Lufthansa Industry Solutions

Internet of Things

Definition: Internet of Things

“The Internet of Things (IoT) refers to connecting objects to the internet so that these objects can communicate independently via the internet and thus perform various tasks for users.” (Gabler Wirtschaftslexikon, 2019 [Dictionary of Commercial and Business Terms])

Technological

The Internet of Things covers interconnecting things with sensors, microprocessors and communication technologies to enable automatic communication and control between these things (machine-to-machine, M2M) and with human-machine-interfaces (HMI). This kind of connectivity has special requirements for the security, energy consumption, data transmission, range, and mobility of the things connected.

Industrial Internet of Things (IIoT)

The IoT specialized in the industrial sector is called the IIoT. The focus here is on industrial processes, which should become more efficient because of IIoT, while at the same time costs are reduced and new business models are made possible. Using the data that is collected and analyzed as part of IIoT, processes can be automated and abnormalities can be recognized at an early stage. Assets (things) can be tracked and new information channels can be developed to connect areas and things which couldn’t previously be interconnected.

Industry 4.0

Industry 4.0 represents the next stage of the industrial revolution. While Industries 1.0 and 2.0 were purely analog (steam engines and later, production lines), in Industry 3.0 computer systems began to enter industrial processes. Industry 4.0 is the next step: computers monitoring and controlling installations and systems can now be interconnected with one another so that they communicate, act and react automatically and intelligently with one another – without human assistance. IIoT and Industry 4.0 overlap somewhat and are therefore not easy to differentiate.

Goals of the Internet of Things

The Internet of Things has many goals. These goals go hand in hand and build on each other. The main goals are:

Connecting machines and installations to the internet
To be able to talk about the Internet of Things, things have to be interconnected: connecting machines and installations to the internet and communicating automatically form a fundamental goal of IoT.

Integration of IT and IoT systems
Isolated applications developed in the past are to be eliminated and integrated into a system landscape in a way that is sensible for users and stakeholders.

Process analysis
IoT can help make better decisions about whether processes are running correctly, whether they can be further improved, or if they're even needed anymore. Data collected as part of data analytics or artificial intelligence can be analyzed in order to evaluate the processes behind it.

Automated process monitoring and control
IoT allows processes to be monitored and controlled fully automatically. System monitoring ranges from asynchronous monitoring to near-real-time or real-time monitoring. Automated control gives process control a new dynamic. Especially for repetitive control tasks, IoT in combination with artificial intelligence can save costs.

Reduction of empty runs
Especially in logistics operations, empty runs mean undesired costs. By recording and evaluating the run information, IoT solutions can optimize route planning and avoid empty runs.

Asset tracking
Complex systems handle a multitude of physical assets. One of the goals of IoT is to precisely detect and visualize the locations and movement sequences of these assets in order to minimize search times and optimize movement sequences. Asset tracking is a helpful support tool to digitally map real things with their surroundings.

Reduction of maintenance costs: damage and mishandling detection
With IoT, users can detect damage in real-time and react accordingly. In this way, not only can maintenance jobs be generated, but the causes of damage can also be determined. Just the possibility of tracking damage can lead to a reduction in the number of cases of damage due to better handling. Data analysis and the use of AI methods allow damage to be predicted before it occurs (predictive maintenance).

What makes a good IoT application?

An integrated, end-to-end application approach
With integrated application architecture, all relevant components are included from the very beginning, and the entire process from the individual asset to the Cloud to the front-end is taken into consideration.

Integration in existing systems
One of the goals of IoT is to integrate isolated applications and analog systems into existing systems and processes. For this reason, it must be possible to integrate a good IoT application so that it does not become an isolated application too. It is only through integration in ERP and SCM systems that the added value can be ensured by IoT.

Security by design
By interconnecting things and automating processes, damage and errors can have even more far-reaching consequences. This is why a good application always takes security into account from the very beginning and makes it a central component.

Hardware security defines the physical security of the things. In particular, the use of non-certified devices and incorrect hardware may pose a significant risk for security. In line with the security-by-design principle, attention is given to the use of secure, certified hardware.

Likewise, software security also has to be guaranteed. Software on devices as well as on the Cloud or on premises must be protected against unauthorized access and information must be encrypted. Device and user authentication must be ensured. Devices must be able to be updated over-the-air so that they can be protected against future risks too. Data security in terms of GDPR must also be ensured to protect the rights of the individual concerned.

Tailored to individual use cases
A good application is tailored specifically to the use case. Each use case has individual properties, focuses and challenges that need to be addressed. Without careful consideration, an application will not fully meet the requirements of the use case and its potential will not be used to its full extent.

