IEC Smart Grid Standardization Roadmap

Prepared by SMB Smart Grid Strategic Group (SG3)
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Part 2:

Smarter Transmission Grid

BY

Eng. Mohamed Taha El-Safty,
Dr. Hassan Mahmoud, **Dr. Dalal HELMI***
Eng. Salah Hemeda, **Eng. Salwa Ali**

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WHY--- SMART GRID

- The classical method of managing supply and demand has worked reasonably well over the decades.
- The system is safe and reliable, and most utilities are very profitable even in economic downtimes.

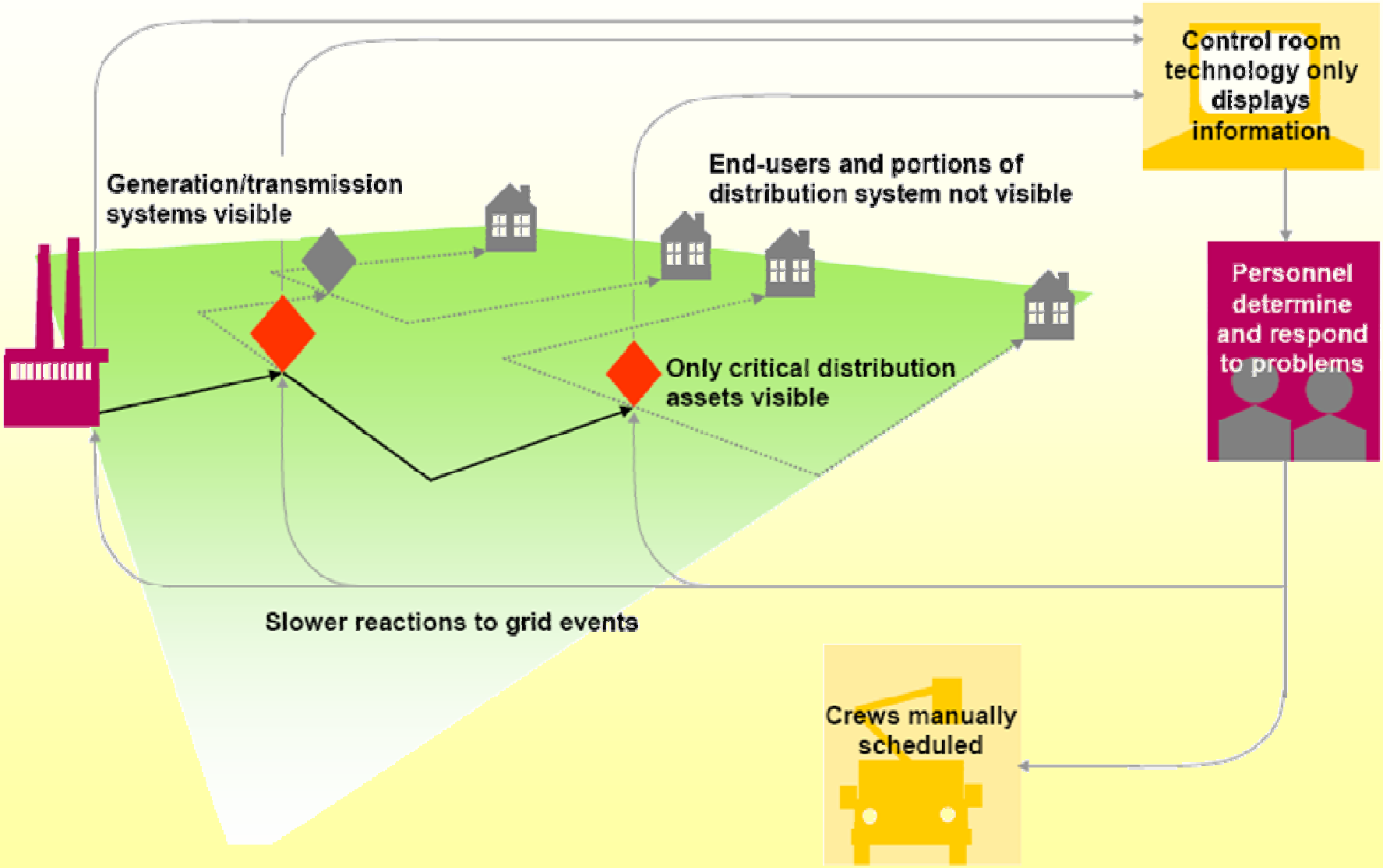
So why implement a smart grid?

The Classical Utility

- **The classical school of utility operations prescribes four priorities, ranked in descending order:**
  - **Safety,**
  - **Reliability,**
  - **Customer service and**
  - **Profit**

The classical model of utility operations is changing……

Today's Electrical Grid *(Passive Network)*



Fully realized smart grid *(Active Network)*

Need for More Flexibility

Increasing energy trade

Changing load flows

Bulk power transmission

Demand growth

Bottlenecks and overloads

Increasing grid size and complexity

Variable infeed

Drivers:
efficiency, reliability, security

CO2 Reduction throughout Grids (from Generation to End Use)

Different philosophy in operation, control and protection

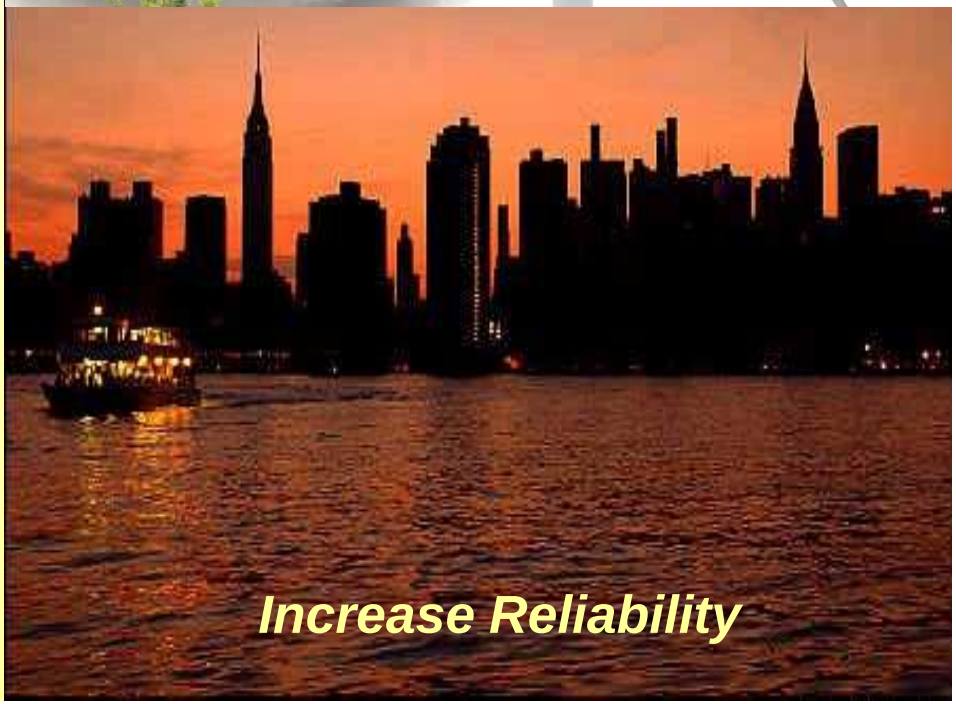
Why Smarter Grid?

