

The Tantalus Outage Solution

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The Cost of Electrical Outages

In the United States, we depend upon electricity for everything yet power outages continue to cause disruptions for businesses and individuals. A 2018 study by the Lawrence Berkeley National Laboratory (LBNL) estimates that power interruptions cost \$44 billion per year in this country, an increase of more than 25% since the initial 2006 study. The hardest hit are customers in the commercial and industrial (C&I) sectors, where 13% of the C&I customers account for more than 97% of these costs.

Distribution system outages can be caused by a variety of events. In the United States, the most frequent causes of outages are associated with animal interference and accidents involving the distribution system. Outages due to storms or other natural disasters are generally infrequent, but when they do occur, tend to be on a much larger scale.

Power outages to a business do more than just halt production temporarily. They can also result in:

- Lost wages to employees
- Spoiled inventory
- Damage to equipment
- Delayed, inconvenienced or missed business opportunities

Tantalus Systems is working with its utility partners to mitigate the impact of power outages through rapid detection, notification and restoration of power. Managing outages and power quality has a significant impact on the bottom-line performance of a utility and by improving key indicators such as the System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI), utilities can save millions of dollars each year and improve relationships with regulators and consumers/members.

The Tantalus Difference

The core architecture of the Tantalus Utility Network (TUNet) is designed to provide the highest level of performance outage and restoral notification in the industry:

Tantalus Focus

Since 1989, Tantalus has had an unwavering focus on serving rural co-ops and municipalities. All of our solutions have been purpose-built to help deal with the unique operational and technological challenges that come with remote and distributed environments. Nobody has a higher concentration of deployments with rural co-ops and communities than Tantalus. No other company is more dedicated to helping utilities deliver safe, smart and sustainable power than Tantalus.

This commitment that has led us to where we are today—a thriving business with 170+ customers across Canada, the U.S. and the Caribbean. Our state-of-the-art smart grid solutions not only deliver immediate operational, business and customer service benefits, they help utilities embrace digital transformation at their own pace. Together, we're laying the groundwork for future innovation and the next generation of truly sustainability utilities. We remain dedicated to evolving our solutions with invaluable input from our cooperative and municipal customers.

The Tantalus Outage Solution

- Tantalus networks are designed and tested to deliver 80 to 100% of outage alarms within two minutes of the outage. All remaining outage alarms are delivered immediately upon power restoration.
- Devices report quickly once power has been restored. Following an extended outage, typically 100% of the devices will report within 10 minutes of the power being restored.
- Tantalus employs true time-stamped outage and restoral reporting from individual meters, in contrast with other AMI networks that passively interpret an absence of communication as an outage, which can result in confusing reports and predictions.
- Tantalus TRUPush technology allows alarms to report all outages and restorations in real time.
 - While TUNet supports pinging as a diagnostic tool, it is unnecessary for outage and restoration reporting because of TUNet's high and fast reporting rates.
- Explicit outage and restoral notifications are time-stamped at the meter and pushed immediately resulting in high accuracy reporting (SAIDI, SAIFI, etc.).

TUNet Insight, a software platform that allows utilities to fully monitor and control TUNet, leverages a number of inherent characteristics of the solution to help utilities minimize the impact of outages:

Feature	Benefit
Smaller, flatter LANs	Less reliance on other devices to get outage messages through the network.
No broadcasts	Outage messages sent only on defined paths, avoiding the pitfall of other AMIs that flood the network with broadcast messages that results in most being lost.
Reliable message delivery	Avoids the need to blindly repeat transmissions in an attempt to improve reliability, which floods the network with messages that cause collisions and bottlenecks and ultimately impede many outage messages from actually getting through.
Prioritized messages	Ensures that outage messages take precedence and get delivered faster than less urgent data.
Efficient packets	Packets are optimized to efficiently convey important data quickly, over long distances. Minimizes addressing requirements within the packet allowing it to carry greater amount of content data.

