Sensory and imaging technology in science, health and security

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Semiconductors are pervasive in our Lives

Every day, we use several hundred electronic devices before arriving at the office

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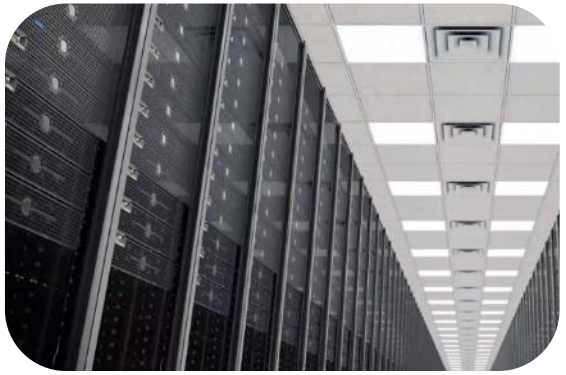
Semiconductors are pervasive in our Lives

Then there is the part we cannot see…
with electronics everywhere to manage all the devices of our daily lives



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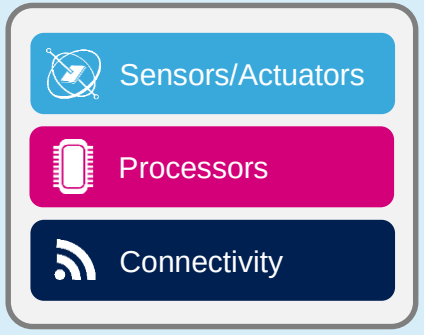
A three step end-to-end Process

Data

Nodes

Sense the world
and pre-process the data

Act on information



Gateway

Gathers the information and connect to the cloud

Connects devices

Cloud

Extracts information from data and determines action

Action

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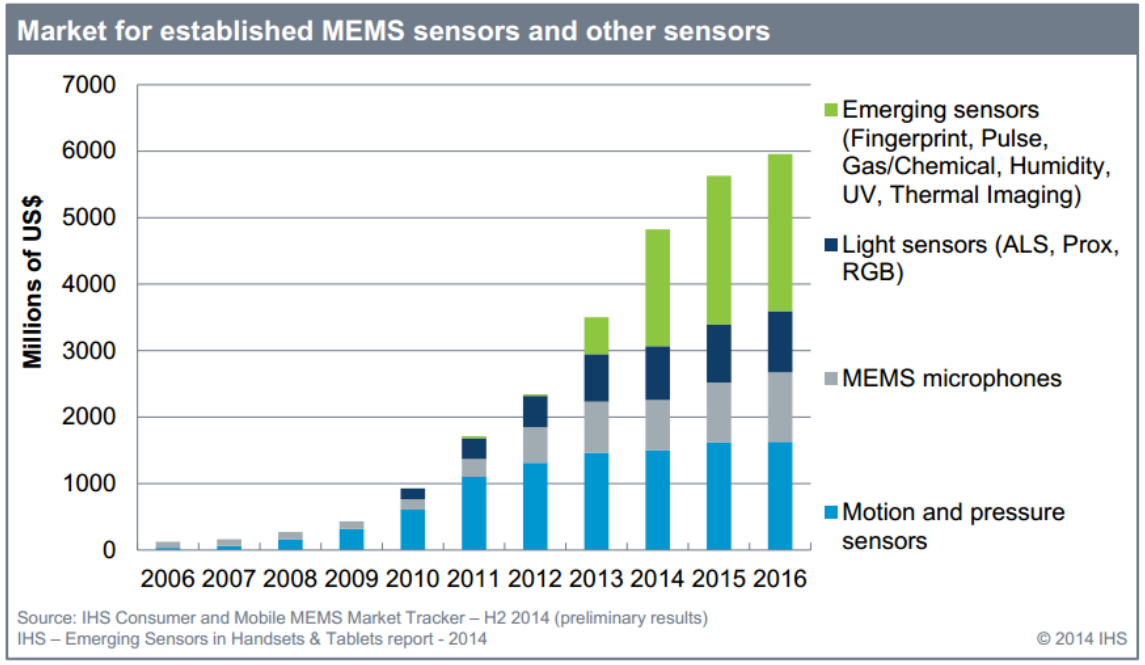
Sensors: An essential Part of the System

Collect data from the environment to build an accurate picture of the world



- Sensors are based on many different technologies
- Silicon sensors seen explosive growth
  - quickly scale in mass production
  - perfect reproducibility of each device
  - economies of scale

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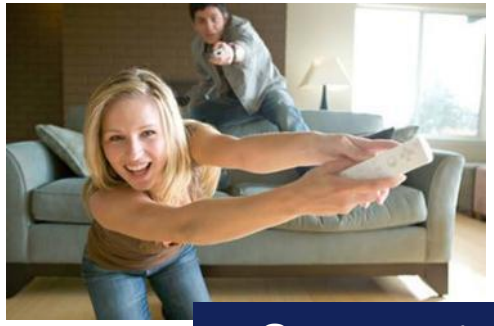
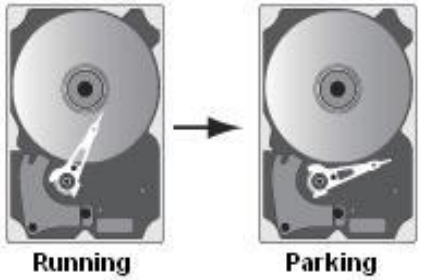
Products driving MEMS Adoption



Game controllers

Portable Devices

Notebook PCs



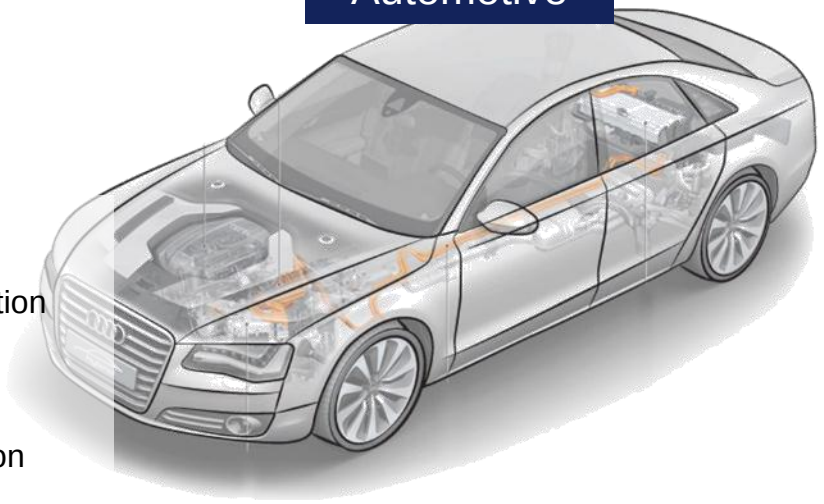
Freefall detection

Input devices
Remote controls

Cameras

- Vehicle control
- Front light inclination
- Assisted GPS navigation
- Roll over detection
- Collision detection
- Antitheft
- Collision reconstruction

