IoT Foundations

Angelo Corsaro, PhD
CTO, ADLINK Tech. Inc.
Co-Chair, OMG DDS-SIG
angelo.corsaro@adlinktech.com

Course Logistics

HW AND SENSORS

Intel Edison: https://software.intel.com/en-us/iot/hardware/edison

Raspberry PI: https://www.raspberrypi.org

Sensors: https://software.intel.com/en-us/iot/hardware/sensors

IDE

Intel IoT IDE: http://intel.ly/2cPa4JP

IntelliJ: http://bit.ly/2dEVOlz

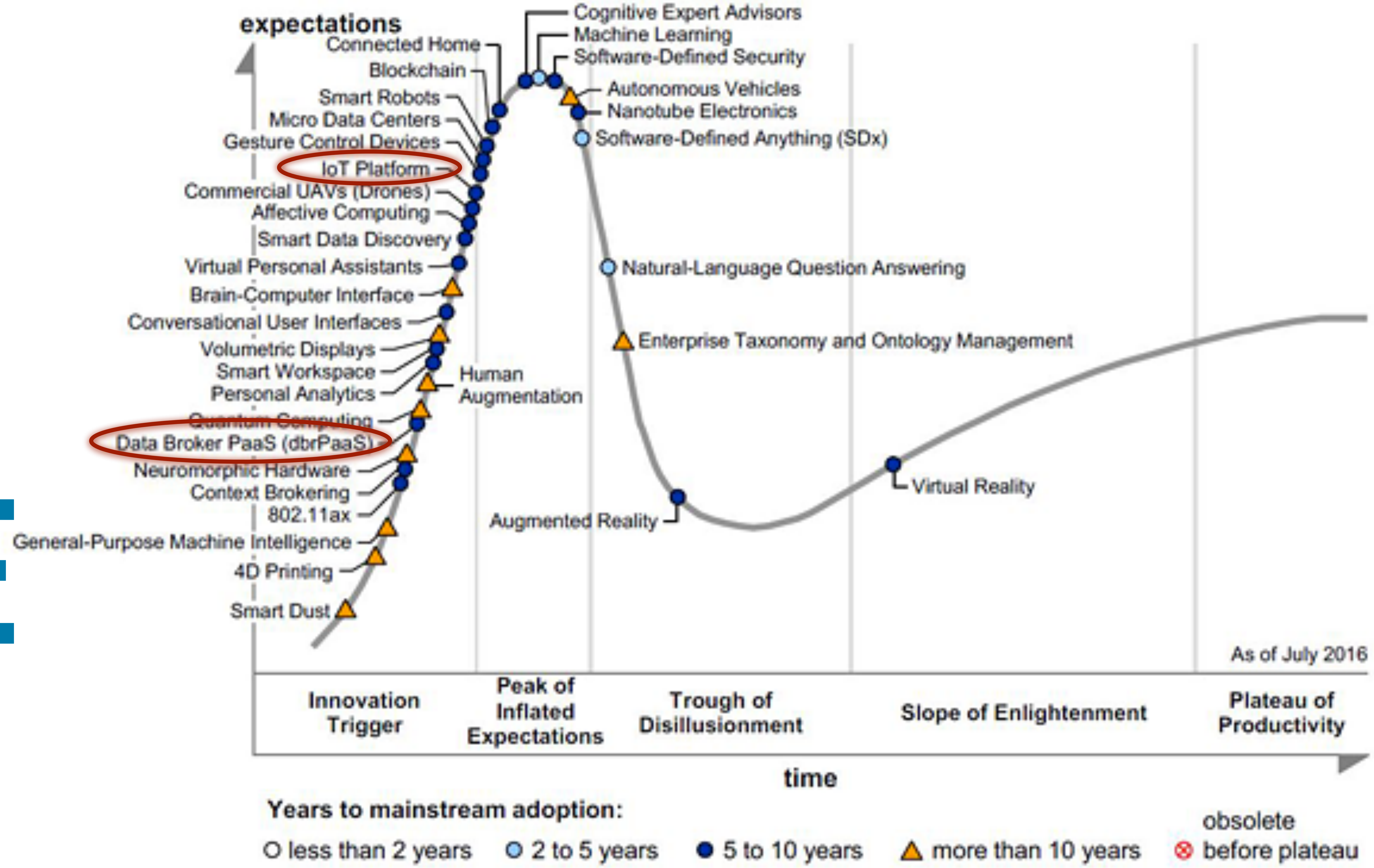
IoT

GARTNER

HYPE CYCLE

2015

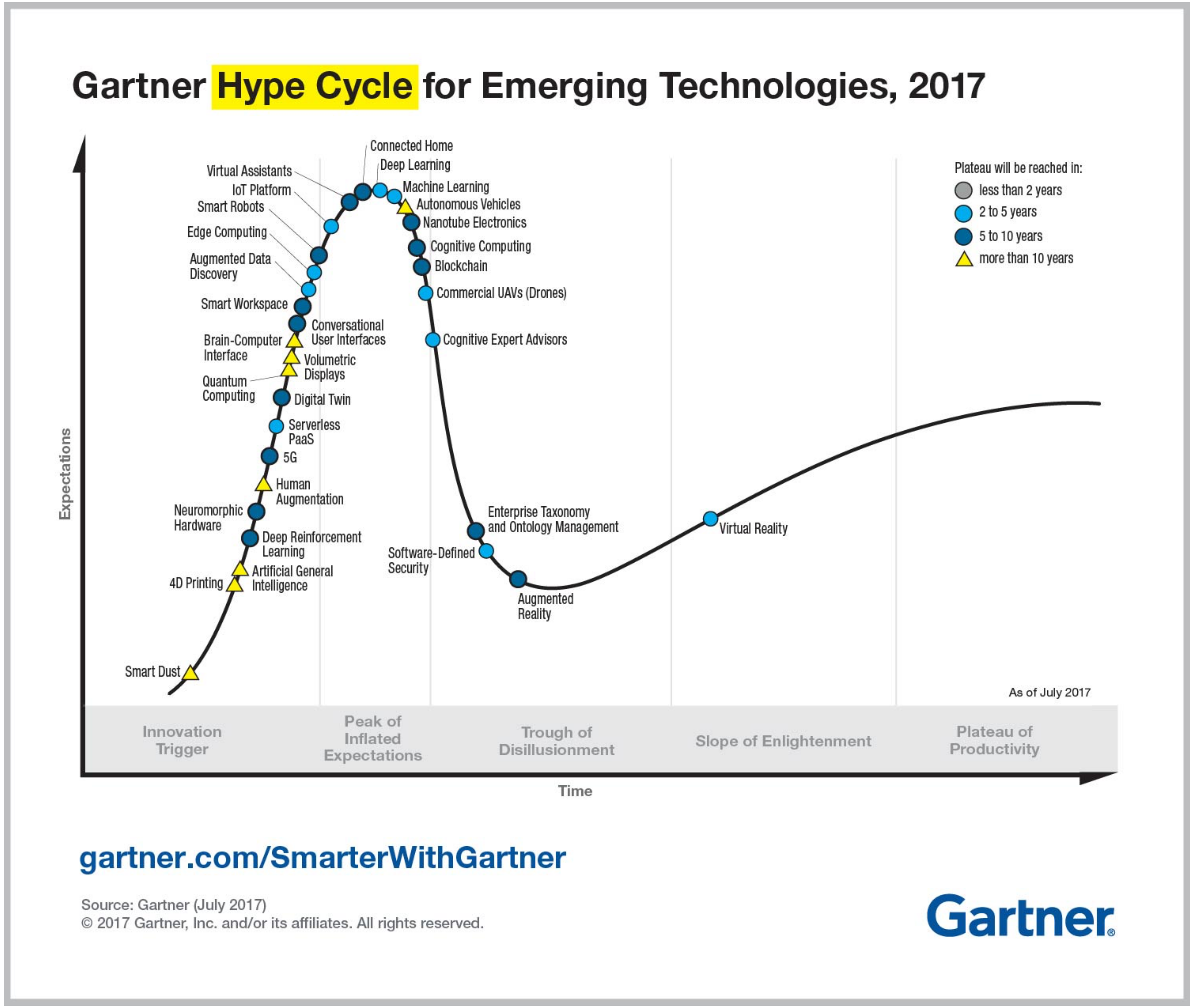
GARTNER HYPE CYCLE 2016



Source: Gartner (July 2016)

GARTNER HYPE CYCLE

2017



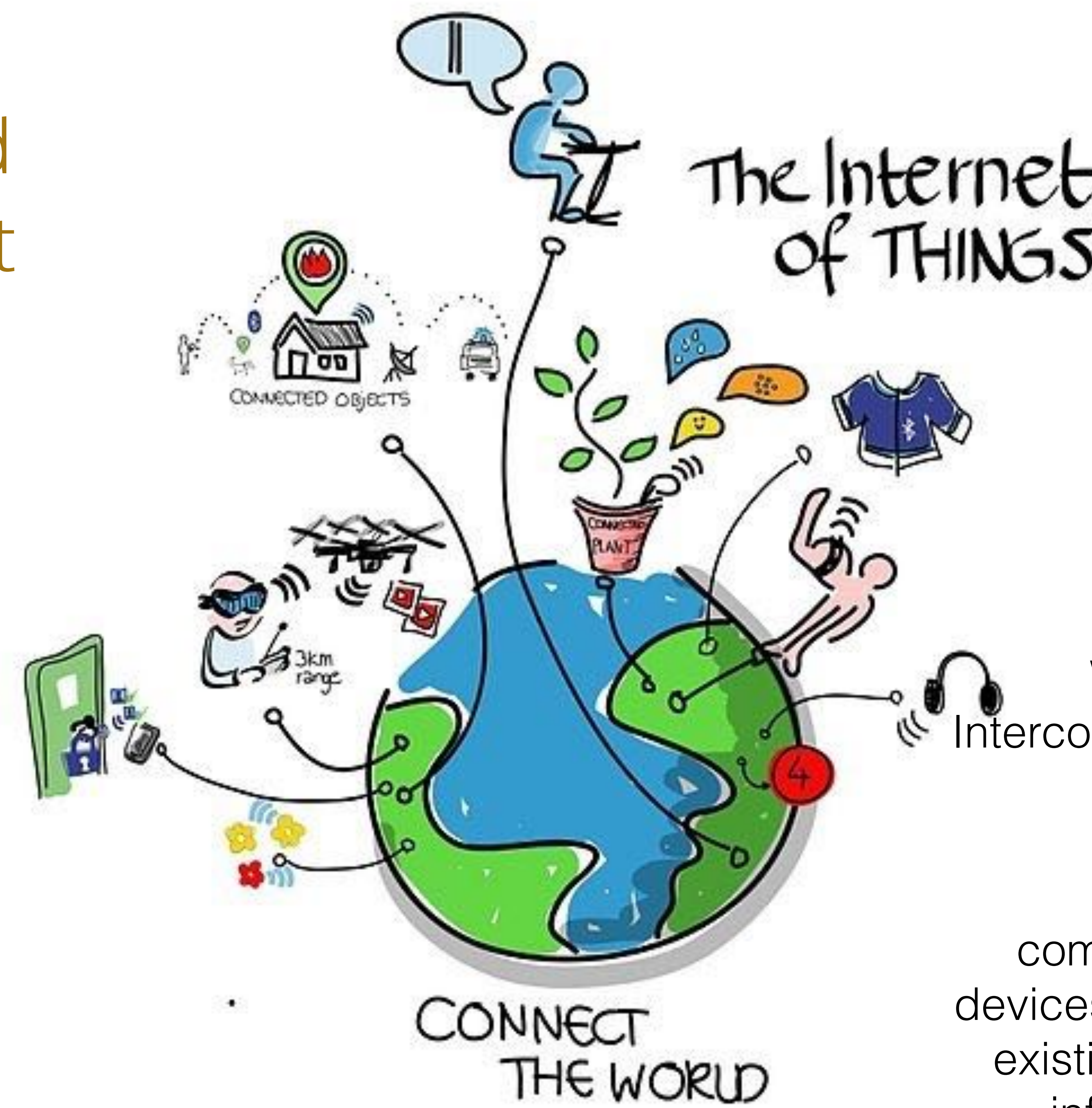
What is
The Internet of Things?

INTERNET OF THINGS FLAVOURS

Internet of Things (IoT) is the term used to describe any kind of application that connected and made "things" interact through the internet

There are at least two kinds of IoT, Consumer IoT (CIoT) and Industrial IoT (IIoT)

The CIoT and IIoT follow the [**Collect | Store | Analyse | Share]** architecture, yet they have some key differences that is important to understand



Wikipedia: Interconnection of uniquely identifiable embedded computing-like devices within the existing Internet infrastructure

IoT is about extracting **value** through the insights derived from the real-time and historical **data** produced by a cyber-physical system

— Data is the currency of IoT —

CONSUMER INTERNET OF THINGS (CIOT)

