

# Information Exchange Between Transmission and Distribution Domains

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# Smart Distribution Grid from the Standpoint of Transmission Operations

- High penetration of new technologies in the customer and distribution domains present significant operational challenges and additional opportunities for transmission operations
- DER-ES-Microgrids, Demand Response, Electric transportation, real-time-pricing, weather, and voltage/frequency sensitivities make the distribution grid a much more dynamic and active component of the entire power system.
- The comprehensiveness of the information exchange between distribution and transmission domains must be measured by the adequacy to the challenges of the Smart Grid.

**EMS APPLICATIONS THAT NEED TO INTEGRATE VARIABLES  
OF THE SMART DISTRIBUTION GRID (ACTIVE  
DISTRIBUTION NETWORK)**

# For Emergency Operating Conditions (WAMCS applications)

- Steady-state and dynamic contingency analyses (ADN variables, DER, Micro-grid, and DR behavior, DA reactions)
  - CA needs to know the reaction of ADN to changes of voltage, frequency, LMP in emergencies)
- Near Real-time Pre-arming of RAS (ADN RAS and Apps)
- Remedial Actions (Reliability DR, load curtailment, emergency volt reduction, ...)
- Restorative Actions (Loads, DER/ES, DR, IVVWO)
- .....

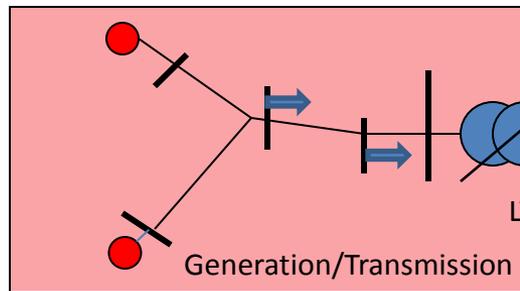
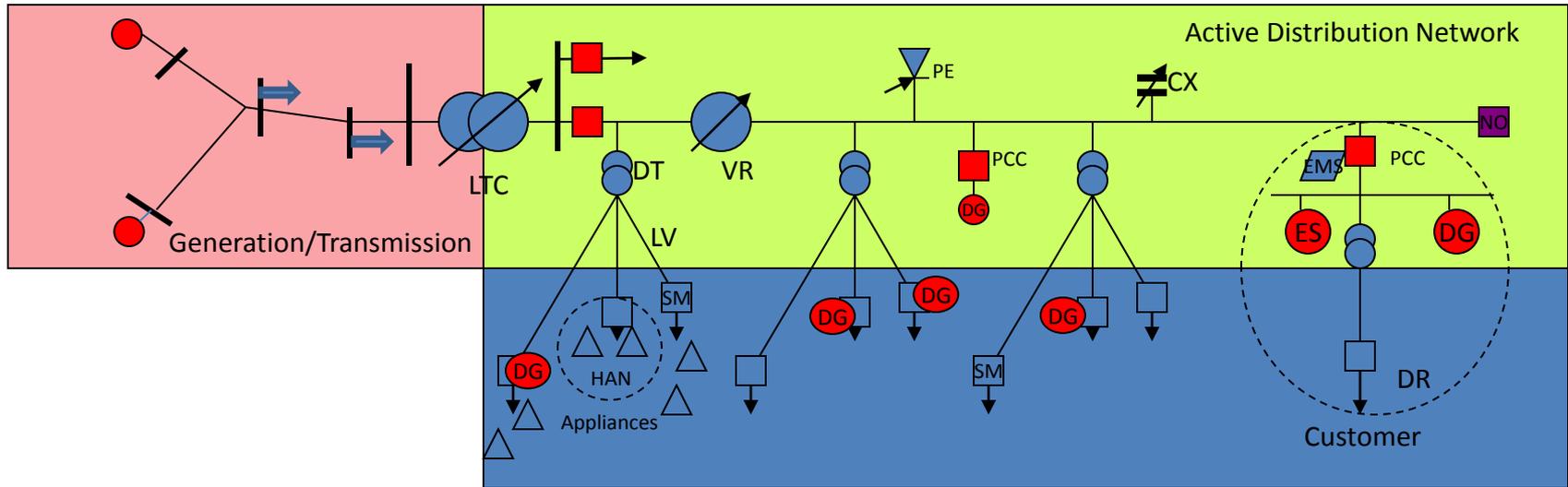
# For normal operating conditions

