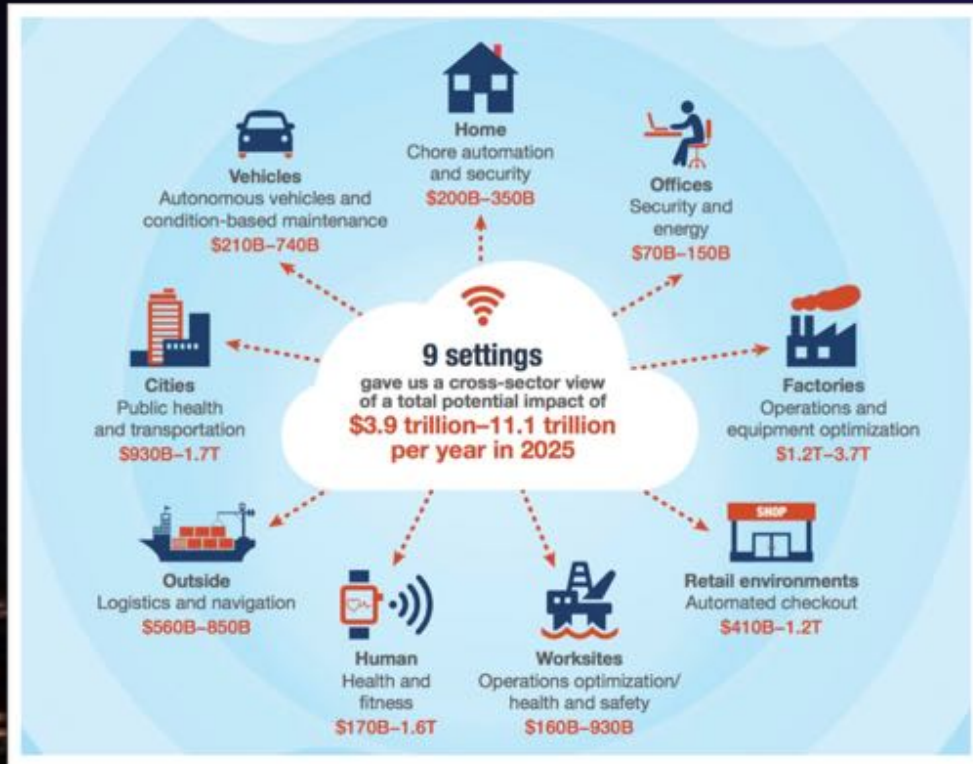


CORE IoT TECHNOLOGIES – FROM 5G TO MACHINE INTELLIGENCE



Jan Höller
Research Fellow - IoT

WHAT IS AT STAKE?



20% water leakage in Europe – 18BUSD revenue in 2020



Smart Grid ICT investments 100BUSD in 2020



Rio Tinto mining savings of 300 MUSD from remote operations



Transport ICT investments 140 B USD in 2020

- 38000 lives yearly in Europe
- Goods transport 50% waste



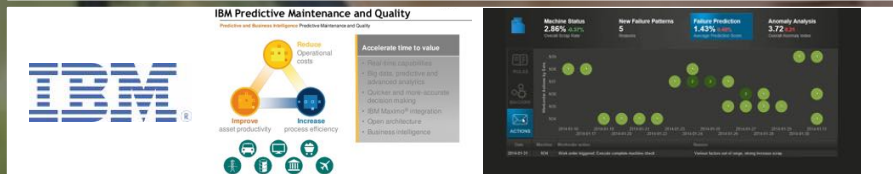
Real-time weather forecasting saves 20 B USD for Monsanto, DuPont

