cnit consorzio nazionale interuniversitario per le telecomunicazioni

Research report

by Susanna Donatelli

Università di Torino, Italy

Topics

1. Modelling requirement of the electrical power system

2. Definition of performance and dependability measures based on stochastic temporal logic and timed automata

Modelling requirements of the electrical infrastructure (EPS)

Work done inside the CRUTIAL project, as part of WP1 (analysis of new control applications)

What is about

WP1: description of a hierarchical electrical power system (based on the status quo in Italy and on the vision of CESI s.p.a.) and of a proposal for Distributed Generation from the University of Leuwen

WP1: description of the scenarios of interest

WP1 languages: natural and UML

UML based description

Objectives:

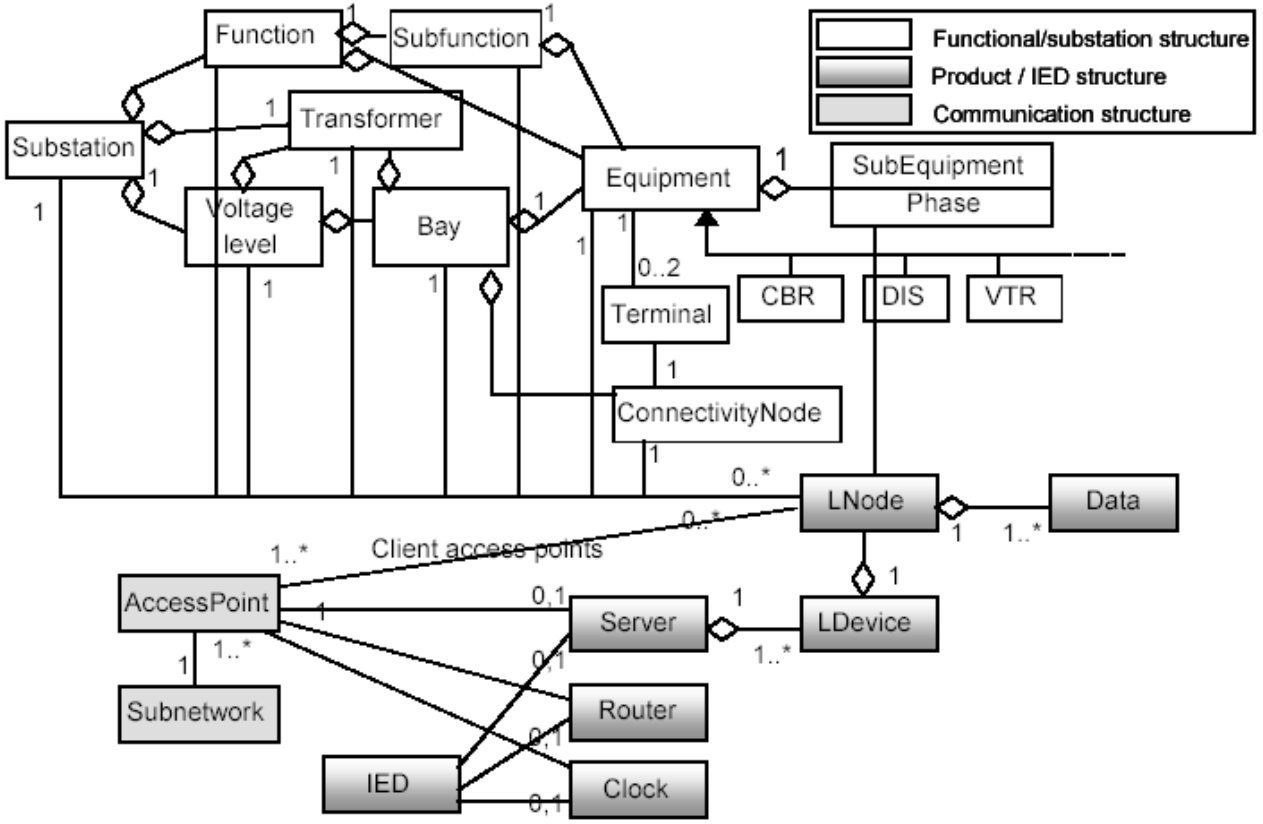
- rationalize the amount of information coming from electrical people
- structured description of the analysis scenarios to be used in the analysis phase
- traceability

Components of the UML description:

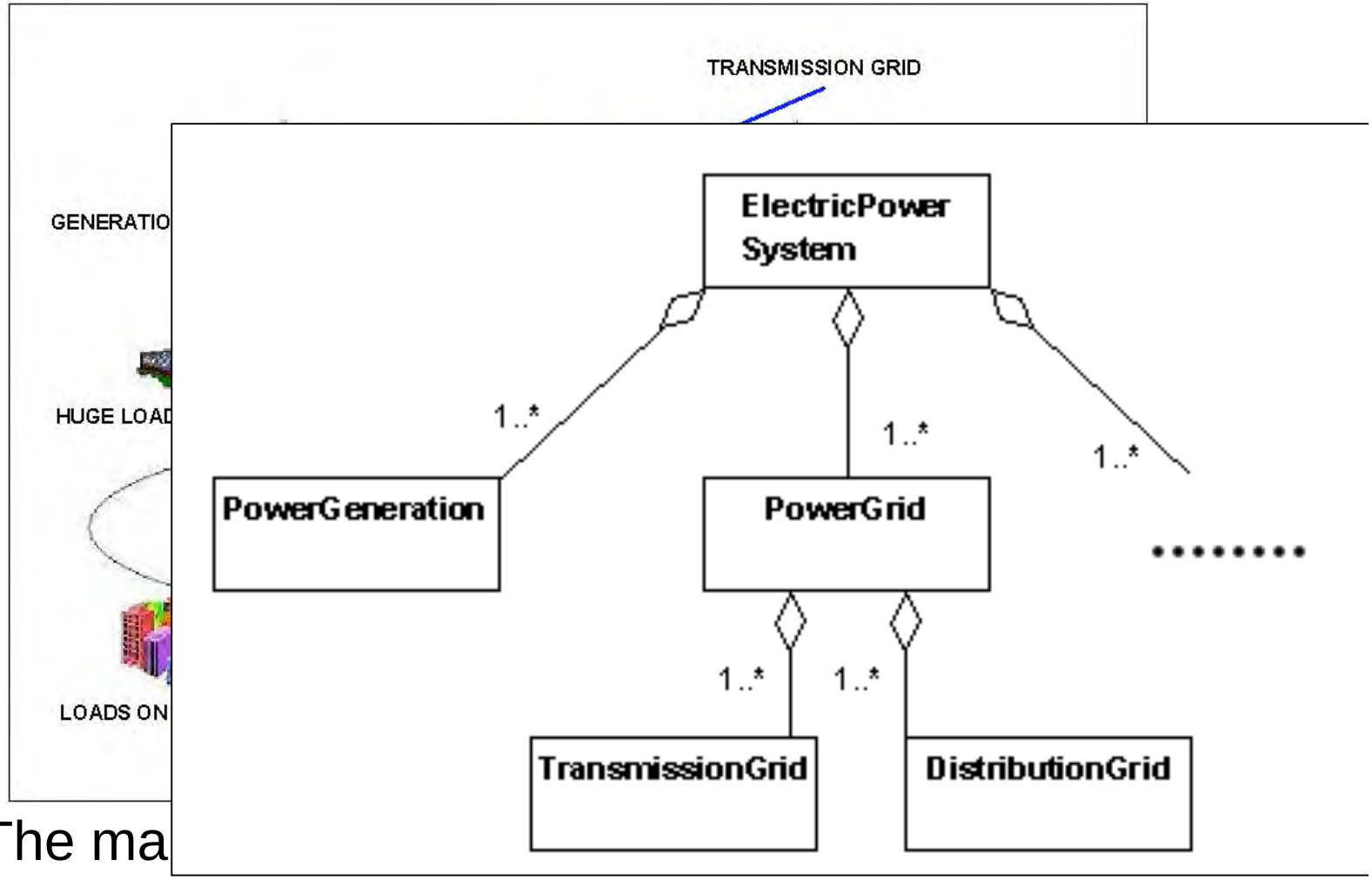
- structure is a set of Class Diagrams
- functionalities of interest are described using Use Case diagrams, and use cases are described with Interaction Diagrams
- state changes of the power grid are described through a set of state charts

