Internet stvari i servisa

Servisno-orijentisane arhitekture

Uvod u Internet stvari i servisa

Katedra za Računarstvo
Elektronski fakultet, Univerzitet u Nišu

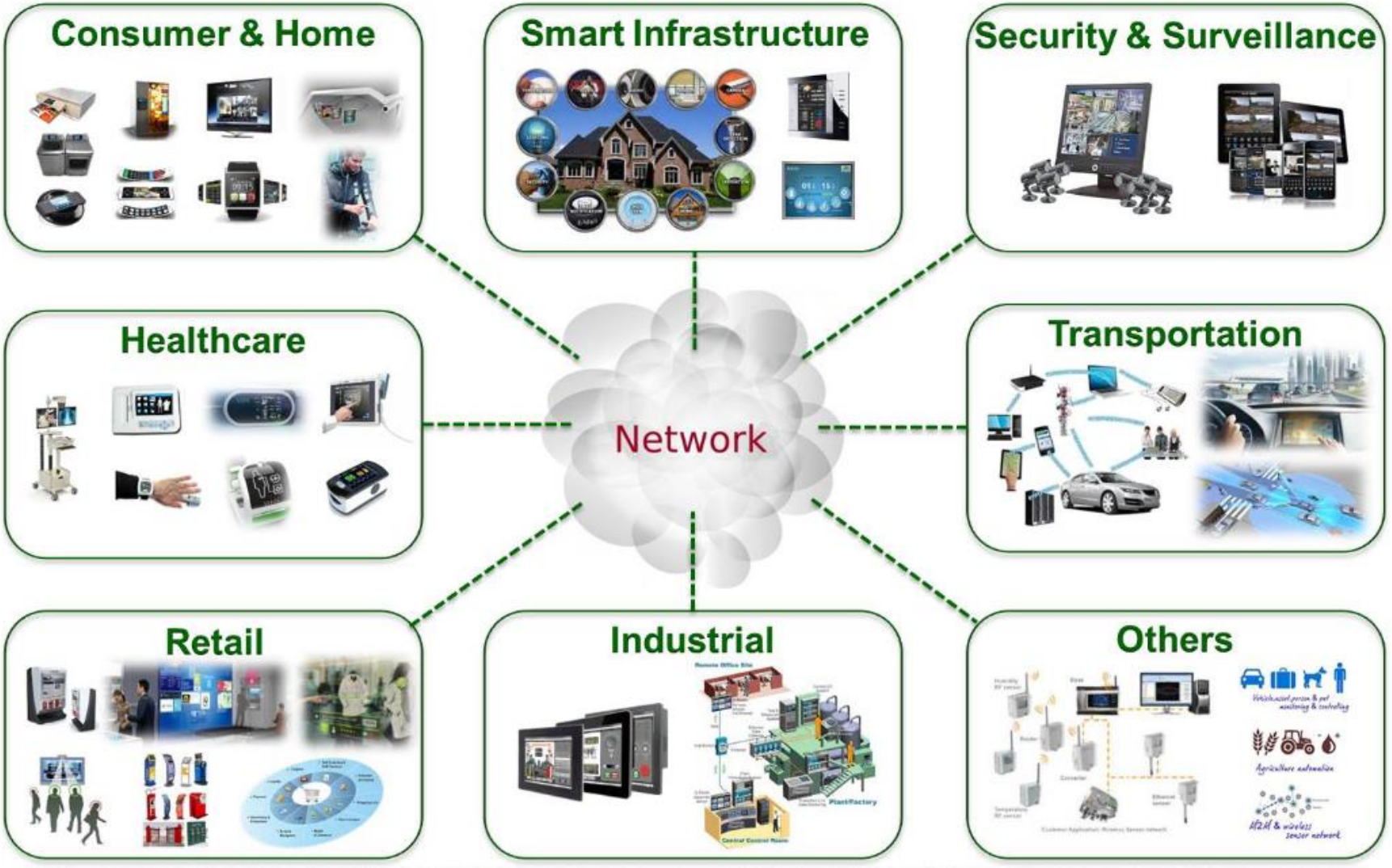
Distribuirani softverski sistemi

- Internet stvari (*Internet of Things* - IoT)
- *Visoko distribuirani* (*large-scale*) servisno-orijentisani
- Veliki podaci (*Big Data*) – *offline & streaming*
- IoT integracija sa *cloud* platformama
  - AWS IoT, Azure IoT Hub, IBM Watson IoT, Google Cloud IoT,…
- Obrada i analiza velikih podataka na granici (*edge*), magli (*fog*) i u oblaku (*cloud*)
- *Smart city*, *home*, *vehicle*, *health*, *mobility*, *grid*, *industry*,…

Servisno-orijentisani sistemi

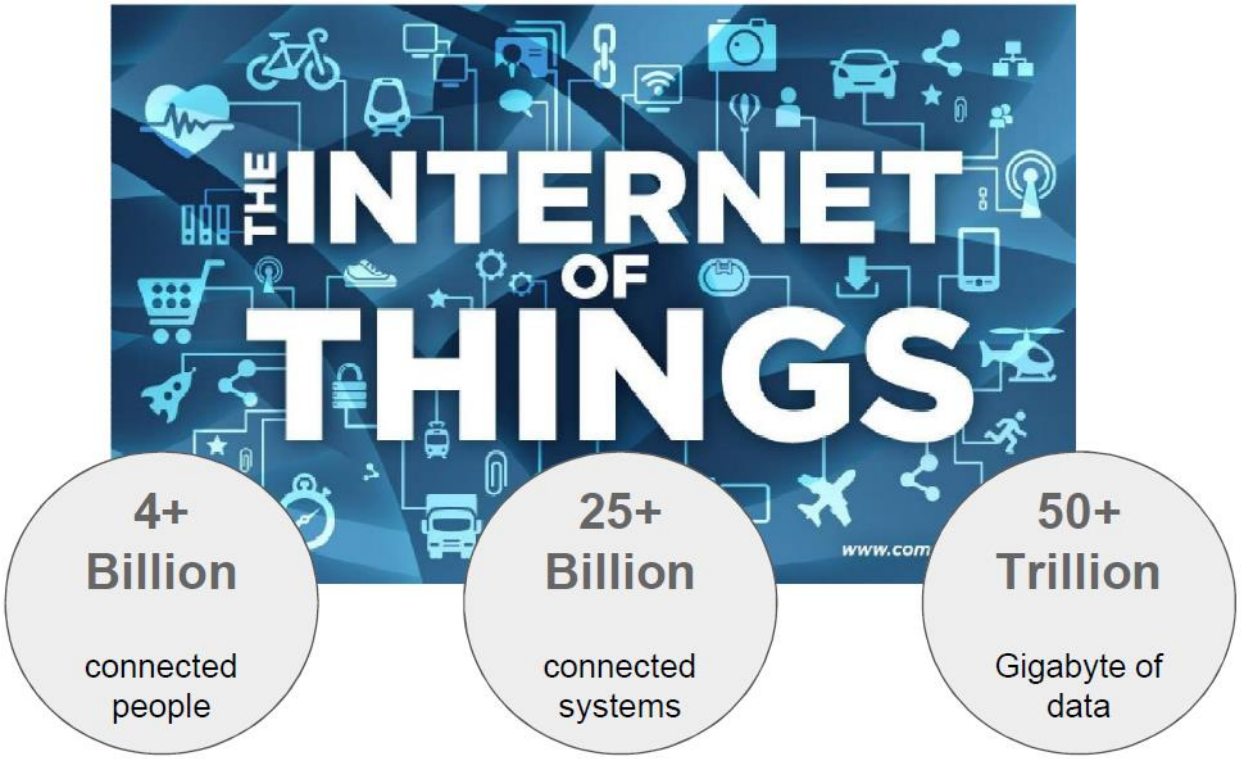
- Web servisi: SOAP, REST, gRPC,…
- Mikroservisi, reaktivni mikroservisi i sistemi
- Elastičnost, skalabilnost i orkestracija mikroservisa na bazi virtuelizacije putem kontejnera
- Izvršavanje servisa na *edge-u, fog-u, cloud-u*
- *Anything/Everything as a Service* (XaaS)
  - *Function as a service* (FaaS) -*Serverless computing*
  - *Data as as Service* (DaaS) – *Data marketplace (lake)*
  - *Sensing as a Service* (SaaS)
  - *Security as a Service* (SECaaS)
  - *Analytics as a Service* (AaaS)

