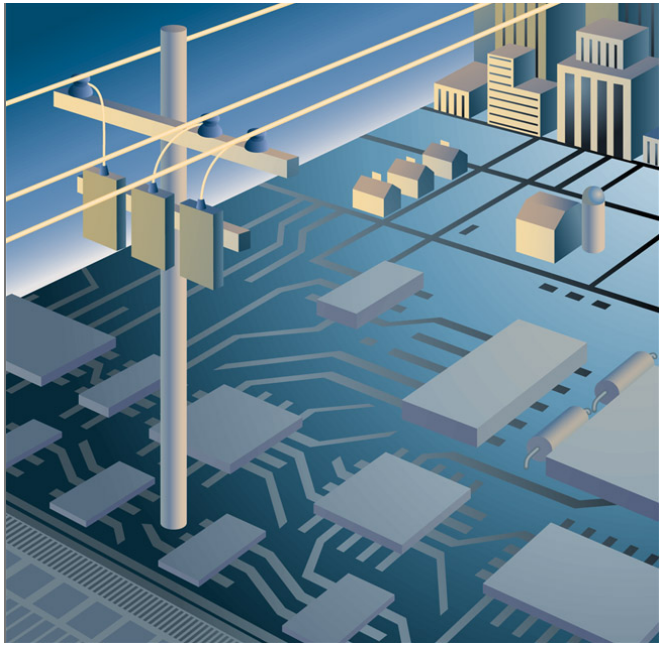

EPRI Research Plan for Advanced Distribution Automation

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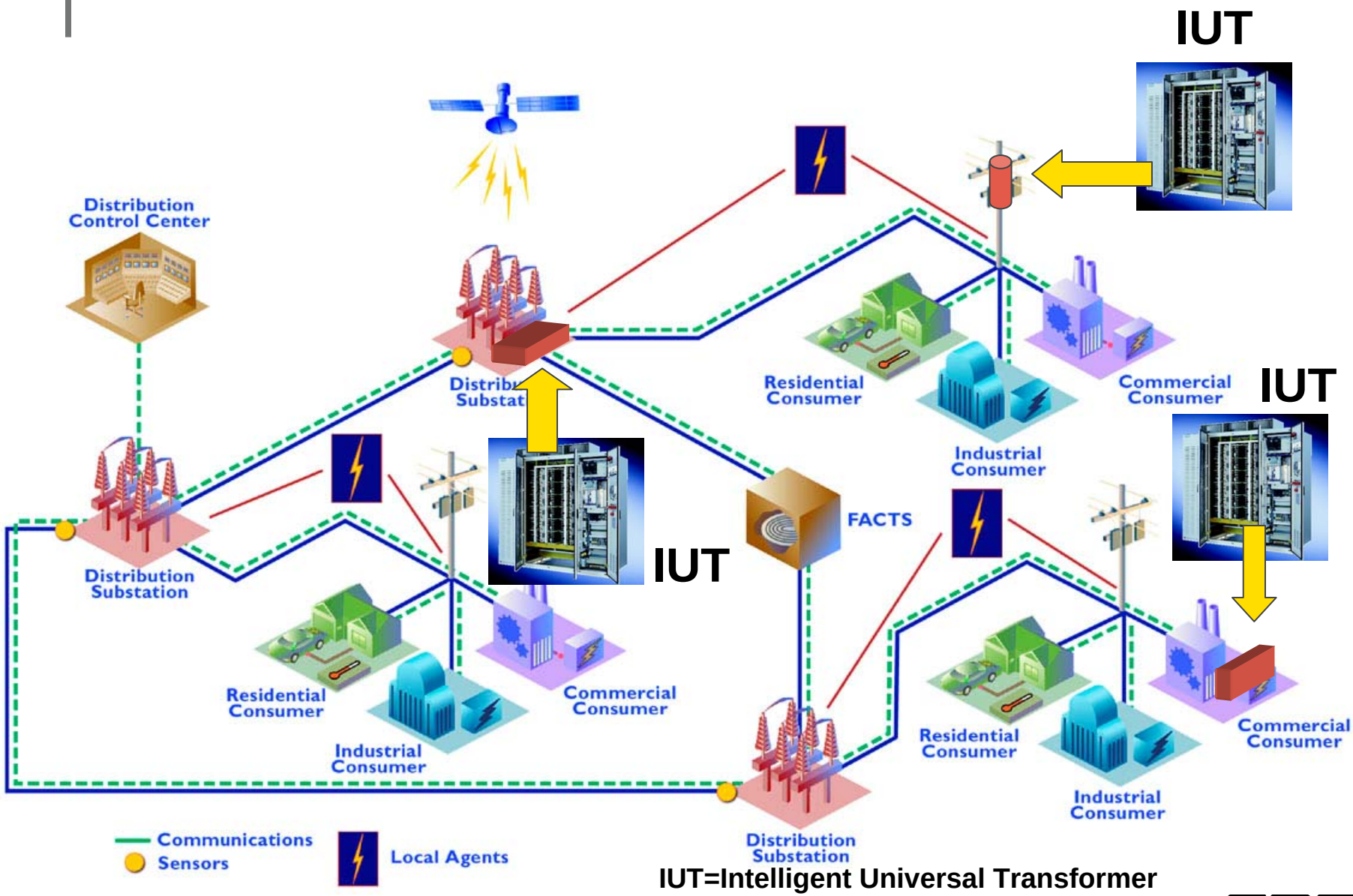
IEEE Power Engineering Society
2005 General Meeting
San Francisco, CA
June 14, 2005