IoT BELIEFS

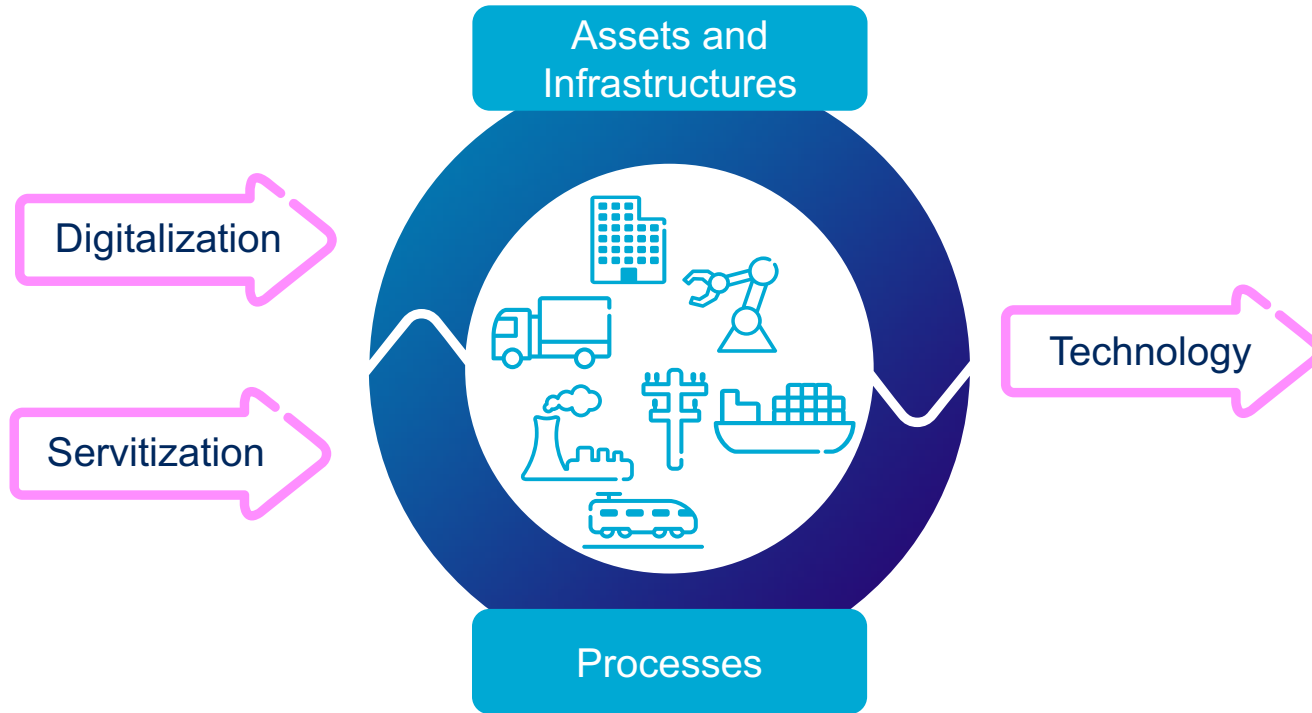
Layman



Reality



TECHNOLOGY DRIVING CHANGE



DIGITAL REPRESENTATION



temp
noise
air_quality
occupancy
energy
water



vibration
temperature
traffic_intensity
surface_condition
noise_level
route_to_work



heart_rate
skin_conductance
calories
gesture
mood
position
movement



irrigation
luminosity
nutrition
moisture
pesticides



location
occupancy
fuel
emissions
speed

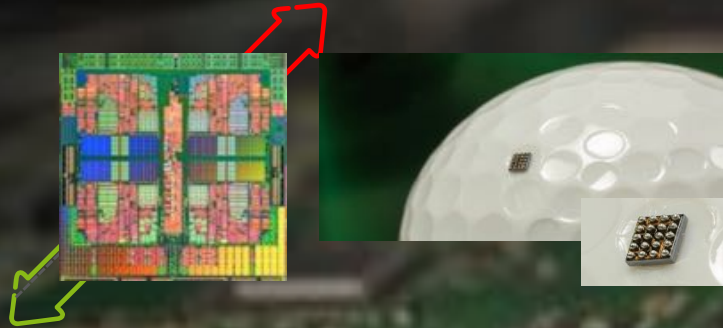


energy
water
waste
CO2_emission
machine_tear
production

DISRUPTIVE TECHNOLOGIES

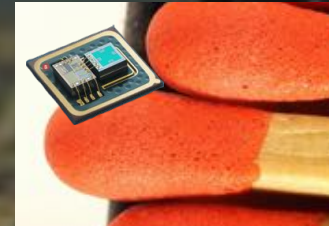


PROCESSORS



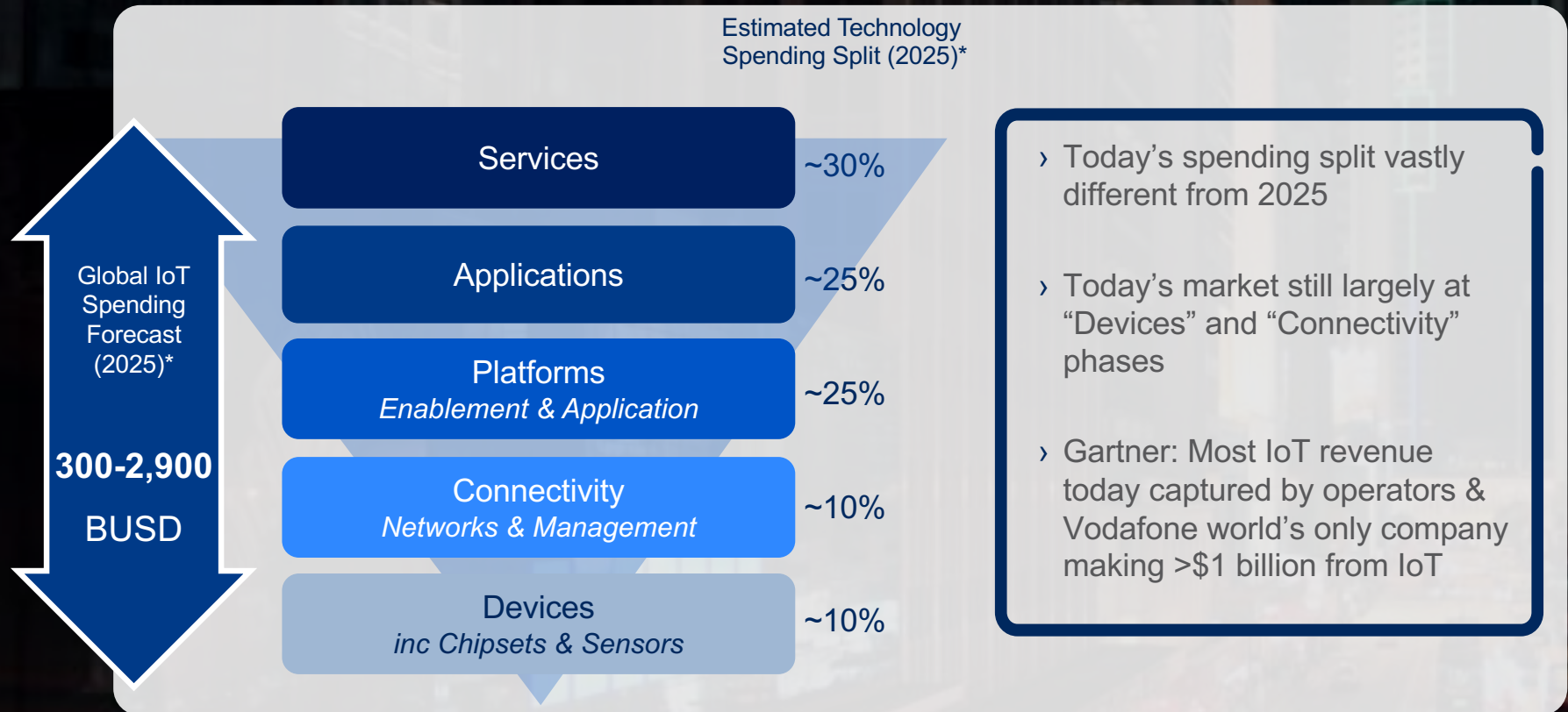
- Smaller
- Lower cost
- Lower power
- Decent compute and storage
- NN capable

