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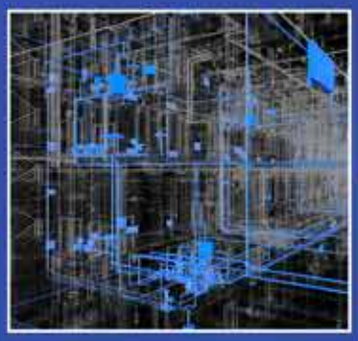
ArcIndia News



COVER STORY
Reinventing utilities for a sustainable digital future

CASE STUDY
Optimizing asset inspection and maintenance using GIS

ARTICLE
Making the best of our water through geo-enabled automation

PRODUCT REVIEW
ArcGIS Utility Network

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FROM THE MD'S DESK

It is not just about our day to day lives, utilities today have a strong bearing on the nation's economic growth and social wellbeing. As economic growth triggers utility demand, changing lifestyles and consumer behaviors are adding pressure on the utility infrastructure. Striking a balance between supply-demand, source-consumer, policy-regulatory environment, and operational challenges in the backdrop of the inevitable impacts of climate change, utility companies are constantly striving to address the expectations of their stakeholders.

As the global efforts towards clean energy and decarbonization are being ramped up, it is no secret that utilities have a vital role to play. While taking a lead with sustainable initiatives, utilities are also on the lookout for avenues that can make a difference in the way they can grow their business while safeguarding the future of this planet. The need for agility and resilience is forcing utility CXOs to reinvent at both strategic and operational levels through digital interventions by contextualizing their business processes. Digitalization of infrastructures, smart meters, smart sensors, IoT devices and smart solutions have been on top of the agenda for most utilities in recent times.

As utilities step into the digital future, for them to stay ahead, technology interventions need to be contextualized on a common ground for better situational awareness along with actionable intelligence for informed decisions. One glaring commonality, often overlooked, is that more than 90% of utility enterprise has a context of location associated which can be easily harnessed for the greater good at a minimal cost.

Esri's ArcGIS has been playing a pivotal role in supporting organizations to harness untapped location intelligence and reinvent their journey into the digital future geospatially. ArcGIS Utility Solutions are making access to contextualized information easier than ever before, helping utility CXOs to address their priorities better, strengthening their ability to stay agile in the changing times and grow sustainably.

Agendra Kumar
Managing Director, Esri India

Making it easier, faster, and cheaper than ever, ArcGIS is providing an opportunity for utilities to proactively interact with every asset and consumer. By augmenting existing frameworks with ArcGIS Utility Network, utility CXOs can enhance their business value delivery while optimizing operations for improved efficiencies and increased customer satisfaction, paramount for a sustainable future.

Recognizing the unique nature of challenges Indian utilities face, our ArcGIS Utility Solutions are being tailored to help utilities to maximize their technology ROI. Our teams are making special efforts to interact with utility CXOs and users in person to understand their pain points and expectations for a sustainable digital future.

As organizations get ready to welcome 2023, we at Esri India are excited and geared up to help our users be more successful. Our multi-disciplinary teams continue to ramp up their efforts to support our customers in their journey into a sustainable digital future.

Esri India takes another step towards building the country's geospatial workforce

Esri India has announced a Scholarship Program for M.Tech students. As part of the program, scholarships worth INR 10 lakh will be awarded to 10 M.Tech students every year. The program is planned to be run for 10 years. The merit-based scholarships of INR 1 lakh each will be awarded to students pursuing the M.Tech (Geoinformatics) program in selected colleges and universities of the country. The scholarship aims to prepare the students for a career as geoinformatics analysts, data scientists, GIS developers, GIS engineers, and other in-demand professionals.

Commenting on the development, **Agendra Kumar, Managing Director, Esri India** said, "There is an increased demand for GIS skilled professionals across sectors. The use of GIS technology is not only crucial for creating a sustainable future but also for driving growth to take India towards its goal of building a $5 trillion economy. According to government estimates, the increased usage of GIS is likely to create 10 lakh jobs by 2025. This M.Tech scholarship will encourage students to gain higher competence in GIS and help them become job-ready. This is one of the many steps taken by Esri India to strengthen the geospatial skill development in the country."

Esri India has been collaborating with academic institutes at all levels by way of learning resources, events, and training programs so that students can embark on GIS education, training, and research in a timely manner. The company has been promoting GIS know-how through various programs like Esri India GIS Academy Program (EIGAP), Young Scholar Program, mApp Your Way, and more.

Esri India offers GIS on Cloud

Esri India announced the availability of its Indo ArcGIS offerings on Indian Public Clouds along with services at GeoSmart India 2022. Organizations will be now able to procure Cloud infrastructure, Indo ArcGIS Pro and Enterprise software, and managed services from Esri India, removing complexity and speeding up their enterprise GIS journey. This will also facilitate easy migration of existing on-premise geospatial infrastructure to the Cloud, to fuel faster adoption and easy expansion of the Indo ArcGIS system.

On the occasion, **Agendra Kumar, Managing Director, Esri India**, said, "The GIS ecosystem has seen exponential growth in the past few years. We see the expansion of our Cloud footprint as yet another opportunity for us to enhance the quality of experience we provide to our customers and drive technology adoption. Indo ArcGIS on Cloud comes with the promise of empowering customers with higher utilization of the latest technologies at a lower total cost of ownership. The aim is to offer a reliable, secure, agile and cost-effective infrastructure for GIS solutions."

Indo ArcGIS on Cloud will provide location-based insights and innovative tools such as predictive analytics, AI/ML integration and other cutting-edge mapping tools to help organizations in realizing the power of 'location' in a flexible and easy-to-deploy manner and deliver increased business ROI.

Esri India marches ahead with 51% Indian ownership

Agendra Kumar, Managing Director, Esri India has consolidated his holding in the company to over 51%.

With this step of majority Indian ownership, Esri India will again be recognized as an Indian company under the guidelines of DPIIT and DST. Esri India was established in 1996 as part of NIIT group, with NIIT Technologies Ltd. holding majority shares. The Government of India announced new guidelines for Geospatial Data last year. Being an Indian entity, Esri India will be able to acquire, process, store and disseminate geospatial data without any restrictions. Esri India already offers more than 630 layers of geospatial data and over 130 solution products developed in India for its users through Indo ArcGIS and this Indian ownership will create more avenues for India-specific offerings.

With over 6 lakh users of Esri technology in India, Esri India counts more than 800 degree-granting colleges and universities, many smart cities and urban local bodies, government mapping agencies, state forest and water resource departments, and leading manufacturing and telecommunication companies amongst its customer base of more than 6000 organizations.

As an Indian entity, Esri India is poised to add many more credible names to its customer base, and much higher growth in the number of users and revenue in the years to come.

Esri India launches carbon footprint awareness app

Esri India has launched an app in Hindi and English to enhance awareness about carbon footprint at an individual level. 'Carbon Jagruk' or 'CarbonAware' app enables citizens to estimate and reduce their carbon footprint. The application is extremely simple to use. It requires no login or download and collects no personal information of the user.

The announcement is part of Esri India's endeavor to promote a sustainable lifestyle through carbon-conscious behavior and choices. This app will help in estimating the causes of a higher carbon footprint at the community level. Esri India plans to share this data with local administrations so that they can take measures to educate citizens.

Every time we travel by car, take a flight, or use an electrical appliance we leave a trail of gases that build up in the atmosphere and contribute to global warming. These emissions are forcing our climate to change for the worse. The CarbonAware App is an initiative by Esri India to help each one of us to understand how much carbon footprint we are creating at an individual level and what we can do to reduce it.

According to **Agendra Kumar, Managing Director, Esri India**, " In an effort to stave off the worst effects of climate chnage such as drought, flooding and loss of species, bringing carbon dioxide (CO2) emissions to 'net zero' by 2070 is the way to go for us a nation. Our Hon'ble Prime Minister, Shri Narendra Modi introduced the terms 'LIFE' – Lifestyle for Environment and 'Pro Planet People' to make people think and be more environment-conscious. Esri India's Carbon Aware App is a step in our sustainability journey, aimed at helping people in thinking, curbing and regulating their carbon footprint. It will help people move towards a more eco-conscious, sustainable way of living, through a carbon-conscious lifestyle." To appreciate the user's efforts in taking part in this campaign and understand their carbon footprint, the app also gives the option to download a certificate at the end. To use the app go to: **https://carbonaware.in**

Esri India launches Policy Maps

Esri India has unveiled Policy Maps to facilitate data-driven policymaking in India. The announcement was made during Esri India's annual flagship event, the User Conference. The Policy Maps have been designed to provide meaningful insights for various government functions with a special focus on Sustainable Development Goals (SDGs). The maps for SDGs provide detailed insights into how India is faring in the achievement of the 17 SDGs. The interactive maps provide data at the granular level and help in analyzing the progress achieved. The data used in Esri India Policy Maps is sourced from authoritative government sources.

A unique feature of the Esri India Policy Maps is that they can help policymakers to understand the relationship between various SDGs. Relationship Maps, created through the dashboard can help in identifying patterns and understanding how working towards one SDG can lead to creating better conditions for another SDG.

Agendra Kumar, Managing Director, Esri India said, "Spatial data can largely help in policy-level decisions. With an intent to enable policymakers to make data-driven decisions, we have developed Esri India Policy Maps. These maps, which have a distinct focus on SDGs, can help in measuring progress as well as identifying relationships between the SDGs. By bridging the gap between data and action, the Policy Maps have the potential to help administrators take smarter decisions for sustainable development."

The link to access the Policy Maps is: **https://policymaps.esri.in**

Esri India Inks MoU with TEXMiN – IIT (ISM) Dhanbad

Building GIS capabilities for exploration mining

Esri India has signed a Memorandum of Understanding (MoU) with Technology Innovation in Exploration & Mining Foundation (TEXMiN) to set up a Geospatial Excellence Centre at the Indian Institute of Technology (Indian School of Mines), Dhanbad. The TEXMiN - Esri Geospatial Excellence Centre at IIT (ISM), Dhanbad will focus on research and innovation in spatial analytics and remote sensing for mining and exploration.

Agendra Kumar, Managing Director, Esri India, said on the occasion, "Location Intelligence is fundamental across the mining life cycle, from mineral exploration to mine remediation. With minerals getting depleted faster than we can replenish, understanding spatial context and integration with other geoscience technologies is critical for the sustainable development of new reserves. With an intent to make future mining professionals spatially intelligent, we are partnering with TEXMiN Foundation and setting up a Geospatial Excellence Centre at IIT (ISM) which will aim at fostering research, innovation, and developing novel solutions for the petroleum and earth science industry."

Dheeraj Kumar, Project Director, TEXMiN & Deputy Director, IIT(ISM) Dhanbad shared, "The objective of TEXMiN is to promote the use of the latest technologies in mining and exploration. GIS can help mining professionals meet the complex challenges of mining operations by providing the necessary tools to visualize and analyze volumes of spatial data. With an intent to build the GIS capabilities of future mining professionals, we are collaborating with Esri India to set up The TEXMiN - Esri Geospatial Excellence Centre. This initiative will help us transform TEXMiN into a single platform for professionals in leveraging spatial analytics & remote sensing for mining and exploration."

Reinventing utilities for a sustainable digital future

Electric and telecom networks have today become the backbone of economic activities, while water, oil and gas continue to be the mainstay for fulfilling basic industrial and human needs. Contributing 2.7% directly to India's GDP (2021-22), electricity, telecom, water, and gas utility services make a significant impact indirectly on the economic, social, and environmental fronts.

Utility challenges and priorities

While economic growth instantly triggers utility demand, changing lifestyles and consumer behaviors add pressure on the utility infrastructure to ensure the provision of their services. Increasing population and industrialization are constantly adding stress to utilities on the demand side, while the supply side continues to be constrained due to financial challenges and dependence on natural resources.

Utilities continue to be pitched against ageing physical infrastructure with poor operational efficiencies, limited avenues for revenue and digital savvy "prosumers" with rapidly evolving expectations. Most of the utility assets and networks are physically exposed and highly vulnerable to disruption by the act of nature or humans. Striking a balance between supply-demand, source-consumer, policy-regulatory environment and operational challenges, utility companies have been constantly striving to address the expectations of their stakeholders.

Rapidly changing dynamics of the industry, depleting natural resources, evolving consumption patterns, and the imminent need for agility and resilience in the backdrop of natural disasters are forcing utilities to adopt innovative ways to plan, design, operate, monitor, and manage at both strategic and operational levels. Some of the immediate priorities for utility CXOs are:

- Reduce the divide and widen the consumer base
- Improve asset monetization and resource sustain ability
- Optimize operational costs and improve margins
- Redefine consumer engagement
- Improve agility and strengthen resilience
- Explore new business models and revenue streams
- Prevent cyberthreats and ensure regulatory compliance

With changing times, utilities too are recognizing the need to address strategic and operational challenges through digital interventions by contextualizing supply-demand and understanding them in the context of source-consumer while ensuring compliance with regulatory requirements.

Going digital

It is no secret that digital transformations are ushering governance, businesses, and societies into a new era. As digital interventions continue to proliferate, dependence on digital solutions for sustainable economic growth becomes inevitable. Digitalization of infrastructures, smart meters, smart sensors, IoT devices and smart solutions are on top of the agenda for most of the utilities embarking on their digital transformation journey.

With increased automation, better accuracies and real-time information, these technologies are helping in improving productivity, efficiency, safety, compliance, and reliability. Followed by better asset management, planning, execution, and faster level of service with higher customer satisfaction. This is also transforming the way utilities interact with their infrastructure and customers.

