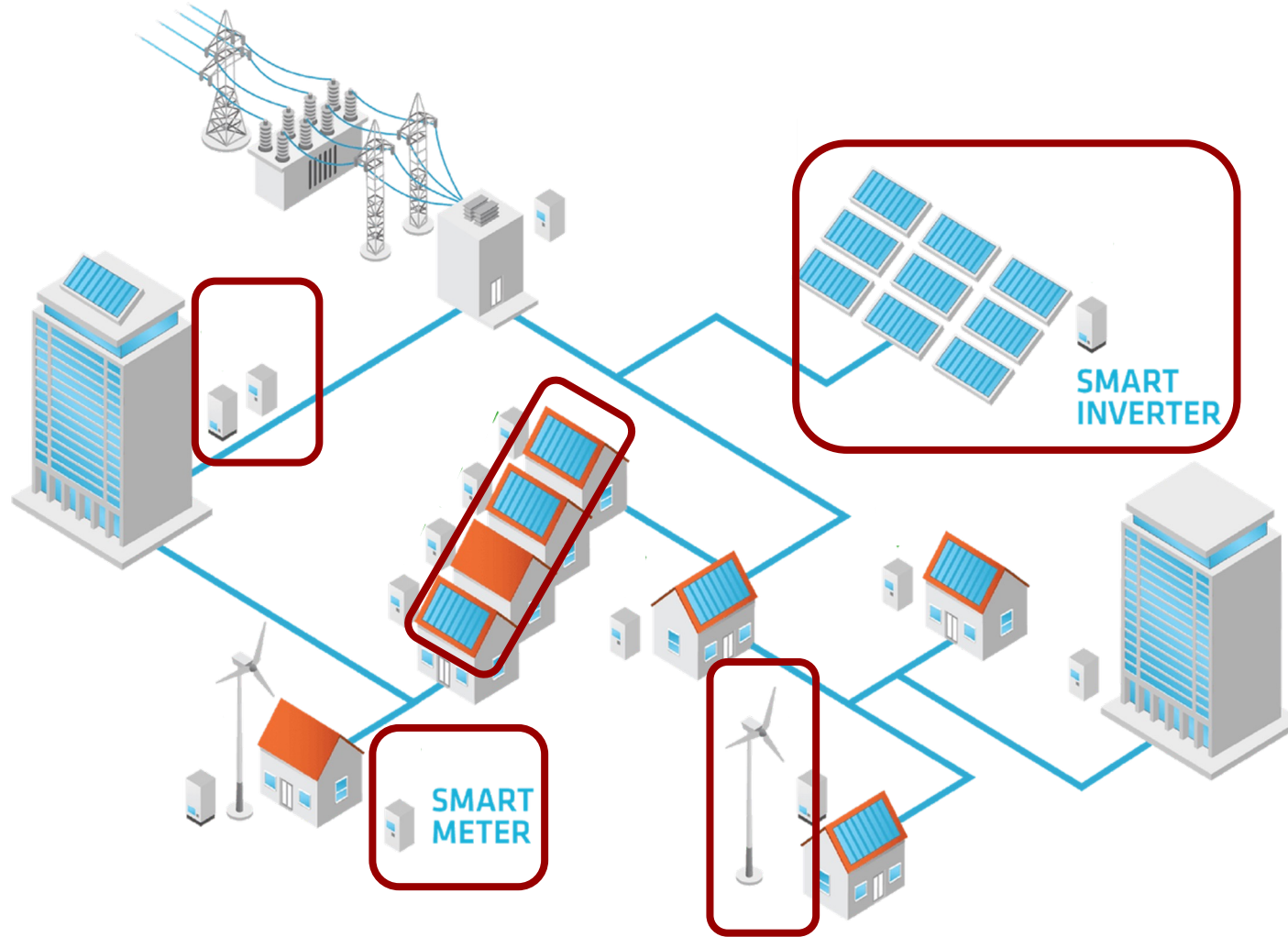


# ASSESSING EFFECTS OF CYBER-ATTACKS ON SMART GRIDS THROUGH POWER GRID AND COMMUNICATION CO-SIMULATION

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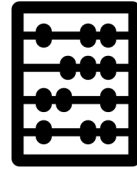


