Imagine IoT Prototype Challenge
Construction Equipment Management in the Age of IoT

Summary
Telematics is the most common use case of IoT (Internet of Things) in the construction industry. Built-in telematics systems have become a standard for heavy construction machines. There are many benefits of construction equipment telematics such as improved asset allocation and optimized maintenance processes.

Story
Let’s consider a construction group offering the full range of construction services: building construction, engineering services, civil engineering and road construction. Within the construction group there is a business unit responsible for the equipment management of the group. This business unit provides construction equipment “as a service” to the group’s construction companies. When a certain type of equipment is needed on the construction site, an equipment request is directed to the equipment managers a couple of days before the machine is needed on-site. If appropriate construction equipment is available for the requested period, a machine that meets the requirements is assigned to the construction site. Otherwise, the equipment manager tries to find third-party rental equipment. In any case, the construction site managers do not have to bother about the availability of the construction equipment needed on site. It is the equipment managers’ task to ensure that first-class equipment is available on-site, meeting the high standards of security, ecology and energy-efficiency.

According to Elvira Wallis (SVP, IoT Smart Connected Business SAP), customers interested in IoT are approaching the topic from a business model angle [1]. They want to improve their business model efficiency or they want to transform their business to a “products as a service” model. We will focus on the first aspect of improving an existing business model. IoT is not only about connecting devices but also about streamlining collaboration between individuals and companies. Consider for example a bulldozer sending maintenance alerts to the operator, the equipment manager and a service technician. Given that a service agreement between the owner of the machine and the service provider has been concluded, the maintenance task can be scheduled automatically.

Developing an IoT prototype via design thinking
Design thinking is a methodology used to solve complex problems and create innovation [2]. The first step in the design thinking process is the “Empathize” step: Identify the persons involved in the business process and try to understand their needs.

| Construction site manager | First-class equipment should be available on site when needed. We are faced with a very tight timeline, equipment downtimes should not occur. Energy efficient machines help us to reduce fuel costs and to stay within budget. |
Machine operator | I really have a physically demanding job; I have to work in all weather. My machines should be properly maintained and in compliance with the highest safety and security standards. Machines are becoming more complex. In case of an alert, I would like to have detailed assistance. Instead of reading manuals, I would prefer to watch a short video on my smartphone.

Equipment manager | For me it is essential to have real-time information about the assets: their location, performance and status. Are they used properly, are there any alerts? Do I have to call a service mechanic to avoid downtime on the construction site?

Billing administrator | Thanks to IoT, we do no longer have to collect and enter the operating hours manually before settlement. Having all the machine data at our disposal, we can define more flexible pricing plans.

Executive | The machine data support our decision-making process. It is possible to make informed investment decisions based on idle times, fuel consumption and maintenance costs.

Licensed service mechanic | Telematics alerts help us to catch a problem ahead of time.

Persona
Freddy, an experienced equipment manager plays a central role in the process described above. He works with the construction site managers, foremen, machine operators, mechanics and executives.

Responsibilities: When an equipment request of a construction site manager comes in, the equipment manager checks whether there is an appropriate machine on the yard. The machine will then be reserved for the construction site. Machines in high demand may be in use on-site when the request comes in. The equipment manager then tries to find an appropriate machine on nearby construction sites which will no longer be in use when needed on the new construction site. The equipment manager is also responsible for transport handling and scheduling of maintenance tasks.

Main goals: ensure that first-class equipment is available on-site when needed.

Needs: the equipment manager needs an equipment management tool for all types of machines. All relevant information, both real-time machine data and equipment data from the ERP system (e.g. SAP on premise) should be available.

Pain points: Every construction equipment manufacturer has its own platform for telematics. Most construction companies use machines from different manufacturers, so the equipment manager has to switch between different systems.

Point of View:
“I want to know everything about the machines, where they are, how they are used and whether there are critical issues”.
## The UX Journey

