M-Class PMU for general purpose embedded controllers in NI-Veristand environment

Anurag Mohapatra,

Steffen Büttner, Vedran S. Peric, Thomas Hamacher

Center for Combined Smart Energy Systems (CoSES),
Technical University of Munich

- Standard measurement unit for power grids.

- Measures Voltage, Current and Frequency as Synchrophasors.

- Two important standards - IEC/IEEE 60255-118-1 (accuracy) & IEEE-SA C37.118.2 (messaging)

- Device must pass accuracy tests and must transfer message in proper format to be called a PMU.

- Has two classes -

- Measurement (M) class – more accurate but slow reporting

- Protection (P) class – less accurate but fast reporting
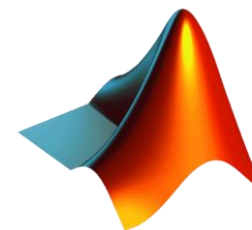
*Siemens PMU

- Increasing computation capacity within active distribution grids. (ADG)

- Potential to reduce reliance individual, specialized devices.

- Align maintenance updates and deployment schedules.

- Increasing computation capacity within active distribution grids. (ADG)

- Potential to reduce reliance individual, specialized devices.

- Align maintenance updates and deployment schedules.

- Increasing computation capacity within active distribution grids. (ADG)

- Potential to reduce reliance individual, specialized devices.

- Align maintenance updates and deployment schedules.

- Increasing computation capacity within active distribution grids. (ADG)

- Potential to reduce reliance individual, specialized devices.

- Align maintenance updates and deployment schedules.

