W3C Web of Things

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Web of Things

- W3C's abstraction layer for digital twins representing
  - Sensors
  - Actuators
  - Virtual devices as virtual compositions of other devices
  - Information services
- Digital twins as *things* with properties, actions and events
- Client applications decoupled from details of underlying IoT protocols and standards
  - Scripting API for digital twins

- This makes it much easier to create services across heterogeneous IoT ecosystems
- Every *thing* has an RDF identifier associated with a symbolic description in JSON-LD
- *Thing Descriptions* cover
  - Interaction affordances: data models for properties, actions, events
  - Semantic interoperability: kinds of things, units of measure, etc.
  - Security and communications metadata used by client platform

W3C Web of Things (WoT)

- W3C Working Group goal: Adapting web technologies to IoT
- Already published: Thing Description (TD) metadata format
  - TD describes the available interactions (network API) of a Thing
- New standards work in progress, including Discovery
  - How does a potential user obtain the TDs for a Thing?
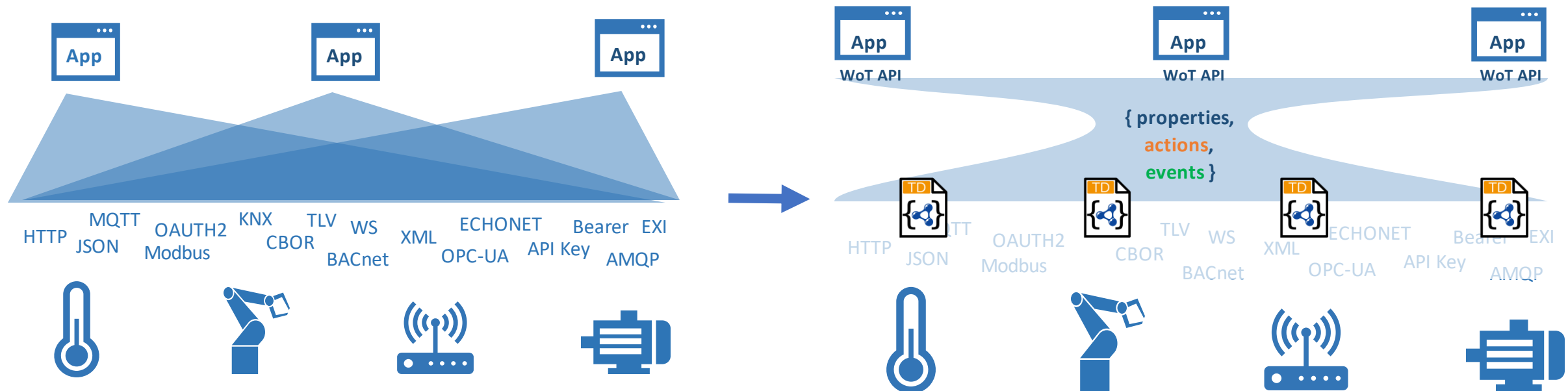
Goal and Use Cases

