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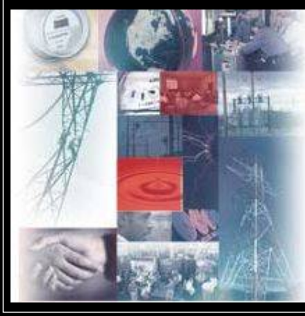
IP Communications for Utility Applications - A Business Case



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About the Presenter: *Dominic holds a Bachelors Degree in Electrical Engineering and has over 34 years of experience in the electric utility industry specializing in real time systems architecture, design, development and implementation with mission critical communications and systems integration for Power Generation, Protection and SCADA, Distribution System Automation, Substation Automation and Integration, Water Systems Process Control, OMS, GIS, AMR, AMI and Workforce Management applications. Dominic is also the President and Founder of SCADASOFT, LLC which is a SCADA Communications Diagnostics Software Tools company with its Website at http://www.scadasoftllc.com*

Agenda

1. Introduction
2. IP Technology & Utility Applications
3. Business Case: IP in Utility Applications

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Introduction

Utility Control Center Applications

Legacy communication technologies in use:

- Leased Telco Lines
- MAS Radio
- Microwave Point-to-Point Backhaul
- Proprietary Protocols

Available low cost options were mostly:

- limited to supporting one application
- of limited value
- insufficient for advanced automation
- not financially viable

Few utilities could justify investments beyond basic SCADA and targeted Distribution Automation.

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Introduction

- Typical applications in 90’s and prior included:
  - SCADA
  - CIS
  - OMS, etc
- Application ownership distributed across different departments.
- Growing need and gradual increase in applications requiring communication with remote sites.
- Each application introduced its own proprietary communication technology.

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Introduction

Each application introduced its own proprietary communication technology… resulting in:

- Proprietary technologies leading to dependencies on individual vendors
- High capital costs
- Islands of complicated technology—expensive to maintain
- Need for skilled manpower towards maintenance of each technology
- Constant threat of companies phasing out products and support
- Poor scaling as the applications’ demands grow in size and nature

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Introduction

Additional factors complicating the situation:

- Changing business environment for Utilities.
- Highly Interconnected Grid: Increased demand for information sharing.
- Mergers and Acquisitions: Separation of electrical assets.
- Increased pressure for regulatory compliance.

Agenda

1. Introduction
2. **IP Technology & Utility Applications**
3. Business Case: IP in Utility Applications

IP Technology & Utility Applications

In Early 90's IP-based Communication:

- Began gaining ground in mainstream IT industry
- Slowly making inroads into other industries
- Applied in applications such as Video over IP, Voice over IP etc.

Limited interest for Utility Control Center Applications largely due to:

- Lack of confidence in IP for mission critical apps.
- Cost to replace legacy systems,
- Lack of awareness in technology advancements,
- Lack of thorough and qualitative business case studies, application studies or field proven success stories.

IP Technology & Utility Applications

Notable Developments to Ethernet Standards

<u>IEEE 802.1p</u>
Priority processing, QoS at physical layer
Permits assigning higher priority for mission critical traffic over types on a network to minimize delays.

<u>IEEE 802.1q</u> (VLAN)
Segregation of single physical network into multiple virtual local area networks.

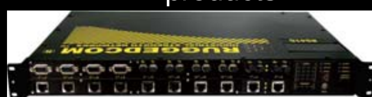
<u>Other's</u> such as:
IEEE 802.3x (Full Duplex operation), 802.1w (Rapid Spanning tree protocol) and broadcast and multi-cast filtering.

IP Technology & Utility Applications

Related Developments in Support of IP

- ✓ Emergence of IP packet-based radios products
- ✓ IEEE 1613: Substation Hardened Communication products

IP Radios



Substation Hardened IEEE 1613 complaint Ethernet Terminal Servers

- ✓ Support for IP by utility standard protocols [DNP, Modbus, IEC 60870-5, IEC 61850]

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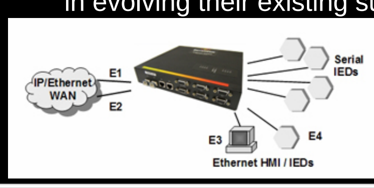
IP Technology & Utility Applications

