

GREENER, SAFER, SMARTER

**TROPOS**<sup>®</sup>  
networks

# Smart Grid Communications Architecture



November 20, 2009

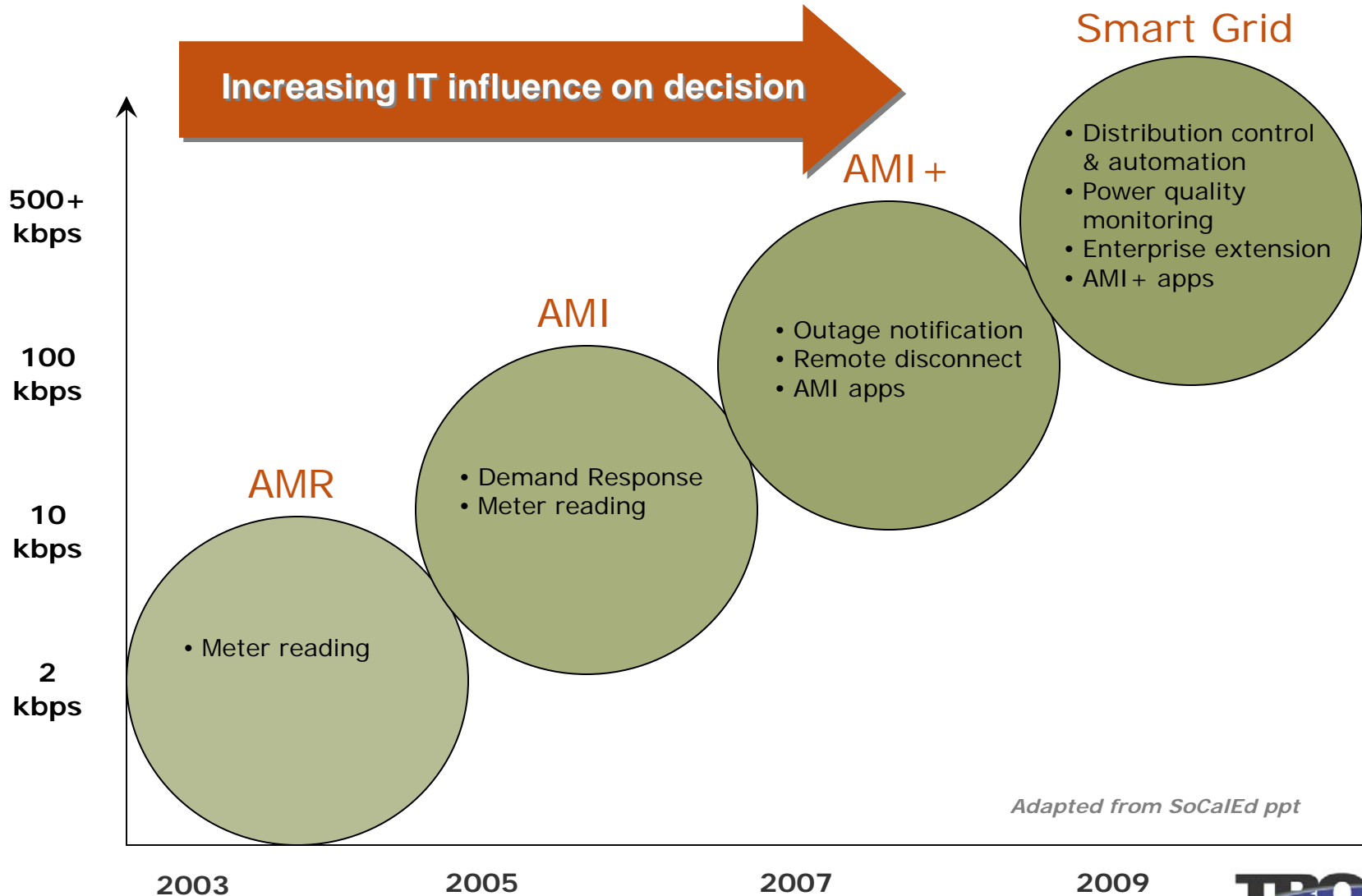
# DOE View of Smart Grid

*Smart Grid is much more than just metering...*

**Distributed intelligence +  
Broadband communications +  
Automated control systems =  
Smart Grid**

*- US DOE: Grid 2030*

# Utility RFP's are Evolving



*Adapted from SoCalEd ppt*

# Smart Grid Applications Require Broadband

Distribution  
Automation &  
Control



Less than 17 ms  
latency



Automatic outage recovery

Power Quality  
Monitoring



Over 50 kbps per  
sensor



Prediction of failure due to  
overload, etc

Automation on a  
multi-app system



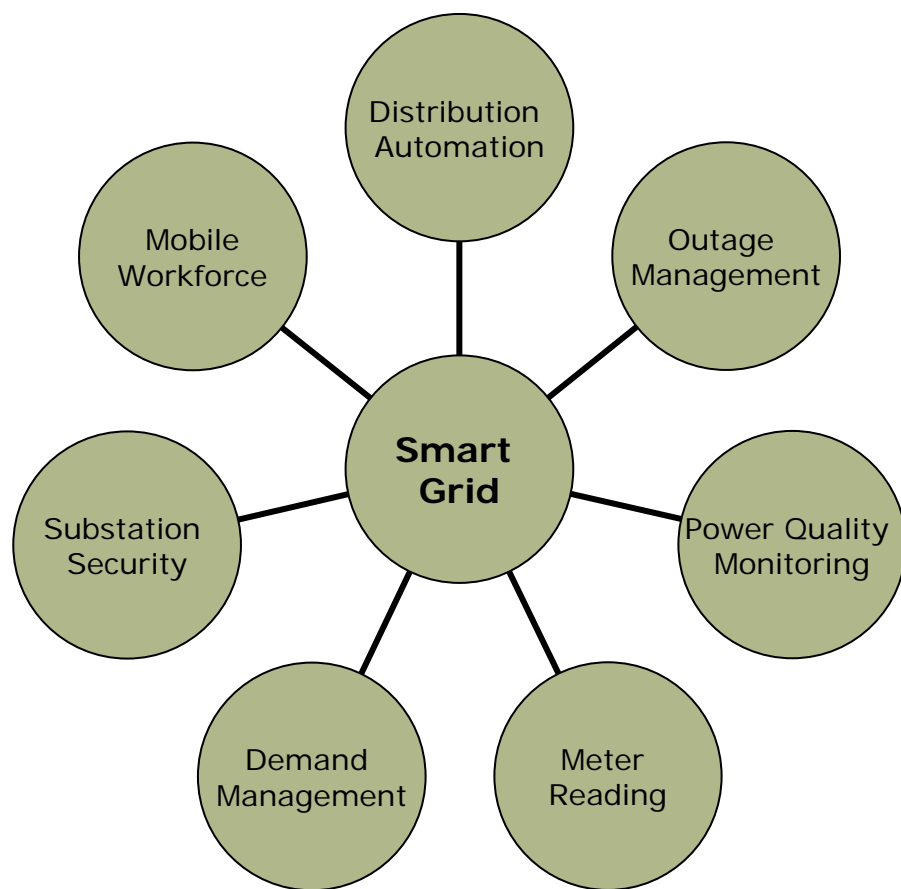
Application QoS



Prioritization of time sensitive  
traffic

Also Mobile GIS, AVL, Substation security, future apps

# Smart Grid is more than just Metering



## Smart Grid Network Requirements

- *Standards-based*
- *IP network*
- *Low-latency*
- *Two-way*
- *Scalable*
- *Manageable*
- *Resilient*
- *Secure*
- *Quality of Service*
- *Mobile*
- *Cost competitive*
- *Broad coverage*
- *Outdoor-proven technology*

# Resilient and Fault-Tolerant Architectures

- Multiple redundant communication pathways
- No single point of failure
- Self-organizing and self-optimizing
- High availability (5 9's or 99.999%)
  
- Example: Wireless mesh networks
  - Self-organizing
  - Dynamic routing and path diversity
  - Frequency diversity and frequency agility
  - Self-optimizing: dynamic radio resource management