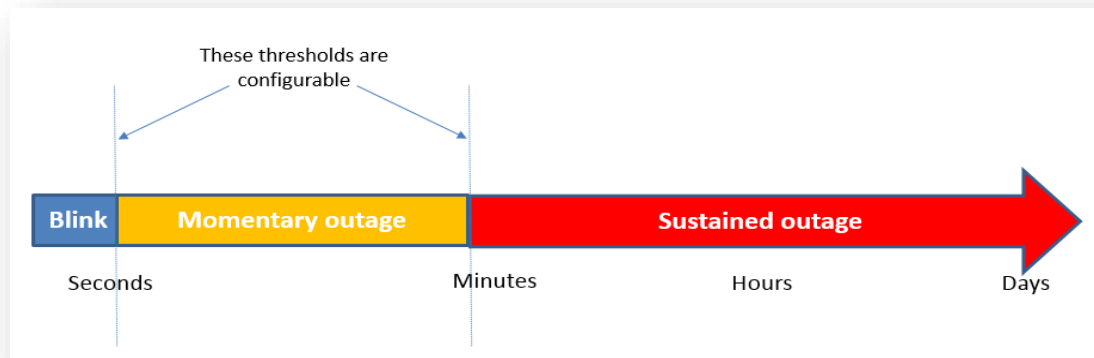
Some AMI system vendors claim to send outage messages in real time and that the use of supercapacitors keep other meters powered so they can relay messages even during an outage. While broadcasting outage messages to as many meters as possible (what mesh vendors do) sounds like a good idea, this brute force approach can actually overwhelm other meters in the network and may prevent some messages from getting through. We've found that a more controlled approach yields better results.

The Tantalus advantage is that the majority of TUNet meters communicate directly with a gateway (i.e., they do not rely on a parent meter to relay their outage messages). In addition, supercapacitors in LAN devices have the energy capacity to pass on the outages of an entire LAN before being depleted.

Outage Definitions and Filtering

TUNet recognizes three types of outages or power interruptions, which allows our utility partners to customize how each one is handled. To help utilities address situations pro-actively, filters are based on utility-defined thresholds.

Blink Short power interruptions lasting up to 10 seconds	Momentary Power interruptions longer than the <i>blink</i> duration	Sustained Power interruptions longer than the <i>momentary</i> duration that have not been closed
<ul style="list-style-type: none"> Blinks are separated from outages in the end device Very short interruptions Upper duration limit configurable from 1 to 10 seconds Not reported as outages Counted and reported as part of <i>power quality</i> data 	<ul style="list-style-type: none"> Can be distinguished from <i>sustained outages</i> according to duration Logged in the Tantalus head end with time stamp and consumption reading taken at the time of the outage Option to suppress sending outage and restoral messages for <i>momentary</i> outages to the OMS 	<ul style="list-style-type: none"> Can be distinguished from shorter <i>momentary</i> outages according to duration Logged in the Tantalus head end with the time stamp and consumption reading taken at the time of the outage Option to send outage and restoral messages to the OMS for only <i>sustained</i> outages



The TUNet communications module samples the AC line every 25 to 50 milliseconds. A voltage drop below the (utility-defined) outage threshold starts a timer. If AC power is restored before the outage qualification period, the event is counted as a blink. Outages exceeding the programmed blink duration are reported to the Tantalus Control Center (TCC) in real time. In this case, a high priority outage message is generated, containing:

- The AC voltage
- The kWh register(s)
- A timestamp recording when an AC power failure was detected

This ensures only power interruptions which are recognized by the utility as outages are reported to the head end and/or outage management system.

Our controlled approach leverages a multi-tiered filtering capability to efficiently sort and send outage messages. For example, understanding blink patterns can help identify maintenance opportunities before an actual outage occurs. If the utility notices blink anomalies in the network, proactive steps can be taken to ensure the reliability of the network (e.g., by addressing vegetation overgrowth).

Filtering in the end device:

- Blinks are distinguished from outages in the end device.
- Outages greater than the blink threshold are reported by the end device to the head end in real time.

Filtering in the head end:

- TUNet can eliminate false positives by differentiating sustained outages from momentary outages.
- The head end can be configured to only report outages that last longer than a specified amount of time.
 - If the corresponding restoral message comes in within that defined period, the outage is not reported to the OMS.
- This eliminates nuisance calls and truck rolls for momentary outages.

All TUNet outage messages include a snapshot of the kWh energy register at the time of the outage to ensure accurate allocation of energy to the correct interval and TOU rate.

Outage Detection for Polyphase Meters

Polyphase meters are typically powered using phase A voltage; the polyphase communications module is powered from the meter electronics. Outage detection is triggered by the loss of this DC power source as follows:

- If Phase A is still present, Phase B and C outages will not cause loss of power to the polyphase module.
- If phase voltage drops below 10 V, a Phase B or C outage is triggered.
- Revenue Guard option
 - If any one of the three phases is powered, the meter and polyphase module continue to be powered.
 - Outages on any one of the individual phases are reported based on the 10 V threshold, whether or not the meter and polyphase module continue to be powered.
 - If all three phases go down, outage detection is triggered when the polyphase module loses DC power.

