

AdOff

Adaptive Offices for People

Deliverable 3.2

Open Gateway API

ITEA 4

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Executive Summary

This deliverable describes the Open Gateway API of the AdOff platform, developed in Task 3.2. The gateway is the single point through which the project's partner systems, occupant-facing applications and building data meet: the Facile workplace platform of PROCOS, the Questions API of KU Leuven, IDEWE's baseline questionnaires, Delta Light's LiveLink lighting system, and the Boolytics IT/OT platform of Boolean, which carries the sensor and building-system data.

Building automation protocols are designed to exchange measurements and commands between devices. They have no notion of an occupant, of subjective feedback, or of the consent and privacy that come with both. The AdOff gateway combines the two worlds: it connects to building data through established IoT and building standards at the edge, and offers partners and applications a REST API in which people are known only by pseudonymous identifiers, every piece of feedback is tied to a time and a place, and data about people is kept apart from data about places by the database itself.

The deliverable covers the state of the art the design builds on, the D2.2 requirements addressed by the gateway, its design, the inventory of 41 gateway and component/provider interfaces, security and privacy measures, and the steps to integrate applications and IoT objects. The inventory classifies 20 interfaces as Tested,11 as Implemented, 6 as Defined and 4 as Proposed. The gateway runs in the reference prototype, while the A400 rollout and adapter integration follow the common contract.

The API is implemented in the reference deployment and is being adopted as the common interface for A400. Deployment-specific telemetry, questionnaire, CV and model components connect through adapters and shared services. Their integration and any required contract extensions are part of the same API development and rollout.

Introduction

Purpose of this document

This document describes the Open Gateway API: what it is for, the standards and approaches it builds on, how it is designed, which interfaces it comprises, how it is secured, and how new applications and devices are connected to it. It accompanies the software deliverable D3.2 and its annex, the API inventory. AdOff uses one Open Gateway API across its deployments: one published contract, one inventory and one versioning policy. Boolean's implementation is the reference deployment. A400 implements the same contract for the Portuguese pilot on its existing telemetry platform, reusing the reference code where the joint code review shows it fits, and connecting its local data sources and services through adapters. Applications, reporting and dashboards use the same operations, schemas and authentication rules in both deployments.

Task 3.2 in the AdOff project

The AdOff project researches the well-being of office residents at the level of the individual workplace, by connecting what residents report about their environment to what is measured there. Work package 3 develops the shared knowledge model and the common services this requires. Within it, Task 3.2 develops the Open Gateway API:

"In this task, an Open Gateway API that enables access to smart office applications and remote IoT objects will be developed. It also describes what steps need to be done in order to integrate a new application and IoT object into the system, so it can be accessed by other objects on the network. […] As current BMS protocols are relatively inadequate to communicate diverse real-time, data-rich information, a custom API will be developed that is able to connect all novel AdOff devices to the AdOff model and its BMS: workstation sensing devices, conversational HBI interfaces, DeltaLight lighting devices, …" (AdOff project description, WP3, Task 3.2)

Boolean is the reviewer of the deliverable and responsible for the Belgian deployment. Its role, as described in the project, is to research the state of the art in other sectors, to propose an API for use in buildings on that basis, and to build a platform on it that provides the common services of Task 3.3. Delta Light, KU Leuven and IDEWE contribute the interfaces of their own systems.

A400 is responsible for the deliverable and for the Portuguese deployment of the gateway: it contributes the interfaces of its telemetry platform, its shared-device questionnaire and chat component and its computer vision service, and validates the common contract against the Portuguese use case.

Relation to other deliverables

Table 1 – Related deliverables

Deliverable	Relation
D2.1 State-of-the-Art analysis	The broader state of the art on smart offices, feedback collection and building management; this document adds the interoperability standards behind the gateway.

Deliverable	Relation
D2.2 Use Case Descriptions and Requirements	The requirements the gateway addresses (section *Requirements Addressed*).
D2.3 Software Architecture Design	The architecture of the AdOff platform as a whole, of which the gateway is one component.
D3.3 Common Services	The services offered through the gateway: dashboards, data ingestion and storage, AI integration, orchestration.
D3.4 Security & Privacy Preserving Guidelines	The security and privacy measures summarised here, in full.
WP4 register, entries 7 and 9	The API/Dashboard and HBI applications of the AdOff orchestrator, which use the gateway.

