Technische Hochschule Rosenheim
Technical University of Applied Sciences

Modul
- Internet of Things (IoT) -

01-Vorlesung

Prof. Dr. Marcel Tilly

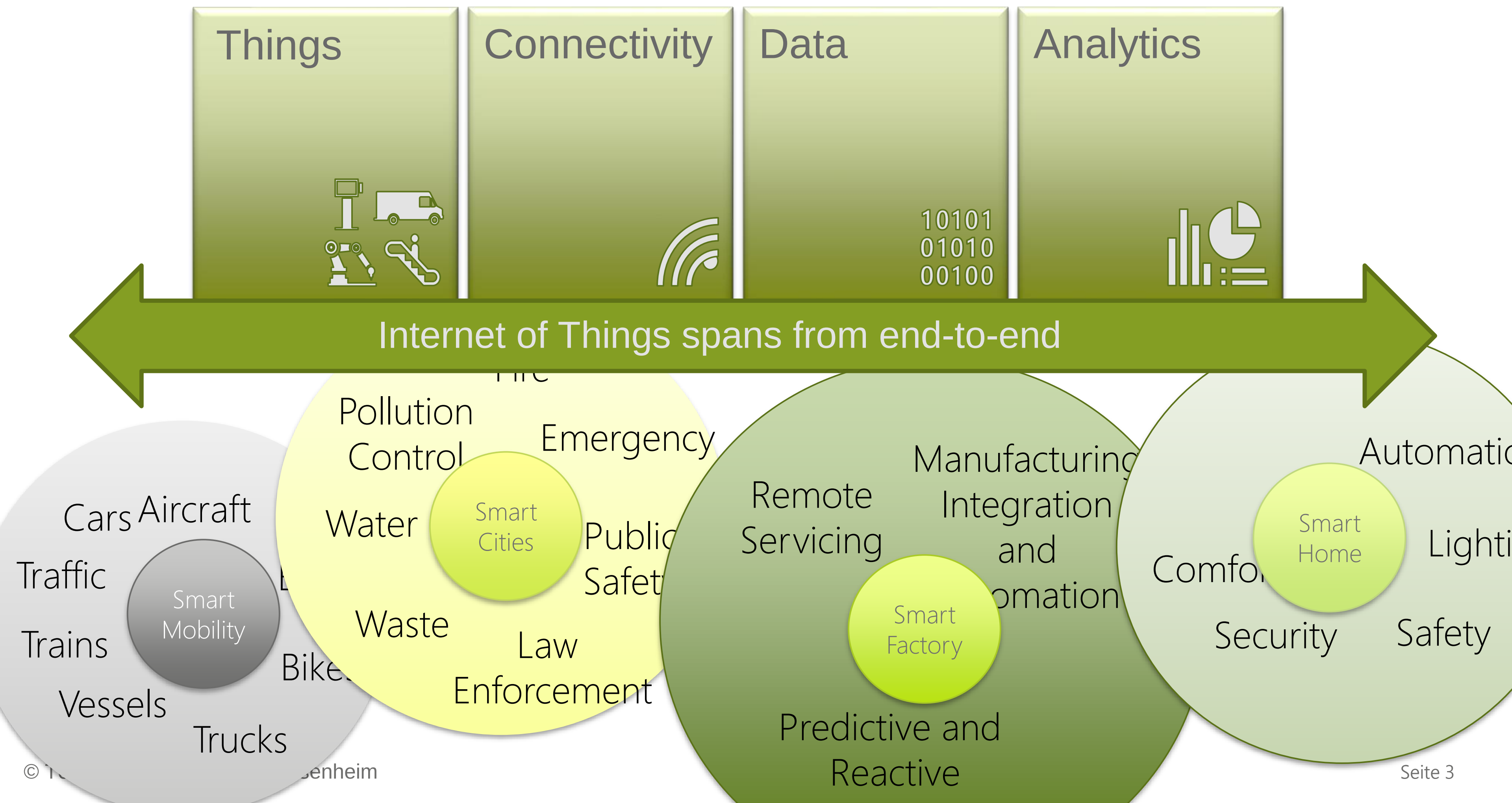
Fakultät Informatik, Cloud Computing

Überblick

21. März	Einführung in das Internet der Dinge
28. März	IoT Architekturen
4. April	Things und Sensoren
11. April	From Device to Cloud
18. April	Vorlesungsfrei – Ostern
25. April	IoT Analytics
02. Mai	Big Data in IoT
9. Mai	Data Exploration
16. Mai	IoT Platformen
23. Mai	Entwicklung einer IoT Lösung
30. Mai	Vorlesungsfrei; Christi Himmelfahrt
05. Juni	opt. Gastvortrag – Digitalisierung
13. Juni	Data Science in IoT
20. Juni	Vorlesungsfrei – Fronleichnam
27. Juni	Intelligente Cloud und intelligente Edge
04. Juli	PStA Abschlusspraesentationen

PStA

Defining Internet of Things (10.000 ft)



Things

Challenges

Memory
Processor
Energy (Battery) , lifetime
Security
Various generations (old vs new)
Heterogeneous platforms
Provisioning
Variety of device categories (sensor, gateways)
Variety of device types
Programming languages
Physical size
Inputs
Connectivity

Technology

Microcontroller vs OS powered
