Situational Intelligence Across the Digital Utility for Outage Response

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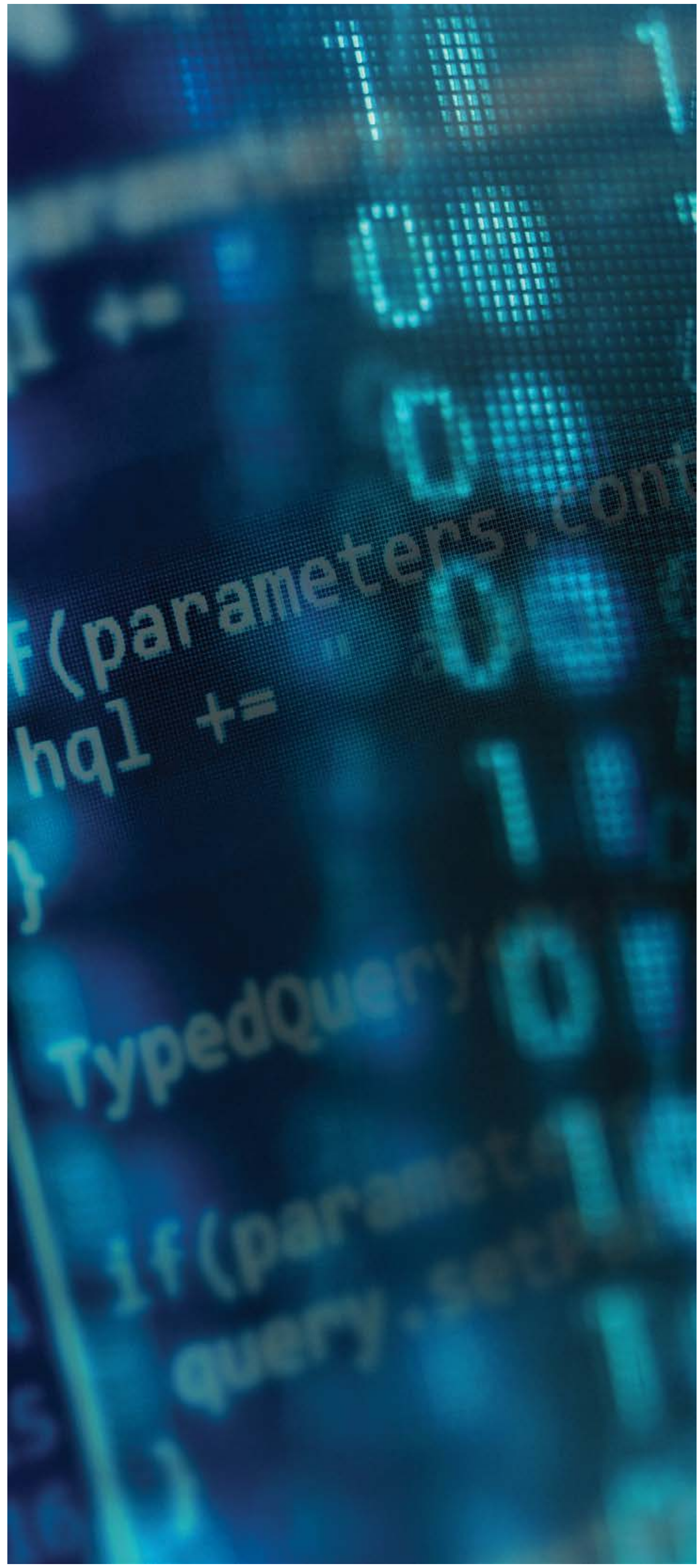


