Smart-Grid Developments: EPRI's IntelliGrid Consortium

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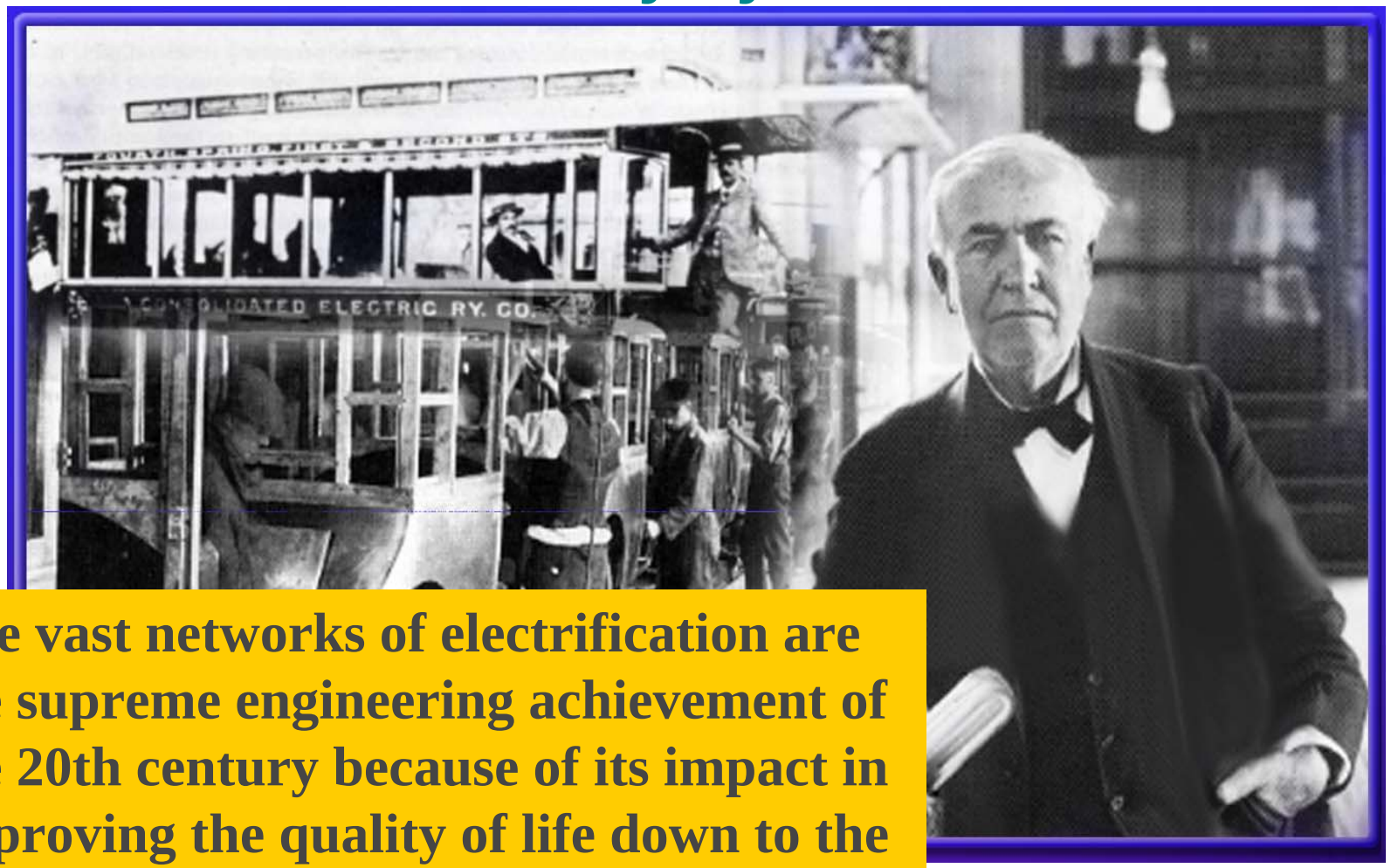
The U.S. Power Delivery System

