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Transmission & Distribution
Scottsdale, AZ September 14-16, 2016

The Role of Advanced DMS/SCADA Software and Systems

in Building a Resilient and Reliable Power Distribution Grid

By Chuck Newton
Newton-Evans Research Company

Newton-Evans
research company

Company's Mission and Role in Life: **Bridging the Gap** Between Suppliers and Users of Grid Modernization Technology

* Multiple studies conducted each year since 1978 on equipment, IT/OT systems and services usage patterns and plans among the world's electric power delivery utilities.

* We serve as a **bridge** between describing what utilities need and want in control systems, infrastructure equipment and services and what systems providers-vendors need to know in order to develop solutions to meet market needs.

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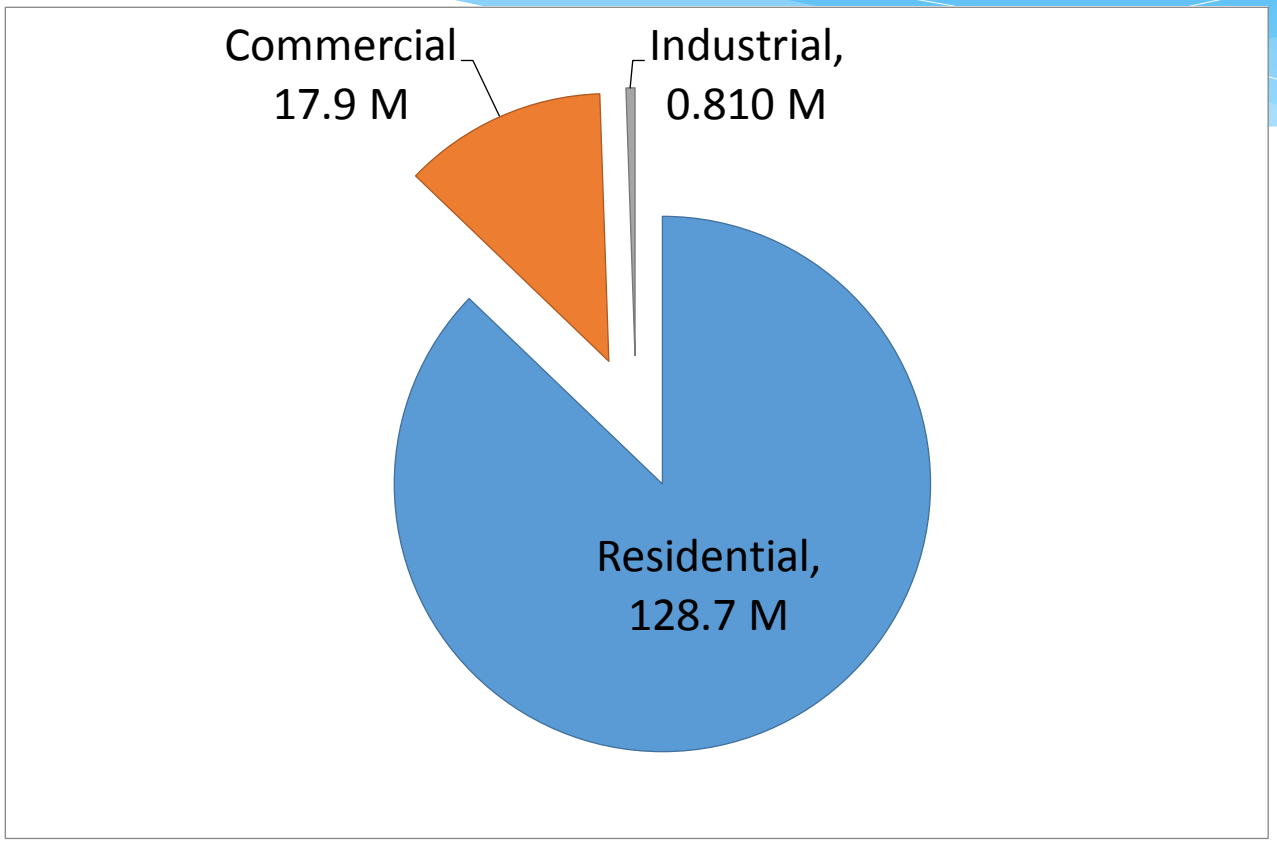
The Global Electric Power Industry

- More than 10,000 electrical utilities in the world.
  - 30% are in the U.S. alone
  - Only about 50 of the world's utilities serve 5 million or more customers directly.
  - There are approximately 1.65 BILLION electric metered sites (customers) throughout the world.
  - Several countries have a SINGLE dominant electric power utility or company for G, T or D (Mexico, France, South Africa, Russia, Italy, Mashreq and Maghreb regions of the Middle East)
- There are thousands of large fossil fuel plants producing electricity
  - Along with about 420 nuclear plants
  - And now, with renewables part of the mix, hundreds of wind farms and solar farms join with the long-term hydro electric production sites around the world.

Global Power Industry Statistics

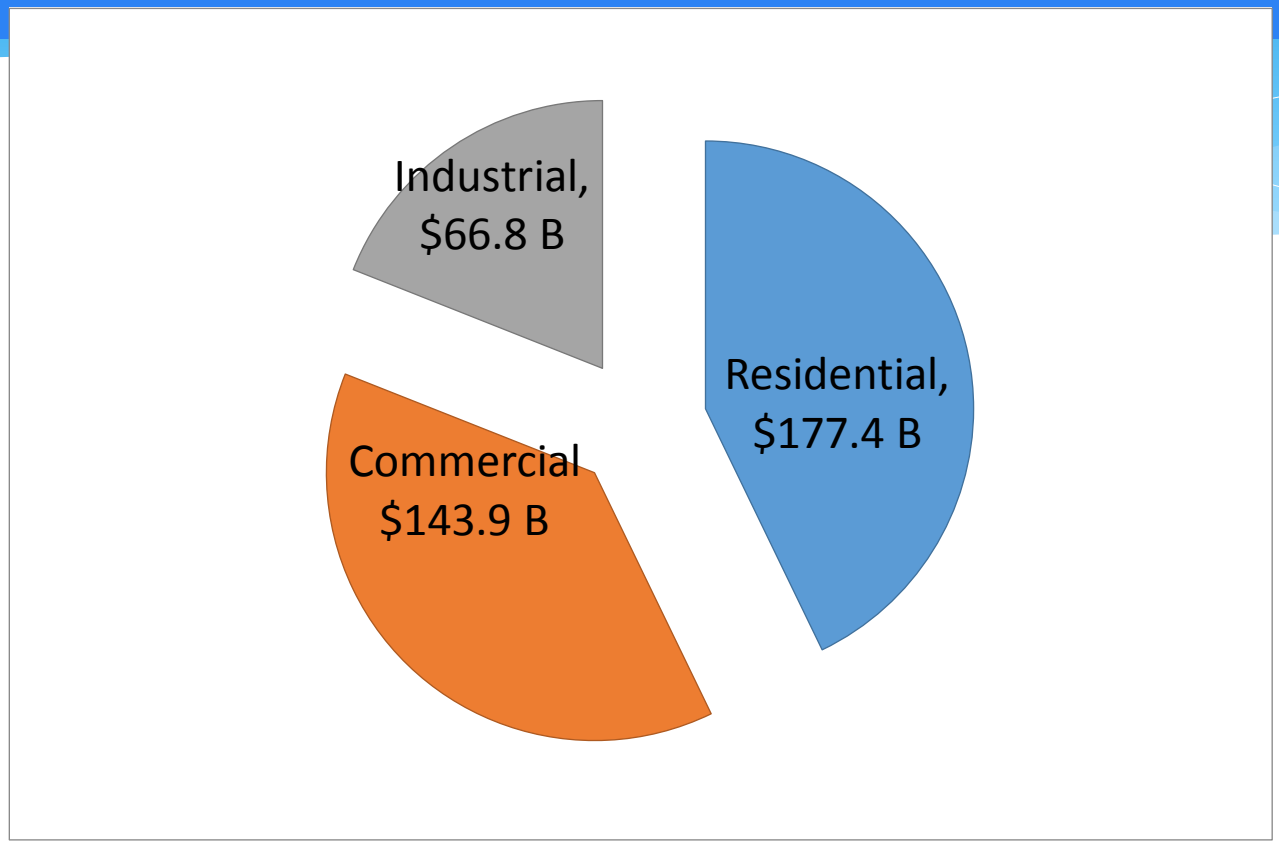
* There are more than 250,000 T&D substations in the world considered “primary”
* There are more than 5,000,000 “secondary” substations around the world.
  * The U.S. alone has an estimated 46 million installed distribution transformers.

U.S. Electric Power Industry Customer Base (Numbers of Customers)



Total U.S. Meter Population at YE 2014 =147.4 Million.
Source: U.S. DoE, EIA as charted by Newton-Evans Research

