



BSI Standards Publication

Intelligent transport systems – Urban ITS – Use of regional traffic standards in a mixed vendor environment

National foreword

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English Version

Intelligent transport systems - Urban ITS - Use of regional traffic standards in a mixed vendor environment

Systèmes de transport intelligents - ITS urbain -
Utilisation des normes de trafic régionales dans un
environnement mixte

Intelligente Transportsysteme - Urbane
Verkehrssysteme - Verwendung regionaler
herstellerspezifischer Normen und Spezifikationen

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CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

This document (CEN/TS 17402:2020) has been prepared by Technical Committee CEN/TC 278 “Intelligent transport systems”, the secretariat of which is held by NEN.

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Introduction

The standard deliverables “Mixed Vendor Environment Guide” CEN/TR 17401, “Mixed vendor environments methodologies & translators” CEN/TS 17400, and this document provide a suite of standards designed to achieve successful implementation of “Urban-Intelligent Transport Systems” (U-ITS) in a mixed vendor environment.

This suite of standards supports the family of existent standards, referencing both common communications protocols and data definitions, that, in combinations, enable Urban-ITS (and ITS in general) to function and be managed, and will reference application standards, and their interdependencies and relationships.

Urban authorities use an increasing array of ITS implementations to deliver their services. Historically, urban ITS implementations have tended to be single solutions provided to a clear requirements specification by a single supplier. Increasingly, as ITS opportunities become more complex and varied, they involve the integration of multiple products from different vendors, procured at different times and integrated by the urban authority.

The need for a mixture of systems provided by different manufacturers to so-called “Mixed Vendor Environments” (MVEs) is a growing paradigm, which results primarily from the demand for the introduction of competition in the context of public tenders, and the increasing networking of existing stand-alone solutions to address complex traffic management systems.

The mix of systems of different manufacturers is also, in part, a result from technological changes. Established companies are suddenly in competition with new companies that exploit technological changes and offer exclusively, or at a reasonable price, new or improved functionality for sub-systems.

However, ITS design is often proprietary and, as a consequence, integration and interoperability can be difficult, time-consuming, and expensive, limiting the ability of urban authorities to deploy innovative solutions to transport problems. In some member states of the European Union, national/regional solutions to this problem have been created, and there are also some solutions in specific domains, which have been very beneficial. However, these are not uniform across the EU, compromising the efficiency of the single market.

This document focuses specifically on the area of traffic management systems in an MVE, identifies appropriate standards to use to enable an MVE, and addresses aspects associated with the accommodation of regional traffic standards in such mixed vendor environments, with particular emphasis on the centre/field systems context. This document also provides information regarding MVE provisions in the public transport domain.

This document should be read together with CEN/TR 17401, which provides a ‘Guide’ giving a high level introduction into the “Concept of Operations” (CONOPS) for MVEs; provides a high-level architectural context explanation of an MVE and its operational requirements, and describes the problems and effects that are associated with vendor lock-in. It also provides a systematic approach for many aspects of U-ITS implementations, and indeed almost all ITS MVE implementations; and provides a methodical guideline with a procedural model, in order to provide assistance to implementers and managers involved with the structure of an MVE and/or with the removal of vendor lock-in.

This document should also be considered together with CEN/TS 17400, which provides the methodologies and translators to avoid vendor lock-in, introducing suitable methodologies for system architecture design, making appropriate use of standards, and specifications to be used when translator systems are adopted.

Over many decades, regional traffic interface standards have evolved and been implemented around Europe. Implemented, they cannot be replaced in the near term. This document is designed to show how they can operate, co-exist and evolve in an MVE over time.

This document also describes the major existing regional traffic standards established in Europe, such as OCIT, UTMCI, DVM/IVERA, and the data exchange provisions provided in the DATEX II series of standards, and how these regional traffic standards and DATEX II are used in MVE or to avoid vendor lock-in. This document recognizes that there are other implemented local traffic management standards and is designed to enable them to also seek to achieve an MVE accommodation path.

The organization of the deliverable is based on functionality, and will provide framework overviews, and minimum system requirements for ITS service provision in the context of regional traffic standards MVEs.

1 Scope

This document provides a background to the relevance of standards concerning mixed vendor environments in the context of urban-ITS. It describes key mixed vendor environments interfaces.

It identifies existing open specifications for

- sensor systems;
- traffic control;
- traffic information;
- public transport information;
- distributed C-ITS;
- central systems.

It provides common specifications of

- sensor systems;
- traffic control;
- traffic information;
- public transport information;
- distributed C-ITS;
- central systems.

It describes openly plied proprietary standards and extant communications protocols that can be used in mixed vendor environments in the context of U-ITS.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12896 (all parts), *Public transport - Reference data model*

EN 12966, *Road vertical signs - Variable message traffic signs*

EN 13149 (all parts), *Public transport - Road vehicle scheduling and control systems*

EN 15509, *Electronic fee collection - Interoperability application profile for DSRC*

CEN/TS 15531 (all parts), *Public transport - Service interface for real-time information relating to public transport operations*

CEN/TS 16157 (all parts), *Intelligent transport systems - DATEX II data exchange specifications for traffic management and information*

CEN/TS 16614 (all parts), *Public transport - Network and Timetable Exchange (NeTEx)*

EN ISO 17419, *Intelligent transport systems - Cooperative systems - Globally unique identification (ISO 17419:2018)*

EN ISO 18750:2018, *Intelligent transport systems - Co-operative ITS - Local dynamic map (ISO 18750:2018)*

CEN ISO/TS 19321:2015, *Intelligent transport systems — Cooperative ITS — Dictionary of in-vehicle information (IVI) data structures*

CEN/TS 17380, *Intelligent transport systems - Urban-ITS - 'Controlled Zone' management for UVARs using C-ITS*

CEN/TS 17400:2020, *Intelligent Transport Systems – Urban-ITS – Mixed vendor environments methodologies & translators*

CEN/TR 17401:2020, *Intelligent Transport Systems – Urban-ITS – Mixed Vendor Environment Guide*

ISO 14906, *Electronic fee collection — Application interface definition for dedicated short-range communication*

ISO/TS 16460:2018, *Intelligent transport systems — Communications access for land mobiles (CALM) — Communication protocol messages for global usage*

ISO 17572-2, *Intelligent transport systems (ITS) — Location referencing for geographic databases — Part 2: Pre-coded location references (pre-coded profile)*

ISO 17572-3, *Intelligent transport systems (ITS) — Location referencing for geographic databases — Part 3: Dynamic location references (dynamic profile)*

ISO/TS 19091, *Intelligent transport systems — Cooperative ITS — Using V2I and I2V communications for applications related to signalized intersections*

ISO 20684 (all parts), *Intelligent transport systems — Roadside modules SNMP data interface*

ISO/TS 21177, *Intelligent transport systems – ITS-station security services for secure session establishment and authentication between trusted devices*

ISO/TS 21184, *Intelligent transport systems – Management of messages containing information of sensor and control networks specified in data dictionaries*

