

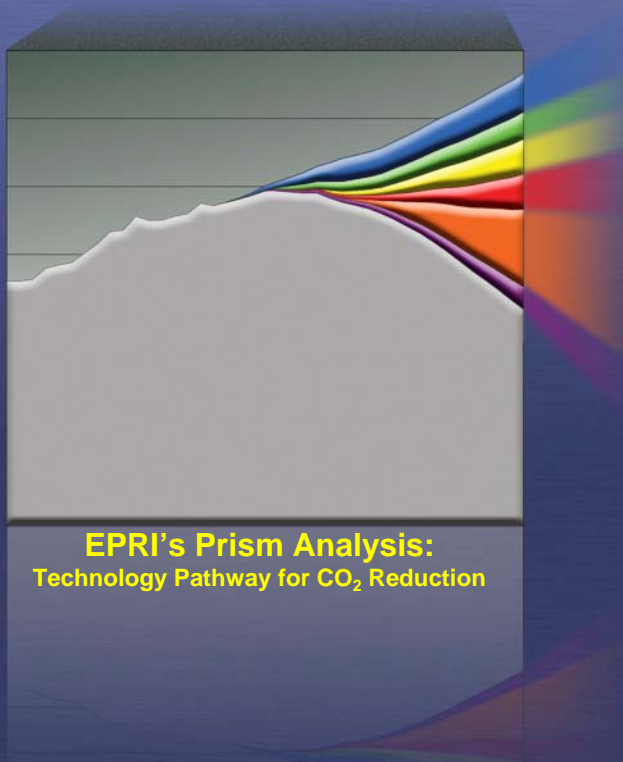


ELECTRIC POWER
RESEARCH INSTITUTE

Smart Grid Characteristics, Values, and Metrics

**DOE Smart Grid Implementation
Workshop**
June 19-20, 2008

Dr. Arshad Mansoor
Vice President, Power Delivery & Utilization
Electric Power Research Institute (EPRI)

A graphic on the left side of the slide. It features a dark blue background with a white, jagged, mountain-like shape. From the top right of this shape, several colorful lines (blue, green, yellow, orange, red, purple) fan out to the right, resembling a prism. Below the white shape, there is a dark blue rectangular box containing yellow text.

