英特佩斯2019 TechDay 汽车以太网研讨会

DoIP

深圳代表处经理

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DoIP

- Retcon: what we have now is “DoCAN”, i.e. Diagnostics over CAN
- DoIP is exactly the same
  - Except where it’s different
- Replace ISO 15765-2 and ISO 11898 with TCP/IP and Ethernet

Stack comparison

DoCAN

OSI	Standard
Application (Layer 7)	ISO 14229-1/5
Presentation (Layer 6)	OEM specifc (J1939, etc.)
Session (Layer 5)	ISO 14229-2
Transport (Layer 4)	ISO 15765-2
Network (Layer 3)	ISO 15765-2
Data Link (Layer 2)	ISO 11898 (CAN)
Physical (Layer 1)	ISO 11898 (CAN)

DoIP

OSI	Standard
Application (Layer 7)	ISO 14229-1/5
Presentation (Layer 6)	OEM specifc (J1939, etc.)
Session (Layer 5)	ISO 14229-2
Transport (Layer 4)	ISO 13400-2 (TCP)
Network (Layer 3)	ISO 13400-2 (IP)
Data Link (Layer 2)	ISO 13400-3 (Ethernet)
Physical (Layer 1)	ISO 13400-3 (100BASE-TX)

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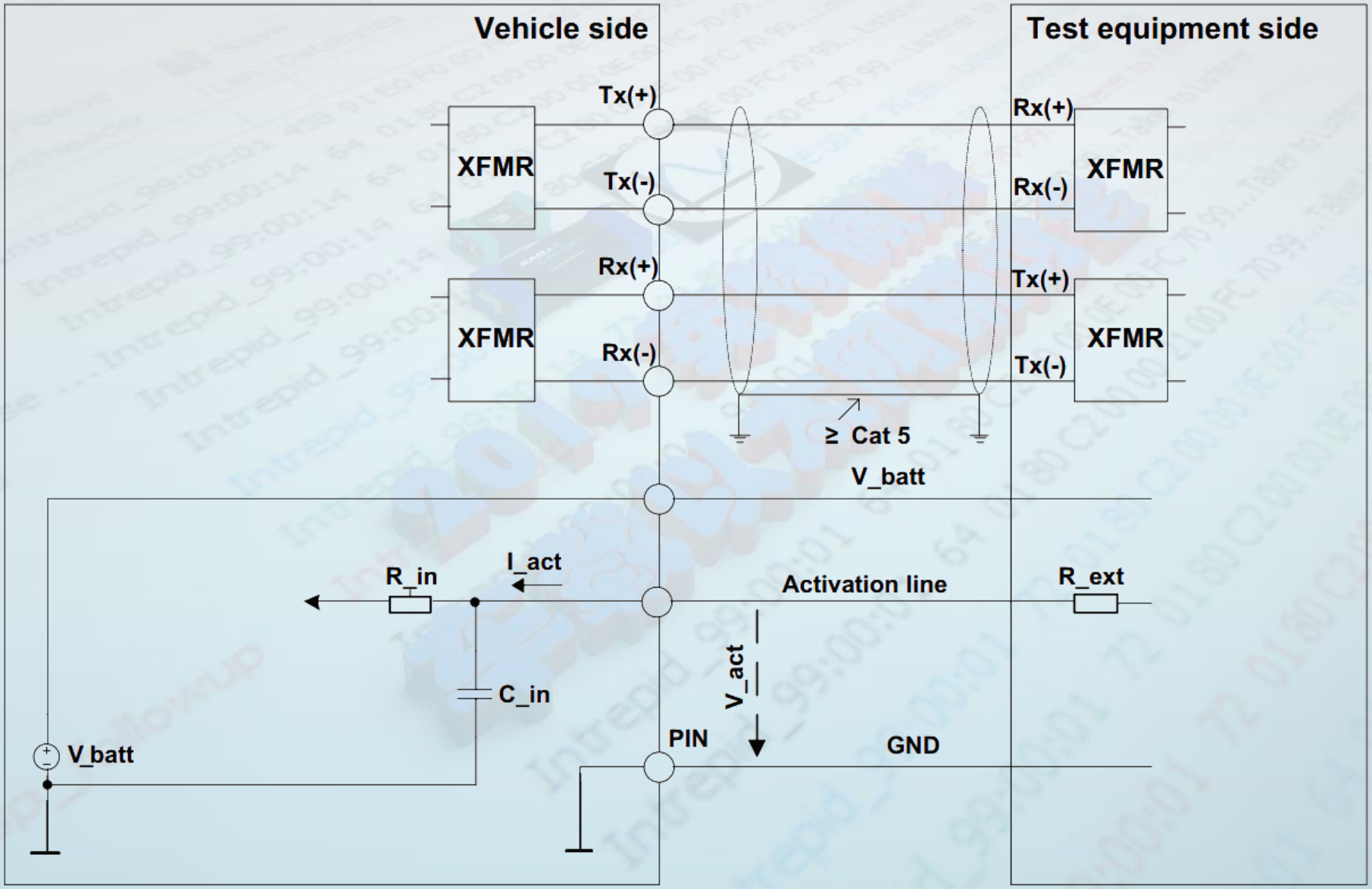
DoIP

