5G Architecture, Mobile Edge Computing and IoT

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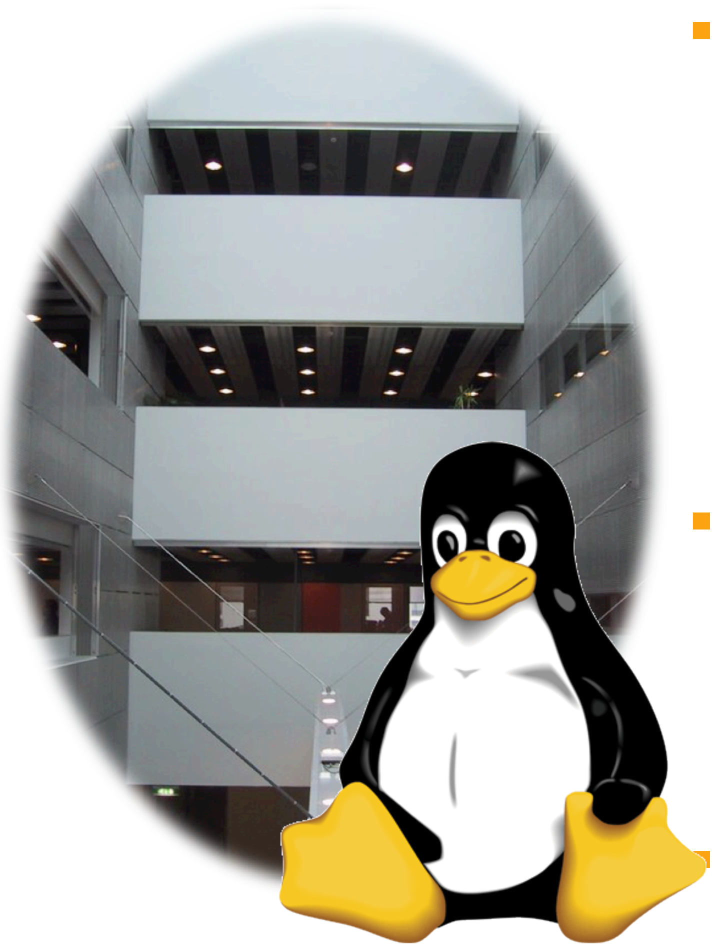
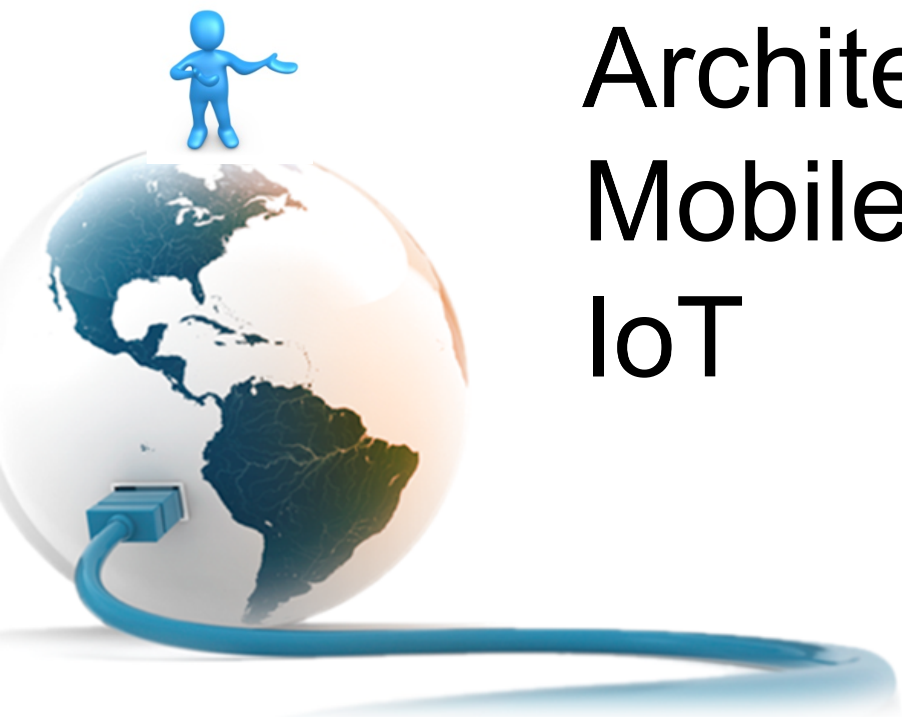
50 Years of Excellence



- **Department of Computer Science**
- Leading institution in Computer Science in Finland
  - #1 in Finland in QS Ranking 2017
  - #1 in Nordic Countries in Times Higher Education 2017
- **Core Computer Science and Data Science**
  - 17 professors and over 200 employees
- **Industry Research Centers:**
  - Nokia Center for Advanced Research (NCAR)
  - Intel CRI-SC



5G Research
Architecture
Mobile Edge Computing
IoT

carat.cs.helsinki.fi

Current research topics include:
Digital services, IoT security and privacy, software-defined networks, Data Science, ...