EPRI's Prism Analysis:
Technology Pathway for CO₂ Reduction

Smart Grid – Exchanging Information Seamlessly Across the Enterprise

Markets



Transmission



Substation



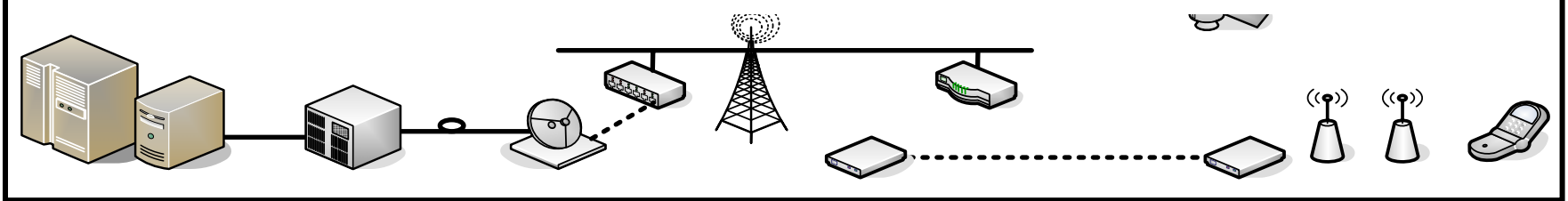
Distribution



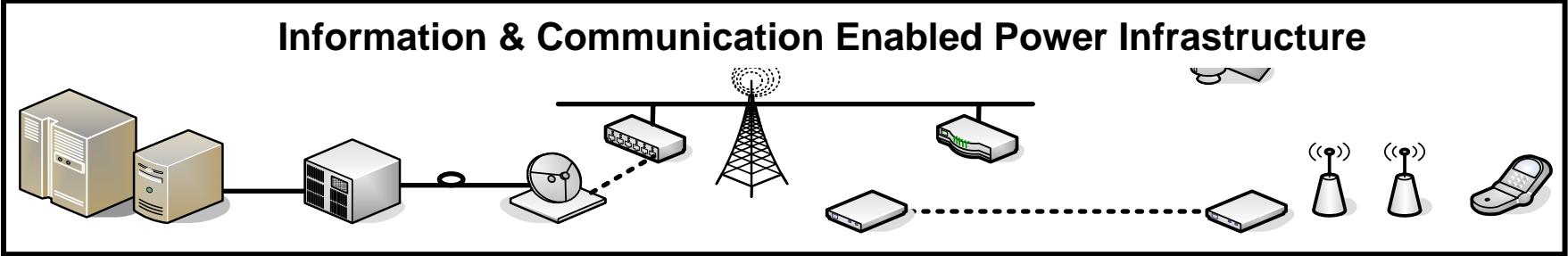
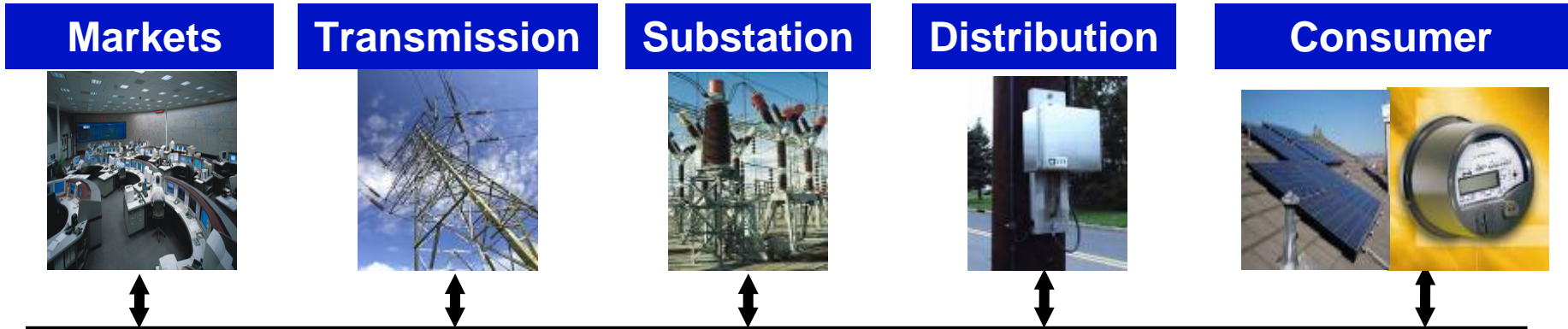
Consumer



Information & Communication Enabled Power Infrastructure



Smart Grid – Exchanging Information Seamlessly Across the Enterprise



Acting on this Information Will:

Enable active participation by consumers	
Anticipate & respond to system disturbances (self-heal)	Accommodate all generation and storage options
Operate resiliently against attack and natural disaster	Enable new products, services and markets
Optimize asset utilization and operate efficiently	Provide power quality for the digital economy

Metrics....Some Thoughts to Trigger Discussion

Smart Grid Metrics

1. **Value Metrics:** Tracking the Value Created by Smart Grid

2. **Build Metrics**

Characteristic-specific: Tracking progress in the build phase of each Characteristic toward its end state

Smart Grid Foundation: Tracking progress in building foundation for all 7 Characteristics

Tracking any single set of metrics does not provide a full view of the progress being made towards creating a smart grid

Value Metrics....No Need to Reinvent Wheel

<i>Value Attributes</i>	<i>Metrics Examples</i>
Distribution Reliability	Outage Duration (SAIDI), Outage Frequency (SAIFI)
Grid Reliability	Loss of Load Probability (LOLP), Number of Major Events as Defined in Section 311 of the Federal Power Act
Power Quality	Momentary Interruption (MAIFI), Voltage Sags (SARFI), Harmonics, Unbalance
Utilization	Load Factor (Average to Peak), Asset Utilization Factor, O&M Labor Utilization factor
Sustainability	Efficiency: Delivery System Losses, Information Enabled End-Use Energy Efficiency; Environmental: CO2 footprint of delivery system
Market Efficiency	Extent of participation of distributed resources in the energy market
Safety	Public and worker safety

