IoT - en ljus framtid med många möjligheter

eHealth arena, 210915

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IoT – Internet of Things

- Definition – what's IoT and what is not?
- It's a broad area
- Applications for health
- Communication, microcontrollers and batteries
- The future is already here -> ML and AI

IoT

The Internet of things (IoT) describes the network of physical objects—"things"—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet.

https://en.wikipedia.org/wiki/Internet_of_things

The 'Internet of Things' (IoT) is an emerging technology that enables interaction of uniquely identifiable computing devices that can be embedded with other inter- faces like machines and humans, linked via wired and wireless networks, to capture contextual data from the environment

Chudhuri - IoT for Things and by Things

IoT

"***If we had computers*** *that knew everything there was to know about things—using data they gathered without any help from us—we would be able to track and count everything, and greatly reduce waste, loss and cost. We would know when things needed replacing, repairing or recalling, and whether they were fresh or past their best. We need to empower computers with their own means of gathering information, so they can see, hear and smell the world for themselves.*"

Ashton, K. 2009. That 'Internet of things' thing. *RFiD Journal* 22 (7): 97–114.

Internet of things (IoT): *A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.*

ITU-T (International Telecommunications Union Telecommunication Standardization Sector). 2005. ITU Internet reports, the Internet of things. Geneva: ITU-T.

The “smart” home

Wearable technology in use today

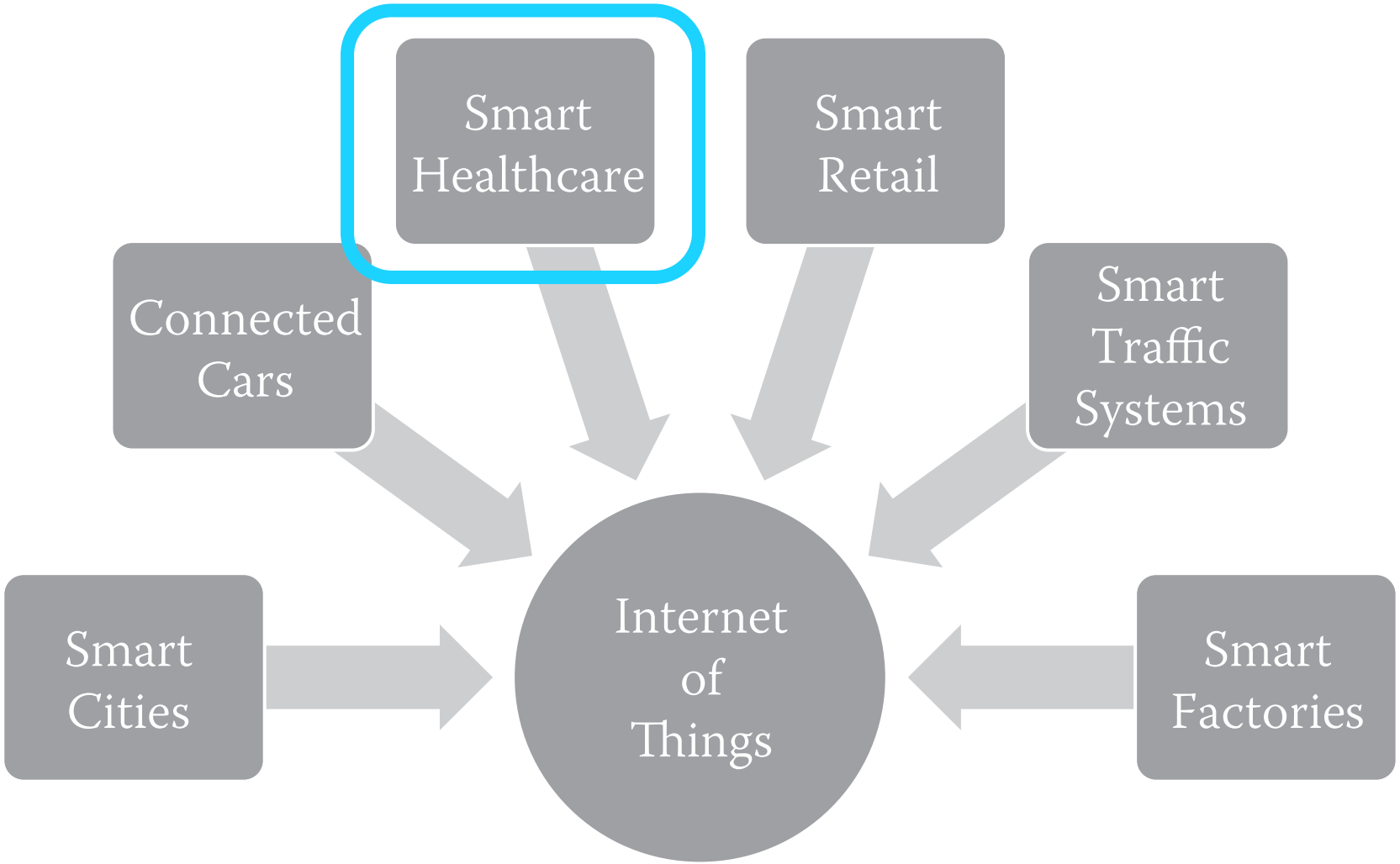
Challenges:

- Sophisticated modelling measuring on the wrist (complex)
- Not clinical grade
- Sharing data from consumer platforms

