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eCOMPASS

eCO-friendly urban Multi-modal route PlAnning Services for mobile uSers

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Preliminary Study of Existing Transportation Data Standards

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Summary

The objective of the current report is to present the existing mechanisms and standards for the distribution and presentation of transport related data. In order to provide a spherical and integrated demonstration of the existing transport data related services in this document we undertook the following approach. First a short presentation of the existing standards is provided. Second, a more analytical description of these standards focusing also in the synergy amongst them is presented and finally we outline a list of existing transport related services in various European services, which are using the presented standards and might be useful for the future developments of the eCOMPASS project (to be completed).

1 Introduction

This internal report outlines the various transportation-related data formats and relevant standards. The presented standards on which this report focuses include: Transmodel, SIRI, GTFS, DATEX II, TPEG, IFOPT, NaTEx. In future versions of this report a more global view is expected to be provided, covering additional formats and providing more details on the synergy between the standards and the services that are available in several European cities. A short overview of the existing online systems providing information on public transportation or other types of relevant information is expected to be added for each one of the most representative European sites. Finally, the report will conclude by proposing a selection of standards to be supported within eCompass and more specifically by the foreseen interfaces to be developed in Task 4.1 as part of the eCompass Common Gateway module.

2 Transport Data European Standards

2.1 Transmodel

Transmodel is the European Reference Data Model for Public Transport; it provides an abstract model of common public transport concepts and structures that can be used to build many different kinds of public transport information system, including for timetabling, fares, operational management, real time data, etc. (CEN TC278, Reference Data Model For Public Transport, ENV1289)

Ever since the invention of the railway, Europe has had the worlds densest and most complex public transit networks and the use of public transport is central to all European economies. These networks are highly interconnected, requiring interoperation between many diverse regions and stakeholders; and multimodal, with rail, metro, bus, coach, ferry and other transport modes. As a consequence, European countries have invested significantly in systematic information models to underpin the development of transport information systems and the management of distributed data sets of many different types.
The main European initiative, undertaken by CEN, the European standardisation body, is Transmodel.

Transmodel has articulated a comprehensive conceptual model for public transport information systems, considering not just the public facing data that is the main focus of GTFS, but also the other back office and operational systems needed to manage, produce and update both reference and real time data, so that end-to-end electronic systems can be developed. Transmodel has been used to underpin a number of message sets to exchange particular types of data, such as SIRI (for real-time transport data).

The Transmodel standardisation program has been running since the early 1990s, and has been able to benefit from the extent and the diversity and extent of European transport networks. Examples of almost every different mode, network topology, constraint, fare model, operational model can be found in Europe, which has both single and multiagency configurations operated by both the public and private sector organisations. Many different systems have been compared to establish a common set of flexible abstractions, systematically documented as the Transmodel Corpus.

2.2 SIRI (Service Interface for Real-time Information)

Public transport services rely increasingly on information systems to ensure reliable, efficient operation and widely accessible, accurate passenger information. These systems are used for a range of specific purposes: setting schedules and timetables, managing vehicle fleets, issuing tickets and receipts, providing real-time information on service running, and so on.

The Service Interface for Real Time Information (SIRI) specifies a European interface standard for exchanging information about the planned, current or projected performance of real-time public transport operations between different computer systems.

- SIRI comprises a carefully modularised set of discrete functional services for operating public transport information systems. Services cover planned and real time timetable exchange; vehicle activity at stops; vehicle movement; and information to assist in the provision of reliable connections between vehicles.

- SIRI aims to incorporate of the best of various national and proprietary standards from across Europe and deliver these using a modern XML schema and TransModel terminology and modelling concepts.
- All SIRI services are provided over a standardised Communications layer, based on a Web Services Architecture. The Communications layer upholds a consistent approach for all the functional services to Security, Authentication, Version Negotiation, Recovery/Restart, and Access Control/Filtering. To support different operating requirements, two main patterns of interactions are supported: an immediate Request/Response protocol; and an asynchronous Publish/Subscribe protocol. The Publish/Subscribe can be further elaborated with a fetched delivery interaction to optimise the use of bandwidth.

SIRI is extensible and it is expected that additional services will be added over time using the same communications bearer.

