

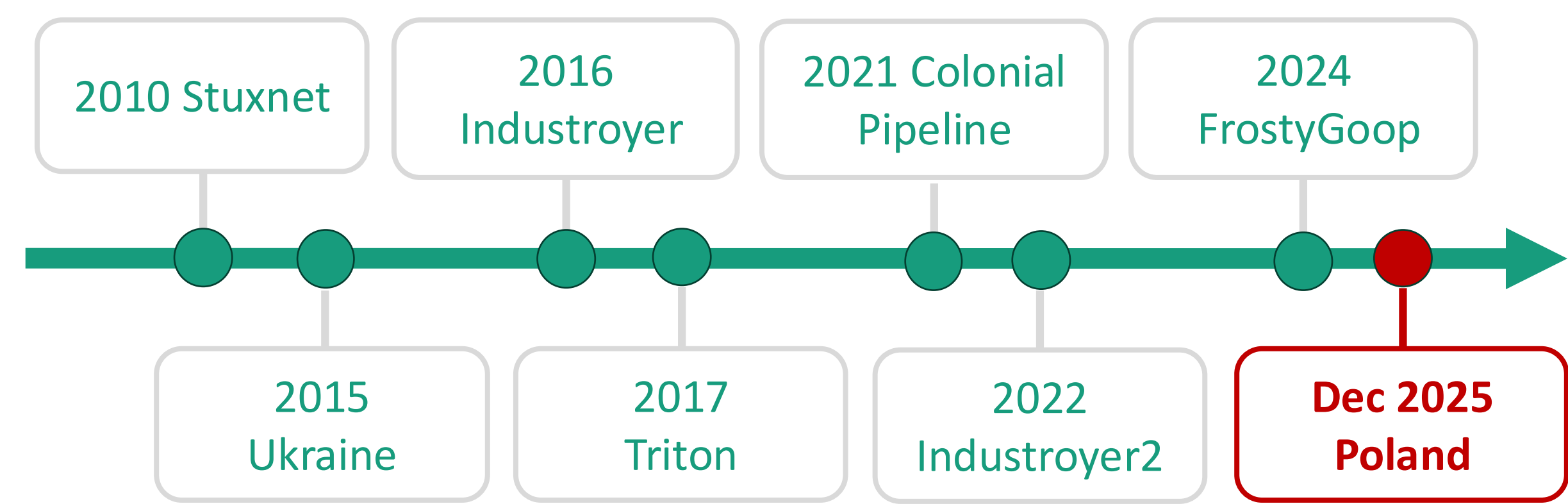
Interactive and Flexible Power Grid Modeling with GridForge

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Digitization Expands the Attack Surface

- Serial legacy links are replaced by IP-based communication; Distributed Energy Resources (DERs) demand **real-time monitoring & control**
- Industrial protocols (e.g. IEC 60870-5-104) were **not designed with security in mind**
- Long device lifecycles** hinder patching and replacement



Dec 2025 – Polish Energy Sector
30+ facilities with **destroyed RTUs and HMIs** — loss of visibility and controllability

Consequence
Experiments on productive grids are impractical (safety, availability) → we need **co-simulation** of power grid + communication network and **co-simulation needs scenarios**.

Why Emulation-Based Co-Simulation?

Approach	Trade-off
Discrete-event EPOCHS, GECCO, FNCS, mosaik, HELICS	Scales well, but abstracts from real protocol stacks and timing behavior
Emulation DSSnet, MiniCPS, WATTSON	Real network stacks and unmodified attack tools, at the cost of scalability

Our Backend
WATTSON: open-source, power flow + network emulation, real IEC 104, validated against a physical testbed. Requires a **scenario**: grid topology + network + OT communication configuration. Automatic scenario creation with **PowerOwl**.

