WoT & BACnet

Enabling IoT in buildings with the power of the web

Doğan Fennibay, Siemens AG

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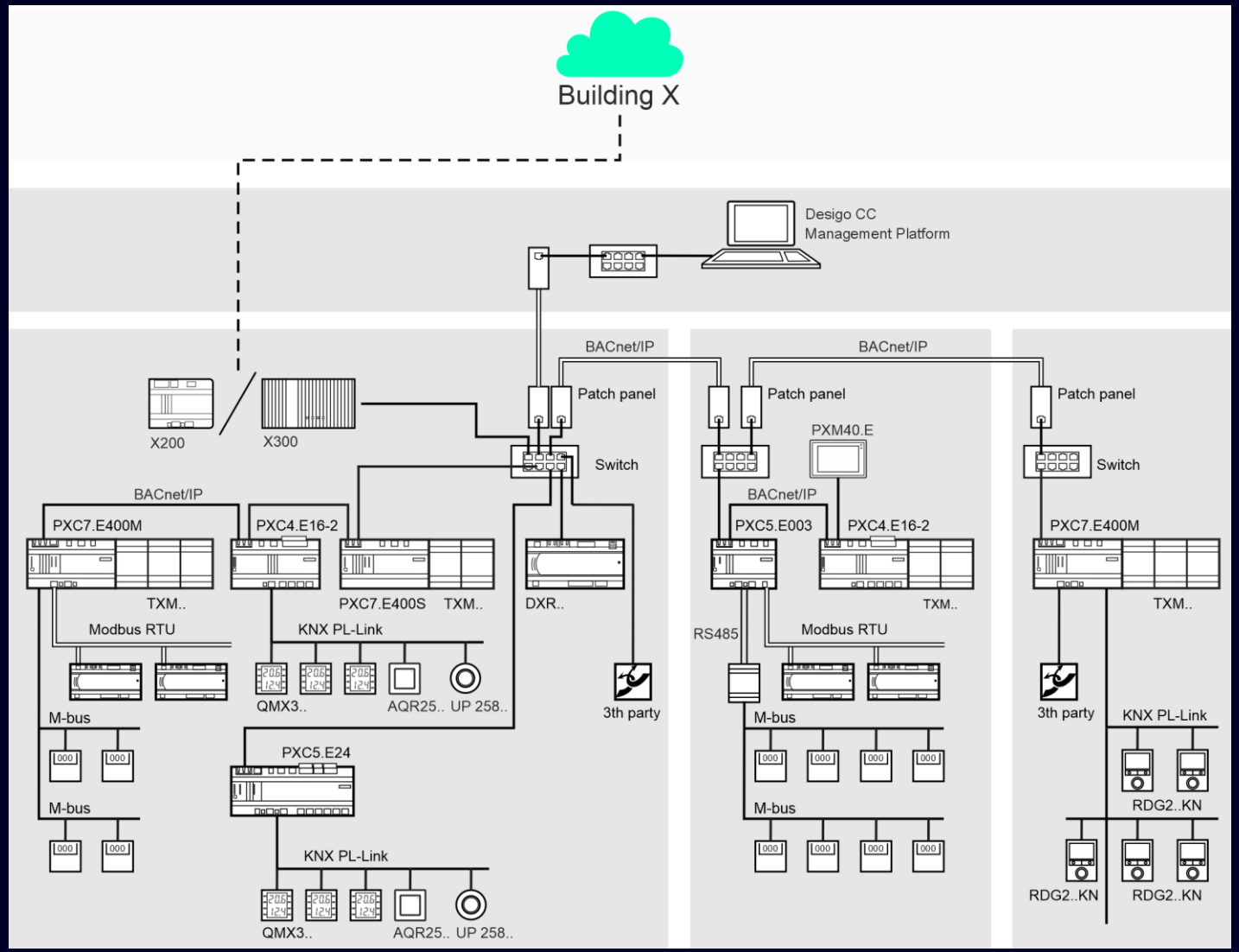
Motivation



Cloud integration

BACnet for management layer

Many fieldbus protocols

Source: Siemens Large automation control projects with Desigo CC and BACnet/IP • Desigo BACnet Networks in Building Automation Basic Documentation • Smart Information Delivery

BACnet has a 77% market share, why is WoT needed?

- Increasing IoT integration
- Smart peripherals
- IP everywhere
- Automation pyramid → IoT Hourglass
- Cybersecurity & zero trust

Keep the power of BACnet and extend with WoT for 100% openness and integration

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Outline

- BACnet: what it is and its impact
- Web of Things: what is it and why do we use it?
- WoT-BACnet Binding

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About me

Doğan Fennibay
Principal Key Expert IoT Systems: Architecture & Core Assets
Siemens Smart Infrastucture Buildings

Interest areas:

- IoT Systems Architecture
- Web of Things
- Metadata management & modelling
- Edge & connectivity

Note: Opinions are my own and do not necessarily reflect the views of Siemens.

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What is BACnet?

Application Layer

Confirmed/unconfirmed, state machines for alarming, change-of-value, object types...

Network Layer

Discovery, routing, fragmentation...