<table>
<thead>
<tr>
<th>Actions</th>
<th>Mindset</th>
<th>Feeling</th>
<th>Touchpoints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freddy receives a new equipment request. A mid-size crawler excavator</td>
<td>These crawler excavators are in high demand.</td>
<td>😞</td>
<td>Person: Construction site manager; E-Mail inbox; Equipment management system</td>
</tr>
<tr>
<td>(110kW) will be needed on the new construction site in Heidelberg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>starting from December 1, 2016.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Looking at the inventory list.</td>
<td>All these machines are currently in operation.</td>
<td>😞</td>
<td>Equipment management system</td>
</tr>
<tr>
<td>Let’s look at nearby construction sites. (“Geo-matching”)</td>
<td>Great. A mid-size crawler will be released on November 18 on a nearby</td>
<td>😊</td>
<td>Equipment management system</td>
</tr>
<tr>
<td>construction site.</td>
<td>construction site.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Looking at the telematics alerts.</td>
<td>Oh, there is an alert. An oil filter has to be replaced.</td>
<td>😞</td>
<td>Equipment management system or web portal</td>
</tr>
<tr>
<td>Call the master mechanic.</td>
<td>He will fix that.</td>
<td>😊</td>
<td>Master mechanic.</td>
</tr>
<tr>
<td>Assigning the crawler excavator to the new construction site.</td>
<td></td>
<td></td>
<td>Equipment management system</td>
</tr>
<tr>
<td>Schedule transport request.</td>
<td>Finished.</td>
<td>😊</td>
<td>Equipment management system</td>
</tr>
</tbody>
</table>

(Smileys from [https://de.wikipedia.org/wiki/Smiley](https://de.wikipedia.org/wiki/Smiley))

## Prototype

Many heavy construction machines are shipped with built-in telematics today. Each manufacturer has its own web portal where the equipment managers can log in and retrieve the necessary information. As many construction companies own equipment from different manufacturers, the equipment managers have to switch between the different web portals. That might be a tedious and time consuming process. There should be one equipment management portal where all relevant information is instantly accessible.

Standardization drives innovation. The International Organization for Standardization has approved a mixed-fleet telematics standard developed by the Association of Equipment Manufacturers (AEM) and the Association of Equipment Management Professionals [4]. Standardized communication protocols will make it easier to reconcile data into a single platform [5].

SAP HANA Cloud Platform (HCP) provides services to build, deploy and manage cloud-based enterprise applications. SAP HCP IoT Services allows us to manage all devices.
For demonstration purposes, we have defined a message type for AEMP Telematics using SAP HCP IoT Services:

**SAP HANA Cloud Platform Cockpit → Services**

**Internet of Things Services**
Enable customers and partners to develop, customize, and operate IoT business applications in the cloud.

(Preliminary version, see [3])

**SAPUI5** is SAP’s powerful and comprehensive UI development toolkit for HTML5. SAPUI5 is the core technology of SAP Fiori, SAP’s award-winning user experience [6]. Therefore, SAPUI5 is our framework of choice when building web applications. In our prototype we would like to illustrate the process of monitoring equipment and geo-matching. So let’s assume an excavator is needed on a new construction site located in the beautiful city of Heidelberg.
On the map above the equipment manager can see all current construction sites in the region of Heidelberg. The colors of the markers indicate whether there is an issue with equipment on-site. Below the map there is a list of all construction machines currently in use on the selected construction site.

Please note: our prototype is rather simplistic. In a real-world application we would incorporate some filters, e.g. for the equipment type (“mid-size crawler excavator”).

Here the equipment manager has found the machine he was looking for. The crawler excavator will be released before the work on the new construction site starts. There are no telematics alerts for this machine. However, there is a problem with another excavator:

(Excavator image from https://commons.wikimedia.org/wiki/File:Graafmachine-Hoornstra.jpg#/media/File:Graafmachine-Hoornstra.jpg)
From data to insight to action.  
"Information is the oil of the 21st century". “Data Scientist: The Sexiest Job of the 21st Century”.  
We have all heard these messages. In the age of IoT, devices are producing huge amounts of data [2]. How can we benefit from these data? This is where Machine Learning comes in. Automated analytics capabilities are available through SAP HCP predictive services. According to SAP, the strategy is to enable “predictive analytics everywhere for everyone” [7].

Some use cases of SAP HCPps for our scenario:

**Time Series Forecasting**: Forecasting capacity utilization based on machine hours.

**Outlier detection**: Identify cases of high fuel consumption.

**Predictive maintenance**: prevent unexpected equipment failures [8]

Links:

BUILD prototype:
[https://standard.build.me/api/projects/01439b1c29b22c5a0cd20316/prototype/snapshot/latest/index.html#/14773905841389746_S0](https://standard.build.me/api/projects/01439b1c29b22c5a0cd20316/prototype/snapshot/latest/index.html#/14773905841389746_S0)

BUILD prototype study:
[https://standard.build.me/home/projects/01439b1c29b22c5a0cd20316/research/participant/ace4f68bc76295cf0cd35dc5](https://standard.build.me/home/projects/01439b1c29b22c5a0cd20316/research/participant/ace4f68bc76295cf0cd35dc5)


Sources:

[1] Smart Connected Business: SAP Innovations in IoT:  

[2] Imagine IoT. openSAP:  
[https://open.sap.com/courses/iot2](https://open.sap.com/courses/iot2)


