

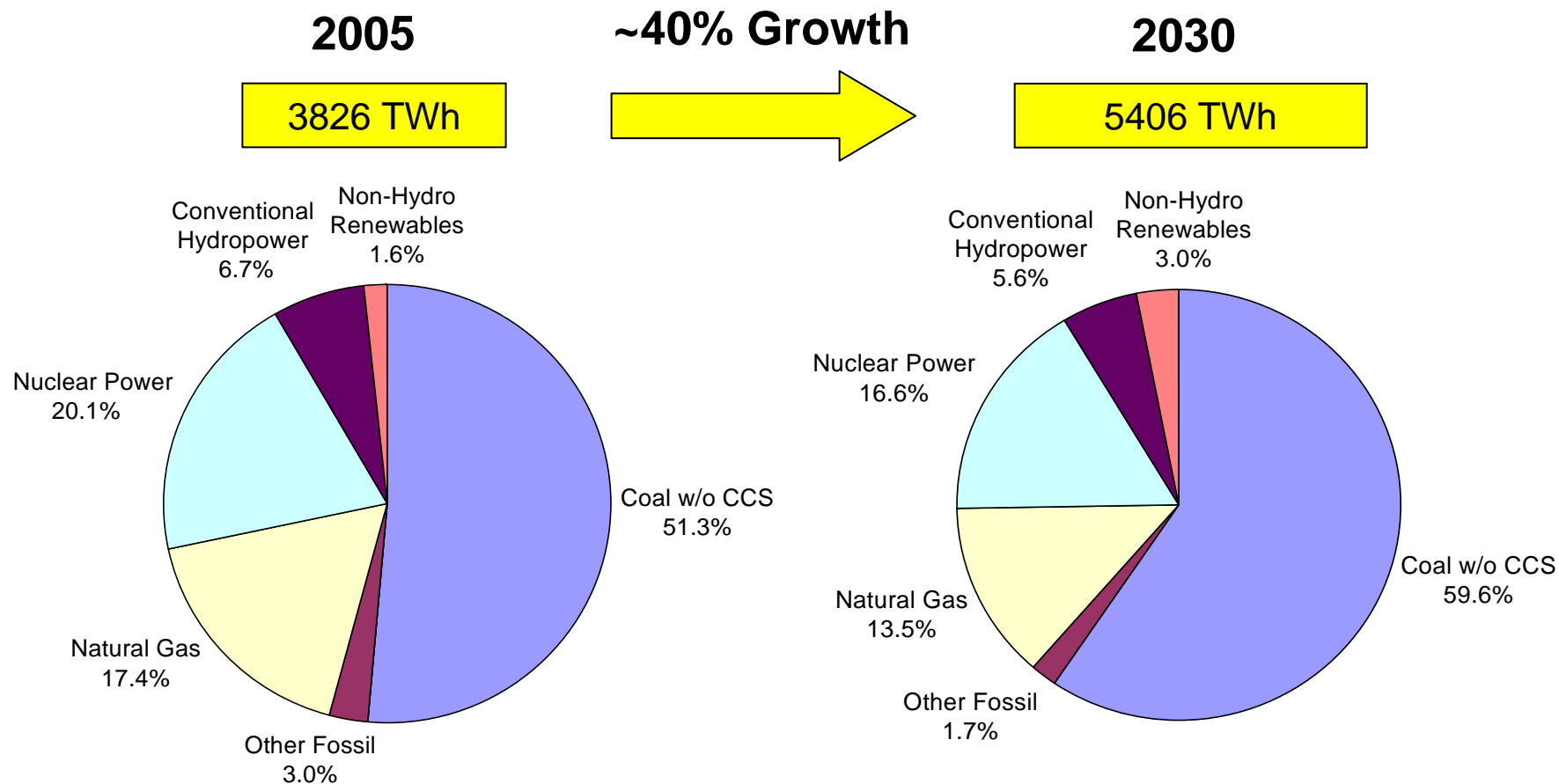


Technology Overview: Smart Grids

**Smart Grid Collaborative Kick-Off
Workshop**
August 14, 2007

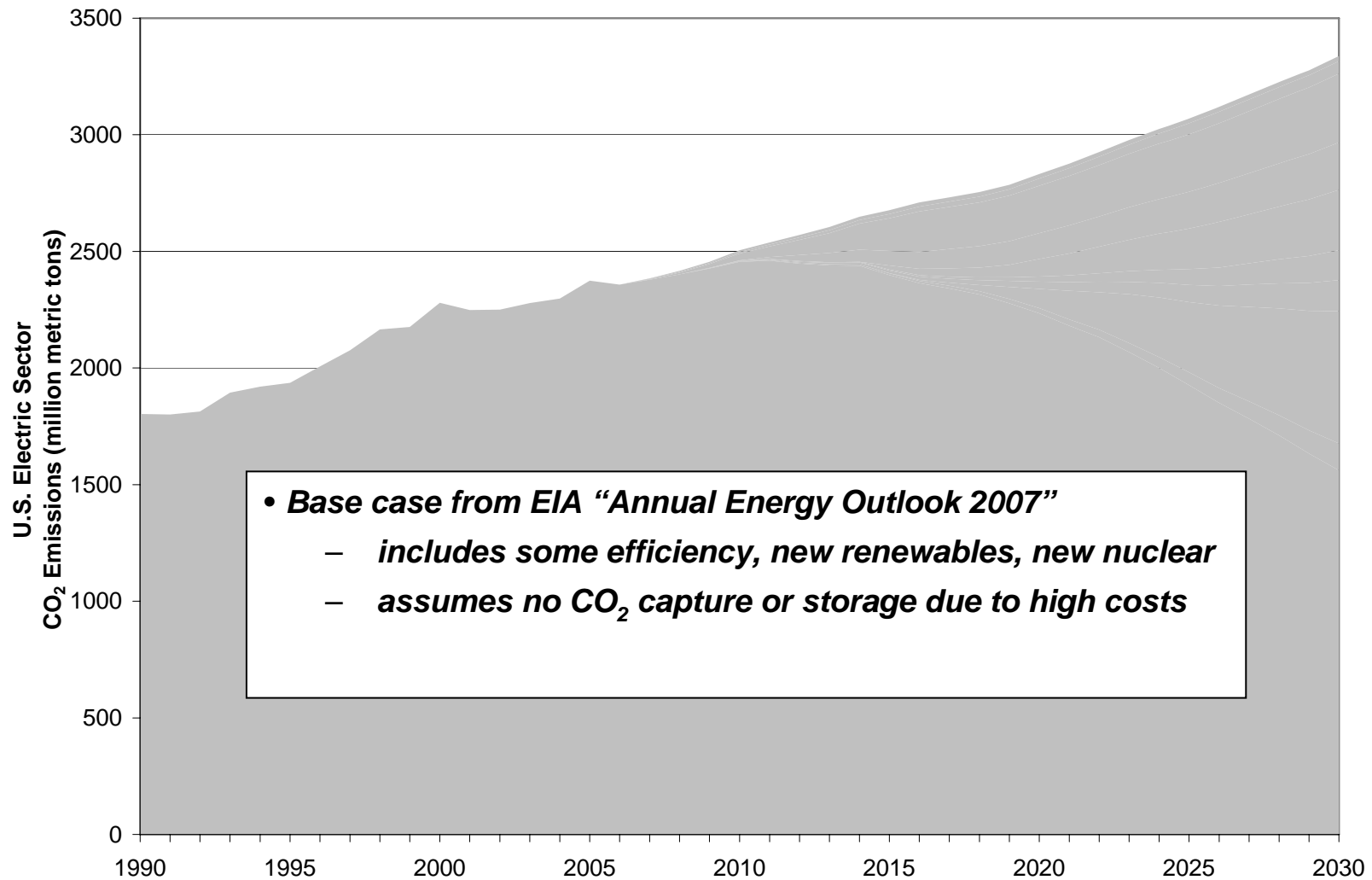
Ellen Petrill
Director, Public/Private Partnerships
EPRI