As digital solutions find their way in, utilities are also staring at a web of direct real-time-intelligent devices and systems generating petabytes of data every passing minute, challenging them to unravel and demystify to make better sense. This large volume scattered across the ecosystem is a goldmine that utilities can dig into, to contextualize their business operations. And by not exploiting this hidden power, utilities are depriving themselves and their stakeholders of benefits. Once successful, utilities have numerous opportunities that can be tapped including graduating towards demand-based generation and distribution, while at the same time providing consumer centric tailored services.

Interestingly, as utilities try to navigate their way in the world of "digital transformation" every effort turns out to be a realization and a story to be told. Easier said than done, implementation of "Digital Utility Solutions" are laden with challenges and unknowns.

Heralding into a contextualized world

As utilities step into the digital future, decision-making at every strategic and operational step will have to be backed with data and insights in the context of the subject that is under review. Digital transformation initiatives also call for innovative approaches and technologies that not only harness the large volumes of data, but also are self-learning, able to analyze and reproduce insights and can be tailored to geographies and situations. By virtue of their inherent design, traditional technologies often pose limitations in looking beyond their boundaries and fall short of providing a holistic picture of the business processes and consumers.

While demand ushers growth and competitiveness, utilities are under constant pressure to respond rapidly to changing business landscape. For utilities to stay ahead, their strategies need to be contextualized and centric to consumer and their behaviors. And this can be only done by connecting assets, people, and processes. And thus, the need for enhanced situational awareness of their landscape with actionable intelligence for advancing their customer experience becomes more than ever.

One glaring commonality, often overlooked, is that more than 90% of utility enterprise has a context of location associated which can be easily harnessed for the greater good at a minimal cost. Be it supply-demand or source-consumer, the context of geography is the common binding factor that can help utilities reinvent themselves for a sustainable digital future.

By helping utilities to map a common ground, Esri's ArcGIS has been playing a pivotal role in supporting them to reinvent their journey into the digital future. Providing a robust platform with tools, utilities can geo-enable their environments with simplicity and leverage 3As (Access, Awareness and Analytics) to start with.

- **Access** by connecting everyone with maps and data facilitating improved availability of information on demand-supply, source-consumer, assets, plans, compliance issues, and future scenarios in one place.
- **Awareness** by providing enhanced visibility of their subjects in the context of their geographical location whilst helping them to keep a pulse on supply-demand, source-consumer, real-time weather, traffic, disasters, etc. arming them with the ability to respond rapidly to evolving situations.
- **Analytics** of all subjects on a unified platform revealing relationships, patterns, trends, and insights from volumes of disparate data for decision support in monitoring, managing, and predicting future scenarios.

Further by bringing in all the elements that are needed to contextualize and solve utility challenges on a common platform, ArcGIS powered geo-enablement arms utilities with 3Ss (System of record, System of engagement, and System of insights) in a language of maps that is understood by all and easy to use.

- **System of record** - ArcGIS gives utilities a design and build data models, providing ease of editing, expanding connectivity capability, and scaling to any size.
- **System of engagement** - ArcGIS integrates all types of data, gives all users access to the data they need for better collaboration, and supports digital transformation.
- **System of insights** - ArcGIS features real-time business intelligence (BI) dashboards and includes out-of-the-box analytics that uncovers never-before-seen patterns. It reveals secrets in the data and unnoticed trends.

Maximizing geographic potential

Globally, GIS has proved to be an irreplaceable tool for demystifying utility data and providing location rich "contextualized" insights. For addressing the complex challenges utilities are faced with, "Geo-Enabled Smart Utility Management" approach provides a bird's eye-view of the utility infrastructure with the ability to narrow down to individual asset and consumer.

Along with tools for analysis, visualization, modeling, and collaboration - GIS amplifies the digital utility operations multifold by enhancing situational awareness along with actionable intelligence for informed decisions both at regional and local levels. While helping to avoid "data traps" the context of geography aids utilities to discover, democratize and contextualize ever-increasing volumes of data by providing stakeholders with the power to see, visualize, detect, assess, and respond.

Benefits of harnessing geographic potential

- Provides a bird's eye view of utility infrastructure from source to consumer, with ability to drill down to finer details on click of mouse
- Access data that is contextualized, can be intuitively visualized, and analyzed for location specific temporal patterns and trends
- On-demand location specific operational picture and actionable intelligence for decision support
- Real-time, non-intrusive monitoring of resources and assets, improved prevention of pilferage and safety of assets
- Anywhere, anytime contextualized & real-time information for customers and other stakeholders
- Improved outage management and reduced down-times, and tailored predictive maintenance
- Optimized mobile workforce management, improved operational fleet management, optimized routing and fuel savings
- Targeted energy consumption management and costs, predictive modelling, and simulation
- Better disaster preparedness and emergency response
- Improved agility, adaptability, sustainability and resilience

With Esri's ArcGIS platform at the center-stage, Indian utilities have been increasingly harnessing the geographic potential in the last few decades. By geo-enabling their infrastructures, utilities capture, store, manipulate, analyze, manage, and present, data from disparate sources across networks on a unified platform. Thrissur Municipality, Orange City Water (Nagpur) and Municipal Corporation of Greater Mumbai (MCGM) have taken lead in geo-enabling automation of their water / wastewater utility operations.

Facilitating planning, design, monitoring and maintenance of networks, GIS technologies are becoming invaluable to utilities for strategic and operational decision support in the management of - land information, distribution, transmission, outages, workforce, revenue, compliance, network integrity, surveillance and infrastructure protection and emergency response. In the power utility sector - Reliance Infrastructure, Sterlite Power, Tata Power, BSES Yamuna and many state owned discoms are leveraging ArcGIS to improve their operational efficiencies, reduce AT&C losses while providing enhanced services to their consumers.

Globally geo-enabled automations are proving to be irreplaceable tools for demystifying utility ecosystem intricacies while providing "contextualized" insights. In the telecom sector, Airtel and Reliance Jio rely on ArcGIS for their network operations, asset management, workforce management, marketing, and customer service improvement. And in the oil and gas sector ONGC, GAIL, IOCL, BPCL, Adani TOTAL GAS, Green Gas, BVRL, MNGL and many others have been leveraging ArcGIS for their operations and asset management.

Seamless flow of data and information from legacy systems, sensors, IoT and smart devices onto a common platform are enabling utilities to respond faster to strategic and operational contingencies. National Smart Grid Mission Project Management Unit (NPMU) and some utilities have taken a step forward by integrating their ArcGIS enterprise implementations with IoT, SCADA, SAP and other ERP systems and extending them to ArcGIS based field tools to leverage their investments for advanced distribution management operations.

These ArcGIS powered interventions have improved operational efficiencies, while significantly improving business continuity and uptime, while enhancing quality of services and resource productivity. Geo-enabled network mapping and asset mapping are enabling quicker detection of faults for faster response while at the same time achieving better management of their assets and resources. These utilities are now advancing towards harnessing location intelligence from all quarters for 360 degree contextualized insights to address strategic and operational priorities.

It is noteworthy that only a small part of the available geographic potential is being currently tapped. With still a lot of potential available that can be leveraged, utilities are gearing up for advancing their geo-enablement efforts for a sustainable digital future. By leveraging machine learning and artificial intelligence, utilities are now aiming to exploit the advanced capabilities for predictive modelling and simulation.

Advancing into a sustainable future

For advancing into a sustainable future, utilities need a robust framework that can contextualize their processes, systems and resources for actionable information while ensuring a safe working environment, delivering reliable services, and maintaining a focus on customer support. Utilities need solutions that can serve as the system of record for the assets and provide information about the past, present, and planned future state of a utility network system. And that is accessible and available anytime-anywhere to all stakeholders.

Some of the technological advances that are at the disposal of utility CXOs to make better contextual sense from the exponentially increasing data volumes for advancing into a sustainable future are:

- Faster computing available at lower costs and their ease of integration with non-spatial enterprise systems with ever increasing volumes of geo-data from UAVs, satellites, LiDAR, and other IoT sensors, along with crowdsourced data.
- Developments in image recognition and feature extraction, coupled with reduced storage costs, are fostering faster data capture and geospatial content creation. Enhancing the quality and accuracy of High Frequency Indicators (HFIs) for constant monitoring and iterative adaptations for dynamically evolving situations.
- "Digital twins" and "virtual utility models" offering an immersive experience and newer opportunities for businesses to access the metaverse in multiple ways, transforming the way utilities interact with their physical assets and infrastructure.
- Emerging cloud based geospatial data/content management tools and capabilities revolutionizing capture, maintenance, and management. Helping utilities to take away the burden of managing the infrastructure and associated challenges.
- Geospatial information combined with other statistical data providing ability to utilities to address ESG challenges with ease. Helping them in regulatory compliance.
- Spatial modeling and analytics, artificial intelligence, machine learning and deep learning.
- Geoinformation driven experiences through mobiles transforming consumer behavior and triggering demand for dynamic, proactive, and even prescriptive, location specific personalized utility services.

And to siege the opportunities they present; utilities need to be ready with next generation information systems that provide advanced spatial capabilities for contextualization by harnessing massive datasets at every scale of resolution.

Such solutions need to be:

- Industry focused and can be configured for any utility (municipality, or organization with linear assets (electric, gas, and water utilities, architecture, engineering, construction (AEC), and telecommunications).
- Allow utilities to model operation and structural networks in an integrated fashion with network rules to build networks that suit business requirements.
- Are scalable and drive better decision-making with high-quality data with right tools for data collection modeling, and analysis.

ArcGIS Utility Solutions are making access to contextualized information easier than ever helping utility CXOs to address their priorities better than before. They are helping organizations to stay agile in the changing times and drive innovation. Making it easier, faster, and cheaper than ever, ArcGIS is providing an opportunity to utilities to proactively interact with every asset and consumer.

By augmenting existing frameworks with A**rcGIS Utility Network**, utility CXOs can enhance their business value delivery while optimizing operations for improved efficiencies and increased customer satisfaction, paramount for a sustainable future. Designed to be the next generation spatial information system, **ArcGIS Utility Network** provides a comprehensive solution for a smooth transition of utilities to be future-ready.

Reinventing geospatially

As a force multiplier, geo-enabled smart utility management is helping utility CXOs to reinvent their business processes in newer ways, like below, for a sustainable digital future.

1. **Next generation data management** – is improving data quality and support analytics to detect patterns and reveal trends for data-driven decision-making.
2. **Real-time communication and collaboration –** is helping in improving efficiency and providing information when it's needed the most.
3. **Data-driven decision making –** is helping CXOs to devour underutilized data with world-class analytics leveraging spatial analysis, machine learning, big data analytics, and image processing and
4. **Digital twin technology –** is helping to connect information, systems, models, and behaviors with spatial context, creating holistic 3D digital representations of environments, assets, networks, and cities.

Enhanced contextualization provided by ArcGIS is enabling digital transformation of utilities, while at the same time positioning them better to progress towards a demand-based generation/distribution and consumer centric tailored services. As an extensive information system that enables new results—solutions that devour underutilized data, harness analytics, and run on any device, ArcGIS based smart utility solutions are helping utilities to reinvent geospatially. ArcGIS catalyzes the improvements utilities desperately seek today and will be seeking tomorrow.

Taking advantage of combined power of computing and the cloud, ArcGIS's cloud-based offerings provide scalable computing, storage of large datasets, big data computation, and the ability to surge resources during critical events such as emergency response. The geospatial cloud strategy allows quick integration and analysis of large datasets and imagery at scale for even the largest utilities in the world. The combination of advanced spatial analytics and new AI tools helps model and visualize complex patterns, relationships, and situations.

Leveraging services-based architecture, ArcGIS Utility Network is a next generation network management framework designed to modernize utility networks with the right tools for data collection, modeling, and analysis and provide secure data access for users across every platform for informed decisions.

Doing away with silos to manage domain specific requirements, ArcGIS Utility Network equips utilities with a comprehensive framework for modeling contextualized utility systems (electric, gas, water, storm water, wastewater, and telecommunications) and allows to build real-world behavior into modeled networks. Configurable for any utility or organization with linear assets, ArcGIS powered smart utility infrastructure is engineered to work well in cloud environments, in on-premises infrastructure, and in hybrid environments.

Acting as a force multiplier, ArcGIS powered utility solutions are enabling utilities to migrate to a real-world model of their assets, building a stronger system of record, liberate information for all stakeholders – internal and external—creating a dependable system of engagement and capitalize on analytics, growing a system of insight. Facilitating better decision making and providing new and flexible ways to deliver the capability utilities need—where and when it is required.

Benefits of using ArcGIS Utility Solutions

Reduce divide and widen consumer base

Utility networks are trans-geographical with multiple dimensions and stakeholders. Till the digitalization curve matures, understanding the existing and future consumers and scenarios is critical to designing a successful digital utility strategy. With the ability to communicate in a simple language of maps ArcGIS fosters enhanced situational awareness, larger participation, and increased collaboration – reducing digital inequality, while at the same time helping utilities to widen their consumer base.

Improve asset monetization and resource sustainability

Efficient asset monetization relies on asset visibility, asset utilization, and data-systems environments for a better understanding across the entire asset life cycle. ArcGIS powered spatial intelligence enables a holistic approach with fresh insights about asset performance, risks, resources, and costs. Using location, utilities can discover patterns and trends that conventional asset reporting cannot detect. With the ability to build accurate, real-world models of the entire network, GIS provides greater insight into assets – in relation to both their surroundings and their threats.

