Recent Trends in Substation Automation and Enterprise Data Management

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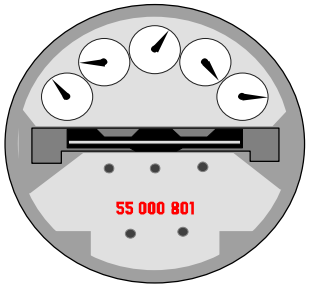
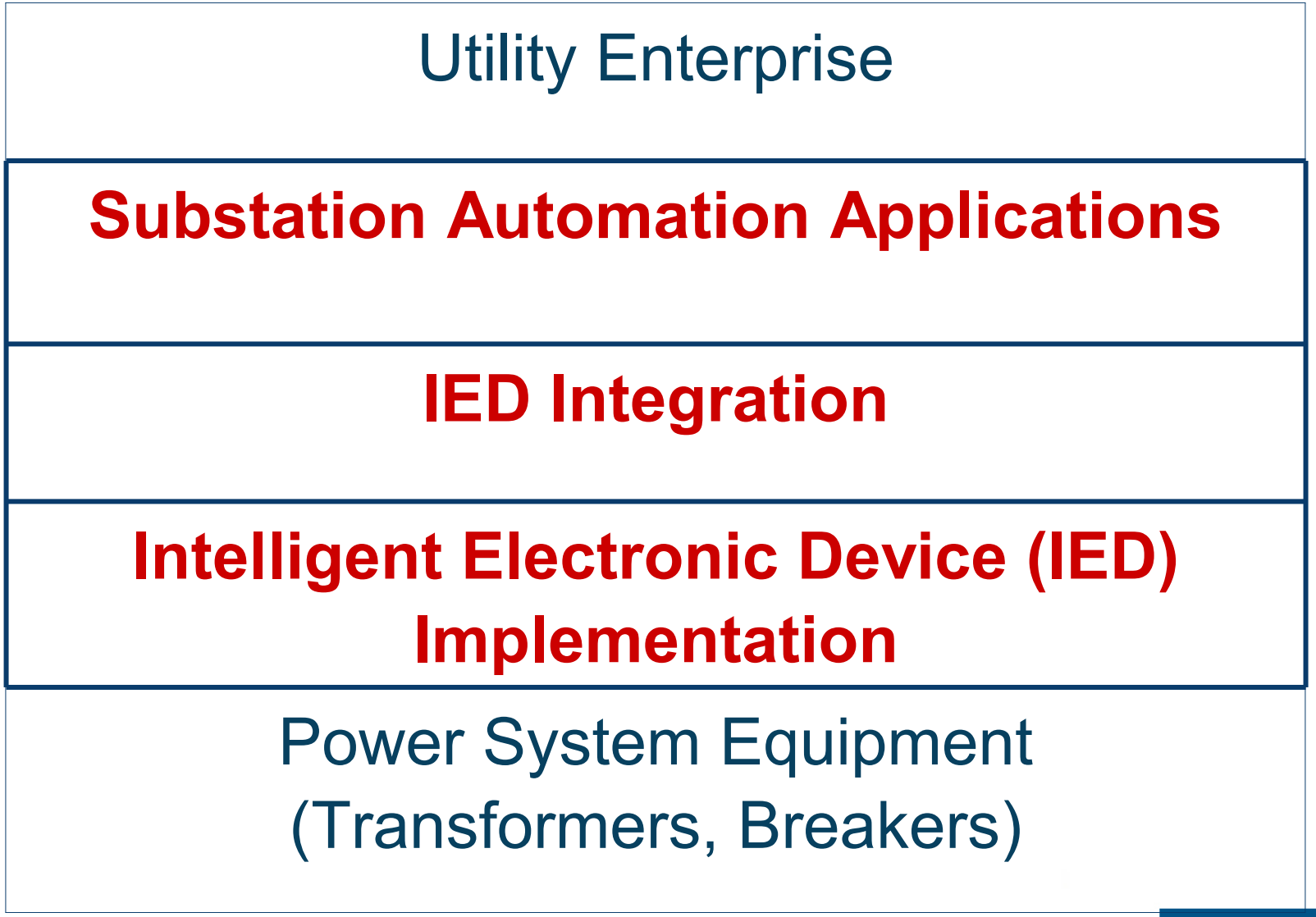
Intelligent Electronic Device (IED)

