



**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;
Release 2**

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Contents

Intellectual Property Rights	8
Foreword.....	8
Modal verbs terminology.....	9
Introduction	9
1 Scope	10
2 References	10
2.1 Normative references	10
2.2 Informative references.....	10
3 Definition of terms, symbols and abbreviations.....	11
3.1 Terms.....	11
3.2 Symbols.....	12
3.3 Abbreviations	12
4 Services provided by the GeoNetworking protocol	14
5 Format convention.....	15
6 GeoNetworking address	15
6.1 General	15
6.2 GeoNetworking address format.....	15
6.3 Fields of the GeoNetworking address	16
7 Security and privacy.....	17
8 Data structures.....	17
8.1 General	17
8.2 Location table.....	17
8.2.1 General.....	17
8.2.2 Minimum data elements of a Location Table Entry.....	17
8.2.3 Maintenance of the Location Table	18
8.3 Ego Position Vector.....	18
8.3.1 General.....	18
8.3.2 Minimum data elements.....	18
8.3.3 Maintenance.....	18
8.4 Sequence number	19
8.4.1 General.....	19
8.4.2 Maintenance.....	19
8.5 Location service packet buffer	19
8.5.1 General.....	19
8.5.2 Buffer size.....	19
8.5.3 Maintenance.....	19
8.6 Forwarding packet buffer	20
8.6.1 General.....	20
8.6.2 Buffer size.....	20
8.6.3 Maintenance.....	20
9 GeoNetworking packet structure and formats.....	21
9.1 Overview	21
9.2 Packet structure	21
9.2.1 General.....	21
9.2.2 Overall packet structure	21
9.2.3 Maximum Transmit Unit	22
9.3 GeoNetworking header structure.....	22
9.4 GeoNetworking Secured Packet.....	22
9.5 Position vectors	22
9.5.1 Overview	22
9.5.2 Long Position Vector.....	23

9.5.2.1	Structure	23
9.5.2.2	Fields	23
9.5.3	Short Position Vector	24
9.5.3.1	Structure	24
9.5.3.2	Fields	24
9.6	Basic Header	24
9.6.1	Composition of the Basic Header	24
9.6.2	Fields of the Basic Header	25
9.6.3	Encoding of the NH field in the Basic Header	25
9.6.4	Encoding of the LT field	25
9.7	Common Header	26
9.7.1	Composition of the Common Header	26
9.7.2	Fields of the Common Header	26
9.7.3	Encoding of the NH field in the Common Header	27
9.7.4	Encoding of the HT and HST fields	27
9.7.5	Encoding of the TC field	28
9.8	GeoNetworking packet header types	28
9.8.1	Overview	28
9.8.2	GUC packet header	28
9.8.2.1	Composition of the GUC packet header	28
9.8.2.2	Fields of the GUC packet header	29
9.8.3	TSB packet header	29
9.8.3.1	Composition of the TSB packet header	29
9.8.3.2	Fields of the TSB packet header	30
9.8.4	SHB packet header	30
9.8.4.1	Composition of the SHB packet header	30
9.8.4.2	Fields of the SHB packet header	31
9.8.5	GBC/GAC packet header	31
9.8.5.1	Composition of the GBC/GAC packet header	31
9.8.5.2	Fields of the GBC/GAC packet header	32
9.8.6	BEACON packet header	32
9.8.6.1	Composition of the BEACON packet header	32
9.8.6.2	Fields of the BEACON packet header	33
9.8.7	LS Request packet header	33
9.8.7.1	Composition of the LS Request packet header	33
9.8.7.2	Fields of the LS Request packet header	34
9.8.8	LS Reply packet header	34
9.8.8.1	Composition of the LS Reply packet header	34
9.8.8.2	Fields of the LS Reply packet header	35
10	Protocol operation	35
10.1	General	35
10.2	Network management	36
10.2.0	Overview	36
10.2.1	Address configuration	36
10.2.1.1	General	36
10.2.1.2	Auto-address configuration	37
10.2.1.3	Managed address configuration	37
10.2.1.3.1	General Requirements	37
10.2.1.3.2	Initial address configuration	37
10.2.1.3.3	Address update	37
10.2.1.4	Anonymous address configuration	37
10.2.1.5	Duplicate address detection	38
10.2.2	Ego position vector and time update	38
10.2.2.1	Overview	38
10.2.2.2	Ego Position Vector update	38
10.2.2.3	Time update	38
10.2.3	Beaconing	39
10.2.4	Location service	39
10.3	Packet handling	40
10.3.1	Overview	40
10.3.2	Basic Header field settings	41

