

susecondigital <sup>20</sup>

# Introduction To Edge Computing

Fundamentals and Technical Challenges

DEV-1359

Madhu Mohan Nelemane

Developer (SLE and CaaSP Networking)

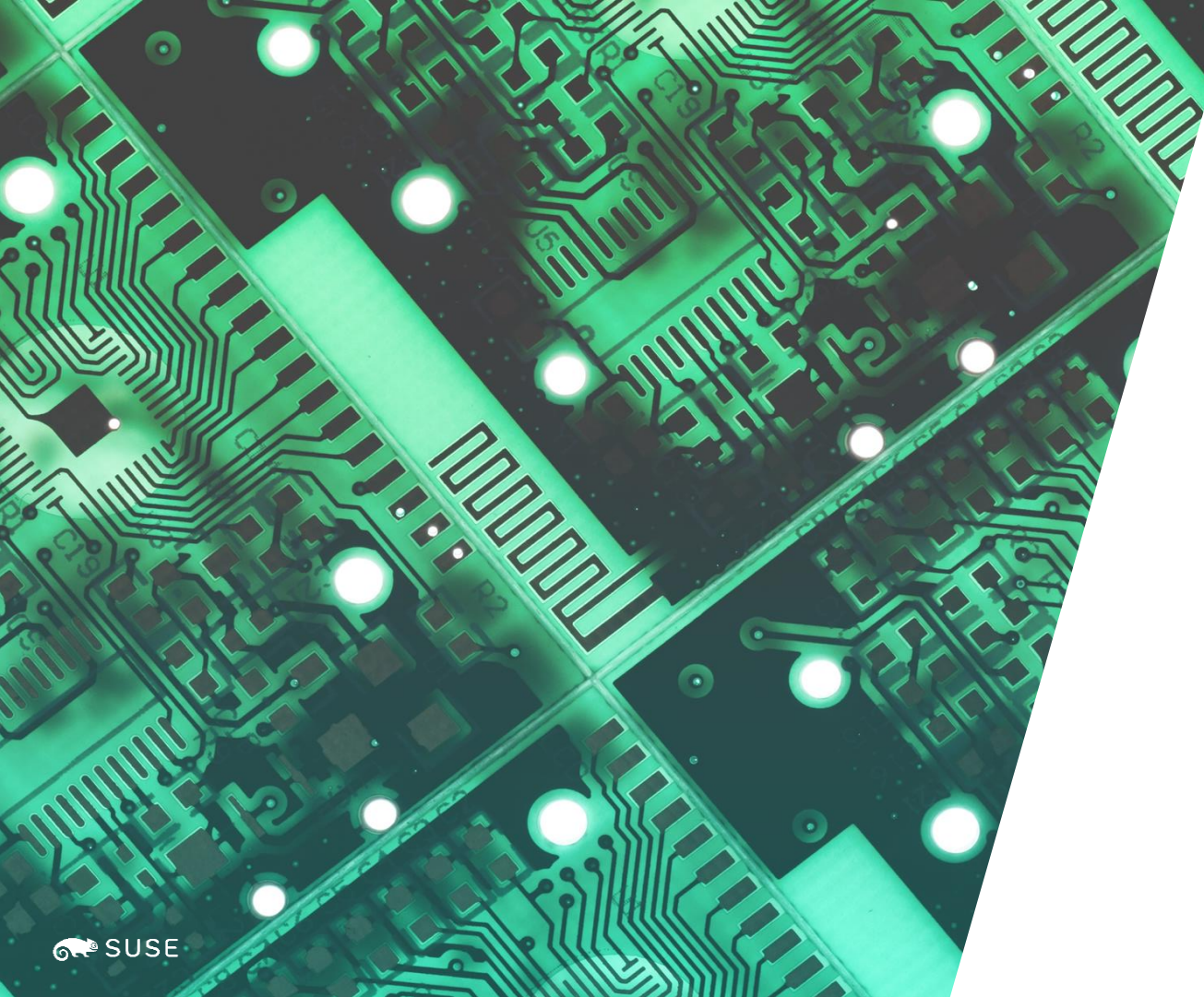
[mmnelemane@suse.com](mailto:mmnelemane@suse.com)

**Questions?**



# Agenda

1. Why edge computing?
2. What is edge computing?
3. Edge devices
4. Architecture and components
5. Networking for edge computing
6. Kubernetes at the edge
7. Q&A



Why are we here?

# *Why Edge Computing*

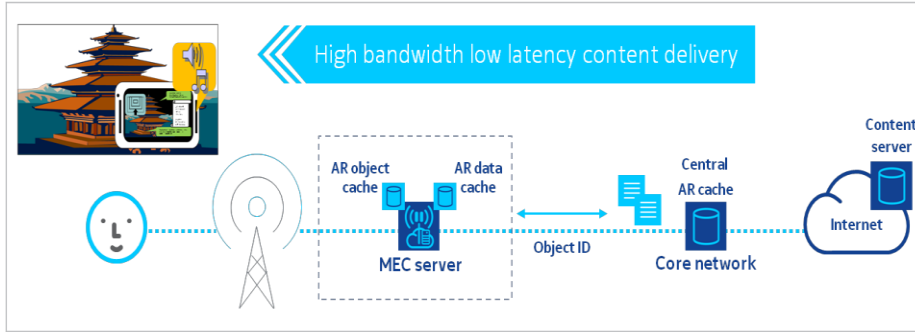


# Why Edge Computing ?

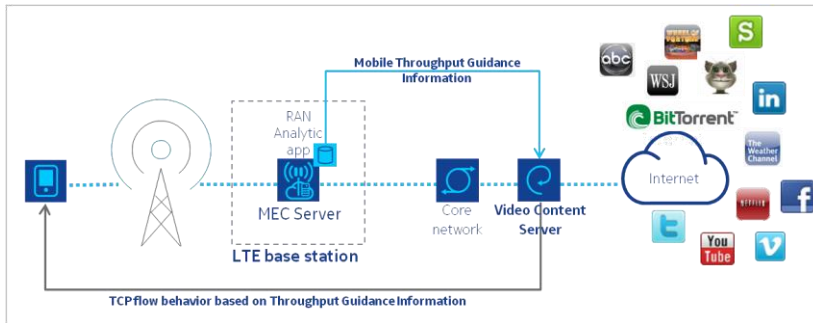
- Evolution towards 5G and growing IoT consumer devices pose several challenges on next generation computing infrastructure: Data processing, Storage and Networking
  - Large amounts of data generated at endpoints (autonomous vehicles, smart phones, sensors, etc..) places heavy burden on traffic between endpoints and the Cloud/Data Center
  - Applications requiring location-aware processing
  - Real-time needs of some applications (e.g Traffic control with Autonomous Vehicles, Real-time content delivery)
  - Applications involving data analytics
- Availability of technologies that makes Edge Computing feasible

