The Value of a Broadband Backbone for America's Electric Cooperatives

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Agenda

- **Introductions**
- Transformation of communication networks
- Broadband technologies and impact
- Broadband backbone use cases and benefit analysis

NRECA and Broadband

Overall NRECA Goals – Broadband

- Work to address the two tiers of Concern:
  - (1) adoption of advanced communications technologies (utility backbone); and
  - (2) deployment of high speed broadband for consumer-members (retail service).
- Provide ***leadership***, promote and propose ***solutions*** to members
- ***Communicate*** and ***advocate*** to public and policy makers
- Identify and create ***strategic partnerships***
- Develop ***due diligence guidance***, economic analysis, business cases and recommendations to members

NRECA Resolution "Broadband for Rural America"

…take a prominent leadership & advocacy role to ensure co-ops have ability to provide broadband voluntarily, on their own or in partnerships.

…NRECA leadership is critical to present a unified voice by working together with others who share electric co-op interests in rural America.

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NRTC provides technology solutions to Rural America

NRTC GRID SOLUTIONS

NRTC BROADBAND SOLUTIONS

SMART GRID NETWORKS | **BROADBAND NETWORKS**

- AMI
- Analytics
- Demand Response
- Advanced Energy

- Broadband Backbone
- Fiber Design & Deployment
- Smart Services
- Mobile & Fixed Wireless

- ISP Services
- Network Management
- Satellite Broadband
- Video Solutions

ASSESSMENT & DEPLOYMENT | **SOURCING & LOGISTICS** | **OPERATIONS**

- Assessment
- Project Management
- Engineering Design
- Vendor Management
- Equipment Procurement
- Distribution/ Warehousing
- Billing on Behalf
- Consulting & Support
- Customer Care

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The impetus for our joint white paper

- The number of electric cooperatives that are evaluating plans for consumer broadband for their territory is growing rapidly
- Many are conducting feasibility studies to understand the economics of a possible deployment
- However, we feel that the first factor that members should evaluate, though one that is more difficult to quantify, is the role of a broadband backbone for their internal operations
- NRTC, NRECA, and Ericsson sought to answer the following questions:
  - What is driving the demand for robust communications options?
  - What are the technology options to connect critical assets?
  - What are the applications enabled by a backbone and can the benefits be quantified?

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Transformation of communication networks

- The DOE outlines four enabling technologies for the smart grid
- Communications is fundamental to the other 3 enabling technologies
- Wide range of smart grid applications increasingly depend on sensors, data, and analytics
- A broadband backbone communications system will provide the enabling technology upon which these applications will be built

Four technologies enable the smart grid

Advanced Metering Infrastructure

Meter Data Management Systems

Supervisory Control and Data Acquisition Systems

Communications

Source: Department of Energy, NRECA

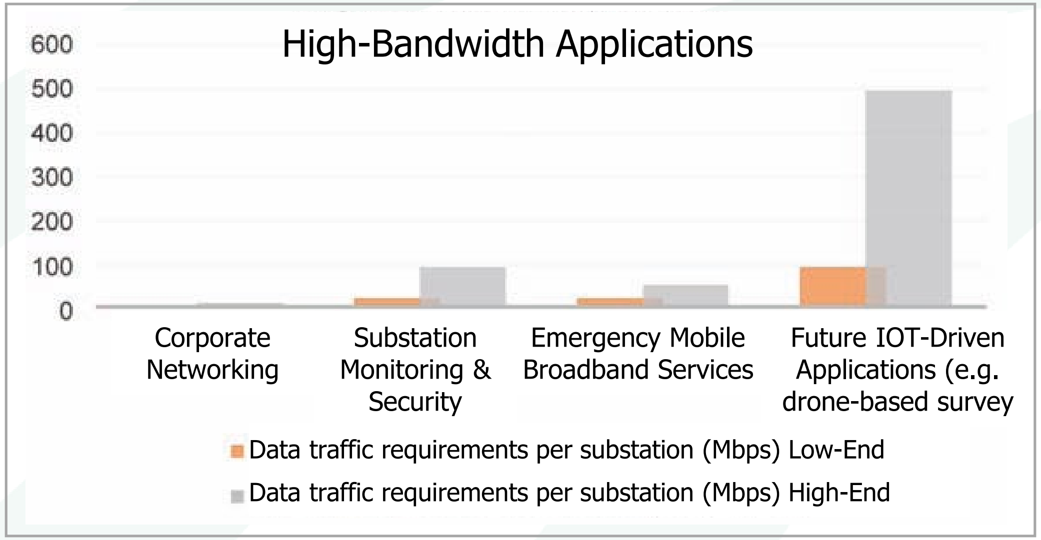
What is a broadband backbone?