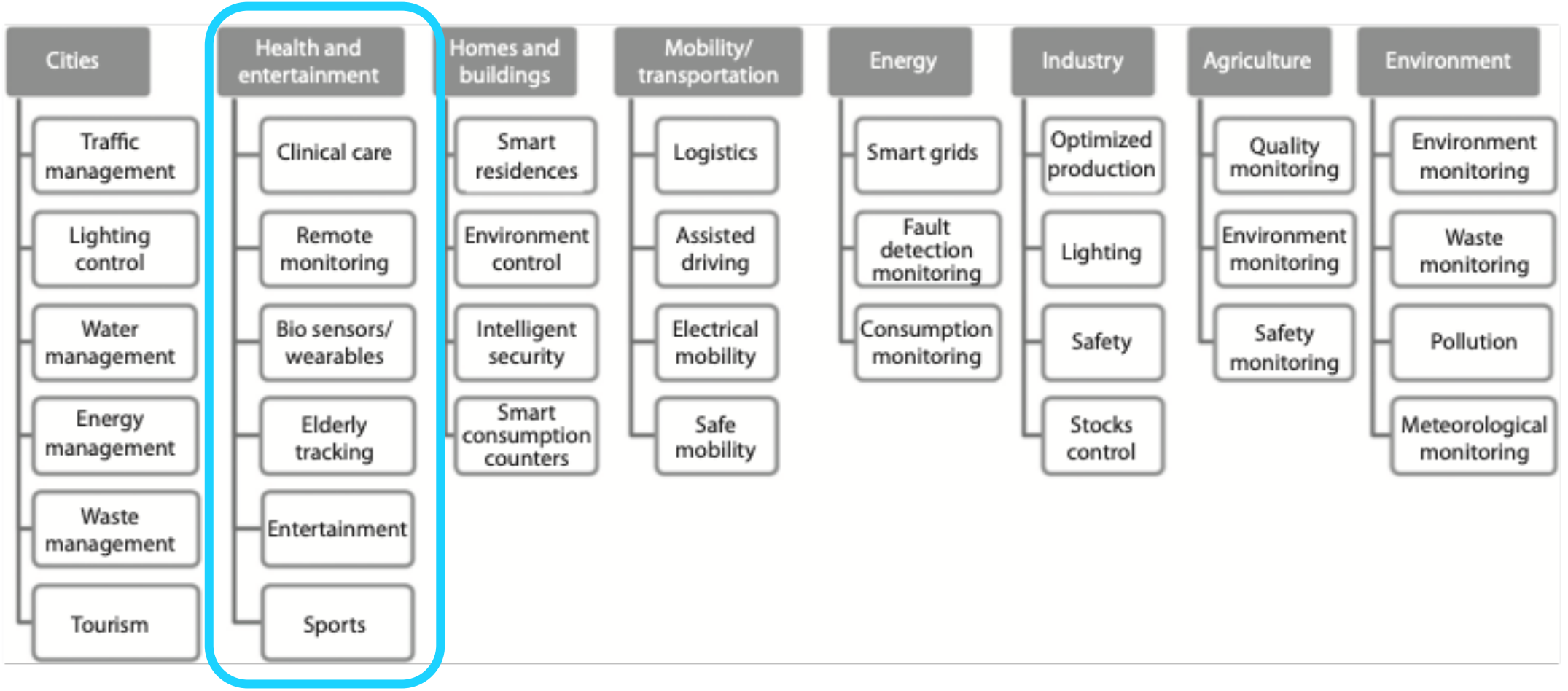
The selected sensor-based approaches and their information.

Scope	Article	Main idea	Evaluation technique(s)	Tool(s) and evaluation environment(s)	Advantage(s)	Disadvantage(s)
Wearable sensors	Ray et al. (2019c)	A galvanic skin response system in smart e-healthcare applications	Prototype	Android	➢ High performance ➢Low energy ➢Low cost	➢Low security ➢Low scalability
	Bhatia and Sood (2017)	An intelligent real-time healthcare framework to predict the health state of the person during the workout	Real testbed	Not mentioned	➢High performance ➢High efficiency ➢High security ➢High stability	➢Low scalability
	Azimi et al. (2019)	A personalized approach for maternal health	Real testbed	Python	➢High accuracy ➢High reliability	➢Low security ➢Low scalability
	Yang et al. (2016)	An ECG-based monitoring system in HIoT	Real testbed	Not mentioned	➢High reliability ➢High accuracy ➢Low cost	➢Low security ➢Low scalability
	Wu et al. (2017)	A wearable sensor node with solar energy harvesting in HIoT	Simulation	LTspice	➢High reliability ➢High flexibility ➢Low energy	➢Low security ➢Low scalability ➢Low stability
	Wu et al. (2018)	A wireless implantable sensor for IoT healthcare applications	Simulation	Not mentioned	➢High flexibility ➢high performance ➢Low energy	➢Low security ➢Low privacy ➢Low scalability
	Niitsuet al. (2018)	A self-powered and disposable supply-sensing biosensor platform for big data in healthcare IoT	Simulation	SPICE	➢High performance ➢Low cost ➢Low energy	➢Low security ➢Low privacy
	Tekeste et al. (2019)	A real-time QRS detector to save energy consumption	Real testbed	Verilog-RTL	➢High performance ➢High efficiency ➢High optimization ➢High reliability ➢Low energy	➢Low security

Hallforset et al. (2018)	Nylon ECG wearable sensors in HIoT	Simulation	SPICE	➢High efficiency ➢Low energy	➢Low security ➢Low scalability
Esmaeili et al. (2020)	A secure sensing scheme for body area networks in HIoT	Simulation	MATLAB	➢High security ➢Low energy ➢Low packet delivery delay	➢Low interoperability ➢Low scalability
Muthuet al. (2020)	A wearable sensor empowered with AI and machine learning	Simulation	MATLAB	➢High sensitivity ➢High specificity ➢High accuracy ➢High precision ➢High performance	➢Low security ➢Low privacy
Huifeng et al. (2020)	Sportsperson health monitoring system using wearable sensor	Simulation	MATLAB	➢High accuracy ➢Low error rate ➢High precision ➢High F-score ➢High performance	➢Low security ➢Low privacy
Wu et al. (2020)	A wearable sensor patch to measure health parameters in HIoT	Real testbed, Prototype	Not mentioned	➢High security ➢High privacy ➢High performance	➢Low scalability


Smart Healthcare
Smart Retail
Connected Cars
Smart Traffic Systems
Smart Cities
Internet of Things
Smart Factories

Application areas



Smart city

- Smart parking
- structural health of the buildings
- bridges and historical monuments
- air quality measurement,
- sound noise level measurement
- traffic congestion and traffic light control
- road toll control
- smart lighting
- trash collection optimization
- waste management
- utility meters
- fire detection
- elevator monitoring and control
- manhole cover monitoring
- construction equipment and labor health monitoring
- environment and public safety

LPWAN Technologies for IoT and M2M Applications (2020). Academic Press, Introduction to low-power wide-area networks, Bharat S. Chaudhari1, Marco Zennaro2

