IoT and Data Standardization Activities in W3C

W3C Staff Contact for Web of Things and Media&Entertainment
W3C Project Specialist, Smart Cities Industry Champion
Project Professor, Graduate School of Media and Governance, Keio University

Kazuyuki Ashimura

11 August 2021

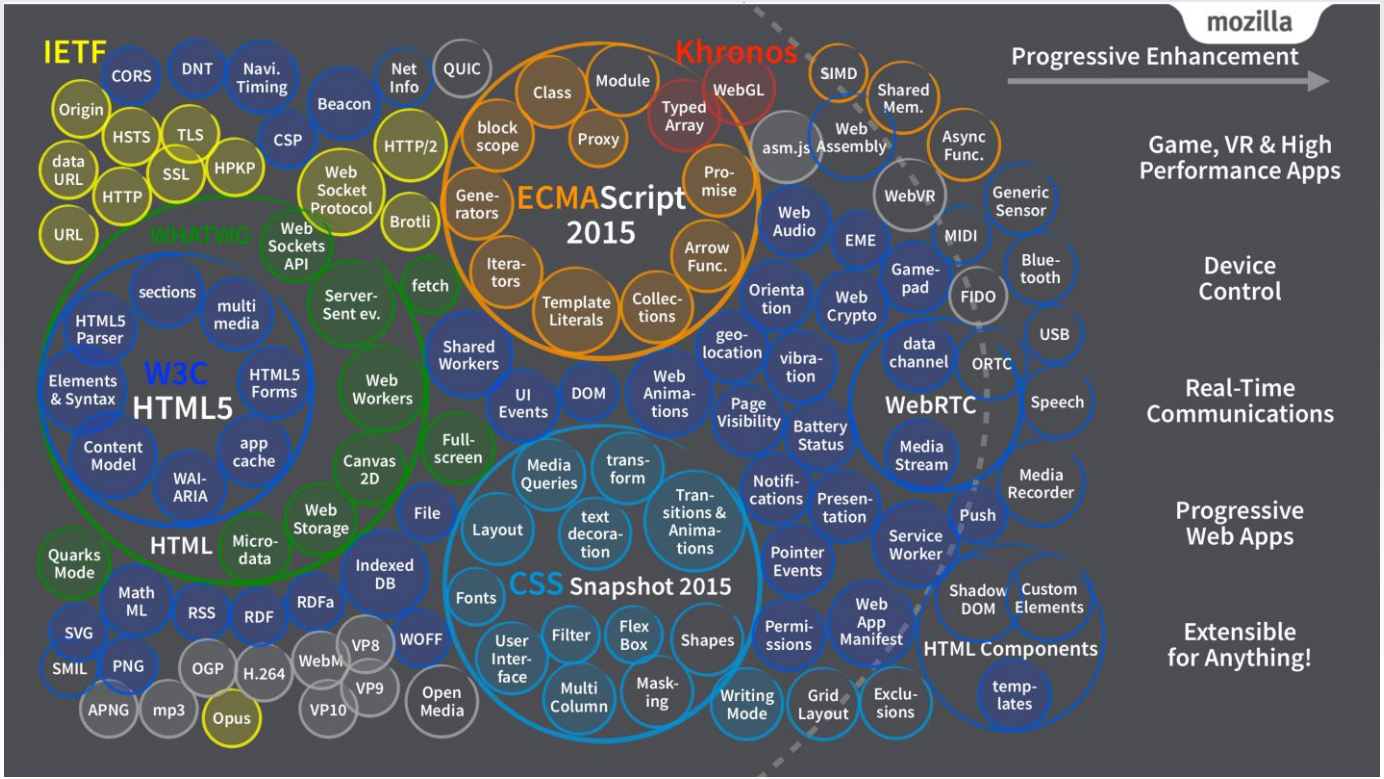
ToC

- Web technologies for various industries
- Web standardization by W3C
- “Web technologies” nowadays
- WoT (Web of Things)
- Smart Cities

Web technologies for various industries

Web technology available everywhere

Open Web Platform: HTML5 and related specs



(by Tomoya Asai from WebDINO; former Mozilla Japan (http://webapi.link))

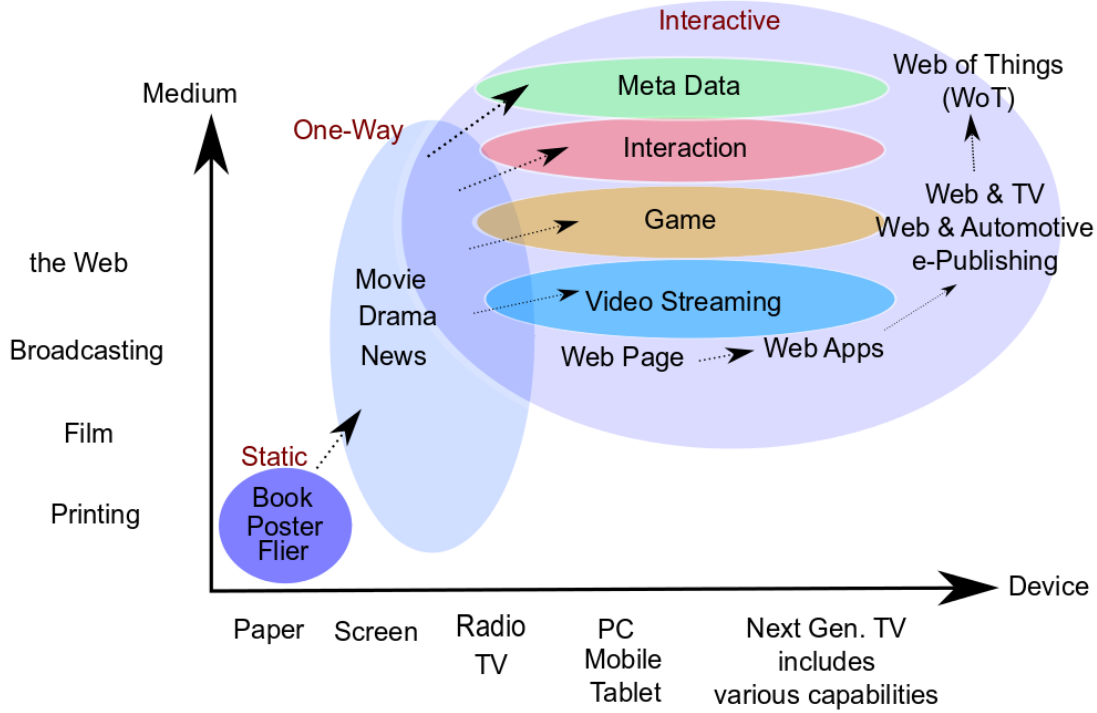
Familiar examples of HTML5 features

- Video/Audio capability without plug-ins
- Duplex network connection using WebSocket
- 2D/3D graphics using Canvas
- Local data storage
- Pulti-processing using Worker

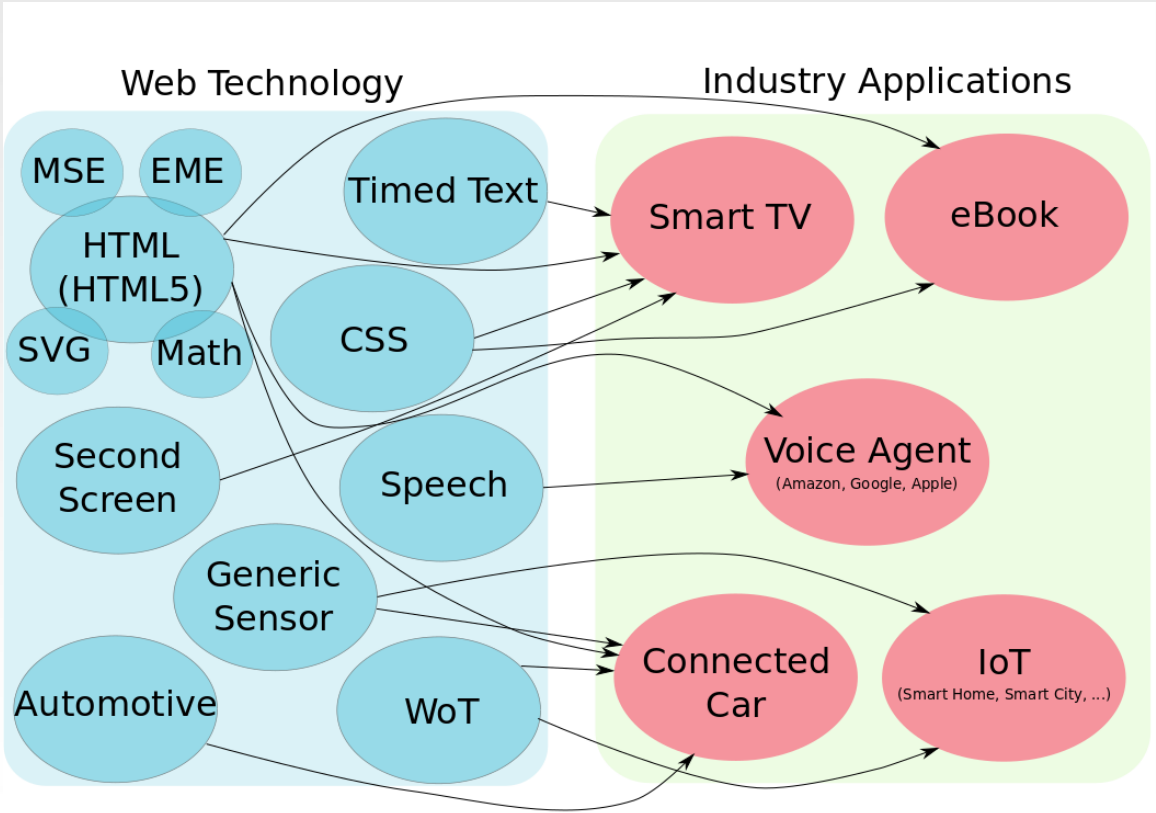
- Your friendly WebApps:
  - Google
  - Amazon
  - Facebook
  - Netflix

    Etc.

