



EPRI

ELECTRIC POWER
RESEARCH INSTITUTE

Infrastructure, Standards and Architecture Development for the “Smart Grid”

IEEE Workshop

State Building, San Francisco

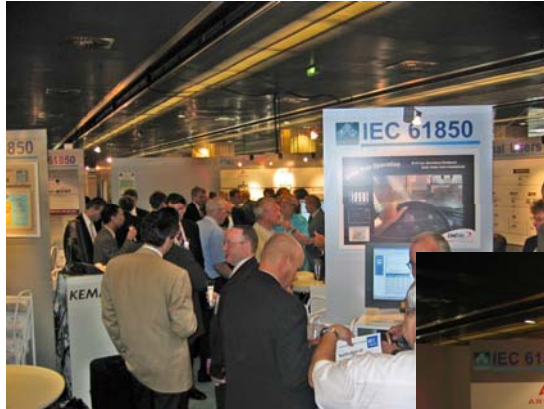
Nov 3, 2008

Joe Hughes

Sr. Technical Manager,

EPRI, Palo Alto, California

A portion of success from focused work...



CIGRE 2004

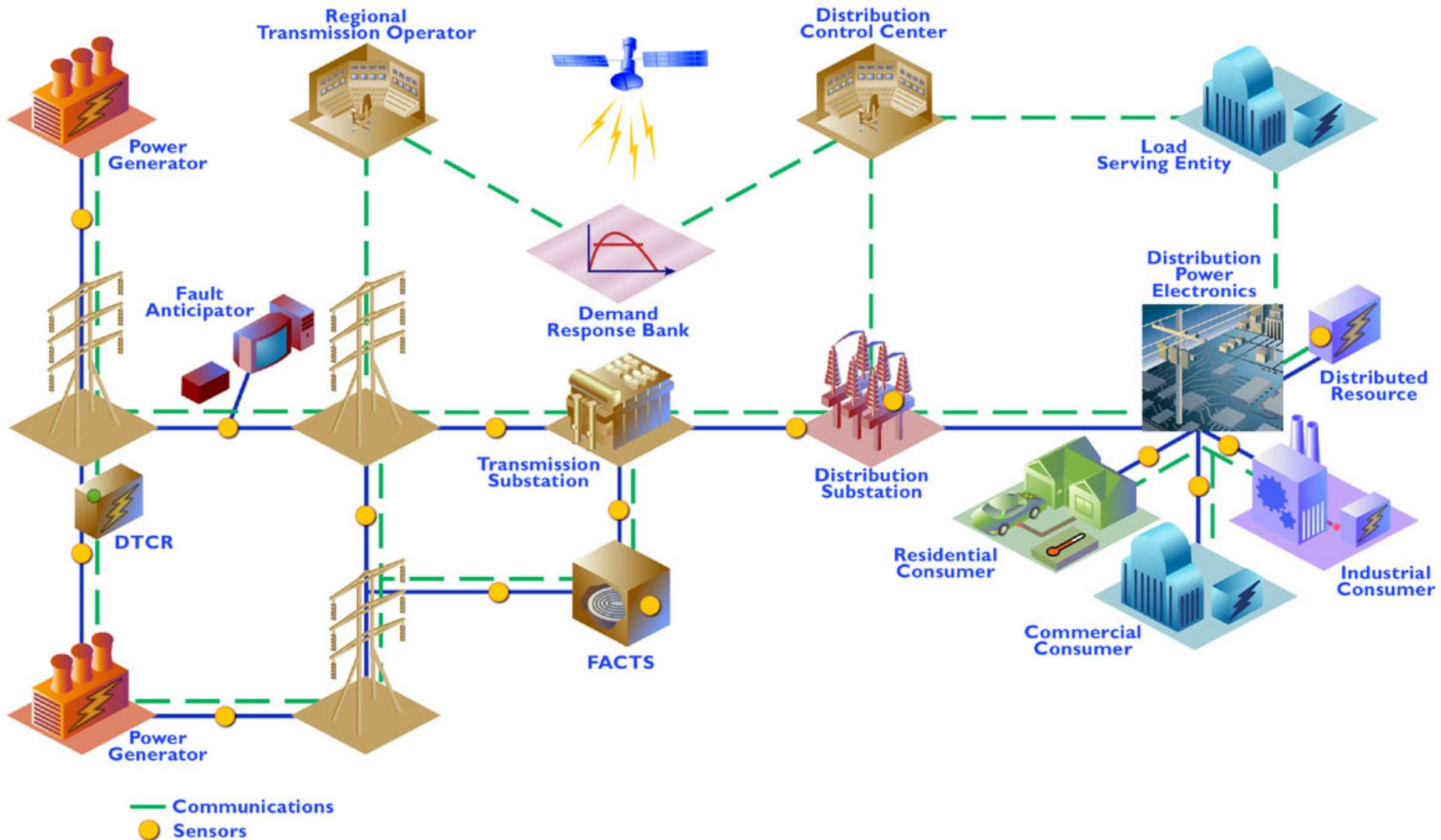
IEC 61850
Interoperability
Booth



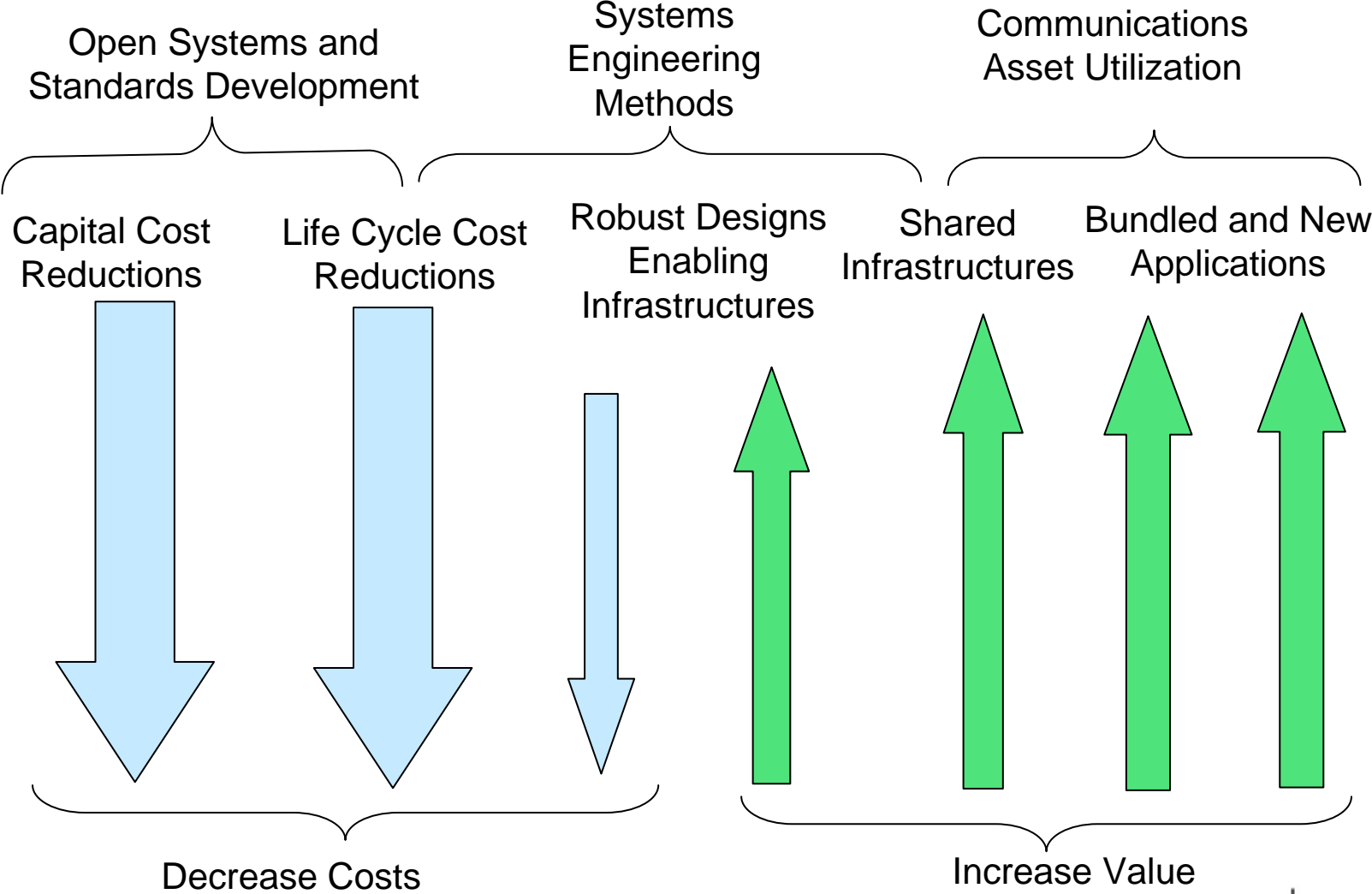
Laufenburg Substation,
Switzerland...61850 in
Use



