The Integrated Wireless and Traffic Platform for Real-Time Road Traffic Management Solutions

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ETSI TC ITS WG3
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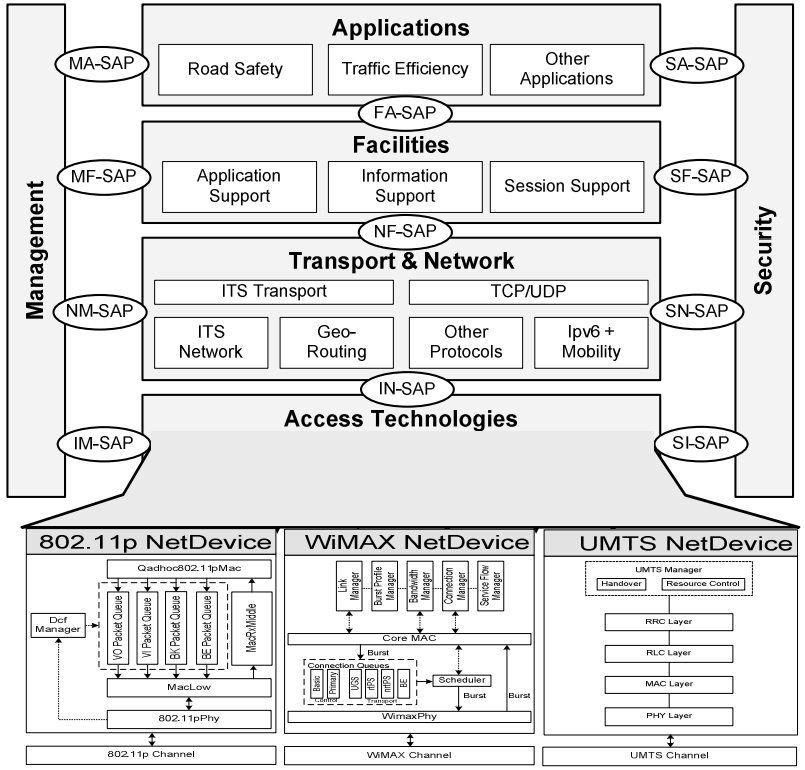
The iTETRIS project

iTETRIS targets large-scale long-term evaluations of performance