

Bentley's iModel 2.0 Platform

The Next Generation Cloud Platform for
Digital Workflows in Infrastructure Projects

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A Bentley White Paper

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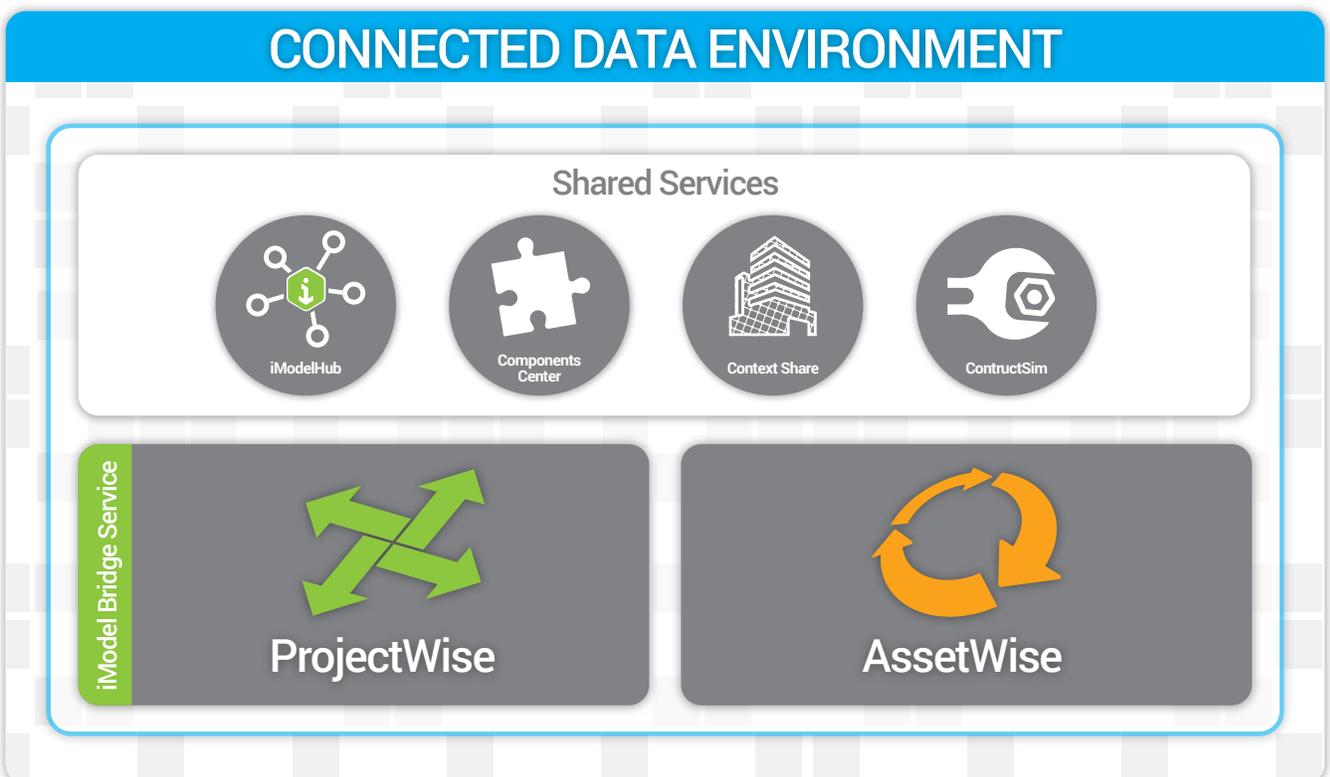
Foreword

The last 20 years have seen considerable evolution in software for infrastructure professionals. We went from CAD to Modeling and then to BIM. We went from individual workstations to networked PCs, from sneaker-net to collaborative work sharing. The state-of-the-art for collaborative BIM is the CONNECT Edition, with its applications and the data they produce managed by ProjectWise services in a *connected data environment*.

Now, cloud services are pervasive, and the promise of new technologies like big data analytics, machine learning, artificial intelligence, and blockchain are top of mind for CIOs and technology leaders in infrastructure. These technologies have piqued interest in how we might better manage change and automate workflows in infrastructure projects. Indeed, as progress is made in other industries, the interest is intensifying.

Infrastructure projects have unique characteristics. They involve many collaborating disciplines where the work is interconnected, with thousands of asynchronous decisions and changes for material choices, design, aesthetics, structural integrity, safety, and more.

