



The Trusted IoT Alliance Challenge Program: The Smart Construction Challenge

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Introduction

The Trusted IoT Smart Construction Challenge is designed to bring together major industry players with start-ups, with the intent to advance the digitalization of the construction industry. The IoT (Internet of Things) provides the foundation for the next generation of smart, sensor-based, connected construction solutions. Trust systems such as Distributed Ledger Technologies (DLTs) enable secure and decentralized data exchange between IoT-enabled construction equipment and all other related IT systems, including BIM (Building Information Model) management platforms. The Challenge endeavors to enable solutions across each of these areas.

Innovation Ecosystem and Joint Go-To-Market

The main goal of the Smart Construction Challenge is to jointly develop solutions which provide real world value-add to the construction industry, based on direct user feedback and field trials. Our intent is to drive the creation of an ecosystem which will jointly bring the new solutions to the market. The initial ecosystem for this challenge includes the following partners:

1. Challenge Supporters

- **Trusted IoT Alliance (TIOTA):** TIOTA is a non-profit foundation with 50+ members, focusing on the advancement of Trusted IoT technologies, including blockchain and DLTs. TIOTA will mobilize

member companies and affiliated start-ups to contribute solution proposals based on trust technologies.

- **Industrial Internet Consortium (IIC):** The IIC is a non-profit industry alliance with 200+ members, focusing on the Industrial Internet of Things (IIoT). As a Trusted IoT Challenge Supporter, the IIC will mobilize member companies and start-ups to contribute solution proposals based on IoT-enabling technologies.
- **MachNation:** MachNation is a global independent IoT research and benchmarking firm. MachNation will analyze and benchmark submitted proposals and make the published report available to the public.

2. Construction Industry Partners

- **Züblin:** Züblin is a construction company with headquarters in Stuttgart, Germany with €3.8B in revenue (2017). Part of Strabag group, Züblin will provide use cases and requirement definitions, as well as access to a real-world construction project/construction site for the pilots.
- **Bosch:** Bosch's internal construction unit is responsible for construction projects with revenue of more than €2B (2018). Bosch's construction unit will also support user feedback and will potentially delivery a construction site for the pilot projects.
- **TÜV SÜD:** TÜV SÜD is a Technical Inspection Association which provides inspection and product certification services, generating €2.4B in revenue (2017). TÜV SÜD will be supporting the Challenge through its Real Estate and Infrastructure division, which supports customers with planning, construction, operations and acquisition, as well as sales of properties.
- **Liebherr:** Liebherr is a large equipment manufacturer (revenue: €9.8bn in 2017). Liebherr will provide requirements from the equipment manufacturer perspective, as well as test equipment for field trials.

3. Technology Partners

- **Autodesk:** Autodesk is a leading supplier of IT solutions for Building Information Model (BIM) management.
- **HERE:** HERE is the global leading location-based services platform which includes (indoor) map, positioning and tracking technologies to bring the location and (dynamic) location context.
- **Ottobock:** Ottobock is an enabling technology sponsor, providing the Smart Worker Exoskeleton.
- **Qtum:** Qtum is a platform designed to simplify the use of smart contracts for inter-business and institutional operations

4. Start-Ups and Solution Providers

- The main goal of the Smart Construction Challenge is to bring together start-ups and other solution providers who will work alone or in small groups to provide solution proposals, Proof of Concepts and eventually pilot implementations to fulfill the requirements outlined by the Challenge, as described below.

How the Challenge is Set Up

The Set Up of the challenge is described in Figure 1 below. It depicts the roles of the Organizers, Construction Industry Partners, Technology Partners, Start-Ups and Solution Providers.

