USE CASES OF LORAWAN SOLUTIONS IN PRODUCTION AND LOGISTICS

RFID and Wireless IoT tomorrow // Darmstadt, Oktober 30, 2018

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USE CASES OF LORAWAN SOLUTIONS IN PRODUCTION AND LOGISTICS

- Fraunhofer IFF
- Comparison of LPWAN technologies
- Use Case Airport
- Use Case Production Plant
- Use Case Building Company
- General Findings
- R&D Priorities

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On one slide

- The Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg was founded in 1992
- Today it is one of more than 70 Fraunhofer Institutes in Germany
  - IFF is part of the Fraunhofer Cluster Production
- At IFF almost 200 employees are researching and developing reliable technologies and solutions for efficient, sustainable and interconnected manufacturing

Digital Engineering and Operation

Smart Work Systems

Resource Efficient Production and Logistics

Convergent Infra-structures

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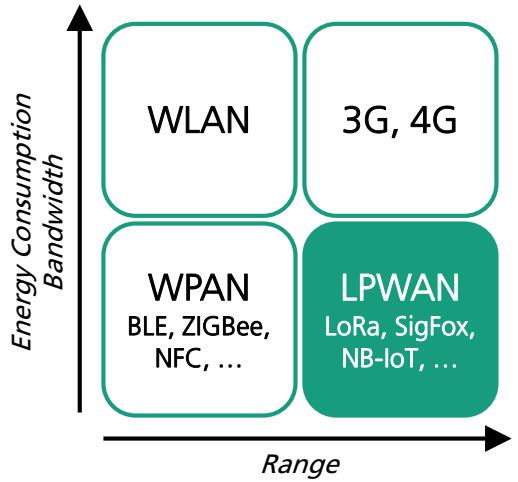
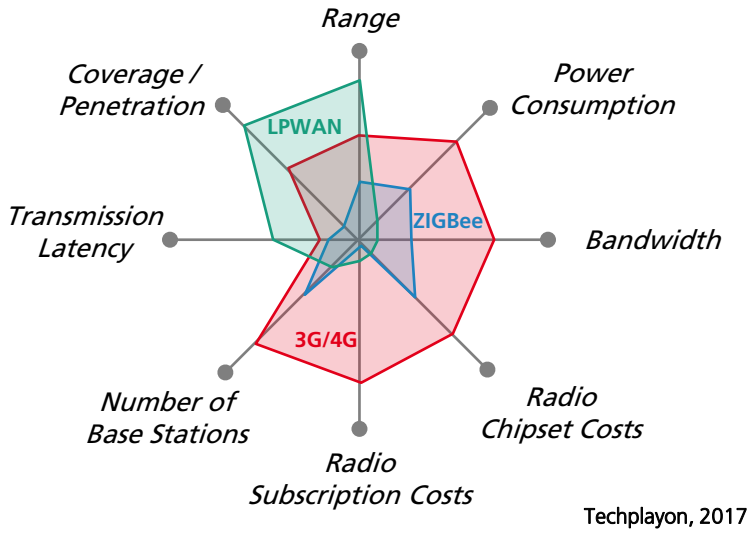
Comparison of LPWAN Technolgies
Overview

- LPWAN (Low Power Wide Area Network) as suitable technologies to transmit small data over large distances with low energy consumption and low costs

→ Suitable connectivity technology for IoT applications in production and logistics.





- LPWAN technologies are not suitable for applications with requirements towards high bandwidth and low latency (real-time capabilities)!

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Comparison of LPWAN Technolgies
LoRaWAN, Sigfox and NB-IoT

- LoRaWAN and Sigfox are the most established LPWAN technologies in Germany – NB-IoT is expected to provide wide coverage

	LoRaWAN	Sigfox	NB-IoT
Frequency Band	ISM (unlicensed)	ISM (unlicensed)	licensed
Message Payload	max. 243 Byte	max. 12 Byte	max. 1.600 Byte
Massages / Day * Device	limited by duty cycle	max. 140 Messages	no limit
Communication	bi-directional	mainly uni-directional	bi-directional
Network Service Provider	local private networks possible	Sigfox	NSPs
Coverage	Local / Campus	good	expected very good
Availability	yes	yes	low

Choice for R&D IoT pilot projects

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Use Case Airport
Overview

- **Ground Support Equipment** (GSE) is required for most of the Processes on an Airport's Apron but **often not used efficiently**!
  - hundreds or even thousands of Equipment – many of them non-motorized (meaning without energy supply)
  - at major Cargo Hubs usually > 1,000 GSEs to be managed
  - ☒ No automated Localisation of GSE
  - ☒ No automated Monitoring of Equipment Status (e.g. Dolly loaded / available)
- ↳ High efforts for searching equipment and keeping track of its status
- ↳ No efficient Process Planning possible
  → leading to inefficient usage of GSE
- ↳ No automated Process Monitoring available

! *In the Past conventional Track+Trace and Monitoring Technologies were technically and economically not feasible for a GSE Tracking Solutions!*