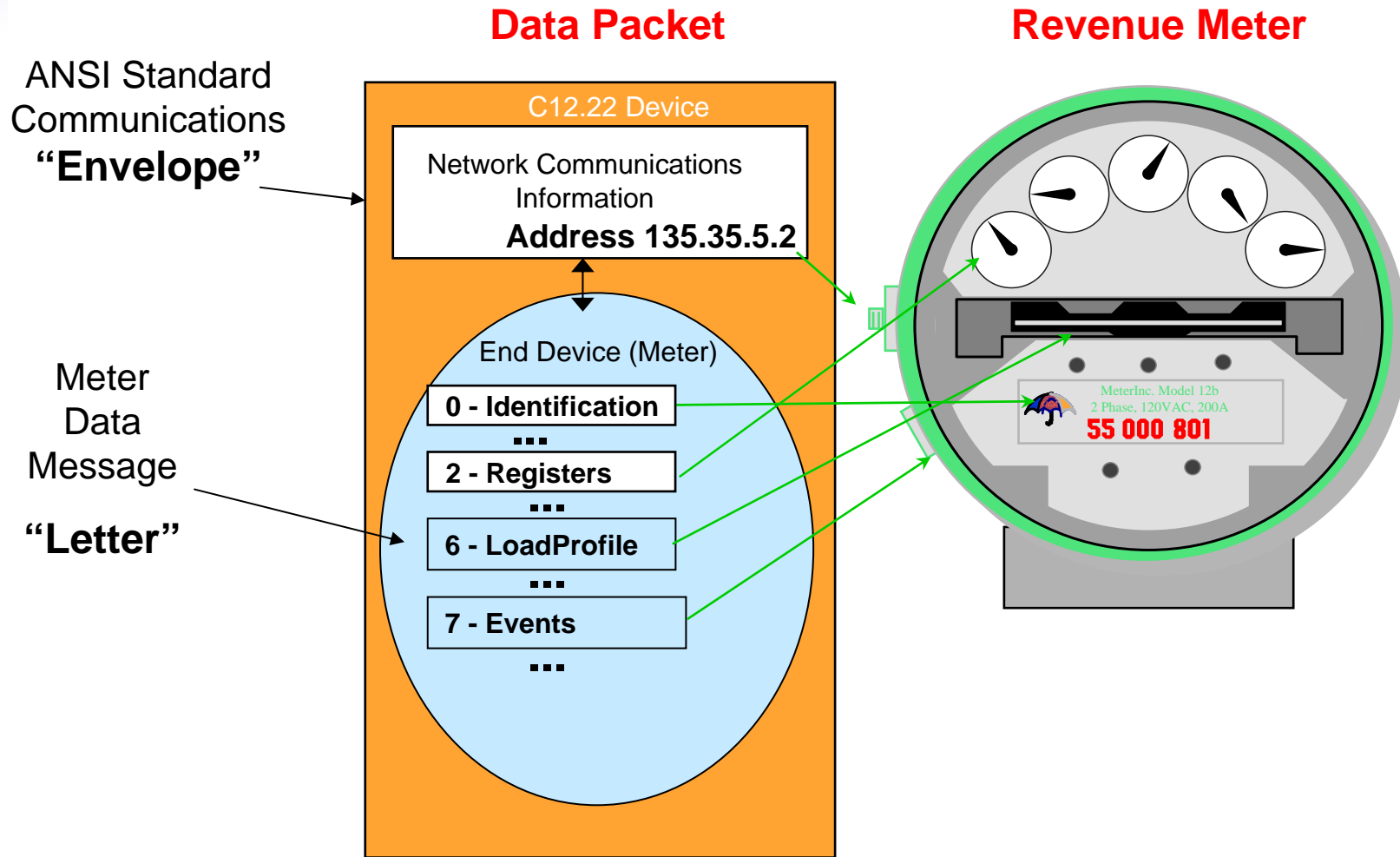
“Smart Grid” Scope is End to End



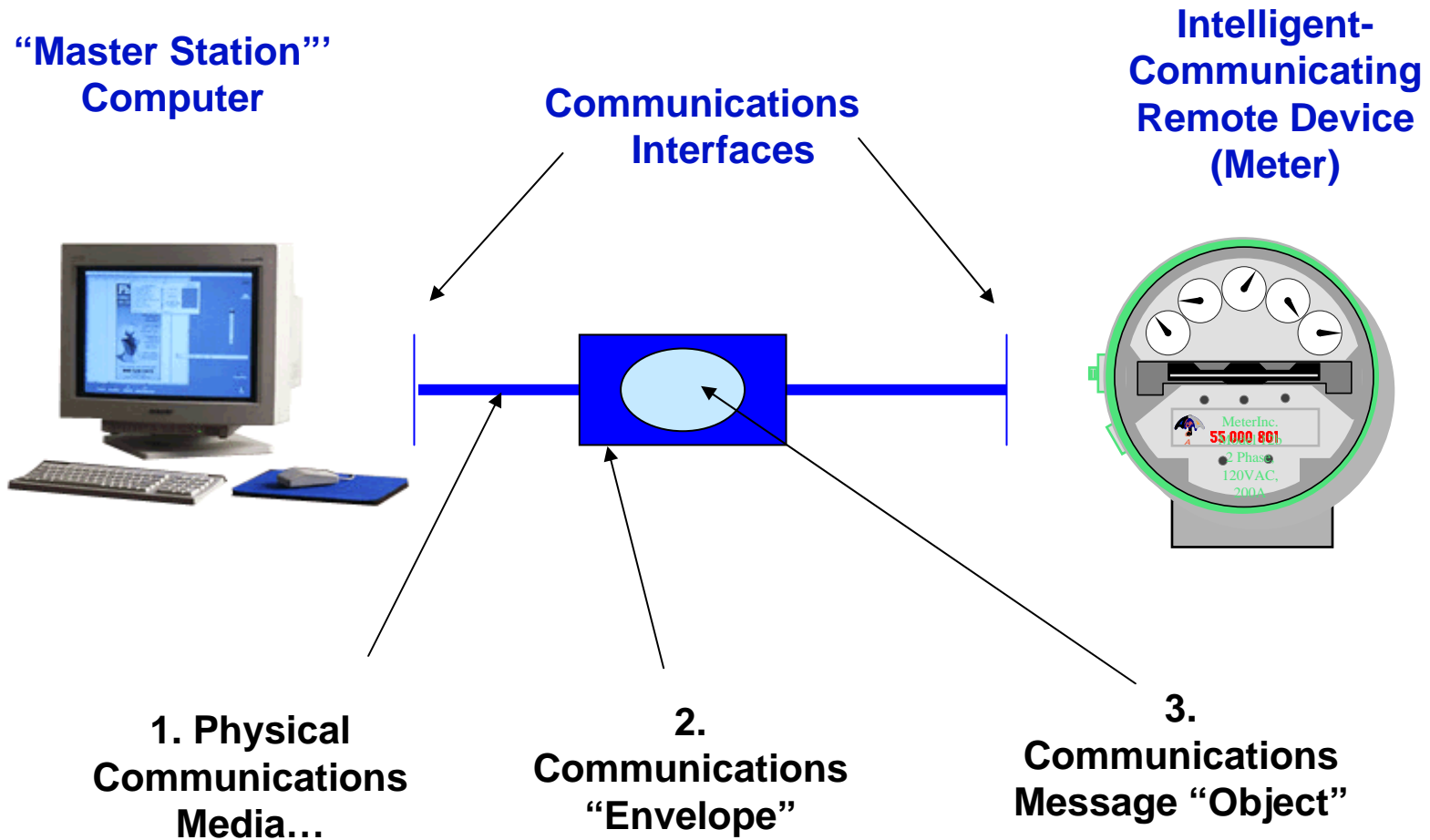
Drivers For Open Standards and Architecture Development



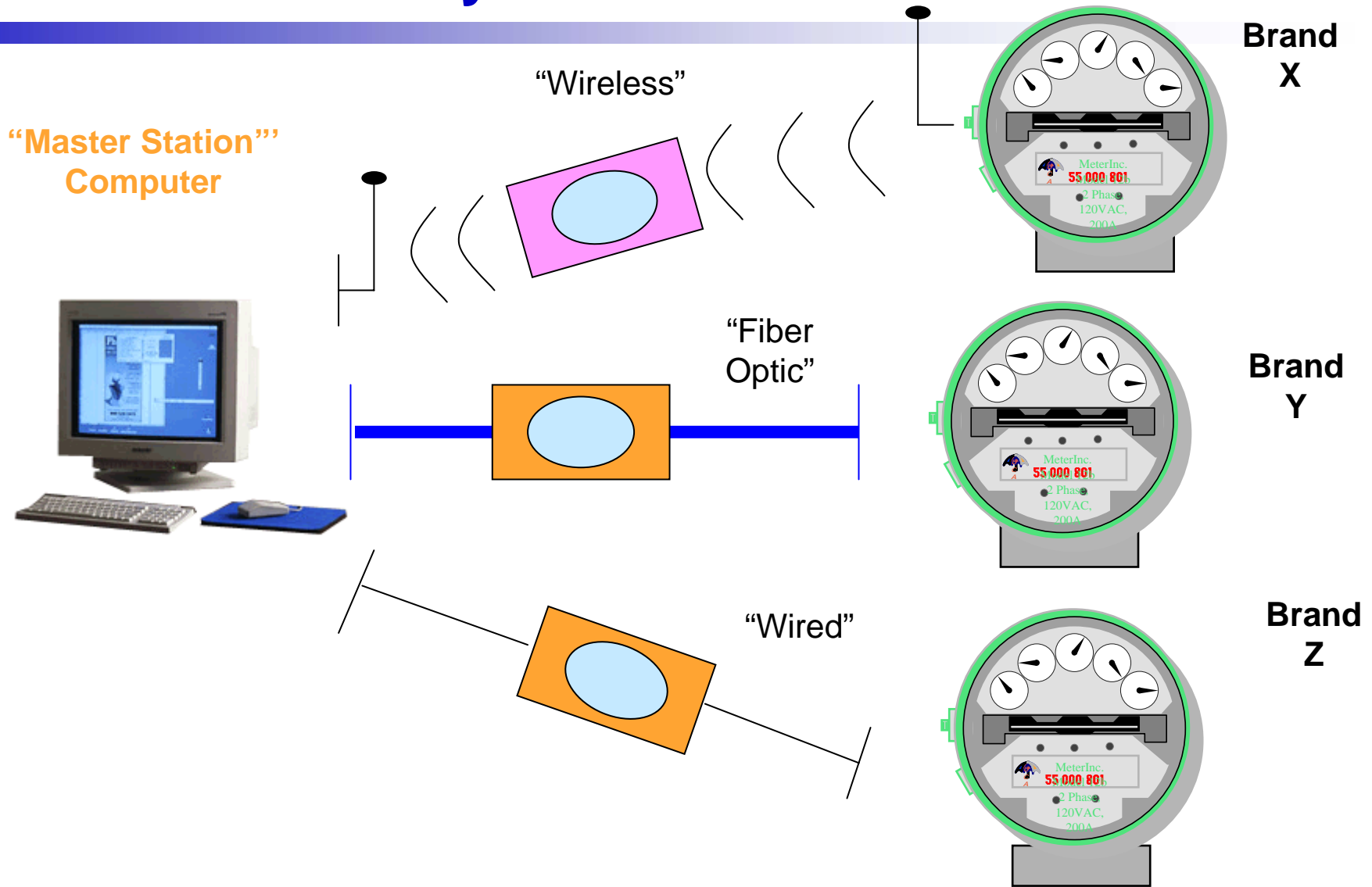
Interoperability Key Concept: Use a Common Language for Communications



What is A Common Language?

