

Web-based Digital Twins for Smart Cities at TPAC 2025

W3C Invited Expert

Professor, Center for Information and Communication Technology, Nagasaki University

Kazuyuki Ashimura

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Agenda for today

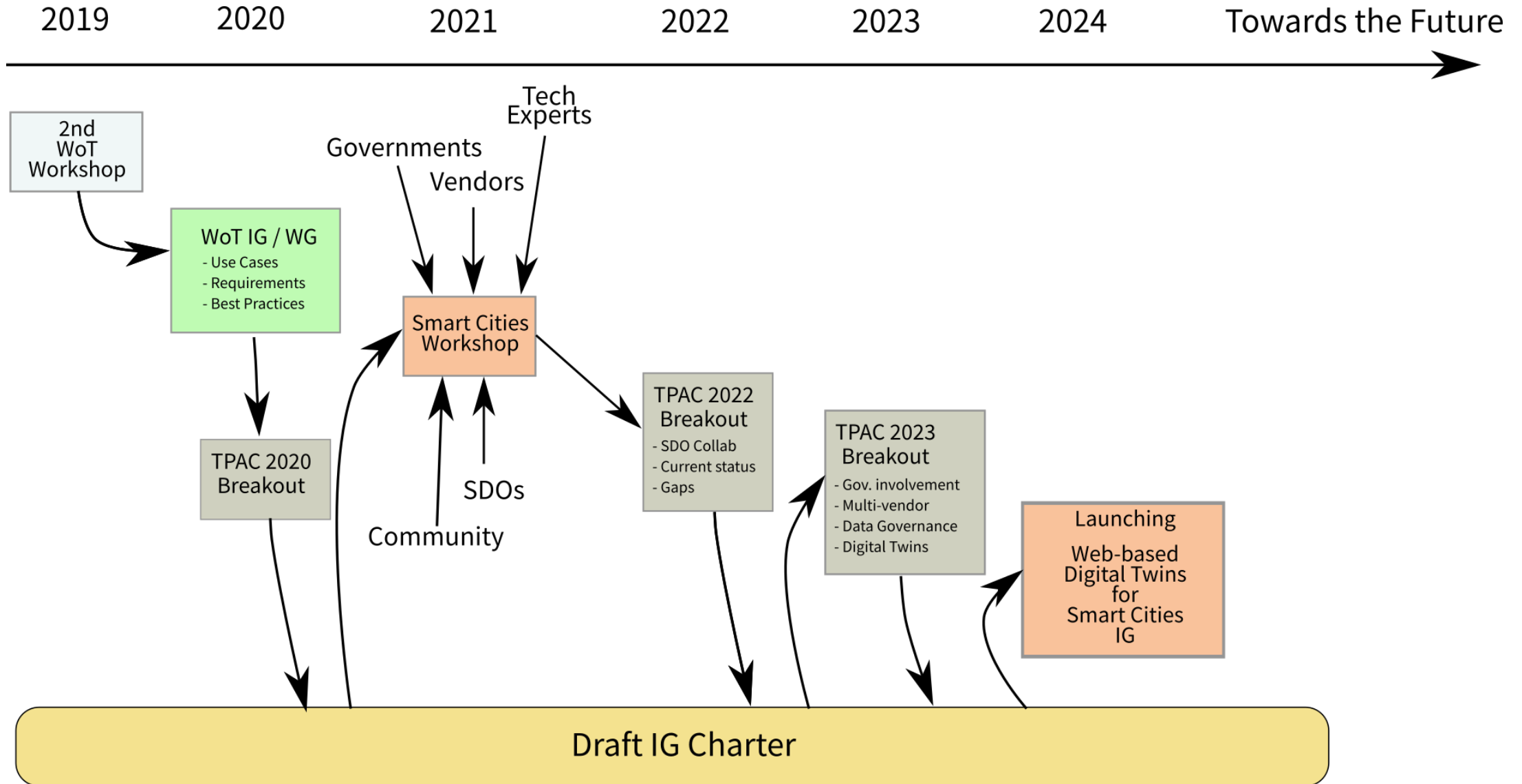
1. Review the discussion so far
2. Get input from stakeholders
3. Discussion on the next steps

Discussion so far

Difficulties with Smart Cities

- "Smart Cities" consists of too many stakeholders (vendors, users, governments, ...) and technologies (Web, IoT, Software, Hardware, ...).
- So strong need:
 - To identify and document **possible use cases**,
 - To obtain **feedback from all the stakeholders**,
 - To gather **experts' input on important features**, and
 - To provide a **forum for technical and business discussions**.

