Keynote

The role of context-aware Edge computing on supporting large-scale people-centric IoT environments

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About fortiss
Research Institute of the Free-state of Bavaria for Software Intensive Systems – Associated to the Technical University of Munich
http://www.fortiss.org

- **Legal form:** non-commercial limited company
- **Foundation:** 2009
- Shareholders: Free State of Bavaria (2/3) and Fraunhofer-Gesellschaft (1/3)
- 2 locations in Munich, 173 researchers

Autonomous Systems
Blockchain Business Models
Human-centered Engineering
Industrial IoT Information Management
Cognitive Structures Robust AI Machine Learning
Human-Robot Interaction Performance Engineering
Software and Systems Engineering
Safety and Security Service Engineering
Decentralized Services Neuro-morphic Computing
Requirements Engineering
Service Engineering
Open Data

Manufacturing  Automotive  Aeronautics  Energy  Smart Cities, Agriculture, etc.
Industrial Internet of Things
-Enabling next generation IIoT Applications-

| Decentralized Edge Computing | Edge/Fog architectures & service orchestration
|                           | Reduced latency & increased efficiency
|                           | Cross-platform interoperability

| Real-time System Adaptation | Semantic integration of brownfield devices
|                            | Artificial Intelligence on the edge (Edge AI)
|                            | Dynamic container orchestration

<table>
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<th>In-network Computation and Analytics</th>
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<td>• In-network processing for control</td>
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<td>• More flexible infrastructures</td>
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<td>• Adaptive computation</td>
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Aims
• Novel communication & computation architectures for IIoT (OSI Layers 2 to 7)
• Efficiently, robustly, and possibly predictively deploy and orchestrate services
• Seamless computing for decentralized IIoT services

Our Offer
Architecting Edge-Cloud Support
• Open-source edge/server gateways
• Semantic integration of brownfield devices
• Dynamic container orchestration (e.g., Kubernetes, Docker Swarm)

Supporting Intensive IIoT applications
• Performance improvement and analysis of communication protocols (e.g., MQTT, Sparkplug, OPC-UA, DDS)
• Adaptation of the infrastructure to better support service decentralisation

Training Aspects
• Hands-on workshops on IIoT
• Technical mentorship on advanced IIoT software
Isolated Villages

Spontaneous Communications infrastructure

Isolated People

Lack of Telecommunications

Telecommunication Network

Exploiting any long range communication capability

Local Communication in Emergency Area

Understanding the Edge: Internet of Things

What is the Internet Today?

Which functions?

- Mobile devices, increasing complex computational capability:
  - Storage
  - Computing
  - Smartness
  - Communication (4G-7G, Wi-Fi6/7/..., LoRa/LoRaWAN/SigFox...)

What else is required?

- Local data exchange, independently of available communication/interconnection.
- Independence from device identifier
- Understanding and use of a device/Thing context
Edge and Service Decentralisation

Industrial IoT Example

Data Capture

Data Communication/Processing

Data processing

Industrial Plants, shop-floors

Greenfield devices

Critical applications

Different protocols

IoT Gateway, Broker(s)

Data filtering

Basic analytics

Data visualization

Real-time data processing

Field gateway

Device to device communication

Fog/Edge

Cloud

Big data processing

Business logic

Data warehousing

HTTP,
Edge and Service Decentralisation

1. Software-based Edges (micro-service architectures; containers)
   - Portable
   - Embedded
   - Integrating physical and virtual sensors
   - Support for intermittent connectivity and mobility
     - Context-awareness, decentralised learning
     - And, new networking architectures (5G/6G but also Delay Tolerant Networking, Information-centric Networking)

Smart Villages/Smart Cities Dienste
Web-basiert

Consumer IoT Example

Edge (Home)

Edge (on the go)

Edge System

Secure data exchange Edge–Cloud
Where next?

Vision

IP Backbone

Service A

Service B

Cloud

On-demand Cross Platform Services

Near Edge

Edge

Far Edge

Customer devices
End-user, field-level

Space (carrier)

Service C

Service D

Space (sensing)

On-the-go

Home/Work

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Context-Awareness

- What is context-Awareness for IoT? And what for?
- Which indicators to consider?
- How to best integrate context? (application to networking layers; decentralisation support)


Decentralised Smart Edge for IoT

Directions

i) Distributed learning approaches; adaptation of ML models to best serve IoT constraints, mobility, intermittent connectivity

The networking infrastructure needs to become more flexible, intent and context-driven, i.e., the network should be seen and worked upon as being a single system (*the network is the computer*)

*John Gage, at Sun Microsystems.*

IoT systems need to be capable of performing real-time system adaptation, e.g., integration of new IIoT devices (or new IIoT microservices) in real-time or with bounded, very low latency, while supporting other types of real-time traffic, e.g., high-definition video

The smallest devices and machines around us are able to sense, learn from, and respond to their surroundings

These follow a social behavior

Context is needed for QoE and not just QoS

Context-awareness needs semantic models/semantic abstractions of Things

Joint computational and networking paradigms, that integrate, by design, aspects such as security/trustworthiness, mobility support, decentralised and flexible naming spaces.

Joint service composition is required
Many thanks.

Any questions?
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