C, Java, Python, JavaScript, C++, C#, ….







Connectivity

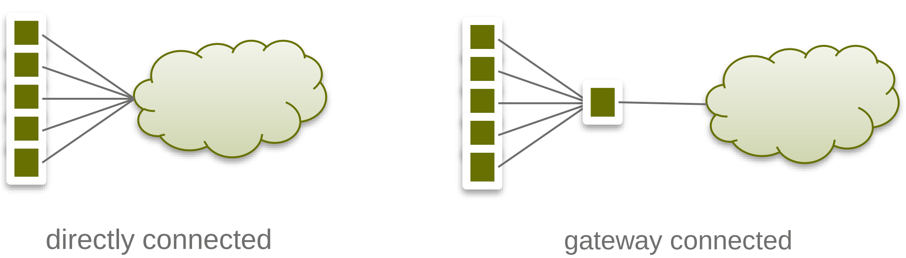
Challenges

Amount of connected things
Variety of protocols
Variety of communication pattern
Security
Variety of topologies
Discovery
Coverage
Partial connectivity
Stability
Bandwidth
Interference
Internationalisation

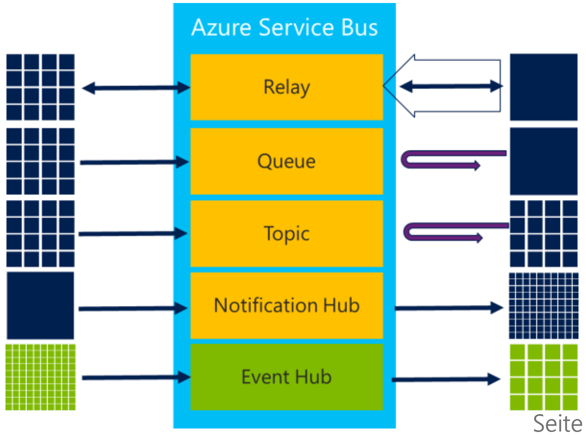
Technology

Device-/Configuration Management
HTTPs, MQTT, AMQP, CoAP
CAN, Modbus,
Bluetooth Low Energy (BLE), Zigbee
6LowPan
OPC-UA
LORA, MIOTY, …

Topology



Communication Pattern



Data Storage

Challenges

Amount of Data (Big Data) - Volume
Speed of Data (Data Rate) - Velocity
Data format (semantics) - Variety
Data trust
Data quality
DSVGO (privacy)
Encryption (Transport security)
Compression
Data Selection

Technology

SQL
Map-and-Reduce (Hadoop)
Stream Processing (Spark)

Analytics Insights

Challenges

Amount of Data

Quality of Data (Bias)

Insights

Data understanding (Exploration)

Scale

Execution of Analytics/ Distribution

Data Format

Error Handling

Correlation

Technology

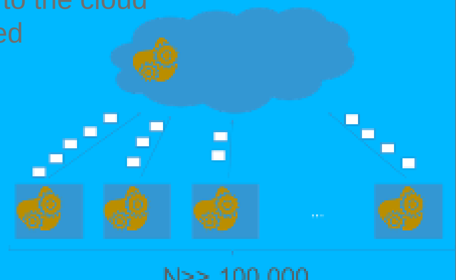
Machine Learning

Why global?