Situational Intelligence Across the Digital Utility for Outage Response

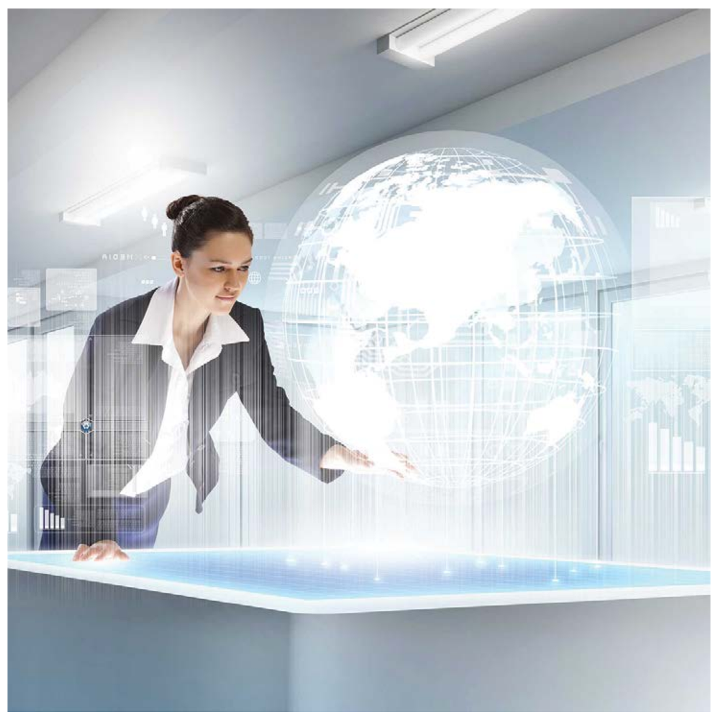
Harnessing Data and Enhancing Situational Intelligence to Improve Outage Response and Restoration Management

For utility personnel, a new type of intelligence is emerging, "situational intelligence" (SI). SI can generally be defined as getting the right information to the right person, at the right time, to support timely and informed decisions and actions. Big data and analytics software can provide a lot of information to the distribution operations center (DOC) or storm response coordinator. Leveraging this information with expertise and process knowledge can lead to more effective decisions in the height of a storm. This whitepaper explores the ecosystem of human behaviors, traits and supporting technological advances in software and user experience (UX) that help utility companies foster a heightened level of SI in their DOC and across the digital utility. All resulting in better informed decision making and action taking at the height of a crisis as well as during everyday business operations.

1. Introduction

As grid modernization of the electric power distribution industry becomes a reality, those utilities that embrace technology and become a true "digital utility" will reap the benefits of more responsive and efficient operations, as well as safer and faster outage restoration. By employing a collaborative control approach that allows operators and field crews to contribute to decision making and action taking in real-time, the digital utility will operate in a more efficient and cooperative manner.

Situational intelligence (SI) is a term you may be hearing more about in the digital utility space, specifically in conversations around outage restoration. The industry's definition continues to evolve, but in general terms, SI can be defined as getting the right information to the right person at the right time, to support more informed and timely decisions and actions. A more specific definition from a recent Wired article tells us, "Situational intelligence combines traditional situational awareness with the collective intelligence of those at the center of a situation, resulting in a dynamic process in which data is gathered and interpreted and the information is shared."[1]



2. The Importance of Situational Intelligence in Utilities

Why is SI so important in the utility context? It all boils down to changing patterns in severe weather events, the resulting increase in outages experienced by utilities, the associated impacts, and what utilities can do to effectively communicate with consumers, regulators and the media while simultaneously streamlining their process of recovery from these extreme weather events.

