



IOT TRAINING SESSION #3 | ISEP | © 2021-24 TG

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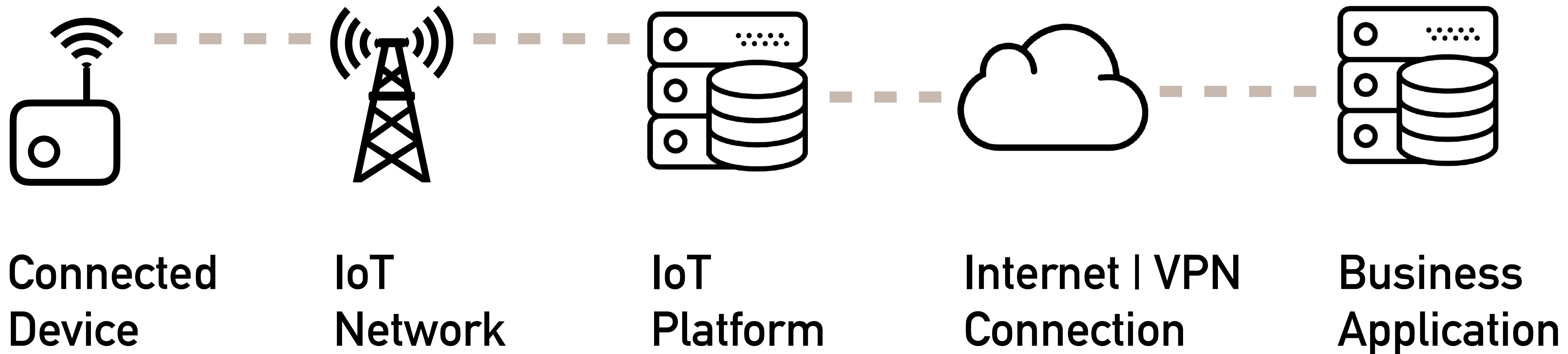
# INTERNET OF THINGS



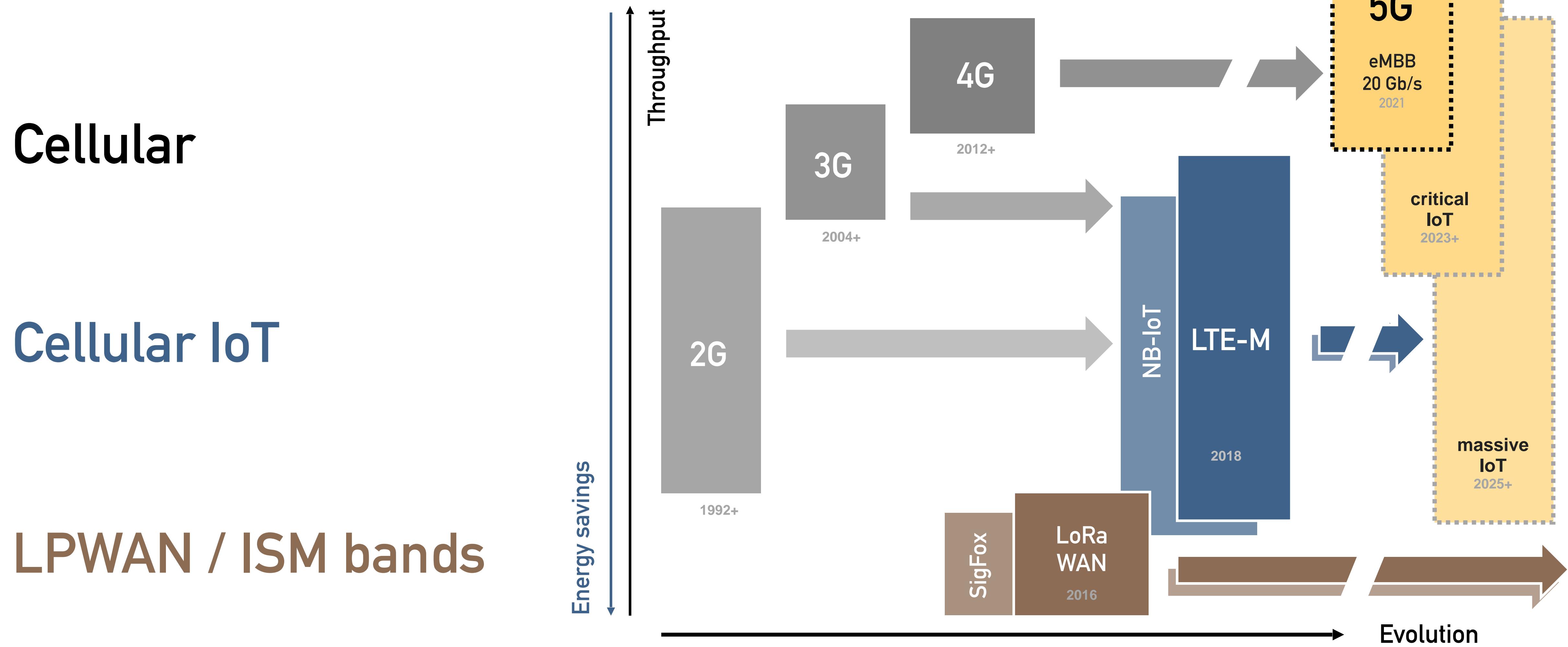
# PREVIOUSLY

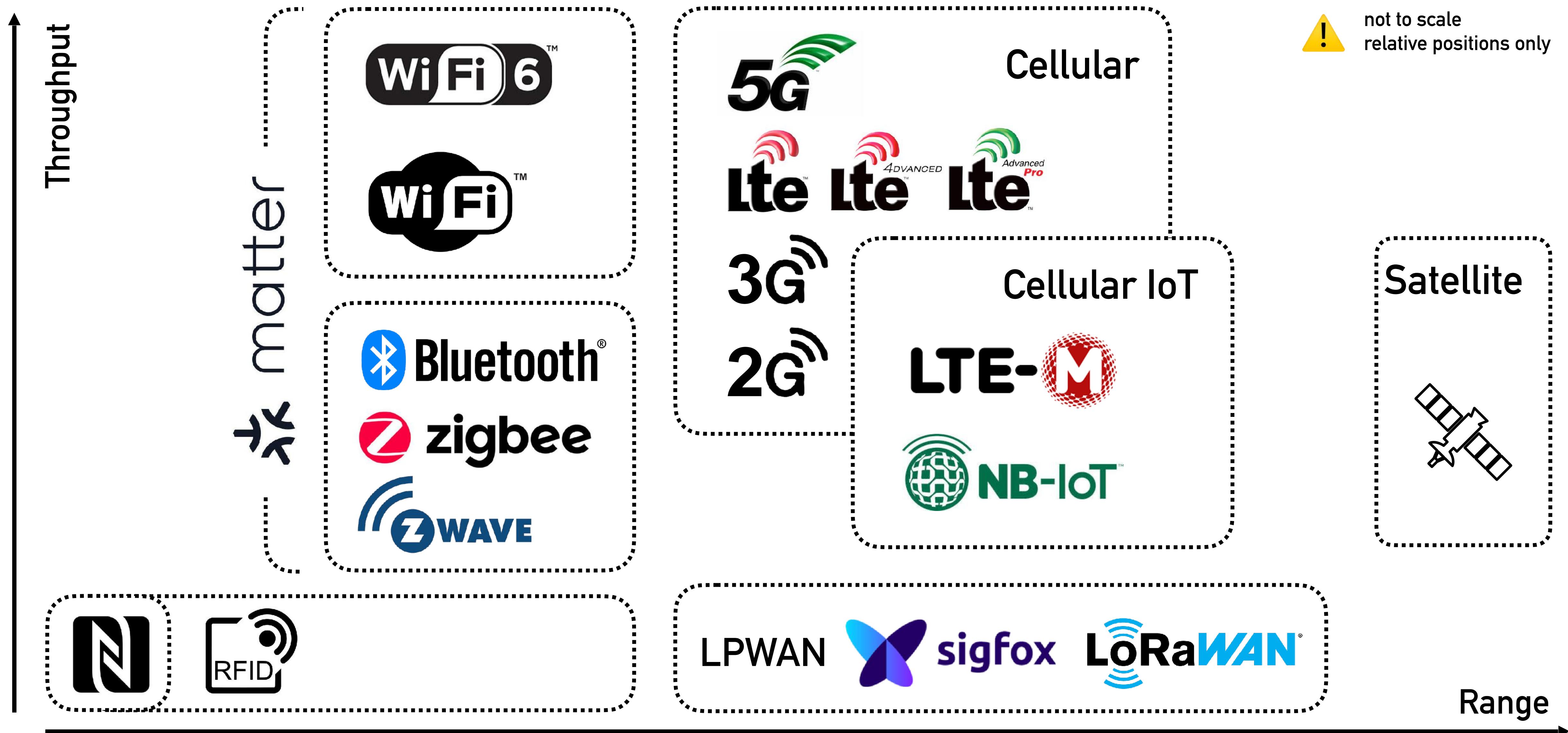
the last recap :-)

# IOT VALUE CHAIN

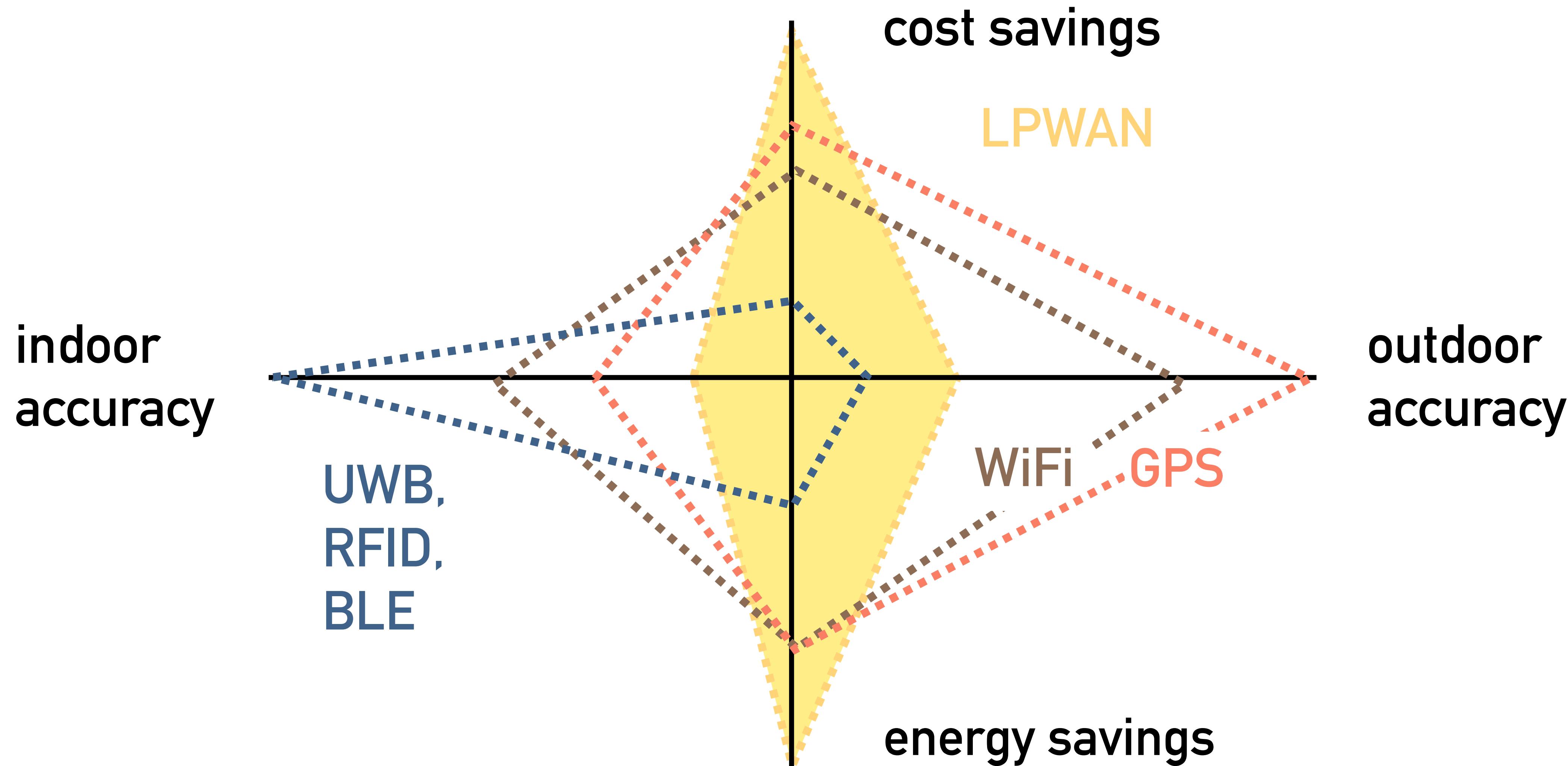


# MOBILE STANDARDS: BIG PICTURE

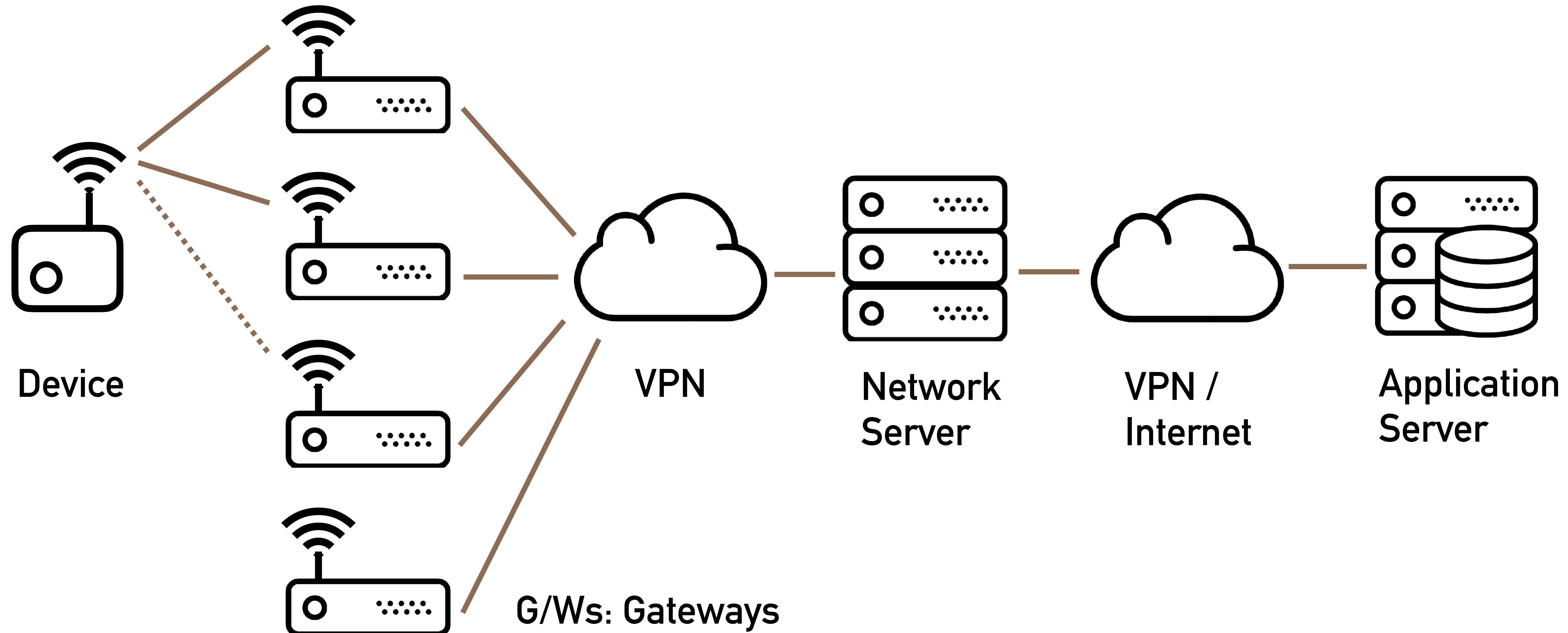




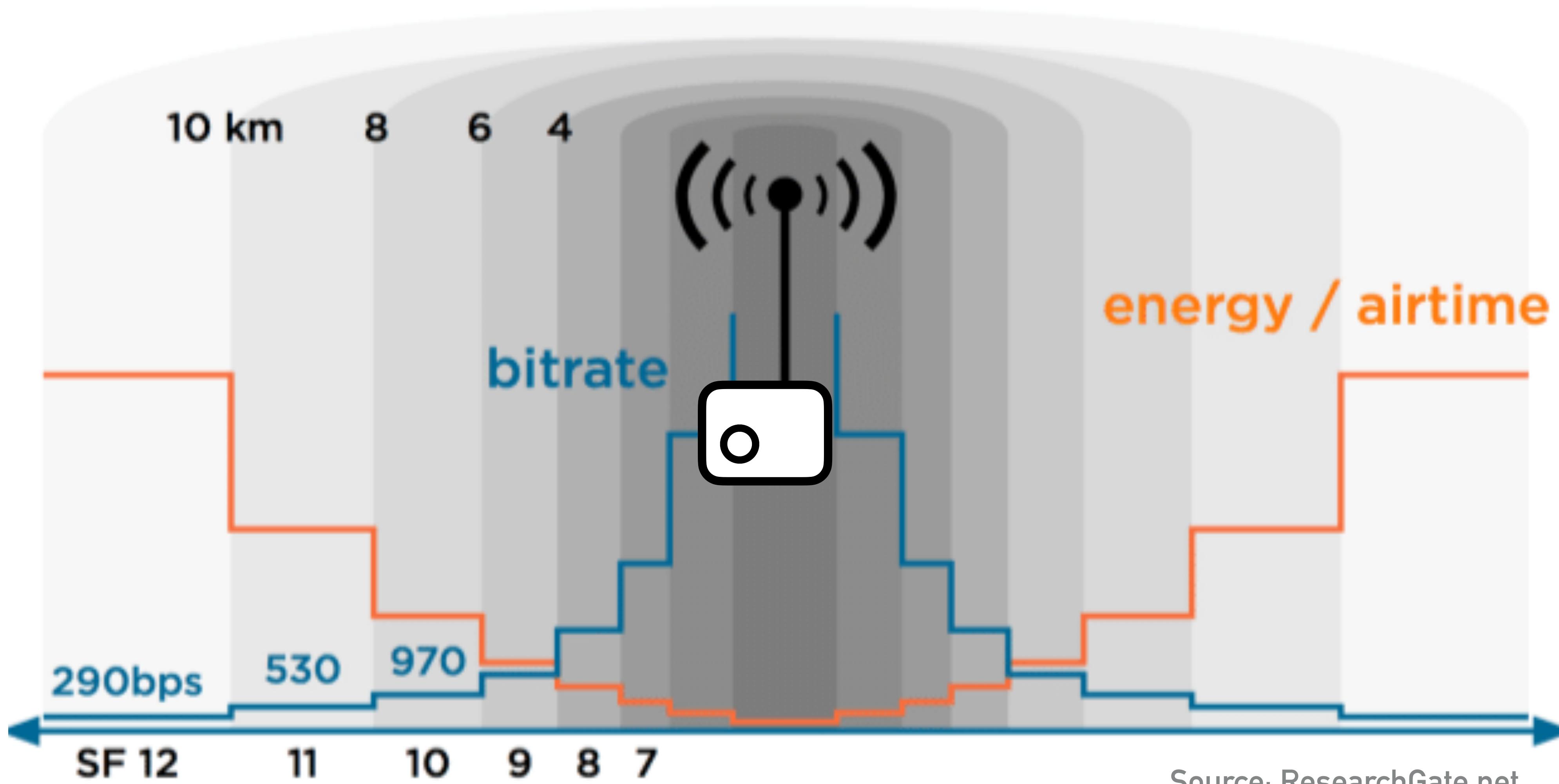
# ASSET TRACKING: TECHNOLOGIES



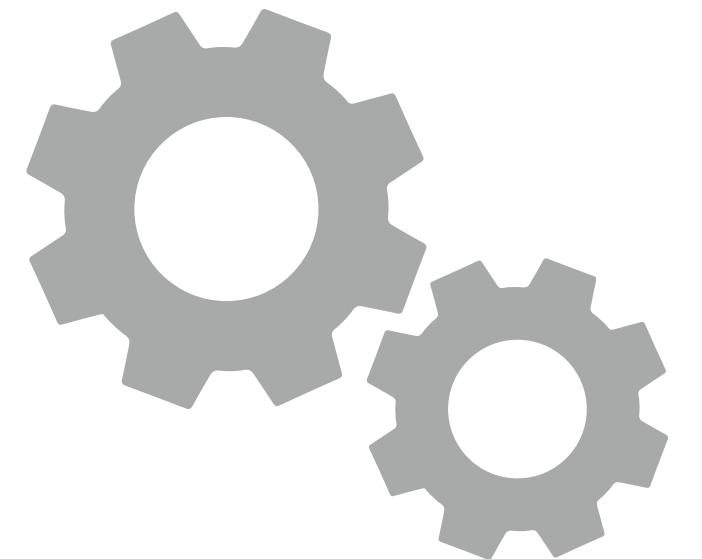
# LORAWAN ARCHITECTURE



# LORAWAN SF: SPREADING FACTOR



# ADR: ADAPTATIVE DATA RATE



Auto adaptative trade-off between QoS and Autonomy

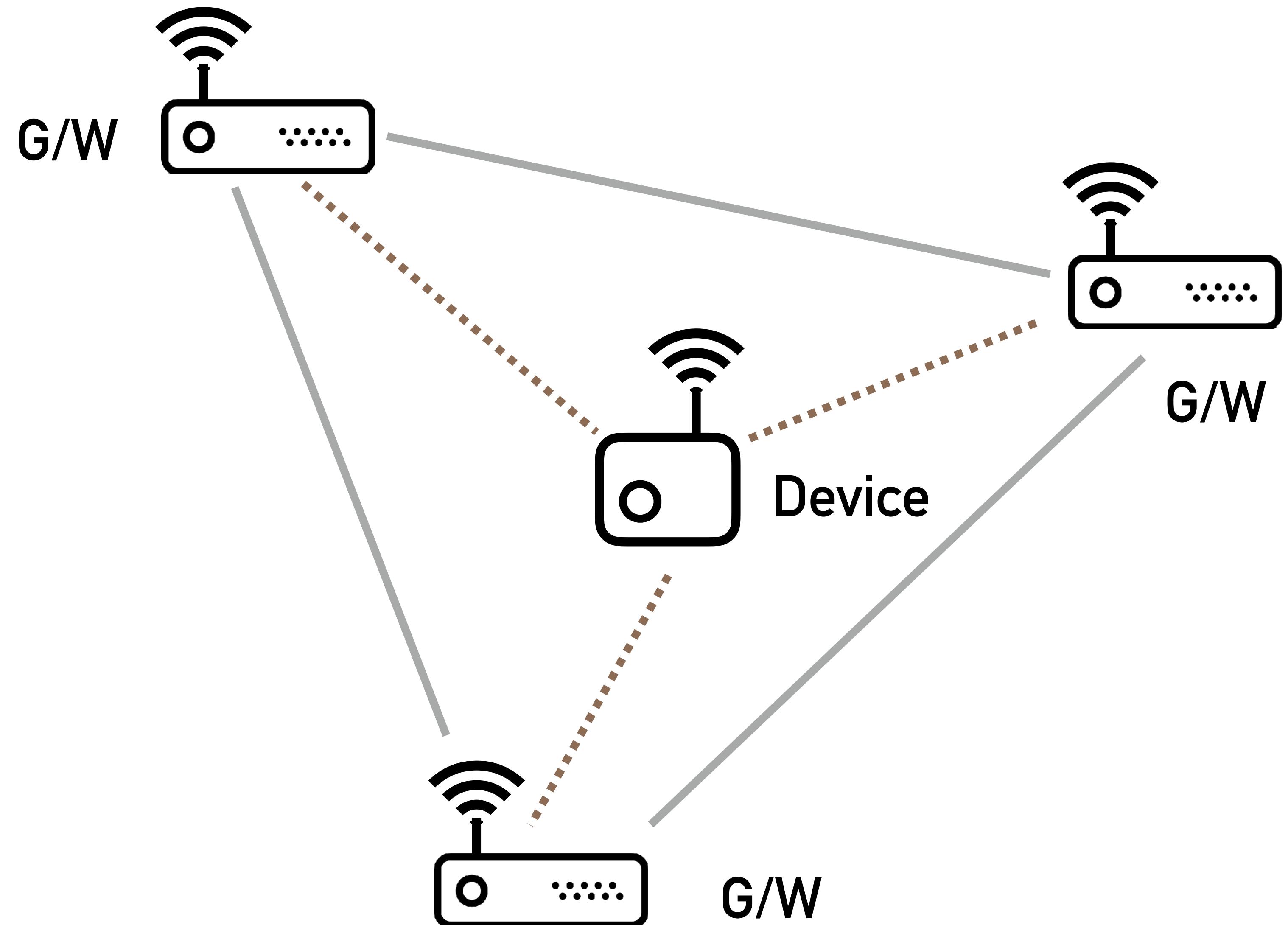
$$\left[ \begin{array}{l} \text{Energy} \\ \text{Repetitions} \\ \text{Spreading Factor} \end{array} \right] = f \left[ \begin{array}{l} \text{Settings} \\ \text{Radio conditions} \end{array} \right]$$

# GEOLOCATION

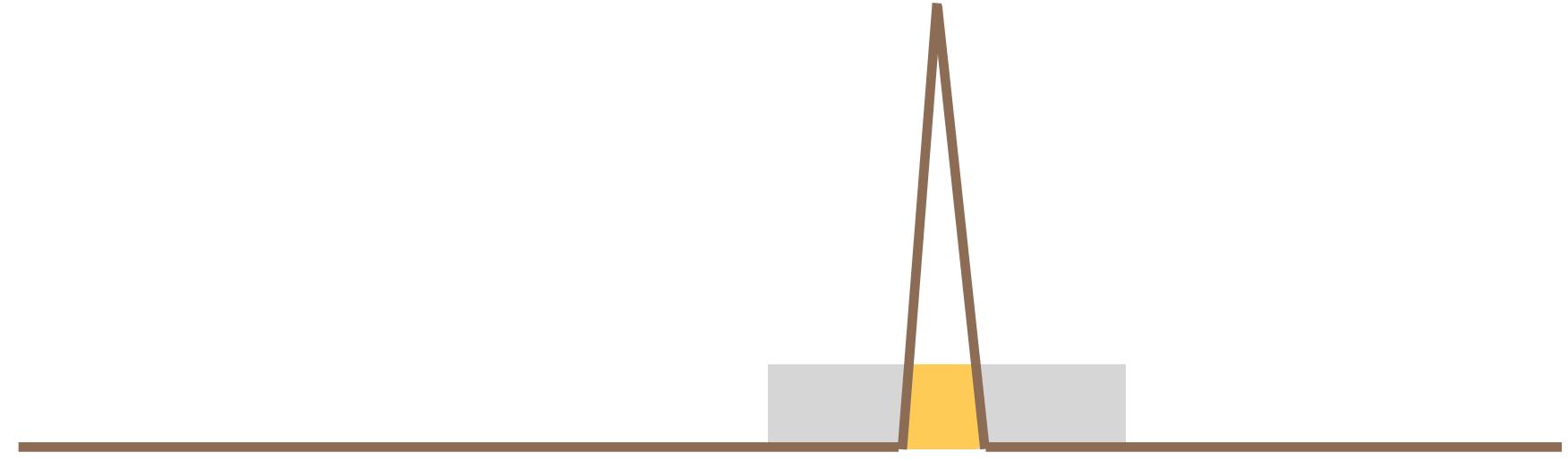
Network based  
macro geolocation

< 10 km accuracy

RSSI vs. TDOA



# SIGFOX



**UNB:** Ultra Narrow Band

12 Bytes / message at 100 b/s

Up to 4 ACKs / day

No end-to-end encryption

Public & proprietary network

# LORAWAN



**Spread Spectrum** > motion, geoloc

More than 50 Bytes / message

Bidirectional

Secure by design (AES128)

Private & public networks / Alliance

# LTE-M ESSENTIALS



LTE evolution for M2M / IoT

Cellular IoT: Cat-M1 at 800 MHz

Lower energy consumption

Mobility: handover

Roaming between operators

Standardized and 5G ready



# NB-IOT ESSENTIALS



Deep-indoor coverage:  
key NB-IoT differentiator

Advanced energy savings

Up to **20+dB** for underground  
and enclosed spaces

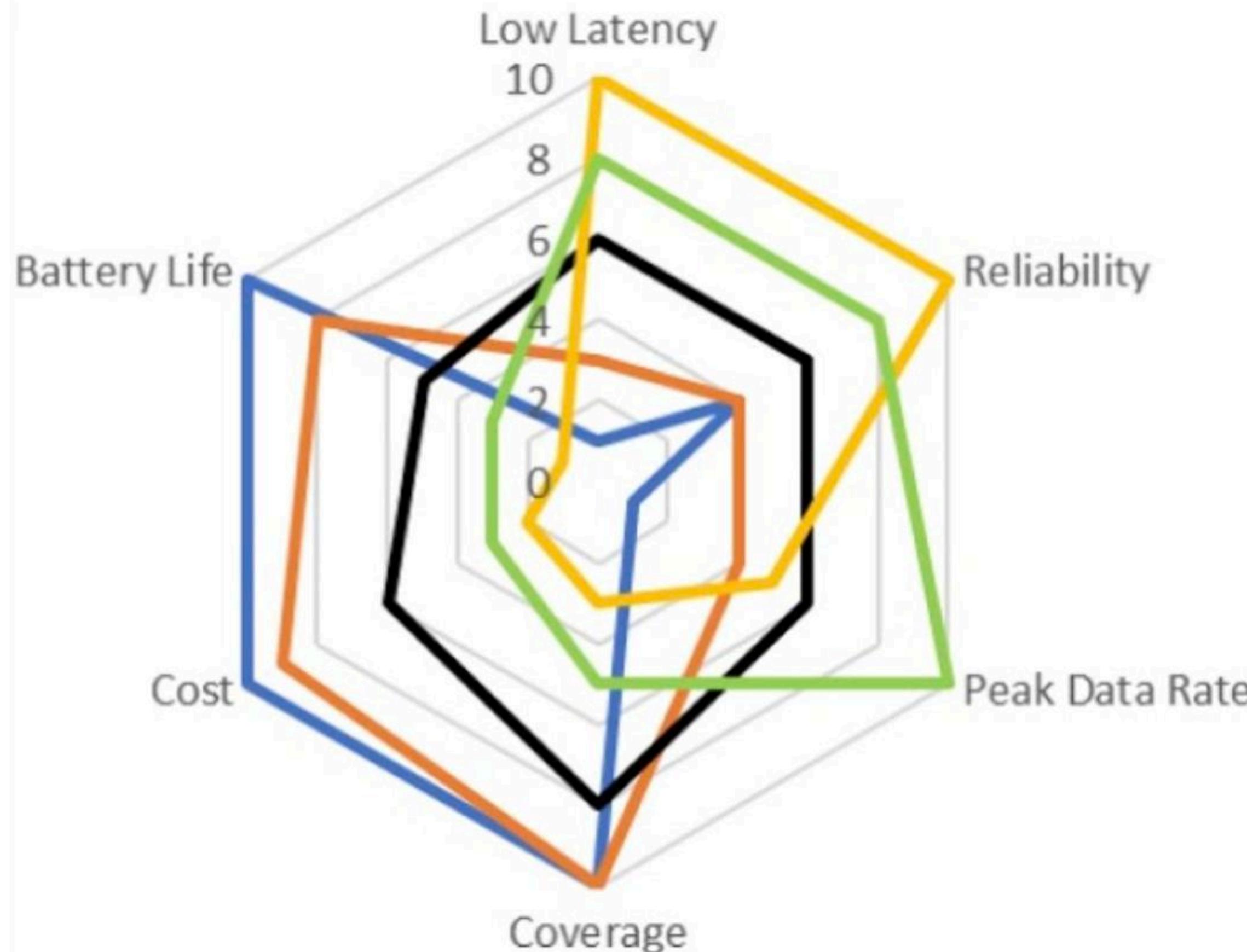
DSSS modulation technology  
vs. LTE-M spread technology



# 5G ESSENTIALS



NB-IoT   eMTC   NR-LITE   URLLC   eMBB



**eMBB** - enhanced Mobile Broadband

**uRLLC** - ultra Reliable Low Latency Communications  
critical IoT

**mMTC** - massive Machine Type Communications  
massive IoT

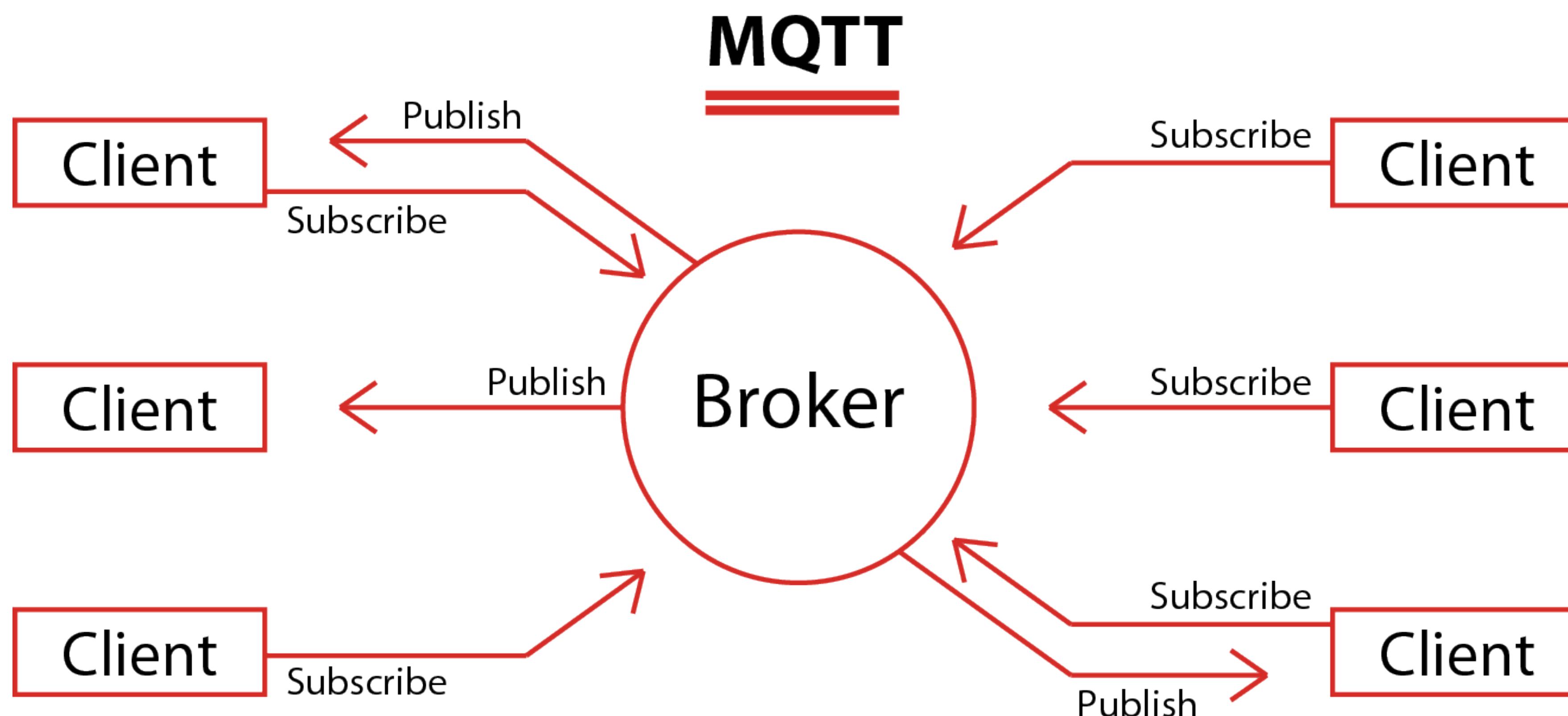
**RedCap** - aka NR Lite - Reduced Capacity



# MQTT

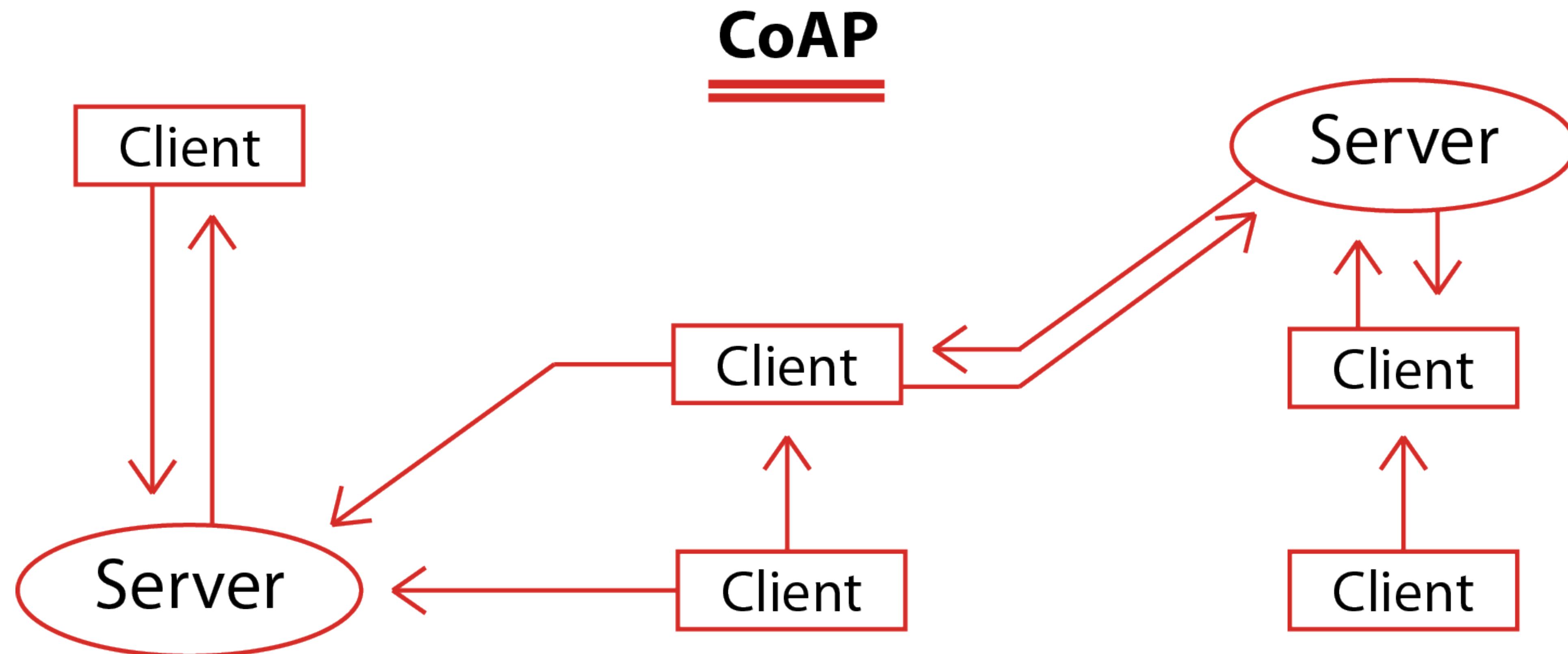
Message Queue Telemetry Transport: publish-subscribe protocol that facilitates one-to-many communication mediated by brokers.