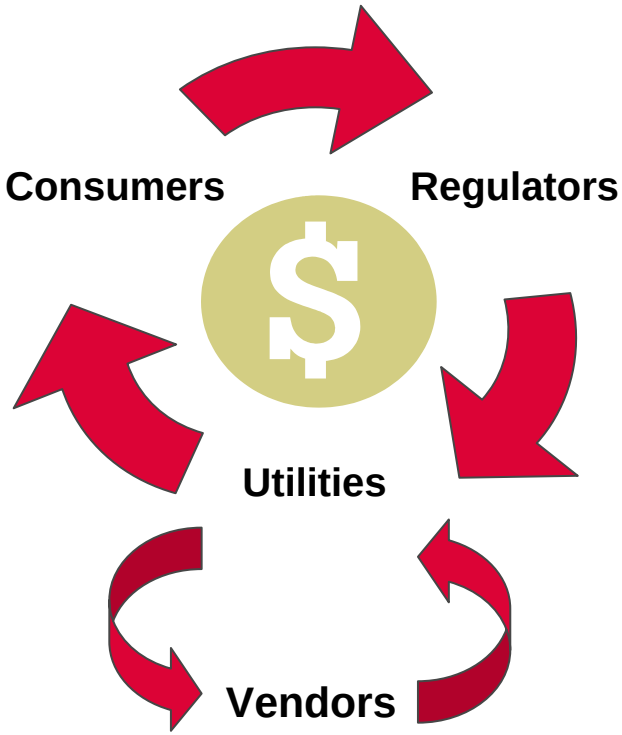


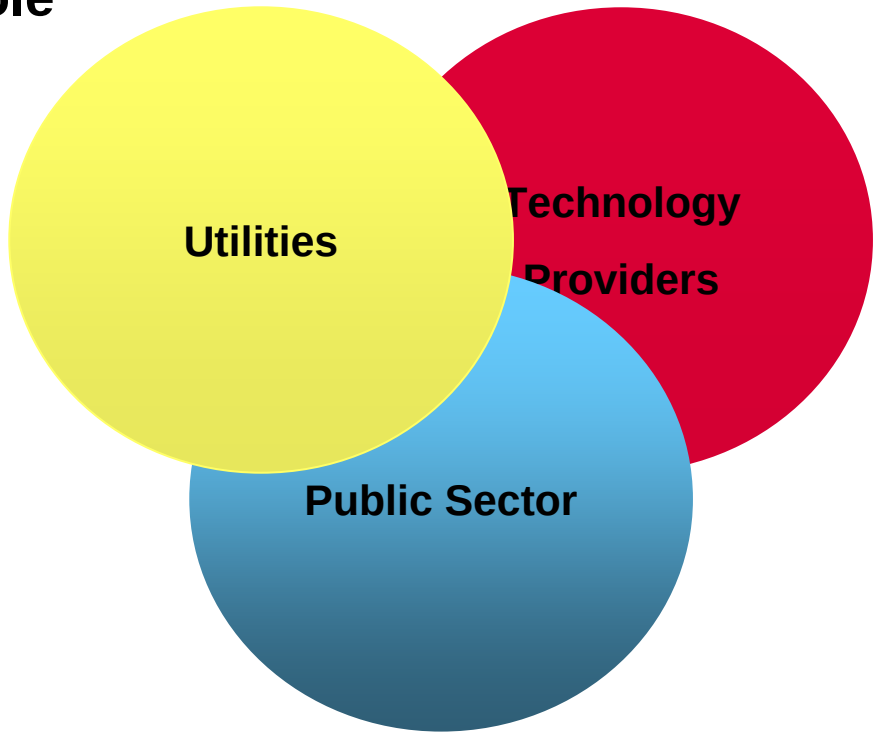
The vast networks of electrification are the supreme engineering achievement of the 20th century because of its impact in improving the quality of life down to the household level

– U.S. National Academy of Engineering

The IntelliGrid Consortium is a Public/Private Partnership

Each stakeholder has a critical role





To affect change, we must collaborate to achieve goals beneficial to society

IntelliGrid(sm) Consortium

IntelliGrid℠

Mission

To accelerate the transformation of the power delivery infrastructure into the intelligent grid needed to support our future society

EPRI

Strategy for Accelerating the Creation of an Intelligent Grid

Lay the Groundwork

- Reach consensus on the needs of the power delivery system of the future and the technologies needed to meet those needs

Develop

- Develop open platforms around critical integrating technologies – such as communications and computing