- **Any device incorporating one or more processors with the capability to receive or sen data/control from or to an external source (e.g., electronic multifunction meters, digital relays, controllers)**



Substation Integration and Automation Levels



Communication Paths From Substatic

- Two second data to SCADA system (operational dat – extracted using industry standard protocol such as DNP3)
- On demand data to utility information server or data warehouse (non-operational data – extracted using IED vendor's proprietary ASCII commands)
- Remote access from remote site to isolate a particular IED (also called "pass through" or "loop through")

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Communication Paths From Substation (continued)

Utility Enterprise Connection		
SCADA Data to MCC	Historical Data to Data Warehouse	Remote Dial-In to IED
Substation Automation Applications		
IED Integration Via Data Concentrator/Substation Host Processor		
IED Implementation		
Power System Equipment (Transformers, Breakers)		

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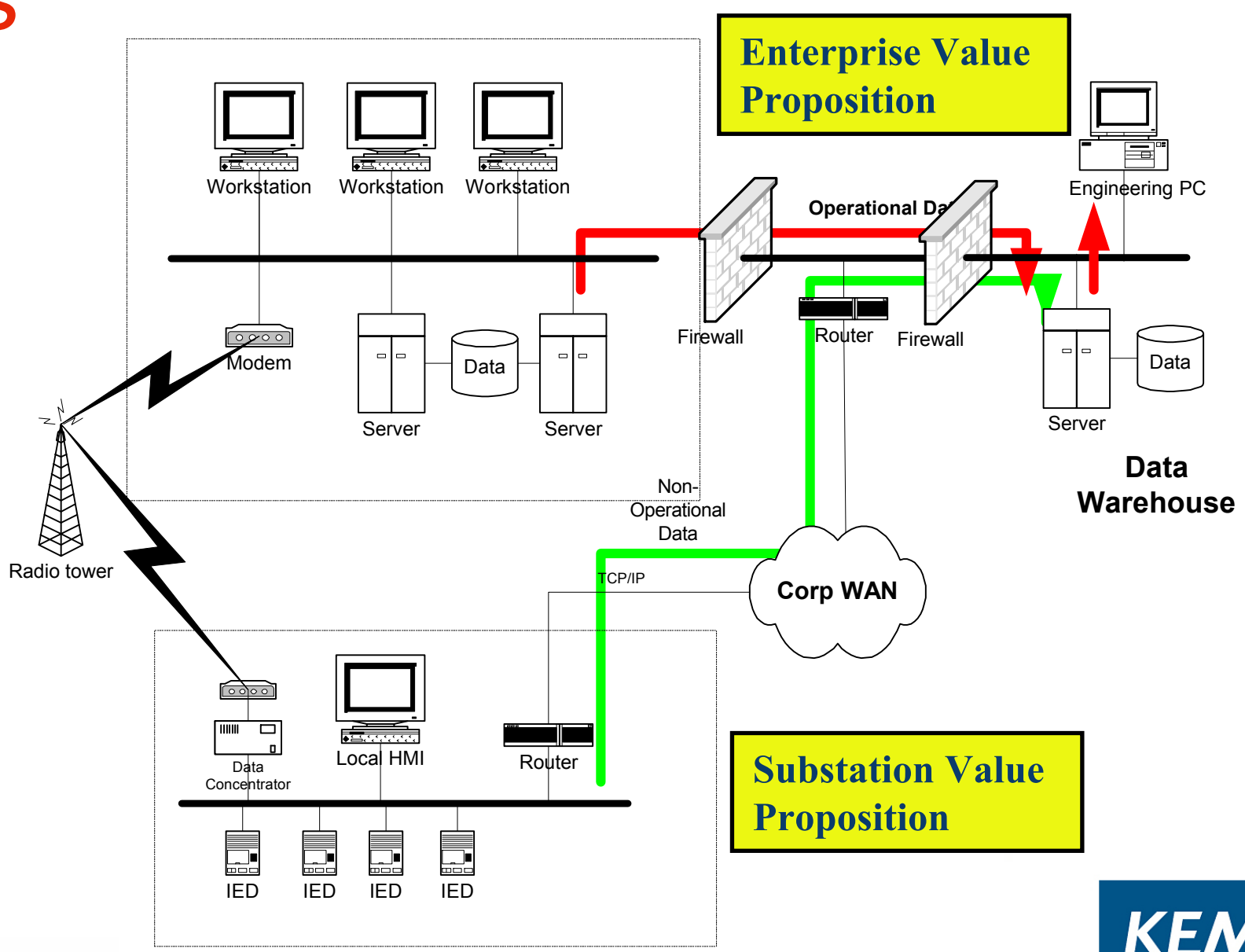
Operational and Non-Operational Data Paths