U.S. Electricity Generation Forecast* - 40% Growth

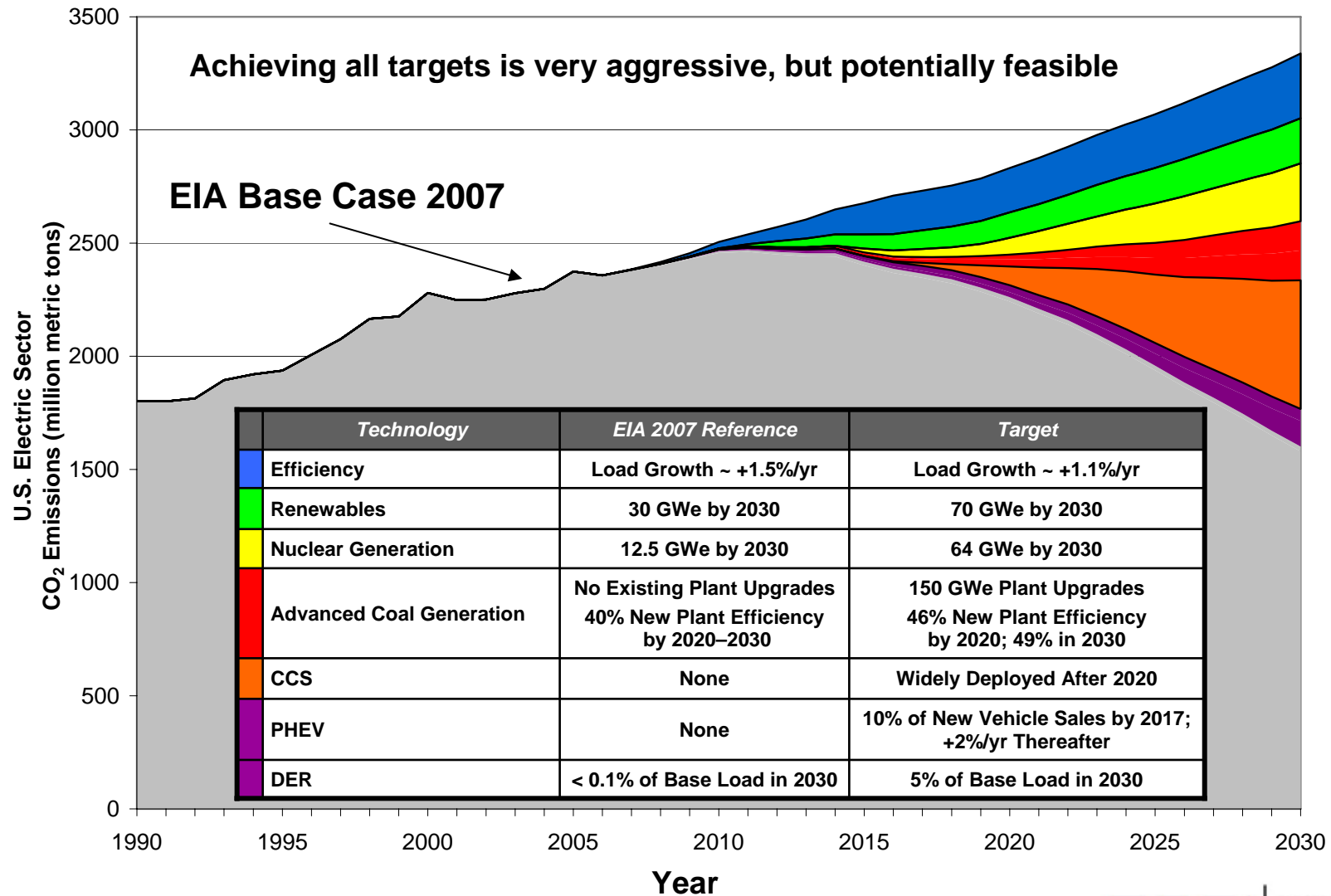


* Base case from EIA "Annual Energy Outlook 2007"

Forecasted U.S. Electricity Sector CO₂ Emissions



EPRI CO₂ PRISM



Key Technology Challenges

Advanced Electricity Technologies needed for “Prism” profile

1. Smart grids and communications infrastructures to enable end-use efficiency and demand response, distributed generation, and PHEVs.
2. A grid infrastructure with the capacity and reliability to operate with 20-30% intermittent renewables in specific regions.
3. Significant expansion of nuclear energy enabled by continued safe and economic operation of existing nuclear fleet; and a viable strategy for managing spent fuel.
4. Commercial-scale coal-based generation units operating with 90+% CO₂ capture and storage in a variety of geologies.

Achieving “Prism” profile requires aggressive public and private sector RD&D programs and accelerated commercial deployment

Today's Power Delivery System Needs Modernization

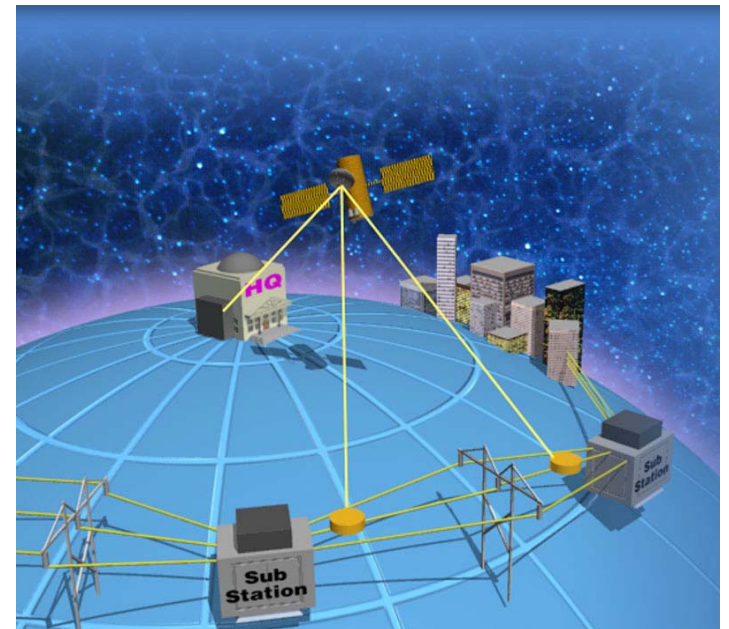
- Current system
 - \$400B book value
 - 1950s technology
 - Designed for lighting, motors
- Needs modernization
 - Reliability, security
 - Control
 - Advanced end uses and customer services



The IntelliGrid Vision

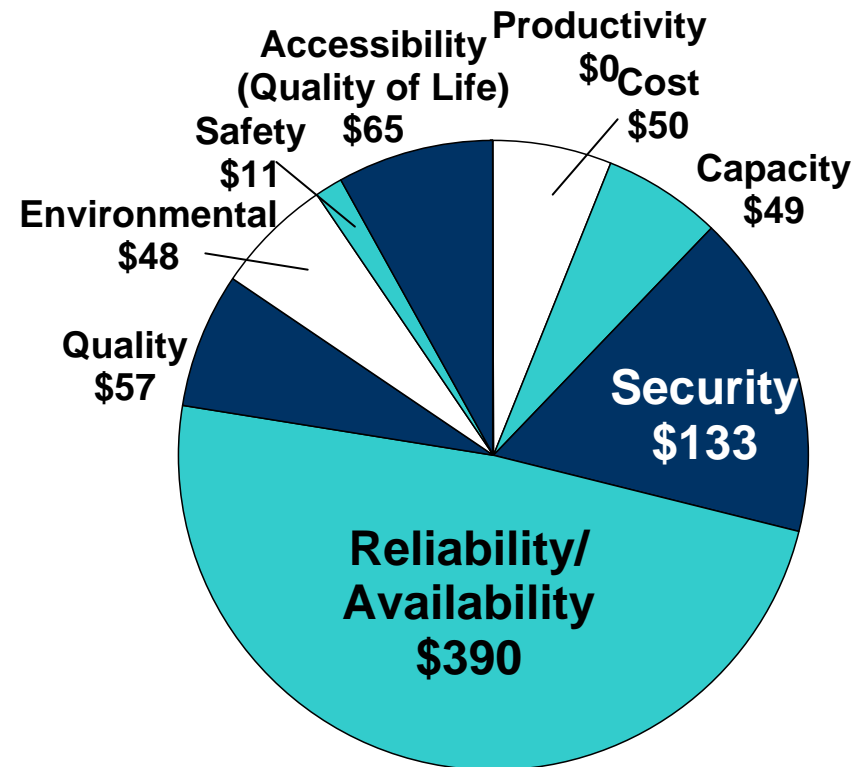
The power delivery system of the future

- Is fully coordinated to operate automatically, efficiently, reliably
- Takes advantage of central and distributed power supply and demand resources
- Handles emergency conditions with self-healing actions
- Communicates intelligently between customers, operators, and decision-makers



A Modernized Power Delivery System Will Benefit Society

- Greater system reliability, functionality, and consumer value at lower costs
- Enhanced system security
- Enables demand response and energy efficiency
- Reduces carbon emissions through optimized use of assets
- Integrates distributed and renewable energy
- Increases economic productivity

