

5G.NRW

Competence Center



Architecting 5G Applications

Marc Hesenius

Universität Duisburg-Essen





- Research Focus
- Cognitive Computing
- Cyber-Physical Systems
- Mobile Applications

- Spin-Offs



Interaction Room®
communicate · understand · decide

<https://www.interaction-room.de>



<https://campus-lab.de>



Agenda

Cloud Computing



Fog Computing



Edge Computing



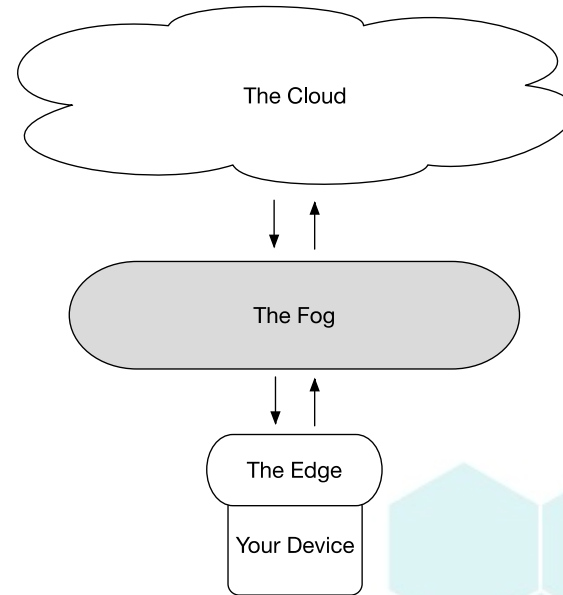
What's this all about?

Images from <https://pixabay.com>



Overview

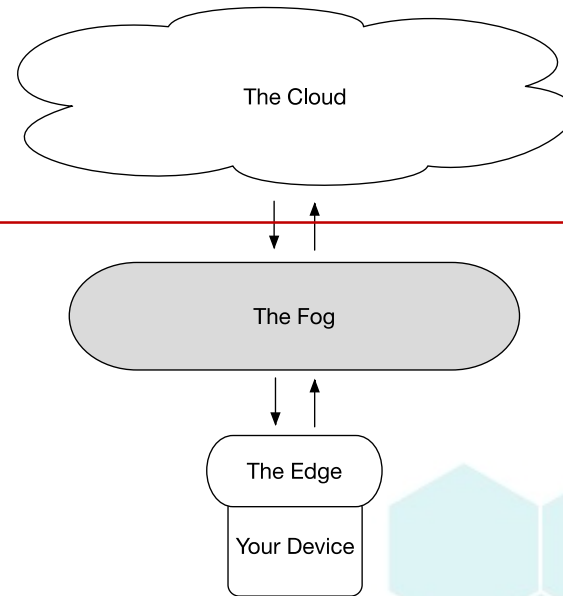
- Cloud
→ Global (company) network
- Fog
→ Local network
- Edge
→ Your device





Overview

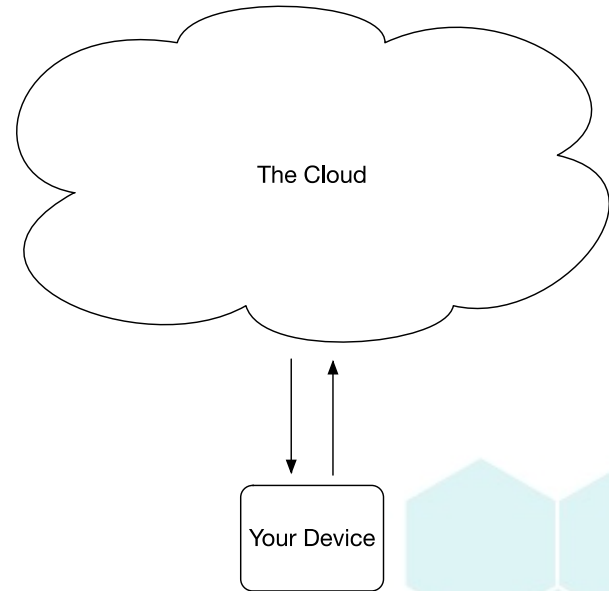
- Cloud
→ Global (company) network
- Fog
→ Local network
- Edge
→ Your device