Around the world, a significant portion of the transmission and distribution network is still above ground, making the delivery of electricity especially vulnerable to the effects of severe weather. In an interview with the Associated Press[2], Allan Drury, a Con Ed spokesperson said, "It was clear to us that weather patterns were changing fundamentally. Severe weather events were becoming more frequent and devastating." In the U.S., weather events are by far the leading cause of large outages with severe weather being responsible for 87% of outages involving more than 50,000 customers from 2002 to 2012[3]. These power losses translate to negative impacts on the services and amenities that people rely on, as well as interrupted business. Recent studies estimate that power outages caused by severe weather cost the U.S. economy between $20 billion and $50 billion annually.[4] Regulatory bodies worldwide are paying close attention to their utilities' outage response, tracking SAIDI, SAIFI and CAIDI, with some demanding that distribution network operators pay reimbursement to customers for long interruptions[5] or imposing severe fines for inadequate outage response[6]. From October 2016 to September 2017, natural disasters around the world have cost utilities an estimated $10 billion in repairs and fines.[7]

Within utilities, severe weather events heavily strain personnel resources and budgets. During these events, networks and substation assets can be damaged. Crews must battle storm conditions to find and assess every fault. Operators and dispatchers must navigate through a sea of disconnected data collected from various sources flooding into a utility's outage management system (OMS). Fostering a heightened level of SI in the digital utility's DOC can result in quality decision making and advanced action taking at the height of a crisis. Cultivating SI during outage restoration is not an isolated exercise—it relies on an ecosystem of people, processes and tools to deliver value. The combination of an OMS, Geospatial Information System (GIS) and integrated damage assessment with the addition of input from drones, improvements in software user interface/user experience (UI/UX) and data visualization, as well as situational preparedness in the DOC, all serve to deliver valuable SI that drive positive outcomes during outage restoration situations.

3. Integration of Damage Assessment with the OMS & GIS

Within many utilities today, the damage assessment process is often conducted and managed in isolation from the OMS and GIS, with many systems focused solely on collecting data on network damage caused by major storm events. Attendees of a 2017 Outage Response and Restoration industry conference, where GE was a participant, clearly illustrated this disconnect. Fifty percent of audience respondents indicated that their company was currently using field device data capture tools to perform storm damage assessment and only 17% indicated that their damage assessment process was integrated with their OMS. In contrast, when asked about this issue, utilities tend to characterize the need for integration as significant. Dennis Lytle, Entergy's Senior Manager of Operations and Safety, categorized the importance of the issue as a 9 out of 10 and commented "If you have the information [integrated] that way it will help you get better results as well as compress the damage assessment cycle."

When a storm hits and outage restoration is underway, the separation of damage assessment data from outage management and geospatial information leads to confusion, extensive manual data re-entry, poor awareness and delays. Siloed systems are unable to support restoration activities in near real-time to restore customer power. During an outage, communications to utility consumers and regulatory agencies needs to be a priority, and having a more complete understanding of the situation will improve the quality and completeness of the information that can be shared by the utility. As per the American Public Power Association "When there's an outage, you must inform customers right away—through your website, social media, and phone recordings—even before sending out a press release to local media."[8]

By integrating field, GIS and OMS data, the digital utility will have a much clearer picture of where network damage exists and what kind of equipment is damaged, enabling more effective crew coordination and allowing repair crews to dramatically speed up the process of getting power restored. Critical information must be seamlessly exchanged between the utility's OMS, GIS and its field workers who are assessing networks and repairing the damage. Utilities need to be able to share network data with all users and various utility stakeholders quickly and efficiently and equip field workers with the technology needed to access and analyze massive amounts of network data on the fly from mobile devices. Enabling maintenance personnel to integrate field damage assessment data directly to the utility's OMS and GIS ensures that data from the field and in the control center are synced and accurate. This enhanced integration dramatically reduces the need for manual data transfers and updates, minimizing the amount of dedicated resources required to effectively manage a utility's network data and reduce manual errors.

Once the data has been collected and integrated, it must then be analyzed, deciphered and employed to help utilities prioritize restoration activities and to ensure crews are aware of the solutions and supplies they need to perform repairs to the network. The integration of damage assessment with the OMS and GIS enables data visualization capabilities and reporting functions, providing operators with an all-encompassing view of their distribution network. It also enables maps of electrical distribution networks to be pre-loaded into mobile data collection devices so that field personnel can initiate new damage assessments and visualize existing damage on the associated circuit. With this technology, personnel performing field assessments can remotely access and use existing outage data stored within the utility's OMS and GIS to reference and identify damaged portions of the network. Even when there is no immediate threat, the solution can be used to collect network data from regularly scheduled inspection processes—keeping utilities well-informed on the condition of their electrical distribution networks.