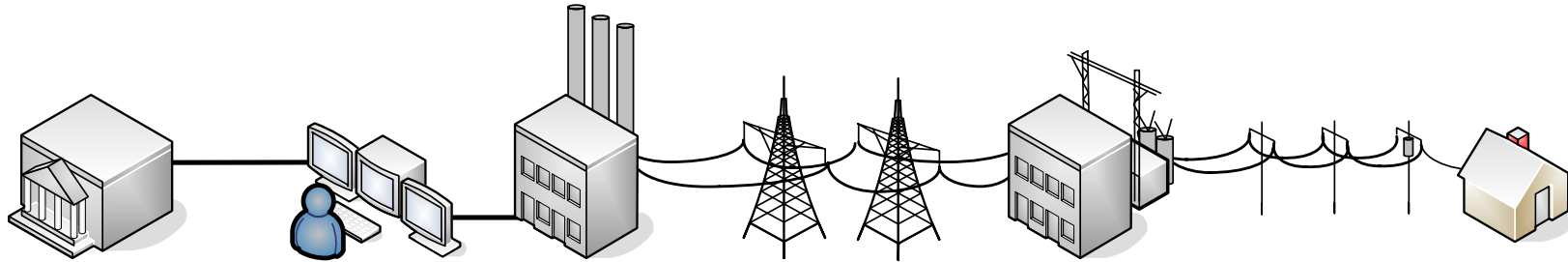


Total Net Present Value = \$802B

Annualized Value= \$64B/year

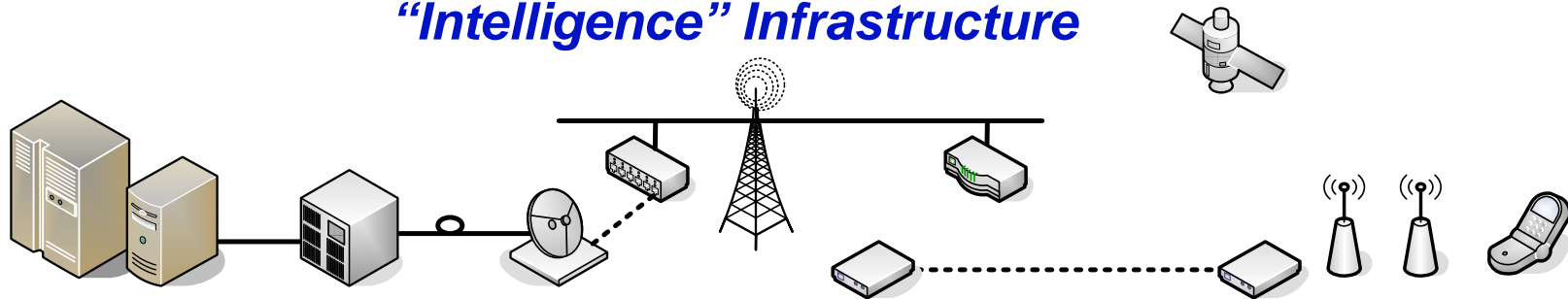
Based on EPRI Survey, 5% Discount Rate

Merging Two Infrastructures

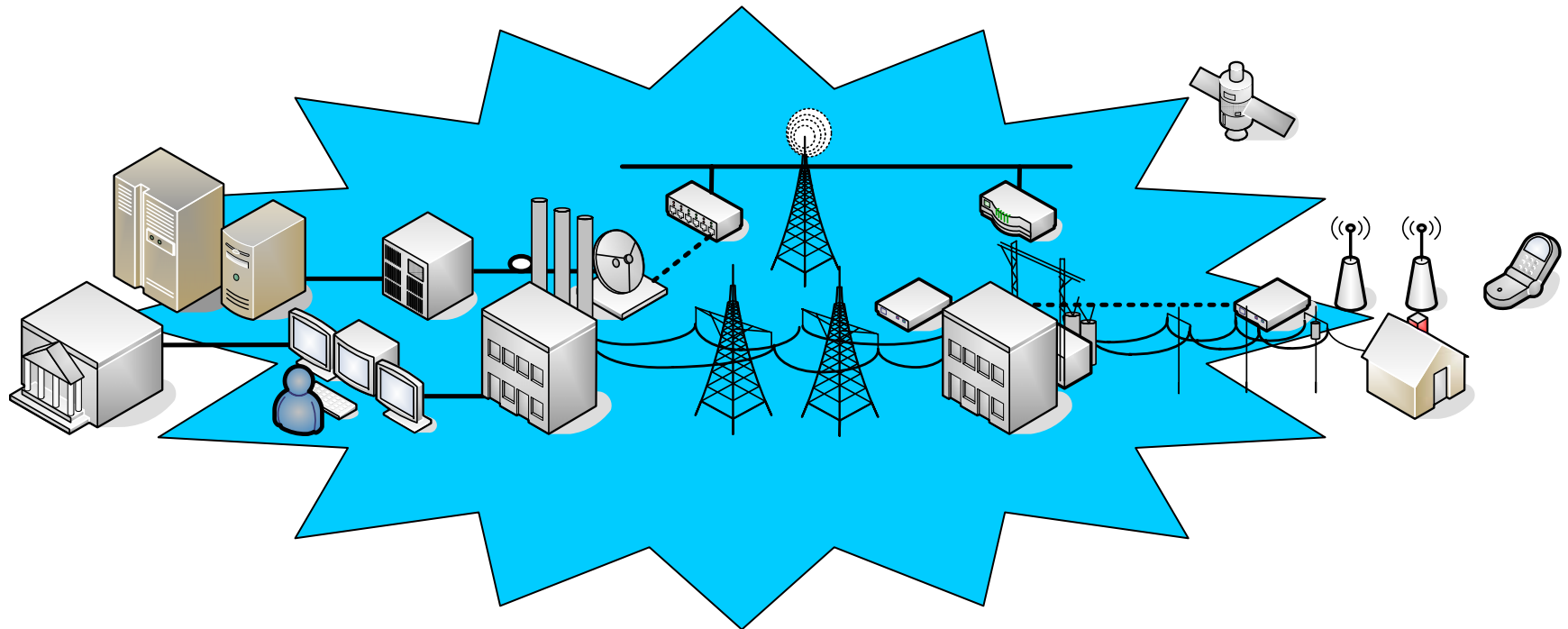


Electrical Infrastructure

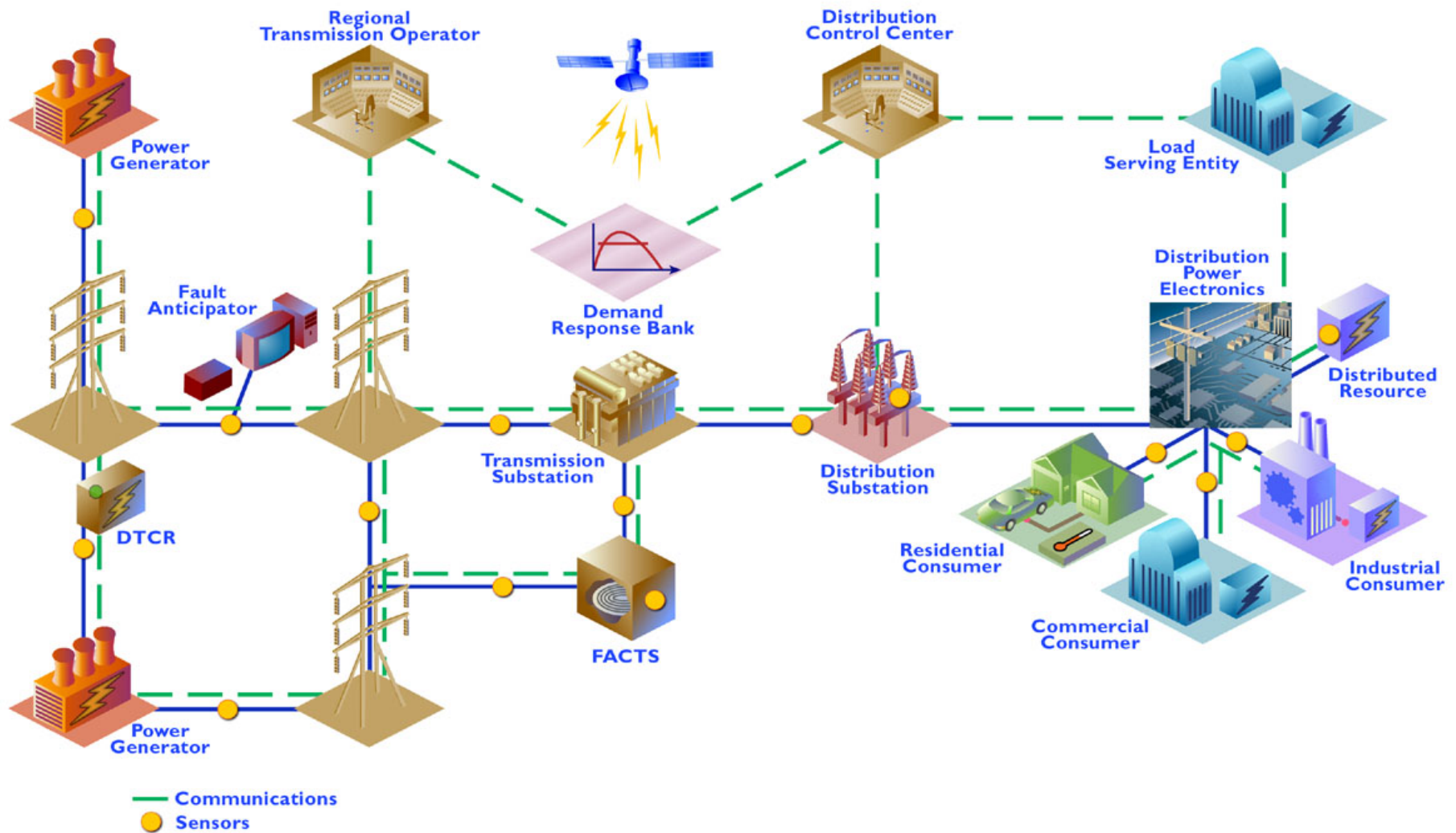
“Intelligence” Infrastructure



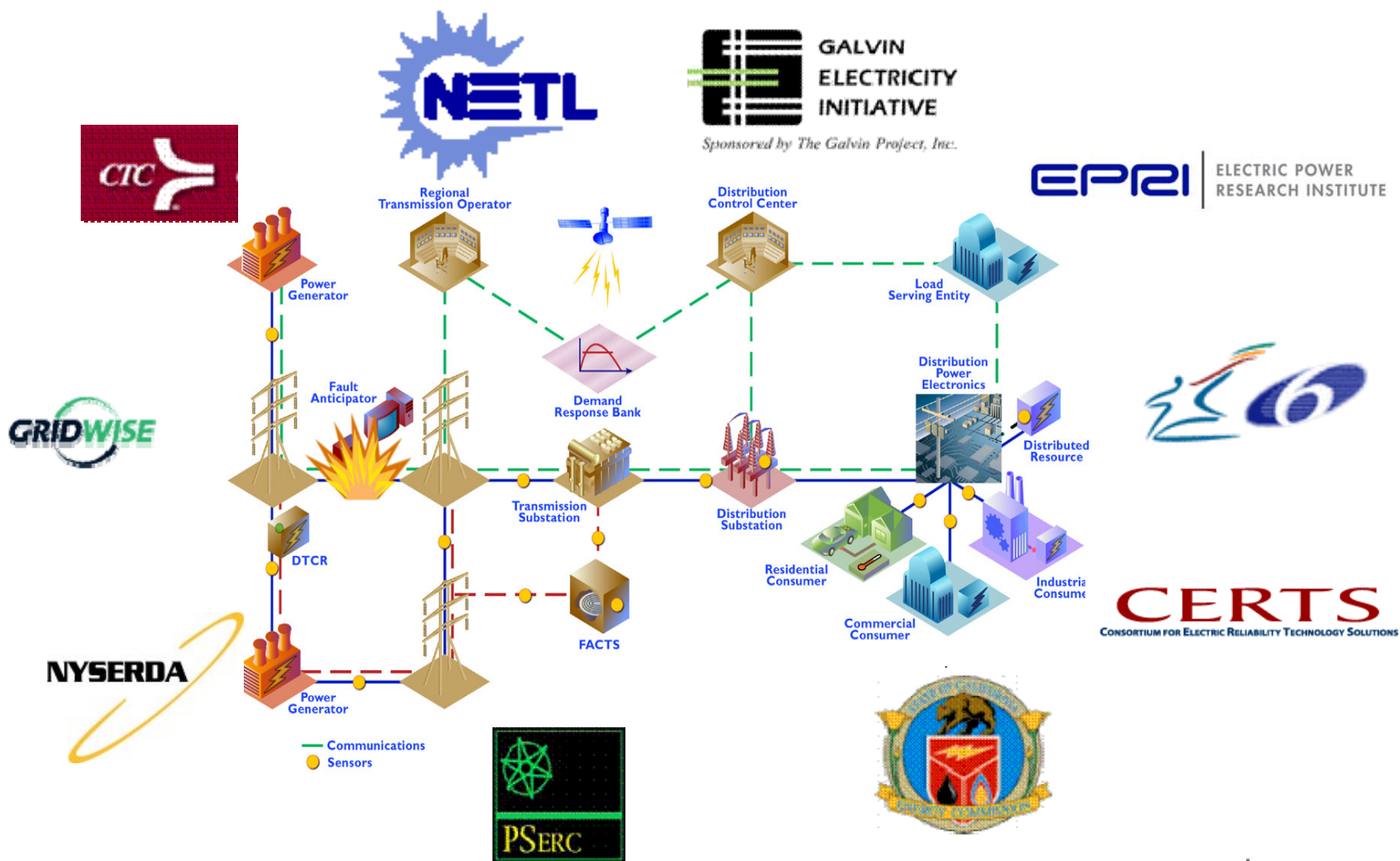
The Intelligent Grid



The Intelligent Grid Uses Smart Devices, Communications, and Computing



Smart Grid Programs Share Same Goals



EPRI IntelliGrid: Since 2001

Technical Foundation: Communications

Enable devices and controllers to “talk” to each other

- ***IntelliGrid Architecture Guidebook***: the building codes to link electricity and communications systems (Completed!)