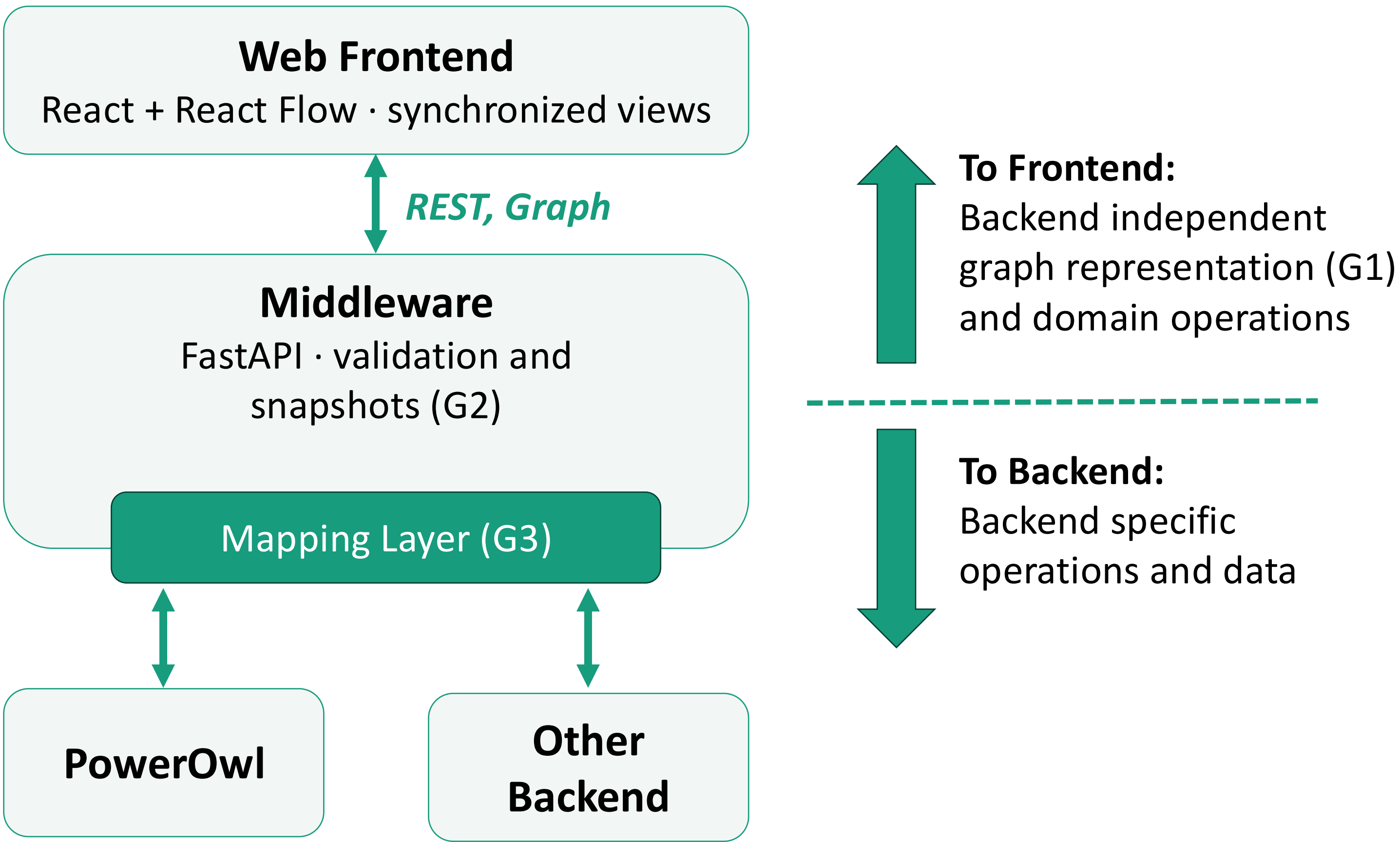
The Gap We Close

	PowerOwl	GridForge
Starting Point	Existing grid model required	From scratch or existing grid model
Derivation logic	Fixed	Revisable, every part editable
Customization via	Code / raw config files	Graphical interface