Mobile Edge Computing

Big Data Frameworks

Streaming

Streaming

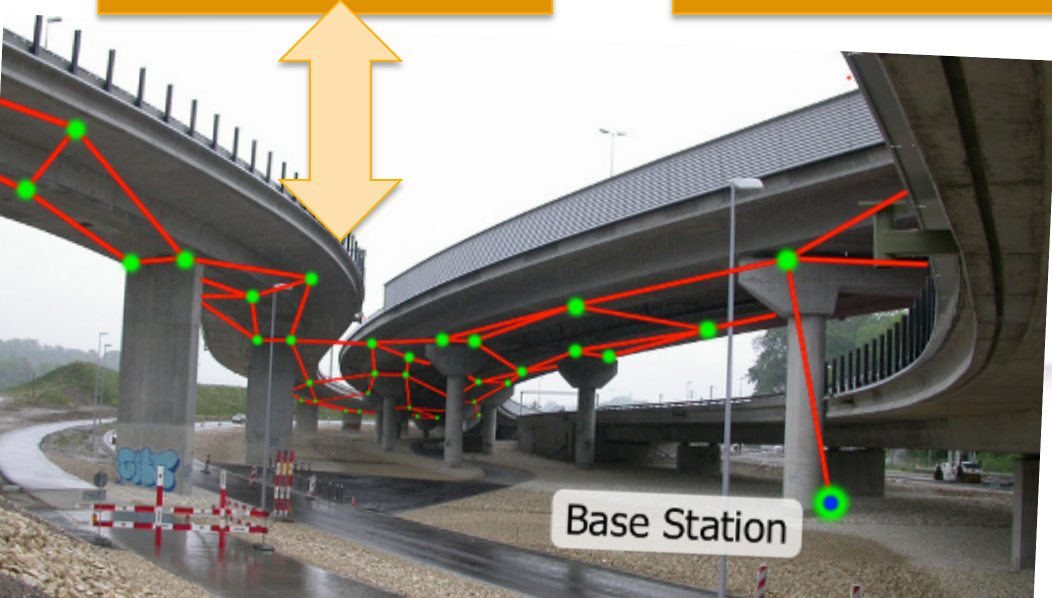
Streaming

Batch processes

Data gathering, processing, and control at the edge

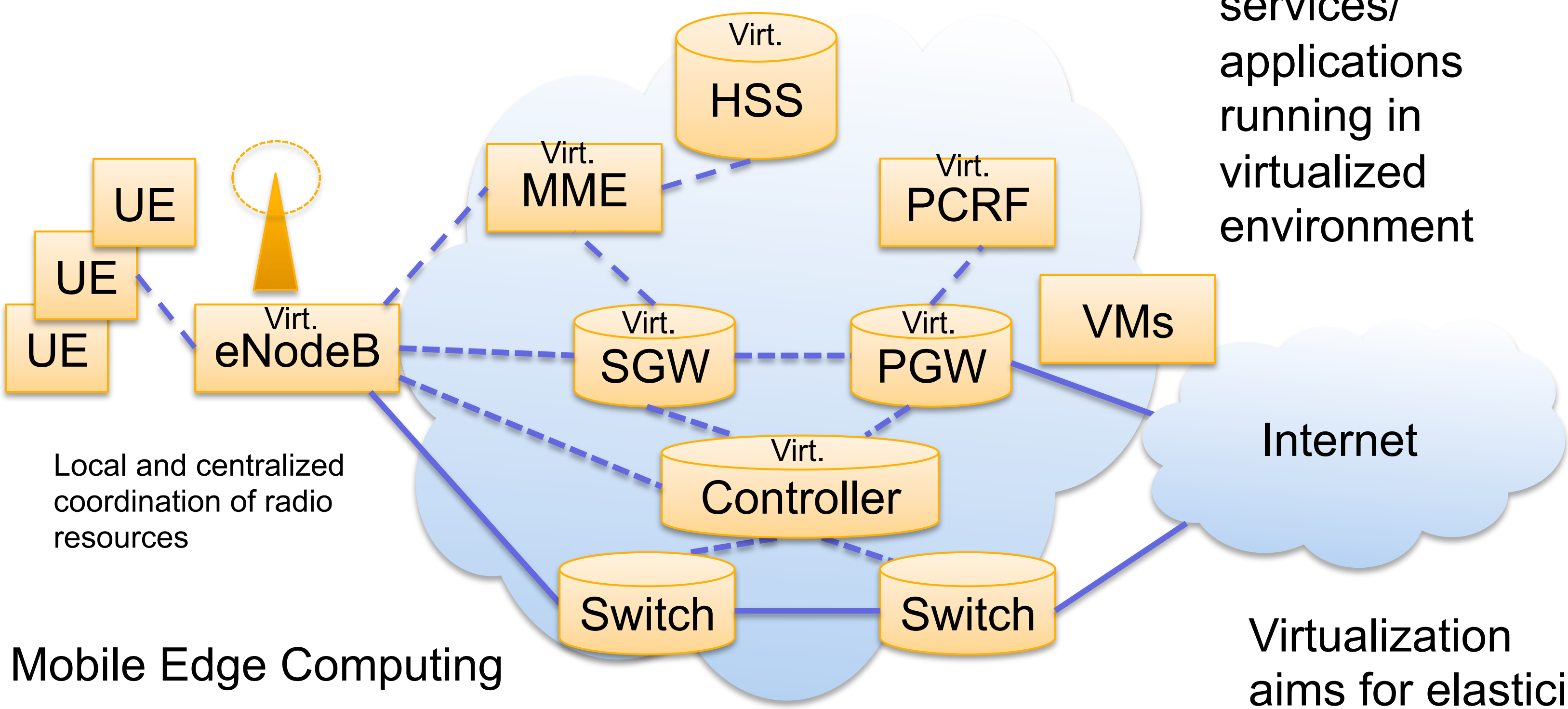
Data processing in the network (4G/5G Mobile Core)

Data processing in the computing cluster (cloud)



