Wireless InterOp Architecture and Design

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Grid-Interop 2010

Agenda

- Smart Grid Concepts
- Use Cases
- Architectural & Design Overview & Considerations
  - Network Overview (BH, WWAN, WLAN, WHAN)
  - Coverage and Capacity
  - Equipment Specifications
  - Indicative Build-outs
- Application Solutions & Profiles
- Equipment Mapping to Applications
- Solution Components
  - Overview
  - Service Delivery
    - Design & Implementation
    - Network Management
  - Industrial Radios & Carrier-grade Equipment

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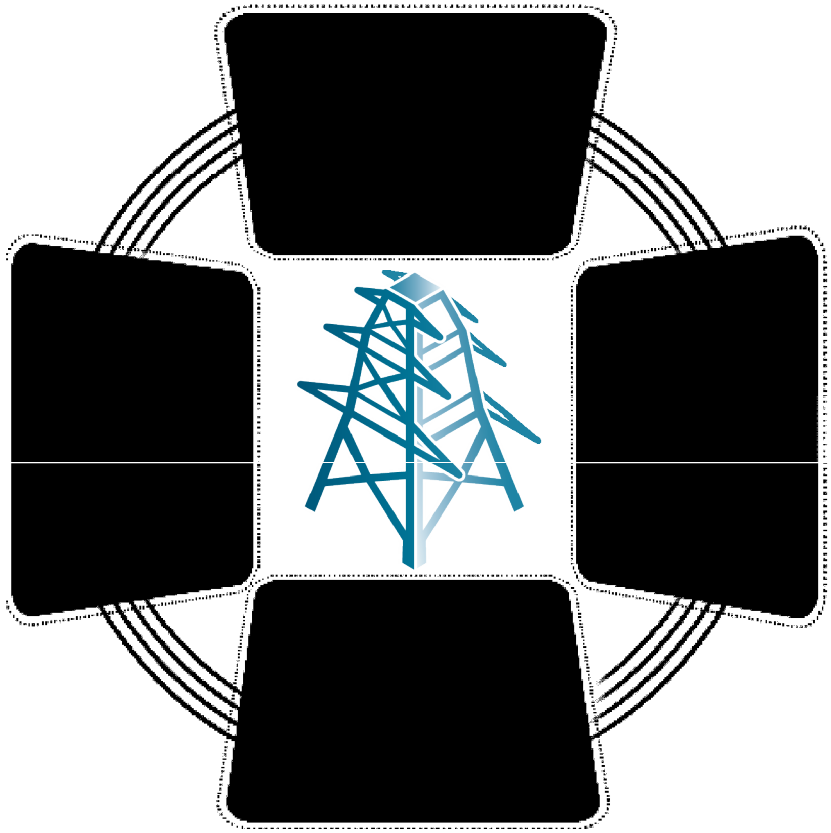
Smart Grid Communications

- The U.S. Department of Energy assigns the following characteristics to smart grid:
  - Self-healing from power disturbance events
  - Enabling active participation by consumers in demand response
  - Operating resiliently against physical and cyber attack
  - Providing power quality for 21st century needs
  - Accommodating all generation and storage options
  - Enabling new products, services, and markets; and
  - Optimizing assets and operating efficiently
- Communications to accomplish
  - Secure
  - two-way
  - high-speed communications

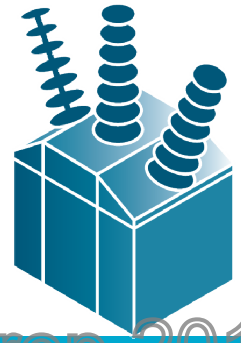
Smart Grid Solutions

- Grid Virtualization
  - AMI/AMR
  - Distribution Automation
  - Substation Automation (Last Mile)
  - Secure SCADA / DCS / Telemetry
- Demand Response / Management
- Condition-Based Maintenance
- Physical Security and Access Manager
- Workforce Empowerment & Mobility
  - VOIP / Internet
  - TMR / AVL / GIS
- Governance & Compliance
  - NERC, FERC, 2005 EPA, DHS-NIMS, CPI