For a damage assessment solution to deliver maximum value, it must be integrated with a utility's OMS and GIS. Integration delivers SI by helping utilities summarize, visualize and understand the extent of storm damage faster, thereby prioritizing restoration activities, driving reduced outage times, lowering operating costs and enhancing public perception.

4. Leveraging Drone Data

Some digital utilities have begun to experiment with drone technology to quickly get "eyes in the air" and increase an operator's SI following a major storm event, as well as to perform routine inspections. With utility substations, lines and equipment covering hundreds of thousands of often inaccessible miles, drones can be deployed to quickly sense the health and status of grid assets, delivering actionable information in real-time. Leveraging data collected by drones offers further opportunity to increase a utility's SI by delivering data that utilities either previously had little or no access to or that would have required significant time and effort to secure and deliver.

As recently reported by Greentech Media[9], the energy sector is leading one of the most significant industry efforts to introduce drones into the field. Attendees of the 2017 Outage Response and Restoration industry conference mentioned previously echoed this trend—33% of audience respondents indicated that they were currently experimenting with unmanned aerial drones and 67% were actively using them. In outage restoration, drones serve the purpose of assessing damage and undertaking detailed inspection of grid assets, mitigating crew safety by eliminating the need for them to enter potentially dangerous situations. Drones' high-zoom cameras and live-streaming videography can be used to capture the aftermath of storm events, allowing utility employees to monitor damage remotely and assign crews closer to the most impacted areas. For example, during 2017's Hurricane Irma, Florida Power and Light (FPL) used 49 drone teams across the state, providing detailed visuals of otherwise inaccessible elements of Florida's badly damaged grid[10]. Iliana Rentz, Program Manager for Emergency Preparedness, explains "the new process this year proved to be more successful and provided more actionable data than in previous years."

In addition to basic surveillance, utilities have begun to analyze the difference between before and after flyover recordings to detect changes in the network infrastructure and highlight potential damage that may be part of the root cause of an outage. Some utilities are even extending their drones' capabilities beyond the visible spectrum, using them to carry thermal cameras able to detect energized equipment[11].

Incorporating this type of drone-enabled damage assessment during storm recovery and restoration processes contributes to a heightened level of SI and enables system operators and storm coordinators to make quicker and better-informed restoration plans at the height of a storm recovery situation.

5. Leveraging Machine Learning and Artificial Intelligence

With the volume of data becoming available via resources and smart equipment connected to the Internet of Things (IoT), digital utilities need to consider innovative ways to integrate this data to deliver SI that better informs restoration and storm recovery operations.

A recent Harvard Business Review[12] article summarizes as follows: “In today’s digitized economy, the ability to use data represents a real and essential competitive advantage.” The IoT brings a wealth of new kinds of data to the fold that needs to be harnessed to better inform restoration decisions. It is harnessing this data that remains a challenge, with some data science experts cautioning to “expect 80% of the work in becoming data-driven to be integrating your data, and making it available to meet the needs of your company as a whole.[12]” Traditional approaches and tools used to integrate various data silos and sources are fraught with budget overruns, missed deliverables and an inability to adapt to changing business requirements. While this may be true of historical techniques, utilities may be surprised to learn that there is a better way to approach the data integration problem so that utilities can better leverage data that is available from within their organization and from the IoT. GE has developed one such platform to handle the volume, velocity and complexity of both operational and IT data—leveraging machine learning and artificial intelligence to automatically map, model and correlate data, developing a semantic understanding of the data.