Starting point in 2014:
LTE RAN and EPC with SDN and Cloud

5G elements as services/ applications running in virtualized environment



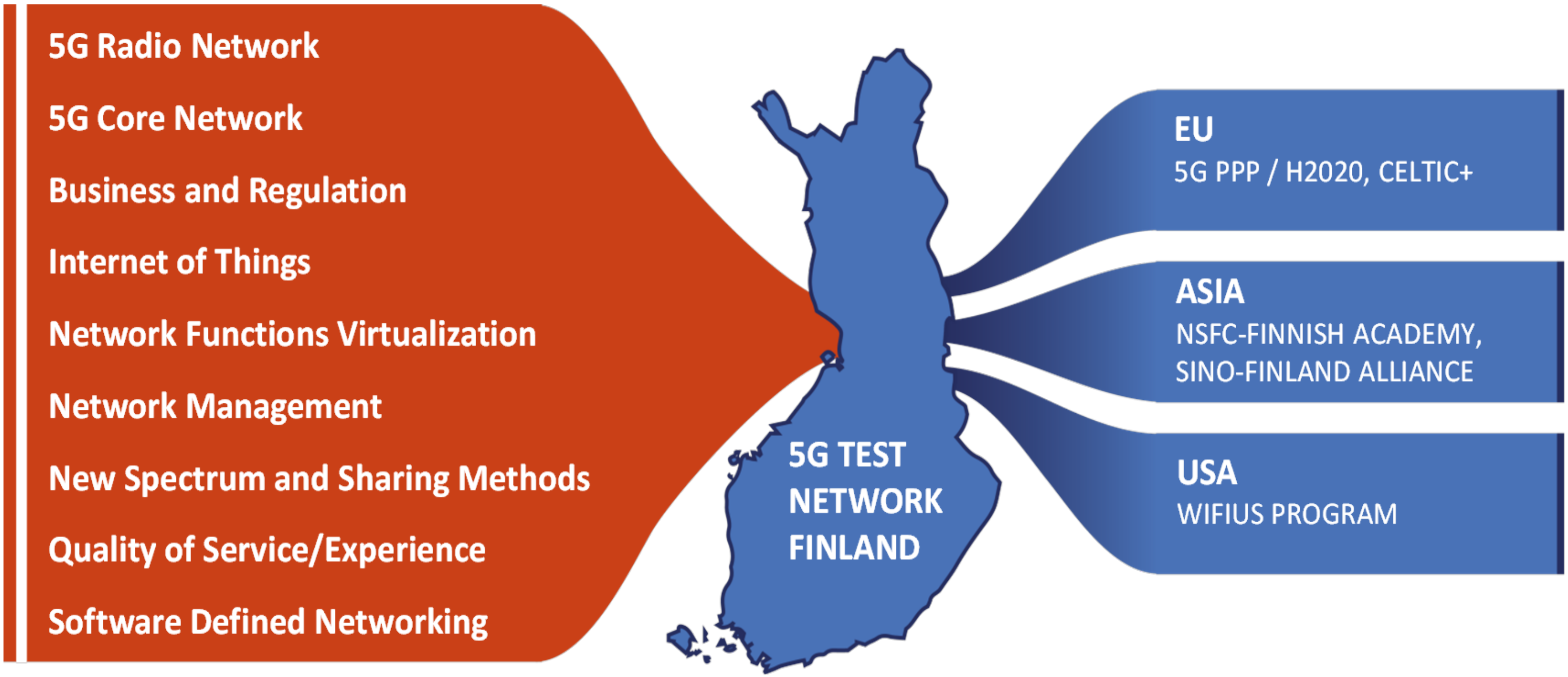
Mobile Edge Computing

Multi-Access Mobile Edge Computing

Network Slicing and Network Service Chains

Virtualization aims for elasticity and runtime configuration support

5G Test Network Finland



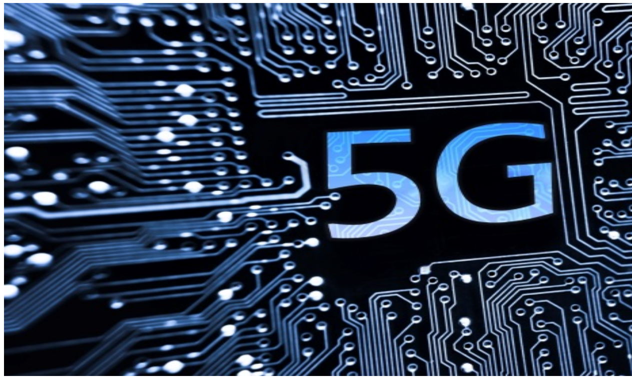
5gtnf.fi

Scaling Mobile Networks

5G is expected to support diverse use cases

Why current LTE networks cannot meet these demands?

- Telephony Centric – IP traffic an afterthought
- Convoluted Control and Data Plane



Solutions

- Move functionality to the Edge
- Move functionality to the Cloud (NFV)
- Network slicing

How do we modularize and refactor the network to meet the use case specific requirements?

Network Refactoring

Three steps:

1. Identifying the **roles** of the network functions
2. Splitting each network function into **modules**, creating one module for each role of the network function. For each module, we identify the requirements of a physical device instantiating that module.
3. Changing the **mapping** between physical devices and modules depending on the requirements (cost, latency, security, ...) from the network.

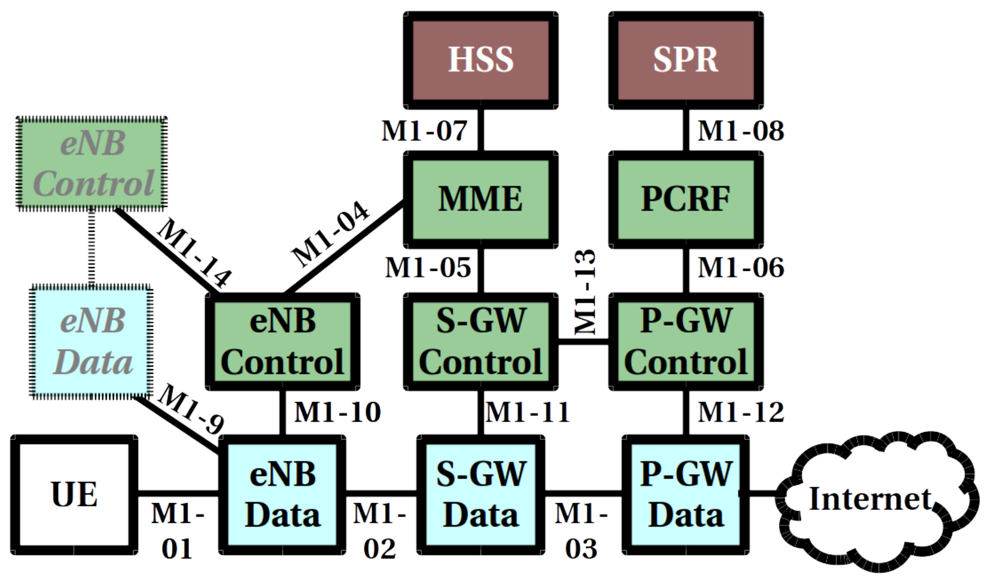
LTE control plane example:

Modularize architecture

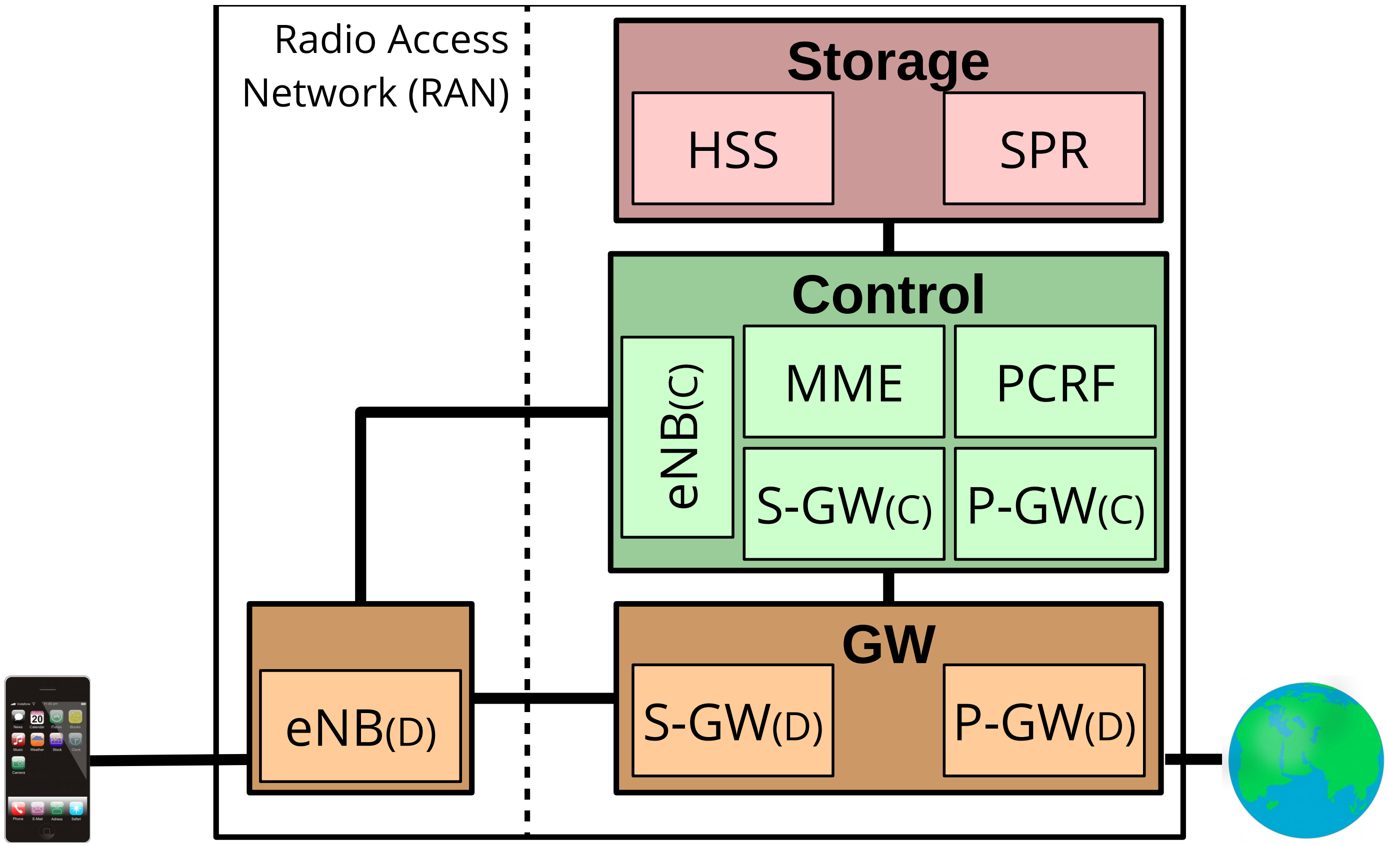
Identify **state variables**

Study **signals** between functions

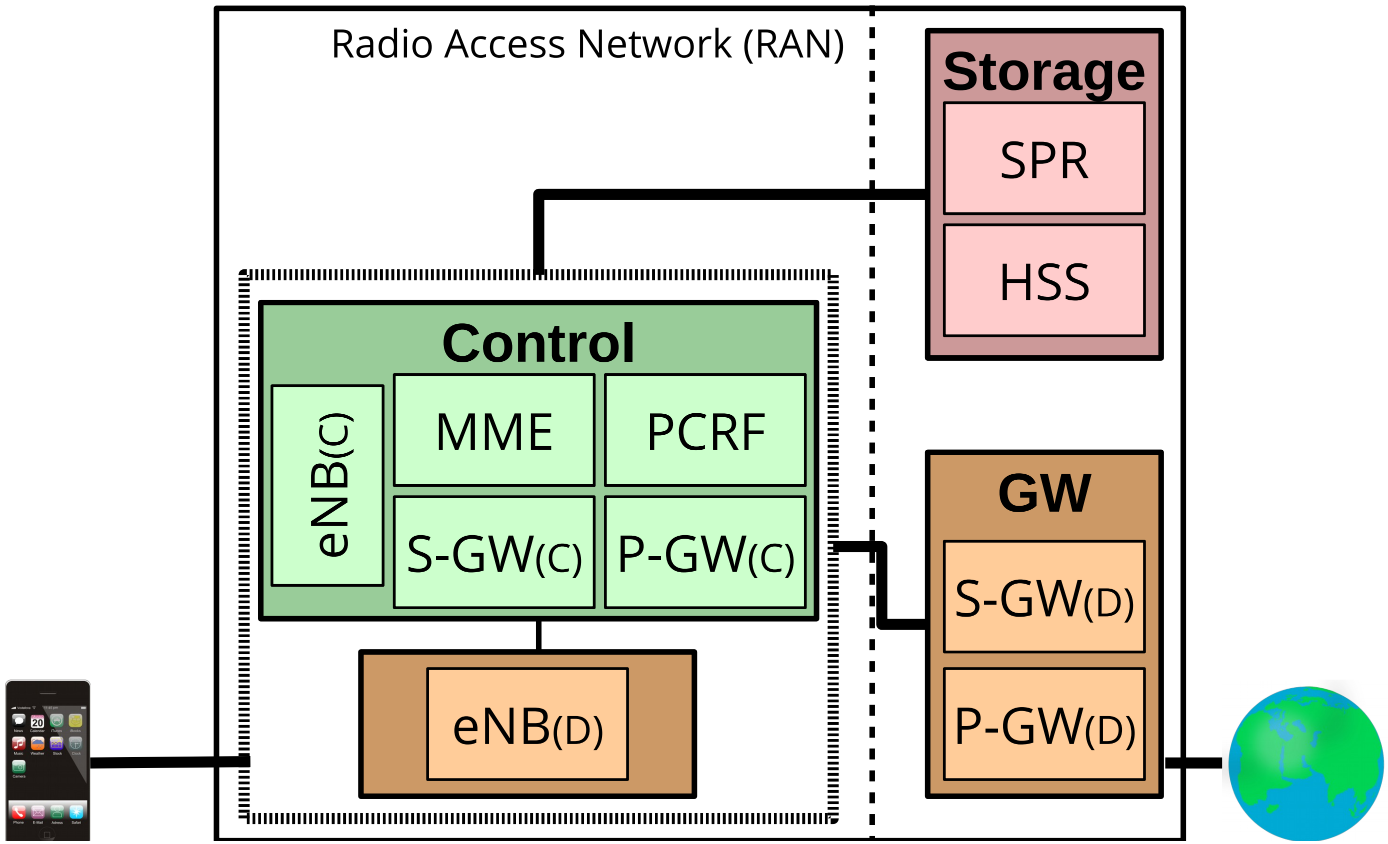
Combine modules



Refactoring: Thin Edge



Refactoring: Intelligent Edge

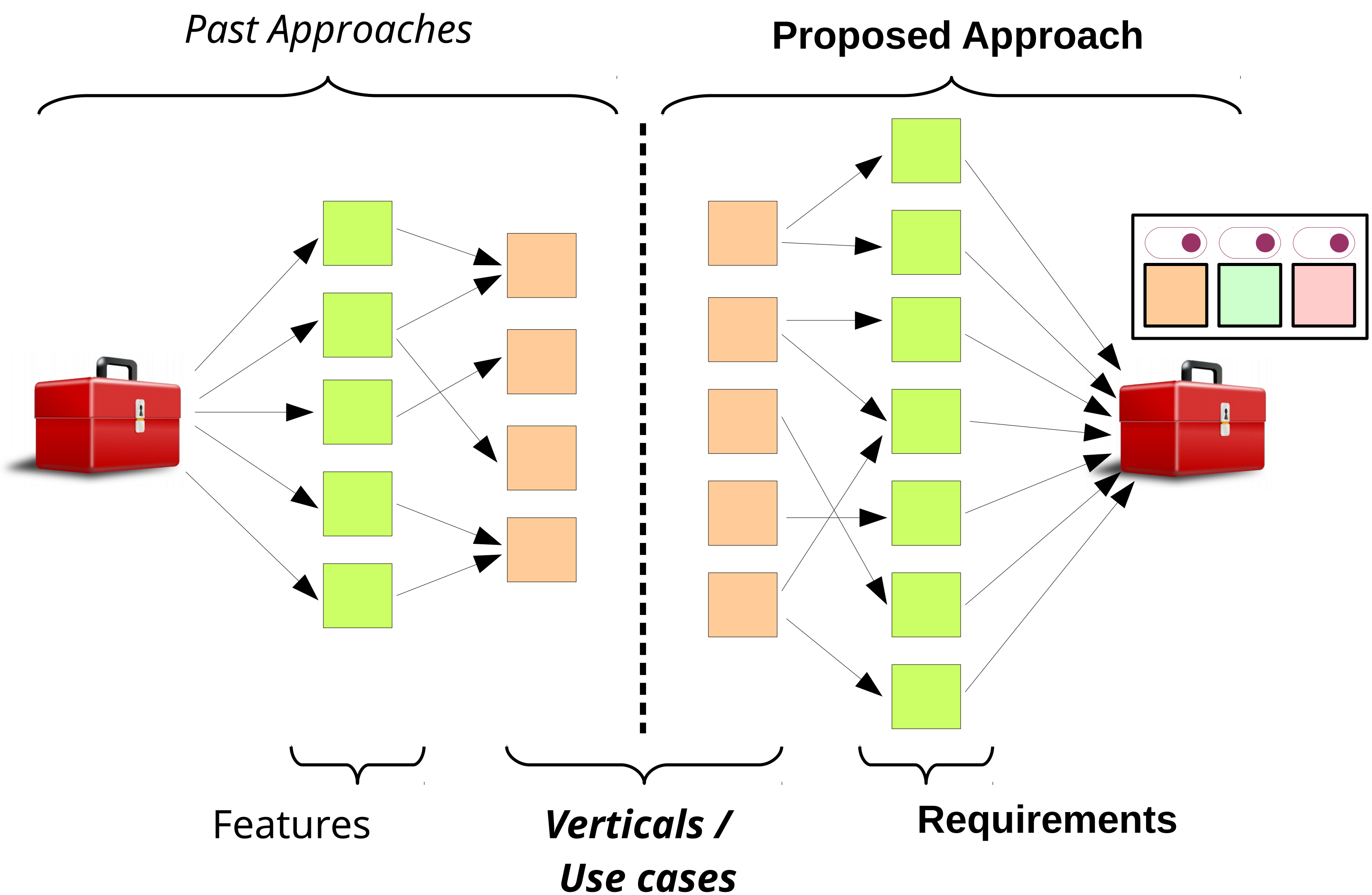


Refactoring Approach for Optimizing Mobile Networks

