Enterprise Web Portal for Outage and Reliability Reporting

Gain Visibility into All Aspects of Your Electric Utility Operations to Increase Efficiency, Productivity, and Customer Satisfaction
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1. Introduction

In today’s electric utility environment, companies are expected to spend less money on maintenance and system upgrades without sacrificing the performance of the electrical network. Companies are accountable not only to their customers, but also to government regulators. Working in this challenging environment, utility executives must re-assess traditional ways of thinking to improve their processes. Successful companies must implement enterprise solutions, discarding or integrating legacy software applications. Facing an increasingly complex electrical grid, unprecedented demand, and unparalleled scrutiny, your utility needs solutions that integrate with the entire enterprise, connect disparate data warehouses, and create transparency into all business processes. Intergraph®’s Enterprise Web Portal provides forward-thinking companies exactly what they require to respond to today’s increasing demands.

Our Enterprise Web Portal gives you more flexibility thanks to visibility across all aspects of your enterprise. From reporting on outages, measuring responses, analyzing trends, and other information about the system, Intergraph’s solution connects and automates processes from end to end. By unlocking data from different departments and in different systems, our enterprise solution can help your utility increase efficiency and productivity, while addressing concerns in the areas of compliance, reliability, safety, and customer satisfaction.

By implementing Outage and Reliability Reporting with Enterprise Web Portal, your utility can gain increased insight into operations. This promotes better decision-making and responsiveness in critical business areas. The promise of enterprisewide solutions and information access has been touted for years in the utility industry, but has been seldom realized. Proprietary systems requiring specialized skills, separate silos of data, and customized applications on department-specific platforms have precluded the open sharing of information and the enterprise collaboration utilities envision. Intergraph’s Enterprise Web Portal helps utilities realize use of truly enterprise data.
2. System Reliability

System reliability is not the same as power quality. System reliability pertains to both sustained interruptions and momentary interruptions. Prior to the establishment of reliability standards, each utility decided what type of outages to include or exclude from their statistics. Major events were determined inconsistently from company to company. In fact, companies were often inconsistent across their own service area. In addition, other issues affected the calculation of reliability statistics. For example, very few utilities had detailed connectivity models that included all customers. Also, most companies used only limited trouble order, outage management, or outage reporting systems. Despite these limitations, utilities compared their performance results, even though they were not using a common methodology.

As companies developed better connectivity models and outage management systems became more commonplace, the need increased for reliability standards across the utility industry. Better standards would generate consistent reliability performance assessments for staff members, management, and stakeholders, including commissions and customers. These standards would establish a common understanding of key concepts, such as a major event. They would also define consistent methods for determining the various reliability indices. Standards would allow for comparisons of system performance across utilities. Common reliability standards would provide a basis for assessment when speaking with regulators and customers. Utilities would finally have a platform to compare system performance by area and from year to year. Companies could develop system performance metrics that would facilitate reliability improvements.

To present a set of terms and definitions to foster uniformity, in 1998, the Institute of Electrical and Electronic Engineers (IEEE) defined the generally accepted reliability indices in its standard number P1366, “Guide for Electric Distribution Reliability Indices.” IEEE-P1366 established common definitions and terminology for the industry and defined key indices. To provide guidance for new personnel and tools for comparison, IEEE tightened the definitions in 2003. These changes also focused on daily metrics, instead of only annual metrics. IEEE-P1366 created the Major Event Day concept, and standardized engineering metrics and approaches for decision-makers and regulators.

As utility companies improved and expanded their outage management system (OMS) capabilities and the connectivity model to the customer, they began looking at the service provided to each customer. Utilities moved from looking at reliability numbers annually, and circuit or regional metrics, to examining customer-centric reliability numbers.
3. Key Definitions

3.1 Distribution System

A distribution system is that portion of the system that delivers electric energy from transformation points on the transmission system to the customer.