Local vs. Enterprise Data Marts

- Local historian at substation level is a component o the Substation Automation System (e.g., PC with local substation HMI and historical data archiving) and is designed for Data Mart integration
  - Ability to push data From substation to enterprise Data Mart based on time, demand or event triggered
  - Enterprise Data Mart can pull data from local Dat Mart in substation

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The Virtual Enterprise Data Mart

- Integrates Data from Many Sources
- Manages Consistency and Owner of Record
- Supports Applications That Need to Reference Many Different Data Types
  - Alarm Files
  - Historical Loadings, Voltages, etc
  - Maintenance Records
  - Design Information
  - Fault Targets and IED ASCII Files
  - Waveform Data
  - GIS and Asset Data
  - Overhead Imagery and IR Imagery

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Background

- State of the Industry…setting the table
  - 90%+ utilities implementing IEDs
  - Extracting only 15% of the benefits
  - Few Have ELSI Architecture and IT Infrastructure in Place
    - Substation, Communications, Data Mart
  - 85% remaining to be tapped – condition, performance, etc. - key indicators that drive the decisions that business users make everyday!
  - More and more utilities are starting to look at the problem
  - Enterprise data management today is where EMS was in 1975
    - Early Adoptors showing the way

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Typical Current State and Implications

- Moderate penetration of IEDs and uneven adoption of existing enterprise data management standards
  - No Focused Plan for IED Penetration
- *Continuous* condition monitoring not being done today; nor is easy retrieval of equipment historical loadings, etc.
- Asset Management not supported by statistical data
- Fault Location not Automatically Integrated with Outage Management
- Lack of distance to fault information
- Many Maintenance / Operations procedures designed around EM relays and lack of continuous condition monitoring.
- Makes statistical analysis and project portfolio optimization difficult

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Develop Design Characteristics for Standard Sub Auto Configuration

- Handling of three data paths:
  - Operational data
  - Non-operational data
  - Remote access (administrative data)
- IED interfaces and protocols (op, non-op, and admin data)
- Local user interface
- Cyber security
- Local data processing capabilities (per-processing and sequence control logic)
- Handling of hardwired data items
- Time synchronization