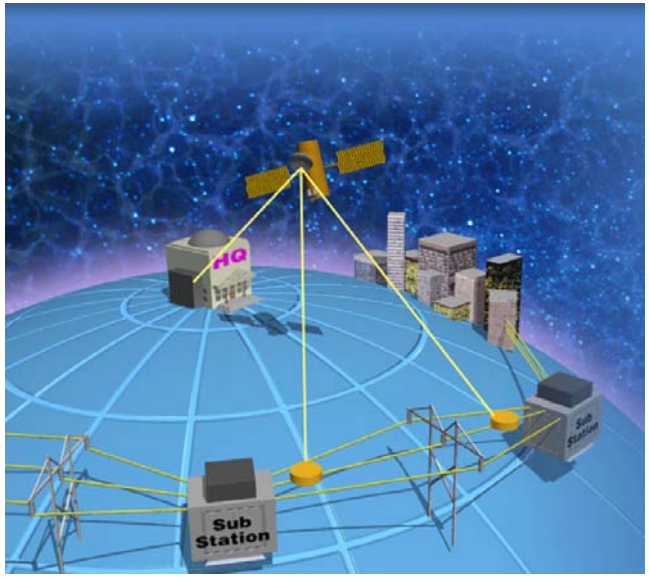
Demonstrate

- Demonstrate key new capabilities of the system

Outreach

- Broadly disseminate results and coordinate with other R&D organizations
- Influence and contribute to relevant standards development efforts
- Inform regulators and policy makers

The Power System of the Future will Use Information and Technology Developed and Enabled by IntelliGrid



- *Self-Healing* and *Adaptive*
- *Interactive* with consumers and markets
- *Optimized* to make best use of resources and equipment
- *Predictive* rather than reactive, to prevent emergencies
- *Distributed* across geographical and organizational boundaries
- *Integrated*, merging monitoring, control, protection, maintenance, EMS, DMS, marketing, and IT
- *More Secure* from attack

The Power System of the Future Will Require Technologies Enabled by IntelliGrid

The Value To Society is

- Increased economic productivity
- Reduced frequency & duration of power outages
- Increased energy efficiency
- Increased power quality
- Reduced peak demand for electricity
- Reduced cost for delivering electricity
- Avoidance of added power plants and lines
- Enhanced infrastructure security

IntelliGrid Consortium Partners

U.S. Utilities

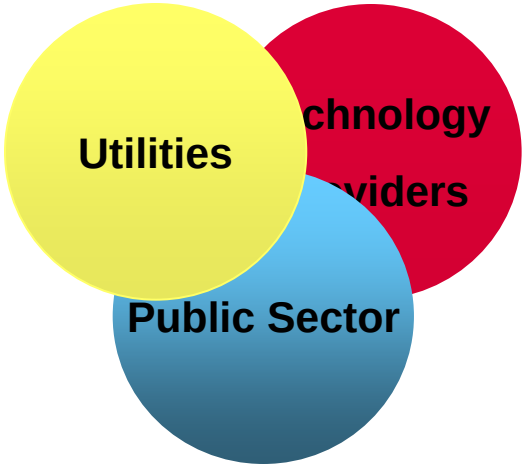
- Public Service Electric & Gas
- Alliant Energy
- Long Island Power Authority
- Salt River Project
- TXU
- We Energies
- Bonneville Power Administration
- Consolidated Edison Company
- New York Power Authority
- Kansas City Power & Light

International Utilities

- Polish Power Grid Company
- Electricite de France

Public Agencies

- U.S. Department of Energy
- California Energy Commission



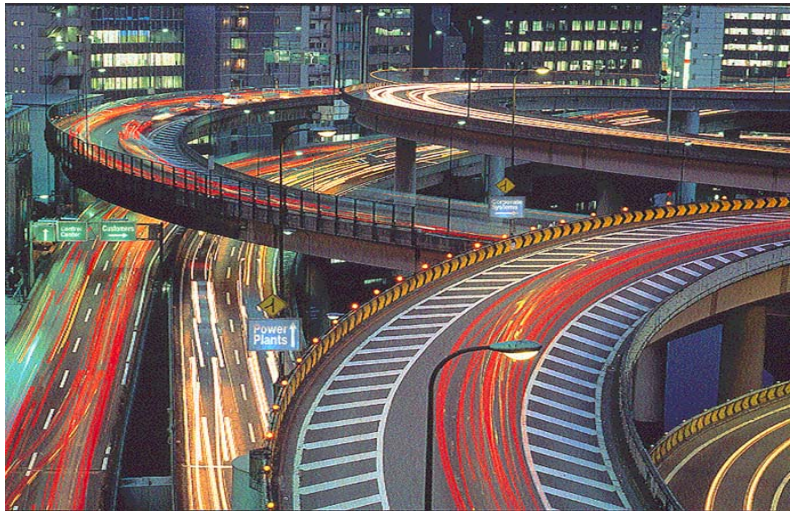
Approach for Creating the R&D Portfolio

Provide Leadership and Enable Innovation in Others by Developing Open-Source Platforms Around Critical Integrating Technologies

