domOS

OPERATING SYSTEM FOR SMART SERVICES IN BUILDINGS

# Decoupling Infrastructure and Services in Smart Buildings

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# Facts & Figures

- Type **Innovation Action (IA)**
- Call **LC-SC3-EE-4-2019-2020**

  **Upgrading smartness of existing buildings through innovations for legacy equipment**
- Partners **11**

  **3 SMEs, 1 multinational company, 2 start-ups, 2 regional energy grid operators, 2 universities, 1 not-for-profit research centre**
- Dates **Sep. 2'020 – Feb. 2'024**
- Budget **4.973 M€**
- Goal **Design an ecosystem promoting the development of smart services in existing buildings**

# Context

## Situation

- **Digitalization** of (small) buildings is **developing**, but in an **uncoordinated way**
  - Mainly silo solutions provided by appliance manufacturers
- **Networking solutions** for appliances are **heterogeneous**
  - and will remain…

**Various…**
- **protocols**
- **security mechanisms**
- **operation model**
- **naming approaches**

## Needs

- **Energy management** for buildings requires **choreography of multiple appliances**
  - Heat pump, PV inverter, EV charger…
- There are **needs beyond energy management**:

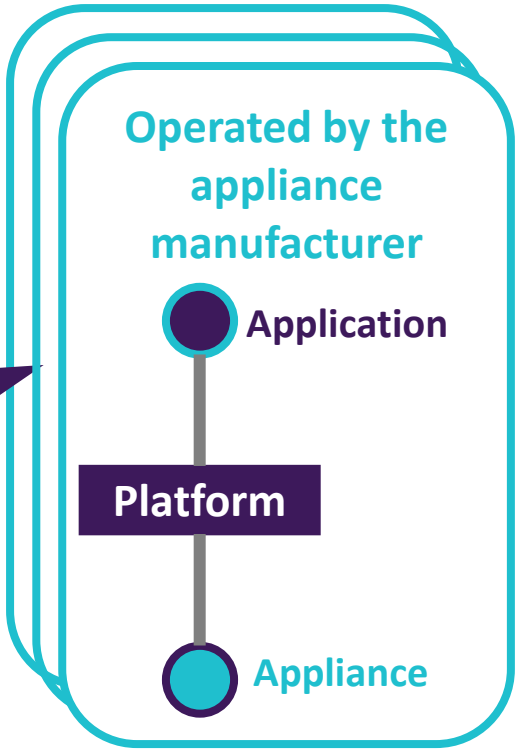
**Energy dashboard, energy performance assessment, smart home, preventive maintenance, non-energy services…**

# Observations

- **Plenty of smart products / services for buildings are available** on the market and deployed by building owners, tenants  or facility operators
  - Smart watering system, on-line heat-pump, security & alarming solutions, on-line photovoltaic inverter, light bulbs , coffee machine…

- Only **large buildings** feature an integrated **building automation system**

**Vertical parallel silo solutions, to become more plentiful in the future…**



# Observations

- Why can the deployment of such smart products / services become a problem?

**Target: small / medium buildings without legacy building automation systems**

  - **Lack of integration**:
    - Multiple gateways, sensors, in-house communication networks, applications, management procedures, access control schemes…
    - No single point of access

  - **Deployment of cross product / service solutions is pointlessly cumbersome**
    - Energy management requires the choreography of the photovoltaic inverter, the grid, the battery, the heat pump, the blinds, the lighting…
    - A security service could make use of the electrical load curve, of the blind control system…

# domOS Vision

## 1. Decouple applications from appliances models

- Applications “view” appliances of the same type in a uniform way
  - Appliance type: heat pump
  - Appliance model: Viessmann Vitocal 350 A