10.3.3	Basic Header processing	41
10.3.4	Common Header field settings.....	43
10.3.5	Common Header processing.....	44
10.3.6	Beacon packet handling	44
10.3.6.1	General	44
10.3.6.2	Source operations.....	44
10.3.6.3	Receiver operations	46
10.3.7	Location service packet handling.....	46
10.3.7.1	Source operations.....	46
10.3.7.1.1	Overview	46
10.3.7.1.2	Operation for initial LS Request.....	46
10.3.7.1.3	Operation for LS Request re-transmission.....	47
10.3.7.1.4	Operation for LS Reply	48
10.3.7.2	Forwarder operations	48
10.3.7.3	Destination operations.....	48
10.3.8	GUC packet handling.....	50
10.3.8.1	General	50
10.3.8.2	Source operations.....	50
10.3.8.3	Forwarder operations	52
10.3.8.4	Destination operations.....	53
10.3.9	TSB packet handling.....	54
10.3.9.1	General	54
10.3.9.2	Source operations.....	55
10.3.9.3	Forwarder and receiver operations.....	56
10.3.10	SHB packet handling	57
10.3.10.1	General.....	57
10.3.10.2	Source operations.....	58
10.3.10.3	Receiver operations.....	59
10.3.11	GBC packet handling.....	60
10.3.11.1	General.....	60
10.3.11.2	Source operations.....	60
10.3.11.3	Forwarder and receiver operations.....	61
10.3.12	GAC packet handling.....	63
10.3.12.1	General.....	63
10.3.12.2	Source operations.....	63
10.3.12.3	Forwarder and receiver operations.....	63
10.4	MCO management	65
10.4.1	Overview	65
10.4.2	MCO Parameters Updates (MPU)	66
10.4.2.1	Overview	66
10.4.2.2	GAGH state.....	66
10.4.2.3	GAGH state update	66
10.4.3	Network Updates (NU).....	67
10.4.3.1	Overview	67
10.4.3.2	Access layer update.....	67
10.4.3.3	Network updates to the Facilities layer	67
10.4.4	ALI Request Handler (ARH).....	68
Annex A (normative):	Duplicate Packet Detection	69
A.1	General	69
A.2	SEQN-based duplicate packet detection	69
Annex B (normative):	Packet data rate and geographical area size control	70
B.1	Overview	70
B.2	Packet data rate control	70
B.3	Geographical area size control	70
Annex C (normative):	Position vector update	71

