EIB technical note

ITS procurement for urban mobility

European Investment Bank

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Steered by a working group composed of the following experts:
PJ Mobility, Air, Maritime & Innovative Transport (AMIT): Ozhan Yilmaz
PJ Mobility, Strategic Transport Advisory (STAD): Paul Riley, Mihai Grecu
PJ Innovation & Competitiveness, Small Businesses and Innovation Advisory (SBIA): Gwendolyn Carpenter

Project management:
PJ Urban and Territorial Development, Urban Advisory (URBAD): Joachim Schneider

Consulted with the informal EIB/JASPERS working group on ICT in Urban Mobility

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98 -100, boulevard Konrad Adenauer – L-2950 Luxembourg
+352 4379-1
info@eib.org
www.eib.org
twitter.com/eib
facebook.com/europeaninvestmentbank
youtube.com/eibtheeubank

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Executive summary

Rationale

This technical note supports the EIB at large and its technical advisory services (including JASPERS) in assisting local authorities with procuring intelligent transport systems (ITS) and overcoming the difficulties that often arise from ITS implementation. These difficulties can manifest themselves in many ways including:

- lack of a strategic context in which the purpose of the ITS system is defined;
- lack of interoperability and modularity leading to vendor lock-in;
- technical problems during implementation causing delays and higher costs for the procuring body;
- poorly performing systems with little means for redress;
- limitations on the reuse of ITS data for other purposes.

The lack of knowledge about ITS and how to properly specify them in public procurement processes are often important contributory factors. By providing detailed insights into ITS procurement practices and principles as well as putting forward a series of practical recommendations, this technical note may help build up the capacity of local authorities to procure ITS in a more efficient and effective manner. It may also help local authorities to specify requests for EIB technical advisory services (including JASPERS) and to seek financial support for the implementation of appropriate investments.

Method

The process of drafting this report has required gathering and analysing information from a wide range of sources related to ITS procurement drivers, practices and outcomes. The information sources have included an extensive literature review that is documented in Chapter 1. The topics covered in this chapter include the relationship between ITS procurement and mobility or city development planning, the need for standardised interfaces to tackle vendor lock-in, which is commonplace in many EU countries, and a review of the European Union's electronic procurement platform TED to get a flavour of how public authorities draft ITS tenders.

A second important source of information for this report was real-life ITS procurement cases carried out in the past ten years in seven different administrations. Information was gathered from interviews and tender documents about the ITS procurement process, implementation experience and the technical requirements. These are described in detail in seven case studies annexed to this report and are the subject of a comparative assessment in Chapter 2. The case studies cover parking guidance (Ghent) and enforcement (Bilbao), enforcement of a low emissions zone (Brussels region) and access restricted zones (Rome), real-time passenger information (Dublin and Utrecht/Netherlands) and, lastly, traffic signal management (Timişoara).

Building on Chapters 1 and 2, a comprehensive set of ITS procurement principles and a series of practical recommendations have been established in Chapter 3, following the full procurement process, from conception to implementation.

Main findings

The report covers a wide range of ITS procurement issues of a technical, functional, policy, organisational and financial nature. A number of recurrent themes have emerged from the research. The first concerns policy, specifically the importance of procuring ITS as part of a wider sustainable mobility or city development plan, to ensure that the ITS procured responds to a genuine goal, need or problem. Building on the policy perspective, the second theme relates to the functional specification of the ITS as opposed to system specification, meaning that the tender should describe the purpose of the system and not the system itself, thereby leaving it to the market to propose solutions that can best serve the identified needs. Developing in-house ITS expertise is the third theme that merits attention because the absence of ITS knowledge makes an administration wholly reliant on consultants and suppliers for advice. However, it should be underlined that building local ITS capacity is not a substitute for external advisory services but a precondition for good use of external advisory services. Another key finding relates to market engagement at the early stages to understand whether the functions that the administration expects the ITS to deliver are realistic. A final important theme is of a technical nature, specifically the use of open specifications and standards to enable a modular architecture and a multi-vendor environment.

Recommendations

A set of guiding principles for procuring ITS, supported by recommendations, is presented in Chapter 3. They cover the most important phases in the ITS procurement planning, specification and implementation phases.

- The first phase 'laying the groundwork' essentially refers to the policy, planning and organisational aspects that need to be in place at the outset, such as starting from a higher level plan, ensuring coordination within the administration and with other agencies and administrative levels, securing political support, ITS capacity building and benchmarking.
- The information gathered in the first phase feeds into the next phase 'strategic decision-making' which deals with big questions with potentially large impacts in terms of delivery and long-term ITS planning, such as getting the procurement timeline right, integrating with legacy systems, achieving a multi-vendor environment, choosing the right contract type and consulting the market.
- The third phase deals with the technical specifications themselves and covers topics such as how to describe tenders functionally, setting data ownership and (re)use conditions, anticipating licence fees and requiring open specifications and standards where possible.
- The fourth phase covers the actual tendering process itself and highlights the importance of building a relationship with potential suppliers and how to achieve it in a fair and transparent manner as well as recommending how to establish award criteria.
- The final phase 'project implementation' addresses the commissioning and testing phase, maintenance practices and tips on sustaining systems in the medium to long term.

Whilst this technical report has been drafted primarily for the benefit of use by the EIB (JASPERS) and local authorities, it may well be of use to other stakeholders such as national authorities, public transport authorities or other lenders.

The table below lists the full set of recommendations in Chapter 3 and indicates which stakeholders they may be most relevant for (of course this may vary depending on local responsibilities), including various types of stakeholder within the local authority (political, urban/transport planners, public transport authority, ITS coordinators).

Summary of recommendations (per stakeholder type)

Stakeholders:	Local politicians	Urban/transport planners (local)	Local ITS coordinator	Local public transport authority	National government	European Commission	Institutional lender (incl. EIB)
1. Laying the groundwork							
1.1. Start from a city development and/or sustainable mobility plan							
Use the objectives and goals of the **sustainable urban mobility plan** (SUMP) or other city/transport development plan(s) as the basis for the procurement.	●	●	●	●			
Always highlight the link between functionalities requested and strategy.			●				
Revisit section 1.2 of this report (ITS from a planning perspective) for further information about mobility and ITS planning and for links to relevant initiatives.		●	●				●
1.2. Improve coordination at all administrative levels							
Disseminate information about upcoming tendering processes within the mobility department; keep other departments informed, so that synergies can be achieved.		●	●	●			
Involve a smart cities manager (or department) in strategic decision-making on ITS tenders to enable synergies (e.g. internet of things (IoT) communication technology, open data).		●	●				
Investigate whether the delivery of a system or function can be more effective at another administrative level ('functional region'). Explore the practices of other regions and/or countries.		●	●	●	●		●
1.3. Involve political representatives							
Involve political representatives in setting the objectives, securing the budget and high-level monitoring through a steering committee. Discourage their involvement in conversations with possible suppliers, or in defining the technology to be used.	●	●	●				
1.4. Capacity building and external expertise							
Make an honest assessment of in-house ITS knowledge. Hire consultants where there is insufficient capacity for specific tasks, but make sure that city staff always remain in control.			●				●
Build in-house ITS capacity at local or inter-municipal level; start with joining the activities of the **national ITS platform** (for language and cultural reasons), and then move on to international activities (ITS congresses, EU projects and city networks).			●				
For tenders for external consultants, use award criteria based on proven experience and documentable references.			●				

Make proactive use of external expertise for internal capacity building.			●				
Approach cities implementing similar systems and enquire about the skills required and the external expertise engaged. Use information sources (CIVITAS and Eltis) and networks (POLIS and **Eurocities**) to identify such cities.			●			●	
Develop familiarity with ITS solutions and the market.			●				
Contact other authorities or organisations implementing similar ITS schemes.			●		●		●
Consult with national ITS departments, the **national ITS organisation** and European networks mentioned above.			●		●		●
Share tendering documents and findings with other cities and governments.			●		●	●	
Build a relationship of trust and transparency with the market as a whole. Engage with local authorities from countries where this type of relationship is well established, such as in the Netherlands, the Nordic countries or the United Kingdom.			●		●		
2. Strategic decision-making							
2.1 Timelines							
Plan in reverse, starting from the expected delivery time and working backwards to the moment the market consultation is launched. Incorporate ample time reserves.			●				
Do not commit to timelines that are not considered realistic by both the city team and the supplier – this may lead to negative consequences in terms of functionality, public perception and financial penalties. Assess feasible timings in a market consultation.			●				
Make sure that, from the very beginning, all parties concerned know what is expected of them and when. Meet with critical stakeholders, such as the legal service, to discuss timelines and availability.			●				
Avoid holiday periods and busy moments for market consultations; give sufficient time to tenders and suppliers for preparing and submitting bids.			●				
2.2. Legacy and future systems							
Conduct a business analysis for (partly) replacing legacy systems.		●	●	●			
Conduct a business analysis regarding customisations needed to connect with existing systems.			●	●			
Draw up a plan for the future and afterlife of the systems to be procured.			●	●			
2.3. Modular architecture and multi-vendor environments							
Consider a modular approach when (parts of) the system will most likely have to communicate with systems from other vendors (e.g. variable message sign (VMS) software with temporary/mobile signs or a traffic light computer with legacy controllers).			●	●			
Clearly define the roles and responsibilities in case of malfunction. Wherever possible, aim to attribute the overall responsibility to a single party.			●	●			
If the system is made up of components that can be clearly separated (like hardware and software) and clear agreements can be made on interfaces and responsibilities, investigate breaking the tender up into different parts, to ensure modularity. Ensure that in such cases a skilled data/IT systems architect is involved.			●	●			

2.4. Managing uncertainty and choosing a contract type							
Thoroughly research the different forms of procurement and contract types.	●	●	●		●		●
Request, in a market consultation, pricing models for several contract types so the right balance can be found between outsourcing work and risk versus affordability.			●				
2.5. Market consultations and tendering procedures							
Prior to the market consultation, carry out benchmarking of the supplier market and of cities implementing similar measures – see section 3.2.5 for organisations that may be able to assist with benchmarking.	●	●	●	●	●		●
Conduct the market consultation at a time when the project team has enough knowledge to ask the right questions.			●				
Maintain transparency and equality in any market consultation, e.g. posting on a public webpage all consultation-related questions from the suppliers and responses from the tendering body.			●				
Consider the competitive dialogue procedure for procurements of a complex nature, where there is uncertainty and a need for negotiation.			●				
If considering a competitive dialogue or innovation partnership for small projects, thoroughly weigh the administrative and legal efforts from both the authority and supplier against the benefits.			●				
Consult the national ITS team and legal department before considering innovation partnerships.			●		●		
3. Technical specifications							
3.1. Procuring systems versus functions							
Make sure the main objectives, functions and context are always described in the tender, and include reference to the wider policy context and/or plan and procedures preceding the tender (e.g. external expertise).		●	●				
Include detailed specifications where they serve a clear purpose.			●				
Clearly define the responsibility of the supplier and separate it from that of the procuring authority.			●				
Describe clear service level agreements (SLAs) and key performance indicators (KPIs) and link them to financial rewards or penalties.		●	●				
Accord the supplier liberty to propose alternative solutions, for example by allowing variants or options in the offers. This can result in better performing or cheaper alternatives.			●				
3.2. Data ownership and/or (re)use conditions							
Include a clause on data ownership as a default clause in all tenders.		●	●				
Include in the tender a description of the data needed, how and when it is to be accessed, and the level of granularity (raw or aggregated).		●	●				
Reference a licensing model for data sharing, such as those from **Creative Commons**.			●		●		●
Visit the national open data portals to obtain an overview of the transport data made available in the public domain in each country; to access these use the **EU open data portal**.			●		●	●	●

3.3. Guarantees and liability							
Make sure that local authorities fall back on the legal European terms for warranty.			●			●	
Clarify who is responsible during the warranty period and afterwards, for example for errors, collisions, vandalism, cleaning and maintenance.			●				
Clearly describe what happens if the system is not accepted after the warranty period.			●				
3.4. Licence fees							
Include a budget for licences. An authority may decide to set a budget range/ceiling for licences, for example 20%.			●				
Ensure that suppliers clearly define all the licences (and contents) that must be procured and give their cost over a given period of time (e.g. yearly, two or five years).			●				
Where possible, use software with an all-inclusive service model.			●				
If the software licence is procured as part of the contract, aim to issue the licence in the name of the tendering authority.			●				
Avoid extensive system customisation (see above on modularity).			●				
3.5. Open specifications and standards							
Carry out an assessment of existing open specifications and standards frameworks (see section 1.3), and review the materials of related projects such as POSSE and SPICE.		●	●	●	●	●	●
Make sure that open specifications and standards protocols are part of the market consultation, with a focus on connections to legacy systems or components that will be replaced or linked in the future.			●				
Outline the use of open specifications and standards as an important dimension in the specifications, and possibly use it as part of the award criteria.			●				
Request a working demonstration from suppliers guaranteeing that their system will work with a certain protocol – compatibility claims have often proven to be less obvious than promised.			●				
Make an assessment of the functionalities needed. Some supplier-proprietary functionalities will not be possible with open protocols.		●	●	●			
If suppliers cannot or choose not to work with standardised protocols or interfaces, request that they work at least with an open protocol and interface, meaning that third parties can create a custom integration if needed.			●				
4. Tendering process							
4.1. Relationship with possible suppliers							
Conduct an open and transparent communication process with suppliers: avoid one-to-one conversations (unless permitted as part of a procurement procedure), and as an authority remain open to questions and ensure that all parties receive the same information.		●	●				
Use the **European Tendering Platform (TED)** for interaction with possible suppliers.			●			●	●
Prepare the award report correctly, referring only to the award criteria, and avoid making comparisons to other suppliers' bids. Ensure that the legal department verifies that the criteria are applied correctly and are well founded.	●		●				

4.2. Award criteria							
Consider benchmarking of award criteria against those adopted in similar schemes procured in other cities. A possible relevant source of information is the European public procurement portal **TED** where tenders display 'Award criteria' in section II.2.5.		●	●				
Give careful consideration to the criteria, as they are decisive and cannot be changed.	●	●	●				
Adopt a limited number of criteria, to avoid certain key criteria having too few points.			●				
Potentially define minimum scores for selected criteria for the offer to be valid, e.g. as applied by Dublin.			●				
Consider, as a tendering authority, providing a standard template for offers to make it easier to compare and score the offers.			●				
5. Project implementation							
5.1. Commissioning and testing							
Carry out a test of each individual component and function and the system as a whole.			●				
Make sure tendering authority staff are present during the testing phase and sign off the testing phase once satisfied with the results.			●				
5.2. Maintenance							
Specify the response times for repairs/replacement, or have suppliers propose a maintenance plan as part of their offer.			●				
Thoroughly consider the duration of the maintenance period against the cost.	●		●				
Consider introducing service-level and/or performance-based agreements in the tender.	●	●	●				
5.3. Sustaining systems in the medium to long term							
Specify the availability of the supplier and of spare parts for a defined period. Consider including a yearly re-evaluation of the price for fast-evolving technologies.			●				
If there is uncertainty about the need for additional related tasks and equipment, include these in the tender, but specify that the tendering authority is under no obligation to commission them and the supplier has no entitlement to the budget. This clause has the advantage of circumventing additional procurements for smaller items without committing the tendering authority.	●	●	●				
Consider training for local operating and maintenance staff and involve those teams – if not already part of the procurement/rollout team – in the implementation of the project.			●				

Chapter 1

Literature review

1.1. Introduction

Intelligent transport systems (ITS) are widely deployed in cities large and small to manage the transport network (infrastructure and services) efficiently and safely, to keep travellers informed and to deliver seamless trips. ITS provides a technological tool for public authorities to manage transport according to their policy goals. It was initially conceived to make best use of road capacity and to obviate the need for constructing more roads to cope with rising demand and growing congestion. While this is still important today, other policy imperatives are increasingly influencing the form and function of ITS adoption, in particular policies addressing decarbonisation, poor air quality (to protect public health and cultural heritage), road safety, modal shift, active travel and wider liveable city objectives.

From a city perspective and for the purpose of this study, ITS is defined as information and communication technologies (ICT) systems enabling typical urban transport functions including:

- managing transport flows (at traffic signals, public transport fleets, bikes, etc.);
- enforcement (of regulations such as parking, speed or access restrictions);
- information to users (for example about the transport service and for trip planning);
- service integration (such as integrated payment schemes).

The first chapter of this technical note provides an overview of the link between ITS and urban mobility policy and planning and highlights some of the challenges arising from ITS procurement and how they can be addressed. The aim of the chapter is to show the importance of adopting a strategic approach to ITS procurement and draw attention to some of the tools (methods, technical specifications, among others) to achieve this, such as the integrated planning process encapsulated in the sustainable urban mobility plan (SUMP) and open standards and specification frameworks that can reduce ITS costs and promote a multi-vendor environment.

The chapter draws on information gleaned from a wide range of ITS procurement-related projects, studies and tenders, which had been identified by the EIB (JASPERS) and/or the expert. It is therefore primarily drawing on secondary sources of information, whereas subsequent chapters will be based on primary sources, in the form of interviews supported by tender documentation. The material reviewed covers many different subjects that are relevant to ITS procurement, including city policy and planning, interoperability frameworks, procurement procedures and guidelines and recent ITS innovations.

The chapter starts by describing the role of ITS as a tool to achieve sustainable mobility goals and the importance of adopting a strategic approach to defining ITS needs, taking advantage of the SUMP framework to identify a mobility vision, the current challenges, the measures identified and eventually an ITS action plan. It then moves on to the actual procurement process itself, focusing on the widespread problem of vendor lock-in and its consequences. An overview of existing open specification and standards frameworks is given along with some of the challenges and opportunities of adopting them. The next section shares the findings from a review of a selection of ITS tenders published in recent years and describes the different procedures for procuring ITS, including the opportunities of procuring ITS innovation. A small selection of new ITS developments is briefly introduced. Finally, a short description is given of the four selected ITS functional domains that are studied at greater length in Chapter 2.

1.2. ITS from a planning perspective

1.2.1. ITS as an enabler of sustainable urban mobility policy

There is a widely held view that ITS has a role to play in addressing some of today's mobility challenges and that ITS deployment should consequently be an important goal of cities. Yet without a strategic framework and/or a vision for mobility or wider city development, ITS implementations may not deliver the expected impact and may well become little more than technological toys. ITS will not be useful if the city fails to produce good policy or implement and enforce other measures. For example, heavily investing in traffic management and optimising junctions without introducing accompanying measures could attract more cars and increase congestion on adjacent junctions. Much of the material reviewed for this assignment supported the assertion that **ITS should not sit outside an (urban mobility) policy framework**. Thus, ITS is a tool to help deliver policy rather than a goal in itself. This point has been comprehensively elaborated, including in the *Applied Guidelines for Projects on Intelligent Transport Systems*.

Sustainable urban mobility planning offers an excellent strategic framework for cities to define their higher-level strategic goals. The sustainable urban mobility plan describes the plans a city has regarding mobility for the coming years and it is the result of a process shaped by many stakeholders, including citizens, public transport providers, businesses, universities, political representatives, schools, cyclists, member organisations, etc. Instead of randomly introducing policy measures to deal with the issues of the day, a **SUMP brings stability and focus**. It enables all stakeholders to sit together, take time to think about the coming years, set out a vision on how to improve mobility in a city or region, establish objectives with indicators/targets and define measures to address these objectives. SUMPs, or parts of them, are mandatory in some EU Member States and this study gives a good overview.

By way of example: in the case of the Romanian city of Cluj Napoca, the problems identified in its 2016 SUMP included growth in car ownership and the relatively low commercial speed of buses. Bus priority at traffic signals therefore emerged as a priority project in the SUMP. Cluj Napoca expressed the wish to move towards an integrated traffic management system with the traffic control centre as the focus for all traffic and transportation-related matters and it formed a working group to develop the idea, involving public transport, parking and traffic management departments. (Source: *Terms of Reference for design and procurement of integrated ITS*).

It is acknowledged that not all cities have a SUMP. Yet most cities do have an urban mobility strategy in one form or another or a set of (modal-specific) policies and/or a smart city strategy. These strategic and/or policy documents can act as a proxy for a SUMP. To achieve multiple policy purposes – especially climate goals such as low emission zones or increased public safety – it is recommended to consider relevant sustainable local and national development plans and to check relevant technical and legal specifications.

Further reading

- **Creating a SUMP:** Eltis, 'The Urban Mobility Observatory' has a broad range of information on its website, including a section on SUMPs (click on the items on the right), policy briefs, best practices and funding opportunities, and it even organises an annual European Conference on SUMPs.
- **SUMP measures:** CIVITAS SUMPs-Up project – SUMP measure selection manual (annex 1). CIVITAS Initiative directory of 663 measures implemented throughout Europe from 2002–2012.

1.2.2. From sustainable mobility planning to ITS planning

A sustainable urban mobility plan will typically not include details on the systems to implement to ensure safe, sustainable and efficient mobility. This is subject to the selection of a set of implementation measures. The measures can include infrastructure adjustments, policy implementations and an ITS action plan. The ITS action plan sets out how ITS can help put the SUMP into practice, thereby starting from the policy rather than the technology. The SUMP topic guide on *The role of ITS in Sustainable Urban Mobility Planning* recommends that the operational responsibility for implementing ITS should be separate from the SUMP creation process and the implementation should be started after completing a first version of the SUMP. This avoids a shift in focus from mobility policy objectives to technologies and solutions.

Just like the SUMP, the ITS action plan ensures stability and overview. One of the main benefits of having a plan is the opportunity it provides to exploit synergies between different systems. ITS planning from an overarching perspective can lead to resource savings.

a) Some technologies can be used to address different challenges, for example automatic number plate recognition (ANPR) cameras can be used to enforce low emission zones, speed limits, pedestrian zones, parking permits and even illegal dumping. The systems studied in the Brussels and Dutch case studies (in annex) demonstrate this multi-functionality. There may be opportunities for synergies in the underlying software and IT systems: using a common architecture, combining data from different systems, using one specific data set for multiple purposes through data analytics, reusing 4G data connections or existing Wi-Fi networks, cloud-based hosting for multiple applications, etc.

b) Synergies may also be found with other departments and agencies; for instance, if installing a fibre optics network to connect the control centre to the traffic signal controller, additional capacity could be built in for the benefit of other public services (libraries, education, police, hospitals, etc.), thereby enabling costs to be shared. The Brussels region adopted this approach when installing fibre optics and it also made use of existing infrastructure by passing a significant part of its fibre optic cables through the metro tunnels.

Although the above process (policy > SUMP > ITS action/deployment plan) is already a very pragmatic distillation from rather lengthy processes described in theory, very few cities actually apply it in practice. ITS action plans do exist at a national, and to a lesser extent, regional level. Under the European Union's ITS Directive from 2010, Member States are required to submit a five-year plan setting out how they propose to implement the ITS Directive delegated acts, as well as regular progress reports. These plans tend to focus on developments at the national level; however, they should in the future include local ITS as recent and future delegated acts are applied at local level (revision of the European Union's MMTIS and RTTI Regulations). On a city level, the desk research has only produced one ITS action plan, for the city of Copenhagen dating from 2015-2016, although they are more prevalent in the United States.

Both the *Applied Guidelines for Projects on Intelligent Transport Systems* and the *Terms of Reference for design and procurement of integrated ITS* recommend that a city should adopt a higher-level ITS strategy as well as an ITS action plan. The interviews conducted for the creation of Chapter 2 are too few to draw general conclusions, but few cities confirmed conducting a formal measure selection process. Timişoara indicated using an action plan added to the SUMP, which is considered a very important document to the mobility department. Ghent appointed a programme manager to implement the SUMP, who supervised a number of smaller projects that were organised thematically or by system: cycling, traffic lights, pedestrian area, park & ride, communication, traffic management, monitoring and evaluation. On the other hand, the city of Ghent indicated that ITS projects are initiated more bottom-up than top-down: each division (from the Mobility Department) will decide which tools and projects are needed for their specific area, and will always refer back to the SUMP to ensure the actions are in line with the high-level policy set. In practice, this means there is a feedback loop going back and forth. When implementing measures, some feedback is generated, and concrete measures are checked with the policymakers in order to align practice with theory and policy. The example is given of an off-street multi-storey car park with three entrances which results in hard-to-manage traffic flows. The traffic control centre requested politicians to validate a change to one of the entrances (as this is a decision which is seen as politically sensitive).

Further reading:

- **SUMP topic guide** on The role of ITS in Sustainable Urban Mobility Planning. Chapter 3 'Considering ITS in SUMP Implementation' indicates how ITS can be used to achieve the SUMP objectives. The creation of an ITS action plan is not explicitly mentioned, instead ITS plays an important role in the SUMP process.
- **SUMP and ITS measures:** The Ch4llenge project created a SUMP Measure Selection Kit: Selecting the most effective packages of measures for Sustainable Urban Mobility Plans (English version). Many objectives and challenges cannot be resolved by ITS per se. Policies, infrastructure, communication, pricing and awareness may be needed to respond effectively to the challenges that local authorities are facing but ITS can play an enabling role in delivering them.
- **SUMP monitoring and evaluation:** The Ch4llenge project has created many SUMP kits to guide the delivery of different aspects of developing a SUMP, including one assessing the impact of measures and evaluating mobility planning processes. This pragmatic guide offers practical advice on choosing indicators, datasets and evaluation methods and presenting results. It is available in English, Croatian, Czech, Dutch, French, German, Hungarian, Polish and Romanian.

1.2.3. From ITS planning to ITS procurement

Moving from the ITS planning to the ITS procurement stage can be daunting for some cities due to the lack of in-house ITS knowledge and skills, particularly among small and medium-sized cities. The importance of developing an institutional framework and capacity is highlighted in the *Applied Guidelines for Projects on Intelligent Transport Systems,* which uses the following metaphor to describe the absence of these elements: *"like a programming company with outdated* *computers and unskilled programmers trying to be competitive by buying state-of-the-art software and operating systems to install on outdated computers."*

Some cities recruit a consultant to advise them on ITS matters, including the procurement process. The EIB (JASPERS) has produced a standard set of Terms of Reference for the procurement of advisory services to support the planning and procurement of an integrated traffic management system.

Further reading: Terms of Reference for design and procurement of integrated ITS

This document (available on request in Romanian and English languages) was drafted to support cities in preparing for the procurement of an integrated traffic management system, including a control centre. The original terms of reference were prepared for the Romanian city of Cluj Napoca; however, the document is sufficiently generic to be applicable to other cities. The document provides detailed guidance on the design, specification, procurement and implementation of an urban traffic management system, including the procurement of the services of a consultant to support the city in carrying out this task. Table 2 provides a useful overview of the phases, tasks and outputs involved in this process along with a tentative timeline.

The terms of reference suggest that the starting points of any ITS procurement should be the SUMP and a definition of the problem or need that the ITS is expected to resolve. Other recommendations include the preparation of an ITS strategy and action plan, consultation with key stakeholders (including other city departments and agencies), the definition of deployment and outcome KPIs, determining the usefulness of open interfaces and conducting market consultation prior to procurement, among others.

A poorly specified tender may perpetuate widespread problems of vendor lock-in, explained in the next section, or of additional costs incurred by the customer (when it wishes to use a particular system or data for purposes other than that for which it was initially procured).

Over the years, cities large and small across Europe have experienced many of the following adverse impacts due to inadequate ITS planning and poorly specified ITS tenders:

a) If a city decides to change one part (e.g. a user interface) of an end-to-end solution procured from a supplier, it needs to replace the entire end-to-end solution.

b) A city typically is not the owner of the data coming out of the ITS solution it has acquired unless it had been written into the initial procurement contract.

c) Spare parts or maintenance can turn out to be extremely expensive if there is a monopoly or no clear agreements have been established.

d) Integration with other solutions or using the ITS solution for another purpose is extremely expensive or impossible.

The EIB's *Applied Guidelines for Projects on Intelligent Transport Systems* underlines the importance of good ITS planning that anticipates continuous maintenance, operation and updates of the ITS systems/platforms. The absence of such planning could lead to isolated systems that are incompatible, redundant, unable to communicate with each other and not guaranteed to be open data/open source and they may become non-functional, partially functional, obsolete or disconnected from mobility needs and realities.

1.3. Open ITS

1.3.1. The challenge of ITS vendor lock-in

Many local authorities across Europe are tied to a single supplier for all their ITS needs because the supplier has proprietary systems. This means that a local authority procuring a central traffic management system from one vendor typically procures all other systems (traffic controllers, variable message signs, car parking management/guidance system, bus priority system, etc.) from the same company. It is possible to procure from multiple vendors, but this requires building costly interfaces or suppliers opening up (part of) their protocols. For these reasons, a multi-vendor environment is not commonplace in cities, although there is growing momentum. This situation, termed vendor lock-in, arises in the absence of open and standardised interfaces. There are many negative consequences of vendor lock-in, namely, higher costs for the customer (local authority), a lesser incentive for the supply industry to innovate and a lack of competition in the ITS market.

The European project SPICE makes some interesting observations about vendor lock-in:

"Often, systems are black-boxed with the purpose of protecting business models. ITS manufacturers and suppliers are interested in supplying systems that keep the client within the suppliers' ecosystem.

As a consequence, if the procurer is not careful, this means that there can be a discrepancy between system and contract lifetimes. Equipment or a system can be purchased with a lifetime of 10, 15 or 25 years, but the service and maintenance contract for this equipment or system can run for a shorter period. After this period, it is expected that another procurement on service and maintenance will commence.

But if the equipment software is closed off, the road authority will be forced to either stick to the same supplier or discard the equipment or system as a whole.

In any case, many cities, countries and regions find themselves in a transition period where some of their systems and solutions are self-enclosed and stand alone, whereas new systems purchased have a higher degree of connectedness. In this transition period, it is recommended to have new suppliers deliver ITS solutions that rely on truly open standards."
(D3 SPICE Analysis and Recommendations, p. 91)

1.3.2. Overcoming vendor lock-in through open specifications and standards (OSS)

Some parts of Europe have been working to overcome vendor lock-in through the development of open specifications and standards, including:

a) German-speaking regions of Europe (DACH) through the OCIT/OTS frameworks

b) The United Kingdom's UTMC initiative

c) The Nordic region's RSMP protocol

d) The Netherlands through the Ivera communication protocol and DVM-Exchange

Through the specification of common interfaces, an OSS framework enables a local authority to procure systems from mixed vendors and suppliers to access a potentially larger customer base. Common interfaces usually enable technical integration of sub-systems, although such systems are rarely able to interoperate. Rather, they can co-exist within an ITS architecture and the actual 'integration' happens at the level of the common database/data centre. Consequently, the 'integrated' systems may not operate in an optimal manner because certain functionalities specific to a supplier can only be enabled by systems from the same supplier. This can give the supplier of the back-office system in a city the advantage over future systems procured. Whether all the system functionalities offered by a system are needed by a city is a question to be asked and a trade-off to be considered.