- **Communications**
  - IntelliGrid Architecture
  - Consumer Communications Portal
  - Communications Architecture for Distributed Energy Resources in Advanced Distribution Automation
- **Computing**
  - Fast Simulation and Modeling

The IntelliGrid Architecture

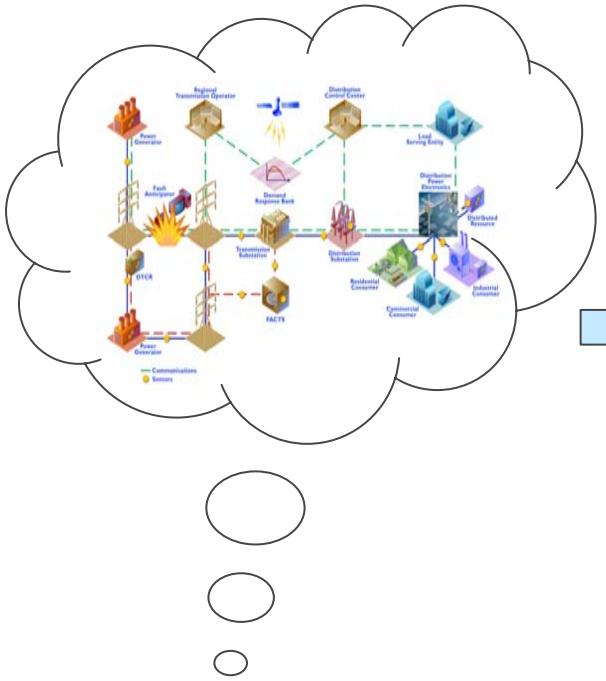
- An open, standards-based architecture for integrating the data communications networks and intelligent equipment needed to support the Power Delivery System of the Future
- Provides utilities and others with the tools and processes for designing communications and automation systems
- Recommends technologies and standards to use



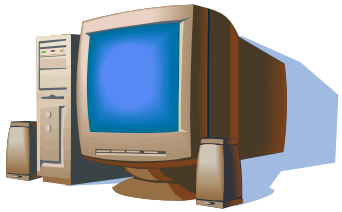
Available for Download and Public Use:

www.epri-intelligrid.com

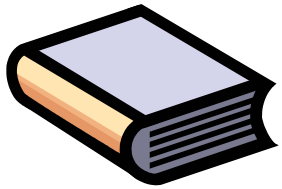
IntelliGrid Architecture



Initial Results



Methods and Tools



Recommendations

Establish the Vision of the Future Energy System

Work with Stakeholders to Refine Vision, Define Requirements and Analyze

Available for Download:

www.EPRI-Intelligrid.com

EPRI

Value of the IntelliGrid Architecture

- Promotes interoperability and enterprise-wide integration of systems
- Allows for “no-regrets” purchasing – focuses investments being made now to meet not only today’s needs but lay the foundation for the IntelliGrid
- Minimizes the impact of obsolescence or changes in technology

Who Will Use the IntelliGrid Architecture?

Executive & Regulator

- Provides a high-level vision of future power system functionality

Procurement Personnel

- Provides insight for functional specifications of devices

Power System Planning

- Provides a vision of future power system functionality

Communications System Architect

- Provides recommendations and requirements that will be the basis for organization's policies and procedures