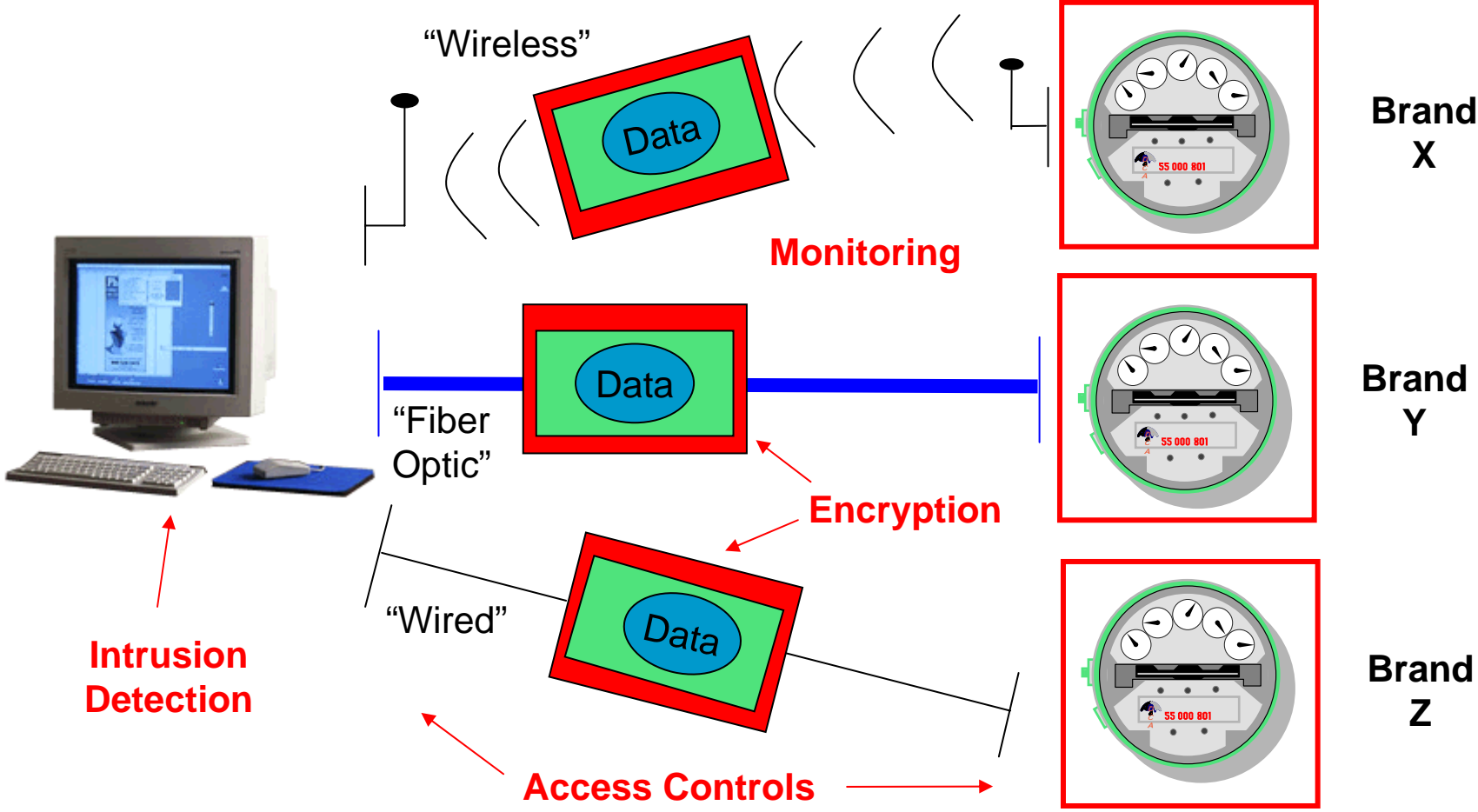


Recommendation: Develop Designs that Make Use of Layered Communications...



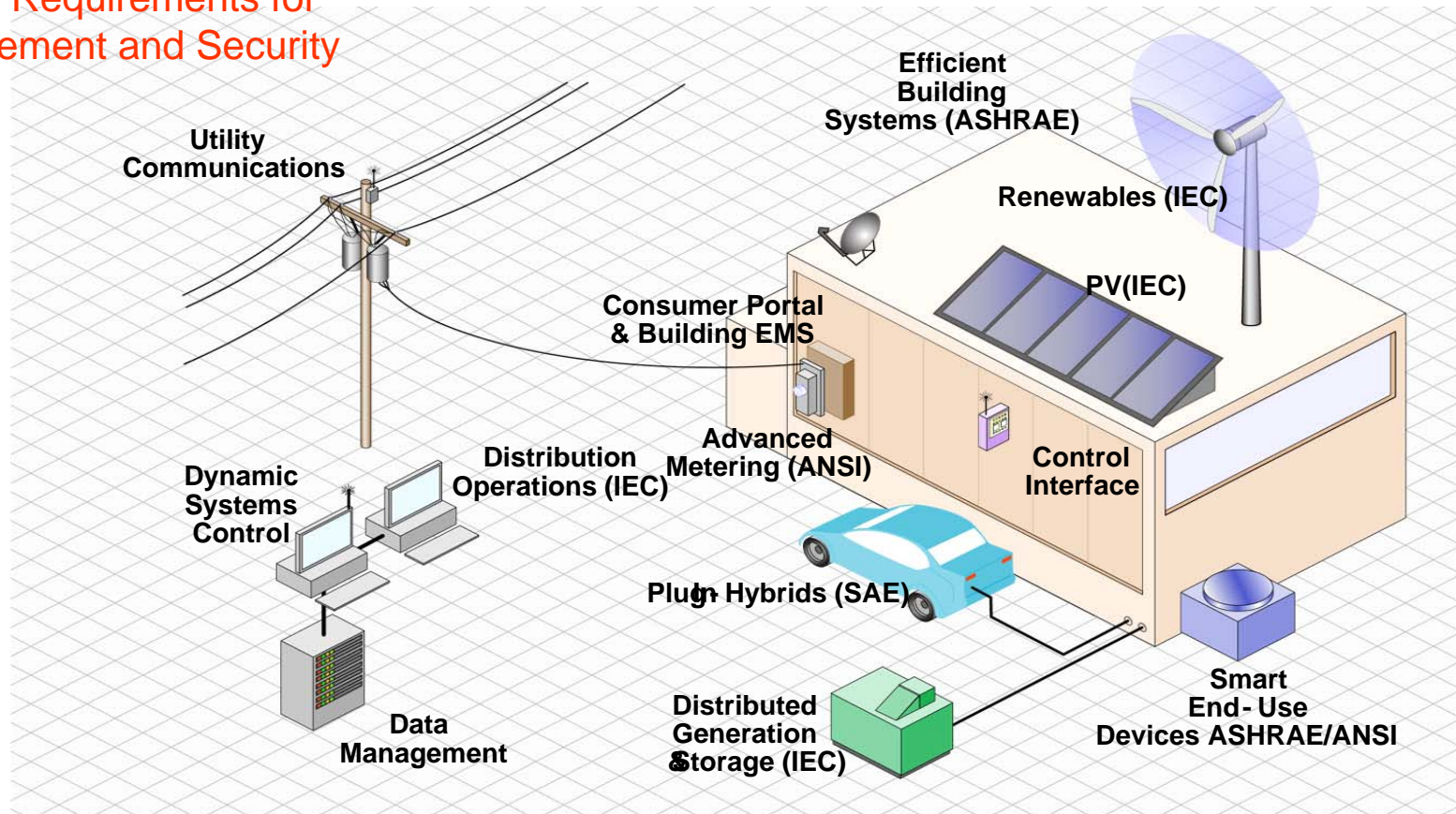
Develop Technology to Enable Consistent Security Policies Implementation

“Security Policies”



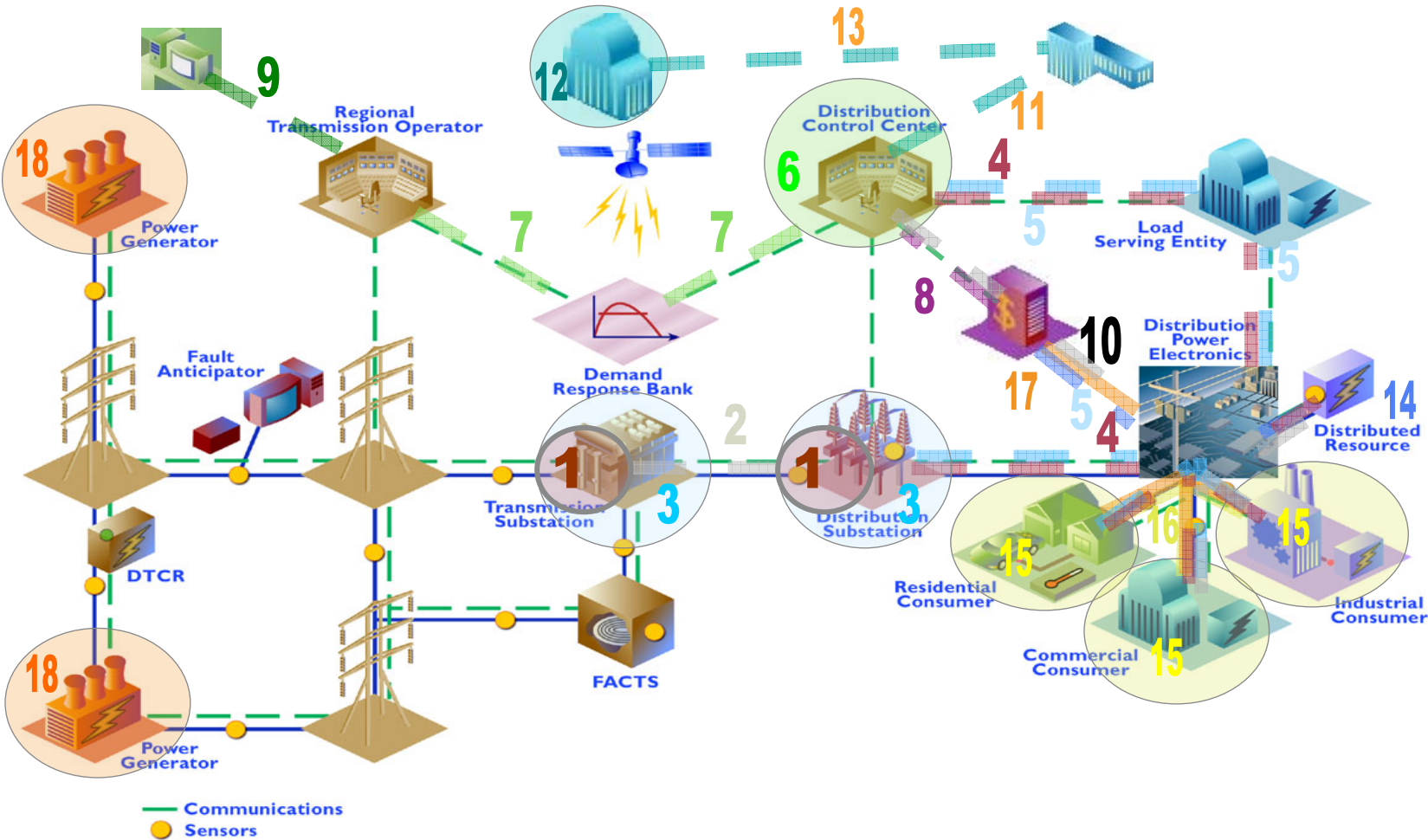
Applications Cut Across Operating Domains and Industries...