Photo: Dirk Mahler / Fraunhofer IFF

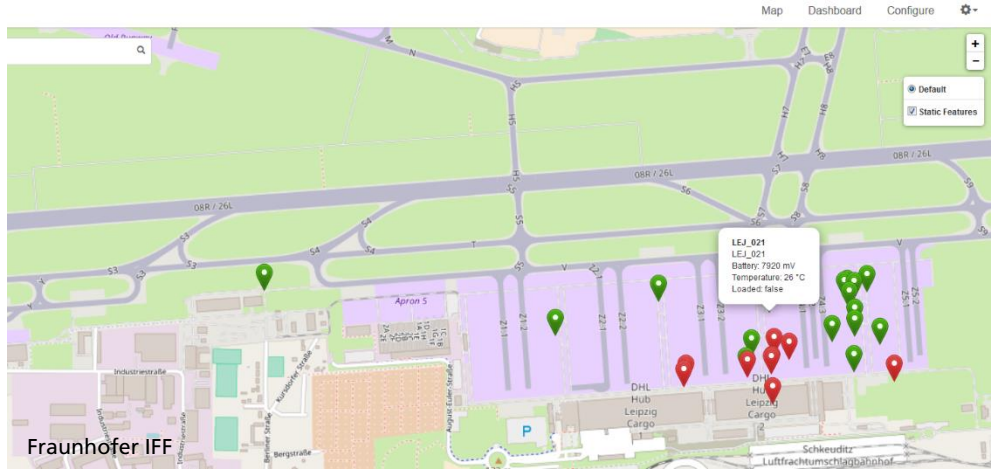
Tug towing four Dollies loaded with ULDs

Photo: Stefan Marx / DHL

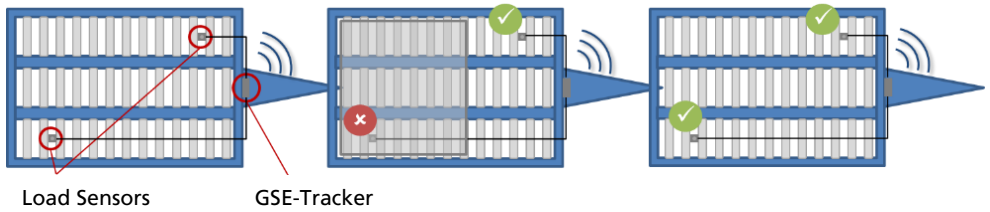
Dolly with Castor Deck

Use Case Airport
Solution Development

- The whole apron area was covered by one LoRaWAN-Gateway
- Tracking Module (GNSS + IPS) and inductive Load Sensors were developed
- 30 Dollies equipped with GSE Tracker and Load Sensors
- Testing in productive Process Environment
  - Singular Test for Accuracy of Localisation, Load Detection etc.
  - Longterm Monitoring in Hub Processes
- Different Message Types were used to monitor Processes
  - e.g. Change of Load Status
  - e.g. last Location before Sleep
  - Permanent Tracking as Test Mode



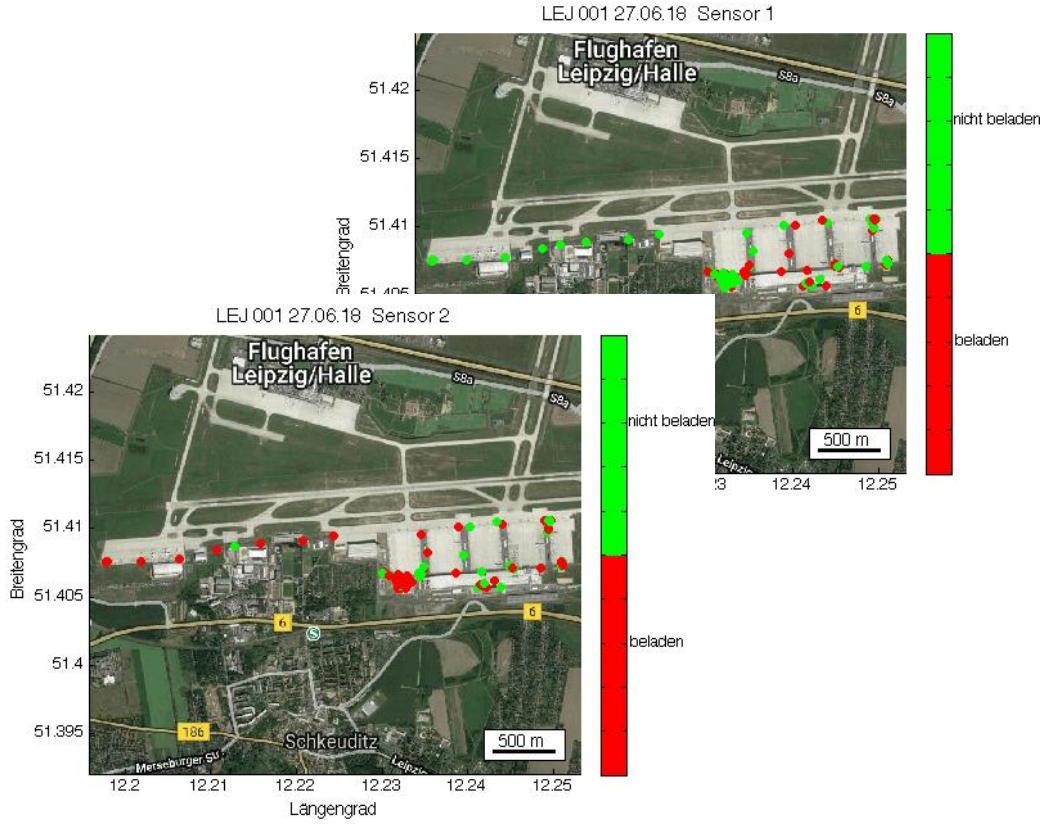
The Data of the Tracking Devices are forwarded to an Application Server (IoT Engine) for Device Management and Status Monitoring



