Approaches to Develop an ITS Architecture and Integrated ITS

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Intelligent Transport Systems – Applications and Architectures
Department of Transport Ho Chi Minh City, Vietnam

BMVBS (2012)

Recent Research on ITS Architectures at TU Darmstadt*

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(1) **International and national guidelines for telematics and ITS architectures in road traffic**

Reports of the German Federal Highway Research Institute (BASt), Vol. F79 (2011)

⇒ http://bast.opus.hbz-nrw.de/frontdoor.php?source_opus=585&la=de

Source: www.bast.de

(2) **Report on existing and planned ITS in Germany ****

Basis of German ITS Initial Report (BMVBS 2011), Referred to: 17(1), Directive 2010/40/EU

⇒ http://ec.europa.eu/transport/themes/its/road/action_plan/doc/2011_its_initial_report_germany.pdf

Source: www.europa.eu

(3) **Identification and analysis of measures for the German National ITS Action Plan****

Basis of the German ITS Action Plan (BMVBS 2012)

⇒ http://www.bmvbs.de/SharedDocs/DE/Artikel/LA/ivs-im-strassenverkehr.html

Bundesministerium für Verkehr, Bau und Stadtentwicklung

Source: www.bmvbs.de

* Basis for Doctoral Thesis of Philip Krueger (2013)

** Cooperation with TU Munich: Prof. Dr.-Ing. Fritz Busch

Status of National ITS Architectures

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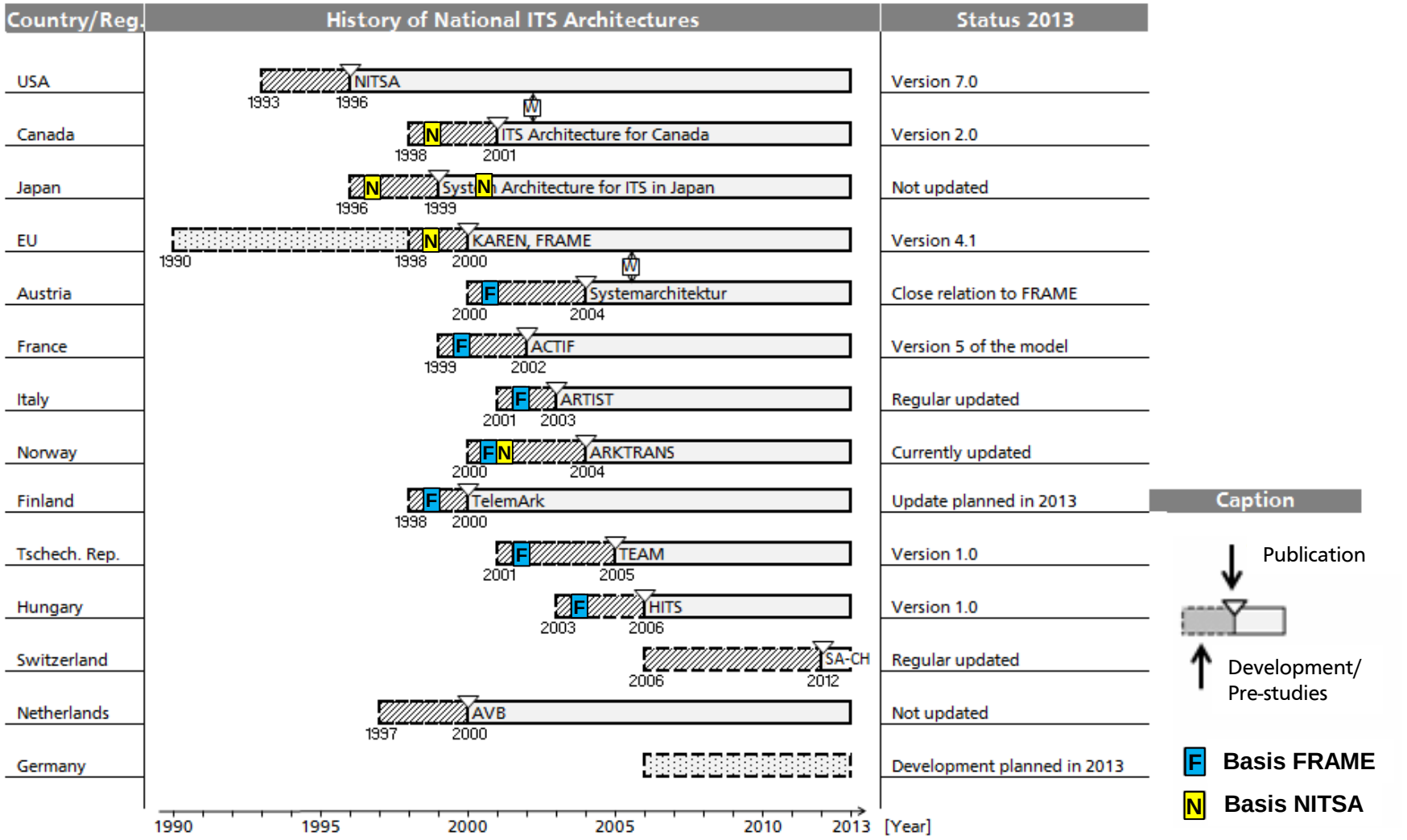

