Real-Time Monitoring of Inter-area Security in the Mexican Power System

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Outline

1. Introduction
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Introduction

- The RT simulators offers opportunities for applications in security analysis, where RT simulator offers solution in accelerated time for multiples contingencies.

- In this paper we shall demonstrate the use of a fully digital RT simulator for the development of a security analysis tool for use in the control center of a power system.

- The propose in this paper is a RT interchange of data between the power system and an optimal power flow program.

Power System Security

- There are three states of a Power System:
  - Normal (**Secure and Insecure**)
  - Emergency
  - Restorative

- A system is normal when it satisfies all load constraints, line flows and voltage magnitudes are within limits.

- On-line Tools requires estate estimator updates.

Methods to evaluate

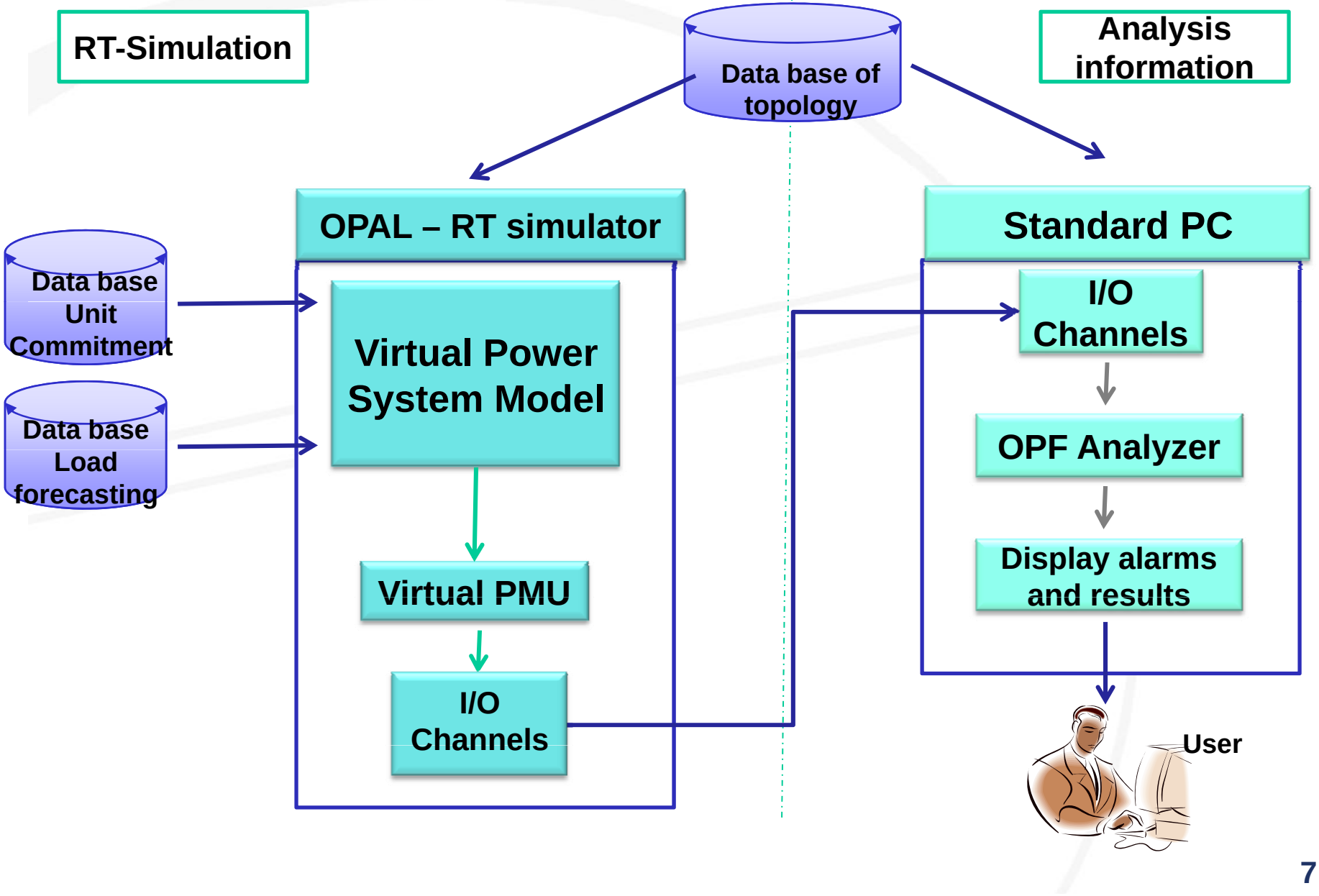
Steady state security

- Apply load flow for contingencies and develop an index for each contingent.
- Rank order the contingencies and present to operator.
- Our way to find vulnerable sections of the system is by the use of RT simulator feed OPF.

How Do We Solve the Problem?

- The on-line analyst considers a dynamic power system model with changes of loads and adjust to generation by AGC model.
- Signals produced to RT simulator are exported to other PC where run the OPF.
- An OPF determines which elements are in-out of limit conditions.