UML in standards

Substation model in the IEC 61850-6



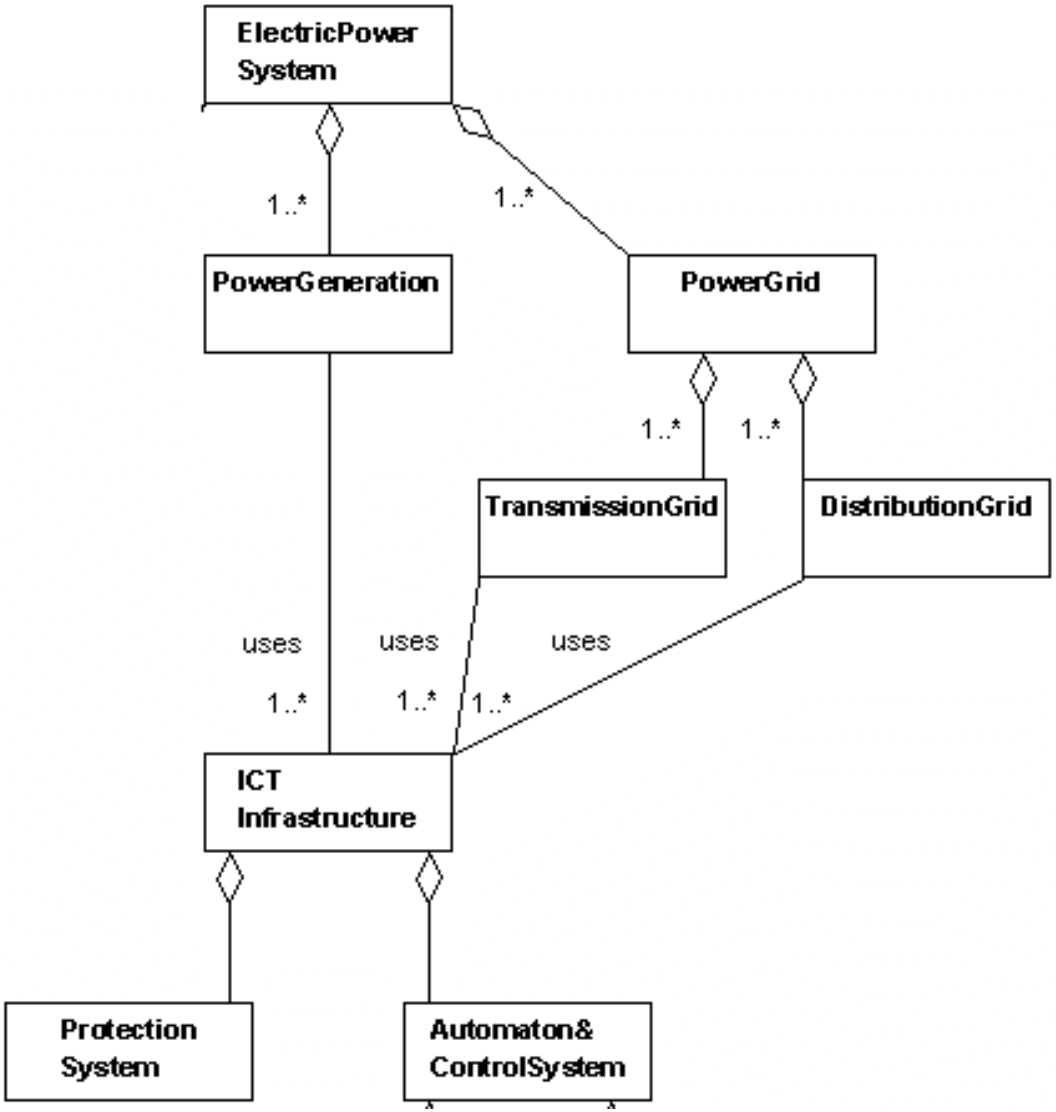
The EPS structure



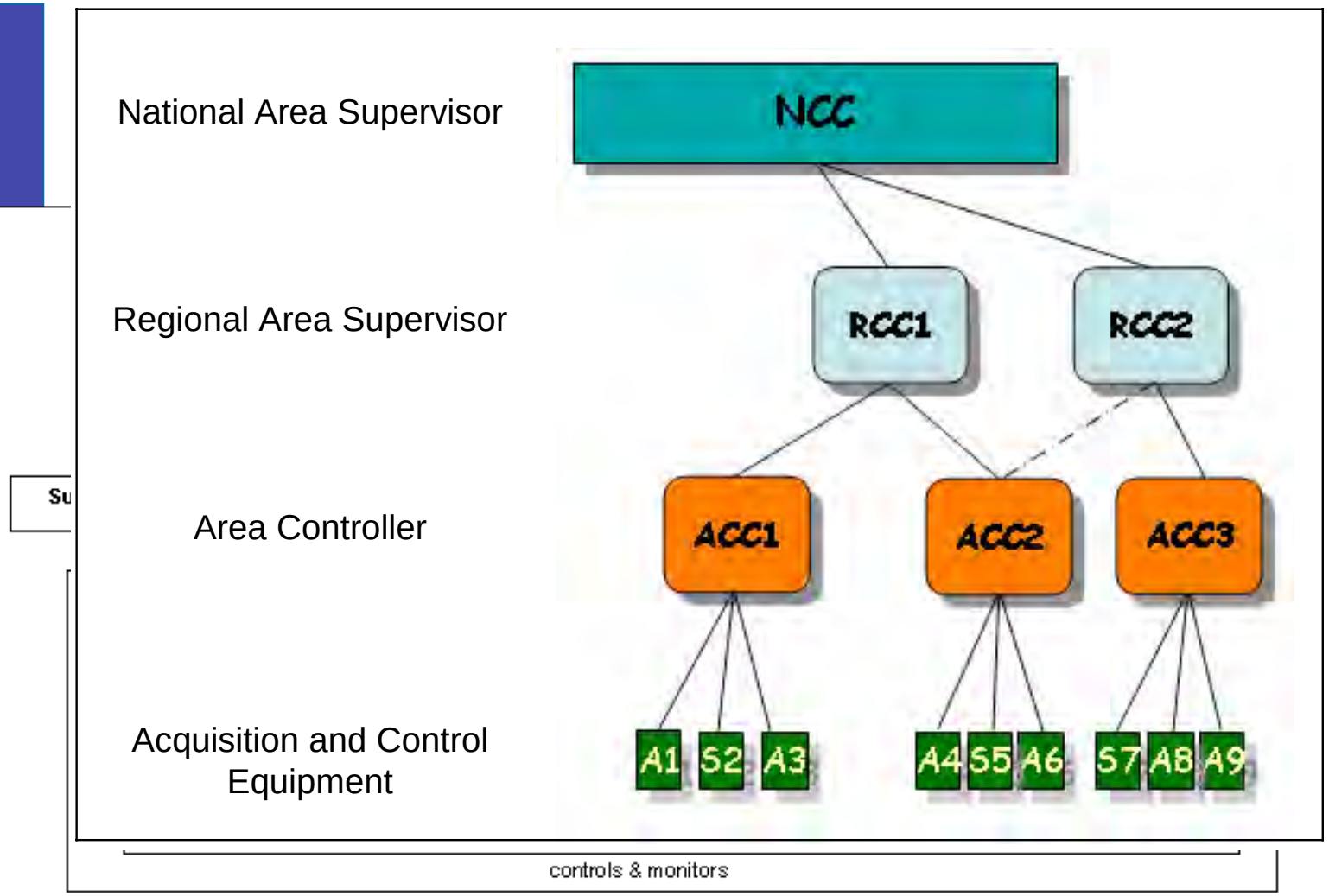
The ma

The EPS structure

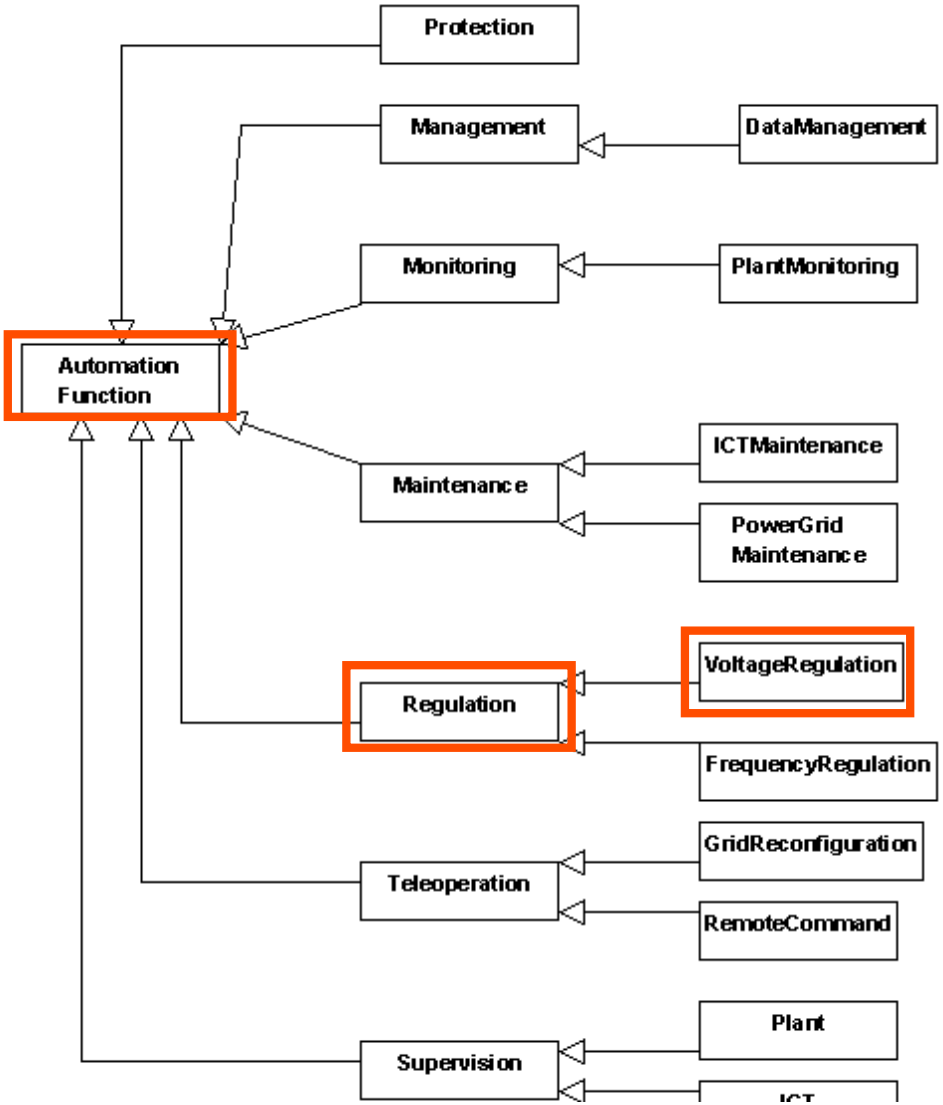
Adding ICT



The hierarchical control structure