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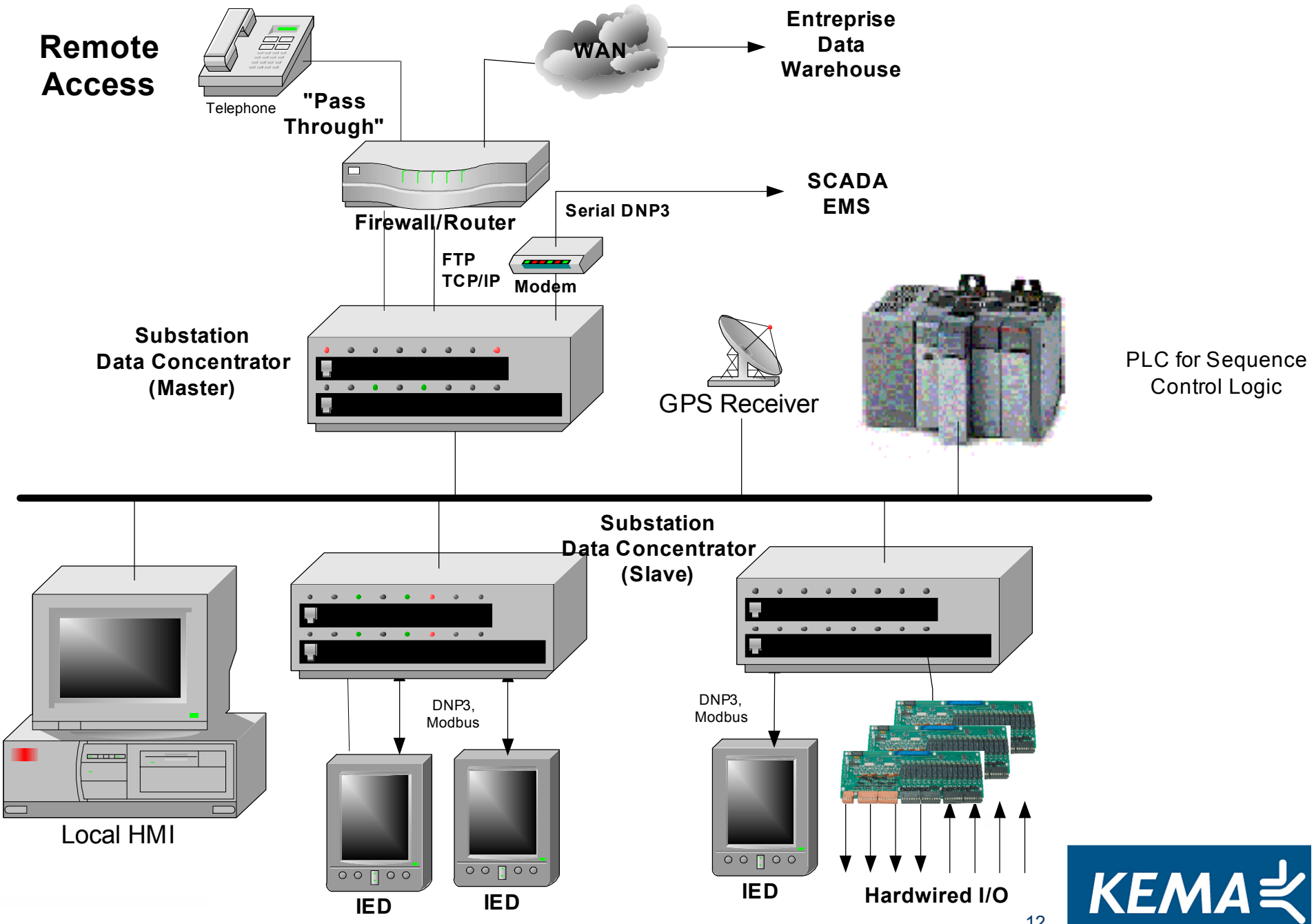
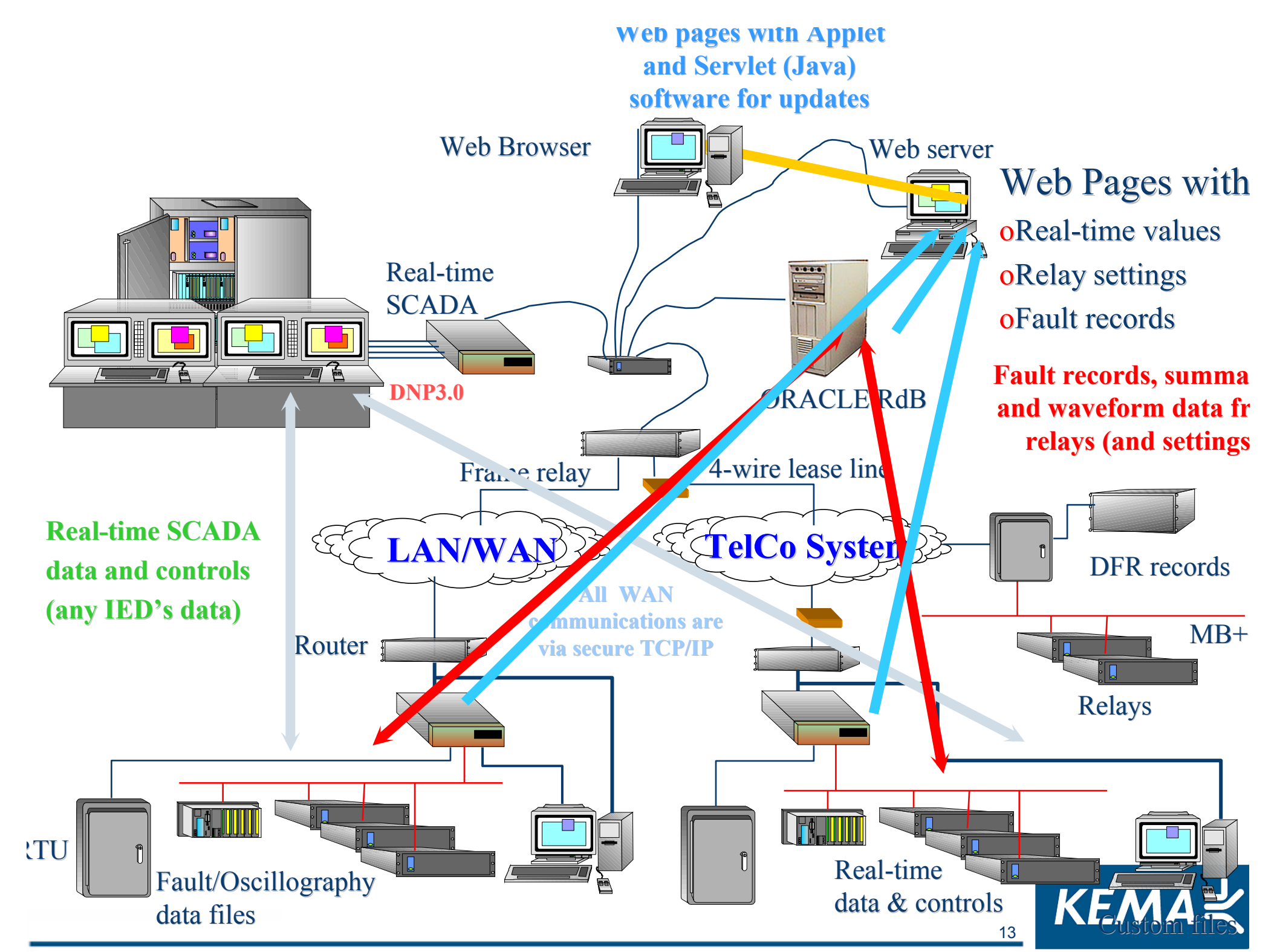
Representative SA Architecture