The European project POSSE (Promoting Open Specifications and Standards in Europe) was an interregional cooperation project running from 2012 until 2014. POSSE was set up to raise awareness of the need for OSS for road-based transport management, and to share the experiences of existing open system frameworks (OCIT/OTS and UTMC) in Europe. A central objective of the project was to build the capacity of European transport authorities to implement OSS. A key output was a set of *Good Practice Guidelines on the Implementation and Development of Open Specifications and Standards for Intelligent Transport Systems* (November 2014). The guidelines offer a very comprehensive overview of UTMC and OCIT/OTS, the benefits and challenges of an OSS framework and a detailed step-by-step guide on how to introduce OSS, including some very useful tips.

The existing OSS frameworks (referred to above) have different starting points and driving forces (national initiative, industry-triggered, local authority grouping) and different governance models. For instance, OCIT is an industry standard developed in response to multiple local authorities joining forces to build their own interface specification. UTMC and RSMP were both initiated at national level (national government or transport administration). There is nonetheless consensus that such an open systems framework can only succeed where it is supported by both the public sector and the supply market. (Sources: OTS and UTMC websites)

1.3.3. The benefits and challenges of adopting open specifications and standards in ITS

The most established OSS frameworks, OCIT/OTS and UTMC, have demonstrated the following benefits for local authorities and suppliers. (Source: POSSE Good Practice Guidelines).

a) **Financial savings**: Greater independence from specific vendors. Cost reductions in the procurement of systems and staff operations. Some early city adopters of the German OCIT standard recorded a saving of between 50% and 80% on the investment and maintenance costs for signal controllers. UTMC adopters typically recorded a saving of 1-3.5 staff in the traffic control centre, according to the POSSE final brochure.

b) **Strategic traffic management**: Data that previously sat in the manufacturer's 'black box' system can now be accessed. The common database/dataset linking data from many systems allows easier control room operation, improved incident management and a better overview of the network status.

c) **Support for ITS procurement**: Simplified ITS procurement for local authorities due to readily available procurement specifications.

d) **Lower investment risks**: Future proofing of investments by providing a simple structure for the addition of new technology. (N.B. the *Applied Guidelines for Projects on Intelligent Transport Systems* also underlines the importance of existing and future systems being able to communicate).

e) **More competitive market**: Improved customer-supplier relations. A greater number of smaller companies winning contracts in an ITS market dominated by large players.

The POSSE Good Practice Guidelines highlight some of the challenges and lessons learnt from implementing OSS.

a) **Uniqueness of each authority**: Each road authority is different and has its own management style and set of needs. Some prefer more expensive, tried-and-tested solutions whereas others are willing to take the risk with a cheaper solution. Some are more focused on traffic control whereas others are more concerned with network monitoring and information provision.

b) **Skills gaps**: Modern networked technologies are easier to develop, install, connect and operate than older systems. But traffic managers often lack the skills to specify them and to manage a supply contract. Non-technical people struggle to understand why two systems that are 'compliant' with the same standard cannot interoperate without specific adaptors.

c) **Technical limitations and value proposition**: The specification and procurement of systems are easier but 'plug and play' are rarely possible. Technical specifications are only useful if they make systems more reliable, cheaper or easier to use.

A further challenge that emerged from informal discussions within the POSSE project, which has not been documented, relates to the willingness of an authority to break open the vendor lock-in. The reality is that some authorities are prepared to accept an exclusive relationship with a supplier because of the advantages this may offer: the supplier will have an in-depth knowledge of the city's ITS systems as well as the mobility system and in some cases will even provide staff for the traffic control centre. This creates a relationship of trust and is viewed by authorities as being more advantageous than going it alone.

1.3.4. Including open specifications and standards in ITS procurement

Local authorities are advised to become familiar with the latest open specifications and standards, such as those mentioned in section 1.3.2, and to use them where possible. It remains to be seen how feasible and practical it is to specify an existing OSS in the procurement for a city or country with no culture of adopting OSS. The POSSE project has mapped out the five steps that an authority can follow to introduce open interfaces into system procurement. It is not necessary to follow all phases nor to implement all functions. The phases and functions are described in detail in the POSSE Good Practice Guidelines.

1.4. ITS procurement in practice

1.4.1. A review of tenders on TED

An exploration of the European public procurement portal TED was undertaken to analyse a representative sample of ITS-related tenders issued by public authorities in recent years. The main purpose of this exercise, as expressed by the EIB (JASPERS), was to build up knowledge on how public authorities tender ITS. There was particular interest in understanding whether authorities procure ITS from a **system/functional** or from a technology perspective and secondary interest in the types of technical clauses that may be included. A total of **33 tenders** were reviewed including 29 contract notices and four prior information notices.

Tenders in the following **functional areas** were targeted: traffic signal priority; low emission zone management; fleet management (bus, tram); real-time public transport information; real-time parking space information availability and guidance; speed warning and enforcement. In order to find a representative number of relevant tenders, the following **search parameters** were used with the below results:

- Search terms: traffic signals (priority): 6; low emission zone: 1; ANPR: 7; fleet management: 0; real-time public transport: 0; automatic vehicle location: 1; passenger information: 3; real-time information: 5; real-time transport: 1; (real-time) parking (system): 6; speed warning: 0; speed enforcement: 0; speed camera: 3
- Countries: Czech Republic: 3; Denmark: 1; France: 3; Germany: 4; Greece: 1; Ireland: 2; Italy: 2; Netherlands: 2; Norway: 2; Poland: 6; Romania: 1; Sweden: 1; UK: 5;
- Languages: CZ: 3; DE: 4; EN: 10; FR: 3; GR: 1; IT: 2; NL: 2; PL: 6; RO: 1; SE: 1. For the non-English languages, online translation tools (mainly Google Translate) were used.
- Issuers: while the focus was on urban authorities, interesting tenders from other public entities were also considered: 26 city/regional authorities and 67 others (national authority, public agency, airport, etc.).

For the tenders selected, the following parameters were investigated and indexed: link to the publication on an e-tendering portal; publishing date; title; contact person; contracting authority; description; reference; value of the contract included (excluding VAT).

Nineteen out of 28 contract notices published the **value**. Procuring authorities tend *not* to indicate the anticipated budget for the solution to be procured if price is an important criterion for awarding the contract. As vendors could start from the targeted budget rather than from the solution they can offer, prices from all vendors could in the same range, close to or just below the target budget. On the other hand, in cases where the budget is fixed, the procuring authority will assess the offers based on what suppliers can deliver for this budget and price will be a less important criterion for scoring the offer.

1.4.2. What did the tenders reveal?

The **TED tender descriptions remain vague and brief**. It is not easy to understand whether an authority seeks to include research in the assignment, what is their vision nor what is the context for the tender. The TED, in most cases, only contains a summary and a link to a national or third-party portal in a national language, requiring login. It is therefore not easy to determine whether an authority is procuring systems or technologies.

Example: *Control system of dangerous goods in Milan: Supply and installation of the control system through the completion of the electronic gates of the accesses to the newly created "low emission zone" and the "limited traffic zone."*

It is **not possible to know what preceded the tendering process** – the TED platform does not mention who wrote the tender. It is perfectly possible that the authority may have hired a study bureau or consultant to study their specific situation and then tendered the exact technology that is the best fit. This would mean that the technology is tendered, but a system-based approach was followed. This information can only be revealed through interviews. Furthermore, the summary does not reveal whether there had been any preceding procurement effort nor the outcomes.

A small but interesting discovery was made with respect to four of the 32 tenders reviewed, which were **prior information notices (PINs)** rather than contract notices. In all four cases, the PIN described the specific challenges and expectations of an authority and invited market players to come forward to discuss potential solutions. Hence, they offer a **means to sound out the market for solutions to specific problems**. A contract notice normally follows a PIN. A subsequent search of the 28 contract notices studied revealed that several commenced the procurement process with a PIN. **Only one of the ten eastern European (PL, CZ, RO) tenders reviewed started the process with a PIN**.

There are technical clauses in the contract notice that can be used by procuring authorities to give greater flexibility to the market to propose alternative solutions and to the authority to manage future procurements: options and variants. Five of the 28 contract notices studied allowed "options" and one allowed "variants."

- An **option** is a right of the contracting authority to purchase additional goods, works or services from the contracted supplier. An option can be the right to procure additional elements (in the field of ITS, for example, a module for bus priority when purchasing traffic light controllers) or a right to extend the current contract (for example, an additional period of maintenance and support). (Source: Public procurement guidance for practitioners).
- If **variants** are allowed, it means the contracting authority is willing to consider an alternative solution not mentioned in the original tender documents. This means the government is open to expertise from the market and welcoming alternative or creative solutions to the problem statement, challenge or objective described in the tender. It does add additional technical complexity to the process because the evaluation committee will need the technological or expert knowledge to compare different technical solutions. (Source: Public procurement guidance for practitioners).

Finally, it should be noted that only public tenders above the EU threshold of €214 000 are required to be published in the Official Journal, meaning that smaller tenders may have been overlooked. Since it is not easy to undertake a keyword-based search not all the specific ITS-related tenders may have been detected, even those above the threshold. Furthermore, in a large number of cases ITS services or hardware are part of larger individual transport projects which are therefore not detectable in TED as ITS projects per se.

1.4.3. ITS procurement procedures

Most ITS procurements are categorised under the **'services' type of contract**. This means the EU procurement procedures must be followed when the value of the contract is expected to be higher than €214 000 for sub-central authorities (like cities) or €139 000 for central government authorities (like EU Member States). Next to the EU thresholds there are also national thresholds.

Besides the budgetary thresholds, there are also some different procurement processes that provide some information about the tender.

Open procedure means that any interested bidder can submit a full tender. This procedure is used most frequently (source). This way of working means that any party can send in a tender that will be taken into account.

A **restricted procedure** means that only pre-selected parties may submit tenders. This could mean the contracting authority only chooses to work with parties it trusts, it has worked with before or believes can deliver the goods, services or quality it needs. This procedure could also be used to exclude certain parties from sending in an offer, like companies with a bad reputation or with which the government has had negative experiences. The procedure could also be used to only work with parties in a certain geographical area.

In a **competitive dialogue** and an **innovation partnership**, there is more room for conversation between the contracting authority and market parties. This approach is typically used when the authority is unsure which solution would be the best fit for their problem statement or need or whether there is a solution in the market (source).

In spite of their potential market consultation value none of the cases studied (or of those detected in TED) have actually used either of the latter procedures.

There are also **framework agreements** with one or a number of companies for tenders requiring **recurring purchases**. The contracting authority provides a list of goods, works or services they may need in the given timeframe, and the market parties define prices. After the framework agreement is signed, the government can purchase the items defined, at the agreed price. This kind of contract can be used when the exact numbers are not yet known. In the field of ITS, a framework contract could for example be signed for installing speed enforcement cameras over a period of five years. The Brussels region has a framework contract in place for surveillance cameras, which it took advantage of for the procurement of ANPR cameras to enforce its low emission zone (case study in the annex and analysed in Chapter 2).

1.4.4. Procuring ITS R&D and innovation

Should there be no known ITS solution in the market to a specific challenge or a limited supply of an innovative solution, authorities can make use of various procedures that support public procurement of innovative solutions (PPI). These include negotiated procedure with competition, competitive dialogue, design contest, innovation partnership or the pre-commercial procurement approach. The SPICE project explored PPI and compiled a set of practical case studies. The P3ITS Handbook focuses on pre-commercial procurement for ITS. To see how public procurement of innovation works in practice, consult the Public Procurement manual by the OMC-PTP project, which includes case studies for Belgium (e-ticketing), the Netherlands (intelligent speed limiter for delivery vans), Germany (fuel cell buses) and Sweden (Stockholm road tax).

The city of Copenhagen's ITS procurement case in particular offers useful insights into the use of PPI to procure a set of five ITS systems, two of which the city had specified to a good level of detail (central traffic management system and traffic controllers) whereas the remainder was described in an abstract way due to the inexistence of plug-and-play solutions in the market. The procedure essentially involved an R&D activity prior to formal tendering, with the aim of narrowing down, defining, and specifying the scope and specifications for the final contract to be tendered.

1.4.5. ITS innovations influencing ITS procurement in the short to medium term

Managing traffic in the cloud: Most businesses have moved a lot of their operations to the cloud. According to Network World, for the first time, enterprises spent more in 2019 on cloud infrastructure services than on data centre hardware and software.

Cloud-based ITS solutions are being introduced at a much slower pace, but their first implementations can be found in the field. A first trend that stands out is the virtualisation of management systems. ITS hardware like traffic signals, detectors, speed enforcement cameras, parking guidance systems, etc. remain installed on the street. The innovation and optimisation are to be found in the management of those systems. An example is the Traffic Management as a Service concept, first introduced in the city of Ghent and described in this article. It strives towards one cloud-based traffic management platform that can be used by many cities. The approach to move away from hardware-based management systems can include the omission of dedicated communication infrastructure (like fibre, phone lines) and a move towards communication through the cloud (digital communication over 4G, Wi-Fi or long-range technology such as LoRa or Sigfox). Reading Borough Council, a medium-sized UK local authority, actually switched its traffic management system to the cloud when it moved offices and had to downsize – the new office simply could not physically accommodate the volume of hardware from the old traffic control centre.

Data as a Service: A second trend is the evolution from sensors and information capturing devices – like inductive loops, cameras or parking sensors – towards third party data-driven systems. There are more and more systems tracking people and vehicle movements that have mobility data as a side-product. These data are becoming accessible and can be purchased through a service model.

Fleet Forwards writes that in 2020, 10.46 million more connected cars will be added to the roadways worldwide, making a total of 170 million connected cars. Companies like Otonomo gather in-vehicle data from different automotive suppliers and make them available to customers through their cloud-based platforms. Access to in-vehicle data is being formalised and standardised through the 'extended vehicle' concept. Another data source is mobile phones, which can provide a very rich insight into people's mobility behaviour and traffic patterns. Such data are easy to purchase from companies like Google or Apple through local, certified resellers. Waze has a Connected Citizens Program where cities can enter into a free data-exchange partnership. Companies like Sentiance have similar offerings, adding even behavioural and predictive patterns. This type of data has been around for a while, from navigation and fleet management solutions, and made available by TomTom, Inrix and Here, among others.

Cooperative ITS (C-ITS): A new technology that may impact traffic management and ITS in the future is C-ITS, which refers to communication between vehicles (V2V) and between vehicles and the infrastructure (V2I or I2V) by means of different communication technologies (Wi-Fi and mobile), each with implications in terms of functionality and costs/business model. At least one major European OEM has committed to start rolling out C-ITS enabled vehicles equipped with Wi-Fi (ITS-G5) in the near future. Why is this relevant for cities? C-ITS provides a means for a direct two-way communication channel between the traffic manager and vehicles to transmit agreed messages, such as speed advice to get a green light at traffic signals (GLOSA message – V2I) or vehicle position, direction and speed (CAM message – I2V). This latter message has the potential to complement and ultimately substitute the traffic flow data that cities currently gather through other means (roadside sensors or floating vehicle data). Other types of 'messages' could potentially be developed in the future to support cities in managing their road network to achieve sustainability goals. The CIMEC project under Horizon 2020 investigated the city perspective on C-ITS and produced a useful guide for cities interested in deploying C-ITS. Another deliverable providing a strategic city perspective on C-ITS came out of the CODECS project and can be found here.

1.5. The four functional systems selected for case studies and recommendations

1.5.1. Traffic signals

A traffic signal priority system enables traffic signals to give special treatment to specific vehicles (fleets) or road users. It is widely used for giving priority to public transport in order to reduce delay at traffic signals thereby increasing the operational speed of buses, in the hope that this will make public transport a more attractive option than private cars. The traffic signal must be able to detect the vehicle on its approach in order to be able to extend or switch rapidly to the green light. Different technologies can be used to detect the vehicles or road users including:

- Induction loops in the road surface that communicate with a transponder in the vehicle.
- Local priority calls can be triggered by on-board radio transponders that communicate (possibly via roadside devices) directly to the local traffic signal controller.
- Centralised priority involves communication between the vehicle's on-board unit and the urban traffic control centre. Bus movements are GNSS-tracked through a system of automatic vehicle location. When a bus enters a virtual detector (specific attributes that must be met for priority to be granted), a request for priority is triggered. The centralised priority method has the advantage of not requiring the installation of additional transponder devices on vehicles or of additional roadside receivers at traffic signals. When priority is centrally managed, traffic management operators also have an overview of the entire network and the efficiency of the system.
- Detection of pedestrians and cyclists with induction loops, fibre detectors, heat sensors, cameras or radars (this has been combined in some cases with rain sensors to enable cyclists to receive a longer/earlier green light when it is raining, for example in Groningen and Rotterdam).
- Detection of pedestrians, cyclists and certain groups of users (blind people, wheelchair users, schools, etc.) using a transmitter or a smartphone application.

1.5.2. Low/zero emission zone management

Low and zero emission zones (LEZs and ZEZs), also known as environmental zones or air quality zones, are areas regulating access to the most polluting vehicles. Usually this means that vehicles with higher emissions, or internal combustion engines (ICEs) in the case of ZEZs, are not allowed to enter the area and can face a fine if they choose to ignore this rule. More and more city authorities are adopting LEZs in a bid to address air pollution, which is a growing threat to public health. LEZs in Europe are primarily targeting three of the biggest pollutants: fine particles (PM10 and PM2.5), nitrogen dioxide and (indirectly) ozone. Vehicle emissions are classified in Europe by the "Euro standards." Most LEZs operate 24/7, the largest exception being in Italy, which is also home to the highest number of LEZs in Europe. (Source: ReVeAL project).

While the adoption of a low emission zone is a policy decision, technology is generally used for management/enforcement and information purposes. Automatic number plate recognition (ANPR) is a commonly used system for LEZ management. It involves the installation of number plate-reading cameras at key locations on the LEZ boundary and within the LEZ area. The Euro standard of the vehicle is verified by checking the captured number plate against the national number plate directory. If the vehicle does not comply with the LEZ in operation, a financial penalty notice is issued. The strong German culture of data privacy and public resistance to monitoring systems means that ANPR is not used to enforce LEZs in Germany. Manual enforcement via stickers is instead adopted (source).

1.5.3. Real-time public transport information

Fleet management systems are used by public authorities primarily for managing public transport vehicles in real time. Managing a fleet of buses or trams dynamically requires the real-time positioning of the vehicles. This real-time positioning can be delivered through an automatic vehicle location (AVL) system, which involves equipping vehicles with a GNSS-enabled on-board unit that communicates its position (geolocation) at frequent intervals to a base station. This base station is normally situated in a public transport control system/centre, which is generally not co-located with an urban traffic control system/centre.

AVL data can also be used to provide real-time information about the arrival/departure of the next bus or tram. This information can be delivered by means of dynamic signs at public transport stops, via the city's travel information website or to a smartphone where an authority has developed a real-time passenger information app or has opened up its real-time data.

1.5.4. Parking management

It is widely known that a substantial proportion of traffic in a city at any given time is made up of cars searching for a parking space (past claims have put this figure at up to 30% although this has been disputed), hence the importance of providing information to drivers about parking space availability. This involves monitoring parking occupancy and communicating this information to drivers, essentially by means of on-street dynamic road panels. Such real-time information primarily applies to off-street parking areas and multi-storey car parks but can also be applied to park & ride areas.

The introduction of on-street parking policies is becoming the norm in cities across Europe. This typically involves setting rules about the type of parking (residential, delivery, short-stay, etc.), the duration and parking fees. Until recently, most enforcement was undertaken manually. There are now technologies that enable this to be done automatically, such as vehicle detectors embedded in the road and a scancar. For very short-stay parking, e.g. shop and go (typically no longer than 20-30 minutes), sensors in the road(side) actually warn the parking warden about cars exceeding the maximum permitted stay.

Chapter 2

A study of ITS procurement cases

2.1. Introduction

The review of ITS tenders on the TED portal, reported in Chapter 1, made it clear that an in-depth study of individual ITS procurement cases is required in order to build up a fuller picture of the system being tendered, the procurement approach, the technical requirements, the context and the procurement experience. A study of ITS procurement examples was therefore carried out, leading to the compilation of seven detailed case studies, which can be found in the annex to this report and are briefly summarised in the next section (2.2). The seven case studies cover the areas determined in section 1.5 of Chapter 1, i.e. (i) parking management, (ii) vehicle restriction management in low emission zones or limited traffic zones, (iii) real-time passenger information delivery and (iv) traffic signal management.

To compile the case studies, a thorough analysis of the ITS tender documentation was undertaken, which was complemented by an interview with a member of the tendering authority's team who was involved in the ITS procurement case investigated. This exercise revealed that while the tender document itself is an important text, it is only one part of the picture and it alone does not allow the reader to conclude that a good system has been procured. For example, while the Timişoara tender was largely described in technical terms, it was in fact the output of an earlier exercise where consultants had converted the city's functional requirements into technical specifications. Without the Timişoara interview, that context would not have been known and it would not have been possible to extract this background information from the specification text itself.

This chapter provides an analysis of the procurement strategy and technical requirements of the tenders selected for study. As such, the content of this chapter draws solely on the case studies. Section 2.2 describes the structure of the case studies and provides a very short overview of each case study. The procurement strategies pursued by the tendering authorities are analysed in a horizontal manner in section 2.3. The technical requirements are analysed by thematic area in section 2.4. Building on the case studies and Chapter 2 analysis, Chapter 3 makes recommendations on ITS procurement principles.

2.2. The case studies

The cities selected for study offer diversity in terms of size and geographic spread. They include cities in western, southern and eastern Europe and range in population size from 250 000 inhabitants in Ghent to nearly 3 million in Rome. There is also variety in the size and nature of the items tendered. For instance, one of the cases involved the procurement of a service rather than a system and ITS was an integral part of the service delivery.

Each case study contains two parts. The first part sets the scene by describing what system was tendered by the city, for what purpose and how the actual tendering process was organised. The second part of the case study describes the main technical requirements and, in some cases, provides an analysis of the practical experience of implementing the ITS, in particular what has not worked as intended and the lessons learnt.

The full case studies can be found in the annex. A summary of each case study can be found below.

Case study: Parking guidance in Ghent, Belgium

As the owner and operator of most off-street parking (and hence the occupancy data), Ghent has extensive experience (20+ years) of implementing parking guidance systems. The case study offers an interesting historical perspective of Ghent's procurement of parking guidance systems (including a €3.4 million contract in 2008 and a €650 000 contract in 2019) and touches on many aspects including policy, technology, technical requirements and tendering procedures. It demonstrates how changing mobility policy has influenced the system's functional requirements.

Case study: Parking enforcement in Bilbao, Spain

Like Ghent, Bilbao also possesses much experience of implementing ITS for parking management with a particular focus on enforcement. The case study describes the 2015 tender of a four-year enforcement service contract, which replaced a 12-year concession contract. ITS plays an integral role in parking enforcement through the use of number plate reading cameras affixed to a fleet of floating vehicles. The €45 million contract was designed to be cost neutral, i.e. the income from fees and fines should cover the expenditure.

Case study: Low emission zone enforcement in Brussels

The focus of the Brussels case study is the procurement (worth €1.65 million) of an automatic number plate recognition (ANPR) system for enforcing the low emission zone introduced at the beginning of 2018. What is interesting about this particular case study is the extension of the tender to applications other than the LEZ. The use of ANPR to measure average travel speeds for speed enforcement purposes and for other potential purposes was included in the tender.

Case study: Vehicle access restrictions in Rome

The Italian capital has a complex set of access restriction regulations, including limited traffic zones and low emission zones, which have been introduced over a 20-year period. The case study covers the most recent procurement of a large number of 'electronic gates' (a contract valued at €3.9 million) that are used to inform drivers about the regulation by means of static and dynamic information and to enforce it through an automatic number plate recognition system.

Case study: Real-time passenger information in the Netherlands

The Dutch approach to delivering real-time passenger information (RTPI) is characteristic of the Dutch philosophy of cooperation and pragmatism. The case study describes how a national body gathers automatic vehicle location data from the different public transport concession holders. Data delivery for real-time passenger information is an integral part of the far bigger transport concession contract distributed to the 13 public transport authorities in the Netherlands. The data serves a dual purpose: on the one hand to provide real-time passenger information to travellers (via public transport stop display signs and open data) and on the other to monitor service performance.

Case study: Real-time passenger information in Dublin

The real-time passenger information system in Dublin shares many similarities with the Dutch case insofar as the RTPI is primarily delivered by a national body in cooperation with Dublin City Council and the public transport operators. Nonetheless, the actual procurement and installation of the system itself was carried out by Dublin City Council. The case study provides an overview of the RTPI procurement process by Dublin.

Case study: Traffic signal management in Timişoara

The Timişoara case study covers the procurement of the city's first set of connected traffic signals and video surveillance, worth €6.5 million. The Timişoara case is quite distinct from the other tenders studied in terms of the length and detail of the task book (170 pages) and the implementation delays arising from legal challenges made by unsuccessful bidders. These issues appear to be cultural in nature.

2.3. A comparison of the ITS procurement approaches across the case studies

2.3.1. Background to the tender

While the starting point of each of the ITS procurements in the seven case studies was different, several common themes emerged. In the case studies of Ghent, Bilbao and Rome, the tenders represented the latest in a long history of procuring a system or service supporting the delivery of a specific transport policy. These city authorities have therefore had the benefit of hindsight and lessons learnt from previous ITS procurements and implementations, which were used to inform their most recent tender.

Ghent's 20+ years' experience of procuring parking guidance systems has enabled it to gain a far better understanding of the small sector for parking systems, the systems it can realistically expect the market to deliver and consequently how it should set the tender requirements. The Ghent case study provides a fascinating overview of how parking guidance system functions have evolved in parallel with changes in mobility policy, from guiding cars to car parks initially towards discouraging cars from actually driving to the city centre today.

In some ways, the Rome case is similar to Ghent, in terms of the necessity of the system to adapt its functionality to respond to changes in mobility policy. The electronic gates in place to enforce access control have to cope with a complex array of vehicle restricted areas and emissions-based regulations adopted by the Italian capital over a period of 20 years.

In the case of Bilbao, the lessons learnt from a 12-year parking enforcement concession contract were instrumental in the decision to move away from a concession model towards a service contract, thereby giving the municipality greater control over the enforcement system and lowering the cost.

The introduction of RTPI in the Netherlands and Dublin shares a national theme. While Dublin took the lead in actually procuring and installing the system in Dublin, it was always intended to be operated by a national body (the National Transport Authority). This national approach may be the most sensible and efficient way to go in smaller countries like Ireland. In the Dutch case, a national partnership of public transport authorities, DOVA, supports its members in procuring public transport services and RTPI delivery through recommendations on concessions and data standards, among others. Public transport operators in the Netherlands are required to provide automatic vehicle location data, meaning that any public authority wanting to roll out RTPI would just have to install the digital signs as the data are already available.

In Timişoara and the Brussels region, the systems implemented represented a first experience for both administrations, although Brussels was able to fall back on an existing framework contract for surveillance cameras to accelerate the tendering process.

2.3.2. Preparing the tender

External expertise was secured in nearly all the case studies to support either the preparation of the tender or the evaluation of the bids. However, the level of external involvement varied greatly. Brussels and Timişoara made extensive use of consultants for the tender specification. The Brussels region's consultants studied the specifications of other cities implementing similar systems (including the offers in some cases) and supported the evaluation process. In Timişoara, the size and complexity of the project was quite unique, requiring the specialised services of a consultant.

After nearly 25 years of going it alone and a sense that ITS procurement success involved an element of luck, Ghent finally took the decision to hire consultants for their next tender, to support the market research stage and specifications definition.

Bilbao and Rome drafted the tender specifications themselves and brought in consultants mainly to review the technical elements of the tender. Rome's extensive experience of procuring an access control system coupled with the mandatory use of Italian standards were no doubt key factors in enabling the Rome Mobility Agency to define in-house the specifications within approximately three person-months. The Bilbao tender (approximately €45 million) had a far higher value than the Rome tender (nearly €4 million) and required about 12 person-months of effort.

Dublin was the exception. It did not bring in external expertise for the technical aspects; however, it did make use of the national public procurement service, which provides advice primarily on legal and administrative aspects of the tender.

In the Netherlands case study, the expertise is centred on the national partnership of public transport authorities, DOVA, whose raison d'être is to provide technical support to its members (13 public transport authorities) in procuring public transport services.

2.3.3. The tendering procedure and market engagement

Most case studies adopted an 'open procedure' tendering process, the exception being Brussels, which made use of its surveillance camera framework contract for tendering the ANPR cameras. Only Ghent ran a small market consultation. In other cases, market studies were carried out (Timişoara and Brussels) or cities relied on good internal knowledge of market offerings (Rome, Bilbao and Ghent). In the case of Dublin, the option to meet with potential suppliers post-submission was offered and provided the city with an opportunity to gain a good understanding of the solution proposed by each eligible bidding company.

The Dutch case study is in a slightly different situation to the other case studies because RTPI is an integral part of the much larger public transport service concession contract. The public transport contract is typically awarded for between nine and 15 years. The RTPI element of the concession contract is an appendix to the main tender and essentially defines how data should be transferred to the public transport authority.

During the phase between the launch and closing of the tender, some cities provided an opportunity for companies to ask questions and to become acquainted with the premises where the management/central system would be located. Bilbao received 104 questions about the tender, which were answered and posted online for other suppliers to consult. Ghent made use of the TED platform and found the experience useful. Rome offered the opportunity to interested suppliers to visit the mobility management centre, which is home to the access control system.

The Timişoara tendering experience was quite different from the other case studies. Project funding was based on EU funds, which come with their own budget rules (scope and timeline), and it was complicated by many legal challenges filed by the unsuccessful bidders. Those challenges led to lengthy protraction of the tendering procedure (23 months). This in turn required implementation to be completed in record time to respect the EU funding conditions.

Overall, it must be assumed that where technical requirements are described in extreme detail and the resulting system does not meet expectations, this may be a sign of the level of maturity and/or limited ITS knowledge of the tendering authority and/or of trust in the market.

2.3.4. Functional versus technological specifications

The level of technological and functional detail in the tenders varies greatly among the case studies, as does the number of pages for the system specifications, ranging from 19 pages for the Ghent parking guidance system to 170 pages for the traffic signals and surveillance cameras in Timişoara. The latter case is partly due to the large number of excessively detailed technical specifications required by Romanian law resulting in the common use of bills of quantities, and partly due to the detailed solution requirements specified by the supporting consultant. In the case of Ghent, the shift from detailed technical specifications (in its 1998 tender) to broader outcome-oriented functional requirements (in the 2019 tender) has been an evolutionary process. Another development has involved the gradual shift from hardware to mobile digital information – the next tender in 2021 will be the final one procuring dynamic street sign hardware with the next tenders focusing entirely on digital communication.

