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J1939-91C in Practice: A New Eagle approach to Secure Network Architecture

Presented by:

Collin Spencer, Staff Software Engineer, New Eagle

Agenda

J1939-91C Overview

- Automotive Security (SecOC)
- J1939-22
- J1939-91C
- Raptor Solution

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Why is cybersecurity needed?

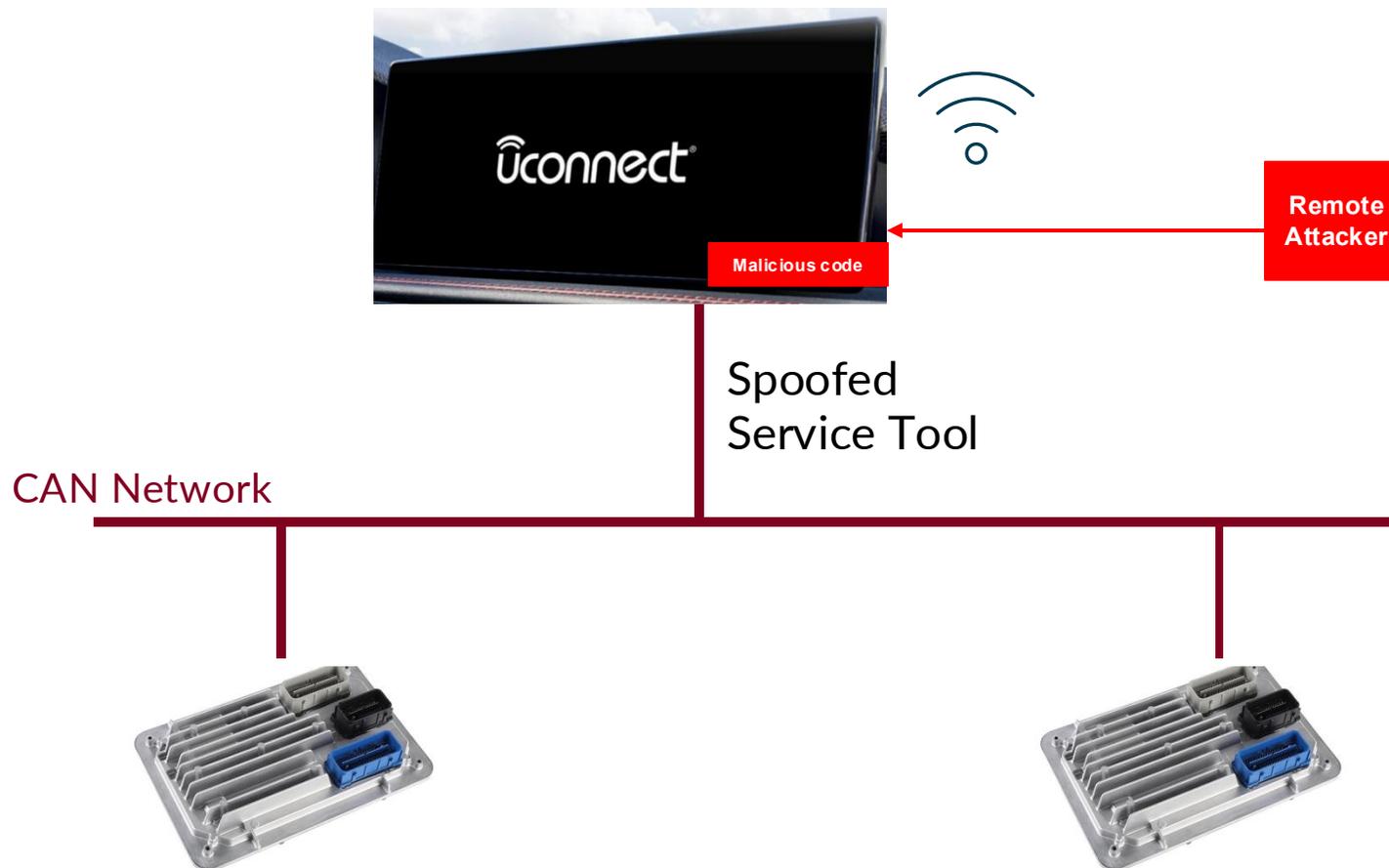
ANDY GREENBERG

SECURITY JUL 21, 2015 6:00 AM

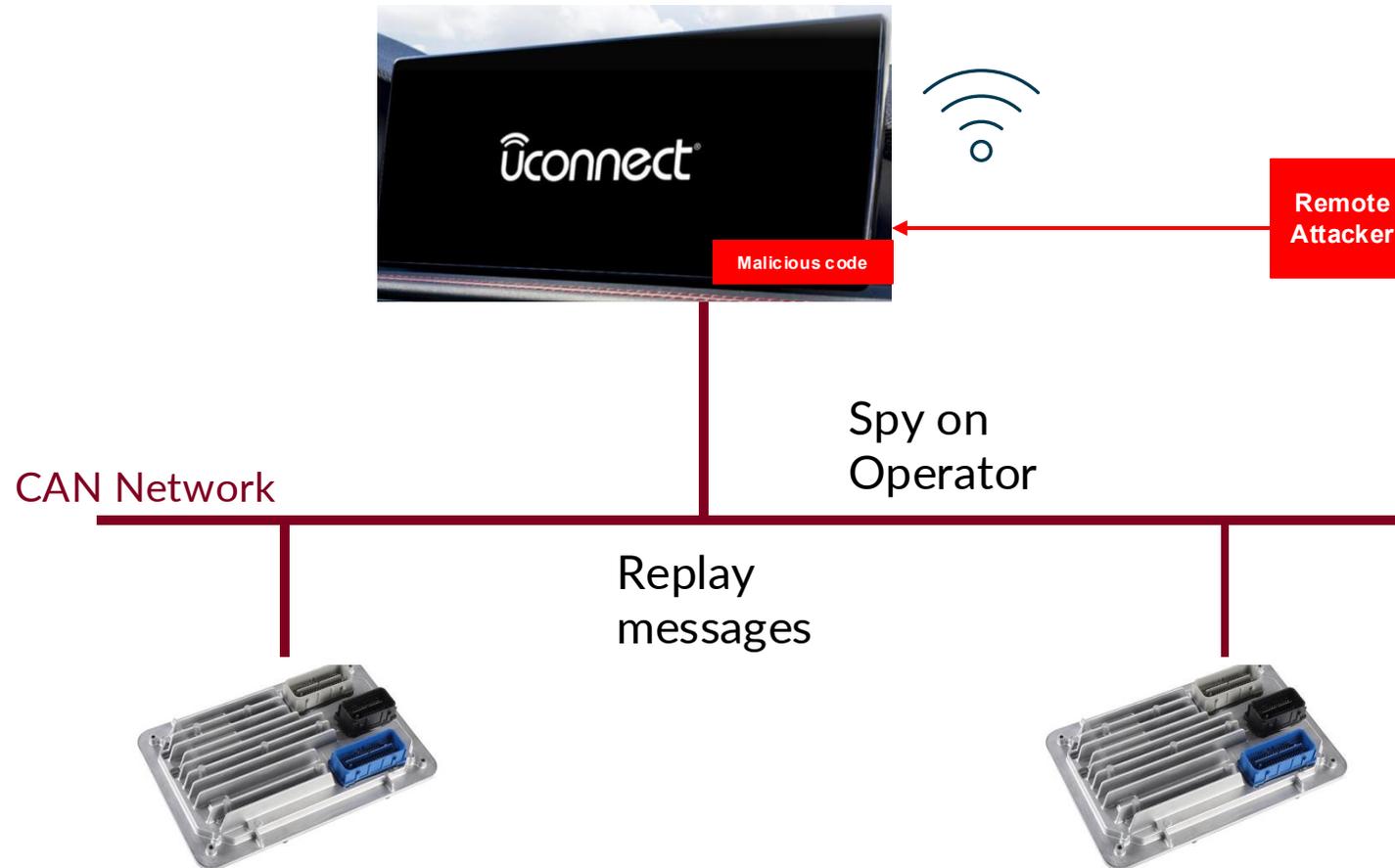
Hackers Remotely Kill a Jeep on the Highway—With Me in It

I was driving 70 mph on the edge of downtown St. Louis when the exploit began to take hold.

How did they do it?



What else could you do?





How do we prevent this outcome?