Structure of this document

The next section reviews interoperability standards in buildings and other sectors and positions the gateway against them. It is followed by the D2.2 requirements the gateway addresses, its design, the inventory of interfaces, security and privacy, the procedure for integrating new applications and IoT objects, the current status and next steps, and a conclusion.

State of the Art: Interoperability Standards

D2.1 reviews the state of the art in smart offices, human-building interaction and building management. This section focuses on one question that review leaves open: which interoperability standards exist for exchanging building data, in buildings and in other sectors, and what each offers an application that must combine building data with what people report.

Building automation and lighting protocols

- **BACnet** (ANSI/ASHRAE 135, ISO 16484-5) is the most widely used protocol for building automation and control networks. Devices expose objects with standard properties — an analogue input with its present value, a schedule, a set-point. BACnet/IP carries it over IP networks, and BACnet Secure Connect (BACnet/SC) adds TLS-secured connections.
- **KNX** (ISO/IEC 14543-3, EN 50090) is a field bus for lighting, shading and HVAC, with standardised data point types and group addressing; KNX IP and KNX IP Secure carry it over IP.
- **Modbus TCP** exchanges numbered registers. It is simple and ubiquitous, but carries no meaning — what a register holds is documented outside the protocol — and has no security of its own.
- **DALI** (IEC 62386, DALI-2) is the digital interface for lighting control gear and sensors.

These protocols are designed for devices and control systems on a building network. They describe measurements and set-points with precision, but none of them has a concept of a building's occupants, of what an occupant reports, or of consent — and they are rarely exposed beyond the building network.

IoT messaging

- **MQTT** (OASIS standard, versions 3.1.1 and 5.0) is a lightweight publish/subscribe protocol. It defines how messages travel, not what they mean: topics and payloads are left to the application.
- **Sparkplug B** (Eclipse Foundation; published as ISO/IEC 20237) adds what MQTT leaves open for industrial IoT: a topic namespace of groups, edge nodes and devices, a compact Protobuf payload, and session state through birth and death messages, so a consumer knows which devices exist and whether they are alive.
- **OPC UA** (IEC 62541) offers rich information modelling and built-in security — authentication, signing and encryption — in both client/server and publish/subscribe form. It is established in industry and increasingly used at the boundary between operational and IT systems.

Semantic models for buildings

- **Brick Schema** is an open ontology (RDF/OWL) describing the equipment, points and spaces of a building and how they relate: which sensor measures which room, which air-handling unit serves which zone.
- **Project Haystack** describes building data with standard tags, making points discoverable across vendors.

Semantic models describe the building — what is where and what serves what — but not the people in it or what they experience. They are candidates for the AdOff knowledge model of Task 3.1.

Approaches from other sectors

- **Smart cities — NGSI-LD.** The context information management API standardised by ETSI (ISG CIM) and used by FIWARE exposes the state of entities in a city — a parking space, a sensor, a street — as linked data through a REST API, independent of the systems that produce it.
- **Healthcare — HL7 FHIR.** FHIR exchanges health data as REST resources. It is relevant to AdOff not for its domain but for its treatment of people: patients are referenced by identifiers rather than by name, data is linked to them through references, and consent is itself a resource that systems check before sharing.
- **Smart home — Matter.** Matter (Connectivity Standards Alliance) is an IP-based application layer that lets devices from different vendors, including lighting, work together under one data model.
- **Web APIs — OpenAPI and OAuth 2.0.** The OpenAPI Specification describes REST APIs in a machine-readable way, from which documentation and clients can be generated; OAuth 2.0 (RFC 6749) is the established framework for authorising applications to use an API.

Gap analysis and positioning of AdOff

No single standard covers what AdOff needs. Building protocols carry measurements and commands but know nothing of people; semantic models describe the building but not its occupants' experience; the healthcare and smart-city approaches show how to expose state

and handle personal data through APIs, but not in a building. AdOff therefore combines them, each at the level where it fits:

Table 2 – Positioning of the AdOff gateway against existing standards

Standard	How AdOff uses it	Why
MQTT / Sparkplug B	Adopted: sensor and building data reach the platform through edge nodes publishing Sparkplug B, including devices bridged from other protocols	Standard namespace and device state at the edge, independent of vendor
KNX, BACnet, Modbus	Mapped at the edge: an edge node or PLC reads the building system and publishes its points (KNX in the pilot office)	Building protocols stay on the building network; applications never speak them directly
DALI / LiveLink (Delta Light)	Consumed: LiveLink publishes lighting state and floor plans over MQTT into AdOff's broker	The vendor's own interface, used as delivered
REST + OpenAPI	Adopted for every partner and application interface; the contract is generated from the running service	One documented, machine-readable contract for all partners
OAuth 2.0	Adopted towards the Boolytics platform (client credentials); per-partner keys towards AdOff in the pilot	Established machine-to-machine authorisation
HL7 FHIR (approach)	Followed in principle: people only by pseudonymous identifiers; consent as an explicit, recorded step before the building acts	Personal data handled by design, not by convention
NGSI-LD (approach)	Followed in principle: the gateway exposes the state of places — rooms, desks — not of devices	Applications reason about places; devices are an implementation detail
Brick / Haystack	Candidates for the knowledge model (Task 3.1)	Semantic description of the building, to be decided in T3.1
LoRaWAN	Adopted in the Portuguese pilot: battery-powered indoor-environment sensors (temperature, humidity, CO_2, light, presence) report through LoRaWAN gateways to the A400 edge layer	Wireless retrofit in occupied offices without new cabling
RTSP (camera acquisition)	Used by the CV acquisition component for the configured camera stream; processed observations are connected through the integration layer.	Keeps camera acquisition behind the gateway's processed-data and application interfaces.

What AdOff adds, and what none of the standards above provides, is a gateway in which **subjective feedback and objective measurements meet at the level of a workplace**: every report carries the time, the place and the measurements of that moment, and the identity of whoever made it is pseudonymous and kept apart from data about places.

Requirements Addressed

The gateway addresses the following requirements of D2.2. *Realised* means implemented in the running prototype; *partial* that part is implemented and the rest planned.

Table 3 – D2.2 requirements addressed by the gateway

Id	Requirement	How the gateway addresses it	Status
DA.ALL.1	Modular infrastructure	Each partner behind its own adapter; the same services serve partners, the LLM, A400 telemetry, questionnaire content, CV and model providers and the dashboards	Realised
DA.ALL.2	Hybrid architecture (local and cloud)	Language model served locally in the Belgian deployment; an alternative provider selectable by configuration. In the Portuguese deployment, a cloud-hosted model is already running. Local hosting is being evaluated as an alternative, and the final choice between local and cloud hosting will be based on performance tests.	Partial
DA.ALL.4	Modular, interoperable platform with open APIs	Open REST API with a published contract; KNX through an edge node. BACnet and Modbus through the same edge layer, and a versioned data dictionary, are planned	Partial
DA.BE.2	System-agnostic integration	Partner adapters with a stub and a live implementation, so a reservation tool or BMS can be replaced without redesign	Realised
HC.ALL.3	Spatiotemporal data alignment	Every feedback report is stored with time, place and the sensor readings of that moment	Realised
UI.ALL.4	Spatially contextualised feedback	A resident's place is taken from the reservation system on every interaction	Realised (pending the mapping of Facile workstations)
LE.ALL.5	GDPR compliance	Pseudonymous identifiers only; personal and place data separated by database permissions. In the Portuguese pilot, age band and sex are collected as optional questionnaire items and camera images are processed on site into clothing-insulation (clo) values only; see D3.4	Partial (see D3.4)
LE.ALL.6	Right to withdraw	Removal of a resident's data by identifier	Planned
D.ALL.2	IT integration, with own application as fallback	Chat embeddable in the partner's application; standalone room page as fallback	Realised
DA.PT.1	Multi time-frame operation	Provides the integration boundary for multi-horizon model services; forecast horizons and result contracts are specified through the model adapters and shared API.	Planned
D.PT.2	REST-based APIs for models	The common REST contract gives applications access to conversational and model-backed services; additional model outputs are integrated through shared services and documented API extensions.	Partial
EM.PT.1	Energy consumption forecast	Makes forecast-service outputs available through the shared service/API layer.	Planned
EM.PT.2	Generated HVAC consumption curves vs user comfort impact in future scenarios	Exchanges HVAC scenario inputs and comfort-impact results with the relevant model services through the common integration layer.	Planned