Automotive



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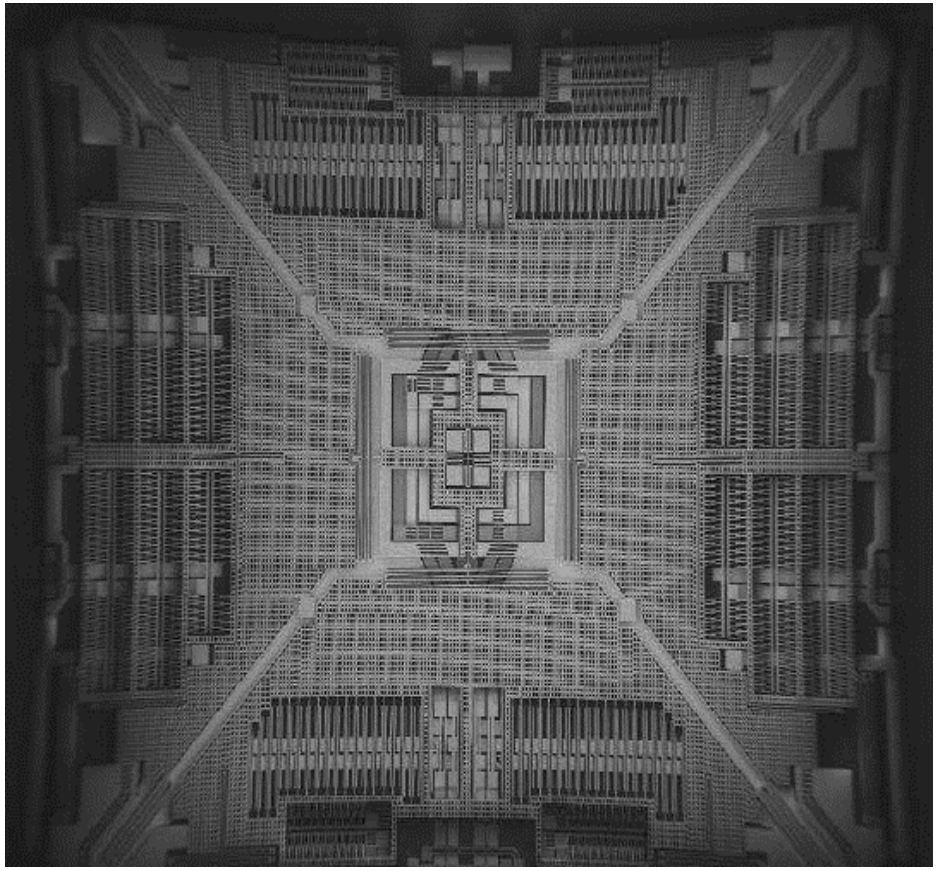
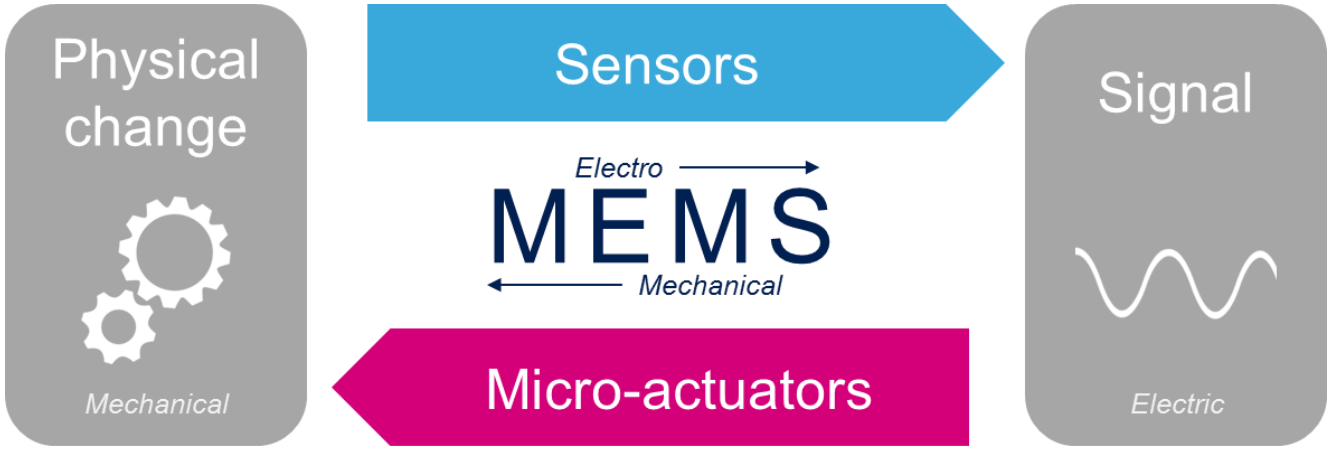
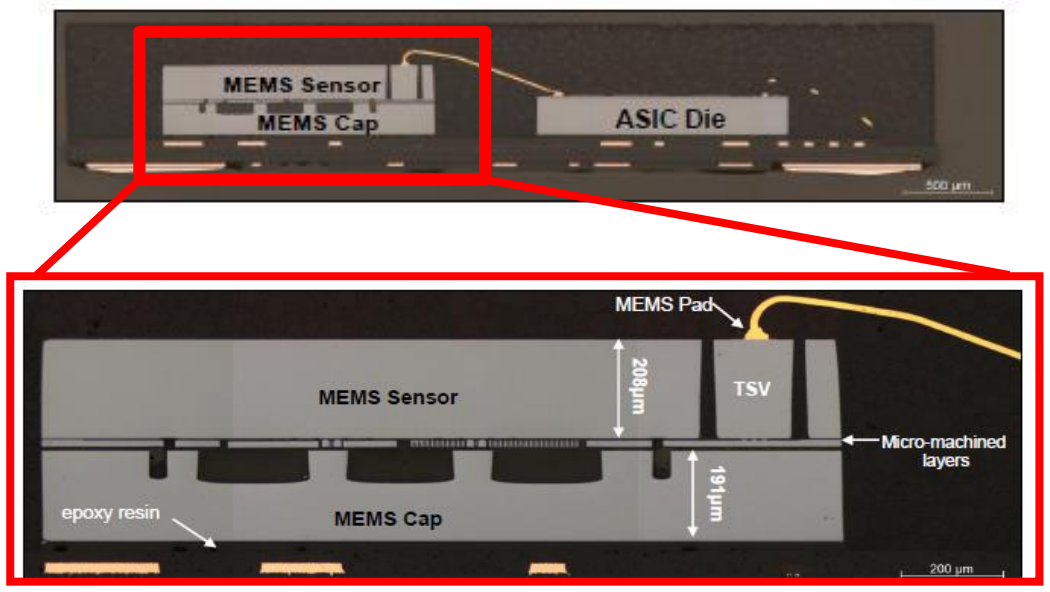
MEMS: The beating Heart



Motion MEMS Sensor
Micro-machines layers





Structure of a Micro-Electro-Mechanical System

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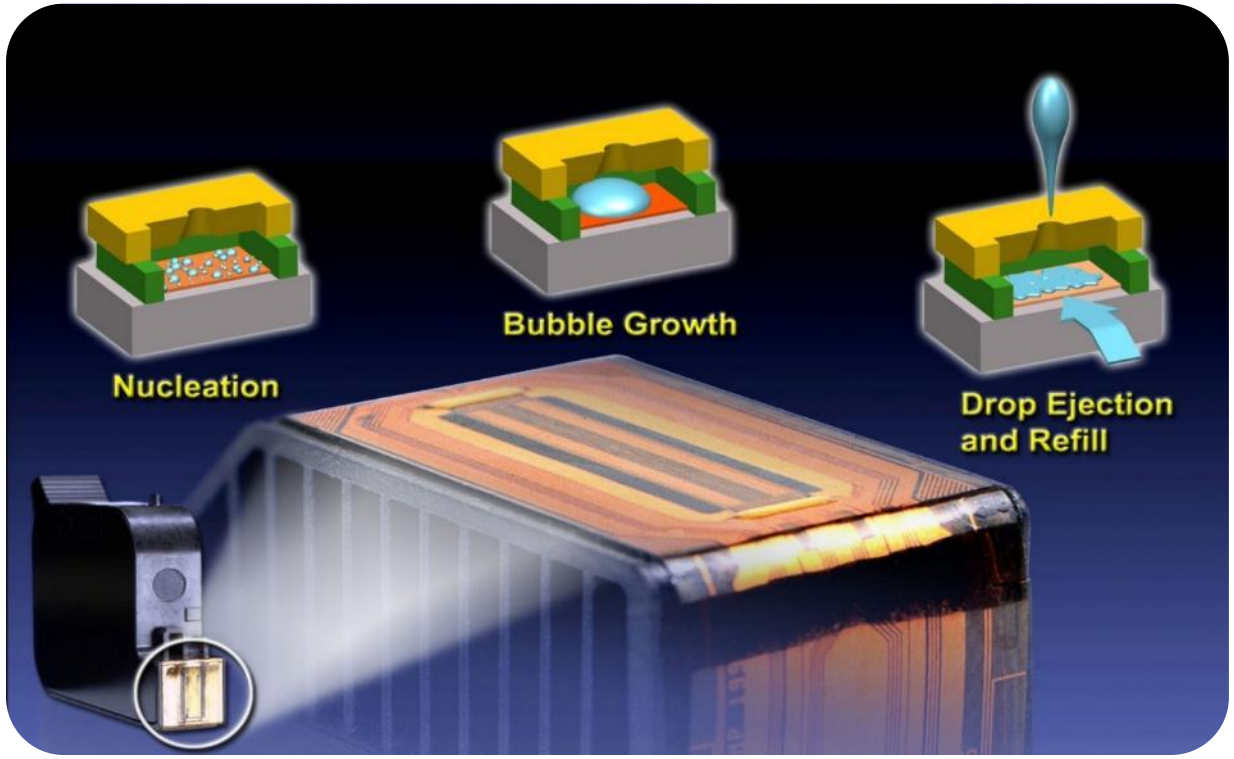
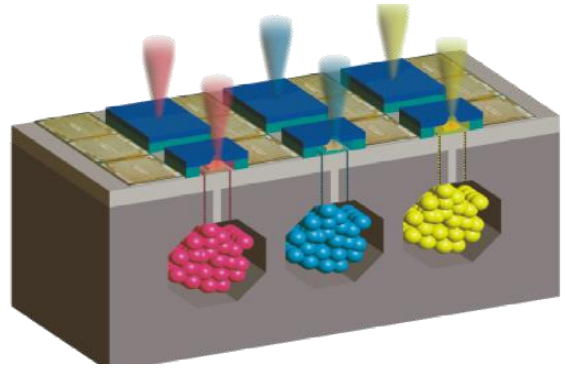
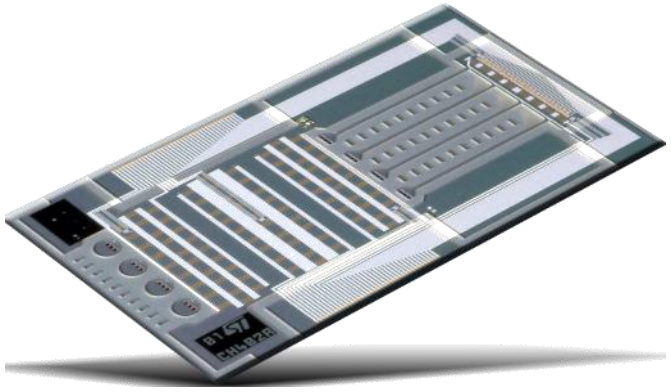
We started 23 years ago with an Inkjet Printer