Web pages with Applet
and Servlet (Java)
software for updates
Web Browser
Web server
Web Pages with
oReal-time values
oRelay settings
oFault records
Real-time
SCADA
DNP3.0
ORACLE RdB
Fault records, summa
and waveform data fr
relays (and settings
Frame relay
4-wire lease line
Real-time SCADA
data and controls
(any IED's data)
LAN/WAN
TelCo Syster
All WAN
communications are
via secure TCP/IP
DFR records
MB+
Router
Relays
RTU
Fault/Oscillography
data files
Real-time
data & controls
Custom files
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New Versus Existing Substations

- New Substations
  - IEDs With Digital Communications
  - PLCs for Direct I/O
  - No Conventional RTUs
- Existing Substations
  - May Integrate IEDs With Existing RTUs (Not Support Non-Operational and Remote Access Data Paths)
  - Integrate Existing RTU as IED or Eliminate Existing RTU and Use IEDs and PLCs for RTU I/

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Protocol Fundamentals

- Communication Protocol
  - Allows Two Devices to Talk to Each Other
  - Each Device Must Have the Same Protocol Implemented, and the Same Version of the Protocol
- Both Devices From Same Supplier, and Protocol
- Both Devices From Same Supplier, with Industry Standard Protocol
- Devices From Different Suppliers, with Industry Standard Protocol

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IEC 61850

- International standard for communications in substations
- Ability for utility to implement depends on:
  - Which IEDs the utility uses
  - Which IED suppliers have incorporated IEC 61850 into their products
  - Commercial implementation that is field proven by suppliers
- Industry interest level different globally
  - Little interest to date in North America
  - Much more interest in Europe with utilities and suppliers

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IEC 61850 (continued)

- Risk averse North American customers
  - Need for education on IEC 61850 (preferably by neutral, unbiased instructor)
  - Customers will not buy if they do not understand
  - Requires Ethernet LANs; there are still a lot of serial communications with IEDs in substations
  - Implement without using Ethernet LANs for protection messaging?
  - Implement without using process bus?

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What Makes a Smart Grid “Smart”?

- Smart Grid is a vision for the electric delivery system of the future: Utilities, and consumers will accrue returns through the convergence of power delivery and information technologies to achieve improved reliability, reduced O&M costs, avoidance of new capacity, and increased customer satisfaction.
- Such an evolution requires a resistance to the lure of easier short-term solutions made with a “silo” mentality – one without regards to the needs of other parts of the grid and utility operations.

