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Challenges for Future IoT Applications

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Challenges for Future IoT Applications

What is the Internet of Things?



- ▶ All over the world, billions of objects are already interacting and sharing information, such as cars and smartphones. Things are increasingly becoming an active part of the internet.
- ▶ How is this possible? Every “thing” in the world can transmit data to the web and communicate with every other “thing” in order to perform a variety of tasks for its owner
- ▶ On the internet of things (IoT), the physical and virtual worlds are fused
- ▶ Bosch is spearheading the Internet of Things with the sensors, software and services

Challenges for Future IoT Applications

Why is the IoT so significant for business?



- ▶ The IoT is growing rapidly worldwide. For business, this means momentous changes and huge opportunities
- ▶ According to the Gartner research institute, some 6 billion objects worldwide are already connected. By 2020, this number is expected to exceed 10 billion
- ▶ As early as 2020, the IoT market will be worth some 250 billion dollars

Challenges for Future IoT Applications

Bosch and the Internet of Things

Market presence

6.2m

connected devices using
Bosch IoT Suite



Know-how

800+

IoT experts around the world (Germany,
Bulgaria, Singapore, China, Japan, USA)



Experience

250+

IoT international projects in the areas of
manufacturing, mobility, energy, home &
building, city, agriculture ...



Mobility

Solutions for
electromobility, intermodal
transportation,
and connected
vehicles



Industry

Solutions for
connected
manufacturing



Agriculture

Solutions to
support the
sustainable
intensification of
food production



Energy

Solutions for
smart and
simple energy
management



Smart
Home &
Building

Solutions for
connected
homes and
commercial
buildings



Smart City

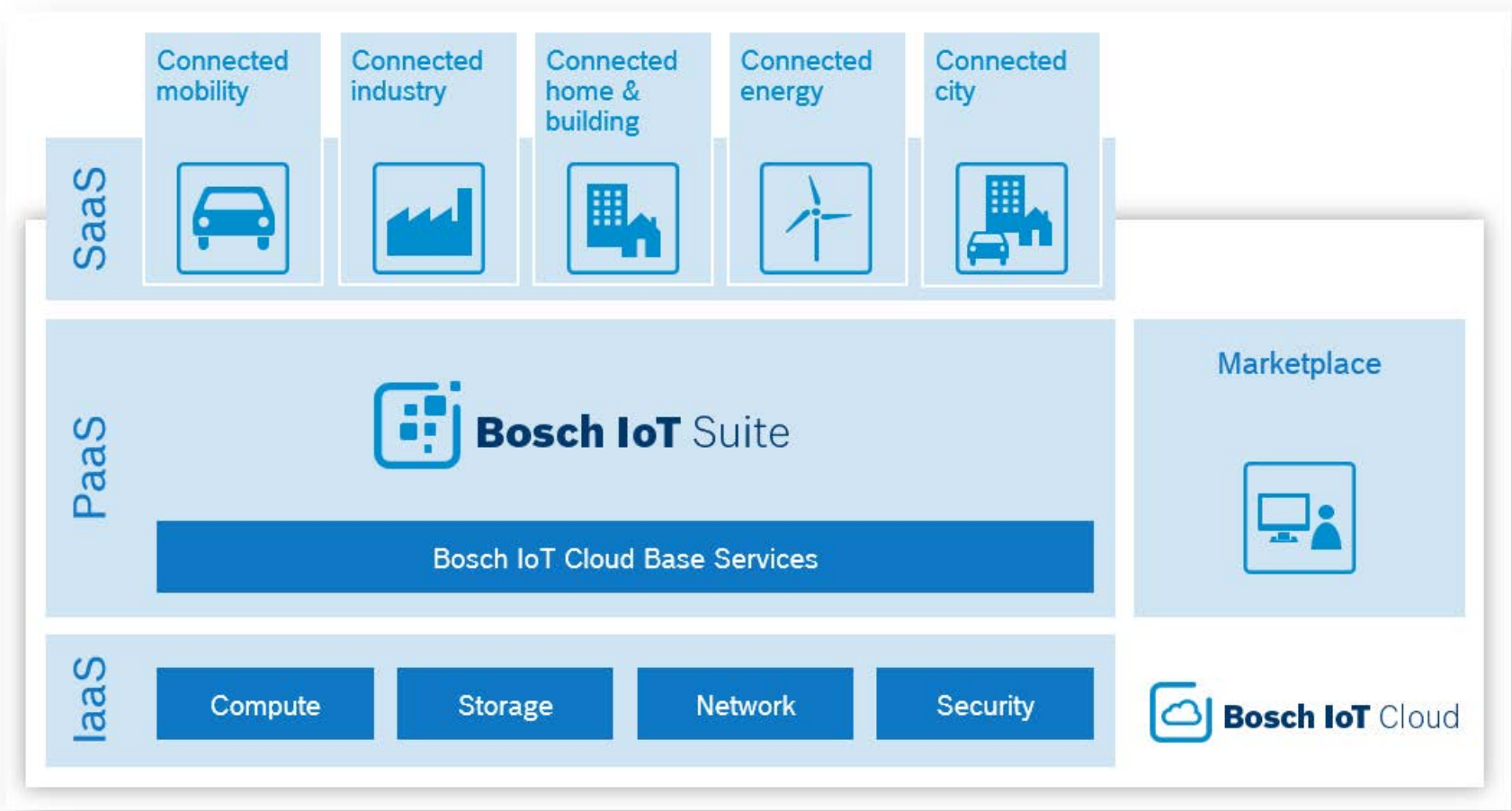
Connected
solutions for
urbanites to
make life easy
and efficient