# Applications

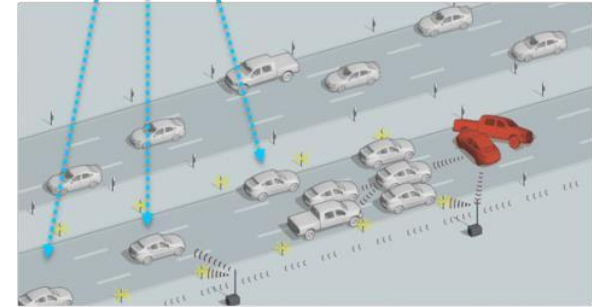
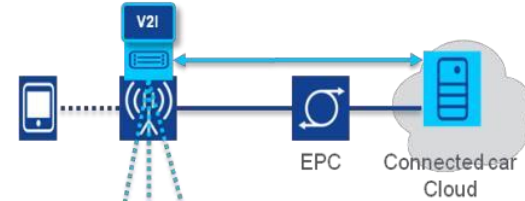
## Augmented Reality



## Video Acceleration (RT)

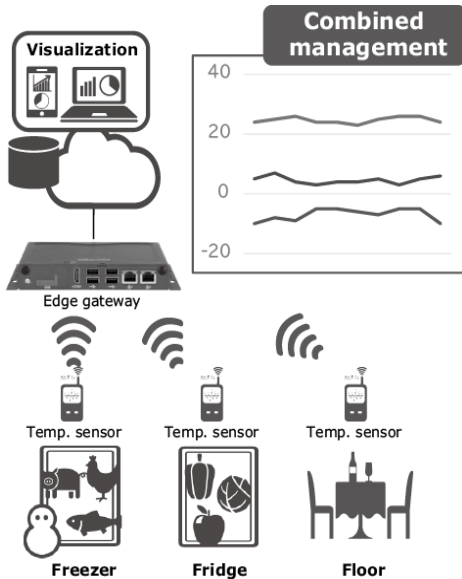


## Connected Cars



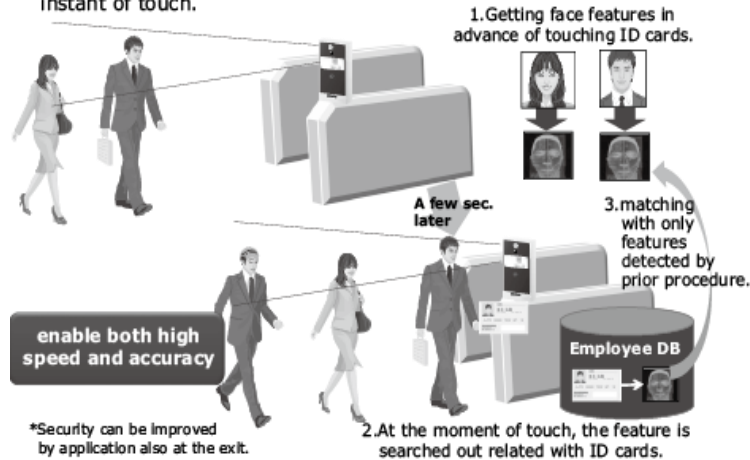
# Edge In Non-ICT/automotive Applications

## Kitchen monitoring for food security and safety

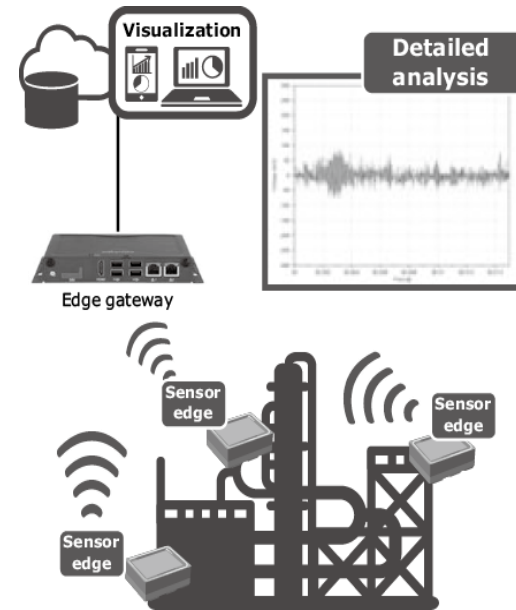


## Walk Through Face Recognition

Features are generated in advance in order to open the gate at the instant of touch.