The Bilbao, Brussels and Rome tenders all specified the technological solution to be implemented. In the cases of Bilbao and Brussels, the solution specification was the outcome of a market analysis and/or investigations of cities implementing similar schemes. Nonetheless, while the Brussels tender specified a camera for reading number plates and measuring average travel speed, it also allowed suppliers to propose applications in addition to this number plate reading technology. Similarly in the case of Rome, the tender was technologically specified to ensure the solution procured could be integrated easily with a widely deployed existing access control system, but there was room for innovation for one specific function (a system to accurately measure long vehicles).

The Dublin RTPI tender is mostly described at a functional level and leaves a lot of room for suppliers to propose solutions. Indeed, some 30% of the evaluation criteria was dedicated to the ‘aesthetics’ and ‘integration’ into the urban environment of the RTPI display signage.

2.3.5. Financial aspects

The case studies have revealed that the funding source influences the functions, technical requirements and timeline. There appear to be far more constraints where third-party funding (usually national or EU level) is concerned. In Timişoara, fibre optics could not be included in the project because this was not eligible under the ITS budget line and therefore had to be funded under another budget line, resulting in two parallel projects with different timelines, leading to delays. Deadlines were also very tight. Due to the long execution time, requirements and contexts changed (road layouts were modified), meaning additional delay was incurred. According to the Dublin case, another tender item that may also be curtailed depending on funding source is systems maintenance because this item is typically associated with revenue/operational costs, which are normally paid from local budgets, as opposed to capital costs, which are often covered by external sources.

With regard to evaluation, the case studies showed that where technical standards are used in the tender, more attention can be given to other selection criteria, such as additional features/functions. In the case of Rome, price was the main criterion due to the mandatory use of Italian technical standards. Interestingly, the Bilbao evaluation criteria were split between qualitative and quantitative 'formulaic' criteria.

Finally, a couple of the tenders (Rome and Bilbao) included clauses and budgets for future works and upgrades and both tenders stipulated that the tendering authority is under no obligation to commission these works nor to award the budget.

2.4. A comparison of the ITS requirements for parking management systems

2.4.1. The Ghent and Bilbao systems

The parking systems featured in the Ghent and Bilbao case studies are very different in function, scope and size, which makes it challenging to compare their technical requirements. The Ghent case study examines the city's procurement of a parking guidance/information system. In contrast, the Bilbao case study focuses on the tender of a comprehensive parking enforcement service, where the ITS element is one of many components of a technological and non-technological nature (e.g. electric vehicle fleet and customer service facility). There are nonetheless some common themes emerging from both case studies.

As mentioned in section 2.1, both cities have learnt a lot from previous experiences of procuring and implementing a parking management system. This has been extremely beneficial for the specification of their most recent tenders. An important development in Ghent has been the general shift in focus from technical to functional requirements whilst nonetheless maintaining a particular focus on issues that have proven challenging in their 20+ years of procurement experience. Issues requiring particular attention in Ghent include:

- the 'pixel pitch' of the dynamic parking information sign;
- software and communication technology that enables the city to see precise information displayed on a sign at any given moment;
- software specification (ideally a non-customised system due to the costs and limitations in developing further a city-customised system);
- a clear responsibility/liability structure where multiple suppliers are part of the contract (ideally, one supplier should assume overall responsibility);
- a single platform that is able to communicate with signs from multiple vendors. In the last-ever 2021 tender of dynamic signs, Ghent is considering specifying that suppliers open up their protocol because in future it will deliver digital information via mobile devices.

In the case of Bilbao, the main change in technical requirements relates to systems and data ownership. Under the previous concessions contract which ran for 12 years, most elements of the system were owned by the concession holder. This proved to be costly for the city because any change to the parking regulation required a system or service reconfiguration by the concession holder, thus incurring a cost. In addition to systems and data, Bilbao also specifies that any documentation, intellectual property rights (IPR) and licences related to the service contract become the property of the city council.

In line with its policy of moving away from physical signs in favour of digital signs, Ghent is paying more attention to the specification of application programming interfaces (APIs) in its tender. These are considered almost as important as the software. The Bilbao tender also requires the contractor to make available real-time parking data on the city's open data portal and to build a parking payment API to enable third parties to provide parking payment services.

2.4.2. Measuring performance

In both Ghent and Bilbao, measurement requirements have been superseded by service level agreements for specific components. These are actually presented as key performance indicators (KPIs). They determine what payment and/or penalties are to be applied to the contractor. Ghent has defined one overall KPI for the entire system which is the functioning of the signs (a yearly average of 99% must be attained). Bilbao has created a series of five KPIs relating to availability of system components and service operational efficiency. These KPIs are measured on a monthly basis and determine the contractor's monthly payment.

Operationalising the KPIs requires a system for measuring and/or verifying the system or service. This is the responsibility of the service contractor in Bilbao, but the measuring and reporting system is described in detail in the tender and Bilbao has the option to check it with 24 hours' notice. In Ghent, the supplier is responsible for performance monitoring; however, the parking guidance system operators of the city of Ghent are able to view the status of the dynamic message signs at any time.

2.4.3. Maintenance and warranty

Finally, with regard to maintenance, both tenders prescribe three types of maintenance: preventative, corrective and on-demand/improvements/developments. The Ghent tender specifies that a maintenance service must be available for up to eight years after the two-year warranty ends; however, the actual maintenance contract term is one year, renewable each year. The purpose of this clause is to ensure that the contractor is available and carries enough spare parts for the duration of the maintenance service period, without committing to offer the supplier an eight-year maintenance contract.

In Bilbao, maintenance of the system is an integral part of the parking enforcement service contract. Targets are set for corrective maintenance: three hours for a system malfunction and 24 hours in the case of a parking meter breakdown. Interestingly, Bilbao has specified just a one-year warranty period for the components making up the service contract, which is well below the average periods specified for software and hardware. According to Bilbao, given that service availability and other KPIs determine the monthly payment to the contractor, it did not see the need to specify a longer guarantee period, i.e. if poor equipment leads to lower service availability, the contractor receives less income.

2.5. A comparison of the ITS requirements for vehicle access enforcement systems

2.5.1. The Rome and Brussels systems

The systems procured in Rome and Brussels share the specification of automatic number plate recognition (ANPR) as the technology to enforce vehicle access restriction regulations. While both tenders share some common functional and technical requirements, there are also many differences due to the nature of the access restriction policy, system operation and specification and legacy. The system tendered in Brussels was primarily intended to enforce the low emission zone regulation in place 24/7 in the Brussels region, i.e. one policy for the whole region. By contrast, the Rome access restriction schemes in place are far more complex, comprising several low emission zones and six different access restricted zones, each one having its own specific operating regime (i.e. when it is active).

In Brussels, the tender covered the procurement of an ANPR system for the purpose of enforcing low emission zones and speed limits (through average travel time calculation) and the potential for other functions to be proposed by the supplier. In Rome, the tender was for an 'electronic gate', which has both enforcement and information/communication functions. The ANPR is one component of the electronic gate, the others being static and dynamic information about the regulation (not all regulations are applicable 24/7) and in some cases a vehicle monitoring (counting, classification and measuring) system. A further big difference relates to legacy: Rome has been running an access control system for more than 20 years and has many electronic gates installed around the city whereas there was no ANPR system previously in Brussels.

2.5.2. Functional requirements

At a functional level, both cities make use of white lists (access-permitted vehicles) and blacklists (irregular vehicles). Systems operation is different. The Brussels system checks a vehicle number plate against a national number plate database to retrieve the emissions class. Where a vehicle is in breach of the LEZ regulation, the number plate information is sent to a penalty processing software application. Rome does not have access to the national number plate directory because under Italian law this is only permitted where a vehicle has already been sanctioned, i.e. it is not permitted to consult the database to check whether a vehicle may or may not be in breach of an access regulation. Instead, the system in Rome is based on checking number plates against the white list, which is a comprehensive list of all vehicles with permission to enter a particular access regulated zone. Where a vehicle is not on the white list, the number plate is shared with the police which then issues a sanction.

Brussels has sought to maximise the functionality of the ANPR system. Beyond LEZ enforcement, the tender stipulates that the system should calculate average travel speeds (for speed limit enforcement purposes) and invites suppliers to propose other potential applications. In addition, other functions required for the ANPR include traffic counting, enforcing the overtaking ban, the detection of transit traffic and some police-related functions (e.g. alert police in the case of an irregular vehicle). In Rome, the ANPR cameras are designed primarily for access control enforcement although there are some police-related functions similar to those in Brussels. For vehicle monitoring, a separate system (embedded loops) was originally used as part of the electronic gate. Proposals for alternatives to the embedded loops were included in the Rome tender, which should specifically have the capability of identifying all vehicles measuring at least

7.5 metres in length. This latter requirement comes from the recent access regulation adopted for coaches and heavy goods vehicles. While ANPR cameras can measure vehicle length, the only systems certified for measuring vehicle length in Italy are loops and radar.

2.5.3. System requirements

In terms of technical specifications for the actual ANPR cameras themselves, the Brussels ANPR cameras must be able to take a picture of the front and rear number plates. The picture of the front number plate, which covers part of the inside of the car, is required for the ANPR enforcement whereas only the rear number plate can be used by law for calculating average speed. For legal reasons, the same camera cannot be used for both LEZ enforcement and speed calculation functions. In the case of Rome, the cameras are required to be able to capture two-lane roads and importantly they must receive national certification related to image processing. Additionally, the entire access control system must be certified according to an Italian technical standard. Italian certification is required for any system used to issue a fine or penalty. A certified system is also required in Brussels for the cameras deployed to calculate average travel speed.

Additional camera requirements relate to image definition, frames per second (60 in Brussels, 25 in Rome), the distance at which a number plate can be read (2–30 metres in Brussels), good operation of the cameras in all weather and lighting conditions and protection of the camera housing against the elements.

2.5.4. Installation

Both the Rome and Brussels tenders set requirements regarding the installation of the field equipment. Brussels describes the challenge of installing new roadside infrastructure and invites suggestions regarding fixing options that are flexible and make use of existing infrastructure. In the case of Rome, it is simply specified that the installation of the electronic gates is not carried out by the contractor but rather by the Rome Mobility Agency in the presence of the contractor and an assembly certificate must then be jointly issued. This requirement was intended to accelerate the installation of the electronic gates.

2.5.5. Performance measurement

Neither Rome nor Brussels established performance metrics in their tender. However, Brussels analysed the performance level claimed by the supplier and adopted this as a KPI. Rome's tender required that both the ANPR camera and the electronic gate system as a whole be certified to Italian standards.

2.5.6. Maintenance and warranty

There are similarities in terms of the approach to maintenance and warranty albeit the timing is different. The Brussels tender stipulates that the contractor is responsible for the repair and maintenance (mainly preventative and corrective) of the system for a five-year period. In Rome, the equipment must carry a three-year guarantee. During this period, the contractor remains responsible for maintenance, is liable for repairs and replacement and must take out an insurance policy. The contractor must also guarantee its availability and the availability of spare parts for a minimum of ten years.

2.6. A comparison of the ITS requirements for real-time passenger information

2.6.1. The Dutch and Dublin systems

The two case studies on RTPI are not exactly comparable because the Dublin case focuses on the procurement of a system to deliver RTPI, whereas the Dutch case addresses RTPI from a service perspective, specifically the obligation on public transport operators to deliver automatic vehicle location (AVL) data. Nonetheless, the way RTPI services are operating in both cases today has many similarities. There is in common a clear distribution of roles and responsibilities between the different stakeholders involved in the delivery of RTPI. Public transport operators (mostly operating under public service obligation (PSO) contracts in both cases) provide the real-time vehicle location data to a national body which processes it and transmits it to the RTPI display sign at public transport stops. The RTPI signs themselves are procured and maintained by the local authority. The main differences are in the data format and function. In the Dutch case, public transport operators are required to provide the real-time vehicle location data in a specified Dutch format and the national body makes additional use of this data for public transport performance monitoring and for open data. In Dublin, the RTPI system is set up to be able to take AVL data in different formats and to normalise it before transmission. Open data are also implemented.

2.6.2. Functional requirements

Of all the ITS procurement cases investigated for this report, the RTPI tenders had the highest level of functional description (despite the difference in tender scope described in the previous paragraph). In the Netherlands, the requirements are mainly set in data quality and format terms, leaving it to the public transport operator to decide which equipment to install to generate the data. These requirements are described in the appendix to the main public transport service tender. The Dublin tender similarly gives suppliers the freedom to propose a system that delivers specified functions and an RTPI display sign that meets certain requirements, such as the number of lines to be displayed on the sign and legibility.

2.6.3. Measurement requirements

The only common measurement requirement relates to the visibility of the RTPI sign on-street. In both cases, the sign must be readable from a distance of 10 metres.

Like any information service, RTPI should aim to be as reliable as possible to be of any real value to passengers. The accuracy of the AVL data is therefore crucial. The delivery of AVL data is outside the scope of the Dublin case study (which focuses on the tender of the RTPI system and not the delivery of AVL data) but it is central to the Dutch case study where the data are used for RTPI as well as for measuring public transport performance and for open data. The level of trust between the national body DOVA and the public transport operators is so high in the Netherlands that no manual checks are carried out. Besides AVL data, Dutch public transport operators must also provide static data, namely timetable updates at least four weeks in advance or with two days' notice in the case of temporary traffic measures.

2.6.4. Data requirements

The data requirements in the Dutch case relate mainly to the unlimited use and reuse of raw and edited data, compliance with data standards and the delivery of quality static and dynamic data (related to updates mainly). The single most important data requirement in Dublin is the system's ability to deal with automatic vehicle location data from different systems. Other data requirements cover the logging of data and system changes and an accompanying reporting tool, as well as the provision of tenderer information as per Irish Freedom of Information legislation.

2.6.5. Performance measurement

Dublin has not established any KPIs for its RTPI system because the actual reliability of the RTPI service relies largely on the reliability of the automatic vehicle location data, which is outside the scope of the tender. Nonetheless, there is a logging system in place for any system malfunctions or changes. By contrast, there are a series of KPIs applied in the Dutch case because automatic vehicle location data are at the core of the RTPI service contract. KPIs relate to both static (mainly timetable) and dynamic (AVL) data. The KPIs are common to all 13 public transport authorities and the authorities are responsible for issuing penalties. Yearly performance averages are published. RTPI system reliability has grown from 80% in 2010 to 98% today.

2.6.6. Maintenance and warranty

Dublin's requirements regarding maintenance and warranty are moderate for reasons of cost and eligibility. Longer warranties have cost implications and maintenance is generally considered a revenue (operational) cost and may not therefore be an eligible cost where funding comes from sources other than the council itself, e.g. national level. Dublin therefore specified just one year for warranty and maintenance. In the Dutch case, the maintenance requirements relate primarily to providing a facility for dealing with interface failures and queries and a target of four hours for resolving a high priority failure.

2.7. A comparison of the ITS requirements for traffic signal installations

2.7.1. The Timişoara and Leipzig systems

A comprehensive study of the new system for a traffic centre in Timişoara, described in the attached case study, was carried out with a focus on traffic lights and traffic control systems. In order to consider the Timişoara case in a broader context, information about the traffic control system operated in Leipzig was evaluated. Leipzig has extensive experience in this area. The information reproduced here is based on a written exchange with Leipziger Verkehrsbetriebe (LVB) and TU Dresden, followed by an hour-long interview.

A complete case study of the system in Leipzig was not carried out. Nevertheless, the comparison of the two applications makes for an interesting exercise, since Timişoara tendered and implemented a traffic light control system for the first time, while conception, tendering and implementation in Leipzig have a much longer history and longer development experience.

The focus in Timişoara was on the invitation to tender for new traffic signal systems and a traffic management system (including infrastructure work, masts, controls, lamps, fibre optic connections, control room, control software, etc.), of which the detection and control of public transport makes up a small part. The €6.5 million project was funded by a national programme with EU funds.

The signalling system infrastructure and traffic control system were already in operation in Leipzig. It was and is still operated by the Leipzig city administration and there has been a public transport priority system since long before 2011. The aim of the new approach, which has been implemented in three stages since 2011, was primarily to fine-tune the existing system for optimising the flow of public transport. The measures since 2011 have contributed to the implementation of the "Green City Master Plan (GCMP)." One measure in the context of the GCMP was the "Chameleon" project which received national funding of almost €3 million. "Chameleon" involved a comprehensive public transport-oriented overhaul of the approximately 500 traffic signal-controlled street crossings and junctions in Leipzig.

In Timişoara, the concept and the tender were coordinated by the city administration. In Leipzig, LVB GmbH has the organisational and financial responsibility for hardware, software and operation of all parts of the traffic control system that are relevant to public transport. All related activities are coordinated with the city administration of Leipzig, which continues to have overall responsibility and decision-making authority for traffic signals and the traffic management system. In Timişoara, all aspects of traffic signals are under the supervision of the traffic management centre.

The procurement as-a-whole approach by Timişoara and the step-by-step strategy from Leipzig also have impacts on the implementation schedule.

The project in Timişoara was defined and tendered in 2011 and implemented in 2016. During that period, some intersections had changed and a pedestrian zone had been implemented in the city. This meant that some changes to the system were required immediately after completion. Technologies had also evolved during these five years. In Leipzig, the project started in 2012 and the overarching system was operational in 2014. Since then, the modernisation of the traffic control system has been implemented on a node-by-node basis, whereby each traffic light controller is configured and updated separately. This process takes six to 12 months in each case. The deployment of personnel from industrial partners is crucial here in order to shorten lead times.

2.7.2. Functional requirements

In Timişoara, the focus was on the detection of all vehicles and the adaptation of the traffic lights to vehicle flows and waiting times for all vehicles. In Leipzig, traffic signal phasing is adjusted to the extent needed to enable the smooth passing of trams and buses. Additional objectives consisted of enhancing safety and improving energy efficiency at traffic junctions. The latter is supported by a tram driver assistance system, which so far has only been installed in a few trams but will be extended to the entire vehicle fleet. Thanks to the efficient communication of the switchover times (e.g. time to green) between the vehicle and the traffic light system, the driver can adjust speed and thus avoid stop and start movements.

In both cases, the system requirements are set up completely differently. In Timişoara, there was no knowledge of connected traffic signal systems in the city nor any previous experience. University experts were brought in to work mainly on the technical requirements. This resulted in a 170-page technical specification document detailing for example the equipment of the control room, the quality of the earth's particles during the earth works, the cable length and detailed descriptions of the user interface software.

In Leipzig, the initiative came from the public transport company, which set up a joint venture with a university, namely Technical University (TU) Dresden. This university has conceptual, practical and operational experience with such projects and previously accompanied a similar system in the city of Dresden. Based on this technical and operational experience, the results to be achieved could be defined with good market knowledge and the technical requirements were brief but specified with precision.

Lastly, there was a difference in the size and shape of the contract. A large call for tenders was drawn up in Timişoara, which included all functions except communication technology. In Leipzig, smaller orders were/are placed with the university (planning and software, total annual payment of between €50 000 and €100 000, depending on the actual number of modernised nodes), and there is close cooperation in the form of a partnership instead of a traditional relationship between the client and the contractor. The Leipzig city transport operator did not consider the tender for a large, complex system (or a "black box") but instead develops each individual step within a local public working group. Usually up to ten traffic light systems per year are revised and optimised on this basis, each of which is procured individually. The related tenders are based on the five-year traffic management framework contract between the city of Leipzig and a consortium of suppliers (currently Siemens and Swarco, worth €250 000 to €1 million annually, depending on the actual annual needs). In the event that the consortium is unable to provide the required system, the tender will involve the entire supply market.

2.7.3. Performance measurement

Both Timişoara and Leipzig set KPIs to monitor the progress and results of the system. Since the scope of both projects is very different, this is also reflected in these monitoring parameters. In Timişoara, this was the first system of its kind to focus on improving traffic flow, reducing car accidents and traffic violations. The number of bike rides per day is also measured. Almost all of the indicators that the university monitors before and after the implementation of the system indicate spectacular progress in all areas, from 20% to almost 100% per KPI.

In Leipzig, the focus is on increasing public transport efficiency, taking into account all surface modes. Indicators measure the success of the project in terms of punctuality of trams, lost time at traffic lights for public transport and other road users, quality of information provided to passengers and energy savings. A side project which LVB and TU Dresden consider to be unique for tram systems enables precise predictions about the point at which the tram vehicle will stop at double stops ("front" or "rear"). Passengers can then wait at the right spot and board more efficiently. The accuracy of the predictions was monitored at a pilot stop and they were found to be 95% correct.

2.7.4. Open specifications and data standards

In Timişoara, the specifications stipulate that the system to be purchased must be compatible with the leading standards in the market so that it can be expanded with third-party applications. In practice, this has not yet happened because the entire ecosystem was supplied by a single supplier. It is currently planned though to expand the system and to bring in additional applications to the market via the open interfaces.

Interestingly, the starting point in Leipzig was different. A first version of the system, which was developed by the University of Dresden in cooperation with partners, has already been used in Dresden. Since the traffic computer in Dresden comes from a different manufacturer than the one in Leipzig and the controllers also differ, it was inherent to the solution that it could work independently of the manufacturer. The interoperability of the system design is also facilitating the current initiative to integrate the driver assistance system, which is implemented via the on-board computer of the public transport vehicles.

With regard to standards and protocols, the relevant EU legislation was implemented in Germany through the federal law on intelligent transport systems. This is supplemented by various regional laws. This does not include all components and must be revised in the future. In practice, several versions of the OCIT standard (see Chapter 1) are used, supplemented by the German VDV standards for the planning and operation of public transport and proprietary standards for some components (see the Dublin case study). Timişoara has a stronger focus on general quality certifications such as ISO 9001 and qualifications related to technical installations, security, fire protection, telecommunications, etc.

Chapter 3

Key ITS procurement principles

3.1. Introduction

This third chapter is the final part of this study and contains some very practical recommendations for cities planning to procure intelligent transport systems. The content of this chapter builds on and refers to the desk study in Chapter 1 and the lessons learnt from the Chapter 2 city case studies. This information was further supplemented by an interview with an ITS expert from Copenhagen and an ITS supplier from Dublin (whose details are provided in the references section). In this chapter, the recommendations are structured according to the chronology of an ITS procurement process: from preparation through purchasing to commissioning of the system.

3.2. Laying the groundwork

3.2.1. Starting from a city development and/or sustainable mobility plan

As indicated in Chapter 1, ITS should support the goals and measures of a transport strategy/vision or city development plan, be that expressed in a sustainable urban mobility plan (SUMP), other type of integrated transport plan or even a more detailed traffic management/ITS plan. A plan can help ensure the system to be procured responds to a real need, problem or goal. It can also lead to a more coordinated ITS procurement process and enhance the prospect of ITS multi-functionality. This latter point was demonstrated in some of the annexed case studies, notably, Brussels and the Netherlands, where data generated by the system served multiple purposes. Finally, a plan should guide the expected outputs (targets) and outcomes (goals) of an ITS project, against which performance can be measured.

The objectives and required functionalities of the system should be defined first and without supplier influence. The interviewed ITS supplier also confirms that if the market is involved too early, this may lead to functionalities entering the picture that do not respond to the challenges of the city. In Timişoara there was no SUMP, but it was drafted in parallel to the ITS procurement to ensure that this and future systems would match their long-term mobility strategy. Functionalities not contributing to policy goals should be brought into question. Ghent has adopted a bottom-up approach to the selection of measures and tools but all divisions within the mobility department must refer back to the SUMP to ensure the actions are in line with the high-level policy and plan.

Recommendations:

- The objectives and goals of the SUMP or other city/transport development plan should be the basis for the procurement.
- The link between functionalities requested and the strategy should always be highlighted.
- Section 1.2 of this report (ITS from a planning perspective) should be revisited for further information about mobility and ITS planning and for links to relevant initiatives.

3.2.2. Improved coordination at all administrative levels

ITS projects are not islands and touch upon other processes and departments within the city. A sustainable mobility plan can encourage a more coordinated approach to the selection of a measure or system, as the Romanian city of Cluj Napoca demonstrated when it formed a multi-stakeholder working group to develop the concept of an integrated traffic management system (source: *Terms of Reference for design and procurement of integrated ITS*). However, this is not the case everywhere. Even within a single department, information sharing can be a problem. For example, in Ghent a new bicycle sharing system was procured, but the traffic control centre was not informed, overlooking the opportunity to add data requirements for their needs.

Coordination at a higher administrative level (provincial, regional, national) may also be beneficial for public authorities and suppliers alike, as seen in the real-time passenger information case studies (Dublin and the Netherlands) in the annex. Coordination at national level makes particular sense for smaller countries.

Recommendations:

- Information about upcoming tendering processes should be disseminated within the mobility department, and other departments should be informed so that synergies can be achieved.
- A smart cities manager or department should be involved in strategic decision-making on ITS tenders in order to seek synergies (e.g. IoT communication technology, open data).
- It should be explored whether the delivery of a system or function can be more effective at another administrative level ('functional region'). The practices of other regions and/or countries should be explored.

3.2.3. The involvement of political representatives

There was formerly little political interest in ITS among political representatives due to the intangible nature of ITS, compared to say a bus. This is changing as more and more cities compete to become a smart city, as FOMO (Fear Of Missing Out) takes hold and as politicians increasingly become the target of technology companies touting their latest wares. It is all too easy to be sold a solution to a problem that has not been identified. Managing politicians' expectations is therefore important.

Where there is a genuine need for an ITS solution, their involvement is important in securing the budget, setting out the strategic objectives for the projects and following up from a higher level, in particular monitoring the implementation, measuring impacts against policy goals and reporting back to citizens. Of all the case studies in the annex, a political decision was made on the kind of technology to use in Brussels alone – for enforcing the low emission zone (number plate recognition).

Recommendation:

- Political representatives should be involved in setting the objectives, securing the budget and ensuring high-level monitoring through a steering committee. They should not be involved in conversations with possible suppliers or in defining the technology to be used.

3.2.4. Capacity building and external expertise

ITS systems tend to be very technical and remain in place for a long time. Therefore, it is difficult for cities to build internal capacity. This can be compounded by a brain drain of ITS staff to the private sector, a trend that could be tackled by having a plan and a vision that staff can be proud of and can see themselves working on in the future. In most of the cases studied, the public authorities called on external expertise to draw up specification texts, to supervise the process or simply to review technical elements of the bid. In Ghent, Bilbao and Rome, there was enough in-house knowledge to write the tenders – although Ghent has decided to call upon external expertise for the upcoming tender (see the Ghent case study).

However, there are some risks involved. Firstly, choosing a consultant is often done through a tendering procedure and it is difficult to grade specific expertise. The ITS supplier noted that *"Appointing a consultant is also a tender process and doesn't guarantee that the consultant with the required skills is appointed. Poorly specified tenders can often be the result. Errors in the tender typically only come to light once the tender has been awarded and ITS implementation has started."* Secondly, there must always be some form of expertise available within the city itself, as it holds responsibility for the process. In Timişoara, there was little to no ITS knowledge within the city, meaning that it was very difficult to judge the consultants' work or the project implementation.

Recommendations:

- An assessment should be made of in-house ITS knowledge. Consultants can be hired where there is insufficient capacity for specific tasks, but the city staff should always be in control.
- Building in-house ITS capacity should become an aspiration, starting with joining the activities of the national ITS platform (for language and cultural reasons) and then moving on to international activities (ITS congresses, EU projects and city networks).
- Tenders for external consultants should use award criteria based on proven experience and references should be provided.
- The use of external expertise should contribute to internal capacity building.
- Cities implementing similar systems should be approached to enquire about the skills required and the external expertise engaged. Information sources (CIVITAS and Eltis) and networks (POLIS and Eurocities) may be helpful in identifying such cities.

3.2.5. Familiarity with ITS solutions and the market

Cities value peer-to-peer learning from other cities about similar ITS projects implemented. The tenders and experiences of other cities can therefore be an excellent starting point. For example, Bilbao visited two other cities operating an automatic parking enforcement scheme similar to the model it has procured. Brussels even managed to look into the non-commercial parts of offers for low emission zone enforcement systems received by other cities. Other stakeholders to be contacted can include the ITS teams of national governments (who have a good overview of European legislation, subsidy channels and projects), the national ITS organisation or the many European platforms and networks such as CIVITAS, Eltis, ERTICO, Eurocities or POLIS.

It is also crucial to get a view of the supplier landscape: who is present in the region, what is their experience and business model, etc. If the tendering process has not yet started and provided equality and transparency are respected, there is no harm in establishing informal contacts. The project team in Ghent found a visit to all suppliers of parking guidance systems worth the effort. The interviewed ITS supplier also confirmed that it is useful to know what questions to ask in a later market consultation. Investigating the supplier landscape and the ITS deployed in other cities can also help reveal the latest technology developments and innovations in terms of communication technology, cloud-based solutions and the shift towards 'as a service' models in ITS procurement (see section 1.4.5.).

Recommendations:

- Other authorities or organisations implementing similar ITS schemes should be contacted.
- National ITS departments, the national ITS organisation and European networks mentioned above should be consulted.
- Cities and governments should share their own tendering documents and findings with peers.
- A relationship of trust and transparency with the market as a whole should be built. It could be helpful to talk with local authorities from countries where this type of relationship is well established, such as in the Netherlands, the Nordic countries, Germany/Austria or the United Kingdom.

3.3. Strategic decision-making

Once the groundwork has been laid, strategic choices have to be made based on the information gathered.

3.3.1. Timelines

Public authorities routinely find themselves dealing with strong timeline pressures. In Timişoara the ITS project had to be completed quickly in order to qualify for external funding sources. A bicycle counting project in Ghent had to be installed before local elections. In both cases, the tight deadlines were accepted by the supplier but ironically the projects took longer than if no such tight deadline had been set. Timişoara indicates that they would now set aside far more time for a similar project. Factors that have an important impact on the timing are the legal minimum periods required for some procedural steps, the endorsement of documents and decisions by the city council, and staff and supplier availability. Furthermore, the scope of the project plays an important role: in Timişoara the project started in 2011 and the implementation was completed in 2016, partly because of the size of the project. As technology and public space can evolve over such a long period of time, some of the initial requirements or technologies can become obsolete by the time of delivery. Where delays are incurred by the procuring authority, for administrative reasons for instance, the supplier may be entitled to financial compensation. A reasonable timeframe should therefore be established to avoid financial penalties on either side.