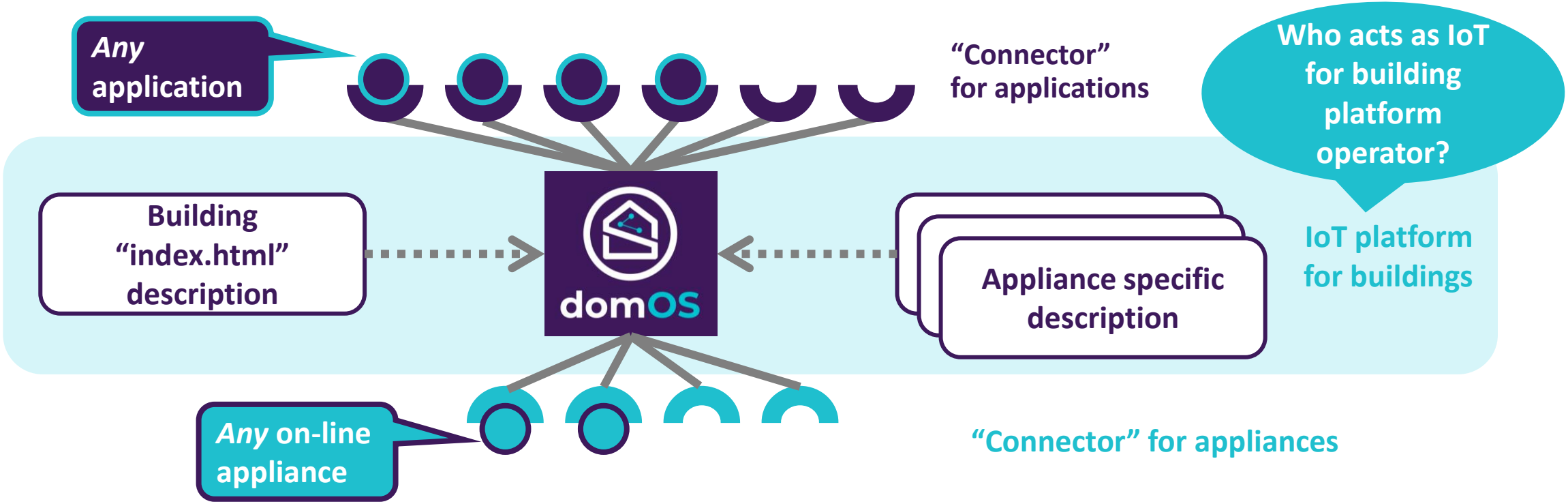
domOS as mediating layer between appliances and applications

## 2. Let applications access a machine-readable description of the building

- “index.html” document for a building, with hyperlinks to access monitoring and control points in appliances

# domOS as Mediating Layer

- domOS: **Operating System** for **Buildings**



# What domOS is / What it is not

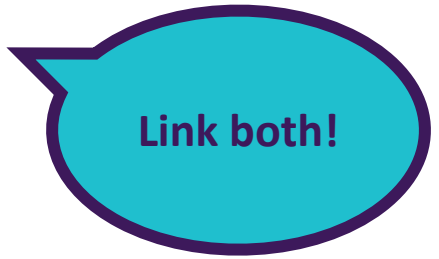
- **domOS is an ecosystem specification**
  - The ecosystem leverages established and emerging IoT standards
    - Goal: lower the step for stakeholder to adopt the domOS technology

- **domOS is not an IoT framework**
  - The domOS IoT ecosystem specification can be implemented on any IoT platform
    - Three platforms upgraded in the frame of the project

# Approach

1. **Decouple applications from appliances models**
   - This is not a building specific challenge
   - **Rely on standards promoted by W3C**

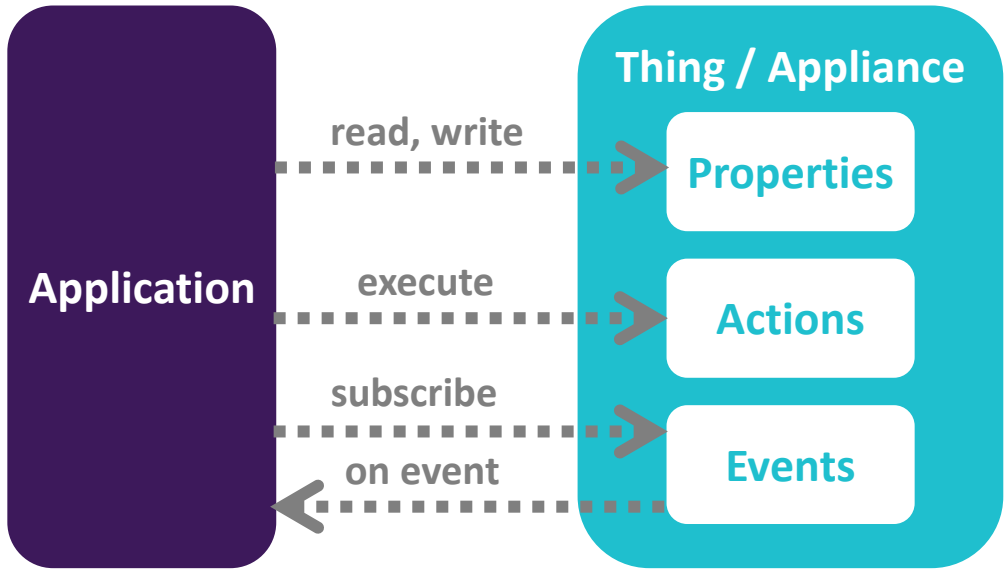
2. **Let applications access a machine-readable description of the building**
   - Define our own ontology for building descriptions
     - Ontology = nomenclature, language
     - **domOS Common Ontology (dCO)**
   - Reuse existing ontologies and complete them where required



