The Transformational Benefits of 3D Facility Mapping for Utilities

Develop accurate digital twins, improve workflows and increase safety and reliability using geospatially precise data

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The pressure to modernize and digitally transform asset management and operational workflows has never been higher in today's utility sector, particularly with aging infrastructure, extreme weather, compliance and increased demand for affordable energy.

Yet, many utilities still rely on incomplete, outdated or low-quality facility data, which introduces risk, hampers efficiency and slows progress for building, upgrading and modernizing the grid. Indeed, 98% of utility companies surveyed expressed a desire to improve their data quality, highlighting widespread recognition of current data shortcomings.

The good news? Utilities today can take advantage of advanced, geo-enabled 3D facility mapping—powered by high-resolution imaging, machine learning and location-based analytics—to overcome these challenges.

Utilities can now capture comprehensive, spatially accurate 3D facility maps of their facilities at **a fraction of the time and cost of conventional methods**. This leap forward accelerates network modernization and empowers teams to make better decisions, reduce safety risks and streamline maintenance and capital planning.

Why 3D Facility Mapping Matters

3D facility mapping involves capturing, modeling and analyzing a facility's physical environment in three dimensions using advanced imaging technologies. Unlike traditional 2D plans or point-based GIS entries, 3D mapping leverages specialized GeoCam cameras and machine learning to create photorealistic digital twins—virtual replicas that include every piece of equipment, its precise location and key attributes such as make, model and serial number.

The workflow typically involves walking through a facility with a 360-degree camera and capturing high-definition images from every angle. These images are then handled using image processing software to generate 3D point clouds, wireframes and spatially accurate models that can be overlaid in GIS and other systems. The result is a data-rich digital environment that supports everything from remote inspections to advanced analytics.

Accurate Facility Mapping Has Historically Been Difficult

Managing assets and infrastructure inside facilities is challenging for any utility. Unlike above ground or outdoor assets, much of the system components, such as compressors, regulators, odor injectors and meters, are located indoors, underground, or in environments inaccessible by conventional mapping methods.

Historically, this has led to several persistent problems.

First, data quality has been a chronic issue. Many utilities have relied on manual data collection, which is time-consuming, costly and prone to human error. Incomplete or inaccurate data means critical asset details—such as make, model, serial number or exact location—are often missing. This lack of data fidelity becomes problematic during maintenance, repair or upgrades when knowing what's onsite and its location matters most.

Second, traditional mapping technologies for inside facilities are prohibitively expensive and slow for widespread use. Scans can take days or weeks per facility and require specialized crews and equipment. The resulting data, while detailed, is usually not integrated with GIS or asset management systems in a way that supports day-to-day operational needs.

Third, available imagery—from legacy blueprints, photos or partial scans—typically lacks the quality and completeness for extracting asset details. This leaves utilities with "blind spots" in their network models, making it difficult to connect upstream and downstream data or to fully leverage geospatial capabilities from software such as Esri's ArcGIS Utility Network.

Another major challenge is the operational inefficiency created by poor facility data. Field teams often must make multiple trips to a site to assess what's there, gather the right parts and tools and perform the actual work. Each visit requires safety clearances, travel time and resource allocation.

Finally, the sheer scale and complexity of utility networks—often comprising thousands of facilities, each with unique configurations—make comprehensive, up-to-date mapping a daunting task. Manual updates are rarely feasible, meaning data quickly becomes stale or out-of-date.

Challenges in facility mapping include:

- Incomplete or inaccurate asset data
- High costs and slow turnaround of traditional mapping methods
- Lack of integration with GIS and asset management systems
- Multiple truck rolls and safety risks due to poor data
- Difficulty scaling and updating records across complex networks

Six Steps to Achieve Complete 3D Data

Thanks to advances in imaging technology, machine learning and geospatial analytics, the once too expensive and resource-draining ability to perform 3D station modeling is now an achievable reality.

These technologies and capabilities, if properly deployed, can streamline data capture, processing and integration. High-resolution 360-degree cameras easily capture terabytes of spatial and asset data in hours. Machine learning algorithms then automate asset identification and classification, extracting details from imagery with minimal human intervention. And geospatial solutions such as the Esri ArcGIS Utility Network integrate these 3D models, overlaying precise coordinates and asset attributes to create "living" digital twins.