EPRI

Outline

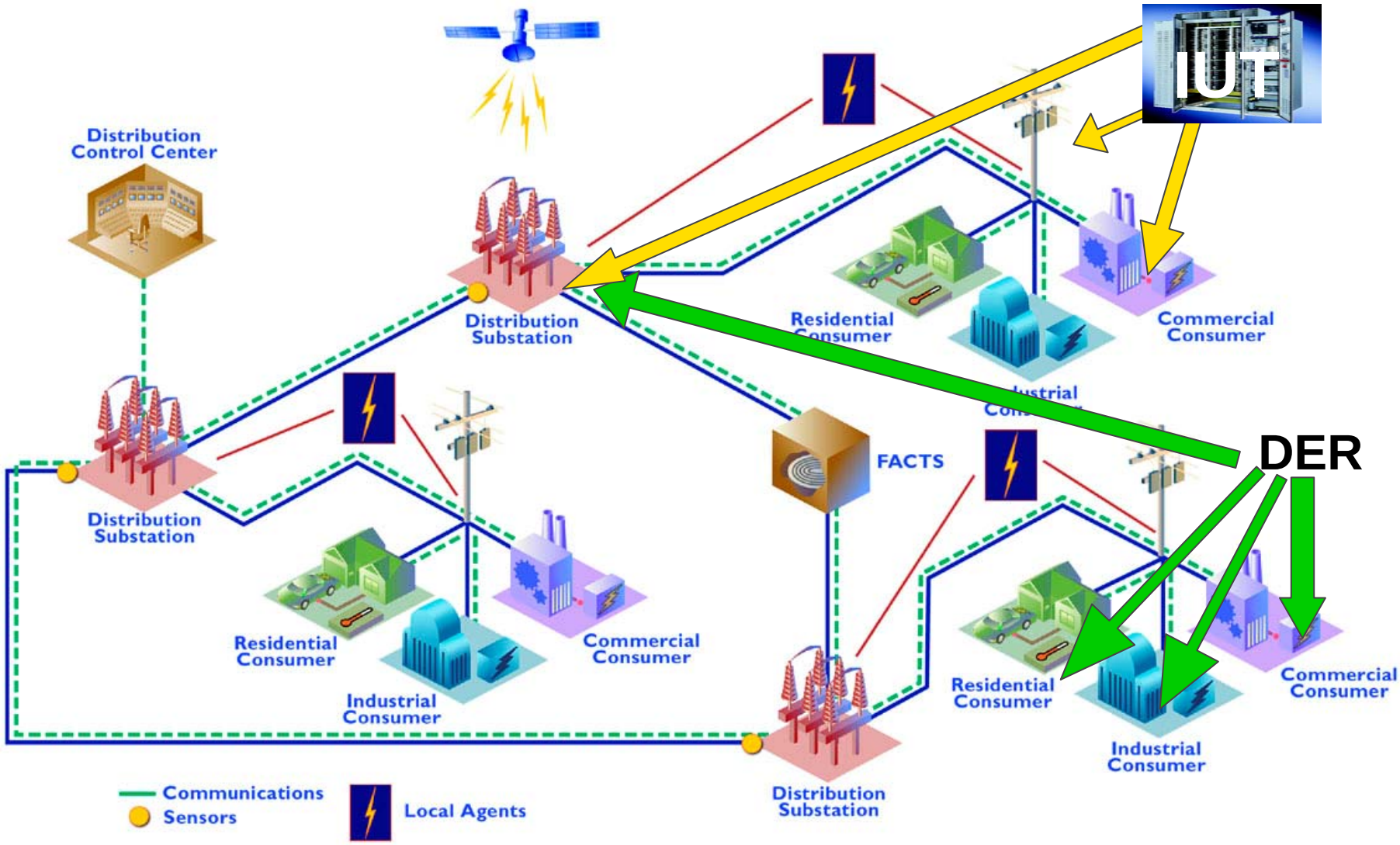
- Overview of Advanced Distribution Automation (ADA)
- Distribution Automation and Reliability
- The EPRI Advanced Distribution Automation research plan

