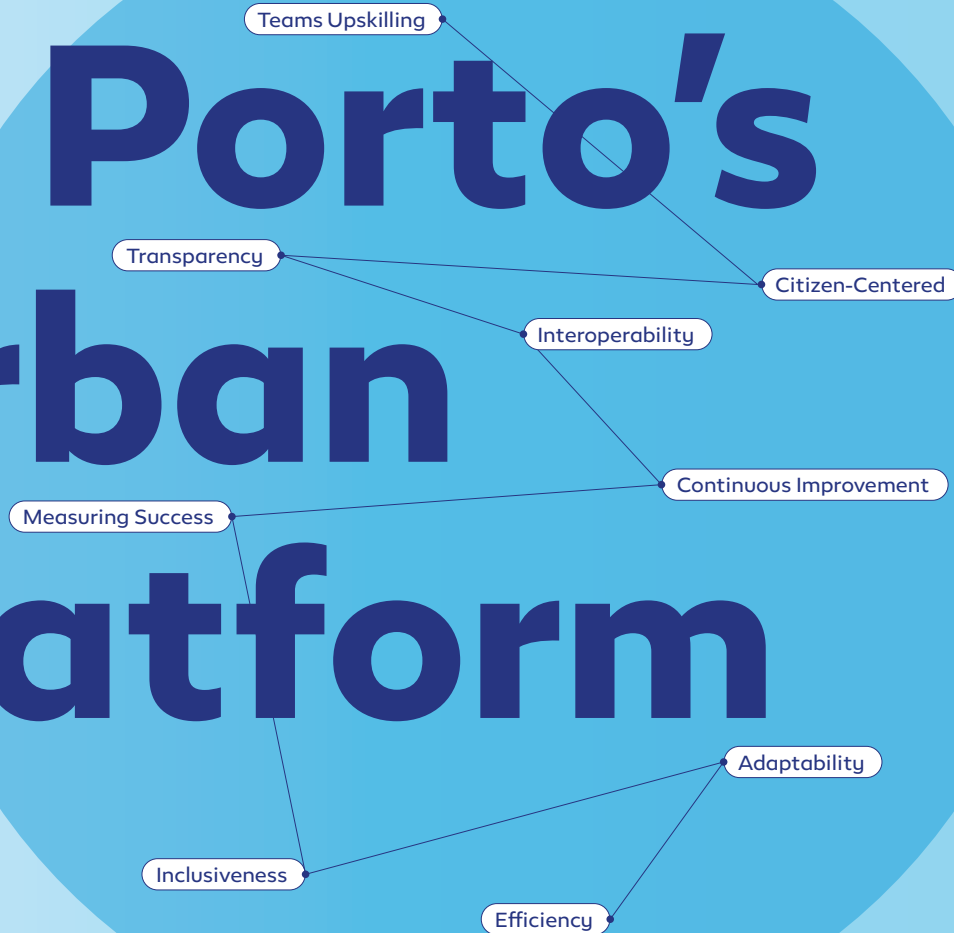


Foundations of Porto's Urban Platform



Strategic Framing,
Vision, Building
Blocks, and
Governance.



Porto.

All photos are made by real
people, with real people
during real activities
organized by Porto Digital

Note to Readers

Want to see how all this
theory plays out in real life?

Just flip the book over to
dive into Part B, where we
show you how Porto's vision
becomes reality!



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Porto.

1. **STRATEGIC FRAMING** Porto and the Portuguese National Smart Cities Strategy

2. **VISION** Innovation-Driven Services for Citizens and Municipal Teams Through the Urban Platform

2.1 Citizen-Centered Service Design

2.2 Municipal Teams Upskilling Through Innovation Management

2.3 Transparency and Inclusiveness in Service Development

2.4 Measuring Success: Defining Clear Key Performance Indicators

3. **BUILDING BLOCKS OF THE URBAN PLATFORM**

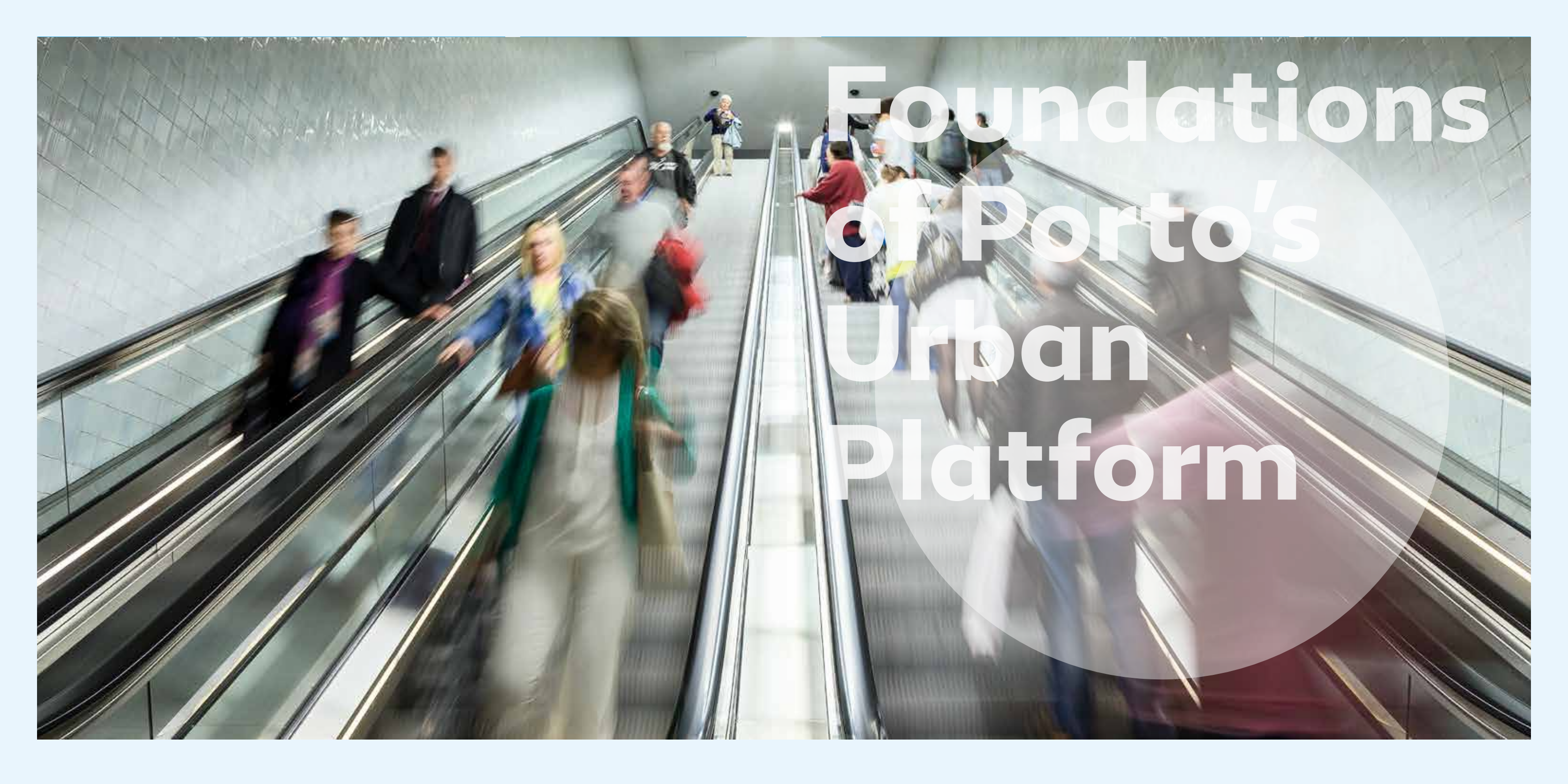
3.1 The Urban Platform as Data Space Enabler

4. **GOVERNANCE PRINCIPLES AND ENSURING A SOLID AND SUSTAINABLE DEVELOPMENT**

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4.3 Continuous Improvement and Co-Creation



Foundations of Porto's Urban Platform



1.

STRATEGIC FRAMING Porto and the Portuguese National Smart Cities Strategy

Since 2015, Porto Digital has been building the Porto Urban Platform, which comprises the results of several European and National funded projects. This platform was consolidated through the work carried out by Porto Digital in the development of the Portuguese National Smart Cities Strategy, particularly through the creation of the Technical Reference Architecture for the Urban Platform.

Led by Porto Digital, this work formed a crucial part of the national strategy's deliverables, establishing a framework that integrates various urban systems and data sources to enable greater interoperability and smarter service delivery across Portuguese municipalities.

As a structural reform, the development of the National Smart Cities Strategy was supported by the European Commission's DG REFORM through its Technical Assistance Instrument. Following a public tender, PwC's strategic consulting team was appointed to lead the implementation, working in partnership with Porto Digital, the Center for Engineering and Product Development (CEiiA), and the Laboratory for Robotics and Engineering Systems (LARSyS).

The initial strategy was completed and launched in 2022 and later revised in 2024 under the new title, "Estratégia Nacional de Territórios Inteligentes – ENTII".¹

Porto's early adoption of smart city principles and its commitment to transforming urban governance through digital solutions have been the driving inspiration behind the broader national strategy. The collaboration between Porto Digital, PwC, and key stakeholders ensured that the lessons learned from Porto's pioneering efforts were embedded into the national technical framework. The technical reference architecture developed by Porto serves as a blueprint for creating integrated, scalable, and citizen-centered smart cities across the country.

By implementing this architecture, cities across Portugal can leverage digital technologies to address a range of urban challenges—whether managing population growth, enhancing public services, or improving environmental sustainability. The collaborative approach that shaped the national strategy ensures that municipalities of all sizes and capacities can participate in this transformation, reinforcing Porto's ambition to continue positioning itself as both a leader and a practical model for urban innovation.

¹ Estratégia Nacional de Territórios Inteligentes, AMA, 2024, <https://www.ama.gov.pt/web/agencia-para-a-modernizacao-administrativa/estrategia-nacional-de-territorios-inteligentes>

VISION

Innovation-Driven Services for Citizens and Municipal Teams Through the Urban Platform

As cities worldwide continue to evolve into smarter, more connected environments, the Urban Platform has emerged as a key tool for enhancing the quality of life for citizens and improving the efficiency of municipal teams. By leveraging innovation management methodologies and service design principles, the Urban Platform delivers a suite of services tailored to the diverse needs of urban populations and operational frameworks, becoming a vital foundation for the development of sustainable and responsive cities.

By implementing an Integrated Operations Management approach, the platform coordinates the management of all municipal services—such as waste collection, street maintenance, and traffic control—into a unified system.

This integrated approach results in a more responsive and efficient public service system that can adapt quickly to the city's evolving needs, ensuring that both citizens and municipal teams benefit from a smarter, more agile urban environment in the long term.

Gradual Implementation and Rethinking Processes

The adoption of each city's specific vertical services should be approached gradually, with a strategic focus on long-term transformation rather than just digitizing existing processes. Digital Transition is not simply about transferring manual workflows into digital formats; it is fundamentally about rethinking those processes from a completely new perspective.

Rethinking urban processes involves evaluating existing workflows, identifying pain points, and redesigning services to be more user-centric, responsive, and efficient. This gradual transformation allows cities to adapt to changes incrementally, minimizing disruption while maximizing the impact of each technological advancement. The focus is on creating services that are not just digital replicas of old processes but innovative solutions that fundamentally enhance the way cities operate.



2.1

Citizen-Centered Service Design

The development of services through the Urban Platform prioritizes the needs and experiences of citizens. Using Design Thinking and human-centered approaches, the platform ensures that solutions are created with a deep understanding of the daily challenges and desires of residents and visitors.

Building on this citizen-centric foundation as mentioned, the Urban Platform acts as catalyst for developing a comprehensive suite of services that directly address key areas of urban life. Each service is thoughtfully designed to enhance the daily experiences of residents and visitors, using innovative technologies to make city interactions smoother and more intuitive. From improving mobility and access to public services to promoting environmental awareness and active civic engagement, these solutions are tailored to meet the evolving needs of citizens. By integrating these services into a unified platform, the city not only streamlines its operations but also empowers its residents to participate more fully in the urban ecosystem, creating a more connected, responsive and inclusive city environment.