Ethernet Serial Servers

- Most notable among products that helped bring IP to substation.
- These devices provide a cost-effective method of integrating legacy serial IEDs that do not support IP-based communication on their own.
- Utilities can make use of such products as a transition strategy in evolving their existing substation IEDs to IP-based devices in



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IP Technology & Utility Applications

Common Utility Communication Transports for IP

- Ethernet
- Microwave radio
- Fiber (SONET)
- Ethernet Radio / IEEE 802.11
- Frame Relay
- MPLS
- Cellular (CDMA, GSM)

IP Technology & Utility Applications

Common Utility Applications Suitable for IP

- SCADA
- Distribution Automation (DA)
- Power Quality Monitoring
- Automated Meter Reading (AMR)
- Load Management
- Mobile Workforce Management
- Automated Vehicle Location (AVL)
- VOIP, Video Surveillance, etc.

IP Technology & Utility Applications

Utilities are Often More Concerned with Core Applications.

Underlying Communication Technology Choices are Mainly:

- Application driven
- Vendor's preference

This approach gives rise to a new breed of problems:

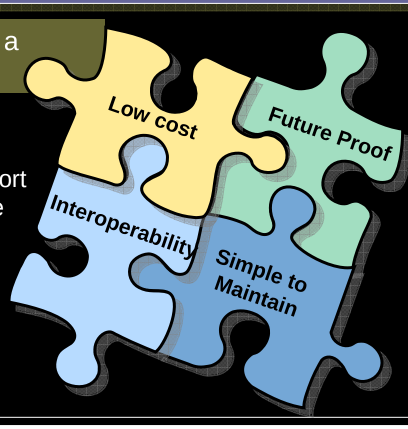
- Plethora of communication technologies
- Often hard-to-understand proprietary technologies
- Extensive and specialized training requirements
- Increased dependency on vendor during downtime

IP Technology & Utility Applications

Utilities are Beginning to Take a Fresh Look at Communication Infrastructure.

Communication Infrastructure Needs a Better Strategy, Focusing on:

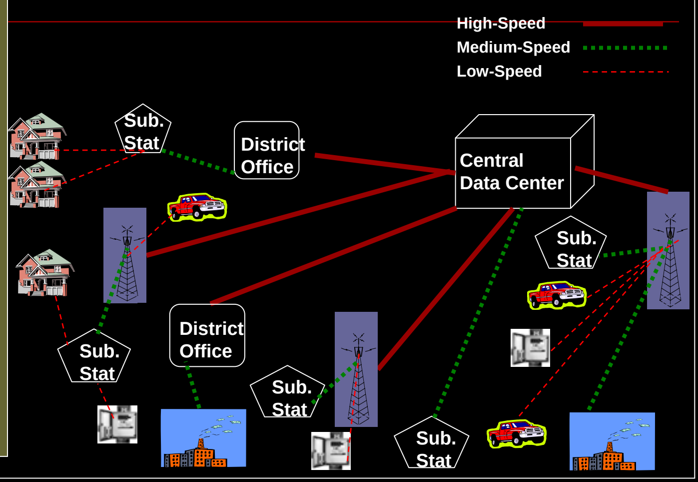
- **Low Cost** – Maximize Benefits
- **Future Proof** – Should be able to support additional applications planned in future
- **Interoperability**
- **Simple to Maintain**



IP Technology & Utility Applications

Modern Approach for Communication Projects

1. **Group applications together: high, medium, low bandwidth**
2. **Evaluate media choices and select optimal technology**
3. **Very strong preference for IP technologies**



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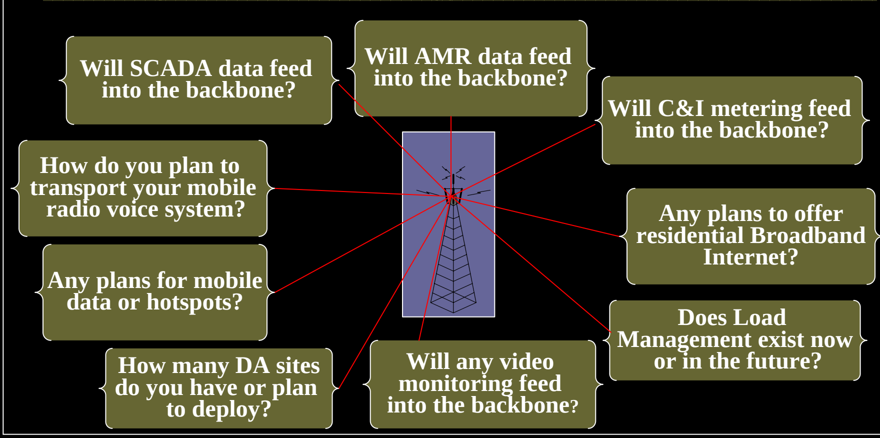
IP Technology & Utility Applications