Improve diversity, availability, and efficiency with information, computation, and communications

Why Smarter Grid?

Improve safety,

Improve reliability, stability, economy, AND supply



- Characteristics of SG -

- ***Smart Grid or Grid of the Future or Digital Grid***
  - **Self-aware**
  - **Self-healing** **automatically avoid or mitigate power outages, power quality problems, and service disruptions.**
    - Anticipation of disruptive events
    - Look-ahead simulation capability
    - Fast isolation and sectionalization
  - **Adaptive and optimizing**
  - **Resists attack**
  - **Predictive (proactive rather than reactive)**
- **Stakeholders:**
  - **Federal**
  - **Lawmakers,**
  - **Environmentalists,**
  - **Utility executives, and**
  - **Technology providers.**

Benefits of The Smart Grid

- Better accommodates a wide variety of generation sources.
- Better accommodates demand side management.
  - Allows customers to monitor their energy usage and price schedule
  - Reduces peak demand (Variable Tariff)
- Optimizes asset utilization and operation
  - More power flow through existing system
  - Reduces oscillations
  - Reduces electrical losses
- Improves power quality

Benefits of The Smart Grid

- Reduces maintenance time
  - Predictive Maintenance
  - Automatic event detection and identification (Web DFR)
  - Self-healing
- Resists attack
  - Security is a required for all elements in the grid
- Foundation of Smart Grid are
  - Two way comms + BPL / Wireless
  - SCADA and
  - Phasor Measurement Technology (4 sec are>>>>)
- The Smart Grid is:
  - not ”One” Product, but rather, a “solution suite” of products and software tech improving the grid’s perform.

  …….
  - And not fixed concept (vary from utility to another)

Specific Transmission Applications

1. **Smart transmission systems, Transmission Level Applications**
2. **Blackout Prevention / EMS**
3. **Renewable Energy Generation**
4. **Smart Substation Automation – Process bus**
5. **Condition Monitoring**

1+2+3

- implementation and the increased use of bulk power transmission will cause
  - a change from the quasi-static state of the transmission grid to a more complex and dynamic behaviour.

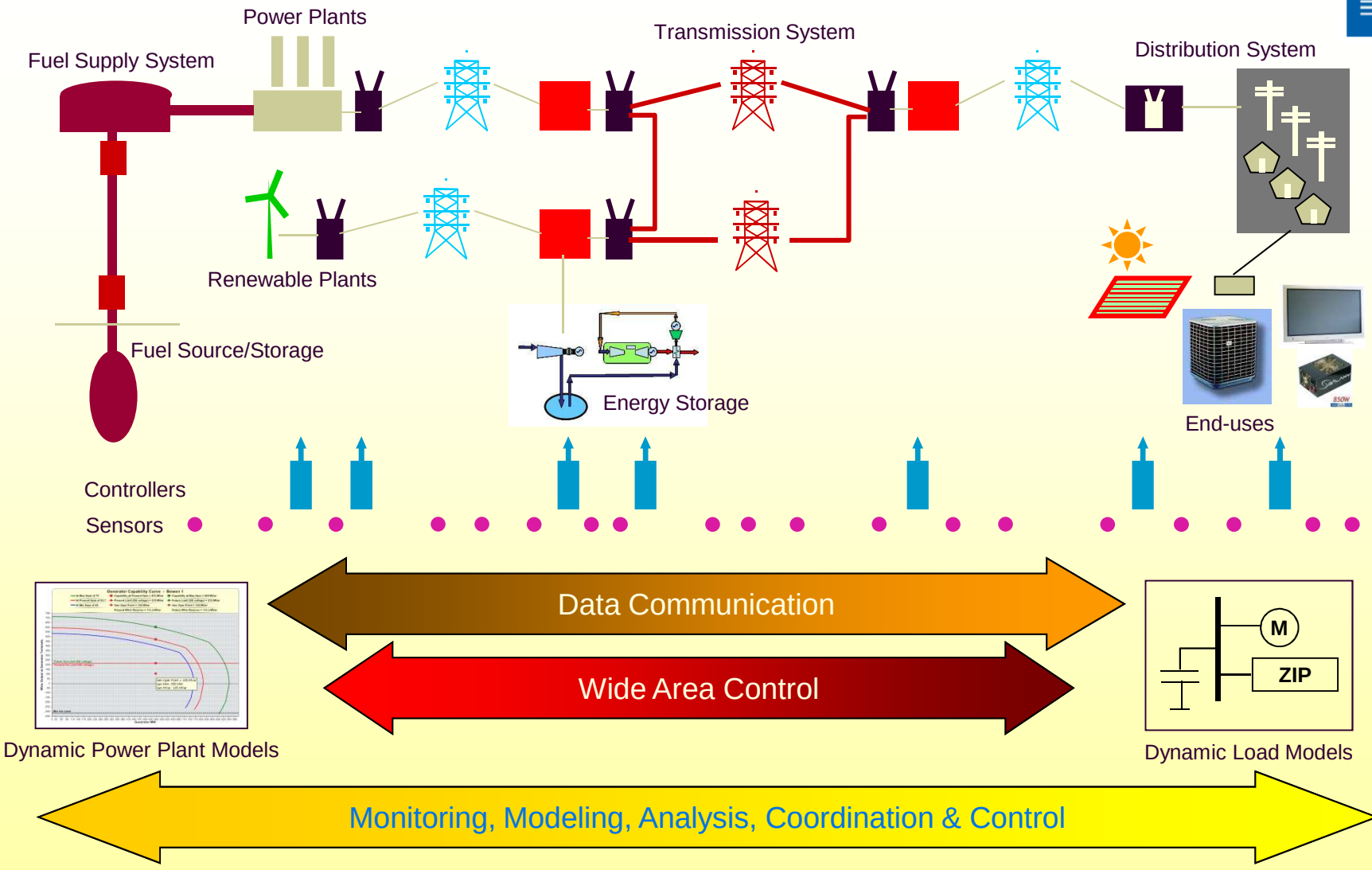
- Therefore the current available supervision, management and control functions will need to be adapted.