Bosch IoT Suite

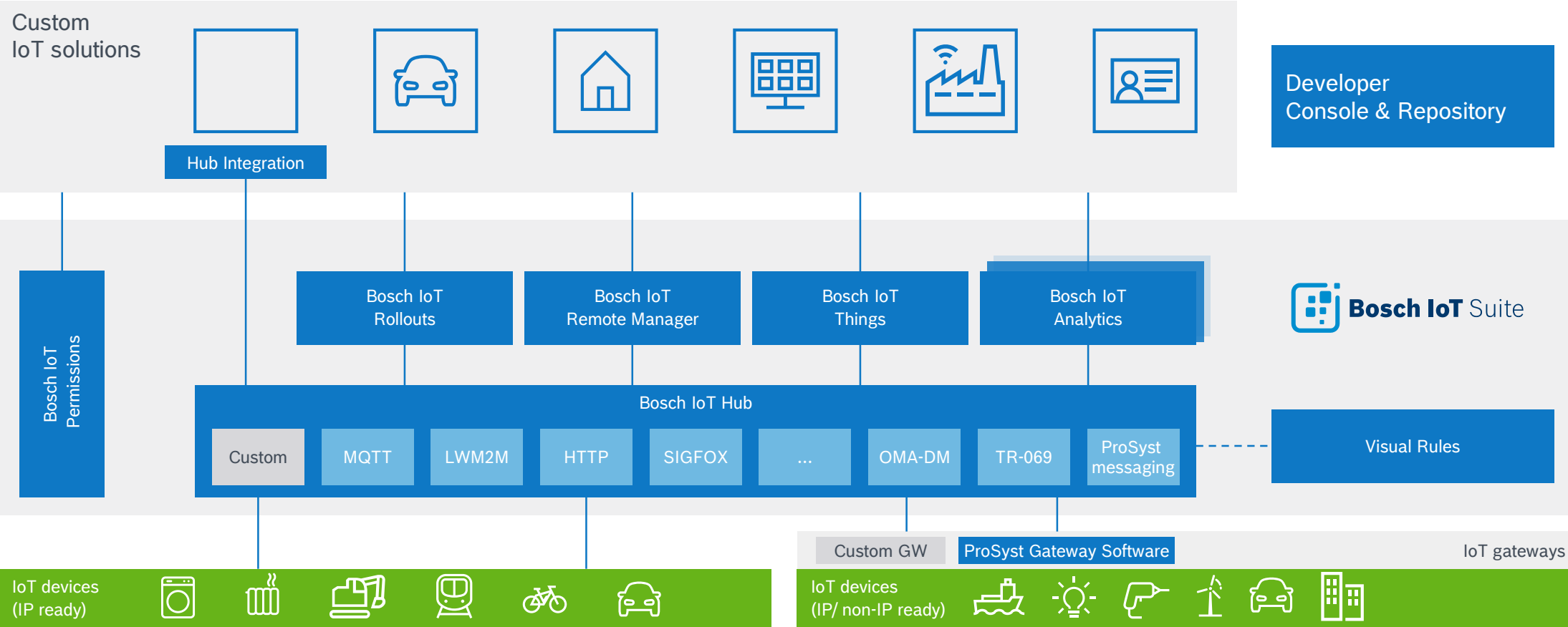
Challenges for Future IoT Applications

Bosch IoT Cloud



Challenges for Future IoT Applications

Bosch IoT Suite: High level architecture



Challenges for Future IoT Applications

IoT Applications @ Bosch



Mobility

- Fleet Management
- **Community-based Parking**
- eCall
- Pay as you Drive (Insurance)



Industry 4.0

- **Connected Logistics**
- IoT Gateway for Machines
- Remote Shopfloor Access
- Predictive Maintenance
- **Production Perf. Manager**



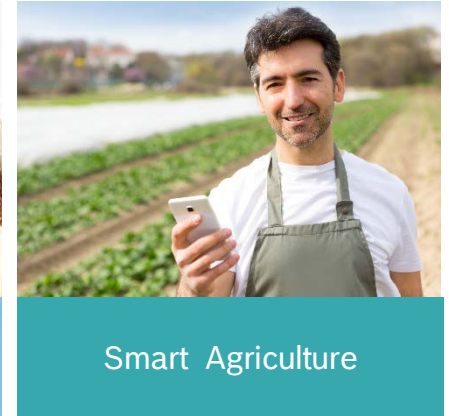
Building Technology
(Heating, Smart Home,
Security Systems)

- Connected Heating
- **Bosch Smart Home**
- Connected Security (Fire / Smoke Detectors IP Cameras)



Household
(BSH)

- Bosch Home Connect API
- Dishwashers
- Fridges
- Washing Machines
- Cooking and Baking
- Vacuum Cleaning

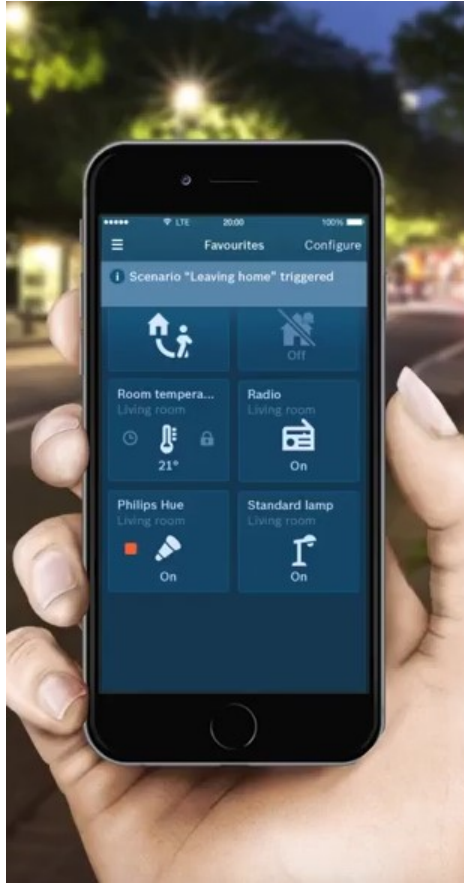


Smart Agriculture

- Asparagus sensors
- **Smart Oysters**

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Bosch Smart Home



Key Facts

- Secure system: extended security of gateway, data stored locally not in cloud
- Easy setup: just scan QR code on sensors/actuators to setup a new device
- Ease of use: Easy to use app for the Smartphone
- Scenario Manager: control many devices by setting up your own scenarios via the app

