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Joint Research Centre

The European Commission's in-house science service

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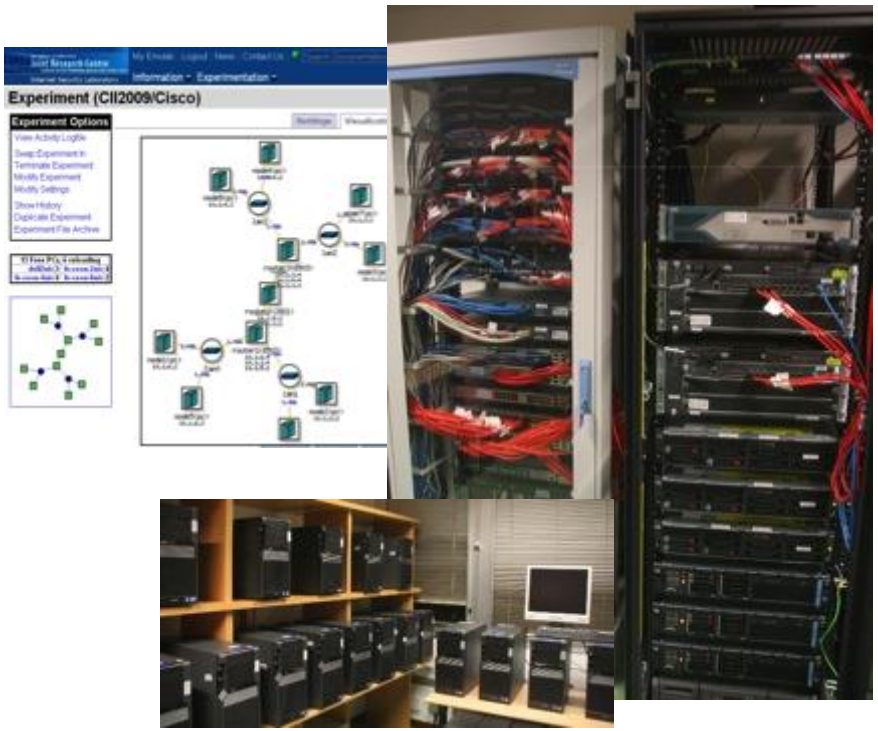
Serving society
Stimulating innovation
Supporting legislation

Modelling Cyber-Physical Systems



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Institute for the Protection and Security of the Citizen (IPSC)

DG Joint Research Centre (JRC)

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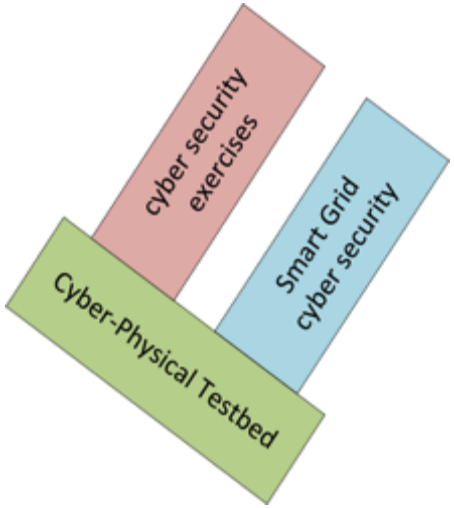
Network & Information Security Laboratory (NISlab)

- What is it designed for?
  - Cyber security experiments (botnets, malware, etc)
  - Experimental assessment of cyber infrastructures
  - Technical exercises
  - Technical demonstrations to EU decision-makers

- What are we currently using it for?
  - Security of Cyber-Physical systems: Power Grid, Smart Grid, with emphasis on CI interdependance.
  - Preparedness exercises

- How is it done?
  - Through EPIC, our in-house emulab flavour



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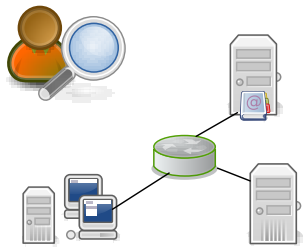
Experimentation options with IP networks