Data Link Layer

IP, IPv6, SC, MS/TP, ARCNET, Ethernet, LonTalk, Point-To-Point, ZigBee, Virtual

Content:

- A communication protocol specifically targeting building automation
- Establishes a multi-data link internetwork
- Provides object types for application interoperability:
  - Points: Analog/Binary/Multistate/Accumulator + Input/Output/Value...
  - Domain-specific: Schedule, Calendar, LifeSafety, Elevator, Access-related, EventLog, AuditLog, Structured View...
  - Infrastructure: Device, Network Port, File,...
- Proprietary extensions possible

Ecosystem:

- Hosted by ASHRAE, standard 135
- Certification and BTL-Logo via test labs

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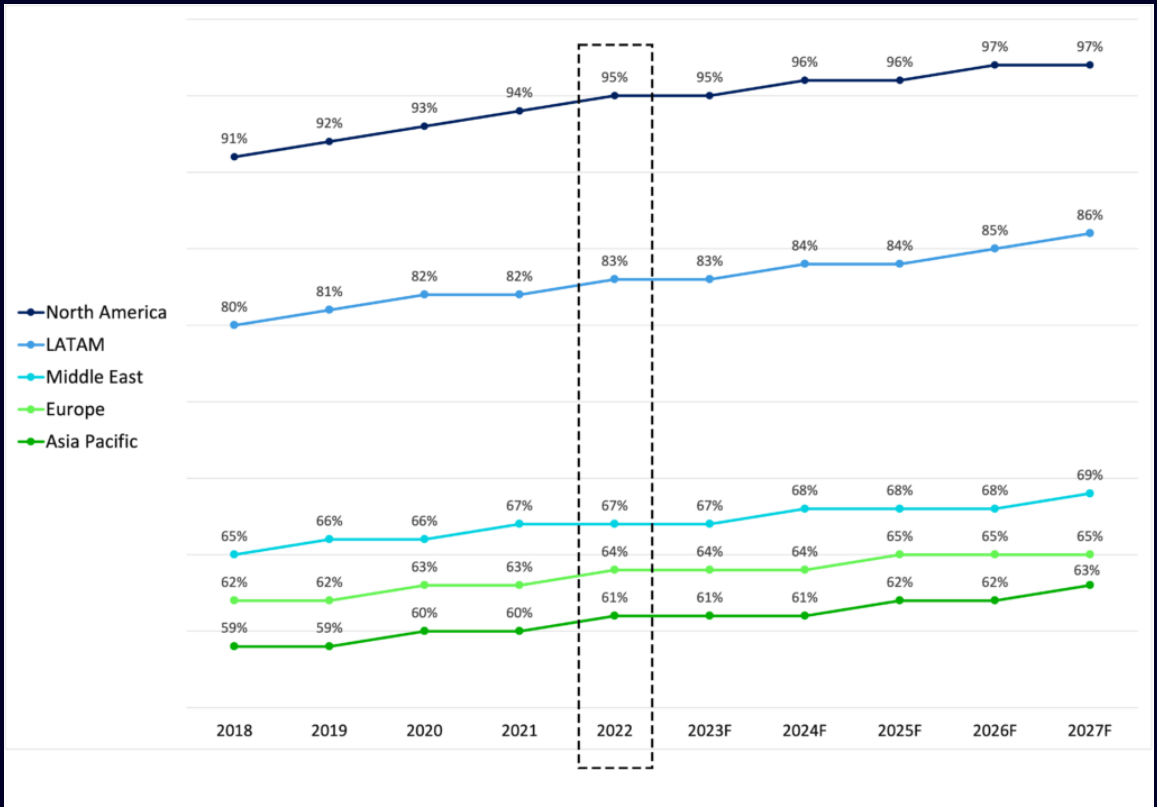
BACnet: market impact



Source:BSRIA, Inc. via https://bacnetinternational.org/news/bacnet-protocol-expands-dominant-market-share-in-latest-market-research-report/

- Globally, %77 of building projects specify BACnet as a requirement
- BTL Listings contain 1462 products from 233 manufacturers
- 1500+ vendor IDs assigned, Siemens: 7...
- Alternatives: KNX, DALI (for lighting), OPC UA (when mixed with other systems), proprietary + IoT ecosystems (Matter, Apple HomeKit...)
- History.
  - 1987: first meeting in Nashville, TN, USA
  - 1995: ANSI/ASHRAE 135 Published
  - 2003: International standard ISO 16484-5