- You dont buy a **new computer** for a new task! You **install a new software on the common OS**
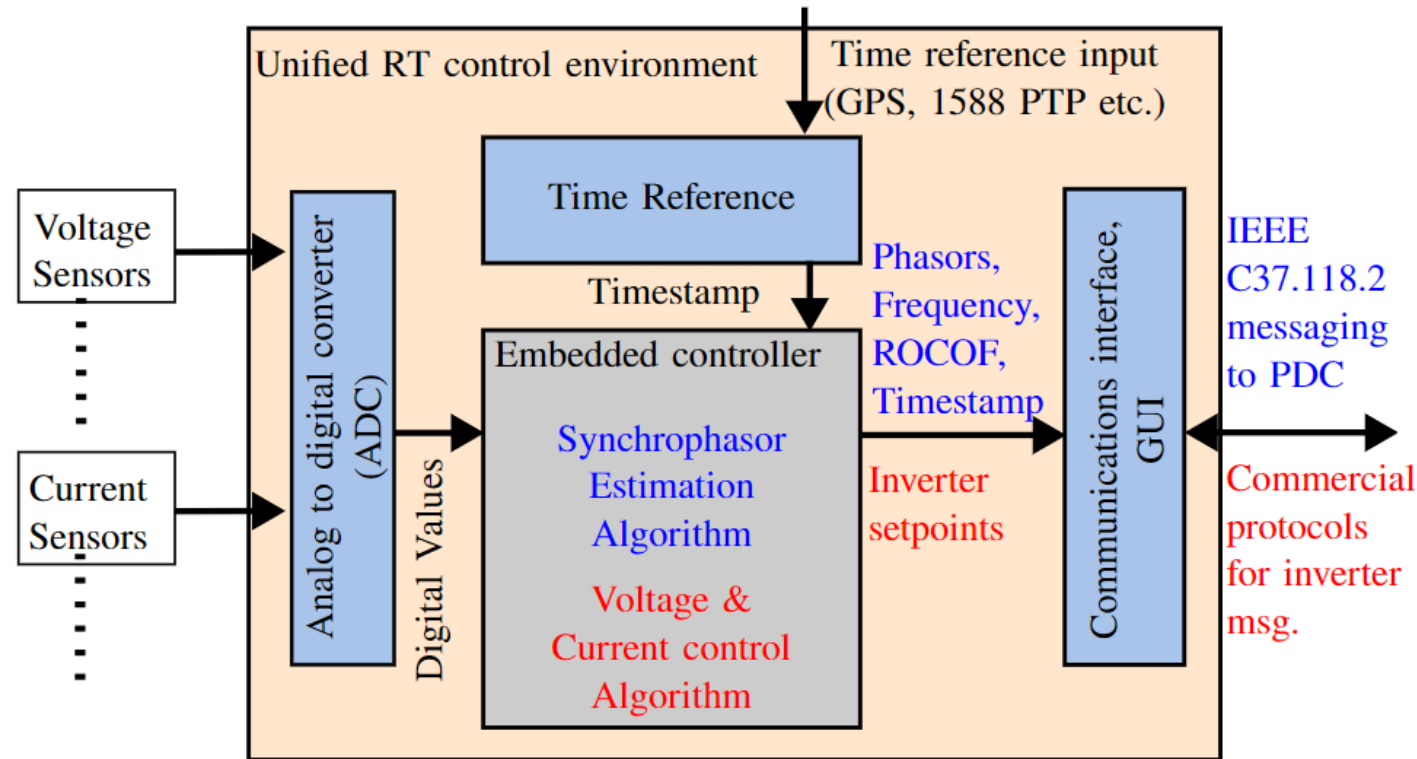
Control and instrumentation architecture for an **Inverter Current/Voltage controller** and a **Phasor Measurement Unit**, hosted in an unified „*Real Time control Environment*"
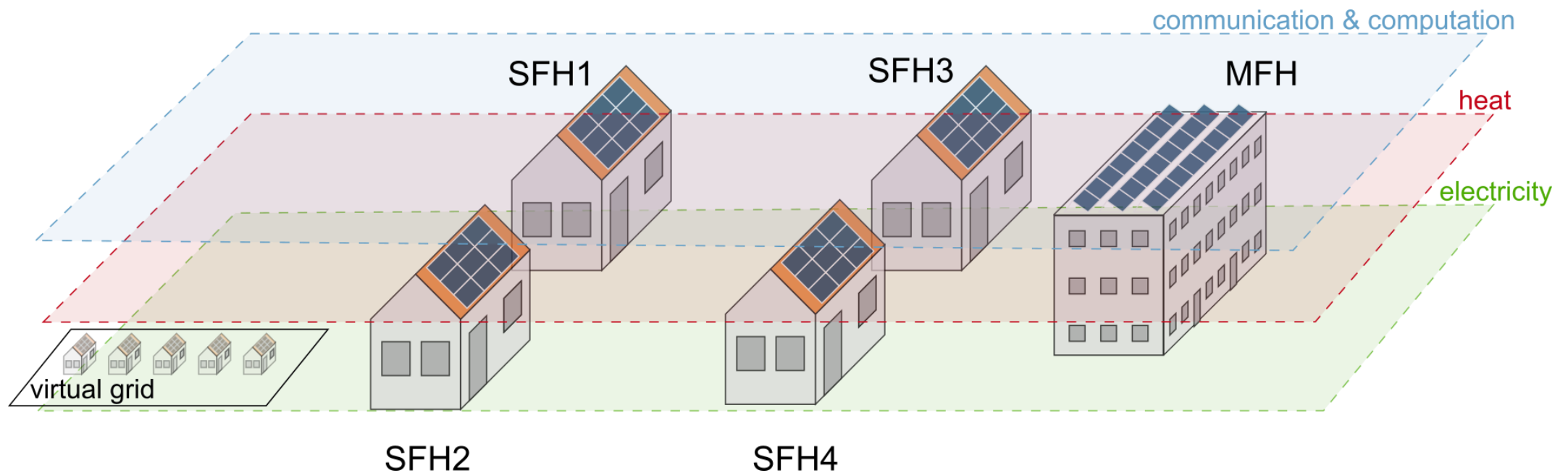
[1] V. S. Perić et al., "CoSES Laboratory for Combined Energy Systems At TU Munich," 2020 IEEE Power & Energy Society General Meeting (PESGM), Montreal, QC, Canada, 2020, pp. 1-5, doi: 10.1109/PESGM41954.2020.9281442.

[2] A. Mohapatra, T. Hamacher and V. S. Perić, "PHIL Infrastructure in CoSES Microgrid Laboratory," 2022 IEEE PES Innovative Smart Grid Technologies Conference Europe (ISGT-Europe), Novi Sad, Serbia, 2022, pp. 1-6, doi: 10.1109/ISGT-Europe54678.2022.9960295.

