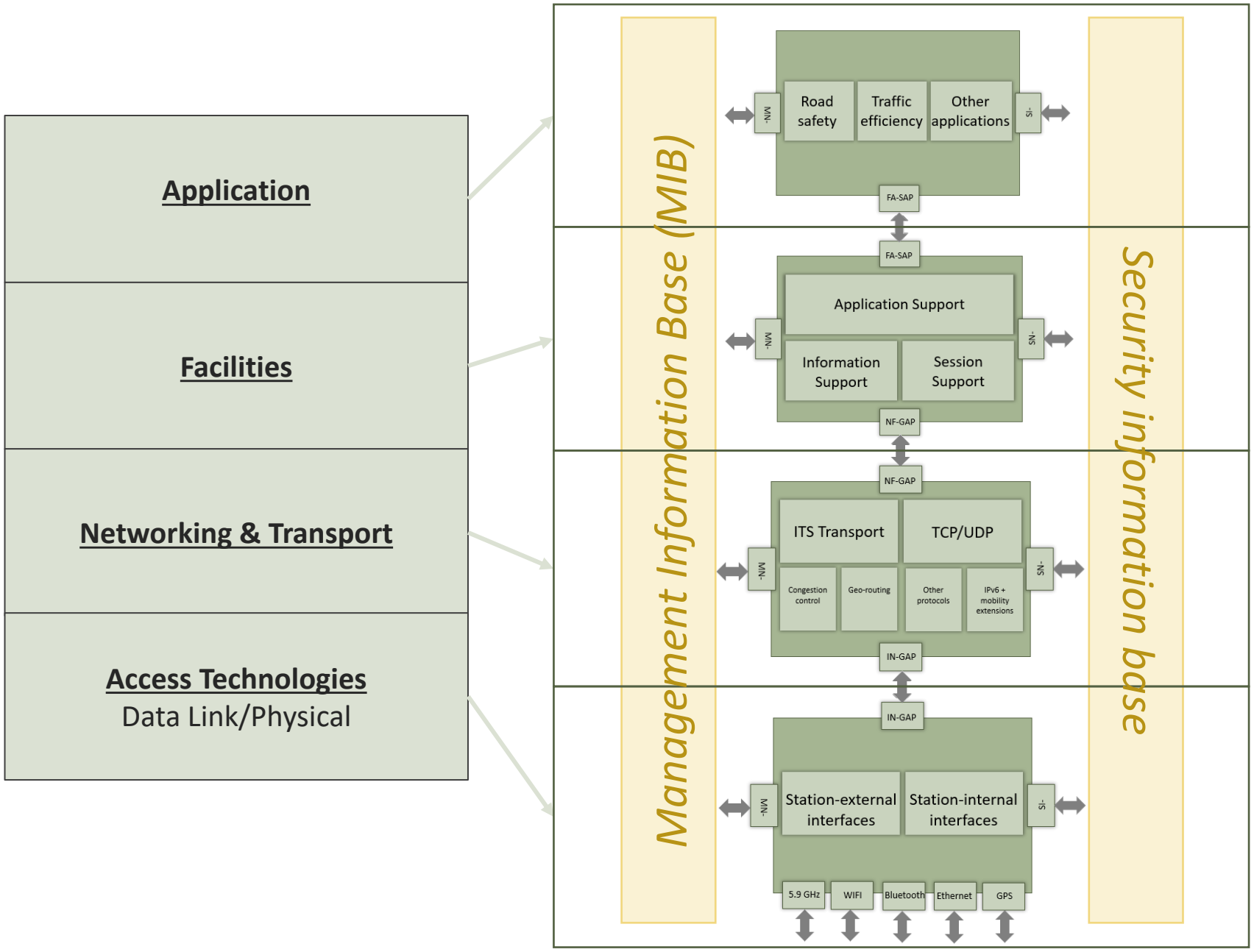
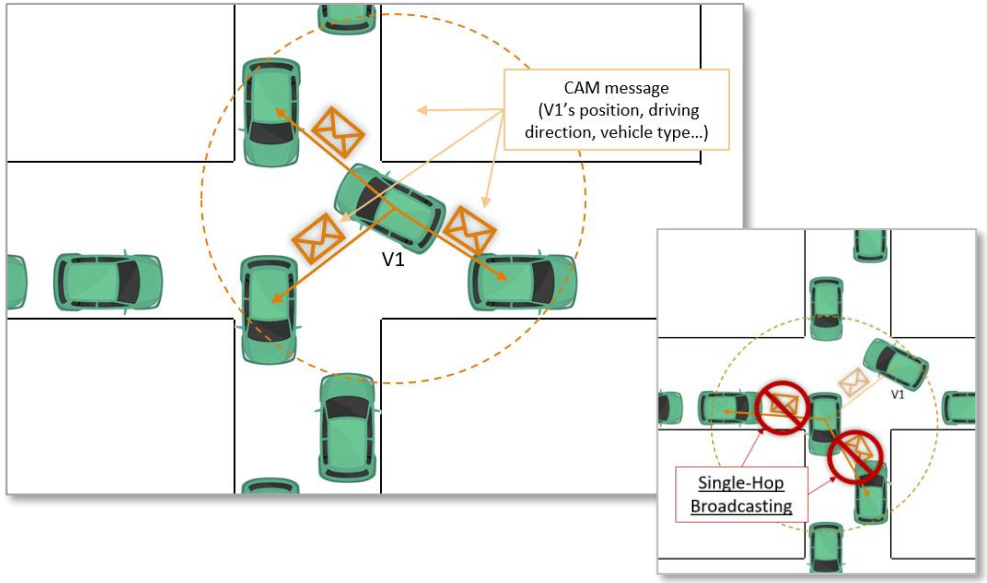