Highlights of the Analysis Results

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- Superordniate role of **NITSA** and **FRAME** as the basis of national ITS architectures.
- Most national ITS architectures focus on **road transport**, only.
- Worldwide, ITS architectures are addressing **three levels:**
  - Functional/logical aspects
  - Technical/physical aspects
  - Institutional/organisational aspects
- Between national ITS architectures **notably differencies** exist, e. g.: Depth of contents, emphasis of included aspects, …
- Two different **types of modelling** are used (according ISO 2010):
  - structured methods
  - object-orientated methods

FRAME: Functional Areas

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1. Provide **Electronic Payment Facilities**
2. Provide **Safety and Emergency Facilities** – includes both in-vehicle and roadside "eCall" plus the management of the Emergency Services responses
3. **Manage Traffic** – includes urban and inter-urban traffic management, plus parking, incident and demand management
4. **Manage Public Transport Operations** – includes both regular and on-demand services, plus fare cards and vehicle sharing
5. Provide **Advanced Driving Assistance Systems** – includes support for in-vehicle services some of which are part of cooperative systems
6. Provide **Traveller Journey Assistance** – includes both pre- and on-trip planning, plus traveller information
7. Provide Support for **Law Enforcement**
8. **Manage Freight and Fleet Operations**
9. Provide Support for **Cooperative Systems** – includes support for cooperative systems not included elsewhere

FRAME (2012)

FRAME: Functional Tree of Area 3.1 (Excerpt)

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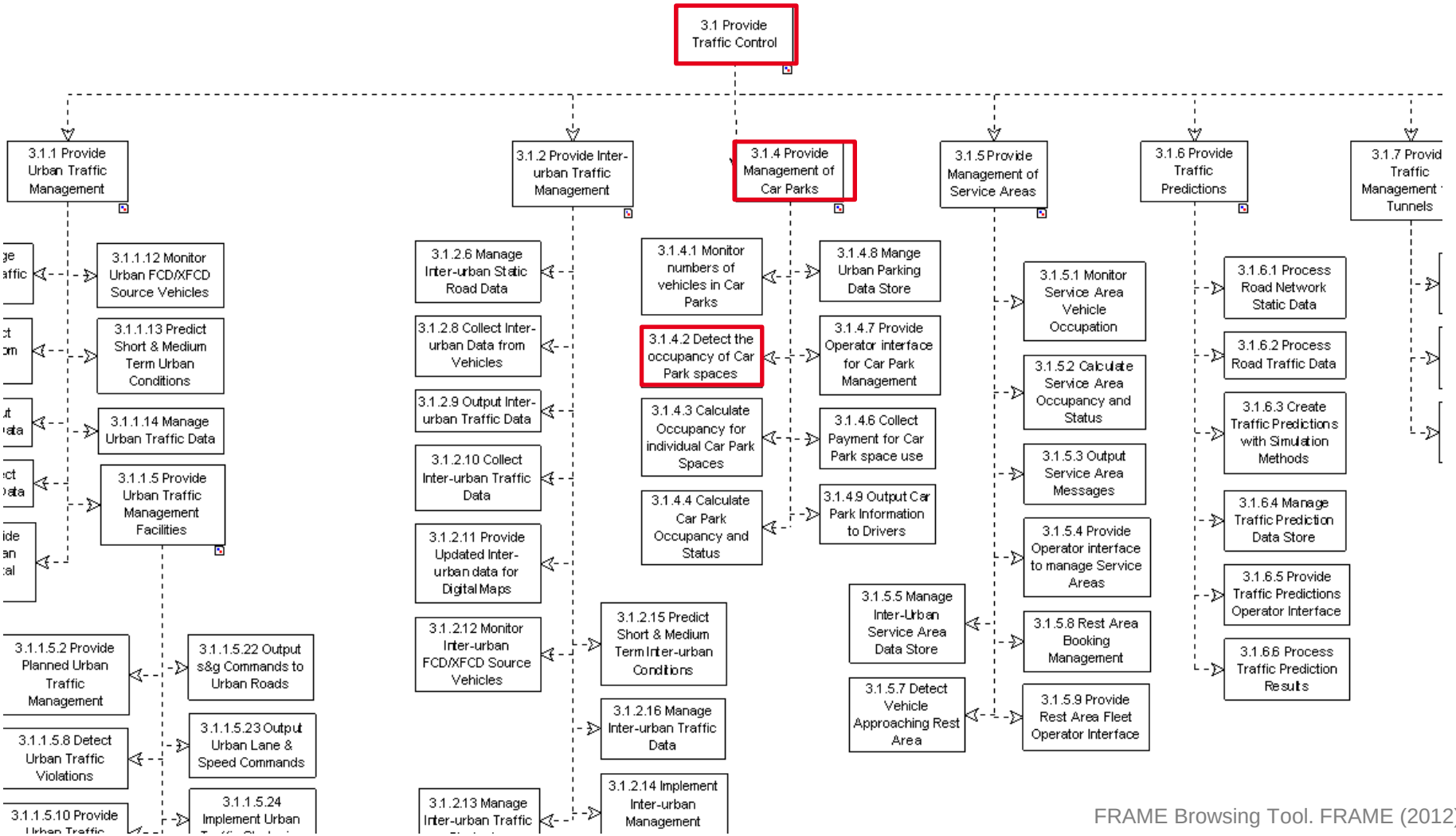