Layer 3:
E/E-Architecture 

- Protect and separate domains
- Secure E/E architectures, and security gateways with adaptive rules to control traffic and access

Layer 4:
Connected Vehicle 

- Protect safety & integrity of vehicle and privacy of driver
- Vehicle firewalls and security standards for communication and external interfaces



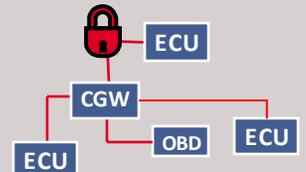
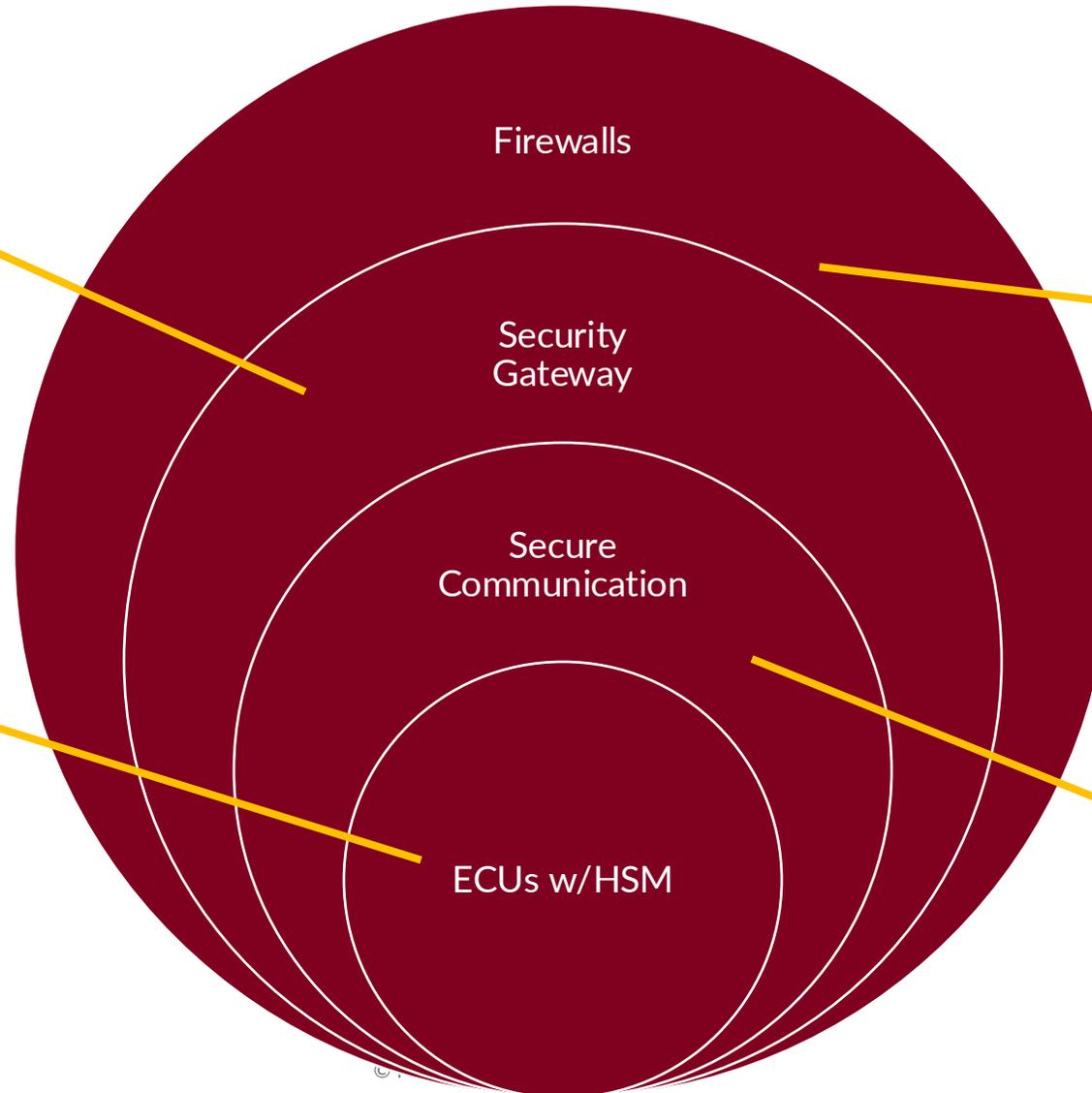
Layer 1:
Individual ECU 



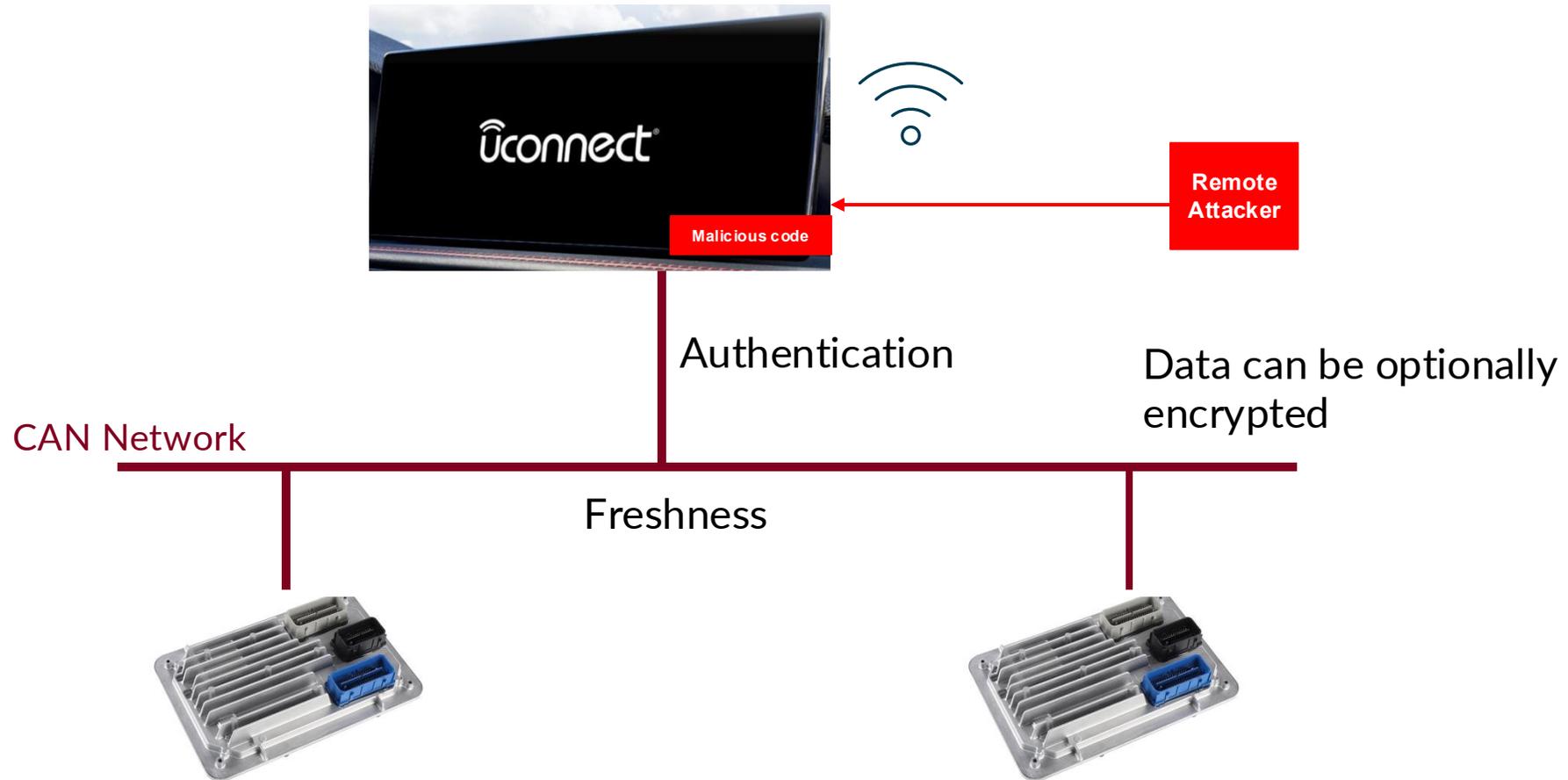
- Protect integrity of ECU SW & data
- Secure Flashing
- Secure Access
- HSM as Trusted Anchor