Buried channels for disposable
Ink-jet printers



Buried channels for PCR
In a disposable lab-on-chip

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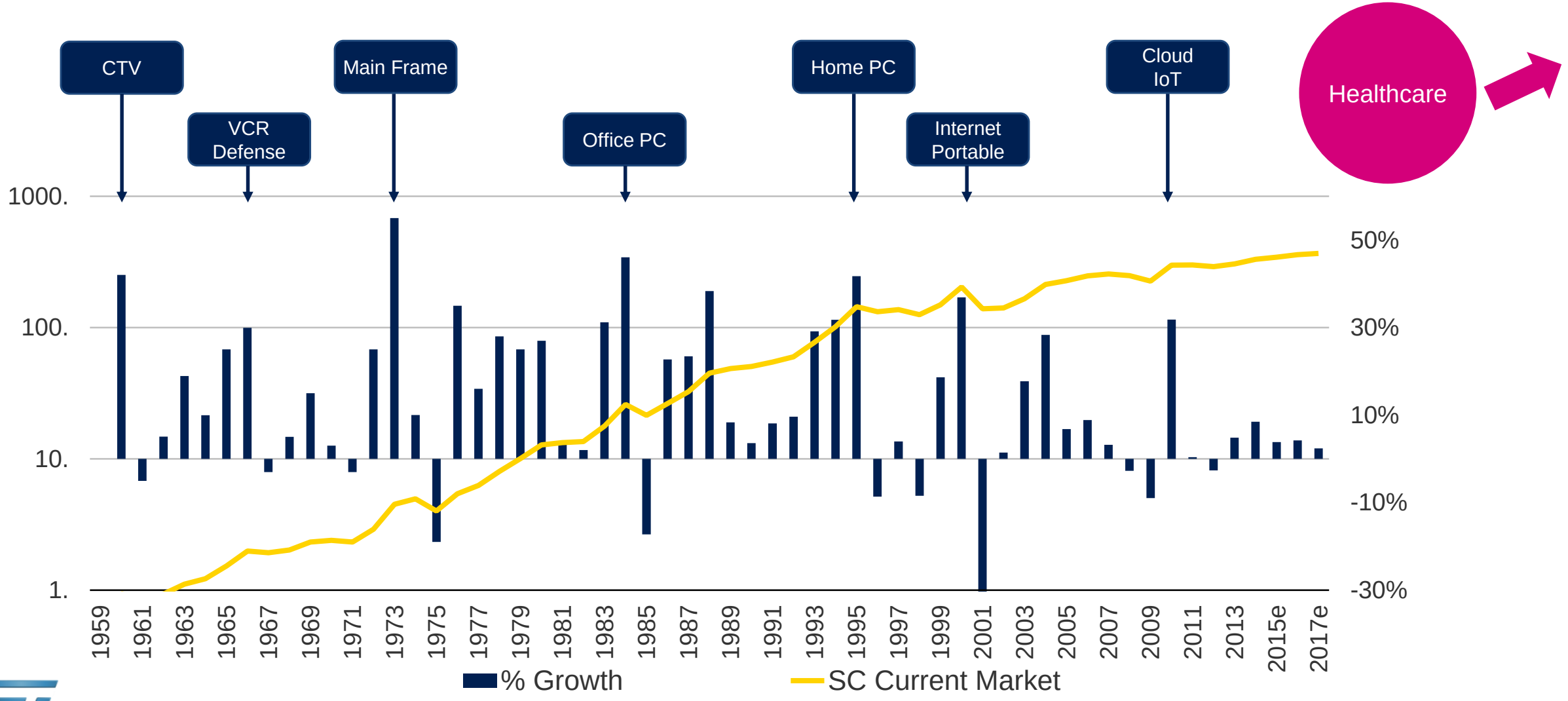
Healthcare is the next Driver



Source: WSTS,ST

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Sensors for Healthcare

Towards personalized healthcare

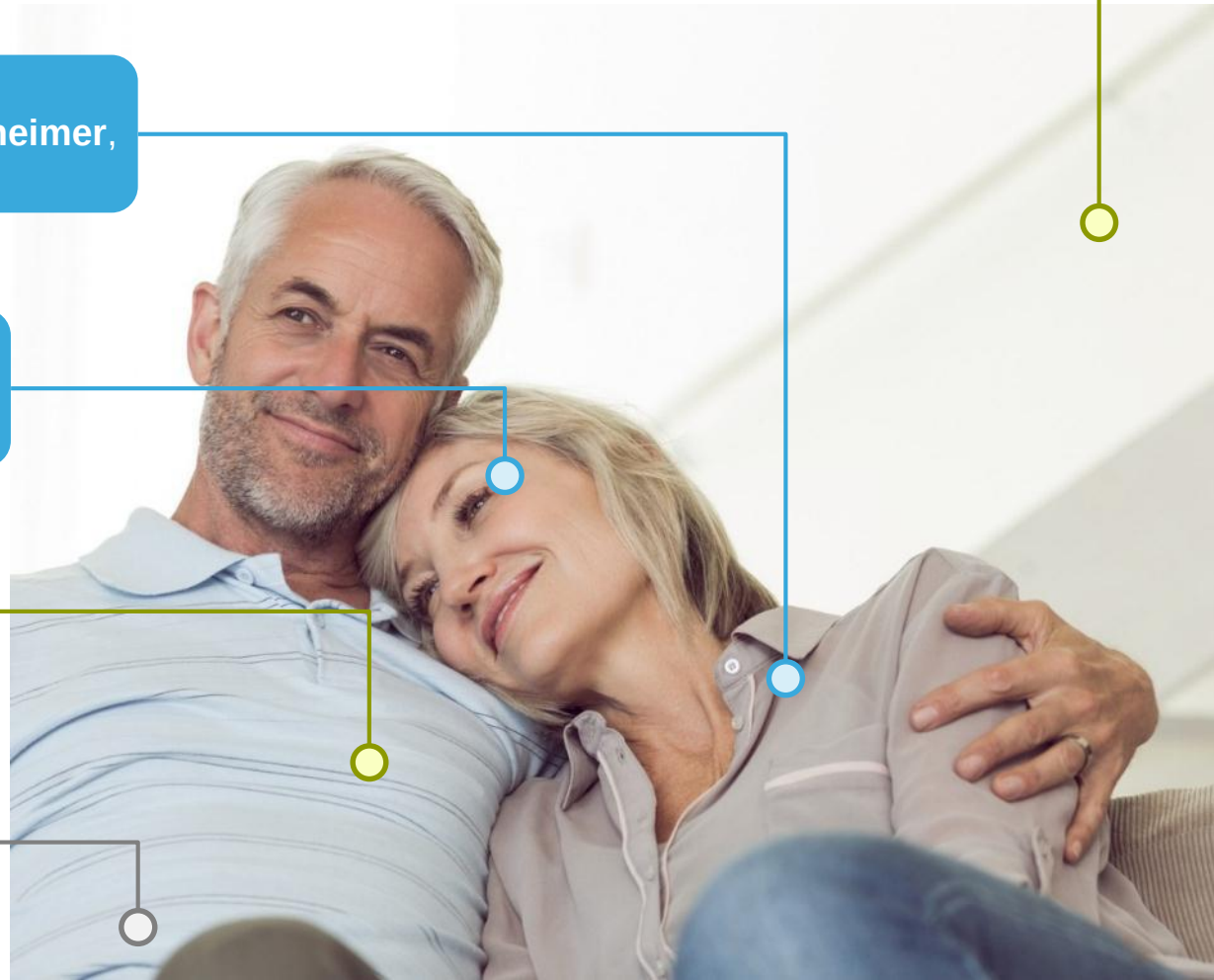
Gas sensors
For asthma prevention (air quality, pollen count)

