IoT and Edge: Manufacturing

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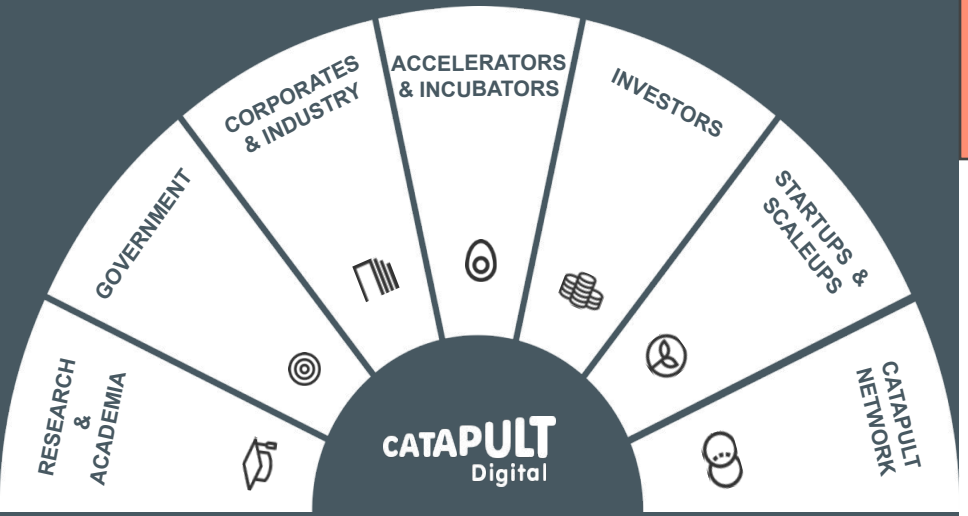
CATAPULT Digital | Digital Catapult: Overview



Future Networks (IoT, 5G)

Immersive Technologies

Artificial Intelligence

Distributed Systems (DLT)

Accelerating the early adoption of advanced digital technologies in the UK

CATAPULT Digital

- Digital Catapult is the **UK's leading advanced digital technology innovation centre.**
- **Uniquely positioned** at the centre of all major contributors to technology advancement in the UK
- We provide physical and **digital facilities** for experimentation and testing.
- Our **innovation programmes** drive collaboration and encourage use of the facilities.
- We utilise our digital skills, expertise and startup ecosystem to **de-risk corporate innovation.**
- We **convene and deliver collaborative research** and development that leads to commercial exploitation and companies reducing risk.

The Edge and The Hype

What Edge Computing Means for Infrastructure and Operations Leaders

*"Currently (2018), around 10% of enterprise-generated data is **created** and **processed outside** a traditional centralized data center or cloud.*
By 2025, Gartner predicts this figure will reach 75%."

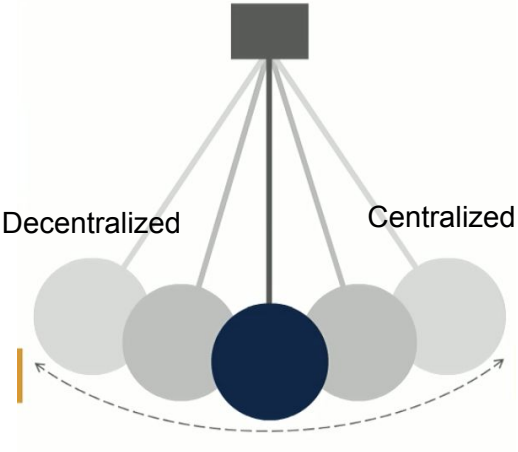
Gartner

Strategic Planning Assumptions

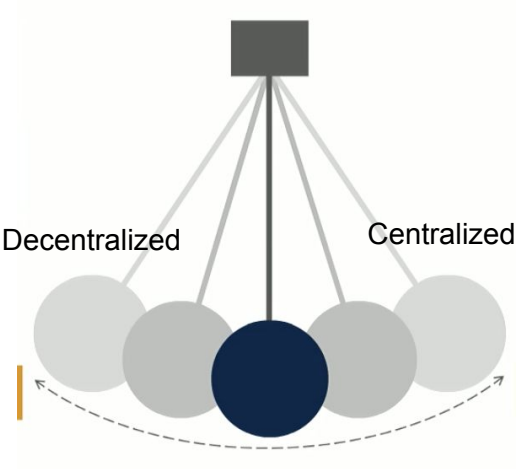
- **Forty percent** of large enterprises will be integrating edge computing principles into their 2021 projects, up from less than 1% in 2017.
- By 2020, **100 million** consumers will shop in augmented reality.
- By 2021, there will be **$2.5 million** per minute in IoT spending and **1 million** new IoT devices sold every hour.

What's good in the centralized Cloud?

- (Almost) unlimited resource scaling
  - For compute, storage, and for in-cloud networking
- Economy of scale
  - When compute/storage is the driving factor, cloud seems unbeatable
- Natural place for working with **big data**
  - Data-driven algorithm development
- Fantastic **IT tooling and abstraction**
  - IaaS / PaaS / SaaS
  - DevOps tooling



What's wrong with the Cloud?