SIRI's modularisation allows an incremental approach: only the subset of services actually required needs to be implemented for a particular application. The expectation is that users may start with just one or two services and over time increase the number of services and the range for supported options. Similarly Suppliers may extend their support for SIRI in their products incrementally.

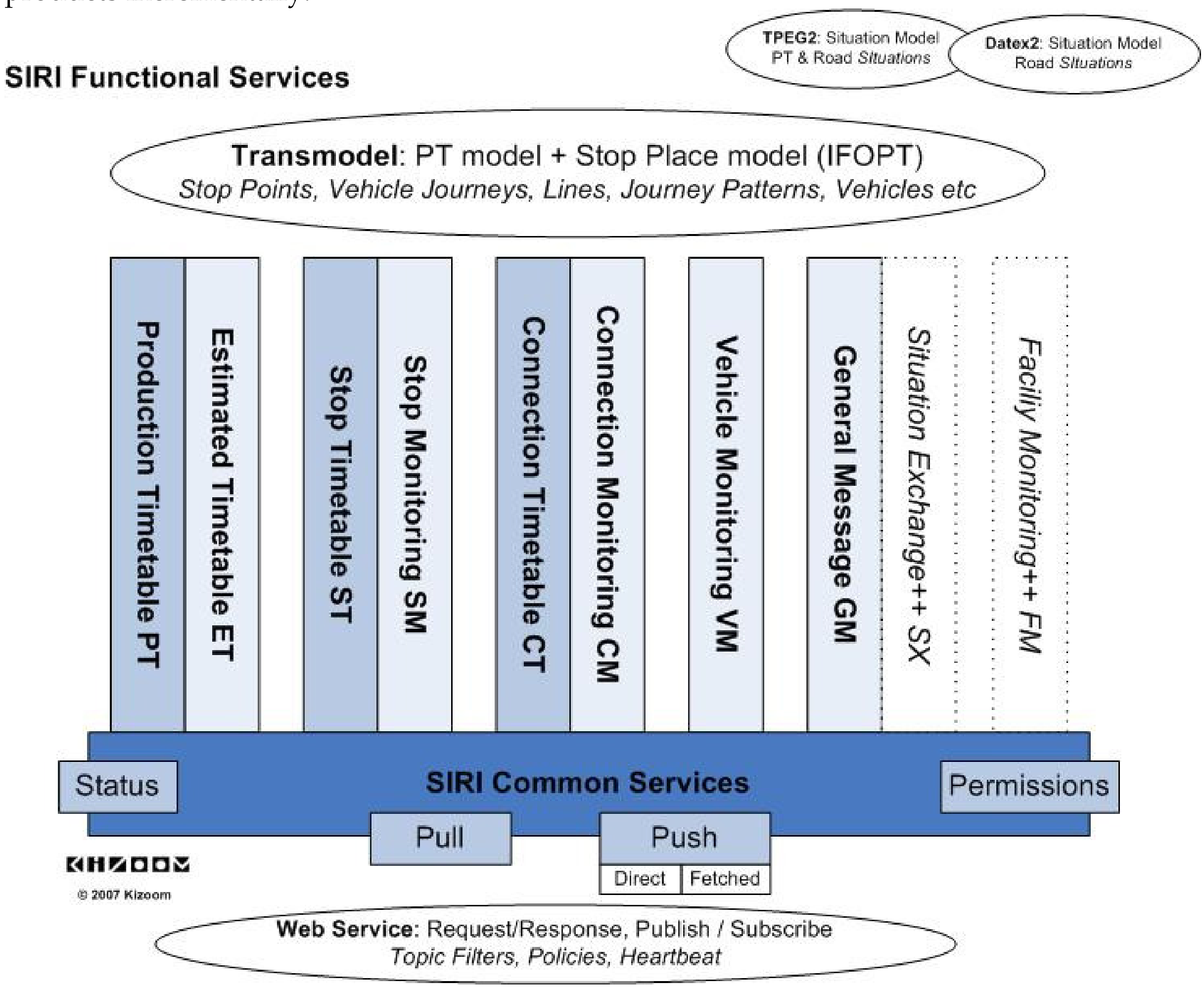

Figure 1 : SIRI Functional Services

SIRI takes a 'joined' up look at all real-time information services, data, data models, transport, and mediation. Considering the whole context is important because for efficiency, real-time services are often only exchanging real-time changes to data, requiring precision about the underlying model assumed by the participants.
A Web Services Discovery process is defined allowing data providers to make the capabilities of their services known to other interested parties.
Across Europe, well-defined, open software interfaces have a crucial role in improving the economic and technical viability of Public Transport Information Systems of all kinds.