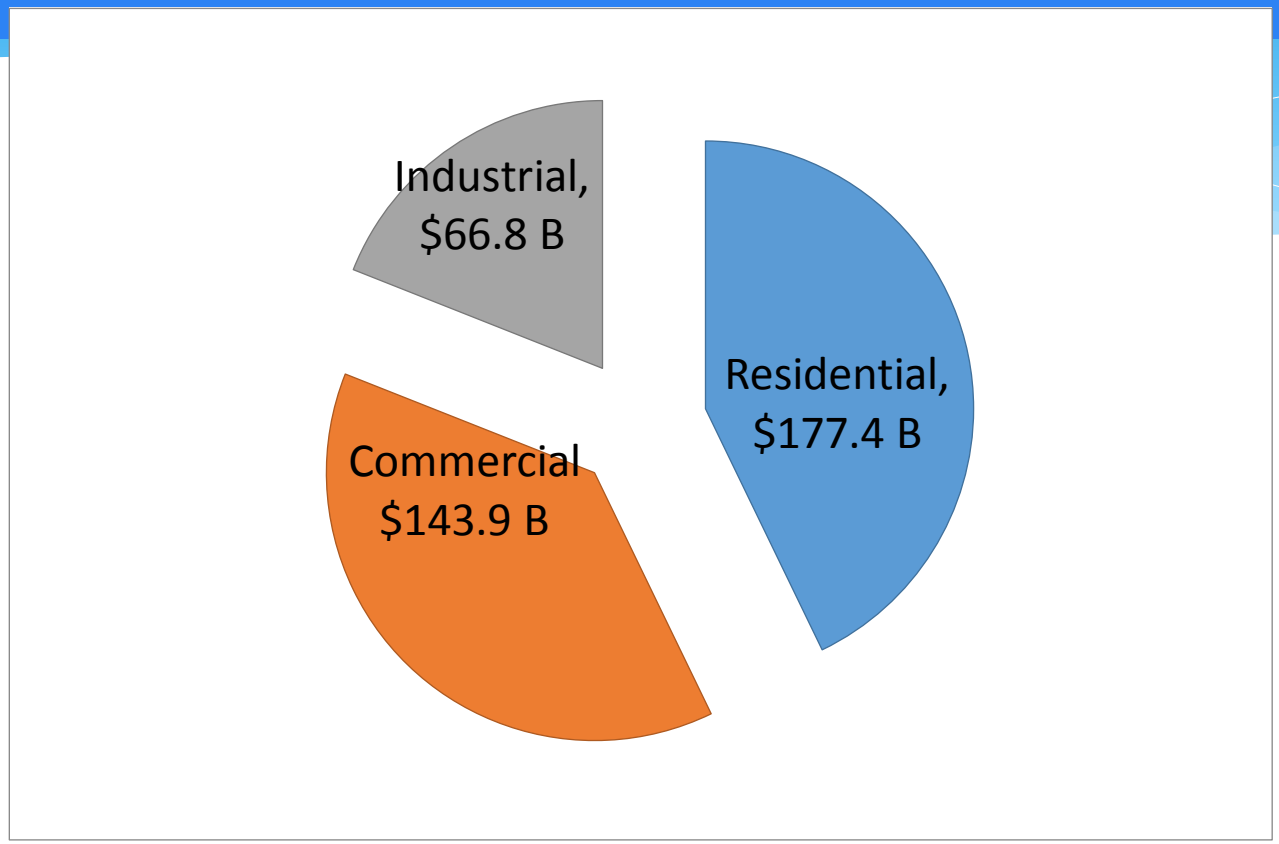
Revenue from Retail Sales of Electricity to Ultimate Customers: Total by End-Use Sector



Total Industry Revenue from Retail Sales of Electricity in 2015 $388.1 B

Source U.S. DoE, EIA. Charting by Newton-Evans Research

Revenue from Retail Sales of Electricity to Ultimate Customers: Total by End-Use Sector



Total Industry Revenue from Retail Sales of Electricity in 2015 $388.1 B

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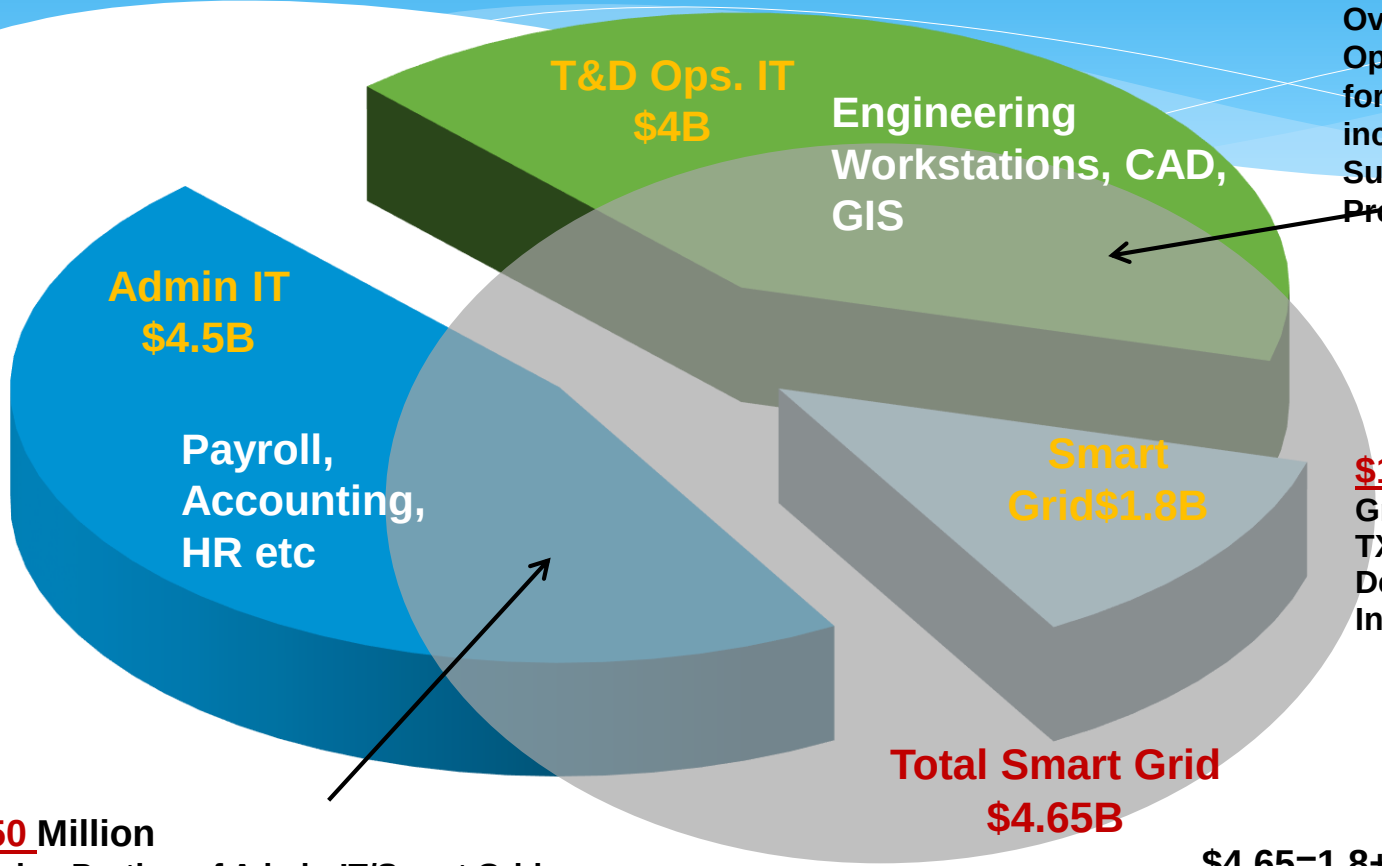
Smart Grid and IT Expenditure
North America Estimates for 2015

Now Including newer additions/ --Expenditures for Grid Analytics and ADMS



$1.9 Billion
Overlap Portion of Operational IT & Smart Grid for Control Systems including ADMS, DA, Substation Automation Protection and Control

$1.8 Billion **"Pure" Smart Grid for DA, AMI, Comms, TX & DX Monitoring/Control Devices, Renewables Interties**

$950 Million
Overlap Portion of Admin IT/Smart Grid for MDM, Portions of CIS, Billing, OMS and Grid Anlytics

$4.65=1.8+1.9+.950

Source: Newton-Evans

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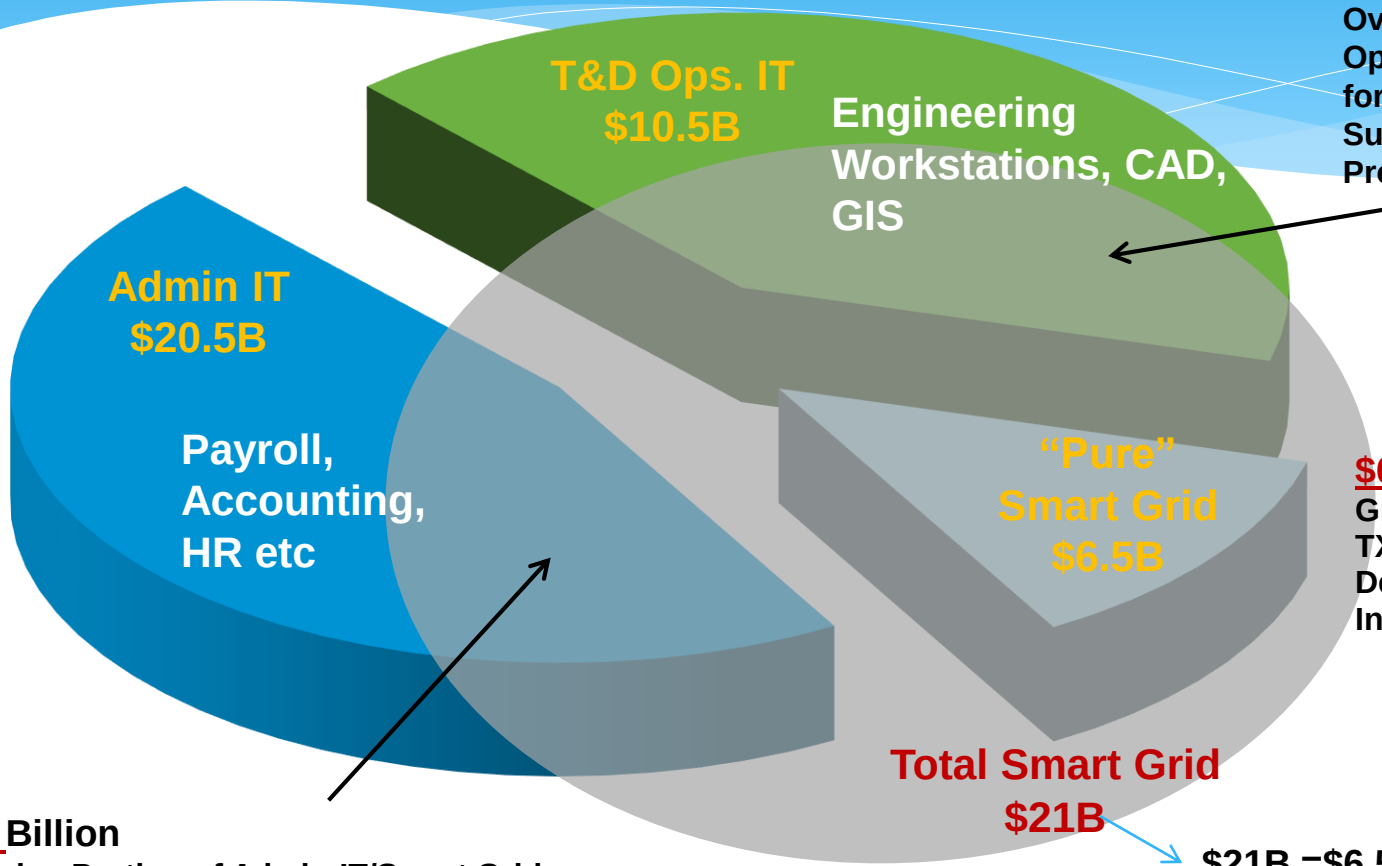
Smart Grid and IT/OT Expenditure Global Outlook for 2020



