The GeoNet project: Combination of IPv6 & GeoNetworking

Geographic addressing and routing for vehicular communications
http://www.geonet-project.eu

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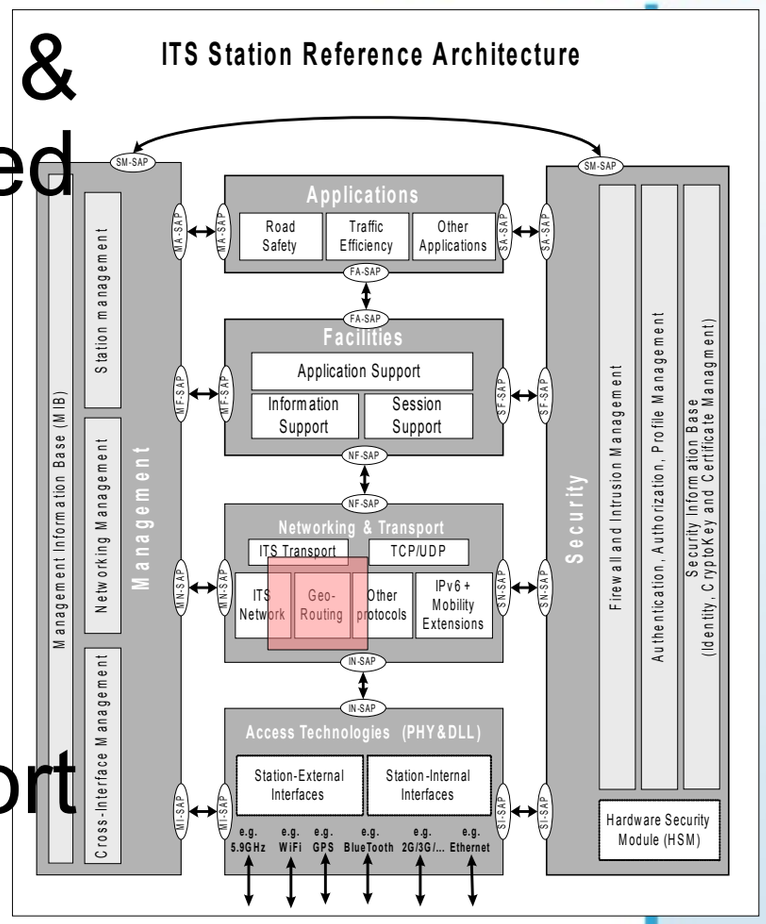
GeoNet Technical Coordinator

Why IPv6 GeoNetworking ?

- V2V: GeoNetworking is the addressing & routing packet forwarding approach favored in ITS communication architectures
  - C2C-CC
  - COMeSafety
  - ETSI TC ITS
  - ISO TC204 WG16 (CALM)

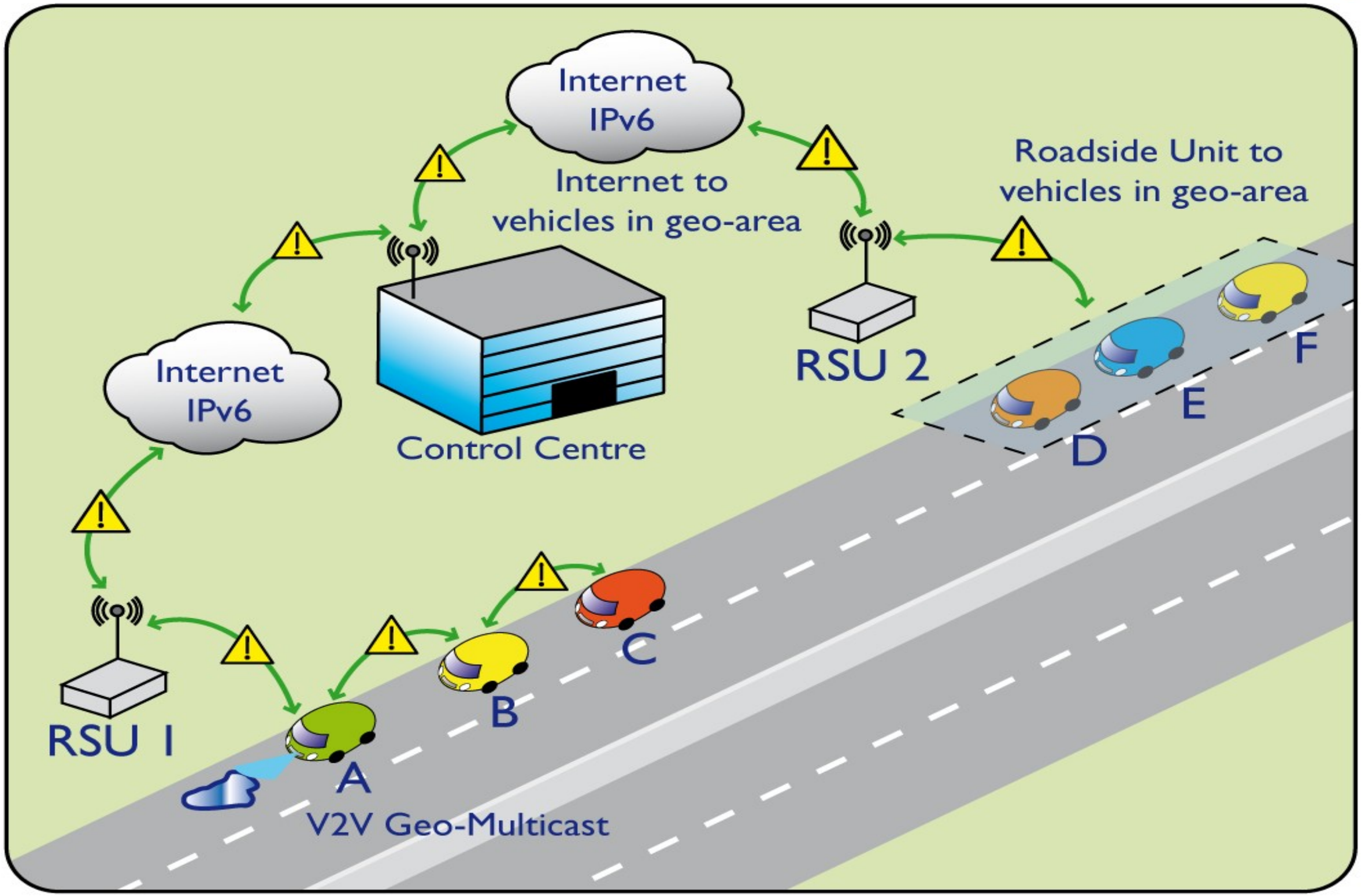


ITS Station

- ITS Architectures must also support Internet-based communications
  - IPv6: Internet Protocol version 6

- GeoNet: IPv6 and GeoNetworking must be combined in a common architecture
  - IPv6 expands the capabilities of GeoNetworking
  - GeoNetworking expands the capabilities of IPv6

Why IPv6 GeoNetworking ?



Why IPv6 ?