- Purpose of DoIP is all the “other stuff” around diagnostics
  - Discovering ECUs
  - Establishing connections
  - Flow control/reliable delivery
- In the end, it’s still the same ISO 14229 messages going back and forth

Activation and wiring

- DoIP uses regular 4-wire Ethernet (100BASE-TX)
  - Not meant for on the road use (EMC issueS)
  - Need a way to disable this when not used
- Uses fifth “activation” line – simple on/off signal
  - When not asserted all of the DoIP circuitry should be off



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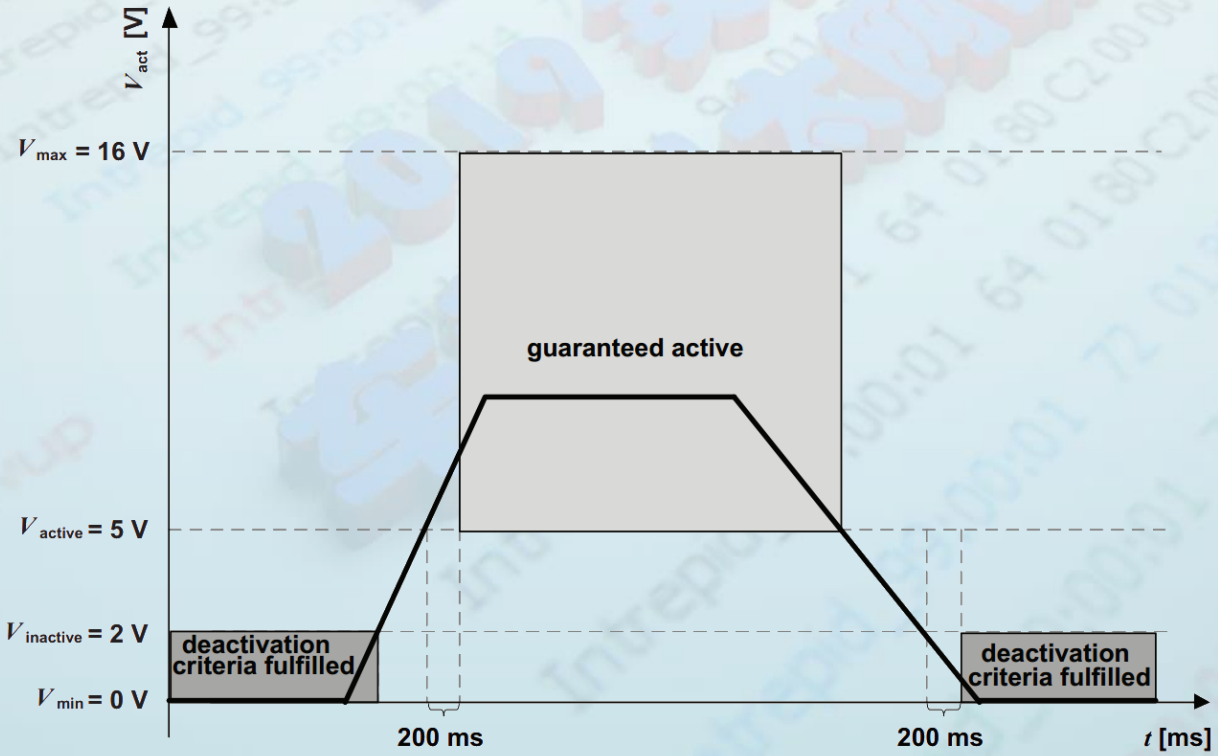
Activation timing