Increased throughput, resiliency and response

* Source Chartwell

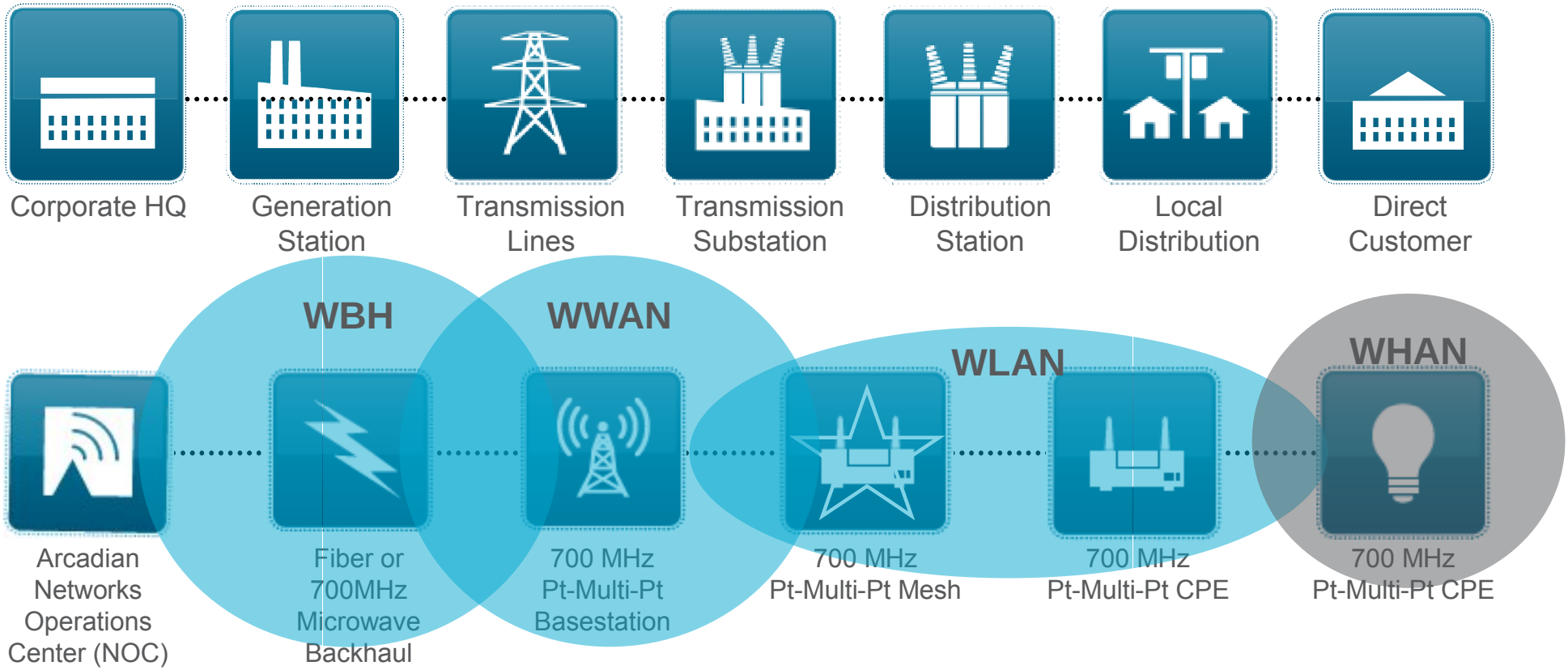


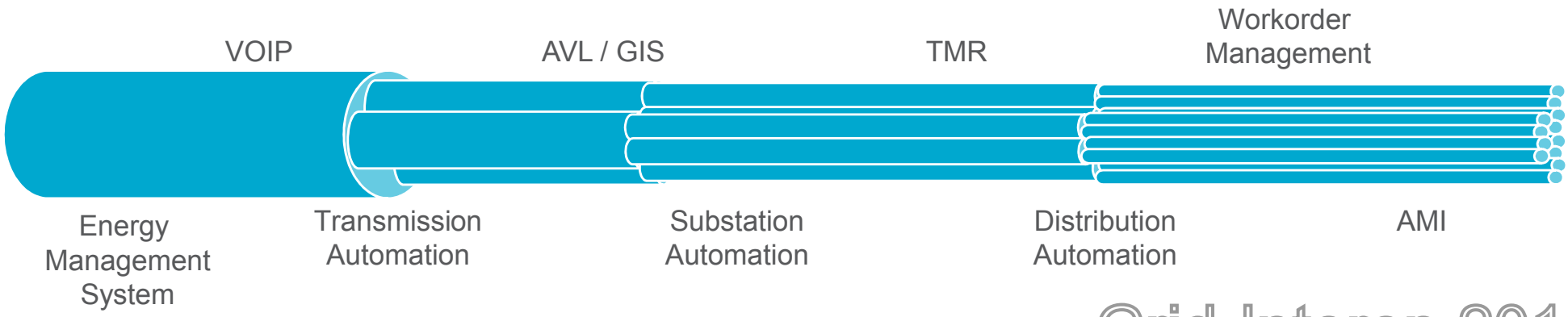
Focus on Performance

- **Design goals**
  - Flexibility
    - Today's needs
    - Growth
    - Standards applied
  - Visibility
    - Network ‘At a glance’
    - Performance ‘At a glance’
    - M2M, M2P
  - Interoperability
    - Legacy needs
    - Industry trends
    - Enable emerging applications

Architectural & Design Overview & Considerations

Network Overview (BH, WWAN, WLAN, WHAN)





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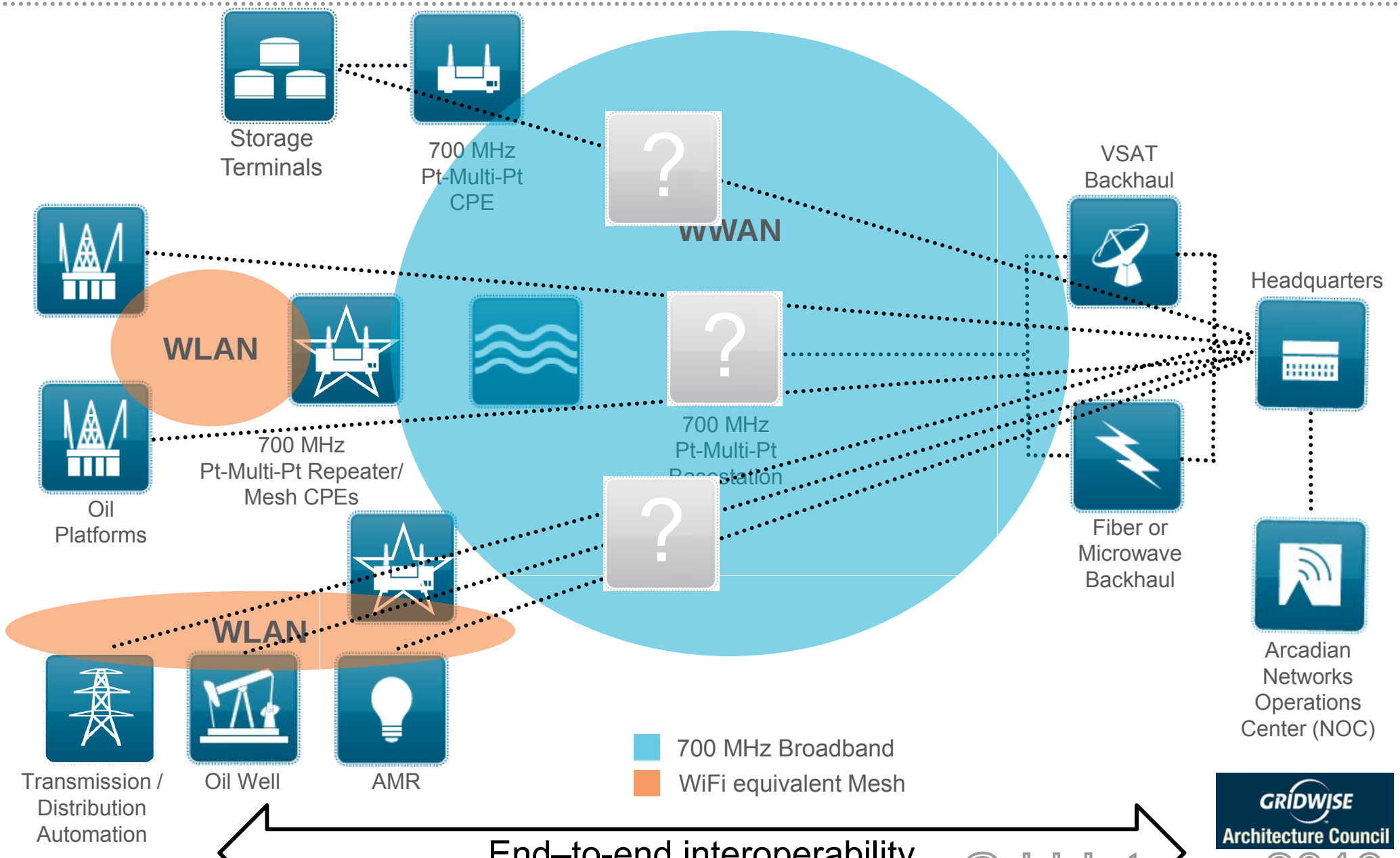
Smart Grid Interoperability Advantages



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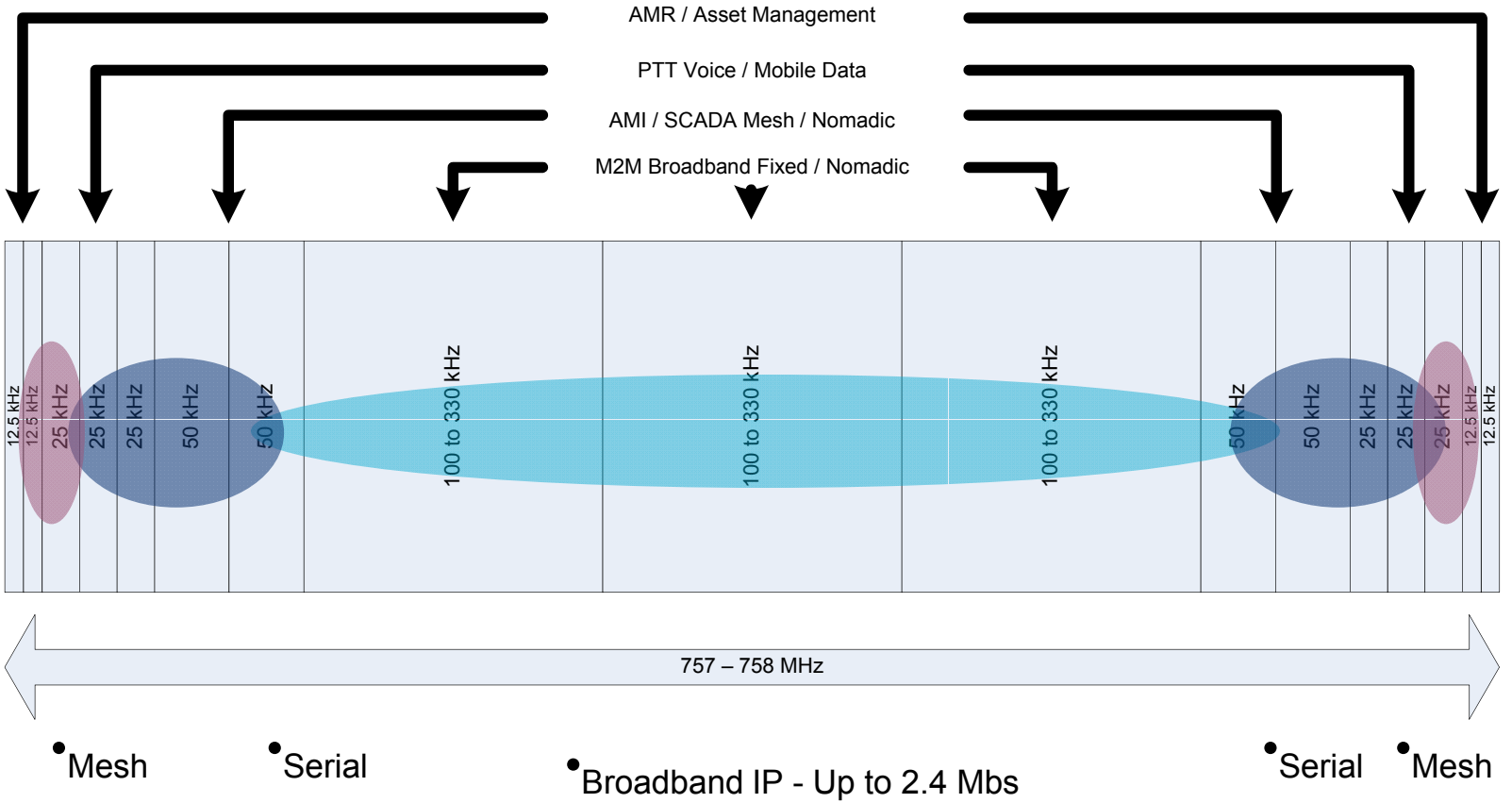
Spectrum Management