$8.3 Billion
Overlap Portion of Operational IT & Smart Grid for Control Systems Substation Automation Protection and Control

$6.5 Billion **"Pure" Smart Grid for DA, AMI, Comms, TX & DX Monitoring/Control Devices, Renewables Interties**

6.2 Billion
Overlap Portion of Admin IT/Smart Grid for MDM, Portions of CIS, Billing, OMS

$21B =$6.5B+$6.2B+$8.3B

Source: Newton-Evans

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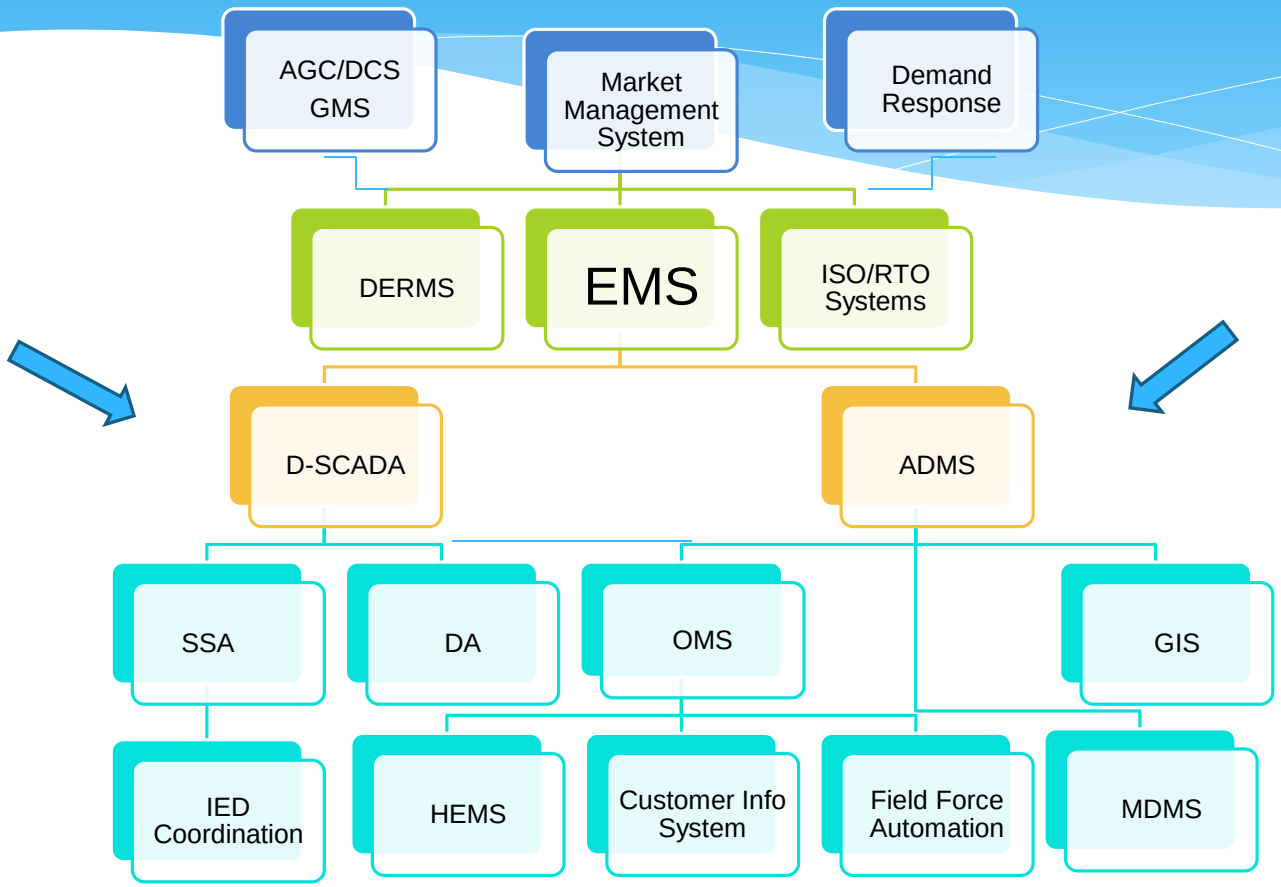
Where Do ADMS and D-SCADA Fit in the Scheme of Grid Control and Monitoring Systems?



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Key Findings from Recent Newton-Evans DMS Studies

Based on this 2015 study and multiple earlier *and more recent* studies, increasing numbers of large utilities have indicated the following:

- Integrated systems are becoming more desirable
- Entrenched suppliers of large control systems (EMS primarily) have an "in" but often cannot provide the required component systems for an integrated approach to DMS-OMS-GIS.
- Many mid-size utilities consider their DSCADA systems (primarily the ACS, OSI, Telvent and Survalent communities) as suitable platforms for DMS/DA.
- A high proportion of all respondents do not yet see a need for a separate DMS. This is especially true among the mid-tier utilities.

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Key Findings from Newton-Evans DMS Studies

Based on this 2015 study and multiple earlier (and more recent) studies, increasing numbers of large utilities have also indicated the following:

- DMS systems can be (*and most often are*) implemented in a single control center that cuts across state lines in the United States.

- Typically, operating companies under a large holding corporation operate their own DMS or DSCADA installations.

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Attributes of an Advanced Distribution Automation Capability

HERE ARE THE 10 ATTRIBUTES OF AN ADVANCED DISTRIBUTION AUTOMATION CAPABILITY BASED ON INTELLIGRID'S DEFINITION.

1. Real-time Distribution Operation Model and Analysis (DOMA)
2. Fault Location, Isolation and Service Restoration (FLISR/FDIR)
3. Voltage/var Control (VVC/VVO)
4. Distribution Contingency Analysis (DCA)
5. Multi-level Feeder Reconfiguration (MFR)
6. Relay Protection Re-coordination (RPRC)
7. Pre-arming of Remedial Action Schemes (PRAS)
8. Coordination of Emergency Actions (CEmA)
9. Coordination of Restorative Actions (CRA)
10. Intelligent Alarm Processing (IAP)

While ADMS platforms are increasingly used by Tier One utilities, many other utilities continue to rely on their DSCADA system to manage a growing portfolio of ADA functions.

Sources: IntelliGrid, Newton-Evans Research Company, Alstom Grid, ABB, GE

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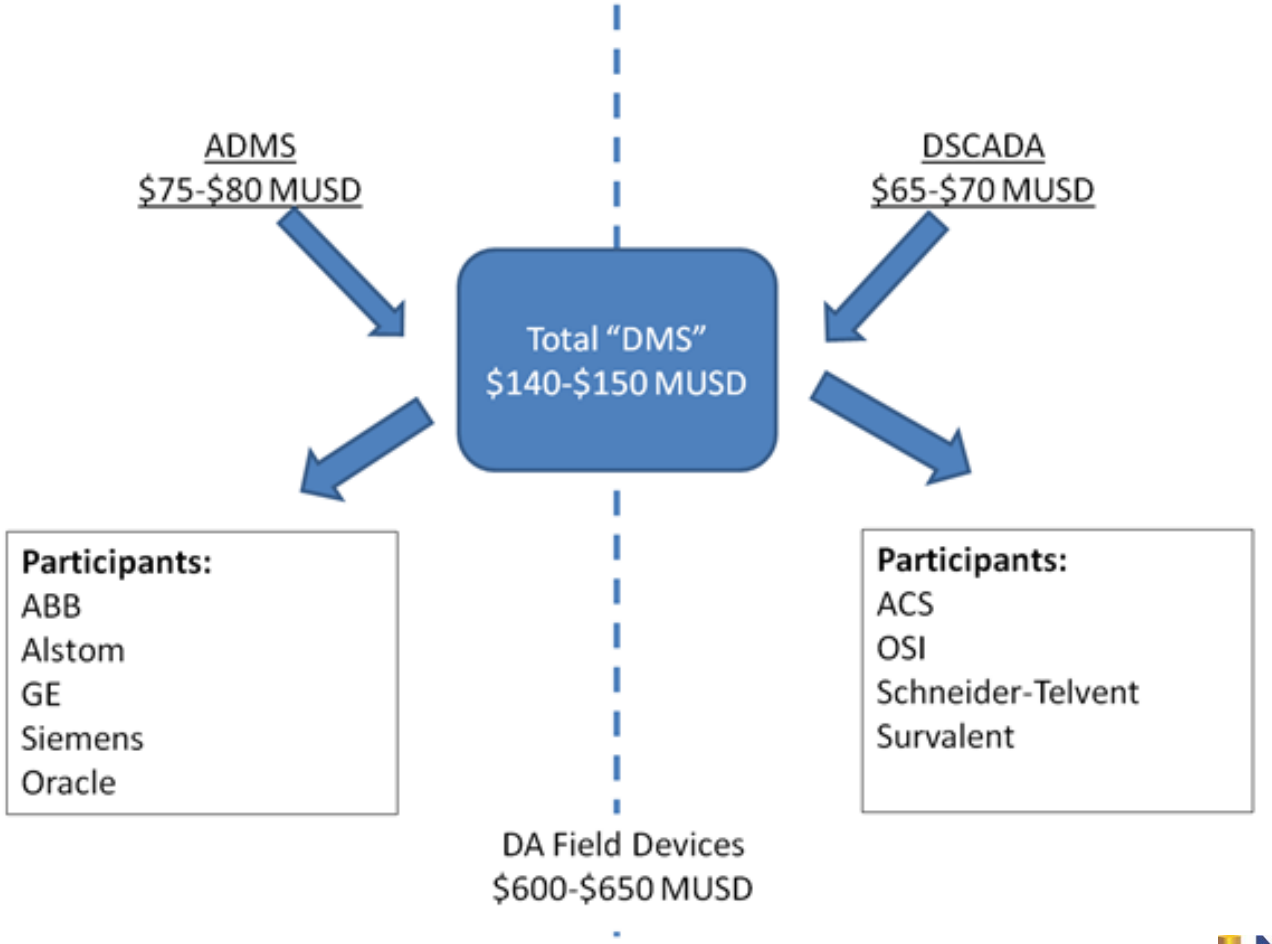
The total North American DMS market is made up of ADM and DSCADA, with some overlapping providers and some different market participants in each category:



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Use of DMS as of Early 2015

(Based on Participants in Newton-Evans' Study)

- Just over 40% of all respondents indicated use of a DMS as of YE 2014 and early 2015.
  - *IOUs were more likely to indicate having a DMS installation than were respondents from other utility types.*
  - Nonetheless, all of the surveyed utilities do have a DSCADA capability and are likely to be applying SCADA control over basic DA functions such as capacitor bank control and recloser control.