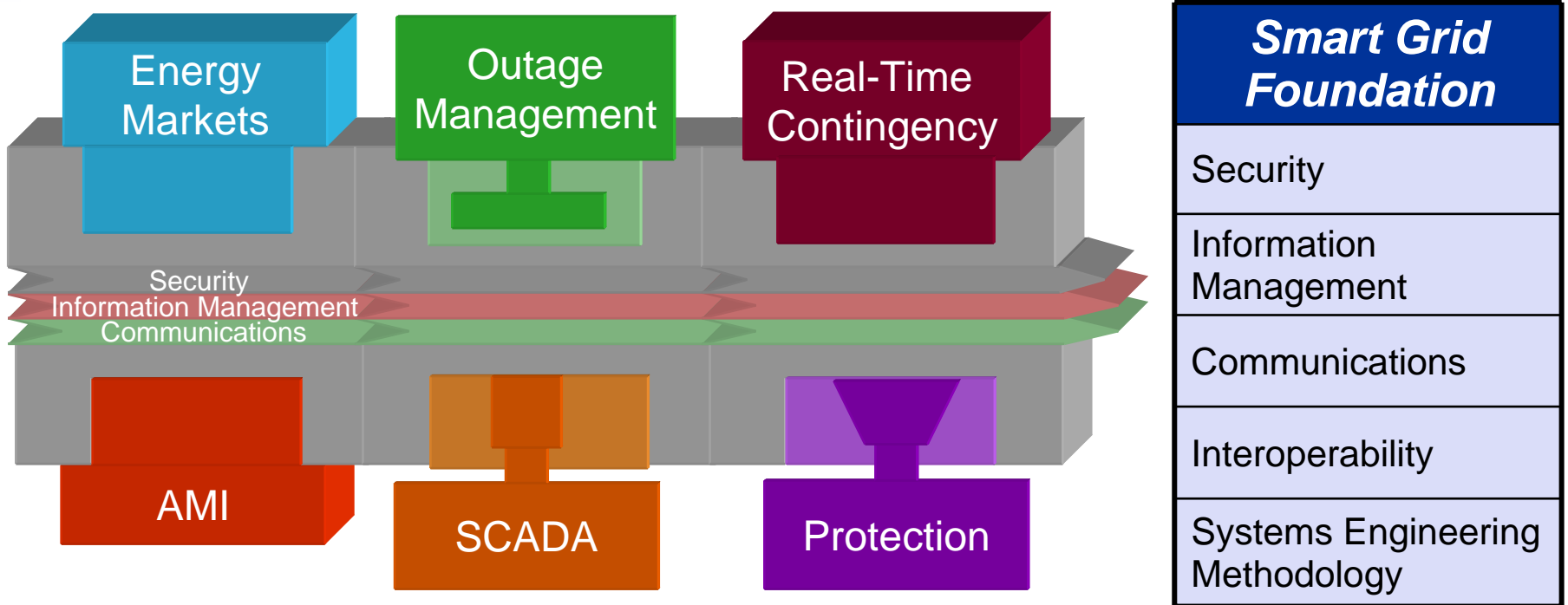
EPRI, Galvin Electricity Initiative, DOE Workshops – Wealth of Information to Define Value Metrics

Build Metrics: Measuring Success in Creating a Smart Grid

<i>Characteristic</i>	<i>Example</i>
Enabling consumer participation	Percentage of homes with home area networks
Accommodating generation/storage	Extent to which distributed generation and energy storage is used as a resource in the electricity sector
Enabling new markets	Extent to which DER participates in ancillary services market
Power quality for 21st Century	Percentage of reduction in costs of PQ disturbance events to the U.S. industry
Optimizing asset use	Extent to which condition-based monitoring has been employed in the electricity sector
Self-healing	Extent to which distribution automation has been employed in the electricity sector
Resilient to attack	Extent to which the electricity sector is secure from the N-1 contingency