Use Case Airport
Test Results

- Good coverage and connectivity provided by just one gateway
  - mainly SF7 – SF9
  - → more Gateways required for scale up (depending on actual Number of Devices and Messages)
- Load Sensors provide robust Information about Load Changes
- Limits of LoRaWAN Uplink were evaluated
  - → High Frequency of Uplink Messages critical for Battery Capacity and Message Collision Rate
  - → Uplink Latency is limiting Real Time Functionalities
- Profiles for optimized Usage of Trackers were developed

→ Energy Consumption + Message Rate vs. actual Needs + Desires



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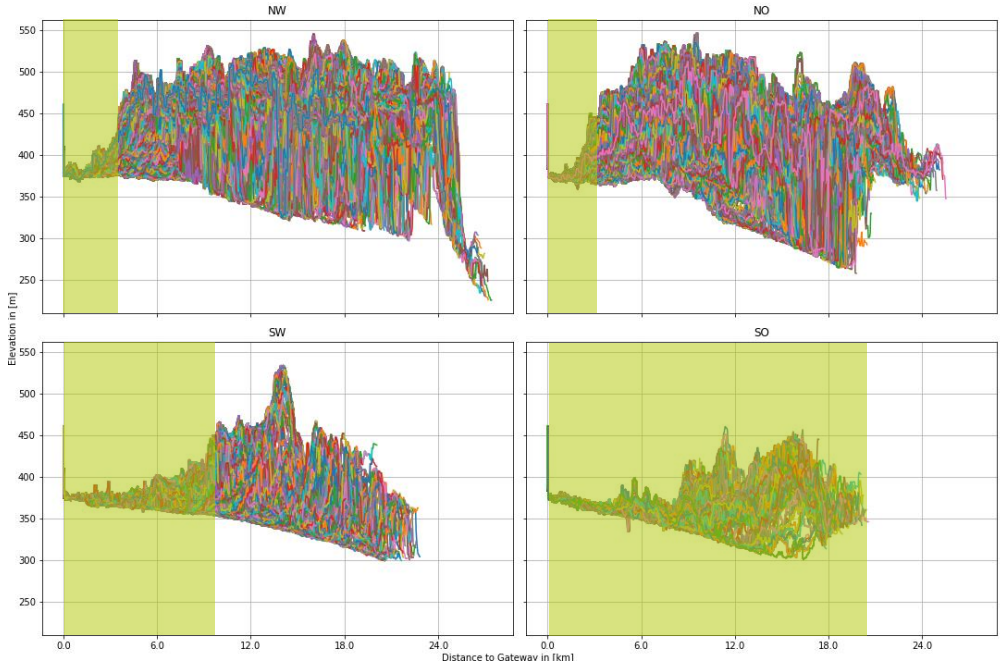
Use Case Production Plant
Overview and Test Setup

- Test-Setups in two Production Plants for Tracking of Assets and Load Carriers
  - Mapping of LoRaWAN Connectivity at the Sites and their Surrounding (with Suppliers)
  - Evaluation and Comparison of different Market-available LoRaWAN Tracking Devices (GNSS + IPS)
- Demonstration of LPWAN Functionalities for Development of IoT Strategy in Production and Logistics Processes
- Per Site 3 LoRaWAN Gateways were installed
  - → Testing the Connectivity in the Surrounding of the Sites
  - → Testing the indoor Coverage
- Evaluation of Usability, Data Quality and potential Benefits



Exemplary Simulation of the Range of an installed LoRaWAN Gateway (based on surrounding Topography)

