Internet of Things Vs. Web of Things

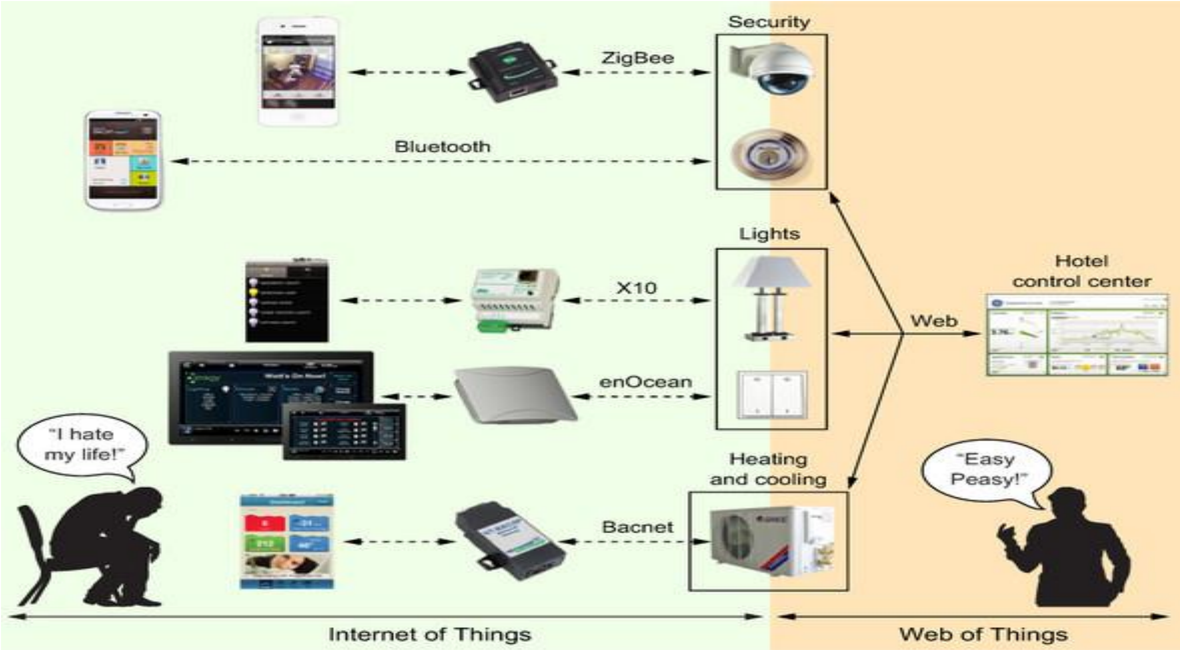
How and why the Web of Things (WoT) is different and why it's promising

If you're holding this book in your hands, it's very likely that you've already heard the terms Internet of Things (IoT) and Web of Things (WoT). Maybe you want to understand what this trend is all about. Or maybe you already understand why this topic has become so popular and you'd like to be part of it, but you're not sure where to start. Or—even further than that—you realize what the IoT could mean for your industry and you'd like to gain the hard technical skills needed to build web-connected products and services. If any of those ring true, you're in for a treat!

What is the IoT, anyway? When and where was it invented? What new types of applications and scenarios does the IoT enable? How will this change the technology and business landscape for the coming years? The next chapters will answer all these questions and many more. But don't throw away this book yet, because it won't just discuss theory. It will also cover in detail all the web technologies and tools that will help you make the Internet of Things a reality. On the other hand, we believe that starting with some background will help you better understand what the IoT really is and how you can use it in your own projects, not just stick to the superficial and stereotypical descriptions of it. Diving into the history of the IoT will help you understand the subtle difference between the Internet of Things and the Web of Things and especially why this distinction matters.