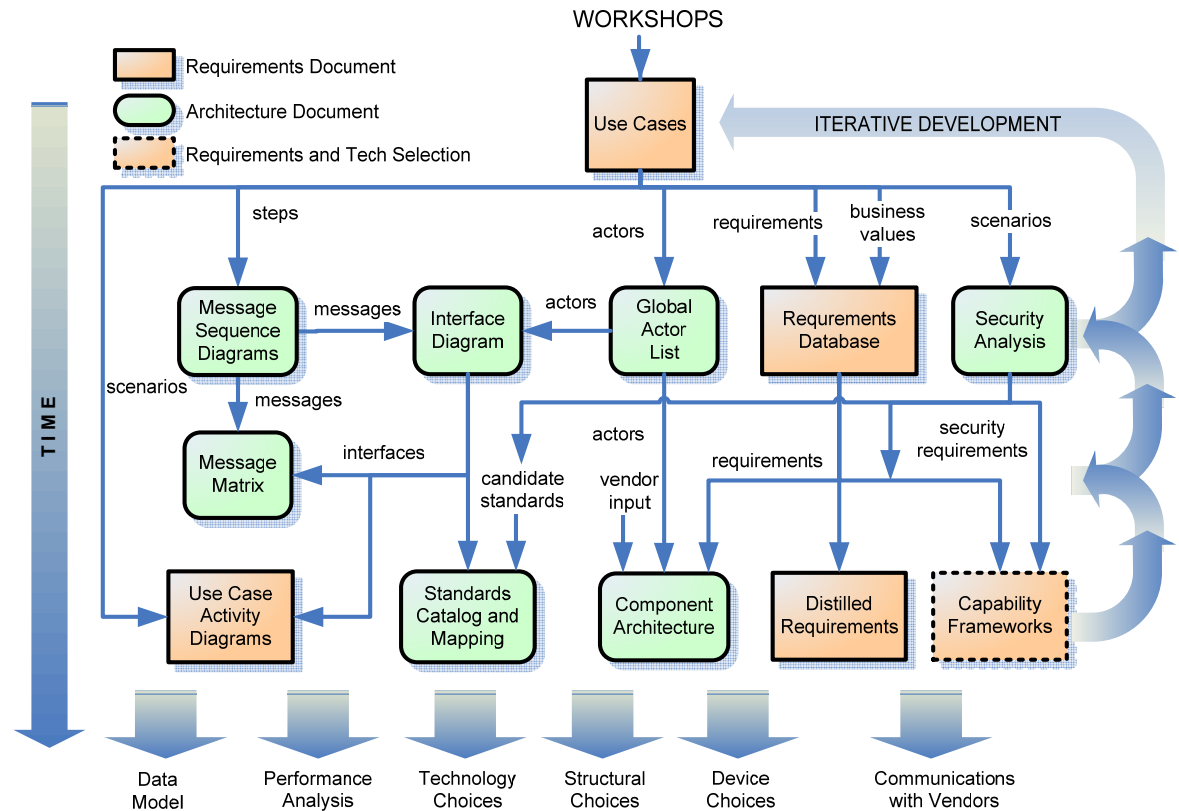
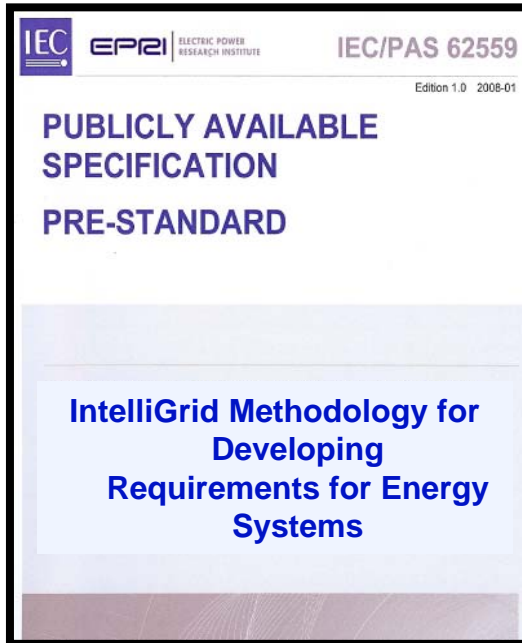
Illustrative Example of a Metric for Building a Specific Characteristic

