THE NEW FACE OF DAMAGE ASSESSMENT

How Damage Assessment Analytics and Integration With Operational Systems Are Transforming the Utility Industry's Approach to Storm Response

A GTM Research White Paper

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CONTENTS

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1. SEVERE WEATHER EVENTS: IMPACT AND RESPONSE

In the wake of a severe storm, tens to hundreds of thousands of customers lose power. Trouble calls, emails, texts, social media, and outage orders overwhelm fully-staffed call centers and dispatch centers. Data from the advanced metering infrastructure (AMI), interactive voice response (IVR) systems, and call centers floods into a utility's outage management system (OMS). The OMS models the state of the distribution grid with awareness of which customers are experiencing outages, but not what caused the outage or the labor and materials needed to restore power. Once the storm restoration process gets underway, dispatchers use the information from the OMS to create and assign work tickets. Dispatcher-guided damage assessors, working without access to OMS data, patrol the lines without adequate prioritization of their efforts. Assessors commonly use paper maps to survey damaged equipment, later returning to regional or central dispatch locations to manually enter the data they collected in the field. The assessment data, stored independently of OMS data, often does not reach repair crews in a timely manner.

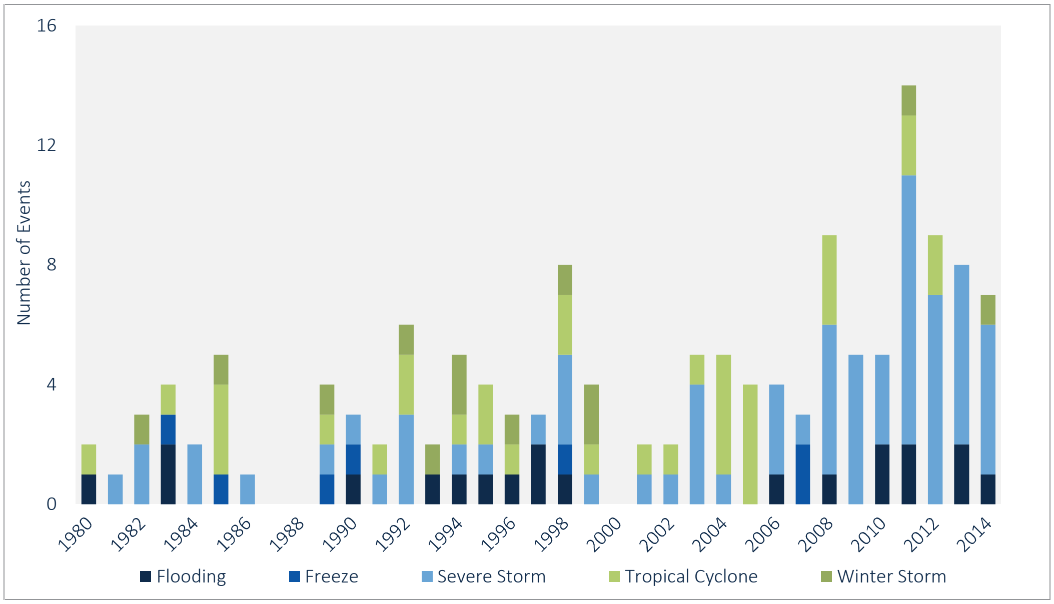
The scenario is not unique to a particular geography, nor to a utility's stage of technological and process advancement. Overhead distribution lines leave utilities across the world exposed to damage from severe storms, tropical cyclones, winter storms, and wildfires. During severe weather events, even utilities with modern operational systems and well-developed storm response procedures reach a point at which their remaining manual processes fail to perform, delaying power restoration efforts and hindering the ability to provide the public, the media and regulatory agencies with accurate status updates.

1.1. Impact on the Economy

Weather events are by far the leading cause of large outages. In the U.S., severe weather was responsible for 87% of outages involving more than 50,000 customers from 2002-2012.[1] There is mounting evidence that the frequency of severe weather events is increasing. In 2011 alone, the National Oceanic and Atmospheric Administration (NOAA) tracked 14 such events in the U.S. that each caused economic losses of at least $1 billion.

