Distribution Automation

Jason Marenda
POWER Engineers
Distribution Engineering

Outline

- Why?
- Status of Industry
- Background
- Items to Consider

Changing Conditions

Past

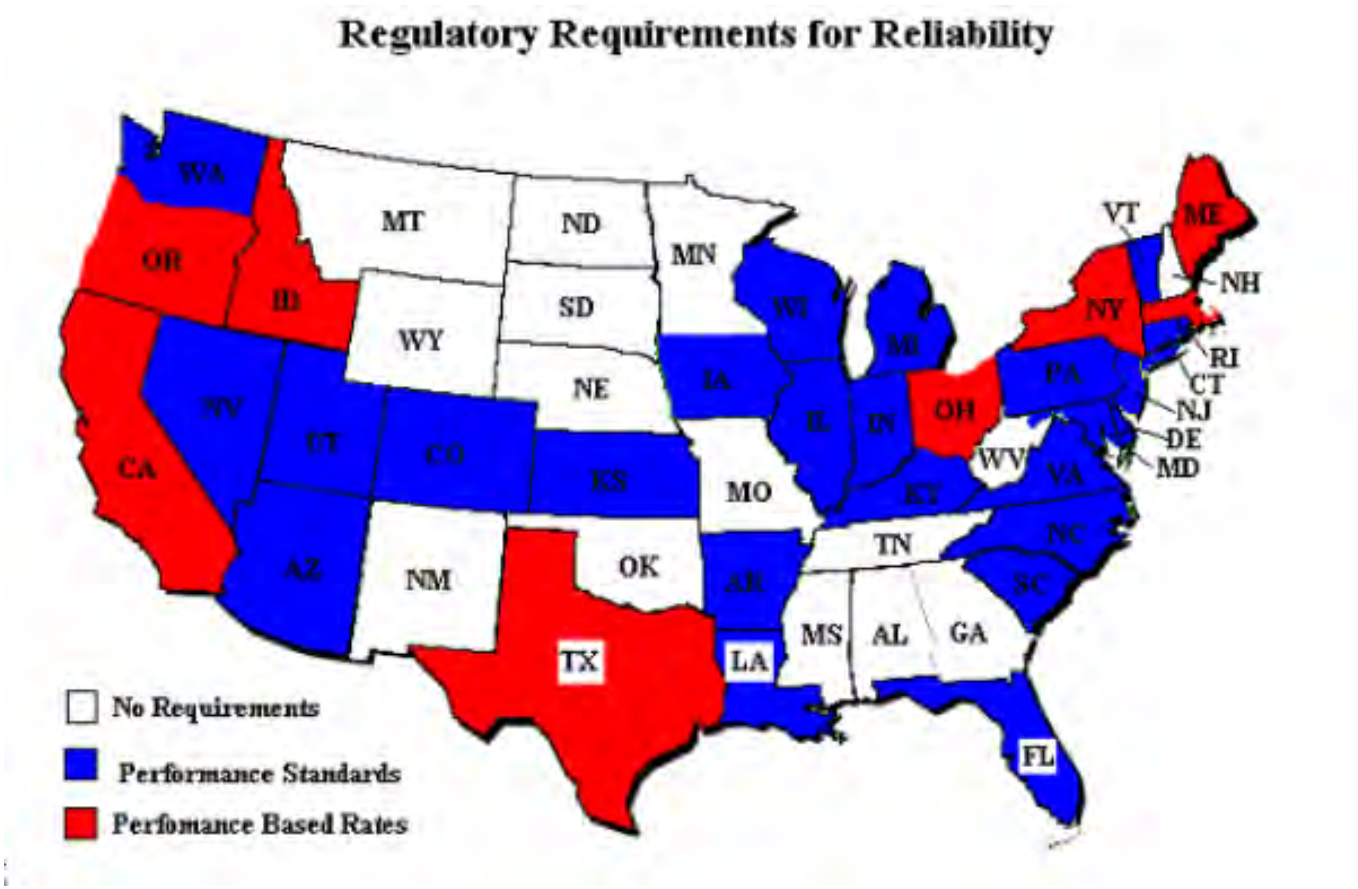
- One-Way Power Flow
- Constant Generation Levels
- Consumers and Producers
- “Dumb” Independent Devices
- Disengaged Customers
- Stable Rate Base Growth

Future (Today)

- Multi-Direction Power Flow
- Variable Generation Levels
- Prosumers
- “Smart” Coordinated Devices
- Engaged Customers
- Flat Rate Base Growth

Why Implement Distribution Automation?