Metrics: Building a Smart Grid Foundation



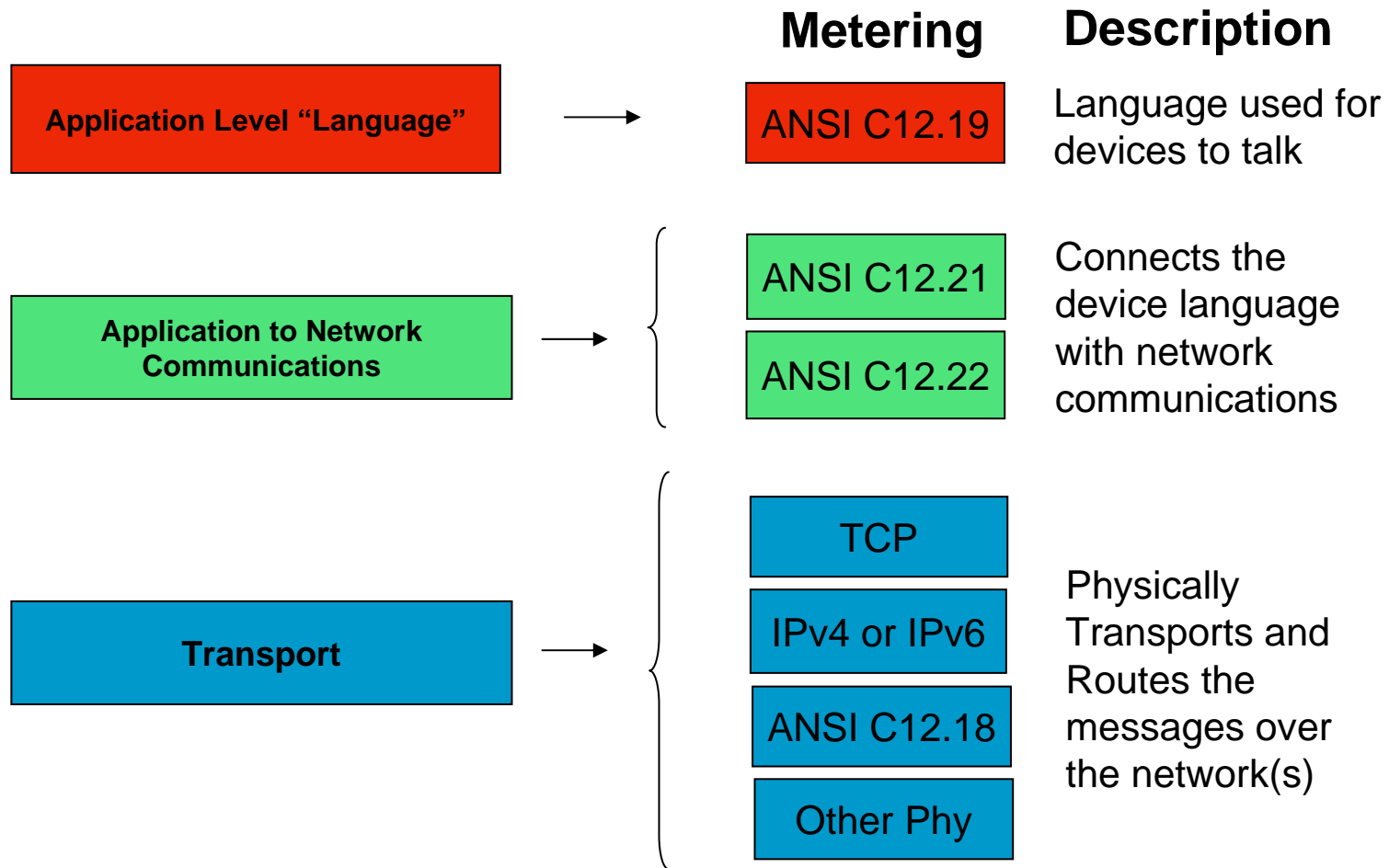
The most important and possibly the most difficult metrics to implement and measure; well established in software and other industries but rarely used by the electricity sector

Metrics: System Engineering Methodology



Methodology starts with developing requirements based on the applications, and includes establishing test and measurement protocols