3.2 Customer

In the utility industry, a customer is a metered electrical service point for which an active bill account is established at a specific location, for example, a premise.

3.3 Outage

An outage is when a component is not available to perform its intended function due to some event associated with that component.

3.4 Interruption

An interruption is defined as a loss of service to one or more customers connected to the distribution portion of the system. It is the result of one or more component outages. When does an interruption begin? It begins when the utility is aware of the interruption.

- The first customer call
- Supervisory control and data acquisition (SCADA)
- Automated meter reading (AMR)
- Field personnel

3.4.1 Momentary Interruption

A momentary interruption is a single operation of an interrupting device that results in a zero-voltage event lasting less than five minutes.

3.4.2 Momentary Interruption Events

Momentary interruption events are interruptions of duration limited to the period required to restore service by an interrupting device completed within a specific time of five minutes or less.

3.4.3 Sustained Interruption

A sustained interruption is any interruption not classified as part of a momentary event.

- Any interruption that lasts more than five minutes
- A sustained interruption can start with the momentary interruptions leading up to a device lockout
3.5 Restoration

A restoration is the process of restoring interrupted customers. When are customers restored?

- The restoration time could be based on when the field person reported in or entered information via a mobile device in the truck.
- SCADA can provide an accurate restoration time.
- AMR can provide accurate restoration time.

Even if an interruption is not restored until subsequent days, its total duration is accrued to the day it began.

3.5.1 Step Restoration

A step restoration is the process of restoring interrupted customers downstream from the interrupting device/component in stages over time. A step restoration has one outage start time with multiple restoration times. Step restoration can be performed with:

- Switching of remote controlled devices
  - Dispatcher initiated
  - Automatically
- Manual field switching

3.6 Major Event

A major event designates an event that exceeds reasonable design and/or operations limits of the electric power system. Major events are determined at the system level based on daily system average interruption duration index (SAIDI) values. Utilities can determine indices for any given region, district, circuit, or transformer station for internal comparison.
4. Index Calculations

The IEEE-1366-2003 presented several reliability indices that could be used to evaluate system performance. These categories include:

- Sustained interruption indices
- Load-based indices
- Momentary indices

4.1 Sustained Interruption Indices

Sustained interruption indices are broken into three categories: system level metrics, average customer metrics, and customer-specific metric. System level metrics include:

- SAIDI
- Average Service Availability Index (ASAI)
- System Average Interruption Frequency Index (SAIFI)

Average customer metrics include:

- Customer Average Interruption Frequency Index (CAIFI)
- Customer Average Interruption Duration Index (CAIDI)
- Customer Total Average Interruption Duration Index (CTAIDI)

The last category is the customer-specific metric, which consists of the Customers Experiencing Multiple Interruptions (CEMin) index.

Today, most utilities track CAIDI, SAIDI, SAIFI, and ASAI as their primary system performance indicators. These are typically used for trending and benchmarking for the company. These statistics generally do not require a substantial amount of resources to record each incident, its duration, or the number of customers affected. Also, these statistics typically do not require a major investment in IT resources. However, the accuracy of the information obtained is greatly dependent on the amount of system information available to the utility. A connected model for each customer to the transformer, lateral, line section, and circuit is required for the greatest accuracy in the calculations.

To calculate these sustained interruption indices, the utility can simply record the number of customers interrupted by each service interruption and/or device outage and the duration of each step restoration. For the definitions below, we will use the following information for a mini-system for a defined period of time. Intergraph’s system serves 50 customers, and all customers were interrupted only once during this time period. Table 1 shows the outages for our given time period. From this simple listing, all metrics can be calculated.