TUNet Performance in an Outage

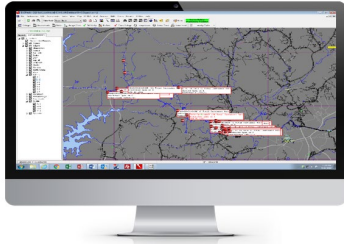
A recent experiment conducted by a utility evaluating Tantalus offerings illustrates the power of TUNet. The utility performed a side-by-side comparison of TUNet and a competing solution by setting up parallel pilot networks of 400 meters and conducting a real outage test on the two

The Tantalus Outage Solution

pilot networks. During the testing, TUNet Insight provided outage messages to the Milsoft Outage Management System, showcasing how TUNet works in tandem with Milsoft to significantly improve overall restoration times.

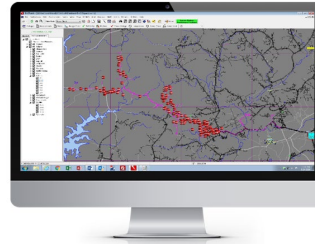
TUNet delivered 80% within the first 2 minutes.

TUNet



Less than 60 seconds post-outage, 20% of meters were reporting; emails from affected customers started to come in.

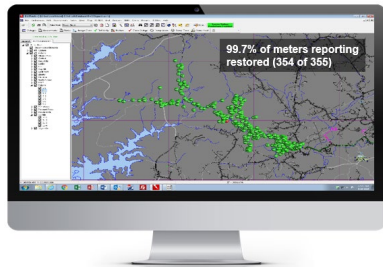
TUNet



At one minute, 47% of meters were reporting an outage and Milsoft OMS was able to identify the source of the outage.

Because of the speed with which outage data was delivered to the OMS, the utility was able to dispatch a crew and correct repair equipment to the outage location within two minutes ... and before the first customer call was received. The utility did not have to wait for more calls in order to identify the location of the outage.

TUNet



Within only 6 minutes, 99.7% of the meters reported as restored. Crews were brought back without delay, reducing overtime.

The utility receives acknowledgement from the meters, which avoids having to go back out to resolve any remaining issues that the crew may not have been aware of, thereby increasing customer satisfaction and providing operational savings.

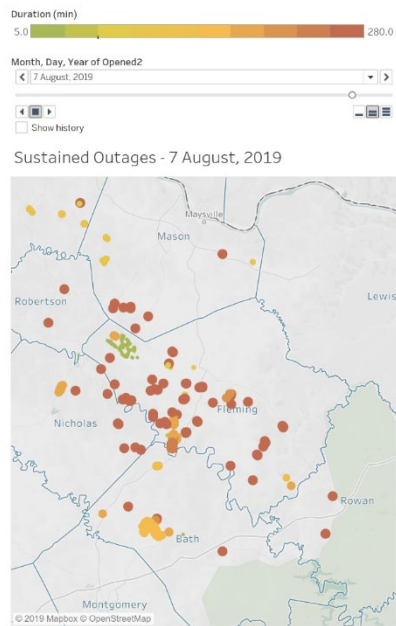
By comparison, the competitive system being evaluated reported only 20% of meters in outage at 4 minutes and after 6 minutes of restoration, only 10% of meters had reported as restored.

Even though the experiment was conducted on a pilot deployment of 400 meters, because of small packets, a resilient physical layer and the power of Tantalus to optimize smaller LANs, these results are representative of a full deployment. In contrast, technologies that don't incorporate these design features are subject to performance degradation as more and more devices are brought online.

Experiences in the Field

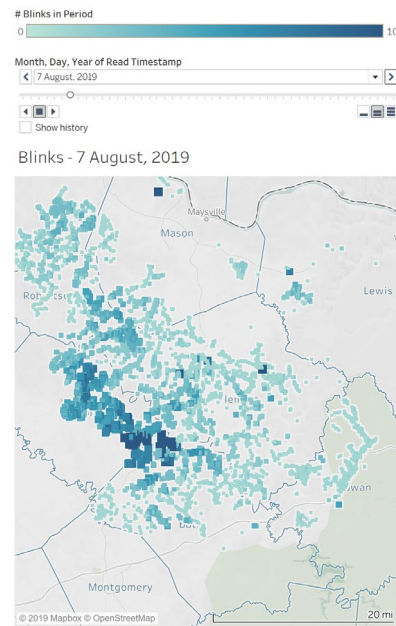
This year, a substantial summer lightning storm hit the grid of a Tantalus customer utility. Through filtering, 364 meters reported utility-defined *sustained* outages in the area shown.