IoT Interoperability

- ## Simplify usage
  - ### Interaction abstraction
- ## Simplify data ingestion
  - ### Unified data schemas
- ## Bridge silos
  - ### Protocol bindings
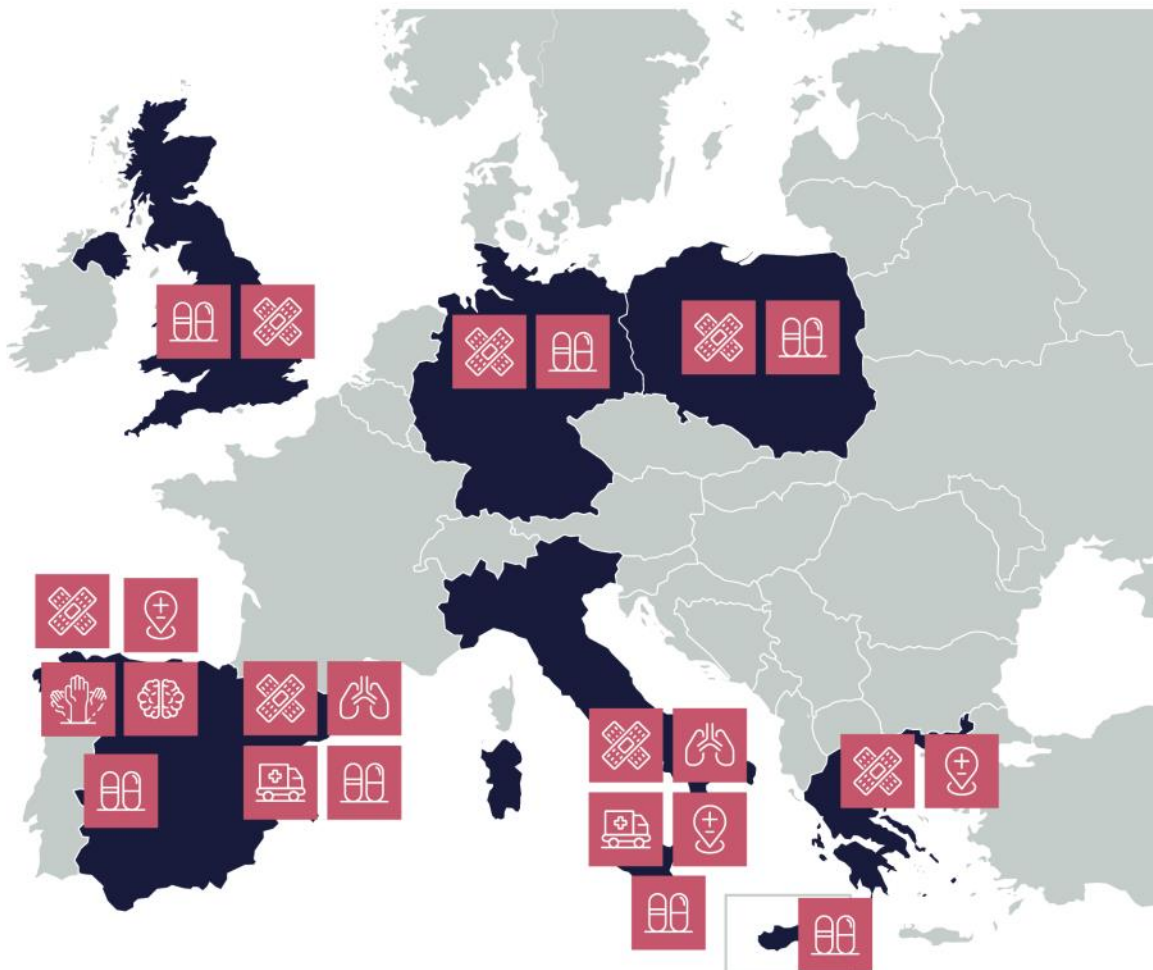- ## Enable "mashups"
  - ### Scripting API
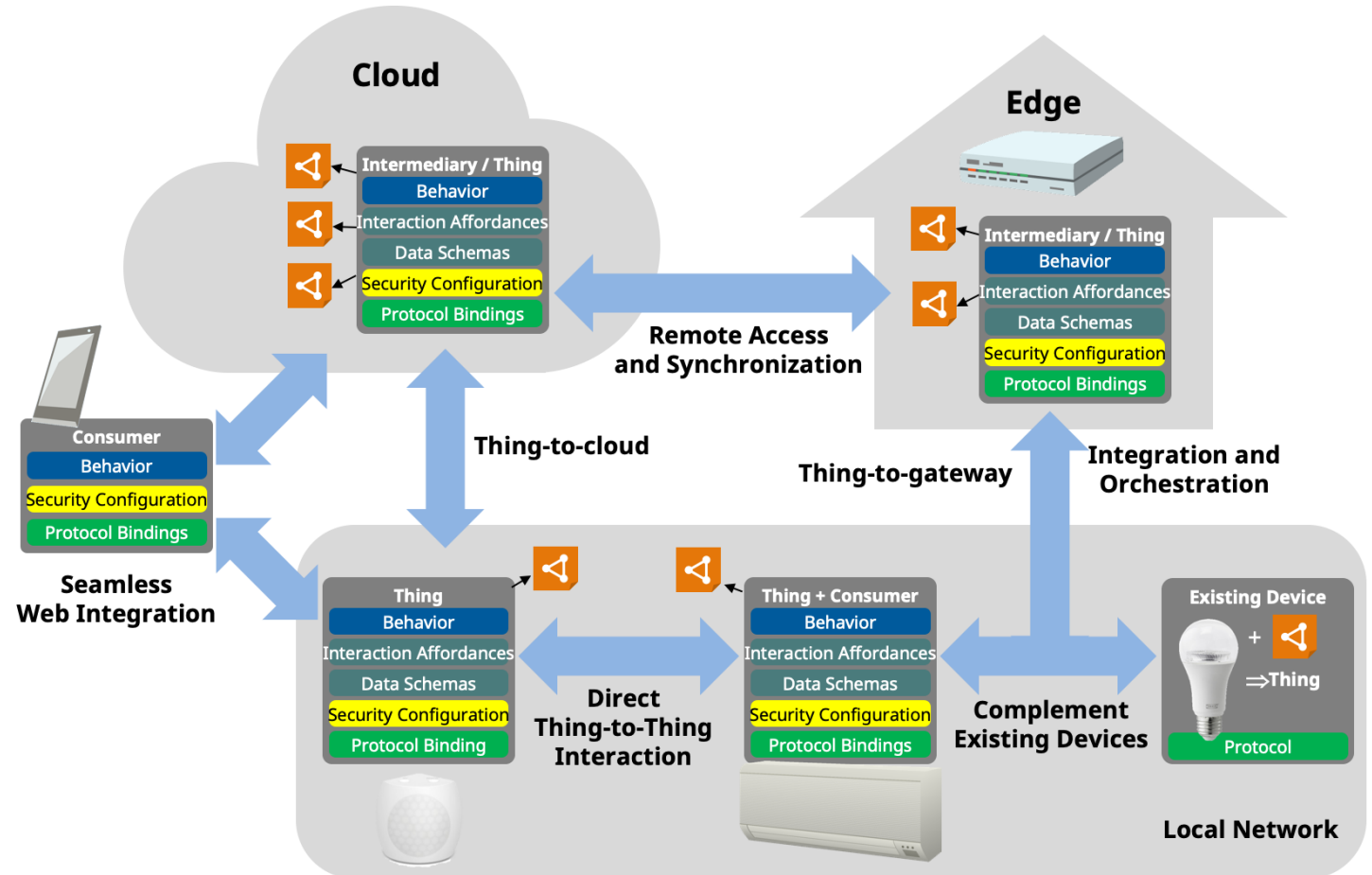
Health & Care Use Cases