In the last few years, the Internet of Things has become one of the most promising and exciting developments in technology and business. The vision of a world where tiny computers with sensors and communication interfaces that are embedded in the infrastructure of our cities or in cars, offices, or clothes is likely to revolutionize every area of our lives—how we play, how we work and do business, and how we live. Until recently, IoT projects mostly focused on building small-scale, closed, and isolated deployments where devices were not designed to be easily accessible or reprogrammable. The bespoke coupling between devices and applications in a given use case means that any change to an existing deployment is complex and expensive. This limits both the maintenance and evolution of the Internet of Things because considerable resources (time, money, and technical skills) are required each time a new function is added.

In contrast, the web has become widely successful in the last two decades because it's simple to learn and use and it also emphasizes loose coupling between servers, browsers, and applications. The simple and clearly defined programming model of HTTP makes it possible for anyone to change pieces of the system without breaking the whole system. Therefore, building new web applications has been relatively inexpensive and accessible to a much larger group of technology enthusiasts.



The Web of Things is a specialization of the Internet of Things that uses what made the web so successful and applies it to embedded devices in order to make the latest developments in the Internet of Things accessible to as many developers as possible. On the Web of Things—just like on the web—anyone with a text editor and the basic understanding of web standards (HTML and HTTP) can quickly start connecting devices and objects to the web. But it also enables going to the next level and helps you to effectively build interactive and innovative real-world applications that blend the physical and digital worlds.

1.1. Defining the Internet of Things

Capturing the essence of the Internet of Things in one sentence is nearly impossible. The concepts have been around for decades and there are no clear boundaries to what the IoT is or isn't. Nevertheless, the broad definition of the Internet of Things vision is a world where the internet is much more than the collection of multimedia content it is today: it extends into the physical, real-time world using a myriad of small or even tiny computers. In short, the simplest definition we can offer for the Internet of Things is the following.

DEFINITION

The Internet of Things is a system of physical objects that can be discovered, monitored, controlled, or interacted with by electronic devices that communicate over various networking interfaces and eventually can be connected to the wider internet.

Two decades ago, a world where everyday objects could feel the world through sensors and then analyze, store, or exchange information existed only in science-fiction novels or in the Jetsons. Today, such scenarios are increasingly becoming reality, thanks to the colossal progress in embedded devices that brought into the world a new class of objects: smart things. A smart thing (which we'll refer to as a Thing—with a capital T—in the rest of this book) is a physical object that's digitally augmented with one or more of the following:

Sensors (temperature, light, motion, and so on)

Actuators (displays, sound, motors, and so on)

Computation (can run programs and logic)

Communication interfaces (wired or wireless)

Things extend the world we live in by enabling a whole new range of applications; see figure 1.1. By deploying a bunch of tiny and cheap—yet increasingly powerful—computers everywhere around us, it becomes possible to monitor and interact with the physical world with a much finer spatial and temporal resolution than ever before.

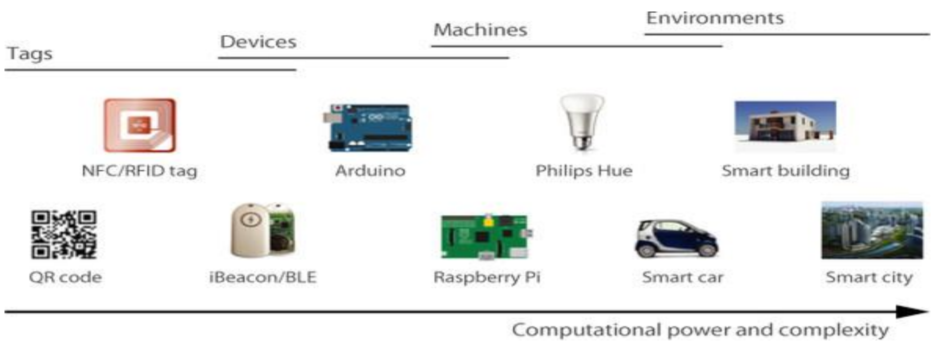


Figure 1.1. The Internet of Things landscape. The IoT is a network of Things, which are anything that can be connected in some form to the internet. From a box of oranges with an RFID tag, to a smart city, to every Thing in between, all digitally augmented objects make up the Internet of Things.

