Applying Predictive Analytics to Deliver Smart Power Outage Communications

By building proactive outage communication that provides accurate, detailed and real-time outage statuses through customers’ preferred channels, power utilities can improve overall customer experience, customer satisfaction and operational efficiency.
Executive Summary

Today’s energy utility customer is likely a user of Amazon, UPS and Uber, and has similar high experience expectations – especially before, during and after power outages. This means utilities must understand and address a wide array of customer concerns, including:

- **What**: providing the most up-to-date outage information.
- **When**: delivering updates in real-time.
- **How**: using channels such as social media, phone calls, SMS and e-mail.
- **Where**: managing crew status and response.
- **Why**: understanding the root cause of an outage.

Doing this requires energy utilities to overcome two major hurdles: One, how can they be early, accurate, proactive and detailed in communicating the power outages to their customers? Second, how effectively can they manage multiple information constraints simultaneously? Power outages can result both from unplanned reasons (weather, equipment malfunctions, third-party actions like digging mishaps, car-pole accidents or vandalism etc.) and from planned reasons such as maintenance, so different communication channels are needed. Communicating an electrical power outage effectively during these cases in our view is hypercritical for overall customer satisfaction.

Many energy utilities are upgrading their existing outage management ecosystem to improve outage communications. However, utilities face some major hurdles, including:

- The lack of an automated and intelligent platform to collect and process all outage inputs.
- Severe limitations of legacy outage management system (OMS) to filter all outage inputs.
- No single source of data to store historical and current/forecasted data.
- No intelligence mechanism for determining which customers are affected by outages.
- Inaccurate outage messages sent to customers.

Based on our experience working with many leading energy utilities on similar initiatives, the above hurdles can be addressed with a smart outage communication ecosystem, one that is machine-learning-enabled. We recommend that energy utilities build this environment holistically and use advanced digital tools that comprise three stages/sub-ecosystems: upstream, midstream and downstream components. This model would definitely help utilities during emergencies or outages caused by natural disasters such as hurricanes by effectively providing the most up-to-date information to customers.

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HISTORICAL CONTEXT

From the dawn of electricity, utility customers were typically left in the dark concerning the cause of an outage or when power will be restored. Traditionally, customers needed to be proactive and communicate with the utility service provider to learn when the lights would come back on. That’s the way utilities operated; customers were conditioned to expect little in the way of communication from their power providers.

However, in today’s age of information and social media, customers expect much more from their utility provider. Utilities are trying to keep pace with the changing times to provide customers with up-to-date outage alerts.

As illustrated in Figure 1, 75% of utility companies are providing outage alerts to their customers. Even though this is encouraging, these alerts have limitations:

- Utilities are often unable to identify which customers have lost power. For example, in the case of a feeder outage, not all customers would be affected but alerts may be sent to customers who still have power. This leads to confusion and frequent calls to the utility’s customer service department.

- Alerts may be based only on the ticket status of reported outages. For example, alerts such as crew status, outage causes, etc. (see Figure 2, next page) are rarely sent.

- Customers do not receive real-time outage alerts. For instance, some customers may have had their power restored due to automatic feeder switching, but the outage restoration alert is provided to them only when the outage ticket is actually closed.

Outage Communications Industry Survey

<table>
<thead>
<tr>
<th>Percentage</th>
<th>2014 (n=52)</th>
<th>2015 (n=47)</th>
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<tbody>
<tr>
<td>33%</td>
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<td>21%</td>
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- Portion of utilities offering a preference portal that allows customers to manage alerts across various channels.
- Portion of utilities offering customers two-way texting for outage communications, including the option for customers to notify the utility about their outage by text message.
- Portion of utilities providing proactive outage alerts to customers.

Source: Chartwell’s Outage Communications Industry Survey
Figure 1
To communicate in real time to customers, utility providers must integrate their OMS with the distribution management system (DMS), advanced metering infrastructure (AMI), supervisory control and data acquisition (SCADA) and the work management system (WMS). Utility companies’ progress in developing such OMS capabilities is shown in Figure 3, next page.

**CURRENT STATE LIMITATIONS**

Customers who experience a power outage currently have two options for reporting it to the utility provider:

- Calling customer service.
- Via online communication (mobile application/utility website).

If the customer calls to report the outage, he can speak with a customer service representative, who will in turn create a ticket in the OMS. The customer can also choose to interact with the voice response unit (VRU) to submit the relevant outage information.

Similarly, information can also be provided on the company’s mobile application or website (if the utility provider offers such support). Once the information is collected, by any of the above methods, an outage ticket is generated in the OMS. The customer will be provided with the ticket number, as well as an estimated time of restoration. Some utility companies offer customers the option to receive updates during the restoration process. Customers must provide a contact number where they can be reached with the outage update information.
Major drawbacks of the current approach include:

- Inability to proactively communicate the outage updates to the affected customers.
- The lack of real-time situational awareness and visibility for accurately determining the affected customers.
- The lack of integration among OMS, AMI and SCADA systems, and inefficiencies caused by the inability to seamlessly transition from a legacy communication system to new digital applications.