Clients can publish messages to a broker and/or subscribe to a broker to receive certain messages. Messages are organized by topics, which essentially are “labels” that act as a system for dispatching messages to subscribers.



# COAP

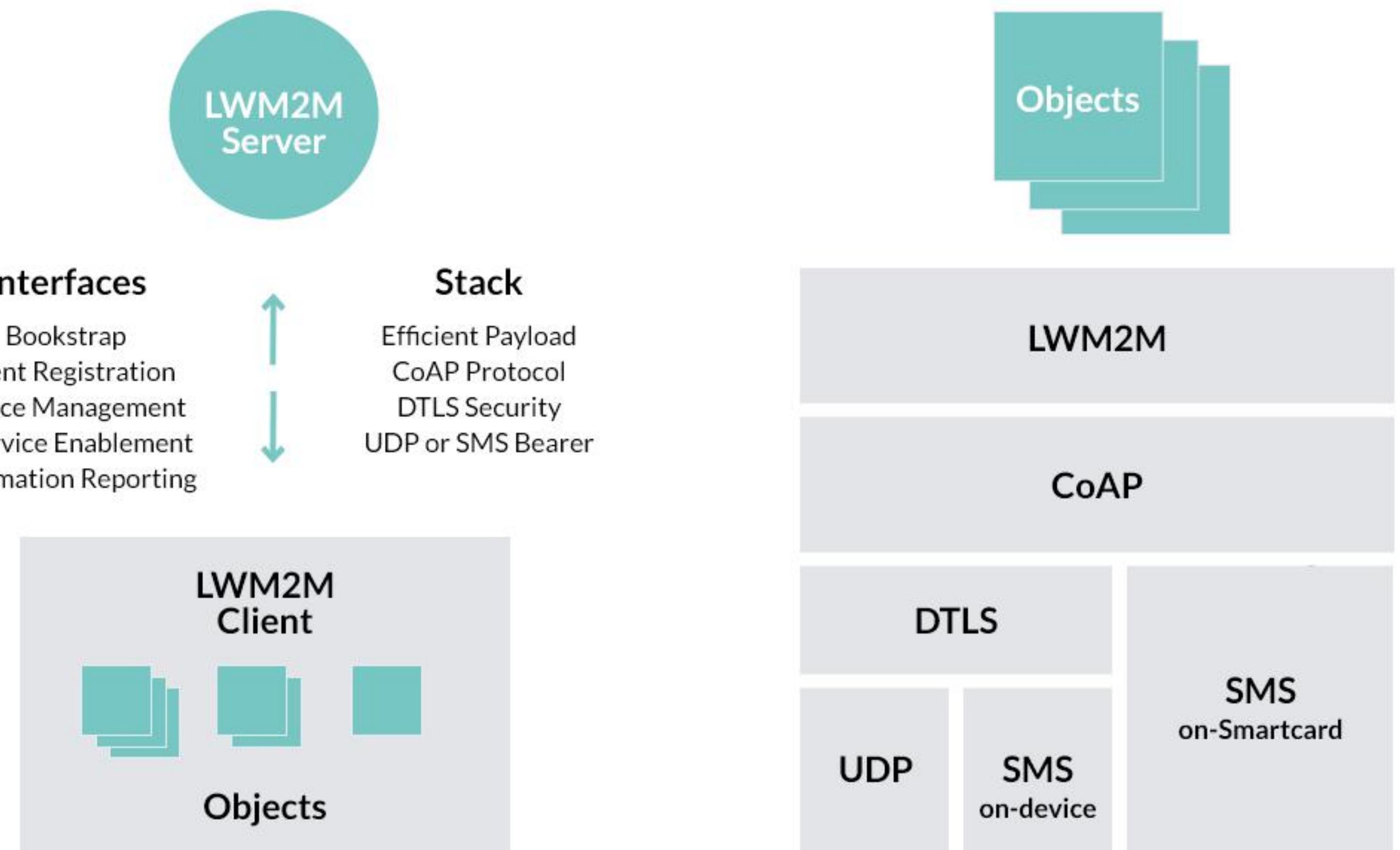
Constrained Application Protocol: client-server protocol not yet standardized.  
A client node can command another node by sending a CoAP packet.  
The CoAP server will interpret it, extract the payload, and decide what to do depending on its logic and acknowledge it or not.



# LWM2M



Application layer communication protocol  
for IoT device management  
an open standard from the  
Open Mobile Alliance (OMA)





# AGENDA

Session 3 of 3

# AGENDA

IoT chips, sensors & actuators

IoT data & platforms

IoT security and AI

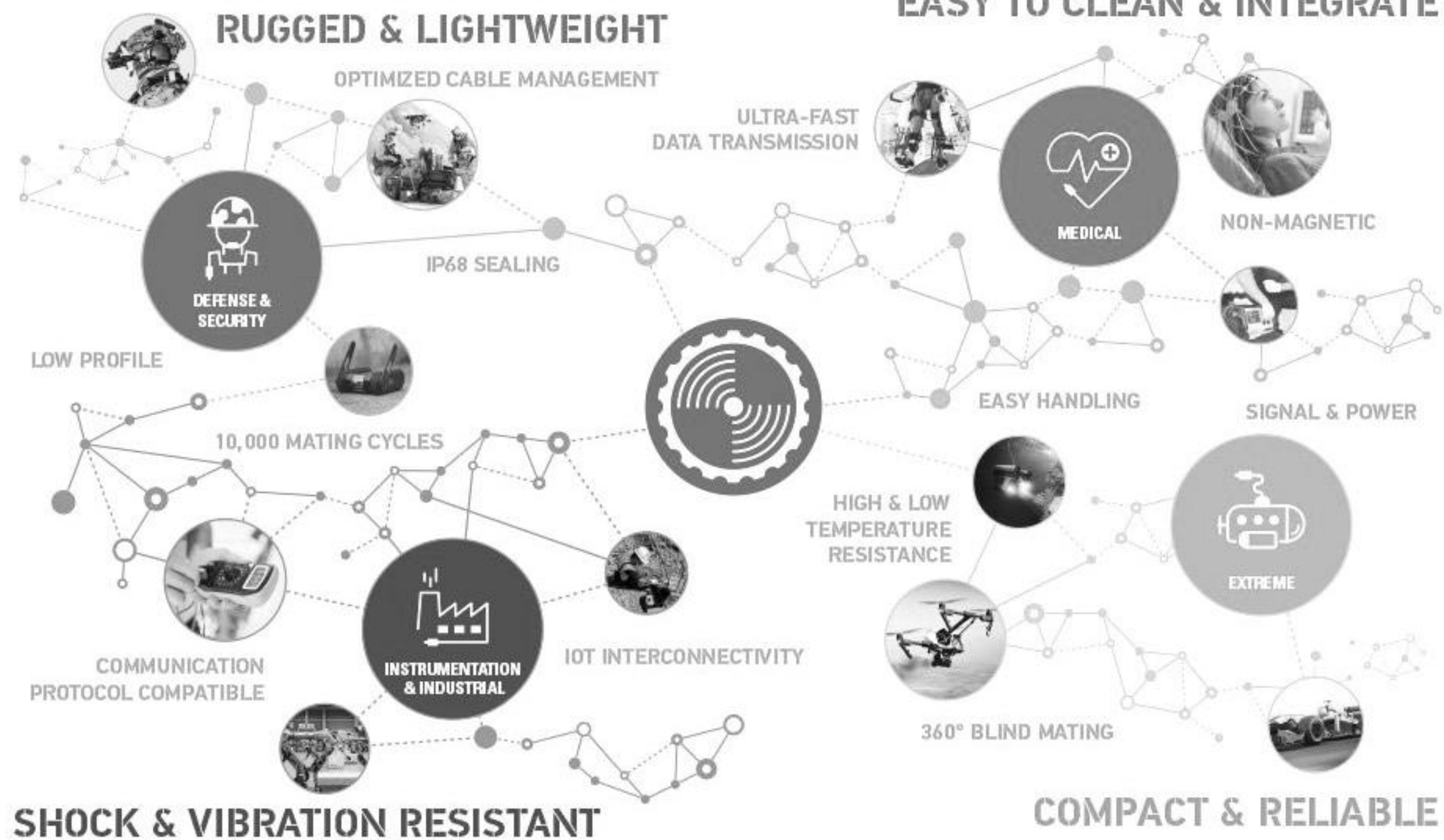
Use cases & workshop



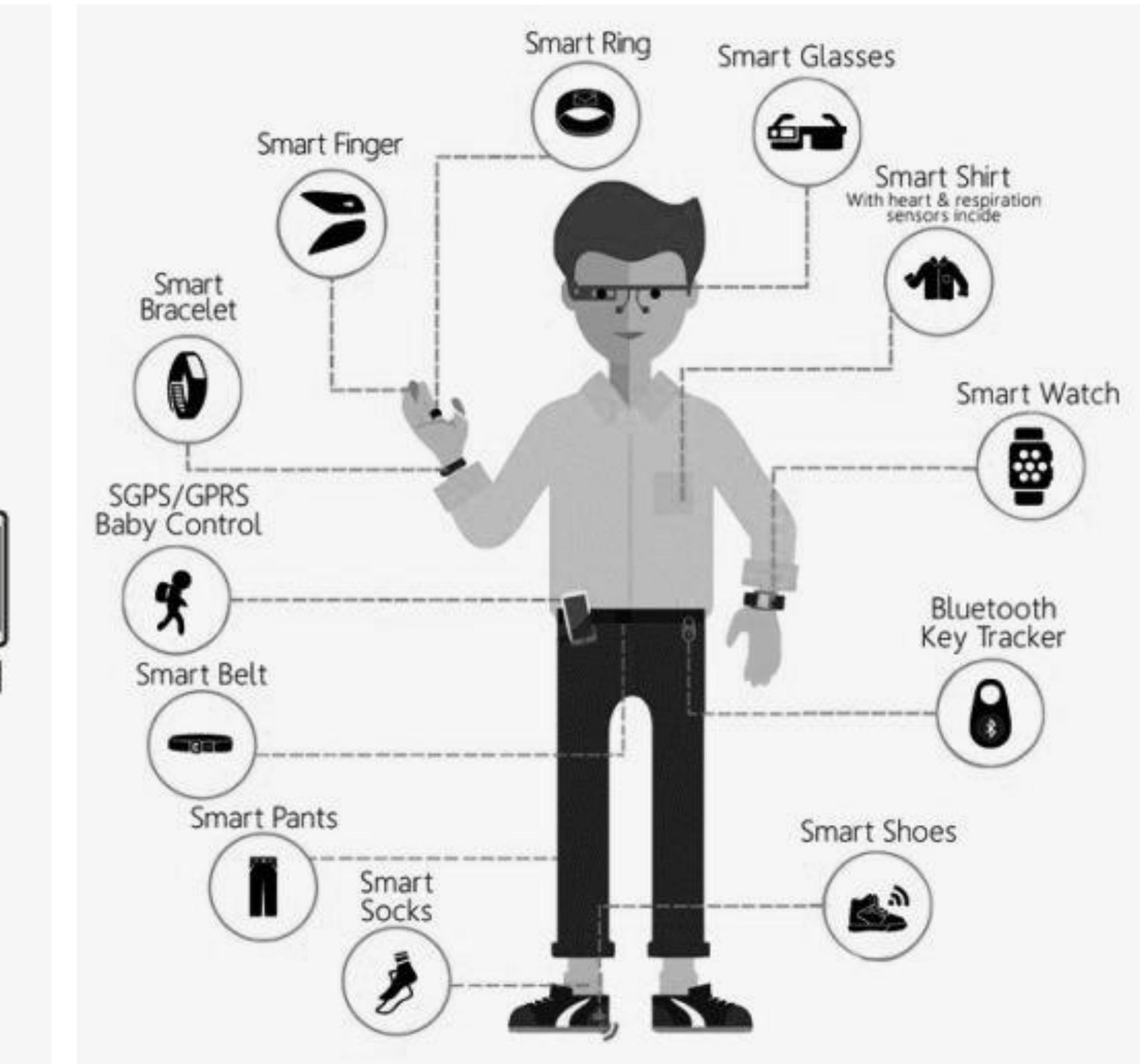
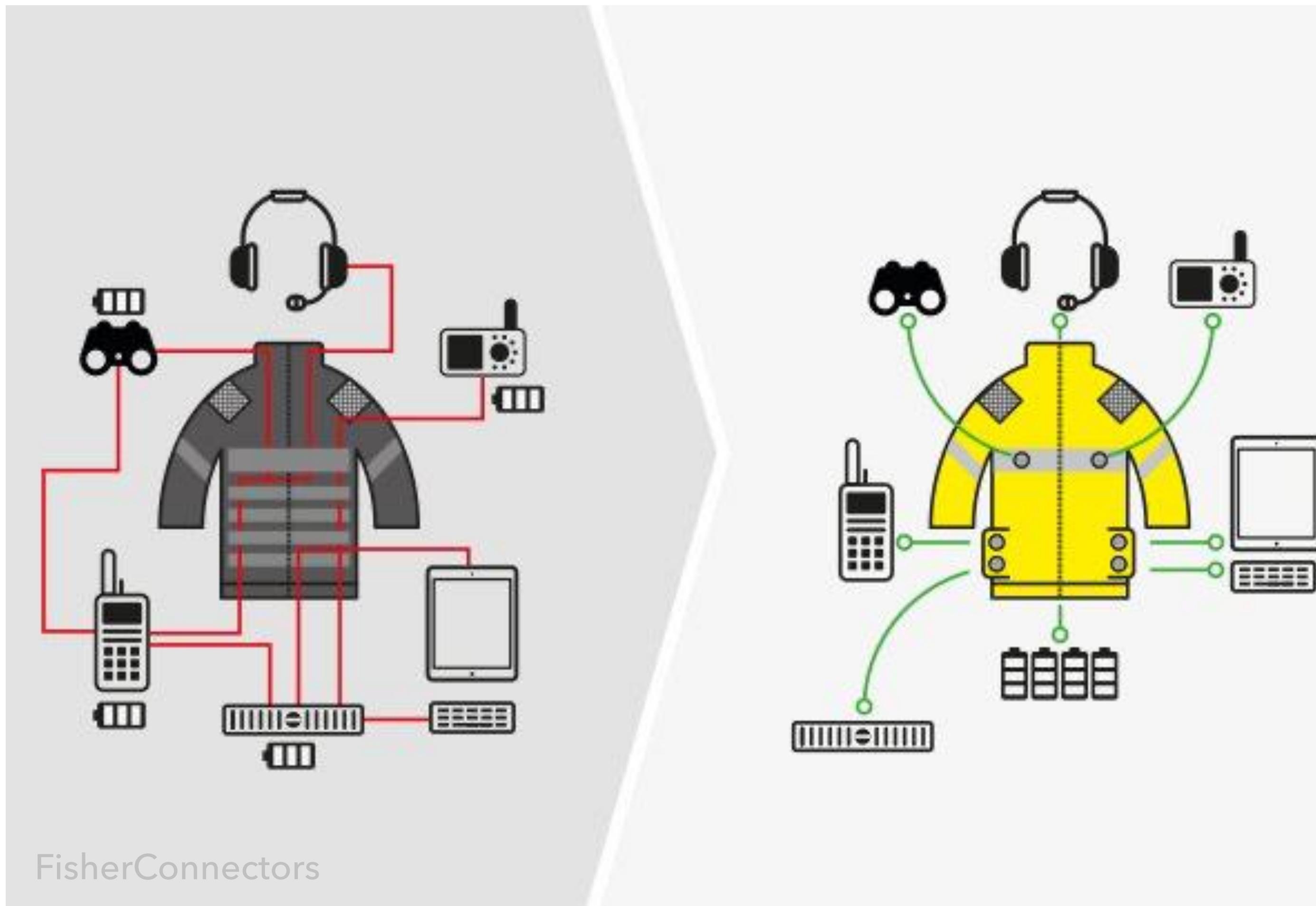
# WEARABLE DEVICES

smart & small

# SEGMENTS



# SMART-EVERYTHING



# IIOT WEARABLES



# IIOT DIAG

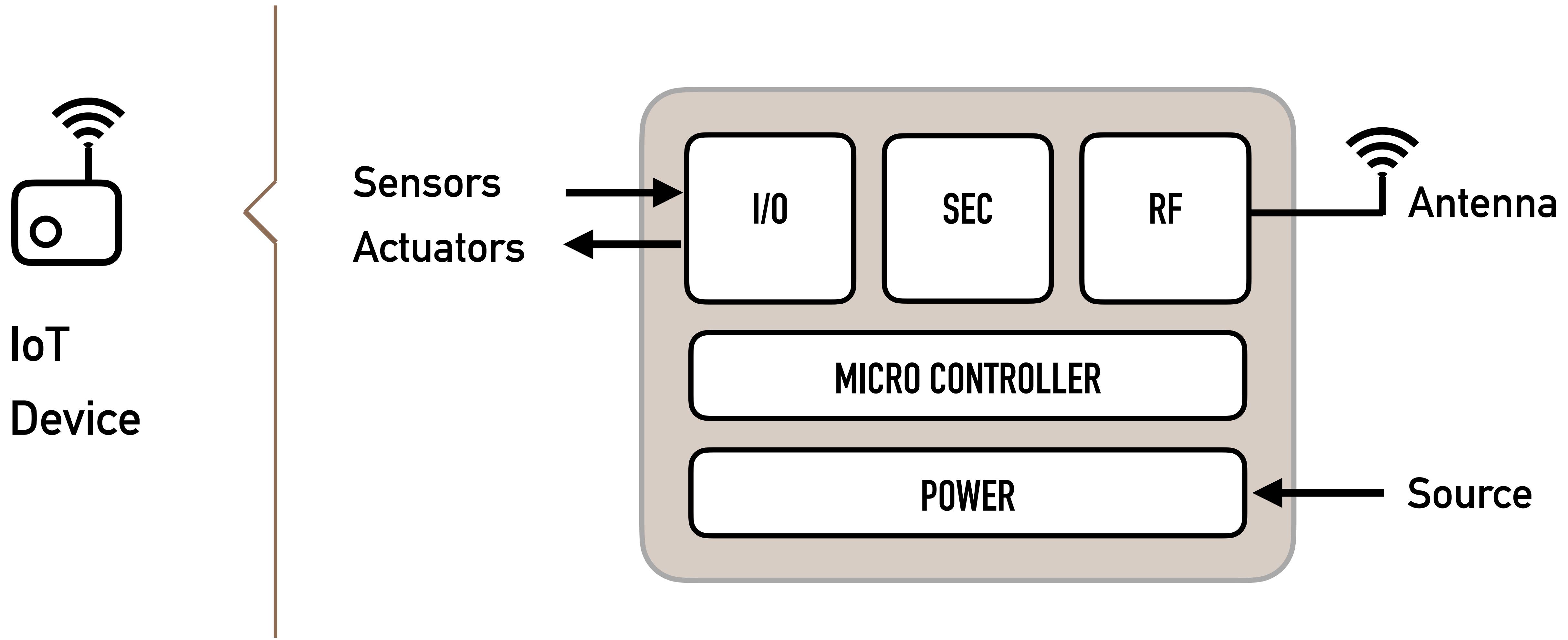




# EMBEDDED DEVICES

Hardware is hard

# IOT: ANATOMY OF EMBEDDED H/W



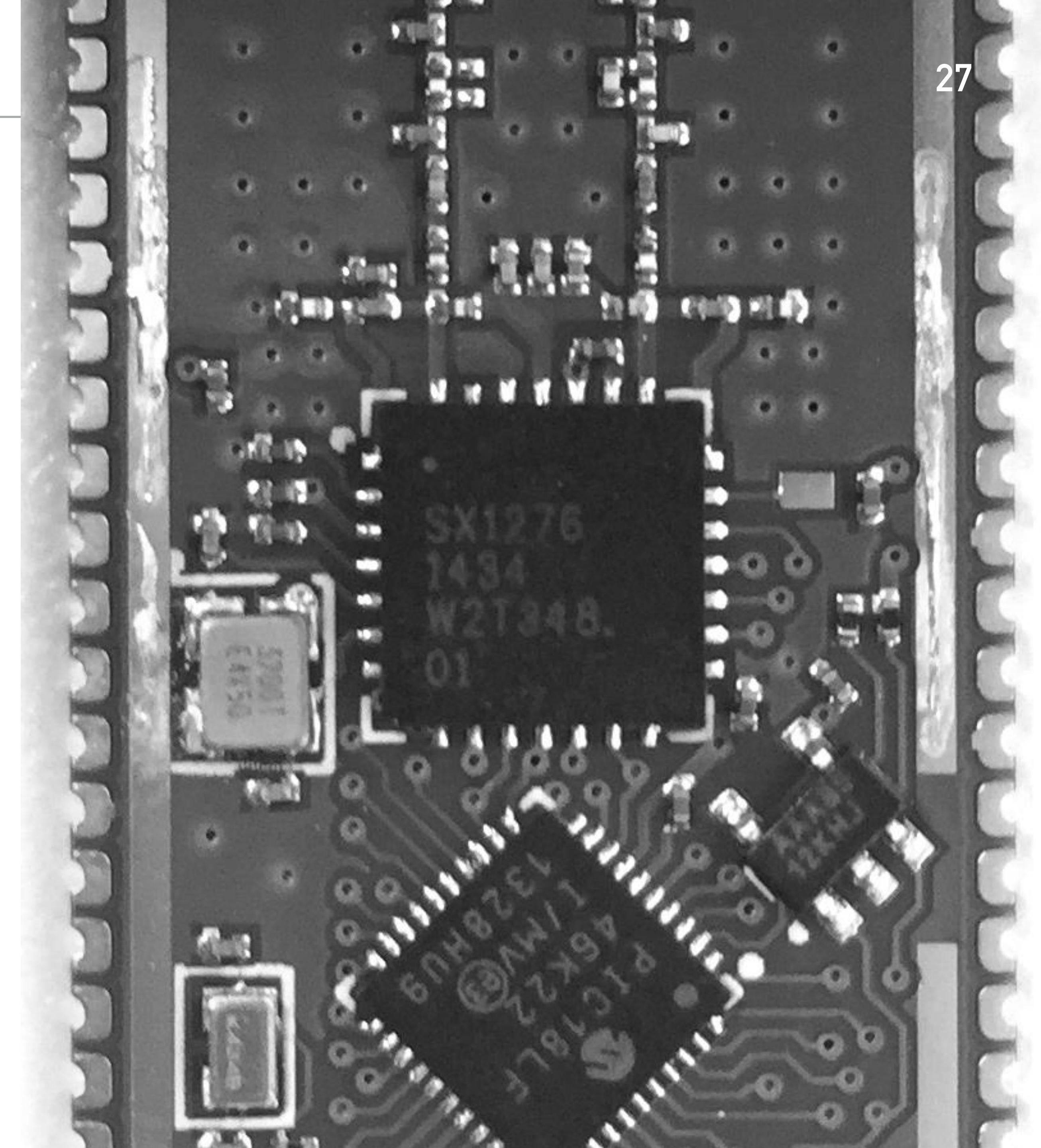
# CHIPS ... MODULES

**Chips**

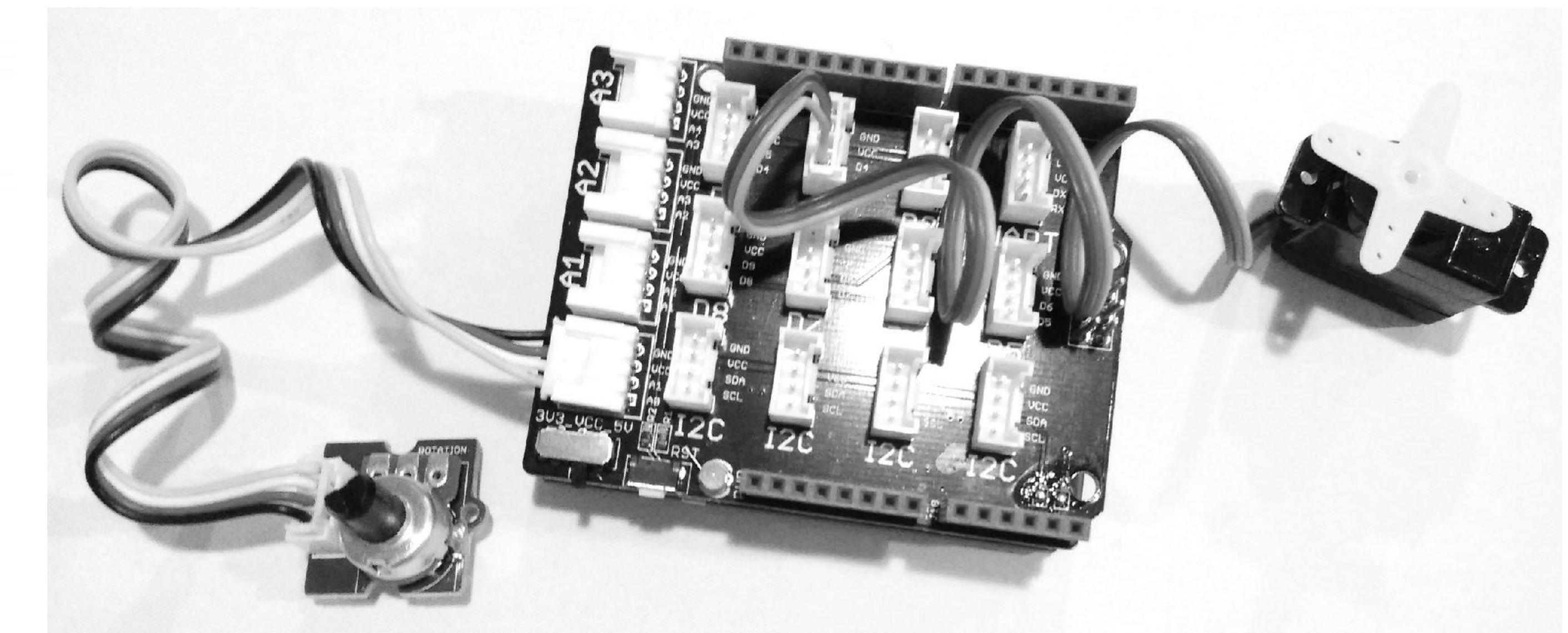
**SiP: System in Package**

**SoC: System on Chip**

**Modules**



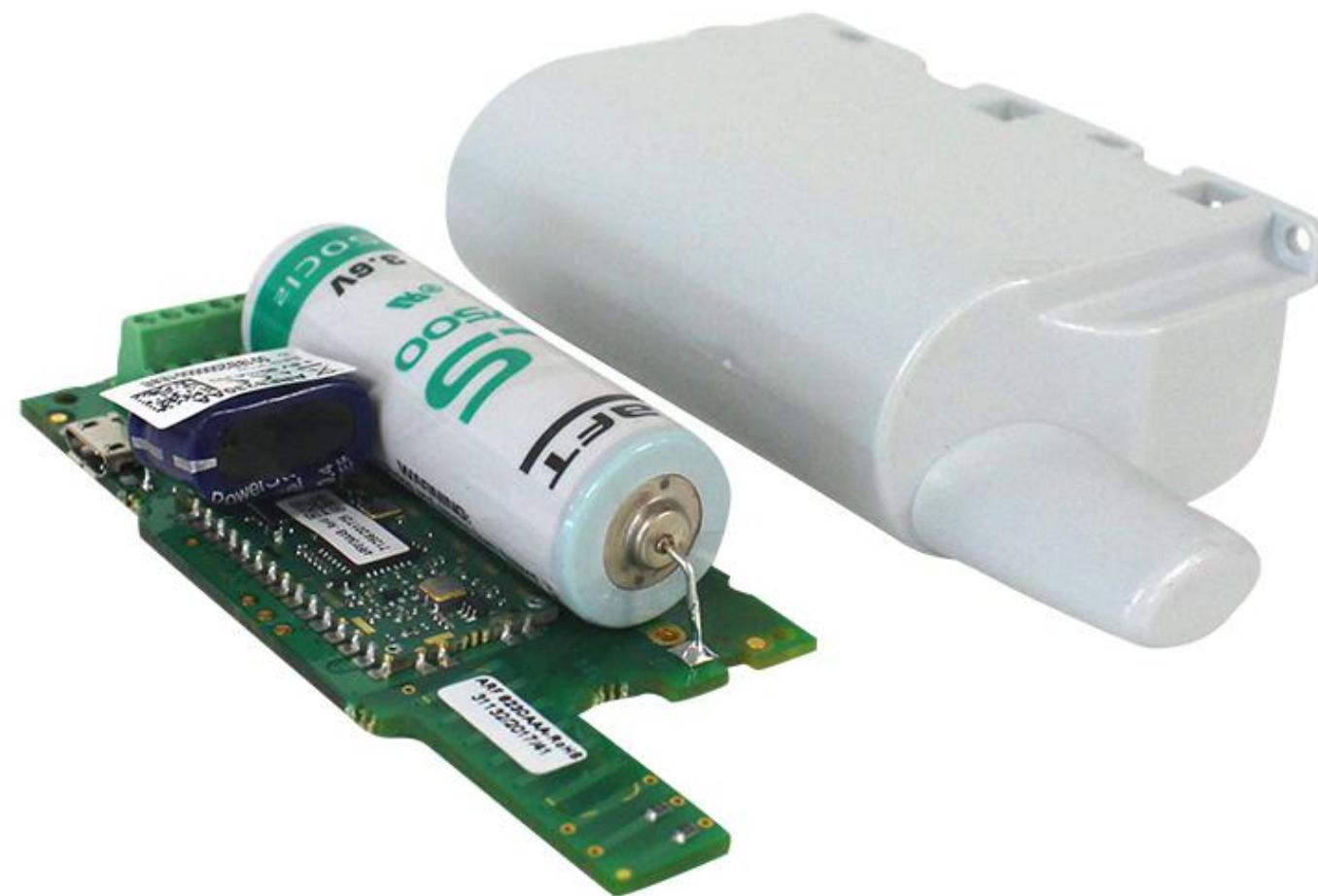
# GROVE STARTER-KIT



# ENCLOSURE DESIGN

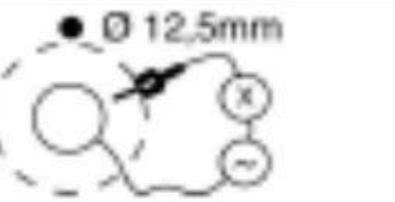
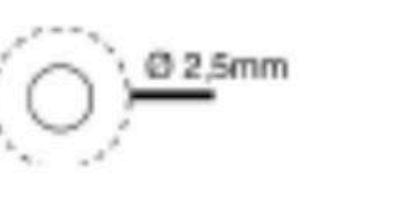
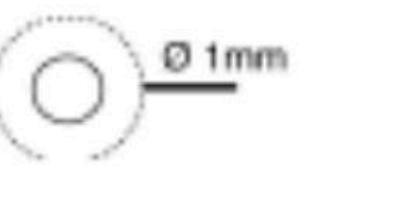
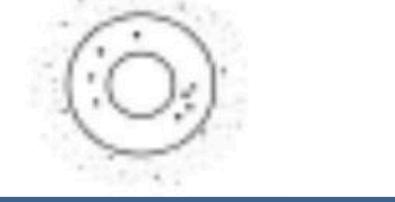
DIN rail mounted

Wall mounted

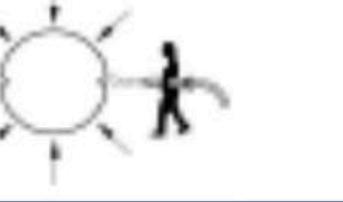
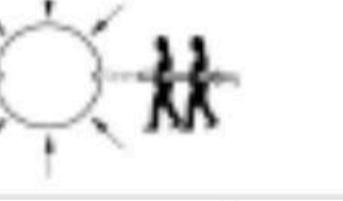


# PROTECTION INDEX: IP..

## IP: first digit

1 = Protected against projection of solid objects 50 mm or greater in diameter	
2 = Protected against projection of solid objects 12.5 mm or greater in diameter	
3 = Protected against projection of solid objects 2.5 mm or greater in diameter	
4 = Protected against projection of solid objects 1 mm or greater in diameter	
5 = Protected against dust (limited ingress, no harmful deposits)	
6 = Completely protected against dust	

## IP: second digit

1 = Protected against vertically falling water drops	
2 = Protected against water drops (15° from vertical)	
3 = Protected against rain (60° from vertical)	
4 = Protected against splashing water	
5 = Protected against water jets	
6 = Protected against powerful water jets	
7 = Temporary immersion (-1 meter for 30 minutes)	
8 = Prolonged immersion (deeper than 1 meter for period defined by manufacturer)	

  
**IP65**

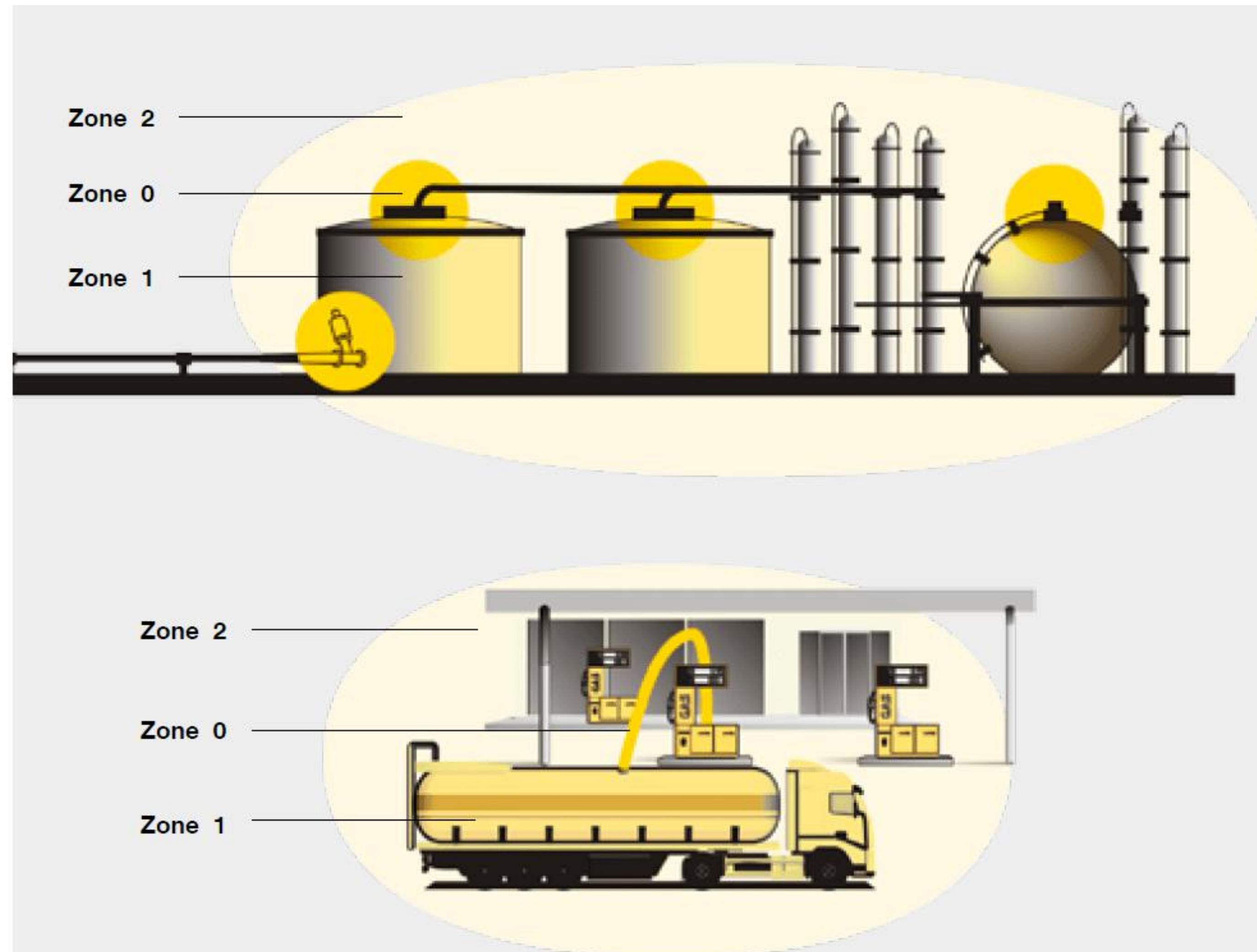
# ATEX: EXPLOSION PROTECTION MARKING

## Hazardous Area Classification



Typical ATEX and IECEx Marking [\*ATEX only]

CE	0359	Ex	II	2	G	Ex	d	IIC	T4	Gb
COMPLIES WITH EUROPEAN DIRECTIVE*	NOTIFIED BODY NUMBER*	SPECIFIC MARKING FOR EXPLOSION PROTECTION*	EQUIPMENT GROUP*	ENVIRONMENT*	EXPLORSION PROTECTION	TYPE OF PROTECTION		TEMPERATURE CLASS (T1-T6)	EQUIPMENT PROTECTION LEVEL	GAS GROUP





# SENSORS

digital view of an analog world

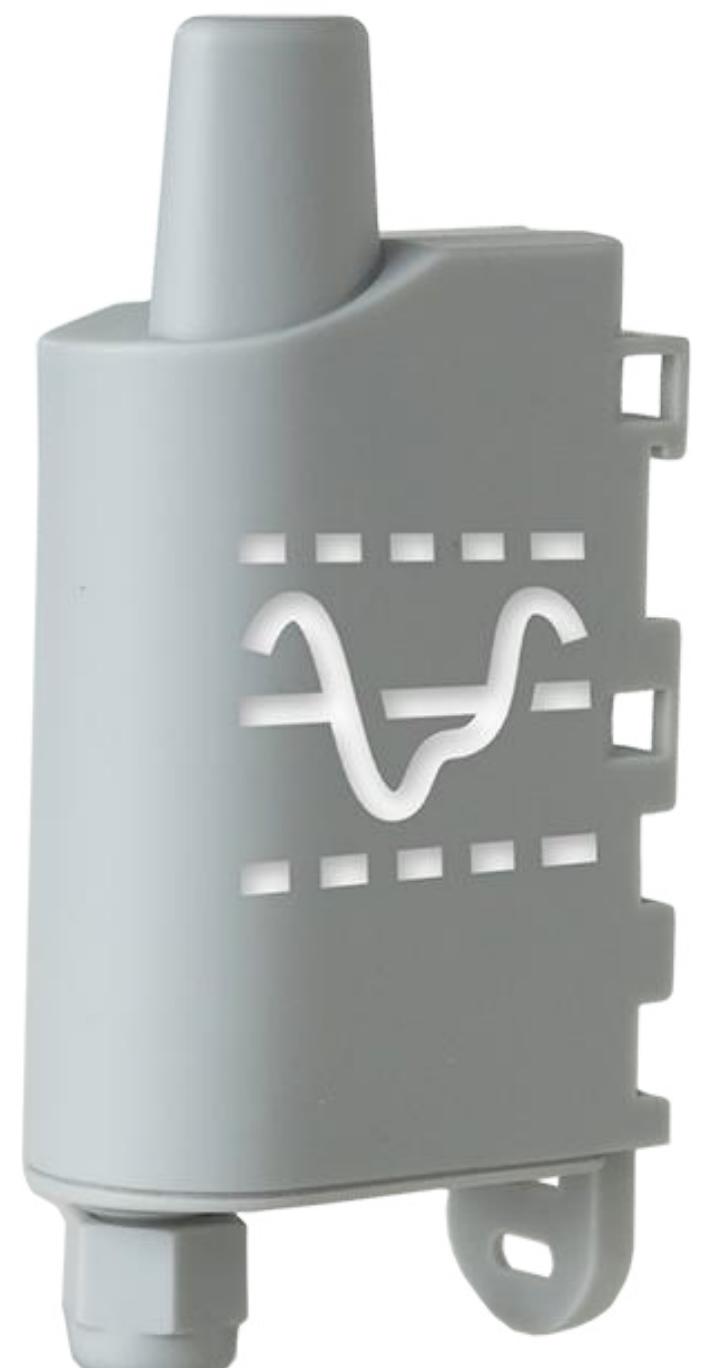
# METERING



To measure the consumption  
of water, gas, electricity...