## Factory Vibration Visualization

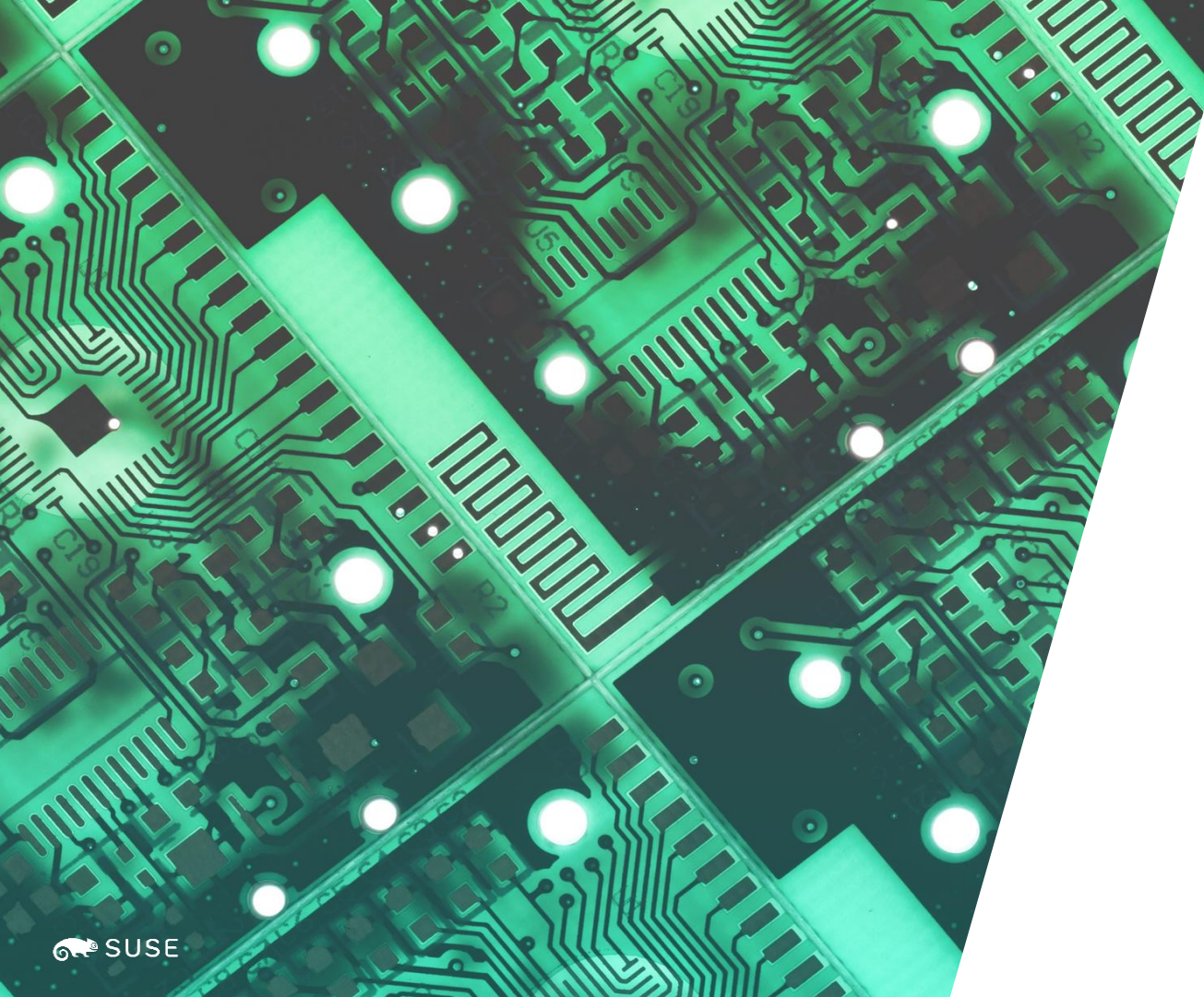




# Use-Cases

- Large scale IoT and IIoT
- Video surveillance
- Video games
- Realtime content delivery
- Autonomous vehicles
- Healthcare
- And more ...





Seeing through the cloud, fog and mist

# *What is Edge Computing*

# Cloud vs Fog vs Mist vs Edge





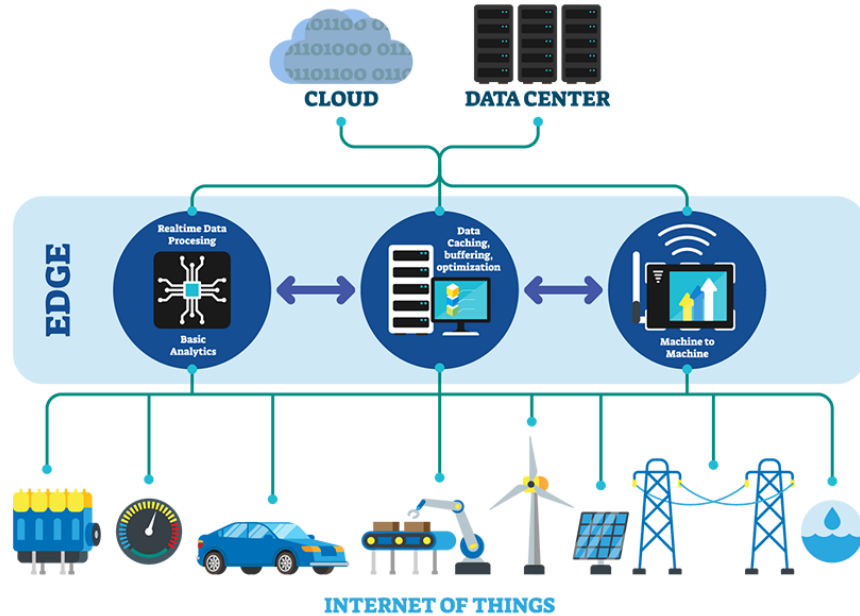
# What is Edge Computing ?

## Wikipedia Definition:

"Edge computing is a distributed computing paradigm which brings computation and data storage closer to the location where it is needed, to improve response times and save bandwidth."