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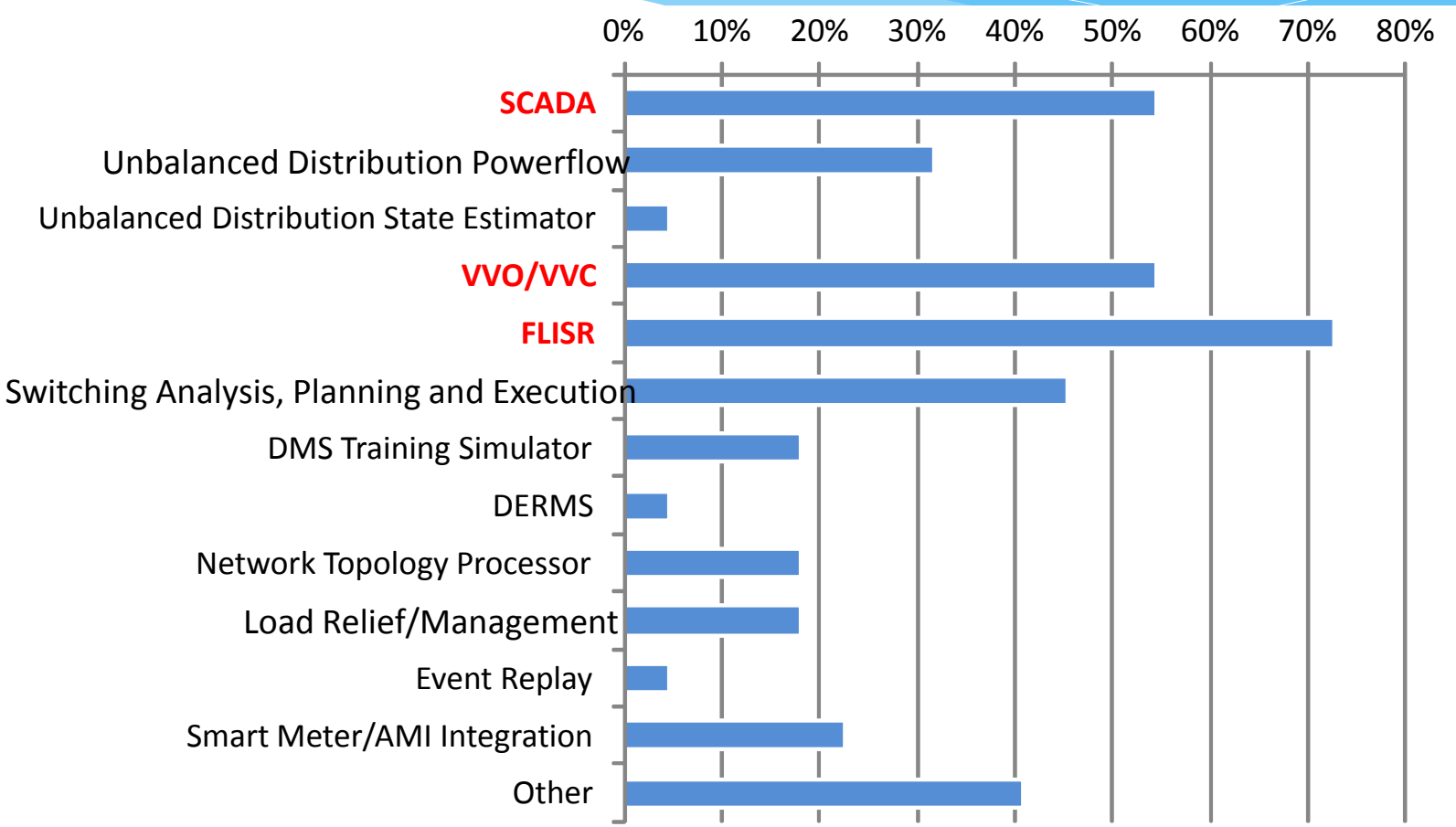
DMS Functionality in Current Deployments



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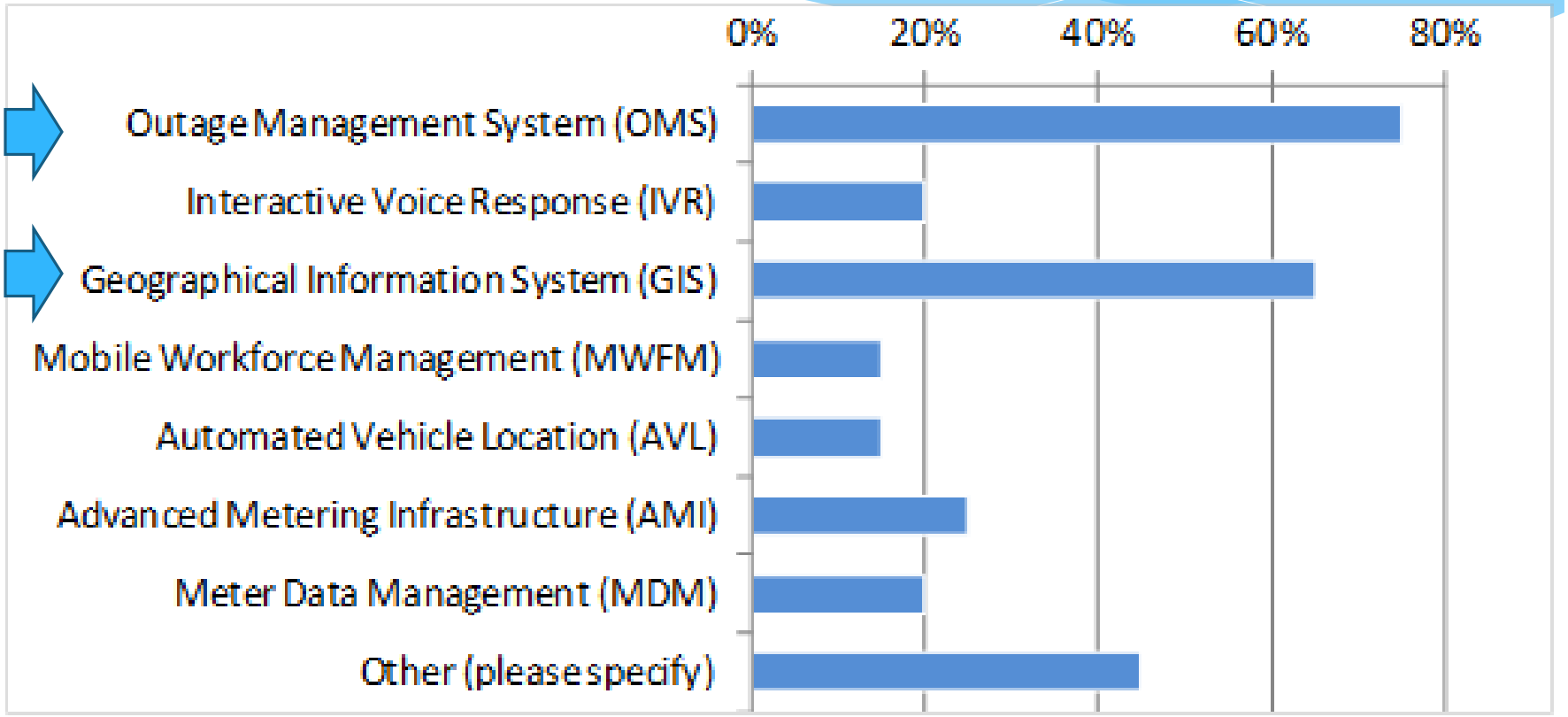
Level of IT/OT Systems Integration with DMS



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Near-Term and Mid-Term Priorities and Challenges for DMS Installations

NEAR TERM PRIORITIES

* **Leveraging** smart grid initiatives in DA and AMI, mentioned by nearly 60% of the group;
* **Integration** with legacy IT/OT systems;
* **Enhancement** of storm preparation and restoration processes.

MID TERM: CHALLENGES:

* Managing EV charging stations;
* Managing microgrid deployments
* Distributed Energy Resources (DER)
* Demand Response/Management
* Knowledge capture
* Integration of automated devices at customer premises locations.