Develop Requirements for Management and Security

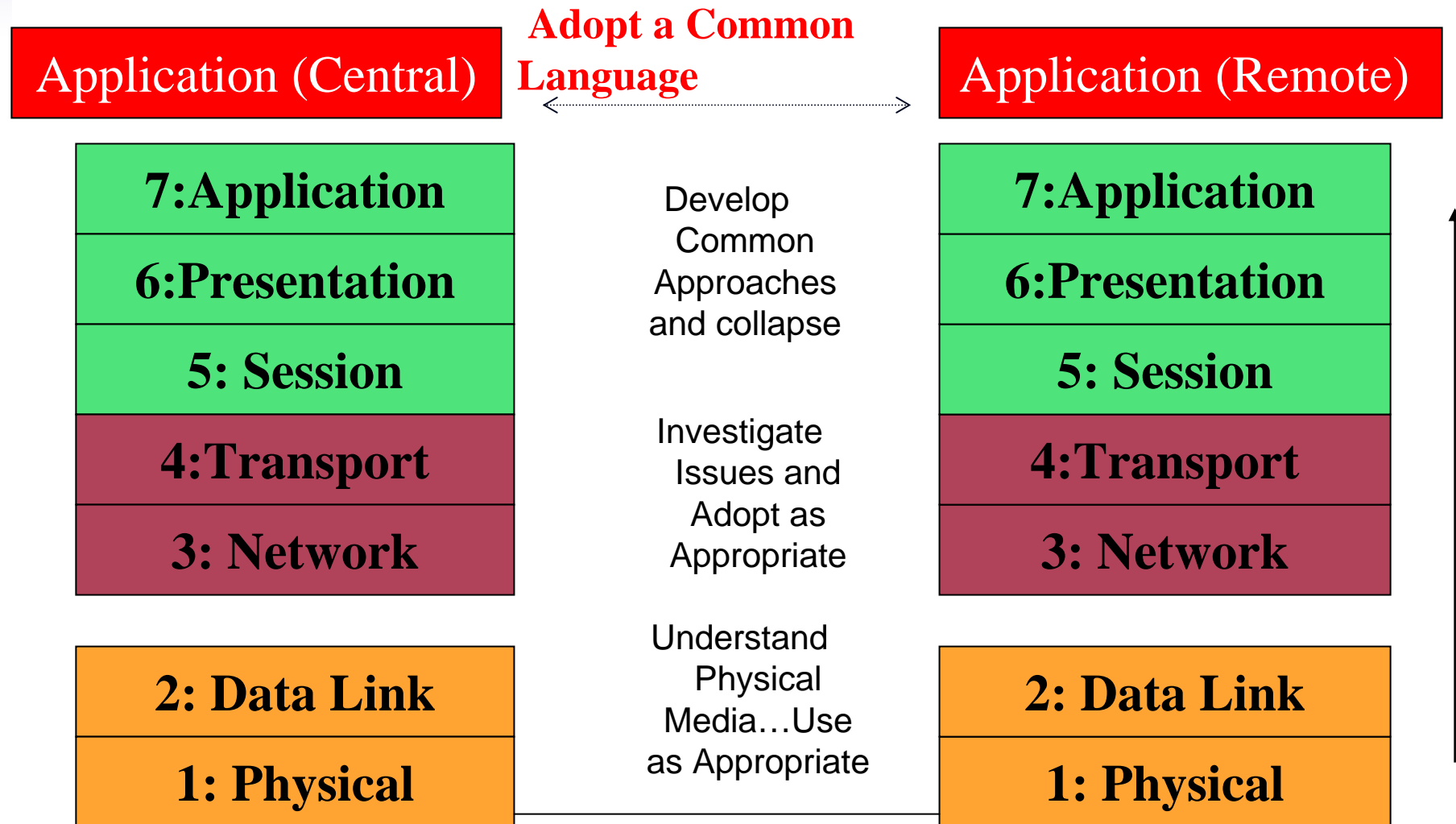


Energy efficiency and demand response *if architected correctly* could assist the development of a smart grid

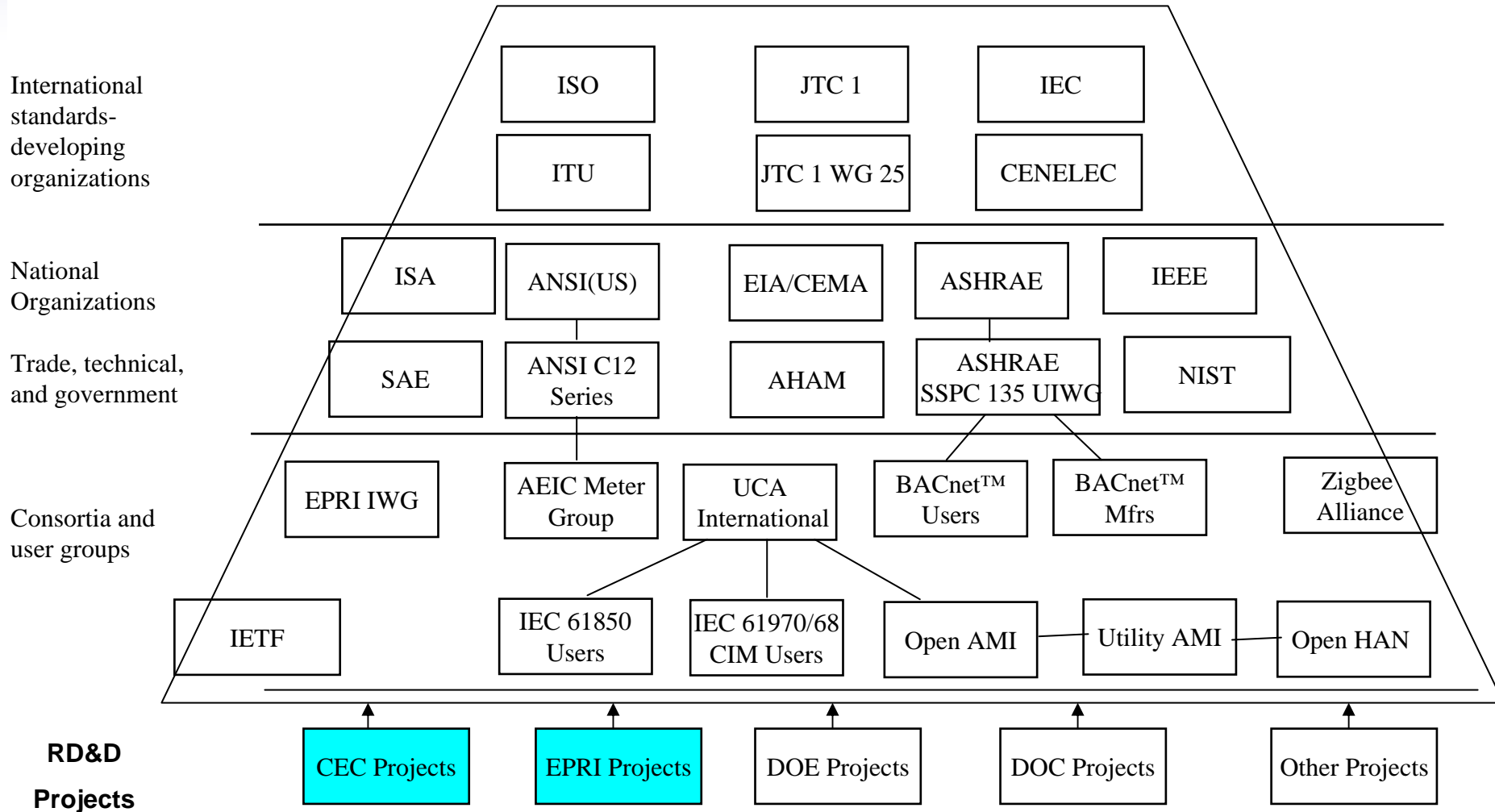
Power Industry Uses a Variety of Distributed Computing “Environments”



Networking Infrastructure Layering Strategies



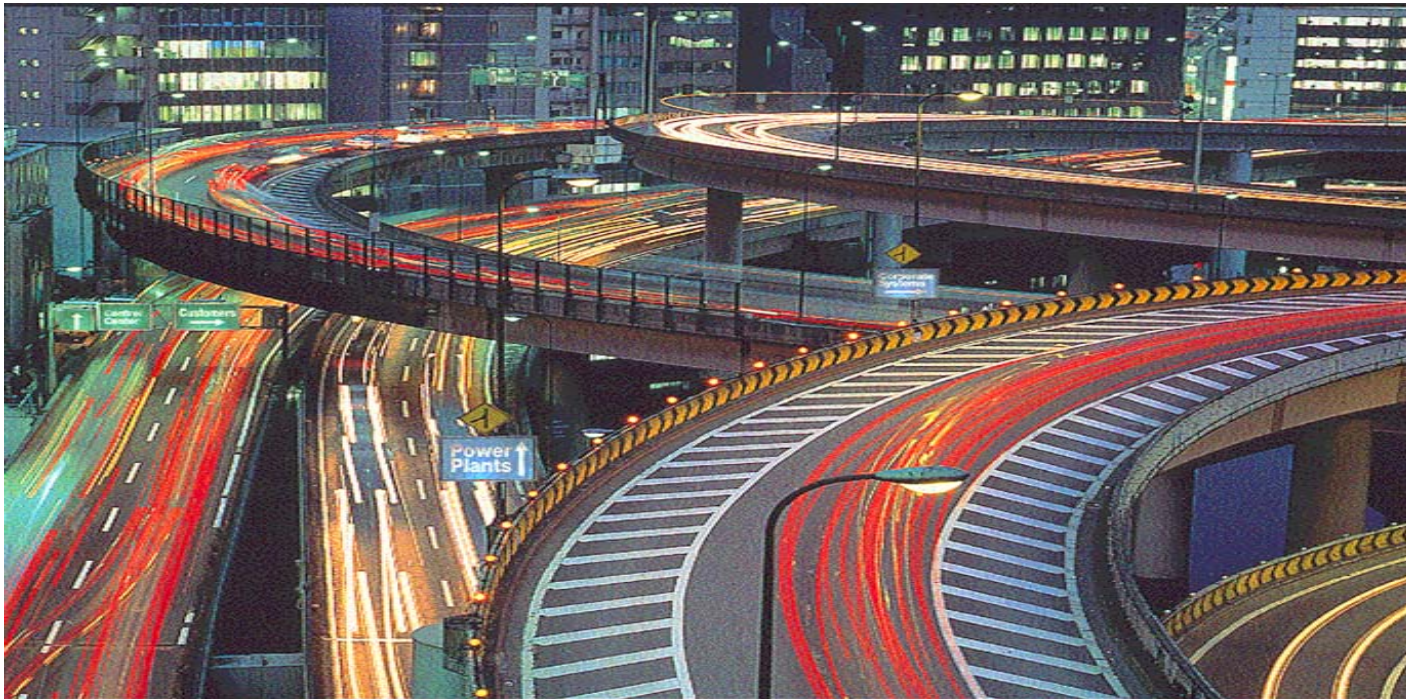
Key Standards Organizations Involved in the Development of “Smart Grid” Infrastructure