[3] E. Sezgin, A. Mohapatra, T. Hamacher, Ö. Salor, V. S. Perić, „Fast harmonic analysis for PHIL experiments with decentralized real-time controllers", Electric Power Systems Research, Volume 211, 2022, doi: 10.1016/j.epsr.2022.108493.

Embedded **hardware**
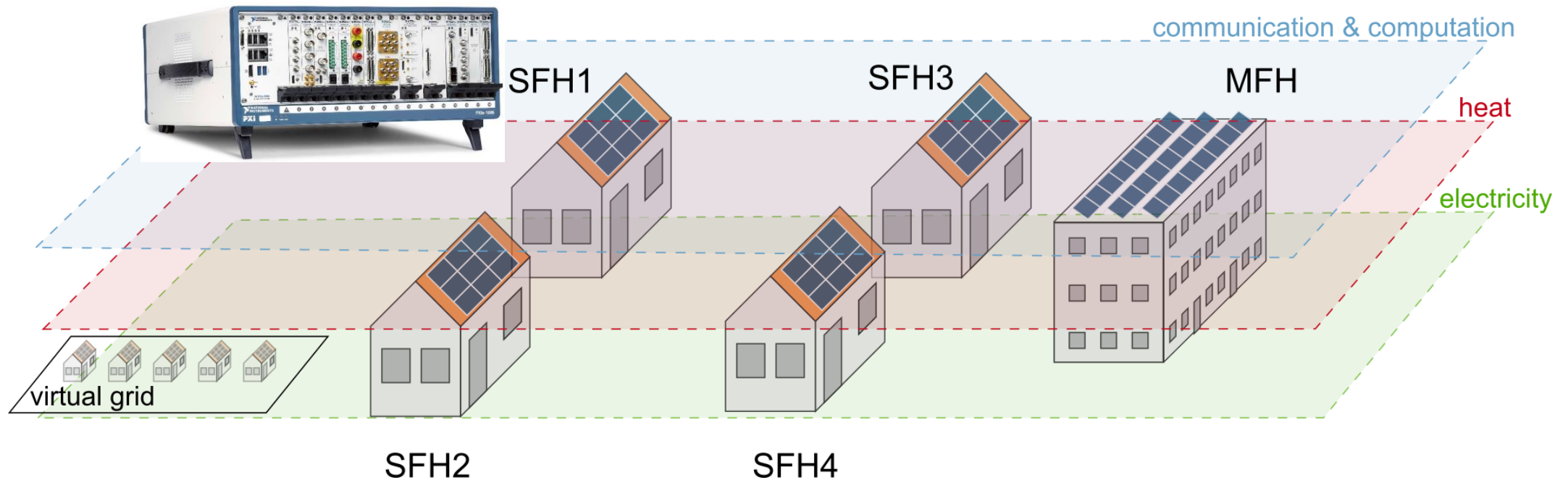
- NI PXIe-8880 with IO cards
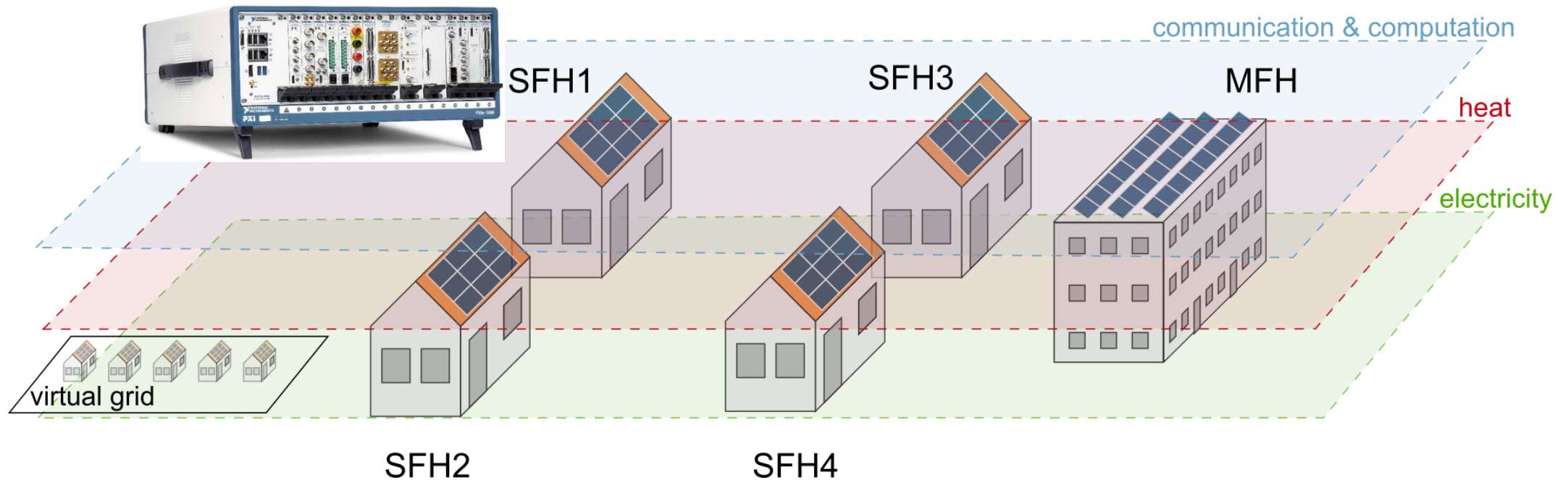- GPS **time sync**
- *LEM Voltage and Current* **sensors**