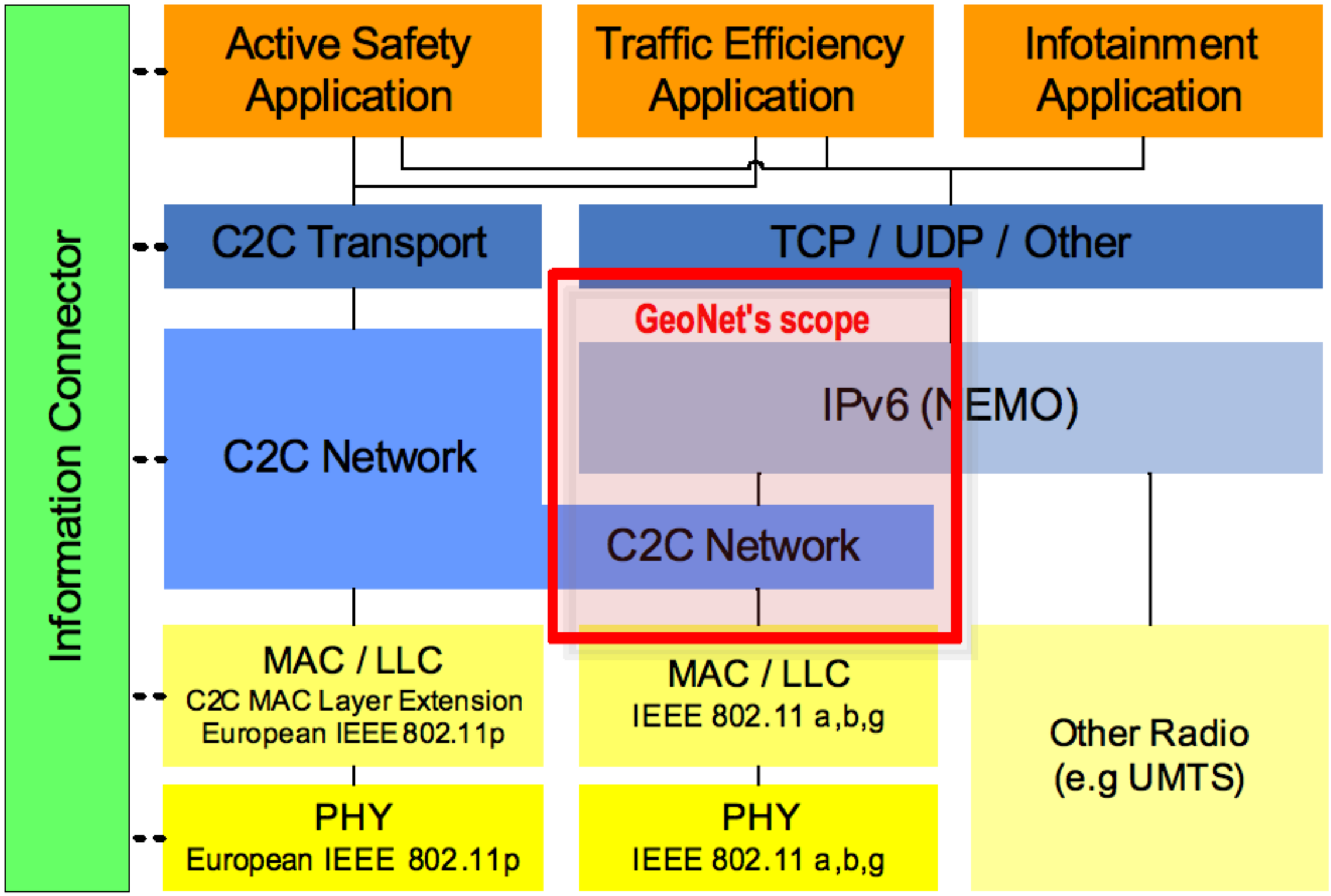
- IPv4 does not fit to ITS requirements
  - 2^{32} = 4,294,967,296 addresses only
  - IPv4 address exhausted by 2011 / 2012

- IPv6: an evolution of IP
  - New IP header
  - Fully specified, implemented - operational deployment started

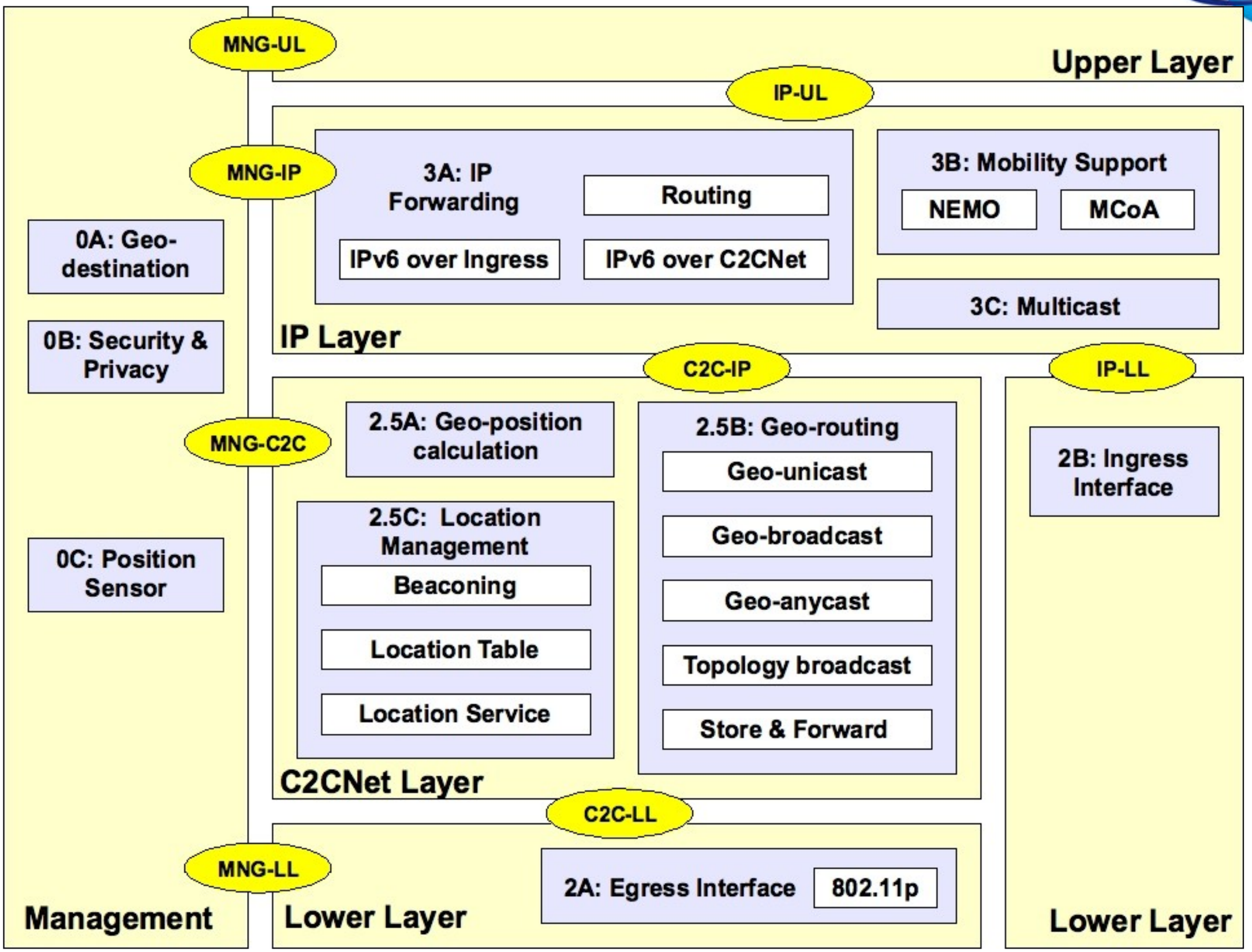
- IPv6 addressing
  - 128 bits instead of 32 (2^{128} addresses instead of 2^{32})
  - Up to 3 911 873 538 269 506 102 addresses / m^2
  - An address for everything on the network

- IPv6 comprises new features absolutely needed for ITS
  - Auto-configuration
  - IP session continuity (NEMO)
  - Multiple wireless media supported at once (McoA)
  - Enhanced security
  - Embedded multicast

