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Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 1: Media-Independent Functionality

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Foreword

This final draft European Standard (EN) has been produced by ETSI Technical Committee Intelligent Transport Systems (ITS), and is now submitted for the Vote phase of the ETSI standards EN Approval Procedure.

The present document is part 4, sub-part 1 of a multi-part deliverable. Full details of the entire series can be found in part 1 [2].

Proposed national transposition dates	
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Introduction

The GeoNetworking protocol is a network layer protocol that provides packet routing in an ad hoc network. It makes use of geographical positions for packet transport. GeoNetworking supports the communication among individual ITS stations as well as the distribution of packets in geographical areas.

GeoNetworking can be executed over different ITS access technologies for short-range wireless technologies, such as ITS-G5 and infrared. The ITS access technologies for short-range wireless technologies have many technical commonalities, but also differences. In order to reuse the GeoNetworking protocol specification for multiple ITS access technologies, the specification is separated into media-independent and media-dependent functionalities. Media-independent functionalities are those which are common to all ITS access technologies for short-range wireless communication to be used for GeoNetworking. The media-dependent functionalities extend the media-independent functionality for a specific ITS access technology. Therefore, the GeoNetworking protocol specification consists of the standard for media-independent functionality and at least one standard for media-dependent functionality. However, it should be noted that the media-dependent extensions do not represent distinct protocol entities.

1 Scope

The present document specifies the media-independent functionality of the GeoNetworking protocol.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

[1] ETSI EN 302 665: "Intelligent Transport Systems (ITS); Communications Architecture".

[2] ETSI EN 302 636-1: "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 1: Requirements".

[3] ETSI EN 302 636-2: "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 2: Scenarios".

[4] ETSI TS 102 636-3: "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 3: Network architecture".

[5] ETSI EN 302 636-5-1: "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 5: Transport Protocols; Sub-part 1: Basic Transport Protocol".

[6] ETSI EN 302 636-6-1: "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 6: Internet Integration; Sub-part 1: Transmission of IPv6 Packets over GeoNetworking Protocols".

[7] ETSI EN 302 931: "Intelligent Transport Systems (ITS); Vehicular Communications; Geographical Area Definition".

[8] Annex to ITU Operational Bulletin No. 741 - 1.VI.2001: "Complement to Recommendation ITU-T E.212 (11/98)".

NOTE: Available at: http://www.itu.int/ITUT/.

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI EN 302 663: "Intelligent Transport Systems (ITS); Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band".

[i.2] ETSI TS 102 636-4-2: "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 2: Media-dependent functionalities for ITS-G5".

[i.3] ETSI TS 102 731: "Intelligent Transport Systems (ITS); Security; Security Services and Architecture".

[i.4] ETSI TS 102 723-8: "Intelligent Transport Systems (ITS); OSI cross-layer topics; Part 8: Interface between security entity and network and transport layer".

[i.5] ETSI TS 103 097: "Intelligent Transport Systems (ITS); Security; Security header and certificate formats".

[i.6] ETSI TS 102 890-3: "Intelligent Transport System (ITS); Facilities layer function; Position and time facility specification".

[i.7] ETSI TS 102 894-2: "Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities layer common data dictionary".

[i.8] ISO/IEC 8802-2:1998: "Information technology-Telecommunications and information exchange between systems-Local and metropolitan area networks-Specific requirements - Part 2: Logical link control".

[i.9] IETF RFC 2578: "Structure of Management Information Version 2 (SMIv2)".

[i.10] National Imagery and Mapping Agency (NIMA), US Department of Defense: "World Geodetic System 1984 - Its Definition and Relation with Local Geodetic Systems", Third Edition - Amendment 1, NIMA TR 8350.2.

[i.11] IETF RFC 2579: "Textual Conventions for SMIv2".

