# Problems of ITS Architecture Development and ITS Implementation in Upper-Silesian Conurbation in Poland

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**Abstract.** The paper presents a review of the current state of ITS implementation in the Upper-Silesian Conurbation in Poland. A methodology for ITS architecture preparing and implementing for the Upper-Silesian Conurbation, necessary for integrated ITS planning and designing and for the conurbation transportation systems development planning, has also been proposed. Special attention was paid to the implementation problems and barriers, both of individual ITS systems as well as of their whole architecture for the Upper-Silesian Conurbation in Poland.

**Keywords:** ITS Intelligent Transportation Systems, Upper-Silesian Conurbation, ITS architecture, ITS Services.

## 1 Introduction

A turbulent development of telematic and telecommunication technologies and also of the automation and control creates unprecedented favourable conditions for *Intelligent Transport Systems* (*ITS*) designing and implementing. However, to make such activities effective and efficient, a systemic and comprehensive approach is required, ensured by so-called *ITS architecture*.

The paper is focused on a proposal of methodology for the Upper-Silesian Conurbation ITS architecture preparing, implementing and using. The analysis of basic strategic documents and of transport development programs for the Upper-Silesian Conurbation shows that now there are no assumptions or plans for such architecture development. Instead, individual cities of the conurbation, recognising the potential of ITS solutions, prepare and slowly implement partial ITS solutions, which cannot be consistent for the whole conurbation as they are aimed at resolving immediate transportation problems of individual cities.

Making an effort to meet the need of developing a comprehensive solution and using the first in the world American ITS architecture[1] as a model, the paper presents

[1] The National ITS Architecture provides a common framework for planning, defining, and integrating intelligent transportation systems. It is a mature product that reflects the contributions of a broad cross-section of the ITS community (transportation practitioners, systems engineers, system developers, technology specialists, consultants, etc.). Source: [12].

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– following [9, 12] – basic stages and actions related to the preparation, implementation, use and maintenance of an ITS architecture allowing to introduce such ITS solutions into the conurbation cities, which will be mutually consistent and introduced in the order appropriate to the needs – both local needs in individual cities and also the needs of the whole conurbation.

## 2 Review of ITS Implementation in Upper-Silesia Conurbation

The Upper-Silesian Conurbation[2] in Poland consists of a group of connected cities, which occupy the area from the city of Dąbrowa Górnicza to the city of Gliwice (see Fig. 1). The Upper-Silesian Conurbation has a strong businesses concentration which covers 18 % of the Silesian Voivodeship (Province) area (1200 km$^2$).

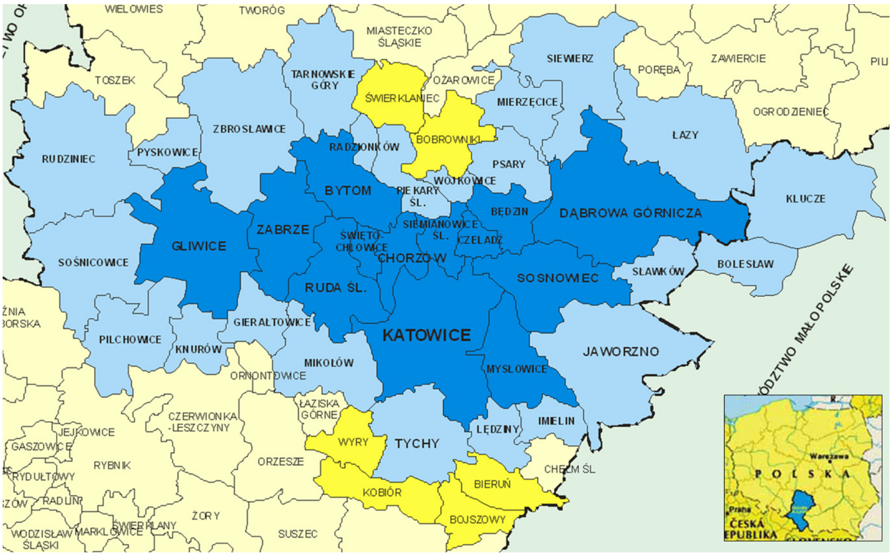


**Fig. 1.** Location of the Upper-Silesian Conurbation in Poland. Source: [13].

The area is inhabited by over 1.8 million residents what is approx. 38.3 % of the Silesian Voivodeship population. However, it should be emphasised that at the same time the Silesian Voivodeship is one of the biggest provinces in Poland in terms of population – 4.7 million people, that is 12.3 % of the population of Poland. The population density in the modelled area amounts to 1780 persons per 1 km$^2$ and is several times higher than in the Silesian Voivodeship – 379 persons per 1 km$^2$. With