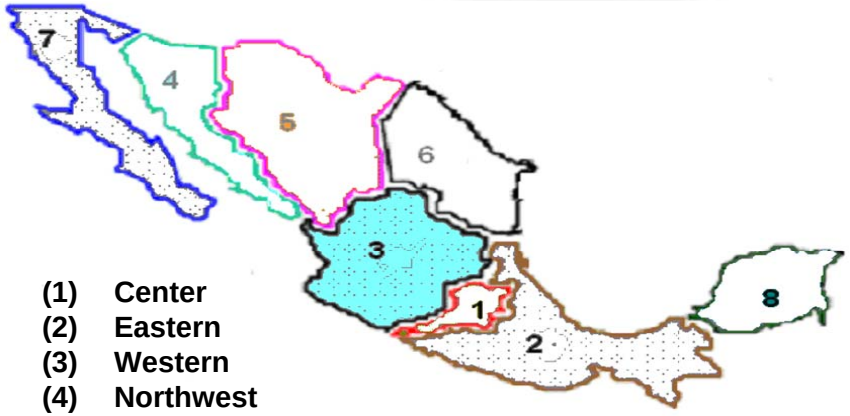
REAL TIME SECURITY ASSESSMENT (RTSA)



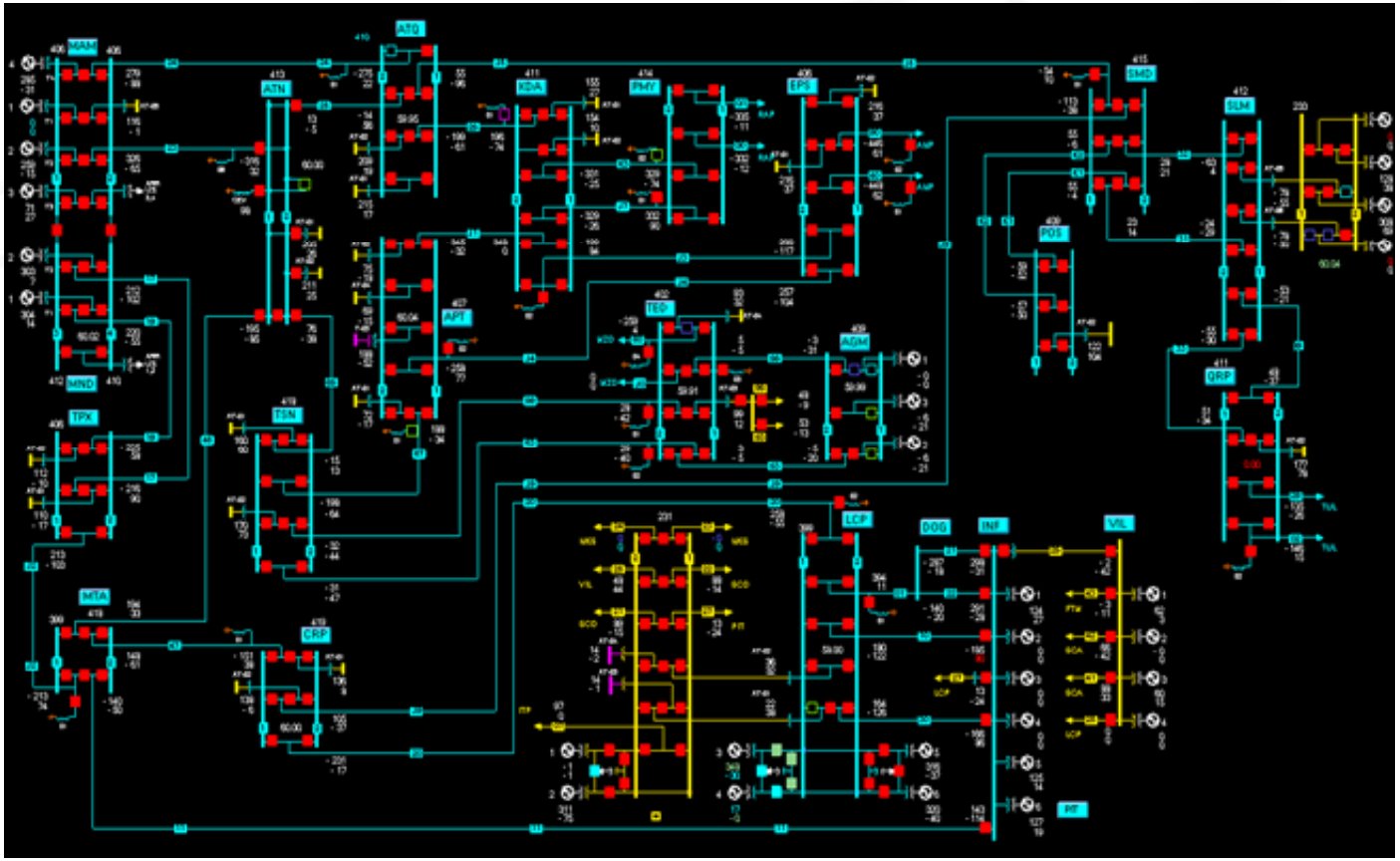
Test case: Control Center of Mexico

- OPAL-RT produces the power system signals.
- The approach provides a solution on-line or accelerated time.
- We consider as contingencies: Load and Generation changes.
- Load consumed is established by Load Forecasting studies.
- Generation is established by Unit Commitment and adjust by AGC model.