- ***Consumer Portal***: two-way communications gateway between consumers and service providers (Defined functions and reference design)
- ***Communications Protocols for Distributed Energy Resources***: Plug and play for DER (Object models completed for fuel cells and reciprocating engines)

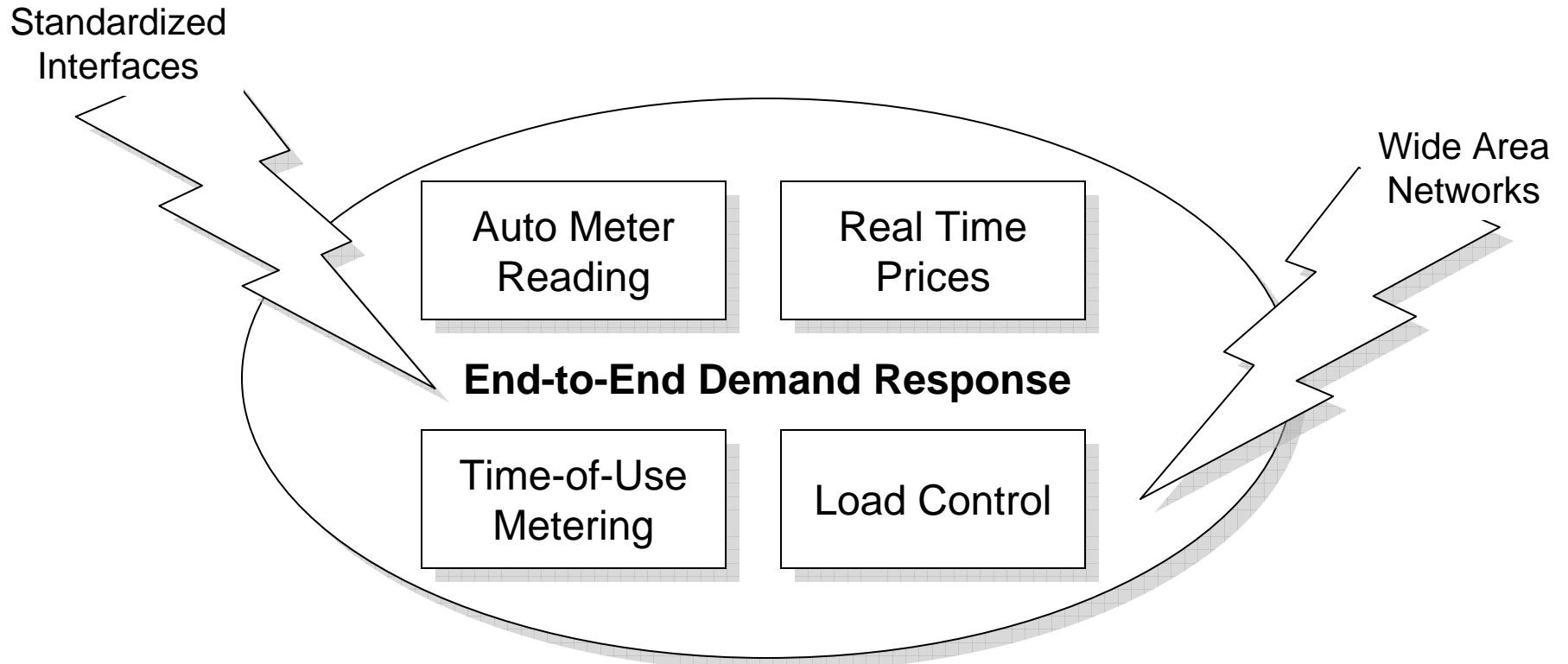
EPRI IntelliGrid: Since 2001

Technical Foundation: Computing

Simulation software of the smart grid must provide information faster than real-time

Fast Simulation and Modeling: Software to predict behavior and optimize or fix the delivery system faster than real time (Functional requirements completed)

Creating an Intelligent System: Demand Response



- A utility sets up basic automated revenue metering...
- Adds a few more advanced capabilities...
- With the addition of new technology, knowledge and/or algorithms
- Creates a next-generation Intelligent System