[2] A *conurbation* is a region comprising a number of cities, large towns, and other urban areas that, through population growth and physical expansion, have merged to form one continuous urban and industrially developed area. In most cases, a conurbation is a polycentric urban agglomeration, in which transportation has developed to link areas to create a single urban labour market or travel to work area.

regard to the area size, the modelled area is 38.1 % of the Silesian Voivodeship area, which in turn is 3.9 % of the area of Poland.

Two of four *transport corridors* run through Poland (of 10 set Trans European Transport Network TEN-T): corridor III: Berlin – Wrocław – Katowice – Kraków – Lvov and corridor VI: Gdańsk – Katowice – Žilina. Historically formed important railway routes, heading north-south and east-west, are within the area of the Silesian Voivodeship, of which the three main railway lines are a part of the international E and C-E (AGC and AGTC) network: E30 and C-E30: Dresden – Zgorzelec – Wrocław – Katowice – Kraków – Medyka – Lvov – Kiev – Moscow, E65 and C-E65 Gdynia – Warsaw – Katowice – Zebrzydowice – Ostrava – Vienna. The municipal transport network in the Silesian Voivodeship is the most developed in Poland, which is evidenced by, among others, over 20-percent share in the length of all the transport lines in Poland. There are 363 km of tram tracks here (whereas in the Łódzkie Voivodeship there are 207 km and in the Mazowieckie Voivodeship – 241).

The following existing situation may be presented on the basis of strategic documents review and of experts reports in the field of transportation development and ITS development plans for the Upper-Silesian Conurbation [1, 2, 3, 10].

The deployment of intelligent transport systems (ITS) in the Silesian Voivodeships, like throughout Poland, is only at an initial phase. Substantial delay in those technologies implementation may be noticed as compared with the Western Europe countries. Also the issues related to the implementation of modern ITS solutions are not regulated in the Polish legislation. The *Directive 2010/40/EU of the European Parliament and of The Council of 7 July 2010 on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport* was passed on the 7$^{th}$ July 2010, however it has not been transposed to the national legislation.

The Silesian Voivodeship and the Upper-Silesian Conurbation have a huge potential and needs in the field of projects implementing the ITS solutions. However, the ensuring of implemented solutions interoperability becomes indispensable to increase their effectiveness. This will enable the interoperation of the equipment of various types and installed in various municipalities.

The following ITS projects are carried out now in the Silesian Voivodeship [1]:

- The City of Gliwice in the Upper-Silesian Conurbation has been implementing a project named "*The expansion of the detection system in the area of the city of Gliwice together with the modernisation of selected traffic lights, stage I*", which is aimed at "*Increasing the traffic smoothness and relieving the traffic jams and as a result the reduction of the amount of pollution emitted by vehicles and of the noise intensity*". The project scope includes the assembling/implementation of the following elements:
  - *Traffic Measurement Systems*,
  - *Automatic Collection of Traffic Data Systems*,
  - modernization of intersections with traffic lights,
  - *Traffic Management Centre*,
  - *Adaptive Traffic Lights*,
  - *Priority for buses in corridors*.

- In the cities of the Upper-Silesian Conurbation the public transport organiser (KZK GOP) has been implementing a project named "*A Dynamic Passenger Information System in the area of KZK GOP activities*" aimed at "*Implementation of an IT system improving the process of public road transport management by the use of solutions from the field of intelligent transport systems.*" The project is related to a pilot implementation of a traffic monitoring system on key transportation routes of the Upper-Silesian Conurbation together with providing the information about the current traffic situation. The project scope comprises the assembling/implementation of the following elements:
  - *Dynamic Passenger Information Management Centre*,
  - the communication infrastructure with a two-way data and control signals transmission between individual system components,
  - *Dynamic Passenger Information* displays together with the necessary stop equipment,
  - the application software for the system together with licences, including a specialised software supporting the traffic analyses in the area of the KZK GOP.
- The City of Katowice in the Upper-Silesian Conurbation has been considering the preparation of a preliminary feasibility study for ITS solutions [1],
- The public transport organiser (KZK GOP) has been considering a solution named "*Silesian Public Services Card – ŚKUP*", which basic services comprise:
  - an *e-ticket* in a "check in – check out" system, due to which the passenger pays only the actually travelled distance and the transport operator will acquire the information on the volumes of passenger flows in the public transport lines; this will be a common ticket for buses, trams, trolleybuses and trains,
  - an *e-wallet*,
  - a *user identifier* (for personalised cards),
  - an *e-signature* carrier.