RTSA, Mexican Power System

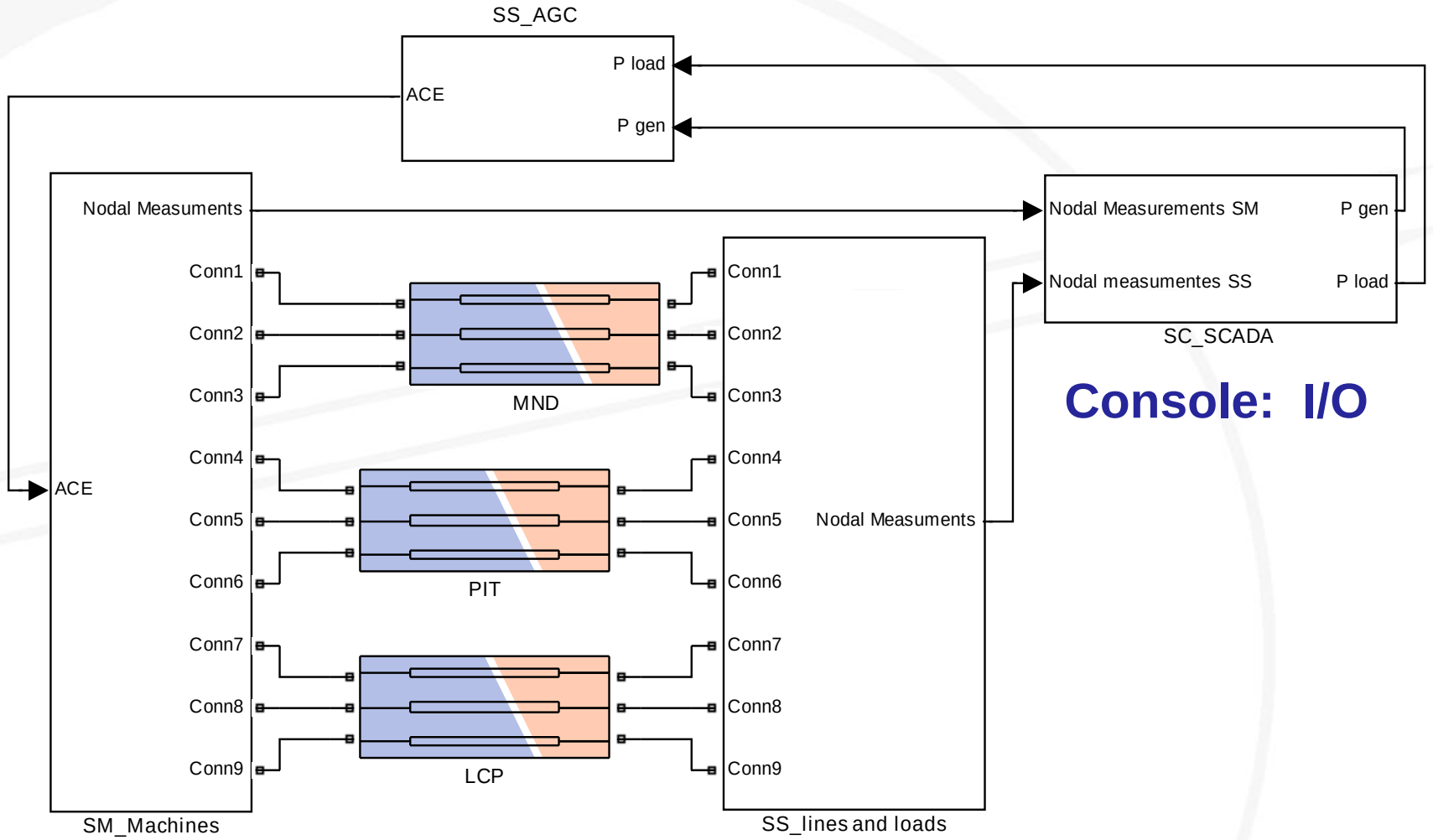


(1) Center
(2) Eastern
(3) Western
(4) Northwest
(5) North
(6) Northeast
(7) Baja California
(8) Peninsular