ADA creates the distribution system of the future



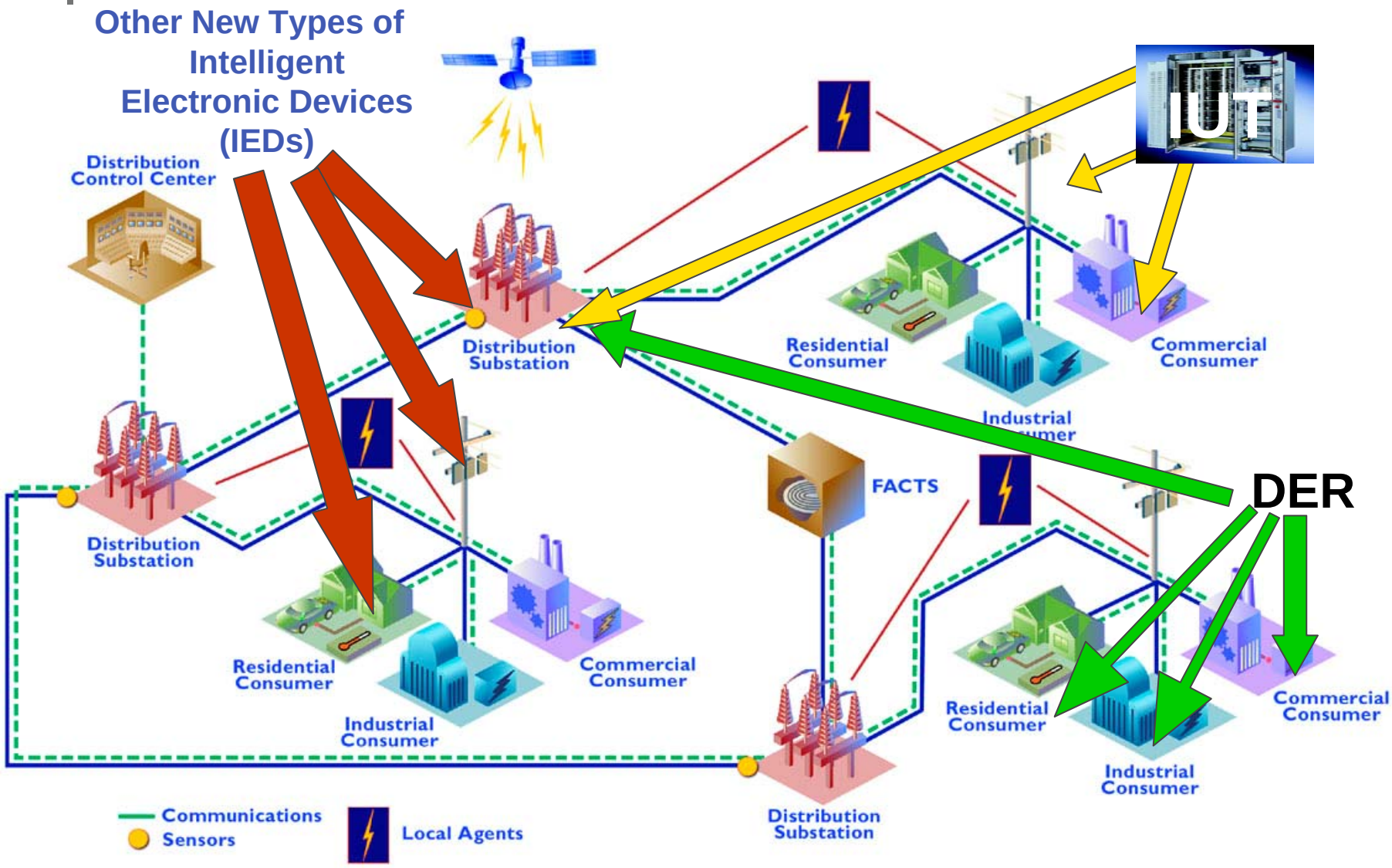
IUT=Intelligent Universal Transformer

DER integration is a component of ADA



IUT=Intelligent Universal Transformer

Other IEDs will be components of ADA



IUT=Intelligent Universal Transformer

Role of Intelligent Universal Transformer

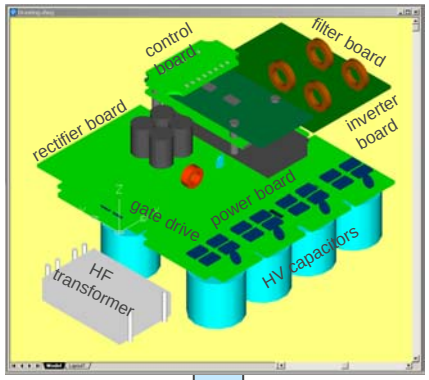
Core Technologies Needed

New State-of-the-Art Power Electronic Topology

New High-Voltage, Low-Current Power Semiconductor Device

Interoperable with Open Communication Architecture

All Solid-State Replacement for Distribution Transformers



Product Spin-offs

Emergency EHV transformer replacement (substations)

Other power electronic applications

Functions and Value

Traditional voltage stepping, plus..

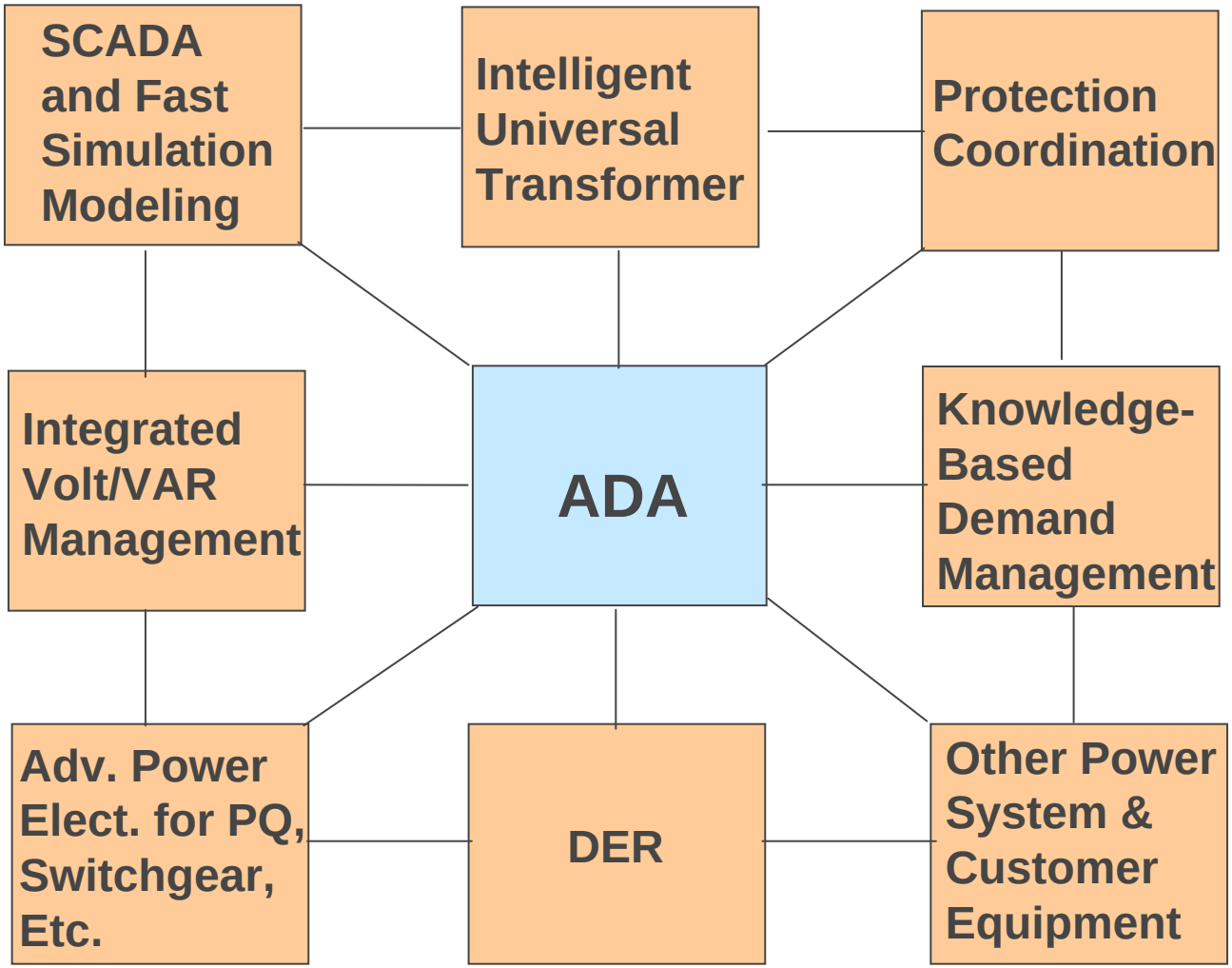
New service options, such as dc

Real-time voltage regulation, sag correction, system monitoring, and other operating benefits

Other benefits: standardization, size, weight, oil elimination

Cornerstone device for advanced distribution automation (ADA)

Future Distribution System Components Will Be Intelligent Electronic Devices (IEDs) That Are ***Interoperable***