Concretely, the Things in the Internet of Things can range from simple tagged products such as your FedEx package with an Auto-ID tag (Automatic Identification methods such as bar codes, QR codes, and NFC and RFID tags) attached to it so it can be tracked from the shipping center to your door; to more elaborate, complex, and wirelessly connected products, devices, or machines such as security systems, your car, or a factory assembly line; and all the way up to a building or even a city. The internet part of the term means that the Thing (or at least its services or data about/from it) can be accessed and processed by other applications through the existing internet infrastructure. Note that this does not imply that the Thing itself must be directly connected to the internet. The communication network used can be an Auto-ID method, short-range radio (Bluetooth, ZigBee, and the like), or the Wi-Fi network in a building.

Unfortunately, building a single and global ecosystem of Things that communicate with each other seamlessly is virtually impossible today. There’s no unique and universal application protocol for the Internet of Things that can work across the many networking interfaces available today. To put it bluntly, the Internet of Things of today is essentially a growing collection of isolated Intranets of Things that can’t be connected to each other.

For the Internet of Things to become real, we need a single universal application layer protocol (think language) for devices and applications to talk to each other, regardless of how they’re physically connected. Rather than inventing yet another protocol from scratch (as many IoT projects have been—and keep—doing), why not reuse something that's already widely used to build scalable and interactive applications, such as the web itself? This is what the Web of Things (and this book) is all about: using and reusing readily available and widely popular web protocols, standards, and blueprints to make data and services offered by Things more accessible to a larger pool of (web) developers.

What is Web Architecture?

Web architecture refers to the overall structure of a website or web application, including the way it is designed, implemented, and deployed. It involves the use of technologies and protocols such as HTML, CSS, JavaScript, and HTTP to build and deliver web pages and applications to users.

Web architecture consists of several components, including the client, the server, the network, and the database. The client is the web browser or application that the user interacts with, and the server is the computer or group of computers that host the website or web application. The network is the infrastructure that connects the client and the server, such as the internet. The database is a collection of data that is used to store and retrieve information for the website or web application.

Web architecture also includes the design and layout of the website or web application, as well as the way it is organized and the relationships between different pages and components. It also includes the way the website or web application is built and maintained, including the use of frameworks and libraries, and the deployment and hosting of the website or web application.

Web Architecture Components

There are several components that make up a web architecture −

The client −This is the web browser or application that the user interacts with. The client sends requests to the server and receives responses from the server.

The server −This is the computer or group of computers that host the website or web application. The server processes requests from the client and sends back the appropriate response.

The network This is the infrastructure that connects the client and the server, such as the internet. It allows for communication between the client and the server.

The database −This is a collection of data that is used to store and retrieve information for the website or web application. The database can be located on the same server as the website or web application, or it can be hosted on a separate server.

The design and layout –This refers to the way the website or web application is structured and organized, including the layout, navigation, and overall appearance.

The frameworks and libraries − These are tools and resources that are used to build and maintain the website or web application. They can include frameworks like Ruby on Rails or Django, or libraries like jQuery or React.