REPRESENTATION OF MEXICAN POWER SYSTEM

Slave: AGC

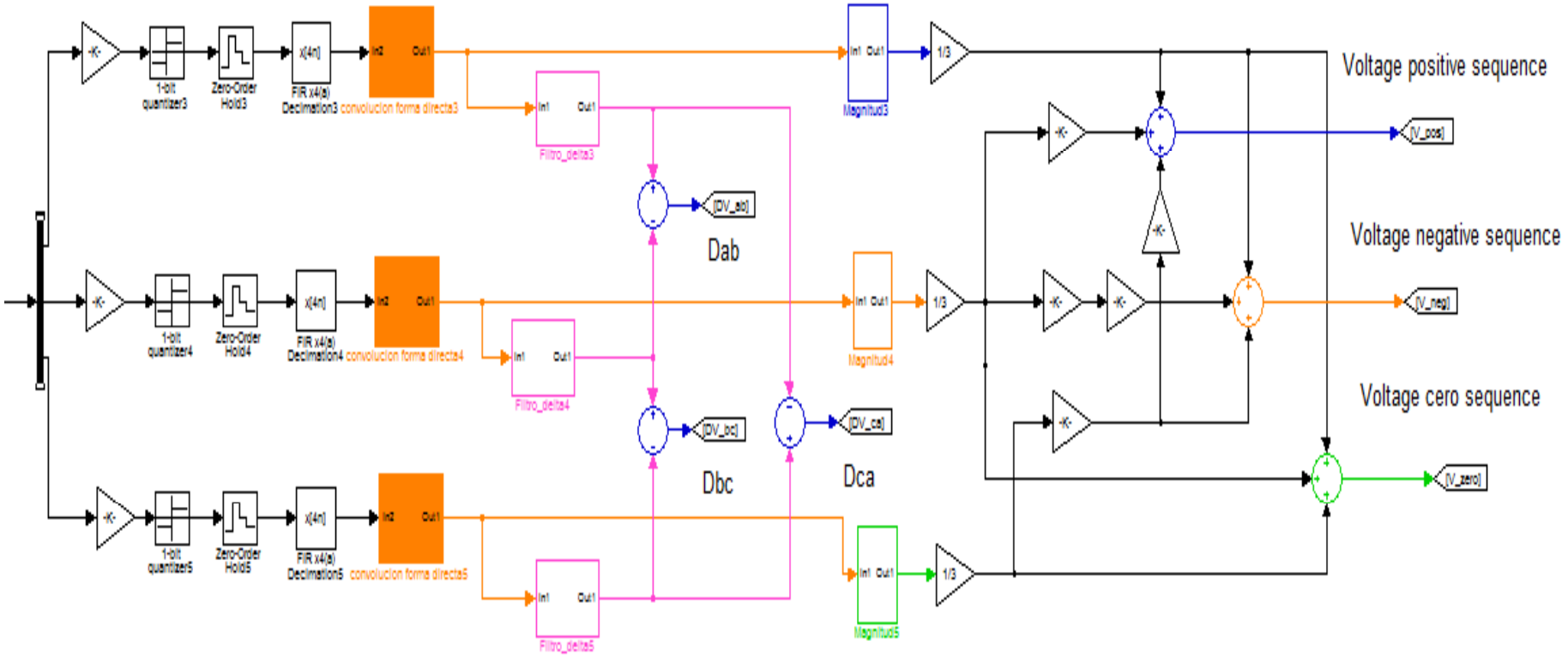


Console: I/O

Master: Units Generation

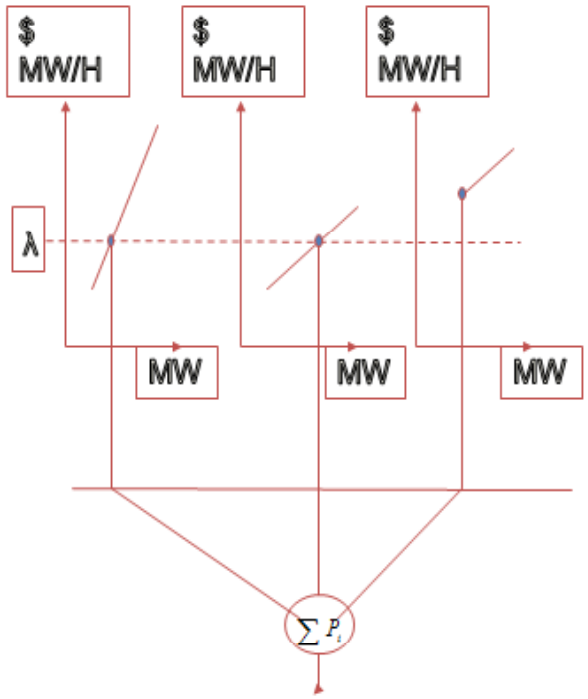
Slave: Transmission system

MODEL FOR SIGNAL PROCESSING TO FEED OPF



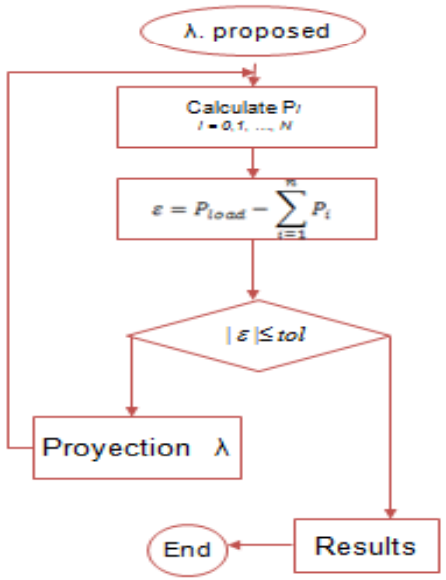
Data Information from SCADA → **RTU** → **OPF analyzer** → **Display alarms** →