1 Executive Office of the President. "Economic Benefits of Increasing Electric Grid Resilience to Weather Outages." August 2013. http://energy.gov/sites/prod/files/2013/08/f2/Grid%20Resiliency%20Report_FINAL.pdf

Figure 1 U.S. Billion-Dollar Disaster Event Types by Year (Excluding Drought and Wildfire)



Source: NOAA's National Centers for Environmental Information

The metrics associated with severe weather events speak for themselves. According to NOAA, seven events in 2014 caused a total of $13 billion in economic losses across 27 states. In 2012, Hurricane Sandy alone caused economic losses of $65 billion, second only to the $125 billion cost of Hurricane Katrina in 2005.

1.2. Impact on Utility Resources, Technology and Processes

Beyond the billion-dollar costs to the economy, severe weather events heavily strain utility personnel resources. The response to a storm that affects hundreds of thousands of customers often requires a workforce numbering in the thousands. To supplement internal field crews and back-office support, utilities rely on contract crews and mutual assistance from other utilities to aid the required damage assessment and restoration efforts following a major storm event.

Figure 2 Selected Severe Weather Restoration Efforts at Major Utilities

Utility	Event	Customers Out	Support	Internal Crews	Mutual Assistance
Alabama Power	Tornadoes	650,000	-	4,000*	~6,000
Ameren	Severe Storms and Tornado	95,000	1,400	1,400	400-500
BGE	Hurricane Irene	680,000	250	2,978+**	1,788
Pacific Gas & Electric	Severe Storms	1,631,765	-	6,000*	620***
Public Service Electric & Gas	Hurricane Sandy	1,700,000	400	4,700	4,454
UK Power Networks	Winter Storms	332,931	115	848	20****

* Includes both support and field crews; **Includes both field crews and dispatch; ***Includes contractors; ****Limited due to widespread damage affecting all regional DNOs

Source: GTM Research

In addition, severe weather events strain the capabilities of utility technologies and restoration processes. Utilities currently use a variety of advanced technologies to address asset management, work management, outage management, and external communication. These include:

- Automated meter systems
- Automation of distribution design and construction workflow using engineering software, GIS, asset management and workforce management systems
- Call center automation, including IVR and automated callbacks
- OMS to perform analysis, prioritize workflow and generate reliability reports, either as part of a standalone OMS or as part of an integrated advanced distribution management system (ADMS)

Such technologies have vastly improved outage response and are adequate to address conditions and events associated with "blue-sky days" and seasonal weather patterns. During severe weather events, increased call-center volumes overload operators (who have inadequate information to report to customers), and extensive storm damage reduces the accuracy of fault analysis. Siloed and ad-hoc storm response processes further limit situational intelligence as damage assessment and outage management efforts occur in parallel, and as emergency reconstruction necessitates bypassing standard engineering workflows.

1.3. Preparing for the Next Storm With Process and Technology Integration

The expectations of politicians, regulators and customers to be informed about outage breadth and impact, as well as to receive timely and accurate estimated times of restoration (ETRs), are rising. Aiming to satisfy stakeholder expectations and expedite restoration, utilities across the world are enabling field crews with mobile data collection tools to link data from the field with information available in outage management systems and call centers. Even for utilities that have invested in such tools, the separation of the damage assessment process from the outage management process leads to confusion, extensive manual data re-entry, poor situational intelligence and delays.

Effective damage assessment solutions must support the entire recovery workflow through integration with core existing software platforms – such as OMS, GIS, mobility and workforce management systems – and business process redesign. Leading vendors are striving to tightly integrate damage assessment solutions and processes with broader utility operations to reduce restoration times, lower operating costs and enhance public perception.

2. CHALLENGES TO RESTORATION AND COMMUNICATION EFFORTS

Technology limitations, insufficient data and inadequate process integration reduce the effectiveness of utility crews during major outage events. Figure 3 summarizes five key technology and process gaps experienced during damage assessment and storm restoration.

