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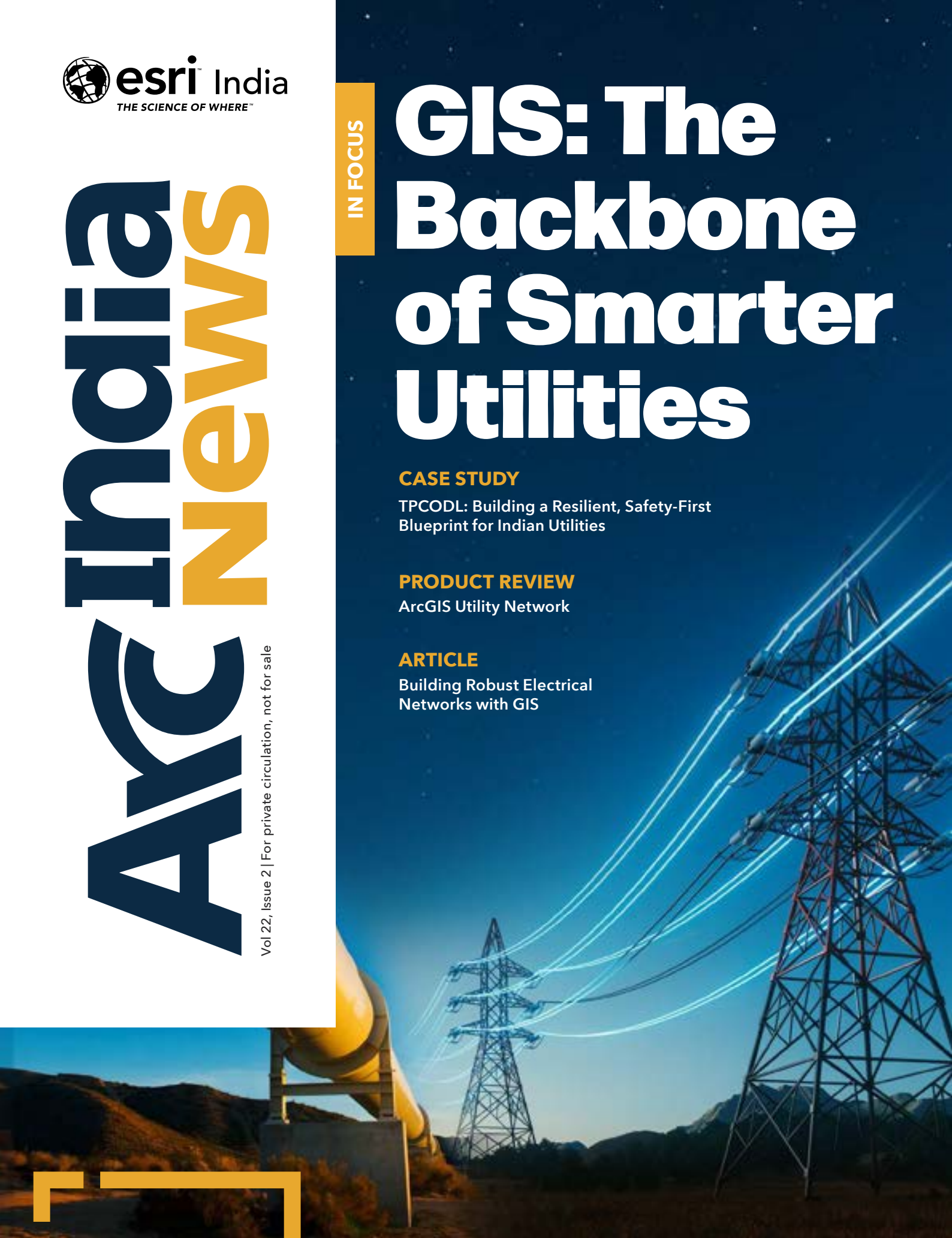
IN FOCUS

GIS: The Backbone of Smarter Utilities

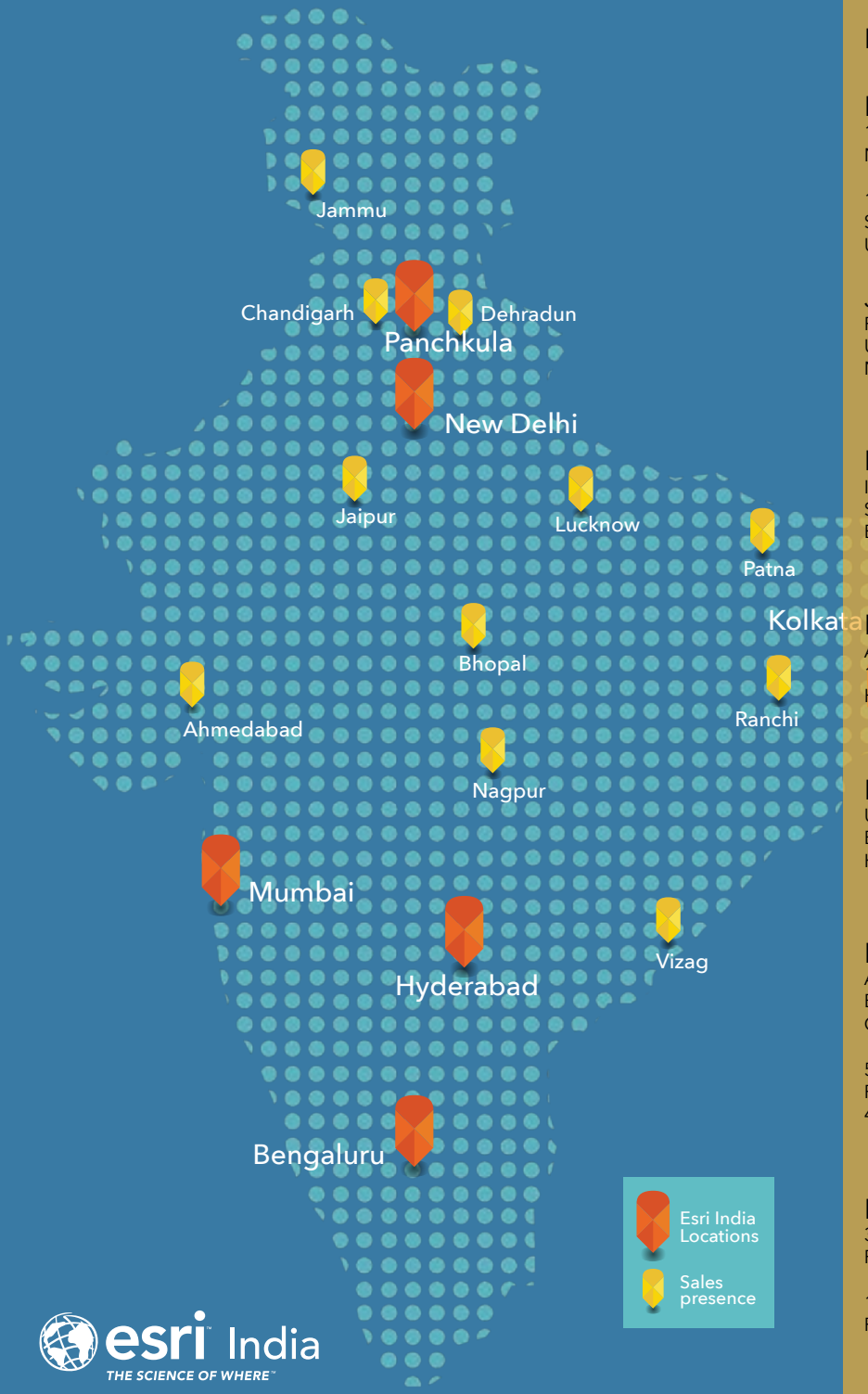
CASE STUDY
TPCODL: Building a Resilient, Safety-First Blueprint for Indian Utilities

PRODUCT REVIEW
ArcGIS Utility Network

ARTICLE
Building Robust Electrical Networks with GIS



ESRI INDIA LOCATIONS



DELHI NCR

Noida (Corp. Office)
10th Floor, Max Tower, Sector - 16B
Noida, Uttar Pradesh - 201301

11th Floor, Berger Tower, Plot No. C-001A/2,
Sector 16B, Noida, Dist. Gautam Buddha Nagar,
Uttar Pradesh, 201301

Jasola (Regd. Office)
Plot no. 8, Elegance Tower, 5th Floor,
Unit No.505 & 506, Pocket - 1, Jasola Vihar,
New Delhi - 110025

BENGALURU
IndiQube Gradeur 14, Walton Rd,
Shanthala Nagar, Ashok Nagar,
Bengaluru, Karnataka - 560001

HYDERABAD
Apeejay Business Center, Tresorie,
1st Floor, The PARK, 22, Raj bhavan Road,
Hyderabad, Telangana - 500082

KOLKATA
Urbanwrk Private Limited, 8th Floor, Technopolis
Building, BP Block, Sector V, Bidhannagar,
Kolkata, West Bengal - 700091

MUMBAI
AWFIS Space Solutions Private Limited, Auram Qparc,
Building Q2, 8th Floor, TTC, Thane-Belapur Road,
Ghansoli, Navi Mumbai, Maharashtra - 400710

5th Floor,Technopolis Knowledge Park Mahakali Caves
Road, Chakala, Andheri East, Mumbai, Maharashtra -
400093

PANCHKULA
3rd Floor, Plot No 16, IT Park, Sector - 22,
Panchkula, Haryana - 134109

1st Floor, Plot No - 1, South Block, IT Park, Sector - 22,
Panchkula, Haryana - 134109

esri India
THE SCIENCE OF WHERE

Esri India Technologies Pvt. Ltd.

10th Floor, Max Towers, Sector 16B, Noida - 201301, Uttar Pradesh (India)

1800 102 1918 info@esri.in esri.in

@esriindia

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MD'S DESK 04

GIS PULSE 05

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MD's Desk

Agendra Kumar

Managing Director, Esri India

Utility systems are no longer merely support services; they are the backbone of national development, economic resilience, and social progress. Without reliable utilities, industrialization slows, and public services degrade. Utility inefficiencies also lead to massive economic leakage. For instance, according to the World Bank, water utilities in India lose about $2.5 billion annually because of non-revenue water. Telecom downtime causes major losses in digital service delivery, and gas distribution inefficiencies increase safety risks and operational costs.

However, the pressure on these vital utility systems is increasing at an unprecedented pace. Rapid urbanization, growing energy consumption, expanding telecom connectivity, and rising demand for water resources are fundamentally transforming the operational landscape for utilities. Traditional infrastructure management approaches, dependent on fragmented data, manual processes, and reactive maintenance, are no longer sufficient to meet the demands of a rapidly evolving economy. This transformation calls for intelligent, connected, and technology-enabled utility ecosystems.

At the center of this transformation lies Geographic Information System (GIS). Whether power, water, gas, or telecommunications, GIS is enabling organizations to modernize their operations and improve service delivery. At Esri India, through multifarious customer success stories, we have witnessed how GIS is helping utility organizations reimagine their workflows, enhance efficiency, and deliver unmatched outcomes. From enabling faster outage restoration in electric utilities to supporting nationwide telecom expansion and improving gas distribution safety, geospatial technology is becoming central to operational excellence and sustainable growth.

What makes GIS especially transformative is its ability to bring together the three pillars of modern utility management: **data, connectivity, and visualization.** Utilities today generate enormous volumes of operational data through IoT devices, sensors, SCADA systems, smart meters, and field operations. GIS provides the framework to unify this data within a spatial context, creating a comprehensive and intelligent view of infrastructure systems.

The emergence of advanced technologies such as **ArcGIS Utility Network, Network Information Management Systems, GeoAI and Digital Twins** is further accelerating this transformation. By combining Artificial Intelligence with geospatial technology, utilities can move from reactive operations to predictive and proactive management. Digital Twins, powered by GIS, enable organizations to create real-time virtual representations of physical infrastructure, improving planning, resilience, and operational efficiency.

The future of utilities will be defined not just by infrastructure expansion, but by intelligence, integration, and resilience. Organizations that embrace GIS-driven modernization today will be better positioned to deliver reliable, efficient, and consumer-centric services tomorrow. As we move toward an increasingly connected and data-driven future, **GIS will continue to serve as the digital backbone of smarter utilities and stronger nations.**

Esri India Developer Summit 2026

Esri India organized an eventful Esri India Developer Summit in New Delhi from 6th-8th May. **The event led to enriching discussions, demos, and technical sessions around enterprise GIS, modern application development, and next-generation GeoAI capabilities across the ArcGIS ecosystem.**

Experts from the global Esri team along with the Esri India team showcased several advanced capabilities of ArcGIS, including simplifying business system integration with ArcGIS Server Object Interceptor, scalable raster analytics, data governance through automation, and AI-driven land intelligence on a knowledge graph. They explored modern application development workflows, including migrating dashboards, building instant apps, configuring ArcGIS Experience Builder, leveraging open-source mapping APIs, developing 3D apps using ArcGIS Maps SDK for JavaScript, and customizing workflows with ArcGIS Pro SDK and Python APIs.