ISO 21210, *Intelligent transport systems — Communications access for land mobiles (CALM) — IPv6 Networking*

ISO 21215:2018, *Intelligent transport systems — Localized communications — ITS-M5*

ISO 21217:2014, *Intelligent transport systems — Communications access for land mobiles (CALM) — Architecture*

ISO/TS 21219 (all parts), *Intelligent transport systems — Traffic and travel information (TTI) via transport protocol experts group, generation 2 (TPEG2)*

ISO 22418:2018, *Intelligent transport systems — Fast service announcement protocol (FSAP)*

ISO 24532, *Intelligent transport systems — Systems architecture, taxonomy and terminology — Using CORBA (Common Object Request Broker Architecture) in ITS Standards, data registries and data dictionaries*

ISO 29281-1:2018, *Intelligent transport systems — Localized communications — Part 1: Fast networking & transport layer protocol (FNTF)*

ETSI TS 102 687 (2011-07), *Intelligent Transport Systems (ITS); Decentralized Congestion Control Mechanisms for Intelligent Transport Systems operating in the 5 GHz range; Access layer part*

ETSI TS 102 724 (2011-07), *Intelligent Transport Systems (ITS); Harmonized Channel Specifications for Intelligent Transport Systems operating in the 5 GHz frequency band*

ETSI TS 102 792 (2015-06), *Intelligent Transport Systems (ITS); Mitigation techniques to avoid interference between European CEN Dedicated Short Range Communication (CEN DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range*

ETSI TS 103 097 (2017-10), *Intelligent Transport Systems (ITS); Security; Security header and certificate formats*

ETSI EN 302-637-2:2014-09, *Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service*

ETSI EN 302-637-3:2014-09, *Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service*

IEEE Std 802.11™, *IEEE Standard for Information technology–Telecommunications and information exchange between systems Local and metropolitan area networks–Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications*

SAE J2735, *Dedicated Short Range Communications (DSRC) Message Set Dictionary*

SAE J2945/1, *On-Board System Requirements for V2V Safety Communications*

ITU-T E.163, *Numbering plan for the international telephone service*

ITU-T E.164 (all parts), *The international public telecommunication numbering plan*

IEC 60870-5-101, *Transmission Protocols - companion standards especially for basic telecontrol tasks*

ISO/IEC 18000, *Information technology — Radio frequency identification for item management*

ISO/IEC 19501:2005, *Information technology — Open Distributed Processing — Unified Modeling Language (UML) Version 1.4.2*

IETF RFC 3411, *An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks*

IETF RFC 3412, *Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)*

IETF RFC 3413, *Simple Network Management Protocol (SNMP) Applications*

IETF RFC 3414, *User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)*

IETF RFC 3415, *View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP)*

IETF RFC 3416, *Version 2 of the Protocol Operations for the Simple Network Management Protocol (SNMP)*

IETF RFC 3417, *Transport Mappings for the Simple Network Management Protocol (SNMP)*

IETF RFC 3418, *Management Information Base (MIB) for the Simple Network Management Protocol (SNMP)*

NF P 99071-1 (*septembre 2002*): Régulation du trafic routier par feux de circulation - Spécification du dialogue standard des équipements de régulation de trafic - Diaser

RTIGT008, *Radio Link Specification for RTI-driven Traffic Light Priority and Display Clear down*

RTIGT030, *Digital Air Interface Protocol*

RTIGT031, *Centre-to-centre traffic signal priority request protocol*

RTIGT035, *Language and terminology in Real Time Information systems*

RTIGT036, *Additional information on RTI signs*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21217:2014 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 Demand Responsive Transit
form of transport where vehicles alter their routes based on particular transport demand rather than using a fixed route or timetable; vehicles typically pick-up and drop-off passengers in locations according to passengers needs

3.2 hybrid communications
simultaneous operation of various communication technologies or operation via a choice from more than one available communication medium dependent on application requirements and applicable regional regulations and specifications

3.3 inter-green interlock
functionality within a signal controller that prevents traffic on conflicting paths through a junction from being assigned a green phase simultaneously

3.4**ITS-S access layer**

protocol layer in the ITS-S reference architecture containing the OSI physical and data link layer protocols for ITS communications

[SOURCE: ISO 21217]

3.5**ITS-S facilities layer**

layer in the ITS-S reference architecture containing OSI layers 5, 6, and 7 that connects applications to the ITS-S networking and transport layer

[SOURCE: ISO 21217]

3.6**ITS-S networking and transport layer**

layer in the ITS-S reference architecture containing OSI layers 3 and 4 that connects the ITS-S facilities layer to the ITS-S access layer

[SOURCE: ISO 21217]

3.7**ITS station**

functional entity comprised of an ITS-S facilities layer, ITS-S networking and transport layer, ITS-S access layer, ITS-S management entity, ITS-S security entity, and ITS-S applications entity providing ITS services

Note 1 to entry: From an abstract point of view, the term “ITS station” refers to a set of functionalities. The term is often used to refer to an instantiation of these functionalities in a physical unit. Often, the appropriate interpretation is obvious from the context. The proper name of the physical instantiation of an ITS-S is ITS station unit (ITS-SU).

[SOURCE: ISO 21217]

3.8**ITS station unit**

implementation of an ITS-S

[SOURCE: ISO 21217]

3.9**local dynamic map**

data storage for location- and time-referenced data providing query mechanisms

3.10**outstation**

roadside equipment for traffic management which communicates with a traffic management centre; also referred to as field-device

3.11**secured ITS domain**

network of communication nodes applying the ITS station architecture specified in ISO 21217

[SOURCE: ISO 21217]

3.12

transmodel

abstract model of common public transport concepts and data structures that can be used to build many different kinds of public transport information system, including timetabling, fares, operational management, real time data, journey planning etc

3.13

transponder

device which responds to the receipt of a specified signal by responding with its identity and sometimes additional information

Note 1 to entry: Passive transponders achieve this by backscatter techniques using the transmitted energy to power their circuits and return the signal, sometimes using batteries to assist this process.

Note 2 to entry: Active transponders act as full transceivers.