Recommendations:

- A reverse plan should be made starting from the expected delivery time and working backwards to the moment the market consultation is launched. A contingency margin should be incorporated.
- No timelines should be accepted that are not considered realistic by both the city team and the supplier. It may lead to negative consequences in terms of functionality, public perception and financial penalties. Feasible timings should be assessed in a market consultation.
- From the beginning, all parties concerned should know what is expected of them and when. Main stakeholders, such as the legal service, should be met to discuss timelines and availability.
- Holiday periods and busy times of the year should be avoided for market consultations and tenders and suppliers should be given sufficient time for submitting quotes.

3.3.2. Legacy systems and future systems

In many ITS procurement cases, decisions must be taken on how to replace or connect to older systems. In Rome, the new electronic gates system had to interface with the existing systems and in Dublin information from existing automatic vehicle location systems had to be processed by the new RTPI system. The ITS expert from Copenhagen confirms that few ITS solutions are 'off the shelf' and most will require some level of customisation to be able to connect with the city's legacy systems. However, some customisations may not make sense from a practical, economic or business point of view. If this is the case, systems can run in parallel without automated connections. For example, an operator can manually programme variable message signs until they are phased out. All new systems will eventually be phased out and replaced too, so it is advisable to think about their future before procurement starts. In Ghent, for example, it is taken into account that the digital parking guidance signs to be procured in 2021 might be the last ever due to the growing importance of mobile information (satnav, smartphones, in-vehicle guidance, etc.) and the emphasis on providing open data to enable mobile information services. This has implications for the robustness (the signs must last as long as possible) and flexibility (they must be able to be used for other purposes) of the installation.

Recommendations:

- A business analysis should be conducted for (partly) replacing legacy systems.
- A business analysis should be conducted for customisations to connect with existing systems.
- A plan should be drawn up for the future and afterlife of the systems to be procured.

3.3.3. Modular architecture and multi-vendor environments

To avoid having to replace an entire system if only one part needs changing, systems must work in a modular way. This means that different modules can be 'clicked' together to fulfil the end-to-end functionality required. A parking meter, a database and a tablet with a ticket printer are all part of a parking enforcement system. If only new parking meters are needed, or new functionality is needed, there should be no need to replace the entire system. In theory this sounds logical, but in practice it is not. Modularity has not always been popular with suppliers: independent modules communicating through open and/or standardised interfaces means more work and trouble. It is also lucrative to sell a whole new suite that only works with other products from the same supplier (see Chapter 1 on vendor lock-in).

A solution can be to purchase all modules from a different supplier. However, this often gives rise to problems, as the city of Ghent observed. Hardware, software, communication and hosting were provided by different parties. As soon as a problem arose, suppliers passed the blame on to each other and the city itself had to find the faulty component before a vendor would take action. In a subsequent tender all components were procured from one supplier – specialised in hardware – in order to clearly assign responsibility, resulting in inferior software. One idea Ghent is considering involves splitting the tender into different parts but encouraging one supplier to take general responsibility (and subcontracting some parts).

According to the ITS supplier interviewed, it is not commonplace to procure hardware and software separately, but it is starting to happen more frequently. Amsterdam's separation of the procurement of digital signs and software – cited in the Ghent case study – is one example. This approach is also described in the Dutch case study where the delivery of data for real-time public transport information has been completely separated from displaying that data on digital signs and both systems' life cycles do not affect each other.

Recommendations:

- A modular approach should at least be discussed when (parts of) the system will most likely have to communicate with systems from other vendors (e.g. variable message sign (VMS) software with temporary/mobile signs or a traffic light computer with legacy controllers).
- The roles and responsibilities should be clearly defined in case of malfunction. If possible, the overall responsibility should be attributed to one party.
- If the system is made up of components that can be clearly separated (like hardware and software) and crystal clear agreements can be made on interfaces and responsibilities, the tender can be broken up into different parts to ensure modularity. In such cases, a skilled data/IT systems architect is required.

3.3.4. Managing uncertainty and choosing a contract type

ITS projects typically carry a lot of uncertainty in terms of technology. A simple way to limit the risk could be to first tender for a limited scope (e.g. a part of the city, like in Ghent). Another way to spread the risk may involve not actually procuring a system, but rather adopting a service contract. This is common for parking enforcement services, as the Bilbao case study shows. They have moved from a concession contract, where most of the risk is borne by the concessionaire, to a service contract, which means the city has more risk on the one hand but greater control (including receiving parking revenue) on the other. In other ITS domains, service models are not yet widespread, but they are slowly taking off. Certainly, software is increasingly being offered through a subscription model (see Chapter 1 on ITS innovations). A supplier also mentioned a Device-as-a-Service contract for traffic signals in Delft. It should be noted that the more risk taken by the supplier, the higher the price will be.

Recommendations:

- Cities should be aware of the different forms of procurement and contract types.
- Pricing models for several contract types should be requested in a market consultation, so the right balance can be found between outsourcing work and risk versus affordability.

3.3.5. Market consultations and tendering procedures

The importance of consulting the ITS market has emerged as a very strong theme in the research for this study. Most of the case studies undertook some sort of market analysis and where this did not happen, it was compensated by knowledgeable ITS staff with experience of procuring similar systems. Both the ITS expert and supplier interviewed agreed that market consultation is critical in order to "*ascertain whether the system and the features the customer would like to implement or the outcome it would like to achieve, are actually feasible*" and whether "*a requirement is realistic from a supplier's business perspective, especially where a high level of customisation is required or a very old protocol is used, meaning there is little prospect of wider commercialisation, interoperability and scalability.*"

A market consultation may lead to a more robust tender and avoid the problems arising from a poorly specified tender according to the ITS supplier: "*Companies bidding for the tender may well notice that some aspects of the tender are problematic but this will not stop them from bidding. They will typically deliver first those elements of the contract that are feasible, drag out those parts that are ambiguous and then argue the case for variations to the contract. Councils finding themselves in this situation normally end up having to agree to additional costs to resolve the issues. It is not clear where the responsibility lies and therefore nobody is held to account*."

A market consultation may result in the public authority revising its requirements or even deciding against launching the tender in the short term at least, which in itself should not be seen as a failure but an opportunity for the public authority to revisit its requirements and expectations. This was the outcome of a market sounding exercise for an electric charging infrastructure procurement carried out by the four local authorities making up the Greater Dublin Area in 2019. It is better to delay a tender rather than launch it (sometimes multiple times) and receive no bids.

The research for this study has shown that market consultations can vary in their approach and can be combined with a formal tendering procedure. For instance, Ghent usually sends out a list of questions or a high-level version of the specifications to check whether these are feasible. Some public authorities make use of the prior information notice (PIN) instrument, which is normally intended for announcing an upcoming tender but which is also used to gather preliminary views from the market (see the review of tenders on TED in Chapter 1).

The choice of procurement procedure, described in Chapter 1, usually depends on the value of the contract and maturity of both the market and procuring authority. While none of the case studies made use of the more collaborative and innovative procedures but rather adopted the conventional open procedure, some of the cities (Rome, Dublin and Bilbao) had initiated or are exploring the competitive dialogue procedure for other procurements. Rome had started a **competitive dialogue** for a traffic control system, but ultimately abandoned it because it was incompatible with the city's deadline. Although the process may be time- and resource-consuming, the ITS expert from Copenhagen views competitive dialogue as a good fit for urban areas where the ITS market is smaller than for highways and where the complexity is higher due to the mixed traffic situation and prevalence of legacy systems. *"Competitive dialogue can facilitate discussion between the customer and suppliers, leading to a common understanding and well-defined specifications, thereby establishing a great foundation for the procurement and future collaboration."* An example cited is a €33 million project for installing public lighting with LED technology in Copenhagen where a competitive dialogue process revealed that a contract is only of interest to suppliers where a long-term maintenance contract is included due to the huge capital outlay required at the outset.

Few of the cities interviewed had implemented an **innovation partnership**, yet the ITS expert from Copenhagen sees this as a good procedure for defining solutions that do not yet exist. Market readiness can be assessed through piloting or design contests. Such innovation partnerships seem to be more common on bigger projects with uncertain outcomes, like the C-ITS (see Chapter 1) projects Talking Traffic in the Netherlands (€90 million) or Mobilidata in Flanders (€30 million). Dublin made use of the pre-commercial procurement procedure to initiate a prototype, which did not necessarily deliver an end product that could be readily used. The Flemish government tried using this process for smaller ITS projects, but the procedural workload outweighed the advantages.

Recommendations:

- Prior to the market consultation, benchmarking of the supplier market and cities implementing similar measures should be carried out – see section 3.2.5 for organisations that may be able to assist with benchmarking.
- A market consultation should be conducted at a time when the project team has enough knowledge to ask the right questions.
- Transparency and equality should be maintained in any market consultation, e.g. posting on a public webpage all consultation-related questions from the suppliers and responses from the tendering body.
- The competitive dialogue procedure should be considered for procurements of a complicated nature, where there is uncertainty and a need for negotiation.
- If considering a competitive dialogue or innovation partnership for small projects, the administrative and legal efforts from both the authority and supplier should be weighed against the benefits.
- The national ITS team and legal department should be consulted before considering innovative partnerships.

3.4. The technical specifications

Following the extensive study phase and adoption of strategic decisions, the technical specifications can be drafted. These form the substantive part of the specifications, which will always serve as a reference point during the execution of the assignment.

3.4.1. Procuring systems versus functions

A key research question for this study was to ascertain whether cities tend to describe *functions* in their tenders, such as a solution needed to enforce a low emission zone, or whether cities themselves decide what solutions they need and procure *systems*, such as ANPR cameras. The case studies in the annex, which all include a paragraph on 'functions and components', revealed a mixture. But it is worth noting that most of the tenders studied date from five to ten years ago, which was a deliberate timing choice in order to build an overview of the full procurement process and implementation experience. What is noticeable is that several factors influence the approach:

- **Governmental directives**: In Romania the application of procurement laws for standard procurement procedures tends to encourage technically specified tenders.
- **Culture**: Also in Romania, a certain lack of trust between the government and the market results in a tight rein over technical details. Whereas in the Netherlands, there is a strong trust in the market and specifications are described in a much more functional way.
- **Experience**: Cities with a lot of experience, such as Ghent, indicate having shifted over the years from very detailed technical specifications to functional descriptions.
- **Politics**: In Brussels, a technological solution was put forward by politicians.
- **European and national standards**: For fields in which standards exist (like the Italian standard for electronic gates used in Rome), authorities can simply refer to these standards.

Experienced cities indicate that it is impossible to describe every technical detail and to close in advance all loopholes in contracts that typically run for five to ten years. Going into much detail can also be counterproductive: Timişoara indicated that it hindered innovation in their procurement project. Suppliers are limited in their freedom to innovate and this may have an impact on trust. The authority may not necessarily have the expertise to check whether the requirements are met. While a functional description should be aspired to, this does not mean that technical expertise can be bypassed. Expertise is required to check that the proposed solution meets the required functionalities, some of which may have a strong technical dimension, such as integration with a legacy system. This was highlighted by the manager of the ANPR system examined in the Brussels case study, where technical expertise was brought in to evaluate the offers to ensure that the systems proposed met the functional requirements.

Cities that have moved away from overly technical specifications have overcome this by clearly defining their objectives and giving more freedom to the supplier to propose solutions. Instead of describing every detail, such as the thickness of cables, they have drawn up KPIs for the overall functioning of the system, which often have financial consequences. The most extreme form of the functional approach is performance-based contracting (the contracting authority sets out some results and the supplier gets paid to the degree that these results are met). A form of this approach has been adopted in Bilbao for parking enforcement (see KPIs section of the Bilbao case study). This guide from the Asian Development Bank describes how to apply it to road maintenance.

Recommendations:

- The main objectives, functions and context should always be described in the tender and reference should be made to wider policy context and/or plan and procedures preceding the tender (e.g. external expertise).
- Detailed specifications should be included where they serve a clear purpose.
- The responsibility of the supplier should be clearly defined and separated from that of the procuring authority (in Rome, the authority installs the supplier's equipment and both parties jointly certify the installation).
- Clear SLAs and KPIs should be described and linked to financial rewards or penalties.
- Some freedom should be accorded to the supplier to propose alternative solutions, for example by allowing variants or options in the offers. This can result in better performing or cheaper alternatives.

3.4.2. Data ownership and/or (re)use conditions

Although it seems logical that the data generated by a system should belong to the procuring authority, this is not always the case. Firstly, it was not commonplace formerly for data access to be a contract clause because cities had little use for it. The open data and big data movements have radically changed this perception; data access is becoming a standard clause in the public procurement of systems (be that in ITS or any other area procuring IT). As the Bilbao case study demonstrates, data ownership not only applies to data generated by the system but to all data related to the service contract. Secondly, suppliers often make it technically difficult to retrieve the data from ITS or incur additional costs. For instance, the raw data generated by the system may require in-house expertise to be able to transform it into meaningful insights and open data. Thirdly, there are often restrictions on sharing the data with third parties such as residents or app developers. Data ownership and/or (re)use are key themes in many of the Chapter 2 case studies, notably the Bilbao parking enforcement and Dutch RTPI case studies.

Recommendations:

- A clause on data ownership should be created and should become a default clause in all tenders.
- A description of the data needed, how and when it is to be accessed and the level of granularity (raw or aggregated) should be included in the tender.
- A licensing model for data sharing should be referenced, like the ones from Creative Commons.
- The national open data portals should be visited to obtain an overview of the transport data made available in the public domain in each country. These can be accessed via the EU open data portal (scroll down to bottom of webpage).

3.4.3. Guarantees and liability

Warranty and liability paragraphs are usually required by the legal department for all tenders. A standard way of working is one in which, after the system has been installed, the supplier remains responsible for the entire system, until the warranty period expires. If functioning as desired, the system will be officially accepted by the contracting authority and the maintenance period will start.

Recommendations:

- Local authorities should fall back on the legal European terms for warranty.
- It should be clearly agreed on who is responsible during the warranty period and afterwards, for example for errors, collisions, vandalism, cleaning and maintenance.
- It should be clearly described what happens if the system is not accepted after the warranty period (this caused issues in Ghent, for example).

3.4.4. Licence fees

Licence fees for systems are an ongoing but necessary cost for the customer. They enable the supplier to develop further the system and the customer to receive system updates and feedback from other users. In some cases, licence fees are simply overlooked by the tendering authority and emerge as an unforeseen cost during project implementation. In the Bilbao and Dublin case studies, particular attention is given to licences and the obligation for any licence purchased to be costed over a given period of time and for the licences to be registered in the name of the tendering body. In other cases, the ITS supplier has seen examples where local authorities bought a system with the necessary licence, yet the system was overly customised to the extent that default updates could not be applied any more. The authority therefore had to choose between a fast-aging system or expensive custom updates. Ghent procured customised parking guidance software in 2008, which the supplier then sold to other cities at a much lower price because the development cost had already been covered. The supplier did not foresee licensing fees. This resulted in software that has not evolved over the past 11 years as there was no budget for extra development and for cities having to pay for mandatory updates (like new Java or Windows versions).

Recommendations:

- Licences should be budgeted. An authority may decide to set a budget range/ceiling for licences, for example 20%.
- Suppliers should clearly define all the licences (and contents) that must be procured and give their cost over a given period of time (e.g. yearly, two or five years).
- Where possible, software with an all-inclusive service model should be used.
- If the software licence is procured as part of the contract, the licence should be in the name of the tendering authority.
- System customisation should be limited (see above on modularity).

3.4.5. Open specifications and standards

In the absence of a Europe-wide standardised interface, some of the existing open specifications and standards referenced in Chapter 1 are starting to spill over their national/regional border (in particular the traffic management centre-field station interfaces of OCIT and UTMC). At the same time, governments are becoming more aware of the importance of interconnectedness within a broader smart city architecture. Furthermore, the integration of legacy systems has sharpened this awareness in many cities. Brussels, for instance, specified in its tender for a new traffic control system that the system should be able to control all its existing traffic controllers and that suppliers should prove this. Although the implementation was not obvious, it has ensured that Brussels is not limited to buying traffic controllers from one specific supplier.

The picture emerging is that the larger ITS suppliers (of traffic systems especially) operating in multiple European countries are increasingly aware of these standardised interfaces and may be able to adapt to such technical specifications. This may not be the case for companies operating primarily nationally or in very small sectors such as parking. For instance, Ghent did not make the use of open protocols mandatory in its tender because not all of the (already limited number of) suppliers indicated in a market consultation they could deal with this. In the end, the winning bid did include the use of a small-scale open specification (Disperanto). In the Netherlands case, open standards are used where possible, national variants are made if needed (such as for SIRI) and if not available, own standards (like BISON) have been created.

Not only does the size of a market limit the use of open specifications, the functionalities needed can also hinder this. Open specifications are mostly designed to work with the basic product functionalities of multiple vendors. Vendor-specific functionalities will require vendor-specific protocols. This can lead to less functionality, even if two components from the same supplier are connected using open specifications. However, it may well be that a city does not require the full set of functionalities of a system, just as the full set of smartphone functionalities are rarely used by users.

Recommendations:

- An assessment of existing open specifications and standards frameworks (see section 1.3) should be carried out and the materials of related projects such as POSSE and SPICE should be viewed.
- Open specifications and standards protocols should be part of the market consultation, with a focus on connections to legacy systems or components that will be replaced or linked in the future.
- The use of open specifications and standards should be indicated as a key asset in the specifications and could form part of the award criteria.
- Suppliers guaranteeing their system will work with a certain protocol should be asked for a working demonstration. Compatibility claims have often shown to be less obvious than promised.
- An assessment should be made of the functionalities needed. Some supplier-proprietary functionalities will not be possible with open protocols.
- If suppliers cannot or choose not to work with standardised protocols or interfaces, they should be asked to work at least with an open protocol and interface, meaning that third parties can create a custom integration if needed.

3.5. The tendering process

3.5.1. Relationship with possible suppliers

Relations with potential suppliers are regulated and stricter during tendering procedures. It is important that the contracting authority creates a climate of confidence by treating every party in a transparent and equal manner. One-to-one meetings with potential suppliers are strongly discouraged. It is possible to organise a clarification meeting inviting all suppliers in a legal manner, as Dublin did. The contracting authority is also encouraged to be open for (written) questions and publish them, and the relevant answers, on its website (as Bilbao did) or on the TED portal. These answers must be provided before the deadline for submitting tenders and timings are defined in the various procedures.

In the Bilbao and Timişoara cases the government decisions for awarding contracts were contested by other bidders through legal procedures. This is a very time-consuming process that can have serious consequences for project implementation, as the Bilbao case demonstrated. Whatever the reason for the dispute (lack of trust, disagreement with evaluation, technical requirement irregularity), it may be avoided or more quickly settled where some of the procurement principles described in this chapter are adhered to, in particular building market trust and adopting a transparent and unbiased tendering process. The award report plays a key role in this.

Recommendations:

- An open and transparent communication process should be conducted with suppliers: one-to-one conversations should be avoided (unless permitted as part of a procurement procedure) and the authority should remain open to questions and ensure that all parties receive the same information.
- The European Tendering Platform (TED) should be used for interaction with possible suppliers.
- The award report should be drawn up correctly, referring only to the award criteria, and no comparisons to other suppliers' bids should be made. The legal department should verify that the criteria are applied correctly and are well founded.

3.5.2. Award criteria

Most governments have evolved from primarily assessing quotes based on price to using more qualitative criteria, especially for complex systems like ITS. This is to ensure that dumping practices are avoided (Rome had to verify this due to the very low price offered by the selected bidder in a tender where price was the main selection criterion) and that quality takes precedence. In addition, in a fair share of the tenders, the maximum value of the contract is stated, which has an effect on the suppliers' bids and makes price a less suitable criterion (see Chapter 1). Price is often supplemented with criteria like experience of the supplier, planned approach, vision, risk management, environmental commitment, proposed project team, etc. High-level technical aspects can also be used as criteria, such as proposed architecture, modularity, accuracy, frequency or connectivity to legacy systems.

Recommendations:

- Benchmarking of award criteria adopted in similar schemes procured in other cities should be considered. Another relevant source of information is the European public procurement portal TED where tenders display 'Award criteria' in section II.2.5.
- Careful consideration of the criteria should be given as they are decisive and cannot be changed.
- A limited number of criteria should be adopted to avoid certain key criteria having too few points.
- Minimum scores for selected criteria can be defined for the offer to be valid, as applied by Dublin.
- Tendering authorities should consider providing a standard template for offers to make it easier to compare and score the offers (Ghent did not do this in the first instance, and suppliers just sent in leaflets on their products).

3.6. Project implementation

3.6.1. Commissioning and testing

The testing phase of a new system and its component parts can be a complicated and resource-intensive process, especially where a new system must connect with a legacy system. The testing of the Dublin RTPI system required a massive effort to bring the RTPI information accuracy from the initial 60% to the required 96%, not least because it required manual on-street verification of the digital signs. Brussels required a proof of concept at a location where video surveillance cameras were already installed, which avoided boots on the ground but nonetheless required manual checking at the control centre. This proof of concept was required before the contract was awarded to a supplier.

Recommendations:

- A test of each individual component and function and the system as a whole should be carried out.
- Tendering authority staff should be present during the testing phase and should sign off the testing phase once satisfied with the results.

3.6.2. Maintenance

The ITS maintenance requirements vary significantly across the case studies and can be influenced by many factors including the type of system procured, the funding source (and eligible costs), the budget size, local needs and the contract model, among others. These all impact on the maintenance functions and the duration of the maintenance contract (from one year in Dublin to five years in Brussels and up to ten years in Ghent, renewable on a yearly basis). As technology evolves quickly and so do prices of spare parts, in the last years of the contract, Ghent was burdened with using technology that was no longer widely available, at a cost that was a multiple of the price agreed in 2009. What is common are the three types of maintenance: preventative, corrective and upgrades/new requests. In some of the Chapter 2 case studies (notably Rome and Dublin), the required maintenance period was aligned with the duration of the warranty. In Rome, general infrastructure maintenance is carried out under a separate contract. Maintenance can be very costly (about 18% of the tender value in Ghent's case study) and should therefore be planned appropriately.

Recommendations:

- The response times for repairs/replacement should be specified by the tendering authority or suppliers should propose a maintenance plan as part of their offer.
- The tendering authority should weigh up the duration of the maintenance period against the cost.
- The tendering authority should consider introducing service-level and/or performance-based agreements in the tender.

3.6.3. Sustaining systems in the medium to long term

Ensuring that the required expertise, materials and resources are available to maintain, repair and develop further systems beyond the agreed maintenance period is a particular concern for public authorities. Some equipment may last up to 20 years and will need to be repaired and upgraded along the way, as the ITS expert pointed out: *"When you buy ITS, it is never 100% done, you have to keep on building it and developing it to meet local needs."* Several case studies in Chapter 2 included some interesting provisions that went beyond the normal maintenance-type requirements. These included: the training of local staff to operate and reconfigure the system; the provision of comprehensive documentation about the system; the availability of the supplier's expertise and spare parts for a specified period of time (eight years in Ghent); the provision of a permanent set of spare parts and a regular inventory (Bilbao); additional works without an obligation to carry them out (in Bilbao and Rome) and a 'drawdown days' budget, where a number of days at a given rate is budgeted for systems development (in Dublin).

It is important that clear agreements are made on handovers. First of all, after the project implementation, (part of) the system will be handed over from the supplier to the public authority. The team procuring the system may not necessarily be in charge of operating or maintaining the system. If this is the case, the latter should be involved well before the handover, so it is aware of the implementation details and the background on important decisions. Secondly, at the end of the contract, there is a possibility that a handover of the system, service or concession to another supplier will be required if it makes a more interesting offer than the current contractor. It is better to provide for this in the initial contract as handovers to competitors might be considered unpleasant.

Recommendations:

- The availability of the supplier and spare parts for a defined period should be specified. A yearly re-evaluation of the price should be considered for fast-evolving technologies.
- If there is uncertainty about the need for additional related tasks and equipment, these can be included in the tender but it should be specified that the tendering authority is under no obligation to commission them and the supplier has no entitlement to the budget. This clause has the advantage of circumventing additional procurements for smaller items without committing the tendering authority.
- Training of local operating and maintenance staff should be considered and those teams – if they are not part of the procurement team – should be involved in the implementation project.

Glossary

Active Directory	Active Directory (AD) is a Microsoft product that consists of several services that run on Windows Server to manage permissions and access to networked resources.
ANPR	Automatic number plate recognition.
API	An application programming interface is a computing interface which defines interactions between multiple software intermediaries.
AVL	Automatic vehicle location is a system allowing the real-time tracking of a fleet of vehicles.
BISON	Organisation in the Netherlands developing standards for the exchange of public transport data.
Blacklist	A list of sanctioned vehicles which are brought to the attention of the police when picked up on a number plate reading camera.
Carrier-agnostic SIM cards	SIM cards that can switch between several cellular networks (also from competitors) to always use the network with the best reception.
CC-0	Creative Commons 'zero' licence – 'Creative Commons'.
CCTV	Closed circuit television.
CE certification	Certification mark that indicates conformity with health, safety, and environmental protection standards for products sold within the European Economic Area.
CIRB	https://cirb.brussels/ – The IT department for the Brussels Region – Centre d'Informatique pour la Région Bruxelloise.
CIVITAS	European funding programme and city network for clean urban transport.
Concession	In the case of a public service concession, a private company enters into an agreement with the government to have the exclusive right to operate, maintain and carry out investment in a public utility (such as a water privatisation) for a given number of years.
Creative Commons	Creative Commons is an American non-profit organisation devoted to expanding the range of creative works available for others to build upon legally and to share. The organisation has released several copyright licences, known as Creative Commons licences, free of charge to the public.
Data lake	A data lake is a system or repository of data stored in its natural/raw format.
DATEX II	A European data exchange standard for exchanging traffic information.
DGDPPRU	The DGDPPRU is a department within Timişoara City Hall that deals with transport infrastructure (roads, bridges, pavements, etc.), road traffic systematisation, public transport, public works management (water, channels, district heating) and public lighting.
Disperanto	Multipurpose signing protocol: open and free-to-use protocol, originated in the Netherlands, for sending text to digital signs for traffic management, among others.
DOVA	A partnership of decentralised public transport authorities, founded by the national government of the Netherlands in 2010 to promote coordination between the Dutch public transport authorities.
DSL	DSL stands for digital subscriber line. Users get a high speed bandwidth connection from a phone wall jack on an existing telephone network.

DVM-Exchange	Dutch standard for Dynamic Traffic Management (DVM) within and across the domains of road authorities.
ELTIS	The European Local Transport Information Service is an EU-funded urban mobility observatory.
EN standards	European Standards (EN) are documents that have been ratified by one of the three European Standards Organisations, CEN, CENELEC and ETSI.
FOMO	Fear Of Missing Out refers to a social anxiety about missing out on a solution that others may be implementing.
GIS software	A geographic information system is a conceptualised framework that provides the ability to capture and analyse spatial and geographic data.
GNSS	Global Navigation Satellite System is a generic term for global positioning satellite systems.
GUI	Graphical user interface: part of a software for user interaction: it displays objects that convey information and represent actions that can be taken by the user.
Horizon 2020	Horizon 2020 is the EU programme for research and innovation for the period 2014-2020.
IEC	An international, non-governmental and non-profit standards organisation for electrical and electronic components.
InTime	An interface for access to real-time data developed in the InTime EU project.
IoT	Internet of things refers to a network of internet-connected objects collecting and exchanging data.
IP	Ingress protection: a certificate guaranteeing protection of electrical installations from dirt, moisture and water.
IPR	Intellectual property rights.
ISO	International Standards Organisation.
IT	Information technology.
ITS	Intelligent transport systems.
ITS action plan	Intelligent transport systems action plan.
IVERA	A Dutch standard for communication between central traffic systems and traffic controllers.
JSON	JSON (JavaScript Object Notation) is an open-data interchange format that is easy for humans to read and write.
KPI	Key performance indicator.
MMTIS	Commission Delegated Regulation (EU) 2017/1926 of 31 May 2017 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the provision of EU-wide multimodal travel information services.
OCIT	OCIT is a German standard for connection between central traffic systems and field (roadside) stations.
Open data	Data that is freely available in the public domain.
Optical fibre	Fibre-optic communication is a method of transmitting information from one place to another by sending pulses of infrared light through an optical fibre.

OSS	“Open specifications and standards” is a loose term for the range of open and standardised interfaces.
OTS	OTS provides a framework for communication in a mixed-age system environment. https://www.oca-ev.info/ots/what-does-ots-stand-for/?L=2
PIN	Prior information notice.
Pixel pitch	The distance between different LEDs in a sign or on a screen. The smaller the pixel pitch, the more detail can be shown.
PM (10 or 2.5)	Particulate matter is an air pollutant. The number denotes the maximum size in micrometres.
PSO	Public service obligation is a legal obligation to provide a service of general interest.
RFP	Request for proposal.
ROP 2007-2013	A €4.4 billion strategic operational programme in Romania, supported by the European Regional Development Fund.
RS-232	In telecommunications, RS-232, Recommended Standard 232 is a standard originally introduced in 1960 for serial communication transmission of data.
RSMP	Roadside Message Protocol is a standard for communication between different traffic installations.
RTPI	Real-time passenger information is a system providing real-time public transport arrival/departure information.
RTTI	Commission Delegated Regulation (EU) 2015/962 of 18 December 2014 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the provision of EU-wide real-time traffic information services.
Ruggedised smartphone	A robust smartphone sealed within a thick housing that is capable of withstanding shock and is water-resistant.
Shapefile	A shapefile is a simple, non-topological format for storing the geometric location and attribute information of geographic features. Geographic features in a shapefile can be represented by points, lines, or polygons (areas).
SIRI profile	The Standard Interface for Real Time Information or SIRI is an XML protocol to allow distributed computers to exchange real-time information about public transport services and vehicles.
SLA	Service level agreement.
SUMP	Sustainable urban mobility plan.
TED	Tender Electronic Daily is the EU public procurement portal.
UTMC	A UK initiative providing technical specifications for integrating traffic-related ITS.
VMS	Variable message sign.
VPN	A virtual private network provides a secure internet connection between networks.
White list	A list of vehicles permitted to enter an access regulated zone, usually a low emission zone.
XML	Extensible Markup Language is a markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable.