Discussion around Web-based Smart Cities@W3C



Collaboration with related SDOs

ECHONET

- Smart home appliances
 - ECHONET spec
 - ECHONET Lite spec
 - ECHONET Lite Web API spec \Rightarrow referring to the W3C WoT spec
- New features for real-world system development
 - Registration of a set of operations first, then execution later
 - History management
 - Authentication and authorization

IEC SC3D

- Common Data Dictionary (CDD)
 - Methodology and products ontology
 - Standardization for representation of technical information along the life cycle of a product
 - Services
 - Devices
 - Systems
 - Software
 - Plants, etc.
 - Classes, Properties, Identification for various industry areas
 - Machine-interoperable methodology
 - Available for all ISO, IEC products and systems
 - Standardized product ontology DB: <https://cdd.iec.ch/>

IPA DADC

=> Smart Building Co-Creation Organization

- Smart building use cases and system development
 - Takenaka Corporation has developed a data platform for smart buildings based on the **W3C WoT standard**.
 - Based on the lambda architecture which is a best practice for **real-time data processing**.
 - WoT is used to implement **data models and APIs**.
 - The platform is the foundation for various services such as **energy management, AI control, personal control** and **digital twin**.
 - Must manage **many devices** and **tons of associated measurement and control points**.
 - So it is impossible to generate a WoT TD for each device manually.
 - Need to extend the WoT standards for batch property acquisition.

ISO/IEC JTC1

- Various standards on Smart Cities
 - ISO/IEC 30146:2019
 - ISO/IEC 21972:2020
 - ISO/IEC 30145-3:2020
 - ISO/IEC 30145-2:2020
 - ISO/IEC 30145-1:2021
 - ISO/IEC 24039:2022
 - ISO/IEC DIS 5087-1
 - ISO/IEC CD 5087-2
 - ISO/IEC AWI 5087-3
 - ISO/IEC CD 5153-1
- Pre-research and gap analysis
 - Standards needs and roadmap analysis for smart city standards from the ICT aspects
 - Data Use in Smart City
 - City digital twin and operating system
 - Unified Digital Infrastructure — ICT Reference Architecture
 - City Knowledge Trustworthiness Evaluation
 - Terminology-Ontology in Smart City System
 - ICT support in Public Health Emergency

ITU-T SG20

- Already done
 - SG20 – Lead group on IoT and Smart Cities & Communities
 - FG-DPM (Data Processing and Management)
 - Web of Things
 - Data models (basic interoperability)
- To be done
 - Smart cities ontology (semantic interoperability)
 - Digital Twin for smart cities
 - AI and data context
 - Artificial Intelligence of Things: CG-AIoT activities