[i.12] IEEE 802.3:2008: "IEEE Standard for Information Technology - Telecommunications and information exchange between systems-Local and metropolitan area networks - Specific requirements - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in ETSI EN 302 665 [1], ETSI TS 102 636-3 [4], ETSI EN 302 636-6-1 [6] and the following apply:

destination: receiver that processes a packet and delivers it to upper protocol entities, but does not relay the packet to other GeoAdhoc routers

forwarder: GeoAdhoc router that processes a packet and relays it to other GeoAdhoc routers

GeoAdhoc router: ad hoc router that implements the GeoNetworking protocol

local position vector: position vector for the local GeoAdhoc router

neighbour: GeoAdhoc router in direct (single-hop) communication range

packet: GeoNetworking PDU

packet transport type: method of handling GeoNetworking packets

position accuracy indicator: binary that indicates whether a position is within a specific confidence interval

position vector: position information of a GeoAdhoc router represented by a tuple of address, timestamp, geographical position, speed, heading and corresponding accuracy information

receiver: GeoAdhoc router that processes a packet, delivers its data to upper protocol entities

sender: GeoAdhoc router that has sent the GeoNetworking packet

source: GeoAdhoc router that originates a GeoNetworking packet

traffic class: identifier assigned to a GeoNetworking packet that expresses its requirements on data transport

3.2 Symbols

For the purposes of the present document, the following symbols apply:

GEO_MAX	Maximum size of the GeoNetworking packet header
H(GN_ADDR)	Heading of the ITS-S GN_ADDR
LAT	Latitude
LL_ADDR	Link layer address that identifies the ITS-S at the link layer protocol entity in the ITS Access Layer
LL_ADDR_NH	Link layer address of the next hop
LONG	Longitude
LS_PENDING	Location Service pending flag
MTU_AL	MTU of the ITS Access Layer
PAI(POS, GN_ADDR)	Position accuracy indicator for geographical position POS of the ITS-S GN_ADDR
PDR(GN_ADDR)	Packet data rate (exponential moving average)
POS(GN_ADDR)	Geographical position of the ITS-S GN_ADDR
RAND[x,y]	Function that returns a random (integer) number from a uniform distribution in the given interval [x,y]
S(GN_ADDR)	Speed of the ITS-S GN_ADDR
SN(GN_ADDR)	Last maximum sequence number received from a GeoAdhoc router
SN_MAX	Largest possible value of the sequence number
SN(P)	Value of the sequence number field carried in a GeoNetworking packet
T(LocTE)	Lifetime of an entry in the location table
TO_CBF_MIN	Timeout; minimum duration a packet is buffered in the CBF cache
TO_CBF_MAX	Timeout; maximum duration a packet is buffered in the CBF cache
TST(GN_ADDR)	Last timestamp received from a GeoAdhoc router
TST(P)	Value of the timestamp field carried in a GeoNetworking packet
TST(TAI)	Number of elapsed TAI milliseconds since 2004-01-01 00:00:00.000 UTC

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI EN 302 665 [1], ETSI TS 102 636-3 [4], ETSI EN 302 636-6-1 [6] and the following apply:

ASN	Abstract Syntax Notation
BC	BroadCast
BTP	Basic Transport Protocol
CBF	Contention-Based Forwarding
DAD	Duplicate Address Detection
DE	Destination
DPD	Duplicate Packet Detection
EMA	Exponential Moving Average
FCS	Frame Check Sequence
FIFO	First In First Out
GAC	Geographically-Scoped Anycast
GBC	Geographically-Scoped Broadcast
GF	Greedy Forwarding
GN	GeoNetworking
GN_ADDR	GeoNetworking ADDRess
GN6ASL	GeoNetworking to IPv6 Adaptation Sub-Layer
GN6-SDU	GN6 Service Data Unit
GN-PDU	GeoNetworking Protocol Data Unit
GN-SDU	GeoNetworking Service Data Unit
GUC	Geographically-Scoped Unicast
HST	Header Sub-Type
HT	Header Type

LL	Link Layer
LLC	Logic Link Control
LocT	Location Table
LocTE	Location Table Entry
LPV	Local Position Vector
LS	Location Service
LT	LifeTime
MAC	Medium Access Control
MFR	Most Forward within Radius
MHL	Maximum Hop Limit
MHVB	Multi-Hop Vehicular Broadcast
MIB	Management Information Base
MID	MAC ID
MTU	Maximum Transmit Unit
NH	Next Header
PAI	Position Accuracy Indicator
PCI	Protocol Control Information
PDR	Packet Data Rate
PDU	Protocol Data Unit
PL	Payload Length
POS	POSition
PV	Position Vector
RHL	Remaining Hop Limit
RTC	Retransmit Counter
SCC	Station Country Code
SCF	Store Carry & Forward
SDU	Service Data Unit
SE	SEnder
SHB	Single Hop Broadcast
SN	Sequence Number
SO	SOurce
SPV	Short Position Vector
ST	Station Type
TAI	Temps Atomique International (International Atomic Time)
TC ID	Traffic Class Identifier
TC	Traffic Class
TSB	Topologically Scoped Broadcast
T-SDU	Transport Service Data Unit
TST	TimeSTamp
UC	UniCast
UTC	Universal Time Coordinated
WGS	World Geodetic System