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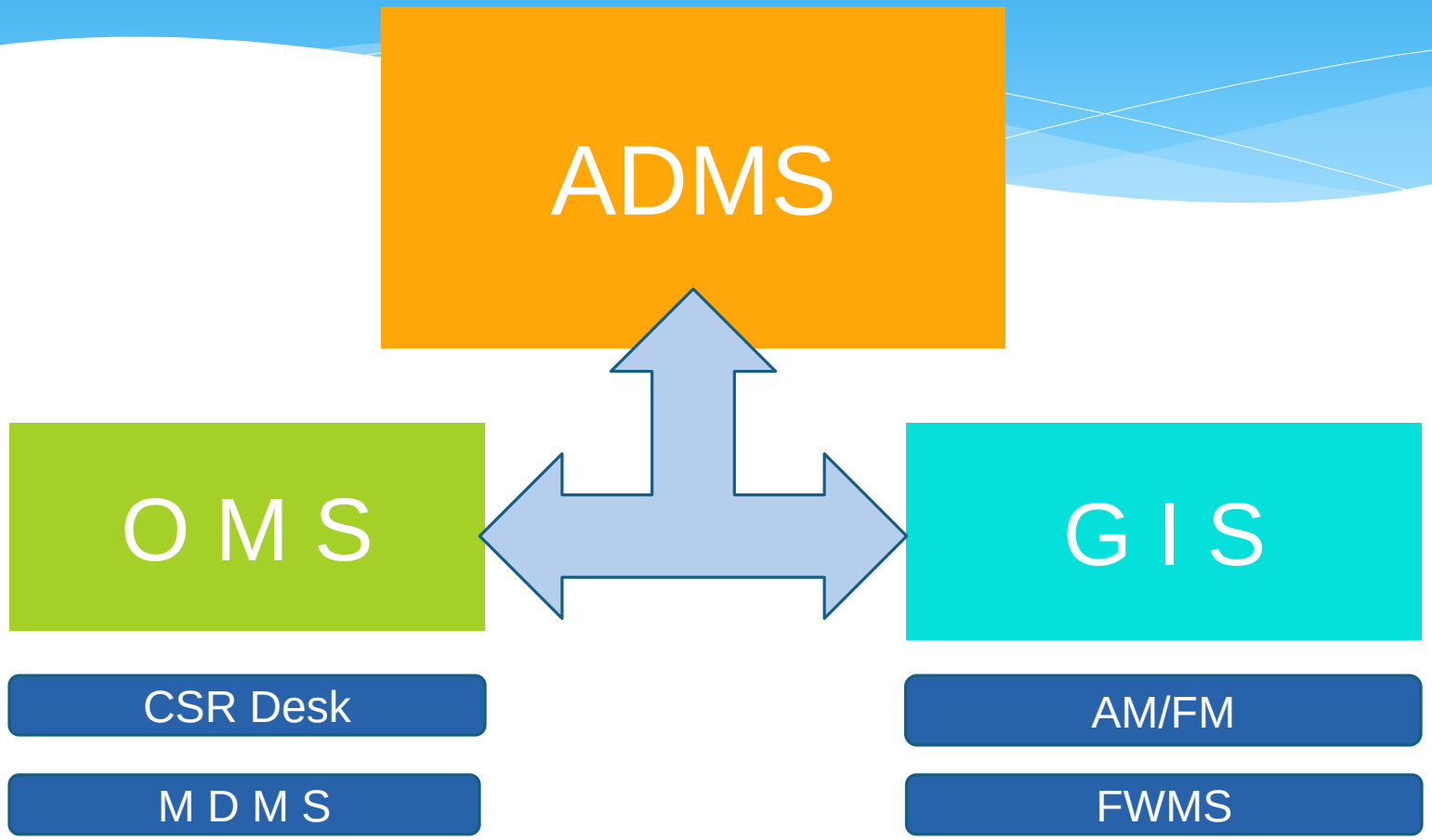
ADMS as Centerpiece System



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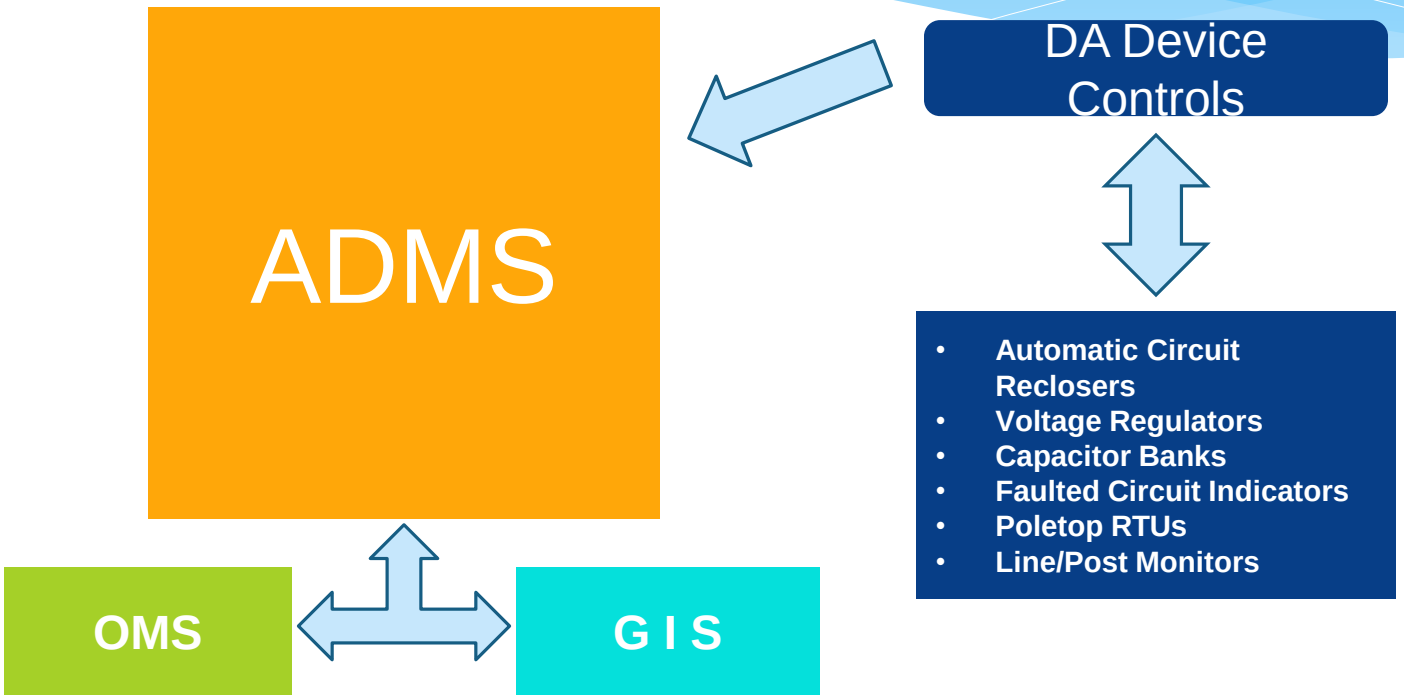

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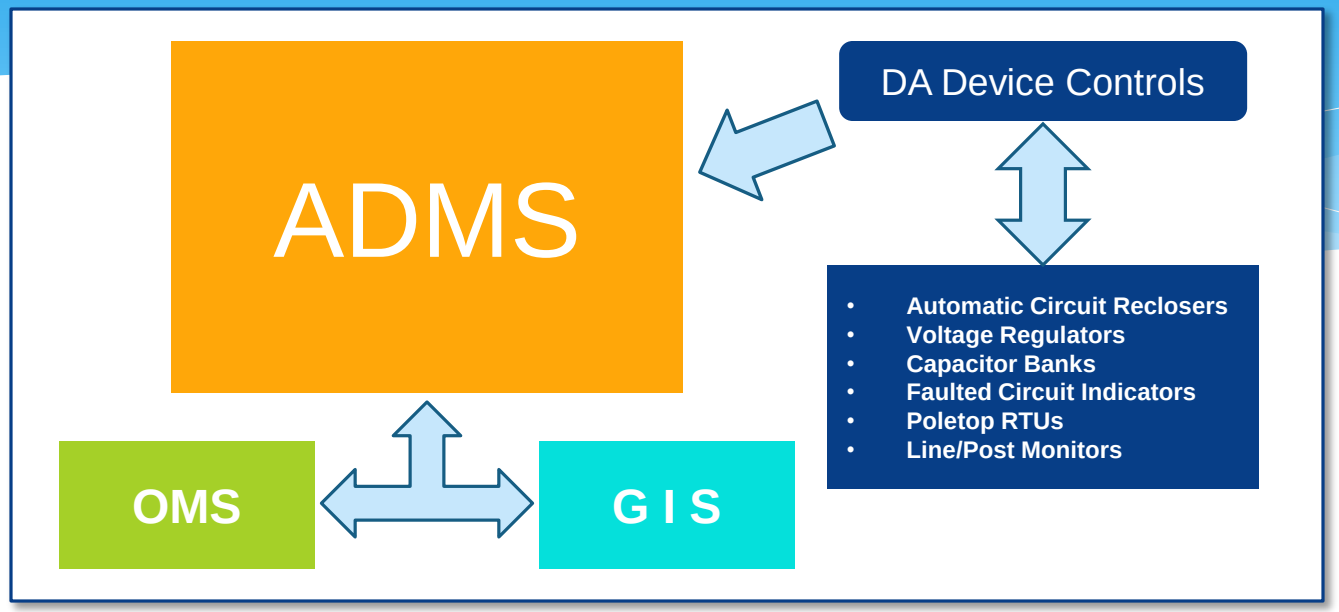

Placement of DA Device Controls

Field

Substation

Control Center

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ADMS as Centerpiece System

Placement of DA Device Controls

Field-Based

S&C Intelliteam II,
L+G Grid Stream; SCADA center product suite,
Cooper/Yukon Feeder Automation,
G&W/Survalent Lazer Automation)

