The Internet of Things: What's Up Next?

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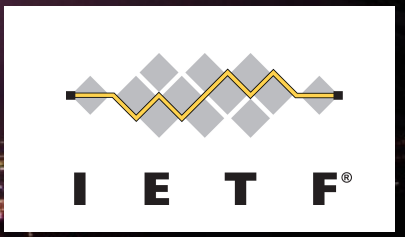
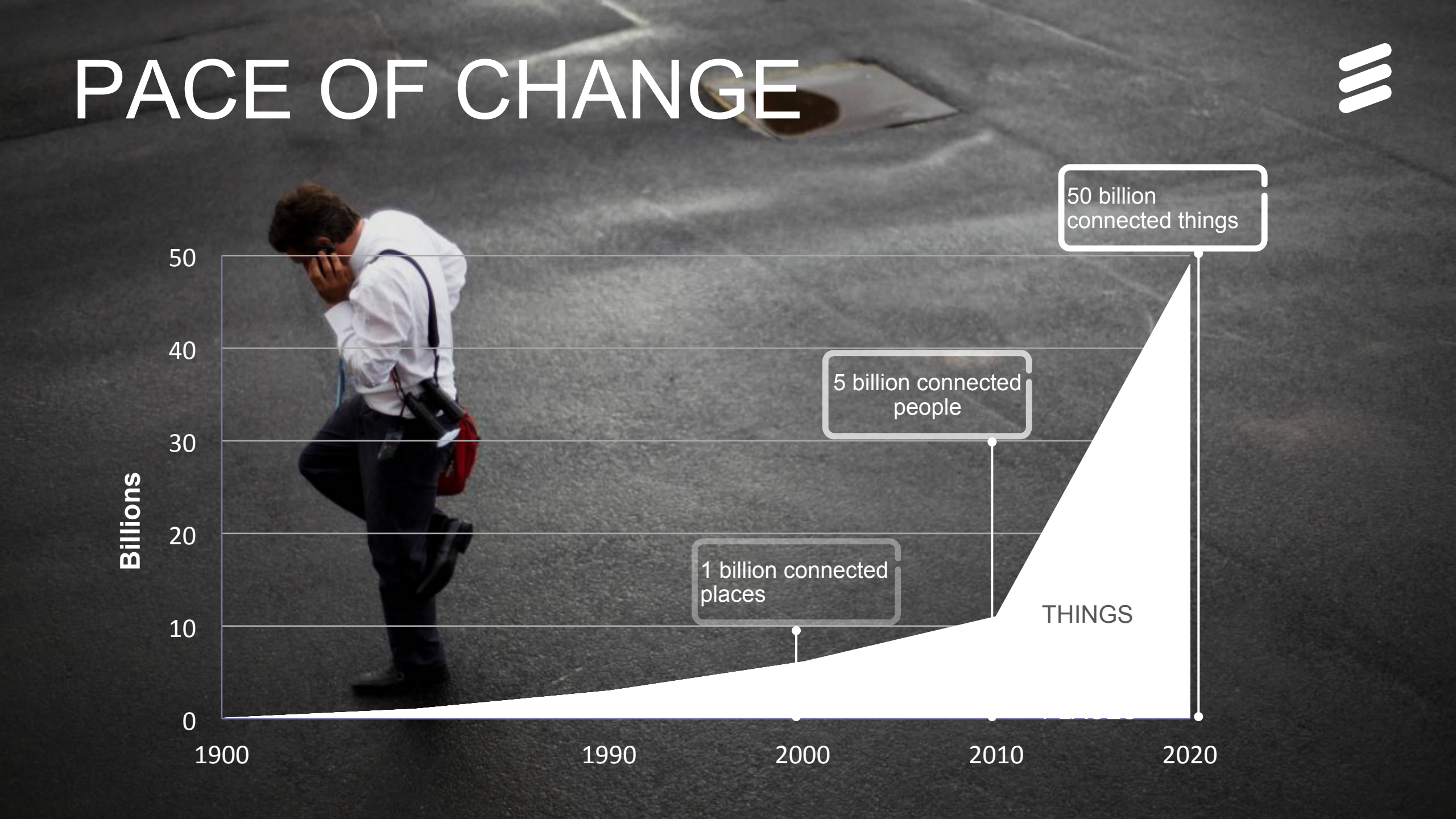
With thanks to Jan Höller (Ericsson) and others who have provided much of this material



PACE OF CHANGE



JUST THE BEGINNING

When one person connects,
their world changes.

With everything connected,
our world changes.