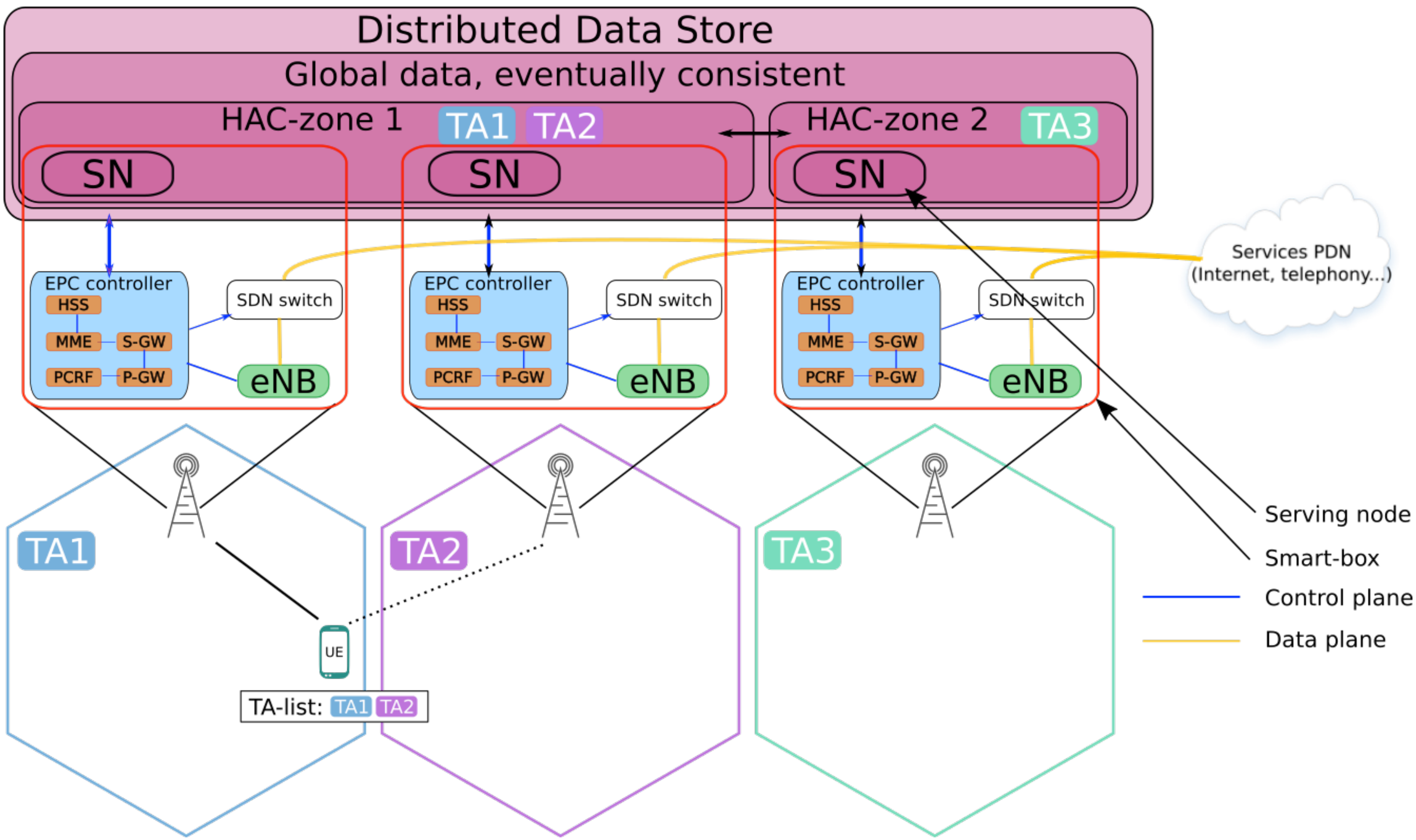
	Total number of signals per event				
Implementation	Initial Attach	Active to Idle	Idle to Active (UE)	Idle to Active (Net)	Handover (S1H)
LTE (Baseline)	35	6	13	17	22
Thin Edge	**24**	**6**	**13**	**16**	**16**
Intelligent Edge	**17**	**3**	**10**	**12**	**12**