3019 X  
Ex ib IIC T4 Gb  
Ex ib IIIC T135°C Db  
-20°C ≤ Tamb ≤ +40°C  
LCIE 18 ATEX 3019 X  
400V, Is10mA, Pd50mW, Csd440μF, Lsd930mH  
400V, Is100mA, Pls3750mW, Cis0μF, Lis126nH  
WARNING - POTENTIAL ELECTROSTATIC  
CHARGING HAZARD - SEE INSTRUCTION  
AROMES - 263 Rue Louis Néel - 38920 CROLLES - FRANCE

Also to read existing values  
on legacy, analog meters:



# TEMPERATURE



To measure the amount  
of heat energy in a source

Indoor & outdoor probes

AgTech: soil temperature  
for crop growth.



# HUMIDITY



To measure the amount of water vapor  
in the atmosphere of air or other gases

Smart Industry/Buildings: in HVAC\* systems

Smart City/Agri: in weather stations

Also to measure the conductivity  
in various solids



\* heating, vents and air conditioning

# PRESSURE



To detect pressure fluctuations



## Board-mount sensors

consider calibration, temperature compensation and amplification separately.

## Transducers

compensated for temperature fluctuations, produces a voltage



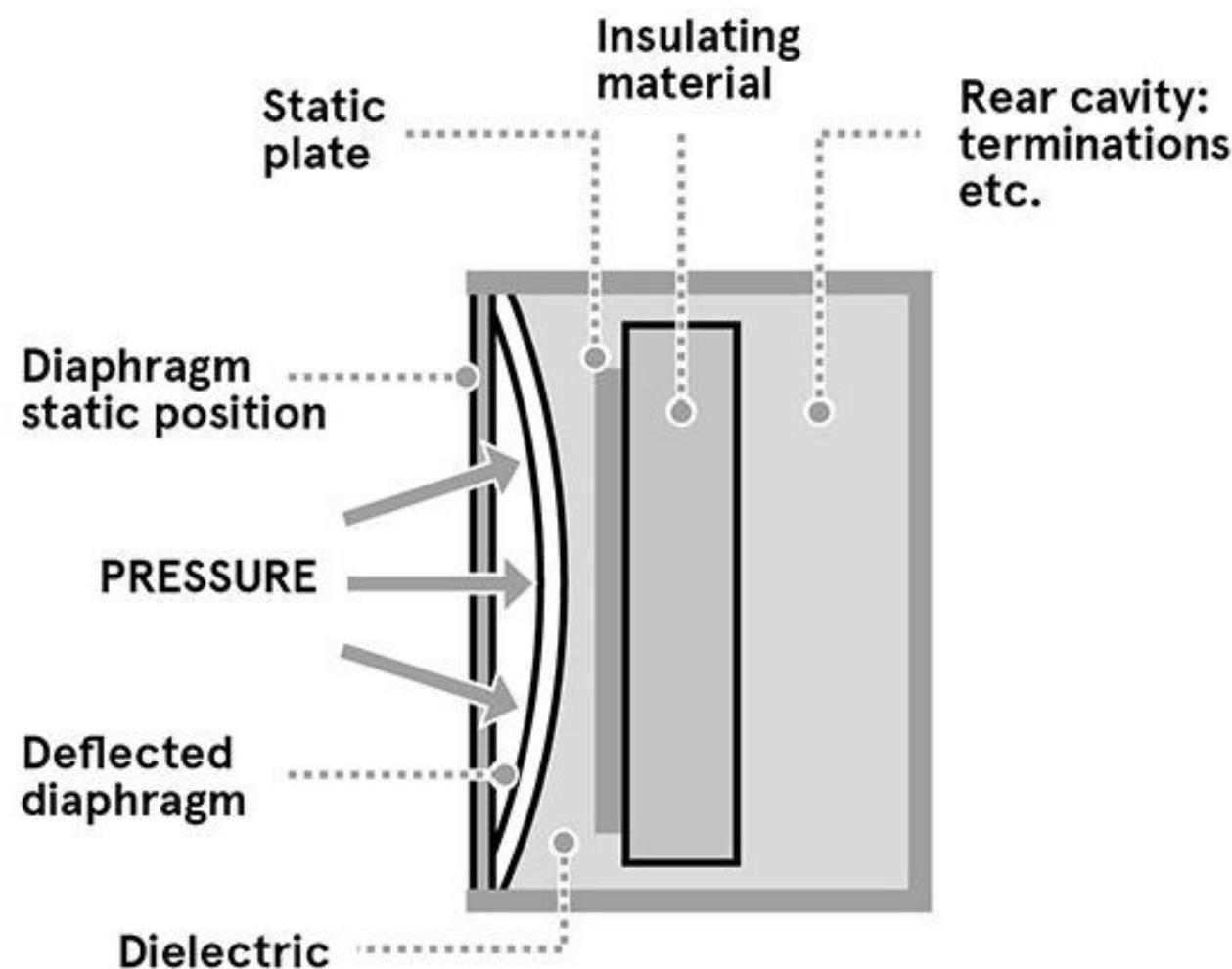
## Transmitters

compensated for temperature fluctuations, produces a 4-20 mA current

## MEMS: Micro Electro Mechanical Systems

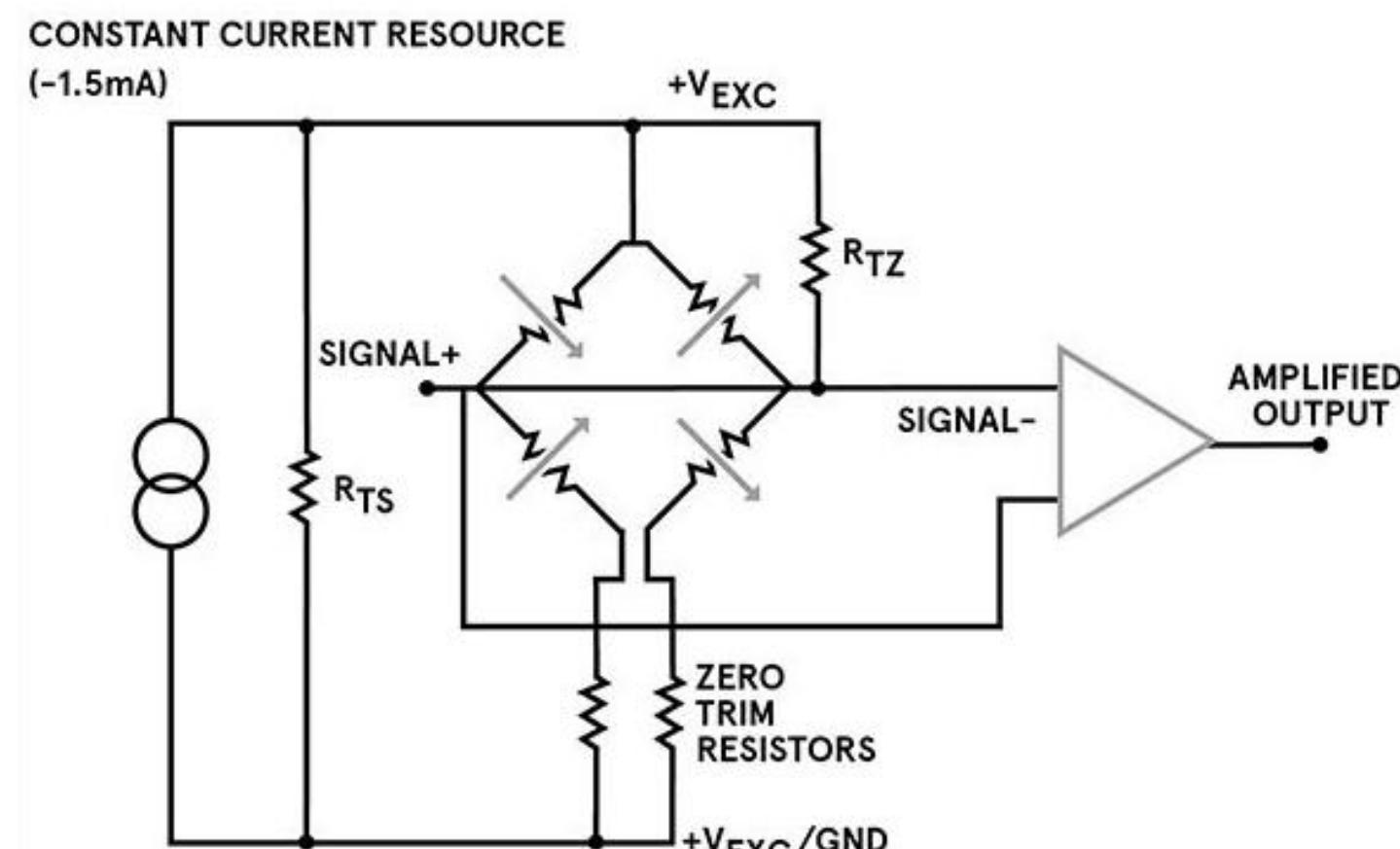
# PRESSURE

## Capacitive



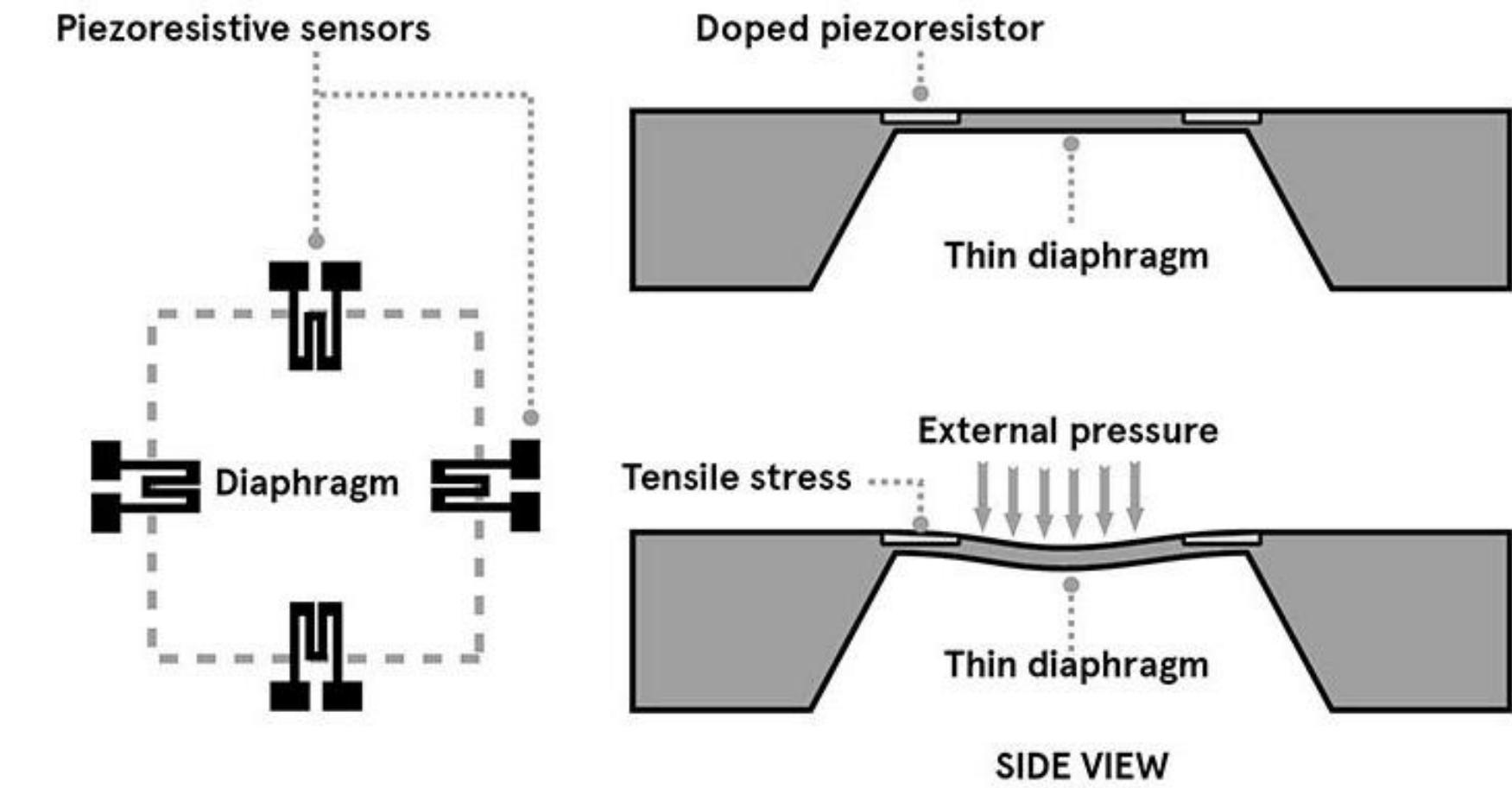
capacitance change produced by deflection of the membrane, which alters the capacitor geometry

## Strain-gauge



foil or silicon strain gauges are arranged as a Wheatstone bridge, in a diaphragm, which deflects when pressure is applied

## Piezoresistive



Piezoresistive sensing elements arranged in a bridge, attached to a flexible diaphragm. Resistance changes according to the magnitude of the diaphragm deflection

# PROXIMITY



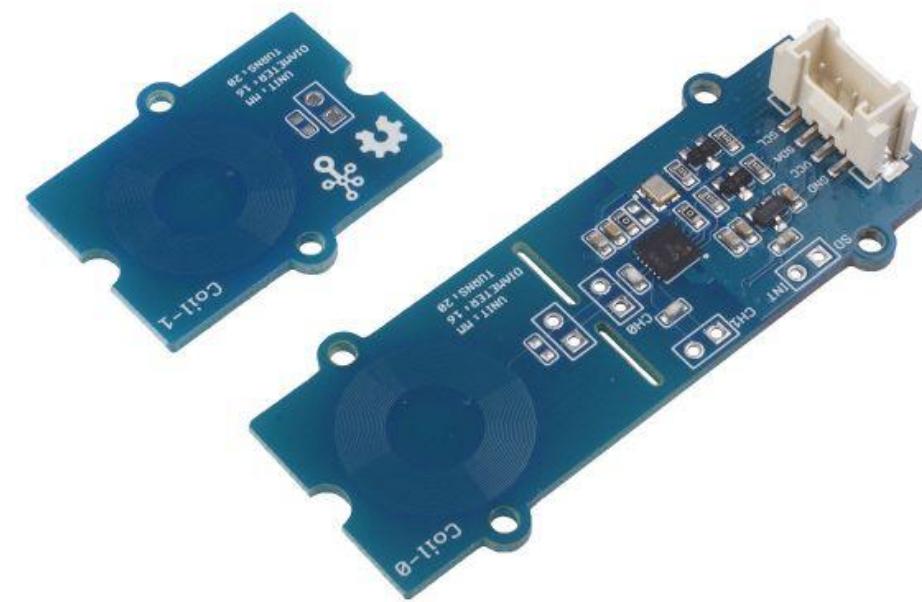
## Ultrasonic



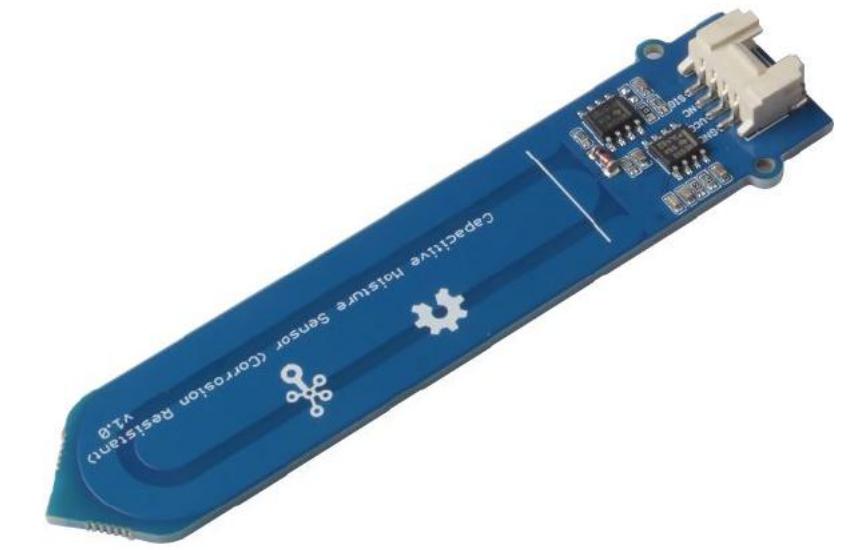
## Infrared



## Inductive



## Capacitive



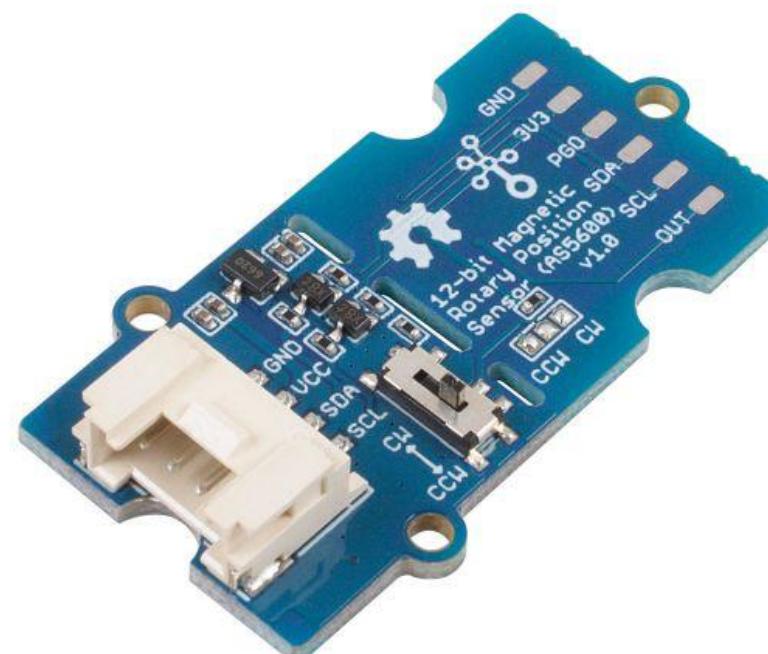
# PROXIMITY



## Photoelectric



## Magnetic



Reflective, Through-beam,  
and Retro-reflective

## LiDAR

Light Detection and Ranging



Low cost, long-range  
Magnets

Excellent long range detection with fast update rates.  
High end, expensive sensors

# PROXIMITY

	<b>Inductive</b>	<b>Capacitive</b>	<b>Ultrasonic</b>	<b>IR</b>
<b>Sensing Object</b>	Metal Only	Metallic and non-metallic objects Including liquid, powders, and granular	Object with simple surfaces	Object with simple/complicated surfaces
<b>Sensing Range</b>	Short	Short	Long	Long
<b>Applications</b>	<b>Industrial Usages:</b> Machinery, Automations	<b>Industrial usages:</b> Machinery, Automations Liquid and moisture  Touch sensing	Distance measurement Anemometers for wind speed and direction detection Automation production processes Fluid detection Unmanned aerial vehicles (UAVs) for object monitoring Robotics	Item counter Security systems such as surveillance, burglar alarms, etc. Monitoring and control applications
<b>Environment</b>	Suited to be used in harsh environment conditions (to an extent)	Extremely suitable to be used in harsh environment conditions	Suited for harsh environment conditions (Not suited to be used in vacuum)	Not suited to be used in harsh environment conditions

# LEVEL



Vibrating  
tuning fork



## Optical



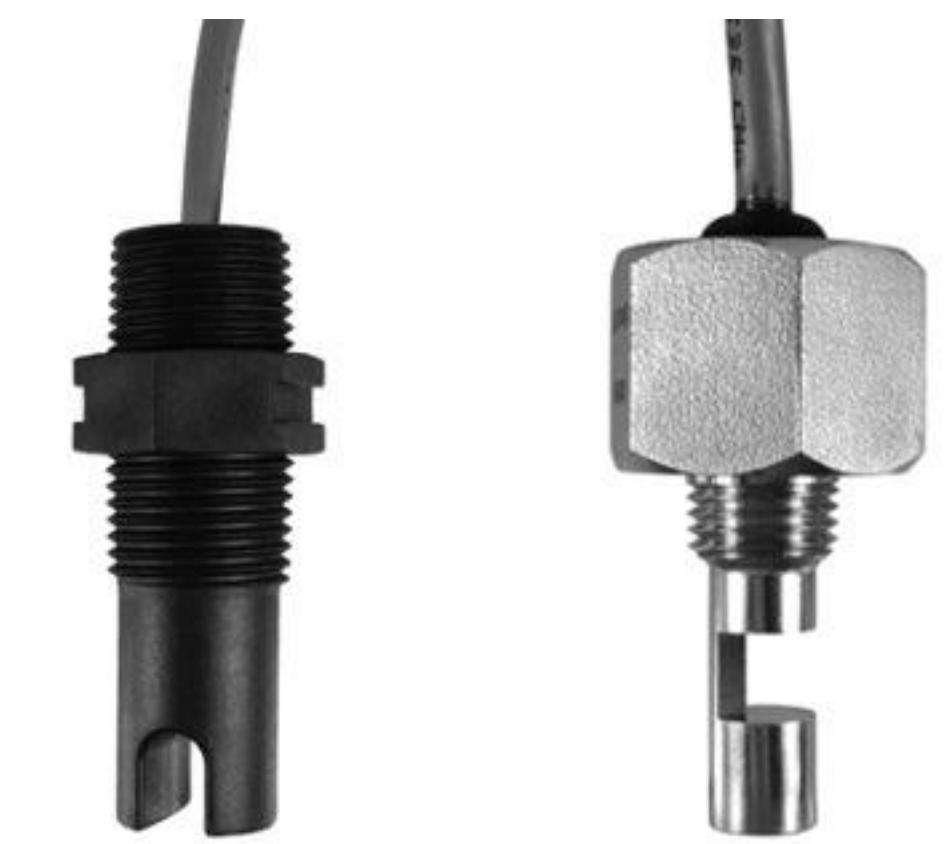
## Floating switch



## Capacitance



## Ultrasonic



## Conductivity



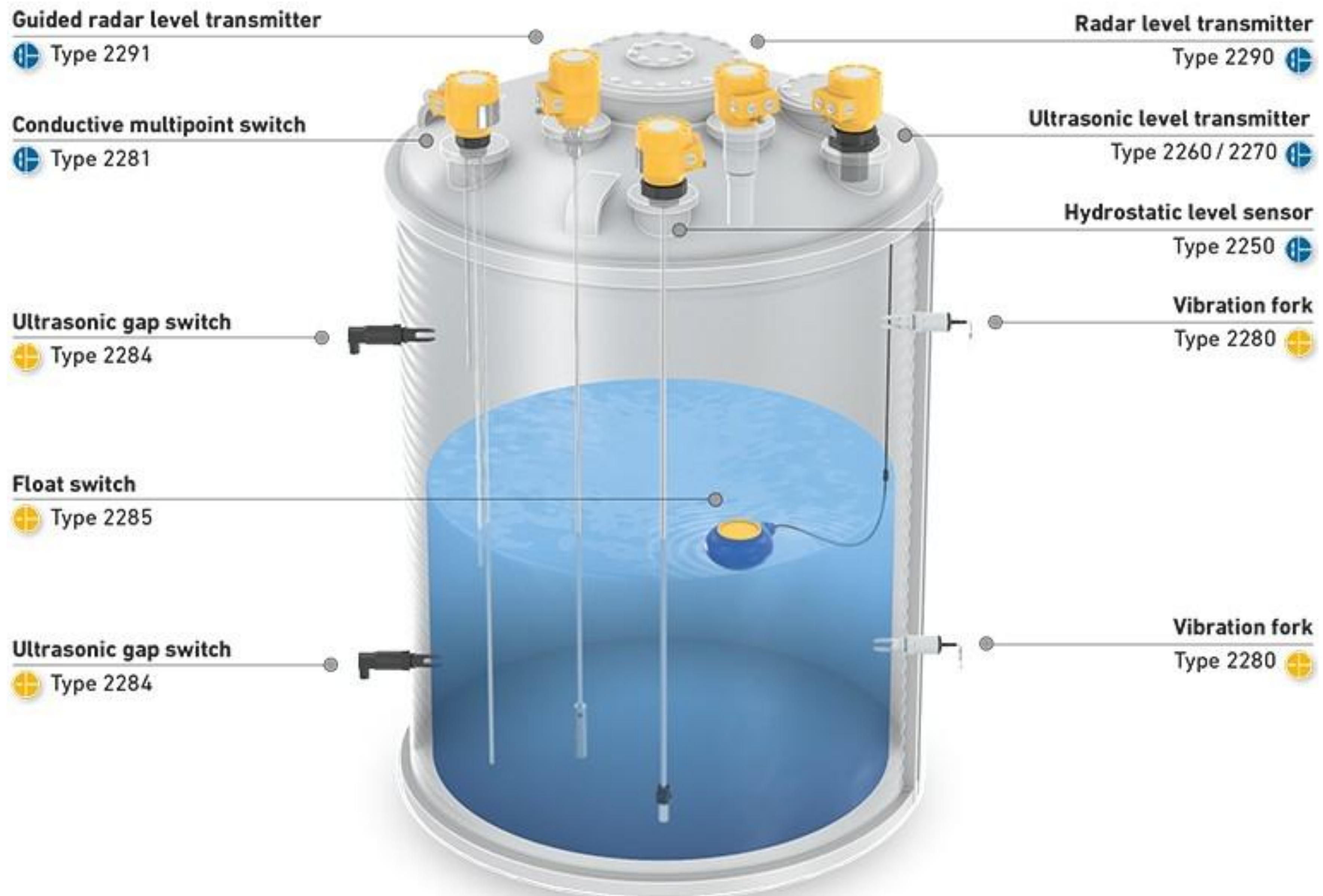
## Microwave



# LEVEL



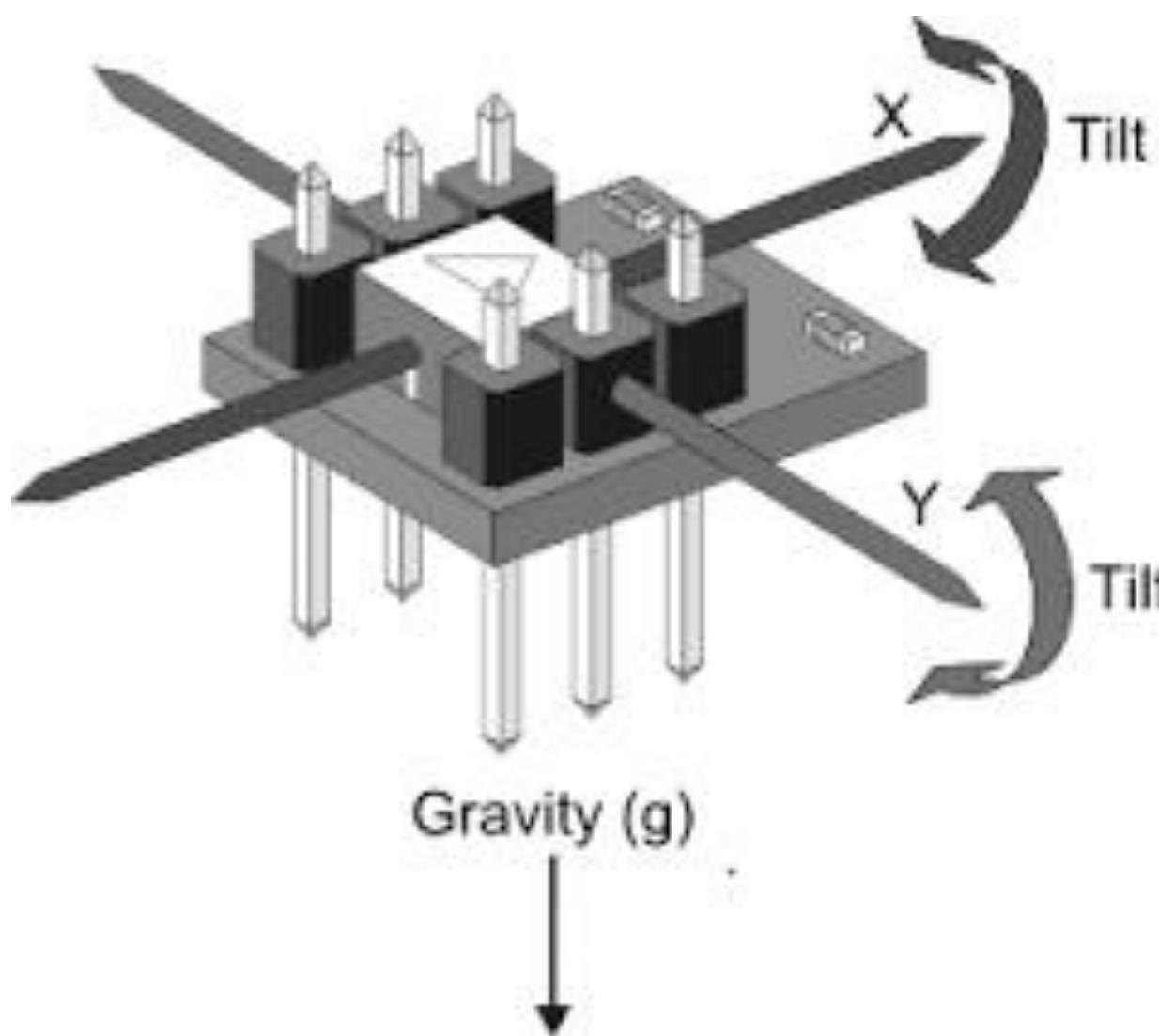
level  
matters



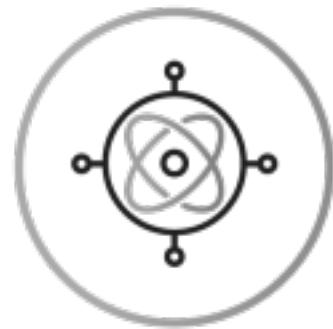
# ACCELERATION



Acceleration / axis

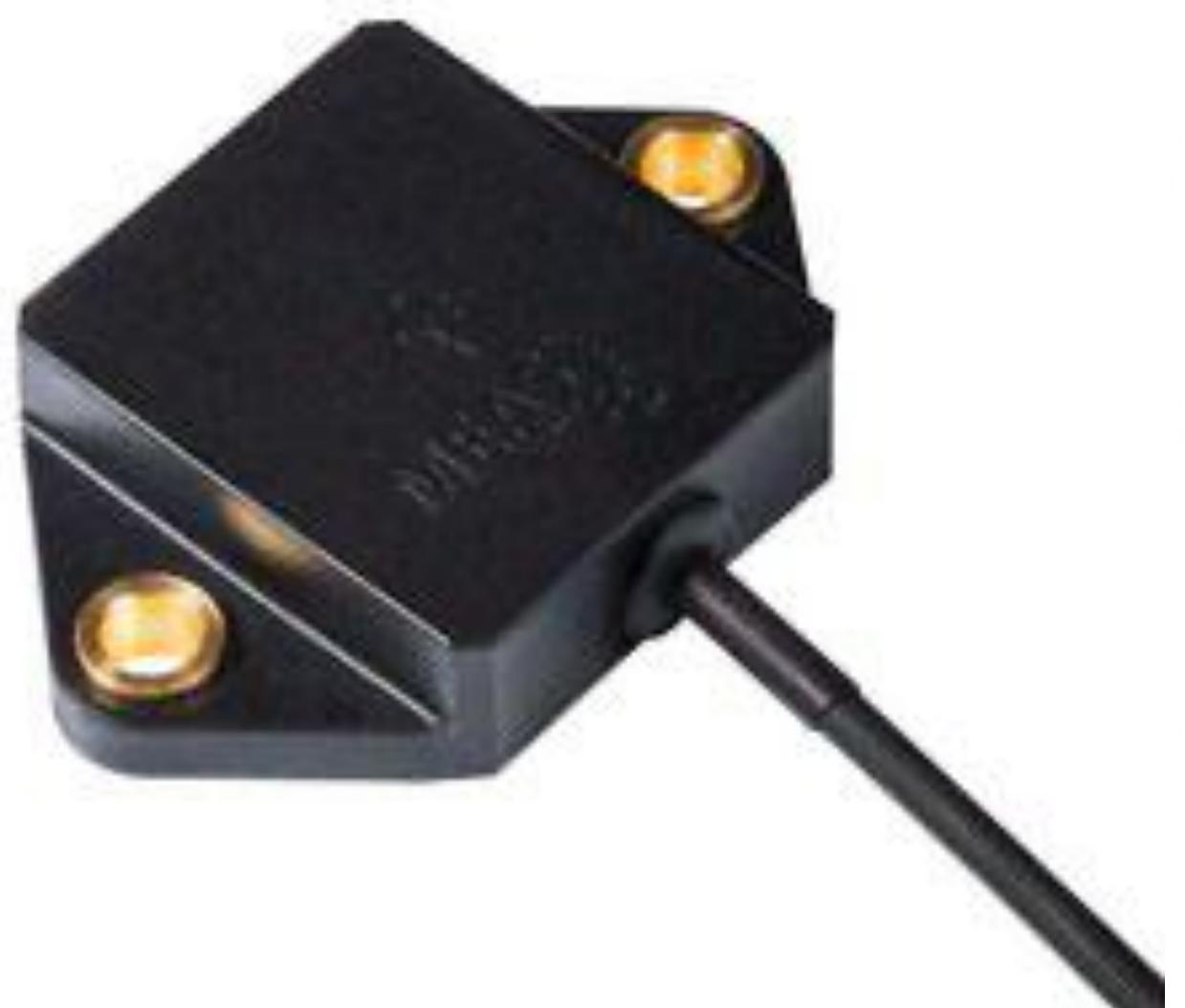


# ANGULAR ROTATION



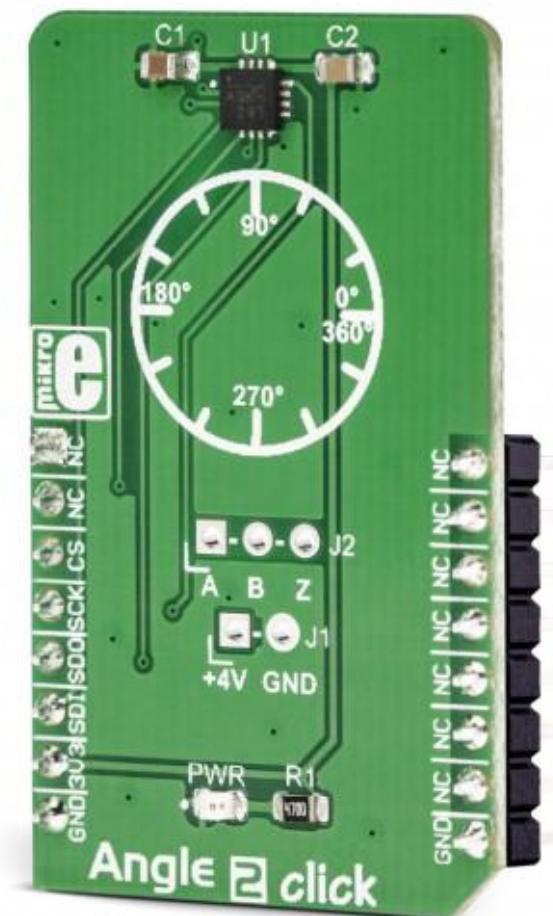
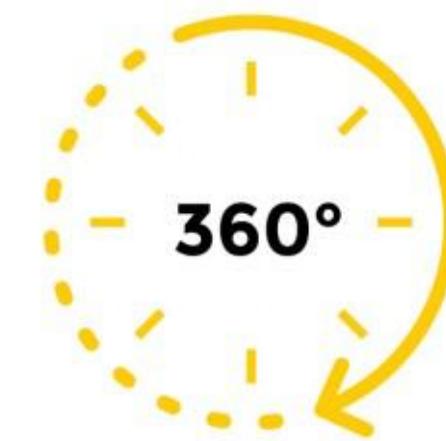
Angle measurements

