



Fourth Annual IFIP WG 11.10 International Conference on Critical Infrastructure Protection

An information-sharing tool supporting operators to prevent LCCIs cascading failures effects

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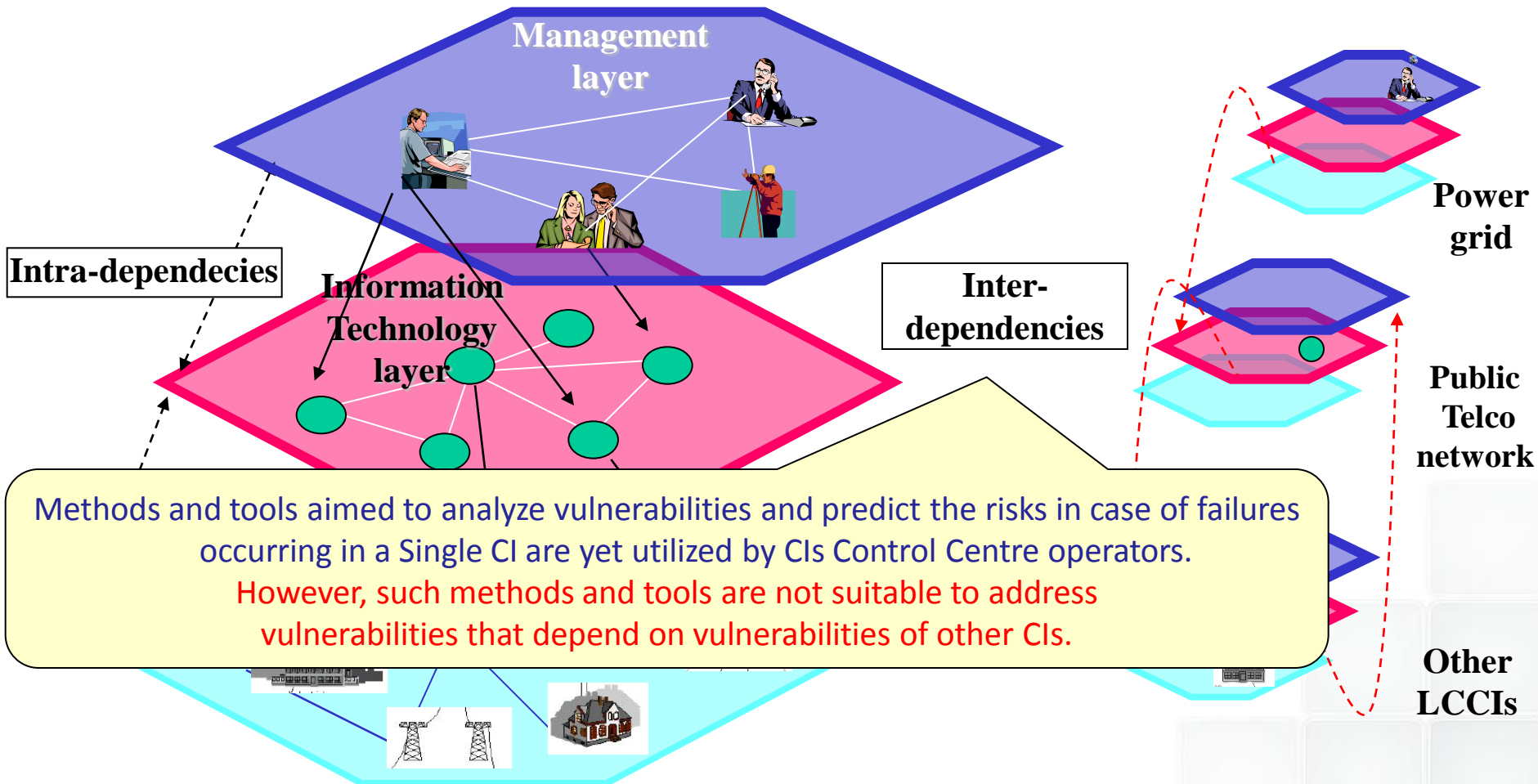
Claudio Balducelli, Roberto Clemente, Giordano Vicoli