# What Is Edge Computing Again ?

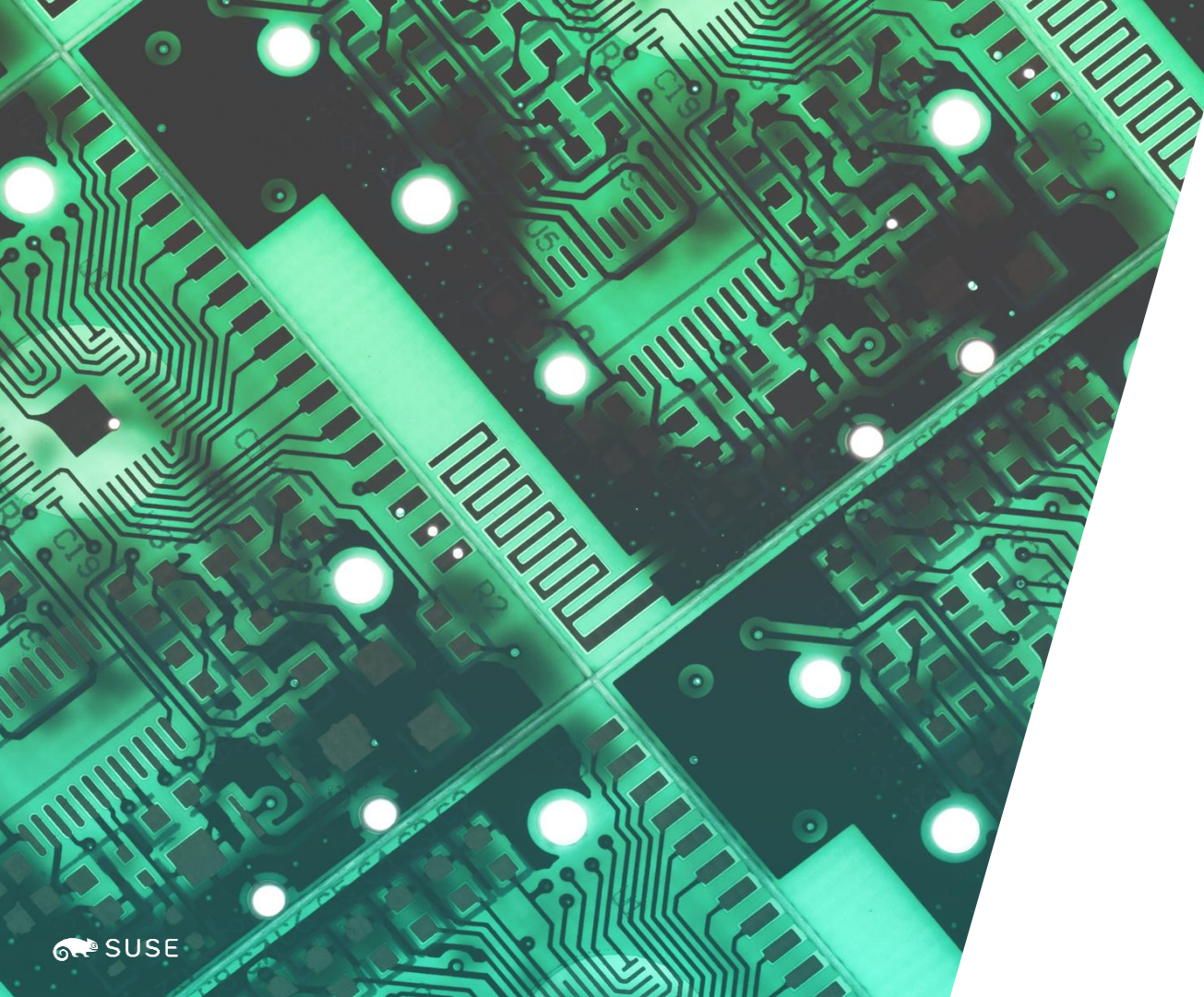
## Edge Computing





# Edge Computing Advantages

- Improve performance
- Compliance
- Privacy and security
- Reduced operational costs
- Ultra-low latency in computation
- Computation offloading to the edge
- Location-aware computing



Where is the edge ?

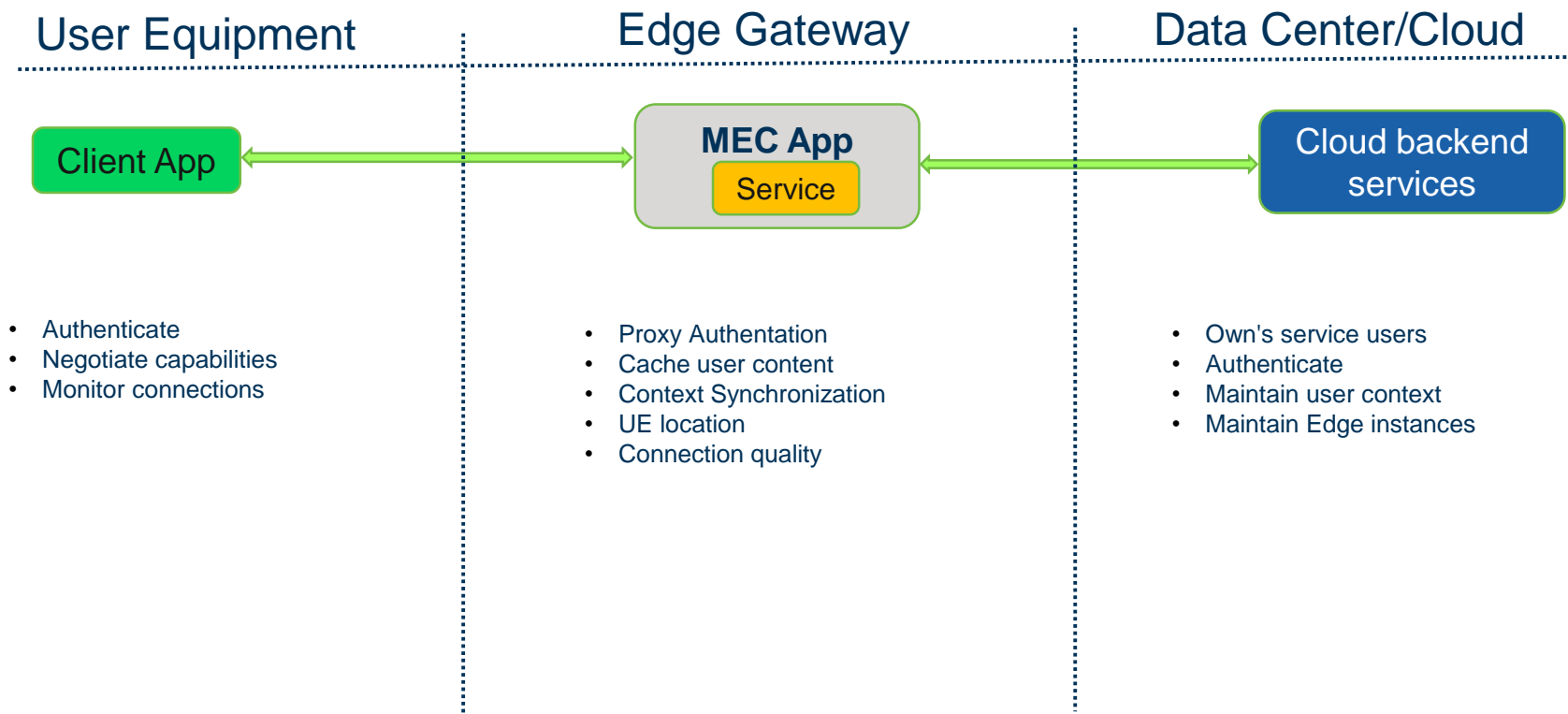
# *Edge Devices*



# Edge Gateway Capabilities

- Distributed computing
- Data persistence
- Network Aggregation
- Intermediary data analytics
- Computing power ranging from an embedded device to an average data center
- Examples: routers, switches, integrated access devices, multiplexers, other access devices, powerful general-purpose servers