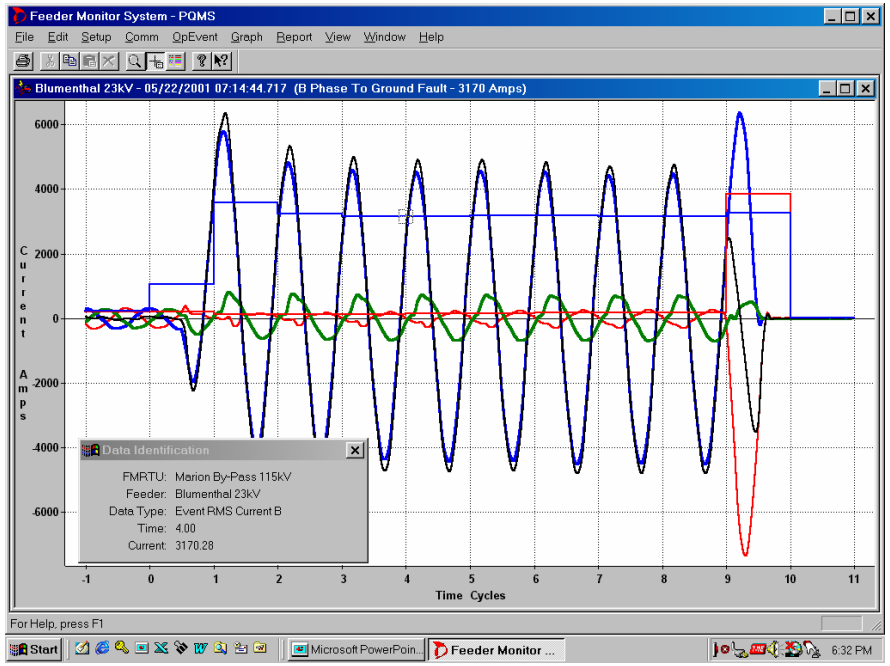


Distribution Automation
The most important impact on reliability

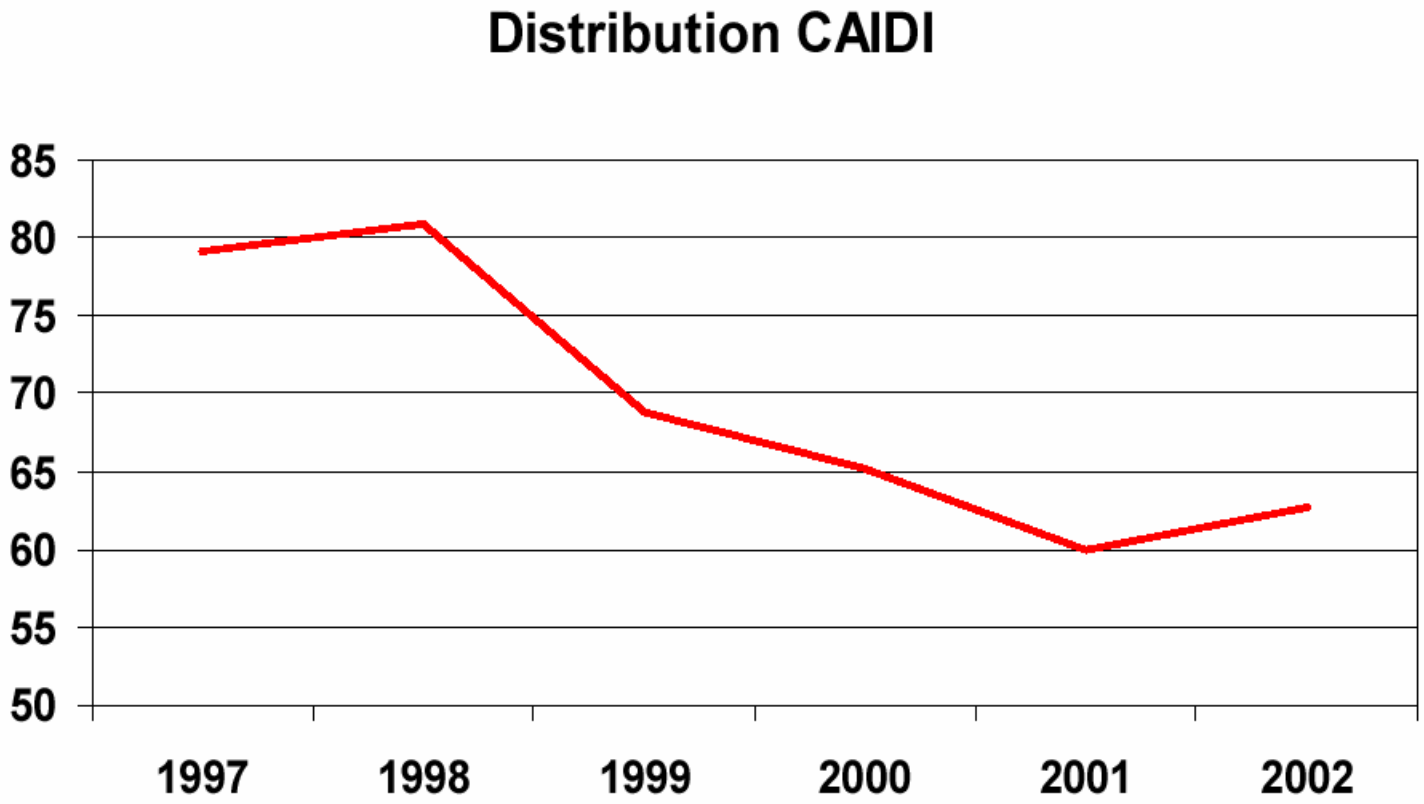
- Substations
  - Less than 1% of outages
  - Contribute 5% to reliability
- Primary distribution circuits
  - 44% of outages
  - Contribute 87% to reliability
- Secondary distribution
  - 55% of outages
  - Contribute 8% to reliability

Intelligent Monitoring Systems

- There is significant opportunity to improve reliability through the use of intelligent monitoring at the substation
- Further improvement when monitoring data from throughout the distribution system is available
- Examples
  - Incipient fault detection
  - Distribution fault anticipator
  - Equipment problem identification
  - Multiple faults in same location
  - Galloping conductors