Inclinometers



**Angle 2 click**

Magnetic rotational sensor



# GAS & PARTICLES



Air Quality:  
up to 6 Gas sensors:  
CO<sub>2</sub>, NH<sub>3</sub>, CO, H<sub>2</sub>S, FA...  
and 4 Odor sensors

Particles:  
PM 2.5 um and PM 10 um



# DISTANT HEAT



To measure the a distant heat,  
with infrared sensors

Security: differentiate humans,  
animals vs. things

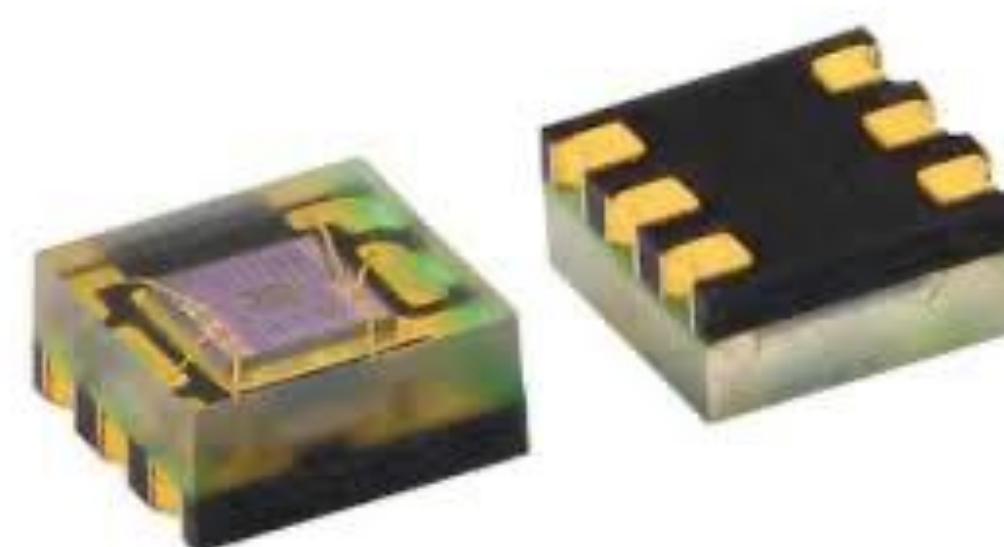
Smart building: people counting



# LIGHT



To monitor lighting  
in buildings and  
tunnels for instance

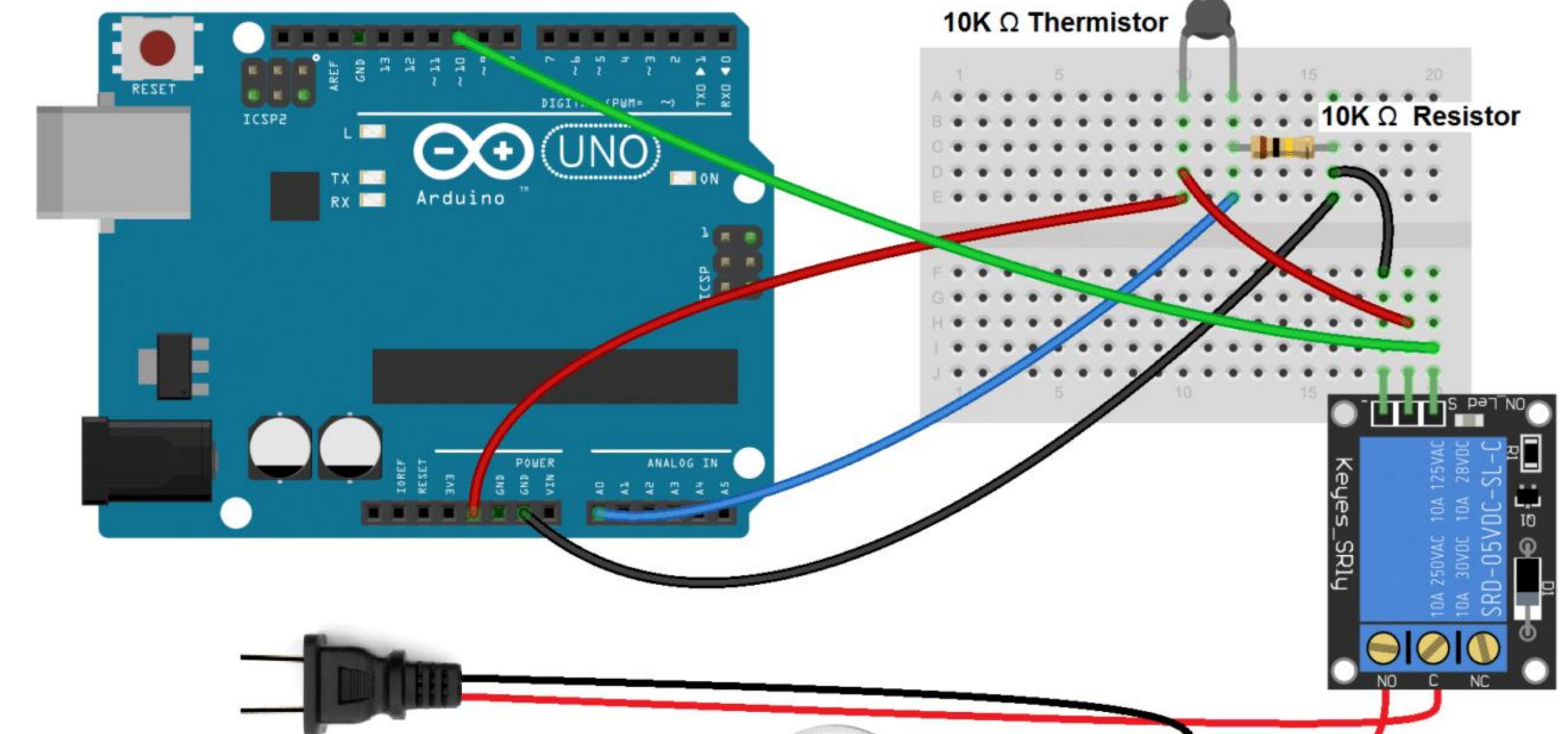
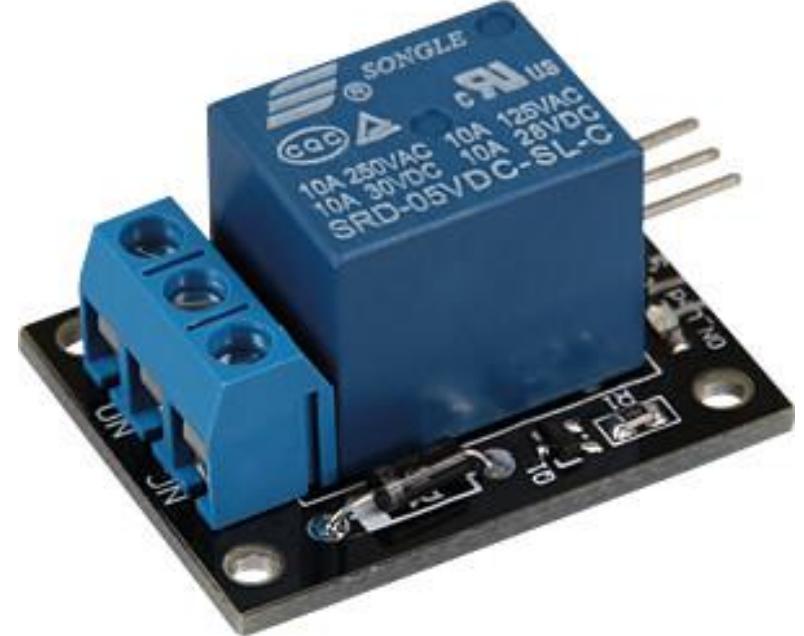




# ACTUATORS

to act

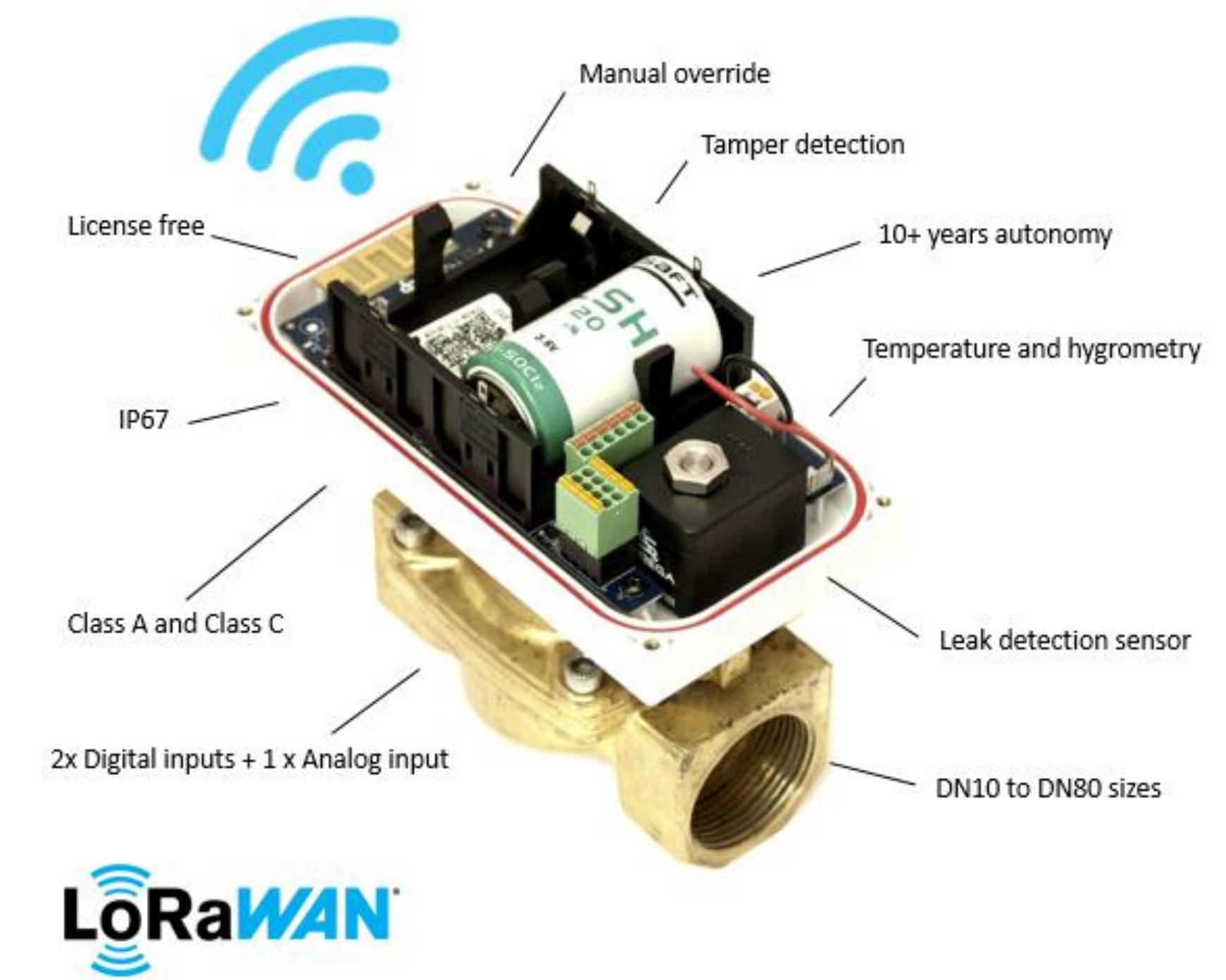
# RELAYS



fritzing

# CONTROL VALVES

to regulate  
the flow  
of fluids



# MOTORS

AC Synchronous Motors

AC Induction Motors

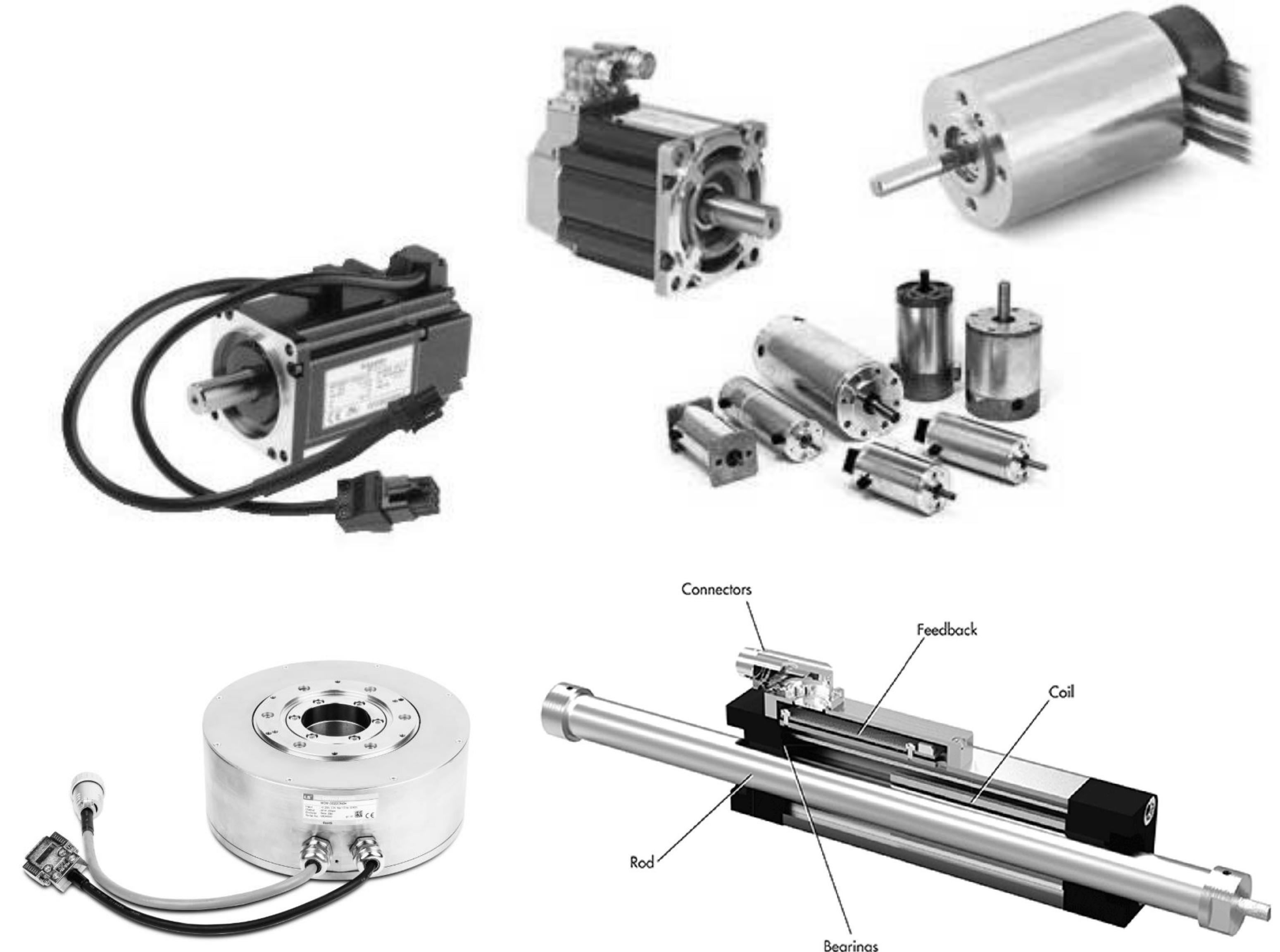
DC Brushed Motors

DC Brushless Motors

...

Direct Drive Motors

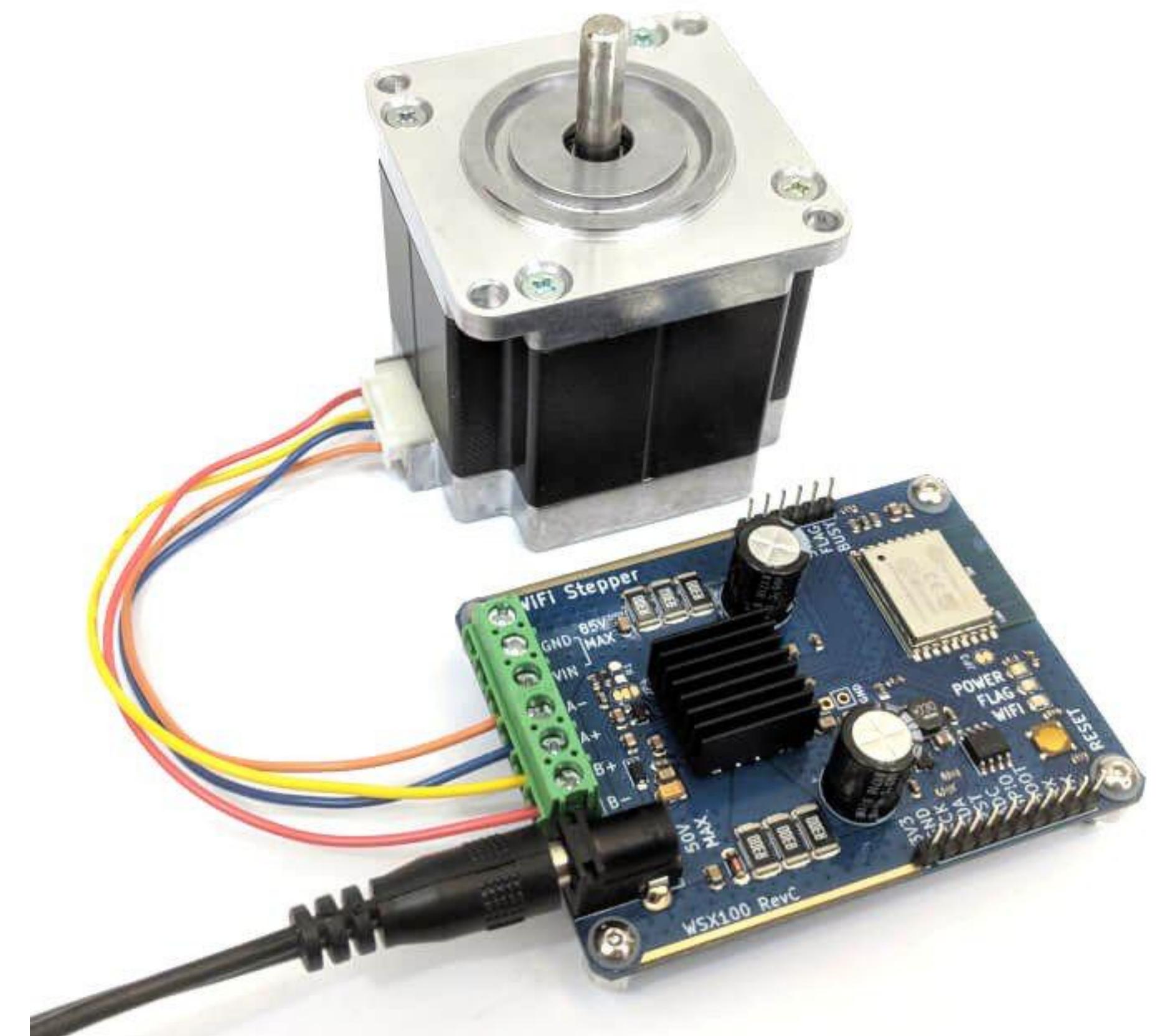
Linear Motors



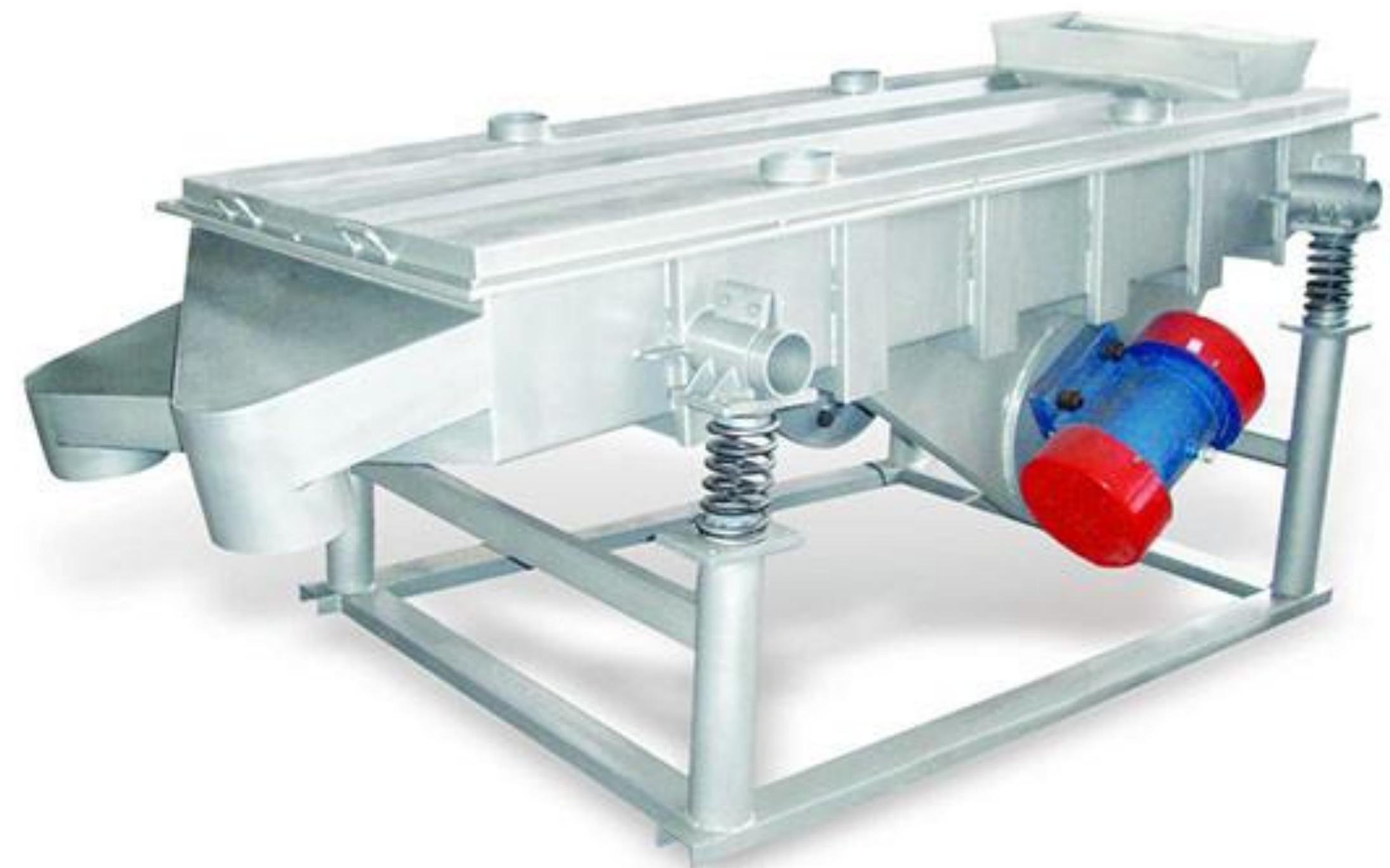
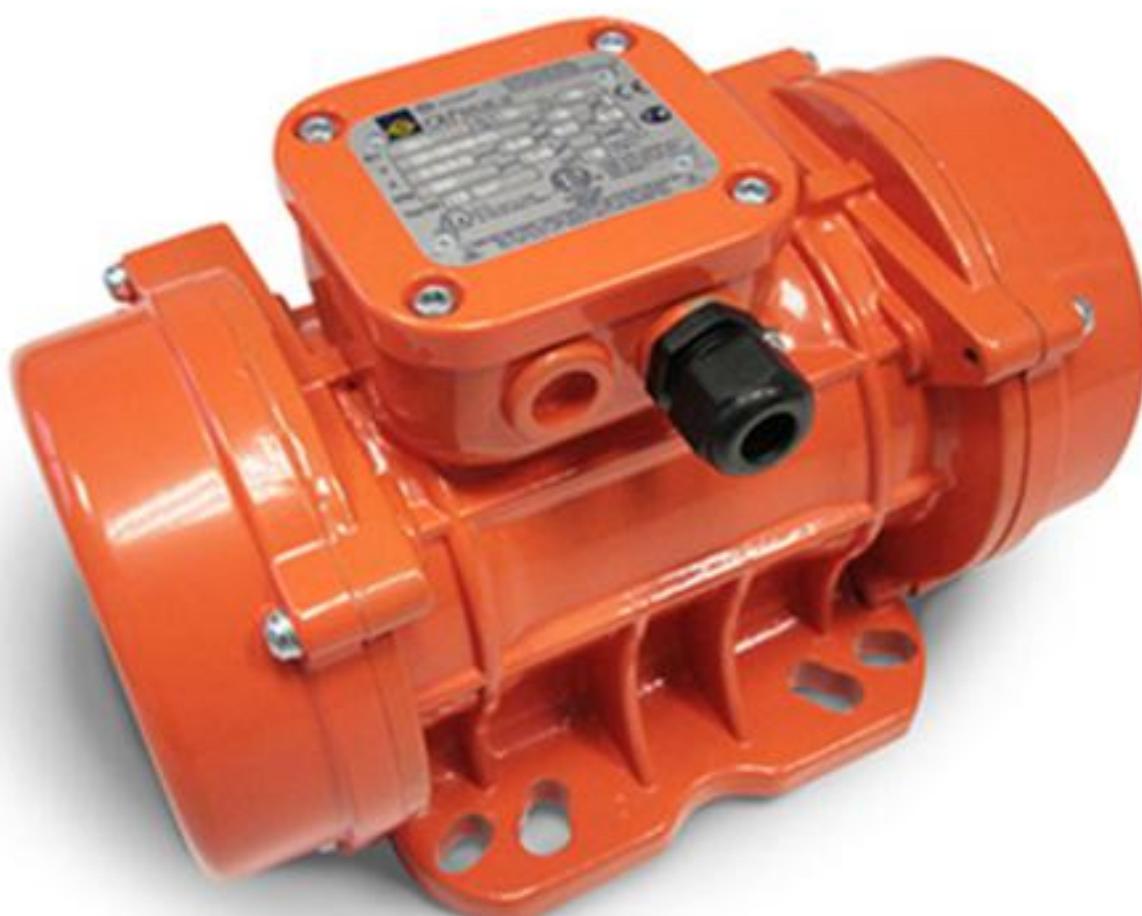
# MOTORS - CONT'D

Servo Motors

Stepper Motors



# VIBRATION MOTORS





# IOT PLATFORMS

# SO MANY IOT PLATFORMS

Number of publicly known "IoT Platforms" (IoT Analytics Research)



40+ example providers



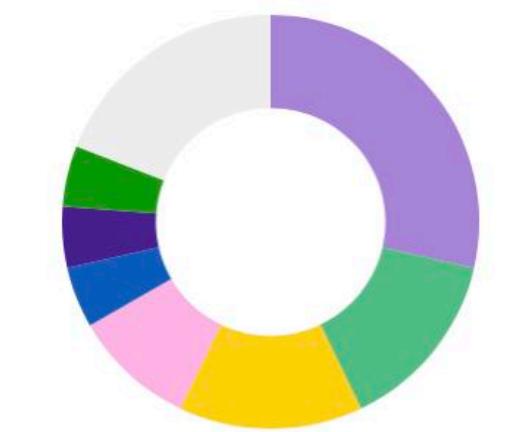
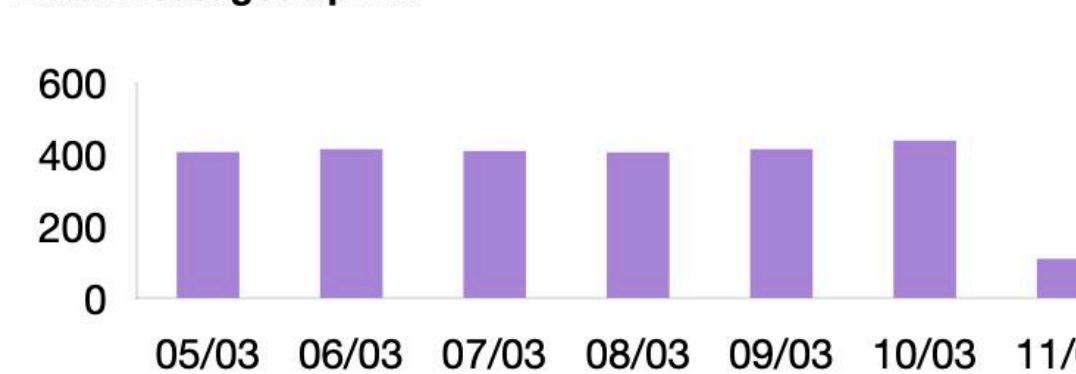
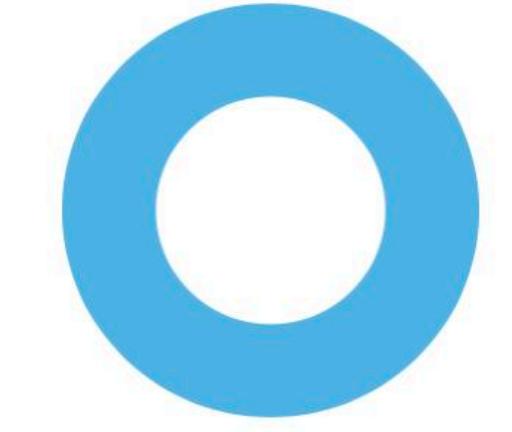
# OPERATORS PLATFORMS

Orange Business Services Orange Developer Hardware LoRa coverage LTE-M coverage Blog EN ▾

**Datavenue Live Objects** Dashboard Devices Data Alarms Administration ? Help center ▾ **ZZZ EVENEM...** ▾

Devices activity ⚡ My fleet Outdoor Smart building Android app Enriched Android App Network monitoring GPS Fleet at a glance TEST David +

Add a widget

Inventory	by tag	Demo group																
<p><b>Devices</b> <b>22</b> 6 Subgroups</p> <p>Last update: 03/11/2022 6:24 AM Source: Group /</p>	<p><b>22 devices</b></p>  <p>Tags</p> <ul style="list-style-type: none"><li>6 test</li><li>3 temperature</li><li>3 tracker</li><li>2 indoor</li><li>1 Corse</li></ul> <p>Last update: 03/11/2022 6:24 AM Source: /</p>	<p><b>Devices</b> <b>6</b> 1 Subgroup</p> <p>Last update: 03/11/2022 6:24 AM Source: Group /demo</p>																
<p>uplink traffic <span>?</span></p> <p>7 days ▾ Last 7 days &lt;&lt; &lt; &gt; &gt;&gt;</p> <p>Data messages uplink</p>  <table border="1"><thead><tr><th>Date</th><th>Messages</th></tr></thead><tbody><tr><td>05/03</td><td>~400</td></tr><tr><td>06/03</td><td>~400</td></tr><tr><td>07/03</td><td>~400</td></tr><tr><td>08/03</td><td>~400</td></tr><tr><td>09/03</td><td>~400</td></tr><tr><td>10/03</td><td>~400</td></tr><tr><td>11/03</td><td>~100</td></tr></tbody></table>	Date	Messages	05/03	~400	06/03	~400	07/03	~400	08/03	~400	09/03	~400	10/03	~400	11/03	~100	<p>Lora devices status</p> <p><b>6 LoRa devices</b></p>  <p>LoRa status</p> <ul style="list-style-type: none"><li>6 Activated</li></ul>	<p>profiles</p> <p><b>LoRa profiles</b></p> <ul style="list-style-type: none"><li>2 Adeunis RF...</li><li>1 ERS ELSY...</li><li>1 Generic_cl...</li><li>1 JRI</li><li>1 SENSING L...</li></ul>
Date	Messages																	
05/03	~400																	
06/03	~400																	
07/03	~400																	
08/03	~400																	
09/03	~400																	
10/03	~400																	
11/03	~100																	

# PURE PLAYERS PLATFORMS

CommonSens...

