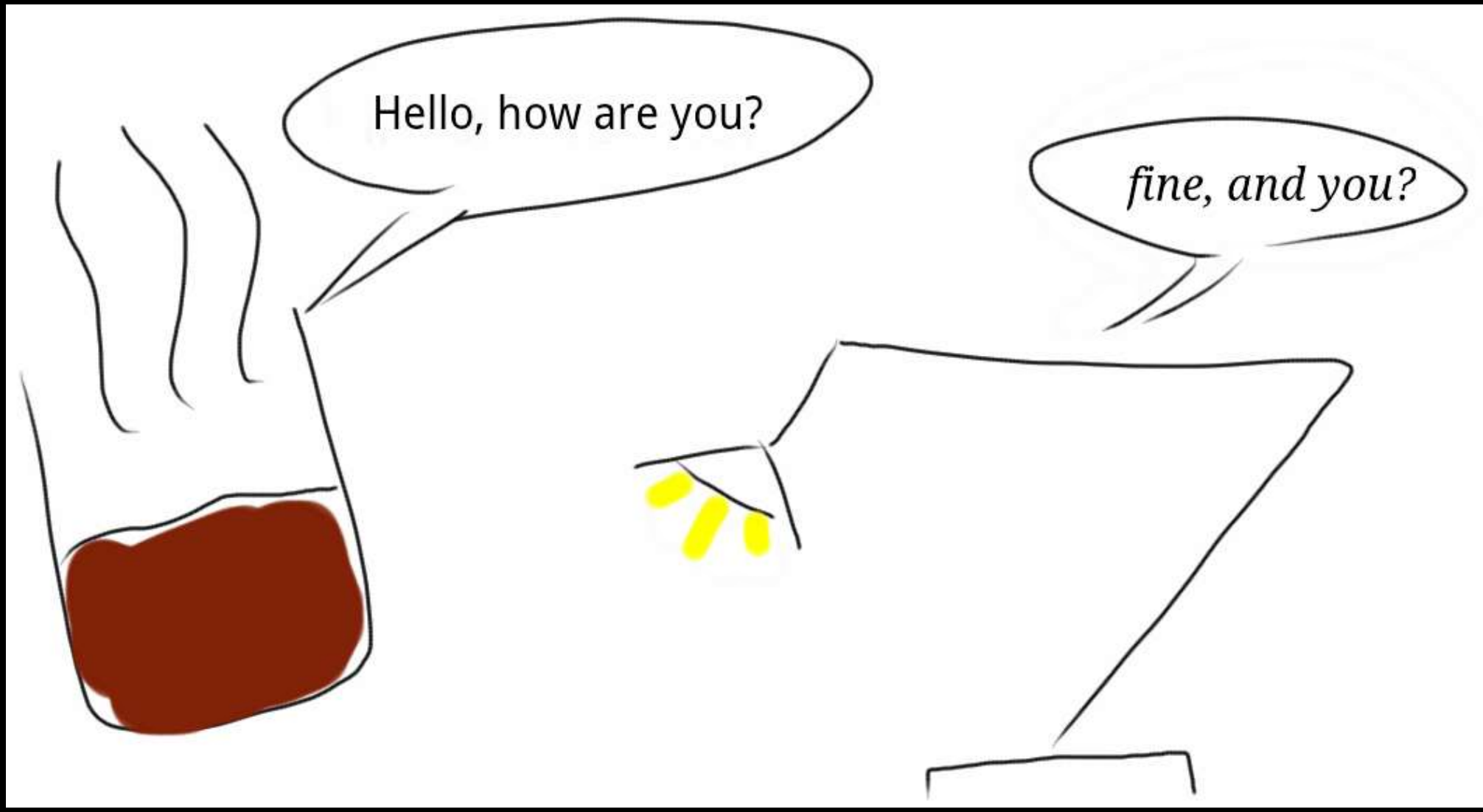
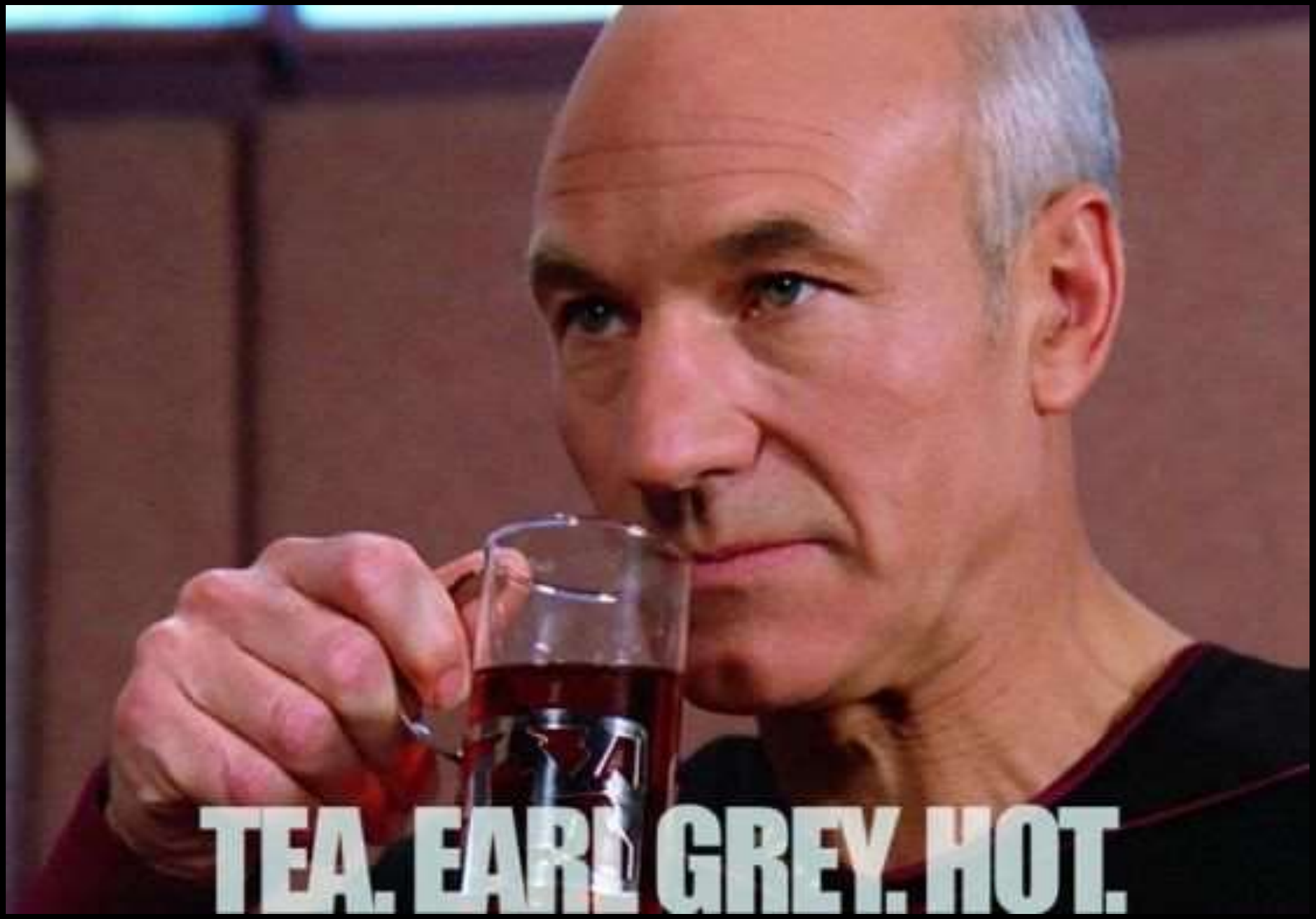
Seven Pitfalls in the Internet of Things

teamwork Forum Arbeitsplatzgestaltung, 21/06/2017, TU Chemnitz

Dipl.-Kfm. Carsten Möllers





Captain Jean-Luc Picard, Star Trek, in front of the „Replicator“

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1. **Not understanding the Paradigm Change**
2. Lack of Interoperability
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5. Lack of User Centered Design
6. Not understanding the real Driver
7. Not understanding the Impacts on Development

Smart Objects connect Digital and Real World

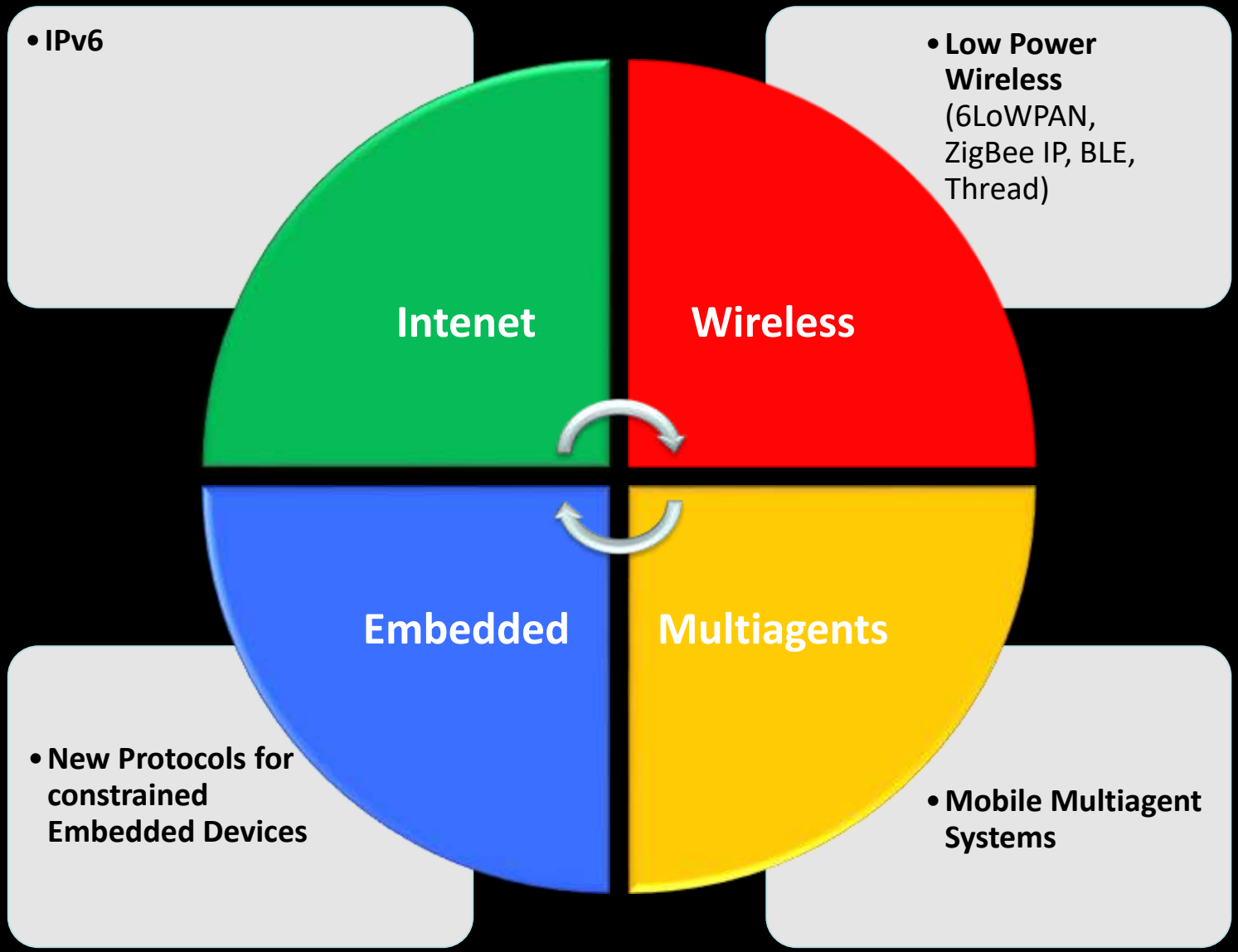
- The digital revolution of the 21st century will be much, much lager than previous two digital revolutions of personal computers and the internet
- We are now facing the digital revolution of the 21st century: Smart objects in the intenet of things, that interconnect the digital world with the physical world
- A smart object is a small mircoelectronic device that consists of a communication device, typically low power radio, a small mircoprocessor and a sensor and/or actuator.