So, what's next? If constant and unrelenting change characterizes infrastructure projects, then it would seem self-evident that our systems should be designed from the ground up to manage change. We need to move away from a futile attempt to maintain a single model of a design as the "current record", as the very concept of "current" is ephemeral in infrastructure. We need a new paradigm for managing change—a better solution for synchronizing work in infrastructure projects.



THE IMODEL 2.0 SERVICES ARE PART OF THE CONNECTED DATA ENVIRONMENT.

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The Next Generation Cloud Platform for Digital Workflows in Infrastructure Projects

Keys to Project Visibility: Alignment, Accountability, and Accessibility

CIOs of engineering firms and infrastructure asset owners have long recognized the value of the information created by a diverse range of tools and workflows that combine to form a “conceptual database” of engineering decisions. They envision a new *digital workflow*, enabled by cloud-based services, that leverages that database to minimize project risk, decrease redundant work, and improve predictability and probability of success. They imagine gaining new insights from their unstructured information from Machine Learning, Artificial Intelligence, and big-data analytics.

Unfortunately, such *digital workflows* are simply impractical with the current generation of engineering design and information management tools that were conceived and invented for a local network of personal computers. The “conceptual database” is really a disconnected array of ever-changing files in formats defined by their authoring applications, stored on file servers as indivisible and indigestible units.

To transform this loose collection of heterogeneous engineering documents into a truly reliable, reusable, and scalable infrastructure asset database (sometimes referred to as an “infrastructure model”) we need to fundamentally rethink:

- **Alignment:** Database queries and analytics only work when the database contains consistent units, semantics, and structure.
- **Accountability:** In infrastructure projects, the adage “the only constant is change” is particularly relevant. Change must be a first-order concept, not an unwelcome inconvenience. Sometimes, knowing what caused a change, and what was impacted by it, is as important as the change itself.
- **Accessibility:** Any authorized user or program that can benefit from information in the database should be able to easily access it without impacting other users. This goal is achieved by replicating the database wherever it is needed. Copies are synchronized when necessary through the iModelHub.

The iModel platform builds on Bentley's successful i-model technology in a way that is radically different from “pre-cloud” software. It is a step change forward and is unique in the industry.

Introducing the iModel 2.0 Cloud Platform

These key points summarize the iModel 2.0 Cloud Platform:

1. **It is architected from the ground up to manage change.** iModelHub maintains a “timeline of changes” that is an *accountable* record of who-did-what and when. Any version of the iModel can be *accessed*, and significant versions can be named. Visual and textual reports can show the difference between any two points on the timeline.

2. **An iModel is a distributed relational database that holds an aligned representation of the changes from the *digital engineering models* for a project or asset.** The models include physical and functional models and related drawings, specifications, analytical models, and so forth.

3. **iModelHub allows unlimited copies of an iModel.**

Users can save copies to any device or service including desktops, mobile devices, deployed servers, or cloud-based services. The consumers of the iModel synchronize their copies via subscription to iModelHub's timeline of changes. With iModelHub, the iModel becomes a distributed cloud-based database that allows unlimited scale-out of clients and services with no centralized bottleneck.

4. **Existing file-based workflows are “bridged” with iModelHub through the ProjectWise iModel Bridge Service.**

Users can contribute *digital engineering models* without any change to existing applications or formats, allowing organizations to take advantage of the iModel 2.0 Platform with almost no disruption of existing workflows and at near zero risk.

Achieving Accountability through iModelHub's Timeline of Changes

Imagine a bank account that only showed your current balance—without the transaction history to show how that balance was achieved. No record of deposits or withdrawals – just the “current balance” without any context. Most people would find that lack of a transaction history entirely unacceptable, yet infrastructure professionals are currently living with such limitations—they can only see the current state of their engineering data.

Change in data is the source of both value and risk in infrastructure workflows. With iModel 2.0, change itself is a first-class concept. iModelHub maintains a timeline of changes stored as a sequence of immutable ChangeSets that capture how, when, and by whom the engineering data has changed. ChangeSets are:

- **Fine-grained**—tracking change on a per-property basis and attributing every changed value to its author in context.
- **Semantically rich**—enabling services to discover how the engineering data is changing in a meaningful way.
- **Records of change**—efficiently communicating changes among geographically distributed teams in both connected and disconnected workflows.

Services and applications can obtain a copy of the iModel from iModelHub and subscribe to notifications of changes added to the iModel's timeline. Upon notification, they can receive the changes and apply them to their copy of the iModel, thereby synchronizing it. This change notification system drives automated *digital workflows*.