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Smart Oyster Harvesting

Conventional oyster harvesting



If harvested at the wrong time, oysters can be dangerous to eat
Regulators conservatively control harvesting via coarse rainfall data



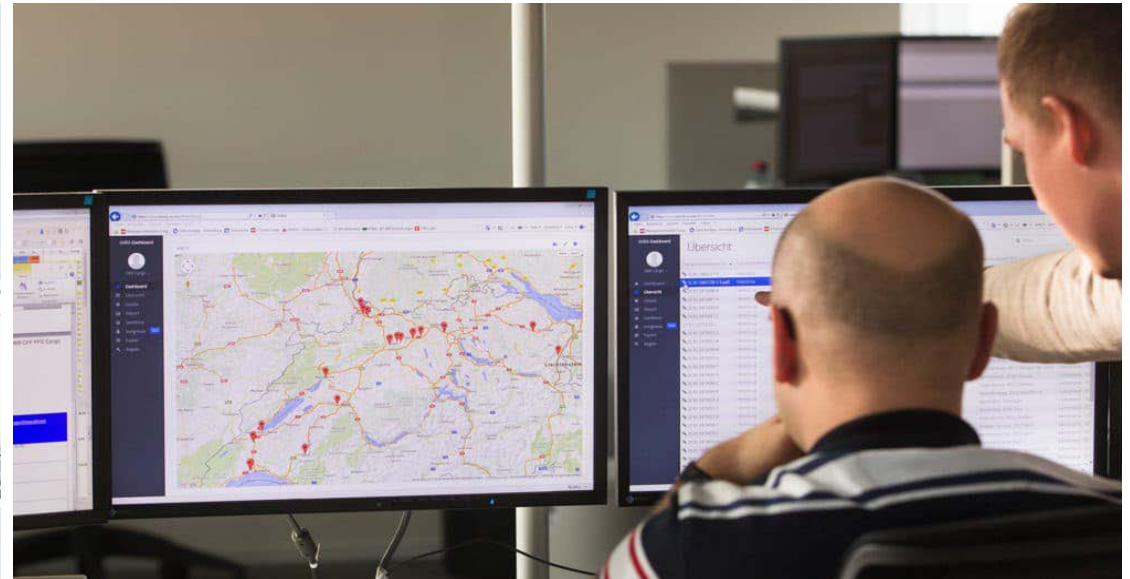
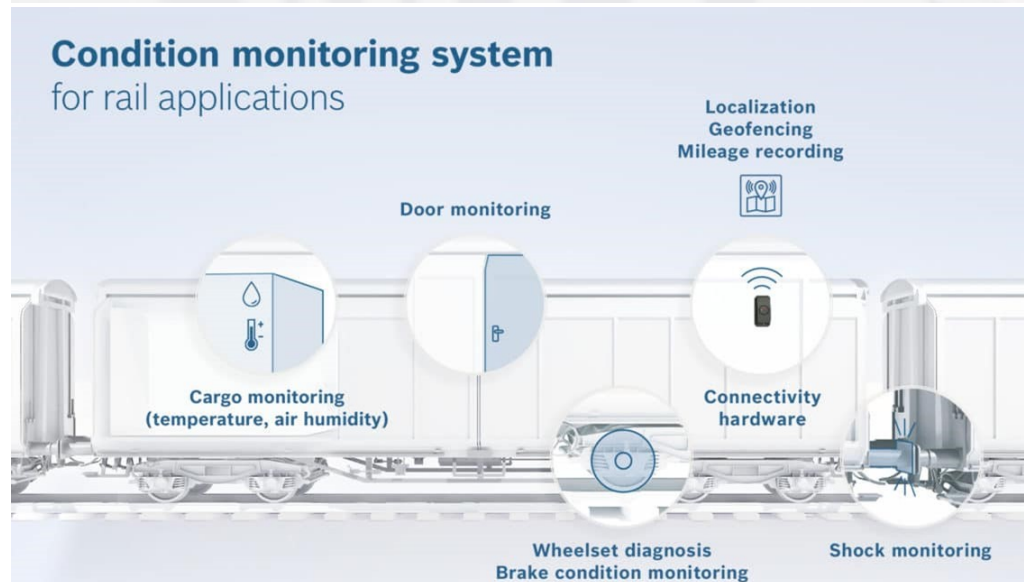
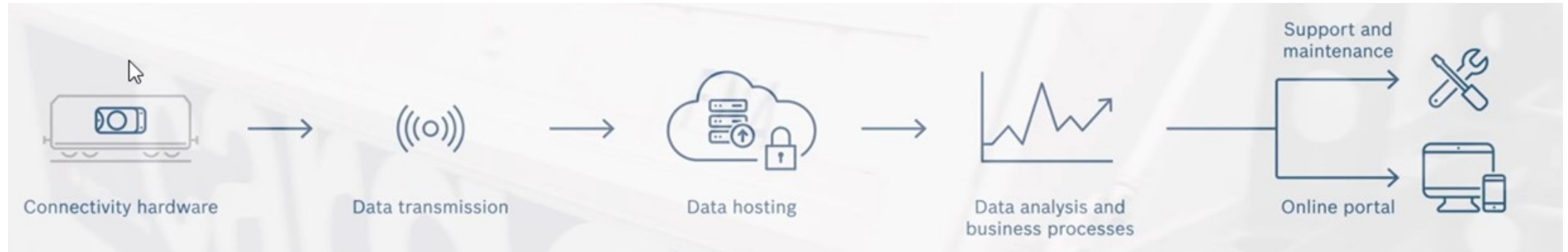
BETTER DECISIONS BETTER HARVESTING BETTER YIELD