The team also demonstrated how Arcade expressions can enhance the ArcGIS Field Maps experience by enabling customized pop-ups, automated form inputs, geofences, and task-based workflows, helping create more intuitive and efficient mobile experiences for field teams. In a parallel session, the team explored how GitHub Copilot and generative AI are transforming development workflows in ArcGIS Pro SDK, enabling faster coding through code completion and more streamlined application development within Visual Studio. The sessions also addressed common challenges in AI-assisted development and approaches to improve accuracy and context awareness.

The sessions focused on building more customizable and accessible GIS applications across the ArcGIS ecosystem.

An engaging **AI Summit** focused on the growing convergence of GIS and AI. The summit highlighted how organizations across domains such as land management, forestry, mobility, and port operations are integrating AI into their workflows to transform operations and decision-making. The Esri India team showcased demos of ArcGIS AI capabilities, AI assistants and AI agents across the ArcGIS ecosystem. The summit concluded with a look at the roadmap ahead for ArcGIS.

Young Scholar Program 2026: Celebrating Excellence in GIS Innovation

Esri India's Young Scholar Program offers students a unique platform to showcase their innovative GIS projects and gain recognition for their achievements. The program provides participants with opportunities to win exciting prizes, access exclusive learning resources, and build valuable connections within the GIS community.

This year, **228 colleges** participated in the program, demonstrating exceptional talent and creativity in the application of GIS technology. Following a rigorous evaluation process, the following students have been selected as the winners of the Young Scholar Program 2026.

Student Name	College/ University	Course	Project
Swapnali Magadum	Shivaji University, Kolhapur	M.Sc. Geoinformatics	Smart FloodGuard: A Mobile and IoT-Based Real-Time Flash Flood Monitoring, Early Warning, and Evacuation System
Saniya Ahmed	TERI School of Advanced Studies	M.Sc. Geoinformatics	Geospatial Deep Learning in ArcGIS Pro for High-Resolution Forest Carbon Monitoring
Haridra Bora	Miranda House – Delhi University	B.A. (Hons.) Geography	Mapping Hotspots of Climate-Sensitive Diseases Using a Syndemic Risk Framework: A Geospatial Model for Golaghat, Assam
Sreya Bhattacharyya	Birla Institute of Technology - Mesra	M.Sc. Geoinformatics	Integrating Convective Atmospheric Parameters and Machine Learning Approach in ArcGIS Pro Environment for Cloudburst Probability Assessment

Winner

Swapnali Magadum
M.Sc. Geoinformatics, Shivaji University, Kolhapur

Runner-Up

Haridra Bora
B.A. (Hons.) Geography
Miranda House – Delhi University

Saniya Ahmed
M.Sc. Geoinformatics
TERI School of Advanced Studies

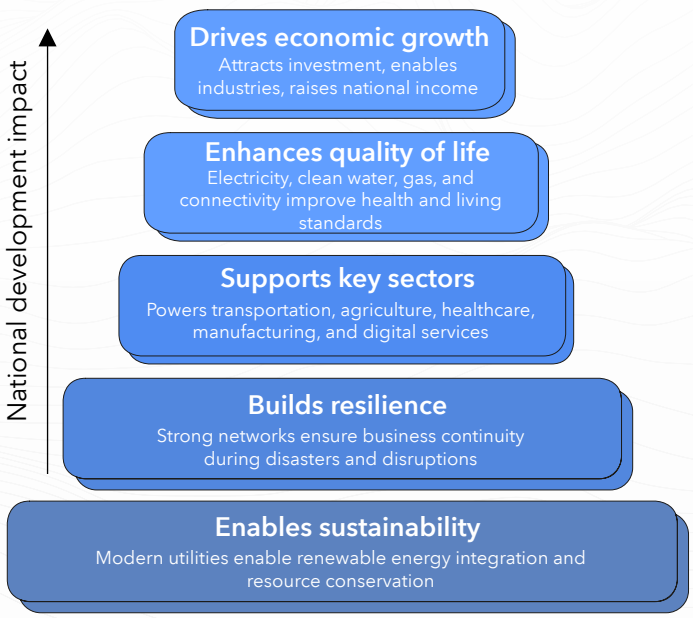
Sreya Bhattacharyya
M.Sc. Geoinformatics
Birla Institute of Technology - Mesra

Scan to View Winning Projects

GIS: The Backbone of Smarter Utilities

Utility systems are not support systems; they are national lifelines. Electricity powers everything. Water sustains cities. Gas fuels industries. Telecom connects economies. Together, these utilities form the operational nervous system of nations.

Countries that invest in reliable utility infrastructure consistently demonstrate higher GDP growth, greater industrial productivity, improved public health, stronger disaster resilience, and faster urban development. Utilities typically account for 40–45% of infrastructure investments, and 60–70% of operational dependency across industries.



Utility systems – a national development pyramid

The Cost of Inadequate Utility Systems

This clearly indicates the importance of efficient utility systems. Without reliable utilities, industrialization slows, and public services degrade. Utility inefficiencies also lead to massive economic leakage. For instance, power outages cost industries **₹2.25 lakh crore annually**, water leakage losses reach **40–50% in urban networks,** non-revenue water losses exceed **₹60,000 crore annually,** telecom downtime causes major losses in digital service delivery, and gas distribution inefficiencies increase safety risks and operational costs.

Additionally, the growing population is putting immense pressure on the existing utility systems. India's population is expected to reach **1.6 billion by 2047,** the urban population is projected to exceed **600 million by 2036,** the **energy demand is expected to triple by 2040,** water demand to increase by **2× by 2030,** and telecom data usage is increasing at **~30% CAGR.** These pressures demand **massive utility scaling.** Without modernization, traditional infrastructure models will not sustain future demand.

India's vision of Viksit Bharat@2047 depends on **strong, integrated, technology-enabled utility networks.** Legacy infrastructure approaches cannot meet these demands. Modernization is no longer optional. It is **strategically essential.**

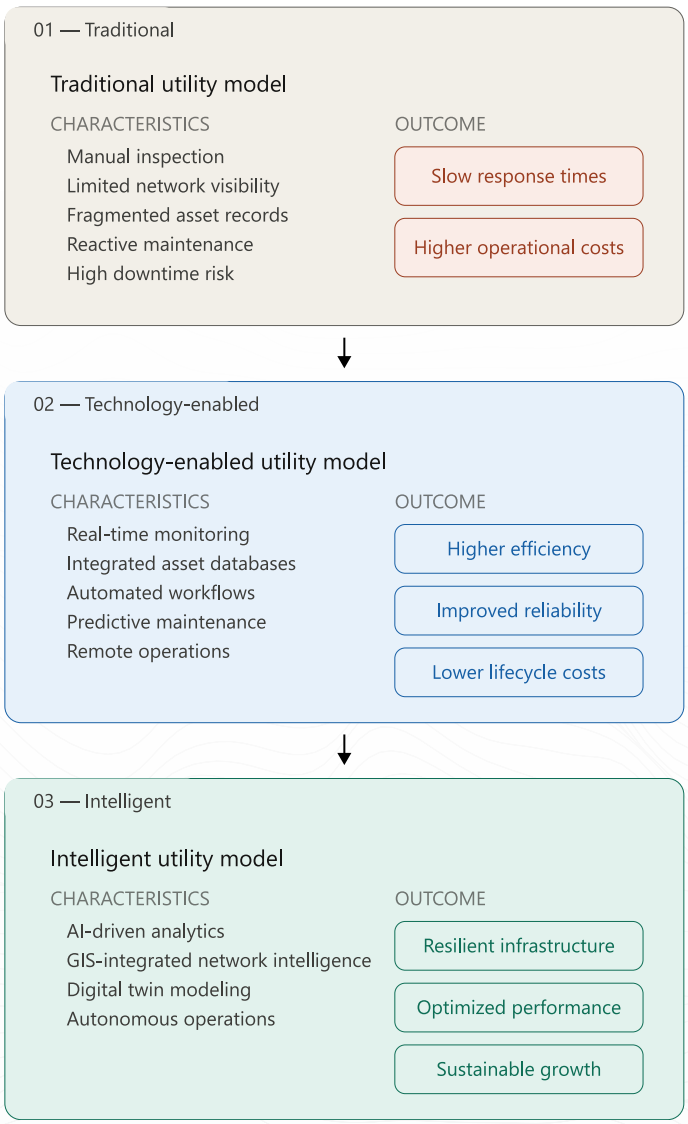
The answer lies in making the utility infrastructure smarter and more efficient using technologies GIS, GeoAI, & Digital Twin.

Why We Need Technology-Enabled Utilities

Traditional utilities are no longer sufficient. Modern economies demand **technology-enabled utility ecosystems** capable of operating intelligently, predicting failures, and responding in real time.

Technology-enabled utilities facilitate real-time

visibility, predictive maintenance, automated response, and integrated operations. This **transition to smarter utilities** is driven by technologies such as Geographic Information Systems (GIS), GeoAI, and Digital twins. With increased automation, better accuracy, and real-time information, these technologies are helping utilities to improve productivity, efficiency, safety, compliance, and reliability. They are transforming utility operations by enabling intelligent asset management, predictive maintenance, and service optimization. With AI-powered GIS, utilities can manage utility infrastructure more effectively, predict equipment failures, optimize service delivery, and generate insights that support better energy and utility operations.



From traditional utilities to digital utilities

Power Utilities

Electricity networks form the **foundation of modern infrastructure,** supporting every sector from manufacturing to healthcare. However, power demand is growing rapidly. Electricity demand is expected to grow **2.5–3× by 2040,** renewable energy is expected to exceed **500 GW capacity,** smart meter installations is projected to exceed **250 million units.** The peak demand of electricity is expected to cross **400 GW by 2030.**

Using GIS, power utilities can manage this rising demand in a better way. By integrating operational data with location intelligence, electric utilities can perform network planning, asset tracking, predictive maintenance, and outage management on a unified platform. With platforms such as Esri's **ArcGIS,** utilities can build a comprehensive system of record and engagement, improving visibility, accelerating project timelines, and enabling more informed, data-driven decisions. Organizations like Adani Electricity Mumbai Limited (AEML), BSES, and TPCODL are using GIS solutions to achieve unmatched efficiency in network planning, outage management, customer service, and more.

When integrated with smart meters, sensors, and SCADA systems, GIS allows utilities to monitor grid performance, optimize maintenance, and respond faster to disruptions. With increasing climate risks, GIS can also help utilities assess vulnerabilities, simulate the impact of extreme events, and strengthen grid resilience.

With advanced tools such as the **Network Information Management System** and **ArcGIS Utility Network,** electric utilities can efficiently manage all the complexities of a modern network.

Adani Electricity Mumbai Limited Optimizes Outage Management with ArcGIS

Quicker & effective response to the customer's power outages in today's ever-changing environment is key to achieving 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.

"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.*" - **Anand Kumar S V, Addl. VP** – IT DevSecOps, Adani Electricity Mumbai Limited.

Water Utilities

Water utilities today face a growing paradox: while demand for water continues to rise due to urbanization, industrial growth, and population expansion, available water supply is becoming increasingly constrained. **Urban water systems are under pressure from aging pipeline infrastructure, high leakage rates, pressure imbalances, and incomplete visibility of underground assets. In India, these challenges are particularly severe, with Non-Revenue Water (NRW) losses estimated at nearly 40–50%,** meaning a significant portion of treated water never reaches consumers. At the same time, pipeline networks are expanding rapidly across urban areas, and overall water demand is expected to double by 2030. Increasing groundwater depletion is also forcing cities to depend more heavily on managed water supply systems.

To address these challenges, modern water utilities are adopting technology-enabled solutions such as smart sensors, pressure monitoring systems, leak detection technologies, and GIS-based network management platforms. **These technologies allow utilities to detect leaks faster, optimize pressure zones, reduce water losses, and improve the reliability and efficiency of water supply services.** Geospatial intelligence and real-time monitoring are becoming essential for sustainable water management and efficient utility operations.

Gas Utilities

Gas distribution systems present unique operational and safety challenges because even small leaks can lead to serious consequences, including fire hazards, environmental risks, and public safety incidents. **As urban gas infrastructure expands rapidly, ensuring the safe and efficient operation of gas networks has become increasingly critical.** In India, the expansion of PNG (Piped Natural Gas) connections across major cities and the rapid growth of CGD (City Gas Distribution) coverage are driving the development of thousands of kilometers of new pipeline networks every year.

