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ArcGIS® Modernizes How Electric Utilities Manage Assets

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ArcGIS Modernizes How Electric Utilities Manage Assets

Executive Summary

The objective of asset management is to maximize the performance of assets while minimizing risks, optimizing existing resources, and observing cost constraints.

ArcGIS® uses location to fine-tune asset management. It provides fresh insights about performance, risks, resources, and costs. Using location, utilities can discover patterns and trends that simple reporting cannot detect——improving asset management results.

ArcGIS does this in three ways:

- Managing asset data
- Assessing performance
- Optimizing the asset life cycle

Managing Asset Data

Utilities tend to piece together information from many other sources—enterprise asset management (EAM), work management, real-time data, metering, customer management, and network analysis systems. ArcGIS provides a new, complete network model that bridges these technologies, consuming critical information from many sources to provide a complete picture of the electric utility system.

Assessing Performance

ArcGIS delivers insight into the past, present, and future performance of the assets and of the grid. Understanding each asset's condition and its context to location is essential. ArcGIS assesses performance by revealing asset vulnerabilities, predicting performance, and providing transparency. The result of performance assessment is a risk profile, based on vulnerability and the consequences of failure.

Optimizing the Asset Life Cycle

The heart of asset management is the optimization of resources. ArcGIS optimizes the entire asset life cycle by centering it around location—coordinating capital and operational plans, and balancing cost, risk, performance, and compliance.

ArcGIS is fully aligned with the ISO 55000 standard series, providing important regulatory compliance functions. It also embodies enterprise capabilities to maintain records, engage all stakeholders, and reveal deep analytical insights. This makes for better asset investment, security, and operational decisions.

What's at Stake

Edison Electric Institute reported that investor-owned electric utilities held over $1 trillion in assets that were in service as of December 2018. The substantial investment in assets—coupled with many challenges—compel utilities to derive as much value from their assets as possible.

The American Society of Civil Engineers gave the condition of American energy infrastructure a grade of D+. Electric outage durations are increasing. Assets continue to age. Competition with distributed energy resources is increasing. Revenues are declining.

Electric companies are undertaking grid modernization programs. These programs require accurate, timely, and complete data about the grid. Grid modernization puts even more pressure on utilities for high-quality asset management.

The objective of asset management is to maximize asset performance while minimizing risk and cost, and meeting compliance requirements. This balancing act provides a framework for decision-making that often creates conflicting priorities.

Figure 1—Asset Management Is a Balancing Act

The Maturity Model of Asset Management

Figure 2 illustrates the maturity of asset management practices. From bottom to top, the practice moves from tactical to strategic. The goal of asset management is to optimize the balance for all stakeholders. There are five ascending practices of asset management.

From tactical to strategic, the practices comprise the following:

- Passive—Run assets to failure. This sacrifices customer service for maximum asset life.
- Reactive—Maintain assets on a scheduled basis. For example, exercise each switch every four years, whether it needs it or not. Replace assets based solely on their age.
- Preventative—Maintain equipment based on its current condition. For example, maintain switches based on their pattern of use. This brings in more intelligence about how the assets are being used and the stresses that they have endured.
- Predictive—Repair and replace based on the asset's condition and on historic failure rates. This also brings in factors like criticality and risk.
- Prescriptive—This is the most strategic practice. This balances costs, conditions, failure rates, environmental conditions, reliability, and risk, and it aligns operational and capital programs.

ArcGIS offers strategic capabilities to dramatically improve asset performance at each level of maturity.

In a survey of several hundred attendees of an Esri webinar, only 6 percent of the participants reported practicing prescriptive asset management; 12 percent practiced predictive practices; and 29 percent, 43 percent, and 9 percent used preventative, reactive, and passive asset management practices, respectively.

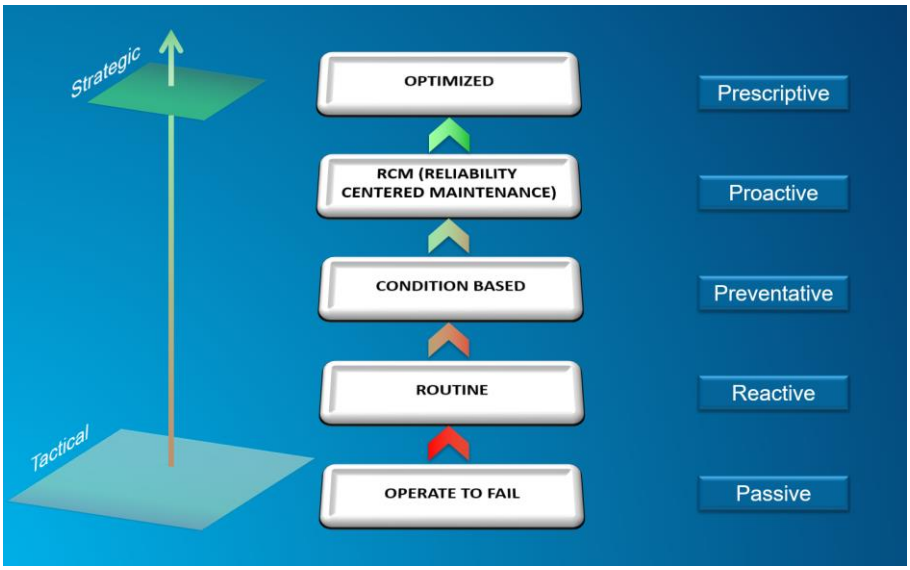


Figure 2—Asset Management, Ranging from Tactical to Strategic

Why Geospatial Technology Matters for Asset Management

"One of the biggest challenges in asset management is the injection of long-term thinking (strategic goals and sustainability) while under pressure to deliver short-term results."—John Woodhouse, Asset Management Thought Leader

Assets are spatial. They influence and are influenced by where they are located as well as the following: their criticality; their relationship to other assets, customers, and external influences; and changing conditions such as emergencies, severe weather, and security.