- **Supports**
  - **Standards Based**
  - **PtMP (Point-to-Multipoint)**
    - Broadband IP/SCADA
    - Serial SCADA
    - Dedicated Channels
    - Shared Channels
    - Mesh/Repeater
    - Data privacy
    - Layered security



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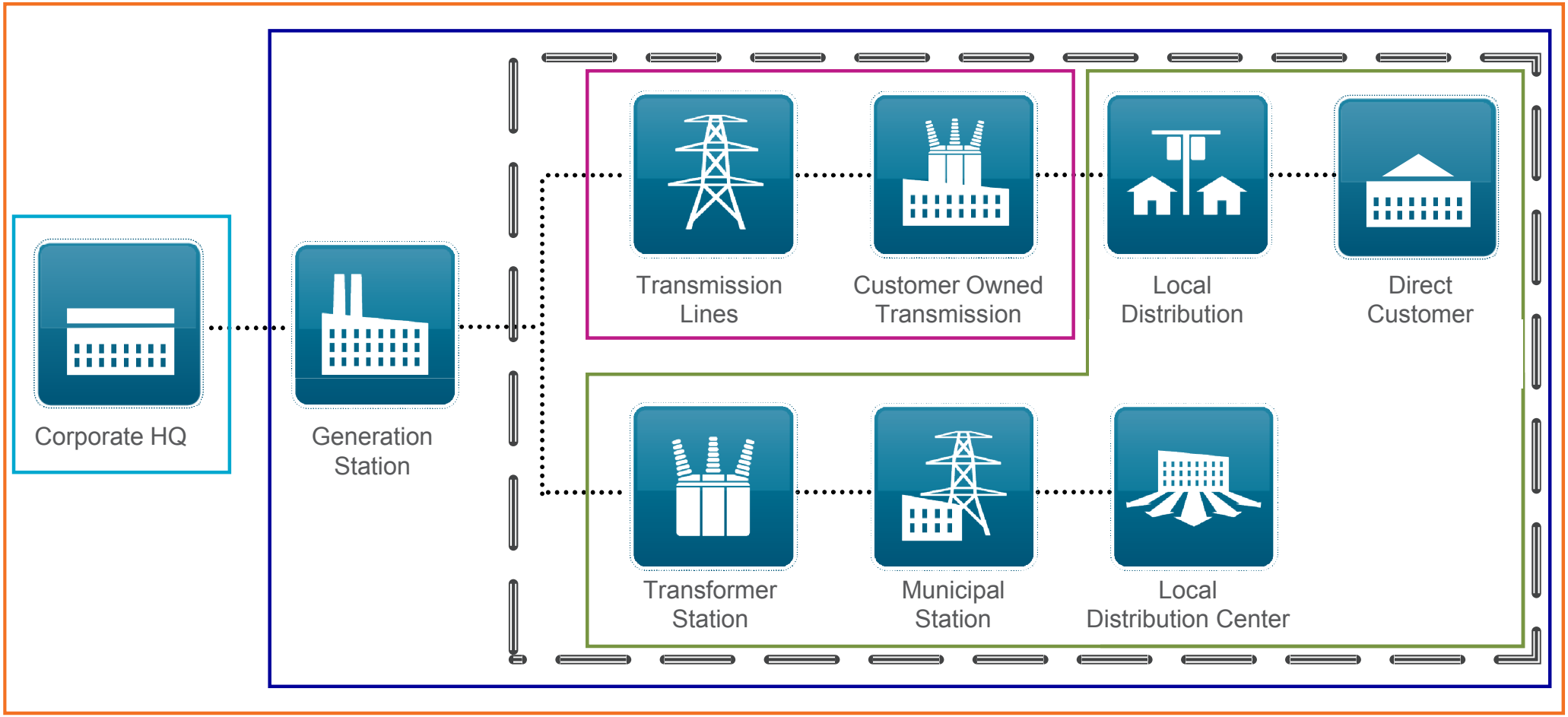
IP Foundation

- **IP Enables**
  - Flat Network
    - Intranet end-to-end
    - IT and Communications – now same language
    - Standards now deployable
  - Collected Data
    - Payload - Use/needs specific delivery
    - Network statistics - Use/needs specific delivery
    - Backup duplication in Real-Time
  - Interoperability
    - Legacy needs
    - Industry trends
    - Enable emerging applications
    - Seamless delivery of Company-Wide Security policies

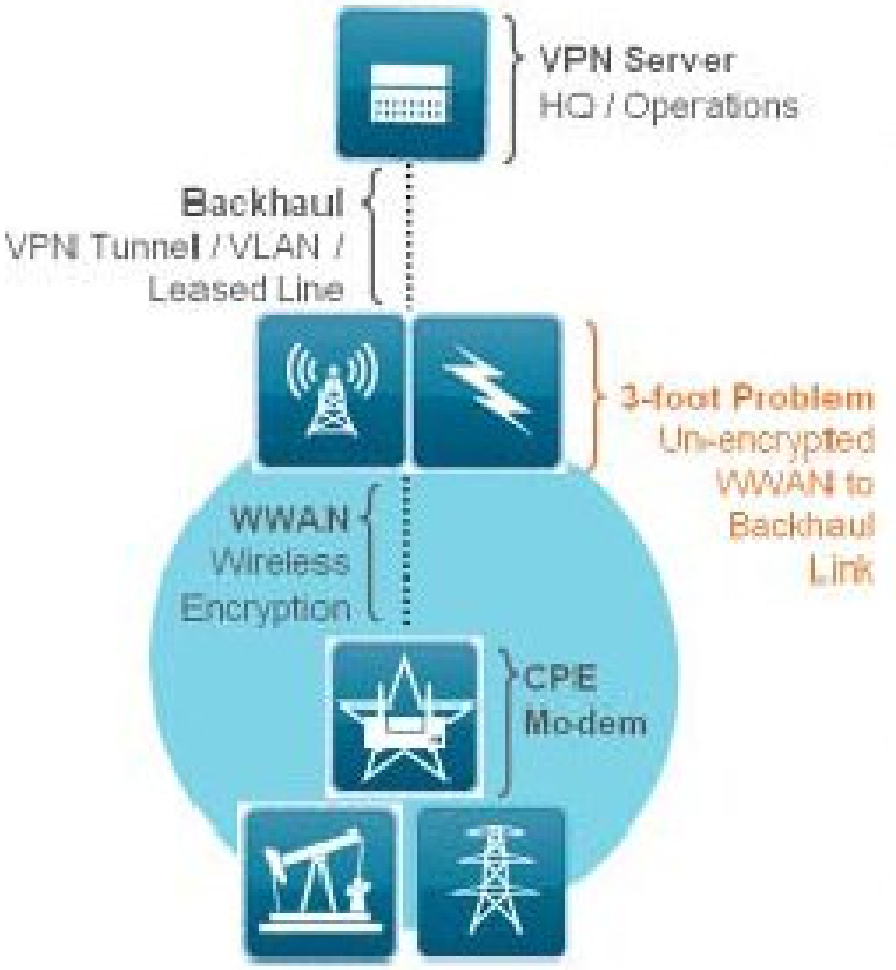
Smart Grid Zoned Security – IP Addressing & VLANs