Linking Intelligent Systems

**Self-Healing
Wide-Area
Protection
& Islanding**

**End-to-End
Demand
Response**

**Participation in
Energy Markets**

**Distributed
Generation &
Renewable
Energy**

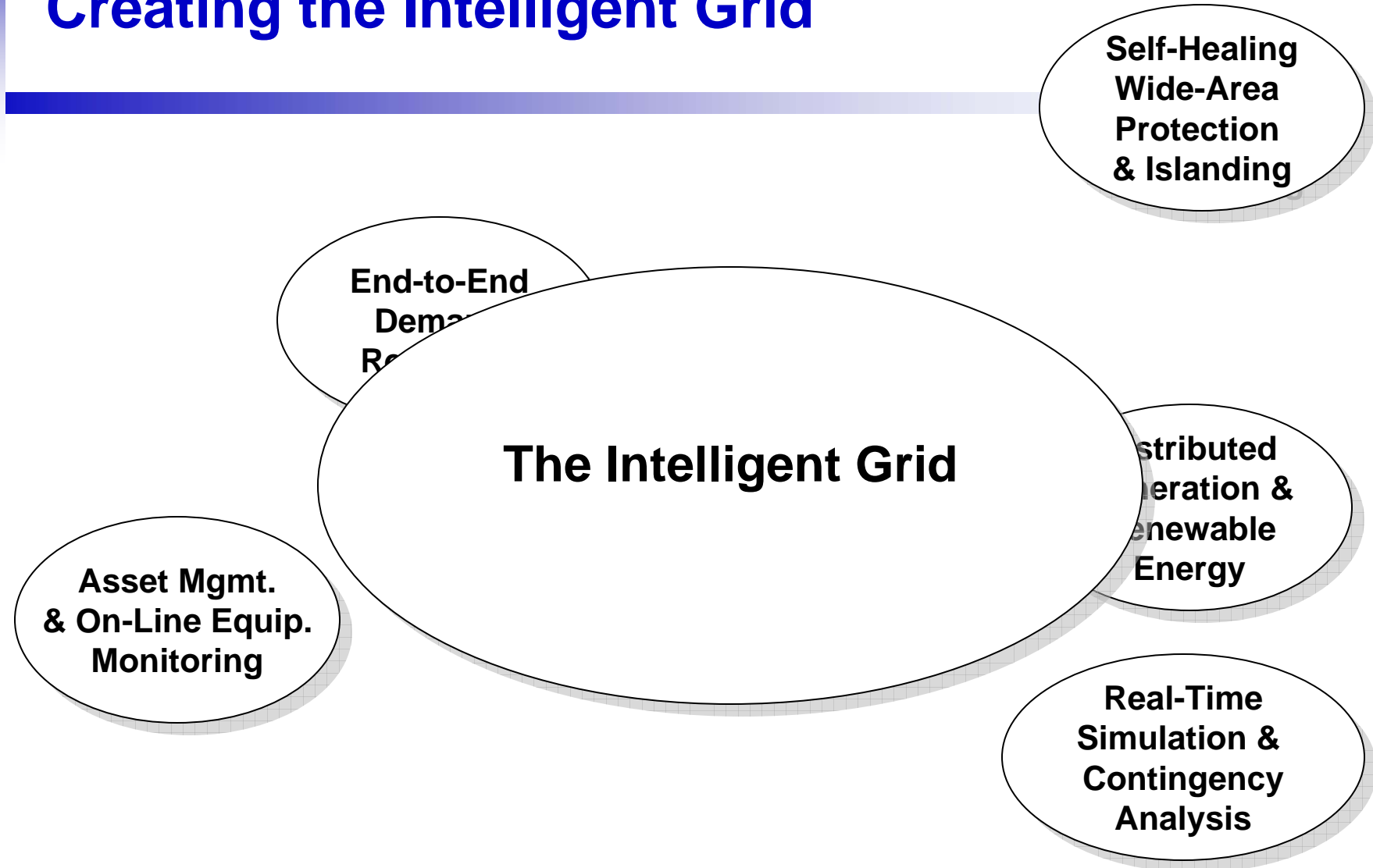
**Asset Mgmt.
& On-Line Equip.
Monitoring**

**Reliability
Management
Thru PQ**

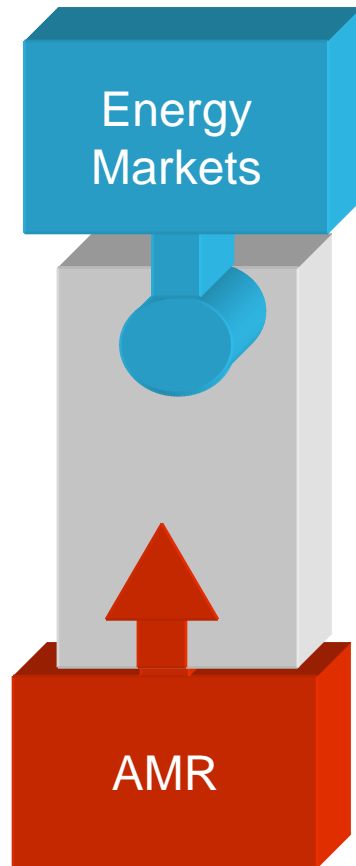
**Real-Time
Simulation &
Contingency
Analysis**

- The complexity of the system keeps increasing
- New technologies increase intelligence

Creating the Intelligent Grid



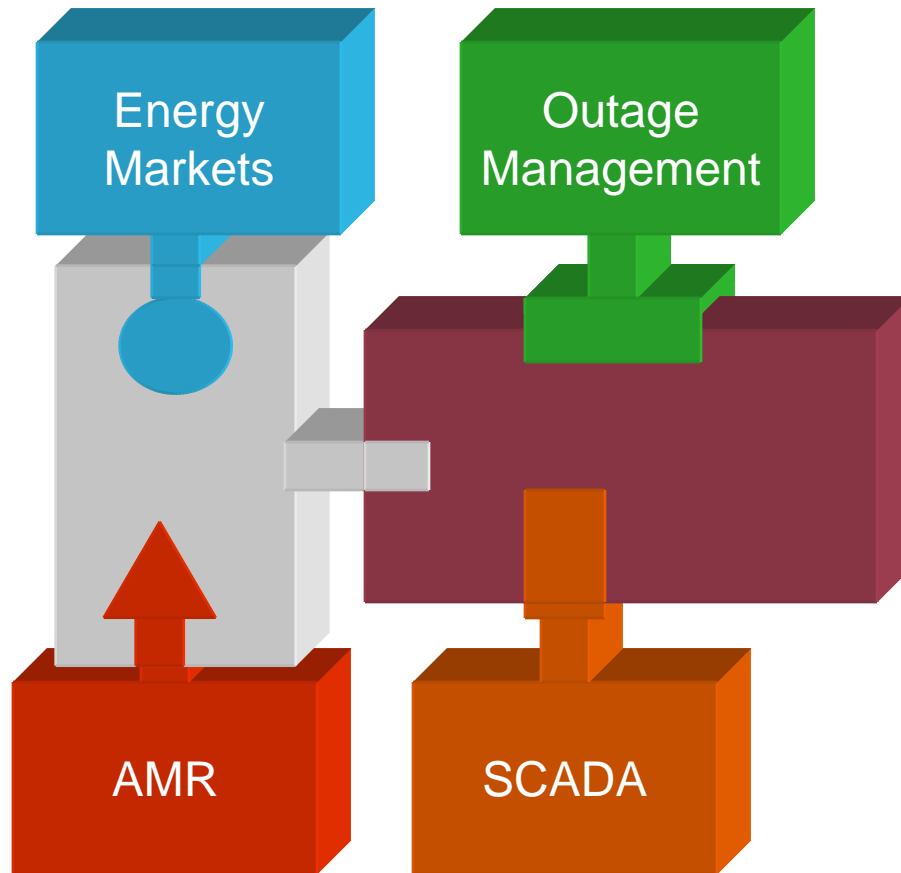
Why Integrate Intelligent Systems?



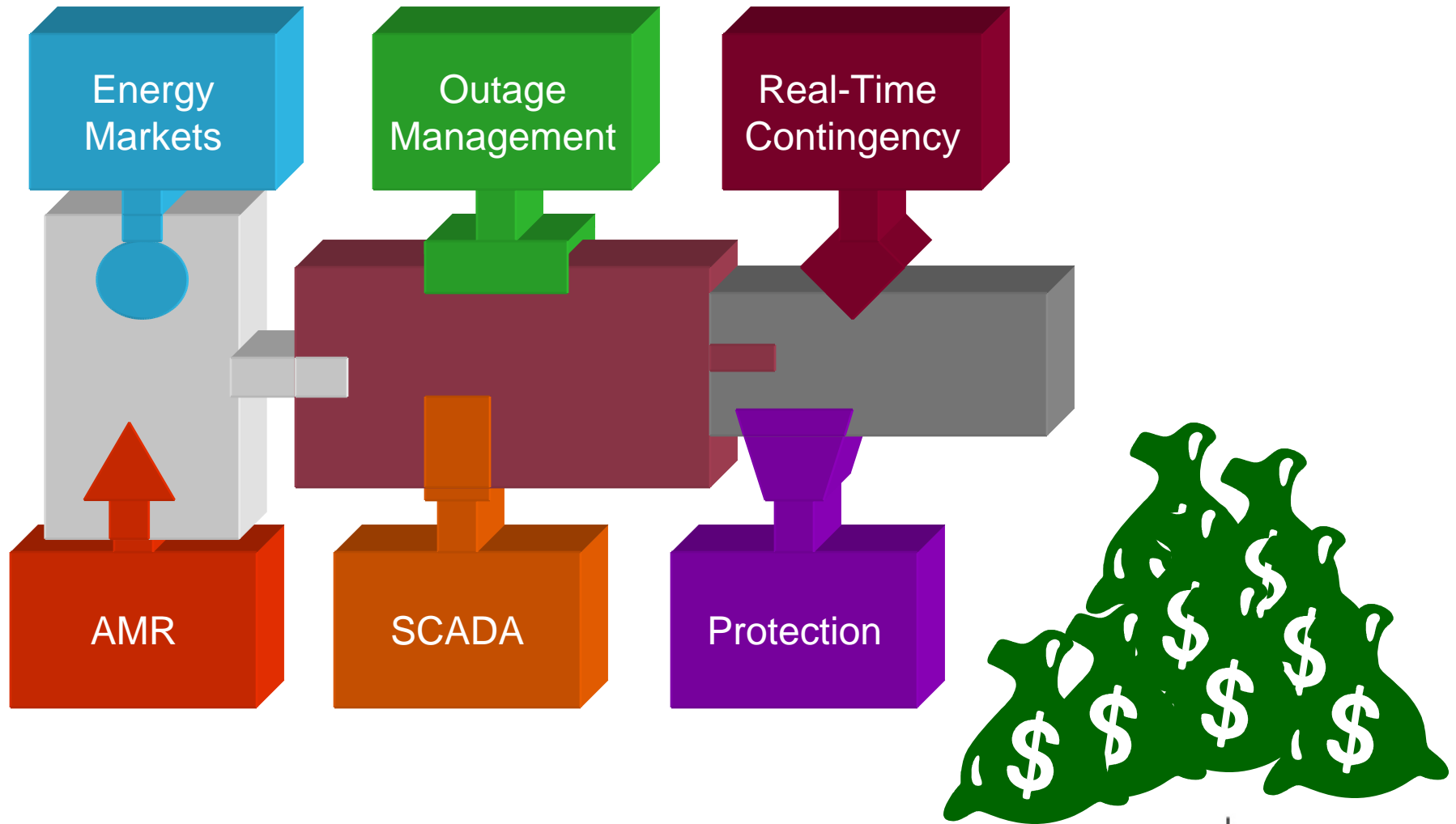
- Integration provides more valuable information
- But, integration is typically done after the fact
- Cost is significant