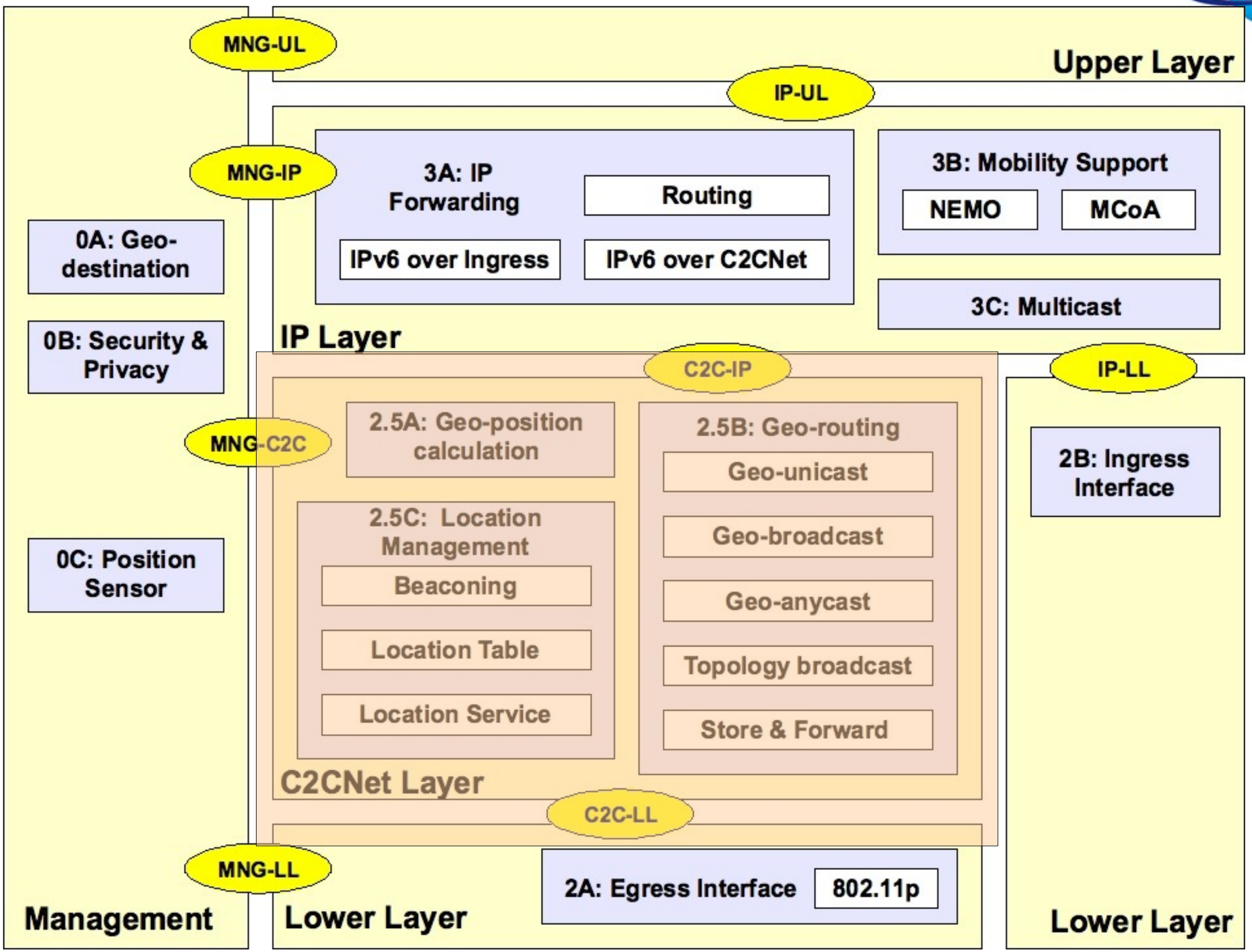
GeoNet: Scope



GeoNet: Functional Modules

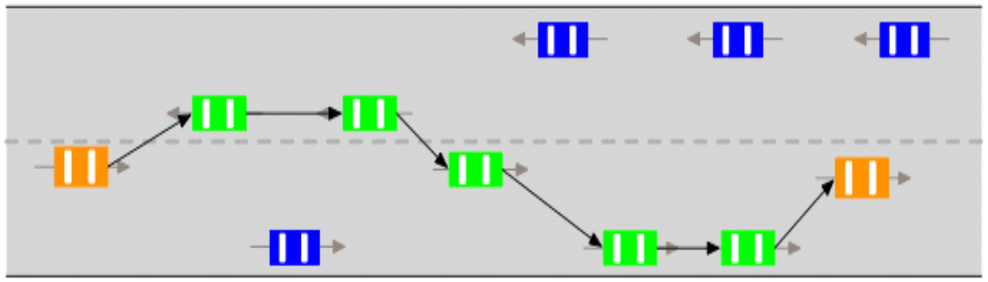


GeoNet: C2CNet Layer

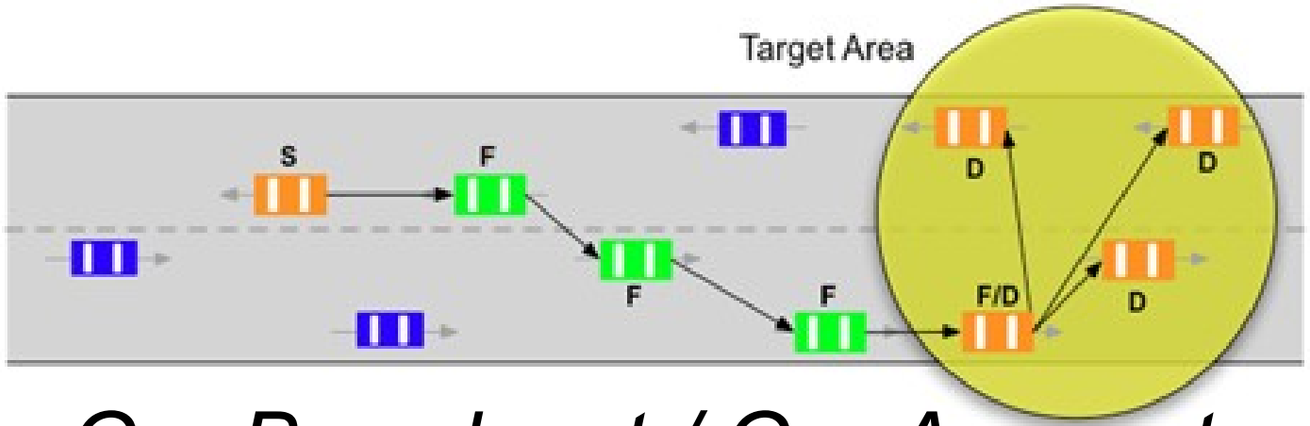


GeoNet: C2CNet GeoNetworking

- Packet forwarding
  - GeoUnicast: from one node to a single node
  - GeoAnycast: from one node to any node in area
  - GeoBroadcast: from one node to all nodes in area
  - TopoBroadcast: from one node to all nodes n-hop away
  - Message buffering (with GeoNetwork triggered re-evaluation)



