Cellular Use In A Utility Scada System: A MPW Case Study SCEC 2016

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Agenda

I. Why Scada Communications Are Important
II. M2M – What is it?
III. What makes cellular M2M attractive
IV. MPW's journey
   - What drove the need for change @ MPW?
   - The process
   - Data plan & usage
   - Overview of our system including complete data path from end point to end point
   - Tools to manage devices and their data
   - DR (Disaster recovery) capabilities comparison
   - Support
V. Conclusion

Why Scada Communications Are Important?

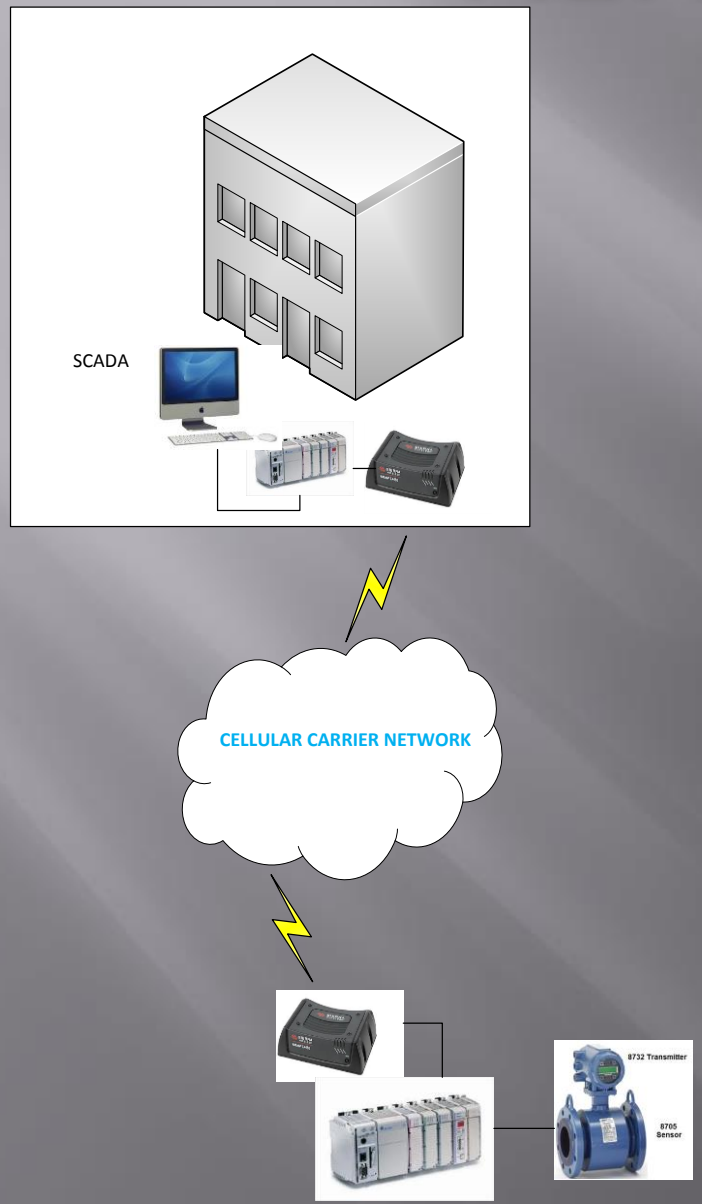
- Utilities **rely** on Scada systems to let them know what is going on in their Water & WW Treatment Plants, Distribution System, Collection System & Facilities during **normal & emergency operations 24-7**
- Communications are the **Backbone** of Scada systems - serves the basic need to communicate & exchange information
- Support our **Strategic Business Plan**

Strategic Business Plan

Target Area Scada Communications supports = **Operational Excellence** which is associated with **4 attributes**:

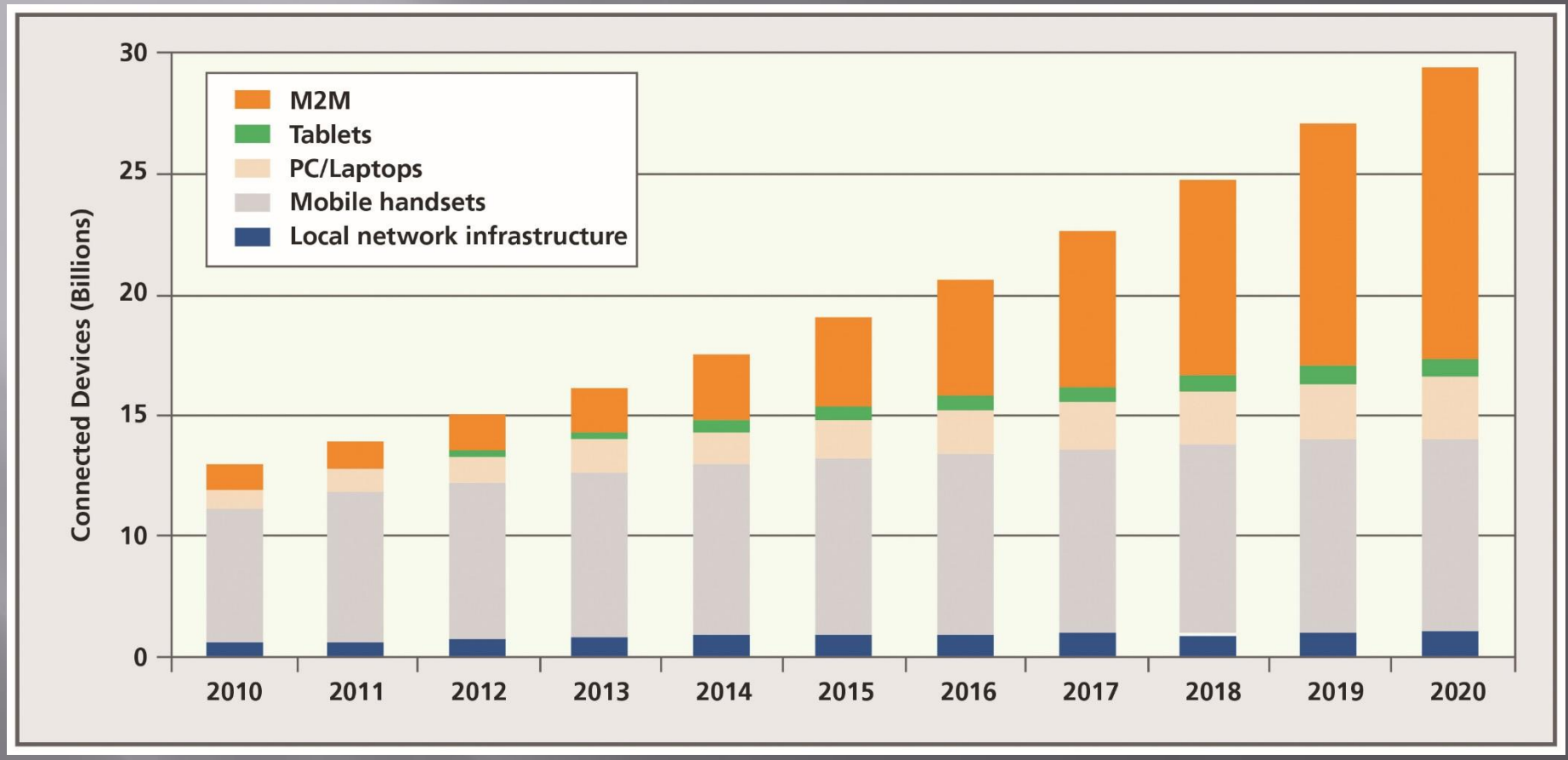
- **Operational Optimization:** helps decrease **cost** to treat, distribute, collect, re-treat & also reduce **miles driven**
- **Product Quality**: helps achieve permit **compliance** & reduce **SSOs** thru monitoring and alarming
- **Infrastructure Stability**: directly monitors how efficient much of our infrastructure is **performing** which in-turn directs **AM activities**
- **Operational Resiliency:** helps mitigate **risk**, ensure system **availability** and overcome challenges

M2M – What is it?



- **Machine 2 Machine** refers to direct communication between devices. M2M terminology is starting to replace the use of "Telemetry." It is essentially the same concept with updated technological capabilities like use of cellular.

M2M Device Growth

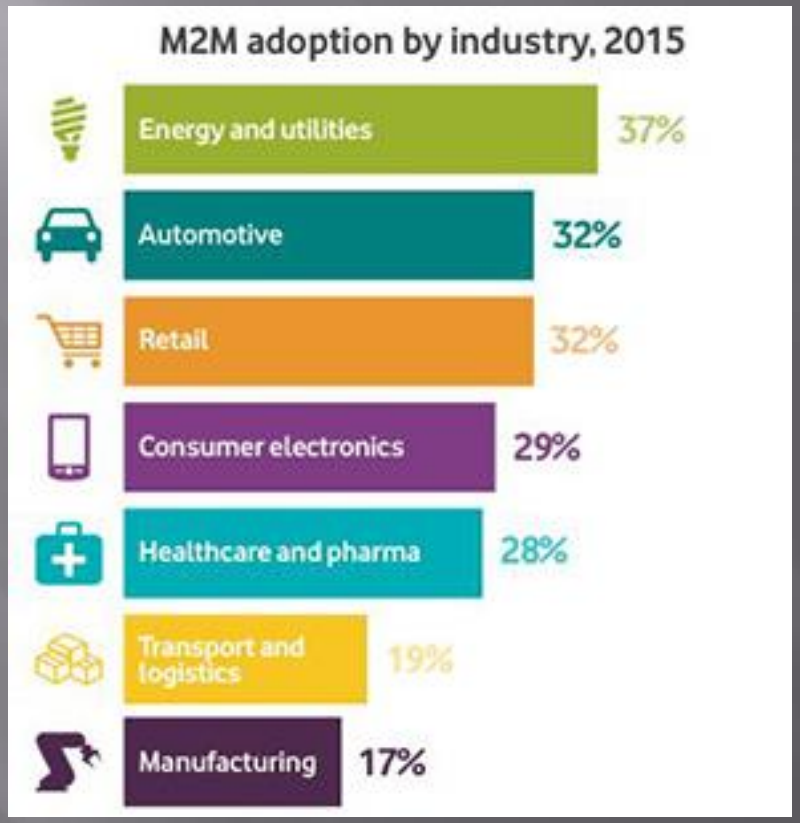


The Growth of M2M Communications

IPV6 addressing = 2^128 = 340,282,366,920,938,464,464,274,607,431,768,211,456

Over 340 Undecillion!