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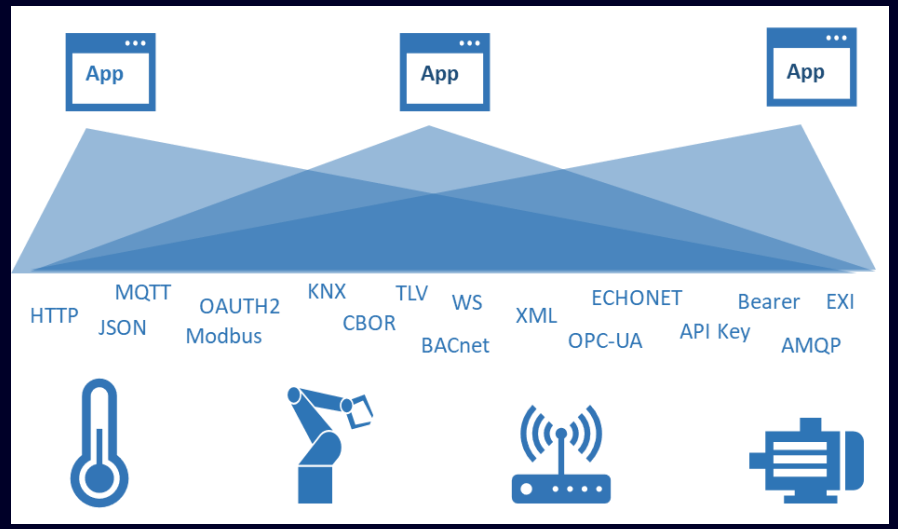
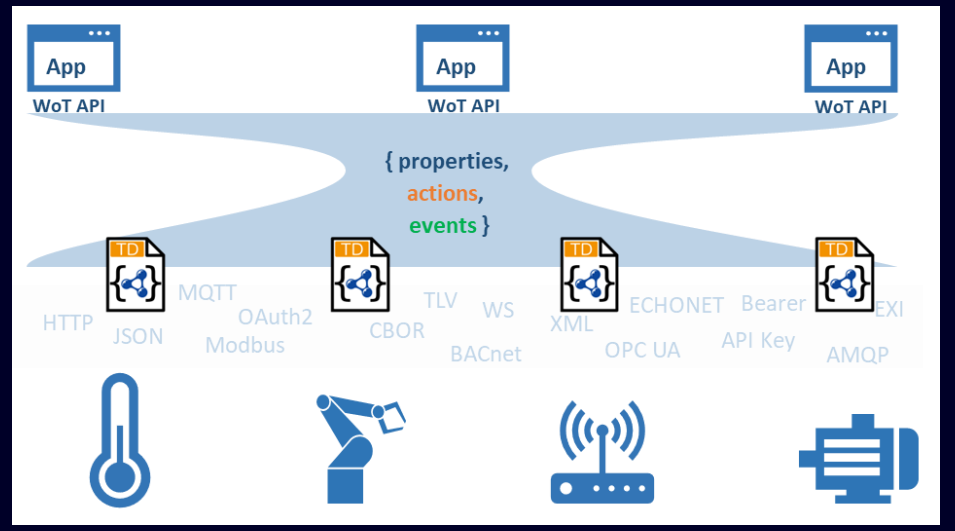
What is Web of Things?





A common abstraction layer for IoT systems to address IoT Fragmentation and achieve an hourglass shaped ecosystem.
Characteristics:

- A common interaction model: properties, actions, events hiding protocol specifics
- Domain-agnostic, is extended with domain-specific ontologies, e.g. Building automation
- Lightweight, referencing existing web standards

WoT Content:

- Architecture: overall concept
- Thing Description: model definition and syntax
- Discovery, Profile, Scripting API, Binding Templates (protocols), Security & Privacy Guidelines

Details: Home - Web of Things (WoT)

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Why Web of Things?

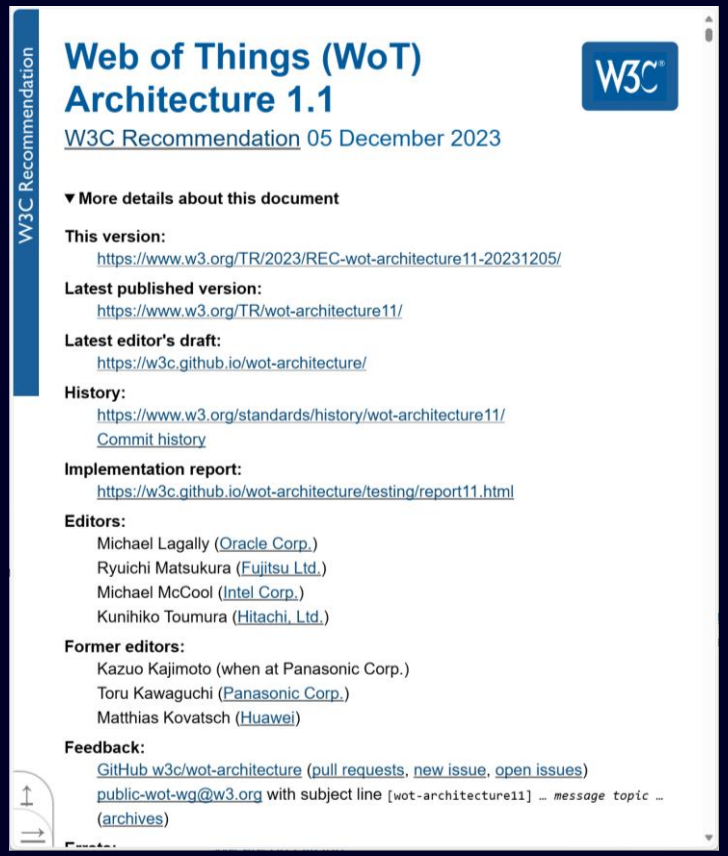
Alternatives to Web of Things:

- Vendor-specific standards: Azure IoT, Apple HomeKit, UDMI (Google)
- Protocol-driven data models: OPC UA
- Consortium-driven standards: OCF, Matter

Web of Things is driven by W3C, is neutral, lightweight and well-accepted.