Web as platform for data transfer
- Independent from devices or OSs

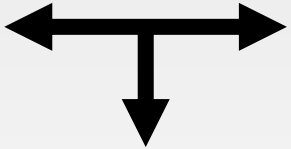


Web standards applied to various industries



TV
— Broadcasting and communications

Broadcasting content from the tuner

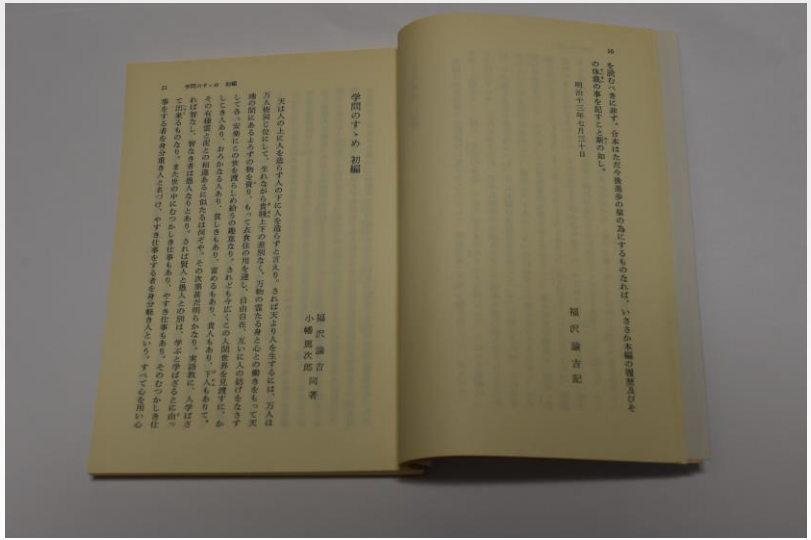


Web content from the browser

Smart collaboration using
another browser on the smartphone

Publishing
— From paper books to E-Books

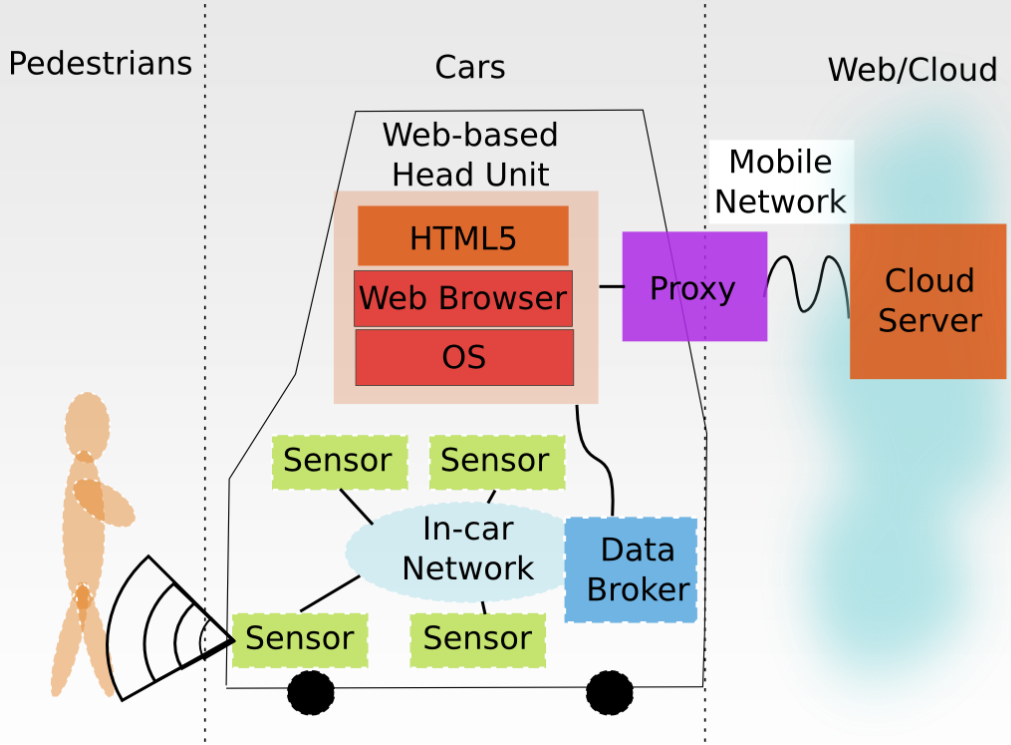
Paper books



E-Books (Web browser)

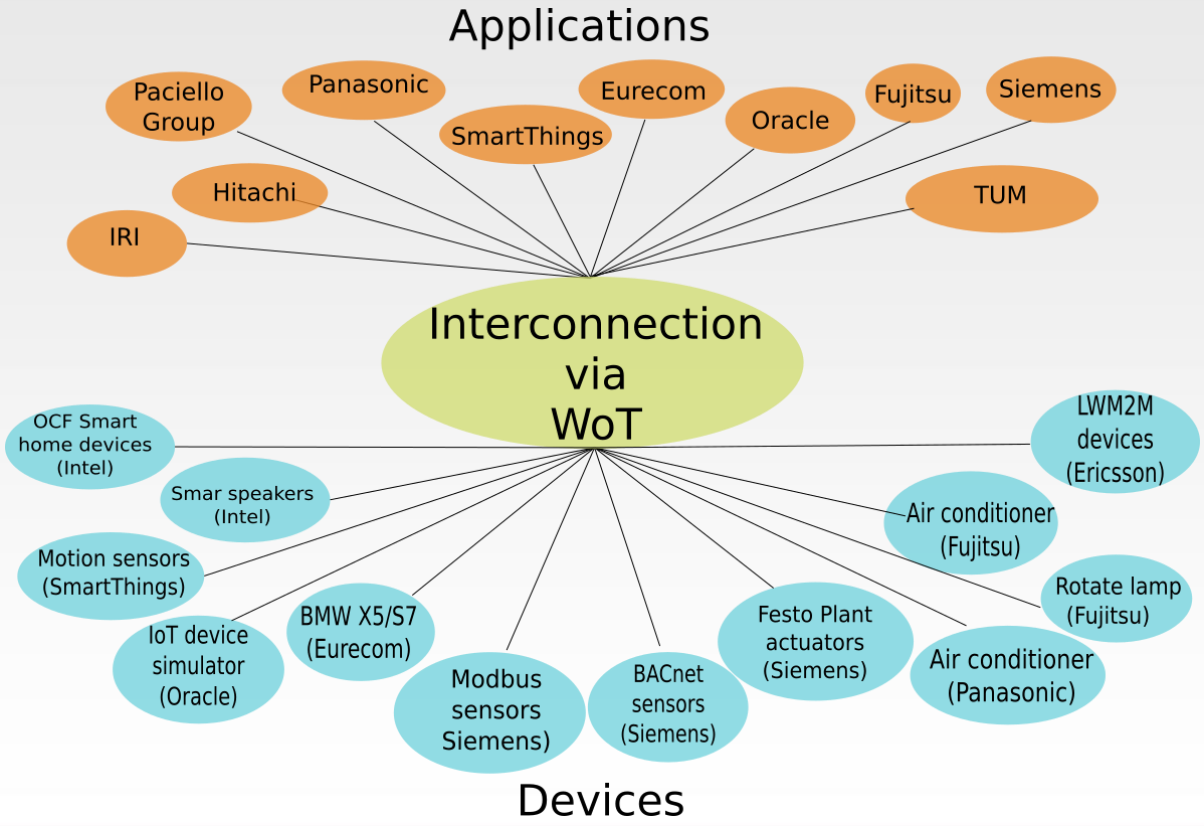
Automotive

—Connected cars using the Web technology



And now for IoT

—WoT: IoT interconnection using the Web technology



Web standardization by W3C

W3C: The World Wide Web Consortium

Lead the Web to its full potential!

- Established in 1994 by the W3C Director, Tim Berners-Lee

- International consortium for Web's interoperability
- Generating W3C Recommendations, e.g., HTML5

⇒ W3C is the one and only SDO tackling Web standards established by the Web inventor, Tim Berners-Lee!

4 hosting organizations

US：MIT

Europe：ERCIM

Japan：Keio university（W3C/Keio Team established in 1996）

China：Beihang university

Web standardization: One Web / Web for All

Standardization is very important for the Web because it interconnects everything!

- **Interoperability**
- **Multilinguality**
- **Multi-Modality**
- **Accessibility**

⇒ available at anytime, anywhere, for anyone

W3C Members

- Global participation：
  - 450 organizations/companies (browser, Web service, CE, communications, publishing, etc.)
  - US/Canada：GAFA, Microsoft, IBM, Adobe, Airbnb, Akamai, Amex, Apache, AT&T, Cisco, Comcast, Federal Reserve Bank of Minneapolis, Intel, Mastercard, Mozilla, Netflix, OASIS, Oracle, Shopify, Thomson Reuters, Verizon, Visa, Walt Disney, Wikimedia, …
  - Europe：BBC, CERN, Ericsson, Fraunhofer, GS1, JLR, SAP, Siemens, Viacom, Volkswagen, Volvo, …
  - China：360, Agora.io, Alibaba, Baidu, Beihang Univ., Beijing Haitai Fangyuan Technologies, Beijing Univ. of Posts and Telecom., Bilibili, China Mobile, CAS, Huawei, Tencent, Xiaomi, …
  - Korea ：ETRI, Gooroome, INCA, Inswave Systms, KETI, LG, Samsung, SCE Kora, SEAK
  - Japan: ACCESS, Alfasado, BPS, DSA, DDS, Dentsu, Design Inc., DCA, EdMuse, EBPAJ, FLUX, Fujitsu, FTL, Gardenia, Hitachi, Infours, Internet Academy, IRI, JPRS, JCB, Kadokawa, KDDI, Keio Univ., Kodansha, LINE, Media Do, Mitsubishi Electric, Mitsue-Links, NEC, Newphoria, NHK, NTT, Panasonic, Rakuten, Shueisha, SIVIRA, Softbank, Sony, JBA, Toshiba, Voyager Japan, Yahoo Japan

W3C Groups

— Working Groups and Interest Groups

- Working Groups (41):