- **State estimation, for example, will have to include the transient behaviour:**
  - **The traditional power, voltage and current measurements must be extended to phasor measurement provided by PMUs (Phasor Measurement Units).**
  - **From State Estimation to State measurement**

- **An optimal representation and visualization as well as decision-supporting tools must be developed in order to support the operator of such complex systems.**

- **The integration of advanced equipment into the overall system architecture of an energy management system.**

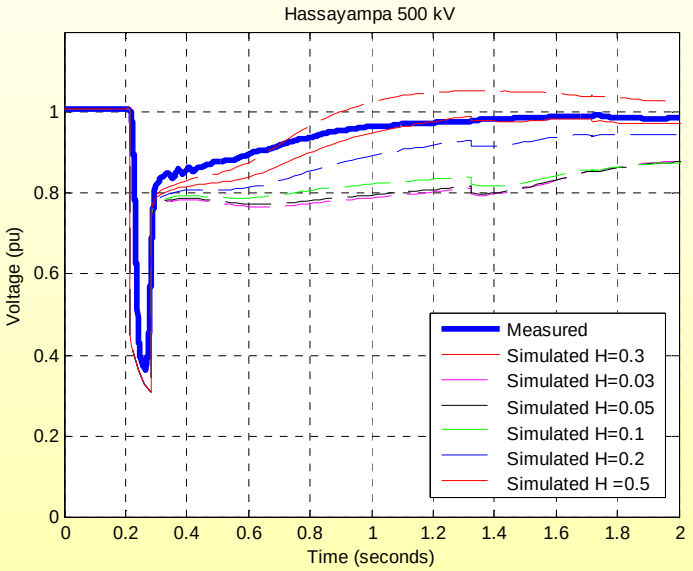
- **i.e HVDC and FACTS must be integrated in the overall concept of *Wide Area Monitoring and Control* for:**
  - **Optimized load flow, and**
  - **Increase network stability.**


Power Plants
Fuel Supply System
Transmission System
Distribution System
Renewable Plants
Fuel Source/Storage
Energy Storage
End-uses
Controllers
Sensors
Data Communication
Wide Area Control
Dynamic Power Plant Models
M
ZIP
Dynamic Load Models
Monitoring, Modeling, Analysis, Coordination & Control

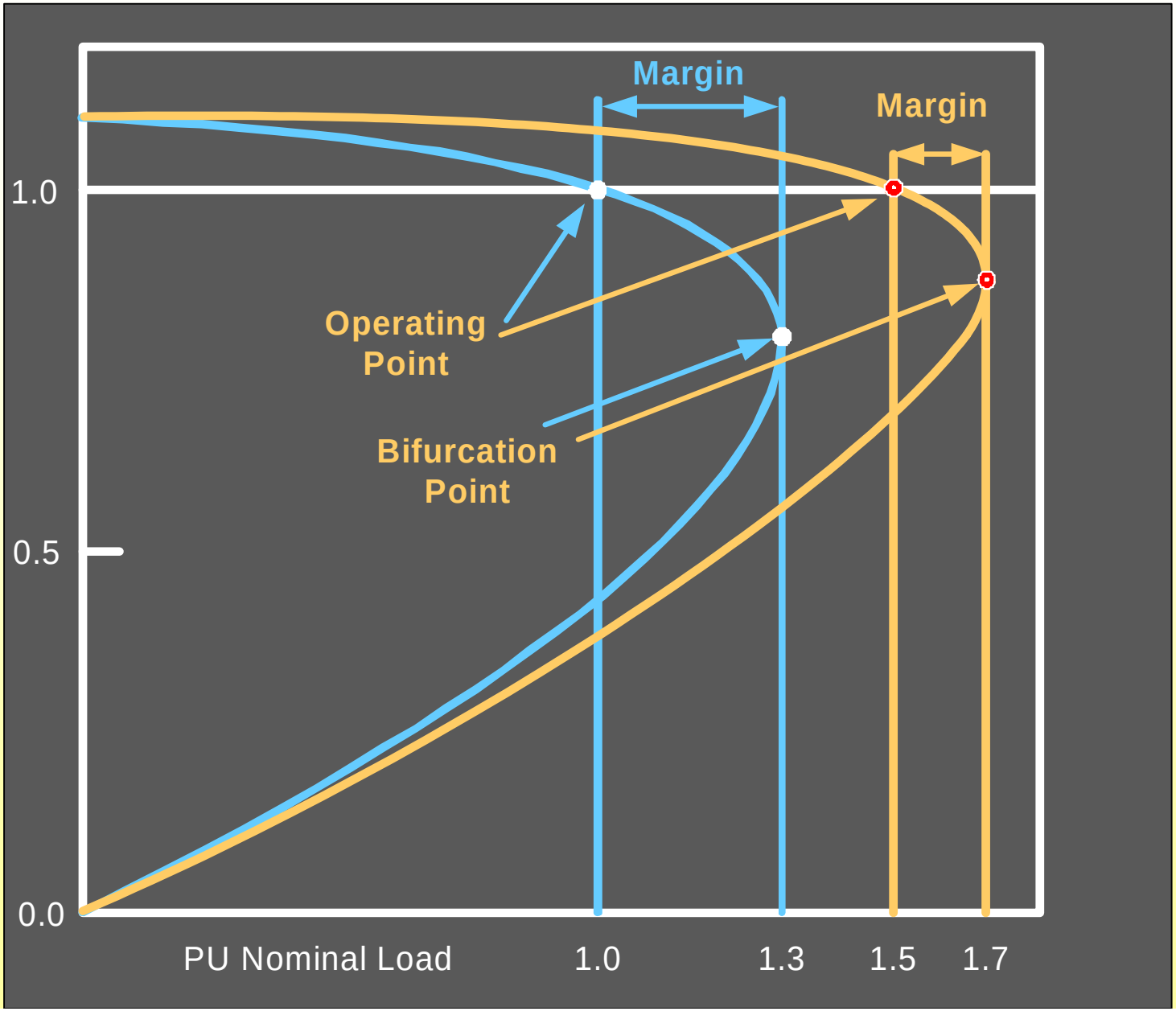
Using WAMPAC Inputs……

Why Accurate Load and Generator Models Are Needed?