The Yield & Bosch innovation project



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Connected Logistics: Location and Condition Monitoring of Trains



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Industry 4.0: NEXEED Production Performance Manager



Shop floor data

Nexeed Production
Performance Manager

Actionable insights for
manufacturing expert



Condition Monitoring



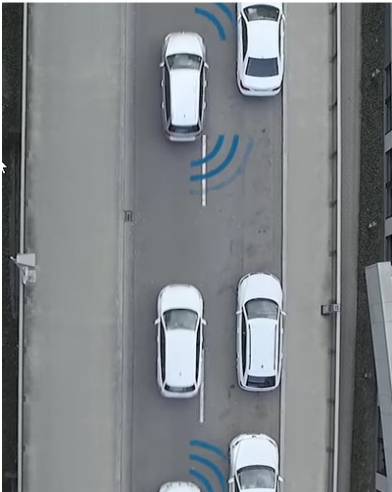
Predictive Maintenance



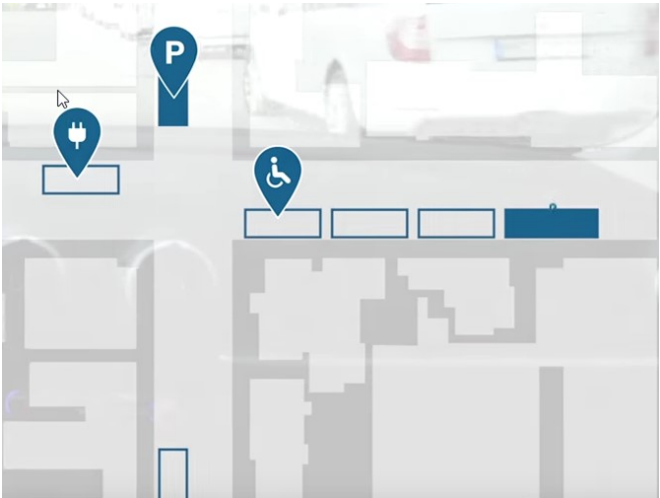
Live Process Data Analysis

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Mobility: Community Based Parking



Detect parking spots by vehicle sensors



Analyze data and generate parking map with occupied and free parking spots



Distribute information to other cars that are searching for parking spaces

Challenges for Future IoT Applications

Overview of Challenges

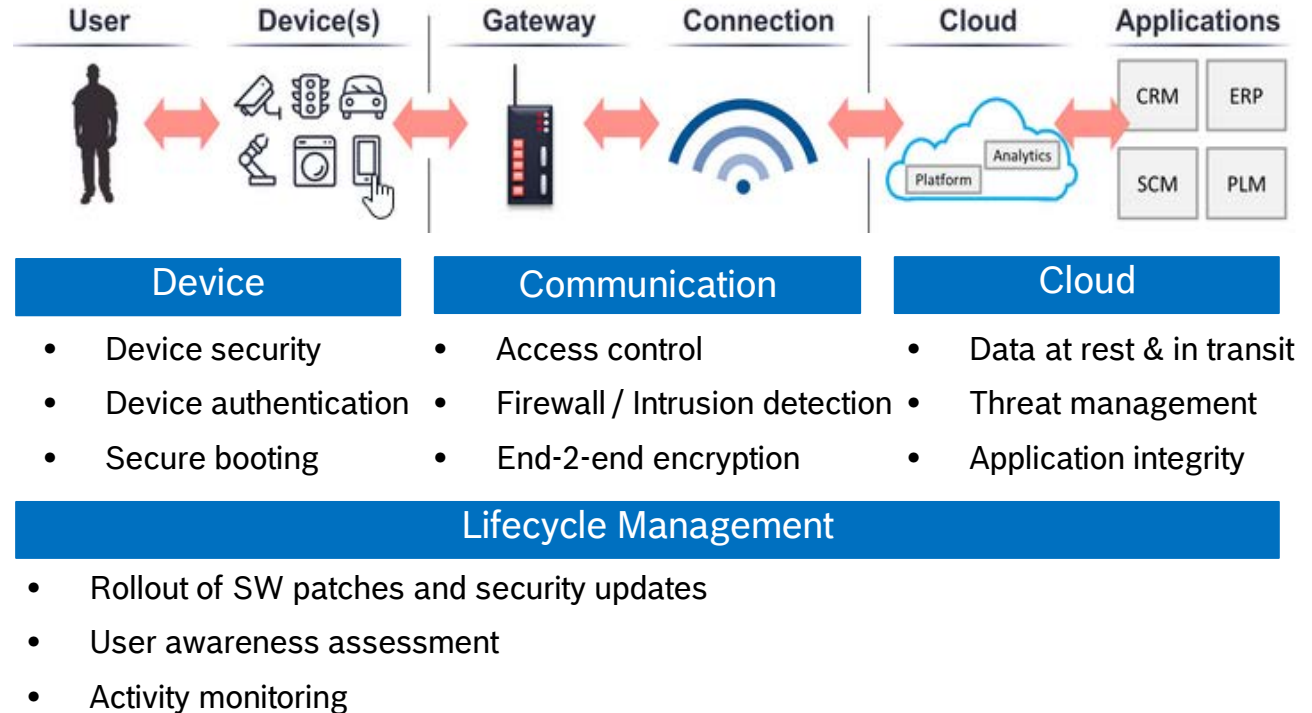
- ▶ Challenge 1: Security
- ▶ Challenge 2: Scalability
- ▶ Challenge 3: Resilience and Reliability
- ▶ Challenge 4: Data Integration
- ▶ Challenge 5: Intelligent Data Analytics