Id	Requirement	How the gateway addresses it	Status
EM.PT.3	Integration with system data and models	Connects telemetry and processed data to the conversational/model services using adapters; prediction-model bindings extend the same API.	Partial — telemetry interfaces available; integration with prediction models remains to be completed and validated.
HC.PT.1	Comfort-Energy Trade-off management	Supplies access to feedback, environmental context and model outputs for the comfort-energy decision loop; optimisation is performed by the relevant services.	Planned
UI.PT.1	Energy-aware interaction	Supplies energy context and model results to the occupant interaction through the common services and contract.	Planned
UI.PT.4	Clear communication based on domain knowledge	Integrates document context and environmental telemetry into the conversational capability exposed by the gateway.	Partial — contextual components available; common-service integration to validate
D.PT.1	Mobile app for centralized feedback	Connects the shared-device questionnaire/chat client through the common application and conversation contract.	Partial — shared-device component available; common-API binding to complete

Design of the Open Gateway API

Design principles

- **People are pseudonymous.** Residents are identified only by the identifier the reservation platform (Facile) issues. No name or e-mail address crosses the gateway.
- **A place is asked, not sent.** Where a resident sits is asked of the reservation platform at each interaction, never taken from the caller: a resident moves desks, and a stale place attaches a remark to the wrong workplace.
- **One source of truth per fact.** Measurements stay in the Boolytics platform and are read on demand; identity stays with Facile; AdOff stores what it is the source of — feedback with its context, and the place model. Additional telemetry or context providers are connected through adapters that preserve the same source-of-truth and data-access boundaries.
- **Data about people is separated from data about places by the database.** Two schemas with distinct permissions; the role that serves place data cannot read personal data.

- **Pending partners are stubbed, visibly.** Until a partner's interface is live, AdOff serves deterministic test data in its place and says so; the platform works before every partner is ready, and never silently mixes test and real data.
- **Degrade, do not fail.** When a partner or sensor is unreachable, an interface returns the best answer it still can, and says what is missing.
- **The contract cannot drift.** The partner API document is generated from the running service and limited to an explicit list of partner routes.

Architecture overview

Figure 1 shows the gateway in its context. Residents reach AdOff through Facile's application or a room tablet; partners through the REST API; the language model and the building data through the orchestrator's own clients. Dashed elements were not yet implemented when the figure was drawn.

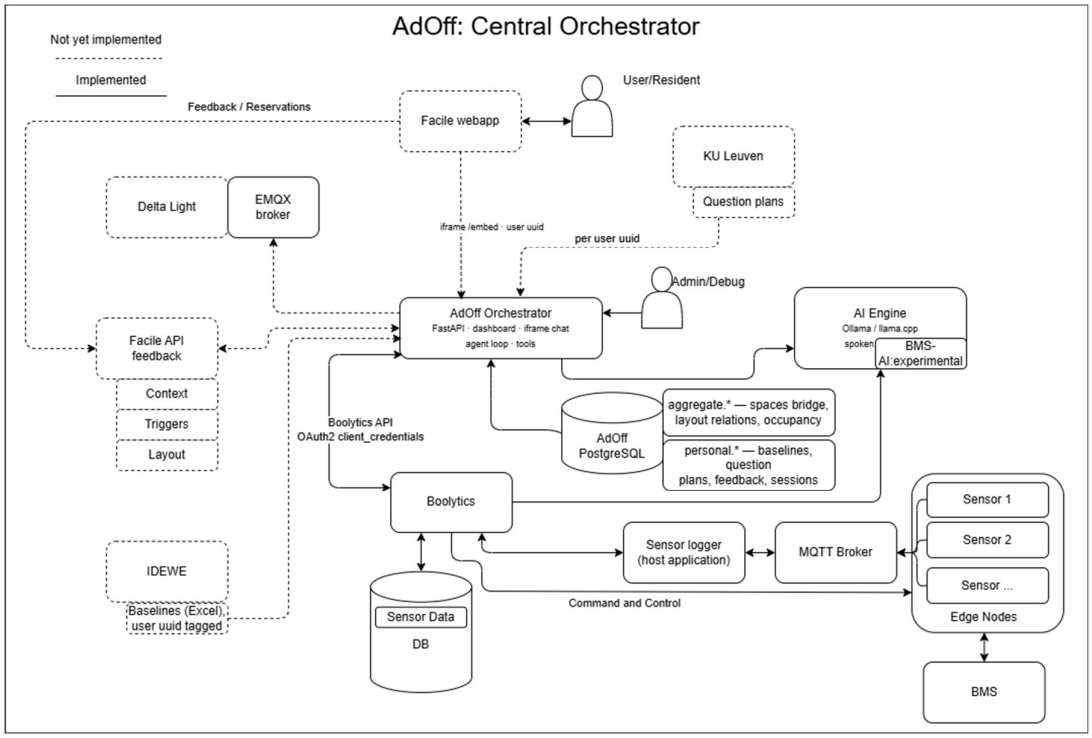


Figure 1 – The AdOff central orchestrator and its connections to partners and residents