## 3 Services and Packages of ITS Architecture

Following [9, p.1] *Intelligent Transportation Systems* (*ITS*) have been defined as: "the application of advanced sensor, computer, electronics, and communication technologies and management strategies – in an integrated manner – to improve the safety and efficiency of the surface transportation system" [3]. ITS are interrelated systems that work together to deliver transportation services. The integration of these

[3] "*Intelligent Transport Systems (ITS)* are advanced applications which without embodying intelligence as such aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated and 'smarter' use of transport networks.". '*Intelligent Transport Systems*' or '*ITS*' means systems in which information and communication technologies are applied in the field of road transport, including infrastructure, vehicles and users, and in traffic management and mobility management, as well as for interfaces with other modes of transport; – source: *Directive 2010/40/EU.*

systems requires an architecture to illustrate and gain consensus on the approach to be taken by a group of stakeholders regarding their particular systems. An ITS architecture defines a framework within which a system can be built. It functionally defines what the elements of the system do and the information that is exchanged between them, as:

**Table 1.** *ITS Services* based on U.S. National ITS Architecture [9, 12]

| Category of ITS Service | ITS Services |
|---|---|
| *Travel And Traffic Management* | ▪ *Pre-trip Travel Information,*<br>▪ *En-route Driver Information,*<br>▪ *Route Guidance,*<br>▪ *Ride Matching And Reservation,*<br>▪ *Traveller Services Information,*<br>▪ *Traffic Control,*<br>▪ *Incident Management,*<br>▪ *Travel Demand Management,*<br>▪ *Emissions Testing And Mitigation,*<br>▪ *Highway-Rail Intersection,* |
| *Public Transportation Management* | ▪ *Public Transportation Management,*<br>▪ *En-route Transit Information,*<br>▪ *Personalised Public Transit,*<br>▪ *Public Travel Security,* |
| *Electronic Payment* | ▪ *Electronic Payment Services,* |
| *Commercial Vehicle Operations* | ▪ *Commercial Vehicle Electronic Clearance,*<br>▪ *Automated Roadside Safety Inspection,*<br>▪ *On-board Safety And Security Monitoring,*<br>▪ *Commercial Vehicle Administrative Processes,*<br>▪ *Hazardous Materials Security And Incident Response,*<br>▪ *Freight Mobility,* |
| *Emergency Management* | ▪ *Emergency Notification And Personal Security,*<br>▪ *Emergency Vehicle Management*<br>▪ *Disaster Response And Evacuation.* |
| *Advanced Vehicle Safety Systems* | ▪ *Longitudinal Collision Avoidance,*<br>▪ *Lateral Collision Avoidance,*<br>▪ *Intersection Collision Avoidance,*<br>▪ *Vision Enhancement For Crash Avoidance,*<br>▪ *Safety Readiness,*<br>▪ *Pre-crash Restraint Deployment*<br>▪ *Automated Vehicle Operation,* |
| *Information Management* | ▪ *Archived Data* |
| *Maintenance and Construction Management* | ▪ *Maintenance And Construction Operations* |

– the functions (e.g., gather traffic information or request a route) that are required for ITS,
– the physical entities or subsystems where these functions reside (e.g., the field or the vehicle) [8],
– the information flows and data flows that connect these functions and physical subsystems together into an integrated system.

The *main components* of an ITS architecture are *subsystems* and *information flows* [9, p3]. *Subsystems* are individual elements of the ITS that perform particular functions such as providing traveler information, managing traffic, etc. Subsystems include center systems, field components, vehicle and infrastructure equipment, and traveler devices that participate in ITS. *Information flows* depict ITS integration by illustrating the information links between subsystems. They define information that is exchanged between subsystems such as traffic information, incident information, or surveillance and sensor control data. ITS integration is not only technical but institutional as well.

ITS offer the potential to improve traffic safety, to reduce traffic congestion, and to increase economic productivity, by means of the *ITS Services* (see Tab.1) and *Service Packages* (see Tab.2).