  Accessibility Education and Outreach, Accessibility Guidelines, Accessible Platform Architectures, Accessible Rich Internet Applications, Audio, Audiobooks, Automotive, Browser Testing and Tools, Cascading Style heet (CSS), Dataset Exchange, Decentralized Identifier, Devices and Sensors, Distributed Tracing, EPUB 3, GPU for the Web, HTML, Immersive Web, Internationalization, JSON-LD, Math, Media, MiniApps, Pointer Events, Second Screen, Service Workers, SVG, Timed Text, Verifiable Credentials, Web Application Security, Web Applications, Web Authentication, Web Editing, Web Fonts, Web Machine Learning, Web of Things, Web Payments, Web Performance, Web Platform, Web Real-Time Communications, WebAssembly, WebTransport

- Interest Groups (10):

  Chinese Web, Internationalization, Media and Entertainment, Patents and Standards, Privacy, Spatial Data on the Web, WAI, Web & Networks, Web of Things, Web Payment Security

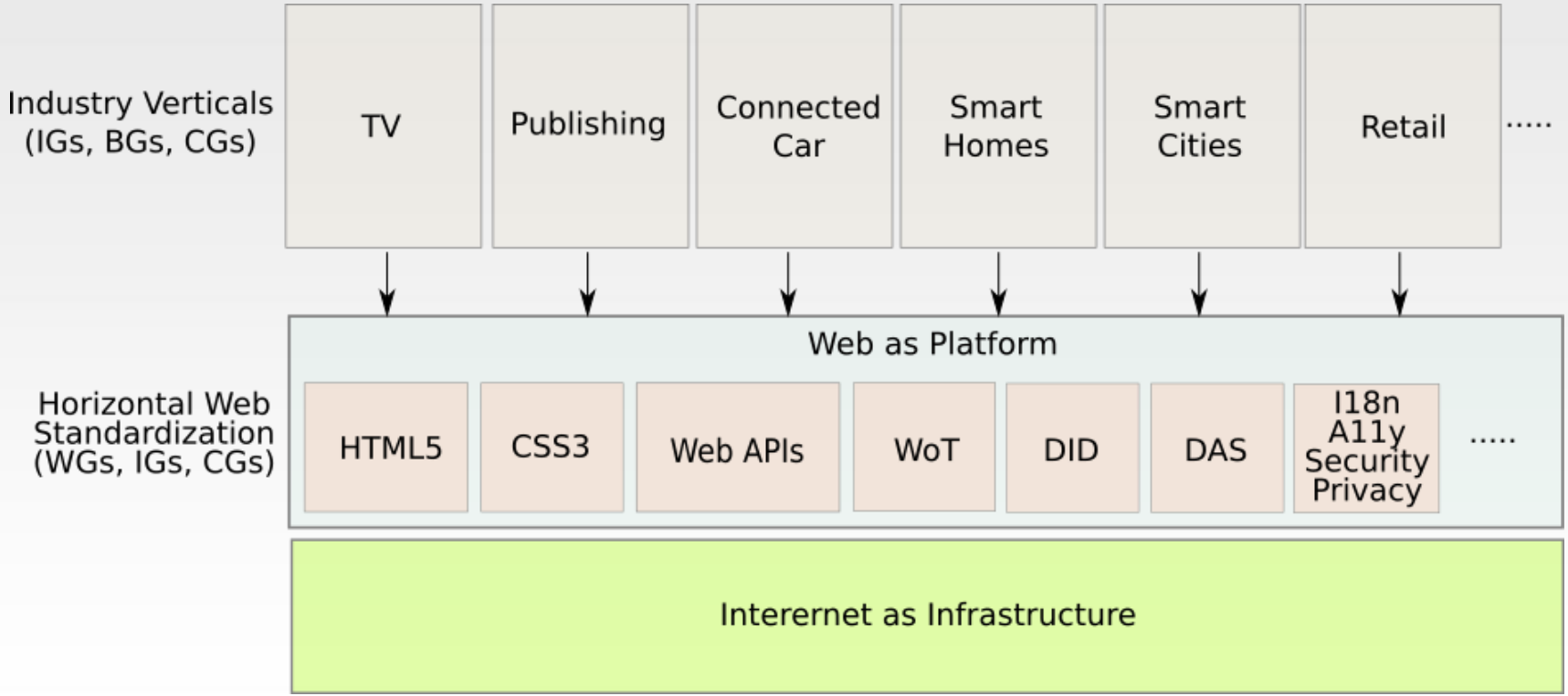
W3C groups
— Business Groups and Community Groups

- Business Groups (3):
  Automotive and Transportation, Improving Web Advertising, Publishing

- Community Groups (355):
  AI KR, Algorithmic Modelling, Automotive Ontology, Big Data, Blockchain, Bullet Chatting, Cloud Computing, Color on the Web, Credentials, EPUB 3, HTTPS in Local Network, Machine Learning for the Web, MiniApps Ecosystem, Revising W3C Process, Schema.org, Speech API, Web Platform Incubator (WICG), …

“Web technologies” nowadays

Layers of the W3C standardization groups



Media&Entertainment IG

Charter: https://www.w3.org/2019/06/me-ig-charter.html
Group type: Vertical (Media)
Activity period: 2011-now
Chairs: BBC, MovieLabs, Sony

Objectives:

- Central forum for all the technical topics related to media distribution on the Web
- Use cases and Requirements
- Send requirements to the related WGs to improve the Web

Related groups:

- HTML WG – HTML 5.2
- CSS WG – CSS3
- Media WG – MSE/EME (Adaptive streaming/content protection)
- Timed Text WG – TTML (Captions)
- Second Screen WG – Presentation API (Synchronization with smartphones)
- Immersive Web WG – VR/AR
- Web&Networks IG – 5G networks, Edge computing

Takeaways: Web as the video distribution platform

- Hybrid TV services
  - Hybridcast - Japan
  - HbbTV - Europe
  - ATSC - US
- OTT (Over-the-top) services
  - Netflix
  - Hulu
  - YouTube, …
- Actual deployment
  - Four W3C international workshops
  - All the TV sets on the market now have Web capability
  - Got Emmy tech award twice (for TTML and MSE/EME)

Lates topics:

- Media Timed Events
- Bullet Chat
- Media Production on the Web

Web&Networks IG

Charter:
https://www.w3.org/2019/05/web-networks-ig-charter.html
Group type: Vertical (Telecom)
Activity period: 2019-now
Chairs: AT&T, Intel, China Mobile

Objectives:
- Improving the Web for smarter apps on the 5G networks
- Use Cases, Requirements and Best Practices
- Sed requirements to the related WGs

Topics:
- Edge computing
- Network quality monitoring/prediction ⇒ Link Performance Prediction

Related groups:
- WebRTC WG – Real-Time connection
- Devices and Sensors WG – Generic sensor API
- Machine Learning CG – Computing load balance
- ME IG – Media pipeline
- Web of Things IG – Network performance
- Web Performance WG – Application performance
- APA WG - Accessibility

Related SDOs: mainly Telecom
- 3GPP
- ARIB
- ETSI
- IEEE
- IETF
- GSMA
- ITU-T
- MPEG
- oneM2M

Web Authentication WG

Charter: https://www.w3.org/2019/10/webauthn-wg-charter.html
Group type: Horizontal (Security)
Activity period: 2016-now
Chairs: Yubico, Invited Expert

Objectives:

- Client-side APIs for secure Web apps
- “Strong authentication” for trading on the Web
  (robust authentication based on strong encryption / environment-independnt)

Topics:

- Web Authentication API Level2
  - (including Test suite/Implementation report)
- Use cases and requirements
- Primer/Best Practices
- Protocol design overview/flow diagrams

Related groups:

- Web Application Scurity WG
- Web Applications WG
- Web Payments WG
- Privacy IG
- Accessible Platform Architecture WG
- Decentralized Identifier WG
- WebAuthn Adoption CG

Related SDOs: mainly Authentication

- IETF Security Area Directorate
  Chairs of all the groups related to Security
- FIDO
  online authentication based on public-key cryptography (biometrics using authenticators)
- EMVCo
  Alliance on smart payment formed by credit card companies (American Express, Discover, JCB, MasterCard, UnionPay and Visa)

Improving the Web Advertisement BG

Home page: https://www.w3.org/community/web-adv/
Group type: Horizontal (Privacy)
Activity period: 2017-now
Chair: W3C Team (Wendy Seltzer)

Objectives:
- Privacy protection within the advertisements on the Web
- Use cases and Requirements

⇒ including the discussion on a possible WG

Topics:
- Draft matrix of use cases and proposals
- Privacy-preserving aggregate measurement
- Client-side interest-based ad selection
- Preparation for a web without third-party cookies

Related groups:
- Web Platform Incubator CG (WICG)
- Privacy CG
- Privacy IG

Web Machine Learning WG

Home page:
https://www.w3.org/groups/wg/webmachinelearning/
Group type: Technical (Privacy)
Activity period: 2021-
Chair: Intel

Objectives:
- Enabling Machine Learning inference in the browser
  - to enhance privacy by keep the input data locally
  - To improve the processing speed (=low latency)
- Use cases and Requirements

Topics:
- Web Neural Network API
- Model Loader API

Related groups:
- Machine Learning for the Web CG
- GPU for the Web WG
- WebAssembly CG
- WebRTC WG
- TAG

Related SDOs:
- Khronos (OpenGL)
- ECMA TC39

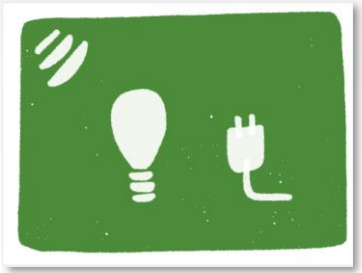
WoT (Web of Things)