Results of feeder monitoring system and fault locating – Carolina Power & Light



Integration of monitoring information is critical

RTU

Revenue Meter

DFR

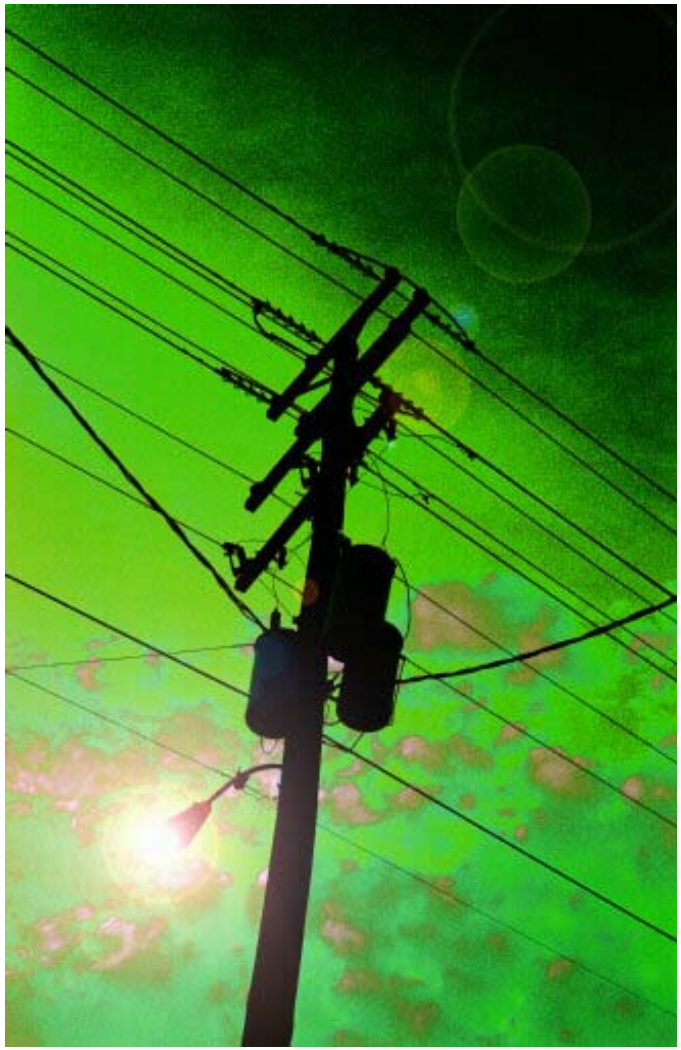
Recloser Control

Relay

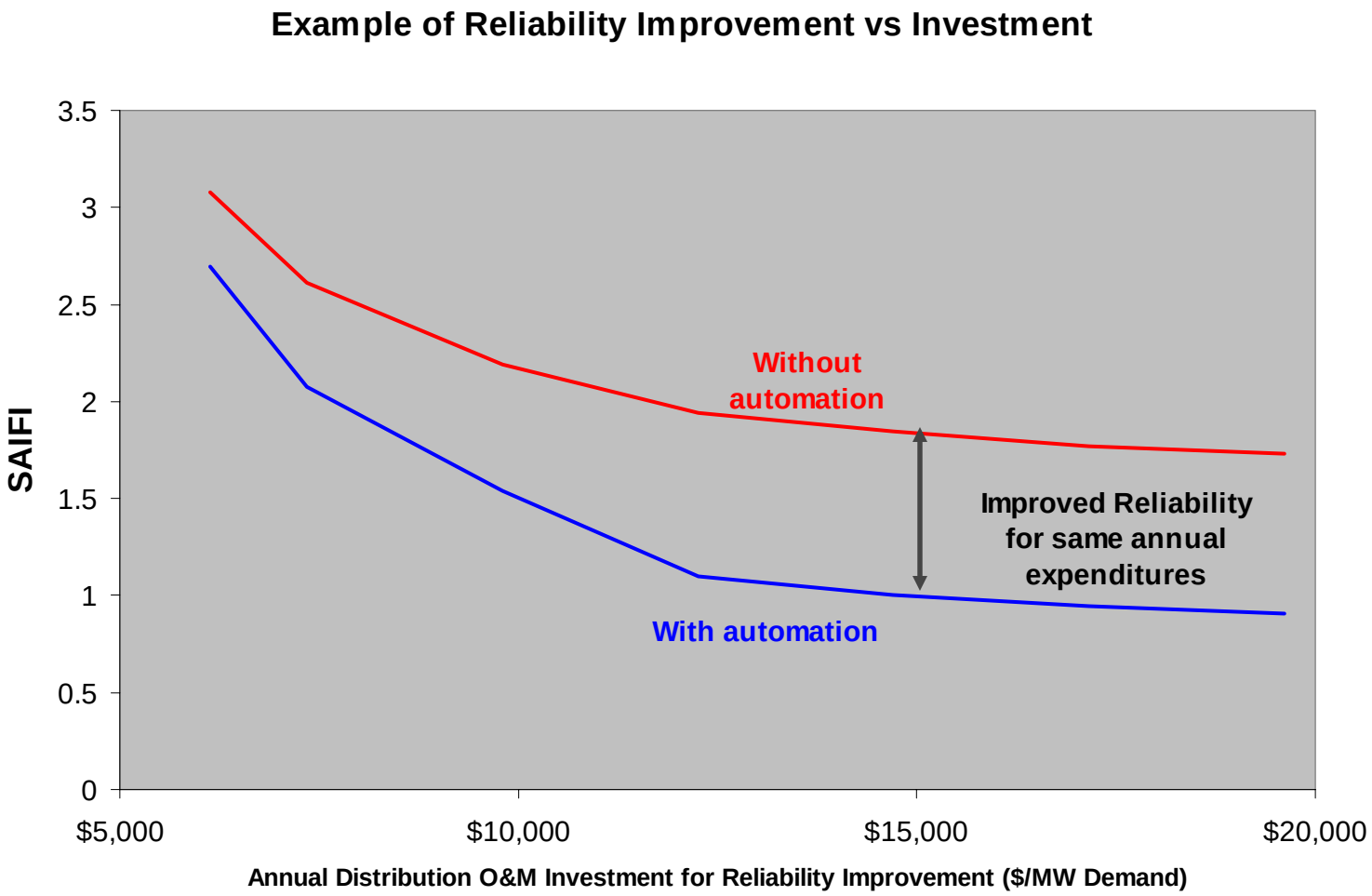
Capacitor Bank Controller

Automating Distribution Feeder Circuits

- More flexible operation of distribution system
- Automated system response to disturbances and outages
- Improved reliability with multiple options for supplying load
- Optimized asset management and system efficiency
- Integration of DER to improve system performance and allow integration with energy management systems