- Using standardised interfaces, systems can be implemented as discrete pluggable modules that can be chosen from a wide variety of suppliers in a competitive market, rather than as monolithic proprietary systems from a single supplier.
- Well defined interfaces also allow the systematic automated testing of each functional module, vital for managing the complexity of the increasing large and dynamic systems that internetworking leads to.
- Individual functional modules can be replaced or evolved, without unexpected breakages of obscurely dependent function.
- The use of common interfaces allows real-time data from different areas to be linked up seamlessly both within and across European borders, enabling true trans-European journey information systems.

The primary motives of Stakeholders are thus:

- *Purchasers* of systems want a straightforward, watertight way of procuring different components of a public transport information system from different suppliers, and to have confidence that these various components will work together. They also want a long term protection of investment, such that there is a continuing support for their systems, a coherent process for evolving the systems, and the comfort that additional components that may be purchased in the future will also integrate into the system.
- *Suppliers* of systems want to develop products for a Europe wide market, ensuring that their systems can be used in every country without needing to implement different interface standards in each region. They also want protection of investment, and an incremental approach that will allow them to spread their investment in standards over an extended period, and to make allowance for different national data sets and business processes for managing data.

SIRI also addressed a growing need to update various national and proprietary standards to conform with modern methodologies and technologies, notably modern data exchange standards (XML), to use standard Public Transport application domain terms and modelling concepts in line with the European TransModel standard, and to build on other relevant CEN, ISO and W3C technical standards for example, for geospatial position, language codes, and so forth.

2.2.1 SIRI available Services

SIRI currently comprises the following functional services:

2.2.1.1 The Production Timetable Service

The Production Timetables service (PT) exchanges information about the expected operation of a transport network for a specified day in the near future. Typically this is produced a few hours or days before the day in question and incorporates any changes to the timetables known at that stage. A Production Timetable can be filtered by Operator, Line and Date

Range, allowing only the section of the timetable of interest to be selected. Suited for provisioning AVL systems and smart devices with base timetables.

2.2.1.2 The Estimated Timetable Service

The Estimated Timetable service (ET) provides details of the operation of the transport network for a period within the current day, detailing real time deviations from the timetables and control actions affecting the Timetable (cancellations, additional Journeys and Detours). An estimated timetable can be filtered by Operator or by Line, allowing only the section of the timetable that is of interest to be selected. Suited for provisioning AVL systems and smart devices with real-time timetables

2.2.1.3 The Stop Services (Stop Timetable and Stop Monitoring)

The Stop Timetable (ST) and Stop Monitoring services (SM) provide **stop-centric information** about current and forthcoming vehicle arrivals and departures at a nominated stop or Monitoring Point, typically for departures within the next 20-60 minutes for display to the public. The SM service is suited in particular for providing departure boards on all forms of device.

2.2.1.4 The Vehicle Monitoring Service

The Vehicle Monitoring service (VM) provides information about of the **current location** and expected activities of a particular **vehicle**, and can give the current and subsequent Journey and the Calling points on each journey, together with the scheduled and expected arrival times. The VM service is suited in particular for onboard displays, and visualisation of vehicle movement, and for exchanging information on roaming vehicles between different control systems. It also constitutes a detailed logging feed suitable for collecting historic about performance against schedule.

2.2.1.5 The Connection Protection Services (Connection Timetable and Connection Monitoring)

The Connection Timetable service (CT) and Connection Monitoring service (CM) allow transport operators to exchange information about the real-time management of interchanges between feeder and distributor vehicles arriving and departing at a connection point, for example, to let passengers on a delayed train know that a local bus service will wait for them. It can be used in particular for Guaranteed Interchange ('Connection protection') services.

2.2.1.6 General Messaging Service

The General Message Service (GM) provides a structured way to exchange arbitrary informative messages between participants, such as travel news, operational advice. Can be used to link together incident management systems in a store and forward architecture.