List of interviews

Bilbao	Pablo Isusi, Deputy Director, Mobility Department, City of Bilbao, Spain
Brussels	Christian Banken, Coordinator, General Secretariat - Regional Security, CIRB Brussels (IT department of Brussels regional government), Belgium
Dublin	Brendan O'Brien, Head of Technical Services, Environment and Transportation Department, Dublin City Council, Ireland
Ghent	Tim Claeys, Verkeerscentrum (Traffic Control Centre), Mobility Department, City of Ghent, Belgium
Rome	Giacomo Tuffanelli, Traffic Engineer, Roma Servizi per la Mobilità (Rome Mobility Agency), Italy
Netherlands	Martin van Vuure, DOVA, Netherlands
Timişoara	Loredana Sibian, Head of Service, Urban Project General Directorate of Roads, Bridges, Parking and Utility Networks, City of Timişoara, Romania
Leipzig	Sven Schöne, Director of Transport Planning, Leipziger Verkehrsbetriebe (Leipzig public transport company) and Tobias Matschek, Technical University of Dresden
ITS supplier	Mark Elmore, Managing Director, Elmore Group Elmore Group specialises in the supply, integration and maintenance of a range of solutions for the traffic and transportation management sector. Based in Dublin, Galway and Tipperary, it offers a nationwide installation and maintenance service across a range of solutions. The company represents various European suppliers of traffic systems and ITS in Ireland.
ITS expert	Bahar Namaki Araghi, PhD, Associate Intelligent Mobility, Arup (Copenhagen, Denmark) Arup is an independent firm of designers, planners, engineers, architects, consultants and technical specialists, working across every aspect of today's built environment.

List of tender documentation

Bilbao

Pliego de Prescripciones Técnicas que han de regir en el contrato de servicio de control directo del cumplimiento de la Ordenanza OTA de la Villa de Bilbao así como servicios vinculados para las personas usuarias del sistema OTA (Google translation: Technical Specifications Sheet to be governed in the service contract for direct control of compliance with the OTA Ordinance of the city of Bilbao as well as services linked for users of the OTA system), 1 March 2016

Brussels

Consultation des entreprises (RFP)- Vidéo Protection de la Région de Bruxelles-Capitale (VPRB), Dossier de Consultation des Entreprises – Spécifications techniques (Google translation: Business Consulting (RFP) Protection of the Brussels-Capital Region (VPRB) "ANPR and route control devices" Technical Specifications), IRISnet, 15 July 2016

Dublin

Tender documents For the Supply, Installation & Commissioning Of a Real-Time Passenger Information System And On-Street Displays, Dublin City Council Office of the Director of Traffic, November 2009

Ghent

- *Leveren, plaatsen, in dienst stellen en onderhouden van een systeem voor verkeersgeleiding op The Loop/Expo* (Google translation: Deliver, install, commission and maintain a traffic management system on The Walk / Expo), MB 02/2019
- *Leveren, plaatsen, in dienst stellen en onderhouden van een systeem voor verkeersgeleiding op TheLoop/Expo voor de Stad Gent* (Google translation: Deliver, install, commission and maintain a traffic management system on The Walk / Expo for the City of Ghent), MB 13/2018
- *Leveren, plaatsen, in dienst stellen en onderhouden van een systeem voor verkeersgeleiding voor de Stad Gent* (Google translation: Supply, install, commission and maintain a system for traffic control for the City of Ghent), PA 09/2009

Netherlands

- *Concessiebijlage datasets OV, Utrecht* (Google translation: Concession appendix data sets OV, Utrecht), Version 1.31, 22 August 2019
- *Dynamische Reizigers Informatie Systemen, Adviesrapport over het weergeven van dynamische reizigersinformatie* (Google translation: Dynamic Traveler Information Systems, Advisory report on the display of dynamic traveler information), Version 2.2, Govi
- *Handreiking plaatsen DRIS-displays* (Google translation: Post guide DRIS displays), CROW-NDOV

Timişoara

- *Trafic Management si Supraveghere Video, in Municipiul Timișoara, Caiet de sarcini* (Google translation: Traffic Management and Video Surveillance, in Timişoara, Task book)
- *Planul de Mobilitate Urbană Durabilă pentru polul de creștere Timișoara* (Google translation: Sustainable Urban Mobility Plan for the Timişoara growth pole), Final report, REP/238624/DSUMP001, Version IV, 12 December 2015
- *Formular F5, Fise tehnice ale utilajelor si echipamentelor tehnologice* (Google translation: Form F5 technical sheets of equipment)

Links to reports and other initiatives

- Andy Patrizio, Network World: https://www.networkworld.com/article/3512885/enterprises-now-spend-more-on-cloud-infrastructure-services-than-on-premises-data-center-gear.html
- CIVITAS Measures Directory, A reference guide to sustainable urban mobility research and demonstration measures implemented by European cities between 2002 and 2012, https://civitas.eu/sites/default/files/civitas-measure-directory-final-www.pdf
- Ch4llenge Project - Rupprecht Consult (editor): CH4LLENGE Participation Manual; CH4LLENGE Institutional Cooperation Manual; CH4LLENGE Measure Selection Manual; CH4LLENGE Monitoring and Evaluation Manual: SUMP Self-Assessment Tool. http://www.sump-challenges.eu/
- CIMEC project: http://cimec-project.eu/
- Copenhagen ITS action plan, https://www.kk.dk/sites/default/files/uploaded-files/ITS%20-%20Action%20Plan%202015-2016.pdf
- Denver City, Denver's Mobility Action plan, July 2017, https://www.denvergov.org/content/dam/denvergov/Portals/728/documents/Denver's%20Mobility%20Action%20Plan_7.7.pdf
- DVM-Exchange website: http://www.dvm-exchange.nl/
- EIB & COWI: Terms of Reference for design and procurement of integrated ITS, Support to Jaspers for railway and urban transport projects TA2017114 RO JEU
- ELTIS website: https://www.eltis.org/
- ERTICO – ITS Europe (editor): Intelligent Transport Systems (ITS) and SUMPs – making smarter integrated mobility plans and policies, September 2019, https://www.eltis.org/sites/default/files/the_role_of_intelligent_transport_systems_its_in_sumps.pdf
- Fleet Forward (staff), 7 January 2020, https://www.fleetforward.com/348051/connected-cars-to-create-more-cooperative-mobility-in-2020
- FRAME architecture website: https://frame-online.eu/
- Fremont Mobility Action Plan, March 2019, https://www.fremont.gov/DocumentCenter/View/40583/FREMONT-Mobility-Action-Plan-Final-3-1-19?bidId=
- Gehl studio San Francisco, Boise Transportation Action Plan, February 2018, https://issuu.com/gehlarchitects/docs/160328_boise_tap_web
- Ivera website: https://www.ivera.nl/
- Jaspers, Applied Guidelines for Projects on Intelligent Transport Systems, part 6 of "Working Documents to Support the Preparation of Sustainable Urban Mobility Projects in Romania," December 2018
- OCA website: https://www.oca-ev.info/
- OCIT website: https://www.ocit.org/en/
- OMC-PTP project: Exploring Public Procurement as a Strategic Innovation Policy Mix Instrument, March 2009, https://www.kozbeszerzes.hu/data/filer_public/14/ce/14ce87e1-4053-4edc-a503-8adb42d30866/strategia-en.pdf

- P3ITS consortium: Pre-Commercial Procurement for Intelligent Transport Systems, June 2011, https://trimis.ec.europa.eu/sites/default/files/project/documents/20130226_161029_17451_001_P3ITSD31Handbookv2.pdf
- Pieter Morlion, Traffic Management as a Service, November 2016, https://www.linkedin.com/pulse/traffic-management-service-pieter-morlion/
- POSSE: Good Practice Guidelines on the Implementation and Development of Open Specifications and Standards for Intelligent Transport Systems (5 November 2014)
- Public procurement guidance for practitioners (2018), European Commission, https://ec.europa.eu/regional_policy/sources/docgener/guides/public_procurement/2018/guidance_public_procurement_2018_en.pdf
- RSMP website: https://rsmp-nordic.org/
- SPICE project, Best Practices: https://spice-project.eu/best-practices/
- SPICE project, 3 SPICE Analysis and Recommendations (Version Final 29/08 2018): http://spice-project.eu/wp-content/uploads/sites/14/2019/03/SPICE-D-3-Analysis-and-Recommendations-FINAL.pdf
- SUMPs-UP project: Standards for developing a SUMP action plan: https://sumps-up.eu/fileadmin/user_upload/Tools_and_Resources/Publications_and_reports/SUMP_Action_Plan/SUMPs-Up_-_Standards_for_Developing_a_SUMP_Action_Plan.pdf
- TED (tender electronic daily): https://ted.europa.eu/TED/main/HomePage.do
- The Guardian, https://www.theguardian.com/environment/2020/jan/20/how-a-belgian-port-city-inspired-birminghams-car-free-ambitions
- UIRS – CIVITAS Prosperity (editor): Prosperity through innovation and promotion of Sustainable Urban Mobility Plans, February 2018, https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5b8ba14bd&appId=PPGMS
- UTMC website: https://utmc.uk/

Annexes

Case studies

Case study 1

Automatic parking enforcement in Bilbao

Background

The Basque city of Bilbao (population 345 000) in Spain tendered for a new parking enforcement system in 2015. The new system consisted of two main innovations in relation to the previous system. Firstly, enforcement moved from a fully manual (parking wardens) to a largely automated system by means of a fleet of floating vehicles roaming the city reading the number plates of parked vehicles. Secondly, the nature of the contract changed: a service contract was introduced replacing the concession contract that had been in place for 12 years previously.

The decision to move towards a service contract was taken by the municipality primarily to enable it to have greater control over the system (software and data) and for economic reasons. Under a concession contract, the concession holder had ownership of most components of the system, meaning that any change to the parking regulation (such as fare structure, parking zone, maximum parking time) incurred a cost for the city. Furthermore, parking income goes directly to the municipality under a service contract, which is not the case for a concession contract.

Bilbao is the largest city in the Basque Country. Besides parking, the municipality is responsible for taxis and for tendering of the urban bus service Bilbobus and the bike sharing service Bilbao Bizi. Other public transport services (tram, metro and regional rail network) are run by the Basque government.

Parking enforcement

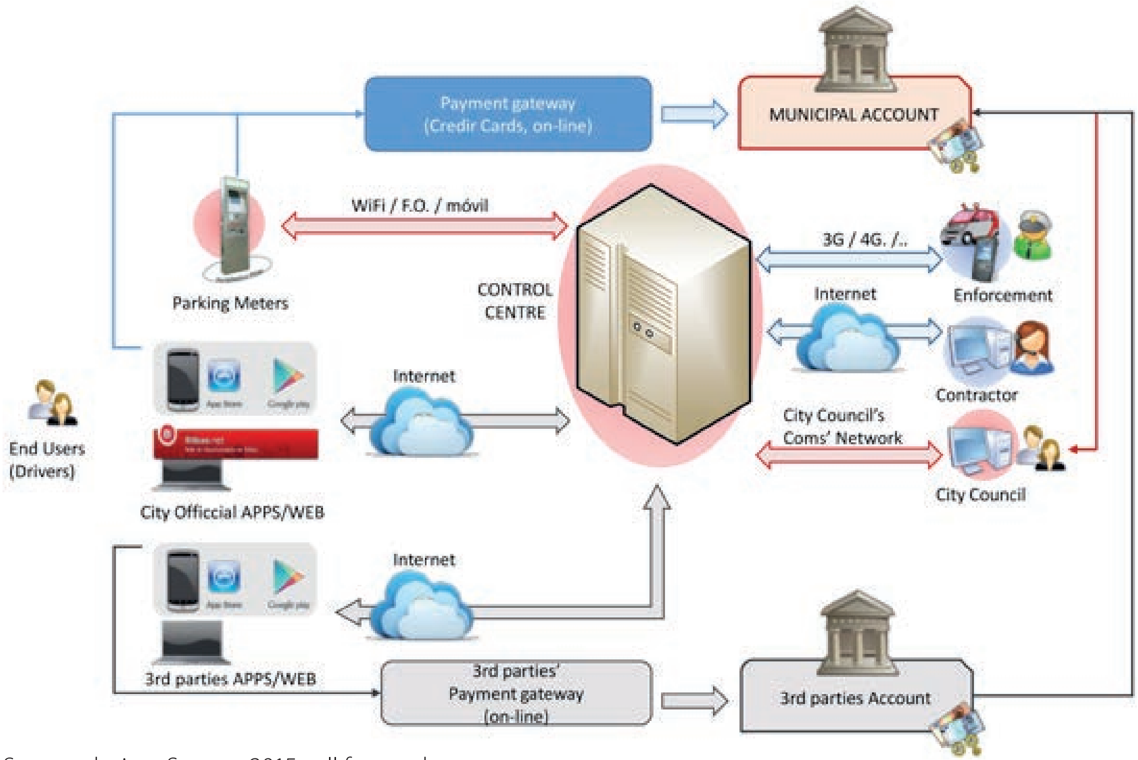
In 2002, Bilbao became the first city in Europe to introduce number plate-based parking tickets, i.e. a driver must enter the vehicle number plate when purchasing a parking ticket. Number plate-based ticketing was a prerequisite for introducing a more automated form of enforcement. The parking enforcement system introduced in 2015 was specified in the tender. Bilbao had visited several other cities in Europe (Rotterdam and Madrid) that were already operating a parking system based on automatic number plate recognition (ANPR). A key factor in the decision to shift to an ANPR enforcement system was the high labour intensity of manual parking enforcement. Through talking with other cities, Bilbao learned that the number of parking places attended to by a parking warden in Bilbao was much lower than elsewhere, hence labour costs represented a substantial portion of the concession contract.

How does the system work?

A fleet of up to 20 electric or hybrid vehicles equipped with a number plate recognition camera patrol the streets of Bilbao during the regulated parking time reading the number plates of parked vehicles. These data are transmitted from the surveillance terminal (an app on a ruggedised smartphone) in the vehicle to the management system, hosted at the municipality's data centre, BilbaoTIK. The management system cross-checks all the number plate-based parking tickets recorded in the system against the data received from the surveillance vehicle. Where there is a mismatch, the vehicle returns ten minutes later to read the number plate a second time (thereby giving the driver time to buy a ticket). If the parked vehicle is still in breach, the information is communicated to a small team of on-foot parking attendants provided by the contractor who issue the penalty. This ground patrol team is required by law due to a local regulation permitting penalties to be paid on the parking meter itself – a legacy of the former concession contact. For the next parking enforcement contract currently under preparation, Bilbao plans to remove this function and replace it with a centralised operational scenario whereby penalties will be sent out by post.

The parking enforcement system has four main components:

1. The **management system** (aka control centre) is owned by the municipality and is located in the municipality's data centre, BilbaoTIK, which is home to all the municipality's IT systems and servers. The development of the management system was part of the tender. Under the previous system, the concession holder owned the management system.
2. The **parking meters** and **mobility application** (for mobile-based parking payment) are the property of the municipality. The mobility app was a part of the tender. Under the new tender, new parking meters were only to be provided if the municipality decided to extend the city's regulated parking area. This has not yet been implemented.
3. The **surveillance terminals** and **vehicles** are supplied by the service provider and therefore remain under the ownership of the provider. Both were part of the tender.
4. The **communication infrastructure** is the responsibility of the contractor although specific technical criteria are required by Bilbao. This is specified in the tender.



System design. Source: 2015 call for tenders

Tendering process

The 2015 tender itself covered the:

- Development of a management system (aka control centre);
- Creation of a mobility app to enable mobile payment of parking, including an API to allow private operators' apps to operate in Bilbao;
- Installation of new parking meters;
- Provision of a fleet of electric vehicles equipped with surveillance equipment;
- Operation of the parking enforcement service (premises and personnel);
- Maintenance of the whole system.

Preparation: The tender was largely prepared in-house although a specialised consultancy was recruited to review the technical elements. During the tender preparation process, many inter-departmental meetings were held. The draft tender was completed by the end of summer 2014; however, it was not adopted by the city council until May 2015 due to a change in the council following local elections. Four staff members were involved in preparing the tender. Bilbao has estimated that approximately 12 person-months in total were required for the preparation stage. This period included visits to cities operating similar systems.

Implementation: Bilbao did not consult the market about the system tendered. An open tendering procedure was adopted. Some 104 questions were received; they can be consulted at this link. The questions did not lead to any modifications to the tender requirements; however, they were fully integrated into the body of the contract with the winning bidder. The new parking enforcement contract (2020 onwards) is currently under procurement and Bilbao recruited the services of a consultancy to carry out a market consultation for this.

A total of eight companies submitted a bid. The tender was won by the local parking operator and the value of the contract was approximately €45 million over four years. The system was conceived to be cost-neutral and this was the case for all four years of the contract. The selection of the company was fraught with difficulty due to a legal challenge from the second-ranked company, which was ultimately resolved in court. This led to the contract changing hands several times, from the first-ranked company to the second-ranked company and then back again to the first-ranked company. The legal challenge was based on a minor technical requirement related to parking meter humidity levels, which ultimately the court ruled to be unfounded. This process has led to delays in the implementation of certain technical requirements, which the municipality is hoping to resolve in the new service contract currently being defined.

'Unquantifiable' criteria accounted for 48% of the evaluation criteria and included objectives alignment, technical merit, maintenance, transition period (including risk management), hardware and software (parking meter, control system and payment app). The remaining 52% was calculated using formulae, including inspection frequency and rotational rates for a given regulated parking area and environmental commitment (type of vehicle), among others. A full description of the evaluation criteria can be found here (URL link must be copied and pasted into browser).

Technical requirements

Functions and components

The tender is largely functional in its description of the service and the management system at its core, although it does specify ANPR as the technology for enforcing vehicles based on the experiences of other cities.

The main functions of the service contract are:

- Monitoring and manual checking of vehicles (badge displayed for authorised vehicles, e.g. for persons with disabilities);
- Enforcing parking regulations through the issuance of penalty notices in the event of parking regulation breach;
- Parking fee management including coin collection, responsibility for fraud/theft/damage, commissions from electronic payments;
- Monitoring, maintenance and repair of all parking meters;
- Customer service (call centre and one physical office, both accessible during office hours, in two official languages and English);
- Emergency works and exceptional services.

The **management system/control centre** must offer the following functions:

- *Economic management of income*, by area, sector, parking meter, period and payment means.
- *Management of penalties* issued by the surveillance terminals and vehicles.
- *Communications management*, particularly the communication status of parking meters.
- *Management of authorisations* of special users (residents, delivery vehicles, etc.).
- *Reconfiguration of parking meters* centrally and remotely.
- *User interfaces* for the (i) contractor to monitor the different elements of the system and (ii) city to be able to audit parking fees, penalties, payment methods and certification methods.
- *Regular reporting* to city council (see Performance indicators on 'reporting').
- *Real-time information* on the status of the system (parking meters, parking space offered/available, occupancy/availability index, identified works).
- *Synchronisation* with the city council's GIS inventory and performance management system.
- *Integration with the municipal financial application* relating to payment and revenue management, including synchronisation with the database related to parking exemptions.
- *Management of disciplinary proceedings* by the city of Bilbao.
- *Mechanisms necessary for integration with applications* marketed by third parties designed to offer payment services for surface parking.
- *Information consolidation* to create a global and integrated vision.
- *No limitations* on number of users, parking meters and surveillance terminals.

Payment gateway: A secure gateway payment system must be established for credit/debit card payments from parking meters, mobile applications and the website. The service must not present any additional cost for the city council nor for the user. A ticket will not be issued until the banking operation has been approved. The gateway will accept both magnetic and EMV debit or credit cards from any financial institution.

Mobility application: The app must be available in the Apple store, on Windows phone and Android and on the corresponding operating systems. It must offer the same functionalities as a parking meter and additional features including recovery of unused parking time and real-time parking availability.

Customer service: Development of web services to provide information to the user through the official website of the city council. Integration into the web portal of other municipal systems, including platforms for electronic signature, sending of messages (texts, emails), municipal GIS, inventory and register. Call centre from 8.30 am to 8.30 pm, Monday to Saturday.

Minimum functionalities for the new parking meters: The tender provides an extensive list of functionalities related to the ticket, notably what data appears on it (including font requirements and languages) and maximum printing time; payment functions (method, cancellation, etc.); screen requirements; automatic malfunctioning alerts and self-protecting mechanisms (e.g. coin slot closes if a foreign object is inserted); energy source (solar panel) and capacity (eight hours' battery life); communication capacity, as well as electro-technical regulations for low voltage.

Surveillance vehicle requirements: The contractor must have a fleet of at least 20 electric or hybrid vehicles for service delivery which are in communication with the management system. Vehicles must carry the city council logo. Other non-surveillance vehicles must meet specific environmental criteria. One surveillance vehicle must carry out service inspection and audit tasks; hence, this vehicle must be equipped with an audit module, providing audit reports showing the percentage of unsanctioned vehicles. Floating surveillance vehicles must provide travel times, driving speeds, speed route and number of stops. To issue the penalty notice, all surveillance terminals and vehicles must have a printer that can accommodate any future regulatory change affecting parking fees and fines.

Personnel: The contractor must provide a list of people assigned to the service and their function and a coordinator (or substitute) with engineering qualifications who liaises with the city council and is available 24/7. For any change vis-à-vis the coordinator, notice must be given to the council one month in advance.

Premises: The contractor must have an office, workshop, warehouse, checking area and garage for surveillance vehicles, within reasonable distance and in good working order. The city shall make available to the contractor some of its own premises; the contractor must then assume payment for bills, etc. A 200 m^2 office in a specified neighbourhood must be open to the public at defined times for customer services.

Service management: The service completion terms shall include the following: the contractor must ensure proper service transfer at the end of the contract, including a service transition plan during the final three months of service, a set of tasks (equipment inventory, condition and capacity), maintenance history for hardware and software, documentation on information systems, etc.

Measurement requirements for each component

The tender does not stipulate the minimum performance levels of the various components of the system. However, the availability/reliability of certain components (such as the parking meters) and other indicators (see performance indicators) are reviewed monthly and determine the monthly amount to be paid to the contractor. The tender describes a **rigorous measuring and reporting system**, which is the responsibility of the contractor and which Bilbao can check with 24 hours' notice. A record of checks and the adjustment operations carried out must be recorded. Bilbao requires the parking enforcement system to be run in 'audit' mode to enable it to check service quality, which it does at least once a month.

General requirements

Within one month of contract signing, the contractor must provide **an inventory of surface parking spaces** and compare this with the data held in the municipal tool. The contractor then has five days to update the GIS tool.

A **Health and Safety Plan** identifying all risks related to the work must be submitted to the council within three weeks of contract signing.

A certified method must be used for **validating** the time and location of the vehicle breaching a parking regulation. Two photographs must be taken of the vehicle flouting the regulation.

Documents to be provided: technical description of system, including equipment; operational manual of all elements; instruction manual (e.g. procedures for maintenance and modifications, use of standards, frequent errors and resolution methods, etc.); map of each installation (equipment plan, wiring plan, connection diagram); equipment photos, equipment inventory (manufacturer, module, serial number); cables/transmission lines used; software licences (serial number, activation key, user name, etc.); maintenance manual and test protocols.

Back office system requirements

The contractor is responsible for connecting the parking meters to the management system via mobile communications. The technical solution is not specified; however, the network must be secure. Ultimately a virtual private network (VPN) solution was adopted. Mobile communication is also used for data transfer between the surveillance equipment and the management system. In terms of intellectual property rights, the city is the owner of any licence that is required for a commercial product. The system components must meet the city's IT system requirements (BilbaoTIK), including any system maintenance carried out. A payment gateway interface is required enabling information relating to operations to be consulted.

Data requirements

A set of parking data, using the InTime format, must be made available on the city council's open data portal. The static data can be found at this link. Real-time parking availability and a parking payment API are also part of the contract; however, there have been delays in implementing these due to the wider implementation delays described earlier. These are scheduled to be implemented in 2021 under the new enforcement contract.

Data ownership is a key aspect of the tender, which clearly states that any component of the system and all contractor-generated documentation are the property of the city council. In terms of data transfer, information related to penalty notice must be transmitted to the city council as per the council's legal and technical specifications abiding by data protection legislation. Contracting staff may only use data for contract purposes. A confidentiality and secrecy clause forms part of the contract terms. A secure mobile network must be established for communication between the management system, parking meters and surveillance equipment and for the credit/debit card payment service.

Environmental conditions

Many standards are required to ensure that the equipment, especially the parking meter, can withstand:

- the elements: -20°C to +50°C; 95% humidity index; stainless steel or other material resistant to moisture and corrosion; dust and water-resistant keyboard (IEC 60529) with IP65 protection and impact resistance (IEC 62262); polycarbonate applied to digital clock and information area.
- malicious attacks: anti-graffiti and anti-adhesive paint.

The contractor is required to have the following certifications: ISO9001 (quality management system standard) and ISO14001 (environmental management system standard adopted in place of individual environmental performance requirements).

Maintenance

A preventative and corrective maintenance plan must be submitted to the city council within three weeks of contract signing. There are three types of maintenance foreseen. Preventative maintenance must be undertaken at specified intervals for checking, cleaning and painting the parking meter and for checking the electrics and the system's operating parameters. As regards corrective maintenance, the deadline for repairs is three hours for the system and 24 hours for a parking meter. Parking meter availability is a variable part of the monthly payment. Upgrades/improvements cover new functionalities and integrations due to new developments, standards or IT systems. In addition to maintenance, the tender requires a spare parts reserve which must be reported monthly, and a specific set of spare parts must be provided at the end of the contract.

Performance indicators

As a service contract, the system and service performance determines the monthly payment to be made to the contractor. The following indicators are used:

- Indicator 1: Availability of parking meters
- Indicator 2: Availability of payment gateway
- Indicator 3: Complaints correctly processed
- Indicator 4: Enforcement control
- Indicator 5: Compliance with the target turnover rate

Other requirements include the following: a daily inspection of all elements making up the system, including data on the open data platform, must be performed; a monthly inventory of spare parts must be submitted to the city council; parking meter coin collection must be undertaken weekly and transferred to the city council's bank account. With respect to exceptional services, the contractor must make available personnel and materials in the event of emergencies within three hours at any time of day or night and execute emergency works within 24 hours. Reports on income, parking fees, penalties issued, vehicles regularly in breach, parking meters, parking spaces occupied and users must be provided daily, weekly, monthly, quarterly, bi-annually and annually. These are presented in a reporting KPI dashboard.

Case study 2

ANPR system for enforcement of a low emission zone in Brussels

Background

The Belgian Region of Brussels-Capital (population 1.2 million) is notorious for its huge traffic jams and its former car-centric approach. However, in recent years, Brussels has followed the example of other European cities in expanding its pedestrian area and introducing a low emission zone (LEZ) and a traffic circulation plan, which discourages through traffic in the city centre. The 'GoodMove' plan – under construction as of writing – will place Brussels at the forefront of sustainable mobility by possibly introducing a total ban on combustion engines from 2035, a kilometre charge, a 30 km/h speed limit covering the entire territory and the introduction of circulation plans for every neighbourhood (these are all under consideration at the moment).

Evolution of the LEZ

Around 2015, the government of Brussels-Capital Region decided that a low emission zone should be installed covering its 19 municipalities. On the one hand, this decision was taken to make the overall car fleet in Brussels cleaner (two-thirds of the entire fleet by 2025). On the other hand, a drastic improvement in air quality was envisioned to meet the European Union's legally binding air quality limit values. The objectives are set out in this comprehensive presentation.

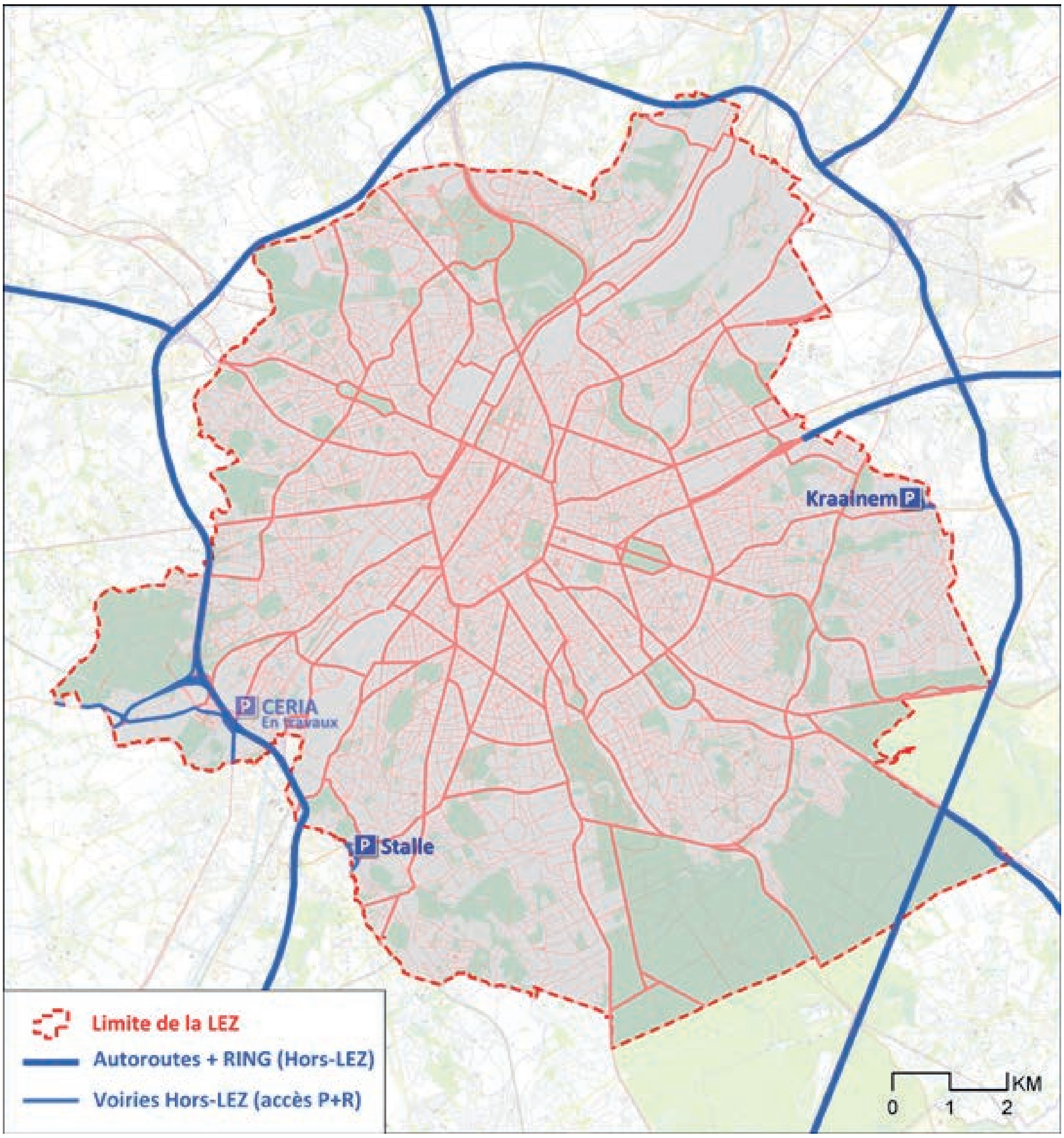
The low emission zone entered into effect in January 2018, and enforcement started in October of that year. Currently, 290 automatic number plate recognition (ANPR) cameras are installed for enforcement purposes and this will be expanded to 330 in 2020. The current framework contract expires next year. The IT department is investigating future measures, including publishing a new tender for continuation of the system using the latest technologies.