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Translated into Requirements

- More visibility to the distribution system
  - IEDs, AMI meters, “inexpensive” PMUs
  - State estimators
- More local intelligence control of the system
  - Communications infrastructure (e.g., PTP)
  - Ability to communicate/interoperate devices
- PHEVs; interface with Home Area Networks (HAN)
- Condition-based maintenance
- DGs, storage & renewable forming micro-grids
- DR, direct load control and DSM programs

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Translated into Requirements (cont'd)

- More hardened system against storms/disasters
  - UG, composite materials poles,
  - Shorter response capabilities (e.g., MDTs)
- System designed, operated and protected for bidirectional power flow
- Differentiated reliability standards for different "grids"
- PQ concerns

Enabling Technologies Make These Applications Possible

- Advanced sensors
- Communications infrastructure
- Enterprise IT system
- Holistic approach in corporate culture

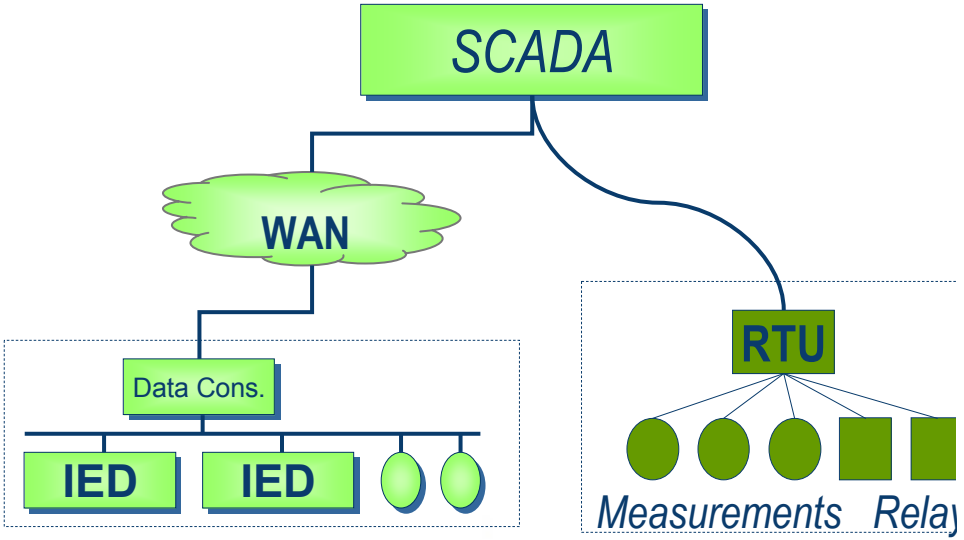
Smart Devices:

Intelligent Electronic Devices (IEDs)

Replacing Traditional Relays
Multi-Function Devices
Many Data Elements
- Measurement and Controls
- Condition Monitoring
- Analog and Digital Values
- Oscillographic Data

Electromechanical Relays vs. IED

- ***Network Devices***
- ***Standardized Interfaces and Protocols***



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Smart Devices:

Advanced Meter as a Sensor and a Control Device

On-board Communications

Interval Reading

Technology Capabilities:

- Remote Connect / Disconnect
- Demand Side Management
- Configurability and Programmability
- Serviceability / Diagnostics
- Power Quality
- Memory
- Reliability
- Interoperability
- Display
- Security
- Tamper / Theft Detection

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Smart Metering for Secondary Networks

- Pressure to know the status on faults in secondary networks in urban areas
- Not necessarily meter solution, but metering and data mining solutions
- Ingenious metering methodology using regular CTs
  - Know where the faults are without metering every cable
  - Mine data from other sources (e.g., AMI meters)