Scaling in all dimensions
Horizontal and vertical scaling: the Internet of Things consists of interconnecting lots of things and generating lots of data. It is constantly growing. Therefore, it is essential that the application allows scaling in all dimensions to ensure it is future-proof.

Common mistakes in IoT applications

Collecting data without a purpose
The IoT constantly delivers new data. However, this data has to actually be used, as otherwise the potential of the IoT cannot develop. Costs for Cloud services, device management and physical maintenance works can only be justified through using the generated data in a sensible way. Even data which does not seem relevant for the use case at a first glance can generate added value by opening up new use cases itself.

Wrong choice of communication technology
To communicate between devices, between a device and the Cloud, or between a device and a user, the right communication technology has to be selected in each case. Requirements such as reception, data throughput, costs and range have to be checked so that the right technologies are selected for the application. The wrong technology can result in data not reaching its goal properly and reducing the application's success.

Wrong choice of localization technology
The selection of the right localization technology is a decisive factor in its success. Accuracy, costs, and availability are constantly battling against one another and have to be correctly estimated according to the use case. If this basic requirement is not upheld, asset tracking which builds on this cannot be performed properly.

Failing to consider maintainability
If a multitude of things are interconnected, then a multitude of things have to be maintained. This is the case for both software and hardware. While software maintenance can be ensured by over-the-air updates, hardware maintenance always has to be done manually. To avoid this hassle, it's important to consider longevity. Particular attention must be given to the energy consumption of the interconnected things.

"One size fits all" approach
There is no one solution that works for everything, and anyone who goes looking for one is bound to fail. Which approach is best for which use case and which one isn't has to be taken into consideration from the very start. It's also essential to bear in mind that the application should be able to be flexibly upgraded so that it's fully equipped for the future.

Sensors, devices and localization

Sensors form the eyes and ears of the Internet of Things. They measure physical and chemical properties as well as signals in their surroundings and turn these into electrical impulses.

Microcontrollers process these signals captured by the sensors, turning them into information that can be interpreted, and then aggregate this information. In addition, they serve the purpose of controlling these sensors.

Devices consist of both sensors and microcontrollers. In the Internet of Things, they are the tools that are in direct connect with the individual thing.

Localization is the means of detecting a location in relation to a fixed point (for example on a map). There are many approaches and technological means to implement localization applications.

Here, various criteria have to be considered:

- Accuracy
- Live measuring, at time intervals, measuring frequency
- Indoor or outdoor localization
- Properties of the surroundings (hot/cold/dusty/moist)
- 2D or 3D localization
- Energy consumption
- Maintenance and installation costs
- Availability

For each use case, the right sensor or localization application has to be selected, correctly calibrated, and tested, and the data generated from it has to be processed into information. A combination of various technologies enables an application which is flexible and cost-effective for a variety of use cases and different requirement levels of accuracy.

Communication in the Internet of Things

In the Internet of Things, a multitude of things communicate with people, systems and other things. A compromise between transmission rate, range, availability, penetration, mobility and costs always has to be found. High transmission rates and volumes always mean high energy consumption and reduced range, and vice versa.

Technologies with high transmission rates and volumes

WLAN, LAN: The internet standard for end users, since it provides the best transmission rates. WLAN routers have a range of a few meters and a high energy consumption. Their mobility is limited due to their short range. A network of routers ensures better coverage but is not always economical.

GSM/LTE: Mobile communication standards provide good coverage at high data rates, moderate indoor penetration and high energy consumption. One disadvantage is that each device has to have a SIM or e-SIM card. For a large number of devices this could result in high costs, both to procure and ongoing per month. Mobility is guaranteed as long as there is a radio station in the vicinity and there is no interference in the transmission signal.

Bluetooth 5 and Bluetooth Mesh: The new Bluetooth standard has a similar range to WLAN, allows for quite high data transmission rates and is energy-saving. The range is similarly small.
A Bluetooth Mesh is a point-to-point connection between various Bluetooth devices. It sends data to the selected end point via multiple devices in between. This increases its range.