and effect of V2X communications for traffic management.

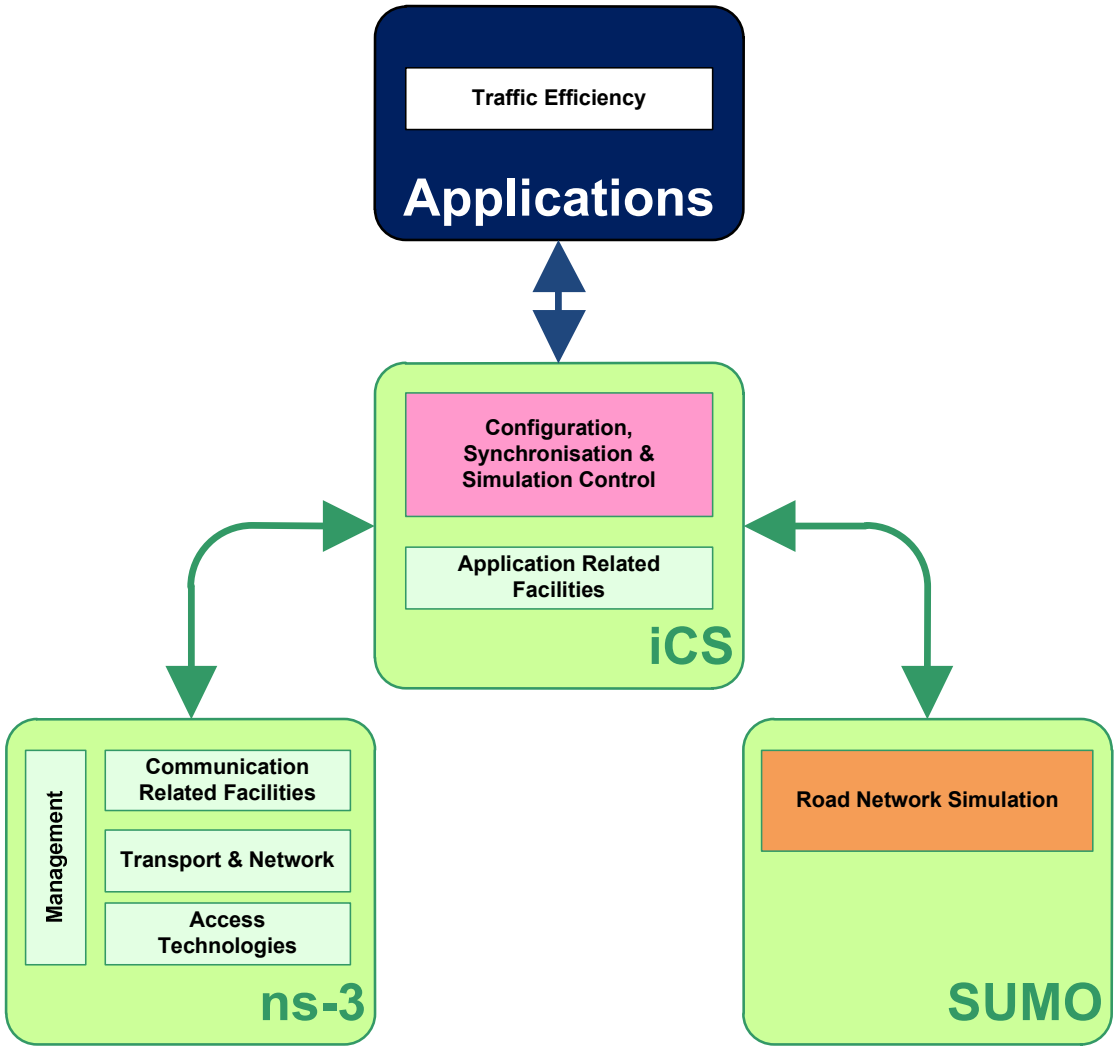
- Development of a holistic closed-loop simulation environment
- Development of general traffic management strategies
- Development of data distribution strategies for V2V+V2I communications
- Evaluations with realistic traffic flows