Cloud Computing

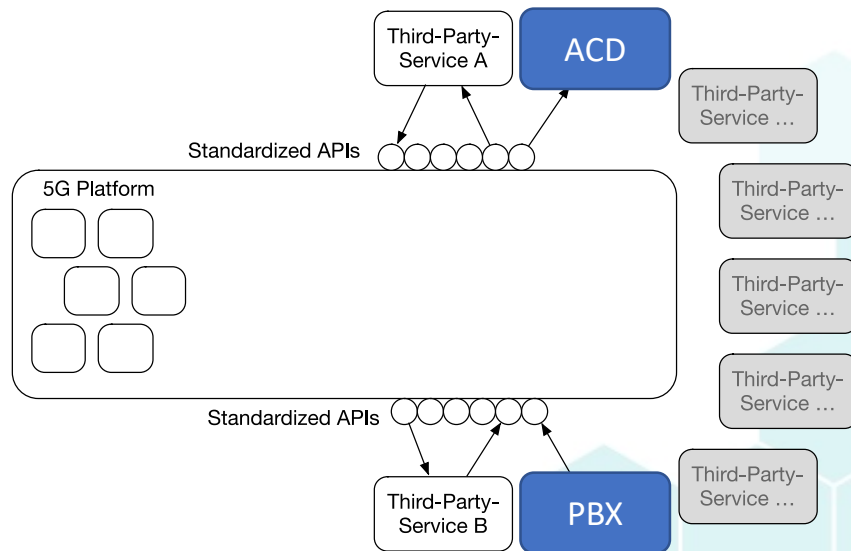
- Calculations, data storage, etc. is done somewhere **in the cloud**
→ You never know where!
- Lots of computing power, storage space, etc.
- Enables IaaS, PaaS, SaaS, etc.





Cloud Computing – Service Marketplaces

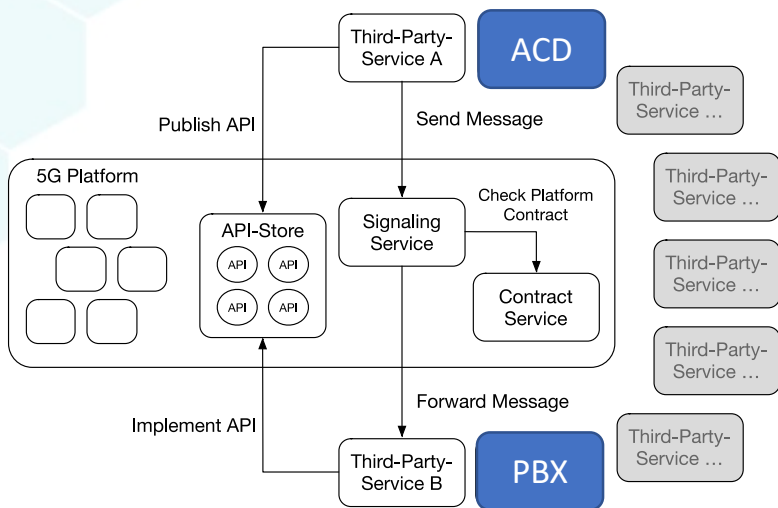
- Services interact via standardized interfaces defined by the platform provider
- Platform provider is a *bene-volent dictator* in the eco system
- Top-Down Standardization*
 - Requires market power
 - Requires compliance from service providers
- 100% compatibility guaranteed



Based on Hesenius et al. „A flexible platform architecture for the dynamic composition of third-party-services“ 2019 IEEE International Conference on Software Architecture Companion (ICSA-C), Hamburg, Germany, pages 210–217, DOI: 10.1109/ICSA-C.2019.00044



Cloud Computing – Service Marketplaces



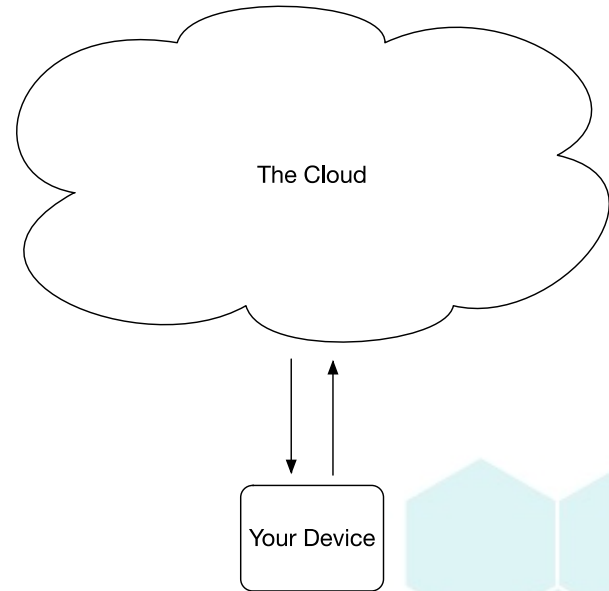
- Alternative:
Bottom-Up Standardization
- Core components
 - API-Store: Database containing APIs from service providers interested in interaction
 - Signaling Service: Distributes messages between services depending on implemented APIs
- Compatibility not guaranteed, but market-driven competition for *best APIs*