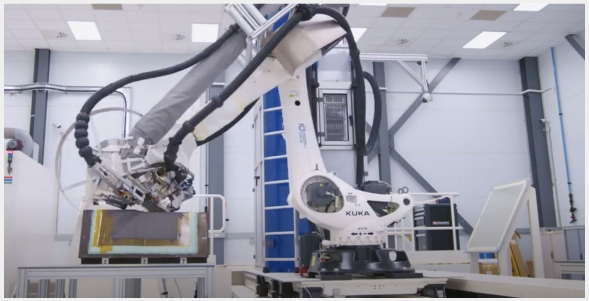
- Cloud is where big data lives. It is not where data is coming from
  - Data is generated at the boundary of the physical and IT(OT) world
- Bandwidth
  - Explosion of data from widespread and rich IoT
- Latency
  - Physics: speed of light
  - Add to it chatty protocol stacks
- Autonomy
  - By necessity and for resilience
- Privacy, or data secrecy
  - Rule no. 1 is still the same
- Cost (money and energy)
  - When the bulk of the cost is in the comms
- Legacy OT tech is embedded in the field
  - Often referred to as an IT/OT divide, it is sometimes more like an Ops vs. R&D divide. More about this later

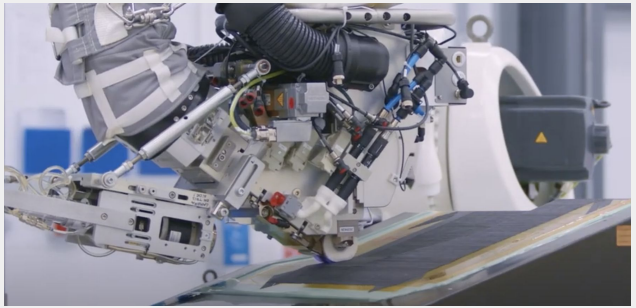
Use Case: Advanced Composite Manufacturing

Automated Fiber Placement

Unique process to manufacture **complex composite parts**

- **tapes** fed through delivery system into a fibre placement **head**
- programmed **fibre paths** placed il **layers** on work surface to **create preform**
- individual layers of the preforms are **consolidated on the fly**
  - pressure roller
  - heating systems (infrared, laser, flash lamps)





IoT around the AFP process

- **Predictive (prev., pres.) maintenance and enabling servitization**
  - Optimizing maintenance operations and uptime

- **Manufacturing process inspection and control**
  - Keeping manufacturing tolerances while materials change and consumables wear

- **Product quality inspection**
  - Wrinkles, gaps, twisting, inclusions, etc.

- **Material and Asset tracking**
  - Tracking material location and conditions, and optimizing supplies

- **Environmental impact monitoring**
  - Quantifying the carbon footprint of the production process
    - AFP machine energy consumption … parts consumption
    - Clean room, building, materials, IT infrastructure, etc.
    - Waste

IoT around the R&D on AFP process

There is **more IoT in R&D** around **the manufacturing process**!

- What are the compromises between cost, speed, structural properties, manufacturing tolerances, and carbon footprint?
- What is the fixed carbon footprint cost of the R&D process itself?
- What level of insight we can provide

IT/OT divide or **OT/R&D divide**?

- Collaborative R&D is extremely difficult on the shop floor
  - IT/IoT/OT tooling related difficulties
  - But mostly: organizational difficulties
- Not just R&D, but any innovation on the factory floor

What **tooling** can help Digital Manufacturing Innovation in Europe?

- Great manufacturing legacy, huge innovation potential, lots of blockers
- **Edge compute** and **reliable wireless** are key to enable innovation

Technology playing field

- **Low-cost, open source based, rapid prototyping enabled IoT gateways capturing process information**
  - E.g. OPC-UA directly from the machines
  - Add-on sensors
    - Energy monitoring
    - Vibration, temperature, force

- **Wireless infrastructure**
  - 4G/5G small cell
  - LoRaWAN/LoRa-based local network
    - Proprietary LoRa, WiFi, LiFi in other projects

- **Asset (Condition) Tracking**
  - RFID and other tags (BLE, UWB, etc.)

- **Keeping data safe**
  - QKD infrastructure

- **Device Edge processing**

Device edge: TinyML

TinyML: ultra-low power (<mW) **machine learning** technology enabling battery-operated on-device analytics **at the very edge**

Technology Enablers of TinyML

Fast progress on enabling technologies

- **Model compression** (INT quantization, pruning, etc.) to <250 KBytes model size
- **HW architecture** innovation
  - Near-memory, in-memory, on-sensor AI
- **Software** frameworks and toolsets

Powerful **data-driven programming paradigm shift** for embedded devices

- Enabling new **use cases**
- Enabling wider **developer ecosystem**

Enabled by TinyML

With low-power sensing and low-power comms, 10.000+ devices will soon be here!

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tinyMLPerf

Task Category	Use Case	Model Type
Audio	**Audio Wake Words** Context Recognition Control Words Keyword Detection	DNN CNN RNN LSTM
Image	**Visual Wake Words** **Object Detection** Gesture Recognition Object Counting Text Recognition	DNN CNN SVM Decision Tree KNN Linear
Industry / Telemetry	Segmentation **Anomaly Detection** Forecasting Activity Detection	DNN Decision Tree SVM Linear

Thank you!

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