*Representative Sample

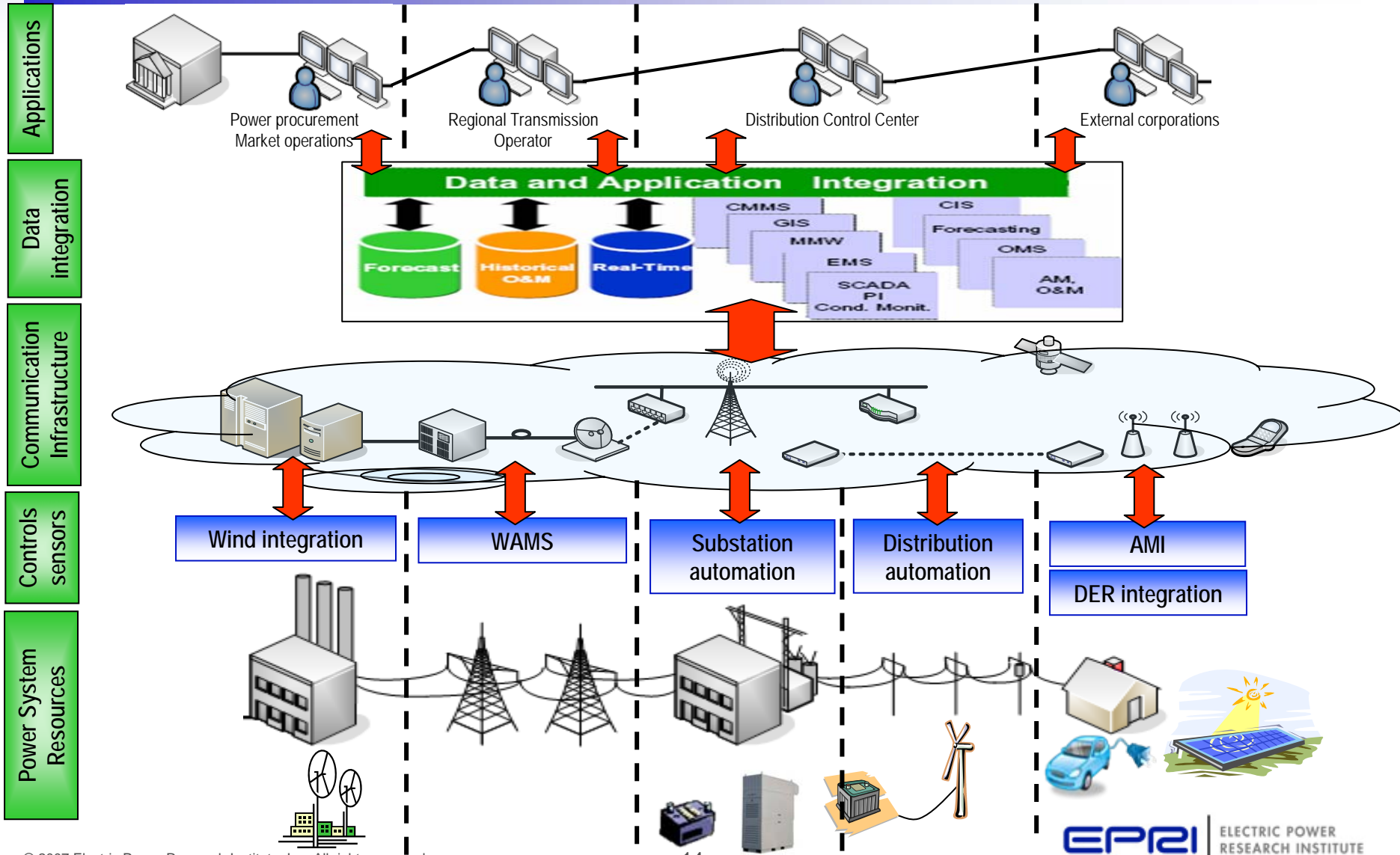
What is an Industry Level Architecture?

Architecture: The Structure of Components, their relationships, and the principles and guidelines governing their design and evolution over time*.



*DoD Integrated Architecture Panel, based on IEEE Std 610.12

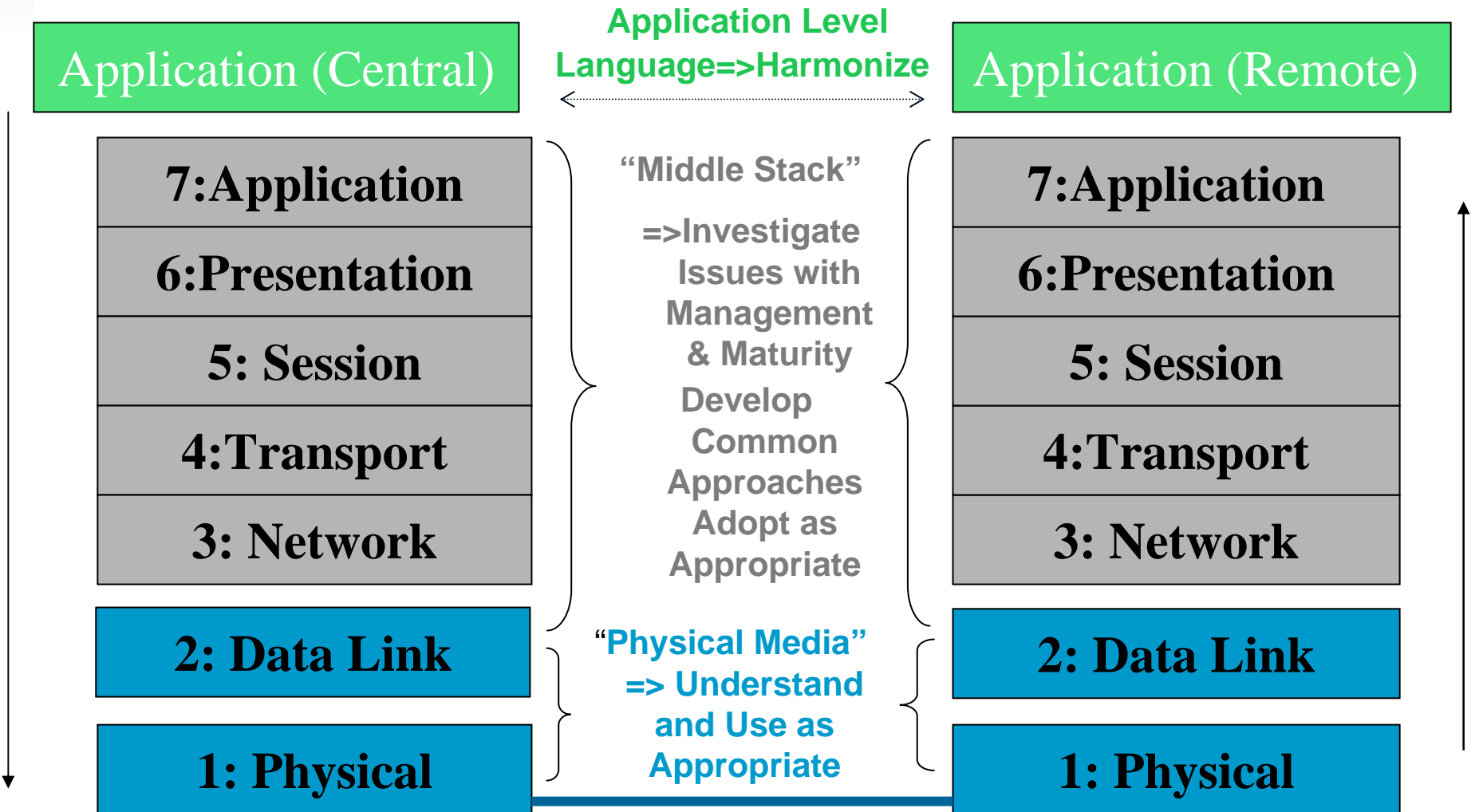
Integration Across Both Information Technology and Field Equipment is Required



Emerging Requirements for Advanced and Mission Critical Applications

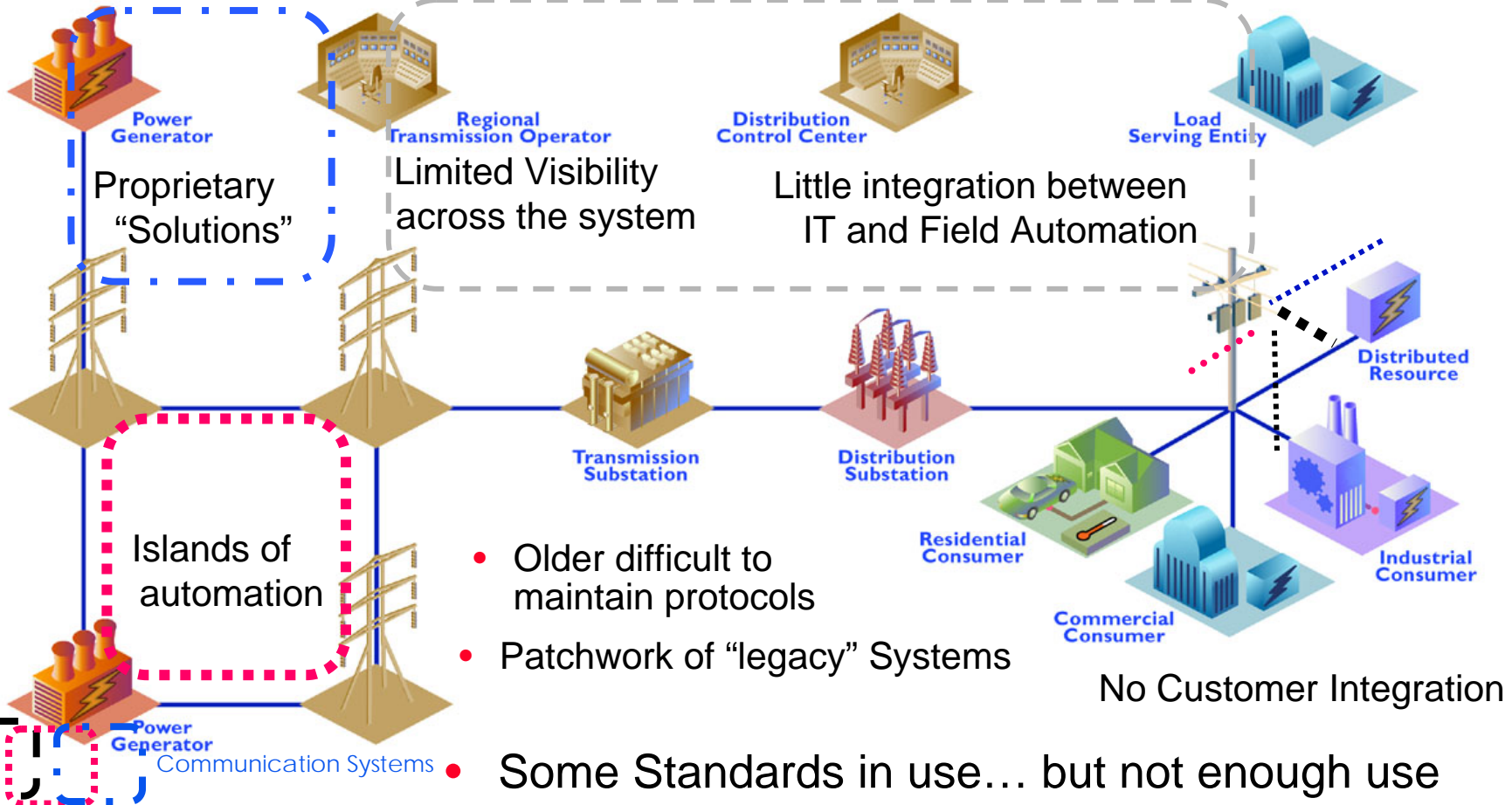
- Mission Critical Power System Automation and Protection
- Real-Time Application Support
- High Reliability
- Full Set of Cyber Security Functions
- Full Set of Systems Management Capabilities
 - Fault, Configuration, Accounting, Performance, Security, Application, Other
- Quality of Service Management
- Scaling and Addressing on Large Scales
- Consistent Policy Based Management over Networks of Networks
- Mobility

OSI Basic Reference Model



“Smart Grid” Today...

