Internet of Things Introduction

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❑ Domains and applications.

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Introduction

Definition

❑ The Internet of Things (IoT) is the network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data.

❑ The Internet of Things (IoT) refers to the use of intelligently connected devices and systems to leverage data gathered by embedded sensors and actuators in machines and other physical objects.

❑ *Things (objects) + Intelligence / Sensors + Connectivity + Data.*

Video from Microsoft

Definition
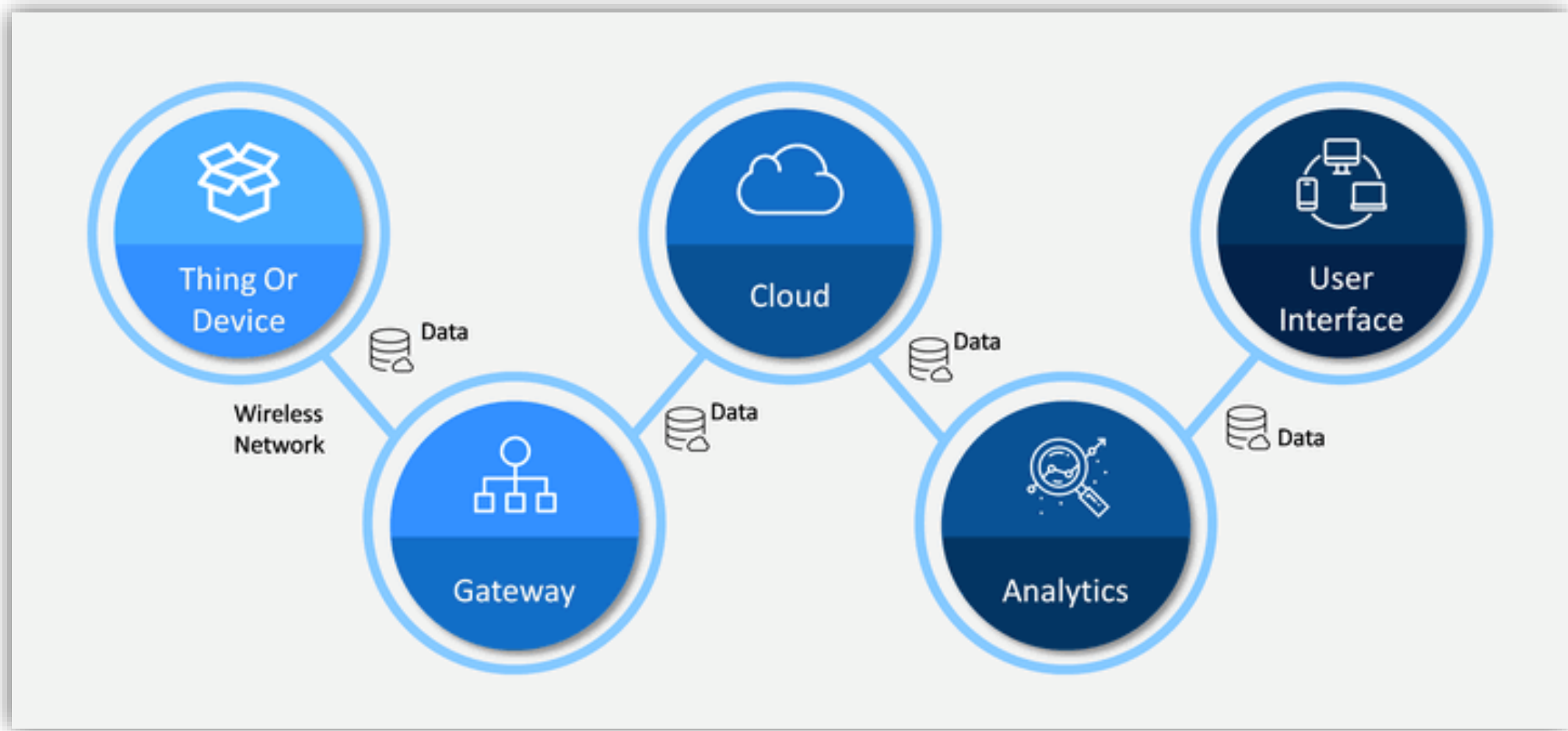
What are the THINGS ?