•Data born in the cloud: There is data which is created in the cloud
•"Wisdom of the crowd": Correlate and aggregate data from various sources to extract knowledge
•Global view
•Scale and history

Why local analytics?

•Data born locally and action is required local
•Data Reduction: Not all data needs to be sent to the cloud
•Connectivity: Devices are not always connected
•Privacy: User is concerned about privacy



MSR ASIA (Jingbo Shang, Yu Zheng, Wenzhu Tong, Eric Chang, and Yong Yu)
http://research.microsoft.com/pubs/217455/frp0542-zheng-final.pdf

Inferring Gas Consumption and Pollution Emission of Vehicles throughout a City

Congestion and traffic jams cause drivers to waste gas, which on a mass scale causes greater air pollution that impacts on the environment and people's health. This study inferred the gas consumption and pollution emission of vehicles traveling on a city's road network, using GPS trajectories generated by a sample of 32,000 taxicabs in Beijing over a period of two months.

http://urbanair.msra.cn/

Fighting wildfires with data

Every second counts when combating a wildfire. Time lost can result in devastating loss of life or property. The University of the Aegean in Greece developed the VENUS-C Fire app—featuring Bing Maps, Microsoft Silverlight, and Windows Azure—to calculate and visualize the risk of wildfire ignition and to simulate fire propagation in the Greek island of Lesvos during its dry season. The university team generates a visualization of environmental factors each morning for the island's fire management team, who then use the app to determine optimal resource allocation across the island for the day.

Windflow: AI Takes to the Skies

- **Research question**: “Could we take the information that was already available and use it to predict wind conditions without needing any additional infrastructure?”
- Could airplanes in flight be employed as a vast sensor network to determine atmospheric conditions?
- Could data available today be used to infer winds on a large scale without special plane-based wind sensors and new infrastructure to access and combine signals from planes?

- http://windflow.azurewebsites.net/

http://research.microsoft.com/en-us/um/people/horvitz/planesenors.pdf

Domain: Manufacturing

- **Monitor manufacturing equipment**
  Improve your processes using industrial IoT solutions. Use sensors and advanced analytics to predict needed maintenance, and reduce unplanned downtime cutting into production time.

- **Provide predicitve maintenance to customers**
  Create new business models that offer predictive maintenance and performance monitoring for the equipment you produce, delivering a richer customer experience

- **Improve field services**
  Access sensor data to improve field service scheduling, ensuring the right technicians and tools are dispatched before potential issues become a major problem.

Domain: Transportation

- **Maintain vehicle performance**
  Keep vehicles on the road by predicting and monitoring maintenance needs—fixing potential issues during downtime to keep your business moving

- **Optimize fleet operations**
  Streamline logistics using real-time data and alerts to optimize delivery routes, monitor performance, and quickly respond to delays or issues as they happen.

- **Keep traffic moving**
  Monitor and process real-time traffic data to help manage transportation infrastructures, assess road conditions, and ease congestion.

Domain: Smart spaces

- **Create safer cities**
  Connect infrastructures to better regulate traffic, make emergency systems more efficient, and reduce police and emergency medical technician response time

- **Create smart buildings**
  Connect building devices and systems to bring more efficient operation and control to building owners, operators, and occupants.

- **Improve service, experience, and support**
  Increase service efficiency, from repairing broken street lamps to maintaining traffic lights to optimizing garbage truck routes