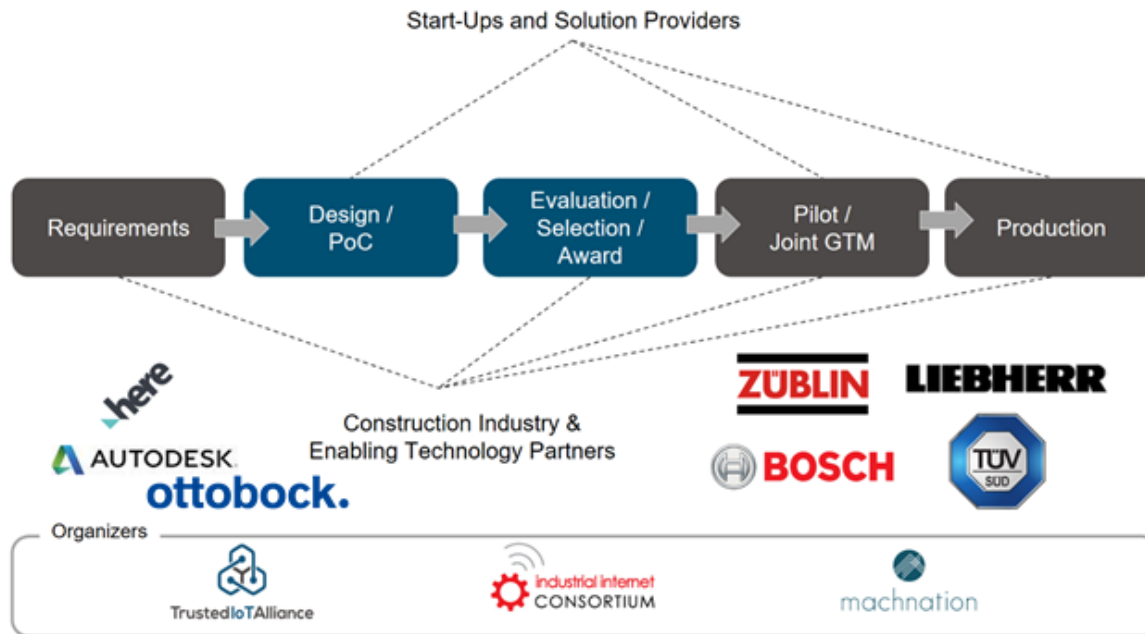


Figure 1: Set up of the Challenge

The Construction Industry Partners provide the requirements and Use Case definitions for the Smart Construction Challenge. They engage with Start-Ups and Solution providers to provide early feedback and guidance. They also provide executives to participate in the jury. They will provide foundational technologies and test installation and real-world test data, which can be included in the Challenge entries. After the awards, the Construction Industry Partners will work with the winners to implement their solutions in real-world pilots.

The Start-Ups and Solution providers make concrete technical and business model solution proposals available in response to the requirements. They can also provide high-level POCs to help with early technical validation as input for the benchmarks provided by MachNation and the jury members to help them with their evaluation. The winning teams will then work closely with the Construction Industry Partners to implement the pilot projects.

The Supporters are responsible for managing the entire lifecycle of the Challenge, including partner and requirements acquisition, marketing of the challenge, acquisition of start-ups and solution providers, set-up and coordination of awards ceremony (including jury), and the marketing of the Challenge results, including benchmark reports.

Awards

The Challenge and the winning solutions will be summarized in a MachNation report that will include benchmarking of different solution proposals. The Smart Construction Challenge is designed to include all implementation lifecycle phases from PoC to Pilot and joint Go-to-Market activities. The Construction Industry Partners will make pilot projects available and will provide at least one construction site for field trials.

Note: These commitments assume that sufficiently attractive proposals will be submitted by the winning teams, that will not only convince the jury, but also the other required customer stakeholders. This is something that cannot be guaranteed before the final results are out, so all parties have committed to make the best effort. The same applies to the Go-to-Market phase.

The awards will include a total monetary reward of €75.000. This money should be used by the winners to fund the pilot projects (i.e. €25.000 per winner/use case). The winners will be admitted into the Open Bosch partner program for startups and presented with Proof-of-Concept opportunities. The award ceremony will take place at Bosch Connected World in Berlin on May 15th, 2019.

The jury will include:

- Züblin: Dr. Klotz, member of the board
- Bosch: T. Spiegel, VP Corporate Real Estate Realization
- TÜV: J. Birnthaler, CEO of TÜV Real Estate and Infrastructure
- Liebherr: Dr. Sieber, Head of Business Development Services
- Representatives from MachNation, TIOTA and IIC.

The Challenge

An overview of the key use cases and the general setting of the challenge is provided in Figure 2 below.