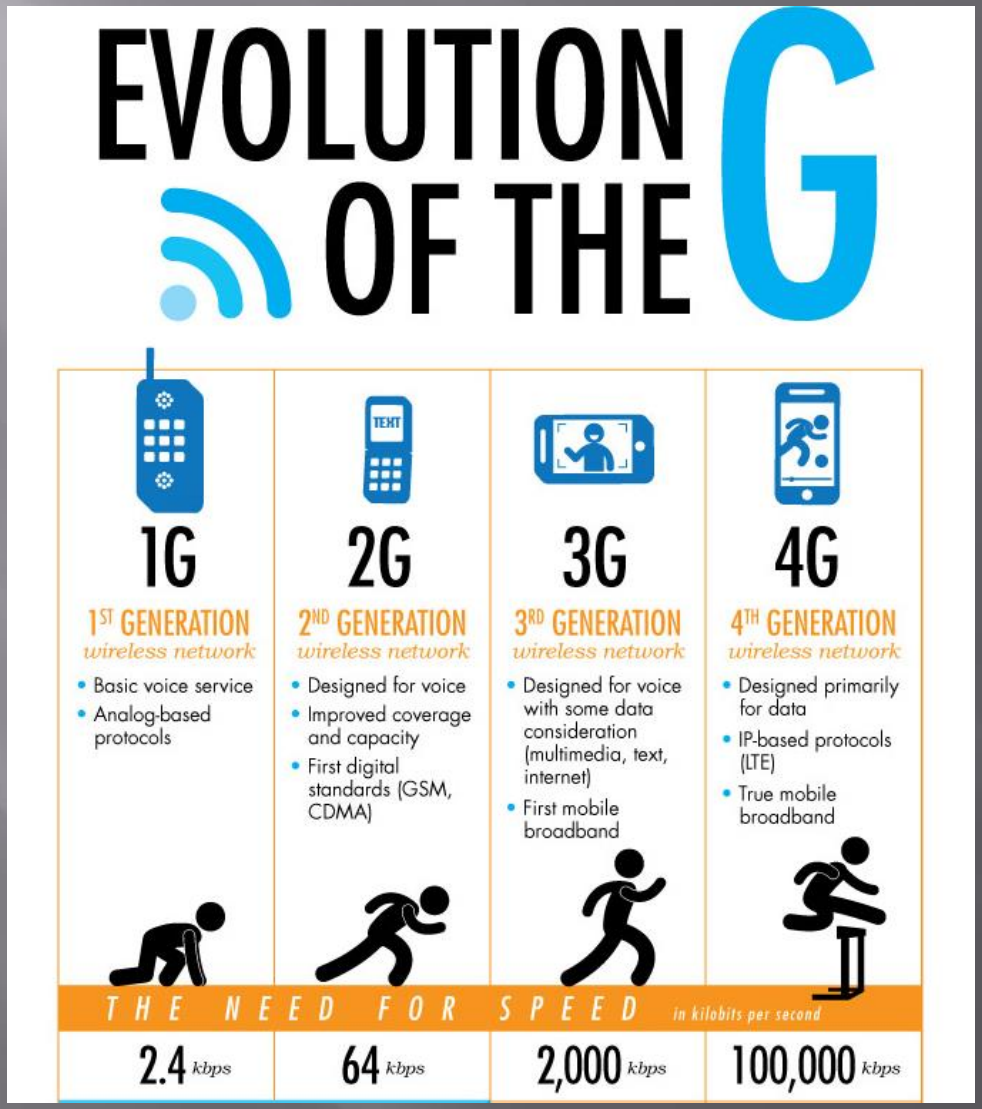
M2M Adoption By Sector



Why Cellular is Attractive & Gaining In Popularity?

Attribute	Cabled	Radio	Cellular
Infrastructure & Points of Failure	Cabling, switches, routers, firewalls, etc.	Repeaters, radios, antennas, Cabling, buildings, support systems (B/U power, UPS, etc.)	Essentially no infrastructure to purchase or maintain other than a modem – IaaS. With cellular, a tower may go down but not the entire system like a loss of a repeater or fiber cut may cause.
Coverage	Geography dependent	Dependent on power, frequency, antenna height, location, environment, and interference.	While geography dependent, in most cases offers the best coverage (95% of Americans & close to 50% of homes wireless only.) Even marginal cov. Is ok.
Performance	Excellent but depends on service available and how much willing to pay. Typical up to 100Mbps.	One RTU at a time on a channel. Typical 1,200 – 19,200 Kbps.	Highest bandwidth that is affordable (4G/LTE 100Mbps) and supports simultaneous RTU communications.
Reliability	Excellent but susceptible to damage in the ground.	Good to Excellent but varies with environmental factors, interference & narrow banding.	Highest reliability due to infrastructure design & redundancy and not susceptible to environmental impacts or cabled cuts.
Security	Excellent	Limited security features	Very robust security with private network and encryption at least equivalent to cabled.
Cost Comparison	High	Medium	Lowest cost – both capital and operating.