ITS standards compliance

- ITS architectures
  - Use the open architectures defined in COMeSafety and ETSI TC ITS as basic reference
- Compliant implementations
  - IEEE 802.11p, ETSI TC ITS (5GA)
  - UMTS, WiMAX and DVB-H
- Contributions
  - Provide inputs to C2C-CC WG and ETSI TC ITS

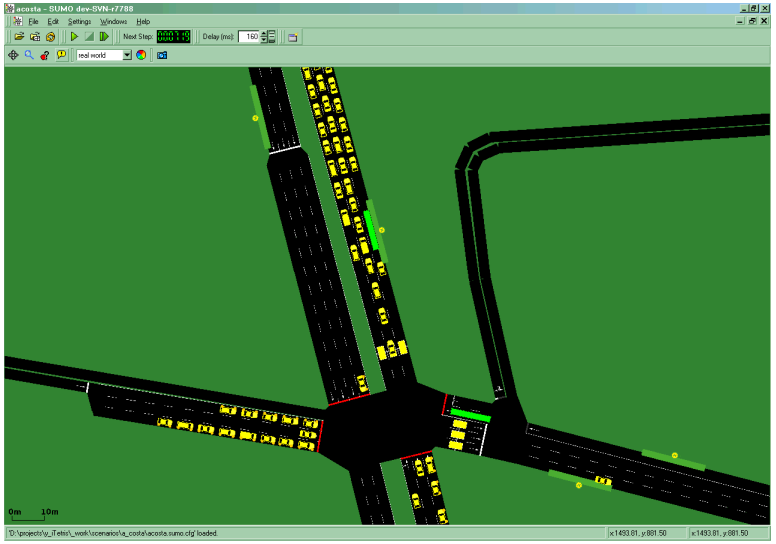


iTetris Architecture Overview



Traffic Simulation

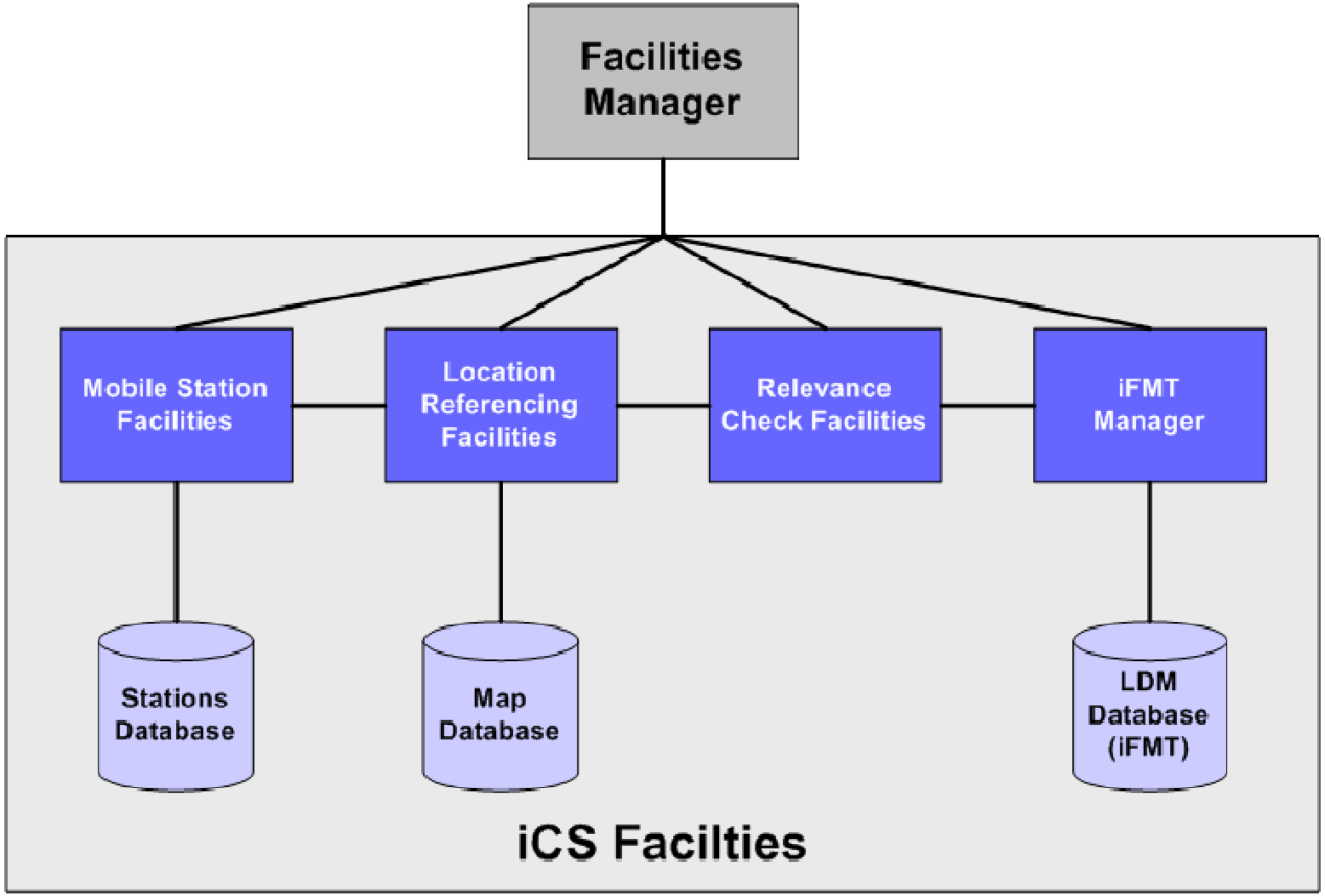
- Microscopic open-source traffic simulator **SUMO** (http://sumo.sourceforge.net)
- Simulation of realistic traffic flows with multiple vehicle classes (cars, busses, electric vehicles, etc.)
- SUMO allows simulation of up to 500 000 vehicles in real-time
- iTETRIS extensions:
  - Emission modeling: CO_2, NO_x, particles, noise, fuel consumption, etc.
  - Adaptive Vehicle Rerouting/ Traffic Light Control: closed-loop simulations