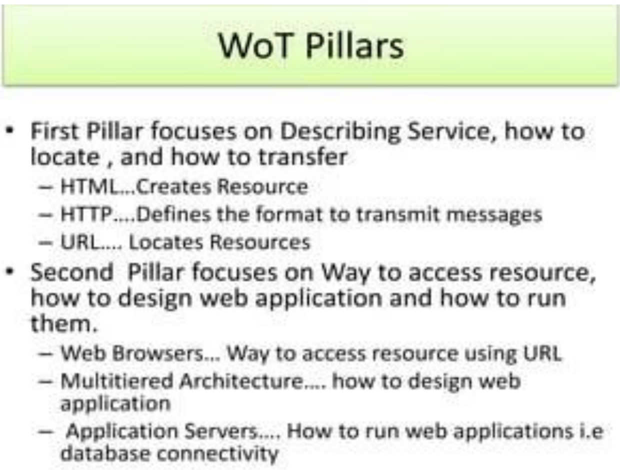
The deployment and hosting − This refers to the way the website or web application is deployed and hosted, including the hosting environment (such as a shared hosting plan or a cloud platform) and the process for deploying updates and changes to the website or web application.

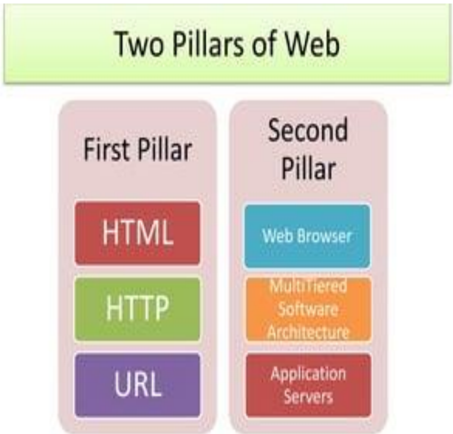
Why is Web Architecture Important?

Web architecture is important because it plays a crucial role in the performance, scalability, and maintenance of a website or web application.

A well-designed web architecture can improve the user experience by ensuring that the website or web application loads quickly and reliably. It can also make the website or web application easier to maintain, as it provides a clear structure and organization that makes it easier to find and modify different components.

Web architecture is also important for scalability, as it determines the website or web application's ability to handle increasing traffic and usage without experiencing performance issues. A scalable web architecture can support growth and handle changes in traffic patterns without requiring major changes to the system.



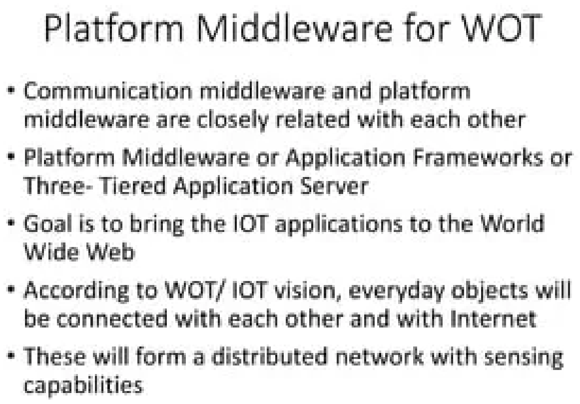


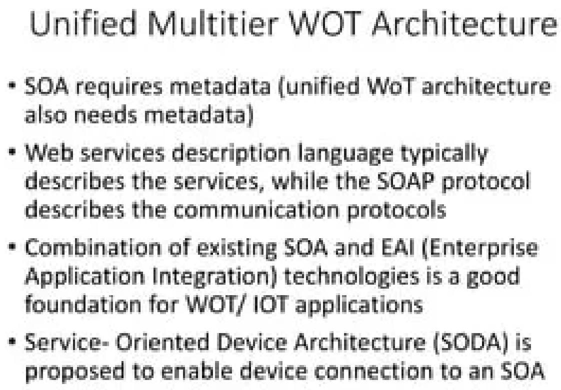
Architecture Standardization for WoT

Platform Middleware for WoT

Current markets of the Internet of Things (IoT) and Web of Things (WoT) are highly fragmented. Various vertical WoT/IoT solutions have been designed independently and separately for different applications, which inevitably impacts or even impedes large-scale WoT deployment. A unified, horizontal, standards-based platform is the key to consolidate the fragmentation.

We talked about communication middleware for IoT . Communication middleware and platform middleware are closely related to and sometimes tightly integrated with each other. However, there are differences between them. We will talk about platform middleware (also called application frameworks, ...