When the significant data integration hurdles are overcome, analytics are then enabled to deliver heightened SI. This moves the utility away from addressing problems as they arise (reactive) to predicting a root cause and addressing a potential risk before it materializes (predictive). In the context of outage response and restoration, these analytics can range from correlating forecasted weather patterns with historical outage and weather data to predict which parts of the network might experience outages during an impending storm—allowing pre-staging of crews and supplies to be at the ready—to automating the triage and prioritization of outage restoration to optimize estimated time of restoration (ETR) and reduce overall customer minutes of interruption (CMI). Furthermore, these tools and techniques can analyze individual grid asset health indicators to predict when and where an outage is likely to occur due to pre-determined factors, thus improving SI and supporting pro-active and pre-emptive action to avoid or at least minimize the impacts of an outage.

6. Importance of the UI/UX

During an outage response situation, utility operators often must work across multiple screens including OMS, DMS and GIS screens, as well as screens including damage assessment and drone data. All this while manually comparing differences in the data to gain an understanding of the extent of the damage and the outage restoration effort required, in order to prioritize work orders and to generate ETRs. The environment that allows operators to do this is the user interface (UI) and user experience (UX).

The UI/UX of automated tools that support the end-to-end outage restoration workflow process is another important aspect to improving the overall effectiveness of the ecosystem that fosters SI in the digital utility. The way in which the user interfaces and experiences the day-to-day management of the data within an information system is an integral part of any software solution. In many regards the existing UI/UX of established IT and OT software products is outdated. Technology drivers—moving away from monolithic desktop applications and trending toward modular, easy to deploy mobile and platform-agnostic clients—and feedback from the market have led GE to the conclusion that there is a need to transform the UI/UX experience.

When managing a crisis wherein a severe weather event has struck a utility's operating territory and caused widespread damage and power outages, another important aspect is how the circumstances of the situation itself affect the operator's stress level. One of the contributing factors to user stress is the result of "cognitive overload." According to a recent Smashing Magazine[13] article, "Cognitive load refers to the total amount of information your working memory can handle. Cognitive overload happens when your working memory receives more information than it can handle comfortably, leading to frustration and [compromised] decision making."

At GE, we have been working with our customers to understand the overall UX across similar users in similar roles within different companies. In doing so we have found that the level of stress felt by the operator is impacted by multiple elements—from environmental factors, to level of user expertise, to other business and infrastructure factors. One of the main points articulated by operators was that information spread across numerous computers and workspaces played a significant factor in increasing their anxiety and the feeling of not being in control, potentially leading to "cognitive overload" and resulting in less effective decisions in the height of a storm.

When the outage restoration process and system are enabled by a UI/UX designed from the ground up with the end user in mind, the overall user experience tends to be far superior. GE's user experience design research has led our teams to conclude that the UI/UX needs to make things straightforward to learn and to use, to support the user in taking the right direction, and also work to alleviate or avoid stress. The purpose of a system's UI/UX is to make the users' lives easier. It needs to foster SI by helping the data find the user and guide users in gaining insight from the sea of data to decide what actions need to be taken and guide their priority, all to address and help resolve the crisis.

7. Improved Decision Making via Data Visualization

We are in an era where unprecedented levels of new and disparate data are available to utilities. New automation technologies, smart sensors and improvements in the communication capabilities of devices have enabled real-time access to information from automatic switches, line sensors and smart meters. Control room systems as well as many other systems outside the enterprise are contributors to the ever-increasing volume of information. Overall, smart grid advances are expected to increase the quantity of data that utilities must manage by a factor of 10,000[14].

These advancements have allowed utilities to access and collect a wealth of data from the OMS, damage assessment and drones during outage restoration situations. But utilities realize that data collection is only the first step in the process of managing outage restoration. Dealing with data is complex, time consuming and presents an obstacle in effectively and proactively managing outage response. Utilities have an abundance of data, but don't know how to utilize it or gain the intelligence from it to drive operational decisions. During outage restoration, the challenge is converting utility data from various systems such as the OMS, GIS, damage assessment and drone inspections, as well as data extracted from machine learning and AI, into usable information.