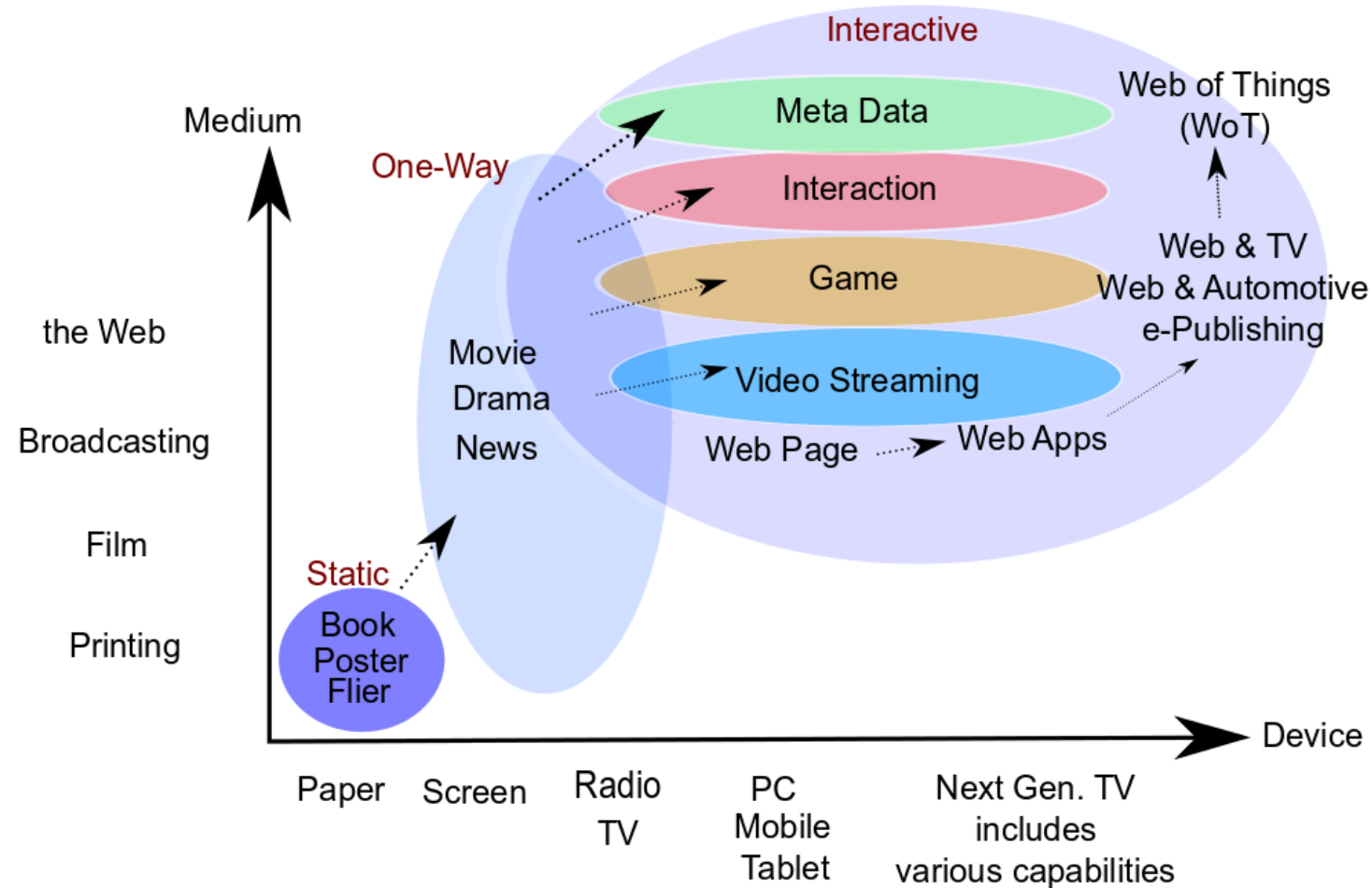
OGC

- OGC Standards and Emerging Digital Twins
 - Tools for representing and observing space
 - General feature model
 - Simple features
 - City GML – CityJSON
 - 3D Tiles – I3S
 - WaterML
 - GeoSciML
 - MUDDI Underground Info
 - OGC API Features
 - Observations and Measurements
 - SensorThings API
 - OGC API Processes
 - Moving features
 - GeoPose
 - IMDF
 - LAS
- OGC Innovation and Future Digital Twins
 - Looks the same, behaves the same, is not the same
 - Location powers urban digital twins
 - Urban digital twin summit
 - 3D-IoT – Modern spatial data infrastructure
 - Integrated digital built environment
 - Simulation, Prediction, Digital Twins in the Metaverse

