Utility Lens: ArcGIS Industry and Technology Pattern

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Table of Contents

Introduction

The utility sector is undergoing significant changes driven by resource constraints, infrastructure modernization goals, and a growing need for resilience. As these challenges intensify, utilities must adopt innovative solutions to ensure efficiency, reliability, and sustainability. Technology plays a pivotal role in this transformation, enabling digital transformation that helps utilities optimize operations, improve decision-making, and adapt to an evolving utility sector landscape. At Esri we support utility organizations in delivering safe and reliable resources with mission-focused ArcGIS systems that realize operational excellence while optimizing the use of assets and resources.

ArcGIS enables this transition through scalable solutions designed to meet the needs of both large and small utility organizations. It uses geospatial technology to model, analyze, and manage infrastructure, allowing utilities to effectively adapt and respond to industry challenges while improving service delivery and resource management.

Utilities often achieve significant return on their ArcGIS investment through building and operating mission focused interconnected ArcGIS systems, ensuring business needs and processes are met while leveraging the advantages of an integrated, data-driven approach. Many of these system types are described in detail within the Utility Lens, which aims to inform utilities on system patterns often deployed by utility customers.

- New to ArcGIS? Consider starting with an Introduction to ArcGIS.

ArcGIS for utility organizations

Utilities operate with various business systems to meet diverse requirements, which can be influenced by regulatory, environmental, and sector-specific standards. Geospatial information and context can significantly enhance operational efficiency, regulatory compliance, and safety within these systems. However, ArcGIS is not merely a collection of mapping tools; it is a comprehensive geospatial enterprise platform that enables organizations to design, build, and operate systems tailored to the unique challenges of modern utilities.

Utility organizations typically operate multiple ArcGIS systems; however, the Network information management system can be considered foundational. Network information management systems provide users across the organization with the ability to create, edit, view, and analyze network features and relationships across an as-built network.

ArcGIS systems approach

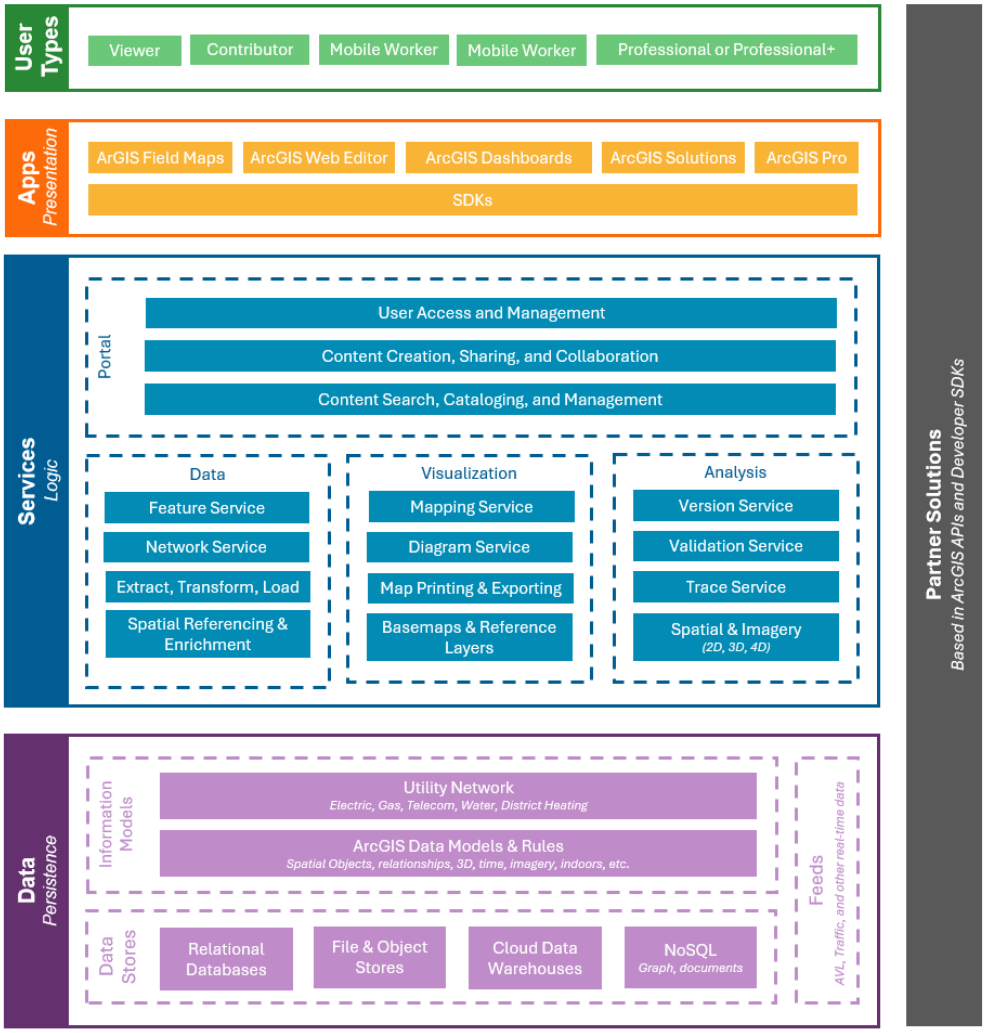
All users authenticate through a portal which provides identity management, content management, and security capabilities. Users access an ArcGIS system with an appropriate User type, which grants them necessary apps and capabilities based on their roles. For example:

- An editor might create and maintain asset information in ArcGIS Pro with a Professional Plus User Type.
- An asset inspector might access and update asset information in ArcGIS Field Maps with a Mobile Worker User Type.
- An operations manager might view assets, issues, and progress in an Operations Dashboard with a Viewer User Type.

This ensures staff receive the right content and capabilities based on their roles. These content and capabilities in turn are powered by several types of ArcGIS services, including:

- Data services, like network topology services to model and validate connectivity
- Mapping and visualization services, like diagram services to create schematics
- Analysis services, like trace services to perform upstream and downstream traces

The services rely on the data tier of ArcGIS, which includes ArcGIS information models like the ArcGIS Utility Network, designed for electric, gas, telecom, and water utilities globally. The utility information is stored in standard databases like SQL Server, Oracle, PostgreSQL, or SAP HANA, and can be integrated with other enterprise business systems like Enterprise Asset Management (EAM), Supervisory Control and Data Acquisition (SCADA), or Automatic Vehicle Location (AVL.)



Adopting ArcGIS

Utilities have flexibility in determining their own path to ArcGIS adoption to enhance operational efficiencies and adaption to emerging industry requirements.

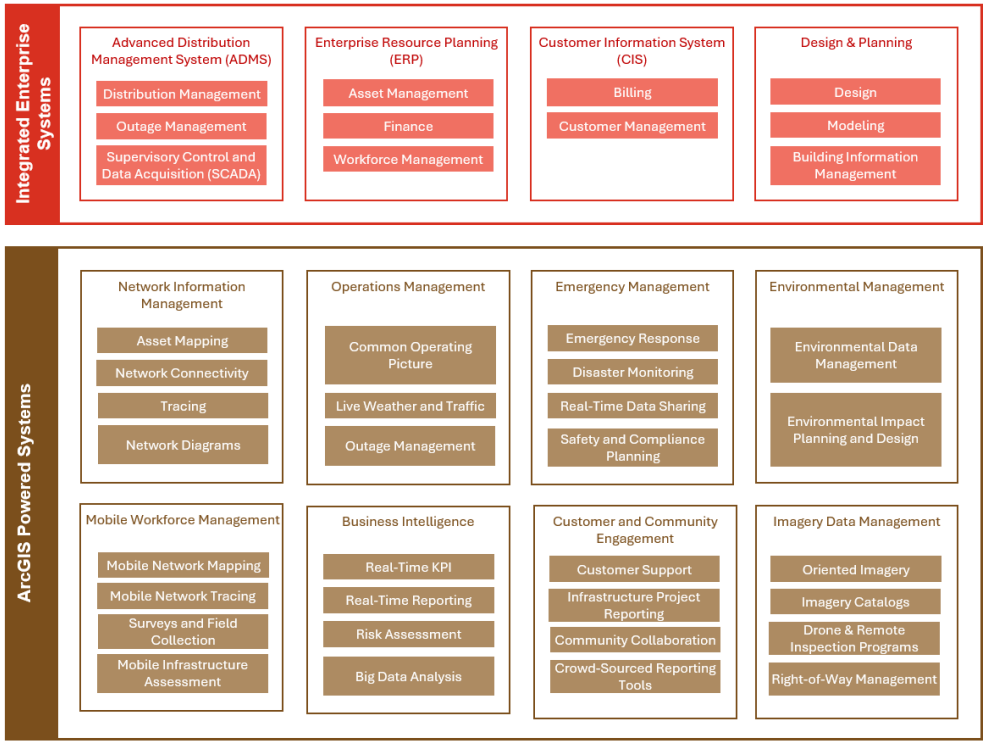
The following sections will provide insight into architecture and system patterns powered by ArcGIS to help utilities enable their business systems with confidence.

Related resources:

- ArcGIS architecture
- ArcGIS for Energy Utilities

Utility systems powered by ArcGIS

ArcGIS is designed to enable collaboration across systems. This interconnected approach ensures that one business system can serve as an ancillary component to another, highlighting the complementary nature of these solutions and maximizing their collective value.