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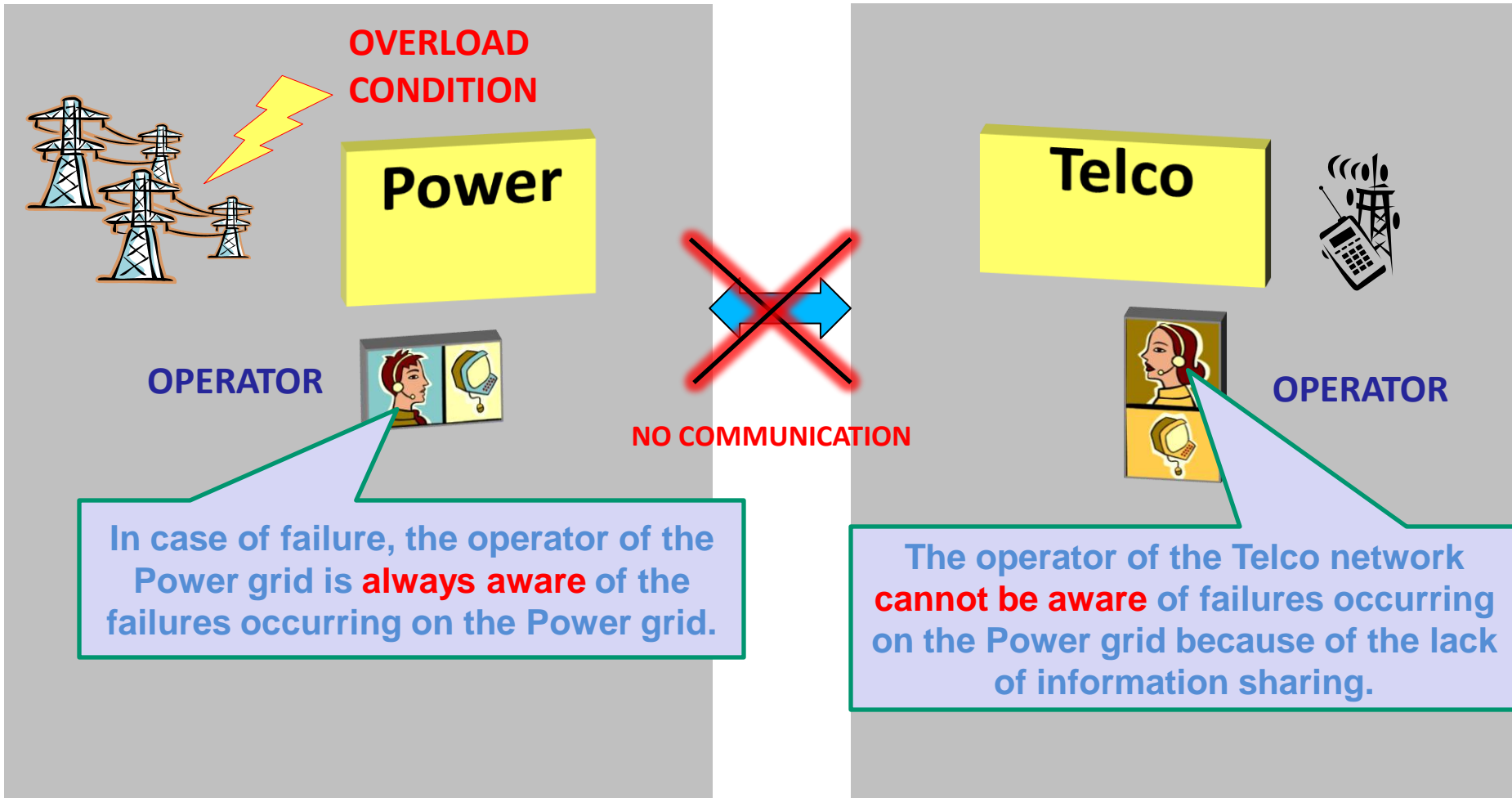
An overview on the problem (1)

Lack of methods and tools that perform risk failure of a CI related to the risk of failure of different CIs.



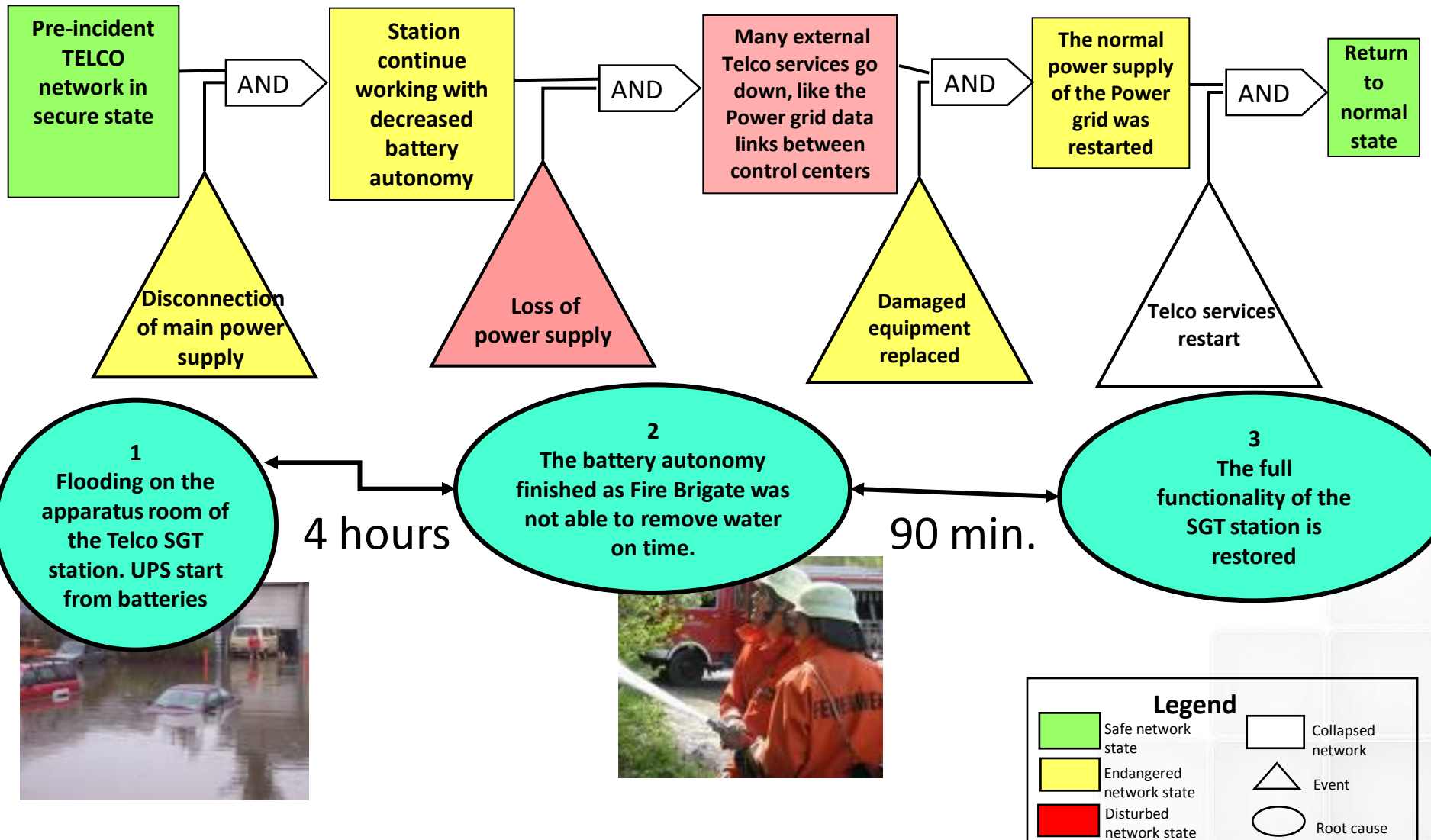
An overview on the problem (2)