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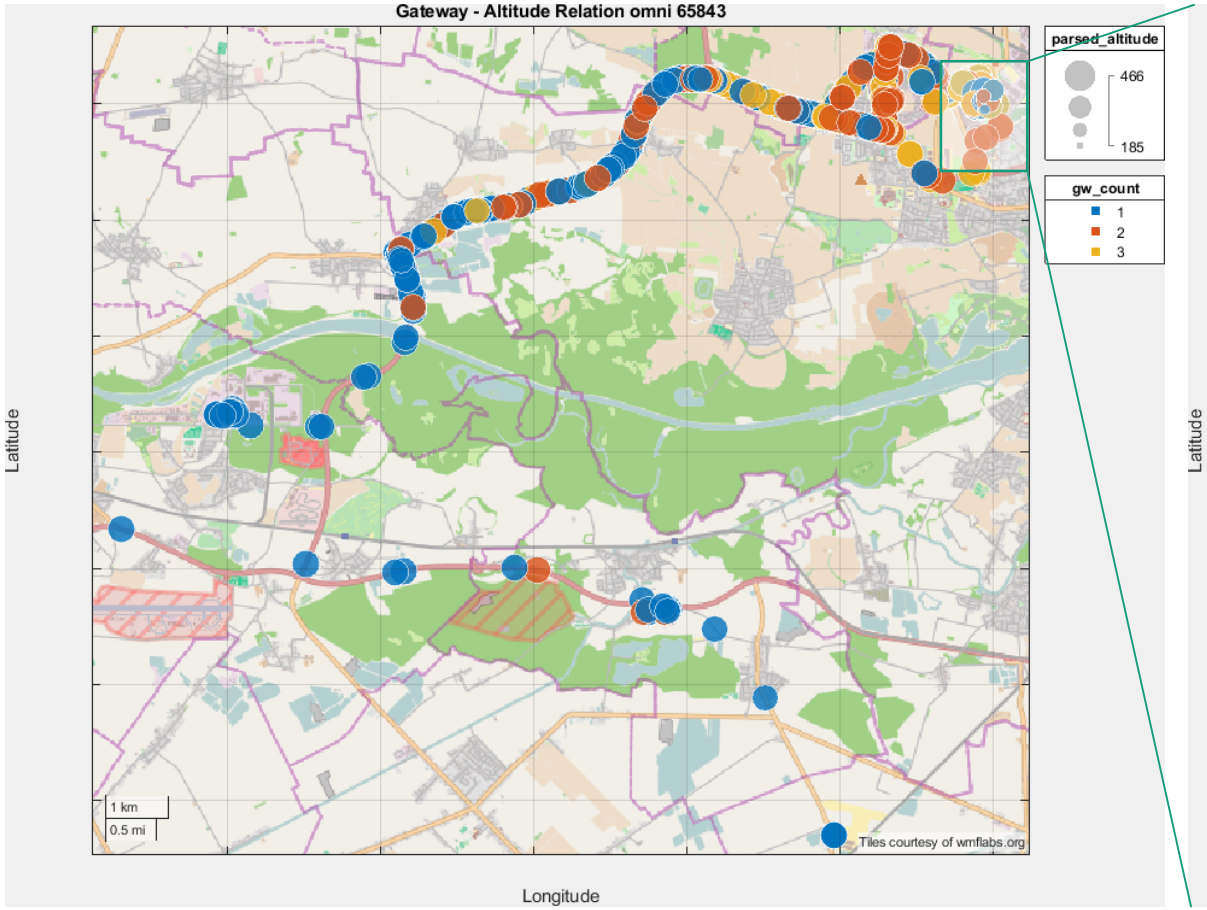
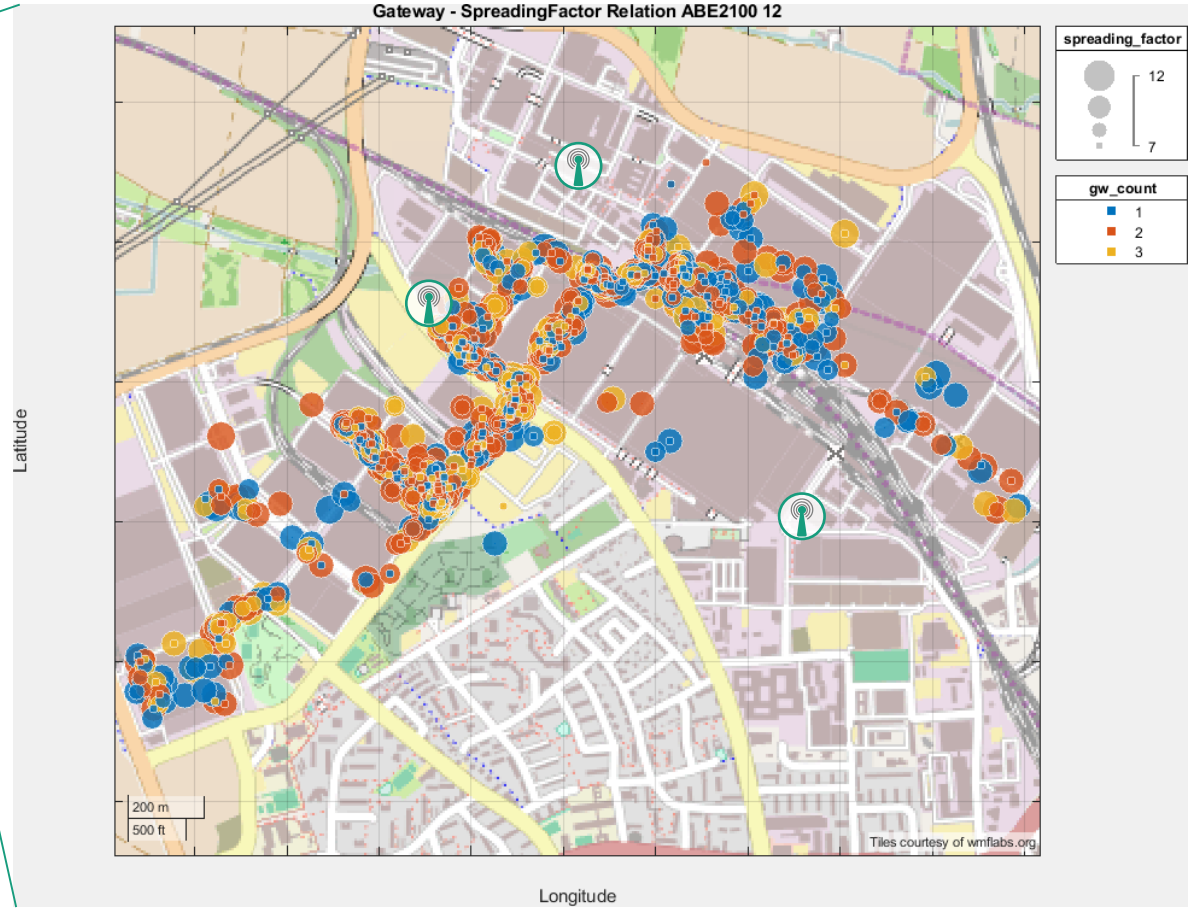
Use Case Production Plant