System Designer/Engineer

- Provides tools, methods and information that will accelerate system design

Equipment Manufacturer

- Provides tools for planning new products

Standards Body

- Identifies gaps and overlaps in existing standards

Research Organization

- Provides a vision for the future and identifies areas for future work

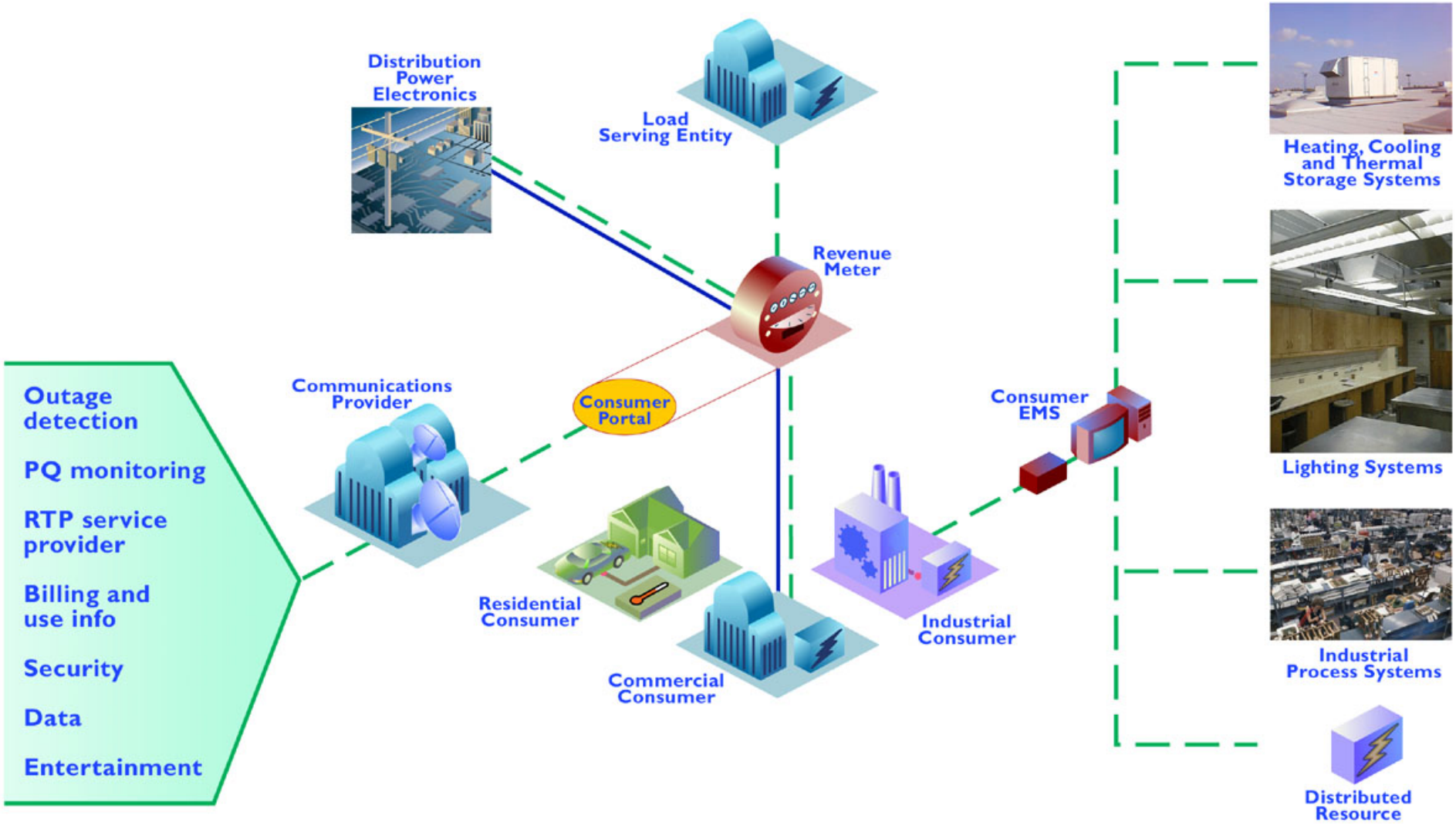
Early Applications of the IntelliGrid Architecture

- **U.S. Department of Energy and NYPA** – Eastern Interconnection Phasor Measurement Project (EIPP)
- **California Energy Commission** - California Demand Response/Innovative Pricing Implementations
- **Electricite de France** – re-designing information system for the new Distribution System Operator (European Directive)
- **Long Island Power Authority** – have identified nine applications

IntelliGrid Architecture – 2005 Activities

- Technology Transfer
  - Web site, Presentations
  - Workshops
- Field Applications
  - Volt/Var Control
  - Enterprise and Field Device Information Fusion
    - IEC 61850 / CIM Integration
  - New Substation Designs
- Contribution to Other Efforts
  - Eastern Interconnection Phasor Project
  - California Advanced Metering Initiative/Demand Response
  - GridWise Architecture Council

The Consumer Portal



IntelliGrid Consumer Portal Project

- Define requirements so that vendors can build components and systems that are interoperable (open systems).
  - Information models, object models
- Define requirements so that systems will be expandable to meet needs of future service offerings.
- Engage stakeholders to create a consensus on these requirements definitions.
- Demonstrate the feasibility and performance of systems that meet these requirements.
- Move these requirements into the standards process to enhance the applications in the market.