Smart agriculture and farming

- Temperature
- Humidity
- alkalinity measurement
- wine quality enhancing
- smart greenhouses
- agricultural automation and robotics
- meteorological station network
- Compost
- Hydroponics
- offspring care
- livestock monitoring and tracking
- toxic gas levels

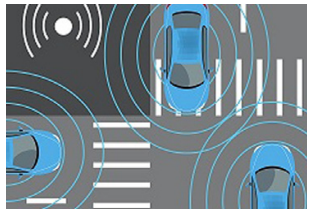
LPWAN Technologies for IoT and M2M Applications (2020). Academic Press, Introduction to low-power wide-area networks, Bharat S. Chaudhari, Marco Zennaro

Patient health

- health parameters
- connected medical environments
- health care wearable
- patients surveillance
- ultraviolet radiation monitoring
- telemedicine
- fall detection
- assisted living
- medical fridges
- sportsmen care
- tracking chronic diseases
- tracking mosquito and other such insects population and growth

LPWAN Technologies for IoT and M2M Applications (2020). Academic Press, Introduction to low-power wide-area networks, Bharat S. Chaudhari, Marco Zennaro

And many, many, more …


Water quality, air pollution, temperature, forest fire, landslide, animal tracking, snow level monitoring, and earthquake early detection, water leakage, river flood monitoring, swimming pool management, and chemical leakage

Smart electricity meters, gas meters, water flow meters, gas pipeline monitoring, and warehouse monitoring, Network control, load balancing, remote monitoring and measurement, transformer health monitoring, and windmills/solar power installation monitoring

Energy and water use, temperature, humidity, fire/smoke detection, remote control of appliances, intrusion detection systems, art, goods preservation, and space as a service

M2M applications, robotics, indoor air quality, temperature monitoring, production line monitoring, ozone presence, indoor location, vehicle auto-diagnosis, machine health monitoring, preventive maintenance, energy management, machine/equipment as a service, and factory as a service

Insurance, security and tracking, lease, rental, share car management, quality of shipment conditions, item location, storage incompatibility detection, fleet tracking, smart trains, and mobility as a service

Supply chain control, intelligent shopping applications, smart shelves, and smart product management

LPWAN Technologies for IoT and M2M Applications (2020). Academic Press, Introduction to low-power wide-area networks, Bharat S. Chaudhari, Marco Zennaro

Broad variety of ready to use devices

- water meters
- pressure meters
- smart plugs
- soil sensor stations
- air quality stations
- GPS trackers
- data loggers
- parking sensors
- padlocks

Images source: Devices Marketplace by The Things Network (www.thethingsnetwork.org)

Temp, RH, GPS, motion, light

EM500-SWL
Wasserstandssensor

Wasserstand

Smart Parking Sensor

LoRaWAN button with e-ink display

LoRaWAN People Counter

Mulch Temperature Probe

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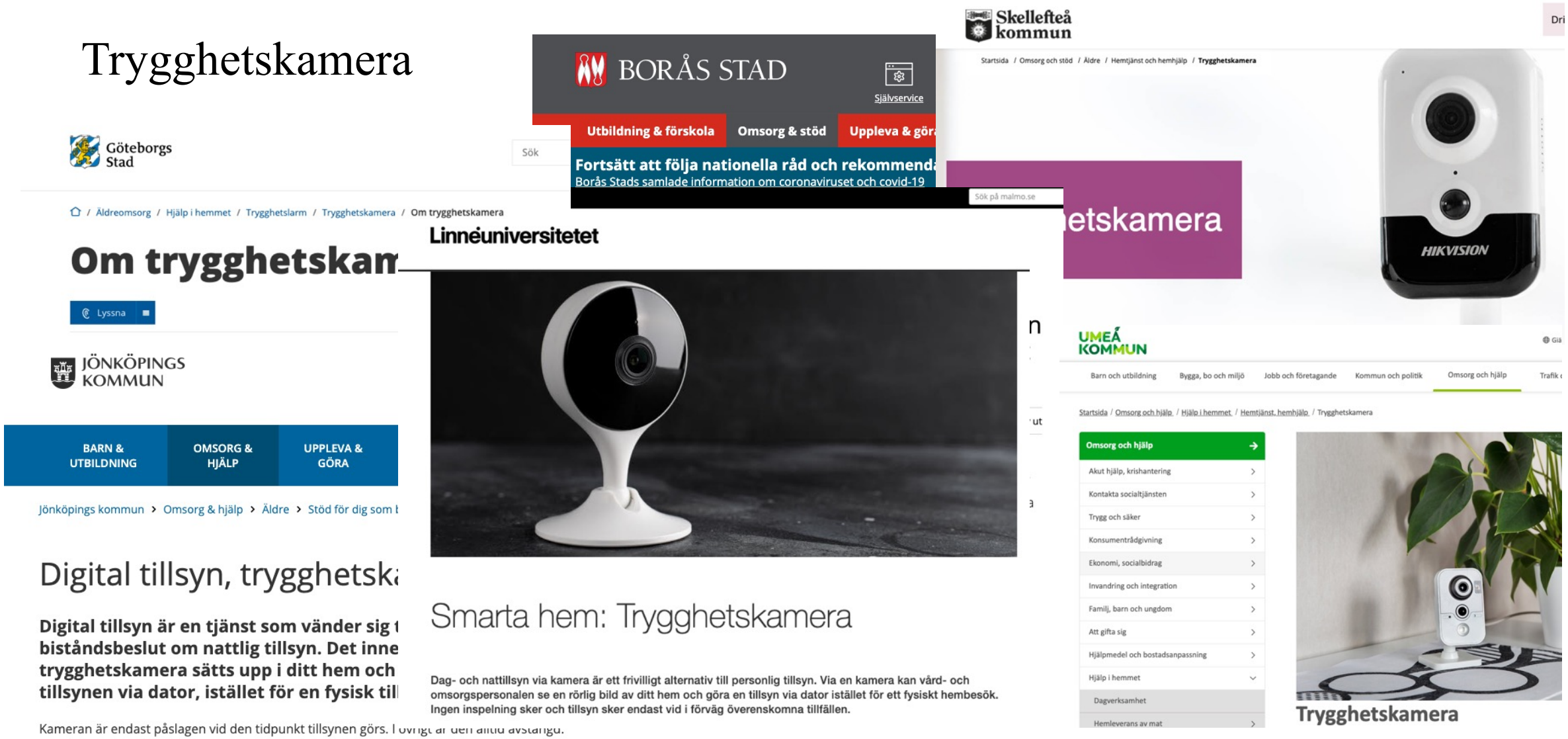
Trygghetskamera



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Worth considering...