Embedded *hardware*

- NI PXIe-8880 with IO cards
- GPS *time sync*
- *LEM Voltage and Current sensors*

Installed *software*

- Inverter control
- Prosumer emulation
- Energy management
- Measurements hub

Embedded *hardware*

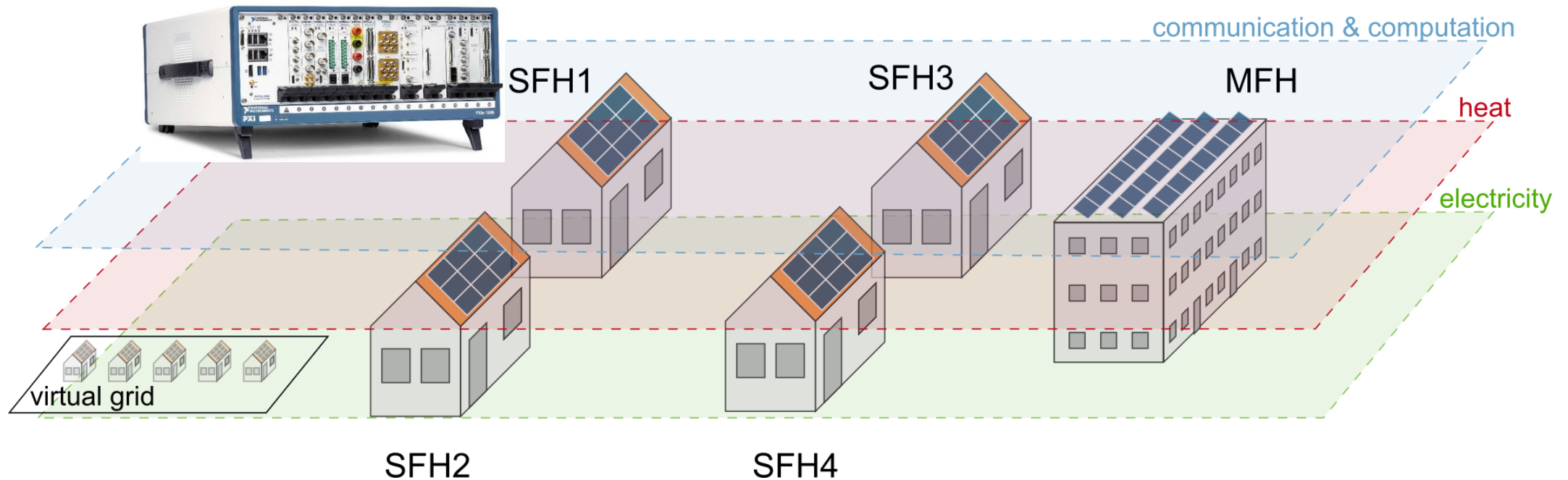- NI PXIe-8880 with IO cards
- GPS *time sync*
- *LEM Voltage and Current sensors*