# MOTIVATION

Management domain  
Communication domain  
Power grid domain



DISTRIBUTION SYSTEM  
OPERATOR (DSO)



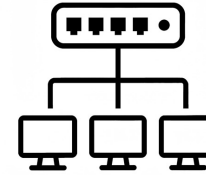
State  
estimation



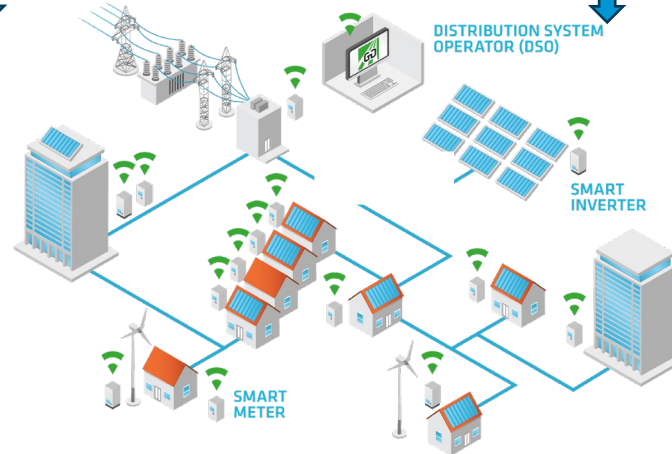
Active  
congestion  
management

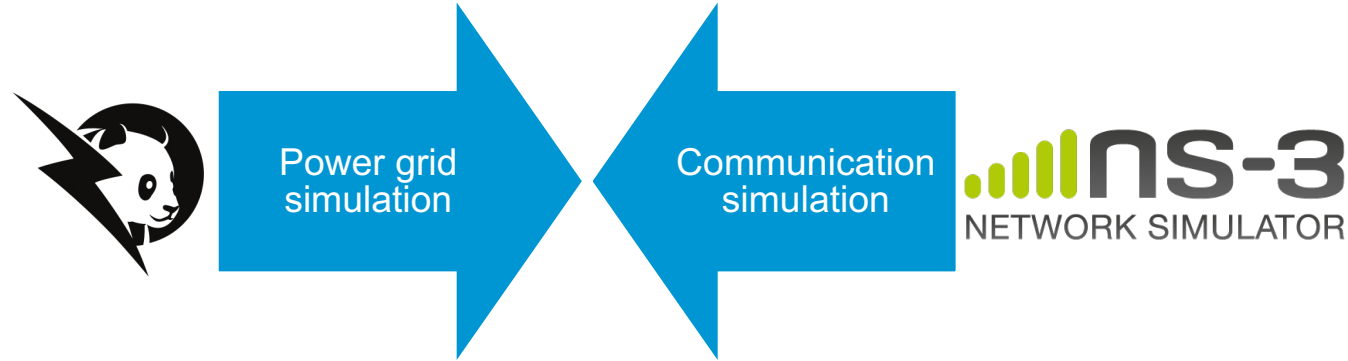


5G/6G



LAN/WAN



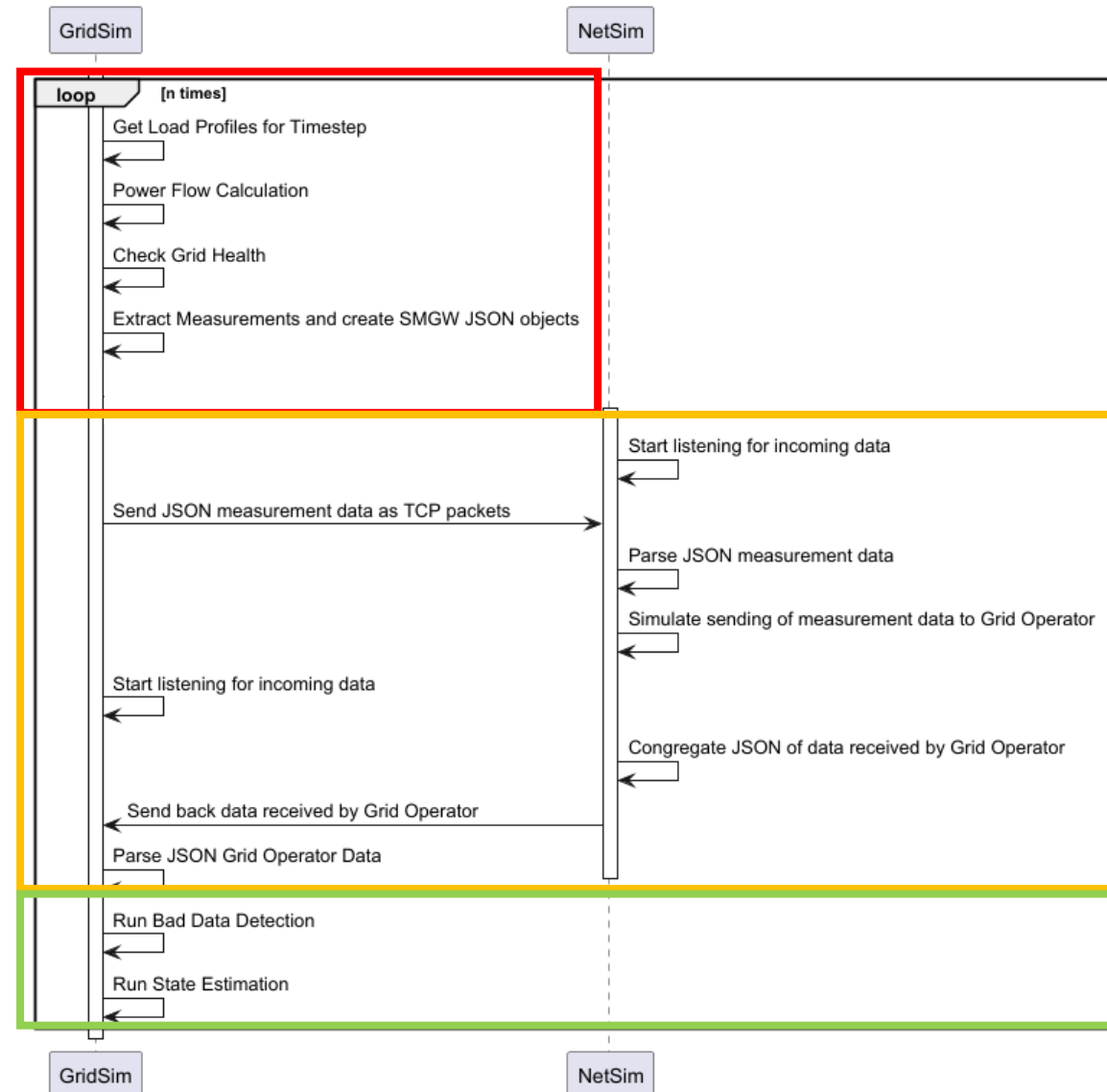


- Simulated smart grid
  - Power flow, congestion, and load calculations
  - AMI data aggregation & state estimation (incl. bad data detection)
- Co-simulation architecture
  - Synchronization via TCP sockets to manage data exchange

Initial phase

Communication  
phase

Analysis phase



**FDIA Goal:** Manipulate meter data to alter state estimation (e.g., masking grid overloads)

$$\hat{x} = (H^T W H)^{-1} H^T W z$$

Grid operators use bad data detection (BDD) (e.g., 2-norm,  $\chi^2$  tests)

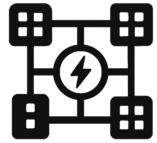
$$\|z - H\hat{x}\|_2 < \tau$$

Attacks must remain within certain boundaries to avoid detection

$$\|(z - H\hat{x}) + (a - Hc)\|_2 < \tau$$

The goal can be achieved by finding an attack vector ( $a$ ) which fulfills to bypass the BDD