To manage these complex networks effectively, gas utilities are increasingly relying on advanced technologies like GIS for leak detection, pressure monitoring, safety compliance tracking, and emergency response planning. Modern gas utility operations require highly accurate spatial intelligence to monitor network conditions, identify risk zones, and respond quickly to incidents. **GIS plays a central role in enabling precise asset mapping, infrastructure monitoring, and real-time decision-making, thereby improving both operational efficiency and public safety.** By providing actionable information, ArcGIS-powered systems are enabling large gas distribution companies like Mahanagar Gas Limited and Gujarat Gas Limited to provide a safe working environment, deliver reliable services, and maintain a focus on customer support.

By serving as a repository for consumer data, GIS enables the creation of thematic maps that aid in identifying future potential consumers. By studying demand-supply dynamics through surveys and mapping, CGD companies can formulate expansion strategies tailored to anticipated growth patterns, thereby ensuring scalability and sustainability.

GIS also enables gas utilities to achieve high levels of efficiency in asset management. Through precise tracking of pipeline assets like main and service lines, coupled with the calculation of relative distances, GIS empowers utilities to effectively monitor and manage their infrastructure. This capability not only enhances operational efficiency but also lays the groundwork for proactive maintenance strategies, mitigating the risks of leaks and accidents.

In the event of an incident, the swift response time facilitated by GIS is paramount. By providing real-time information to response teams, GIS ensures rapid and coordinated action, minimizing the potential impact on both public safety and the environment. By leveraging spatial data and advanced analytical techniques, GIS empowers operators to make informed decisions and take timely actions to address faults.

ArcGIS Enhances Efficiency of MGL's City Gas Distribution (CGD) Network

MGL's evolving business needs have been addressed by implementing a comprehensive GIS system that fosters collaboration and connectivity across different teams.

The new web application, powered by ArcGIS, is set to empower MGL's organization-wide GIS users by allowing them to access and visualize the MGL pipeline network and its assets from both office and field locations. This enhanced accessibility will equip users with valuable insights, enabling them to make informed decisions in the performance of their duties. Furthermore, MGL is actively engaged in the development of a Corrosion Protection (CP) module within ArcGIS. This module will serve as a valuable tool for recording TLP readings, conducting in-depth analyses based on these readings, and generating comprehensive reports within the software, thereby supporting the CP team's operational efficiency. Similarly, the valve chamber cleaning process flow is streamlined in order to manage the effectiveness of cleaning activities through intuitive mobile applications using Survey123 forms.

The integration of Survey123, ArcGIS JS API, and Dashboards creates a comprehensive GIS solution that caters to the diverse needs of departmental stakeholders, from field data collection to visualization and analysis. ArcGIS Dashboards provide a way to create data visualizations and present key indicators, charts and visual elements (attachments) captured from the field in a dashboard format. The GIS ecosystem also helps in reducing data silos and enabling different teams or departments to work with a unified dataset. This promotes collaboration and avoids duplication of efforts in maintaining separate datasets.

> *"The implementation of Esri's ArcGIS Enterprise solution at Mahanagar Gas Ltd. (MGL) marks a transformative milestone for the organization, bringing about a variety of benefits. Firstly, the new GIS system enhances overall performance, leveraging cloud implementation of the software for more efficient data processing, analysis, and visualization. This allows MGL to handle larger datasets and perform complex spatial analyses with greater ease. The advanced workflows and functionalities offered by Esri's GIS platforms, including ArcGIS Dashboards, provide a comprehensive view of assets under regional territories, empowering users to make informed decisions."*
> ***– Viraj Kulkarni, Ch. Manager - GIS, MGL***

Telecom

Telecommunication networks have become as critical to modern society as electricity infrastructure, serving as the digital nervous system that supports financial transactions, emergency services, remote healthcare, digital education, and industrial automation. India's telecom sector is experiencing unprecedented growth, driven by increasing mobile data consumption, nationwide 5G deployment, and the expansion of fiber optic connectivity into rural regions. Mobile data usage is growing by nearly 30% annually, while telecom tower density and digital infrastructure continue to expand significantly across the country.

Managing such vast and complex telecom infrastructure requires precise asset tracking, efficient fiber route management, accurate fault location systems, and continuous network optimization. **Technology-enabled telecom networks depend heavily on geospatial intelligence and GIS platforms to manage assets, monitor network performance, and ensure reliable service delivery.** As telecom infrastructure continues to scale rapidly, spatial technologies are becoming essential for planning, maintenance, outage management, and future network expansion.

At Esri India, we have witnessed the impact of GIS technology while working with the two major telecom service providers (TSPs) in India, Reliance Jio and Airtel. Jio has harnessed the various capabilities of ArcGIS during its 4G and 5G implementations, achieving

the most effective outcomes in network planning to management. ArcGIS has also enabled Airtel to map its network assets along with their coverage capacities. The technology allows the teams to collaborate, share, and perform a variety of spatial analyses such as identifying coverage blind spots, hotspot analysis, and network route planning.

Jio Achieves Excellence in AirFiber Deployment across India with ArcGIS

As India raced into the digital future, Jio introduced a groundbreaking service: Jio AirFiber. Designed to deliver gigabit-speed broadband over the air using 5G and unlicensed band radio (UBR) frequencies, AirFiber doesn't require traditional fiber lines to the home. Instead, it uses rooftop or in-building equipment to receive wireless signals directly from nearby towers. The result is an internet service that is fast to deploy, easier to install, and perfectly suited for dense urban areas or hard-to-reach regions where traditional fiber buildouts would be costly or slow. But deploying a service like this at a national scale—within months—demanded reimagining how telecom networks are planned, activated, and optimized. That's where GIS stepped in. Jio turned to geospatial technology to power every stage of its AirFiber deployment. At the heart of the effort was a national-scale 3D GIS system built on Esri's ArcGIS platform. From data preparation to planning, execution, and maintenance, GIS has been the connective foundation of Jio's AirFiber program. It has unified business units, enabled smarter decisions, and allowed one of the world's most ambitious telecom rollouts to happen on time and at an incredible scale.

Looking forward, as Jio continues to evolve its digital platform, GIS will remain at the heart of its strategy—connecting towers to homes, signals to services, and customers to what's important in their lives.

"We at Jio cannot envisage any other system than the one we built at the shortest possible time to support our AirFiber deployment. Super-fast planning and faster deployment helped us disrupt the broadband internet market by positioning AirFiber as a premium and affordable product with same-day installation time. Our continuous investment in GIS data, people, and Esri's technology along with AI and Cloud platforms helped us build these systems in-house at record speed." ***- Dr. Biswaketan Kundu, VP and Head of GIS, Jio Platforms.***

As utility networks expand and become more complex, organizations require systems that can accurately manage infrastructure, monitor network behavior, and support faster decision-making. **This transformation depends on three critical pillars: data, connectivity, and visualization.**

The first pillar is **data**, which involves maintaining accurate and up-to-date asset information across the utility network. Utilities manage vast numbers of physical assets such as pipelines, transformers, substations, valves, meters, towers, and cables. Without reliable asset data, utilities struggle with maintenance planning, outage management, compliance reporting, and infrastructure expansion. GIS provides a centralized system for storing, managing, and updating this critical asset information.

The second pillar is **connectivity**, which focuses on understanding how utility networks function as interconnected systems. Utilities are not simply collections of individual assets; they are highly connected networks where one failure can impact thousands of customers. GIS enables utilities to model these network relationships, analyze connectivity, trace service paths, identify affected areas during outages, and understand how resources flow through the system. This network intelligence is essential for efficient operations and rapid incident response.

The third pillar is **visualization**, which allows utilities to see infrastructure relationships spatially and operationally. GIS transforms complex infrastructure data into intuitive maps and interactive visual systems that help operators, engineers, and decision-makers understand asset locations, network conditions, and operational risks in real time. Visualization improves planning, field coordination, situational awareness, and communication across departments.

Because GIS supports all three pillars, data management, network connectivity, and spatial visualization, it has become the operational foundation of modern utility systems. However, as utilities continue to evolve, traditional GIS approaches are no longer sufficient to handle the scale and complexity of modern infrastructure networks.

Today's utilities require advanced capabilities such as detailed network modeling, real-time system intelligence, enterprise-wide integration, and support for increasingly dynamic operations. They must manage rapidly expanding infrastructure, integrate data

from IoT sensors and smart devices, support predictive maintenance, and coordinate operations across multiple business systems. **This need has led to the emergence of modern GIS platforms designed specifically for advanced utility management.**

One of the most significant developments in this area is the **ArcGIS Utility Network**. ArcGIS Utility Network provides a next-generation framework for modeling, analyzing, and managing complex utility systems across electric, water, gas, telecom, and wastewater networks. ArcGIS Utility Network supports advanced network topology, real-time connectivity analysis, intelligent tracing, multi-user editing, and enterprise-scale integration. It enables utilities to create highly accurate digital representations of their infrastructure, often referred to as digital twins, which support better operational awareness and smarter decision-making. The platform also integrates seamlessly with enterprise systems such as SCADA, ERP, asset management, outage management, and field workforce applications, allowing utilities to move toward fully connected and intelligent operations.

As utilities worldwide adopt smart infrastructure strategies and digital transformation initiatives, ArcGIS Utility Network is becoming a critical technology platform that enables utilities to modernize operations, improve reliability, reduce operational costs, and build resilient infrastruwcture for the future.

Modern ArcGIS powered Network Information Management Systems offer improved data integrity and analysis capabilities. By understanding connectivity and device behavior, we can model subnetworks, improve data quality, and perform analysis to gain a better understanding of the system. Utility organizations can leverage these capabilities to meet their needs, most effectively.

GeoAI for Utilities

GeoAI, the convergence of Geospatial technology and Artificial Intelligence, is reshaping how utility organizations operate. By integrating AI with spatial data and geospatial technology, GeoAI empowers utilities to automate workflows, uncover patterns, and model future scenarios, enabling smarter, data-driven decision-making.

Demand Forecasting

Accurate demand predictions help optimize power generation, reduce energy wastage, prevent grid overloads, and support better infrastructure planning. This also assists in renewable energy management by forecasting fluctuations in energy consumption and production. As utility systems become increasingly complex due to rapid urbanization and climate change, advanced forecasting tools like Time-MoE within ArcGIS offer a scalable, data-driven, and intelligent approach for sustainable energy management and resilient utility planning.

Intelligent asset management & Failure Prevention

GeoAI can automate asset inspections using imagery, drone and sensor data, predict maintenance needs and infrastructure failures before they occur, manage vegetation-related risks through advanced image analysis, and improve data quality by identifying anomalies and inconsistencies.

Deep learning models within ArcGIS Pro can analyze asset conditions, environmental variables, and real-time sensor inputs to detect early warning signs of failure, enabling utilities to plan maintenance and inspections before issues escalate, reduce unplanned downtime, lower repair costs, and speed up field response. Similarly, by using imagery, LiDAR, and spatial analysis, utilities can **detect vegetation encroachment** risks near critical infrastructure, prioritize those risks by severity, and even predict future growth patterns, turning a perennial operational challenge into a manageable, proactive workflow.

Overall, by embedding GeoAI into their workflows, utilities can move **from reactive to proactive** operations, saving time, reducing costs, and improving service reliability, marking a fundamental strategic shift in how utility infrastructure and demand is monitored and managed.

Digital Twins and Utilities

For utilities, the value of a GIS-powered digital twin is wide-ranging and deeply practical. Investment planning becomes more informed as ArcGIS enables teams to visualize and analyze different system scenarios and model their potential impacts before committing resources.

Real-time data feeds from IoT devices are seamlessly integrated, formatted, and displayed in ways that generate actionable insights. Improved mapping and modeling bring greater clarity to the management of facilities and assets, while AI and machine learning capabilities support predictive maintenance and scenario simulation.

Digital twins break down departmental silos, enabling cross-functional collaboration and clearer communication with stakeholders, transforming utilities from reactive operators into proactive, data-driven organizations ready for the challenges ahead.

In Closing

As utilities navigate an increasingly complex digital landscape, the imperative to make data-driven decisions, contextualized to assets, consumers, and geographies has never been greater. Traditional technologies, constrained by their own boundaries, can no longer deliver the holistic visibility that modern utility management demands. **The future belongs to platforms and approaches that are self-learning, spatially aware, and capable of transforming vast volumes of operational data into actionable intelligence.** Utilities that remain ahead of the curve will be those that successfully connect assets, people, and processes into a unified, insight-driven ecosystem, one where consumer behavior, network performance, and business strategy are understood not in isolation, but in relationship with one another.

This is precisely where **GeoAI and Digital Twins are proving to be game changers.** GeoAI brings the power of machine learning and spatial intelligence together, enabling utilities to move from reactive operations to predictive, proactive decision-making, automating asset inspections, forecasting infrastructure failures, and optimizing field workflows with unprecedented accuracy. Digital Twins complement this by creating living, dynamic models of utility networks that simulate real-world scenarios, support investment planning, and foster cross-functional collaboration in ways that were previously unimaginable. Together, they represent the convergence of intelligence and geography that utilities need to thrive.