❑ Every thing .. Yes every thing ..
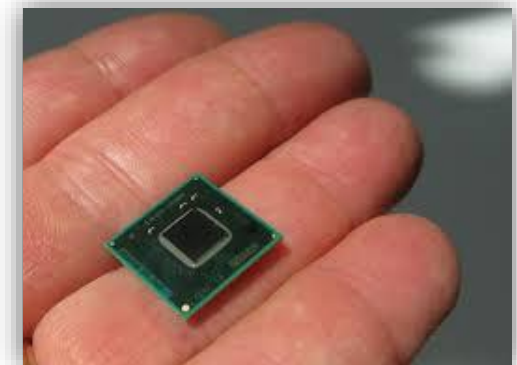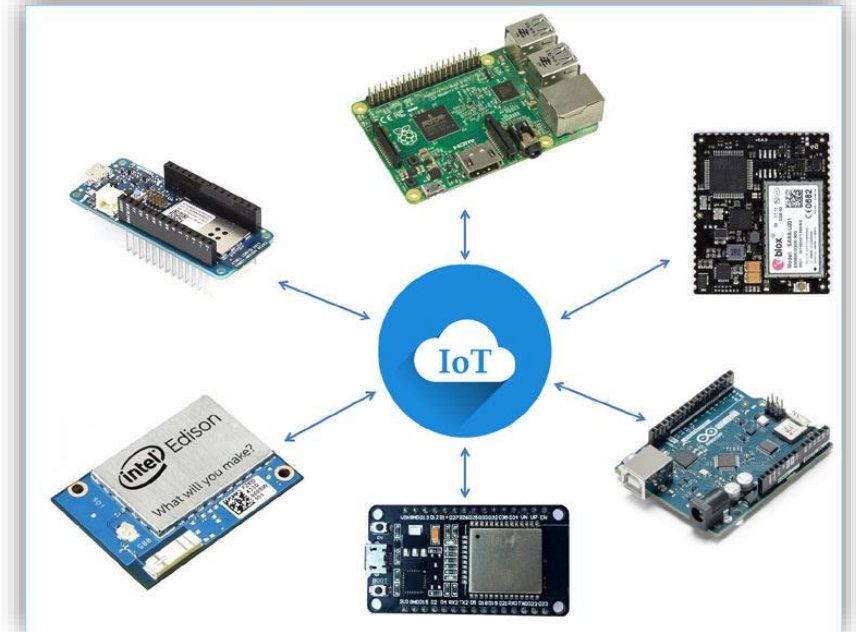
❑ Existing objects.

❑ Newly created objects.

https://www.nike.com/adapt

Intelligence / Sensors

❑ Microprocessors, mini computers.

❑ Sensors :

    ❑ Temperature.

    ❑ Pressure.

    ❑ Humidity.

    ❑ Acceleration.

    ❑ Laser.

    ❑ Health monitoring

sensors.

    ❑ …

Connectivity

❑ Key element of IoT.

❑ Different types of networks and technologies depending on application and needs.

❑ RFID, NFC, GSM (GPRS/3G/4G), Wifi, Bluetooth, LPWAN, nano satellite.

❑ Important considerations:

  ❑ Range, power consumption, data rate and cost.

Key characteristics of IoT networks

	Satellite *(Low Earth Orbit)*	Traditional cellular *(2G, 3G, 4G, 5G)*	LPWAN *(Lora, Sigfox)*	IoT Local Area Networks *(BLE, ZigBee)*	General Local Area Networks *(Bluetooth, wifi)*
Network area	Wide area			Local area	
Spectrum	Dedicated, managed QoS		Shared, best-effort QoS		
Power consomption			Low power		
Connectivity cost	High	Medium	Low	Low	Low
Module cost	High	2G → 5G lower → higher	Low	Low	Low
Typical Bandwidth	Low	2G → 5G lower → higher	Low	Low	High

Activity

❑ What do you think would be the most suitable network for the following IoT applications :

T-shirt connecté

Smart oil field

Suivi de flotte de véhicules

Compteur électrique connecté

Caméra de surveillance

Volets connectés

❑ Go to Socrative to start the quiz !

Data

❑ Collect data from devices.

❑ Processing data:
  ❑ Simple: temperature, pressure …
  ❑ Complex: identify objects in videos, behaviour analysis …