- **Inadequacy of current model data**
  - **Inaccurate voltage recovery simulation after disturbances**
  - **Uncertainty about generator reactive power capabilities**
- **Implications**
  - **Uncertainty about the stability margin of the power grid**
  - **Unaware of real risk of cascading blackouts or voltage collapse, or**
  - **Under utilization of available stability margin for greater economic benefits**



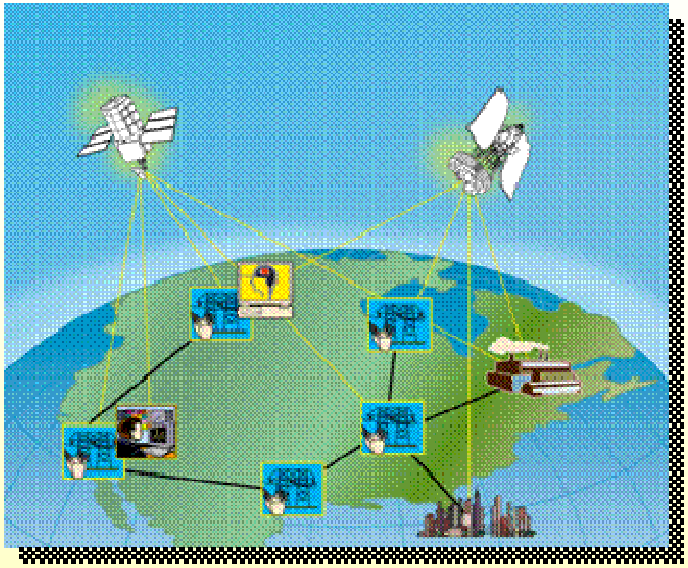
Utilities Are Operating Closer to the Edge

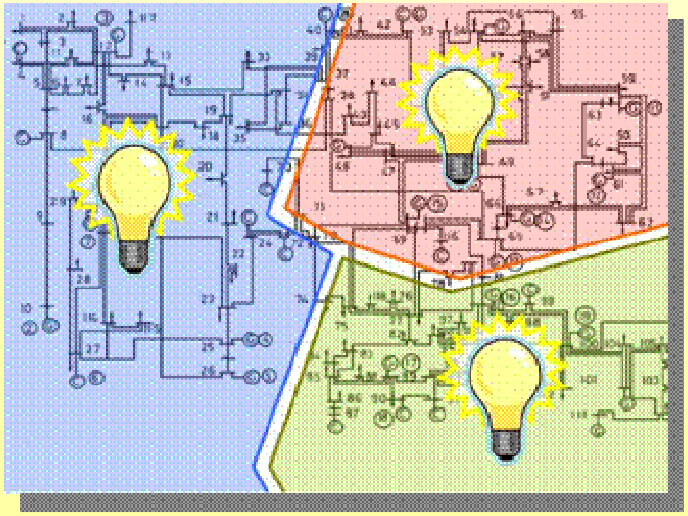


How Close Are You to the Edge ?

Prevention of Cascading Outages – Safety Nets

- **Application of SynchroPhasor Measurements for Controlled Separation, Load Shedding and Generation Rejection**
  - **Controlled separation is an effective last resort to mitigate severe cascading failures**
  - **Voltage Instability Load Shedding**
  - **Online risk monitoring of potential cascading outages**





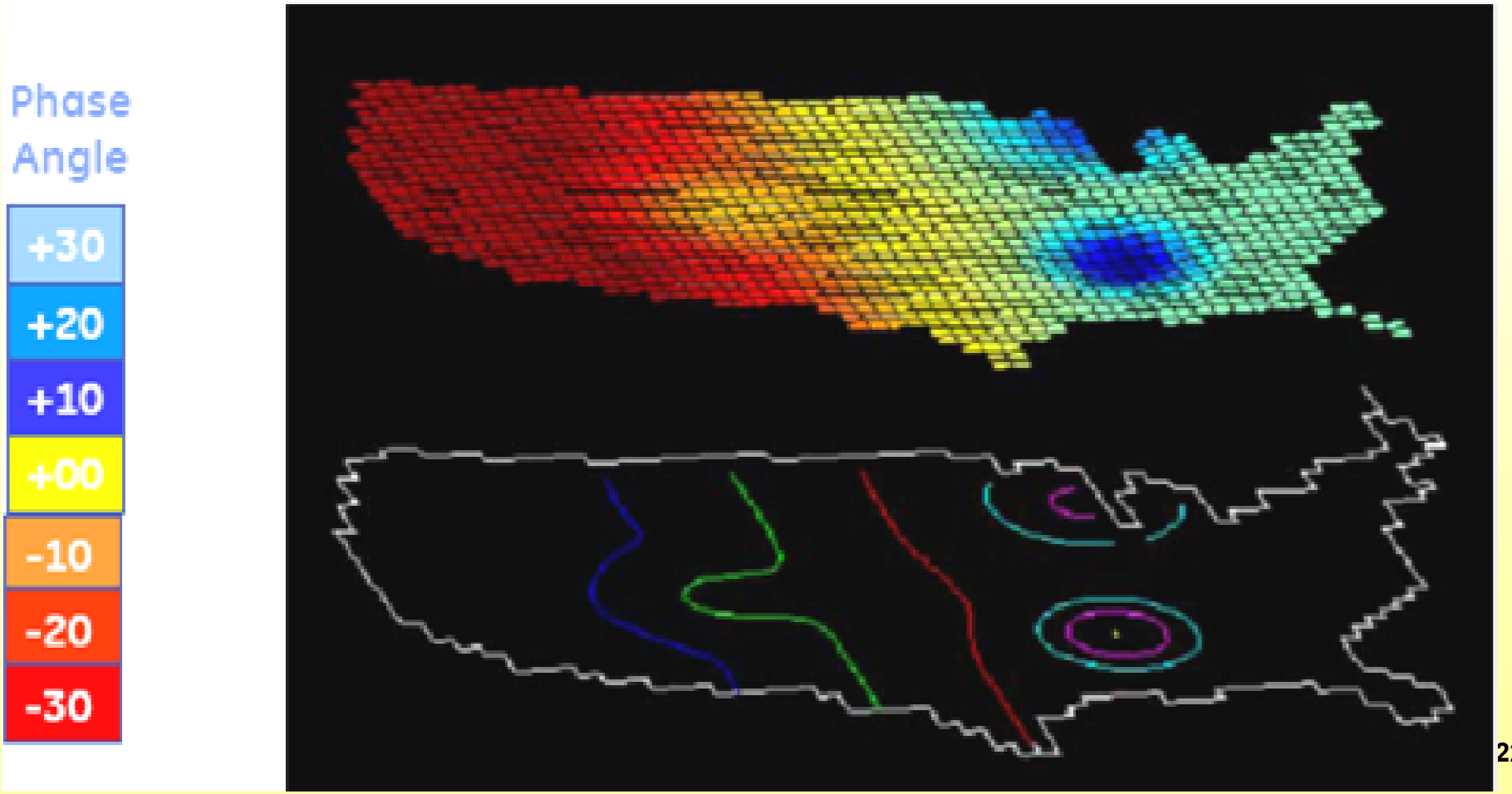
PM Applications

1- On-Line Applications - WAMS (Currently used)