The tendering process

The Brussels regional government immediately specified that the low emission zone should be enforced by using ANPR cameras, leaving no room for other systems. Brussels' environmental department was appointed for the overall coordination of the LEZ, and the IT department for the Brussels region (the CIRB) was requested to procure an ANPR system.

The IT department was able to fall back on a 2012 framework contract for surveillance cameras and was therefore able to move forward quickly. Within this framework, a request for proposal (RFP) was sent in 2016 to various parties for the delivery of number plate recognition cameras. This was done after consultation with several other cities in Europe (Antwerp, Paris and Zurich) that already had such a system in place. Consultations were also held with the various departments within the Brussels government and the federal police, which had plans to create a national licence plate recognition database. The IT department was assisted by two consultants who studied the specifications of other European cities. For some cities, they were even able to review the technical parts of the offers received from suppliers.

In addition to using the ANPR cameras to maintain the LEZ, it was also immediately planned that the cameras should be used for a number of other applications. Some cameras were also procured under the same contract for speed enforcement (trajectory control) and for police purposes. When asked for success criteria, the manager in charge of the system indicated that it was fundamental from the outset that the cameras be used for multiple purposes. Not only on a technical level, but more important, legally. The ANPR camera takes pictures that can be used for any kind of system and the request for proposal provides for this (see below where the functions are described). Alongside this, legal procedures and definitions were put in place providing for the data produced by the cameras to be used for different purposes. The five-year contract is worth €1.65 million (excluding VAT).



Boundaries of the LEZ in Brussels and the P+R zones (that can be reached without entering the LEZ). Source.

How does the ANPR system work?

The system aims to only allow vehicles (cars, vans, buses and coaches) that meet the emission standards in the LEZ. If a vehicle does not meet the current Euronorm required by the Brussels regional government, the owner will be fined €350, a fine that can be issued only once a quarter. A large number of cameras capture the licence plates of all cars driving in and through the LEZ. The data are checked against the Belgian national car register which returns information about the emissions of each vehicle. If a car does not comply, a fine is sent to the address linked to the licence plate.

Technical requirements

Functions and components

Brussels has clearly opted for a description of functions, not of technology. This results in a functional description of only 14 pages for the ANPR cameras. The persons in charge of the assignment were not ANPR specialists and they did not want to get lost in technical details or try to close every loophole upfront. The request for proposal contains the objectives, and suppliers were expected to propose solutions to materialise those objectives. The IT manager stressed several times that in such a way of working, the analysis of the offers is key. Therefore, two consultants were hired to ensure that the solutions proposed were a good match for the functions described. It is also a matter of knowing the market: the supplier they eventually selected had a sufficient base of projects and customers in Belgium, a factor that built trust.

The request for proposal consists of three parts. First, there is a section on **enforcing the LEZ** through ANPR for five years. The second part is about **enforcing speed limits** by means of trajectory controls with ANPR cameras. The third part is more **general** and enables the supplier to formulate additional functionalities like detecting vehicles blocking intersections or occupying bus lanes and the procurement or usage of mobile ANPR devices.

The assignment of the request for proposal has currently resulted in the installation of 290 cameras for the LEZ and 16 cameras for speed enforcement. Both functions use exactly the same camera types but cannot be exercised by the same physical camera. This is technically possible, but the current legislation in Belgium does not allow speed enforcement cameras to be used for other purposes. In addition, these cameras – and the associated trajectories – must be certified.

In this case study, we focus on the part of the request for proposal defining the procurement of ANPR for low emission zone enforcement, which should deliver the following:

- *Management and monitoring of the camera system*: ensure the sound configuration of all cameras and monitor connectivity and functioning.
- *Recordings of licence plate pictures:* storage of pictures and image materials.
- *Checks if vehicles are registered:* obtain this information from the national vehicle register. A daily back-up should be downloaded if the online register is not available.
- *Blacklist*: obtain lists including blacklisted vehicles (owner or car involved in illegal activities) or descriptions from different sources and generate alerts when such a vehicle passes an ANPR camera.
- *White list*: obtain lists with vehicles that are allowed to pass, e.g. public transport or certain vehicles in pedestrian areas.

- *Low emission zone*: the system should be able to send a licence plate number to the national vehicle database and retrieve the Euro standard for CO_2 emissions that is applicable to the vehicle. If this does not meet the access conditions for the LEZ the licence plate number is sent to a penalty processing software.
- *Manual search:* authorised users should be able to manually search in the database.
- *Sending text messages and emails automatically:* the system should be able to send messages when a certain event occurs.
- *Detection of traffic:* during a certain period of time, all traffic passing by two specific cameras is captured and listed.
- *Enforcing overtaking bans:* two cameras are used for this; if car A drives in front of car B at the first camera, and B drives in front of A in an area where overtaking is banned, a traffic violation is registered.
- *Detection of transit traffic:* detection when trucks (or cars) are cutting through the city centre or are actually delivering goods.
- *Statistical analysis:* scrambles the licence plates for privacy reasons but allows statistics on travel behaviour.
- *Travel times*: the system can calculate the time it took a vehicle to travel between two cameras.
- *Counting:* the system counts vehicles (and differentiates between different types of vehicles).
- *Nature of traffic:* the system can differentiate between local traffic and transit traffic.
- *Identification for police purposes*: some advanced queries should be able to be executed by the system, based on police requests.

System

Although Brussels mostly describes the system in a functional way, two technical requirements should be emphasised nonetheless. Firstly, the number plate recognition system: the current generation of systems takes a photo where the licence plate is expected to be located and tries to recognise any characters afterwards. A newer way of working involves artificial intelligence with a whole new algorithm that analyses moving images and detects the licence plate and its components. This has some advantages: the area filmed is bigger and the images can also be used to check who or what is in the vehicle, overtaking manoeuvres, etc. This leads to the second important requirement: the resolution of the camera. When larger areas are filmed, high resolution images are required to distinguish enough detail.

Measurement requirements for each component

Cameras should be high definition and capture at least 60 frames per second, registering number plates at distances of between 2 and 30 metres and at speeds between 0 and 250 km/h. For speed cameras, the installations and trajectories need to be approved by the national meteorological institution in order to ensure that the speed measurements are correct.

A car has two number plates and there is a difference as to which number plate is needed for which function. The police requires the front plate to be captured (because this also enables some of the inside of the car to be seen). The Court of Brussels has ruled that only rear number plates can be used for speed enforcement. This means the system should be able to capture both.

The accuracy of the cameras was not specified in the tender but formed part of the analysis of the offers. Instead of the City of Brussels – which lacked detailed technical knowledge – setting a random KPI, they analysed the performance promised by the supplier and used this as a KPI. Currently, the system performs well according to the City of Brussels' IT department and around 93% of number plates are recognised. Every car is spotted on average by three cameras during a journey throughout the region.

The cameras should be able to monitor at least two lanes, for all speeds and independent of weather conditions.

Safety

The installations should in no way jeopardise the safety of property and people. In general, it is specified that cars should not stop or change their behaviour for the system to function properly. It should also not hinder road users (by, for example, using a flash visible to the human eye).

Back office system

To ensure future expansions, the request for proposal stipulates that the system should be compatible with other similar back office systems and it should be able to connect with fixed and mobile ANPR cameras from other suppliers. Tenderers should add a list of compatible cameras (also from other suppliers) to their proposal, to prove this. The IT department is not involved in sending fines or police tasks. Therefore, the software must be able to automatically exchange data with the tax department and the police.

After the ANPR system was procured, it was successfully interfaced with the platform Brussels uses to process and store all video surveillance data. If a vehicle is on a blacklist and the plate is seen, an automatic alarm is sent to the video platform and all the video surveillance cameras in the location are automatically displayed. A connection to the national car registry (DIV) is made by the department that collects the fines, and in the near future, a connection with the federal ANPR back office will be made to send the captured data from Brussels' cameras to the federal police.

Data

The system should have interfaces that can exchange data with other organisations and software systems such as the integrated crisis communication centre and the national register for vehicle registration. It should show and store the geolocations of the cameras in a format compatible with the GIS software used in Brussels and the user management should be compatible with their Active Directory (meaning the user accounts from PCs and other applications can be reused).

The central storage space required for ANPR images is not that big. In addition, the Brussels government prefers not to use cloud storage and therefore all images are stored in the storage platform that is used for the surveillance cameras. In the Brussels request for proposal, suppliers are free to use a technology of choice for data communications. This meant that in practice they were able to be flexible and use whatever was at hand: existing fibre optic networks from other city departments, DSL modems, Wi-Fi networks and 3G/4G connections.

Environmental conditions

One of the difficulties is mounting the cameras. After receiving permission from all municipalities involved, for every camera a support needed to be found: an existing pole with the authorisation of its owner, a building/house, a bridge, a new pole, etc. Then, a power supply needed to be found: traffic lights, public lighting, new connections, etc. Therefore, the tender specifies that the supplier should include as many implementation and fixing options as possible, to allow maximal flexibility and reuse the existing infrastructure where possible.

The cameras are required to read licence plates correctly, including at night and in difficult weather conditions. This works fine, the only difficulty is detecting the colour of the car (which is checked automatically with the national car registry). In case of a temporary breakdown in connectivity or a power outage, data are stored in the camera for a maximum of seven days and will be retransmitted later when the connection is restored.

Maintenance and liability

The supplier is responsible for any works, services, configurations, etc. that are needed to put the system in place, have it working, and keep it working for five years.

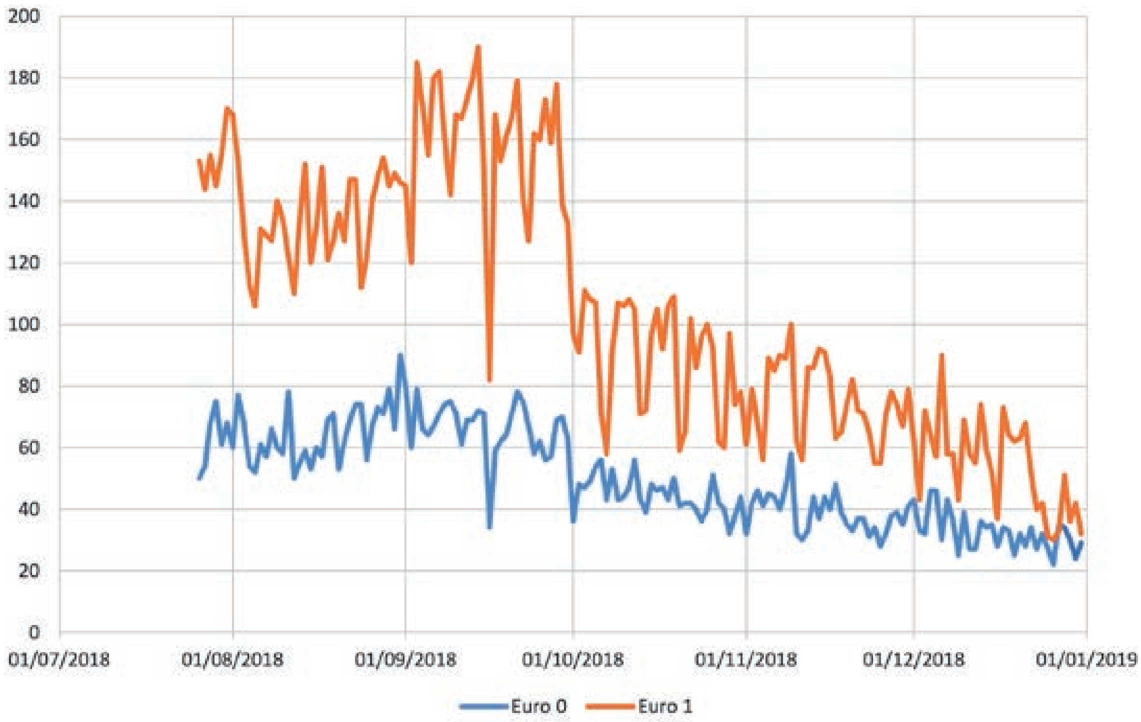
Both preventive and corrective maintenance are part of the contract. There is not a lot of vandalism in Brussels (in comparison with that caused to public surveillance cameras). Most issues arise from roadworks, meaning the ANPR installations should be dismantled and reconfigured after the road modifications.

Performance indicators

The Brussels government is transparent on how the LEZ is reaching its objectives, by releasing an annual report. Nevertheless, the performance indicators are not part of the specifications towards the suppliers in the request for proposal documents. The latest KPI report published dates from 2018 and is available in Dutch and French.

Testing requirements

The request for proposal stipulated that suppliers should take part in a proof-of-concept exercise. One location was selected where video surveillance cameras were already installed, so the accuracy could be verified by manually checking the surveillance footage. The system manager indicated that a lot of time was invested in this phase, but that it was really worthwhile and they learned a lot before procuring any system.



Absolute numbers of Euro 0 and Euro 1 vehicles entering the LEZ, before and after imposing fines (01/10/2018). Source.

Case study 3

Real-time passenger information for buses in Dublin

Background

In 2009, Dublin City Council (population 1.39 million), the largest local authority in Ireland, launched a tender for the supply, installation and commissioning of a real-time passenger information (RTPI) system and on-street displays for bus services. Dublin City Council is responsible for all aspects of urban transport management with the exception of public transport contracting. The initiative for the system came from central government, as did the funding. The two main bus operators in Dublin, representing 99% of the market at the time, already had an automatic vehicle location and control (AVLC) system, although the systems were different. *Dublin Bus* had a system based on the European SIRI standard whereas *Bus Eireann* had the German VDV system.

While Dublin City Council was responsible for tendering, procurement and installation, it was always intended that another body, the National Transport Authority (NTA), would operate the system. The NTA was created in 2009 to oversee strategic transport planning and regulation of all modes of transport throughout the country. It was also envisaged that the installation of an RTPI system in Dublin would be the first step of a plan to roll out nationally to all public transport modes.

Evolution of RTPI in Ireland

The Dublin RTPI system for buses entered operation in 2010. By 2012, all public transport operators around the country were on board. An RTPI system covering all modes (heavy rail, light rail and bus) both urban and interurban has since been introduced. The installation of RTPI in Dublin and then nationally was facilitated by the very small number of transport operators, which were and still are state-owned. There is now more deregulation of the transport sector and a commercial bus operator has since entered the Dublin market operating under a PSO contract. The NTA provided this operator with the necessary equipment to be part of the AVLC system and thereby the RTPI system. The RTPI responsibilities of Dublin City Council today relate to communications and the installation of on-street displays. There are approximately 660 RTPI displays in the Greater Dublin Area and about 900 throughout the country. With a population of 1.9 million, the Greater Dublin Area, comprising Dublin and six surrounding local authority areas, accounts for 40% of Ireland's population.

How does the system work?

The real-time passenger information system receives the following data from the AVLC systems of the bus operators: bus stop unique identifier and next arrival/departure time. The bus stop number on an AVLC feed is not necessarily the same across all operators; hence, the data needs to be normalised by the system. Then the system sends the estimated arrival/departure time to the displays located at bus stops and at interchanges.

The system has four main components:

1. Central system (MORTPI) to receive data from a number of AVLC systems
2. A user interface
3. RTPI displays on-street with a communications link to the central system
4. Mounting poles, mechanism and accessories

Tendering process

The 2009 tender comprised the following elements:

1. A multi-operator real-time public transport information system (MORTPI)
2. Real-time passenger information displays (+ mounting poles) at up to 500 locations, plus installation
3. Audible announcement system for up to 500 bus stops or interchanges

The tender was drawn up in-house and launched via an open competition. Approximately six to eight bids were received. Dublin City Council invited all eligible bidders to a bilateral clarification meeting following submission. The purpose of this meeting was to go through the bid to clarify certain points and generally ensure that Dublin City Council had not overlooked anything. It is in meetings such as these that certain tricky points can be teased out, for instance, software licensing agreements. Software procurement is rarely a one-off cost, rather it tends to have ongoing costs related to annual maintenance (for updates). This is often overlooked in tenders.

The criteria for evaluating the bids were as follows: 30% each for the ultimate (total) cost and for the look of the signs; 25% for specification compliance; and 15% for availability and level of resources offered. The call for tenders also stipulated that the city council is not required to access the lowest or any bid and that it will not offer a contract to any bid failing to reach 50% of marks in three out of four evaluation criteria.

In terms of payment methods, two payment schedules are stipulated:

- MORTPI system: 20% upon acceptance of the detailed design phase; 70% upon acceptance of the software and demonstration of the data on-street; 5% upon completion of the training course and 5% held for 12 months after acceptance of the tendered MORTPI price.
- RTPI display signs: 30% upon installation of the signs; 65% upon satisfactory commissioning and operation of the service; and 5% held for 12 months after satisfactory commission.

Technical requirements

Functions and components

The call for tenders is described at a purely functional level. There are very few technical requirements set, leaving a significant amount of liberty to the contractor in the solution it proposes. For instance, the actual look of the RTPI sign as well as the font used is discretionary. The tender document simply specifies how many lines should be displayed on the signs (between two and six lines), that it should be visible from 10 metres, be aesthetic and blend well into the street environment.

A detailed design stage is scheduled during the two months immediately following the contract signing. At the end of these two months, the tenderer must ensure that all detailed data components, user interfaces, workflow process, RTPI sign specification, drawings, layouts and project plans are documented and detailed for the final system. Dublin City Council must sign off all aspects of the Detailed Design Stage.

The components of the system are described below:

1. The **central system, MORTPI (multi-operator real-time passenger information)**, should offer the following functionalities:
    - *AVLC interfacing*: The system must be capable of interfacing with current and future AVLC systems in Dublin used by different manufacturers. The bus stop identifier may be different from one AVLC feed to another and the system must be able to accommodate this. The reference to interfacing with future systems anticipated the opening of Dublin's public transport market to competition. Hence, an open interface was stipulated.
    - *RTPI dissemination:* The system should normalise all AVLC data received and then transmit the information to the network of RTPI display signs. It should also be possible to logically group bus stop IDs and RTPI according to bus corridor or geographical region so that service messages can be quickly and easily set along designated routes or corridor sections.
    - *RTPI display tactics*: The contractor must build and demonstrate a logic showing how the system can handle the information (i) where the number of buses expected to visit a bus stop within the set look-ahead period is greater than the available display lines; (ii) where the next bus from a given operator may be required to be displayed even if out of time step (i.e. several other buses are scheduled to arrive beforehand but the given bus arrival must be displayed nonetheless); and (iii) when there is no service.
    - *Future extension*: While the tender covered the delivery of up to 500 RTPI signs, Dublin expected all 5 000 bus stops in the Greater Dublin Area to be on the MORTPI system and thus ready for operation in case RTPI signs were rolled out more widely in the future. Tenderers were invited to specify the maximum number of stops that could go onto the system and set out any licensing issues per RTPI display sign.
    - *Server and operating system specifications*: The tenderer was invited to provide the specifications for the server and the operating system whereas Dublin City Council would procure the server and the software licences – this is a requirement of the information systems department of Dublin City Council. A standby server is required in case the main server failed, making it possible to move seamlessly from one server to the other.
    - *Users of the system* should be described at four levels – guest, operator, engineer and administrator – and offer different levels of access from least access (guest) to full access (administrator). Dublin City Council would have full administrator rights. Each user should be uniquely identified on the system and should have the ability to customise the user interface.
    - *User interface*: The system must provide a map-based user interface for adding, removing and (re)configuring the bus stops and RTPI display signs and for checking the real-time status of the stops and RTPI sign. The map should be easily zoomable and customisable to the user. The operator should be able to see all displays with faults, no data or with operator-inserted text. Information on the map should be layered so that any layer can be turned on or off. The map would become the property of

Dublin City Council.

- *Self-learning*: The system should have some self-learning capability, namely it should be able to automatically build up a profile of all bus routes using individual bus stops and learn route changes, log this information and provide a notification to the system user.

2. The main requirements regarding **on-street display signs**:
   - The signs should be suitable for outdoor use in all lighting conditions, for mounting on a pole or bus shelter and the text must be visible from up to 10 metres away. The display must have a dimming mechanism for night-time operation. Details of any European regulation (or equivalent) applied should be provided.
   - The type of information that must appear on the display is specified, namely, route variant, destination, countdown (arrival or departure), wheelchair accessibility, and whether scheduled or tracked bus time. Each RTPI display sign must have a unique identifier which must appear on the sign in a clear and indelible manner. Units must be interchangeable with displays of the same type.
   - The contract also includes the provision of suitable mounting poles for the displays and the actual installation of the displays themselves. Regarding energy source, the assumption was that the units would be mains-powered but alternative solutions would be considered. Tenderers were also invited to propose battery or solar-powered displays for temporary bus stops.

3. The third main component of the tender relates to **information provision for visually-impaired persons**.
   - Whatever solution is proposed – traditional or based on best international practice – ideally it should be provided centrally for all bus stops and not just at stops with RTPI display signs. The detailed costs of this feature per sign and of any additional items must be provided.

Other channels for RTPI dissemination

The dissemination of real-time passenger information through channels other than the on-street display signs was required in the tender, namely, SMS, email and web services. Again, few technical details about these services were included beyond the type of information a user should achieve. Examples of such services operating elsewhere were welcomed.

Measurement requirements for each component

The tender does not stipulate measurement requirements for the system nor for its individual components. The accuracy of the RTPI displayed on-street is not specified either because the data feed comes from the AVLC system and reliability therefore is the responsibility of the public transport operator. Nonetheless, ensuring that information sent to the RTPI sign is the same as the data received from the AVLC system is a requirement and presented a huge challenge. When the testing and commissioning of the MORTPI system commenced, the information displayed on the on-street sign was only 60-70% correct. This anomaly was not due to poor quality AVLC data but the technical difficulties that arise in taking the data out of the different AVLC systems, amalgamating and normalising them and then sending them out to the RTPI displays. Even when two AVLC systems adopt a standard like SIRI, that does not necessarily mean they are able to talk to each other because the data parameters may be different. To reach the required 96% accuracy involved a massive and labour-intensive effort.

Back office system requirements

A **simulation system** of the MORTPI central software is required, which should have the same functionality as the main system except for sending data to RTPI display signs. The simulation system must operate the same version of software as the 'live' system and any updates should be made to both systems. For the dynamic data, the simulation MORTPI must be able to take inputs also from an AVLC feed. The purpose of this simulation package is to enable operator training and testing of messages, etc.

The tenderer is required to list and describe any **licences** that the RTPI system and displays would require, and any third-party licences and their cost on a per-year basis for the following five years. The provision of the required **server hardware** and the necessary **operating system software licences** is the responsibility of Dublin City Council, but the tenderer must provide the necessary specification for the hardware and software platforms.

Communications requirements

The main type of communications is envisaged to be via the mobile network; however, tenderers must provide details of the interfaces available with their displays as well as the cost of each interface and may, if they so wish, submit a separate communications proposal if available. Tenderers must submit full details of communications between signs and software and in particular an estimate of the monthly data usage per sign. Ultimately, a separate communications proposal was not submitted. The communications aspect is organised by Dublin City Council since it has a framework for all its mobile data communications.

Data requirements

The single-most important data requirement is that the MORTPI system is able to deal with data from any AVLC system using either the SIRI or VDV interface.

Another data-related requirement relates to **logging** to ensure all data aspects and system changes are documented. A **reporting tool** should be an integral part of the system and an easy-to-use **interface** is required to allow system users to view the logged information and to build reports. Pre-defined reports would be clarified during the Detailed Design Stage.

A further requirement relates to freedom of information. Any offer received by Dublin City Council is subject to the provisions of the **Freedom of Information** (FOI) Acts 1997 and 2003. However, tenderers may request an exemption for any information that is commercially sensitive or confidential in nature, provided justification is given.

Maintenance and warranty

The warranty and maintenance of software and hardware (including on-street signs) must be provided for a period of one year after final system acceptance of the MORTPI system and the cost of this must be deemed to be included in the tendered prices. The contract is required to indicate the lifetime of displays, any issues with output degradation over time and recommended maintenance schedule. The contractor is also required to submit a list of recommended spare parts, itemised and costed, that may be required for the first year of operation. The contractor must also provide details of the proposed maintenance service, including response times and hours of operation.

Dublin City Council explained that requiring a longer warranty period usually increases the cost. Given that the ITS market is relatively small, company reputation is important and therefore, there is little risk in specifying a short warranty period. Maintenance is a trickier matter because it is linked to operations and is therefore considered from a financial perspective as a revenue cost rather than a capital cost. Where an ITS project is funded by a third party, which is usually the case for Dublin, this is usually intended for capital costs only and therefore maintenance may not be an eligible cost.

Environmental conditions

There are few details about environmental conditions beyond the requirement for RTPI display signs to be weatherproof and tamper- and vandal-resistant.

Performance indicators

No performance indicators were specified in the tender. Dublin City Council's view is that it is very difficult to measure indicators and reports would be needed.

Testing

Testing of the individual components and functions of the system is required, as is a test of the full system. A testing and commissioning plan must be agreed with Dublin City Council and carried out in the presence of an appointed city council staff member.

Training

The contractor must provide training for city council staff on the use of the MORTPI system, including installation as per an approved training plan and manual. 5% of the total contract value is held back until the training is completed. The contractor must also provide manuals for operating the MORTPI system.

Financial and technical capacity

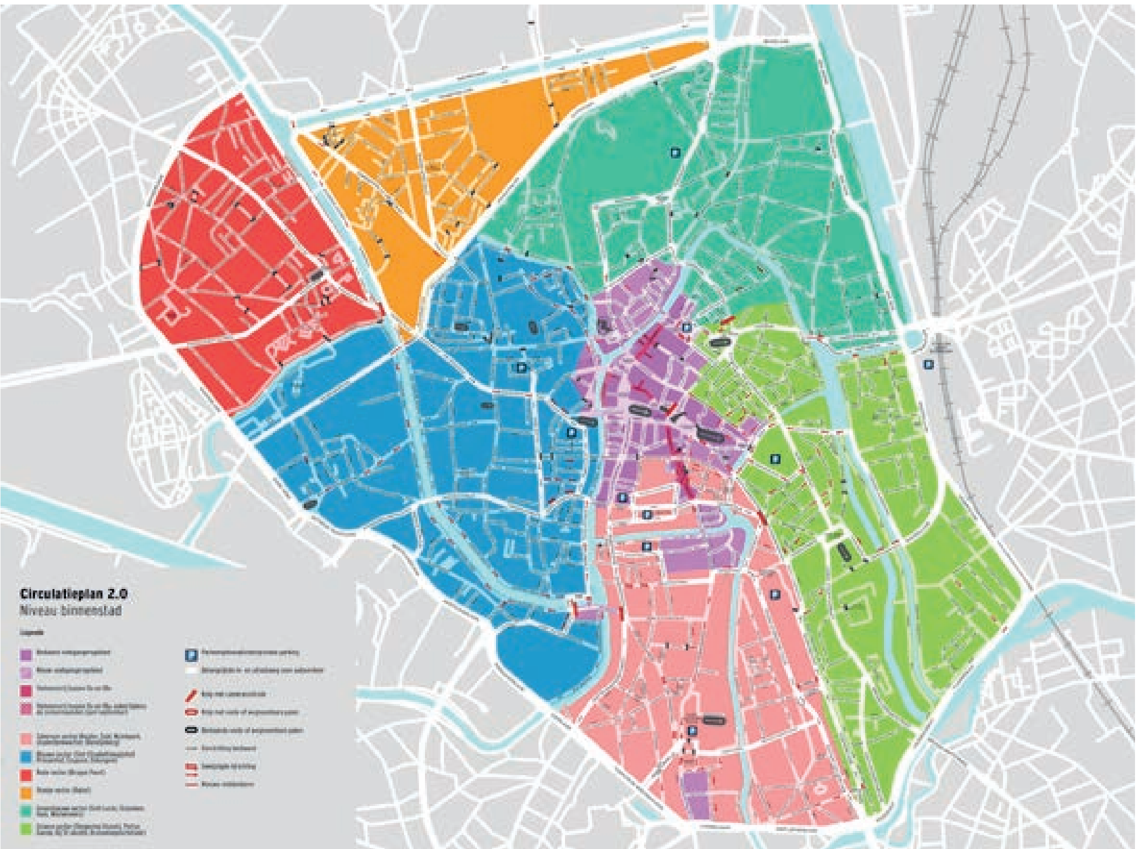
Two full pages of the tender are reserved for requirements of a financial and technical capacity nature. Bidders must provide: audited accounts for the previous three years; two references from any two of their four largest contracts; a list of relevant contracts; a signed statutory declaration form as per Article 45 of EU Directive 2004/18/EC (no criminal record, bankruptcy, etc.); and information related to project time schedule, responsibility breakdown matrix and work breakdown structure. In addition, the tender excludes companies that have not been involved in an RTPI project in the past three years.

Case study 4

Parking guidance system in Ghent

Background

Ghent is a city of roughly 250 000 inhabitants in Belgium. It is known for a series of sustainable urban mobility plans (SUMPs) which started in 1976. The city has implemented a huge pedestrian area and expanded it over the years to cover the entire historical centre. Other SUMPs have resulted in a number of parking plans, cycling streets (where cars are not allowed to overtake cyclists) and recently in a low emission zone. The best-known measure is the 2017 'traffic circulation plan', sometimes referred to as a 'pizza model' because it divides the city centre into a number of slices. Travelling from one slice to another by car is no longer possible. Citizens wanting to do so have to first drive back to the 'crust', i.e. the ring road, and follow it until they reach the next slice.



The different 'slices' into which the city is divided – cars cannot drive from one part to another. Source.

Evolution in parking guidance

Although Ghent has 45 years' experience in urban mobility planning, they have been remarkably reluctant in procuring intelligent transport systems. There has always been a strong focus on implementing urban mobility plans through policy, rather than technology. When introducing the 2017 traffic circulation plan for example, changing driving directions in a smart way on 77 streets made the use of technology almost superfluous. ITS was only used where other measures could not be applied: number plate recognition cameras were installed in a few places to enforce the new circulation rules.

One area in which the city does have a lot of experience is parking guidance systems. This is mainly due to the fact that the city owns and operates the majority of off-street parking itself. The first system was installed in 1997 and replaced in 2008. Currently a new system that was tendered in 2019 is being installed in one part of the city. In parallel, studies have started for a tender to replace the 2008 installations in the rest of the city. Ghent has 25+ years' experience in procuring three generations of parking guidance systems and is therefore an excellent case study to gain progressive insights into the field.