Challenges for Future IoT Applications

Challenge 1: Security

Security Challenges

- Large attack surface due to distributed nature of IoT applications (user, device, gateway, connection, cloud, application)
- How to manage frequent update of IoT devices?
- Compromised IoT devices can be used for severe DDoS attacks
→ device security is highly important
- Protection of data at rest, in motion and during computation



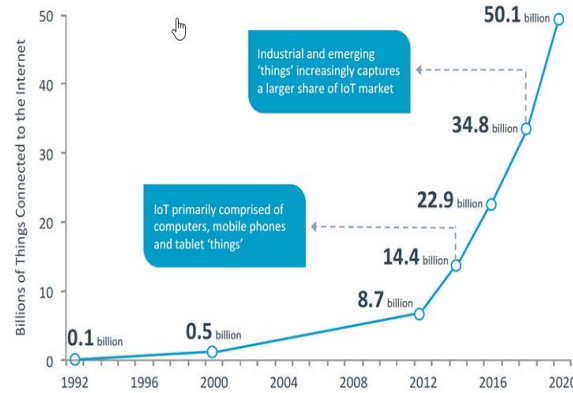
IoT Security requires a comprehensive approach

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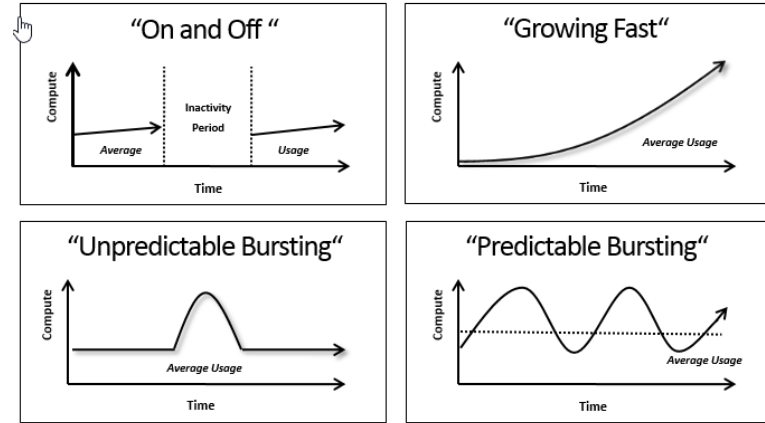
Challenge 2: Scalability

Scalability Challenges

- Exponential increase in IoT devices and explosion of data being sent by the devices leads to high load on cloud backend
- Workload patterns are often unpredictable and can change frequently
- State of the art auto-scaling is not sufficient due to limited configurability and cost limits for IoT applications
- Many systems still contain components that do not scale (→ bottlenecks)



Exponential increase of devices



Unpredictable and changing workload

Cloud Application



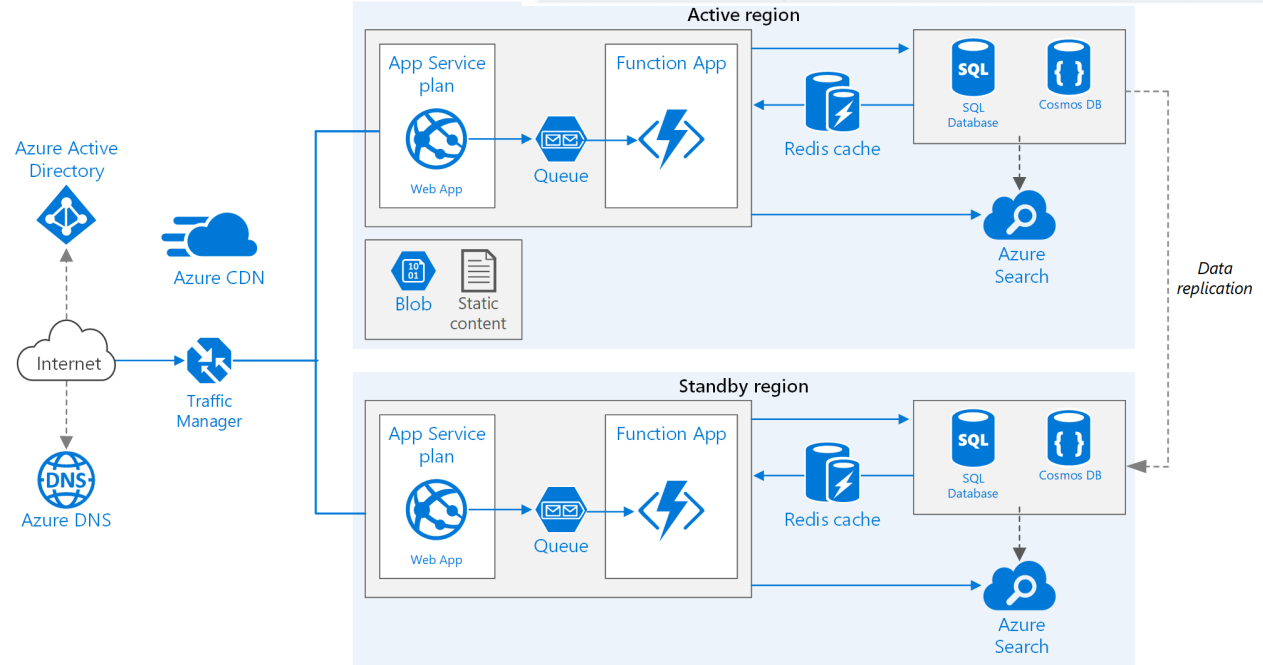
New and more intelligent approaches are required to achieve real scalability for all IoT applications

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Challenge 3: Resilience and Reliability

Resilience and Reliability Challenges

- IoT applications are often not designed wrt. resilience but more and more IoT applications are becoming safety-relevant (e.g. eCall, I4.0 appl.)
- Cause-effect-chains and failure propagation often not clear due to complex infrastructure, layered structure (IaaS, PaaS, SaaS) and multiple vendors
- Redundancy and fault-tolerance mechanism not implemented correctly and failover not tested thoroughly



Amazon Web Services
@awscloud

Follow

S3 is experiencing high error rates. We are working hard on recovering.