FRAME Browsing Tool. FRAME (2012)

Definitions – Overview

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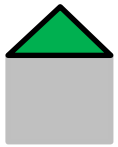
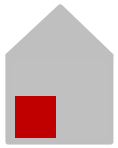
	National Guidelines / Standards	⇨	Implementations
	National ITS Vision	⇨	Operators/local ITS Vision
	Framework Architecture	⇨	Overall Architecture
	Reference Architecture	⇨	System (Architecture)

According to: (Boltze, Krueger, Reusswig 2011)

National ITS-Vision Definition

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*The **National ITS Vision** represents a high-level, long-term orientated and political strategy for the use of ITS. It should be a commitment for ITS which encompasses the aspirations of all stakeholders including the users. It also illustrates the aims as well as the expected benefits of using ITS. Furthermore, the National ITS Vision will be substantiated in a framework plan which comprises specifications regarding roles, responsibilities, as well as general specifications for measures and a timeline for the implementation.*

*When defining an ITS Vision on the level of a transport operator or local authority, the term "**Operators/Local ITS Vision**" is used. It correspondingly comprises the content of the National ITS Vision.*

These Definitions have been developed with relation to:

- Busch/Keller/Riegelhuth/Schnittger: Systemarchitekturen für Verkehrstelematik in Deutschland. Straßenverkehrstechnik Heft 4, 2007.
- Rittershaus: ITS-Architektur Deutschland – Aktivitäten und Begriffsbestimmungen. Arbeitspapier, unveröffentlicht, 2009.

National ITS Vision Recommendations

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- A timeline as well as a funding concept for realising the ITS Vision should be developed.
- By defining the ITS vision, cost-benefit analyses should be applied to identify suitable measures.

Framework Architecture Definition

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*The **Framework Architecture** is based on the national ITS Vision as well as on the framework plan. It is more concrete than the ITS Vision but still technology-independent. The Framework Architecture contains functional (equivalent: logical), physical, and organisational aspects, which aims to ensure interoperability on the level of the reference architecture, but also has to provide flexibility for the detailed implementation of ITS in specific projects.*

*When defining a Framework Architecture on the level of operators or local authorities the term **Overall Architecture** is used which correspondingly comprises the content of the Framework Architecture.*

Framework Architecture Recommendations

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- The ITS framework architecture should be designed to include all modes of transport.
- The ITS framework architecture should comprise functional (logical), physical, and organizational aspects.

Reference Architectures
Definition

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*The **Reference Architecture** specifies the framework architecture for one ITS-related function, e. g. traffic signal control systems, and the Reference Architecture is used as a blueprint for implementing this function. The Reference Architecture comprises all specifications and, if necessary, also standards to ensure integrated ITS implementations.*

*When defining a Reference Architecture on the level of operators or local authorities, the term **System Architecture** is used which correspondingly comprises the content of the Reference Architecture.*

*The **Reference Architecture** generally includes specifications*

- *of the related function,*
- *for implementing components of the related function,*
- *of interfaces as well as for the communication between components,*
- *of data protocols,*
- *of roles and responsibilities for the involved stakeholders.*

Reference Architectures Recommendations

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- As a part of reference architectures, standards should be comprised to ensure interoperability of ITS services. In particular, existing established standards should be considered for this purpose.
- It should be elaborated whether the development of specific modules is appropriate, such as service packages in the USA.