The City of Ghent indicates that there is a clear shift away from putting hardware road signs on the street towards digital parking guidance. They are preparing for the future by specifying signs that will merely be a hardware layer on top of a smart and modular platform. A platform that can keep on communicating with in-car devices and apps once the signs have been removed from the streets. They envision a more regulated parking ecosystem and more digital guidance. Today, however, it is still too early to remove all the variable message signs from the streets. The 2017 traffic circulation changes have increased the dependency on parking guidance. Cars cannot easily navigate from a full car park to a vacant one as they have to return to the ring road in order to access a car park in another 'pizza slice' of the city centre. Therefore, efficient and reliable guidance is needed to avoid an increase in traffic looking for parking. This means that there will be one more tender for hardware-based parking guidance. The 2021 specifications that are now being drafted may be the last ones requiring hardware signs on the street. The resulting system will therefore have to last a long time and be flexible enough to accommodate any further changes to parking policies and practices in the years to come.

The tendering process

Three tenders were studied in the context of this case study: a 2008 tender (worth €3.4 million excluding VAT) for a new parking guidance system for Ghent, a 2018 tender for a new traffic guidance system for a site including a large events venue called 'The Loop' and a 2019 version of the latter (resulting in a €650 000 contract), after no supplier was found in the 2018 tender. Although three suppliers submitted offers for the 2018 tender, various factors (like administrative and price conformity, uncertainty on the quality of prices of some proposed elements, etc.) meant that none of the three was eligible for the assignment. The procurement procedure had to be started over again, and the opportunity was taken to fine-tune the specifications: guidelines for responses were added to structure the input from possible suppliers and to prevent them from just sending in leaflets like they did the first time; more details were added in some areas; and most importantly, questions and remarks from suppliers on the TED portal were taken into account.

How does the parking guidance system work?

The operation of the parking guidance system is quite simple. Motorists can already see the availability of off-street car parks before they reach the city centre. This enables the city to avoid unnecessary car traffic and recommend alternatives like park & ride.

A central system collects data on the occupancy of off-street car parks and places this information on digital signs on the streets of Ghent. The information is also shared as open data to enable service providers, such as navigation apps, to display parking information. In addition, the system works with scenarios: messages about events, roadworks or safety campaigns can be programmed in advance and activated at a certain time. The system can also automatically activate scenarios on triggers, like a fully occupied car park.

Technical requirements

Functions and components

Throughout the years, the functionalities described in the tenders have shifted slightly. The first system in 1997 was almost designed to attract cars to off-street car parks in the city centre by indicating free spaces. In the later specifications, the ambitions have shifted from strict 'parking guidance' to 'traffic information' and latterly to 'traffic management'. The second generation of signs was equipped with LEDs that could not only show 'full'/'free', but also display messages concerning roadworks, safety campaigns, planned events, etc. The functionalities evolved further, where the city showed strong ambitions to reduce the nuisance of car traffic in the city centre, promote sustainable mobility and actively manage traffic. This has been implemented through scenarios that self-activate when a car park is almost full or a prohibitory sign that lights up when a traffic jam is detected, blocking the tramway.

Something that stands out when comparing the different tenders is the evolution of technical details throughout the years. In the 2008 tender only a few lines were dedicated to the context, whereas the technical requirements were described in engineering detail. The 2018 tender explicitly sets out the challenges the city is facing and explains how a traffic guidance system can help solve these challenges. Instead of wanting to control every technical detail, the City described how it expects the system to behave and how it should affect mobility (avoid traffic jams, make it smooth and intuitive to find an off-street parking spot, allow flexible use of car parks, reassure drivers by giving them qualitative information, provide up-front information about events and roadworks).

The evolution from technical to functional descriptions is largely due to the high number of technical standards in the field of digital signs. Once a supplier meets the EN standards, there are few quality differences in terms of hardware with other providers. That is why Ghent only attributed a small number of points (20 out of 100) to the rating of technical quality. Instead, more service level agreements have been described to which fines are attached. From the 2018 tender onwards, 99% availability for each sign is expected. Once a sign is defective more than 1% of the time in a given year, fines are imposed. This system is not yet in operation, but Ghent thinks it is a very transparent and clear way of working for all parties. The only drawback is that the City has to rely on the supplier's reporting on uptime and defects.

General requirements

In the current parking guidance system, responsibilities are shared between the supplier of the hardware, the supplier of the software and the IT department of the city that ensures the communication between the signs and the software. When parts of the system fail, this sometimes causes friction because it is unclear what component is causing the issue. In practice, this means that the City has to find out where the issue lies before one of the suppliers is willing to take action. Therefore, when procuring a new system, the City prefers just one party to take responsibility for the overall operation.

Measurement requirements for each component

The 2008 tender included clauses on numerous measurement sensors in the different components: a sensor that notifies the central system when the door/hatch for maintenance is being opened, sensors for temperature and air humidity, a power consumption sensor notifying the central system of peak loads and loss of power, a function that informs the central software when more than 3% of the LED modules are defective, and the sign should indicate when it is not able to show the requested information within a definable time interval.

One of the main issues with the 2008 system was that it remained unclear if a message sign was working or not, and in particular what message was being shown on the sign (this could lead to potentially dangerous situations). If the sensors installed in the sign were not working because of a power outage, the controller freezing or malfunctioning communication hardware, the operator had to physically cycle to the sign to check on its status or wait until somebody notified an error. Detailed specifications for sensors were left out in the 2018 tender, but service level agreements were added to cover this, supplemented by the requirement that the operator should at all times be able to know what is displayed on the sign.

System requirements

In recent tenders, Ghent has defined most things at a reasonably high and functional level. However, in their experience, there is one aspect of the hardware that is very important to specify: the distance between the different LEDs, also known as 'pixel pitch'. Originally, they left this to the supplier to decide, and merely specified that the maximum distance between the pixels should be 20 mm. It subsequently became clear that 20 mm is not sufficient for displaying detailed messages. This resulted in some suppliers also sending in quotes for signs with a 10 mm pixel pitch that are significantly more expensive but offer a much better image quality. This made it very hard to compare tenders. After consulting the suppliers and other cities, in the renewed tender a pixel pitch of 16 mm was required. This resulted in suppliers sending in quotes that were comparable. Conversations on this also led to the conclusion that signs tend to be custom-made for every city and every project. Consequently, from an economic perspective, it is not feasible for the City to order a few panels and add some more later on. Everything must be well thought out from the outset. Adding extra signs at a later stage would imply a whole new order for custom-built panels that need to be shipped halfway around the world.

When it comes to the software, the system should be based on 'scenarios', meaning that a text can be programmed with the following parameters: the signs on which the text should be displayed, a date and a time when the text should be displayed (this can be once or recurrent) and priority (if there are two active scenarios for the same sign, the scenario with the highest priority will be shown). The scenarios can also be linked to a 'trigger' that can activate the scenario (e.g. a multi-storey car park that is more than 90% full or a temperature warning) and an image library (e.g. digital representations of legally binding road signs).

Just a few defective LEDs can make the entire sign or even system look unprofessional, something that will be avoided in Ghent in the future.

Ghent has experienced difficulties in finding qualitative and intuitive software for parking guidance systems. They indicate that this might be due to the tendering procedure in Belgium, where both software and hardware are procured at the same time, from the same (main) supplier. Another approach they have studied for the upcoming tenders is that practiced by Amsterdam, for example. The City first acquires software that can operate different types of equipment like variable message signs and retractable posts. The digital signs are bought through a separate framework contract and are required to communicate with the software through standard protocols. This means hardware and software are procured separately. An alternative that Ghent considered involved splitting the future tenders into two parts, and assigning extra points if suppliers send in quotes for both parts. The downside is the difficulty ensuring both procurements (and systems) are perfectly aligned. The risk is that the City ends up in discussions with both suppliers: if something goes wrong, who is responsible? The final choice is not easy to make, and the perfect answer does not exist.

Data requirements

The 2008 tender specifies that the same XML specifications should be used as the traffic control centre of Flanders. Other digital communication standards were not that common at the time – the tender refers to radio frequency and analogue RS323 connections. This does not mean Ghent has not advanced in the meantime. After the contract was signed, new modifications were requested that include formatting the data in the DATEX II standard for some functionalities. Ghent was for example one of the first cities to publish parking occupancy as real-time open data. Initially, the parking data were published in a proprietary format (in XML/JSON), subsequently the data were also published in DATEX II. The new tenders will build further on the work done in recent decades.

Some ambitions were visionary in 2008 (links with traffic lights, park & ride, public transport, etc.), but hard to achieve due to the lack of standardised application programming interfaces (APIs) and system integrations at the time. This has changed: more attention has been paid to APIs in the recent tenders, which are considered as important as the software that comes with the signs. The system should be able to retrieve parameters from external systems (temperature, parking occupancy, travel times, etc.). Open interfaces should enable signs from other suppliers (like the Flemish road operator and temporary/mobile message signs) to be controlled using the newly acquired platform.

The recent tenders also mention open specifications like RSMP, but these are not formulated as a hard requirement. The City has not gone this far, because the authorities expect it would result in some of the suppliers – in this already very small field – not being able to tender. The experts are nevertheless happy that the new system being installed after the 2019 tender uses Disperanto as an independent communication protocol. Ghent wants its platform to be able to communicate with signs from other suppliers and is looking into how to include this in the 2021 tender. A possibility being considered is an in-between, for example a clause that specifies that suppliers should open up their protocol to the City, whenever the City wants to link with signs from other suppliers. The City is using a 'data lake' to collect and store mobility data, such as parking occupancy data.

Environmental conditions

The 2008 tender defines that components are to be CE-certified and come with the necessary documents to prove this. All material should be new, waterproof (IP66) and work under any climate conditions in Belgium. All signs should comply with the European regulation EN 12966 drawn up by CEN/TC 226. During the last tendering procedure, it became clear that the 2014 EN certifications still had not yet been officially approved, meaning it was impossible for suppliers to retrieve the certificate.

All signs should be compliant with the colour schemes of the city and have anti-graffiti coating, and stickers should be easily removable. Every installation on the street should wear an indelible mark that shows the logo of the City, the name of the supplier, year and month of production, serial number and identification code. The signs include heating and ventilation to assure that the temperature inside is always within the operational range specified by the supplier. The installations should include a light sensor to adapt the brightness of the LEDs and avoid dazzling, and may under no circumstances harm people or animals.

Communication requirements

When it comes to communication, the 2008 system is not performing very well due to a lack of good cellular technology at the time. For most of the signs, radio technology is used, but this is rather slow and requires a digital to analogue conversion. It lacks good two-way communication, which means that it remains unclear if there is text on a sign, and what is displayed. The traffic control operators sometimes literally have to take their bicycles to go and check the sign. Other signs are equipped with a 2G connection, but at busy times there are too many mobile phones in the area which can cause connection problems. To overcome this, the new signs will be equipped with carrier-agnostic SIM cards: the sign will use the network with the best range/reception. New technology also enables the operator to take a snapshot of the sign, so she or he knows exactly what is displayed on the sign at all times.

Maintenance

The 2008 contract specified that the supplier should propose a maintenance contract to the City, including three types of maintenance, firstly preventive maintenance: cleaning and checking all signs, changing parts that might be prone to failure soon (once or twice a year). Secondly, corrective maintenance: after defects or collisions, damage or vandalism (prices for spare parts for the entire duration of the contract are mentioned). And lastly, orders on demand: relocation of signs, adding signs, editing signs, additional programming to the software, etc. (hourly rates will be specified in the contract). The maintenance contract will be valid for eight years (after the warranty period ends, thus ten years in total) and the supplier is obliged to deliver parts and services during this period to keep the system up to date. The duration of the maintenance contract is a maximum of one year and can be extended up to eight years. At the end of each year, the contract can be terminated. The ten-year contract is worth €529 000 excluding VAT, or about 18% of the investment cost. In the 2019 contract, maintenance accounted for 30.4% of the capital cost, or €156 000. The supplier should ensure there are enough spare parts for the duration of the entire maintenance contract (including extensions). In Ghent, there were some issues with ending the warranty period. The final delivery of the system was never accepted by the City, meaning the contract got stuck between the warranty and maintenance periods, a possibility not provided for in the tender.

Performance indicators

As mentioned earlier, Ghent has mainly focused on an overarching KPI in the latest tenders, which monitors the overall functioning of the system. This means that every sign should work 99% of the time. To date, there is no experience with this KPI in practice. In addition, the data centralised via the system are also meticulously monitored to investigate parking trends in Ghent. In particular, the system collects the occupancy rates of all off-street car parks in the city, and these data are used to plan future and evaluate past policies.

Case study 5

Real-time passenger information in the Netherlands

Background

This case study was originally to be based on the experiences of a single city. Soon, it became clear that real-time public transport information in the Netherlands is organised on a provincial level, and the provinces share experiences. This means that every municipality in the Netherlands can benefit from knowledge gathered in other parts of the country. The working methods employed in the Netherlands can be inspiring in two ways. First of all, organising the concessions and tendering for public transport on a provincial and/or national level can be an interesting mid-term goal, as public transport does not stop at city borders. Secondly, the Netherlands has a very broad history and experience of gathering real-time information on public transport and traffic. They do this in close collaboration with the market and their tendering and concession specifications are very inspiring for others, not only on a technical level, but also on how they collaborate with suppliers.

Evolution of real-time passenger information systems

The national government of the Netherlands was responsible for the operation of public transport until 1988. Thereafter, the operating budgets and responsibility for urban public transport were transferred to the municipalities. Public transport was fully decentralised in 1998, after which it was gradually centralised again, this time at the provincial level. Today there are 14 public transport authorities in the Netherlands: 12 provinces and two city regions.

DOVA, a partnership of the decentralised public transport authorities, was founded by the national government in 2010 to promote coordination between the Dutch public transport authorities. They facilitate decision-making, capacity building, data standardisation and knowledge sharing, both on a technical and policy level. Part of their job is also to make recommendations on concessions and follow up on the performance of public transport operators.

Before this national collaboration, local authorities were entering into separate agreements with public transport operators, resulting in incompatibilities and inefficiencies. DOVA started small in 2010 with one municipality. From then on, their geographical scope expanded rapidly and soon covered the whole country.

The tendering process

The public transport authorities issue concessions to public transport operators, who are then the 'concession-holders' or concessionaires for typically nine to 15 years. DOVA does not have a formal role in the tendering or concession process. They do provide the concessionaires with advice and draft appendices for the concession contracts. For this case study, we examined the concession appendix for real-time public transport information. It is an addendum to the contract for the concession and defines how data should be transferred to the public transport authority.

The Dutch authorities provide a transparent overview on past, present and future concessions on the internet. Once a concessionaire is chosen, DOVA assists with the data flows, tracks the performance of the transport operator in a management dashboard (not open to the public) and fosters capacity building and knowledge exchange with other public transport authorities.

How does the system work?

Public transport operators are asked to install equipment in their vehicles that automatically sends messages containing, for example, the vehicle location. Those messages are used internally by the transport operator to monitor the fleet and provide real-time passenger information through the message signs installed inside the vehicles. The messages are also forwarded in real time, or at least every minute, to DOVA through a number of interfaces. DOVA processes the data and extracts information for three main purposes. First of all, the information is formatted and sent to the variable message signs (VMS) at the public transport stops to inform travellers. Secondly, the information is shared through an open data licence so it can be reused in applications and route planners. Finally, DOVA visualises data on the performance of the public transport providers in a management dashboard.

Technical requirements

Functions and components

The system in the Netherlands has two very clear functions. On the one hand, providing public transport information to travellers and on the other hand, monitoring the quality of the services provided by concessionaires. This way of working goes much further than a simple tendering procedure between a government body and a supplier. In the concession tender in the Netherlands, the public transport authority avoids delving into technical details. The pragmatic concession's appendix is written smoothly, contains virtually no technical details and explains what is expected of the public transport operator, which is considered an equal partner. The competences are distributed in a smart way, each of the public transport providers in the country can do things their own way and still achieve the common objectives. The government puts a lot of trust in the market; however, it clearly determines what it wants and monitors the functioning of the concessionaires. This meticulous follow-up is primarily intended to improve services for travellers, not to give suppliers a rap on the knuckles.

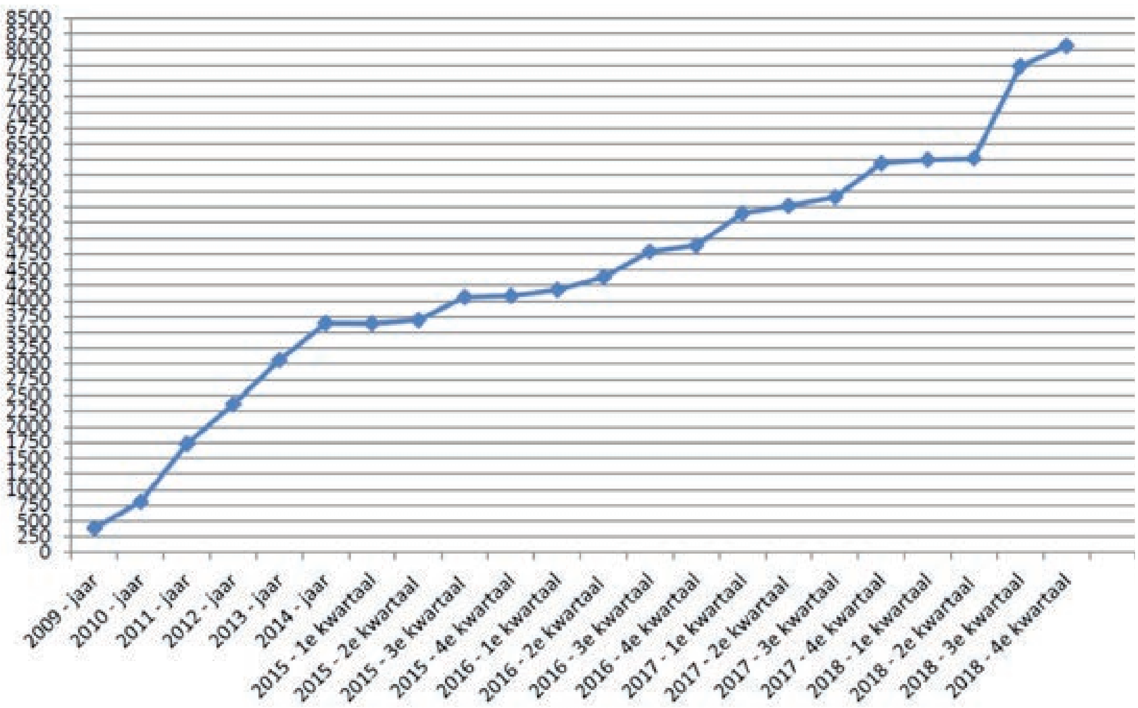
The components are clearly defined and assigned to a partner:

1. **In-vehicle location and communication systems** (responsibility of the transport operator): tracks the location of the vehicle and sends this to the operator, via 4G for example. A message is also sent when a vehicle arrives at a stop.
2. **In-house message processing system** (responsibility of the transport operator): receives the messages from the vehicles and transforms them into the BISON standards applicable in the Netherlands. The information is sent in real time (max. every minute) to the DOVA interfaces. This in-house system also sends information to the in-vehicle message signs.
3. **DOVA interfaces** (responsibility of DOVA): receives the messages from the public transport operators. There are several incoming interfaces with their own specifications:
   a. Interface 1: timetables
   b. Interface 4: planned arrival and departures

c. Interface 6: actual position of the vehicle and punctuality
d. Interface 15: free text messages
e. Interface 17: (last-minute) deviations from the timetables
f. Interface PPT: products, prices and tariffs

4. **Information signs at the public transport stops** (responsibility of the sign supplier): public transport authorities contract hardware and service suppliers to operate digital information signs at stops. These tendering procedures are completely independent from the concessions with public transport providers, and are sometimes established on another governmental level (a city instead of a province, for example). Several companies are active in the Netherlands, but because they all use the same data standards, all hardware is compatible with the DOVA messages. DOVA provides the information on an open interface; it is the supplier's responsibility to make sure the data are shown on the sign correctly.
5. **Management dashboard** (responsibility of DOVA): the incoming information is processed and vehicle locations are compared with lines, timetables, etc. and visualised in a dashboard so the public transport authorities can monitor the performance of the operator (punctuality, safety, etc.).
6. **Open data interfaces** (responsibility of DOVA): the incoming information is shared on a Creative Commons 0 'no rights reserved' basis with whoever wants to use the information: route planners, navigation apps, etc.

In general, the specifications are clear and concise. Because the concession holders know in what format they have to send the data, few additional specifications are required. No statements are made about how or with what kind of hardware the public transport provider should collect the information. It only sets requirements for the quality of the data: frequency, format, accuracy, etc.



Number of VMS at public transport stops in the Netherlands – more than 8 000 in 2018. Source.

Measurement requirements for each component

Among the few specific requirements are data legibility for stops at ± 10 metres distance and ± 22.5 degrees for orientation.

The data coming in are used to perform quality checks. The two kinds of vehicle messages – an update on the location every minute and a separate message when halting at a stop – are a source that is highly trusted by DOVA today. DOVA cross-checks both types of messages (real-time locations and stops), and rarely sees differences of more than 10 metres – the data are believed to be 98% or 99% correct. There is so much trust that no manual performance checks are carried out on-street. There have been cases where transport operators have sent modified/counterfeit messages, but this always becomes clear at some point, e.g. data indicated buses were still driving through a road that was blocked. This discredits the reputation and trustworthiness of the operator. Furthermore, passengers receive the real-time transit information through apps and digital signs at the stops. If the information differs too much from reality, feedback is received from end-users.

Back office system

Operators should update their system to the new specifications or versions of the government APIs once a year, provided this concerns relatively small updates. For bigger changes, separate agreements are made that may involve financial compensation. Furthermore, few specifications are included, because each party remains responsible for its own software and hardware, and the quality requirements and expectations of the data are very clear.

Data

The concession grantor obtains the unlimited right of use of all data made available by the operator. The data can be used and reused without limits or prior permission, in both raw and edited form, and will be released under a CC-0 disclaimer.

Information about stops is an important part of the travel information: location, name, facilities, accessibility, etc. Therefore, the concession holder must use the central register on public transport stops and the accompanying formats, issued by the Netherlands. New stops must be requested from the national government and the concession holder must also have temporary stops registered and keep all the information up to date.

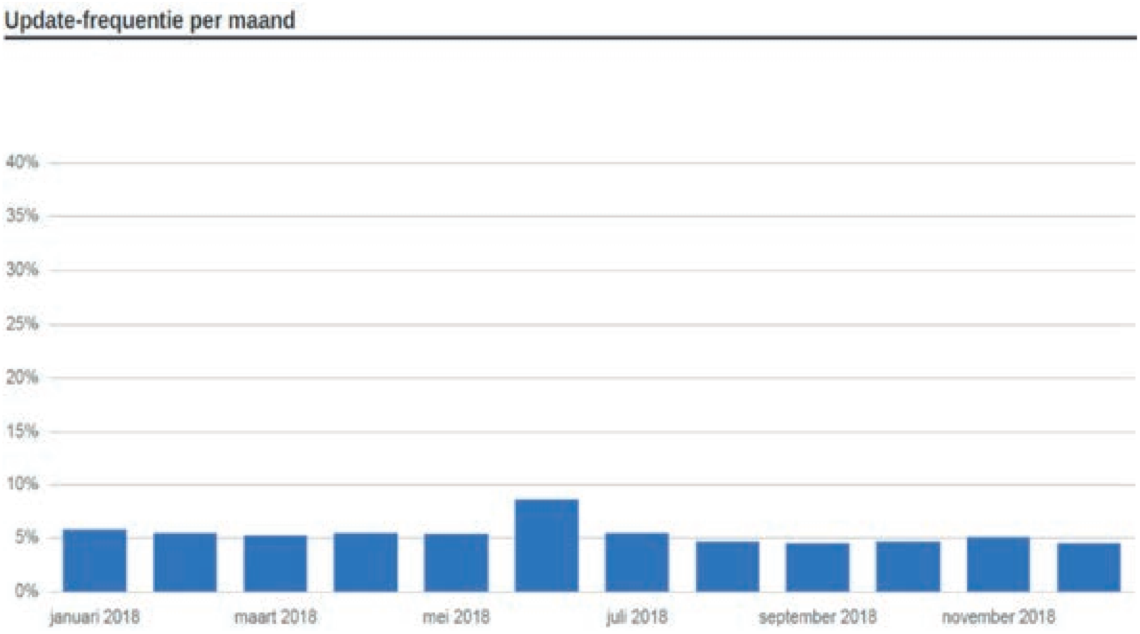
An important part of the data concerns public transport zoning: among others, this has an influence on connections and user tariffs. The zones are defined in a digital map (a shapefile). Concession holders wishing to make adjustments should send a change request that must be approved by the concession provider.

The basis of correct travel information is the timetable, which contains information about the location of the stops and information about the routes. These should always be up to date and contain information about diversions. The information about the stops, routes, lines, journeys and destinations must correspond to how the concessionaire presents the information to its customers through a website, app, press releases, etc. The timetables are always provided at least four weeks in advance, with the exception of temporary traffic measures, in which case a minimum period of two days applies. The information also contains the vehicle types, in order to derive the accessibility of this vehicle. Planned deviations from the published timetables, such as diversions, extra vehicles or deleted journeys due to, for example, strikes or snow are communicated by the concessionaire in a daily plan according to the Dutch SIRI profile. In addition, information must also be provided about possible connections between different bus lines in a pre-defined format.

Concessionaires must provide information about the current position and speed of the vehicle, including the punctuality per trip. Detailed information on the ride should be transferred within five seconds of arrival at the stop. The transport operator will also inform DOVA about diversions and disruptions involving deviations from the timetables, by providing free text messages, according to the Dutch SIRI specifications. In addition, there is a separate interface for deviations from the timetables that cannot be communicated via a standard interface. Lastly, the concessionaire must also provide information about products, prices and rates. Based on this interface, a customer of a product or a service can calculate the cost of a trip.

Maintenance

The operator must set up a management environment to handle failures and questions related to the interfaces they deliver. The concessionaire has a hotline that can be reached by telephone and email every day between 8 am and 5 pm. For high-priority failures, which should be picked up within the hour and solved within four hours, the concessionaire is available every day of the week between 8 am and 10 pm. Further details and working arrangements are fixed in the implementation plan.



% of minutes where no update message is received from a public transport vehicle. On average, a message is received during 95.5% of the time. Source.

Performance indicators

All KPIs are visible to the public transport authorities in a management dashboard and once a year a public report is published. Regarding the data, the following indicators have been defined and are followed up:

- the number of last-minute changes to timetables (this is seen as something positive, as more and more operators manage to send in planned deviations correctly);
- the number of vehicles sending in location messages (this also depends on the type of vehicle, as smaller vehicles are not required to have an on-board computer with GPS);
- the number of messages received when vehicles reach a stop;
- the update frequency (see the above image);
- the timeliness of the first message of a ride (if the first message is received too late, this vehicle/ride will be removed from the passenger information screens);
- messages regarding last-minute deviations and route issues;
- the number and timeliness of messages indicating a (part of a) ride was cancelled, e.g. when a vehicle is experiencing technical problems.

It is up to the provinces or concession grantors to impose penalties. DOVA follows up on the quality and provides input on quality standards and what KPIs can be used. There are authorities who do impose fines, like Amsterdam, and there are some who do not provide for this as part of the concession.

A system of progressive KPIs is being used, called 'Best in Class' in the concession specifications. On a yearly basis, the KPI measurement results are being compared between all regions and operators. The results of the best and worst performing operator are not included, the values of the other operators are averaged. If this average is higher than last year's KPI, it will be the new measurement standard for next year. This way of working has been very effective for public transport punctuality, for instance. When measurement began in 2010, punctuality was about 80%, today this has increased to over 98%.

Case study 6

Vehicle access restrictions in Rome

Background

The municipality of Rome (population 2.87 million) has a complex set of urban vehicle access regulations, which are a combination of limited traffic zones (LTZs) and low emission zones (LEZs). The LTZ was the first type of access restricted zone to be introduced in the 1990s with the aim of reducing vehicular movements and air pollution and preserving cultural heritage in designated areas of the historical city centre. LTZs reserve vehicular access to specific groups only (residents, businesses, deliveries, taxis, public service vehicles and electric vehicles). They are mainly present in the city centre (zones 1 and 2 of figure 1). LEZ schemes have been introduced with the specific goal of reducing polluting emissions (zones 3 and 4 of figure 1).

The first plan for a concentric scheme of access restricted zones in Rome was set out in the General Traffic Master Plan (PGTU in Italian law) approved in 1998. It was updated by the General Traffic Master Plan approved in 2015 and has since been integrated into the SUMP approved in 2019. There are six areas with increasing constraints placed on private vehicles heading towards the city centre, as shown in figure 1.

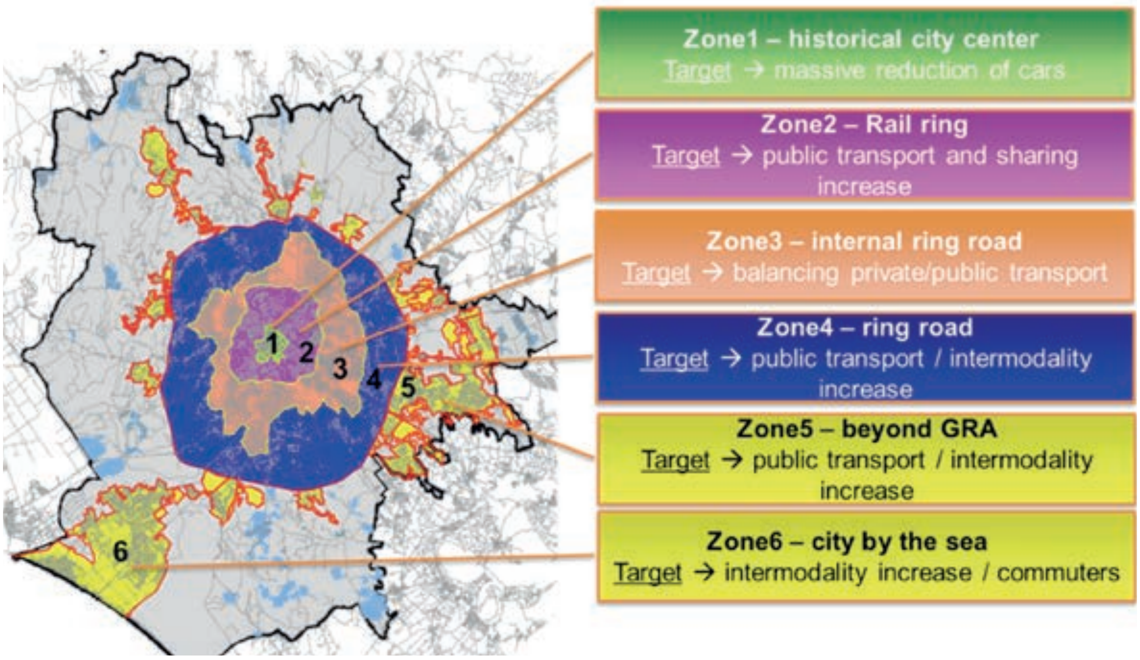


Fig. 1: Vehicle restriction zones defined in the 2015 General Traffic Master Plan

The access control system used to manage Rome's LEZs and LTZs comprises various components, including on-street electronic gates for the access restricted zones (LTZs) installed in zones 1 and 2 (figure 1). There are at least 92 electronic gates installed around the city, supplied by at least three different companies over the course of the last 20+ years. In 2019, a tender was launched to procure nearly 100 gates to (i) replace the oldest gates and (ii) manage the more recently implemented freight and coach regulated zone (figure 2) with the installation of the 53 missing e-gates (green dots in figure 2). In addition, vehicle length measuring equipment formed part of the procurement.