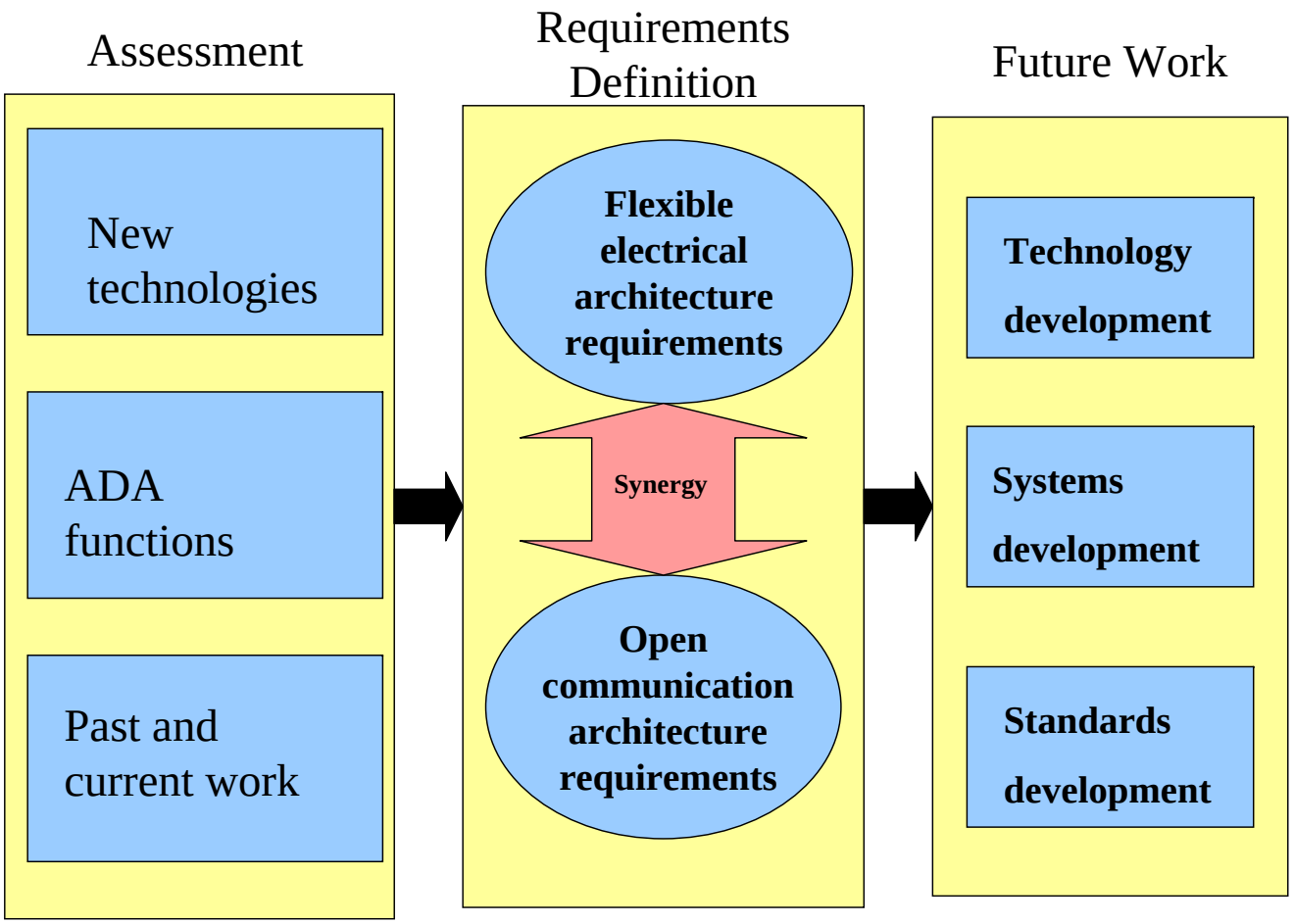
Summary – automation can provide step change in reliability



Major components of ADA

- Flexible electrical system architecture (including integration of power electronics and DER)
- Real-time state estimation tools and predictive fast simulation modeling to continuously optimize system performance (energy, demand, efficiency, reliability, quality)
- Communications and control system based on open architecture and information exchange model
- Integration of system operation and control all the way to consumer facilities