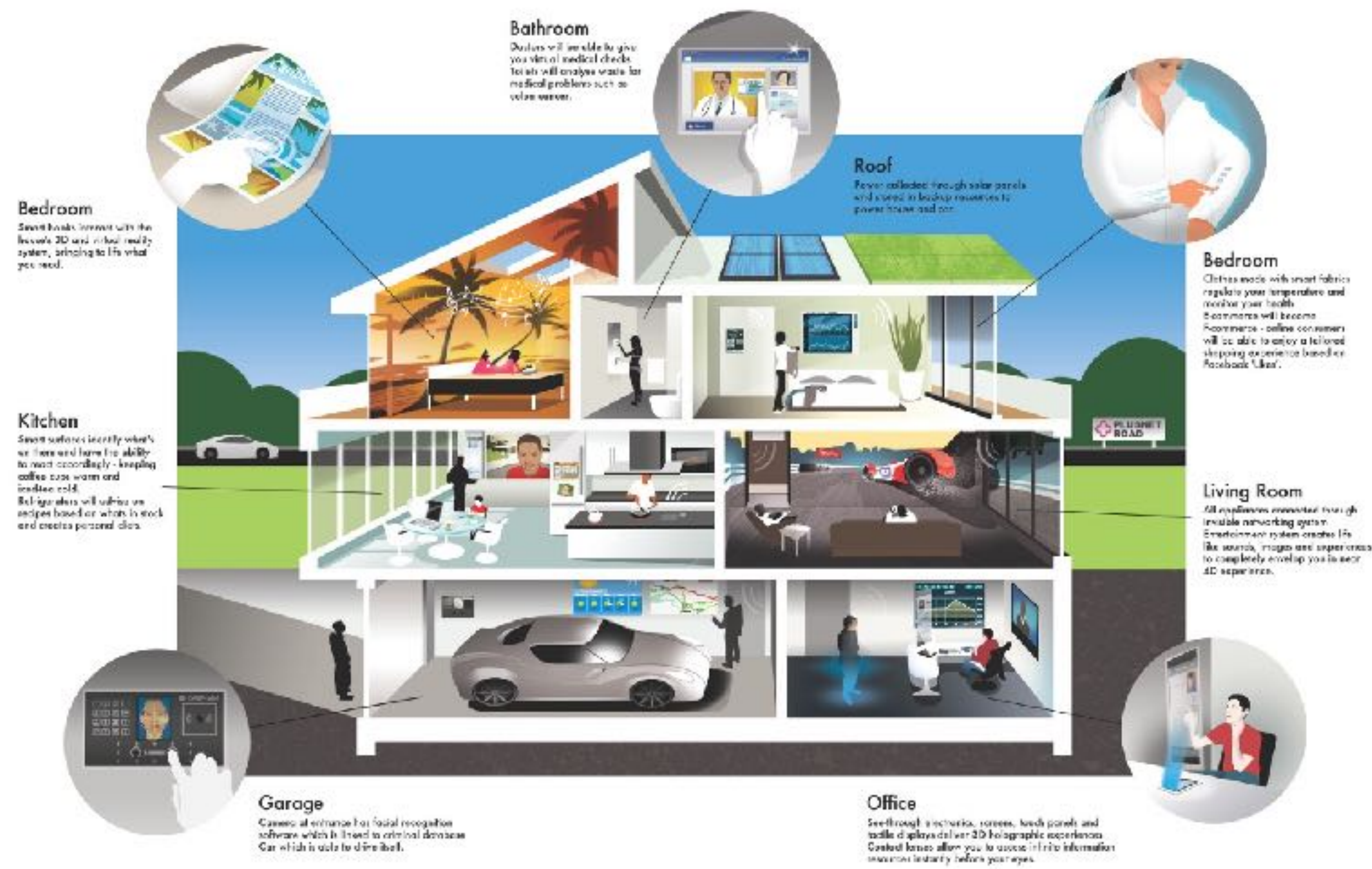
The Consumer Internet of Things (CIoT) represents the class of consumer-oriented applications where:

Devices are **consumer devices**, such as smart appliances, e.g. refrigerator, washer, dryer, personal gadgets such as, fitness sensors, google glasses, etc.

Data volumes and rates are relatively low

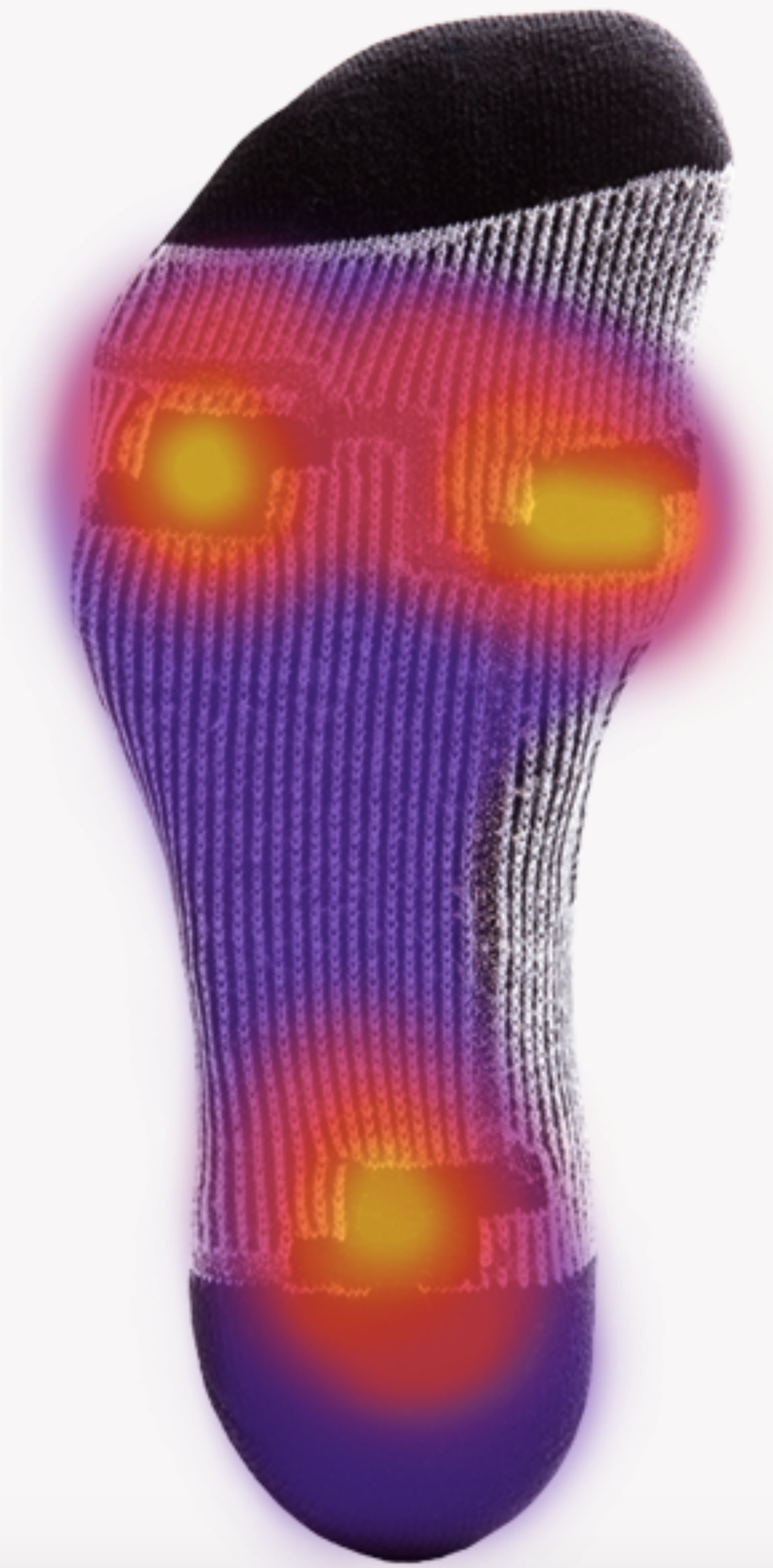
Applications are **not mission or safety critical**, e.g., the failure of fitness gadget will make you, at worse, upset, but won't cause any harm

CIoT applications tend to be "**consumer centric**"




smart
collar

f0rk connected



smart
socks


SMART LIGHTBULBS

INDUSTRIAL INTERNET OF THINGS (IIOT)