Technologies with high range and high penetration with low energy consumption

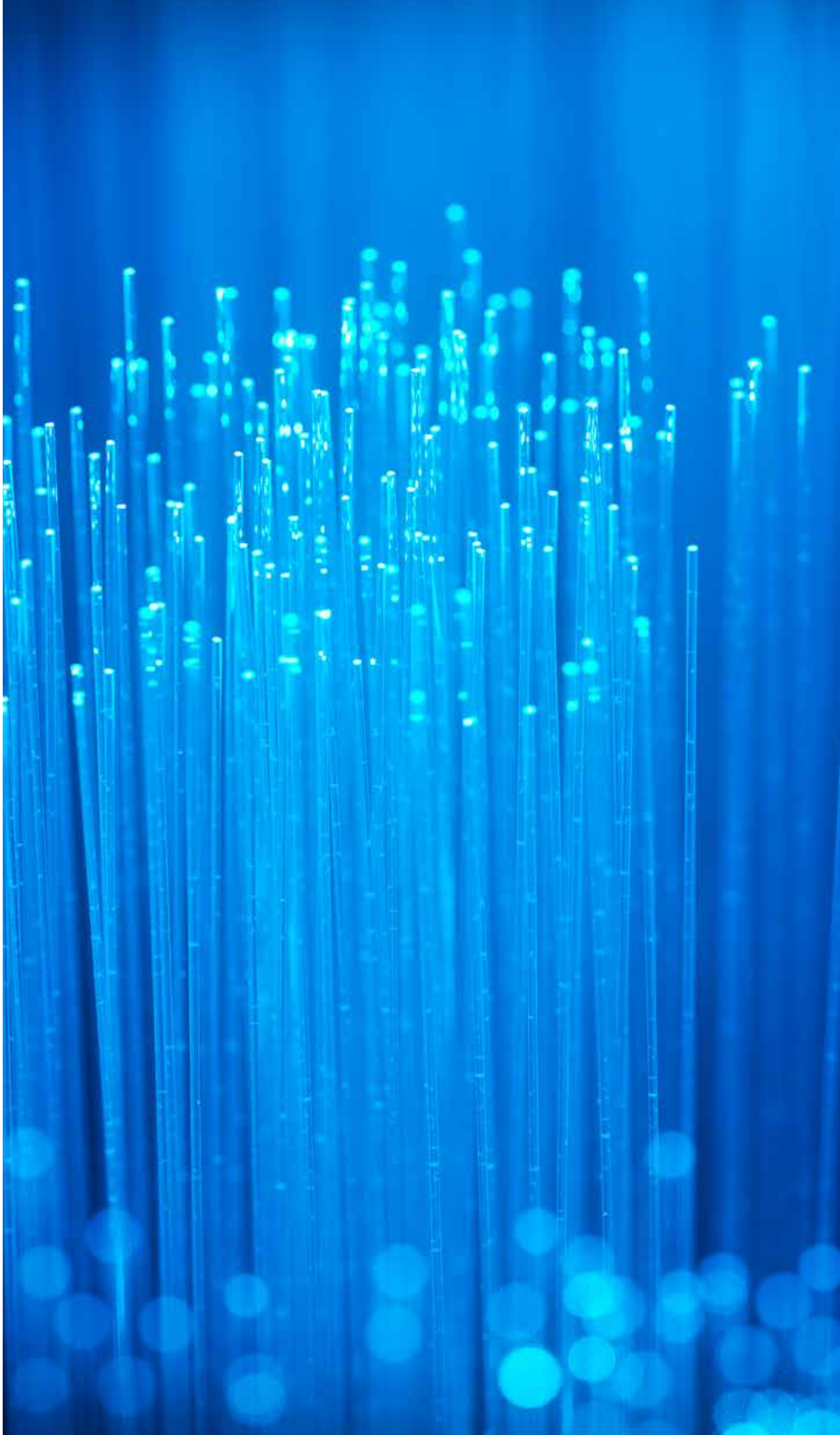
LoRa WAN: LoRa WAN is a communication protocol that specializes in high range and penetration and low energy consumption with low data rates. Using LoRa WAN gateways opens an interface to the internet. These can be set up anywhere and allow ranges of up to 30 km. In this way, a separate IoT network can be set up quickly and flexibly to cover entire halls and facilities.

Sigfox: The Sigfox protocol enables a high range (up to 20 km from a Sigfox radio tower) and high indoor penetration with a low transmission rate at the same time. Sigfox is especially suitable for devices that only have to send small amounts of data (e.g. devices that send their hourly status). All data sent goes through the Sigfox Cloud.

NB-IoT: Similar to Sigfox, Narrowband IoT provides a high range (up to 35 km), very good building penetration and a low transmission rate. It is based on the LTE standard, but is also designed to be energy-saving and to penetrate buildings easily. NB-IoT SIM cards have to be inserted. This technology is already available in some urban areas, and is set to be rolled out across the whole of Germany at the end of 2019. NB-IoT will be part of the future 5G standard.