Recommendations related to the Process for the Development , Maintenance and Updating of a National ITS Architecture (1)

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- Leadership and responsibility regarding ITS architecture should be held by the respective ministry of transport. If necessary, additional ministries should be also involved.
- The responsibility for the development of the national ITS architecture should be assigned by the leading ministry to a suitable institution.
- All relevant stakeholders should be involved (including provinces, cities, scientific bodies, private companies).
- As part of the development of a national ITS architecture the exchange with other countries should be encouraged.
- Compatibility to ITS architectures of neighbouring countries should be achieved.

Recommendations related to the Process for the Development , Maintenance and Updating of a National ITS Architecture (2)

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- It should be analyzed which models of existing ITS architectures can be used or modified to serve as a starting point for the development of the National ITS architecture.
- The ITS architectures content should be continuously maintained and updated. The ITS architecture should be flexible and allow to adopt new services or functions.
- The development and maintenance of the national ITS architecture should be financed by public authorities.
- The use of the ITS architecture should be mandatory to ensure its dissemination. Therefore, public funding should be linked with the use of the ITS architecture.
- Suitable aids and tools, e. g. software tools, manuals, guidelines, training courses, workshops, website, etc. should be developed.

NITSA: Service Areas

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User Service Bundle	User Service
Travel and Traffic Management	Pre-Trip Travel Information En-Route Driver Information Route Guidance Ride Matching and Reservation Traveler Services Information Traffic Control Incident Management Travel Demand Management Emissions Testing and Mitigation Highway-Rail Intersection
Public Transportation Management	Public Transportation Management En-Route Transit Information Personalized Public Transit Public Travel Security
Electronic Payment	Electronic Payment Services
Commercial Vehicle Operations	Commercial Vehicle Electronic Clearance Automated Roadside Safety Inspection On-Board Safety and Security Monitoring Commercial Vehicle Administrative Processes Hazardous Material Security and Incident Response Freight Mobility
Emergency Management	Emergency Notification and Personal Security Emergency Vehicle Management Disaster Response and Evacuation
Advanced Vehicle Safety Systems	Longitudinal Collision Avoidance Lateral Collision Avoidance Intersection Collision Avoidance Vision Enhancement for Crash Avoidance Safety Readiness Pre-Crash Restraint Deployment Automated Vehicle Operation
Information Management	Archived Data Function
Maintenance and Construction Management	Maintenance and Construction Operations

Key Concepts of the National ITS Architecture (ITERIS, 2012)