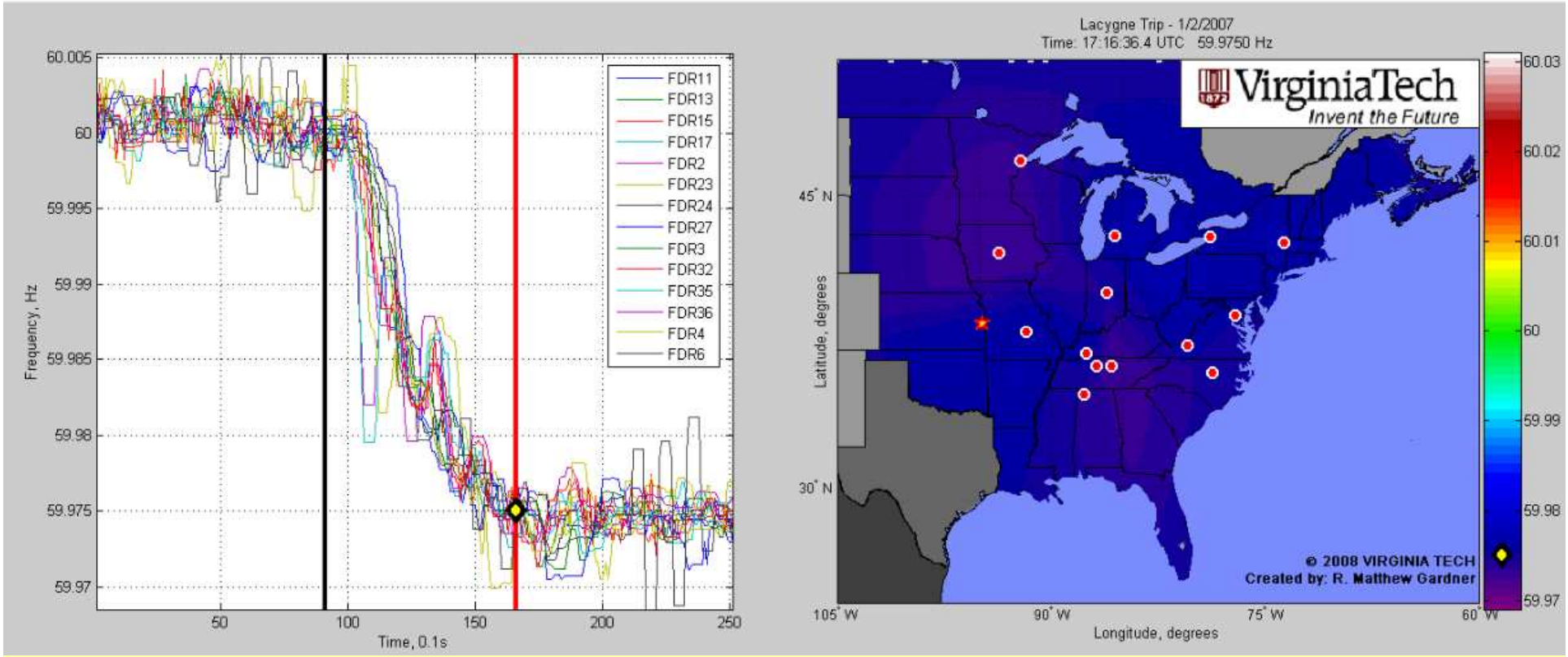
- Data Visualization
- Dynamic Power Flow
- Phase Difference
- Real Time Frequency
- Frequency Rate of Change (df/dt)
- State Estimation
- System Stability Monitoring

PM Applications (cont.)

Data Visualization – Operator Awareness



PM Applications (cont.)



PM Application (cont.)

2- Off-Line Applications (Currently used)

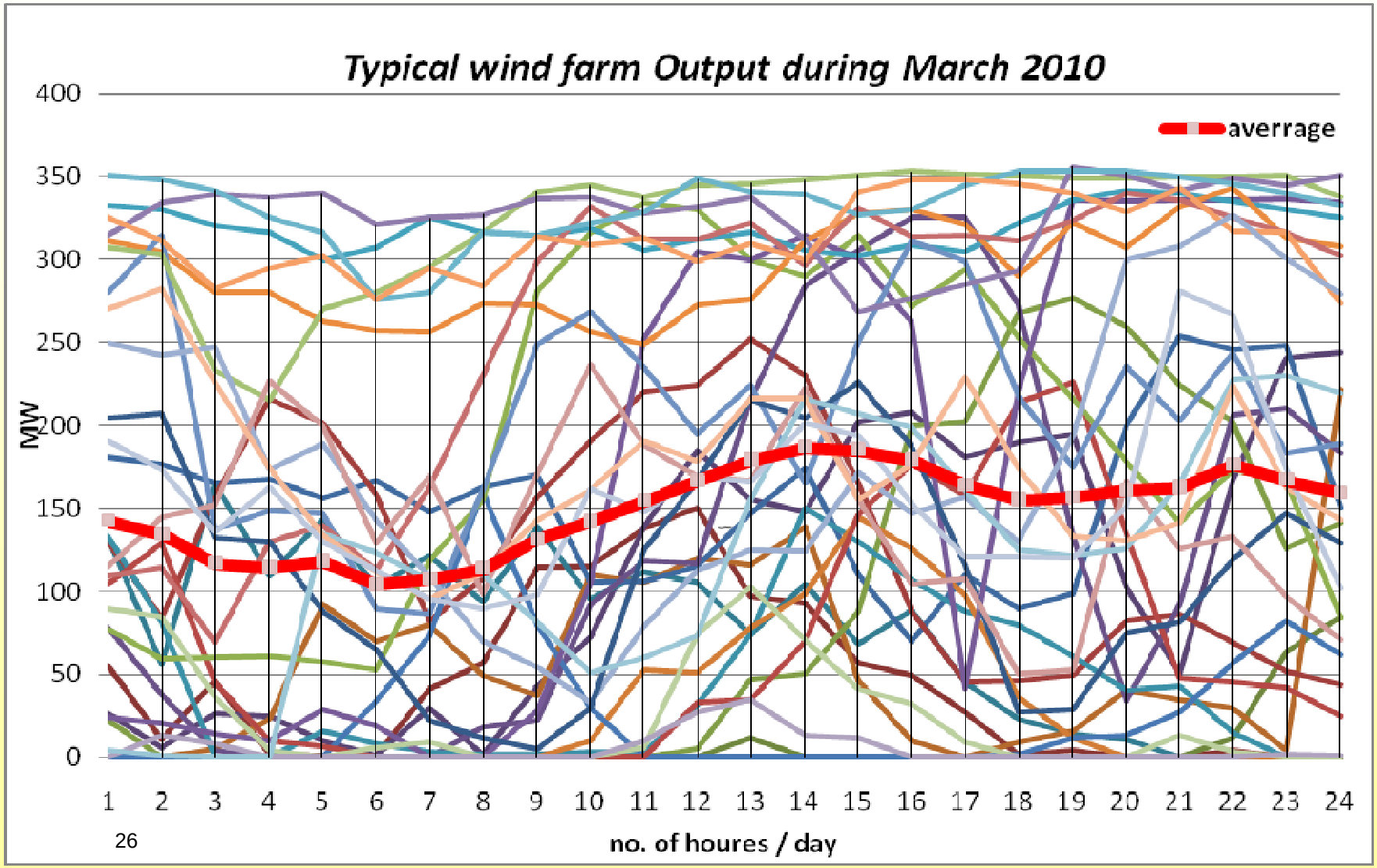
- Post-mortem analysis
- Performance analysis
- Modal Validation
- Fault Location
- System planning
- Studies of Power swing
- Oscillation monitoring and damping studies
- Supporting new schemes for WA PAC