Evolution of G



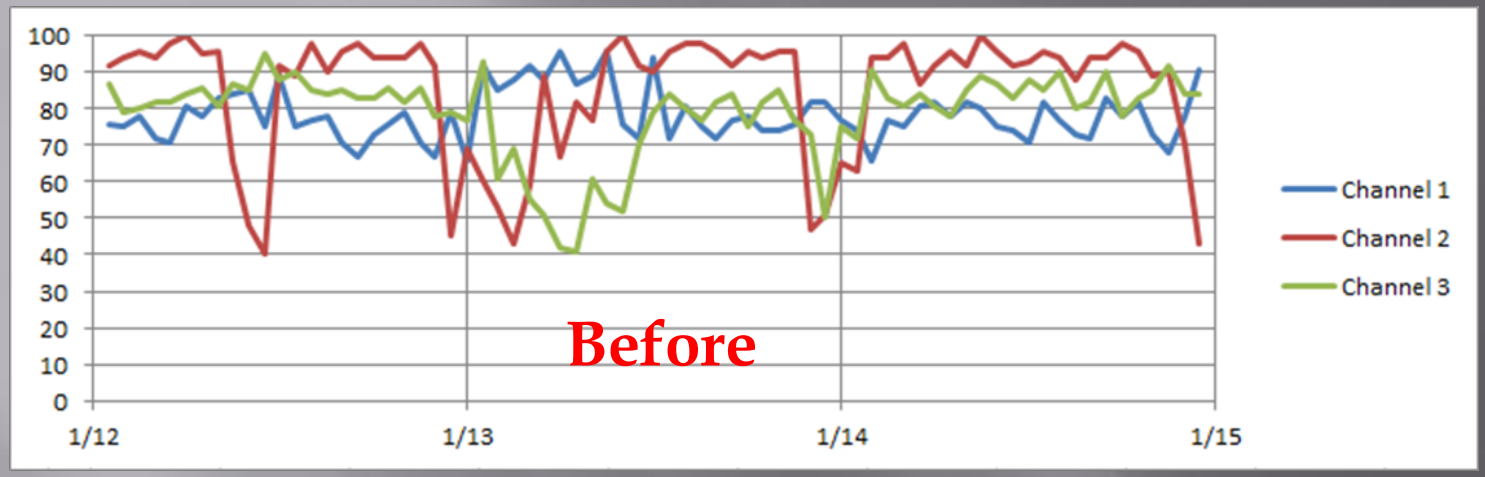
5G est. = 2020 or sooner (1-10Gbps.) When will wires become obsolete?

MPW's Journey

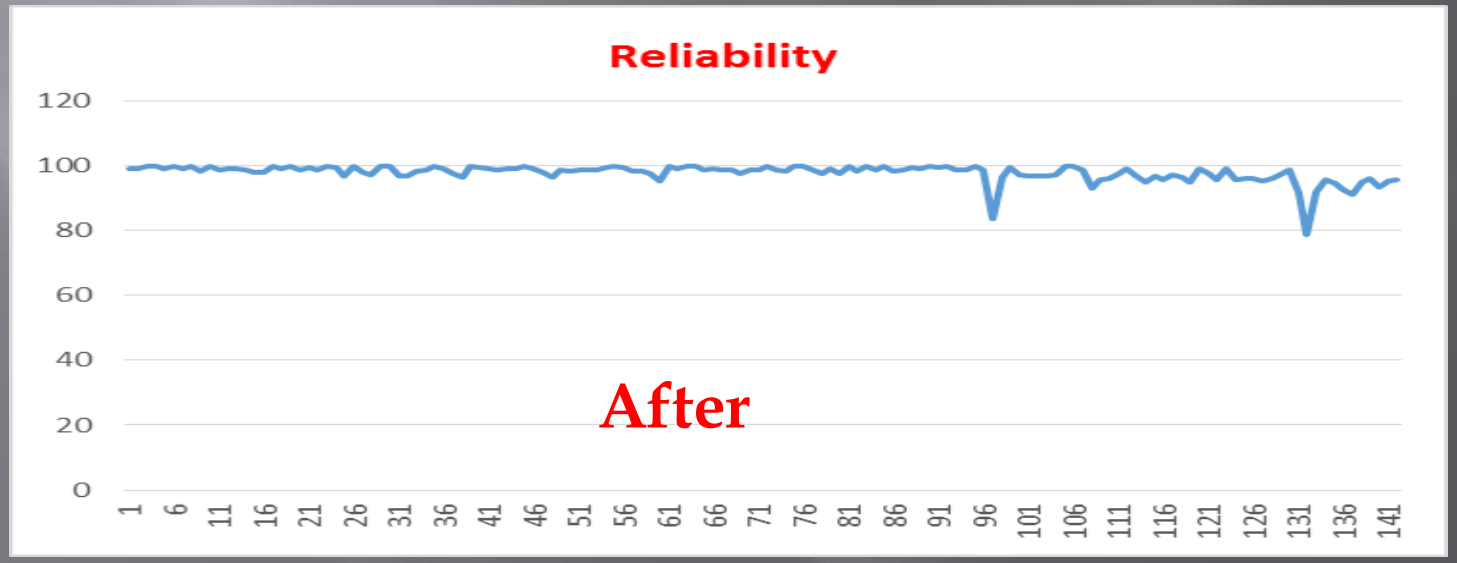
Drivers for Change @ MPW

- Improve Reliability & Confidence
- Improve Performance
- Secondary Drivers:
  - No infrastructure to maintain
  - Improved coverage
  - Increased security
  - Eliminated single point of failure
  - Better DR posture
  - Improved remote access
  - Tools available to manage
  - Cost reduction (50-80% Capex & 50% Opex)