Optimize operational costs and improve margins

Understanding spatial relationships enables utility organizations to identify, evaluate, and mitigate risks. Dashboards display operational views of work—specific to the user's needs. Seeing field activities in real time improves workflows, resulting in more work completed in less time while optimizing costs. Analytics determine why assets failed, identifies patterns, and trends, and helps focus investment where it is needed most. ArcGIS helps manage data, share information, and visualize system status by providing all the key facts in one place, avoiding confusion, saving time, and providing insight into live operations for timely tactical responses and improved margins.

Redefine consumer engagement

Understanding consumer demographics vis-a-vis consumption patterns, critical assets, and utility projects increases the ability to communicate and engage with them. ArcGIS integrates business systems, providing a holistic view of consumer information in one place. Empowering consumers to access the information they want, when they want it, increases consumer satisfaction. ArcGIS provides better access to the information consumers need (real-time data on service outages, restoration, maintenance, etc.), resulting in more informed, knowledgeable, and satisfied consumers.

Improve agility and strengthen resilience

The advanced capabilities of ArcGIS support utility project planning and management with simplicity, efficiency, and intelligence, improving the agility of utilities. State-of-the-art visualization brings these ideas to life while sophisticated data management and powerful analytics make them real. ArcGIS brings exceptional value to every utility's engineering, planning, design, and construction practice by supporting real-world modeling. Delivering rich visualization and analytics with artificial intelligence (AI), ArcGIS enables immediate coordination and collaboration with stakeholders. By placing the right information in the right hands at the right time, ArcGIS provides all the elements needed to meet planning and engineering challenges and strengthen resilience.

In closing

Overcoming the challenges facing utilities today seems overwhelming at times. As utilities struggle to remain relevant and strive, changes in the utility environment and the explosion of data demand vastly better ways of managing, examining, and communicating utility information.

Owing to the trans-geographical nature of utility ecosystems and their multiple dimensions (political, economic, social, and environmental), just focusing on the assets and/or consumers in isolation is not enough. There is a need for a bird's eye-view that provides us with spatial and temporal understanding of the expanse, dependencies, and linkages at a regional scale. At the same time, there is also a need for minute details at a local scale that provide intelligence for action on the ground, which only GIS provides.

Only geo-enabled smart utility networks can ensure reliability and strengthen the network resilience to bounce back in the event of disruptions. By reinventing their processes geospatially, utilities can not only improve their own operations, but also provide their customers with greater flexibility, transparency, and choice over their services. With the profound impact current utility operations have on the future generations, sooner utilities reinvent themselves geospatially, the faster they can gear up for a sustainable and resilient digital future.

GIS – Key to 5G rollout

5G in India is coming with the promise of not only multi-Gbps speeds, low latency and higher reliability but also a whopping contribution of $450 billion to the economy in the next 15 years. The cumulative economic impact of 5G is estimated to be $1 trillion by 2035 itself. The next-gen technology has the potential to significantly boost India's agriculture, education, manufacturing, healthcare, infrastructure and logistics sectors.

5G will also have a huge social impact, getting highlighted through its contributions to health and well-being, infrastructure development and sustainable industrialization. PwC has highlighted 11 key areas in which 5G can deliver social value that corresponds with the United Nations' Sustainable Development Goals. Keeping in mind these exceptional benefits, it is not surprising that India is focused on becoming Atmanirbhar in telecom and inaugurated its first indigenous 5G testbed (set up at about ₹220 crores) on May 17.

Another big positive outcome of the 5G roll-out will be the creation of more 'private networks' within campuses and facilities. This is already happening at the global level. For instance, Nokia's leading 5G manufacturing plant in Oulu, Finland leverages Nokia's private (4.9G/LTE) wireless networks to achieve secure and reliable connectivity for all assets within and outside its factory. This has led to more than 30% increase in its productivity, 50% time savings in product delivery to market, and cost savings of millions of Euros annually. Indian industries are getting prepared to bring such improvements home with 5G. As per Deloitte's 'Global Advanced Wireless Survey – India edition, 80% of Indian enterprises have kept 5G at the top of their priorities list.

GIS will be the backbone technology for India's 5G success story. At Esri India, we have already witnessed the impact of GIS while working with the two major telecom service providers (TSPs) in India, Reliance Jio and Airtel. Using Esri ArcGIS, Reliance Jio rolled out a modern and extensive 4G telecom network comprising more than 250,000 kilometers of fiber-optic cables, covering 29 states, 18,000 cities and over 100,000 villages. By using GIS, Jio achieved large financial and time savings during the network build phase itself. It has also observed multi-fold improvements in field operations with the use of ArcGIS.

Eliminating today's network deficiencies with GIS

To successfully deliver the promises of 5G, TSPs must eliminate today's network deficiencies, reduce data latency, and expand network coverage to more customers. They need to look at the 'fiberisation' of telecom towers to grow from the current level of 30-35% to 70% or more. The network infrastructure also needs to be upgraded and that would require an entirely new orchestration layer to achieve the critical feature of 5G network slicing. GIS will be the foundation for these modernizations.

Utility Network technology, which is part of Esri ArcGIS, is well-equipped to play a vital role here, enabling TSPs and enterprises to visualize their assets, model operation and structural networks in an integrated fashion, and build networks that suit their business requirements the best. In recent years, many organizations have also moved their core systems to Cloud and looking at using technologies like Kubernetes to run their infrastructure with greater flexibility. ArcGIS deployment with Kubernetes can provide them the benefits of streamlined deployment, scalability, lesser infrastructure costs, capacity building for GIS services, and many others.

By combining machine learning, big-data processing, and predictive analytics technologies with GIS, telecom service providers can analyse similarities among dropped call incidents and create heat maps that highlight specific areas where network quality is subpar. Such comprehensive maps can enable the network planners to identify the right places where they need to add access points for optimal 5G coverage. GIS-powered AI can also help them to identify the infrastructure for the buildout—poles of the right height, buildings that might host antennas along with the emerging hot spots, i.e., areas where subscribers are using more data. These areas will be the emerging market opportunities for the telecom companies and accordingly, they can plan capacity building in these areas.

The network planners can get a full picture of the emerging 5G opportunities by including changing population dynamics in their analysis. For instance, if the smart maps predict significant population growth in a particular area in the next 5 years, it would be more profitable for the 5G planner to invest in setting up the network infrastructure closer to that area.

Reports indicate that Reliance Jio has already taken the advantage of GIS to complete its 5G coverage planning for 1,000 cities. On the basis of targeted consumption and revenue potential, it has generated heat maps and 3D maps, which have helped the company to achieve precise coverage planning. The story will get repeated as other players, both small and big, try to make a mark in the competitive 5G market.

Going much beyond deployment

The role of GIS will continue to be vital even after the 5G networks are deployed. The GIS map that was used throughout the deployment process contains all the data related to design, planning, and construction. With time, as the demands of users will change, so will the requirements of the network. Updated location data will be crucial, and an updated GIS map will become the central source of truth again. It will aid in identifying faulty locations, areas of network expansion, etc. – all leading to quicker resolutions and enhanced customer services. This will minimize downtime and prevent economic losses.

We also foresee a potential convergence of 5G and GIS. 5G will fuel the adoption of GIS technology as it will enable more efficient spatial data creation and this, in turn, will further increase the deployment of GIS applications across industries including e-Governance, Smart Cities, Climate Change, Disaster Management, Defense, Manufacturing, Agriculture, Healthcare and many more. Both 5G and GIS would complement one another and play a transformational role in the success of Digital India.

Optimizing asset inspection and maintenance using GIS

Utility infrastructure networks are massive and complex. Consequently, the process of building, inspecting, and maintaining utility networks is full of challenges. GIS can help utility companies to overcome these challenges and achieve excellence in everyday utility operations, right from asset management to outage management.

Using GIS, utility service providers can track projects, document inspections, and streamline maintenance processes, leading to higher operational efficiency across the board. Quicker resolutions, based on geographic intelligence provided by GIS systems lead to higher customer satisfaction and improved business.

Project Summary

Quicker & effective response to the customer's power outages in today's ever-changing environment is key to achieving Adani Electricity Mumbai Limited's (AEML's) primary goal of enhanced customer satisfaction. To enable this, AEML's Mumbai Distribution Business has implemented an Enterprise GIS solution developed by Esri India. The GIS-based Outage Management System (OMS) has replaced its legacy application, a call-based Complaint Management System (CMS).

The Enterprise GIS solution is aimed to minimize average complaint management time by focusing on network abnormalities rather than customer calls thus improving the overall reliability of the electric system. The system determines the "most probable" location of fault that has taken place in the field on receipt of power outage complaints. With the accurate knowledge of outages & associated up-to-date distribution networks, dispatching outage crew & carrying out the field operations is improved.

Challenges with the CMS

The Enterprise GIS solution has helped AEML to overcome the following challenges that existed with the previous system.

- Managing assets spread geographically
- Reaching asset locations on-time for timely isolation and restoration
- Work-hour loss due to work duplication & subsequent data entry
- Unnecessary efforts spent on tracking jobs
- Delay in site data capture and knowing real-time progress and variance
- Errors in site data capture and having accurate and reliable data
- Non-availability of network data on demand for analysis and value engineering

The Solution

The GIS-based OMS provides a number of advantages over the legacy CMS, some of them are:

- With the introduction of OMS, there is a paradigm shift in the overall approach of managing outages. Now, the focus has been shifted to the root cause of the outages (Network Device level fault, in OMS terminology: Incidents) rather than concentrating on the symptoms (individual customer complaints, in CMS terminology: Calls). This has improved the overall outage management efficiency, fewer outages and better customer satisfaction.
- As a lot of changes are being carried out in the vastly dispersed distribution network, it is vital for the utility personnel in the control centre /outage management centre to know what exactly is happening in the field. The CMS has limitations in providing this critical information since it does not maintain field network snapshots. On the other hand, GIS based OMS provides a common window through which one can visualize & understand network changes & field operations being carried out on near-real time basis without any overhead to operation & maintenance personnel.
- The home-grown legacy CMS provides functionality to attend & handle Customer Outage Calls whereas OMS technology has progressed into determining "where" the actual outage has taken place.

- The dispatcher (Shift Engineers/System Controllers) can quickly view consumer/outage location within OMS. This has improved the dispatching of crews, provided the utility's customer service representatives with up-to-date outage knowledge and increased the overall effectiveness of outage restoration personnel.
- Now dispatcher overhead of performing analytical processing to understand all the outages received from a particular area in case of bulk outages is minimized.
- Even in case of bulk area outages, the dispatcher working on CMS has to manage every complaint. But in case of OMS all complaints received from a particular area, which forms a considerable part of the common feeder/distribution network automatically get attached to common upstream device (i.e. most probable location identified by in-built heuristic engine). This has immensely benefited in saving outage management time.
- Sometimes during the course of outage management, it is necessary to reassign outage complaints to other crews. This was time-consuming in the earlier system whereas OMS provides an effective way of crew re-assignment.
- Instead of the crew providing the affected area information, now Dispatcher is in the position to guide the crew who are not familiar with the feeder network.
- Considering the geographic nature of Mumbai City, a considerable part of the network is laid through the hutment area. Locating outage consumers & their supply delivery points (Service points) that belong to the slum area has been a herculean task earlier. With the help of the new system, now locating outage consumers & their related feeding points is less laborious & efficient.
- Overall reliability of the electric system is improved due to the shorter outages and hence increases overall customer satisfaction level.
- OMS enforces better adherence to the rules (e.g. defining faults in terms of network equipment). This has brought improvement in overall consumer tagging & network updation errors.
- Since OMS keeps a record of all the outages in terms of network abnormalities; it is crucial information for short-term as well as long-term network planning and improvement.
- The underlying application architecture provides numerous advantages for integration. COM and XML (extensible Markup Language), and other existing standards enable the solution to be deployed along with work management systems, customer information system (CIS), and other technical/business systems without the need for proprietary programming tools or closed interfaces. By using open standards, both deployment and maintenance costs of integrated systems are minimized.

Fig 1: GIS View on Portal

Organizational Profile

Adani Electricity is India's largest private sector power distribution utility, distributing electricity for over nine decades in Mumbai, the commercial capital of India. It is the distribution arm of the Adani Transmission Limited (ATL), formed after the acquisition of Reliance Infrastructure Limited's integrated Generation, Transmission and Distribution utilities powering the city of Mumbai. A huge customer base and the spread of electricity distribution has made Adani Electricity, a business powerhouse of Mumbai. The Company owns the largest, advanced and efficient power distribution network which helps in meeting the power demand of 2,000 MW in Mumbai. Additionally, the Company offers, world class customer care service through various customer convenience offerings spanning issuing bills in multiple languages, more than 2,000 payment avenues, 24X7 multi-lingual toll-free number, contemporary customer care centers and a bouquet of other technology-driven and value-added services.

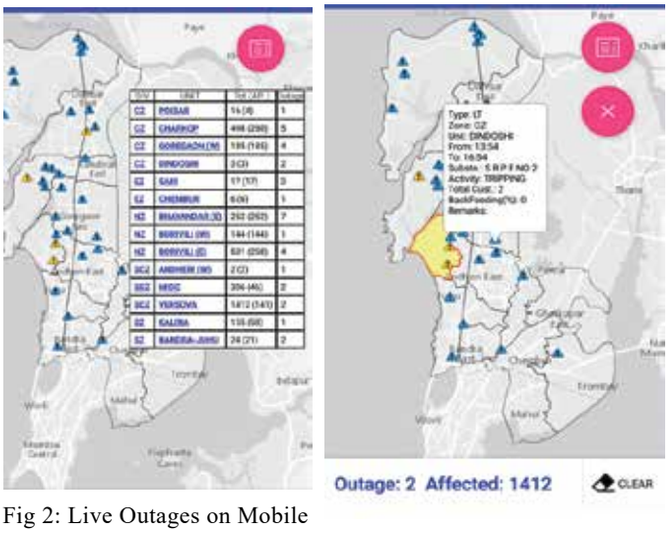


Fig 2: Live Outages on Mobile

OMS also effectively handles the Planned Outage Process by:

1. Creating & executing the switching plans for HT network

Switching orders which include attaching tag-out/lock-out involve isolating specific networks, both electrical and mechanical, from equipment that is to be repaired, inspected, or tested.

