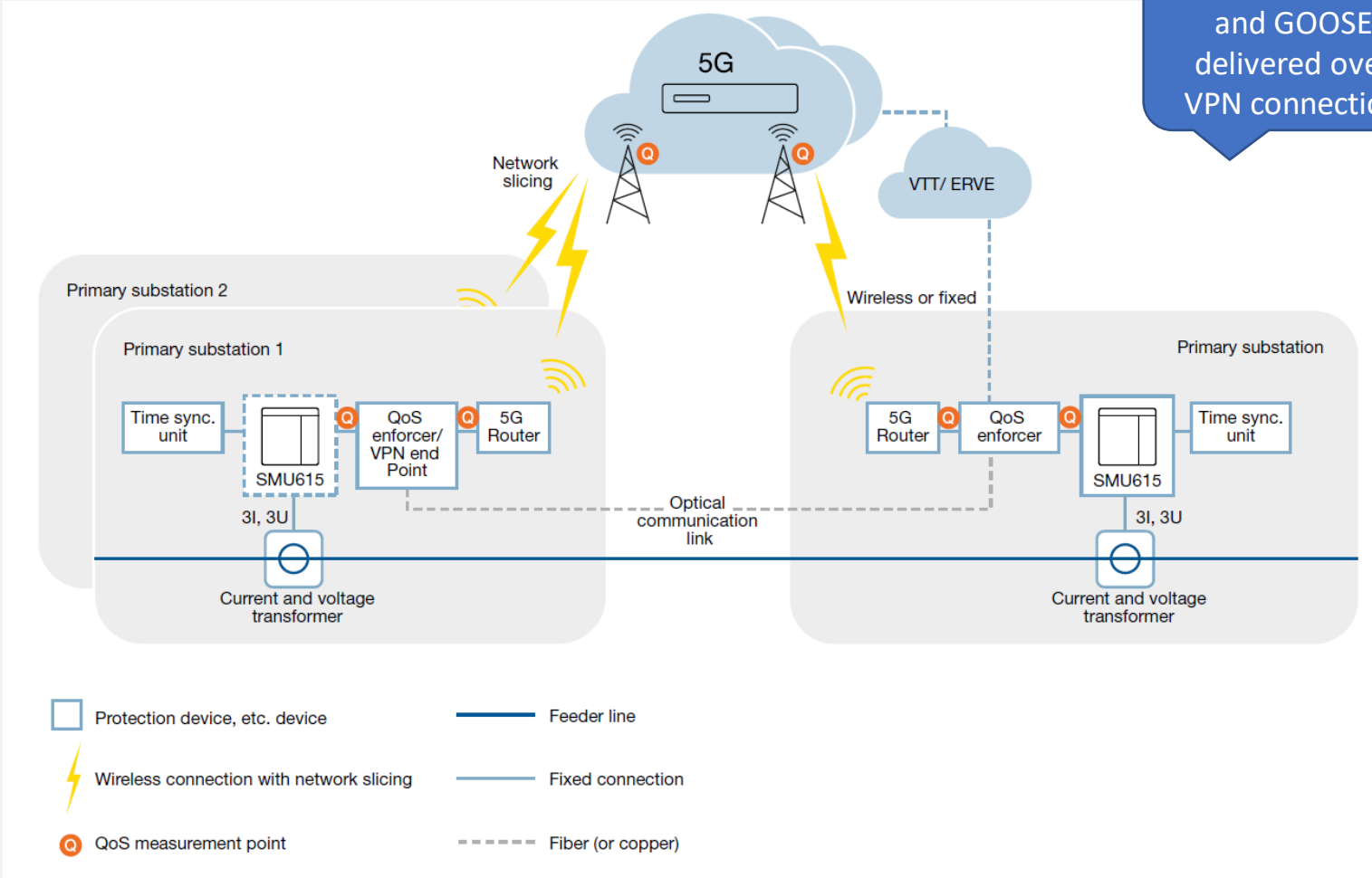
# LINE DIFFERENTIAL PROTECTION

IEC 61850 routable R-SV and R-GOOSE



# FAULT PASSAGE INDICATION

IEC 61850-9-2 SV and GOOSE delivered over VPN connection



# ADVANCEMENTS WITH RTDS

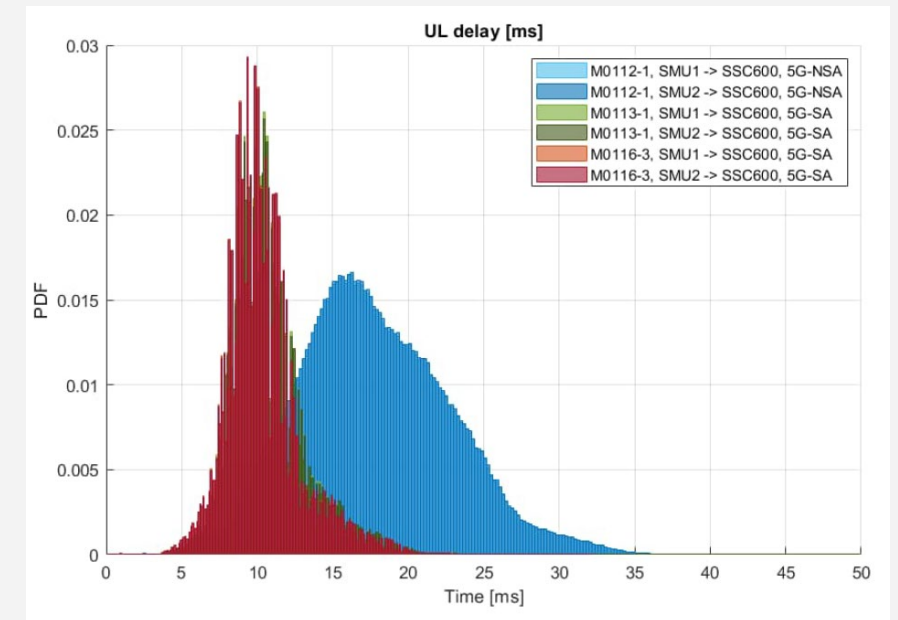
- Controller-Hardware-in-the-loop (CHIL) simulation
- Protection relays and merging units as Devices under Test (DuT)
- Increase in inputs and outputs for both analogue measurements and digital control and status signals
- Capability to test various protection functions
- Realistic power system in simulation