What Is Business Intelligence?

Business intelligence (BI) is using and analyzing data to provide historical, current, and predictive views of how the business operates or could operate.

BI often gives people the ability to create reports, view and analyze analytics, and mine data. Companies frequently use both internal and external data to make decisions about things like pricing, product position, and strategic planning. Having easy access to data and the ability to create reports with specific data sets can lead to better operational planning.

Data intelligence is an evolving field. At one point, only management and business analysts used business intelligence for companies they contracted with. Today, companies themselves are using it.

“Data is everything,” says Mark Hensley, Marketing Operations Manager at Liferay, a software manufacturer. Liferay’s products allow companies to create digital experiences on web, mobile, and connected devices. “BI has come a long way. It used to be highly focused on showing the now, why, and what. Today, it is more progressive and predictive, in that it can tell you, ‘If we do this, here’s what you can expect,’” he explains.

What Is a Business Intelligence Portal?

A *business intelligence portal* is a tool that you can use to store all of a company’s data so that those who need to access to it can and will be able to use the data in any way necessary. A BI portal is basically a centralized repository for data analyzing and reporting tools. The portals are often web-based and give people a way to visualize data and spot trends in a format that’s far easier to view and leverage than the original data.

“[A business intelligence portal] is an interactive portal that connects all of your data content. You don’t always have time to find all of the information you need,” says Zoe Hagfeldt, Marketing and Account Manager for Metric Insights, a data portal company based in San Francisco. “[BI portals] give you all your metrics in a single portal.”

Business intelligence utilizes several different kinds of data:

- **Enterprise Data**: This is data people in an organization share, usually across departments or locations.

- **Structured Data**: This kind of data is highly organized, usually in a database or spreadsheet. It is easily searchable and predictable. The data fields can be related to other data fields with the same structure. Structured data is easy to upload, extract, load, store, query, and analyze.
- **Semi-Structured Data**: This data is somewhat organized and contains tags or markers to separate elements, but does not conform to data models in typical relational databases. It is more difficult to search.
- **Unstructured Data**: This type of data contains items that are not organized and stored in predictable columns or rows. It can include emails, documents, presentations, PDFs, images, and videos.

Industrial IoT Application:

Industrial IoT is defined as a **network of devices, machinery and sensors connected** to each other and to the Internet, with the purpose of collecting data and analyze it to apply this information in continuous process improvement. There are many Industrial IOT applications out there, and they have driven an increasing number of companies to engage in this new paradigm to improve their productivity and optimize their expenses and profits.

This is a market that is constantly expanding – one that major players have already adopted. Even though studies show different figures when it comes to accurate predictions of the market value of IIoT in the upcoming years, the most important reports agree that investment will increase threefold at the very least.

To have access to this competitive advantage, one would be wise to know the main IIoT applications and how to implement the system.

The main Industrial IOT applications

Studies published by Deloitte show the importance given by the business world to generating IoT environments: in its 'Industry 4.0' report, 94% of the survey participants stated that digital transformation is an **essential strategic objective** for the organization.

While this is a **global trend**, in the case of the industrial sector, businesses need to be aware of the usefulness of Industrial IOT applications to generate processes that remain relevant in the upcoming years.

Automated and remote equipment management and monitoring

One of the main IIoT applications is related to the automated management of equipment, allowing a centralized system to control and monitor all company processes.

This ability to **remotely control** equipment via digital machines and software also implies that it is possible to control several plants located at different geographic locations.

This gives companies an unprecedented ability to oversee advances in their production in real time, while also being able to analyze historical data that they obtain in relation to their processes. The objective of collecting and using that data is to support the improvement of processes and generating an environment where **information-based decisions** are a priority.

Predictive maintenance

Predictive maintenance consists of detecting the need for a machine to be **maintained before a crisis** takes place and production needs to be stopped urgently. It is therefore among the reasons to implement a data acquisition, analysis and management system.