Modern Approach for Communication Projects:
Develop a Plan: *Forecast what applications will feed into the backbone*



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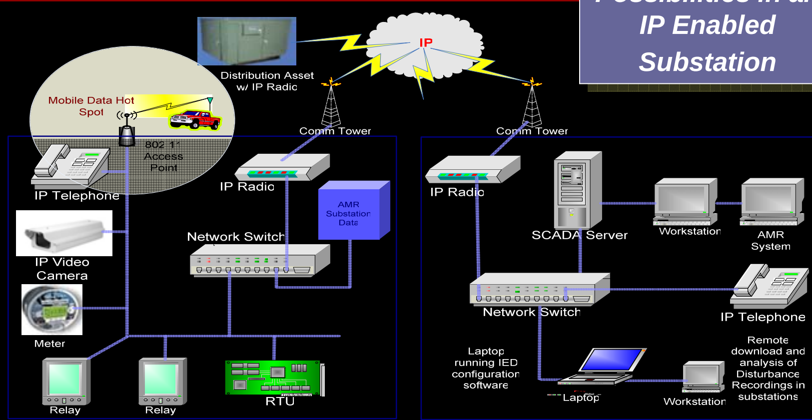
IP Technology & Utility Applications

Possibilities in an IP Enabled Substation



Agenda

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3. Business Case: IP in Utility Applications

Business Case: IP in Utility Applications

Approach:

- Enterprise-level deployment vs. piece-meal approach
- Focus on “Hard” as well as “Soft” benefits
- Real world data

A solid business case should clearly:

- ✓ Define existing system costs and functionality
- ✓ Define inputs and assumptions
- ✓ Develop cost analyses
- ✓ Evaluate “soft” and future benefits

Business Case: IP in Utility Applications

Assumptions (*utility profile*):

- A total of 106 substations and radio tower locations with existing Telco lines. Some tower sites were connected through SONET technology.
- About 157 substations and radio towers currently using MAS radio technology.
- About 250 substation and remote DA sites that have no communication link of any type.
- Existing applications were limited to SCADA and simple Mobile Workforce Management (MWM), while the utility might implement other applications such as AMR/AMI.

Business Case: IP in Utility Applications

Assumptions (*continued*):

- For MWM and AVL, occasionally, service crew will depend on the new IP communication infrastructure for communicating with the dispatch center.
- It was also expected that the new IP-based communication backbone would provide for AMR/AMI backbone to back office.
- Other applications such as Video Surveillance, business LAN to selected substations, Voice over IP were included.

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Business Case: IP in Utility Applications

Cost/ Quantitative Analysis: **Assumptions**

Per-site IP communication costs of $3,500 (additional per-site costs might be expected. In the actual case for the electric utility, additional per-site costs were involved; however, these were allocated to another application - e.g. AMR, AVL, etc.)

13 microwave paths were added at a cost of **$80,000 per path**. This assumed a combination of 5.8 GHz and 6 GHz microwave radios. Other applications' business cases (e.g. AMR) would also include additional microwave paths and/or SONET fiber from several tower sites as a means to expand the Ethernet IP backbone.

8-year and 10-year depreciation on the substation IP radios and microwave radios, respectively.

The hardware costs for the existing CSU/DSU and the line isolation equipment were assumed to be fully depreciated.

Monthly Telco lease costs would increase by 2% per year.
The number of outages and trips by staff to support the substations & towers would be the same with Telco media as with IP media.