ArcGIS effectively handles asset transactions, real-time data, and situational awareness for short-term results. At the same time, it provides trends and analytics and enables discovery for long-term strategic decision-making. To climb the maturity ladder from passive to prescriptive practices, utilities need better data management, engagement from all parts of the company, and greater insight into the nuances of their assets' performance.

ArcGIS provides outstanding data management, transparency throughout the organization, and sophisticated insights, enabling any utility to improve its asset management practice.

ArcGIS

- Delivers a complete and accurate model of all aspects of the grid.
- Brings disparate systems together.
- Includes analytics to optimize the multitude of factors. It sees what others can't.
- Presents information to all stakeholders on any device, anywhere, anytime.
- Models the past, present, and future state of the grid.

At a utility, there are several conflicting goals. Operations people focus on the immediate. Planning and engineering employees worry about the longer term. Finance is single-minded around business success or even survival. The value of geospatial technology is that it allows the stakeholders to visualize each of their individual issues in one environment.

Location Is a Common Theme

What do the assets have in common? Location. ArcGIS underpins nearly every aspect of asset management.

ArcGIS reveals The Science of Where, showing

- Where to invest in resiliency
- Where assets have failed.
- Where future growth is forecasted
- Where hazards threaten the grid.
- Where to invest based on risk, cost, and operations.
- Where renewables (solar panels/batteries/electric vehicles are connecting to the grid.
- Where costs are high or low.
- Where losses are high.
- Where environmental factors—such as the weather, humidity, temperature, salt contamination, or soil conditions—impact the grid.

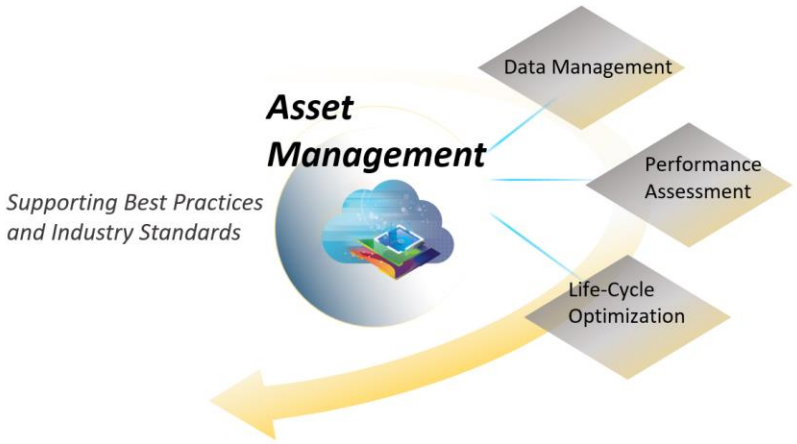


Figure 3—ArcGIS Modernizes Asset Management

ArcGIS modernizes electric utility asset management by supporting best practices and industry standards in three ways, as illustrated in figure 3:

- Data management
- Performance assessment
- Life cycle optimization

These concepts are detailed in the sections the follow.

Data Management

Understanding the current state of the electric utility system is the first step in asset management. Utilities tend to piece together information from many other sources—EAM, work management, real-time data, metering, customer management and network analysis systems. ArcGIS provides a new, complete network model that bridges these technologies, consuming critical information from many sources to provide a complete picture of the electric utility system.

Utilities have used geographic information system (GIS) technology for decades as a cartographic system of record. This is changing. Esri's new ArcGIS Utility Network Management extension creates a system of record based on how assets exist in the real world—not how assets can be represented on a two-dimensional map. If a two-dimensional map is required, it can be abstracted from the model. It is not the model itself.

This allows utilities to build a much more accurate, timely, and complete system of record. Data management is supported in three ways:

- Connecting enterprise data
- Easing data collection
- Consuming real-time data

Connecting Enterprise Data

ArcGIS provides a bridge between IT and OT systems. It works closely with the company's EAM, work management, and customer management systems. ArcGIS provides insight into the stages of assets, from procurement through retirement. EAM and work management systems handle the asset attributes and transactions of a life cycle. They cannot manage assets' spatial relationship to each other or to other, nonutility assets. That's why the interoperability of ArcGIS with IT and OT is so valuable. Bringing data sources together enhances a utility's asset management practice, regardless of where the assets are on their maturity journey.