Welcome, DemoVM2MZ

Device Management Platform

Containers

Devices

- Products
- Categories
- Provisioning
- Mass Provisioning
- Statistics
- States
- Cartography
- Groups

Alarms

**601** Alarms

date : 2021-11-29 00:00:00



Filter Statistics

Alarms



Values

800

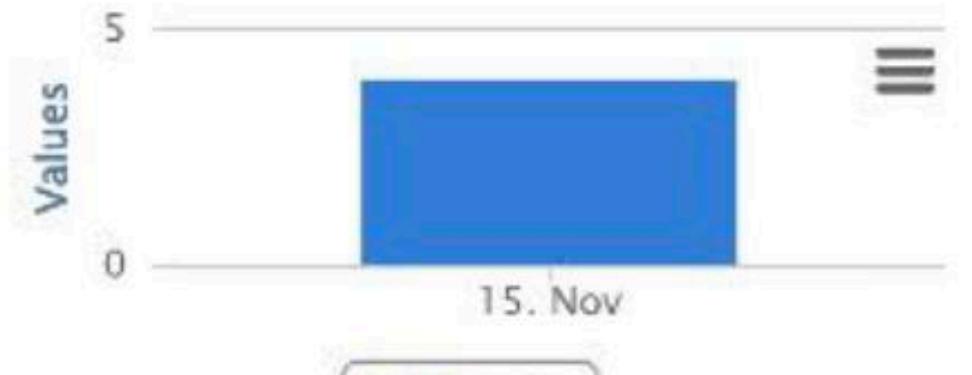
0

8. Nov 22. Nov

Alarms

Highcharts.com

Emails



Values

5

0

15. Nov

Emails

Highcharts.com

Agents

**11** Agents

date : 2021-11-29 00:00:00



Number of data

**64 496**

Number of data

date : 2021-11-29 00:00:00

Devices

**156-5-110 / 271**

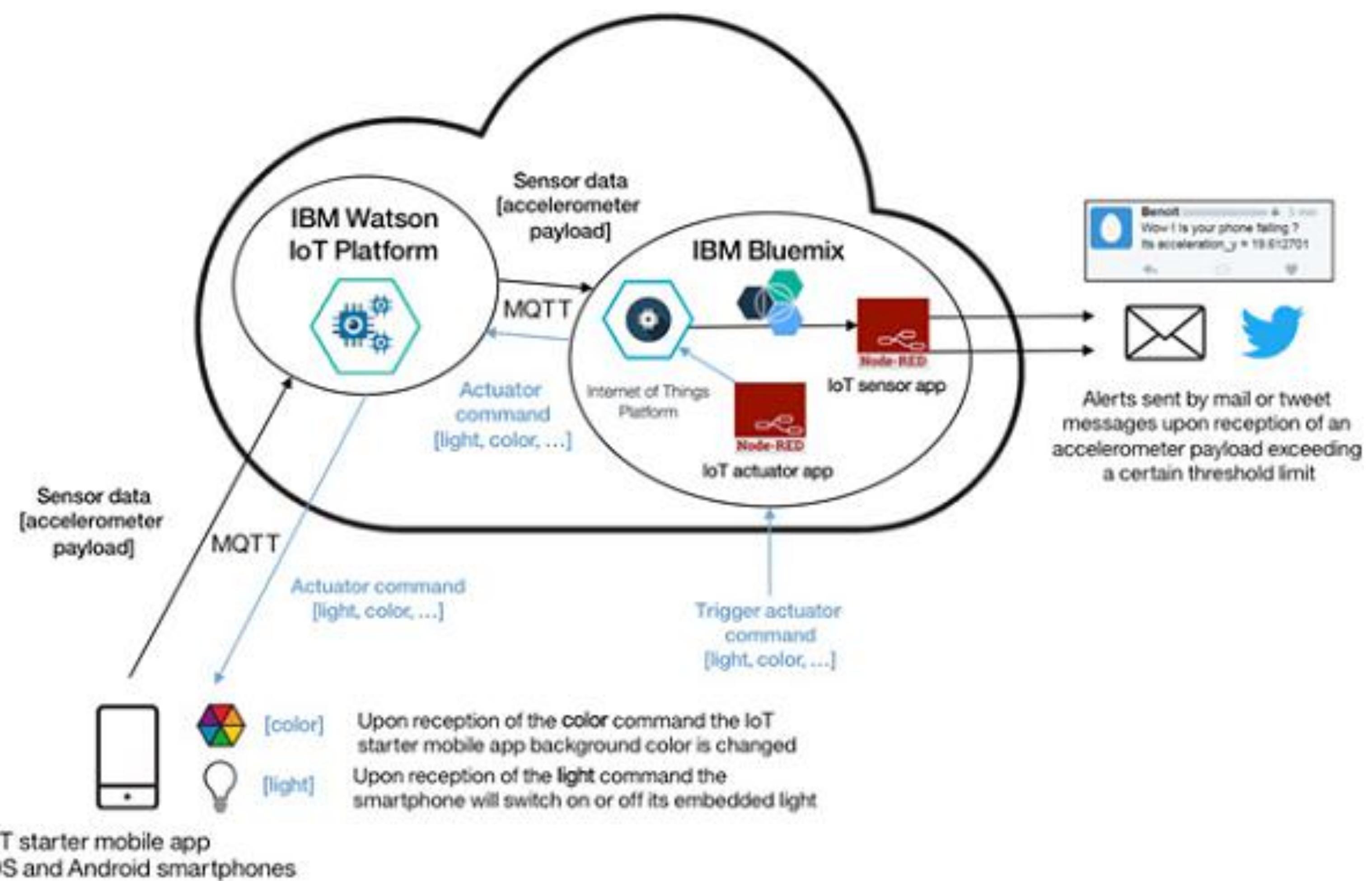
Devices

date : 2021-11-29

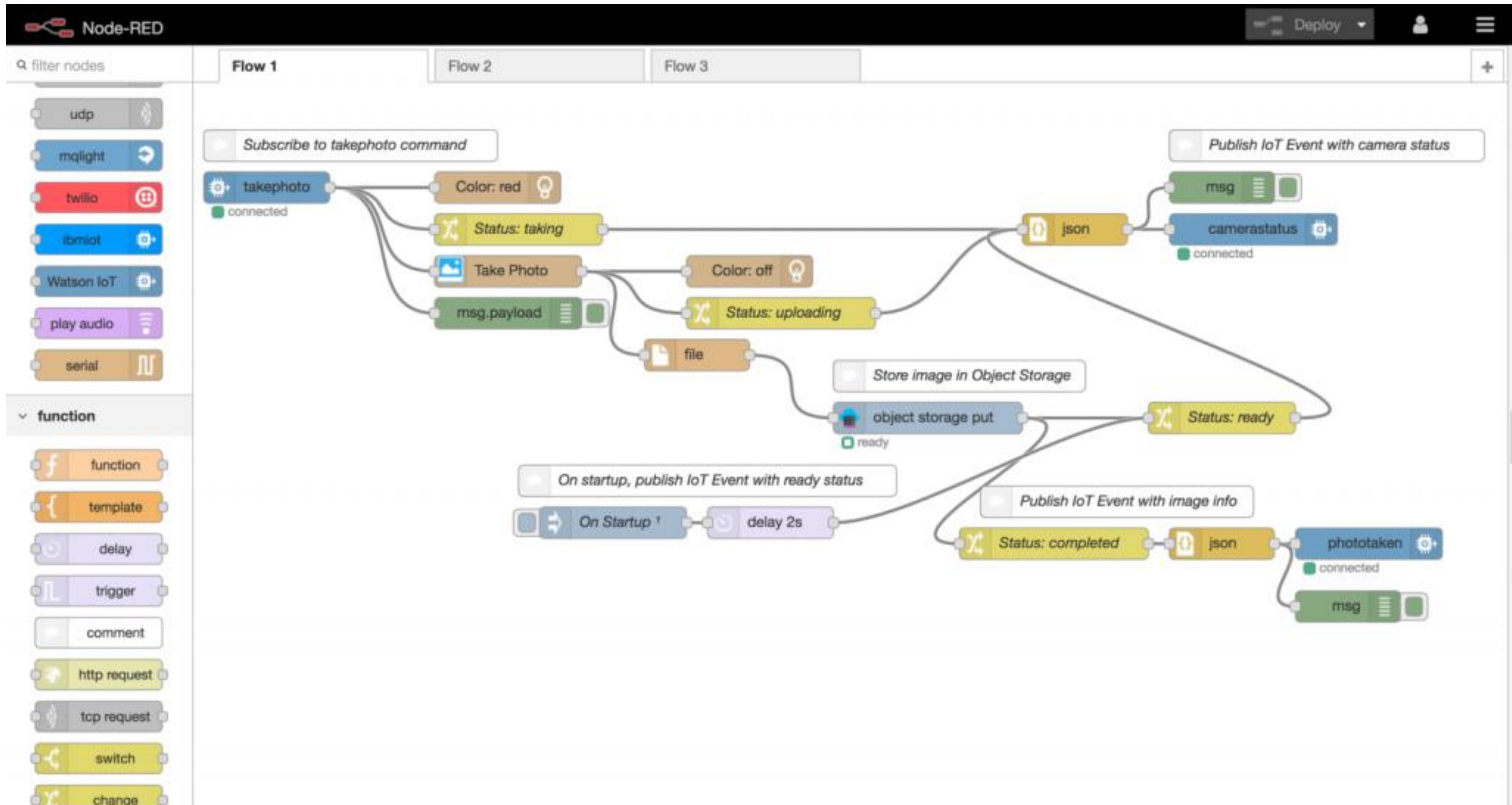


Active agents

# IBM WATSON IOT + BLUEMIX



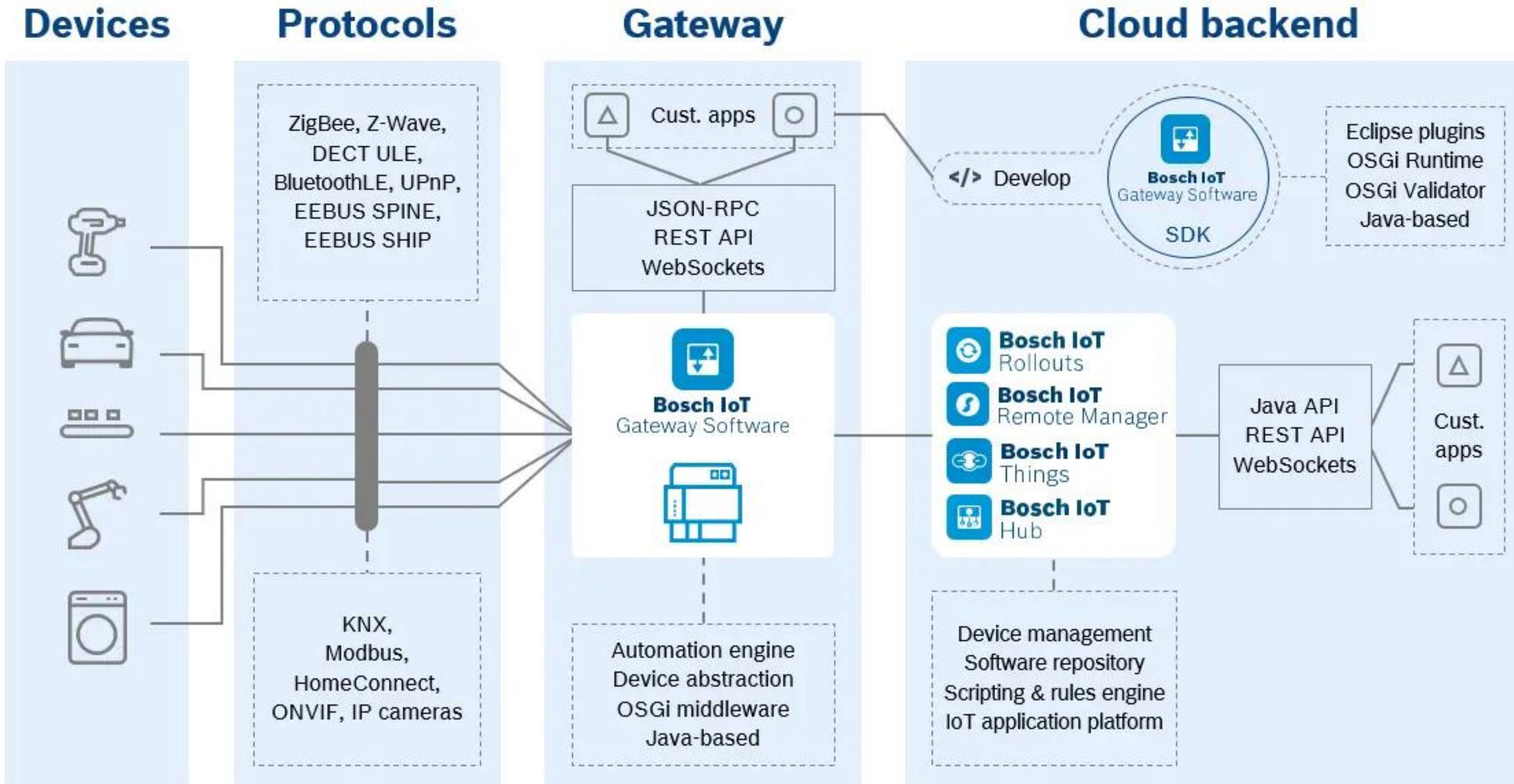
# IBM NODE RED



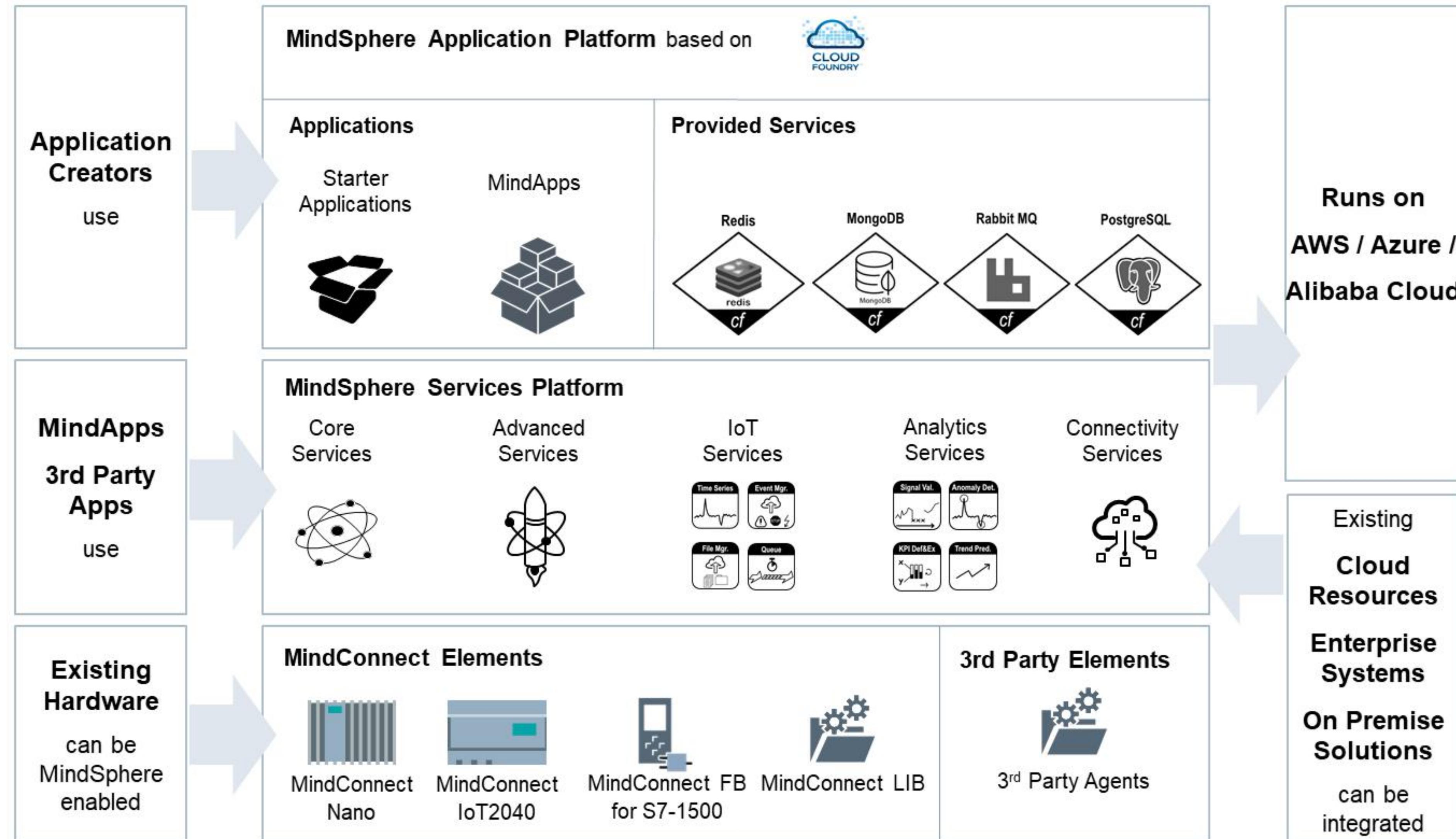
# MICROSOFT AZURE IOT

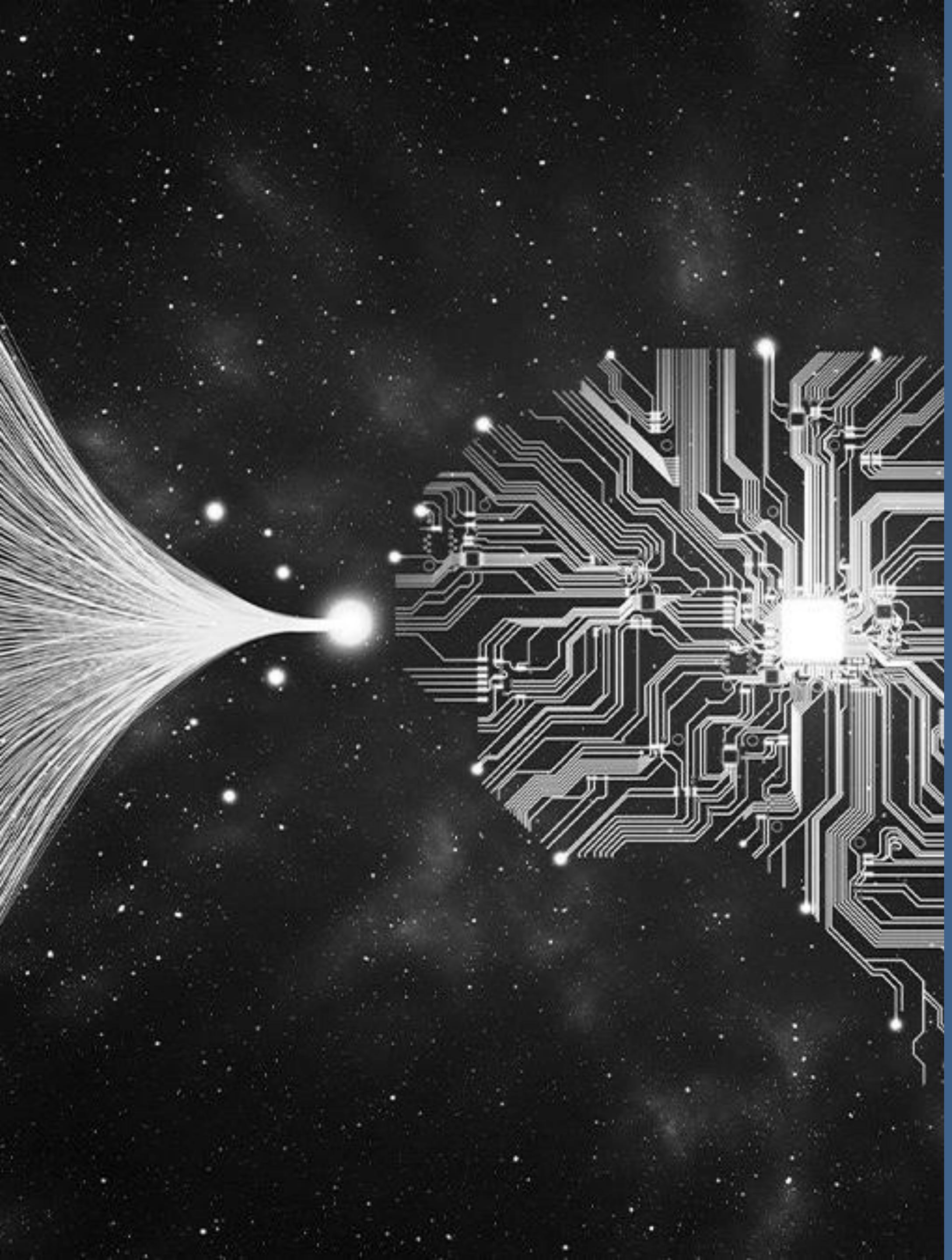
<b>Azure Security Center for IoT</b> 	<b>IoT Central application templates</b>	Retail	Health	Energy	Government
	<b>IoT Solutions</b>	Azure IoT Central - managed application platform	Reference Architecture and Accelerators (PaaS)	Dynamics Connected Field Service (SaaS)	
	<b>Azure Services for IoT</b>	Azure IoT Hub Azure IoT Hub Device Provisioning Service Azure Digital Twins Azure Time Series Insights Azure Maps	Azure Stream Analytics Azure Cosmos DB Azure AI Azure Cognitive Services Azure ML Azure Logic Apps	Azure Active Directory Azure Monitor Azure DevOps Power BI Azure Data Share Azure Spatial Anchors	
	<b>IoT and Edge Device Support</b>	Azure Sphere Azure IoT Device SDK Azure IoT Edge Azure Data Box Edge	Windows IoT Azure Certified for IoT—Device Catalog Azure Stream Analytics Azure Storage	Azure ML Azure SQL Azure Functions Azure Cognitive Services	

# BOSCH.IO



# SIEMENS MINDSPHERE

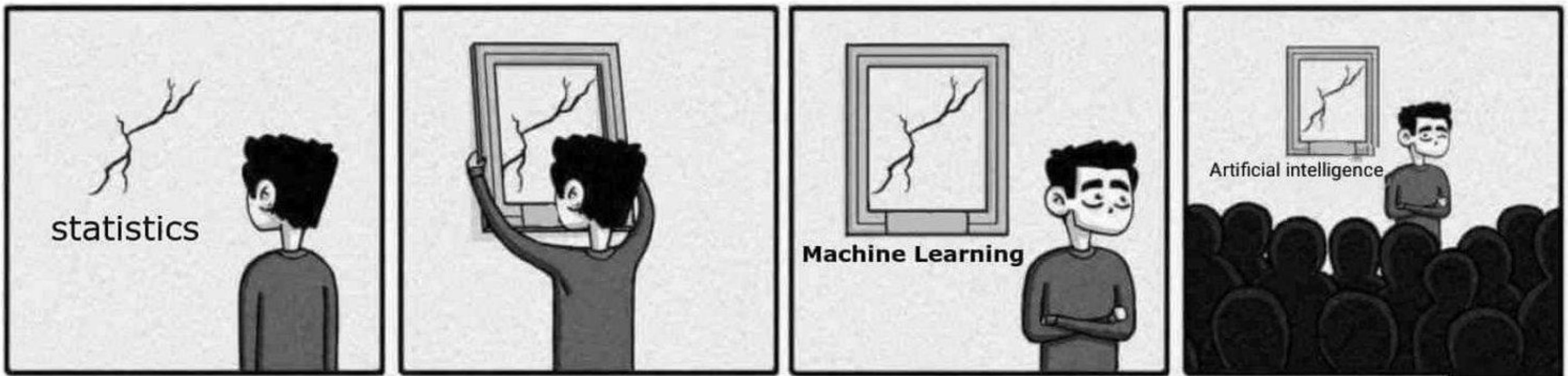




# AI

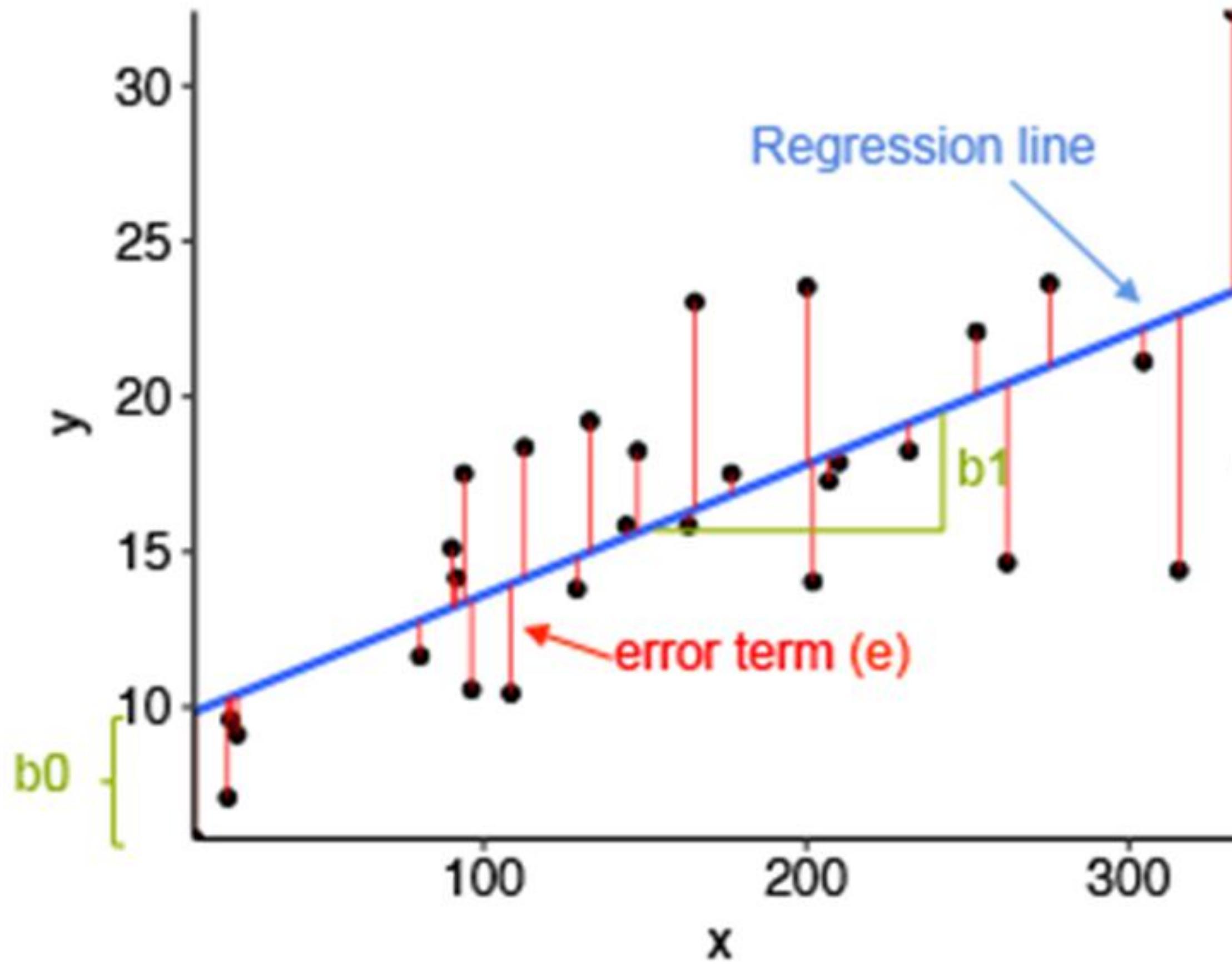
## Essentials

# LET'S MAKE STATISTICS GREAT (AGAIN)



# LINEAR REGRESSION

Regression analysis estimates the relationship between two or more variables



$$Y_i = \beta_0 + \beta_1 X_i$$

Annotations for the equation:

- Constant/Intercept: Points to  $\beta_0$
- Independent Variable: Points to  $X_i$
- Slope/Coefficient: Points to  $\beta_1$
- Dependent Variable: Points to  $Y_i$

# LINEAR REGRESSION APPLICATIONS

Business: Relationship between advertising spending and new revenue.

Medecine: Relationship between drug dosage and blood pressure of patients.

Agriculture: Effect of fertilizer and water on crop yields.

Sports: Effect that different training regimens have on player performance.

Stocks: Prediction of how stocks will perform in the future based on past data

Retail: Prediction of consumer behavior

Etc.

File Home Insert Draw Page Layout Formulas Data Review View Help Tell me what you want to do

Cut Copy Paste Format Painter Clipboard

Font Alignment Number Styles

A2 : X ✓ fx =SLOPE(B2:B8,A2:A8)

	A	B	C	D	E	F	G	H	I	J	K
1	<b>Homework Scores</b>	<b>Test Scores</b>									
2		57	65								
3		98	87								
4		95	98								
5		80	72								
6		86	82								
7		0	25								
8		46	50								
9											
10	r=		0.9758322								
11	y=ax+b										
12	slope a=										
13		=SLOPE(B2:B8,A2:A8)									
14											
15											
16											

**Homework vs Test Scores**

The scatter plot displays the relationship between Homework Scores (X) and Test Scores (Y). The data points show a strong positive correlation, with the regression line indicating a positive slope of approximately 0.6905.

Homework Scores (%)	Test Scores (%)
0	25
45	50
55	65
80	72
85	82
90	98
95	87
100	80

# STATISTICAL APPROACHES

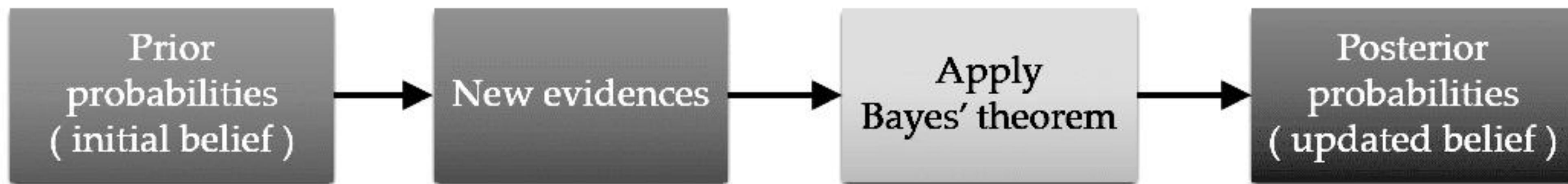
## Frequentist approach

Method which makes predictions on the underlying truths of the experiment, using only data from the current experiment.

## Bayesian approach

Method that encodes past knowledge of similar experiments into a statistical device, known as prior. This prior is combined with current experiment data to make a conclusion on the test. Essentially, you start out with a prior belief and then update it in light of new evidence.

# BAYESIAN STATISTICS



probability a hypothesis is true  
given the evidence

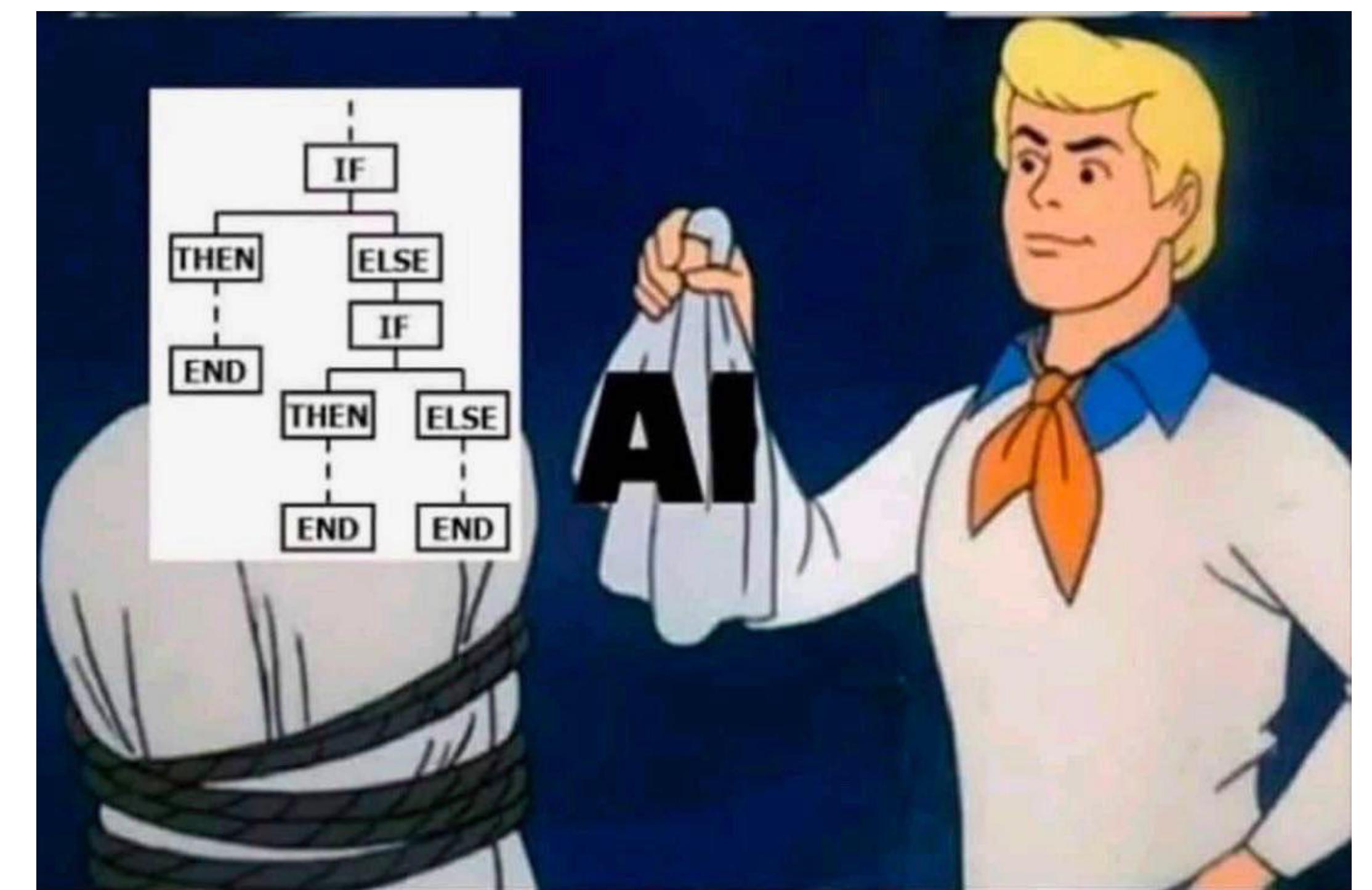
$$P(H/E) = \frac{P(H) P(E/H)}{P(E)}$$

probability a hypothesis is true  
(before any evidence is present)

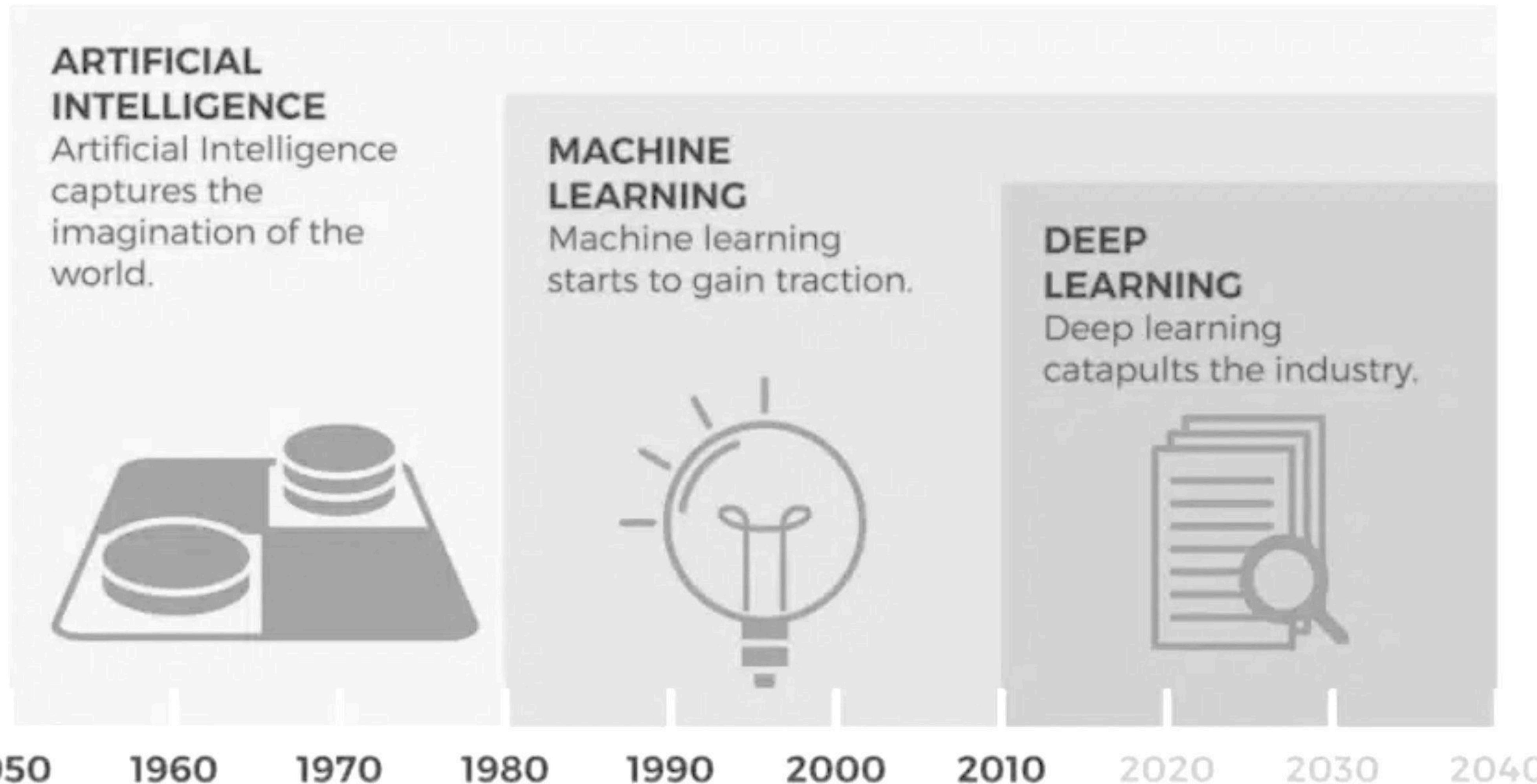
probability of seeing the evidence  
if the hypothesis is true

probability of observing the evidence

# AI-WASHING...

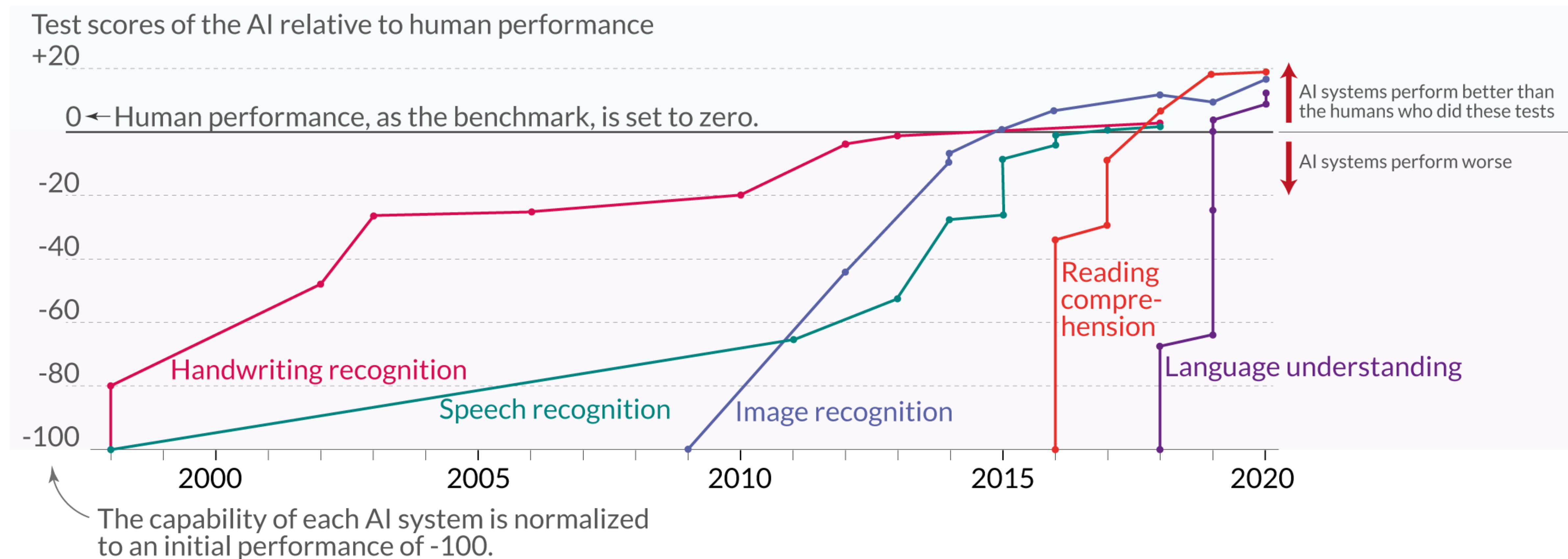


# SHORT HISTORY OF AI



# PERFORMANCE EVOLUTION VS. HUMAN

Language and image recognition capabilities of AI systems have improved rapidly



# MACHINE LEARNING

**Supervised learning** - system trained with data examples with previously known results

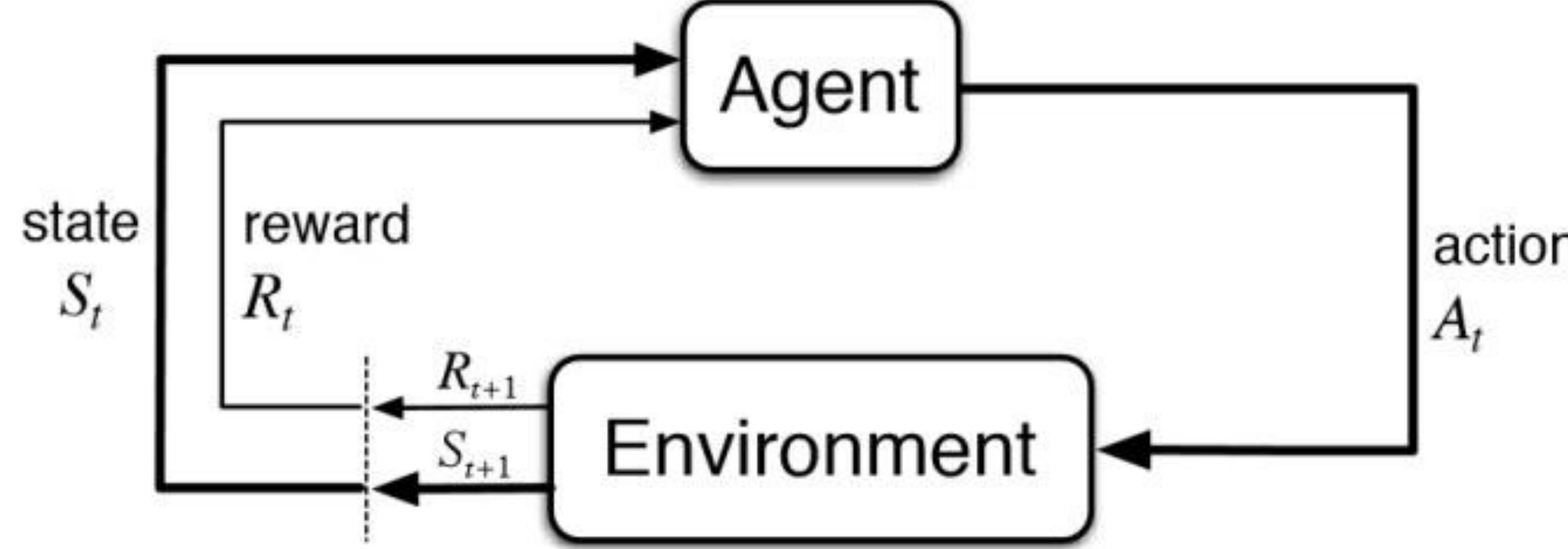
- > Regression: prediction of a continuous outcome,  
e.g. level of manufacturing emissions.
- > Classification: category (class) prediction,  
e.g. whether an email is a spam or not

**Self/Un-supervised learning** - the system finds internal relationships and patterns in the data.  
In this case, the results for each example are unknown.