Control Center-Based

ADMS or DSCADA
GE and Others

Substation-Based

Alstom Grid-ASAT
Cooper Cybectec
GE Digital Energy
Novatech
SEL
Subnet Solutions

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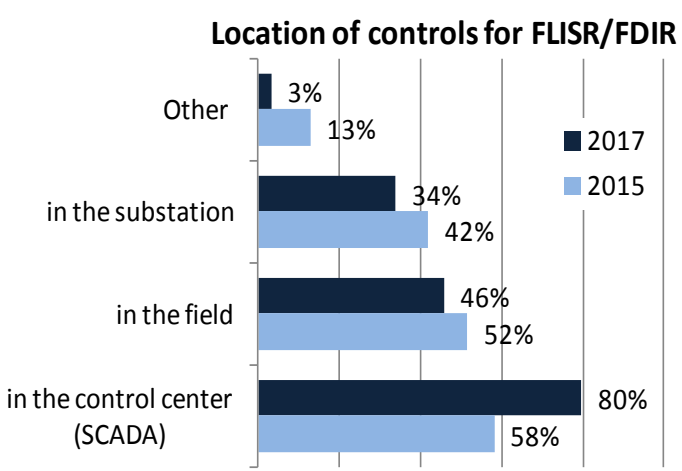
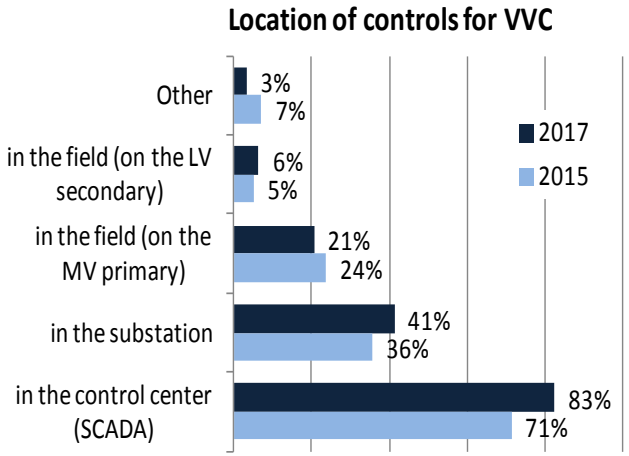
Placement of DA/DMS Controls

- Findings from 2015 DA Study
  - Three approaches in use today
  - Trending toward Control Center in future





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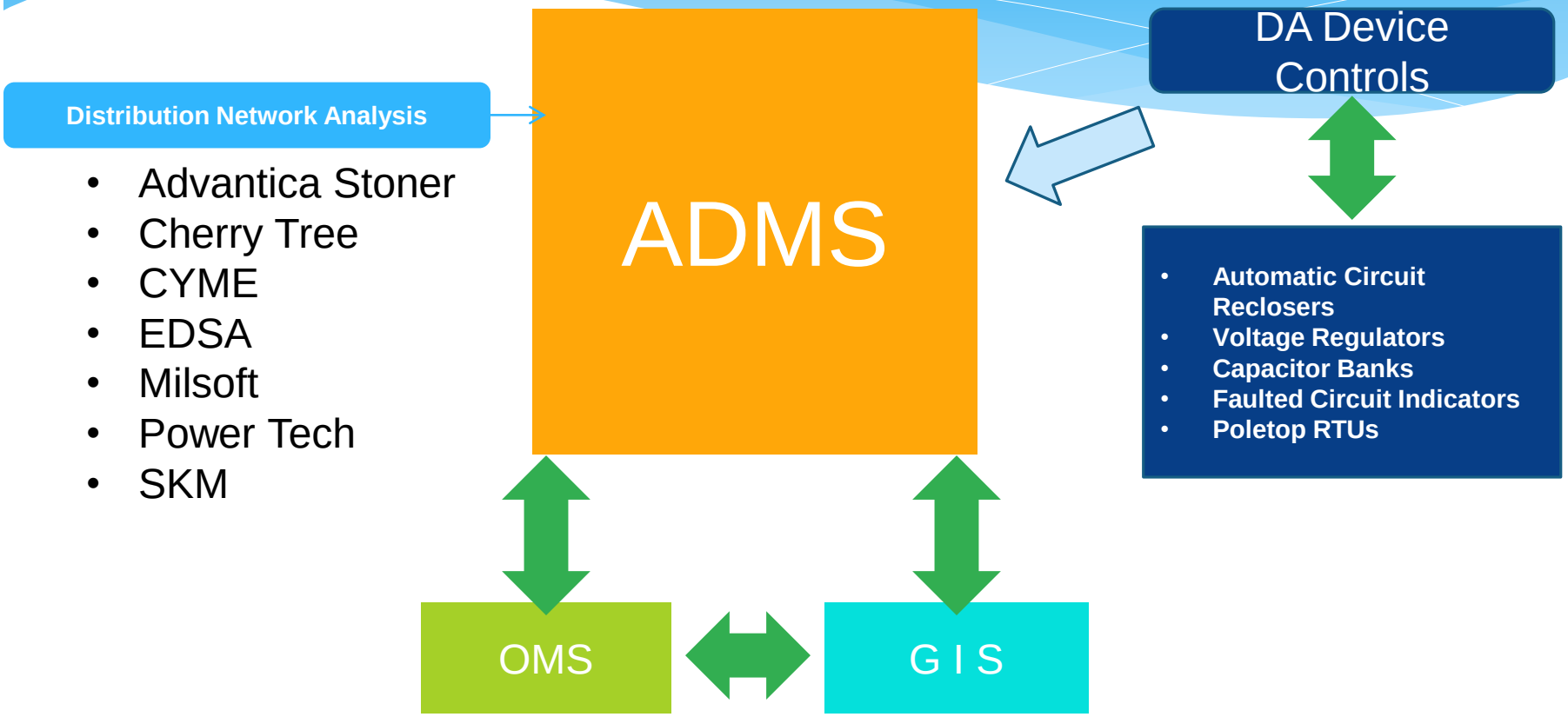

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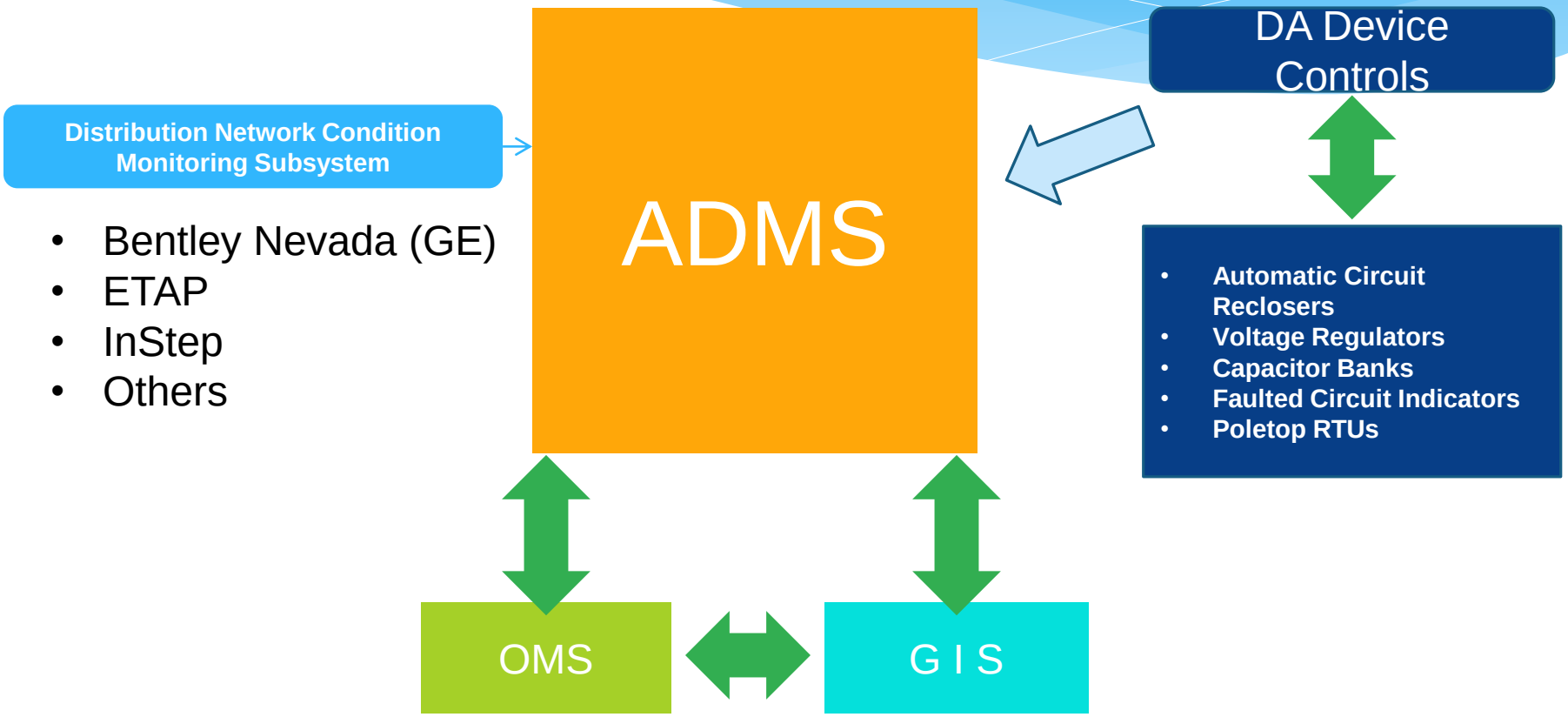

- Bentley Nevada (GE)
- ETAP
- InStep
- Others

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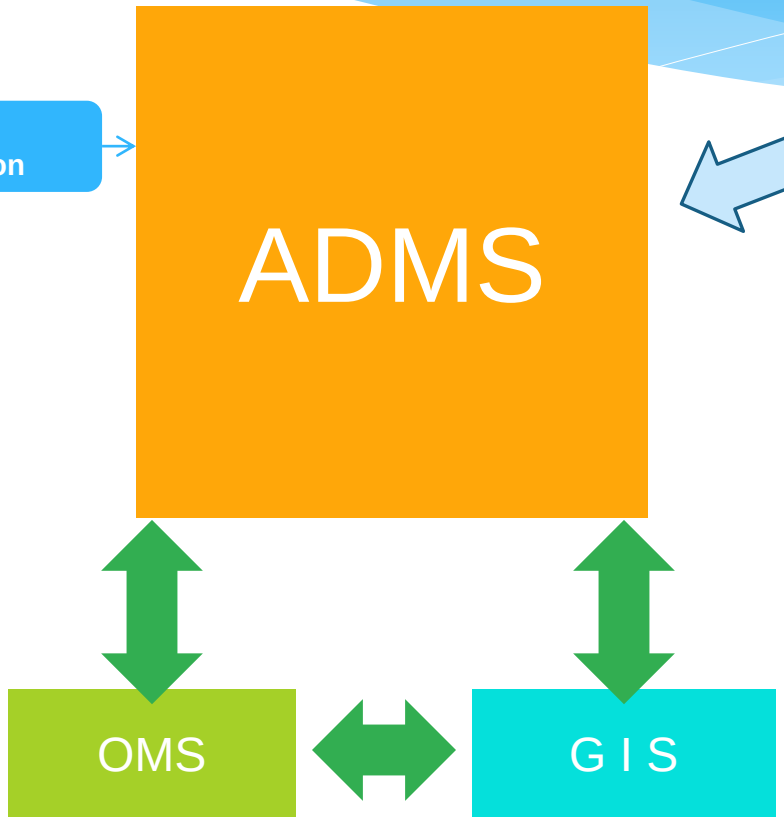
ADMS as Centerpiece System