In some engineering workflows, such as approval workflows, users may not want to work with the “current” or latest version of information. iModelHub allows access to any version of the iModel along its timeline, and significant or milestone versions can be named (e.g. “90% submittal”).

iModelHub is the hub of engineering data and change in the *connected data environment*. Its timeline of changes facilitates automated *digital workflows*, as-needed synchronization of iModels, and insights into how the data is changing.

Accessibility: iModelHub Embraces Distributed Work

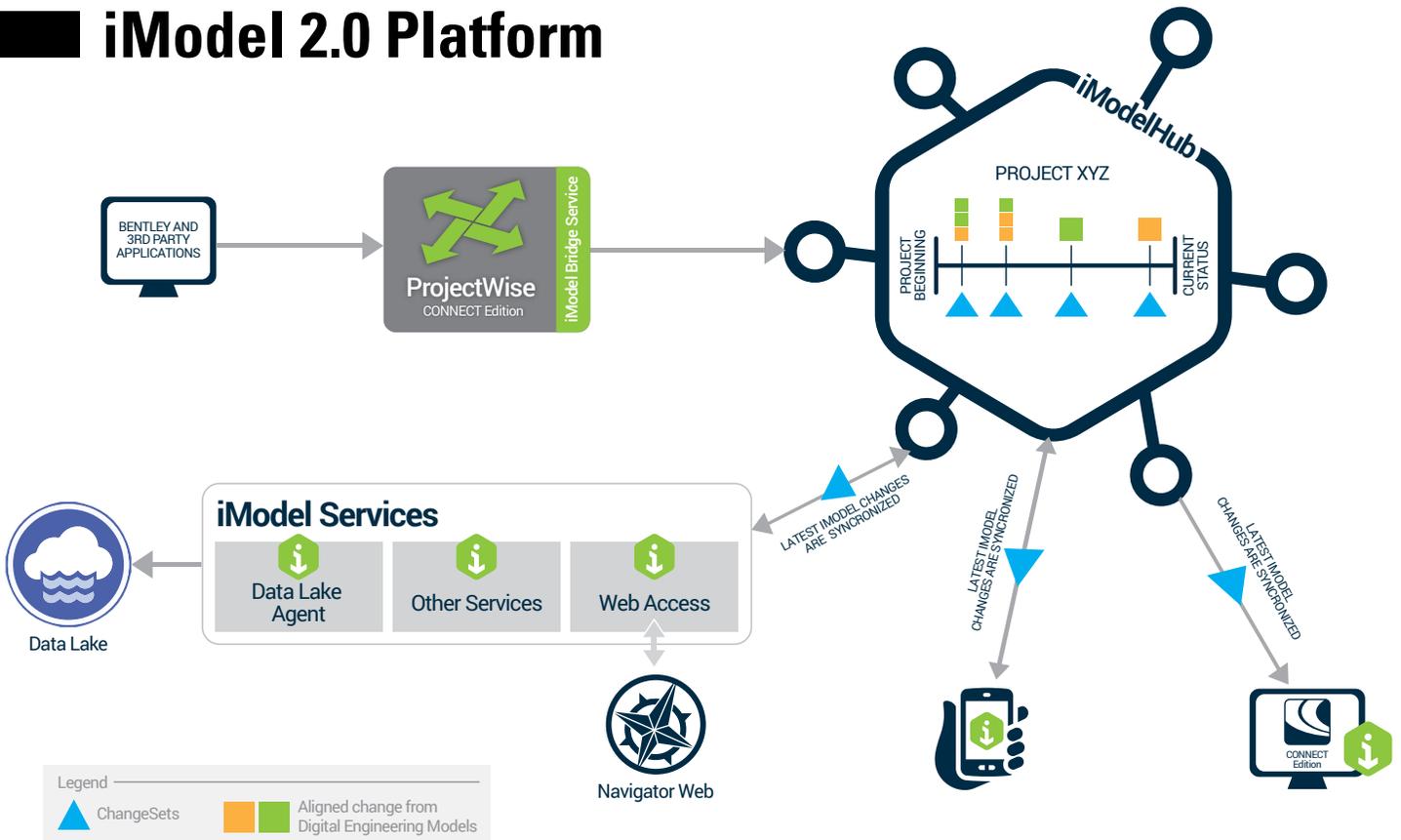
Design, construction, and operations are not centralized activities—work is distributed across multiple organizations, individuals, and locations. A single centralized database is not the optimal solution for managing change in engineering data across a fundamentally distributed environment. Remote offices with poor internet connectivity need full access to the data. Field workers also need access to data, and may not have WiFi or cellular connectivity.