Figure 4—Data Consumed via Web Services from EAM into ArcGIS

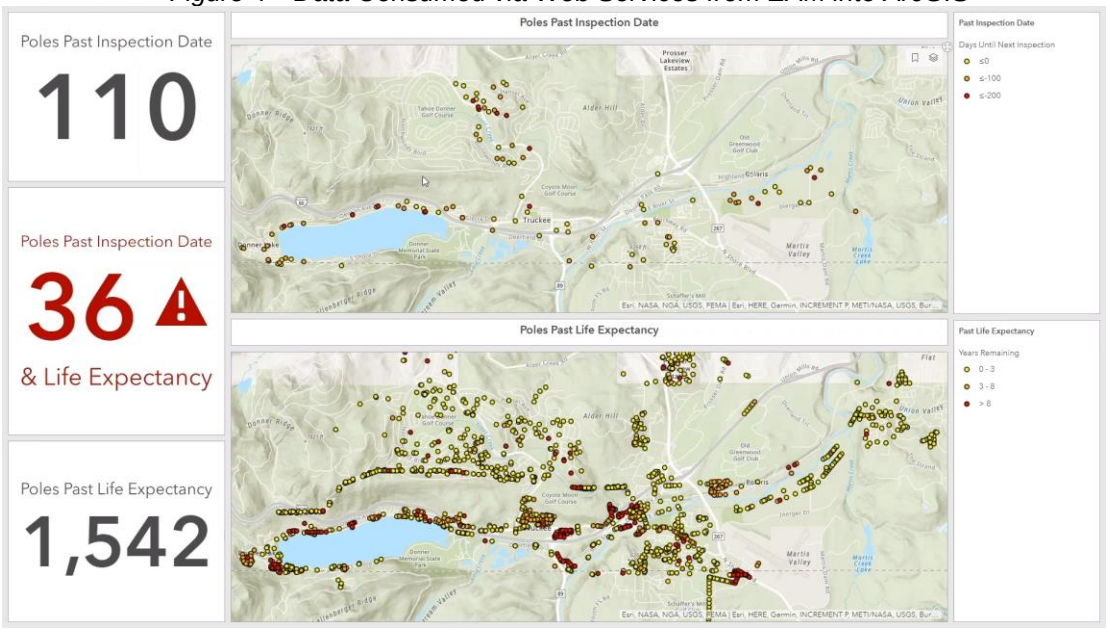


Figure 4 shows an ArcGIS dashboard that displays pole information. The dashboard pulls data from inspections and an analysis of pole life expectancy into a single display. The dashboard also includes simple analytics of counts of various pole issues.

Easing Data Collection

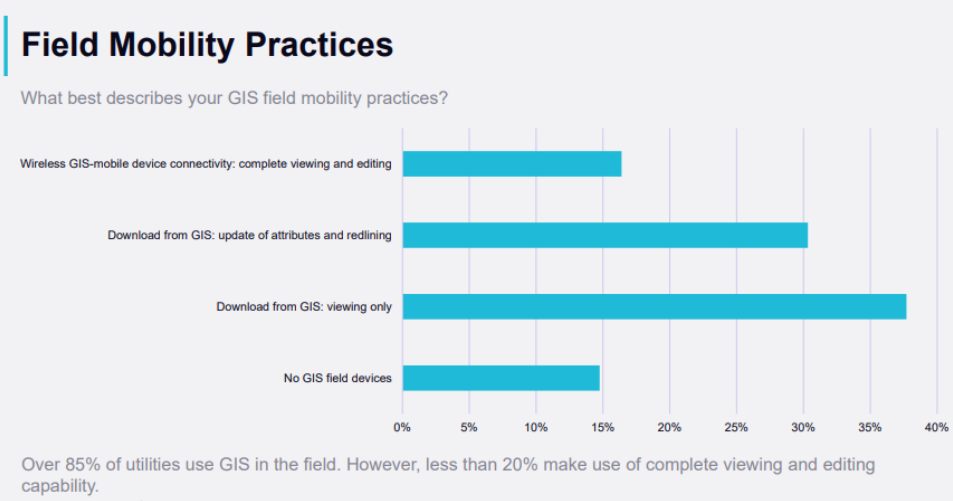


Figure 5—Field Mobility Practices Impact Data Quality

Outstanding data quality is a fundamental requirement of asset management.

As noted in the figure 5, while 85 percent of utilities use GIS in the field, only about 20 percent make use of the ability to edit in the field. That means that 80 percent collect data using paper forms or redline markups of paper maps. Those utilities will have a collection of paper records in a queue to be incorporated into their GIS (and other systems).

ArcGIS has a suite of field apps. The field apps ease asset data collection by using simple-to-use interfaces on consumer-friendly devices. Since ArcGIS is built on web services, once the data is captured by using the field apps, that data is immediately available to anyone using ArcGIS. This does two things. First, it makes it easy for field personnel to capture information in the field. Second, it communicates that information back to the office and others right away. The lag time—which historically could be days, weeks, or sometimes months—from when something happens in the field to when it is processed into the corporate record is shortened to seconds.

The positive impact on asset management is clear. Data that is current and accurate dramatically improves the quality of analysis.