Various IoT platforms

Smart Homes

Wearables

Healthcare

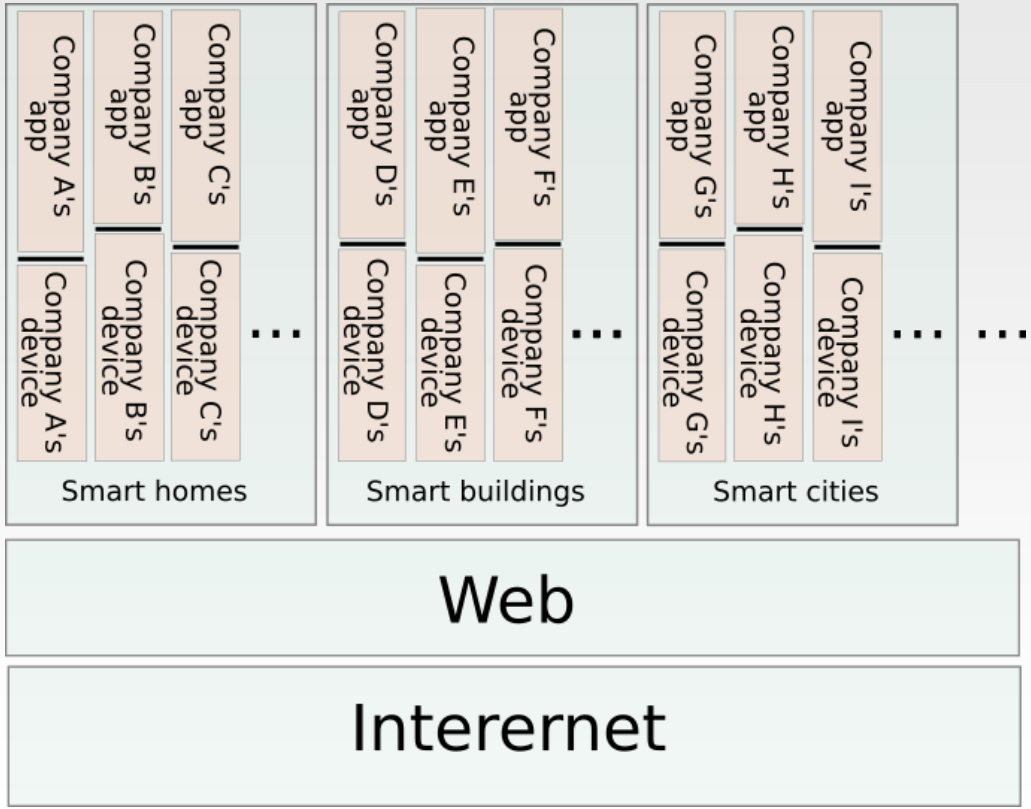


Power & Environment

Smart Cities

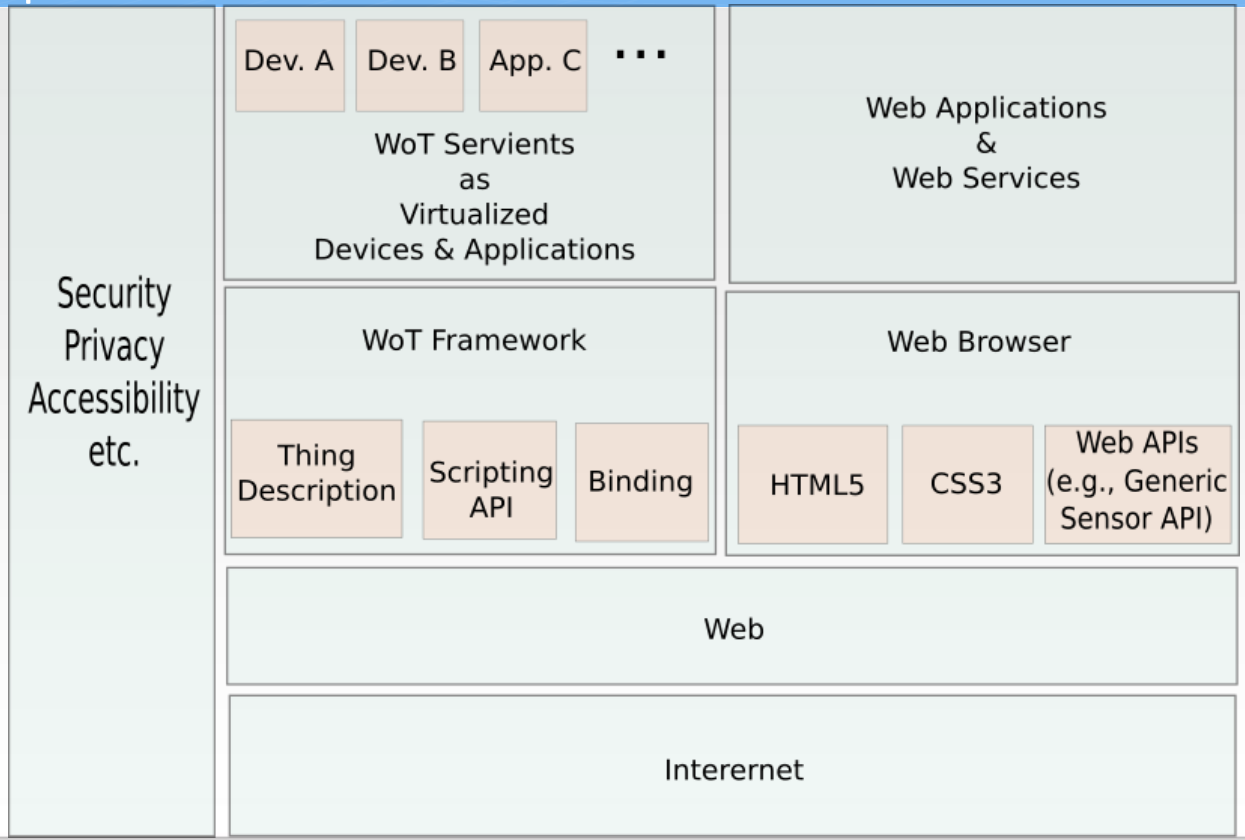
Manufacturing

Problems of IoT silos

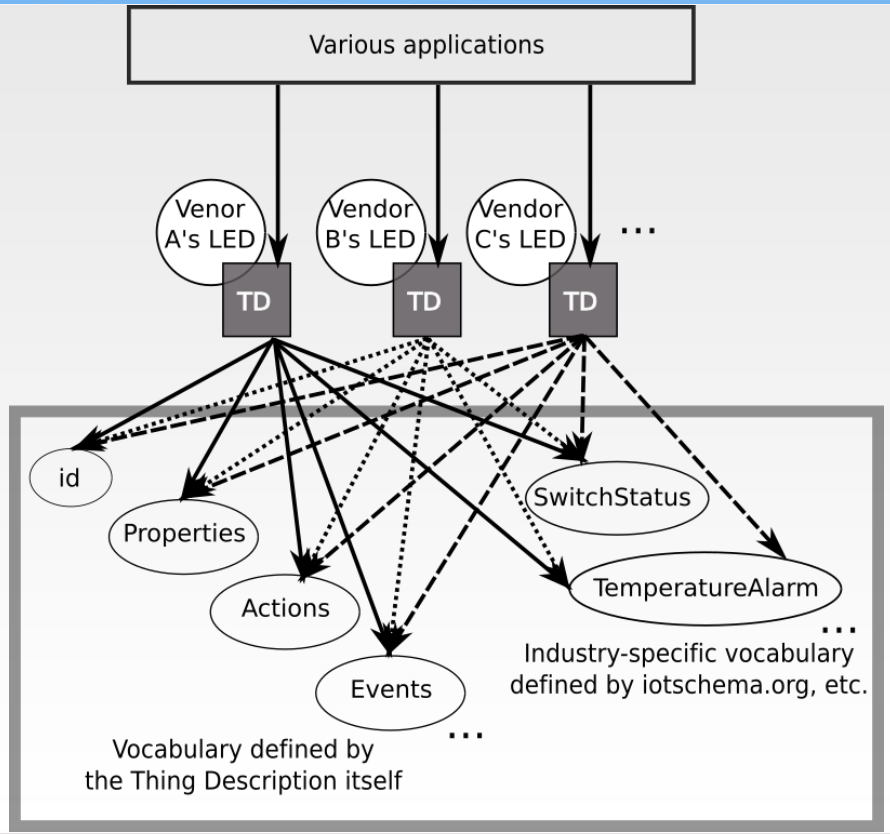


WoT: IoT interconnection using the Web

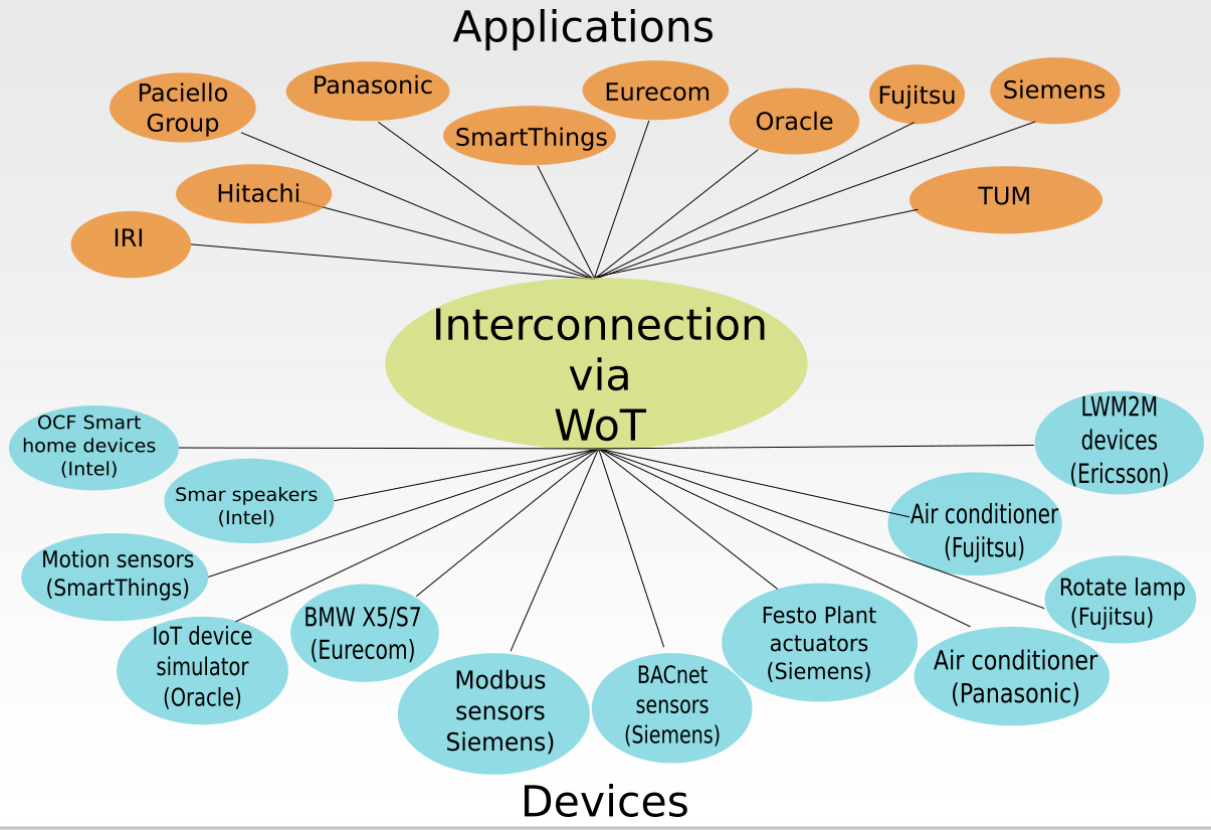
- Web as the platform for data transfer



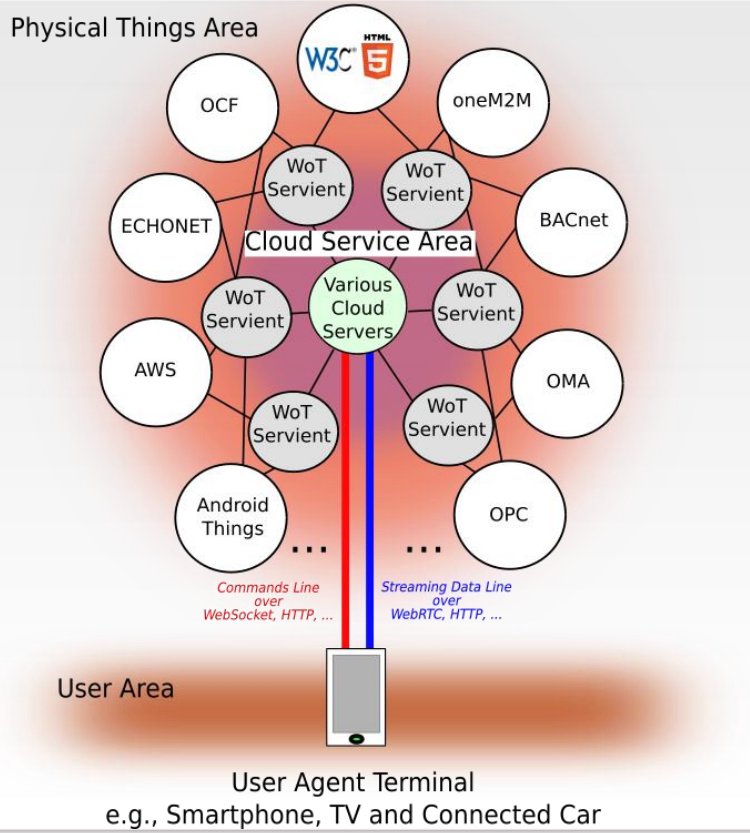
Unified vocabulary references by Thing Description



PlugFest: Proof-of-Concept for interconnectivity

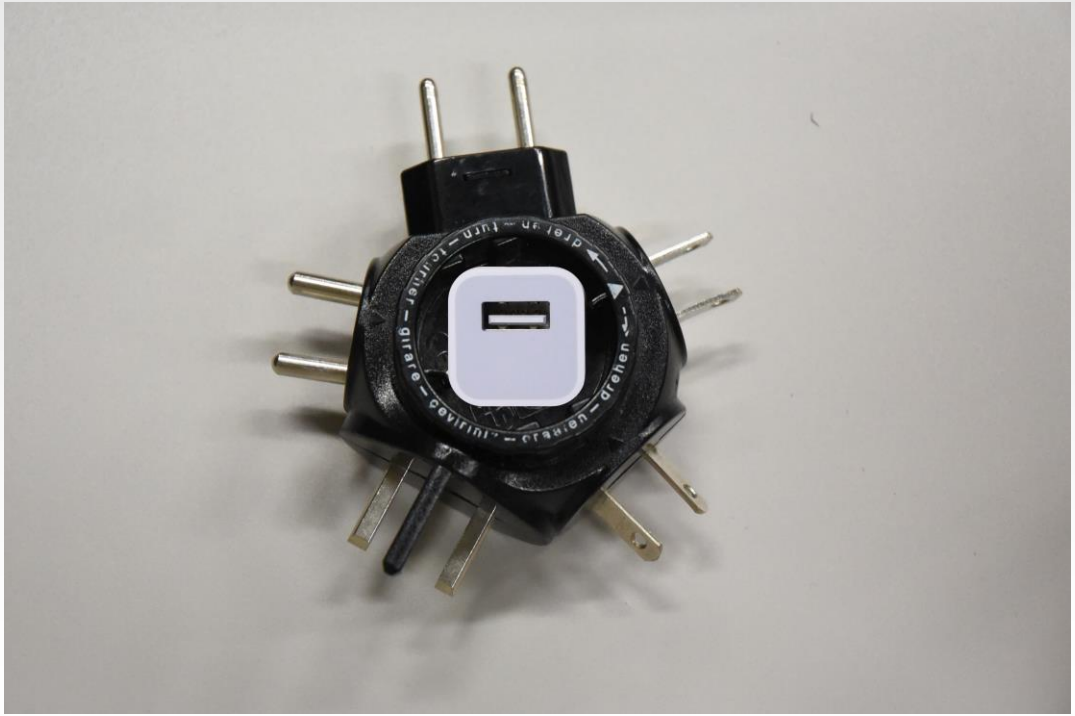


WoT connects various IoT platforms with the Web



Like this ☺

Integrating various IoT standards using the Web



WoT participants within W3C

Liaison with related SDOs