Some users:

- Asset Administration Shell, SDF, Microsoft, Intel, Oracle, Panasonic, Hitachi, Fujitsu, Deutsche Telekom, Sick AG, Schaeffler, Siemens



W3C Recommendation

Web of Things (WoT) Architecture 1.1

W3C Recommendation 05 December 2023

▼ More details about this document

This version:
https://www.w3.org/TR/2023/REC-wot-architecture11-20231205/

Latest published version:
https://www.w3.org/TR/wot-architecture11/

Latest editor's draft:
https://w3c.github.io/wot-architecture/

History:
https://www.w3.org/standards/history/wot-architecture11/
Commit history

Implementation report:
https://w3c.github.io/wot-architecture/testing/report11.html

Editors:
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Feedback:
GitHub w3c/wot-architecture (pull requests, new issue, open issues)
public-wot-wg@w3.org with subject line `[wot-architecture11] … message topic …` (archives)

W3C Recommendation

Web of Things (WoT) Thing Description 1.1

W3C Recommendation 05 December 2023

▼ More details about this document

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https://www.w3.org/TR/2023/REC-wot-thing-description11-20231205/

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Latest editor's draft:
https://w3c.github.io/wot-thing-description/

History:
https://www.w3.org/standards/history/wot-thing-description11/
Commit history

Implementation report:
https://w3c.github.io/wot-thing-description/testing/report11.html

Editors:
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Former editors:
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Feedback:
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public-wot-wg@w3.org with subject line `[wot-thing-description11] … message topic …` (archives)

Errata:

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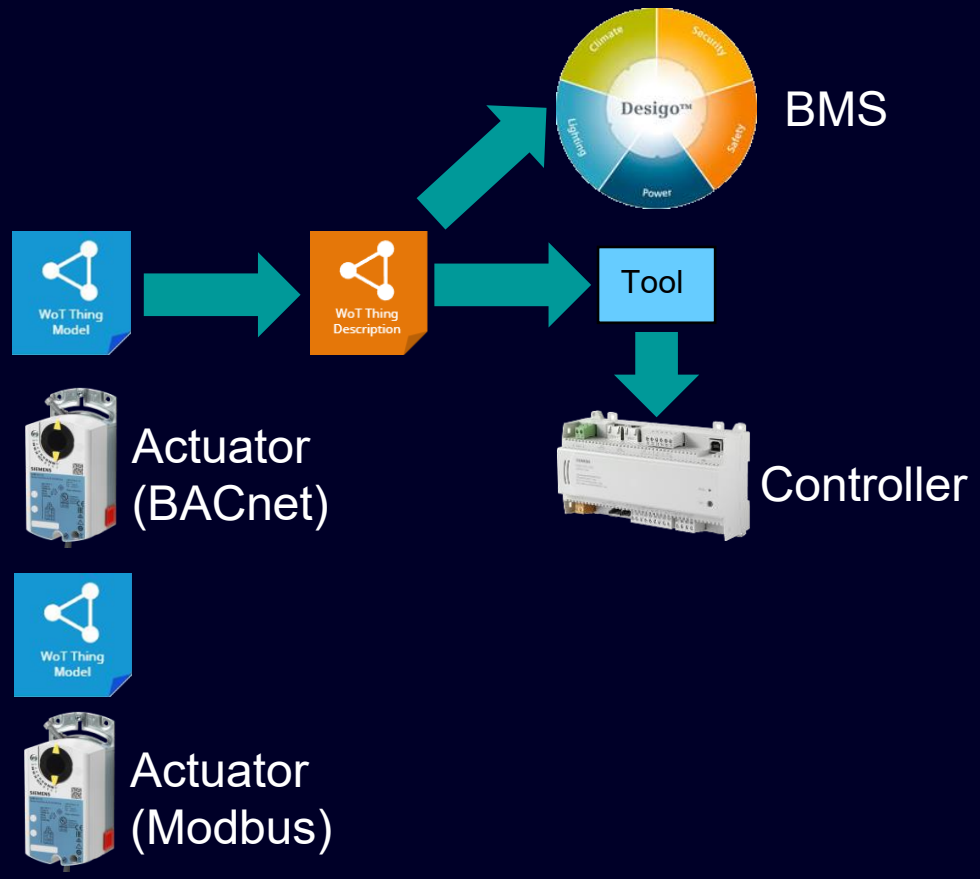
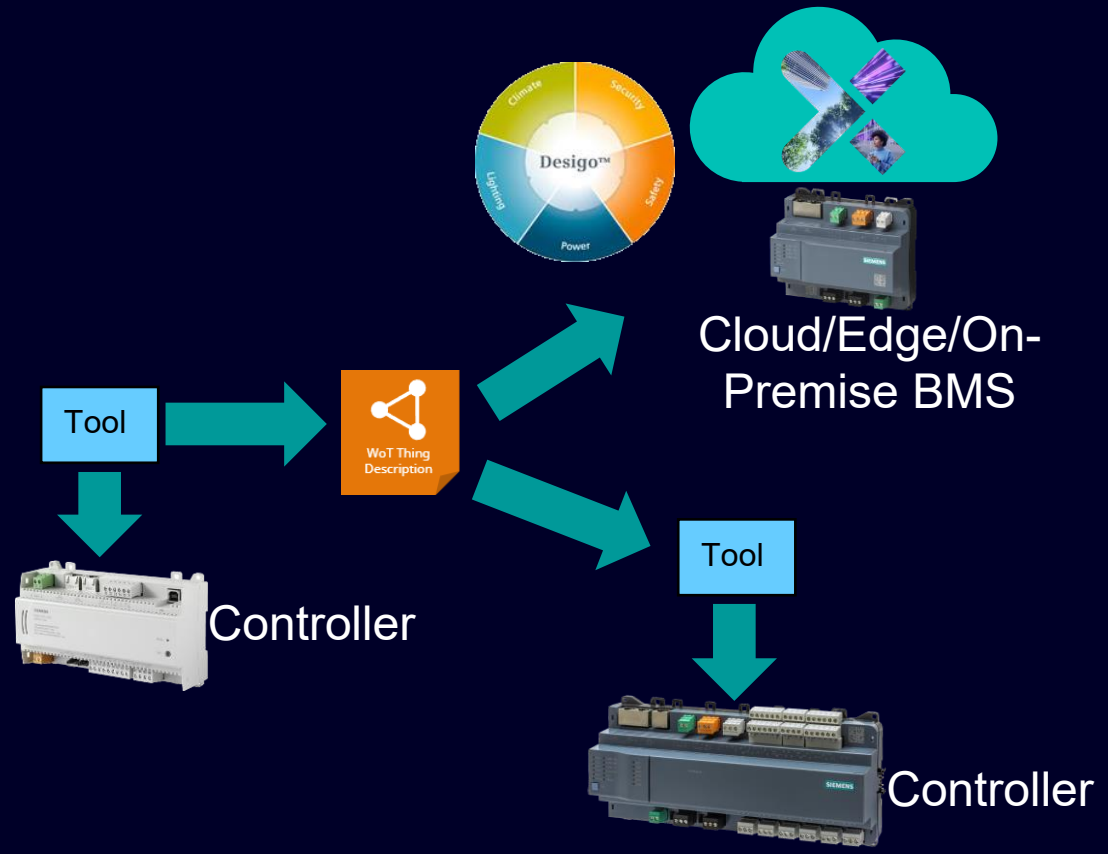
Selected use cases