*Table 1: This table calculates the total metrics for an outage period.*

<table>
<thead>
<tr>
<th>Number of customers affected</th>
<th>X</th>
<th>Duration of Interruption</th>
<th>=</th>
<th>Customer minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>X</td>
<td>120</td>
<td>=</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>6</td>
<td>X</td>
<td>45</td>
<td></td>
<td>270</td>
</tr>
<tr>
<td>5</td>
<td>X</td>
<td>60</td>
<td></td>
<td>300</td>
</tr>
<tr>
<td>10</td>
<td>X</td>
<td>50</td>
<td></td>
<td>500</td>
</tr>
<tr>
<td>23</td>
<td>TOTAL</td>
<td></td>
<td></td>
<td>1310</td>
</tr>
</tbody>
</table>

4.1.1 System Average Interruption Duration Index (SAIDI)

SAIDI is the total duration of sustained interruptions for the average customer over a defined period of time.

\[
SAIDI = \frac{\sum \text{Customer interruption durations}}{\text{total number of customers served}}
\]

\[
SAIDI = \frac{\sum r_i N_i}{N_T}
\]

\[
SAIDI = \frac{1310 \text{ customer minutes}}{50 \text{ customers}} = 26.2 \text{ minutes}
\]

\(N_i = \text{Number of customers interrupted for each outage}\)

\(N_T = \text{Total number of customers served}\)

\(R_i = \text{Restoration time for each outage}\)

4.1.2 System Average Interruption Frequency Index (SAIFI)

SAIFI is how often the average customer experiences a sustained interruption over a defined period of time.

\[
SAIFI = \frac{\sum \text{Total number of customers interrupted}}{\text{total number of customers served}}
\]

\[
SAIFI = \frac{\sum r_i N_i}{N_T}
\]

\[
SAIFI = \frac{23}{50 \text{ customers}} = 0.46 \text{ interruptions}
\]

4.1.3 Customer Average Interruption Duration Index (CAIDI)

CAIDI is the average time required to restore service.

\[
CAIDI = \frac{\sum \text{Customer interruption durations}}{\sum \text{Total number of customers interrupted}}
\]

\[
CAIDI = \frac{\sum r_i N_i}{\sum N_i}
\]

\[
CAIDI = \frac{1310}{23} = 59.96 \text{ minutes}
\]

CAIDI can also be calculated by \(\frac{SAIDI}{SAIFI}\)
4.1.4 Customer Total Average Interruption Duration Index (CTAIDI)

CTAIDI is the total average interruption time for those customers who actually experienced an interruption in a reporting period (customers with multiple interruptions are counted only once).

CTAIDI = \[ \sum \text{Customer interruption duration} / \text{Total number of customers interrupted} \]

CTAIDI = \[ \sum \frac{r_iN_i}{CN} \]

CTAIDI = \[ \frac{1310}{23} = 59.96 \text{ minutes} \]

CN = Total number of customers interrupted

It should be noted that each individual customer is counted once regardless of the number of times interrupted during the reporting period.

4.1.5 Customer Average Interruption Frequency Index (CAIFI)

CAIFI is the average frequency of sustained interruptions for those customers experiencing sustained interruptions in a reporting period. The customer is counted once regardless of the number of interruptions.

CAIFI = \[ \sum \frac{\text{Total number of customer interruptions}}{\text{Total number of customers interrupted}} \]

CAIFI = \[ \sum \frac{N_i}{CN} \]

CAIFI = \[ \frac{23}{23} = 1 \text{ interruption} \] (assumes the 23 customers were out only once)

It should be noted that to calculate CAIFI, the utility has to have the ability to uniquely track the customers interrupted during the reporting period.

4.1.6 Average Service Availability Index (ASAI)

ASAI is the fraction of time (often in percentage) that a customer has received service during the reporting period.

ASAI = \[ \frac{\text{Customers hours service availability}}{\text{Customer hours service demands}} \]

ASAI = \[ \frac{NT \times (\text{Number of hours/year}) - \sum r_iN_i}{NT \times (\text{Number of hours/year})} \]

ASAI = \[ \frac{(50 \text{ customers} \times 8760 \text{ hours} \times 60 \text{ hrs/min}) - 1310 \text{ minutes}}{(50 \text{ customers} \times 8760 \text{ hours} \times 60 \text{ hrs/min})} = 0.99995 \]
5. What is a Web Portal?