Individual teams may need to keep their work isolated as work in process—only synchronizing with the larger project at appropriate milestones.

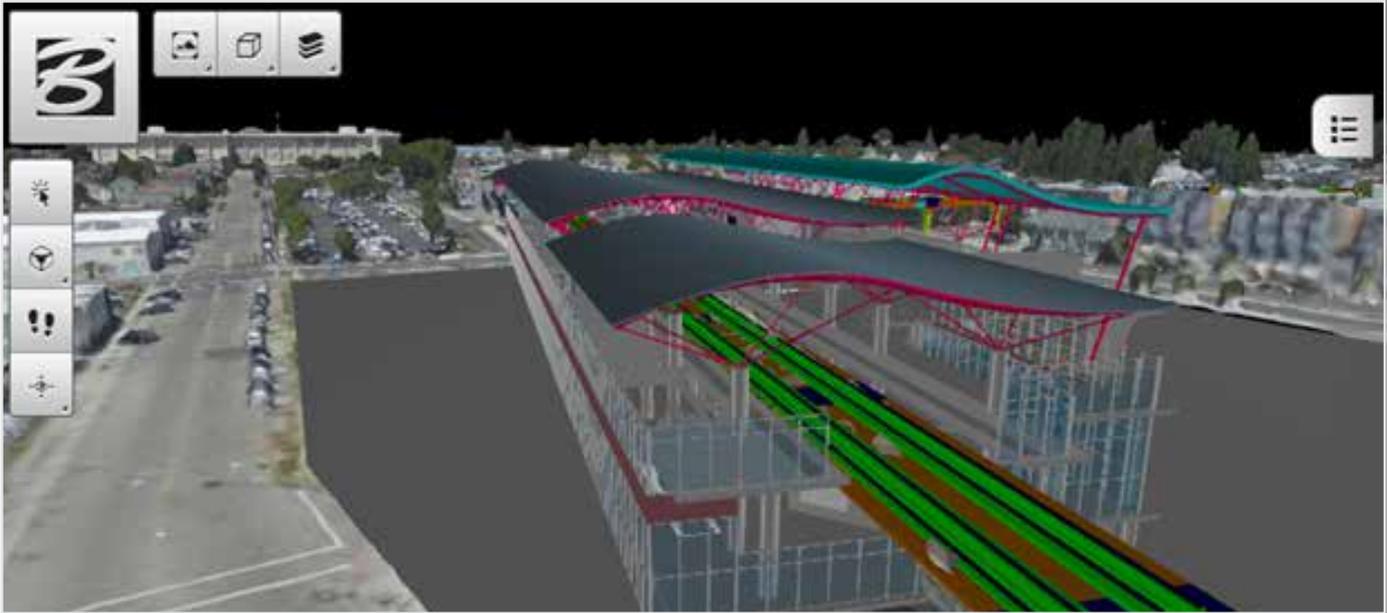
For these diverse workflows, portable databases that can be synchronized are the optimal solution. A completely centralized database is impractical; it does not lend itself to distributed work, and it requires a strict commitment to a prescribed data format. iModelHub, in contrast, embraces distributed work using distributed databases (iModels) that synchronize as-needed via iModelHub cloud services.

iModelHub’s distributed approach means that new users, services, or automated processes can access the iModel without slowing down existing users. Contrast this scalability with that of a centralized database where additional activity can slow down access for all—an inherent bottleneck as use scales. iModelHub is built for distributed cloud scale-out, with clients and services using synchronized copies of any version of the iModel on its timeline.

iModel 2.0 Platform



The source of information for the iModel’s timeline of changes is ProjectWise workflows; iModel Services and web, mobile, and desktop applications consume iModels.



With Navigator Web, any version of an iModel (at any point along its timeline) is accessible in a web browser. This example shows an iModel that aggregates data from Revit, OpenRoads, and AECOSim Building Designer, along with reality context from ContextShare.

Accessibility: iModel Services for Digital Workflows

iModelHub is a key part of the iModel 2.0 platform and will make possible an ecosystem of iModel-based applications and services for a wide range of possible workflows on the web, on mobile devices, and on desktops.

iModel Web access services will make graphical and non-graphical information from iModels accessible to cloud-services and browser-based workflows. The iModel Web SDK allows third parties to create custom web applications that mash-up iModels, reality context from ContextShare, and information from other *connected data environment* sources for use in powerful web applications with full 3D navigation, filtering, and property browsing.