2.2

Municipal Teams Upskilling Through Innovation Management

The Urban Platform not only transforms how citizens interact with their city but also fundamentally reshapes how municipal teams operate. This transformation is driven by three main innovation pillars:

Data-Driven Governance

It is essential that an Urban Platform is powered by data, with the capability to collect and analyse large volumes of information. This data-centric approach is crucial for empowering municipal teams to make informed, data-driven decisions, optimizing resource allocation, enhancing service delivery, and ultimately improving the overall efficiency of city operations. However, this approach will only succeed if the Urban Platform's data strategy is supported by a clear and robust data-governance policy. This policy should provide the necessary tools to offer a holistic and comprehensive view of all the data pipelines utilized by the municipality, ensuring that decisions and activities are consistently based on reliable and well-managed data.

Collaborative Tools

The platform fosters cross-departmental collaboration by providing shared data and communication tools. By breaking down silos between different municipal sectors, the platform promotes teamwork across different sectors of the municipality, leading to a more coordinated and comprehensive service delivery and maximizing their collective impact on urban management.

Innovation Hubs and Labs

Establishing dedicated spaces for experimentation allows municipal teams to test new solutions and refine services before full-scale implementation. These innovation hubs and labs not only foster a culture of continuous innovation—where ideas can be rapidly prototyped, tested, and adjusted based on real-world feedback—but also serve as training grounds for municipal teams. Here, staff can develop the new skills required to effectively operate and manage the Urban Platform, from data analysis and digital service design to understanding advanced technologies like AI and IoT.

Harnessing the full potential of a data-driven Urban Platform requires more than just access to data; it demands a commitment to innovation and empowering municipal teams with the right skills.

2.3

Transparency and Inclusiveness in Service Development

An Urban Platform must prioritize transparency and inclusiveness in the design and delivery of its services to foster trust and ensure that all citizens benefit from its capabilities. This means that citizens should be fully informed about how data—both private and publicly available datasets—is used within the platform. Clear communication on data usage builds trust between the city and its residents, allowing them to understand the role of data in shaping public services.

To achieve this, the data-driven decision-making policies and the data governance strategy already outlined should be complemented with a dedicated transparency strategy. Aligning the development of the Urban Platform with a transparency strategy is essential for ensuring the ethical and inclusive use of data and AI. This approach helps citizens understand how algorithms influence decision-making, while also supporting efforts to bridge the digital gap, ensuring that all residents, regardless of digital literacy, can benefit from digital transformation.

2.4

Measuring Success: Defining Clear Key Performance Indicators

An essential component of the Urban Platform's success lies in the definition of clear Key Performance Indicators (KPIs) that measure the platform's progress and impact. Well-defined KPIs help track the efficiency of services provided by the platform and gauge citizens' satisfaction with the quality of public services. These indicators enable the city to monitor how effectively the platform is improving areas such as service response times, resource allocation, and user engagement, providing valuable insights into where adjustments or enhancements are needed.

Equally important is the establishment of a solid baseline from which these KPIs are developed. A well-documented baseline provides a clear picture of the city's starting point in terms of service efficiency and citizen satisfaction. It allows municipal teams to set realistic and achievable targets, ensuring that the KPIs reflect the city's unique context and needs. With a reliable baseline, progress can be measured accurately over time, allowing the city to make data-driven adjustments and continuously optimize the platform's performance.

By focusing on measurable outcomes and maintaining a data-centric approach, cities can ensure that their Urban Platform initiatives are not only aligned with strategic goals but also deliver tangible benefits to both citizens and municipal teams. This focus on clear metrics and realistic targets is vital for building a transparent, accountable, and results-oriented urban platform strategy.

BUILDING BLOCKS OF THE URBAN PLATFORM

The Urban Platform is built on a microservices architecture and employs Minimum Interoperability Mechanisms (MIMs) to ensure effective operation, seamless data flow, and integration. This approach enables the platform to deliver a wide range of urban services while supporting informed decision-making processes. The platform's architecture is guided by the principles of openness and interoperability, aligned with the vision of Open and Agile Smart Communities (OASC)² and the European Data Spaces Strategy³, both of which are instrumental in shaping its foundational elements.

Figure 1 (pag. 18) provides a high-level overview of the architecture of the Urban Platform, depicting the interaction between its core components. The white boxes represent software components/tools, while the black arrows illustrate the data flow between them. These components can be grouped into the following categories:

1. Data Sources

This foundational layer gathers data from a variety of sources, including IoT devices, transportation networks, energy grids, environmental sensors, traffic, roadblocks, and more. These sources provide real-time information on the state of the city, which can be used to manage resources and respond to incidents.

2. Data Processing and Analytics

At the heart of the Urban Platform is its capability to process and analyze the vast amounts of data collected from various sources. Using advanced machine learning and AI algorithms, the platform transforms raw data into actionable insights, such as predicting traffic congestion, identifying pollution hotspots, or optimizing energy use in real-time.

3. Service Layer

This layer provides direct access to a wide range of city services, such as public transportation, emergency response, waste management and utilities. These services are delivered through an intuitive interface accessible to both city officials and citizens.

4. Interoperability Layer

This layer ensures that the platform can communicate with external systems, such as other city platforms, national government systems, and European smart city frameworks.

5. Support Services

To ensure the smooth operation of the Urban Platform, this layer includes essential shared services such as authentication, notifications, and security management, which provide the necessary support for the operation of the Urban Platform.



² Open and Agile Smart Cities (OASC), <https://oascities.org>

³ Common European Data Spaces, European Commission, <https://digital-strategy.ec.europa.eu/en/policies/data-spaces>

3.1

The Urban Platform as Data Space Enabler

The Urban Platform, while providing a centralized view of urban management, adopts a federated approach that seamlessly connects with both internal platforms and external systems, particularly those specialized in regulated areas such as water and waste management. To fully realize this vision, the Urban Platform is evolving to align with the EU's vision for Data Spaces by enhancing its infrastructure and governance frameworks to support the Minimum Interoperability Mechanism (MIM) standards established by OASC. This strategic alignment involves integrating key EU data-sharing frameworks to ensure seamless data flow across sectors and platforms, adhering to principles of interoperability, security, and privacy.

Integrating the OASC Vision and European Data Spaces Strategy

By adopting MIM standards, the platform will enable the effective sharing and reuse of its urban data—ranging from mobility to environmental monitoring—within European Data Spaces. This strategic alignment positions the Urban Platform paradigm as a key role in fostering innovation, ensuring data sovereignty, and contributing to the European Digital Single Market, all while promoting sustainable urban development and smarter city services. The platform's development based on these principles will not only enhance its local capabilities but also enable it to become a pivotal instrument in the broader European tech ecosystem.

The alignment of the Urban Platform with the OASC vision and European Dataspaces strategy is not merely a technological enhancement; it represents a fundamental shift in how cities manage, share, and utilize data. By adopting OASC's principles, the platform is built on open standards and common data models, promoting transparency and accessibility. This approach enables data-driven decision-making processes that are more democratic and inclusive, allowing both public institutions and private stakeholders to innovate and collaborate effectively.

The European Data Spaces strategy advocates for creating a unified digital market where data can move freely, fostering innovation across sectors. By aligning with this strategy, the Urban Platform supports the creation of a data-driven ecosystem that can scale beyond municipal boundaries, linking with other cities and data initiatives across Europe.



GOVERNANCE PRINCIPLES AND ENSURING A SOLID AND SUSTAINABLE DEVELOPMENT

Effective governance is essential to the success of any Urban Platform, ensuring that its development is not only sustainable but also adaptable to the evolving needs of the city. A successful Urban Platform strategy requires not only strong governance structures focused on gradual implementation, interoperability, continuous improvement, and active collaboration with stakeholders, but also broader support with high political sponsorship. This political backing is crucial for securing the necessary resources, aligning strategic priorities, and fostering the long-term commitment needed to drive the platform's development and integration across all levels of urban management.

4.1 Partnerships and key stakeholders

Building strong partnerships with key stakeholders is vital to the sustainable development and governance of the Urban Platform. Effective collaboration across different sectors ensures that the platform remains innovative, scalable and aligned with broader urban and regional goals.

Public-Private Partnerships

The platform's success relies on robust public-private partnerships that bring together technology providers, data analysts and urban planners. These collaborations leverage the expertise of both sectors to create cutting-edge solutions that benefit the entire city ecosystem.

Engagement with Academia and Research Institutions

Engaging with universities and research centers ensures that the Urban Platform remains at the forefront of technological advancements. Partnerships with academic institutions like the Universities and international collaborations help in testing new ideas, validating technologies, and fostering a culture of innovation within the city.

Involvement of Citizens and Community Organizations

Citizens are not just users of the platform but active contributors to its development. Community organizations and local groups play a crucial role in providing feedback, raising awareness and advocating for digital inclusivity. This grassroots involvement ensures that the platform's services are equitable and accessible to all residents.

Government and Regulatory Bodies

Collaboration with national and regional governments ensures that the platform aligns with regulatory standards and policy frameworks. This alignment is essential for securing funding, scaling initiatives, and ensuring compliance with data protection and privacy laws.



4.2 Interoperability

Interoperability is a cornerstone for the solid and sustainable future of an Urban Platform. Ensuring that the platform remains open and maintains strong connections with key ecosystem partners allows it to stay flexible and adaptable to future challenges and evolving technological demands. Interoperability, along with modularity, enables functionalities and services to be easily swapped or updated, making the Urban Platform truly “future-ready.” Additionally, the interoperability layer establishes rules and standards that minimize the risk of vendor lock-in, ensuring that the platform remains open, collaborative, and capable of integrating new solutions over time.

The platform should employ the following interoperability aspects:

Semantic Interoperability

This ensures that data exchanged between systems is interpreted uniformly, regardless of the technology used by each system. This is satisfied by following a known and standardized ontology, as defined by MIM2 (Minimum Interoperability Mechanism 2), which in this case ensures that data within the platform is modeled following the ontology of the SmartDataModels.

Service Interoperability

This allows services from different platforms to work together seamlessly by using Open APIs and common standards. All services exchange data following Open API standards and all real-time data exchange such as using the ETSI NGSI-LD API. This ensures that the Urban Platform avoids vendor lock-in and ensure that the Platform remains flexible and adaptable to future technological advancements.

4.3 Continuous Improvement and Co-Creation

At the core of the Urban Platform’s success is the commitment to continuous improvement and co-creation. Services are not static, instead evolve based on feedback from users—both citizens and municipal teams—ensuring that they remain relevant and effective.

Agile Development

The platform should employ Agile methodologies to continuously iterate on service delivery. New features are developed in short cycles, tested with real users, and adjusted based on feedback. This allows for rapid deployment of improvements and a high degree of flexibility in responding to user needs.

Co-Creation with Stakeholders

Citizens and municipal workers alike are involved in the development process. Through workshops, focus groups and testing phases, both groups contribute to the design and refinement of services. This participatory approach ensures that the platform serves the true needs of its users while fostering a sense of ownership and collaboration across the city.

A Twofold Approach to Adaptability and Efficiency

To keep the Urban Platform adaptable, with new features and services continuously tested and refined in real time, it is crucial to adopt a twofold approach—aligning improvements in citizens’ quality of life with increased operational efficiency for municipal teams. This strategy is supported by innovation management methodologies like Agile development and service design, which provide the flexibility needed to respond swiftly to emerging challenges and opportunities. By embracing this approach, the municipality remains ahead of urban challenges, ready to implement cutting-edge solutions that drive progress and set a benchmark for smart city innovation.