- Once activation line > 5 V, 200 ms to boot up



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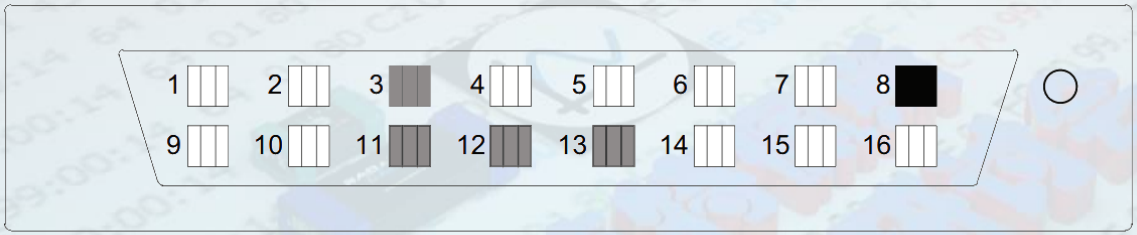
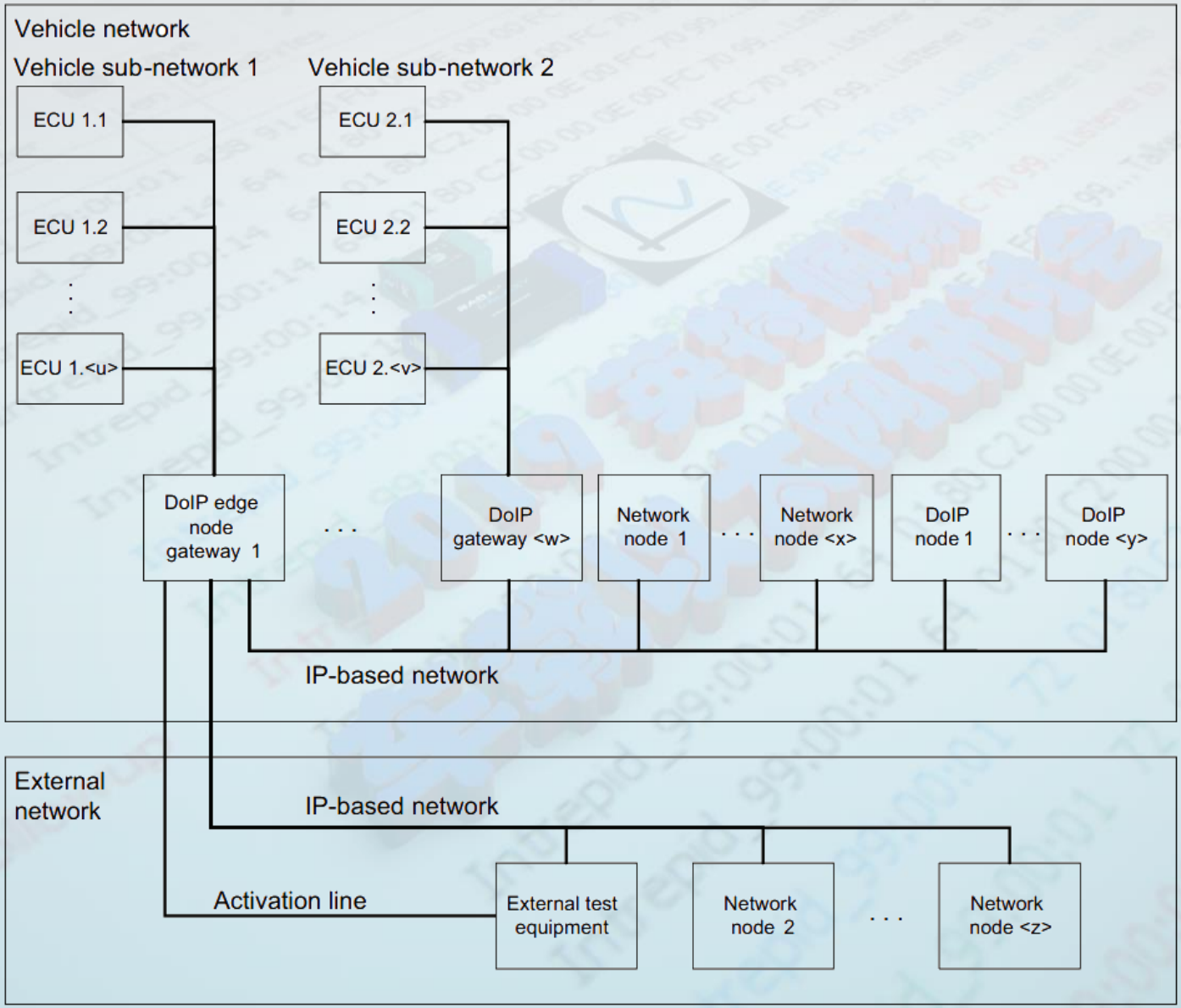
OBD