- Wide Area Situational Awareness (WASA)
  - Model Updates (ADN model)
  - State Estimation (angles for MFR)
  - Network Sensitivity Analysis (including ADN model)
  - COMFEDE
- Optimal Power Flow (variables in ADN, volt/var support, congestion management support...)
- Economic Dispatch/Unit Commitments (DER/ES)
- Reserve Monitoring (DER/ES, DR, IVVWO)
- Other

# How to Exchange Information between T&D to Coordinate with Multiple DERs?

- It is unrealistic to expect that the monitoring and control of transmission operations will reach out to every device and every function in the distribution and customer domains.
- The T/D buses of the near-real time model of transmission operations are the demarcation points between transmission and distribution domains.

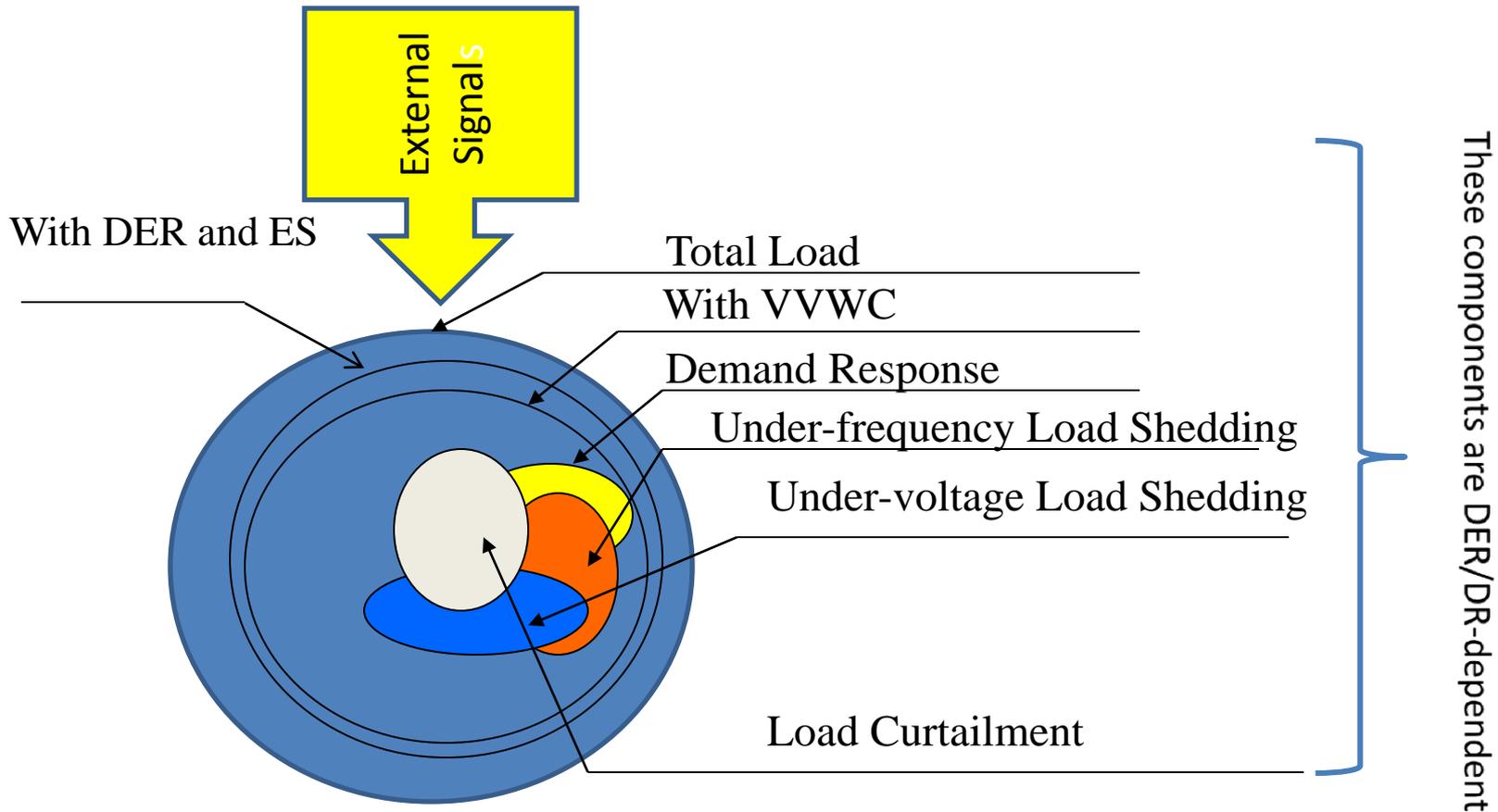
# Transmission Bus Load Model (TBLM)