This system is one of the most effective Industrial IOT applications and works via sensors that, once installed on the machines and operating platforms, can **send alerts** when certain risk factors emerge. For example, the sensors that monitor robots or machines submit data to the platforms, which analyze the data received in real time and apply advanced algorithms that can issue warnings regarding high temperatures or vibrations that exceed normal parameters.

Faster implementation of improvements

IIoT generates valuable information so that those in charge of improving processes in an **industrial business model** (process, quality or manufacturing engineers) can access data and analyze it faster and automatically, and remotely perform the necessary processes adjustments. This also increases the speed in which changes and improvements are applied in Operational Intelligence and Business Intelligence – changes that are already offering competitive advantages to a myriad of industrial businesses.

Pinpoint inventories

The use of Industrial IoT systems allows for the automated **monitoring of inventory**, certifying whether plans are followed and issuing an alert in case of deviations. It is yet another essential **Industrial IOT application** to maintain a **constant and efficient workflow**.

Quality control

Another entry among the most important **IIoT applications** is the ability to monitor the **quality** of manufactured products at any stage: from the raw materials that are used in the process, to the way in which they are transported (via smart tracking applications), to the reactions of the end customer once the product is received.

This information is vital when studying the efficiency of the company and applying the necessary changes in case **failures are detected**, with the purpose of optimizing the processes and promptly detect issues in the production chain. It has also been proven that it is essential to **prevent risks** in more delicate industries, such as pharmaceutics or food.

Supply chain optimization

Among the Industrial IoT applications aimed at achieving a higher efficiency, we can find the ability to have **real time in-transit information** regarding the status of a company's supply chain.

This allows for the detection of various hidden **opportunities for improvement** or pinpointing the issues that are hindering processes, making them inefficient or unprofitable.

Plant safety improvement

Machines that are part of IIoT can generate **real-time data** regarding the situation on the plant. Through the monitoring of equipment damages, plant air quality and the frequency of illnesses in a company, among other indicators, it is possible to **avoid hazardous scenarios** that imply a threat to the workers.

This not only boosts safety in the facility, but also **productivity and employee motivation**. In addition, economic and reputation costs that result from poor management of company safety are minimized.

Nexus Integra, the platform that provides access to IIoT applications

Choosing the right software to benefit from all the **advantages of Industrial IoT applications** is key. At **Nexus Integra** we offer a unique platform that gathers all data generated by the company. With intuitive and simple operation, this software boosts the efficiency and organization of industrial businesses.

The process of implementing Nexus Integra is simple and works in four phases that range from the first technical meetings with our experts with the purpose of setting a timeline, to the training of the personnel that will be charged with operating the application.

FUTURE FACTORY AND INDUSTRY AND TECHNOLOGIES

Industry 4.0 is the fourth industrial revolution, which is transforming production and manufacturing processes with the help of cutting-edge technologies. This includes using cyber-physical systems, the Internet of Things (IoT), artificial intelligence (AI), blockchain, and cloud computing, among other cutting-edge technologies. This new technology is driving an unprecedented level of efficiency and productivity in the production process, and the buzzword "Future Factory" is a term that has emerged to describe this revolution.

At its core, the Future Factory is designed to revolutionise how products are designed, produced, and delivered to customers. The idea is to use computers, sensors, and algorithms to become more efficient and flexible in production. This will require deeper integration of machines into the production process and the increased use of Automation and AI to make decisions with greater accuracy and speed.

The use of cyber-physical systems gives manufacturers the ability to quickly and efficiently monitor and control the production process. By connecting the machines in the factory to the internet, manufacturers can monitor the process in real time and make adjustments as needed. Furthermore, the use of AI and machine learning can be used to identify potential problems or inefficiencies in the production process and take corrective actions.