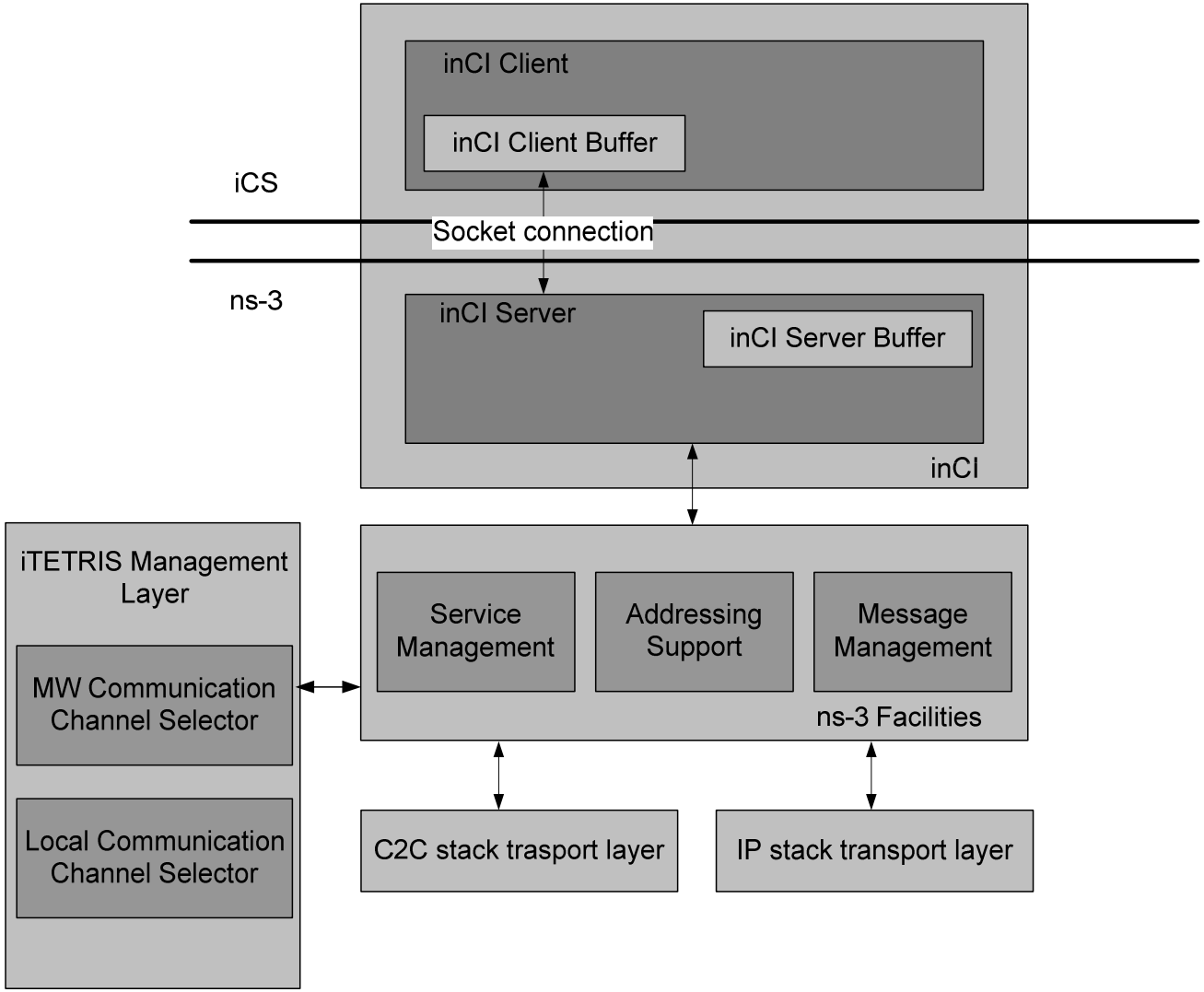
Split of ITS Facilities between Components

iTETRIS Block	Facility
Application-Related Facilities (iCS)	Mobile Station
	Location Referencing
	Relevance Check
	iFMT Manager
Communication-Related Facilities (ns-3)	Service Management
	Message Management
	Addressing Support
	Session Support