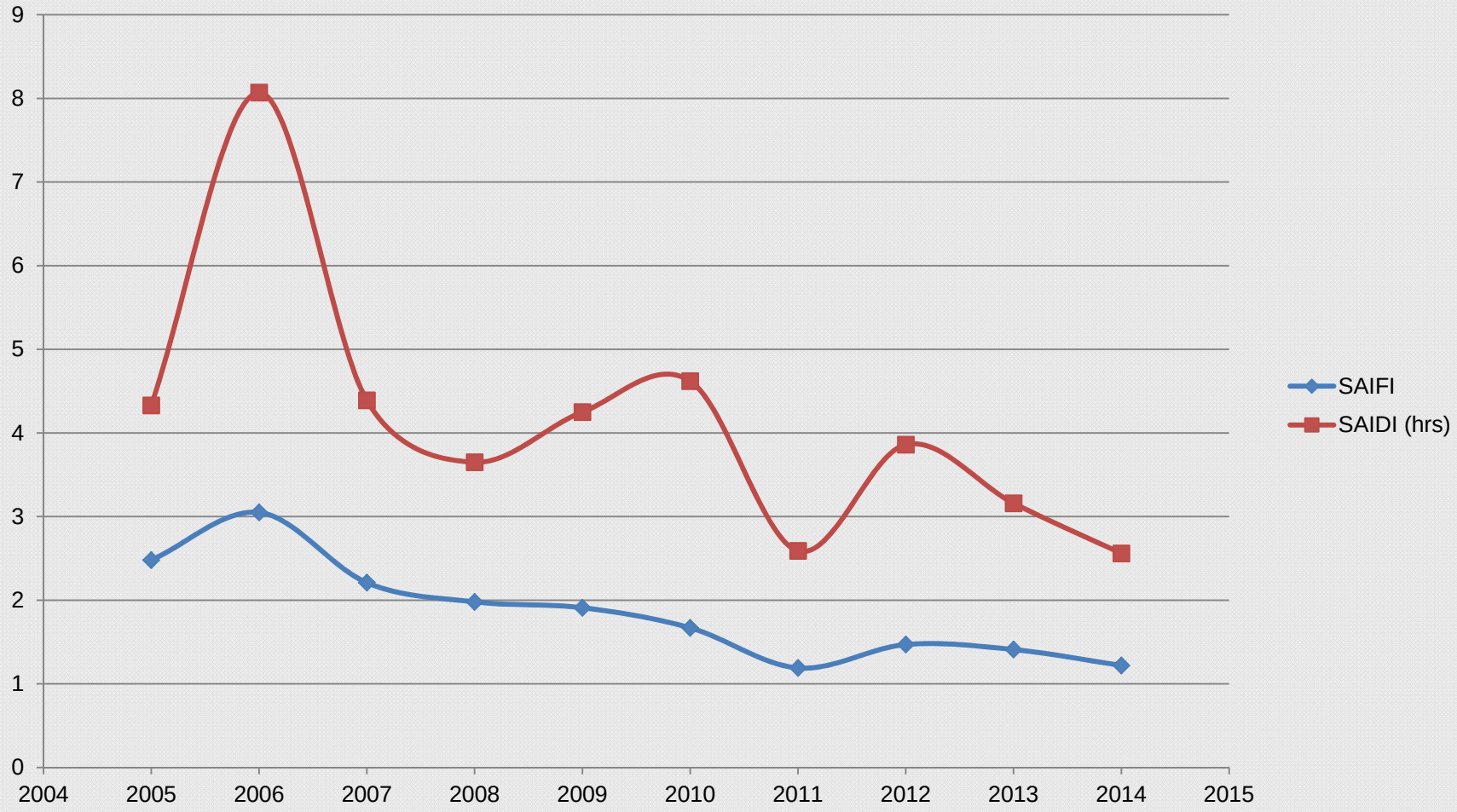
Graph from L2 Engineering



Reliability Indices

- SAIFI
  - **SYSTEM** Average Interruption **FREQUENCY** Index
  - Number of Total Customer Interruptions (>5 min)
  - Over Predefined Period of Time
  - Divided by Total Number of Customers
- SAIDI
  - **SYSTEM** Average Interruption **DURATION** Index
  - Duration of Total Customer Interruptions
  - Over Predefined Period of Time
  - Divided by Total Number of Customers