Layer 2:
In-vehicle Network 

- Protect the integrity of critical in-vehicle signals
- Authentic communication

SAE J1939-91C Network Security



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J1939-22 Introduction



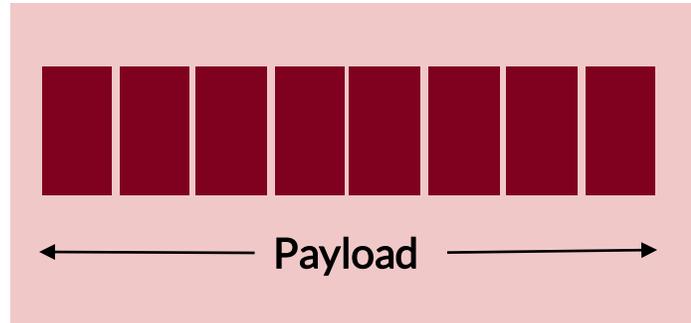
SURFACE VEHICLE RECOMMENDED PRACTICE	J1939™-22	SEP2022
	Issued	2021-03
	Revised	2022-09
Superseding J1939-22 JUL2021		
CAN FD Data Link Layer		



J1939-22 MultiPG vs. J1939-21 PGN



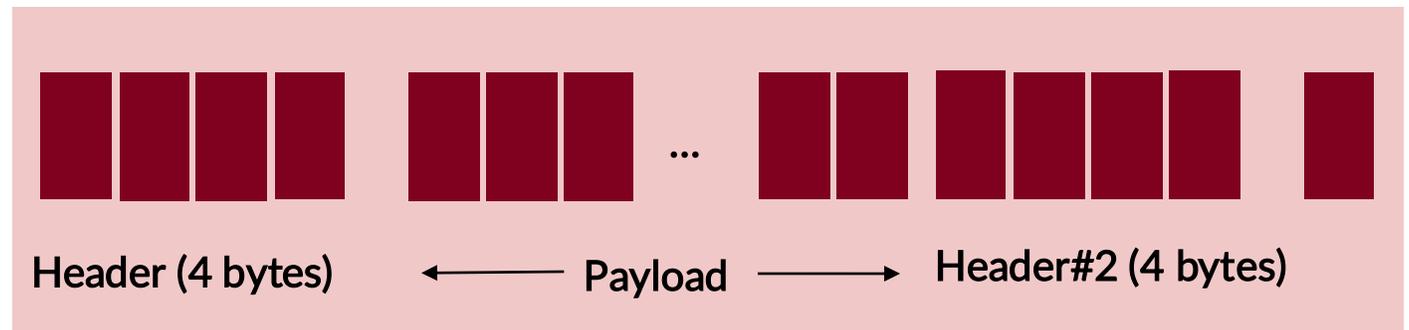
CAN ID



Data (0 ... 8 bytes)

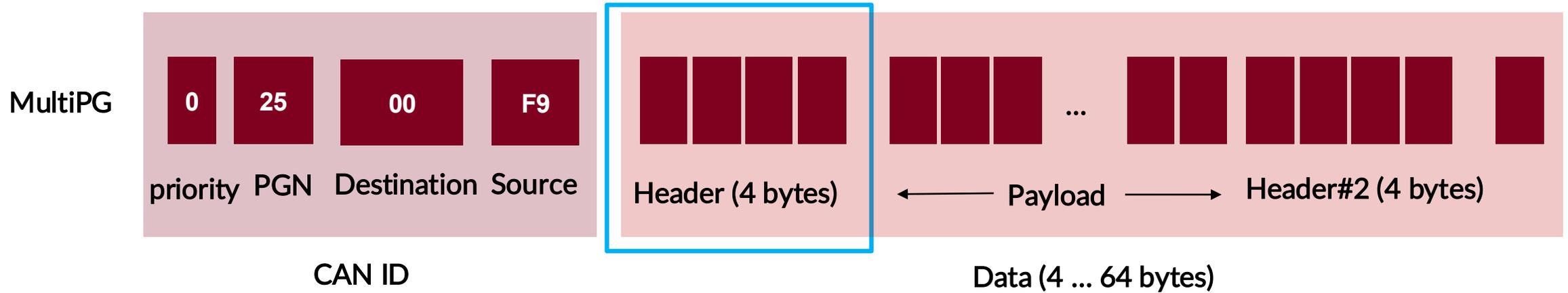


CAN ID



Data (4 ... 64 bytes)

J1939-22 MultiPG Header





J1939-22 MultiPG Header



TOS	TF Value	Trailer format
001 _b	000 _b	Reserved
001 _b	001 _b	32-bit manufacturer specific (OEM) cybersecurity assurance data
001 _b	010 _b	32-bit manufacturer specific (OEM) functional safety assurance data
001 _b	011 _b	32-bit manufacturer specific (OEM) cybersecurity followed by a 32-bit manufacturer specific (OEM) functional safety assurance data
001 _b	100 _b	Reserved
001 _b	101 _b	64-bit manufacturer specific (OEM) cybersecurity assurance data
001 _b	110 _b	64 bit manufacturer specific (OEM) functional safety assurance data
001 _b	111 _b	Reserved
010 _b	000 _b	SAE J1939 with no assurance data
010 _b	001 _b - 111 _b	Reserved
011 _b - 111 _b	Reserved	Reserved