# SIMULATION SETUP



Simbench semi-urban low voltage grid



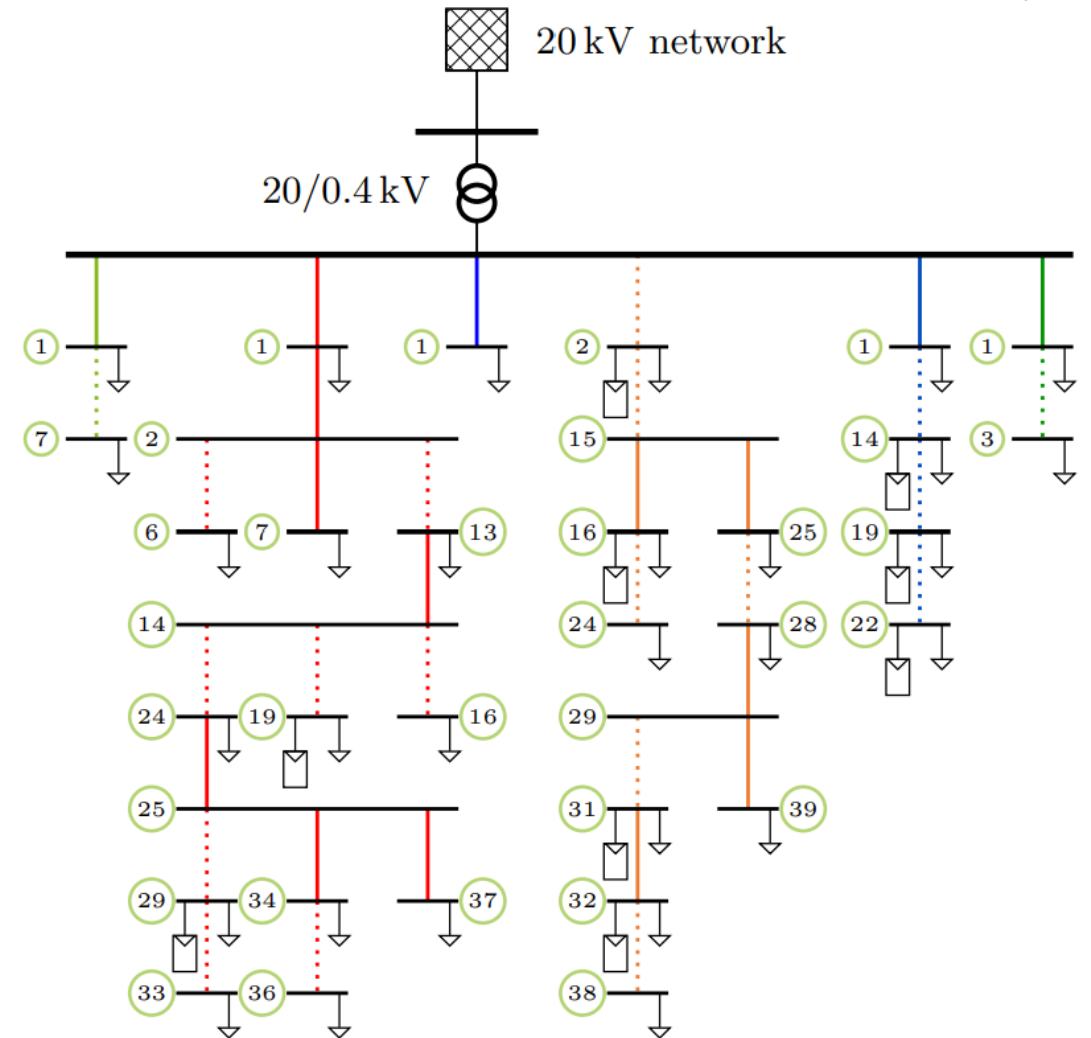
43 active metering points

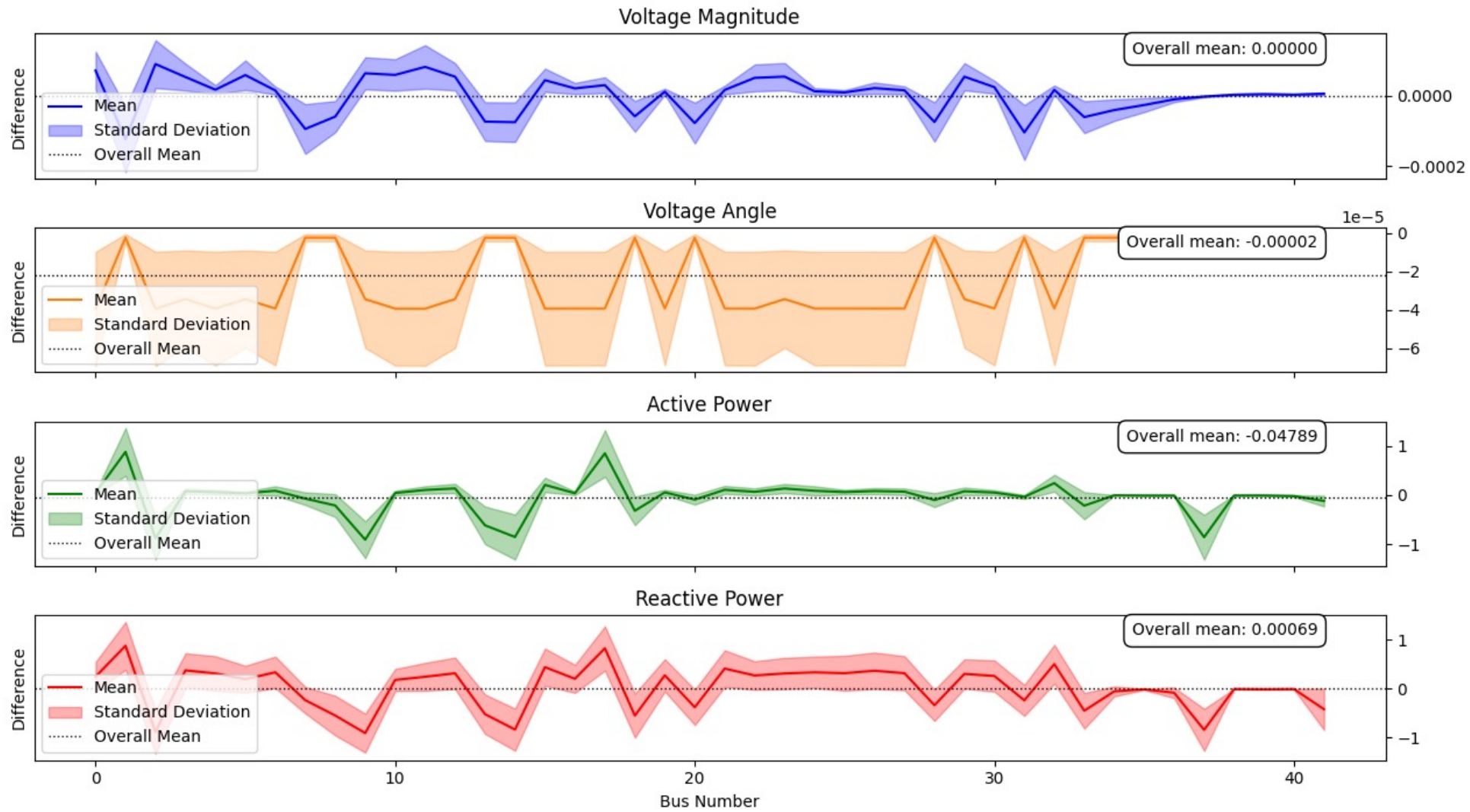


6 attacked metering points



96 timesteps in 15 min intervals





- Current state
  - Simulation tool is in an early development stage
  - Provides a solid foundation for further research
- Future enhancements
  - Integration of SDN (software-defined networking) and NFV (network functions virtualization)
  - Improved communication simulation (e.g., encryption, wireless communication)
- Expanding attack scenarios
  - FDIA is just one possible attack vector
  - Tool will be adapted to test other attack vectors, including SDN attacks

# THANK YOU FOR YOUR ATTENTION

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