NITSA: Subsystems and Communications

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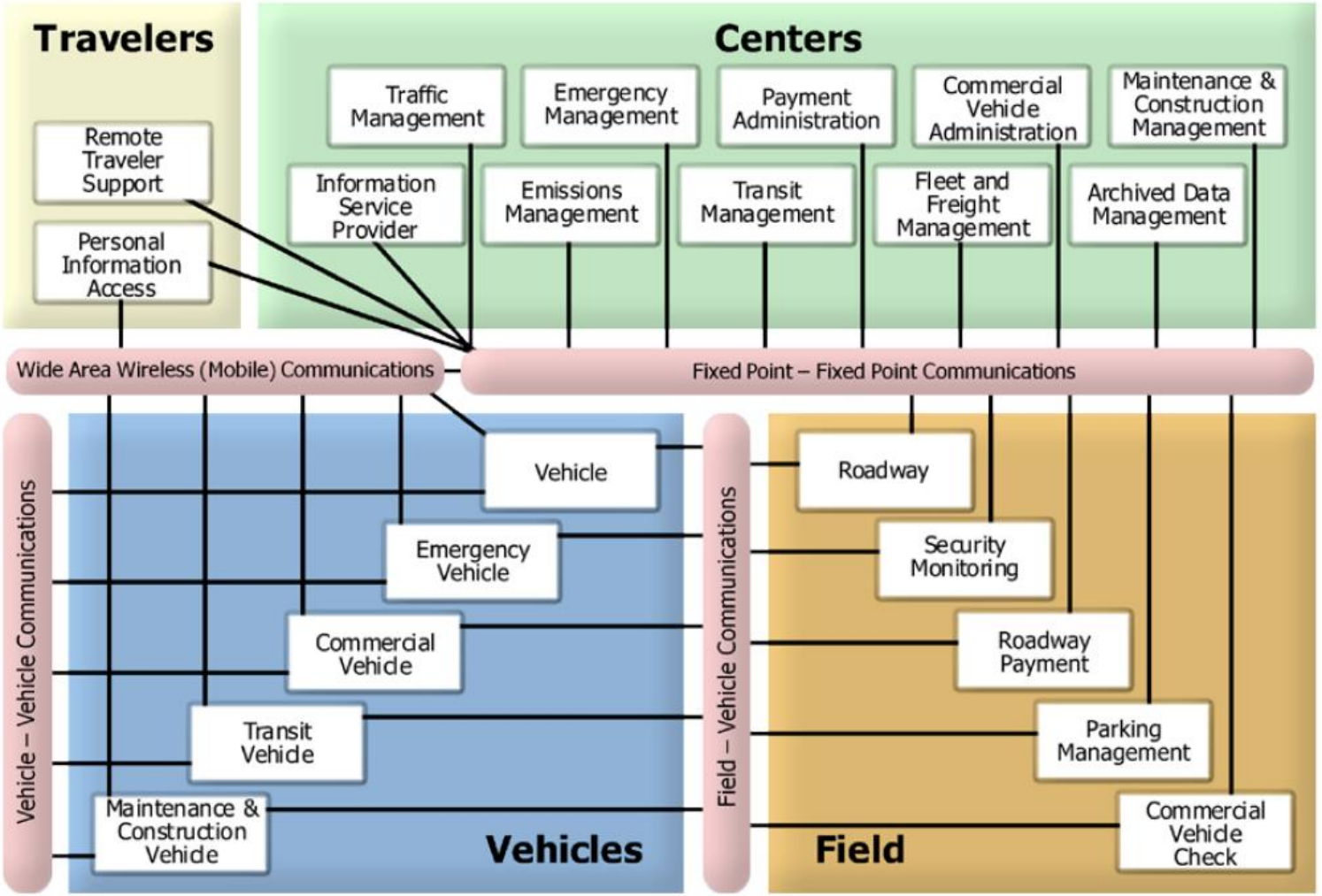

Quelle: National ITS Architecture Service Packages (US DoT, 2012)

NITSA: Application Areas and Service Packages

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ATMS – Advanced Traffic Management Systems

APTS – Advanced Public Transportation Systems

ATIS – Advanced Traveler Information Systems

CVO – Commercial Vehicle Operations

EM – Emergency Management

AD – Archived Data

MCO – Maintenance and Construction Management

AVSS – Advanced Vehicle Safety Systems

APTS01	Transit Vehicle Tracking
APTS02	Transit Fixed-Route Operations
APTS03	Demand Response Transit Operations
APTS04	Transit Fare Collection Management
APTS05	Transit Security
APTS06	Transit Fleet Management
APTS07	Multi-modal Coordination
APTS08	Transit Traveler Information
APTS09	Transit Signal Priority
APTS10	Transit Passenger Counting

Quelle: National ITS Architecture Service Packages (US DoT, 2012)