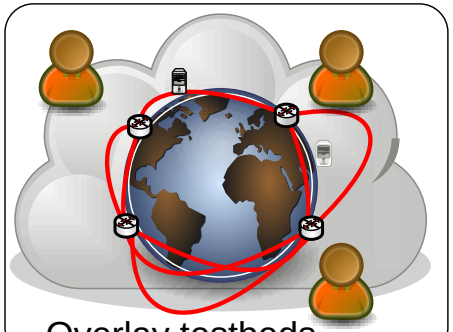
Traditional



Ad-hoc testbeds

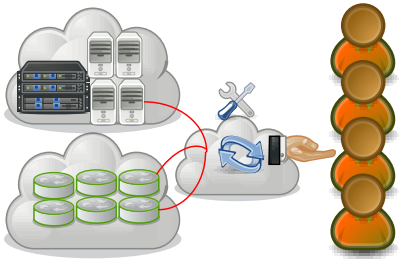
Simulators

Recent



Overlay testbeds

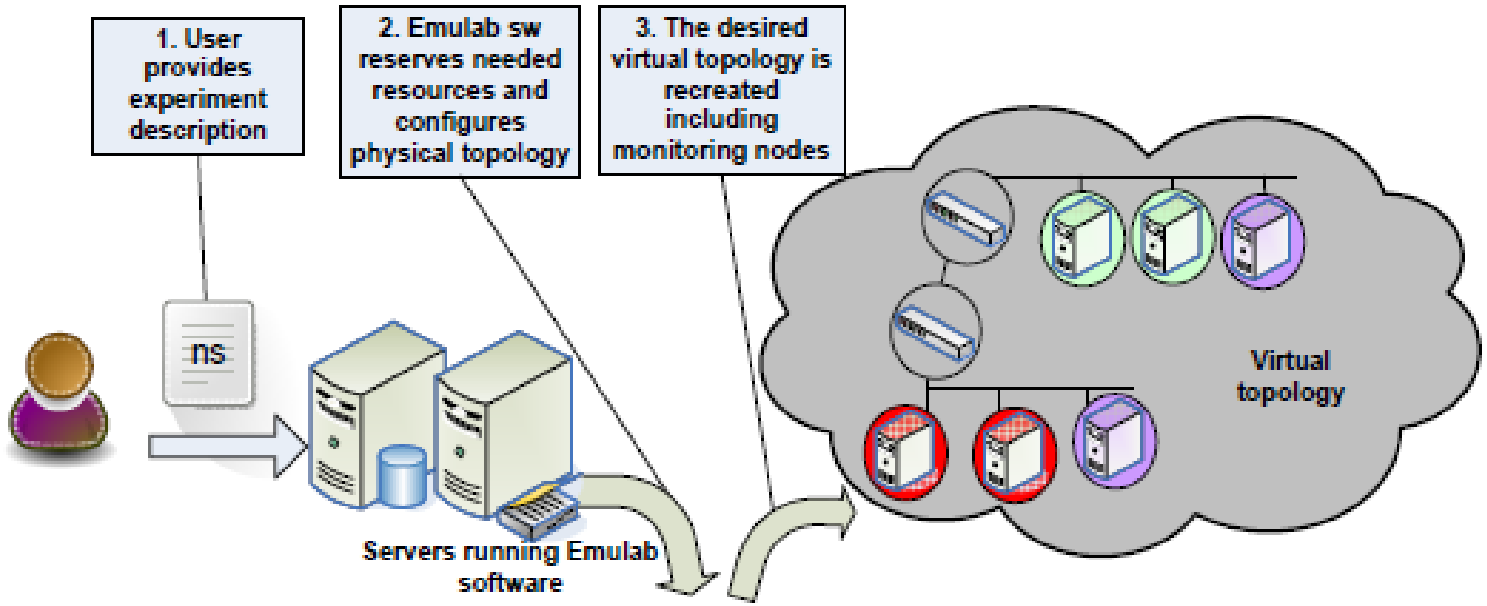
(on top of existing infrastructures)