RETWEETS
127

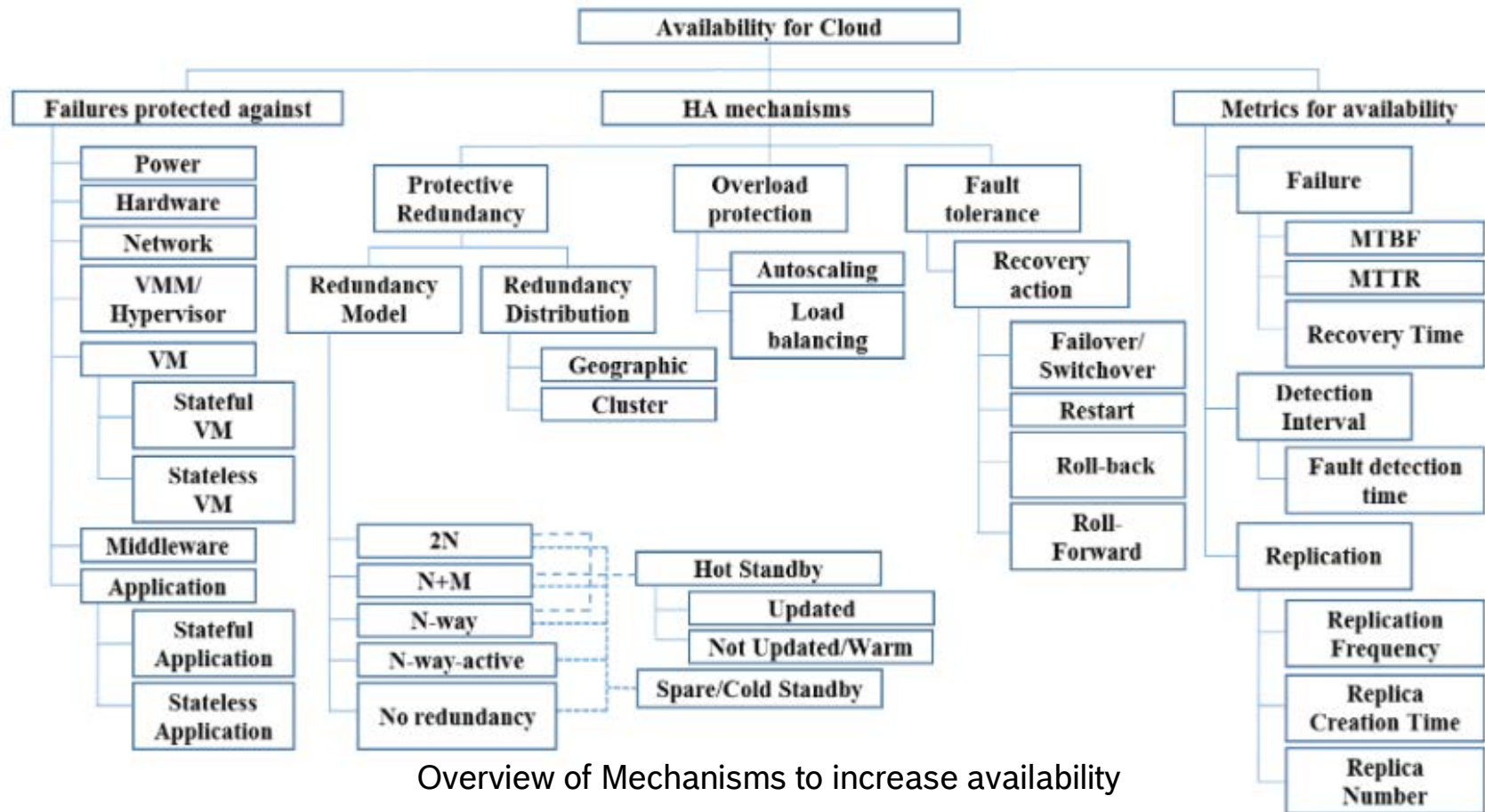
LIKES
51



Making IoT applications resilient requires new approaches such as self-adaptation and self-healing

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Challenge 3: Resilience and Reliability