# Software Components

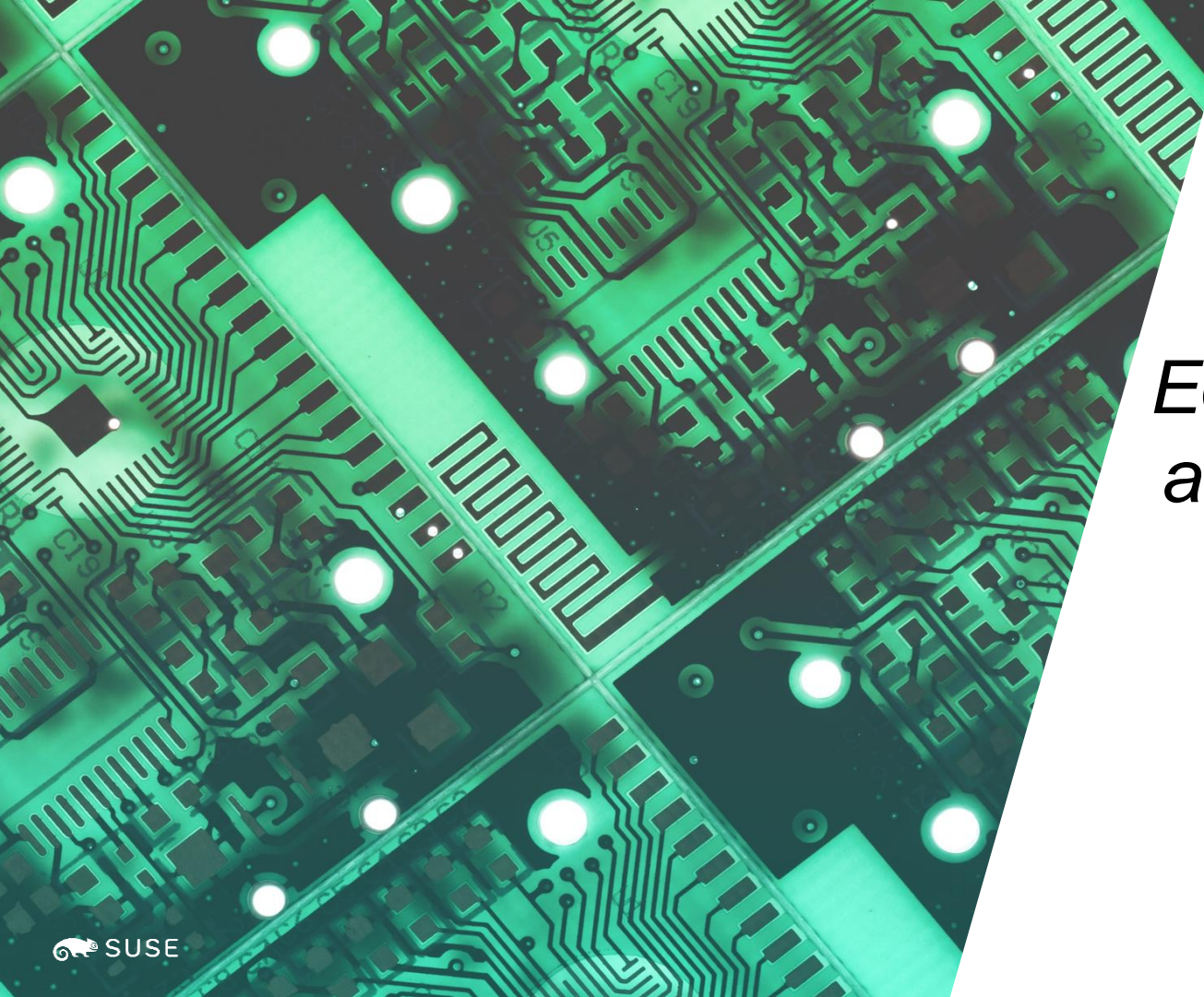






# Edge Host Selection

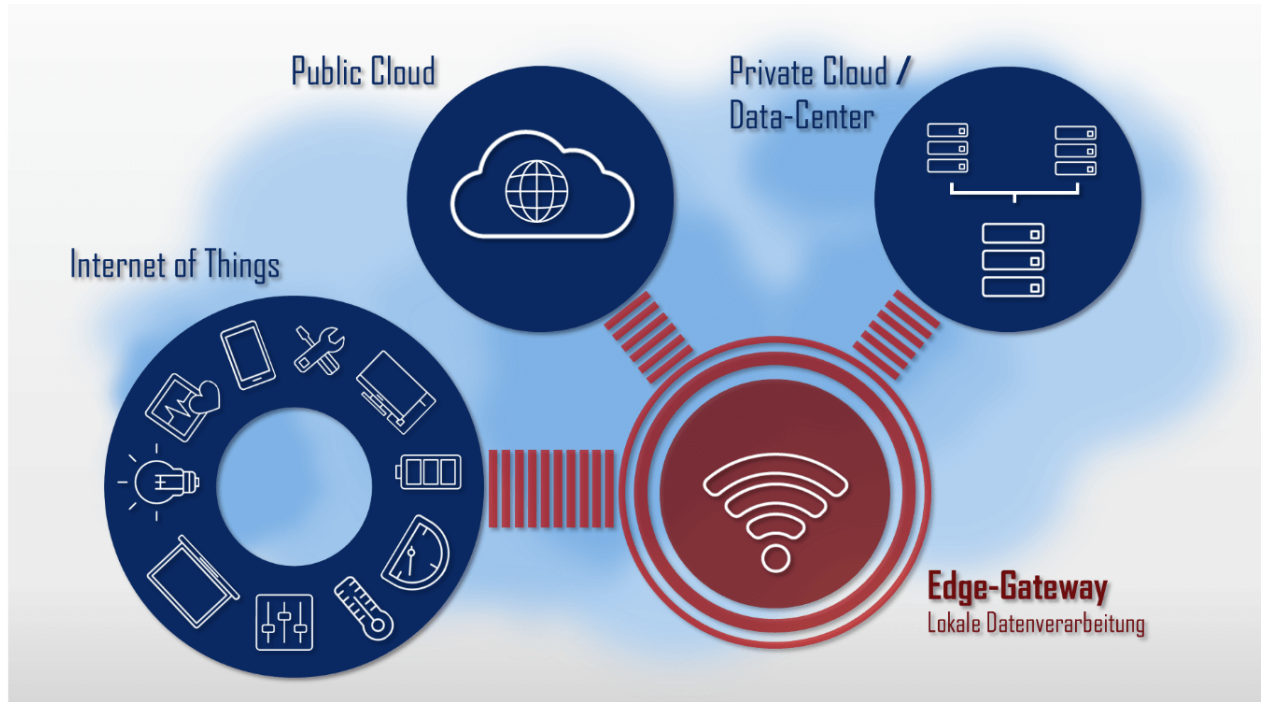
- Deployment model
- Virtualized resource requirements
- Latency requirements
- Location and Mobility
- Platform services
- Network connectivity
- Access requirements
- Storage requirements