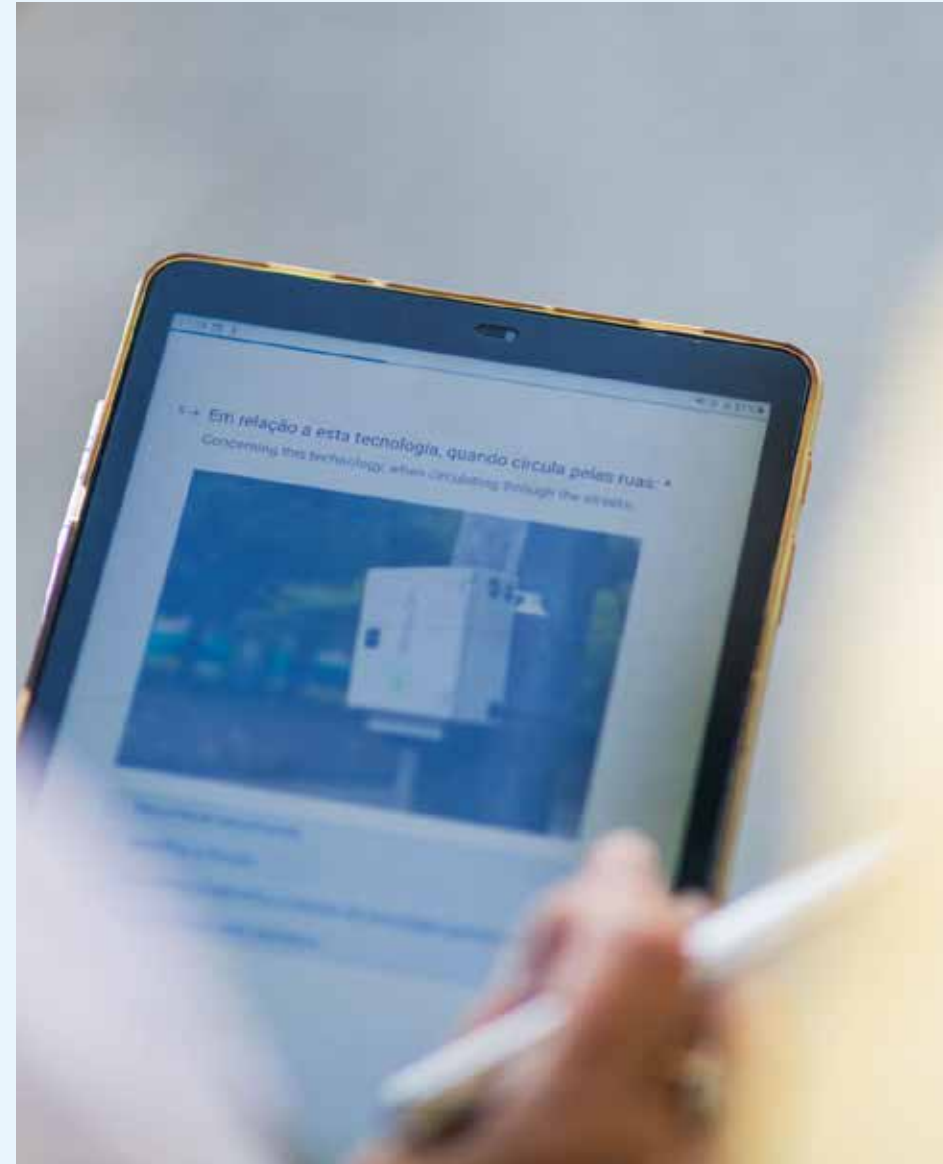
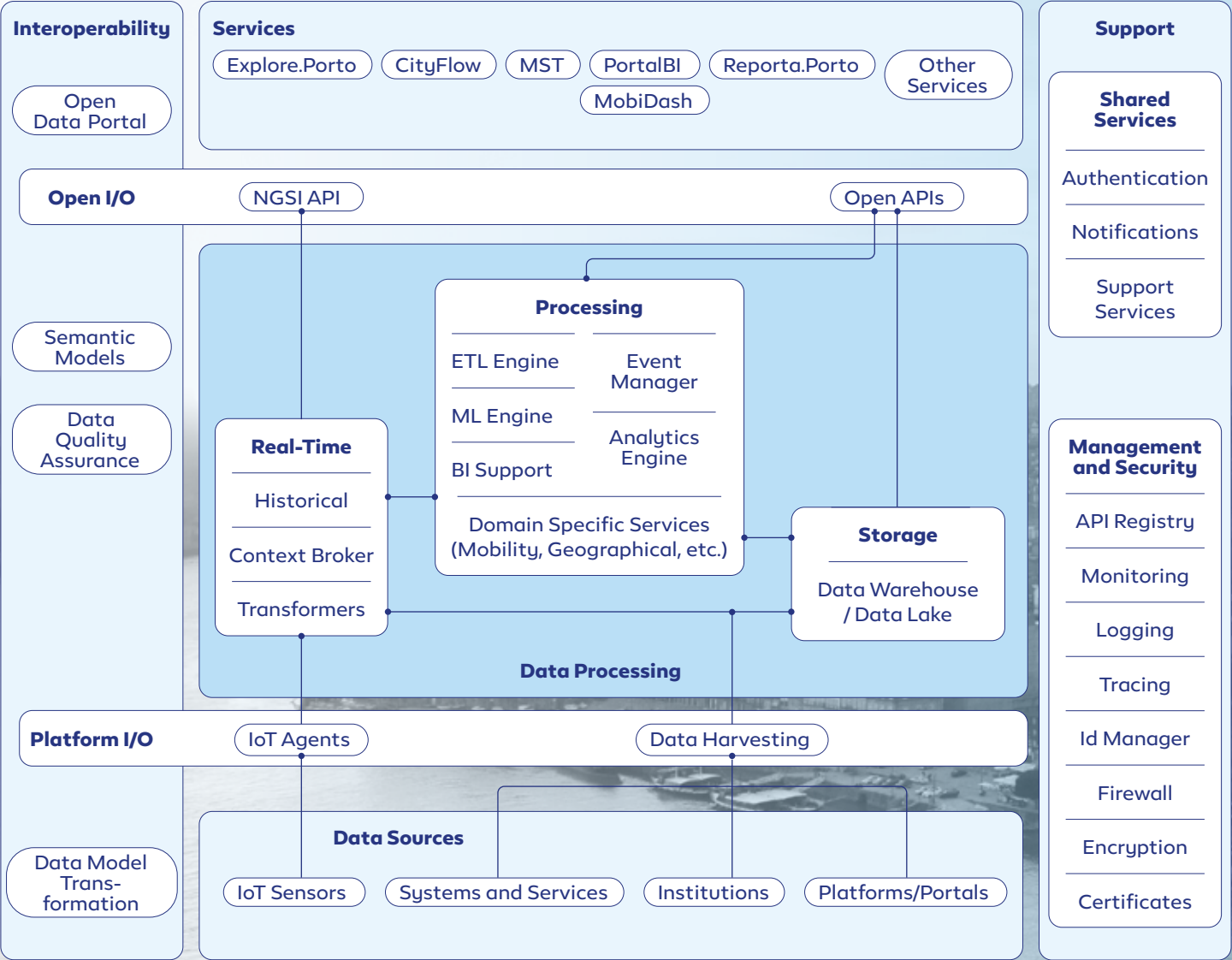


Figure 1
High-level overview of
the architecture of the
Urban Platform and its
components.



Reference Numbers

Porto's Urban Platform showcases its significant impact through a range of concrete metrics.

— In the first half of 2024 alone, the platform logged **1.7 billion telemetry records**, generating over **200,000 records daily** to support soft-mobility management, demonstrating its ability to handle vast amounts of data.

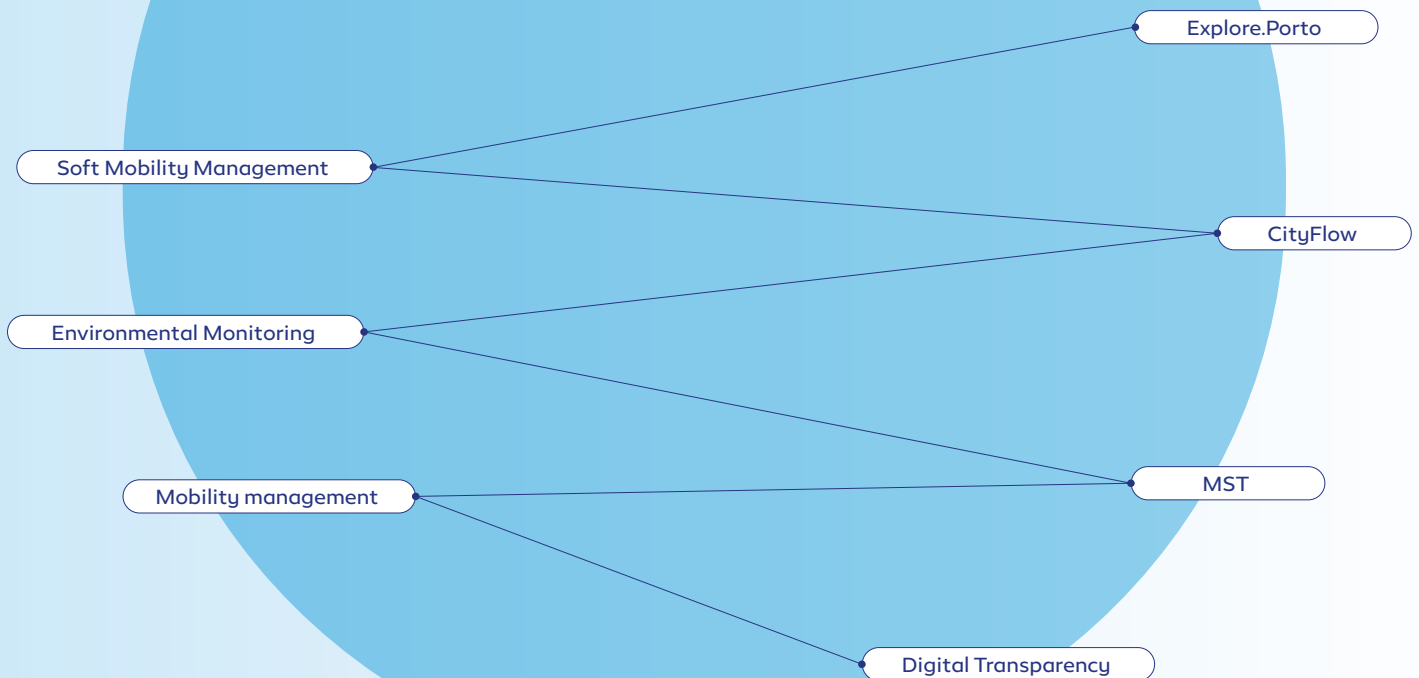
From a citizen's perspective, the Citizen Issues Reporting and Management system has processed over **100,000 issues** to date, with more than **100 new reports** submitted each day and over **250 employees** actively engaged in resolving them.

Focusing on citizens and visitors, the real-time data for citizens and tourists platform – Explore. Porto, has attracted **1.2 million visits** in the past 12 months, with **54%** of users searching for mobility information, **17.3%** exploring nearby points of interest, and **7.7%** using it for route planning.

From the perspective of municipal teams, the City Workflow Management Platform offers concrete improvements by handling more than **13,500 garden interventions** and **10,000 equipment maintenance tasks** each month. Additionally, it manages over **120 animal registrations** and **300 clinical observations** related to the city's animal care.

In terms of data-driven policymaking and digital transparency, citizen feedback revealed that **58.3% have a low overall knowledge of city technologies**, while 74.6% emphasized the need for clear signage. Furthermore, 48.9% expressed a desire to better understand the location and purpose of these technologies, and **44% highlighted the importance of citizen information and integration.**

Foundations in Action



Porto's Vision
in Practice and
Real-World Impact.



Porto.

All photos are made by real
people, with real people
during real activities
organized by Porto Digital