With more than 90% of utility enterprise data carrying a location context, geography remains the most powerful and underutilized binding factor across the supply-demand and source-consumer continuum. **GIS-driven utility management, augmented by GeoAI and Digital Twin capabilities, is no longer simply a technological upgrade, it is a national development imperative, one that must be embraced at full scale, and with urgency, to build a resilient, sustainable, and consumer-centric digital future.**

TPCODL: Building a Resilient, Safety-First Blueprint for Indian Utilities

Client

TP Central Odisha Distribution Limited (TPCODL)

Industry

Utilities (Power Distribution)

Organization Profile

TP Central Odisha Distribution Limited (TPCODL) is a Joint Venture of Tata Power and the Government of Odisha. Tata Power is India's largest integrated power company with a growing international presence. The Company, together with its subsidiaries and jointly controlled entities, has an installed gross generation capacity of 10,613 MW and a presence in all the segments of the power sector, namely, Fuel Security and Logistics, Generation (Thermal, Hydro, Solar, and Wind), Transmission, Distribution, and Trading. Tata Power is serving more than 26 Lakh distribution consumers in India (Mumbai, Delhi & Ajmer) and has developed the country's first 4000 MW Ultra Mega Power Project at Mundra (Gujarat) based on super-critical technology.

Website

www.tpcentralodisha.com

Applications Building Proactive Resilience

The state of Odisha, characterized by its extensive coastline, is historically prone to severe tropical storms and cyclones. These natural disasters frequently devastate electrical infrastructure, leading to prolonged service outages that can last weeks. TP Central Odisha Distribution Limited (TPCODL), a joint venture between Tata Power and the Government of Odisha, has transformed its disaster response and operational safety by leveraging Esri's ArcGIS Enterprise platform. By integrating real-time weather intelligence and national geospatial datasets, TPCODL has moved from reactive maintenance to a model of proactive resilience and absolute workforce safety.

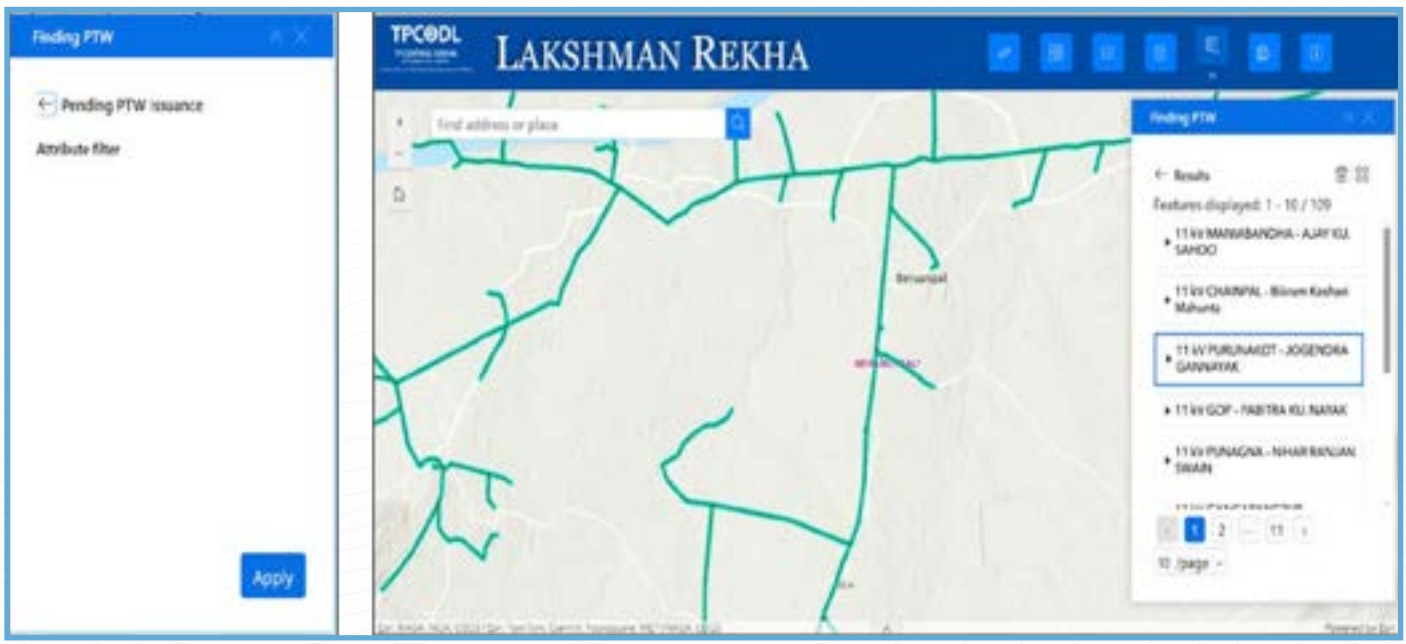
Bhaugolik Bidyut Sanchalan Manachitra

The Bhaugolik Bidyut Sanchalan Manachitra (Operations using Geographic Maps) allows the Power Systems Control Center to predict infrastructure damage with high confidence. By visualizing wind speeds and cyclone tracks against the 11kV and 33kV network, TPCODL was able to strategically pre-position man and material, during the Dana cyclone, resulting in service restoration within a remarkable 24 hours after landfall for majority of the affected areas.

Bhaugolik Bidyut Sanchalan Manachitra

The Lakshman Rekha Application

A Permit to Work mechanism has been put in place by TPCODL to ensure safety in operations, whenever some work has to be undertaken on the distribution network. The organization previously utilized one custom grown solution titled '*Suraksha-Kawach*' app for Permit to Work (PTW) requests. But there remained a gap in verifying if field crews were operating on the exact device for which the permit was granted. This problem was solved by The *Lakshman Rekha* application, which utilizes ArcGIS Field Maps and real-time geo-fencing to define a virtual safety zone around authorized work sites.



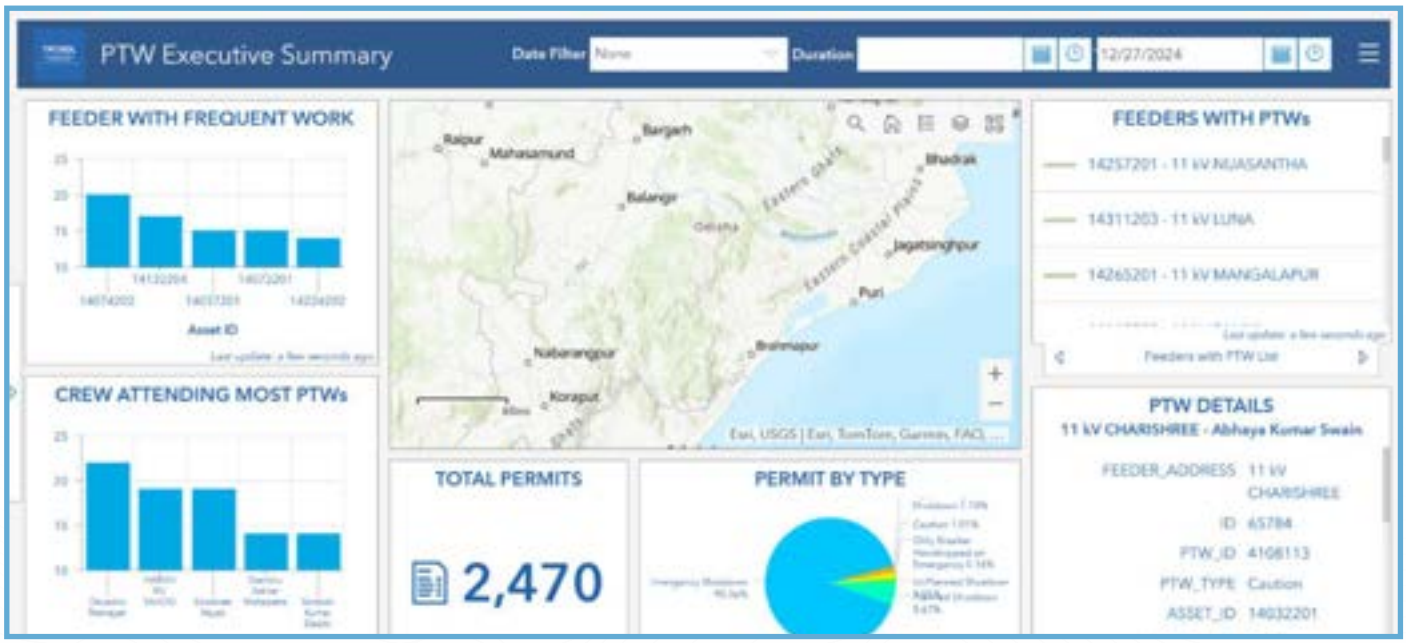
The *Lakshman Rekha* Web Application includes custom-developed modules for the departmental users. Different functionalities of these modules aid application users to perform the desired operations in a user-friendly manner.

Virtual Inspection: Supervisors can now see the 100% real-time location of field users relative to the electrical assets (transformers, switches, or poles).

Safety Assurance: If a crew member attempts to operate outside the notified work zone, the system provides immediate alerts, ensuring the Suraksha Kawach (Safety Shield) protocol is strictly maintained.

PTW Executive Dashboard

The PTW Executive Summary Dashboard serves as a comprehensive tool for supervisors and higher-level officials to gain an overview of the entire feeder network and its associated PTWs. This dashboard provides valuable insights into the operational status, trends, and activity patterns within the network. It consolidates critical data into an interactive and visually engaging interface, facilitating informed decision-making. This dashboard empowers stakeholders to manage the feeder network efficiently and ensure smooth operational workflows.



ArcGIS Driving Transformation across TPCODL

One of the cornerstones of TPCODL's digital transformation is the integration of diverse data streams into a single, cohesive interface. Using Esri's ArcGIS technology, TPCODL successfully combined its enterprise distribution network data with high-fidelity external sources, such as:

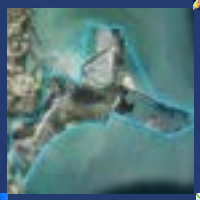
- **The ArcGIS Living Atlas of the World:** TPCODL utilizes this globally curated collection of geographic information to access real-time weather forecast models from the Indian Meteorological Department (IMD). Cyclone streams of data have been especially useful.
- **Survey of India (SoI):** Following the democratization of data under the National Geospatial Policy, TPCODL integrated SoI's administrative village boundaries to pinpoint specific areas of potential impact.

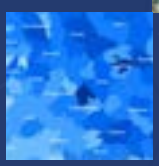
> The application of geo-fencing to track the proximity of crew with the specific device on which the permit to work has been issued is a novel leap for the utility industry. By harnessing Esri's technology, TPCODL is not just distributing power; it is building a resilient, safety-first blueprint for the future of Indian utilities. **– Shri. Dhruba Banerjee, Head – GIS, TPCODL**

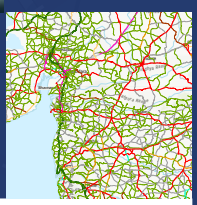
Indo ArcGIS®

Living Atlas

Foremost Collection of Geographic Data



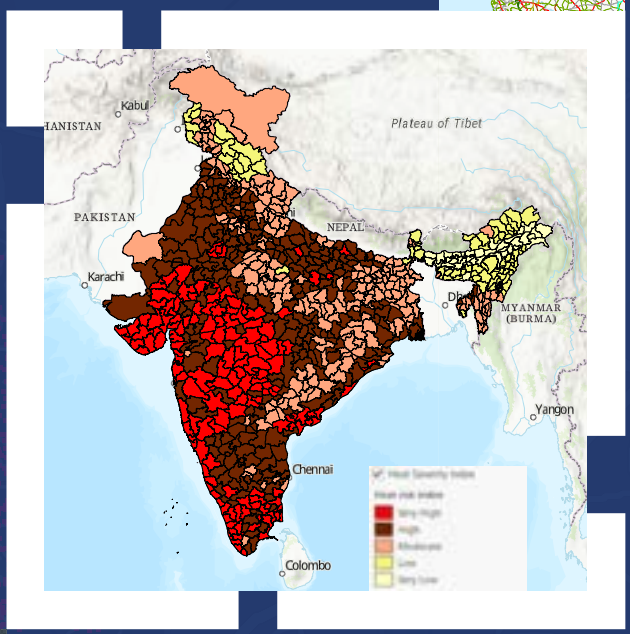


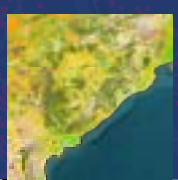


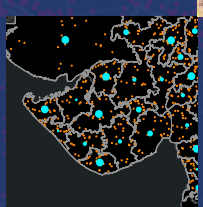
100+
Segments and Content categories

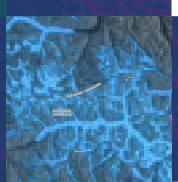
50M+
Annual data requests

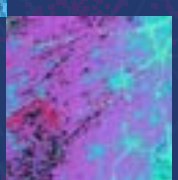
- Get ready-to-use geographic content for India
- Access curated content from across 100+ categories
- Create maps, apps, and perform analysis











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Airtel Empowering the Telecom Sector through GIS Innovation

Geographic Information Systems (GIS) play a crucial role in the telecom industry by enabling efficient planning, deployment, and management of network infrastructure. Telecom companies such as Airtel are using GIS to enhance decision-making, reduce operational costs, and support the development of reliable and high-performance telecom networks. An engaging conversation with **Mr. Ramakrishna Reddy, General Manager, Airtel**, tells us more.