Consumer Portal Project Implications

- Wide variety of new services will be supported by the consumer portal.
- These will be facilitated by open standards for information exchange
- Previous efforts provide foundation
  - IntelliGrid provides overall framework
  - DER/ADA provides more detailed methods for object model development
- Many activities under way in the industry
  - Must take advantage of these activities
  - Direct future work towards industry standards

Consumer Portal Applications

Current Applications (examples)

AMR (radio and low speed PLC)

Time of Use Rates

Special load control during peak periods

Direct Load Control (e.g. radio), controllable thermostats

Building energy management systems

DG (backup) Aggregation for Market Participation

Metering information and energy analysis via website

Outage detection and notification

Metering aggregation for multiple sites or facilities

Future Applications

Continuous metering information available to customer

RTP for customer market participation

Integration of customer-owned generation

Automatic load controls integrated with RTP

Remote power quality monitoring and services

Facility sub-metering and energy analysis

Remote equipment performance diagnostics

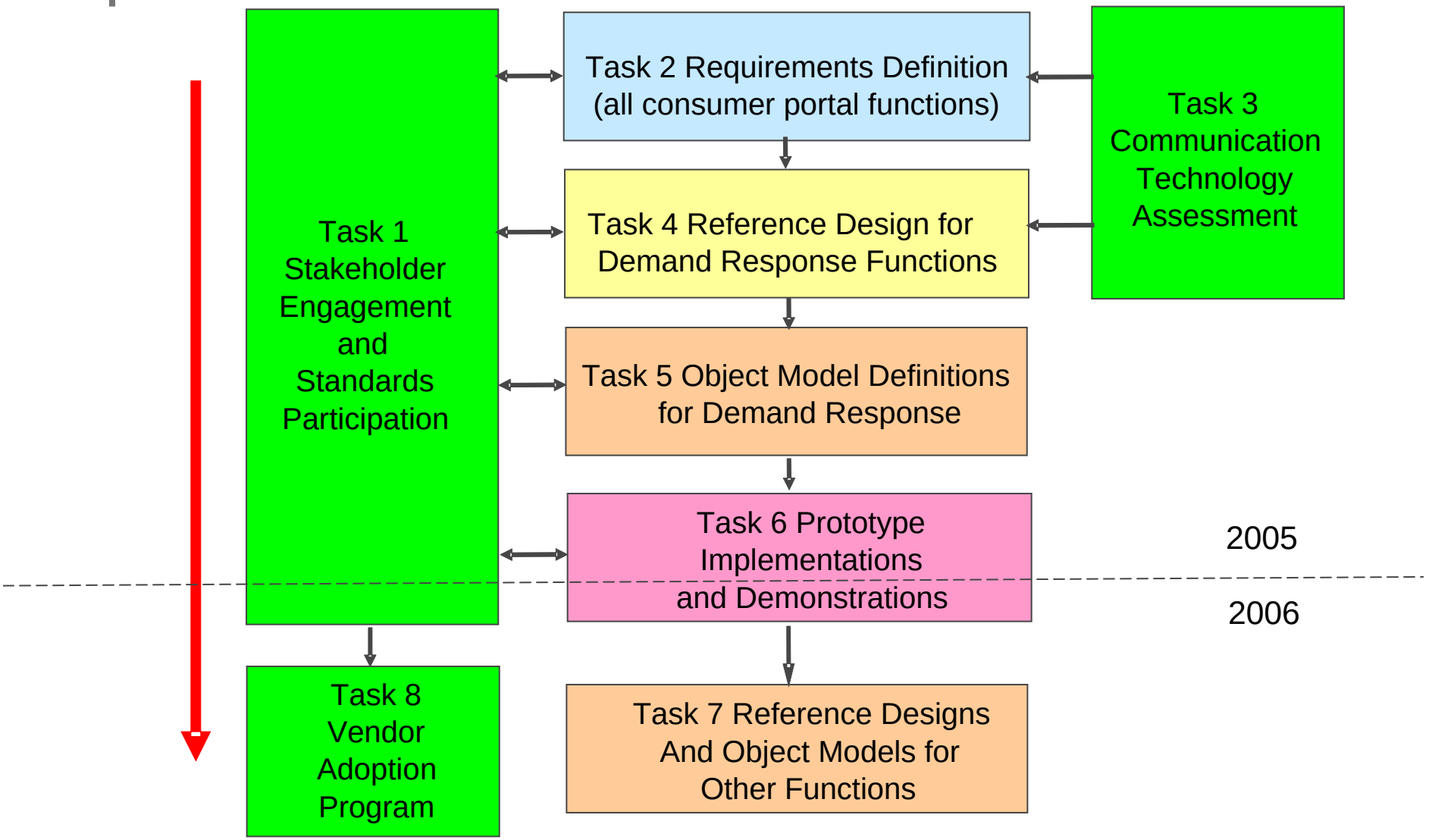
Theft control

Customer monitoring integration with FSM

What's the Holdup for Widespread Implementation and a Broader Range of Options?