4 Services provided by the GeoNetworking protocol

The GeoNetworking protocol is a network protocol that resides in the ITS network and transport layer (ETSI EN 302 665 [1]) and is executed in the ad hoc router (ETSI TS 102 636-3 [4]), specifically in the GeoAdhoc router. It provides the transport of packets in the ITS ad hoc network (ETSI TS 102 636-3 [4]). It shall support the requirements specified in ETSI EN 302 636-1 [2] and the scenarios specified in ETSI EN 302 636-2 [3].

The GeoNetworking protocol provides services to upper protocol entities, i.e. the ITS Transport Protocol, such as the Basic Transport Protocol (BTP) as specified in ETSI EN 302 636-5-1 [5], and the GeoNetworking to IPv6 Adaptation Sub-Layer (GN6ASL) as specified in ETSI EN 302 636-6-1 [6]. The services are provided via the GN_SAP using service primitives of different types that carry parameters and the PDU of the upper protocol entity, i.e. T/GN6 PDU (see figure 1). A PDU of the transport protocols is considered as SDU in the GeoNetworking protocol. The SDU is complemented with Protocol Control Information (PCI) and transmitted as GN PDU to the peer entity.

In order to provide its packet transport services, the GeoNetworking protocol uses the services of the ITS Access Layer.

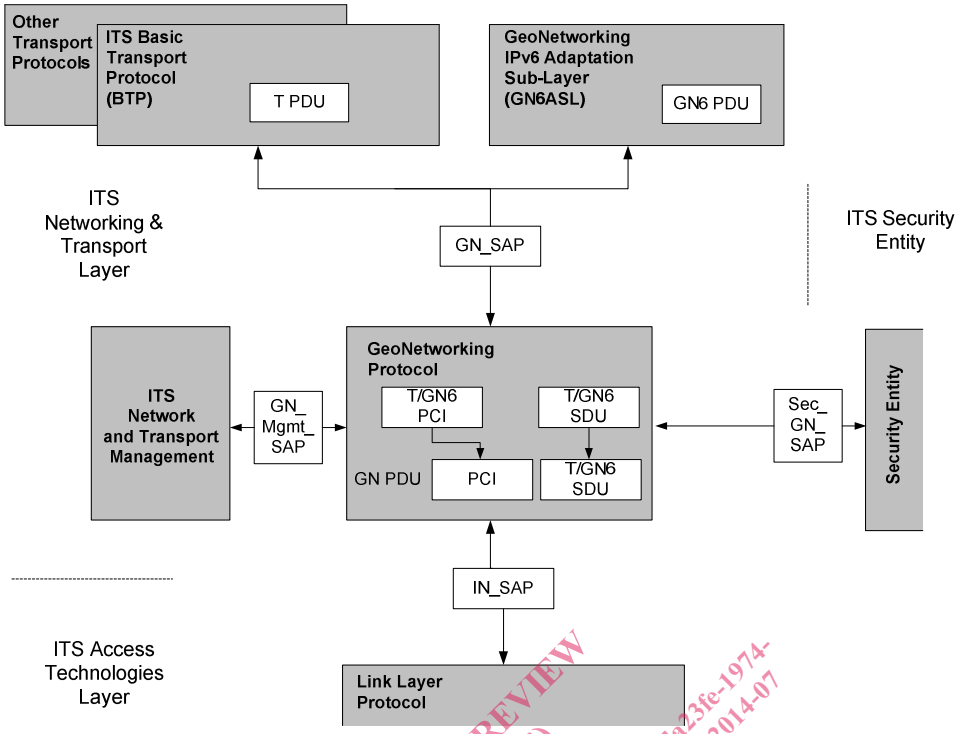

Figure 1: Service primitives, SDUs and PDUs relevant for the GeoNetworking protocol