- INDUTRIE 4.0
- Industrial Internet Consortium
- Open Connectivity Foundation
- OPC Foundation
- IETF/IRTF
- oneM2M
- AIOTI
- Etc.

Standardization status - REC Track documents (=W3C Specs)

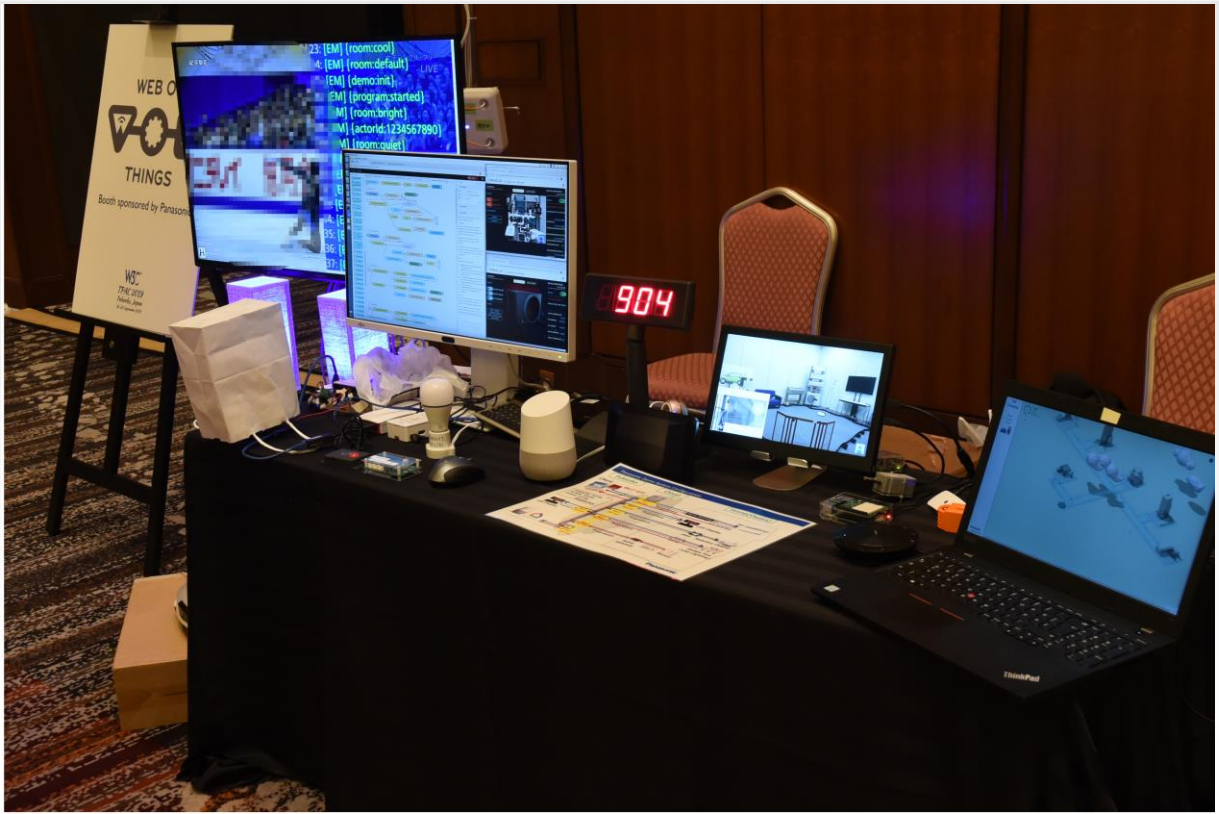
- WoT Architecture:
  - Ver 1.0: https://www.w3.org/TR/2020/REC-wot-architecture-20200409/ (REC)
  - Ver 1.1: https://www.w3.org/TR/2020/WD-wot-architecture11-20201124/ (FPWD)
- WoT Thing Description (TD):
  - Ver 1.0: https://www.w3.org/TR/2020/REC-wot-thing-description-20200409/ (REC)
  - Ver 1.1: https://www.w3.org/TR/2020/WD-wot-thing-description11-20210607/ (WD)
- WoT Discovery: https://www.w3.org/TR/2020/WD-wot-discovery-20210602/ (WD)
- WoT Profile: https://www.w3.org/TR/2020/WD-wot-profile-20201124/ (FPWD)