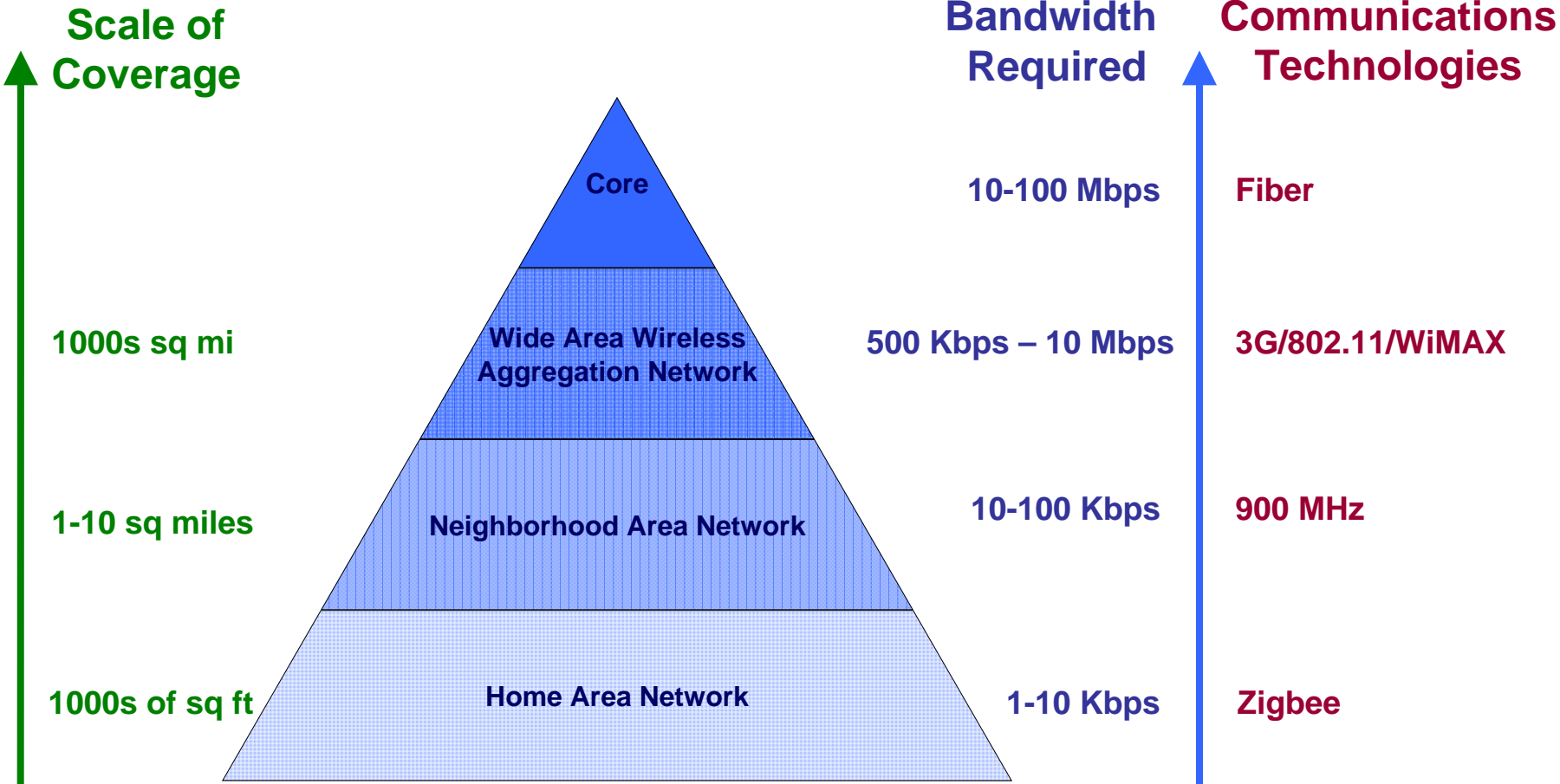
# Multi-layer Security Model

- Layered approach compatible with L1-L7 security approaches, from the physical layer upto and including end-to-end application layer security
- Based on open industry standards (e.g., NERC CIP, FIPS, IPSec, AES, etc.)
- Extensible and upgradable to evolve along with the standards
- Strong authentication, access control, encryption, networked asset protection, traffic segmentation

# Scalable Network Management

- Scalable to manage millions of devices
- Scalable to wide-area network footprints
- Extension of utility enterprise network management
- Fault management and fault isolation, configuration and bulk provisioning, performance management, enterprise-level security and more

