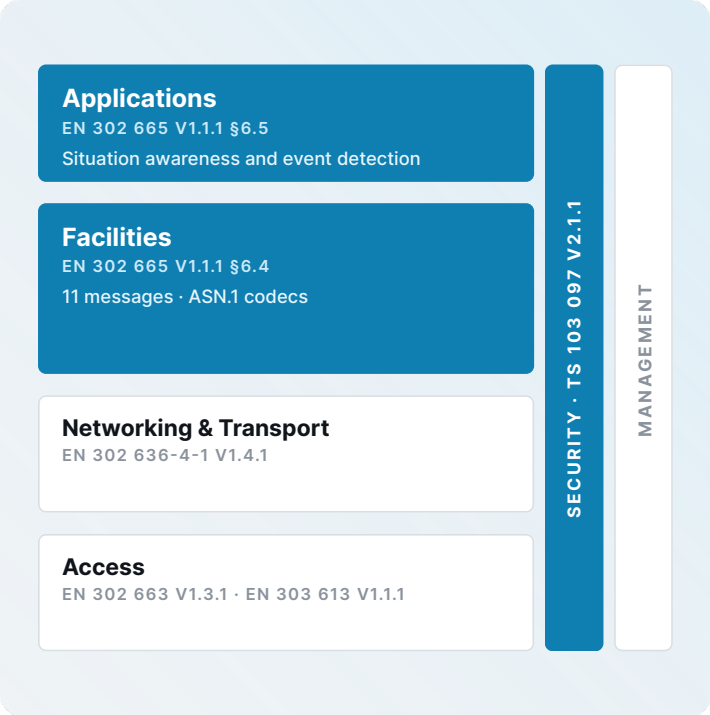
V2X Stack — ETSI Release 1 and 2

C-ITS protocol stack for European roadside and vehicle stations



MESSAGES

- CAM
- SPATEM
- IVIM
- SSEM
- VAM
- SAEM
- DENM
- MAPEM
- SREM
- CPM
- POIM
- RTCMEM

USE CASES

- Traffic light information
- Green light speed advisory
- Priority vehicle management
- Intersection collision warning
- VRU presence awareness
- Augmented perception
- Roadwork warning
- Detour management