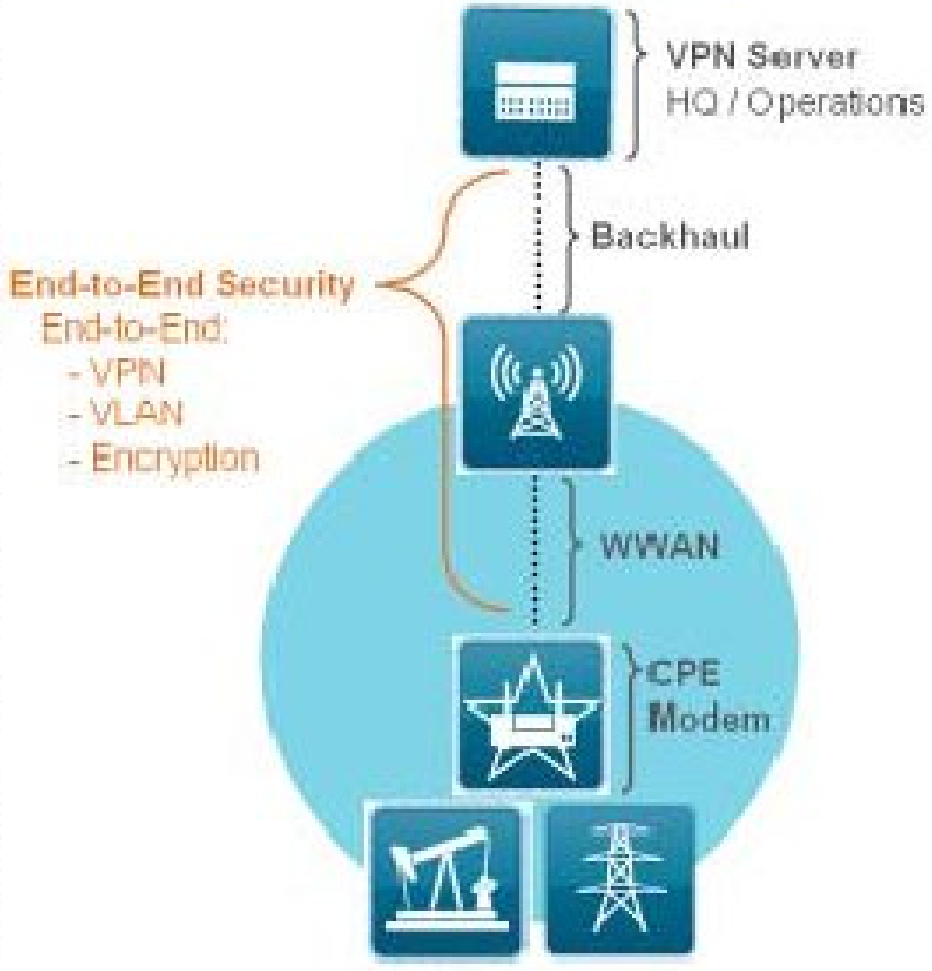
- Options: logical IP segregation by Region or Technology
  :VLAN segregation by "network": security, users, network management

Security Advantages

Typical, Weak Network Security



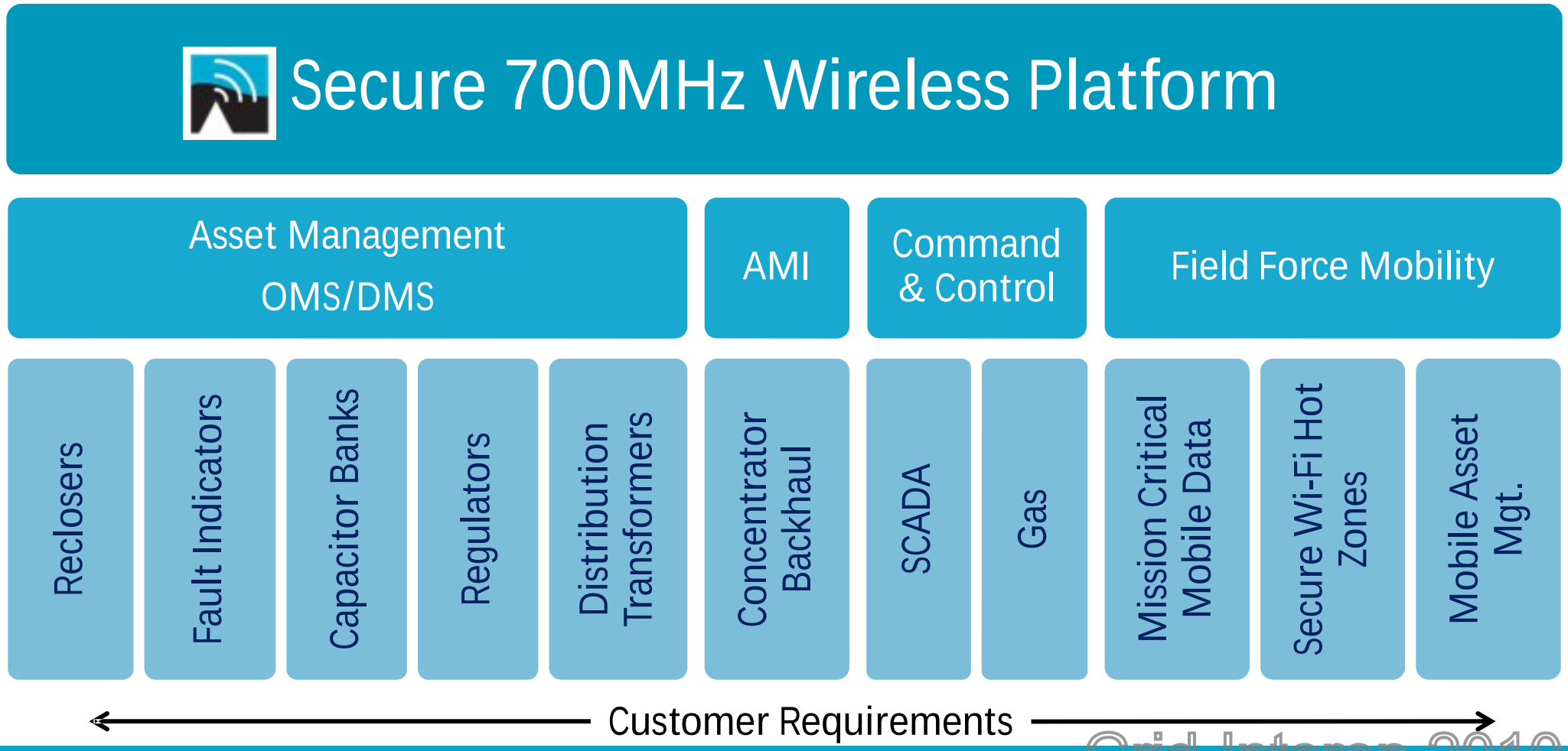
Arcadian Networks End-to-End Network Security



Application Solutions & Profiles

Integrated IP Network Consolidation

- Consolidation leads to:
  - Lower total cost of ownership
  - Reduced complexity
- Increased service level availability
- Grouping by application types/use
- Greater reliance on individual systems