Consuming Real-Time Data

Utilities get monitoring from their core operational technology systems (SCADA, generation control, advanced metering infrastructure [AMI] system, Advanced Distribution Management System [ADMS]). Utilities also have video surveillance, cybersecurity, and automatic vehicle location (AVL) technology. Billions of people are using Twitter, Facebook, YouTube, and Instagram. Sensors are enabling real-time understanding of the assets. This could be from load, operations, or temperature data, with each type of data providing insight into how the utility should adapt to manage the asset. ArcGIS organizes these sensors by location. That leads to discovery and insight. This gives a much fuller view of asset performance and is the key to discovering failure. No other system can do that.

Performance Assessment

Layering on the accurate model of the grid, ArcGIS provides insight into the past, present, and future performance of the grid. Asset management doesn't stop at maintaining a complete static model of the grid. Understanding the condition of the assets is required. There are three elements to performance assessment:

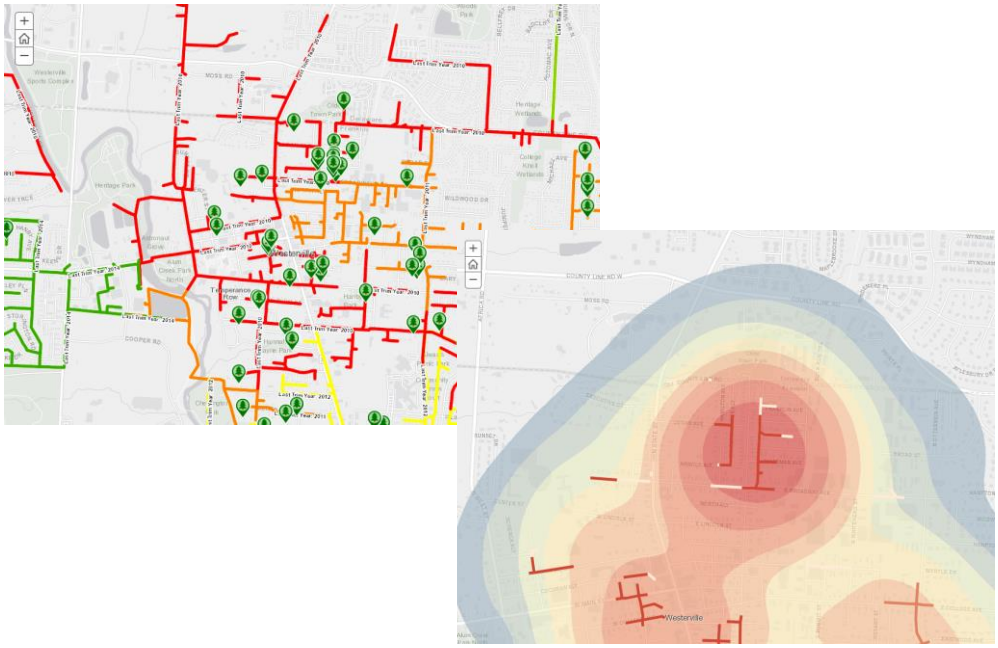
- Revealing asset vulnerabilities
- Predicting performance
- Providing enterprise transparency

Revealing Asset Vulnerabilities

Figure 6 shows a simple case of how ArcGIS determines network vulnerability. As shown in this story map example, understanding several factors contributes to minimizing network vulnerability. The first factor discussed in this example is the time since the utility trimmed trees. Trees falling on power lines are a major cause of outages during a storm situation. The second factor is the history of outages caused by trees. The third factor is composed of issues that were identified during inspections but have not been corrected. If left uncorrected, they could cause outages during a storm.

Figure 7 shows the result of a spatial analysis. The analysis weigh each of these factors, combines them, then overlays the results on the network model. Figure 7 is a heat map that shows where the network is most vulnerable to failure during a storm. The network elements shown in red are the elements that are most at risk.

The action resulting from this kind of analysis is to focus efforts on these network elements. Of course, in a real case, there would be many more factors, including planned work, cost of maintenance, and asset failure history. What this illustrates is that spatial analysis is a key tool for asset management.



Figures 6 and 7—Maps of Network Vulnerability

The collection of historic failure locations and rates and their causes add richness to the analysis. This analysis could include key performance indicators such as the system average interruption duration index (SAIDI) and system average interruption frequency index (SAIFI).

The result of the performance assessment is a risk profile.

