Federated Learning for Autonomous IoT Systems:

Tiny data collectors, vastly distributed systems, and the land of tiny challenges

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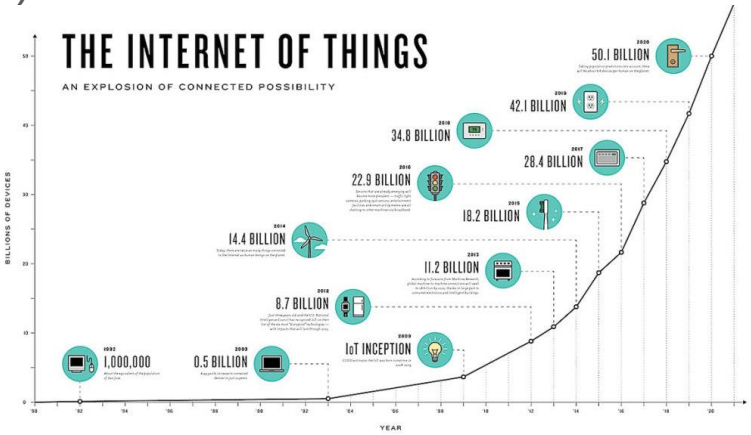
Tiny data collectors

- Embedded devices connected to a variety of sensors (IoT)
  - **Accessible**? (maintenance & management)

  - Fault tolerant / **Reliable** or Robust?
  - Secure?
  - Privacy preserving?

  - **Understandable**?
  - Data correctness?
  - Distributed but not really decentralised!



Source: https://gigazine.net/gsc_news/en/20170412-iot-market-2023

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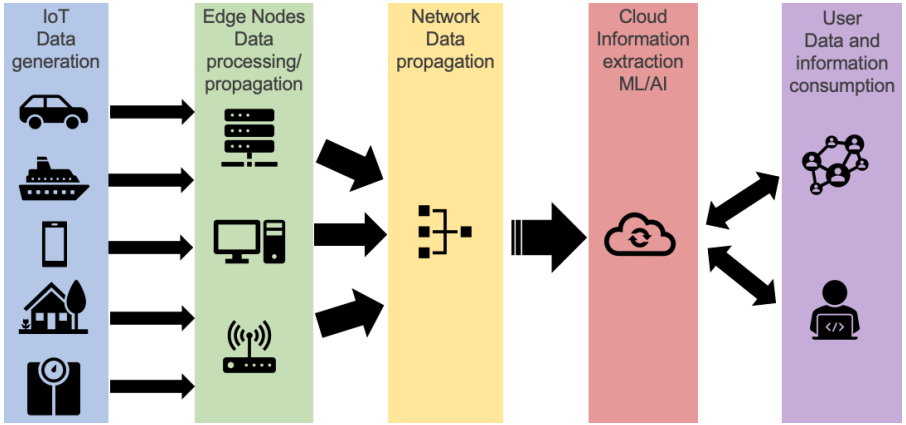
Tiny data collectors

- **IoT** capabilities increase (CPU, memory, GPUs, FPGAs and custom accelerators)
- The **cloud** is not enough!
  - Latency
  - Privacy
  - “Dirty” data
  - Demand
- ML is becoming an **Edge** core component

- But what will the Edge look like?



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On the Edge

AURO'18

Solving the task variant allocation problem in distributed robotics

José Cano[1] · David R. White[3] · Alejandro Bordallo[1] · Ciaran McCreesh[2] · Anna Lito Michala[2] · Jeremy Singer[2] · Vijay Nagarajan[1]