The Internet of Things (IoT) provides a platform for connecting machines, devices, and systems for collecting data. This data can be used to improve production processes and make more accurate decisions. For example, sensor data can be used to identify when a machine needs maintenance or replace faulty parts. Furthermore, predictive analytics can be used to predict future trends and optimise production outputs.

Blockchain technology also has the potential to revolutionise the production process. By enabling the secure and decentralised storage and transfer of data, blockchain can help guarantee the integrity of each transaction throughout the supply chain. Additionally, blockchain can be used to verify the identity of contractors and suppliers, ensuring that only authorised people have access to the factory and its resources.

The use of cloud computing can also improve the efficiency of production processes. This technology can be used to store and analyse large amounts of data in order to identify patterns and trends. Additionally, cloud computing can be used to deploy applications and services quickly and securely, making it easier for a factory to scale up operations and speed up production.

Learn more about **RTLS tags and factory efficiency**.

ROBOTICS AND AUTOMATION

Robotics and automation have become key components of Industry 4.0 and the future factory. Automation of production processes is a significant element of the Industry 4.0 shift to the future factory. Automation of the factory processes can save time and money, improve production precision and reduce environmental impact. With automation, production systems can be designed to detect and correct issues in production processes quickly. This helps to reduce delays, minimise waste and increase the overall efficiency of production processes. By including robotics, the future factory can optimise production processes and increase the speed of production. Robotics can be used to automate tedious and repetitive tasks that could be dangerous for humans to complete – thus ensuring the safety of workers. Robotics can also be used to simplify and streamline the production process. This helps to reduce the cost of production and increase the overall productivity of the factory.

FUTURE FACTORY: IMPLEMENT INDUSTRY 4.0 AT LOW-COST

We described the technologies and concepts of industry 4.0 in a nutshell. As this is the theory and ideal scenario, what about the reality of today's factories such as **brownfield operations**?

Tobias Herwig: Paperless has been a goal in the factory for some time. But I find it exciting that barcode scanners also cause a problem. Why it became a problem?

Urban Siller: The scan of a barcode links logically the process with the physical process, so for example, you should somehow bring material to a production island, and then the expectation is that you now carry out the scan, so that, for example, your material flow system, production planning system, really knows that the material is there now and I can take the next step. So when I forget the scan because I've already done the physical job, the process goes no further. So then the machine stops, the production stops, and then I don't manage the output on the day I planned.

Tobias Herwig: Yes, that's a big problem. You just said the scanners are an attempt or a good way to link the real world with the digital world and close this gap, which in practice, is simply there. What other options exist for doing this because that is a significant point, especially with manual processes?

Urban Siller: So ideally, you find a solution to do it so that the employee does his job. For example, "Go to a location and get a certain material there." And now you can, of course, say yes, the employee should now be in an area that you can maybe somehow narrow down a bit because maybe someone scanned it beforehand, and you say, please get the material from the area, but in fact, he has to look for it now. He might need different materials now.

Tobias Herwig: Yes, in the best case, knows precisely which shelf or which position, but...

Urban Siller: If you see shelves in front of you, I'm with you, then it might be even better, although one likes to fill shelves in a chaotic way, and then I must be sure that who filled the shelves did the job right. That's where the scanner often comes into play; if people forget to scan, we're as far as we were before, but I think there must be a more clever way, so you don't say the employee has an additional job here beside his normal physical work. I would suggest that the employee does his job without scanning involvement, meaning that the link to the digital world is made automatically. And you can think of that in two directions. On the one hand, you can also use localisation techniques to know where something is. This prevents searches because I can pinpoint them on digital media. But I can also go further and work with features like Pick-By-Light. Let me give you an example. An employee wants to pick up a particular material from a specific batch of perishable goods. What matters now is that you take the right material carrier with you, and you can work with a pick-by-light system that assists you, for example, on a tablet. It will then light up the carrier, making it easy for everyone to select the right one. It's a very established technique on shelves, which you mentioned earlier. Amazon, for example, works with **Pick By Light**, Pick By Voice, but it's less common in such large-scale storage areas in a manufacturing company.