Predicting Performance

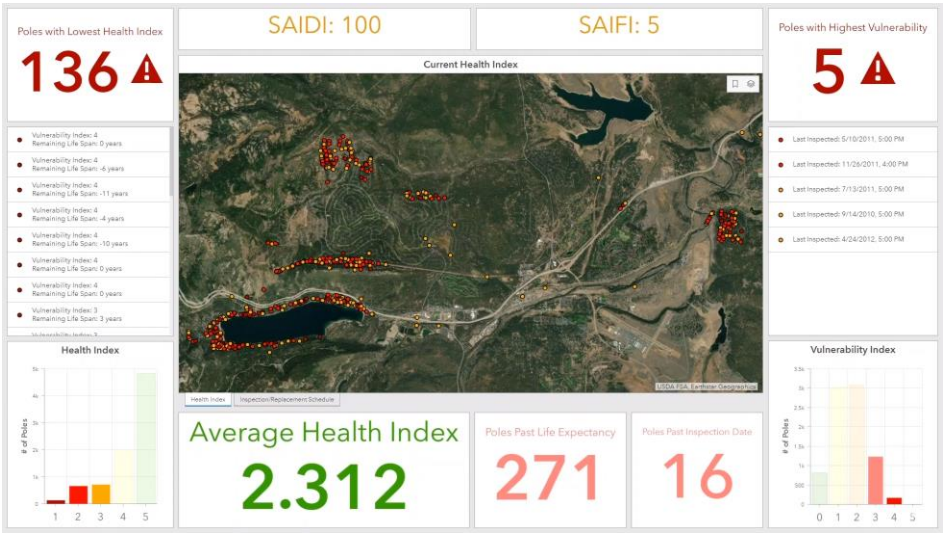


Figure 8—Predicting Future Asset Life

Figure 8 is an example of an ArcGIS operations dashboard. This shows the health of poles and predicts which poles are likely to fail. This is based not simply on their age but on a variety of factors such as fire zones, termite infestations, and the water table. This dashboard provides a road map that sharpens decision-making about what actions to take, now and in the future.

Providing Enterprise Transparency

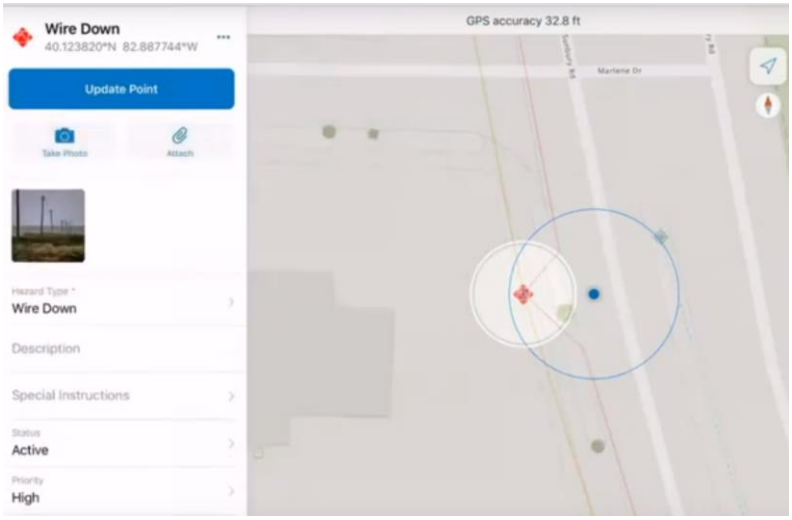


Figure 9—Capturing and Receiving Asset Data on a Tablet

Figure 9 is screenshot from a smart tablet that illustrates how ArcGIS provides information about an asset, its condition, and a photo showing the asset. This information can be shared in real time on any device with any authorized user in the company. It provides immediate awareness to all utility stakeholders.

Life Cycle Optimization

ArcGIS is the equalizer between operations, engineering, customer care, corporate management, regulatory affairs, and audit and finance. It also helps break down barriers within an organization. ArcGIS does this in these ways:

- Centering the life cycle around location

- Coordinating capital and operational plans
- Balancing cost, risk, performance, and compliance

Centering the Life Cycle around Location

The core idea around asset management is simple: understanding location—where the assets are in relation to other assets and their surroundings. Other concepts include knowing the variety and patterns of the assets. Another notion is understanding when things change.

ArcGIS helps asset managers

- Understand the quantity and distribution of assets.
- Determine which assets are within an area.
- Know what assets are closest.
- Find the best route to an asset or set of assets.
- Craft a risk profile by location.
- Predict where assets will fail, then act to mitigate.
- Organize assets by attribute.
- Spatially enable EAM data.
- Visualize failure mode, effects, and criticality analysis (FMECA).
- Report the results.

ArcGIS can provide insight into the work order process by analyzing past work orders that were corrective, planned, forced, or routine. ArcGIS is a natural companion to the utility's work management system.

Coordinating Capital and Operational Plans

Figures 10–13 illustrate the differences among the various asset management practices and the value that ArcGIS brings, each step of the way. The run-to-failure tactic has no real coordination and is not shown.

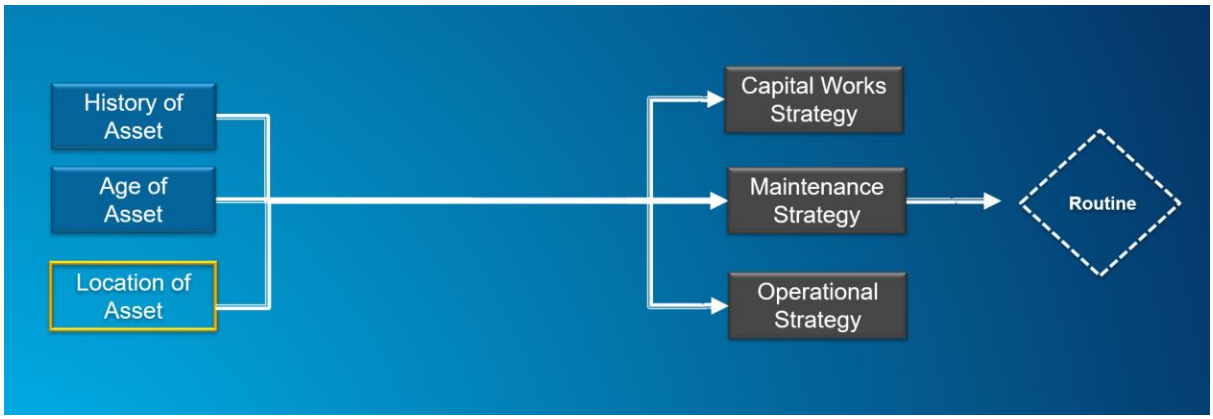


Figure 10—Location Adds New Capability to Preventative Asset Management

Figure 10 illustrates the common practice of using asset age to determine the relationship of replacement versus repair and its overall impact performance. With location information, ArcGIS provides rich context, value, and insight through visualization.