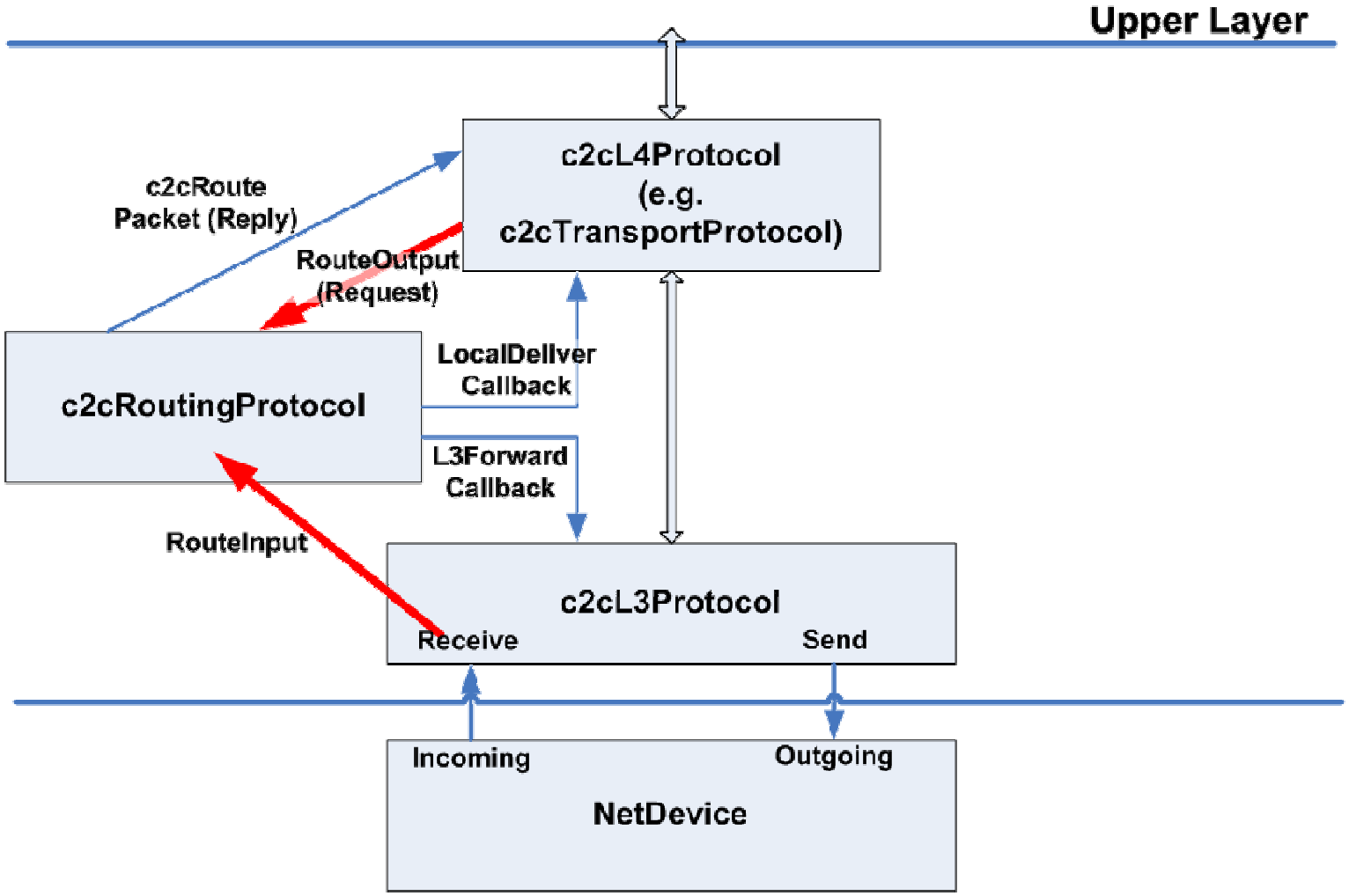
ITS Facilities in iCS



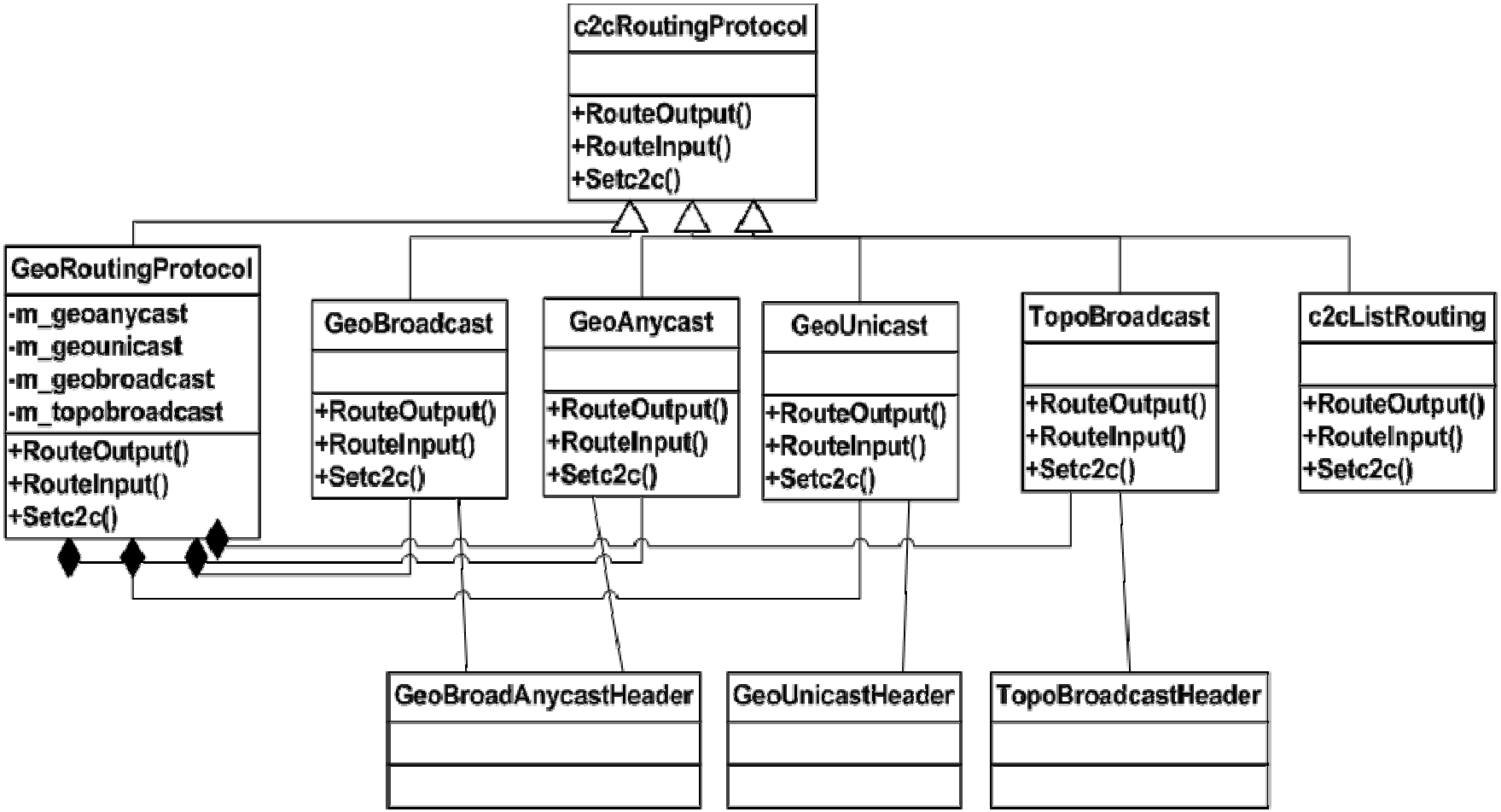
ITS facilities in ns-3



GeoNetworking (Standard-compliant)



Class diagram of GeoNetworking protocols



GeoNetworking Addressing Formats

	GeoBroadcast	GeoUnicast/ Node Address	GeoAnycast	TopoBroadcast
m_id	BROADCAST_ ADDR_CST	Node ID	ANYCAST_ ADDR_CST	BROADCAST_ ADDR_CST
m_geoareapos1	Geo destination area 1 position	Node geoPosition	Geo destination area 1 position	NULL
m_geoareapos2	Geo destination area 2 position	NULL	Geo destination area 2 position	NULL