C.1	Overview	71
C.2	Update of LocT position vector.....	71
C.3	Update of GeoNetworking packet position vector	72
Annex D (normative):	GeoNetworking forwarding algorithm selection procedure	73
Annex E (normative):	Non-area forwarding algorithms.....	75
E.1	Overview	75
E.2	Greedy forwarding algorithm.....	75
E.3	Non-area contention-based forwarding algorithm.....	76
E.3.1	Overview	76
E.3.2	Calculation of non-area CBF timeout for newly received GN packets	77
E.3.2.1	Overview	77
E.3.2.2	Calculation of the segment number SEGN.....	78
E.3.2.3	Calculation of non-area CBF timeout without Access Layer constraints	78
E.3.2.4	Calculation of non-area CBF timeout with Access Layer constraint.....	79
E.3.3	Recalculation of non-area CBF timeout upon reception of a forwarded packet.....	79
E.3.4	Activity diagram.....	80
E.3.5	Pseudo code.....	82
Annex F (normative):	Area forwarding algorithms	84
F.1	Overview	84
F.2	Simple GeoBroadcast forwarding algorithm.....	84
F.3	Area contention-based forwarding algorithm.....	84
F.3.1	Overview	84
F.3.2	Calculation of area CBF timeout for newly received GN packets.....	85
F.3.2.1	Overview	85
F.3.2.2	Calculation of the segment number SEGN.....	85
F.3.2.3	Calculation of area CBF timeout without Access Layer constraints.....	86
F.3.2.4	Calculation of area CBF timeout with Access Layer constraint	86
F.3.3	Recalculation of area CBF timeout upon reception of a forwarded packet.....	86
F.3.4	Activity diagram.....	87
F.3.5	Pseudo code.....	89
Annex G (normative):	GeoNetworking traffic classification.....	90
Annex H (normative):	GeoNetworking protocol constants	91
Annex I (informative):	ASN.1 specification of the GeoNetworking MIB.....	93
Annex J (informative):	GeoNetworking data interface.....	94
J.1	General	94
J.2	TRANSP_CORE.request	94
J.3	TRANSP_CORE.confirm.....	95
J.4	TRANSP_CORE.indication	96
Annex K (informative):	GeoNetworking management services	98
K.1	General	98
K.2	CORE_MMT.request.....	98
K.3	CORE_MMT.response	98
K.4	CORE_GAGH.indication	99
Annex L (informative):	MCO_NET services for the GN Core	100

L.1	General	100
L.2	<i>CORE_MCO.request</i>	100
L.3	<i>CORE_MCO.response</i>	100
L.4	<i>CORE_MCO.indication</i>	101
Annex M (informative):	MCO_NET services for the GAGHs	102
M.1	General	102
M.2	<i>GAGH_MCO.request</i>	102
M.3	<i>GAGH_MCO.indication</i>	102
Annex N (informative):	MCO services for the Facilities layer	103
N.1	General	103
N.2	<i>MCO_FAC_NET.request</i>	103
N.3	<i>MCO_FAC_NET.indication</i>	103
N.4	<i>MCO_FAC_NET.response</i>	104
Annex O (informative):	Bibliography	105
Annex P (informative):	Change history	106
History		107

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Intelligent Transport Systems (ITS).

The present document is part 4, sub-part 1 of a multi-part deliverable covering the Vehicular Communications; GeoNetworking, as identified below:

Part 1: "Requirements";

Part 2: "Scenarios";

Part 3: "Network Architecture";

Part 4: "Geographical addressing and forwarding for point-to-point and point-to-multipoint communications";

Sub-part 1: "Media-independent functionality";

Sub-part 2: "Media-dependent functionalities for ITS-G5";

Sub-part 3: "Media-dependent functionalities for NR-V2X PC5 and LTE-V2X PC5";

Part 5: "Transport Protocols";

Part 6: "Internet Integration".

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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.

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1 Scope

The present document specifies the Release 2 of the GeoNetworking protocol. Compared to the Release 1 specification, Release 2 primarily adds support for multi-channel operation.

2 References

2.1 Normative 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.

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

- [1] [ETSI TS 103 899](#): "Intelligent Transport Systems (ITS); Vehicular Communications; Geographical Area Definition; Release 2".
- [2] [ETSI TS 102 894-2](#): "Intelligent Transport Systems (ITS); Facilities Layer; Part 2: Common Data Dictionary (CDD); Release 2".
- [3] [ETSI TS 103 836-5-1](#): "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 5: Transport Protocols; Sub-part 1: Basic Transport Protocol; Release 2".

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The following referenced documents may be useful in implementing an ETSI deliverable or add to the reader's understanding, but are not required for conformance to the present document.