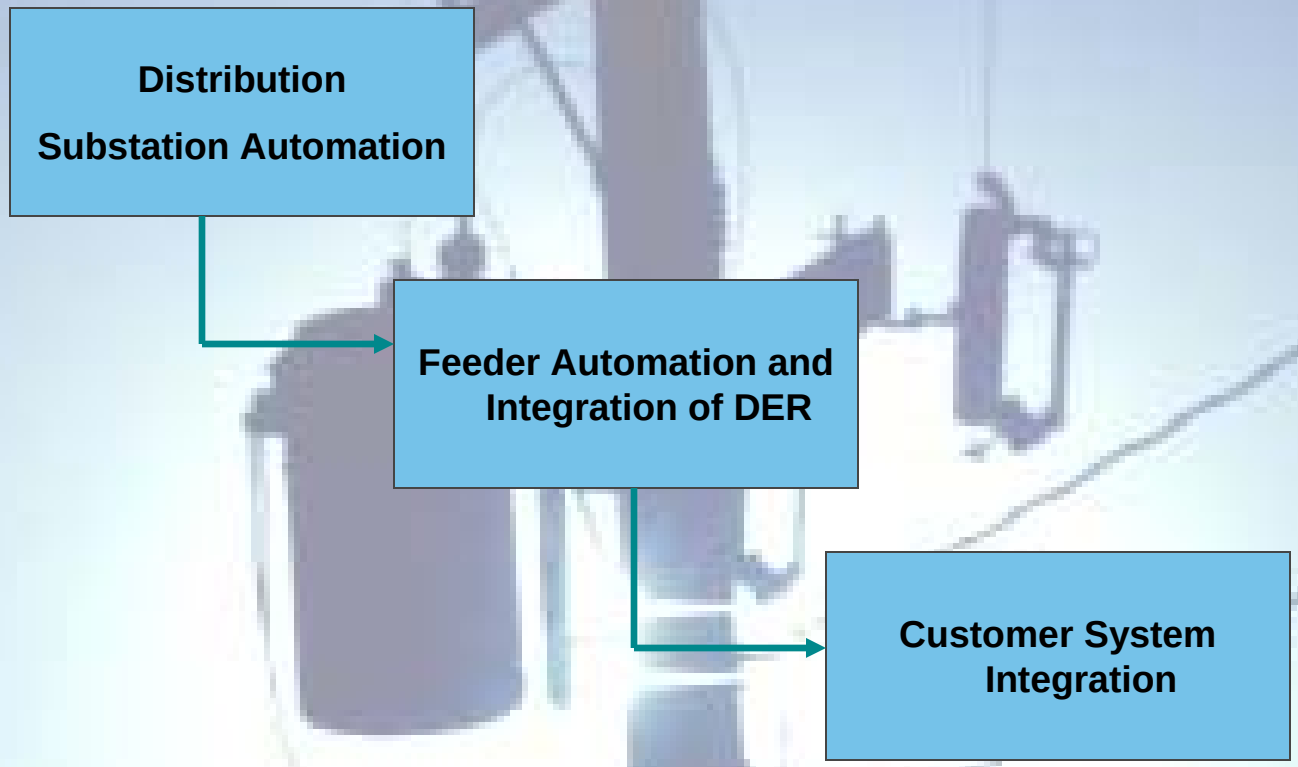
Developing the ADA Research Plan



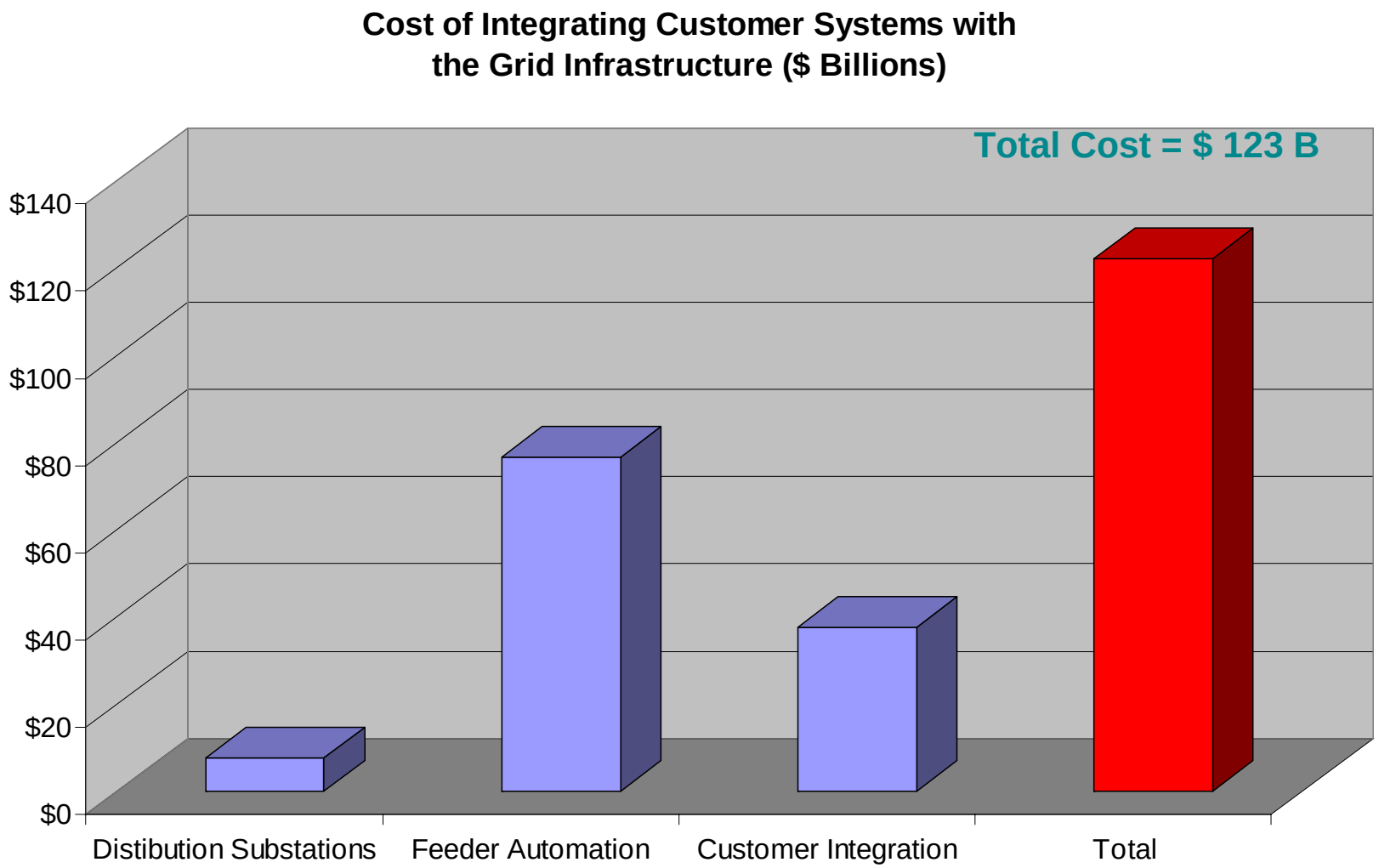
ADA Workshop hosted by Con Edison

- Expertise invited from three key stakeholder groups in roughly equal numbers
  - Electric utility industry
  - Equipment vendors and consultants
  - Academic and other research organizations
- State-of-the-art
- Prioritize research activities