4 Symbols and abbreviations

2G	Second generation of cellular networks
3G	Third generation of cellular networks
4G	Fourth generation of cellular networks
AES	Advanced Encryption Standard
ANPR	Automatic Number Plate Recognition
API	Application Programming Interface
ASN.1	Abstract Syntax Notation 1
BLE	Bluetooth Low Energy
BTPPL	Basic Transport Protocol Layer
CAM	Cooperative Awareness Message
CCAM	Cooperative, Connected and Automated Mobility
CCTV	Closed Circuit Television
CORBA	Common Object Request Broker Architecture
CZ	Controlled Zone
DENM	Decentralized Environmental Notification Message
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
GTFS	General Transit Feed Specification
HARTS	Harmonized Architecture Reference for Technical Standards
HTML	Hyper Text Markup Language
IFOPT	Identification of Fixed objects for Public Transport
IP	Internet Protocol
ISM	Industrial, Scientific, Medical
ISO	International Standards Organization

ITS	Intelligent Transport Systems
ITU	International Telecommunication Union
JDK	JAVA Development Kit
JVM	JAVA Virtual Machine
LTE	Long Term Evolution
MIB	Management Information Base
MOVA	Microprocessor Optimized Vehicle Actuation
MVE	Mixed Vendor Environment
NEMA	National Electrical Manufacturers Association
NTCIP	National Transportation Communications for Intelligent Transportation System Protocol
OCIT	Open Communication Interface for Road Traffic Control Systems
ONVIF	Open Network Video Interface Forum
OSI	Open Systems Interconnection
PSTN	Public Switched Telephone Network
PTZ	Pan, Tilt and Zoom
RDS-TMC	Radio Data System - Traffic Management Channel
RTI	Real Time Information
RTIG	Real Time Information Group
RTP	Real-time Transport Protocol
SCATS	Sydney Coordinated Adaptive Traffic System
SCOOT	Split Cycle and Offset Optimization Technique
SIG	Specialist Interest Group
SIRI	Standard Interface for Real-time Information
SNMP	Simple Network Management Protocol
SOAP	Simple Object Access Protocol
SPaT	Signal Phase and Timing
TCP	Transmission Control Protocol
TISA	Traveller Information Services Association
TMC	Traffic Management Centre
TPEG	Transport Protocol Experts Group
TPEG	Transport Protocol Experts Group
TSS	Traffic Signal System
UDP	User Datagram Protocol
U-ITS	Urban ITS
UML	Unified Modelling Language

USDOT	United States Department of Transportation
UTMC	Urban Traffic Management and Control
VMS	Variable Message Sign
WAVE	Wireless Access in Vehicular Environments
WSA	WAVE Service Advertisement
WSMP	WAVE Short Message Protocol
XML	Extensible Markup Language
3GPPP	Third Generation Partnership Project

5 Requirements

This document pairs communication requirements and data requirements for traffic management systems with appropriate standards and methodologies.

In order to claim compliance with this specification U-ITS implementations shall use the standards listed in Clause 2, which are referenced and explained in Clauses 6, 7, 11, 12, 13, in preference to other specifications covering the same service.

Clauses 8, 9, 10, and 14, and Annex A and Annex B provide informative descriptions.

6 Context

6.1 Background

The context of the provision of MVEs in U-ITS paradigms is described in some detail in CEN/TR 17401, and the reader of this document is referred to that document for such detail.

6.2 Interoperability requirements in the traffic management domain

Interface requirements for MVEs in ITS are described in CEN/TR 17401 to which the reader is referred for detail.

In summary, interface requirements for all systems exist at two levels:

- a) Communications
- b) Data

CEN/TR 17401 identifies typical systems that deliver traffic management as:

- real-time traffic monitoring;
- dynamic message sign monitoring and control;
- incident monitoring;
- traffic camera monitoring and control;
- active traffic management;
- ramp meter monitoring and control;
- arterial management;

- traffic signal monitoring and control;
- road weather information system monitoring;
- highway advisory radio;
- urban traffic management and control;
- traffic optimization;
- speed limit: variable speed limits;
- variable-message signs;

This document pairs communication requirements and data requirements for such systems with appropriate (regional) standards and methodologies.

- **UTMC** is a framework of national specifications for traffic management systems, originating in the UK. The initiative was founded by the UK Government in the early 1990s, but is now managed by an independent body whose members are urban authorities and system suppliers: the “UTMC Development Group”. The approach of UTMC is more fully described in CEN/TS 17400; the website is <http://www.utmc.eu>.
- The “**OCIT** Developer Group” is a consortium of signal construction companies, largely focussed in the German speaking countries of Europe. Their goal is to standardize the most important interfaces of traffic control. They focus on standardized connections between distributed central and distributed components, such as sub-systems, tools and field devices. With the use of Internet technology, they enable the construction of traffic management systems and system-wide networks, which include field devices and control panels. The OCIT definitions specify system architecture, rules, OCIT protocols, functions, and transfer protocols. See the OCIT web at [42].

6.3 Communication standards for traffic management

6.3.1 General overview on communication standards

The wide range of technologies and techniques for Traffic management ITS described in this document make use of a variety of general communications protocols, depending on their need for bandwidth, latency, security etc. Traditionally, this includes but is not limited to the following wired and wireless technologies:

- “Public Switched Telephone Network” (PSTN): The technical operation of PSTNs adheres to the standards created by the ITU-T. These standards allow different networks in different countries to interconnect seamlessly. The principal standards are ITU-T E.163 and ITU-T E.164.
- Private Wire Circuit: Being a private circuit the protocols can be proprietary, but IEC 60870-5-101 is very widely used. It provides a 3-layer communications protocol designed primarily to meet the needs of real-time exchange of data between compute-constrained devices over media-constrained communication channels (typically less than 1200 bps).
- “Global System for Mobile Communications” (GSM) – widely known as 2G/3G standards, “General Packet Radio Service” (GPRS) – Mobile communication data service provided by 2G/3G mobile network operators, and LTE/4G – Packet switched (IP) mobile communication data service provided by mobile network operators, are based on various releases of 3GPP communication standards: 3GPP ETSI TS 122 101 [56], 3GPP ETSI TS 124 008 [57], 3GPP ETSI TS 122 003 [58], 3GPP ETSI TS 122

011 [59], 3GPP ETSI TS 127 007 [60], 3GPP ETSI TS 102 164 [61], 3GPP ETSI TS 151 010-1 [62], 3GPP ETSI TS 121 133 [63], 3GPP ETSI TS 122 071 [64].

- Broadband IP addressed circuits.
- Data are packet switched using standard Internet protocols.
- Other wireless radio communications: In the past these systems have largely been proprietary, or have used standards specific to the radio frequencies used. The most widely used standards are IEEE Std 802.11™.

The EC's mandate M/453 on Cooperative ITS (C-ITS) [3] and recently technically detailed in the draft C-ITS Delegated Act [4], C-ITS communication technologies are being utilized and also applicable for U-ITS. Development of standards for C-ITS started originally in ISO TC204, and was later specialized at ETSI TC ITS for the service domain of road safety.

As part of the “EU/US Joint Approach towards C-ITS” [2], considerable effort has been made to align the work of ISO/CEN with the work of IEEE in the USA so that C-ITS systems and WAVE systems can co-exist and support interoperability modes. They are based on a combination of ISO 21217:2014 and ISO 21215:2018 (referred to as ‘ITS-M5’), and on the IEEE 1609 series (primarily 1609.2 [39] and 1609.3 [38])/IEEE Std 802.11™ OCB.

Considerable effort has also been made to align the ISO/CEN work on messaging protocols FNETP: (ISO 29281-1:2018) and service advertisement protocols FSAP: ISO 22418:2018 /ISO/TS 16460:2018) with WSMP and WSA: (IEEE 1609.3 [38]).