2.2.2 SIRI Architecture

SIRI is intended to be used to exchange information between servers containing real-time public transport vehicle or journey time data. These include the control centres of transport operators and information systems that utilise real-time vehicle information to operate the system, and the downstream systems that deliver travel information to the public over stop and onboard displays, mobile devices, etc.

- SIRI uses on eXtensible Markup Language (**XML**) to define its messages. A careful separation is made between **Transport** (how the data is transported) and **Payload** (the domain data exchanged), so that SIRI messages may be exchanged as either XML documents with http POST or using Simple Object Access Protocol (SOAP) A Web Service Definition Language (WSDL) binding is also defined for the latter.
- The payload model is wrappered in a **Mediation** layer, also described with XML, that both provides common management functions and also formally describes as policies the parameterised aspects of mediation or exchange behaviour or that can be carried out by a service.
- CEN **TransModel** terminology and relationships are followed in the underlying PT application data model.

SIRI is designed for efficient operation in a wide variety of contexts. It can be used both for the bulk pipelining of large amounts of data between different computer systems, and for lower traffic ad-hoc queries.

SIRI uses a consistent set of general communication protocols to exchange information between client and server. The same common patterns of message exchange are used in all the different functional interfaces. Two well-known specific patterns of client server interaction are used: *Request/Response* and *Publish/Subscribe:*

- *Request/Response* allows for the ad hoc exchange of data on demand from the client.
- *Publish/Subscribe* allows for the repeated asynchronous push of notifications and data to distribute events and Situations detected by a Real-time Service. This can be much more efficient for some types of communication as the client does not need to poll to detect changes to the data; rather the notifying service triggers a data exchange only when it detects an event. The SIRI *Publish/Subscribe* Protocol prescribes particular *mediation* to filter the number of messages returned, for example, only creating updates if real time predictions change by more than a certain threshold from a previous value.

The use of the *Publish/Subscribe* pattern of interaction follows that described in the Publish-Subscribe Notification for Web Services (WS-PubSub) specification, and as far as possible, SIRI uses the same separation of concerns and common terminology for publish/subscribe concepts and interfaces as used in WS-PubSub. WS-PubSub breaks down the server part of the *Publish/Subscribe* pattern into a number of separate named roles and interfaces (for example, subscription, publication and notification production, notification consumer): in an actual SIRI implementation certain of these distinct interfaces may be combined and provided by a single entity.

For the delivery of data in responses (to both requests and subscriptions), SIRI for efficiency, supports two common patterns of message exchange, as realised in existent national systems:

- A one step '*Direct Delivery*', as per the classic client-server paradigm, and normal WS-PubSub publish subscribe usage; and;
- A two step '*Fetched Delivery*' which elaborates the delivery of messages into a sequence of successive messages pairs to first notify the client, and then to send the data when the client is ready.

The respective delivery patterns allow different trade-offs for implementation efficiency to be made as appropriate for different target environments. A SIRI implementation may support either deliver methods; in order to make the most efficient use of the available computational and communication resources.

The Interaction patterns and the Delivery patterns are independent aspects of the SIRI protocol and may be used in any combination in different implementations. Care is taken to separate concerns of message transport from those of functional service content. For a given SIRI Functional Service type (Connection Monitoring, Stop Monitoring etc), the message payload content is the same regardless of whether information is exchanged with a *Request/Response* or *Publish/Subscribe* pattern, or whether it is returned by *Direct* or *Fetched* Delivery.

SIRI takes a consistent approach to handling common functions needed for all services, such as subscription management, recovery and restart, version negotiation, access control (which clients may use which functions), capability discovery, and error handling.

All optional features are explicitly parameterised as named capabilities and the schema includes a configuration profile that a client system can use to automatically detect the capabilities of another system. This makes it possible for suppliers to create adaptive systems that adjust their behaviour automatically to optimise.
Several different forms of documentation are available to support the use of SIRI. Expertise can be found through respective different national standards bodies such as

- **Web site:** (www.siri.org.uk). An online web site provides resources and links to National organisations and Companies offering services.
- **National Web site :** An online web site provides resources and links to National organisations and Companies offering services, and including National Implementation guidelines
- **Schema:** A robust XML schema is available. The schema is encoded as a W3C .xsd schema, and is modularised into a number of reusable sub schemas and type packages. The schema and has been validated against mainstream validators and there are working applications using common tools such as JAXB.
- **WSDL** Binding the schema is accompanied by a WSDL binding for creating SOAP services.
- **Specification:** The SIRI documentation, prepared as an electronic document to CEN standards, describes the architectural principles as well as the detailed functional services.
- **Examples:** There are example XML documents providing instances of request and response messages for all the different functional services.