A Web portal is a Web site that provides access to a variety of information from differing sources. This information is presented in a cohesive view customized for particular users or groups of users, normally through standard Web browser technology. When defining the Web portal, it is important to understand it is more than a flashy Web site – it is a Web-based, business-critical system.

5.1 What Makes Intergraph’s Enterprise Web Portal Different?

Intergraph’s Enterprise Web Portal is a spatially enabled reporting solution. Beyond a simple map display, it combines geographic information system (GIS), mapping data, and location-specific and temporal information to bring an added dimension to the data. What does this mean to your electric utility? The Web Portal is a visualization and analysis tool that provides real-time links to geospatial data warehouses. It equips you with geospatial query, analysis, and visualization tools so you can interrogate, analyze, assess, and formulate decisions in support of core business objectives. Users equipped with a standard Web browser can accomplish these tasks and more with little or no GIS training. Intergraph’s Web Portal application represents an investment in software development and configuration. You can quickly implement and gain a rapid ROI for your business.
6. Outage and Reliability Reporting with Intergraph’s Web Portal Solution

Our Enterprise Web Portal is a preconfigured application for electric utilities that is ready to be implemented at the customer site within three to four weeks. Implementation services complement the application with site-specific configuration, such as feature lists and database connection/configurations. As described previously, the preconfigured system includes powerful mapping and reporting capabilities for outage and reliability analysis and reporting.

6.1 Mapping Capabilities

Intergraph’s Enterprise Web Portal provides many mapping capabilities with an intuitive user interface that you can use to view, map, and analyze the utility’s service area. These include the following:

- Basic viewing functions
  - Zoom in/out
  - Window zoom
  - Pan
  - Pre-defined zoom levels
  - Toggle layers on/off
  - Coordinate readout
  - Measure distance
  - Measure area
  - Bearing and distance

- Additional map options
  - Accessing features from any warehouse
  - Autozoom to selected features
  - Map extras
    - Toggle map logo on/off
    - Toggle scale bar on/off
    - Toggle north arrow on/off
    - Change north arrow symbol

6.2 Dashboard Metrics

The portal provides the capability for configurable dashboards. This includes a quick-look page that consists of three user-configurable gauges. There is also a link that opens a page with a 4x4 matrix of definable gauges. Gauges use a Web service that provides the displayed values. Typical gauge configuration includes:

- Total number of customers currently out
- Number of open outage events
6.3 Reports

There are several pre-defined reports available with the portal. A metadata table drives the report list, which provides a mechanism to easily add reports to the interface. Reports are grouped by report categories. Each of these categories drives an accordion tab that provides a list of reports.

6.3.1 Current Reports

These are reports on open current outage and non-outage information. Current reports provided with the solution include:

- The Current Non-Outage Events report provides a list of the non-outage events currently in the system. You can filter the data, define display options, and add results to the map.
- The Manpower Forecasting report allows you to perform “what if”-type scenarios by providing the number of crews and adjusting the time the work will be completed.
- The Current Outages report provides a list of the current open outage events currently in the system. You can filter the data, define display options, and add results to the map.

6.3.2 Unit Info Reports

If the field units are global positioning system (GPS)-enabled, you can deliver several reports to allow analysis of this data. These reports include:

- The Event Summary report allows you to select an event and display all the records in the GPS table associated with this event.
- The Driver Performance report allows you to select a date and a speed and returns all the GPS records where the recorded speeds exceed the selected speed. You can then add these locations to the map.
- Detailed Summary allows you to select a unit and a day. All GPS records are then returned and can be added to the map.
- The Unit Detailed Line report allows you to select a unit and a day. All GPS records are then merged into a single line, which is displayed on the map.