Agenda

J1939-91C Overview

- Automotive Security
- J1939-22
- **J1939-91C**
- Raptor Solution



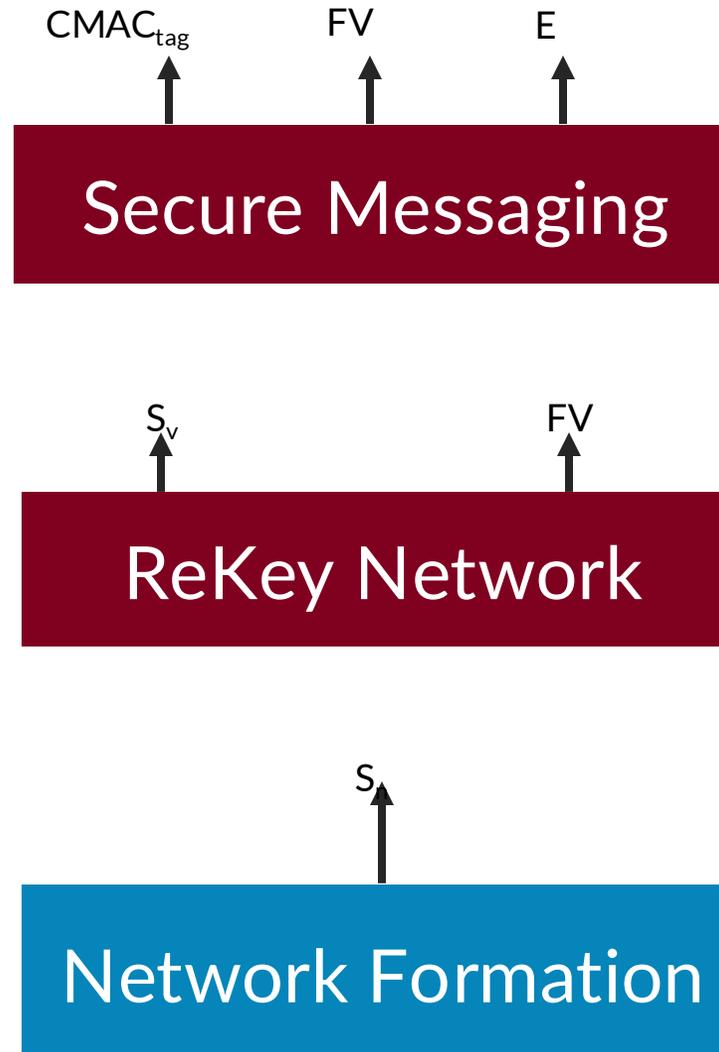
Introduction to J1939-91C



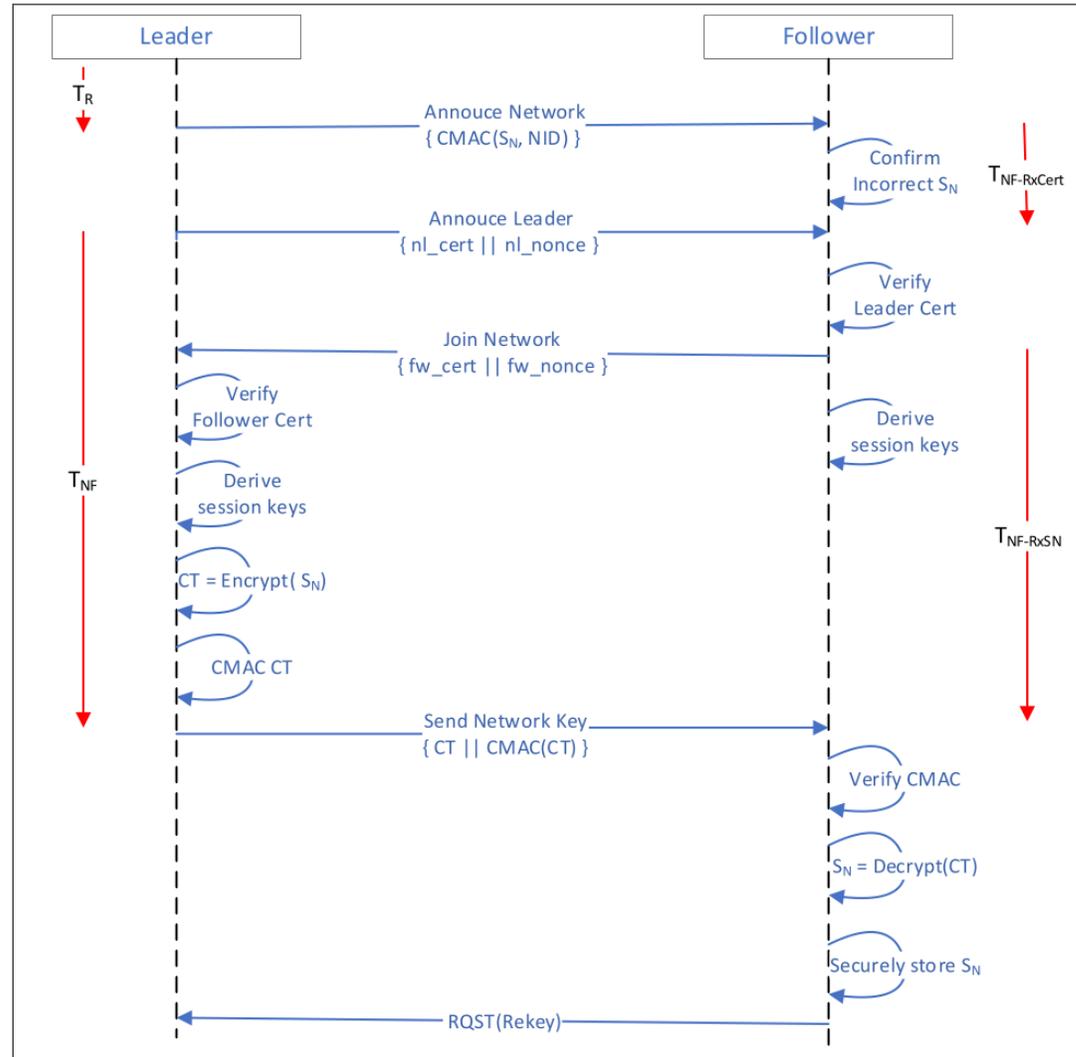
SURFACE VEHICLE RECOMMENDED PRACTICE	J1939™ -91C	MTH2023
	Issued	2023-XX
CAN FD Network Security		