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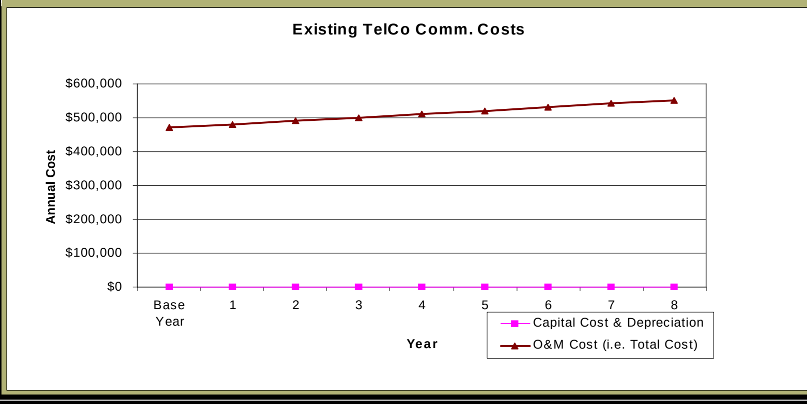
Business Case: IP in Utility Applications

Part A: Recurring costs of Telco line (Eight year Period)

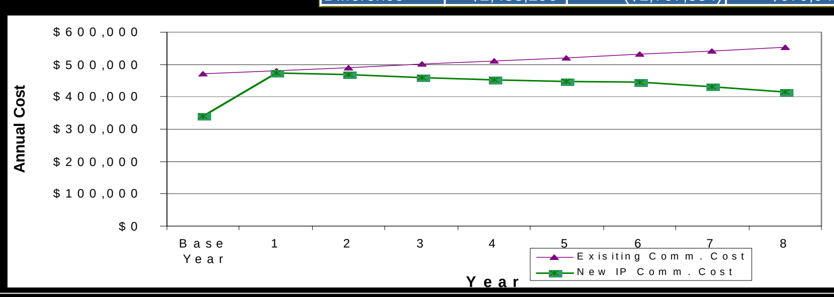


Business Case: IP in Utility Applications

Part A: Net Asset Value of IP infrastructure at end of eight year period - $670,942

Cost Analysis
(Over an Eight year Period)
(Telco v. IP, continued):

	O&M Cost	Cost of Capital & Depreciation Expenses	Total Cost
Existing Telco	$4,602,361	$0	$4,602,361
New IP	$2,164,064	$1,767,354	$3,931,418
Difference	$2,438,296	($1,767,354)	$670,942



Business Case: IP in Utility Applications

Part B: Add Remote Access to Substation IED Maintenance Ports

Cost Analysis – Additional Quantifiable Savings:

Assumptions:

- •Locations: 106 Substation and Towers
- •Annual visits to Substations by Engineer for IED settings (baseline): Twice / yr.
- •Annual visits saved by remote access: Once / yr.
- •Loaded Labor Rate for an Engineer: $60 / hr.
- •Average Travel Time of each substation visit: 2.5Hrs

Total annual cost for IED configuration- ***WITHOUT remote configuration (IP):***	Total annual cost for IED configuration- ***WITH remote configuration (IP):***	**Cost avoided per Year**
106 sites x **2 trips**/site x 2.5 hr/trip x $60/hr **=$31,800**	106 sites x **1 trip**/site x 2.5 hr/trip x $60/hr **=$15,900**	**$31,800 - $15,900 = $15,900**

Business Case: IP in Utility Applications

Part C: Add Advanced Metering Infrastructure (AMI)

Considers cost avoidance while implementing AMI

- Typically, AMI systems require some form of backbone to transport data to central office.
- Bandwidth requirements are usually in the range of 200 kbps and higher, depending on AMI functions.
- Traditional approach requires custom-built backbone installation.

Well designed IP-enabled substations:

- Can be reconfigured to provide backbone to central office from substations
- Incremental costs to reconfigure IP network vs. capital intensive new backbone solely for AMI
- Minimum effort
- Low risk

Business Case: IP in Utility Applications

Part C: Add Advanced Metering Infrastructure (AMI)

Assumptions:

- Locations: 80 AMR concentrator nodes
- AMR Backhaul technology: Conventional Microwave, hybrid.
- Minimum installed cost for traditional standalone AMR backhaul for 80 sites: $300,000
- Maximum cost to reconfigure the IP infrastructure to accommodate AMR traffic: $80,000.