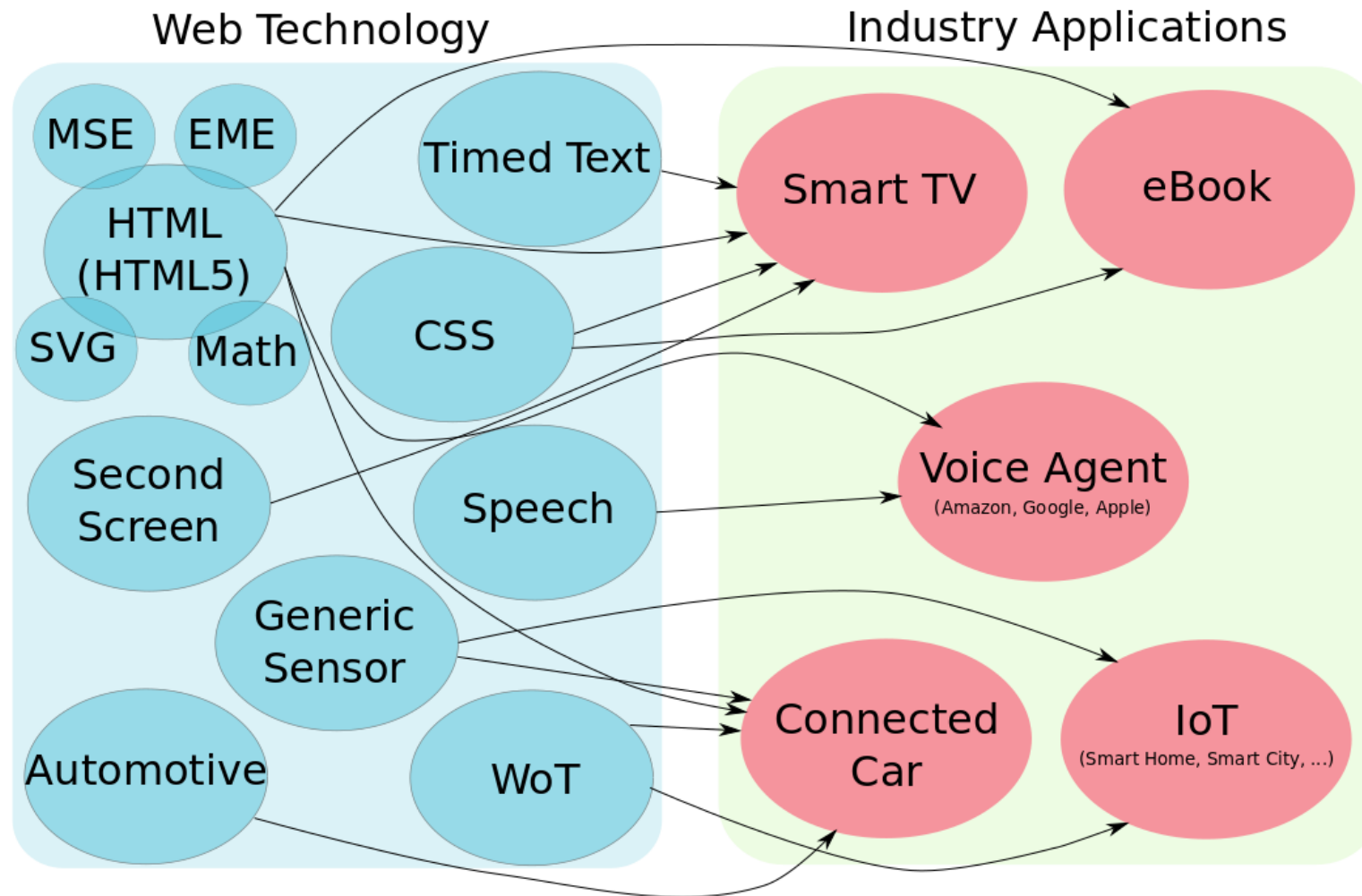
W3C's Web Standardization related to Smart Cities