Installed *software*

- Inverter control
- Prosumer emulation
- Energy management
- Measurements hub

Common **Operating System**

- NI Veristand Real time control environment
- Models as .dll or .fmu

PowerTech Belgrade 2023
LEADING INNOVATIONS FOR RESILIENT & CARBON-NEUTRAL POWER SYSTEMS
25-29 JUNE, 2023, BELGRADE, SERBIA

Embedded *hardware*
- NI PXIe-8880 with IO cards
- GPS *time sync*
- *LEM Voltage and Current sensors*
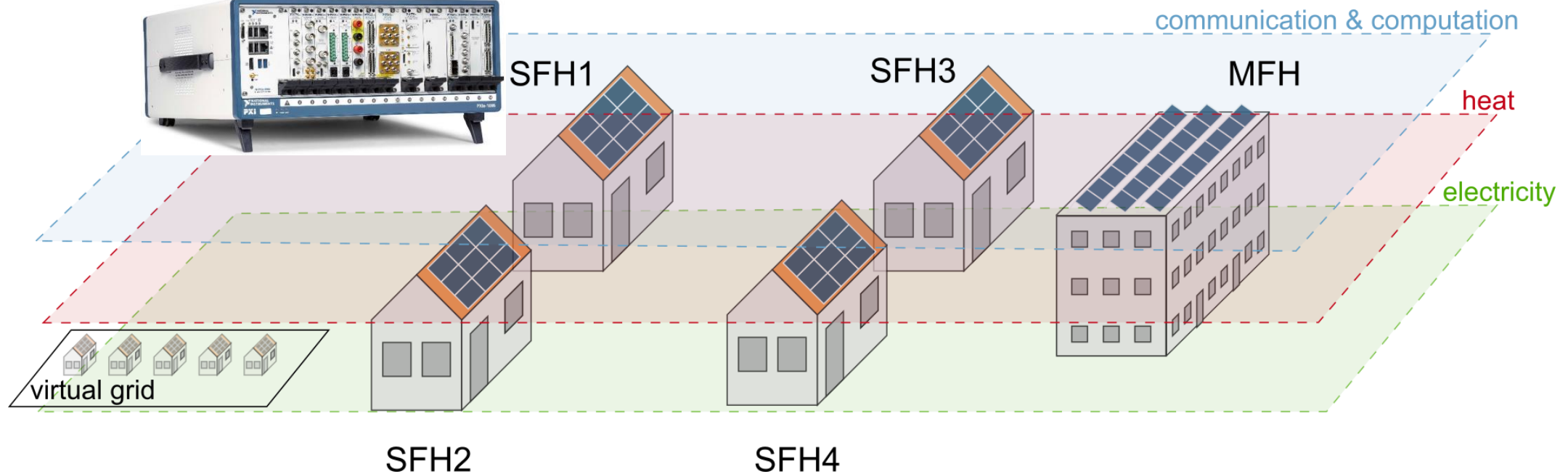
Installed *software*
- Inverter control
- Prosumer emulation
- Energy management
- Measurements hub
- **Phasor measurement unit**

Common **Operating System**
- NI Veristand Real time control environment
- Models as .dll or .fmu

NI VeriStand

communication & computation

heat

electricity

SFH1

SFH3

MFH

virtual grid

SFH2

SFH4

- Synchrophasor algorithm – 3 x Single phase PLL + Inverse Park transform + Phase step filter

- Tuned with a simple Particle Swarm Optimization.