Rome's access restrictions are managed by the Rome Mobility Agency (Roma Servizi per la Mobilità), which is wholly owned by the Municipality of Rome. The tasks of this public company are the strategic planning, supervision, coordination and management of public and private mobility. It provides support to the Department of Transport and Mobility of the Municipality of Rome and its subsidiaries, including the public transport operating company Atac SpA. Besides managing Rome's access restrictions, the agency is responsible for many other transport aspects including traffic management, road safety and developing the city's SUMP. Cooperation with the province and region is managed by the Municipality, which mandates the Rome Mobility Agency to work on specific tasks depending on the particular matter that is discussed with the province or region. Atac SpA is the operator of most public transport services in Rome and is also responsible for parking management, with the exception of managing parking permits which is part of the Rome Mobility Agency's remit.

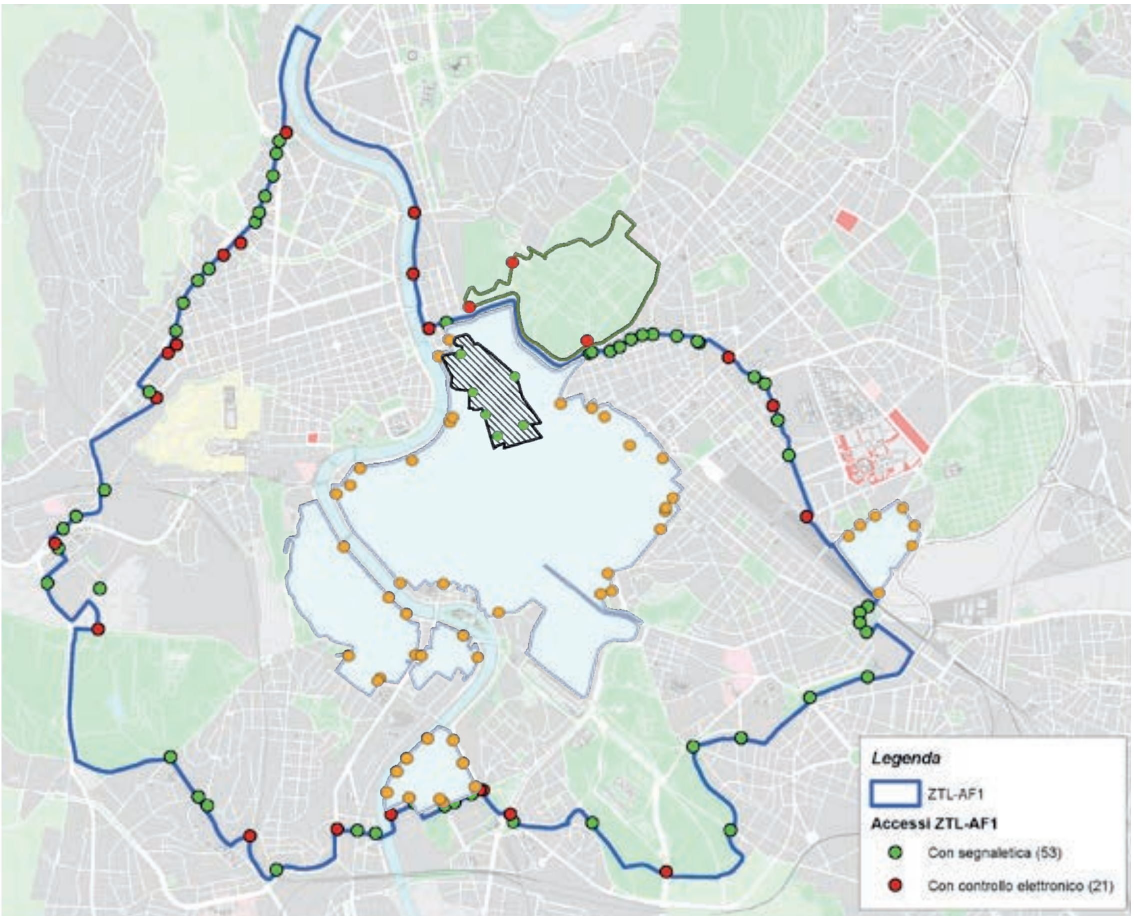


Fig. 2: Map of restricted access zones (LTZs) in city centre

Evolution of vehicle access restrictions

The first limited traffic zone, implemented in the historical city centre (*centro storico*) in 1995, was followed by a further six LTZs over the course of the next 20 years: 2001 in the historical city centre (became fully operative with 23 gates); 2006 in the Trastevere district; 2007 in the San Lorenzo district and Villa Borghese park; 2013 in the Testaccio district; and 2016 for the coach and freight regulated zone (AF1-VAM). Each zone has its own timetable for LTZ operation, covering either daytime or night time only or a mixture of both. The LTZ does not apply on Sundays and public holidays. While the LTZs were successful in reducing traffic, poor air quality has remained a challenge. Therefore, in the 2015 General Traffic Master Plan revision, Rome decided to introduce LEZs. There are two main types of LEZs in operation today:

- The Railway Ring (zone 2 in figure 1) bans all passenger cars and commercial vehicles below Euro 3 petrol and Euro 4 diesel at all times.
- The Green Zone (zone 3 in figure 1) bans Euro 1 and 2 vehicles. Further bans are triggered as air quality limit values are exceeded. The more often the limit values are exceeded, the higher the emissions threshold is set. For instance, from the eighth day of exceedance, the ban is extended to Euro 3 petrol with a complete ban on diesel vehicles.

In addition to the traditional LTZs and LEZs, there are further regulations targeting goods delivery vehicles and coaches:

- There is a near total ban on lorries longer than 7.5 metres in the city centre (zone 1 in figure 1 and part of zone 2). Euro 4, 5 and 6 lorries above 3.5 tonnes are banned between 7 am and 8 pm and lorries below 3.5 tonnes between 5.30 pm and 8 pm.
- Coaches must obtain a one-off or annual permit to enter a specific part of the city inside zone 4. The fee charged depends on the size of the coach (below or above 8 metres) and the area to be accessed. From January 2021, coaches must be Euro 4 or later.
- Further limitations also apply to motorcycles with combustion engines in Tridentino (inside the historical city centre zone).

Since many limited traffic zones are contiguous or even overlap, it can become confusing for the driver. Rome is in the process of building a simplified scheme based on a concentric model which would imply greater access and emissions restrictions as the city centre is approached. This will be a long process as regulations would need to change and businesses and residents would need to be consulted.

LTZ Historic Center
Mon. to Fri. 6.30 am - 6 pm
Sat. 2 pm – 6 pm
Fri. & Sat. 11 pm – 3 am

LTZ Trastevere
Mon. to Fri. 6.30–10 am
Fri. & Sat. 9.30pm–3am

LTZ Villa Borghese
Mon. to Sun. 0 –24

LTZ San Lorenzo
From Wed. to Sat. 9.30 pm – 3 am
(May to July & September- October)
Fri. & Sat. 9,30pm–3am
(November – April)

LTZ Testaccio
Fri. & Sat. 9.30pm–3am

Fig. 3: Daily operation of Rome's Zone 1 access restricted zones (LTZs) and an electronic gate

How does the system work?

Electronic gates (figure 3) are installed throughout Rome to inform drivers, to monitor traffic and to enforce the access restriction. An electronic gate holds static signs carrying information about the access rules for the zone and a variable message sign (VMS) indicating whether the rules are active or not. (*N.B. most access restriction rules apply at different times of the day – see figure 3*).

The gate also includes the vehicle detection and classification equipment (currently loops but replaced by radar in the new contract) as well as automatic number plate recognition (ANPR). These latter systems are not mounted on the pole itself but located at a tactical point in the vicinity of the gate. Electronic gates are installed at all main intersections on the boundary of each of the different access restricted zones in the historical city centre.

The number plate data are transmitted to the management system at the Rome Mobility Agency's control centre where it is checked against a 'white list' of number plates with permission to enter a zone. If a given number plate is not on a white list, details are sent to the local police enforcement centre, which then takes action (i.e. issues a fine or other sanction).

As the authority with responsibility for issuing permits for the limited traffic zones, coaches and parking, the Rome Mobility Agency knows which vehicles have permission to enter each and every zone. The agency has two different electronic gate management systems, which are both connected to one desk-top system at the police enforcement centre.

Tendering process

The 2019 tender covered the supply of:

- 98 electronic gates (hardware, software, control cabinet and VMS);
- 63 devices for detecting and measuring the length of vehicles passing through a gate;
- 45 VMS for indicating the status of a traffic regulation.

Preparation: Given Rome's extensive experience of procuring and operating electronic gate systems and the technical expertise available internally, the tender was prepared in-house. Furthermore, there was no need to develop technical and quality specifications because mandatory Italian standards for electronic gates (vehicle classification and image processing) were specified in the call for tenders. An estimated three person-months were required for tender preparation. This tender was launched as an open procedure.

Implementation: Interested bidders were offered the possibility of carrying out an on-site inspection at the control centre up to 14 days before the tender deadline. No company took up this offer. Three bids were received in response to the tender, which were all eligible. Price was the main selection criteria for evaluating the bids because the tender did not set any technical and quality requirements due to the necessity of supplying a Ministry of Transport-certified system.

The winning company, one of the three companies already present in Rome, offered the greatest discount (72.5%) in relation to the amount for the system quoted in the tender (€2 905 335). Before accepting this competitive offer, Rome requested evidence that the supplier was not practicing price dumping. This was not difficult to justify given that there are no global prices for electronic gates (the market being quite small). The discounted rate was not the only reason for selecting the company. The company proposed a new system for detecting oversized lorries and coaches, which appealed to the city given the limitations of the current system. The contract was signed at the end of 2019.

It is worth noting that for another project currently under procurement (a €14 million ERDF-funded traffic control system) the Rome Mobility Agency brought in a consultant to advise it on procuring the system through a tendering procedure called competitive dialogue. This procedure enables communication between the customer and companies under set conditions without precluding the latter from taking part in the tender itself. Rome held preliminary talks with various companies but ultimately the process was abandoned because it was deemed too long and bureaucratic and did not fit Rome's timeline.

Technical requirements

Functions and components

There are two main innovations in the 2019 tender in relation to the previous electronic gates procured. The first requires gates to be able to operate on both single and dual lane roads and be able to carry out the required functions (number plate recognition, vehicle classification and total traffic counting) without the vehicle having to slow down. Under the previous system, all gates were placed on single lane roads forcing vehicles to slow down when passing. The second relates to the technology for classifying vehicles, in particular identifying vehicles longer than 7.5 metres for enforcing the coach and goods delivery regulation: Rome is looking for a more cost-effective technology than the current inductive loops which are expensive to maintain.

While ANPR cameras can measure vehicle length, the only systems certified for measuring vehicle length in Italy are loops and radar.

The system components are mostly described in functional terms.

Field components

- The ANPR system must comprise in its housing:
  - The number plate reading camera using infrared and offering a high resolution (minimum of 1 megapixel) with a frame rate of 25 fps, able to operate on lanes up to 3 metres wide.
  - A context camera that synchronises with the number plate reading camera and must be capable of providing good quality colour images.
  - High power LED lighting that must not cause disturbance or danger to a third party.
  - A system of hardware and software capable of managing the gate and identifying by image processing and optical character recognition (OCR) the number plates of passing vehicles.
- Sensors, other than inductive loops, for classifying vehicles passing through the electronic gate. This functionality is especially sought to be able to identify coaches and heavy goods vehicles (HGVs) above 7.5 metres entering the regulated area (figure 2).

  The winning company proposed radar as the technology to measure the length of a vehicle. This was the second reason (beyond the price quoted) for selecting this company.
- A field cabinet for housing and protecting the electronic instruments.
- A communication unit for data transfer between the local processing unit and the central system.
- An uninterruptible power supply that must guarantee operation for at least 30 minutes in the event of a power cut.
- An industrial PC to ensure maximum efficiency in detecting vehicles, image processing, reading number plates, providing diagnostics, two-way communication and remote-control activities.
- An RFID tag placed inside the cabinet that can be read at a distance of 10 metres, to be used for maintenance purposes.
- A VMS able to give the activation status of the traffic restricted zone and using LED, full matrix type with internal control unit microprocessor, equipped with fixing mounts.

Management module

This component is responsible for supervising all the field equipment, receiving data from the electronic gates and transmitting these data to the control centre for validation and exportation to the police enforcement centre in the event of a breach of the access regulations. It also manages the field equipment diagnostics by sending reports to the control centre. The management module must allow for future extension of the system, in particular to additional electronic gates and field devices.

Measurement requirements for each component

A system of alert and diagnostics must be developed in case of irregular events related to connectivity, overvoltage, temperature thresholds, unauthorised opening of field cabinet doors, connectivity with and status of the VMS and its LED. Detailed diagnostic information must be available to third-party maintenance operators.

General requirements

Italy requires certification for any system that is used to issue fines and penalties. The Rome tender therefore requires the **whole system** to be approved by the Italian Ministry of Transport according to the Italian Presidential Decree 22/06/99, which authorises automated access control to restricted zones through the use of digitised images and vehicle classification. An additional Italian standard is required for the **image processing system**: UNI 10772: 2016. This standard requires products to offer enhanced vehicle classification functionality, notably the identification of motorcycles and mopeds. The supplier has 30 days from contract signing to secure approval from the Italian Ministry of Transport. A copy of the test report issued by an accredited laboratory (ACCREDIA) must be supplied.

An **RFID tag** must be placed inside the cabinet, which must be compliant with EPC Class 1 Gen 2 ISO 18000-6C standards with adequate memory to host a GS1 GIAI code, minimum reading distance of 10 metres, in the frequency range 860-960 Mhz.

A wide range of **documentation** related to the plans, assembly, testing procedures, operations, user manual, serial number and part number of the system (hardware and software), sub-systems and component parts needs to be provided.

For the entire duration of the contract, the contractor must be legally domiciled in Rome. This is a legal requirement in Italy.

The **installation of the electronic gates** is carried out by and at the expense of the Rome Mobility Agency; however, the supplier must make available at its own cost a technician for the installation to check the correct assembly. A report will be jointly drawn up to certify the installation process.

Back office system

The tender required the integration of the new system with the system already in place in the Rome mobility centre. The software module should be implemented on a virtual machine made available by the contracting authority on a VMware workstation, which the contractor must then install in the server room of the mobility centre, under the supervision of Rome Mobility Agency personnel. The contractor should build interfaces to enable third-party applications and web services to be developed and provide adequate documentation and operational assistance during the configuration and implementation of the interface. The mobility centre operators must be able to reconfigure the parameters of the electronic gate remotely.

Data requirements

The tender specifies that the system must be data transmission technology independent. Data exchange must take place between the field stations and the central system via REST HTTP(S), which is a protocol for secure data transfer. The data conveyed within REST messages must comply with the XML standard.

Environmental conditions

The number plate reading and context cameras must be able to operate in any meteorological and lighting conditions. The ANPR housing must offer IP65 protection against weather elements.

Maintenance and warranty

The products supplied must be guaranteed for a period of 36 months from the date on which the certificate of verification of conformity is issued by the Rome Mobility Agency. The contractor is responsible for repairing and replacing parts whose damage is not attributable to third parties, force majeure or other unforeseeable circumstances. Any delay in repairing or replacing a part incurs a penalty. The contractor must take out an insurance policy covering the full duration of the contract, including the warranty period. The insurance company must be registered on the national insurers list maintained by IVASS. The conformity certificate is provisional until two years have passed. Prior to the conformity assessment, the contractor must provide a whole series of documents (equipment diagrams, conformity declarations, operator and administrator manual, maintenance manual, ministerial approval of the access detection system, software installation licences and instructions). The contractor undertakes to guarantee its availability and the availability of spare parts for a minimum of ten years.

Training

Once the system is in operation a **training course** of not less than 16 hours must be offered to ten members of staff to enable them to manage and configure the system.

Future works

The contractor may be invited to carry out **additional works** up to three years after contract signing and is under obligation to provide this. A budget of €1 000 000 is set aside for this, to which the contractor has no claim in the event that no additional works are commissioned.

Performance indicators

There are no explicit indicators because the tender requires that both the ANPR camera and the electronic gate system as a whole be certified according to Italian standards – a requirement for any system used to issue a fine or penalty. The systems must pass tests involving strict performance criteria.

Case study 7

Traffic signal management in Timişoara

Background

Timişoara, nicknamed 'Little Vienna' or 'City of Flowers' is, with 320 000 inhabitants, the third most populous city in Romania. Timişoara has struggled with car congestion in the past but has taken some action in the last decade to move towards sustainable urban mobility. A pedestrian area was created and the city is investing heavily in cycling and has rolled out a bicycle sharing scheme. The first Sustainable Urban Mobility Plan of 2015 outlined the city's ambitions. Several measures were proposed to be implemented by 2030, including: a reform of parking policy and control, a reform of the public transport agency and the transport planning agency, the development of an urban and regional bicycle network, park & ride infrastructure, pedestrian infrastructure and several road layout changes.

Evolution of the traffic management system

The DGDPPRU is a department within Timişoara City Hall that deals with transport infrastructure (roads, bridges, pavements, etc.), road traffic, public transport, public works management (water, channels, district heating) and public lighting. They started working on a combined tender for traffic signals and video surveillance before the SUMP was released. Nevertheless, the drafting of both documents was done in parallel and accordingly there was alignment between both teams. The SUMP contains an action plan, which is an important starting point for everything concerning ITS and contains, among others, the traffic management system.

Before this project was implemented, there was no connected traffic light installation in Timişoara. The tender aimed at installing new infrastructure and upgrading existing installations, so that 134 intersections could be fully equipped with the latest traffic signal technology and be connected with the future traffic management centre.

The tendering process

External consultants started writing the specifications in 2011 and the contract was launched in 2013. Projects of this size and complexity are unique for Timişoara and the wider region. The reason why 23 months were spent on the tendering procedure was because several companies were contesting the award. For every contestation, the project needed to be stopped and could only be started again upon receiving clearance from a legal body following up this process. The Timişoara administration indicated that it is under great pressure from potential bidders during procurement for large projects. If the contracting authority does not accept their demands, inevitably complaints appear from those suppliers.

The planned execution time of the contract was 12 months. However, given that the tender took longer than anticipated and was funded by the Regional Operational Programme (ROP 2007-2013, a €4.4 billion strategic operational programme in Romania, supported by the European Regional Development Fund) that ended in December 2015, implementation had to be completed in seven months to respect funding conditions. In theory this was feasible, but the works sometimes had to be stopped because of unfavourable weather conditions during the winter months. In parallel, another project to realise the fibre optic network incurred some delays, meaning the traffic lights could not be connected and tested in time.

In the end, the implementation took 18 months and cost €6.5 million, €2.5 million less than expected. Given the complexity of the project, the Timişoara road infrastructure management would recommend a longer implementation period, ideally about 30 months.

During the time that elapsed between the writing of the project (2011) and the period of its implementation (2015-2016), part of the road network had been configured and repurposed (e.g. the pedestrian area, new intersections were added, road layout changed at some locations), which had the potential to significantly affect the initial project. To ensure maximal usefulness of the traffic management system for citizens and the local public administration, a series of changes was tendered separately in 2016 to align the system with the latest situations on the streets of Timişoara: for example, 17 intersections were connected to the platform.

How does the traffic management system work?

During this project, 134 intersections were equipped with ITS equipment and connected to a command centre that was installed. The system concentrates all mobility data in one place and can work automatically without staff. However, there are municipal staff present daily from 8 am to 8 pm to manage unforeseen road events. The functioning of the traffic lights is managed from the command and control centre. The operators also design the traffic light programmes and upload them directly to traffic light controllers installed at intersections and can switch between programmes when necessary. The system functionality is also broader than traffic signal management: a video surveillance system is installed to monitor the traffic and make the detection and follow-up of crimes a lot easier for the police, using number plate recognition software. The platform also consists of some speed enforcement cameras and digital information signs, linked to the control centre software. In general, the new command and control centre is extremely helpful for decision-makers concerning the approval of major new investments, decisions that used to be taken based on the intuition of the city hall's clerks.

The supplier has uploaded a presentation to its website with an overview of the system, including pictures.

Technical requirements

Functions and components

In the specifications, the *functions* of the system are not emphasised and no descriptions are added on how the project will improve mobility in Timişoara, although the city indicates that this was indicated in the broader tendering documentation (which was not provided for this study). The 170-page task book focuses strongly on the technical requirements of the solution to be procured. The document details, among others, the metres of cable that will be needed for each intersection, very specific instructions on the preparation of concrete and specifications on particles and swelling factors for soil during the roadworks.

It is common practice in Romania for city administrations to identify the problems/challenges that need addressing. An external consultant is then engaged to help the municipality find the best solutions for the city's problems/challenges. This means that the translation from functional descriptions to technical specifications is carried out in a phase prior to tendering, which explains the highly technical nature of the task book researched for this case study.

Another reason for the high level of technical detail arises from the very tedious procurement laws in Romania that stipulate a detailed framework for public procurement and court involvement to decide on every aspect of the bid. It is therefore common practice in Romania to detail the material needed in bills of quantities. In hindsight, the Timişoara administration indicated that it would make the specifications more general to encourage – instead of limiting – the proposal of new, innovative solutions. Given the rapidly evolving ITS domain, this way of working could result in products or solutions that are superior to the initial demands.

The tender specifies the following components:

- The Traffic Control Centre of Timişoara Municipality: designing and furnishing the building and supplying software and hardware for traffic management.
- The integration platform.
- The detection sub-system (inductive, video).
- The traffic light sub-system (134 intersections were equipped with new or updated traffic signals).
- The road traffic centralised management and control sub-system.
- The public transport management sub-system.
- The video surveillance and communication sub-system (CCTV).
- The road legislation breach detection sub-system (speeding, driving through a red light) (37 cameras for enforcement were installed).
- The information and mobility sub-system (LED VMS).

The supplier indicated that the system can be extended to include modules in the fields of parking, traffic control adaptive simulation and traffic management, and the command and control centre can be used in the future to centralise management of the city's bicycle sharing system, for example.

Timişoara traffic management command centre. Source.

General requirements

For the final acceptance of work, the contractor has to hand over all documents of attestation, quality checks, working equipment, exact plans for underground cables, etc. The supplier has to deliver a Certificate of Quality and Warranty that must be verified and approved by the customer through its control and final acceptance committee.

For each of the 134 locations, a detailed description has been provided of what needs to be updated and added regarding the geometry of the intersection, traffic light equipment, cables, inductive loops, sensors, video cameras, etc.

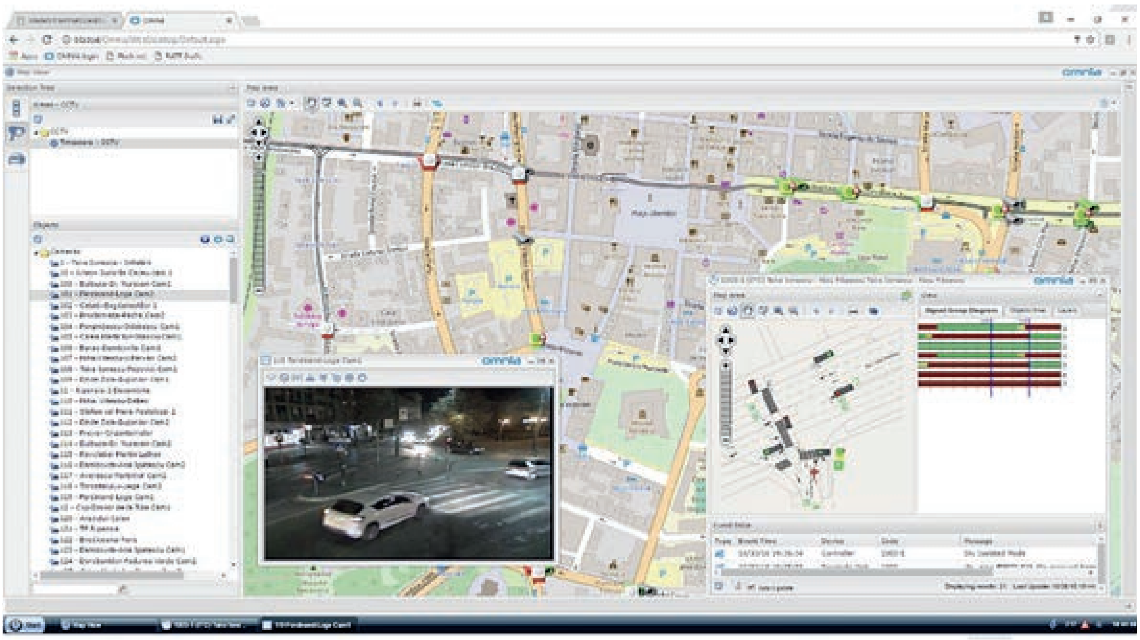
Measurement requirements for each component

All works should be tested, verified and measured by the authorised representatives of the contractor, in cooperation with representatives of Timişoara City Hall. All active devices, programmable electronic systems, including related software must meet ISO 9001 standards, confirmed by specialised institutions in Romania. The following standards apply: I NP 7 2002 (design and execution of electrical installations with voltages up to 1 000 V and 1 500 V), DCMLSP-1997 (specific rules of labour protection for transport and distribution of electricity), Law 333/2003 on the protection of objectives, goods, values and protection of persons, Decision 1010 of 25 June 2004 – rules for the application of Law 333/2003, I 18 January 2001 (standard for the design and execution of telecommunication and signalling installations in civil buildings and production), IN 009/93 (rules for extinguishing and fire equipment for the generation, transmission and distribution of electricity and heat), P 118 (technical construction rules for fire protection), MO 225/1999 (ordinance on fire protection), Law 112 (general rules for fire prevention and extinguishing approved by Ordinance 60/97), Occupational Health and Safety Act No. 319/2006.

Back office system

The supplier must use an existing building owned by Timişoara City Hall in which to establish the traffic management centre. The tender contains a floor plan of the future command room, detailed descriptions of the control room including furniture, electricity, ergonomics, screens, the range of head movement for the operators, the number of monitors, furniture, fire detection, server room, toilets, kitchen, ceilings, doors, plumbing, harnessing of cables, fire protection, power supplies, etc.

The specifications for the software are very detailed as well: for every screen of the graphical user interface (GUI) the tender describes what should be visible for the user and how the user should control the software. When asked if these very specific requirements would be feasible for suppliers, the Timişoara transport department indicated that it relies on the specifications from the consultants, as it is a local public administration that does not have experts in every field in which projects are conducted.



Screenshot of the software showing signal timings and CCTV images. Source.

Data

The tender explicitly specifies that the system should be open so it can be adapted and extended for use in the metropolitan area of Timişoara. Furthermore, the system should be able to handle functionalities in other areas such as parking and intelligent street lighting. The protocols described in the tender are implemented in the command centre and enable connection between the command and control centre and the traffic controllers, although no controllers from other suppliers have been put in place yet. Other open interfaces are present and will be used for other projects that are being planned as of writing. The Municipality currently uses the data storage facilities that are part of the system procured.

Communications

The traffic management system communicates with ITS equipment throughout the city, using a dedicated communication network from optical fibre, connecting 150 signalised intersections, among others. This optical fibre project was executed at the same time as the traffic management project with the aim of ensuring communication services for all the components of the system (traffic management, video surveillance, detection of vehicles driving through a red light, etc.) as well as supporting communication for other smart city applications. The city of Timişoara recommends using a dedicated optical fibre network to ensure communications services for these systems.

The communication project was executed separately from the traffic management project for administrative reasons (communication infrastructure was not eligible for funding from the structural programme), but this caused some interferences and delays. The Timişoara project team indicated that combining both projects could have avoided some issues.

Environmental conditions

All materials, equipment and electrical equipment should meet climate protection type N criteria (macroclimate temperate zone) in accordance with STAS 6692-83 and 6535-83. Tests and checking shall be conducted in accordance with the PE116 / 94 guidelines.

The specifications for earthworks are very detailed and take up more than 60 pages of the tender. There are paragraphs on numbers of particles, the water used, rocks, soil, ballast, cement, aggregates, etc.

Maintenance

The tender stipulates that any defects occurring at least three times within the same equipment during the warranty period should result in that equipment (or part thereof) being replaced. The supplier must provide maintenance training to staff for maintenance work on the operating system and for shutting down the systems without programming. The supplier ensures a minimum warranty of 24 months on all facilities (equipment, materials, defence system). During a minimum five-year period, the supplier will provide spare parts under a contract for service.

Performance indicators

Timişoara has defined a number of indicators that were fine-tuned throughout the project and which were later evaluated by the Transport University of Bucharest. For example, the initial intention was to save 20 minutes per journey at the start of the implementation period, but this was lowered to 15 minutes at the end of the implementation period. An evaluation that took place at the end of September 2017 measured a saving of 10.19 minutes per journey. All of the other indicators were met. The measurements for the KPIs, based on the data from the traffic management system, show improvements of an extreme nature. In our experience, we have not found such improvements anywhere else in Europe. In the list below, the 2017 measurements are compared to the initial KPIs:

- Public transport trips/day: + 17.8%
- Number of bicycle trips/day: + 18.1%
- Average traffic speed: + 91.0%
- Delays/vehicle: - 69.4%
- Road accidents: - 79.2%
- Traffic violations: - 96.0%

EIB technical note

ITS procurement for urban mobility

European Investment Bank
98-100, boulevard Konrad Adenauer
L-2950 Luxembourg
+352 4379-22000
www.eib.org – info@eib.org