ETSI TS 103 836-1 V2.1.1 (2024-07)

Intelligent Transport Systems (ITS);
Vehicular Communications;
GeoNetworking;
Part 1: Requirements;
Release 2

Reference
DTS/ITS-00379

Keywords
autonomic networking, ITS, network, safety

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° w061004871

Contents

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The declarations pertaining to these essential IPRs, if any, are publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI Directives including the ETSI IPR Policy, no investigation regarding the essentiality of IPRs, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members. **3GPP™** and **LTE™** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners. **oneM2M™** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM**® and the GSM logo are trademarks registered and owned by the GSM Association.

Foreword

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

The present document is part 1 of a multi-part deliverable covering Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking, as identified below:

Part 1: **"Requirements; Release 2";**

Part 2: "Scenarios; Release 2";

Part 3: "Network architecture; Release 2";

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

Part 5: "Transport Protocols";

Part 6: "Internet Integration".

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Executive summary

The present document defines general design guidelines, functional requirements and performance requirements for support of single-hop and multi-hop communications in vehicular ad hoc networks. It is applicable to ITS stations implementing the GeoNetworking protocol.

Introduction

Wireless communication is a cornerstone of future Intelligent Transport Systems (ITS). Many ITS applications require the dissemination of information with a rapid and direct communication, which can be achieved by ad hoc networking. GeoNetworking is a network-layer protocol for mobile ad hoc communication based on wireless technology, such as ITS-G5 or 5G-NR PC5. It provides communication in mobile environments without the need for a coordinating infrastructure. GeoNetworking utilizes geographical positions for dissemination of information and transport of data packets. It offers communication over multiple wireless hops, where nodes in the network forward data packets on behalf of each other to extend the communication range. Originally proposed for general mobile ad hoc networks, variants of GeoNetworking have been proposed for other network types, such as Vehicular Ad hoc Networks (VANETs), mesh networks and wireless sensor networks. Therefore, GeoNetworking can also be regarded as a family of network protocols based on the usage of geographical positions for addressing and transport of data packets in different types of networks.

In VANETs, GeoNetworking provides wireless communication among vehicles and among vehicles and fixed stations along the roads. GeoNetworking works connectionless and fully distributed based on ad hoc network concepts, with intermittent or even without infrastructure access. The principles of GeoNetworking meet the specific requirements of vehicular environments: it is well suited for highly mobile network nodes and frequent changes in the network topology. Moreover, GeoNetworking flexibly supports heterogeneous application requirements, including applications for road safety, traffic efficiency and infotainment. More specifically, it enables periodic transmission of safety status messages at high rate, rapid multi-hop dissemination of packets in geographical regions for emergency warnings, and unicast packet transport for Internet applications.

GeoNetworking basically provides two, strongly coupled functions:

- geographical addressing; and
- geographical forwarding.

Unlike addressing in conventional networks, in which a node has a communication name linked to its identity (e.g. a node's IP address), GeoNetworking can send data packets to a node by its position or to multiple nodes in a geographical region. For forwarding, GeoNetworking assumes that every node has a partial view of the network topology in its vicinity and that every packet carries a geographical address, such as the geographical position or geographical area as the destination. When a node receives a data packet, it compares the geo-address in the data packet and the node's view on the network topology and makes an autonomous forwarding decision. As a results, packets are forwarded "on the fly", without need for setup and maintenance of routing tables in the nodes.

The most innovative method for distribution of information enabled by geographical routing is to target messages to certain geographical areas. In practise, a vehicle can select and specify a well-delimited geographic area to which messages should be delivered. Intermediate vehicles serve as message relays and only the vehicles located within the target area process the message and further send it to corresponding applications. In this way, only vehicles that are affected by a dangerous situation or a traffic notification are notified, whereas vehicles unaffected by the event are not targeted.