Credits: Jean Phlippe Vasseur, Adam Dunkels

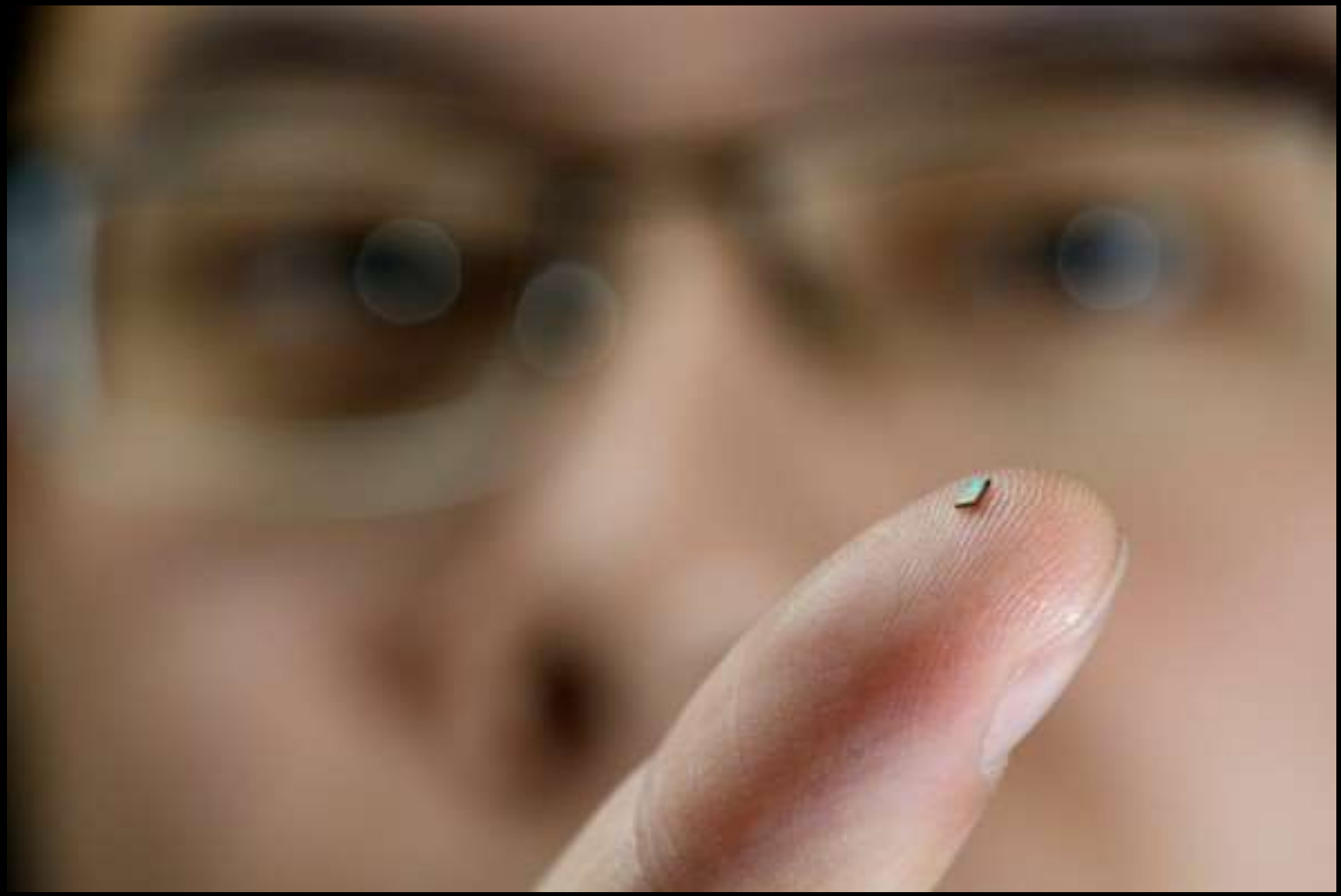
Internet of Things changing Automation Paradigm

- The "Internet of Things" (IoT) is describing billions of embedded devices that are communicating with each other through internet technology without involving human beings directly
- In the automation context, the IoT means the shift from **centralized and hierarchical control** towards **cooperative, distributed networks and control structures**
- Formerly passive sensors (simple objects) become active players (smart objects) in networks and are enhanced with the capability for computation and decision making.

Enabling Technologies

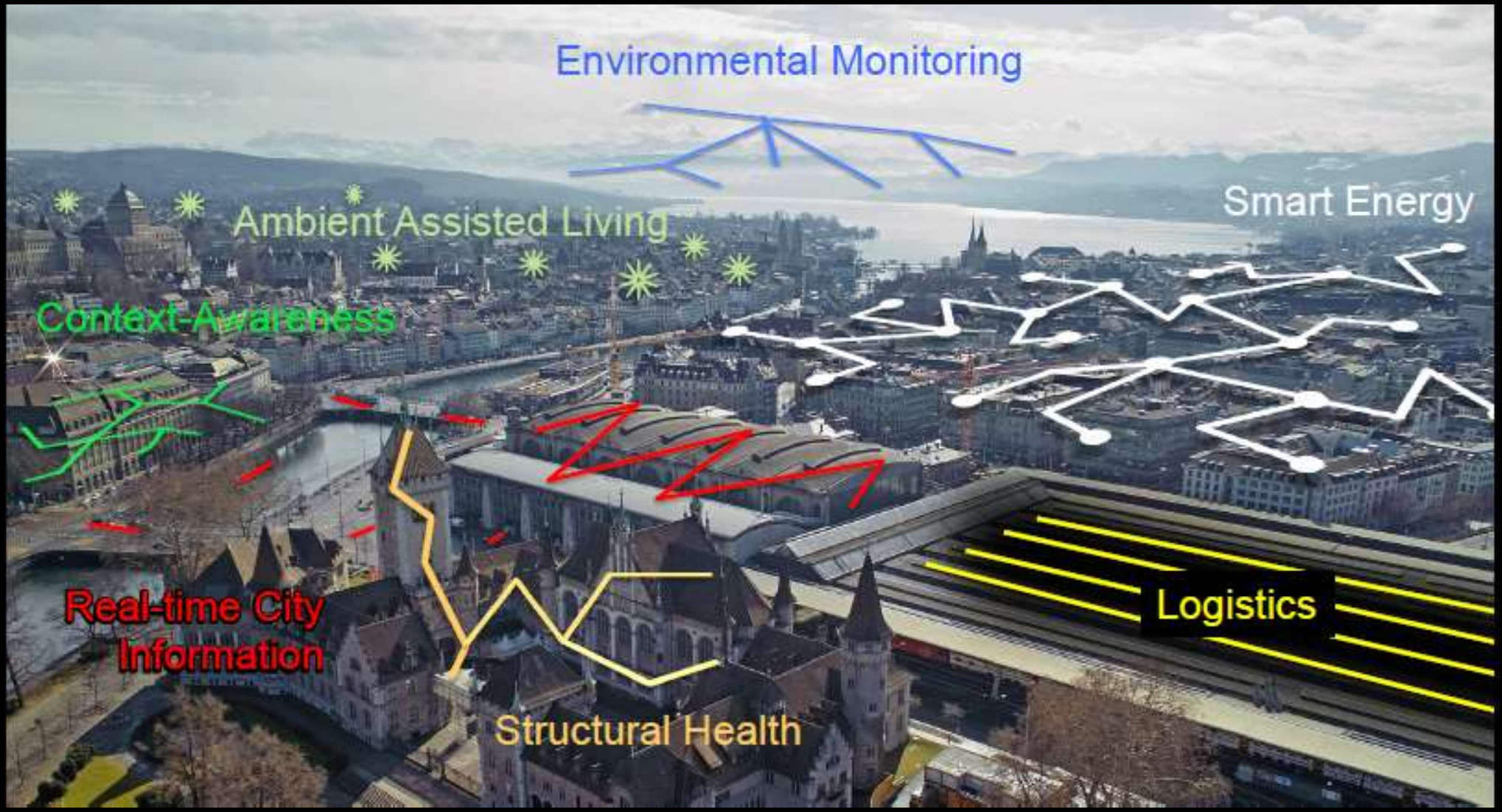


Wireless Sensors



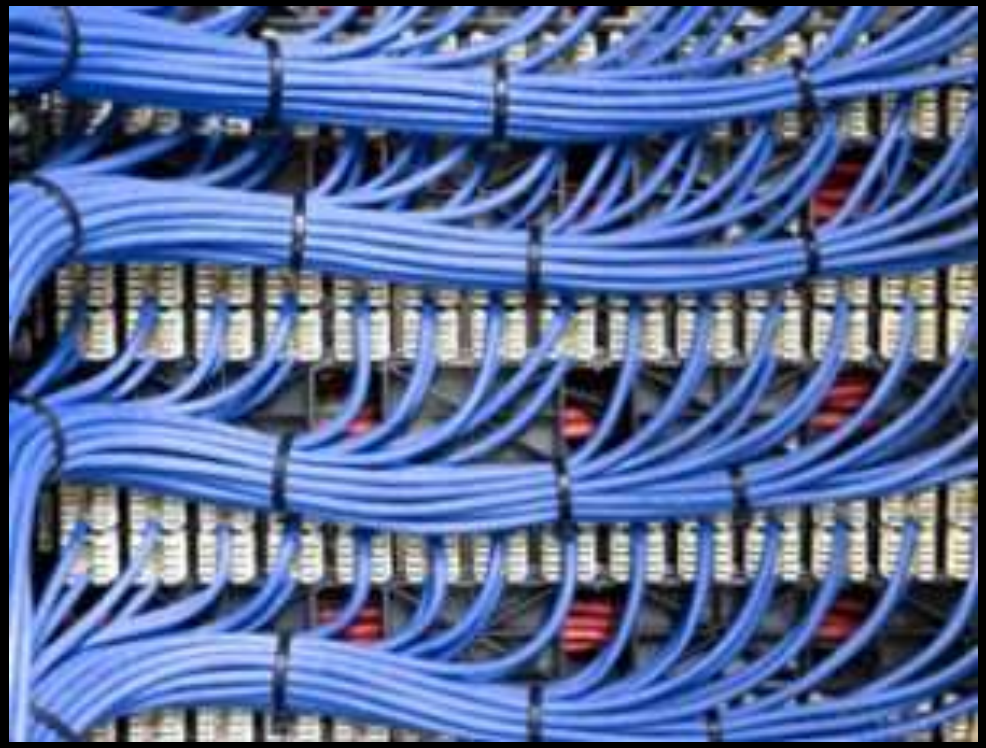
Credits: Hao Gao

Wireless Sensor Networks



Credits: Matthias Kovatsch

Why Wireless?



