System Modeling: Distribution Automation & Management System

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1. Role of DA/DMS in Smart Grid

Old Grid

- You call when the power goes out.
- Utility pays whatever it takes to meet peak demand.
- Difficult to manage high Wind and Solar penetration.
- Cannot manage distributed generation safely.
- ~10% power loss in T&D

Smart Grid

- Utility knows power is out and usually restores it automatically.
- Utility suppresses demand at peak. Lowers cost. Reduces CAPEX.
- No problem with higher wind and solar penetration.
- Can manage distributed generation safely.
- Power Loss reduced by 2+%... lowers emissions & customer bills.
2. Overview Distribution System

Service Territories *(System, Zones, Substations)*

- Zone A
- Zone B
- Zone C
- Substation W
- Substation Y
- Substation Z
3. A Typical Distribution Substation and Feeder

138kV

40 MVA 138/12.47

Substation

12.47kV 9 MVA

1 MVA 12.47kV / 4.16kV / 2.4kV

1 MVA 12.47kV / 480V

12kV/240-120V Secondary Dist.

Single Phase lateral
Distribution Substation

Transmission System

Src Bus-1

Xfmr-1

Substation

Src Bus-2

Xfmr-2

Distribution System

Fd-1

Distribution Substation

Fd-k
Feeder Circuits

Fd a  Fd b

M1  Br1  Br2  M2

M3  Br3  L1

Br4  M4  L2

Br5  C2  C1

L4  L5

Br2  Br1

Fd 4x  Fd y

L6  TS1
4. Hierarchy of Distribution System Model

Communication to Control Center

System (Company) → Zone → Substation → Feeder/Bay

Branch → Node

Connectivity

Line, Xfmr, V-Reg, Switch, Cap, Load, DG

Measurement, Monitoring, Control, Protection

IEDS/Devices
5. DA/DMS Hardware Architecture

- **DMS Master**
- **Historical Server**
- **Communication Servers**
- **Substation Unit (RTU)**
- **Fiber LAN to substations**
- **NTU: Poll / Report by exception (2 sec)**
- **Pole Top and Pad Mounts (underground)**
- **Feeder Terminal Units (FTU)**

**100 Mbit**
6. Layout of a DMS System Control Center

**Diagram Details:**
- **DMS Prime** and **DMS Backup**
- **Historical Server Prime** and **Backup**
- Development
- Optical JB
- Communications Servers
- Front End Processors
- Multiple Channels to Multiple RTUs
- OMS System
- Trouble Call Client
- RAID
- Enterprise LAN
- Hub
- Ethernet TCP/IP
- Dispatcher #1
- Dispatcher #2
- Maintenance Center
- Engineer Application
- Training
- Plotter
- Scanner
- Multiple DCUs
- AMI Servers
- CTU
- ICPS
- HDCS
- Fiber Optic
- Adjacent Building
Backup