- A high bandwidth, low-latency communications system to transport data critical to electric co-op operations
- It is an advanced electric utility infrastructure that enables a cooperative to maximize value from its smart grid
- A broadband backbone meets the volume-of-data and low-latency demands of current and future grid applications

Factors driving backbone demand

Factor	Description
Proliferation of Smart Grid	Backhaul communications necessary to support the data
Cyber Security Needs	Older technologies do not have the encryptions and firewalls necessary to protect data in transit over lines
Additional Data Usage	New applications, particularly video monitoring, require high bandwidths to leverage them to their full potential
Latency Requirements	Technologies with automated response systems require low-latency systems to respond to signals quickly enough to make actionable decisions
Improved Distribution Reliability	Real-time monitoring of critical equipment can identify failures before they occur, allowing for replacement and circumventing a potential outage
Availability of Current Communications Services	3rd party carriers and providers are discontinuing older technologies as they transition to digital networks

- These factors create the need for utilities to upgrade systems as they operationalize emerging technologies
- The lifecycle of a long-term asset forces them to look beyond current use cases to the expected needs of the future



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A broadband backbone supports grid optimization

- Grid optimization is all about improving performance, reducing costs, and enabling DER

- A broadband backbone can save co-ops money by avoiding significant costs when combined with distribution optimization techniques

Projection of DER Generation, by Type

	2018	2019	2020	2021	2022	2023	2024	CAGR
Distributed Solar PV	4,548	5,777	6,478	7,588	8,888	10,411	12,194	20%
Small & Med. Wind	14	18	22	28	35	43	54	20%
Microturbines	131	157	185	221	245	287	340	19%
Fuel Cells	146	206	279	356	451	558	696	31%
DG	20,801	22,916	24,577	26,714	29,096	31,801	34,872	9%
Energy Storage	1,694	1,824	1,976	2,197	2,301	2,410	2,527	16%
Microgrids	550	627	746	790	906	1,038	1,190	16%
EV Charging Load	4,557	5,964	7,551	9,179	10,884	12,640	13,950	23%
DR	35,456	40,200	45,291	50,582	57,214	62,877	69,125	12%
Total	63,058	71,532	80,141	89,462	100,401	110,766	121,664	12%