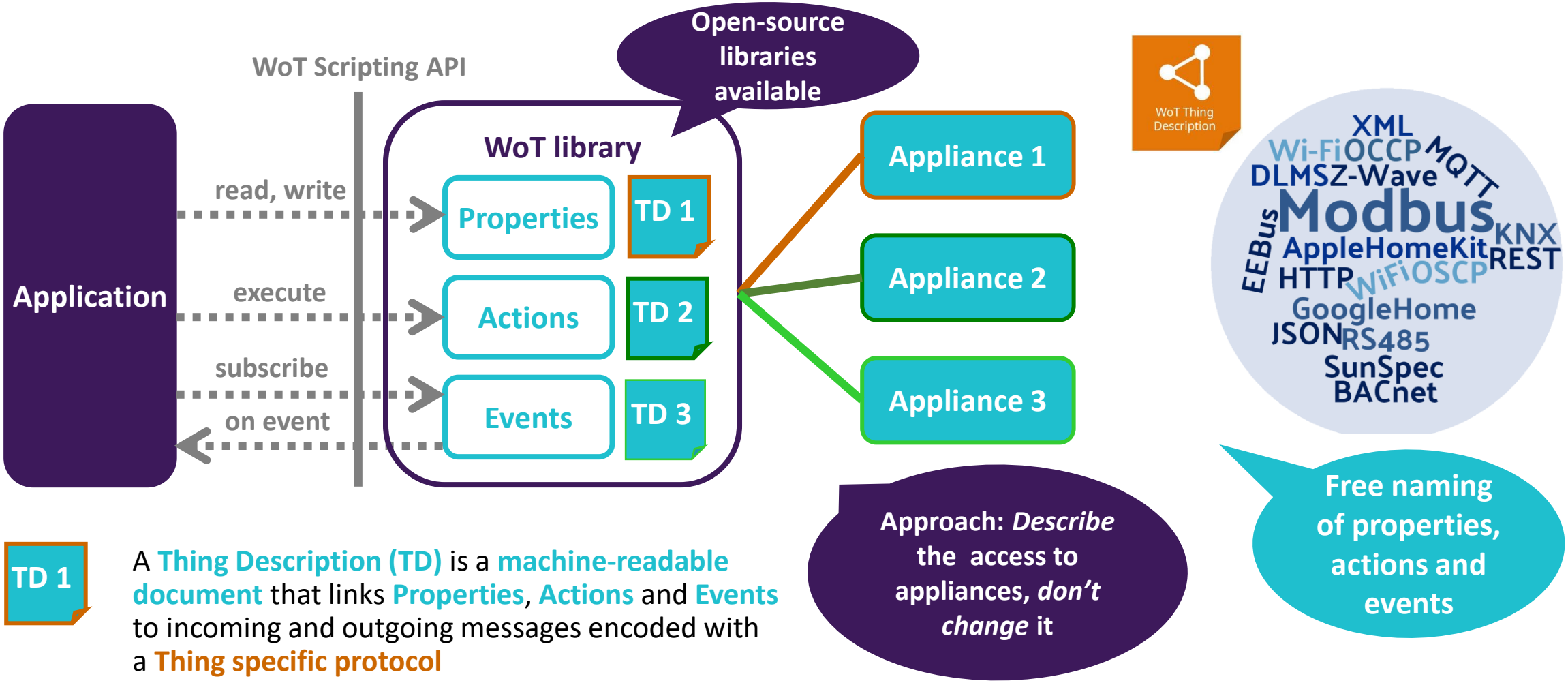
# IoT Model of an Appliance

- The **W3C**'s **Web of Things** (**WoT**) Interest Group has defined a **generic model for Things**
  - **A domOS Appliance is a WoT Thing**