2. Ensuring safety

The existing permit process is integrated with OMS. Tag-outs are implemented for related maintenance activities and removed for the return of equipment to service in a timely manner. This ensures the safety of operating personnel and equipment during maintenance and also reduces the length of an outage.

3. Increased transparency

The system provides near real-time operational view including outages, permit issued/put-back, & network operations to all Concerned stakeholders. This provides transparency at all levels and reduces excessive communication among the stakeholders.

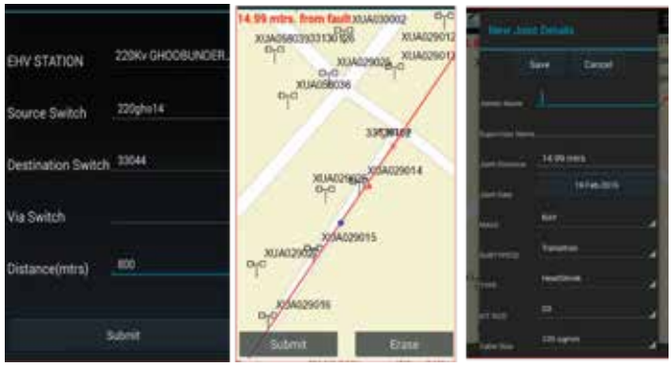


Fig 3: Fault Locator App on Mobile

"With the implementation of GIS, we could achieve a single window concept for viewing assets spread across geographical extents. With the help of COTS functionalities available through the product like Electrical Network Tracing, we could derive Consumers connected to DT/Feeder and vice versa. The software is easy to learn, and comes with a whole range of plug-ins for specific needs. Esri India's GIS solution has given us a platform to view all the utility assets in a single screen which is available to all stakeholders. ArcFM gives the user "a power to trace the electrical network" and identify the assets/consumers related to a feeder. Tracing functionality is one of the backbone tools for the utility industry. With this tool, the user can easily visualize, get instant information and take effective decisions. Esri's GIS system has helped us to achieve higher productivity and deeper insights with many such tools. **- Anand Kumar S V, Addl. VP – IT DevSecOps, Adani Electricity Mumbai Limited**"

Effective pipeline asset management with GIS

Networks of large transmission pipelines form energy highways. These pipelines carry both natural gas and oil over large distances — from remote locations to cities where the products are actually needed. A robust pipeline network is therefore critical for transferring the finished petroleum products to end-users or dependent industries. At the same time, safety is also a very important concern.

The Government of India in association with the Oil & Gas sector has a strong focus on developing a robust pipeline network in various parts of the country. However, numerous challenges occur in the process of planning and finalizing optimum, safe and constructible pipeline routes.

GIS can help Oil and Gas companies overcome these challenges and achieve unmatched outcomes in pipeline route survey, planning, and execution.

Challenges

The process of planning and implementation of gas pipeline routes includes challenges like rugged terrain, landslide, steep sloping ground, extreme weather conditions like flash flood, snowfall, intense summer, environmental sensitivity, major development, etc. Due to these constraints, normal survey procedures fail to give optimum results in pipeline surveying, planning, and execution.

Therefore, it is recommended that Oil & Gas companies use modern technologies for pipeline route optimization. The process involves 3D Modelling Survey using 0.3m /0.4m High Resolution Stereo Satellite Image, followed by the development of an up-to-date GIS Base map using Digital Elevation Model (DEM) and GIS Database with the help of rapid field validation and ortho-rectifications through photogrammetry.

SECON used Esri's ArcGIS platform to customize such a robust system of Pipeline Geographic Information System (PGIS) involving data of pipeline route survey, planning, and execution for GAIL, India's leading natural gas company, helping it deliver unmatched results across the natural gas value chain.

Solutions

GIS mapping and route survey activities for the cross-country pipeline were carried out using modern techniques of surveying. The objective was to achieve optimization of the pipeline route, selection of the most feasible route, and finalization of project planning for engineering including other pipeline related activities. This GIS database comprises of different map layers and associated tables pertaining to pipeline alignment, stations and facilities, dwellings and structures along the pipeline alignment, pipeline depth of cover, points of interest along the route, etc.

Before the finalization of the pipeline route, paper alignment was optimized and validated with the following considerations:

- Safety of public lives, property, and local impact.
- Minimize environmentally sensitive areas, forests, sanctuaries, marine parks, places of worship, burial and public events, annual fairs, mining areas, archaeological importance, etc.
- Future expansion, developments, upcoming projects, townships, layouts, industrial parks, etc.
- Avoid areas likely to have future expansions, especially around built-up/industrial areas.
- Favorable terrain, stable ground, landslips and geologically sensitive areas.
- High ground, deep valleys requiring tunnels and pylons.
- Avoid low lying, flood prone areas, marshy land and waterbodies.
- River crossings will include shortest length between Bank-to-Bank, cross-river at right angles and river course not meandering.
- Land use, Land cover and prevailing cropping pattern.
- Broad information of type of crops / plantation, land use pattern, etc.

- Realignment requirements including provision for possible alignment / alternatives at congested areas.
- Inventory of corridor, terrain, existing road/ railway track details, bridges and structures (type, size and location), intersections and crossings.
- Existing utility services along the alignment (within 300m - 500m corridor).
- Inventory of the existing structures within the 300m corridor.
- Capturing existing NGCPs & GTS BMs at site with photographs and descriptions.
- Identification of best suitable locations for DGPS Control Point with Location sketch.

The process of preparation of up-to-date Base Maps for optimum pipeline route planning and execution included the following steps:

- Procurement and Processing of 0.4 m High Resolution Stereo Satellite Images (HRSI) covering 1.5 Km on either side of pipeline.
- Establishment of Ground Control Network with DGPS
- Post-processing, Geo-metric, Radiometric Corrections, Orthorectification of Satellite Images, Digitization, Vectorization and Compilation and site validation.
- Finalization of pipeline alignment with various options, merits and demerits of each route and approval from competent authority.
- Fixing of pipeline route on ortho-rectified satellite images.
- Generation of Profiles / Alignment Sheet using Ortho-rectified satellite image /DEM.
- Generation of Cross Section drawing from DEM.
- Transferring of Pipeline alignment from HRSI to Ground for VALIDATION /Verification and Fixing of Route.
- Stacking of pipeline route and Monumentation of pillars.
- Population density index survey and class location survey for engineering and designing of pipeline.
- Soil Resistivity Survey, Soil Stratification and Corrosion Survey along the selected route and integration of data / reports in PGIS software.
- Cadastral Survey, geo-referencing of maps and integration of Land Acquisition document for Rights of Land (RoU) Acquisition with PGIS.
- Submission in hard copies and .shp files for entire project deliverables including integration with GIS system.

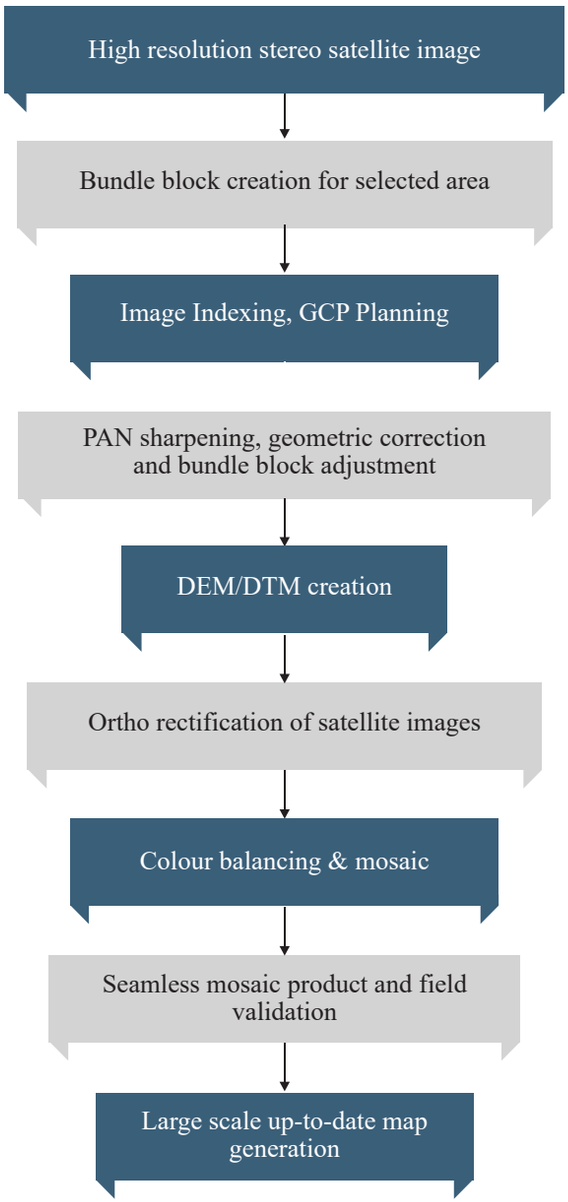


Fig 1: Process Flow Chart for Preparation of Up-To-Date Base Map

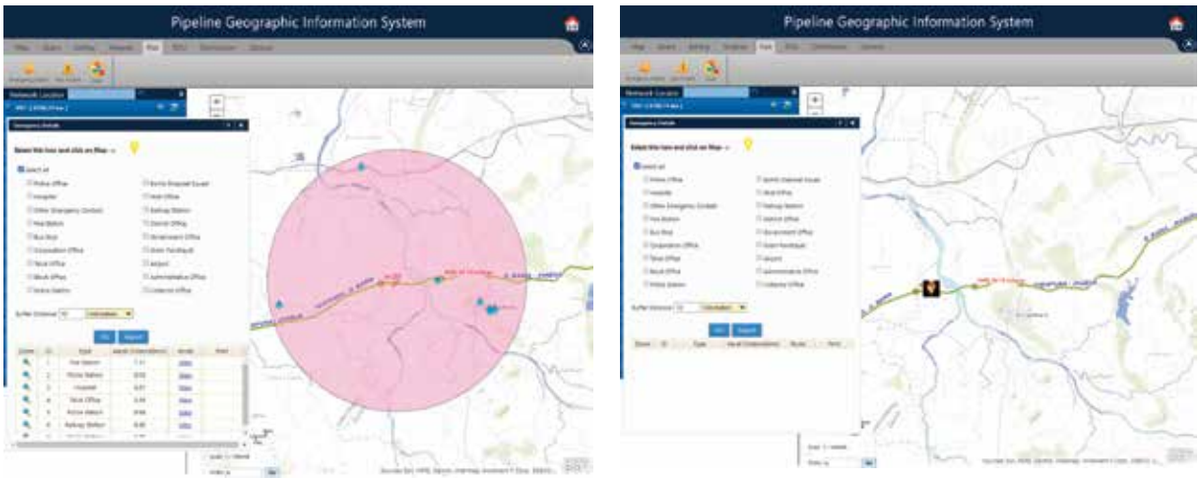


Fig 2: Pipeline Geographic System

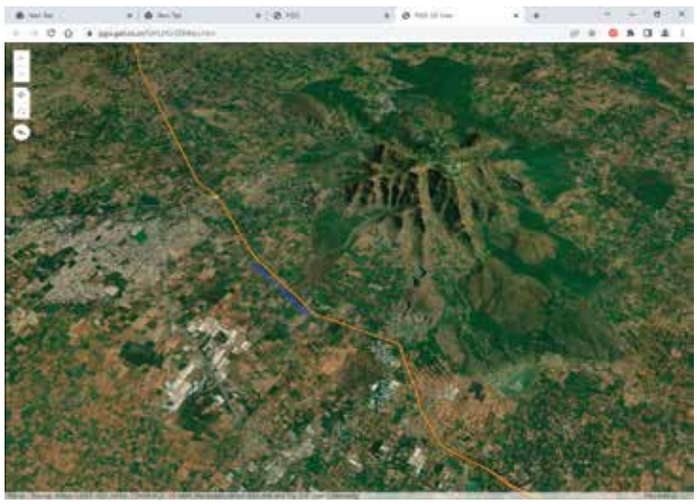


Fig 3: Pipeline 3D View

Outcomes

The innovative technologies, based on Esri's ArcGIS brought unmatched excellence in the pipeline route management process. The Alignment Profile and DEM Generated using HRSI were useful for planning the pipeline network. The up-to-date base map prepared using High Resolution Satellite Images and Digital Elevation Model (DEM) generated for AOI included information like land use information, terrain, vegetation information, topographical features, dwelling, developments, etc. along the pipeline, administrative jurisdiction, important locations, access to emergency location and more. The maps could help during emergencies, specific affected locations can be identified easily using DEM and also residence/dwellings information. Data integrated with GIS can be used for the updation of Population Density Index (PDI) data, emergency location details from time to time at regular intervals, etc. 3D-GIS converts complex infrastructure networks into easy-to-understand visualization. Also, with the use of GIS, the operation and maintenance of pipeline have also become easier since pipeline sections requiring due attention can become immediately noticeable.

In conversation with Prof. Prateek Sharma

Vice Chancellor, TERI SAS

Why do you think it is important to inculcate geographical thinking among the young generation?