CREATING A SMART POWER OUTAGE COMMUNICATION ECOSYSTEM

A smart power outage communication ecosystem should be able to resolve the following business cases:

- **Case 1**: Predict the impact of special weather events on the power grid and customers.
- **Case 2**: Predict the impact of near-term asset failures on the power grid and customers.
- **Case 3**: Detect possible outages based on smart meter events.
- **Case 4**: Detect outages at specific premises/regions/areas based on the data from social media channels.
- **Case 5**: Filter outage inputs from various traditional and smart channels in real time and predict the outage type.
- **Case 6**: Accurately confirm an outage for a given customer and send a personalized outage message to the customer.

We recommend that energy utilities build such an environment to address upstream outage
detection, midstream outage filtration and data storage, and downstream outage communication sub-ecosystems.

Figure 4 provides a high-level framework of our proposed smart power outage ecosystem.

**Stage 1 (Upstream): Outage Detection Sub-Ecosystem**

The goal here is to continuously collect, process and provide unplanned outage predictions.

In this stage, continuous outage feeds are collected from multiple sources such as asset/smart device sensors, weather forecasting systems, smart-meter head-end systems/AMI, and also via various customer information channels such as customer calls, IVR, web reporting and social media.

The core component of this stage is the outage prediction engine (OPE), which comprises the following engines:

- Weather-based outage prediction engine to predict the impact of special weather events on the power grid and customers.
- Predictive asset failure/fault detection engine to predict the impact of near-term asset failures on the power grid and customers.
- Smart meter event processing engine to detect possible outages at the premises level.
The Anatomy of a Prediction Algorithm

Weather-based Outage Prediction Engine (WOPE)

Predictive Asset Failure/Fault Detection Engine (PAFDE)

Social Event Processing Engine (SEPE)

Smart Meter Event Processing Engine (SMEPE)

- Based on meter events - last gasp (LG) and power restoration (PR).
- Social media event processing engine to detect outages at specific premises/regions/areas based on social-media data.

Illustrated in Figure 5 are the key building blocks for building each of the aforementioned engines.

The above engines leverage predictive modeling and machine learning algorithms to proactively detect outages. The OPE, tightly coupled with the advanced distribution management system (ADMS), feeds potential outage inputs. In addition, it is bidirectionally integrated with a data lake to get insights on real-time and historical distribution grid information, as well as feedback on potential outage inputs for future reference.

Stage 2 (Midstream): Outage Filtration and Data Storage Sub-Ecosystem

The goal here is to collect planned and unplanned inputs, gather damage inputs, remove duplicates, and maintain historical and current data.

In this stage, planned and unplanned outage inputs, restoration status inputs and damage inputs are collected by the ADMS, which comprises integrated SCADA, outage management and distribution management system data from multiple sources, such as the OPE, damage assessment systems, enterprise asset and work management systems, and field service management systems.

Moreover, the data lake - a storage repository that holds a vast amount of mirage image data from multiple systems such as ADMS, OPE, weather forecasting system, damage assessment system, customer information system...
Building a Smart Outage Communication Ecosystem

(CIS), enterprise asset and work management system, field service management system and geographic information system (GIS) – will maintain historical as well as near-real-time data such as ticket patterns, actual damages, ERT and average restoration times. The filtered outage inputs from ADMS and historical outage-specific data from the data lake will be then fed into the downstream ecosystem.

Stage 3 (Downstream): Outage Communication Sub-Ecosystem

The goal here is to further refine the information, accurately identify affected customers and then feed outage messages into multiple communication channels.

In this stage, feeds from the ADMS, data lake, meter ping and customer preference portal are processed by the outage notification processing engine (ONPE), which runs on the machine learning and predictive analytics algorithm. It is used to accurately confirm the premises affected based on outage types (such as feeder, lateral, transformer, etc.) and real-time meter pings to confirm its findings, deliver estimated time of restoration (based on the historical data/status restoration crew data) and provide alerts based on weather/damage data.

Moreover, this engine utilizes customer preferences portal data to identify the list of enrolled customers who wish to be contacted via any of the preferred communications channels. Finally, the communication channel platform retrieves inputs from the ONP engine and processes customized notifications to be sent out via the customer’s preferred channel.

Key benefits from our proposed approach include:

• Improved prediction of outages using the OPE. For feeder-related outages, we estimate an accuracy of more than 95% in identifying the right set of affected premises.

• Reduction in the number of incoming calls from customers enquiring about outages, which will yield monetary benefits. By proactively communicating to customers regarding outage status, we estimate that outage-related inbound calls can be reduced by at least 50%.
Energy utilities can reduce the cost of operations by limiting outage-specific customer calls and can also comply with regulations.

- Accurate real-time outage alerts sent to the right set of customers based on their preferred communication channel.
- Increased customer satisfaction.
- Enhanced compliance with established regulations.

As our experience suggests, energy utilities are not very well equipped with the required resources and skills to build complete smart outage communication ecosystems concurrently. Figure 6 (previous page), however, can help utilities to realize that vision.

LOOKING FORWARD

The concept of smart power outage communication is at a nascent stage in the utility industry. By making proactive outage communication a central part of the business strategy and by providing accurate, detailed and real-time outage statuses through customers’ preferred channels, energy utilities can improve overall customer experience, customer satisfaction and operational efficiency. Moreover, energy utilities can reduce the cost of operations by limiting outage-specific customer calls and can also comply with regulations.
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