General flow of ADA implementation



Cost for the distribution system of the future: Initial estimate



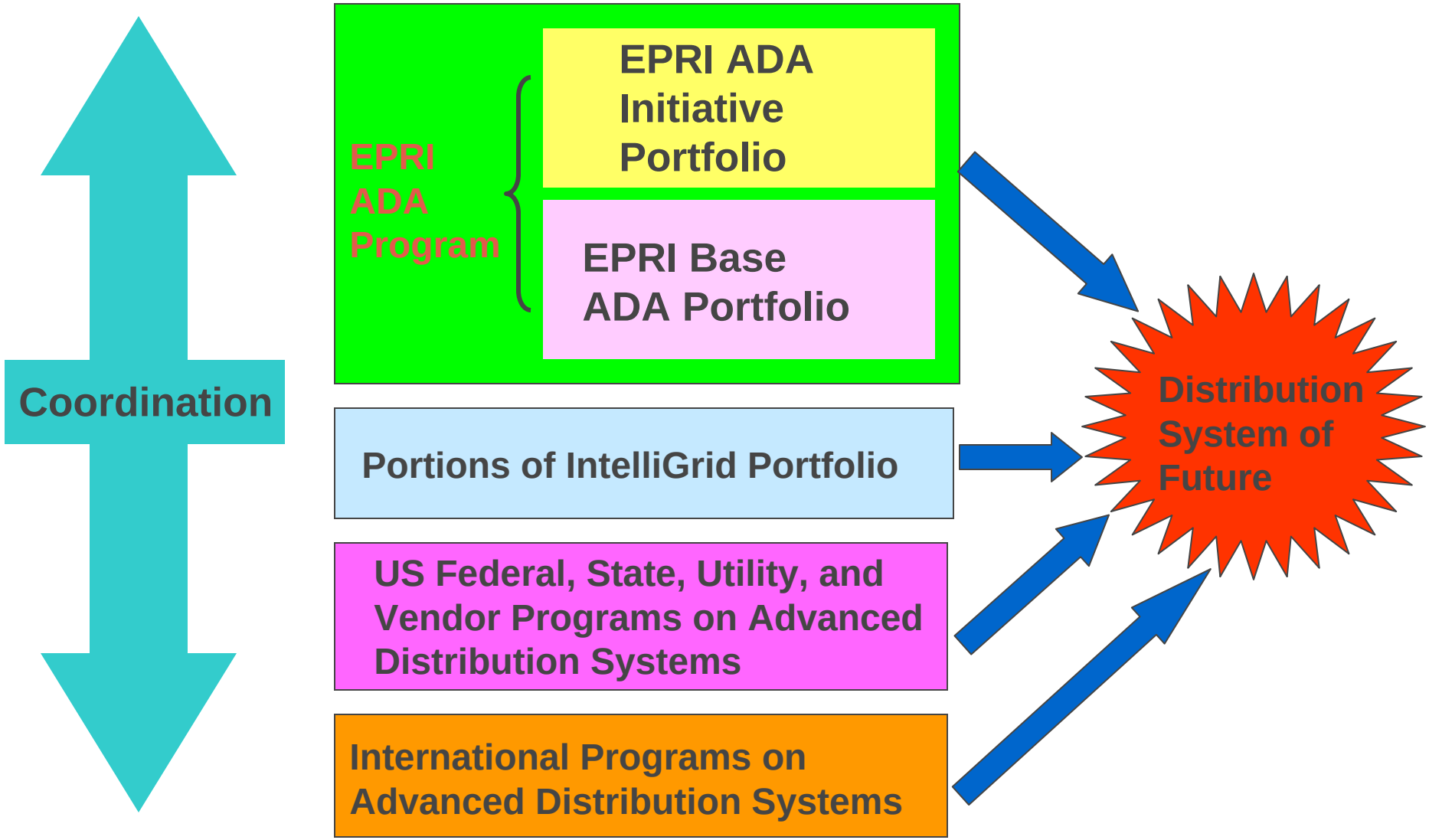
EPRI Vision for Advanced Distribution Automation

- Traditional Distribution Automation
  - Automation of switching functions with some reconfiguration capabilities
  - VAR control
  - Other individual functions
- Advanced Distribution Automation
  - Automation of all controllable equipment and functions
  - Advanced reconfiguration capabilities for optimizing performance and improving reliability
  - Communication and control infrastructure
  - Distribution systems become multi-function systems
  - Integration of distributed generation, including microgrids

Strategic drivers for ADA

1. Improve reliability and power quality
2. Reduce operating costs
3. Improve outage restoration time
4. Increase customer service options
5. Integration of DER
6. Integration of the customer

Revolution by evolution will be a collaborative process



All Current EPRI ADA Projects by Functional Area

Functional Area from EPRI ADA Roadmap	Project Title	EPRI Base ADA Program No. 124	EPRI ADA Initiative Program
New Distribution System Topologies and System-Level Concepts	Distribution Design to Integrate Distributed Generation and Other New Intelligent Electronic Devices	x	
	Feeder and Network Evolution to Support ADA		x
	Advanced System Reconfiguration Capabilities		x
	Distribution Protection for ADA		x
Electronic/Electrical Technology Development for ADA	Family of Multi-Function Low-Cost Solid-State Switchgear	x	
	Intelligent Universal Transformer	x	
	Smart-Node Power Electronics for ADA		x
Sensor/Monitoring Systems for ADA	Distribution Fault Anticipator: Algorithm/Locator Development	x	
	First-Generation Integrated Sensor and Monitoring System for ADA	x	
	Advanced System Monitoring for ADA (Second-Generation System)		x
Communication Systems and Standards for ADA	Communication Architecture/Standards for ADA Feeder Equipment		x
	Communication Standards for DER in Electric Power Systems (under the IntelliGrid DER/ADA project)		
Advanced Distribution System Controls	Advanced Volt/VAR Management		x
	Advanced Management of System Performance		x
	Adaptable, Distributed Control for ADA		x

EPRI ADA Initiative Project Content

Functional Area from EPRI ADA Roadmap	Project Title
New Distribution System Topologies and System-Level Concepts	Feeder and Network Evolution to Support ADA
	Advanced System Reconfiguration Capabilities
	Distribution Protection for ADA
Electronic/Electrical Technology Development for ADA	Smart-Node Power Electronics for ADA
Sensor/Monitoring Systems for ADA	Advanced System Monitoring for ADA (Second-Generation System)
Communication Systems and Standards for ADA	Communication Architecture/Standards for ADA Feeder Equipment
Advanced Distribution System Controls	Advanced Volt/VAR Management
	Advanced Management of System Performance
	Adaptable, Distributed Control for ADA

A few important conclusions

- COORDINATION
  - European and UK projects have specific tasks in the initiatives related to tech transfer and coordination
- ADA is an international priority, especially involving integration of DER
- Vendor involvement is very important to make sure that results can be implemented in actual products
- Results must be available to assure that they are used
  - Especially in development areas that relate to standards
  - Open Source development is a possible approach to accomplish this
- Tremendous opportunity to make a step change in the performance of distribution systems
  - Reliability improvement
  - Optimizing performance

Questions/Discussion

Benefits and Value of ADA

- Improvements in:
  - Cost of Energy
  - Service Capabilities
  - Security
  - Quality and Reliability
  - Environment
  - Safety
  - Accessibility
  - Productivity