SENSORS



- MEMS and Nanotechnology
- One third in size in 3 years
- One third in cost in 3 years
- Higher accuracy

IoT VALUE CHAIN QUANTIFIED



* Source: Various inc McKinsey, AT Kearny, Heavy Reading, IDC, Machina, etc

ERICSSON IoT ACCELERATOR



Industry specific Applications

ERICSSON IOT ACCELERATOR



MARKETPLACE & ECOSYSTEM ENABLEMENT



ORCHESTRATION, INTEGRATION & AUTOMATION



DEVICE & DATA MANAGEMENT



CONNECTIVITY MANAGEMENT

*Professional
Services*

CLOUD

On Premise*

Private*

Public

NETWORK CONNECTIVITY

Cellular IoT

Non Cellular IoT

5G-Core Ready

DEVICES



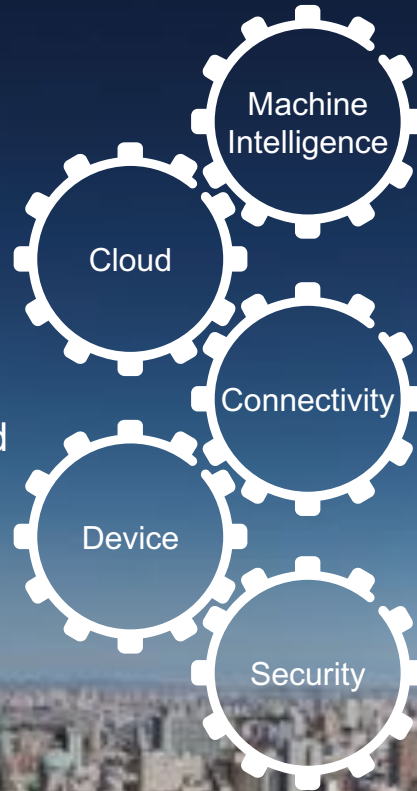
SDK integration

MAIN TECHNOLOGIES AND FOCUS



Distributed cloud and edge computing including devices

Stack-wide interoperability and Web approach to tiny devices



Use case driven value creation and replicable solutions

Wide variety of connectivity requirements

Automated secured lifecycle and layered security management

DEVICES - CURRENT ISSUES



- › One Device - One App
- › Manual Provisioning

- › No Interoperability



McKinsey&Company



**Interoperability
required to capture
40% of total value**

**Machina
Research**

IoT Deployments – Stds vs. BAU

- 27% increase of deployed devices
- 30% reduced cost of solutions

INTEROPERABLE AND SIMPLE



› Go IP

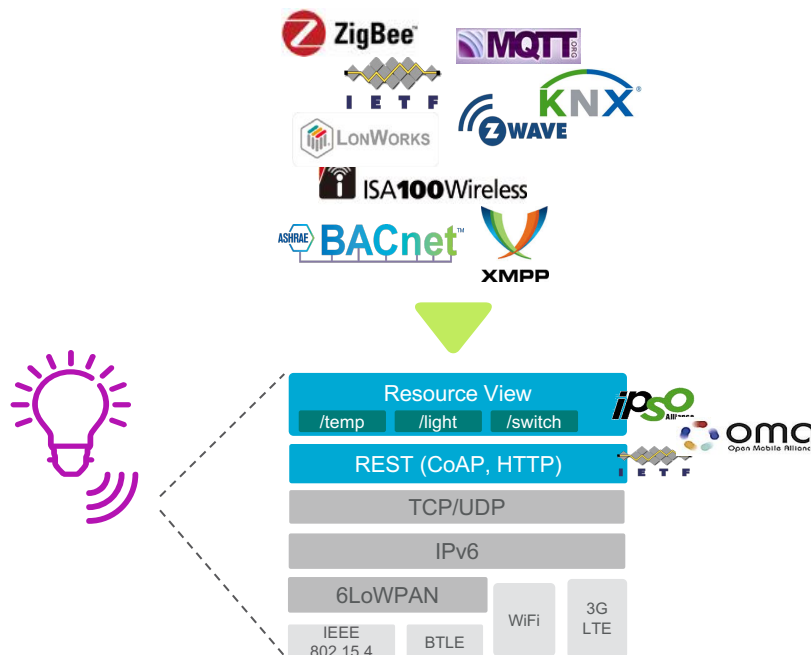
- Reduce technology fragmentation
- Drive IP to the “tiniest of devices” – widely accepted

› Standard Web technologies for IoT

- REST APIs and web resources
- Easy enterprise integration
- Well known application development practice
- Rapid industry consensus building up

› Go Simple

- Make devices application generic
- Drive value from devices to cloud enablement



[Read more](#)