- Integrity and privacy
- Scaleability
- Ease of setup
- Dependencies
  - WiFi coverage
  - Internet providers

Carbon dioxide levels reflect COVID-19 risk

Science News *from research organizations*

Carbon dioxide levels reflect COVID-19 risk

Research confirms value of measuring carbon dioxide to estimate infection risk

Date: April 7, 2021

Source: University of Colorado at Boulder

Summary: Tracking carbon dioxide levels indoors is an inexpensive and powerful way to monitor the risk of people getting COVID-19, according to new research. In any given indoor environment, when excess carbon dioxide levels double, the risk of transmission also roughly doubles, scientists report.

Share:

RELATED TOPICS

Health & Medicine
- Cholesterol
- Asthma
- Workplace Health
- Viruses

Earth & Climate
- Air Quality
- Environmental Science

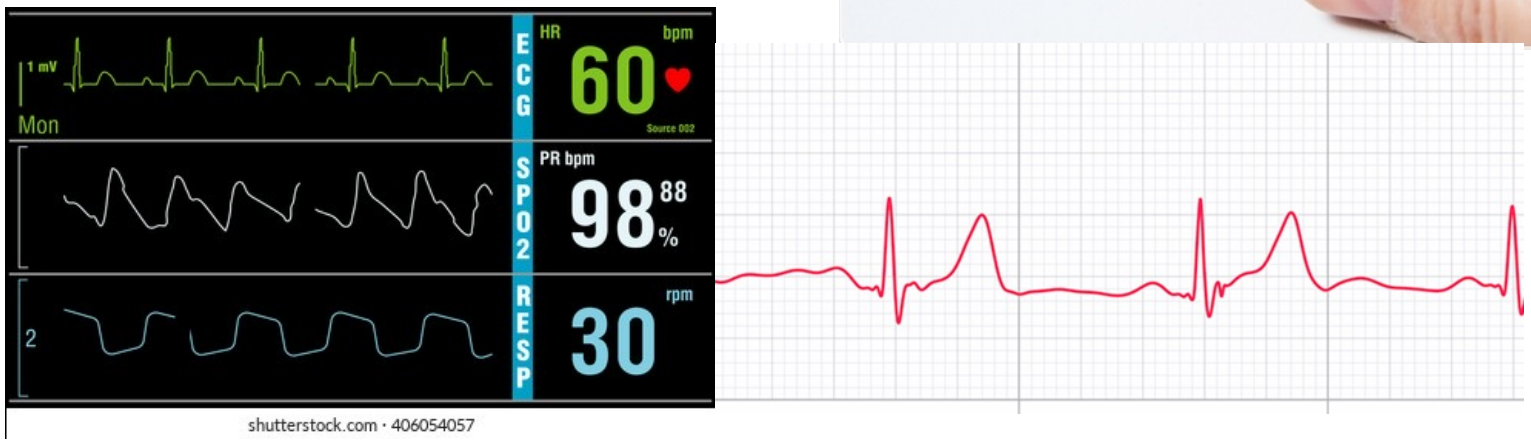
FULL STORY

Tracking carbon dioxide levels indoors is an inexpensive and powerful way to monitor the risk of people getting COVID-19, according to new research from the Cooperative Institute for Research in Environmental Sciences (CIRES) and the University of Colorado Boulder. In any given indoor environment, when excess CO_2 levels double, the risk of transmission also roughly doubles, two scientists reported this week in *Environmental Science & Technology Letters*.

https://www.sciencedaily.com/releases/2021/04/210407143809.htm

Measurements in health

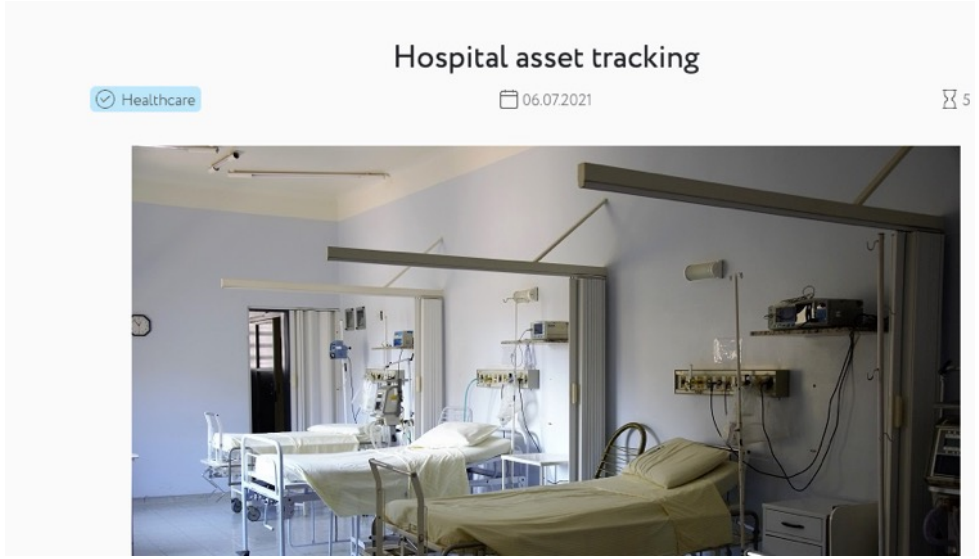
- Temperature Trends
- SpO2
- Respiration rate
- Heart rate
- ECG



Application area – asset tracking medical equipment

- Santa Clara Valley Medical Center in San Jose, CA, reported 383 items missing from 2010 to 2014, valued at more than $11 million.
  - https://www.nbcbayarea.com/news/local/santa-clara-valley-medical-center-missing-equipment-taxpayers-money/123864/

https://www.healthcaredive.com/news/lost-and-found-keeping-track-of-healthcare-equipment/434353/