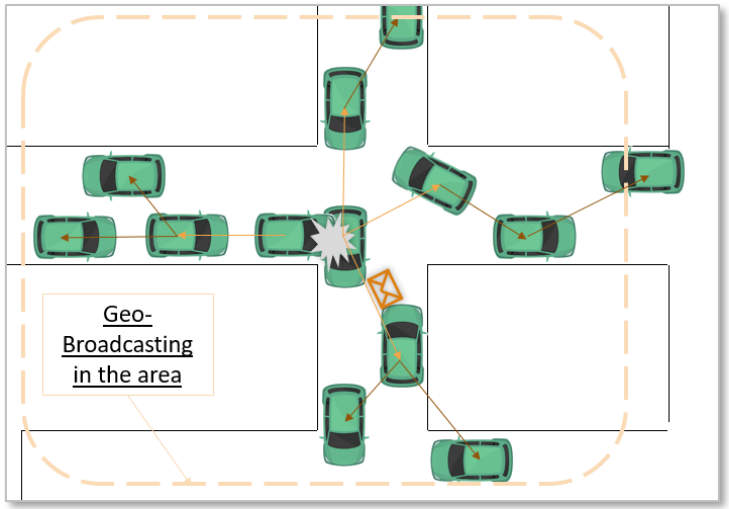
ITS Station Reference Architecture