**Reinforcement learning** - approach in which the system is rewarded for correct actions and penalized for wrong ones. As a result, the system learns to develop an algorithm in which it receives the highest reward and the lowest penalty.

	<i>Supervised Learning</i>	<i>Unsupervised Learning</i>
<i>Discrete</i>	classification or categorization	clustering
<i>Continuous</i>	regression	dimensionality reduction

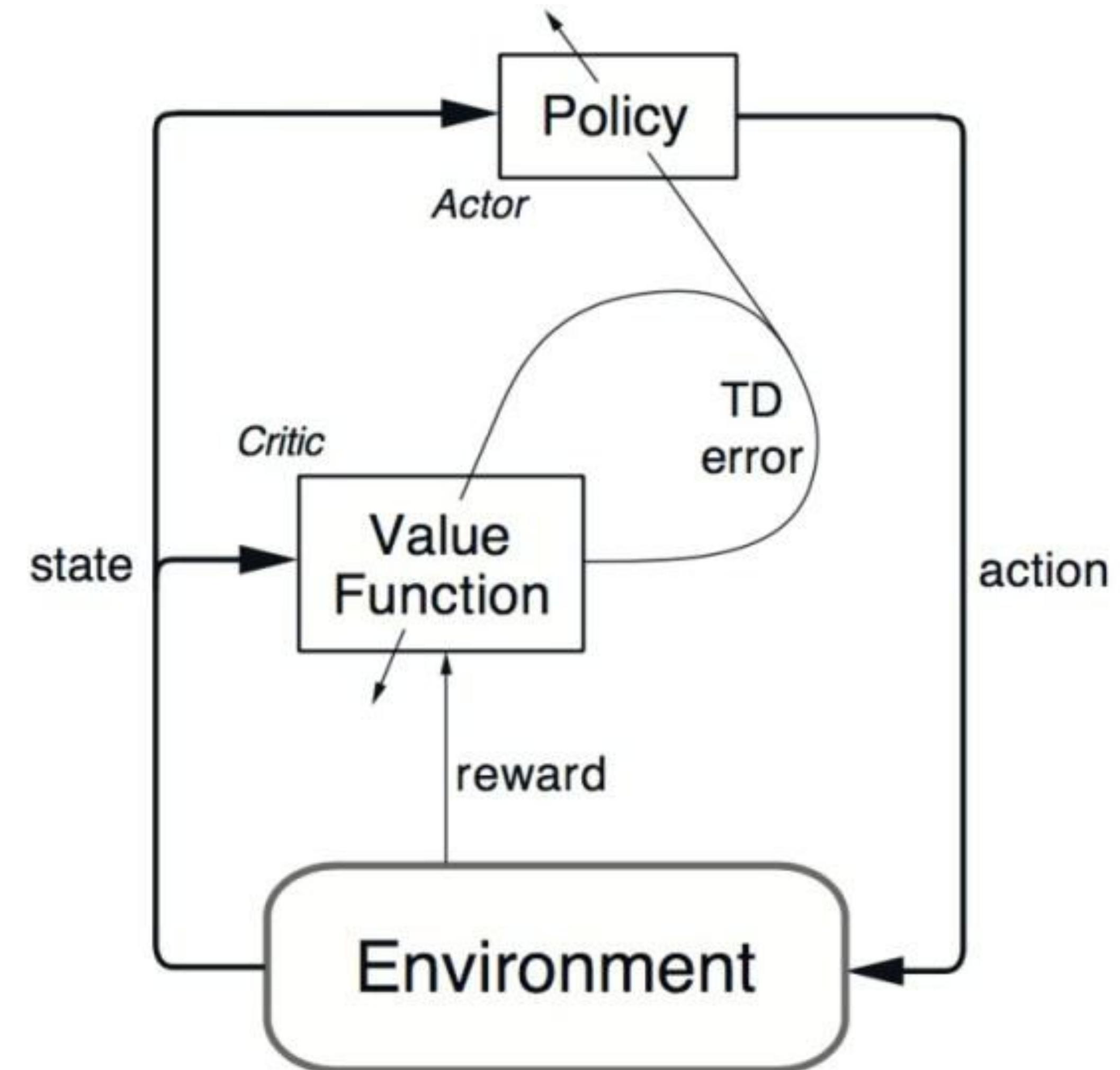
# REINFORCEMENT LEARNING



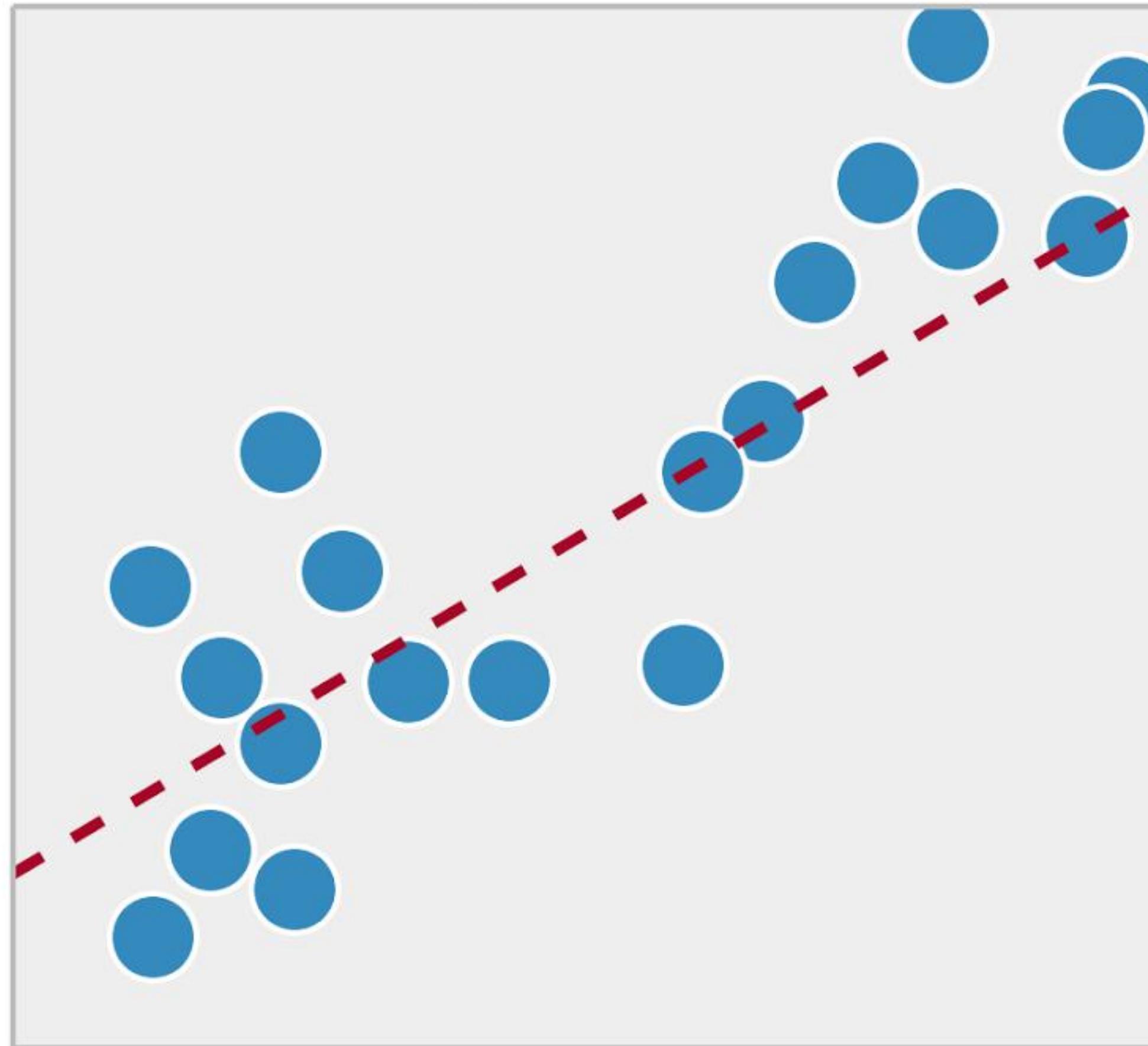
PacMan example: where the goal of the agent (PacMan) is to eat the food in the grid while avoiding the ghosts on its way.

The grid world is the interactive environment for the agent. PacMan receives a reward for eating food and punishment if it gets killed by the ghost (loses the game).

The states are the location of PacMan in the grid world and the total cumulative reward is PacMan winning the game.



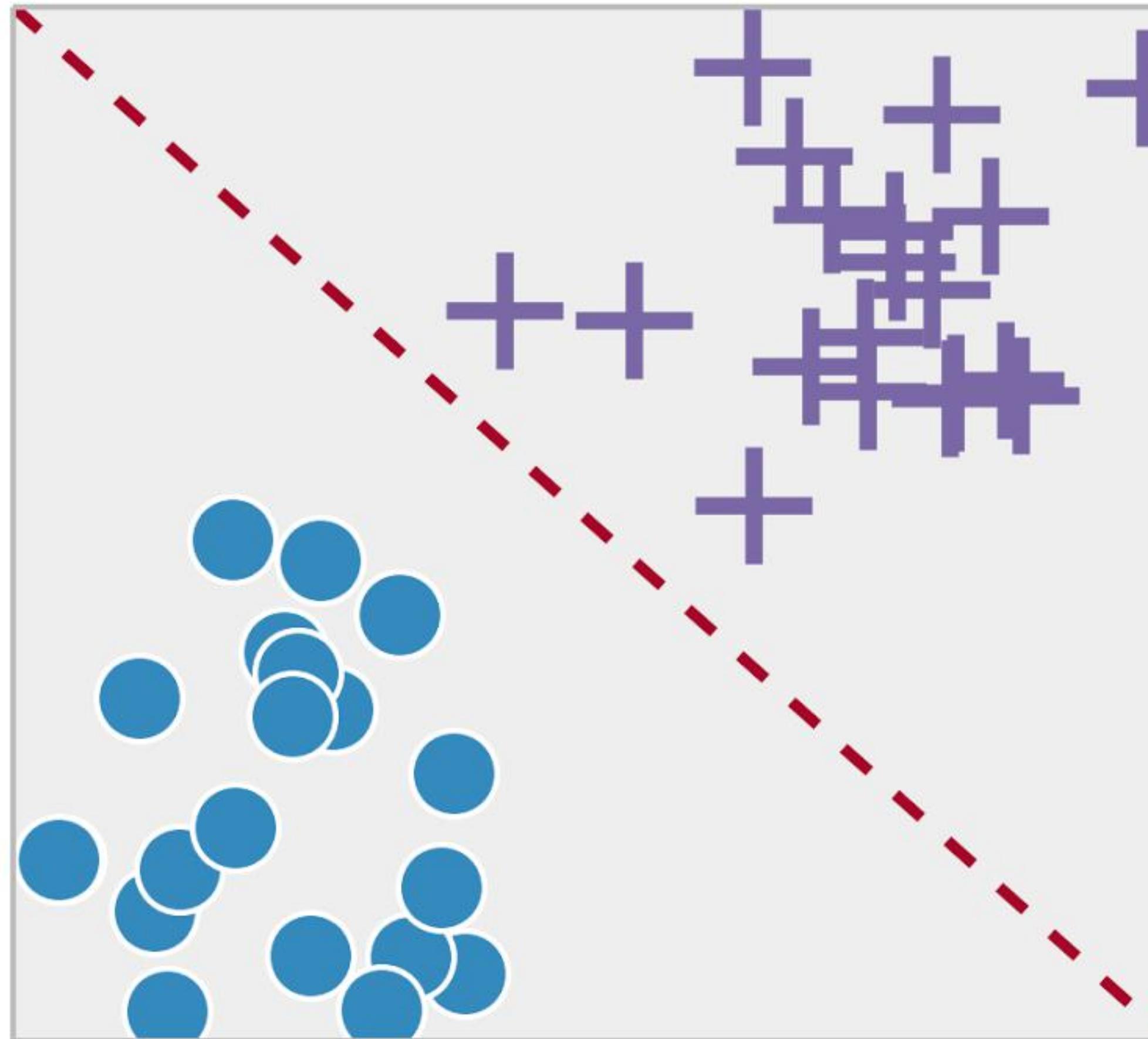
# LINEAR REGRESSION



Derived from statistics, there are multiple types of regression algorithms:

- ➊ Simple Linear Regression
- ➋ Multiple Linear Regression
- ➌ Polynomial Regression
- ➍ Support Vector Regression
- ➎ Decision Tree Regression
- ➏ Random Forest Regression

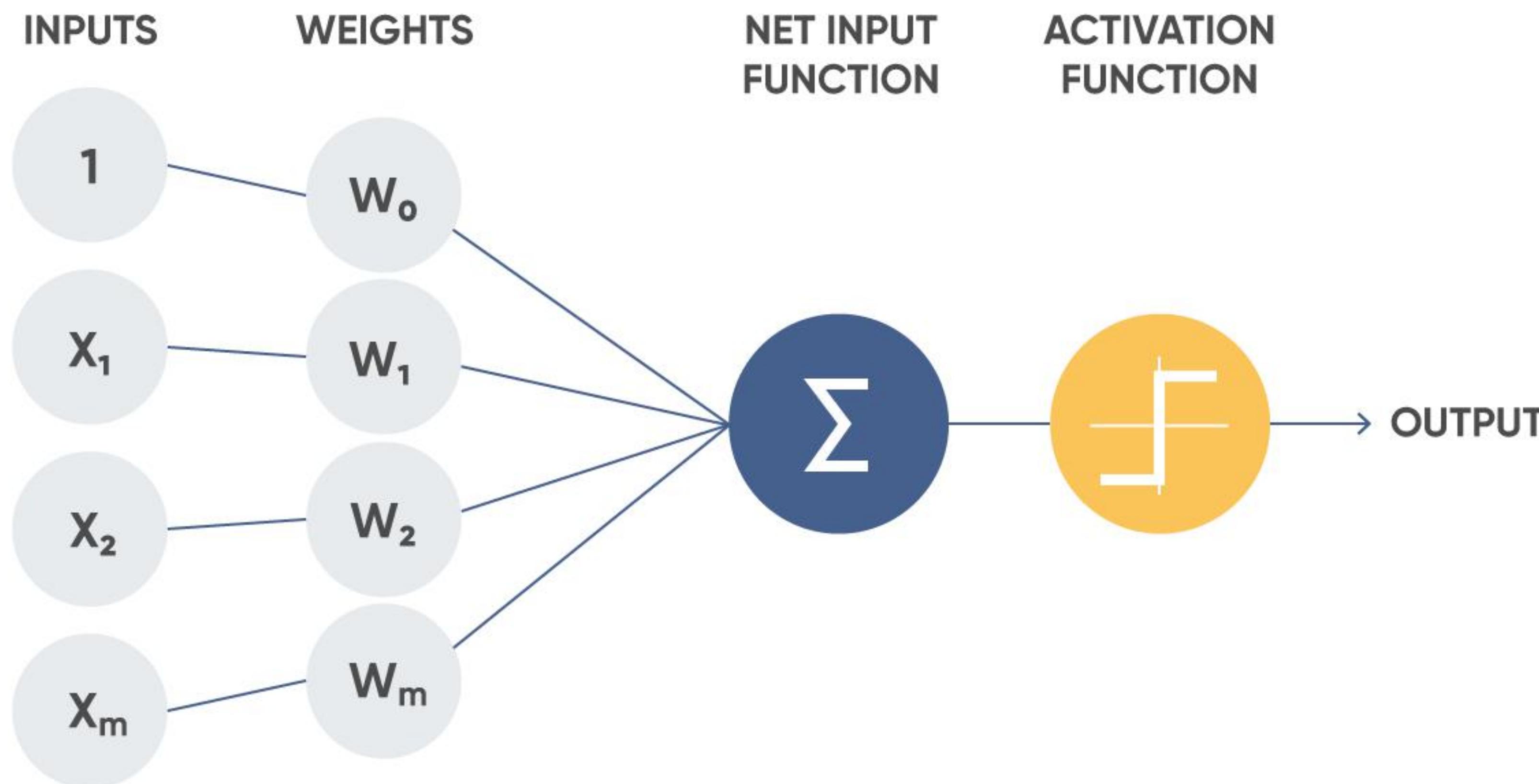
# CLASSIFICATION



Classification Algorithms can be further divided into the following types:

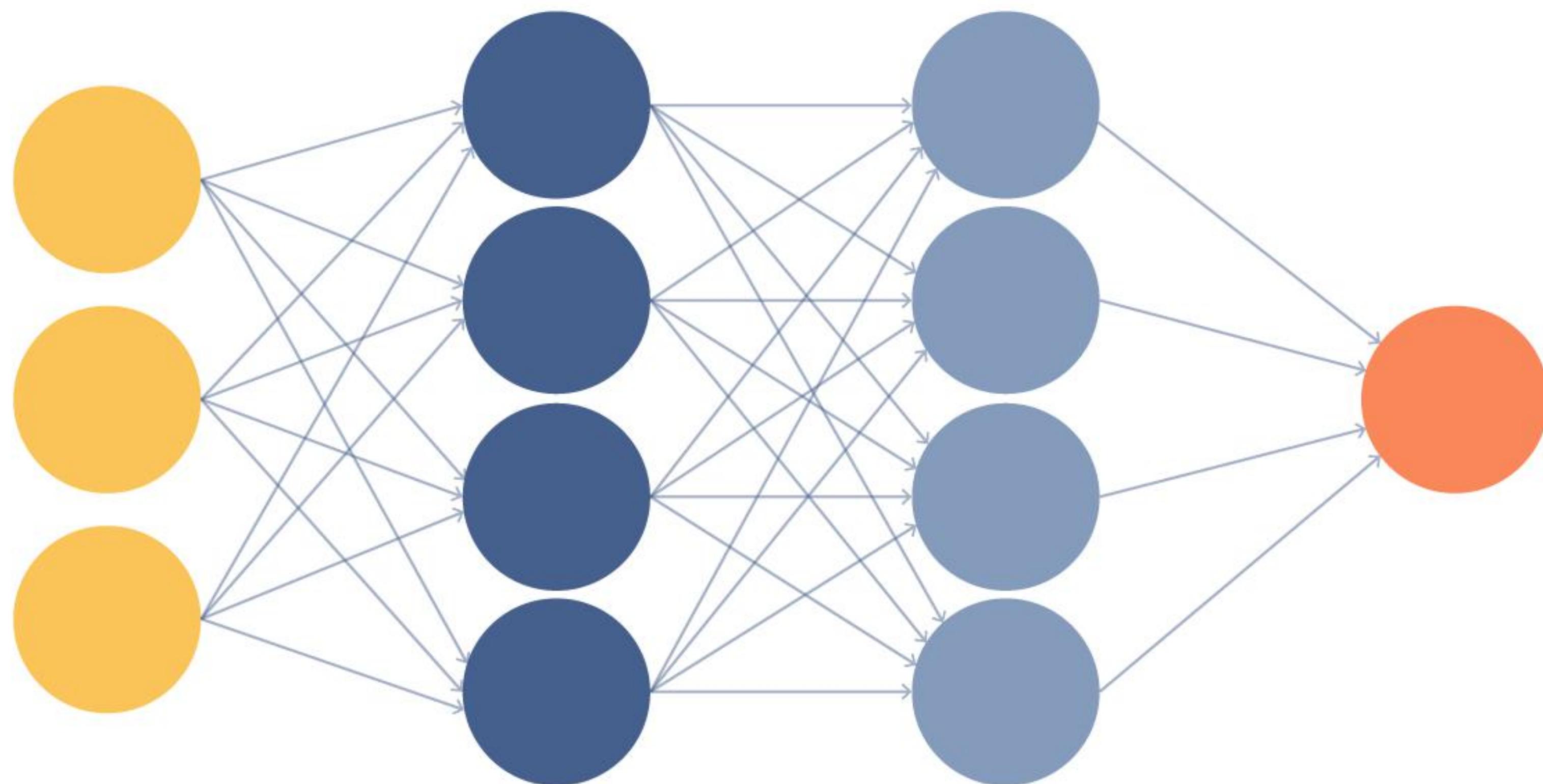
- Logistic Regression
- K-Nearest Neighbours
- Support Vector Machines
- Kernel SVM
- Naïve Bayes
- Decision Tree Classification
- Random Forest Classification

# NEURAL STRUCTURE



# STRUCTURE W/ HIDDEN LAYERS

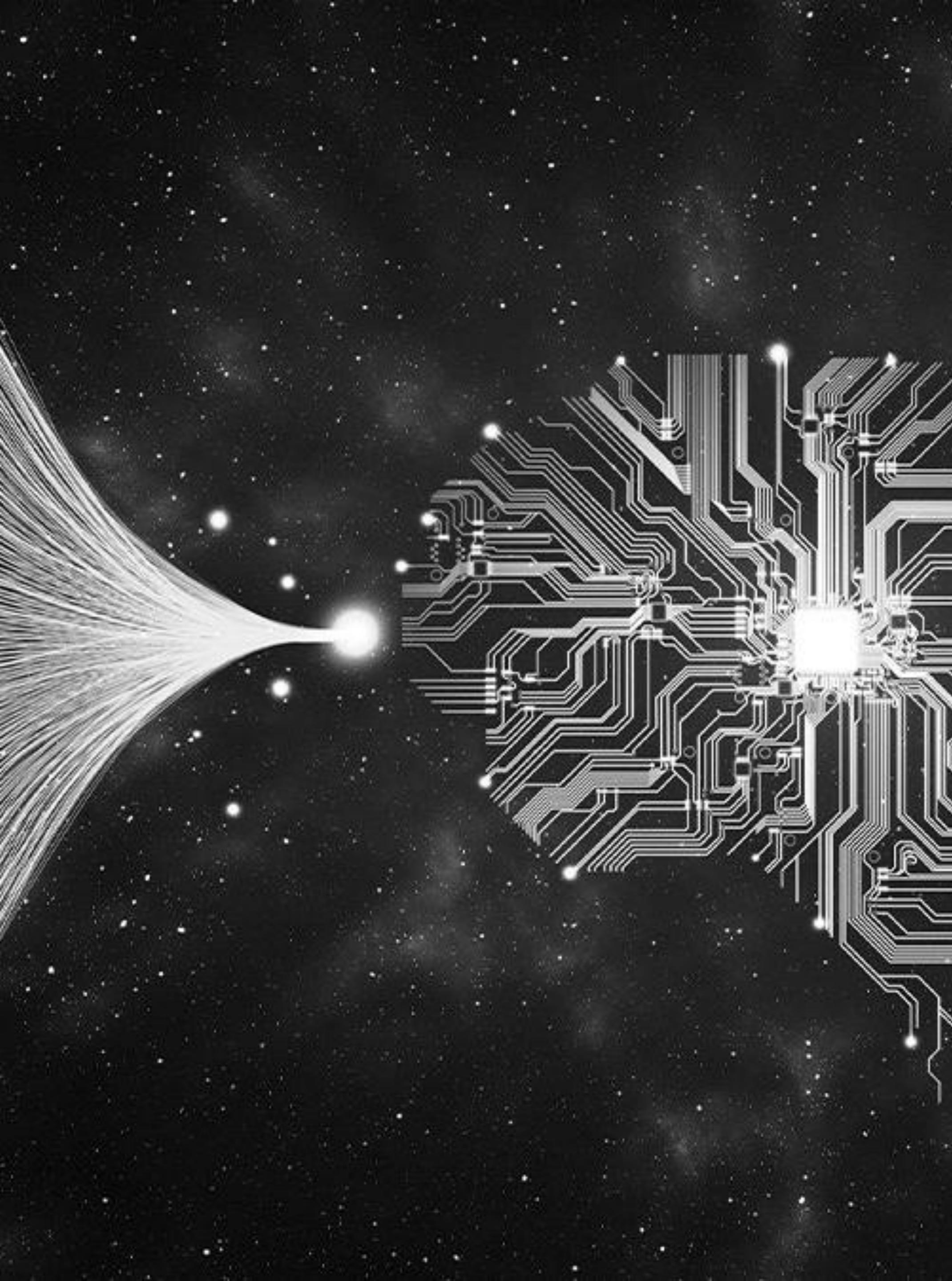
INPUT LAYER      HIDDEN LAYER 1      HIDDEN LAYER 2      OUTPUT LAYER





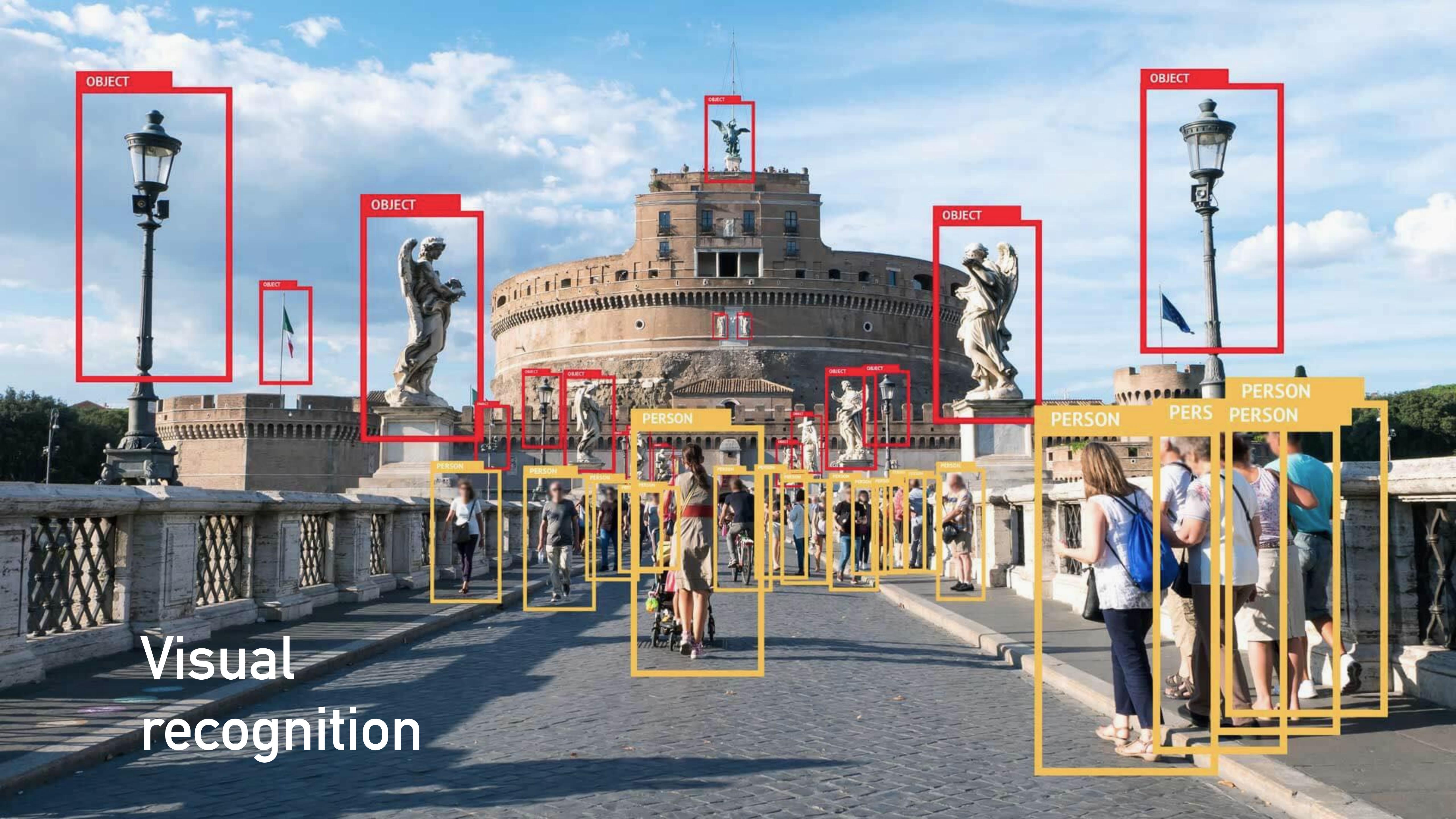
THE CONVERSATION

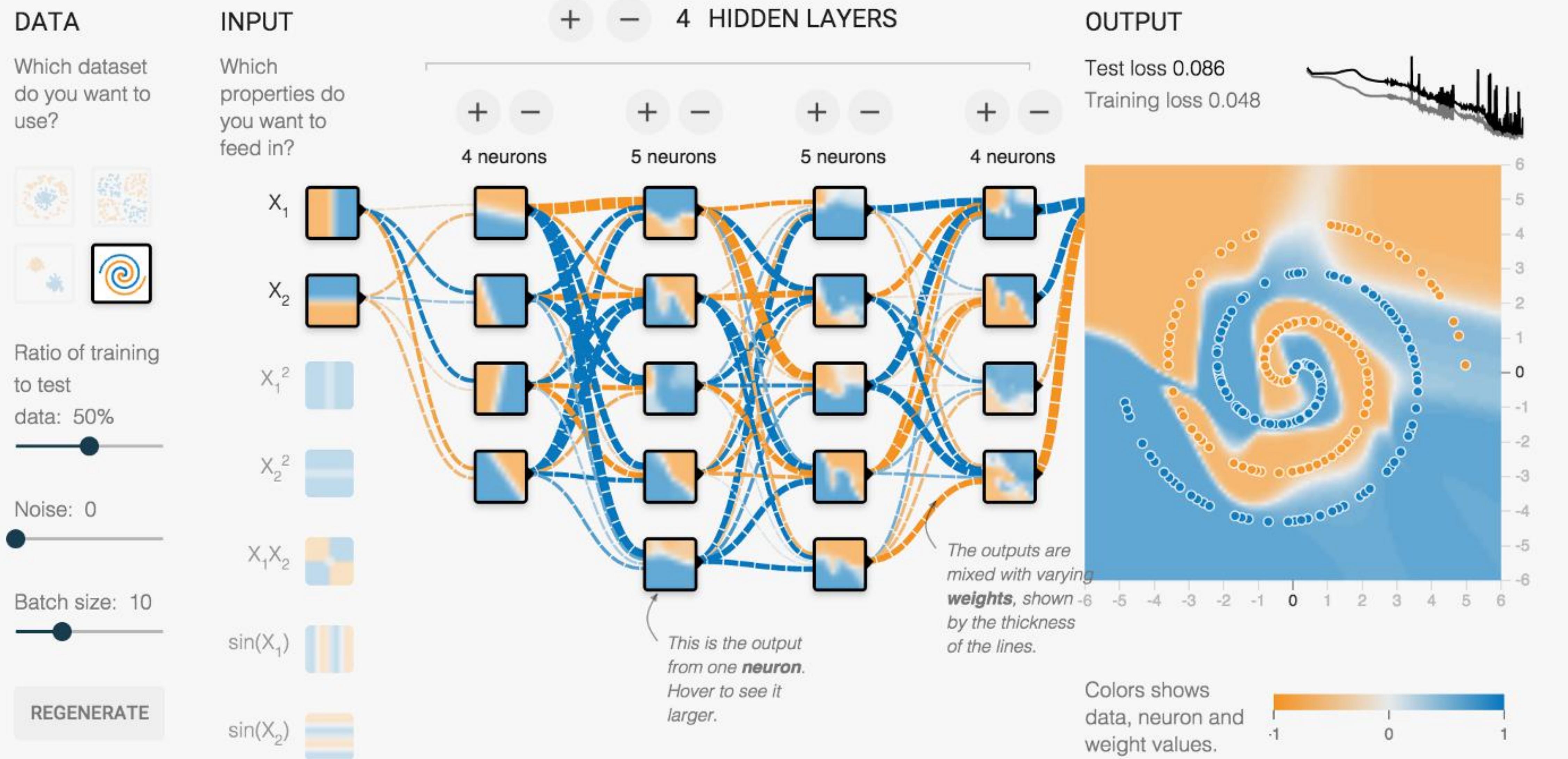
Video: neural network examples



**AIOT = AI + IOT**

# Visual recognition

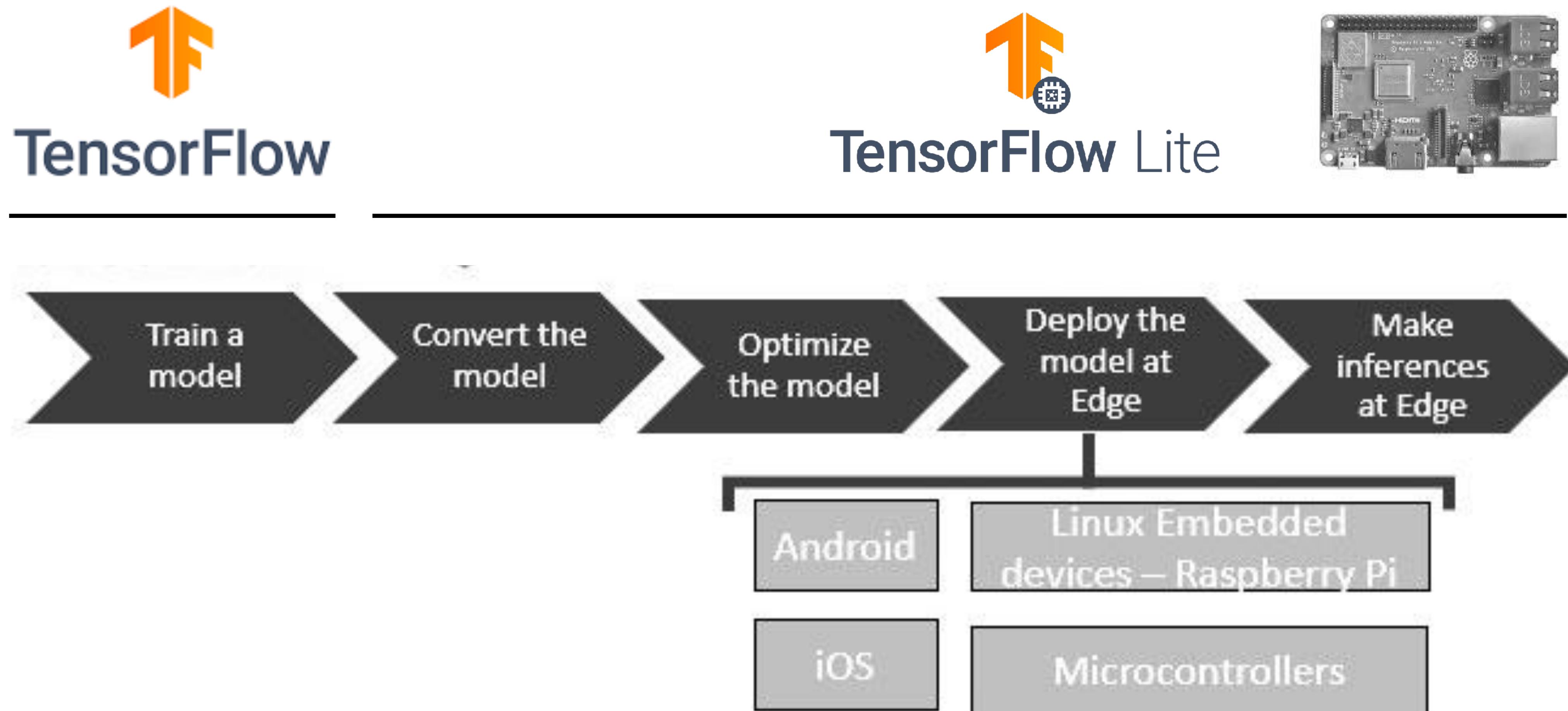






## The Google's 7 steps of Machine Learning in practice

- 1. Gathering data**
- 2. Preparing data**
- 3. Choosing a model**
- 4. Training**
- 5. Evaluation**
- 6. Hyperparameter tuning**
- 7. Prediction**



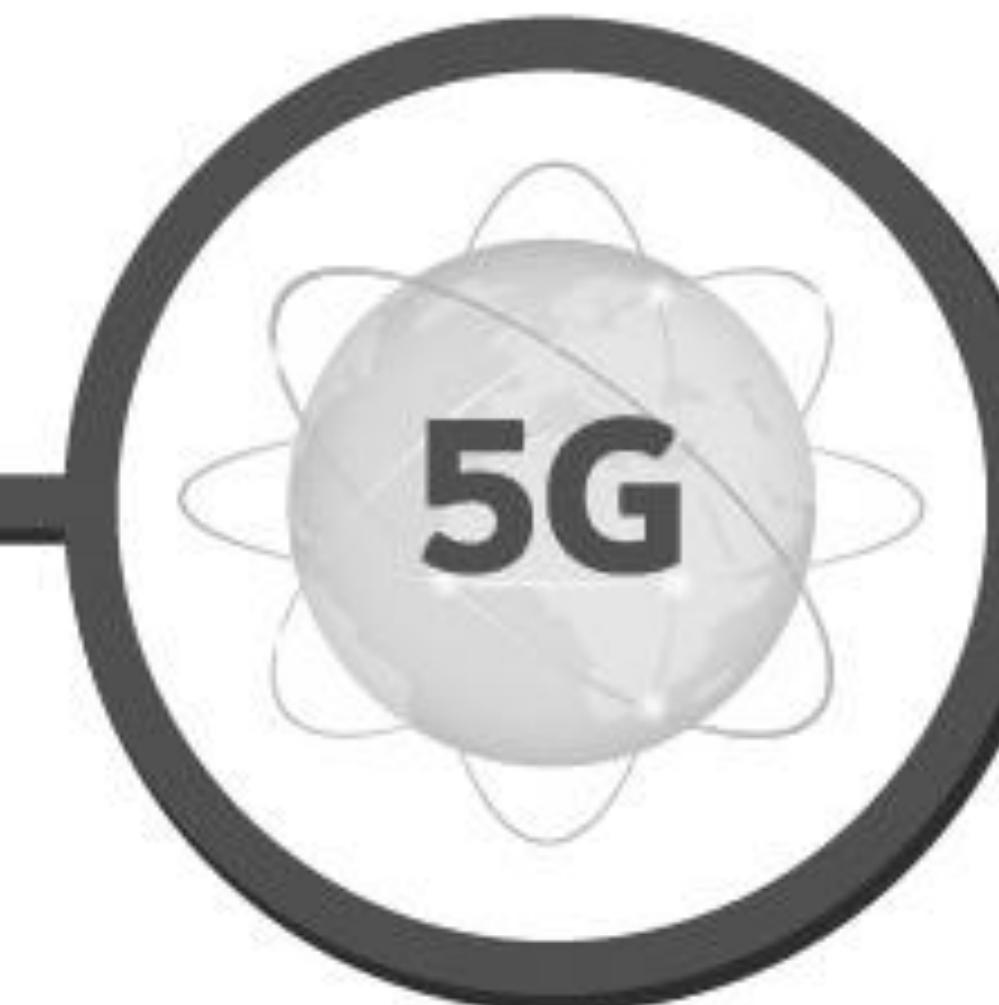
IoT is empowered by  
**three key technologies:**

**Artificial  
Intelligence (AI)**



Programmable intelligence enabling devices to learn, reason, and process information like humans

**5G Networks**



5th generation mobile networks with extremely fast, near-zero latency for real-time data processing

**Big Data**



Volumes of data from numerous Internet-connected sources, that are too large for normal processing methods

## Wearables

Wearable devices continuously monitor and track user preferences and habits. Applications include fitness and health trackers, heart rate monitoring, wireless headphones, and AR/VR devices.