As mentioned in American National ITS many of the user services are too broad in scope to be convenient in planning actual deployments. They often don't translate easily into existing institutional environments and don't distinguish between major levels of functionality. In order to address these concerns and to support the creation of service based regional ITS architectures, e.g. ITS architecture for conurbation, finer grained set of deployment-oriented ITS service building blocks, called *Service Packages*, were defined from the original user services [6, 12] (see Tab.2).

**Table 2.** *ITS Service Packages* based on U.S. National ITS Architecture [6, 7, 12]

| Group of ITS Service Package | ITS Service Packages |
|---|---|
| *Traffic Management* | ▪ *Network Surveillance,*<br>▪ *Probe Surveillance,*<br>▪ *Traffic Signal Control,*<br>▪ *Traffic Metering*<br>▪ *HOV (High Occupancy Vehicle) Lane Management,*<br>▪ *Traffic Information Dissemination,*<br>▪ *Regional Traffic Management,*<br>▪ *Traffic Incident Management System,*<br>▪ *Traffic Decision Support and Demand Management,*<br>▪ *Electronic Toll Collection,*<br>▪ *Emissions Monitoring and Management,*<br>▪ *Roadside Lighting System Control,*<br>▪ *Standard Railroad Grade Crossing,*<br>▪ *Advanced Railroad Grade Crossing,*<br>▪ *Railroad Operations Coordination,*<br>▪ *Parking Facility Management,*<br>▪ *Regional Parking Management,* |

| | |
|---|---|
| | ▪ *Reversible Lane Management,*<br>▪ *Speed Warning and Enforcement,*<br>▪ *Drawbridge Management,*<br>▪ *Roadway Closure Management,*<br>▪ *Variable Speed Limits,*<br>▪ *Dynamic Lane Management and Shoulder Use,*<br>▪ *Dynamic Roadway Warning,*<br>▪ *VMT (Vehicle Miles Traveled Tax) Road User Payment,*<br>▪ *Mixed Use Warning Systems.* |
| *Public Transportation* | ▪ *Transit Vehicle Tracking,*<br>▪ *Transit Fixed-Route Operations,*<br>▪ *Demand Response Transit Operations,*<br>▪ *Transit Fare Collection Management,*<br>▪ *Transit Security,*<br>▪ *Transit Fleet Management,*<br>▪ *Multi-modal Coordination,*<br>▪ *Transit Traveler Information,*<br>▪ *Transit Signal Priority,*<br>▪ *Transit Passenger Counting,*<br>▪ *Multimodal Connection Protection.* |
| *Traveler Information* | ▪ *Broadcast Traveler Information,*<br>▪ *Interactive Traveler Information,*<br>▪ *Autonomous Route Guidance,*<br>▪ *Dynamic Route Guidance,*<br>▪ *ISP (Information Service Provider) Based Trip Planning and Route Guidance,*<br>▪ *Transportation Operations Data Sharing,*<br>▪ *Travel Services Information and Reservation,*<br>▪ *Dynamic Ridesharing,*<br>▪ *In-Vehicle Signing,*<br>▪ *Short Range Communications Traveler Information.* |
| *Advanced Safety Systems* | ▪ *Vehicle Safety Monitoring,*<br>▪ *Driver Safety Monitoring,*<br>▪ *Longitudinal Safety Warning,*<br>▪ *Lateral Safety Warning,*<br>▪ *Intersection Safety Warning,*<br>▪ *Pre-Crash Restraint Deployment,*<br>▪ *Driver Visibility Improvement,*<br>▪ *Advanced Vehicle Longitudinal Control,*<br>▪ *Advanced Vehicle Lateral Control,*<br>▪ *Intersection Collision Avoidance,*<br>▪ *Automated Vehicle Operations,*<br>▪ *Cooperative Vehicle Safety Systems.* |