TBLM/VP  
P

It is suggested  
aggregating the  
capabilities and the dynamics  
of distribution operations into  
TBLM

# Aggregated Bus Load Model is a Component of TBLM

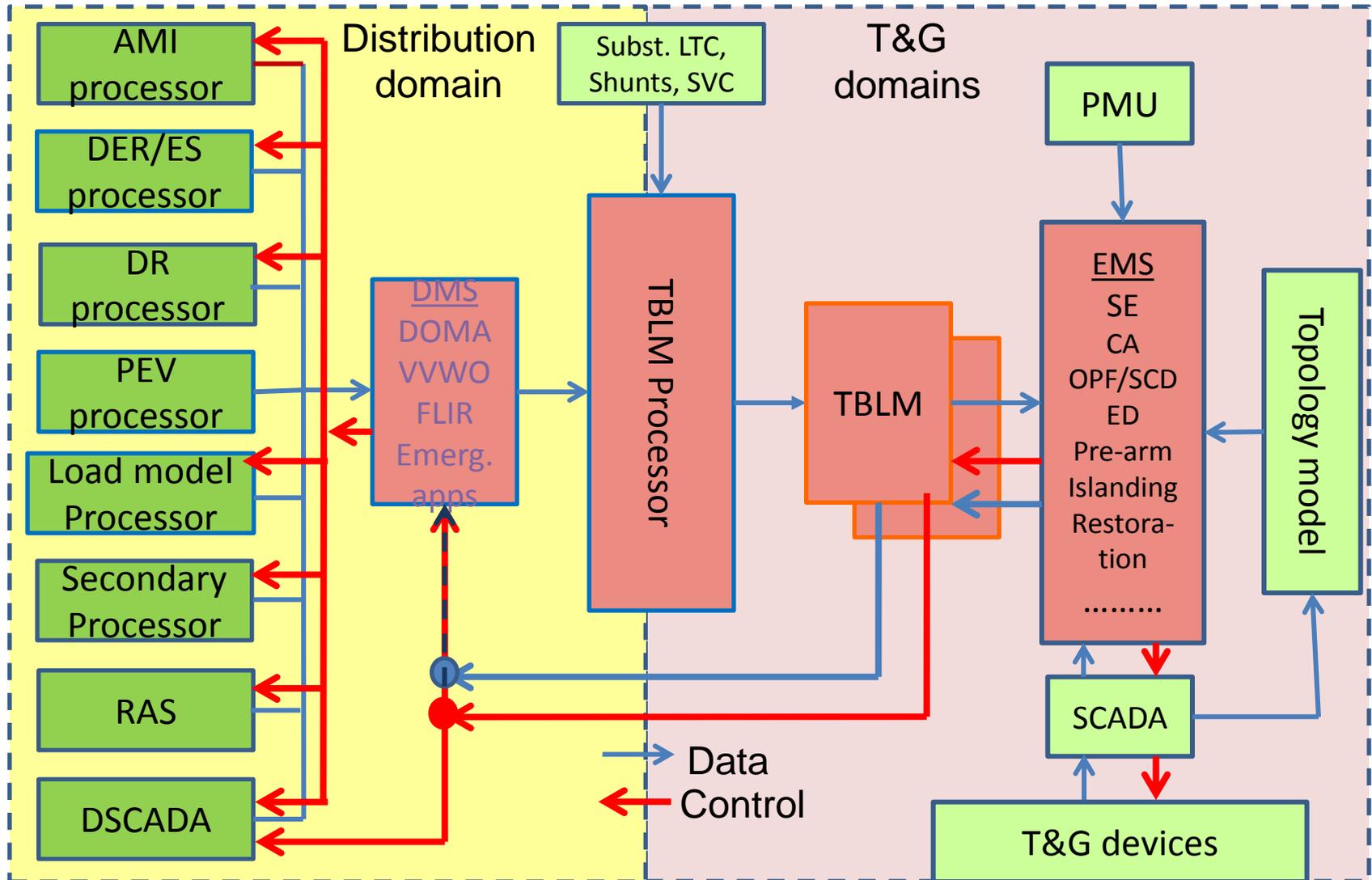


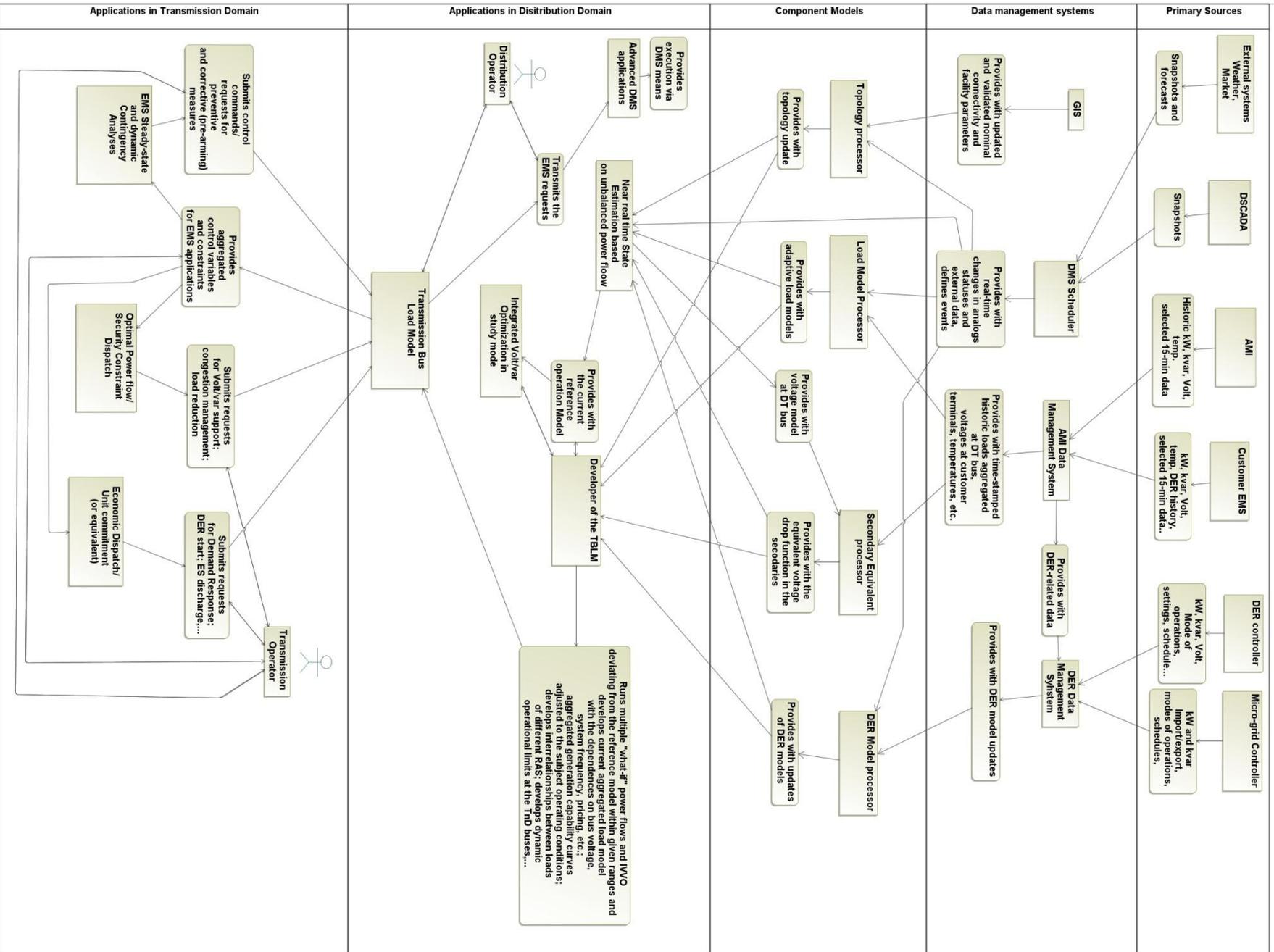
- This information should be generated by DMS and should be made available to EMS