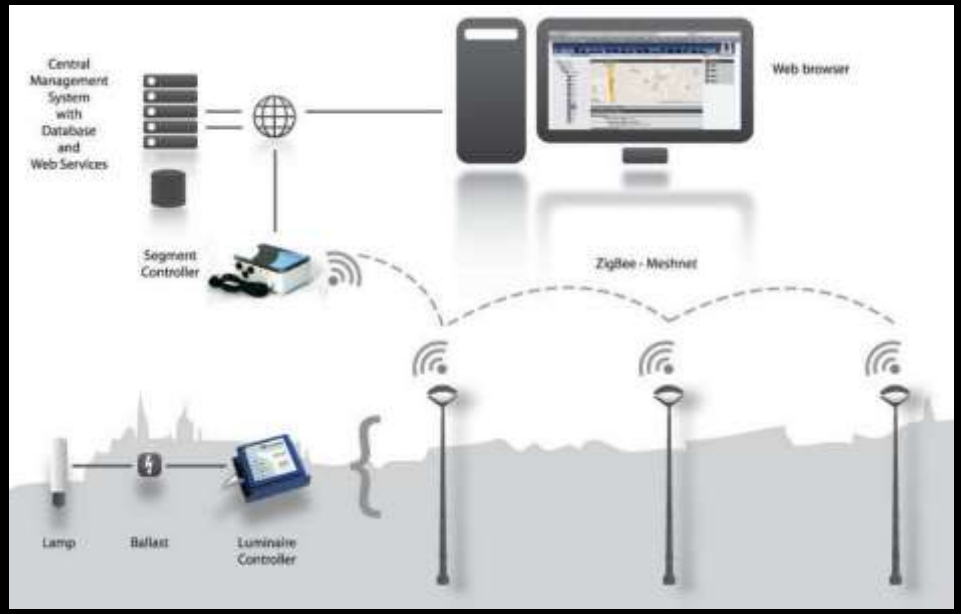
- Electrical wall socket + installation = 60 €
- CAT 5 socket + installation = 110 €
- 1 billion nodes?

Credits: Carsten Bormann

Wireless Networking Technologies

	Bluetooth 4.1	**Wifi**	**ZigBee 3.0**	**ZigBee Green**	**EnOcean**
Standard	IEEE 802.15.1	IEEE 802.11	IEEE 802.15.4	IEEE 802.15.4	IEC 14543-3-10
Topology	**Piconet, Scatternet**	**Star**	**Mesh, Star, Tree**	**Mesh, Star, Tree**	**P2P, Star**
IPv6	Coming 4.2	Yes	ZigBee IP	./.	./.
RF frequency	2.4 GHz	2.4 GHz, 5,8 GHz 3.65 and 3.7 GHz	868/915 MHz, 2.4 GHz	868/915 MHz, 2.4 GHz	868 MHz/315 MHz
Data rate	<= 305 Kbit/s	<= 600 Mbit/s [n]	<= 250 Kbit/s	<= 250 Kbit/s	<= 125 Kbit/s
Range	**<= 50 m**	**<= 100 m** (depending on frequency)	**<= 300 m** (depending on frequency)	**<= 50 m** (depending on frequency)	**<= 300 m**
Power	Very low	High	Very low	Harvesting	Harvesting
Wakeup time	**<= 6 ms**	**<= 3 s**	**< 30 ms**	**< 30 ms**	**< 10 ms**
Battery lifetime	Weeks to month (rechargeable)	Hours (rechargeable)	Month to years		
Security	AES 128 + + application layer	SSID	AES 128 + application layer	AES 128 + application layer	Option
Nodes	**Depending on implementation**	**32**	**2^{16}**	**2^{16}**	**2^{32}**

Benefits of Wireless Lighting Controls

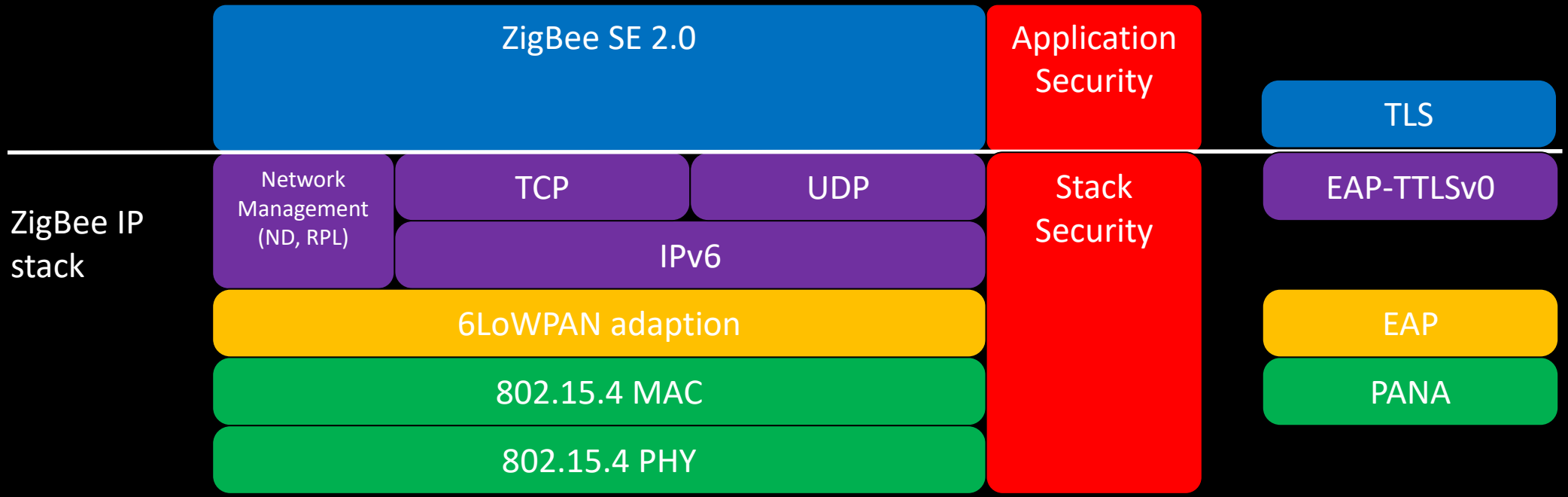


- Cost savings
- Demand management
- Flexibility
- Scalability
- Simplicity uf use
- Energy management
- Other add on.

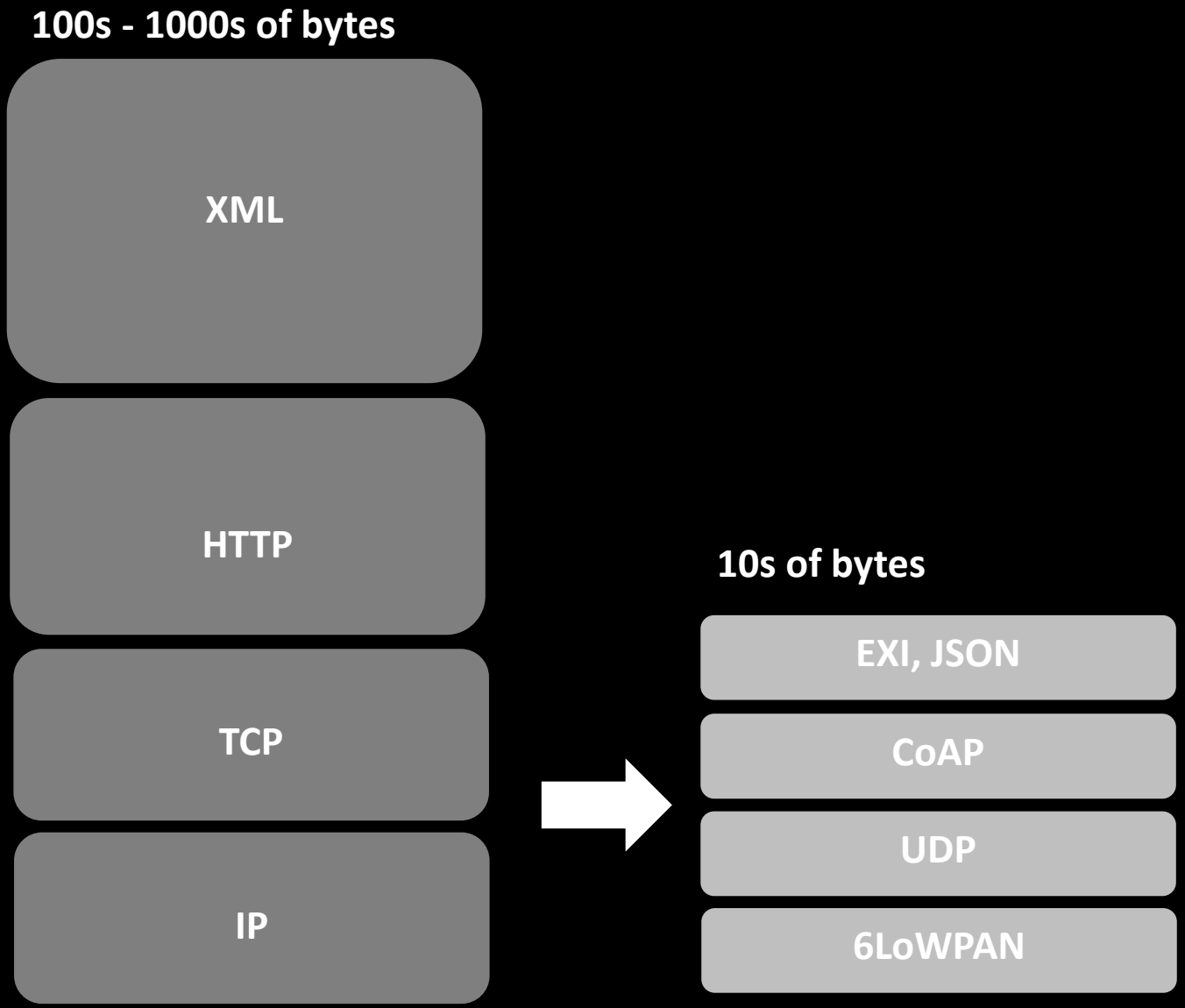
Why IPv6?

- IPv4 is limited to 4.294.967.295 addresses
- IPv6 provides 3.4 x 10^{38} addresses
- There are only 10^{25} graints of sand on earth
- Let‘s settle for 10^{10} objects on the IoT
- IPv6 is an enabling technology for the IoT

IPv6 in ZigBee and 6LoWPAN



Protocols for constrained Embedded Devices



Credits: Zach Shelby

Multi Agent Systems

- Autonomous software agents colaborating in one system
- Decentral concept with distributed intelligence, no manadory central control, no need of designated controlling agent
- Not necessarily determined, can be self-organzing and self-learning
- Enables loose couplings
- More flexible and reliable.