DATA TO RT SIMULATOR



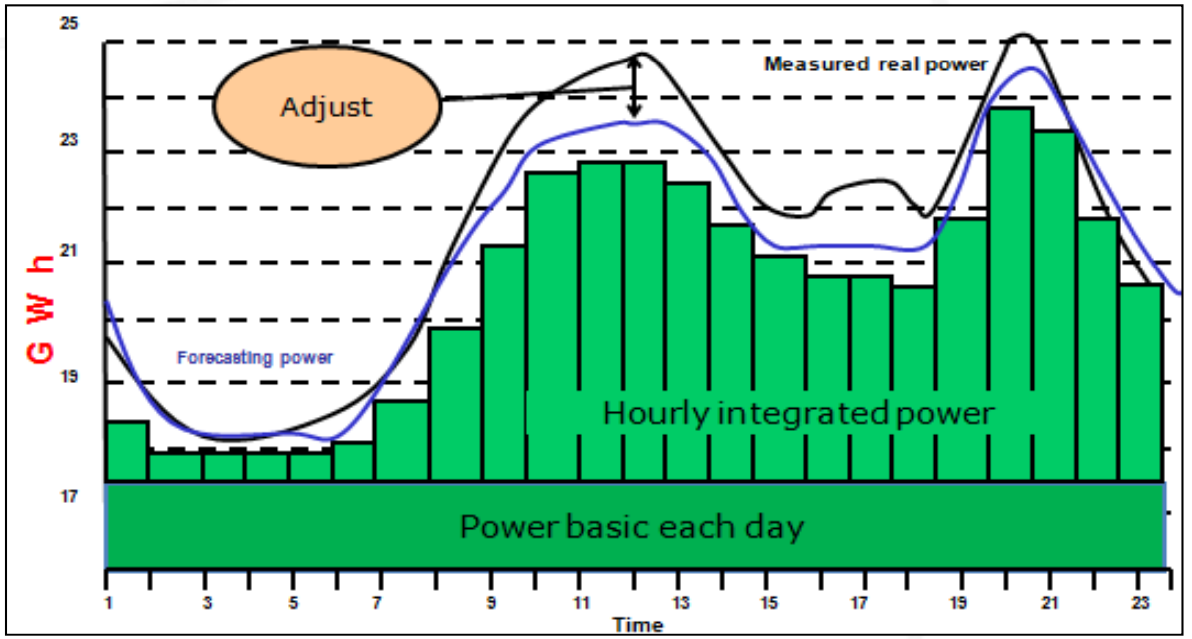
$P_{load} = P1 + P2 + P3$

Unit Commitment

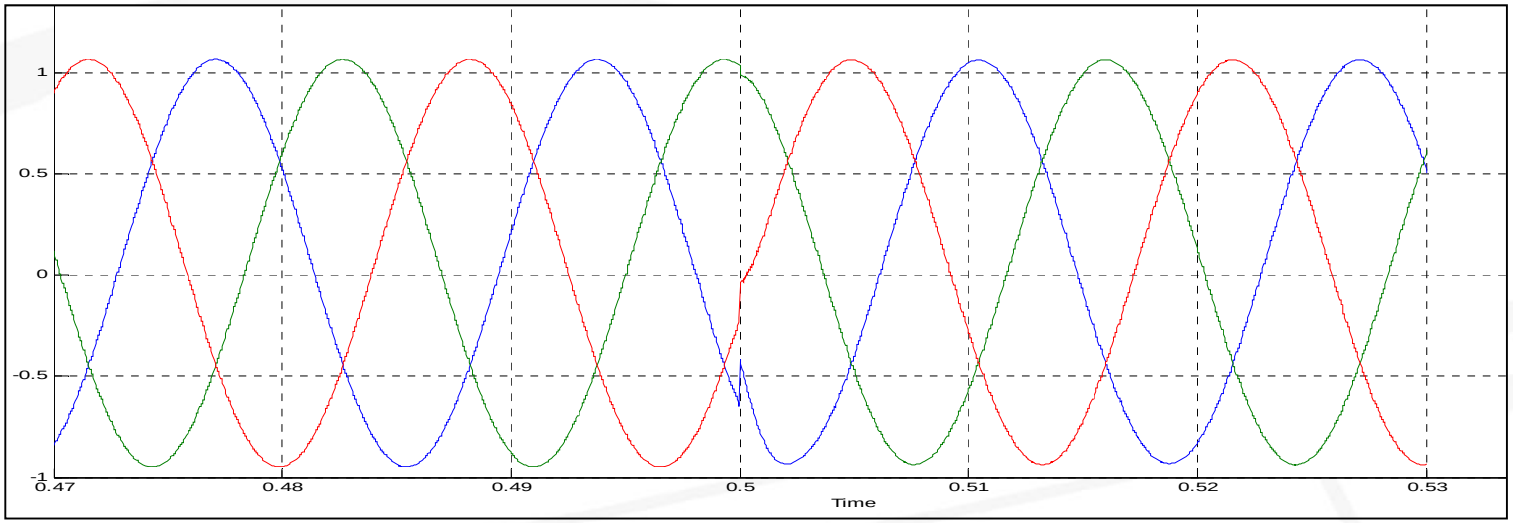


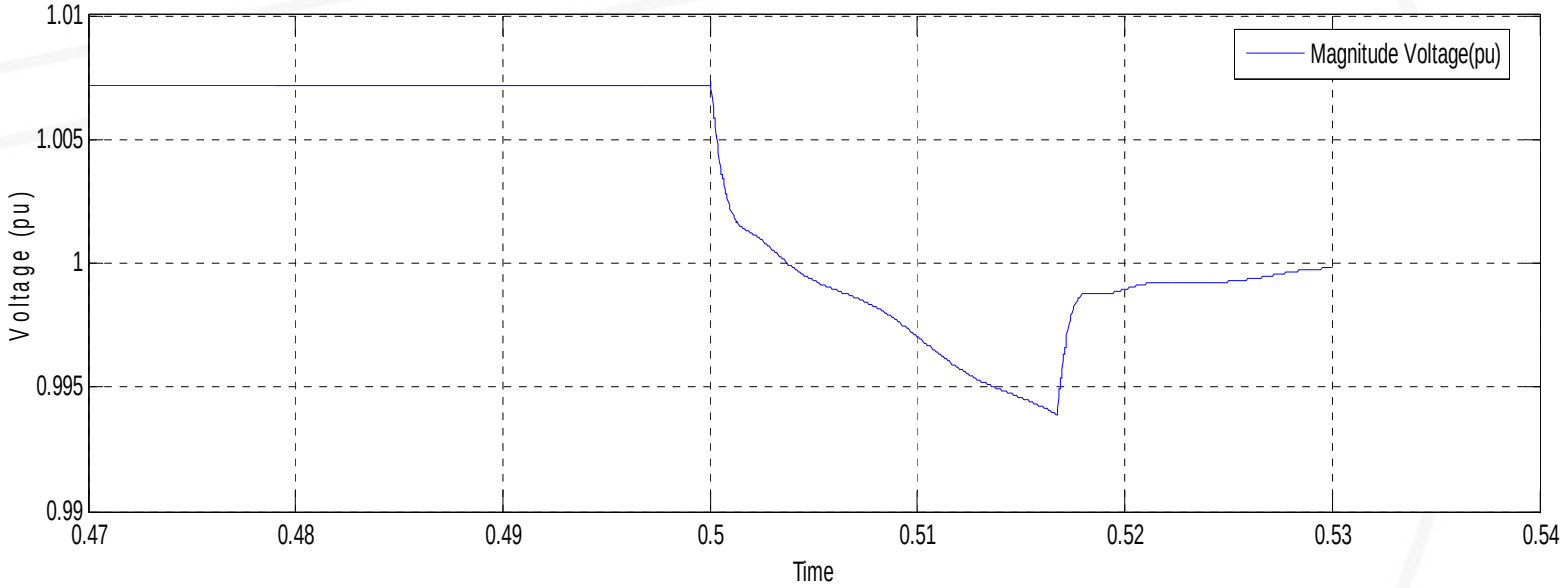
Area Control Error to AGC

$$ACE = \left(\sum P_{ITL_8} + \sum_{i=1}^{N} Pi \right) - \left(P_{load} \right)$$