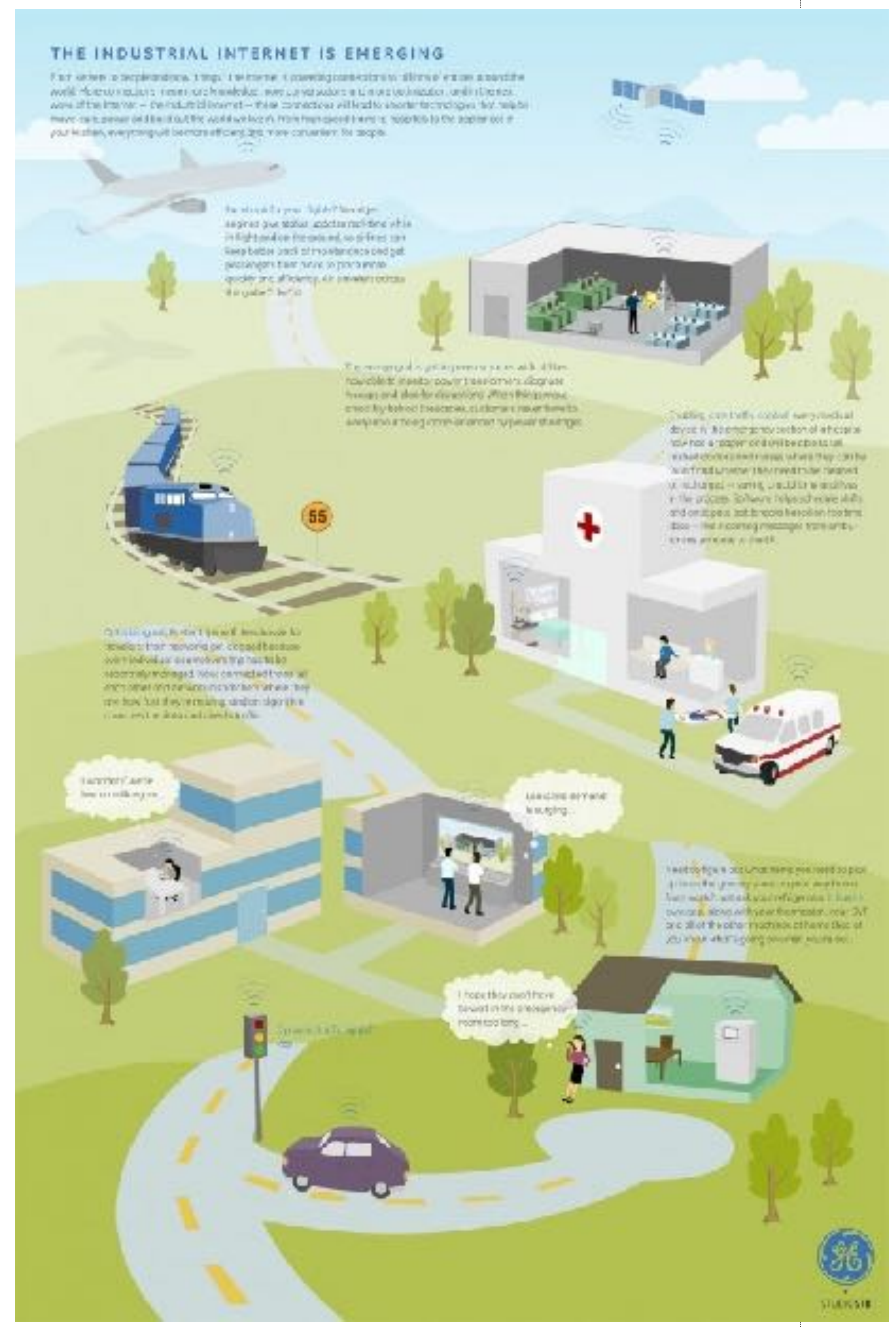
The Industrial Internet of Things (IIoT) represents industry-oriented applications where:

Devices are machines **operating in industrial, transportation, energy** or **medical environment**[1]

Data volumes and rates tend to be from **sustained to relatively high**

Applications are **mission and or safety critical**, e.g. the failure of a smart grid has severe impact on our life and economy, the misbehaving of a smart traffic system can threaten drivers

IIoT applications tend to be "**system centric**"