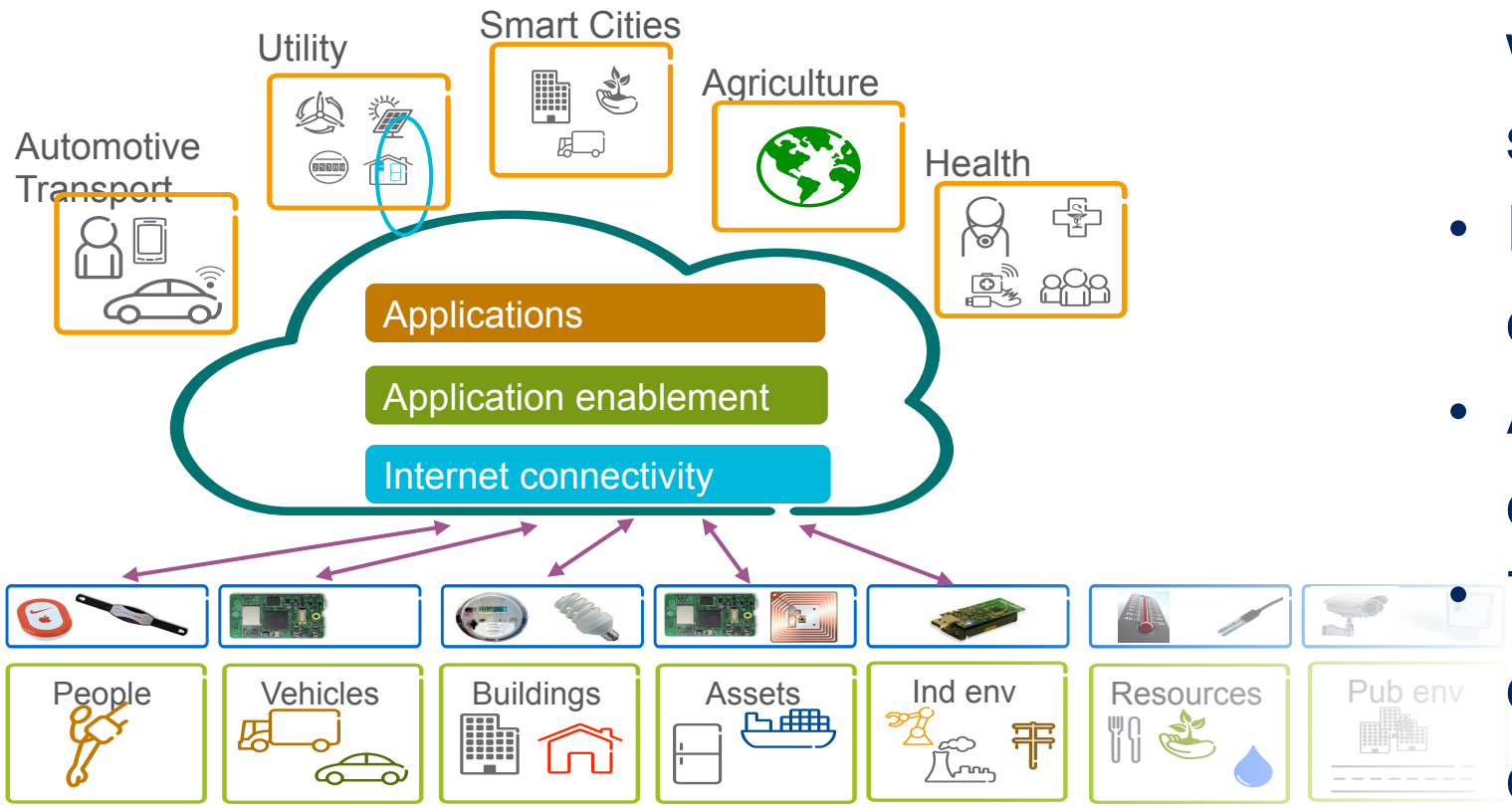
NETWORKED
SOCIETY

A VISION

In the networked society things, places, and real-world processes are first-class citizens on the Internet

And they network – for the benefit of society, life and business

THE INTERNET OF THINGS



- Monitoring and controlling real world objects – provide smartness
- Meeting the needs of enterprises, people and society
- Application domains are endless
- The underlying technology is embedded networked computing with sensors, actuators and tags

DRIVERS AND CHARACTERISTICS

Lean

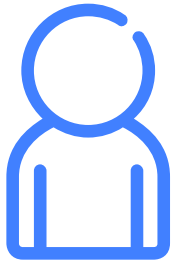
Green

Safe

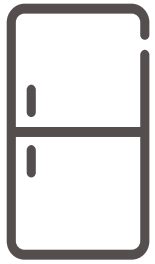
Innovation

Collaboration

Fun



Servitization



Marketplaces

Participation

Transformation - The Big Picture

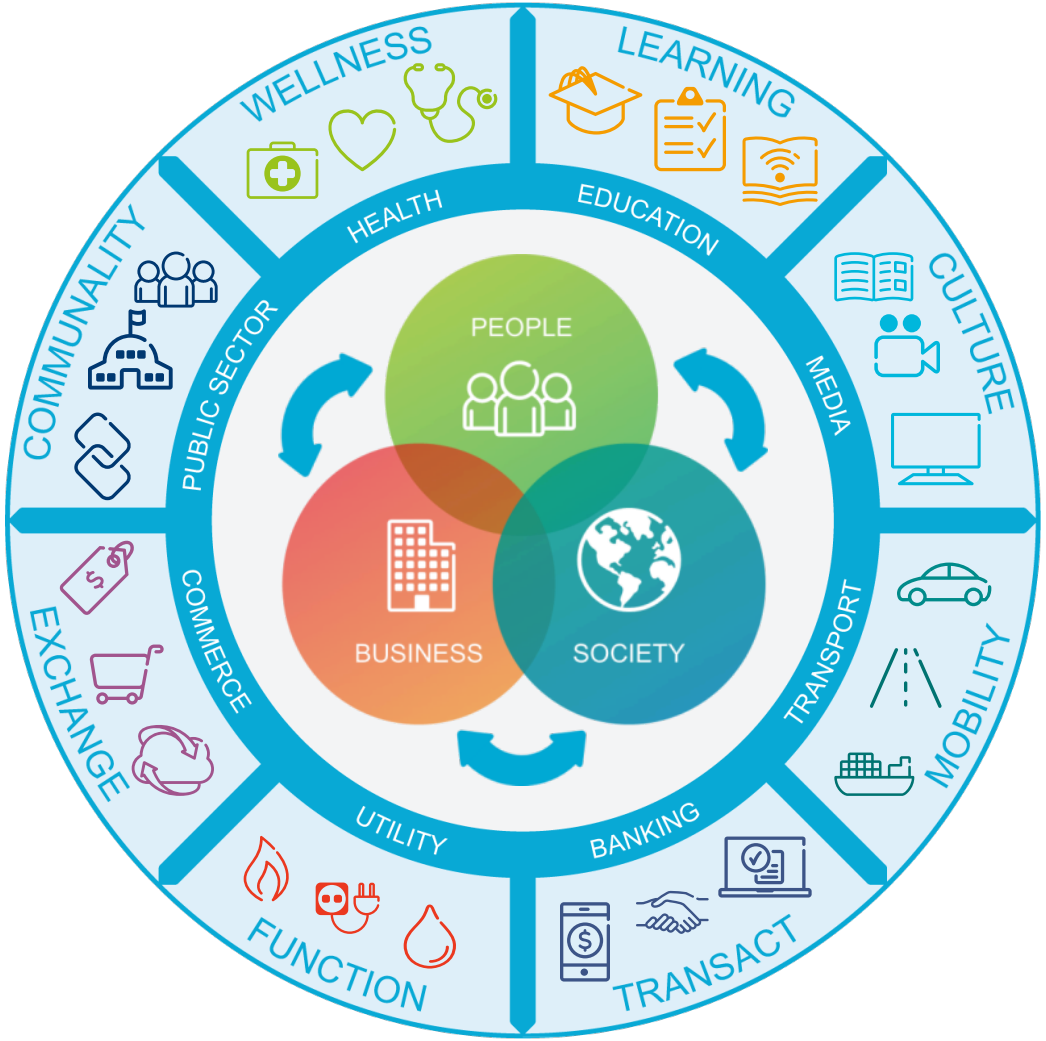
POWER SHIFT

RESOURCES & ENVIRONMENT

GLOBAL CONNECTEDNESS

ENVIRONMENT

URBANIZATION



INTERNET OF THINGS

DATA AND INSIGHTS

SOCIAL MEDIA

CLOUD & NETWORKS

PERMISSIONLESS INNOVATION & OPEN GLOBAL INTERNET

IS IT HAPPENING?

WHAT IS NOW AND NEXT?

“THEN AND NOW”

- Metering
- Telematics
- Point-of-Sale
- Healthcare
- Security and Surveillance
- Smart Grid
- Transport

“RECENT”

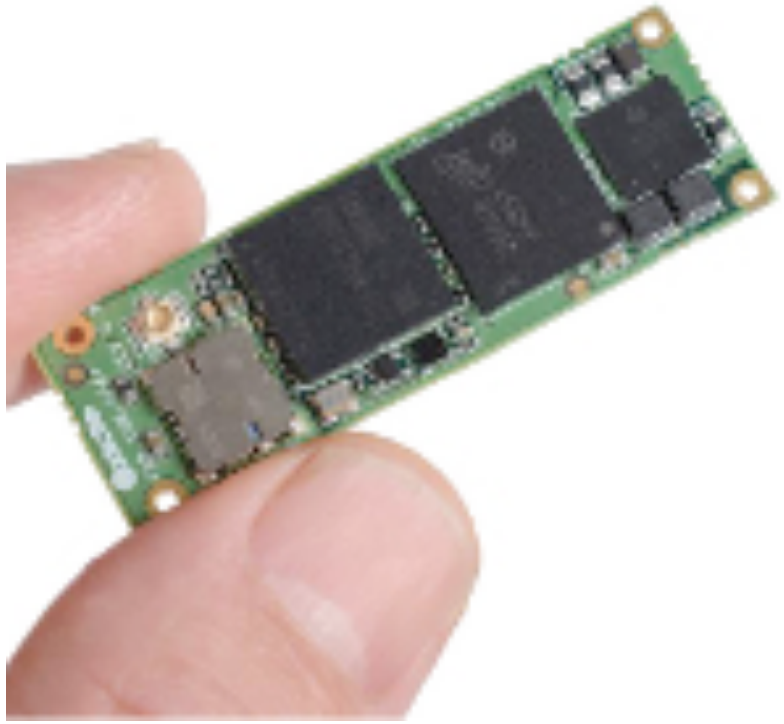
- Wearables
- Sports and wellness
- Home automation
- Smart appliances
- Industrial
- Streetlights