m_areasize	Geo destination area size	NULL	Geo destination area size	TTL

Advanced Networking Protocols

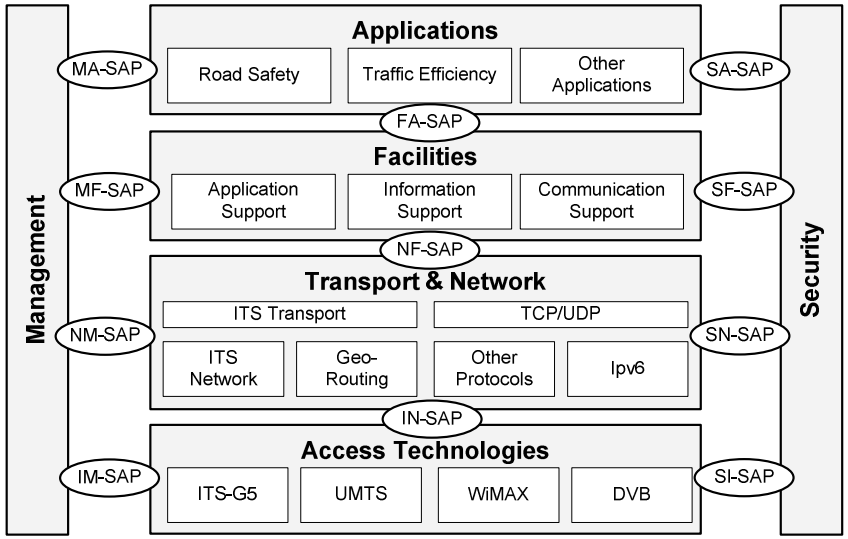
Name of Protocol	Main Functionalities / Type of Protocol	Other Capabilities
BZB	FW +GB	
GPSR	GA + GU	
CBF	GA + GU	
SAR	GA + GU	
Abiding Geocast	GB + TB	Lifetime for geocast messages
LANE-RP	GA + GU	Road topology aware
REDNET	FW + GA + GU	Reliable forwarding
OPRAM	FW + GB + GA + TB + GU	Opportunistic congestion control
DiRCoD	FW + GB + GA + GU	Supporting mechanism for georouting message dissemination
MobCast	FW	DTN