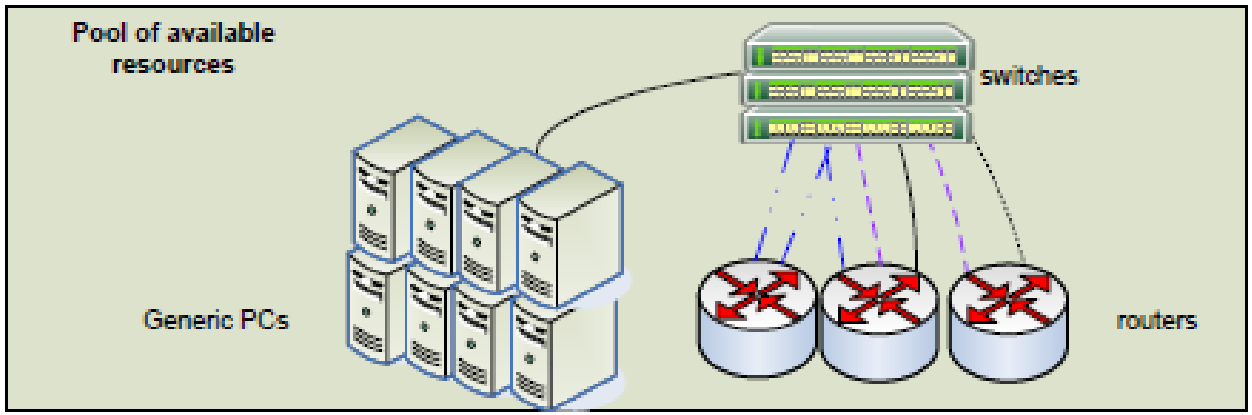


Emulation testbeds

(dedicated physical resources)

EPIC





Advantages:

Controllability

Repeatability

Fidelity

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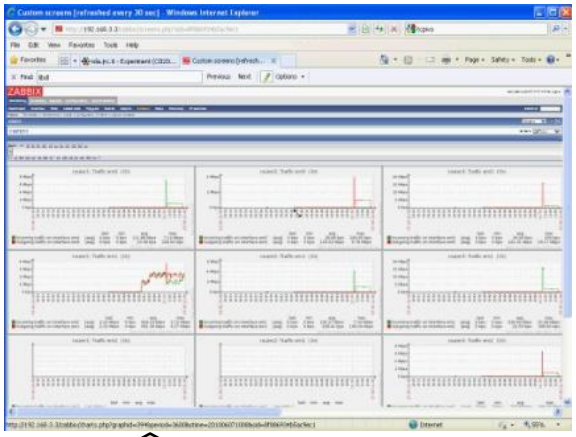
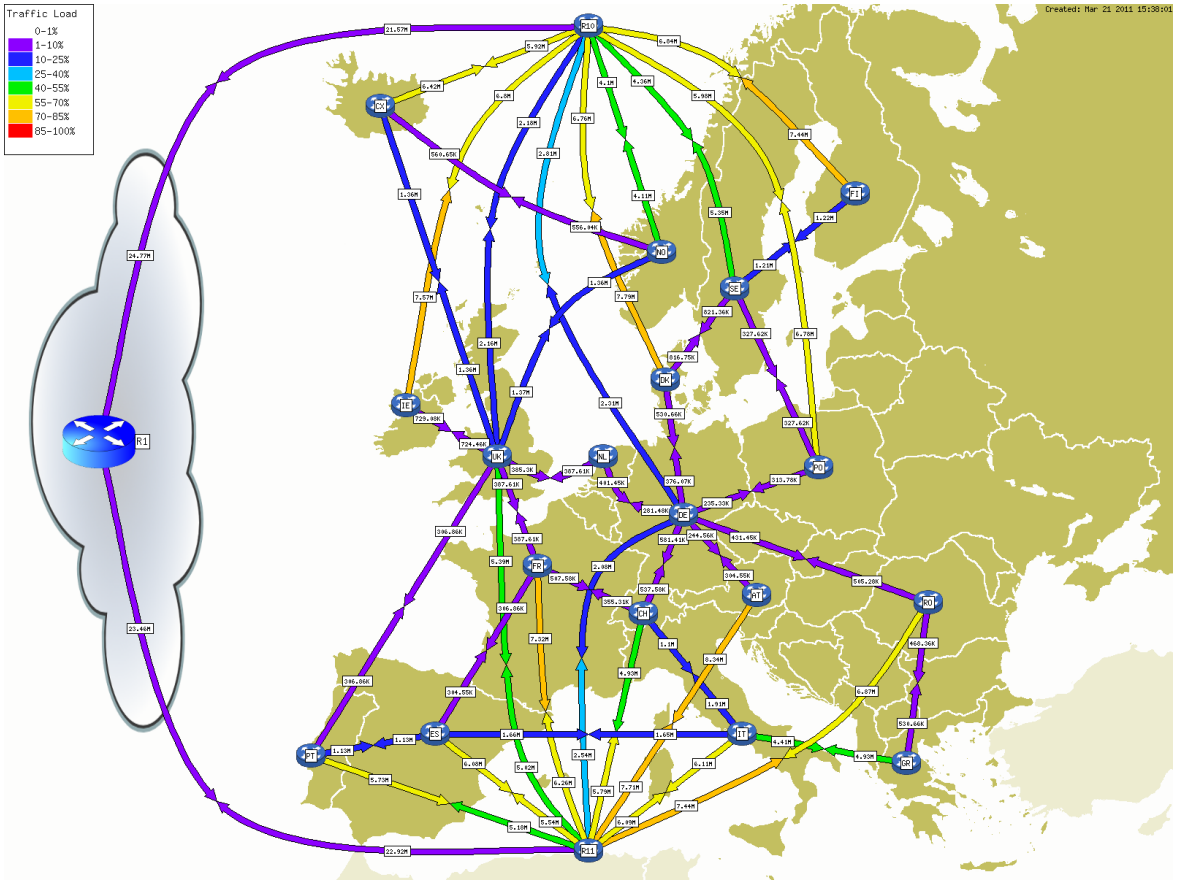
Experimental scenario: BGP MiM attack