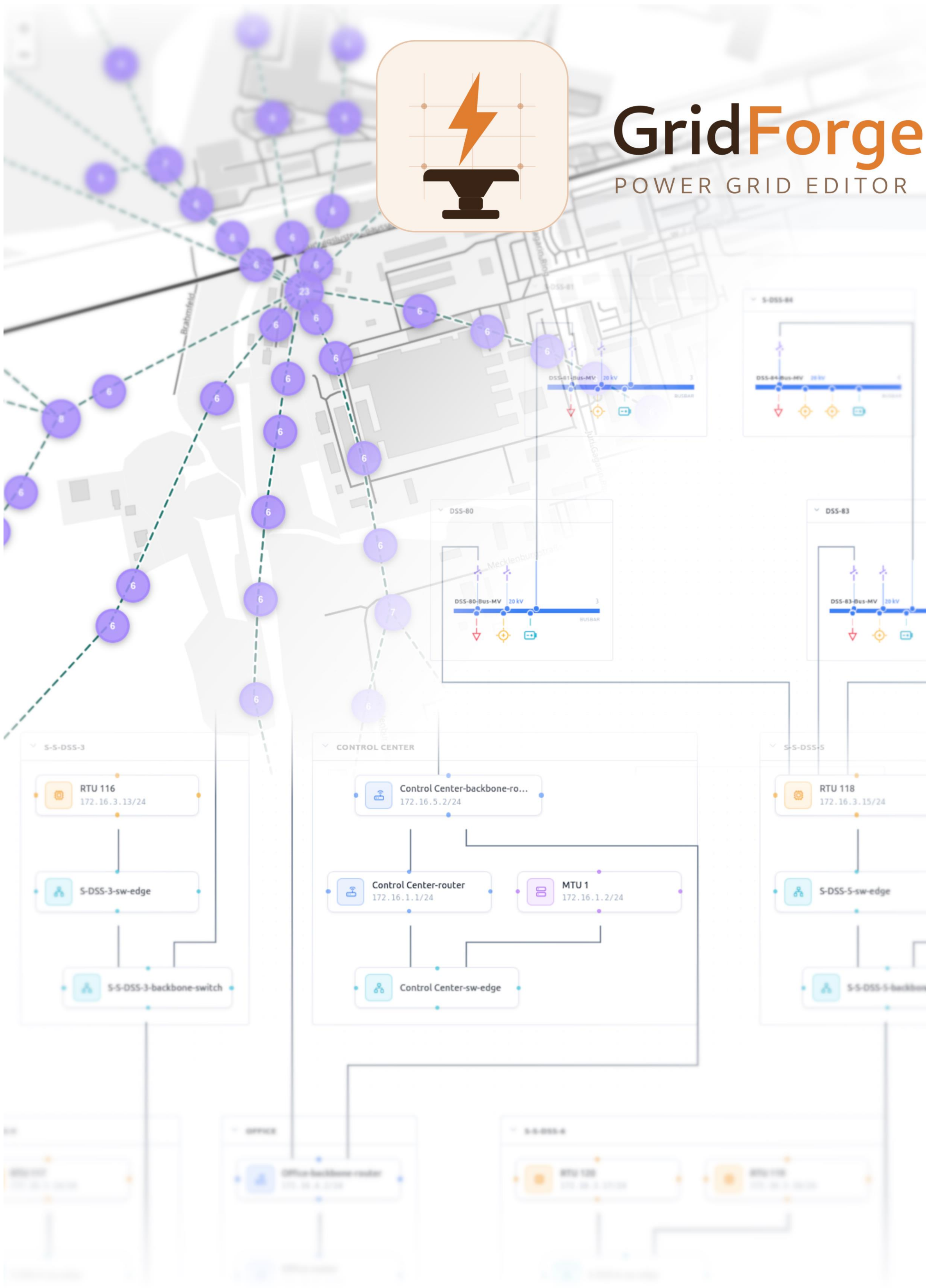
Design Goals & Mechanisms

- G1 Flexibility**
Edit every part of a scenario — no code, no raw config.
→ **Shared graph representation** of both domains
- G2 Consistency**
Scenario and all views stay valid and mutually consistent.
→ **Transactional edits + snapshot validation**
- G3 Backend independence**
General-purpose editor, not a WATTSON-only frontend.
→ **Client-server architecture, REST API**

Architecture



GridForge in Action

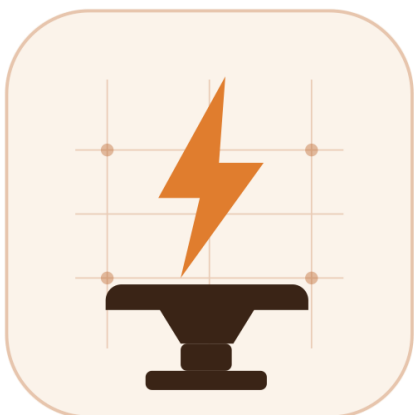


Conclusion & Outlook

- GridForge **complements derivation-driven** scenario generation with a flexible visual workflow
- Next: validation of **operational realism**, i.e., flagging configurations that are inefficient, unusual, or unsafe in practice
- Next: **user study** with the power systems *and* cybersecurity communities
- Open source**, adaptable to other co-simulation backends

Follow GridForge

Open-source release
coming soon



GridForge
POWER GRID EDITOR

github.com/fkie-cad/gridforge