How has the use of GIS helped Airtel in its 4G and 5G implementations?

GIS has played a significant role in supporting Airtel's 4G and 5G implementations across multiple stages of the network lifecycle. Initially, it helped in network planning by identifying potential locations for tower deployment, such as high-rise buildings, commercial hubs, and priority coverage areas where network demand is high. This enabled efficient site selection and ensured optimal coverage from the beginning.

After deployment, GIS supports the operationalization of the network by helping manage infrastructure and monitor service performance. It also plays an important role in customer acquisition. For example, with services like AirFiber, GIS is used to check whether a customer location is serviceable, estimate connection feasibility, and determine timelines for installation. Overall, GIS has been instrumental in enabling efficient planning, faster deployment, and improved customer onboarding, which are all critical for successful 4G and 5G network rollouts.

How has the use of ArcGIS been especially beneficial?

ArcGIS has been especially beneficial because it is a robust platform with strong spatial intelligence capabilities. It provides a wide range of services, including web interfaces, mobile applications, and SDKs that can be integrated into third-party or internally developed applications. This flexibility allows organizations to embed spatial intelligence directly into their business workflows. By leveraging these capabilities, we have been able to build customized solutions that support our operational and decision-making processes. Overall, the strong technical foundation of ArcGIS enables us to efficiently exploit spatial data and enhance business processes across the organization.

With GIS capabilities getting increased with AI, how is Airtel leveraging that?

We have also been utilizing the AI capabilities of ArcGIS. We are looking at enabling our teams with generative AI. In the future, we want our users to enter basic prompts and get responses to questions related to connectivity, service availability, etc. This will reduce their dependency on others for getting basic information like this.

How does GIS aid in expanding services to rural or underserved areas?

GIS plays a vital role in expanding telecom services to rural and underserved areas by integrating business analytics with local spatial data. By combining demographic information, terrain details, and development patterns, GIS helps identify locations that may be rural, semi-rural, emerging urban peripheries, or densely populated regions lacking adequate coverage. This integration enables telecom planners to pinpoint priority areas where connectivity demand exists, but infrastructure is limited. As a result, companies can strategically plan tower placements, optimize network expansion, and extend services beyond major urban centers to even the most remote locations. Ultimately, GIS supports inclusive connectivity by ensuring that rural and underserved communities are effectively identified and served.

Tell us about your experience with Esri India.

The Esri India team has been very supportive, very proactive. I have been interacting with people at all levels. They are very positive and good at resolving any challenge, either on the product side or on the support side.

GIS Strengthening India's Energy Infrastructure Ecosystem: PFC

Power Finance Corporation Limited (PFC) is a key financial pillar of India's energy infrastructure ecosystem. Through an insightful conversation with **Mr. Saurav Shah, Executive Director (RDSS), PFC**, we explored how the use of GIS is enabling the organization to serve the power sector better.

What are the main advantages of using GIS in your area of work?

In power sector, specifically, towards the distribution sector, we realize that the importance of GIS or maps is growing every single year as the urban utility space is getting crowded with more and more utilities coming in, be it gas, water or power.

To manage capacity growth, the urban strata has to be very carefully mapped so that when new work is taken, it does not impinge upon existing lines, does not really disturb something. Similarly, areas where there is a probability of disaster, early warning systems and prediction systems can aid in customizing the network load. This can happen right from the planning phase. Many of these things cannot be overcome later in the project life or retrofitting may not be possible. So, the best thing is to have is an understanding as to where, in what area the planning is happening and to prepare likewise so that you are prepared for any kind of contingencies that can happen in that particular area. This is one part.

The other thing is network planning. With emerging load centres such as EV charging hubs, electric bus depots, and data centres driving unprecedented power demand, network planning has become more critical than ever. Accurate electrical network mapping combined with load flow analysis can help utilities and planners identify where future demand will arise, optimize infrastructure deployment, and ensure upstream power availability in advance.

This approach not only prevents unnecessary infrastructure investments, but also enables faster, smarter, and more resilient network expansion to support India's growing energy and digital ecosystem.

How are Esri's technologies helping PFC in its business?

We are using Esri's technologies extensively in our SCADA, ADMS systems. The right information is crucial, but in SCADA or ADMS systems, you are not just getting informed, you are also controlling remotely. When you control remotely, there cannot be any kind of accuracy challenges. This is where we find a lot of application of Esri's technologies.

Also overall, in state level asset monitoring, because asset mapping as well as asset health monitoring, both are reliant upon Esri's technologies. We are using more and more technology to enable more informed decisions around capital expenditure planning as well as ongoing operations and maintenance (O&M).

How can GIS aid in developing an EV/ hydrogen economy?

Already in network planning, we are seeing that with

more renewable energy ingestion in the network, there is a timing issue. There is both a spatial and temporal challenge, unless represented on a map. GIS can help us understand where is the power coming from? When is it coming? What will be the alternate feed? If there is a feeder which is getting fed by renewable energy in the daytime, where is the feed coming from? This requires a clear load flow study to understand where the alternate source is, whether the alternate source will be overburdened by supplying to multiple feeders in the night, etc.

All this decision making can only happen when you have the proper maps in place, proper tools to analyze. With renewable energy, the importance of integrated decision-making has only grown. Conventional power was one way, now the flow is bidirectional, now there are prosumers who will be supplying power to the grid in turn. So, this makes for very complicated grid economics, but that can be solved when you have the right load flow, right representation. GIS only gets more essential from here.

How's the integration of GIS and AI useful for organizations like PFC?

Today, there is a lot of input that is coming in, in terms of visual data, there is satellite imagery, there is LiDAR based data, there is drone based data. Thus, the absolute data size is mind boggling. To manage this large amount of data effectively, to avoid false positives, we need to train our models better. We can achieve this with the application of AI.

To keep both DISCOM and company personnel engaged, the data must be accurate, high-quality, and capable of generating reliable insights for better decision-making. The accuracy range has to go from 10-20% to say 70-80%. AI can help us in achieving that. If you are able to train your models better and better, the accuracy improves. If the events are reduced, then you are getting more accurate events and you are able to decide on them more effectively.

Indian Institute of Petroleum and Energy: Preparing Tomorrow's Energy Leaders

How is GIS being used to address real-world challenges such as energy exploration, pipeline management, or environmental monitoring?

GIS is playing a transformative role in addressing real-world challenges across the energy sector by enabling better visualization, analysis, monitoring, and decision-making using spatial data. GIS complex technical data into intuitive maps, dashboards, and models that help engineers, administrators, policymakers, and communities make informed decisions quickly and effectively.

In petroleum, renewable energy, and environmental management, most datasets are geographically linked, making GIS an essential technology. In oil, gas, geothermal, and critical **mineral exploration**, GIS helps integrate geological maps, geophysical surveys, well logs, and remote sensing datasets. This integration supports basin analysis, prospect identification, reservoir characterization, and reduction of exploration risk.

GIS is also widely used for solar radiation mapping, wind resource assessment, green hydrogen potential studies, site suitability analysis for **renewable energy** projects, and transmission and infrastructure planning. It helps identify locations that are technically efficient, economically viable, and environmentally sustainable.

Pipeline systems extend across complex terrains and environmentally sensitive areas. GIS assists in optimal pipeline route selection, terrain and hazard analysis, monitoring encroachments and right-of-way issues, leak detection and emergency response planning, and asset integrity management. When integrated with IoT sensors and satellite monitoring, **GIS enables real-time pipeline surveillance**.

Environmental, Social, and Governance (ESG) compliance is becoming critical for energy industries. GIS is extensively used to **monitor and manage environmental impacts** through Environmental Impact Assessment (EIA), oil spill tracking, coastal zone monitoring, groundwater and air quality analysis, land-use and ecosystem studies, and climate vulnerability assessment. It helps industries comply with environmental regulations and supports sustainable development. It is also getting increasingly used in carbon capture and storage (CCS) site screening, methane emission monitoring, carbon footprint mapping, energy transition planning, and creating sustainable urban energy systems.

Overall, GIS has evolved from a mapping tool into a strategic decision-support system that connects exploration, infrastructure, sustainability, safety, and digital intelligence across the modern energy ecosystem.

What future advancements do you foresee in GIS applications for petroleum, energy transition, and sustainability?

GIS is expected to evolve from a visualization tool into an intelligent decision-making platform for the global energy ecosystem. When integrated with **Artificial Intelligence and Machine Learning**, GIS will enable automated seismic interpretation, predictive exploration of hydrocarbons and critical minerals, smart reservoir characterization, real-time anomaly detection in pipelines and infrastructure, and faster environmental risk prediction. AI will significantly reduce interpretation time and improve accuracy. GIS combined with robotics and AI may support semi-autonomous exploration and monitoring systems where drones conduct surveys automatically, AI identifies exploration targets and real-time geospatial analytics guide drilling operations.

Future energy systems will also increasingly use **Digital Twins** connected with GIS for smart oilfields and refineries, offshore platform monitoring, pipeline integrity management, urban energy systems, and smart campuses and industrial infrastructure. These virtual systems will simulate real-world operations continuously using live data.

Also, as billions of **IoT devices and remote sensors** will continuously feed spatial data into GIS platforms, we will have real-time production optimization, leak and methane emission detection, predictive maintenance, environmental compliance monitoring, and automated safety systems. Future GIS may also integrate with **augmented reality (AR), virtual reality (VR)**, and immersive visualization systems, enabling engineers and decision-makers to interact with complex subsurface and infrastructure models in real time.

Overall, the future of GIS lies in intelligent, real-time, and predictive geospatial systems that will help industries achieve safer exploration, cleaner energy production, improved sustainability, and smarter management of Earth's resources.

How is GIS incorporated into your curriculum across undergraduate, postgraduate, or doctoral programs?

At Indian Institute of Petroleum and Energy (IIPE), GIS applications are integrated across undergraduate, postgraduate, and doctoral programs to support geoscience, petroleum, and energy-related studies. The curriculum emphasizes both theoretical understanding and practical application of spatial analysis tools relevant to industry and research.

In the **B.Tech. programs**, GIS concepts are introduced through courses and laboratory sessions related to Earth sciences, and spatial data analysis. Students are trained in basics of GIS and Remote Sensing, spatial data interpretation and visualization, and applications in petroleum exploration.

As part of the **M.Sc. Applied Geology program**, students learn about various Remote Sensing and GIS techniques, geological and hydrogeological mapping, integration of field, satellite, and geospatial datasets, and GIS-based applications in mineral exploration and environmental geology.

GIS is also widely used as a research and analytical tool in **doctoral studies**. Scholars apply GIS in spatial and geostatistical analysis, hydrogeological and environmental modelling, geological hazard and resource mapping, basin and reservoir characterization, and integration of GIS with remote sensing, geophysical, and numerical modeling techniques.

Overall, GIS education at Indian Institute of Petroleum and Energy is designed to progressively build spatial analysis capabilities from foundational exposure at the undergraduate level to advanced research-oriented applications at the doctoral stage.

How has GIS training influenced student employability and career opportunities in the energy sector?

GIS training has significantly improved student employability and expanded career opportunities in the energy sector because industries increasingly rely on spatial data, digital mapping, and geospatial intelligence for decision-making.

GIS IN EDUCATION

As GIS education connects geosciences, petroleum engineering, environmental science, computer science, economics, and policy studies, it creates interdisciplinary energy professionals.

Students trained in GIS gain practical skills in spatial analysis, mapping, remote sensing, and data integration using platforms such as ArcGIS. These skills make them employable not only in oil and gas companies but also in renewable energy firms, government organizations, environmental agencies, urban planning bodies, disaster management agencies and research institutions and startups. Additionally, since GIS technologies are used worldwide, students trained in geospatial methods can compete for international opportunities in energy exploration, environmental monitoring, and sustainability projects.