FW = Efficient Forwarding Mechanism
GB = GeoBroadcast
GA = GeoAnycast
TB = TopoBroadcast
GU = GeoUnicast

Wireless Access Technologies

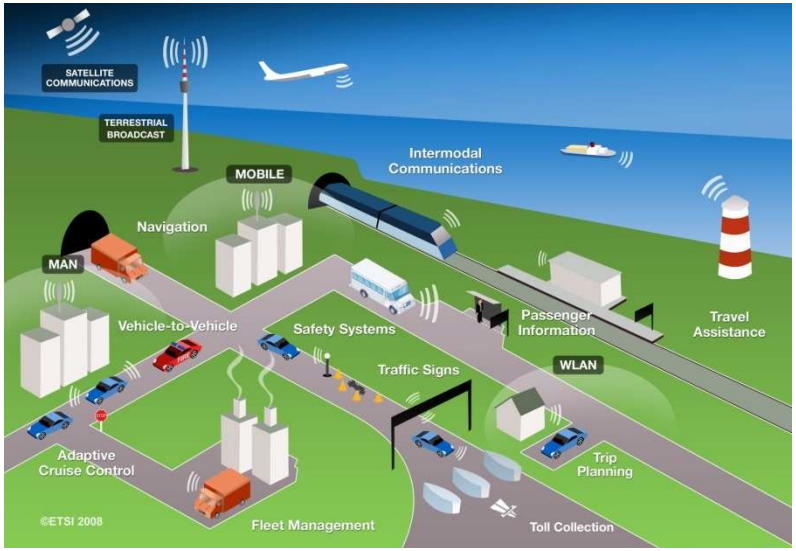
Heterogeneous wireless communication platform

- Different communication modalities required by iTETRIS applications (traffic efficiency)
- V2V and V2I combined strategies -> ITS-G5/802.11p, WiMAX, UMTS and DVB-H



Access technology selection mechanisms

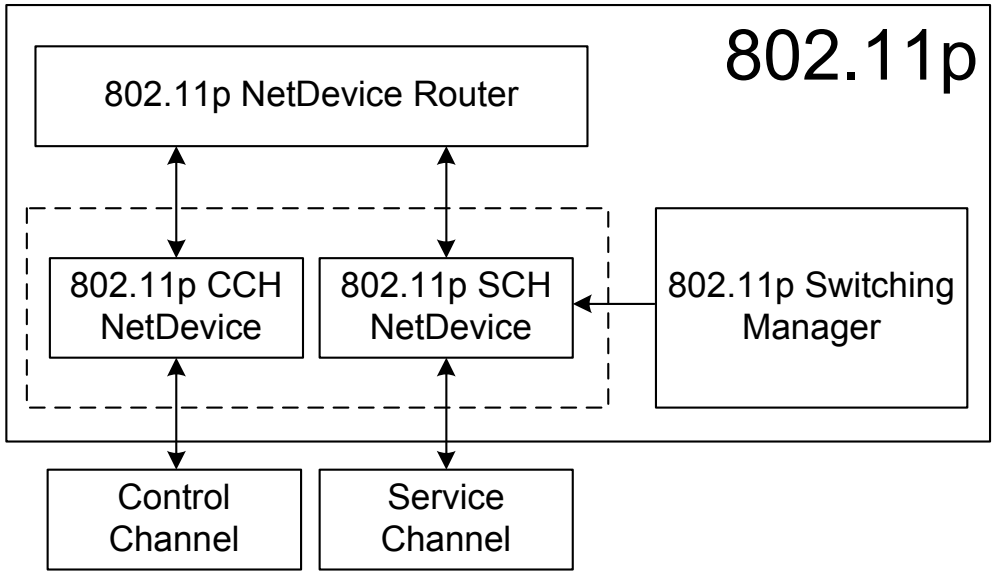
- Most suitable option in time and space
  - User preferences
  - Application requirements
  - Technology status and availability
- Use of dedicated networks for ITS services
  - Based on technical and financial aspects
- Split of ITS communication traffic over more than one technology



ITS-G5A/802.11p modeling in iTETRIS

- ITS-G5A/802.11p implementation based on current ns-3 WiFi module
- New functionalities/modules implemented for ITS-G5A/802.11p operation

802.11p functionality
10Mhz channel spacing
Control of transmission parameters by upper layers/management block
Routing packets to 802.11p channel
Channel switching
V2V and V2I propagation models
Optimized PHY model