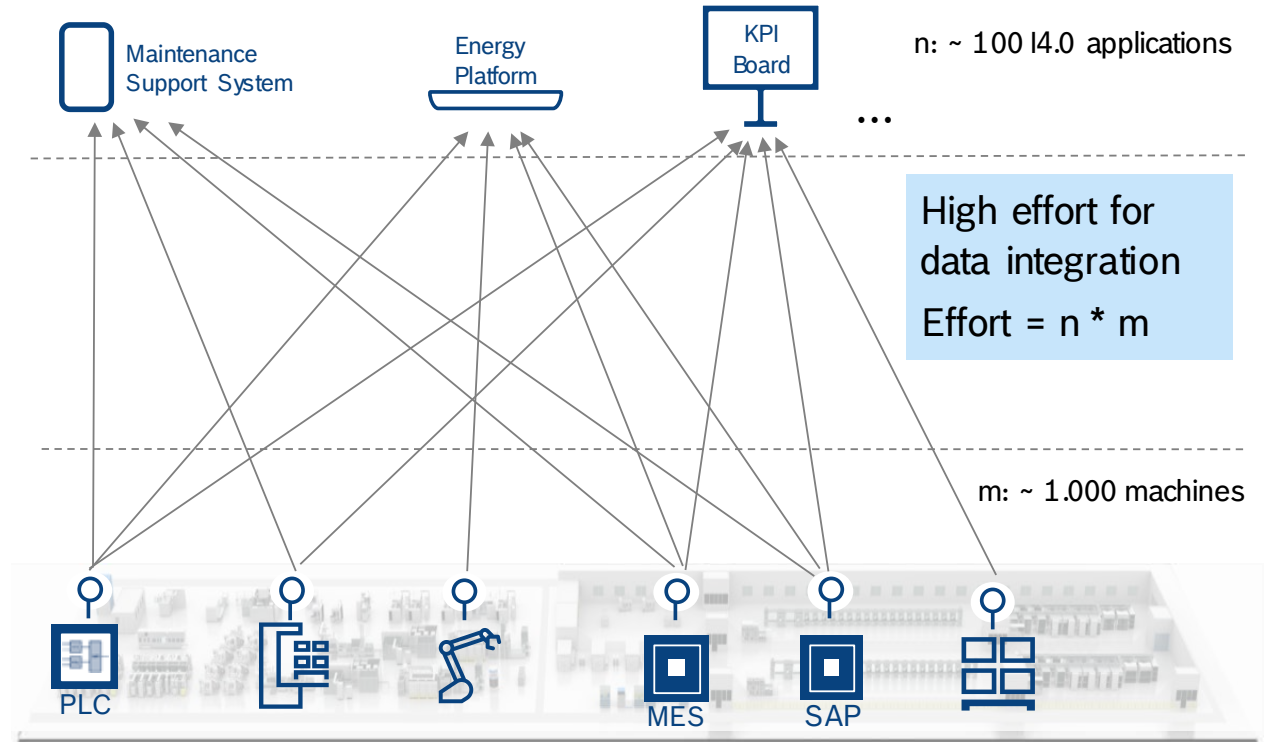


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Challenge 4: Data Integration

Data Integration Challenges

- Large number of heterogeneous data sources (e.g. machines, sensor data, IT systems)
- IoT applications require an integrated view
- High effort for extracting, loading and transforming data for IoT applications (80% of development effort spent on ETL)
- No schema available for data sources

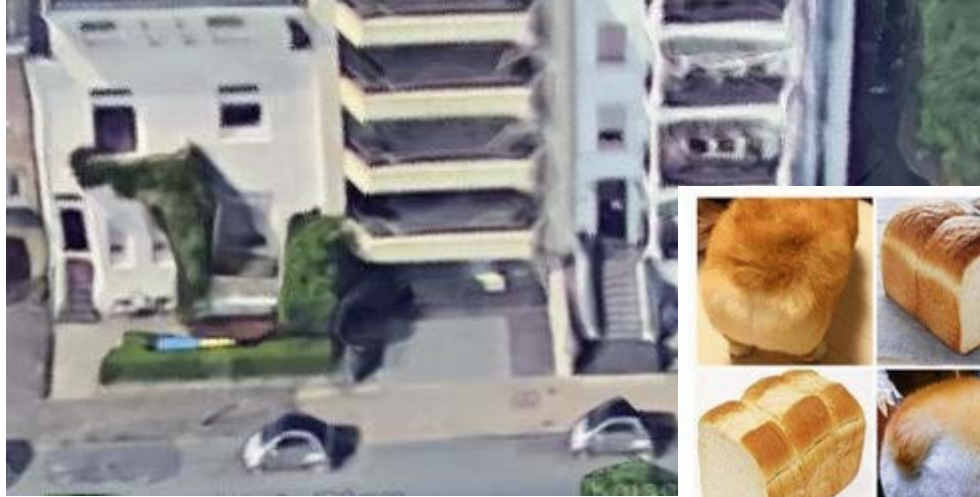


Challenges for Future IoT Applications

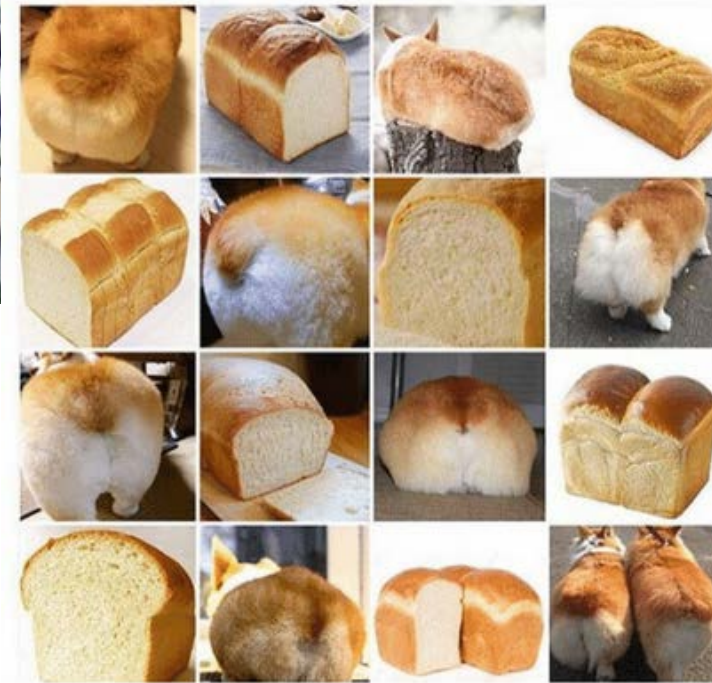
Challenge 5: Data Analytics and Artificial Intelligence

Data Analytics Challenges

- Sometimes not enough data available for analytics and AI
- Predictions learned by data analytics and AI sometimes not appropriate (e.g. multiple users of a smart home system)
- Adversarial examples for AI leading to wrong assumptions (e.g. can be fatal in case of autonomous driving)
- Data analytics and AI require a lot of computing power often not available on resource constrained IoT devices



Entrance or parking spot?