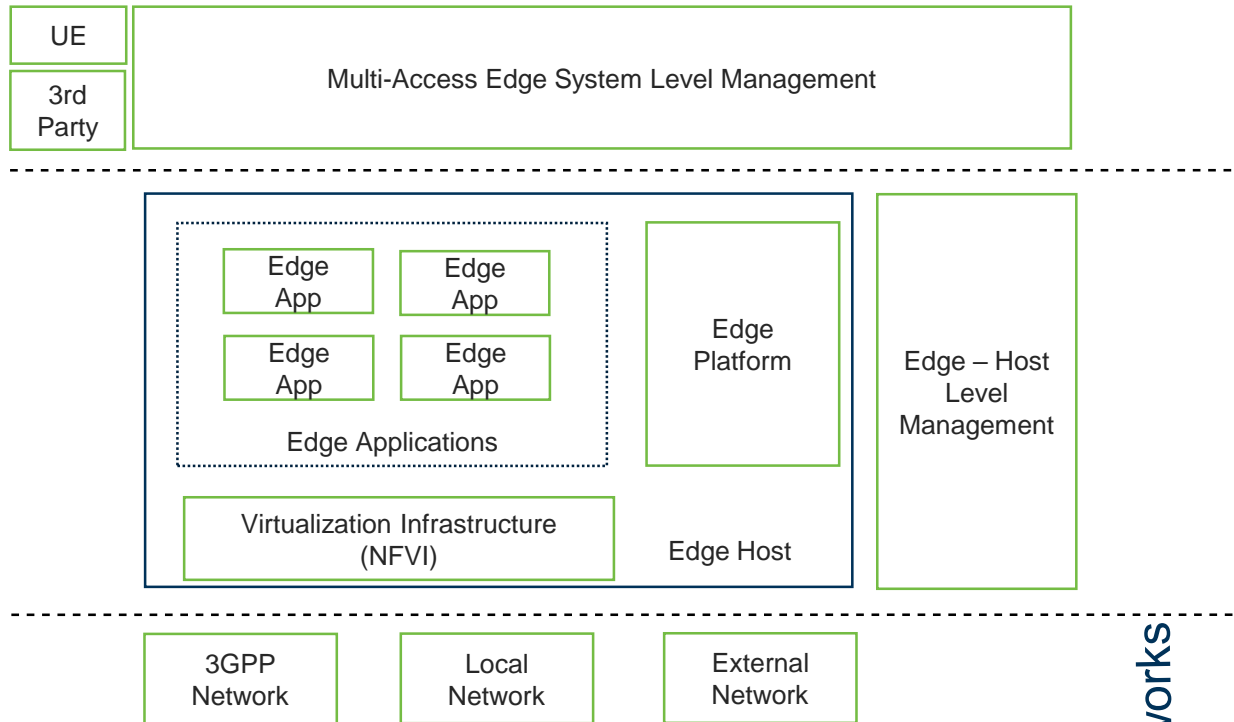
Its finally technical

# *Edge Architecture and Components*

# A Very High-Level View



# ETSI Edge Computing Framework



# Multi-Access Edge Reference Architecture

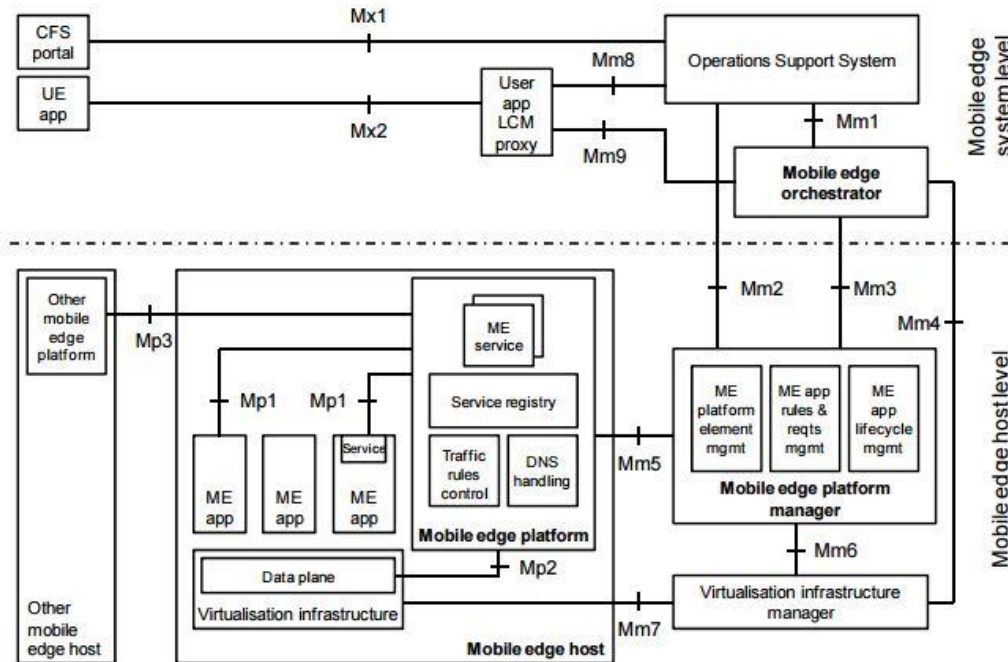
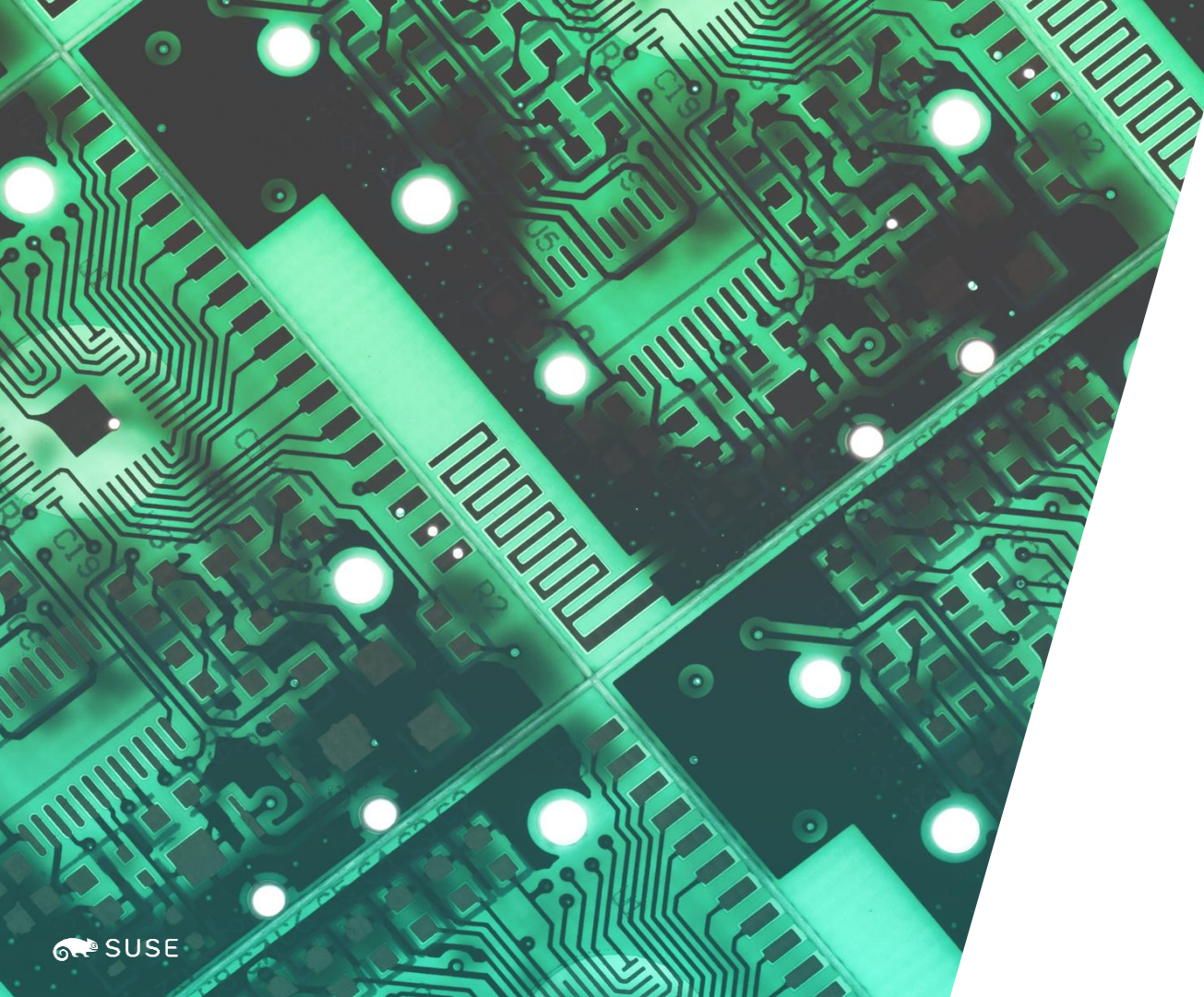