- CAIDI
  - **CUSTOMER** Average Interruption **DURATION** Index
  - Duration of Total Customer Interruptions
  - Divided by Number of Total Customer Interruptions (>5 min)
- MAIFI
  - **MOMENTARY** Average Interruption **FREQUENCY** Index
  - Similar to SAIFI
  - Includes short (<5 min) outages

Actual Reliability Indices



Status of Industry

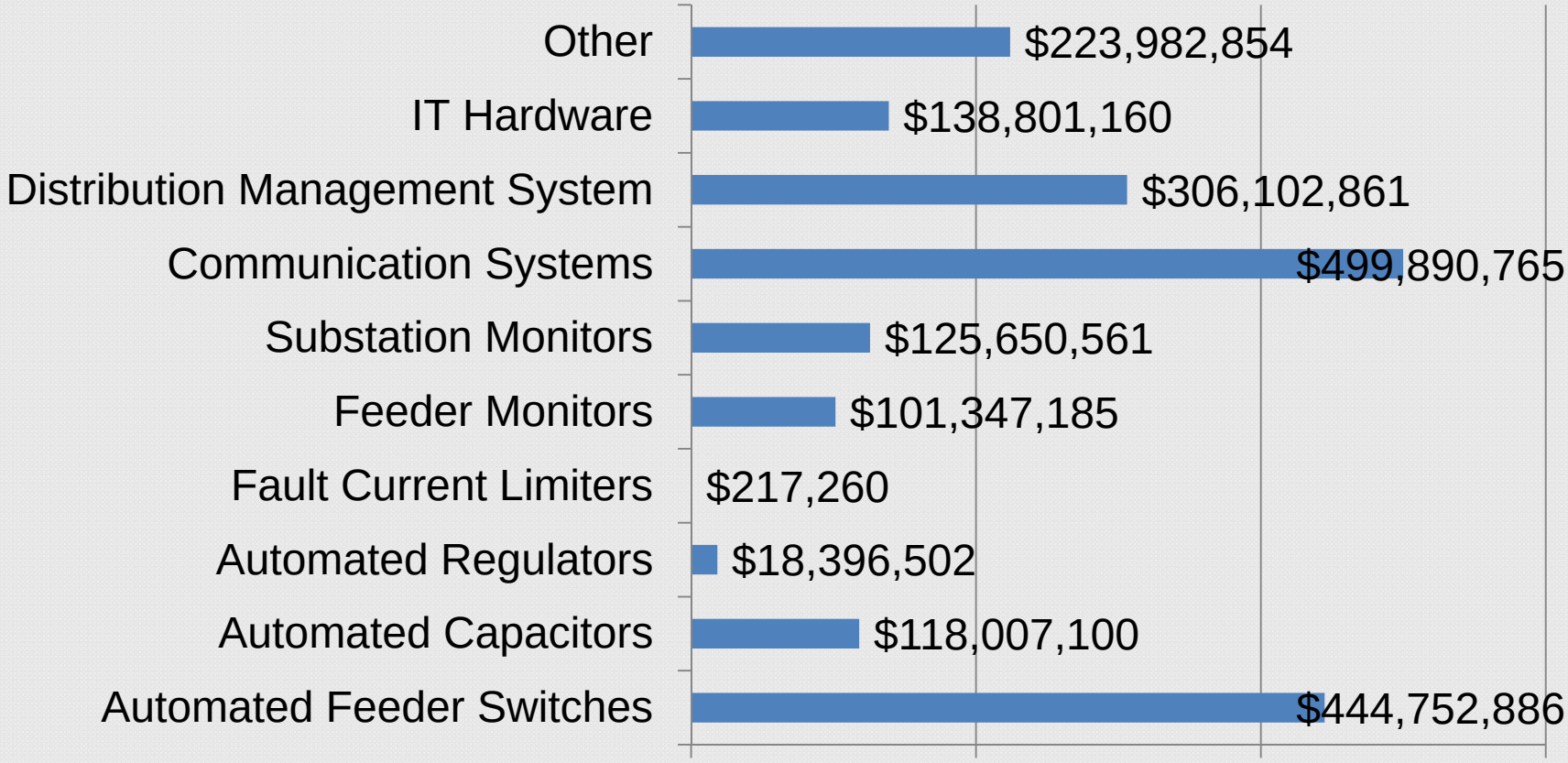
- Estimated Spending
- What are We Observing?
- What is Working?
- What Isn't?