Almost everything that we deal with in our day to day life has spatial coordinates. Geographic thinking can surely help everyone to make better decisions in their daily lives. Be it hailing a cab for your regular commute or ordering food, location intelligence helps in achieving better outcomes. Gaining knowledge and understanding of location or imbibing geographical thinking will make our existence more efficient and we will be able to save much more time in all that we do.

How is India placed when it comes to education in GIS?

There is an urgent need to build capacity both at school and higher education levels. We have made progress in bringing GIS education to schools and colleges, but still, a lot needs to be done. Right now, in colleges, GIS education is limited mostly to geography and civil engineering programmes. I believe that given the powerful nature of GIS and its widespread applications, this needs to be extended. An introductory course in GIS should be introduced as a mandatory course across all engineering disciplines.

A student in the medical field or sociology can also make effective use of GIS to gather invaluable insights about the surroundings. For instance, a student of sociology who wants to gather insights about the penetration of Swachh Bharat Abhiyan in villages can use GIS to achieve far better results than a manual survey. Similarly, as part of preventive and social medicine (PSM), doctors can use this technology to assess the prevalence of diseases and correlations can be established with contributory factors to the diseases by doing overlay analysis.

What role are institutes like TERI SAS playing in building the GIS capabilities of the young generation?

TERI School of Advanced Studies (TERI SAS) came into existence in 1998 and Geo-informatics got introduced as a part of the master's program in Environmental Studies and Natural Resource Management in 2003. This was a welcoming step since the 'environment' is very spatial in nature. The problems of resource allocation, resource utilization, and pollution — all are related to the environment, and these can be mapped using technologies like GIS. Thus, we introduced certain elemental and advanced GIS-related courses in our curriculum. Eventually, in 2009, we introduced a specialized master's program in Geo-informatics. The program is being successfully run since then. More than 200 students have completed the course so far. Many students have published research papers and there has been an adequate amount of application of this technology by the students, who are now placed with well-known organizations.

How is the collaboration with Esri India helping in this process?

The application of GIS technology is all pervasive and ubiquitous. The potential of this technology exists everywhere, in education, medicine, physics, etc. However, there exists a gap between the demand and availability of skilled workforce in GIS, and this is where collaboration between industry and academia can largely help.

Esri India happens to be the leader when it comes to GIS technology and TERI SAS is a premier academic institution committed to building capacity in the broad area of sustainable development. To build capacities, it is very important that academic institutions and industry leaders like Esri India join hands and offer short-term training programs. This is an industry requirement because GIS technology keeps on changing rapidly and at a very fast pace. We can also look at building a center for excellence collaboratively where we can undertake research for knowledge creation, conduct workshops, faculty development programs, and conferences and disseminate knowledge.

> “The application of GIS technology is all pervasive and ubiquitous. The potential of this technology exists everywhere, in education, medicine, physics, etc. However, there exists a gap between the demand and availability of skilled workforce in GIS, and this is where collaboration between industry and academia can largely help.”

- Prof. Prateek Sharma, Vice Chancellor, TERI SAS

About TERI SAS

TERI SAS commits itself to academic excellence and provides an environment that encourages both personal and intellectual growth through teaching, creating and sharing knowledge.

TERI School of Advanced Studies was set up as a Trust by TERI (The Energy and Resources Institute) - a not-for-profit, independent research institute recognized globally for its contribution to scientific and policy research in the realms of energy, environment, and sustainable development in 1998. In 1999, the TERI School of Advanced Studies was granted the ‘Deemed to be University’ status by the University Grants Commission (UGC). The objective of the TERI SAS is to build capacity around various themes of sustainable development adopting an inter-disciplinary approach and incorporating the most contemporary, research-based evidence into the curriculum. Since its inception, the TERI SAS has offered not just world-class education, but also an environment that enables its students to develop fresh perspective in their subject areas. Beyond the academic programmes, the deemed University is actively reaching out to school and college students as also to mid-career professionals to sensitize them towards the environment and sustainable development in a systemic, solutions-oriented manner. The deemed University started functioning from its ‘green campus’, located in Vasant Kunj, in 2008 and today offers a dozen Masters programmes and has nearly 200 PhD students enrolled.

ArcGIS Utility Network

ArcGIS Utility Network is designed to be the next-generation spatial information system to provide greater functionality over massive datasets at every scale of resolution. Now, utilities can leverage the power of the entire ArcGIS Enterprise to provide tools with a focus on the user experience and improve communication across your organization.

A utility network is the main component users work with when managing utility and telecom networks in ArcGIS, providing a comprehensive framework of functionality for the modelling of utility systems such as electric, gas, water, stormwater, wastewater, and telecommunications. It is designed to model all the components that make up your system—such as wires, pipes, valves, zones, devices, and circuits—and allows you to build real-world behaviour into the network features you model.

Capabilities of ArcGIS Utility Network

Industry focused

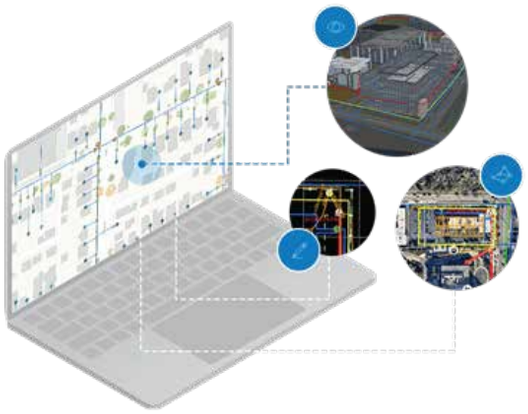
ArcGIS Utility Network is configurable for any utility, municipality, or organization with linear assets. Esri solutions explore the world of electric, gas, and water utilities, architecture, engineering, construction (AEC), and telecommunications.

Integrated network

Capture the operational requirements of utility assets with the ArcGIS Utility Network framework. Network domains let you model operation and structural networks in an integrated fashion, while network rules help you build networks that suit your business requirements.

Scalable for your organization

ArcGIS Utility Network operates at all scales of resolution, giving your organization the ability to model features and assets at the right scale for your needs. From the largest facility to the smallest asset.



Data quality control

Drive better decision-making with high-quality data. Network and attribute rules provide an extra layer of quality control to enable your GIS team to build and support utility models that produce actionable information.

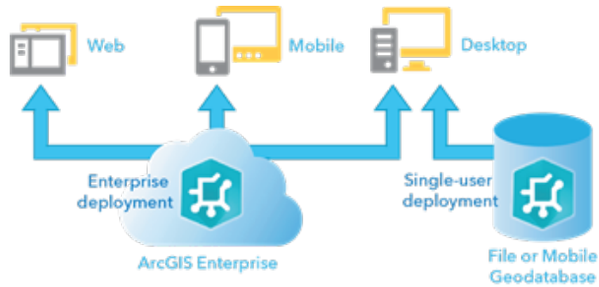
Future proof your utility

Leveraging services-based architecture, this next-generation network management system is designed to provide secure data access for your users across every platform. Modernize your utility network with the right tools for data collection, modeling, and analysis.

Integration with ArcGIS

The utility network can be accessed with either an enterprise or single-user deployment:

Enterprise deployment: An enterprise deployment provides the richest capabilities of the utility network through a services-based architecture using ArcGIS Enterprise. This model enables large-scale, multiuser deployments and full network display, editing, and analysis capabilities through web maps and apps, mobile apps, and ArcGIS Pro on the desktop.



Single user deployment: A single-user deployment provides the full analytic capability of the utility network while hosted on a file or mobile geodatabase. In this model, you interact with the utility network through ArcGIS Pro on the desktop or mobile device.

Working of ArcGIS Utility Network

Visualize your network

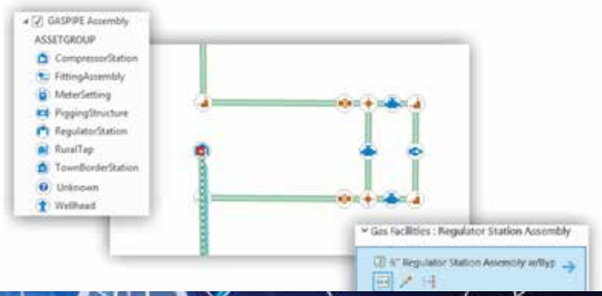
Create network views using maps, diagrams and internals. Visualize resources temporally and in 3d for user solutions across the ArcGIS platform.

Analyze your network

Use analysis and tracing tools to perform a large variety of analytic workflows.

Edit your network

Streamline your editing workflows to get the most out of your utility network.



ArcGIS Utility Network
Managing the modern utility and telecom

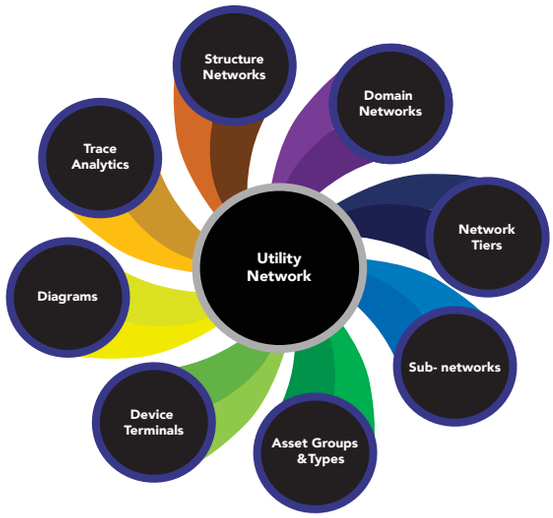
The next 5 years will bring more change to utilities than the previous 50. New entrants from the tech giants will bring severe competitive pressure to telecoms. That's not all.

The workforce will rapidly evolve. Skilled workers will retire at an alarming pace. Electrification of transportation will mushroom. Renewable energy and carbon reduction regulation will erode revenues for energy companies. Infrastructures will age faster than replacement. Climate change and severe weather patterns will increase. Customer demands will increase rapidly.

What is ArcGIS Utility Network?

1. A comprehensive framework for modeling utility assets and networks. This simplifies the integration of corporate OT systems such as ADMS. It provides a quantum leap in network representation in 2D and 3D. It closely represents assets as they appear on the ground.

2. An encapsulation of business rules and logic to maintain an accurate geospatial representation of assets and networks. Data errors will be dramatically reduced.
3. A data type within the geodatabase, including a transaction model, attribute rules, and editing tools, exposed as REST services. Services architecture delivers network functions to any device, anytime and anywhere.
4. A creation, editing, managing, analysis, visualization, and sharing network information system through user-focused maps and apps. This provides the most flexibility ever available to utility and telecom users.
5. An ArcGIS Utility Network Service user type extension. This provides secure access to content and system capabilities.



Getting started with the Utility Network

Often, the hardest part of every journey is taking the first step. We will show you how you can take your first tangible step towards implementing the ArcGIS Utility Network today using these five key steps we see in every successful implementation:

1. Look at how you organize your data into networks
2. Identify the fields you use to manage those networks
3. Prepare for and perform data cleanup tasks
4. Consider how you organize or classify your assets
5. Review your data for unused or unreliable fields

Organizing your data into networks

Every utility manages some type of commodity and the way these commodities are conveyed to customers are via networks. The ArcGIS Utility Network is capable of modelling systems like stations and plants that haven't historically been modelled in a GIS. So, when planning you need to consider how much of your network data you want to model and ask the following questions:
Which networks you want to model?
Do you have the data to support these networks?
What existing business processes and workflows are in place to maintain this information?

Once you've identified which networks you will and won't be modelling, the next step is to determine how you will store this information in your data model.

Identifying the fields used to manage your network

While it is true that every network is different and that every customer does things differently, there are some things that are universal to the way that networks behave. Once you understand how to organize and configure the utility network dataset you can use it represent any kind network.

ArcGIS Pro has a built-in set of tools to help you identify where your utility network data is incomplete or inaccurate. In fact, most customers find that they have an improved level of confidence in their data once they completed their implementation. This is not only because they have worked through the inconsistencies of their data, but because they know that going forward the system will catch any mistakes as they are made before they become committed to the model.

Preparing and performing data cleanup

A self-checking system sounds great, but most of us recognize that our data isn't perfect, and we may even be nervous about how much work it's going to take to implement this model.

If you already have a mature quality assurance program and tools, then you can expect to have an easier time implementing this solution. As your project progresses your data quality will improve as you develop a robust quality assurance process that use ArcGIS Pro and the utility network dataset.

The utility network dataset requires that there be no bad data present in your network to ensure the system behaves as expected.

Resolving errors

Esri's online help provides a comprehensive description of all the different types of topology and subnetwork errors. The most common resolutions to these errors involve backfilling missing data and correcting inconsistencies within the data.

There are other types of data cleanup you will want to perform as part of your implementation, but the priority should always be to correct topology and subnetwork errors. Any networks that contain errors can't be traced, analyzed, or exported.

Classifications

Now that you've figured out your network model and data cleanup strategy it's time to focus on organizing and classifying data in a way that is meaningful to your end users and meets your existing and future requirements. Features in the utility network dataset are classified using three sets of identifiers:

- Table
- Asset group
- Asset type

Asset groups and types

Asset groups are used to organize common sets of features with the same purpose and similar characteristics. Features in the same asset group appear on the same layer in the application and have a common set of fields and pick lists. Features within each asset group can be further divided into different asset types. Each asset type has a different set of business rules that control how they connect and relate to other network features.

Industry models

These models are designed to be comprehensive and cover a broad domain of generation, transmission, distribution, and service assets. Because most customers only exist within one of these domains, they may only use a subset of the available classifications.

Now that you've determined what your classifications are you now need to review your source data and ensure you can determine the classification of every feature.