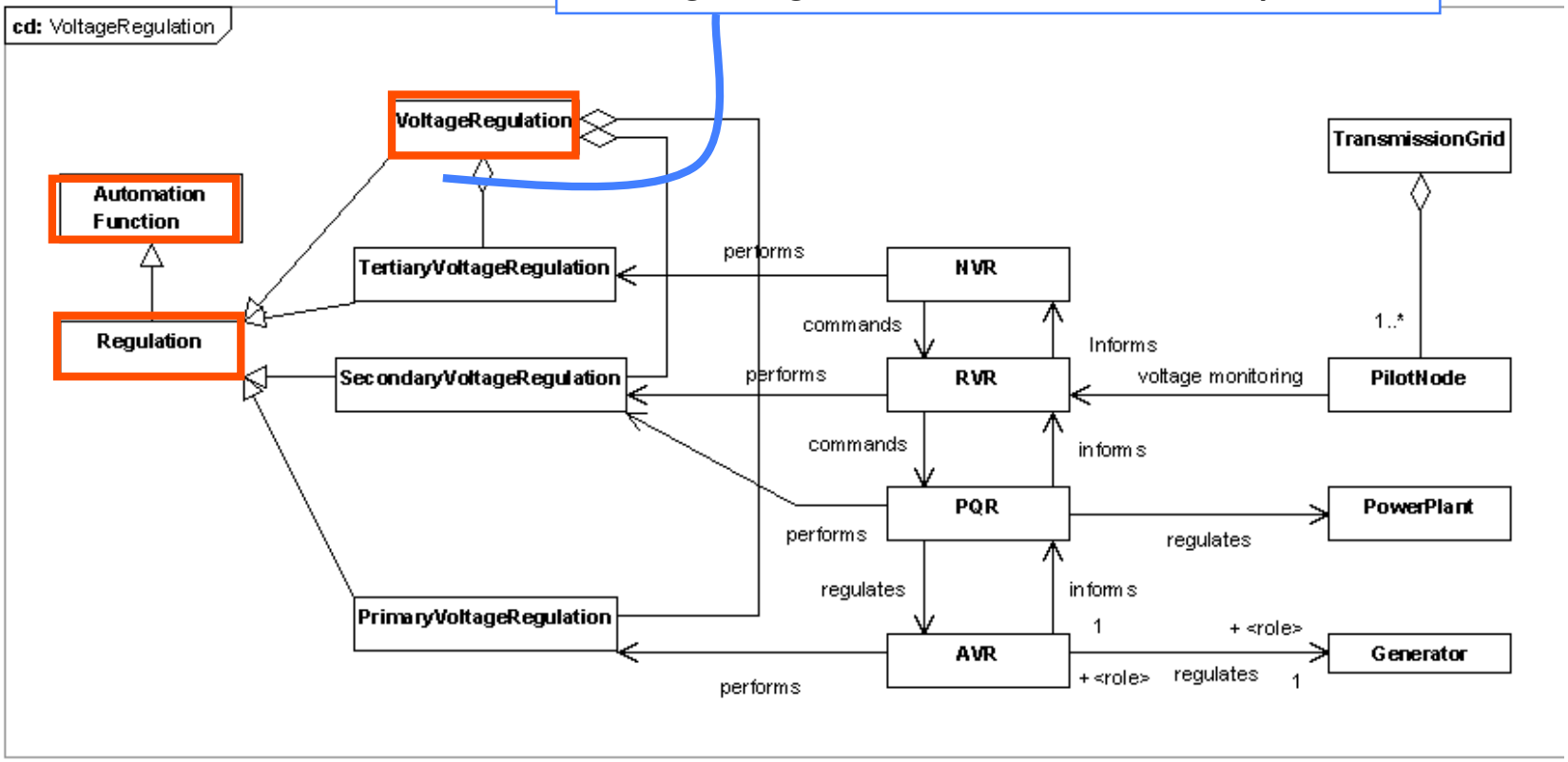


The EPS - functionalities



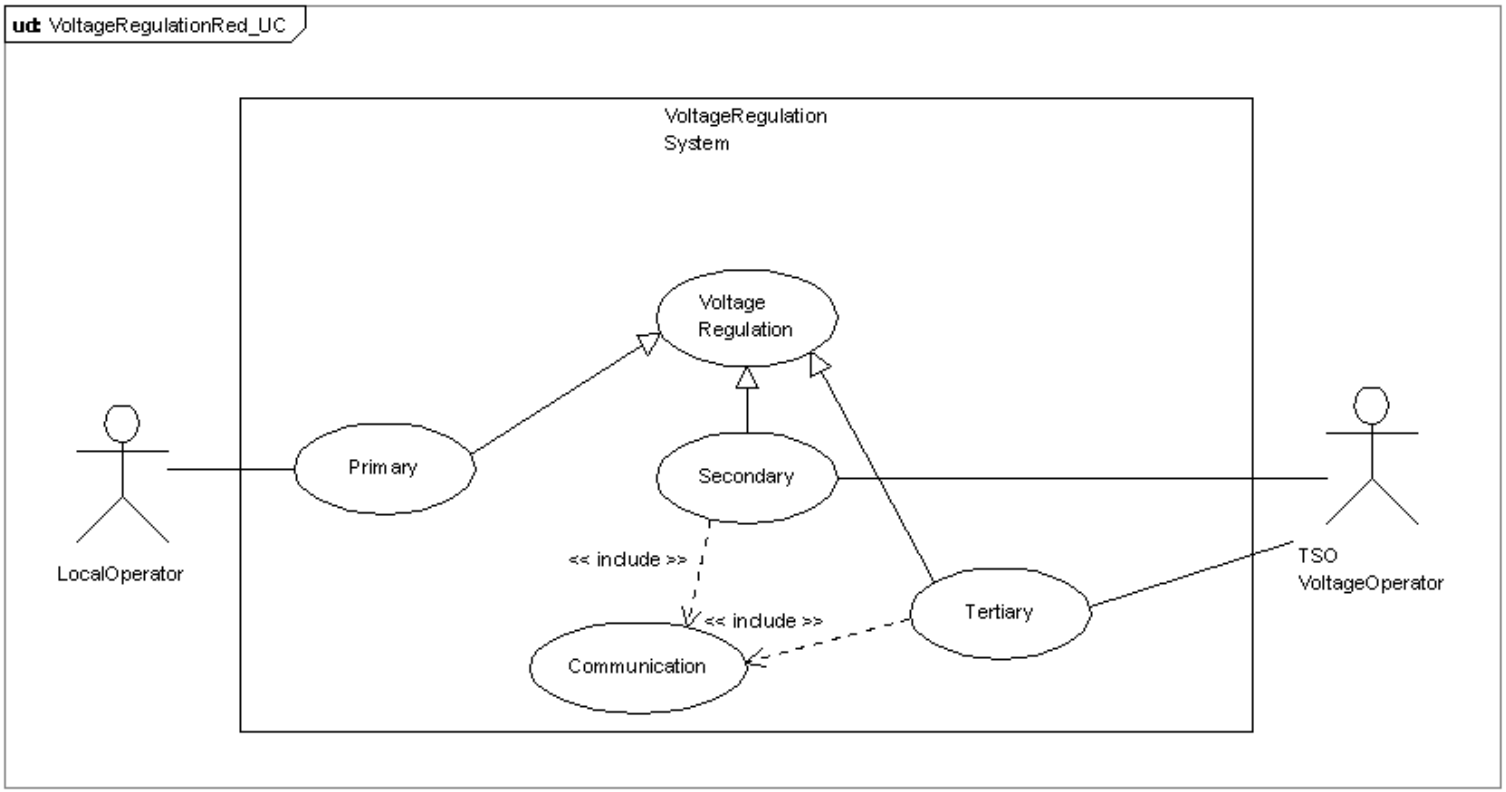
Voltage regulation - CD

Voltage regulation has three components



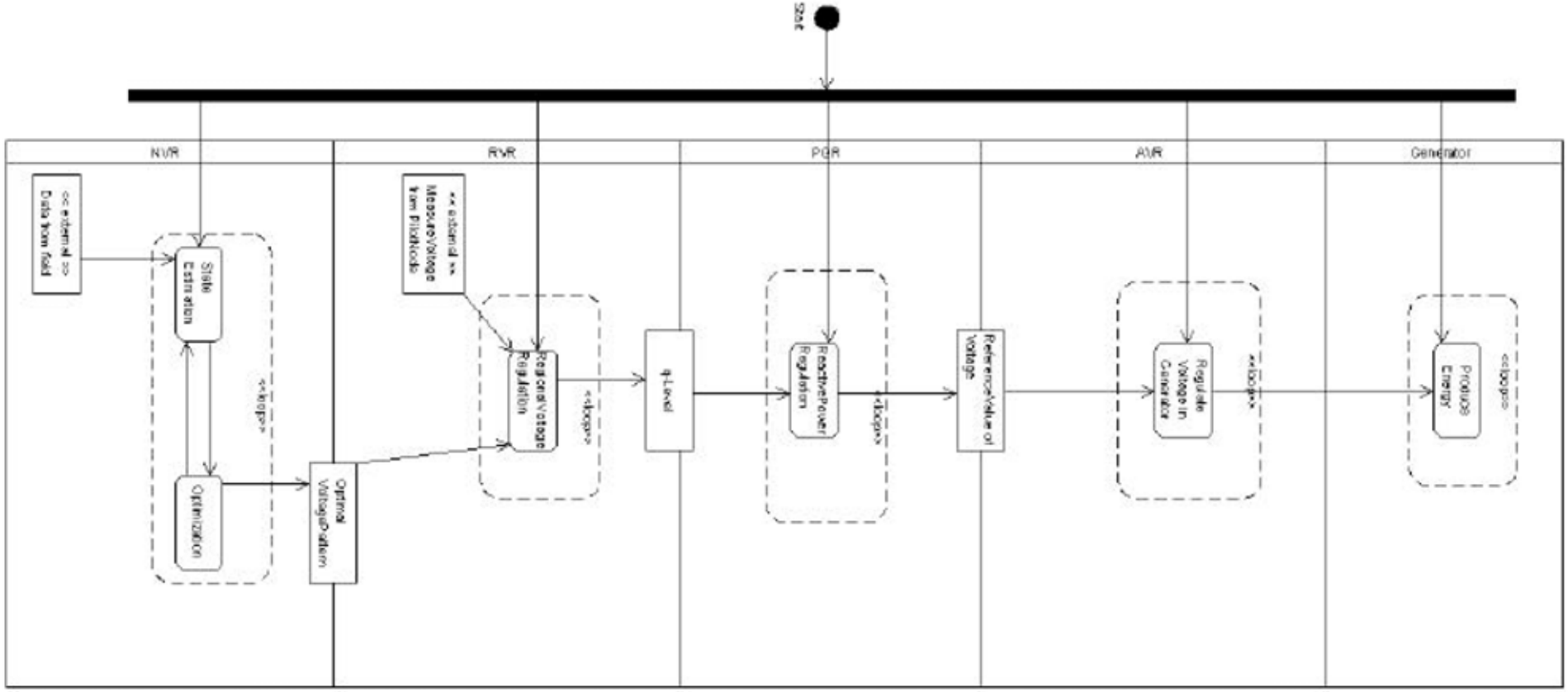
Voltage regulation - Use case

Voltage regulation has three components



Created with Poseidon for UML Community Edition. Not for Commercial Use.

Voltage regulation - activity



Scenario specification

Specification: structured description of the portion of the system of interest and of the attack/malfuntioning behaviour

UML description:

- object diagram --> structural elements involved
- collaboration diagram, sequence --> instantiated EPS behaviour
- state charts --> cause-effect expected chain

UML - one year later - *sort to say*

It helps to clarify concepts and to discuss, also with non-CS colleagues

Limited by:

- limited tools (cost, standard, model import/export)
- continous variable, support for experiment specification

Plans:

- move to SysUML (possibly integrated with some of the UML profiler that include dependabiliy aspects)
- use the UML based description for the analysis task of Crutial