By pulling disparate data into a single platform with an effective UI/UX, utilities are empowered to translate data into actionable intelligence for empowered decision making. A platform that aggregates, integrates, correlates and visualizes power system data, in real-time, from multiple internal and external sources or systems, into one dashboard view can be used to drive critical and actionable business and operational decisions to meet KPIs and power system performance metrics.

Turning the sea of data flowing throughout the organization into actionable SI takes coordination across the organization including leadership's commitment to digitizing the utility to leverage all the distributed "nuggets" of intelligence and help people make cause and effect determinations quicker than ever before. When this eco-system is sustainable it will foster a heightened level of SI inside the DOC and across the entire digital utility eco-system.

8. Improved Outage Response with Situational Preparedness

The recent increase in storm activity and extreme weather events worldwide has highlighted the need for improving the resiliency of utilities. Resiliency measures do not prevent damage; rather they enable electric facilities to continue operating despite damage and/or promote a rapid return to normal operations when damages and outages do occur.[15] Resiliency in the utility world relies on situational preparedness.

Situational preparedness is all about SI, meaning getting the right information to the right person at the right time, to support decisions and actions. During severe weather events, utility personnel resources are heavily strained to respond effectively and efficiently. SI allows personnel to make the correct decisions and carry out the appropriate actions during a utility's outage response. At Alabama Power Company, they have adopted some specific situational preparedness practices. As Larry Clark, Principal Engineer, Distribution Management Systems describes: "We use the GIS to look at predicted storm surges along the coast as well as previous years' records and what that meant in terms of poles and wires. We then start moving people to potentially impacted areas before a storm hits. This gives us a chance to be proactive in addressing damage."

Part of situational preparedness is the need for utilities to be ready to rapidly and effectively assess the damage to their systems and use that information to restore power quickly and safely during a storm event. To do so utilities are now undertaking storm response training. FPL is one such utility that routinely trains their employees via an annual storm drill.[16]

Though much of current utility training focuses on those in the field during a storm event, utilities are now also turning to software to facilitate situational preparedness. Software allows Distribution System Operators (DSOs) to train their operators on routine and complex operations. Event scripters enable teams to develop complex training scenarios with simulated power system models generating accurate network responses. DSOs can create a range of "scripts" of widespread outage events, run simulations with their team, and then evaluate system and team performance for responsiveness and capacity.

Situational preparedness allows utilities to improve their SI and thereby their outage response to become more resilient in the face of more frequent and devastating severe weather events.

9. Conclusion

With changing patterns in severe weather events driving increasing outages, utilities need to look to their digital solutions and situational preparedness to deliver SI. For utilities today, reconciling all the data sources and systems to streamline work processes and to ensure that the right information gets to the right people at the right time can seem an insurmountable task. Digital utilities need to move from reactive to predictive operating practices, and work with their solution providers to implement systems that integrate distinct domain areas such as outage management (OMS), asset management (GIS), damage assessment and drone data, and leverage machine learning and artificial intelligence, all to provide actionable intelligence via an effective UI/UX that weaves a more complete picture of the end-to-end operations. This will enable the entire workforce internal and external to the control room to contribute to and benefit from a heightened level of SI.

GE's Advanced Distribution Management System (ADMS) solution provides the foundation for the digital utility. The ADMS includes integrated SCADA, Distribution Management System (DMS) and Outage Management System (OMS) functionality across a single dynamic network connectivity model and a single comprehensive operator user interface. This integrated platform eliminates the "swivel chair" effect in control rooms while providing enhanced SI, improving the ease of operation and performance of operators, particularly under storm conditions presenting significant outages. Along with integrated mobile damage assessment capabilities, distributed energy resource (DER) enablement, machine intelligence and learning, and up and coming technologies such as drone inspections, GE provides end-to-end solutions to enable utility companies of today to transform to the digital utility of the future.