The ETSI work on C-ITS as common roots to the ISO/CEN work, being based on the twin standards ISO 21217:2014/ ETSI EN 302 665 [23]. The current ETSI profile ETSI EN 302 663 [22] on 5,9 GHz communications does not specify directly how to use cellular technology, as in hybrid communication (see below). However, considerable effort has been spent on making messages and protocol functions bearer independent, so that the hybrid standards from CEN/ISO are directly applicable to most ETSI TC ITS standards.

Considerable effort has been made recently to align the ETSI work with the security work in IEEE 1609.2 [39], which is now finalised and approved, and the CEN/ISO work with the security work in IEEE 1609.2 [39], which is TS 21177 now approved as ISO TS 21177.

There is now one reference communication standard suite for interoperable communications (IEEE Std 802.11™ OCB and its profile standards from ETSI, IEEE and ISO) that ITS-M5/FNETP/FSAP and US DSRC/WSMP/WSA are based on, even if there are differences remaining at the implementation levels. In addition, the European and US security provisions (two stage Public Key Infrastructure (PKI) and conformance assessment) are, although two different standards, implementing the same paradigm.

A basic principle in CEN/ISO C-ITS is “Hybrid Communications”, which enables simultaneous operation of various communication technologies in a station, e.g. dedicated to the ITS service domain. Recently, in addition to the above mentioned reference communication standard suite for localized communications (vehicle-to-vehicle, and vehicle-to-roadside), C-ITS deployment projects now also require Internet technologies for localized communications.

Details on C-ITS technologies are presented in Clause 12.

Where possible, direct reference to the appropriate protocols has been referenced in the various sections of this document.

6.3.2 Use-case-specific communication standards

6.3.2.1 Active traffic management

Active traffic management systems are described in CEN/TR 17401, and use a mix of detectors, signals and VMS with their associated communications standards (see below).

6.3.2.2 Arterial road management

Arterial road management systems are described in CEN/TR 17401.

For appropriate standards, see control zone management below.

6.3.2.3 Control zone management

Management of traffic in a “Controlled Zone” (CZ) are described in CEN/TR 17401.

The principal standard for CZ management is CEN/TS 17380.

6.3.2.4 Dynamic message sign monitoring and control

Variable message sign (VMS) systems are described in CEN/TR 17401.

Technology standards used include TCP / IP, RS485, RS232, GPRS, NTCIP [40], Paknet, NMCS2 and unspecified licence-free radio.

UTMC includes a specification for a “VMS” object (UC/023) in UML format, and an associated “Extensible Markup Language” (XML) implementation, as well as specific support objects. More recently this has been adapted towards alignment with DATEX II; a specification document is posted on the UTMC website as a “proposed addition”. UML is standardized in ISO/IEC 19501:2005.

For basic VMS, UTMC also provides an SNMP-based protocol, the VMS MIB; see 7.3.1.

6.3.2.5 Incident monitoring

Incident monitoring systems are described in CEN/TR 17401.

This service is largely undertaken using “Closed Circuit Television” (CCTV), see 6.3.2.9, or the presence of a policeman or traffic management officer.

Communication medium standards:

Technology standards used are those for CCTV, see 6.3.2.9.

UTMC includes specifications for both an “accident” object (UC/002) and an “incident” object (UC014) in UML format, and an associated XML implementation for each.

DATEX has part 3 of CEN/TS 16157 dedicated on Situation Publication regarding incidents; see 7.2.2.3.

SIRI also has a profile in part 5 of CEN/TS 15531 on incidents from a public transport perspective; see 7.3.11.

Both DATEX II and SIRI use XML so assume an internet connection.

The set of standards ISO/TS 21219 from the “Transport Protocol Experts Group” (TPEG) (see 13.2) has a number of parts (applications) concerned with incidents:

- Part 14: TPEG2-PKI - Parking
- Part 15: TPEG2-TEC - The main incident application
- Part 16: TPEG2-FPI - Fuel Price Information
- Part 18: TPEG2-TFP - Travel time and prediction

— Part 19: TPEG2-WEA – Weather

6.3.2.6 Parking management

Parking management systems are described in CEN/TR 17401.

Communication medium standards:

UTMC includes a specification for a “car park data” object (UC/004) in UML format, and an associated XML implementation, which contains elements related to the total capacity and current utilization of the parking facility. It is not designed for on-street parking.

Car park management usually includes other ITS, including traffic counters (see 6.3.2.9), entry/exit barriers (see 6.3.2.10), CCTV (6.3.2.9), etc.

6.3.2.7 Ramp meter monitoring and control

Ramp metering systems are described in CEN/TR 17401.

Ramp meter monitoring and control require vehicle detectors on the on-ramp and main carriageway to measure traffic conditions:

- Main carriageway detectors;
- On-ramp detectors.

The EC Project “Easyway” recommends the use of DATEX II for communications between a “Traffic Management Centre” (TMC) and its ramp monitoring and management systems. Communications protocols: DATEX II. CEN/TS 16157. See 7.2.2.

Normally, communications of this nature are locally wired. If ramp detector data are sent remotely, it should use standard IP following the mainstream signals industry protocols.

If the detectors-centre-signal is made indirectly, it will normally use traffic signal protocols as referred to elsewhere - just the decision application will be written differently.

A DATEX II link could be used where the highways authority needs to communicate its ramp meter status, after capture, across its system.

6.3.2.8 Real-time passenger information

Real time passenger information systems are described in CEN/TR 17401.

Standards for vehicle to control centre communications: 2G/3G/4G; see the set of GSM standards referenced in 6.3.1, and communications specified in ISO 21217:2014 and in related standards for ITS.

Reference data model (Transmodel): EN 12896; capture of data on vehicle (including locations and timing): EN 13149; exchange of real time information (SIRI): CEN/TS 15531; routes and timetables (NeTEx): CEN/TS 16614.

National standards in UK, governed by RTIG (www.rtig.org.uk): Air interface vehicle-to-centre RTIGT030; traffic signal priority RTIGT008 and RTIGT031; display of information on signs RTIGT035 and RTIGT036; and display sign interface RTIG-PR020-D001.

In addition, there are national standards for stops, routes and timetables (NaPTAN and TransXChange) maintained by UK Government; these are currently widely used but are evolving towards NeTEx.

In Germany, VDV maintains a series of national standards. These include VDV-Schrift 300 [48] “IBIS-IP” (connected to EN 13149 but much more extensive), VDV-Schrift 430 [49] “EKAP” (travel information advisory services), VDV-Schrift 453/454 [50] (now incorporated into SIRI), VDV-Schrift 452 [51], and VDV-Schrift 462 [52] (related to NeTEx).

Recently proposed advanced systems include concepts such as Demand Responsive Transit, reducing the wait time and the ride time of the passengers by using the information provided by the passengers about their source and the destination.

Communications - control centre to bus stops etc.