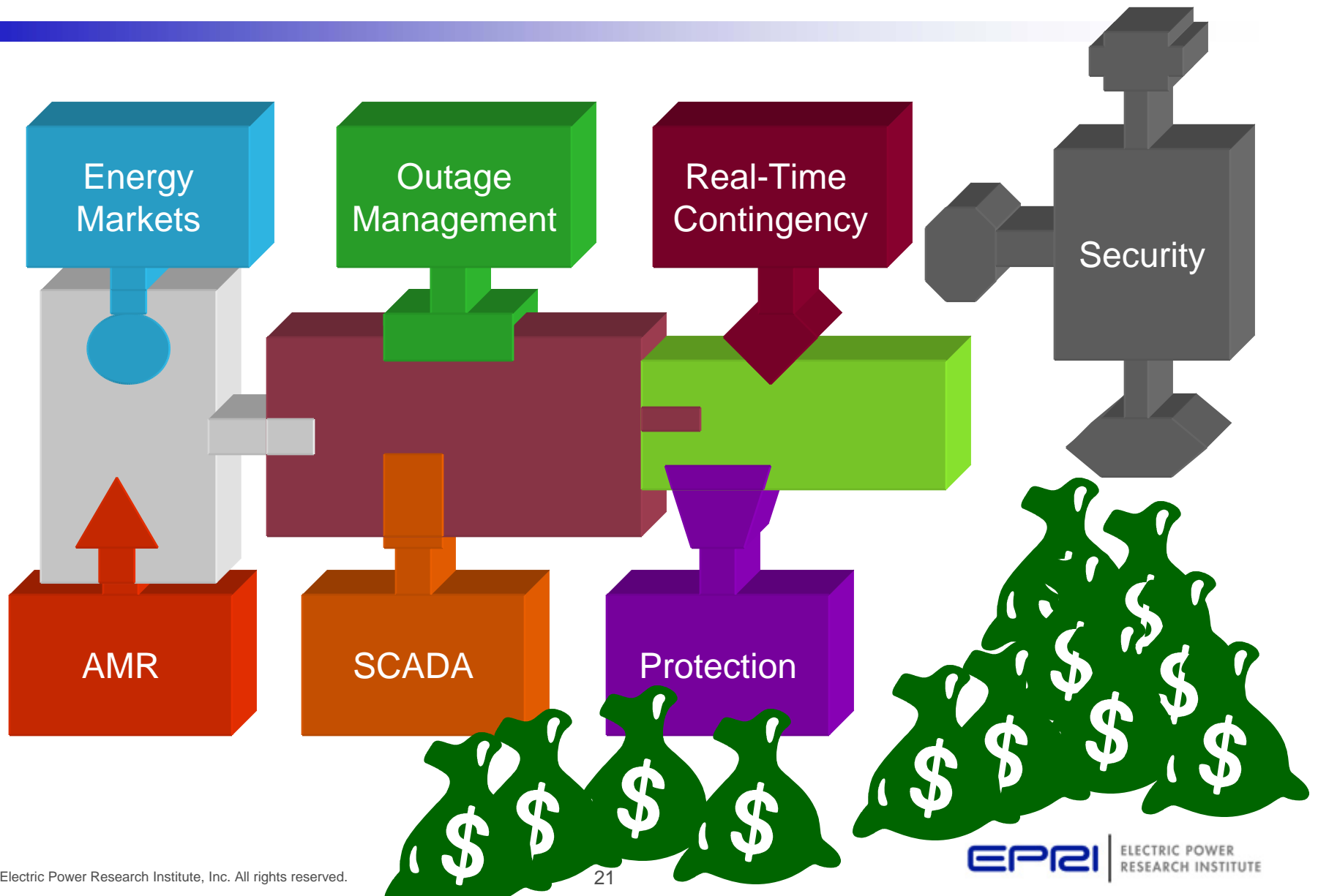
Customized Integration is Costly



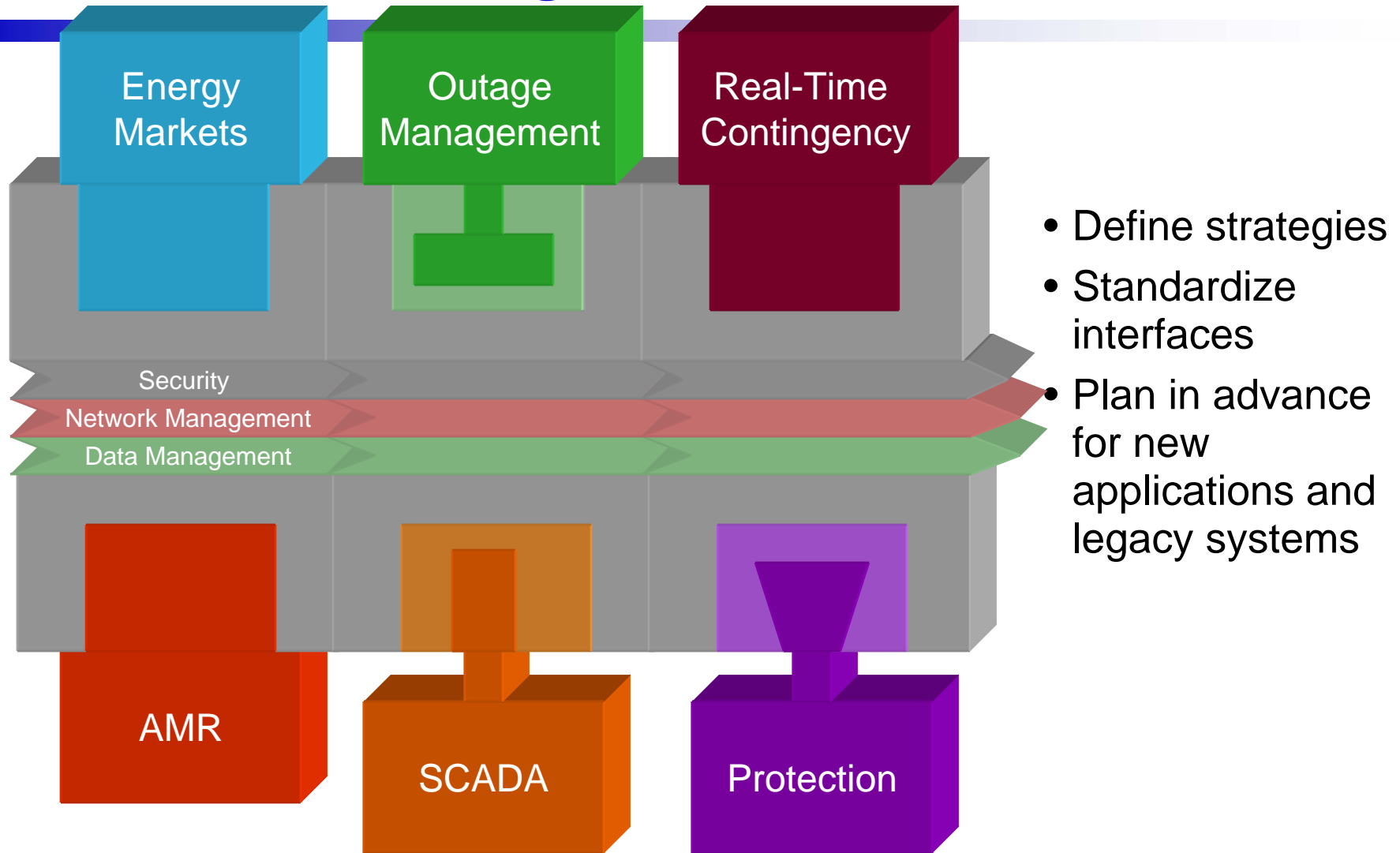
The Resulting Integrated System Has High Value... at a Cost