Domain: Healthcare

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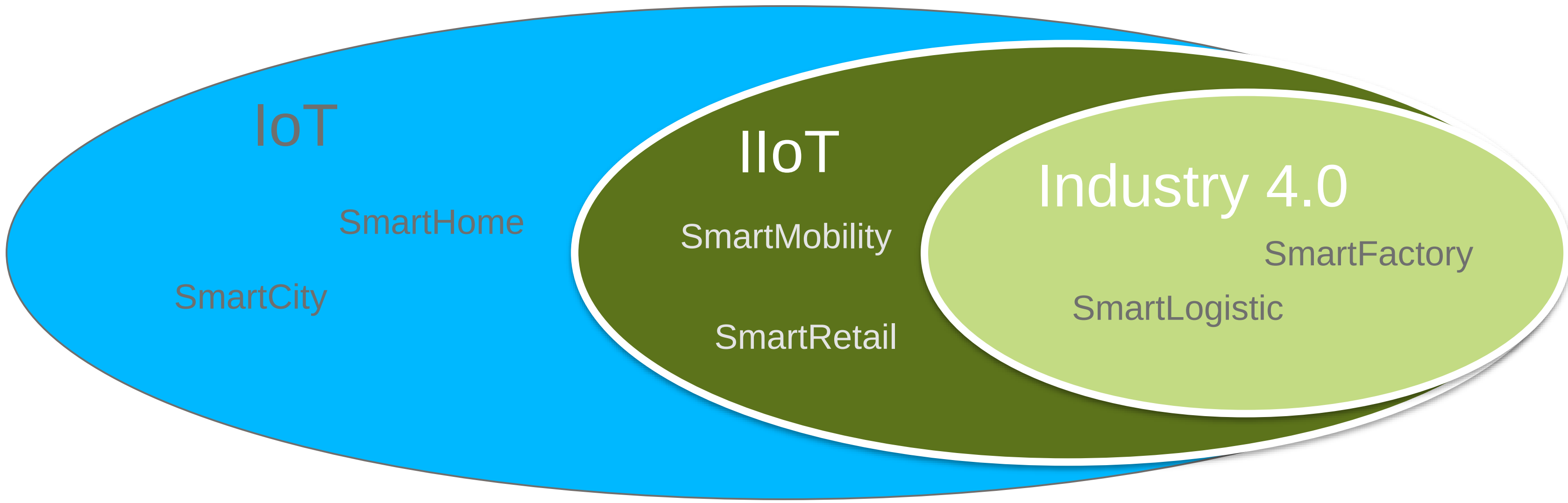
- **Evolve patient care**
  Allow patients to receive care away from their hospital at home, elsewhere around the world. With wearable sensors and service solutions, doctors can reduce readmissions and enable proactive care.

- **Monitor medical assets**
  Help your staff spend less time searching and more time with patients by better tracking and managing supplies and medicine—all on a cloud platform that's HIPAA compliant.

- **Track equipment usage**
  Enhance the overall well-being of patients by tracking how equipment is used, from employing hospital bed sensors to monitoring room temperature and hand washing stations

- **Maintain vital equipment**
  Ensure critical medical devices are ready to use when your patients need them most by fixing potential problems before they occur with predictive maintenance.

IoT vs IIoT vs Industry 4.0



Internet of Things:

Connection of all (smart) things (=physical objects) to a network (internet?) for all kind of domains and scenarios

Industrial Internet of Things:

Connection of all things in **industry** to enable new scenarios with business relevance (worldwide)

Industry 4.0:

Connection of all things in industry to enable new scenarios with business relevance (**in Germany**!)

“IoT applications conceptually can be described as Things (or devices) sending data or events that are used to generate Insights, which are used to generate Actions to help improve a business or process”

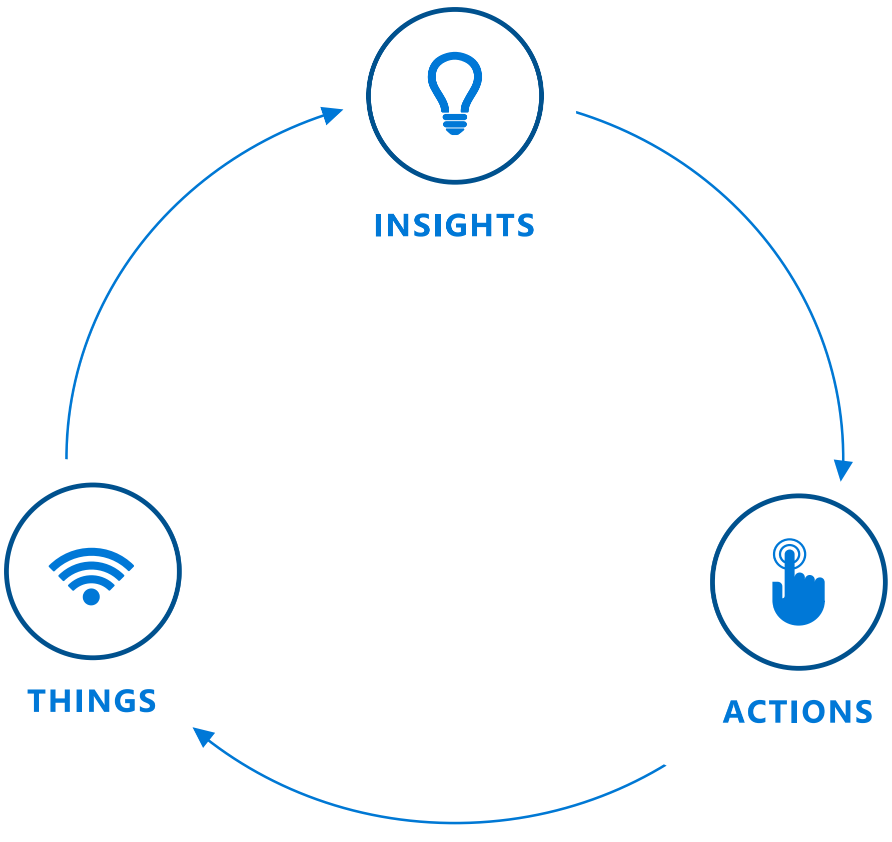
Things
(Generate Data)