Figure 6-1: Mobile edge system reference architecture



# *Networking for the Edge*



# Networking Requirements

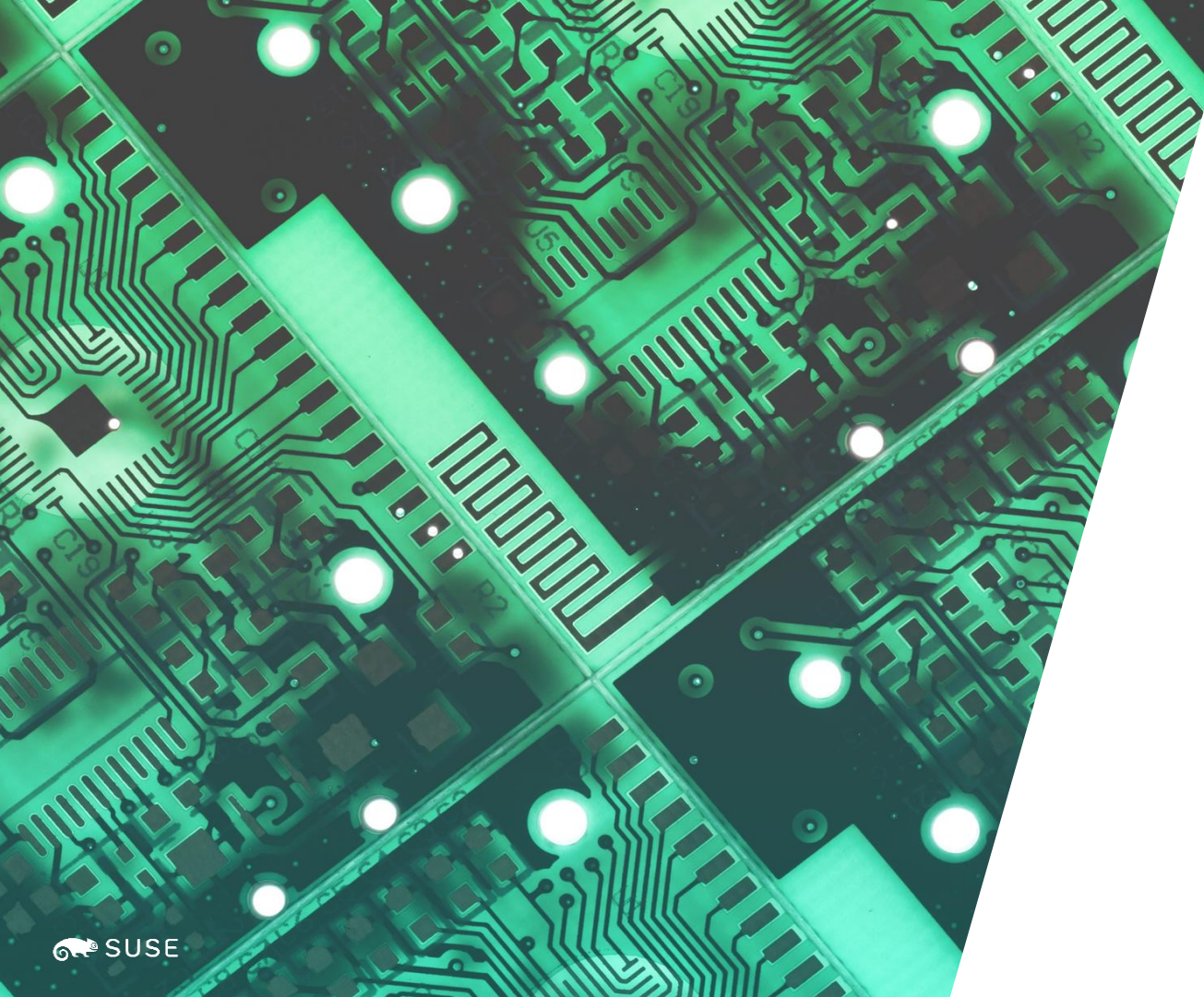
- Low Latency
- Traffic Slicing
- 5G Network Functions
- Orchestration
- Connecting to Cloud



# New Challenges

- Mobility
  - Sustained connectivity
  - State and instance relocation
- Traffic Filtering and Routing (Distributed Computing)
  - Managing east-west traffic
- Location consideration
- Security – footprints all over the place
- Data storage, backup and protection
- General purpose computing on edge devices

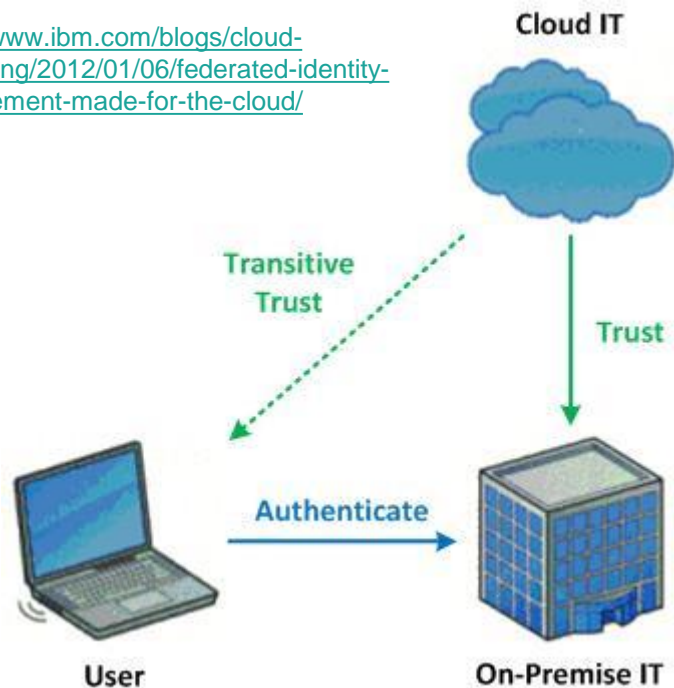




# *Additional Features*

# Federated Identities

<https://www.ibm.com/blogs/cloud-computing/2012/01/06/federated-identity-management-made-for-the-cloud/>