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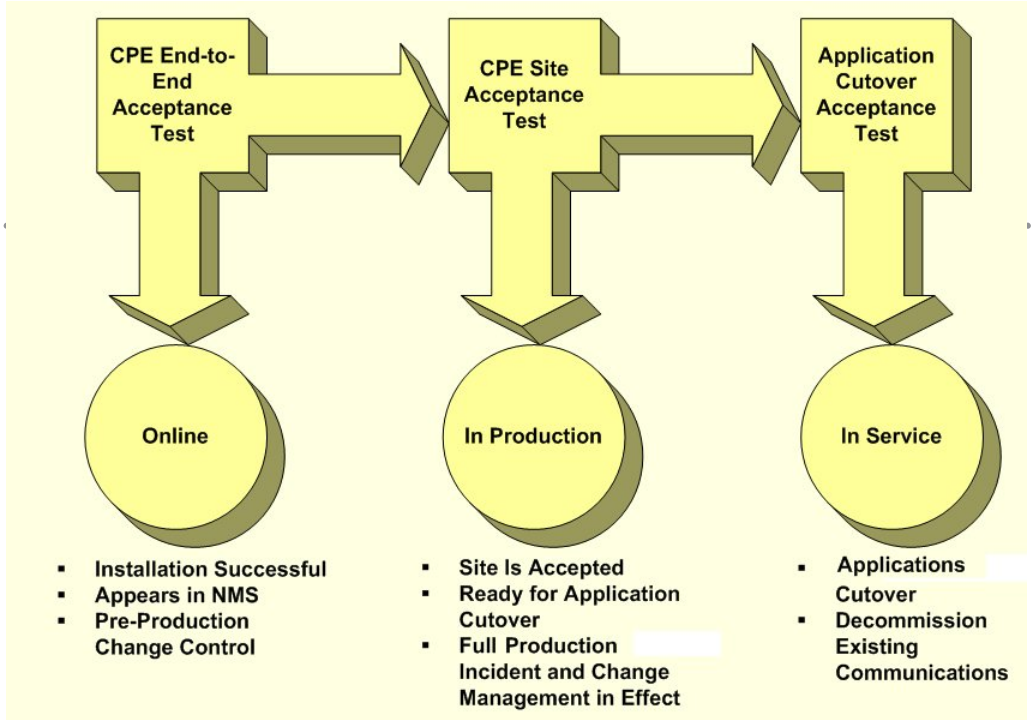
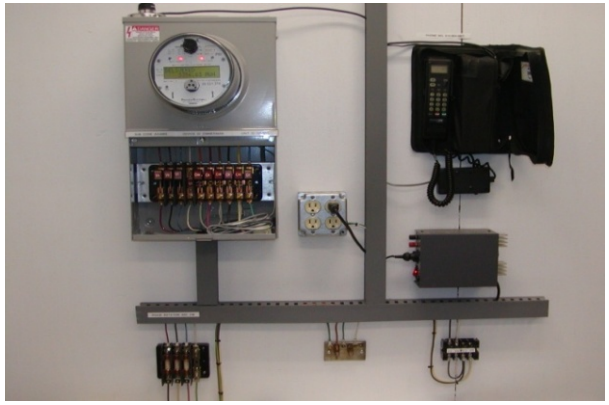
Data Integration Example



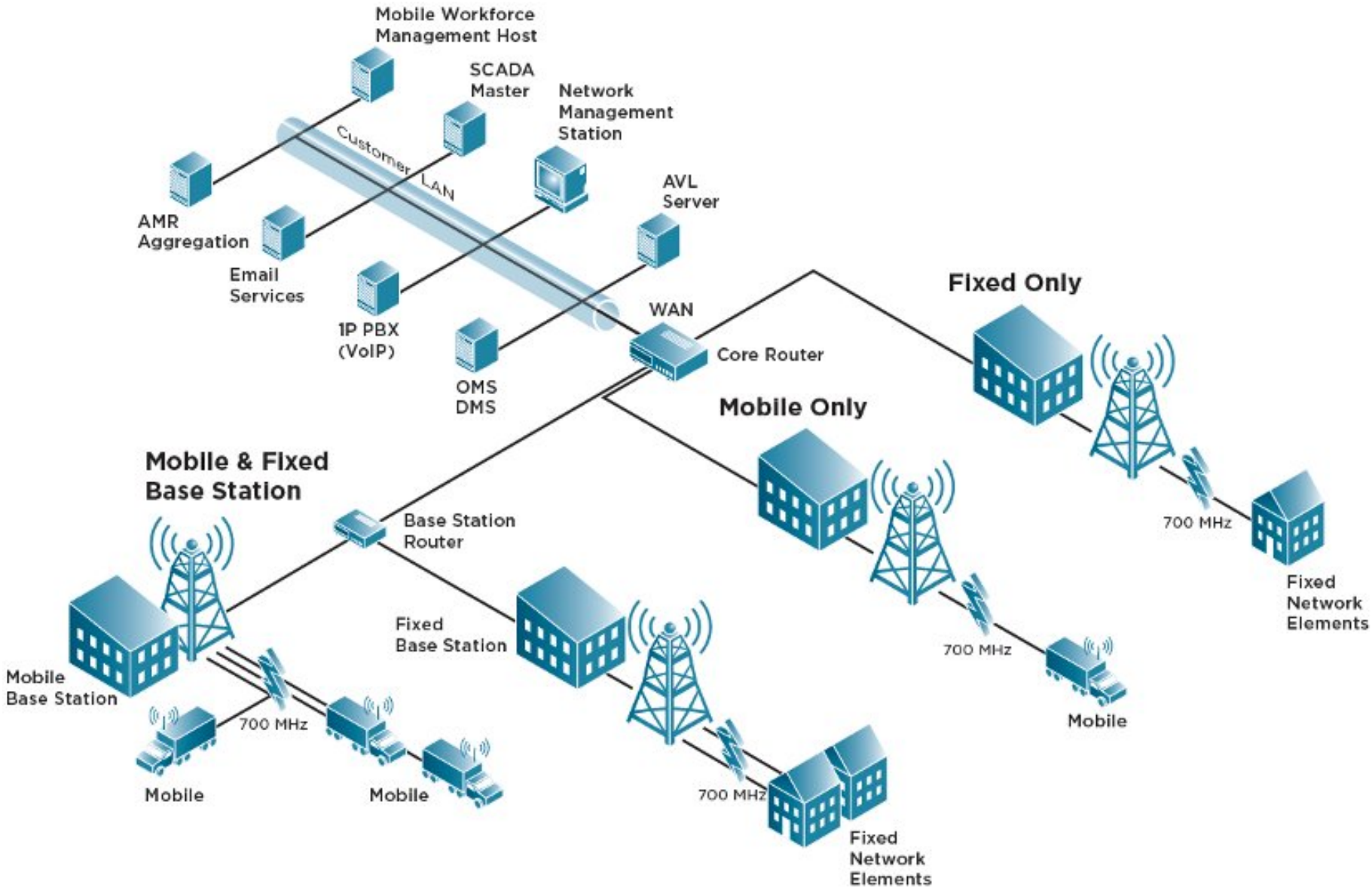
- SCADA RTUs
- Meters
  - MV90 and real time
- SEL 2030 interface to relays
- VoIP Phone
- WiFi Access Point
- Load management transmitters (where the transmitter is not on the communications backbone)
- AMR/AMI Backhaul – PLC, wireless
- Remote Generators (customer premises)
- Security (video, card key access – future)