The Open Gateway API is the common application boundary for the AdOff deployments. The A400 deployment follows the Boolean implementation and the same published contract: clients use the documented operations, schemas, authentication and response conventions, with the deployment base URL and credentials supplied by its operator.

Behind that boundary, configured adapters connect shared services to building telemetry, questionnaire content, CV observations and comfort/energy models. Existing A400

components supply those capabilities through the integration layer. Their internal routes and processing protocols do not define another public gateway API.

Processed results are made available through the common services and the operations documented in the shared contract. Any additional operation needed for research, reporting or dashboards is incorporated into that contract and adopted consistently by the deployments.

In the Portuguese pilot, LoRaWAN indoor-environment sensors and the existing building systems (BACnet/IP, Modbus) are read by A400 edge gateways installed in each building. The gateways forward telemetry to Azure IoT Hub; the time series are stored in Azure Data Explorer and exposed by the A400 telemetry API, which the gateway's telemetry adapter queries on demand. Occupant feedback is collected on a shared tablet in each office through the questionnaire and chat component, and a possible computer vision service at the office entrance publishes clothing-insulation observations. All three connect to the common contract through adapters.

Interfaces

Table 4 – Interfaces of the gateway

Interface	Clients	Form	Status
Partner REST API	Facile, KU Leuven, IDEWE. Partner systems and applications using the published contract	HTTPS, JSON	Implemented
Conversation API	Partner applications; evaluation. Partner applications and integrated shared-device clients	HTTPS, JSON	Implemented
Embedded resident chat	Facile's application (iframe); also delivers PINPOINT questions as a card above the chat	HTTPS, HTML	Implemented
Room chat page	A shared tablet in a room	HTTPS, HTML	Implemented
Building data	AdOff ← Boolytics IT/OT platform (Belgium); AdOff ← A400 telemetry platform (Portugal)	HTTPS, JSON; Sparkplug B at the edge (Belgium); LoRaWAN, BACnet/IP, Modbus and Azure IoT Hub at the edge (Portugal)	Implemented (read); control planned
Lighting data	Delta Light LiveLink → AdOff	MQTT	Specified; consumer planned
Operations	Monitoring; partners	HTTPS, JSON	Implemented
Shared-device questionnaire and chat (Portugal)	A shared tablet in each pilot office	HTTPS, JSON	Planned
Computer vision observations (Portugal)	A400 CV service → telemetry and model services	HTTPS, JSON; MQTT	Implemented (under testing)

The interfaces above form the common gateway boundary and apply to its deployments. The implementation at A400 adopts the same contract, while telemetry, questionnaire, CV and model integrations are bound to the underlying services through configured adapters.

Component operations used for device administration, acquisition or local processing remain behind that integration boundary. New externally required capabilities are added to the shared OpenAPI definition and inventory; deploying an existing operation at another installation does not create a second operation or API.

Identity and the shared place model

Four systems each have their own idea of a place: Facile (building, floor, workstation), the Boolytics platform (edge nodes and devices), Delta Light (rooms and fixtures) and AdOff's own layout. The gateway joins them in one place model, keyed on Facile's identifiers. A **space** in the API has a kind: a *desk* (a workstation in Facile's terms), a *floor*, or an *office* — the room level between them, which a CO_2 sensor measures but Facile does not model. Each space carries its parent, so a desk is always placed in its room and floor, and the place model records which devices speak for which space.

The common API retains the identifier semantics defined in its published contract. Deployment adapters map source-specific site, area, sensor and session references to the shared place and feedback model. Facile-specific operations keep their documented UUID semantics and access restrictions; an internal device or questionnaire session identifier is not substituted for a resident UUID.