RATIONALE

J1939-91C Three Phases

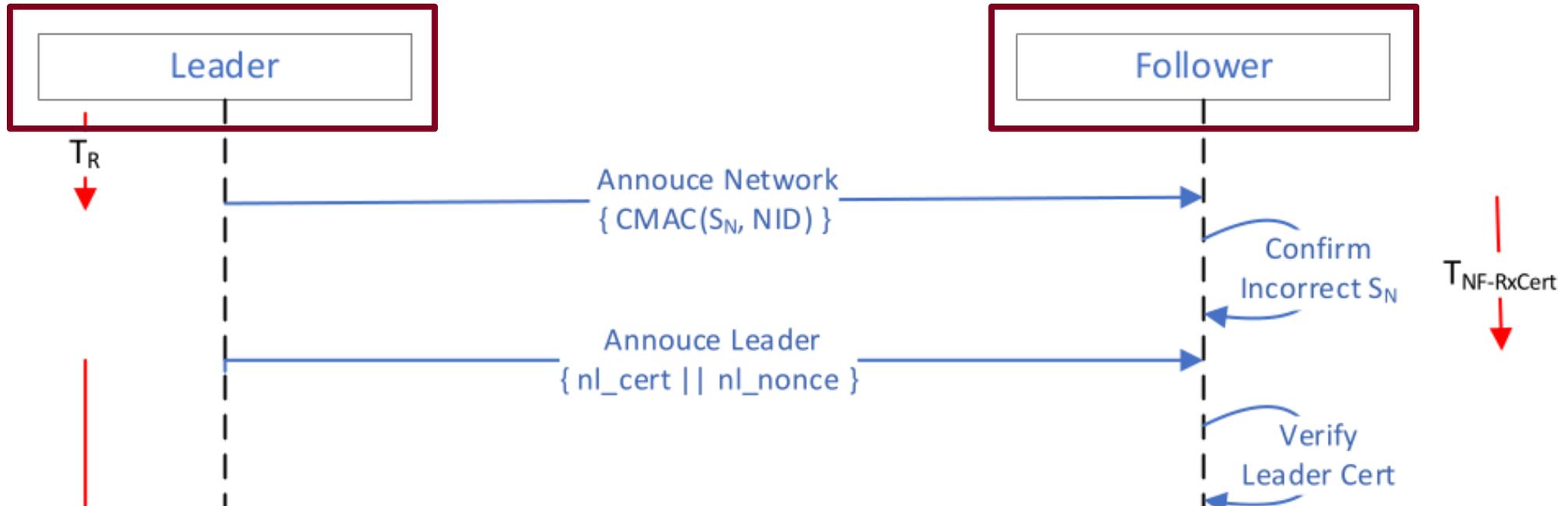


Network Formation



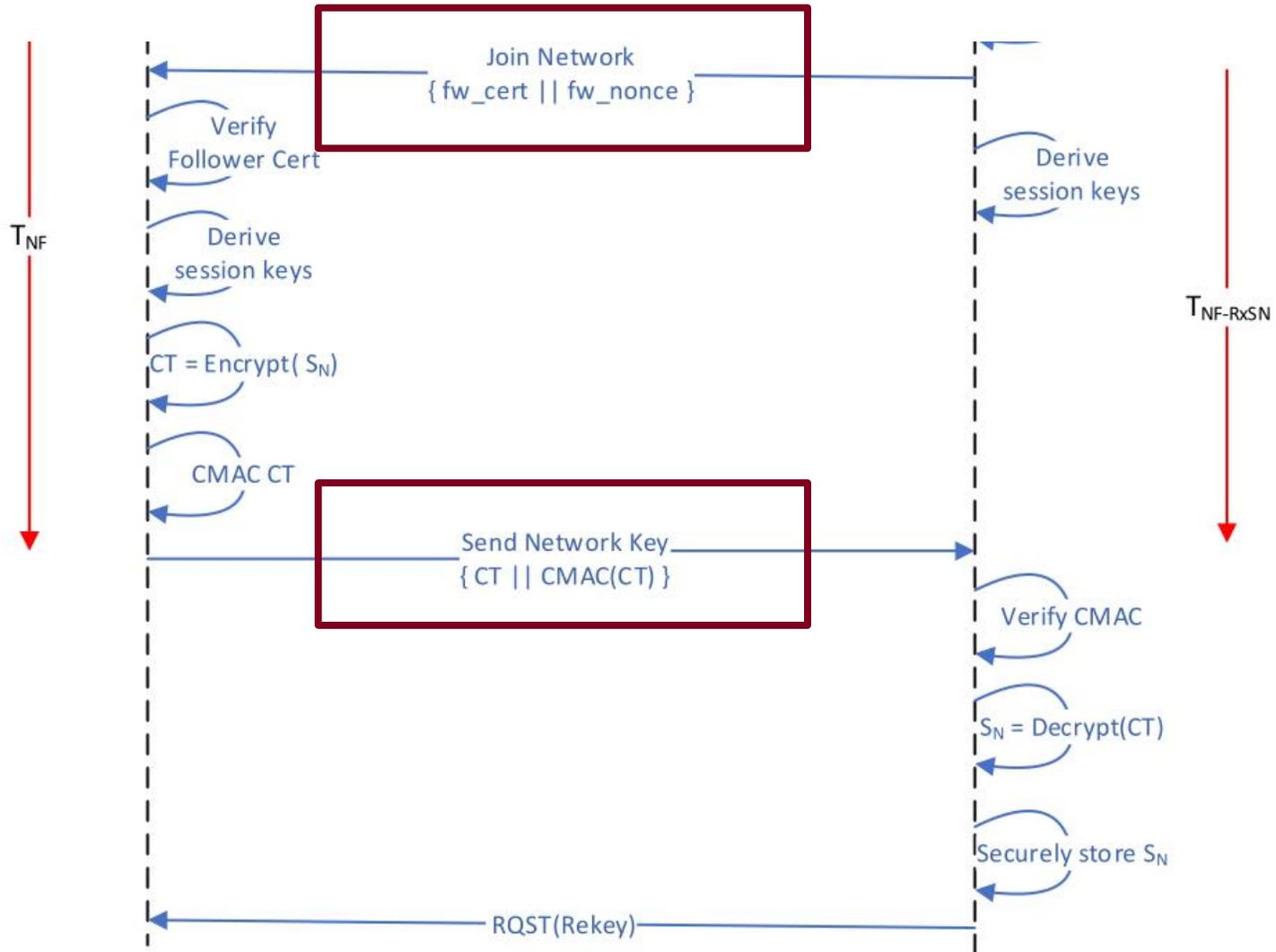


Network Formation - Network Roles

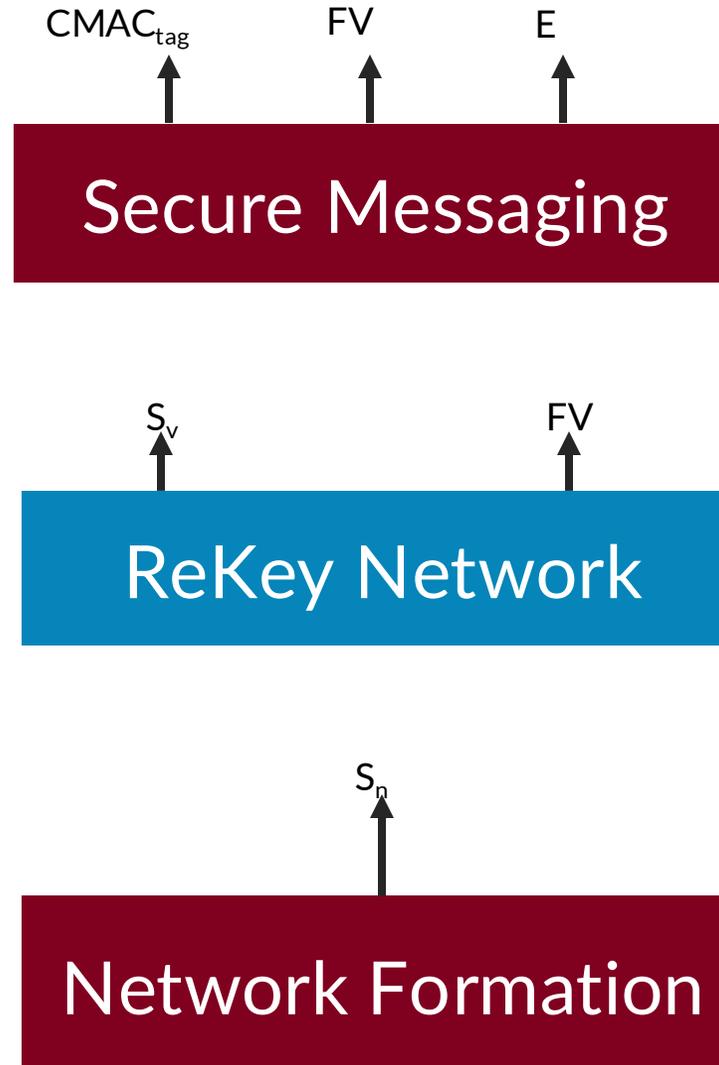




Network Formation - Join Network

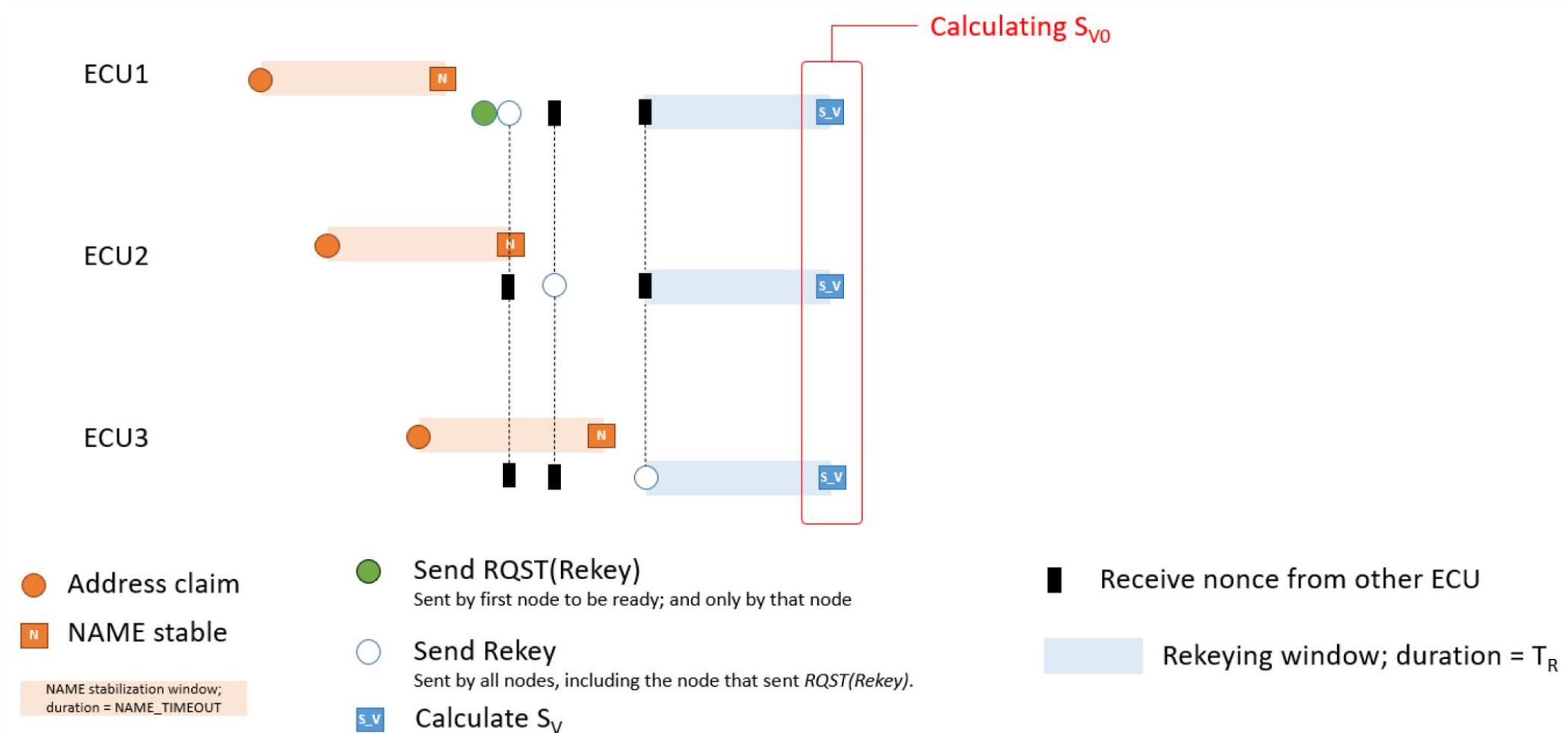


J1939-91C Three Phases

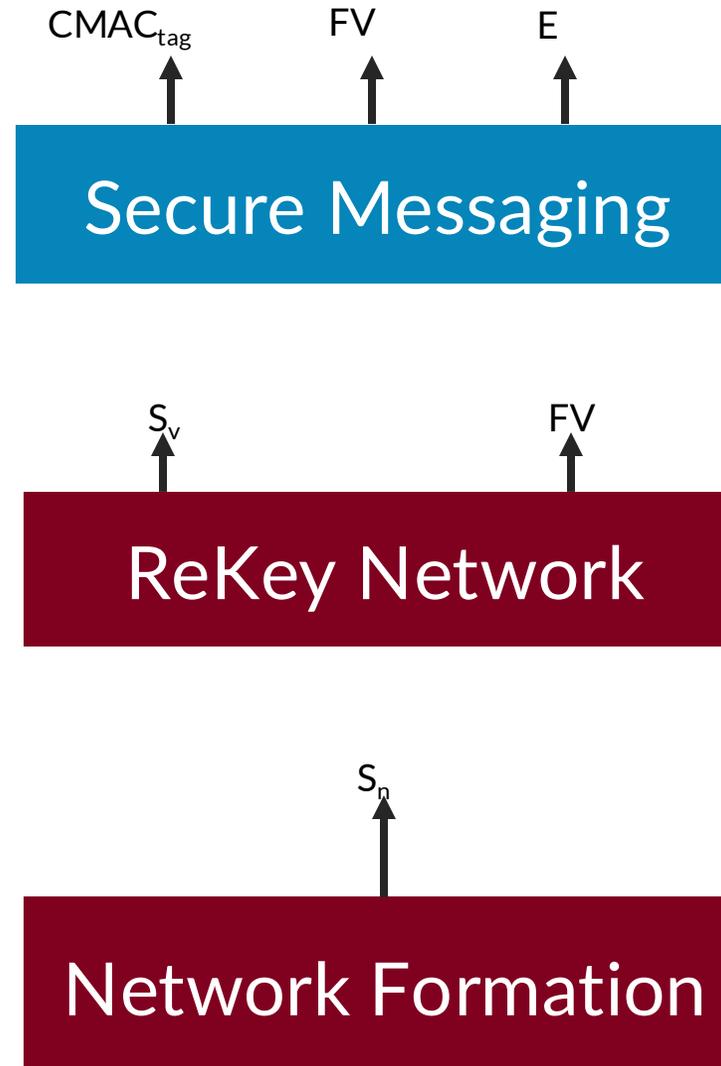




Rekey Sequence

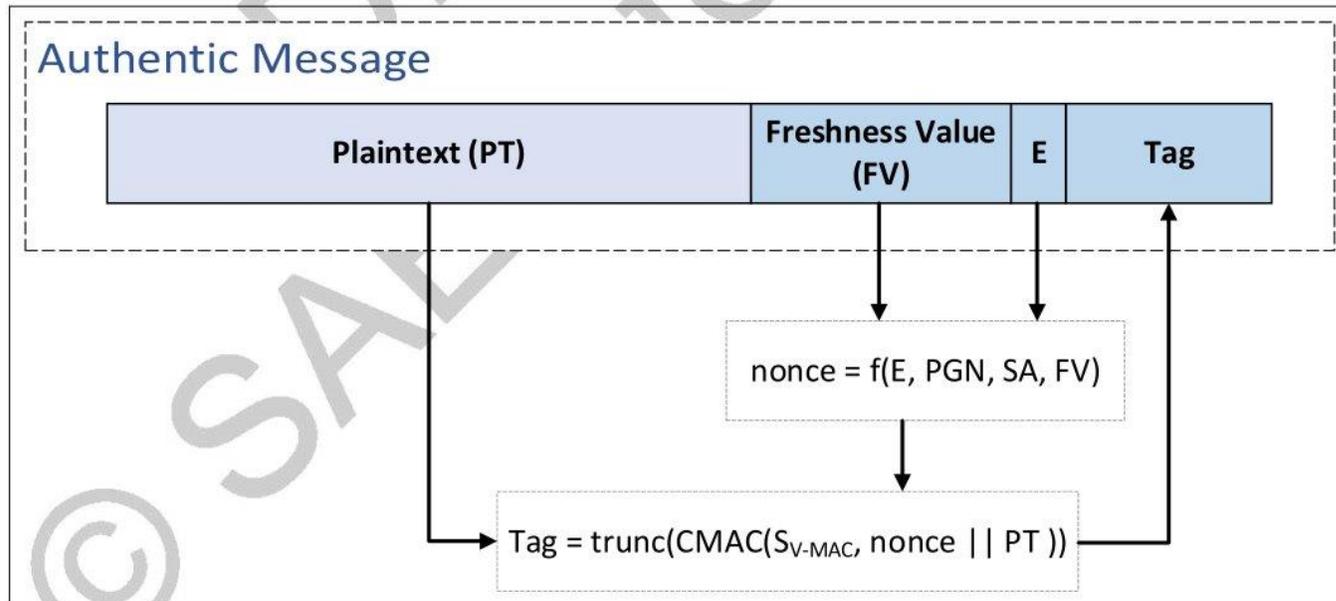


J1939-91C Three Phases





Secure message format



$$f() = ((E \ll 23) \text{ OR'ed } PGN) || SA || FV$$

Note: If the new FV value is larger than the maximum allowed value, the Tx device should request a rekey at its earliest opportunity.



Rekey and Secure Messaging

```

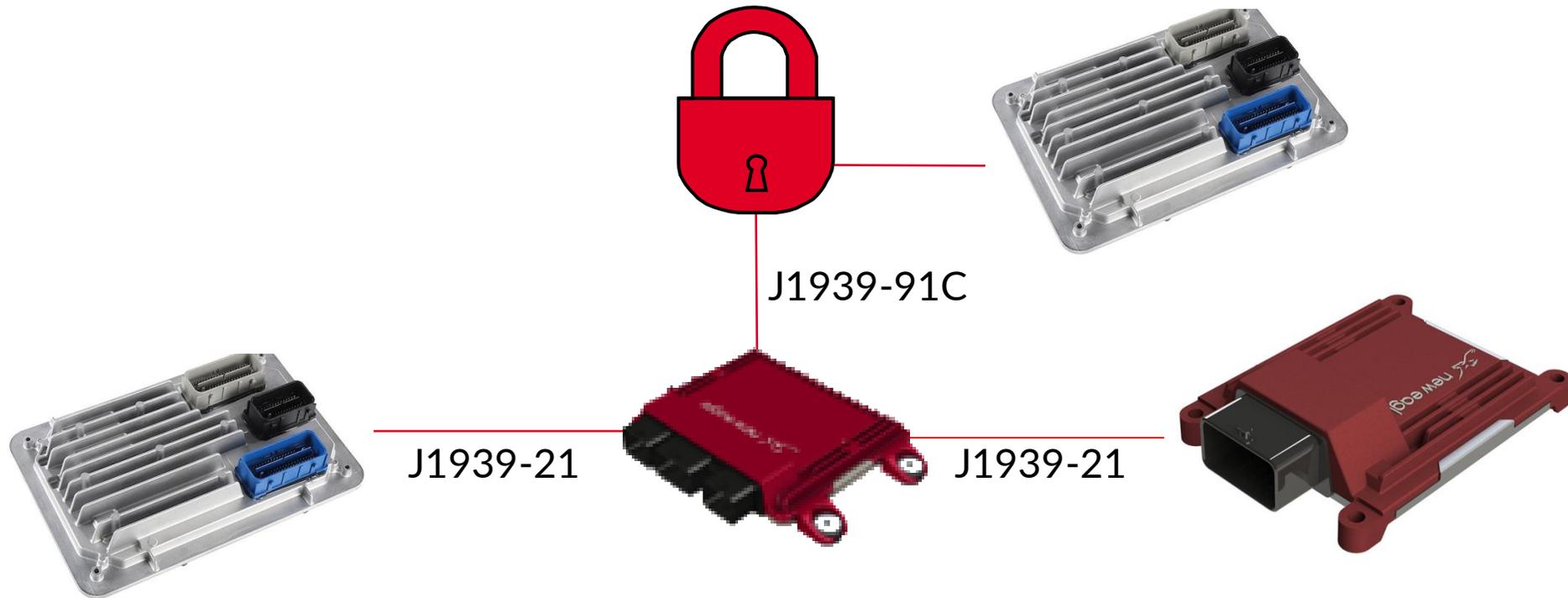
CAN 2 0025FF02 XFB 7 5939.097
      40 EA 00 03 04 FA 00

CAN 2 0025FF02 XFB 48 5939.114
      40 FA 04 24 FF FF 01 FF CA FE FE 5A 53 63 27 53