Also, modern GIS training often includes drone mapping, satellite data analysis, machine learning, and spatial data analytics. This interdisciplinary exposure helps students fit into Industry 4.0 and digital energy workflows.

Students with geospatial skills are often preferred for internships, field projects, and funded research because they can handle real-world datasets and produce meaningful spatial interpretations.

GIS training transforms students from conventional domain specialists into multidisciplinary professionals capable of working in modern, data-driven energy industries. This greatly enhances both employability and long-term career growth.

Responses attributed to:
Prof. Shalivahan, Director, IIPE

Building Robust Electrical Networks with GIS

India's electricity sector has achieved near-universal access, electrifying over 597,500 villages and serving more than 1.4 billion people, with installed capacity growing from 1.3 GW in 1947 to 520.51 GW (as on January, 2026). Government initiatives like Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY), SAUBHAGYA, Integrated Power Development Scheme (IPDS), and Revamped Distribution Sector Scheme (RDSS) have played a key role in expanding access and improving last-mile connectivity. However, with this growth, challenges such as high AT&C losses and aging infrastructure have also intensified, which can be resolved only with higher integration of advanced technologies in the power utility ecosystem.

Achieving More with GIS

Using technologies like Geographic Information Systems (GIS), power utilities can map and analyse the entire lifecycle of transmission and distribution assets, including substations, transformers, feeders, and transmission lines. By integrating operational data with location intelligence, electric utilities can perform network planning, asset tracking, predictive maintenance, and outage management on a unified platform. With platforms such as Esri's **ArcGIS**, utilities can build a comprehensive system of record and engagement, improving visibility, accelerating project timelines, and enabling more informed, data-driven decisions. For instance, organizations like Adani Electricity Mumbai Limited (AEML) and BSES are using GIS solutions to achieve unmatched efficiency in network planning, outage management, customer service, and more.

When integrated with smart meters, sensors, and SCADA systems, GIS allows utilities to monitor grid performance, optimize maintenance, and respond faster to disruptions. With increasing climate risks, GIS can also help utilities assess vulnerabilities, simulate the impact of extreme events, and strengthen grid resilience.

With advanced tools such as the **Network Information Management System** and **ArcGIS Utility Network**, powered by **ArcGIS**, electric utilities can efficiently manage all the complexities of a modern network.

Going Further with AI

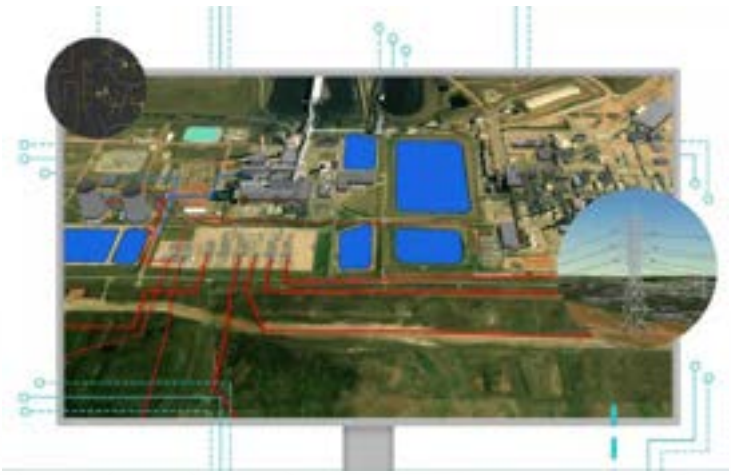
AI can further enhance transmission and distribution planning by evaluating multiple route options to minimize costs, land conflicts, and environmental impact. Through terrain and land-use analysis, it can identify optimal locations for transmission poles, while site suitability assessments improve safety and efficiency. AI-powered assistants and inspection tools can provide real-time insights and enable faster, data-driven decisions, including anomaly detection for proactive maintenance.

When combined with GIS, these capabilities can become even more powerful, allowing power utilities to visualize and analyze spatial data effectively. This integration enables a shift from reactive operations to predictive modelling, improving accuracy, reliability, and long-term planning in the power sector.

Along with overcoming the mentioned challenges, we also need to prepare well for the renewable energy transition. As India continues to add 15–20 GW of renewable capacity annually, with solar energy being at the forefront of this expansion, **GeoAI (GIS powered by the capabilities of AI) can aid in forecasting solar energy generation by leveraging weather forecast data.** This can lead to better power planning. Overall, GIS can empower power utilities to optimize asset management, enhance outage response, and plan infrastructure with greater precision. It is thus imperative for the stakeholders to accelerate adoption and invest in GIS-driven innovation to build smarter, more resilient, and future-ready power networks.

ArcGIS Utility Network

The Digital Engine for Modern Infrastructure



ArcGIS Utility Network is a comprehensive next-generation framework within ArcGIS Pro and ArcGIS Enterprise used to model, edit, and analyze network-based infrastructure systems like water, electricity, gas, or telecommunications. It manages a connected network with a single unified model.

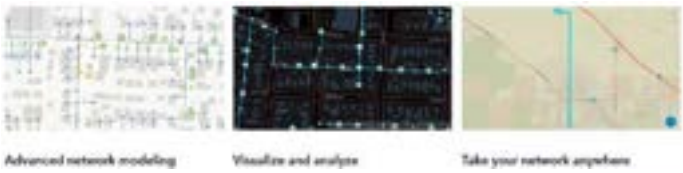
Using ArcGIS Utility Network, you can:

Model your entire network: High-end 3D visuals help you view complex assemblies of devices and lines and manage how assets are connected within them. ArcGIS Utility Network (UN) offers advanced modeling capabilities that allow you to create digital twins of complex infrastructures.

Aggregate and report events dynamically: Use advanced analytics and tracing capabilities of ArcGIS Utility Network to aggregate and report events dynamically. This provides accurate and timely reporting for both current, historic, and future states.

Connect your organization across desktop, mobile, and web environments: Provide role-based, secure access to your users to streamline communication and collaboration for managing your network.

Features of ArcGIS Utility Network



Advanced Network Modeling: The Utility Network is designed to represent complex utility systems, including electric, gas, water, and telecommunications networks. It supports the modeling of devices, lines, junctions, and hierarchical network structures, enabling organizations to accurately capture and manage their network assets.

Connectivity and Topology Management: The Utility Network maintains asset connectivity by enforcing predefined connectivity rules that govern how network components interact. It also manages network topology to identify connectivity issues and data errors, helping ensure the accuracy and reliability of network information.

Powerful Tracing and Analysis: The Utility Network provides advanced tracing capabilities, including upstream and downstream tracing, isolation tracing, and subnetwork tracing. These analytical tools help utilities understand network behavior, identify affected assets, assess service impacts, and support informed operational decisions.

Rule-Based Data Integrity (Attribute Rules): Attribute rules help maintain data quality by preventing incorrect data entry and enforcing business rules. They also automate data updates and validation processes, reducing manual effort and improving consistency across the network.

Web GIS Integration and Enterprise Deployment: The Utility Network is fully integrated with ArcGIS Enterprise

and ArcGIS Pro, providing a comprehensive platform for network management. It supports web applications, mobile applications, and GIS services, ensuring that network information remains accessible to users both in the office and in the field.

Benefits of Using ArcGIS Utility Network

- Quickly identify affected areas and fault locations to restore services using network tracing. This improves reliability and customer satisfaction.
- Maintain consistent and reliable network information.
- Automate workflows, reducing considerable amount of time.
- Support planning, expansion, and risk analysis.
- Identify critical assets and problem areas. This helps with planning preventive maintenance.

ArcGIS Utility Network brings effective outcomes across utilities. It helps in field crew operations, including visualizations and monitoring of assets, updating status, and capturing issues in real time.

Specifically, in case of electric utilities, it helps in power outage management, fault isolation, service restoration, load balancing and network planning. For water utilities, the benefits extend to leak detection, isolation and pressure zone management. For gas utilities, it helps in emergency response (gas leak), maintenance, and inspection planning. For telecom companies, ArcGIS Utility Network helps in fiber network management, service provisioning, and more.

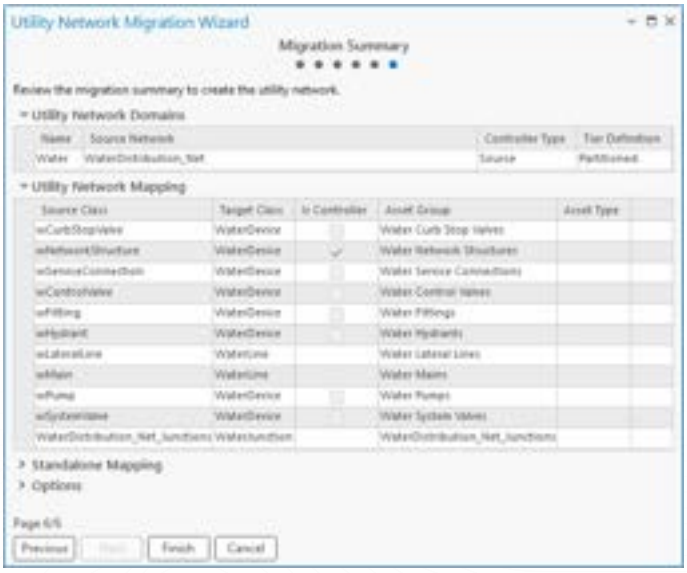
Introducing the Migration Toolset and Wizard in ArcGIS Utility Network

Since the initial release of ArcGIS Utility Network in 2018, Esri has provided users with industry-specific data models, called Utility Network Foundations. These industry models for electric, gas, water, sanitary sewer, stormwater, and district energy are fully configured to support each industry's specific network information management needs and have been very successful in helping utilities around the world take full advantage of the capabilities of ArcGIS Utility Network.

Esri has also released simpler data models, providing tools to streamline migrations and extend models with the users' own requirements.

ArcGIS Pro 3.5 has introduced the **Migration toolset and Utility Network Migration Wizard**. These tools allow you to migrate your data into a base utility network model as quickly and simply, while also minimizing the amount of change required. This migration approach provides those with modest requirements a clearer path forward and allows any organization that manages geospatial data to quickly migrate their data to a utility network to evaluate data quality.

The **Migration toolset** contains **three tools** designed to help you migrate data from an existing geometric network or set of feature classes into a new geodatabase and utility network dataset. The **Migrate To Utility Network tool** creates and loads data to a utility network based on the classes and fields of your existing GIS features. This model is unique to your organization and is not based on or related to any of the Utility Network Foundation data models. The initial utility network created by the tool is very simple, capable of supporting basic editing and tracing workflows. More advanced capabilities of the utility network specific to your requirements can be progressively configured over time, when you want them.



The **Analyze Network Data tool** is designed to identify the most common topological errors found in a utility network. While this tool works best when run against a geodatabase created by the Utility Network Migration Wizard or Migrate to Utility Network tool, it can be run against any geodatabase that contains a utility network (file, mobile, or enterprise geodatabase).

The **Apply Error Resolutions tool** is used as part of the data migration process to apply resolutions from a resolutions table to address common error types identified by the Analyze Network Data tool.

Note: For those currently using ArcGIS Pro 3.3, a standalone toolbox containing the Migration toolset has been made available in this earlier release.

The **Utility Network Migration Wizard** is built around the Migrate to Utility Network tool and is designed to guide you through the workflow associated with migrating existing data into a utility network. The wizard can help to simplify the mapping of existing data to asset groups and asset types in an output utility network.

One of the drivers for the adoption of ArcGIS Utility Network is the inherent quality assurance and quality control (QA/QC) features, which help you maintain high data quality. When working with a utility network, QA/QC is built into every tool and the entire editing workflow. Every edit is tracked, every change is validated, and every error must be corrected. This gives organizations that have implemented ArcGIS Utility Network an unprecedented level of confidence in their data. However, getting your data to the point of being "clean" can be a struggle.

Discover and address errors in the network topology before enabling

A **new capability** introduced with ArcGIS Pro 3.5 is the ability to discover and report a subset of errors for correction before enabling the network topology. This allows you to identify and address common errors in your data prior to enabling. This can improve the efficiency of data cleanup once the topology has been enabled. You can take advantage of this capability by using the **Enable Network Topology tool** with the Only generate errors check box checked. Any errors discovered before reaching the threshold you specify in the Maximum number of errors parameter are written to the dirty areas table for review.

You can now also choose to leave the Maximum number of errors parameter empty or specify -1 to allow an unbounded number of errors to be discovered.

Use the Only generate errors checkbox on the Enable Network Topology tool to discover and report the first 500 errors encountered in the utility network dataset.

Integrate with other datasets easily

With this release, you can now leverage geodatabase relationship classes to include field values from related records in the JSON output for features returned by a trace, or with export of a subnetwork.

A **new Related** records result type option is provided along with Related Record Fields, which allow you to specify the relationship class and field containing the values to be returned in the results.