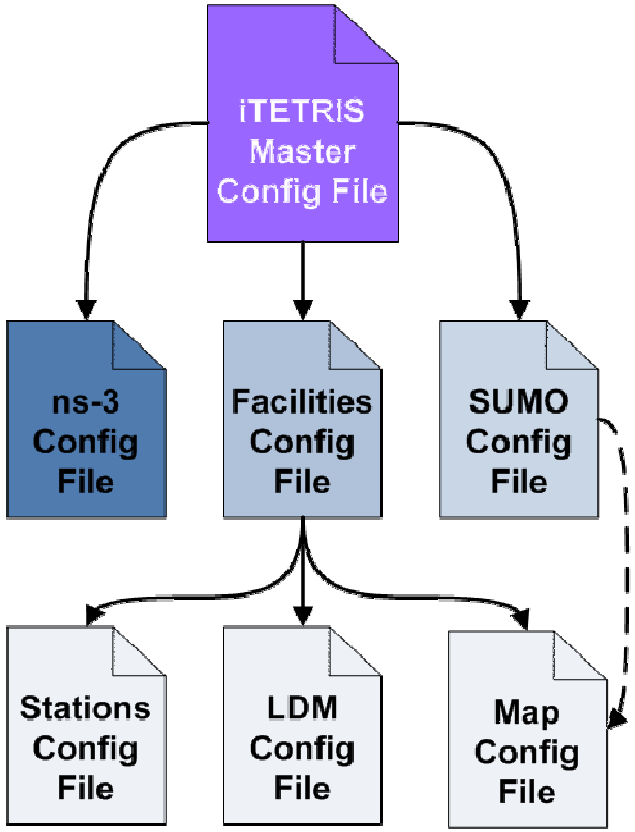


- 802.11p NetDevice Router -> Routing of packets to the correct NetDevice
- 802.11p Switching Manager -> Cancellation/storing/resuming of packets
- Support for congestion control -> Per-packet control of power and data rate

Example of Scenario Definition for iTetris Validation

- Scenario (Bologna) Orbital/Highway
- Strategy S8 : Event Based Traffic Condition Notification
- Event : detection of traffic jam by S1 or S2
- Facilities : DENM message
- Networking protocols : broadcast + geocasting /+ advanced protocols /+ DTN
- Technologies : 802.11p, UMTS , DVB
- Penetration rate : varying from 100%
- Application : When a traffic jam has been detected, a notification is broadcasted and we measure the number of vehicles informed

iTetris Simulation Configuration




```
- <configuration >
  - <scenario >
      <begin value="0" />
      <end value="3600" />
      <penetration-rate value="100" />
      <interactive value="true" />
      <facilities-config-file value="facilities-config-file.xml " />
      <interactive value="true" />
      <cooperative value="true" />
    </scenario >
  - <trafficsim >
      <traffic-executable value="sumo -c" />
      <traffic-file value="myscenario.sumo.cfg " />
      <traffic-host value="localhost " />
      <traffic-port value="1984" />
    </trafficsim >
  - <communicationsim >
      <communication-executable value="main-inci5 " />
      <communication-host value="localhost " />
      <communication-port value="1982" />
      <communication-general-params-file value="/myns-3path/configGeneral.xml " />
      <communication-config-technologies-file value="/myns-3path/configTechnologies.xml " />
    </communicationsim >
  - <applications >
      <app-config-file value="/home/arubio/Proyectos/trunk/iCS/application -config-file.xml " />
    </applications >
  - <logs>
      <ics-log-path value="ics-log.txt " />
      <ns3-log-path value="ns3-log.txt " />
    </logs>
</configuration >
```

Conclusions

Future usage of the iTETRIS platform:

- Performance evaluations of communication protocols
- Evaluation of the effect of traffic management applications
- Simple integration of novel applications and scenarios
- Help the future FOTs for planning in their preliminary phase
- Extend the SUMO or ns3 simulator to cover new emerging use cases and scenarios, or even replace either of them with another simulator, as interoperability is a key objective of the development of the iCS.

Feel free to visit our website http://www.ict-itetris.eu or contact one of the project members directly

Project Details

Partners

- Peek Traffic B.V. (The Netherlands)
- CBT Comunicacion & Multimedia (Spain)
- City of Bologna (Italy)
- German Aerospace Center – DLR (Germany)
- Hitachi Europe SAS (France)
- Innovalia Association (Spain)
- Eurecom (France)
- Thales Communications (France)
- Universidad Miguel Hernandez (Spain)

Project details

- Duration: 30 months (07/2008 – 12/2010)
- Budget/EC Funding: 4.42 M€ / 2.96 M€
- Website: www.ict-itetris.eu
- Contact: Thales Communications
  coordinator@ict-itetris.eu