- Market Obstacles
  - Regulatory structure is not set up to encourage implementation of flexible rates and related consumer response
  - High initial capital expenditures – (must be able to assure a return on this investment)
  - Proprietary products still pushed and used in the marketplace
  - Last mile economics and performance issues
  - Lack of Standards/Interoperability

Project Tasks



Communications Architecture for Distributed Energy Resources (DER)

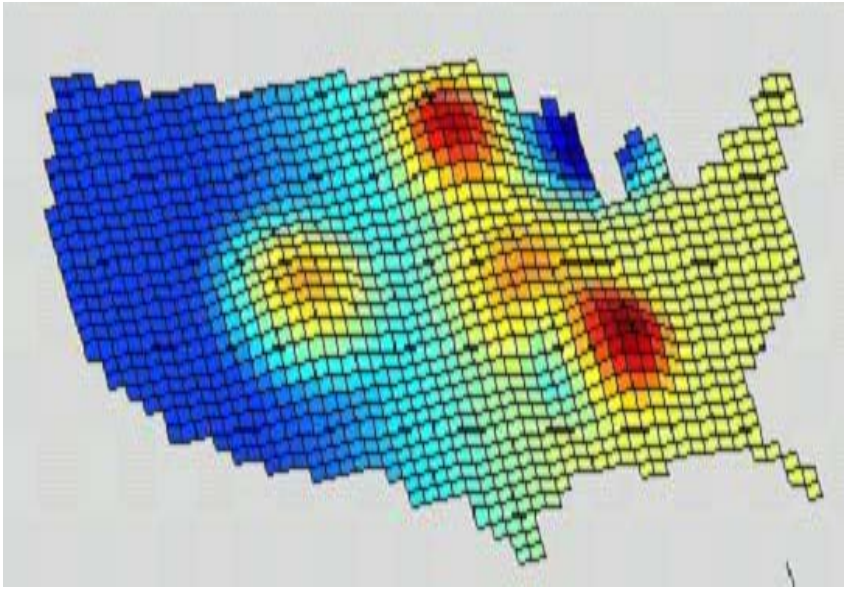
- Develop, validate and pilot test communication object models that will enable the strategic use of DER in Advanced Distribution Automation for functions such as
  - Routine energy supply, peaking capacity, voltage regulation, power factor control
  - Emergency power supply, harmonic suppression, and disaster recovery operations (e.g., intentional islanding)
- Contribute object models to relevant standards bodies

2005 Activities

- Continue leadership of two relevant IEEE and IEC working groups (P1547.3 and WG-17):
  - Get Draft 2 of IEEE P1547.3
  - Get first committee draft of IEC standard
- Complete abnormal condition operations studies