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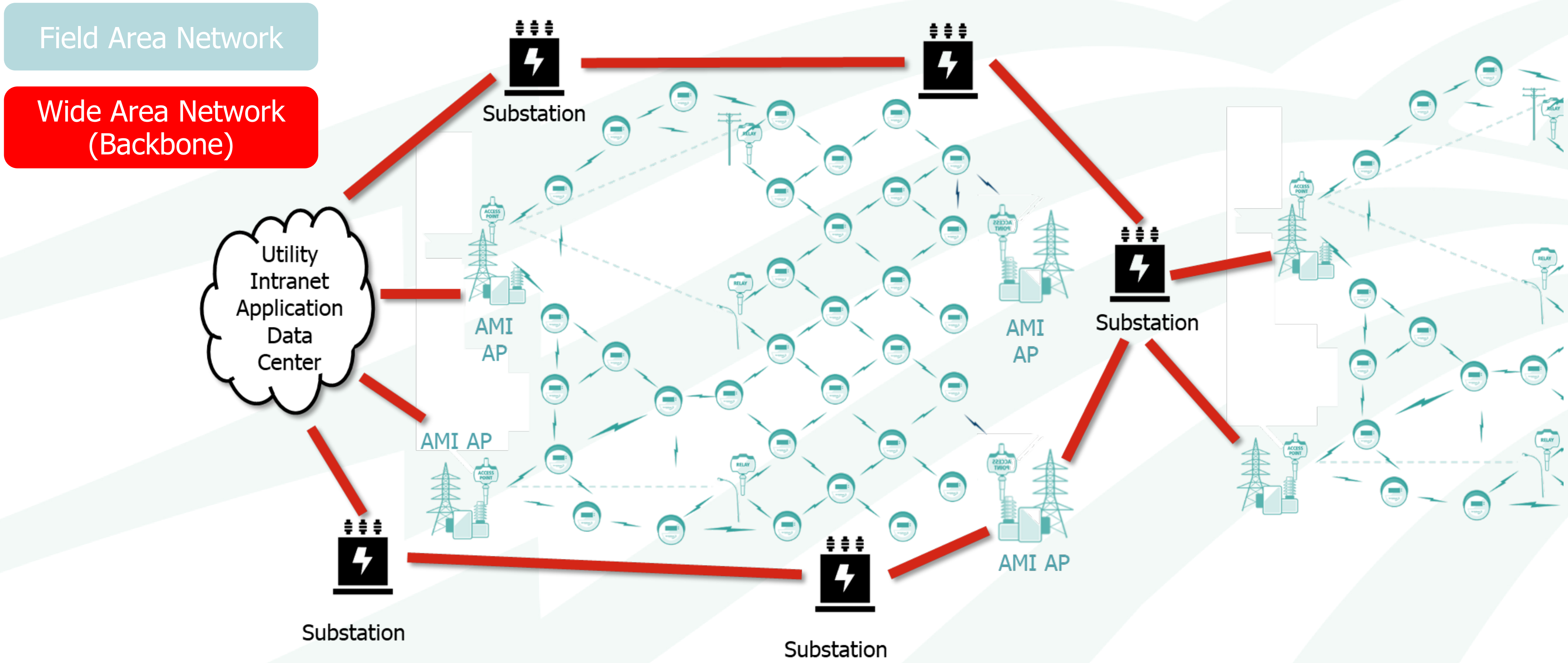
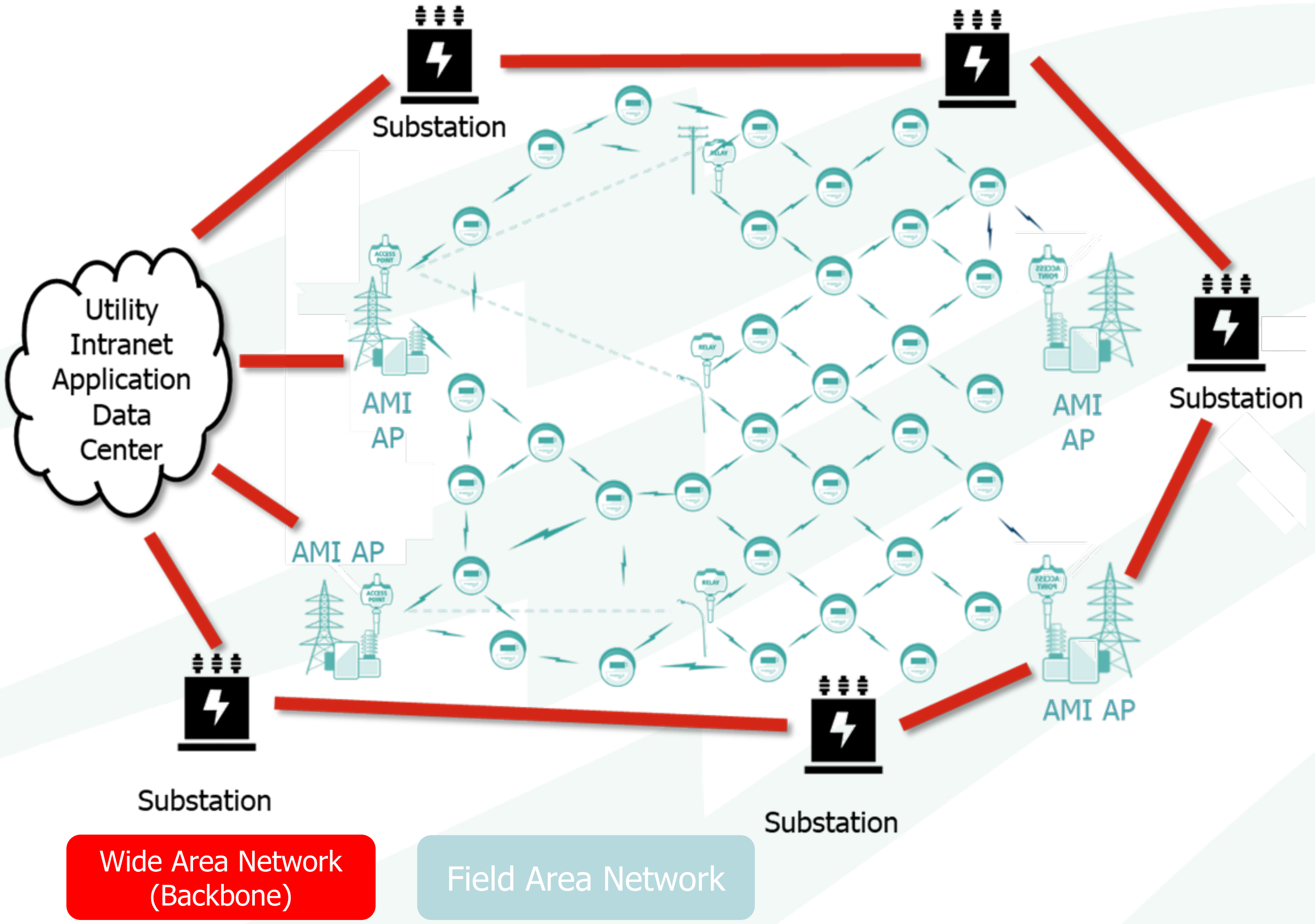
Network Backbone: Technology Options and costs