“NEXT”

- Manufacturing
- Home convenience (ambience, lighting, assisted living)
- Food safety
- Agriculture
- Water
- Natural resources
- Materials
- Self-driving vehicles
- …. the unpredictable

MICROELECTRONICS

Dual-Core ARM Cortex-A9 Module
1 GB RAM and 8 GB Flash
(Source: linuxgizmos.com)



LOW POWER

Low-power ARM CPU
(Source: arstechnica.com)

Also matches what is becoming achievable in mobile networks

New ARM-powered chip aims for battery life measured in decades

Atmel's 32-bit SAM L controllers, shipping soon, take low power to new extremes .

by **Sean Gallagher** - Mar 31, 2015 1:45am EEST

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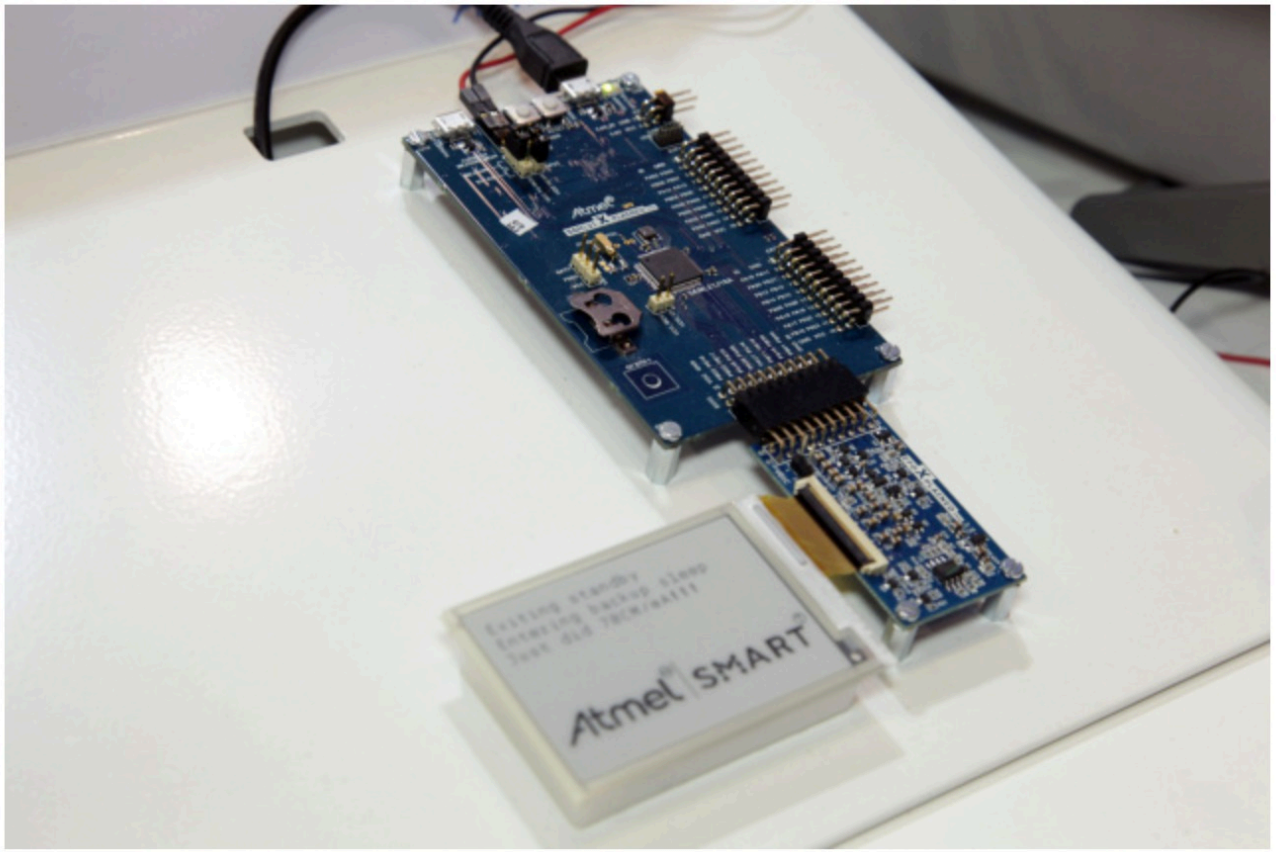
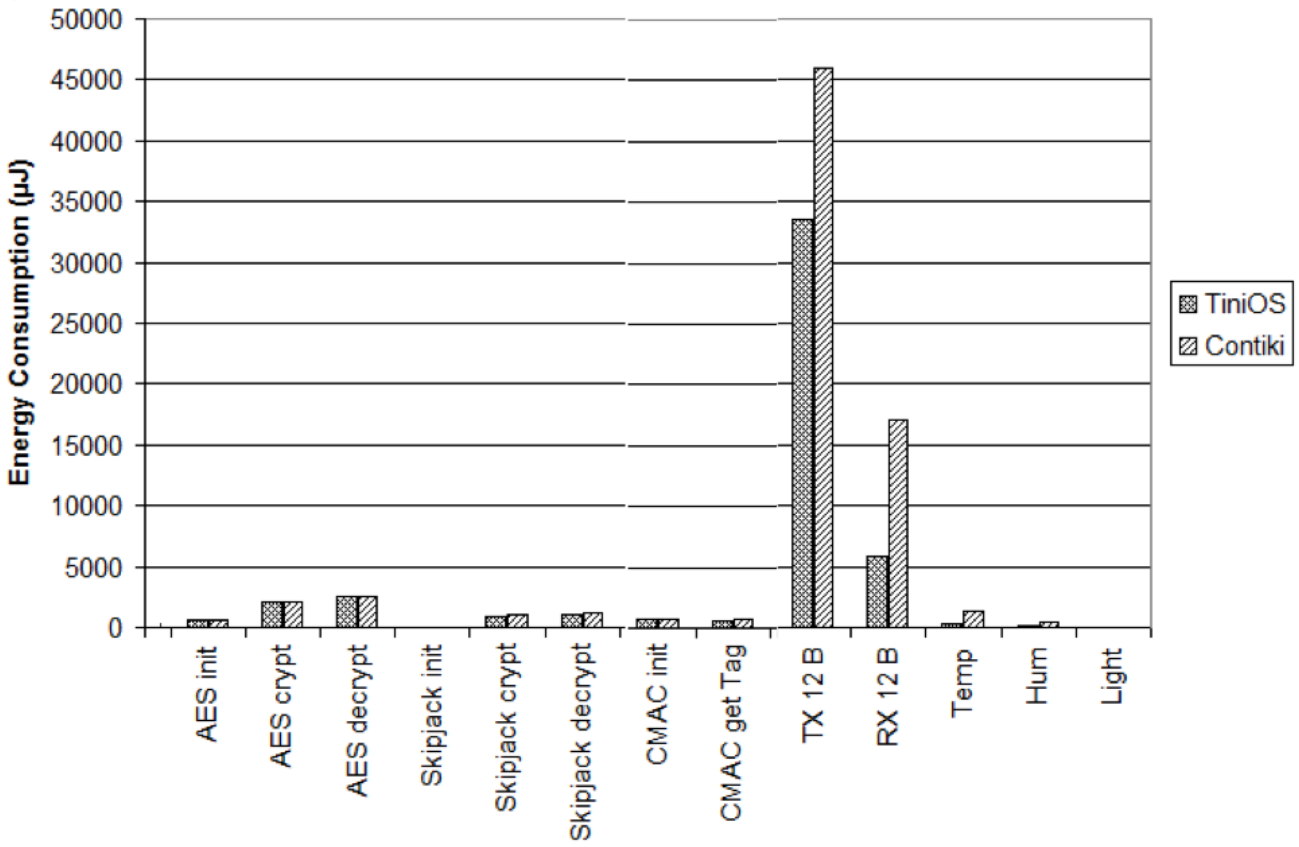
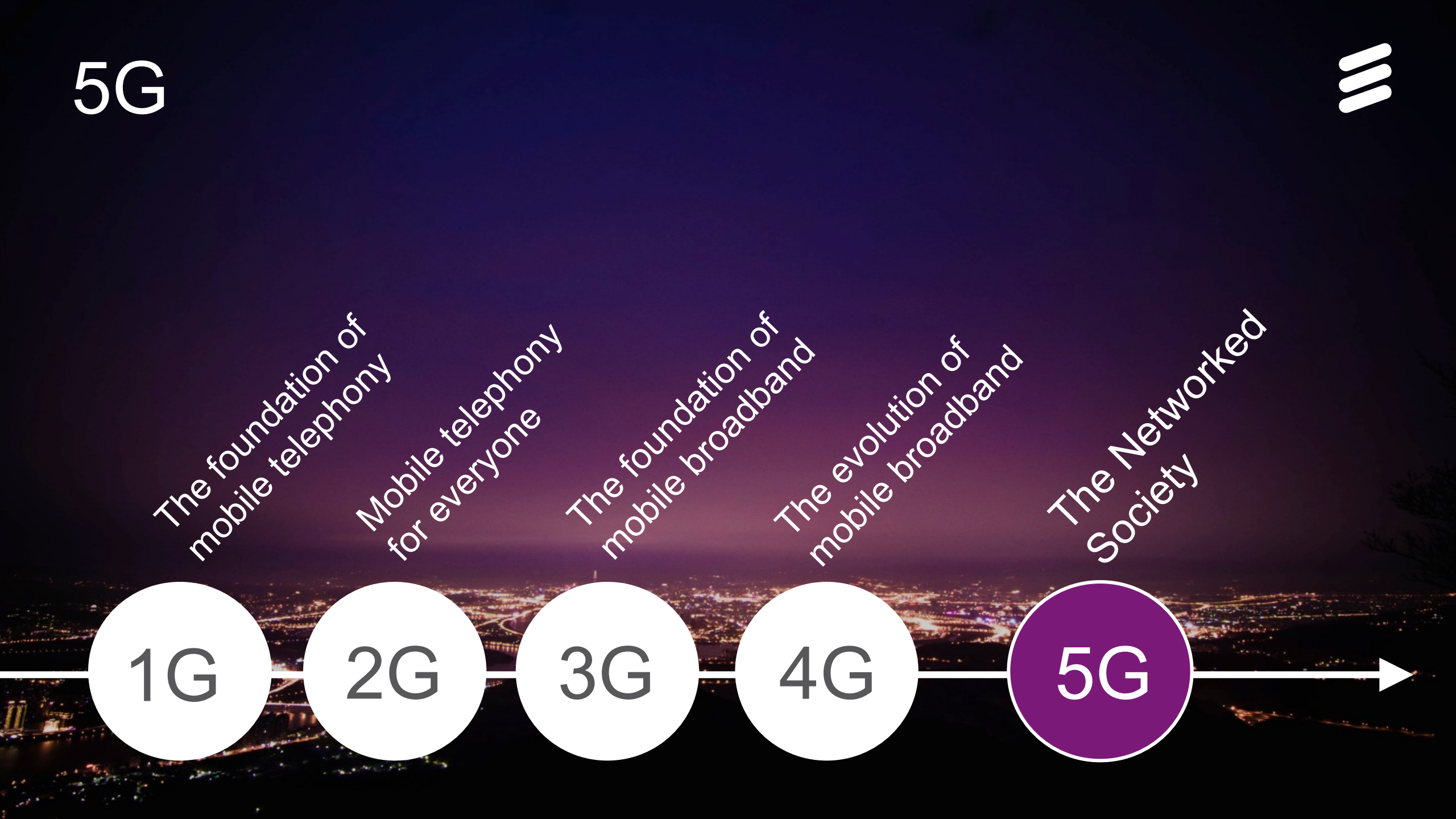