Standardization Status - Group Notes

- WoT Scripting API: WG Note
  - https://www.w3.org/TR/2020/NOTE-wot-scripting-api-20201124/
- Security&Privacy Guidelines: WG Note
  - https://www.w3.org/TR/2019/NOTE-wot-security-20191106/
- Binding Templates: WG Note
  - https://www.w3.org/TR/2020/NOTE-wot-binding-templates-20200130/
- Use Cases: IG Note
  - https://www.w3.org/TR/2021/NOTE-wot-usecases-20210518/

Demo at TPAC2019 in Fukuoka

- TPAC (Technical Prenary & Advisory Committee Meetings)



- Oracle: Cloud services, Digital twin simulator
- Siemens: Electric car charger
- Panasonic: Air conditioner, Robot cleaner, Bulletin board, LED lamps
- NHK: HybridCast app on TV
- Fujitsu: Proxy server, Smart meter, LED lamp, Air conditioner, Battery, Window blinds
- Mozilla: WebThing lamp
- Hitachi: NodeRED app
- Intel: Webcam, Amazon Echo

Demo at virtual TPAC2020

- TPAC held as a virtual remote event using Zoom and WebEx
  - PlugFest demo also held as a virtual event
  - VPN service using SoftEther to emulate the local network for all the participants
  - mDNS-based device discovery service using LinkSmart
- Participants
  - Virtual local net using SoftEther VPN
    - Fujitsu: Proxy service, Various sensors (acceleration, brightness, proximity, PIR, temperature, humidity, air pressure)
    - Hitachi: LED connected to Raspbery Pi, NodeRED app
    - NHK: Hybridcast emulator, Hybridcast Connect app, smartphone, haptic device
    - RIOT OS: BLE prototype
  - Outside the virtual net (connected via proxies)
    - TUM: Remote Lab (belt conveyer, HUE LED, IR sensor, Robot arms, Coffee machines)
    - Siemens: Multi-language counter, Coffee machines, TestThing (including geolocation information), browser UI
    - Intel: Proxy server, Webcam, Speech synthesis (Amazon Echo)
    - UNIBO: WoT Farm emulator (virtual sensors and sprinklers)
  - TPAC Breakout demo
    - Slides: https://www.w3.org/2020/10/27-wot-breakout/2020-10-WoT-Breakout.pptx
    - Minutes: https://www.w3.org/2020/10/27-wot-breakout-minutes.html

Expected use cases for the future apps

WoT 1.1 Use Cases
— Multi-vendor integration

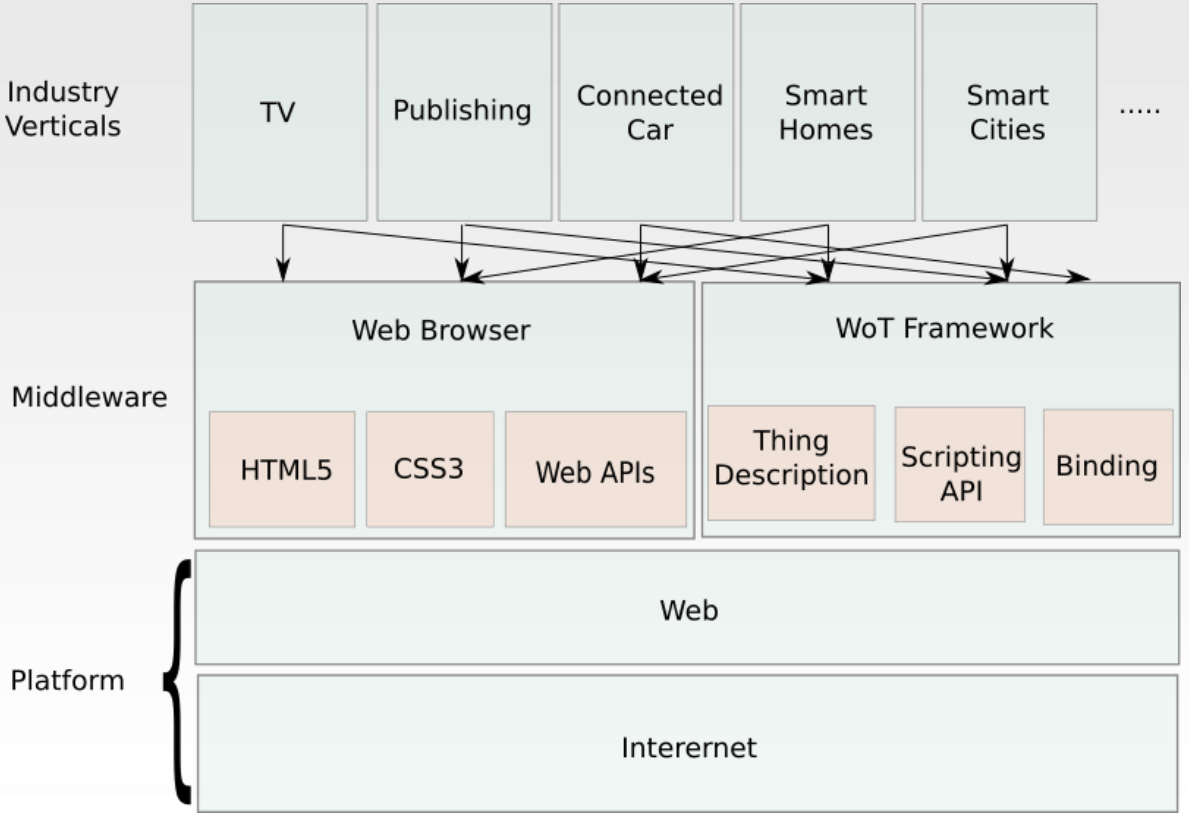
- So far…
  - Just part of the discussion for the WoT specifications by the WoT WG
- However, since this year…
  - Getting inputs/ideas from the WoT IG participants as well as the WoT WG participants
  - and even from the outside of the W3C ☺

Working area:
https://github.com/w3c/wot-architecture/tree/master/USE-CASES

Consolidated document on Use cases and Requirements:
https://w3c.github.io/wot-usecases/

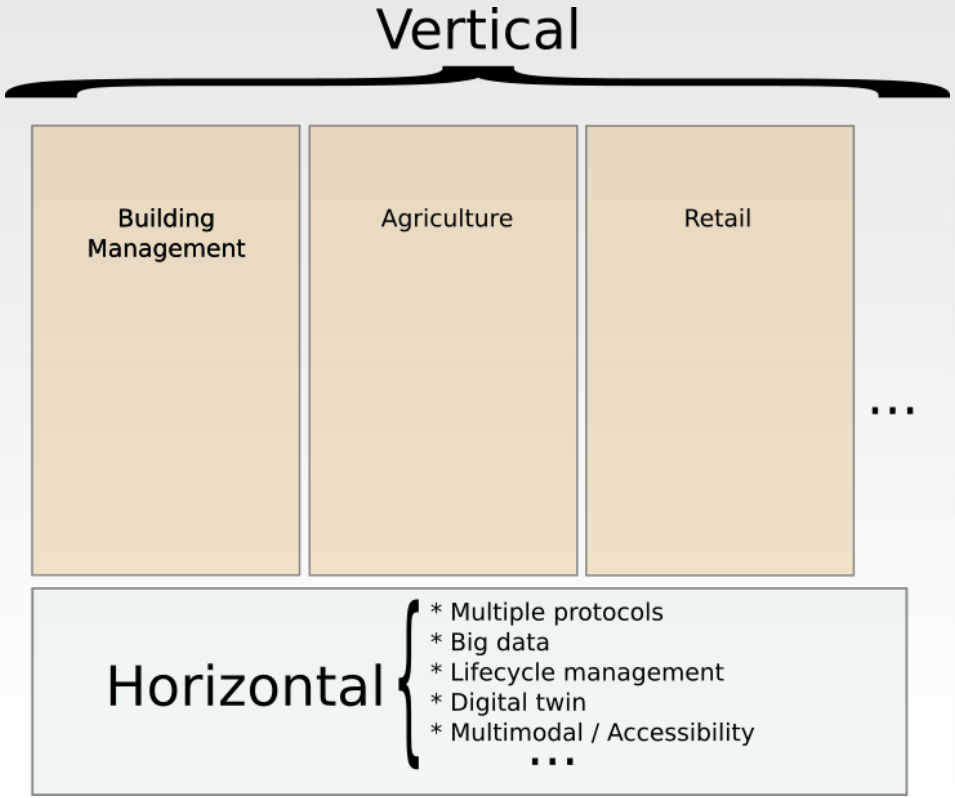
WoT Positioning

— Middleware for IoT purpses based on the Web platform!