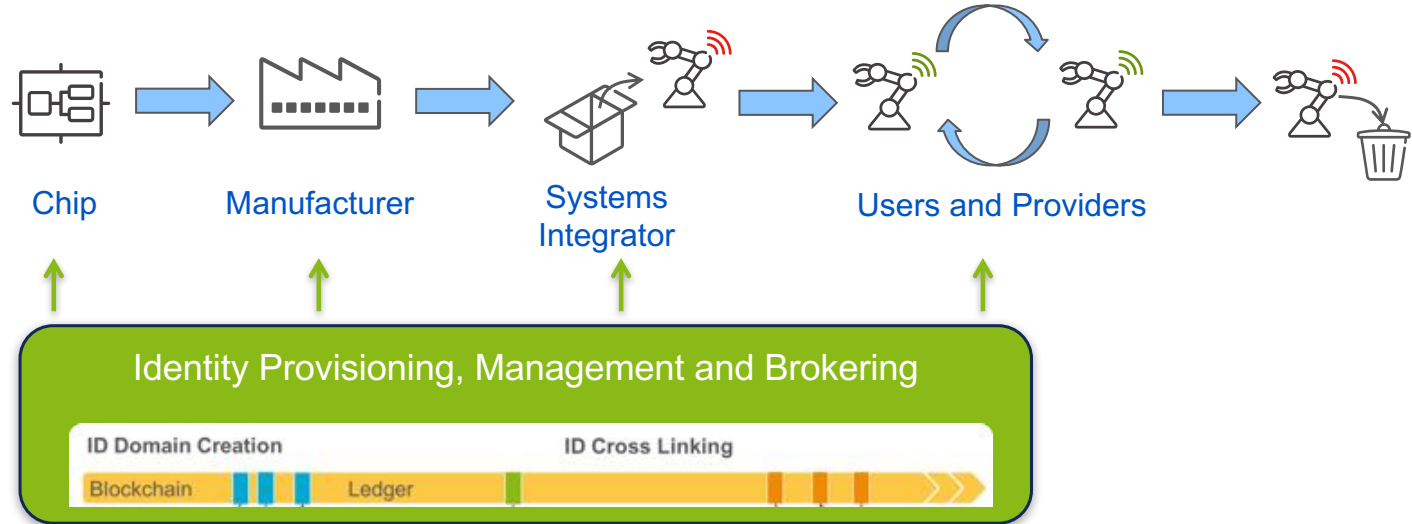


MASSIVE DEPLOYMENTS – AUTOMATED SECURE PROVISIONING



Heterogeneous Identities – Layered Security

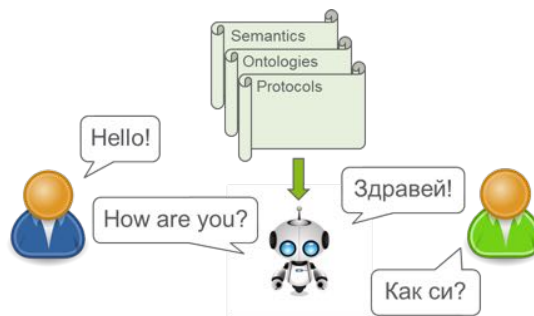
ARM mbed



DEVICE SEMANTICS



- › A key enabler for automated integration of Machine Intelligence across domains
 - Beyond protocol and syntactical interoperability
 - No human interpretation needed
 - Mapping between disparate ontologies
- › Strong growth in research community interest
 - <https://github.com/t2trg/2017-07-wishi>
 - <https://www.iab.org/activities/workshops/iotsi/>



Semantics

Resource View
/temp /light /switch

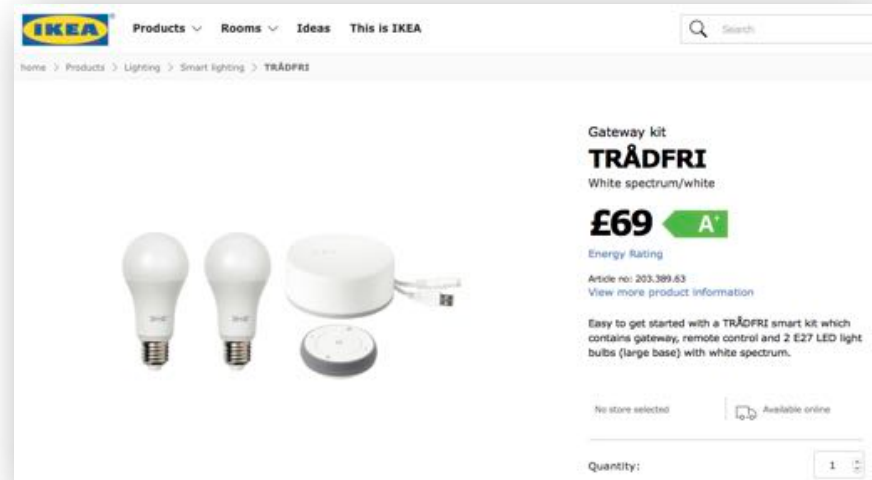
HTTP, CoAP, H/2



IKEA TRÅDFRI

Constrained Web stack and Smart Objects are taking off

- › From research in 2008 (SENSEI), via standardization (IETF, IPSO, OMA) to products
- › IKEA implement CoAP in their home lighting product Trådfri, and seem to use IPSO objects for light control