Lack of information sharing among Control Centre operators of different CIs.



Rome Mini Telco blackout (2004)

NETWORK STATE OVERVIEW & ROOT CAUSES



What we have done



MIT Technology (*Middleware Improved Technology*)

Definition of a Risk Estimation software that makes use of information sharing among CI operators aiming at:

- preventing or limiting cascading effects in critical situations
- enhancing the resilience of CI

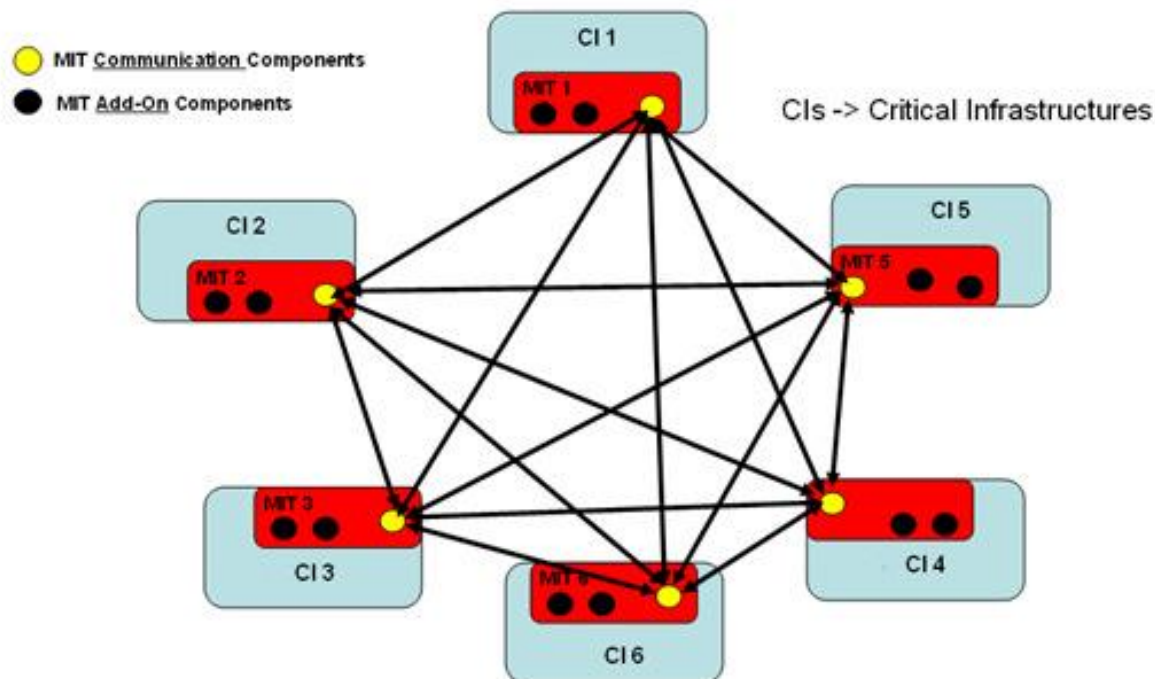
Development of an experimentation environment

Definition of a Test bed facility to test the MIT technology including:

- an agent-based simulator called SimCIP
- two specific domain simulators (one for the Power CI and one for the Telco CI)

Data collection. Considered networks:

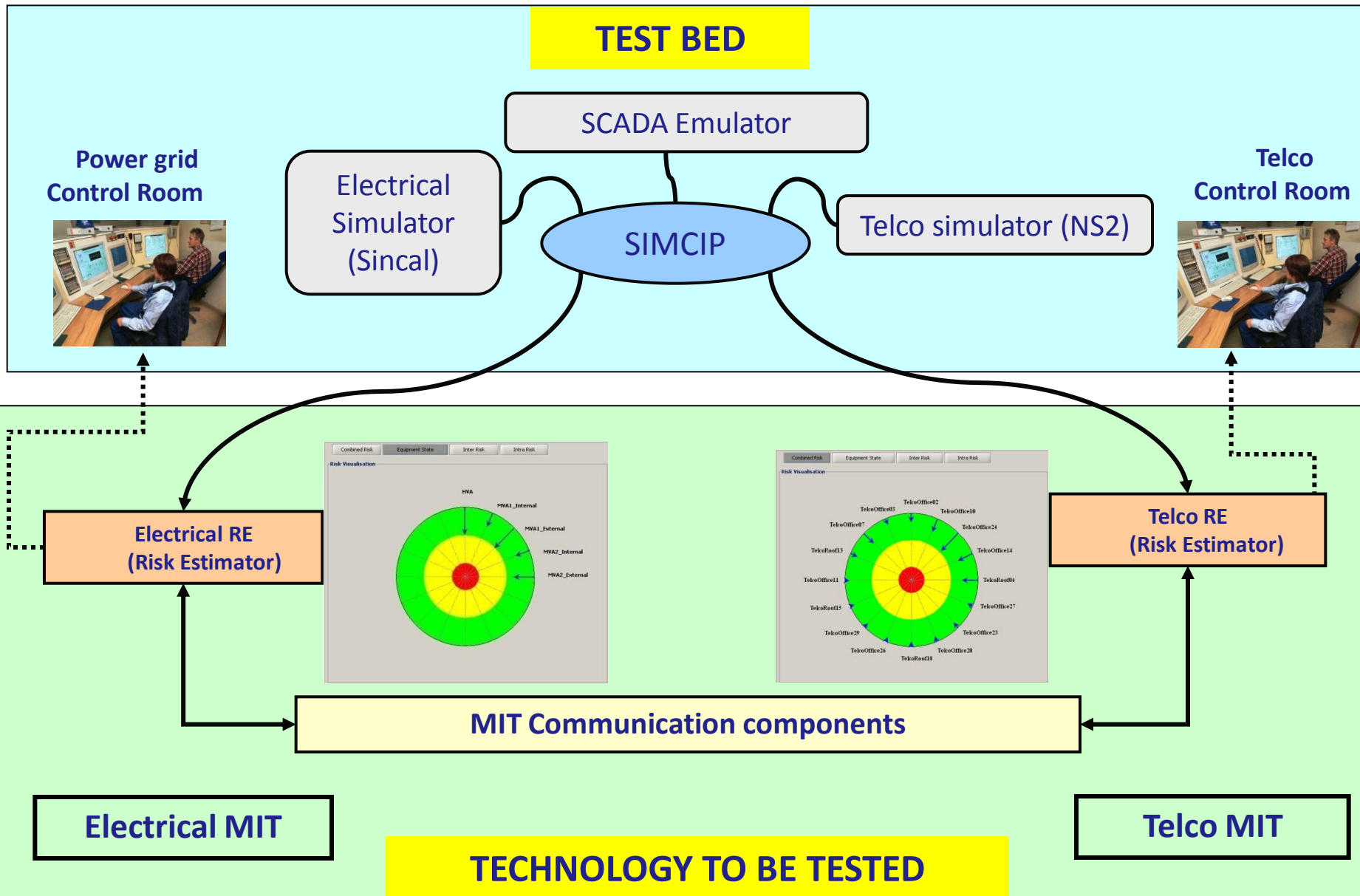
- the **150 kV** Distribution Power grid serving the area of Rome
- **PSTN** and **GSM** telecom network devices located in the same area of Rome
- **SCADA** devices (2 Control Centres and RTUs) serving the electrical networks



MIT systems are installed in each CI making use of the **client-server paradigm** through the **Internet Public channel**. Each MIT System is composed by:

- Communication Components
- Add-on Components (e.g. the **Risk Estimator**)