- **Things** (**Appliances**) are **modelled** as collections of **properties**, **actions** & **events**
  - An application can:
    - **read** (possibly also **write**) **properties**,
    - **execute actions**, and
    - **subscribe to** events and **process** incoming **events**



# WoT Approach



# Crafting TDs for Appliances

- **TDs** are **appliance instance specific**
- They can be derived from **appliance model generic Thing Models (TM)**
- As of today, domOS users must craft themselves TMs / TDs
- The vision is that **manufacturers provides TMs for their appliances**
  - https://smartgridready.ch
    “Product & Communicator” program hosts a “TM-like” repository

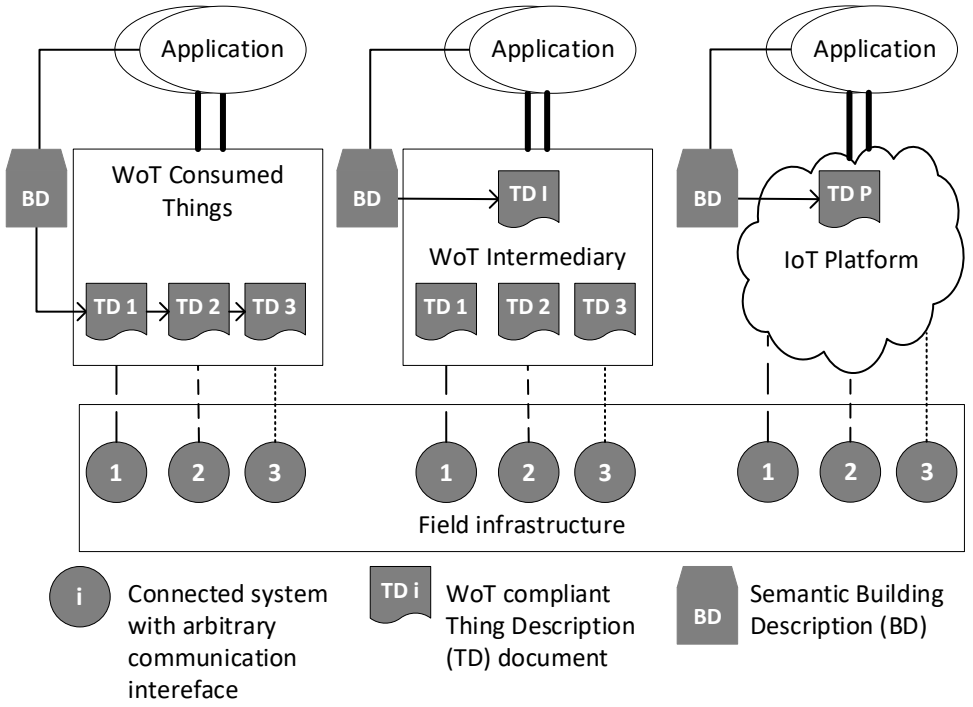
# The domOS Common Ontology (dCO)

- **The initial version of the dCO stems from the requirement of demonstrators**
- The **dCO** is an **evolving ontology** describing:
  - The **building environment**: position,  reference to grid feeder
  - **Building meta-data**: size, construction type, envelope, heated surface
  - The **energy flows** in the building
  - The **measurement and control points** in the building
    - **Reference to properties / actions / events in TDs**

**Current version available online at https://www.dco.domos-project.eu/**

# Deployment Issues

- The **domOS ecosystem** puts **no (few) constraints on deployment**
  - **Purely local** solutions possible
  - Several **hybrid local / cloud** topologies possible
  - TDs may also reference endpoints provided by **IoT platforms**



# Demonstration Sites


- **Smart Services for Electrical Energy**
  - Paris (F)
  - Sion (CH)
- **Smart Services for District Heating**
  - Aalborg (DK)
- **Smart Heat Generation Control**
  - Skive (DK)
  - Neuchâtel (CH)

# Demonstrated Services

- **Energy flexibility**
  - Integration into electrical grids
  - Peak shaving for district heating
  - Maximisation of self-consumption
- **Closed-loop control for energy efficiency**
  - Minimisation of the temperature of the fluid in the in-building heat distribution circuit (less thermal losses, more efficient heat generation)
- **Open-loop control for energy efficiency**
  - Analysis of the performance of heating systems
- **Prosumer empowerment**
  - Dashboard service for building occupants
  - Automated coaching on energy consumption
- **Non-energy services, Ambient Assisted Living (AAL)**
  - Warning service based on detection of behaviour deviation for elderly people

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