❑ User interface:
  ❑ Analyse processed information.
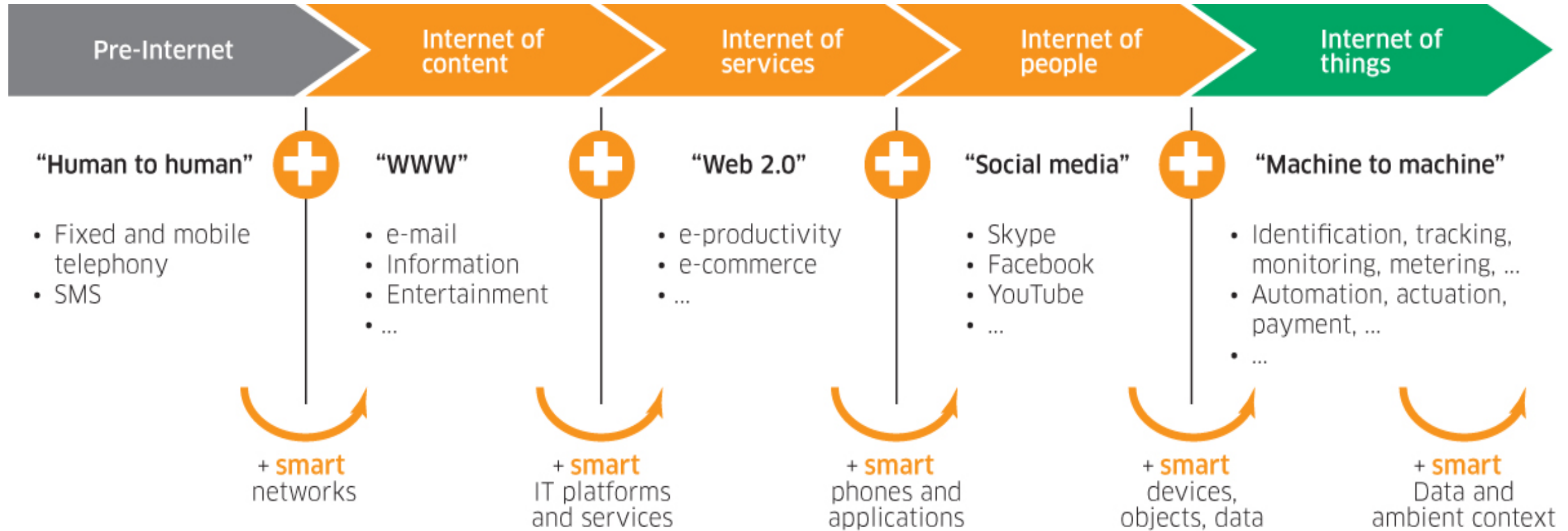 ❑ Synthesis, summary.
  ❑ Alerts.

Evolution of IoT

Image Source: Nokia Insight

IoT vs Traditional Internet

	Traditional Internet	IoT
Who creates content ?	People	Devices / Objects
What is the value ?	Answer questions	Trigger action and timely information
How is the content consumed ?	By request	By pushing information and triggering actions
How is the content combined ?	Direct links	Data combined for analysis and detect situations

Domains and applications

Domains and applications

Smart Cities

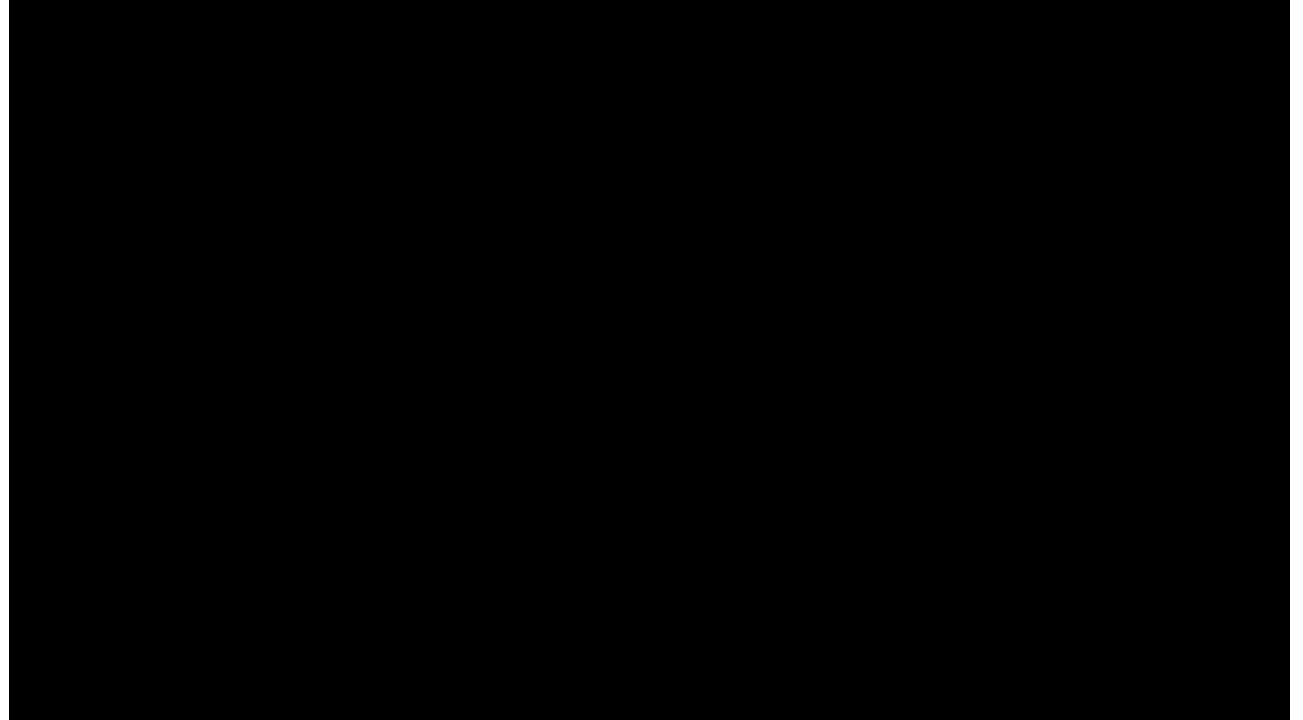Health

Agriculture

Smart Home

Transport

Smart Retail

Connected Cars

Industry

Energy

Smart Home

❑ Use connected objects to save time, energy and money.