Onboard configurable peripherals via TM/TD to Controllers or Building Management Systems:



Integrate programmable controllers via TD to other Controllers or Building Management Systems:



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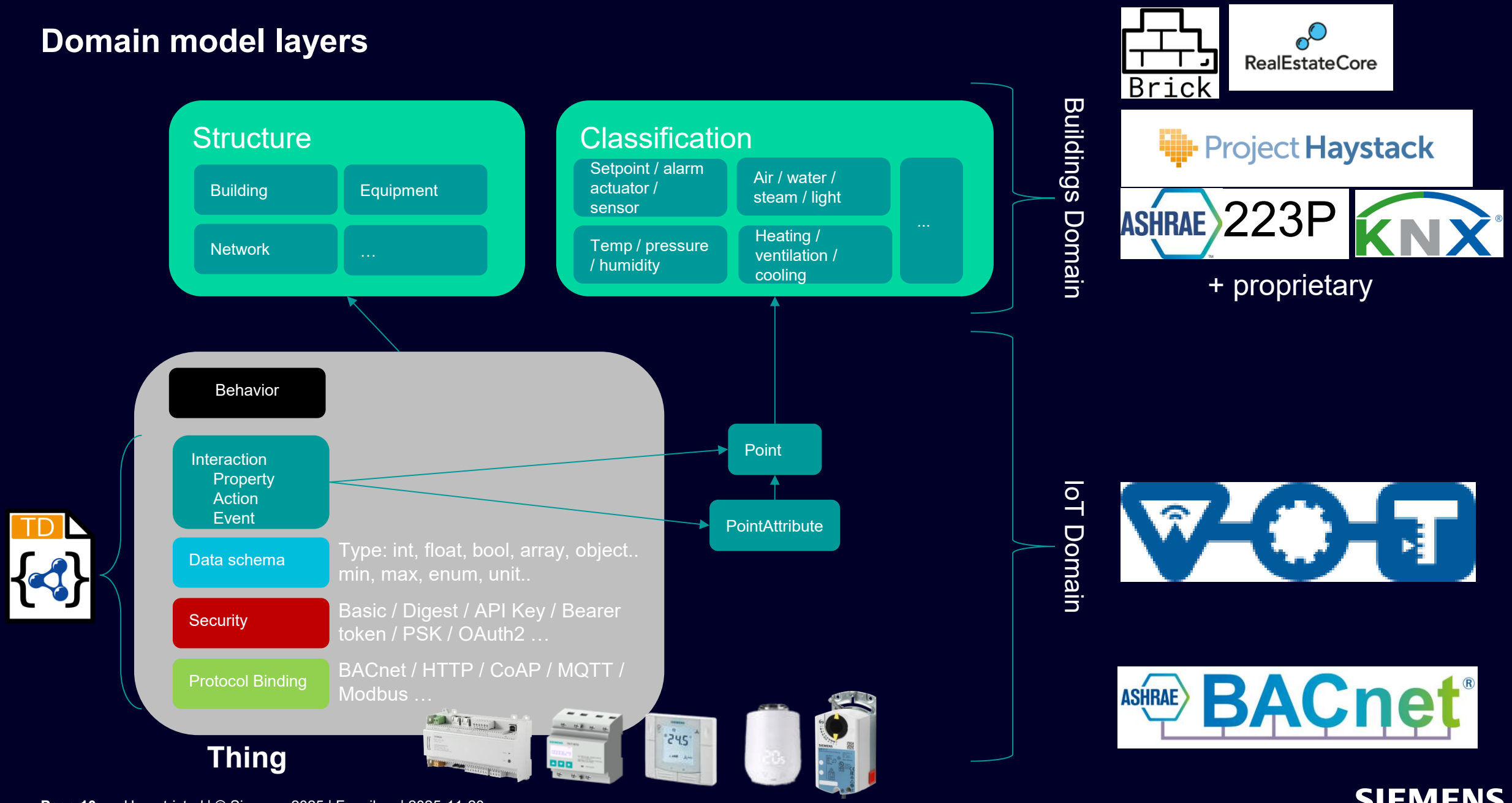
Domain model layers