Note to Readers

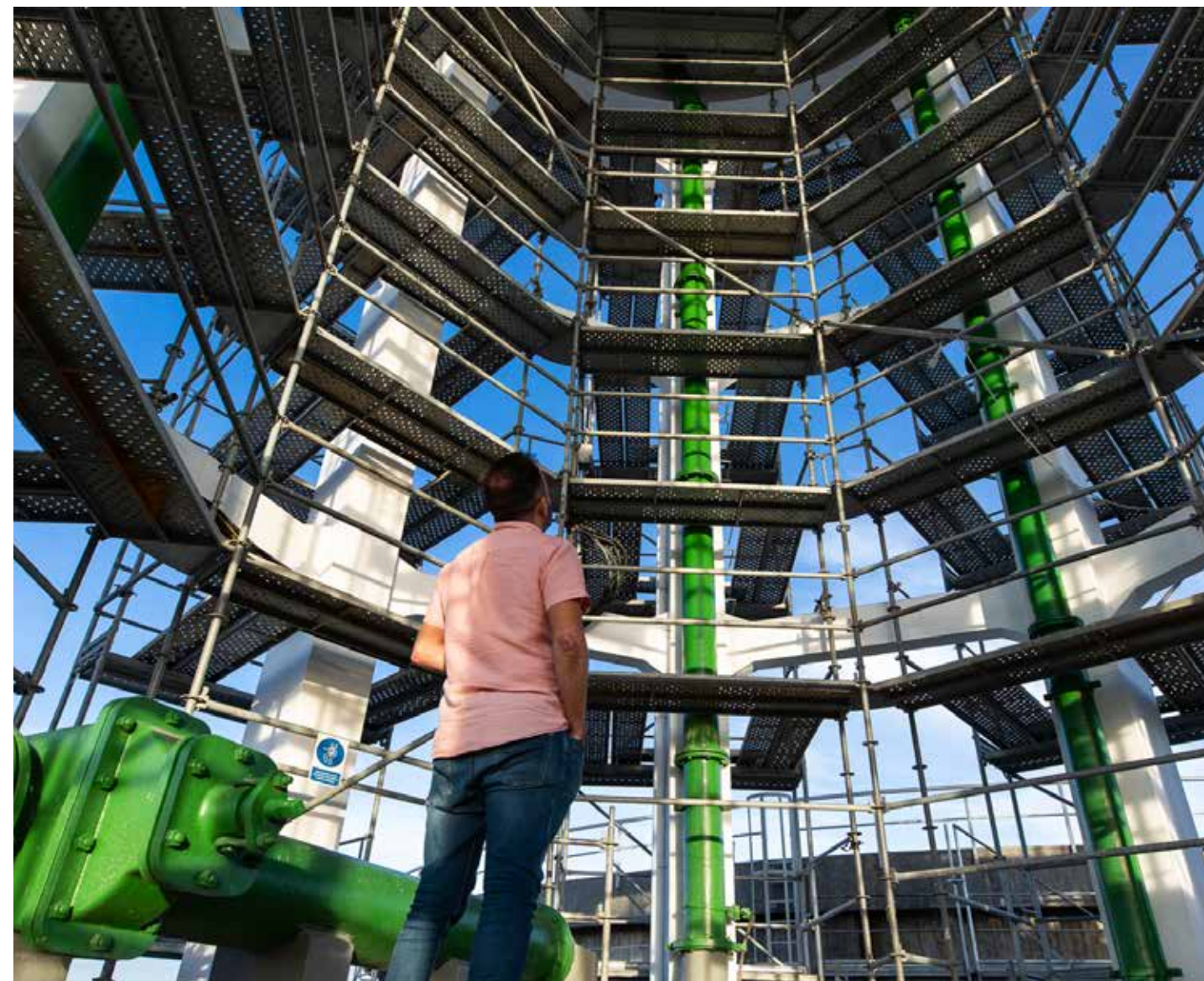
“Need a refresher on the big ideas behind the Urban Platform concepts? Flip the book over and check out Part A for the strategy, vision, and building blocks that set the stage!”



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PORTO'S VISION IN ACTION

Porto's Urban Platform and Services serves as the backbone for smart city and digital operations in Porto. This platform allows for the seamless integration of data, services, and technological solutions across multiple sectors, enabling cities to optimize resource management, enhance citizen services, and foster innovation. Porto's Urban Data Platform is aligned with broader European initiatives such as the European Interoperability Framework for Smart Cities and Communities (EIF4SCC) ¹, the MIM's sponsored by OASC and supports the Digital Single Market by facilitating the use of open standards and shared services across municipalities. The data strategy of Porto, emphasizes the importance of interoperability, scalability, and flexibility, ensuring that they are adaptable to different urban contexts and capable of interacting with other national and European systems.

The Porto Urban Platform services are a central component of the city's smart city infrastructure. The platform acts as a unifying digital layer that integrates various urban services and facilitates the efficient delivery of public services. By harnessing data and technology, the services provided by the platform enable real-time monitoring, decision-making, and optimization across different sectors such as mobility, energy, public safety, and more. These interconnected services ensure that the city operates efficiently, sustainably, and with a focus on improving the quality of life for its residents. By driving the city's digital transformation, they enhance public services and foster a more connected urban environment.

¹ European Interoperability Framework for Smart Cities and Communities (EIF4SCC), <https://op.europa.eu/en/publication-detail/-/publication/f69284c4-eacb-11eb-93a8-01aa75ed71a1/language-en>

USE CASES

The selected use cases illustrate how the Urban Platform is already making a tangible difference in the daily lives of Porto's citizens, providing a variety of digital services that improve efficiency, transparency, and engagement. These examples highlight the practical applications of the platform in different domains:

CITIZEN ISSUES REPORTING AND MANAGEMENT

A platform enabling citizens to report public space issues and request services, keeping them informed throughout the resolution process. It empowers residents to participate actively in urban management while offering transparency in how incidents are addressed.

CITY WORKFLOW MANAGEMENT PLATFORM

At the heart of the municipality's adoption of the Urban Platform paradigm, CityFlow is more than just a workflow management platform. It digitizes and optimizes various administrative processes, supporting municipal teams by streamlining operations such as requests for services and maintenance tasks, ultimately making service delivery more efficient and responsive.

ENVIRONMENTAL MONITORING

An IoT sensor network monitors weather, air quality, and noise levels, providing real-time data for both residents and city officials. This system supports better decision-making for environmental and emergency management.

REAL-TIME DATA FOR CITIZENS AND TOURISTS

Explore.Porto is a digital platform offering detailed information on points of interest (POIs) for both citizens and tourists, integrating real-time data on public transportation and mobility options, thereby enhancing the city's accessibility and navigation.

SOFT MOBILITY MANAGEMENT

This system tracks data from soft mobility providers, like e-scooters, to ensure compliance with regulations and improve urban mobility management. It offers insights into vehicle positions, trip details, and regulatory adherence.

ADVANCED ANALYTICS FOR MOBILITY MANAGEMENT

A dashboard that consolidates traffic and mobility data, offering city officials a comprehensive view of real-time traffic conditions and predictive insights for better management of urban mobility.

DIGITAL TRANSPARENCY

A pilot platform aimed at increasing transparency about the technologies used in the city, providing citizens with easy access to information on data collection and usage through digital platforms and physical signage. These use cases demonstrate how the Urban Platform integrates advanced technologies and data-driven solutions to enhance service delivery, improve urban management, and actively engage citizens, making Porto a model for smart and connected cities.

Citizen Issues Reporting and Management

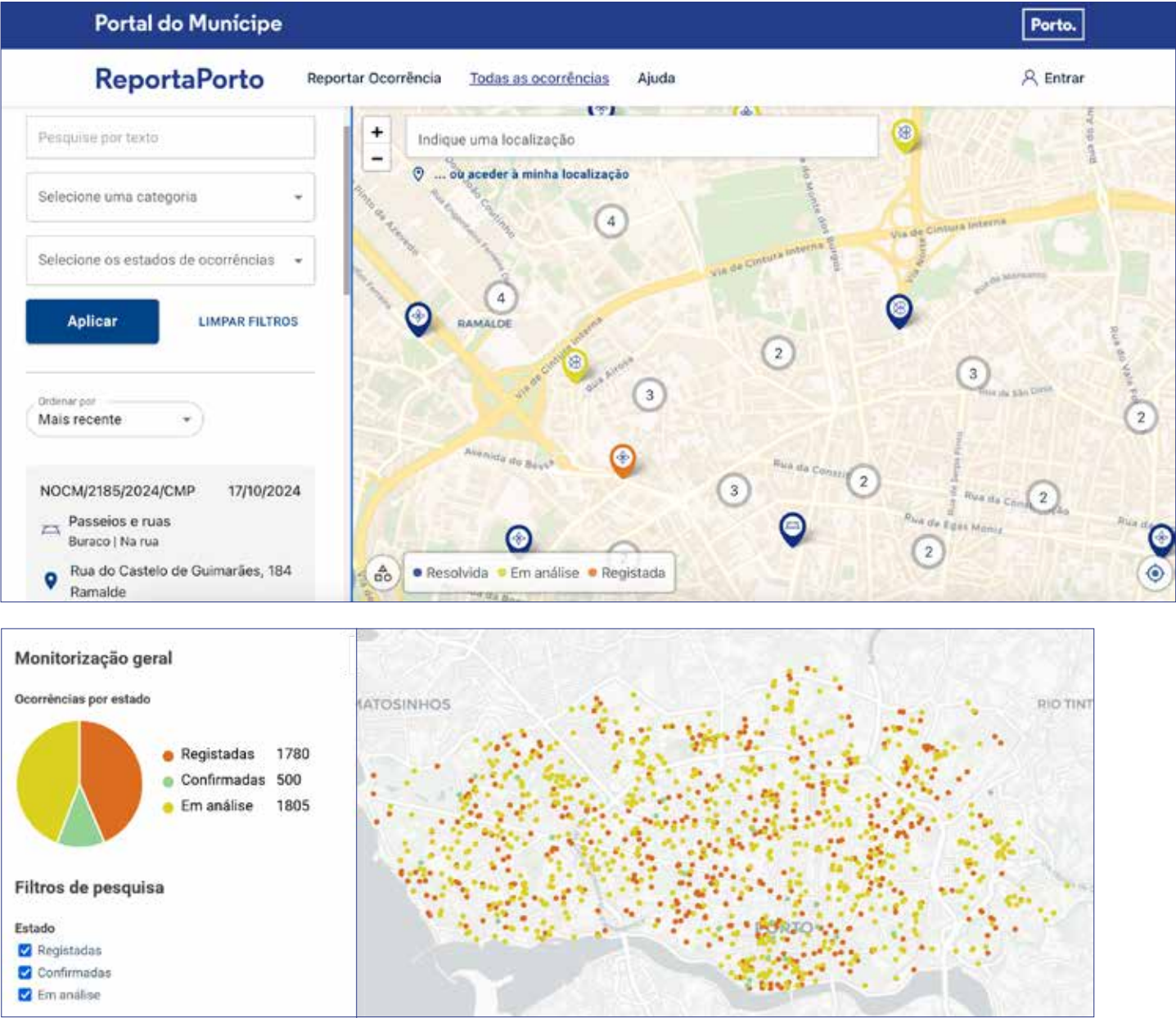
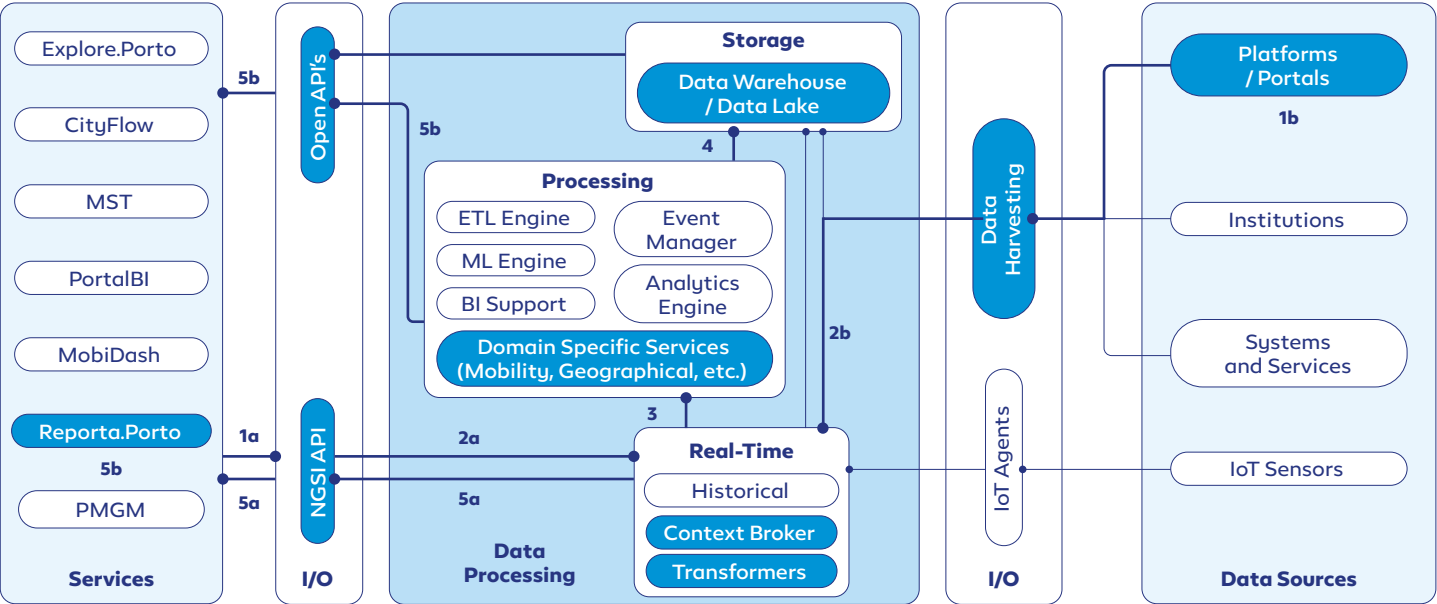
DATA MODELS
Open311, Services, ServiceRequest and IssueReporting.

COMPONENTS AND DATA FLOW

- 1 Data Collection.
- a From incidents reported in the Reporta.Porto platform.
- b From incidents reported in other platforms.
- 2a and 2b Loading into the Context Broker.
- 3 Data Processing.
- 4 Storage.
- 5 Digital Service and Data Visualization.