Internet of (Every)Things



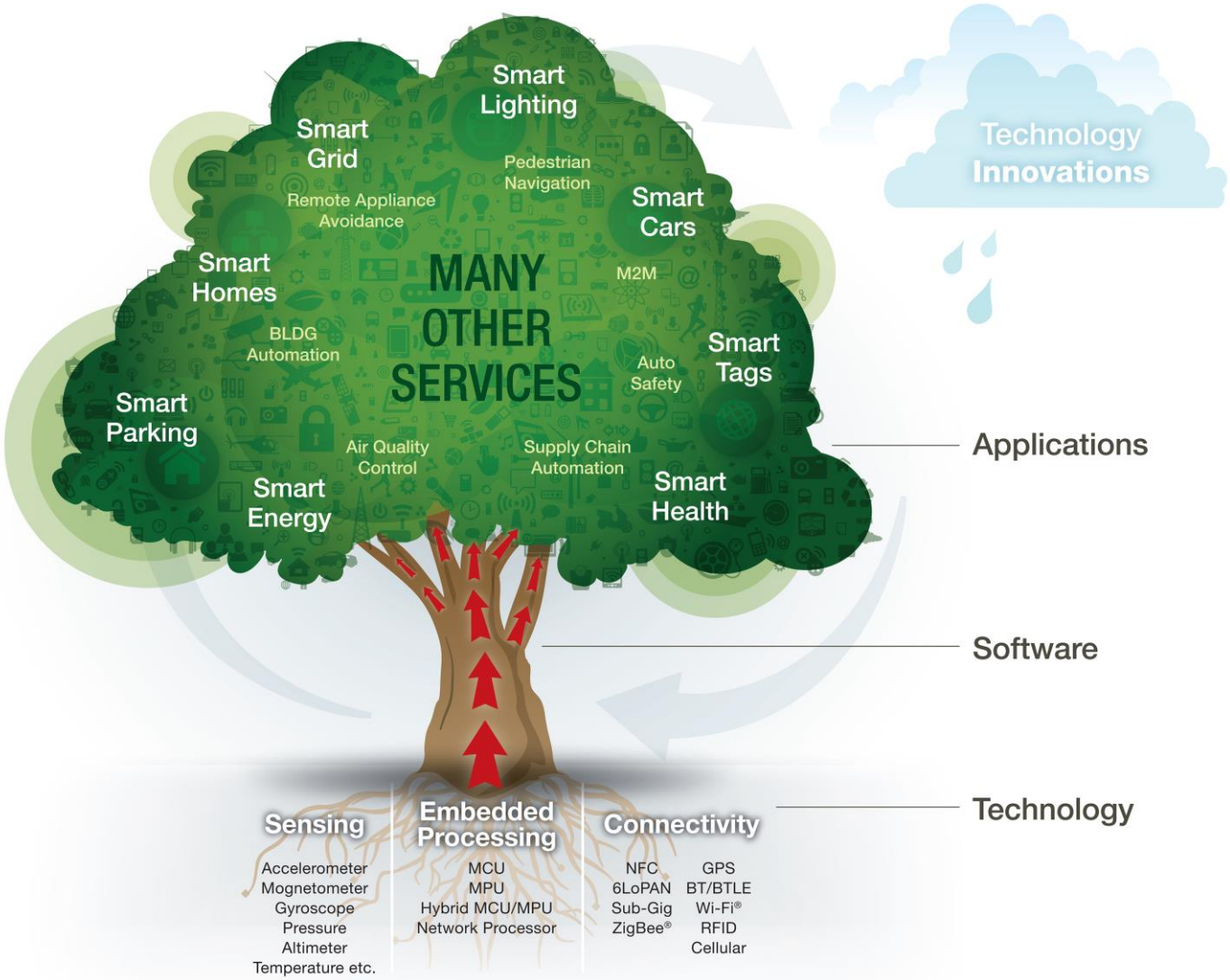
IoT – *ultra-large-scale systems*

- IoT pomera granice današnjih softverskih sistema u svakom pogledu i meri



2021

IoT smart systems



Source: http://eecatalog.com/IoT/files/2014/04/Freescale-Internet-of-Things-Tree.jpg?file=2014/04/Freescale-Internet-of-Things-Tree.jpg

Internet of Things

- Pametni telefoni, pametni satovi, …
- Mnogi "glupi" objekti/stvari postaju "pametni" i konektovani preko Interneta

Pametna industrija (Industry 4.0)

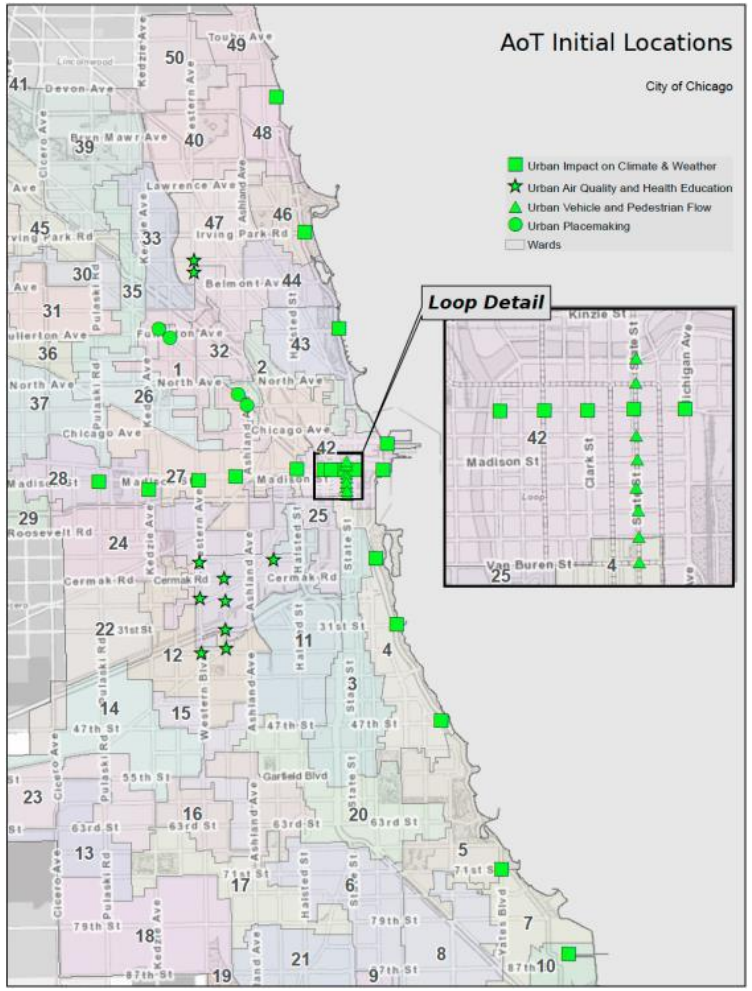
Automotive Telematics - Pay As/How you Drive

