# OpenTower iQ:

## The Answer to Telecom Tower Lifecycle Management

Bentley®

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# **Capture the Lifecycle:** Advancing the Telecom Tower Industry

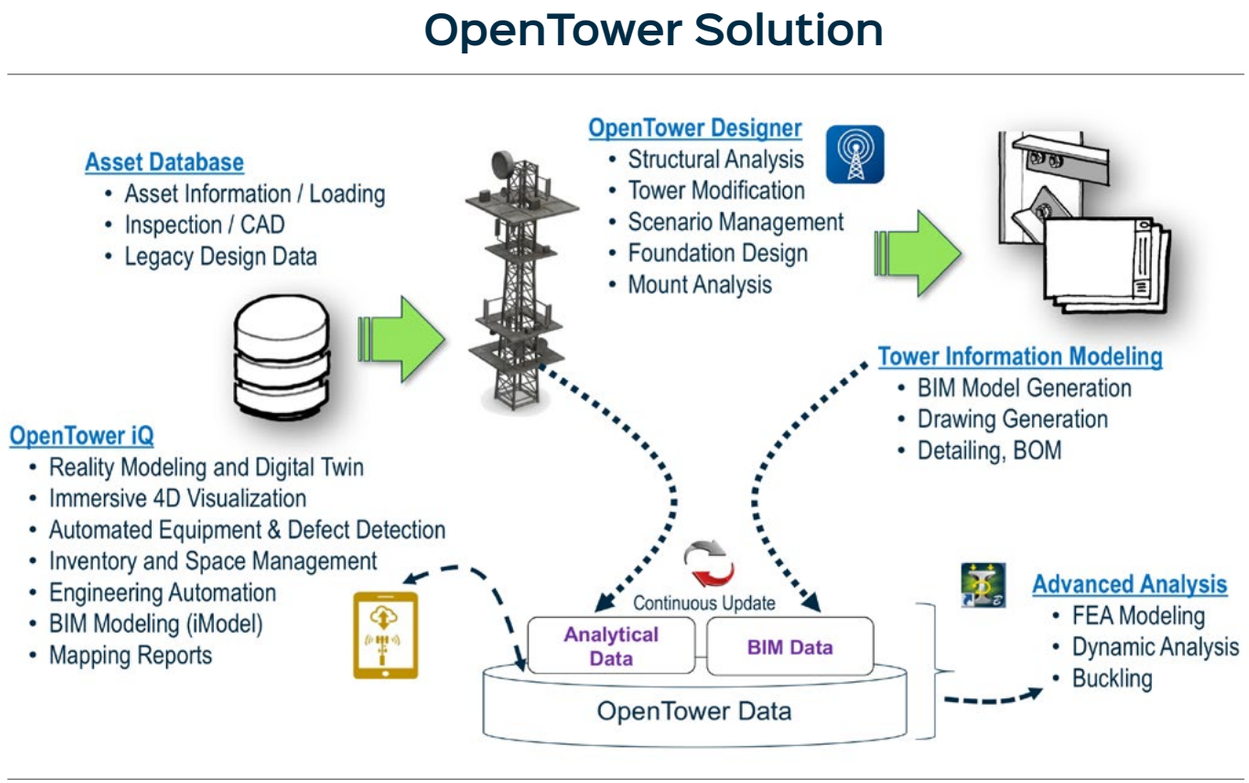
## OpenTower: Digitizing Towers Through Automation

The telecom industry's transition to fifth-generation technology (5G), along with digitization of its infrastructure for 3D representation, document management, and colocation analysis will lead to the creation of smart cities — and that will revolutionize everyday lives.

To realize this monumental feat, the telecom industry requires a trusted and experienced infrastructure software partner that can help deliver high-quality, resilient connectivity on an unrivaled scale and can guide them through a full digital transformation. A true 360-degree approach to the entire lifecycle of a physical tower site is key to enhancing the utilization of infrastructure assets. It also leads to significantly lower maintenance costs, reduced risks, and increased safety.

As a global provider of digital twin software and services to organizations that are responsible for the delivery and operational performance of infrastructure assets, Bentley Systems (Bentley) is uniquely qualified to help the telecom industry achieve its digitalization goals. As the only provider of a true lifecycle management solution, Bentley's Digital-Twin is at the center of its universe.

Bentley's OpenTower is a purpose-built one-stop solution that advances the industry practices of telecom towers by encompassing all the critical aspects of the lifecycle management — from structural analysis and inspections to planning, change detection, and a tower digital twin. You'll gain continuous access to near real-time information to make actionable insights and better monitor, predict, and react to any required changes by leveraging OpenTower iQ.

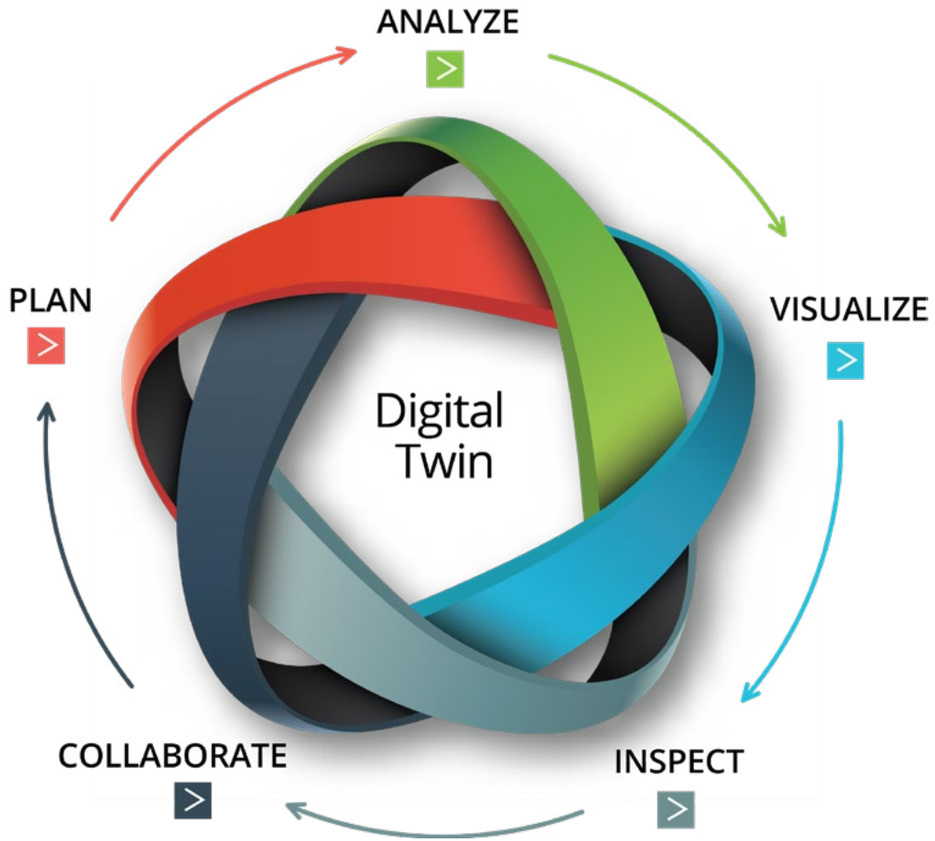



*OpenTower solution - products*

# **OpenTower iQ:** Managing the Lifecycle of a Telecom Tower

OpenTower iQ is the only end-to-end solutions provider that encompasses all of the stages of a telecom tower's lifecycle. The solution is comprised of 5-pillars with a Digital Twin at its center.

## One Stop Solution for Telecom Towers



# **Tower Lifecycle** Management

## Analyze

OpenTower iQ captures tower engineers' imagination for the most advanced analysis which includes precision modeling, modification layers, multiple scenarios, foundation checks, and connection design. The program's open architecture streamlines workflow enabling seamless integration with asset systems and delivers tower analysis faster than ever.

## Visualize

Current engineering data for telecom assets are 2D, and the reality models captured through drones lack context. OpenTower iQ's immersive 4D graphical experience empowered by the common-data-environment provides a complete digitization of your telecom tower. It ensures precision graphics and visual validation to gain insights into your tower digital-twin.