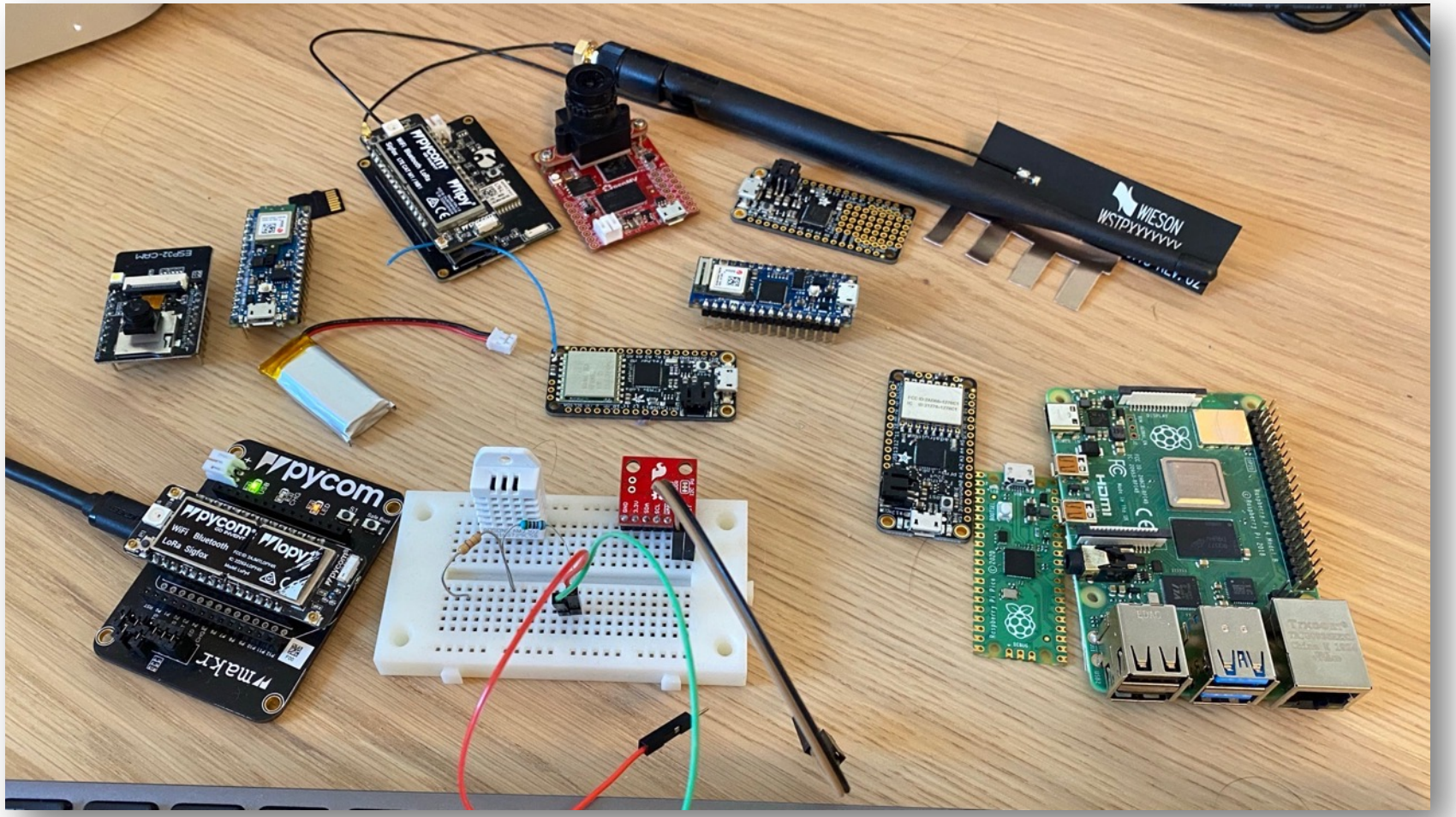


https://navigine.com/blog/tracking-assets-in-hospitals-and-medical-institutions/

https://kontakt.io/blog/wheelchair-tracking-hospitals-ble-location-services/

Automation and analysis -> increase the “human” part.

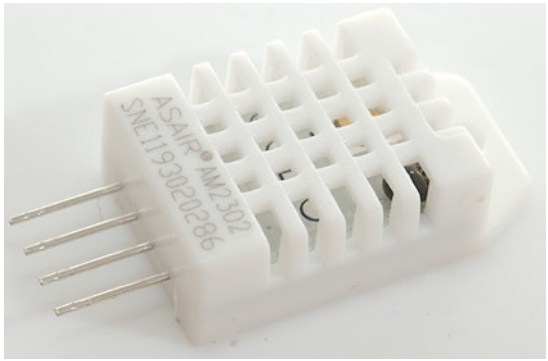
Our lab



”Thing” in IoT

- A sensor is connected to a micro-controller fitted with hardware for communication.
- The sensor is sensing the environment