Web as platform for data transfer in general

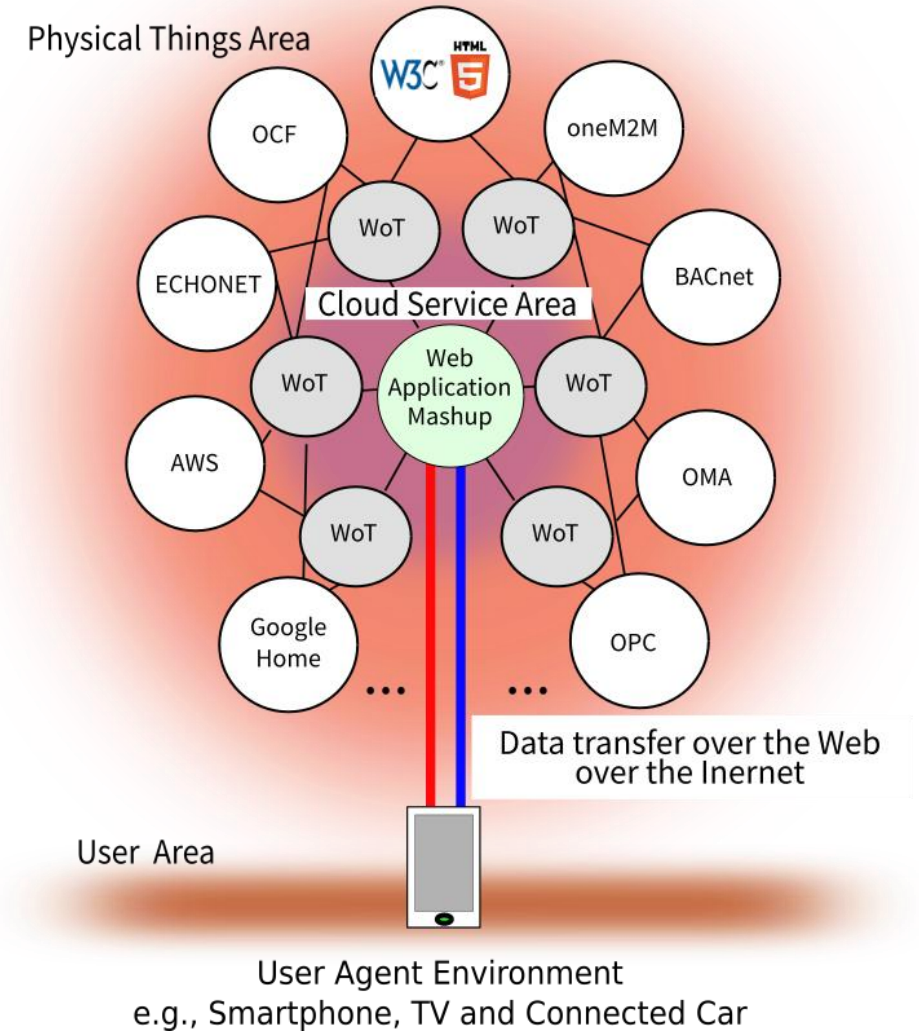
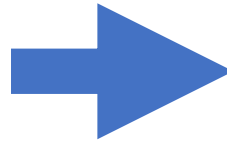
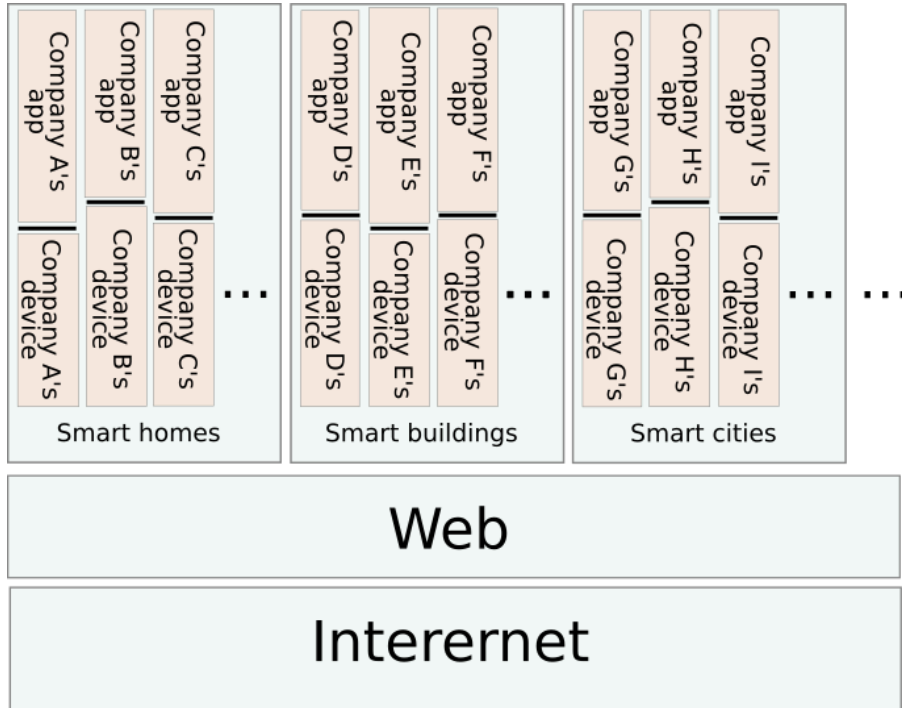
- Independent from devices or OSs