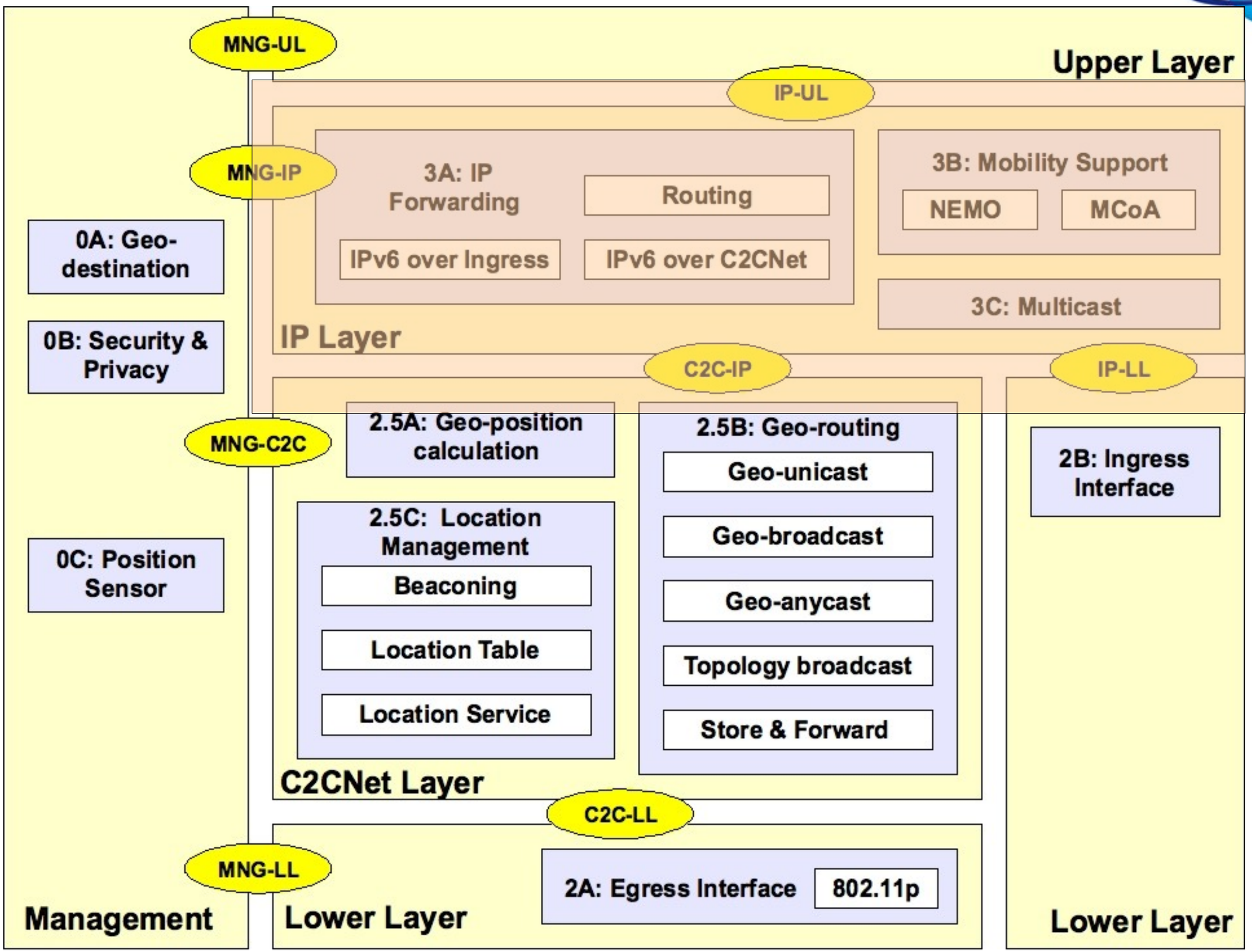
GeoUnicast



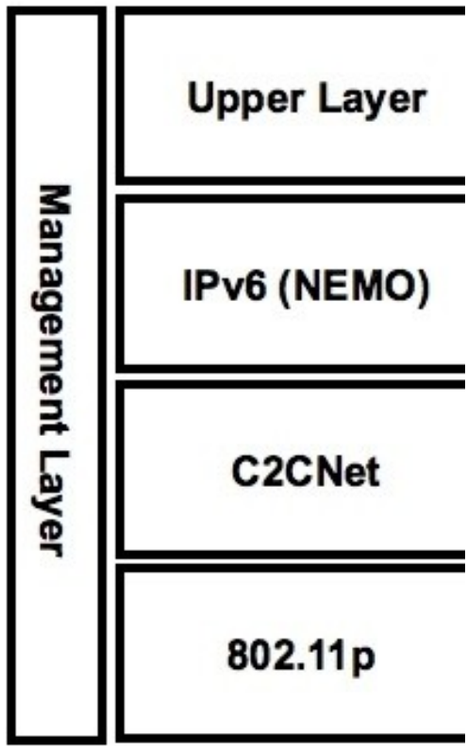
GeoBroadcast / GeoAnycast

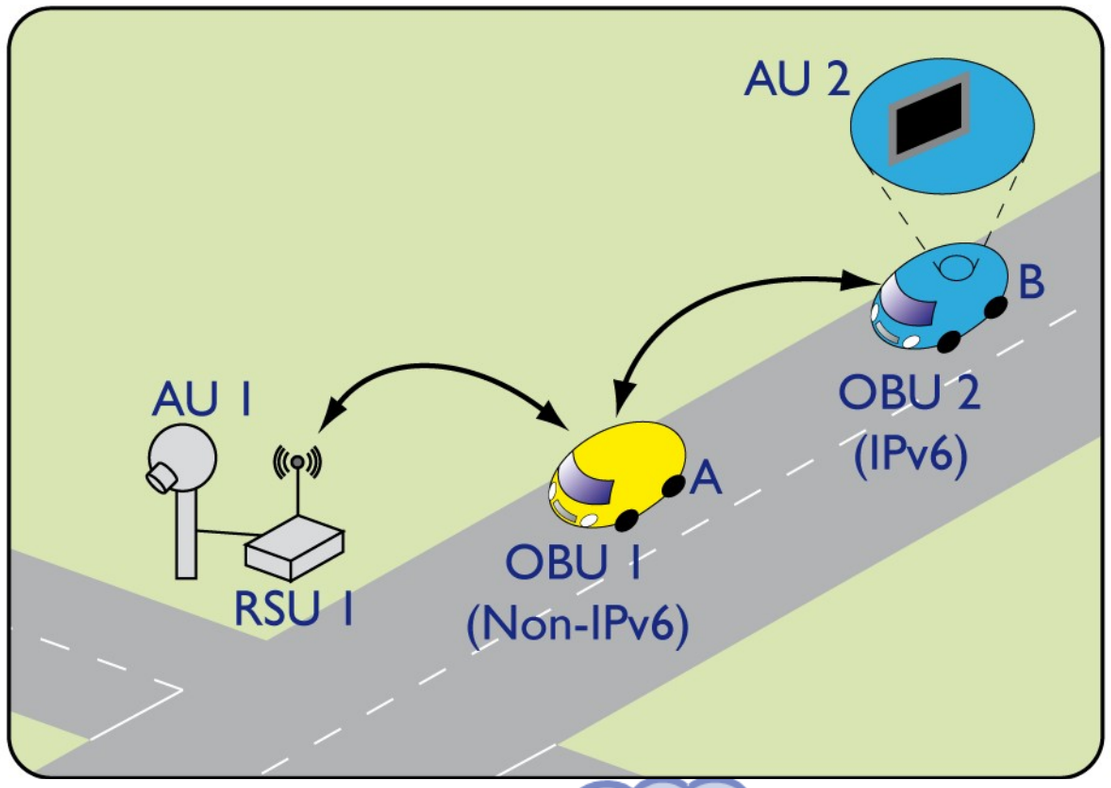
- Location management
  - Beaconing (periodic single-hop broadcast)
  - Location Table
  - Location Service (lookup of unknown destinations)