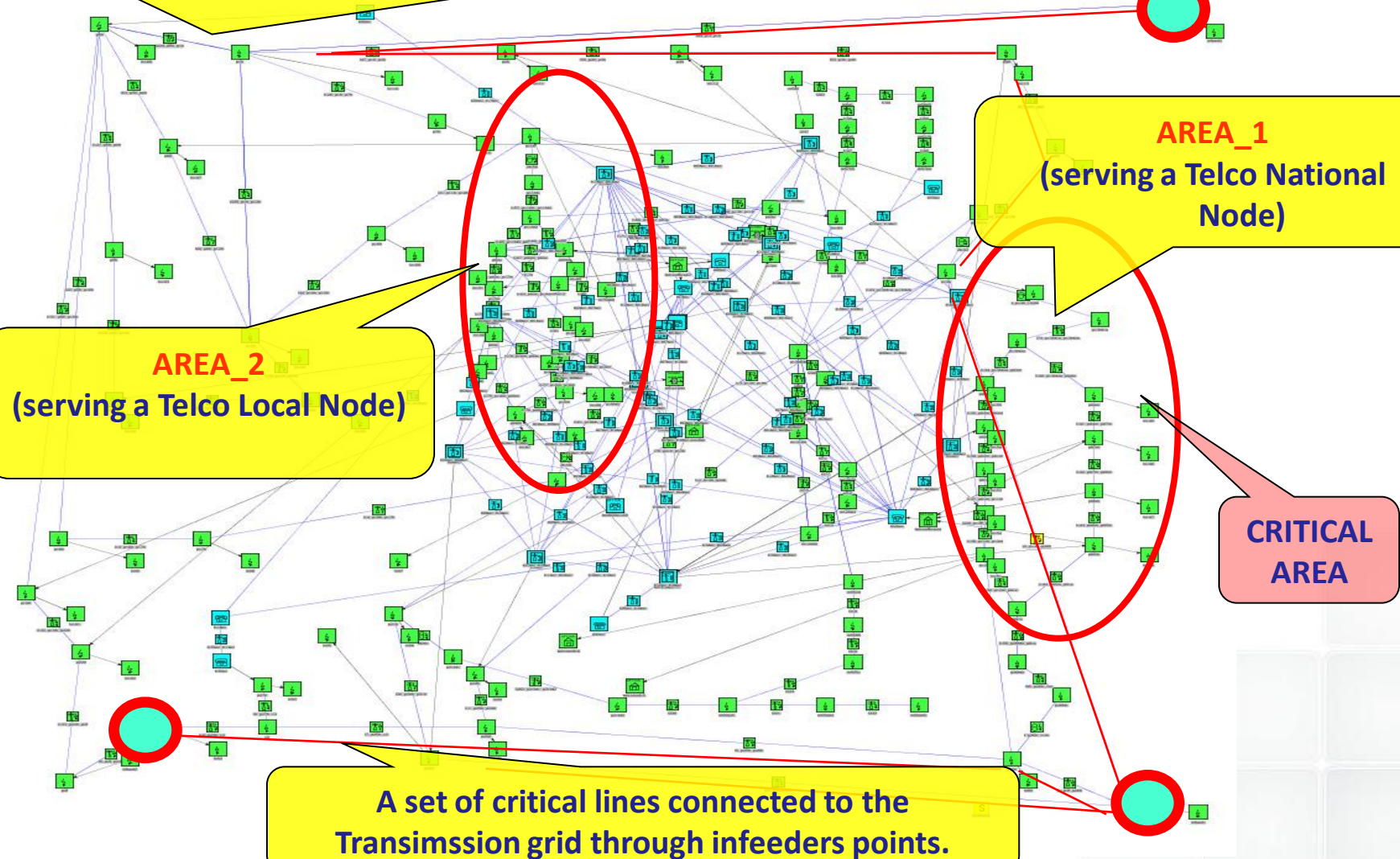
The experimentation environment



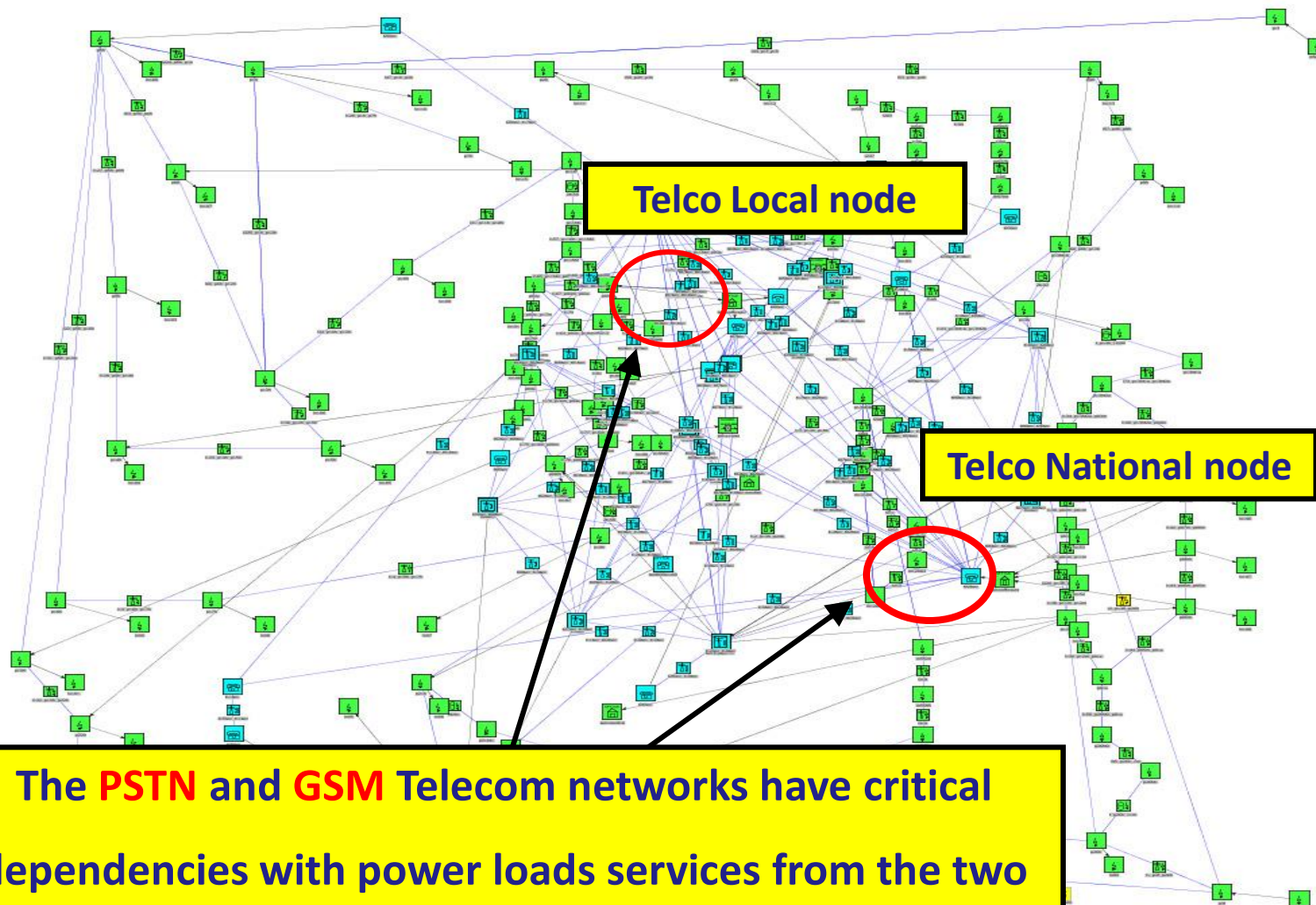
The considered networks as modeled into SimCIP