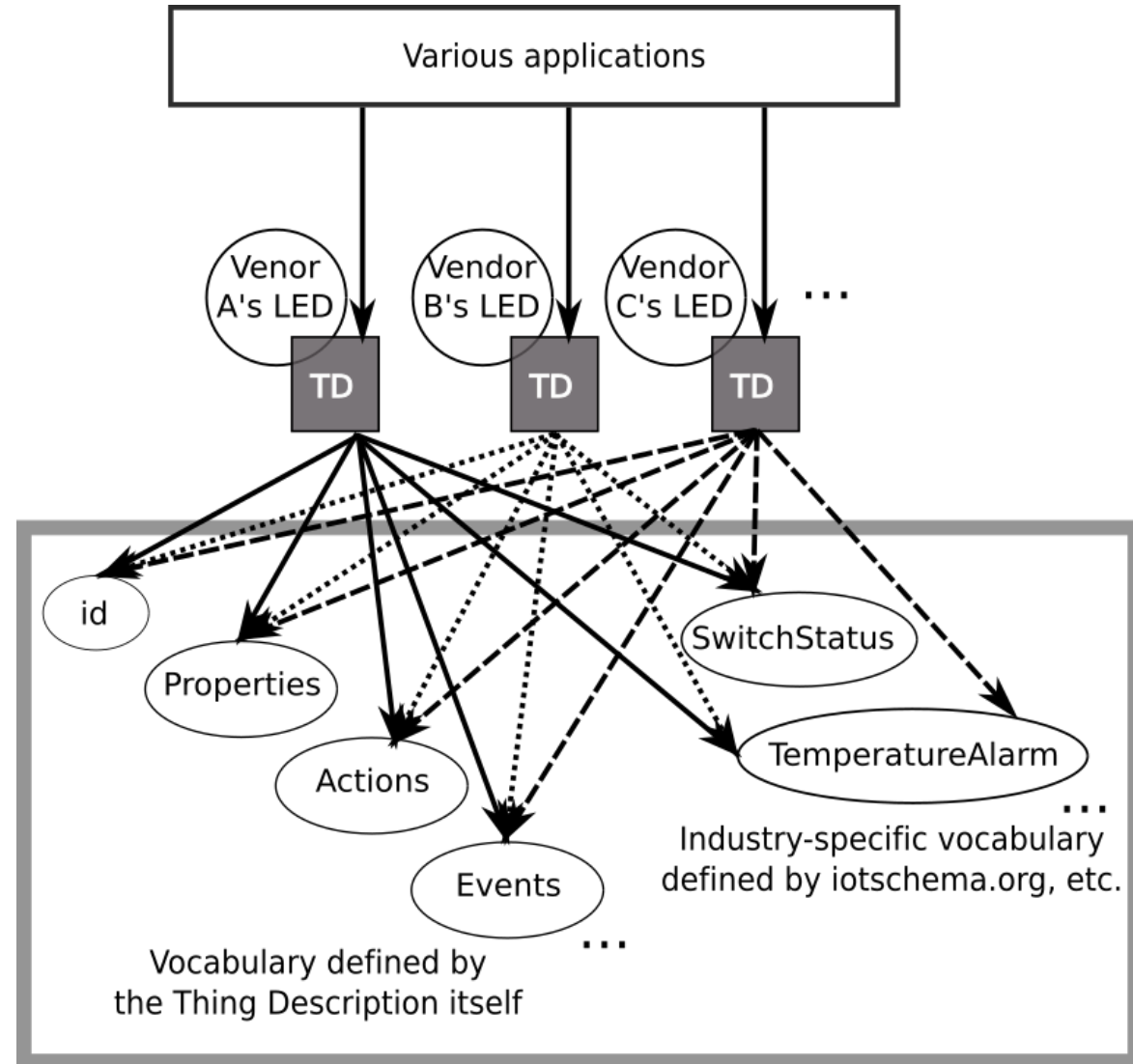
Web standards applied to various industries



WoT: Interconnection of IoT silos



Unified vocabulary references by Thing Description



What is still missing
for global “Smart Cities”?

Strong need for...

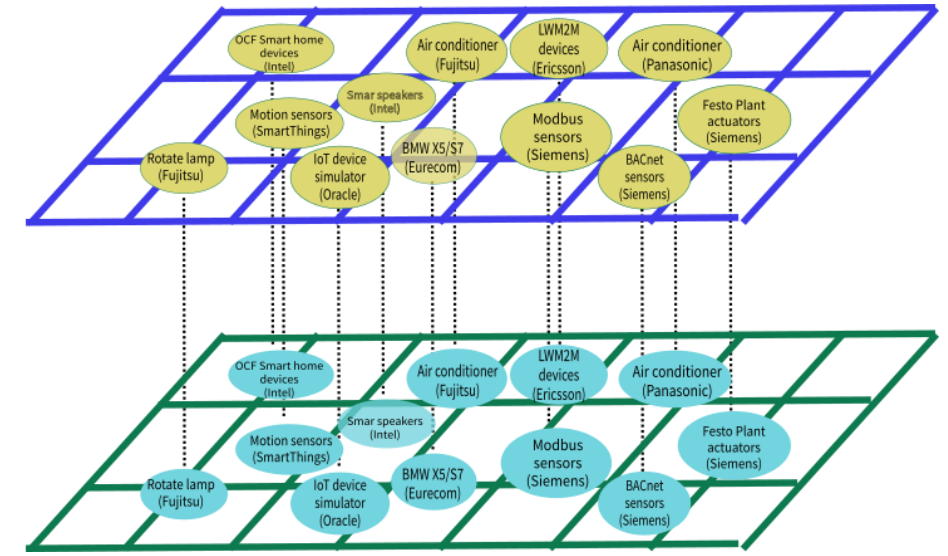
- Standardized platform for data transfer and distribution
 - Binding among various systems
 - ID authentication and management
- Standardized vocabulary
 - Semantic interoperability among various systems
 - Catalog for easy data access