NITSA: Service Package APTS01 Transit Vehicle Tracking

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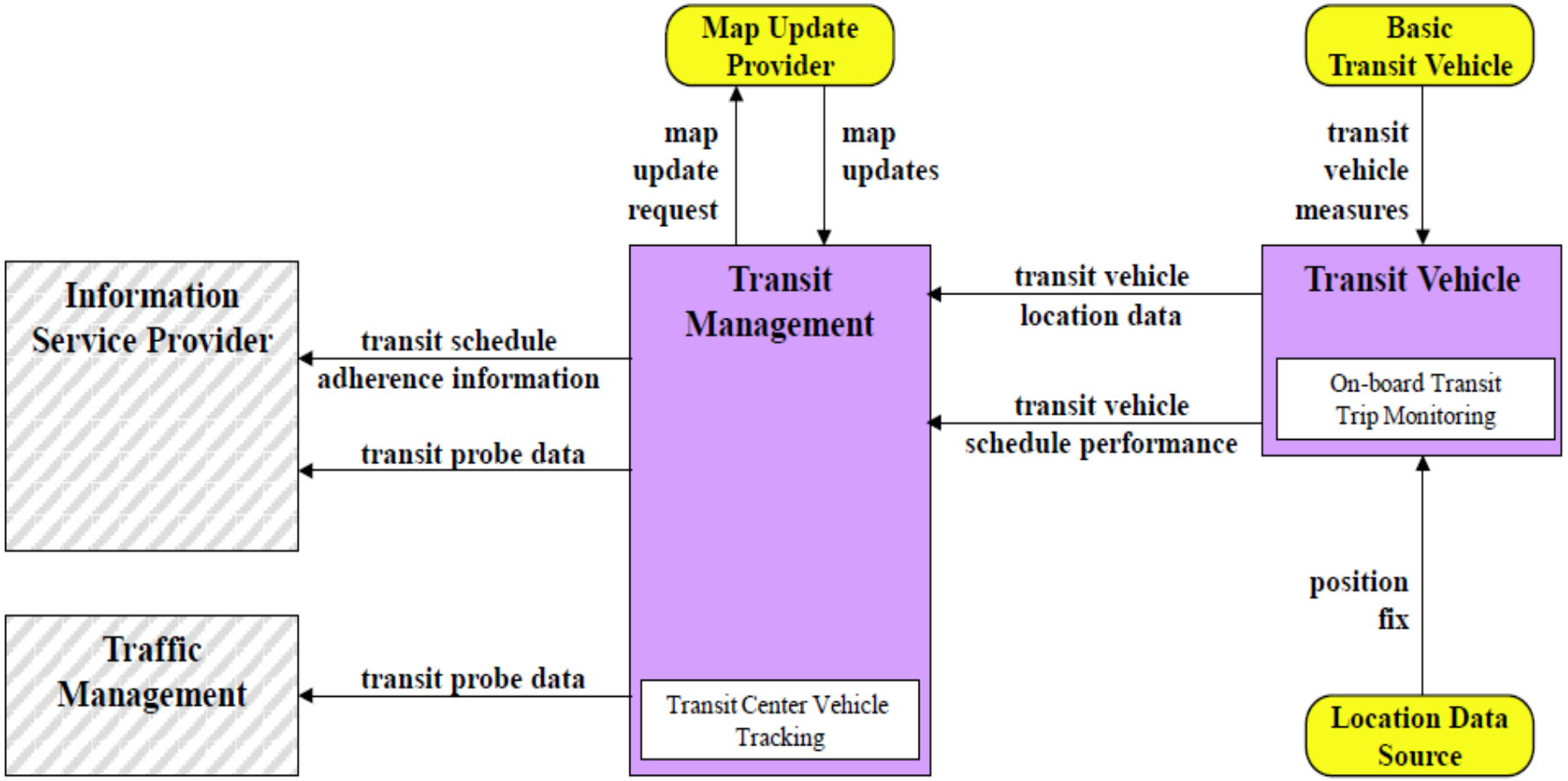

*Note: Graphic shows key service package elements. Some elements are omitted for clarity.

Source: National ITS Architecture Service Packages (US DoT, 2012)

NITSA: Service Package APTS03
Demand Response Transit Operations

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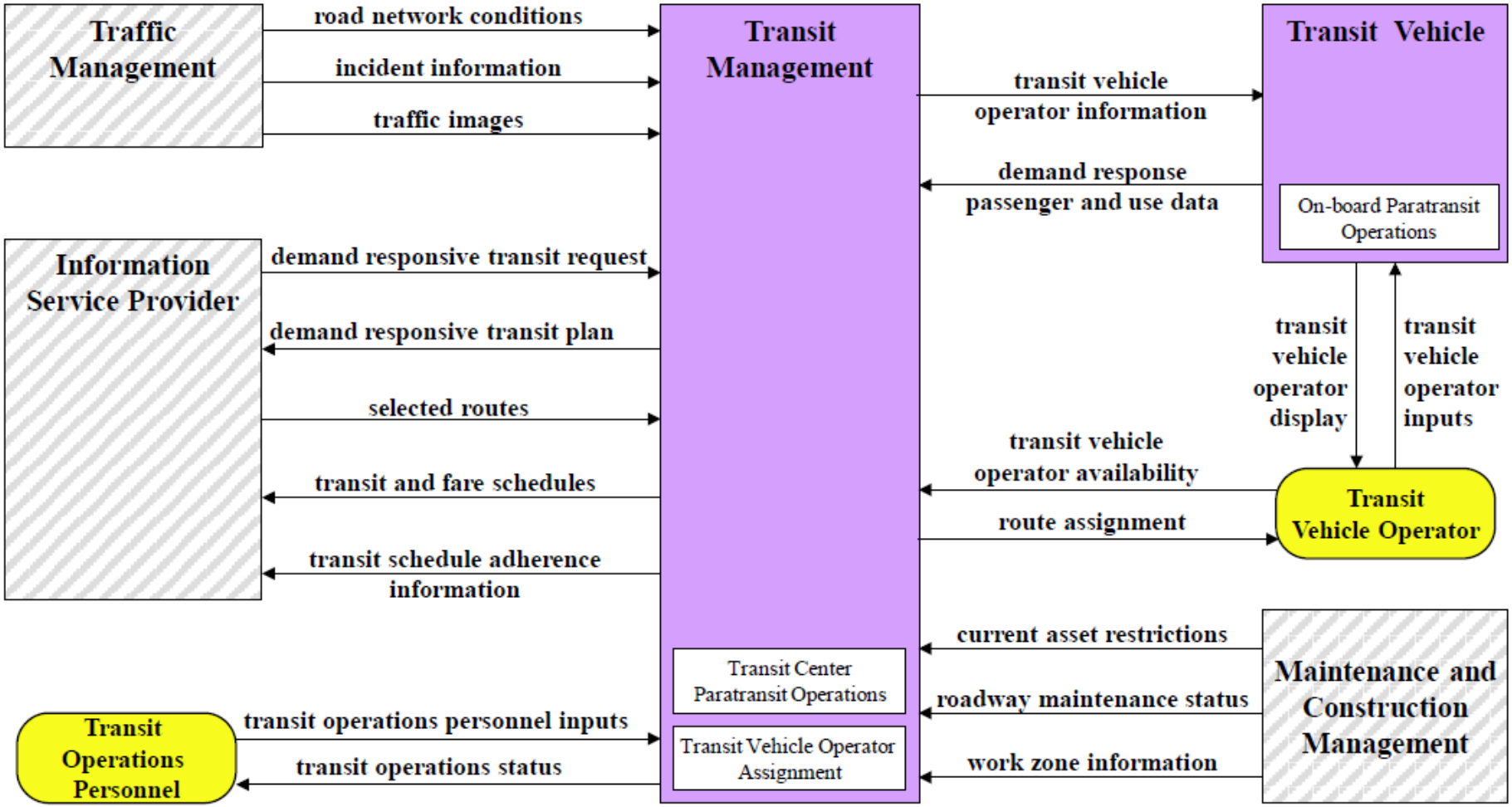