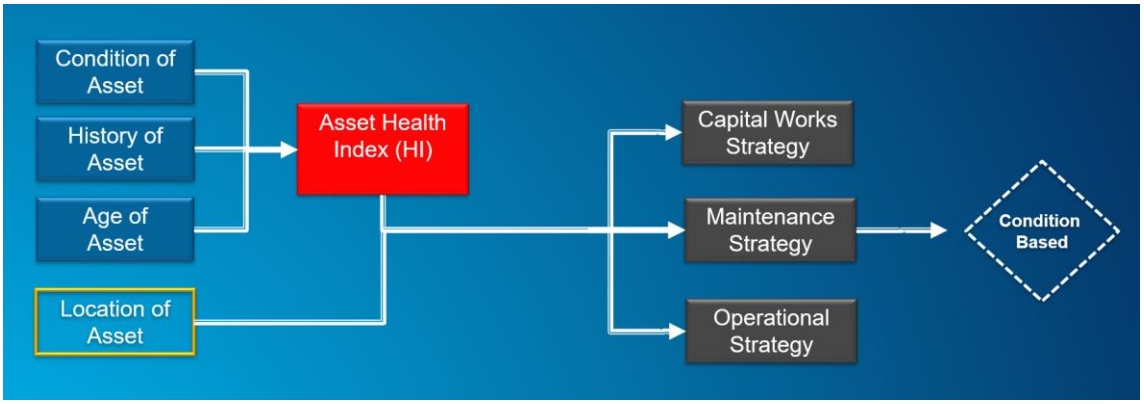


Figure 11—Adding Condition and Health Data Enhances Asset Management

Figure 11 illustrates adding asset condition data. Condition-based asset management begins to look at the heath index of the asset. This is where coordination of multiple systems—such as EAM and work management systems—with the GIS reveals greater understanding of the causes and symptoms of asset failure. Location begins to reveal clues as to why assets are failing.

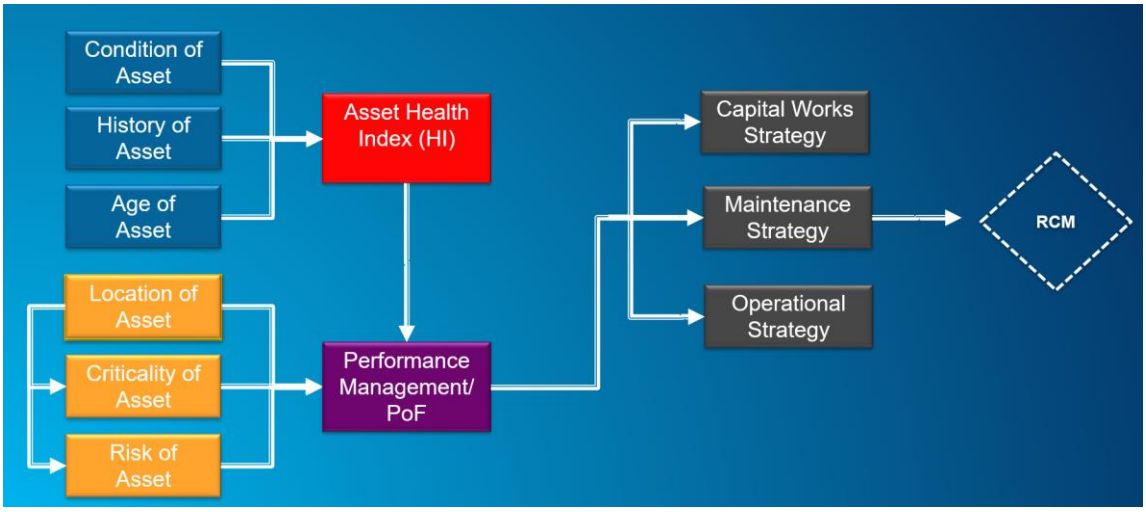


Figure 12– Adding Consequence of Failure and Criticality Strengthens the Value of Asset Management

Figure 12 details how reliability center maintenance (RCM) asset management adds information to the practice. While condition-based asset management focuses on the assets themselves, RCM adds the consequence of failure and criticality of the assets. This is where ArcGIS provides substantial value, since it highlights where assets are most critical and will have the greatest impact on the performance of the system. ArcGIS helps answer questions, such as which asset failures would incur the most cost, cause the greatest customer impact, and create possible regulatory problems. This begins to provide a more integrated approach to asset management.