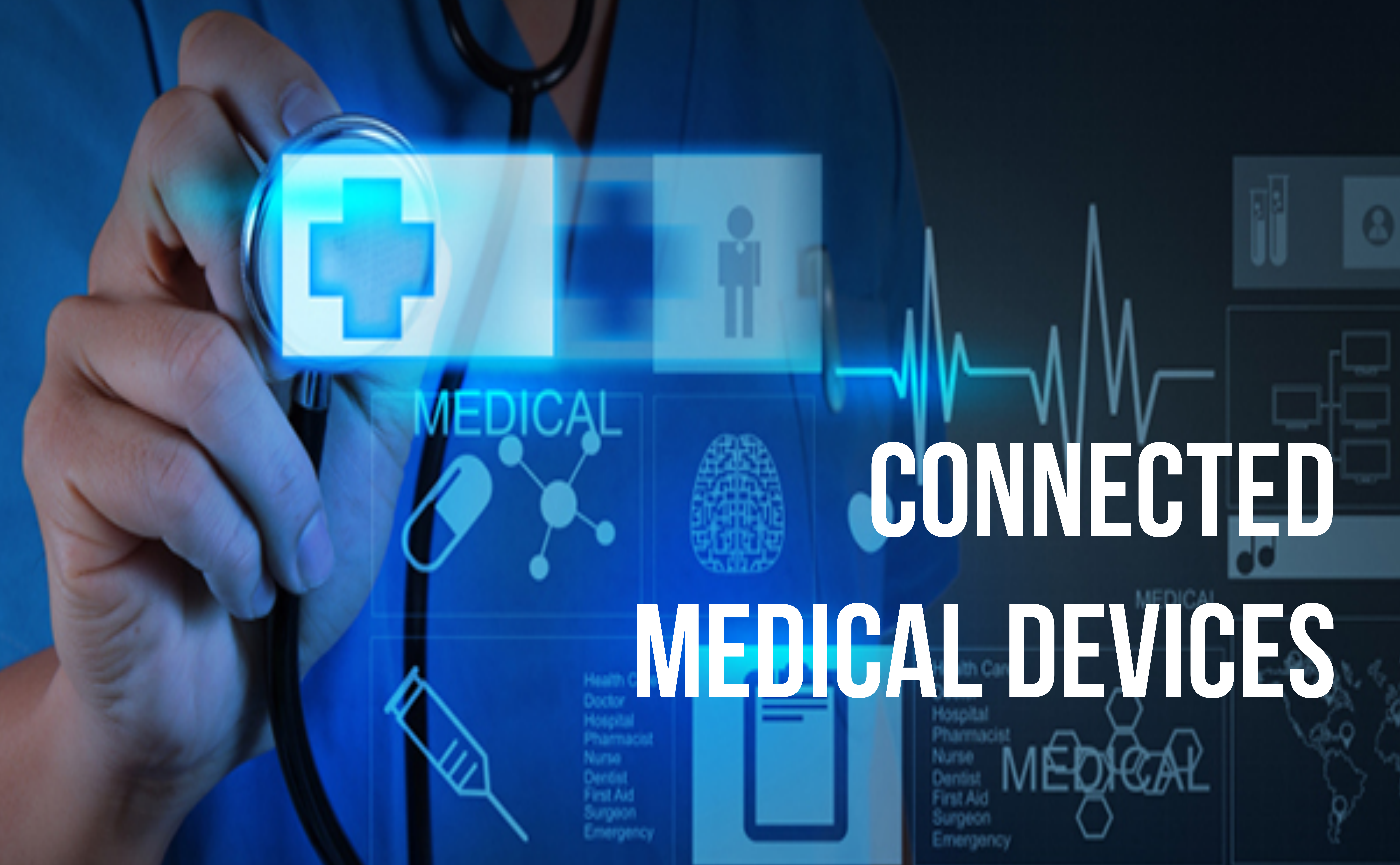


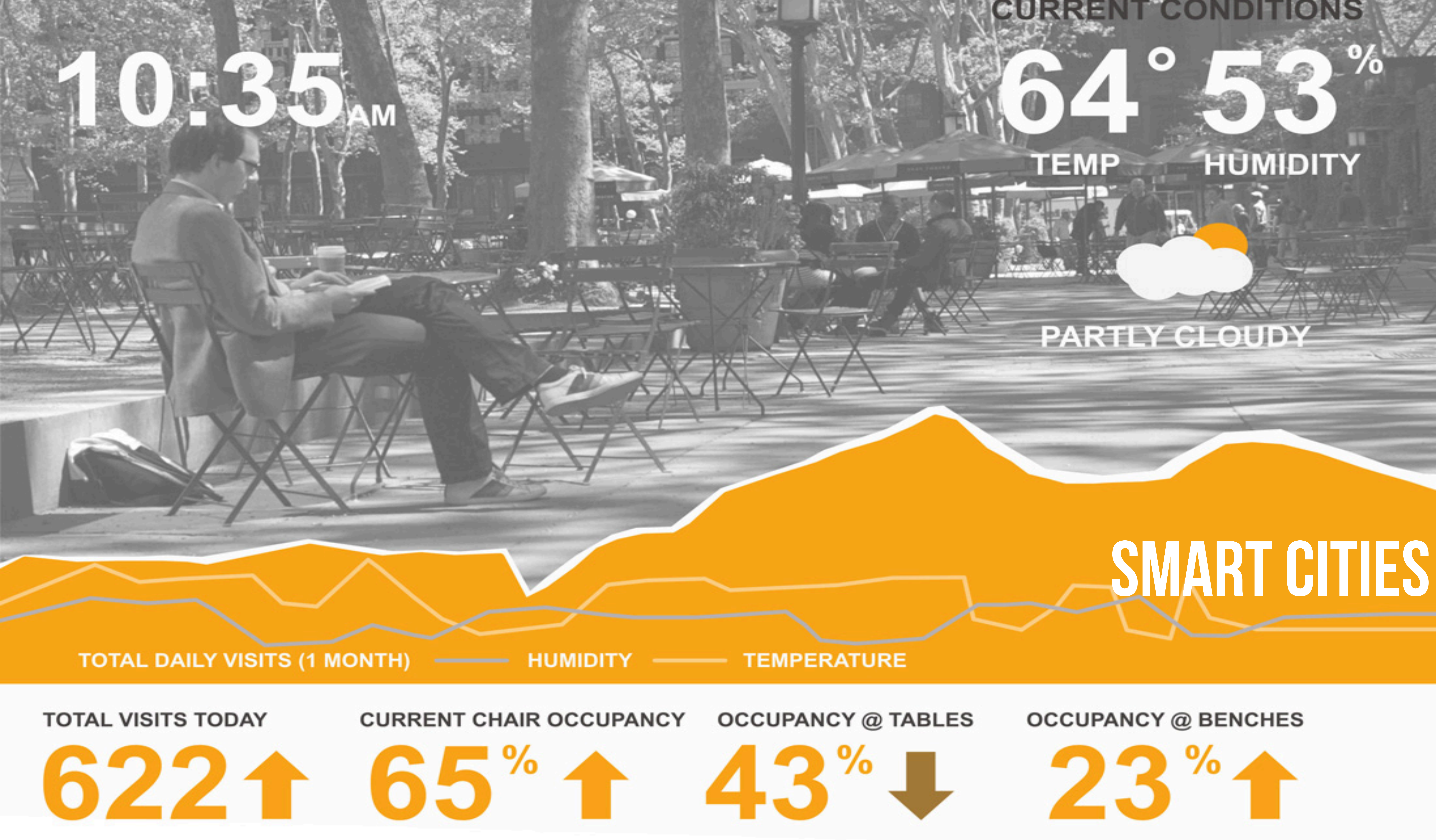
[1] The list of application domains is supposed to give examples and is not exhaustive


Smart Factory

AUTONOMOUS VEHICLES


SMART-GRID


MEDICAL
Doctor
Hospital
Pharmacist
Nurse
Dentist
First Aid
Surgeon
Emergency
CONNECTED
MEDICAL DEVICES
MEDICAL


CURRENT CONDITIONS
10:35 AM
64° 53 %
TEMP
HUMIDITY
PARTLY CLOUDY
SMART CITIES
TOTAL DAILY VISITS (1 MONTH)
HUMIDITY
TEMPERATURE
TOTAL VISITS TODAY
622
CURRENT CHAIR OCCUPANCY
65 %
OCCUPANCY @ TABLES
43 %
OCCUPANCY @ BENCHES
23 %