Figure 3 Key Technology and Process Gaps During Damage Assessment and Storm Restoration

Key Gap	Result
Manual damage assessment data collection and sharing	Conducting damage assessments and sharing assessment data is time- and labor-intensive
Inability to access and use assessment data in conjunction with OMS data	Reduced situational intelligence, delays in determining resource needs, and increased time required for restoration crews to evaluate site conditions
Lack of coordination between damage assessment and OMS workflows	Inefficient use of assessment and restoration crew and equipment resources
Accommodating infrequent and temporary users of storm-response tools	Intensive training requirements and reduced process adherence
Lack of data integration, analytics, and visibility for utility stakeholders	Delayed and/or inaccurate external communication

Source: GE Grid Solutions

The gaps span across three broad categories of challenges: situational intelligence, field resource and operations coordination, and external reporting.

2.1. Situational Intelligence Challenges

During a severe weather event, the standard process of responding to an outage breaks down. While the OMS collects data from calls, outage notifications and restoration crew feedback, key damage information is captured outside of the OMS by field assessors. The assessors do not have access to OMS data, and OMS users do not have access to assessment data. Manual data collection, along with independent and redundant storage of outage and damage data, contributes to a lack of situational intelligence.

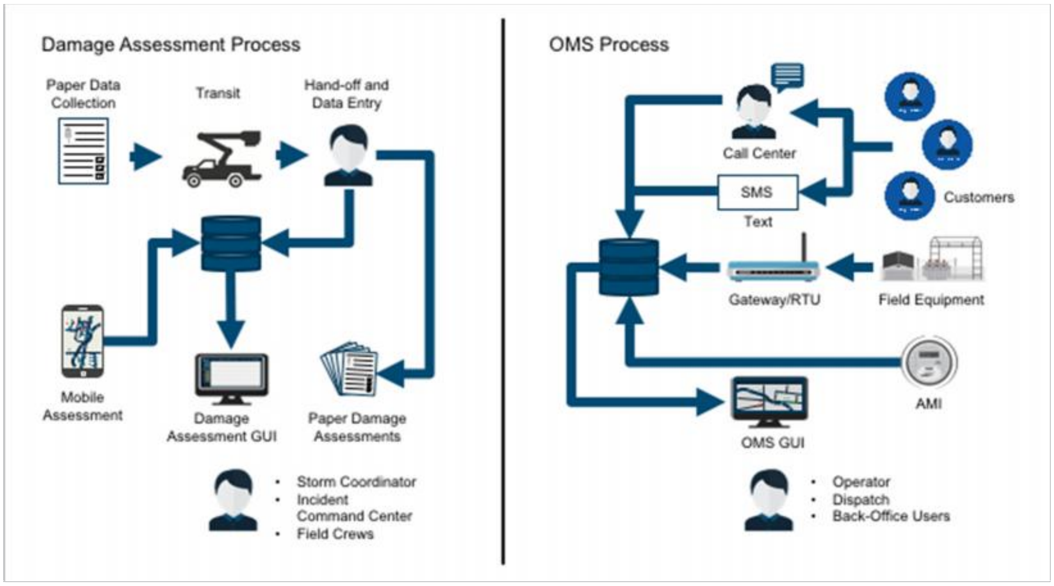
Manual Data Collection and Sharing

Many utilities continue to take a pen-and-paper approach to damage assessment. Using paper maps and forms, assessors record the type of damage, along with any safety and environmental concerns. Assessors call coordinators to report data, if cellular connectivity is available, or send marked-up maps and paper reports to the control center at the end of their shift. More advanced utilities have deployed mobile devices to provide assessors with access to digital maps and/or web-based forms to input damage-assessment data. These early point applications improve field assessor productivity, but the applications often have their own database, graphical user interface (GUI) and analysis. This creates yet another application for response coordinators to monitor, manually analyze and compare with, and redundantly re-enter into existing OMS and GIS platforms, increasing both labor requirements and process complexity.

Damage Assessment and OMS Data Silos

The data that assessors collect is essential in creating material and resource lists, prioritizing work, and determining the number of work hours required for reconstruction or repair, which are all key inputs to providing accurate ETRs. At the same time, the OMS independently generates and prioritizes work orders based on its device prediction algorithms. The result is two parallel, siloed sets of data and restoration processes, as shown in Figure 4.

