A Customer Experience Based Approach to Improving Access Network Power Reliability

An Operational Practice prepared for SCTE•ISBE by

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Introduction

Customers drive the Broadband industry's revenue. Customer experience is a major factor in determining MSO success, however, traditional Outside Plant (OSP) power reliability improvement strategies are based around arbitrary maintenance cycles, and not targeted toward addressing network elements that most effect customer experience. These strategies have an inconsistent effect on overall plant power reliability and fail to take advantage of modern big data analytics to maximize customer impact.

In 2018 a major US MSO set out to revolutionize reliability improvement by flipping this paradigm and beginning the process with a customer-driven metric that truly shows where customers are being impacted. Their Data Driven approach began by collecting and analyzing customer impacting node outage statistics and ended with a goal of significantly reducing customer affecting node outages in 2018. This paper will detail the process of developing a customer focused Reliability Improvement Strategy and show the real-world results of this strategy. This study will demonstrate how the major MSO under study, using the tenants described to focus efforts on the issues that directly impact customers, will maximize spend on preventative and on-demand maintenance in order to greatly improve power reliability and customer experience.

Content

1. Why Does Power Reliability Matter?

MSOs have consistently driven the broadband industry forward. Billions of dollars have been spent to create a network that can deliver data and video at speeds that continue to push the envelope of what was once thought impossible. New technologies that leverage the power of the HFC network are being introduced with increasing frequency. VOD platforms provide customers with a simple, yet engaging user interface that makes the actual experience of searching for new content to binge-watch fun. MSOs have been successful at building an attractive product and while the robust HFC network is designed to consistently deliver this product to customers, key components of the network depend upon reliable power to make that happen.

In the United States this need for reliable power poses a huge risk**.** Contrary to what many believe, the grid in the US is significantly less reliable than other industrialized nations.

> *"More than 70% of the grid's transmission lines and transformers are 25 years old; add nine years to that and you have the average age of an American power plant. According to industry expert Peter Asmus, we rely on twice as many power plants as we actually need because of "the massive inefficiencies built into this system." As a result, significant power outages are climbing year by year, from 15 in 2001 to 78 in 2007 to 307 in 2011. America has the highest number of outage minutes of any developed nation – coming in at about six hours per year, not including blackouts caused by extreme weather or "acts of God," of which there were 679 between 2003 and 2012. Compare this with Korea at 16 outages minutes a year, Italy at 51 minutes, Germany at 15, and Japan at 11. Not only do we have more outages than most other industrial countries, but ours are getting longer. The average U.S. power outage is 120 minutes and growing, while in the rest of the industrialized world it's less than ten minutes and shrinking. According to Massoud Amin, a power systems engineer, on "any given day in the U.S. about half a million people are without power for two or more hours."*
>
> - *Gretchen Bakke, PHD., Bloomsbury Publishing USA, Jul 26, 2016*

The unreliable US grid is only a part of the story. The utility grid and the HFC network are not aligned, which allows the possibility for the unreliable grid to cause outages for customers who are unaware of any utility outage. If a power supply injecting power to the plant is on a different powering leg of the grid than the customer premise, power to the plant can go down without affecting power that runs customer devices in the home, causing customer frustration and trouble calls. Additionally, an increasing number of US customers, particularly business services customers, are backing up premise power to ensure connectivity.

2. Evolution of HFC Power Reliability

As a result, MSOs have spent significant time building the most reliable backed-up powering networks possible. Since the advent of standby power for OSP, operators have spent immense time and capital dollars ensuring that their networks can withstand the vast majority of nuisance outages caused by the unreliable US utility grid. The HFC network has grown from a simple video delivery network to a secondary utility network capable of powering and backhauling a myriad of devices.

Plant engineering standards have been created for the OSP that ensure battery backup time available during an outage is well above the US average outage time. Many US MSO power supplies are capable of being remotely status monitored and tested. Many MSOs have developed methodologies for using remote battery testing results to prioritize maintenance and plant upgrades. Remote status monitoring has provided immense amounts of data on plant inventory and risk factors to help prevent customer impacting plant outages. When properly maintained and monitored the powered coax network of most US MSOs is significantly more robust than that of the utility grid.