Utility network information management systems frequently act as foundational collaborators, integrating with various systems to enhance overall functionality. Community utility systems powered by ArcGIS include:

- Network information management
- Operations management
- Emergency management
- Environmental management
- Mobile workforce management
- Business intelligence

- Customer and community engagement
- Imagery data management

Network information management system

A network information management system is built upon a network information model designed to enable different kinds of user personas across an organization to create, edit, maintain, view, and analyze network features and relationships across an as-built network. This ArcGIS powered system provides the core foundation for utilities to maintain a system of record.

Utilities have flexibility in determining their own path to adoption of a modernized network information management system, enhancement of operational efficiencies, and adoption of emerging industry requirements.

Capabilities provided by a network information management system include:

- Asset location mapping and visualization with spatial or location context
- Query by attribute, geometry, and geography
- Data management and editing through desktop, mobile, and web applications
- Integration with other business systems (SCADA, ERP and EAMs), geospatial and non-geospatial through data or service-based integration
- Network diagrams for visualization and operational insight
- Analysis of network connectivity and device status
- Flexibility in implementation profile to meet an organization's business and technical requirements

Learn more about the reference architecture for a Network information management system pattern.

Operations management system

Operations management plays a fundamental role in utility network management by providing the decision-makers and stakeholders involved in day-to-day operations with the ability to consume, share, and analyze geographic data regardless of their technical background. The capability to process and analyze real-time data streaming enhances operational efficiency and supports timely decision-making. As utilities integrate network management with other business systems, having a platform that empowers staff to discover and make decisions based on up-to-date, authoritative data drives bottom-up efficiency and improves organizational operations.

Utilities have complex networks of assets to maintain. Operations management is a key element of successful maintenance and administration. The ability to provide stable, reliable geospatial content and functionality to stakeholders who do not possess significant technical expertise or GIS knowledge enables:

- Establishment of a common operating picture through which all stakeholders can share an explicit understanding of the current status of their utility system(s)
- Delivery of real-time access to event specific updates and alerts, such as weather and traffic, that have the potential to impact stakeholders and assets
- Management of outages, relights, track and trace operations, damage assessments, and similar activities to ensure swift response and recovery

Learn more about the ArcGIS system patterns that enable operations management systems:

- Real-Time data streaming and analytics system pattern
- Enterprise application hosting and management system pattern

Emergency management system

Emergency management plays a vital role in utilities by providing them with the ability to monitor, analyze, and respond to emergencies. As utilities modernize their infrastructure and integrate network management, having a system that enables situational awareness and decision making is crucial for mitigating risks, minimizing disruptions, and helping to ensure public safety.

Utilities face a wide range of emergencies, including wide-spread power outages, gas leaks, water main breaks, wildfires, and extreme weather events. The ability to ingest, visualize, and analyze real-time data from sensors, IoT devices, and emergency reports empowers utilities to:

- Detect and respond to outages or infrastructure failures in real time to minimize service disruptions
- Monitor environmental conditions, such as flooding, wind speed, or seismic activity, to anticipate potential network disruptions and use predictive mitigation strategies to minimize impacts
- Automate alerts and dispatch field crews to affected areas based on live sensor data and predictive analytics
- Enhance safety and compliance by integrating emergency response plans with local agencies, ensuring a coordinated response to disasters
- Support real-time data sharing with first responders, government agencies, and disaster management teams

Additional resources:

- Learn more about the Real-time data streaming and analytics system pattern, a foundational ArcGIS system pattern that enables emergency management systems.
- Learn more about Emergency and Disaster Management with ArcGIS.

Environmental management system

Utilities manage assets that exist and operate within the natural environment. Environmental management plays a critical role in ensuring that stakeholders are informed about the potential needs, impacts, and opportunities related to the intersection of the utility's assets and the surrounding environment.

The ability to deliver authoritative environmental information to key stakeholders through Enterprise application hosting and management requires utilities to maintain rigid technical requirements, structured workflows, and comprehensive governance. As a result, this utility system enables asset planning efforts to strive for sustainability and focus on reducing the environmental footprint.

Utilities strive to ensure high trust in the accuracy, readiness and availability of the data displayed via their enterprise applications. An Environmental Management system benefits the organization by:

- Maintaining and enriching a Parcel management system with asset and environmental data
- Ensuring that field crews can identify areas of environmental sensitivity so that they traverse them in an appropriate manner
- Empower engineers and construction leads to understand the impact of their designs on local communities and the environment
- Providing general users with a performant, reliable, and authoritative platform on which to perform their environmental management workflows

Learn more about the ArcGIS system patterns that enable environmental management systems:

- Enterprise application hosting and management system pattern
- Self-service mapping, analysis, and sharing system pattern

Mobile workforce management system

Mobile workforce management plays a critical role in utility network management across all levels by providing field teams with access to view, update, and interact with network information from the field. As utilities modernize their infrastructure with the network information management model, integrating mobile operations and offline data management ensures coordination between the office and field.