- Little or no enterprise level integration

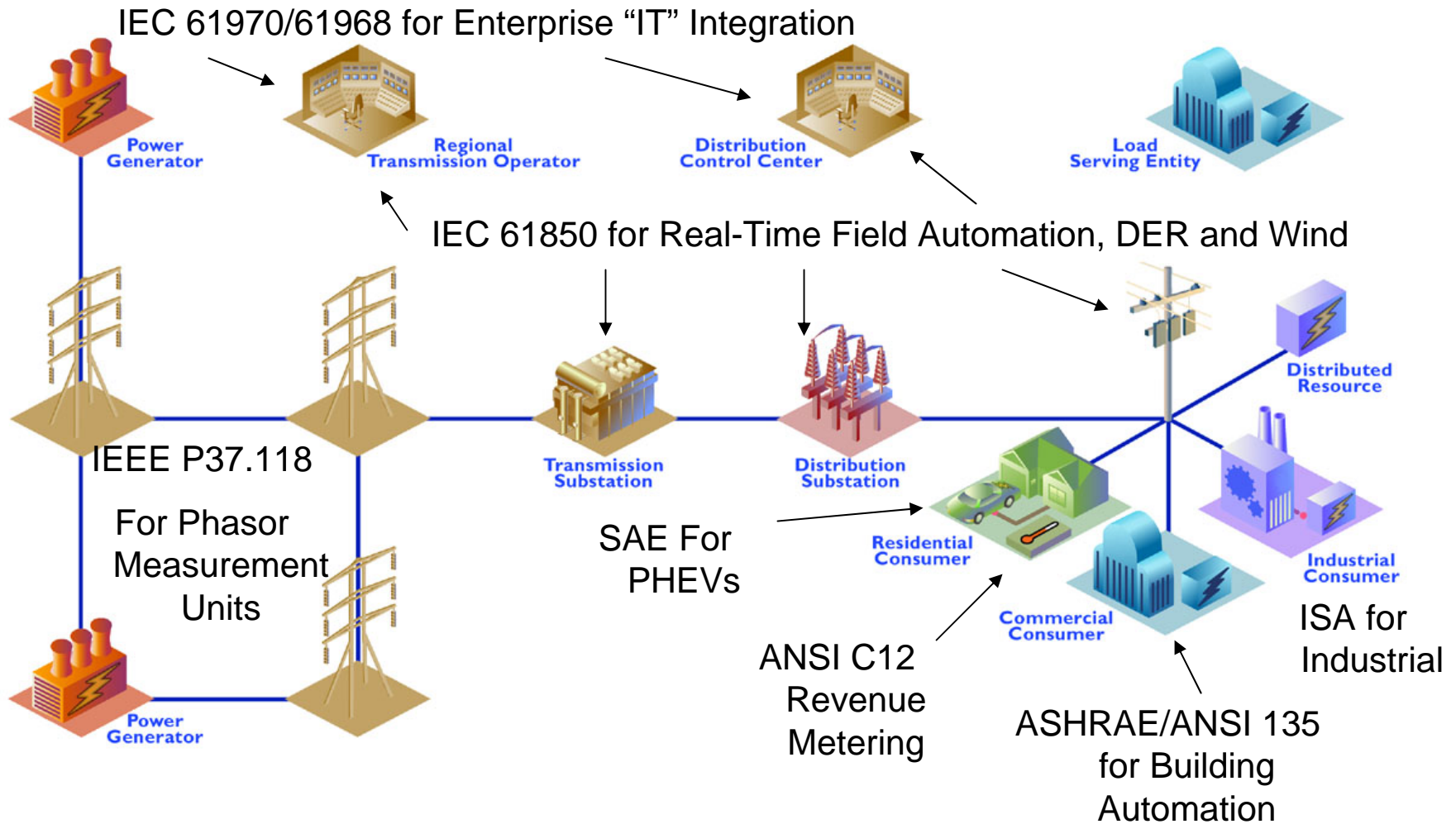


Where’s the Architecture?

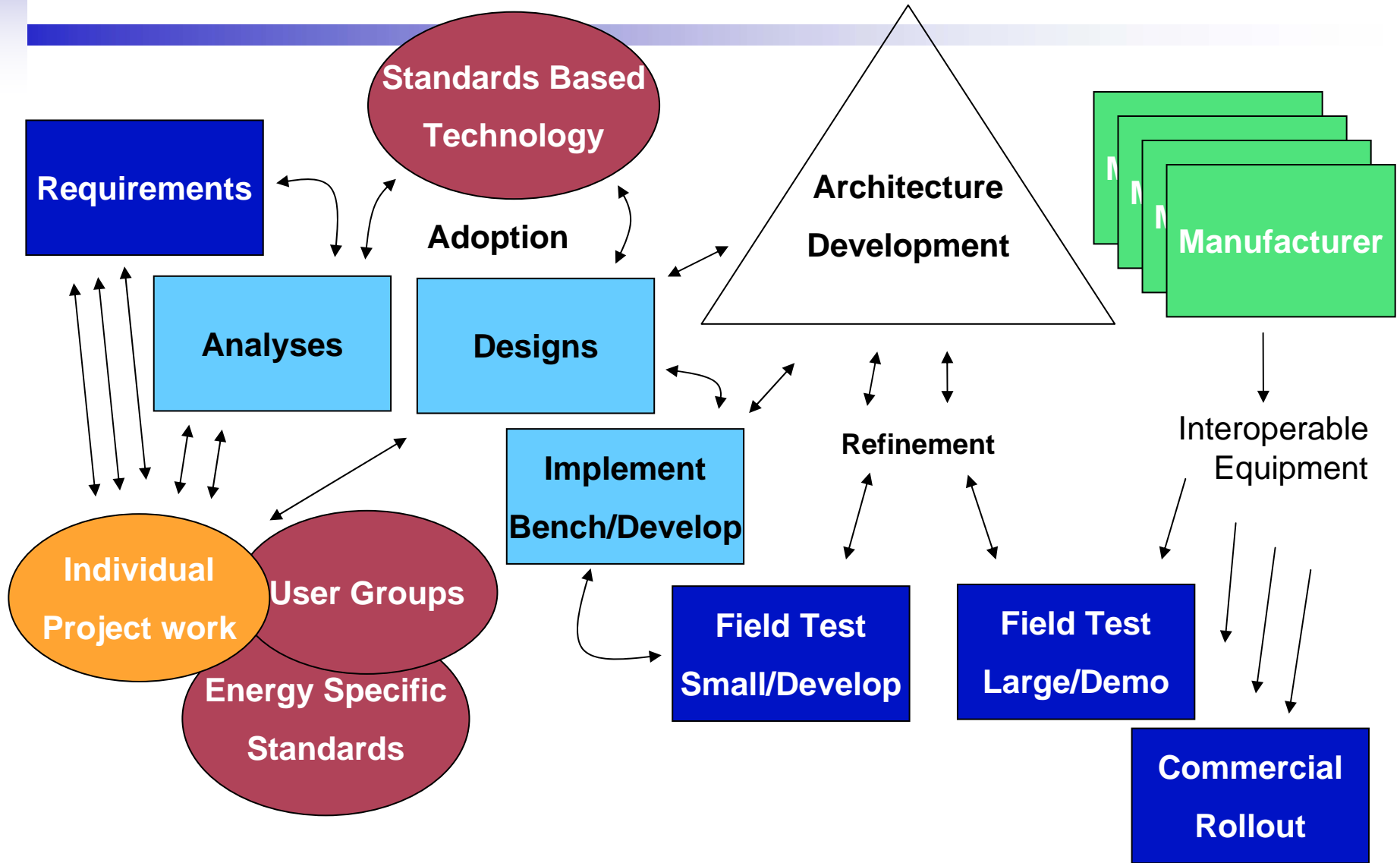
Architecture Vision

- Uses Consistent Policies Across Operating Domains
- Integrates a Wide Variety of Networks
- Integrates a Wide Variety of Physical Media
- Enables Interoperability among Intelligent equipment
- Uses a Carefully Integrated Set of Standards from Different Industries
- Standards are Supported by Effective User Groups
- Industry Requirements are Shared across the industry
- Interoperable Equipment is available Across the Industry
- Conformance and Interoperability Testing widely adopted
- Standardized Notation and Systems Engineering is Widely Used to Specify and Manage Systems

A Sample of “Smart Grid” Infrastructure work that has taken place and needs to be built upon...

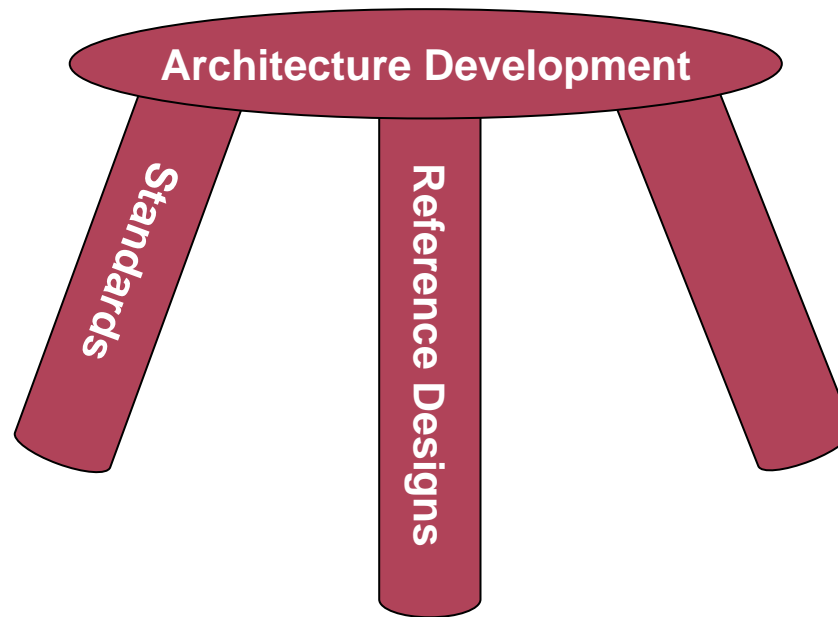


Applications and Infrastructure Development Needs to Occur in Parallel: Designs are Critical to Architecture



Ingredients for Successful Industry Level Interoperable and Managed Systems Development