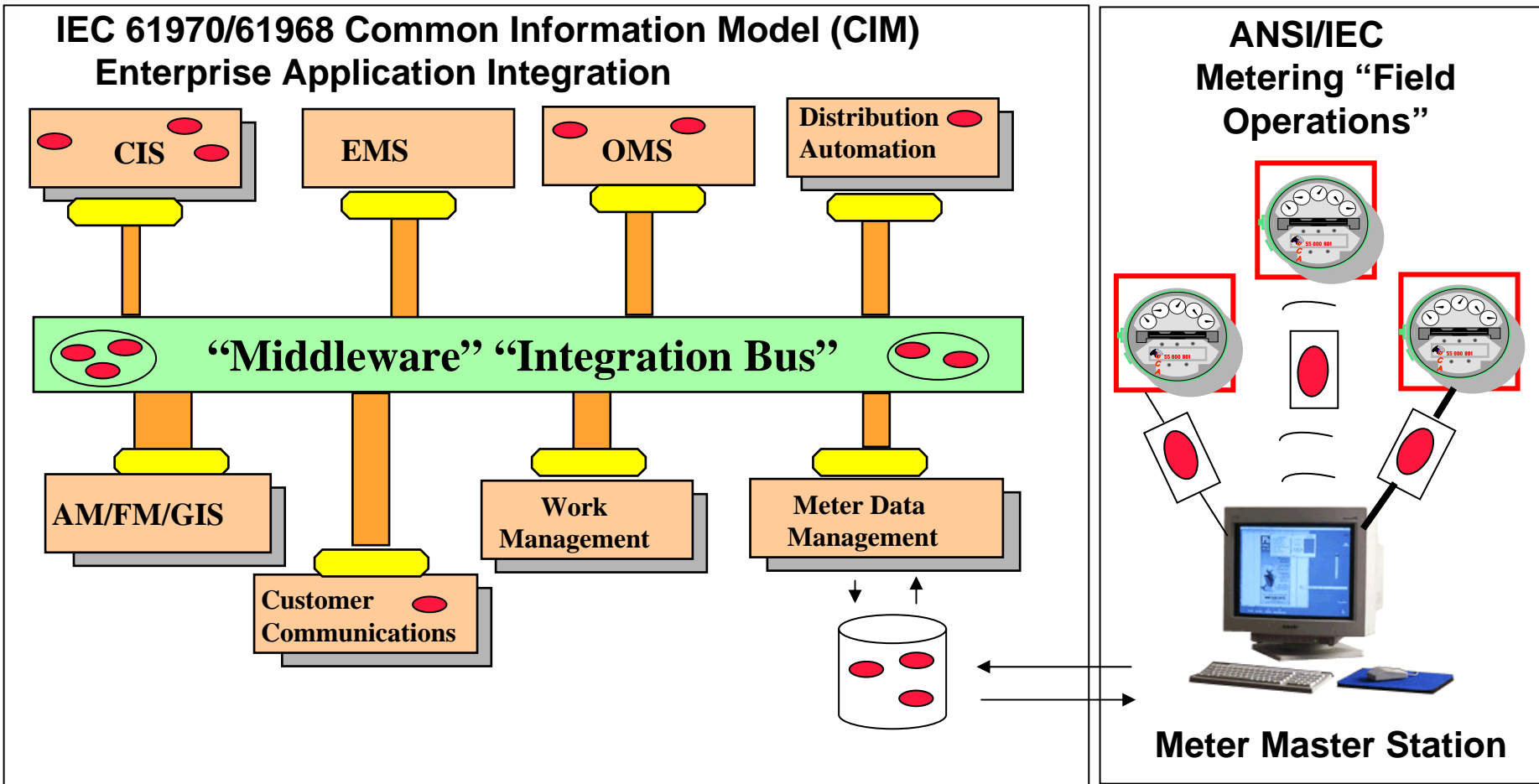
Metrics: Standards Based Communication Infrastructure



National Institute of Standards and Technology (NIST)
 Conducting a Standards Landscape Assessment for Smart Grid