IEEE WoWMoM'21

Optimizing Task Allocation for Edge Micro-Clusters in Smart Cities

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IEEE VTC'21

Real-time Recursive Risk Assessment Framework for Autonomous Vehicle Operations

Wei Ming Dan Chia[1,2], Sye Loong Keoh[2,3], Anna Lito Michala[2], Cindy Goh[3]
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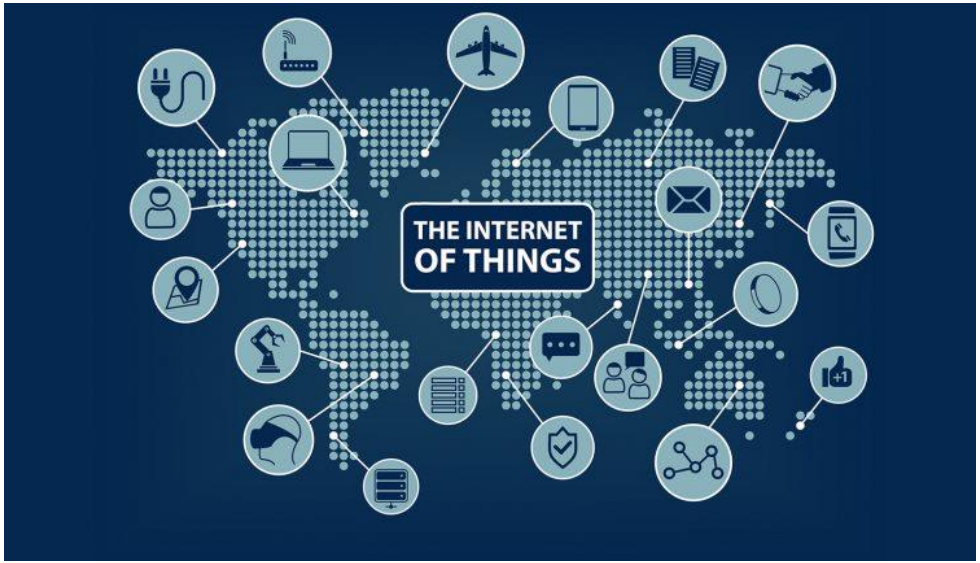
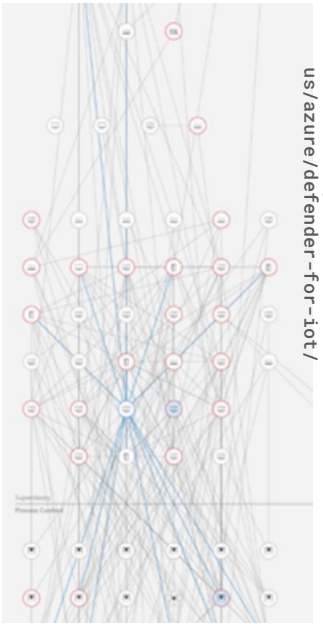
Vastly distributed systems