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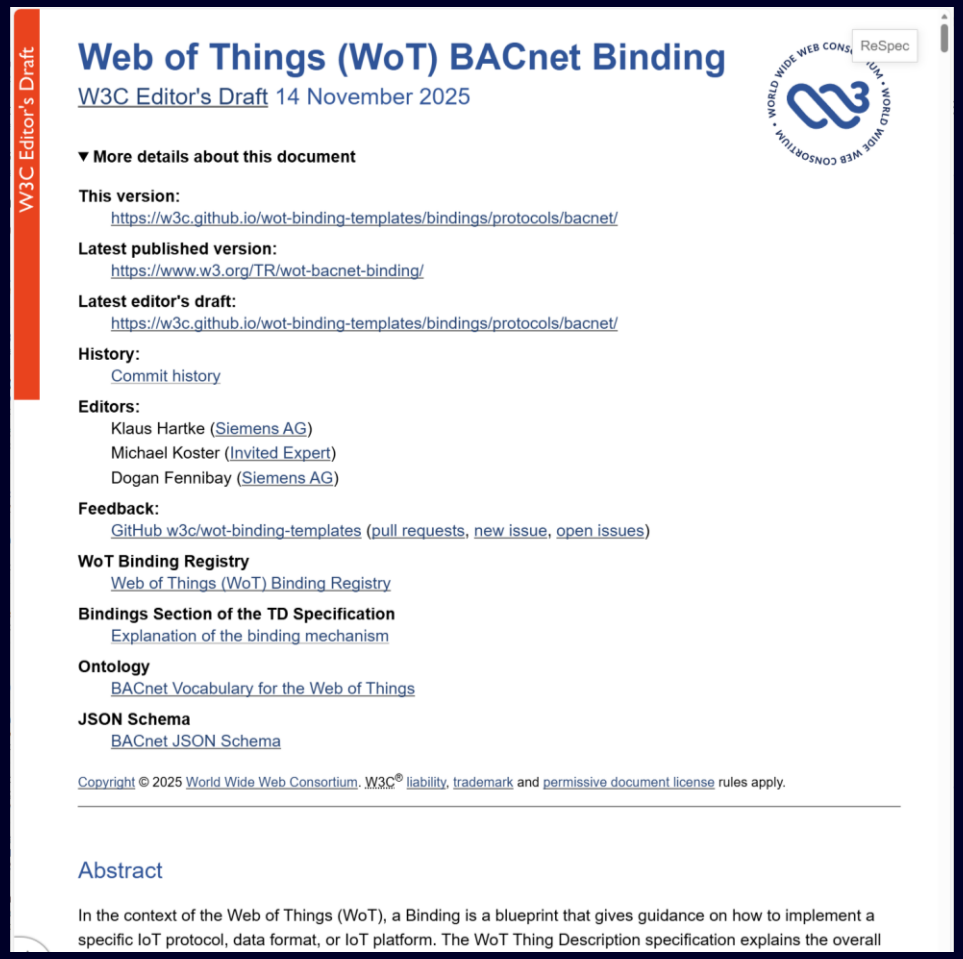
Web of Things BACnet Binding



W3C Editor's Draft

Web of Things (WoT) BACnet Binding

W3C Editor's Draft 14 November 2025

ReSpec

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Dogan Fennibay (Siemens AG)

Feedback:
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WoT Binding Registry
Web of Things (WoT) Binding Registry

Bindings Section of the TD Specification
Explanation of the binding mechanism

Ontology
BACnet Vocabulary for the Web of Things

JSON Schema
BACnet JSON Schema

Abstract

In the context of the Web of Things (WoT), a Binding is a blueprint that gives guidance on how to implement a specific IoT protocol, data format, or IoT platform. The WoT Thing Description specification explains the overall

Available at https://w3c.github.io/wot-binding-templates/bindings/protocols/bacnet/

Brief history:

- 2022: Work started, with K. Hartke & M. Koster
- Mar 2023: First using product released
- Oct 2023: First draft published: readproperty, writeproperty, observeproperty, unobserveproperty
- Mar 2024: Second release (with adaptations to the draft)
- Jul 2024: Eventing published: subscribeevent, unsubscribeevent
- Continuous: small fixes & improvements ☺