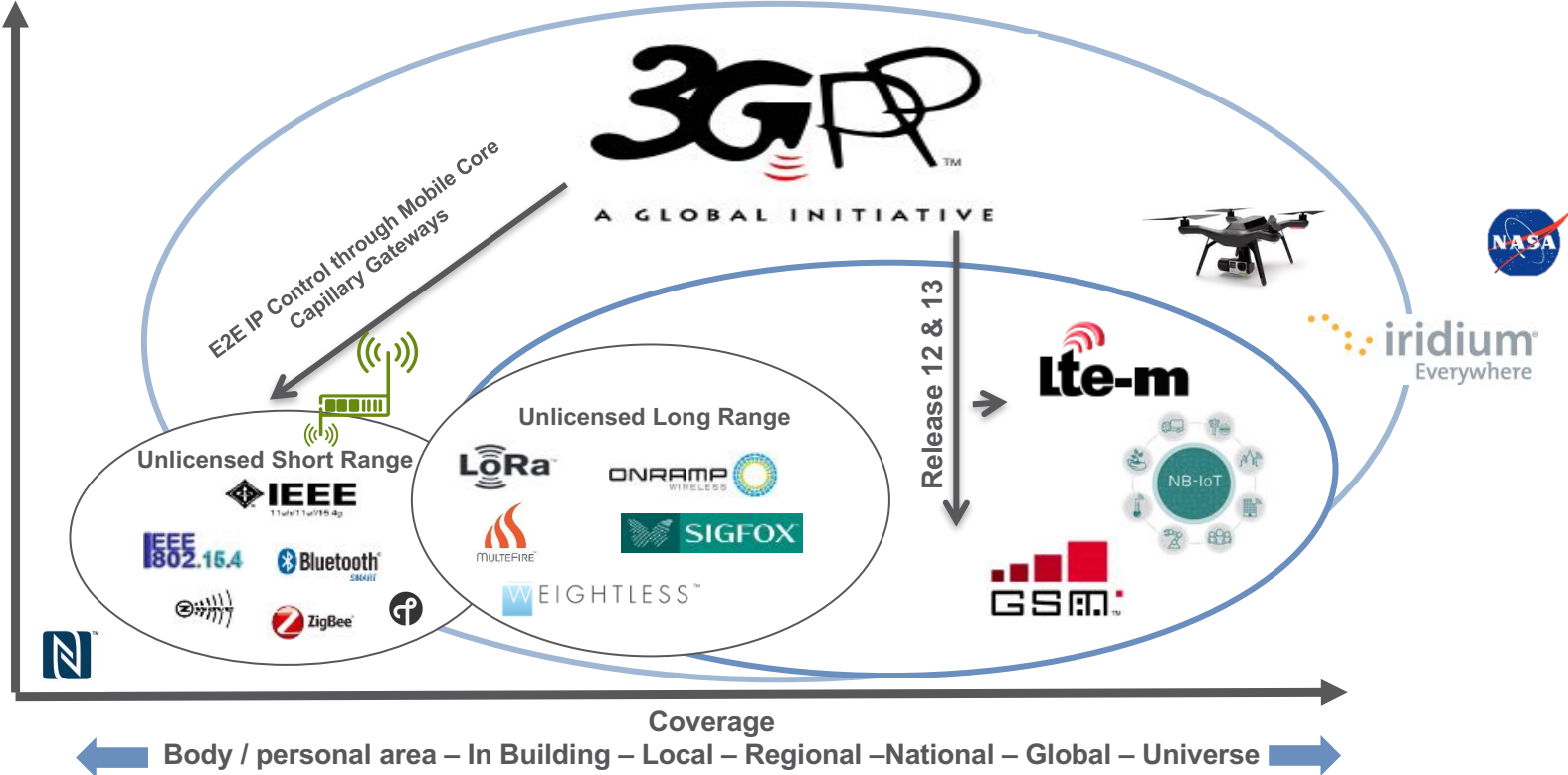


IOT CONNECTIVITY OPTIONS



- Device Cost
- Battery Life
- Bandwidth
- Bi-Directional
- Latency
- Throughput
- Mobility
- Coverage
- Reliability
- Security
- QoS