•Courtesy of Great River Energy

Architectural & Design Overview & Considerations

Indicative Build-outs



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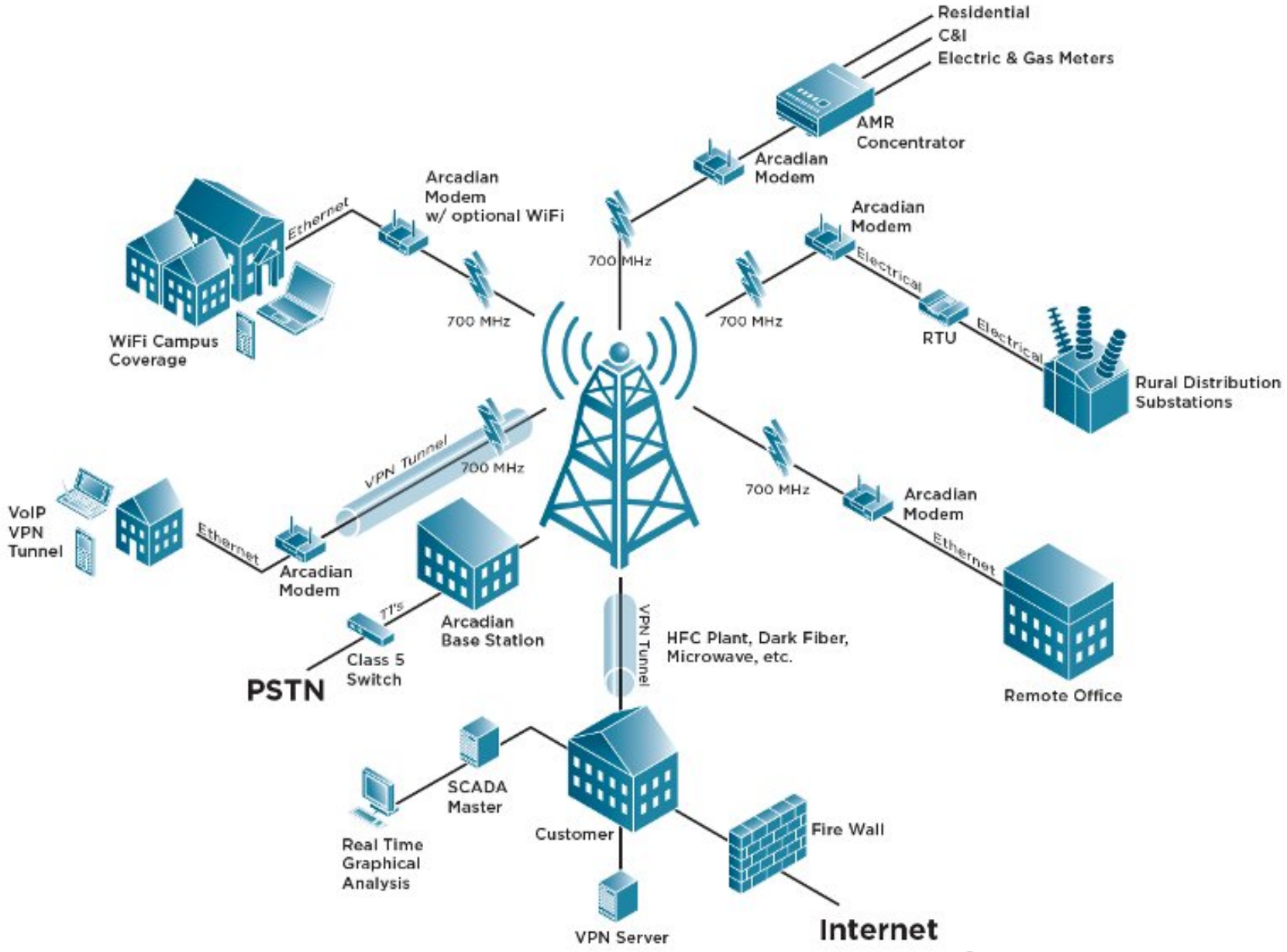

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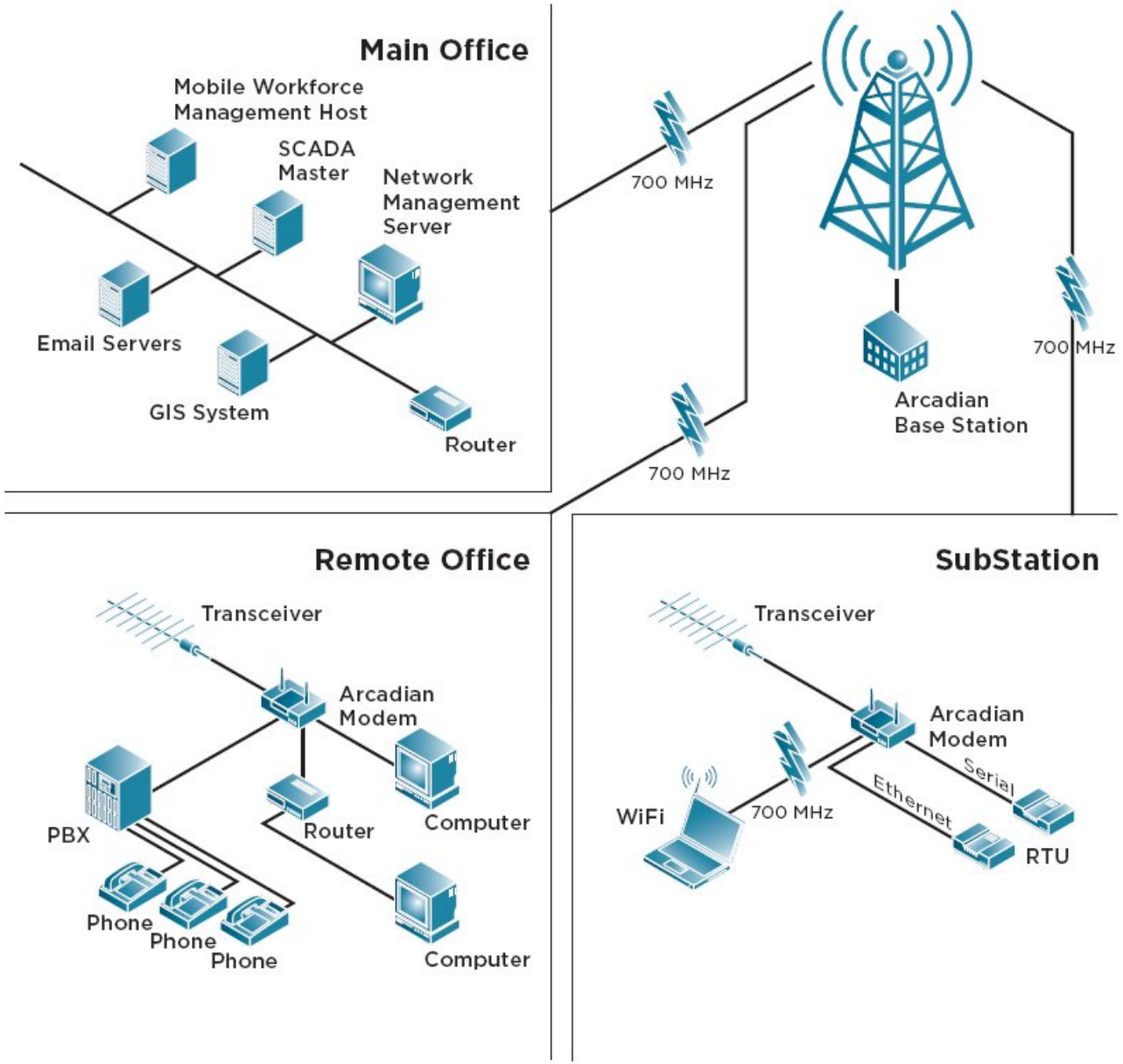