Three Legged Stool: For Interoperable Products



1) **Open Mature standards:**
Protocols, test schemas, object models

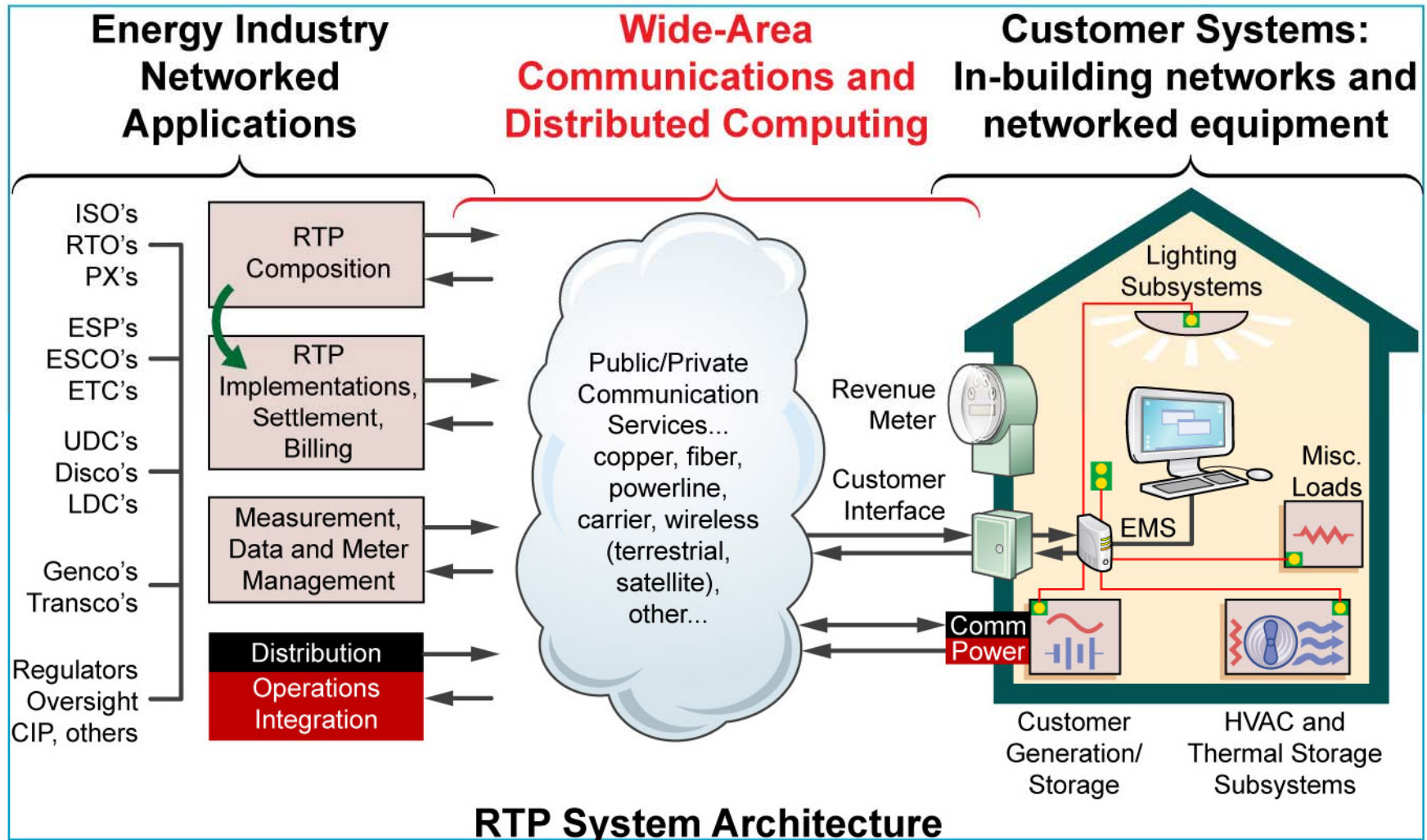
IEC TC57,
ANSI C12,
ASHRAE SPC135,
Other

3) **Reference implementations and Designs:** Developer Tools, Standards Implementations and test implementations

2) **Involved User Group:** Interoperability Agreements, Labeling, Testing, Marketing

UCA International,
BACnet Mfgs. Assoc.
Assoc. of Edison
Illuminating Cos

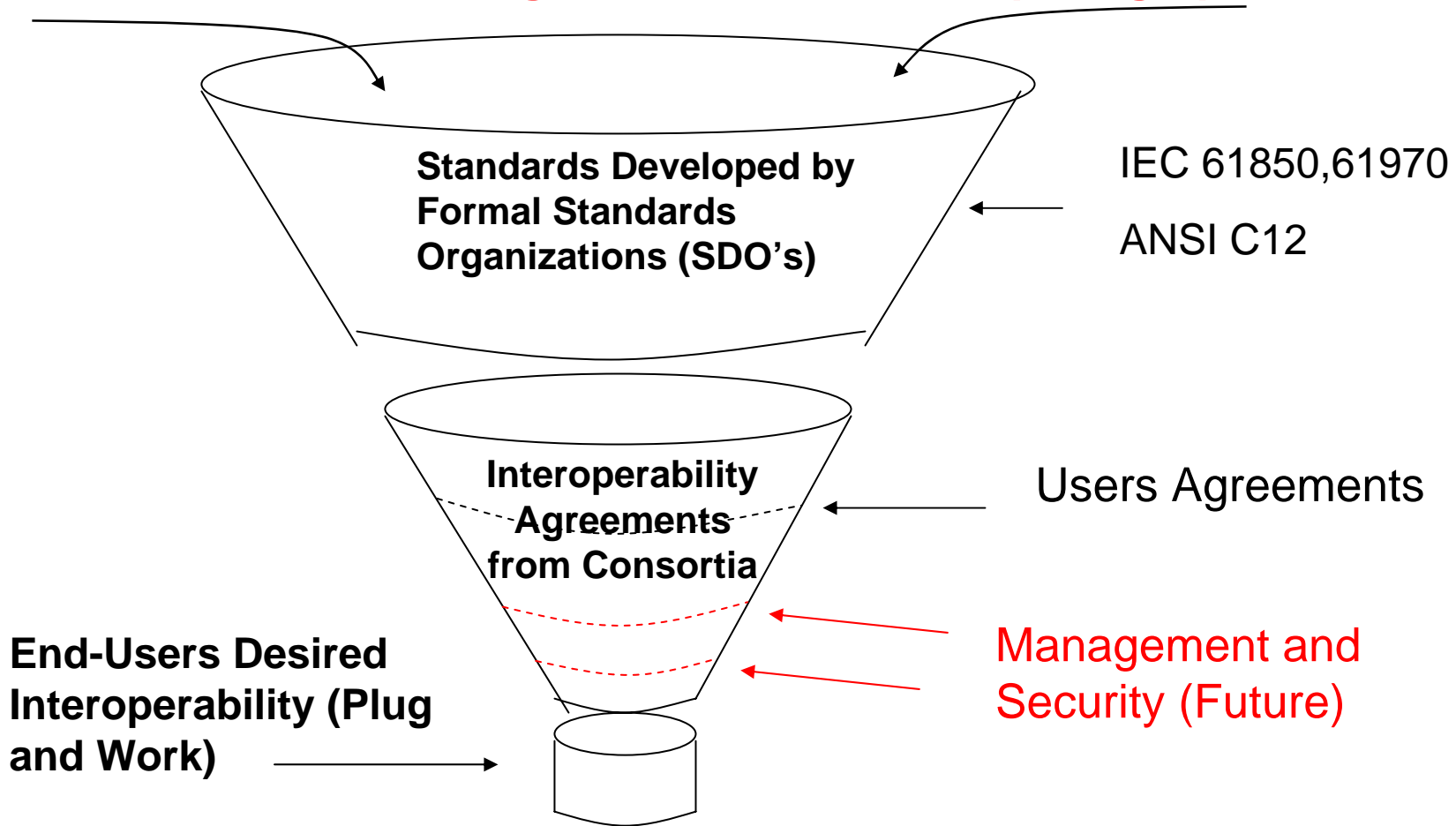
Customer Communications (AMI) Scope: Integrated Wide Area and Local Area Networks



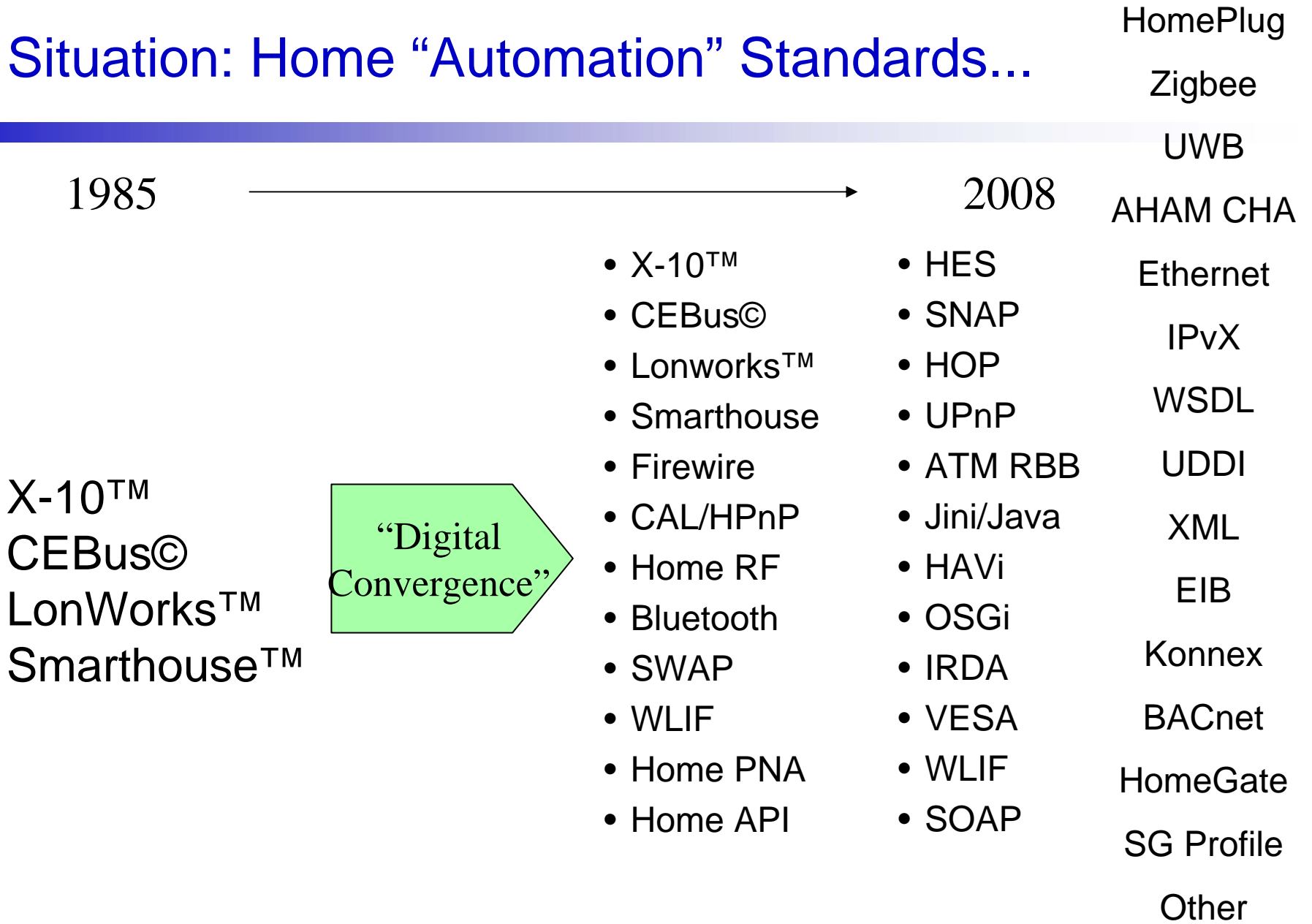
RTP System Architecture

Standards alone are not enough for interoperable product development...