Navigator Web uses the iModel Web SDK to enable viewing of named versions of an iModel from any modern web browser, without the need to install plugins or download the iModel.

iModelHub serves as an engineering data distribution hub for mobile devices—synchronizing data to the devices using ChangeSets. The mobile apps keep a complete copy of the iModel, for disconnected operation in the field. By updating the iModel with ChangeSets, users can significantly reduce the data downloaded to keep the iModel current.

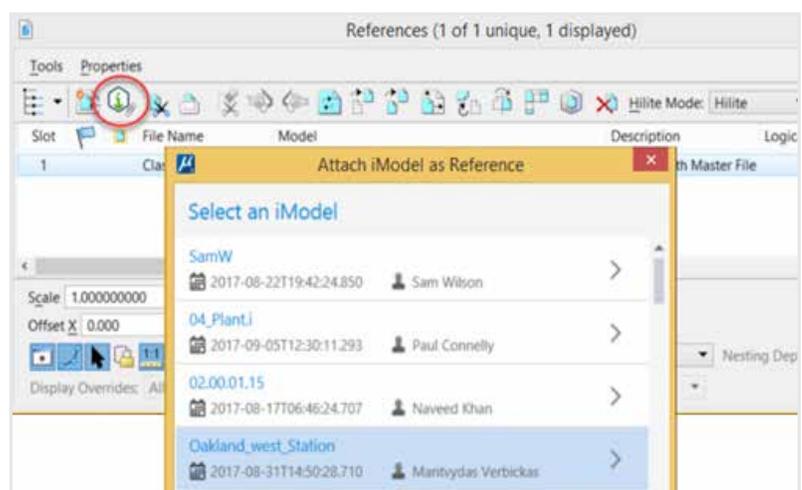
CONNECT Edition desktop applications can attach models from iModels as “reference attachments” and receive notifications of changes added to the timeline. CONNECT Edition users can review both graphical and non-graphical changes.

iModel transformation services will enable purpose-specific republishing of the iModel’s data for targeted workflows.

An iModel Data Lake service receives notifications of changes added to the timeline and extracts *aligned* information to populate a data lake for analytics and Artificial Intelligence solutions.

An iModel for a design and construction project becomes ever more valuable after project completion. An iModel can be provided as the as-built representation of the asset. It becomes the as-is iModel—the backbone of a digital representation that holds the physical and functional context of the asset for operations and maintenance.

The *aligned* iModel can be maintained and used much more easily and cheaply than the original design artifacts and does not require the applications that originally created them. The iModel’s timeline will be reset at handover, but the iModel will continue to evolve as changes to the infrastructure are made. The iModelHub will hold the living history of the physical and functional models of the asset.



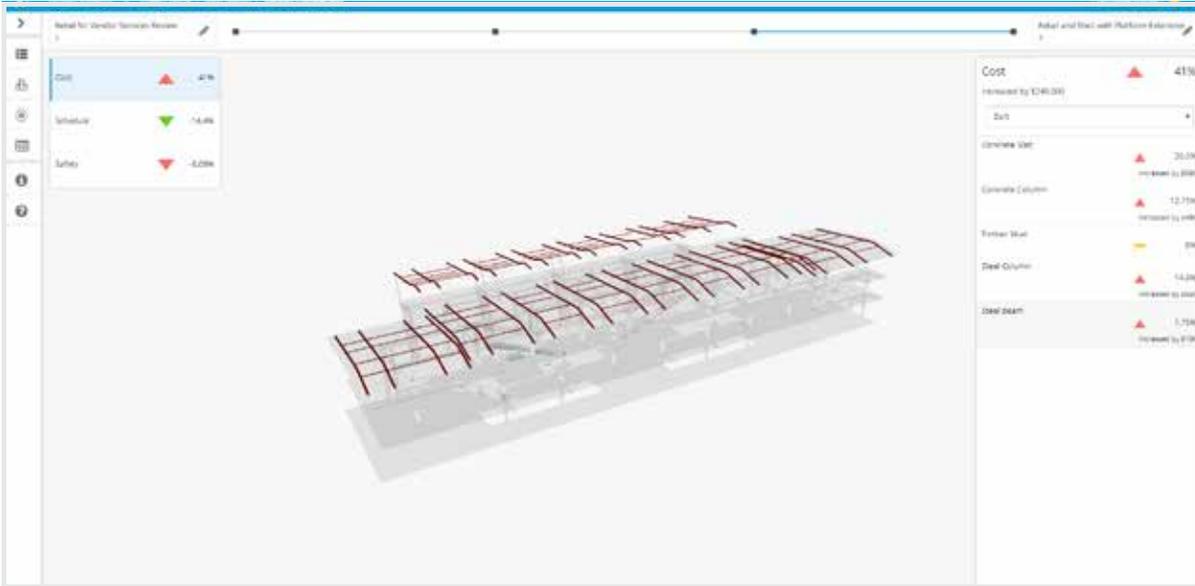
MicroStation CONNECT Edition referencing a physical model from an iModel