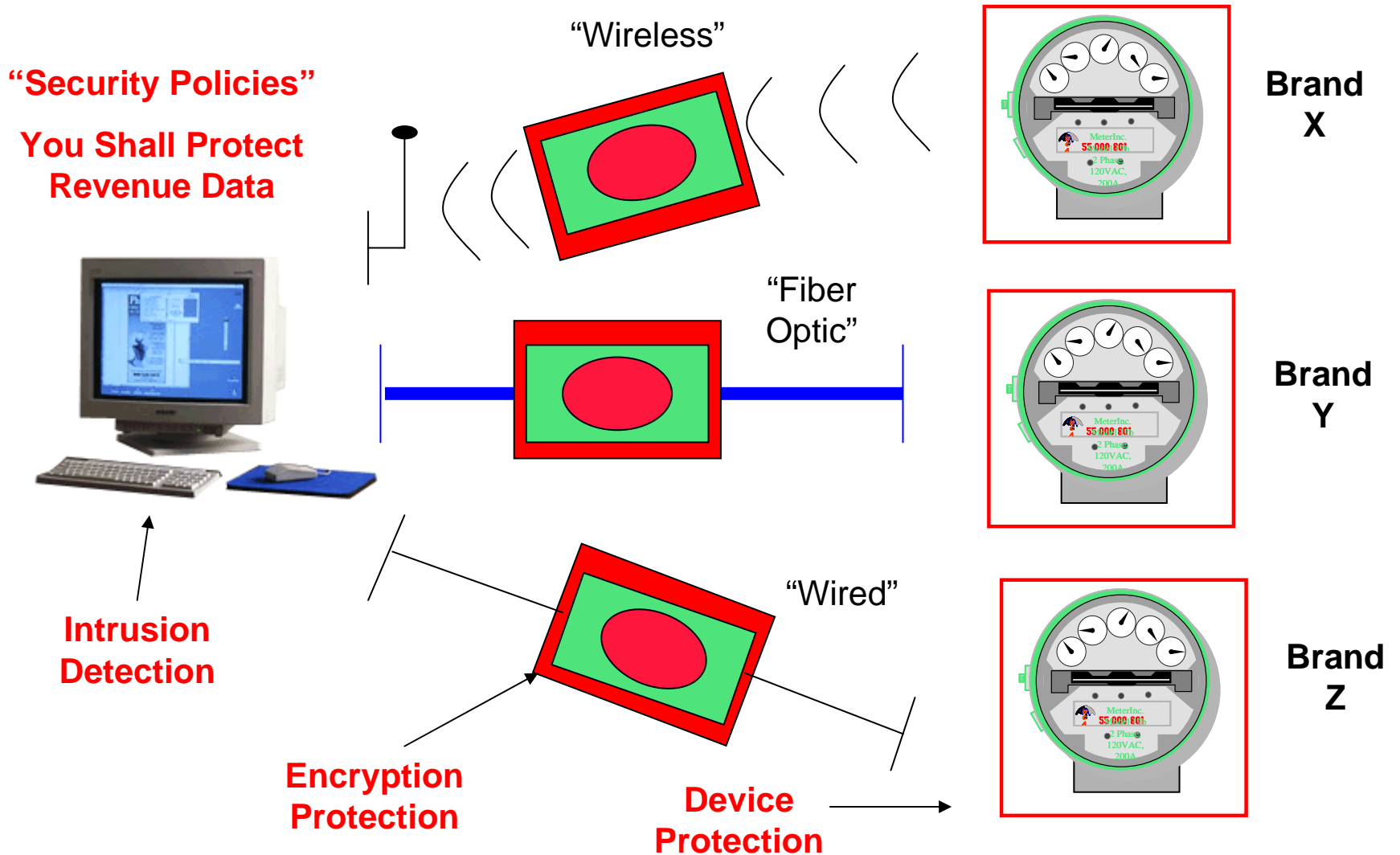
Metrics: Information Management

Common Data Models to Facilitate Exchange of Information



Metrics: Security

Consistent Security Policies Across Various Interfaces



Metrics: Interoperability

- **Interoperability usually defined at the 50,000ft level**
 - “The ability of systems to provide services to and accept services from other systems and to use the services so exchanged to enable them to operate effectively together” [DoD 77].
 - “The ability of two or more systems or components to exchange information and to use the information that has been exchanged” [IEEE 90].
- **Interoperability is not an “absolute”**
 - Interoperability depends on architecture and the resultant requirements specification
 - There are degrees of interoperability when referring to specific applications

GridWise Architecture Council and EPRI Interoperability Checklist is a Starting Point for Quantifying Interoperability

Mapping Characteristics to Metrics

Our Focus for this Workshop: Build Metrics

Smart Grid Characteristics	Smart Grid Metrics		
Enable active participation by consumers	Metrics for building a specific characteristic	Metrics for building a smart grid foundation	Value metrics (not subject of workshop)
Accommodate all generation and storage options			
Enable new products, services, and markets			
Provide power quality for the digital economy			
Optimize asset utilization and operate efficiently			
Anticipate & respond to system disturbances (self-heal)			
Operate resiliently against attack and natural disaster			