Voice communications / PSTN



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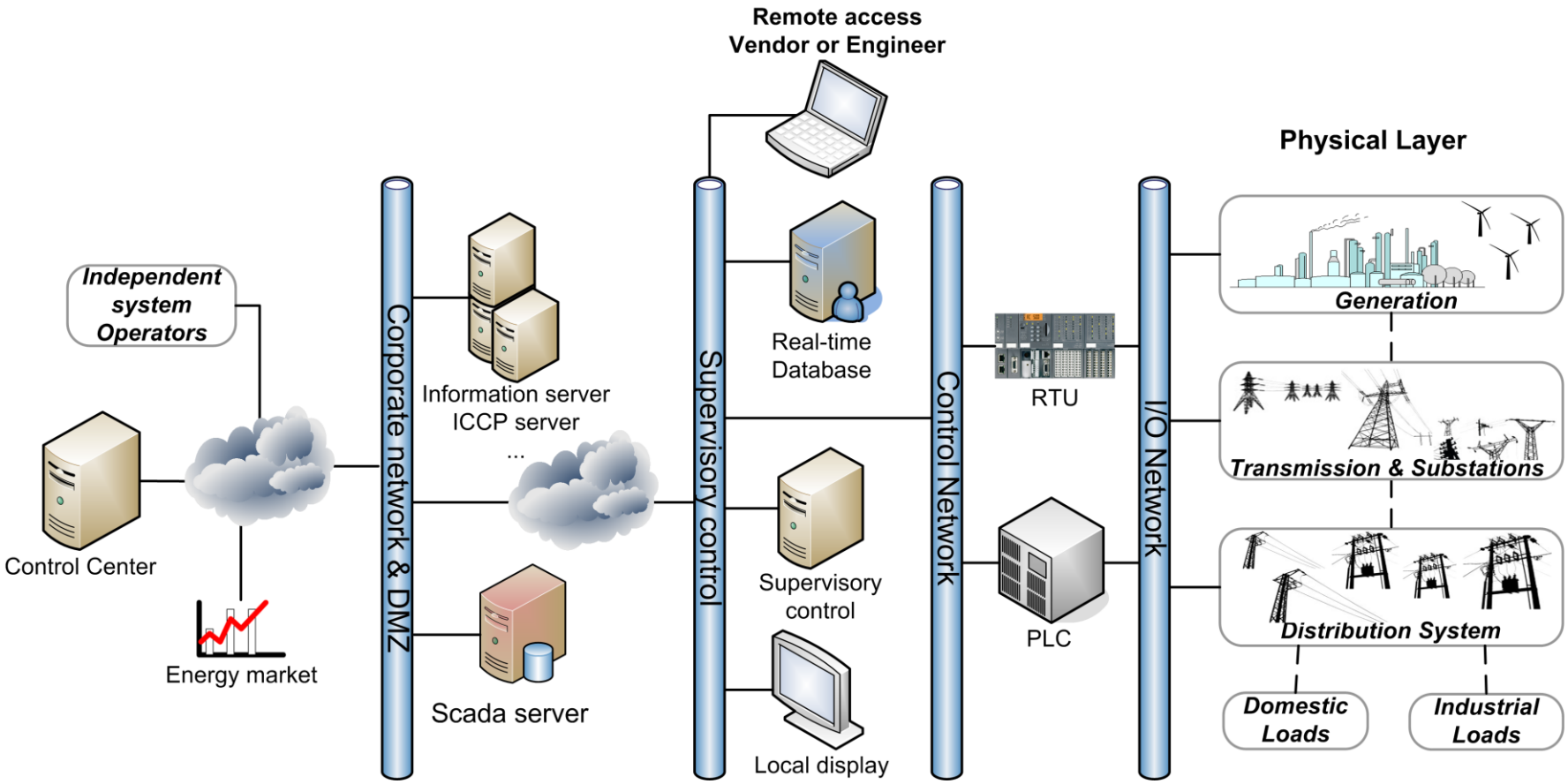