Source:
https://www.supply-chain.gr/



Source: https://docs.microsoft.com/en-us/azure/defender-for-iot/

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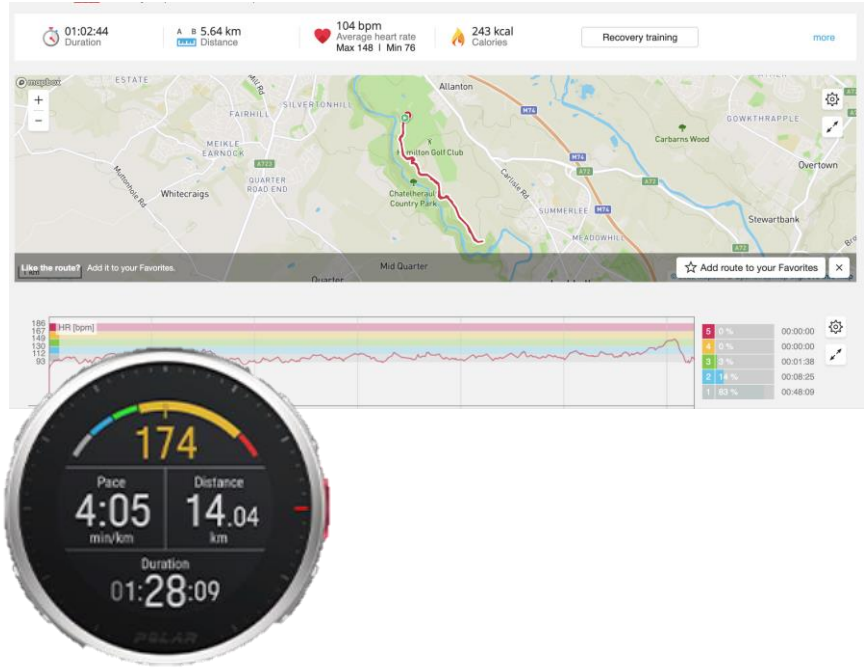
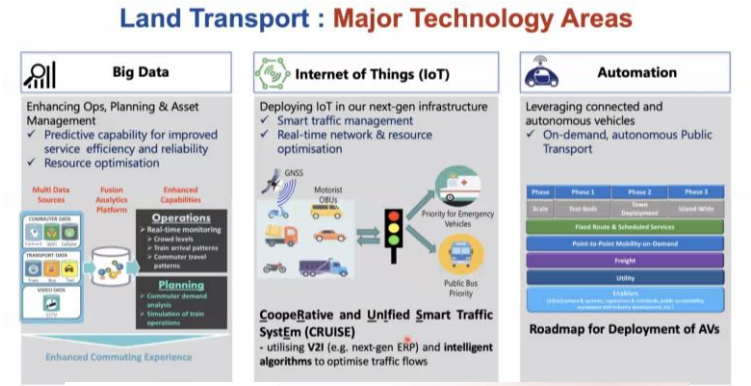
Vastly distributed systems





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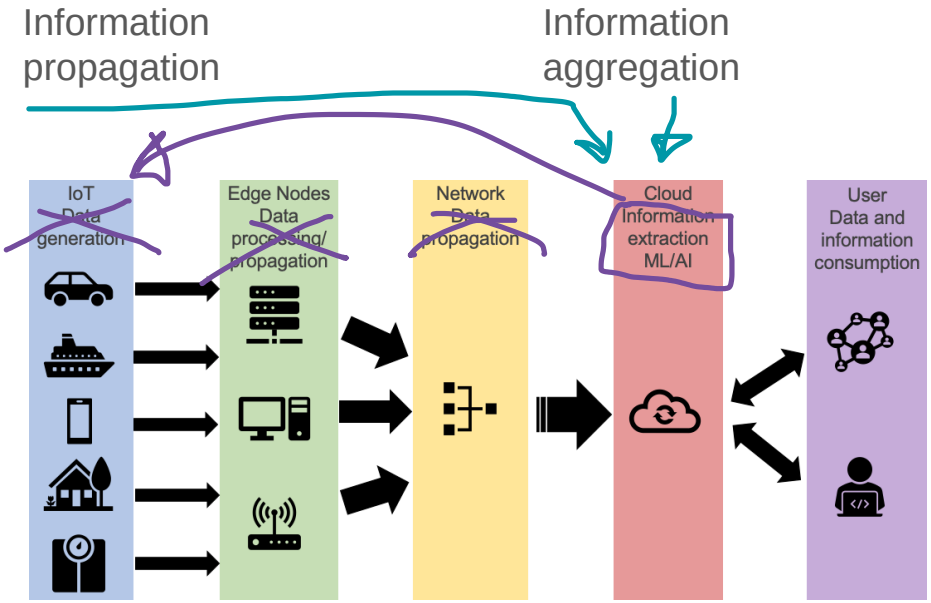
Federated Learning

- A new architecture
- Still vastly distributed
- Where should the aggregation take place?
- How computationally intensive is the information extraction when looking at one set of collected data ?
- Can it be deployed in IoT or should it be on the Edge?