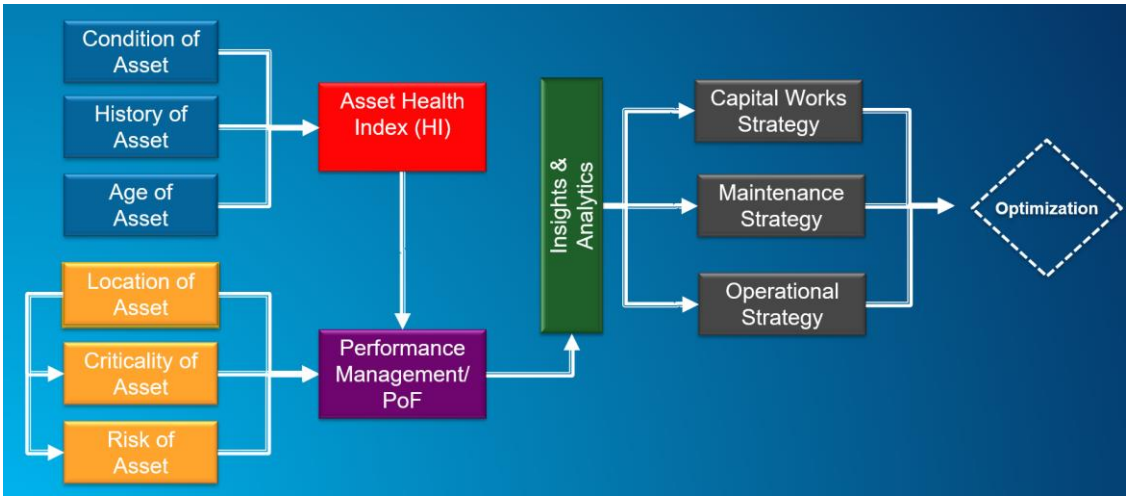


Figure 13—Optimization Requires Additional Insight and Analytics

Figure 13 illustrates the most holistic and integrated approach to asset management, building on RCM to add further insight by using spatial technology. Here, additional tools such as machine learning and advanced use of imagery can reveal factors that even RCM cannot uncover. ArcGIS provides the means to consume data from an endless array of data sources. These include historic and predicted weather patterns and analysis of potential natural disasters such as landslides, fires, floods, and lightning strikes. This additional insight gives asset managers the ability to fully integrate their maintenance, capital, and performance plans in full alignment with their corporate objectives.

Balancing Cost, Risk, Performance, and Compliance

As utilities move to optimization, they leverage the value of ArcGIS. It provides the tools to help utilities gain insights that previously had been virtually hidden from them. ArcGIS brings disparate types of data together. For example, it can analyze which parts of the network are predicted to cost more to maintain, based on their location and the physical conditions that impact their total life cycle. ArcGIS can determine vulnerability and risk by consuming real-time operational data and predictive and historic failure data. ArcGIS can uncover areas of potential compliance violations, ranging from failing to inspect to having equipment that's likely to cause damaging wildfires.

Optimized asset management leverages as much data as possible. It is composed of a holistic and integrated approach to asset management. Utilities will continue to face challenges. To meet those challenges, they will need new tools to increase the value from their assets. ArcGIS supports their efforts to balance cost, risk, performance, and compliance.

Supporting Best Practices and Industry Standards

In a recent survey for the report *Is Your GIS Ready for Grid Modernization?*, Esri and market research firm Energy Acuity asked participants to rate the quality of their GIS data.

Figure 14 illustrates the results. Note that 23 percent of respondents report confidence. Yet many utilities have high data error rates.

ArcGIS Utility Network Management prevents the most common data errors. It includes a set of rules to guide users to add data correctly the first time. Since it is based on true electric modeling, it eliminates incorrect connectivity and structural attachment.

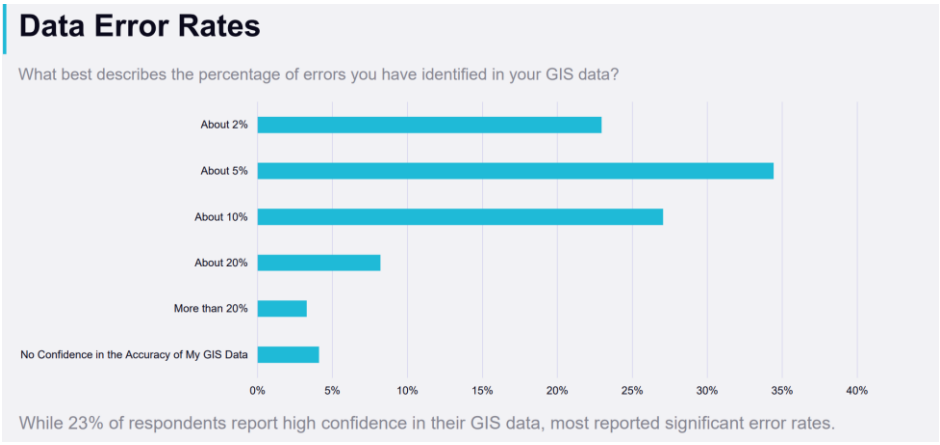


Figure 14– Survey Detailing Data Error Rates

Alignment with ISO 55000

One of the shortest sections in ISO 55001 is section 7.4. It is about communication.