DESCRIPTION
The Citizen Issues Reporting and Management Platform offers a centralized hub for reporting and managing issues in public spaces. While the Reporta.Porto web app serves as the primary entry point for citizens to submit reports, the platform also integrates with apps from Porto Ambiente (waste management) and the city's water treatment infrastructure provider. This federated approach ensures that reports from various sources are consolidated into a single workflow, improving coordination between municipal teams. This platform not only enables active citizen participation but also enhances transparency, offering insights into the number of incidents, their status, and the efficiency of the resolution process.

CONTEXT
The service focuses on helping municipal teams and citizens manage incidents and service requests within the city, following two approaches:
1) Administrative: Allows municipal or regional actors to create, view, and resolve occurrences.
2) Public: Enables society (citizens and visitors) to report occurrences, with the ability to track their status and progress.
For example, a citizen or visitor reports an obstacle on a road, the occurrence is listed and displayed on a geographic map, publicly visible. The status of the occurrence is then updated or resolved by the responsible municipal entities.
The application includes a dashboard displaying key performance indicators (KPIs) such as average response time and the number of occurrences. Occurrences are not reported exclusively through the provided application; data is also absorbed from other existing portals and platforms through the interoperability of data, systems, and services.



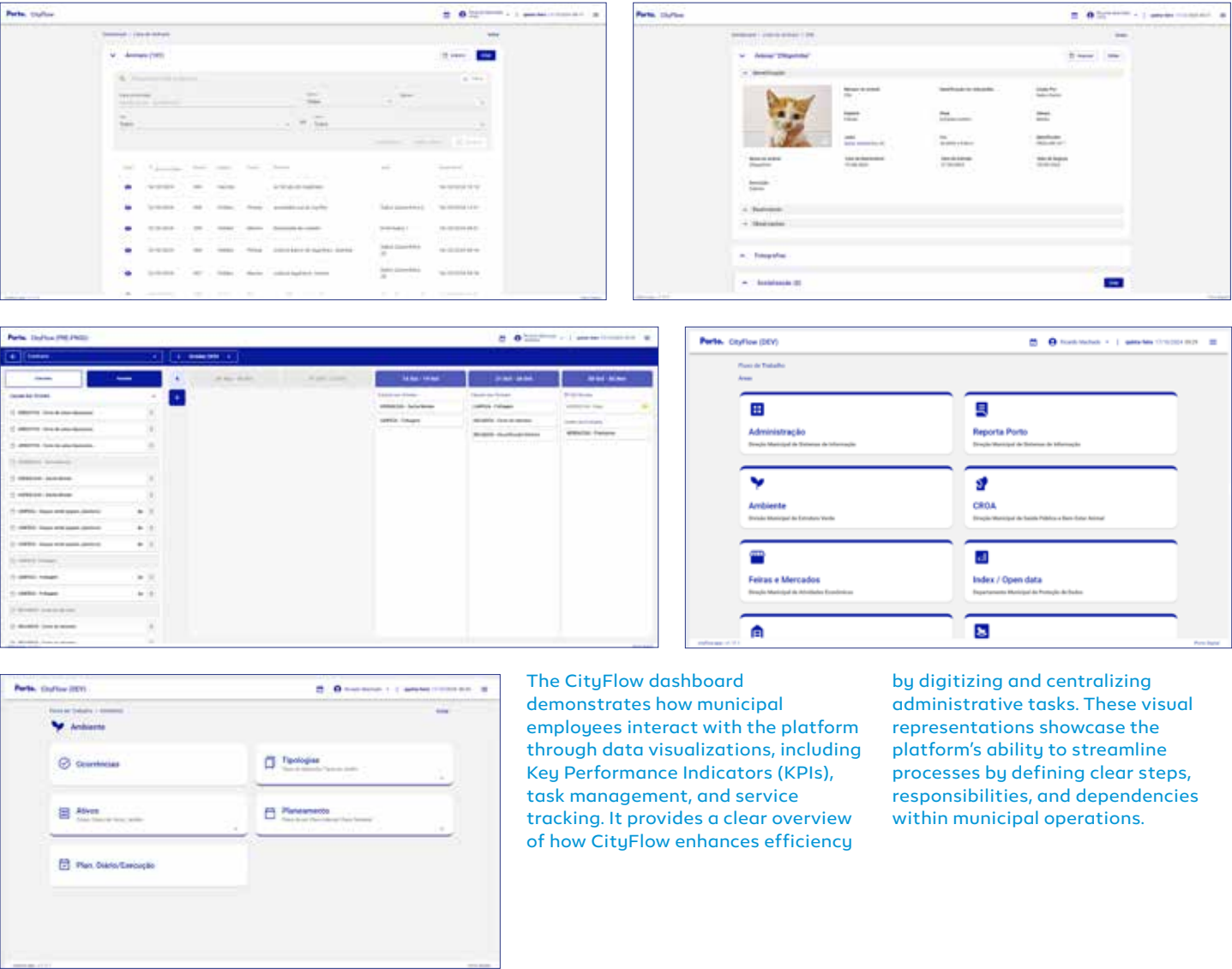
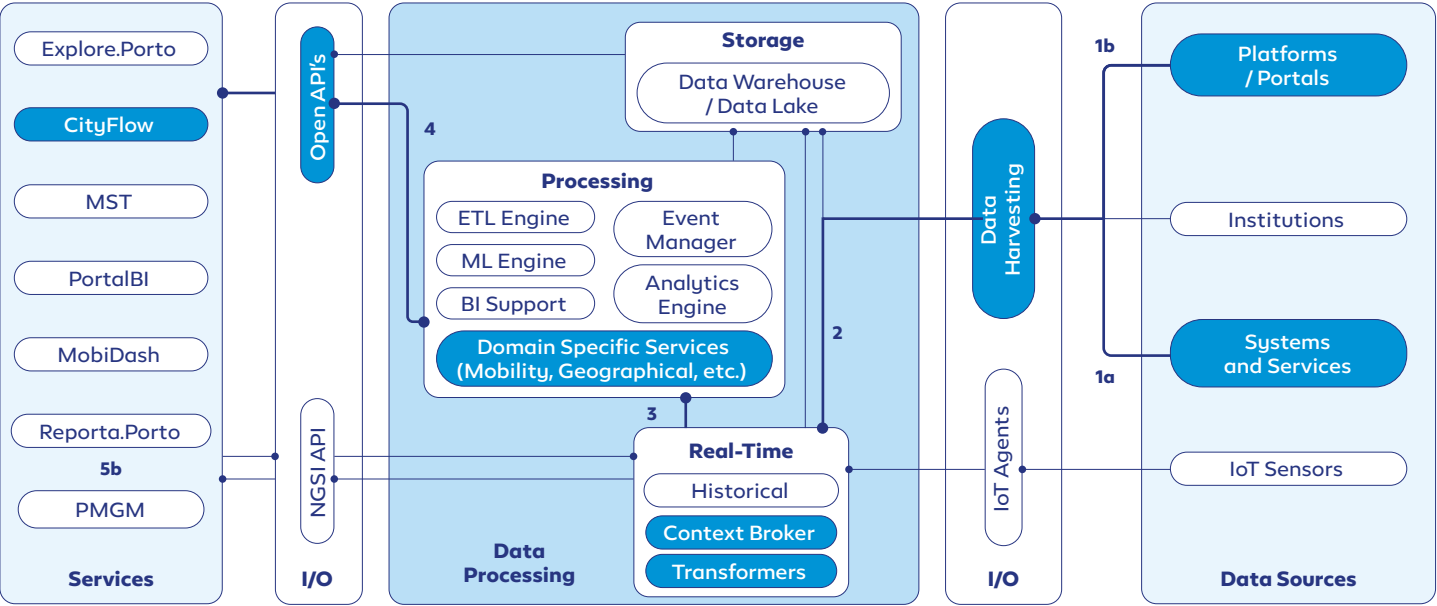
City Workflow Management Platform

DATA MODELS
Open311, Services, ServiceRequest, IssueReporting and CityGML

- COMPONENTS AND DATA FLOW**
- 1 Data Collection.
 - a From services, like the ArcGIS service.
 - b From other Plataforms like Report.Porto.
 - 2 Loading into the Context Broker and ElasticSearch platform.
 - 3 BPMN Processing using Camunda.
 - 4 Data Sharing via Open API.
 - 5 Digital Service for end-users.

DESCRIPTION
The City Workflow Management Platform was developed to provide city council departments with a tool to optimize processes and streamline the recording and management of operations. It is an administrative application that digitizes processes through modeling with BPMN (Business Process Model and Notation), followed by the creation of a web interface for process execution. By modeling processes, the platform clearly defines steps, dependencies, and responsibilities, making workflows simple and traceable. This model then drives the creation of web pages, forms, and validations that guide users through each step, ensuring consistent and efficient execution of administrative tasks.

CONTEXT
It is an administrative application aimed at digitizing administrative processes through their modelling using BPMN, followed by the association of the process with a web application that enables process execution. By modelling the processes, it is possible to identify the steps, dependencies, and responsibilities in a simple and traceable manner. As an example of this use case, the process of issuing parking permits is highlighted. Since the operational tool covers all types of administrative processes in a general manner, such as municipal licensing, permit requests, or certificate issuance, it is a vital tool in the efforts to digitise municipal administration. In addition to ease of use and high accessibility, the automation and digitisation of these processes provide several KPIs that can be used for improvements and the evaluation of bottlenecks in the processes.



The CityFlow dashboard demonstrates how municipal employees interact with the platform through data visualizations, including Key Performance Indicators (KPIs), task management, and service tracking. It provides a clear overview of how CityFlow enhances efficiency

by digitizing and centralizing administrative tasks. These visual representations showcase the platform's ability to streamline processes by defining clear steps, responsibilities, and dependencies within municipal operations.