Test Results



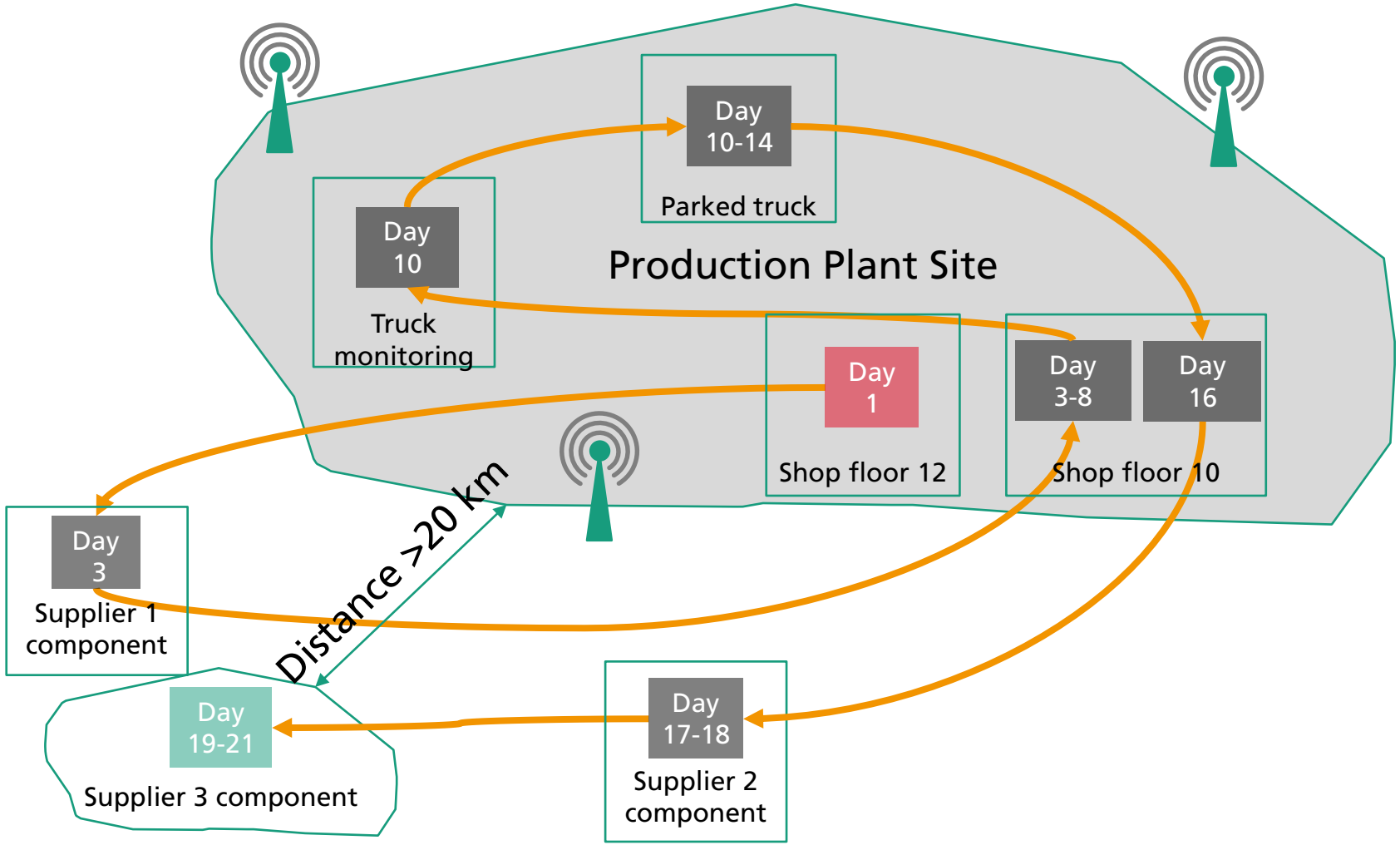
Achieved Range with LoRaWAN Gateways at Site