The integration records how location was obtained and how it maps to the relevant measurements. A participant-selected area is preserved as reported context until the mapping is validated. Any identifier support required beyond the current contract is added to the common model and documentation, rather than introduced as an incompatible deployment-specific payload.

Conventions

- Invalid input returns HTTP 422 with an explanation of what to correct.
- Feedback is accepted asynchronously with HTTP 202 and stored together with the sensor readings of that moment.
- Every request from a partner is attributed to that partner by its key, so the source of every report is recorded.
- The state of each integration — live or stubbed, and which parts of its contract are still open — is available at `GET /api/partners/status`.

API Inventory

The annex *AdOff_D3.2_OpenGatewayAPI.xlsx* lists every interface between AdOff, the Boolytics IT/OT platform and the partners — those AdOff provides and those it consumes — with its purpose, provider, consumer, protocol, endpoint, data exchanged, authentication, documentation and status. The statuses are: *Proposed* (agreed in principle, no specification), *Defined* (specified, not yet implemented on both sides), *Implemented* (built and in use) and *Tested* (built, in use and covered by automated tests). The inventory covers the common

gateway and its provider integrations. An operation retains one identity across deployments; deployment applicability, adapter bindings and validation evidence are recorded with that operation. Replication alone does not increase the number of interfaces. The inventory also lists the internal component interfaces of the A400 deployment (API-034 to API-036), for completeness; they are not part of the public gateway contract.

Table 5 – Interfaces per provider and status

Provider	Interfaces	Tested	Implemented	Defined	Proposed
Boolean — AdOff	15	14	1	–	–
Boolean — Boolytics IT/OT platform and edge	4	3	–	–	1
Boolean — local model server	1	1		–	–
PROCOS — Facile	5	–	4	–	1
KU Leuven — Questions API	5	1	1	3	–
IDEWE — baseline questionnaire	1	–	–	1	–
Delta Light — LiveLink and projector	4	–	–	2	2
A400 — questionnaire, device and session component	**3**	**1**	2	–	–
A400 — telemetry platform	**1**	**-**	1	–	–
A400 — Computer Vision service	**2**	**-**	2	–	–
Total	**41**	**20**	**11**	**6**	**4**

The partner-facing part of AdOff's own API is published as an interactive OpenAPI document at https://adoff.boolean.be/docs/partners.

Security and Privacy

WP3 Task 3.4 requires authentication, authorisation and access control, and an audit log, in compliance with the GDPR. D3.4 describes the measures in full; for the gateway they are:

Table 6 – Authentication per party

Party	Authentication
Partner systems → AdOff	A key per partner, optionally restricted to source addresses; each request is attributed to a named partner
Residents in Facile → AdOff	A signed, expiring token binding the conversation to the resident's pseudonymous identifier; framing allowed only from Facile's origin
Residents at a room tablet → AdOff	None — anonymous by design; nothing identifies the resident
Operators → AdOff dashboards	Login with a signed session
AdOff → Boolytics IT/OT platform	OAuth 2.0 client credentials
AdOff → Facile	API token issued by PROCOS
Delta Light → AdOff broker	MQTT credentials; TLS available
Questionnaire/chat application integration → A400 device/session component (internal)	Device HTTP Basic authentication; session-bound operations also carry X-Session-ID and validate that the session belongs to the authenticated device.

Party	Authentication
Provisioning operator → device registration component (internal)	Provisioning Bearer credential for POST /api/devices, separate from application device credentials.
AdOff telemetry adapter → A400 telemetry platform	OAuth 2.0 / OpenID Connect through the A400 identity provider (Keycloak); one client per application, with tokens scoped to the AdOff sites
AdOff component integration → A400 CV REST service	The authentication and exposure configuration of the deployed CV REST service remains to be verified and documented.
A400 CV publisher → configured MQTT broker	The gateway MQTT broker supports authentication, TLS and topic access controls. The CV publisher's connection configuration remains to be verified and documented for the deployment.

The common gateway contract defines authentication and access rules for each public operation. The A400 deployment preserves those rules, including partner authentication and route restrictions, while using installation-specific credentials and provider configuration. Deployment validation checks that the same authorised calls, error responses and data boundaries are enforced.

Device provisioning, session administration and component credentials can support the application integration behind the gateway. They do not replace the public partner authentication scheme. Model hosting, telemetry access, CV processing, downstream data access and logging are configured and verified against the platform's common security and privacy requirements.