Protocols for industrial communication

In addition to wireless communication, communication via industry protocols such as OPC, UA, CANopen, and IO-Link is still very important. These are fast, resilient, largely independent of outside influences, and widespread. However, they are not suited for mobile applications.



Architecture in the Internet of Things: interaction between front-end, back-end, and devices

In the Internet of Things, countless IoT devices and things have to be managed, administered, protected, monitored, analyzed and maintained. IoT platforms are essential for these tasks as they are a central component of IoT architecture and therefore of IoT strategy.

The first step behind the devices and things: Sensor hub and edge

- The sensor hub consists of one or more microcontrollers. They form the interface for the connected sensors, detect the required protocols and transmit the data. Authentication and encryption are already important at this stage.
- The edge is a more powerful sensor hub. Instead of microcontrollers, different computer systems in various sizes are used. Data is analyzed in these systems before being forwarded. This is particularly useful when data traffic should be minimized.

The second step: Device management (Cloud, on premises)

- The message hub receives data transmitted from a sensor hub/edge and forwards this onto the next relevant components. It uses a variety of different communication standards and is highly available and scalable.
- The persistence layer archives, collects and aggregates this data and logs it additionally. It is practical to integrate it into existing database systems.
- The asset management is responsible for handling, identifying and reporting a multitude of devices.
- Device operation: this interface is responsible for monitoring devices. It is the digital twin, i.e. the digital image of the device, from the real world. The device operation is used to ensure that remote devices can be updated.
- Event processing handles the events triggered by devices or their data in the IoT platform and preprocesses the data so that it can be further used for analytics and processing.

The last step: Analytics and processing

- Streaming analytics analyzes “live” data, i.e. data from a constant stream of data.
- Machine learning models are trained with data in order to gain insights.
- Open interface: data and information obtained from data must be made available via open interfaces to be able to provide this to the IoT landscape, for example, the ERP system.
- Visualization: the information obtained must be presented in a way that is comprehensible, clear and useful to the user so that they can make use of this information.
- Flow management: the flow of data must be able to be controlled and managed. Generated data is valuable and should therefore only reach its intended and authorized recipient.

IoT at Lufthansa Industry Solutions

Our IoT applications are tailored to the needs and requirements of our customers and their use cases. We pursue a holistic approach for this, i. e. an application from end-to-end. This approach ranges from

- an individual thing in the Internet of Things,
- to communication,
- and to applications in the Cloud backend and front-end for the end user,
- in extensive and comprehensive architecture that takes operability and IoT security into account.

We thereby do not just implement IoT, but also carry out the data analysis in conjunction with this, which is done by data analytics and AI.

In the constantly-changing IoT landscape we are engaged in intensive technology scouting:

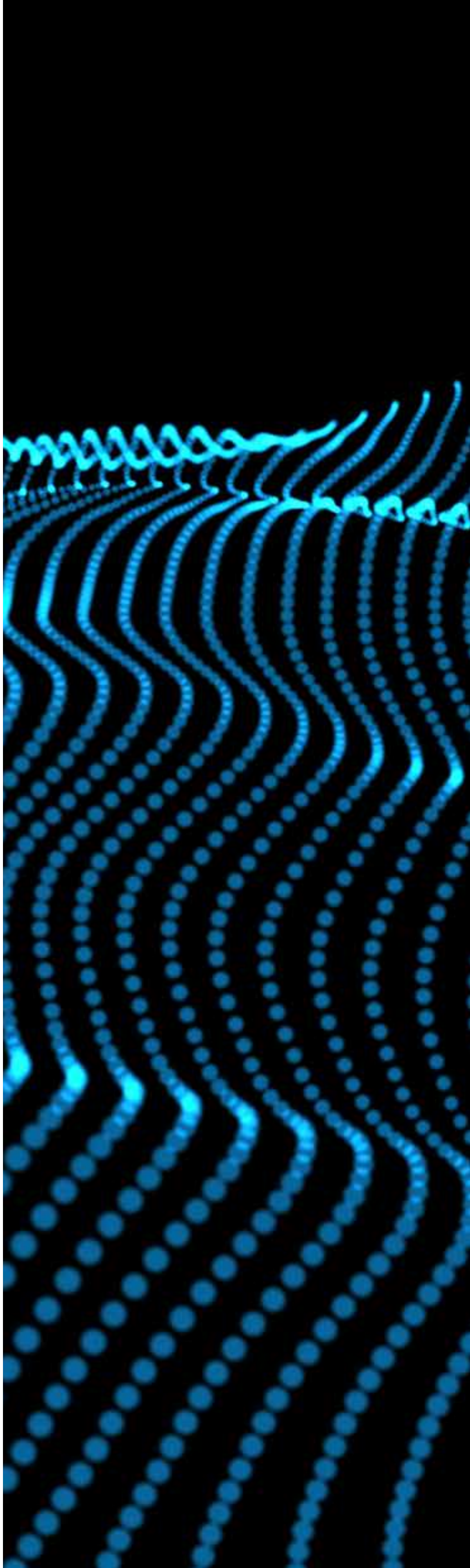
- We are constantly looking for and evaluating the latest technologies in the fields of sensors, localization, communication, Cloud, architecture, and data analysis and visualization.
- We not only present our customers with an up-to-date portfolio, but also implement this according to our customers' requirements.