## Inspect

Telecom towers must be inspected periodically because of regulatory requirements. The current process is time consuming, unsafe, and expensive. Bentley's OpenTower iQ solution revolutionizes this workflow by applying machine learning (ML) and artificial intelligence (AI) on high fidelity reality models. Automatic change detection and visual comparisons between as-built and as-designed overlaid models enables engineers and planners to accurately assess their asset conditions, including occupancy while updating their inventory database ensuring accurate analysis.

## Collaborate

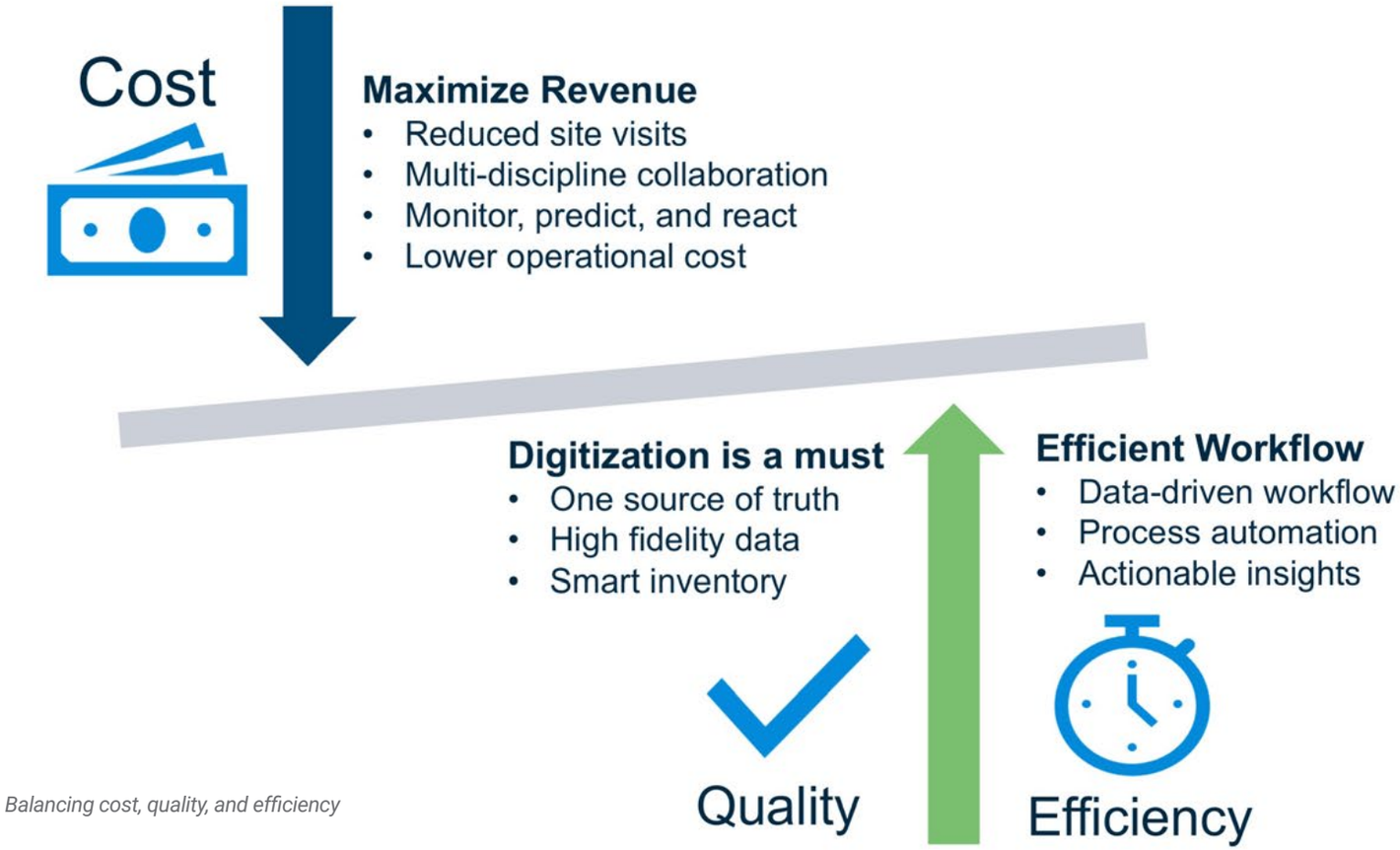
Telecom tower owners and service providers are trying to digitize their asset information to help them make real-time decisions quickly and accurately. However, the industry finds it challenging as their data is sparse and file based. OpenTower iQ's cloud innovation enables seamless intradisciplinary collaboration resulting in a single source of accurate information through data reconciliation. And, OpenTower iQ is the only solution on the market that offers a true end-to-end workflow by combining an engineering model with a reality model, thereby providing deep insight into an organization's assets. Plus, users will have the ability to share data securely and efficiently through OpenTower iQ's cloud portal and promote a collaborative environment among clients and vendors to increase business efficiency.

## Plan

Planning is a critical step in tower lifecycle management — and space availability is one of the key pieces information that tower owners must have at their fingertips. OpenTower iQ provides comprehensive tools to mimic telecom tower planning steps including equipment swapping and predictive analysis. Planners will be empowered to assess space availability in 3D and run numerous scenarios by adding or removing different equipment on the tower to optimize space management.

# **The Value** Proposition

Businesses always strive to optimize the delicate balance of cost, quality, and efficiency. OpenTower offers the perfect set of tools and services to evolve, digitize, and respond to market demand faster than ever before.



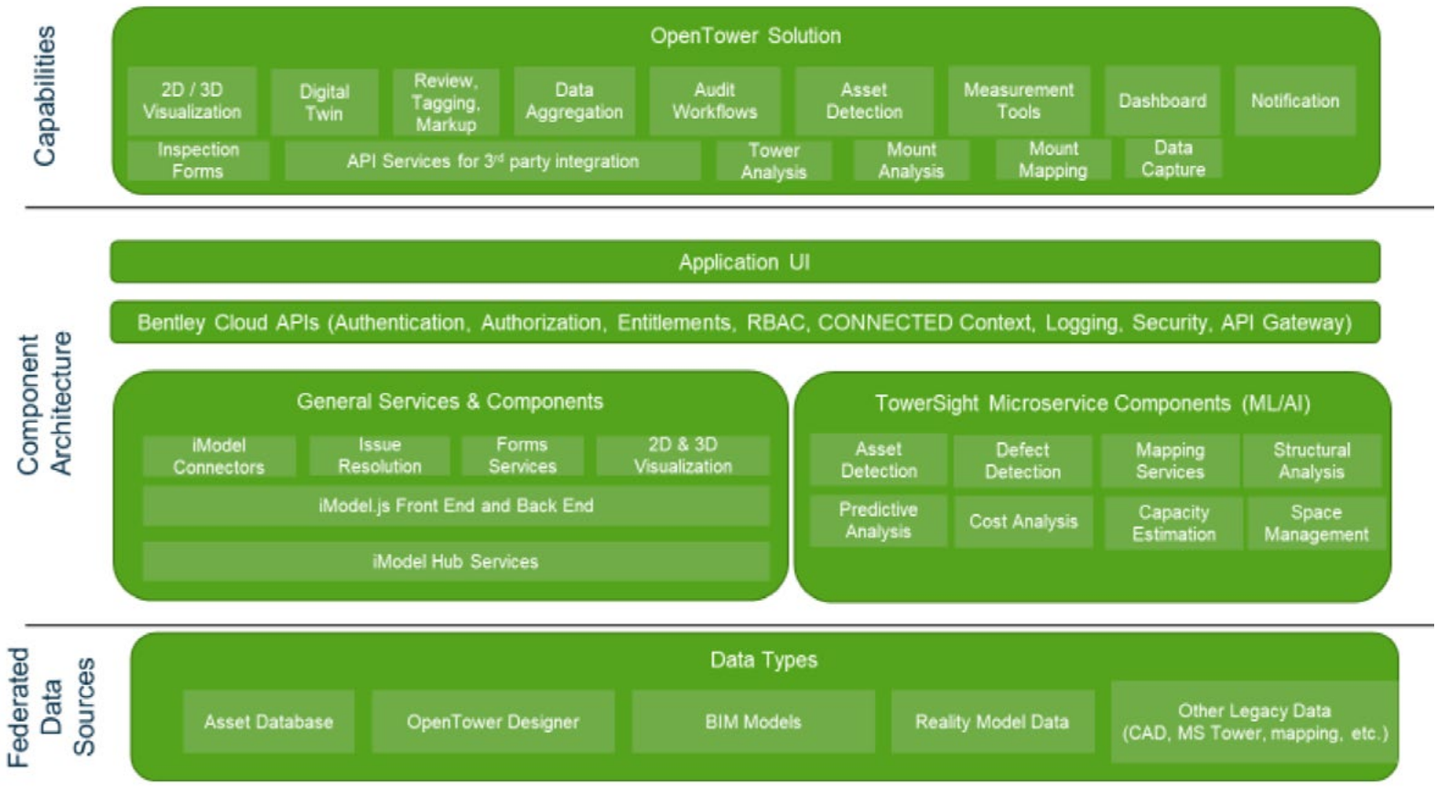

*Balancing cost, quality, and efficiency*

# **OpenTower** Solution Architecture

OpenTower iQ is the only end-to-end solution for a complete lifecycle management of telecom towers. It offers a platform that brings together all the required components and synchronizes them via a data driven model to provide a highly efficient workflow and improved user experience.