Indoor and Outdoor Connectivity at Site

Use Case Production Plant
Test Results

- LoRaWAN enables Visibility in Logistics Processes
  (see on right for exemplary for a single Load Carrier)
- LoRaWAN is feasible to cover Production Sites (indoors + outdoors) with low Investment
- Network and Trackers offer Potential for easy retrofitting
- Indoor Positioning is crucial for many Processes



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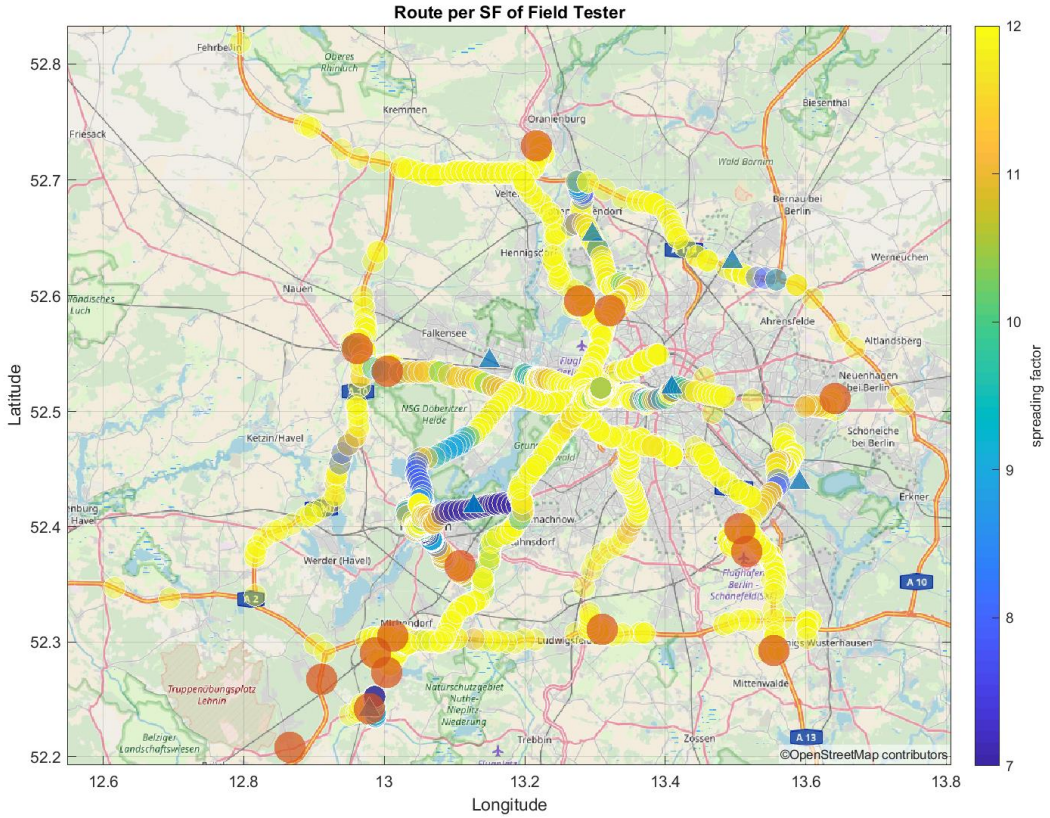
Use Case Construction Company
Overview and Test Setup