Drivers - Reliability & Confidence



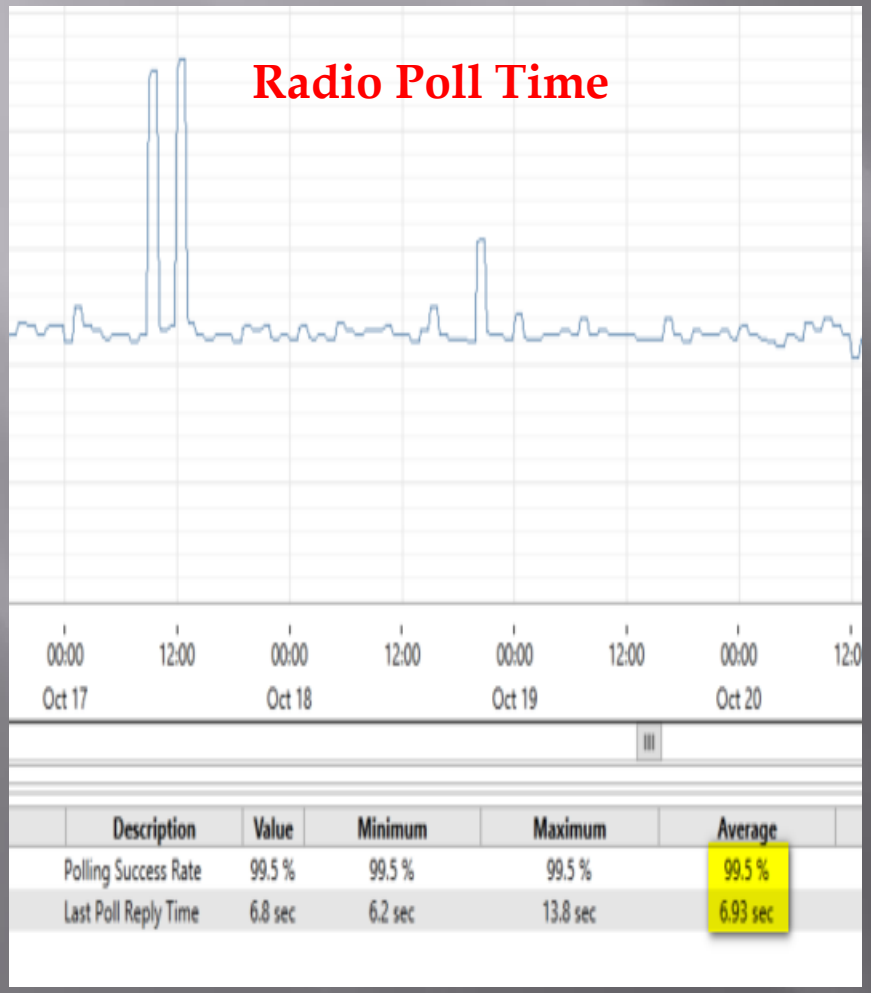
Radio System Reliability: 40-98%

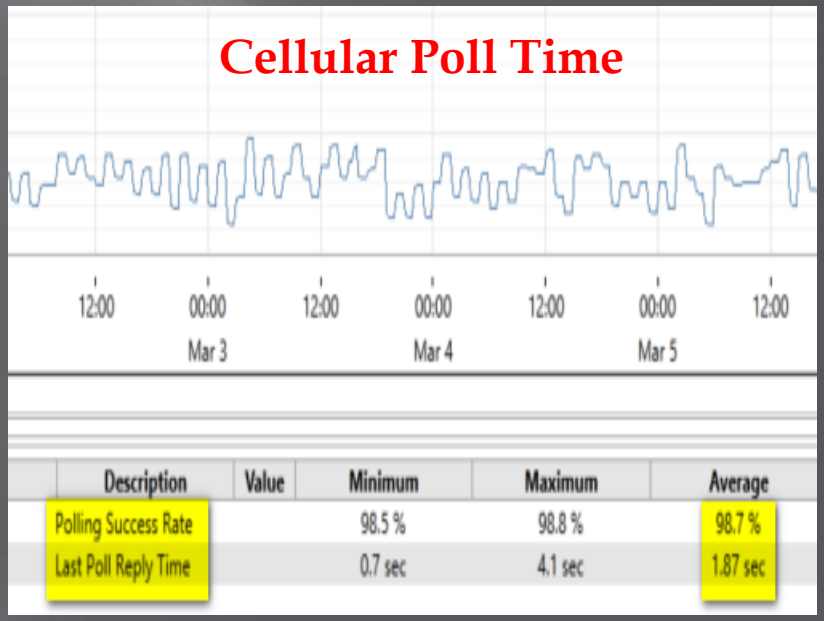


Cellular System Reliability: 97.7-100%

Drivers - Performance

- **Average Polling Time/Site** was reduced from 6.93 sec. to 1.87 sec.
- **Average Poll Time/System** was reduced from 35-45 mins. to 6.82 mins. In reality, this can be reduced to under 2 seconds if we change our philosophy on polling.





The Process

- Developed a **Scada master communication plan** in Oct. 2013 with Star Controls (ISA Water/WW & Automatic Controls Symposium)
- Evaluated **cost** to verify affordable: hardware and data usage
- Evaluated **coverage**: provided Verizon with lat long of all sites
- Conducted **product selection**: selected the most forward-adaptable cellular 4G LTE modems to future proof
- Performed **design phase:** engaged Star Controls for configuration & integration level of effort
- **Piloted:** 8 sites for 8 months starting Dec. 2014 including samples AB PLC, MOSCAD CPU420 & CPU300, ACE3600 RTUs. Scattered geographically and in poorer reception areas. Utilized public network. Tested different connectivity methods (serial / Ethernet.) Determined actual vs. estimated data usage. Determined performance benchmarks
- Developed **private Verizon network & IP scheme:** Class A private range X.X.PS#.DeviceTalkingTo
- Initiated a **SC State M2M Data Plan** w/ Verizon: none were in place
- **Budgeted** for remaining equipment
- Performed **complete deployment** in-house July 2015 – Nov. 2015
- **Monitoring** performance and usage