- **Privacy by design.** Residents are pseudonymous; personal data and place data are separated by database permissions, verified by the running service; presence is stored only in coarse time buckets; raw telemetry is retained by its provider; selected contextual snapshots and derived records may be stored with feedback under the documented access and retention rules; in the Belgian deployment the language model runs locally, so no resident data is sent to a cloud service; in the Portuguese deployment, a cloud-hosted model is already running. Local hosting is being evaluated as an alternative, and the final choice between local and cloud hosting will be based on performance tests.
  In Portugal, occupants are anonymous; age band and sex are optional questionnaire items used only to describe the sample, and camera images are processed on site and discarded, only clothing-insulation values are leaving the computer vision service. Compliance with the EU AI Act for the computer vision and language model components is documented in D3.4.
- **Access control.** Routes declare what they require; routes acting on behalf of a partner accept only that partner's key; the published contract lists only partner routes.
- **Audit.** Every interaction is logged by kind, time, tool, duration and outcome — by default without the content of what residents wrote — and every feedback report records the channel it came through.

- **In progress** (D3.4): scopes per partner on routes that return personal data, an audit trail of access to personal data, key rotation and signed webhooks, retention periods, and removal of a resident's data on withdrawal.

Integrating a New Application or IoT Object

The task requires the gateway to describe how a new application or IoT object is integrated so that others on the network can use it. Two rules apply to every integration: people are identified only by Facile's pseudonymous identifiers and places by Facile's space identifiers; and no client tells AdOff where a resident is — AdOff asks.

An application that calls AdOff

- Read the partner contract at https://adoff.boolean.be/docs/partners.
- Obtain a partner key from the AdOff operator; it may be restricted to the application's source addresses. The key's name is recorded as the source of everything the application submits.
- Send the key with every request (header `X-AdOff-Key`); check the connection with `GET /api/partners/status`.
- Exchange data through the partner routes, or converse with the language model through `POST /api/chat`.
- A route the application needs that is not yet in the contract is added to AdOff, restricted to that partner where it acts on the partner's behalf, and published in the contract.

An application that embeds the resident chat

- Have the application's web origin added to AdOff's list of allowed embedding origins.
- Open one frame per resident at `/embed?user=<user uuid>` — the resident's identifier only; AdOff resolves the place itself.
- For a shared device in a room, use the room page `/room?room=<room key>` instead: anonymous, and a fresh conversation on every visit.

A sensor or other IoT object

- Publish the device's data into the Boolytics IT/OT platform under an edge node, using Sparkplug B. A device that does not speak Sparkplug is republished by a bridge acting as an edge node; a building system (KNX, BACnet, Modbus) is read by an edge node or PLC on the building network.
- Publish values as numbers, and use metric names AdOff recognises (temperature, humidity, CO_2, light, sound, presence) or add a mapping for a new naming scheme.
- Bind the device to its room in AdOff by device name and edge node.
- Place the device on the office plan in AdOff's layout editor. From then on it speaks for the desks around it: as a measurement for desks within 2 m, as an inference for desks further away.

In the Portuguese deployment

- Register the LoRaWAN sensor on the building's LoRaWAN gateway; the A400 edge gateway decodes its payload into named metrics (temperature, humidity, CO_2, light, presence).
- For a building system, configure the BACnet/IP or Modbus points on the A400 edge gateway of that building.
- The edge gateway forwards the values to Azure IoT Hub; they become available as time series in the A400 telemetry API.
- Bind the sensor to its area or workstation in the site floor-plan configuration, so the adapter can attach it to the right space of the shared place model.

A system AdOff calls

- Define the operations AdOff needs as a typed interface, with a deterministic stub for development and demonstration.
- Implement the live client when the partner's specification is available, and select stub or live per deployment.
- Report the integration's mode and the open points of its contract through `GET /api/partners/status`, and record it in the API inventory.

Devices that publish MQTT directly, and actuators

A device publishing MQTT straight into AdOff's broker — such as Delta Light's LiveLink — needs a consumer for its topics; the first, for LiveLink, is planned. Actuators — HVAC set-points, lighting, blinds — will be integrated through the Boolytics platform's BMS interface and the vendors' control APIs, always behind a consent step.