The SIRI schema is available for use free of charge and without warranty under public Licence. Copyright is retained by the respective national organisations that developed SIRI.

In line with CEN regulations, the Published Specification Documentation must be obtained through the respective National Standards Bodies such as the British Standards Institute, or industry bodies such as VDV or RTIG.

SIRI has been developed as an evolution and a harmonisation of existing National Standards such as VDV, Trident and RTIG and a simple mapping of existing elements and data types onto the revised format has been established for the contributing standards. It should be straightforward to migrate a working service to use the SIRI format.

2.2.3 SIRI future developments

SIRI is designed to be extensible: new services may be added within the framework, and individual services might be enhanced by additional function, following a systematic versioning scheme. A number of additional SIRI Services are under consideration which would complement the existing services.
The site provides information for the public about the project and its goals. The home page appearance is shown in Figure 2.1. A visitor can be informed by reading the pages under the "About" tab in the website. Specifically, the "About" tab contains the following sections:

- Objectives of the project
- Expected Results
- Methodology
- Use cases and pilots

2.3 GTFS (Google Transit Data Feed Specification)

The General Transit Feed Specification (GTFS) defines a common format for public transportation schedules and associated geographic information. GTFS "feeds" allow public transit agencies to publish their transit data and developers to write applications that consume that data in an interoperable way.

Google Transit is one of a number of innovative Google services such as Google Maps, which provide rich search functions using a free-to-user business model funded by Googles location aware advertising.

In summer 2006 the Google Transit (http://www.google.com/transit) site published a new data exchange format, Google Transit Data Feed Specification (GTFS), through which Transport authorities can make their data available to the Google t ransit site. Since then the specification has been enhanced through several versions. It has gained considerable momentum, with a number of data sets made available in the USA and many other different countries, and also a growing body of tools such as validators. The original focus of Google transit has been metropolitan area transport networks, comprising primarily bus, metro and ferry. Intercity rail is available and bus information is available in a few countries, such as Switzerland, Austria and Japan.

2.4 DATEX II – CEN TS 16157

DATEX II has been developed to provide a standardised way of communicating and exchanging traffic information between traffic centres, service providers, traffic operators and media partners. The specification provides for a harmonised way of exchanging data across boundaries, at a system level, to enable better management of the European road network.

DATEX II will play a strong role for the implementation of integrated ITS in Europe. This brochure has been produced to describe the remit of DATEX II, its basic design principles, its ownership and the state of development.

DATEX II is at this time developed and maintained under the umbrella of the EasyWay project and is supported by the European Commission.

Allowing the exchange of traffic information to take place directly between control room operating systems considerably increases the safety and performance of transportation networks. With any exchange taking place at the system level, information is transferred instantaneously and does not involve the intervention of the operator, allowing for faster more responsive management of road networks. This 'dynamic system state' lies at the heart of the concept of Intelligent Transport Systems (ITS). When considering the volume, availability and accuracy of data, combined with the many descriptors of traffic state or situations, the importance of the concept becomes obvious.

The harmonisation and standardisation of data structures and data exchange services are fundamental challenges for both the information society as a whole, as well as for ITS. DATEX II is a specification that is meant to operate at and represent the interface between the worlds of dynamic traffic and IT.

Today there are over 100 road operators active on the Trans-European Road Network (TERN). Whilst the road infrastructure itself with its general layout, physical properties and signing have considerably converged, this is not necessarily true for ITS applications.
Wherever a road operator must adapt his actions to a region beyond his own area of control, they will rely on the availability of comprehensive, relevant and accurate information from others.

The coordination and harmonisation of traffic management measures between road operators on the TERN is an essential part of maximising the capacities of their road networks to reduce the negative effects of congestion, whilst improving safety.