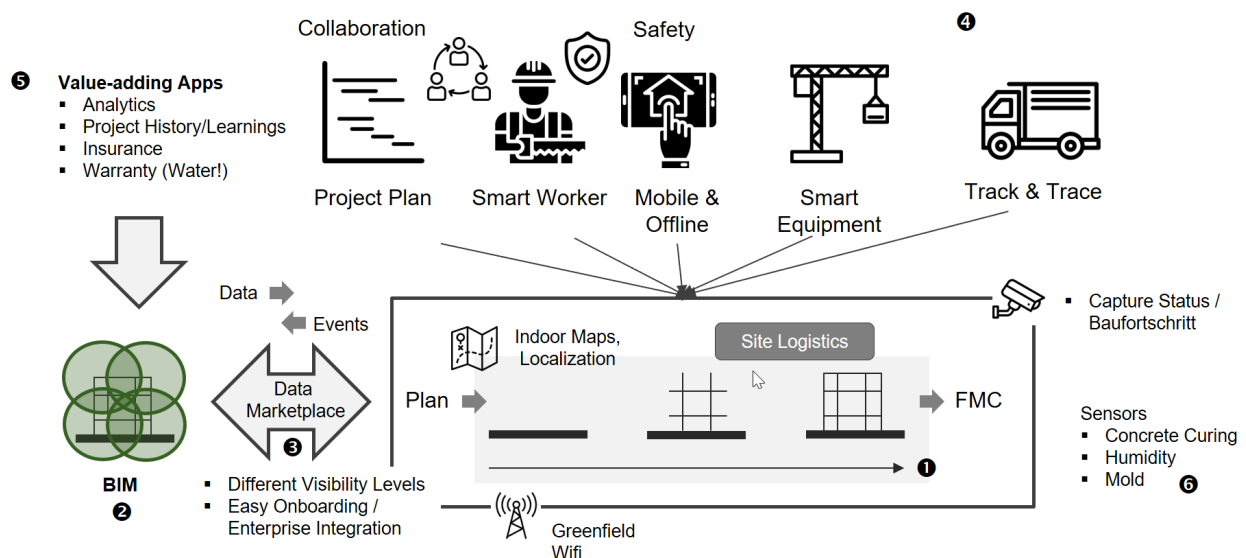


Figure 2: Overview

The Smart Construction Challenge looks at the complete property lifecycle, from the initial planning to the operation by a Facility Management Company (FMC). A key assumption is that the construction site will evolve over time, from an empty site toward a final and complete building, as depicted by 1.

This imposes many challenges for any technical solution, starting with basics such as providing Wi-Fi/networking infrastructure on the green field that can evolve with the building structure. Automatic

monitoring of the construction progress is another key deliverable, where IoT can potentially play an important role.

The Challenge is working under the assumption that BIM (Building Information Modeling) is used as the foundation for planning, construction and operations, providing a digital representation of the physical and functional characteristics of the building. The different circular shapes over the digital model of the building as depicted by ② symbolize the need to make different subsets of the BIM model data available to different stakeholders at different times – as well as allowing them to write back data to update the BIM model.

This includes data, which could be generated by IoT, e.g. for construction progress monitoring, etc. One goal of the Challenge is to examine the extent to which DLTs would be suitable to support a de-centralized approach to managing BIM data. This would require some kind of de-centralized data market place or similar mechanism (③), which could help making BIM data selectively available, as well as writing events back to the BIM model.

This mechanism will have to ensure that different visibility levels for the BIM data can be ensured. Furthermore, it is important that the means of onboarding new partners are simple. In particular, they should not require the use of complicated and advanced APIs and data structures. They should fit in well with MS Excel-like data transfer mechanisms and with typical enterprise IT environments, including corporate firewalls and VPNs.

As depicted by ④, a number of interesting use cases can be built on this core infrastructure. They include:

- *Collaboration*: Efficient collaboration between all construction stakeholders is essential, leveraging BIM data as the foundation. Elements of the agile planning processes, such as SCRUM, are now also becoming popular in construction. Mobile and offline data access is a key prerequisite.
- *Safety*: Ensuring worker safety is an important use cases in many countries around the world. IoT has the potential to dramatically improve worker safety through innovative use of sensors.
- *Smart Workers and Smart Equipment*: Using IoT and related technologies to make workers and equipment smarter is another very interesting Use Case. Examples include use of Smart Helmets with IoT sensors, or Smart Goggles, e.g. with Augmented Reality.
- *Track and Trace*: Managing the flow of materials and equipment on a constantly evolving construction site with stakeholders from many different companies is essential for any lean construction project.

We believe that these use cases must be supported by the concept of smart, value-adding apps for the construction industry, which make use of the basic infrastructure (including the BIM “data market place”, ②/③), as well as the IoT sensor data (⑥). Examples of such apps include:

- Analytics apps, in particular analytics for the project history, which can be used to generalize learnings from previous projects and apply them to new projects (e.g. for planning purposes)
- Construction warranty and insurance. Being able to use advanced sensor data – in combination with forgery-proof data management – has a potentially huge impact on Use Cases in this area.

Figure 3 shows the top priorities that have been identified for the Smart Construction Challenge:

- The foundation should be a de-centralized market place/data hub, which can be used by different stakeholders according the requirements outlined above (③).
- Based on the feedback from the involved construction experts, three use cases have been prioritized: Construction Assurance, Track and Trace for Onsite Logistics, and Smart Worker Equipment.