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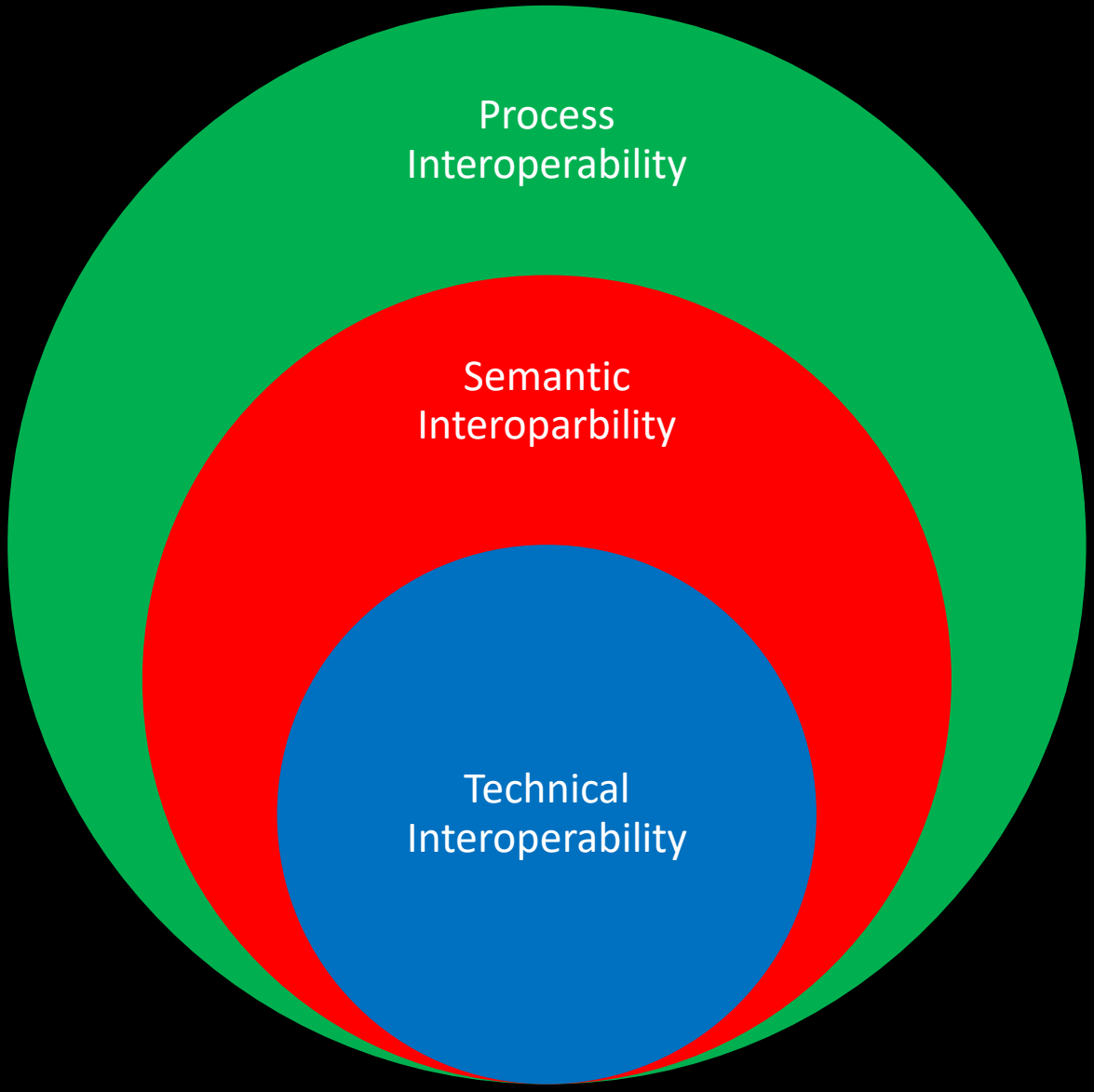
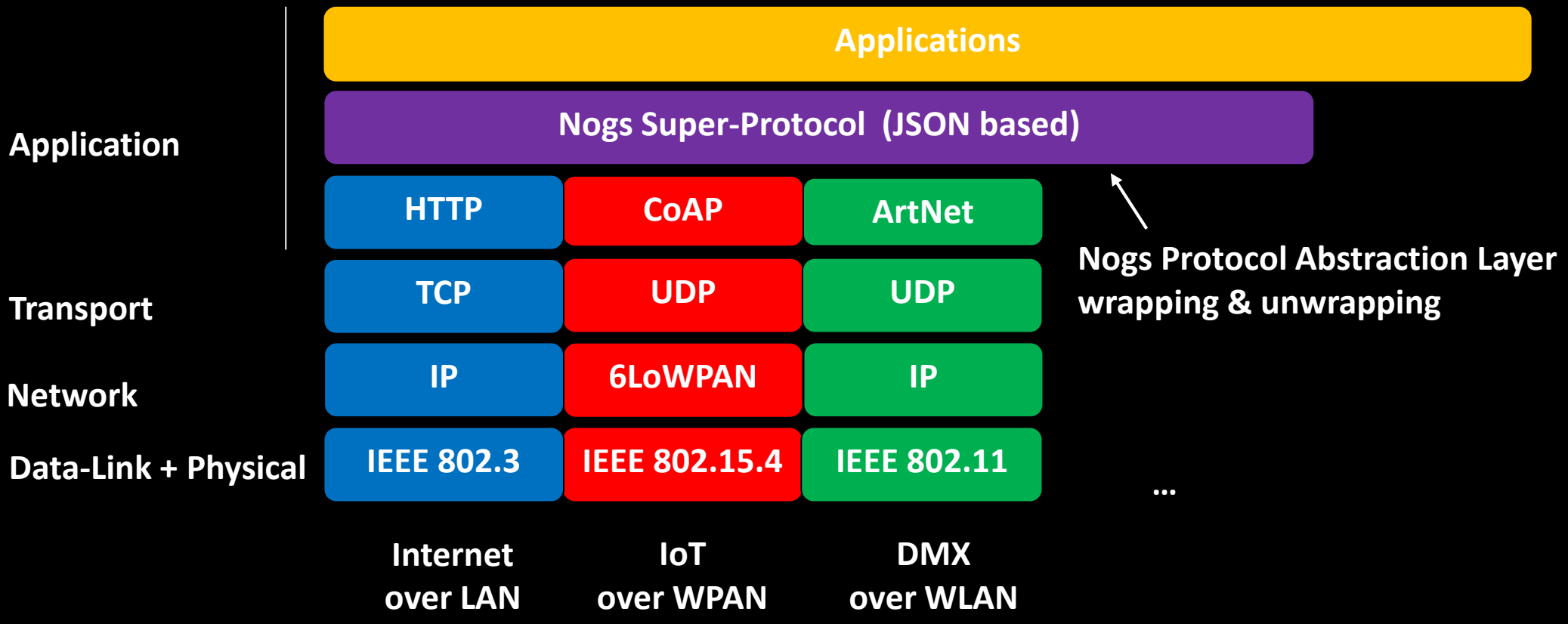
Dimensions of Interoperability



Unified Communication & Protocol Abstraction



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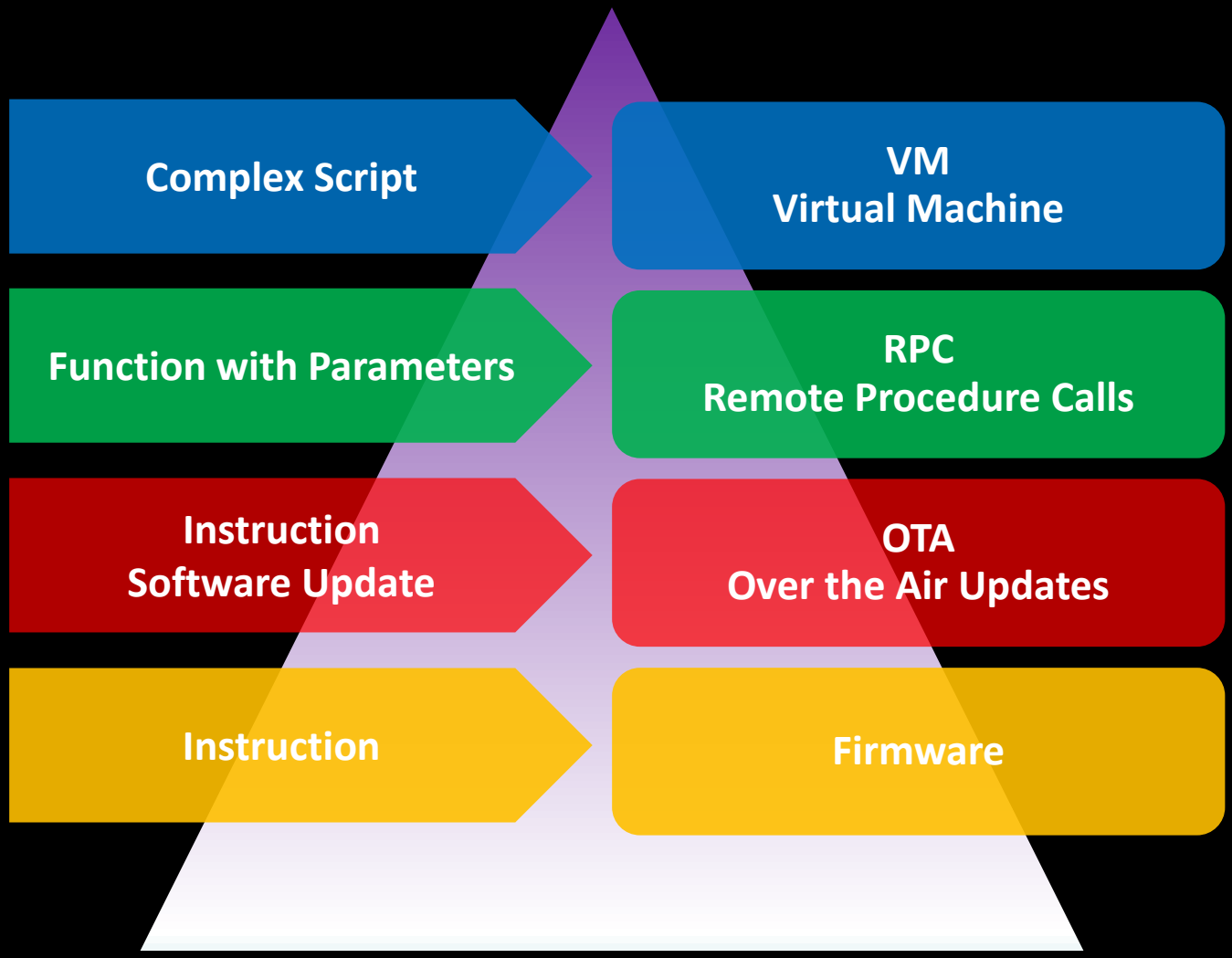
Artificial Intelligence

Intelligence of Smart Objects & Hardware Abstraction

"Smart Objects are Objects which with the embedding of Information Technologies possess capabilities over and above their primary applications."