The term *connected* is critical. Operational silos create barriers to connecting people, processes, and technology. Section 7.4 of ISO 55001 states:

> *The organization shall determine the need for internal and external communications relevant to assets, asset management and the asset management system including . . . what it will communicate, when to communicate, with whom to communicate, and how to communicate.*

What to communicate is clear: as much information as possible about the asset's life cycle, its condition, and the relationship of assets to each other. Utilities need to communicate that information rapidly. This has not been the practice historically. Field information commonly wouldn't reach corporate for days, weeks, or sometimes months. Breaking down silos is key to allowing everyone in on information that has been hoarded—intentionally or not—by departments.

Esri's system of engagement architecture, built on web services, affords this level of communication, collaboration, and coordination.

ISO 55000 states that organizations need to determine how to communicate. Esri's system of engagement provides immediate communication of assets. In addition, it eases communication of information about external factors, such as assets from the city, the gas company, or the communications provider; or about the weather, traffic, lightning strikes, and data from literally any IoT sensor.

Change Management

Section 8.2 of ISO 55001 speaks of change management. A planned, permanent, or temporary change in assets will impact asset performance. Section 8.2 recommends assessing the impact, particularly the risk associated with that change. As noted, ArcGIS is a complete GIS that creates systems of record, engagement, and insight. Utilities gain insight into contemplated changes by performing spatial analysis and data science. This involves the following:

- Data engineering uses out-of-the-box tools to transform data into information. It brings disparate types of information together to see patterns that are hidden from decision-makers.
- Machine learning and artificial intelligence (AI) solve complex problems to determine the impact of changes, and they leverage advanced tools that make predictions about behavior, based on past patterns.

- Big data analysis crunches billions of data elements to uncover surprising results that sharpen decision-making about contemplated asset changes.

ArcGIS creates new information. It reveals patterns and behaviors that cannot be determined from charts and graphs alone. It sees spatial relationships of disparate types of data. Contemplating changes in asset management requires the geospatial system of insight delivered by ArcGIS.

The Complete GIS

Often when utilities are asked what the main application of their GIS is, they will say that it's asset management. In this context, that simply means network documentation or the maintenance of a system of record.

ArcGIS is much more than network documentation. It is a complete system of record with a full model of the electric utility system, from generation to the customer. It is a full system of engagement providing collaboration throughout the company. It is a system of insight, uncovering patterns about asset performance.

System of Record for Asset Management

Recently, utilities recognized the limitations of a cartography-based GIS. As utilities implement grid modernization, they see the need for a model-based GIS, not a digital version of paper maps. Esri led this movement by completely revising the GIS from paper based to model based.

As noted above, this resulted in the ArcGIS Utility Network Management extension. It allows utilities to model assets in four dimensions (three physical, plus time). Esri designed the extension to be compatible with industry-standard data models such as the Common Information Model (CIM).

System of Engagement for Asset Management

ArcGIS goes beyond modeling the electric utility system. It is a system of engagement. It takes its cue from social media. It shares information about the grid on any device, anytime and anywhere. Using web services, fieldworkers, contractors, and even customers can share information with anyone—other fieldworkers, members of the media, first responders, or anyone else who has permission. As a system of engagement, it can consume data from billions of data sources on the web and from government and other utilities. It can consume real-time data and services from other IT types of systems like EAM, work management, and customer management; any IoT device; and any web service that is location based. This is in complete alignment with ISO 55000.

System of Insight for Asset Management

ArcGIS is a system of insight. It is about discovery. It uses the systems of record and engagement to uncover hidden patterns and behaviors of the assets and the factors that impact their performance. It brings disparate types of data together, organized by location. This brings to light connections that otherwise could not be seen.

What does the system of insight have to do with asset management? The foundation of asset management is understanding the balance of cost, risk, performance, and compliance. Retiring an asset too soon is costly and wasteful. Waiting for it to fail not only is costly but also negatively impacts customer service. For utilities to move up the maturity curve, from tactical to strategic asset management, they require greater insights to support informed decision-making. Understanding asset failure patterns, criticality to network, and risk is dependent on bringing in location analysis. Location information is the enabler to move from existing business practices to optimized asset management.

Wrap-up

Utilities face enormous challenges today and will continue to do so in the future. They have invested billions of dollars into their assets and must gain as much value from

them as possible. ArcGIS brings value to every utility regardless of how its asset management practice has matured.

As utilities observe ISO 55000, they will need better tools to balance cost, risk, performance, and compliance. One common attribute of utility assets is location. That's why geospatial technology and, particularly, ArcGIS fine-tune asset management.

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Esri inspires and enables people to positively impact their future through a deeper, geographic understanding of the changing world around them.

Governments, industry leaders, academics, and nongovernmental organizations trust us to connect them with the analytic knowledge they need to make the critical decisions that shape the planet. For more than 40 years, Esri has cultivated collaborative relationships with partners who share our commitment to solving earth's most pressing challenges with geographic expertise and rational resolve. Today, we believe that geography is at the heart of a more resilient and sustainable future. Creating responsible products and solutions drives our passion for improving quality of life everywhere.

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