Insights
(Based on Data)

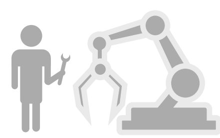
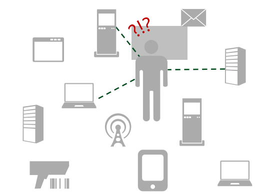
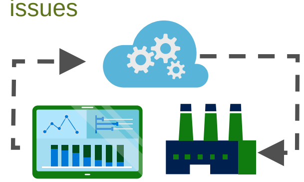
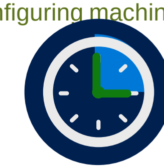
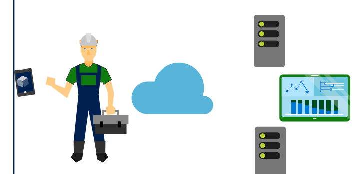
Actions
(Based on Insights)

Digital Feedback Loop

A realtime connection enables new breakthrough levels of insights that in turn drive informed actions



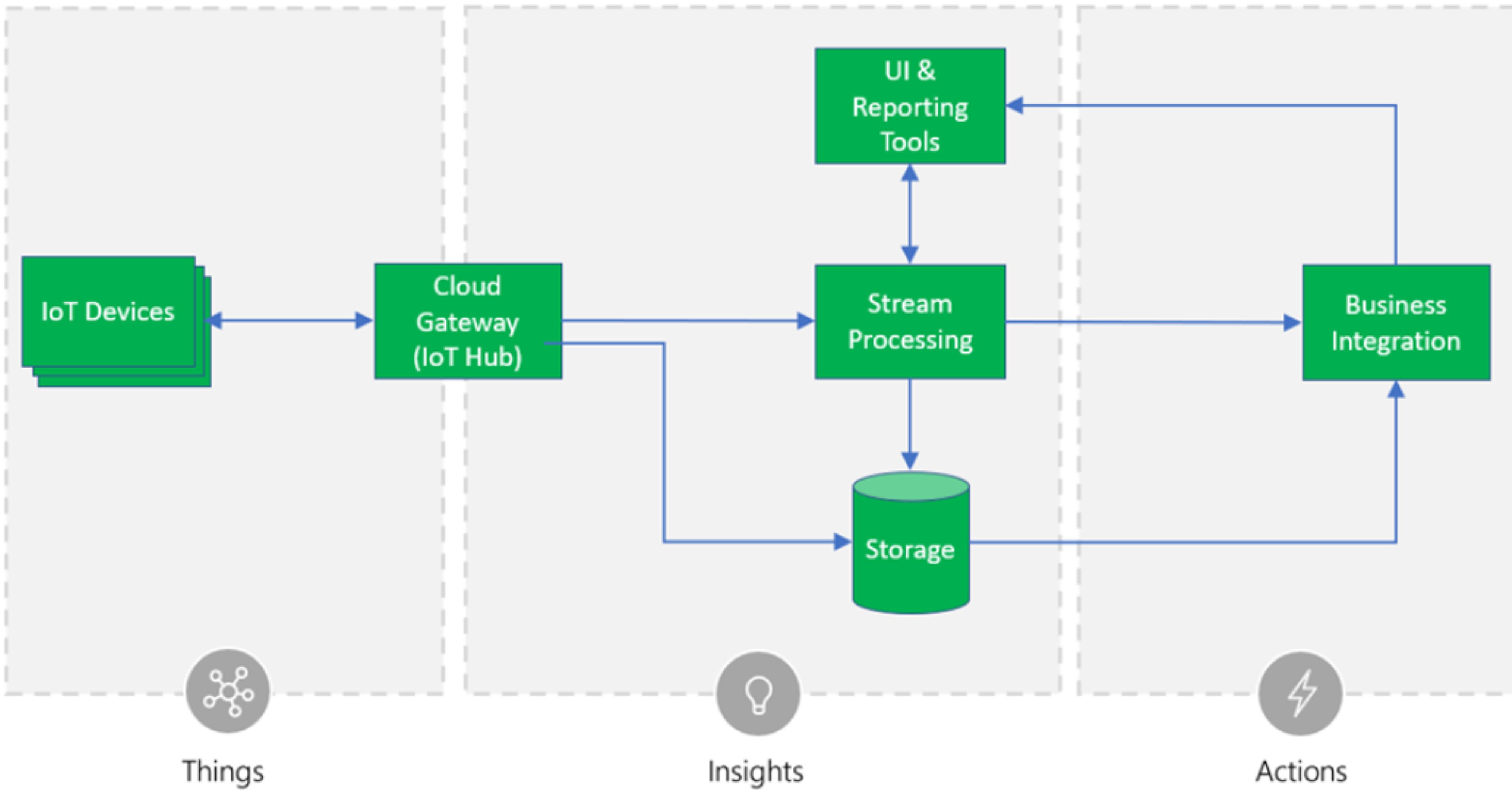
Use Case: Respond and recover quickly

	1	2	3
With fragmented solutions	**Maintain technicians onsite** to determine and resolve issues 	**Take days or weeks** to reroute and reconfigure devices 	**Search for data** needed for root-cause analysis 
With IoT	**Access devices remotely** to diagnose and resolve issues 	**Complete corrections within hours,** including rerouting processes and reconfiguring machines 	**Access comprehensive data immediately** to perform root-cause analysis 

Use Case: Expand, change and scale easily

	1	2	3
With fragmented solutions	**Solve storage on your own** using capacity planning, capital purchases and on-going maintenance	**Connect new devices later** after customizations and integration efforts are complete	**Take weeks or months** to modify and extend systems with custom connections
With IoT	**Exploit cloud solutions** to scale instantly and pay for only what you need	**Connect new devices now** with little or no configuration required	**Add to and extend systems faster** by building on the extensible architecture