Based on Hesenius et al. „A flexible platform architecture for the dynamic composition of third-party-services“ 2019 IEEE International Conference on Software Architecture Companion (ICSA-C), Hamburg, Germany, pages 210–217, DOI: 10.1109/ICSA-C.2019.00044



Cloud Computing

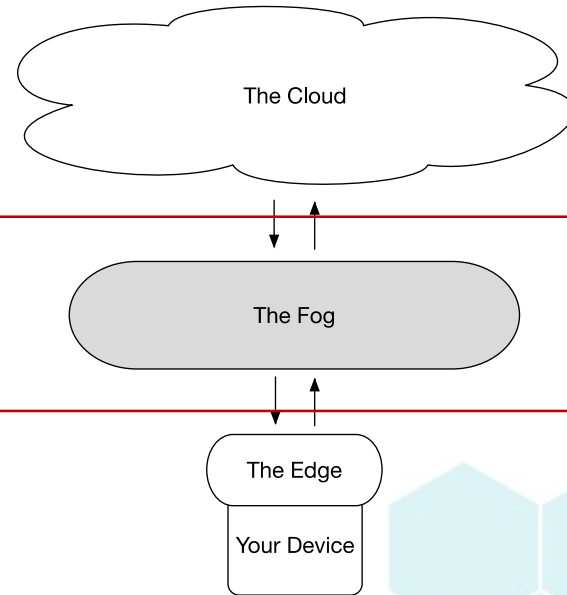
- Calculations and storage costs
 - intransparent billing
 - Vendor lock-in
- Privacy issues
- Latency issues





Overview

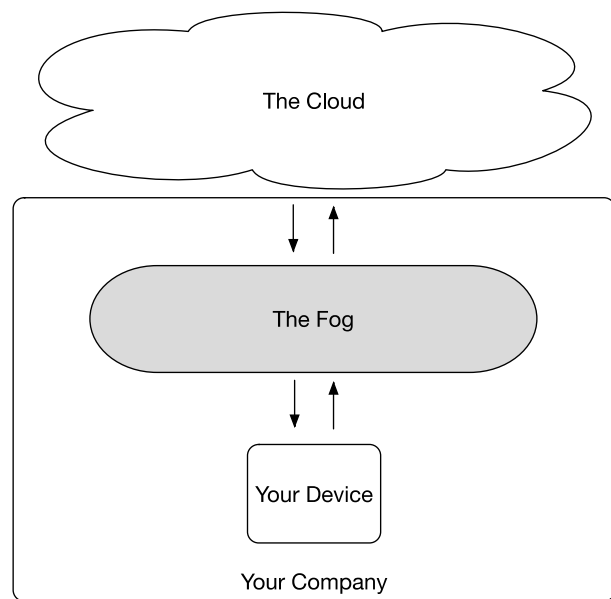
- Cloud
→ Global (company) network
- Fog
→ Local network
- Edge
→ Your device





Fog Computing

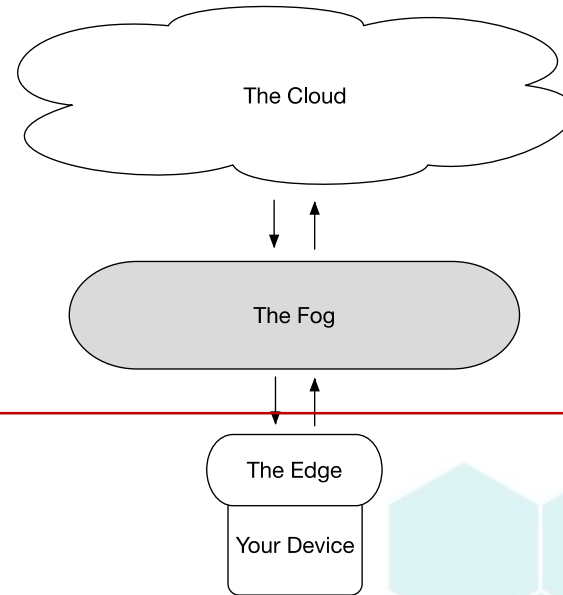
- ◆ Introduces a decentralized layer at the edge of your network
→ multiple instances
- ◆ Mediates information between your devices and the cloud
- ◆ Preprocesses information and reduces latency
- ◆ Distributed system with (potentially) multiple error sources