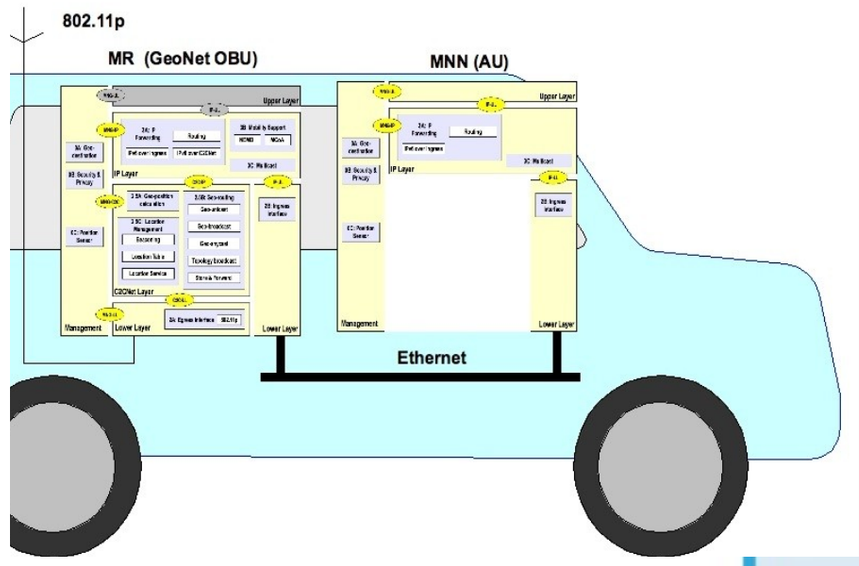
GeoNet: IP Layer

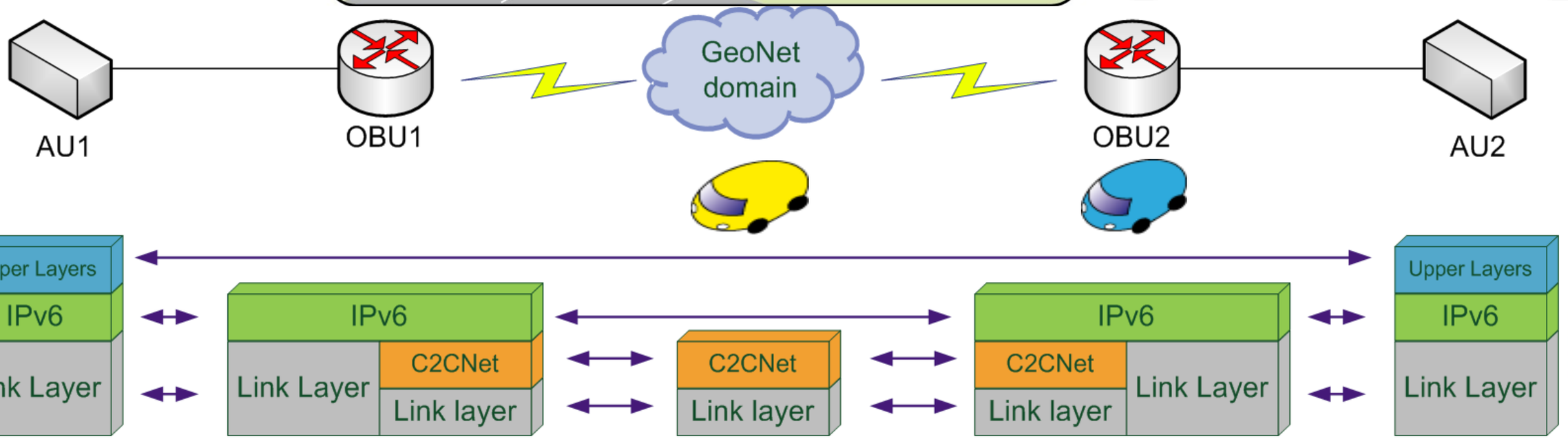


IPv6 over C2CNet



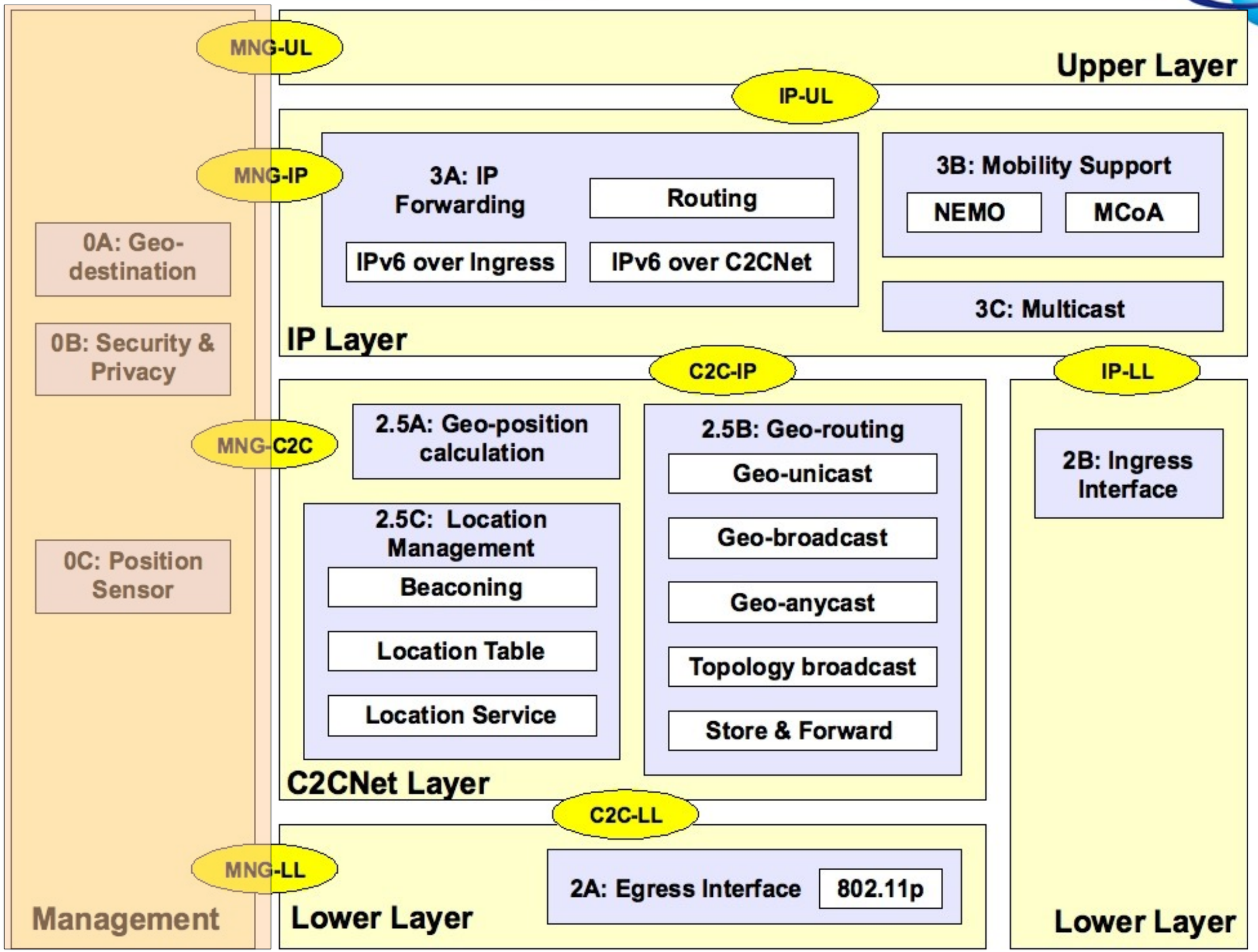




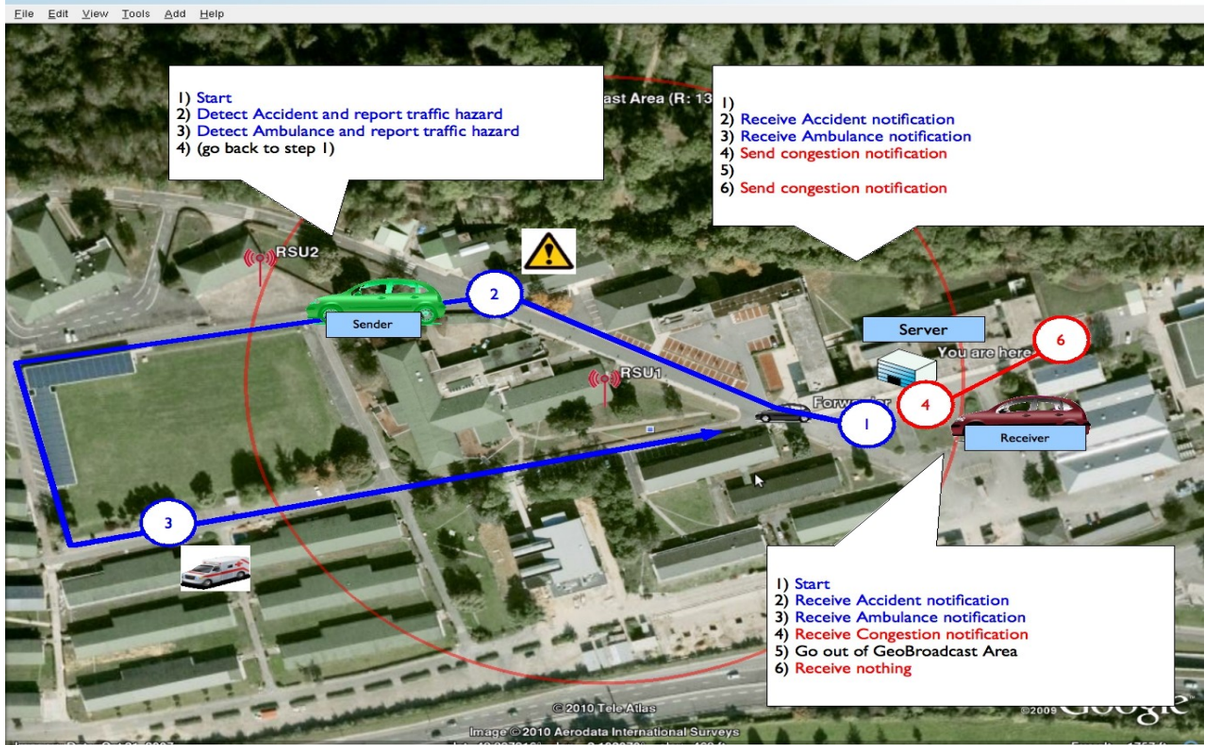


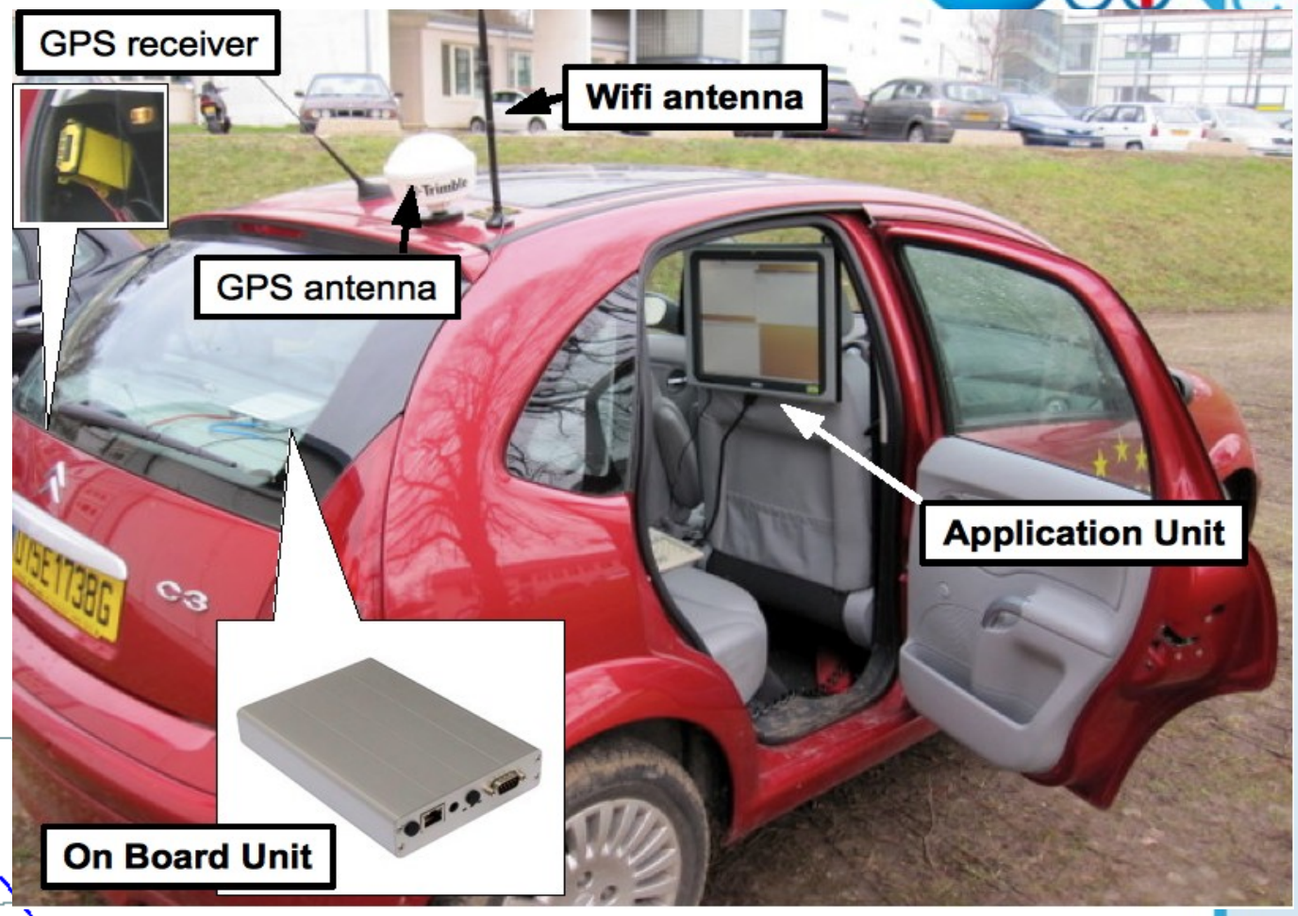
- IPv6 C2CNet link: viewed as virtual link with GeoNetworking capabilities

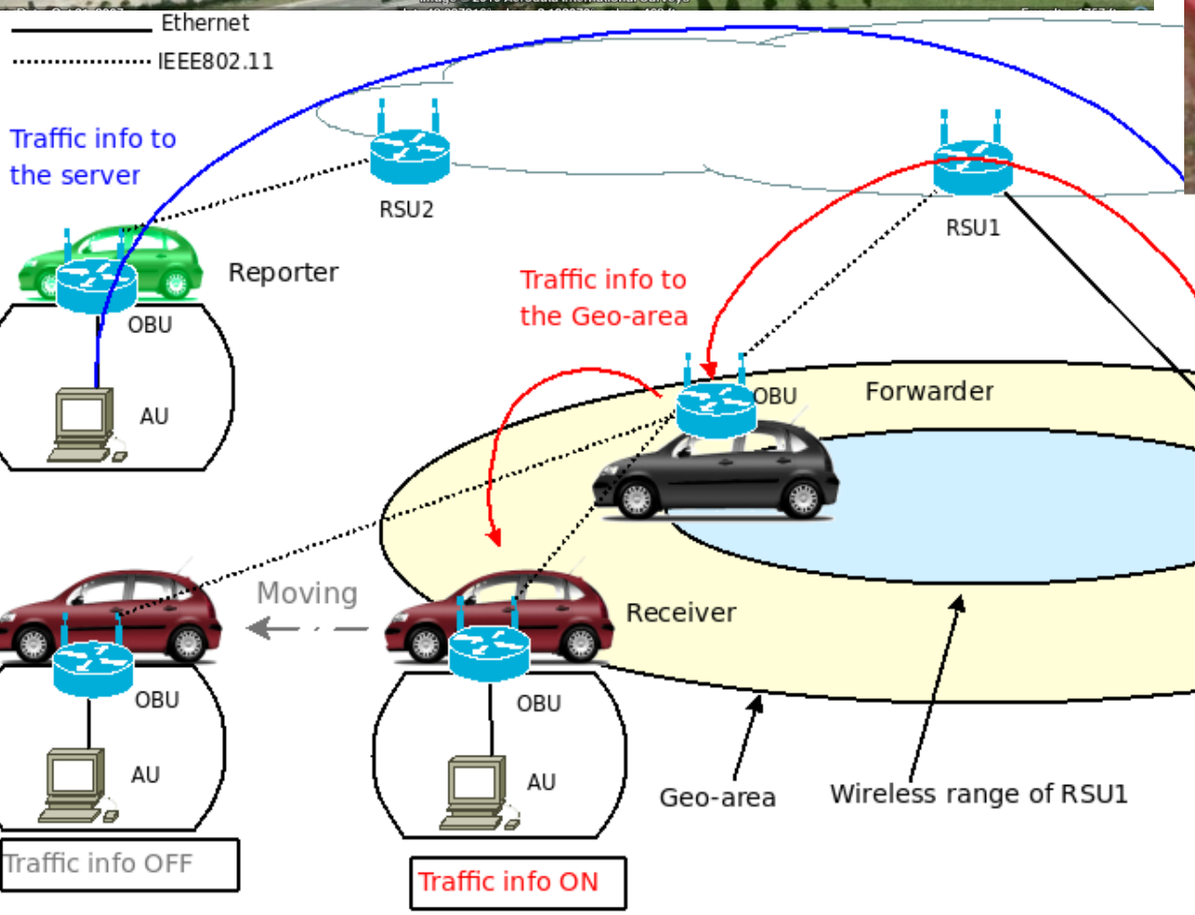
GeoNet: Management Layer



GeoNet: Workshop Demo







GeoNet: Summary

- IPv6 + GeoNetworking = Enabling technology for better:
  - Road safety
  - Traffic efficiency
  - Value added services

- Well supported at time of set-up
  - C2C-CC, SafeSpot, Coopers, CVIS

- Status
  - 1 reference specification
  - 2 prototype implementations (Linux 2.6 / UMIP)
  - Experimentation on a fleet of 4 vehicles
  - Conformance tests: TTCN-3
  - Emulation with NCTUns
  - CVIS selected as the target platform

- Effective dissemination in SDOs (ISO, ETSI, IETF)

Thank you for your attention

Most deliverables are public and will be available on

http://www.geonet-project.eu

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GeoNet Technical Coordinator

ETSI ITS Workshop – February 2010 – Sophia-Antipolis

GeoNet Fact Sheet

- Feb. 2008 – Jan. 2009
- Budget: 3 M€
- Funding: 1.9 M€
- 7 partners
  - 2 Research Institutes (INRIA and IMDEA)
  - 1 SME (Broadbit)
  - 4 industrial partners (Hitachi, NEC, Lesswire & Efkon)