6.3.3 Outage Analysis Reports

- The Reliability Indices report allows you to create the common IEEE indices based on a date range, including SAIDI, ASAI, SAIFI, CAIFI, CAIDI, and CTAIDI.
- The Outage Statistics Calendar report shows historical information in a monthly view. The calendar shows the number of outage events, the number of customers affected, the total outage minutes, the total customer minutes, and the CAIDI for each day. You can also filter the historical data using several parameters.
Events by Time allows you to specify a date range and a grouping parameter. You can group events by month, day of week, or hour of day. A bar chart shows the total number of events.

The Cause Summary report generates a report showing a summary of causes for a given date range.

The Outage Query allows you to query the historical database and then plot the results on the map.

The Outage Summary report allows you to group outages based on cause and date range. These outages are then grouped by some attribute, such as dispatch group, feeder, substation and phase.

Outage Trends allow you to identify trends in the historical data by selecting the date range, cause, and the time frame.

6.4.4 Workforce Reports

Number of Jobs allows you to select a date range and a time frame. The system then displays results in a table and a chart.

Number of Calls allows you to select a date range and a time frame. The system then displays results in a table and a chart.

The Average Dispatch Time report calculates the average dispatch time per unique event. You can select the date range.

The Average Drive Time report calculates the average drive time per unique event. You can select the date range.

The Average On-site Time report calculates the average on-site time per unique event. You can select the date range.

The Event Summary report allows you to select a specific date. The results include the log in/log out times, minimum/maximum speed, the average speed, the miles driven, and the number of events worked. You can view detailed records for the selected unit.

6.4 Analysis

The Enterprise Web Portal has several analytical functions, such as attribute queries and spatial query functions. Functions include:

The Find function allows the user to run pre-defined queries.

Several functions can spatially filter features. These include:

Select by Line allows you to digitize a line. A buffer zone is then created around this line and a report shows features within this buffer zone.

Select by Circle allows you to draw a circle. A report shows features within this circle.

Select by Polygon allows you to draw a polygon. A report shows the features contained within this polygon.

Select by Rectangle allows you to draw a rectangle. A report shows the features contained within this rectangle.
7. Architecture

7.1 Web Portal

The Enterprise Web Portal is based on Intergraph's GeoMedia® WebMap, with additional reporting capabilities built in a standard browser (Figure 1). The application incorporates a .NET framework supported by AJAX functionality. It also uses several custom Web services that adhere to Service Oriented Architecture (SOA) standards. Metadata tables are used to define all aspects of the portal’s functions. The metadata defines warehouse connections, features to display, symbology, tooltips, actions, and many other functions.

![Enterprise Web Portal Architecture](image)

*Figure 1: Intergraph’s Enterprise Web Portal is based on GeoMedia WebMap.*

7.2 GeoMedia WebMap

GeoMedia WebMap provides Intergraph’s GeoMedia geospatial technology in a fully scalable server application. It can be deployed as Web services or interactive Web sites (thin-client solutions), including enterprise data access, sophisticated geospatial analysis, and map generation, thus reducing the overall cost of such solutions. By providing direct, real-time access to enterprise geospatial data with all of the spatial analysis functionality of GeoMedia, this product lets you build a Web site that gives thin-clients with only a Web browser access to a powerful, dynamic, and open geospatial application previously available only in a powerful desktop application.
8. Summary

The preconfigured solution provides a mechanism to quickly identify and monitor all of the factors on your grid to ensure they perform at a level that will allow you to achieve your business objectives. When one or more of your business’s key performance indicators is underperforming, you can quickly see what is happening and drill down to the root cause to take corrective action.

The automation of your key performance indicators can provide many benefits to your organization. With Intergraph’s software, you can:

- Increase bottom-line revenue
- Promote greater business insight, more informed decision-making, and better results
- Identify and correct trends before they become an issue
- Reduce labor effort and overhead costs
- Eliminate duplicate data entry
- Provide detailed, accurate, and analytical reports quickly