Basically, geographical routing comprises the following forwarding schemes:

- GeoUnicast: figure 1 shows a possible method of packet delivery between two nodes via multiple wireless hops. When a node wishes to send a unicast packet, it first determines the destination's position and then forwards the data packet to a node towards the destination, which in turn re-forwards the packet along the path until the packet reaches the destination.

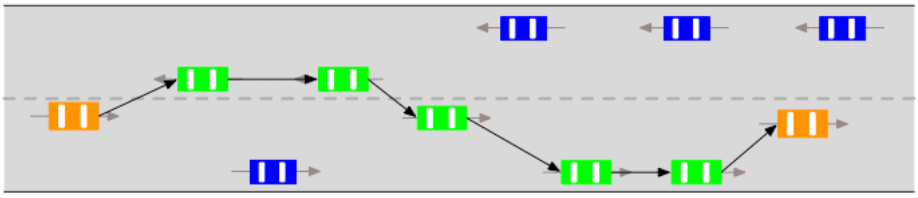

Figure 1: GeoUnicast

- GeoBroadcast: figure 2 shows a possible method of geographical broadcast. A packet is forwarded hop-by-hop until it reaches the destination area determined by the packet, and nodes rebroadcast the packet if they are located inside the destination area. GeoAnycast is different from geographical broadcast in that a node within the destination area will not re-broadcast any received packets.

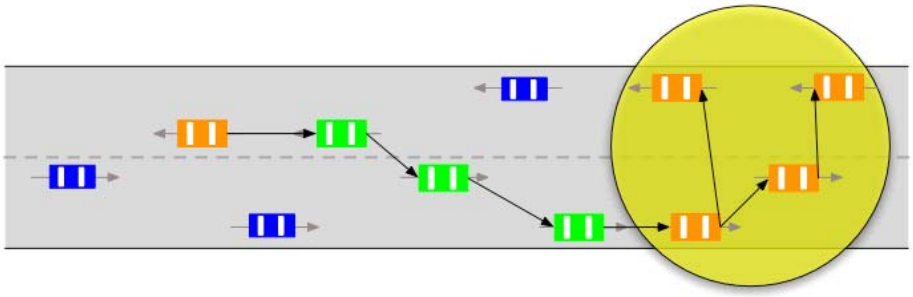

Figure 2: GeoBroadcast

- Topologically-scoped broadcast: figure 3 shows rebroadcasting of a data packet from a source to all nodes in the n-hop neighbourhood. Single-hop broadcast is a specific case of topologically-scoped broadcast, which is used to send packets only to one-hop neighbourhood.

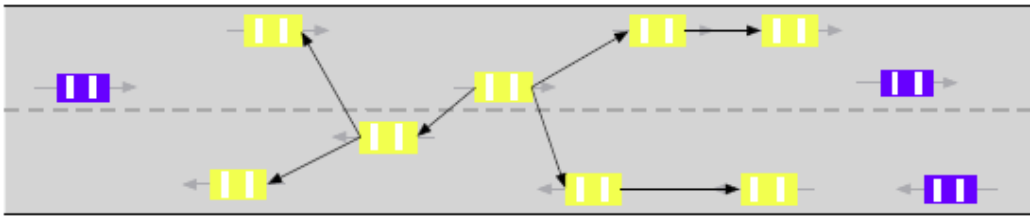

Figure 3: Topologically-scoped broadcast

1 Scope

The present document specifies, at an abstract level, the general, functional and performance requirements that apply to the GeoNetworking protocols (ETSI TS 103 836-4 [i.1], ETSI TS 103 836-5 [i.2] and ETSI TS 103 836-6 [i.3]) for use in ITS-G5 (ETSI EN 303 797 [i.4]), LTE-V2X or 5G-NR (ETSI EN 303 798 [i.5]) access technologies.