Due in part to the increased power-reliability possible from the powered coax MSO network, a new growing focus on business-to-business services is driving a strong interest in this reliable HFC powering network, as well as the backhaul and real-estate that it also provides. Today, B2B activities like Small Cells, WiFi, IoT, Security & Surveillance (SWISS) are taking advantage of the HFC network in a whole new fashion. Over the past five years, a number of operators have been adding WiFi access points to their networks to create a stickier environment which allows their customers to always utilize their network. There has also been a new demand for IoT networks which allow machine to machine connections to happen across large areas with single access point coverage. Connections of all kinds will be required to create a ubiquitous network across a geography and right now the HFC network is in a great position to take advantage of these new service requirements.

3. Need for a Better Process

This robust design requires significant time and effort to effectively maintain. The Outside Plant is so named because it is, in fact, outside. This fact makes maintaining the powering elements of the network – power supplies, batteries and outdoor hardened transponders and cable modems – an operational nightmare. Weather extremes, dust particulate, and an array of small animals offer constant assault on these powering elements that necessitate constant and consistent maintenance. For example, in the last year alone, the US network experienced temperature extremes from -42 F in the Northeast to 122F in the Southwest, multiple hurricanes in Texas and Florida and a parade of blizzards in the Northeast.

Additionally, it covers an immense geography which makes it expensive and time consuming to maintain. The vast US HFC network consists of enough miles of plant to stretch to the moon and back again twice.

With more than a million miles of HFC plant to maintain and more than 650,000 power supplies the amount of time required to do yearly maintenance on every power supply is quickly becoming prohibitive to operations budgets set aside for maintaining every inch of this network.

As DOCSIS advances have expanded the capability of the HFC network and the options for new revenue generating services off of the network have grown, the need to ensure network power reliability is more crucial than ever. In spite of this fact, the geography and uncontrolled environment of the OSP network continue to present a huge risk that needs to be managed. Without a more focused method to improve and maintain HFC network power reliability, MSOs will struggle to meet customer expectations for reliability.

4. Six Sigma/Customer Focus

The need for a more focused process is exactly what led the MSO studied by this paper to a huge step forward in power reliability assurance. The search for a more focused methodology led to a simple yet brilliant answer which ties in several key concepts of one of the great operational improvement philosophies, Six Sigma.

Volumes have been written on Six Sigma, but in short it is a disciplined, statistically-based, data-driven approach and continuous improvement methodology for eliminating defects in a product, process or service.[1] Developed by Motorola in the 1980's and then adopted and honed by General Electric in the early 1990's, the original focus of the philosophy was on manufacturing. The principles have since been used by hundreds of organizations to improve a variety of operational processes. The term Six Sigma is derived from the goal of achieving six standard deviations (σ or Sigma) between the mean and the nearest specification limit with regard to variation in process outcomes.

The studied MSO used two key concepts from Six Sigma to focus their power reliability improvement efforts. First, every decision was driven by data. For every key decision point all available data was analyzed to provide direction for process improvements. The analysis of that data, decisions made from it, and new processes driven by it will be given significant focus later in this paper.

Second, and perhaps more importantly, data analysis and process improvements were all focused on customers. In the defining book on Six Sigma, former Motorola employees Mikel Harry and Richard Schroeder state:

> *"The heart of Six Sigma lies in improving products and services that will benefit the customer. Companies need to understand how their customers define [value] and to create products and services that meet their expectations. Six Sigma translates issues critical to customers' satisfaction to what is critical to a product's or service's [value.]"*[2]

Focusing improvement efforts on creating value for customers is a key tenant of Six Sigma, but the reason for this goes beyond just the obvious improvement in customer satisfaction. Many organizations, and specifically many MSOs, spend significant time troubleshooting and fixing customer issues after they've occurred. This reactive response is inefficient and is done to the detriment of any potential efforts to proactively improve services or products. In short, so much time is spent putting out fires that no time is available to prevent them from happening in the first place. By focusing on fixing the root cause of the customer-based issues that are costing the most, the resulting savings will be maximized and will often fund future continual improvement efforts.