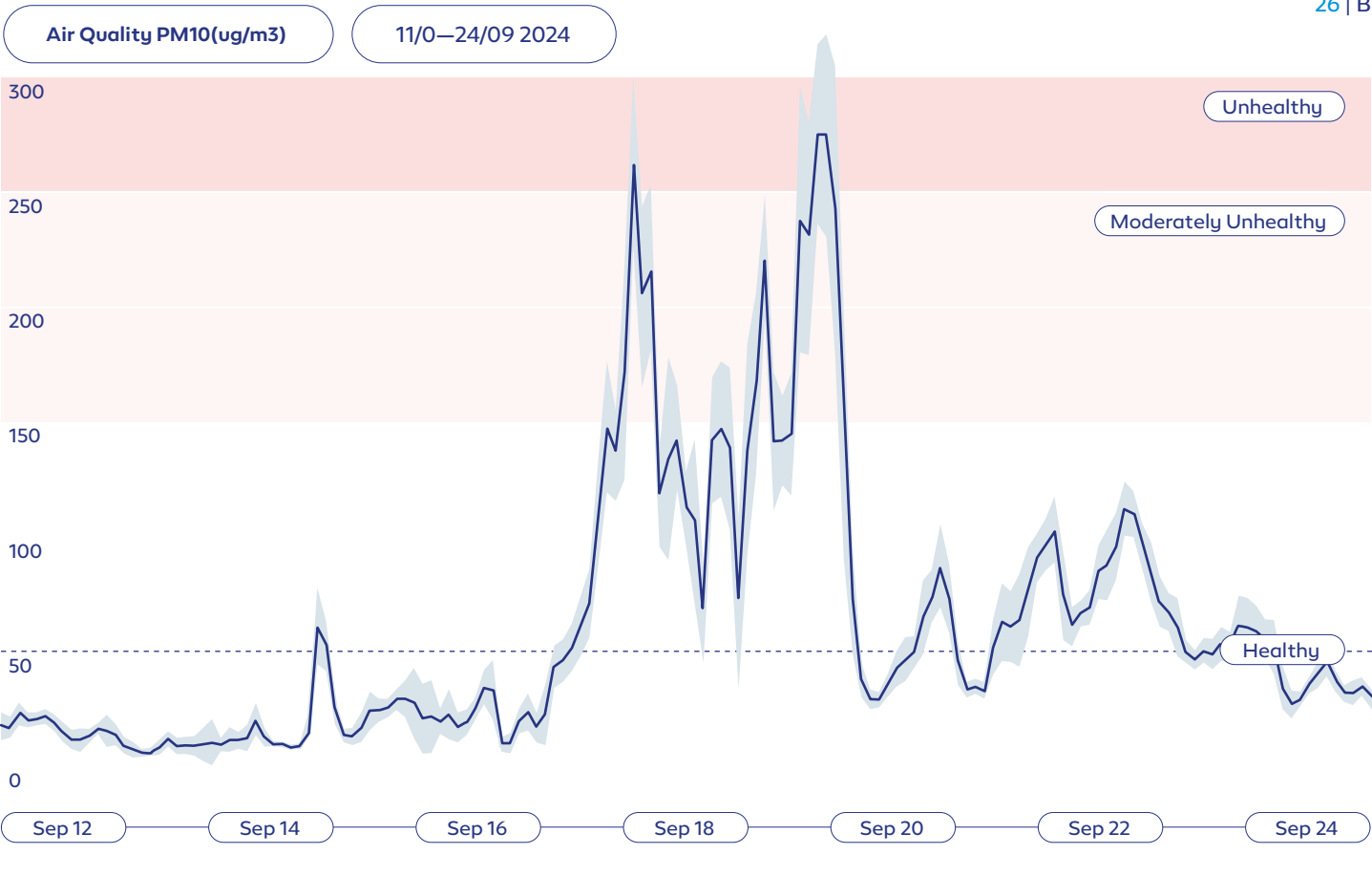
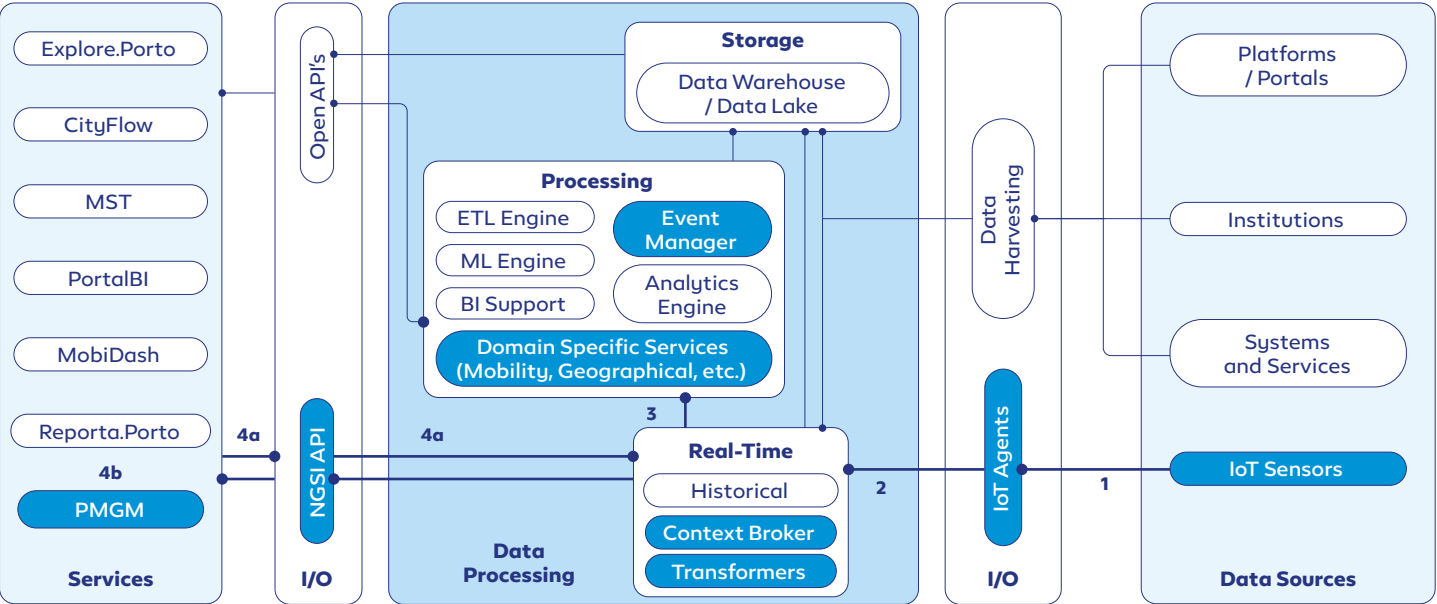
Environmental Monitoring

DATA MODELS
Alerts, AirQualityObserved, NoiseLevelObserved, WeatherObserved and WeatherForecast

- COMPONENTS AND DATA FLOW**
- 1 Data Collection from IoT Sensors.
 - 2 Transformation and Loading into Context Broker.
 - 3 Data Processing and Analysis.
 - 4 Data Visualization and Services.

DESCRIPTION
The Environmental Monitoring System consists of a network of IoT sensors distributed throughout Porto, tracking key variables such as weather, air quality, and noise levels. These sensors are integrated with Porto's Urban Platform, providing real-time data visualization through an interactive dashboard and enabling the monitoring of environmental events like wildfires and flooding. Additionally, flood prediction algorithms are under development to improve forecasting capabilities and enhance the city's preparedness for future events.

CONTEXT
The Environmental Monitoring System (PMGM) is the main hub of the Urban Data Platform to gather insights regarding weather and other environmental monitors within the city of Porto. The system uses data collected by the several IoT sensor stations spread within the city that are collected and aggregated by the Urban Platform. The data is transformed into standard formats and data models (following the MIMs approach) and made available for consumption through NGSI-LD and other Open API's. The platform processes this data, offering intuitive visualizations that enable users to quickly monitor real-time conditions and make informed decisions for the city. It also provides access to historical data, allowing for the analysis of trends and phenomena, such as tracking air quality during wildfires in Portugal.



In September 2024, northern Portugal experienced an unprecedented number of wildfires, significantly impacting air quality in the region and in the city of Porto. The Environmental Monitoring component of the Urban Platform played a key role in helping the city track air quality in real time and implement policies to protect citizens from hazardous conditions.

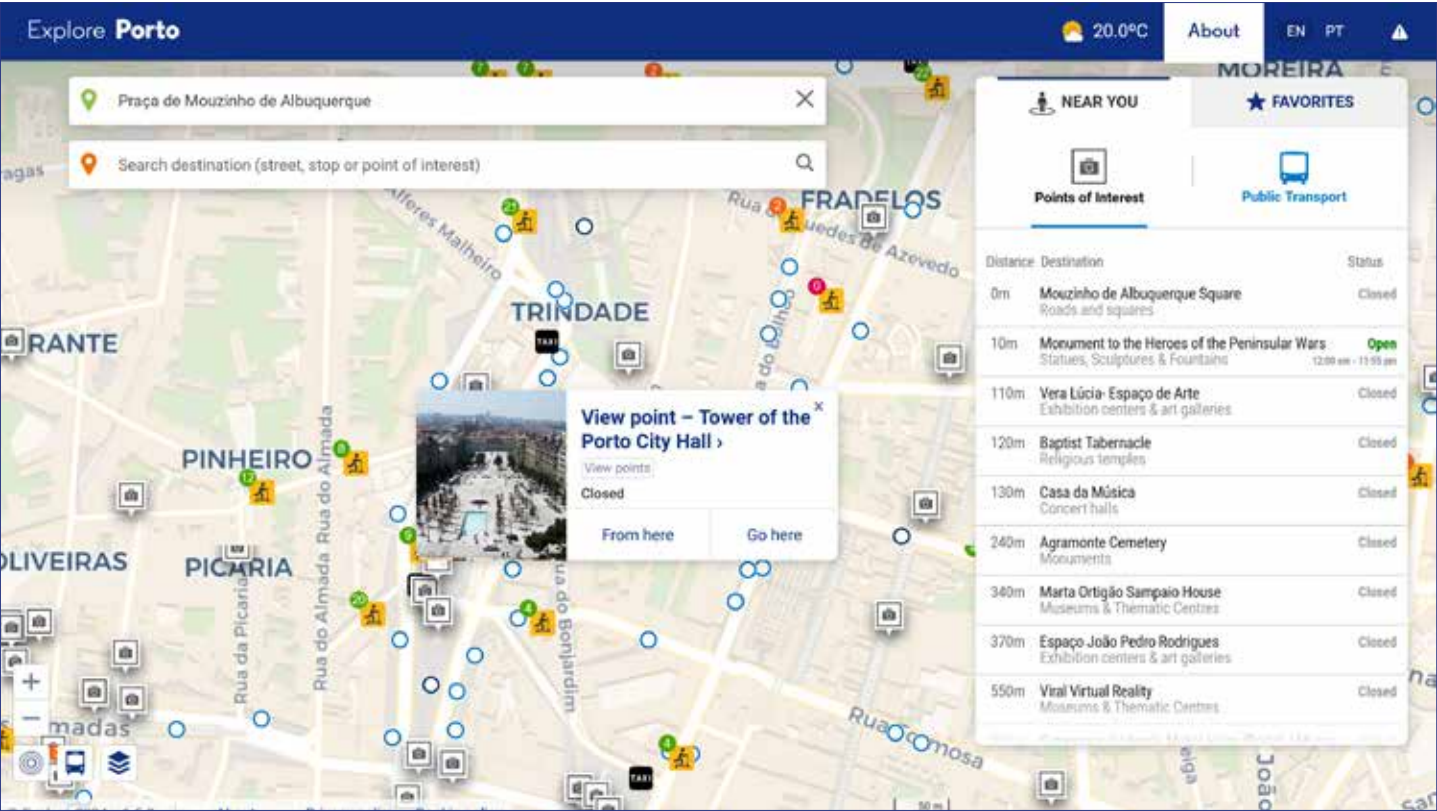
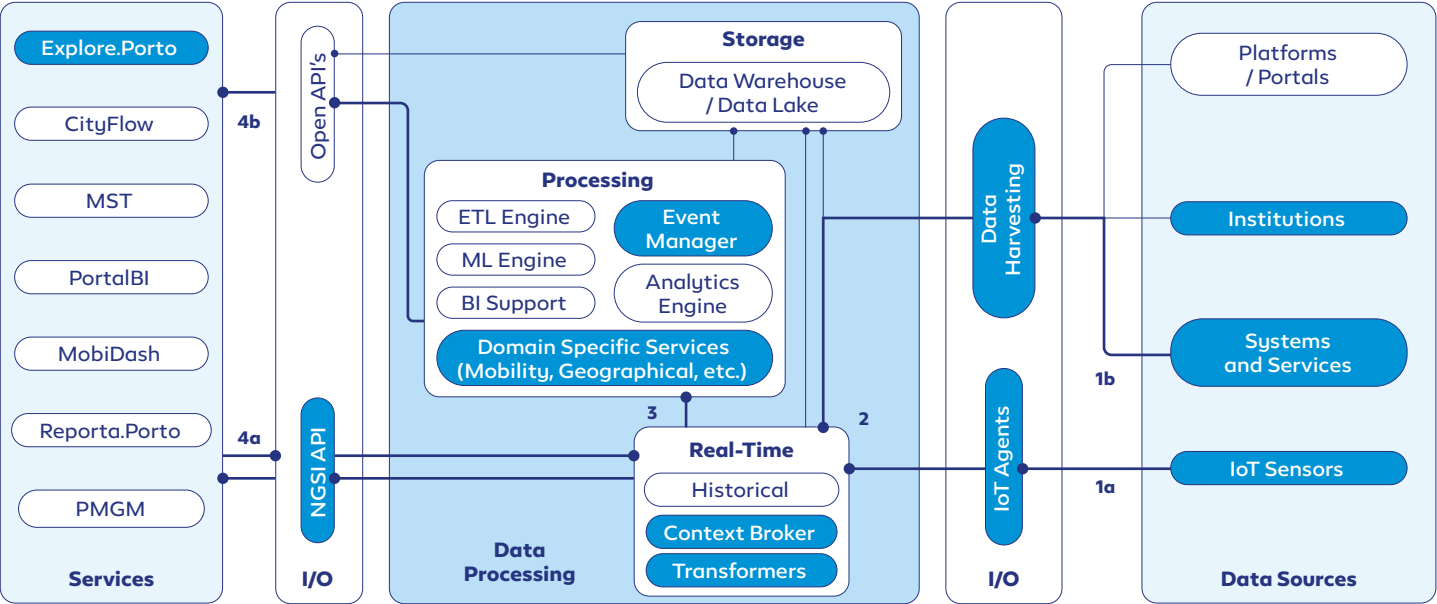
Real-Time Data for Citizens and Tourists

DATA MODELS
Alerts, Vehicles, OnStreetParking, WeatherObserved and GTFS

- COMPONENTS AND DATA FLOW**
- 1 Data Collection.
 - a From Vehicles like E-Scooter and Taxis.
 - b From Services and Public Transport Entities (GTFS).
 - 2 Data Loading into Context Broker.
 - 3 Data Processing using OTP and other Mobility tools.
 - 4 Data Exchange using Open API and NGSI-LD.
 - 5 Service for end-user.