Requirements Complexity
 Low to High



ONE NETWORK – MANY INDUSTRIES



5G

4G

3G

2G



BROADBAND EXPERIENCE
EVERYWHERE, ANYTIME



MEDIA
EVERYWHERE



MASSIVE SENSOR
DEPLOYMENTS

Low cost
Low energy
Small data volumes
Massive numbers
Long ranges



SMART MACHINES,
INFRASTRUCTURES

Ultra reliable
Very low latency
Very high availability



CRITICAL CONTROL
OF REMOTE DEVICES

WIDE RANGE OF ACCESS REQUIREMENTS



MASSIVE MTC



SMART BUILDING



LOGISTICS, TRACKING AND FLEET MANAGEMENT



SMART METER



SMART AGRICULTURE



CAPILLARY NETWORKS

CRITICAL MTC



REMOTE HEALTH CARE



TRAFFIC SAFETY & CONTROL



REMOTE MANUFACTURING, TRAINING, SURGERY



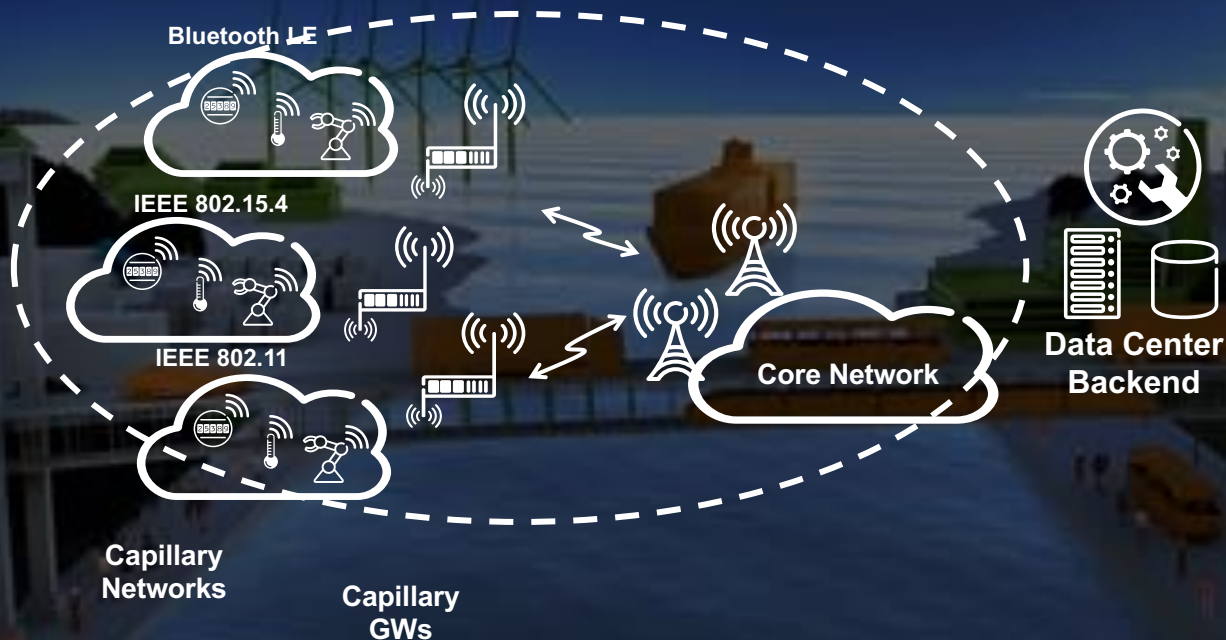
INDUSTRIAL APPLICATION & CONTROL

LOW COST, LOW ENERGY
SMALL DATA VOLUMES
MASSIVE NUMBERS

ULTRA RELIABLE
VERY LOW LATENCY
VERY HIGH AVAILABILITY

CAPILLARY NETWORKS

END-TO-END CONTROLLED IP CONNECTIVITY



FEATURES

- Bridging xAN-WAN
- Auto-configuration & Management
- Security
- Ensured E2E connectivity
- Life-cycle robustness
- Edge and Fog computing
- Radio mesh networks

DEPLOYMENTS

- Neighbourhood Area Networks
- Buildings and Homes
- Remote Plants and Sites

Auto-Configuration, Integrated Security, Edge and Fog, Dynamic GW Selection, Localized Applications, Legacy Integration

RESEARCH PROJECT EXAMPLES

In Transport, Manufacturing and Process Industries



KOI Coordinated Industry Communication

- Low latency & high reliability wireless industrial communication
- Radio interface design for local communications in production units
- Coordination system for realistic large scale deployments in the factory for efficient radio resource management, interference coordination and coexistence management
- Security aspects

↓

- Increased flexibility
- Decreased costs
- Fast and simple deployments

Partners: Fraunhofer, ERICSSON, WEISS, Bosch, Siemens, Volkswagen

CHRONOS C-ITS Test & Validation for future transportation systems

- Establish an open and controlled test arena for validation of Connected Driving (C-ITS)
- Increase knowledge on use cases and business drivers

Partners: Fraunhofer, ERICSSON, WEISS, Bosch, Siemens, Volkswagen

5GEM 5G Enabled World Class Manufacturing

- Evaluate 5G technology in a manufacturing industry
- Understand ICT opportunities and solutions

Partners: SKF, CHALLENGE, ERICSSON

CMA Test Site for Future Automated and Shared Mobility Systems

- Exploring the use of 5G networks for intelligent transport systems
- Investigating "as-a-service" offerings for network operators and automotive OEMs

Partners: Ericsson, CMA

REMOTE OPERATION Robot remote control with haptic feedback over LTE

- Evaluate mobile communication in industrial remote operation
- Remote operations in mines – an industrial use case with strict requirements on reliability and latency.

Partners: Ericsson, Husqvarna

5G NETMOBIL

- Develop overall communication infrastructure for tactile connected driving beyond the self-contained sensor based autonomous driving
- Improved road traffic safety, less environmental impact, and higher efficiency of road transportation
- Provide 5G communication technologies and network architecture for tactile connected driving
- Low latency required by real-time vehicle control and cooperative manoeuvres
- High reliability and availability for highly mobile environments

Use cases:

- Parallel cooperative driving of a fleet of farm machinery in off-road areas
- Tactile connected driving of vehicles at intersections of urban roads
- High-density platooning of trucks in automotive test field

Partners: ABB, Ericsson, Bosch, Siemens, Volkswagen, ABB, Ericsson, Bosch, Siemens, Volkswagen

PIMM Pilot for Industrial Mobile Communication in Mining

- Explore future 5G Use Cases in underground mining
- Evaluate mobile communication infrastructure in an industrial context

Partners: Ericsson, ABB, Volvo, SKF, SKF, ABB, Volvo, SKF

WITOOOL Wireless Internet of Tools

- Enable IoT for construction equipment OEM (Husqvarna) and rental companies (Cramo)
- Capillary network connectivity, cloud, service enablement and machine analytics capabilities
- Demonstrated through automation of return process of machines at Cramo depot

Partners: Ericsson, Husqvarna, Cramo

DATA (AND SEMANTICS AGAIN)



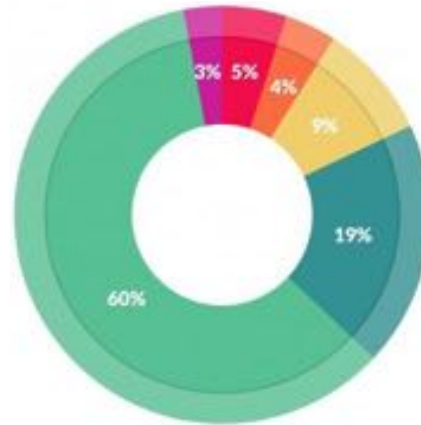
McKinsey&Company



< 1% of data currently used, mostly for alarms or real-time control; more can be used for optimization and prediction

Forbes

***Data preparation** accounts for about 80% of the work of data scientists*



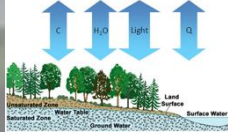
What data scientists spend the most time doing

- Building training sets: 3%
- Cleaning and organizing data: 60%
- Collecting data sets: 19%
- Mining data for patterns: 9%
- Refining algorithms: 4%
- Other: 5%