Tower owners and operators often need to integrate their digital-twin portal with their asset management systems to deliver a seamless user experience to their clients and vendors. To facilitate such an experience, OpenTower iQ can further be expanded and integrated through its API layer.

For example, a design change proposed by a carrier can be visualized and validated by Bentley's OpenTower iQ, run a stability analysis, and then output construction drawings, custom reports, update asset data, etc.



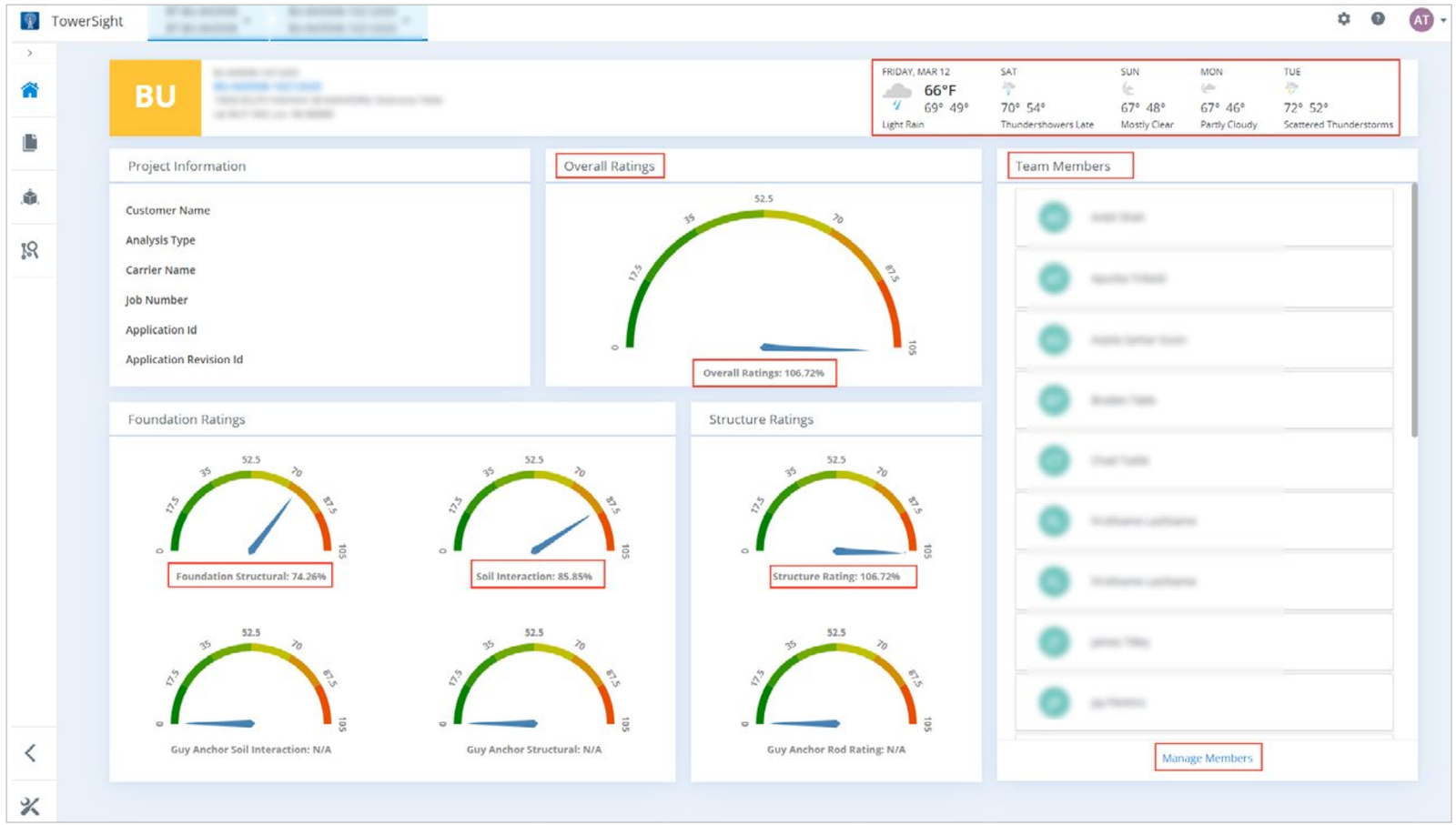

*OpenTower solution architecture*

# **Asset** Registration

## Each Tower Provides its own Lifecycle Space and Management

OpenTower was developed in collaboration with tower owners, carriers, and engineering service providers. It's built to register towers with precise geolocation, and users can register as many projects as needed during its lifecycle, preserving the history and enabling scenario management.

The project dashboard (landing page) provides a summary of the tower status along with collaboration tools to share the project with internal and external stakeholders.

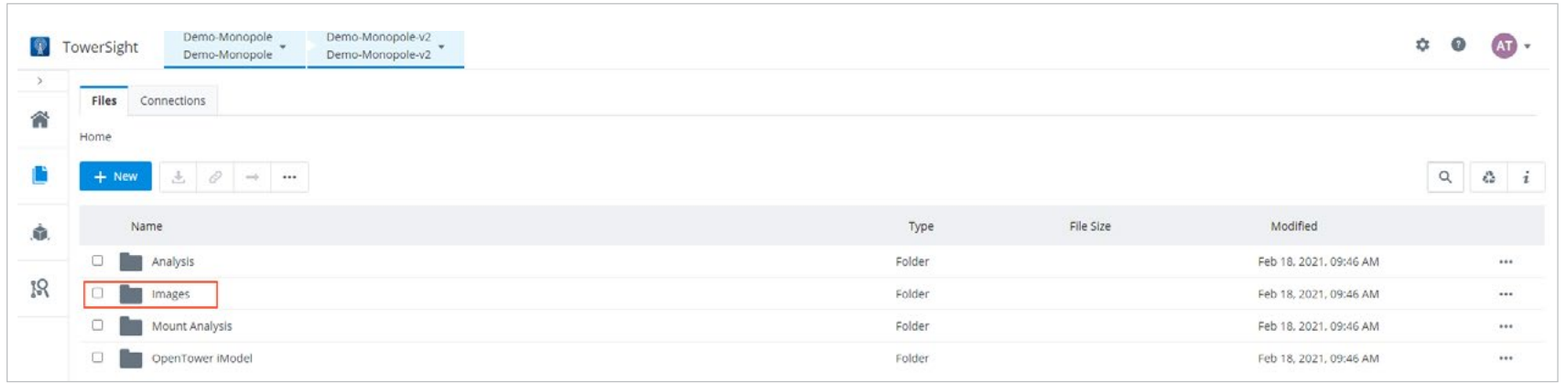



*Project dashboard*

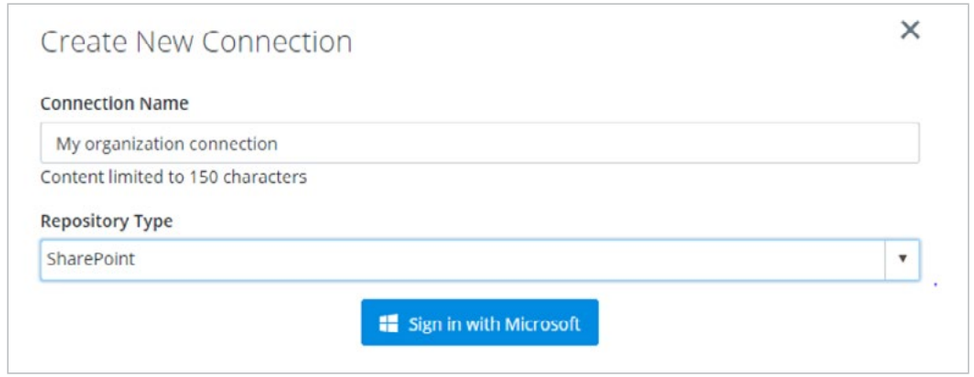
## Document Management

As an integral part of OpenTower iQ, document management means all project documents can be stored and managed in the Documents portal, including a connection with your SharePoint site and Bentley's ProjectWise data repository.