Either fibre optic or other direct wired connections between control centre and bus stop, or 2G/3G GPRS or 4G LTE using IP protocols. (Some legacy systems use proprietary GPRS applications, others use proprietary radio communications, including analogue systems).

6.3.2.9 Real-time traffic monitoring

Real time traffic monitoring systems are described in CEN/TR 17401.

— Counters

Also known as “Automatic Traffic Recorders”, traffic counters/classifiers store count and/or classification data recorded in memory in a timestamp or interval fashion that can be downloaded and viewed in software or via a count display on some equipment. The device is usually deployed in near proximity to the roadway and uses an on-road medium, such as pneumatic road tubes laid across the roadway, piezo-electric sensors embedded in the roadway, inductive loops cut into the roadway, or a combination of these to detect the passing vehicles. Traditionally these devices had a count display which was physically inspected and read from time to time. Modern systems connect using 2G/3G GPRS or 4G LTE, frequently using multi-sim devices. Where fibre optic Internet capability is nearby, they can be directly wired and communicate using standard internet protocols. SNMP (see 7.3.1) or XML may be used.

— Communication standards:

Typically 2G/3G GPRS or 4G LTE, or hard wired, typically using fibre optic cable/IP protocols.

UTMC includes a specification for a “detector” object (UC/010) in UML format, and an associated XML implementation. This is quite generic and applicable to many types of on-street data capture device

In addition there is a specific low-level protocol, the traffic counter MIB (UM/007) which is platform-specific for SNMP-based communications; see 7.3.1.

References, here and below, to UML UTMC models are all within the documents UTMC-TS004.006 [53] and UTMC-TS004.0061 [54], unless indicated otherwise.

— Classifiers

Communication standards:

Typically 2G/3G GPRS or 4G LTE, or hard wired, typically using fibre optic cable/IP protocols.

UTMC traffic counters (see counters above) transmit classification information; however, they do not specify either how detections should be used to classify a vehicle, nor the structure of the classification to be used.

— “ Automatic Number Plate Recognition ” (ANPR) cameras

Communication standards: As CCTV, see below.

UTMC includes a specification for an “ANPR” object (UC/024) in UML format, and an associated XML implementation. This is closely related to, but distinct from, the UTMC CCTV object (see below).

— CCTV cameras

Around the world countries have implemented similar protocols for traffic monitoring, such as the US NTCIP [40]. UK has developed CORBA middleware technology to interface between legacy analogue CCTV systems and CCTV components developed by different organisations, and uses TCP/IP and UDP for network communications. CORBA is standardized in ISO 24532. However, in many places, proprietary CCTV protocols (e.g. Pelco D) remain widely used.

UTMC includes a specification for a “CCTV” object (UC/005) in UML format, and an associated XML implementation. This is closely related to, but distinct from, the UTMC ANPR object (see above).

Previous generations of analogue CCTV cameras use established broadcast television formats, e.g. Common Intermediate Format, NTSC, PAL, and SECAM). IP cameras may differ from one another in features, video encoding schemes, available network protocols, and the API for video management software.

ONVIF is a standardized approach for a common communication interface for IP-based surveillance cameras. These specifications cover local and remote device discovery, device management, imaging configuration, media configuration, real-time streaming of audio and video, event handling, video analytics, PTZ (Pan, Tilt and Zoom) control and security; see 8.2.3

There is an important ITS trend to using digital traffic monitoring cameras as intelligent sensors by monitoring digitally encoded video streams of traffic camera data to immediately detect incidents and continuously collect real-time traffic data.

— Weigh in motion

A variety of communication methods are typically installed on the measurement system. A modem or cellular modem can be provided. If no communication infrastructure exists, WIM systems can be self-operating while saving the data, to later physically retrieve it. Increasingly, systems are directly connected via the internet using fibre optic cable.

— Over-height vehicle detection

These are typically bespoke systems.

A variety of communication methods are typically installed on the measurement system. A modem or cellular modem can be provided. Increasingly, systems are directly connected via the internet using fibre optic cable.

UTMC includes a specification for an over-height vehicle detection MIB (unnumbered but available on the UTMC website [41]), for use on devices with SNMP-based communications; see 7.3.1.

6.3.2.10 Rising bollards and barrier control

Rising bollard systems are described in CEN/TR 17401.

Communications standards:

Transponders – The series of standards ISO/IEC 18000 (parts 1 through 6) provides communication and minimum performance standards for transponders.

Vehicle transponders – ISO 14906 / EN 15509 provide the European Standard for vehicle transponders used for electronic fee collection, but can also be used for access control.

Carriageway loops, magnetometers, micro-radar presence indicators detect the presence of vehicles, and when used together with other detection equipment, may be able to identify vehicle type, but are not able to identify specific vehicles so are normally used in conjunction with CCTV or ANPR cameras to ensure only valid vehicles are allowed access. See “real-time traffic monitoring” above.

UTMC includes a specification for an “access control” object (UC/001) in UML format, and an associated XML implementation.

6.3.2.11 Road Weather Information System monitoring

Road Weather Information Systems are described in CEN/TR 17401.

Communications are frequently proprietary using local area networks, optical fibre cable networks, or wirelessly. More recently they are simply connected via the internet.

UTMC includes a specification for a “meteorological data” object (UC/015) in UML format, and an associated XML implementation. This has more recently been incorporated into a broader, and enhanced, specification for environmental (i.e. primarily air quality) and met data, reference UTMC-TS004.0063 [55].

6.3.2.12 Speed limit: Variable speed limits

Variable speed limit systems are described in CEN/TR 17401.

At the moment they are communicated to the driver using variable message signs. See 6.3.2.4, 7.2.2.4, and Clause 12 for communications aspects related to variable message signs.

6.3.2.13 Traffic camera monitoring and control

Traffic camera monitoring and control systems are described in CEN/TR 17401.

6.3.2.14 Bus gate/lane camera

Communications standards: see 6.3.2.9.

6.3.2.15 Traffic signal monitoring and control

Traffic signal monitoring and control systems are described in CEN/TR 17401.

Communications standards:

See the set of GSM standards referenced in 6.3.1.

UTMC includes a specification for a “traffic signal” object (UC/020) in UML format, and an associated XML implementation. In addition, it has the “full UTC MIB” (UM/008) for use in devices using SNMP-based communications; see 7.3.1.

Separately, UTMC has a streamlined “remote monitoring” MIB (unnumbered but available on the UTMC website), for use where direct control of signals is not required.

NOTE In the USA, the controllers communicate using the National Transportation Communications for ITS Protocol (NTCIP) [40], based on Internet Protocol, ISO/OSI, and ASN.1)

6.3.2.16 Traffic optimization

Predominant applications include fixed time UTC, SCOOT (Split Cycle and Offset Optimization Technique), SCATS (Sydney Coordinated Adaptive Traffic System) an adaptive signal control system; and MOVA (Microprocessor Optimized Vehicle Actuation) at isolated junctions. Other systems include Main Traffic Signal System and Adelaide Coordinated Traffic Signal.