The **Trace and Export Subnetwork tools** use the Related records result type to return values from related tables in the result.

Output .json file for an export subnetwork operation using the related records result type option.

Specify the utility network version that will be created

With ArcGIS Pro 3.5, you can now specify the version of the utility network that will be created with the Migrate to Utility Network or Create Utility Network tools.

Unless otherwise specified, the tool will default to "Compatible" and continue to create the latest version of the utility network compatible with the current ArcGIS Pro and ArcGIS Enterprise releases. Alternatively, you may choose to use "Current" which will create a version compatible with the current version of ArcGIS Pro, or create a version 5, 6, or 7, depending on your needs.

While introduced in the ArcGIS Pro 3.4 release, users of ArcGIS Pro 3.5 can now also utilize the **Download Map** command to take the utility network offline with a sync enabled utility network in this network management release. While offline, users have the ability to edit and trace their data as if they were still connected to the feature service. Once network connectivity is restored, any modifications made to offline data can then be synchronized with the feature service. Additionally, any changes made to the feature service since taking the data offline can be synchronized with the replica. This is all accomplished using the **Sync tool**, which uploads changes from the replica, checks for any updates made to the feature service since the last synchronization and downloads any necessary updates to ensure that the offline data remains current with the service. **ArcGIS Enterprise 11.3 and later support the capability of taking utility network data offline, and are compatible with this version of ArcGIS Pro.**

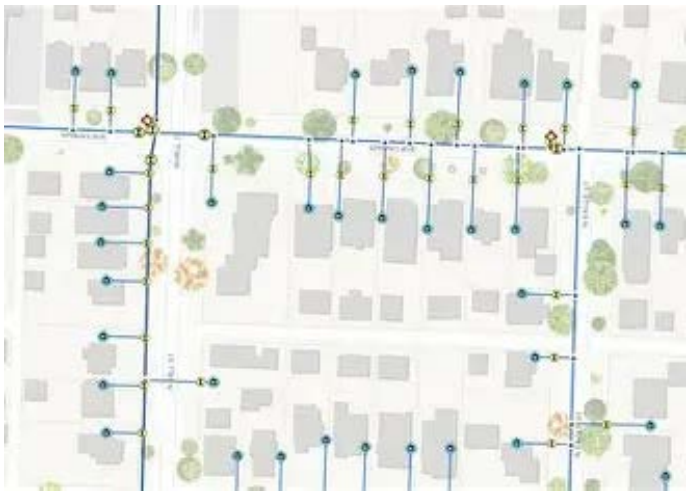
Delete multiple rules from the network

You can now delete multiple rules from the network using the **Delete Rule** tool. This provides the ability to quickly delete duplicate rules that may be causing ambiguous connectivity errors or preventing changes to an asset type's terminal configuration.

Perform Traces more efficiently

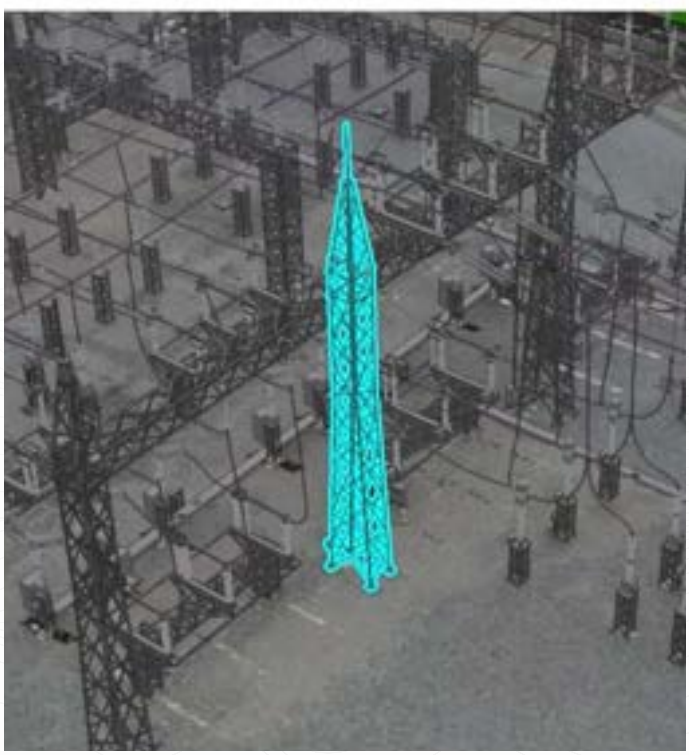
Using a large amount of nonspatial junction and edge objects to model your network features can improve the user experience when working with networks that contain a dense array of geographic features by preventing the need to model each piece of equipment using a separate feature. The introduction of cluster keys with this release provides a mechanism which allows analytical operations such as traces, to be performed more efficiently in scenarios such as this.

A cluster key is an integer value that is added to every



feature in your network. This value is used to partition the spatial and nonspatial data into a uniform grid of cells, which when consumed by the enable network topology operation, works to "locate" the nonspatial objects in the network topology along with its spatial container to improve the efficiency of processing these features.

Cluster keys are supported with utility network version 4 and later. **The Enable Cluster Keys tool** is used to update the schema with the CLUSTERKEY field, and the Calculate Cluster Keys tool is used to populate this field with a value.



Tips to streamline ArcGIS Utility Network Migrations

Recent improvements to the ArcGIS Utility Network focus on **reducing complexity while increasing flexibility**. Instead of starting with a highly detailed and rigid data model, users can now begin with a **clean, extensible foundation** that can grow over time to meet specific business needs. This approach lowers the learning curve, reduces implementation risk, and enables teams to focus first on core utility workflows.

These enhancements also simplify the target data model, supporting a **faster, more predictable migration process** by minimizing upfront configuration and data transformation effort.

We see improvements in three key areas:

- Simplified Data Model
- Simplified Data Mapping
- Simplified Data Migration

Simplified Data Model

To address the complexity of previous models with large numbers of fields, asset types, and rules, Utility Network foundations are now delivered with:

- An **Essentials model** for simpler needs
- An **Expanded model** for advanced requirements

To optimally use these models:

Tip 1: Start Simple with the Essentials Model

Instead of beginning with a complex, highly detailed schema, start with the **Essentials model**:

- It's a **fully functional, preconfigured Utility Network** model.
- Includes fewer fields, domains, asset types, and rules.
- Ideal for organizations new to Utility Network.

Why it helps: Lower complexity means a faster learning curve and reduced implementation risk.

Tip 2: Use the Expanded Model Only When Required

The Expanded model is best suited for:

- Advanced requirements
- Highly detailed asset management
- Mature Utility Network implementations

Best practice: Don't overconfigure upfront—move to Expanded only when complexity is justified.

Tip 3: Evolve Your Model at Your Own Pace

The Essentials model is designed to be extensible:

- Add custom fields and domains when needed.
- Introduce new rules incrementally.
- Import configurations from the Expanded model at any time.

Pro Tip: Start small, validate core workflows, then extend only what you truly need.

Simplified Data Mapping

Migration projects often stall early due to the time and expertise required to map data. To reduce this effort, focus on:

- Simplifying data mapping
- Automating migration setup

Tip: Simplify Data Mapping with Automated Tools

Data mapping can be time-consuming—use the **Create Simple Data Mappings** tool to speed things up:

- Automatically analyzes your source database.
- Generates a mapping spreadsheet.
- Includes source layers, feature counts, and descriptions.

Result: Minimal manual effort and no need for specialized migration expertise.

Simplified Data Migration

Data mapping is only the first step. You may also need to build a repeatable migration process, extend the data model, and configure behavior for new assets.

Tip 1: Build a Repeatable Migration Process

Once mappings are defined, use the **Create Migration Workspace tool**:

- Converts mappings into an executable migration workspace.
- Works directly with Esri's Data Loading tools.
- Requires no additional third-party software.

Key Benefit: You get a reusable, predictable migration workflow.

Tip 2: Take Advantage of Automatic Field Matching

When source and target field names match:

- Field mappings are **pre-populated automatically**.
- Use the **Copy Fields** option for like-for-like migrations.

Ideal For: Rapid prototyping and early-stage validation.

Tip 3: Extend the Data Model Automatically

When introducing new asset types:

- Fields, domains, and asset types extend automatically.
- New assets can inherit configuration from existing ones.

This Reduces: Manual work, configuration errors, and rework.

Optimize Subzone Boundaries for Effective Outage Management

Mr. Manoj Kumar Singh[1], Mr. Kaushal Shah[2]

[1]Business Analyst, Tata Consultancy Services Ltd.

[2]Business Analyst, Tata Consultancy Services Ltd.

Abstract

This paper presents an innovative Geographic Information System (GIS) solution designed for utility companies to effectively identify and propose new subzone boundaries for operational and maintenance purposes. As utility providers face increasing demands for efficiency and reliability, the need for precise spatial analysis and data-driven decision-making becomes most important. TCS designed GIS solution integrates advanced spatial analytics, real-time data visualization, and user-friendly interfaces to empower utility operation managers in assessing infrastructure performance, optimizing resource allocation, and enhancing service delivery. By leveraging geospatial data, the tool facilitates the identification of subzone boundaries based on factors such as service demand, customer & substation density asset condition, and geographical constraints. This approach not only improves operational efficiency but also supports proactive maintenance strategies, ultimately leading to enhanced customer satisfaction and reduced operational costs. The implementation of this GIS solution positions utility companies to meet future challenges while fostering sustainable growth and resilience in their service areas.

Introduction

The most important characteristic of a utility company is to minimize the outage. Better outage management helps utility companies in the following areas:

1. Minimizing outage.
2. Improving customer satisfaction.
3. Preventing revenue loss caused by interrupted services.
4. Preventing accidents and increasing public safety
5. Streamlining the processes and compliance with the regulatory authority, avoiding penalties.

Power companies divide the operational area into zones and subzones for easy distribution and work allocation. The zones and subzones are identified based on the customer type, customer density, power demand etc. The outage management team is distributed between the zones and subzones.

Applying GIS Technology to redefine the subzones to minimize the restoration time

In a utility company, the operation management team is responsible for performing the following:

1. Operation and Network Monitoring
2. Workorder Management
3. Crew Management
4. Emergency Response
5. Asset Management
6. Performance Metric and Report
7. Analyzing the Budget and Cost Management

The strategic operation management team keeps monitoring the operations team and their work allocation. This is achievable by utilizing the data and network analysis available via Esri's state of the art technology.

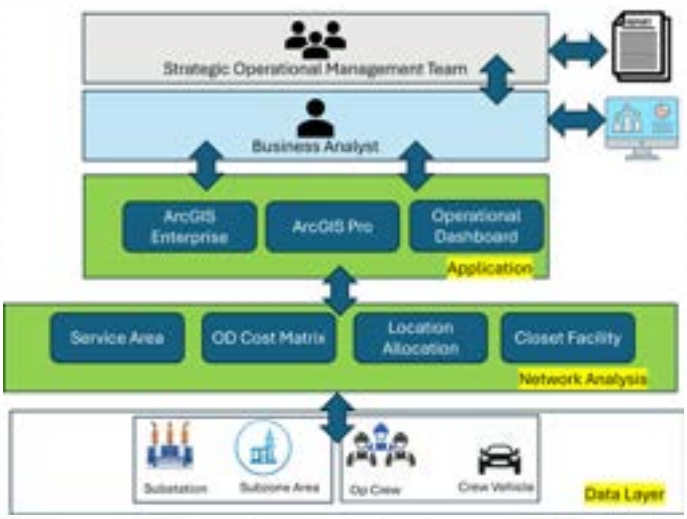
A utility company divides the operational area into zone and subzone levels. TCS implemented a solution at one of the client organizations, where the utility company

had 3 zones (A, B and C). Every zone was subdivided into subzones. Zone A has ~55 subzones, Zone B has ~90 subzones and Zone C has ~110 subzone service around 1 million customers. Field crews were divided into different zones based on customer, substation and historical outage record density. The counts were as follows:

1. Zone A had 12 Field Crews
2. Zone B had 15 Field Crews
3. Zone C had 20 Field Crews

Outage management has predefined MTTR (Mean time to Restore), SAIDI (System Average Interruption Duration Index), SAIFI (System Average Interruption Frequency) and Outage duration. The key activity was to improve these metrices by using GIS Analysis and Effectively utilizing the Man and material Cost budget.

Today, GIS technology has expanded and provides comprehensive capabilities that support all aspects of the outage management team. GIS solution enables outage Management team to manage complex operations by delivering critical capabilities that support the entire mission.



High Level Conceptual Design

Following are the key points of the solution which can help utility companies to optimize their operations by reducing the impact, enhance emergency operations, improving key metrics, and improve customer experience:

- **Zone Boundary Layer**

This layer is used to divide the complete operational area into three Main segments. Their names are used as A, B and C.