Typical Utility Network



Backbone is often a mix

- Some Fiber
- Microwave
- DSL or Satellite

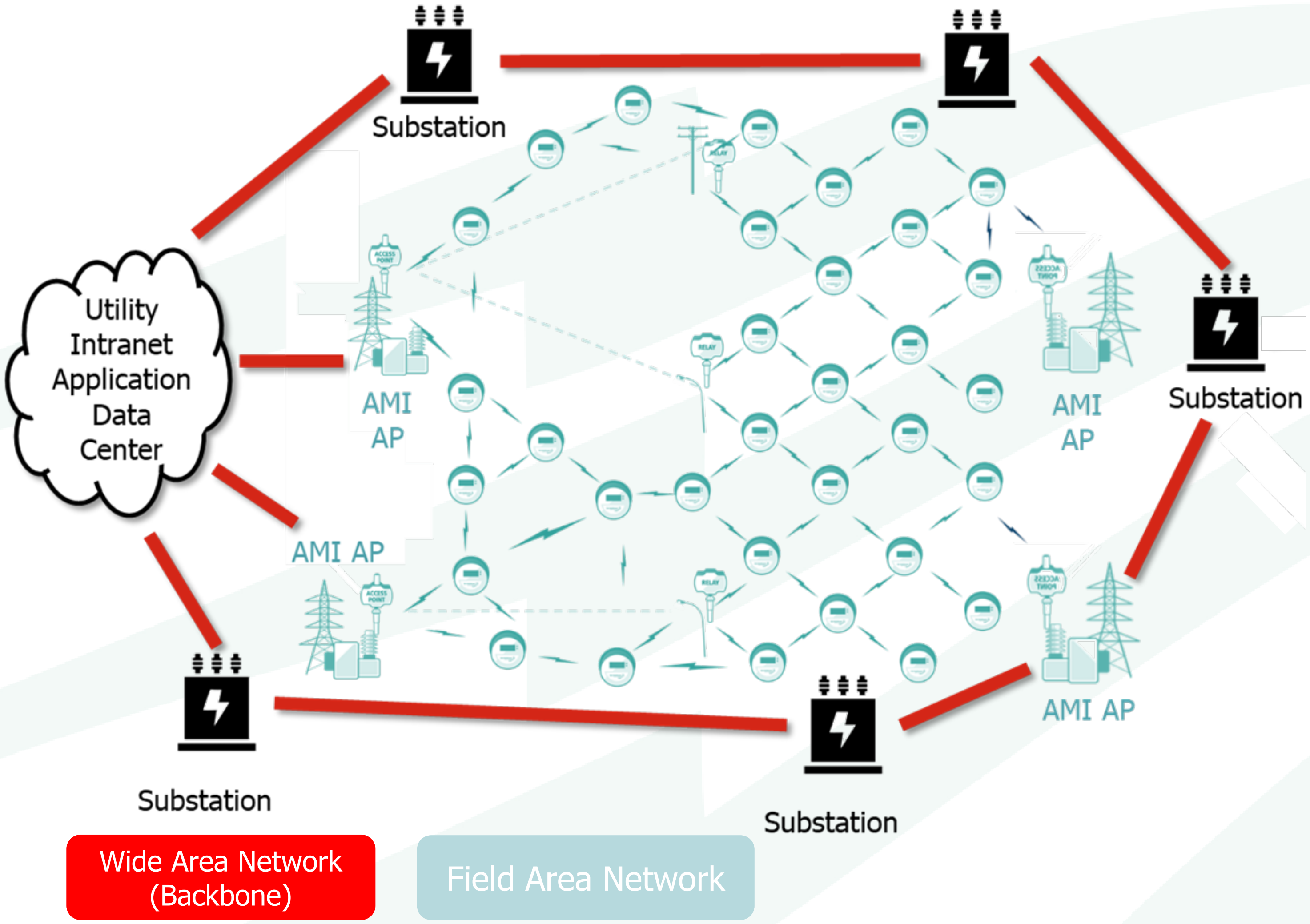
Field Network varies

- Metering Networks - PLC, PtMP or Mesh
- Control Network – SCADA
- Communications Networks
  - Radio Dispatch, Fleet Mgmt

Office/Application Networks

- IP Based
- Multiple Applications
- Hosted or on Prem
- Separately Managed

Typical Utility Network



Challenges

- Multiple networks using different technologies
- Complex and expensive to deploy and support
- Little interoperability
- Hard to scale
- Not well positioned for future new services

Network Backbone: Technology Options and Costs

Fiber

- Most secure, most reliable, highest throughput, and lowest-latency option
- Most future-proof, long-lived asset
- Can be leveraged for FTTH
- More capital intensive and longer to deploy

Point-to-Point Wireless

- Historically lower bandwidth
- Current technology offers up to 1 Gbps
- Faster and more cost-effective to deploy

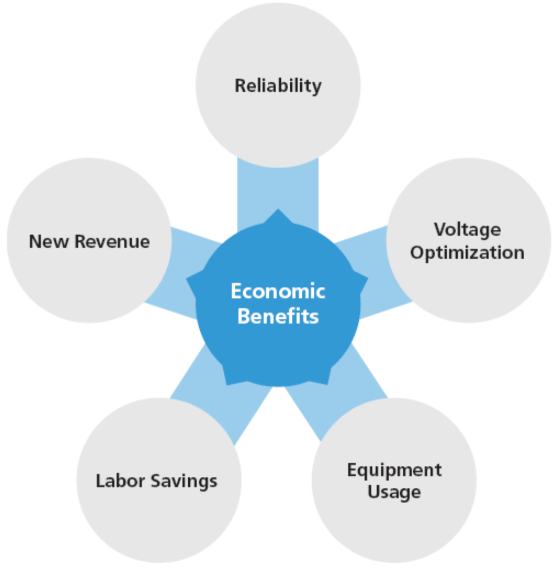
Cost Considerations

- For fiber, costs will depend on a number of factors
  - % aerial vs. underground
  - Make ready costs
  - Distances of the runs
  - Strand count
- Wireless costs substantially lower and will also depend on a number of factors