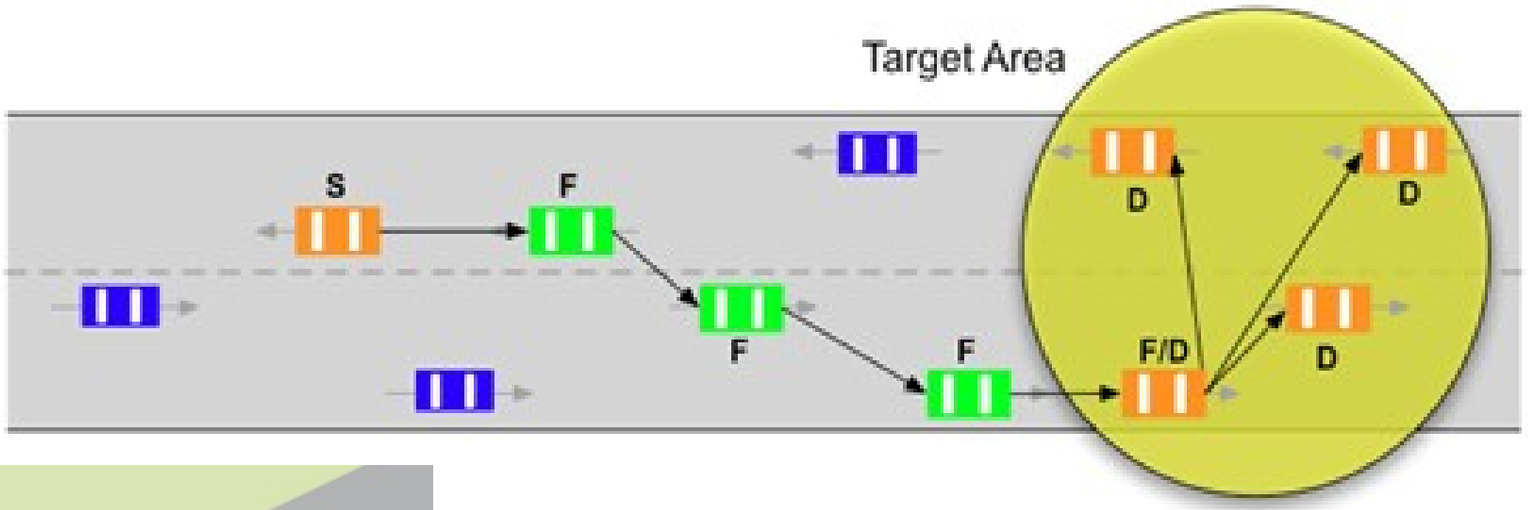
- Web: http://www.geonet-project.eu
  - News, deliverables, presentations

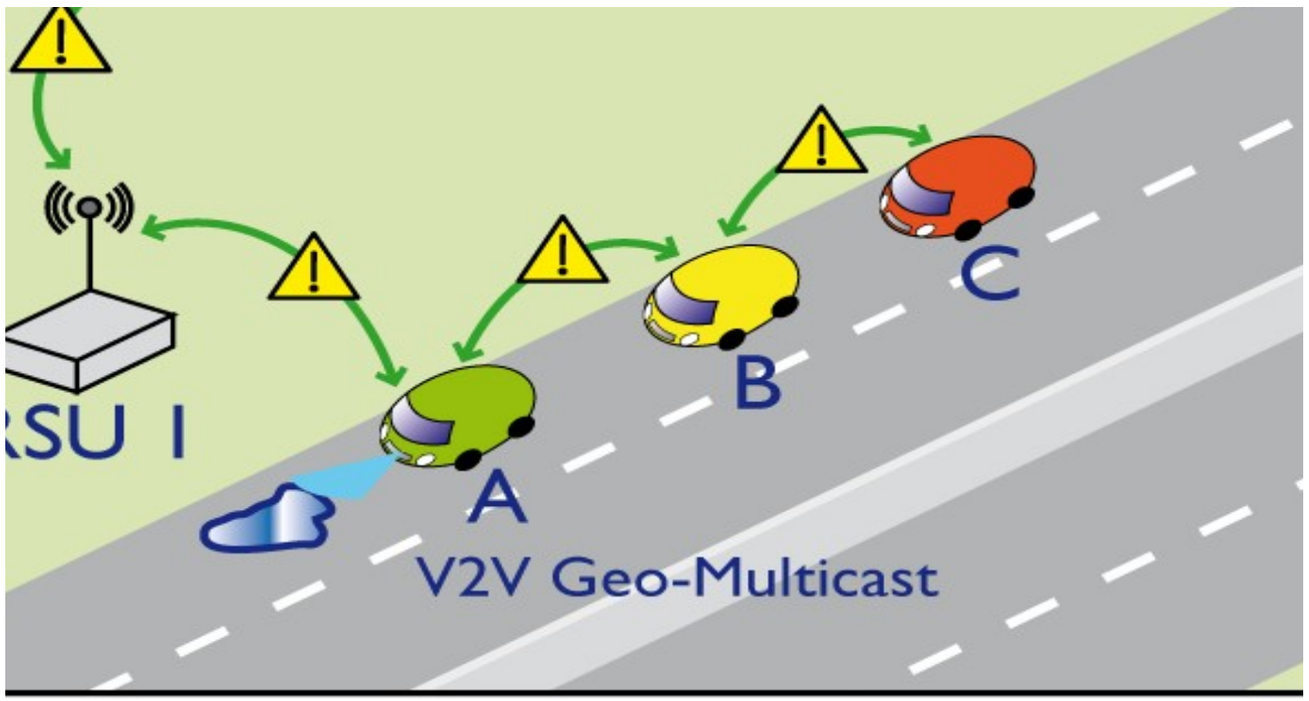
- Objective: Design the concepts linking geographic addressing and routing with IPv6 mobility mechanisms (IPv6 GeoNetworking)

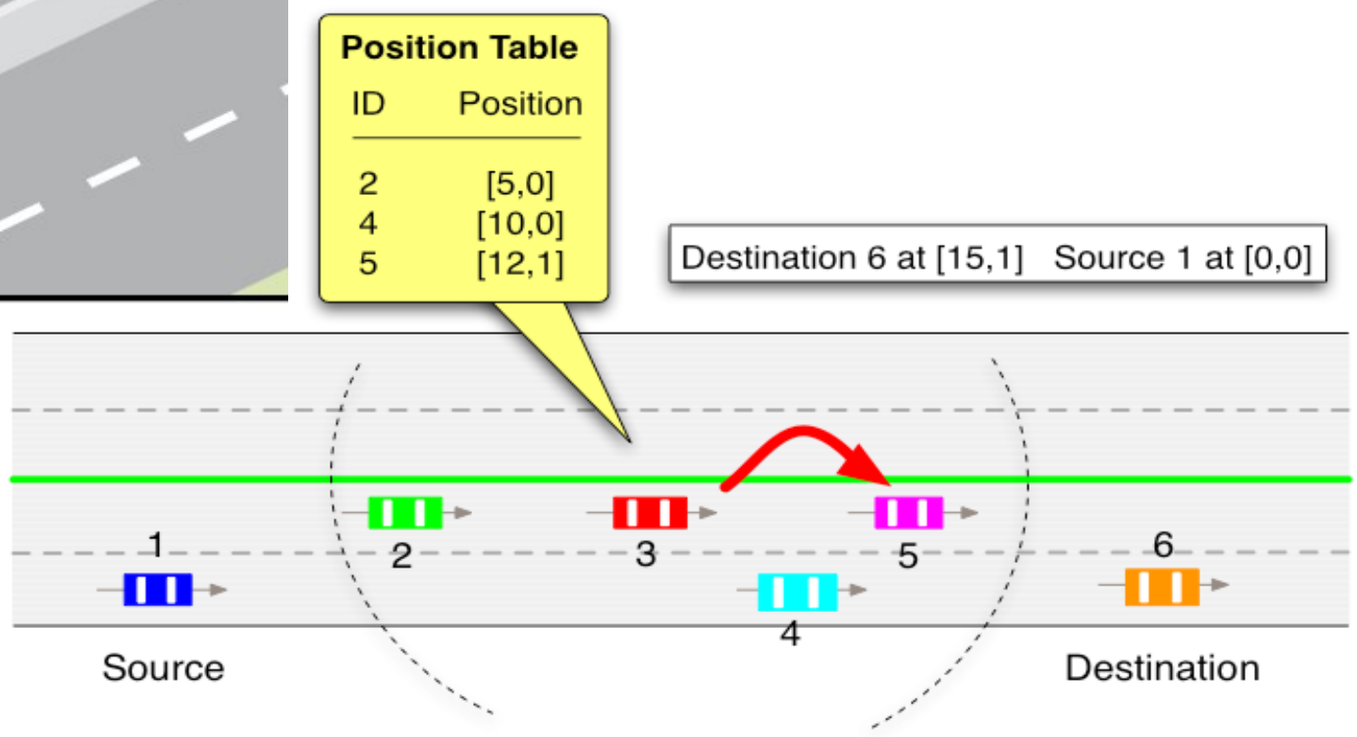
GeoNet: Scope

- 3 main axes:
  - **Knowledge**: elaborate a unified IPv6 GeoNetworking architecture compliant with best practices in vehicular communications;
  - **Standards**: produce a reference IPv6 GeoNetworking specification and push it to SDOs (ISO, ETSI, IETF);
  - **Software**: produce two prototype implementations and disseminate it to existing consortia (particularly SafeSpot, CVIS, COOPERS and C2C-CC).