By using these guiding principles of being data-driven and customer focused, the studied MSO identified an appropriate metric to help baseline and drive power reliability improvement - truck-rolled node outages (TRNO.) For the studied MSO, several metrics are used to track the reliability of utility power, node health and customer modems in their network, all of which are extremely useful to help ensure network reliability. However, a TRNO incorporates the element of true customer impact, by including only node outages that lead to customer calls and a truck roll to address customer issues, making this the perfect metric to use for this process.

5. Analysis of the Truck-Rolled Node Outage Metric

After identifying a customer focused metric to drive the improvement process, the studied MSO analyzed data and made some key discoveries. For the analysis, a year worth of data on truck-rolled outages was used from August of 2016 to August of 2017. It was discovered that nodes with an average of at least one truck-rolled outage per month anywhere within the node boundary made up approximately 3% of the total nodes, but accounted for 17% of total TRNOs. This key discovery led to the next question – why? What did these nodes have in common that created such a high rate of this type of outage? This paper will delve into deeper analysis later, but the simple answer is risk. These nodes displayed a higher rate of key powering risk factors that can lead to outages.

A power related TRNO is essentially an intersection of multiple risk conditions existing simultaneously. First, a loss of utility power creates the possibility for loss of plant powering. Second, a failure of standby power drops power to the network shutting off service to the customer premise. And, lastly, the loss of service must impact the customer significantly enough to pick up the phone and call for service. The studied MSO also analyzed data pertaining to non-powering related node issues, but found these issues to be much less significant. For this paper, focus will be given to power related node outages. By identifying and mitigating risk around these conditions, TRNOs can be significantly reduced.

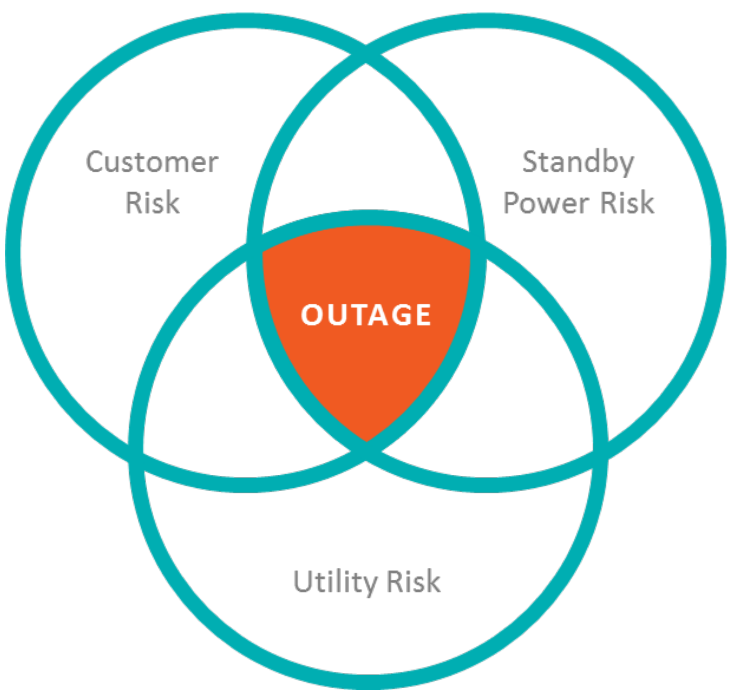

Figure 1 – Overlapping Risks in a Truck-Rolled Node Outage (TRNO)

As discussed earlier in this paper, the utility grid in the US is an inherent risk to plant powering. However, understanding which power supply sites have the highest risk or least stable utility power allows MSOs to bolster standby runtime capacity at those specific sites with additional batteries or other more significant back up strategies, if necessary. Having site specific knowledge of utility stability can also allow MSOs to address potential grid stability issues with local utility companies and hopefully see improvement through that process.