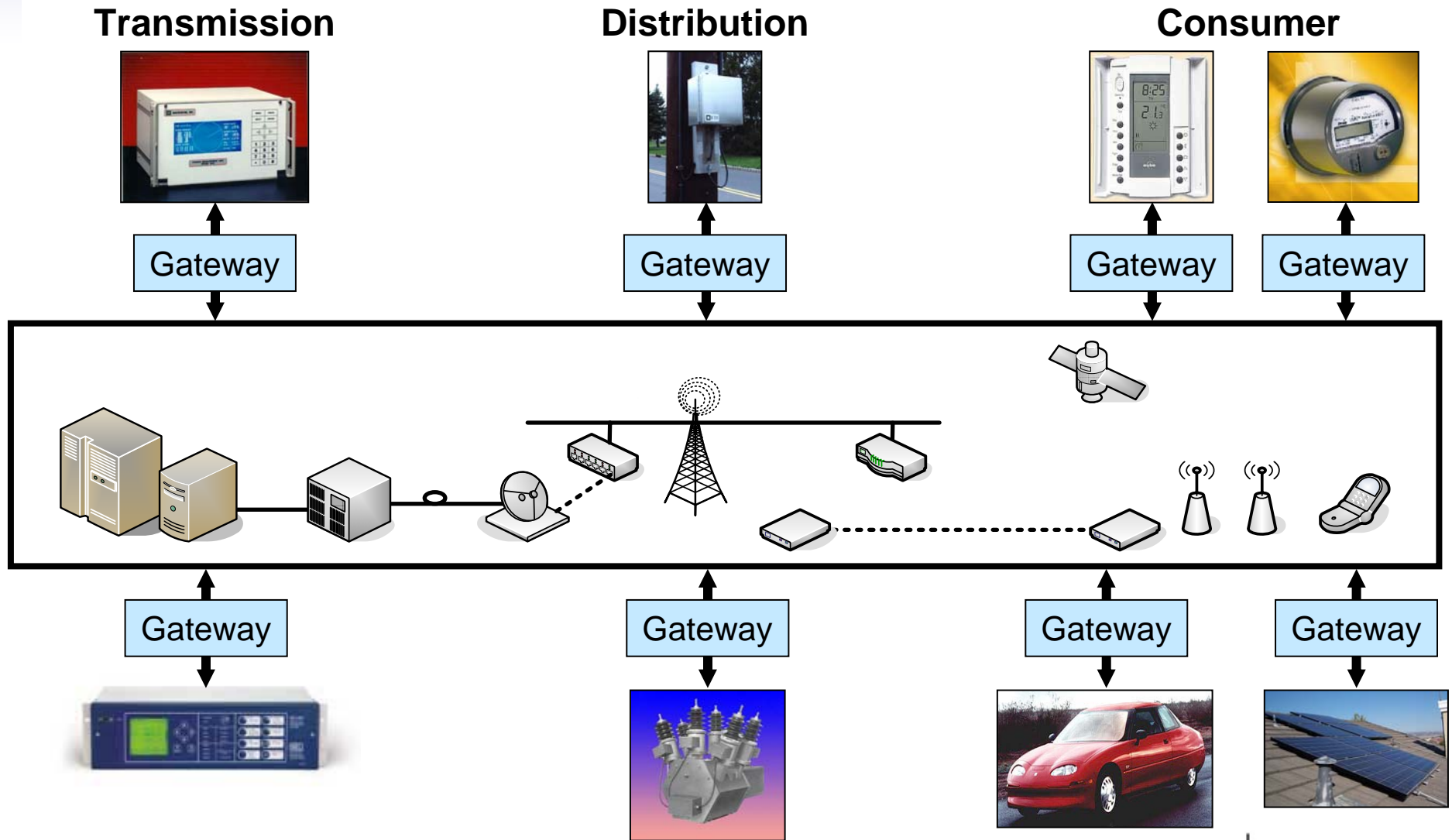
Overarching Strategies are Costly to Retrofit



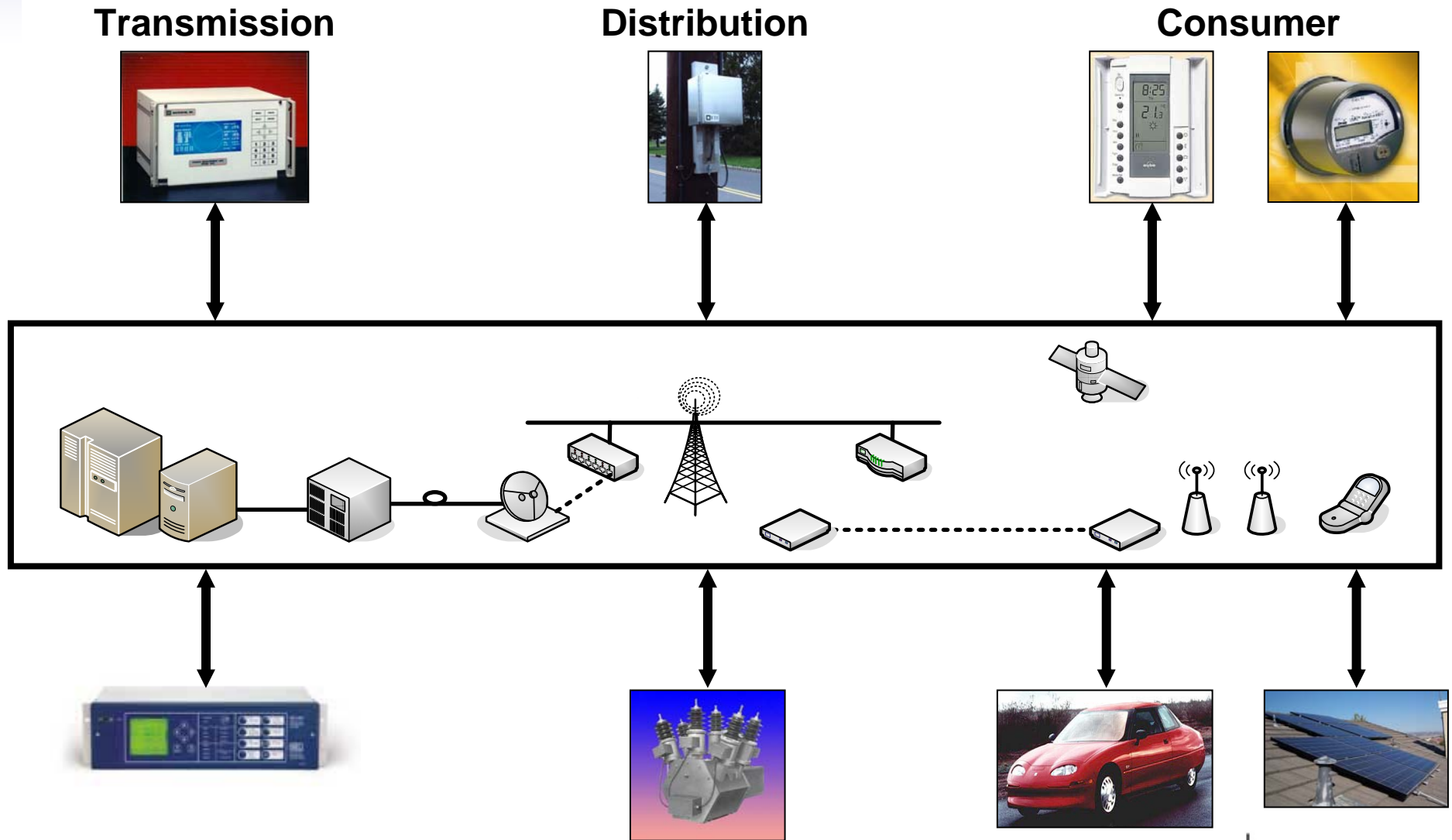
The IntelliGrid Architecture: Planned and Standardized Integration