# Smart Grid Communications Hierarchy



# Smart Cities – Greener, Safer, Smarter

Conserving resources & reducing carbon footprint



Efficient, on-time public transit



Increasing visibility & safety



Helping reduce crime



Increasing mobile worker efficiencies



One Network  
Many Applications



Timely information for visitors



Enhancing revenue capture & improving visitor experience



Building economic development



Creating educational opportunities



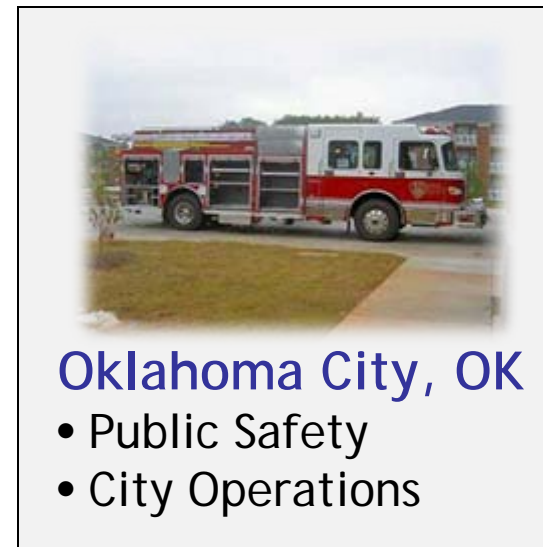
Improving traffic flow & reducing carbon emissions



# City of Oklahoma City

## City-wide public safety network

- Identified as a top priority following the 1995 Oklahoma City bombing
- Required multi-Mbps mobile data rates over entire 555 sq. mile city area
- Result: largest mesh wireless mobile broadband network in the world
- True multi-use network – 180 concurrent municipal applications for 1,200+ city workers



“The Tropos metro-scale Wi-Fi system is the one solution that allows us to deploy the best communications and investigative tools to the field, at by far the fastest, lowest cost and most reliable way possible.”

*Kerry Wagon, Project Office Manager for Oklahoma City*

“Tropos helped us achieve our goals in creating a completely independent mobile network. Now that the first phase of the system is in place, it’s easy to build off of it, expanding capacity and adding applications as needed. The Tropos wireless network is part of what makes Oklahoma City a great place to live.”

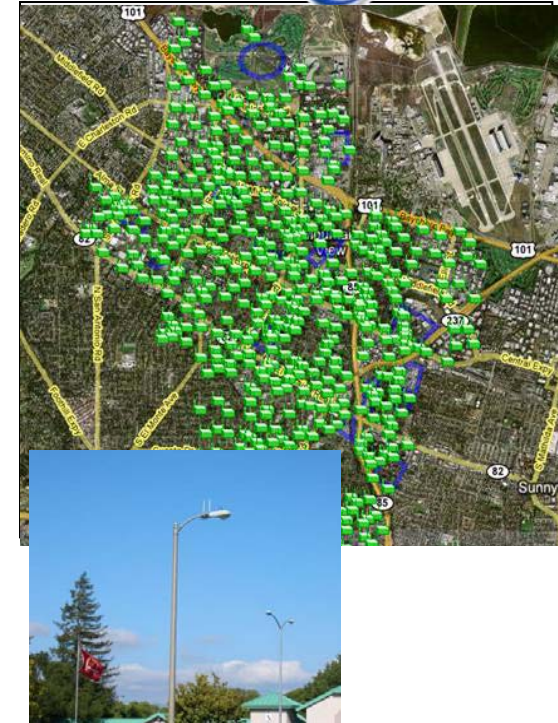
*Mark Meier, Director of IT Services for Oklahoma City*

# Google Mountain View

## One of the most highly utilized outdoor networks in existence

- 12 square miles covered by 500 Tropos routers (~90% single radio router)
- 15,000 unique users each month
- Network handles +500 gigabytes per day
- 10% monthly traffic increase
- >100 distinct types of Wi-Fi devices

Google™



# Burbank Water & Power

## Creating a SmartGrid to manage demand and minimize capital spending

- Smart metering solution with two-way communication
- Power Conservation through innovative, automated demand response program
- Reduction of Greenhouse Gasses by delaying construction of new power generation
- Enables Load Management & Customer Curtailment programs
- Mobile access to work orders and real-time data
- Future access for other city departments



### Burbank, CA

- AMI / SmartGrid
- Mobile workforce

"If this system is able to shave five megawatts off my peak through better conservation, and demand response, and energy efficiency, that will more than pay for the cost. Five megawatts is worth to me in capital costs about \$7.5 million to \$10 million."