Distribution Network Fault Characterization and Location

- BPL Global
- CYME
- ETAP
- GE Multilin
- Milsoft
- Oracle



- **Automatic Circuit Reclosers**
- **Voltage Regulators**
- **Capacitor Banks**
- **Faulted Circuit Indicators**
- **Poletop RTUs**

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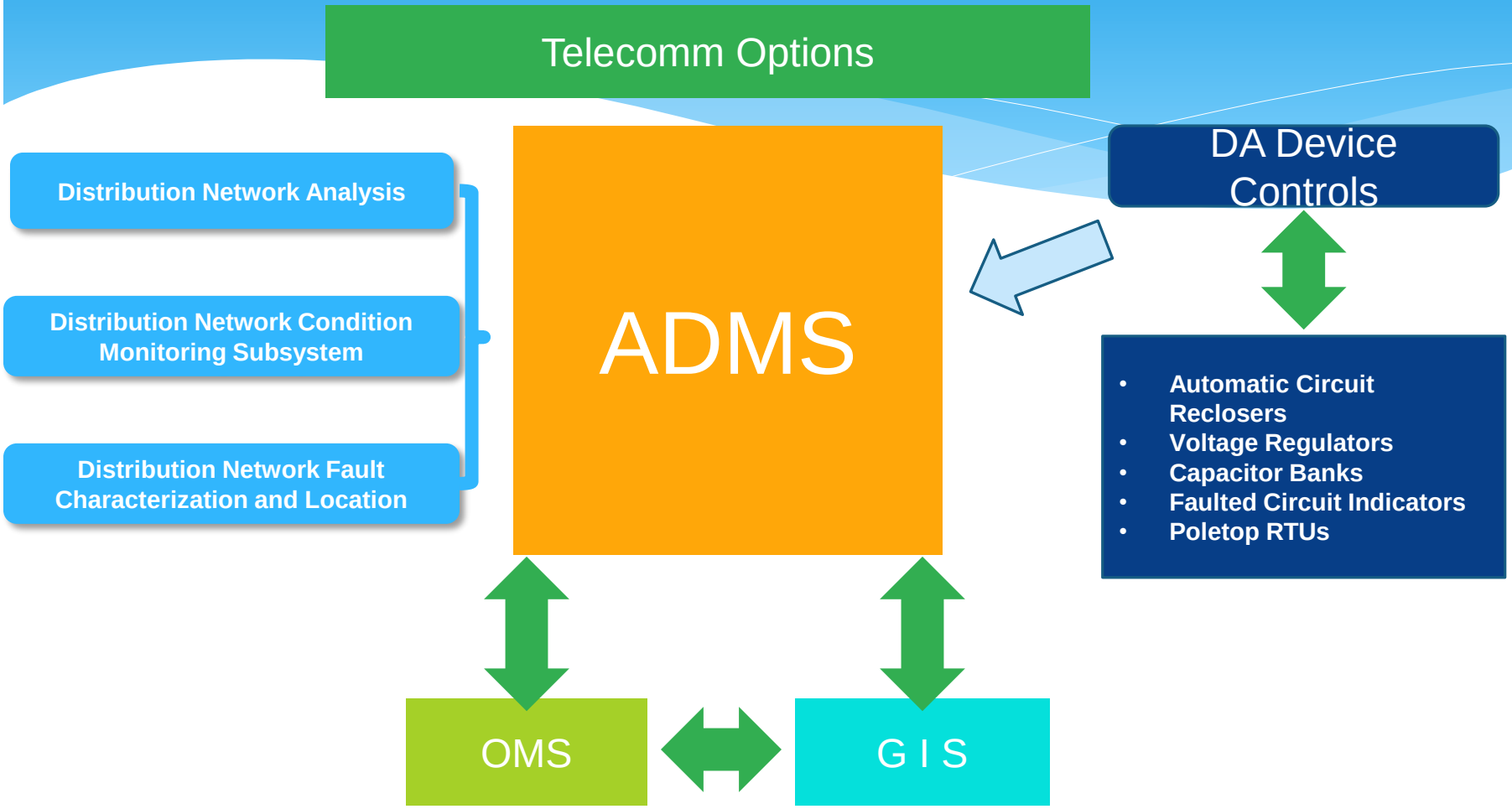
ADMS as Centerpiece System



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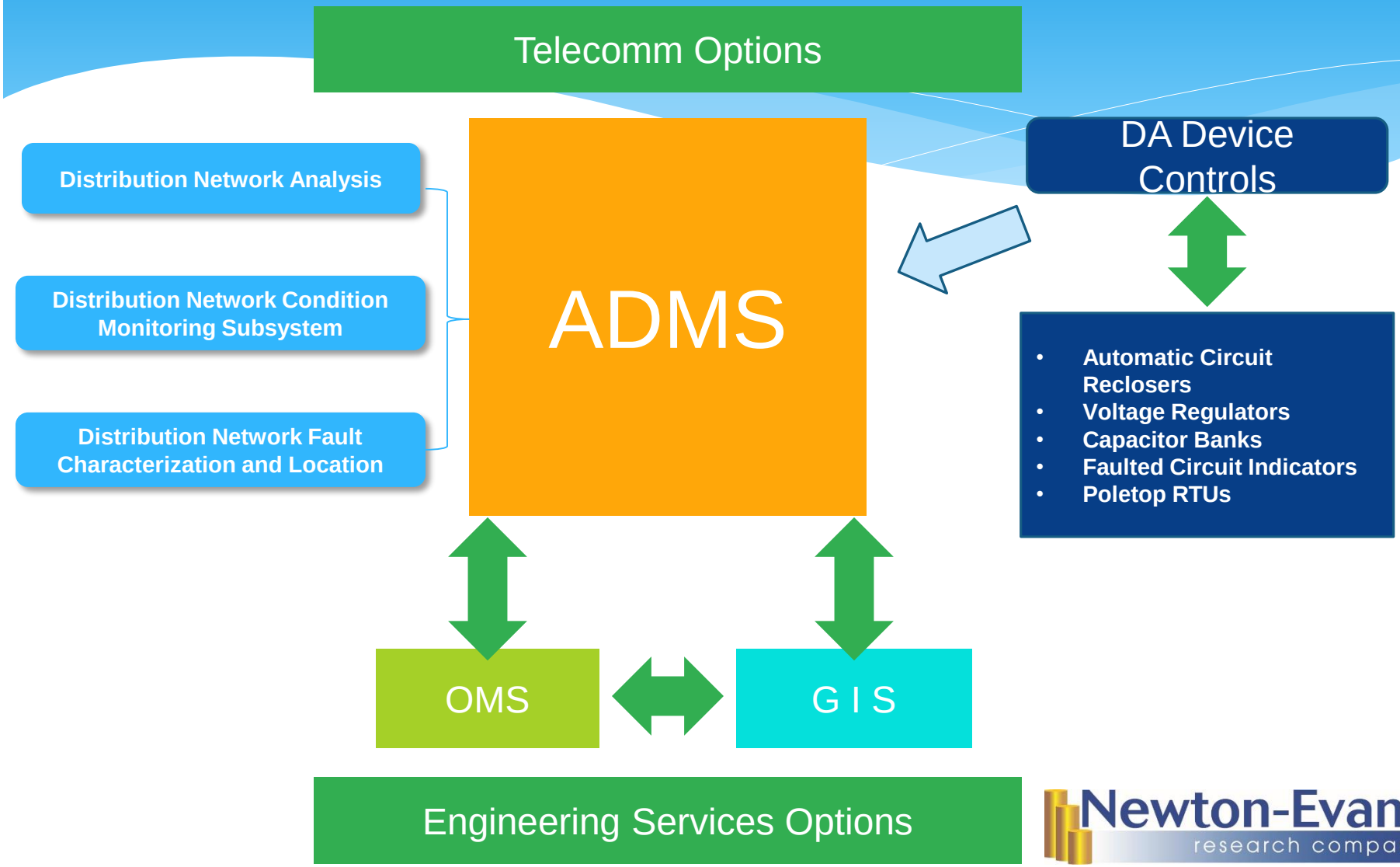
ADMS as Centerpiece System



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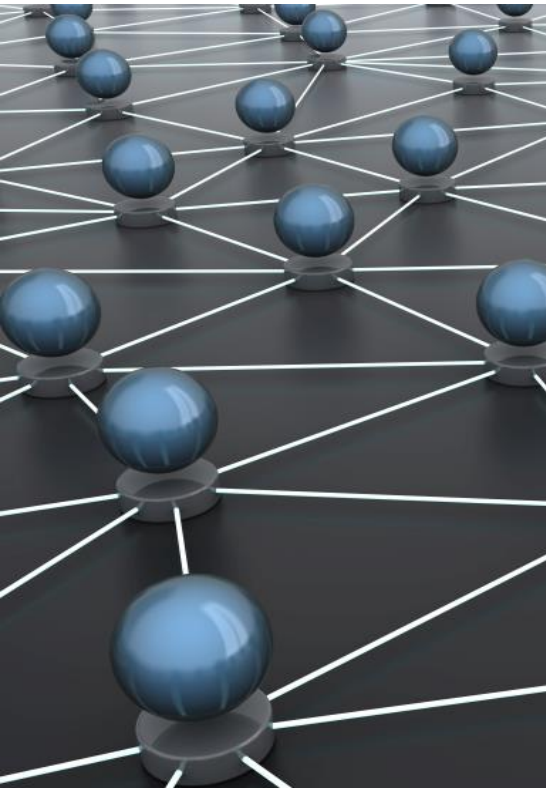
Drivers of Growth in ADMS Usage