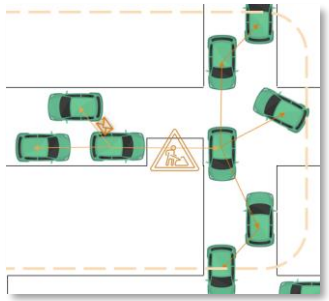
CAM



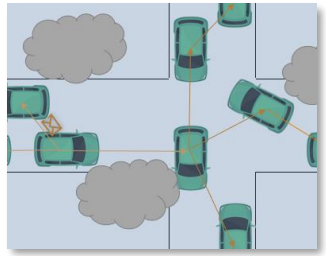
DENM



Accident

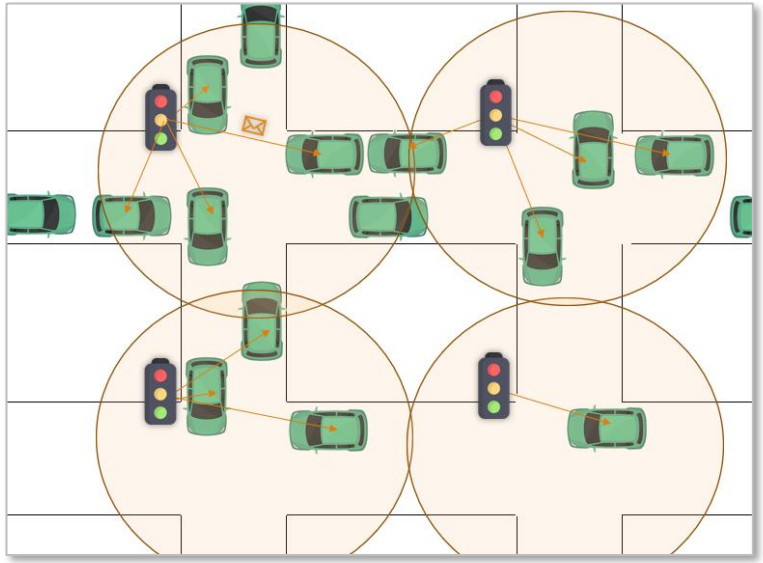


Road works

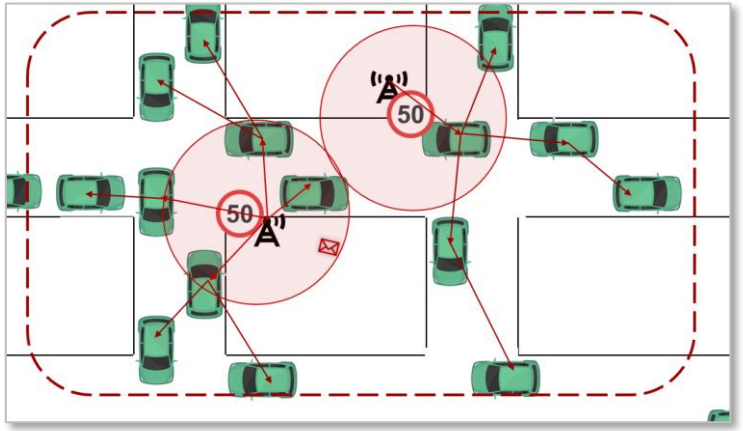


Weather conditions

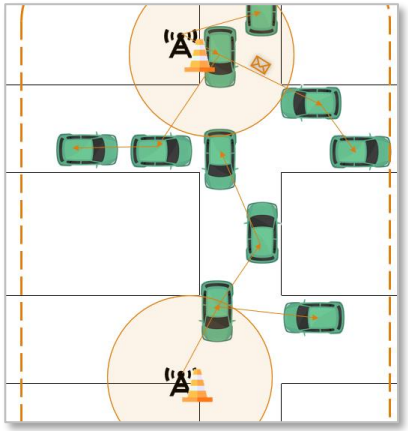
SPAT/MAP



IVIM



Static or dynamic road signs



Road works warnings

GeoNetworking protocol

ITS Station reference architecture

Application

Facilities

Networking & Transport
GeoNetworking

Access Technologies
Data Link/Physical
IEEE 802.11

BEACON
used to periodically advertise a GeoAdhoc router's position vector to its direct neighbors.

The MTU (Maximum Transmit Unit) depends on the MTU of the MTU_ALL (access layer technology) over which the GeoNetworking packet is transported.

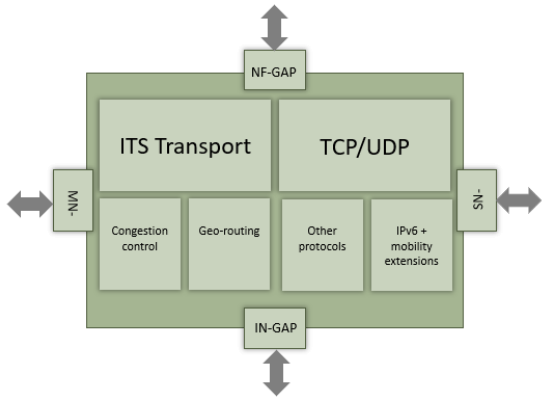
Packet structure

~~secured~~

MAC header Link layer address (= MAC address)	LLC (Logical Link Control header)	GeoNetworking header *basic, common, (extended) headers*	Optional payload

secured

MAC header Link layer address (= MAC address)	LLC (Logical Link Control header)	GeoNetworking *basic* header	GeoNet Secured Packet	GeoNetworking *common* and *extended* header	Optional payload
Define and identify the next hop of a GeoNetworking packet.	Ethernet type field indicating GeoNetworking packet				User Data Beacons don't have payload



Basic header

Version	Version of the GeoNetworking protocol.
NH	Next Header identifies the type of header immediately following the basic header.
Reserved	
LT	Lifetime field, maximum time a packet may be buffered until it reaches its destination.
RHL	Remaining hop limit, decremented by each router that forward the packet.