HVA

150Kv *High Voltage Area (HVA)* of Rome containing two 20 kv distribution areas



Modeling the Power – Telco interdependency

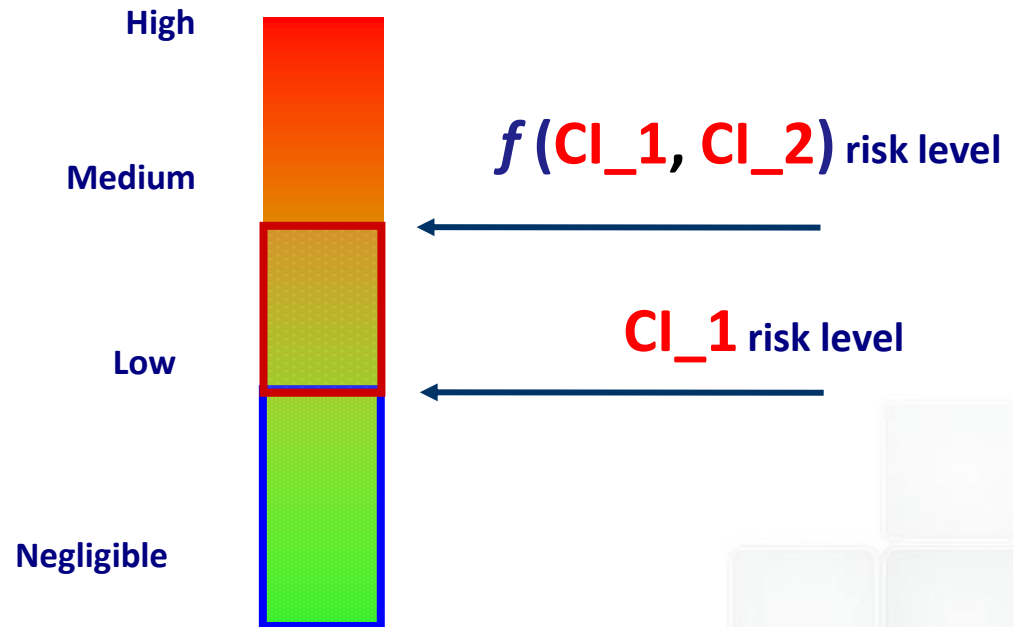


The **PSTN** and **GSM** Telecom networks have critical dependencies with power loads services from the two electrical 20 kV areas (**AREA_1**, **AREA_2**)

Interdependency Risk Model

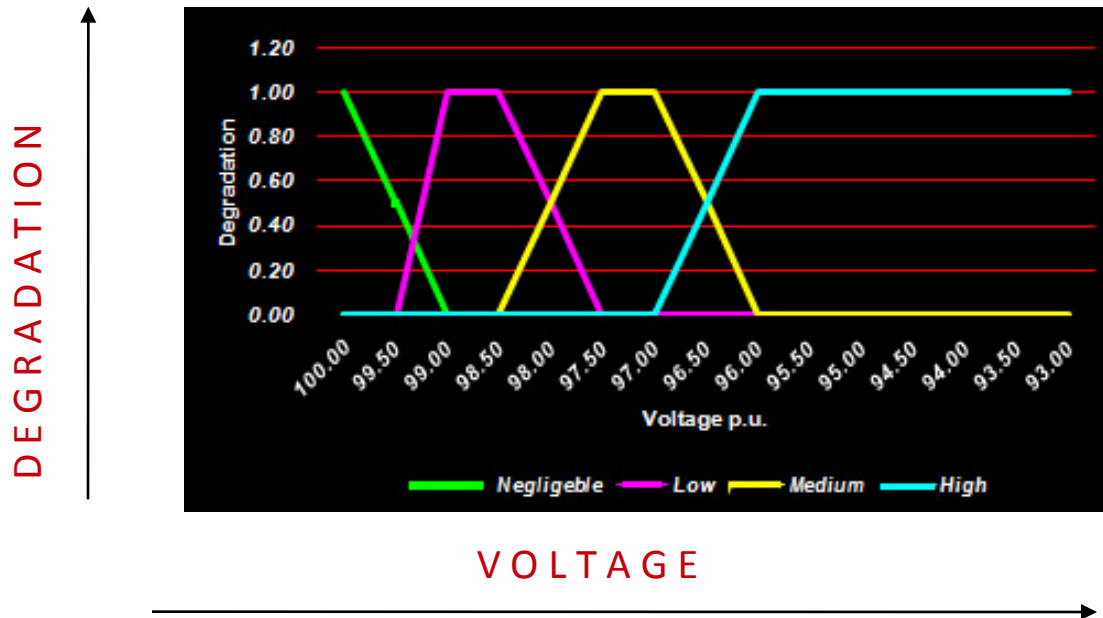
Risk levels evaluated by Risk Estimator are associated to the service provided by a certain CI (**CI_1**) and depend not only on the possible degradation of the services produced locally (i.e. inside **CI_1**) but also on the services provided by external CIs (**CI_2, CI_3, etc.**) which the considered CI (**CI_1**) is dependent to.

Four different “qualitative” degradation levels (**Negligible, Low, Medium, High**) to model the process degradation level (e.g. the voltage condition of a certain electrical area).