The present document is applicable to ITS stations implementing ETSI ITS G5 (ETSI EN 303 797 [i.4]), LTE-V2X or 5G-NR access technology (ETSI EN 303 798 [i.5]) and the GeoNetworking protocols (ETSI TS 103 836-4 [i.1], ETSI TS 103 836-5 [i.2] and ETSI TS 103 836-6 [i.3]) for both single hop and multi-hop communications.

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.

Referenced documents which are not found to be publicly available in the expected location might be found at https://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.

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

[1] ETSI TS 103 836-2: "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 2: Scenarios; Release 2".

[2] IETF RFC 4861: "Neighbor Discovery for IP version 6 (IPv6)".

[3] IETF RFC 4862: "IPv6 Stateless Address Autoconfiguration".

[4] IETF RFC 3775: "Mobility Support in IPv6".

[5] IETF RFC 3963: "Network Mobility (NEMO) Basic Support Protocol".

[6] IETF RFC 5648: "Multiple Care-of Addresses Registration".

2.2 Informative 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.

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

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 TS 103 836-4 (all parts): "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Release 2".

[i.2] ETSI TS 103 836-5 (all parts): "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Release 2".

[i.3] ETSI TS 103 836-6 (all parts): "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 6: Internet Integration, Release 2"Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 6: Internet Integration; Release 2".

[i.4] ETSI EN 303 797: "Intelligent Transport Systems (ITS); ITS-G5 Access layer in the 5 GHz frequency band; Release 2".

[i.5] ETSI EN 303 798: "Intelligent Transport Systems (ITS); LTE-V2X and NR-V2X Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band; Release 2".

[i.6] ETSI TS 103 836-3: "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 3: Network Architecture; 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.6] and the following apply:

ad hoc communication: communication in an ad hoc network

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI TS 103 836-3 [i.6] and the following apply:

MCoA	Multiple Care-of Addresses Registration
NEMO	NEtwork MObility
VANET	Vehicular Ad hoc NETwork

4 Design guidelines

The GeoNetworking protocols as defined in this multi-part deliverable shall be designed to:

- efficiently disseminate safety and traffic efficiency messages considering functional requirements on applications;
- support all communication scenarios specified in ETSI TS 103 836-2 [1];
- transparently transport IPv6 packets with minimum changes to IPv6;
- support privacy and security functions;
- support different communication media and interfaces.

5 Functional requirements

5.1 Communication mode

The GeoNetworking protocols as defined in this multi-part deliverable shall support self-organized communication among vehicle ITS stations without assistance from an infrastructure network, and also allow communication with assistance from an infrastructure network. These GeoNetworking protocols shall also support self-organized communication between vehicle ITS stations and roadside ITS stations.

For safety applications that have stringent requirement on the latency of message delivery, these GeoNetworking protocols shall support communication without the need to exchange any signalling messages beforehand.

5.2 GeoNetworking addressing

An ITS station implementing the GeoNetworking protocol shall have at least one unique address at the ITS-S networking & transport layer. The address may be based on each individual ITS stations' identity or geographical position.

NOTE: Details of the address are out of scope of the present document and will be specified in other standards.

The GeoNetworking protocols as defined in this multi-part deliverable shall support at least circular, rectangular and ellipsoidal geographical target areas and may support other types of geographical target areas needed by applications.

The GeoNetworking protocols as defined in this multi-part deliverable shall support automatic address configuration, which does not require any manual configuration from human beings. These GeoNetworking protocols shall also allow manual address configuration.

5.3 Geographical routing

Routing functions of the GeoNetworking protocols as defined in this multi-part deliverable shall support all communication scenarios specified in ETSI TS 103 836-2 [1].

5.4 Status information signalling

The status information of ITS stations for the GeoNetworking protocols as defined in this multi-part deliverable shall include each ITS station's network address, position, speed, heading, time stamp and their accuracy, and may also include other information such as altitude. The GeoNetworking protocols as defined in this multi-part deliverable shall have access to these data.