❑ Smart washing machines, connected ovens, smart fridge, connected doors …

❑ How our homes will look like in the future ?

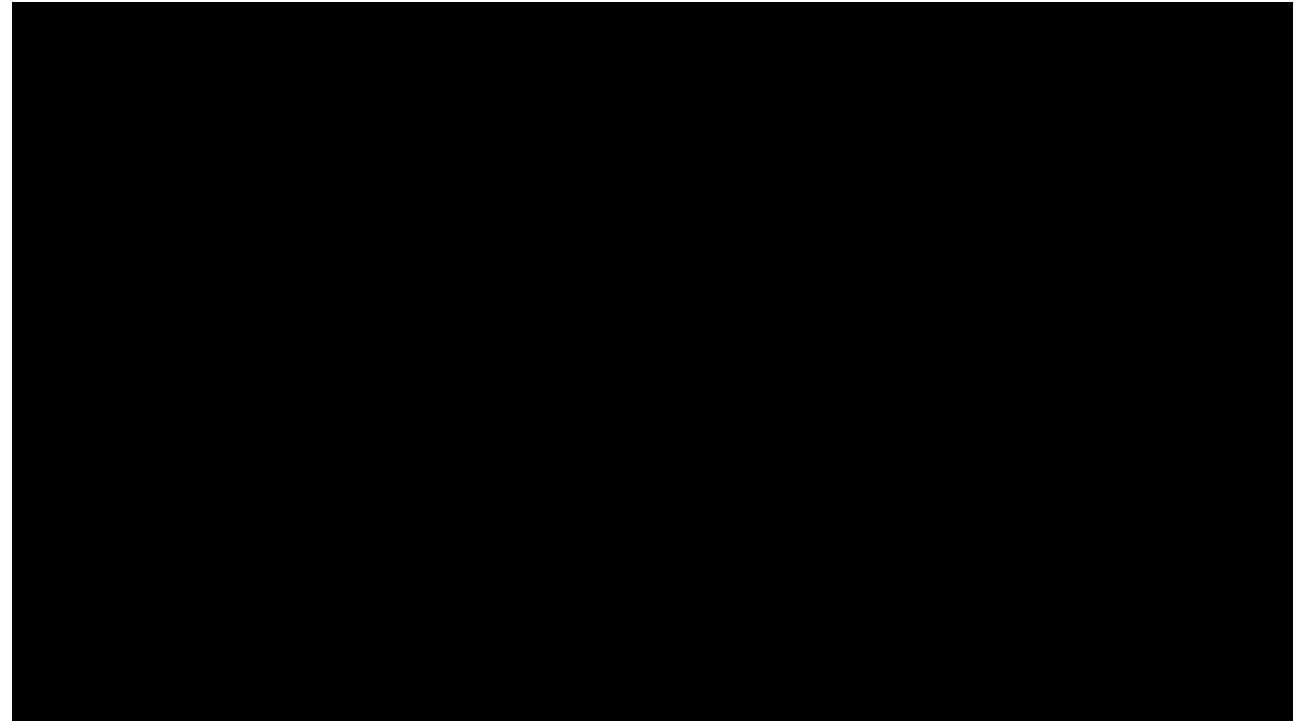Smart Home

https://www.youtube.com/watch?feature=oembed&v=NjYTzvAVozo

Smart Retail

❑ Retail stores open 24h 7/7.

❑ No checkout, you take your products and walk out directly.