Core IoT Architecture



Core IoT Architecture & Non-functional Needs

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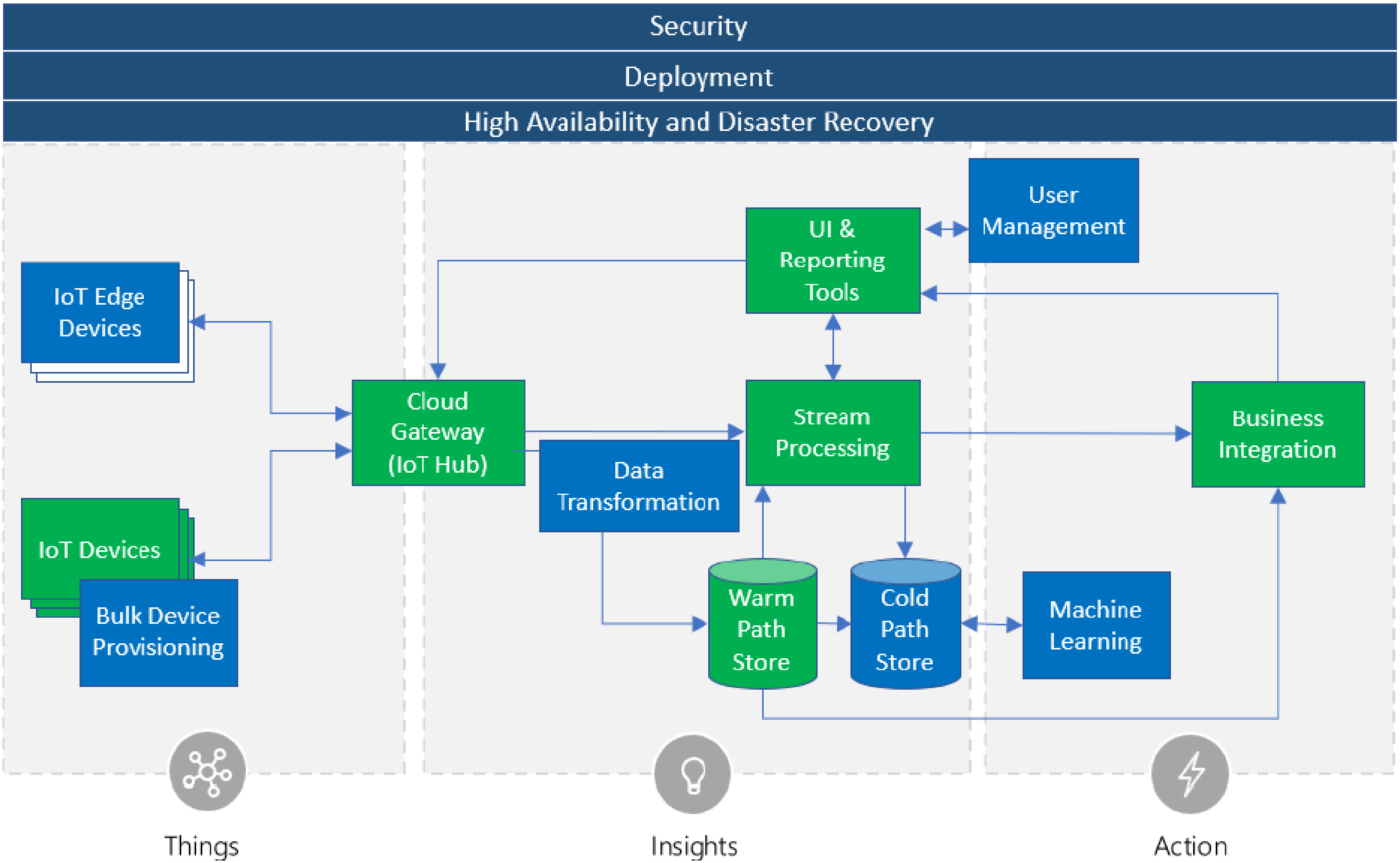

Azure IoT Stack

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Solutions (PaaS)

Azure IoT (PaaS)
Partner repeatable solutions