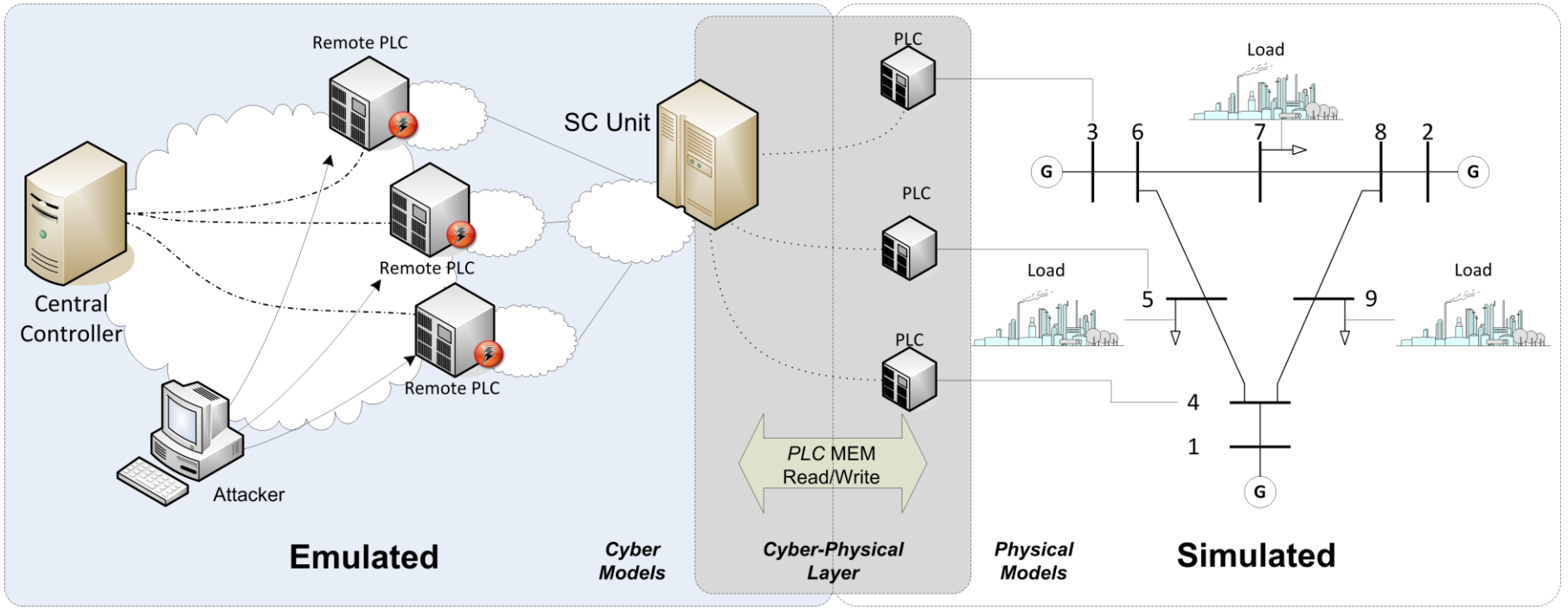
Beyond IP networks… Cyber-physical systems