Inertial modules
For activity monitoring in **Alzheimer**, o**besity, sleep disorders**

Pressure sensor
In the eye for **Glaucoma diagnostic**

Chemical sensors & analog
For blood analysis and ECG

Actuators
Glucose monitoring & Insulin nano pump for **diabetics**



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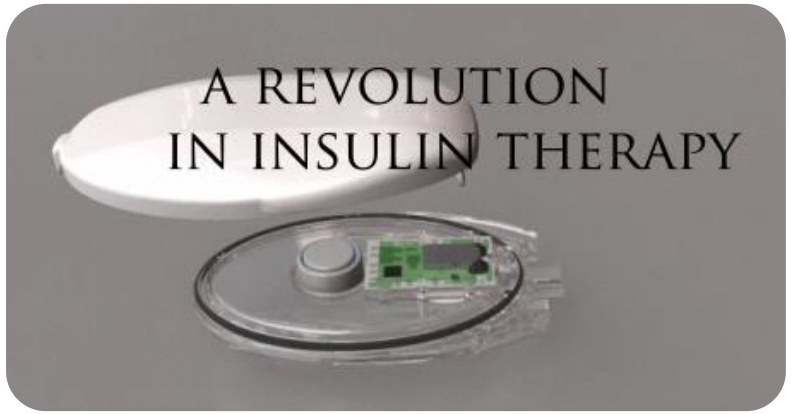
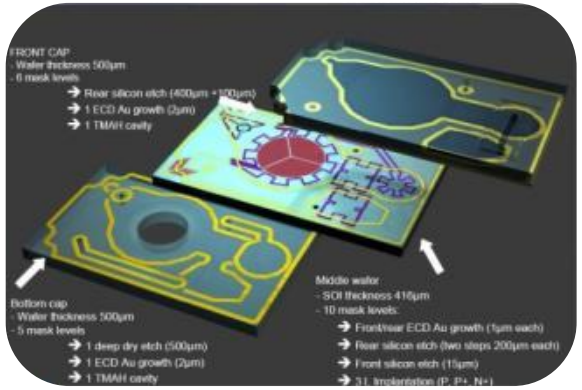
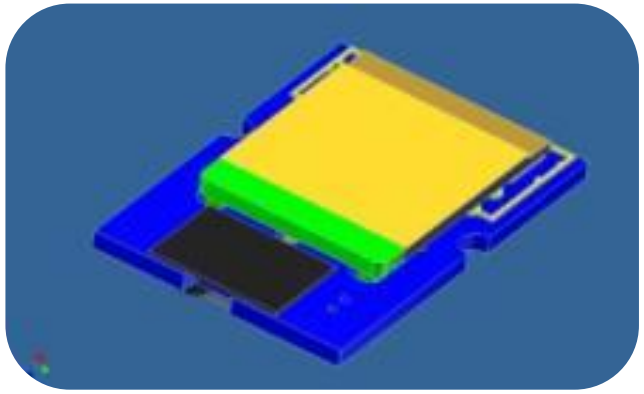
JewelPUMP™ for Insulin

Nanopump developed by Debiotech with ST for diabetes management







Easy to use. Personalized

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Source: www.jewelpump.com

SENSIMED
innovation in medical micro-technology

Triggerfish™ Contact Lens Sensor

Contact Lens for non-invasive early diagnosis and personalized treatment of Glaucoma

- Sensor is a strain gauge & antenna embedded in a silicon contact lens
- The sensor is capable of measuring cornea deformations due to Intra-Ocular-Pressure (IOP) variations
- The IOP Sensor is a wireless sensor that acts as a transducer, antenna and mechanical support for additional read-out electronics

ST wafer containing lens sensors

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Implanting Silicon is not new

BIOTRONIK

Medtronic

Boston Scientific
Advancing science for life™

ST. JUDE MEDICAL

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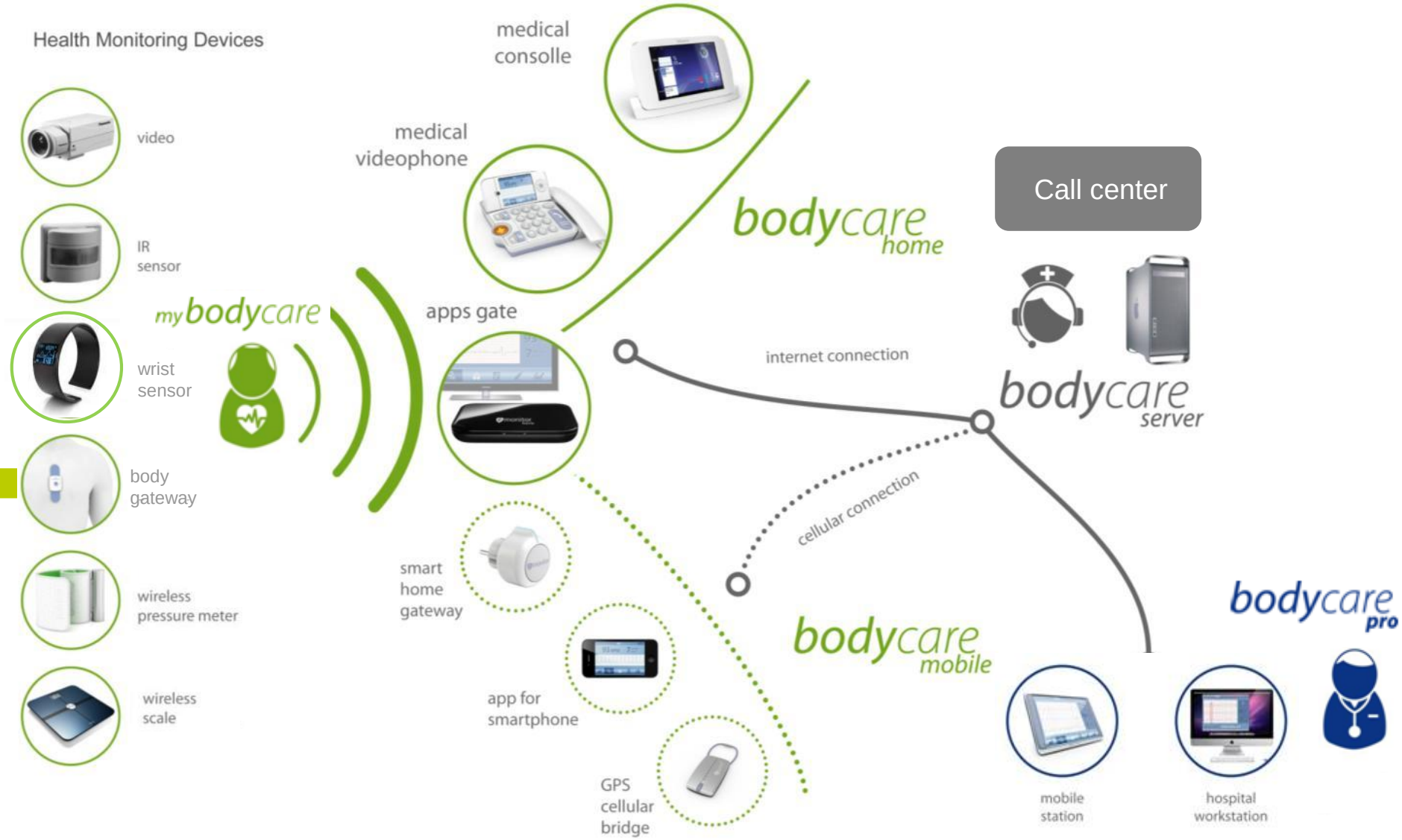
The Real Innovation is the Connectivity