PM Application (cont.)

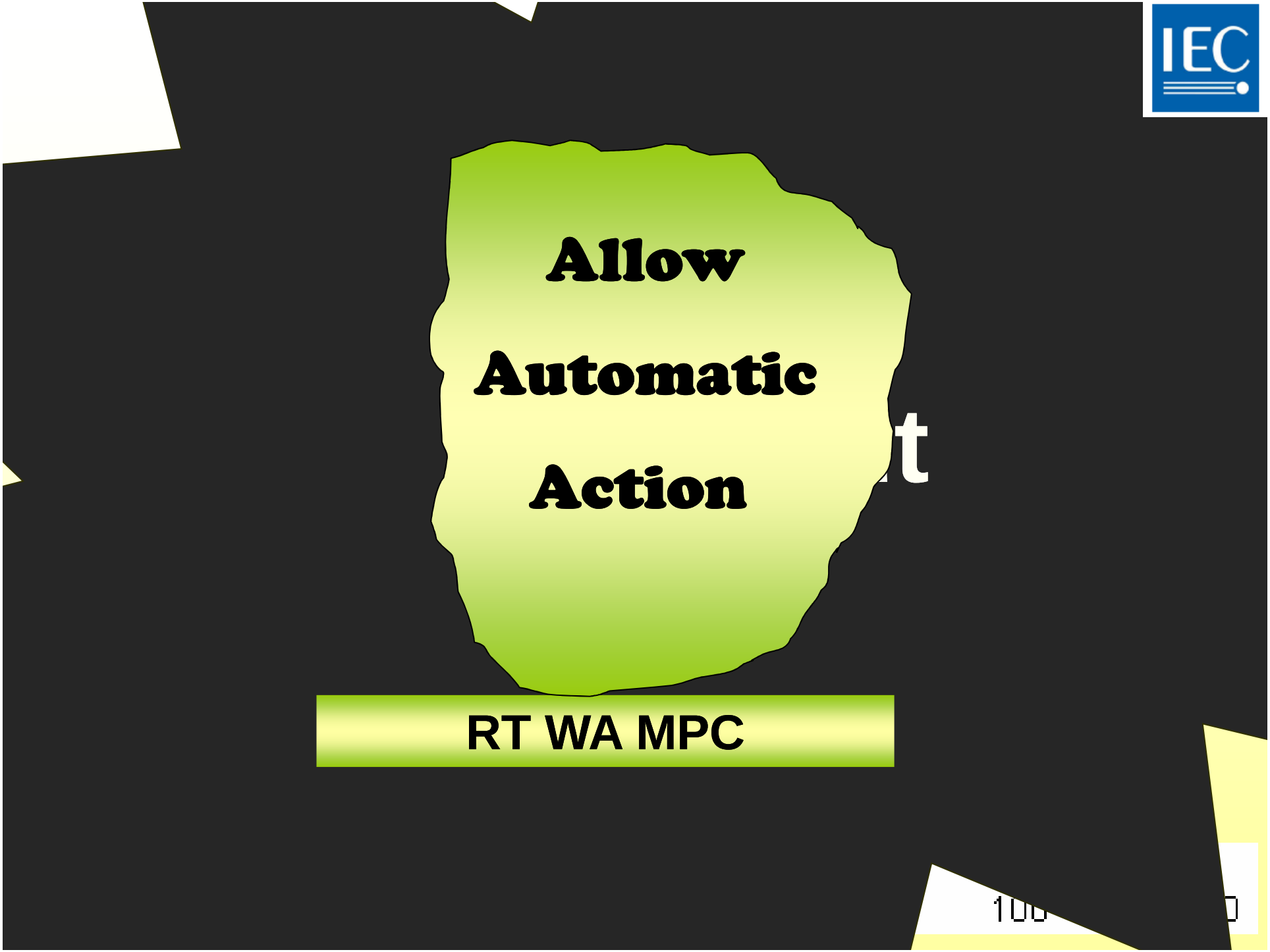
3- Closed Loop Control WACS+WAPS (Under R&D)

- Studies for control and protection strategies, such as
  - Speed regulation
  - Voltage regulation
  - SVC Control
  - HVDC, FACTS control
- For the purpose of:
  - Damping of Oscillation
  - Improving stability
  - AVR
  - Detection and prevention of voltage collapse
  - Out-of-Step Blocking/Tripping
  - Adaptive Relaying

Wind Intermittency



Rotating Phasors Can Change Suddenly


Allow
Automatic
Action
RT WA MPC

Existing….