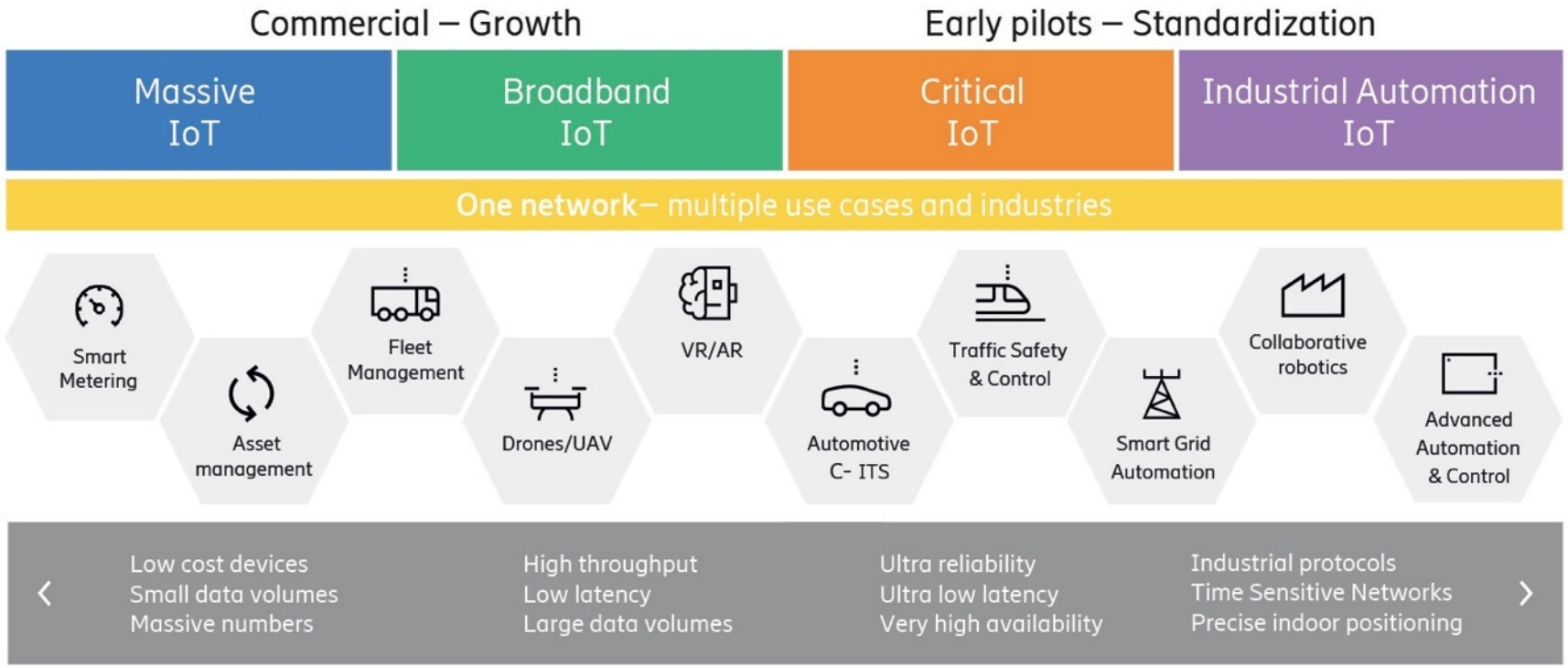
”Thing” is **micro-controller + sensor**



Challenges – a combination of design choices

- Battery and power
- Communication
  - range
  - transmission rate
  - latency
  - downlink/uplink
- Cost
- Coverage
- Quality of Service
- Encryption

Use cases



https://www.ericsson.com/en/reports-and-papers/white-papers/cellular-iot-evolution-for-industry-digitalization

LPWAN is the new black[1]

- NB-IoT
- LTE Cat-M1
- LoRa
- Sigfox

"As recently as early 2013, the term "LPWAN" did not even exist."

A survey on LPWA technology: LoRa and NB-IoT☆,☆☆ Rashmi Sharan Sinha, Yiqiao Wei, Seung-Hoon Hwang

[1] https://www.avsystem.com/blog/iot-connectivity/

Low power wide area network (LPWAN)

- IoT applications have specific requirements such as
  - long range
  - low data rate
  - low energy consumption
  - cost effectiveness

- Zwave, ZigBee, Bluetooth, WiFi are not adapted for scenarios that require long range transmission

- Solutions based on cellular communications (e.g., 2G, 3G, and 4G) can provide larger coverage, but they consume excessive device energy.

A comparative study of LPWAN technologies for large-scale IoT deployment
Kais Mekkia,∗, Eddy Bajica, Frederic Chaxela, Fernand Meyerb

The Future of ML is Tiny and Bright[1]

[1]https://blog.tensorflow.org/2020/08/the-future-of-ml-tiny-and-bright.html

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Advantages of TinyML

- **Low Latency:** Since the model runs on the edge, the data doesn't have to be sent to a server to run inference. This reduces the latency of the output.
- **Low Power Consumption:** microcontrollers consume very little power. This enables them to run without being charged for a really long time.
- **Low Bandwidth:** As the data doesn’t have to be sent to the server constantly, less internet bandwidth is used.
- **Privacy:** Since the model is running on the edge, your data is not stored in any servers.

https://www.digikey.in/en/maker/projects/intro-to-tinyml-part-1-training-a-model-for-arduino-in-tensorflow/8f1fc8c0b83d417ab521c48864d2a8ec

The fight against illegal deforestation with TensorFlow

"analyze all the auditory data in real-time and listen for chainsaws, logging trucks and other sounds of illegal activity that can help us pinpoint problems in the forest"

https://blog.google/technology/ai/fight-against-illegal-deforestation-tensorflow/

Penn State-developed plant-disease app recognized by Google

A Tanzanian cassava farmer, left, learns to use a plant disease mobile app developed as part of the PlantVillage initiative led by Penn State researchers. **IMAGE: PENN STATE**

https://news.psu.edu/story/513236/2018/04/02/research/penn-state-developed-plant-disease-app-recognized-google

Advantages of TinyML

- **Audio:** Chainsaws, voice interfaces, bird calls
- **Detect movement:** Gesture recognition, magic wands, packages
- **Detect images:** Count people, cars, animals, inventory
- **Other sensor data:** Monitor machinery, temperatures, power usage