- [i.1] ETSI TS 103 836-3: "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 3: Network architecture; Release 2".
- [i.2] ETSI TS 103 697 (V2.1.1): "Intelligent Transport Systems (ITS); Architecture; Multi-Channel Operation (MCO) for Cooperative ITS (C-ITS); Release 2".
- [i.3] 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.4] Void.
- [i.5] 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".

- [i.6] ETSI TS 102 965: "Intelligent Transport Systems (ITS); Application Object Identifier (ITS-AID); Registration; Release 2".
- [i.7] ETSI TS 103 695: "Intelligent Transport Systems (ITS); Access layer specification in the 5 GHz frequency band; Multi-Channel Operation (MCO) for Cooperative ITS (C-ITS); Release 2".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI TS 103 836-3 [i.1], ETSI TS 103 697 [i.2] and the following apply:

CBF packet buffer: local buffer used by a GeoAdhoc router to temporarily store packets for contention-based forwarding

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

duplicate packet list: local record maintained by a GeoAdhoc router to identify and suppress duplicate packets

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

forwarding candidate: GeoAdhoc router that is eligible to forward a received packet according to the forwarding algorithm

forwarding packet buffer: local buffer used by a GeoAdhoc router to temporarily store packets awaiting forwarding

forwarding progress: advance in distance in the distribution of a packet achieved by a GeoAdhoc router relative to the sender

NOTE: In non-area CBF (annex E), the forwarding reference point is the destination or the centre of the destination area. In area CBF (annex F), the forwarding reference point is the position of the previous forwarder.

GeoAdhoc router: networking functionality that implements the GeoNetworking protocol

local position vector: position vector for the local GeoAdhoc router

location service packet buffer: local buffer used by a GeoAdhoc router to temporarily store packets related to the location service

media dependent procedures: packet handling steps that are specific to the Access Layer technology over which the GeoNetworking packet will be transmitted

more advanced forwarder: forwarding candidate that provides greater forwarding progress than another forwarding candidate

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

optimal forwarder: forwarding candidate expected to forward a packet first according to the forwarding algorithm

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

segment: distance range in which a forwarding candidate lies for the purpose of determining its CBF timer

segment number: integer value identifying the segment in which a forwarding candidate lies

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 symbols given in ETSI TS 103 697 [i.2] and the following apply:

ALI_ADDR	Address of the Access Layer instance that identifies the ITS-S at the link layer protocol entity in the Access Layer
DIST_MAX	Maximum communication range
F_DIST	Forwarding progress in area CBF as distance between the GeoAdhoc router's local position and the sender position
GEO_MAX	Maximum size of the GeoNetworking packet header
H(GN_ADDR)	Heading of the ITS-S GN_ADDR
LAT	Latitude
LONG	Longitude
LS_PENDING	Location Service pending flag
MTU_AL	MTU of the Access Layer
NH_ALI_ADDR	Address of the link layer of of the next hop
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
PROG	Forwarding progress in non-area CBF

NOTE: It is the difference between the sender's distance to the destination and the local GeoAdhoc router's distance to the destination.

PV(GN_ADDR)	Position vector 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
SEQN_MAX	Largest possible value of the sequence number
SEQN(P)	Value of the sequence number field carried in a GeoNetworking packet
SEGN	Segment number
T(LocTE)	Lifetime of an entry in the location table
TO_ACC	Time interval until the packet can be transmitted by the Access Layer, taking into account both congestion-control deferral and medium access procedures
TO_CBF	CBF timeout with Access Layer constraints
TO_CBF_MIN	Timeout; minimum duration a packet is buffered in the CBF packet buffer
TO_CBF_MAX	Timeout; maximum duration a packet is buffered in the CBF packet buffer
TO_CBF_RP	CBF timeout calculated for a received packet
TO_CBF_WO_ACC	CBF timeout without Access Layer constraints
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 TS 103 836-3 [i.1], ETSI TS 103 697 [i.2] and the following apply:

ALI	Access Layer Instance
AliID	Access layer instance Identifier
ARH	ALI Request Handler