Status of Industry

- Increased Spending in DA
  - Estimated $1.9B annually in US for 2017
- Pilot Projects
  - Many Utilities still in Pilot Phase
- Most using a Phased Approach
- Many Rely on Single Vendor Approach
- DOE Releases Biennial Smart Grid System Report

1. Navigant Research study from July 2013

Smart Grid Investment Grant Spending (Sept, 2014)



Items to Consider/Typical Roadmap

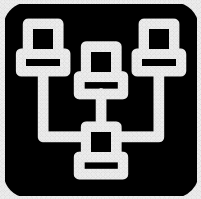
- Develop a Plan
- Communications and Infrastructure
- Monitoring and Control
- Implement Schemes

Develop a Plan

- Determine Goals
- Small Pilot Project
- Low Hanging Fruit
- Consider Multi Vendor Solution
- Design Tradeoffs
  - Cost
  - Complexity
  - Benefits

Communications

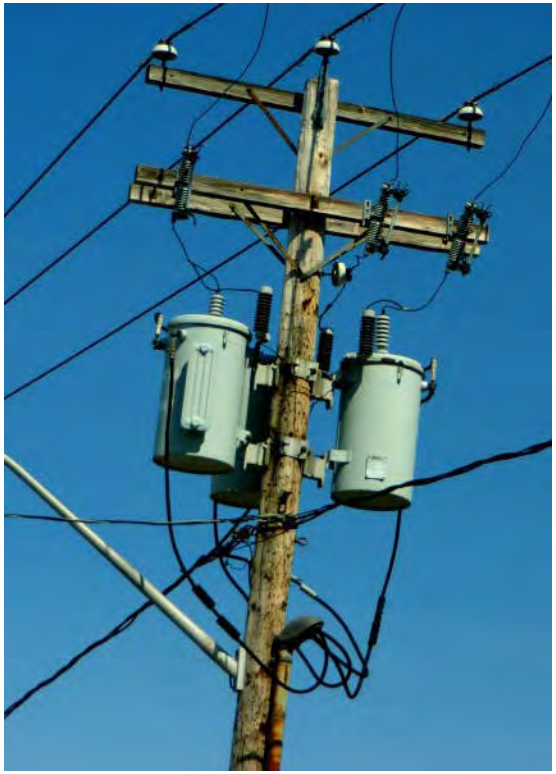
- Leverage Existing Infrastructure
- Shared or Private
  - Shared
    - Reduced Initial Costs
    - Limited Versatility for High Speed Applications
  - Private
    - Increased Installation and Costs
    - Increased Control and Versatility
    - Licensed or Unlicensed



Communications - Private

- Wireless
  - Mesh or Point-to-MultiPoint
  - Security equivalent to other means
- Power Line Carrier
- Fiber
- Microwave
- Satellite
- Combination

Infrastructure and Equipment



- Use devices with comms capability
  - Even if not currently using comms
- Keep future in mind when updating standards
  - Transformer Monitoring
  - Regulator Controls
  - Capacitor Controls
  - Remote Switch Controls
  - Feeder Monitoring
  - Fault Locators
- Optimized Device Placement

Monitoring and Control

- Bring Data to Control Center for Monitoring
- Enable Remote Control of Regulators, Cap Banks, Switches, Sectionalizers, etc…
- Minimize Service Truck Rolls
- Reduce Outage Times
- Allows Manual Implementation of Schemes

Methods

- Local
  - Individual Device Control Based on Historical Data
  - Time of Day Switching
- Decentralized or Coordinated
  - Coordinate Control of Capacitors, Regulators, and Tap Changers
  - Requires Communications Between Devices and Accurate Real Time Status
- Centralized or Integrated
  - Centralized System Coordinates Control Throughout System
  - Use System Model to Determine Optimal Volt/Var Control
  - Manually Update Non-SCADA Items

Fault Location and Restoration

- FDIR and FLISR
- Most Common type of DA currently being used
- Why?
  - Improve Reliability
  - Reduce Outage Times
  - Reduce Operational Costs
  - Increase Customer Satisfaction
  - Regulatory (SAIDI, SAIFI, CAIDI, etc…)
- Methods
  - Where do you want to do the Logic?