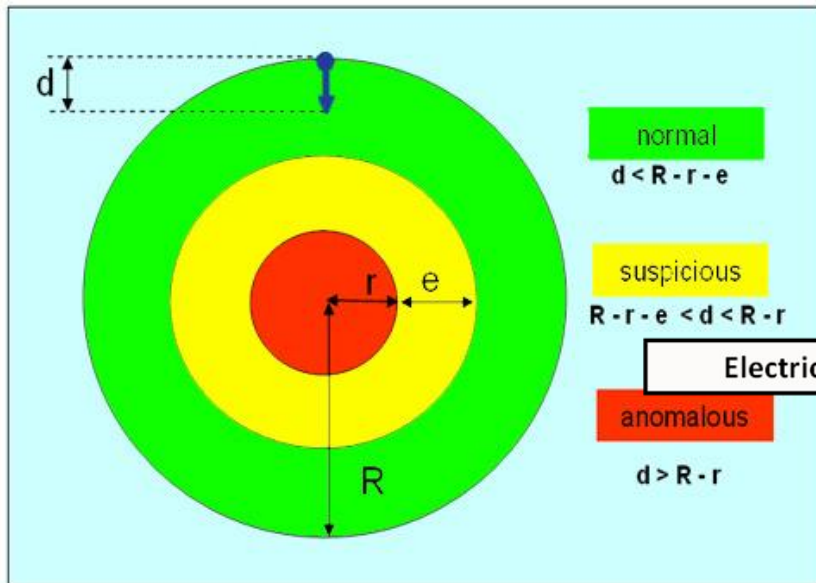
Risk level of a CI service

Definition of a **RULE-BASED SYSTEM** to model the relationships between the degradation of a certain **service** as a qualitative function of the variation of the **processes** states through fuzzy logic rules.

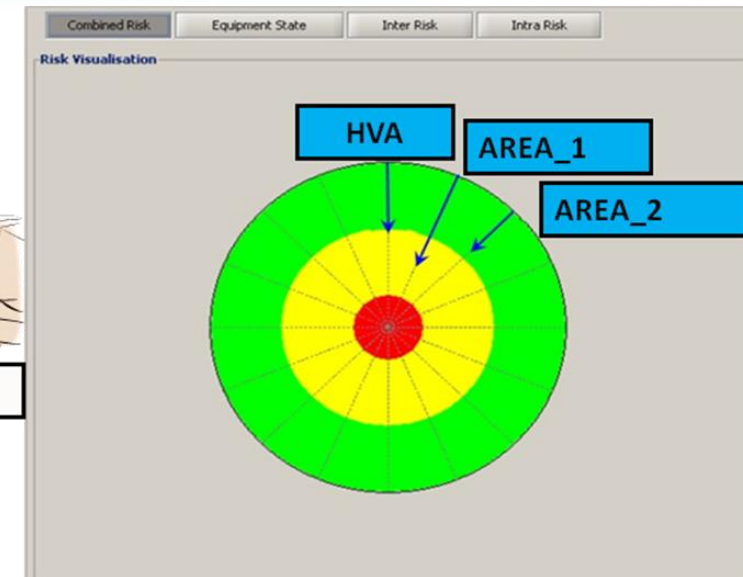


To model the degradation level associated to a generic area of the Power Distribution grid, voltage values of bus bars are evaluated together with Telco communication parameters.

Risk Estimator panels



METRIC USED TO ASSESS RISK LEVEL



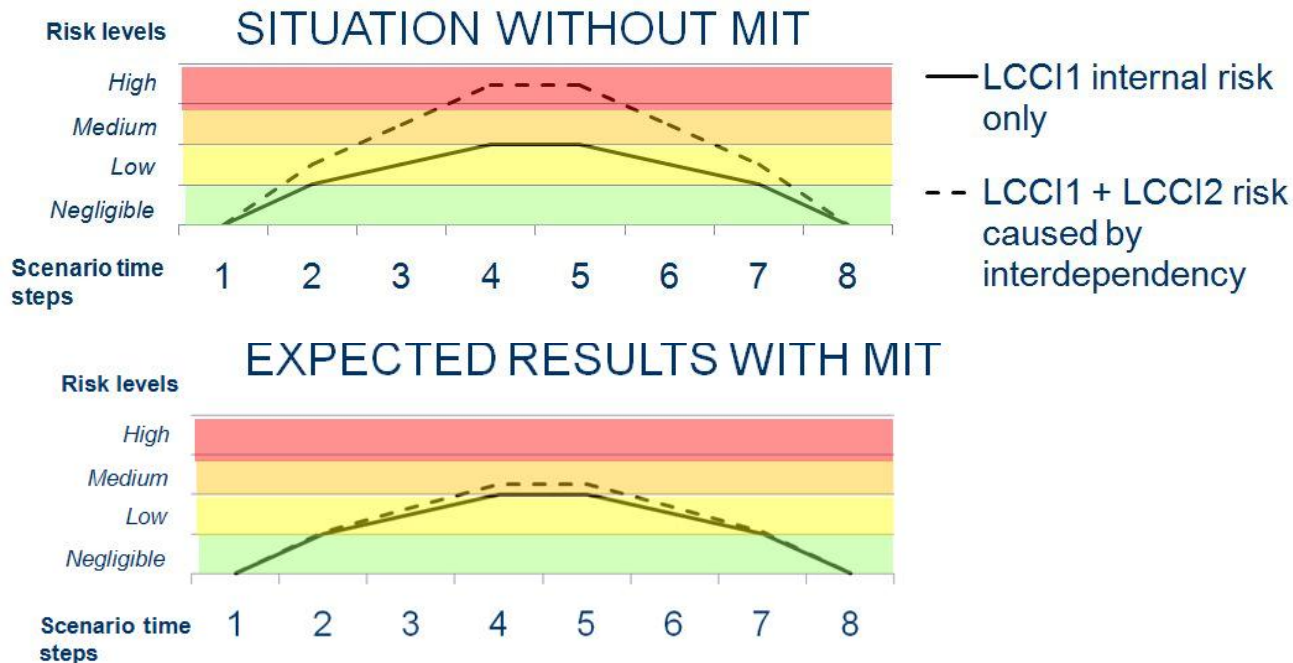
**RISK ESTMATOR PANEL FOR
POWER DISTRIBUTION GRID**