PIN	ISO 15031-3/SAE J1962 definition	Ethernet 100BaseTx usage
1	Defined in ISO 15031-3/SAE J1962	
2	Defined in ISO 15031-3/SAE J1962	
3	Discretionary	Ethernet Rx (+)
4	Chassis ground	
5	Signal ground	
6	Defined in ISO 15031-3/SAE J1962	
7	Defined in ISO 15031-3/SAE J1962	
8	Discretionary	Ethernet activation line pull-up
9	Defined in ISO 15031-3/SAE J1962	
10	Defined in ISO 15031-3/SAE J1962	
11	Discretionary	Ethernet Rx (–)
12	Discretionary	Ethernet Tx (+)
13	Discretionary	Ethernet Tx (–)
14	Defined in ISO 15031-3/SAE J1962	
15	Defined in ISO 15031-3/SAE J1962	
16	Permanent positive voltage	

DoIP terminology

- **DoIP edge node**: Node inside the vehicle where the activate line terminates; main gateway
- **Subnetwork**: Internal network not directly connected to an IP network (i.e. CAN)
- **Logical address**: Two-byte value that identifies a particular node
- **Test equipment:** An external tool like the neoVI FIRE 2



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Generic DoIP header

Item	Pos.	Len.	Description	Values
Generic DoIP header synchronization pattern				
Protocol version	0	1	Identifies the protocol version of DoIP packets.	0x00: reserved 0x01: DoIP ISO/DIS 13400-2:2010 0x02: DoIP ISO 13400-2:2012 0x03…0xFE: reserved by this part of ISO 13400 0xFF: default value for vehicle identification request messages
Inverse protocol version	1	1	Contains the bit-wise inverse value of the protocol version, which is used in conjunction with the DoIP protocol version as a protocol verification pattern to ensure that a correctly formatted DoIP message is received.	Equals the <Protocol_Version> XOR 0xFF (e.g. 0xFE for protocol version 0x01).
Generic DoIP header payload type and payload length				
Payload type (GH_PT)	2	2	Contains information about how to interpret the data following the generic DoIP header (e.g. gateway command, diagnostic message, etc.)	See Table 12 for a complete list of currently specified payload type values.
Payload length (GH_PL)	4	4	Contains the length of the DoIP message payload in bytes (i.e. excluding the generic DoIP header bytes). Some payload types do not require any additional parameters (payload length is 0), some require a fixed DoIP message length while others allow for dynamic length DoIP messages.	0…4 294 967 295 bytes (= <d>)
Payload type specific message content	8	…	The payload type specific message content starts here. NOTE This implies that, for example, byte position 0 of the payload type-specific part of the message (see 7.1.1) means byte position 8 in the context of the overall DoIP message.	

Discovery

- UDP based protocol for discovering vehicles on the network
  - Find all vehicles
  - Look for a specific VIN
- Remember: multiple vehicles can be on the same IP network!
  - Factory setting: access all vehicles off the line from your desk!