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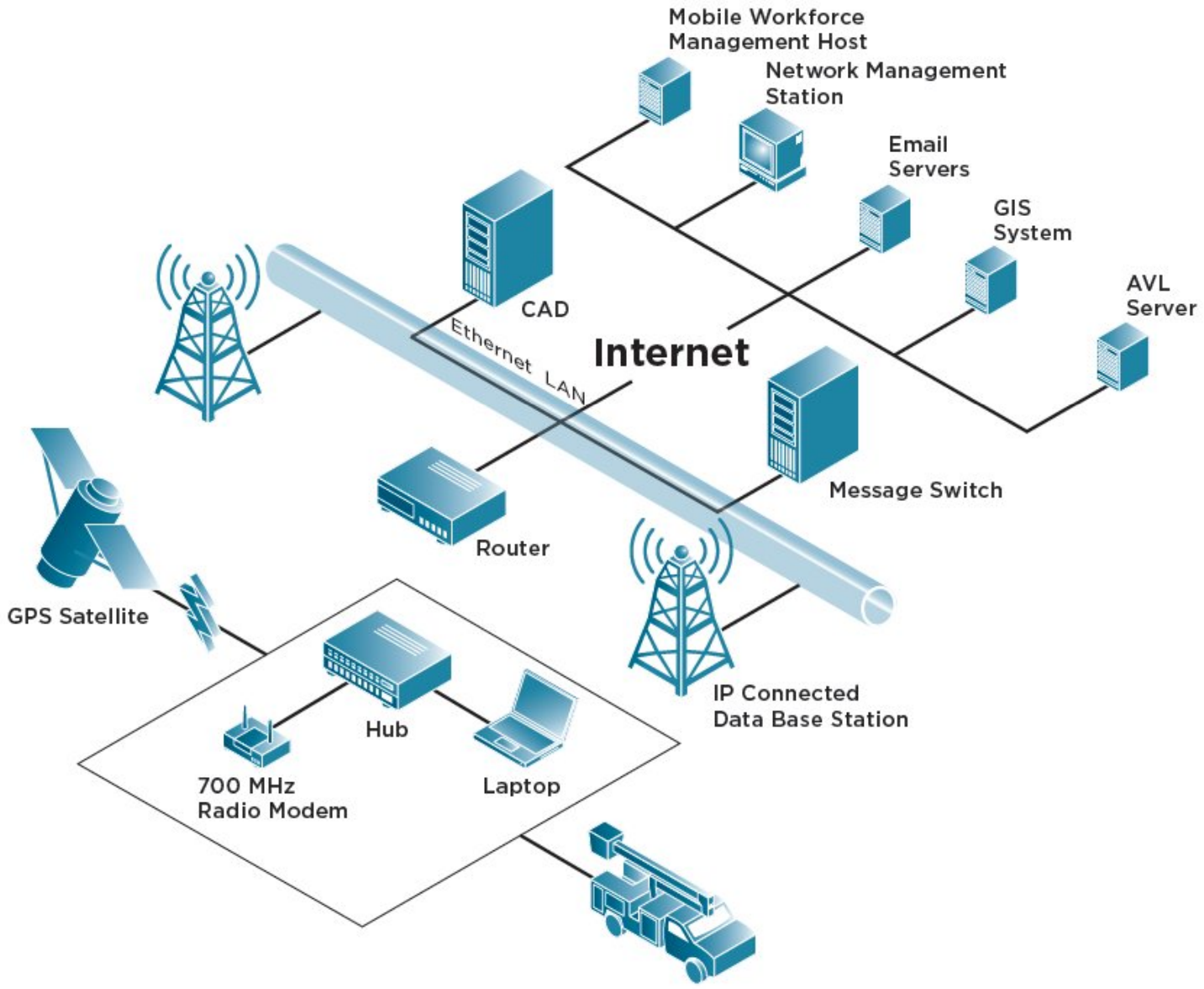

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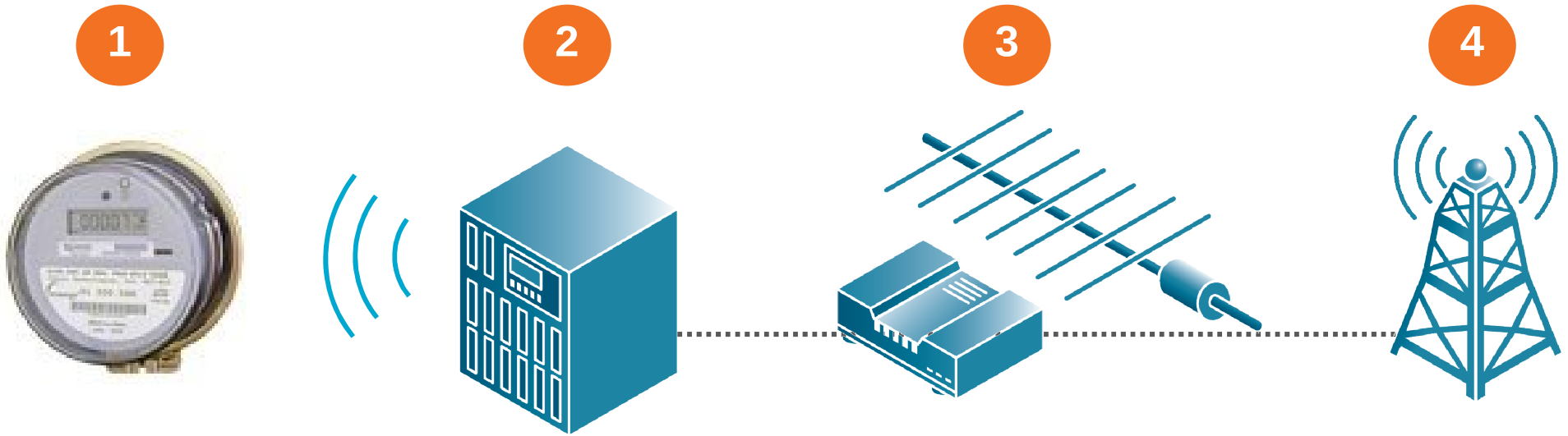
Application Solutions – Electric Utilities

Corporate, Industrial & Agricultural AMI for Load and Outage Management

1. Meter can be connected directly to radio or via a
2. concentrator for bi-directional communications
   - Equipment can be placed in NEMA enclosure if it requires protection from the elements
3. Radio or concentrator connects to broadband network
4. Data is routed via private 700MHz backhaul WWAN



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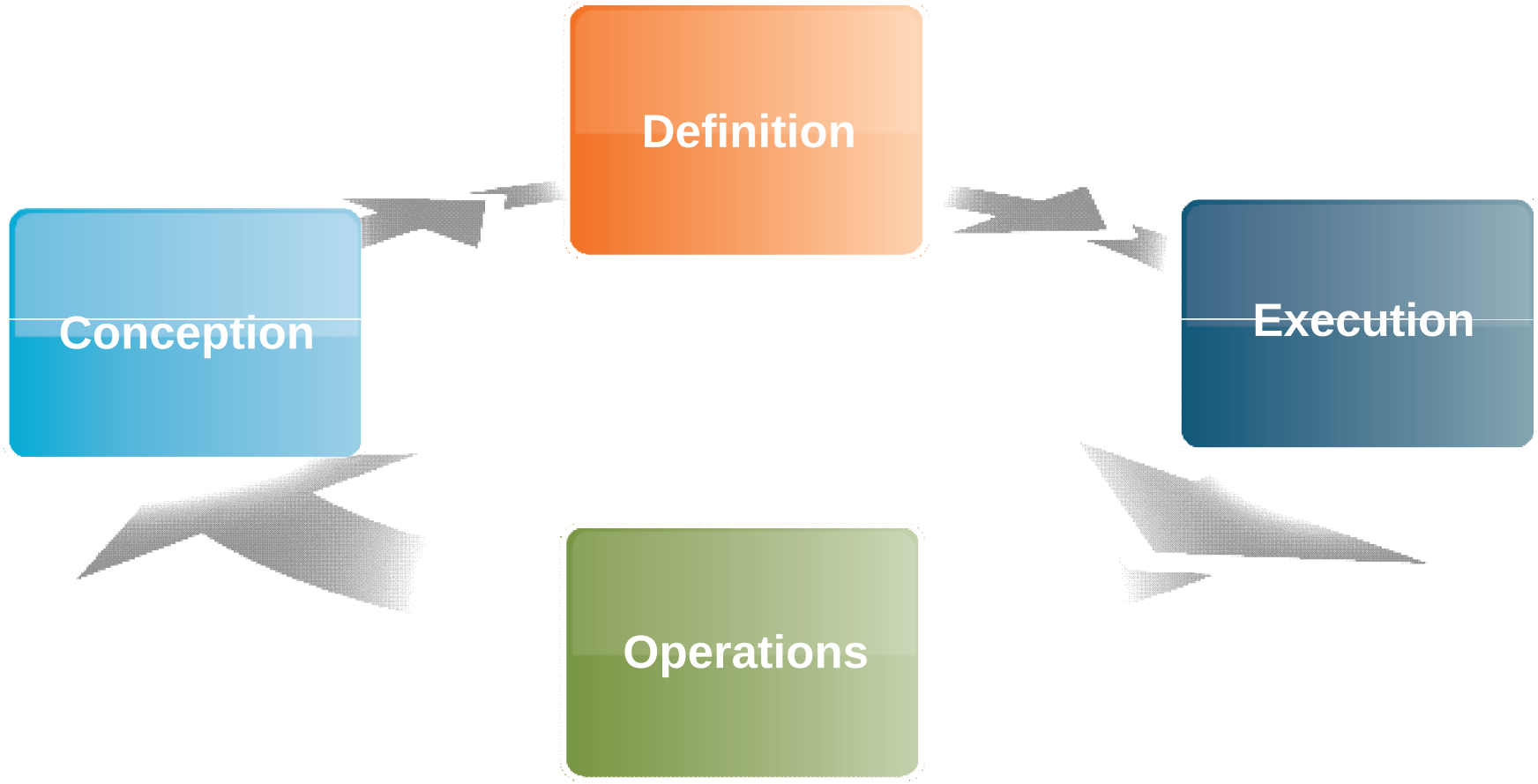
Estimating & Planning