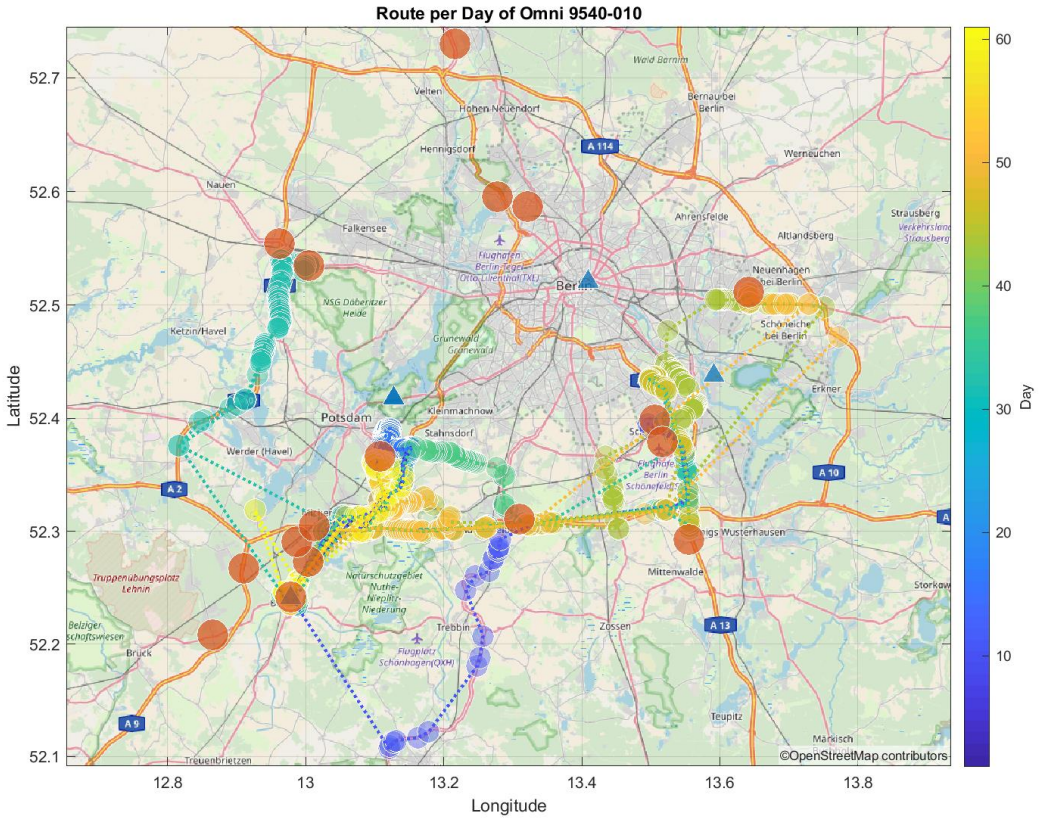
- Construction Companies need to keep Track of their mobile Equipment and Assets
  - Position and State of Skip Containers
  - Containers distributed over large Areas
  - Containers without own Energy Supply
  - → Evaluation of LoRaWAN for energy and cost efficient Tracking of Skip Containers
- Case Study with a Construction Company from the Berlin Area
  - 6 Containers of different Types equipped with Market-available LoRaWAN-Trackers
  - 8 Weeks of Container Movements evaluated
  - 19 Construction Sites in and around Berlin
  - Use of established LoRaWAN Networks of NSPs Digimondo and Telent

Use Case Construction Company

Test Results



Evaluation of LoRaWAN Connectivity in and around Berlin



Exemplary Tracking of a single Container

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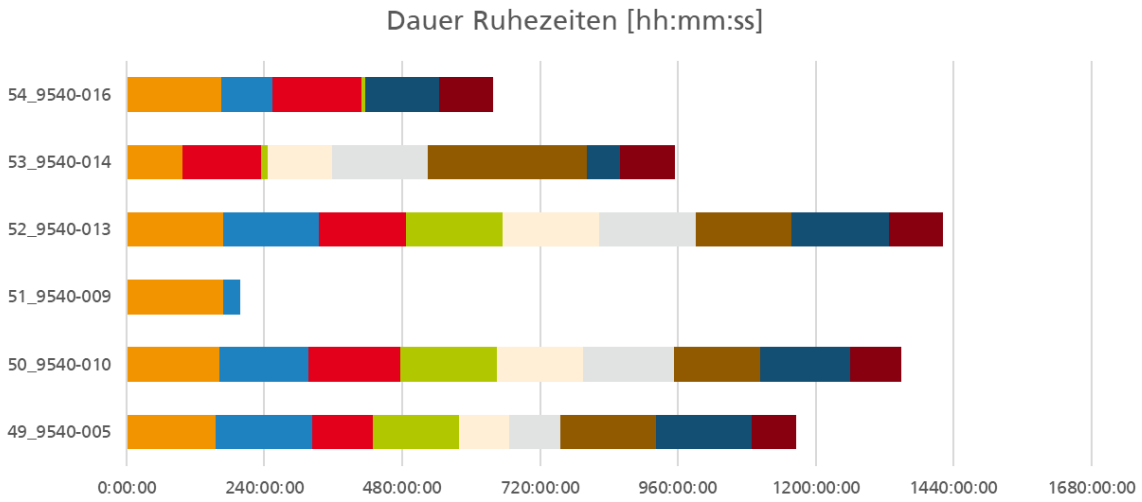
Use Case Construction Company
Test Results

- Activity Monitoring helps to optimize the Management and Usage of Equipment
  - current Location and State for optimized Planning and Scheduling
  - e.g. Reduction of Searching and Waiting Times
- LoRaWAN Trackers feasible for long-term Usage and low Maintenance Efforts
  - Trackers physically robust
  - low Energy Consumption *(at low Event Rate)*
  - good and reliable Localization
  - good Connectivity when Infrastructure is given → setup of additional Gateways may be required, as LoRaWAN does yet not provide seamless Coverage