Vehicle identification request

- Sent to UDP broadcast address
- Payload type $0001
  - Empty payload
- All nodes should respond with a “Vehicle identification response” message
  - Source IP: node
  - Destination IP: test tool

Special identification requests

- Two special identification request messages
  - $0002: Only the specified EID should respond
    - EID is the “entity identification”, usually the MAC address
  - $0003: Only the specified VIN should respond
    - Assumes VIN has been programmed
- Use special requests to find the IP of a specific vehicle

Establishing a connection

- To do actual diagnostics, we need to establish a connection to the edge node
  - Got the IP address from the discovery mechanism
- Open a TCP connection on port 13400 (the ISO number of the spec)
- The edge node will forward our diagnostics to the correct ECU

Routing activation

- Before we can actually do diagnostics, we need to send a routing activation request ($0005)
- Tells the edge node what kind of diagnostics we will talk
- Request contains source address (logical address of test tool) and an “activation type”

Activation type

Value	Description	Required action	Support
0x00	Default	none	mandatory
0x01	WWH-OBD	none	mandatory
0x02 to 0xDF	ISO/SAE reserved		
0xE0	Central security	OEM-specific	optional
0xE1 to 0xFF	Available for additional OEM-specific use	OEM-specific	optional

- “Default” for regular ISO 14229
- WWH-OBD for OBD
- Central security: can enable OEM specific authentication features
  - For example, implement challenge/response before allowing any diagnostics

Diagnostic messages

- Once we've done the routing activation we can send diagnostic messages ($8001)
- Contains source address (test tool) and target address (ECU)
  - Just like we need to know CAN IDs for DoCAN, need to know logical addresses of ECUs
    - Come from ODX? ARXML? OEM defined

Logical addresses

Address	Description
0x0000	ISO/SAE reserved
0x0001…0x0DFF	Vehicle manufacturer specific
0x0E00…0x0FFF	Reserved for addresses of external test equipment
0x0E00…0x0E7F	External legislated diagnostics test equipment (e.g. for emissions test scan-tool use)
0x0E80…0x0EFF	External vehicle-manufacturer-/aftermarket-enhanced diagnostics test equipment
0x0F00…0x0F7F	Internal data collection/on-board diagnostic equipment (for vehicle-manufacturer use only)
0x0F80…0x0FFF	External prolonged data collection equipment (vehicle data recorders and loggers, e.g. used by insurance companies or to collect vehicle fleet data)
0x1000…0x7FFF	Vehicle manufacturer specific
0x8000…0xCFFF	ISO/SAE reserved
0xD000…0xDFFF	Reserved for SAE Truck & Bus Control and Communication Committee
0xE000…0xE3FF	ISO/SAE-reserved functional group addresses
0xE000	ISO 27145 WWH-OBD functional group address
0xE001…0xE3FF	ISO/SAE reserved
0xE400…0xEFFF	Vehicle-manufacturer-defined functional group logical addresses
0xF000…0xFFFF	ISO/SAE reserved

Diagnostic messages

- After source and destination addresses, we just send the raw ISO 14229 payload

Message direction:	client → vehicle		
Message type:	Functionally addressed request message (read protocol identification InfoType identifier)		
Data byte	**Description**	**Byte value**	**Mnemonic**
0	ISO 13400 – protocol version	0x01	—
1	ISO 13400 – inverse protocol version	0xFE	—
2	ISO 13400 – payload type	0x8001	GH_PT
3	ISO 13400 – payload type		GH_PT
4	ISO 13400 – payload length	7	GH_PL
5	ISO 13400 – payload length		GH_PL
6	ISO 13400 – payload length		GH_PL
7	ISO 13400 – payload length		GH_PL
8	ISO 13400 – source address	e.g. 0x0E00	SA
9	ISO 13400 – source address		SA
10	ISO 13400 – target address	0xE000	TA
11	ISO 13400 – target address		TA
12	ISO 13400 – user data / ISO 27145-3 – ReadDataByIdentifier request SID	0x22	UD / RDBI
13	ISO 13400 – user data / ISO 27145-3 – DataIdentifier #1 (HB) = ITID = protocol identification	0xF8	UD / DID_HB
14	ISO 13400 – user data / ISO 27145-3 – DataIdentifier #1 (LB) = ITID = protocol identification	0x10	UD / DID_LB

Diagnostic message positive /negative acknowledge

- When the edge node gets our diagnostic message, it makes a routing decision
- Sends back either a diagnostic positive or diagnostic negative acknowledge
- This is NOT the positive/negative response for the diagnostic message
  - Merely indicates if the diagnostic message was forwarded