SCATS is able to operate over PAPL, ADSL, PSTN and 3G IP network connections to each intersection. SCATS can also operate on a network of private cables not requiring third party telecommunications support.

- SCOOT is typically able to support a wide range of communication options including copper, fibre, GSM, GPRS, 3G and Mesh radio or can be IP ‘cloud’ hosted.
- In the German-speaking area of Europe, environmentally sensitive, adaptive network controls are used for traffic management (e.g. Sitraffic Motion MX, GEVAS Balance).

These applications rely on communications with signals/signal controllers – see 6.3.2.15.

6.3.2.17 Tunnels and bridges

UTMC offers a guidance document on the inclusion of tunnels and bridges into urban traffic management systems, which includes the application of available UTMC protocols (available on the UTMC website).

The architectural assumption is that there is a separate tunnel/bridge management system which acts as a “black box”, but where there are necessary interfaces into the wider city system for issues such as traffic flows.

6.3.2.18 Variable-message sign

See 6.3.2.4 on dynamic message sign monitoring and control.

7 Data model requirements

7.1 General

Data model requirements are described in CEN/TR 17401.

Relevant standards are referenced below.

7.2 DATEX II

7.2.1 General

Many TMC standards use DATEX II data models.

“DATEX II” points to a set of standards on

- traffic data, and
- how to exchange traffic data.

It is designed to accommodate many of the data exchange situations in mixed vendor environments for traffic management, e.g. traffic incidents, current road works and other special traffic-related events.

DATEX II is applicable to:

- traffic and travel information which is of relevance to road networks in non-urban and urban environments;
- public transport information that is of direct relevance to the use of a road network, e.g. road link via train or ferry service.

DATEX II provides specifications for data exchange between any two instances of the following actors:

- traffic information centres;

- traffic control centres;
- third party service providers.

DATEX II specifications cover, at least, the following types of informational content:

- road traffic event information - planned and unplanned occurrences both on the road network and in the surrounding environment;
- operator initiated actions;
- road traffic measurement data, status data, and travel time data;
- travel information relevant to road users, including weather and environmental information;
- road traffic management information and information and advice relating to use of the road network.

Data typically is encoded in XML-format and is modelled with UML. The standards are developed by the technical body CEN/TC 278 of the European Committee for Standardization.

7.2.2 DATEX II standards CEN/TS 16157

7.2.2.1 Part 1: Context and framework

Part 1 of CEN/TS 16157 specifies and defines component facets required to support the exchange and shared use of data and information in the field of traffic and travel.

The component facets include the framework and context for exchanges, the modelling approach, data content, data structure and relationships, communications specification.

Part 1 of CEN/TS 16157 specifies the DATEX II framework of all parts of these (16157-x) Technical Specifications, the context of use and the modelling approach taken and used throughout these Technical Specifications. This approach is described using formal methods and provides the mandatory reference framework for all other parts.

7.2.2.2 Part 2: Location referencing

Part 2 of CEN/TS 16157 specifies the informational structures, relationships, roles, attributes and associated data types, for the implementation of the location referencing systems used in association with the different publications defined in the DATEX II framework. It also defines a DATEX II publication for exchanging predefined locations.

7.2.2.3 Part 3: Situation Publication

Part 3 of CEN/TS 16157 specifies the informational structures, relationships, roles, attributes and associated data types required for publishing situation traffic and travel information within the DATEX II framework. This is specified as a DATEX II Situation Publication sub-model which is part of the DATEX II platform independent model, but this Part excludes those elements that relate to location information which are specified in part 2 of CEN/TS 16157 and those elements that relate to VMS settings which are specified in part 4 of CEN/TS 16157.

7.2.2.4 Part 4: Variable Message Sign (VMS) Publications

Part 4 of CEN/TS 16157 specifies the informational structures, relationships, roles, attributes and associated data types required for publishing variable message sign information within the DATEX II framework. This is specified in two parts, a DATEX II VMS Publication sub-model and a VMS Table Publication sub-model. The VMS Publication supports the exchange of the graphic and textual content of one or several VMS plus any status information on device configuration that aid the

comprehension of the informational content. This content is potentially subject to rapid change. The VMS Table Publication supports the occasional exchange of tables containing generally static reference information about deployed VMS which enable subsequent efficient references to be made to pre-defined static information relating to those VMS. These publications are not intended to support the control or configuration of VMS equipment. Each is part of the DATEX II platform independent model.

7.2.2.5 Part 5: Measured and elaborated data publications

Part 5 of CEN/TS 16157 specifies the informational structures, relationships, roles, attributes and associated data types required for publishing measured and elaborated data within the DATEX II framework. This is specified in three submodels, a 'DATEX II Measurement Site Table Publication' submodel, a 'DATEX II Measured Data Publication' submodel and a 'DATEX II Elaborated Data Publication' submodel.

7.2.2.6 Part 6: Parking Publications

Part 6 of CEN/TS 16157 provides a DATEX II Level B extension (two publications and a Truck Parking profile) that supports the exchange of static as well as dynamic information about parking facilities and areas, including intelligent truck parking as defined by the Directive 2010/40/EU [1] priority actions e and f. The publications are intended to support the exchange of informational content from the organization performing measurements and collecting/eliciting basic data to other organisations providing ITS services or onward information exchange. It is the ambition to harmonize existing information models from different sources such as EasyWay deployment guidelines, In-Time CAI and truck parking initiatives, and to liaise with the stakeholders involved.

7.2.2.7 Part 7: Common data elements

Part 7 of CEN/TS 16157 provides common data elements that are used in more than one publication. It specifies reused structures and definitions of information that may be exchanged to convey information described in the other parts of this EN. The elements described in this document have their own namespace "Common".

7.2.2.8 Part 8: Traffic management publications and extensions dedicated to the urban environment

Part 8 of CEN/TS 16157 provides:

- Extensions to existing DATEX II publications, to better support use within an urban context. The extensions are specified as 'Level B' extensions to the DATEX II model.
- Specifications for the publication of traffic management plans extending the existing DATEX II core model to better support application to the urban environment.

The specification for the publication of traffic management plans draws on work undertaken within the DATEX II 'Programme Support Action' tasks, supported by the European Commission, and other related project work undertaken on these topics.

It is specified as a 'Level B' extension to the DATEX II model.

7.2.2.9 Part 9: Traffic signal management publications dedicated to the urban environment

Part 9 of CEN/TS 16157 deals with the publication of traffic signal related information that are most relevant in the urban environment. It specifies the structures and definitions of information that may be exchanged within two publications:

- The map data publication conveys static information related to the intersections and road segments belonging to a road network, related to traffic signal-controlled intersections. The map data

publication is the translation in UML of the MapData message (MAP) as it is defined in ISO/TS 19091 and its European profile.

- The Traffic Signal Phase and Timing Publication conveys the dynamic information related to traffic signal-controlled intersections belonging to a road network. 'Traffic Signal Phase and Timing Publication' is the translation in UML of the "Signal Phase And Timing" message (SPaT) as it is defined in ISO/TS 19091 and its European profile.