❑ Already in service :

    ❑ Amazon Go

    ❑ Le 4 Casino, Paris
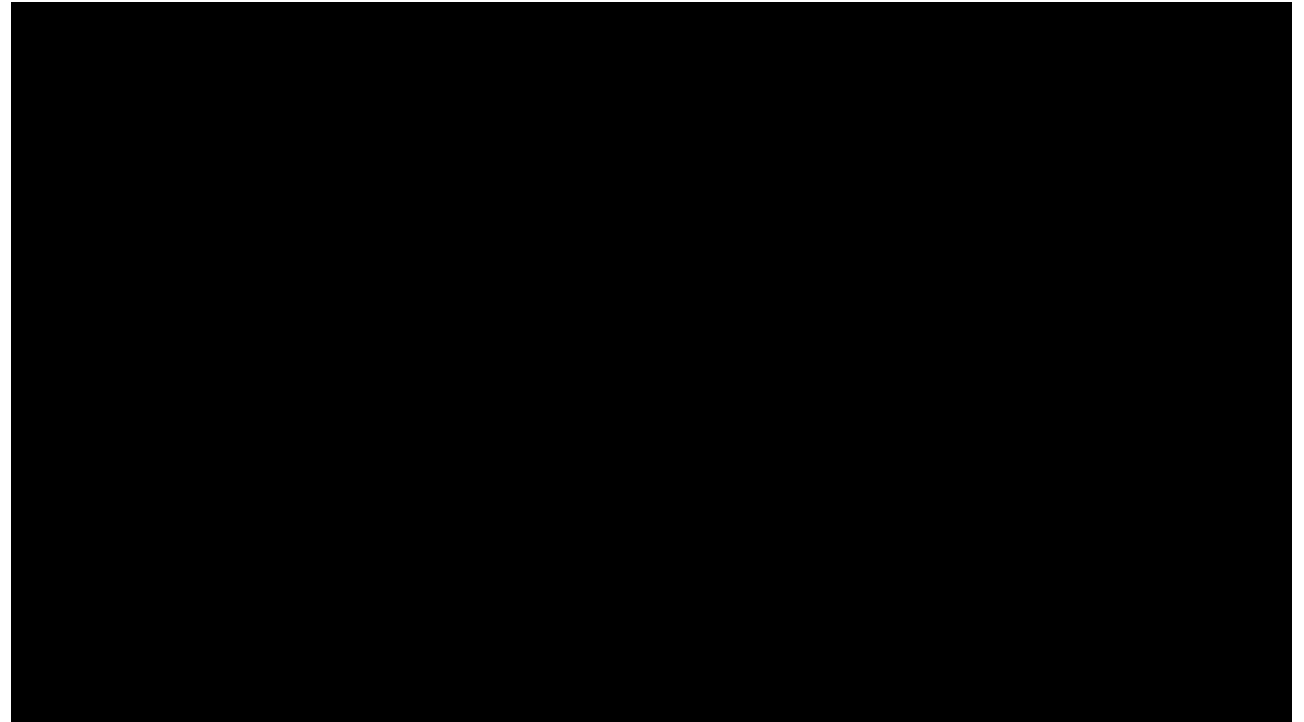

Amazon Go

https://www.youtube.com/watch?feature=oembed&v=NrmMk1Myrxc

Smart Cities

❑ Save time, preserve environment, save energy and money, enhance safety.

❑ Real world example : connected and smart street trash cans.

❑ Reduce collection rounds.

❑ Collect cans only and as soon as it is full.

Example of smart trash cans

https://www.youtube.com/watch?feature=oembed&v=gwDXldBLusc

Agriculture

❏ Use IoT and advanced technologies in farming and food production.

❏ Smart farming is one of the fastest growing fields in IoT.

❏ Increase food production, save water and ressources.

❏ Sensing for soil moisture and nutrients, controlling water usage for plant growth and determining custom fertilizer.

Smart agriculture using IoT – Victoria, Austrialia

https://www.youtube.com/watch?v=pOLAIVUs9S8

Health

❑ Empowering people to live healthier life by wearing connected devices.

❑ Personalized analysis of an individual's health using collected data.