- Developed in collaboration with Mayo Clinic (US)
- Care Platform from Preventice



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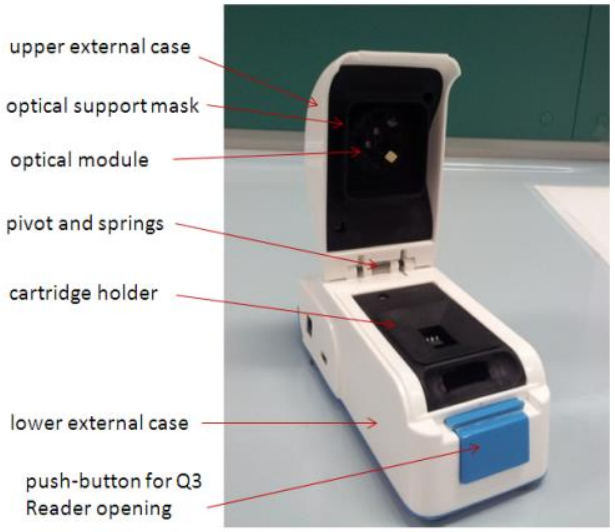
But this is just the Beginning

Example of BioToBit real time PCR* platform

Identification of multiple analyses of specific nucleic acids (DNA, RNA) sequences

Today



Next Year

*Real time Polymerase Chain Reaction (PCR) amplification

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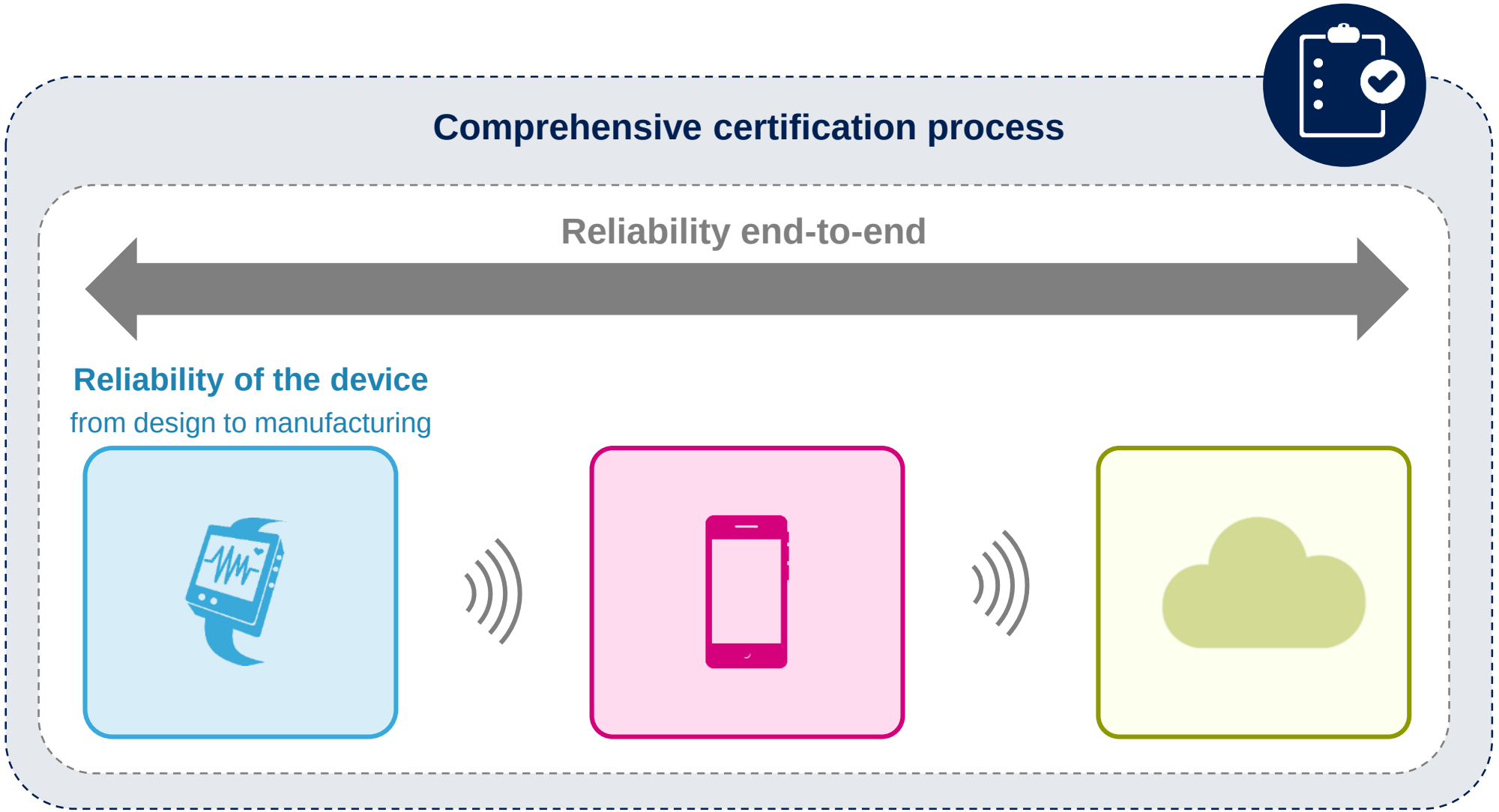
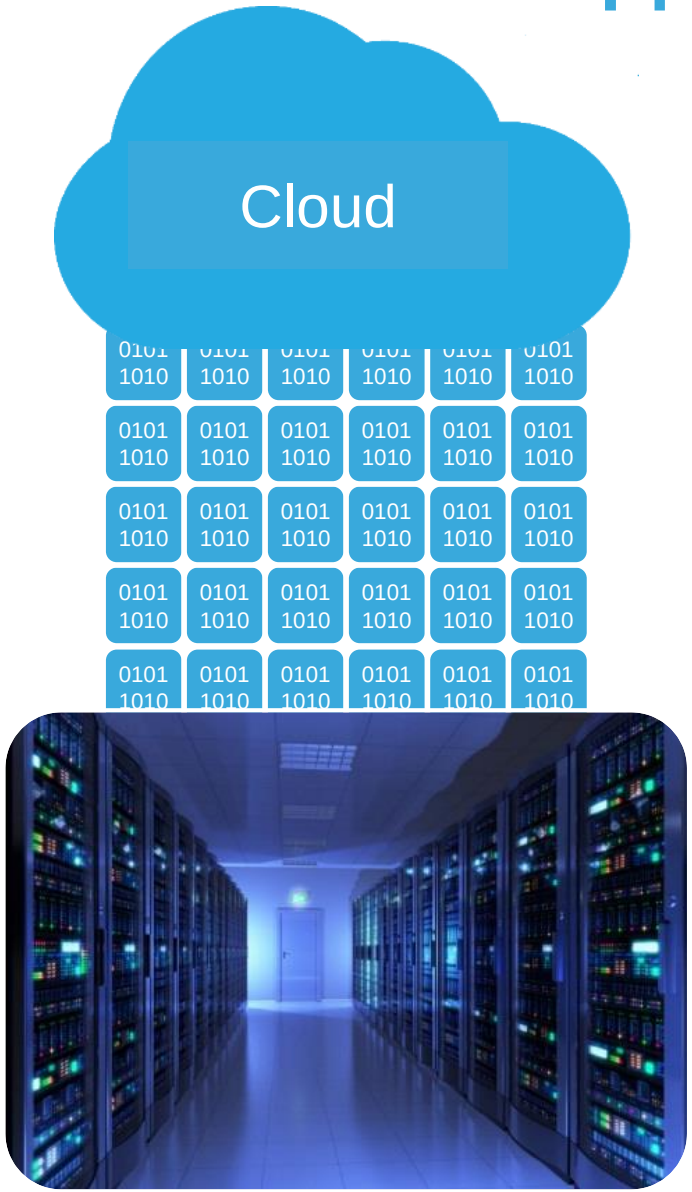
What's different in Healthcare