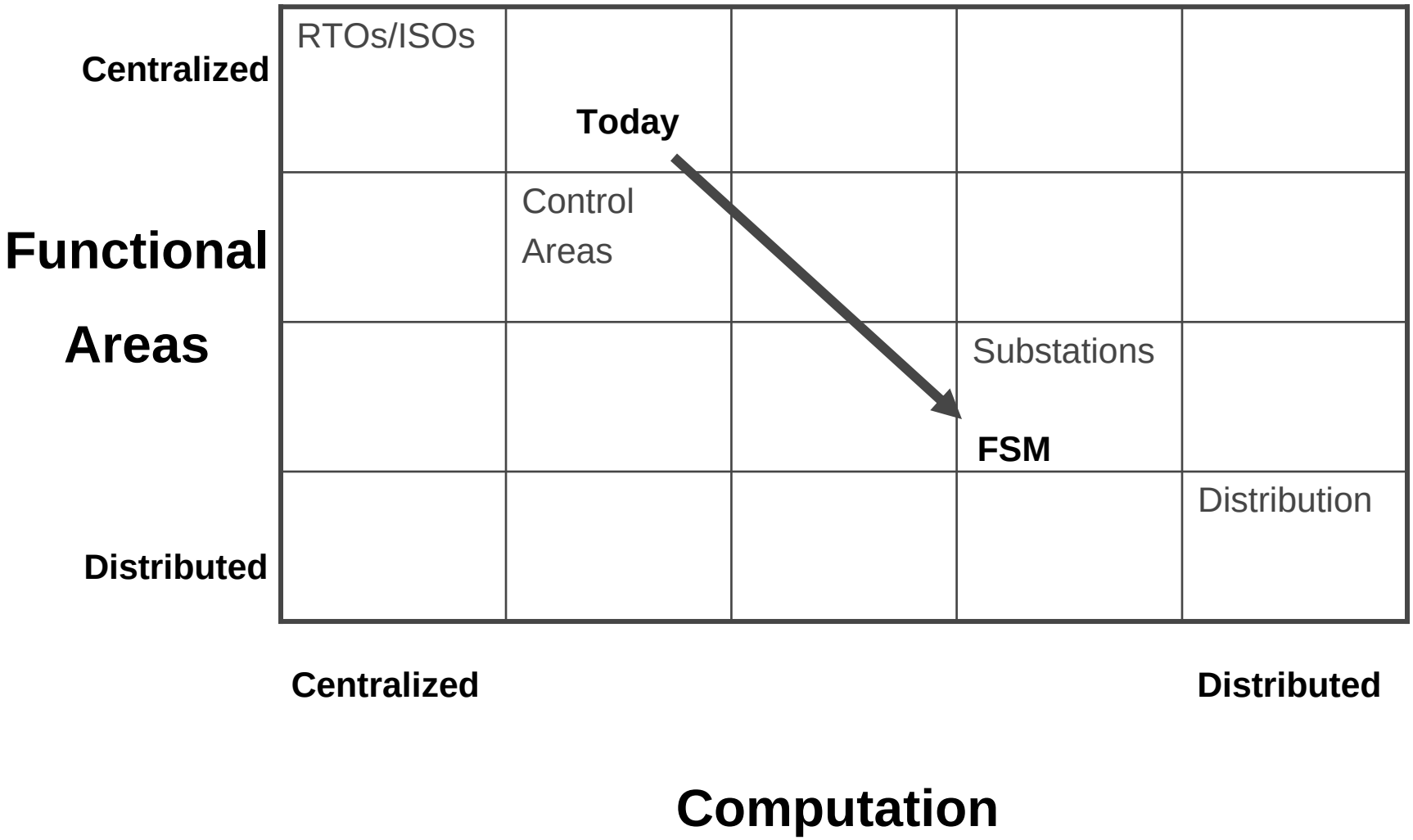
Fast Simulation and Modeling (FSM)

Design, development and incremental deployment on the top of existing systems, from now to the next 5+ years, of a suite of software tools that would



1. Provide faster-than-real-time, look-ahead simulations, to avoid previously unforeseen disturbances
2. Perform “what if” analysis for large-region power systems
3. Integrate market, policy, and risk analysis into system models, and quantify their effects on system security and reliability.

FSM: Moving Computation from Centralized Systems to Hierarchical/Distributed Computation



FSM Milestones and Tasks

- **Stakeholder Engagement** Plan approval (end of May 2004) - Complete
- Stakeholder Interviews (June 2004) - Complete
- **Transmission FSM High level Requirement** released in August 2004 - Complete
- **Distribution FSM High level Requirement** released in Nov 2004 - Complete
- **Transmission FSM Functional Requirements & Computing Architecture final report** available in April 2005
- **FSM Mock-up Demonstration** available in Sept 2005
- **Distribution FSM Engineering Requirement Document** (ERD) available Sept 2005
- **Transmission FSM Reference Implementation and Cost/Benefit Analysis** – available Dec. 2005

Task 0:
FSM Stakeholders engagement plan

Task 1:
FSM high level requirements

Task 2:
Engineering Requirements Document for FSM

Task 3 :
Contribution to the Computing and Data Architecture Document

Task 4:
Transmission & Distribution FSM Harmonization

IntelliGrid: Enabling the Power System of the Future

- The power system of the future will be built over time through the incremental addition of technologies that provide new capabilities.
- Communications, computing and power electronics are the foundation of the IntelliGrid
- Key applications that IntelliGrid enables include:
  - Monitoring the transmission system using advanced sensors
  - Automating the distribution system
  - Enabling consumers to manage demand and participate in energy markets

Take Action—Join IntelliGrid

- Join the IntelliGrid Consortium or the Public Advisory Group
- Encourage utilities in your state to participate in IntelliGrid
- Host an IntelliGrid demonstration in your state. Hosting entails;
  - Participants
  - Site
  - Funding
- Encourage investments with the IntelliGrid vision of transforming the power delivery system, such as;
  - IntelliGrid-compliant communications systems