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About GE Power:

GE Power is a world energy leader that provides technology, solutions and services across the entire energy value chain from the point of generation to consumption. We are transforming the electricity industry by uniting all the resources and scale of the world's first Digital Industrial company. Our customers operate in more than 150 countries, and together we power more than a third of the world to illuminate cities, build economies and connect the world.

[1]Dent, Claudia. WIRED. 2013. "**Situational Intelligence for Effective Decision Making, Critical Communication.**" http://www.wired.com/insights/2013/07/situational-intelligence-for-effective-decision-making-critical-communications/

[2]Mohr, Holbrook; Burke, Garance. Associated Press. 2015. "**Extreme weather poses increasing threat to US power grid**" https://apnews.com/843e1c7d1fdd494fb73bdfda47283fc9/extreme-weather-poses-increasing-threat-us-power-grid

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

[4]Kenward, Alyson; Raja, Urooj. Climate Central. 2014. **"Blackout: Extreme Weather, Climate Change and Power Outages."** http://assets.climatecentral.org/pdfs/PowerOutages.pdf

[5]ENSTO. 2016, **"SAIDI and SAIFI indices guiding towards more reliable distribution network."** https://www.ensto.com/company/newsroom/articles/saidi-and-saifi-indices-guiding-towards-more-reliable-distribution-network/

[6]Tweed, Katherine. Greentech Media. 2012. **"Mass. Imposes $24.8M Penalty on Utilities for Storm Response."** https://www.greentechmedia.com/articles/read/mass-imposes-24-8m-penalty-on-utilities-for-storm-response

[7]Bhandari, Tarun. Energy Digital. 2017. http://www.energydigital.com/utilities/avoiding-disaster-how-effectively-utilise-disaster-operations-management

[8]Porter, Jessica. American Public Power Association. 2017. **"Don't leave your customers in the dark; Outage communication best practices."** https://www.publicpower.org/periodical/article/dont-leave-your-customers-dark-outage-communication-best-practices

[9] Wessof, Eric. Greentech Media. 2017. **"Hit-and-Run Drone Collision Causes Power Outage for 1,600 in Google's Hometown."** https://www.greentechmedia.com/articles/read/hit-and-run-drone-collision-causes-power-outage-for-1600-in-googles-home

[10]Moore, Jim. AOPA. 2017. **"Drones Deliver Storm Response."** https://www.aopa.org/news-and-media/all-news/2017/september/18/drones-deliver-storm-response

[11]Orlando Political Observer. 2017. "**Update From Duke Energy On Power Outages In Central Florida.**" http://orlando-politics.com/2017/09/12/update-from-duke-energy-on-power-outages-in-central-florida/

[12]Wilder-James, Edd. Harvard Business Review. 2016. **"Breaking Down Data Silos."** https://hbr.org/2016/12/breaking-down-data-silos

[13]Halarewich, Danny. Smashing Magazine. 2016. **"Reducing Cognitive Overload for a Better User Experience."** https://www.smashingmagazine.com/2016/09/reducing-cognitive-overload-for-a-better-user-experience/

[14]Sumic, Zarko et. al. Gartner. 2014. **"Top 10 Technology Trends Impacting the Utility Industry in 2014."** https://www.gartner.com/doc/2687015/top--technology-trends-impacting

[15]U.S. Departments of Energy. 2010. **"Hardening and Resiliency. U.S. Energy Industry Response to Recent Hurricane Seasons."** https://www.oe.netl.doe.gov/docs/HR-Report-final-081710.pdf

[16]T&D World. 2017. **"FPL Conducts Annual Storm Drill in Coordination with Hurricane Exercise."** http://www.tdworld.com/electric-utility-operations/fpl-conducts-annual-storm-drill-coordination-hurricane-exercise

Imagination at work

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