# Other Components of TBLM

- VPP technical and economic functions and attributes
- Aggregated capability curves
- Aggregated real and reactive load-to-voltage dependencies
- Aggregated real and reactive load-to-frequency dependencies
- Aggregated real and reactive load dependencies on
  - Demand response control signals,
  - Dynamic prices,
  - Weather, etc.
- Aggregated dispatchable load
- Model forecast
- Overlaps of different load management functions, which use the same load under different conditions.
- Degree of uncertainty.....

# Information Exchange between T&D Domains



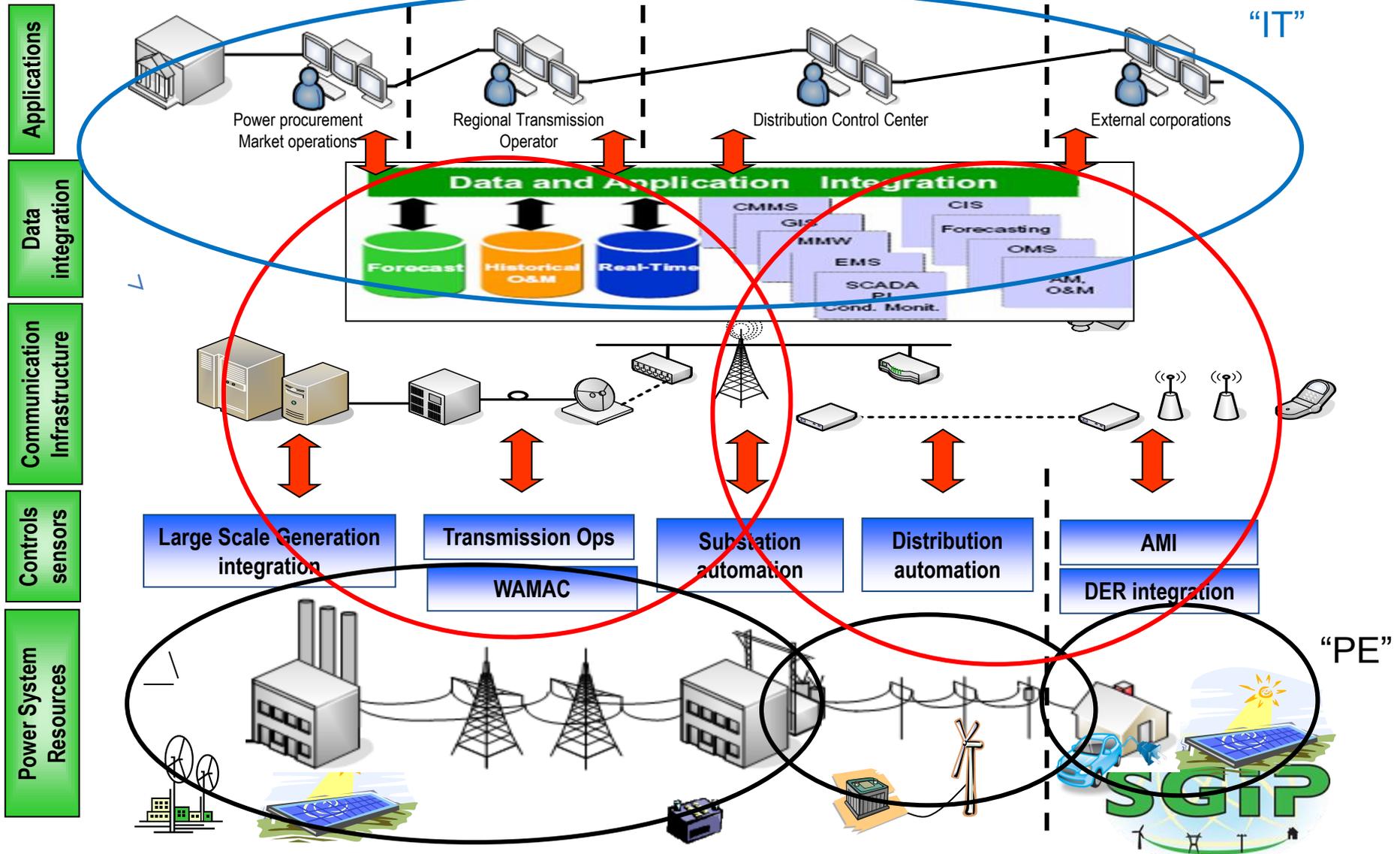


Draft High-level Activity Diagram of the TBLM Use case

# Standards involved in the support of TBLM

- IEC 61850-x
- IEC 61970
- IEC 61968
- ICCP/TASE 2
- Multispeak
- COMFEDE: IEEE P37.239
- DNP3
- .....

# Integration Across "Smart Grid"



# Acronyms

ADA	Advanced Distribution automating
ADN	Active Distribution Network
CA	Contingency Analysis (implies in transmission)
CEMS	Customer Energy Management System