Butt or bread?

Challenges for Future IoT Applications

From Challenges to Research Topics

Challenges

Security
Scalability
Resilience and Reliability
Data Integration
Intelligent analytics

Research Topics

Real-time intrusion detection
Serverless-computing
Performance analysis
Self-adaptation and -healing
Service meshes
Edge computing
Semantic data access
Runtime management
Overload protection

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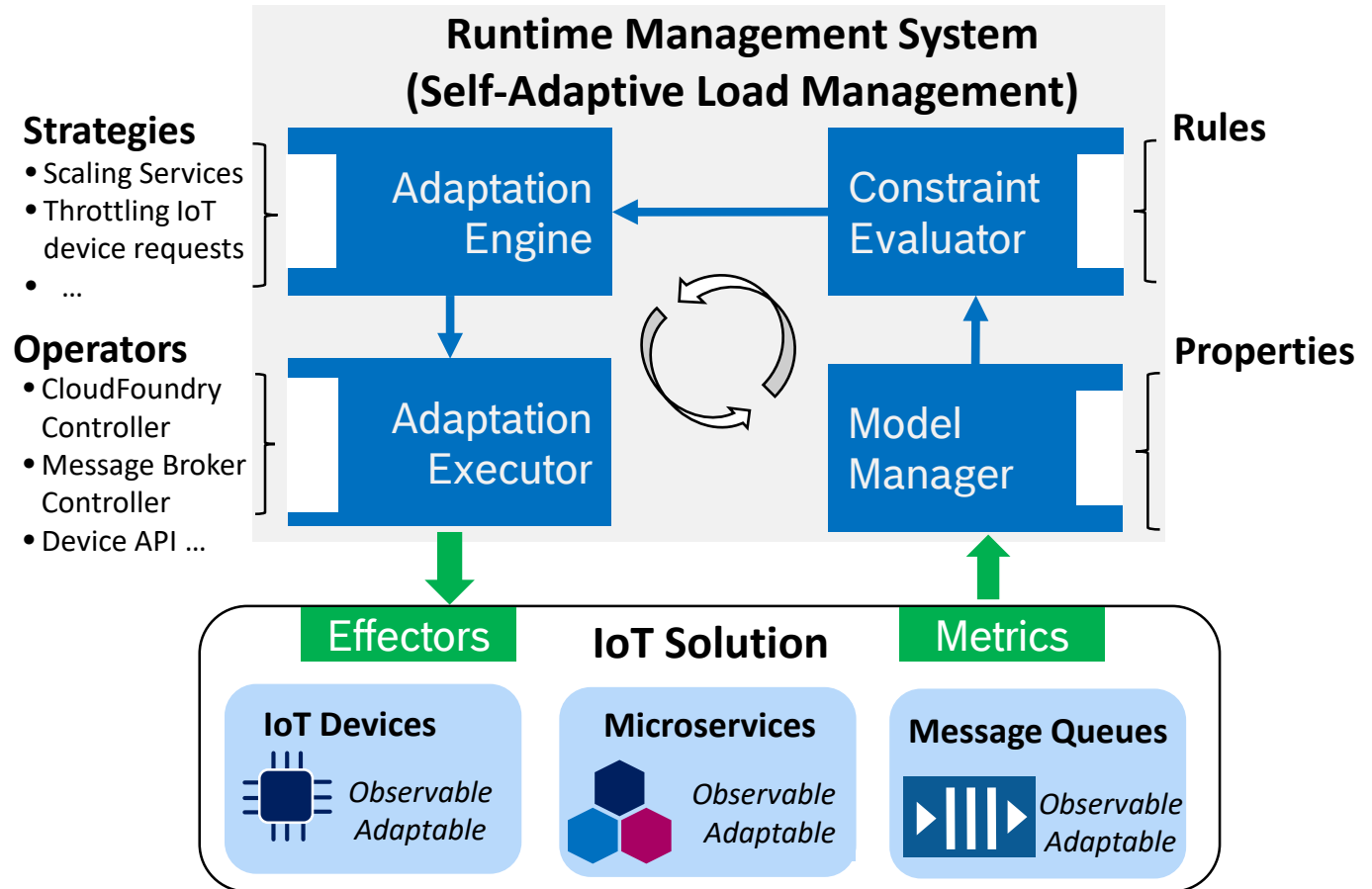
Research Topic: Runtime Management for IoT Applications

Contributions

- » *Inclusion of **IoT devices*** (e.g. throttling of device requests in overload situations of cloud backend) in the adaptation process.
- » *Automated Self-adaptation of IoT Solution* during runtime without required manual work or human intervention.

Benefits

- » *Increased level of automation* by automated execution of mitigation actions
- » *Increased service availability* by prevention of overload situations and failure of critical infrastructure services due to automated scaling of resources and IoT device throttling



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Research Project: MOSAIC

► Modelling, Design and Simulation of Self-Adaptive Systems in the Cloud (11/2018-10/2021)

► Joint BMBF project

- University of Stuttgart (Prof. Steffen Becker)
- FZI Karlsruhe (Dr. Jörg Henss)
- Robert Bosch GmbH – Corporate Research (Dr. Felix Lösch)



► Focus Topics

- Elasticity (scalability) and resilience (fault-tolerance, availability)
- Self-adaptation of IoT systems
- Modelling, simulation and runtime-management

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Summary and Conclusion

► Summary

- Internet of Things is disrupting our life
- The IoT provides many useful applications
- However, as IoT is becoming more and more a part of our live the challenges have to be solved to let the vision of a connected world become true

► Conclusion

- Making IoT applications secure, scalable and reliable is a **really challenging task**
- IoT provides **many interesting research topics**
- Let's discuss **research topics** in the **breakout sessions**

THANK YOU