While it is the most difficult risk to control, there are some potential ways to mitigate customer risk. A key fact about customer risk is that any customer who has called about a service related issue in the past is significantly more likely to call again in the future than a customer who has never had an issue. Conversely, customers who have never called are more likely to ignore short-lived issues. Therefore, mitigation of other risk factors will inherently help mitigate customer risk. Additionally, it is possible to analyze data on customer services and data usage to determine which customers rely more heavily on the HFC network and thus would be more likely to notice an outage and submit a trouble call. Similarly, it is theoretically possible to analyze the layout of the HFC network versus the grid and better understand which customers' home power and plant power are on different sections of the grid. With both customer reliance risk and grid misalignment risk, MSOs could target upgrades and enhancements to plant powering equipment to help mitigate these risks.

Of the risk elements that go into a truck-rolled node outage, standby powering risk is the easiest to control. Unlike the other risk elements, plant standby powering equipment, once permitted and provisioned, is completely owned and controlled by the individual MSO. Most US MSOs have some manor of remote status monitoring that can provide an immense amount of information on where standby powering risk exists in the HFC network. Once the studied MSO had identified the 3% of their high-outage nodes, they commissioned Alpha Technologies to analyze standby powering risk at these sites and provide data to help determine how to solve the problem.

6. Analysis of Stanby Powering Risk in High Outage Nodes

6.1. Risk Analysis

To better understand standby powering risk in the studied MSO's HFC network, historical status monitoring data was analyzed alongside the MSO's TRNO data. The analyzed data showed the following:

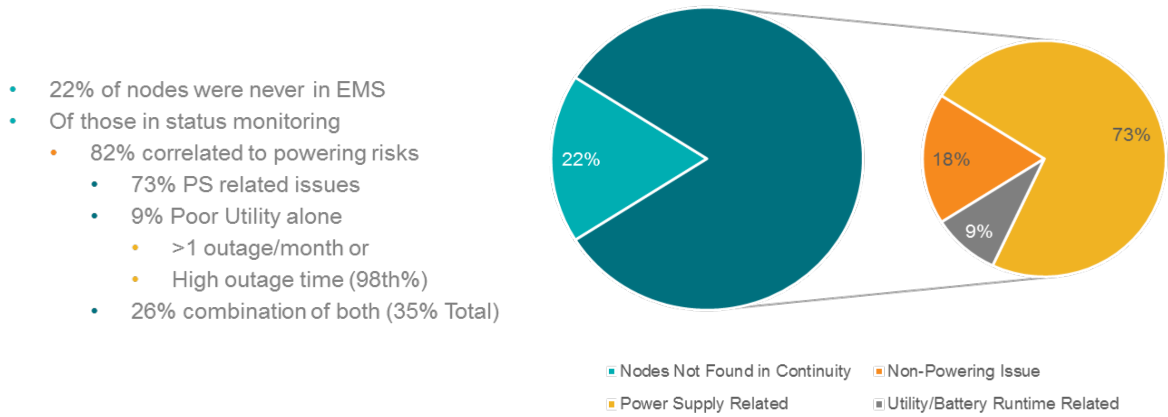

Figure 2 – Power Analysis of High Outage Nodes

The significance of the nodes that were not in status monitoring will be discussed in more detail later, but at this point we will dive deeper into the powering risks discussed above. Firstly, utility risk has already been identified as a key factor in power related TRNOs but, it is significant to point out that 35% of these high risk nodes have at least one power supply showing a utility risk of either extreme high outage time, – in the 98th percentile of all monitored power supplies - extreme outage frequency, – at least one outage month, 10X the national average – or both.

Most significantly, 73% of the analyzed nodes had at least one power supply with an identified powering risk factor. So what are these risk factors and why are they significant. Below is a breakdown of the power supplies that show a powering risk factor.