A Refactoring Approach for Optimizing Mobile Networks. Matteo Pozza, Ashwin Rao, Armir Abujari, Claudio Pallazi, Hannu Flinck, and Sasu Tarkoma. *In the Proceedings of IEEE ICC 2017*

Network in a Box
Create, scale, upgrade networks



Coreless Mobile Networks
A state management perspective



Frans Ojala, 2016

Implications

In theory, if the **data store** is the bottleneck, our results indicate the following numbers for a simulation of 15 eNB with Apache Geode:

Current deployments are seeing a maximum of 1000 UE / eNB

UE per area increases depending on configuration: ~84 - 740 x

5G prospects for the control plane scalability: 100 - 1000 x

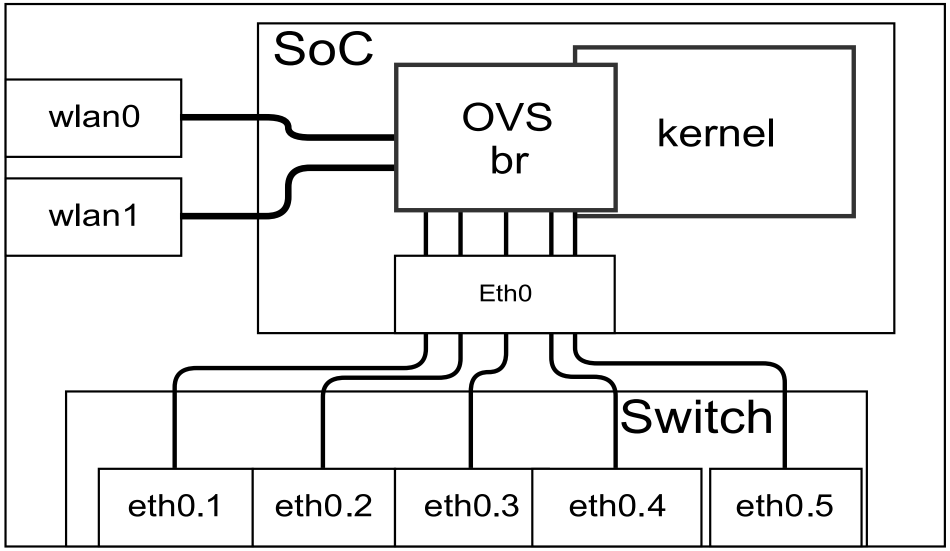
Off-the-Shelf Software-defined Wireless Networks

Open vSwitch (OVS) in base station
Use **Wireless Isolation** to force flows to OVS

Two approaches, Intelligent and Thin AP

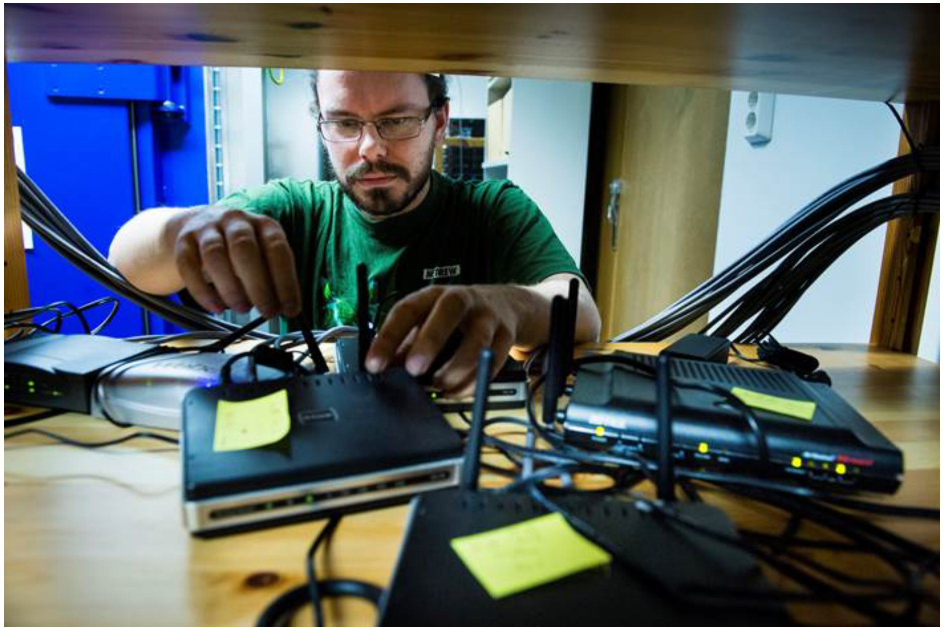
Thin AP: Traffic is forced to flow through external host