Deploying the common API and connecting an application

The A400 deployment uses the API implemented by Boolean as its reference. The rollout and client integration follow the same published contract:

1. Select the contract revision to implement and the reference components to reuse, and configure the deployment's HTTPS base URL and required services.
2. Configure the local providers through adapters, including the required telemetry, questionnaire, CV and model integrations. Map their identifiers and data to the common service model.
3. Publish the partner documentation and OpenAPI definition at the deployment's /docs/partners and /openapi/partners.json locations, following the reference contract.
4. Obtain the appropriate partner credentials from the operator and follow the documented authentication scheme. Partner calls use X-AdOff-Key, with the same route restrictions as the reference implementation.
5. Use GET /api/partners/status to inspect the configured integrations. For conversation, call POST /api/chat with the documented request shape and return the session_id from the response on subsequent turns.

6. Adapt the shared-device questionnaire/client workflow through the application integration. Device administration remains internal; any public operation required beyond the reference contract is added to the shared definition and tests.
7. Check schemas, authorised and rejected requests, error conventions and applicable API tests against the reference. Record the deployment revision and integration evidence before making the installation available to consumers.

Status and Next Steps

The gateway runs in the AdOff prototype at the Boolean office, on live building data, with partner authentication and the separation of personal data in force. The interfaces AdOff provides are implemented and covered by automated tests. The interfaces it consumes follow the progress of the partners' own systems:

- **Facile** — the live client exists for Facile's questionnaire API; resident location, the space hierarchy and messaging are to be specified with PROCOS, and Facile's workstation identifiers mapped to AdOff's desks.
- **KU Leuven** — PINPOINT is in operation: AdOff checks the participating desks every five minutes, asks Facile who holds a desk, and obtains the question from KU Leuven's engine, which is deployed beside AdOff and runs on AdOff's language model. The resident answers in the embedded chat, or through Facile. REACT and PULSE follow the same specification (draft v0.3).
- **Research data** — KU Leuven exports the project's datasets through an authenticated, logged research API (`/api/research/v1`).
- **IDEWE** — the import of baseline questionnaires exists; the meaning of each item is to be specified.
- **Delta Light** — the LiveLink telemetry is specified and AdOff's message decoders exist; the consumer and the control interfaces follow the specification of the LiveLink REST API and the projector API.
- **Boolytics BMS control** — reading building data is in place; the BMS state and action endpoints are to be added to the platform, behind a consent step.
- A400 — the questionnaire and chat component, the telemetry API and the computer vision service are either implemented and running or in the process of being installed in the pilot buildings; the adapters to the common contract, the mapping of sites and areas to the shared place model. The CV service is implemented and is being tested at an office outside the ADOFF pilot sites. Rollout and validation in QDL and EVF remain pending. The REST access configuration and the CV publisher’s use of the gateway MQTT security controls remain to be verified and documented. Automated tests against the common contract are planned.

Two further points are open. **Versioning**: the published contract (version 0.2.0) carries no version in its paths; a versioning policy will be fixed before the first partner depends on it in production. **Peer-to-peer**: the task description refers to a gateway to a P2P network. In the current design, the closest realisation is the publish/subscribe namespace shared by the edge

nodes, in which devices and consumers exchange data without a central request path; whether a further peer-to-peer layer is needed will be decided with the partners.

The Open Gateway API implemented in the reference deployment is the basis for the A400 rollout. The work at A400 adopts that contract, integrates the existing questionnaire, telemetry and CV components through adapters, and connects the required comfort/energy services. Applications and reporting consumers use the same API across deployments.

The next steps are to complete the adapter and client mappings, validate the deployment against the reference contract and applicable tests, and record its configured providers and operational evidence. Any additional processed-data or reporting operation is developed as a shared extension, with a common schema, inventory entry and versioning decision. These steps extend and deploy the existing API rather than define a separate gateway.

Conclusion

The AdOff Open Gateway API connects the project's partners, its occupants and its building data through one interface. It builds on established standards where they fit — Sparkplug B and the building protocols at the edge, REST, OpenAPI and OAuth 2.0 towards applications — and adds what none of them provides: feedback from people and measurements from the building, joined at the level of a workplace, with people known only pseudonymously and their data kept apart by design. The interfaces AdOff provides are in operation in the prototype; the remaining interfaces are specified or proposed with the partners who provide them, and are tracked in the API inventory annexed to this deliverable. The same contract underpins deployment at A400, with the local data sources and services connected through adapters. Deployment rollout and shared extensions are tracked within this single API and its inventory.

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