SPECIFICATIONS

MESSAGES
11 · ETSI TS 103 248 V2.5.1

ENCODING
ASN.1 UPER

DAY-1 HARMONISED
EN 302 637-2 V1.4.1 · EN 302 637-3 V1.3.1

RELEASE SELECTION
One per deployment

NETWORKING AND TRANSPORT
EN 302 636-4-1 V1.4.1 · EN 302 636-5-1 V2.2.1

SECURITY
ETSI TS 103 097 V2.1.1 · IEEE 1609.2 v3

SIGNATURE
ECDSA · NIST P-256 · brainpool P-256 / P-384

PKI
ETSI TS 102 941 V2.2.1 · pseudonym rotation

CONGESTION CONTROL
ETSI TS 102 687 V1.2.1 · C-Roads 3.2.0 profile

RADIO
ITS-G5 · C-V2X PC5

POSITIONING
ETSI EN 302 890-2 V2.1.1

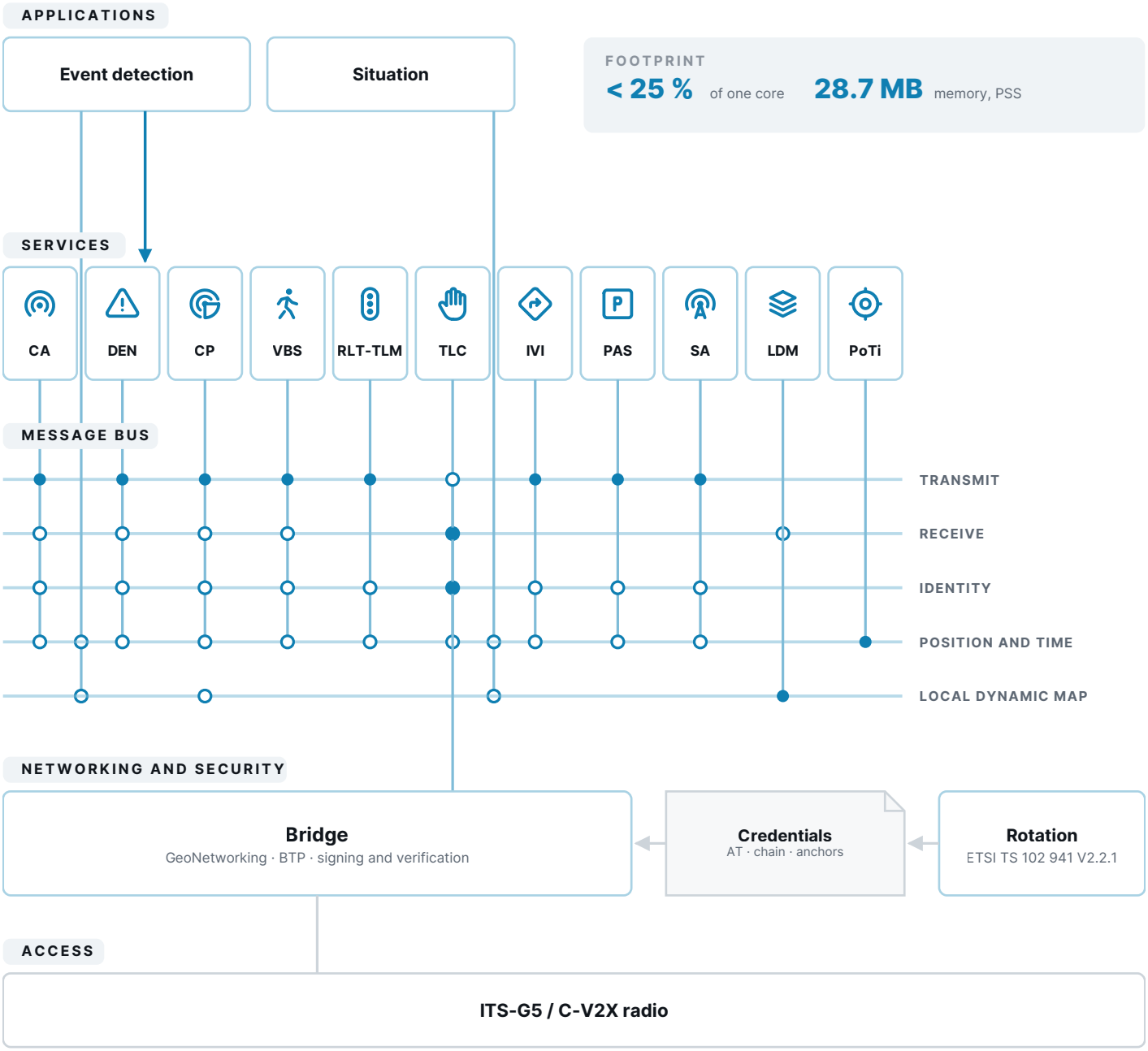
PLATFORMS
x86-64 · armv7 hard-float

< 25 % OF ONE CORE

28.7 MB MEMORY

11 C-ITS MESSAGES

Complete roadside station on a single-core Cortex-A7 at 792 MHz.



Interfaces: GNSS · traffic controller · perception · PKI · client application

Process · Files on disk · Topic lane · Publishes · Subscribes

SUPPORTING SERVICES

PoTi	Position and time · EN 302 890-2 V2.1.1
LDM	Local dynamic map · EN 302 895 V1.1.1
Signal controller	Southbound interface · adapter per vendor