0	ANY (unspecified)
1	Common header
2	Secured packet 1. Execute the SN-DECAP service 2. Process the service primitive SN-DECAP.confirm 3. Report a. SUCCESS b. !=SUCCESS i. If constant = 0 → discard ii. If constant = 1 → Pass the payload to the upper protocol entity (GN-DATA.indication)

Forwarders decrement RHL by one.
- If RHL = 0 discard the packet
- If RHL > 0 update the field of the basic header

1	- Packet transport type in GN-DATA.request is SHB - Header type is 1 → BEACON
Value of Maximum Hop Limit	From service primitive GN-DATA.request
GN protocol constant	GN protocol constant itsGnDefaultHopLimit

Common header

NH	
Reserved	
HT	Header type of the GeoNetworking.
HST	Header Sub-type of the GeoNetworking.
TC	Traffic Class, represents facility layer requirements on packet transport.
Flags	Indicates whether the ITS-S is mobile or stationary.
PL	Length of the GeoNetworking payload.

0	ANY (unspecified)
1	BTP-A (interactive packet transport)
2	BTP-B (non-interactive packet transport)

0	ANY
1	**BEACON**
2	**GEOUNICAST (GUC)**
3	GEOANYCAST (GAC)
4	**GEOBROADCAST (GBC)**
5	TSB
6	LS

SCF	Channel Offload	TC ID
Store Carry Forward Indicates whether the packet shall be buffered when no suitable neighbor exists.	Indicated whether the packet may be offloaded to another channel.	

If secured : GeoNetworking Secured packet between this 2 headers.

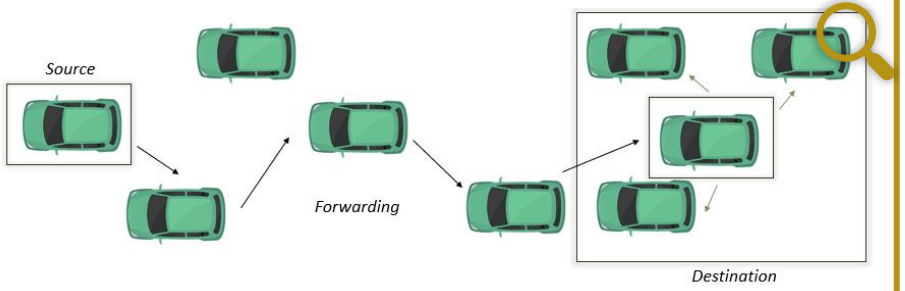
Extended header

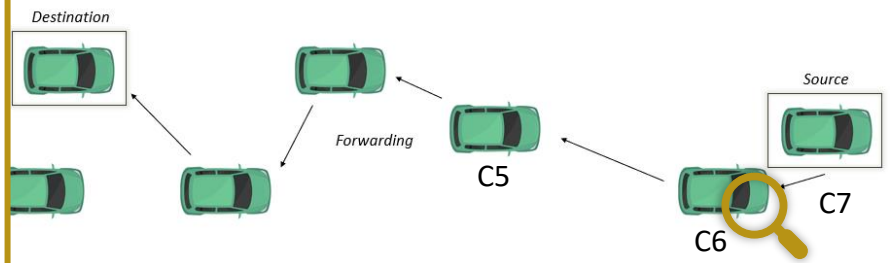
Cf. ETSI EN 302 639-4-1 V1.3.1

GBC

Geo Broadcast Communication

A packet targets all nodes inside a specific geographic area. The packet is first geo-routed to a target geographic zone, and then delivered to all nodes located inside the destination area.





GUC

Geo Unicast Communication

The destination of the packet is a node located at a specific position. The packet is forwarded hop by hop towards the position of the destination and delivered to that specific node.

