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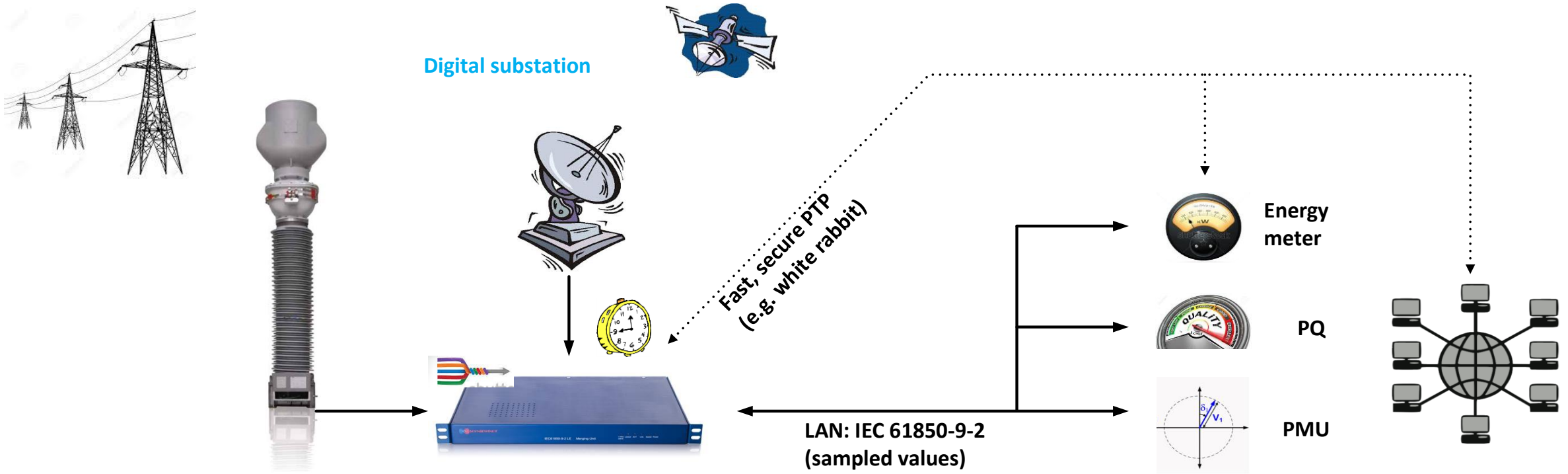
# Metrology for digital substation instrumentation (Digital-IT)

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METROLOGY PARTNERSHIP | EURAMET

# Digital substation




- In digital substation the signals from Instrument Transformers (ITs) to instrument are **bitstreams** (Sampled Values) over Ethernet **instead of analog signals**
- Digital technology **requires very precise timing** down to nanosecond scale

**Traceable and/or accredited calibration and testing services are just emerging**

# Need

## for traceability to digital instrumentation



- New, emerging digital technology
  - Analog systems have well established traceability
  - First services for digital systems have emerged during last years
  - New requirements have been set by standardization (e.g. on SAMU's), not yet covered by the lately introduced services
  - At the moment only a few NMIs offer limited range of calibration services
- End-users have urgent need for traceability
  - Wider application of the technology is not foreseen before accredited calibrations and type tests are available

*"need to **fill in existing gaps in the procurement and qualification process** of SAMU and LPIT."*