Source: National ITS Architecture Service Packages (US DoT, 2012)

NITSA: Service Package APTS09
Transit Signal Priority

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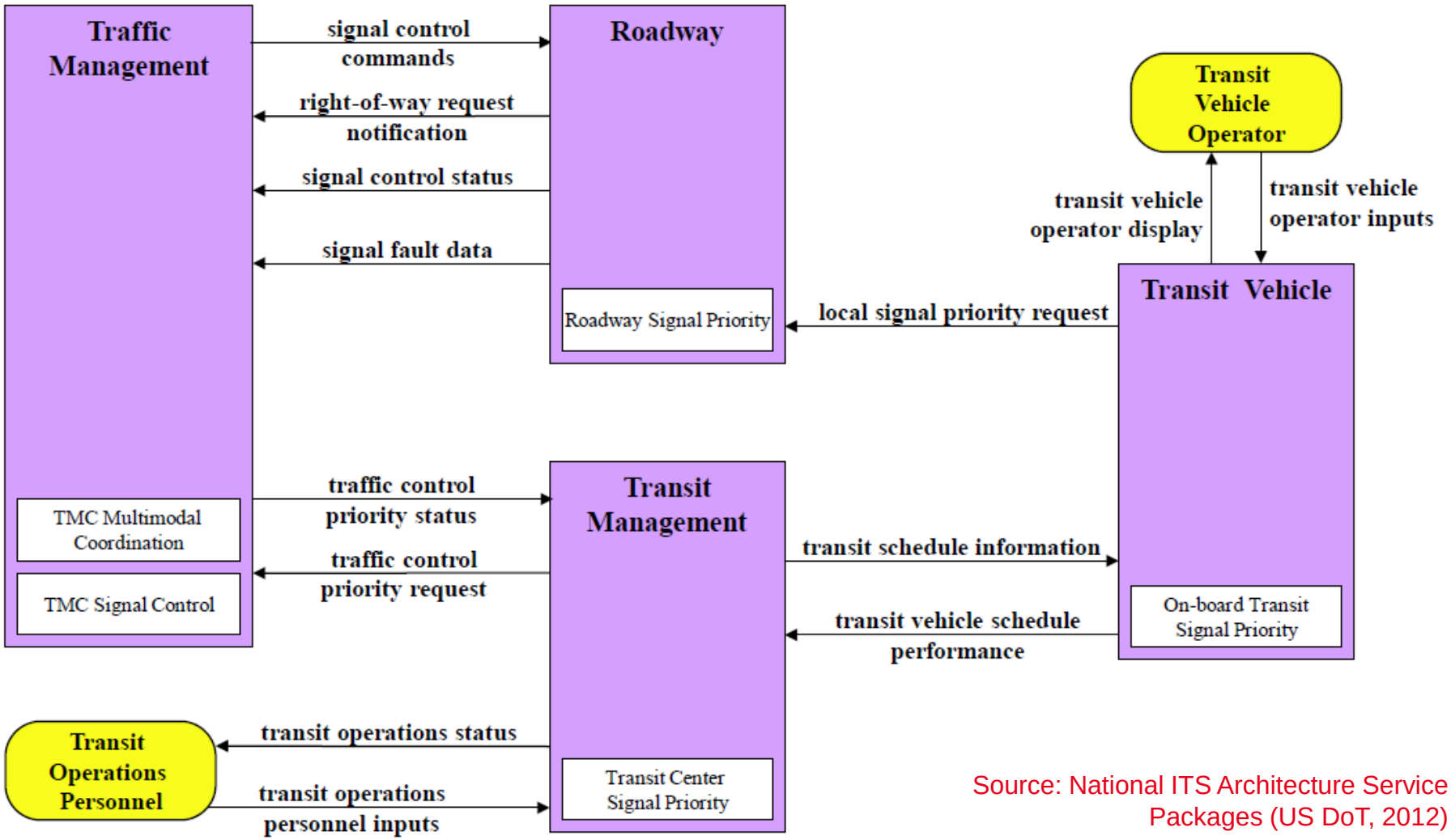