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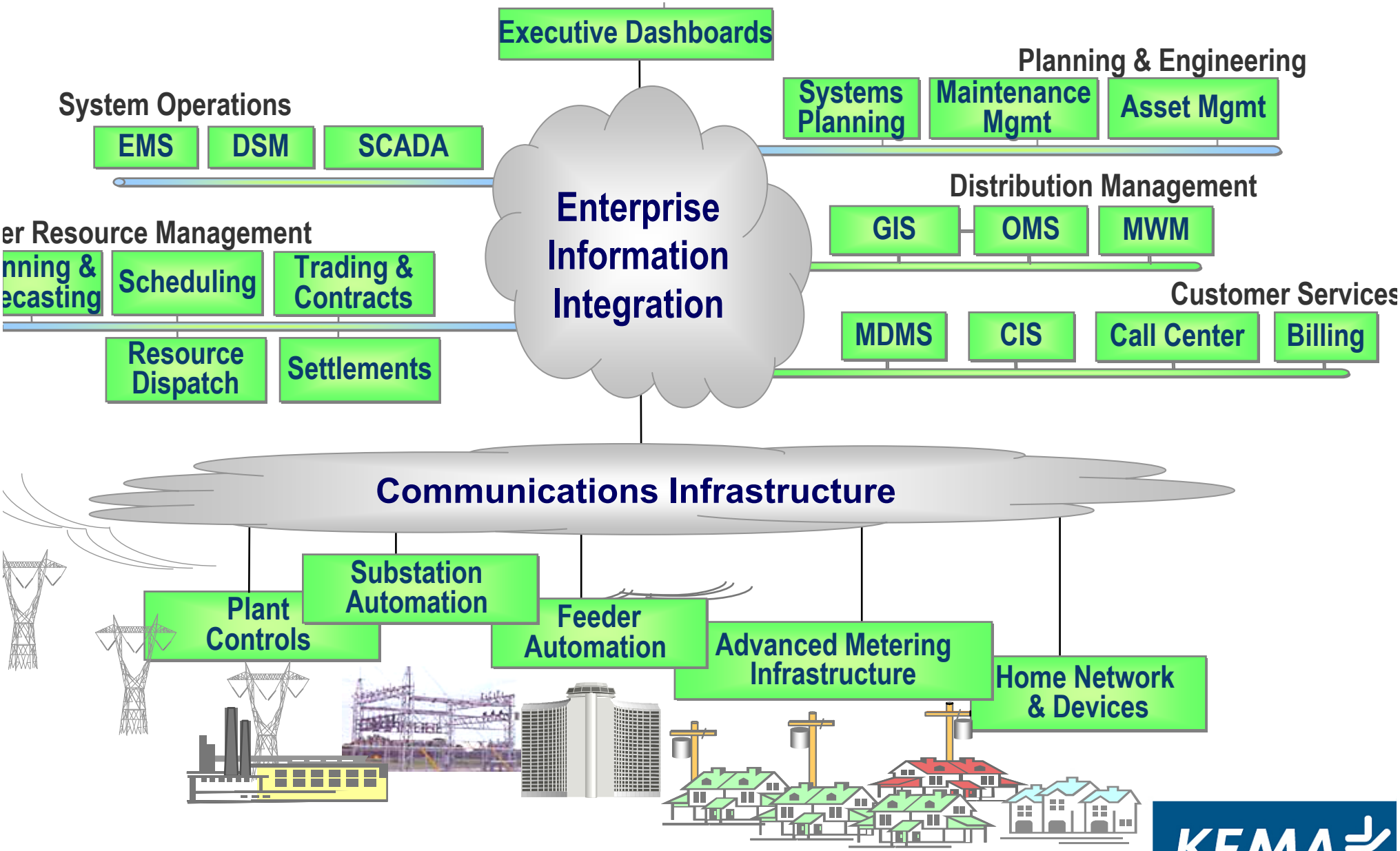
nterprise Level Integration

nely access to information critical for Planning, Engineering, and Operations



The Smart Grid of The Future

20th Century Grid	21st Century Smart Grid
Electromechanical	Digital
One-way communications (if any)	Two-way communications
Built for centralized generation	Integrates distributed generation & renewables and supports EVs or hybrids
Radial topology	Network topology; bidirectional power flow
Few sensors	Monitors and sensors throughout; High visibility
Manual restoration	Semi-automated restoration & decision-support systems, and, eventually, self-healing
Prone to failures and blackouts	Adaptive protection and islanding
Scheduled equipment maintenance	Condition-based maintenance
Limited control over power flows	Pervasive control systems; state estimator
Not much sustainability concern	Sustainability and Global Warming concern
Limited price information	Full price information to customers – RTP, CPP, etc.

d from the Emerging Smart Grid: **Investment And Entrepreneurial Potential in the Electric Power Grid of the Future, Global nent Fund, October 2005**

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Thank You!