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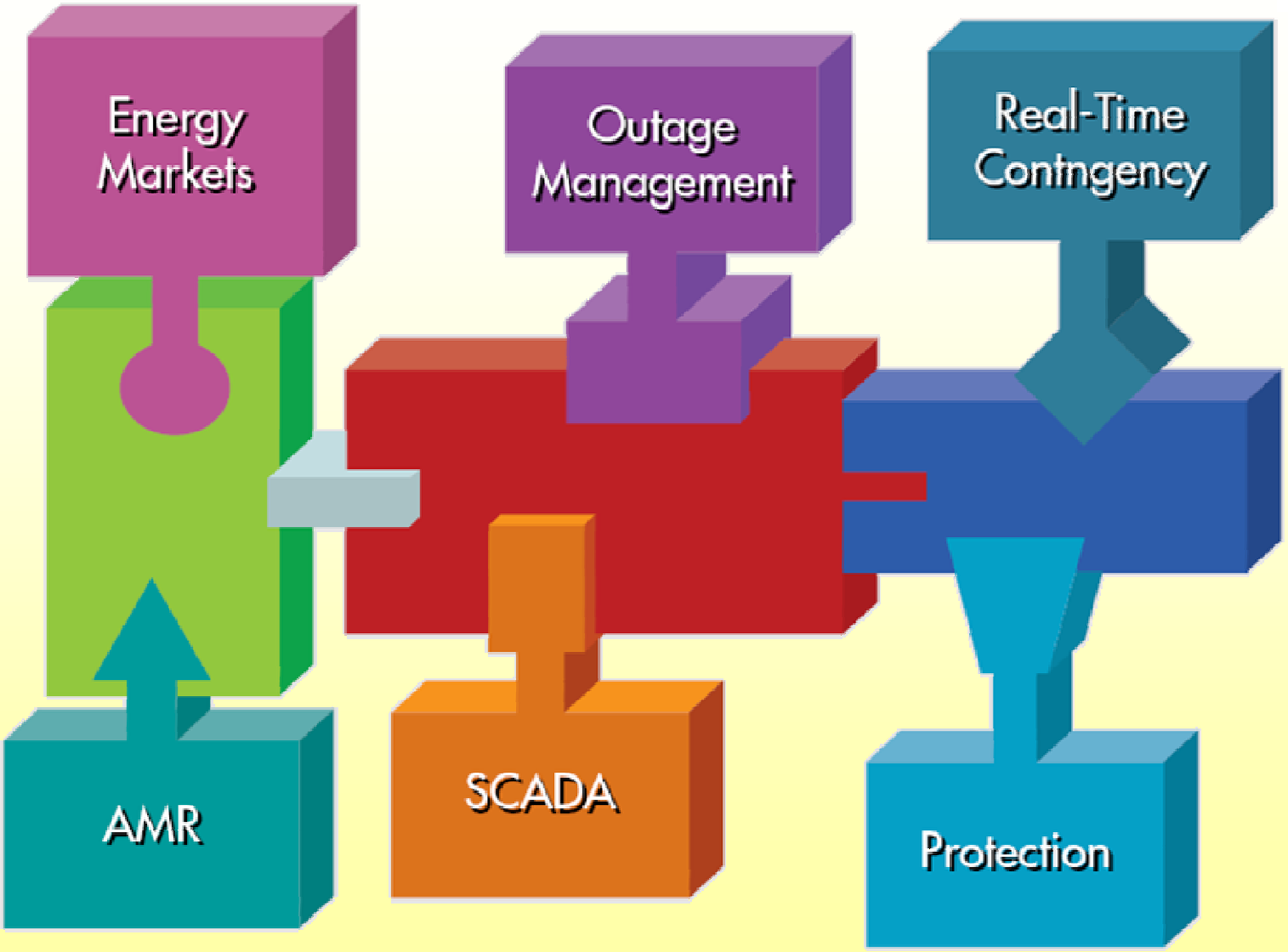
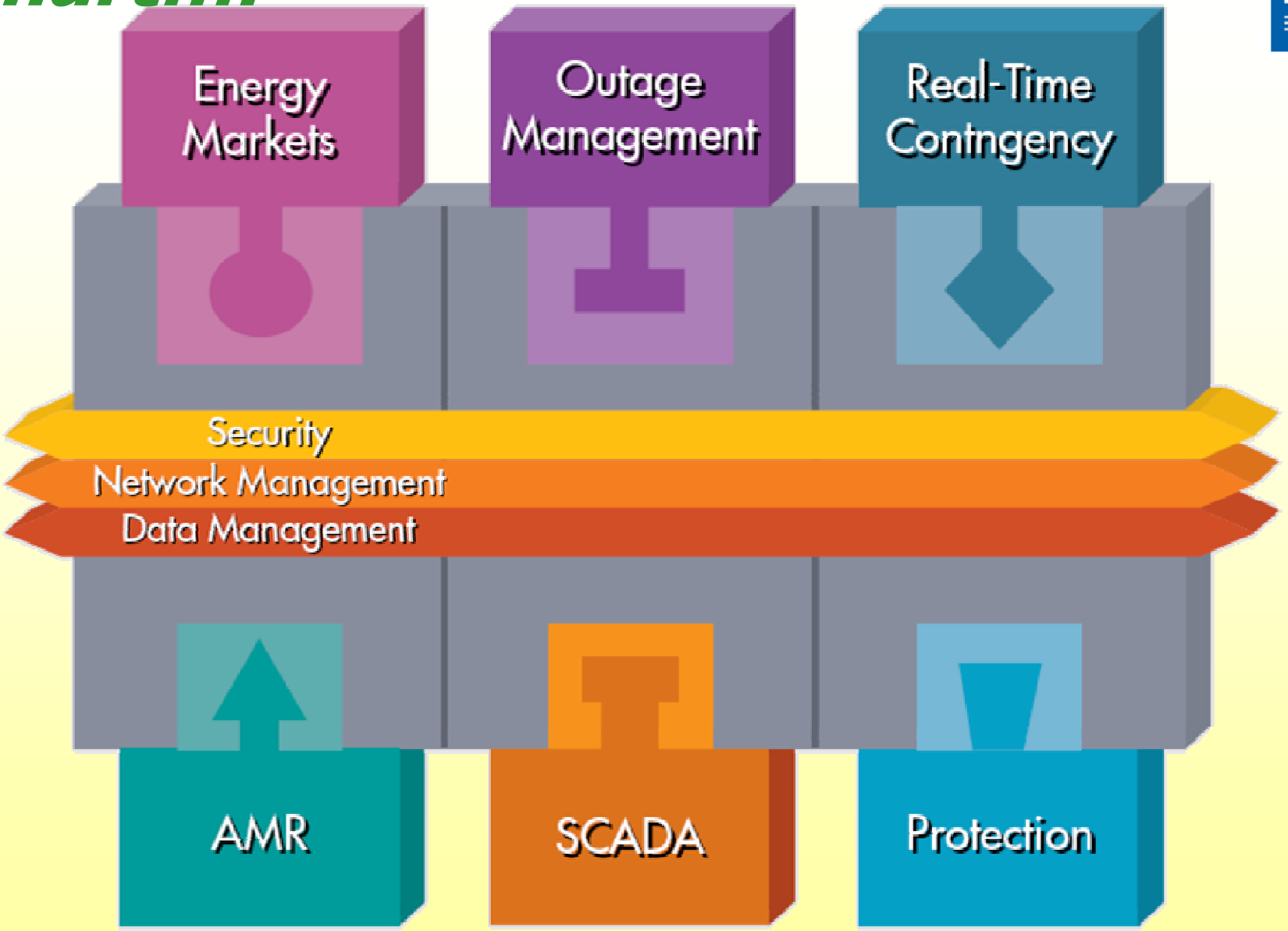


have difficulty "speaking" to each other.