- **Regulatory Actions** aimed at increasing reliability
- and grid resilience.
- Increased use of "**smart" field devices** on the poles and on the lines,
- Development of integrated device **controllers**.
- Ability to **monitor and control** feeder activity.
- **DOE** - 2009 Program Funding as part of ARRA
- Availability of **newer apps** that work well to enable . . .
  - *FDIR and FLISR*
  - *VVC/VVO*
  - *CVR*

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Development and Availability of Advanced Field Devices

- **Reclosers and Sectionalizers** – Bi-Directional
- Voltage Regulators – Bi-Directional
- **Sensor-Based Tools and Instruments**

  Automatic Fault Sensors (Indicators, Locators)
- Advanced Poletop Data Aggregators
- **Pole and Line Mounted Monitoring Devices**

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DA Device Installation Points

DA Devices are installed at/mounted on these locations:

- Poletops
- Main Feeder Lines
- Secondary Lines
- Laterals

Examples of DA Field Devices in Use today

- Pole-Top RTUs
- Line Monitors
- Capacitor Bank Controls
- Automated Recloser Controls
- Sectionalizers
- Fault Indicators
- Voltage Regulators
- Apparatus Monitors

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Figure 5. Density of Field Devices on a "per feeder" basis in American Electric Utilities: Mid-2014 Estimates by Type/Size of Utility

(Basis: Newton-Evans study of FDIR in 2007; Newton-Evans-Motorola Study of 2009; Newton-Evans Study of 2010; Update of Aug 2013, June 2014, Feb 2015)

Type of Utility	Density of Poletop RTUs	Density of Pole-Top Switches	Density of Line Reclosers	Density of Sectionalizers	Density of Fault Interrupters	Density of Capacitor Controllers	Density of Overhead Switchgear	Density of OH/MV Distribution Transformers	Meter Density per square mile
Investor-Owned-TOP 50	3-5	6-10	2-4	2-4	5-7	5-7	3-5	70-100	250-6000
Investor-Owned – Other	1-2	5-9	2-4	2-4	2-4	4-6	3-5	40-65	200-2500
Public Power Large(Munis)	2-4	6-10	2-4	2-4	2-4	5-7	3-5	50-70	200-2000
Public Power – Other	3-5	2-4	2-4	1-3	1-3	3-5	3-5	25-50	100-1000
Cooperatives-Large	2-4	6-10	2-4	2-4	3-5	5-7	3-5	30-50	10-50
Cooperatives - Other	2-4	2-4	1-4	1-3	1-3	3-5	3-5	20-40	3-25

Core SG Technology: Automated Field Devices

(from DOE report prepared by Newton-Evans)

- Technology Status:
- *Emerging, Significant Deployment of one or more types of field automation devices by most utilities (serving >10,000 customers)*

- Deployment Status:
  Some of each device type is deployed in each region of the U.S.

- Key Developments:
  Several smaller firms are manufacturing line monitors and fault indicators
  GridSense, GridSentry, GridCo, Tollgrade

  SCADA integrators provide monitoring and control software

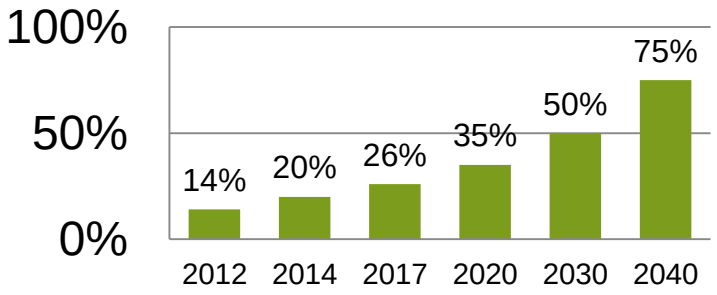
  Larger national and international firms provide the field equipment (with controls)
  GE, Hubbell, S&C, Cooper

  Some specialists provide distribution apparatus monitoring capabilities. (GE, Serveron)

- Key Obstacles:
  Standards for conformance testing not yet defined.

  DA morphing into ADA with more devices, more linkages, active Volt-Var control, Fault detection, Isolation and Service Restoration.

Timeline for Deployment



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Longer Term Outlook Is For Widespread Use of these Field Devices

(*from DOE Report*)

- Pole-Top RTUs
- Line Monitors
- Capacitor Bank Controls
- Automated Recloser Controls
- Sectionalizers
- Fault Indicators
- Voltage Regulators
- Apparatus Monitors

ADMS

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Leading Suppliers of ADMS and D-SCADA

ADMS Developers include:

- GE, Alstom, ABB-Ventyx, Siemens, OSII
- *GE alone offers uniqueness with internal capabilities for OMS and GIS*.

D-SCADA/DMS

- Advanced Control Systems, C-G Automation, Schneider-Telvent, Survalent,

Distributed DA Device Management Software:

- S&C Intelliteam II,
- L+G Grid Stream suite,
- Cooper/Yukon Feeder Automation,
- G&W/Survalent Lazer Automation) Controller Devices/Systems:

Field Devices:

- Line Monitors: All of the above plus specialist firms with sensor-based line mounted devices (Gridco, Gridsense, Tollgrade, Grid Sentry, PDP)
- Fault Indicators: Some of the above plus (Tollgrade, PDP, Eaton-Cooper, T&B)
- Poletop RTUs: (GE, ACS, Telvent, Siemens, OSI, NovaTech, DAQ)

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Excerpts from Series of DA Overviews

Feeder Automation – To What Ends?

- Enabler for VVO/VVC
- Enabler for FDIR/FLISR
- Key to SAIDI and SAIFI improvements

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Telecoms – Key to DA Success

Issues:

- Capacity
- Latency
- Security (Isolated Operation?)
- Shared Network Services

  (With AMI? Alone?)

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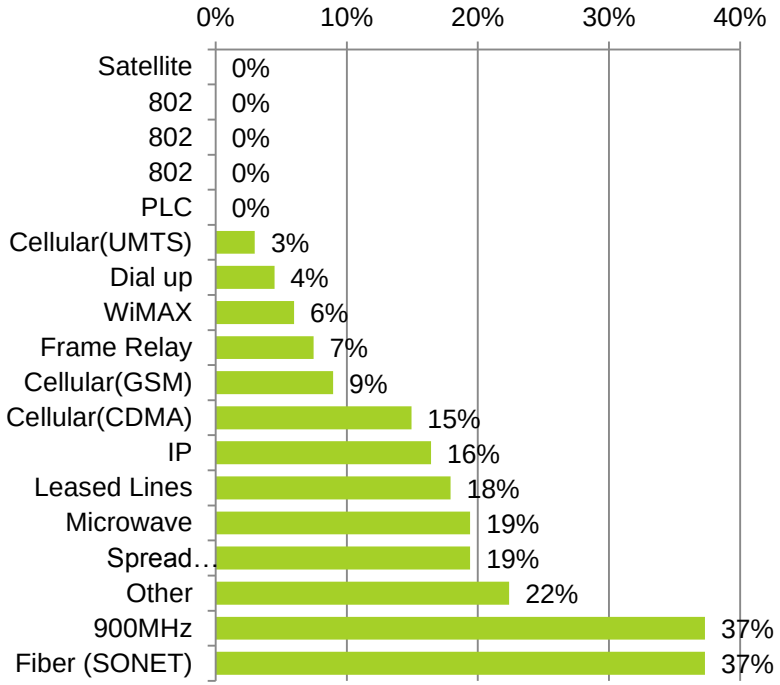
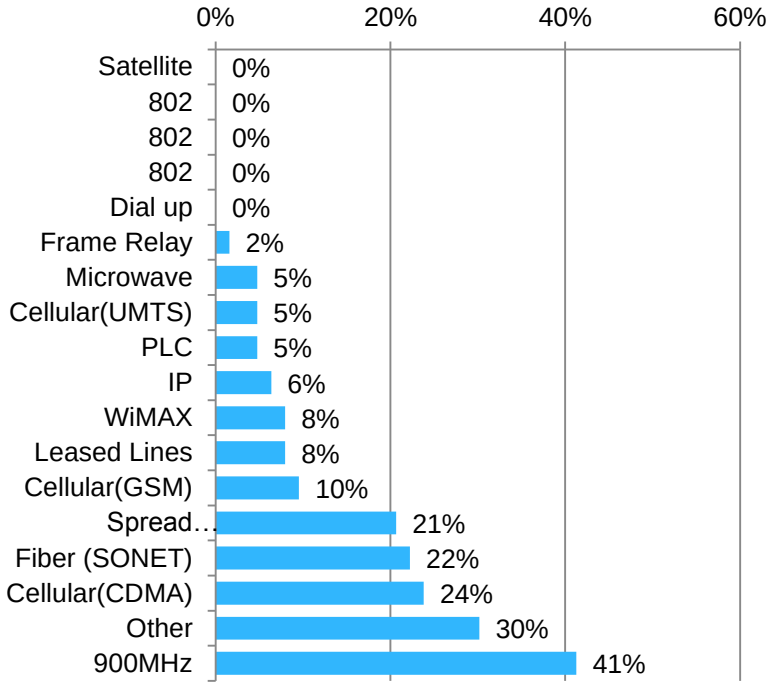
Telecommunications Options for DA/DMS

DA Backhaul



DA "Last Mile" Telecoms



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Quarterly Journal:
Market Trends Digest

Energy Management and Market Operations Systems User Group

2017 EMMOS Users Conference
Energy Management and Market Operation Systems
September, 2017

Current hot topics affecting utility operations will be addressed, including NERC CIP readiness, cyber security lessons learned, control systems usage patterns and plans, situational awareness and visualization advances, and the future of energy - smart grid and beyond.

Participate in the upcoming 2016 Newton-Evans Research Study of EMS/SCADA/DMS

* **Looked to for guidance by Suppliers and End-Users**
* Non-intrusive questions and topics
* Study will be underway in October-December 2016
* Findings are reported back to all study participants
* Additional incentives provided for time expended

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