Buffer

LS buffer	UC (Unicast) buffer	**BC** (Broadcast) **buffer**
Queue a packet for the sought destination until the LS is completed.	Store geo-unicast and geo-broadcast packets when the forwarding algorithm fails finding a valid neighbor to route the packet towards the destination. There are flushed when the LT is updated with information about packets' destination, so packets can be forwarded	

LocT Location Table

Contains information about other ITS-S.
Entries are added with a *lifetime* constant

GeoNetworking address
LL address of the ITS-S
Type of ITS-S
Version of the GeoNetworking protocol
PV (Position Vector)
Flags **LS_PENDING** indicating that a LS (Location Service) is in progress
Flag **LS_NEIGBOUR** indacting that the GeoAdhoc router is in direct communication range, is a neighbor.
DPL (Duplicate Packet List)
TST (Timestamp)
PDR (Packet Data Rate) as EMA (Exponential Moving average)

C6's LOCT

⏱	C5
⏱	C7

Address

Every GeoAdhoc router shall have a unique GeoNetworking address. To ensure the uniqueness of GeoNetworking address, DAD Duplication Address Detection, is applied.

SN

Determines the Sequence Number (SN) field of the next GeoNetworking packet to be transmitted. Single hop does not carry SN. *Examples:* Beacon, SHB.

PV Position Vector

The position vector update is executed in the forwarding process when a PV in a LocTE is updated by PV carried in a GeoNetworking packet header. Long and short PV exists.

GN_ADDR network address for the GeoAdhoc router
TST at which time latitude and longitude of the ITS-S were acquired by the router, in ms.
Lat (latitude)
Long (longitude)
PAI (Position accuracy indicator)
S (Speed)
H (heading of the GeoAdhoc router)

Only for **long** PV

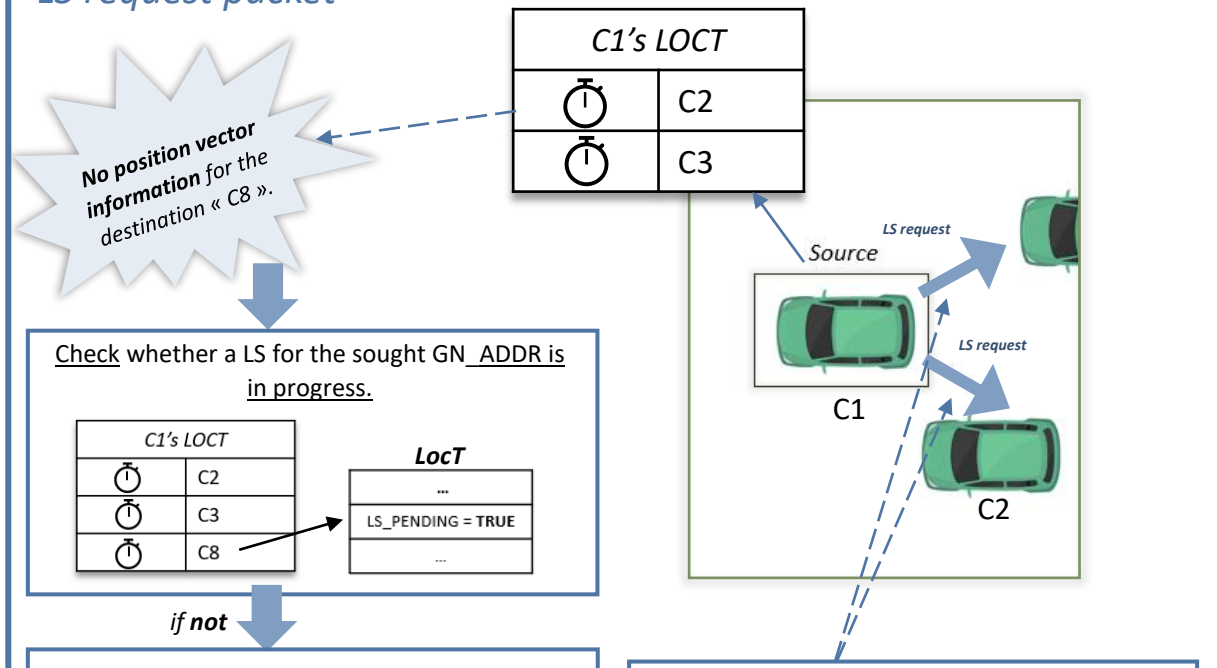
DPL

A GeoAdhoc router maintains a duplicate packet list DPL(GN_ADDR, list with sequence numbers and counter that indicates how often the packet with a particular sequence number has already been received from the source) for every entry in its LocT