Data Plan and Usage

Mobile Broadband Machine-to-Machine (M2M) Share Plans Low Usage Group					
Domestic Shared Data Allowance Per Month	1 MB	5 MB	25 MB	50 MB	150 MB
Monthly Access Charge	$5.00	$7.00	$10.00	$15.00	$18.00
Remote WW Pump Station Motorola ACE sites (Small)	144				
Remote WW Pump Station AB PLC sites	16				
Remote WW Pump Station AB PLC sites (Big Six)					6
Overage Rate Per MB	$1.00				

Mobile Broadband Machine-to-Machine (M2M) Share Plans High Usage Group				
Domestic Shared Data Allowance Per Month	250 MB	1 GB	5 GB	10 GB
Monthly Access Charge	$20.00	$25.00	$50.00	$64.00
Polling Master (FIU)			1	
Overage Rate Per MB	$0.015			

Station Group Name	# Sites	Poll Cycle	Est. MB/Site/Mo.	Tot. MB est./Mo.	Mon. Data Allow
Remote WW Pump Station Motorola ACE sites (Small)	144	30 mins	2 MB	288 MB	144 MB
Remote WW Pump Station AB PLC sites	16	15 mins	7 MB	112 MB	16 MB
Remote WW Pump Station AB PLC sites (Big Six)	6	15 mins	7 MB	42 MB	900 MB

$5.00-1MB (160 Sites low usage share group)

$18.00-150 MB (6 Sites low usage share group)

$50.00-5GB (1 Site –FIU at the main office)

Total Estimated Monthly Data Usage = 442 MB

Remaining MB reserved for troubleshooting and data overage = 618 MB

Total Shared = 1060MB

Est. Monthly Charge = $958.00 (private radio system = $1,707.18)

Est. Average Monthly Cost per Site = $5.73 (private radio = $10.22)

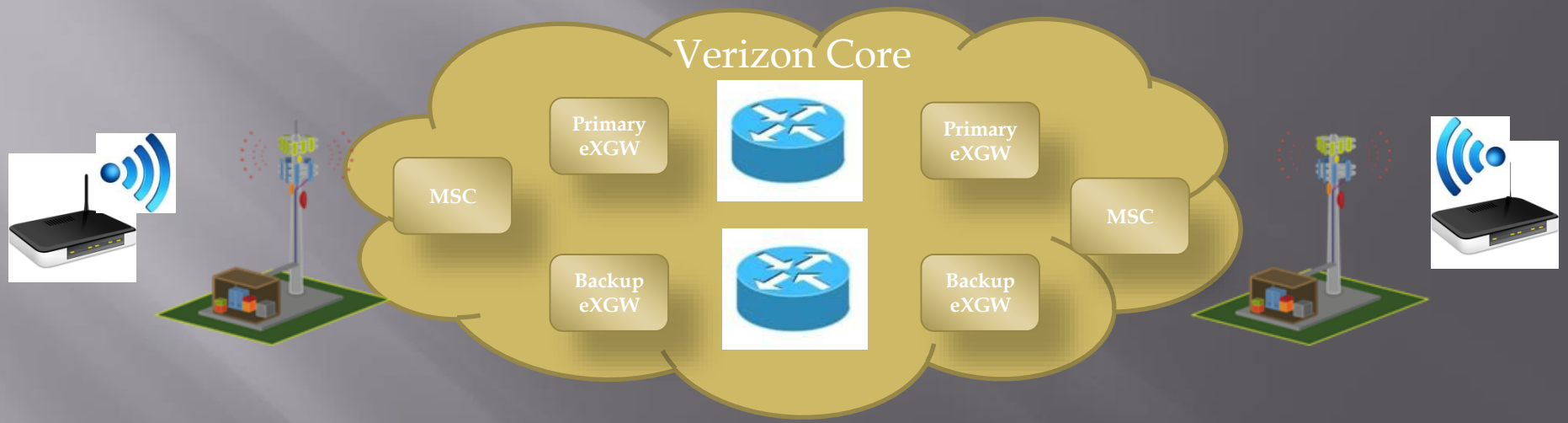
Usage Considerations - Protocols

- Most SCADA protocols were not designed with a consideration for a monetary cost associated with data usage.

- To minimize data usage, consider using protocols that support **Unsolicited** Messaging (such as DNP3, MDLC, CIP unsolicited message) which don't require constant polling of the sites by the master, but rather allow sending of alarms and data by the RTUs independently (they push the data.) Also, consider using "connectionless" protocols such as UDP which use much less overhead and the ability to transmit to and receive from dozens of remote units simultaneously.