ASN	Abstract Syntax Notation
BC	BroadCast
BTP	Basic Transport Protocol
CBF	Contention-Based Forwarding
CLR	Channel Load Ratio
DAD	Duplicate Address Detection
DE	Destination
DPC	Duplicate Packet Counter
DPD	Duplicate Packet Detection
DPL	Duplicate Packet List
EMA	Exponential Moving Average
EPV	Ego Position Vector
FIFO	First In First Out
GAC	Geographically-scoped Anycast
GAGH	GeoNetworking Access layer instance Group Handler
GBC	Geographically-scoped Broadcast
GF	Greedy Forwarding
GN	GeoNetworking
GN_ADDR	GeoNetworking ADDRESS
GN-PDU	GeoNetworking Protocol Data Unit
GN-SDU	GeoNetworking Service Data Unit
GN6ASL	GeoNetworking to IPv6 Adaptation Sub-Layer
GN6-SDU	GN6 Service Data Unit
GUC	Geographically-scoped Unicast
HST	Header Sub-Type
HT	Header Type
LocT	Location Table
LocTE	Location Table Entry
LPV	Local Position Vector
LS	Location Service
LT	LifeTime
LTE	Long Term Evolution
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
MPU	MCO Parameters Update
MTU	Maximum Transmit Unit
NH	Next Header
NU	Network Updates
PAI	Position Accuracy Indicator
PDR	Packet Data Rate
PDU	Protocol Data Unit
PL	Payload Length
POS	POSition
PV	Position Vector
RHL	Remaining Hop Limit
RTC	Retransmit Counter
SCF	Store Carry & Forward
SDU	Service Data Unit
SE	SEnder
SHB	Single Hop Broadcast
SEGN	Segment Number
SEQN	Sequence Number
SO	SOUrce
SPV	Short Position Vector
SSP	Service Specific Permissions
TAI	Temps Atomique International (International Atomic Time)
TC	Traffic Class
TC ID	Traffic Class Identifier

TPT	Traffic Participant Type
TSB	Topologically Scoped Broadcast
T-SDU	Transport Service Data Unit
TST	TimeSTamp
UC	UniCast
UTC	Universal Time Coordinated
V2X	Vehicle-to-Everything
WGS	World Geodetic System

4 Services provided by the GeoNetworking protocol

The GeoNetworking protocol is a network protocol that resides in the Networking & Transport layer. Requirements on the GeoNetworking protocol are specified in ETSI TS 103 836-3 [i.1]. It is executed in the ad hoc router, specifically in the GeoAdhoc router. It provides the transport of packets in the ITS ad hoc network (ETSI TS 103 836-3 [i.1]).

GeoNetworking comprises several components, namely GeoNetworking Core (GN Core), GeoNetworking ALI Group Handlers (GAGHs) and MCO_NET (see figure 1). GN Core provides channel- and media-independent GeoNetworking functionalities. A GAGH realizes channel dependent, media-dependent, and media-independent GeoNetworking functionalities. The MCO_NET entity is optional and provides MCO management functionalities as part of the GeoNetworking protocol for ITS-Ss that support multiple communication channels on one or more access layer technologies.

The GeoNetworking protocol provides services to upper protocol entities, i.e. the transport protocol, such as the Basic Transport Protocol (BTP), the GeoNetworking to IPv6 Adaptation Sub-Layer (GN6ASL), and MCO-related services to the Facilities layer entities.

In order to provide its packet transport services, the GeoNetworking protocol uses the services of the Access Layer via the NET_ACC_DATA interface. To provide MCO functionalities to upper layers, MCO_NET uses services provided by the Access layer via the MCO_NET_ACC_MMT interface.

NOTE: When data are delivered via the NET_ACC_DATA interface and uses MCO, the interface may be also called MCO_NET_ACC_DATA (see e.g. ETSI TS 103 697 [i.2]).