      89 C0 9A 7F DE 7D CA FE A3 6E B3 DD 67 65 E0 D6
      95 31 F9 62 12 7E 0A DE 00 00 00 AA AA AA AA AA

CAN 2 1C25FF00 XFB 48 5939.129
      40 FA 04 24 FF FF 01 FF 00 00 00 10 50 81 D7 50
      50 80 00 2D 00 00 00 10 4D 87 37 3F B1 DB 74 65
      42 1E A3 50 BF 67 0F B2 00 00 00 AA AA AA AA AA

CAN 2 00250200 XFB 16 5940.632
      34 02 00 0C 00 00 00 00 00 00 00 00 8B BD 9C C5
  
```

J1939-91C Gateway



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J1939-22 Transport Protocol

J1939 FD Server Channel

Physical Bus : CAN2FD
J1939 Bus : J1939_1
J1939 Protocol : FD (J1939-22)
Channel Address : 0x00 (0)
Max Message Length : 200 bytes
Tx Connections : 3 (600 bytes)
Rx Connections : 3 (600 bytes)

J1939 STD/FD

Block Parameters: raptor_j1939_std_fd_tp

J1939 STD/FD Transport Protocol Definition (mask) (link)
This block is used to define a J1939 STD/FD bus to be used by other Raptor J1939 STD/FD blocks.