Figure 4 Parallel Damage Assessment and OMS Data Collection Processes



Source: GTM Research

The lack of integration between the two sets of data has a variety of negative consequences.

- Incidents documented by the OMS are not always available to prioritize assessments, leading to inefficient routing of assessors.
- Assessment data is not associated with OMS outage orders, reducing the effectiveness of the OMS' device prediction algorithms and understanding of what is required to restore service.
    - In addition, the OMS is unable to recognize all the outages below the highest-level protective device, also called "nested" outages. Assessment data on undetected nested outages has no available association within the OMS.

- Operators must consult multiple screens including an OMS, DMS, damage assessment and GIS, manually comparing differences in the data to understand the extent of an outage, prioritize work orders, and estimate restoration times.
- It is also possible that the damage is so significant that entire circuits may require reconstruction rather than repair or replacement. In these cases, the as-built network model in the GIS and as-operated network model in the OMS/DMS may not reflect these changes.

2.2. Challenges to Coordinating Field Resources and Operations

Severe weather events strain utility personnel resources. Given the relative infrequency of such events, it's impractical to maintain a workforce large enough to support the associated wide-scale damage assessment and restoration efforts. On top of this fundamental constraint, internal utility personnel may themselves be unable to perform assigned duties during an event due to travel conditions and other factors. It is thus common for utilities to rely on mutual assistance and contract crews to augment internal resources. As a utility's workforce undergoes rapid temporary expansion during an event, advanced workforce management systems (WMS) and mobile applications for onboarding, scheduling and tracking crews are essential. The WMS must be able to coordinate and quickly add large numbers of temporary crews for storm restoration.

At the same time, utilities are challenged to quickly arrive at an integrated and prioritized view of the work, materials and specialty equipment required for restoration. Once the utility reconciles the results of damage assessments with OMS orders to arrive at a full view of the required repair work, informing internal and mutual assistance crews is a challenge. Operators, dispatchers and storm coordinators lack the means to present damage assessment results alongside work assignments to field crews.

Infrequent and Temporary Users of Damage Assessment Tools

Contract crews and mutual assistance are critical to damage-assessment efforts. This requires that a utility's damage-assessment tools be extensible to support large numbers of new users. The users (including temporary users within the utility) may be unfamiliar with tools and processes unique to the utility, highlighting the need for straightforward processes for assessment, as well as simple and intuitive methods for data input. Utilities employing manual methods of data collection face the procedural challenge of maintaining consistency in the recording and interpretation of assessors' notes on similar types of damage.

2.3. Sharing Data With External Stakeholders

Utilities have a social responsibility to communicate with the public throughout a storm event. Furthermore, public perception of a utility hinges on its ability to communicate well, regardless of how effectively the utility restores power. A core tenet of successful communication is frequency. For example, during one of the past decade's largest winter storms in California, PG&E published a press release each day for all seven days that crews worked to restore power to over 1.6 million customers. A second key tenet is accuracy: the utility must be able to provide ETRs based on OMS and assessment data. Current utility processes for external communications rely largely on time-consuming manual data collection and preparation of reports. For this data to be maximally useful, damage assessment and restoration technology must include tools for analytics, visualization, and reporting that allow a variety of internal stakeholders to gain better situational intelligence and provide timely status updates to external stakeholders.

3. UTILIZING THE VILLAGE: LEVERAGING INTEGRATED TECHNOLOGY AND PROCESSES

The limitations of existing approaches to severe weather events present an opportunity for leading utilities to adopt solutions that can enhance existing core systems and drastically reduce the impact of such events on utilities' operations, financials and public perception. These solutions address key technology and process gaps by enabling digital and mobile data collection, integrating assessment data with operational systems and workflows, and enabling data visualization with reporting capabilities under a utility's broader web of business processes.