Categorization of the use cases
- collaborative work with related WGs and SDOs

- Vertical (Industry-dependent)
  - Devices and Sensors
  - Automotive
  - Media and Entertainment
  - Other SDOs
- Horizontal (Industry-independent)
  - Accessibility
  - Privacy
  - Security
  - Internationalization



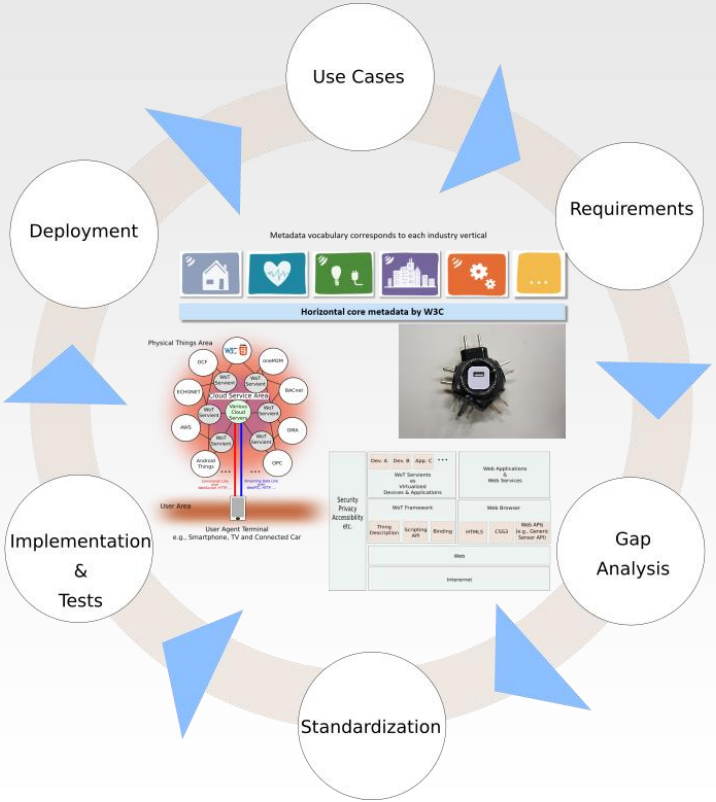
Use cases – Vertical ones

- TV industry
  - Media distribution
  - Multi-program collaboration
  - AR/VR
- Smart agriculture
  - Plastic greenhouse
  - Openfield management
  - Smart water management
- Smart building
  - Sensors
  - Maintenance
- Smart city
  - IoT mashup
  - Geolocation
  - Healthcare
- Others
  - Retail
  - Traffic
  - Smartgrid
  - Education
  - Medical care

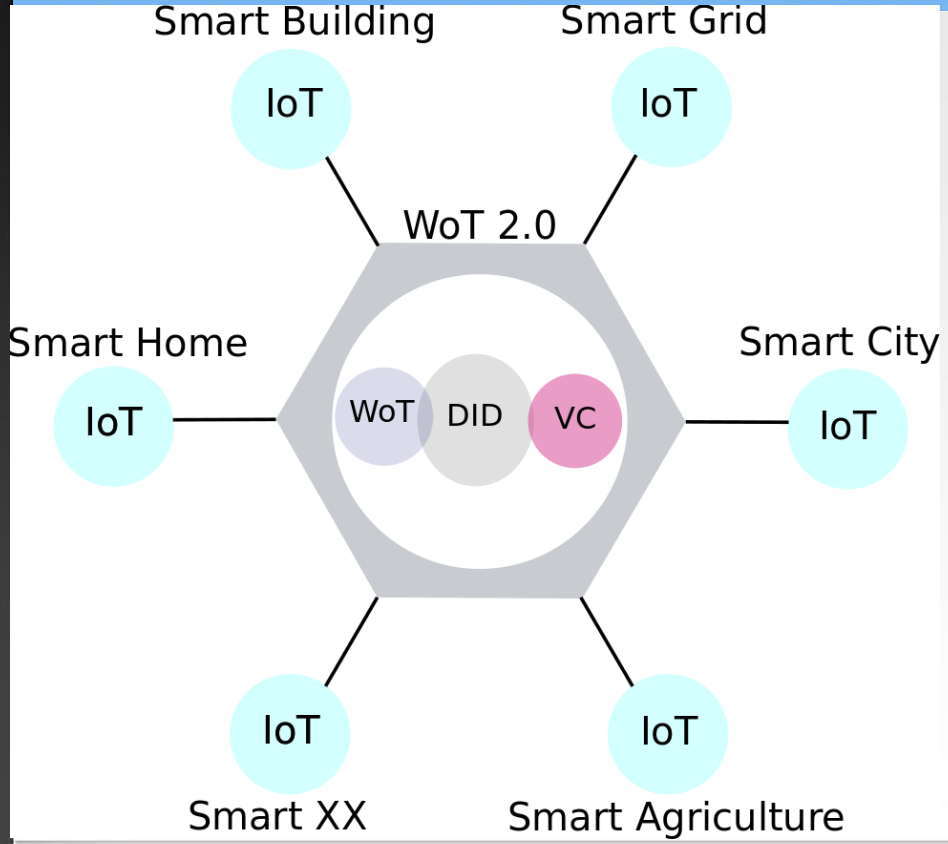
Use cases – Horizontal ones

- Digital twins
- Multi-protocol integration
- Big data
- Lifecycle management
- Multimodal interfaces (improved UX)
- AI & Machine learning
- Edge computing
- IoT orchestration

Extracting requirements from all the use cases
— collaboration with industries and SDOs



Then towards WoT 2.0: WoT + DID + VC

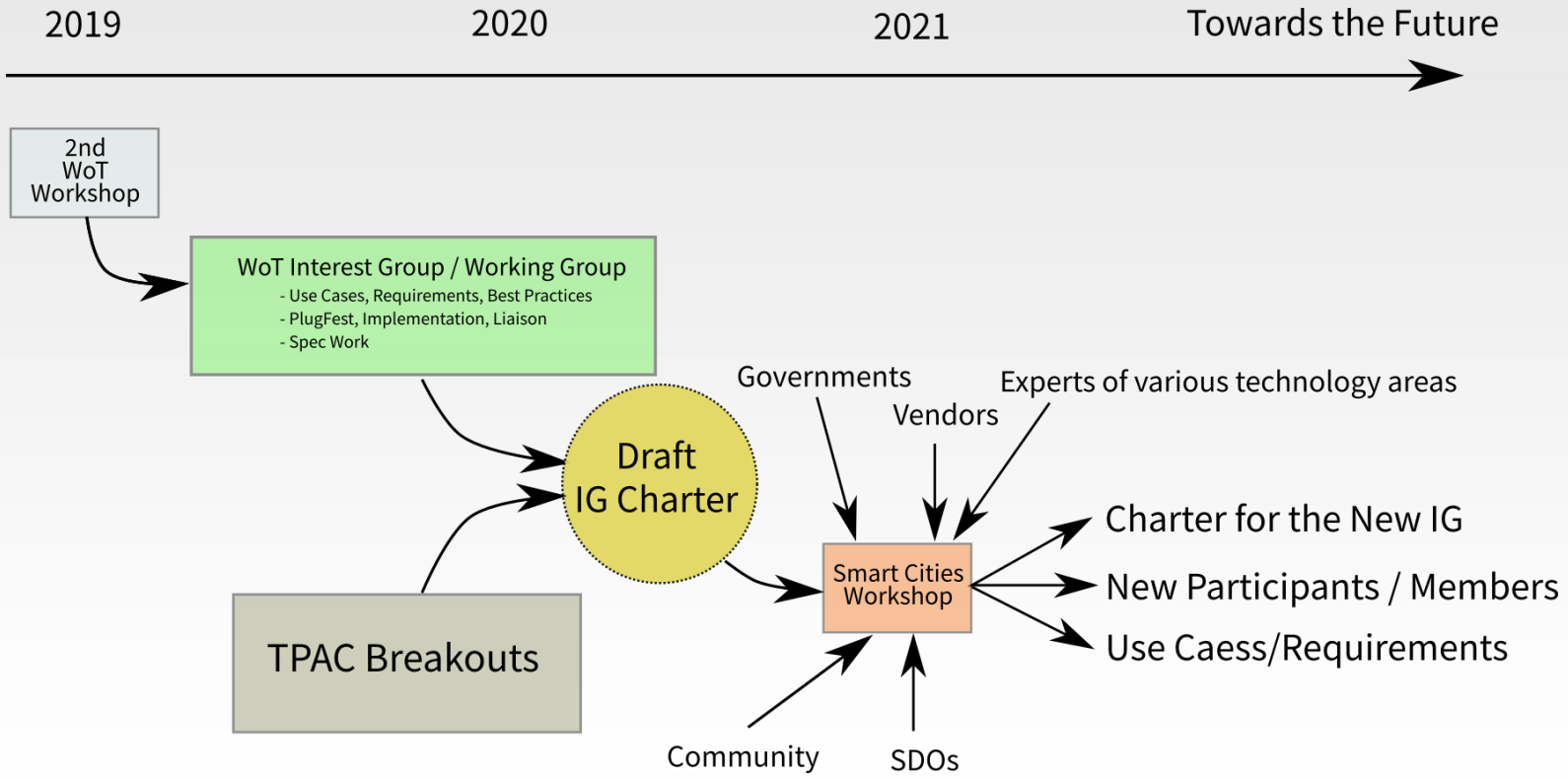


Managing devices and users using the DIDs:

- **DID: Decentralized Identifiers**
  - **IDs for identify devices and users**
  - **Encrypted and distributed**
  - **Blockchain is a possible system platform**
- **WoT: Web of Things**
  - **Standard description for devices' capability and behavior**
- **VC: Verifiable Credentials**
  - **Standard description for users' credentials**
  - **Encrypted and self-sovereign**

Smart Cities

Smart Cities Discussion at W3C



Need for a Dedicated IG

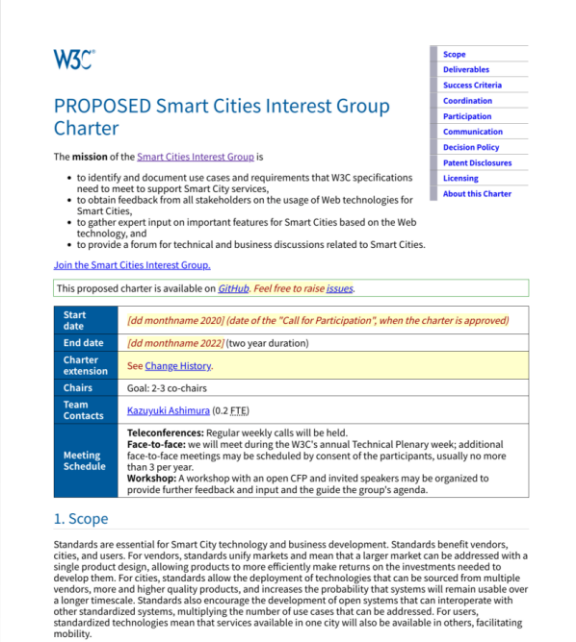
- "Smart Cities" consists of (too) many stakeholders (vendors, users, governments, …) and technologies (Web, IoT, Software, Hardware, …).
- So strong need:
  - To identify and document **use cases and requirements** that W3C specifications need to meet to support Smart City services and users,
  - To obtain **feedback from all stakeholders** on the usage of Web technologies for Smart Cities,
  - To gather **expert input on important features** for Smart Cities based on Web technology, and
  - To provide a **forum for technical and business discussions** related to Smart Cities.