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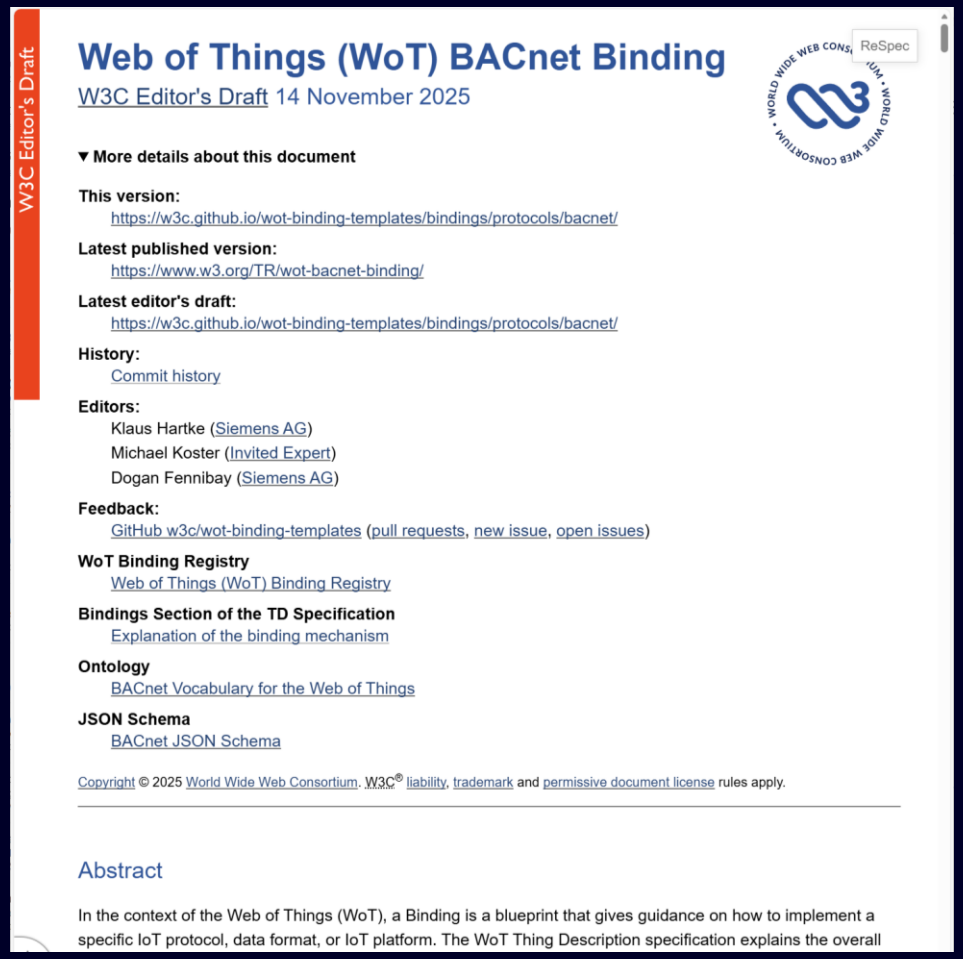
Web of Things BACnet Binding



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Mindset:

- Less is more:
  - do not try to model complete BACnet, just enough for WoT-interoperability, e.g. bacowl ontology contains 17601 triples, WoT-BACnet only 174 triples
  - use case-driven, e.g. we didn't model event subscription parameters (days of week etc.) yet
  - Leave data link layer-specifics out
- Reuse existing definitions:
  - e.g. URI syntax from BACnet standard
- Opinionated for Web:
  - e.g. ISO8601 timestamps instead of BACnet's centiseconds

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Detailed view of BACnet-Thing Mapping

BACnet Object: Structured View: Room Sensor

BACnet Object Analog Input: Temp.

Present Value	20.0
Units	°C
Min. Pr. Value	0
Max. Pr. Value	50.0
Tags	sensor, temp
Reliability	no-fault
Out of Service	False
...	

BACnet Object: Humidity

...	

Thing: VNO/Device/ControlProgram/...

PropertyAffordance/Point: Temp.

type	number
unit	qudt:DEG_C
minimum	0
maximum	50.0
<custom_attr>	sensor, temp

Static standardardized attributes

Static domain-specific attributes

PropertyAffordance/Point Attribute: Reliability

PropertyAffordance/Point Attribute: Out of Service

Dynamic domain-specific attributes

PropertyAffordance: Humidity

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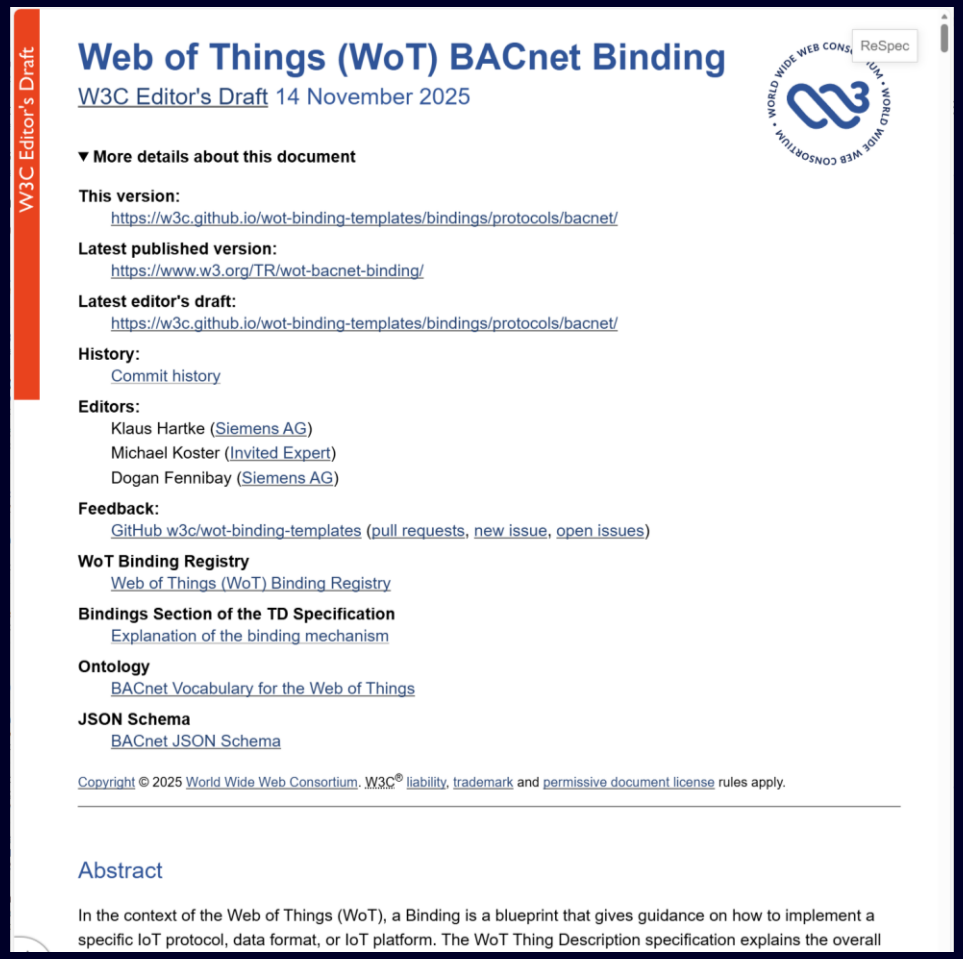
Web of Things BACnet Binding: Walkthrough