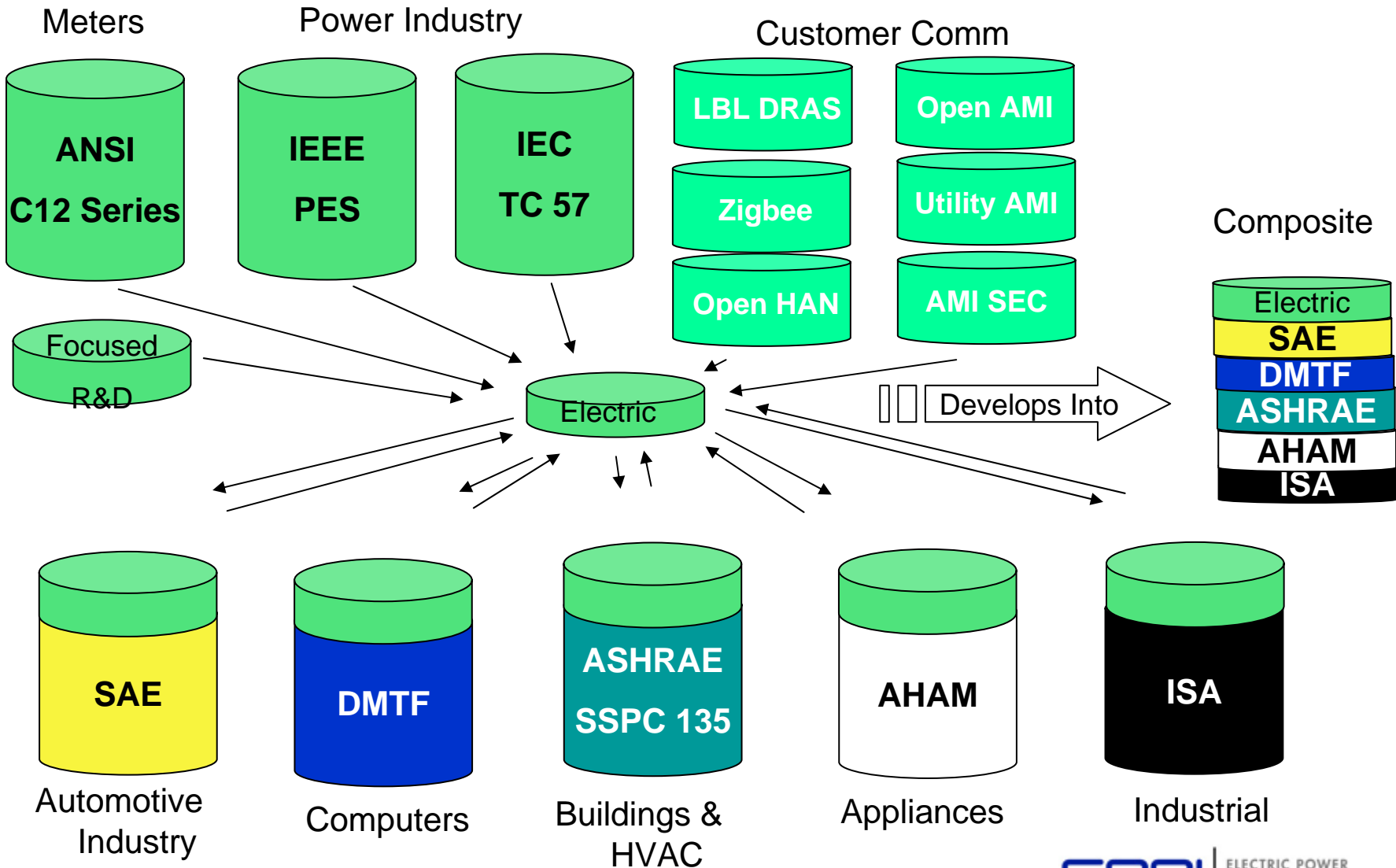
Universe of networking and distributed computing options



Situation: Home “Automation” Standards...



Application Language Strategy for Working with Industry: Mutual Respect For Domain Knowledge



Architectural Gaps

- Policies for management and security need to be further developed and consistently applied
- Network and Systems Management Infrastructures need to be further specified, evaluated and adopted/developed
- Security Architecture Needs to be Developed/Adopted for Advanced Automation and Customer Communications
- Physical Media Options Need to be Better Understood for California Specific Functions, Designs Developed Implemented and Tested
- Networking Infrastructure Options Need to be Better Understood and Designs Developed, Implemented and Tested

Architectural Gaps Continued

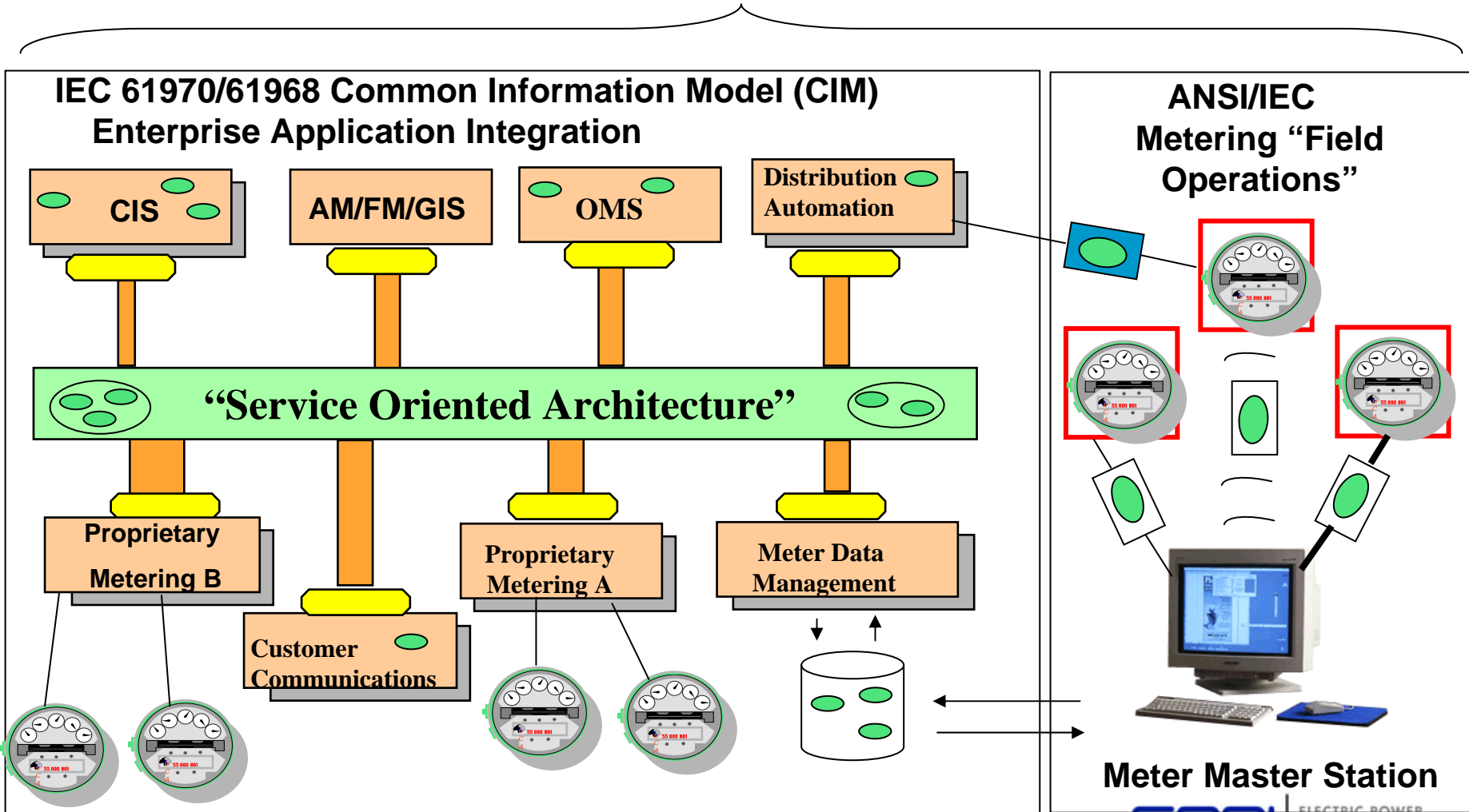
- Requirements and Reference Designs for Advanced Automation and Customer Communications need to be fleshed out for California Specific Functions:
 - Distributed Energy Resource Integration
 - Advanced T&D Automation
 - Customer Communications and Metering
 - In-Building Equipment Integration for Energy Functions
 - EV/PHEV Integration for Advanced Operations
- Common Application Level Communication Objects need to be developed for key applications that cut across traditional Operations

Architectural Development Recommendations

- Develop and Use Systems Engineering Tools to Collaboratively develop requirements that support the key California Applications
- Document requirements in standardized notation and industry models
- Evaluate Requirements and Develop standards based equipment Designs based on the requirements
- Use these designs to evaluate the supporting standards.
- Contribute results to appropriate Standards and User Groups
- Assist the integration of key standards necessary to support next generation applications for California

Develop/Harmonize Common Meter Data Models for Integration of MDMS with Field Operations

R&D Needed: Integrate Across Standards=> Common Meter Data Model



Moving Forward: A Ten Step Program

1. Work toward consistent industry level policies for customer communications infrastructure
2. Use Systems Engineering and Architecture Development Methods and Tools
3. Use a “Requirements Driven” approach to technology adoption and development
4. Work toward an industry level strategic architecture model and development pathway in key areas such as customer interface
5. Do not do “one off” or custom projects that are not on a strategic open systems architecture pathway
6. Do not “wait” for standards: Use, adopt, further develop, contribute to and procure to key industry level standards
7. Understand where the technology “gaps” and “overlaps” are and work on collaborative solutions
8. Adopt technology from other industries only as appropriate making sure it meets energy/power industry requirements
9. Develop energy specific standards where needed: i.e. applications level language
10. Recognize where collaborative R&D is needed and actively participate

Industry Architecture Development Puts a Technical Framework around Key Relationships...