The importance of the cloud



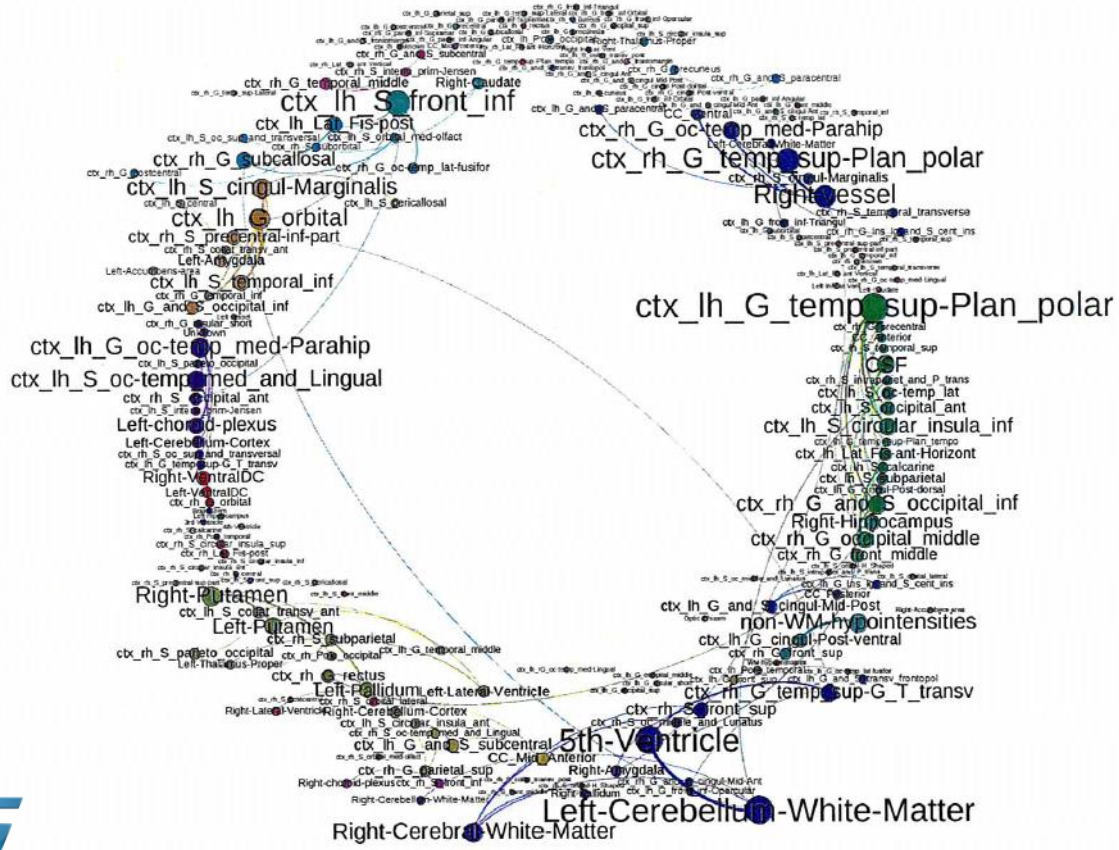
Zetabytes of data collected every year

Filtered and analyzed to provide valuable information

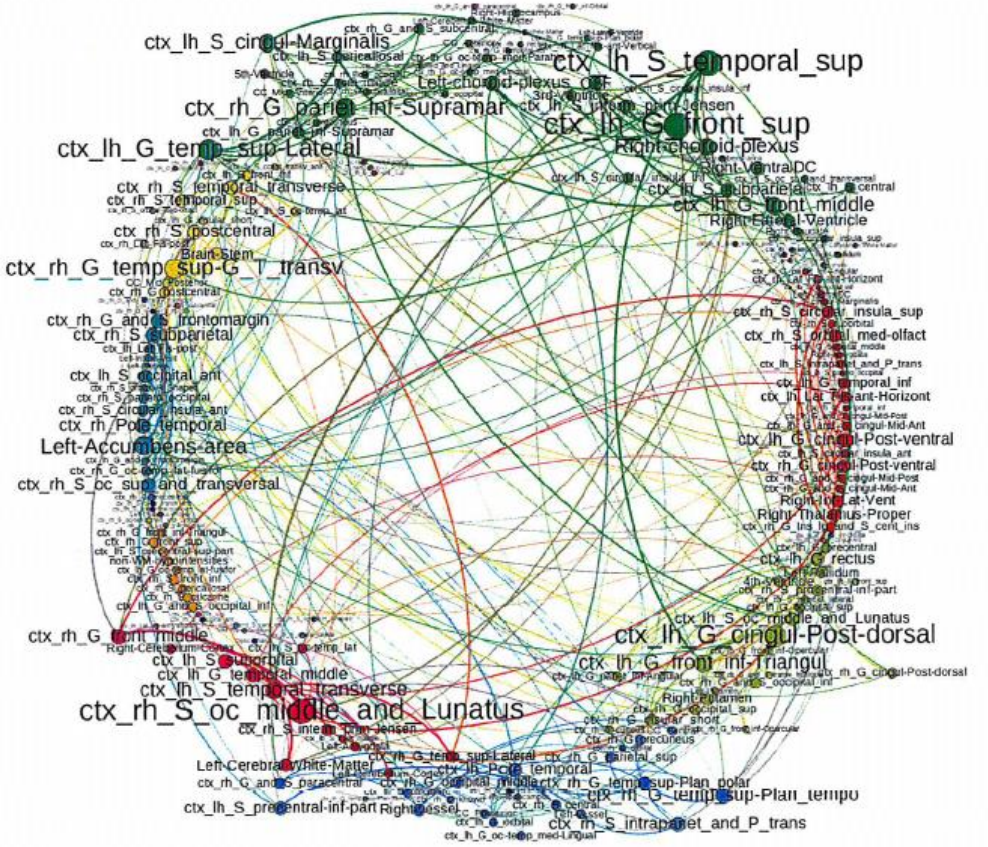
From analytics towards cognitive computing

Analytics, an Example

“Normal subjects”



Psilocybin (psychoactive drug) treated subjects



Source: ISI Torino

What is cognitive Computing

Huge computing power required to operate

Cognitive Computing

Example of IBM Watson

- Operates at 80 teraflops. The human brain is estimated to have a processing power of 100 teraflops (100 trillion operations per second).
- Has the equivalent in memory (RAM) that the Library of Congress adds in books and media over a 4 month period
- Can process 200 million times more instructions per second than the Space Shuttle's computers
- Parses within 3 seconds the equivalent of the number of books on a 700 yard long book shelf…and picks out the relevant information, and create an answer.

Security is key

Our lives are increasingly dependent on data

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Security ⟺ Safety

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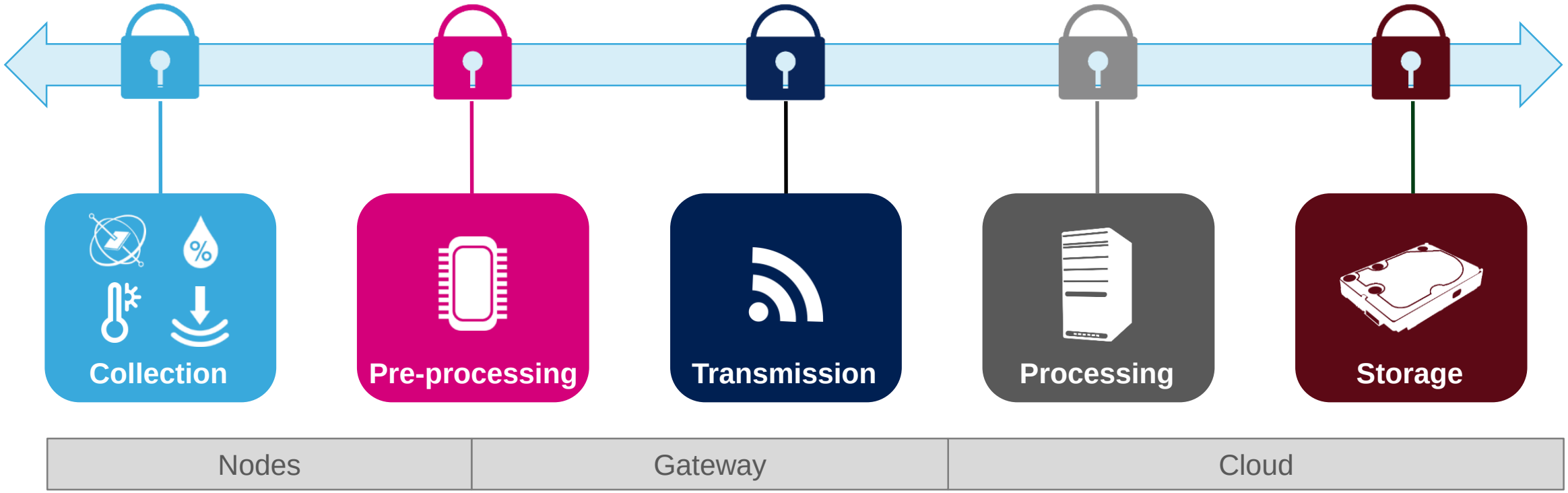
ST Know-how in Security