Goals of The Workshop

- **Identify stakeholders** of Smart Cities standardization to drive the development of Web standards aligned with the real needs of Smart Cities
- **Clarify reasonable applications** for Smart Cities technologies we agree to build
- **See how to improve the draft Charter** for the potential Smart Cities Interest Group for further discussions within that I

⇒ Workshop report available at:

https://www.w3.org/2021/06/smartcities-workshop/report.html



W3C

PROPOSED Smart Cities Interest Group Charter

Scope
Deliverables
Success Criteria
Coordination
Participation
Communication
Decision Policy
Patent Disclosures
Licensing
About this Charter

The **mission** of the Smart Cities Interest Group is

- to identify and document use cases and requirements that W3C specifications need to meet to support Smart City services,
- to obtain feedback from all stakeholders on the usage of Web technologies for Smart Cities,
- to gather expert input on important features for Smart Cities based on the Web technology, and
- to provide a forum for technical and business discussions related to Smart Cities.

Join the Smart Cities Interest Group.

This proposed charter is available on GitHub. Feel free to raise issues.

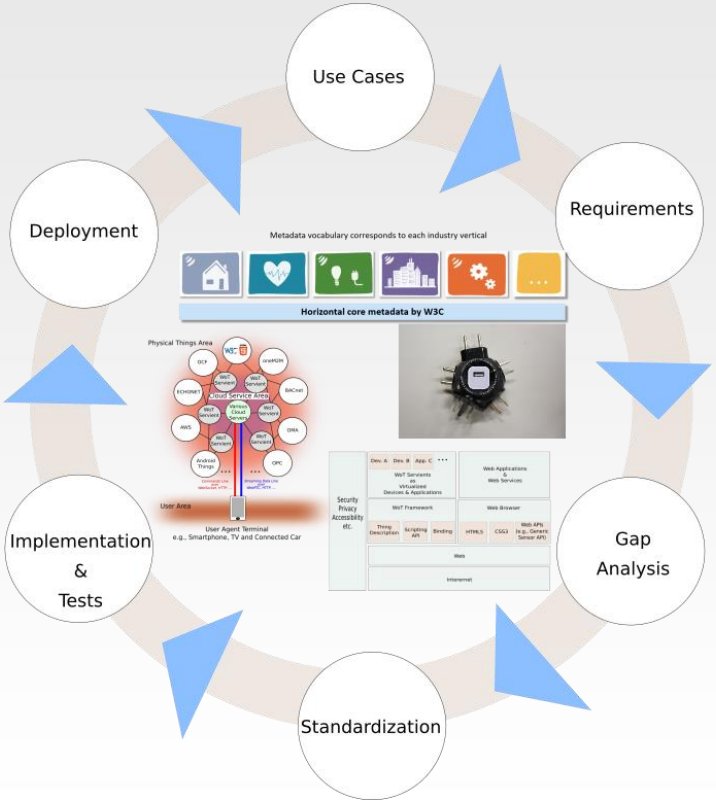
Start date	*[dd monthname 2020] (date of the "Call for Participation", when the charter is approved)*
End date	*[dd monthname 2022]* (two year duration)
Charter extension	See Change History.
Chairs	Goal: 2-3 co-chairs
Team Contacts	Kazuyuki Ashimura (0.2 FTE)
Meeting Schedule	**Teleconferences:** Regular weekly calls will be held. **Face-to-face:** we will meet during the W3C's annual Technical Plenary week; additional face-to-face meetings may be scheduled by consent of the participants, usually no more than 3 per year. **Workshop:** A workshop with an open CFP and invited speakers may be organized to provide further feedback and input and the guide the group's agenda.

1. Scope

Standards are essential for Smart City technology and business development. Standards benefit vendors, cities, and users. For vendors, standards unify markets and mean that a larger market can be addressed with a single product design, allowing products to more efficiently make returns on the investments needed to develop them. For cities, standards allow the deployment of technologies that can be sourced from multiple vendors, more and higher quality products, and increases the probability that systems will remain usable over a longer timescale. Standards also encourage the development of open systems that can interoperate with other standardized systems, multiplying the number of use cases that can be addressed. For users, standardized technologies mean that services available in one city will also be available in others, facilitating mobility.

W3C Standarization Cycle

— based on industry use cases and implementations



Pros and Cons of Smart Cities…

- "Smart City" by Wikipedia: https://en.wikipedia.org/wiki/Smart_city
  - An urban area that uses **different types of electronic methods and sensors to collect data**.
  - Insights gained from that data are used to **manage assets, resources and services efficiently**; in return, that data is used to improve the operations across the city.
  - The smart city concept integrates **information and communication technology (ICT),** and various physical **devices connected to the IoT (Internet of things)** network to optimize the efficiency of city operations and services and connect to citizens.
  - Smart city technology allows **city officials** to interact directly with both **community and city infrastructure** and to **monitor what is happening** in the city and how the city is evolving.

Various Adoptions All Over the Wolrd

- Amsterdam
- Barcelona
- Columbus, Ohio
- Copenhagen
- Dubai
- Dublin
- Gdynia
- Isfahan
- Kyiv
- London
- Madrid
- Malta
- Manchester
- Milan
- Milton Keynes
- Moscow
- New Songdo City
- New York
- San Leandro
- Santa Cruz
- Santander
- Shanghai
- Singapore
- Stockholm
- Taipei
- …

Criticism

- A **bias in strategic interest** may lead to ignoring alternative avenues of promising urban development.
- A smart city, as a scientifically planned city, would defy the fact that real development in cities is often **haphazard**. In that line of criticism, the smart city is seen as unattractive for citizens as they "can **deaden and stupefy** the people who live in its all-efficient embrace". Instead, people would **prefer cities they can participate to shape**.
- The focus of the concept of smart city may lead to an **underestimation of the possible negative effects** of the development of the new technological and networked infrastructures needed for a city to be smart.

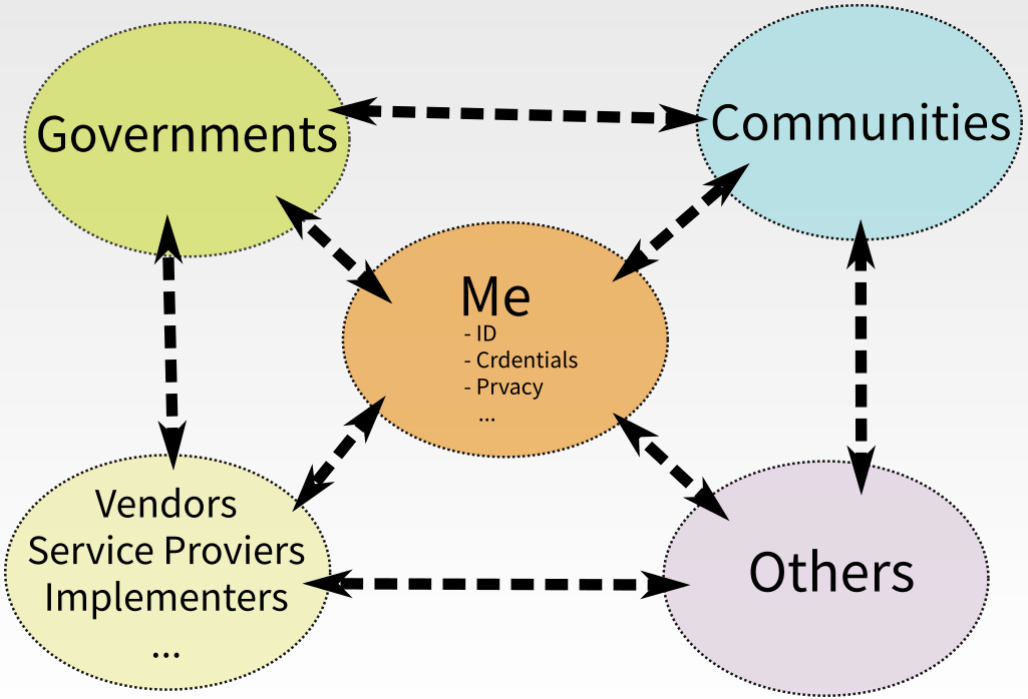
Criticism (contd.)

- As a globalized business model is based on capital mobility, following a business-oriented model may result in a **losing long-term strategy**: "The 'spatial fix' inevitably means that mobile capital can often 'write its own deals' to come to town, only to move on when it receives a better deal elsewhere. This is no less true for the smart city than it was for the industrial, [or] manufacturing city."
- The **high level of big data collection and analytics** has raised questions regarding surveillance in smart cities, particularly as it relates to predictive policing.
- As of August 2018, the discussion on smart cities centres around the **usage and implementation of technology** rather than on the inhabitants of the cities and how they can be involved in the process.

Criticism (contd.)

- Especially in **low-income countries**, smart cities are irrelevant to the majority of the urban population, which lives in poverty with limited access to basic services. A focus on smart cities may worsen inequality and marginalization.
- If a smart city strategy is not planned taking into account people with **accessibility problems**, such as persons with disabilities affecting mobility, vision, hearing, and cognitive function, the implementation of new technologies could create new barriers.

Data Governance for Smart Cities



Data Transfer among various stakeholders

- Who
- What
- When
- How
  - ➢ Need clarification based on concrete Use Cases by a dedicated IG ☺

Please remember Web technology for whom?

- When / Where / For whom / How it works

- Various possible stakeholders and roles
  - Governments?
  - Content producers?
  - Network providers?
  - System developers?
  - Hardware vendors?
  - Infrastructure providers?
  - Service providers?
  - Users (=Everybody) ⇐ Most important stakeholders ！

Thank you!

May the Web standards be your companion helping you improve the world!