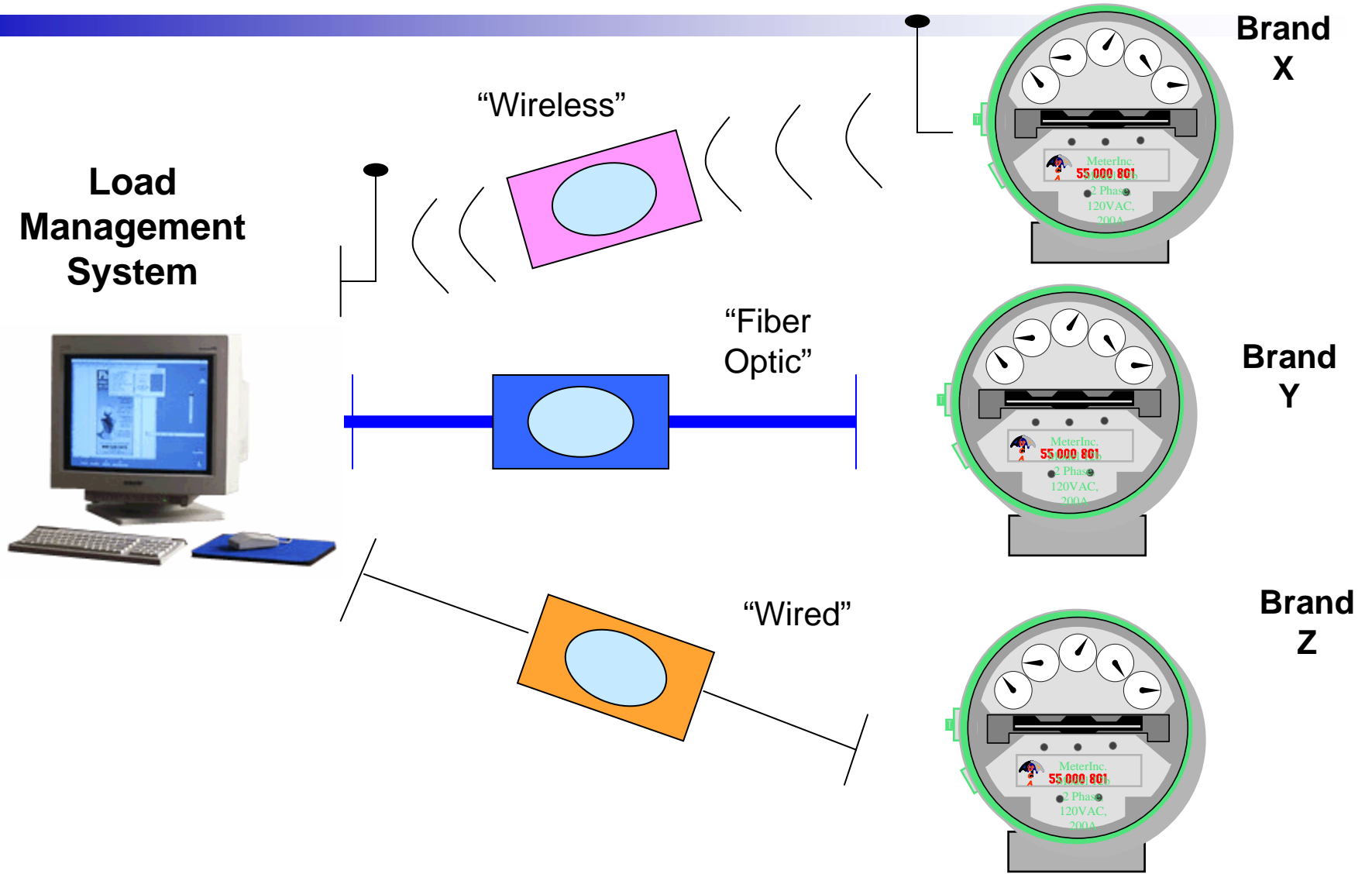
Today's Smart Infrastructure is Customized



The Interoperable Infrastructure is Smarter



IntelliGrid Key Concept: Multiple Vendor Products and Capabilities Work Together



Industry-Level Architecture Enables Security Policy Administration

**Security Policy:
Protect Revenue Data**



**Intrusion
Detection**

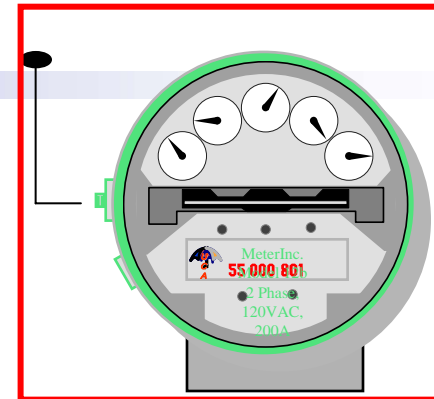
**Encryption
Protection**

**Device
Protection**

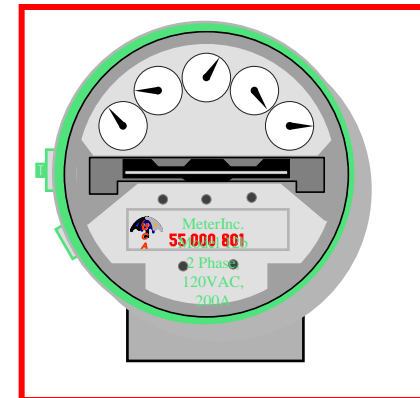
“Wireless”

“Fiber
Optic”

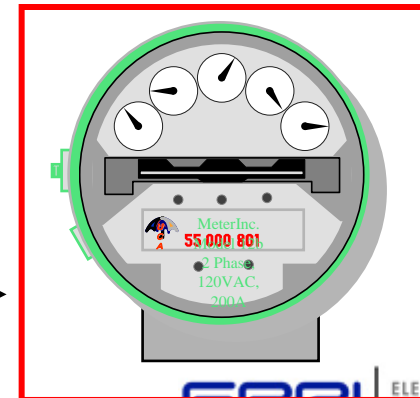
“Wired”



**Brand
X**



**Brand
Y**



**Brand
Z**

The Key to Investment -- to Meet Current and Future Needs

Interoperability

- The ability to “plug-and-work” devices and software

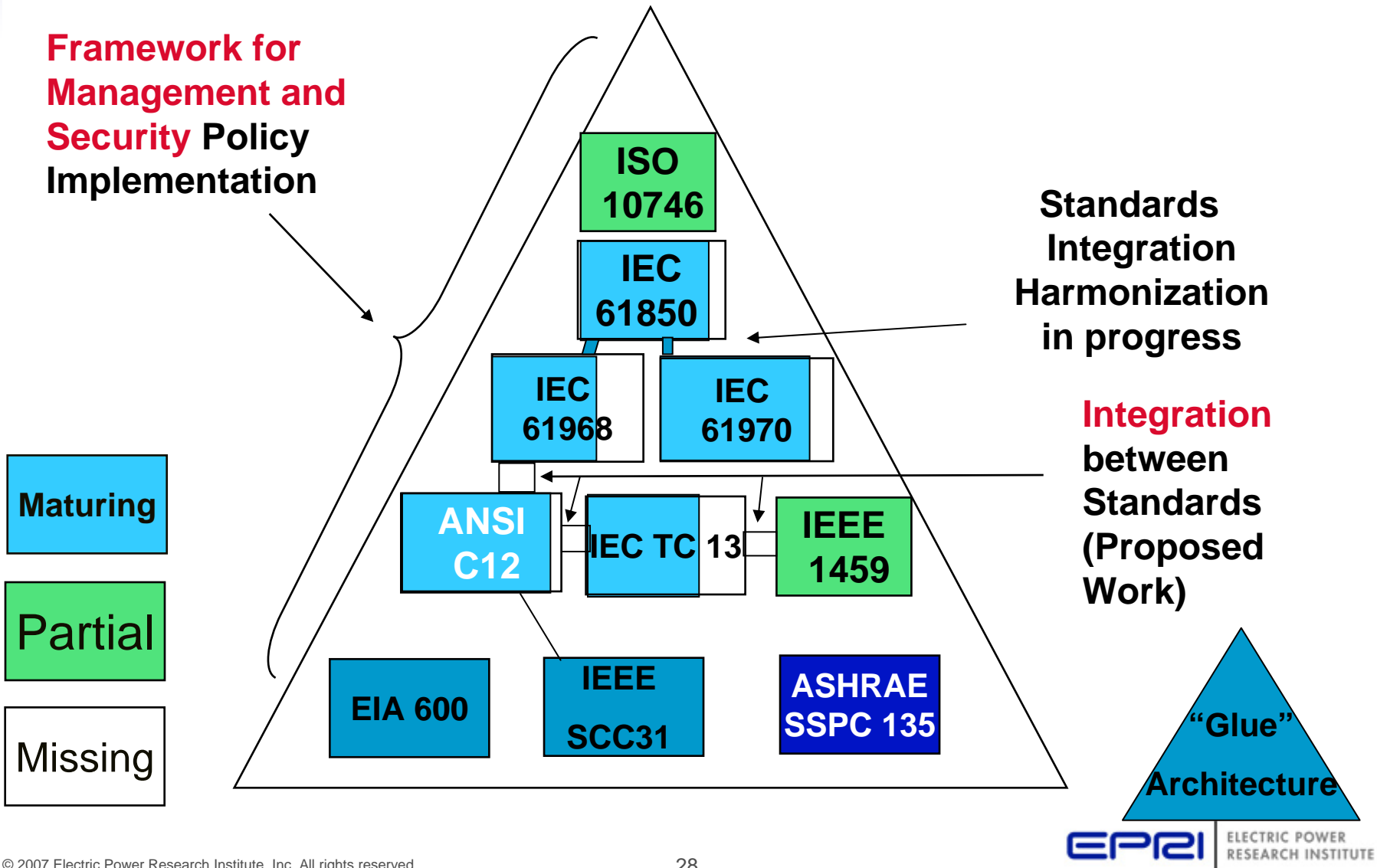
Open Architecture

- Non-proprietary communications infrastructure means no vendor lock-in
- Because vendors compete, innovations will result

Based on Industry-Accepted Standards

- Encourages confident infrastructure investment
- Reduces risk of obsolescence

Industry-Level Architecture Requires Standards Integration



Engineering Approach

- Develop requirements
 - Engage stakeholder
 - Create “use cases”
- Specify hardware/software
 - Be patient - it may not be available -- yet
 - But if there is a market, it will likely become available

IntelliGrid Architecture Is Being Used Now

- Southern California Edison
Advanced Metering Infrastructure for
Demand Response
- Long Island Power Authority
Advanced Automation, Consumer
Communications, Enterprise Architecture
Development
- TXU
Enterprise Software Integration



Available for download
and public use:
www.epri-intelligrid.com

Discussion

What are the smart grid needs and opportunities for Michigan?