Smart  
watches



AR/VR  
goggles



Wireless  
earbuds

## Smart Home

Smart home devices such as thermostats, coffee makers, lights, and smart TVs learn a user's habits to develop automated home "support" for everyday tasks. Applications include energy efficiency, safety, entertainment, access control, and personal comfort.



Smart  
speakers



IoT  
appliances



Smart  
thermostats

## Smart City

Smart cities that integrate all levels of municipal services are becoming safer, more convenient places to live. Applications include open data for better urban planning, optimized energy consumption, and increased public safety through smart traffic surveillance.



Smart  
energy grids



Smart  
streetlights



Smart public  
transportation

## Smart Industry

Smart industry devices—the Industrial Internet of Things (IIoT)—use real-time data analytics and machine-to-machine sensors to optimize operations, logistics, and supply chain. Data generated from these devices helps industries foresee challenges—preventing costly errors and workplace injuries.



Autonomous  
manufacturing  
robots

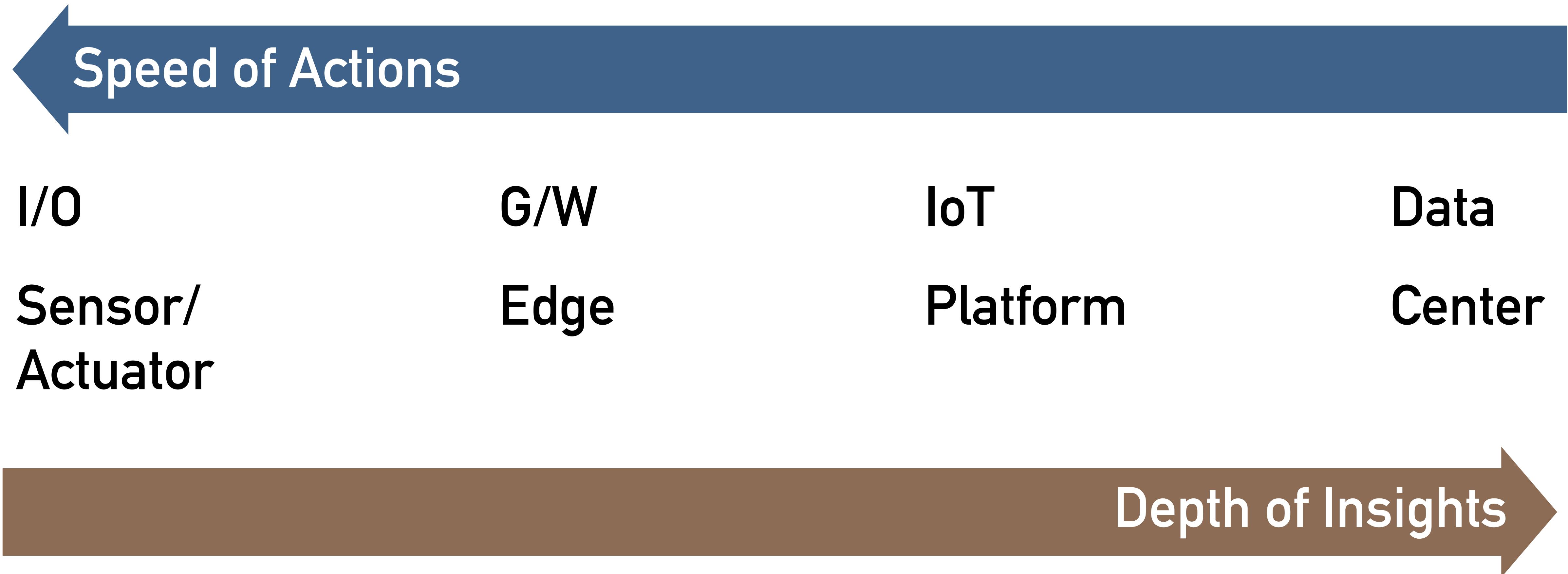


Automated  
supply chain  
management



Predictive  
maintenance  
sensors

# DEPTH OF INSIGHTS VS. SIMPLE IMMEDIACY



# DISTRIBUTED LEDGERS

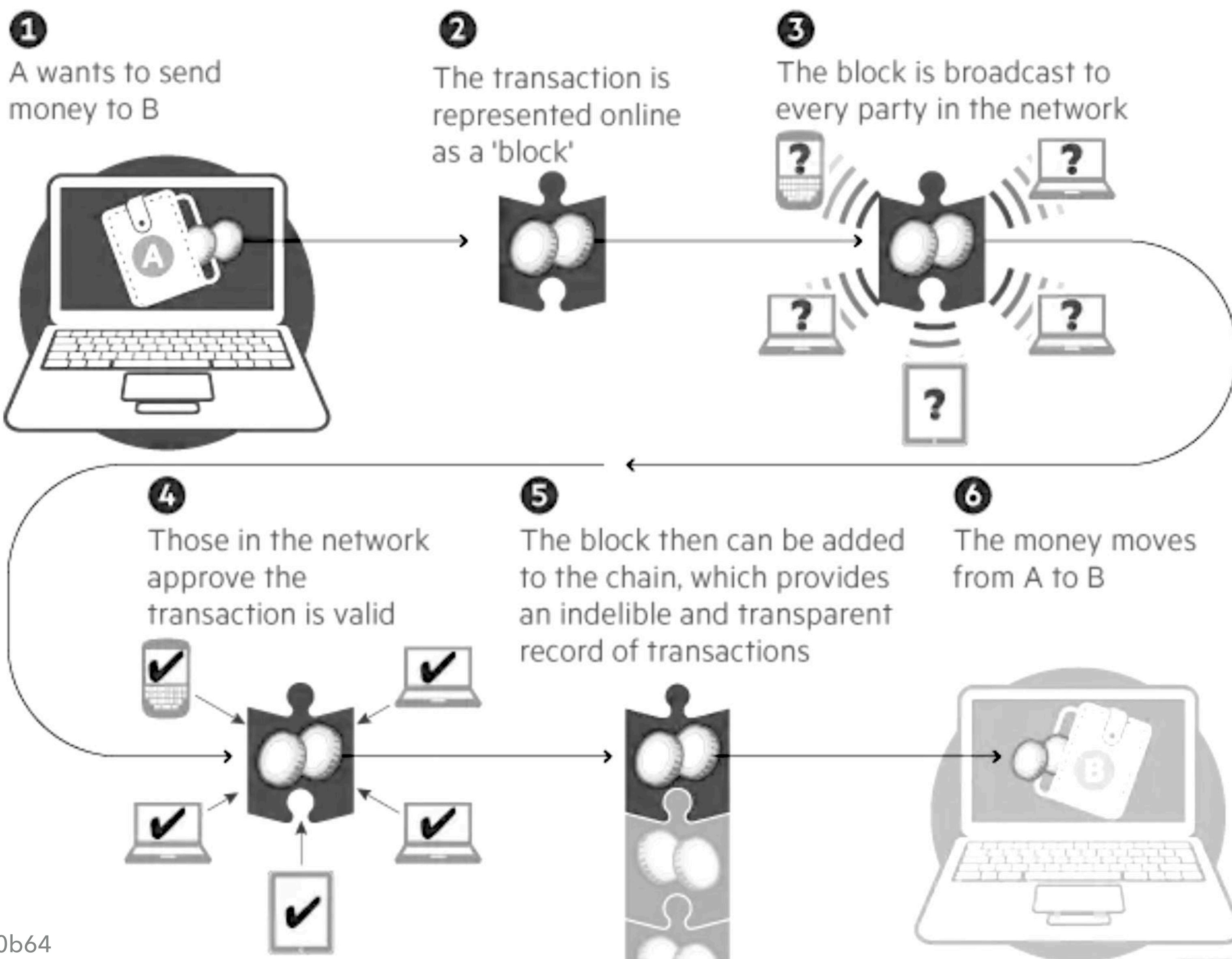
DCT, blockchain, smart contracts

# BLOCKCHAIN

**Blockchain is essentially a shared database filled with entries that must be confirmed and encrypted.**

- Business insider Intelligence

# HOW BLOCKCHAIN WORKS



# DISTRIBUTED LEDGER TECHNOLOGY (DLT)

**Distributed ledger technology provides a trusted, immutable ledger on which organizations can transmit and store valuable information based on internal operations or interactions with the organization's environment, including IoT devices.**

[https://www.iiconsortium.org/pdf/Digital\\_Transformation\\_in\\_Industry\\_Whitepaper\\_2020-07-23.pdf](https://www.iiconsortium.org/pdf/Digital_Transformation_in_Industry_Whitepaper_2020-07-23.pdf)

[https://www.iiconsortium.org/pdf/Distributed\\_Ledgers\\_in\\_IoT\\_White\\_Paper\\_2020-07-22.pdf](https://www.iiconsortium.org/pdf/Distributed_Ledgers_in_IoT_White_Paper_2020-07-22.pdf)

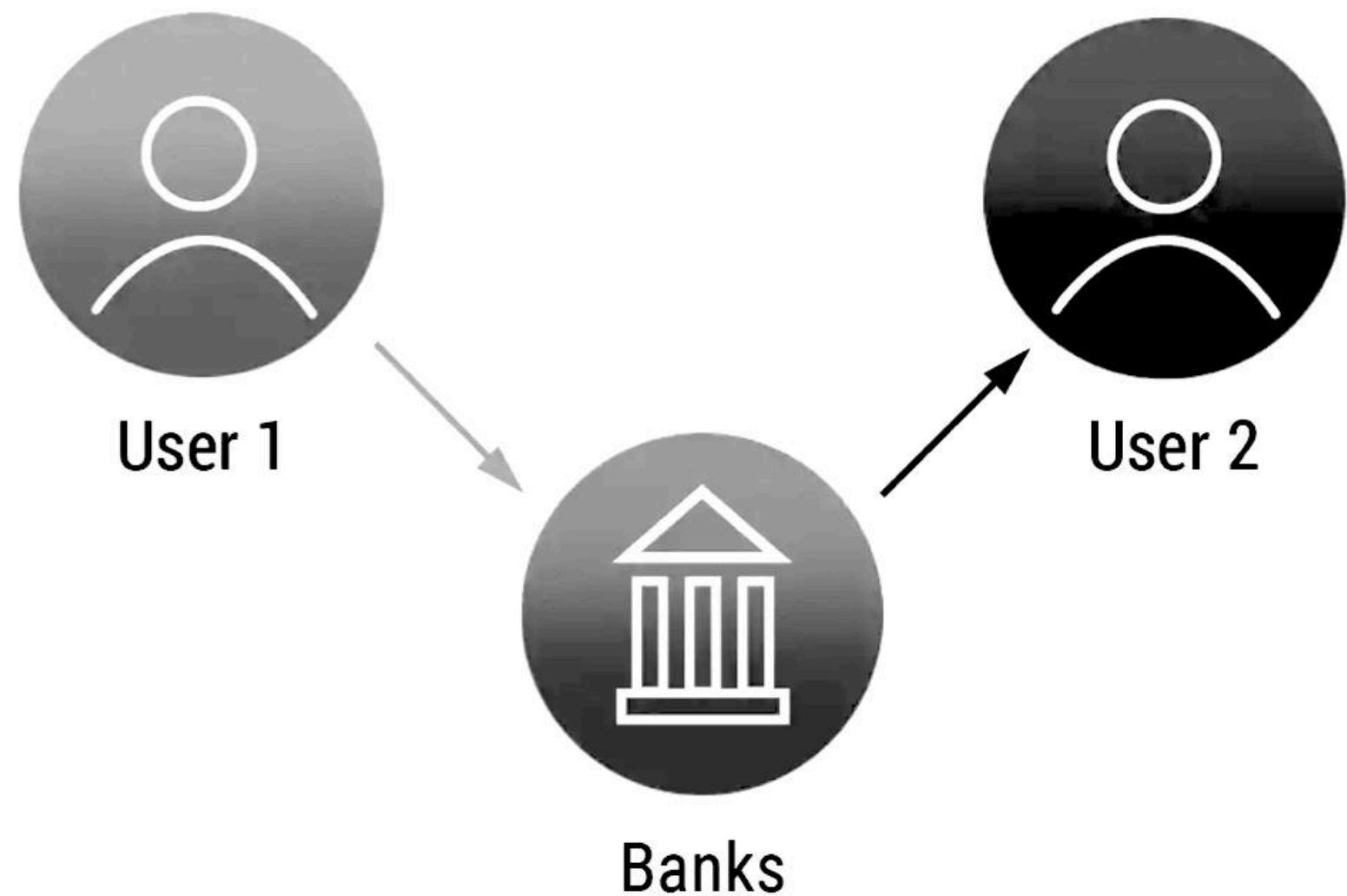
# SMART CONTRACTS

Smart contracts are simply programs stored on a blockchain that run when predetermined conditions are met.

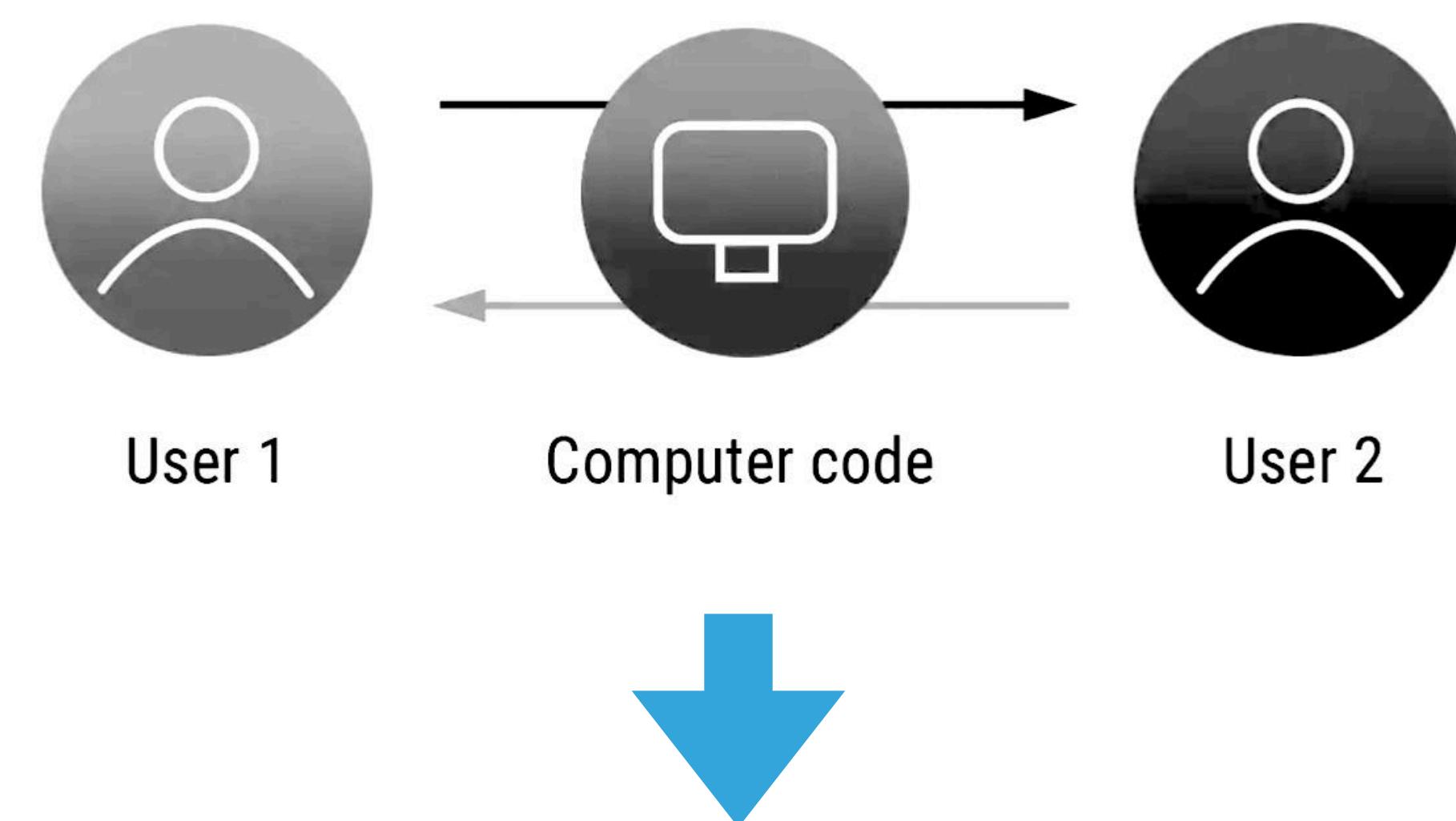
They typically are used to automate the execution of an agreement so that all participants can be immediately certain of the outcome, without any intermediary's involvement or time loss.

# SMART CONTRACTS

**Traditional Transactions**



**Smart Contract**



**Efficiency, Sovereignty  
Trust, Security, Savings**

# CONNECTING FOOD

Food traceability  
increases consumer trust



[https://youtu.be/n\\_XnEKJVXo](https://youtu.be/n_XnEKJVXo)



# IOT SECURITY

IoT vulnerabilities & best practices

# SECURITY ALERT



# SECURITY ALERT

**5.8b** enterprise & automotive devices  
were connected to the internet in 2020.

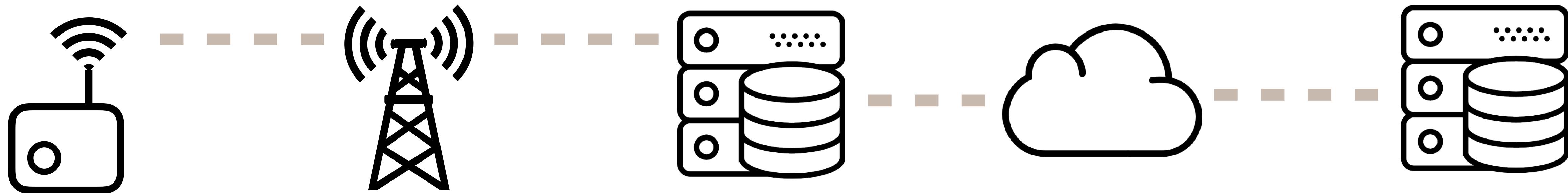
**98%** of all IoT device traffic is unencrypted.

**57%** of IoT devices are vulnerable  
to medium or high severity attacks.

# THREATS ALONG THE VALUE CHAIN

Design faults  
No updates  
Bad lifecycle

unsecure  
communications



policy  
management  
...

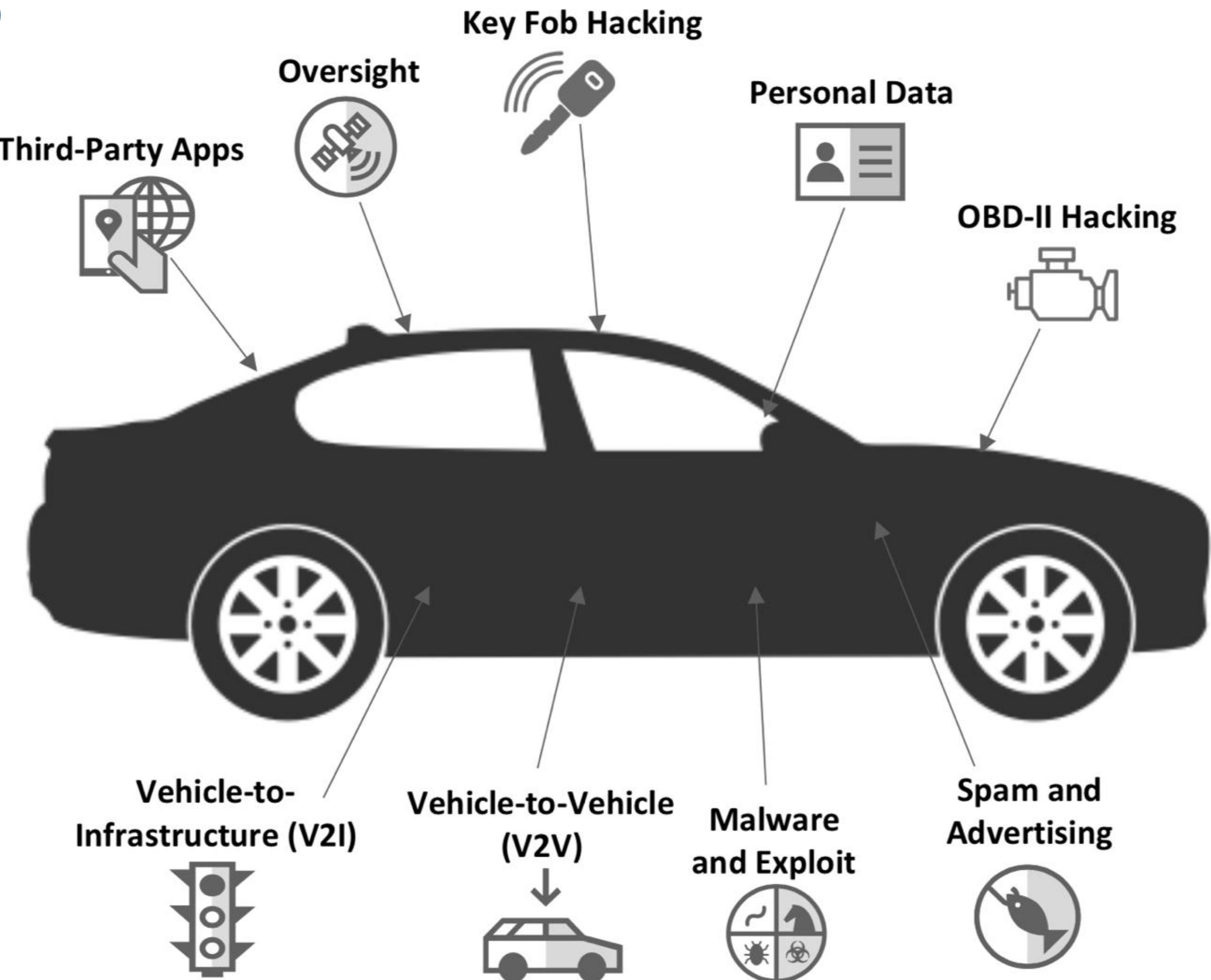
no https  
no VPNs  
...

code, lack of  
penetration  
testing...

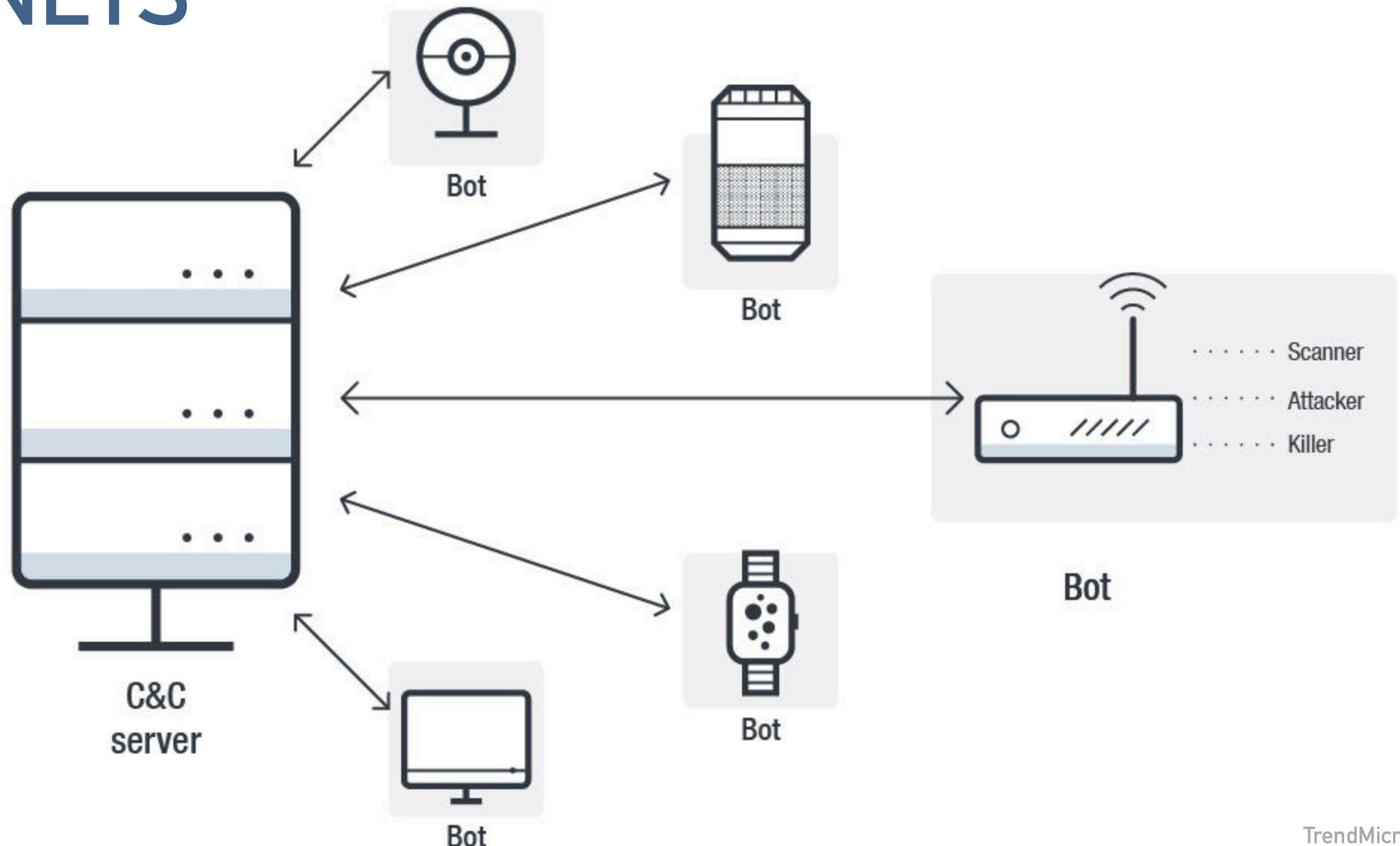
DoS, policy management,  
No/insecure updates  
Physical attacks...

# CONNECTED CARS

multi-layered  
vulnerabilities



# IOT BOTNETS



# SOME FAMOUS BOTNETS

Hydra (2008)

DDoS via brute force attacks / routers

Aidra (2012)

Cryptocurrency mining via Telnet attacks

Bashlite (2014)

Attacks / Cameras, DVR, routers, etc.

Remaiten (2016)

Sophisticated DDoS attacks via IoT devices

Mirai (2016)

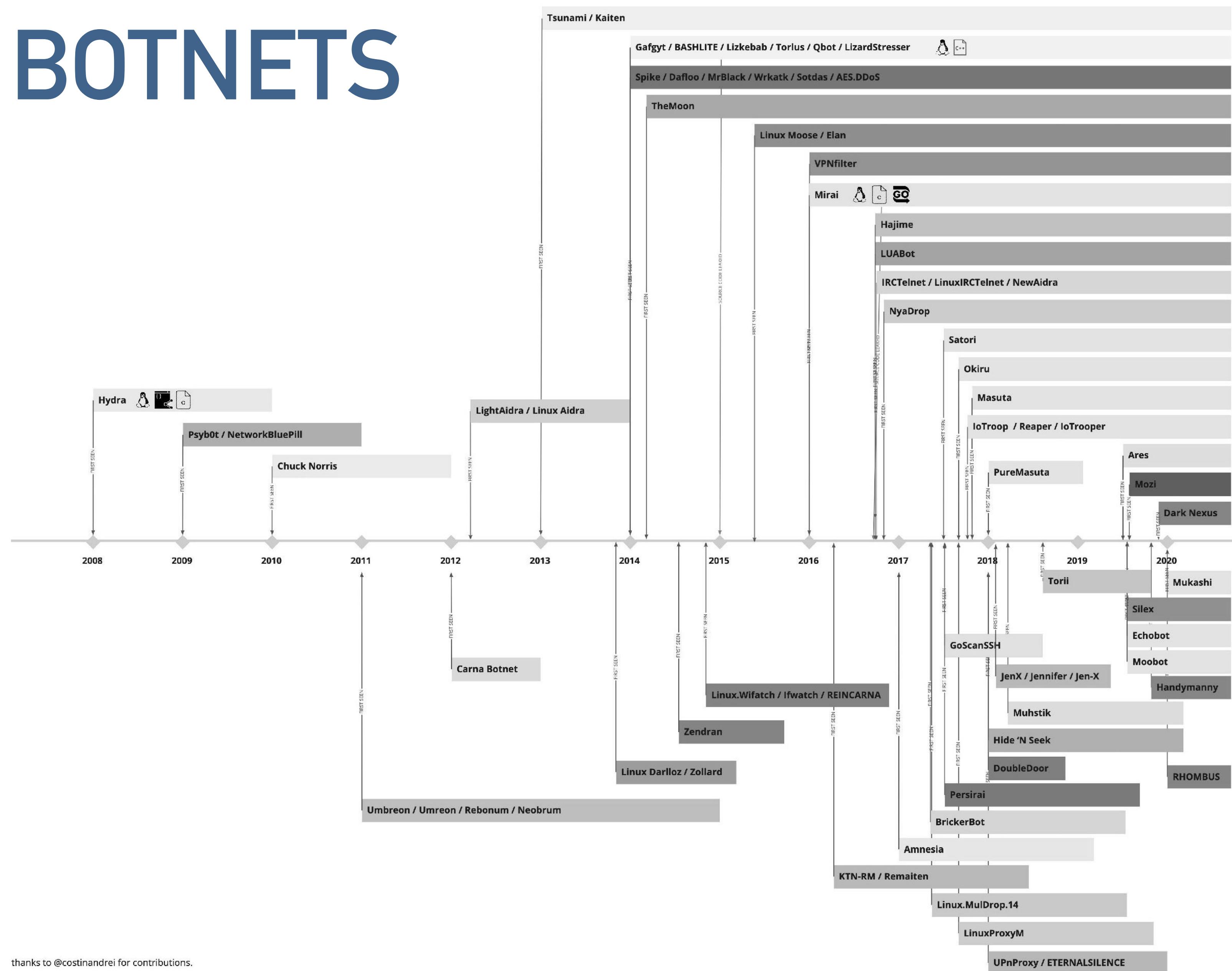
DNS attacks via 100,000 infected devices:  
cameras, baby monitors, home routers, etc.

Persirai (2017)

Camera control (1,000 models) via uPnP attacks

# MORE FAMOUS BOTNETS

- | 2017 | Persirai
- | 2017 | Satori
- | 2017 | LinuxProxyM
- | 2017 | IoTroop / Reaper / IoTrooper
- | 2017 | Masuta
- | 2017 | GoScanSSH
- | 2017 | Okiru
- | 2018 | UPnProxy / ETERNALSILENCE
- | 2018 | DoubleDoor
- | 2018 | Hide 'N Seek
- | 2018 | JenX / Jennifer / Jen-X
- | 2018 | Muhsrik
- | 2018 | PureMasuta
- | 2018 | Torii
- | 2019 | Ares
- | 2019 | Mozi
- | 2019 | Silex
- | 2019 | Echobot
- | 2019 | Moobot
- | 2019 | Dark Nexus
- | 2019 | Handymanny
- | 2020 | Mukashi
- | 2020 | Rhombus

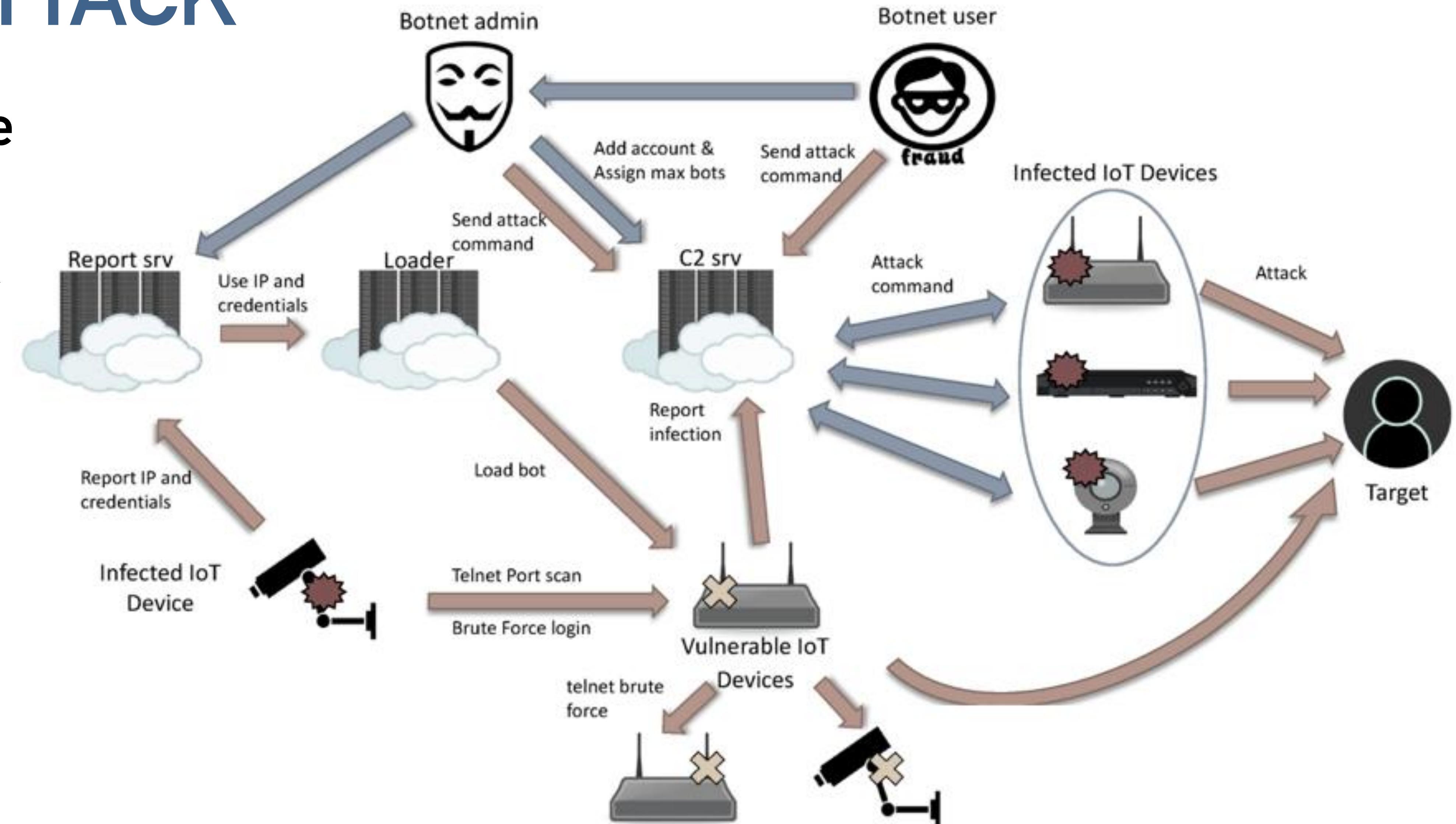


# MIRAI ATTACK

Attack module  
DoS methods

Process killer  
telnet, SSH,  
HTTP...