End-Point to End-Point Path

Verizon Zero vs. VPN Tunnel Method Private Network



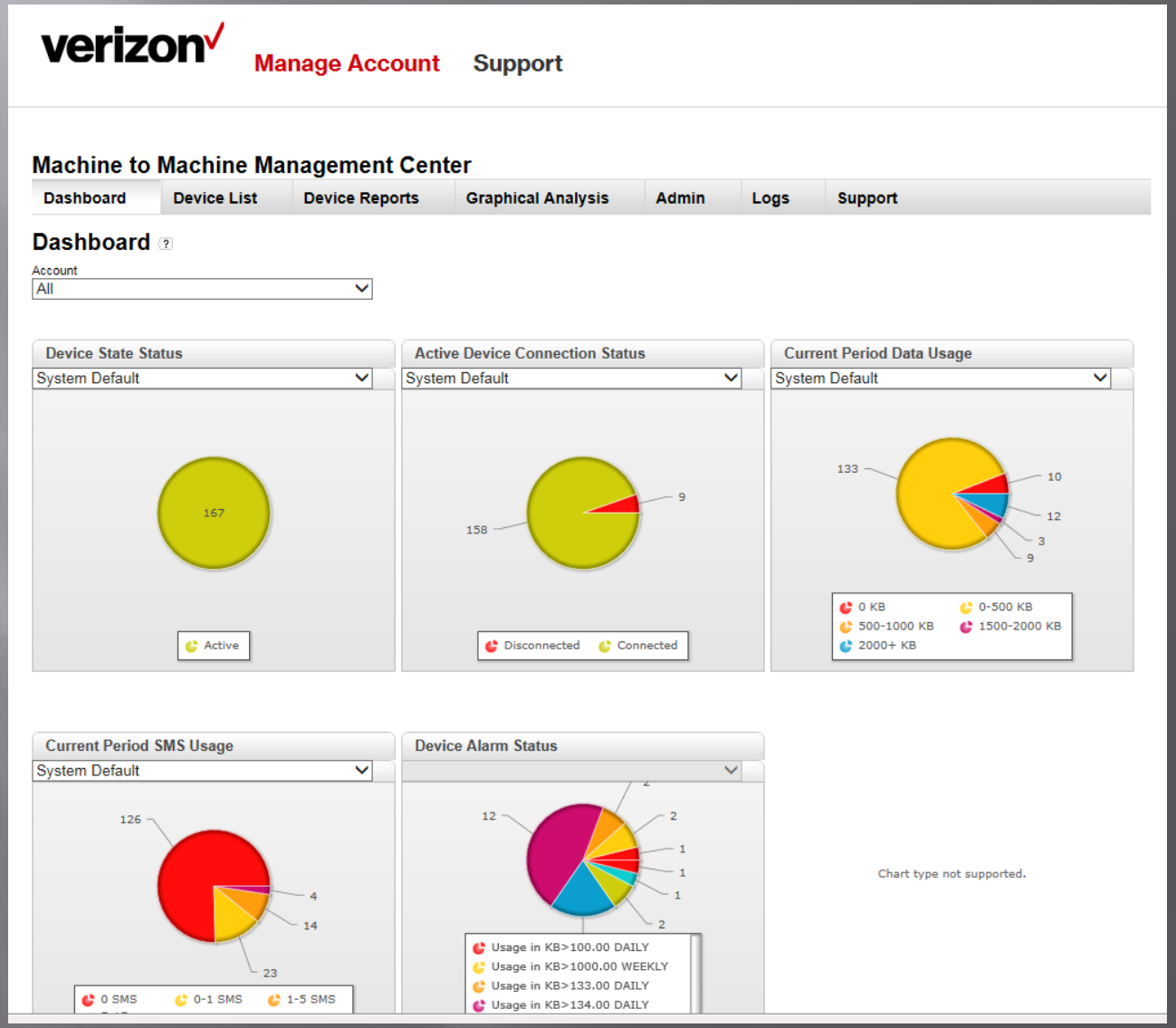
Remote Site ⟷ Cell ⟷ Cell Tower ⟷ Fiber ⟷ Mobile Switch Center Ladson ⟷ Fiber ⟷ Primary Gateway Charlotte Or Backup Gateway Nashville ⟷ Fiber ⟷ Mobile Switch Center Ladson ⟷ Fiber ⟷ Cell Tower ⟷ Cell ⟷ Ops Center

Tools To Manage Our Devices

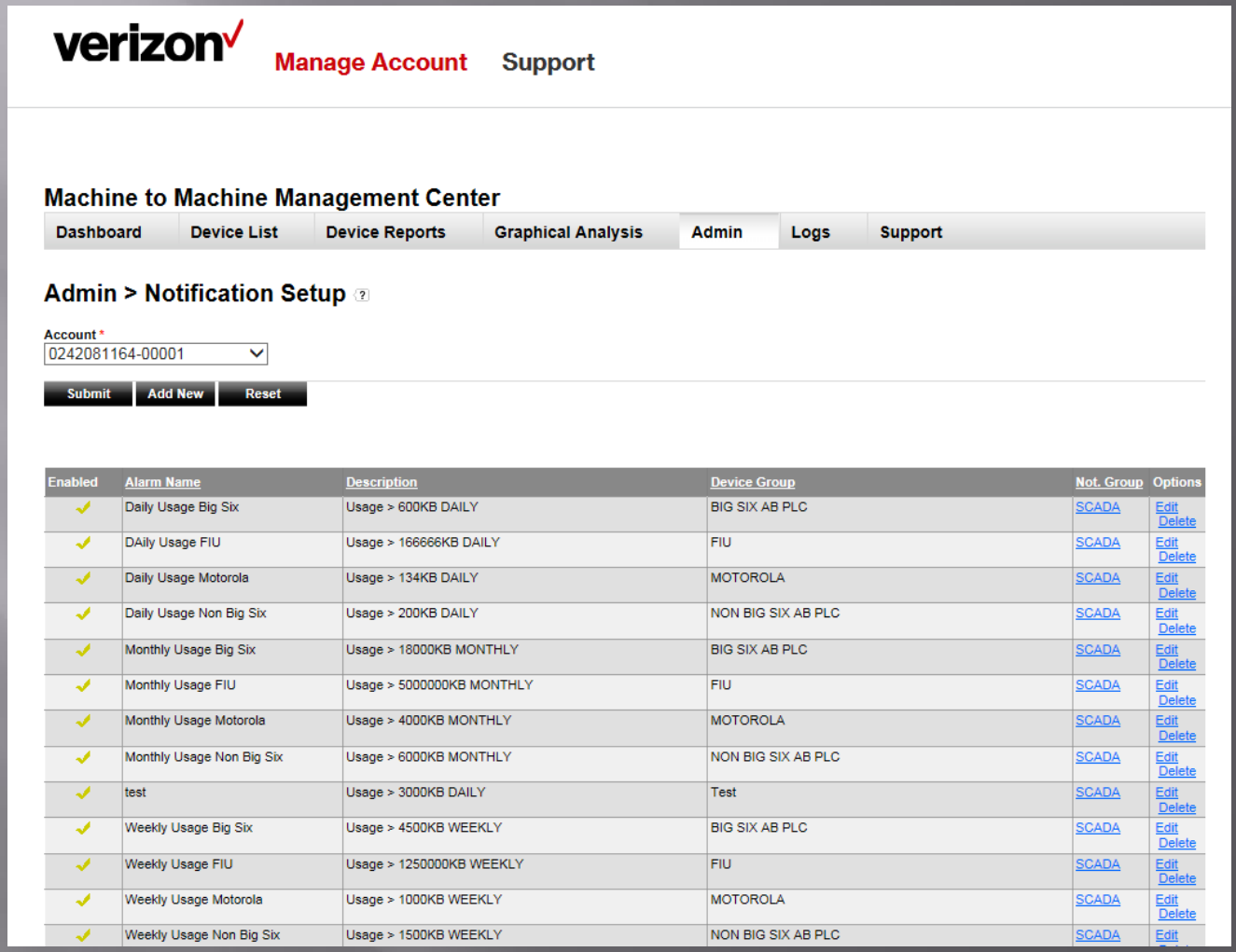
- There are several ways to monitor data usage:
  - Verizon M2M Management Center provides a monitoring system which samples data usage several times a day & provides alerts
  - The Cellular modem may be configured to send an email or text message if a pre-defined daily usage maximum has been reached
  - The RTU may be programmed to grab the data usage from the modem very frequently (every few seconds) or calculate data usage on the modem connection (Ethernet port) and take action in case of a threshold passage or high rate of change events