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Outline:

- URI syntax
- URI variables
- Properties
- Events
- Examples

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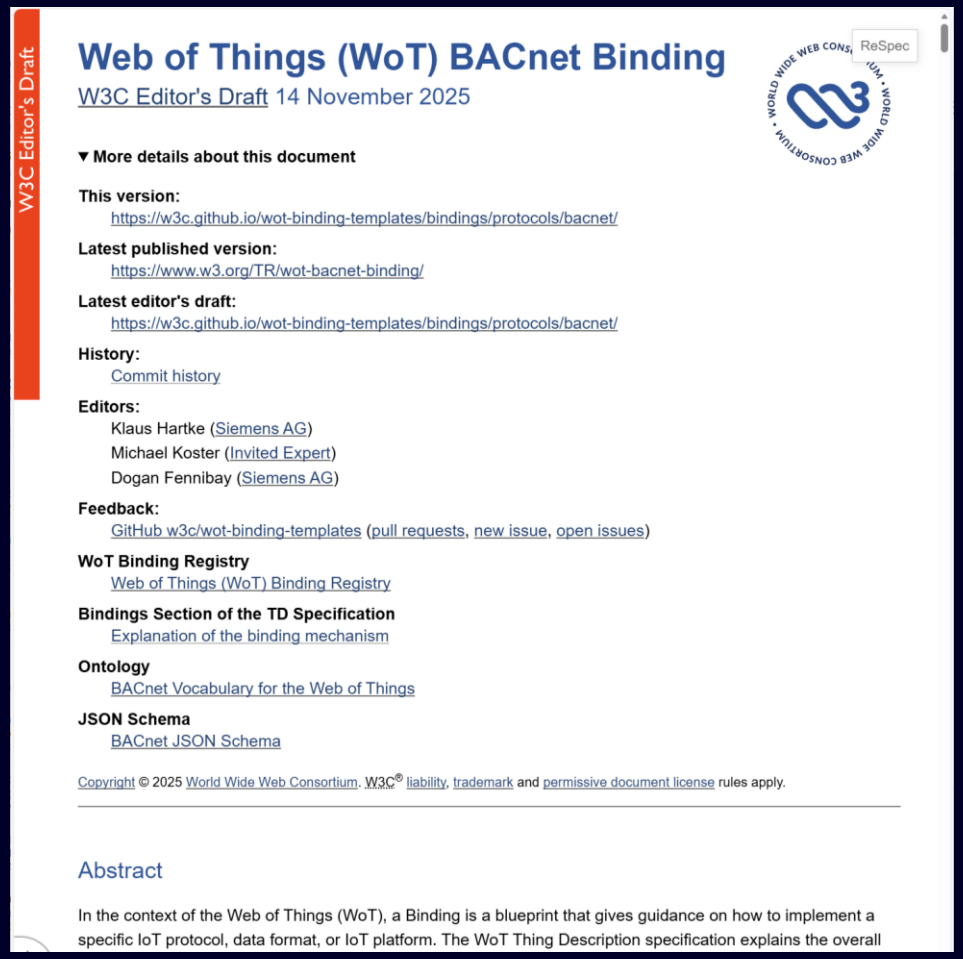
Web of Things BACnet Binding: Next steps



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- Migrate to the new WoT Bindings Registry
- URI schema IANA Registration → to be checked with ASHRAE
- Potential adaptations for WoT 2.0
- New features: point attributes, time series (TrendLog, EventLog)

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Disclaimer

Subject to changes and errors. The information given in this document only contains general descriptions and/or performance features which may not always specifically reflect those described, or which may undergo modification in the course of further development of the products. The requested performance features are binding only when they are expressly agreed upon in the concluded contract.

Thank you!

Questions & comments?

Resources:

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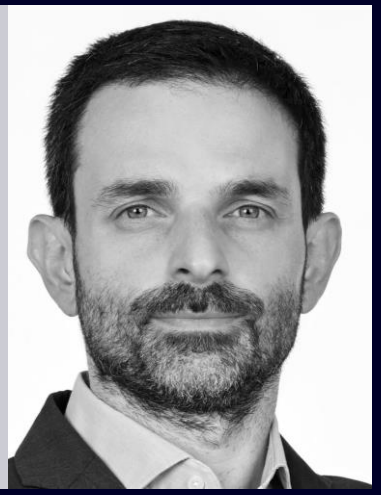
Doğan Fennibay
Principal Key Expert



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