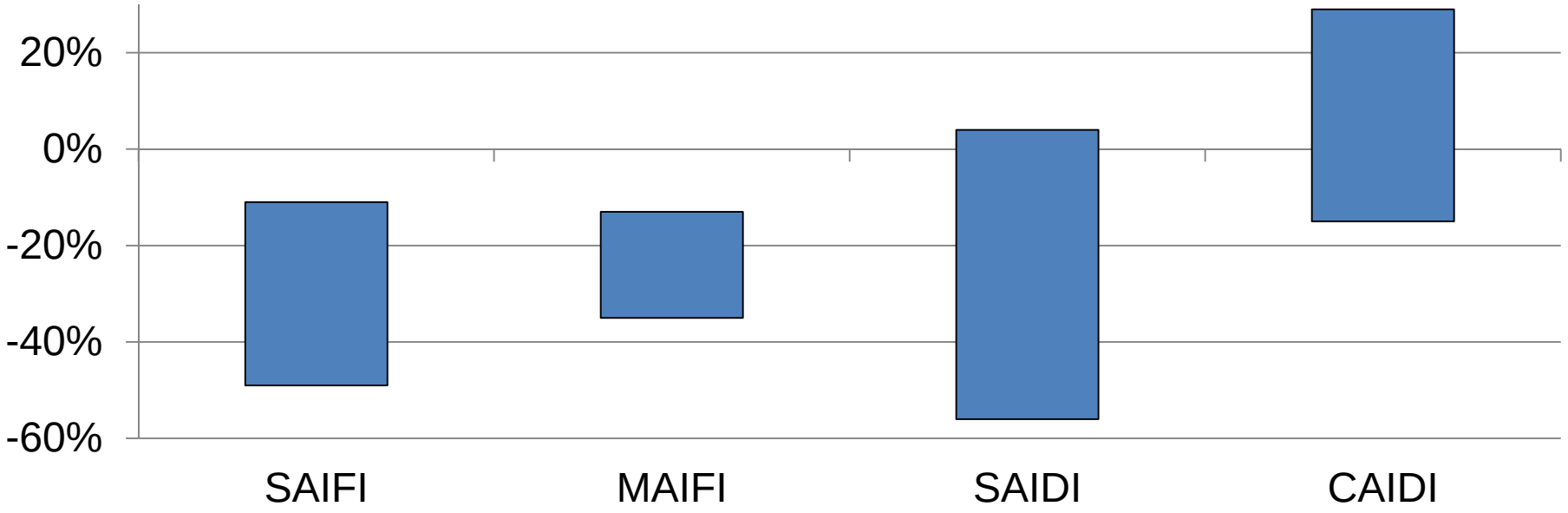
Voltage Control – Why?

- Reduce Losses
  - Losses on dist system can be almost 10% of delivered power
- Reduce Load (Peak Shaving)
- Reduce Equipment Requirements
- Regulatory Requirements
- Reduce Carbon Footprint

Voltage Control – How?

- Reduce Losses using Switched Capacitors
- Reduce Demand using LTCs and Voltage Regulators
- Static Var Controllers
- Use Reactive Capabilities of Distributed Generation

US Department of Energy Study - 2012



- Negative change indicates improvement in indices
- Study done on reliability upgrades made to over 1250 feeders nationwide
- Changes compared to previous three years of data
- Learning curve for operators exists and contributed to results
- However, SAIFI and MAIFI showed improvement across the board

OT/IT Convergence

- You have the data, how can you use it?
  - Use current data to make accurate predictions on future (Load and DG Forecasting)
  - Give customers indication on when power will be restored
  - Asset Health Management
    - Replace equipment before it completely fails
    - Optimize Transformer Sizing
  - Consider Complexity vs. Value of system

QUESTIONS?