The impact of communications network transformation

Utilities

Advanced communications offer the ability to **control & operate the grid** in new ways, and allow cooperatives to track their assets in the field and operate a two-way grid, integrating new assets



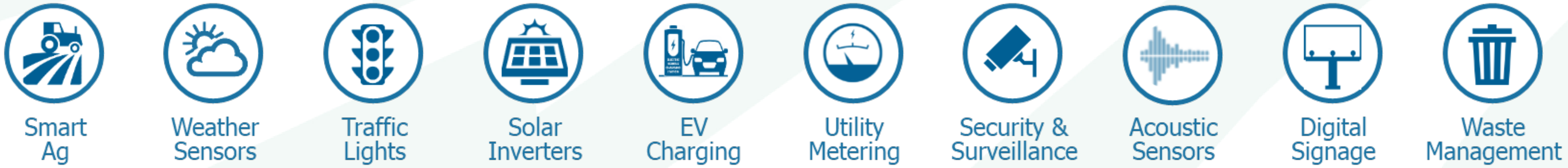
Communities

Communications technology can provide benefits to all parts of their communities

- Utilities can provide a bridge to **smart towns** and cities, and new services, such as smart traffic lights, digital infrastructure, and waste management
- Can leverage fiber and other communications to connect their members to **broadband internet**
- Access to broadband enables advances in **health care, education, business and economic growth**
- Broadband is therefore a vital component in **keeping rural communities competitive** in the long term

Connected Communities: A backbone is an asset not just to the utility, but to the community

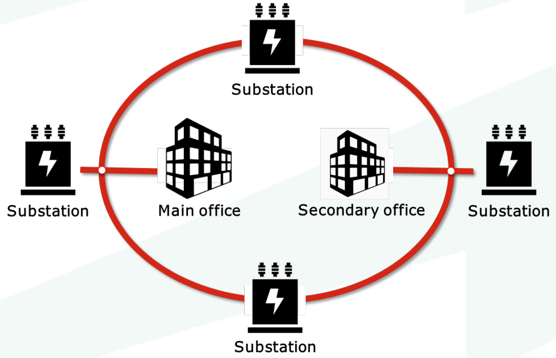
Smart Community Use Cases



Projects can be deployed in stages

A Broadband Backbone and other utility assets can be leveraged to provide broadband to your members

Focus on **backbone** to start



Edge out to serve cell towers/hospitals, etc.

Serve your members with **the right last-mile** solution for you

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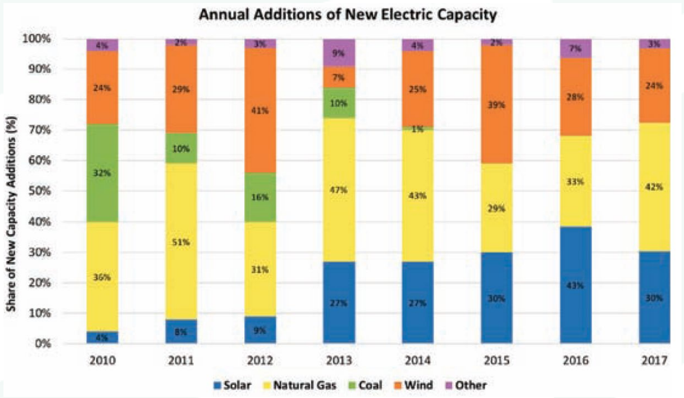
Broadband Backbone Use Cases