Scanner  
random IP  
addresses to  
brute force



# INDUSTRIES: VIDEO CAMERAS



**+19% increase**

in the actual number  
of **products affected**

**139**



2020 2H

**165**



2021 1H



VULNERABILITIES DISCLOSED BY NOZOMI NETWORKS



**Vendor**

Reolink

**Equipment**

P2P Protocol

**Sector**

Communications

**Disclosure Date**

Jan. 19, 2021

**ICS Advisory**

ICSA-21-019-02

## Reolink P2P Video/Audio Lack of Encryption and Stream Reconstruction — CVE-2020-25169

**CWE-321**

Use of Hard-coded Cryptographic Key

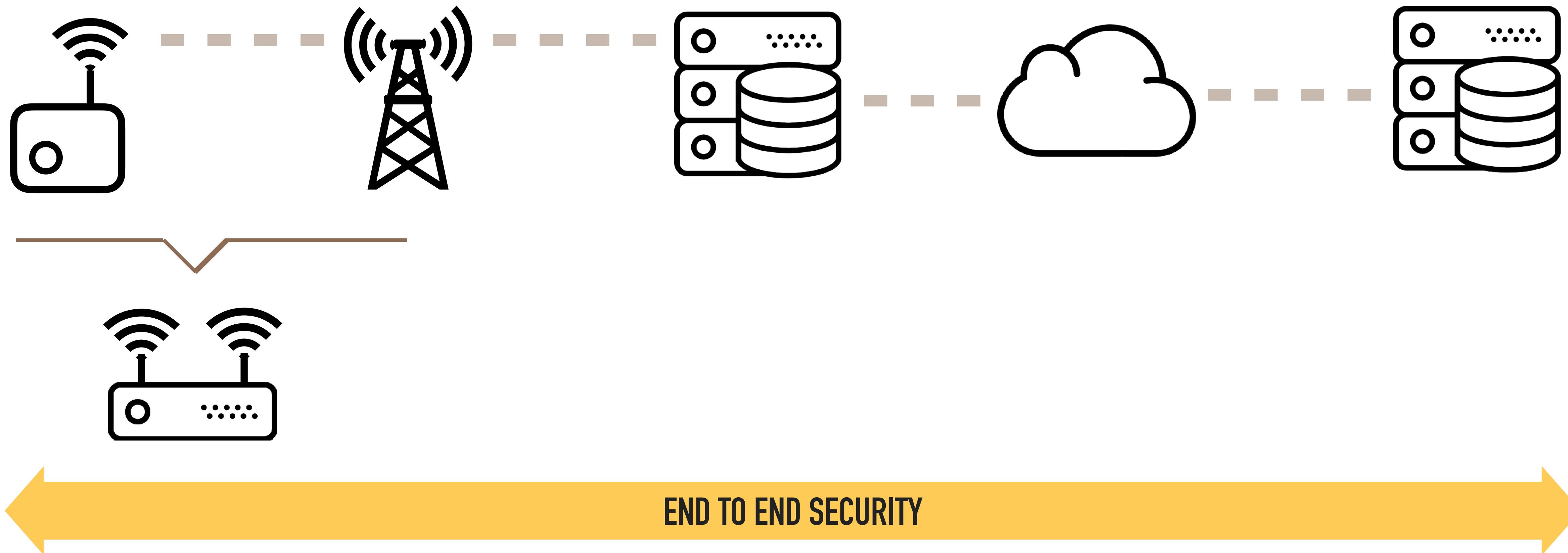
**CWE-319**

Cleartext Transmission of Sensitive Information

**Description**

Reolink P2P video/audio stream is transmitted without any encryption. Any actor who can access the client/NVR traffic as it traverses the internet can access its content with no confidentiality for the parties involved.

# AVOIDING WEAKEST LINK > E2E SECURITY



# GUIDANCE

Zero Trust approach

Security by design

Security by operations

**SASE approach**

Strong Authentication

Strong Encryption

IoT SAFE (SIM based)

Etc.

# ALLIANCE



**ioxxt**  
internet of **secure** things

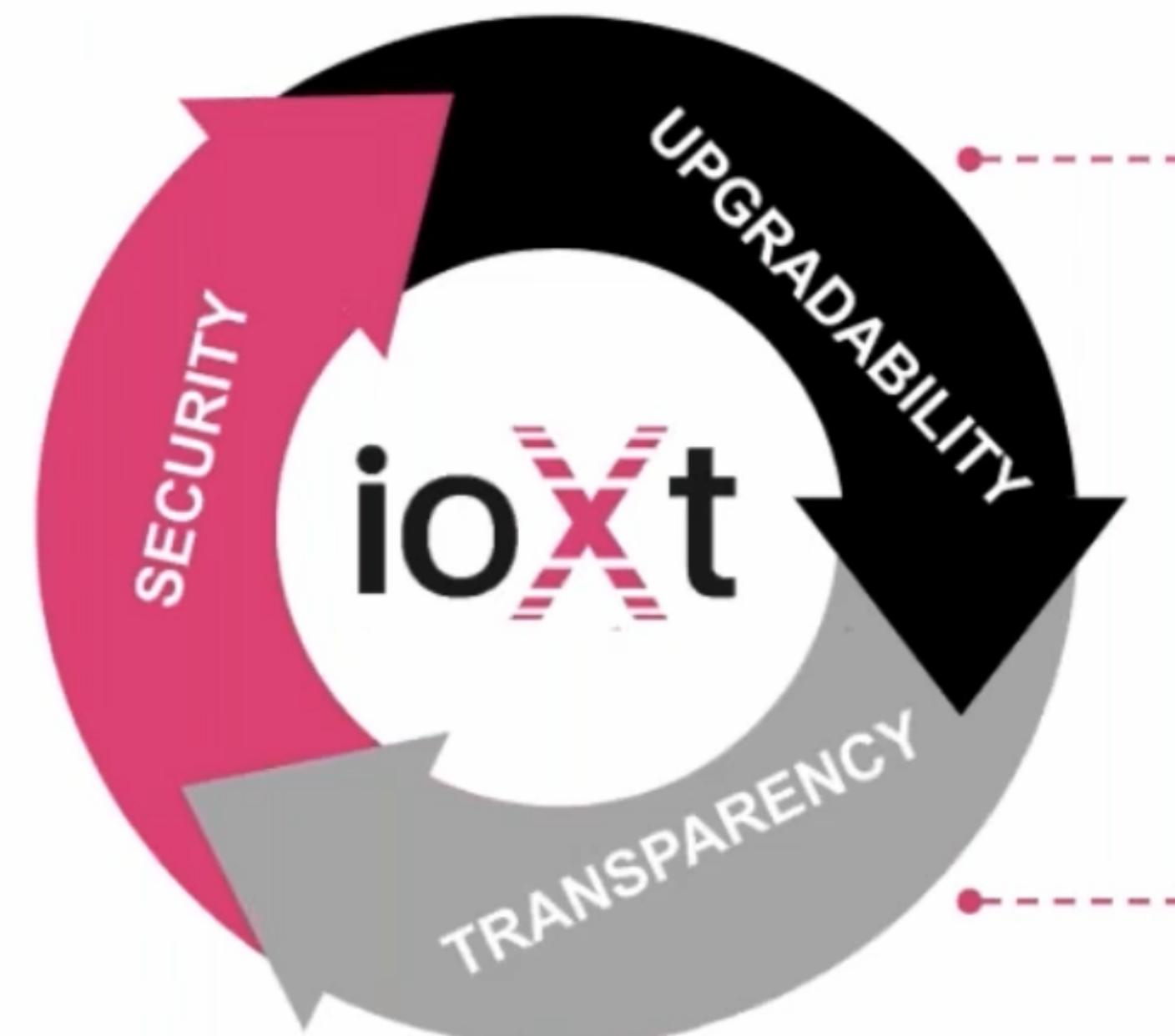
# BEST PRACTICES

## ioXt Security Pledge



### SECURITY

- No Universal Passwords
- Secured Interfaces
- Proven Cryptography
- Security by Default



### UPGRADABILITY

- Automatic Security Updates
- Verified Software



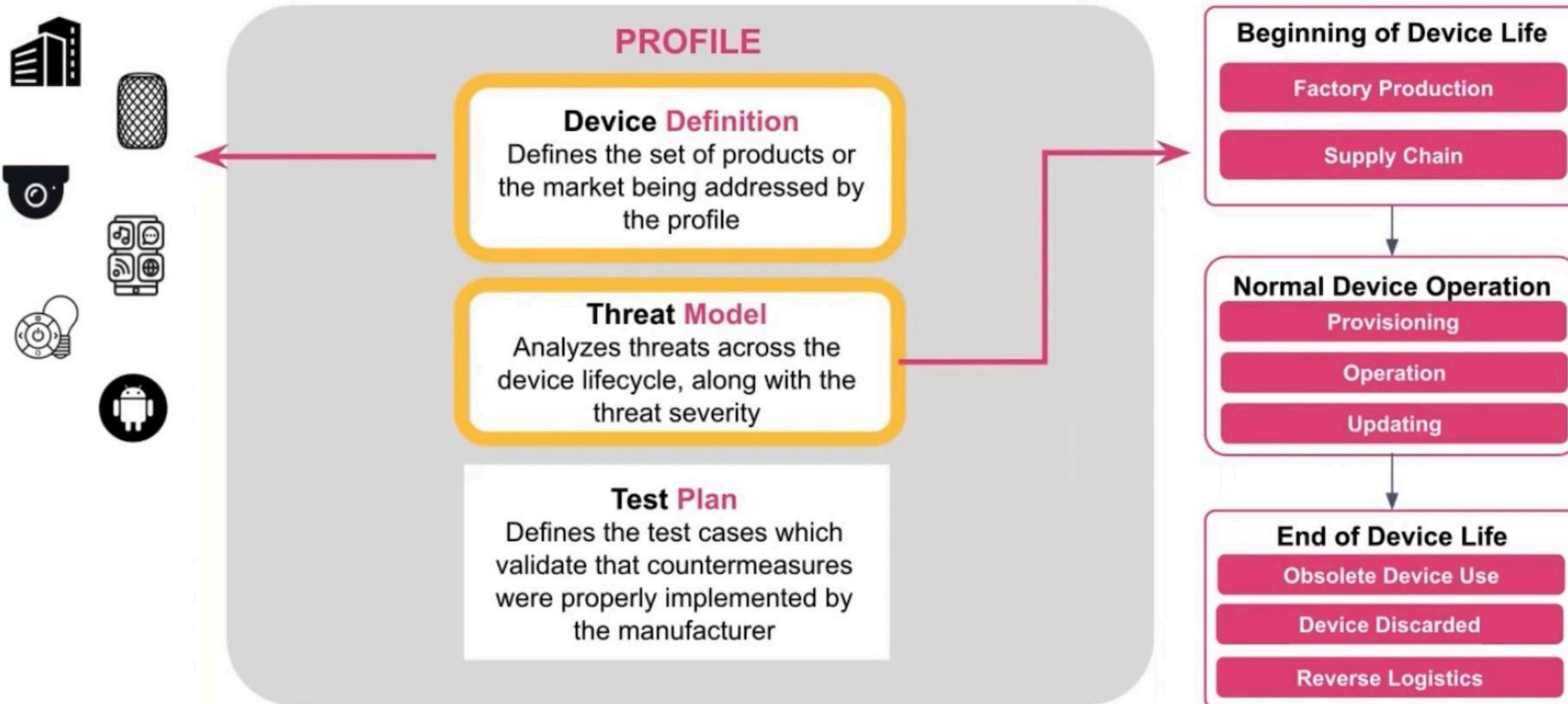
### TRANSPARENCY

- Security Expiration Date
- Vulnerability Reporting Program

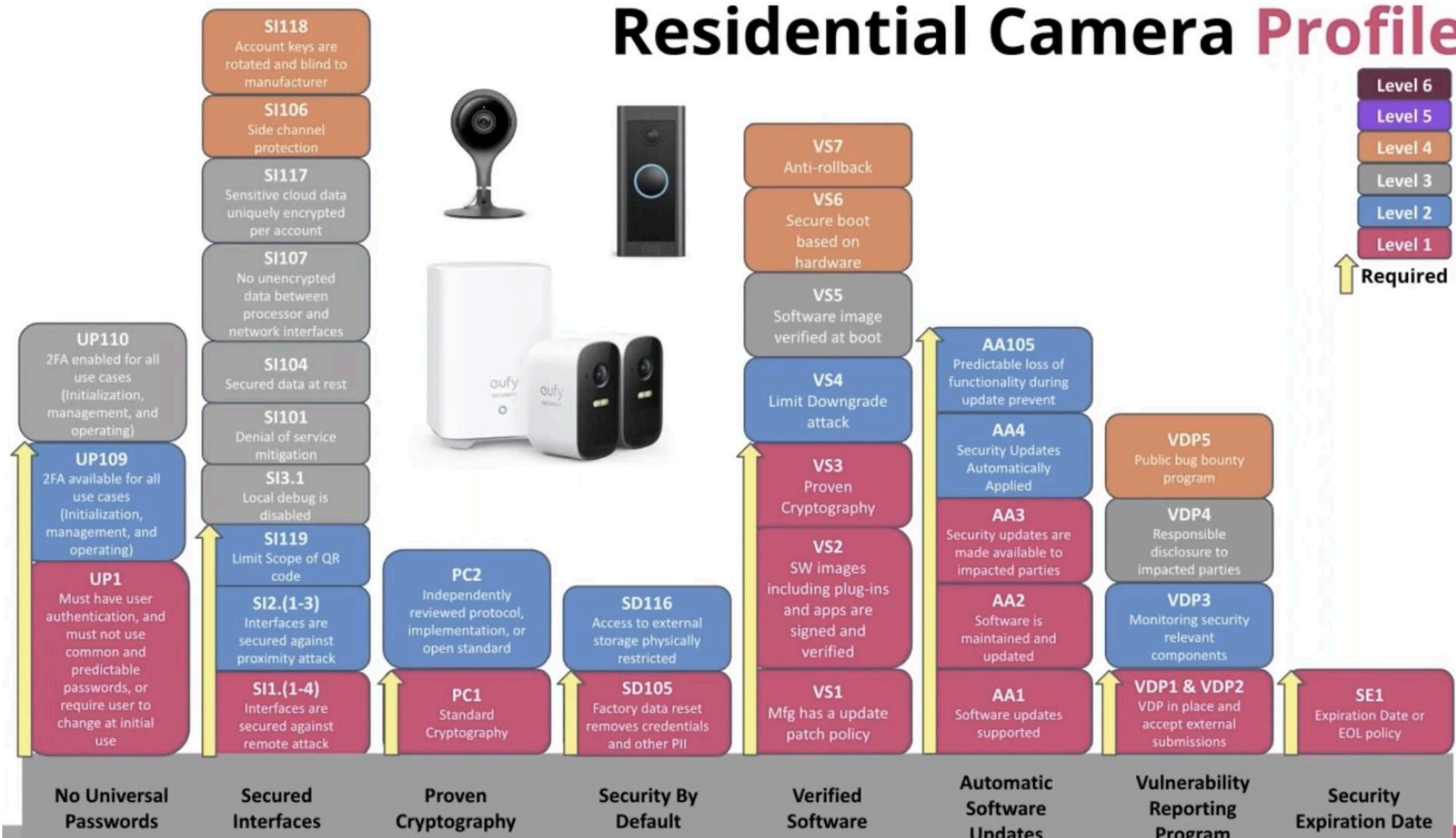
# BEST PRACTICES

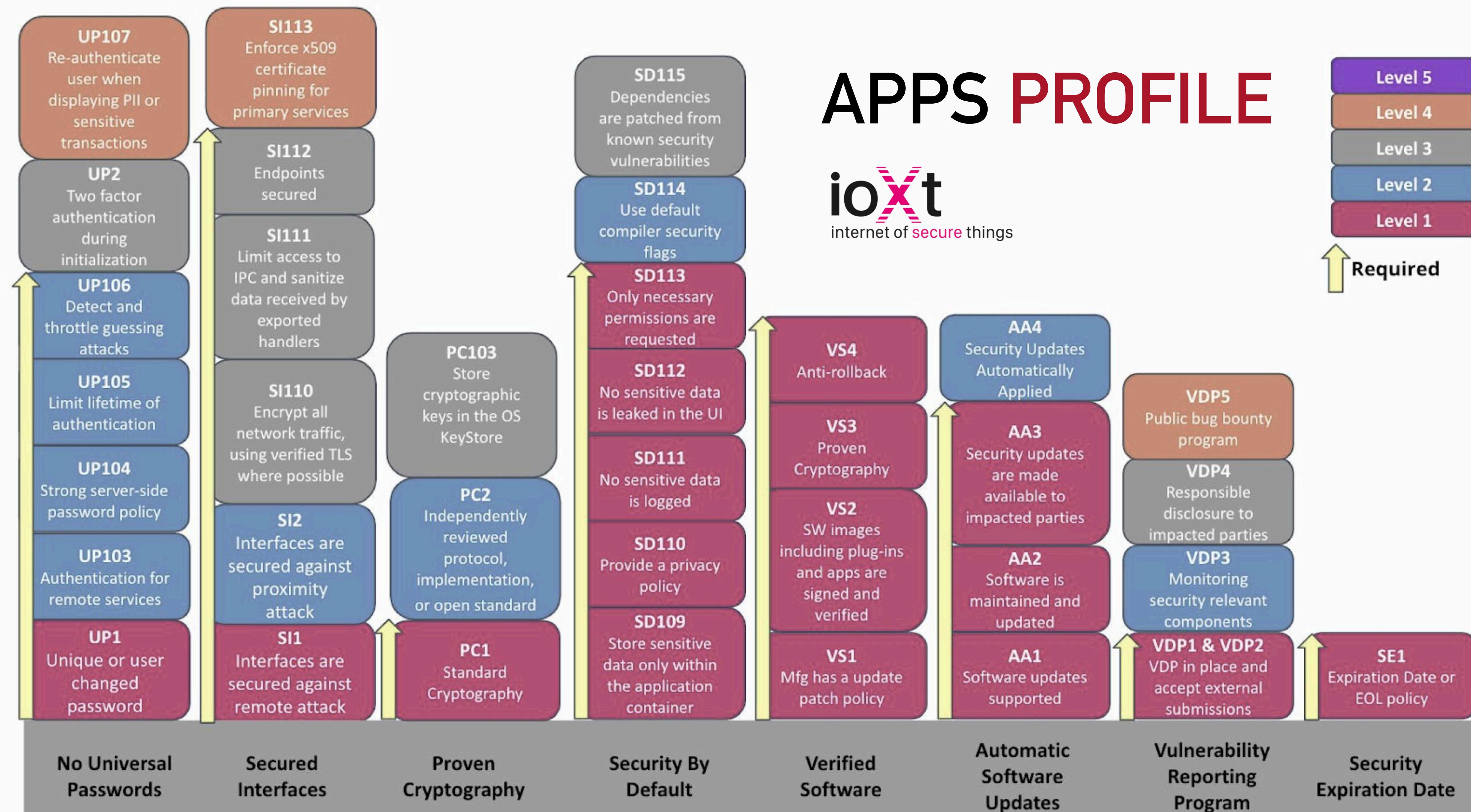
## Security Profile

A Profile Customizes the ioXt Security Pledge to Meet Specific Product or Market Security Needs



# Residential Camera Profile





# 7 PRINCIPLES

to secure  
connected  
devices



Hardware-based  
Root of Trust

Unforgeable cryptographic keys generated and protected by hardware. Physical countermeasures resist side-channel attacks.

*Does the device have a unique, unforgeable identity that is inseparable from the hardware?*



Small Trusted  
Computing Base

Private keys stored in a hardware-protected vault, inaccessible to software. Division of software into self-protecting layers.

*Is most of the device's software outside the device's trusted computing base?*



Defense in Depth

Multiple mitigations applied against each threat. Countermeasures mitigate the consequences of a successful attack on any one vector.

*Is the device still protected if the security of one layer of device software is breached?*



Compartmentalization

Hardware-enforced barriers between software components prevent a breach in one from propagating to others.

*Does a failure in one component of the device require a reboot of the entire device to return to operation?*

# 7 PRINCIPLES - CONT'D

to secure  
connected  
devices



Certificate-based  
Authentication

Signed certificate, proven by unforgeable cryptographic key, proves the device identity and authenticity.

*Does the device use certificates instead of passwords for authentication?*



Renewable Security

Renewal brings the device forward to a secure state and revokes compromised assets for known vulnerabilities or security breaches.

*Is the device's software updated automatically?*



Failure Reporting

A software failure, such as a buffer overrun induced by an attacker probing security, is reported to cloud-based failure analysis system.

*Does the device report failures to its manufacturer?*



# IOT USE CASES

## Workshop

# TRANSPORTATION

Please select ideal connectivity type(s) for

- handover at high speed > 300 km/h
- seamless roaming
- relatively high data rate (standard video)



# SUPPLY CHAIN

Please select ideal connectivity type(s) for

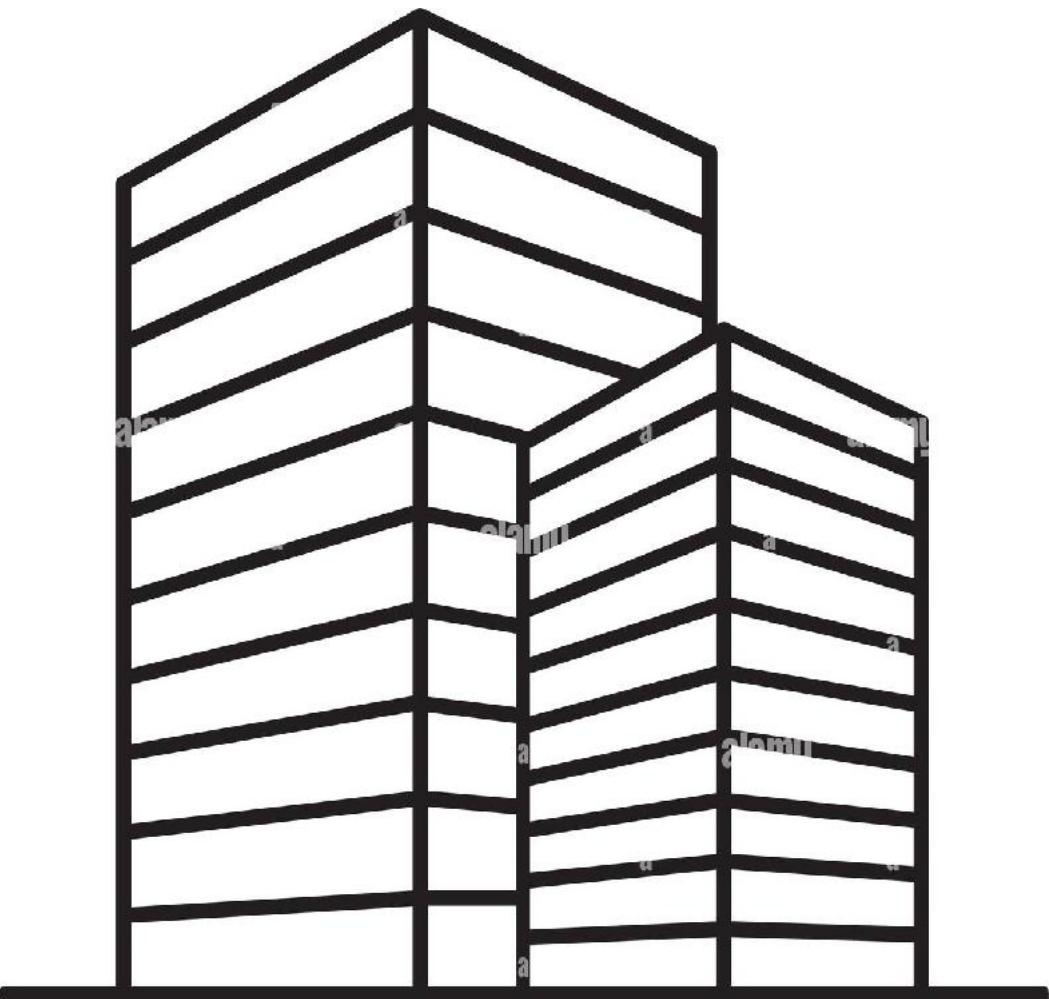
- European roaming
- Geolocation
- Fleet management
- Updates over the air, etc.



# ALARMS: LIFT OF DOUBT

Please select ideal connectivity type(s) for

- Large data volume
- Reliability, QoS
- Remote control, etc.



# PERSONAL SAFETY

Please select ideal connectivity type(s) for

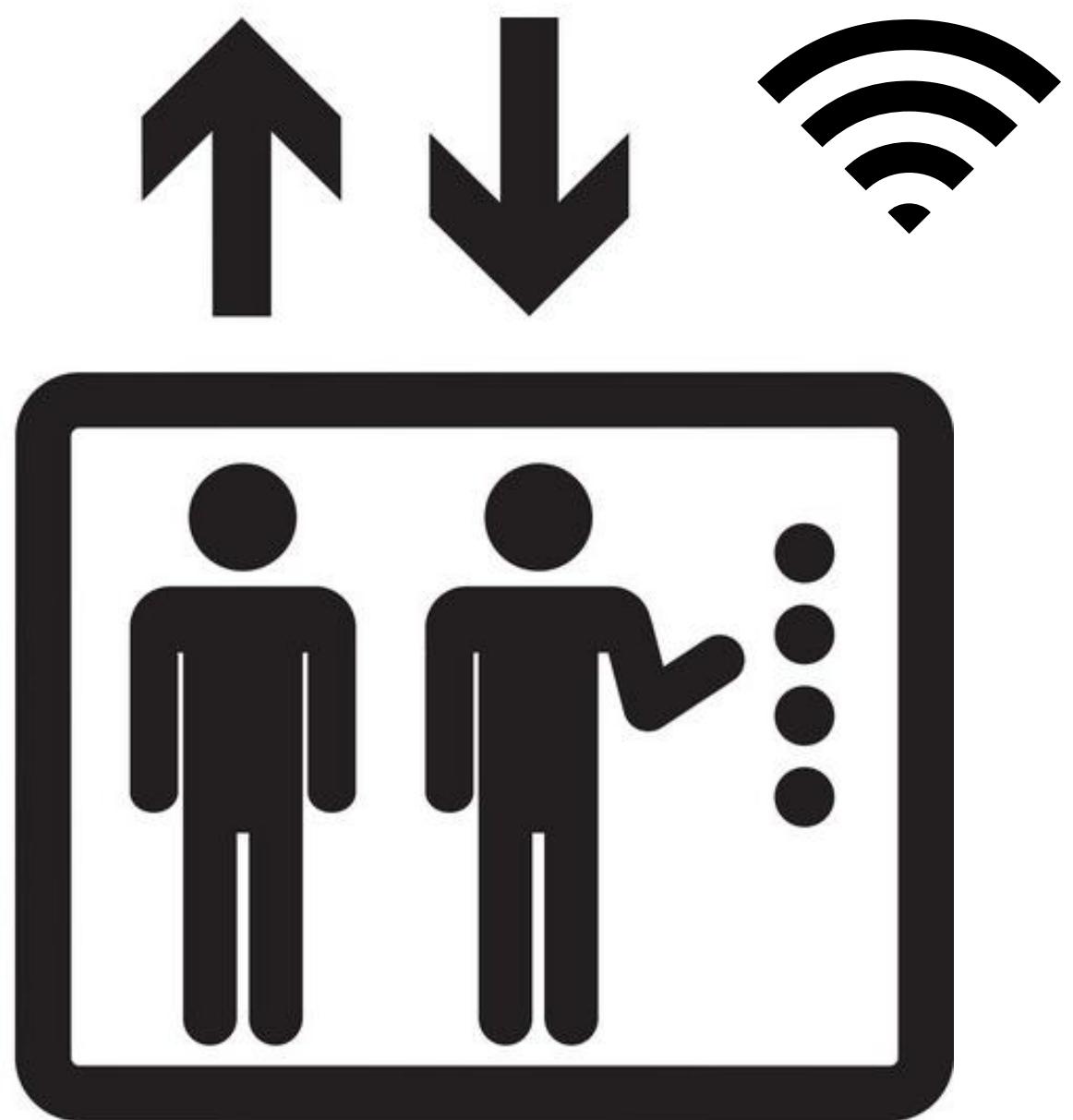
- Reliability
- Autonomy (edge computing)
- Remote control
- Indoor coverage, etc.



# ALERT BUTTONS

Please select ideal connectivity type(s) for

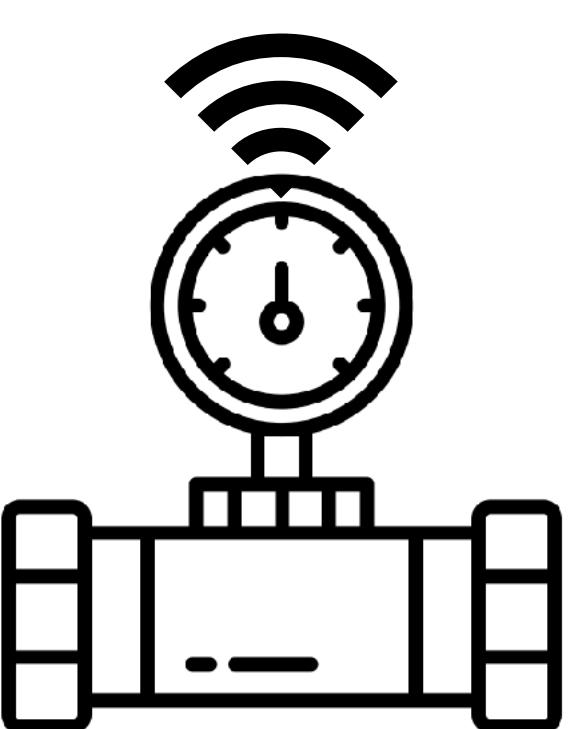
- Deep indoor coverage
- 2G sunset
- Reliability, QoS
- Etc.



# METERING / UTILITIES

Please select ideal connectivity type(s) for

- Deep indoor coverage
- Energy savings
- Over the air updates, etc.



# SUPPLY CHAIN / SHIPPING

Please select ideal connectivity type(s) for

Containers tracking  
Global coverage



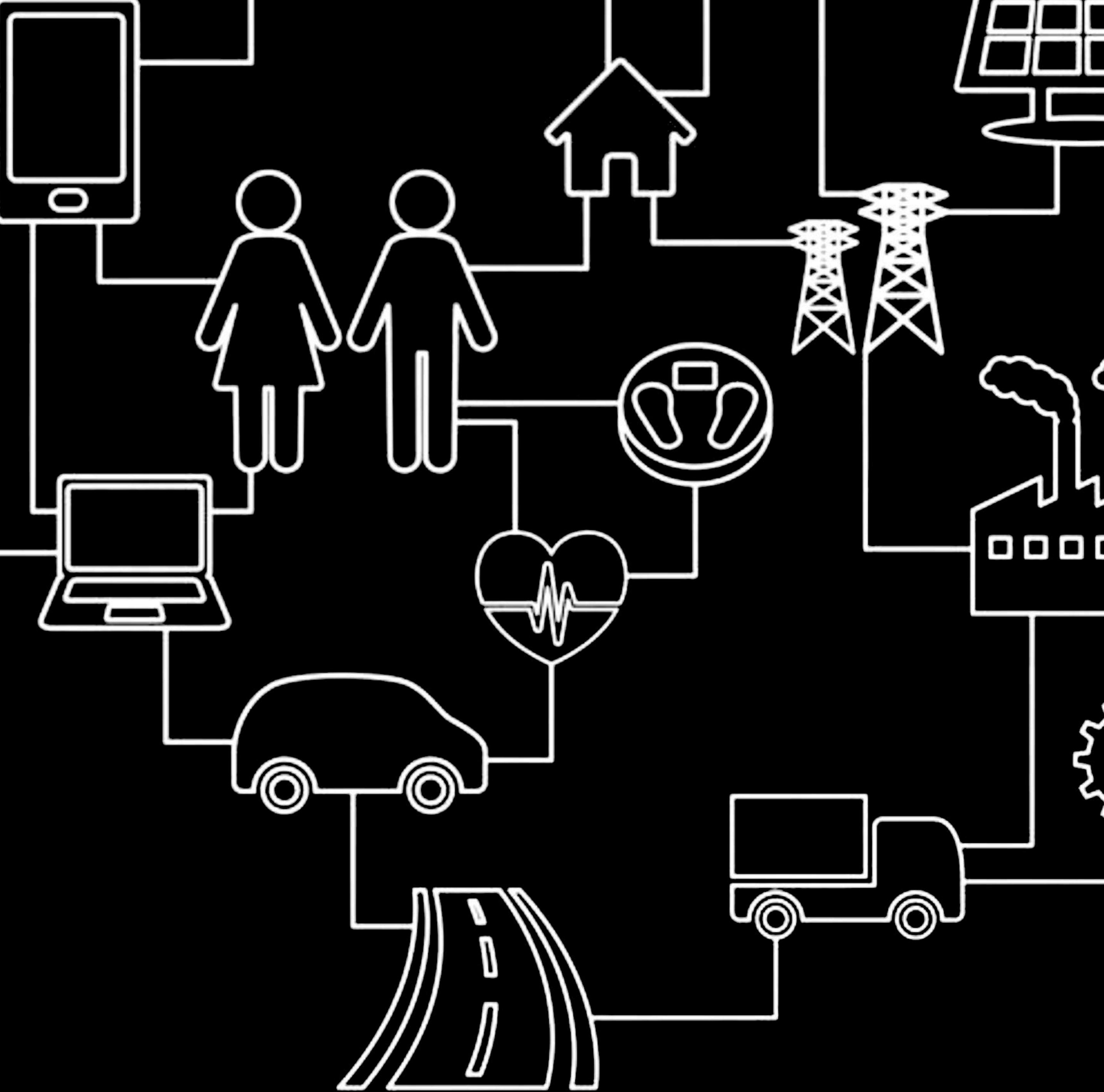


# GLOSSARY

IoT

6LOWPAN	Communication protocol which compresses IPv6 packages
Actuator	Transforms electrical signal into different forms of energy - see sensor
ADR	Adaptive Data Rate - to optimize LoRaWAN SF
API	Application Programming Interface
BLE	Bluetooth Low Energy
COAP	Constrained Application Protocol
DCS	Distributed Control System
Edge	Where the action is, near data source
eMBB	5G's enhanced Mobile Broadband
EnOcean	Energy harvesting wireless technology
ERP	Enterprise Resources Planning
GSM	Global System for Mobile communications
I2C	Inter Integrated Circuits protocol
IaaS	Infrastructure as a Service
IoT	Internet Of Things
IP	Internet Protocol - See TCP and UDP
IPv6	Version 6 of IP - allowing fixed addresses for all devices
LoRaWAN	Long Range Wide Area Network
LTE-M	Long Term Evolution : 4G
LTE-M	Long Term Evolution / Cat M1
M2M	Machine to Machine - part of IoT legacy
MES	Manufacturing Execution System
ML	Machine Learning
mMTC	5G's massive Machine Type Communications
MQTT	Message Queuing Telemetry Transport

NB-IoT	Narrow Band IoT
NFC	Near Field Communication
PaaS	Platform as a Service
PAN	Personal Area Network
PLC	Programmable Logic Controller
PoE	Power over Ethernet
QoS	Quality of Service
RFID	Radio Frequency Identification
RSSI	Received Signal Strength Indication
SCADA	Supervisory Control and Data Acquisition
SaaS	Software as a Service
Sensor	Determine physical characteristic and transform them in electrical signals
SF	Spreading Factor for LoRaWAN - SF7 (highest speed) to S12 (best coverage)
SLA	Service Level Agreement
SNR	Signal over Noise Ratio
TCP	Transmission Control Protocol / IP - connected mode
UDP	User Datagram Protocol / IP - non connected mode
UMTS	3G
URLLC	5G's Ultra Reliable Low Latency Communications



# IOT, NETWORKS & TELECOM

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