CONNECTED AIRCRAFTS

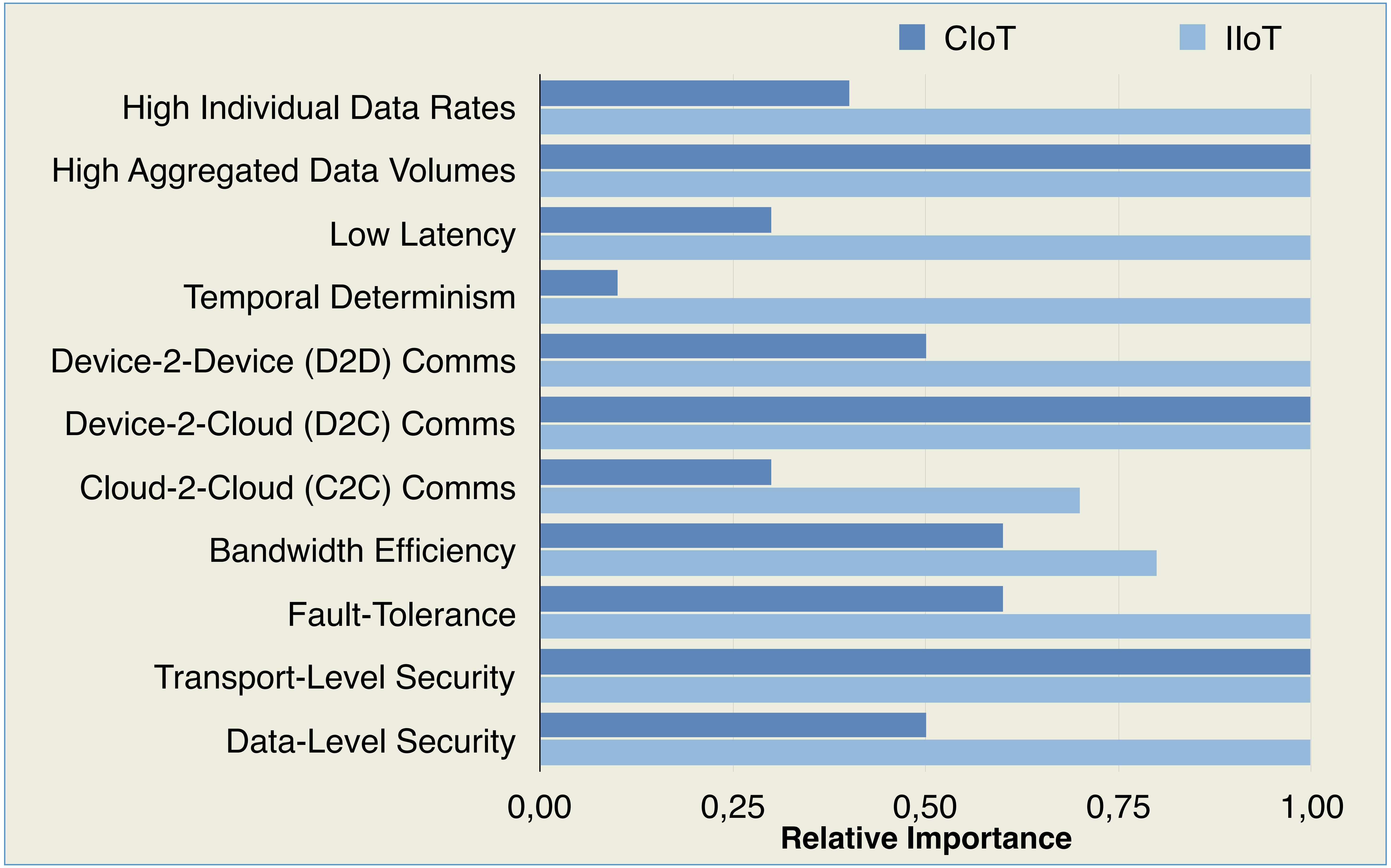

IIoT is concerned with **reactive cyber-physical systems**
IIoT is about interacting with the physical world

CIOT/IIOT DATA SHARING REQUIREMENTS

Efficient and scalable Data Sharing is a **key requirement** of practically any **IoT** system

The degree of **performance and fault-tolerance** required by the data sharing platform **varies** across **Consumer and Industrial Internet on Things** applications

Fog Computing support is key for **IIoT**



[Ref: A Comparative Study of Data-Sharing Standards for the Internet of Things, Cutter Journal, Dec 2014]

IoT Architectures' Evolution

CLOUD-CENTRIC ARCHITECTURES

The majority of IoT systems are today cloud-centric

These systems are characterised by **device-to-cloud** communication and **in-cloud analytics**

CLOUD-CENTRIC IOT PLATFORMS

The large majority of IoT platform have been built with Cloud-Centric architectures in mind

Digi Device Cloud

Azure

ThingSpeak

SensorCloud™
Powered by LORD Sensing

EDC
Everyware Device Cloud

IBM Bluemix

Axeda®

Telit

xively™
by LogMeIn

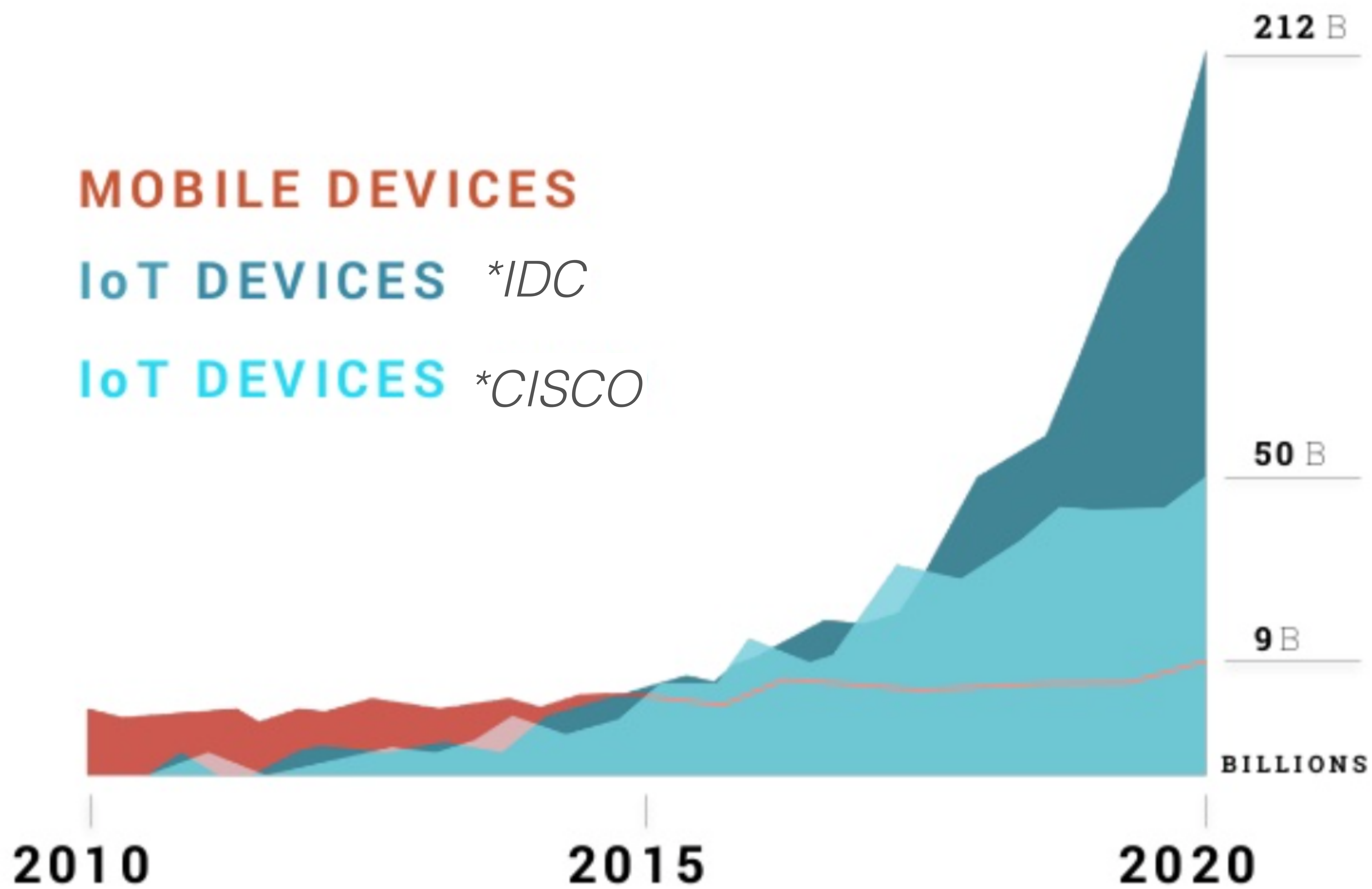
AWS IoT

ThingWorx™
A PTC® Business


DO WE NEED
SOMETHING ELSE?