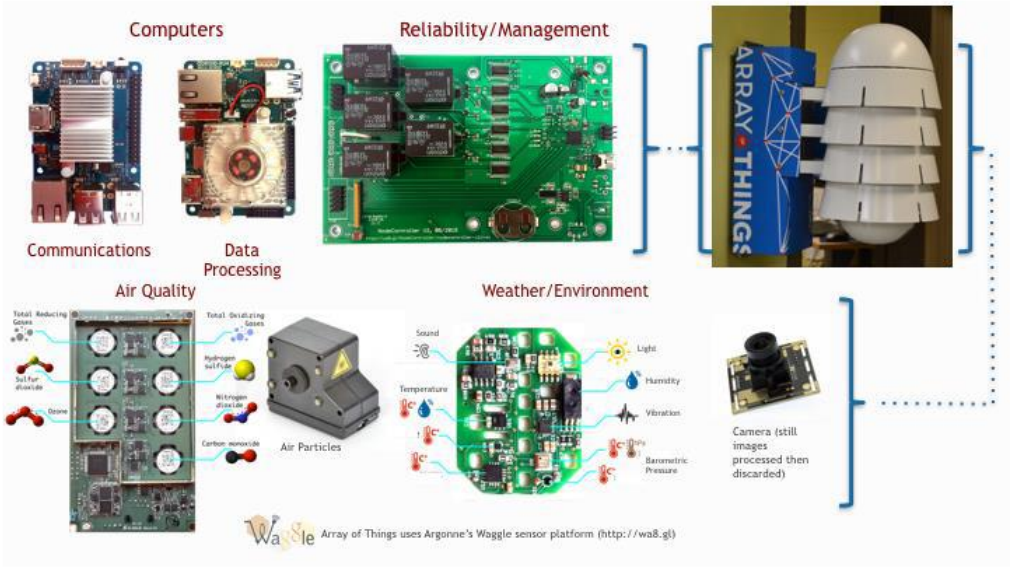
Home Automation and Security - Claim Prevention

Source: Allianz SE

Source: Siemens AG

IoT u pametnim gradovima

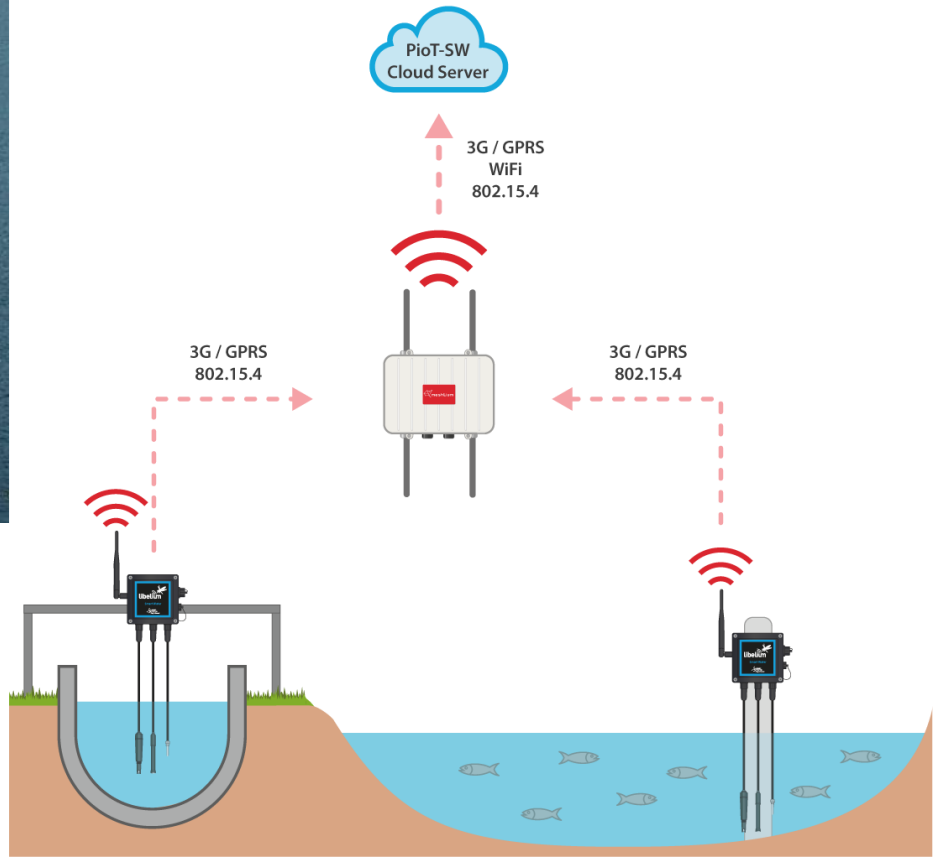




https://arrayofthings.github.io/index.html
https://arrayofthings.github.io/node.html