Generation Applications

Integration of Renewables



Distribution Applications

Substation Automation

Volt/VAR Optimization

Distribution Automation

Fault Location, Isolation, & Restoration

Distributed Energy Resources Integration

Retail Applications

Advanced Metering

Demand Management

Application selection and classification

Application and Benefit Cases that were considered

Application	Benefit Case	Data Need	Broadband Impact
AR-Based Substation Monitoring	Condition-Based Asset Monitoring	Bandwidth, Latency	High
DA	Reliability, Equipment Usage, Labor Savings	Latency, bandwidth	High
AMI	Reliability, Volt Opt, Equipment Usage, Labor Savings	Bandwidth	High
SA	Reliability, Volt Opt, Equipment Usage, Labor Savings	Latency, Reliability, Security	High
Demand-Side Mgmt (DSM), Volt/VAR, CVR	Volt Opt, Equipment Usage, Labor Savings	Reliability, Security	High
AM	Volt Opt, Equipment Usage, Labor Savings	Reliability, Security	High
Broadband to Home	New Revenue – Triple Play Services	Bandwidth, Reliability	High
Security – Video Surveillance	Threat Reduction	Bandwidth	High
Emergency Load Shedding	Volt Opt, Equipment Usage	Latency, Reliability, Security	High
Broadband Service to C&I	New Revenue	Bandwidth, Reliability	High
DR	Volt Opt, Equipment Usage, Labor Savings	Reliability, Security	High
Outage Management	Reliability, Volt Opt, Equipment Usage, Labor Savings	Bandwidth	High
Self-Healing Feeder Automation	Reliability, Volt Opt, Equipment Usage, Labor Savings	Latency, Reliability, Security	Medium
Load Forecasting	Volt Opt, Equipment Usage	mMTC	Medium
EV Management	Volt Opt, Equipment Usage	mMTC	Medium
Relay Protection	Reliability, Volt Opt, Equipment Usage, Labor Savings	Latency, Reliability, Security	Medium
Phasor Measurement Unit	Reliability	Latency	Medium
DER, Renewables	Volt Opt, Equipment Usage	Security	Medium
Teleprotection	Equipment usage, labor savings	Latency, Reliability, Security	Medium
SCADA	Reliability, Volt Opt, Equipment Usage, Labor Savings	Latency, Reliability, Security	Medium
Workforce Mobility	Reliability, Labor Savings	Reliability	Medium
Mission-Critical Apps (PTT)	Reliability, Labor Savings, Equipment Usage	Reliability	Medium
Power Quality	Volt Opt	Latency, Reliability, Security	Medium
Smart Home	Volt Opt, Equipment Usage, Labor Savings	mMTC	Low
Electronic Mapping	Equipment Usage, Labor Savings	Latency, Reliability, Security	Low
Energy Conservation	Volt Opt, Equipment Usage	mMTC	Low
Energy Efficiency	Volt Opt, Equipment Usage	mMTC	Low
Facilities Energy Management	Volt Opt, Equipment Usage	Latency, Reliability, Security	Low
Building Automation	Volt Opt, Equipment Usage	mMTC	Low

Use cases were prioritized and divided into major application areas to be valued

Application
DA
SA
AMI
VVO
DM
Outage Reduction
AMI
DER
Carrier Cost Replacement

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Benefit quantification

- Benefits estimated on a per-meter basis, assessed and adjusted based on cooperative use cases, and vetted with subject matter experts including vendors and cooperative employees
- Initial valuations were then scaled over time to account for growth in customers, loads, and use cases
- Regional variability informed the ranges of values
- Some caveats:
  - Communications are only one part of the value chain – they are necessary to enable the efficiencies, but investment in each application is necessary
  - These quantifications should be viewed as directional assessments of the value of a broadband backbone and its enabling use cases

Application and Valuation

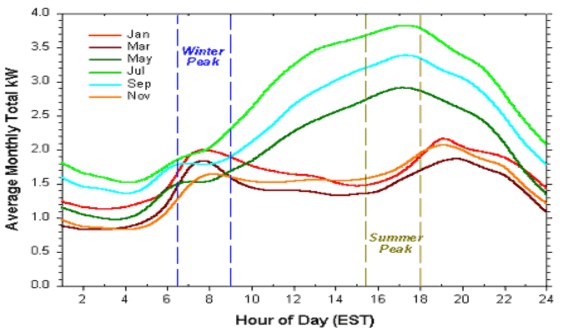
Application	Annual Valuation per Meter
DA	\$20–\$30
SA	\$1–\$3
AMI	\$12–\$18
VVO	\$14–\$29
DM	\$88–\$140
Outage Reduction	\$1–\$3
AM	\$45–\$85
DER	\$3–\$6
Carrier Cost Replacement	\$1–\$3

Additional Value Considerations

Each utility is unique and needs to take into account use case applicability and service territory

Load Profile

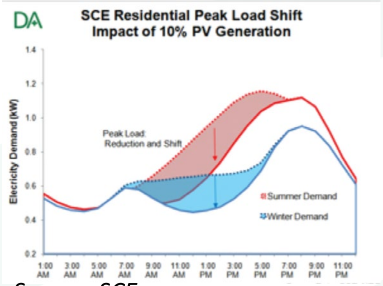
- Summer or winter peaking
- Flexibility of generation



Source: Florida Solar Energy Center

Geographic Features

- Geographic density (line loss)
- Applicability of use cases
- Renewable integration needs (wind, solar, other)



Source: SCE

Existing Technologies

Must have smart meters

Can't double count savings (some use cases will attack same savings)

An utility specific business case is necessary for appropriate quantification- vendors can be a strong resource