Why GeoNetworking ?







Why IPv6 GeoNetworking ?

- GeoNet: scenarios requiring both IPv6 and geonetworking

- Scenario Type 1: sender is in the Internet
  - Packets are transmitted in IPv6 until the RSUs serving the geographic area where they are GeoRouted through intermediate vehicles to the final destination(s).

- Scenario type 2: receiver is in the Internet
  - Packets are GeoRouted through intermediate vehicles (using GeoUnicast) until a RSU where they are transmitted in IPv6 to the final destination.

- Scenario type 3: sender and receiver(s) are only reachable through the Internet
  - Combination of Scenarios Type 1 & 2 where source and destination(s) are out of multi-hop wireless range

GeoNet: Design Goals (D1.2)

- Architecture combining IPv6 and GeoNetworking

- Communication modes
  - Vehicle-based: without infrastructure (V2V)
  - Roadside-based: with roadside infrastructure (V2I)
  - Internet-based: with the Internet

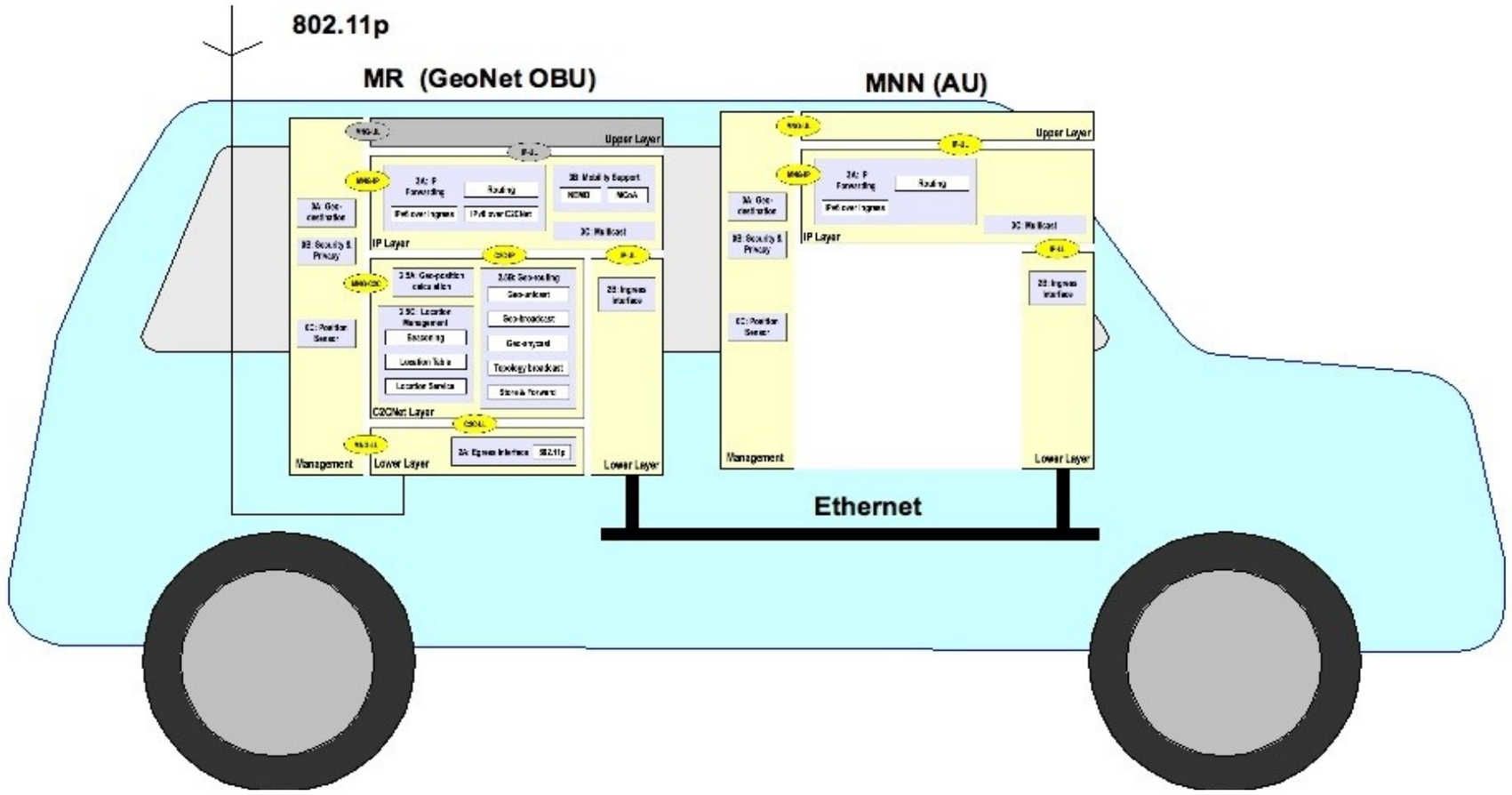
- Destination set
  - Single destination
  - Multiple destinations

- Preserve security and location privacy

- Compatibility and interoperability

Why IPv6: address requirements

- Vehicles will be connected to the Internet
- In-vehicle IP network => Several IP addresses / vehicle
- Number of cars worldwide
  - 1997: 600 millions
  - 2030: 1200 millions (at present trend)
- IPv4 does not fit to ITS requirements
  - 2^{32} = 4,294,967,296 addresses only
  - IPv4 address exhausted by 2011 / 2012



GeoNet: Documents

- Most deliverables are public and will be uploaded as soon as they are completed (this month)
  - Check http://www.geonet-project.eu
- D1.2 Final GeoNet Architecture Design
  - http://www.geonet-project.eu/?download=GeoNet-D1.2-architecture_design.pdf
- D2.2 Final GeoNet Specification
  - http://www.geonet-project.eu/?download=GeoNet-D2.2-final_specification.pdf
- GeoNet Final Workshop
  - http://www.geonet-project.eu/?p=223

GeoNet: IPv6 Layer

- IPv6 is not Geo-Aware
  - How IPv6 packets could be transmitted to a destination(s) in a specific geographic location ?

- GeoNet relies on IPv6 multicast
  - Several GeoDestination – IP Group ID encoding approaches

- GeoNet hides GeoNetworking from the IP layer
  - Enhancements required at the IP layer for location privacy (pseudonyms) & direct V2V (MNP exchange)

- GeoNet complies with ETSI and ISO architectures
  - NEMO is used to guarantee reachability at a permanent address and maintaining sessions
  - The Mobile Router entity at the OBU manages the connectivity on behalf of all the in-vehicle nodes

GeoNet: Work Ahead

- Progress work items in SDOs
  - ETSI: GeoNetworking (TS 102-636-4-1)
  - ETSI: IPv6 GeoNetworking (TS 102-636-6-1)
  - ISO CALM
- Validation in Field Operational Tests (FOTs) needed
- Expand the architecture / specification
  - Tighter integration of IPv6 & GeoNetworking: Position aware IP applications / GeoDestination encoding within IPv6 multicast
  - IP-layer security & QoS
  - Transport layer
  - Congestion control

Why IPv6 ?

- IPv6: Internet Protocol version 6
  - Designed by the IETF since 1995 as a replacement of IPv4
- IPv6 is an evolution of IP
  - New IP header
  - Fully specified, implemented - operational deployment started
- IPv6 addressing
  - 128 bits instead of 32 (2^{128} addresses instead of 2^{32})
  - Up to 3 911 873 538 269 506 102 addresses / m^2
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- IPv6 comprises new features absolutely needed for ITS
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