The operator of the Power Distribution grid can be able to monitor the risk degradation of the services provided (low voltage level of bus bars). Such a risk includes the risk of degradation of Telco services (lack of communication).

$$\text{Risk}_{EL} = f(\text{Risk}_{EL}, \text{Risk}_{Telco})$$

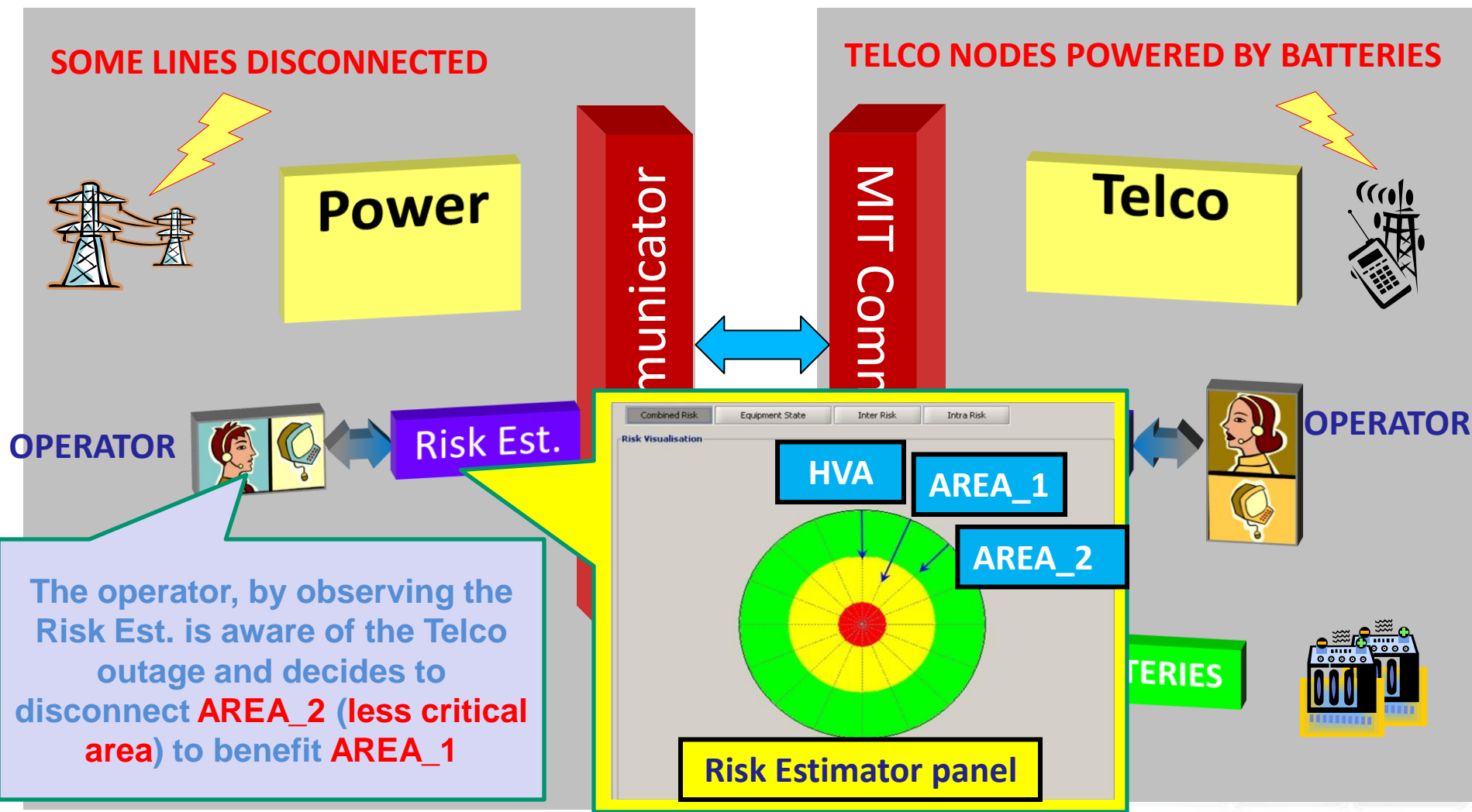
Experimentation strategy

- Simulation of sequences of failure occurring on the **Power grid** to evaluate interdependency effects on the **Telco network**.
- Comparison among scenario evolutions obtained **by using against not using** the Risk Estimator as a decision support tool in case of CI failures.



Experimentation results

The Risk Estimator supports operators of Control Centres to take actions that can leverage the risk of outage due to interdependency relations among CIs.



Conclusions



- Methods and tools aimed to analyze vulnerabilities and predict the risks in case of failures occurring in a single CI, are well known and exhaustively utilized by CIs Control Centre operators. However, such methods and tools are not suitable to address vulnerabilities that depend on vulnerabilities of other CIs.
- We showed how MIT Risk Estimator might be a useful tool for the operators located in the Control centres to assess critical situations so that recovery actions may be taken considering the interdependent risk of other CIs.
- At the moment the potential benefits of MIT Risk Estimator is still under evaluation by experimenters.
- The effective improvement that MIT Risk Estimator may produce in real Control centres needs to be evaluated by CI operators by considering different failures scenarios.