- Automated recurring tests
- Interconnection to 5G test network and commercial wireless networks
- Capability to test telecommunication equipment and operator services



# SELECTED RESULTS

## Edge computing supported fault indication – 5G NSA vs. SA

- Delays on average 5 ms smaller
- UL latencies are 7.9 ms and DL latencies 0.5 ms lower
- Buffer size of edge device could be lowered to default



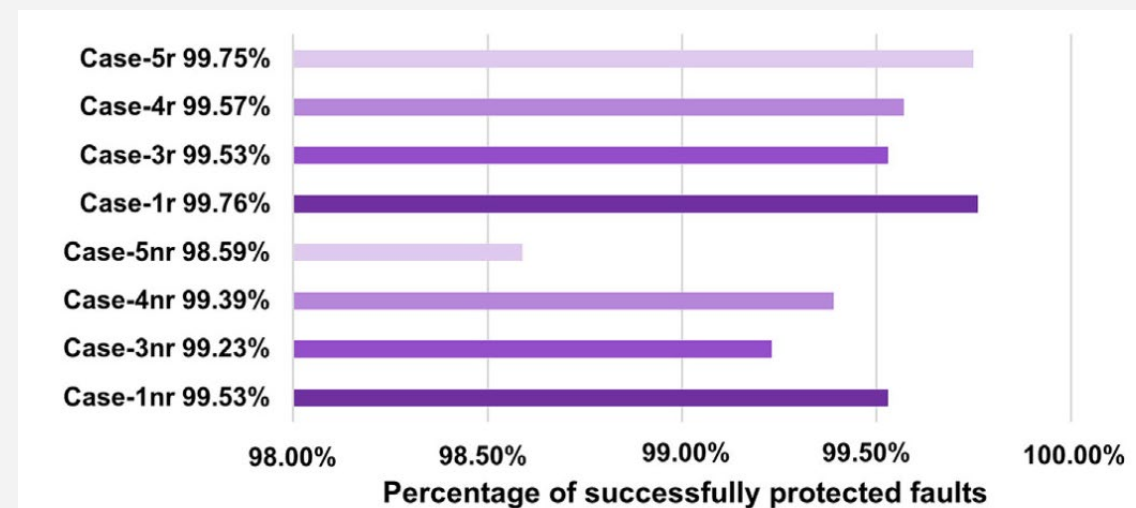
*Distribution of UL latencies for two Sampled Value streams in one 5G NSA and two 5G SA measurements.*