Our computer scientists, engineers and scientists provide us with the technical and scientific expertise and understanding required to understand the many points of contact in the IoT:

- Together with our data analysts, data scientists and AI experts, we can generate added value from the data collected.
- With the help of security experts, the application is designed so that it is compliant with both the security standards of your company and of the GDPR.

We not only provide consulting services on which applications are good and suitable for our customers, but we also offer to implement these applications.

- Depending on our customers' wishes, we can provide a proof of concept and develop a minimum viable product or an enterprise-ready application.
- Customers are always involved in the development process and continually kept up-to-date on all progress.



A broad partner network with certified products

- Our hardware partners constantly deliver suitable tools for your applications. They have the necessary certifications for industrial operation purposes, fulfill modern security standards and provide options for encrypting data.
- If required, our partners can prepare individual hardware specially tailored just for you.

IoT architecture: Implementation and development

- Working together with you, our software experts develop IoT architecture that matches your IoT strategy and use cases, that is scalable and expandable, and that fits perfectly into your IT landscape.
- And not only do we offer to develop this architecture, but we can also implement it into your landscape.

Extensive experience with leading IoT platforms

- Implementation of the IoT platform required for your application is done with established platform providers.
- We evaluate which of these platforms is best suited for your requirements and work together with you to set it up.

Localization

- Our localization applications allow you to easily keep track of and retrieve items, plan routes, trigger alarms, and much more. The possibilities for use are numerous.
- Our localization applications meet your accuracy requirements – from an accuracy of several meters to less than 30 centimeters, both indoor and outdoor in industrial environments.
- Our localization applications enable asset tracking in both 2D and 3D.

Condition-based and predictive maintenance

- Condition-based maintenance: Sensors measure installations and systems and detect anomalies. If threshold values have been reached, a maintenance job is generated, for example. This reduces over-maintenance as it is carried out at a sensible time.
- Predictive maintenance: Both historical data and data that is detected during the measurement are evaluated with data analytics and AI in order to generate maintenance jobs on the basis of statistical statements. In this way, damage can be prevented before it even occurs, while at the same time reducing maintenance intervals.

Connecting to machines and retrofitting

- Retrofitting: Existing installations are fitted with sensors to allow for precise, smart monitoring. This enables customers to save themselves the hassle of new installations and at the same time increase the efficiency of their old installations.
- Connecting to machines: Installations that already have sensors are equipped with Connectivity and are integrated together into a platform designed according to the customers' wishes. In this way, customers have a unified view over their installations. Installation KPIs can be collected, analyzed and processed in a clear manner.

Embedded development

- For use cases that have special requirements for microcontrollers and energy management, we provide embedded development. This means that applications are developed directly on the chip of IoT devices in order to meet the special requirements of energy management and device mobility. Here you can be sure that you are getting the most out of your IoT hardware.

Rapid prototyping

- Functional prototypes can be created within a short amount of time in order to prove the feasibility of your vision, allowing you to constantly keep up with innovations.
- Your prototypes are developed both as software and hardware, using the latest production technologies such as 3D printing and CAD.

(Near) Real time data analytics

- We provide data analysis in (near) real-time. This in turn enables you to monitor, evaluate and control your processes – and intervene if necessary.
- The data produced is used to further optimize processes and create a better picture of the performance of your installations.

In combination with AI applications

- While IoT is crucial for generating data, in combination with AI it provides completely new use cases. This means that the efficiency of processes increases further, and anomalies or errors can be detected better with image recognition.

Visualization

- Visualization helps bring the flood of data under control. It allows information obtained from the data to be depicted in a clear way. Whether it's in localization, data analysis or the sensors, clever visualization enables you to see more quickly what conditions, processes and prognoses are looking like.

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