- Wide offering in Secure microcontrollers, including Secure Elements, NFC transceivers and java cards
- #1 WW supplier in Secure Element (SIM form factor or Embedded)
- Vast support of cryptography in HW and SW for STM32
- Flash protection mechanism and pre-integration of SW stacks
- Certified HW & SW solutions
- Availability of cryptographic HW support in connectivity devices (STarGrid, STComet, SPIRIT1)
- Leader in PAY-TV SIM card
- Inventor of Keccak algorithm adopted by US NIS for new SHA-3 hash standard
- Strong ecosystem: Conditional Access, Digital Rights Management, new crypto technologies, watermarking

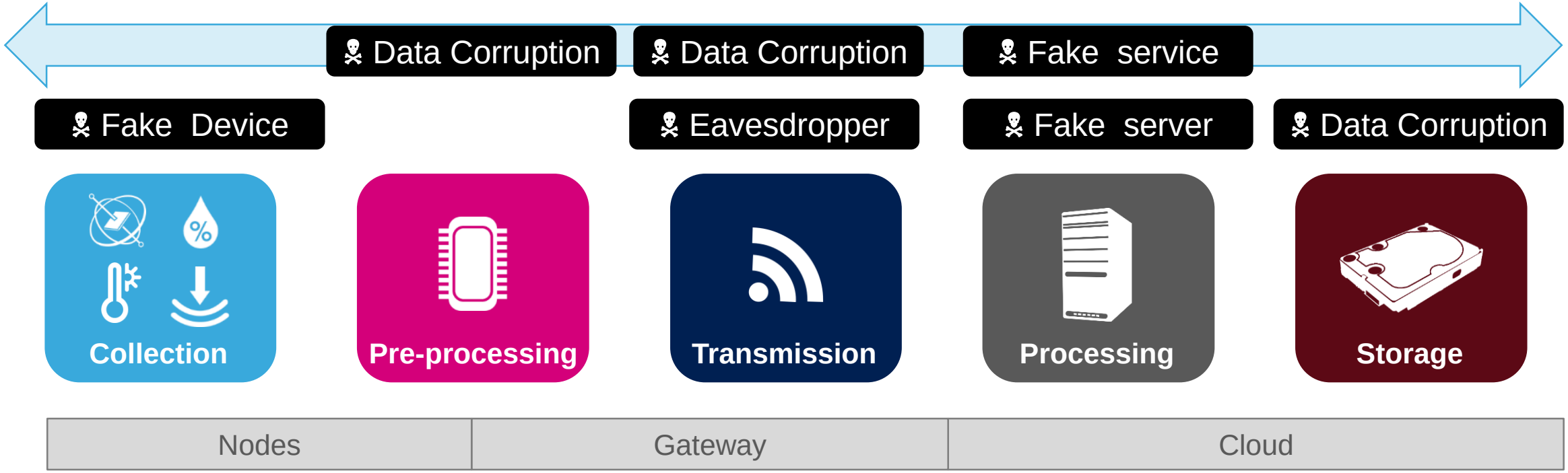
End-to-end security

Importance of security throughout the whole chain

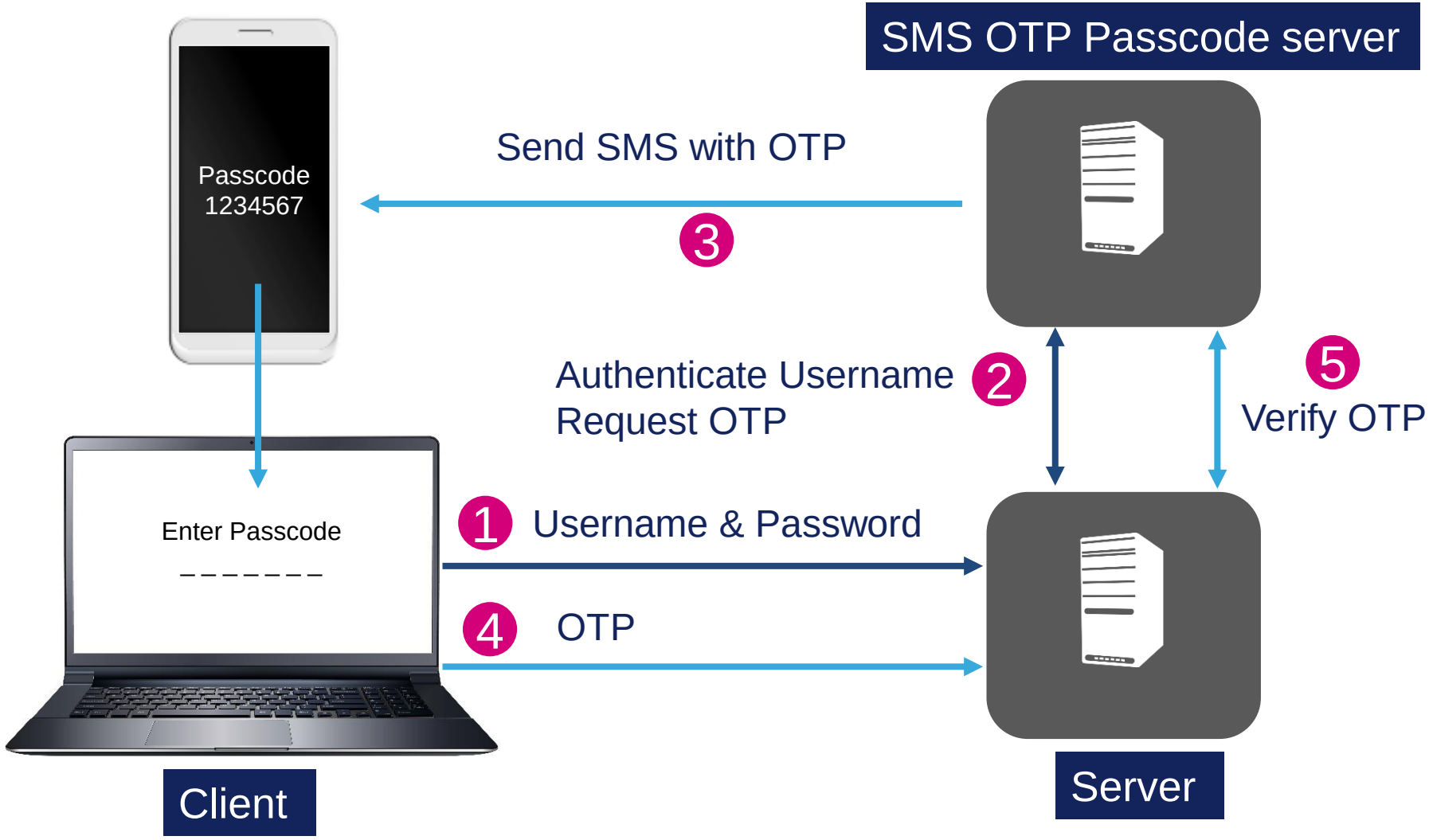


Threats to Data

Data is vulnerable to attack at all points in the chain



Multichannel Authentication



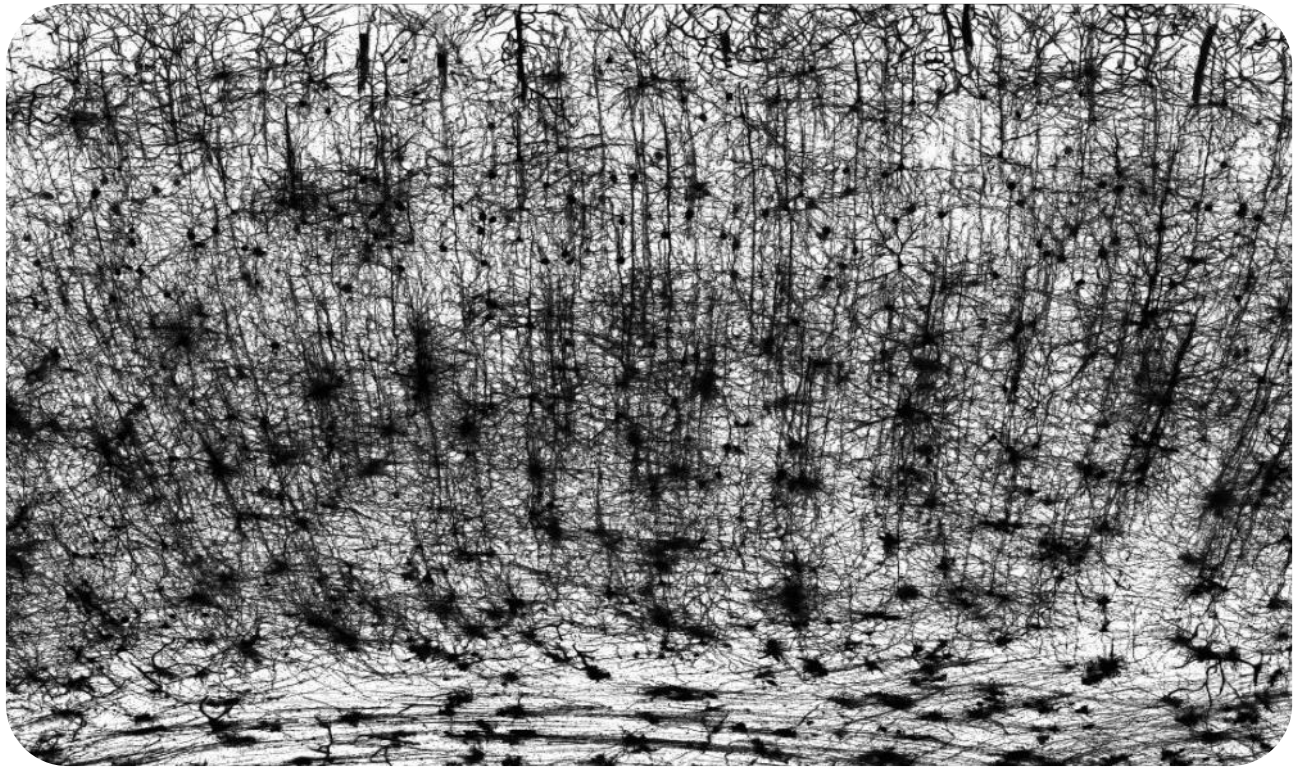
OTP = One Time Passcode

IoT Security Challenges

Source: CISCO

The Future is ..

replication of the oldest computing architecture



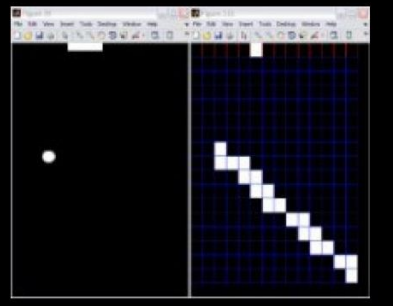
The human brain has **100 billion neurons**, **1000 trillion synapses** and consumes **only 20W**

It integrates sensor **processing**, data **conversion**, **transmission** and **storage**, **analytics**, **cognitive computing** and even **intuitive thinking**!

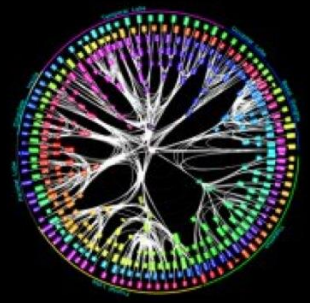
Beyond Von Neumann Machines

Cognitive Systems: SyNAPSE

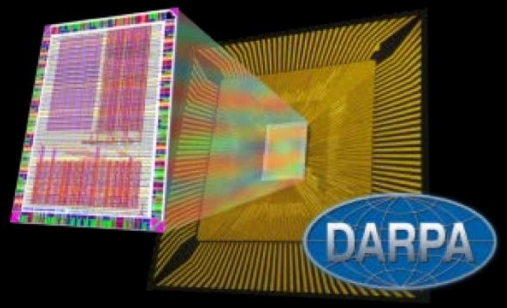
- "Neuron" and "synapse"-like computing model