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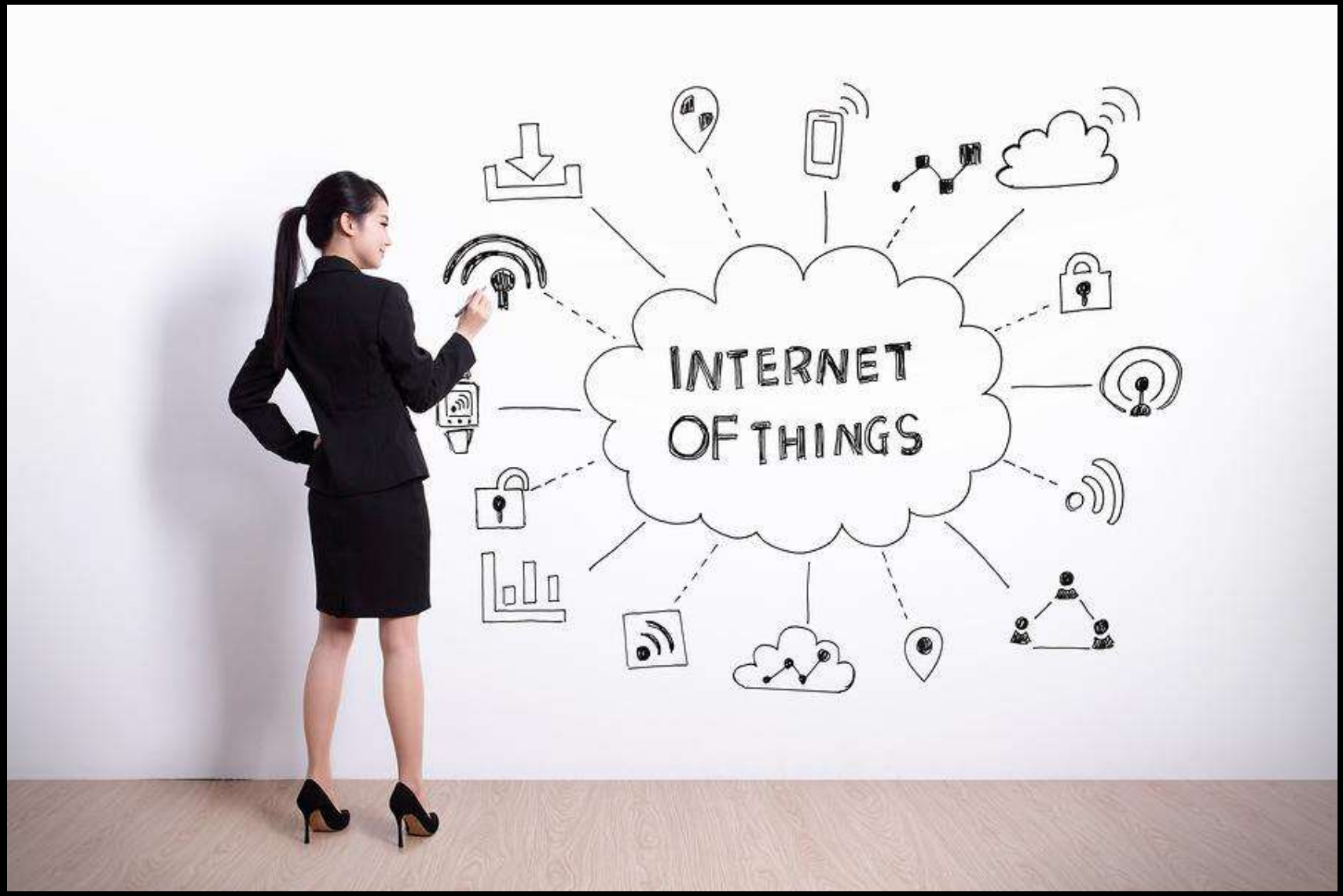
Security in Building Automation System & IT

	BAS standards				IT mechanisms	
	BACnet	LonWorks	KNX	ZigBee	IPsec	TLS
Entity authentication	+	-	-	+	+	+
Authorization	-	-	~	+	+	+
Data integrity	+	~	-	+	+	+
Data freshness	+	~	-	+	+	+
Data confidentiality	+	-	-	+	+	+
Data availability	-	-	-	-	-	-
Embedded devices	+	+	+	+	-	~
Communication models	-	~	-	-	~	-
Scalability	-	-	-	-	-	-
Non IP networks	+	+	+	+	-	~
QoS features	-	-	-	~	~	+

Credits: Wolfgang Kastner

Security by Design



Security

- Security is not only a question of the communication protocol
- Security has to start with hardware
  (e.g. hardware encryption, hardware based communication)
- Security as to be included in the apllication level (e.g. authentification, sandboxes)
- Special mechanisms
  e.g. for man in the middle & overload attacs & APT-infection
- Open Source.

Open Source

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User Centered Design

UCD Standards

- User-Centered Design process
  for interactive systems

  EN ISO 9241-210 (replaces EN IS0 13407)
  ISO PAS 18152

- Ergonomics of Human Machine Interfaces (HMI)

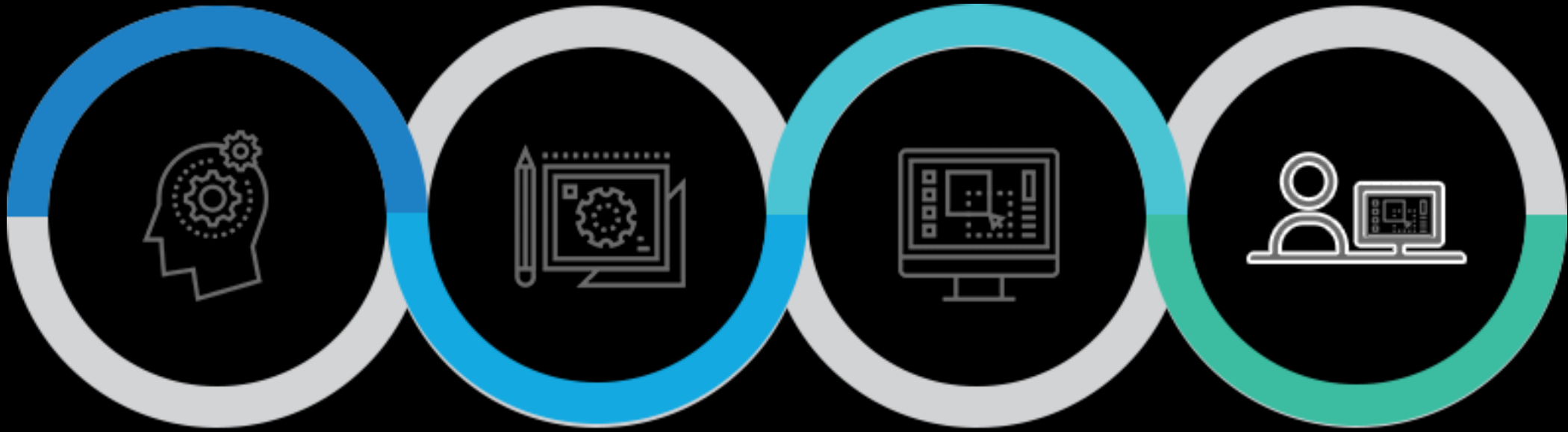
  EN ISO 9241-110
  ISO TR 16982

- Software Usability

  EN ISO 9241-11
  EN ISO 14915

- Design for All.

UCD Process



Plan

Define user requirement & analyze competition

Design

Design wireframes, interaction sequences & navigation

Proto type

Develop & test dynamic prototypes for usability

Review

Review wireframe designs with customer

DYI - Maker Culture

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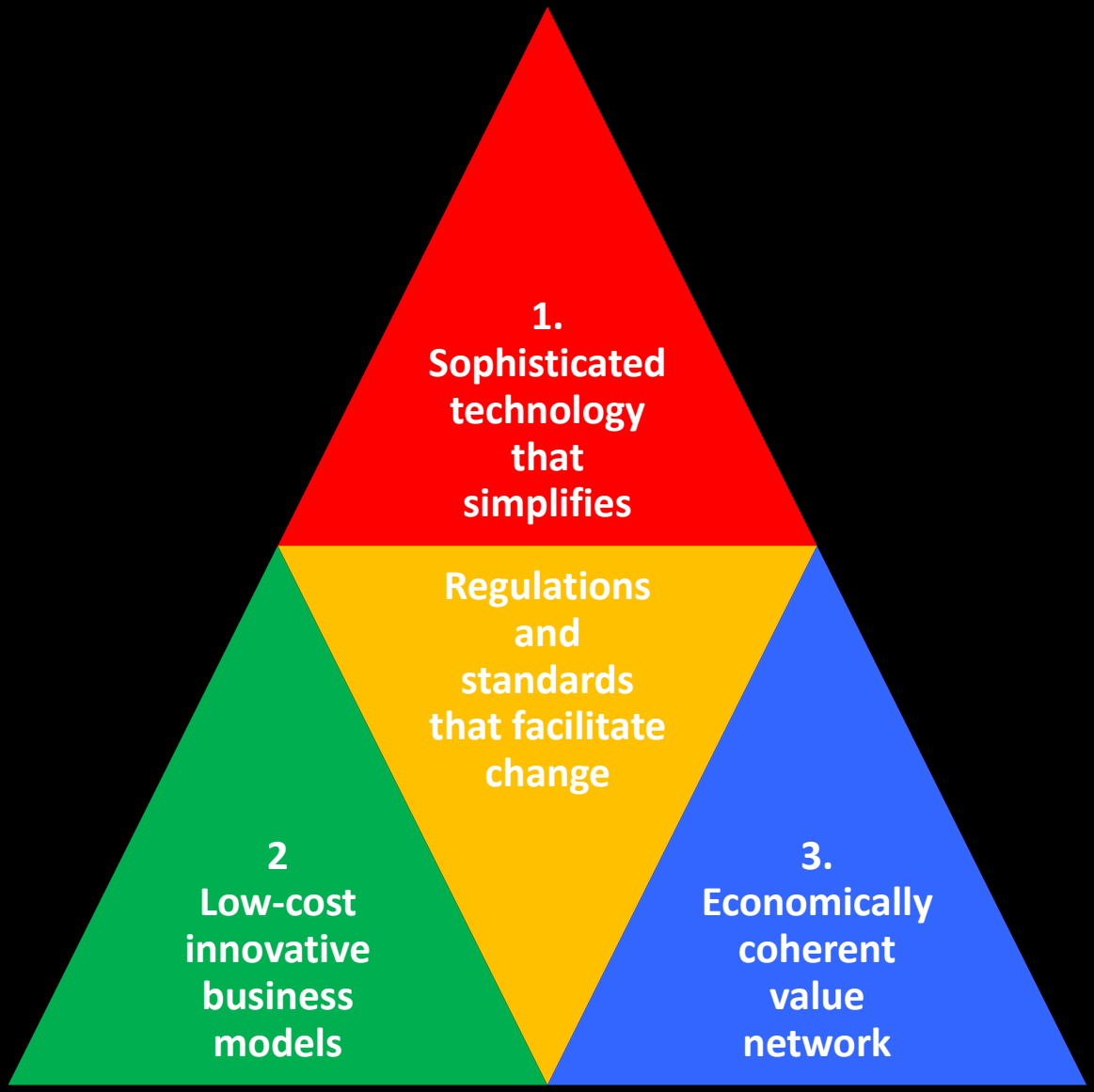
Elements of disruptive Innovation