- At the Edge
  - Monitoring patient health
  - Reminders for taking medication, light exercise, etc.
  - Warnings for use by care givers, e.g. family members and nursing staff
  - Privacy-friendly distributed machine learning
- In the Cloud
  - Simplifying integrated access across Health centres, regional and national organisations, and third party services
  - Monitoring and research
  - Early diagnosis for better outcomes

- Integration of HL7's FHIR formats for medical records with W3C's Web of things
- Graph databases as the means to simplify working with heterogeneous data models
- Importance of shared vocabularies and ontologies
- W3C's RDF and Linked Data as basis for semantic interoperability across heterogeneous information sources, e.g. RDBMS, spreadsheets, CSV files, and Property Graphs

GATEKEEPER Pilots and Reference Use Cases

Lifestyle-related early detection and interventions

COPD exacerbations management

Diabetes: predictive modelling of glycemic status

Parkinson's disease treatment Decision Support System

Predicting readmissions and decompensations in Heart Failure

Primary and secondary stroke prevention

Multi-chronic elderly patient management including polimedication

Current Work Items

Deliverables	Updates	New

Informative	• Scripting API
	• Security and Privacy
	     • Guidelines
	     • Best Practices
		• Use Cases

Normative	• Architecture • Thing Description • Thing Models	• Discovery • Interoperability Profiles

Thing Description

- Metadata for IoT services
  - ID, versions, types, creation time, …
  - Titles, descriptions, …

- Describes interactions
  - What they are (abstraction)
  - How to use them (protocol binding)
  - How to interpret data (schemas)