Intelligent AP: OVS in base station

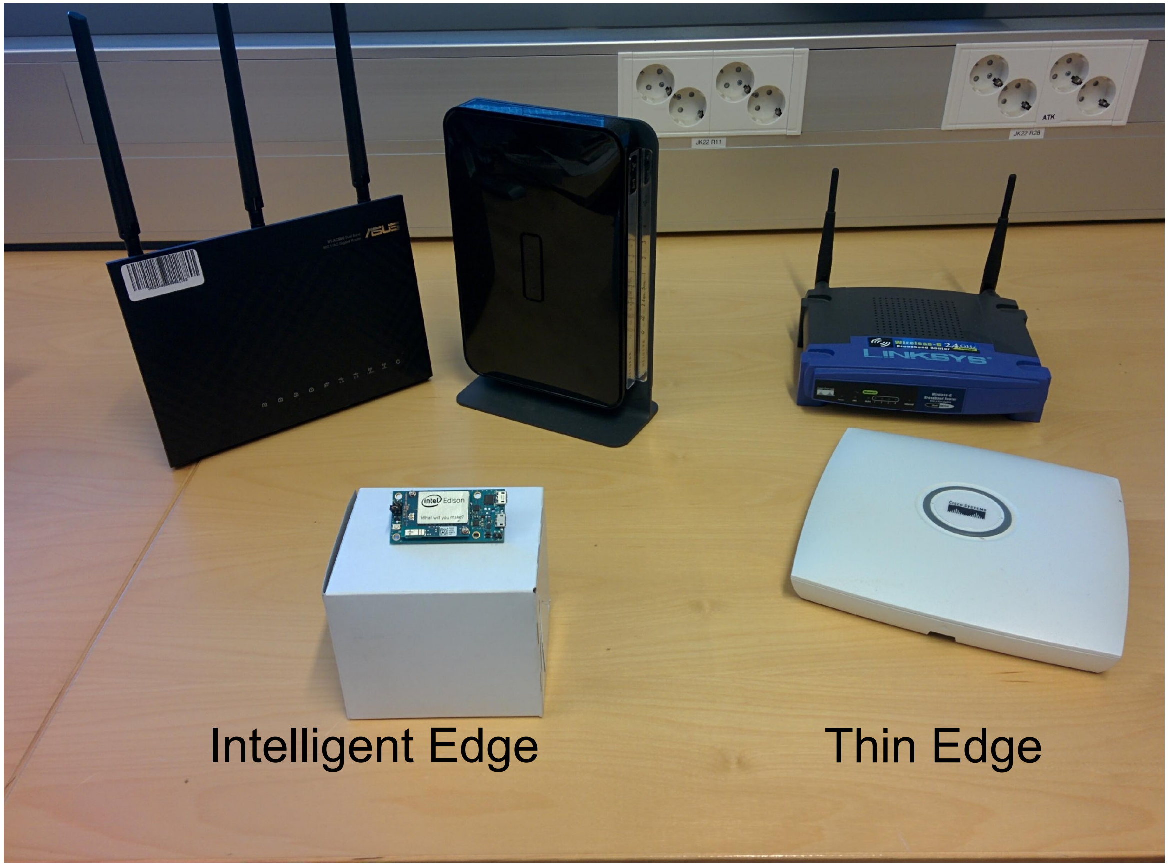


Seppo Hätönen, Petri Savolainen, Ashwin Rao, Hannu Flinck, and Sasu Tarkoma. ACM SIGCOMM 2016 demo.

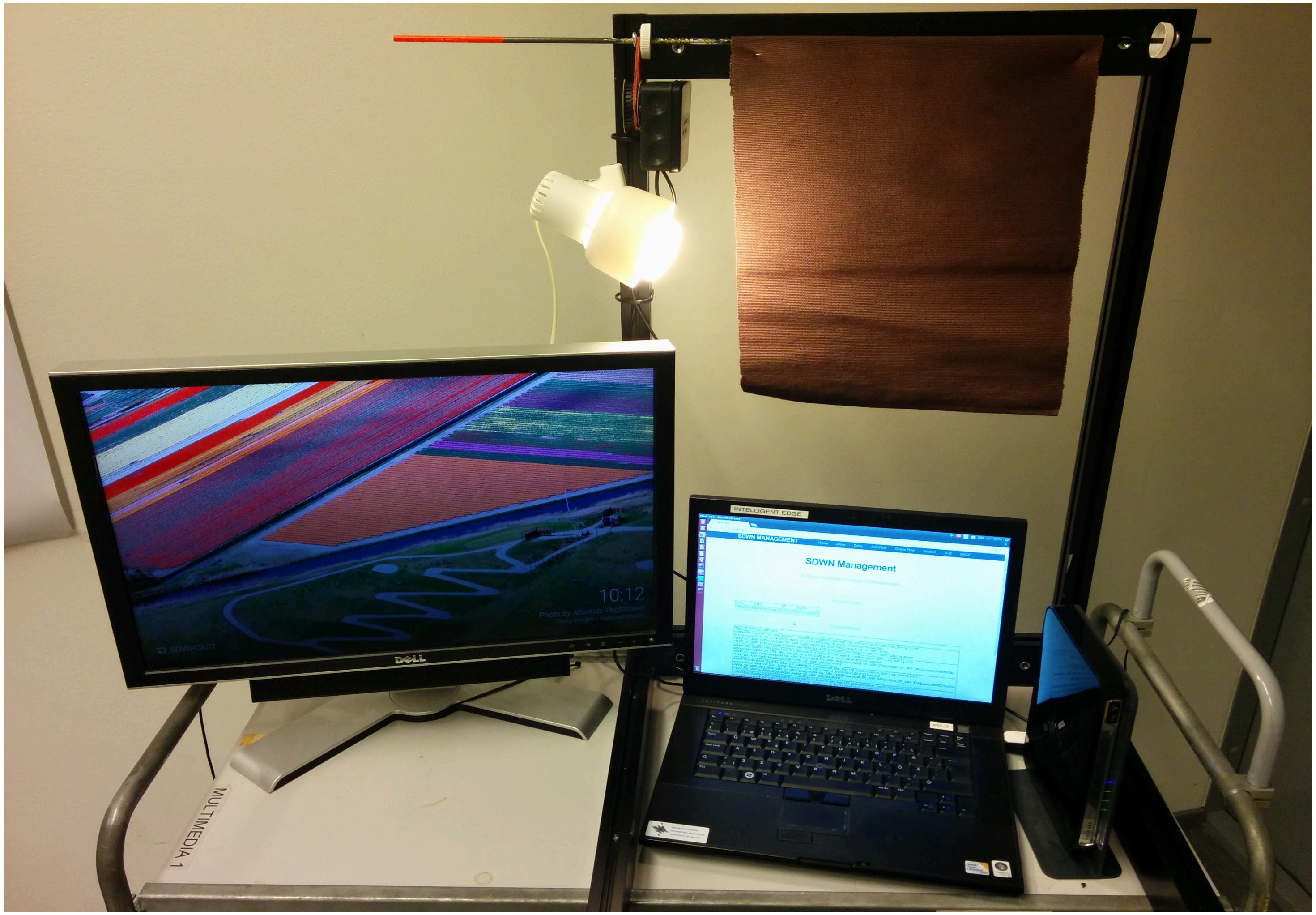
Instructions:
https://wiki.helsinki.fi/display/WiFiSDN/