LOW POWER

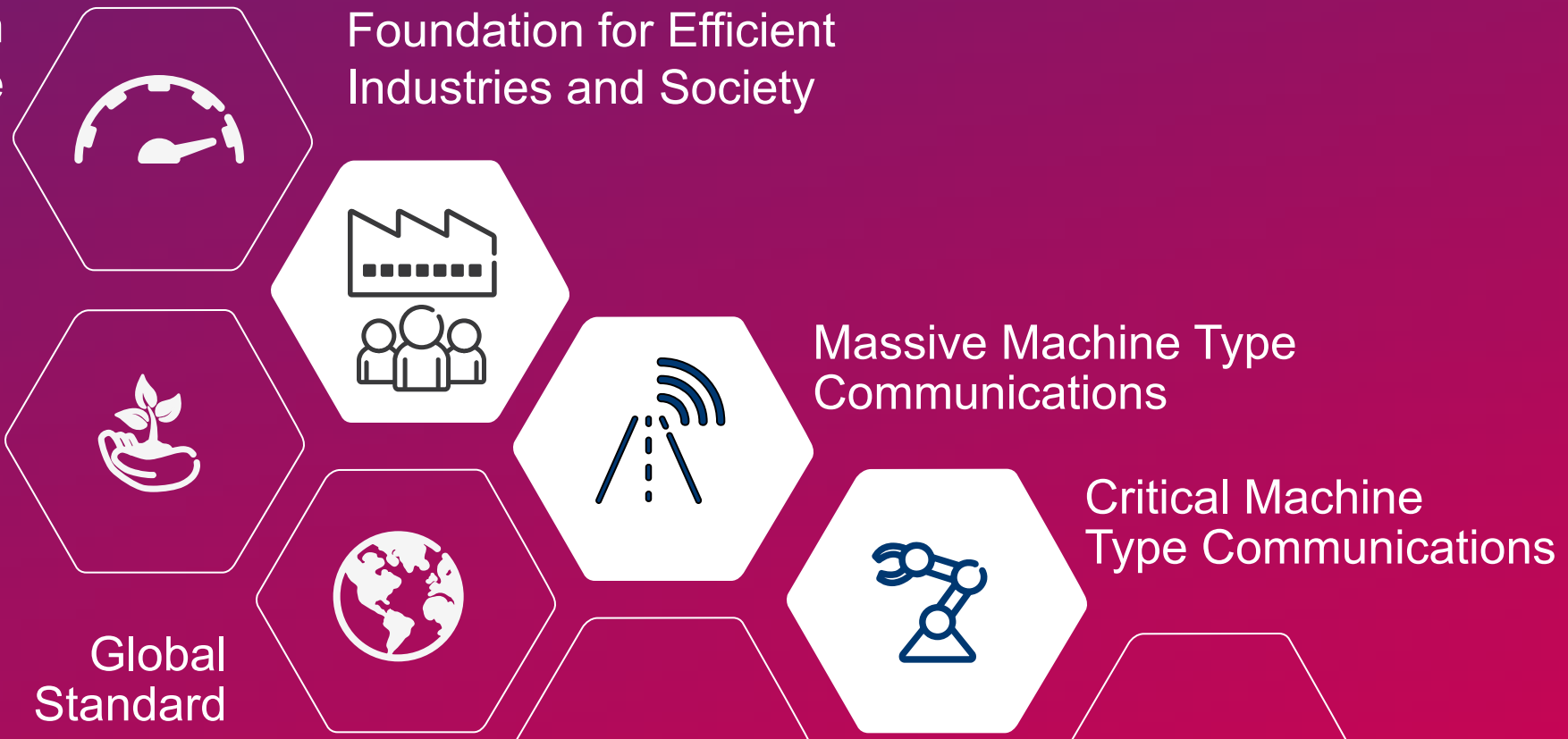
Energy consumption of various tasks on 8-bit CPUs
(Source: Margi et al at IEEE WiMAN 2010)