“Digital Twins” as the Key Concept

- Virtualization of
 - Devices
 - Users
 - Services
- Correspondence between:
 - Virtual Layer
 - Physical Layer

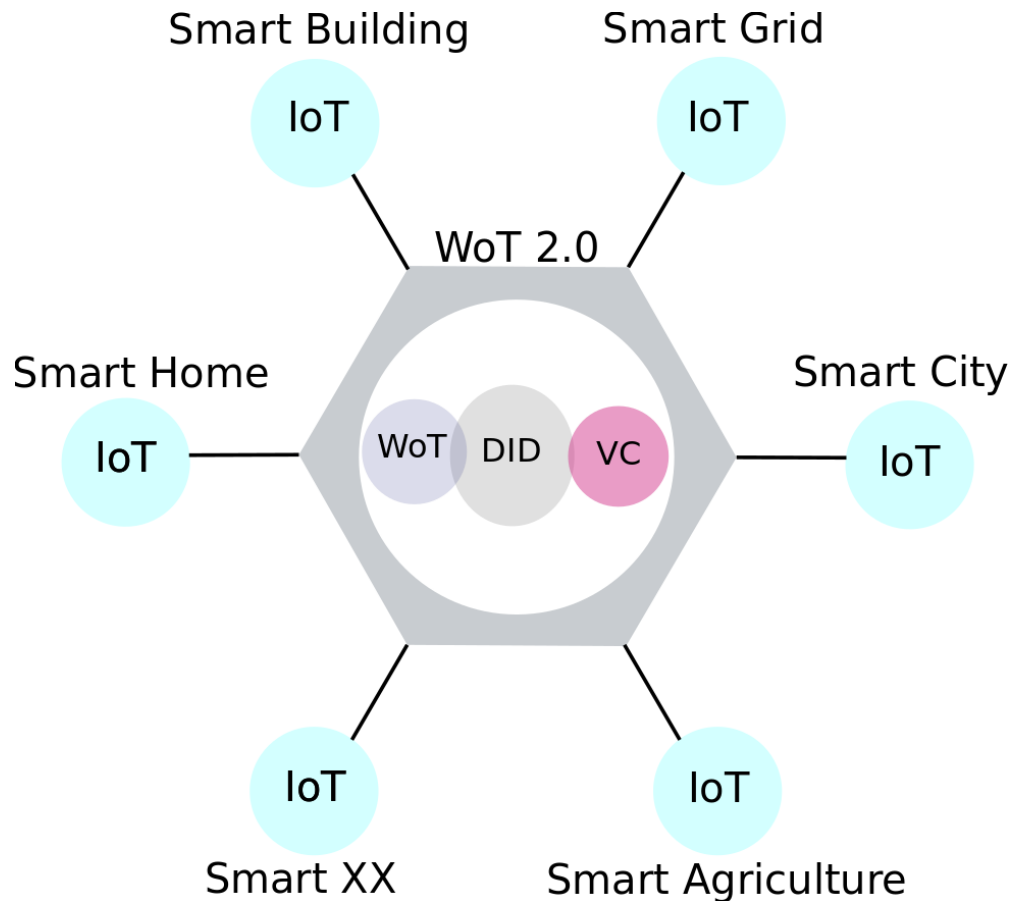
Virtual Layer

Physical Layer



⇒ Useful for easy handling from Web Applications

Web-based Digital Twins Framework



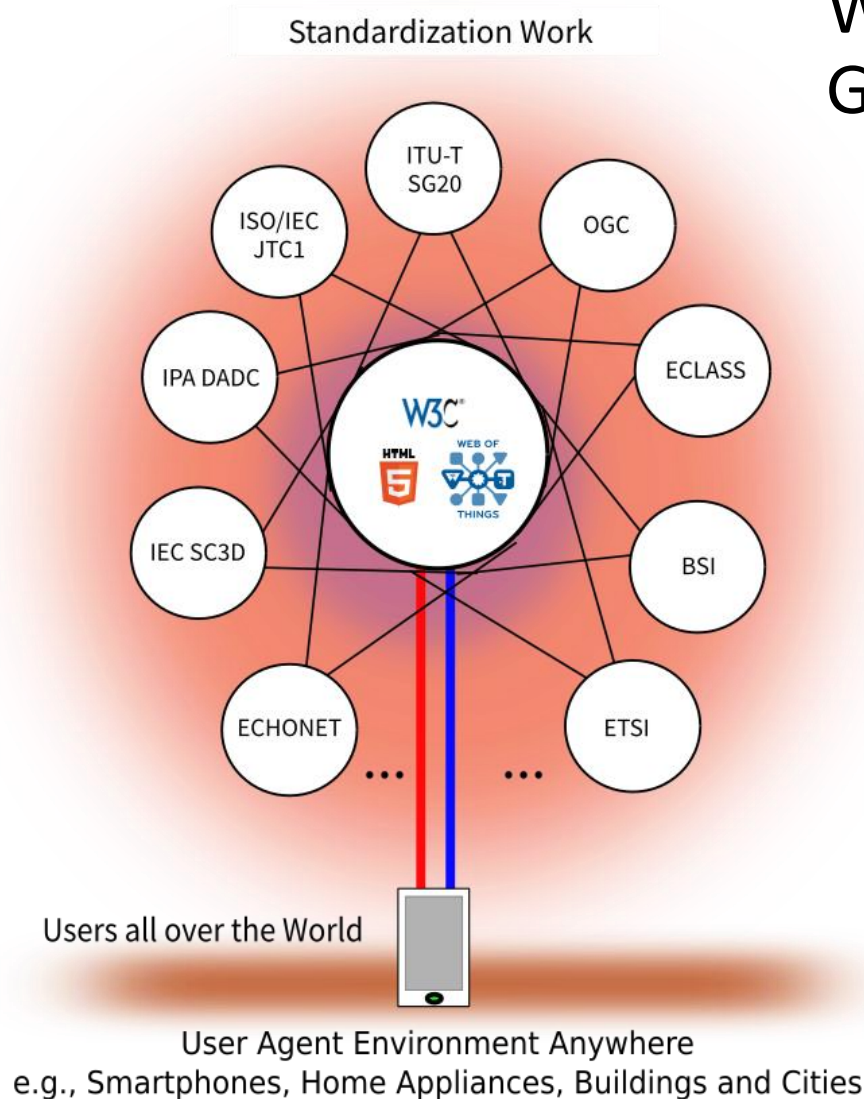
- Decentralized Identifiers (DID):
 - Unique identifier for the Virtual Layer
 - Identify Devices, Users and Services
- Web of Things (WoT):
 - Handling Devices on the Virtual Layer
 - Mapping to the Physical Devices
- Verifiable Credentials (VC):
 - Manage User Credential on the Virtual Layer
 - Describe User Credential for Device/Service access

Need for Standardized Vocabulary

- Definition and References
- Ontology standards are provided by W3C:
 - [RDF](#) and [RDF Schemas](#)
 - [Web Ontology Language \(OWL\)](#)
 - [Rule Interchange Format \(RIF\)](#)
 - [Data Catalog Vocabulary \(DCAT\)](#)
- Proposal:
 - Let's have collative discussions at W3C as a hub to clarify what 's done and what's missing!

W3C as the Hub for Collaborative Discussions!

Web-based Digital Twins for Smart Cities Interest Group has been established!!!



Web-based Digital Twins for Smart Cities Interest Group Charter

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

The **mission** of the [Web-based Digital Twins for Smart Cities Interest Group](#) is