One of the use cases is to upload all the raw drone images in the "images" folder before you initiate the processing of 3D reality models.




*Manage documents through ProjectWise connections*

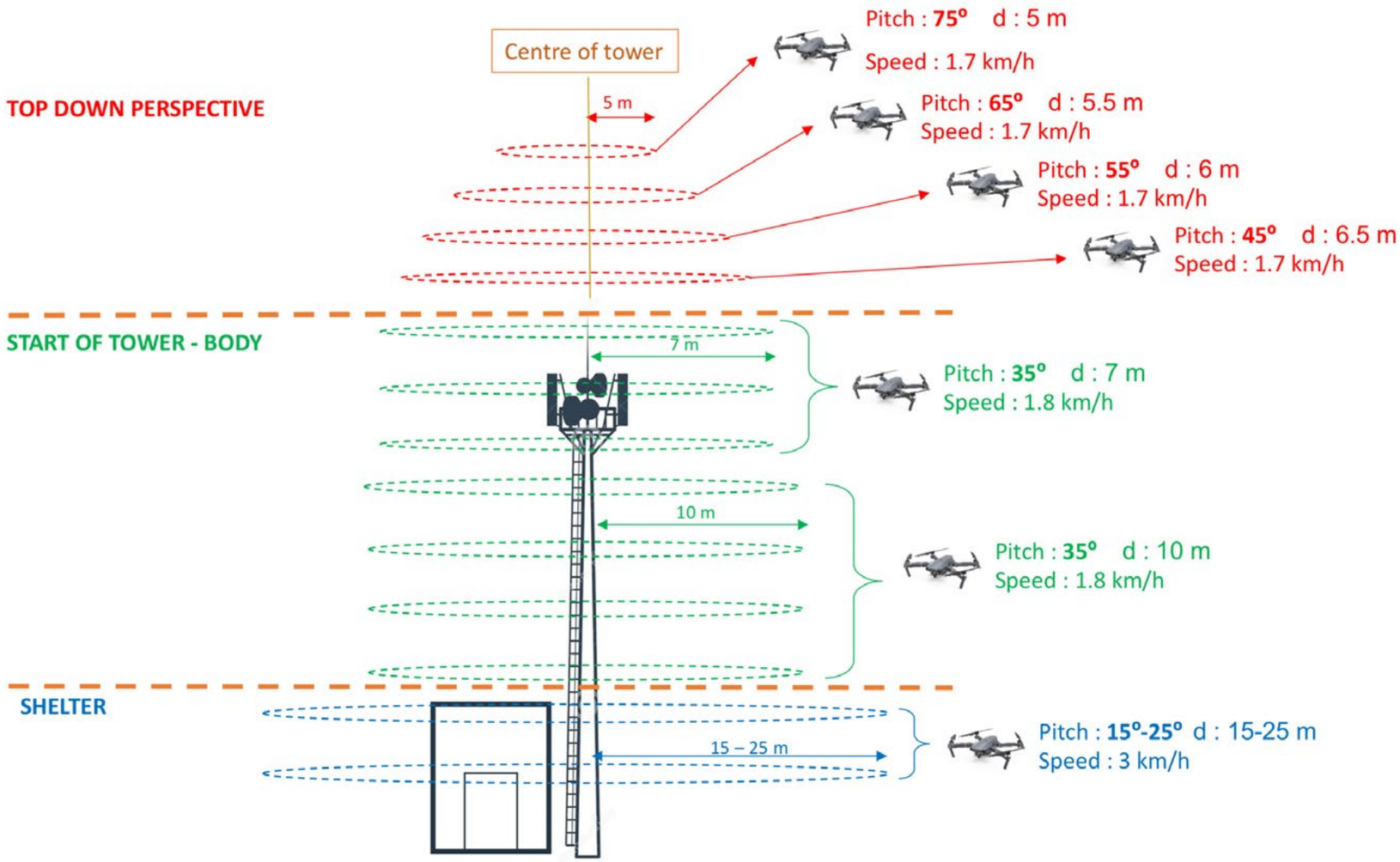



*Connect to a SharePoint site through OpenTower iQ*

## Reality Modeling

OpenTower iQ provides services to create 3D reality (as-built) meshed models through an automated and scalable process. Bentley's ContextCapture, the industry leading 3D mapping and modeling software, is used to create high quality models enabling all downstream workflows including inspection, data extraction, asset detection, and even engineering.

As a specialized service provider, Bentley has developed an orbital data collection process that yields high-quality, scalable models resulting in cost and time savings of up to 50%. The result is an engineering-ready, high-fidelity model with high positional accuracy enabling real world digital context.

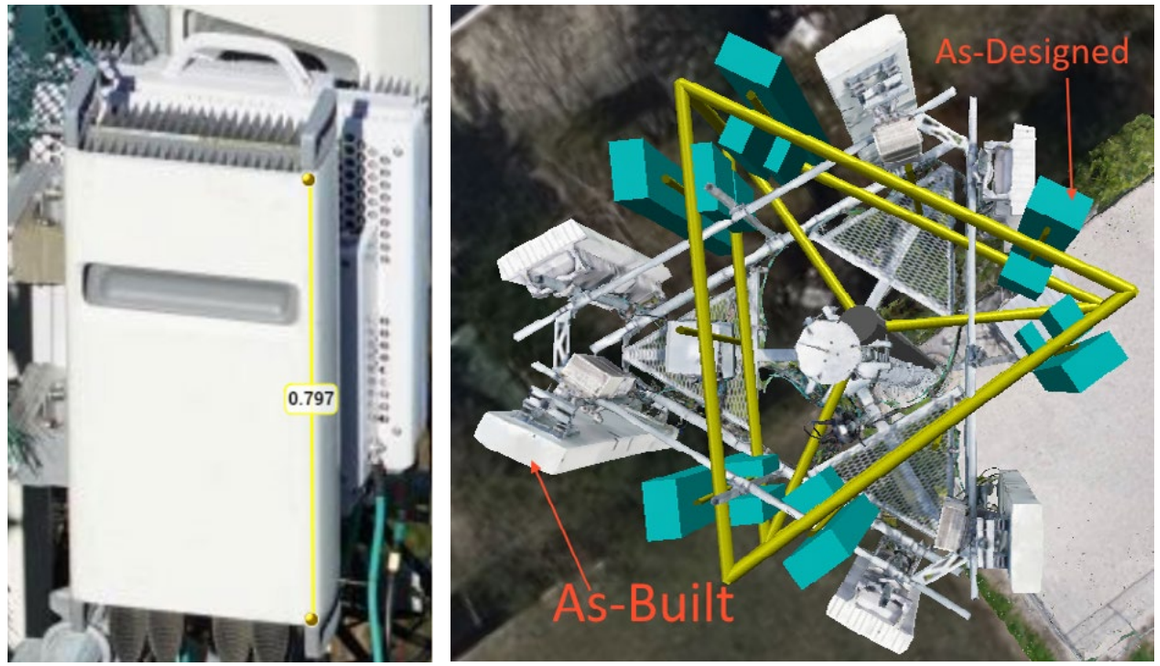



*Orbital data collection process*

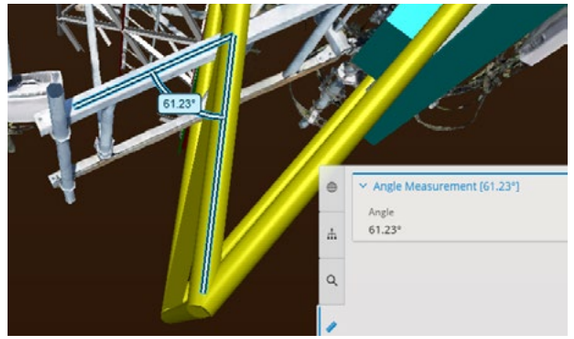
# **Digital Twin** Visualizer and Model Explorer

Bentley's iTwin viewer is a industry leading Digital Twin visualizer, enabling a 4D immersive graphical experience. Some of the functionalities include: Superimposed as-built vs. as-designed 3D Models for visual comparison, overlay of satellite imagery, overlay of aerial imagery (i.e., Ortho photomaps), etc. Utilities-like sectional views, switching on/off components, and color coding greatly enhances users' experience.