❑ Connected devices in hospitals, faster intervention and continued monitoring.
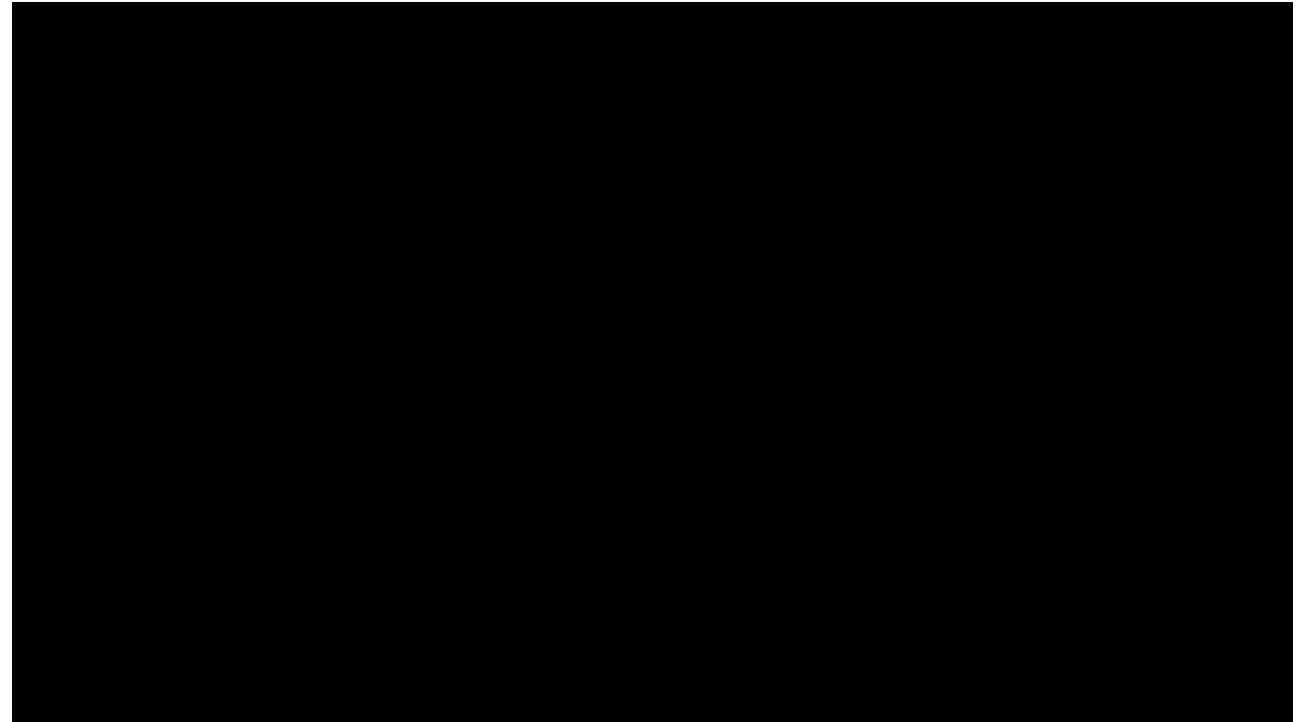
IoT in the healthcare domain

https://www.youtube.com/watch?feature=oembed&v=g8e7ZAg_DxU

Enabling technologies

Wireless Sensor Networks

❑ Distributed network of sensors used to monitor the environmental and physical conditions.

❑ WSN consists of a number of end-nodes and routers and a coordinator.

❑ End Nodes have several sensors attached to them, nodes can also act as routers.

❑ The coordinator collects the data from all the nodes. Coordinator also act as a gateway that connects the WSN to the internet.
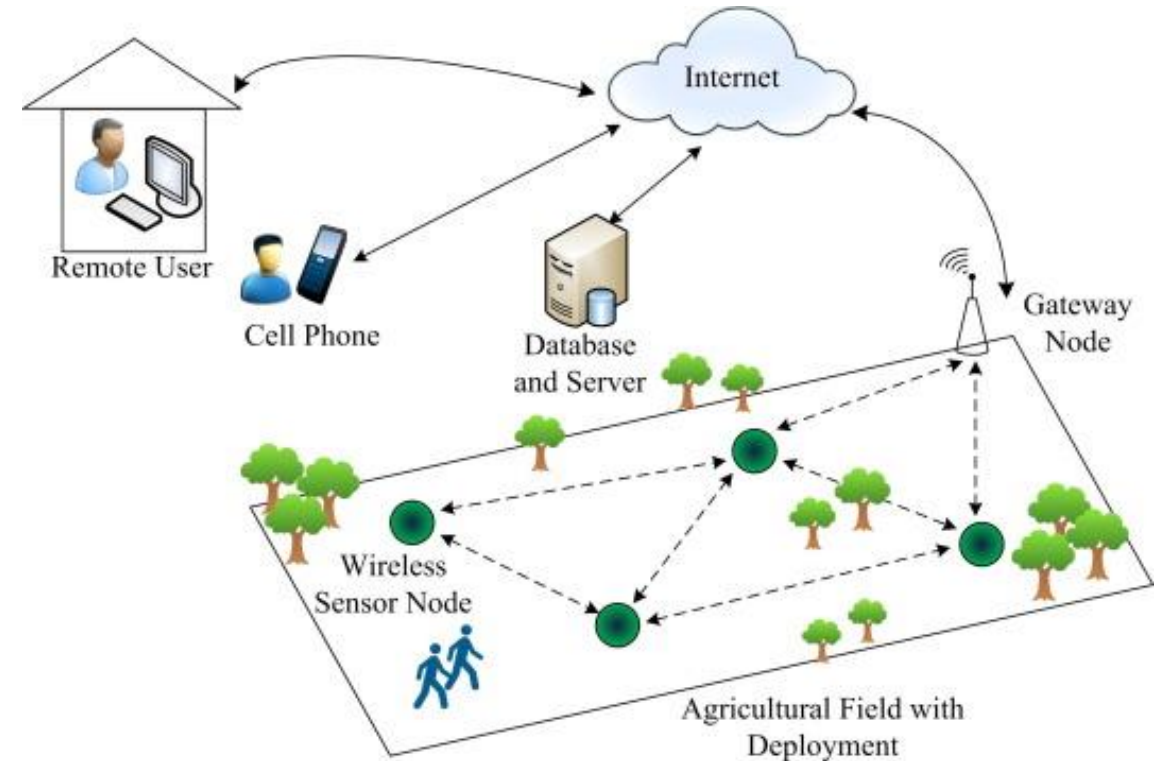
Big Data Analytics

❑ More connected objects → more data is collected.