It is specified as a Level B Extension to the DATEX II model.

7.3 Use-case specific data model requirements

7.3.1 Simple Network Management Protocol

The "Simple Network Management Protocol" (SNMP) is an Internet standard protocol specified in IETF RFC 3411, IETF RFC 3412, IETF RFC 3413, IETF RFC 3414, IETF RFC 3415, IETF RFC 3416, IETF RFC 3417, and IETF RFC 3418, designed for collecting and organizing information about managed devices on IP networks, and can also be used to modify that information to change device behaviour. It is therefore appropriate where the internet is used to communicate between devices. Devices that typically support SNMP include cable modems, routers, switches, servers, workstations, printers, etc.

SNMP version 1 (SNMPv1) is the initial implementation of the SNMP protocol.

The first Request for Comments (RFCs) for SNMP, now known as SNMPv1, appeared in 1988.

Version 1 has been criticized for its poor security. Authentication of clients is performed only by a "community string", in effect a type of password, which is transmitted in cleartext.

SNMP version 2 (SNMPv2) IETF RFC 1441 – 1452 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36] revise version 1 and include improvements in the areas of performance, security, confidentiality, and manager-to-manager communications. It introduced GetBulkRequest, an alternative to iterative. This version of SNMP reached the proposed standard level of maturity, but is made obsolete by version 3.

SNMP version 3 (SNMPv3) retains version 2 protocol and adds cryptographic security and remote configuration enhancements. The security is addressed by both strong authentication, and data encryption for privacy. The administration aspect is focused on two parts, namely notification originators and proxy forwarders. The changes also facilitated remote configuration and administration of the SNMP entities.

Version 3 enables Identification of SNMP entities in order to facilitate communication only between known SNMP entities. Each SNMP entity has an identifier called the SNMPEngineID, and SNMP communication is possible only if an SNMP entity knows the identity of its peer.

IETF recognizes SNMPv3 as defined by RFC 3411–RFC 3418 (also known as STD0062) as the current standard version of SNMP.

The set of ITS standards ISO 20684 is under developed by ISO TC204 for ITS use of SNMP.

The introduction to part 1 of ISO 20684 states:

ISO 20684 consists of multiple parts as follows:

- *Part 1 introduces the scope of the set of standards and provides an overview of the structures and conventions used in the other parts.*
- *Parts 2-9 define various capabilities for the management of generic field devices.*
- *Parts 10-19 define various capabilities for managing message signs.*
- *Additional parts are expected, which will define features for other types of field devices.*

Figure 1 depicts how various parts of ISO 20684 relate to other standards using the ITS station architecture defined in ISO 21217:2014.

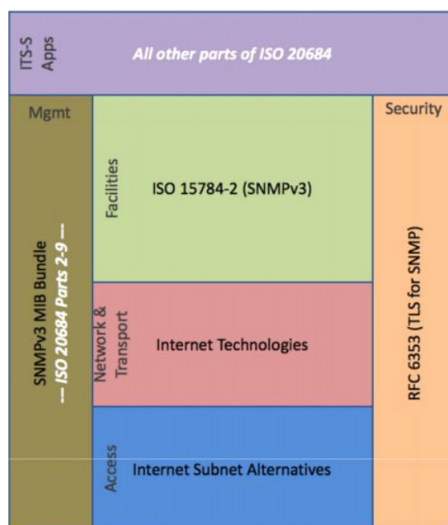


Figure 1 — Typical communications stack (Part 1 of ISO 20684)

Parts 2-9 of ISO 20684 are dedicated to features that are a part of the management entity of an ITS station. These standards do not define end-device functionality; rather they define management services that may support end-device functionality. The management entity will typically also support other data to manage the communications stack as defined by a variety of SNMPv3 MIBs.

Other parts of ISO 20684 will address the end-device functionality and are be considered part of the definition of ITS-S applications.

The information defined for the management entity and ITS-S applications can theoretically be exchanged over any communications stack, but is designed to be exchanged using SNMPv3 with certificate-based security using TLS for SNMP. SNMPv3 is typically exchanged using well-known Internet protocols, such as UDP/IP over any number of access layers to media.

7.3.2 Traffic messages

Applicable standards: CEN/TS 16157.

7.3.3 Traffic data

Applicable standards: Parts 2, 3, 4, and 5 of CEN/TS 16157.

7.3.4 Parking data

Applicable standards: Part 6 of CEN/TS 16157.

7.3.5 Weather and environment data

Applicable standards: Parts 2, 3, 4, 5, and 7 of CEN/TS 16157.

7.3.6 Cameras

Applicable standards: See 6.3.2.9 on real-time traffic monitoring – CCTV, and 8.2.3 on ONVIF.

7.3.7 Situations and strategies

Standards: CEN/TS 15531.

7.3.8 Operating messages

Applicable standards: Parts 8 and 9 of CEN/TS 16157.

7.3.9 Ramp metering

DATEX II enables “plug and play” ramp monitoring and management service implementation by providing one such formal data definition for each service supported by most ramp monitoring and management implementations.

7.3.10 Signs (VMS)

Applicable standards: Part 4 of CEN/TS 16157.

7.3.11 Public transport passenger information

Applicable standards: Part 3 of CEN/TS 16157.

The SIRI specification is given in five parts, each compliant with the CEN Transmodel EN 12896:2006:

- CEN/TS 15531 Part 1 - Context and framework;
- CEN/TS 15531 Part 2 - Communications infrastructure;
- CEN/TS 15531 Part 3 - Functional service interfaces;
- CEN/TS 15531 Part 4 - Functional service interfaces: Facility Monitoring;
- CEN/TS 15531 Part 5 - Functional service interfaces – Situation Exchange

EN 12896:2006: “Transmodel” has been approved as the European Standard. It has been developed by a European team within which various levels of end users were represented.

7.3.12 Traffic signal systems (TSS)

Applicable standards: Parts 8 and 9 of CEN/TS 16157.

7.3.13 Traffic signal systems raw data

Applicable standards: CEN/TS 16157.

7.3.14 Traffic signal systems configuration data

Applicable standards: CEN 16157 DATEX II.

OCIT (Remote configuration)

- Basic traffic data (switch-on/switch-off programs, signal programs, offset, intermediate and minimum times).
- Time switch (local annual automatic).
- A control procedure and parameters.
- Extensive functions for checking the configuration status (versioning of the user and manufacturer configuration, data backup, reading the user configuration).
- Blockwise writing of complex structured user program values (AP values).

Safety-relevant data can only be supplied by means of the manufacturer!

7.3.15 Binary container

Applicable standards: Part 5 of CEN/TS 16157.

7.3.16 Distributed C-ITS via a secured ITS domain

The ITS architecture, which is formally already specified for “Cooperative ITS” (C-ITS) in the European Union, is specified in ISO 21217:2014 and in the EC's Delegated Act on C-ITS [4]. There exists an earlier ETSI version EN 302 665 [23] of the ITS architecture based on a predecessor of ISO 21217:2014. ISO 21217:2014 is aligned with the set of ITS standards from CEN and ISO, and from ETSI, IEEE, and SAE.