Delivering European Transport Policy in line with the White Paper issued by the European Commission requires co-ordination of traffic management and development of seamless pan European services. With the aim to support sustainable mobility in Europe, the European Commission has been supporting the development of information exchange mainly between the actors of the road traffic management domain for a number of years. In the road sector, the DATEX standard was developed for information exchange between traffic management centres and constitutes the reference for applications that have been developed in the last 10 years. With DATEX II the DG TREN now also pushes the door wide open for actors from the wider traffic and travel information sector.

Much investment has been made in Europe both, in traffic control and information centres over the last decade and also in a quantum shift in the monitoring of the Trans European Network. This is in line with delivering the objectives of the Tempo projects for safer, better-informed travellers. Collecting information is only part of the story – to make the most of the investment data needs to be exchanged both with other centres and, in a more recent development, with those developing pan-European services provided directly to road users.

DATEX was designed and developed as a traffic and travel data exchange mechanism by a European task force set up to standardise the interface between traffic control and information centres. It has been the reference for applications that have been developed and implemented in Europe. The existing DATEX network consists of 50 to 60 operational nodes organised in different network and node types throughout Europe. The majority of nodes are used for national exchange of data, but some of them support international exchange.

The DATEX technical documents namely the data dictionary (pre-standard ENV13106:2000) and the DATEX-net specifications for data exchange (pre-standard ENV13777:2000) needed to evolve to reflect technological evolutions, the experience gained in data exchange implementations that were achieved between the European countries and the new needs that have been identified by the market.

Alongside the DATEX pre-standards, a Data Exchange Memorandum of Understanding (DATEX MoU) covering international exchange of traffic data was formally established in October 1997. The MoU confirmed in a formal manner that the development of international traffic data exchange would be based on the DATEX technical specifications, and it established an organizational framework that enabled users to influence and participate in the developments. Different organisations were created under the umbrella of this MoU (Supervisory Management Committee, Technical Committee and User Forum).

The signatories of the current DATEX MoU decided to work on a revised MoU which is more focused on the availability of traffic and travel data to third parties.

It should be noted that many of the original signatories were participants in the Euro-Regional projects which form the EU deployment programme for ITS, know as the TEMPO Programme1, involving more than 80 organisations from 14 Member States and three neighbouring countries. The development of DATEX II was begun in late 2003 and has been supported and partially funded by the European Commission who see it as playing a fundamental role in the ITS domain within European states. This role now extends from traffic control centre / road authority usage to include all types of service provider usage in the ITS domain. Its data content domain is also now extended from the trunk / motorway / TERN road network to include urban network information. Thus DATEX II is aimed at a very wide user base which is far broader than that of the original DATEX specifications.
The original DATEX specifications suffered from a number of shortcomings which made it unlikely to achieve "plug and play" interoperability between DATEX nodes from different manufacturers.

Updating the technology, addressing the interoperability issues and the latest stakeholder requirements were the key drivers in the development of DATEX II. DATEX II was not intended to be a rigid set of specifications, but rather one that allowed a degree of choice and one that was able to evolve to allow stakeholders to exchange additional new types of information in the future.

However, interoperability between disparate DATEX II systems was still given a high priority. A first version (1.0) was then produced at the end of 2006 and was then quickly disseminated among countries. The corresponding implementations raised a number of mistakes and requests for Management Overview - White Paper Prepared by CEN TC 278 Working Group 3 Sub Group 7 Version 1.0 change. After more than one year of work, a first proposal for the version 2.0 was issued in July 2009. In parallel, CEN TC278 circulated the first standard parts for comments. The comment resolution as well as the integration of the work carried out in TG involved producing a new proposal called "release candidate 2" or "RC2".

On October 5, DATEX II TS 16157 1-3 has been published. With this milestone reached there is now an acknowledged European Technical Specification for modelling and exchanging ITS-related information between many partners.

2.5 TPEG (Transport Protocol Experts Group)

TPEG specifications offer a method for transmitting multimodal traffic and travel information, regardless of client type, location or required delivery channel (e.g. DAB, HD radio, Internet, DVB-x, DMB, GPRS, Wi-Fi …). Language independence has also been a prime principle in the design.