Azure IoT Solution Accelerators

Solutions (SaaS)

Azure IoT Central
IoT SaaS

Microsoft Dynamics
Connected Field Service

Technologies (PaaS)

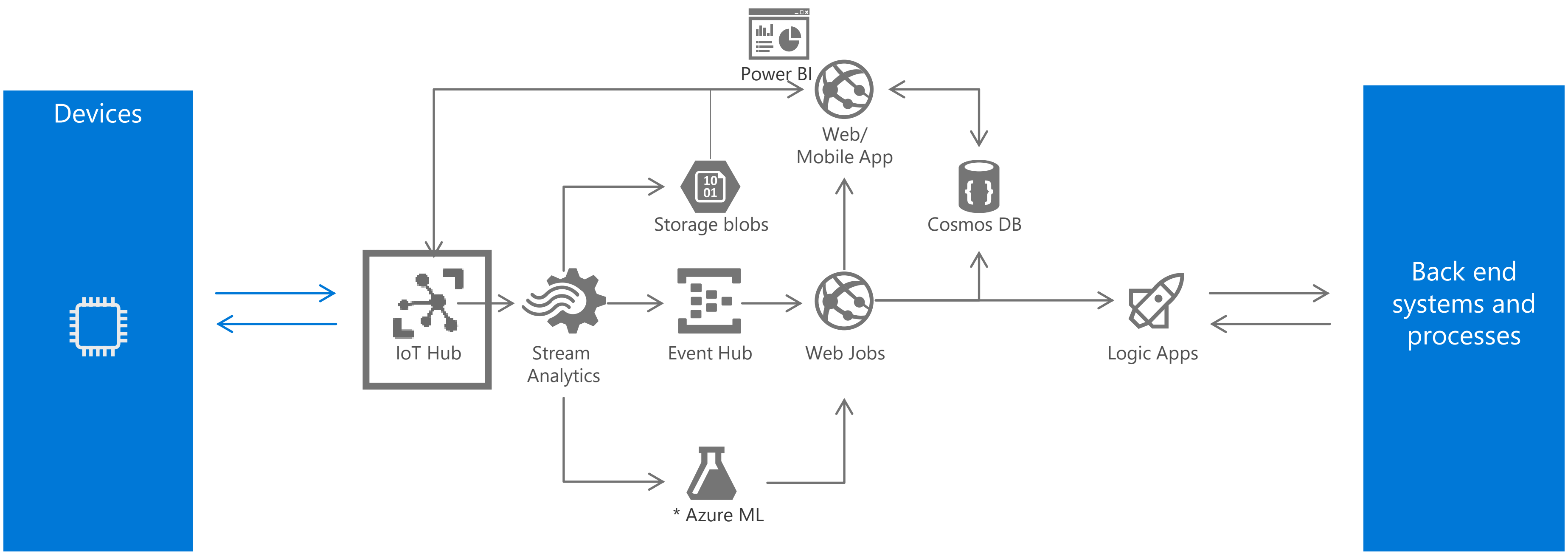
- Azure IoT Device SDK
- Azure IoT certified devices
- Security Program for Azure IoT
- Windows 10 IoT