* Note: 3rd party solutions like Air Vantage can't be used for private network monitoring

M2M Management Center



M2M Management Center



Enabled	Alarm Name	Description	Device Group	Not. Group	Options
✓	Daily Usage Big Six	Usage > 600KB DAILY	BIG SIX AB PLC	SCADA	Edit Delete
✓	DAily Usage FIU	Usage > 166666KB DAILY	FIU	SCADA	Edit Delete
✓	Daily Usage Motorola	Usage > 134KB DAILY	MOTOROLA	SCADA	Edit Delete
✓	Daily Usage Non Big Six	Usage > 200KB DAILY	NON BIG SIX AB PLC	SCADA	Edit Delete
✓	Monthly Usage Big Six	Usage > 18000KB MONTHLY	BIG SIX AB PLC	SCADA	Edit Delete
✓	Monthly Usage FIU	Usage > 5000000KB MONTHLY	FIU	SCADA	Edit Delete
✓	Monthly Usage Motorola	Usage > 4000KB MONTHLY	MOTOROLA	SCADA	Edit Delete
✓	Monthly Usage Non Big Six	Usage > 6000KB MONTHLY	NON BIG SIX AB PLC	SCADA	Edit Delete
✓	test	Usage > 3000KB DAILY	Test	SCADA	Edit Delete
✓	Weekly Usage Big Six	Usage > 4500KB WEEKLY	BIG SIX AB PLC	SCADA	Edit Delete
✓	Weekly Usage FIU	Usage > 1250000KB WEEKLY	FIU	SCADA	Edit Delete
✓	Weekly Usage Motorola	Usage > 1000KB WEEKLY	MOTOROLA	SCADA	Edit Delete
✓	Weekly Usage Non Big Six	Usage > 1500KB WEEKLY	NON BIG SIX AB PLC	SCADA	Edit

DR Capabilities Include…

- **Facility:** seismic stds, complete system redundancies, fire control, security, remote monitoring, fail-over capability, 99.95% up-time
- **Electrical Systems:** battery B/U 6-8 days, standby generators, redundancy with hot standby, grounding a priority
- **Cell System:** continuous testing = they know before you do
- **Fiber Service:** complete redundancy, separate carriers, separate entrances
- **Maintenance & Testing:** extensive AM program, fail-over systems tested regularly
- **Staffing:** fully staffed and cross-trained w/ extensive resources
- **Cell Towers:** coverage over-lay by design, all connected with fiber w/ site to site capability, battery B/U 4-6 hrs., permanent generator, redundancy of major electrical equipment
- **Resources like COWS & GOATS:** "Cell On Wheels" w/ 2 mi. radius coverage. "Generators On A Trailer" for portable B/U.
- **Annual Drill for emergency preparedness and readiness:** Planning, executing & recovery

Support Experience

- 1st question that popped into our minds: are we going to be a priority?
- MPW is an Enterprise account = highest priority
- 24X7X365 monitoring of all facilities, switches and cell sites
- All devices are validated by Support as part of the hand-off from engineering
- If have an issue, MPW 1st contacts Enterprise Level Contact Center in Salt Lake Utah: private number and not published
- If can't resolve in 15 minutes over the air then a WO is Dispatched to the Charleston office at which time boots hit the ground. Have on-call staff locally & regionally if additional resources are needed
- Account manager and private network engineer are additional resources

Conclusion

- Cellular is a viable option for Scada communications today: was a smart solution for MPW. It's not for everyone – coverage and situations vary geographically and between utilities
- Do your homework: cost, coverage, data usage and reliability. Weigh all of the pros and cons
- You have to monitor data usage & economize: name of the game for carriers

Thank You!

Questions?

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