Hybrid architecture: Emulation + Simulation



Physical layer:

- Soft real-time execution of a model of the physical system

Cyber layer:

- Emulab testbed architecture and software

Cyber-physical layer:

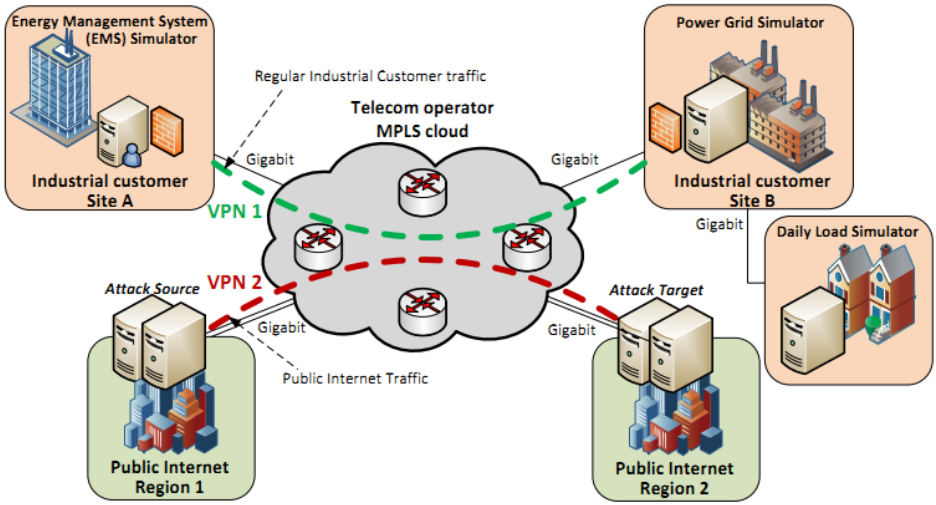
- Provides the "glue" between the two layers

Experimental scenario – DDoS attack

- A telco operator provides
  - internet access to the public and
  - a dedicated connectivity solution to an energy operator linking the Energy Management System (EMS) deployed on site A to the power plant on site B.
- The telco operator uses a shared infrastructure for both services, using a non optimized MPLS setup.
- An internet inbound-outbound DDoS attack will transit through the MPLS cloud.
- The attack increases the latency of between Site A and Site B beyond acceptable parameters, blinds the operator and the EMS →blackout.
- Not even intended!!!