TPEG refers to a whole set or toolkit of specifications, for offering a wide range of services to a wide range of users and devices.

TPEG services are defined in a modular way and can therefore vary in a number of 'directions':

- Application - e.g. Road Traffic Messages, Public Transport Information or Parking Information. Each Application is uniquely identified by an Application ID (AID) that are allocated by the TPEG Application Working Group (TAWG) of TISA.
- Transmission method - e.g. DAB digital radio, DMB, internet
- Location referencing method - e.g. table-based (using for example TMC location tables) or on-the-fly (using a method that gives a location reference that works with or without maps and does not require a look-up table to decode in the receiver)
- Device - e.g. intended for vehicle navigation systems, internet browsers or mobile devices
- Conditional Access - whether data is sent for free or only to users/devices who have somehow established the right to receive it, e.g. by paying a subscription. Encryption of TPEG data is possible by means of Standardised Encryption Indicators which are allocated by the TPEG Application Working Group (TAWG) of TISA.

The term "profile" is used to define a combination of the above which, together, make up what you might think of as a single TPEG service. For example:

- displaying traffic incidents on a map graphic and supporting re-routing or route optimisation
- displaying public transport status information on a cell phone screen

2.6 IFOPT (Identification of Fixed Objects in Public Transport)

IFOPT (*Identification of Fixed Objects in Public Transport*) is a prCEN Technical Specification that provides a **Reference Data Model** for describing the main fixed objects required for public access to Public transport, that is to say Transportation hubs such as airports, stations, bus stops, ports, and other destination places and points of interest, as well as their entrances, platforms, concourses, internal spaces, equipment, facilities, accessibility etc.). Such a model is a fundamental component of the modern Public transport information systems needed both to operate Public transport and to inform passengers about services.

IFOPT is itself built upon the CEN Transmodel standard and defines four related sub models.

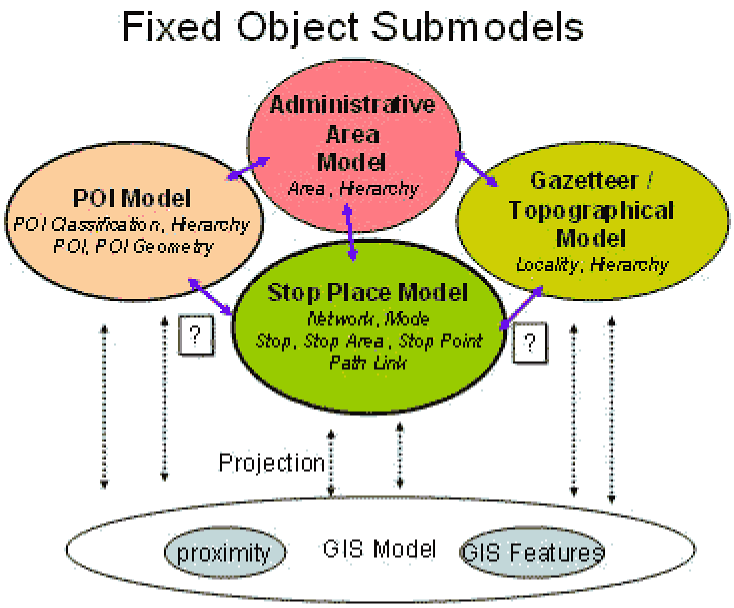

Figure 2 : IFOPT submodels

- *Stop Place Model:* Describes the detailed structure of a Stop Place (that is stations, airports, ferry ports, bus stops, coach stations, etc, providing a point of access to public transport) including Entrances, pathways, and accessibility limitations.
- *Point of Interest Model:* Describes the structure of a point of interest (that is tourist attractions, leisure facilities, stadia, public buildings, parks, prisons, etc) to which people may wish to travel by public transport) including physical points of access, i.e. Entrances.
- *Gazetteer Topographical Model:* Provides a topographical representation of the settlements (cities, towns, villages etc) between which people travel. It is used to associate Stop and Station elements with the appropriate topographic names and concepts to support the functions of journey planning, stop finding, etc.
- *Administrative Model.* Provides an organisational model for assigning responsibility to create and maintain data as a collaborative process involving distributed stakeholders. Includes namespace management to manage the decentralised issuing of unique identifiers.