Diagnostic message

- The edge node forwards on the message to the target ECU
- Any response comes back as a diagnostic message itself
  - Target/source address flipped from our request

DEMO

可以使用两个FIRE2设备来模拟实现DoIP整个过程；一个用作DoIP测试者；一个用作模拟的车内GateWay被测试方。

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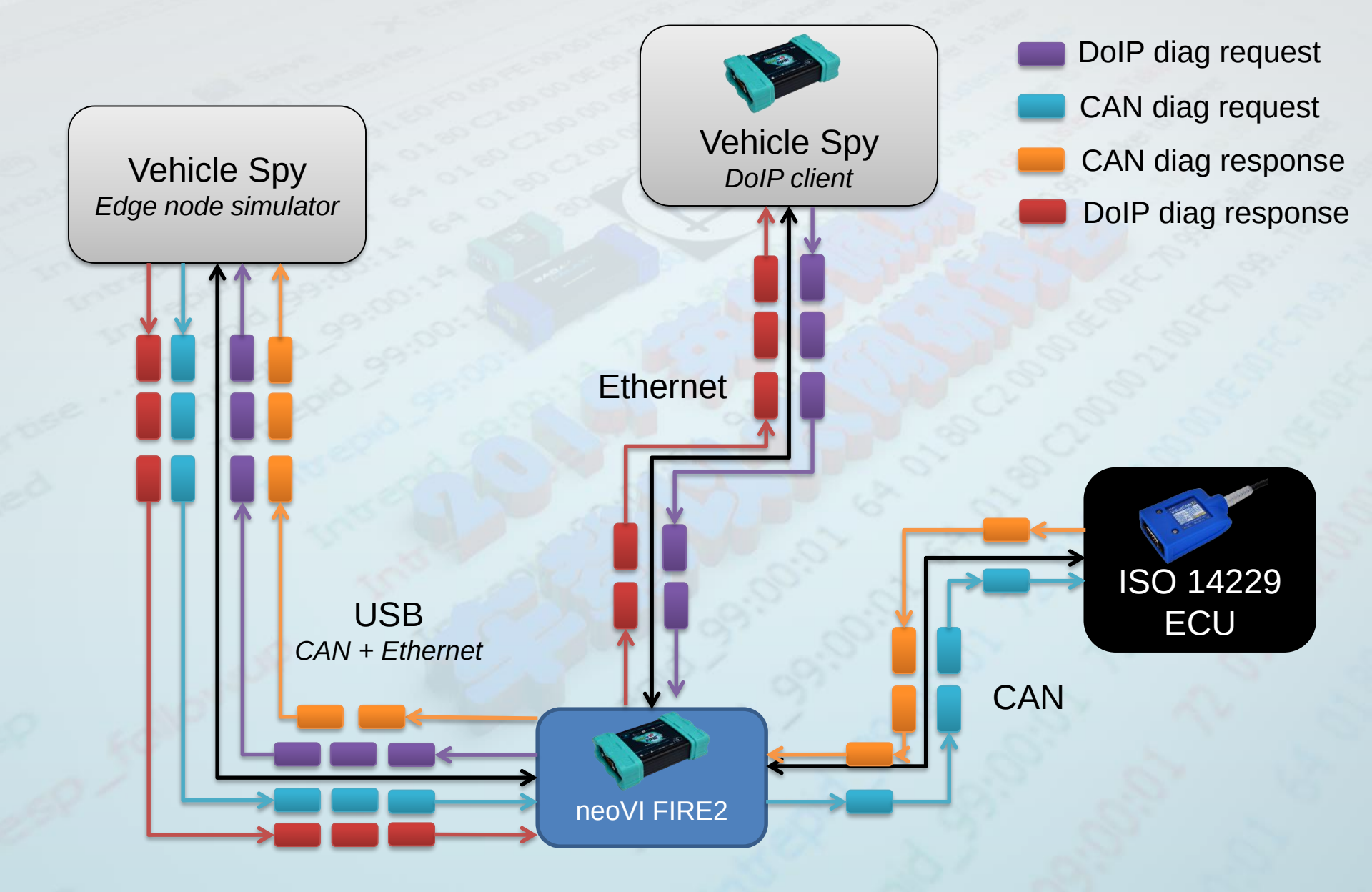

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