| | |
|---|---|
| *Commercial Vehicle Operations (CVO)* | ▪ *Carrier Operations and Fleet Management,*<br>▪ *Freight Administration,*<br>▪ *Electronic Clearance,*<br>▪ *CV (Commercial Vehicle) Administrative Processes,*<br>▪ *International Border Electronic Clearance,*<br>▪ *Weigh-In-Motion,*<br>▪ *Roadside CVO Safety,*<br>▪ *On-board CVO Safety,*<br>▪ *CVO Fleet Maintenance,*<br>▪ *HAZMAT (Hazardous Materials) Management,*<br>▪ *Roadside HAZMAT Security Detection and Mitigation,*<br>▪ *CV Driver Security Authentication,*<br>▪ *Freight Assignment Tracking.* |
| *Emergency Management* | ▪ *Emergency Call-Taking and Dispatch,*<br>▪ *Emergency Routing,*<br>▪ *Mayday (SOS) and Alarms Support,*<br>▪ *Roadway Service Patrols,*<br>▪ *Transportation Infrastructure Protection,*<br>▪ *Wide-Area Alert,*<br>▪ *Early Warning System,*<br>▪ *Disaster Response and Recovery,*<br>▪ *Evacuation and Reentry Management,*<br>▪ *Disaster Traveler Information.* |
| *Archived Data* | ▪ *ITS Data Mart,*<br>▪ *ITS Data Warehouse,*<br>▪ *ITS Virtual Data Warehouse.* |
| *Maintenance and Construction Operations* | ▪ *Maintenance & Construction Vehicle and Equipment,*<br>▪ *Tracking,*<br>▪ *Maintenance & Construction Vehicle Maintenance,*<br>▪ *Road Weather Data Collection,*<br>▪ *Weather Information Processing and Distribution,*<br>▪ *Roadway Automated Treatment,*<br>▪ *Winter Maintenance,*<br>▪ *Roadway Maintenance and Construction,*<br>▪ *Work Zone Management,*<br>▪ *Work Zone Safety Monitoring,*<br>▪ *Maintenance & Construction Activity Coordination,*<br>▪ *Environmental Probe Surveillance,*<br>▪ *Infrastructure Monitoring.* |

# 4 Development of ITS Architecture for Upper-Silesian Conurbation

An architecture is important because it allows the integration of options to be considered prior to investment in the design and development of the elements of the system. It defines the systems and the interconnections and information exchanges between these systems. It is functionally oriented and not technology specific, which allows the architecture to remain effective over time. It defines "what" must be done, not "how" it will be done. The functions the system performs remain the same while technology evolves.

Because of the spatial scale of the Upper-Silesian Conurbation and the lack of a single authority managing its development, including the transport development as well, separate ITS systems are operating or are being designed and under construction in individual cities of the conurbation. However, there is no single consistent concept of their architecture, which would allow providing *appropriate ITS services*, adapted to individual cities specific situation and to their local needs as well as to the specific nature and needs of the whole conurbation area and its links with other conurbations and with the national transport system.

A comprehensive approach to the ITS architecture creation for the conurbation requires the application of *Systems Engineering*[4], because it reduces the risk of schedule and cost overruns and increases the likelihood that the implementation will meet the user's needs. Also Systems Engineering benefits include: an improved stakeholder participation, more adaptable, resilient systems, a verified functionality and fewer defects, a higher level of reuse from one project to the next, and a better documentation. In this context the *ITS project* term may be defined as follows: "*ITS Project means any project that in whole or in part funds the acquisition of technologies or systems of technologies that provide or significantly contribute to the provision of one or more ITS user services as defined in the conurbation ITS architecture*." This broad definition, adopted following [11], comprises both smaller ITS projects limited to the purchase and installation of field equipment – controllers, signals, etc., and also larger ITS projects which support integration of multiple systems and development of custom software – for example, transportation management centres and traveller information systems.

The development of an ITS architecture for the Upper-Silesian Conurbation will enable its use by the stakeholders (cities of the conurbation) to prepare specific ITS

[4] *Systems Engineering* (International Council of Systems Engineering - http://www.incose.org/) is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem. Systems Engineering integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation. Systems Engineering considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs.

projects, meeting the regional objectives and also having a dynamic traffic management in view [4, 5]. In addition, together with the operating ITS systems offering inter alia services of the Electronic Payment System, it is possible to apply specific *Demand-Side Strategies*, like [4]:

– *Financial Incentives: Tax Incentives, Parking Cash-Out, Parking Pricing, Variable Pricing, Preferential Parking, Distance-Based Pricing,*
– *Incentive Rewards Programs, Travel Time Incentives, Transit / HOV Signal Priority Systems & Queue Jumps, High-Occupancy Vehicle (HOV) Lanes, High-Occupancy Toll (HOT) Lanes,*
– *Targeted Strategies: Mode Strategies, GRH - Guaranteed Ride Home, Transit Pass Program, Shared Vehicles,*
– *Departure-Time Strategies, Worksite Flextime, Coordinated Event or Shift Scheduling,*
– *Route Strategies: Real-Time Travel Route Information, In-Vehicle Navigation Systems, Web-Based Route-Planning Tools,*
– *Trip Reduction Strategies: Employer Telework Programs & Policies, Employer Compressed Work Week Programs & Policies.*