5G


The foundation of mobile telephony
Mobile telephony for everyone
The foundation of mobile broadband
The evolution of mobile broadband
The Networked Society
1G
2G
3G
4G
5G

5G AND NETWORKED SOCIETY



MACHINE TYPE COMMUNICATION

Monitoring & automation of buildings, city infrastructure, smart metering

Long battery life

Smart agriculture and farming

Low cost

Remote patient monitoring

Massive numbers

Connected vending machines

Long range

Small data

Logistics, tracking and fleet management

Smart grid distribution automation

Reliable real-time communication

Industrial manufacturing and control

Autonomous vehicles

High reliability

High availability

Remote control of machines

Remote manufacturing, training, surgery

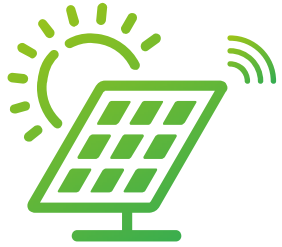
Low latency

Critical machine-type communication

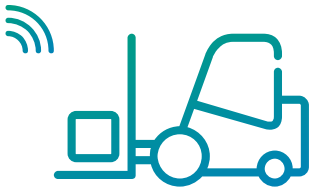
Factory Automation

Motion Control

Intelligent Transportation Systems



Smart Grid



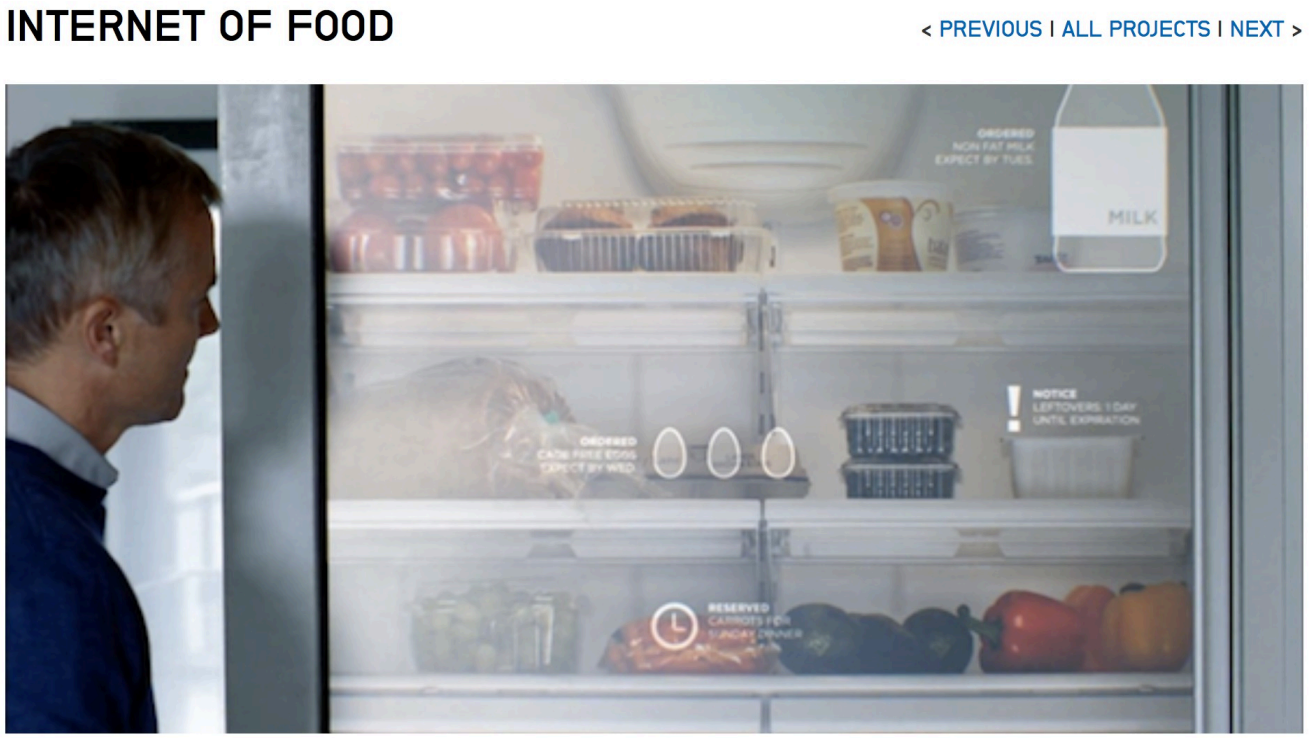
Automated Guided Vehicle

Process Automation

MATERIALS

Smart clothing technology
(Source: digitaltrends.com)

Internet of Food projects
(Source: thnk.org)



MATERIALS

Concrete instrumentation
(Source: Construction and Building Materials Vol 22)

Cement (Photo: Oussame Zrafi, Wikipedia)

Smart igloos
(Source: Arkko & Keränen, Ericsson Labs)