TOO MANY DEVICES

The number of IoT devices is expected to grow exponentially



INDUSTRIAL IOT

Industrial IoT applications such as Smart Grids , Smart Factories, Smart Farming, Connected Vehicles and Smart Cities are **not compatible with** the assumptions of **Cloud Centric Architectures**

CLOUD COMPUTING

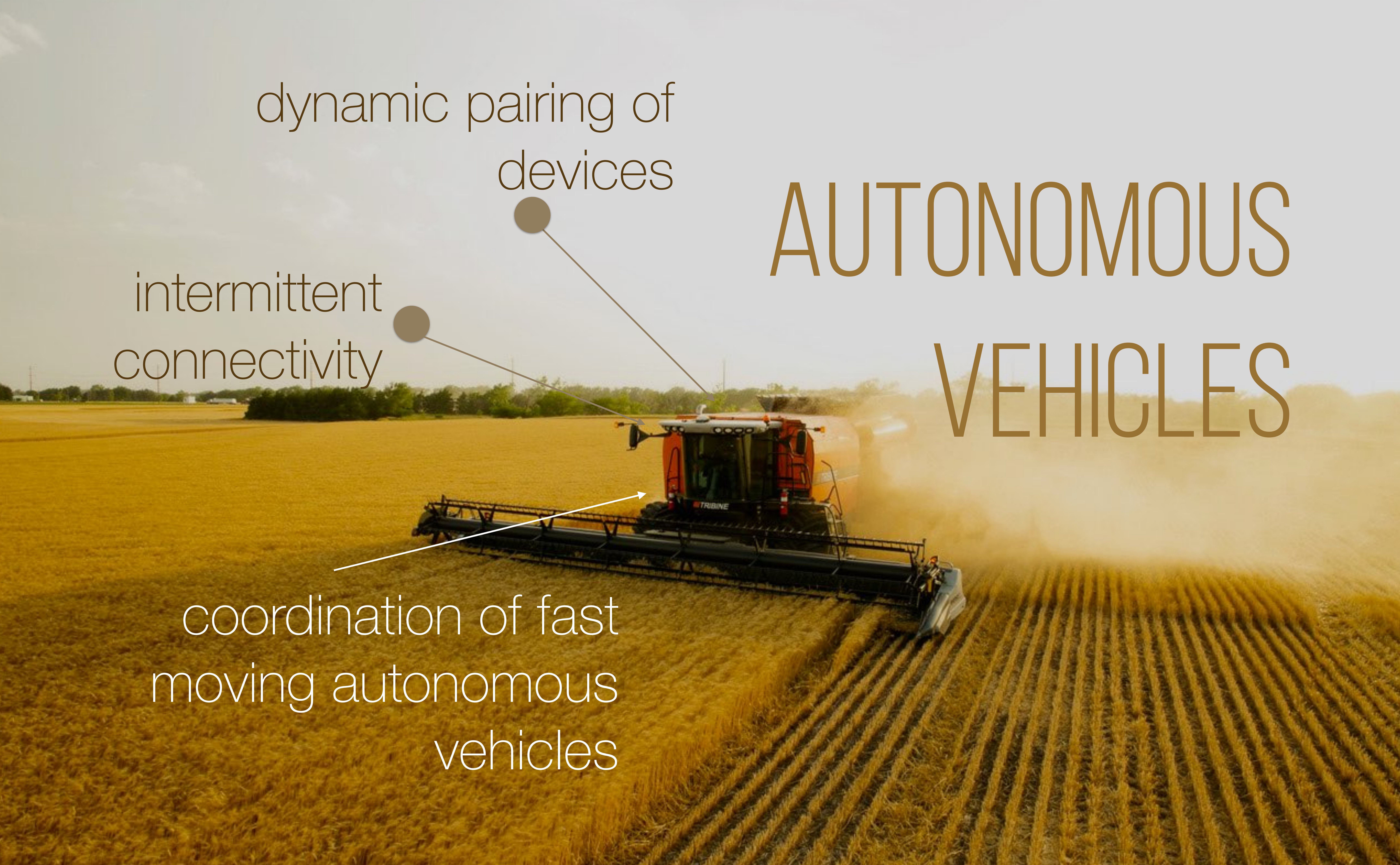
ASSUMPTION #1

There is sufficient **bandwidth** to push data to the Cloud.

SMART FACTORY

CLOUD COMPUTING
ASSUMPTION #2

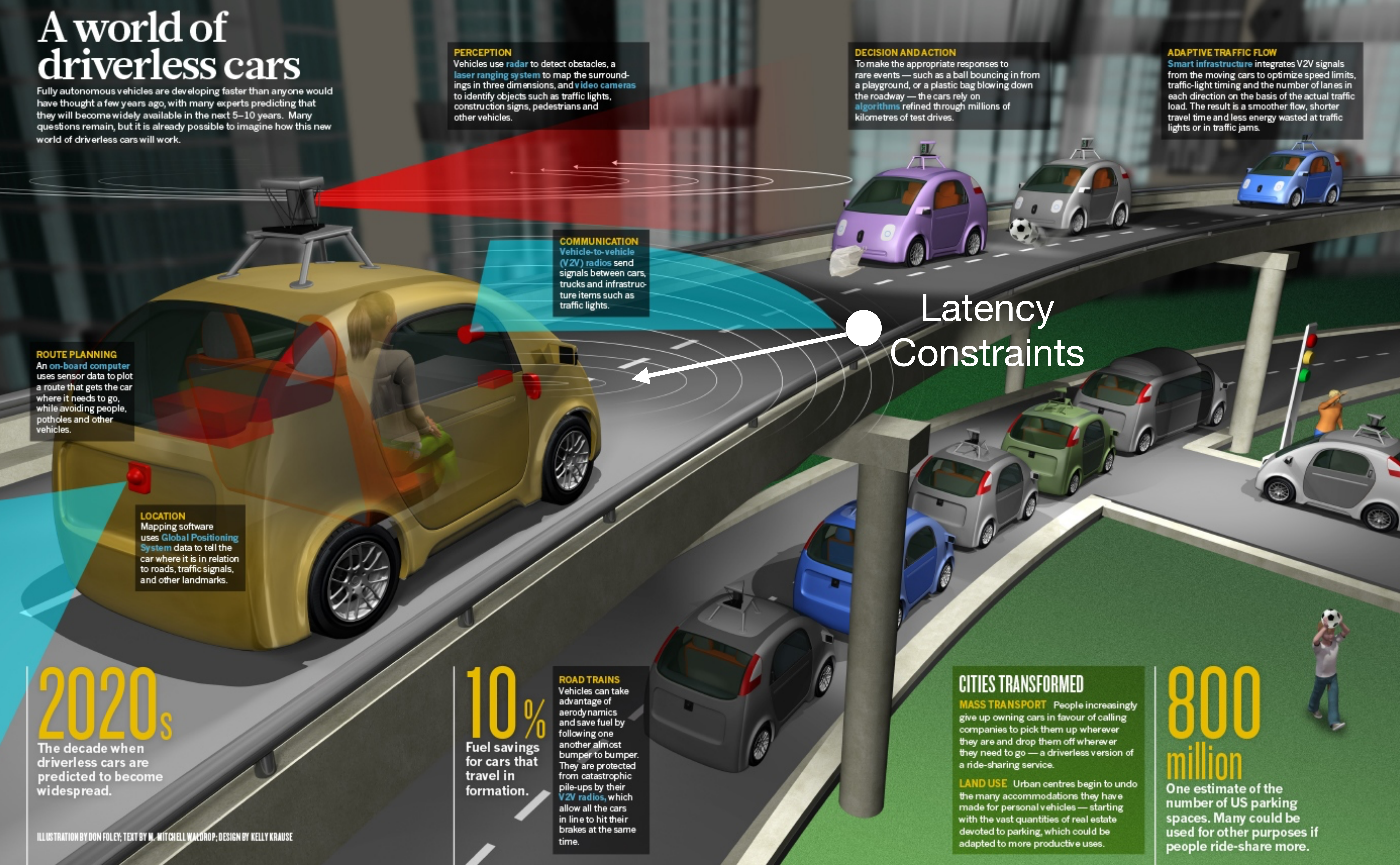
Connectivity is not an issue. A device will (almost) always be connected to the cloud.