ISO 21217:2014 especially introduces the “secured ITS domain”. Details on how to set up and maintain secure sessions between ITS-SUs specified in ISO 21217:2014 are specified in ISO/TS 21177.

ISO 21217:2014 supports the “hybrid communications” paradigm explained in ISO/TR 21186 [13], i.e. communications is not limited to a single specific type of communication - localized or networked -, or any specific technology, but is open for all existing and future technologies in addition to those dedicated for ITS.

ITS communications are not just secured communications between ITS-SUs, but also include communications between ITS-SUs and other devices operated outside the secured ITS domain, but with appropriate restrictions protecting ITS-SUs, e.g. prioritization and access rights to station-internal services, see EN ISO 17419.

Access to local data network, e.g. sensor network in a vehicle or at the roadside, typically is protected by a secure gateway. Data management in such secure gateways is specified in ISO/TS 21184 for usage in the secured ITS domain.

7.3.17 Central systems

OCIT-C is a specification providing functionalities for communication between:

- traffic computer centres and traffic management centres (city);
- traffic engineer workplace with traffic computer centres;
- traffic computer centres (regional, supra-regional) and traffic management centres;
- parking guidance systems, parking garage systems;
- construction site management systems;
- local Internet users (urban information on the Internet);
- transfer of data from other standards (e.g. TLS: VDV, DATEX II) or proprietary solutions.

7.4 NTCIP

The “National Transportation Communications for Intelligent Transportation System Protocol” (NTCIP) specification from the US Department of Transportation provides a family of standards [40] designed to achieve interoperability and interchangeability between computers and electronic traffic control equipment from different manufacturers. NTCIP has been focussed on centre-to-centre and centre-to-field communication and command/control of equipment from different manufacturers to be specified, procured, deployed, and tested. Although not European, it provides another set of regional standards (that have wide acceptance beyond USA) to create a functioning MVE, and are referenced in this document as another widely used regional standard, although it is noted that NTCIP is in many ways unsuitable for implementations in Europe, because it is founded on the philosophy of a centralized control (as opposed to the decentralised Member State subsidiarity applicable in Europe). Further, many

NTCIP aspects use DATEX, while many existing established traffic management communications already widely deployed in Europe, and those recommended in this series of Standards deliverables, use DATEX II Standards. NTCIP standards do not therefore form part of the recommendations or requirements of this deliverable, but a summary of them is provided in Annex A for information.

8 Open specifications for sensor systems

8.1 Introduction

Effective traffic management relies on the ability of the responsible authority to obtain an accurate, current view of the state of the network: at least where road users are and how they are moving, but sometimes also who they are, where they want to go, and something about their “value” on the network in accordance with local policy.

To achieve this, a wide range of sensor systems has been developed over many years for installation at the roadside, or within the road surface. Each sensor is designed for a specific purpose: it captures its data and then sends this back to the place where management/control decisions are taken. This may be local (for example, linking the devices around a single complex junction) or central (ie at a coordinating central system).

Where a single sensor type is used to drive control decisions, this is relatively straightforward to achieve, and technical decisions may remain with the supplier. Where multiple sensor types are used, however, the context may change to being an MVE, and agreed formats are needed for data sent from each sensor to the decision system.

Communication of the sensor data may occur across several links: locally from a sensor to a coordinating device or router; over backhaul to a control centre; between applications in a control centre; or from a control centre out to a third party (perhaps a neighbouring authority, a road user, or an external system manager/maintainer).

NOTE This subclause covers only sensors specified, owned and operated by the traffic authority. Solutions using data sourced directly from road users are addressed as cooperative systems, see Clause 10.

8.2 Existing open specifications

8.2.1 OCIT

Sensors are partly considered in OCIT for signal controller detectors, but OCIT has no explicit standard for sensors.

8.2.2 UTMC

UTMC includes a set of sensor interface specifications, as well as some limited guidance on appropriate communications protocols. The basic element is the “detector data object” which is modelled in UML, and may be generically used for any sensor.

A basic implementation may be sufficient for vehicle counting. Specific extensions of this object also exist for individual sensor types, including:

- air quality monitors (capturing information about pollutants);
- ANPR (capturing number plate identifiers for passing vehicles);
- CCTV (capturing images and, sometimes, streamed video of local traffic conditions).

Each of these is provided with an XML implementation.

For some applications, there is also a MIB specification for devices that use SNMP as a simple, cheap protocol. Standardized MIBs exist for traffic counters and air quality monitors, since high data rates are not required for these purposes.

In addition to these structures, there are a range of underlying objects that permit a description of the road network; support objects that support features like fault monitoring; and analytical objects that enable presentation of historical profiles and future predictions.

All UTMC communications are based on IP networking. However, the use of IP stack profiles is left largely to the choice of implementers based on their local and system requirements.

8.2.3 ONVIF

ONVIF (Open Network Video Interface Forum) is a standardized approach for a common communication interface for IP-based surveillance cameras. These specifications cover local and remote device discovery, device management, imaging configuration, media configuration, real-time streaming of audio and video, event handling, video analytics, PTZ (Pan, Tilt and Zoom) control and security.

ONVIF is an industry forum which develops and publishes a global open standard for the interface of physical IP-based security products (is primarily video systems). While not specifically traffic related, its widespread acceptance among the camera sector make it very relevant for traffic monitoring CCTV systems. The ONVIF core specification defines a communication framework based on global internet standards. Version 1.0 includes a range of tools including IP configuration and device discovery/management, camera control (PTZ), real time viewing, video analytics and security. Version 2.0 also covers storage and additional aspects of analytics.

Standards used include SOAP, RTP, and Motion JPEG, MPEG-4, and H.264 video codecs. The ONVIF specifications are available at the ONVIF website [43].

Profile C of ONVIF includes physical access control products reflecting the increasing integration in the industry between IP-based video and access control products.

Profile G (2014) increases interoperability between live video and video storage. This profile covers cameras, encoders and network video recorder devices, as well as client systems such as video management systems, building management systems and physical security information management systems.

Profile Q is designed to increase ease of configuration between devices – so called ‘out of the box functionality.’

8.2.4 DIASER

First release of DIASER was published in 1996, and first full-DIASER UTC was operational in 1998. Revision were published in 1999 and 2015.

The French standard NF P 99071-1 (septembre 2002) fully describes the data field for each function

8.2.5 Other European regional standards

None considered so far in this document.

9 Open specifications for traffic control

9.1 Introduction

Based on available data, a traffic management system takes the necessary steps to control traffic through a range of additional mechanisms. There are static tools like carriageway layout and direction signage, but these are not able to respond to dynamic conditions. This is achieved using ITS in three generic ways:

- provision of information about conditions and/or suggestions for road users (on routing etc);