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Parameters

J1939 Bus Name: J1939_1

Physical CAN Bus Name: CAN2FD

Type Server

Standard or FD: FD (J1939-22)

Channel Address: 0x00

Max Message Length (bytes): 200

Tx Connections: 3

Rx Connections: 3

Join Network J1939 -91C

J1939 -91C Network Name Network_1

Enable Unconditional Address Claim

--- Define NAME

OK Cancel Help Apply



J1939-91C Network Definition

J1939-91C Network Configuration

```

Name : Network_1
J1939 Channel : J1939_1
Maximum Network Nodes : 2
Max Auth Limit : 15
Dropped Message Function : DroppedMessageCb
Formation Permission Function : NetworkFormationPermCb
  
```

J1939 STD/FD

J1939-91C Current Network State	
Network_1	state
J1939 STD/FD	

Block Parameters: raptor_j1939_91c_network_def1

J1939 -91C Network Definition (mask) (link)

This block configures a J1939 -91C network connected to a particular J1939 channel.

Copyright New Eagle 2024

Parameters

Name 'Network_1'

J1939 Channel Name 'J1939_1'

Maximum Number of Nodes 2

SN Key x06, 0x07, 0x08, 0x09, 0x0a, 0x0b, 0x0c, 0x0d, 0x0e, 0x0f

Certificate Identifier [B, 0xCC, 0xDD, 0xEE, 0xFF, 0x00, 0x01, 0x02]

Private Key [0x7d, 0xb1, 0x77, 0xfb, 0xa5, 0x1d, 0xb9, 0x2c, 0x2a]

Maximum Authentication Limit 15

Add Dropped Message Callback

Dropped Message Simulink Function Name

'DroppedMessageCb'

Update Create

Add Network Formation Permission Callback

Network Formation Permission Simulink Function Name

'NetworkFormationPermCb'

Update Create

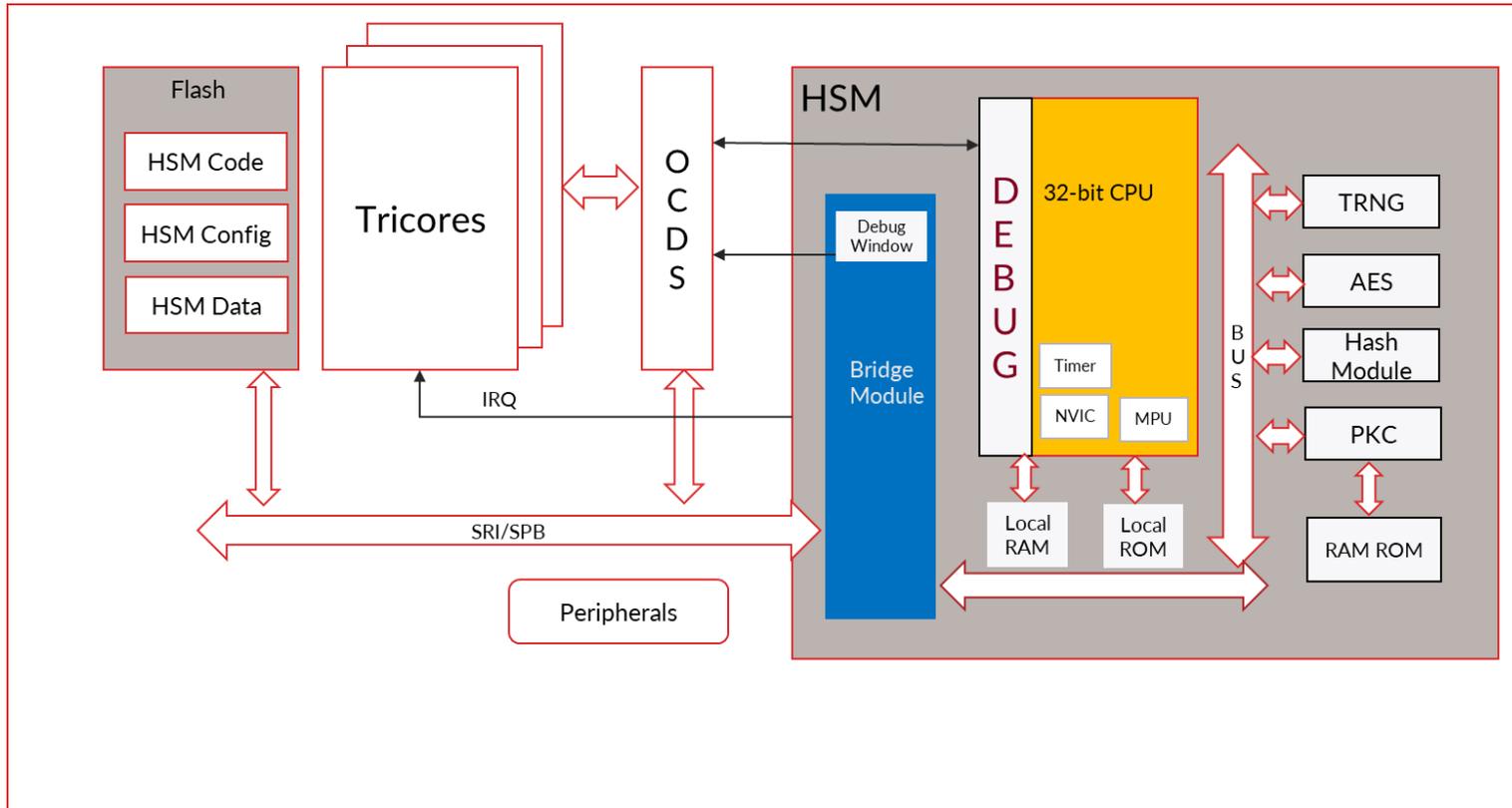
OK Cancel Help Apply





HSM Architecture and CycurHSM

Hardware Security Module (HSM)



ETAS Cycur HSM software



Transmit Block



J1939 STD/FD Tx Raw

> Priority [uint8]

> Length [uint16]

> Data [uint8[]]

J1939 Bus : J1939_1
PGN : 0x000500 (1280)
Destination Address : 0x02 (2)
Transmit Latency : 0 ms
Max Data Size : 10 bytes

J1939 STD/FD

J1939 STD/FD Tx Raw

> Priority [uint8]

> Data [uint8[]]

J1939 Bus : J1939_1
PGN : 0x000500 (1280)
Destination Address : 0x02 (2) FuSa Result [uint32] >
Transmit Latency : 0 ms
Max Data Size : 10 bytes
E2E Specification : AUTOSAR E2E Profile22
Cyber Assurance : J1939 -91C

J1939 STD/FD

Receive Block



J1939 STD/FD Rx Raw

Age [uint16] ▶

PGN [uint32] ▶

Source Addr. [uint8] ▶

Length [uint16] ▶

Data [uint8[]] ▶

J1939 Bus : J1939_1
PGN : 0x000800 (2048)
Source Address : 0x02 (2)
Max Data Size : 50 bytes

J1939 STD/FD

J1939 STD/FD Rx Raw

Age [uint16] ▶

PGN [uint32] ▶

Source Addr. [uint8] ▶

Length [uint16] ▶

Data [uint8[]] ▶

J1939 Bus : J1939_1
PGN : 0x000800 (2048)
Source Address : 0x02 (2)
Max Data Size : 50 bytes
E2E Specification : AUTOSAR E2E Profilee22
Cyber Assurance : J1939 -91C

J1939 STD/FD

FuSa Result [uint32] ▶



J1939-22 E2E Configuration

Block Parameters: raptor_j1939_std_fd_rxraw

J1939 STD/FD Rx Raw (mask) (link)
This block is used to receive a raw J1939 message from the J1939 bus.
Copyright New Eagle 2024

Parameters

J1939 Bus Name: 'J1939_1'

Show Age Output

PGN: 0xB00 2816 Source Address: 0x02 2

Max Data Size: 16

E2E Specification AUTOSAR E2E Profile22

Data IDs (uint8) uint8(1:16) <1x16 uint8>

Byte Offset in Header 0

Max Delta 3

Assurance Header None

OK Cancel Help Apply

J1939-22 E2E Configuration



Block Parameters: raptor_j1939_std_fd_rxraw

J1939 STD/FD Rx Raw (mask) (link)
This block is used to receive a raw J1939 message from the J1939 bus.

Copyright New Eagle 2024

Parameters

J1939 Bus Name: 'J1939_1'

Show Age Output

PGN: 0xB00 2816 Source Address: 0x02 2

Max Data Size: 16

E2E Specification AUTOSAR E2E Profile22

Data IDs (uint8) uint8(1:16) <1x16 uint8>

Byte Offset in Header 0

Max Delta 3

Assurance Header None

OK Cancel Help Apply

J1939-22 Assurance Configuration



Assurance Header

None

None

Cyber 64 Bit

OK Cancel Help Apply

J1939-22 Gateway



J1939 FD Gateway Channel

Physical Bus : CAN4FD
J1939 Bus : myJ1939_22_Port
J1939 Protocol : FD (J1939-22)
Channel Address : 0x38 (56)
Max Message Length : 200 bytes
Tx Connections : 3 (600 bytes)
Rx Connections : 3 (600 bytes)
Gateway Name : Gateway
Port Number : 2
Forwarding Address : 0x03 (3) 0x04 (4)
J1939 -91C Network : Network_1

Block Parameters: raptor_j1939_std_fd_tp6

J1939 STD/FD Transport Protocol Definition (mask) (link)
This block is used to define a J1939 STD/FD bus to be used by other Raptor J1939 STD/FD blocks.