Reported Outages



Over 8,000 endpoints experienced blinks. Based on utility-defined thresholds, most of these were filtered out, mitigating the number of crews dispatched to restore power.

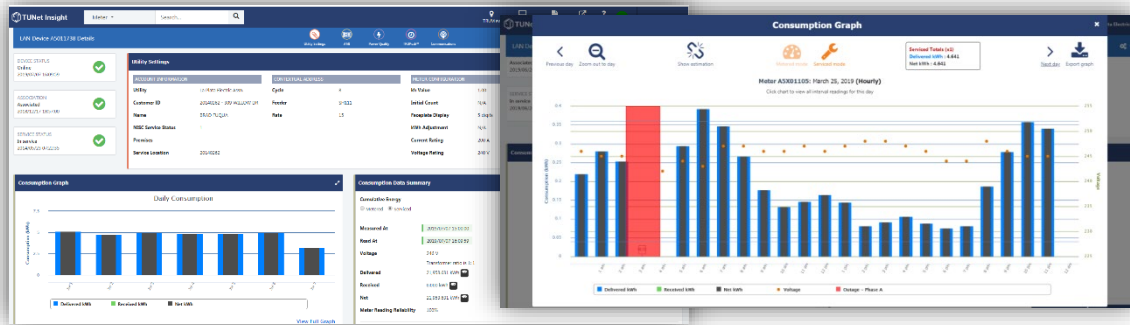
Unfiltered Impact



Using the analytics available in TUNet, utilities can more easily determine how to mitigate these types of events. These analytics include:

- Consumption over time
- Aggregate consumption over time by customer type or user defined groups
- Voltage graphing over time
- Blink count graphing over time by customer type or user defined groups
- Network outage graphing
- Aggregate outage event graphing
- Identification of over- or under-consuming accounts

The TUNet Insight user interface helps the dispatcher or customer service representative (CSR) reduce call times. Using the intuitive visualization features in TUNet, a CSR has at-a-glance access to details of the account and can quickly verify any issues with the customer. The CSR also has access to the latest readings and alerts, which is not the case with the “on-request read” required by some systems. Instead, TUNet Insight allows the CSR to see exactly what the customer is experiencing during the call.



TUNet Insight user interface

Additional Outage Reporting and Notification Options

TUNet reporting features are designed so utility personnel can recognize and deal with outages effectively:

- Multiple outage notification options:
 - System dashboard
 - Alarms
 - TRUView GIS
 - Real-time email or text notification
 - OMS
- kWh reading included in all outage messages:
 - No loss of billing data
 - May provide some indication of conditions at the time of the outage

Tantalus and Milsoft Working Together

Streaming event data and meter analytics result in a higher percentage of meters reporting in less time than can be achieved with competing solutions. OMS vendors such as Milsoft have enjoyed the superior benefits that the TUNet solution provides. TUNet's superior outage reporting performance and event management supercharges Milsoft OMS by adding highly accurate outage prediction capabilities that enable the Milsoft system to typically locate the fault before the first customer call.

Milsoft OMS provides calculations for utility indices, typically based on outages of at least 5 minutes. TUNet tracks every blink and momentary outage to provide utilities with a new level of control. Using this data, utilities can easily prioritize routine activities such as transformer maintenance, brush clearing, wildlife deterrents, splice replacement and locating underground faults. Utilities can also use this data to optimize recloser operations. In addition, many Tantalus customer utilities have successfully used single momentary outages to track theft occurrences and unauthorized electrical work.

Milsoft and Tantalus are working together to bring utilities:

- Automated data collection
- Improved reporting
- Enhanced productivity
- Increased safety
- Improved employee morale
- Automated data collection to improve customer and stakeholder communications

In Summary

In order to bring more value to our shared customers, Milsoft and Tantalus continue working together in response to utility requests and by exploring opportunities to improve our combined solution. Now that the initial MultiSpeak integration has been deployed in real-world scenarios, we are optimizing the passing of data from one system to the other. The ability to deploy solutions even as they evolve is very important. The close relationship between our development teams bodes well for continued collaboration between Milsoft and Tantalus.

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