DESCRIPTION
Explore.Porto serves both citizens and tourists by providing comprehensive information on Points of Interest (POIs) enhancing the navigation and exploration of the city. In addition to offering historical details and schedules for Porto's POIs, it provides real-time data on public transportation and shared mobility options such as e-scooters and taxi ranks, including current locations, schedules and availability. All data is curated by the municipality, ensuring accuracy and relevance, which also features itinerary suggestions, helping users plan routes and explore the city efficiently, keeping their favourite spots at their fingertips and discovering Porto in a seamless way.

CONTEXT
Explore.Porto' system relies on advanced technologies like Vector Tiles, Orion Context Broker and GraphQL to deliver a seamless experience. By using these tools, Explore.Porto offers real-time data on the availability of shared mobility options. Taking as an example the e-scooter where the data is gathered from the GPS sensors installed, which is then processed through the Orion Context Broker to display the exact number of scooters available at each Shared Mobility Point. All the information is processed and integrated into OpenTripPlanner which then is used by Explore. Porto, allowing users to access up-to-date, real-time insights on mobility and POIs in the city.



After four years of activity, with over 2.8 million sessions and more than 300,000 users, Explore.Porto is now being developed into a new product focused on cities and communities in north of Portugal.

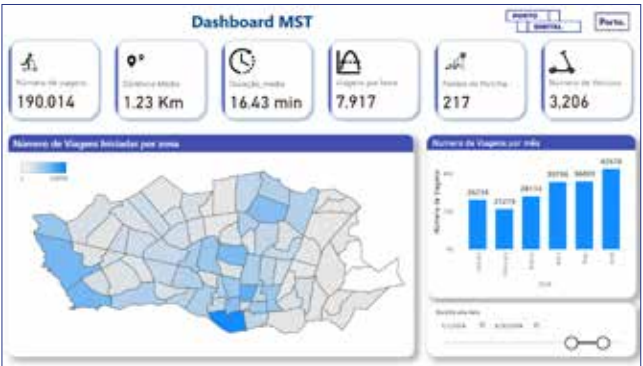
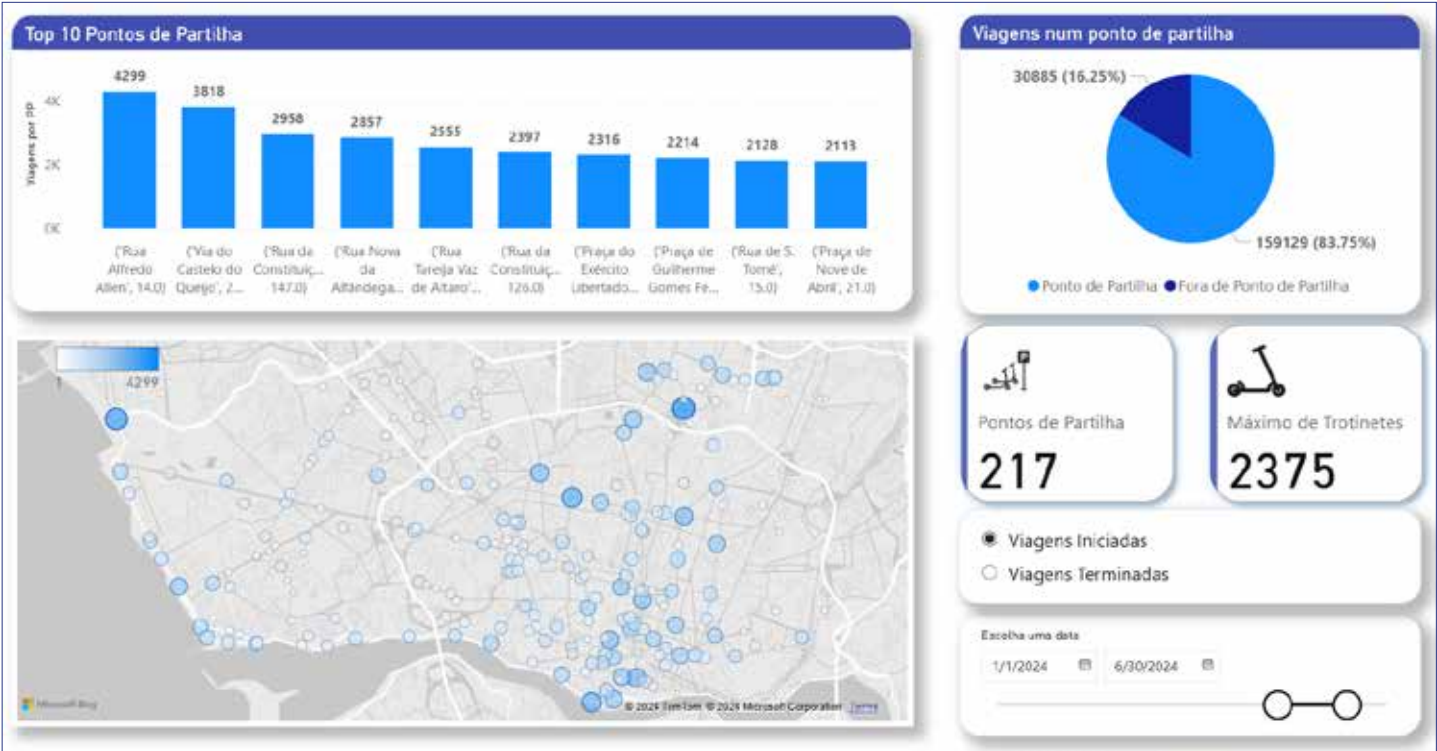
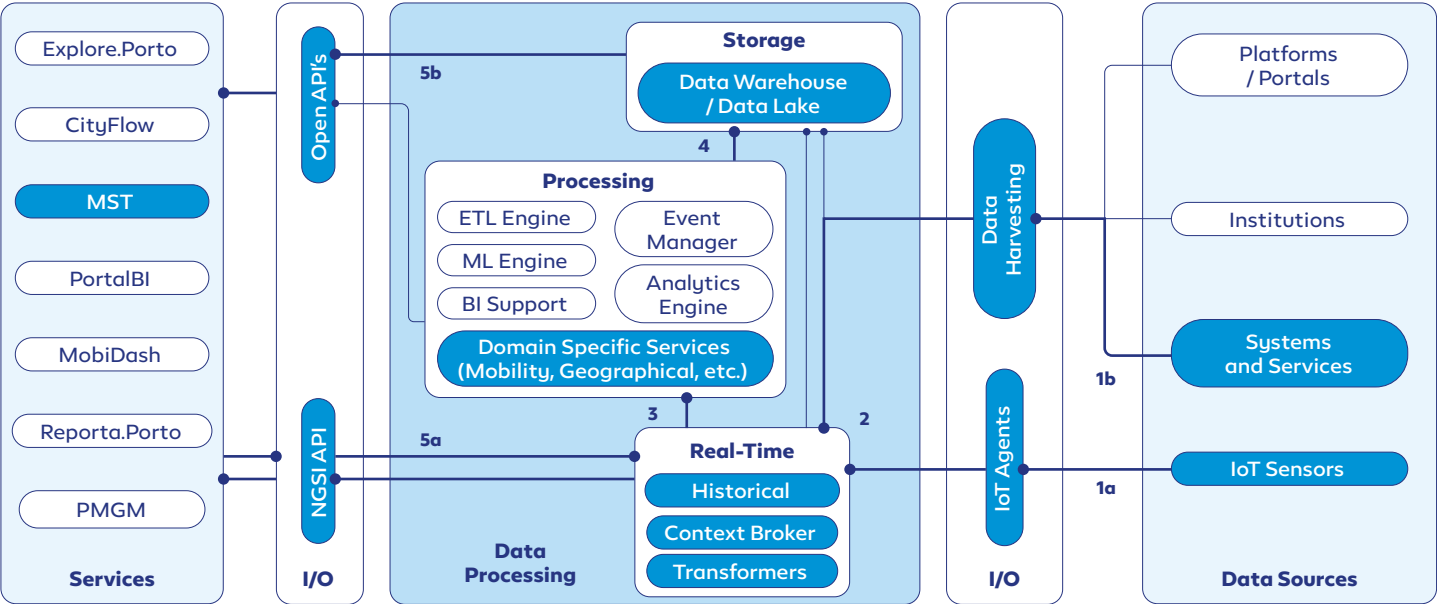
DATA MODELS
Vehicle, OnStreetParking and Alert

COMPONENTS AND DATA FLOW

- 1 Data is received directly from Soft Mobility providers via MDS and Geofencing data collected from Municipal Services.
- 2 Loading and transformation into Context Broker.
- 3 Domain specific processing to generate alerts and trip accounting.
- 4 Storage into Data Warehouse.
- 5 Data collected for a) real-time and b) historical analysis view in MST Service.

DESCRIPTION
The service gathers data from Soft Mobility Providers using the Mobility Data Specification (MDS), allowing for the real-time collection of critical mobility information such as vehicle positions, trip details, and irregularities like incorrect parking. This data is then securely stored and processed to identify key patterns and events, which are crucial for urban mobility management. Through open APIs, such as NGSI-LD, the processed information is made available, enabling the MST Dashboard to present these insights in a clear, intuitive format. This empowers city officials to easily monitor and manage mobility services, ensuring a more efficient and organized urban environment.

CONTEXT
The city of Porto has implemented strict regulations for the operation of Soft Mobility services, requiring comprehensive monitoring of all circulating vehicles. Service providers must adhere to these rules, and violations result in alerts and fines. To facilitate this oversight, the city developed the Soft Mobility Monitoring (MST) service. The MST service collects telemetry data from soft mobility vehicles via the Mobility Data Specification (MDS), which is provided by all operators in the city. This data is processed and stored in the Context Broker for real-time monitoring, and in the Data Warehouse for trip records and accounting purposes. An in-house developed service analyses this data, calculating warnings and alerts for rule violations. These alerts are loaded back into the Context Broker and sent to providers via email notifications. The data is also visualized in an intuitive dashboard, providing the city's Mobility Operations teams with real-time insights for effective management.



In the city of Porto, all soft mobility providers are required to share real-time operational data with the municipality, including the location of each vehicle. The Urban Platform's dashboard displays this real-time data from soft mobility vehicles such as e-scooters and bikes, including vehicle locations, trip details, and any violations like improper parking. By aggregating telemetry from multiple providers, the dashboard offers city officials a clear and actionable visualization for effectively managing soft mobility throughout the city.

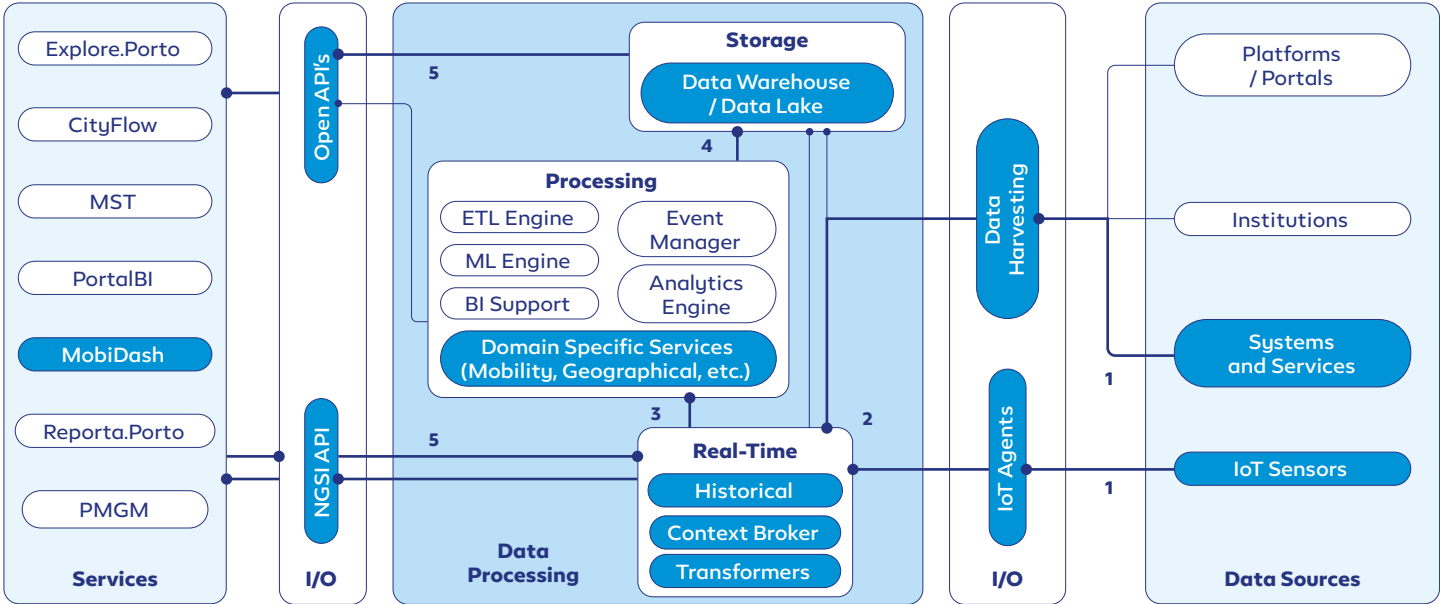
Advance Analytics for Mobility Management