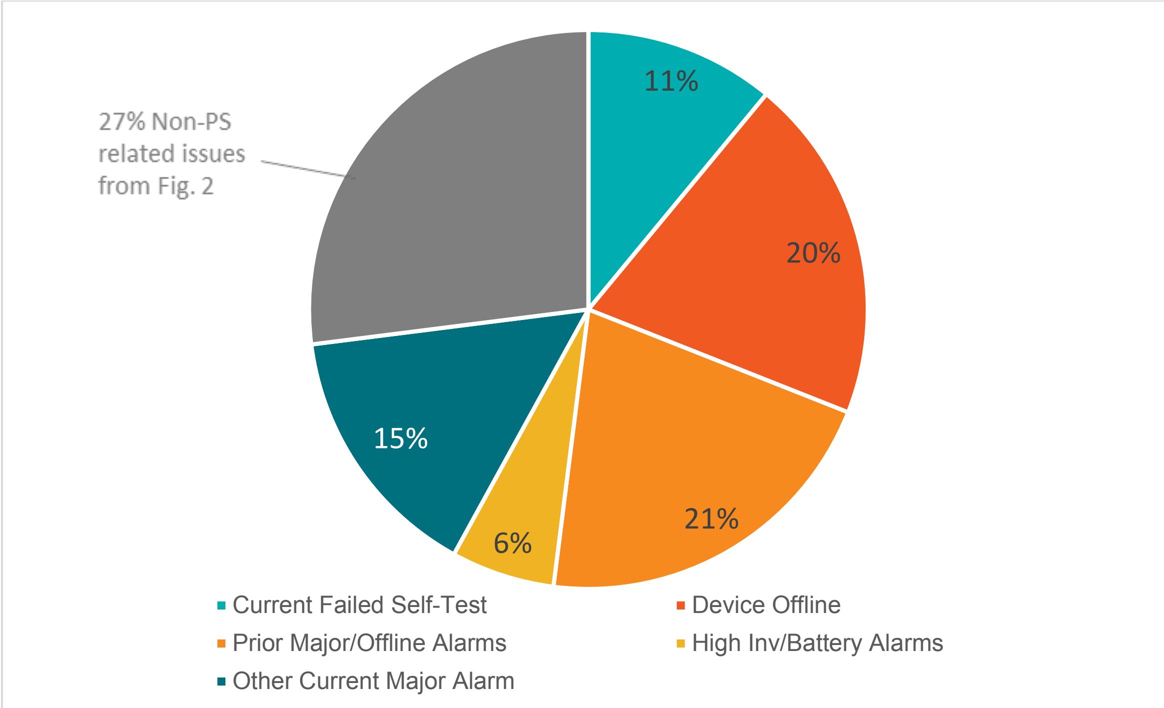

Figure 3 – Stanby Power Risk of High Outage Nodes

These risk factors are designed to identify standby devices that will not be able to perform their most important function, providing backup power to the HFC network in the case of a utility outage. Current Failed Self-Tests and Other Current Major Power Supply Alarms are essentially identifying power supplies that will not provide even minimal back-up time. Offline power supplies will be discussed in more detail later, but are at best unknown and at worst already impacting customers. And lastly, due to the historical nature of the TRNO data analyzed, it was necessary to look at historical occurrences of Alarming and offline conditions to identify devices that most likely caused TRNOs, but have since been remedied.

6.2. Control Comparison

While this data seems to be significant, understanding how these high risk nodes compare to the rest of the network provides a meaningful control data comparison. If there is no significant difference in risk factor frequency between high outage nodes and the rest of the nodes in the network, these risk indicators may not be a key factor in causing TRNOs. The chart below shows a comparison between key powering risk factors for the high outage nodes and the rest of the network.

High Outage Nodes Vs Rest of Network

- Poor Utility Power Supplies – 1.8x
- PS with Failed Self-Test – 2.6x
- PS with Other Major Alarms – 2.7x
- Offline Power Supplies – 2.2x
- Aging PS (> 15 years) – 1.6x