The advanced measurement tools help capture precision measurements through section slices and directly measure assets on 2D photos. Some of the built-in measurement tools include distances, angles, areas, and volumes.



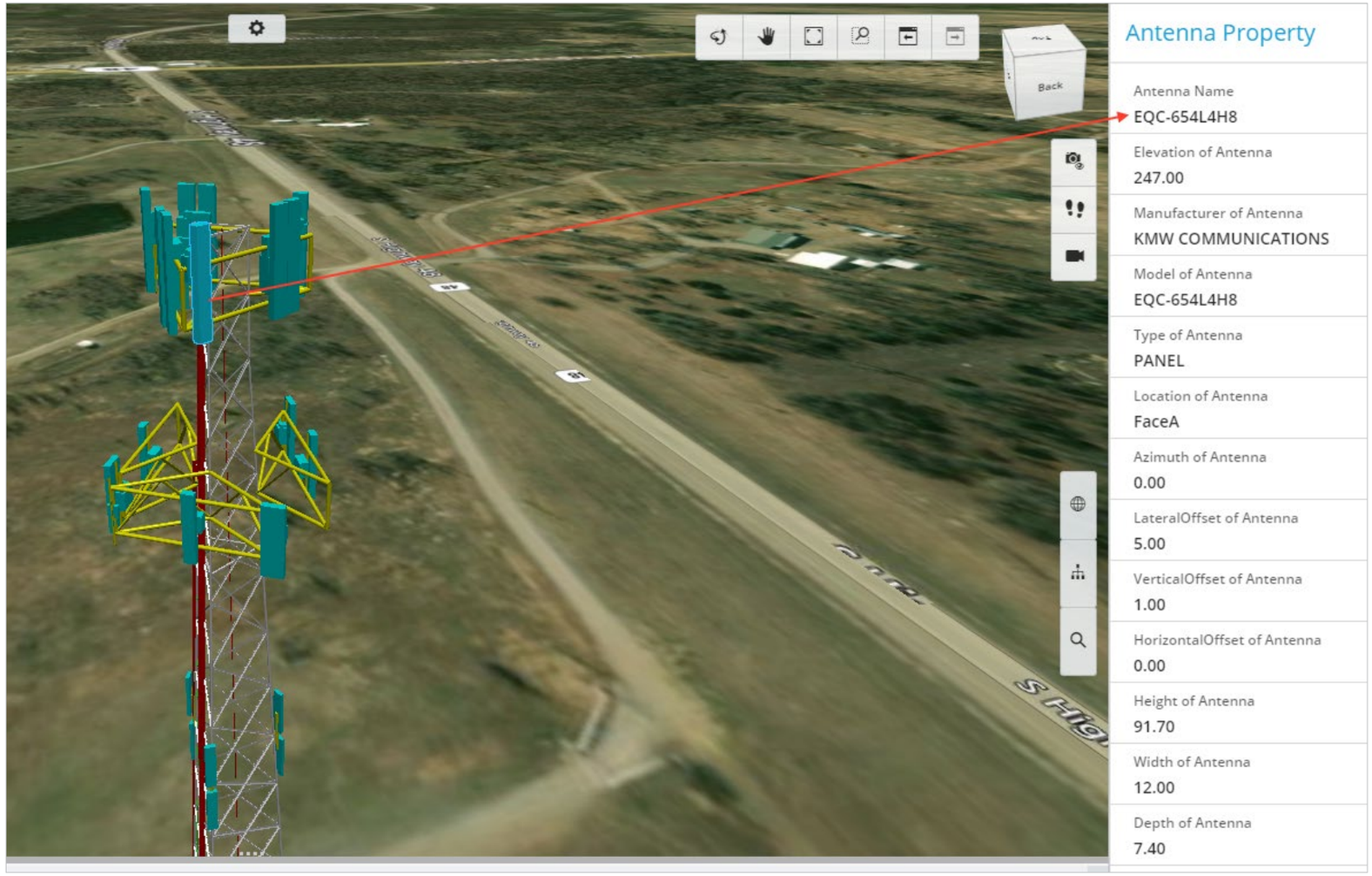

*Measure distances*




*Measure angles*

## Model Explorer

The most unique feature of OpenTower iQ is its engineering data review functionality. The design model (iModel) is published through OpenTower Designer and brings all critical engineering information, including wind load parameters, analysis report, discrete and linear appurtenances, tower geometry, etc. It enables quick QA/QC process without the need of a structural analysis program, ensuring faster and cheaper delivery.



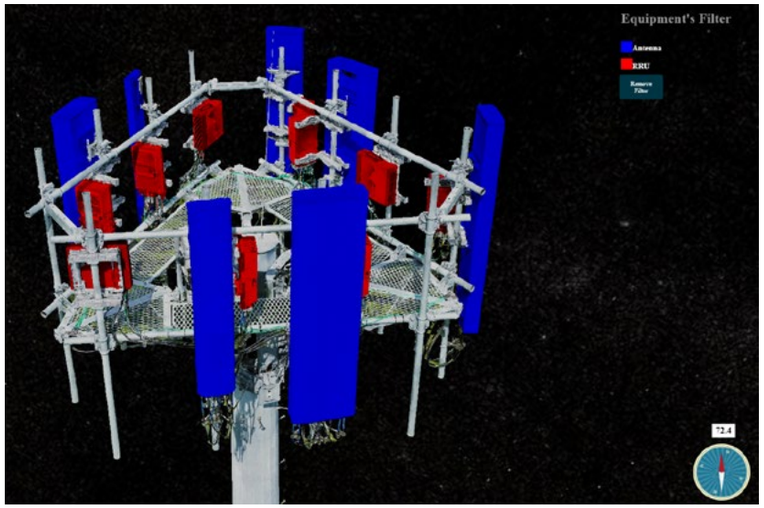

*Explorer – Review design model*

# **Analytics** and Smart Inventory

As we thrive to digitize towers through automation, machine learning (ML) and artificial intelligence (AI) play a very important role in gaining context of as-built models. By applying advanced AI, Open Tower iQ disrupts today's manual workflows with machine-based automation capabilities, thereby reshaping the operating environment for tower companies and MNOs.

## Equipment Detection

Equipment is automatically detected and fully characterized by extracting its main parameters like dimensions, orientations, and position on the tower. OpenTower's equipment catalog can then be used to find a match for corresponding manufacturer and model number. A user's asset database can be securely updated with the detected as-built information.