Utilities rely on accurate network information to maintain infrastructure, conduct inspections, and respond to service disruptions. Mobile operations and offline data management provide a system to leverage network models for field operations by enabling field teams to:

- Access network maps and asset data from the field
- Improve asset lifecycle management by capturing infrastructure conditions and supporting proactive maintenance
- Improve operation and maintenance by providing field teams with network tracing capabilities
- Conduct surveys and field collection for damage assessments, collect breadcrumbs for inspection compliance, and similar activities to enhance data accuracy and operational effectiveness

Learn more about the Mobile operations and offline data management system pattern, a foundational ArcGIS system pattern that enables mobile operations and offline data management systems.

Business intelligence system

Business intelligence empowers utilities to determine risk, improve planning activities, and enhance their reporting capabilities. As utilities plan infrastructure modernization projects, it's critical to leverage big data analytics to ensure that the most high-impact projects are identified and initiated. Utilities that excel at spatial intelligence also ensure accurate regulatory reporting and can deliver in-flight project status tracking to key stakeholders by leveraging location services.

Business intelligence provides enterprise-wide support for:

- Identifying risk to assets and determining the best mitigation strategy
- Ensuring that reporting data is up-to-date and accessible by service on any device, at any time.
- Leveraging big data to analyze the best investment opportunities and modernization targets
- Delivering real-time, asset-specific key performance indicators

Learn more about the ArcGIS system patterns that enable business intelligence systems:

- Location services system pattern
- Big data analytics system pattern

Customer and community engagement system

Customer and community engagement, facilitated through the self-service mapping, analysis, and sharing system pattern, plays a crucial ancillary role in utility network information management by providing a mechanism for utilities to interact with customers, stakeholders, and the broader community. As utilities modernize their infrastructure and integrate advanced GIS capabilities, transparent communication and self-service options become essential capabilities for operational efficiency and customer satisfaction.

By their nature, utilities need to engage with the communities they serve. This engagement may take the form of project tracking dashboards intended to inform stakeholders about ongoing modernization efforts, weather-driven alerts such as unseasonably low temperatures, or solving localized problems through the analysis of information presented via authoritative applications. The ability to support enterprise application hosting and management augments the capability for a diverse set of personas to discover and utilize geographic data to improve their decision-making.

Utilities serve a wide range of stakeholders, including customers, government agencies, and emergency response teams. The self-service mapping, analysis, and sharing system pattern enables organizations to share necessary network information, outage updates, and service plans in a secure, flexible manner. Key capabilities include:

- Improve customer trust and satisfaction by offering self-service portals that allow customers to view outage maps, service availability, and planned maintenance schedules.
- Real-time updates on infrastructure projects, enabling proactive communication with communities regarding service disruptions and improvements
- Crowd-sourced reporting tools, allowing customers to report service issues such as leaks, power outages, or infrastructure damage
- Integration with customer service platforms, providing support teams with accurate network data to assist customers effectively

Learn more about the ArcGIS system patterns that enable customer and community engagement systems:

- Enterprise application hosting and management system pattern

- Self-service mapping, analysis, and sharing system pattern

Imagery data management system

Large collections of aerial, LiDAR, elevation, multidimensional, and oriented imagery play a crucial role in the operation, management, and modernization of utility infrastructure. Utilities often need to capture, store, deliver, and/or consume thousands of collections worth of imagery data.

An imagery data management and analytics system can support a utility through many use cases and projects. The system can be designed to implement data in multiple formats from multiple sources and data collection methods to standardize the imagery offerings across the organization.

Utilities leverage imagery and raster data to support a variety of workflows that range from change detection for right-of-way management, pervious surface mapping, and remote inspections. The imagery data management and analytics system pattern enables organizations with the capabilities to support their operations and stakeholders. Key capabilities include:

- Design, implement, and administer right-of-way management programs that leverage machine learning and object detection workflows
- Implementation and administration of drone programs for on-demand and scheduled inspection of assets and collection of aerials, oriented imagery, and LiDAR
- Oriented imagery catalogs are used by utilities to perform remote inspection of assets, maintain historical records of asset condition, and can be used for asset collection.
- Having a catalog of LiDAR data provides utilities with elevation data which can be used for modeling stormwater sewer sheds, validation of surveyed assets, vegetation change detection, and engineering design
- Catalog and maintain a collection of current and historical ortho mosaics for temporal base mapping in engineering design, visualization, and field wayfinding

Learn more about the Imagery data management and analytics system pattern, a foundational ArcGIS system pattern that enables imagery data management systems.