- Systems learn through analytics / experience
- Advantages: Ultra energy-efficient, flexible, learning



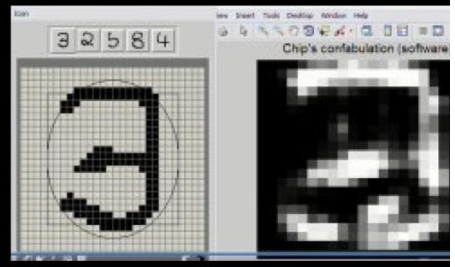
Learning Pong



Wiring diagram – monkey brain



'True North'



Character ID

Source: IBM

A Path to the Future?

Unprecedented scale

This second generation chip is the culmination of almost a decade of research and development, and is a huge leap forward from the initial single-core hardware prototype developed in 2011.

	2011	2014
Programmable neurons	256	1 million
Programmable synapses	262,144	256 million
Neurosynaptic cores	1	4,096

1/10th of a Watt powers the neurosynaptic chip's 256 million synapses
...with the goal to simulate 1 trillion synapses using only **4 kW of energy**

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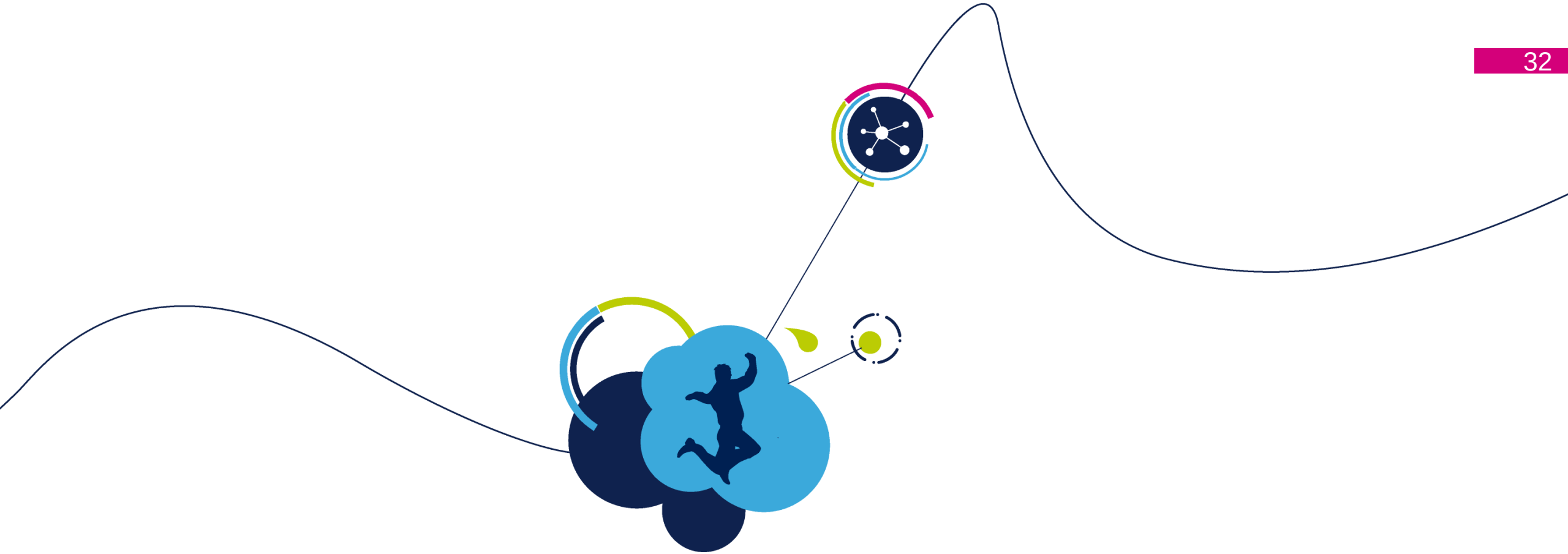
Source: IBM

Reinventing Electronics

- Integrating neuron based computing architectures with sensors will move more functions from the cloud to the system periphery
- Local battery operated nodes will be able to replicate a good part of the basic human activities: sense, analyze, organize data into information and decide on actions.
  - These Intelligent sensor nodes will become the core of systems
- The cloud will become the repository of the global experience where all facts will be stored, analyzed and the "learning of the species" will take place to be transferred to new generations
- It is somewhat like the difference between fast, automatic, amygdala-based responses and slower, knowledge brain-processed responses. Somewhat …



Thank you