Challenge Use Cases

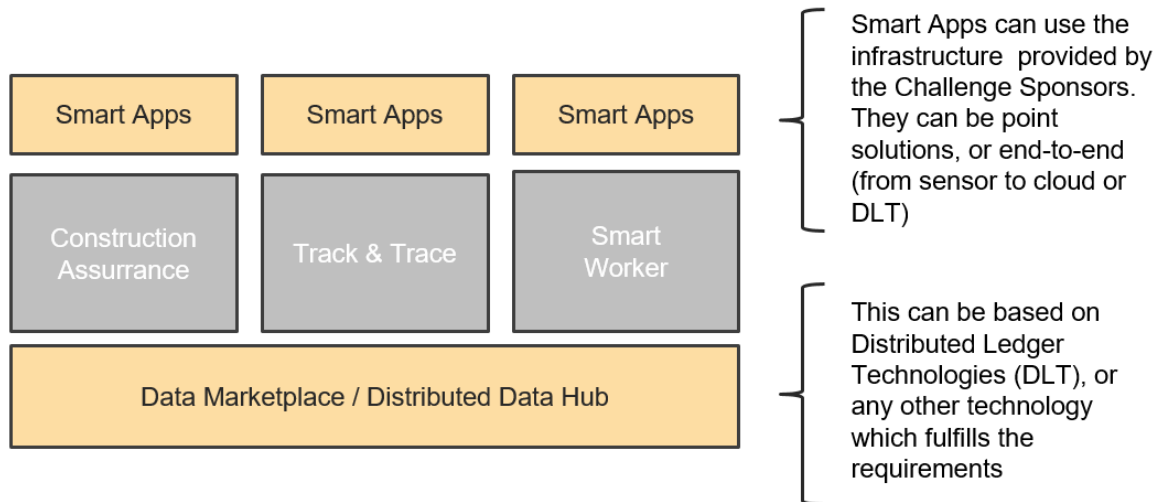


Figure 3: Use Cases

We are assuming that many interested applicants will team up to provide solution proposals, which combine IoT technologies as well as DLT.

Use Case 1: Construction Assurance

One of the main concerns of construction acceptance and assurance is water damage, as well as resulting consequences, such as mold. This includes water entry through the roof, basement, or any other entry point. Consequently, the first Use Case of the Smart Construction Challenge is centered on this topic. We are asking applicants to submit entries based on the following assumptions:

- Construction assurance will cover digital monitoring scenarios across all construction stages from planning, construction and operation.
- Concept development will consider the planning phase, on-site construction phase, and operational phase of a building.
- The entry will make use of existing building data infrastructure systems (i.e. GLT/BMS) to collect and transmit harmonized selected building parameters into a safe and secure environment for later expert evaluation.
- The entry will involve and integrate sensor technology or other technologies (sensor grid, visual detection methods) into the existing building management system to avoid water/mold damage. It will include alarm limits for efficient upfront counter-measures.
- The entry will include a standalone sensor network solution for water detection. Transmission and storage should be part of the entry, including financial calculations.

- The entry will establish a concept for safe and secure data transmission (cyber security), storage, evaluation and dashboard visualization, including the best possible digital reporting (on-site and off-site).
- Buildings will include a minimum 200-square-meter area for commercial buildings. (e.g. shopping mall, office building, manufacturing facility).
- Flat roofs will be considered a more common and more challenging requirement for facility façades and basements.
- The entry must include 7 years of coverage after the initial acceptance of construction work.
- The Total Cost of Ownership (TCO) that must be met by each entry is €1.000 or below per property.
- Likewise, the TCO for the water/mold monitoring solution must include hardware/sensors, software (licenses and subscriptions), installation (on-site), as well as operations and support for 7 years.

If additional assumptions are made, please document them in your submission. Some examples might include:

- Standard protocols to be used for later evaluation of data.
- Hardware and infrastructure needed during the construction phase to collect and transmit data.
- Number of sensors per square meter, or equivalent technologies required for positioning in the building.
- Details of TCO calculations.
- Minimal required number of total deployments required to meet per-property target TCO,

We recommend that you do not limit your focus to the user-related aspects of the building; also focus on the planning, construction, and operational phases, through the integration of sensors in the network.

Use Case 2: Track and Trace for Onsite Logistics

Efficiently managing the flow of materials and equipment in construction is essential for any lean construction project. However, there are many challenges, including:

- Providing the required network infrastructure in a way that grows and evolves with the construction site, starting with a green field environment (i.e. the empty site)
- The fact that the construction site is constantly evolving is a challenge both for the tracking technology and the map data (indoor and outdoor maps).
- Integrating products and stakeholders from many different companies, for data collection as well as data distribution.