Exchange of status information for the GeoNetworking protocols as defined in this multi-part deliverable shall be carried out by at least one of the following means:

- explicit status information exchange protocol, e.g. location resolution of an ITS station by means of a location service;
- implicit status information signalling by periodically sending packets including status information.

The GeoNetworking protocols as defined in this multi-part deliverable shall support status information signalling that will not cause congestion in the network.

5.5 Priority and buffering

The GeoNetworking protocols as defined in this multi-part deliverable shall support packets with different priorities. These GeoNetworking protocols shall treat packets with different priorities such that that high priority packets have preferred access to communication channel(s).

The GeoNetworking protocols as defined in this multi-part deliverable shall be able to temporarily buffer packets and either drop them or send them to the lower layer at a later time. Such buffering functions are necessary in certain conditions, for example in case the location of the destination is unknown or there is no direct neighbour to forward packets to the destination.

5.6 Data congestion control

In case information to control the congestion needs to be exchanged to keep the network load at an acceptable level by GeoNetworking, congestion control shall be supported.

5.7 Security and privacy

The GeoNetworking protocols as defined in this multi-part deliverable shall support security objectives for both single-hop and multi-hop communication. Security objectives particularly include integrity, privacy and non-repudiation. The security measures shall protect the GeoNetworking protocol header. These GeoNetworking protocols shall also protect privacy, i.e. provide confidentiality to personal data such as ITS station's ID and location.

5.8 Cross-layer signalling

The GeoNetworking protocol as defined in this multi-part deliverable shall support information exchange between different layers, and entities at each layer may select the required information to be received. The information exchange shall be bi-directional, structured and efficient in terms of processing and data overhead.

5.9 GeoNetworking and IPv6

The GeoNetworking protocols as defined in this multi-part deliverable shall allow legacy IPv6 applications to run on top of the GeoNetworking protocols and support transparent routing of IPv6 packets. The following functions shall be supported by the ITS-S networking & transport layer implementing these GeoNetworking protocols:

- Efficient methods to support IPv6 Neighbor Discovery function (IETF RFC 4861 [2]).
- IPv6 Stateless Address Autoconfiguration (IETF RFC 4862 [3]).
- Interfaces and method to support IPv6 unicast.
- Interfaces and method to support IPv6 multicast.
- IPv6 mobility protocols (IETF RFC 3775 [4]) if the ITS station represents a single IPv6 node.
- IPv6 Network Mobility (NEMO) Basic Support Protocol (IETF RFC 3963 [5]) if the ITS station represents an IPv6 mobile network.

The following functions may be supported by the ITS-S networking & transport layer implementing the GeoNetworking protocols:

- Multiple Care-of Addresses Registration (MCoA) (IETF RFC 5648 [6]).

5.10 Transport layer functions

The transport protocols as defined in this multi-part deliverable and used together with GeoNetworking shall support multiplexing and de-multiplexing of data from upper layers.

6 Performance requirements

In general, the GeoNetworking protocols as defined in this multi-part deliverable shall:

- provide low-latency communications;
- provide reliable communications with the highest reliability for safety messages;
- keep signalling, routing and packet forwarding overhead low;
- be fair among different ITS stations with respect to bandwidth usage considering the type of messages;
- be robust against security attack, mal-function in ITS stations;
- be able to work in scenarios with low and high density of GeoNetworking-enabled ITS stations.

Annex A (informative): Change History

Date	Version	Information about changes
February 2022	0.0.1	Initial version based on EN 302 636-1 v1.2.1 using ETSI TS template
October 2023	0.0.2	Update for discussion in ITS-WG3#64
January 2024	0.0.3	Update based on discussions in ITS-WG3#64
March 2024	0.0.4	Update based on discussions in ITS-WG3#65
March 2024	0.0.5	Clean version created after ITS-WG3#66 for remote consensus
June 2024	2.1.1	First published version

History

Document history		
V2.1.1	July 2024	Publication