Figure 1 illustrates the interfaces and SAPs of the ITS networking and transport layer as specified in ETSI TS 102 636-3 [4]. The present document specifies the internal GN_SAP between the GeoNetworking protocol and the ITS transport protocol, such as the Basic Transport Protocol (BTP) as specified in ETSI EN 302 636-5-1 [5], the GeoNetworking IPv6 Adaptation Sub-Layer (GN6ASL) as defined in ETSI EN 302 636-6-1 [6] and other transport protocols, the GN_Mgmt_SAP between the GeoNetworking protocol and the *ITS Networking & Transport Layer Management*, as well as the Sec_GN_SAP between the GeoNetworking protocol and the ITS Security.

5 Format convention

The basic convention for the specification of packet formats is illustrated in figure 2. The bits are grouped into octets. The bits of an octet are always shown horizontally and are numbered from 0 to 7. Up to 4 octets are shown horizontally; multiple sets of 4 octets are grouped vertically. Octets are numbered from 0 to N-1.

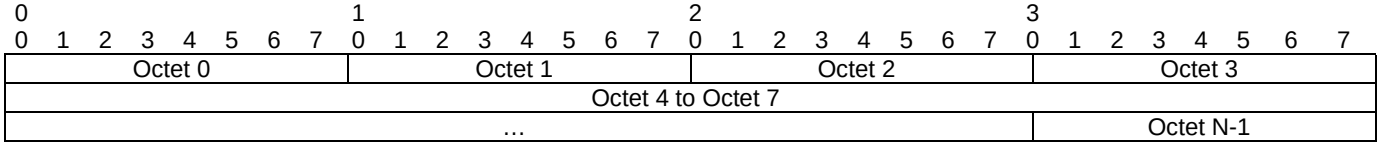

Figure 2: Format convention

When (a part of) an Octet represents a numeric quantity the left most bit in the diagram is the most significant bit (Big Endian). Similarly when a numeric value spans multiple octet fields the left most field is the most significant.

Octets are transmitted in ascending numerical order (left to right).

EXAMPLE: The decimal value 199 shall be represented as shown below.

0	1	2	3	4	5	6	7
1	1	0	0	0	1	1	1

6 GeoNetworking address

6.1 General

Every GeoAdhoc router should have a unique GeoNetworking address. This address shall be used in the header of a GeoNetworking packet and identify the communicating GeoNetworking entities. In order to ensure the uniqueness of the GeoNetworking address, duplicate detection as specified in clause 9.2.1.5 is applied.

6.2 GeoNetworking address format

The format of the GeoNetworking address is described in figure 3.

<table>
<tr><td>0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>M</td><td colspan="5">ST</td><td colspan="10">SCC</td><td colspan="16">MID</td></tr>
<tr><td colspan="32">MID</td></tr>
</table>

Figure 3: GeoNetworking address format

6.3 Fields of the GeoNetworking address

The GeoNetworking address shall be comprised of the fields specified in table 1.

Table 1: Fields of the GeoNetworking address

Field #	Field name	Octet/bit position		Type	Description
		First	Last		
1	M	Octet 0 Bit 0	Octet 0 Bit 0	1 bit unsigned integer	This bit allows distinguishing between manually configured network address (clause 9.2.1.3.2) (update) and the initial GeoNetworking address (clause 9.2.1.3.1). M is set to 1 if the address is manually configured otherwise it equals 0.
2	ST	Octet 0 Bit 1	Octet 0 Bit 5	5 bit unsigned integer	ITS-S type. To identify the ITS-S type. 0 - Unknown 1 - Pedestrian 2 - Cyclist 3 - Moped 4 - Motorcycle 5 - Passenger Car 6 - Bus 7 - Light Truck 8 - Heavy Truck 9 - Trailer 10 - Special Vehicle 11 - Tram 15 - Road Side Unit (see note 1).
4	SCC	Octet 0 Bit 6	Octet 1 Bit 7	10 bit unsigned integer	ITS-S Country Code (see note 2).
5	MID	Octet 2	Octet 7	48 bit address	This field represents the LL_ADDR.
NOTE 1: The values of the ITS-S type are aligned with ETSI TS 102 894-2 [i.7] "Applications and facilities layer common data dictionary". NOTE 2: The semantics of the SCC is deployment specific and therefore out of scope of the present document.					