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Parameters

J1939 Bus Name: 'myJ1939_22_Port'

Physical CAN Bus Name: 'CAN4FD'

Type Gateway

Gateway Name 'Gateway'

Port Number 2

Forwarding Address [0x03 0x04] [3,4]

Standard or FD: FD (J1939-22)

Channel Address: 0x38 56

Max Message Length (bytes): 200

Tx Connections: 3

Rx Connections: 3

Join Network J1939 -91C

J1939 -91C Network Name 'Network_1'

Enable Unconditional Address Claim

► --- Define NAME

OK Cancel Help Apply



J1939-22/-21 Gateway Link Configuration

Block Parameters: raptor_j1939_gateway_link4

J1939 Gateway Link (mask) (link)
The Gateway Link block defines a single port to port transfer in the Gateway. It describes the source port (where the messages come from) and the destination port (where the messages will be sent).

Each connection has an optional address translation layer which describes the address conversion from the source port (source address) to the address used on the destination port (destination address)

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Parameters

Name: 'Link_P1_P3'

Source Port Name: 'myJ1939_22_Port1'

Destination Port Name: 'myJ1939_21_Port3'

PGN Whitelist Table

Filter table contents

PGN	Source Address	Destination Address	Assurance
0x2B00	2	4	None
0xFDA5	1	255	-91C
0x2F00	2	4	-91C
0x2D00	2	255	-91C

Add Row Delete Row

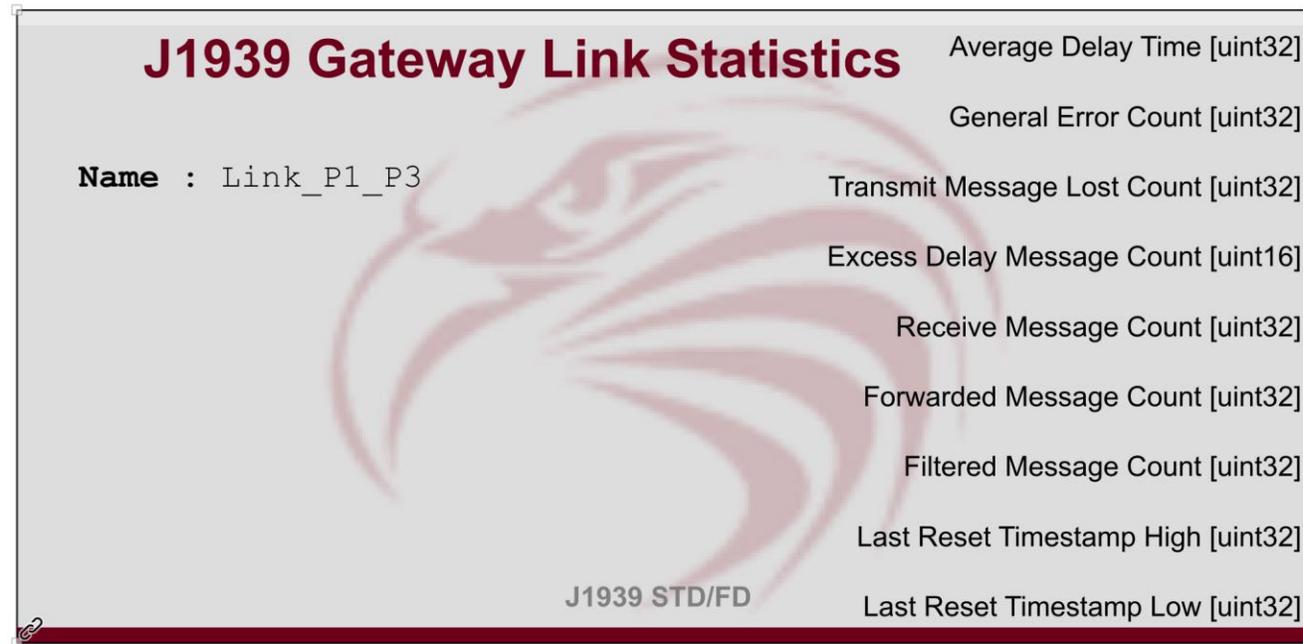
Address Translation Table

Filter table contents

Received Address	Updated Address
1	5
2	6
3	7
4	8

OK Cancel Help Apply

J1939-22/-21 Gateway Statistics





J1939-22/-21 Gateway Network Configuration

J1939 Gateway Network

```
DBC file : j1939_gw_network_dbc.dbc
Ports networked : myJ1939_21_Port3, myJ19..
Tx/Rx nodes routed : myJ1939_21_Port3, myJ19..
# J1939 msgs routed : 23
# Addresses translated : 16
```

J1939 STD/FD

Summary



SecOC

Why its important

Protocols

J1939-22

J1939-91C

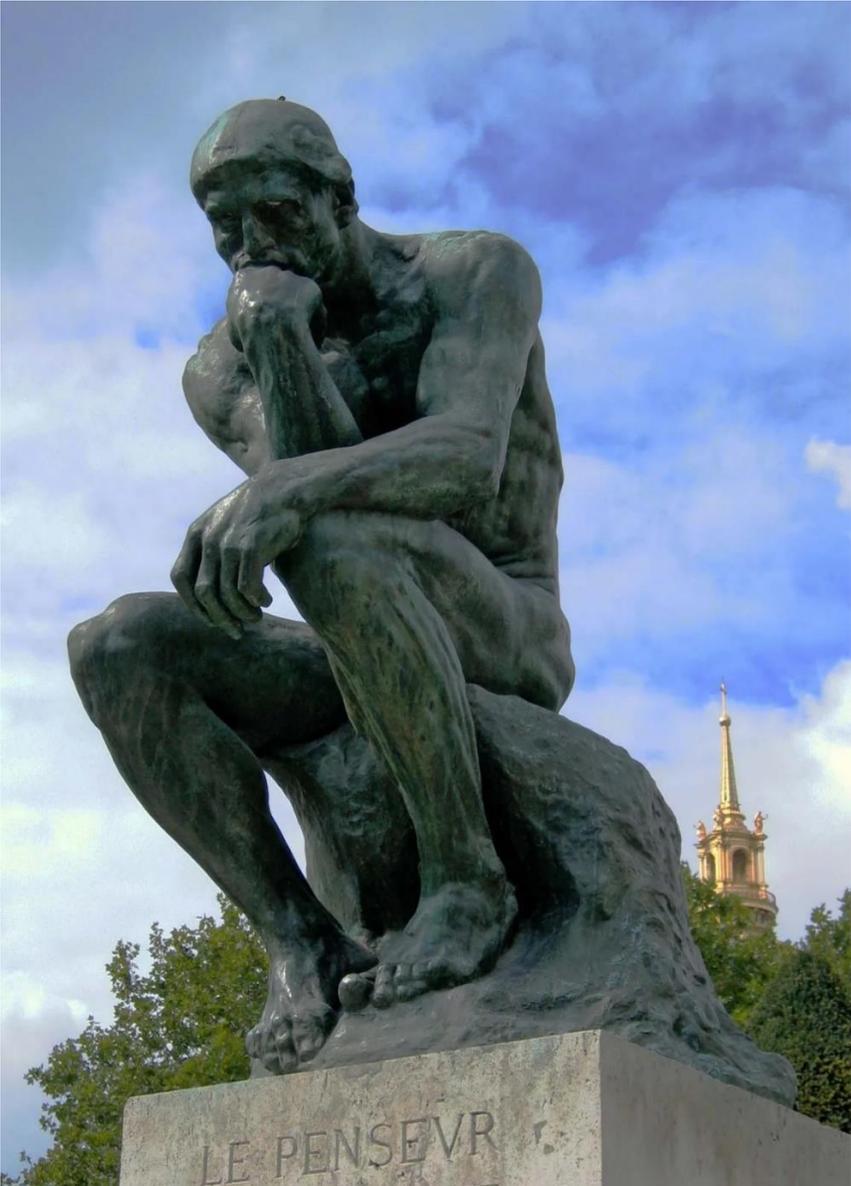
AUTOSAR P22 Support

Raptor Solutions

Protocol Support

Gateway

Questions?



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