❑ Petabyte = 1000 Terabyte = 1000000 Gigabyte.

❑ Large data sets that need to be collected, stored, queried, analysed.

❑ Insight, analysis, knowledge → Business decisions.

❑ The three V's: Volume (amount), Velocity (collection speed), Variety (types).

Cloud Computing

❑ "Cloud Computing" refers to being able to access computing resources via the Internet rather than traditional systems.

❑ Cloud computing features.

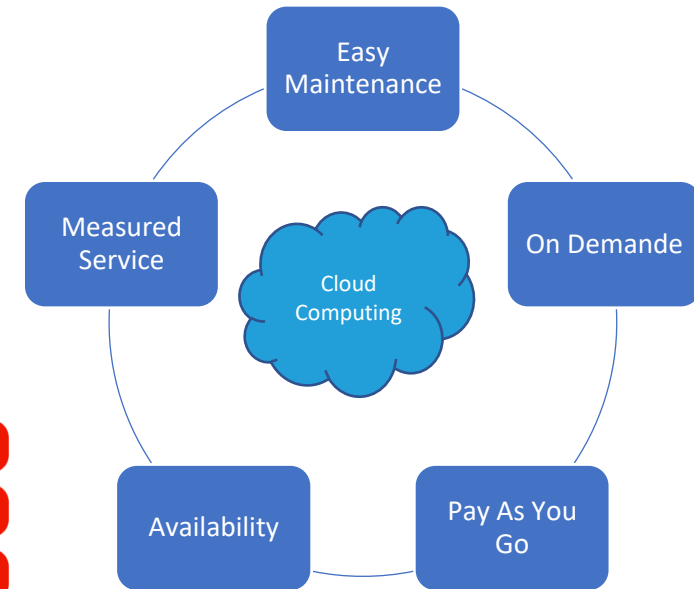❑ Service models:

   ❑ Infrastructure as a Service (IaaS).

   ❑ Platform as a Service (PaaS) .

   ❑ Software as a Service (SaaS).

On-site	IaaS	PaaS	SaaS
Applications	Applications	Applications	Applications
Data	Data	Data	Data
Runtime	Runtime	Runtime	Runtime
Middleware	Middleware	Middleware	Middleware
O/S	O/S	O/S	O/S
Virtualization	Virtualization	Virtualization	Virtualization
Servers	Servers	Servers	Servers
Storage	Storage	Storage	Storage
Networking	Networking	Networking	Networking

■ You manage
■ Service provider manages

https://www.redhat.com/fr/

Easy Maintenance

Measured Service

Cloud Computing

On Demande

Availability

Pay As You Go

Communication protocols

❑ Backbone of IoT systems.

❑ Allows devices to exchange data over networks.

❑ Define data exchange formats:

  ❑ Data encoding.

  ❑ Addressing schemes.

  ❑ Routing of packets from source to destination.

❑ Other functions: Sequence control, retransmission of lost packets.

Advantages and challenges

Advantages of IoT

❑ Productivity improvement:

Monitoring, control and optimise operations.

❑ Predictive analysis:

Big data, recurrent patterns, behaviour, improve existing services and processes.

❑ Rapid response:

Data in real time, remotely control objects and intervention.

❑ Reduction of risks and human errors.

Challenges of IoT

❑ Security: Authentication, hacking …

❑ Privacy: Personal data, GPS tracking, Health data …

❑ Flexibility: Integration with other systems, network challenges …

❑ Complexity: Design, deployment (including cost), maintenance, Autonomy.

Case studies

Case studies

❑ We will consider real world scenarios in 3 domains.

❑ Health: Smart continuous glucose monitoring (CGM) and insulin pens.

❑ Transport: Connected and smart road signs (WP Signalisation).

❑ Environment: LoRhino project (HEIG-VD/IICT).

Smart continuous glucose monitoring (CGM)

❑ Requires continual monitoring and administration of treatment.

❑ CGM is a device that helps diabetics to continuously monitor their blood glucose levels by taking readings at regular intervals.

❑ Smart CGMs like Eversense and Freestyle Libre send data on blood glucose levels to an app on smartphone.

❑ Allows for remote monitoring by caregivers (parents of children, relative of elderly patients, medical staff).