Location Service

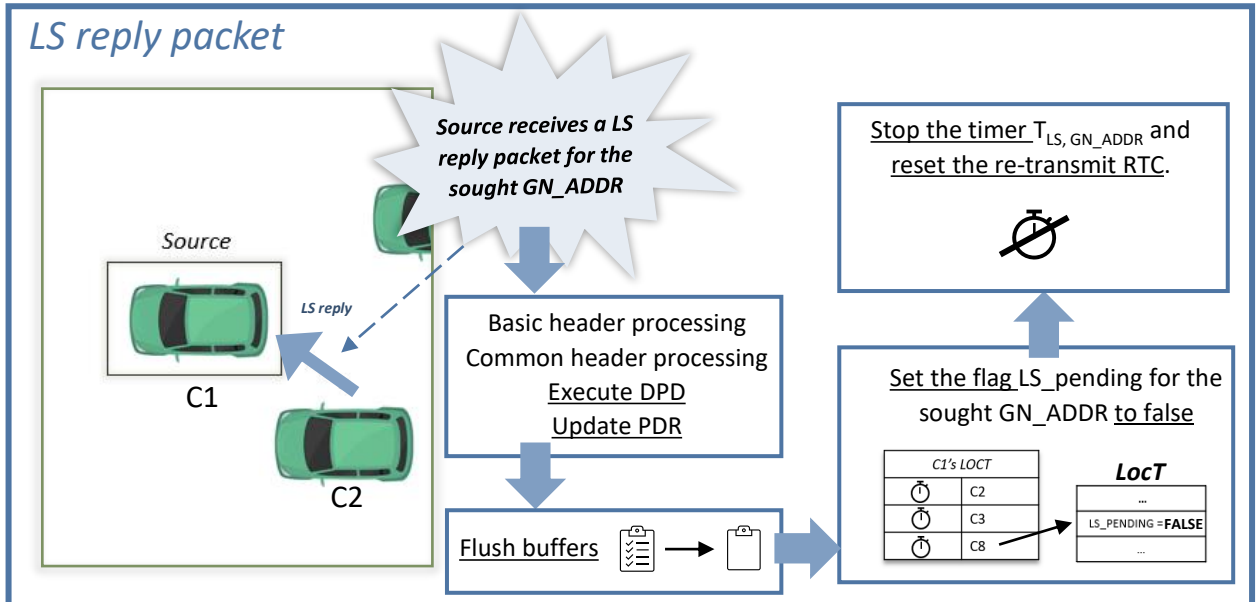
To **discover the position** of another ITS station, for instance when sending a geo-unicast packet to a destination that is not in the LT, the source node uses the Location Service (LS). Based on the exchange of control packets between GeoAdhoc routers.

LS request packet

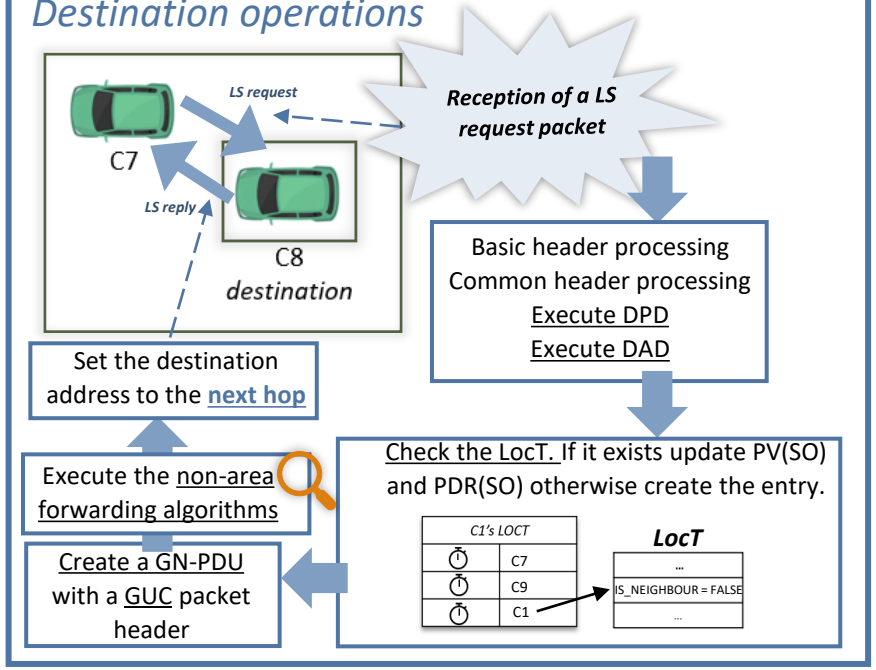


If the source node does not receive a LS reply packet, it continues sending LS request packets each LS retransmission interval until it receives a LS reply packet or the retransmission counter reaches the maximum LS retransmissions.