This partitioning of Fixed Object into distinct sub-models is in particular of significance for data exchange. For data exchange, a model held on one computer system must typically be serialised into an XML document or other flat file format and then, after transmission, be de-serialised and rereferenced back into another model on a different system. In order to exchange data efficiently it must be possible to partition the data of a large model (for example all the bus stops in a country) into smaller coherent subsets (for example all the bus stops in a single area within a country) that include references to objects that are not included in the export (for example stops in adjacent areas, or the full definitions of the areas). This raises considerations for ensuring integrity of reference and in particular for the management of the identifiers that are used to implement the reference across different systems.

In practice the coherent subsets of data that are needed for efficient exchange must reflect the operational processes and frequency of change of the data. The four Fixed Object submodels represent four primary sets of data that usually will be exchanged as distinct documents between different parties on different timescales. Thus for example, the Administrative model is a small model that typically needs to be set up centrally with a view to coordinating the work of different stakeholders; once created, its data will change only occasionally, but it will be extensively referenced by other documents. At the other extreme, the Point of Interest and Stop Place models will need to be managed as discrete large data sets for each locality, each requiring detailed geographical surveying and local access knowledge for its creation and maintenance.

A second reason for modularisation is that it allows a more flexible and incremental approach to adoption of the standards.

2.7 NeTEx (Network Exchange) CEN TC 278 WG9

NeTEx is a prCEN/ Technical Standard currently in development. The goal of NeTEX is to provide an efficient European wide standard for exchanging Public Transport schedules and related data. NeTEX is intended to be a general purpose format capable of exchanging timetables for Rail, Bus, Coach, Ferry, Air or any other mode of public transport. It includes full support for rail services and can be used to exchange UIC (International Union Of Railways) data .

NeTEx is based on the CEN Transmodel standard which specifies a Conceptual model for Public Transport data, extended with additional concepts for stops and stations from the CEN Technical standard IFOPT (Identification of Fixed Objects in Public Transport).

NeTEX uses a fully articulated model that represents PT concepts as well characterised, layered abstractions; the format is designed for the efficient, updateable exchange of complex transport data between distributed systems. This allows the data to be used in modern web services architectures and to support a wide range of passenger information and operational applications. The NeTEX schema is free to use and its development is managed by the CEN standards process.

2.7.1 What is NeTEx for?

NeTEx provides a means to exchange stops, routes and timetables between different computer systems, together with related operational data.

NeTEx comprises the following main components:

1. A Specification
2. A modular NeTEx XML Schema.
3. Descriptions of protocols for exchanging documents created with the schema.
4. Documentation on the NeTEx schema and the processes to use it.
5. Examples of schedules encoded as NeTEx XML documents.

2.7.2 What Sort of Information Does NeTEx Exchange?

NeTEx defines a standard for exchanging Timetable related data for public transport services, including:

- **Network Topologies** (e.g. routes, journey patterns
- **Timetables** (including Journey patterns, vehicle journeys, operating days
- Data to support **real-time** operations
- Basic **Fare** data

XML documents based on the NeTEx schema can thus be used to exchange the following information:

- Public Transport **schedules** including stops, routes, departures times / frequencies, operational notes, and map coordinates. May include
- Routes may have complex topologies such as circular routes, cloverleaf and lollipops, and complex workings such as short working and express patterns. Connections with other services can also be described
- The **days** on which the services run, including availability on **public holidays** and other **exceptions**.
- Journeys may include composite journeys such as train journeys that merge or split trains
- Information about the **Operators** providing the service.
- Additional operational information, including, **positioning runs**, **garages**, **layovers**, **duty crews,** useful for AVL and on-board ticketing systems.
- Data about the Accessibility of services to passengers with restricted mobility.
- Data is versioned with management **metadata** allowing updates across distributed systems

2.7.3 How is data exchanged between systems?

NeTEx describes data as XML document that can be exchanged by many different communication protocols (e.g. FTP, http, SNMP) etc. It can therefore be used both for the bulk exchange of XML documents based on the Schema and for the dynamic exchange of individual data objects or groups of objects, fro example as http request using the SIRI framework

NeTEx XML serialises complex PT models into a standard flat file format that can be processed cheaply and efficiently using mainstream modern computer technologies.