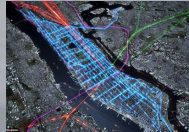
Source: Forbes

VALUE GENERATING USE CASES

MASSIVE MONITORING



INFRASTRUCTURE MONITOR AND CONTROL



ASSET MANAGEMENT



LOGISTICS



ROBOTS AND AUTONOMOUS MACHINES



REMOTE OPERATIONS



PEER TO PEER



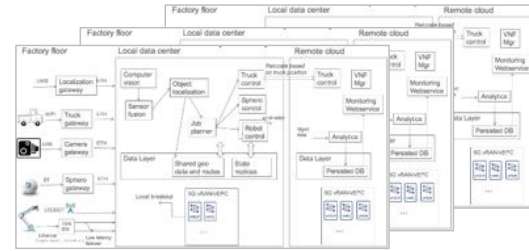
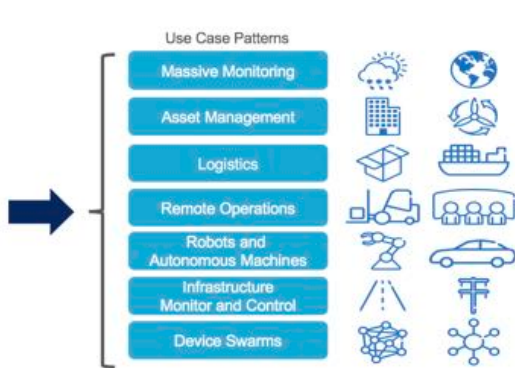
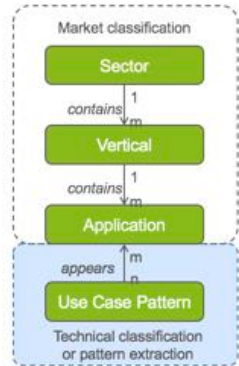
REPLICABLE SOLUTIONS



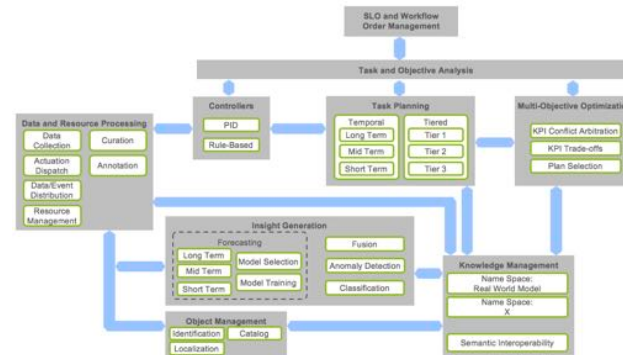
Proposition: Replicability

Vertical industry independent recurring use cases and corresponding reusable solution blueprints