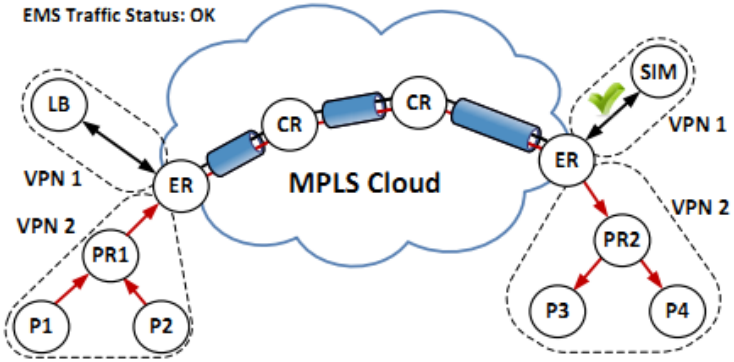
Experimental setup – DDoS attack

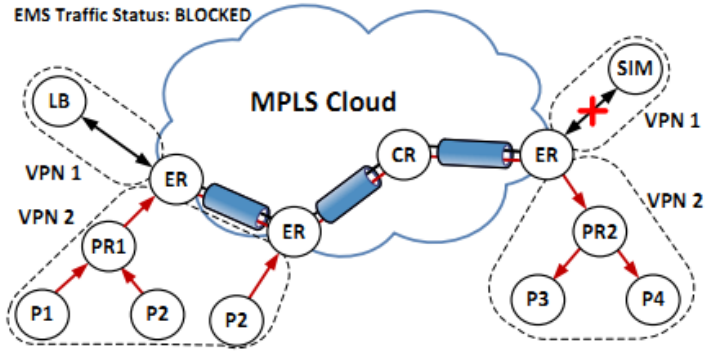
- real-time simulation of an electrical grid, the IEEE 39-bus grid, under typical daily load
- simulation of an Energy Management System (EMS) that used the MPLS network to remotely ensure the voltage stability of the Power Grid
- Emulation of the MPLS network using 4 Cisco 6503 routers
- Public internet emulation: 14 PCs

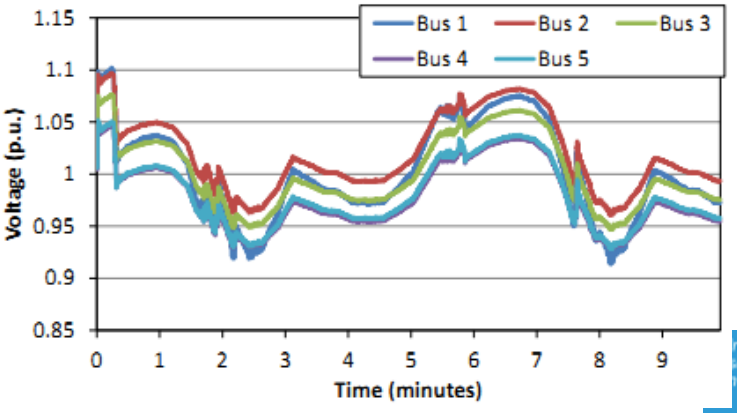


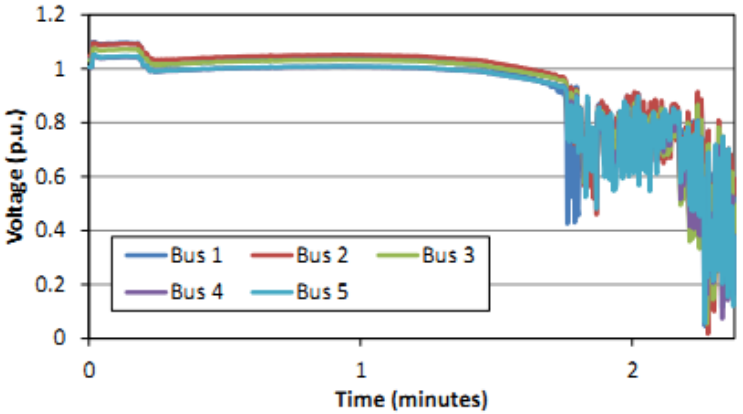
DDoS Attack Impact

- Dual and triple DDoS source with one external router and one/two edge routers









Conclusion

Experimental assessment of **cyber-physical infrastructures security**

- e.g. study the consequences of cyber attacks on the Power Grid

Approach:

- **Simulation for physical components**
- **Emulation with real components for cyber layers**

Advantages:

- Repeatability, flexibility, multi-user platform.
- Using emulation yields more accurate results than simulation.
- Goes beyond IP-only systems for exercising or cybersecurity studies.
- Malware and real cyber components can be used in a safe way
- Cost-efficient approach

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Thank you !!

" By **failing** to prepare, you're preparing to **fail**"

- Benjamin Franklin

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