The combined solution involves a six-step process that results in accurate, timely and complete 3D data that feeds multiple systems.

1. Rapid, High-Fidelity Image Capture

The foundation of 3D facility mapping is high-quality optical image capture. Teams with 360-degree, multi-view GeoCam cameras can walk through a facility daily, capturing comprehensive images of every piece of equipment and infrastructure. Adequate lighting ensures that every angle is recorded, and the process is fast—much quicker than traditional LiDAR scans or manual surveys.

2. Automated Image Processing and Modeling

Once captured, the imagery is processed using advanced imaging software—or delivered by solutions providers like TRC. This software applies techniques such as structure-from-motion to derive 3D coordinates from the images, generating point clouds and wireframes that represent the facility's interior in detail.

Machine learning models are then used to segment the data, identifying and classifying each asset—valves, meters, pipes and electrical lines—within the facility. This automated extraction ensures that even small or complex components are accurately captured and labeled. The result is a high-quality digital twin consisting of a photorealistic 3D model with spatial (location) and attribute (equipment details) information.

3. Integration with GIS and Asset Management Systems

A key advantage of this approach is the ability to overlay extracted asset data with precise spatial coordinates in GIS platforms. For utilities migrating to Esri's ArcGIS Utility Network, every facility—previously represented as a single point or "pseudo node"—can be modeled in full detail, with each component mapped and connected to the broader network.

This level of integration supports advanced asset management, network analysis and operational planning.

4. Scalable, Repeatable and Cost-Effective

One of the most significant breakthroughs is the cost-effectiveness and scalability of modern 3D mapping. Common methods might cost $35,000–$50,000 per facility and take weeks, but today's solutions deliver results at less than a quarter of that cost in a few days. This makes it feasible to scan and update facilities more frequently, supporting ongoing operations and maintenance.

Utilities can choose to have initial scans performed by experienced professionals—ensuring a highly accurate baseline—and then transition to in-house teams for routine rescanning and updates. GeoCam cameras and software can be rented or licensed as needed, and data can be processed internally or by trusted third parties, depending on organizational preference and IT strategy.

5. Enabling Remote Access and Virtual Workflows

Perhaps the most transformative aspect of 3D facility mapping is the ability to support remote access and virtual workflows. Digital twins allow teams to conduct virtual walkthroughs, inspect assets and plan maintenance or upgrades without setting foot onsite. This reduces the need for truck rolls, lowers safety risks and dramatically improves operational efficiency.

Virtual reality overlays can further enhance these experiences, providing immersive, location-accurate views of the facility and its assets. Crews can review work orders, see operational data and even compare current and historical scans to identify changes—such as new corrosion, leaks, or unauthorized modifications—enabling predictive maintenance and change detection.

6. Continuous Data Improvement and Advanced Analytics

With each scan, utilities build a richer, more accurate dataset that can be mined for additional insights over time. High-definition imagery enables the extraction of serial numbers, asset IDs and manufacturing details, supporting sophisticated inventory management and risk analysis. For example, if a part is recalled or subject to new tariffs, utilities can quickly identify affected assets and plan accordingly, avoiding costly delays or compliance issues.

Mapping Delivers Transformative Results

For utilities across the country and around the world, 3D facility mapping delivers true digital transformation in areas previously never achieved. Manual methods and repeat onsite visits give way to digital processes and data in an accurate virtual reality that provides speed, precision and flexibility in workflows. The numerous benefits include:

Improved Data and Analytics

High-fidelity digital twins provide a complete, accurate, and up-to-date record of every asset. They enable advanced analytics, trend identification and data-driven decision-making across the organization.

Superior Decision-Making

With precise asset data and spatial context, leaders can make better-informed decisions about maintenance, capital investments and risk mitigation, reducing uncertainty and optimizing resource allocation.