Capital cost reductions due to IP: > $220,000

Business Case: IP in Utility Applications

Part D

Mobile Work Force Management

Assumptions:

- Utility had satellite-based data communication system for Mobile Work Force Management (MWM)
- Service was charged based on kilobytes of data transmitted

Having IP to substations would provide a cost effective backup solution for MWM data. Substations could be turned into 802.11a/g/n standard hotspots. Mobile service crews could drive up to the nearest substation perimeter and securely login to exchange bulk data from central servers, thereby avoiding the satellite service costs when and where possible.

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Business Case: IP in Utility Applications

Soft Benefits

Frequently overlooked during evaluations are the qualitative or "soft" benefits, which are inherent in many business cases.

Soft Benefits:

- Are often hard to quantify
- Can significantly improve long-term profitability
- May Improve staff productivity
- Can result in increased customer loyalty

Business Case: IP in Utility Applications

Soft Benefits

Consider, for example:

- Increased operational efficiencies and possibilities under contingencies and major storms.
- Increased access to substation data → early detection of impending problem → preventing or reducing # of outages → improved SAIDI/CAIDI/SAIFI, etc. → greater customer satisfaction, reduced regulatory pressures, greater kWh billings.
- Standards-based IP technology → reduction in specialized skill sets required and less vendor dependence → Reduced network downtime → more productive employees → improved productivity and satisfaction.

Business Case: IP in Utility Applications

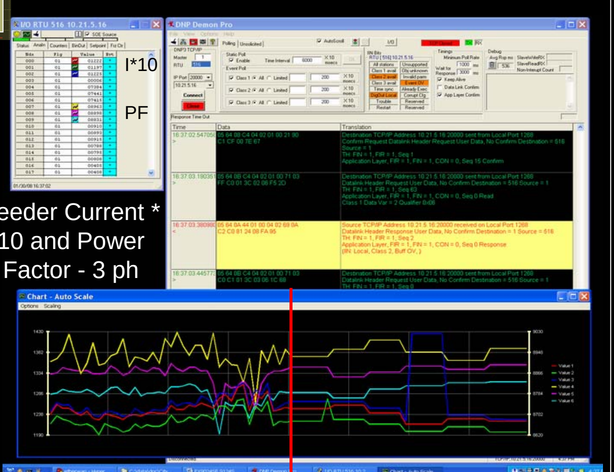
Soft Benefits, cont.

- Standards-based IP network → Commercial off the shelf products → Choice of best in breed products → Low cost, High performance → Low technology risks → Greater ability to upgrade and innovate.
- Reduced maintenance related travel → cost savings and increased capacity for value-added productive work.
- Higher quality data available due to increased bandwidth → Historian data quality increased → Predictive maintenance, Load forecasting

Higher Quality Data Available with Increased Bandwidth

Soft Benefits, cont.

- IP Band-width = Increased Data Resolution
- Consider Integrity Polling vs. Event Polling



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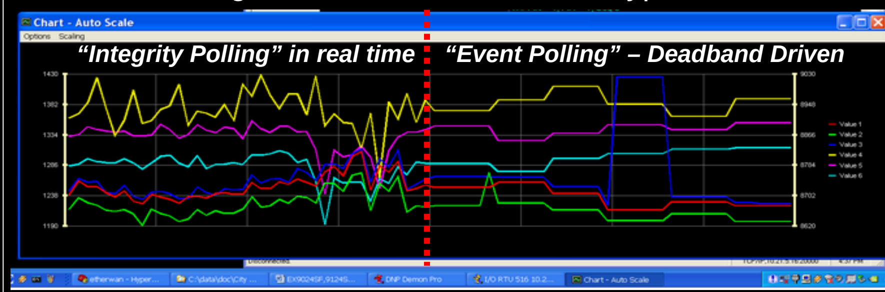
Better Data = Better Decisions

Soft Benefits, cont.

- Not just more accurate *Monitoring*
- Improved perspective on *Cause & Effect*
  - Voltage/Current, Power Factor, Type of Load, …



Business Case: IP in Utility Applications

Conclusion

IP-based technology is:

- Mature
- Standards based
- Enthusiastically supported by vendors
- Technology with dwindling bandwidth costs
- A gateway to future advancements in Utility Automation

Questions?

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