The conurbation ITS architecture may be an important tool for use in the transportation planning, programming, and project implementation. It can be used to maximize appropriate integration of projects identified by the planning process. The planning process and related outputs also refine the architecture over time as the feedback is incorporated as part of architecture maintenance. And therefore the relationship between the conurbation ITS architecture and transportation planning is on-going and iterative.The conurbation ITS architecture provides information for updating the long range plan, the transportation improvement program and other plans. It will also provide information for use in other planning studies and activities, including the congestion management plans, corridor and sub-area studies, performance-monitoring activities, transit development plans, and other locally defined studies or plans [5].

**Table 3.** Steps of development of ITS architecture based on U.S. National ITS Architecture [9]

| **Steps of ITS architecture development** | **Description of objectives and results** |
|---|---|
| **Step #1** Identification of conurbation and needs of ITS architecture | Step #1 Defines *who will be involved* with (and served by) the architecture and *how the conurbation ITS architecture* development will be *structured*. |

**Table 3.** (*continued*)

| | |
|---|---|
| **Step #2** Data collection for ITS architecture | At step #2 the existing and planned ITS systems in the conurbation are inventoried, *the roles and responsibilities of each stakeholder in developing, operating, and maintaining these ITS systems are defined*, the *ITS services* that should be provided in the conurbation *are identified*, and the contribution (in terms of functionality) that each system will make to provide these ITS services is documented. |
| **Step #3** Definition of interface between ITS systems | At step #3 the existing and planned *interfaces between ITS systems are defined*. First, the connections between systems are identified, and then the information that will be exchanged on each of the interfaces is defined. |
| **Step #4** Implementation of ITS architecture | Step #4 include a *sequence of projects*, a *list of needed agency agreements*, and a *list of standards* that can be considered for project implementation. |
| **Step #5** Use of conurbation ITS architecture | The ITS services can provide the basis for *operational strategies* that can be used to *improve the transportation system* to meet the *conurbation's vision* and *goals*. The conurbation ITS architecture in step #5 is an important *tool* for use in transportation *planning*, *programming*, and *project implementation*. The conurbation ITS architecture can be used to support evaluation and prioritization of strategies in two ways:<br>- the 1st is through the definition in the architecture of *archiving and data collection systems* that *support collecting the data needed for evaluation*,<br>- the 2nd is through the *detailed definition of ITS projects* and their *sequencing* that can be used to *support prioritization efforts*. |
| **Step #6** Maintain the conurbation ITS architecture | A maintenance plan is used to guide *controlled updates to the conurbation ITS architecture* baseline so that it continues to accurately reflect the region's existing ITS capabilities and future plans. As ITS projects are implemented, new ITS priorities and strategies emerge through the transportation planning process, and the scope of ITS expands and evolves to incorporate new ideas, the conurbation ITS architecture will need to be updated. |

Source: steps based on [9]

Basic stages of the ITS architecture for the Upper-Silesian Conurbation development and expansion may be formulated so as presented in Table 3.

Objectives, sources and results of each steps are presented in Fig. 2÷7 (based on [9]).