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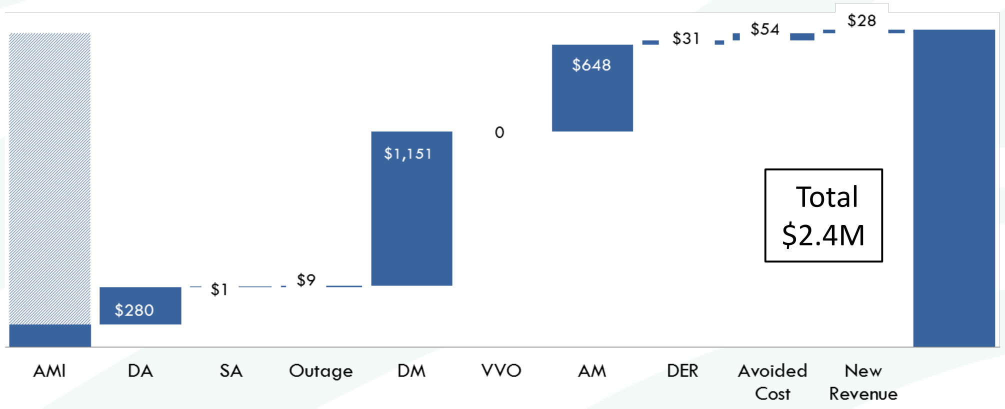
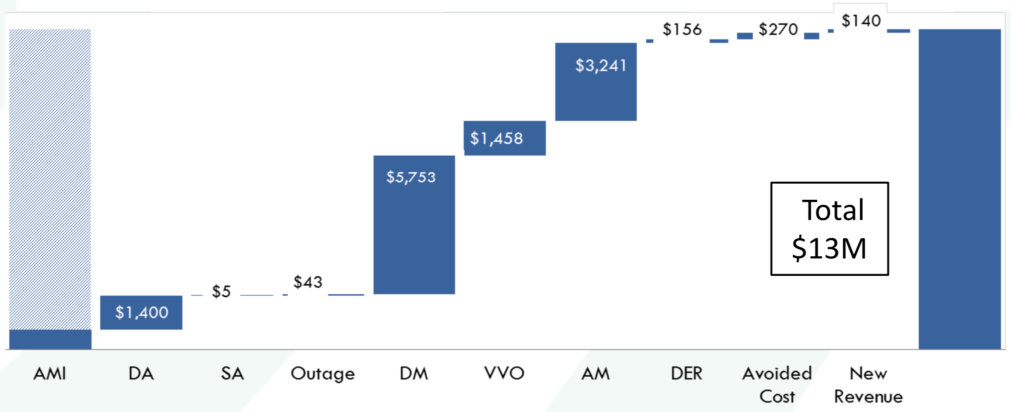
Benefit quantification

10,000 Member Coop	2018	2019	2027
Item			
Revenue			
Business	$28,000	$28,840	$36,534
Revenue – Total	**$28,000**	**$28,840**	**$36,534**
Cost Avoidance			
Distribution Automation	$280,000	$288,456	$365,975
Substation Automation	$1,000	$1,021	$1,205
AMI	$167,400	$172,455	$218,801
Outage Management	$8,500	$8,757	$11,110
Demand Management	$1,150,680	$1,185,431	$1,504,002
Volt/VAR Optimization	$0	$0	$0
Asset Management	$648,148	$667,722	$847,165
DER	$31,107	$44,060	$347,748
Previous Telecom Costs	$54,000	$65,880	$323,320
Cost Avoidance - Total	**$2,340,835**	**$2,433,782**	**$3,619,327**
Total Economic Value	**$2,368,835**	**$2,462,622**	**$3,655,861**
High Estimate	$2,961,044	$3,078,277	$4,569,826
Low Estimate	$1,776,626	$1,846,966	$2,741,895

2018 Valuation for a 10,000 Member Coop



2018 Valuation for a 50,000 Member Coop



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Where are we going?

Most applications will grow in value with customer growth, but two technology changes will drive faster growth

Distributed Energy Resources

DER benefits of a broadband network will grow at 31% CAGR over the next 10 years

Distributed Solar — Off peak charge and peak discharge creates a 5%-10% peak load reduction

Energy Storage — Off peak charge and peak discharge creates a $0.07kWh savings

Electric Vehicles — Off peak charge and peak creates a $450 annual revenue opportunity per EV

*note: did not value EVs used as storage

Legacy Telecom Costs

Dedicated support from telecoms for legacy circuits will increase costs at 22% per year

Leased Line Tension
Carriers are decommissioning pre-existing connections due to new / efficient solutions

Operational Challenges
Complexity and the pace of change are difficult to manage

Reliability
Having one connection creates a single point of communications failure

Co-op Specific Quantifications

The value of Smart Grid Applications will be different depending on a member's situation

Co-op specific AMI quantification examples

	Co-op #1: Manual reads to AMI	Co-op #2: AMR to AMI upgrade
Remote disconnect/ reconnect	✔	✔
Save on past-due bills	✔	✔
Save on non-technical loss	✔	✘
Meter reading	✔	✘
AMI backhaul	✔	✔

Forecasted Yearly Benefit: ~$1.3M

Forecasted Yearly Benefit: ~$700K

Co-op specific OMS quantification example

Co-op #1: Forecasted OMS implementation benefit

~400 truck rolls saved @ $500 each → **Yearly savings for reduced truck rolls - $200K**

	Before	After	Change
SAIFI	320	272	15%
CAIDI	3.0	2.3	15%
SAIDI	881	637	28%

→ Yearly **economic value to end-members** of avoiding outages & minimizing restoration time - **$1.2M** (this is **more intangible** - actual revenue saved is significantly less)