Kokkonniemi-Tarkkanen, H., Raussi, P., Horsmanheimo, S., Hovila, P., Kulmala, A. & Borenius, S. (2023). 5G Edge for Power System Applications. In CIREN 2023.

# SELECTED RESULTS

## Prioritisation of protection communication traffic in 5G slice

- Parallel traffic flows deteriorate the QoS of protection communication
- HTB Traffic shaping increased successfully protected faults by
  - 1.16% in non-congested network scenario, and
  - 47.57% in a congested network scenario
- UL bitrate adaptation of live video stream increased the successfully protected faults by 3.69%



Successfully protected faults with variable amounts of traffic with (r) and without (nr) prioritization.

Raussi, P., Kokkonen-Tarkkanen, H., Ahola, K., Heikkinen, A., Uitto, M. (2023). Prioritizing protection communication in a 5G slice: Evaluating HTB traffic shaping and UL bitrate adaptation for enhanced reliability. The Journal of Engineering, e12309(2023). DOI: 10.1049/tje2.12309

# FUTURE WORK

- Expanding System under Test to mobile operator's data center
- Measurement campaigns in commercial 5G-SA continue
  - Multi-operator network slicing & multi-subcarrier transmission
- 6G proposed features & architectures -> time sensitivity and reliability

**GOODMILL**  
Always online |

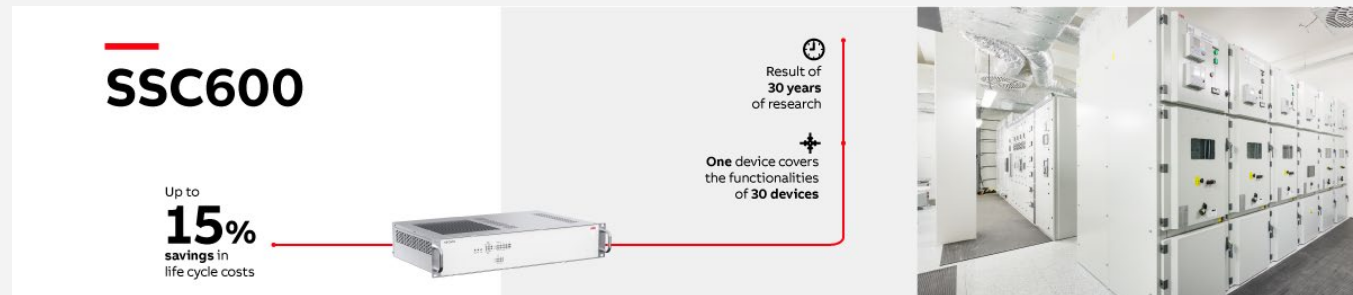


**SSC600**

Up to **15%** savings in life cycle costs

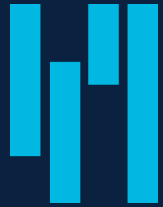
Result of 30 years of research

One device covers the functionalities of 30 devices





Available free of charge via H2020 ERIGRID 2.0 lab access:  
<https://erigrd2.eu/lab-access/>



# THANK YOU!

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