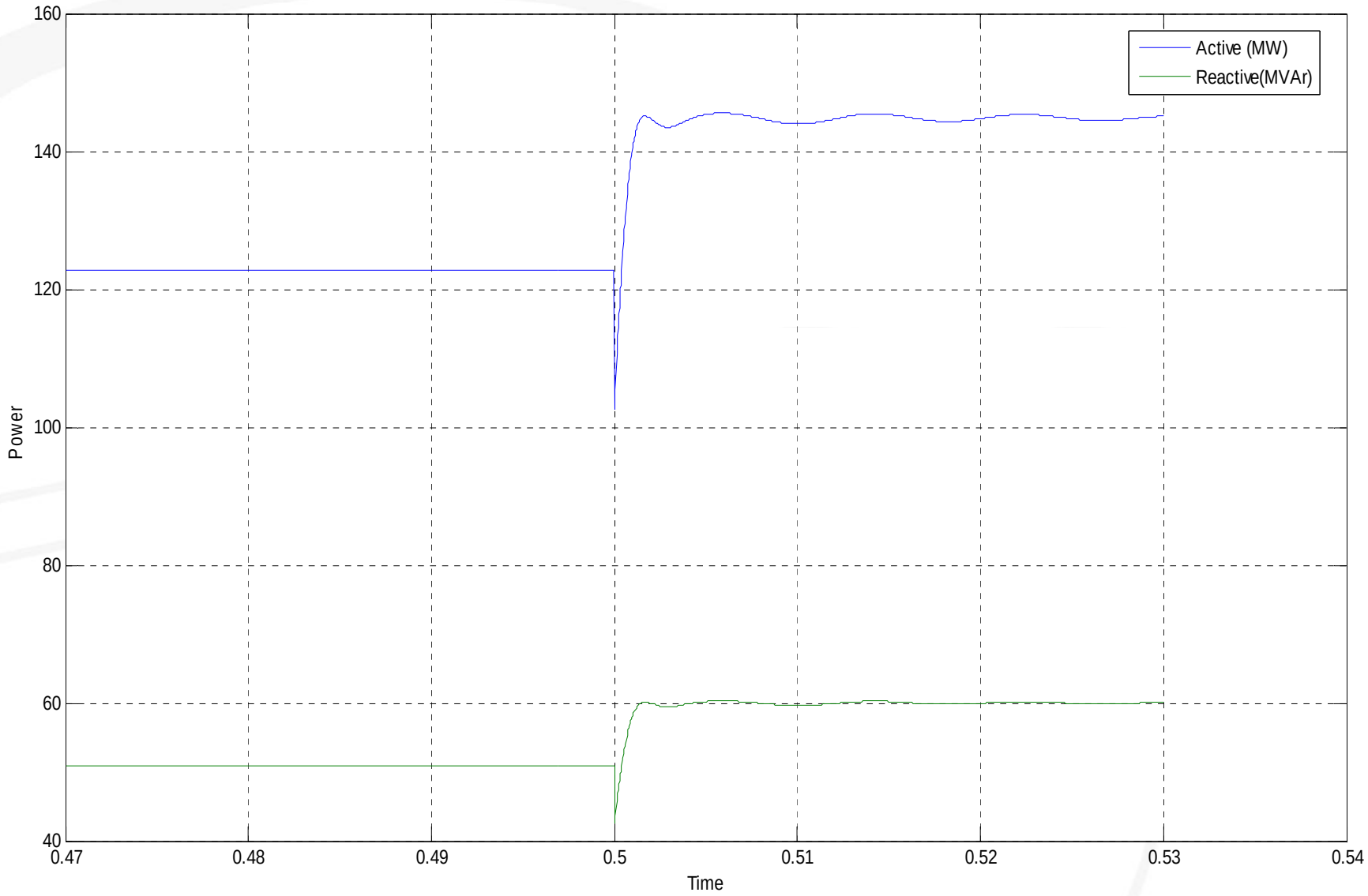


RT SIMULATIONS LOAD INCREMENT 30%

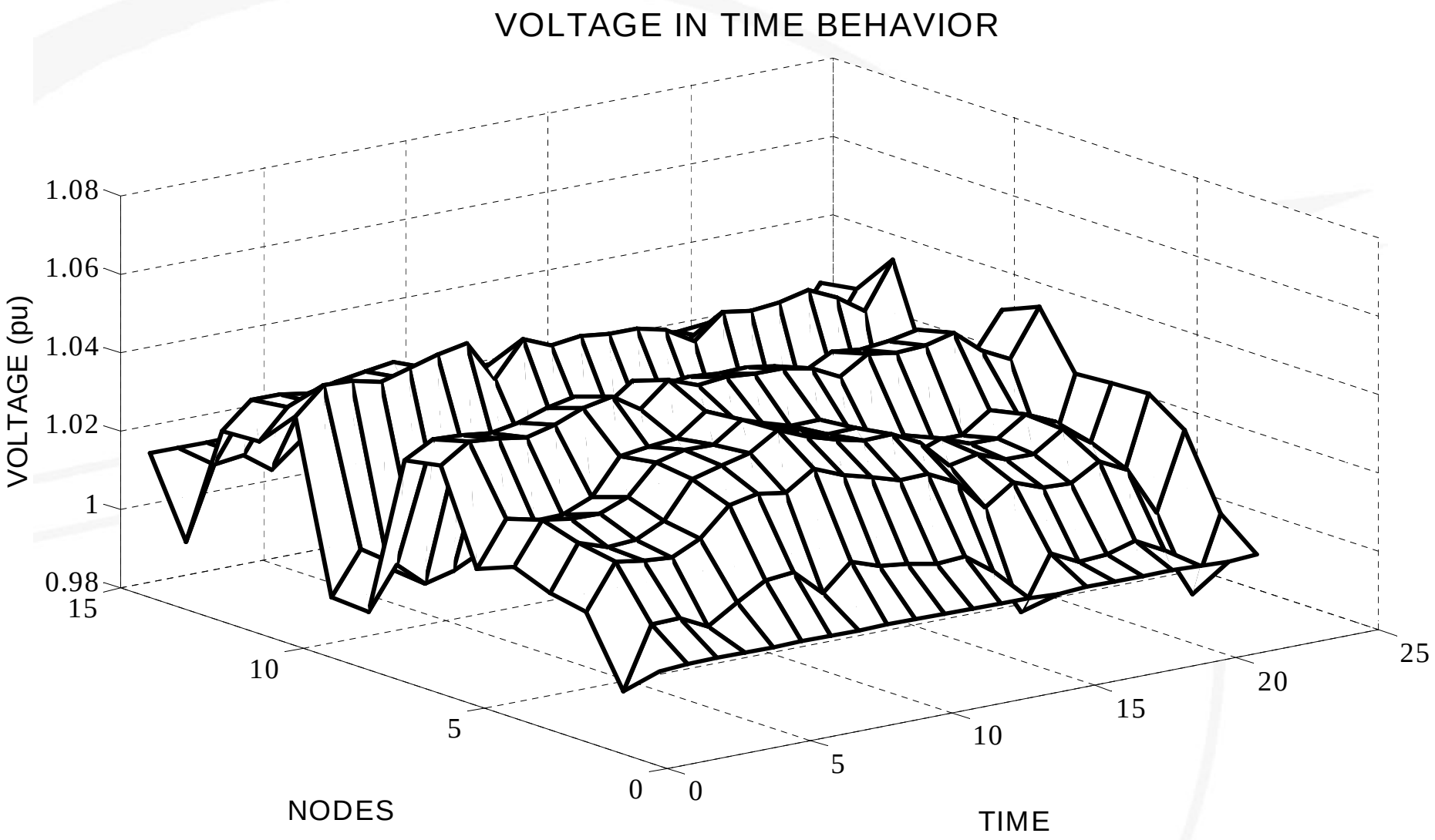




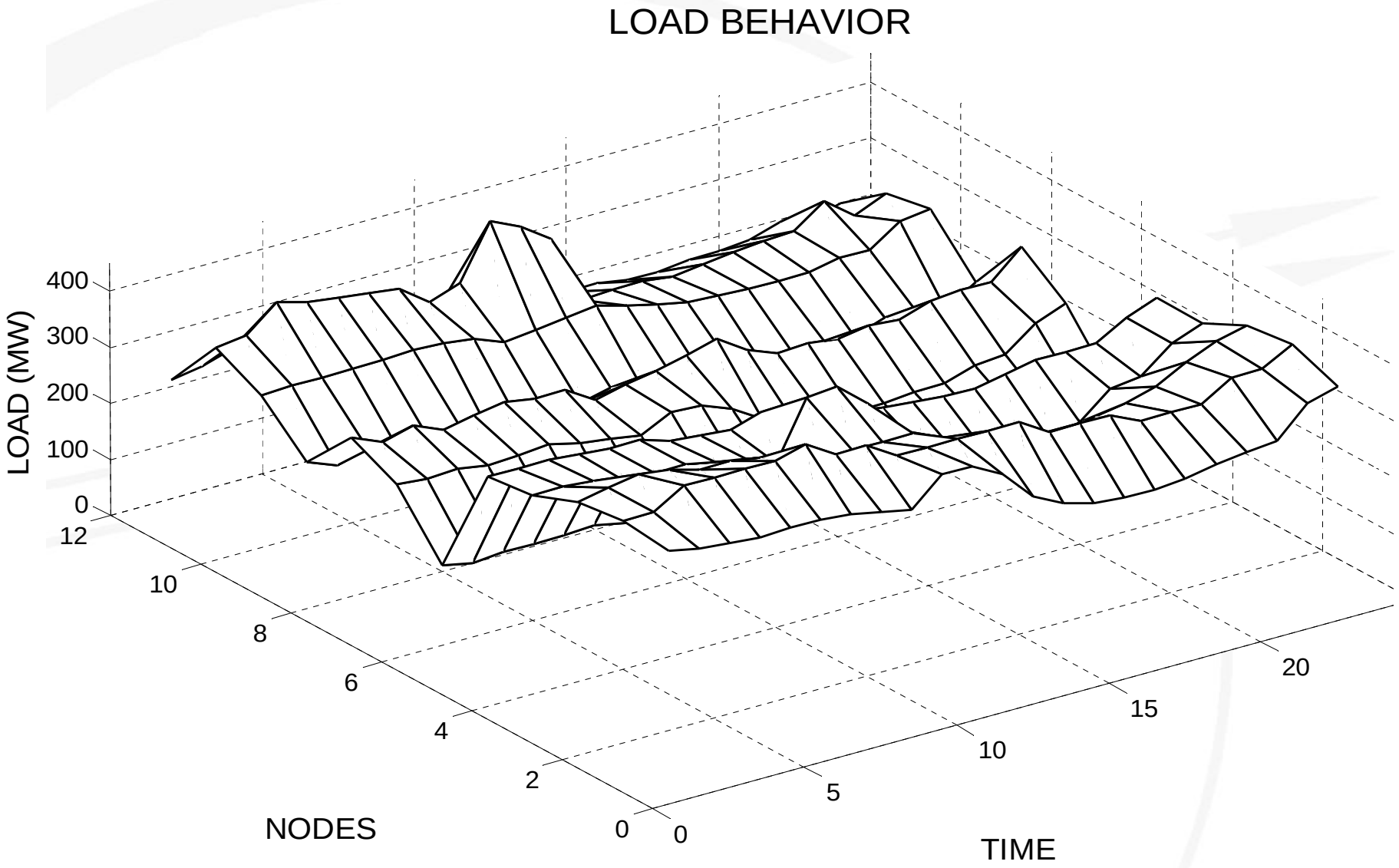
POWER OUTPUTS DUE LOAD INCREMENT 30%



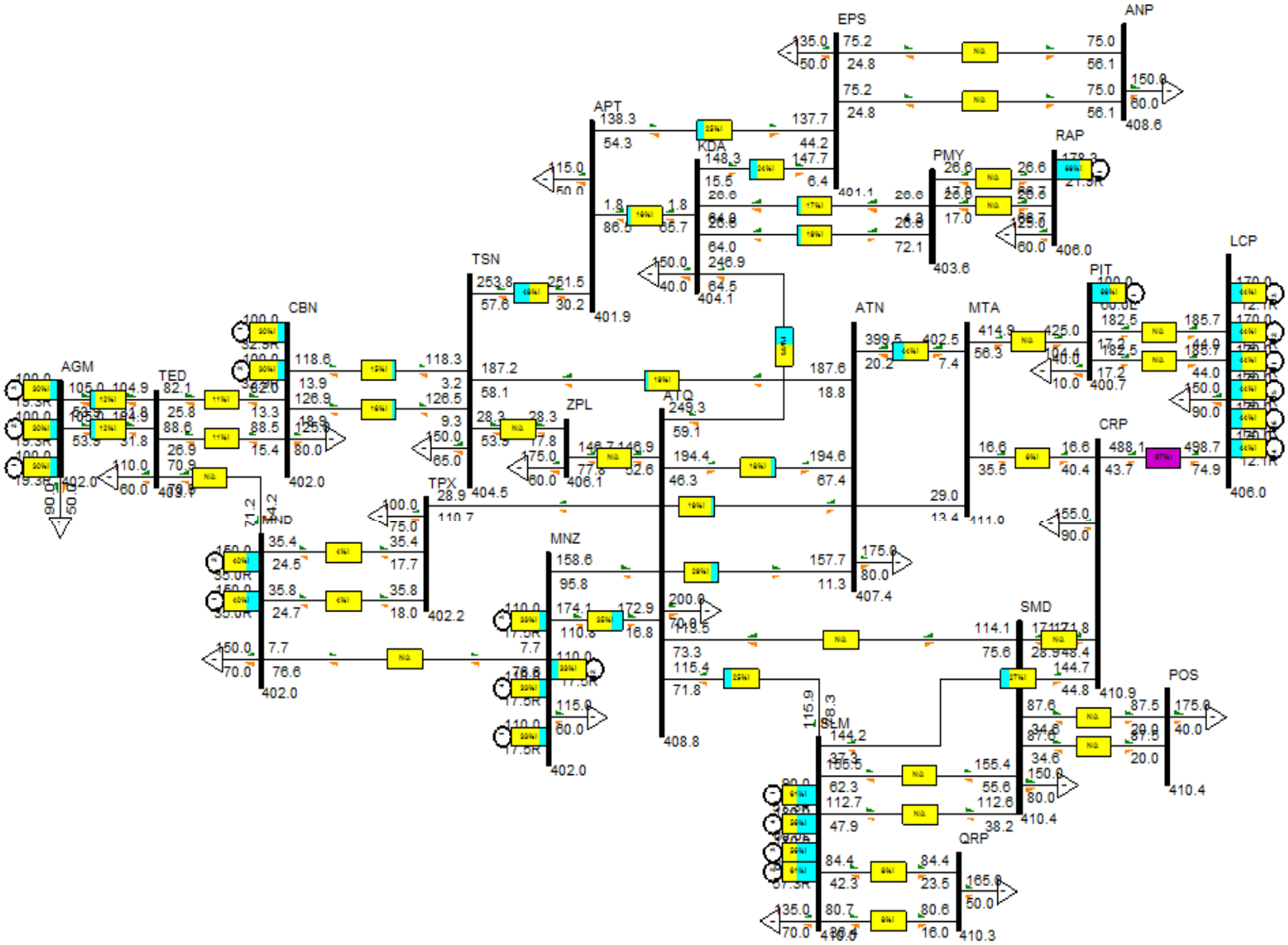
NODAL VOLTAGE 24 HRS



LOAD POWER CONSUMED 24 HRS



OPF VISUAL SECURITY ASSESSMENT



Conclusions

- It was presented the use of a RT simulator for implementation of improved strategies in power system security assessment.
- Virtual PMU's feeds an OPF to provide information for applications such as wide area protection, emergency control and system optimization.
- The OPF determines limits and restricted conditions.

Conclusions

The benefits of using a combined RT simulator and OPF program include:

- Wide-area on-line solution of security assessment even for very large networks
- An improved visualization of the overall state of the network
- Global security assessment rather than local.

Future works

- Applying an AGC model for small signal perturbations.
- Fault contingencies and switching devices as reactors or capacitors.
- Adaptation of a close loop approach.
- Evaluation of the effect on transient stability resulting from the connection of machines.
- Dynamic security analysis.

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Thanks for your attention

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