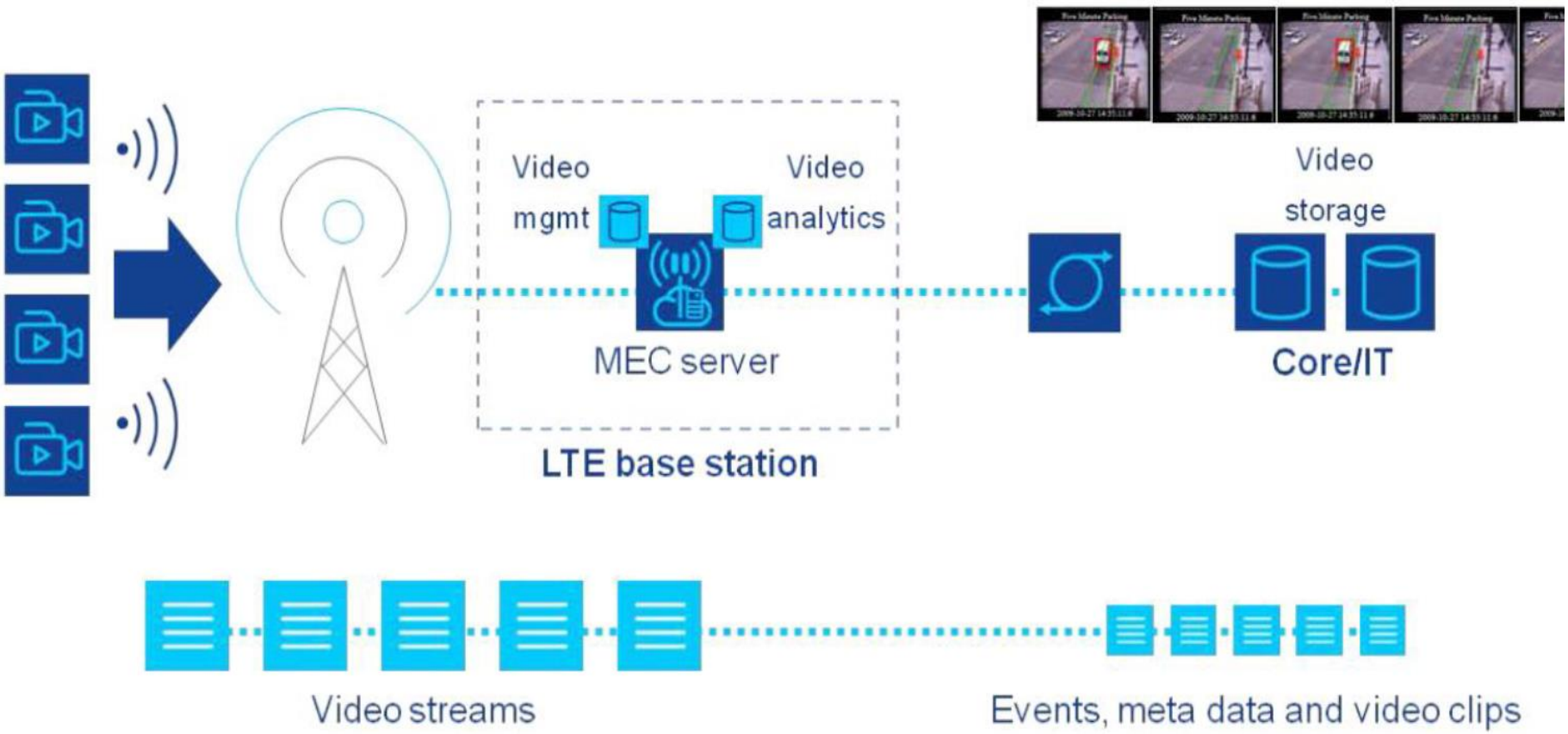
IoT u pametnoj poljoprivredi

http://www.sensorfish.eu/

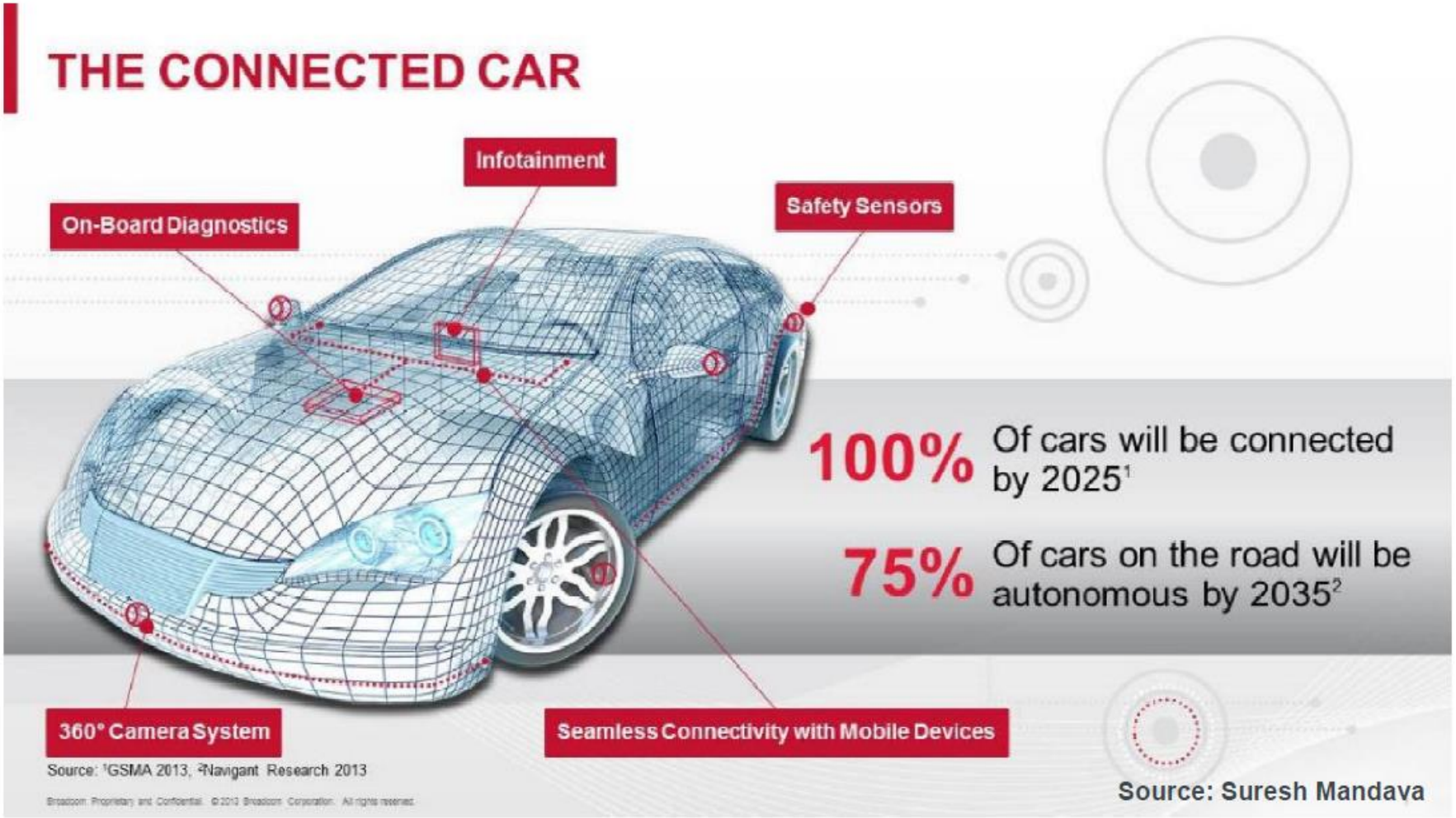


http://www.libelium.com/fish-farm-monitoring-in-vietnam-bycontrolling-water-quality-in-ponds-and-tanks/