- Modelled as a .dll from MATLAB/Simulink for NI Veristand

- Connect the output from to a Phasor Data Concentrator software like a true PMU.
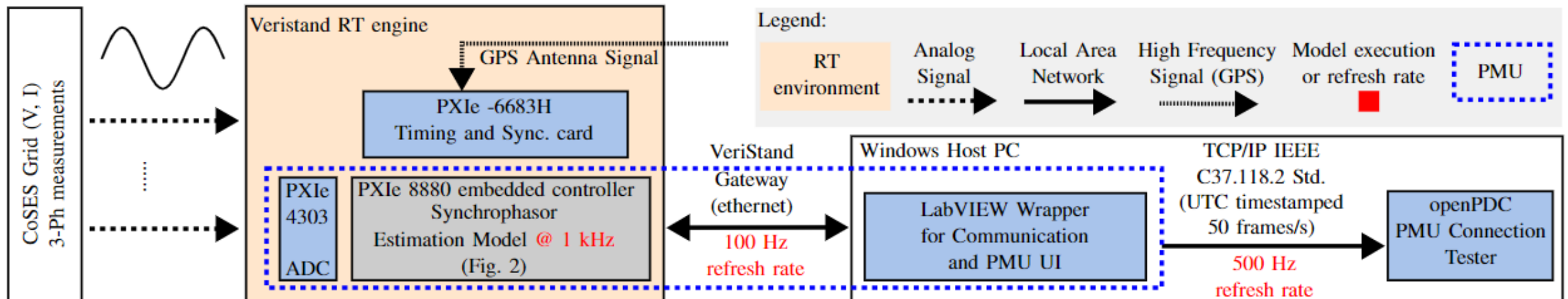
- PMU model passes all mandated static and dynamic tests for M-Class PMU in IEC/IEEE 60255-118-1

- No additional wirings needed

- Controller is performing other tasks in parallel

- Can deploy multiple PMU instances on same controller
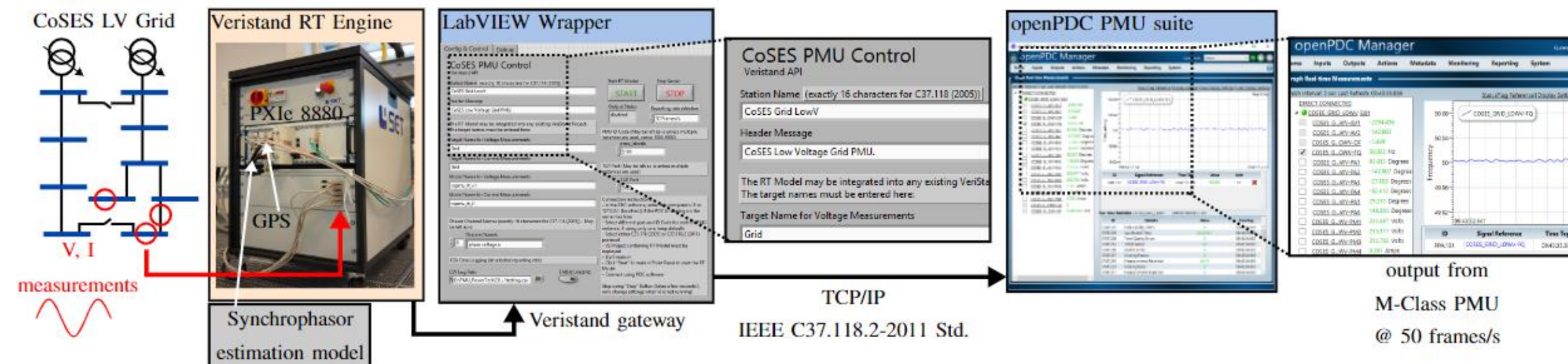
- Increasing computation capacity in ADGs

- Opportunity for shared hardware basis for grid servicing equipment

- Developed a M-Class PMU to be deployed as a model on general purpose embedded controller in an ADG lab.

- Added PMU functionality to the controller at zero extra cost of instrumentation and wiring.

Future tasks

- Improve the PMU algorithm.

- Integrate other services as a software bundle for existing grid controllers.

THANK YOU FOR YOUR ATTENTION!

PowerTech Belgrade 2023

LEADING INNOVATIONS FOR RESILIENT
& CARBON-NEUTRAL POWER SYSTEMS

25-29 JUNE, 2023, BELGRADE, SERBIA

Contact Information:

Anurag Mohapatra
Center for Combined Smart Energy Systems (CoSES), TU Munich
anurag.mohapatra@tum.de

PowerTech
Belgrade **2023**

LEADING INNOVATIONS FOR RESILIENT
& CARBON-NEUTRAL POWER SYSTEMS
25-29 JUNE, 2023, BELGRADE, SERBIA