Overview

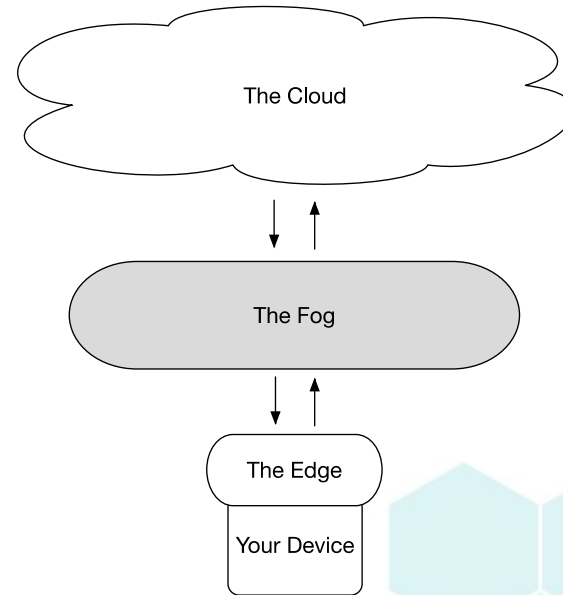
- Cloud
→ Global (company) network
- Fog
→ Local network
- Edge
→ Your device





Edge Computing

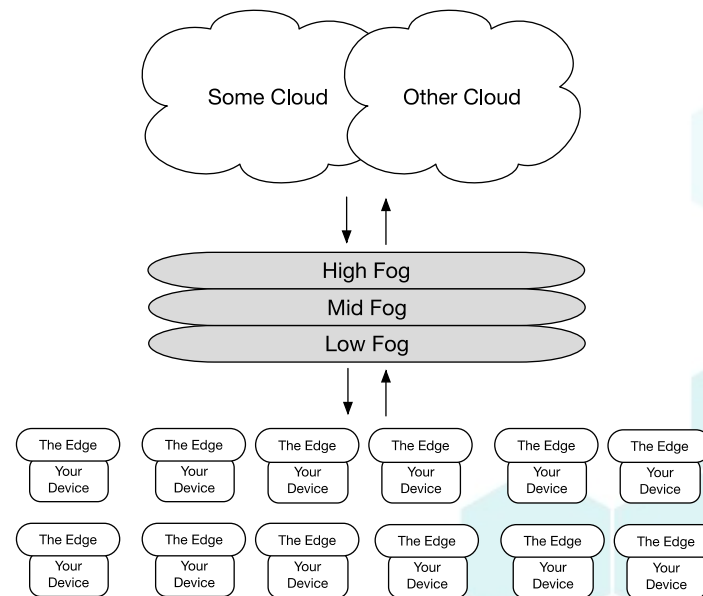
- Data is processed on your device
- No latency
- Limited processing power
→ Depends on the device



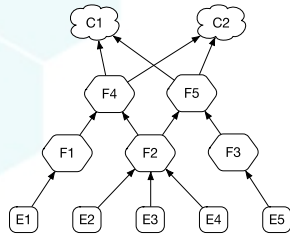


Overview

- In reality, several layers of cloud, fog, and edge elements will occur

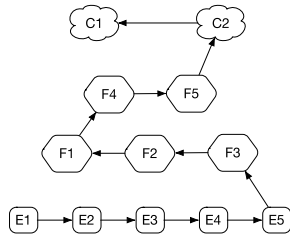
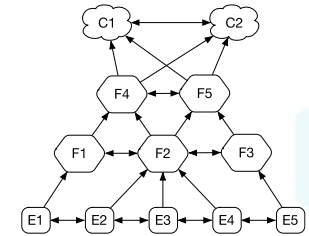


Architecture Styles



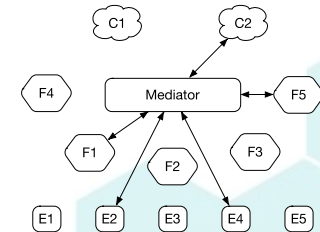
Vertical

Vertical
with Clusters



Incremental

Session



Based on K. Bierzynski et al. "Cloud, fog and edge: Cooperation for the future?," 2017 Second International Conference on Fog and Mobile Edge Computing (FMEC), Valencia, 2017, pp. 62-67. doi: 10.1109/FMEC.2017.7946409