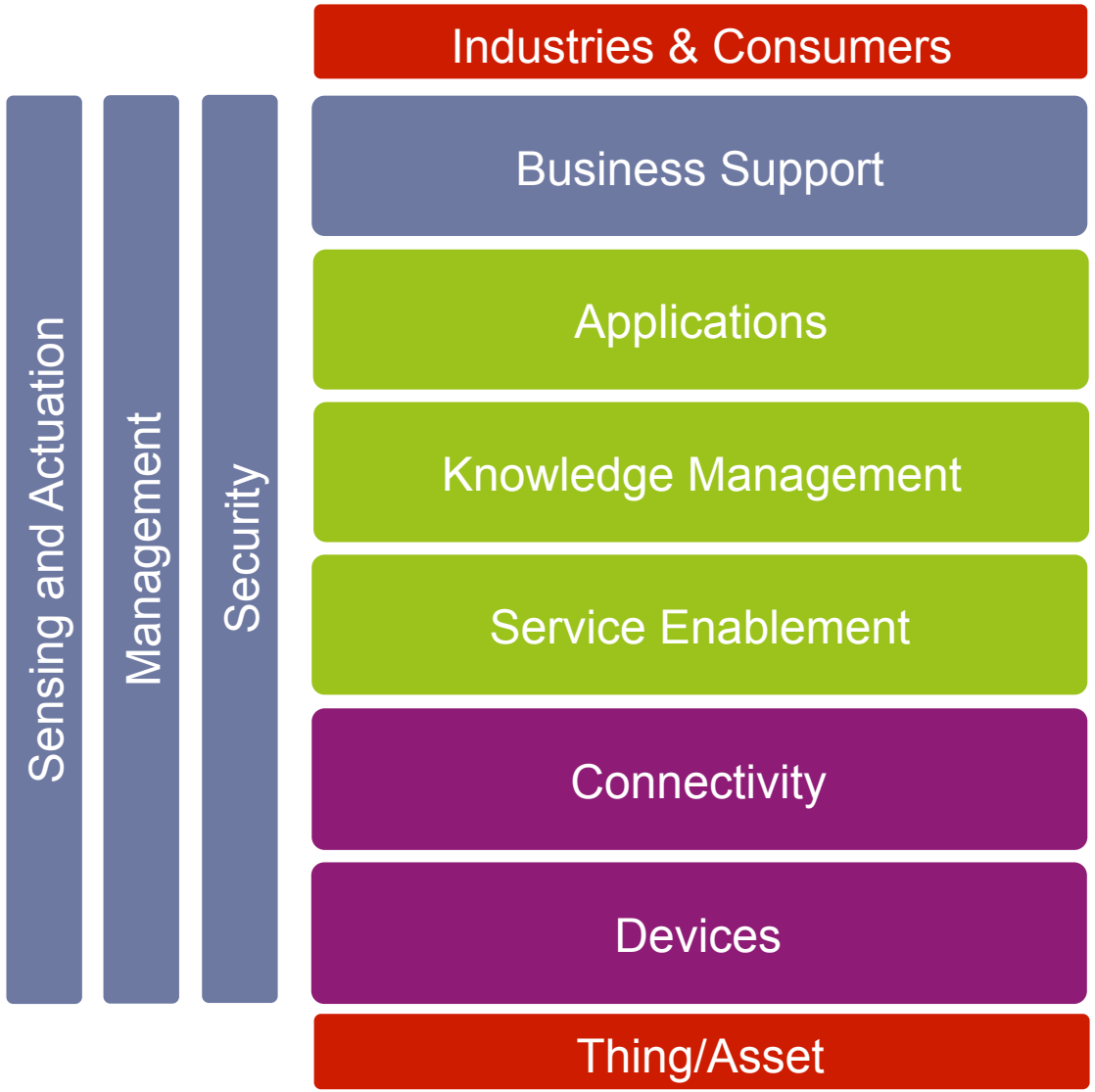
The intelligence is in the network, not the devices

Cloud – connecting the devices together

User interfaces modeled on social networking

A shift of focus

MORE THAN CONNECTED DEVICES



***Enterprise business support and integration**: CRM, ERP, ...*
***User exposure**: Retail, Portals, Visualizations, APIs*
***Marketplaces:** Brokering, transaction mgmt,*

***Common applications**: Preventive Maintenance, Automation, Items Tracking, Building Automation, Farming Control, Environmental Monitoring, ...*

***Knowledge Management and Processing**: Real World Model, Resource modelling, Analytics, Context Awareness, Reasoning, Actionable services, Learning, Automation, ...*

***Common enablers:** Device and Resource Management, Data and Event capture, Data Warehousing, Cloud, Distributed Execution Environment*

***Connectivity**: Cellular, Fixed, Satellite, Capillary Networks, Managed Connectivity*

***Monitor&Control:** Sensors, Actuators, Tags, Devices, Gateways, WSAN*

***Real World Assets:** Building, Smart Grid, Vehicle, Body,...*

Necessary developments

Devices

Intelligent software

Semantic interoperability

Open

NETWORKED VALUE CHAINS

70% of all computer chips do not go into computers

John Deere CEO Bob Lane says he doesn't make tractors but rather "sophisticated mobile information factories."

- GPS shows where it is
- Microwave sensors measure cotton flow
- RFID tags let processors know origin of each bundle
- Wireless communications
- Computing power of 8 PC's

THE INFORMATION TECHNOLOGY & INNOVATION FOUNDATION

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CONSUMER
“Instant bicycling – just add muscles”

INDUSTRIAL

Remote operation

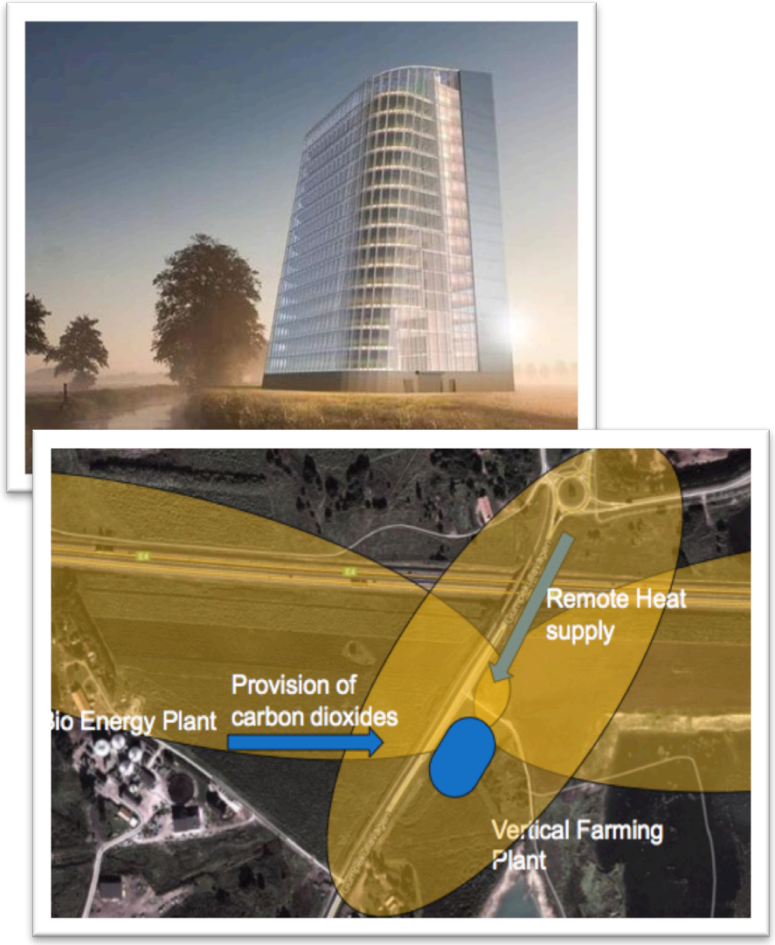
”MINING 2.0”