Figure 5 Solutions to Key Technology and Process Gaps

Key Gap	Solution
Manual damage assessment data collection and sharing	Deploy a digital, mobile, and asset-based approach to damage assessment
Accommodating infrequent and temporary users of storm-response tools	Increase familiarity through "blue-sky" use of applications, with bring-your-own-device capability
Inability to access and use assessment data in conjunction with OMS data	Build a single repository and view of data for damage assessment and OMS data
Lack of coordination between damage assessment and OMS workflows	Leverage data and technology integration to bridge damage assessment and OMS workflows
Lack of data integration, analytics and visibility for utility stakeholders	Develop data analytics and visualization tools that provide information to key stakeholders for external communication

Source: GE Grid Solutions

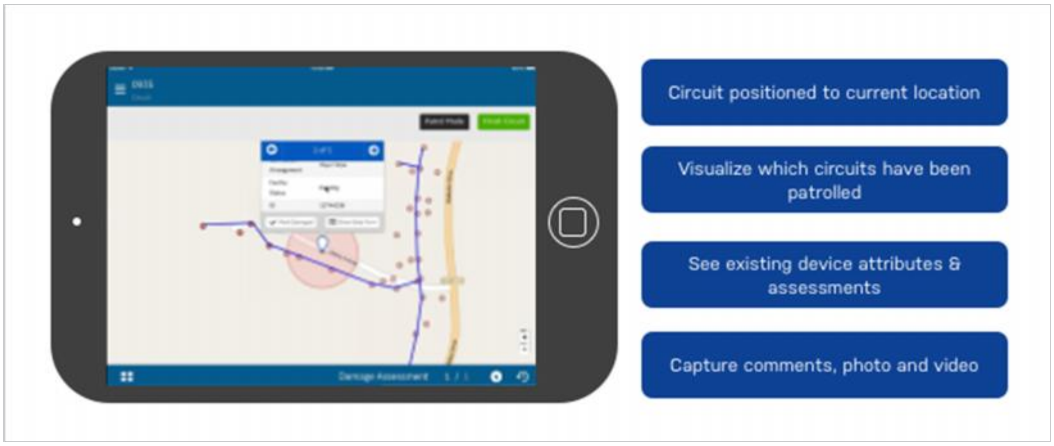
3.1. Digital and Mobile Damage Assessment

Mobility solutions are the technological foundation of advanced damage-assessment solutions. Assessors must be able to quickly and easily report damage via digital channels. Mobile devices can provide field crews and assessors access to asset- and circuit-level system data, as well as enabling field crews and dispatchers to share data specific to a particular work order. Integrating and providing access to underlying assessment, asset management, DMS, GIS and OMS data can lead to faster completion of work and a reduction of redundant site assessments. Mobility solutions have the added benefit of eliminating the time required to travel to a central site to turn in damage assessments, which expedites the creation of ETRs.

Interactive Applications

Beyond the digitization of data, mobile damage-assessment applications can provide extensive capabilities that manual assessment forms lack.

Figure 6 Key Capabilities of Mobile Applications Integrated With GIS for Damage Assessment



Source: GE Grid Solutions

The benefits of these capabilities are numerous:

- Mobile applications can leverage integration with a GIS' static system model and/or an OMS' or DMS' as-operated system model to quickly locate a circuit by operations area, substation or circuit ID, drastically shortening the time required to find the circuit on a paper map. As the user moves, the view of the circuit can be set to adjust to the user's new location.
- Mobile applications can display a host of details provided by GIS or asset management systems alongside the circuit, including device attributes, prior assessment details and various data visualizations, such as a record of which circuits have already been patrolled.
- Mobile applications can capture and share photos and video in addition to core damage-assessment data and estimated repair hours. Key to the latter two capabilities is the option to access the circuit data and to capture assessment data both online and offline, as network connectivity may vary according to the level of damage. As soon as a wireless network becomes available, the captured data is transmitted electronically to central servers.

Extracting Value and Ensuring Familiarity

Training on emergency systems requires significant and recurring resources to maintain familiarity and ensure process adherence. Deploying an integrated damage-assessment tool only when severe storms occur not only increases the total cost of ownership via increased need for training and drills, but also eliminates some of the inherent value and benefits provided by mobility solutions.