The entries in this Use Case should combine indoor and outdoor tracking. Particularly, it should ensure that required materials and equipment are made available in the required areas at the required time.

The Track and Trace Use Case will support two scenarios:

1. Indoor tracking and navigation, with a focus on the continuously evolving building site
2. Outdoor tracking, with a focus on tracking of heavy equipment and machines.

Some potential concrete examples within Onsite Logistics include:

- Track and Trace for construction materials
- Construction elevators, including cameras for congestion analysis and avoidance of bottlenecks
- Any idea that enhances onsite logistics.

These aspects can be combined and connected in a seamless information stream to enable a broader view of where is the material located, when it has been delivered, when it will be moved around on the construction site, and when it will be installed.

Entries should make and document assumptions regarding the management of the evolution of the construction site and the corresponding map data. Planning data from the BIM model should be matched with IoT data from construction progress monitoring.

Use Case 3: Smart Worker Equipment

Advancements in technology have the potential to benefit construction workers and companies in many ways:

- Smart Hard Hats and Safety Vests equipped with sensors can help improve safety.
- Smart Glasses and Augmented Reality can help improve efficiency and ensure adherence to standard construction procedures (and in turn, help improve safety)
- Wearables such as smart watches and wristbands can support construction processes and collaboration
- Bionic Exoskeleton Suits can aid construction workers in lifting heavy loads, reducing the risk of injuries from muscle strain
- Enhancing the interaction between smart workers and heavy equipment and machines

This Use Case is the most open in terms of requirements. The organizers are specifically looking for proposals which combine existing innovations in worker equipment and tools with the broader picture outlined in Figure 2, and can ensure high quality production and safety onsite.

For example, an entry might look at how existing smart equipment for construction workers can integrate with a BIM-based open infrastructure to support construction efficiency or safety. We are open to any proposal in this area, and will focus the evaluation on how the proposal combines existing innovations in construction worker equipment with new ways of integrating them into the broader data and process context.

Equipment and Infrastructure Provided by Challenge Sponsors

The Smart Construction Challenge sponsors will make the following products available as foundational services. These products can be used free of charge by contestants for building value-added solutions that support the three Use Cases outlined above. The use of these products is not mandatory for Challenge participants. They are simply offered to avoid having to start from scratch, allowing the focus of the Challenge to be on business value creation.

Product	Description
AutoDesk FORGE	FORGE provides web-based model viewers (2D and 3D), the BIM 360 API and data management APIs. A complete BIM example will be provided in the test system, which

	can be used to simulate real-world access to BIM data required by the three Use Cases in the Smart Construction Challenge.
<u>Bosch</u>	<p>Bosch products and services are designed to spark enthusiasm, improve quality of life, and help conserve natural resources. We want to deliver top quality and reliability. In short: we want to create technology that is “invented for life.” For the Smart Construction Challenge, Bosch is providing the following:</p> <ul style="list-style-type: none"> • RefineMySite provides a platform to support construction project flow planning. It includes all the particular knowledge of all crafts in an aligned schedule, so all participants can access their information from everywhere. It includes the planning aspect as well as the communication during the execution of the task directly from the site among all team members. • <u>TRACI</u> is an innovative connectivity solution that localizes and seamlessly monitors vehicles, machines, accessories and special equipment (referred to as “asset tracing”). This makes it possible to optimize processes and reduce downtimes • <u>Nexeed Track and Trace</u> provides real time tracking data (based on BLE-tags and Gateways) with context information (IDs, barcodes, etc.) for assets, such as power tools, for a clever and smart Industrial Area tracking of the future. This makes it possible to depict a complete transport process. By using appropriate IoT devices, data is acquired about each packaged unit, and their position and their condition in transit are tracked.
<u>HERE 360 Indoor Maps and Indoor Positioning</u>	HERE is the global leading location-based services platform, which includes (indoor) map, positioning and tracking technologies to bring the location and (dynamic) location context. HERE 360 Indoor Maps provide accurate indoor maps for all common mobile devices. HERE Indoor Positioning seamlessly utilizes Bluetooth and Wi-Fi to boost accuracy and reliability. The HERE Mobile SDK integrates easily into your existing Android and iOS applications allowing you to add wayfinding, proximity detection, indoor geocoding and other complex features quickly.
<u>Ottobock</u>	Ottobock HealthCare is a leading global supplier of innovative solutions for people with limited mobility. For the Challenge, Ottobock is contributing the Exoskeleton for Smart Workers, a mechanical exoskeleton that makes manual labor for factory workers easier.
<u>Qtum</u>	Qtum offers blockchain-enabled smart contracts that employ proof-of-stake validation for transactions, promising significant performance advantages.