IoT u javnoj bezbednosti

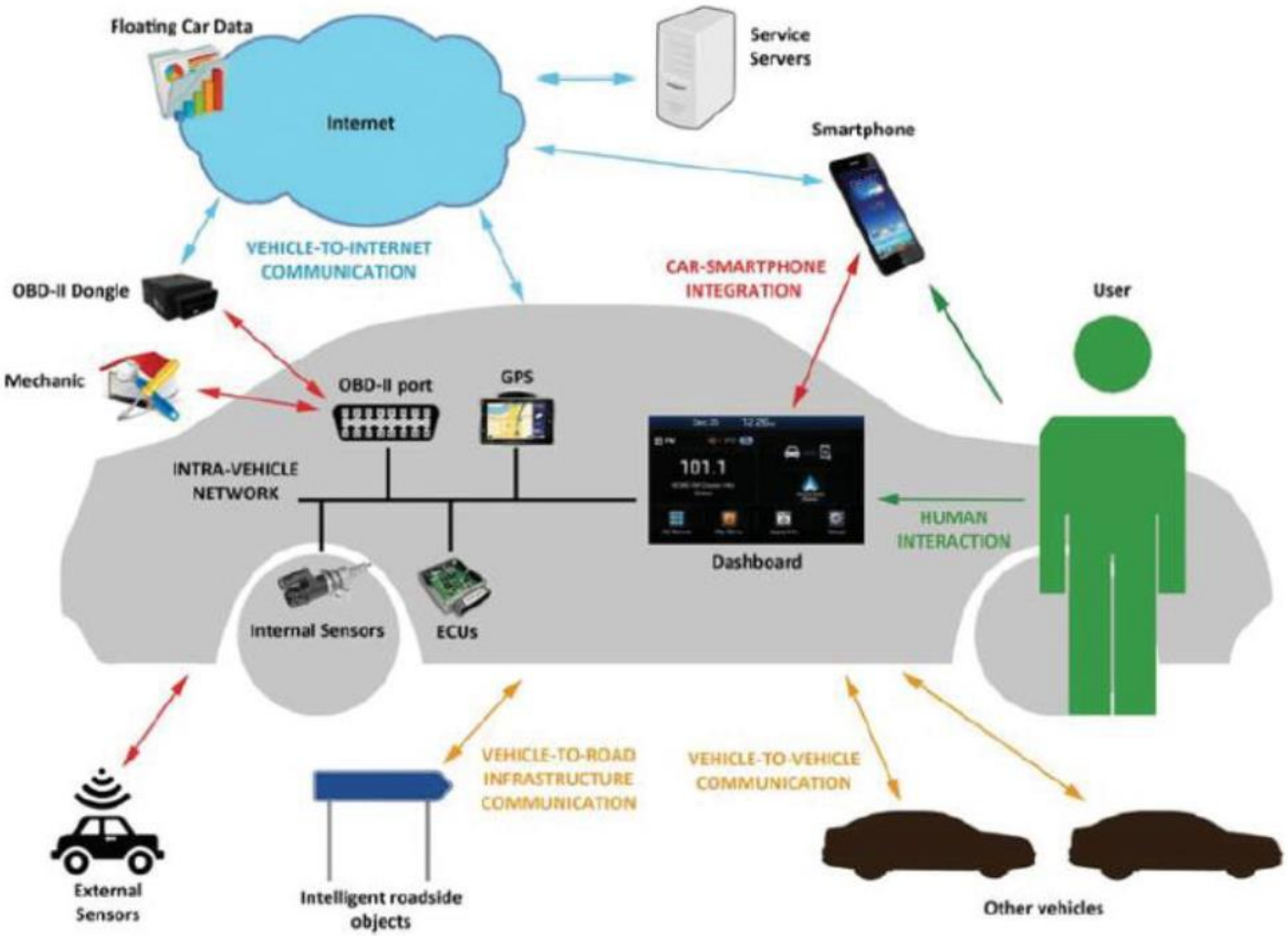


Kompleksni "pametni" objekti



IoT u pametnim vozilima

- *Connected cars*

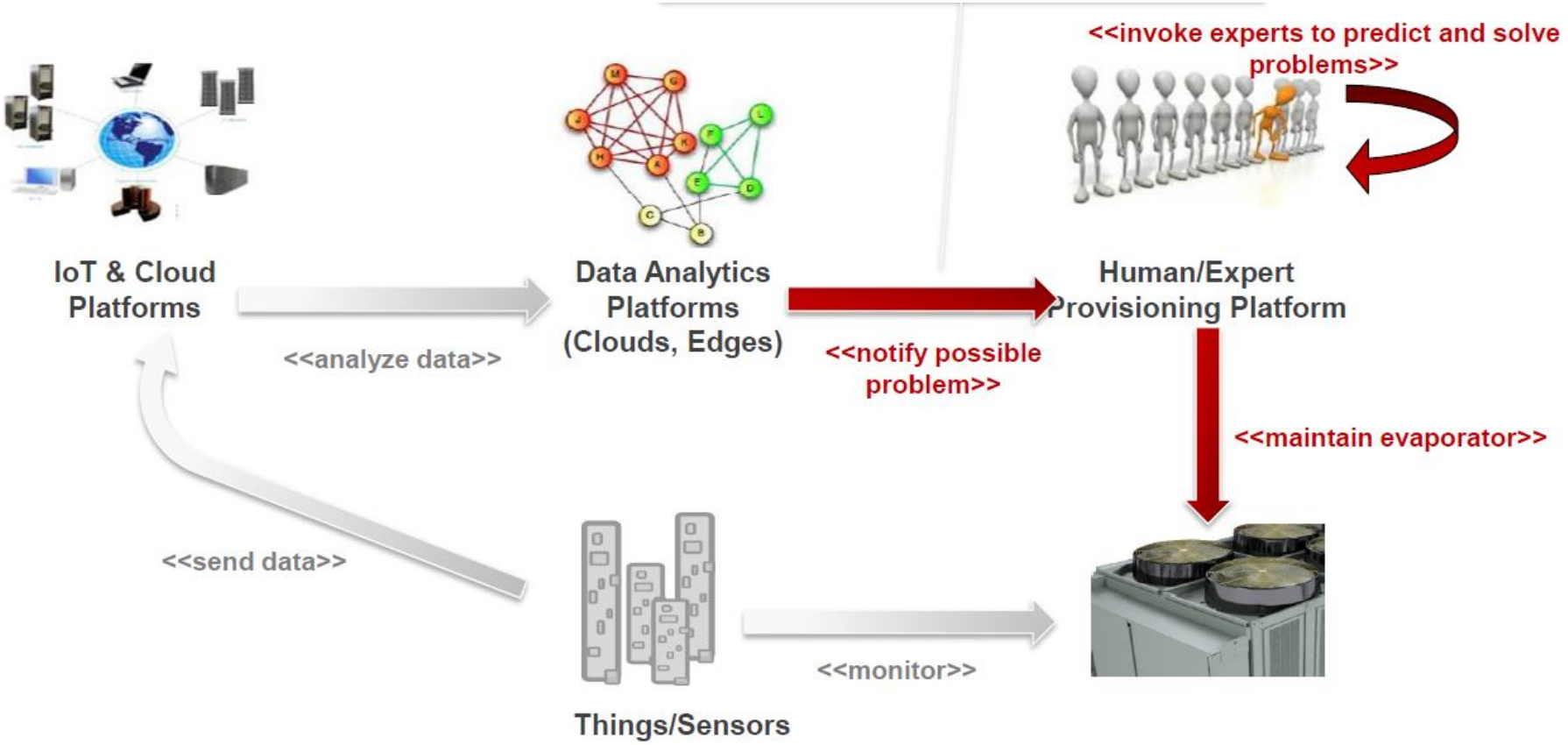


IoT & UAV

- *Unmanned Aerial Vehicles*

IoT u pametnim zgradama

- *Predictive Maintenance in Smart Buildings*



IoT sistemi

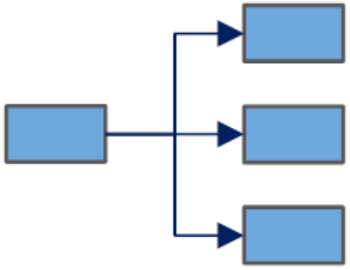
- Računarsko-komunikacioni uređaji (mikrokontroleri, mikroračunari), opremljeni senzorima i aktuatorima, povezani međusobno ili sa IoT gateway-om bežičnim mrežama,
- Veliki tokovi podataka (*Big data*) sa IoT uređaja, ljudi (*crowd sourcing/sensing*), socijalnih mreža/medija,...
- Obrada i analiza velikih skladištenih i brzih tokova podataka na *edge-u, fog-u i cloud-u*
- Rezultati dostupni korisničkim aplikacijama u vidu *dashboard-a*, notifikacija, alert-a,...
- Pokretanje akcija, delovanje i upravljanje okruženjem preko aktuatora na krajnjim IoT uređajima