Significant value can be gained by using flexible, integrated mobile tools for various tasks, such as routine circuit inspections. Many utilities perform periodic circuit inspections as required by regulators or safety standards. Similar to traditional damage-assessment tools, these daily maintenance assessments are primarily manual and paper-based.

Using damage-assessment tools for circuit inspections has the added benefit of ensuring that crews are ready to use these tools during severe weather events, avoiding the need to train internal users during an event. While user guides and quick-reference guides remain key resources for internal and external personnel, "blue-sky day" use of tools minimizes the time that must be spent on training during a severe weather event. Whether such events occur months or years apart, crews will have the familiarity with assessment technology that is necessary to make a seamless transition from daily inspections to emergency response.

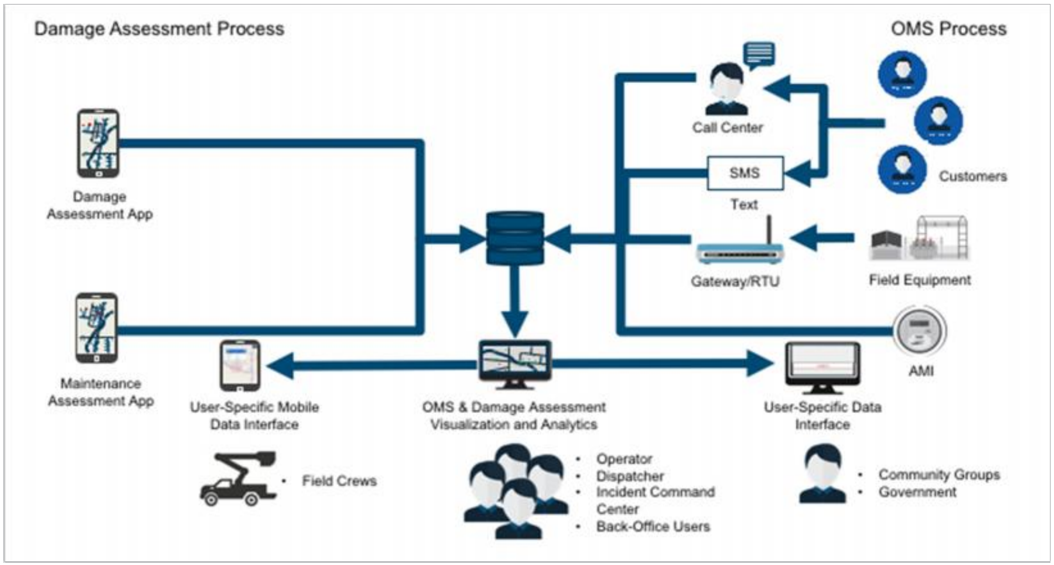
Bring Your Own Device

The bring-your-own-device (BYOD) concept is integral to reducing solution costs among internal employees, contractors and mutual assistance crews. Given the large number of temporary and external users of assessment and repair tools during a severe weather event, mobile applications must be device-agnostic to accommodate all users, devices and operating systems. Applications that are agnostic to device type and operating system allow new users to download those applications to their device through a utility-authenticated and -managed corporate server. The BYOD concept enables a utility to leverage existing internal and external mobile devices, rather than having to invest in and inventory hardware that is only used on an infrequent basis.

3.2. Integration of Technology and Business Processes

For a damage-assessment solution to deliver maximum value, it must be integrated with a utility's OMS. Sharing data between systems must be seamless and occur as part of the storm recovery workflow, eliminating manual processes and redundant data entry.

Figure 7 Integrated Damage Assessment and OMS Data Collection Processes



Source: GTM Research

With a single data repository for data, OMS functionality can expand to include key components of the damage-assessment process. Early additions to traditional OMS capabilities include the following:

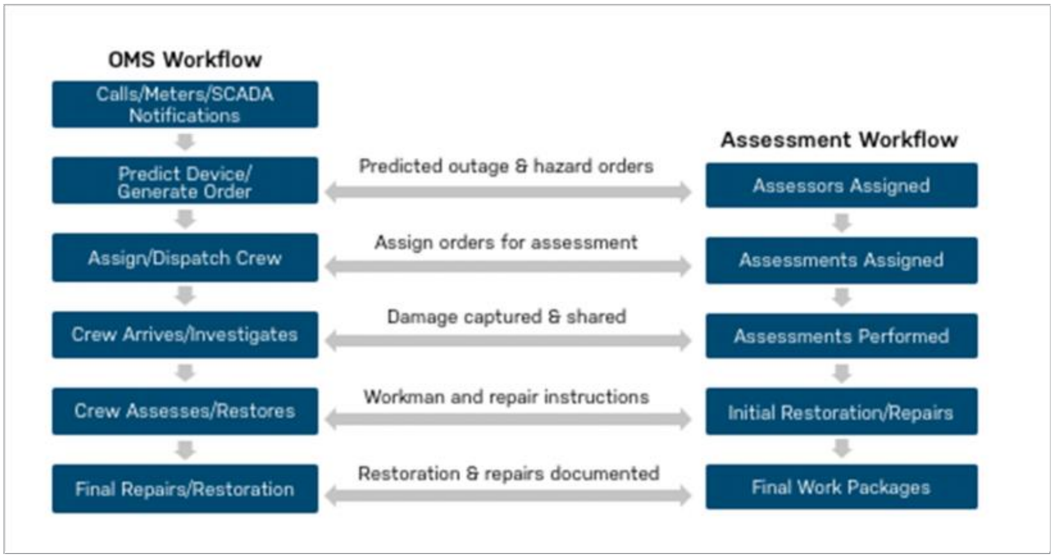
- Integration of outage orders, hazard orders and damage reports in outage lists and in a map window, with the ability to group orders by circuit
- Creation of nested outage orders to associate with damage assessments
- Enhanced accuracy and granularity of ETRs, informed by the estimated repair hours from assessments

To overcome hurdles during implementation and integration, the deployment of damage assessment tools should minimize the upgrades necessary to existing systems. Similarly, as utilities continue to upgrade legacy systems such as OMS and DMS to ADMS – or deploy them for the first time – the design of damage-assessment tools should enable integration of the tools with old and new systems alike.

Integration of Business Processes

Improved response to severe weather events depends on the development and implementation of streamlined business processes that leverage improved data collection and enable data sharing and efficient restoration. Just as new assessment technology should integrate with existing systems, new damage-assessment processes should enhance existing processes for outage management, work management and external communication. Figure 8 illustrates the integration of traditional OMS workflow with damage-assessment workflow.

Figure 8 Integration of OMS and Assessment Workflows



Source: GE Grid Solutions

At each step of the process, technological and process integrations enable data sharing and reconciliation, thus increasing overall situational intelligence within command and operations centers.

1. Outage and hazard orders serve as inputs for the assignment of assessors and assessments, ensuring that an appropriate number of patrols reaches the most critical locations first.
2. Assessment and outage data are collected and stored centrally, jointly accessible within the OMS to operations center personnel, as well as storm coordinators in incident command centers. Crew and equipment resource needs are thus more transparent to dispatchers.
3. As repairs commence and restoration occurs at various points along a circuit, damage and outage updates are reflected within the same window in the control room. This enables timely and accurate communications throughout the damage assessment and restoration processes to customers, the media and regulatory agencies.

4. CONCLUSIONS

Leading vendors are already offering end-to-end solutions that enable utilities to take an integrated, advanced approach to damage assessment and outage restoration. These solutions are reducing outage times for severe storms by hours and even days, and keeping stakeholders well-informed throughout the restoration process. The public perception and economic benefits to the utility, from lower operational costs to improving storm response ETRs, are clear.

As technology continues to evolve, utilities will see further growth of damage assessment capabilities. Advanced scheduling and analytics will improve ETR accuracy to better justify decisions around restoration, ultimately enabling a utility to calculate how many crews should be deployed to achieve a particular speed of restoration. Customized reporting of damage and granular ETRs will satisfy any level of inquiry from customers, regulators and the media. The utility will have better insight into the total cost associated with a severe weather event. New damage assessment tools and technology are equipping utilities with the tools to respond to the most challenging operating conditions, meeting the rising needs and expectations of customers and regulators alike.

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