Le réseau de transport d'électricité

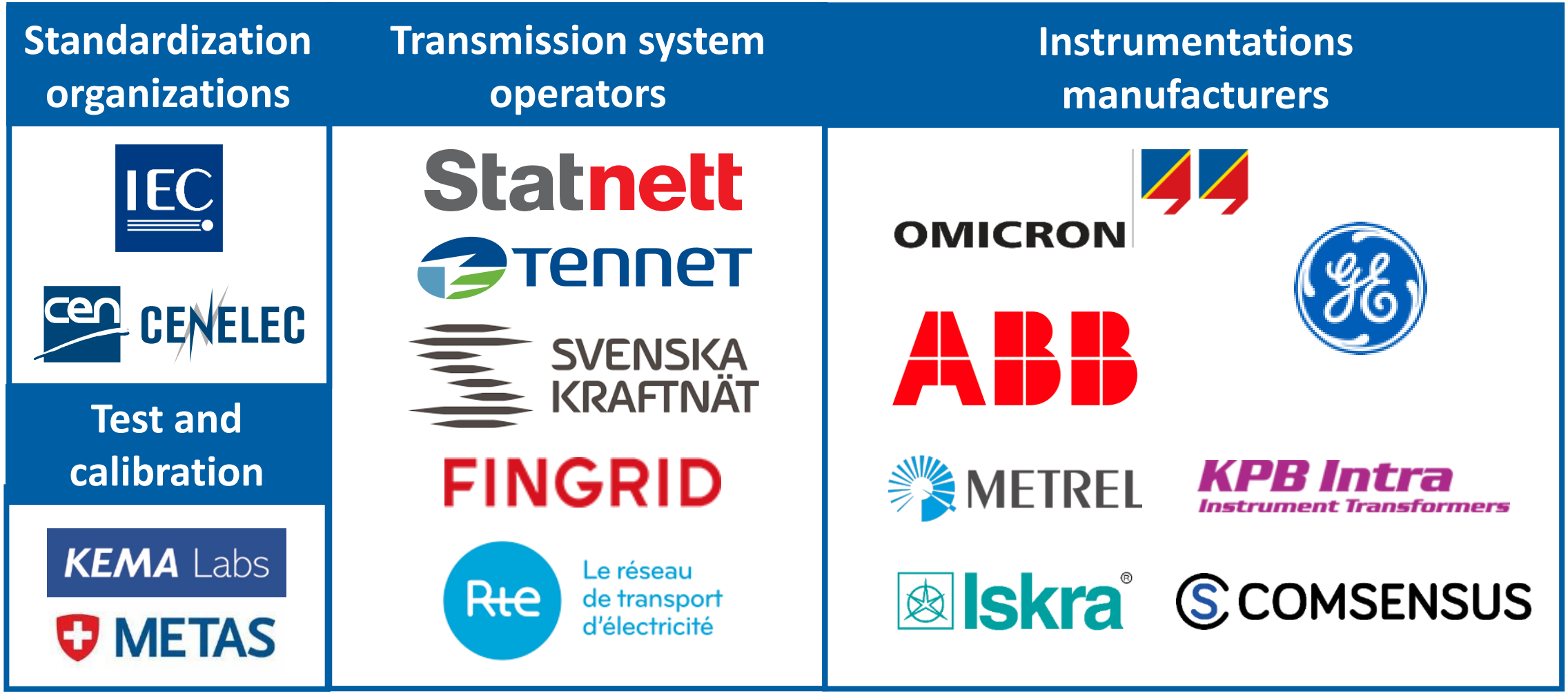
# The digital-IT project

- **Strong consortium**
  - 8 NMIs
  - 3 Research organisations
  - 1 TSO
  - 1 Instrument manufacturer
- September 2022 – August 2025
- Funding from **a Normative call of the European Partnership on Metrology** (budget 1 M€)
- Supported by IEC & CENELEC TC 38
- Strong stakeholder interest: TSOs, test and calibration labs, instrument manufacturers
- Part of the **European Metrology Network (EMN) on Smart Electricity Grids**

www.euramet.org/smart-electricity-grids

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# Strong stakeholder network




Statnett and OMICRON are unfunded project partners



# Technical objectives

The overall objective is to develop the metrology infrastructure for traceable calibration of sampled value (SV) enabled equipment such as merging units, digital instrument transformers and instrument transformer measuring bridges.

**In order to achieve the main objective, the project will:**

1. develop reference systems (hardware) for calibration of sampled value (SV) enabled equipment
2. develop software for controlling the calibration setups and for handling of SV data streams
3. develop timing networks and establish traceable link between PTP timing and 1PPS reference pulse

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# State of the art

## Current

- Calibration capability
  - Low sample rate, 4 kSPS
  - Fundamental only, 50/60 Hz
- Timing
  - 1PPS based timing
- Service availability

  Only from a few NMIs with limited scope

## After Digital-IT

- Calibration capability
  - Higher sample rates, 14.4 and 96 kSPS
  - Also Power Quality measurements
- Timing
  - Traceability implemented for PTPv2
- Service availability
  - Wider scale available from larger number of NMIs
- New open access reference software

**Outputs & Impact:**

- Traceability for Sampled Value based system
- Traceability for timing of Sampled Value streams
- New reference systems
- Calibration services for digital instruments

→

- Support for revision of TC38 standards
- Wider introduction of new digital substations

# Scientific excellence



- Calibration techniques for stand-alone merging units will be developed for sampling rates up to 96 kSPS and include harmonics.
- Calibration techniques for conversion between 1PPS and PTP timing protocols will be developed, to enable calibration of PTP enabled devices.
- Developments will lead to several Open Access publications.

**Separate presentation by Tapio Lehtonen**

# Impact

- Create metrology infrastructure for latest generation digital substation instrumentation
  - Update existing NMI capabilities to match requirements of new standards
  - Introduce services in new NMIs
    - SRT: "*... opportunities for the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased*"

- Standardization
  - Metrology community support for standards development, especially TC 38
- Environmental and social impact
  - Energy savings through better control of electrical grids
- Technological impact
  - Trust for the new digital substation instrumentation
- Economic impact
  - Annual European energy production value is c. 150 B€
  - Value of 0.1 % contribution to this is 150 M€



# Conclusions

- Strong need for written standards and traceable reference systems for calibration of digital substation instrumentation
  - TSOs cannot use digital technology without verification of its reliability!
- EU project digital-IT aims to fill the present gap
- Key scientific challenges
  - Reference systems for calibration of sampled value (SV) enabled equipment, such as SAMUs, up to 96 kSPS and including harmonics
  - Software to control calibration setups and handle SV data streams
  - **Timing networks, traceable link between PTP timing and 1PPS**





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# Metrology for digital substation instrumentation

## September 2022 – August 2025

The project 21NRM02 Digital-IT has received funding from the European Partnership on Metrology, co-financed from the European Union's Horizon Europe Research and Innovation Programme and by the Participating States

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# Background

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| Time | Funding | Project | Outcome / plan |
|---|---|---|---|
| **2014-2017** | EU EMRP Energy | **FutureGrid** Non-conventional voltage and current sensors for future power grids | One work package on digital ITs. First NMI calibration services for digital substation instrumentatation. |
| **2018-2021** | EU EMPIR Industry | **FutureGrid II** Metrology for the next-generation digital substation instrumentation | Further development of traceable calibration methods and services by several NMIs. |
| **2022-2025** | EU EPM Normative | **Digital-IT** Metrology for digital substation instrumentation | Emphasis on standardization (IEC TC38). New methods for timing calibration. |
| **2015-2018** | Statnett, Fingrid, RTE | **COSECTIME** Coordinated Secure Timing for the Smart Grid | Pilot for time distribution using optical fibers (White Rabbit) |