Bentley provides format-specific “iModel Bridges” for ProjectWise that incrementally *align* engineering data from all relevant sources, including non-Bentley formats, into iModels. An API also allows third parties to create iModel Bridges.

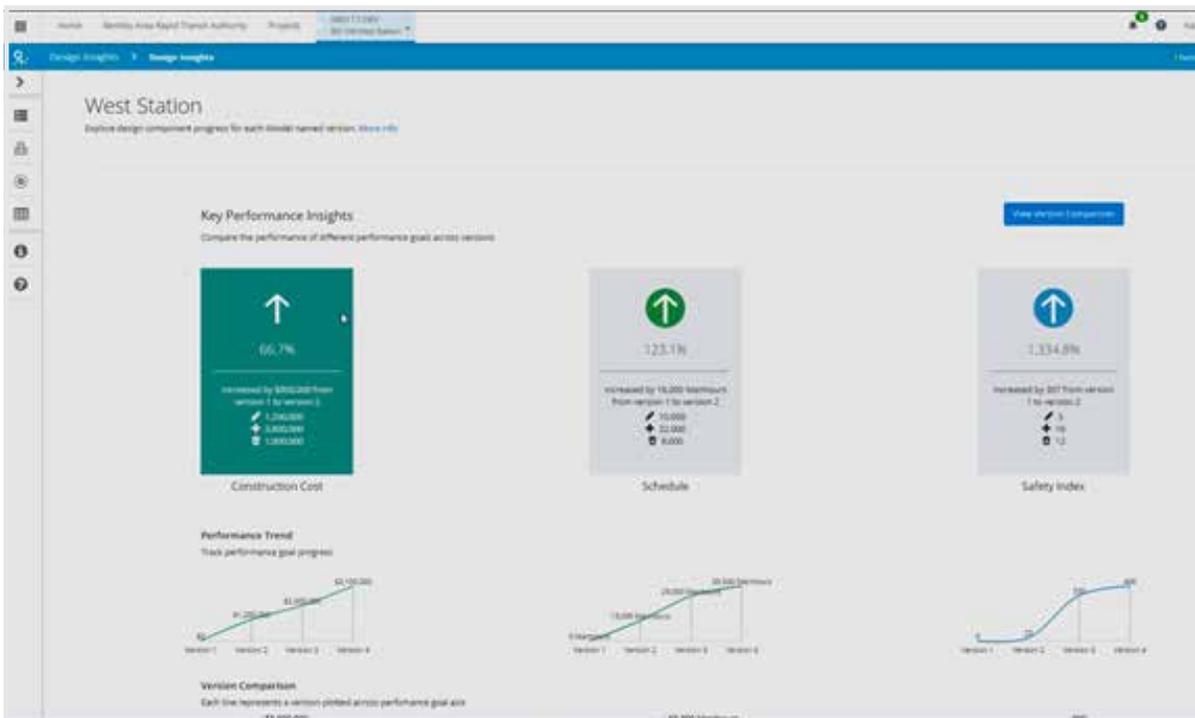
Once the changes are *aligned* and added to the iModel’s timeline, they can be fully leveraged by iModel applications and services. Getting started with iModelHub is as simple as using ProjectWise and turning on the iModel Bridge Service.

iModelHub Will Drive the *Digital Workflows* of the Future

In the era of self-driving cars and ubiquitous digital assistants, engineering data should not sit in dark repositories inaccessible and ignored — it should feed iModel timelines and change-driven *digital workflows* that leverage the rich, *aligned* semantics of iModels. The iModel 2.0 cloud platform will enable a new generation of cloud services that leverage iModels and iModelHub to analyze trends across and within projects, to reduce risk, improve operational proficiency and optimize organizational efficiency.



Design Insights shows the impact of change between iModel versions on the key indicators of cost, schedule and safety



Design Insights provides access to change in KPIs along the iModel’s timeline.



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