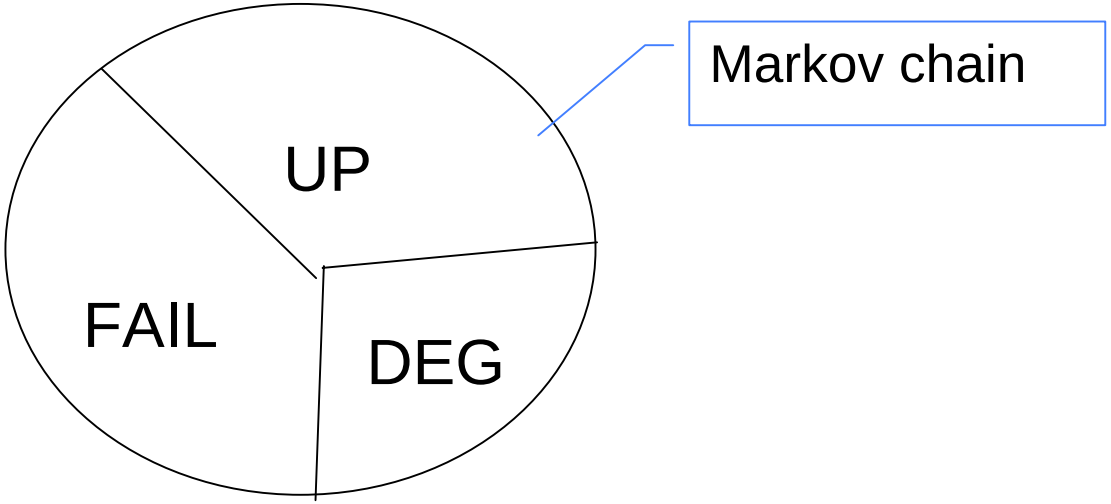
Performance indices

Definition of performance and dependability measures based on stochastic temporal logic and timed automata for Markov chains

(with Jeremy Sproston and Serge Haddad)

Performance indices

Motivations:



standard:

1. Prob. of being in a FAIL state at time t

CSL:

2. Prob. of going directly from an UP state to a FAIL state whithout passing through DEG states (and of being there at time less than t)

CSL&TA:

3. Prob. of a going from UP to DEG in X unit time, and from DEG to FAIL in Y time unit

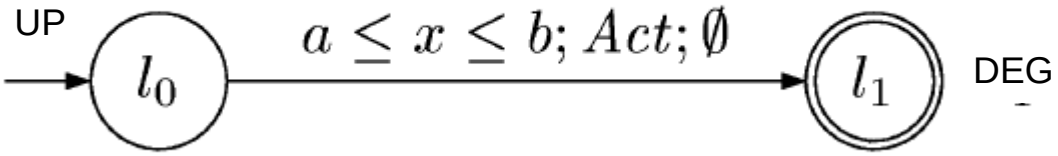
Our proposal: CSL-TA

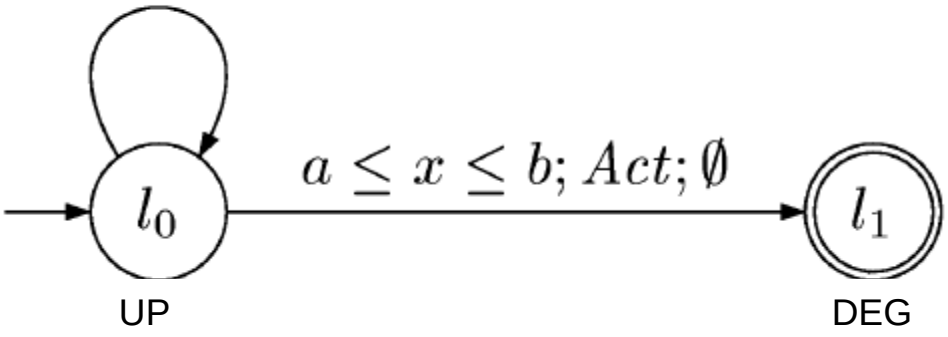
Informal definition:

Steady state
(prob. of UP states)

$$\Phi ::= p \mid \neg\Phi \mid \Phi \wedge \Phi \mid \mathcal{S}_{\sim\alpha}(\Phi) \mid \mathcal{P}_{\sim\alpha}(\mathcal{A})$$

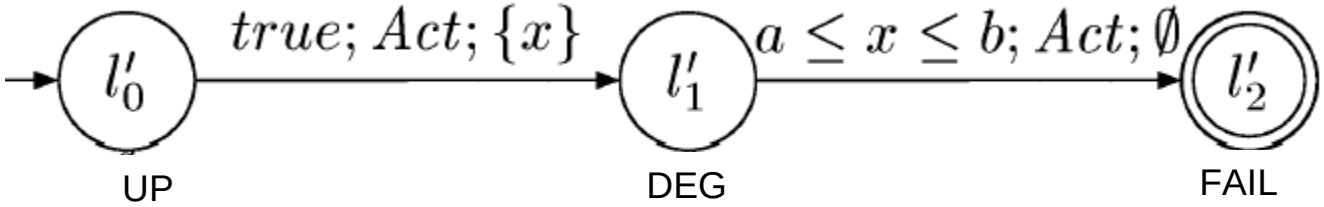
Transient prob (prob. of all paths
that "satisfy" a certain timed automata)





Our proposal: CSL-TA

Concatanating requirements



Model checking CSL-TA

The stochastic process is Markov regenerative, very similar to that of DPSN (exponentional Petri nets that can include at most one deterministic transitions enabled at any one time) ---- we use TA with a single clock

We have proved that CSL-TA is more expressive than CSL (and its variant asCSL) and it seems to be more versitile than the work of Obal and Sanders.

Thank you for your attention

susi@di.unito.it
www.di.unito.it/~susi