- **Subzone Boundary**

This layer denotes a small grouping or subsection of Zone called Subzone boundary. This subzone boundary is created based on customer and substation density.

- **Operational Crew**

Operation crew are users who is using the Tablet device having Field map installed to track the user location.

- **Crew Vehicle**

Crew vehicles which are stationed into a substation can move to any other substation based on Outage incident reported.

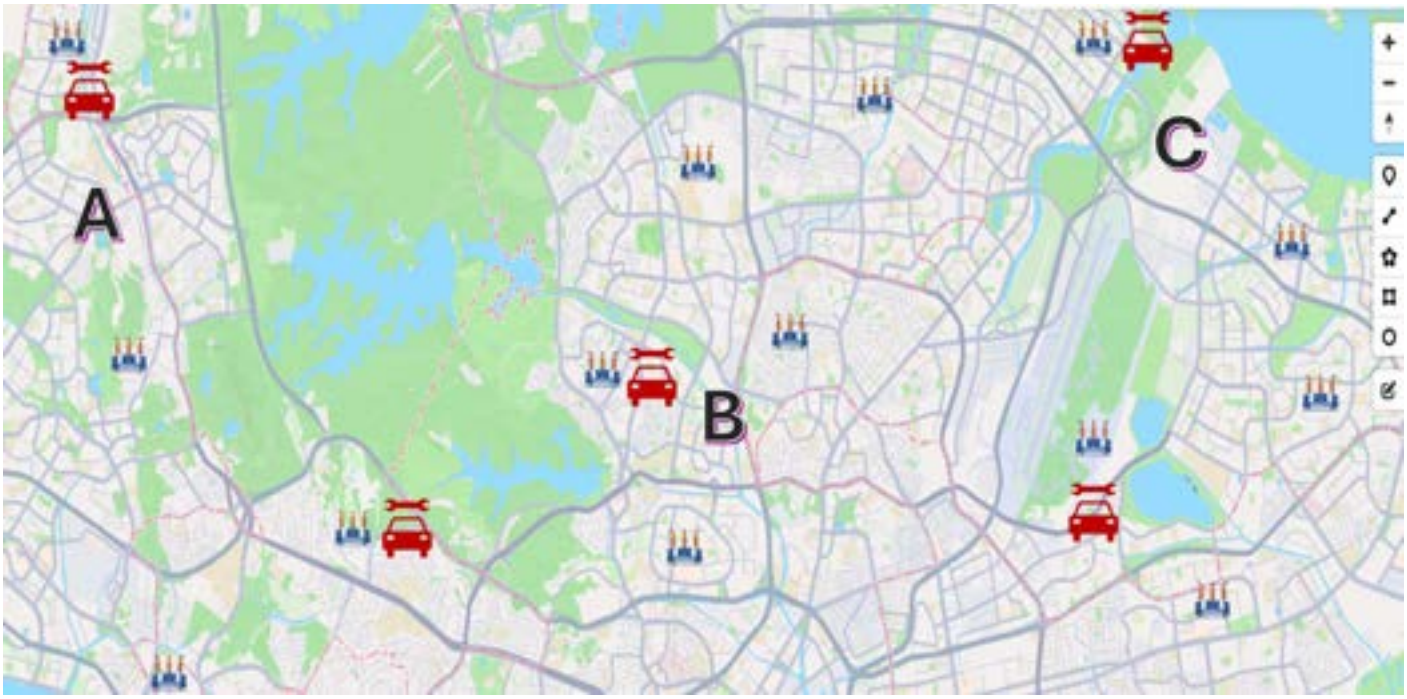
Solution Approach

The key solution developed to meet the requirements utilize the **Esri Network Analysis modules.** Custom Analysis module was developed which perform the following modules in sequence.

1. Execute **Location Allocation** tool to identify the substation where crew and vehicle can be stationed. This analysis take all substation data and load into Facility and Demand layers. It identifies the 1 best substation which can be used to station the crew.

2. Execute the **OD Cost Matix** tool to identify the min and max time between identified substation and all other substations. This also needs substation data to use as Origin and Destination. This analysis' results help to understand the current reach time to any substation within zone.

3. Execute the **Service Area** Tool from this substation to all other substation within reach of 15 Minutes time. This generates a new subzone boundary so that all other substation boundary is not intersected. Manager can provide the different parameters of time and redefine the subzone boundary.



Conclusion

This paper presents the overview of extensive use of GIS analysis collectively to efficiently manage outages.

The outage management team now generates the GIS Report which displays:

1. Subzone boundary count before and after analysis.
2. Best and Optimum substation location where field crews can be stationed.
3. New subzone boundary helps the management team to take decision to revise their metrics and plan their workforce.

The GIS Solution generates reports which help the strategic team in following decision making.

- Optimizing the staff for maintenance as per new subzone boundary.
- Finalizing the subzone boundary keeping metrics in mind.
- Optimizing the key metrics to improve the customer satisfaction.
- Increase revenue by reducing the impact due to outage.

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GLOBAL CUSTOMER SUCESS STORY

City of Hastings: Going All in with Esri's ArcGIS Utility Network

The City of Hastings, Nebraska, serves a community of 25,000 people with all their utility needs: water, sewer, gas, and electricity. With Hastings' expanding and aging utility infrastructure, the city wanted to take its geographic information system (GIS) to the next level in order to provide extensive data to employees in the office and the field; be able to provide analytic data for project planning, replacement programs, and inspections; and integrate electric service with outage management and advanced metering infrastructure (AMI) systems. All of this would require eliminating paper-based workflows and moving to digital data collection in the field so that updates are made and viewable by staff daily.

Lindsey Stone, GIS coordinator for the City of Hastings, had started at the city using GIS for land management. Her role grew when she began managing the utility GIS data as well, and there was work to be done in order to achieve the goals the city had identified.

GIS infrastructure for utility services was previously maintained using a combination of CAD drawings, GIS records, paper forms, and Excel documents. The data was not organized in a consistent manner, which caused concern about reports' accuracy. Also, there were several aspects of data completely missing from the GIS dataset and only being kept on AutoCAD files. For example, the electric system only had medium-voltage lines and no devices in the GIS. In most cases, updates regarding the types and locations of assets were being given via paper forms and hand-drawn pictures and, at times, took months to be entered into GIS. This way of doing things was not going to support requests made by staff. The city needed to undertake a massive cleanup and collection of data to fill in the gaps.

Paving the Way Forward

Stone knew she wanted all four of the services to have similar database structures and naming conventions. This would make data maintenance consistent across all services. In addition, staff requested the ability to do inspections and run reports for replacement programs. To determine the best way forward, Stone reached out to several utility companies and municipalities in the

Midwest, asking them how they maintain their utility services and what they did to get their data into GIS. Several companies reported that they were currently using Esri's geometric network and would be converting to Esri's ArcGIS Utility Network due to the geometric network's upcoming end of life. She also talked with several companies on how to convert the city's current CAD drawings into GIS or using GPS to collect data in the field, knowing that it would take years to complete if staff relied solely on an already busy workforce.

Ultimately, Hastings decided to convert its data into ArcGIS Utility Network because it provided technology that would support the city's multiple utilities for years to come. In addition, ArcGIS Utility Network has an out-of-the-box data schema with preloaded fields and domains for each service as well as the similar setups the city was looking for. This schema would allow for the consistent data management that staff wanted, along with the capabilities of built-in inspection and maintenance-related tables that could be utilized in the field. In addition, it opens up the opportunity for the GIS to be expandable, with many fields and domains already in place for data that Hastings doesn't currently collect but could in the future as the GIS develops.

Hastings' Water Utility Network Viewer Application enables staff to see the water network and access attribute data from any device.

Partnering Up

In order to reach the goals of converting all four utility services to ArcGIS Utility Network and obtain the massive amount of missing data from within the electric system, Hastings staff members knew they needed help without overloading the budget.

First, staff members needed knowledge on how to deploy ArcGIS Utility Network—which they had no experience in—for each of the utility services. After several interviews with Esri, Esri partners with the ArcGIS Utility Network Management specialty, and other specialists, Hastings decided to collaborate with GISinc—now known as Axim Geospatial—because of the company's unique product, called Jumpstart Package. Axim would teach city staff as well as guide and review one deployment of ArcGIS Utility Network side-by-side with Hastings, instead of just doing all the work and then handing it back to Hastings. This placed the workload in Hastings employees' hands, enabling them to learn as the ArcGIS Utility Network deployment was developed. Since the water dataset was the most complete, they started with that, and by the end of the project with Axim, Hastings staff members were able to understand the requirements, configure and migrate the existing data, deploy a brand-new ArcGIS Utility Network implementation, and maintain it all by themselves. This gave the City of Hastings the opportunity to deploy ArcGIS Utility Network in the sewer and electrical utilities without spending additional budgetary resources on any outside companies' assistance.

"Our team has been able to learn and transition more easily by working side-by-side with expert partners. In addition to helping migrate our data, Axim has helped us implement new tools and processes which have improved efficiencies for our department and other users." ***—Lindsey Stone, GIS Coordinator, City of Hastings***

Secondly, the City of Hastings knew it needed to get all its missing electrical data into GIS in a timely manner. Since staff resources were limited, Hastings contracted with Midland GIS Solutions—now known as SAM, LLC to locate and map the city's entire electric network. SAM used GPS devices to collect asset locations and data for over 12,000 poles and devices attached to poles or pad mounts and over 300 miles of high-, medium-, and low-voltage lines. This gave Hastings an extreme leap ahead in terms of the data that staff needed in order to implement ArcGIS Utility Network and meet the requirements for a future outage management system.

Mobile workers access data and complete field workflows using mobile applications. Data collected in the field is shared with stakeholders in the office.

Dashboards are used to monitor and prioritize work.

Improving Workflows

With the water and sewer utilities' deployments of ArcGIS Utility Network, Hastings has given employees the data they need with a high level of detail viewable in the office and the field. What used to take employees days to filter out through dated drawings and Excel spreadsheets can now easily be filtered through GIS, giving them greater resources for project planning and replacement programs. Field crews use ArcGIS Field Maps on iPads that are paired with external GPS receivers. The crews collect service line and device locations along with information such as size, installation dates, and models at the time of installation. This process increases the level of accuracy of spatial and attribute data and gives the updated information to all employees instantly via web maps, instead of taking months to get updates via handwritten forms and maps from the field to GIS. The water and sewer services have taken their inspection programs from paper forms and lists to inspections being inserted directly into ArcGIS Utility Network technology-related tables via Field Maps. Supervisors and staff then use ArcGIS Dashboards to pinpoint where they need to go next as well as to see any patterns of problem areas. The electric service has deployed streetlight replacement programs that utilize Field Maps and Dashboards; previously, staff used Excel worksheets and paper forms to track the programs' progress. The staff mindset of using the GIS has gone from thinking, "Here is a nice map of where the service is," to envisioning what GIS can do next to improve efficiency and quality of work.

> *We've utilized the GIS software to provide exclusive, interactive maps for our two most severe events in water/sewer. We have generated a water main break map with about 35 years of data, and a sewer main backup map utilizing about 25 years of paper reports. With these tools, we are able to report new events in real time direct to the software, [and] we are able to visually inspect the community for patterns/problem areas and more efficiently plan for budgets regarding system upkeep and replacement.* — ***Brandan Lubken, Water and Wastewater Superintendent, City of Hastings***

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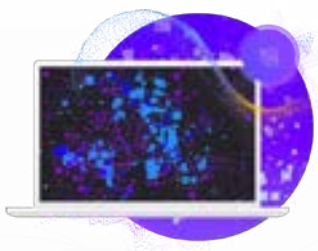
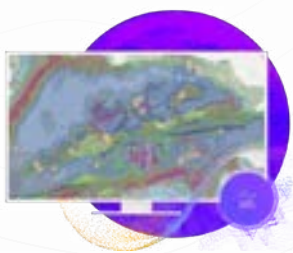
Unlock the Full Potential of Your Enterprise Systems

Create an innovative system for network information management, which reduces silos, makes it easier to share data, and integrates business systems to improve efficiency and reduce costs.

A Network Information Management System (NIMS):



- Serves as much more than a repository for network maps and asset locations.
- Supports multiple business functions.
- Supports infrastructure planning



- Supports work order management, inspection tracking, outage and incident management, and mobile workforce enablement.
- Supports real-time monitoring through integration with SCADA, IoT devices, and enterprise applications.
- Serves as a foundation for advanced capabilities such as digital twins, predictive maintenance, AI-driven analytics, environmental and safety monitoring, risk assessment, and scenario-based planning.

Esri India Technologies Private Limited

10th Floor, Max Towers, Sector - 16B, Noida - 201301, Uttar Pradesh (India)
Toll Free No. 1800 102 1918 | Email : info@esri.in | Web : esri.in