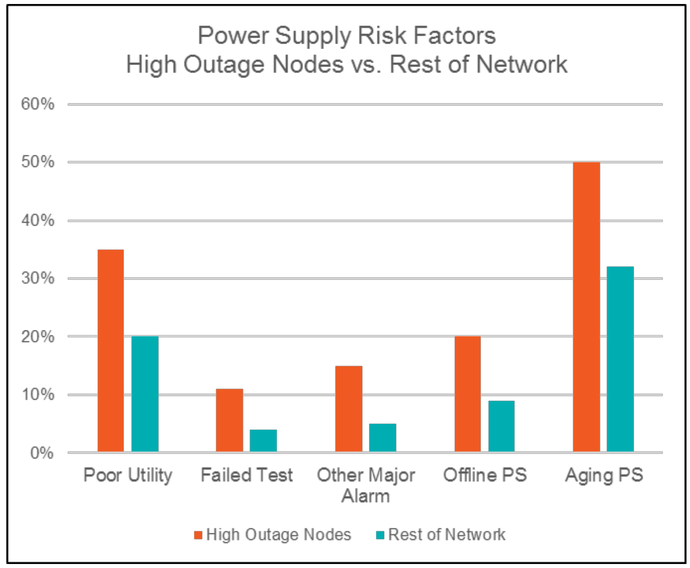

Figure 4 – High Outage Nodes vs Rest of Network

Clearly the comparison data shows a significant correlation between Power Supply related issues and TRNOs as high outage nodes have a significantly higher occurrence of all key risk factors identified. Additionally, high outage nodes had a 60% higher likelihood of having at least one aging power supply of greater than 15 years. As these devices age, they present several additional powering risks to the outside plant including: poor output voltage regulation, lowered efficiency, reduced backup runtime, potential failure of inverter electronics and reduced monitoring capability. These are additional risks that can easily lead directly to TRNOs.

6.3. Field Verification

The data analyzed clearly demonstrated that high outage nodes tended to have a greater occurrence of powering risk. In order to verify this data, a small sample of these high outage node sites were identified and field verification was performed by an Alpha field engineer and an experienced employee of the studied MSO. Examples of issues found included significantly aged batteries (2x useful life,) sites where batteries had been stolen or were never installed, improper grounding or line powering, or the absence of a tap or drop to allow remote monitoring of the power supply. The field findings definitively confirmed the data.

Figure 5 – Examples of Risk Factors Seen During Field Verification

7. Measure It to Manage It

The data analysis and field verification show a clear correlation between standby power risk factors and high outage nodes. Now that the data had shown the studied MSO a clear path to improve power reliability and reduce TRNOs, the next step was to create a process to address these standby power risks in high outage nodes. The first step of this process was to tackle the problem of *blind* power supplies. For the purposes of this paper, a blind power supply is any power supply that is not being actively monitored in the customers power Element Monitoring System (EMS) because it has either gone offline and lost connection to the EMS or was never provisioned to be status monitored. Any node with at least one of these power supplies would essentially have a blind spot that could lead to further outages and would also make baselining an improvement process and measuring success almost impossible. The study MSO had at least one blind power supply in more than one third (37%) of the high outage nodes studied.

Why is monitoring power supplies so crucial and how can it prevent future power related TRNOs? Many MSOs have inherent monitoring and management of customer modems that allows for an understanding of plant RF issues and customer outages. Power supply status monitoring gives MSOs several ways to inform tech ops teams of potential issues before they become customer impacting and are seen by systems monitoring customer modems.

First, a power supply EMS has the ability to inform customers of critical issues with a power supply's ability to provide adequate backup during a utility outage, such as bad or missing batteries or a failed inverter. Without the ability to see and address these issues, even momentary outages in utility power could become customer affecting. Next, status monitoring provides visibility of stand-by powering events caused by utility outages which can then be managed by tech ops to ensure that portable backup generators can be deployed successfully to keep the plant up and running. Again, without this visibility, perfectly healthy power supplies with adequate backup time could potentially run for hours without being addressed and lead to TRNOs. Additionally, an EMS can provide visibility to power supplies that have gone offline as a result of an extended outage and provide answers on a proper fix agent to address the lynch pin causing a large customer outage. And finally, status monitoring can provide key inventory data for proactive reliability planning and budgeting. Being able to monitor powering issues is unmistakably a key tenant of any process designed to improve power reliability and was a priority in the program developed and implemented by the study MSO.

8. Developing a Reliability Improvement Program

The customer-focused, data-driven approach had helped to identify key risk factors to be addressed at the study MSO and the decision had been made to focus on ensuring all power supplies were able to be monitored in the EMS. The next step was to develop aggressive but realistic improvement goals around TRNOs and create an action plan to get there. Our sample MSO started with a goal of reducing TRNOs and customer services calls by 15 to 20%.