Fields and Lookups

Like classifications, Esri also provides a recommended set of fields and pick lists in their standard model. The next step in the process it to review the data dictionary provided with your industry model and reconcile it with your current model.

It is recommend doing this one asset group at a time. Look at the fields and pick lists in the data dictionary and compare them with your existing fields and pick lists for each source table. If you find any columns that are blank, sparsely populated, or contain unreliable information you will want to consider either correcting the data before you migrate or not migrating that column.

You will then take the remaining list of "good" columns and compare them to the target data model and if you find that the industry model has the corresponding field then you will map your field to it. If you can't find a corresponding field in the industry model then you are free to add fields to the model, although some care should be exercised to ensure that tables don't become too large or unwieldy for end users to maintain.
Finally, if the source or target field has a pick list associated with it, we will also want to make sure that you create a lookup that can help translate values between the two fields. In some cases, you will need to add new values to the target pick lists.

Management

Utility, pipeline, and telecommunications companies have used GIS to manage network asset data for decades. After all, knowing asset locations, their conditions, and their relationship to one another is fundamental to managing them.

In this new world of limited resources and increasingly complex networks, companies need a new wave of GIS-based network management with more functionality, added flexibility, and better access. That is why Esri is building the Utility Network in the ArcGIS platform.

The Utility Network lets users create, manage, and share electric, water, wastewater, gas, district heating, and telecommunications asset data. The releases of the Utility Network come with base data models for electric, gas, and water networks.

The Utility Network is fast. It can handle billions of data elements with ease. Moreover, as part of the ArcGIS platform, the Utility Network will be available on any device, anytime, anywhere. The technology can handle modern data needs and makes it easy to share information securely with those who need it.

Here's what else the Utility Network offers:

Flexibility: Users can edit the network data seamlessly via web services.

Asset connectivity: Users can mine the behavior of networks.

Containment: Users can place objects or devices within structures, such as buildings or cabinets.

Attachment: Users can model network element attachments, such as how a transformer or telephone cable is affixed to a pole.

Quality: The technology leverages built-in, industry-standard rules that guard against users making data entry mistakes.

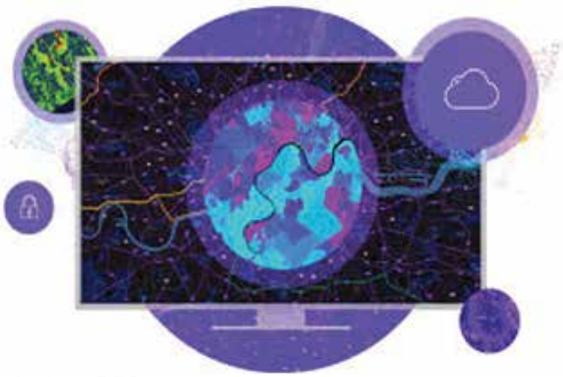
Modeling: Users can specify where sources of electricity, gas, or water are located to facilitate network simulation. They can also model devices that have many connection points, such as complex switches and valves.

The Utility Network's releases come as forward-thinking organizations envision how they use GIS. These companies are building information systems that engage users with modern functionality, allowing their employees to have access to data anytime, anywhere, on any device.

This new vision of getting information to anyone at any time enables people and organizations to make better use of limited resources. Companies that employ the Utility Network will manage their assets more efficiently and with enviable flexibility. It is the next, smarter wave of utility management.

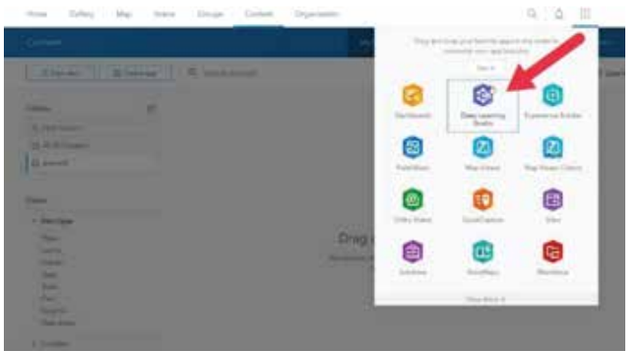
ArcGIS Enterprise 11.0

ArcGIS Enterprise 11.0 introduces new features for data management and administration, updates across applications, and enhanced functionality throughout the product. Here are the updates available in ArcGIS Enterprise 11.0



1. ArcGIS apps

a) ArcGIS deep learning studio: ArcGIS Deep Learning Studio is a new app available in ArcGIS Enterprise. It provides a focused user experience to extract information out of imagery and share it with the organization. This app allows you to perform an end-to-end workflow which includes capturing training data, training a model, and running inferencing. It also provides flexibility to perform individual steps when you have a custom workflow.



b) ArcGIS solutions: Starting with this release of ArcGIS Enterprise, ArcGIS Solutions now come installed with the Portal for ArcGIS component. There is no need for a separate install, as there was with previous releases of ArcGIS Solutions in ArcGIS Enterprise.

2. ArcGIS server roles

a) ArcGIS GeoAnalytics Server: This release of ArcGIS GeoAnalytics server includes new analysis tools and tool enhancements. The new SnapTracks tool matches time enabled points (tracks) to nearby lines. The Snap Tracks tool can be run through ArcGIS REST API, ArcGIS Pro, and ArcGIS API for Python.

b) ArcGIS GeoEvent Server: ArcGIS GeoEvent Server 11.0 includes significant performance improvements for users discovering and selecting features in their ArcGIS Server, ArcGIS Enterprise, and ArcGIS Online registered data stores. There is also improved performance and load times for GeoEvent Manager and data sources and services on the spatiotemporal big data store page.

c) ArcGIS Image Server: This release includes support for new raster types and multidimensional support, and enhanced OGC support.

d) ArcGIS Knowledge: ArcGIS Knowledge 11.0 introduces a new licensing model with ArcGIS Enterprise 11.0. In this release, users will no longer need the Knowledge user type extension in order to use ArcGIS Knowledge. Licensing ArcGIS Knowledge Server will only require an ArcGIS Knowledge Server license.
Add a NoSQL data store item to the portal that references an empty Neo4j database to store knowledge graphs you create in ArcGIS Pro. When you use your own Neo4j instance, you can scale the instance as necessary to accommodate the number of databases and graphs that you require.

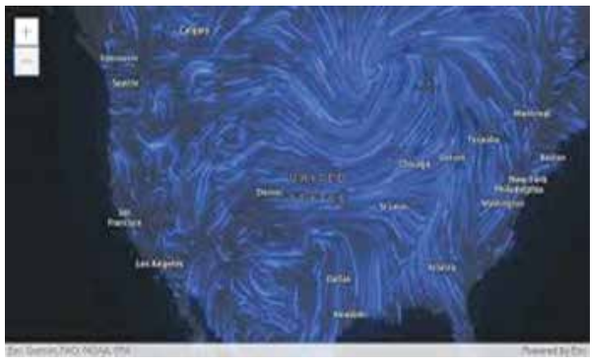
e) ArcGIS Notebook Server: In this release, ArcGIS Notebook Server now includes Esri-curated Python code snippets that can be accessed from the Notebook editor

and added to your notebooks. Code snippets are pre-written code that can be called into your notebooks to perform common workflows. ArcGIS Enterprise 11.0 also includes updates to the "Publish a notebook as a web" tool and "Overwrite web" tools.

f) ArcGIS Workflow Manager: In ArcGIS Enterprise 11.0, you can now switch workflow items from any page in the Workflow Manager using the My Workflow Items button at the top of the Workflow Manager web app. The Details panel in the Workflow Manager web app has also been updated to include animates that make job updates more visible and responsive.

3. ArcGIS Enterprise Portal

a) Map viewer updates: Map Viewer was introduced last year in ArcGIS Enterprise 10.9.1. With this latest release of ArcGIS Enterprise, Map Viewer includes enhancements in its interface and new functionalities. Map Viewer Classic is still available for use in ArcGIS Enterprise 11.0 but is no longer the default for creating web maps in your organization.



Map Viewer highlights include New layer effects, Pop-up improvements, New pop-up improvements, Sketch enhancements, Create charts.

b) Hierarchical categories for Enterprise portal members: Hierarchical categories are member categories that allow administrators to organize members of their organization by various characteristics. ArcGIS Enterprise administrators can now set up hierarchical categories to group members by categories such as department, location, and expertise. Once these hierarchical categories are configured, administrators and members with the correct privileges can filter the list of members by member category which are also displayed on the member's user settings page. This categorization further helps organizations ensure members are seeing relevant information and eases privilege management work for administrators.

c) New member privileges, reassign content and receive content: There are two new member privileges in ArcGIS Enterprise 11.0: reassign content and receive content. These new privileges allow organization members to transfer content amongst other members of their organization. Organization members can reassign content they own to other members without requiring an administrator to perform the change. Having these new privileges puts more power into individual members' hands, minimizing privilege changes that require administrators to be involved.

d) Esri raster basemaps are in mature support: Several Esri raster basemaps have moved to mature support and will no longer be updated. New installations of ArcGIS Enterprise 11.0 will have Esri vector basemaps configured by default and there will be no means for customers with new installs to switch to using Esri raster basemaps.

Other important changes in ArcGIS Enterprise 11.0

- Removal of the ArcMap-based runtime
- Move of ArcGIS Enterprise SDK to .NET 6
- Removal of classic Esri Story Map templates
- Removal of ArcGIS Dashboards Classic
- Removal of Presentation for Map Viewer Classic
- Removal of many Configurable App templates

RESEARCH PAPER

Utility Network
The next-generation solution for utilities

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Introduction

Esri Utility Network is fast evolving into a technology platform that would replace the existing Esri GIS for Utilities and transform them into a future-ready model. This will transform ArcGIS desktop to ArcGIS Pro, make Server Applications more aligned towards Portal for ArcGIS, mobile Apps more important, and the ability to use GIS from anywhere at any time, and on any device. This will be a major shift from a centralized desktop-based approach to a more flexible and adaptable way of carrying out business operations from anywhere. With the emergence of new platforms and technologies, GIS is no longer perceived as a separate system, it will be rather a spatial enablement of systems across all application stacks and technology platforms.

The journey to the Utility Network platform is complex and transformational in nature. It is an amalgamation of various processes, at the functional and technical levels. Through our extensive experience in dealing with multiple Utility customers, we have taken up the prototypes to Utility Network transformation on customer-specific datasets and evaluated the changes that they would experience in the new system. This is complimented by learnings from several knowledge sessions, user conferences, Developer summits all over the world.

The current paper highlights some of the advantages of the new platform, the intricacies and what might be the actual path for the transformation journey. The proposed transformation approach is based on the results of the prototypes conducted, and the knowledge gathered from several industry forums. The approach and value might slightly differ depending on the customer's business priorities, future directions and roadmap. However, the key essence of the journey is to be "future ready" so that all risks to the transformation are covered and there is minimal impact on business.

Advantages and key value differentiators

Following are some of the key value differentiators of the new platform:

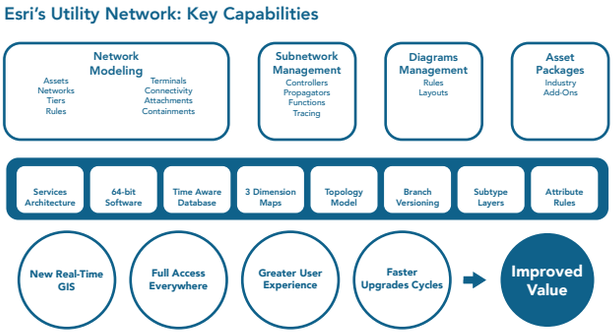

Fig 1: Utility Network Offerings Source: www.esri.com

- Better spatial representation of objects: Unlike its predecessor, all the assets that are a part of the network are spatially represented in the map. For example, the transformer or Fuse units which were depicted as objects are captured as spatial entities in Utility Network. This helps in mapping individual assets and customers to the parent objects.
- Advanced analytical capabilities that include but not limited to the following:
  - Inside plant schematics- representing the individual assets within a substation (Electric) or Regulator Station (Gas)
  - In Built 3D capabilities of the Network
  - Stepwise tracing across different voltage levels (electric) or pressure zones (gas or water)
  - Structural Attachments - Connectivity between Network and non-network objects i.e. association between a Pole and transformer bank within one or different networks (i.e same Power Pole shared by Distribution and Transmission Network). This is an example of logical connectivity between network and non-network objects.
  - Containments - Link feature classes as a containment of the parent object i.e. transformers contained by a transformer bank, or assets that are contained by a substation object. The parent-child objects in the containment are logically connected.
  - Ability to represent one or more connection points on a device in the form of connection points. They support a more realistic representation of devices which would help in a variety of complex situations like source-sink scenario, high and low sides for analytical purpose (e.g. Distribution Step down transformers), asymmetric traversal (check valve) etc.
- Seamlessly work for Transmission and Distribution Network or between network types e.g. Water and Wastewater. The different types of networks can be connected, yet logically separated from each other.
- Detailed attribute and connectivity rules are built within the Utility Network framework. The connectivity rules are governed by Esri topology framework that would prevent any incorrect data updates in the system. The attribute rules powered by cross platform Arcsde expressions operate at an attribute level for validation and auto-calculation of attributes. The rules can be customized based on customer-specific scenarios.
- The solution is enriched with advanced editing capabilities in complex editing scenarios (feature templates). This allows the placement of features grouped together as assemblies (Bus bar assembly) within built-in snapping and connectivity rules.
- The new solution is fully service based taking a stride from the traditional client-server architecture, making all applications and offerings platform and device agnostic. So, the same set of functionalities and capabilities can work across desktop, web and mobile platforms.
- Increased performance- The Utility Network framework because of its architecture and design offers a faster performance.
- New versioning capabilities- partial posting, reduced states etc. With this offering there is a new concept of versioning- that is transactional nature. The new versioning concepts get rid of the states and branches in A and D tables.
- Collaboration with real time events and big data is much easier to achieve providing powerful analytical capabilities.
- All objects in the Utility Network Data model are 3D enabled offering powerful 3D mapping and analytical capabilities.
- Utility network also supports Linear referencing that helps to isolate and find out sections of pipes in the network that are likely to be impacted due to damages.