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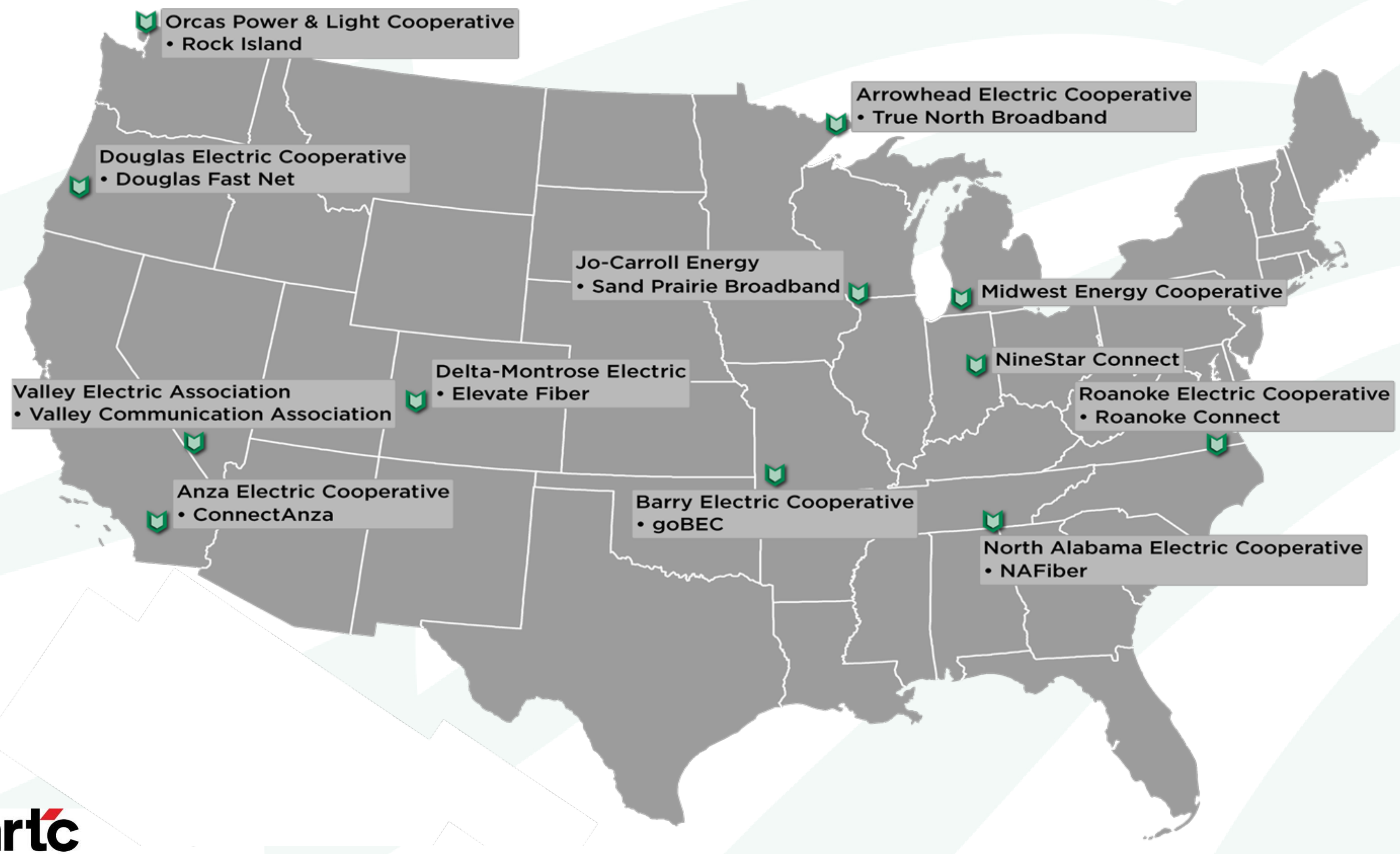
Co-op specific VVO & DVR quantification examples

	Co-op #1: Less peak demand		Co-op #2: More peak demand	
VVO	**Wholesale Power Purchases: $25M**	**Forecasted yearly benefit: ~$500K**	**Wholesale Power Purchases: $50M**	**Forecasted yearly benefit: ~$1M**
DVR	**Peak Demand: 45 MW**	**Forecasted yearly benefit: ~$100K**	**Peak Demand: 200 MW**	**Forecasted yearly benefit: ~$450K**

Cooperatives Featured in NRECA's 2018 Broadband Case Study Series



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https://www.cooperative.com/topics/telecommunications-broadband/Pages/default.aspx

Take-Aways from Case Studies

- In every case: The decision was made to leverage the utility's own broadband network backbone to serve members of the community at large
- No universally applicable technology solution or well-tread business path

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Summary

- New applications and use cases for utility data will continue to grow, making a broadband backbone an important component of cooperative networks
- A broadband backbone is a long-term asset that can also be leveraged to provide benefits to our communities as a whole
- Cooperatives should develop a comprehensive 10-year plan that accounts for communications needs for all anticipated use cases over that period