Smart continuous glucose monitoring (CGM)

https://www.ascensia-diabetes.ch/fr-CH/eversense-e3/

Connected and smart road signs

❑ Autonomous road sign equipped with an electronic module.

❑ Real-time alert in case of
    ❑ Falling.
    ❑ Moving.
    ❑ Low battery level.

❑ Road sings monitored and geolocated in real time.

❑ Periodic feedback of information.
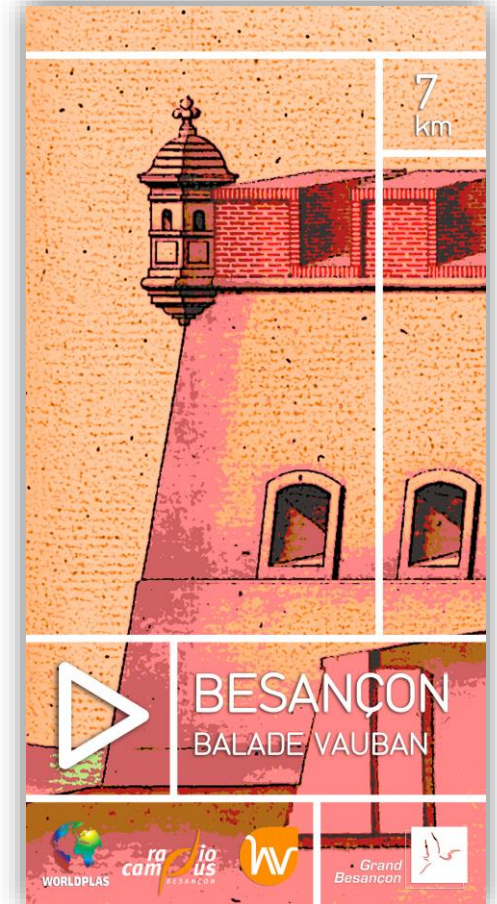
❑ Rechargeable battery.

Connected and smart road signs

# Connected and smart road signs

VAUBAN FORTIFICATIONS

Connected and smart road signs

LoRhino

❑ LoRhino = LoRa + Rhinoceros.

❑ UniNE + HEIG-VD (IICT).

❑ Goal: better understand them to better protect them.

Microcontrolleur LoRA (le cerveau du tracker)
Pile 3.6V lithium
Antenne LoRa
Antenne GPS/GNSS

❑ Rhinos are equipped with trackers
  ❑ GPS + Lora connectivity.
  ❑ Autonomy: 18 months.
  ❑ Glued to their rear horn.
  ❑ Understand how they move during the day as well as during different seasons.

❑ There are 7 antennas (Gateways) installed which cover the 300km2 of the reserve.
  ❑ Solar powered.
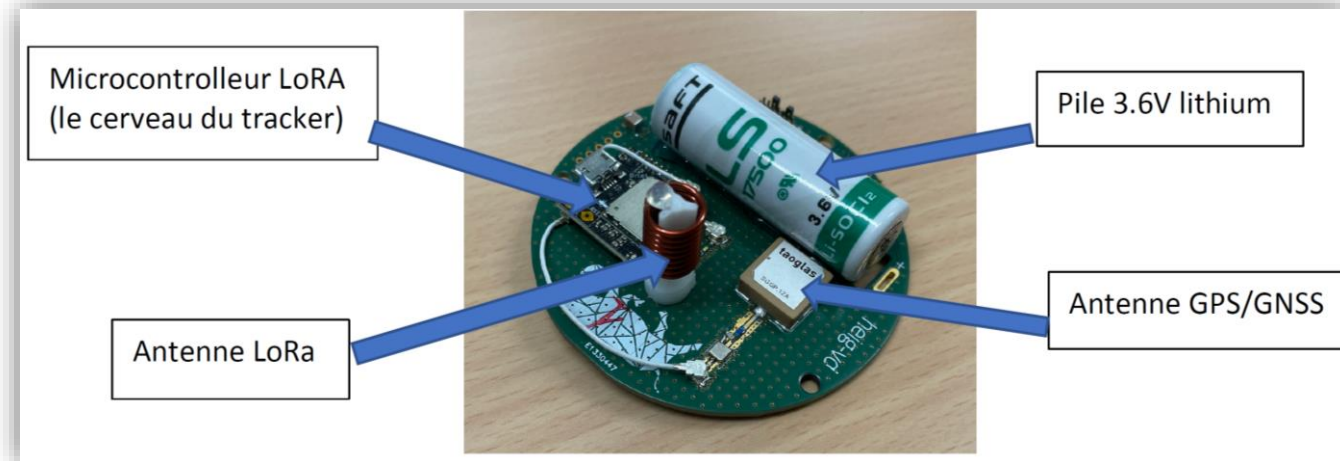
LoRhino

LoRhino

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