Arhitekturni principi IoT sistema

Ultra-large Scale

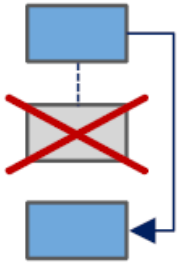
You are not in control

Distributed



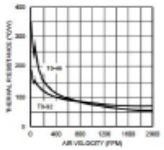
Concurrency, messaging, events

Resilience



Things will always be broken

Full Stack

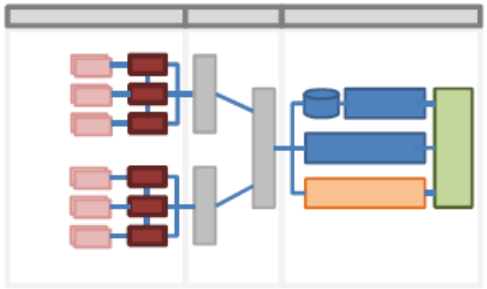


Bit	7	6	5	4	3	2	1	0
byte 1	MQTT Control Packet type				Flags specific to each MQTT Control Packet type			
byte 2...	Remaining Length							

```
ldi r16, 0x01
out TCNT1H, r16
```

Sensors, protocols, processors

End-to-end

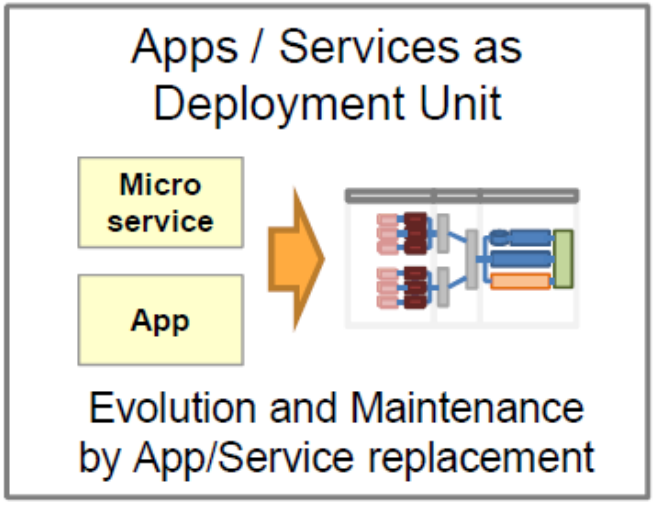


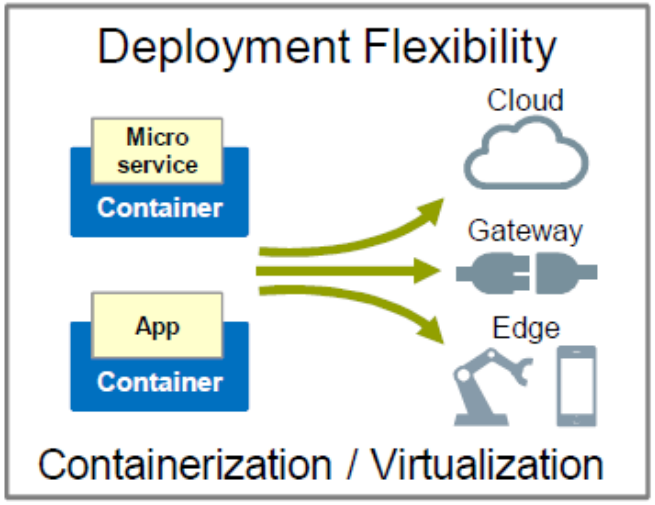
Edge to cloud

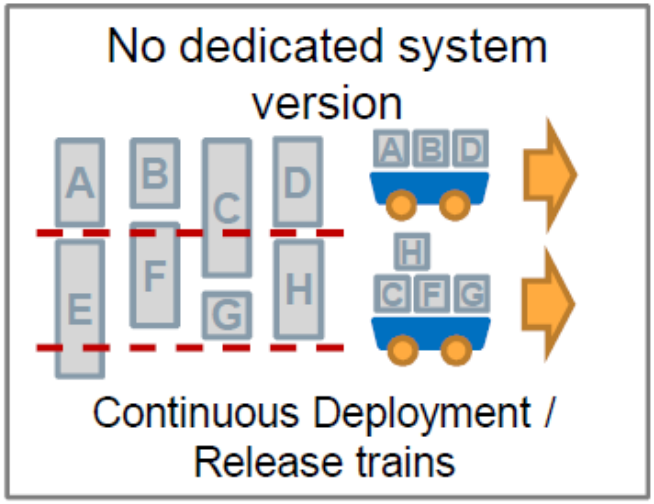
Beyond Tech

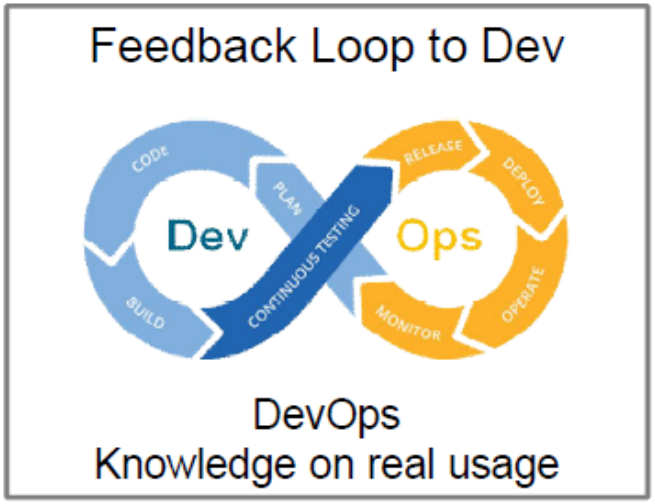
Privacy, Liability