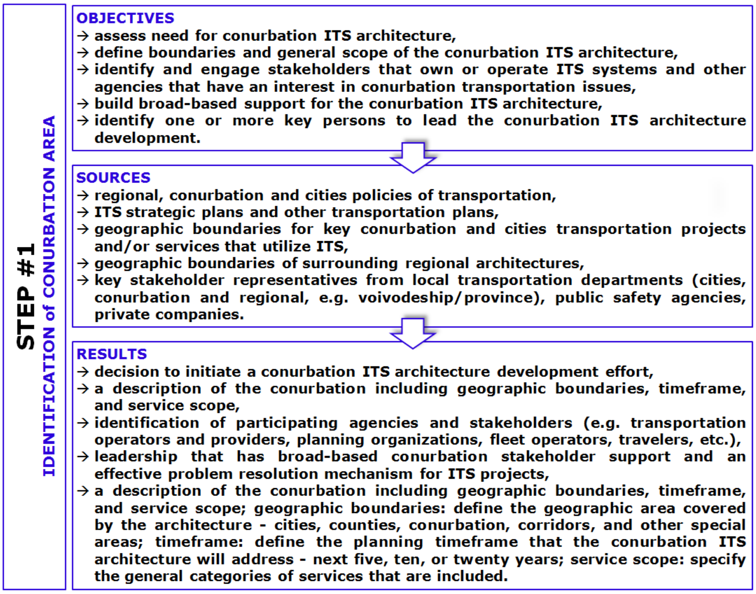


**Fig. 2.** Step #1 – Identification of conurbation and needs. Source: based on [9].

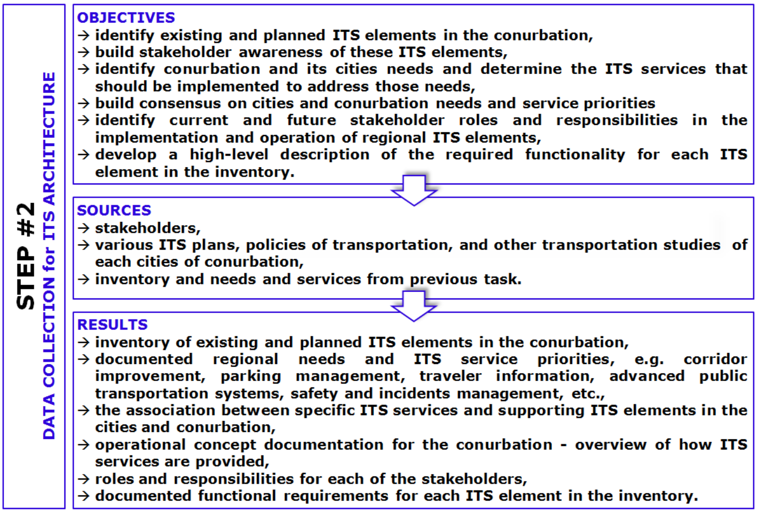


**Fig. 3.** Step #2 – Data collection for ITS architecture. Source: based on [9].

**STEP #3**

**DEFINITION of INTERFACE BETWEEN ITS SYSTEMS**

**OBJECTIVES**

→ identify and document the existing and planned connections between ITS elements in the conurbation,
→ ensure the stakeholders associated with each interface agree with the connections that are identified,
→ based on the inventory, services, operational concept, and functional requirements, identify inventory elements that will exchange information,
→ identify the information to be exchanged between elements,
→ verify that the stakeholders that provide and consume the information agree with the identified information exchanges.

**SOURCES**

→ stakeholders,
→ current conurbation communications or network architecture strategy,
→ conurbation services and needs, operational concept, and functional requirements obtained from previous step #2,
→ inventory of existing and planned ITS elements obtained in previous step #2.

**RESULTS**

→ list of existing and planned interconnects in the conurbation ITS architecture,
→ definition of information to be exchanged between ITS elements in the conurbation.

**Fig. 4.** Step #3 – Definition of interface between ITS systems. Source: based on [9].

**STEP #4**

**IMPLEMENTATION of ITS ARCHITECTURE**

**OBJECTIVES**

→ define ITS projects for the conurbation and cities in terms of the conurbation ITS architecture,
→ evaluate each ITS project, considering: costs and benefits, technical feasibility, institutional issues, readiness (agreements in place, funding available, etc.),
→ identify the dependencies between ITS projects – identify projects that must be implemented before other projects can begin,
→ develop an efficient project sequence that takes the feasibility, benefits, and dependencies of each project into account,
→ develop a list of required agreements between agencies (of the following: handshake agreement, memorandum of understanding, interagency agreements, intergovernmental agreements, operational agreements, and funding agreement),
→ ensure all stakeholders are aware of the required agreements and their status,
→ educate stakeholders on the use of ITS standards,
→ identify the ITS standards that support the interfaces identified in the conurbation ITS architecture - using the information flows identified in Step #3,
→ identify the relevant ITS standards for the conurbation; identify other conurbation and/or regional standards that might apply.

**SOURCES**

→ previous documents of plans and strategies of cities and conurbation,
→ ITS deployment plans, ITS project dependency chart for conurbation (if available).
→ existing operational, intergovernmental, interagency and/or funding agreements between ITS element operating and user stakeholders,
→ existing process and procedures for executing agreements between agencies,
→ operational concept, interconnects, and project sequencing outputs from conurbation ITS architecture,
→ regional information flows derived from step #3,
→ various standards and standards organizations.