- Azure IoT Hub
- IoT Hub Device Provisioning Service
- Azure IoT Edge

- Azure Stream Analytics
- Azure HD Insight
- Azure Time Series Insights
- Azure Data Lake Analytics
- Azure Machine Learning
- Azure Data Lake
- Cosmos DB

- Microsoft Flow
- Azure Active Directory
- Azure Logic Apps
- Microsoft Power BI
- Notification Hubs
- Azure Monitor
- Azure Websites

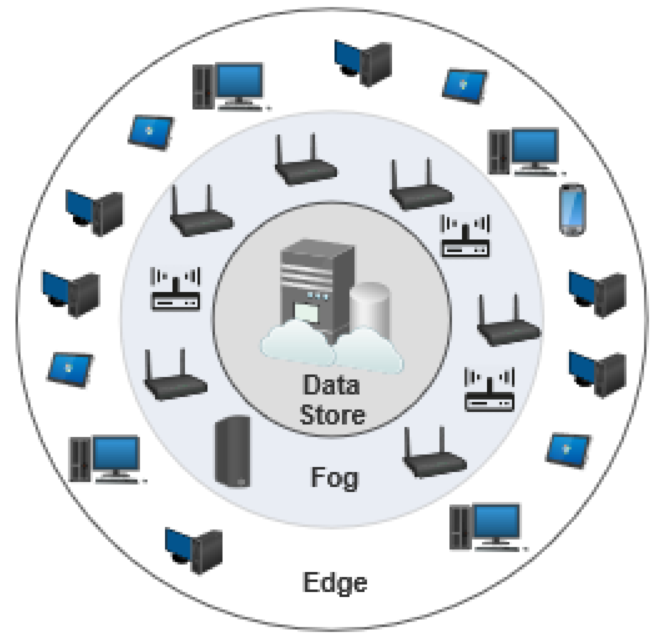
IoT Architecture



Edge-Fog-Cloud Architecture

Edge Layer: The outermost layer of the cloud is Edgelayer. The Edge is a collection of loosely coupled, voluntary and human-operated resources such as desktops,laptops, nano data centers, tablets, etc. As the name suggests, the resources reside at the edge of the network and are within one/two-hop distance from the IoT sensors and clients

Fog Layer: The Fog layer resides on top of the edge and is a consolidation of networking devices such as routers and switches with high computing capabilities and ability to run cloud application logic on their native architecture.



Iot Plattforms

- Amazon Web Services
- Google Cloud IoT
- Azure IoT Suite
- SAP
- Salesforce IoT
- IBM Watson Internet of Things (Bluemix)
- Oracle Internet of Things
- Cisco IoT Cloud Connect
- Bosch IoT Suite
- GE Predix
- Siemens Mindsphere

> *The Internet of Things is not about the things or even the platform the same way we thought about motors or microprocessors. The big winners in IoT will be thinking about an entirely different future, not just connecting to things we already use today in ways we already use them.*

Steven Sinofsky