To maximize the program's impact on plant reliability, high data on high outage nodes was updated starting at the beginning of 2018 and high outage nodes were redefined as any node averaging at least 1 TRNO per month for 3 months. For the study MSO this definition identified 20% of the MSOs nodes which accounted for 55% of TRNOs. This is significant as it shows how this process allowed the MSO to focus on a manageable subset of identified high risk sites and still potentially impact more than half of TRNOs. The focus of this study is on efforts to improve power reliability using the prescribed methodology, however, additional focus was given to addressing a small subset of non-powering risk factors as well.

Now that the focused subset of power supplies had been identified, standards and processes could be created to ensure standby powering risk factors were eliminated at each site. All identified sites would receive a Preventive Maintenance (PM) visit following the SCTE recommended practice (SCTE 205 2014) to ensure that all risk factors were addressed. By using this industry standard recommended practice, the study MSO could be sure that all risk factors, even those that may not be easily seen by status monitoring, were being addressed and sites would be left in the most reliable state possible.

In addition to a standard PM each site would have steps taken to address identified risk factors.

1. All necessary steps will be taken to ensure proper EMS monitoring, including replacement or addition of transponders and installation of a tap and/or drop where necessary.
2. All sites are required to meet a 3-hour estimated back up runtime standard based on plant power loading at that site.
3. Aging power supplies will be replaced in lieu of repair to address risk factors.
4. Accurate collection of field inventory data is a point of emphasis for technicians to enhance future reliability planning efforts.

In addition to performing maintenance and upgrades to identified sites using the guiding principles above, geographical efficiencies will be leveraged where possible to address additional sites that are currently not being actively monitored or sites that display standby power risk factors. These simple principles will guide the process to drive improved power reliability and ultimately reduce TRNOs.

8.1. Key Program Challenges

While the guiding principles of the program were relatively straightforward, several key challenges needed to be addressed in order to ensure success of the program implementation. Many of these challenges are experienced by US MSOs who deal with trying to implement similar power reliability improvement plans and are the result of one key fact – MSOs are Multi-System Operators that are originally made up of multiple independent systems with disparate standards and geographies.

Due to this fact, a key challenge for the studied MSO was the efficient identification of missing nodes and power supplies from original plant maps. Until these nodes and all power supplies within them could be identified, it would be difficult to plan and budget for upgrades to bring these devices into a monitored state. The studied MSO addressed this key issue quickly and decisively by using data from all available tools to create a list of missing sites. From this list EMS and CMTS data could be used to identify a subset of devices that were online but not monitored and bring those devices into a monitored state without a truck roll. The remaining sites were then disseminated to system ops teams to use all tools at their disposal to provide location and inventory data on missing sites, with technician truck-rolls as an absolute last resort. Once this site data was gathered at the system level, data was compiled from all systems and more precise planning and budgeting could take place.

Several other challenges resulting from the compilation of multiple independent systems are the regional disparity of hardware standards, EMS alarming and ticketing methodologies, and SOWs for site upgrades and maintenance. The study MSO created small working groups to document regional differences in each of these and used available data to successfully address the disparities and create corporate standards.

8.2. Data Challenges

Another challenge that often arises when driving progress through an identified metric is the emergence of data outliers. Most metrics have parameters set around them based on assumptions and desired outcomes. For example, the TRNO metric used by the study MSO does not include widespread storm or utility events for good reason, as these are generally due to large weather events and not operational or plant issues. During these large events customer expectations and behaviors tend to change with the realization that many services will go down, so considering them a part of the TRNO metric does not make sense. However, the numeric definition of what constitutes a storm event can impact the metric drastically.

The logic involved in this storm case and other data outliers were reviewed and adjusted in several cases during the program to ensure that ongoing measurement of TRNOs would be as accurate as possible. While this was the best course of action in the long term, it did create some difficulty in measuring progress against the original baseline. Additionally, the studied MSO is in the process of significant plant architecture changes to improve plant capability which have added some additional complexity to the measurement progress. Neither of these issues is insurmountable, but this type of shifting data should be accounted for as often as possible prior to creating a power reliability improvement program.