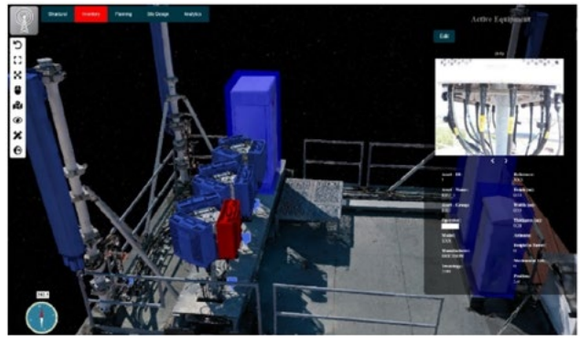



*Automated equipment detection*

## Inventorization Tools & Report Generation

OpenTower iQ implements inventory digital system tools with, but not limited to, the following functionalities:

- Import checklists coming from the field technicians
- Display checklists in a tabular format in the portal
- Change inventory items in the platform and have them reflected into the inventory parameters
- Remove/add inventory parameters and assets
- Report generation capabilities



*Tagging information of components in 3D*

# **AI-Based Structural** Defect Detection

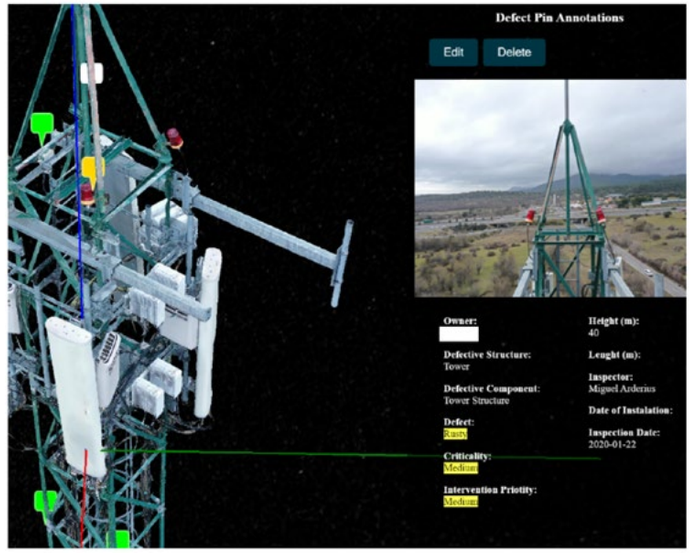
AI-based structural defect detection or asset condition provides an automated 360° defect recognition and classification. The ML algorithms continuously classify and learn from existing defects such as structural rust as well as new types of defects like broken night beacons or damaged antennas.

*Auto rust detection in shelter*

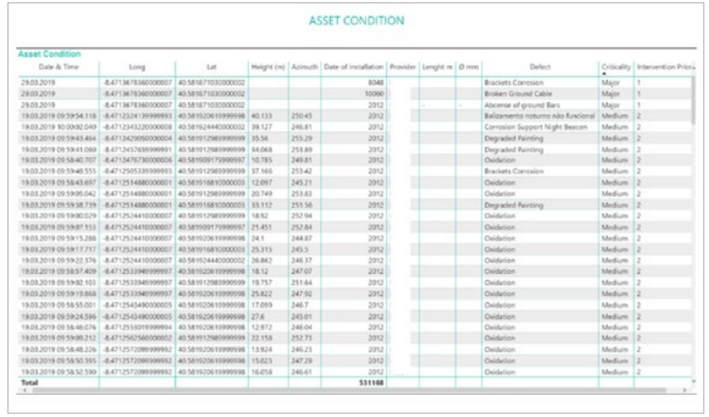
*Auto rust detection in screws*

## Asset Condition Tools

Defects can be manually identified and tagged on the pictures and on the 3D model using asset condition annotation tools. A report then can be generated listing all the defects along with relevant characterization.




*Asset condition annotation tools*




*Defect Tables*

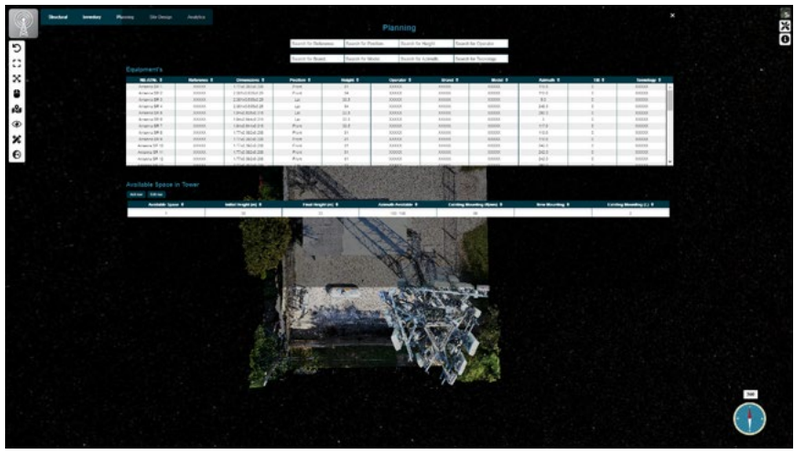
## Planning

Planning functionalities provide design engineers with the needed tools and information to accurately design and project a radio system in tower as In-shelter.

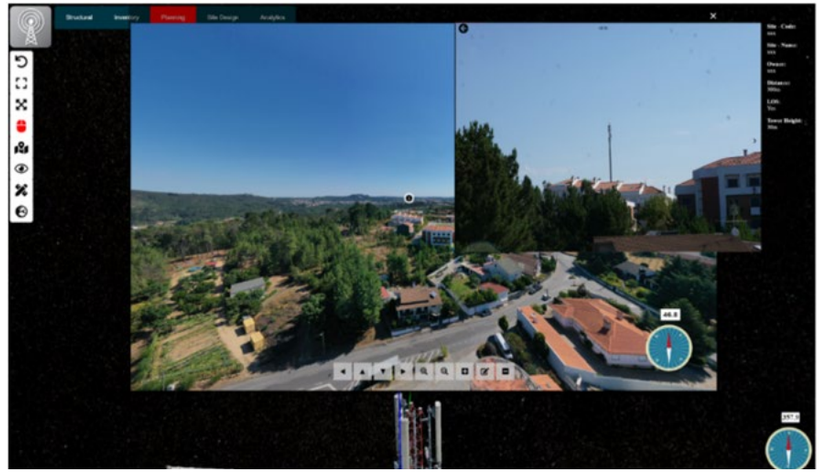
Accurate information regarding available space in a tower, as well as existence of mounting frames and associated characteristics, are fully available, mitigating uncertainties, reducing the need for site visits, and ensuring significant operational cost savings.

Additionally, radio engineers and designers can easily access a series of visualization capabilities to support them on planning decisions, such as spherical views and line-of-sight, top and lateral views, and panoramas at several azimuths. The user is provided with exportation and report generation capabilities including, but not limited to, all planning information:

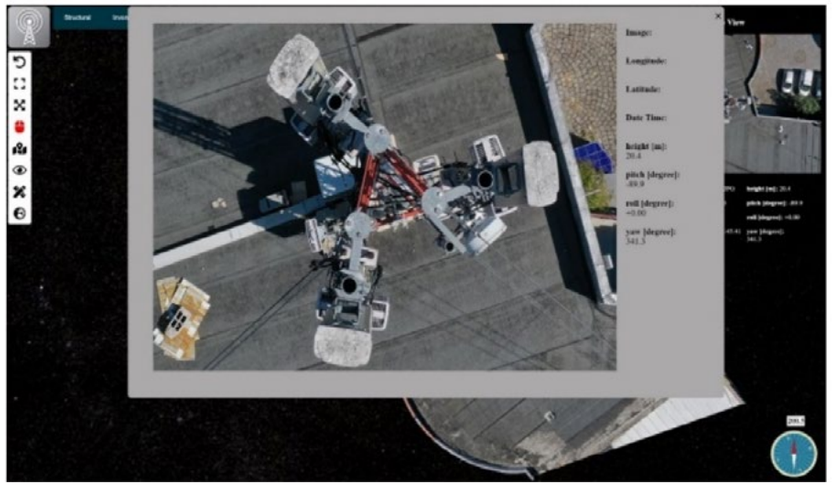
- Equipment
- Available space
- Most relevant imagery for planning support



*Planning parameters table*



*Spherical view and line of sight*



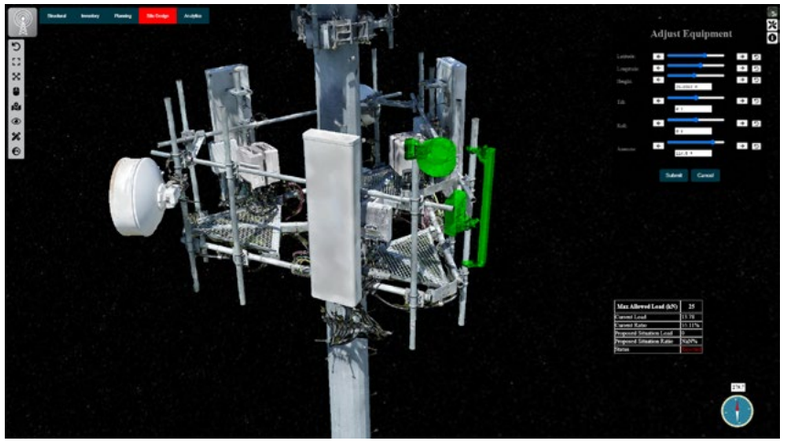
*Top view*

# **Site Design** & Early Wind Load

OpenTower iQ is the perfect tool for transition planning to the 5G market. It helps tower owners and operators evaluate different scenarios to optimize the rollout plan consistent with their 5G deployment strategy. Users can make informed decisions based on detailed knowledge of up-to-date asset conditions.