Source: National ITS Architecture Service Packages (US DoT, 2012)

NITSA: Equipment Packages
Example „Transit Center Vehicle Tracking“

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This equipment package monitors transit vehicle location. The location information is collected via a data communication link between the transit vehicles and the transit center. The location information is presented to the transit operator ……

Functional Requirements

The center shall monitor the locations of all transit vehicles within its network.

The center shall determine adherence of transit vehicles to their assigned schedule.

The center shall support an interface with a map update provider, or other appropriate data sources, through which updates of digitized map data can be obtained and used as a background for transit tracking and dispatch.

The center shall provide transit operational data to traveler information service providers.

The center shall provide collected transit probe data to traffic management centers and traveler information service providers for use in measuring current traffic conditions.

Pspecs:

4.1.5-Provide Transit Vehicle Status and Probe Information
4.1.6-Manage Transit Vehicle Operations
4.2.3.9-Update Transit Map Data

Quelle: National ITS Architecture Service Packages (US DoT, 2012)

NITSA: Equipment Packages
Example „Transit Center Vehicle Tracking“

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Inputs/Outputs (Included Architecture Flows)

Source	Architecture Flow	Destination
Map Update Provider	map updates	Transit Management
Transit Management	transit probe data	Information Service Provider
Transit Management	transit schedule adherence information Standards	Information Service Provider
Transit Management	map update request	Map Update Provider
Transit Management	transit probe data	Traffic Management
Transit Vehicle	transit vehicle location data Standards	Transit Management
Transit Vehicle	transit vehicle schedule performance Standards	Transit Management

Standards

This icon indicates that the associated architecture flow either has been or will be addressed by ITS Standards. Select the architecture flow for more information on relevant standards activities.

For all „Architecture Flow“ more detailled advice is available, Including cross-references with relevant standards.

Source:
http://www.iteris.com/itsarch/index.htm

Conclusion and Proposal for Next Steps

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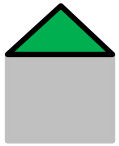
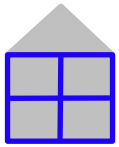
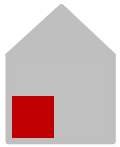


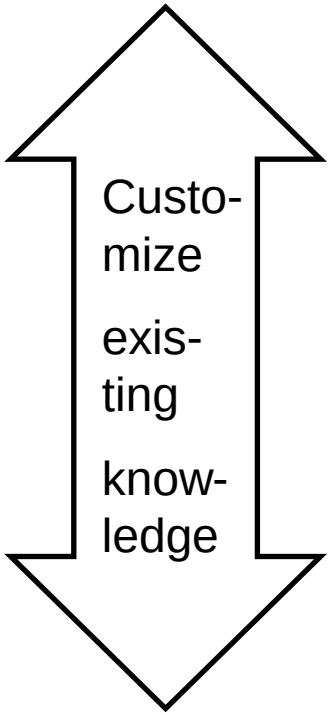
Define a National ITS Vision and a Framework Plan. Include a Strategy for the use of ITS. Define functional of ITS application and fix them with a time line.



Customize / develop a Framework Architecture and include functions, physical elements and organisational issues.



Customize / develop Reference Architectures and detail functions, physical elements and organisational issues.



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Trung tâm Nghiên cứu Giao thông Vận tải Việt-Đức