DATA MODELS
Alerts, TrafficFlowObserved, Devices and Vehicles

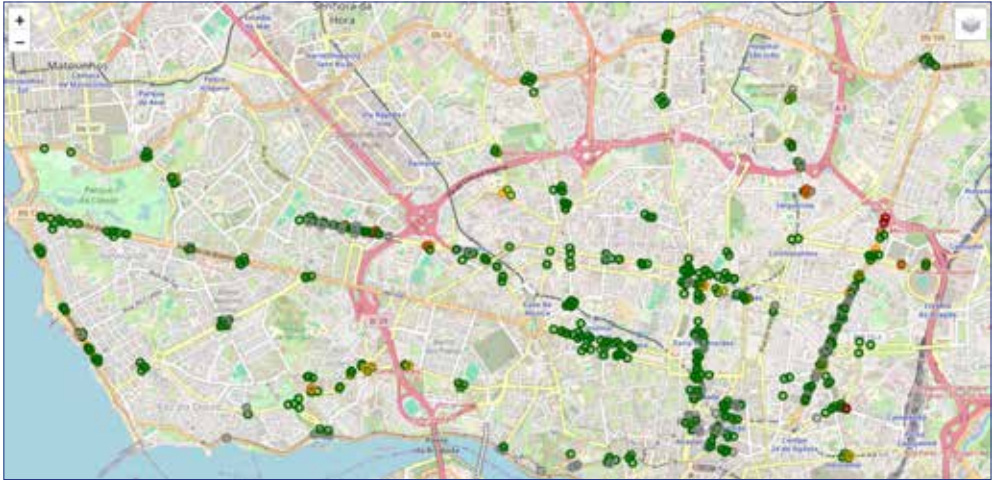
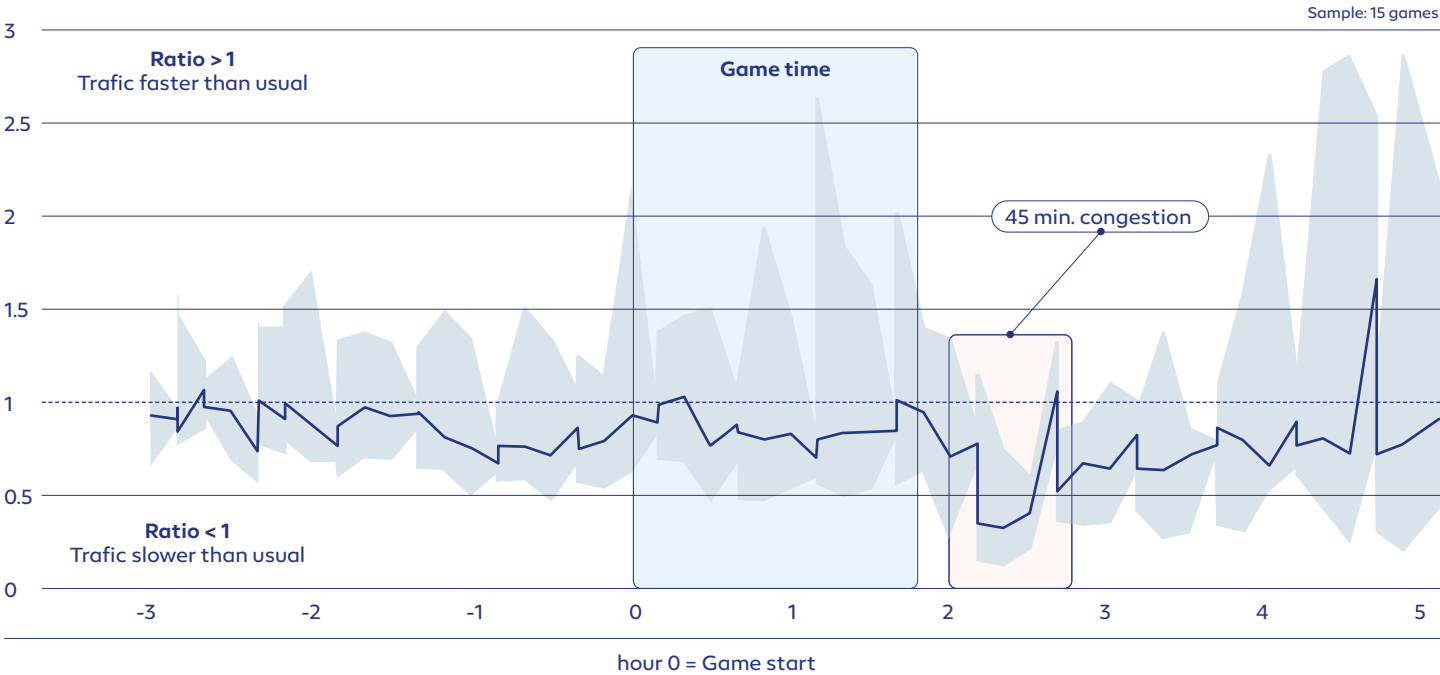
- COMPONENTS AND DATA FLOW
- 1 Data Harvesting and Transformation.
 - 2 Data Transformation and Loading.
 - 3 Processing Mobility Specific Data Services.
 - 4 Storing Historical Data.
 - 5 Servicing Data to MobiDash for visualization.

DESCRIPTION
MobiDash (Mobility Dashboard) is the product of a collaborative effort between data and mobility experts, designed to provide a streamlined way to visualize and manage traffic information through a single, intuitive dashboard. The development team works closely with City Officials responsible for traffic management, gathering their requirements and challenges to deploy tailored data services that meet their needs. Currently, the dashboard offers a map-based visualization that integrates data from traffic loop inductors and road alerts within the city, with real-time bus movements and floating car data set to be added in the near future.

CONTEXT
MobiDash is a StreamLit-based application designed to provide comprehensive data services and visualizations for the Traffic Management team at the Municipality of Porto, powered by the Urban Platform. The dashboard integrates data from multiple sources, including Traffic Loop Inductors, Bus Systems, CCTV Cameras and Road Alerts, which are collected through Data Harvesters and Transformers. This data is then stored in the Context Broker and Data Lake for long-term retention and historical analysis. By accessing this information via NGSI-LD, the backend processes the data to create real-time traffic services, which are visualized through the platform's user-friendly interface. Currently, Floating Car Data is being incorporated into the Urban Platform, enhancing MobiDash's data capabilities. Additionally, the team is developing a Proof of Concept for predictive analytics services, aimed at improving traffic flow management and decision-making.



Game day velocity
1 = normal day velocity



Advanced analytics for mobility provides valuable insights into the impact of large events, such as football games, on city traffic. In this example, a graphic visualization displays normalized traffic data collected from 15 FC Porto matches, based on information gathered from more than 1700 traffic controllers near Estádio do Dragão. The shaded area in the center represents game time, where traffic fluctuates around the baseline. Notably, a 45-minute period of congestion after the game (highlighted in red) indicates a significant slowdown compared to normal conditions.

Digital Transparency

DATA MODELS
Devices, Access Point and CCTV

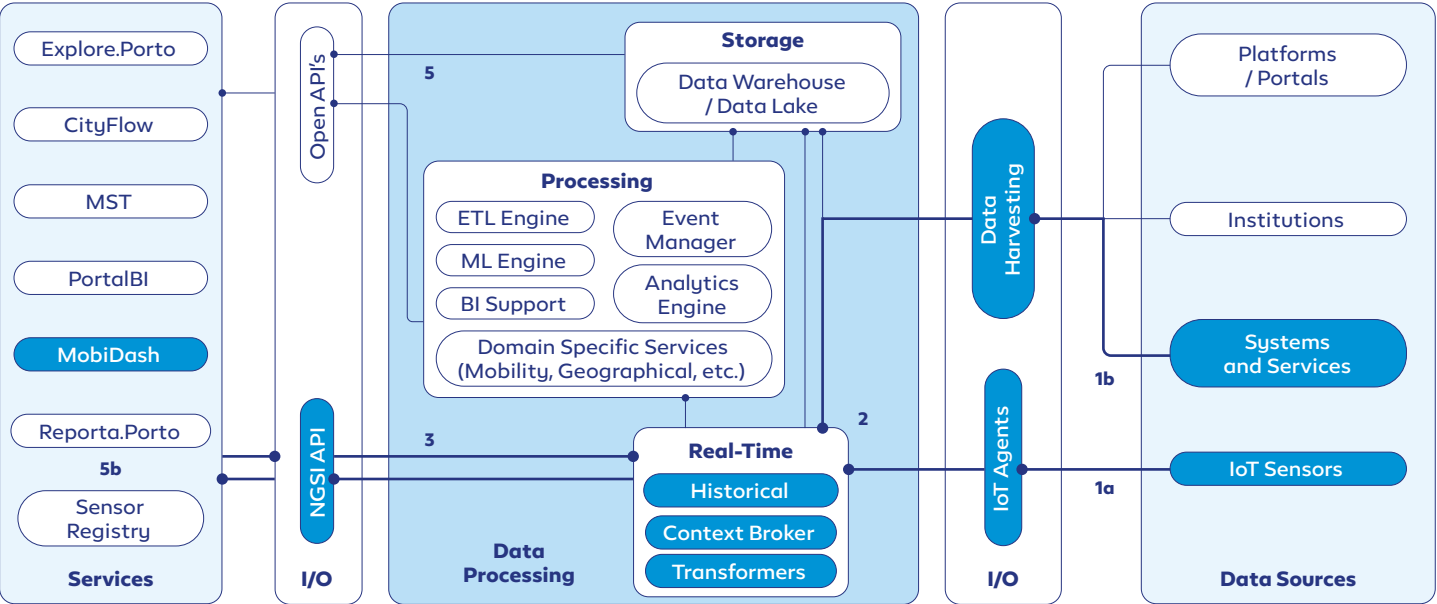
- COMPONENTS AND DATA FLOW
- 1 Data collect from IoT infrastructure and other Platform regarding the type and location of Devices.
 - 2 Data is stored and transformed using the SmartDataModels ontology.
 - 3 Data is shared with service layer via NGSI-LD API.
 - 4 The data is then visualized in the Sensor Registry Platform.

DESCRIPTION

The “Digital Transparency in Porto” project promotes transparency by providing access to data on the technologies shaping the city. This pilot combines physical signage with a digital platform, allowing people to easily access information about the city’s technologies and services. The signage identifies five types of technology: weather stations, air quality stations, noise sensors, traffic CCTV and Wi-Fi access points. Using the DTPR (Digital Trust for Places & Routines) taxonomy, the signs feature icons showing the type of technology, responsible organization, and a QR Code linking to the “Porto City Digital Systems Information Platform,” where users can find detailed information on data collection and processing.

CONTEXT

The “Digital Transparency in Porto” project aims to identify public space technologies and provide easy access to information, while evaluating the impact of signage and a digital platform on fostering civic dialogue and raising awareness about data’s importance over a six-month pilot. The data is collected from the information available within the Context Broker regarding location of IoT Infrastructure gathered the Urban Platform. This data is then collected via the NGSI-LD API and used by the Sensor Registry platform, managed by Helpful places to make it easy to visualize and interact with. Overall, this project reinforces Porto’s commitment to transparency and digital rights, enabling citizens to understand and participate in the urban digital ecosystem.



In September, signage developed to highlight urban technologies was installed in strategic locations throughout the city of Porto. Following this installation, Porto Digital conducted an awareness campaign aimed at informing citizens about these

technological solutions and digital rights, while also gathering feedback on the usefulness of the signage. In a subsequent phase, a second survey was carried out to assess citizens' perceptions of urban technologies, their benefits, and usefulness, as well

as the impact of these technologies on the city. This new survey also allowed for a comparison of the evolution of citizens' knowledge with the results obtained before the signage was installed.