## Site Design

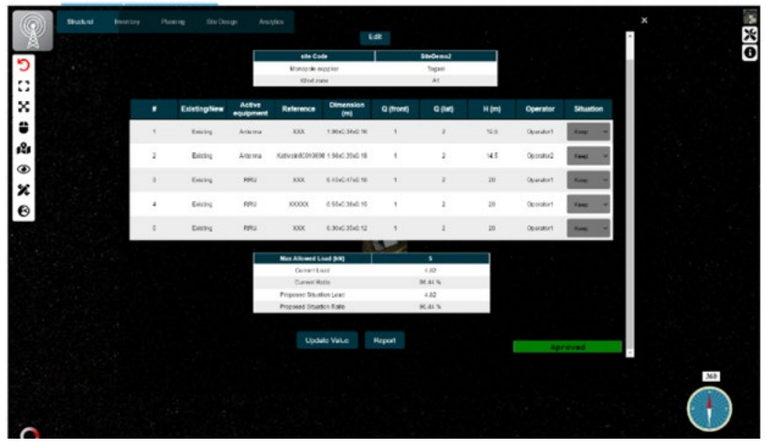
Site Design makes use of the AI-based element identification and segregation to implement reality model-based design functionalities. Engineers can simulate proposed changes on the tower by adding, removing or swapping equipment in order to make better and faster decisions.




*Site design*

## Early Wind Load

Early Wind load is a simple simulation tool to evaluate tower capacity comparisons for “Before” vs “After” design changes. It’s not designed to replace the need of a detailed structural analysis but rather provides estimates to enable quick decision making.



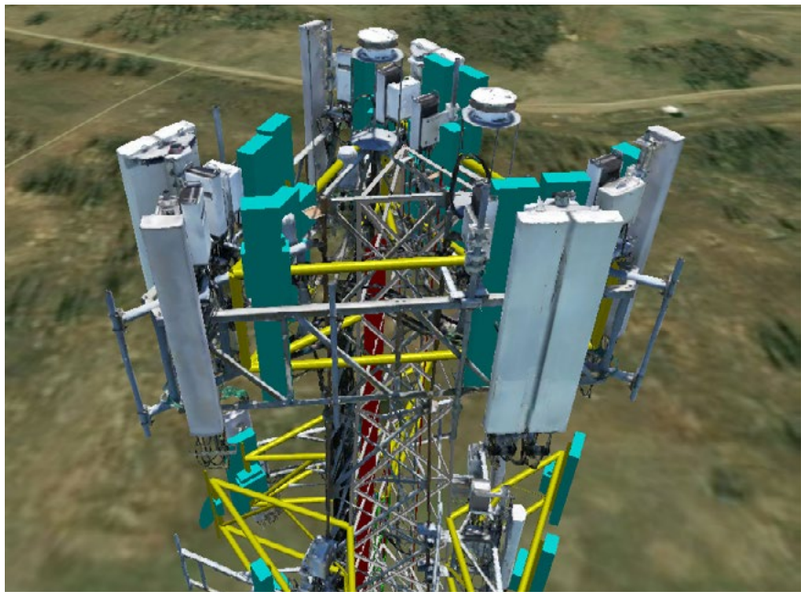
*Early wind load*

# **Design Model and** Change Detection

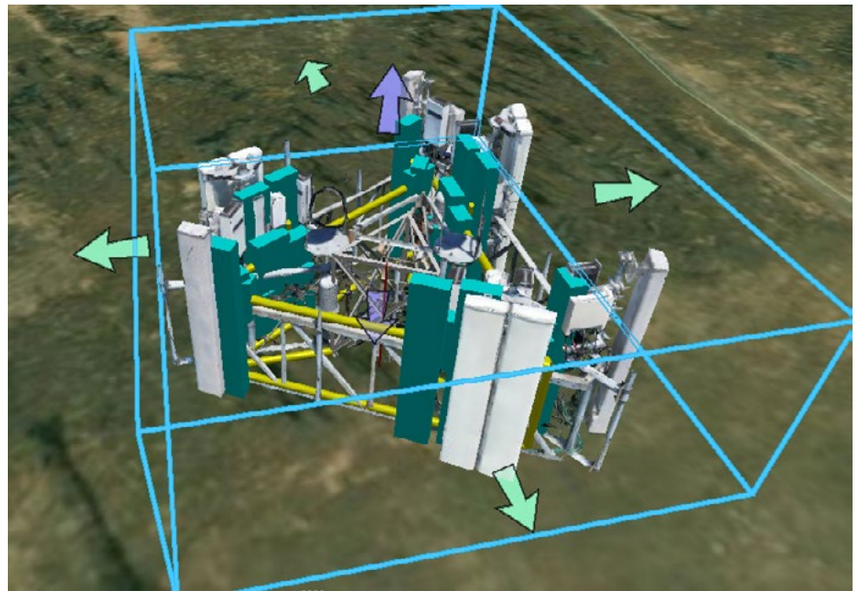
OpenTower is a one-stop solution for telecom tower digitization, including structural analysis, drawing generation, and more. OpenTower Designer is purpose-built tower modeling (BIM) and analysis software. Bentley's open standard iModel is authored from OpenTower Designer and published into OpenTower iQ for visualization, review, update, and change detection.

## Change Detection: As-Built vs As-Designed

One of the salient features of the OpenTower iQ is Change Detection. The Design Model can be overlaid on top of the reality model (as-built) to visually compare the differences between those two models, including bearing angle, equipment position, azimuth, missing members, etc. Through our AI based automation, detected equipment can be compared to the design model, yielding a comparison table, organized at different mount levels.



*Overlaid As-built and As-designed models*

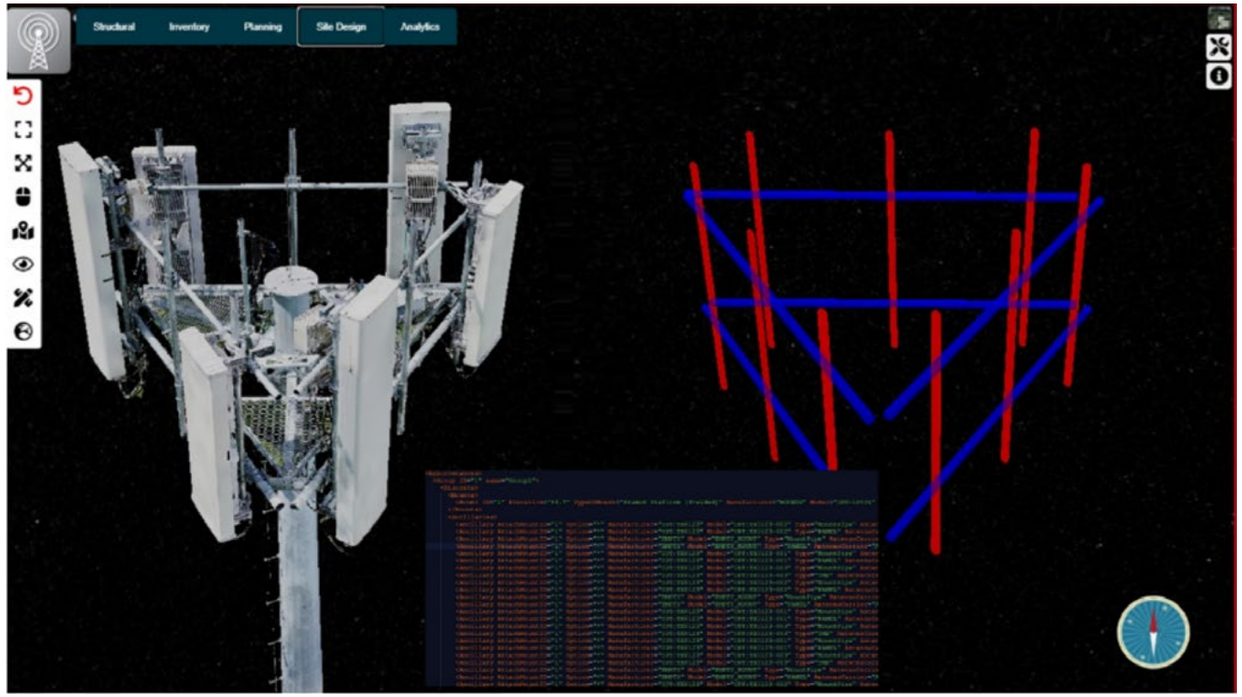


*Sliced overlaid models*

## Mount Detection for Engineering Automation

One of our advanced AI/ML capabilities is to detect platform mounts and equipment installed on those mounts, including mount pipes, handrails, etc. The program then automatically generates loading mapping data from the extracted parameters.