- JSON-LD 1.1
  - Vocabulary extensions
  - Semantic annotation (e.g. OneDM)
  - Protocol-specific vocabulary

```json
{
  "@context": [
    "https://www.w3.org/2019/wot/td/v1",
    { "iot": "http://iotschema.org/" }
  ],
  "id": "urn:dev:org:32473:1234567890",
  "title": "MyLEDThing",
  "description": "RGB LED torchiere",
  "@type": ["Thing", "iot:Light"],
  "securityDefinitions": ["default": {
    "scheme": "bearer"
  }],
  "security": ["default"],
  "properties": {
    "brightness": {
      "@type": ["iot:Brightness"],
      "type": "integer",
      "minimum": 0,
      "maximum": 100,
      "forms": [ … ]
    }
  },
  "actions": {
    "fadeIn": {
      ...
```

New Work Items

Use Cases:

- Expanding catalog of use cases
- Identifying requirements
- Identifying gaps and overlaps
  - Edge computing
  - Geospatial systems
  - Data modeling
  - ...

Discovery:

- Define how TDs are distributed
- Both local and global contexts
  - Spatial search not limited to local network
- Two-phase introduction/exploration
- Emphasis on privacy protection
  - Protected queries and exploration services

Architecture:

- Lifecycle
- Updated requirements analysis
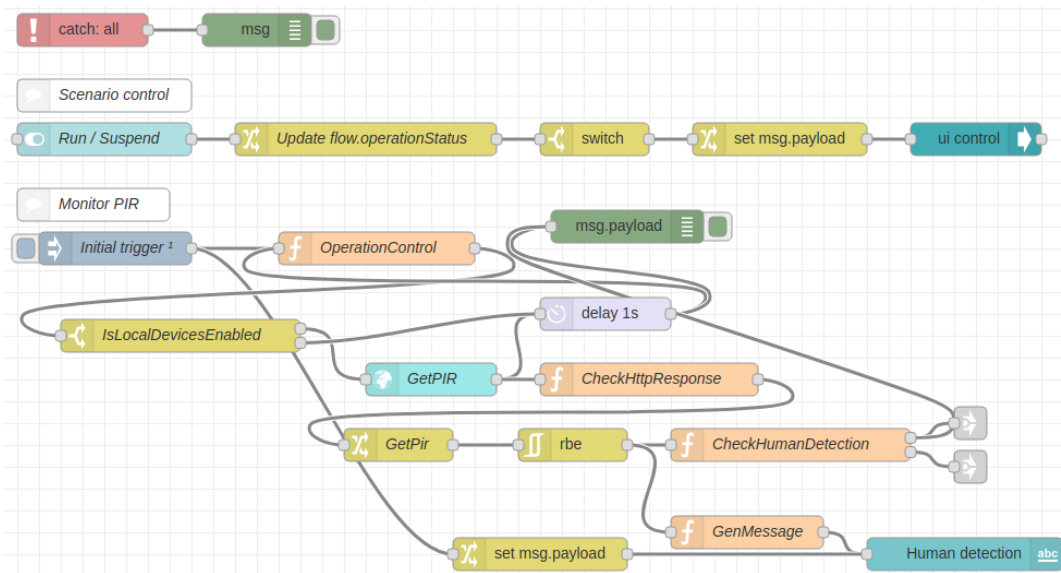 - Based on new use cases
- Alignment with other standards

Interoperability Profiles:

- Support interoperability
  - Out-of-the-box plug-and-play
- Constrain features
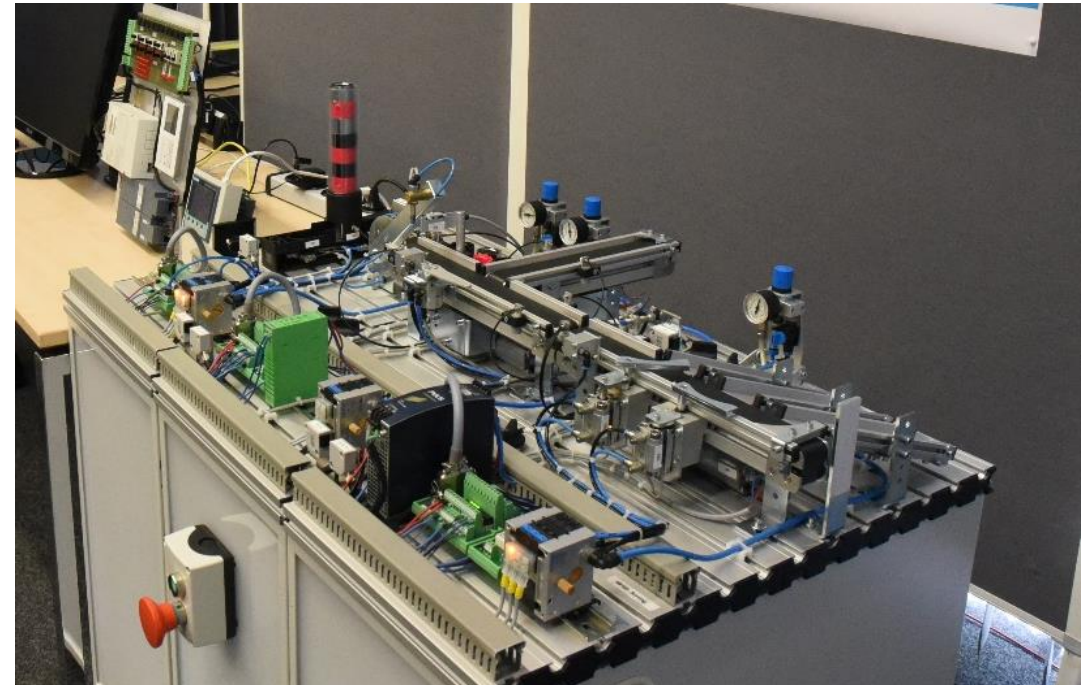 - Allow for finite, in-advance implementation of consumers

Other Activities

Some Implementations

- Node-wot
  - Scripting API implementation

- Node-gen
  - Node-RED integration

Testing and Validation

- Playground
  - TD checker

- Plugfests

W3C WoT Resources

- W3C WoT home page
  - https://www.w3.org/WoT/

- W3C WoT Wiki
  - https://www.w3.org/WoT/IG/wiki
    (IG/WG organizational information)

- W3C WoT Interest Group
  - https://www.w3.org/2016/07/wot-ig-charter.html
    (old charter)
  - https://www.w3.org/2019/10/wot-ig-2019.html
    (new charter)
  - https://lists.w3.org/Archives/Public/public-wot-ig/
    (mailing list)
  - https://github.com/w3c/wot
    (technical proposals)

- W3C WoT Working Group
  - https://www.w3.org/2016/12/wot-wg-2016.html
    (old charter)
  - https://www.w3.org/2020/01/wot-wg-charter.html
    (new charter)
  - https://www.w3.org/WoT/WG/
    (dashboard)

- W3C WoT Candidate Recommendations
  - https://www.w3.org/TR/wot-architecture/
  - https://www.w3.org/TR/wot-thing-description/

- W3C WoT Working Drafts / Group Notes
  - https://www.w3.org/TR/wot-binding-templates/
  - https://www.w3.org/TR/wot-scripting-api/
  - https://www.w3.org/TR/wot-security/

- W3C WoT Editors' Drafts and Issue Tracker
  - https://github.com/w3c/wot-architecture/
  - https://github.com/w3c/wot-thing-description/
  - https://github.com/w3c/wot-binding-templates/
  - https://github.com/w3c/wot-scripting-api/
  - https://github.com/w3c/wot-security/
  - https://github.com/w3c/wot-security-best-practices/
  - https://github.com/w3c/wot-profile/
  - https://github.com/w3c/wot-discovery/

- Reference Implementations and Tools: node-wot
  - node-wot: https://github.com/eclipse/thingweb.node-wot
  - TD playground: http://plugfest.thingweb.io/playground/