The following example shows the difference between the objects mapped in geometric and utility network:

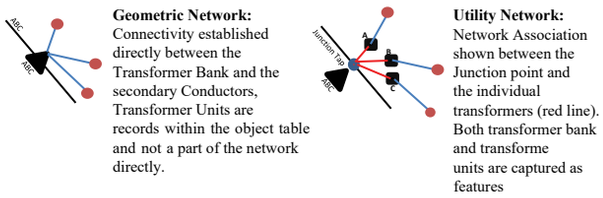

Fig 2: Spatial Representation of Objects in Geometric and Utility Network

Data Structure

The Utility Network data structure differs from the existing data structure and layout in Geometric Network. Instead of mapping objects into different feature classes and objects, the utility network data objects are mapped into five categories, and each asset is derived as a sublayer from that category. Following is a high level diagram of the Utility Network Data model.

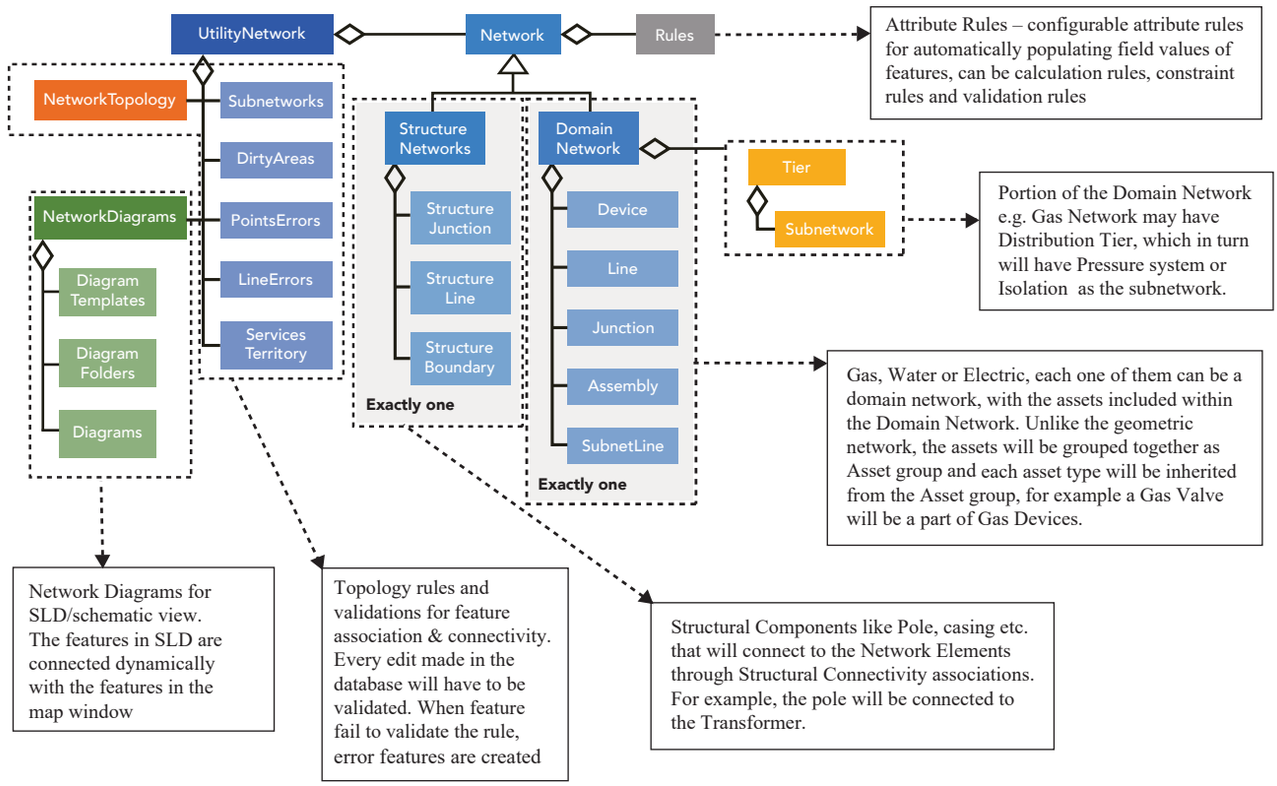

Fig 3: Utility Network Data Model

While Geometric Network primarily relies on logically grouping of objects into Electric, Water, Wastewater or Gas Domains, Utility Network categorizes the objects into different Domains. So, in a geometric network, the objects can be logically grouped into Electric Network and all assets within the network are grouped into different feature classes and related tables. The different asset types represented in the geometric network need to be physically connected.

In Utility Network, the objects are grouped into different asset types within each of the domains. The Domains (e.g. Electric, Water or Gas) can be interlinked with cross domain trace functionalities, different domains sharing the same structural network. Not all objects in the Utility Network need to be physically connected, the connectivity rules are based on a combination of physical and logical connectivity.

The following diagram shows a high-level view of how differently the objects are mapped in the Utility Network unlike its predecessor- Geometric Network.

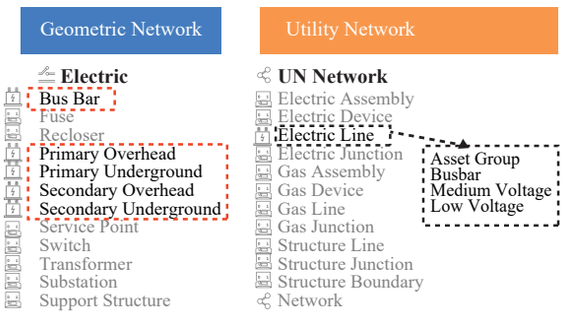

Fig 4: Utility Network Data Model Comparison- Example

Design Considerations

The Utility Network Suite is services based, there is no direct connection to the database from the application, all connection to the data elements from ArcGIS Pro will be through services. The different kinds of services used in Utility Network are Feature Service (data access and editing), Utility Network Service (tracing and other Utility network analysis), Network Diagram Service (generate and maintain Network diagrams and SLDs) and Version Management Service (new transactional versioning principles including options for partial posting).

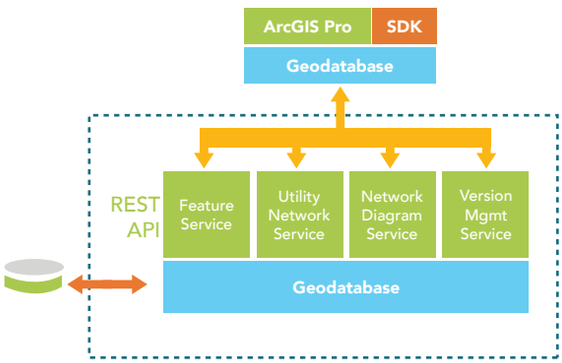

Fig 5: Service architecture in Utility Network Management

As mentioned earlier, The Utility Network offering is cross platform, implying that it will work across all the platforms: web, desktop and mobile. The services based architecture enables the users to have access to all tools (including the complex tracing tools) across all platforms.

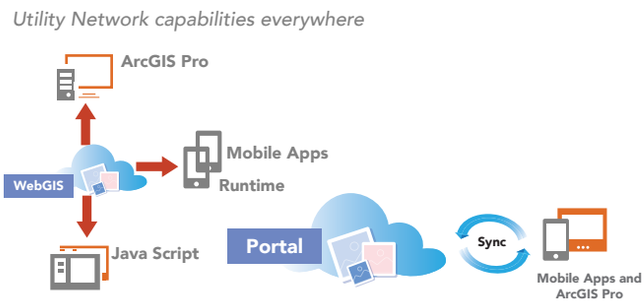

Fig 6: Utility Network Capabilities

The Transformation Journey

The Utility Network migration should include all the key stakeholders and the processes within the system. Today GIS is an integral part of majority of the applications within Utility companies. All applications are spatially aware, so it is important to know which pieces will be taken up in the sequence as the transformation journey commences. There can be a big bang transformation to bring all the data elements and some of the key application components in the Utility Network and establish a process such that incremental updates keep coming in from the existing editing environment until the editing apps are all moved to the new framework. The figure below shows a high-level approach for the migration. The GIS vendors, users and System Integrators all have an important role in this ecosystem. The platform transformation would also mean redesigning and redeveloping some of the key interface components that point to non-GIS applications and systems (like Work and Asset Management Systems, Billing, CIS etc.)

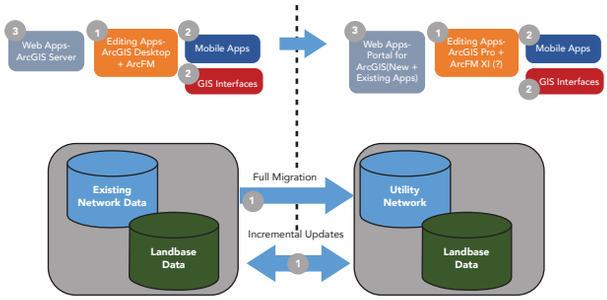

Fig 7: Migration to Utility Network (Numbers indicate the sequence/order in which the migration of data/Apps should be taken up

The recommended approach would be to get all the editing components together followed by the read-only components. Some of the read only mobile Apps and interfaces can be pushed to a later release depending upon the priority of the business.

The above diagram shows one approach for the migration, however it would vary between organizations, depending on the GIS outreach and the scale. Due diligence is important before undertaking such an initiative. It is recommended that the organization conducts a small prototype (maybe a circuit/feeder or a pressure zone that is representative of all the key components and objects of the data model), assess the impact and then plan for the transformation journey.

The plan for the transformation journey might span across close to a couple of months following an iterative approach of prototypes, Pilots and final migration iterations, each cycle refining the process for the next run.

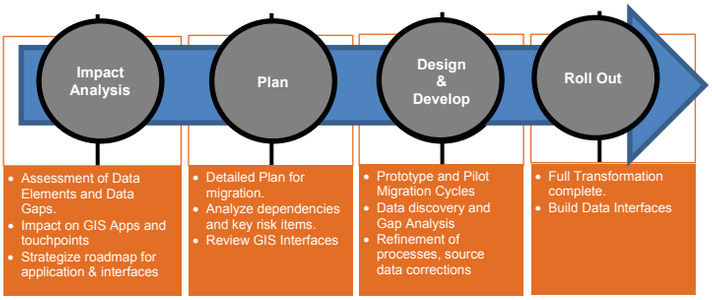

Fig 8: Utility Network Transformation plan

The results from Prototype migration of Utility network have shown that the new application on Utility Network datasets is much faster as compared to the existing ArcMap application working on a geometric network. Also given the fact that all objects are accessed through feature services (instead of the traditional client-server DB access approach), the number of chatty calls to the DB is very low, which makes the queries much faster on the client side. The new method of de-normalizing the tables in Utility Network reduces the number of joins and nested queries that the earlier versions of database were using. The start of the transformation needs a proper consideration and review of the existing GIS and all the related systems. The recommended approach would be to conduct a pilot/prototype to understand the impact encompassing all the possible factors, risks and parameters, and be "future-ready" before the actual transformation.

UN Enabled Utility GIS

Utility GIS will change with the introduction of this new platform, and this will impact the applications and the way the business would operate. Following figure shows a view of Utility Network platform, along with the applications and enablers:

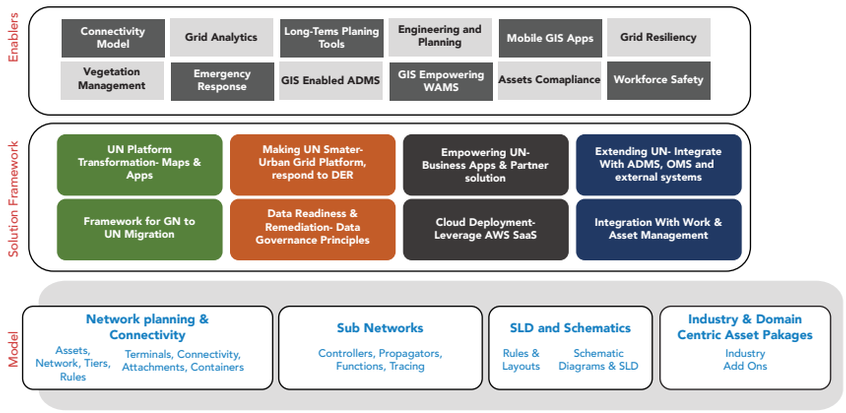

Fig 9: Utility Network - The Destination

Conclusion

Utility Network is a leap towards the utilities GIS built on the Esri platform. Implementing Utility Network will provide the GIS organization with a more real-time depiction of objects coupled with powerful analytical capabilities. The utilities today need to plan and embrace for the inevitable change that will serve them for good in the long run.

References

1. https://www.youtube.com/watch?v=BwThh93YAxc: Insight into the Utility Network explained by Eric Hoel and Tom Brown
2. http://www.esri.com/esri-news/arcnews/spring17articles/introducing-utility-network-for-arcgis

Making the best of our water through geo-enabled automation

Much has been talked about the precarious water situation we are likely to face in the next few years and the urgent need for integrated water resource management that addresses the entire water value chain from "source to tap" holistically. It is no secret that we are racing against time in our pursuit to achieve universal and equitable access to safe and affordable drinking water, adequate sanitation, and hygiene for all, notwithstanding the inevitable threat to economic growth due to depleting water resources. Automation is undoubtedly the way forward to protect and secure our future.