For a safer and healthier working environment

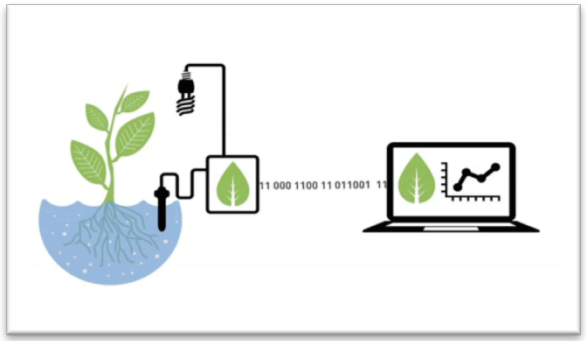
For a more efficient operation

AGRICULTURE

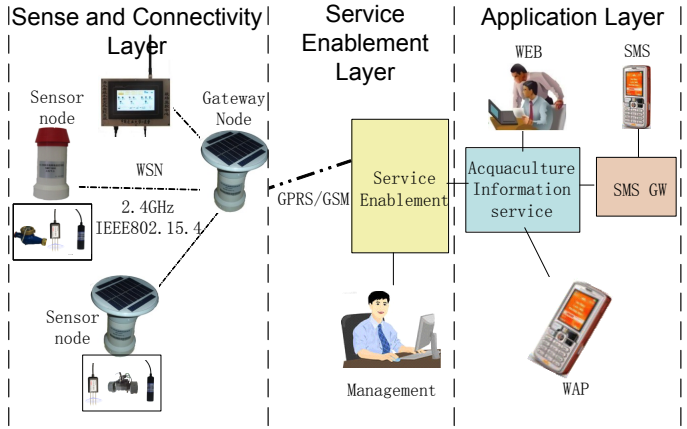
Industrial: Plantagon



Urban: Bitponics



Field: Crab farming



“PERMISSIONLESS INNOVATION”



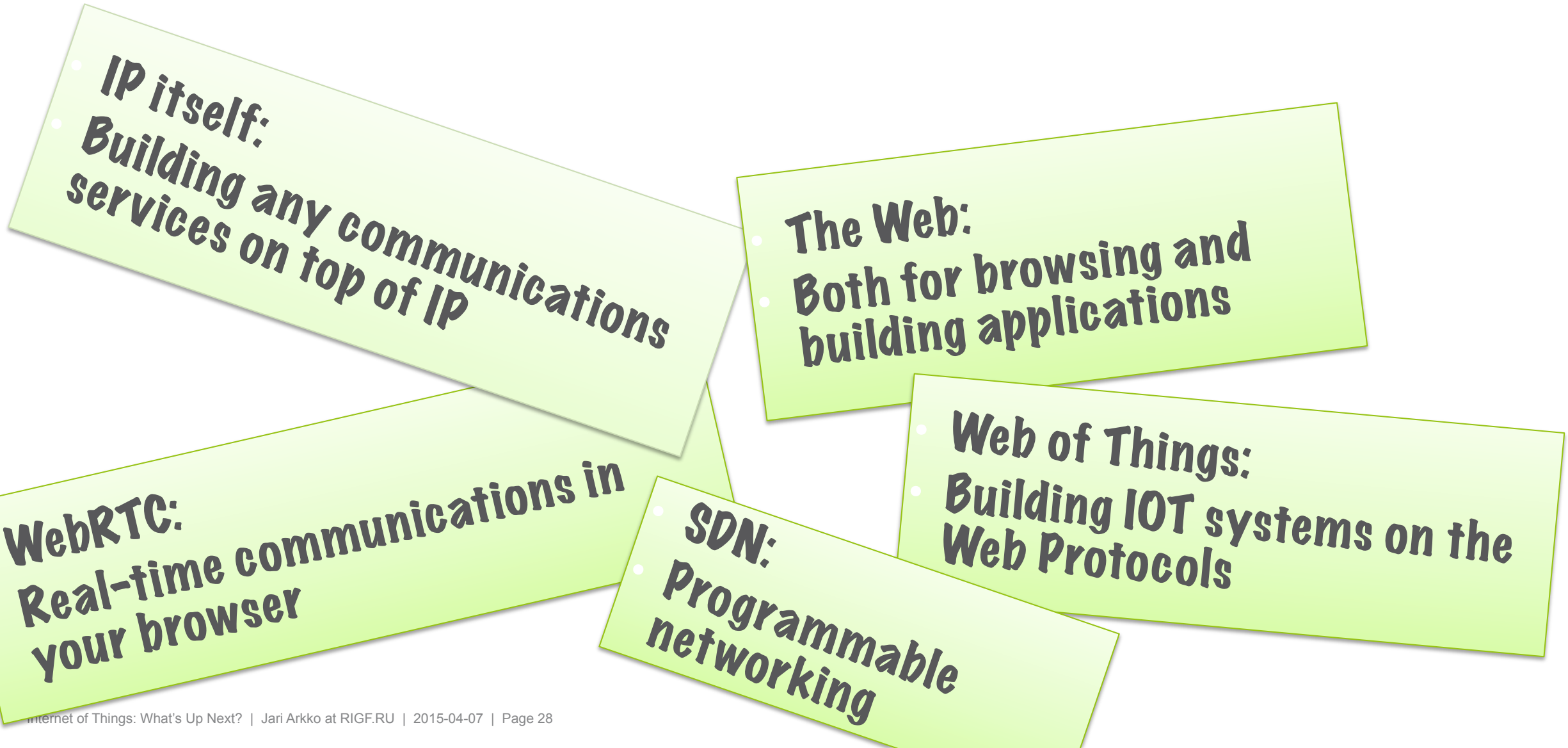






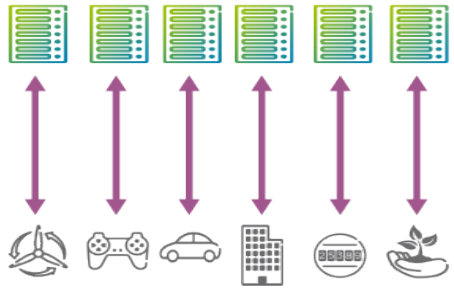



SOME AREAS OF INNOVATION



EXPERIENCES

- Legacy devices are moving to an all-IP model
- It is important to reach interoperability at all layers; formats and web interfaces are very important too, not just IP
- The key is general purpose technology (3G, WLAN, web)
- Web tools is the way the market is going