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

[Join the Web-based Digital Twins Interest Group.](#)

Charter Status	See the group status page and detailed change history .
Start date	7 August 2024
End date	31 July 2026
Chairs	Michael Koster (Invited Expert)
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.

(<https://www.w3.org/2024/06/smart-cities/>)

Further Collaborations during the Interest Group Calls

Invited Guests from related SDOs

- Mark Fox, ISO/IEC JTC1/WG11/AHG16
 - Terminology and Ontology
- Torbjorn Lahrin, JWG between ISO/IEC JTC1 and IEC/SyC Smart Cities
 - Local Digital Twins Sweden Metaverse Including Citiverse
- Juanjo Hierro & Martin Bauer, ETSI / FIWARE
 - NGSI-LD, Data Exchange API
- Linda van den Brink, Geonovum
 - Geospatial information, e.g., OGC GeoPose

Continue Discussion on Web-based Smart Cities

- Dedicated session NOW during the W3C TPAC!



- Resources
 - <https://github.com/w3c/smart-cities/blob/main/technology-categories.md>
 - <https://github.com/w3c/smart-cities/blob/main/resources.md>

Get input from stakeholders

- Latest updates, proposals, etc.

- Smart Building Co-creation Organization (SBCO)
- IEC SC3D
- ECHONET
- OGC
- ISO/IEC JTC1

Discussion on the next steps
- How to proceed?

Thank you!

May the Web always be with you
and help you improve the world!