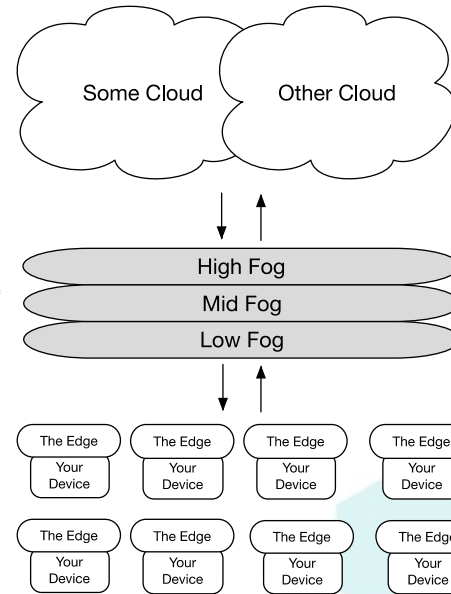
Main Question: Where to calculate what?

- ◆ Depends on the use case!
- ◆ One idea ...

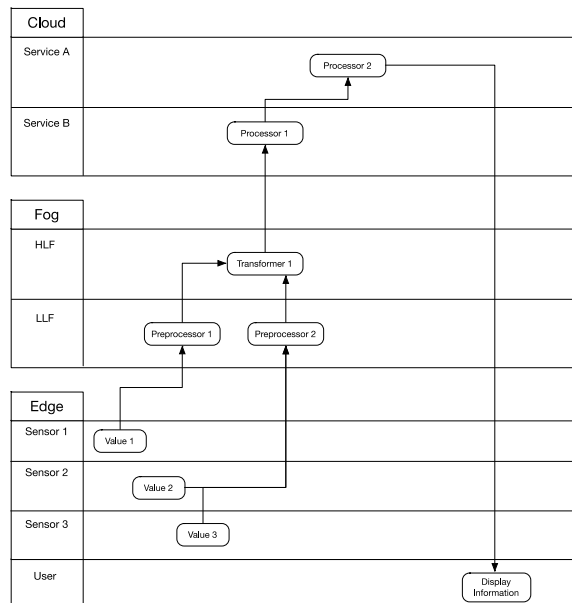
Business Logic, Response
Planning and Execution

Verification
and Aggregation

Data Collection
and Preprocessing



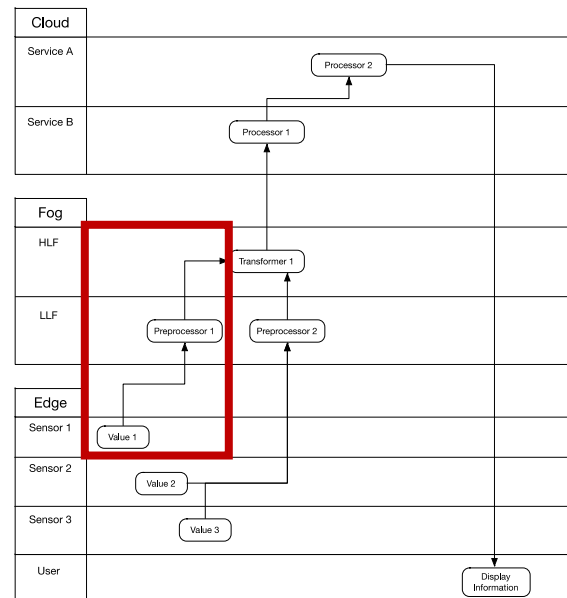
Architecture Trace Diagrams to Visualize Data Flows





Architecture Trace Diagrams to Visualize Data Flows

- Moving parts of the infrastructure into separate slices ensures communication quality
- Depends on the use case!





Recap

- ◆ Architecture for 5G Applications
- ◆ Cloud vs. Fog vs. Edge
- ◆ Data Flow Visualization
- ◆ Slicing

Interested?

- ◆ Use Case Analysis
- ◆ Architecture Sketches
- ◆ Prototyping
- ◆ Please contact me!





Thanks! Questions?

Dr. Marc Hesenius
University of Duisburg-Essen
marc.hesenius@uni-due.de
<https://se.wiwi.uni-due.de>