Deployable on Off-the-Shelf Devices



Unified Mobile Edge for IoT Devices



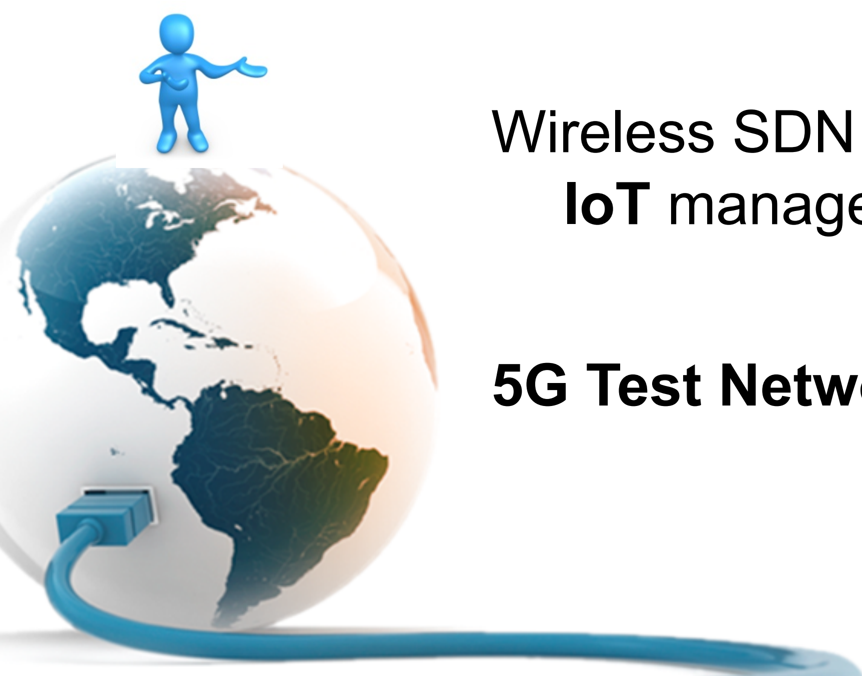
Programmatically manage and compose IoT devices and services

IoT hub running at the edge as an SFC service
Intelligent AP, Philips Hue bridge and a light, Chromecast, connected curtain

Summary

Network Refactoring methodology for analysis and runtime network generation supported by network slicing

Wireless SDN for secure and stratified wireless networks



Wireless SDN and **multi-access edge computing** for **IoT** management and traffic offloading

5G Test Network Finland

Thank You!

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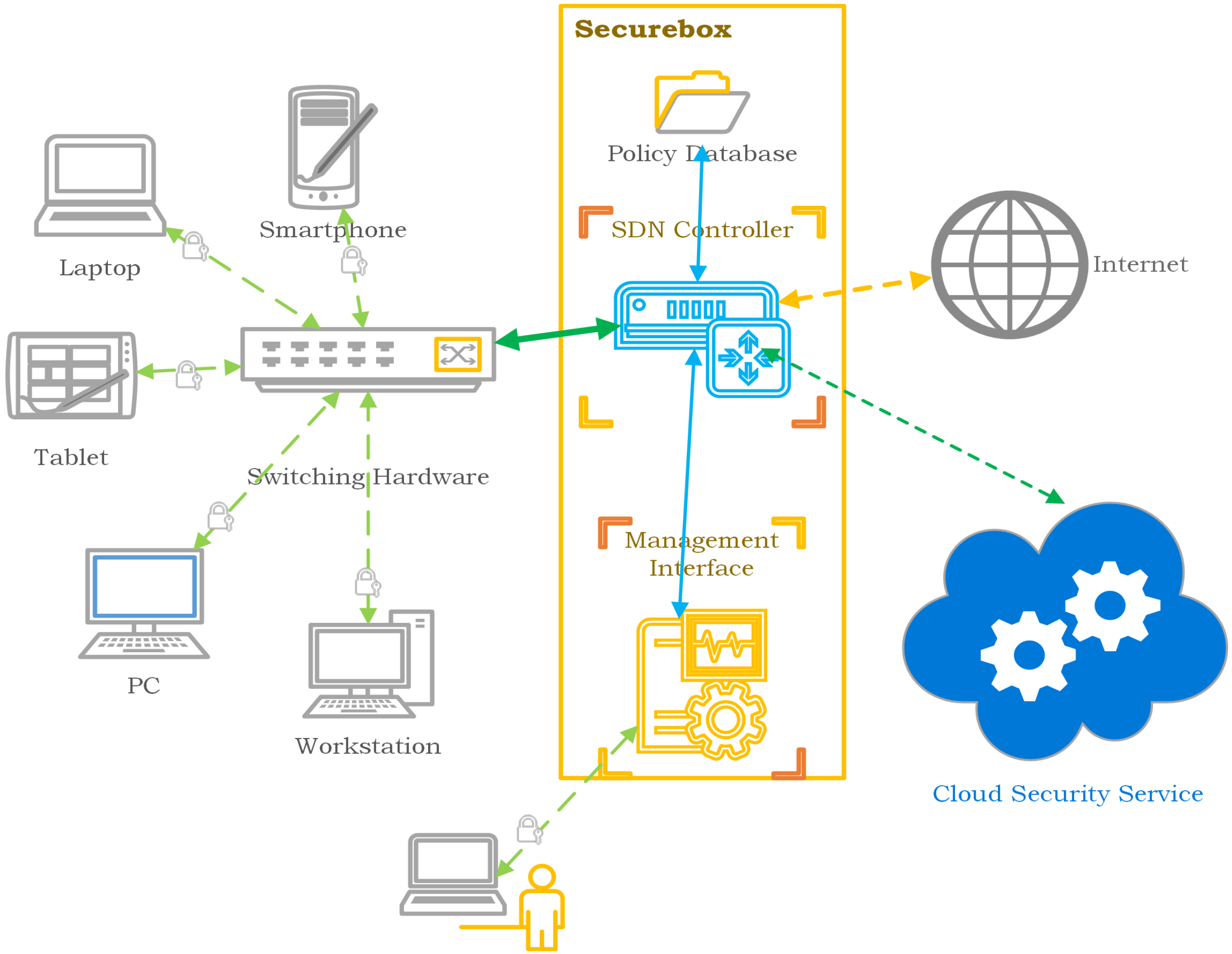
Additional slides

Securebox Edge Architecture



Securebox is a novel cloud-driven, low cost Security-as-a-Service solution that applies Software-Defined Networking (SDN) to improve network monitoring, security and management for smart IoT environment.

SoftOffload

SoftOffload is an open-source software defined platform for achieving intelligent mobile traffic offloading.

It collects various traffic context from both end-users and network operators, and performs optimal mobile offloading to increase user-side throughput and reduce network congestion.

Code and demo:

www.cs.helsinki.fi/group/eit-sdn/softoffload.html