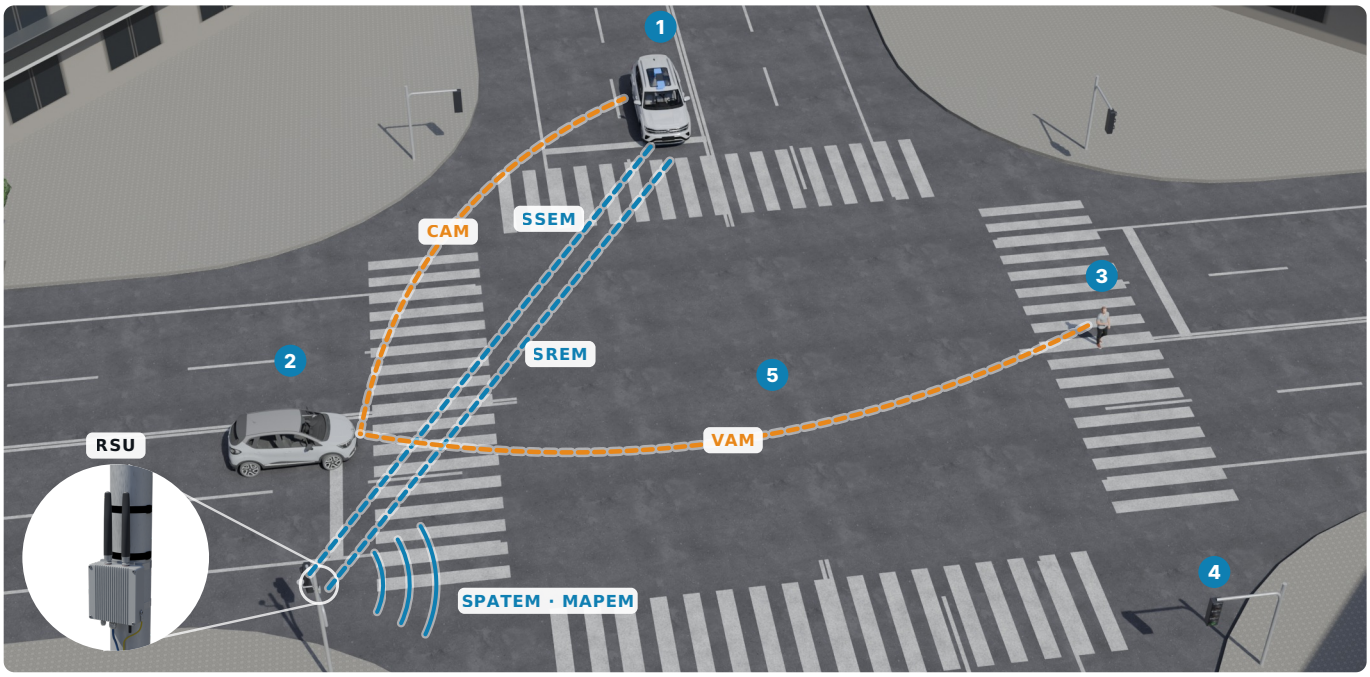
APPLICATIONS LAYER

Situation	Neighbours · time to collision · signal phase
Advisory	Green light optimal speed advisory
Detection	DENM triggering conditions

SERVICE	FUNCTION	MESSAGE	STANDARD AND EDITION	CDD
CA	Cooperative awareness	**CAM**	TS 103 900 V2.2.1 EN 302 637-2 V1.4.1	v4.2 v1.3.1
DEN	Decentralized notification	**DENM**	TS 103 831 V2.3.1 EN 302 637-3 V1.3.1	v4.3 v1.3.1
RLT	Road and lane topology	**MAPEM**	TS 103 301 V1.3.1	v1.3.1
TLM	Traffic light manoeuvre	**SPATEM**	TS 103 301 V1.3.1	v1.3.1
SA	Service announcement	**SAEM**	EN 302 890-1 V1.2.1	v1.3.1
IVI	In-vehicle information	**IVIM**	TS 103 301 V1.3.1	v1.3.1
TLC	Signal request	**SREM**	TS 103 301 V1.3.1	v1.3.1
TLC	Signal status	**SSEM**	TS 103 301 V1.3.1	v1.3.1
CP	Collective perception	**CPM**	TS 103 324 V2.1.1	v3.1
VBS	VRU awareness	**VAM**	TS 103 300-3 V2.2.1	v3.1
PAS	Point of interest	**POIM**	TS 103 916 V2.1.1	v4.1
GPC	GNSS positioning correction · planned	RTCMEM	TS 103 301 V1.3.1	v1.3.1

The correction stream comes from an external NTRIP caster.

AT THE INTERSECTION



1. SREM · SSEM
2. SPATEM · MAPEM
3. VAM · CPM
4. SPATEM · MAPEM
5. CAM · CPM

V2I and I2V · with the roadside

V2V and P2V · between road users

ON THE ROADSIDE MODULE

NXP i.MX6UL, single-core Cortex-A7 at 792 MHz, 488 MB

	ITS-G5	C-V2X PC5
Roadside station, 9 services	20.1 % of one core, 28.7 MB	20.5 %, 28.2 MB
Vehicle station, 3 services	4.77 %, 10.5 MB	4.76 %, 10.4 MB

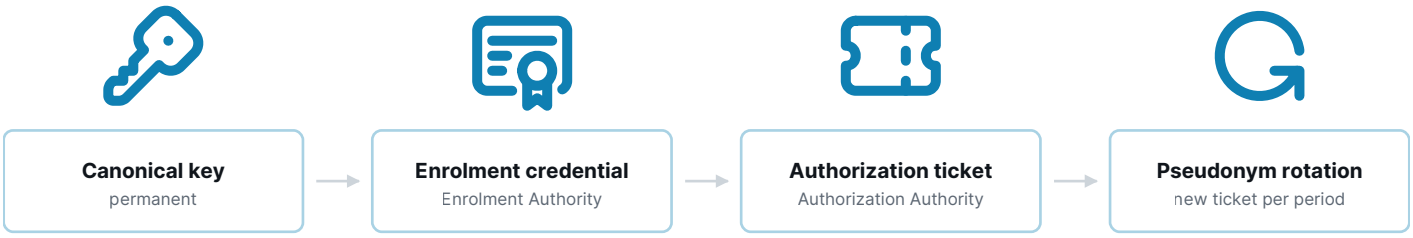
Warm start to first frame	57.2 s · radio switch and satellite fix included
Duty cycle	0.92 % of each second · limit 3 %, EN 302 571 V2.1.1