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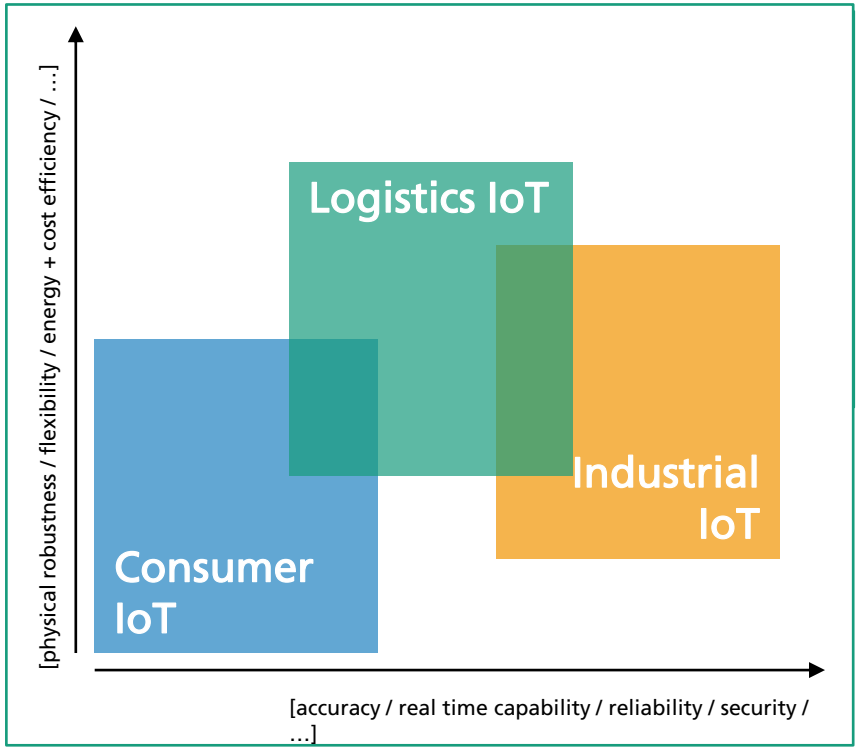
KW5	154:27:06	160:56:29	168:45:38	167:45:29	97:08:07	165:05:06
KW6	168:43:47	155:13:40	28:37:18	167:45:01	0:00:00	88:49:35
KW7	105:07:39	161:08:19	0:00:00	150:59:19	136:28:30	155:13:11
KW8	150:17:37	167:41:00	0:00:00	167:43:35	12:17:40	6:26:57
KW9	88:01:53	150:04:22	0:00:00	168:46:34	112:32:21	0:00:00
KW10	88:01:53	158:51:13	0:00:00	167:43:06	166:40:36	0:00:00
KW11	166:55:30	148:53:28	0:00:00	167:45:56	276:09:44	0:00:00
KW12	167:25:27	157:21:57	0:00:00	168:44:20	58:12:38	128:32:34
KW13	76:59:00	88:19:29	0:00:00	94:25:30	94:56:38	93:39:59

General Findings
LPWAN Usage in Use Cases

- LPWAN Solutions need to be tailored for individual Use Cases
  - → different LPWAN Technologies will be relevant for different Types of Use Case
  - → for Use Cases requiring good Network Coverage Sigfox and potentially NB-IoT are more feasible than LoRaWAN
  - → LoRaWAN offers Potentials for private operated Networks
  - → LPWANs can not fulfill *IIoT* Requirements for minimal Latency and maximum QoS

- Focus of Fraunhofer IFF are Use Cases and Applications with mobile Objects in Production and Logistics with their specific Requirements
  - e.g. Objects highly mobile / Process Chains covering large Areas / heterogenuous environmental Conditions along Process Chains / high Cost Pressure (esp. in Logistics) / Availability of Power Supply



R&D Priorities

Fraunhofer IFF as your R&D Partner for IoT Application

Technology Selection

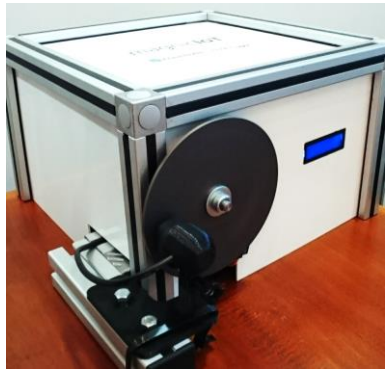
- Analysis of Process Requirements
- Selection of appropriate Technologies (Connectivity, Sensor, Localization)
- Valuation of Technical Feasibility, Costs and Benefit Potentials
- Feasibility Tests in Practical Applications
- R&D for scale up of IoT Applications *(e.g. Number and Density of Devices + Gateways)*

Data Interpretation

- Configuration of IoT Devices to provide custom-fit Data
- Aggregation and Interpretation of Data to derive Added Value
- Intuitive Visualization of IoT Data
- Consulting for Selection of Integration Platforms

Energy Management

- Evaluation of Energy Consumption and Configuration of IoT Devices for energy-optimized Operation
- R&D for Energy Harvesting in IoT Devices
  (e.g. ***MagnicIoT*** *→ meet us at our Booth)*



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Thank you for your attention!

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