Use Case Patterns

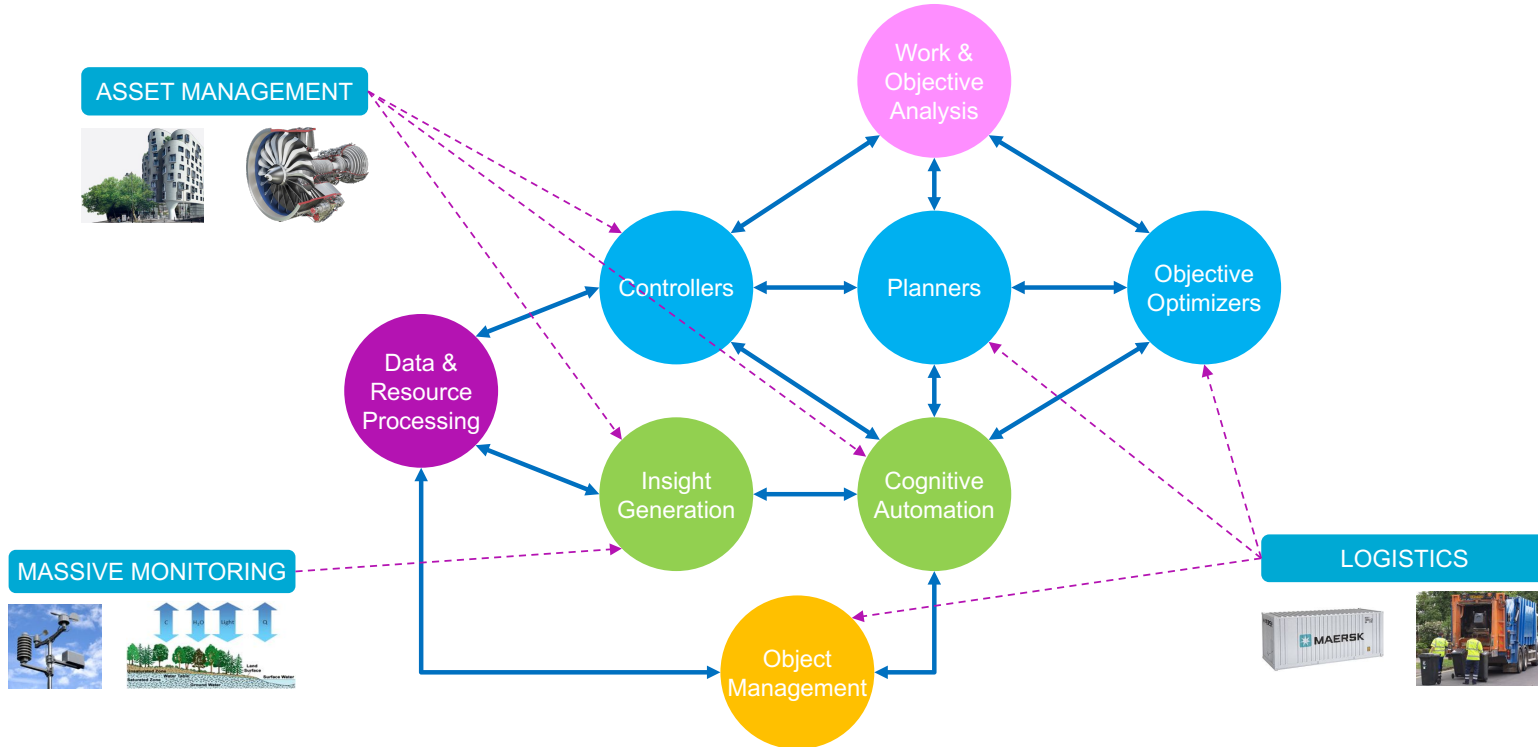


High Level Solution Blueprints

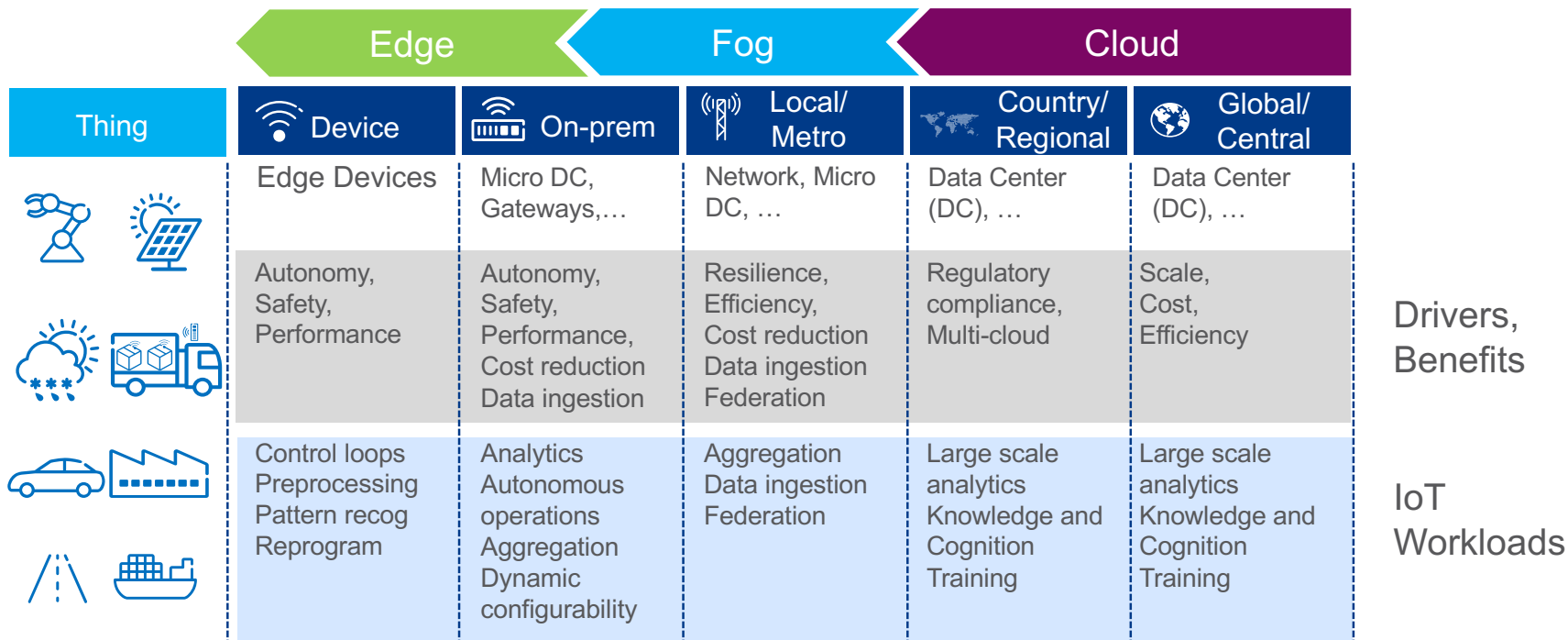


Distributed Machine Intelligence Capabilities

MI++ TOOLS FOR IoT USE CASES



DISTRIBUTED CLOUD AND EDGE COMPUTING



Gartner *By 2022, 50% of enterprise-generated data is created and processed outside the data center or cloud*

INDUSTRIAL CLOUD PLATFORM

- › Next evolution of Cloud designed for Cloud-native apps
- › Multipurpose accommodating multitude of Industrial apps incl. IoT
- › Apps implemented as series of functions to be executed

Requirements:

- Distributed by nature
- Auto scaling of resources by demand
- Automated deployment of functions
- Multi-tenant on device/edge/central
- Autonomous operation
- Multidomain with isolation and privacy



MAIN TECHNOLOGIES AND FOCUS



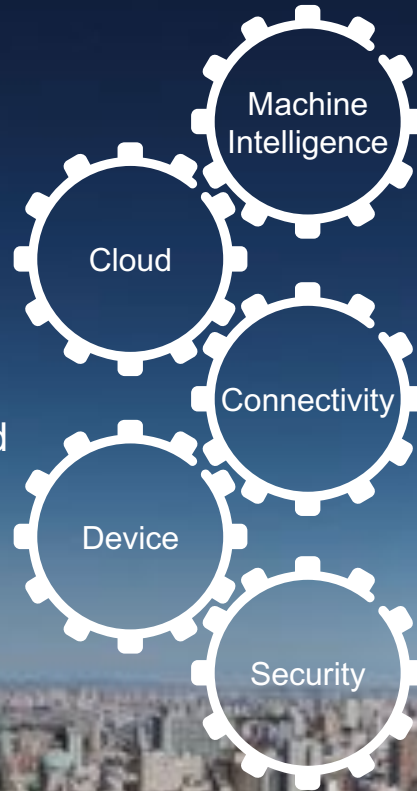
XaaS, new business models
Digital Marketplaces

Distributed cloud and edge
computing including devices

**Object localization and
identification**

Stack-wide interoperability and
Web approach to tiny devices

Legacy and brownfield
Unification of transfer stacks



Use case driven value creation
and replicable solutions

**Trusworthy data, liability,
provenance and QoI**

Wide variety of connectivity
requirements

Privacy, ownership of data
Safety, actuation...

Automated secured lifecycle and
layered security management

THANK YOU!

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