Arhitekturni principi IoT sistema

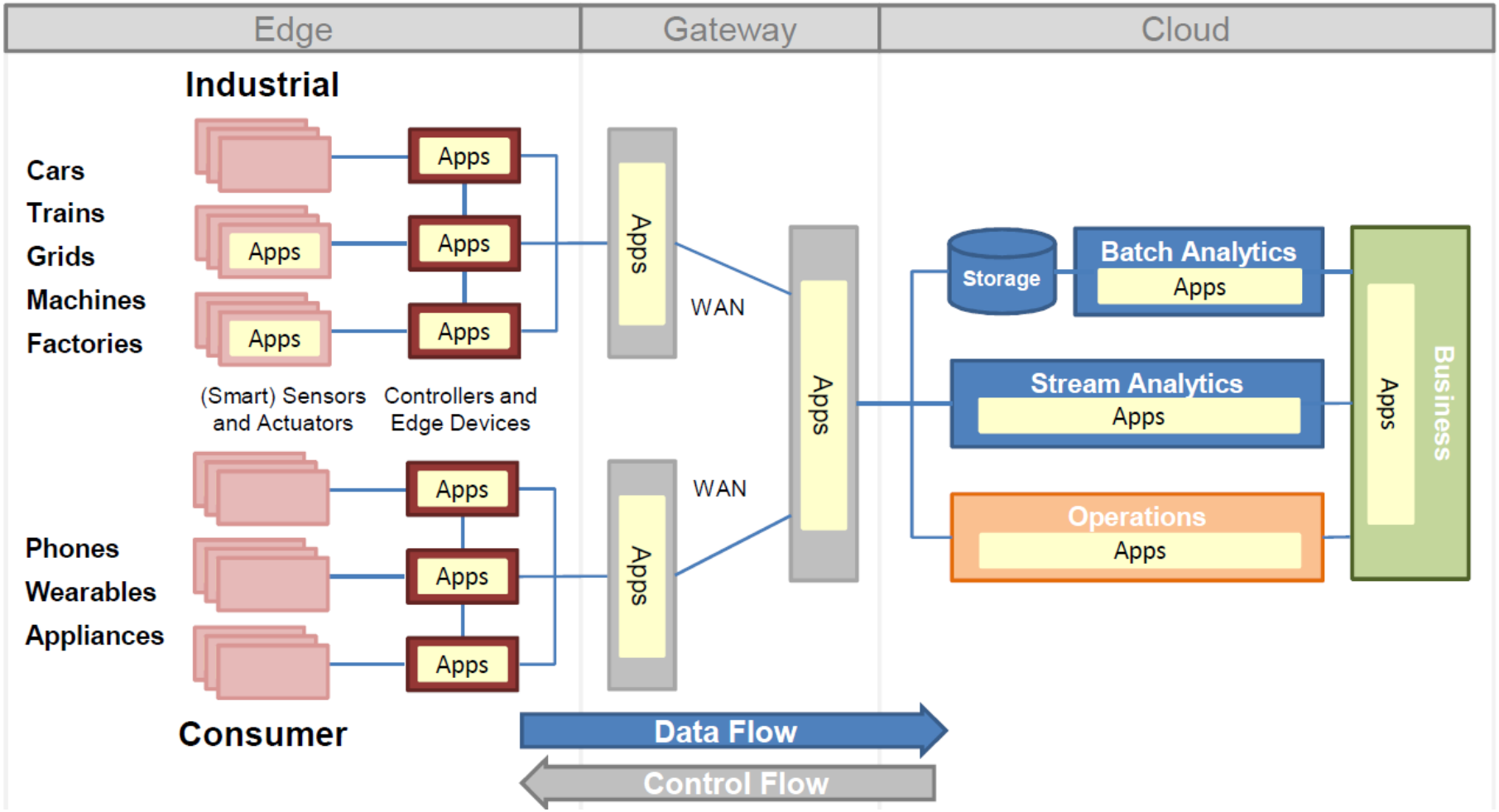






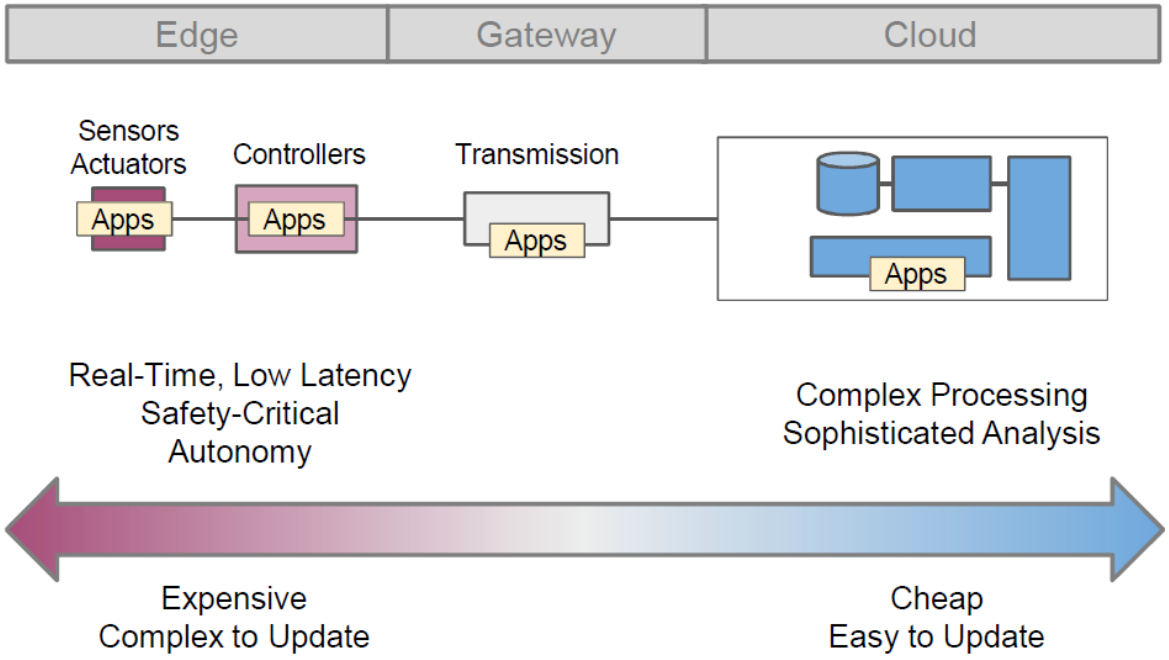


IoT arhitektura



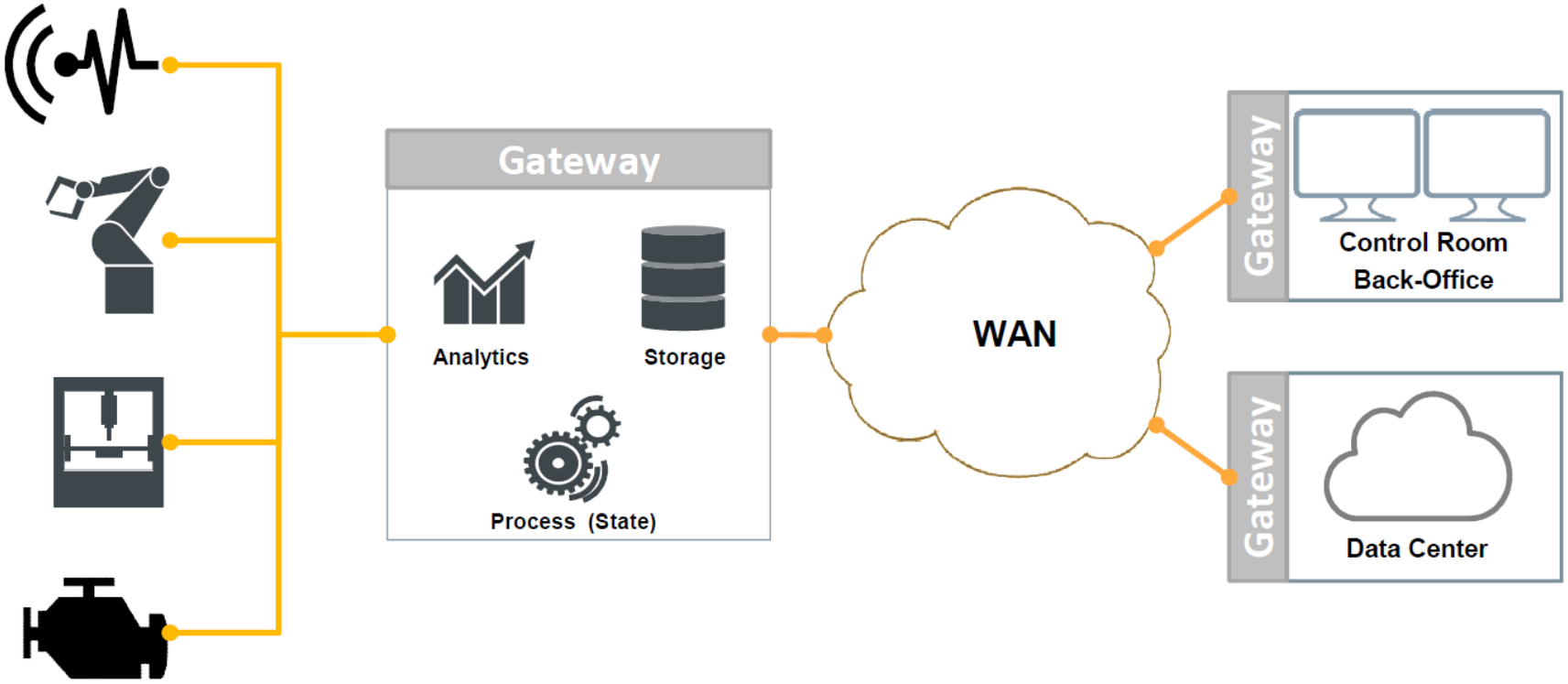
IoT arhitektura

- Servisno-orijentisana i *event-driven* arhitektura
- Mikroservisi
- Reaktivni mikrosistemi, elastični i otporni na otkaze
- *Computing continum – edge-fog-cloud* servisi

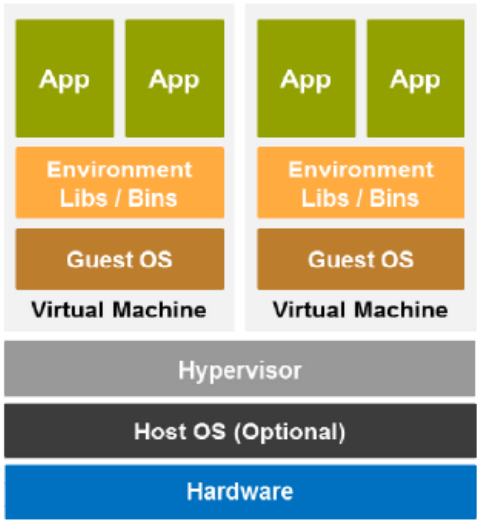


IoT Gateway

- Obezbeđuje servise za obradu i analizu IoT podataka blizu „stvari", mesta gde se generišu/prikupljaju podaci i vrši aktuacija



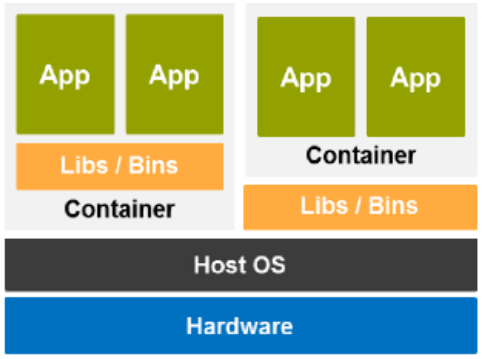
Virtuelizacija



vmware redhat

Suitable for all system architectures
Supports legacy applications
Security (hypervisor as barrier)
Off-the-shelf technologies available