Transformation

multi-purpose devices

web paradigm

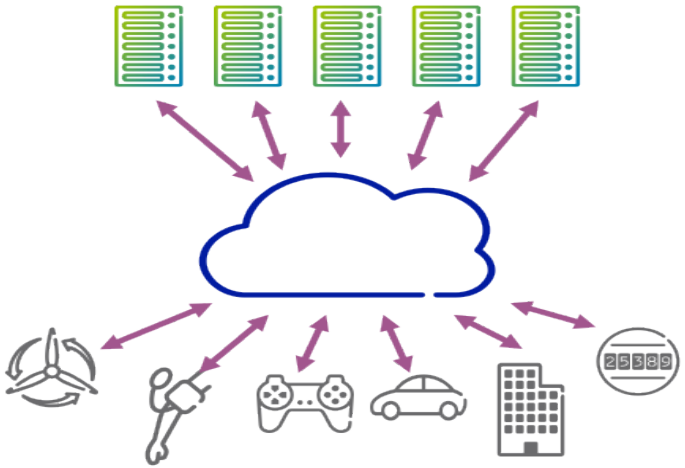
apps migrate to cloud

Benefits

cost efficient devices

large developer community

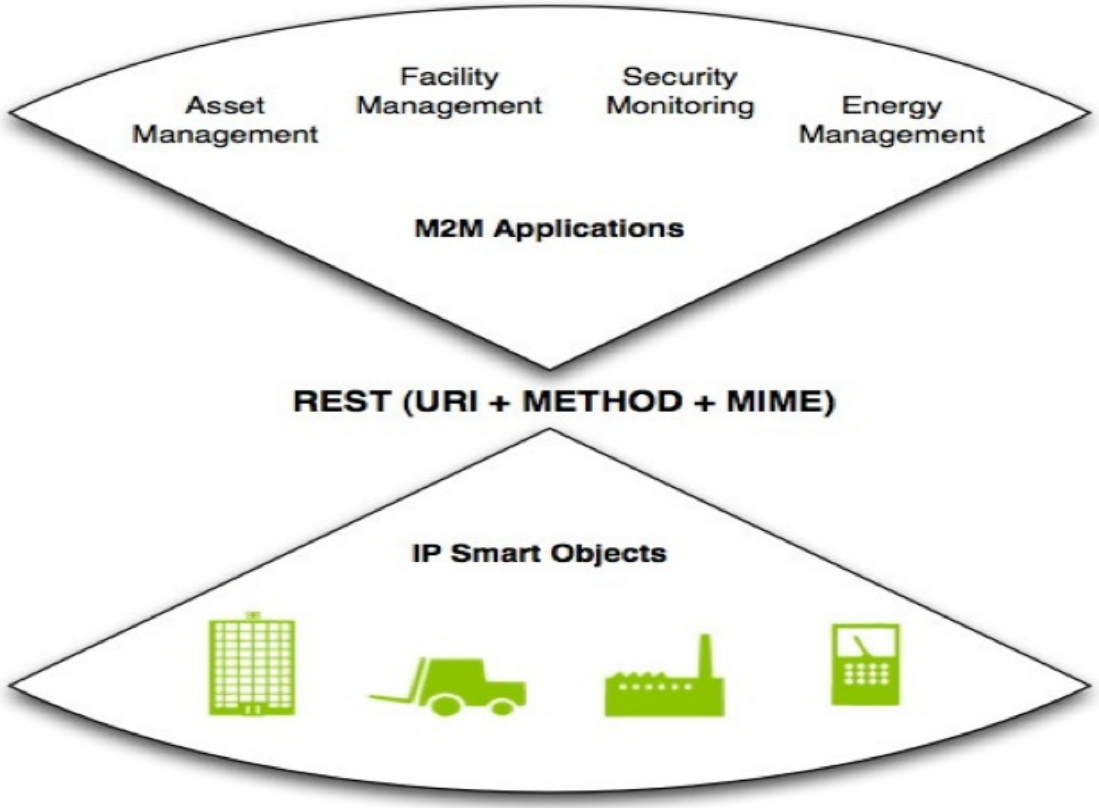
new roles in the value network



THE WEB OF THINGS (WOT)

This is a very attractive model for developing smart object applications

- Very successful for other applications
- Widely available tools & millions of programmers
- Simple and well-defined
- “Permissionless innovation”



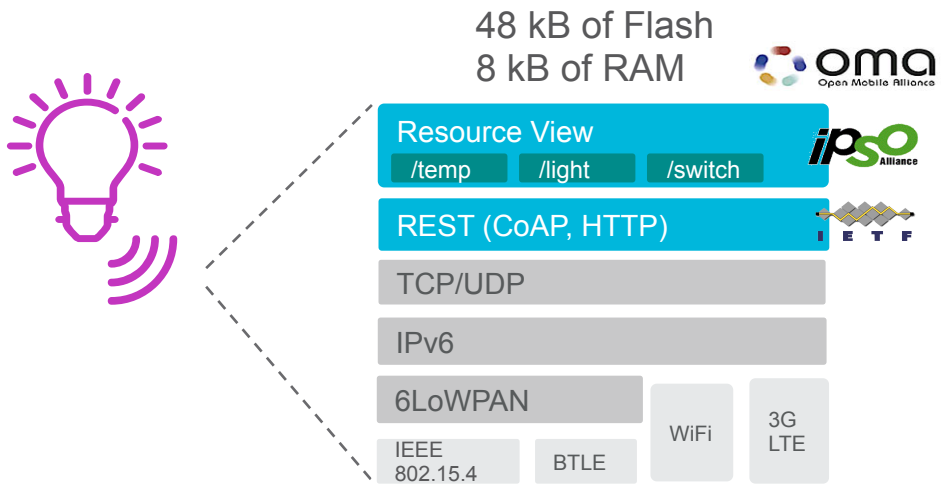
(Source: Zach Shelby)

MAKE IOT GO MAINSTREAM

› Go IP
  – Reduce technology fragmentation
  – Drive IP to the “tiniest of devices”

› Go Web
  – Use standard web technologies
  – Ease enterprise SOA integration
  – Attract the global developer community

› Go Simple
  – Make devices application generic
  – Drive value from devices to cloud enablement
  – Break device silos



IETF & THE INTERNET OF THINGS

› Basic IP communication

- IP(v6) over Foo
- 6TISCH WG

› Web tools

- CORE WG & COAP
- HTTPBIS WG & HTTP/2
- JSON, JOSE WG

› Security

- TLS, DTLS, JOSE
- DICE WG, ACE WG

› Routing

- Mesh networking
- Ad hoc networks
- ROLL WG & RIPL
- MANET WG & OSLR, AODV, …

› Configuration

- Autonomic networking
- HOMENET WG
- ANIMA WG

› Other

- EMAN WG

IOT AND INTERNET GOVERNANCE

First answer: nothing changes

No new Internet Governance needed

- Does not need new naming
- Most operations are in databases & private clouds

IOT AND INTERNET GOVERNANCE

Privacy

- Technical and practical issues
- User ownership of data

Market creation

- Ensure competitive market
- Many players for different roles

IPv6

- Important for reachability

Interoperability

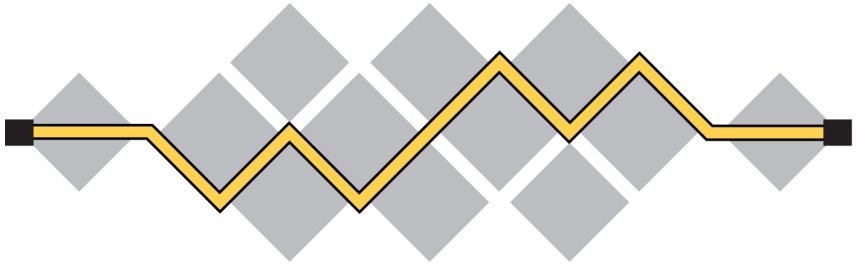
- Competition
- Switching costs
- Long-life devices

SOME CONCLUSIONS

Building the networked society

- Machine-type communication is a fundamental building block
- Microelectronics, mobile networks, IP, the web protocol stack are all evolving to meet the needs
- The ability to connect different pieces together in innovative & open ways is a key enabler

ERICSSON



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