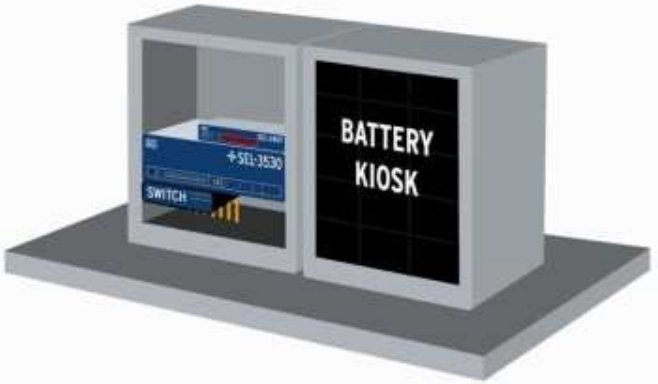
Smart....

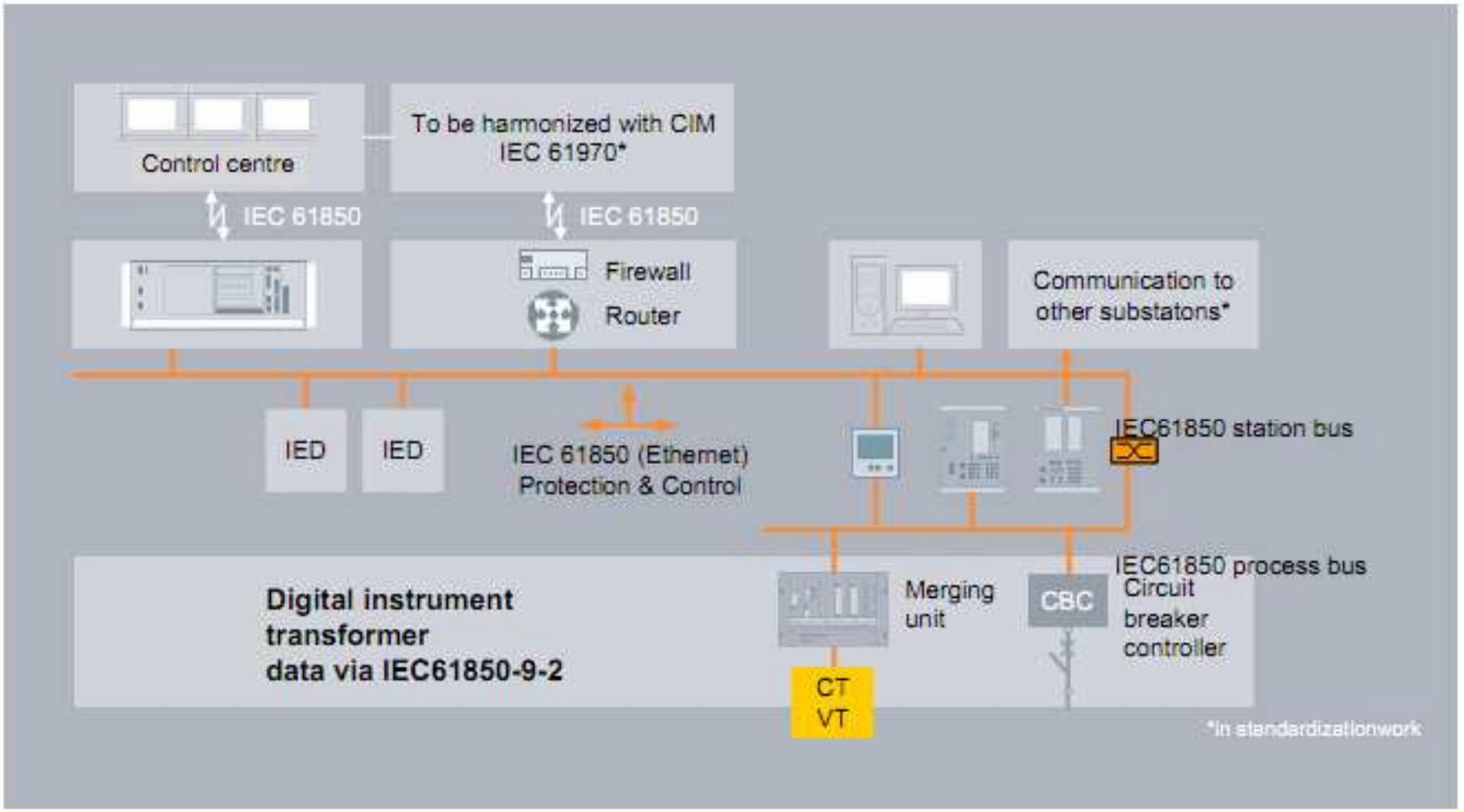


Interoperability using IEC 61850

Ex. Yard Wiring Reduction .....Yields Benefits

Replace Copper With Fiber, Monitor Health of Signal, Reduce Footprint / Cost



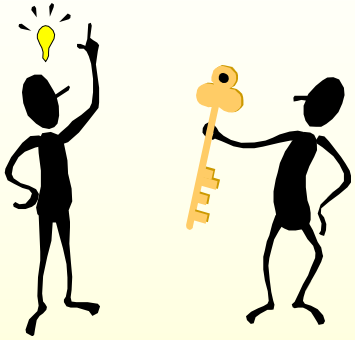


Smart Substation Automation – Process bus

- 5 -
Condition-based Maintenance?

3. New Concept……

“If it doesn't tell you, don’t fix it”



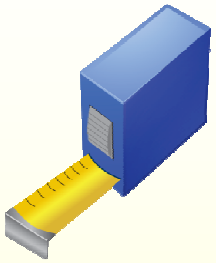
Different Monitoring and Analysis tools inside the DMS can predict the need for maintenance

and after detailed analysis, help to "correct" the faulty part

Maintenance is not scheduled, it is done when Monitoring says “it is needed”

Through Fault Damage

Smart Grid: Observe, Decide, Act



Measure

Calculate

Protect

Time Stamp

Locate

Isolate

Communicate

Educate

Analyze

Control

Restore

Diagnose

Report

Qualifications to Jump…..

- **Capacity Building should be conducted by *expertise* to the utility personnel in order to be capable making this *JUMP* to the new fast coming future……..**


dalalhelmi@hotmail.com