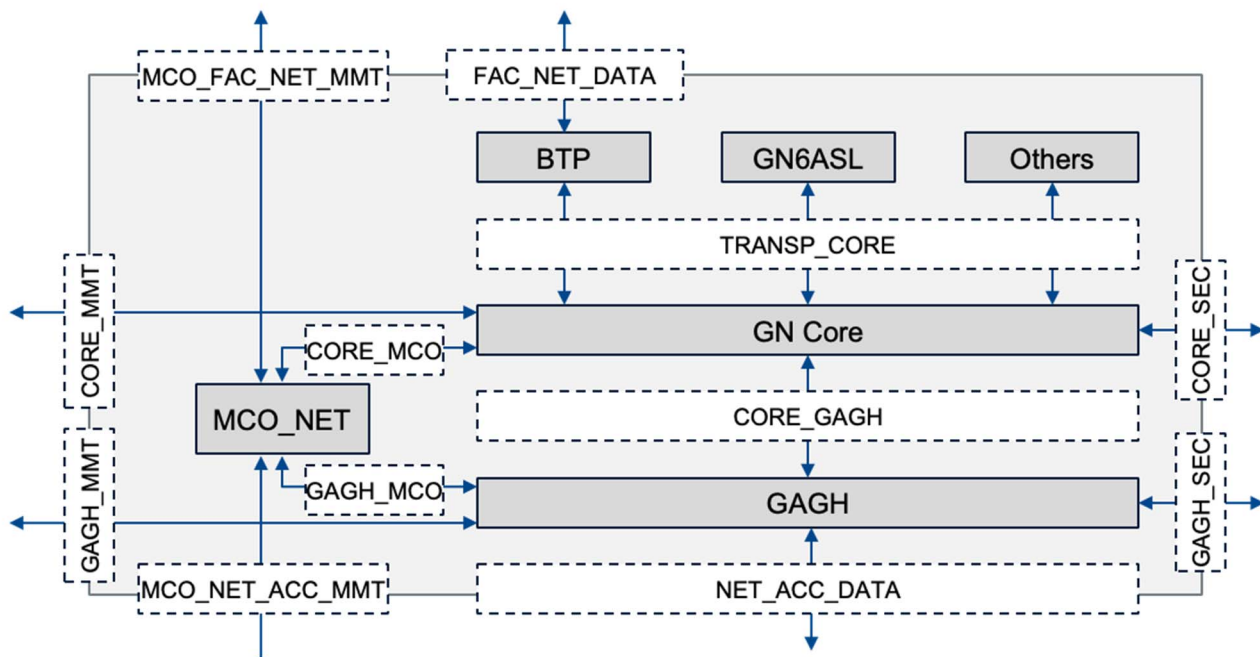


Figure 1: GeoNetworking-related components and interfaces

The present document specifies the internal interfaces of the Networking & Transport layer as defined in ETSI TS 103 836-3 [i.1] (see figure 1), i.e.:

- the interface between the GeoNetworking protocol and the ITS transport protocol, such as the Basic Transport Protocol (BTP), the GeoNetworking IPv6 Adaptation Sub-Layer (GN6ASL), and other transport protocols;
- the interface between the GeoNetworking Core and the GeoNetworking ALI Group Handler;
- the interface between the GeoNetworking Core and the MCO_NET entity;
- the interface between the GeoNetworking ALI Group Handlers and the MCO_NET entity.

To provide MCO services to the Facilities layer entities, the present document specifies the MCO_FAC_NET_MMT interface between the Networking & Transport layer and the Facilities layer.

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.

0								1								2								3															
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7								
Octet 0								Octet 1								Octet 2								Octet 3															
Octet 4 to Octet 7																																							
...																								Octet 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, irrespective of the number of GAGHs, shall 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 10.2.1.5 is applied. For multi-channel operation, an ITS-S with several GAGHs shall use a single GeoNetworking address.

NOTE: In case the GN MID changes, the ALI address should also be changed. In one possible implementation the ALI address is set from the GeoNetworking protocol entity.

6.2 GeoNetworking address format

The format of the GeoNetworking address shall be as described in figure 3.