- Single-Sign-On
- Centralized Authentication
- Multitenancy
- Role-based Access and Control (RBAC)
- Authentication at different levels of abstraction:
  - IaaS, PaaS, SaaS



# Resource Caching

- Important for addressing network traffic management
- Should consider limited resources on the edge
- Aspects to consider:
  - Caching Locations
  - Caching insertion strategy
  - Caching Eviction/replacement strategy
  - Caching behavior/performance/optimization models



# Distributed Computing & Computation Offload

## What can be offloaded?

- Information Collection
- Cognitive Computing
- Request Handling

## Types of Offloading:

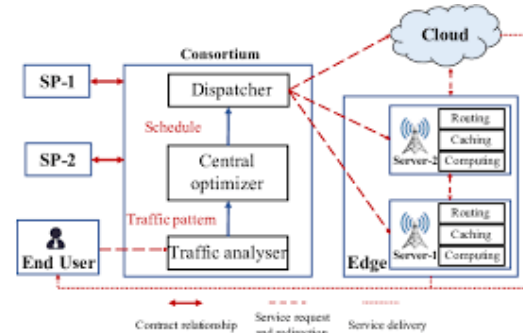
- Local Execution
- Full Offloading
- Partial Offloading

# Provisioning, Management And Operations

## Challenges:

- Trade-off between the cloud and the edge
- Optimization of services (distribution/limitations)
- Computation-intensive services vs limited resources

## Edge Federation Architecture (example)



Implementation

# *Kubernetes on the Edge*



Kubernetes



Mosquitto



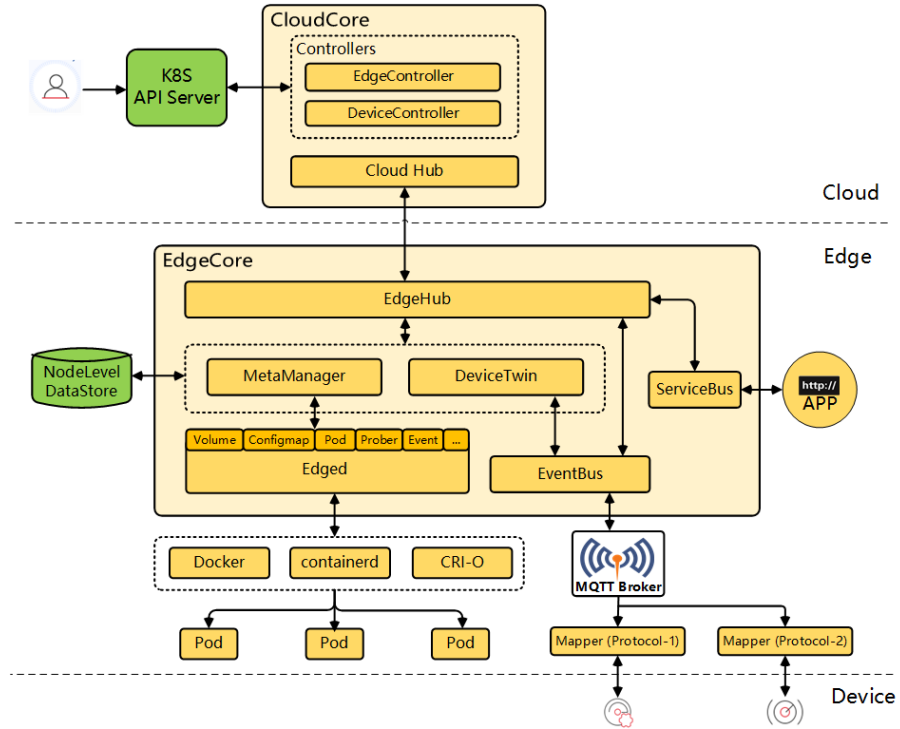
Docker



# Features

- Fully Open Source
- Offline mode support (with/without cloud)
- Kubernetes based
- Scalable Microservices
- Resource Optimized
- Platform agnostic
- Supports Data Management and Analytics
- Heterogenous (multiple CPU architectures)
- SDK based development and device integration
- Easy Maintenance with monitoring, upgrade and rollback

# Architecture







# Components

- Edge Controller – manage edge nodes and pods metadata
- Edged - agent on the nodes running containerized applications
- EdgeHub – WebSocket Client to talk to Cloud Service about edge
- CloudHub – WebSocket Server to talk to EdgeHub about cloud
- EventBus – MQTT Client providing messaging infrastructure to components
- DeviceTwin – Stores device status and syncs to the cloud
- MetaManager – Metadata management and messenger between Edged and EdgeHub

# Other Implementations (From LF Edge)





What did I read ?

# *Bibliography*



# Blogs and Articles

1. <https://objectbox.io/what-is-edge-computing/>
2. <https://www.nec.com/en/global/techrep/journal/g17/n01/170106.html>
3. <https://www.ionos.com/digitalguide/server/know-how/edge-computing/>
4. <https://www.networkworld.com/article/2285444/understanding-federated-identity.html>
5. <https://innovationnetwork.ieee.org/real-life-edge-computing-use-cases/>

# Q&A

Further contact:

Me: [mmneleman@suse.com](mailto:mmneleman@suse.com), Team: [network@suse.de](mailto:network@suse.de)

## General Disclaimer

This document is not to be construed as a promise by any participating company to develop, deliver, or market a product. It is not a commitment to deliver any material, code, or functionality, and should not be relied upon in making purchasing decisions. SUSE makes no representations or warranties with respect to the contents of this document, and specifically disclaims any express or implied warranties of merchantability or fitness for any particular purpose. The development, release, and timing of features or functionality described for SUSE products remains at the sole discretion of SUSE. Further, SUSE reserves the right to revise this document and to make changes to its content, at any time, without obligation to notify any person or entity of such revisions or changes. All SUSE marks referenced in this presentation are trademarks or registered trademarks of SUSE, LLC, Inc. in the United States and other countries. All third-party trademarks are the property of their respective owners.

The background is a solid green color with a white grid pattern that forms wavy, organic shapes. The grid lines are thin and create a mesh-like texture. The overall aesthetic is clean and modern.

SUSEcon digital '20