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Federated Learning Frameworks

- IntegrateFL (MLOps platform)
  - Python SDKs
  - Differential privacy Real-time Data network monitoring and metrics
  - Mostly built around **Kubernetes**, AWS and similar infrastructure technologies with some interesting web interfaces to improve usability and scalability
- NVIDIA Flare
  - Similar to above but Open Source. Implemented in **Python**.
- Flower
  - **Docker** and **Python**, Open source

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The land of tiny challenges

- Power
- CPU
- RAM
- Networking
- Cost

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The land of tiny challenges

ACM TIOT

Vibration Edge Computing in Maritime IoT

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IOANNIS VOURGANAS, Abertay University, UK
ANDREA CORADDU, University of Strathclyde, UK

TrustCom'22

mini-ELSA: using Machine Learning to improve space efficiency in Edge Lightweight Searchable Attribute-based encryption

Jawhara Aljabri *†, Anna Lito Michala*, Jeremy Singer*, Ioannis Vourganas ‡
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nature electronics

ARTICLES

https://doi.org/10.1038/s41928-021-00612-x

Check for updates

Smartphone-based DNA diagnostics for malaria detection using deep learning for local decision support and blockchain technology for security

Xin Guo[1,4], Muhammad Arslan Khalid[1,4], Ivo Domingos[2], Anna Lito Michala[2], Moses Adriko[3], Candia Rowel[3], Diana Ajambo[3], Alice Garrett[1], Shantimoy Kar[1], Xiaoxiang Yan[1], Julien Reboud[1], Edridah M. Tukahebwa[3] and Jonathan M. Cooper[1]✉

Data Privacy Threat Modelling for Autonomous Systems: A Survey from the GDPR's Perspective

Naila Azam*, Lito Michala*, Shuja Ansari†, Nguyen Binh Truong*
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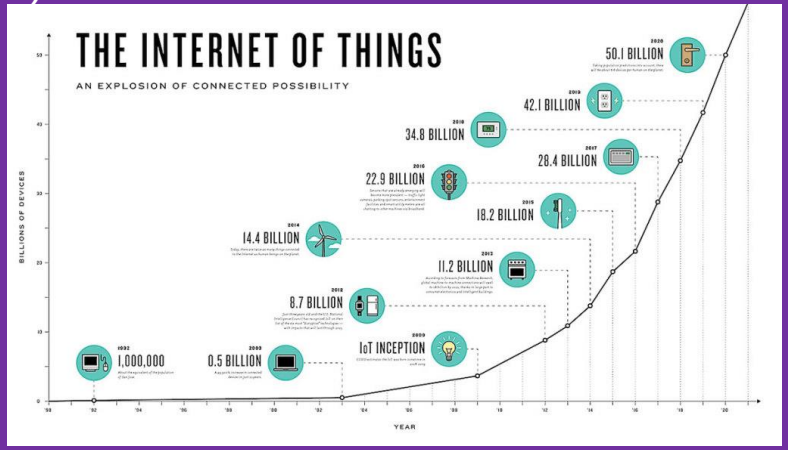

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Elixir benefits

- High availability
- High concurrency
- Reliability by design
- Fault tolerance
- Communication protocols
- Quick development time
- Easier code maintenance (source code lines)
- Heterogeneous hardware compatibility

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Erlang/Elixir ecosystem

- Nerves (OS targeting IoT)
- Kry10 (secure OS)

- Nx (Tensor math)
- evision (OpenCV Elixir bindings)

- Explorer, Livebook

- Other projects looking at
  - Learning/Federated learning
  - IoT programming in general

https://www.nerves-project.org/

https://kry10.com/

https://dashbit.co/blog/nx-numerical-elixir-is-now-publicly-

https://github.com/cocoa-xu/evision

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CAEFL: Composable and Environment Aware Federated Learning Models

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ACM SIGPLAN ICFP'22

The land of opportunities

- Are we saving enough power by not sending each data point from the IoT device?
- Is that sufficient to be used for our computation needs efficiently?
- Can other algorithms adapt to such vast distribution?
- What happens when we have small local datasets?

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Thank you!

Questions?

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