DA	Distribution automating
DCA	Distribution Contingency Analysis
DER	Distributed Energy Resource
DMS	Distribution Management System
DOMA	Distribution Operation Model and Analysis
DR	Demand Response
DSA	Dynamic Security Analysis
DSCADA	Distribution SCADA

# Acronyms

ED	Economic Dispatch
EMS	Energy Management System
ES	Electric Storage
FLIR	Fault Location, Isolation, and Service Restoration
IVVC	Integrated Voltage and Var control
IVVO	Integrated Voltage and Var Optimization
IVVWC	Integrated Voltage, Var, and Watt Control
IVVWO	Integrated Voltage, Var, and Watt Optimization
LMP	Locational Marginal Price
OPF	Optima power flow
PEV	Plug-in Electric Vehicles

# Acronyms

PHEV	Plug-in Hybrid Electric Vehicles
PMU	Phasor Measurement Unit
PV	Photovoltaic
RAS	Remedial Action Scheme
RTP	Real-time Pricing
SCADA	Supervisory Control and Data Acquisition
SCD	Security Constrained Dispatch
SE	State Estimation
TBLM	Transmission Bus Load Model
UC	Unit Commitment
VVC	Voltage and Var Control
WAMCS	Wide Area Measurement and Control System
WASA	Wide Area Situational Awareness