LS reply packet



Destination operations



Forwarding operations

If a GeoAdhoc router receives a LS Request packet and the Request GN_ADDR field in the LS Request header does not match its GN_ADDR, the GeoAdhoc router shall handle the packet according to the packet handling procedure for TSB, except for passing the payload of the GN-PDU to the upper protocol entity.

Non-area forwarding algorithm

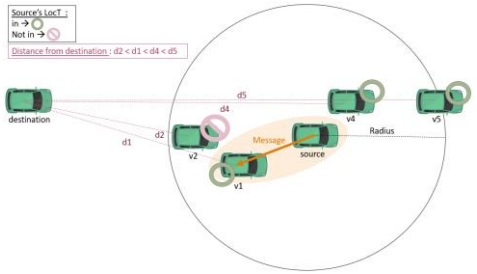
It is used to route a packet towards a destination. It is executed by a GeoAdhoc router to relay a packet to the next hop.

GF Greedy

The GeoAdhoc selects one of the neighbors as the next hop.

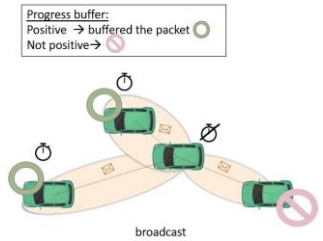
The algorithm applies the most forward within radius (MFR) policy, which selects the neighbor with the smallest geographical distance to the destination, thus providing the greatest progress when the GN packet is forwarded.

Returns:
- The LL address of the next hop
- 0 → the packet is buffered



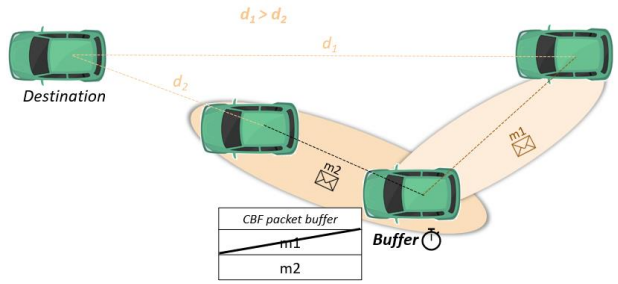
CBF
Contention based forwarding

A receiver decides to be a forwarder of a GN packet. With CBF, the GeoAdhoc router broadcasts the GN packet.



All neighbors, which receive the packet, process it: those routers with a positive progress buffer the packet in the CBF packet buffer. Upon expiration of the timer, the GeoAdhoc router re-broadcasts the GN packet.

Before the timer expires, the GeoAdhoc router may receive a duplicate of the packet from a GeoAdhoc router with a shorter timeout, i.e. with a smaller distance to the destination. In this case, the GeoAdhoc router inspects its CBF packet buffer, stops the timer and removes the GN packet from the CBF packet buffer.



Area forwarding algorithm

The area forwarding algorithms assume that the sender of the data packet is located inside or at the border of the target area. If this is not the case, the packet can be transported from the sender towards the target area using non-area forwarding algorithms.

CBF

Like the non area contention-based algorithm, but the definition of the distance is different.

Simple geo-broadcast

The packet is re-broadcasted.

Advanced

CBF is used to deal with uncertainties in terms of reception failure caused by mobility of ITS-S, fading phenomena and collisions on the wireless medium.

In order to minimize the additional forwarding delay introduced by CBF, CBF is complemented with the selection of one specific forwarder, referred to as next hop, at the sender

The efficiency of CBF is improved by choosing potential forwarders only from a specific sector of the circular forwarding area; i.e. GeoAdhoc routers located inside the sector (defined by an angle and the maximum communication range) refrain from retransmission of the packet (sectorial backfire).

The reliability of the dissemination process is increased by a controlled packet retransmission scheme within the geographical target area