Credits: Clayton Christensen

Business Model

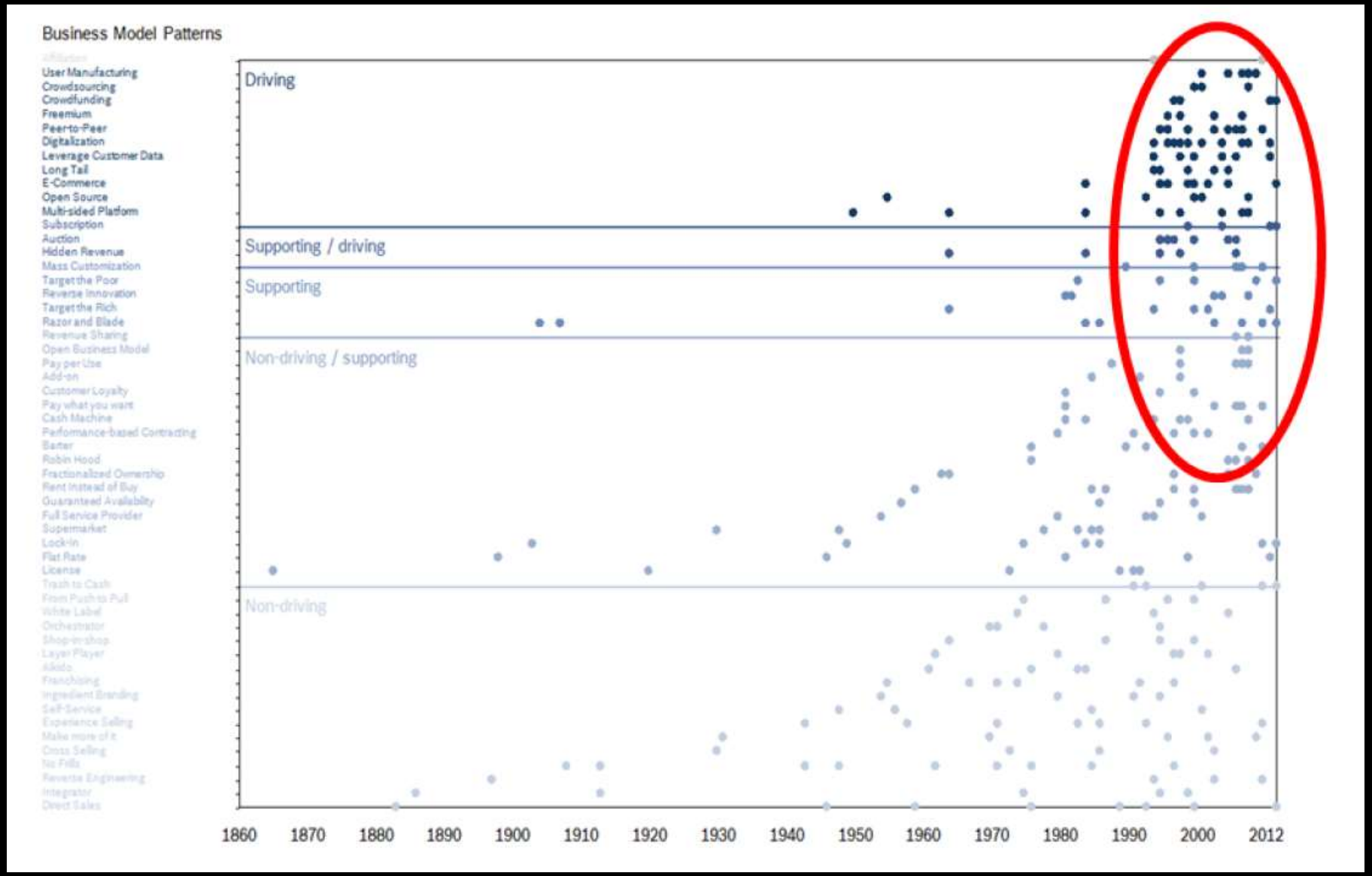
Who are the customers?

What is being sold?

How is it produced?

How is the revenue earned?

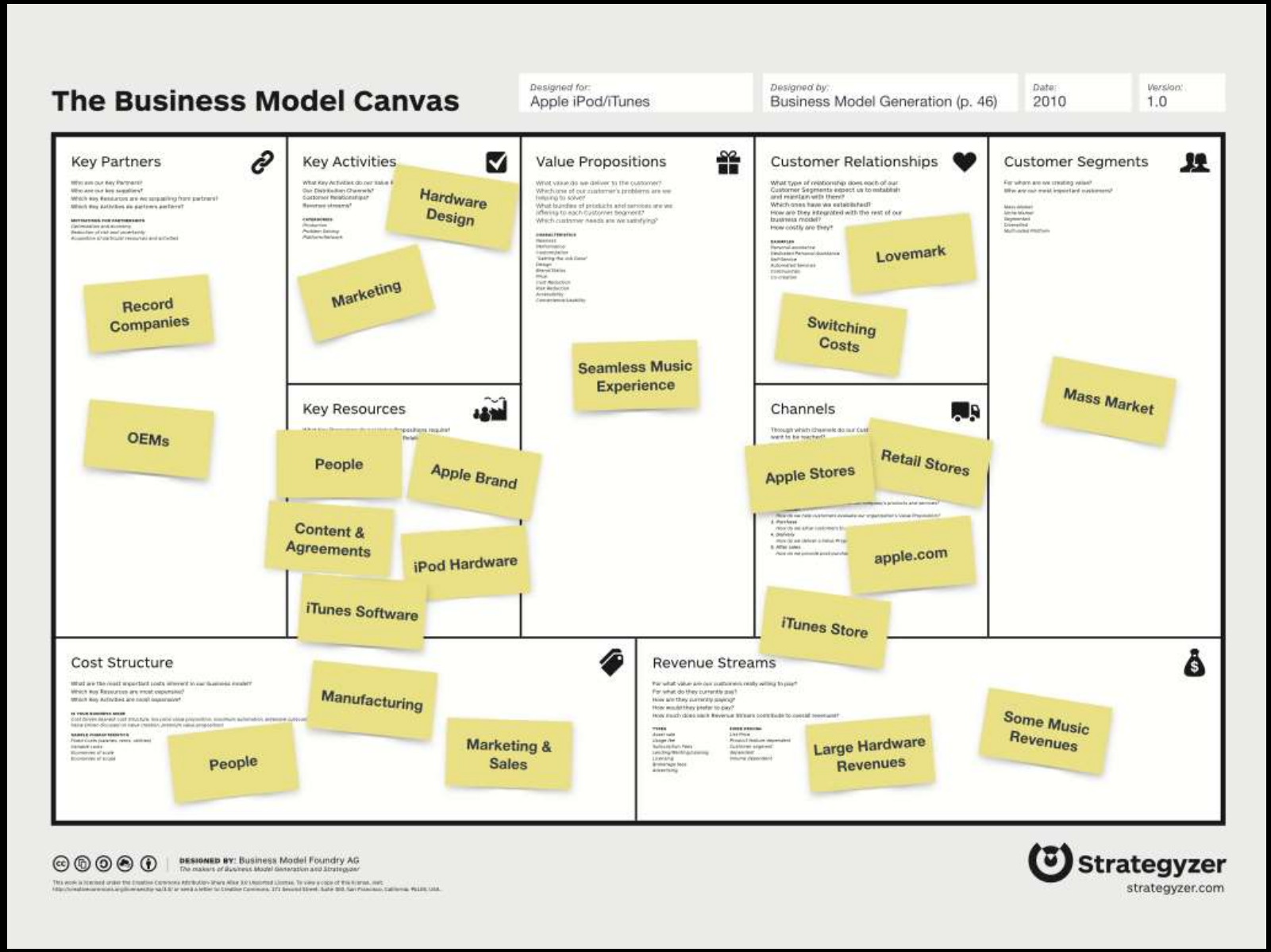
How IT transforms the Business Model



Credits: Oliver Gassmann

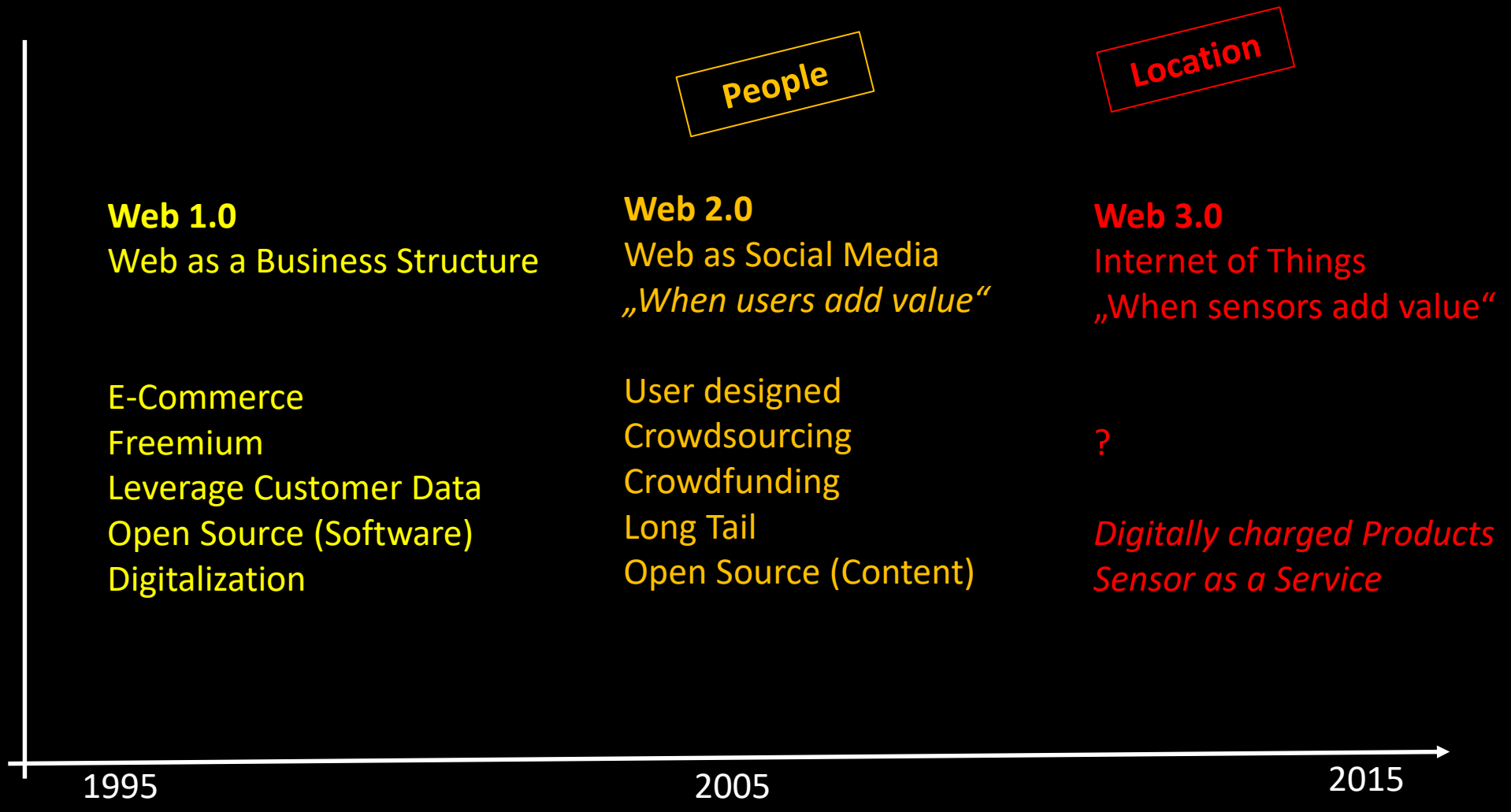
Keep on moving - reinvent your Business Model