Tobias Herwig: Do you have a practical example that we can imagine better?

Urban Siller: Sure. A relatively large number of products are mass-produced in this way, but it is only partially automated. So imagine you make car tires or imagine you make air conditioners. These are all things that need a lot of different materials to start your production. And now you have to bring all these materials to the machine or the manufacturing cell. There are sometimes 15/20 other materials, and now you can, of course, say, why don't you use a conveyor belt? We are now looking more into areas where we have many variants, i.e., car tires are an excellent example, but also air conditioning systems. So you quickly get into constellations where you say I have to keep it flexible, I have to use one machine, one production cell, to carry out one hundred or two hundred variants and have to produce them there, and then you need these manual supply processes,

Brownfield IoT Technologies: Extending the Internet of Things to Legacy Devices

This article outlines the concepts of greenfield and brownfield and provides an overview of strategies for bringing IoT technologies to brownfield environments. After a brief look into current industry trends, the article offers a concrete solution.

How do you create value when it comes to the Internet of Things? While transitioning to Industry 4.0 is no longer simply a trend but a necessity, an ongoing concern for decision-makers is finding a solution that is actionable and feasible. And the difficulties begin with collecting data at the edge and communicating that data to the cloud.

Brownfield Vs Greenfield

The term *greenfield* was originally used in construction to designate land that has never been used and therefore, involves no need to rebuild or to demolish existing infrastructures. In software development, the term references software built from scratch, in a new environment, without the necessity to consider prior work or to integrate with other systems. Greenfield, in sum, suggests a straightforward process and infrastructural homogeneity. Also, greenfield means a relatively low entry threshold—you start with a clean slate, without the burden of past development efforts.

The Downside Of Greenfield Development

How about the downside? For one thing, greenfield products may force companies to dispose of devices that could have served them for decades. Starting with a clean slate, at times, means discarding everything that had existed so far. The compatibility issue is particularly poignant with industrial manufacturers. Here, going greenfield means those whole infrastructures will need to be replaced.

As Ben Dickson predicted in 2016, "Such efforts cause the IoT landscape to grow in many different directions at the same time, effectively becoming a fragmented hodgepodge of incompatible and non-interoperable standards and protocols." Surely enough, this does not quite sound like the IoT vision of pervasive connectivity and an ecology of unsupervised autonomously communicating devices.

Challenges To Brownfield Development

What is *brownfield*, then, and is it any better? Brownfield designates industrial or commercial property that is either underused or considered as a potential site for redevelopment. In urban planning, this is an area that has been previously built on. In software development, this is software building on heritage systems or created to work alongside already existing systems. Implementing IoT technologies in brownfield scenarios poses a similar challenge.

What are Smarts Objects in IoT

The concept of smart in IoT is used for physical objects that are active, digital, networked, can operate to some extent autonomously, reconfigurable and has local control of the resources. The smart objects need energy, data storage, etc.

A **smart object** is an object that enhances the interaction with other smart objects as well as with people also. The world of IoT is the network of interconnected heterogeneous objects (such as smart devices, smart objects, sensors, actuators, RFID, embedded computers, etc.) uniquely addressable and based on standard communication protocols.

In a day to day life, people have a lot of object with internet or wireless or wired connection. Such as:

- Smartphone
- Tablets
- TV computer

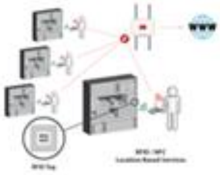
These objects can be interconnected among them and facilitate our daily life (smart home, smart cities) no matter the situation, localization, accessibility to a sensor, size, scenario or the risk of danger.

Data Collection Devices

Smart Machinery

Phones and Tablets

Home Automation



RFID Systems

Digital Signage

Security Systems

Medical Devices