One of the key aspects of this feature is to generate mount mapping reports and subsequently automate mount and tower analysis. Positional parameters, like horizontal offset, vertical offset, standoff distances are auto calculated.




*Mounting extraction via AI/ML*


*Auto-detection of Platform Mounts with Mount pipes*

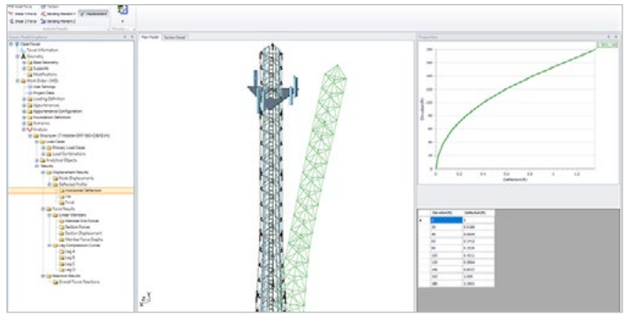
# **Mapping** & Analysis

A purpose-built solution for telecommunication tower analysis and design, OpenTower Designer captures real-life workflows including tower modification, multiple scenario evaluations, foundation checks, and connection designs. It connects to equipment databases to automatically generate wind and seismic loadings, analyze the structure, and produce custom reports. The advanced graphics produced by OpenTower Designer show a realistic view of the tower, including 3D renderings of equipment and feedlines.

OpenTower Designer includes a comprehensive library of panel types and ancillary equipment that enables quick creation of the structure. It automatically generates loads for any number of directions with user-defined topographic configurations while quickly performing design checks and creates reports with virtually any output — from structure data to loading analysis results to design capacities for members and bolts.

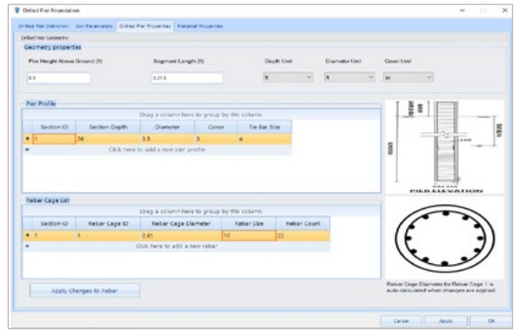
## Additional features and benefits of OpenTower Designer include:

- **Tower Modification/Scenario Analysis:**
  - — Automatic generation of wind, ice, and seismic load cases for tower structures and external attachments per the local design standards
  - — Hierarchical modification layers and scenario analysis for “what–if” scenario investigation and data management



*Scenario analysis*

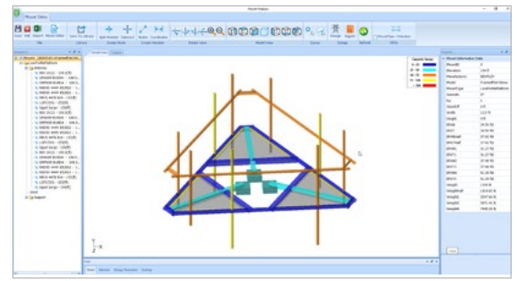
- **Analysis-linear Static, P-delta, Nonlinear, Cable, and Modal Analysis**
  - — Post-processing features include joint displacements, member forces, stresses, support reactions, leg compression, deflection, tilt, and twist results in terms of diagrams and tables
  - — Enables the user to have a detailed insight of the analysis results
  - — Helps to plot multiple post-processing diagrams for a selective set of physical members for complex structures
- **Foundation, Connection, and Member Design**
  - — Integrated foundation design saves time and reduces errors
  - — Design as per Standards Custom tower catalogue for commonly used built-up section profiles and materials



*Foundation design*

## Structural Analysis of Mounting Frames

OpenTower Mount Analysis is built specifically for designing and analyzing mounts on communication structures including Sector-Frames, Platforms, T-Arm, and more. The integrated design workflow eliminates the need for time-consuming in-house tools to pre-process data, expensive structural analysis programs, and manual report generation.



*Mount analysis*

# **Summary and** Features Comparison

| Features | Tier 1 | Tier 2 | Tier 3 | Tier 4 |
|---|---|---|---|---|
| Data Hosting | ✓ | ✓ | ✓ | ✓ |
| Digital-Twin Visualizer | ✓ | ✓ | ✓ | ✓ |
| Measurement Tools | ✓ | ✓ | ✓ | ✓ |
| Tower Registration | ✓ | ✓ | ✓ | ✓ |
| Document Management | ✓ | ✓ | ✓ | ✓ |
| Issue Resolution | ✓ | ✓ | ✓ | ✓ |
| Reality Model Generation from raw images | | ✓ | ✓ | ✓ |
| Equipment Detection (AI/ML) | | ✓ | ✓ | ✓ |
| Rust Detection (AI/ML) | | ✓ | ✓ | ✓ |
| Smart Inventory | | ✓ | ✓ | ✓ |
| Planning Tools (adding, removing equipment) | | ✓ | ✓ | ✓ |
| Overlaid as-built and as-designed models | | | ✓ | ✓ |
| Change Detection | | | ✓ | ✓ |
| Mount mapping reports from reality model | | | | ✓ |
| Mount structural analysis | | | | ✓ |
| Tower mapping reports from reality model | | | | ✓ |
| Tower Structural Analysis | | | | ✓ |

*My company has been analyzing towers since the early 2000s. We have performed structural analyses on thousands of towers and have used software packages such as GuyMast, IES, NuTower, PLS Pole and Tower, ERI/RISA/TNXTower, and now OpenTower and I can say hands down OpenTower blows away the competition in terms of features, ease of use and depth of analytical rigor offered."*

— Aaron Broderick, P.E. | Principal,
Johnson Broderick Engineering, LLC

*"The flexibility of a single model to check scenarios is one of the greatest advantages of OpenTower. It allows us to provide our clients as much feedback as possible to promote a long-term relationship."*

— Matthew K. Lackey, P.E., Charlotte Structural Division Manager,
Tower Engineering Professionals, Inc.

*" This technology brings transparency by capturing the reality from the ground and bringing it to the desktop."*

— Nozer Turel, Assistant Vice President,
Geotechnology at Genesys International

*"Bottom line, a purpose-built solution, OpenTower iQ for tower planning and management is a game changer for the telecom market segment."*

– Nikhil Jani, Vice President Telecom and Utilities,
Genesys International

# **About** Bentley Systems

Bentley Systems is the leading global provider of software solutions to engineers, architects, geospatial professionals, constructors, and owner-operators for the design, construction, and operations of infrastructure. Bentley's MicroStation-based engineering and BIM applications, and its digital twin cloud services, advance the project delivery (ProjectWise) and the asset performance (AssetWise) of transportation and other public works, utilities, industrial and resources plants, and commercial and institutional facilities.

Bentley Systems employs more than 3,500 colleagues, generates annual revenues of over $700 million in 170 countries, and has invested more than $1 billion in research, development, and acquisitions since 2014. From inception in 1984, the company has remained majority-owned by its five founding Bentley brothers. Bentley shares transact by invitation on the NASDAQ Private Market.

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