Heavyweight (multiple OS)
Limited deployment flexibility (Host OS dependencies)

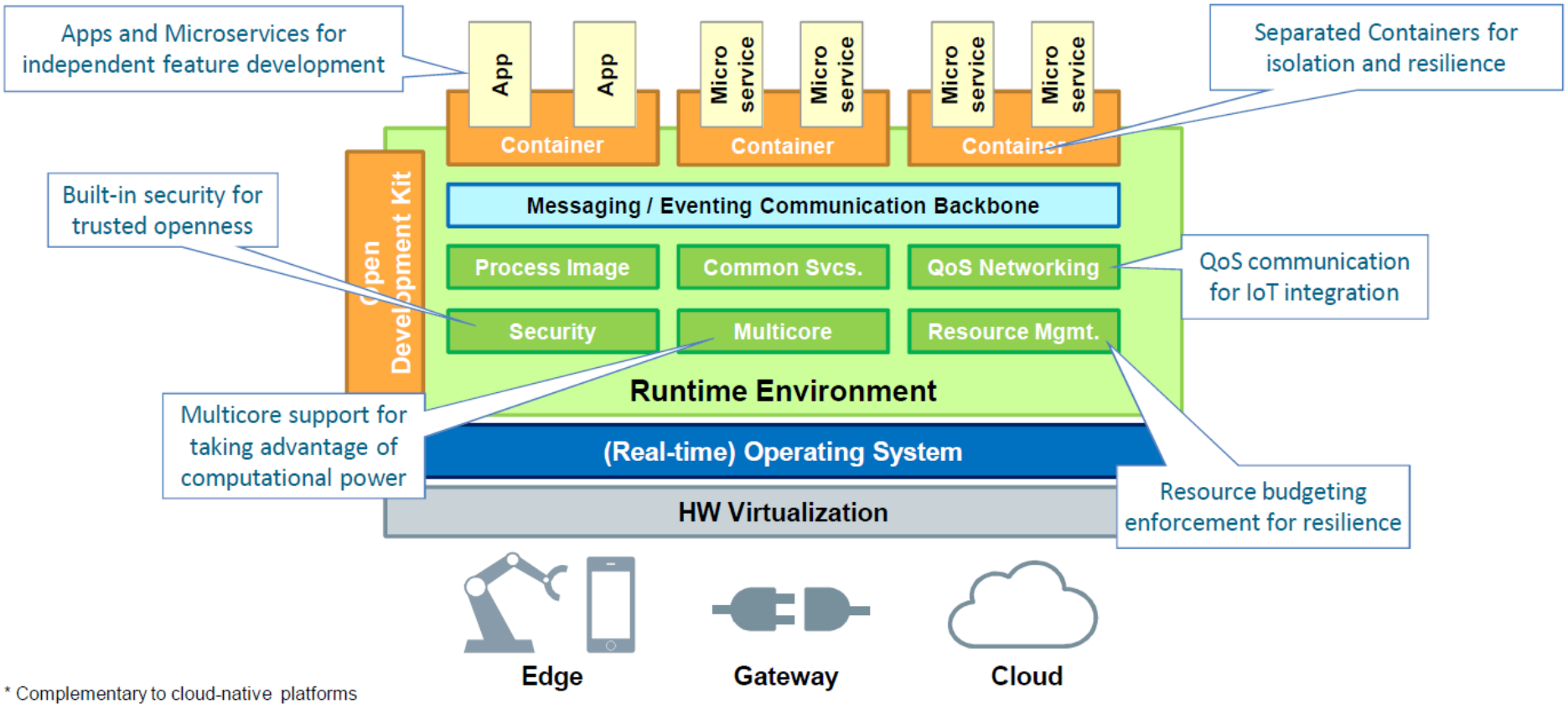


rkt

Suitable for apps and microservices
Lightweight
High deployment flexibility, DevOps friendly
Off-the-shelf technologies available

Security (OS vulnerabilities)
Limited legacy support

IoT – edge - cloud continuum



* Complementary to cloud-native platforms

Reference

- Sofware Architecture in the Age of Things, Frank Buschmann, Gregor Hohpe, **GOTO 2018**, Amsterdam

- Advanced Services Engineering, Prof. dr. Hong-Linh Truong, Faculty of Informatics, TU Wien
  - Emerging Distributed Computing and Challenges for Services Engineering
  - The role of IoT, Cloud, Blockchain and Machine Learning as Service