Enhanced Network Operations

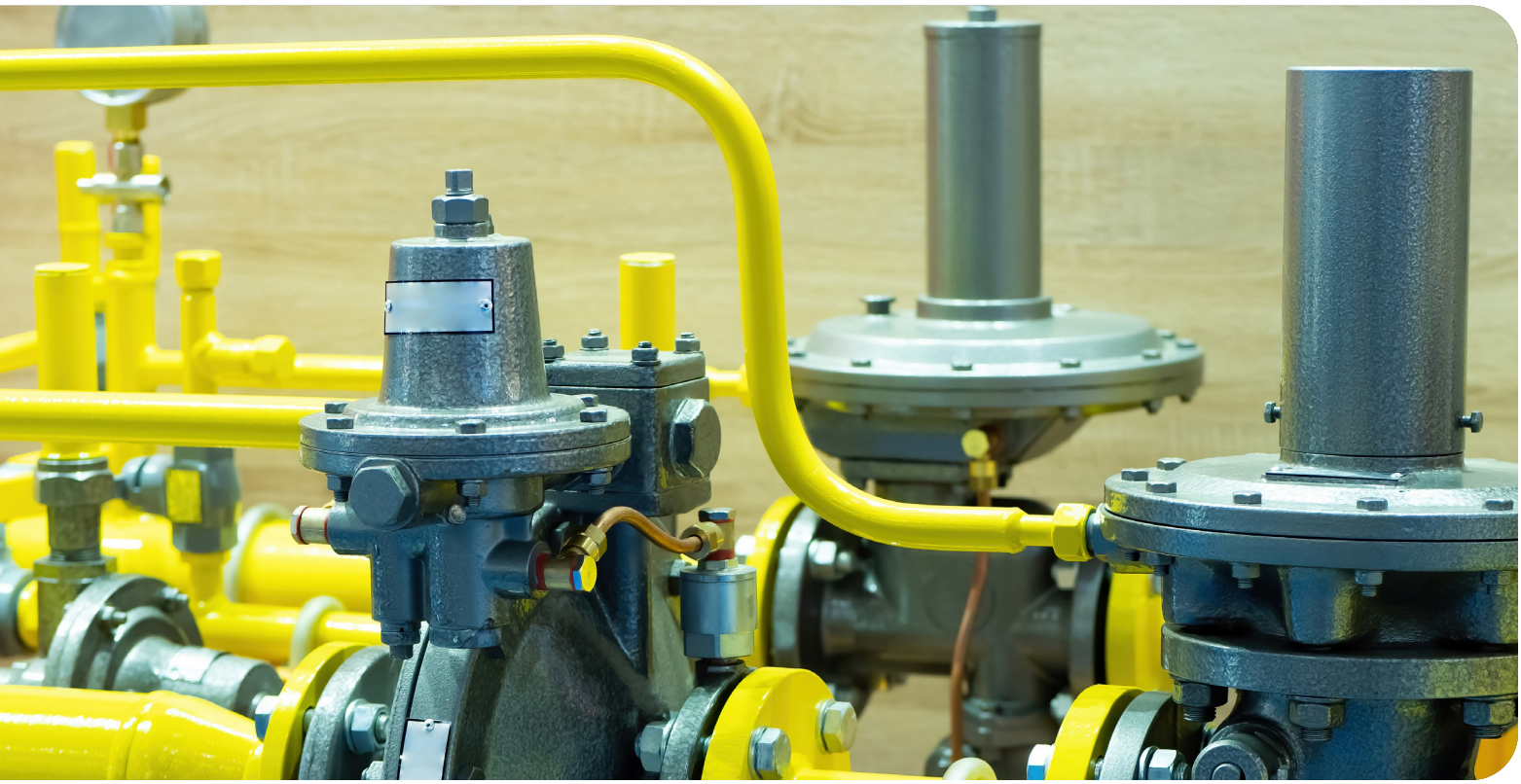
Integrated 3D models support seamless network management, allowing teams to connect upstream and downstream data, streamline workflows and improve coordination between field and office staff.

Predictive Maintenance

The ability to compare current and historical scans enables early detection of wear, corrosion and other issues, supporting proactive maintenance strategies that minimize downtime.

Cost and Time Savings

Fewer truck rolls, reduced site visits and faster, automated data capture translate into significant operational savings and accelerated time to value for critical projects.