WoT Working Group Contacts

https://www.w3.org/WoT/WG/

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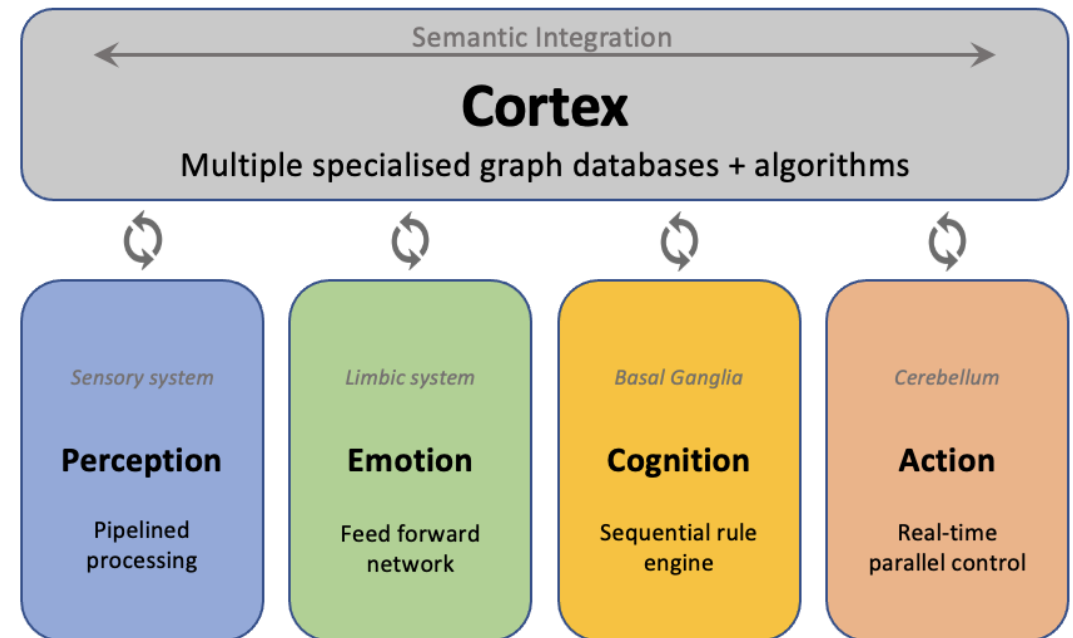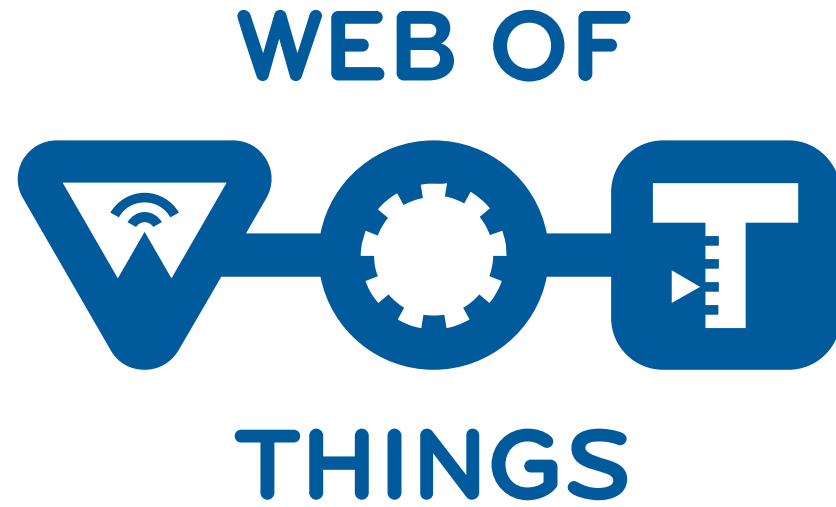
Sentient Web and Human-like AI

- Future applications of the Web of Things as smart cognitive agents with perception, cognition and action

- **Perception** involves intelligent interpretation of sensor data
  - Context-based + dynamic focus of attention

- **Cognition** is about memory, reasoning, continuous learning, and decision making
  - Sentient in terms of self-awareness

- **Action** is about driving actuators, e.g. robot arms, autonomous vehicles
  - Real-time orchestration

- **New generation of AI** inspired by human brain as nothing yet matches up to the human mind
  - More than 500 million years of neural evolution
  - Deep semantics as compared to deep learning which only deals with statistical correlations

- Mimicking human memory, reasoning, learning, and feelings for cognitive control and prioritising what's important
  - Combination of graphs + statistics + rules + algorithms

- Web of Sentient agents subsumes the IoT
  - Agents as providers and consumers of services
  - Responsible, collaborative, multilingual AI
  - Machine learning replaces manual development

Cognitive Architecture with multiple cognitive circuits loosely equivalent to shared blackboard

Questions and Answers