Finally, with technicians visiting a large number of sites with no EMS data, the studied MSO had a great opportunity to gather previously unrecorded plant inventory data for future planning. Although this seems relatively straightforward, the key obstacle to be overcome is that the field personnel collecting the data do not generally value it as much as executives who need it to make informed decisions. If the process to collect key information and quickly compile it to be analyzed is not user-friendly for technicians the data collected may not be correct. Additionally, if there is no process set in place to ensure that the data is consistently maintained, it will quickly become useless. The studied MSO mitigated both of these problems by identifying and implementing software tools to make data collection and maintenance by field and NOC technicians as painless as possible.

9. Results

While results of this program are ongoing and will be updated continually, the studied MSO has thus far seen very positive results through the customer-focused, data-driven reliability enhancement program

To date the study MSO has accomplished:

- 9,990 power supplies brought into a monitored state in the EMS
- 9,098 system battery runtime upgrades

The resulting impact on key metrics has been*:

- 19% reduction in trouble calls
- 14% reduction in TRNOs

Reduction of 45,000 maintenance hours in identified nodes**These results are tentative and must be updated before presenting*

10. Building on Success

In order to ensure positive gains achieved by this program and others similar to it are maintained, next steps and a long-term strategy must be considered. Several key next steps should be taken after the initial year of the program. In order to maximize effectiveness in the next program year it will be necessary to do a program review and analyze the first year results. Were initial goals achieved? What were key lessons learned that should be incorporated into improving the program for the next budget year? Data for TRNOs should be reevaluated and target nodes should be redefined for year two. Program spend versus ROI and NPV should be analyzed and adjusted based on new program goals. While it is impossible to completely eliminate TRNOs, the positive results shown in year one should theoretically make year two less daunting.

In addition to analyzing the program and adjusting for a second year deployment, several other parallel initiatives should be considered by the studied MSO. First, nodes with frequent outages caused by plant powering issues should be identified and addressed sooner to alleviate customer frustration from calling multiple times on the same issue. A more effective real-time feedback loop between software tools designed to monitor powering issues and those designed to initiate truck-rolls on customer calls would allow technicians to more easily triage and repair power related node issues at the time of outage and avoid repeat customer calls. Next, continuing to improve processes for collection of site inventory data will allow for a more precise and predictable budgeting process built around useful asset life versus documented age, thereby ensuring adequate inventory levels to deploy for on-demand outage fixes. Lastly, using the improved inventory data in combination with the recently improved monitoring visibility, enhancements could be made to the EMS to better predict system health and backup time. All of these improvements could be used to proactively eliminate additional TRNOs.

Conclusion

The need to continually improve the reliability of the HFC network and meet the growing demands of customers as well as prepare for the opportunity of new revenue generating services, coupled with the financial, geographic and environmental challenges present with the OSP network, demands a more focused method for driving increased power reliability. In order to increase effectiveness toward this goal, the Major MSO studied in this paper was able to achieve significant impacts on customer experience and operational costs by centering their continual reliability improvement process around a customer-focused, data-driven core.

Beginning with the analysis of TRNOs, a key customer focused metric, the studied MSO was able to build a program of hyper-efficient power reliability improvements. Spearheading this program was a push to ensure all powering devices were visible through their powering EMS and ensure reliability improvements could be effectively measured. In order to ensure the best results possible with regard to field execution of this program, SCTE recommended practices were leveraged. As challenges arose around numerical outliers and corporate standardization, data was continually used as a pathway to the optimal solution. And, now that the first year of the study MSO’s reliability improvement program is winding down as a resounding success, a blueprint has been created for other MSOs to use a similar customer-focused, data-driven approach to achieve the access network power reliability needs of tomorrow’s HFC network.

Abbreviations

B2B	Business to Business
CMTS	Cable Modem Termination System
DOCSIS	Data Over Cable Service Interface Specification
EMS	Element Management System [power focused]
HFC	Hybrid Fiber Coax
INV	Inverter
MSO	Multi-System Operator
NOC	Network Operating Center
NPV	Net Present Value
OSP	Outside Plant
PM	Preventive Maintenance [Visit]

PS	Power Supply
ROI	Return on Investment
SCTE	Society of Cable Telecommunications Engineers
SOW	Scope of Work [for a project]
TRNO	Truck-Rolled Node Outages
VOD	Video On-Demand

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