Use Cases Improved by 3D Facility Mapping

3D facility mapping is more than a technology and data upgrade—it's a catalyst for operational excellence across a wide range of utility workflows. From design to construction, maintenance and replacement, all asset lifecycle phases are improved using locationally-aware, digital representations of real-world infrastructure.

Infrastructure Planning and Design

Accurate 3D models allow planners and engineers to visualize existing conditions, assess spatial constraints and optimize designs before construction begins, reducing rework and project delays.

Construction Coordination

Teams can use digital twins to coordinate construction activities, track progress and ensure that new installations align with existing assets, minimizing conflicts and improving quality control.

Asset Management and Maintenance

Comprehensive asset records—including make, model, serial number and location—support efficient maintenance planning, inventory management and lifecycle analysis.

Asset Repair and Replacement

Remote inspections and detailed asset data enable faster diagnosis of issues, better preparation for repairs and more accurate scoping of replacement projects, reducing downtime and costs.

Safety and Risk Management

Virtual walkthroughs and remote inspections reduce the need for personnel to enter hazardous environments, improving worker safety and compliance with safety protocols.

Regulatory Compliance

Detailed, auditable records of assets and facility configurations support compliance with regulatory requirements and facilitate faster, more accurate reporting.

Digital Twin and Advanced Analytics

Creating digital twins enables advanced analytics, scenario modeling and integration with other digital initiatives, unlocking new opportunities for innovation and continuous improvement.

Three Recommendations Before You Start

Beginning any new digital project can be scary. And for good reasons. Up to 75 percent of software projects fail to meet their objectives, timelines, or budgets. In addition, a 2023 Standish Group Chaos Report found that only 31 percent of IT projects are considered successful. These figures highlight the significant risks of deploying IT initiatives like 3D facility mapping.

For companies looking to begin their own 3D facility mapping project, there are three main things to consider:

1. Start with a Pilot Project

Begin by piloting 3D Mapping at a representative cross-section of your facilities—ideally those with varying levels of complexity. This allows you to validate the technology's value, understand the workflow and build internal buy-in before scaling up. Partnering with experienced providers like TRC ensures a smooth rollout and high-quality results.

2. Define Asset Management Objectives and Data Granularity

Clarify what level of detail you need for your asset management and operational goals. Determine the most critical asset attributes—serial numbers, manufacturer details and maintenance history—and ensure your 3D mapping approach captures this information. This focus will drive better integration with GIS and asset management systems.

3. Plan for Integration and Ongoing Updates

Ensure your 3D mapping solution integrates seamlessly with existing GIS, asset management and network modeling platforms. Develop a strategy for routine rescanning and data updates through internal teams or trusted partners to keep your digital twins current and maximize long-term value.

Partner with TRC and Geocam for 3D Facility Mapping Excellence

Don't let the fear of IT failure or a lack of dedicated internal resources prevent your organization from taking its next significant modernization step forward.

TRC offers a complete solution set to help utilities harness the full power of 3D facility mapping and digital twins. Our approach combines deep utility expertise, advanced imaging technologies and proven machine learning models to deliver precise, actionable asset data at scale. We understand the operational realities of utility networks and tailor our solutions to fit your needs—whether modernizing asset management, driving digital transformation or simply migrating to Esri's Utility Network.

GeoCam

Our 3D station modeling solutions reduce time to value from months to days, enabling rapid, comprehensive image capture and automated asset extraction. We offer flexible deployment models, from turnkey services to training teams for ongoing image capture and data management. Our solutions are cost-effective, scalable and designed to integrate seamlessly with your existing systems, ensuring you get maximum ROI from your technology investments.

With TRC, companies gain a partner committed to client success, from initial pilot to enterprise-wide rollout. We help companies build greater resiliency by providing the data foundation for predictive maintenance, regulatory compliance and operational agility. And our digital twins empower teams to work smarter, safer and more efficiently, positioning the utility business for a future of innovation and reliability.

Author

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Todd Slind is a VP of Technology and TRC's AI Capability Leader. In his roles as a technology leader, Todd facilitates innovation amongst the team and helps to ensure customers get the best solutions TRC and its partners have to offer. Todd's background spans a wide array of sectors and involves developing data and applications in: civil infrastructure, technology, agriculture, financial services, land rights, climate adaptation and natural resources conservation among others.

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