MESSAGE CADENCE

Measured with 20 stations sharing the channel

Heartbeat within 0.98 to 1.00 s	**96.2 %**
Intervals above 1.05 s	**0.57 %**

SECURITY



ETSI TS 102 941 V2.2.1

ON SEND

- Every outgoing message signed
- IEEE 1609.2 v3 envelope · ETSI TS 103 097 V2.1.1 profile
- Credentials checked before emitting CAM and DENM

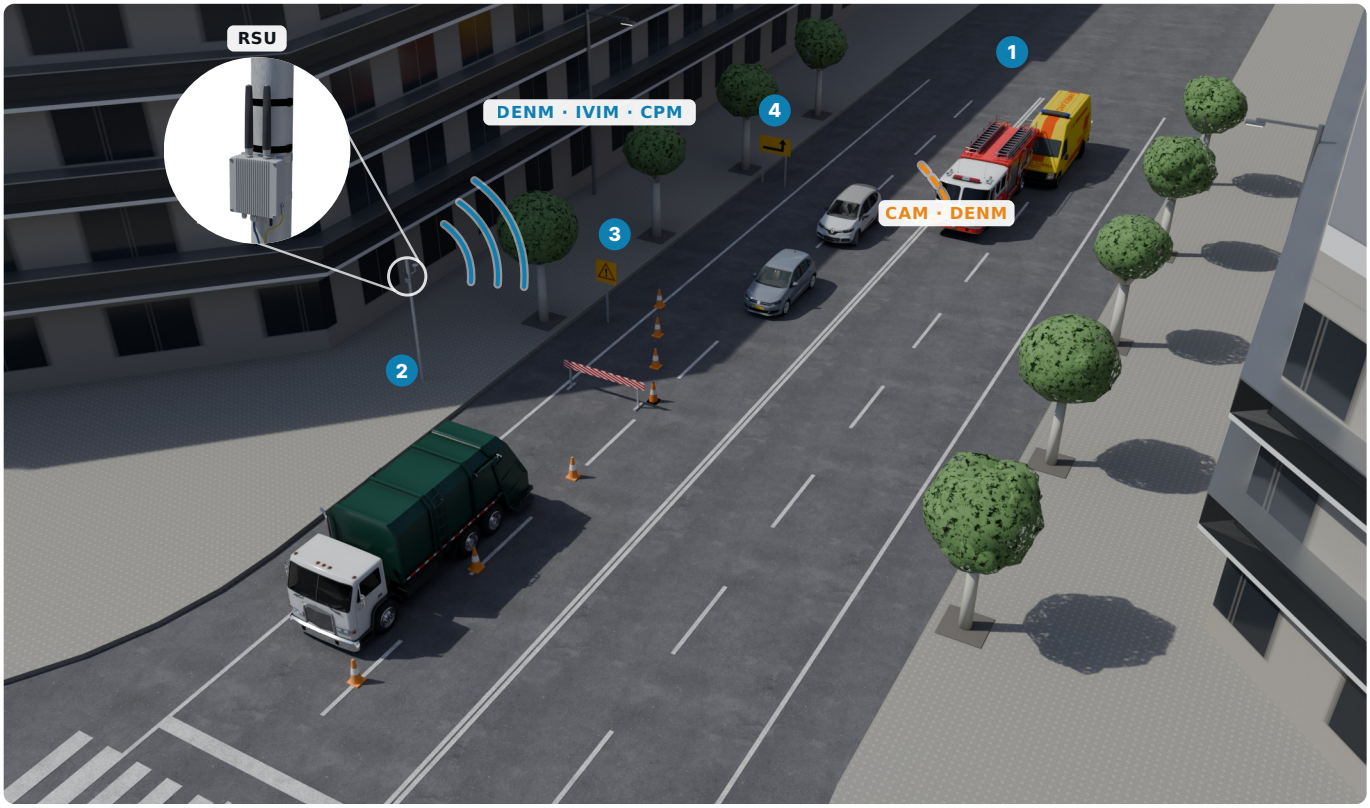
ON RECEIVE

- Generation time window · C2C-CC BSP R1.6.10
- Message content against certificate permissions
- Trust anchors from the certificate trust list

SIGNER PROFILE

CAM	Digest · certificate once per second
DENM	Certificate on every message
Infrastructure messages	Digest or certificate, generic profile
VAM	TS 103 300-3 V2.2.1

ROADWORKS AND A CORRIDOR



1. CAM · DENM
2. CPM · DENM
3. DENM
4. DENM · IVIM

V2I and I2V · with the roadside

V2V · between road users