Easier said than done, implementation of "digital water" technologies is laden with challenges and unknowns. Water challenges are multi-disciplinary in nature, intricately related to the economy, environment, and society with interactions at local, regional, national, and global levels. As we steer our way ahead with automation, our approach needs to be well informed, which unravels the intricacies, interrelationships, and interdependencies that are critical to ensure equal justice to all the stakeholders while protecting 'the precious natural resource.'

Over the years, the Government of India has launched multiple initiatives to strengthen the nation's water security and resilience. While its ambitious program - "Jal Jeevan Mission" is envisioned to cater to rural India, Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Smart Cities Mission, Swachh Bharat Mission, and Heritage City Development and Augmentation Yojana (HRIDAY) are some of the schemes that address urban segments. Through various automation initiatives, increasingly governments and water boards are making efforts to acquire, process, manage and maintain the "water data" in "real-time" to address challenges for informed decisions.

These central initiatives supported by state-level programs are by and large well designed to embrace the water challenges holistically addressing all the aspects from source to tap namely infrastructure, water-use efficiencies, water quality, source sustainability, black water/grey water management, water conservation, etc. through a collaborative and participatory approach. Notwithstanding the prohibitive cost and multi-jurisdictional operational scenarios, addressing these individual challenges in isolation is often resulting in "technology myopia," delivering suboptimal outcomes. To overcome this, there is a dire need for "Mapping a Common Ground" that brings together all the subjects and actors, provides actionable intelligence, fosters a collaborative environment for finding solutions, and helps in reaching an agreement for positive action.

While GIS mapping and geo-tagging happens to be one of the key features of these programs, its suboptimal usage has been a cause of concern, which warrants immediate attention to bridge the implementation gaps and improve the ROI on these huge investments.

Interestingly, about 80% of the water data has the context of location associated with it, and by not tapping this hidden power in the larger context of the water ecosystem, we are denying ourselves numerous benefits.It is incumbent on us to harness this untapped power to strengthen our water resilience. Below are some ways in which the current efforts of GIS mapping and geo-tagging can be harnessed for larger benefit using geo-enabled automation:

- To get a bird's eye view of water infrastructure from source to tap with the ability to drill down to an individual tap at a click of the mouse.
- To access data that is contextualized, can be intuitively visualized, and analyzed for location-specific temporal patterns and trends.

- To have an on-demand location-specific operational picture and actionable intelligence for decision support.
- To provide real-time, non-intrusive monitoring of resources and assets, improved prevention of pilferage, and safety of assets.
- To have anywhere, anytime contextualized & real-time information for customers and other stakeholders.
- To enable improved outage management and reduced downtimes and tailored predictive maintenance.
- To enable optimized mobile workforce management, improved operational fleet management, optimized routing, fuel savings, targeted energy consumption, better disaster preparedness, emergency response, etc.

Globally geo-enabled automation is proving to be an irreplaceable tool for demystifying intricacies while providing "contextualized" insights. The seamless flow of data and information from location intelligent sensors and smart devices are enabling utilities to respond faster to operational contingencies. A GIS platform integrated with IoT, SCADA, and other components of the distribution systems, by leveraging machine learning and artificial intelligence, offers numerous opportunities for advanced applications including predictive modeling and simulation.

By streaming the water quality information to a central environment in real-time, location intelligent water testing devices are facilitating rapid action and targeted interventions in the water quality affected areas. Real-time data delivered via easy-to-understand maps and mobile apps foster transparency and improves citizen engagement. By getting all the data on a GIS platform – geo-enabled automation is strengthening integrated water resource management efforts.

While helping to avoid "data traps," geo-enabled automation aids in deciphering and democratizing ever-increasing volumes of location-rich data for strategic and operational decision support including management of – assets, leakages/pilferages, outages, workforce, revenue, compliance, network integrity, and emergency response through a single window.

At the same time, such infrastructure also supports efforts in improving water quality, increasing water-use efficiencies, protecting, and restoring the water ecosystems, and strengthening community participation in water and sanitation management.

Urban Water

Increasing urbanization, population explosion, changing climate patterns, and increasing expectations are constantly adding pressure on the urban local bodies. Leveraging the context of location, GIS aids in designing, modeling, planning, and maintenance of urban water distribution networks, thus, helping the utilities to optimize costs and improve turnaround times. Geo-enabled DMA approach aids in better management of the water distribution systems by enhancing situational awareness while providing actionable intelligence for improving operations. These benefits in reduction of non-revenue water, lesser leakages/pilferages, improved grey water management, better water quality, and optimized energy consumption.

Geo-enabled urban water systems around the world have vastly improved the management of complex water utility operations, reducing non-revenue water (which is almost 40%) and improving efficiencies and workforce management (by up to 30%). **With Esri's ArcGIS at the center stage, bodies like Thrissur Municipality and Orange City Water (Nagpur) have taken lead in geo-enabling automation of their water operations.** These utilities are now providing location-specific insights with actionable intelligence for rapid decision support to their stakeholders while addressing operational contingencies.

Rural Water

For ensuring a long-term assured service delivery of safe drinking water to rural households, and village-level institutions to work like public utilities they need to be armed with granular information that can be easily visualized, understood, and analyzed in the context of a village. For Village Water and Sanitation Committee (VWSC) or Pani Samitis to come up with effective community programs to promote gram swaraj, they need data and insights that are contextualized and easy to understand.

While arming the villagers with contextualized actionable intelligence, geo-enabled automation of village utilities can empower the stakeholders in improved planning, design, operation, and maintenance of water supply schemes. Location intelligent sensors and IoT devices for water

testing aid in safeguarding rural health and preventing the spread of water-borne diseases, while helping gram sabhas to take up targeted interventions.

While mapping a common ground for the village, through its simple, easy-to-use map-based language, geo-enabled automation helps communities to overcome the literacy barriers and encourages larger participation and collaboration including women and weaker sections of the society. This will be a critical success factor for the long-term sustainability of the community-owned water supply schemes.

A map-based Village Action Plan (VAP) and dashboard for their water resources can be an invaluable tool in the hands of communities to understand and appreciate the intricacies and interdependencies of various factors from source to tap. Geo-enabled tools can be force multipliers that empower the gram sabhas and every villager in the participatory decision-making process. Geo-enabled village action plans can be easily aggregated at district and state levels for decision support, financial planning, and policy formulation.

In Closing

While the pace of automation is picking up, due to poor awareness geo-enablement is lagging, which is rather unfortunate. As the governments and water agencies pump in their efforts for GIS mapping and geo-tagging, there is also a need for harnessing this geo-enablement for the larger good and enhancing the ROI on investments being made. Continuing to address the challenges in isolation will be a trap we will be forcing ourselves into and regret later.

As the Cloud-based GIS, Platform-as-a-Service (PaaS), and smartphones make access to GIS easier, faster, and affordable, stakeholders have more incentives at their disposal for integrating their automation efforts with the ever-increasing volumes of geo-data from source to tap and enrich the contextualized intelligence for informed decisions and iterative improvements.

With the prowess of innovative minds and a large talented resource pool, there is no reason why we cannot harness the geo-location to make the best of our water resources and set an example for others to follow.

City uses ArcGIS solutions to replace lead water pipes

Every person deserves clean drinking water. Unfortunately, this basic standard goes unmet in many communities due to lead-contaminated water. When consumed, this can cause impaired mental and physical development in children and accumulate in adults to the point that it damages the nervous system, the brain, the kidneys, and red blood cells.

These ill-health effects can be completely avoided by removing lead pipes from water service lines. Despite this well-known fact, the Natural Resources Defense Council (NRDC) estimates that between 9.7 million and 12.8 million homes in the United States are connected to water mains via lead service line (LSL) pipes. Funding to assist communities with replacing lead pipes was negligible until the Infrastructure Investment and Jobs Act, passed with bipartisan support at the end of 2021, allocated $55 billion for expanding access to clean drinking water, particularly in low-income communities.

With this new influx of capital, the City of Oconomowoc, Wisconsin, acted quickly and began taking elevated measures to replace all the lead service lines within its jurisdiction. Together with Esri partner Symbiont Science, Engineering, and Construction, Inc., the city implemented some of the latest Esri technology—including the Lead Service Line Inventory solution and ArcGIS QuickCapture—to get moving in the right direction.

Water utility staff members use a dashboard to track lead service line materials and pipe replacement statuses.

Gaps and inefficiencies in data and documentation

A key component of implementing a lead service line eplacement program is having an inventory of service line locations and the materials the pipes aremade from. This helps utilities better understand, plan for, and manage all the activities associated with the replacement. However, in many cases, utilities lack complete and accurate information about pipe materials.

As operations staff at the City of Oconomowoc's water utility got started on the replacement project, they soon identified significant gaps and inefficiencies in their existing datasets and documentation practices. For one, the city recorded information about service lines and replacement activities in spreadsheets. Additionally, supplemental datasets on sidewalks, street surface condition ratings, and water main breaks simply didn't exist.

To support the LSL replacement program, the city needed a way to quickly advance its datasets and develop new tools to monitor progress. The timing proved ideal. The city was already undergoing a multiyear GIS conversion from an external, third-party provider to an in-house ArcGIS Enterprise system.

"It became apparent that there had to be a better way," said Joe Pickart, the City of Oconomowoc's utility manager.

The team implemented ArcGIS QuickCapture, which allows mobile crews to walk fast while capturing highly accurate data on sidewalks.

This realization prompted Pickart to contact Symbiont, a nationally recognized engineering, design-build, and construction firm. The GIS team there introduced the utility's operations staff to the Lead Service Line Inventory solution from Esri, which, although it wasn't available in ArcGIS Enterprise, could serve as a framework to support the LSL replacement program. The solution was built with inventory, tracking, and reporting in mind, and it is meant to be a comprehensive system that can also incorporate supplemental datasets. Symbiont offered to replicate the solution's data structure and apps in the city's ArcGIS Enterprise implementation.

But first, the City of Oconomowoc was going to need to collect data, and leaders wanted that done in just two months, since the water utility had a number of assignments to tackle in fast-approaching 2022. This was going to be tough because the team had to gather some critical data from scratch.

Quick and accurate mobile data collection

In many cases, water service pipes cross beneath sidewalks as they extend from the water main to a house. Thus, replacing lead pipes often requires digging up sidewalks, which adds to the cost of an LSL replacement project—unless pipe and sidewalk replacements can be done in tandem.

This is what the City of Oconomowoc sought to do. Staff from the water utility got in touch with the city's engineering department to identify sidewalks that needed to be moved or replaced. However, the engineering department didn't have maps that pinpointed the locations of previous data collection activities, which made it difficult to determine the scope of the project and estimate costs.

When Symbiont got involved, the team there proposed that Oconomowoc map every single sidewalk as an individual asset instead of a line, which is what the city had been doing before. This way, the data would better support long-term sidewalk management and simplify coordination between the sidewalk and LSL replacement projects.

After doing a quick analysis, Symbiont's GIS team determined that it would have to gather data on an estimated 135 miles of sidewalk. Using a high-precision GPS unit, Symbiont planned to capture data on approximately 8 miles of sidewalk per day. Instead, after one day of mobile work, the team collected fewer than 2 miles of sidewalk data. This would have made it impossible for the team to meet the city's data collection deadline.

Having heard of ArcGIS QuickCapture, a simple geospatial app that speeds up field data collection, the team at Symbiont decided to try using it for the sidewalk project. QuickCapture allows mobile crews to walk at a faster pace while still capturing information about each asset—in this case, sidewalks—using high-accuracy data collection software.

QuickCapture took just a few hours to configure. After also implementing the R2 backpack-mounted GPS unit from Esri partner Trimble, the team tested this new approach to mobile data collection. Immediately, crew members recognized the benefits of using QuickCapture: collection speeds improved significantly while still maintaining accuracy.

On average, the team gathered 6,000 data points per day, which amounted to more than 100,000 points by the time the project was finished. This reduced the time it took to collect sidewalk data from an estimated 59 days to just 16 days, allowing the team to meet the city's data collection deadline.

And because the city streamlined data collection and management for its supplemental datasets, various teams can better prioritize their city improvement projects as they set out to achieve the goals in Oconomowoc's five-year capital

Sidewalk and lead service line data is incorporated into one map.

Streamlined data helps prioritize improvement projects

With the sidewalk datasets complete, Symbiont's GIS team focused on implementing the Lead Service Line Inventory solution for the City of Oconomowoc. The solution engages many Esri products that the city already had in place, including ArcGIS Field Maps, ArcGIS Dashboards, ArcGIS Web AppBuilder, and ArcGIS StoryMaps. This made it easier to implement a comprehensive software solution for the LSL replacement project that provides precise mapping, accurate infrastructure analysis, ongoing tracking and reporting, increased field mobility, and detailed communication and outreach with stakeholders.

improvement plan. The web mapping app built for the LSL replacement project integrated so much information—including sidewalks in disrepair, poor street conditions, historic water main breaks, and water quality complaints—that city staff can now focus on clusters of issues in problem areas instead of dealing with issues one by one.

Of course, the city has also been able to use the Lead Service Line Inventory solution to identify customers with suspected lead laterals and integrate this information with precise sidewalk, street, water main, and customer datasets. Now, the City of Oconomowoc is actively removing lead pipes from residents' service lines, paving the way for other efforts to provide safe, clean drinking water to all.

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