Project Management:
Four-Phase Iterative Methodology



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Architectural & Design Overview & Considerations

Coverage & Capacity

- Coverage
  - Base station Antenna Height
  - Coverage Area
    - ROM
    - Coverage Simulation
    - Site Visits
  - CPE End-point Antenna Height
  - Frequency
    - 700MHz, 2.4GHz, 3.65GHz, 5.8GHz
  - Noise-floor
    - dB, determines power CPE end-point radio needs to “hear” a base station at the given base station power and antenna height
- Capacity
  - Application Requirements
    - # of Intelligent End Devices
    - Reading intervals
    - # of Bytes per read
    - Maximum Latency Tolerable
  - Equipment Capabilities
    - # of Base stations / Sectors
      - Payload
      - Duty Cycle
      - Bits/hertz
      - Serial / Ethernet
    - Maximum radios per channel

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ROM Decision Points

- Coverage and capacity concepts are relevant for all technologies
  - Bandwidth, range, channel size, data rate
  - Private
  - Consumer
  - IP or Serial
- Attributes/symptoms differ by technology
- Consumer networks are more difficult to model due to limited visibility and control over to components and inputs

Architectural & Design Overview & Considerations
Equipment Specifications

- Specifications
  - Channel Bandwidth (kHz): spectrum available & frequency planning
  - Modulation: defines bit/hz, data rate potential, and performance thresholds
    - Data rate / channel (kb/s)
    - Combined with bandwidth defines receiver (Tx) sensitivity
  - Duplex:
    - Frequency division: Tx and Rx simultaneously – requires more spectrum for data rate
    - Time Division: Tx and RX share time – use caution when co-locating devices
  - Power: combined with Rx sensitivity gives link budget and range potential
  - Data Interface: serial, Ethernet, OEM, etc.
  - Radios/BTS architecture:
    - Point-to-point, Point-to-multipoint, Mesh/Repeater
  - Transaction / time
    - Influences latency

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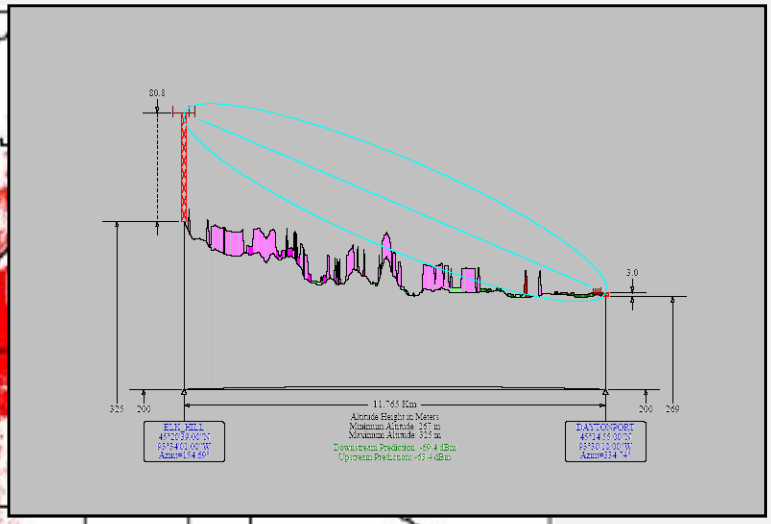
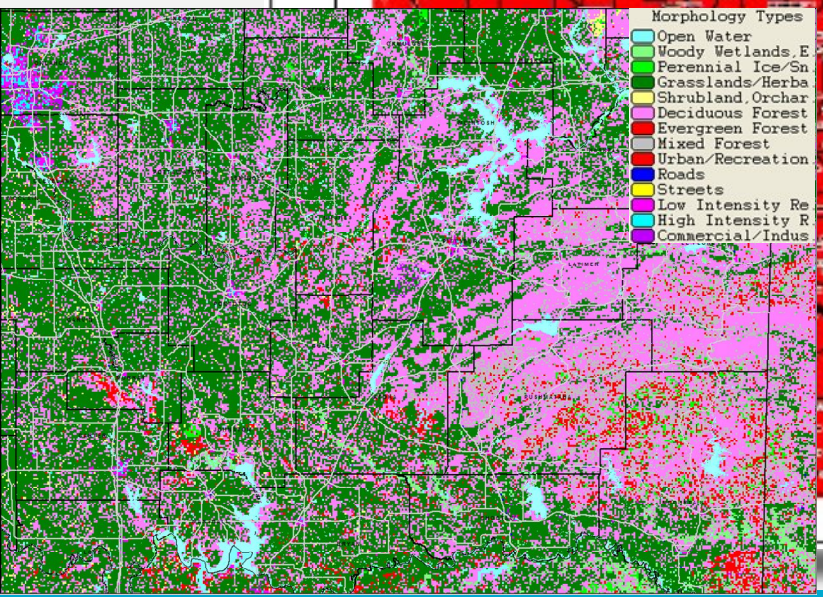
RF Design – CelPlan Example

Radio Frequency Design Antenna Height Optimization

- High Resolution Terrain
- Multi-factor Clutter
- Signal Testing & Model Tuning





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Diagnostics & Lessons Learned

- Asset location information
  - Actual vs. location of record
  - Continual feedback to the design team
- Integrity of as-built information
- Aptitude of design support personnel
  - Future training needs
- Integrity of deployment closeout packages
  - Existing processes may be insufficient for current projects
  - Methods, thresholds and scope
- Network touch versus performance failures
- Measurement granularity aligned with application profiles
- RF environmental factors
- A positive mindset approach to deployment
  - New technology deployment identifies improvement opportunities for related business and technology systems
  - Benefits and opportunities transcend technologies
- Project Management Areas Impacted:
  1. Project planning and network design
  2. Asset information and logistics
  3. Spectrum integrity
  4. Core network deployment and testing
  5. Application cutover
  6. Ongoing Operations

Managed Services

Network Operations Center (NOC) Capabilities

- Network Awareness
  - Tailor NMS for individual customer needs and SLA performance requirements
- Alarm notification and correlation
  - SMS
  - eMail
  - Visual Map with News and Weather feed
  - NMS Alarm Summary Page
  - Auto-Generated Incident Ticket
- Troubleshooting
  - Methodical, NERC-CIP troubleshooting techniques and methodology
  - Converged realtime and historical, performance & RF, statistics
- Incident Resolution
  - Tailored for customer needs based on SLA MTTR requirements with custom escalation policies
  - Technician oriented and proactive
    - Root cause
    - Steps to be taken
    - Site access information and location
- Network and HelpDesk Reporting
  - Fully customizable reports
  - Customer site performance
  - Customer SLA reporting
    - MTTR
    - Availability
  - RF statistical reports for proactive optimization
  - Informative customer ticket summaries

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