**RESULTS:**

→ a documented sequence of projects, which can be used as input to the transportation improvement plans and other planning documents; a projects sequence defines the order in which ITS projects should be implemented,
→ a list of agreements required for operations, including those affecting ITS project interoperability,
→ report listing each information flow in the conurbation architecture with corresponding ITS standards,
→ plan or strategy for how ITS standards will be evaluated and implemented as ITS is deployed in the conurbation.

**Fig. 5.** Step #4 – Implementation of ITS architecture. Source: based on [9]

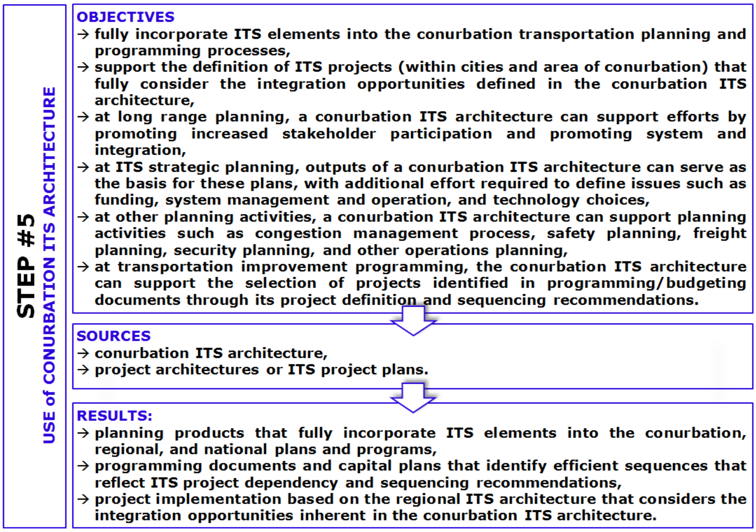


**Fig. 6.** Step #5 – Use of conurbation ITS architecture. Source: based on [9].

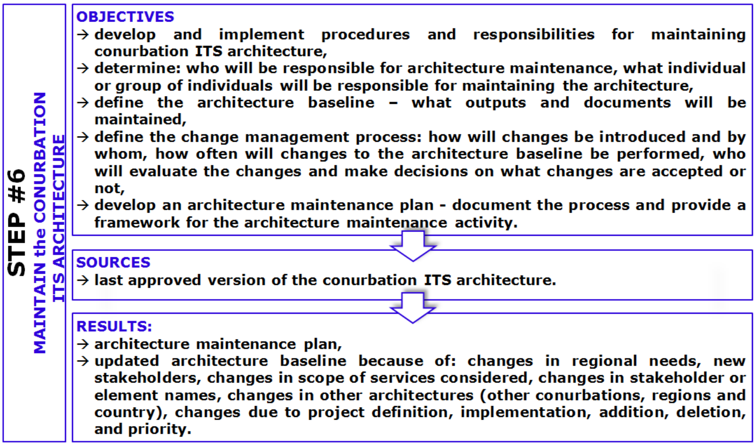


**Fig. 7.** Step #6 – Maintain the conurbation ITS architecture. Source: based on [9].

## 5 Conclusion

The most popular ITS solutions being implemented now in the Upper-Silesian Conurbation include: *Adaptive Traffic Lights*, *Public Transport Priority and Supervision*, *Video Surveillance* with the signal transferred to selected institutions, i.e. police, rescue centre, fire brigade / municipal police and also Dy*namic Passenger Information*, *Parking Guidance and Information*, *VMS for Route Guidance*.

The following issues are mentioned among main barriers of ITS solutions implementation in the Upper-Silesian Conurbation [1, 2, 3, 10]: formal-legal problems and procedures and also limited funds. The formal-legal barriers are related among other things to the lack of ITS strategy implementation on the national level and to insufficient adaptation of the Polish legislation to faster and faster developing intelligent technologies. A great amount of time needed for a project preparation as compared with a quick development of ITS technology frequently makes that the equipment planned to be deployed – due to a long time of necessary permits obtaining as well as of design documentation preparation – at the moment of investment implementation uses a technology considered obsolete on the market.

Moreover, the lack of common transportation policy of the cities of the Upper-Silesian Conurbation is a significant barrier. Because of the legislation, each city on its own takes care of the road infrastructure passing its territory and hence also pursues its own policy relating to ITS solutions implementation. This results in the individualisation of cities activities, in the lack of information exchange between them and in the impossibility to start common actions.

The specified problems substantially restrict a possibility of creating integrated ITS systems in the Upper-Silesian Conurbation and delay the development of their appropriate architecture – especially under conditions of missing national ITS architecture.

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