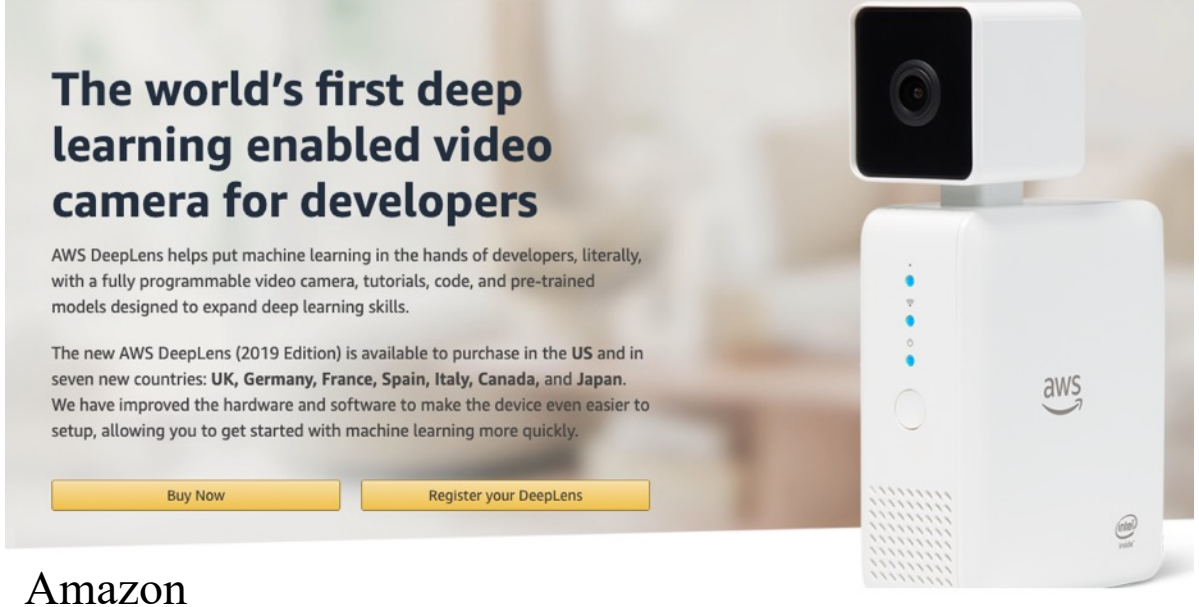
Pete Warden (Google). How TinyML Could Help Developing Countries - QLS AP Colloquium

https://youtu.be/1yeJQdvXP1E

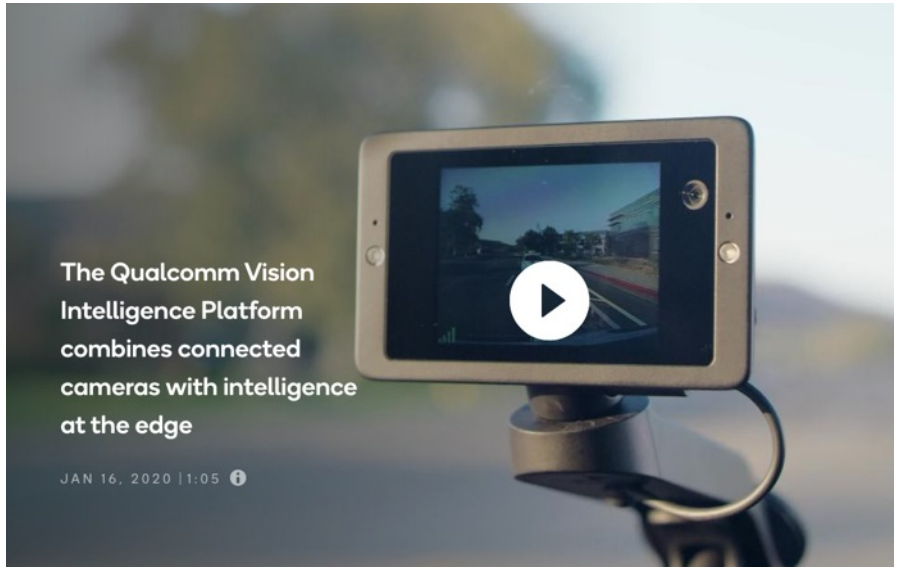
ML on the Edge

- Privacy
- Lower transmission rate

OpenMV Cam



Amazon



Qualcomm

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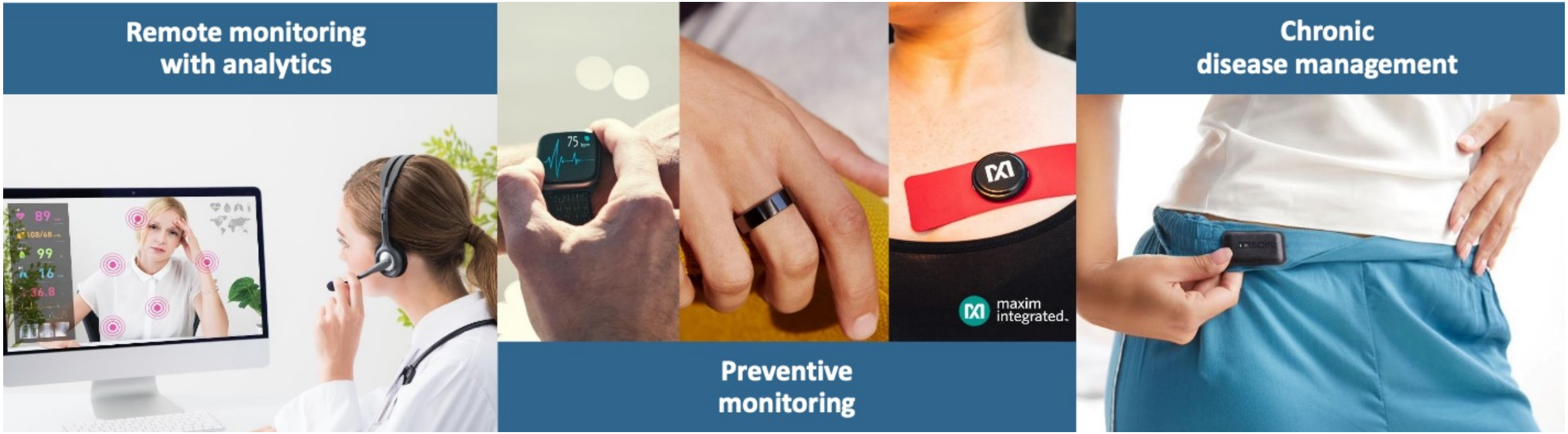


(CR) Maxim Integrated

Predictive Screening

Temp & SpO_2

Onset Monitoring (Hi Risk)

Temp, SpO_2, HR/ECG & Respiration

Periodic Telemetry

FDA

Post Hospital Monitoring

Temp, SpO_2, Heart Rate/ECG, Respiration

24/7 Telemetry

FDA

Deteriorating Condition

Body Temperature, SpO_2, Heart Rate/ECG, Respiration

24/7 Telemetry

FDA

(CR) Maxim Integrated

TinyML talks

https://www.youtube.com/watch?v=Uyo5-7NHE-s

https://www.youtube.com/watch?v=RFhVcD9jR9E

Track record summer course Applied IoT @ LNU 2020 - 2021

- Summer course,
  - Tillämpad IoT 2020.
    - In Swedish - Tillämpad IoT, >1000 applicatants
    - **185 (!!!)** IoT projects all over Sweden
  - Applied IoT 2021.
    - In English. >750 applicants.
    - Students from all over Europe.
    - 170 IoT projects