Business Model Canvas

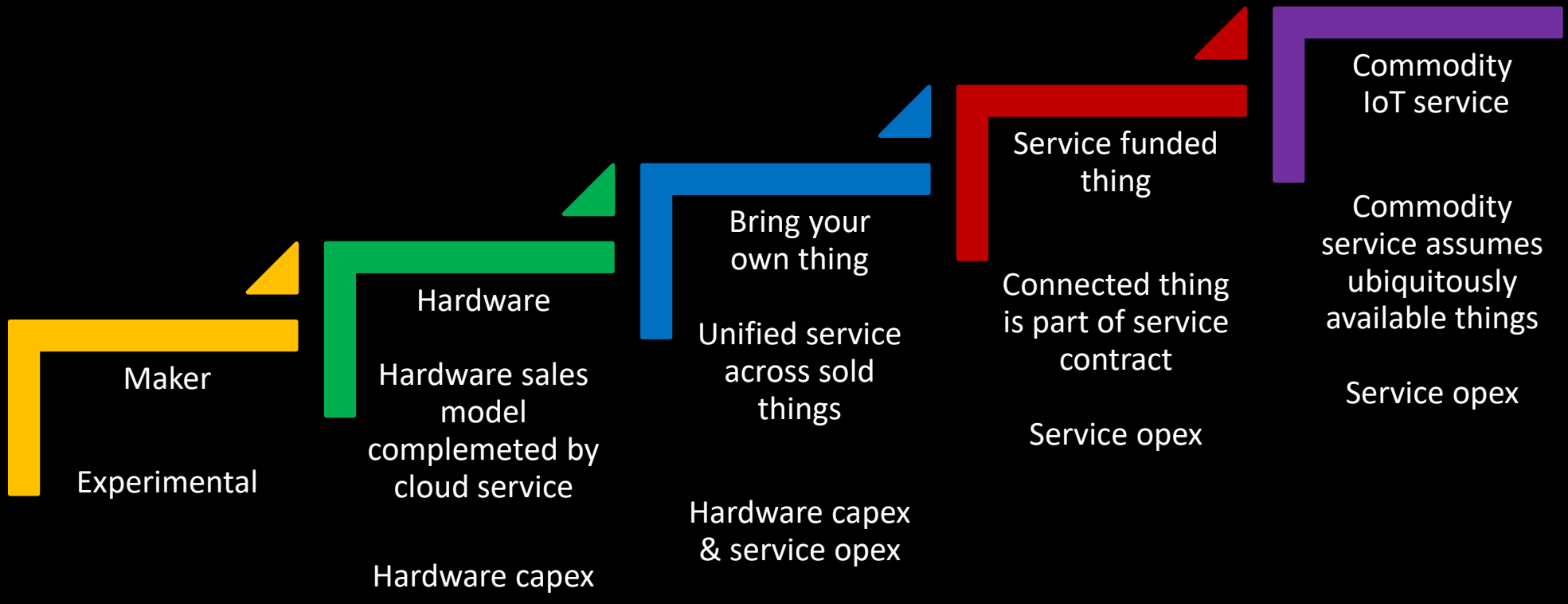


Credits: Alexander Osterwalder

Internet driven Business Models



IoT Business Models - Grades of Maturity



Credits: Forester Research

New Quality of IoT Data

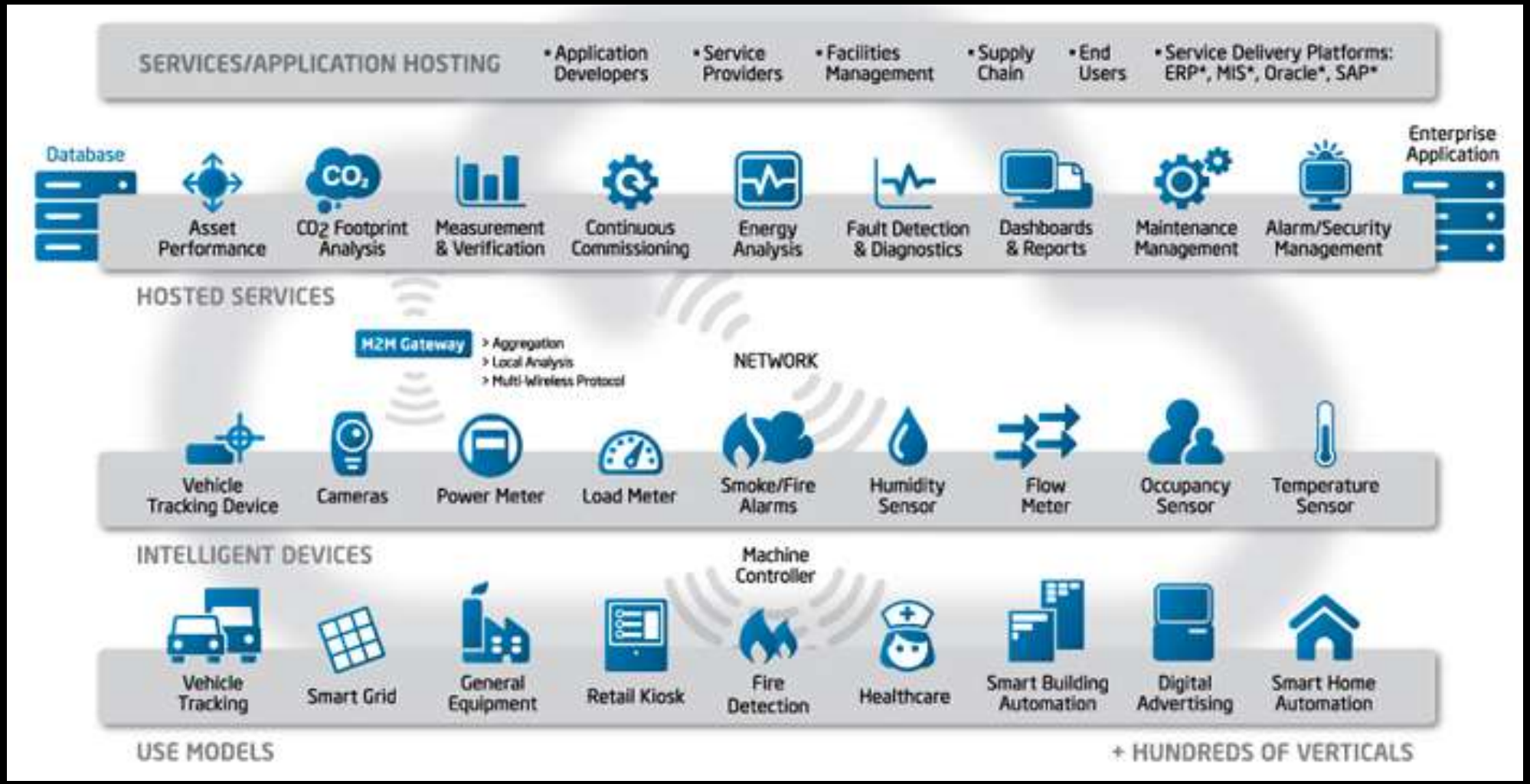
- Location based
- Realtime
- High resolution
- Ubiquitous

Data based Services

- ThingSpeak
- If this then that (IFTTT)
- Wolfram Alpha

...