dynamic pairing of devices
AUTONOMOUS VEHICLES
intermittent connectivity
coordination of fast moving autonomous vehicles

CLOUD COMPUTING

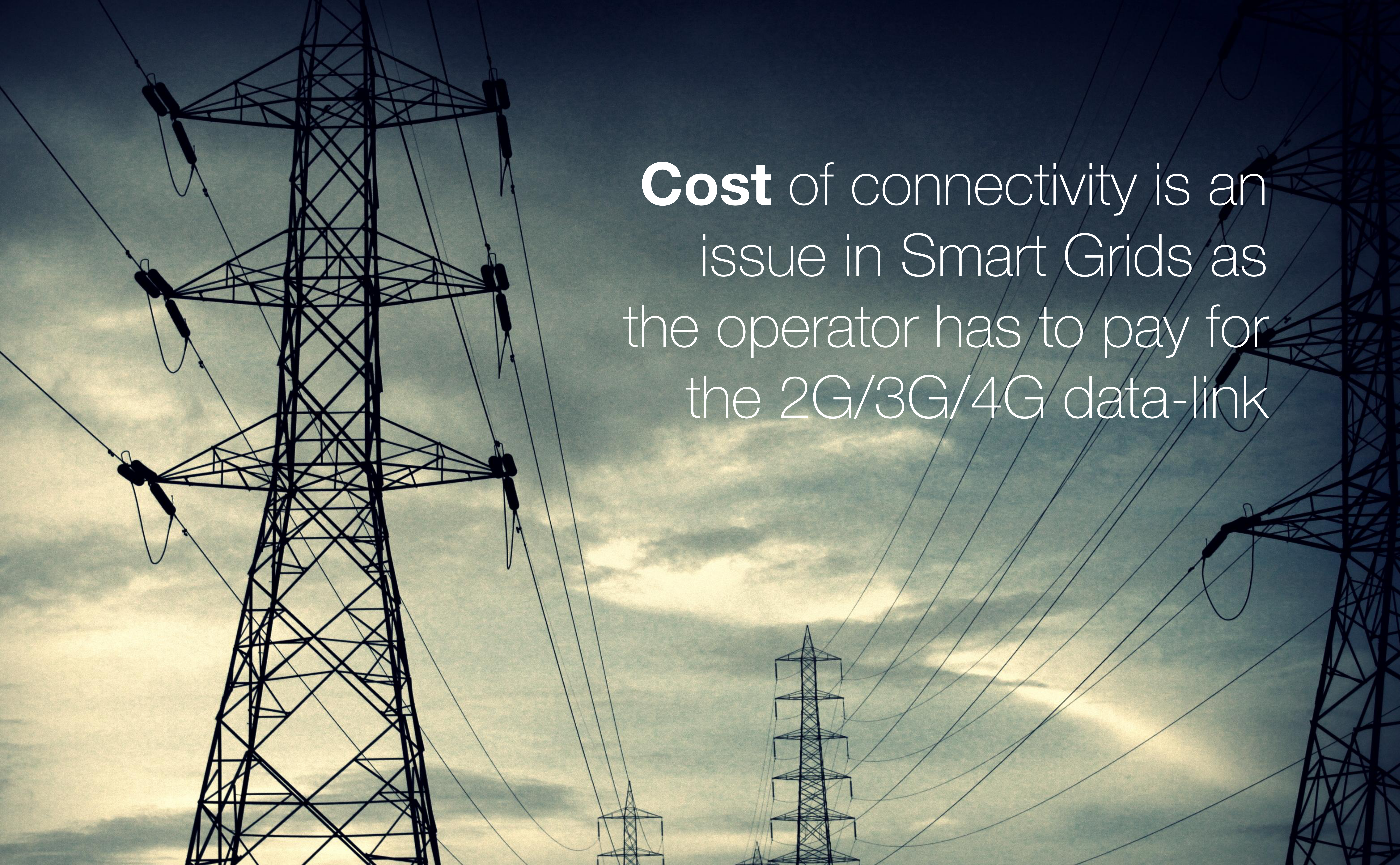
ASSUMPTION #3

The **latency** induced by cloud-centralised analytics and control is compatible with the dynamic of the IoT system


A world of driverless cars
Fully autonomous vehicles are developing faster than anyone would have thought a few years ago, with many experts predicting that they will become widely available in the next 5–10 years. Many questions remain, but it is already possible to imagine how this new world of driverless cars will work.
PERCEPTION
Vehicles use radar to detect obstacles, a laser ranging system to map the surroundings in three dimensions, and video cameras to identify objects such as traffic lights, construction signs, pedestrians and other vehicles.
DECISION AND ACTION
To make the appropriate responses to rare events — such as a ball bouncing in from a playground, or a plastic bag blowing down the roadway — the cars rely on algorithms refined through millions of kilometres of test drives.
ADAPTIVE TRAFFIC FLOW
Smart infrastructure integrates V2V signals from the moving cars to optimize speed limits, traffic-light timing and the number of lanes in each direction on the basis of the actual traffic load. The result is a smoother flow, shorter travel time and less energy wasted at traffic lights or in traffic jams.
COMMUNICATION
Vehicle-to-vehicle (V2V) radios send signals between cars, trucks and infrastructure items such as traffic lights.
Latency Constraints
ROUTE PLANNING
An on-board computer uses sensor data to plot a route that gets the car where it needs to go, while avoiding people, potholes and other vehicles.
LOCATION
Mapping software uses Global Positioning System data to tell the car where it is in relation to roads, traffic signals, and other landmarks.
2020s
The decade when driverless cars are predicted to become widespread.
10%
Fuel savings for cars that travel in formation.
ROAD TRAINS
Vehicles can take advantage of aerodynamics and save fuel by following one another almost bumper to bumper. They are protected from catastrophic pile-ups by their V2V radios, which allow all the cars in line to hit their brakes at the same time.
CITIES TRANSFORMED
MASS TRANSPORT People increasingly give up owning cars in favour of calling companies to pick them up wherever they are and drop them off wherever they need to go — a driverless version of a ride-sharing service.
LAND USE Urban centres begin to undo the many accommodations they have made for personal vehicles — starting with the vast quantities of real estate devoted to parking, which could be adapted to more productive uses.
800 million
One estimate of the number of US parking spaces. Many could be used for other purposes if people ride-share more.
ILLUSTRATION BY DON FOLEY; TEXT BY M. MITCHELL WALDROP; DESIGN BY KELLY KRAUSE

CLOUD COMPUTING
ASSUMPTION #4

The connectivity **cost** is negligible


Cost of connectivity is an
issue in Smart Grids as
the operator has to pay for
the 2G/3G/4G data-link

CLOUD COMPUTING

ASSUMPTION #4

Industrial companies are **comfortable** in **exposing** their **data** to the **cloud**.


10
9
7


WHAT ELSE?