University program courses

Project courses with IoT-focus in:

- Computer Engineer (Högskoleingenjör Datateknik)
- Software Engineer (Högskoleingenjör Mjukvaruteknik)
- Webprogrammers (Webprogrammerare)

- ~ **30-40 st IoT** projects in Kalmar/Växjö annually

Project showcase https://hackmd.io/@lnu-iot/good-examples

Sensor applications

Student name	*Project name*
David Lindgren	IoT tracker - validation of vehicle performance
Elias Lindfors & Hamed Talebi	Indoor Air Quality Monitor
Fabian Fröschl	Light intensity, temperature and humidity sensor for the desk
Oskar Almqvist	(VibSense) - build a third hand by creating a IOT assistant capa of sensing vibrations and impacts with ultra high sensitivity
Peter Daniel	Smart Aquarium using PyCom
Andreas Hedlund	Monitoring of wastewater treatment plant
Mikael Johannesson	Remote temperature log with local alarm
Alex Karlsson	IoT tutorial on monitoring weather data in your home using the TIG stack
Pierre Lantz Söderlund	Monitor your plants and their environment
Ammar Shihabi	Smart irrigation system using LoPy4 and WiFi
Anton Bengtsson	Build a solar panel table to keep your beer cold using the sun
Erik Claesson	Authentication system featuring a prototype door, NFC technology and JSON Web Tokens
Xi Chen	Home Winery Assistant
Nicole DiNatali	Smart Doorbell with motion sensitivity and camera function on Raspberry Pi 2
Erik Gustavsson	Smarter IOT connected window
Mika Persson	Build a Public Locker Alarm

Monitor your plants & the weather with an awesome wall-mounted dashboard

Victor Krook - vk222ii

In this project we're going to build a system that allows us to track and monitor the temperature, humidity and the moisture in our plants and display it on a wall-mounted dashboard. We're going to store the data in a database runing locally, so you'll have full control of all the dataflow!

https://hackmd.io/@victorkrook/HyEEBujaI

IoT Project - Combining an aeroponic system with pH-level and temperature measurements

Finalizing the design

Here is some pictures i have taken for the final result of the project. They are taking inside my garage were the growing will take place later on.

[1]

[2]

[3]

https://hackmd.io/@re222km/Sk0zck2h8

Build a simple (but not very secure) alarm system for your home or dorm room

Author: Arvid Berntsson (ab225hz)

This is a project for the course 'Applied IoT' at the Linnaeus University. The principles on which this project is based upon was taught during the first half of the course and then this project was started. The project took around 2 weeks and was completed in July of 2020.

The project aims to create a simple **motion detection alarm system** for home use, which notifies a desired user of the trigger. It won't necessarily scare off burglars, but will hopefully keep nosy roommates at bay.

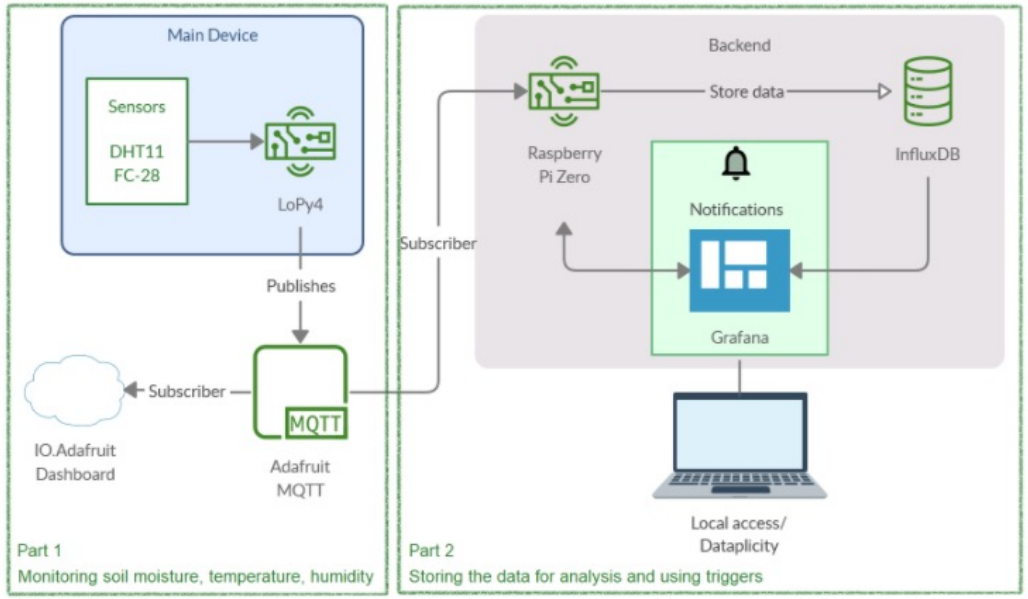
https://hackmd.io/@Berntzone/rk-tYaQRL

Plant, temperature and humidity monitor with optional database and notifications

Most of us have plants in our homes and I know I tend to forget to give them their essentials: water and a pleasant living area.

This tutorial aims to get you through building a plant monitoring system with additional temperature and humidity monitoring. The sensors are connected to a LoPy4 who then communicates through MQTT. The data can be presented on a dashboard using Adafruit or using Grafana and storing the data on InfluxDB for further analysing (on a Raspberry Pi).

By: Leyla Wejdell (lw222te)



https://hackmd.io/@wtfkiwi/Plant-T-H-Monitor

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IoT lab SMF

Mail goal: Strengthen the competitiveness for small and medium sized companies within the Linnaeus region by new innovation processes in IoT.

- **Inspirational talks**
- **Teaching activities**
  - **workshops**
  - **guest lectures**
  - **open lab days. Last Wednesday each month 12-17.**
- **test and development of IoT ideas**
- **new business models within IoT**

We are building a new IoT lab

- IoT-lab for SMF
  - Two engineers
  - Two postdocs

- Build a new lab – reasearch and IoT testbed
  - Development hardware, sensors, ready to use products
  - Applied focus

Are you an SMF representative? Keep in touch!

Lnu.se