*Fred Fletcher, Assistant GM, Burbank Water and Power*

# Large Middle Eastern Utility

- **Coverage**

- >5,000 sq kilometers
- 3,000+ Tropos routers

- **Applications**

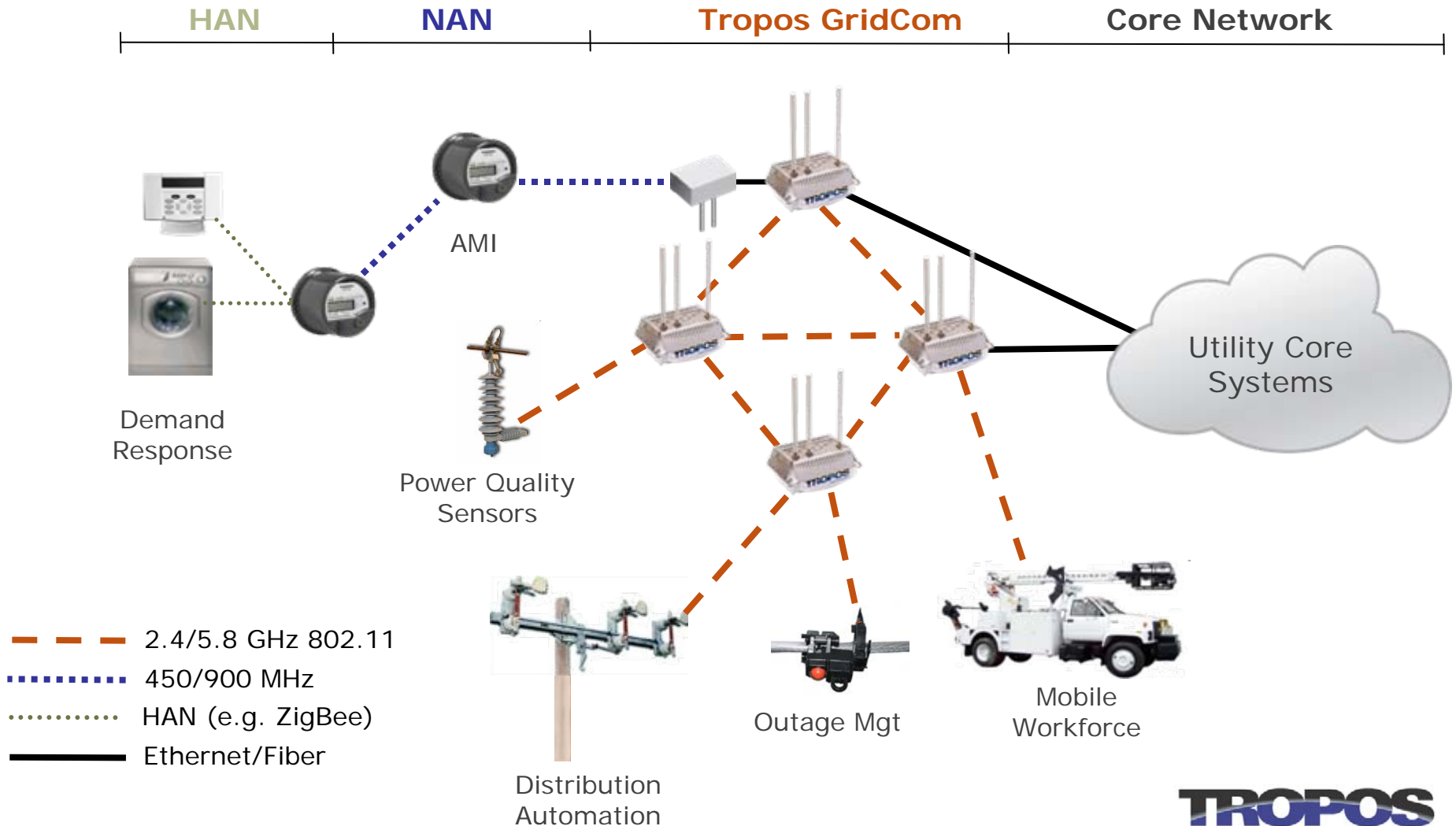
- Electricity & Water Meter Reading
- Mobile Broadband for Field Workers
  - 2,100 Vehicles
  - 7,200 Field Workers
- SCADA Control
  - Transmission & distribution
  - Source, pump stations & storage

- **Planned Results**

- Reduces carbon footprint
- Resource recovery
- Demand side management
- Cost savings & avoidance
- Improved customer service
- One network for Utility



# GridCom Wireless Wide-Area Aggregation Network Architecture



# Tropos Wireless Mesh System

## Tropos Routers

- Reliable, cost-effective, easy to use and deploy fixed and mobile routers
- Single and multi-radio options

## Patented Tropos Operating System

- Predictive Wireless Routing Protocol (PWRP)<sup>TM</sup>
- High capacity via efficient routing software
- Proven scalability and metro-scale deployments
- Easy installation, maintenance and upgrade
- Services & APIs for applications

## Tropos Control and Analysis Tools

- Complete management system for planning, deploying, optimizing and managing IP mesh networks



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