Services powered by Embedded Devices



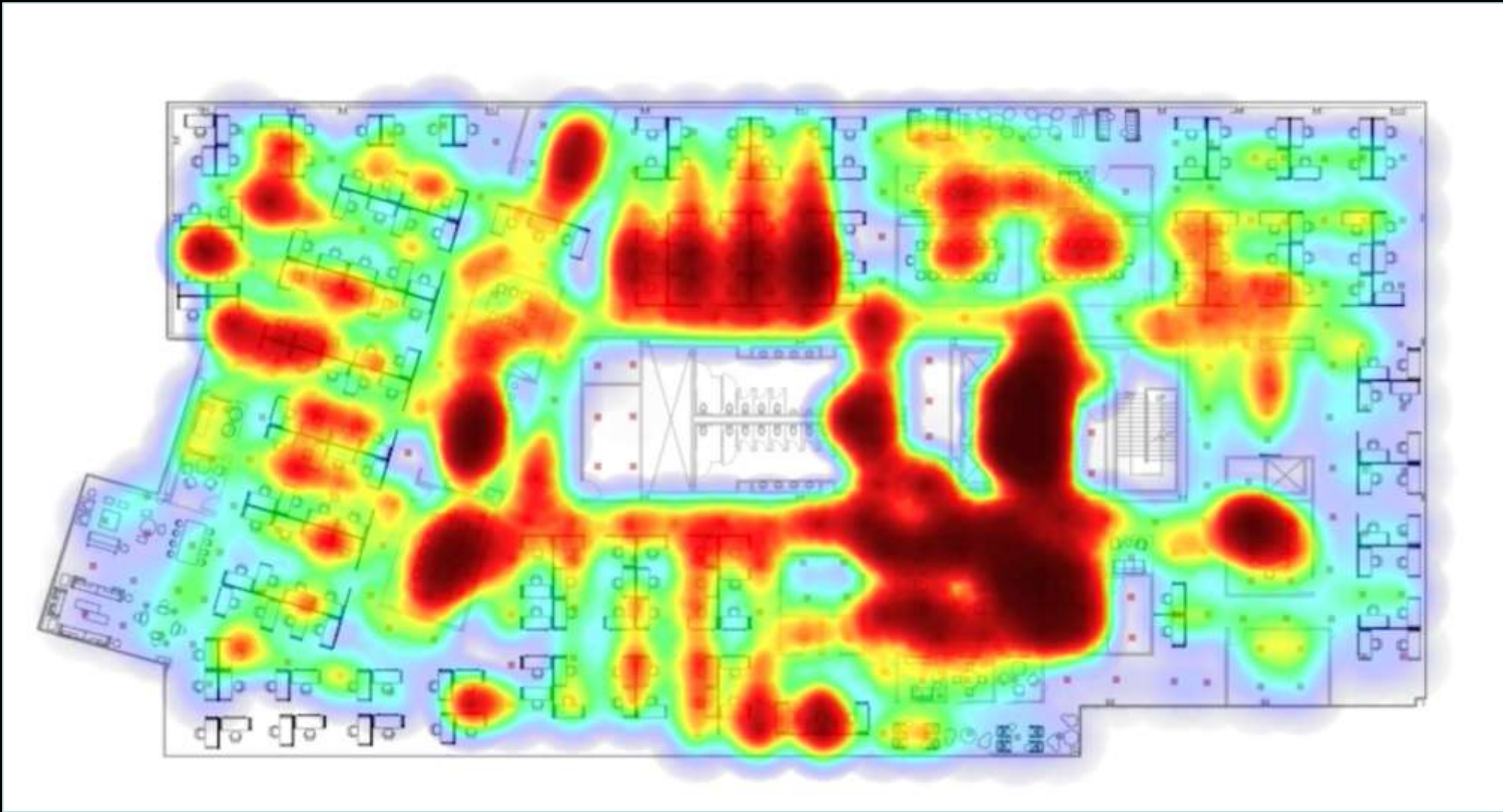
Smart Building

Real Time Location Services

Technologies:
Qualcomm
Lumicast
or Bytelight

Database with
fixture coordinates
merchandise map
+ **Analytics**

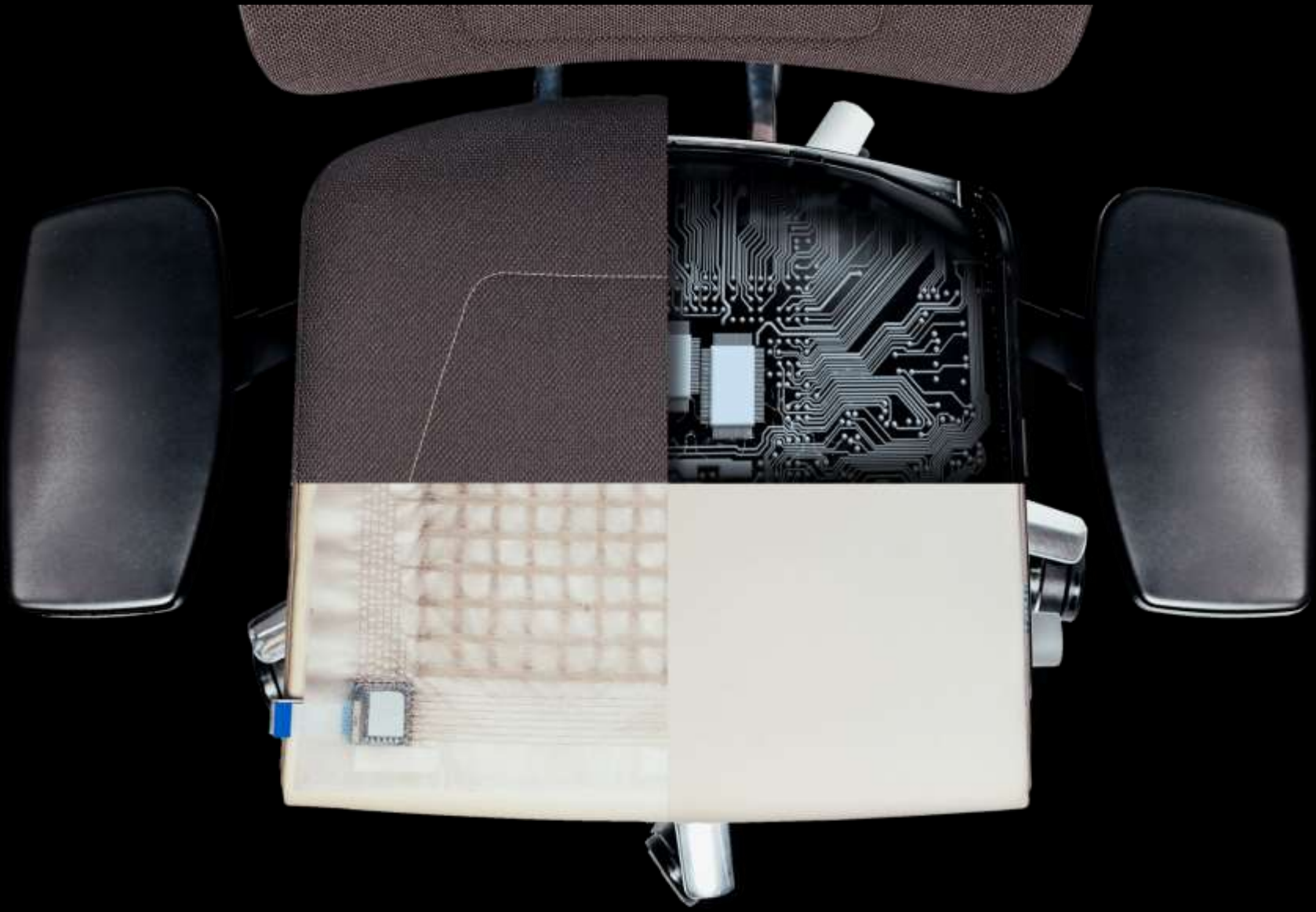
Heat-map of Occupancy Activity



Augmented Reality

- AR is a live view (direct or indirect) of a real world environment whose elements are augmented by computer generated sensory input such as graphics, video, sound or GPS-data
- Augmentation is conventionally in real time an in semantic context with the environmental elements
- With the help of technologies like computer vision and ojbect recognition the surrounding real world of user becomes interactive and digitally manipulable.

physio sense



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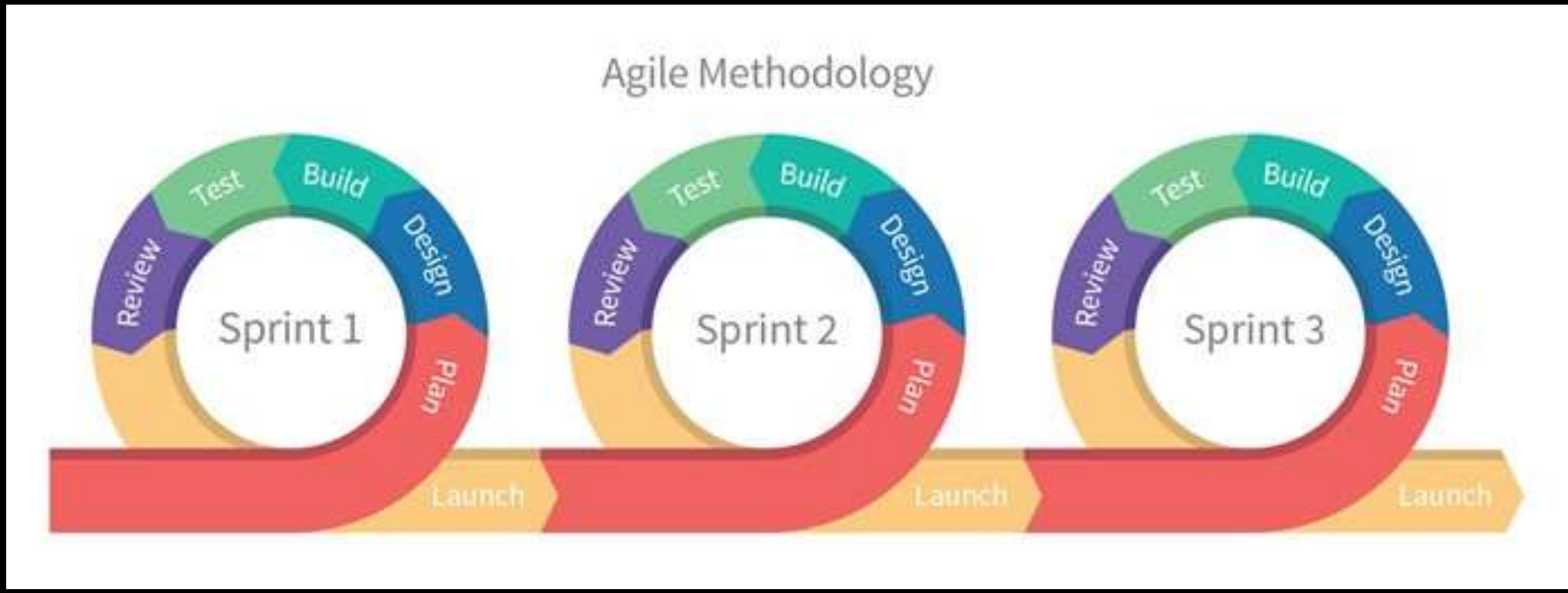
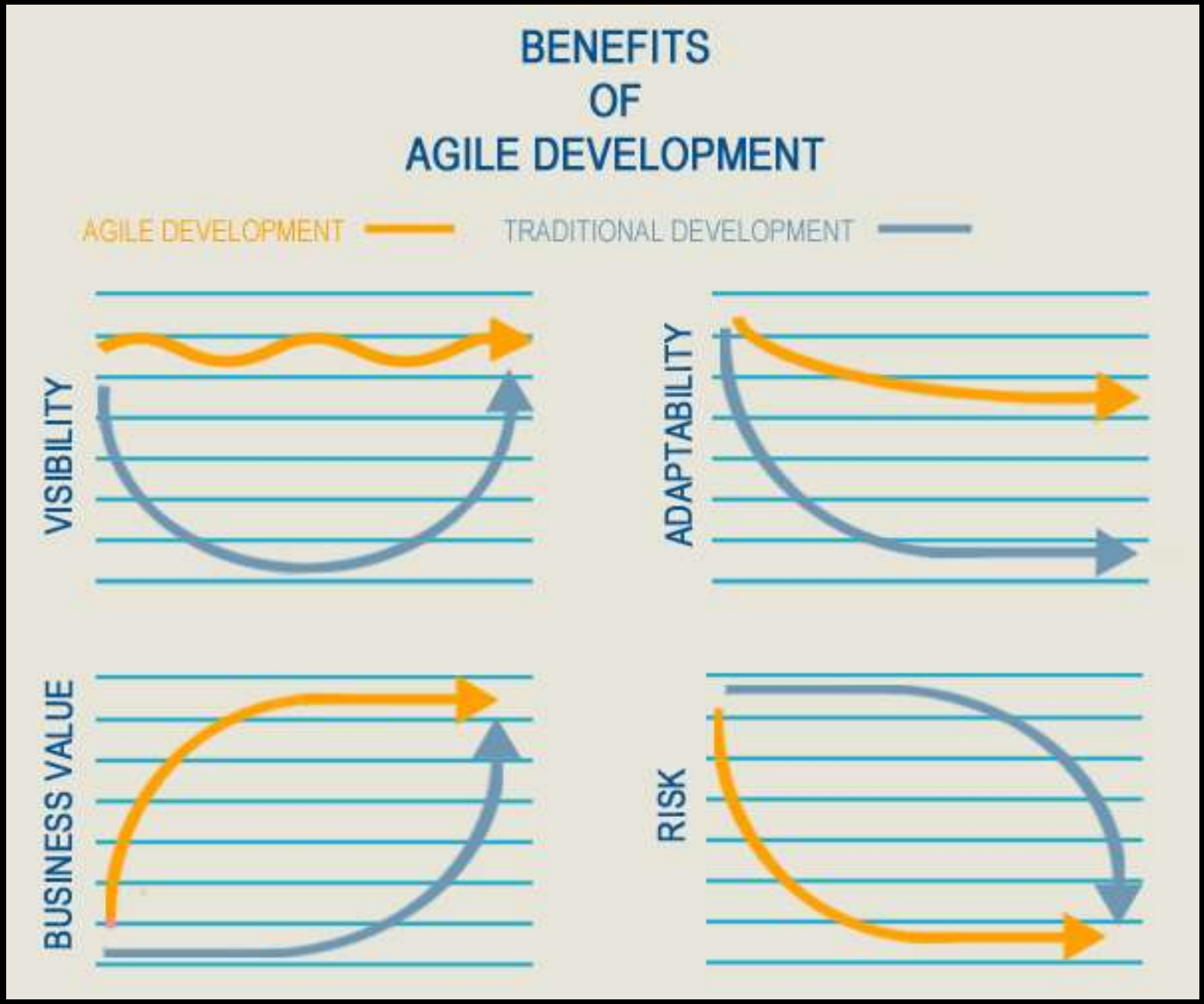
What‘s new for many Industries?

- **Intelligent Sensors**
- **Microcontroller**
- **Software**
- **Distributed Intelligence**
- **Data**
- **Analytics**
- **Services**

Agile Development




BENEFITS
OF
AGILE DEVELOPMENT
AGILE DEVELOPMENT
TRADITIONAL DEVELOPMENT
VISIBILITY
ADAPTABILITY
BUSINESS VALUE
RISK

Wrap-up - Impacts

- Future-proof products have to adopt to **IoT technologies**
- IoT is non **domain-specific** (e.g. lighting controls)
- Developing IoT based solutions requires a deep understanding of **embedded systems**
- **Intelligent software concepts** will be the key factor to generate USP in the industry
- Connecting products with the IoT opens complete **new business models** in several industries
- Industries have to rethink it‘s development approach and consider open source
- Solely hardware based business models gonna have though times.

Thank you - Questions?