

## Simulation- and Test-Tools for CAN XL



## Agenda

1. You decided to develop a CAN XL network ...

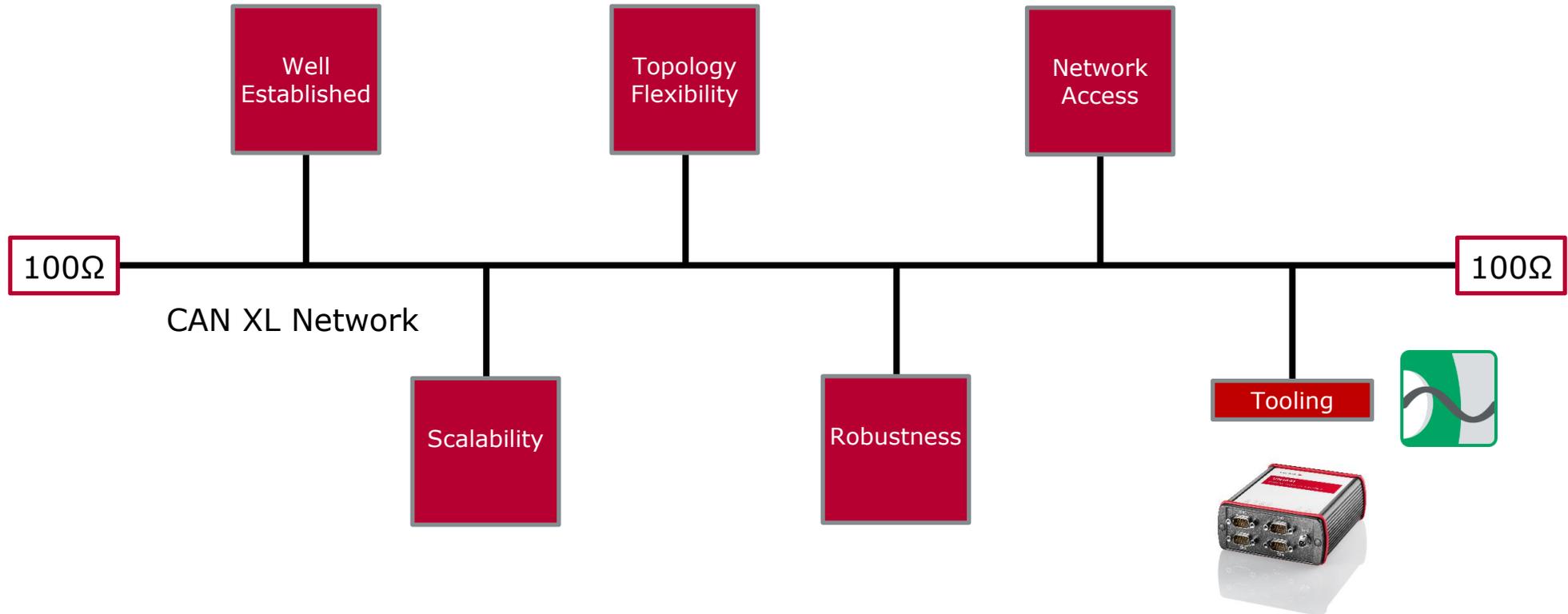
2. CAN XL Network Interfaces

3. CAN XL Transceivers

4. Vector CANoe and CAN XL

# You decided to develop a CAN XL network ...

## Reasons for CAN XL





## Agenda

1. You decided to develop a CAN XL network ...

2. **CAN XL Network Interfaces**

3. CAN XL Transceivers

4. Vector CANoe and CAN XL

# CAN XL Network Interfaces

## Getting Started



IP TechDay  
We enable possibilities

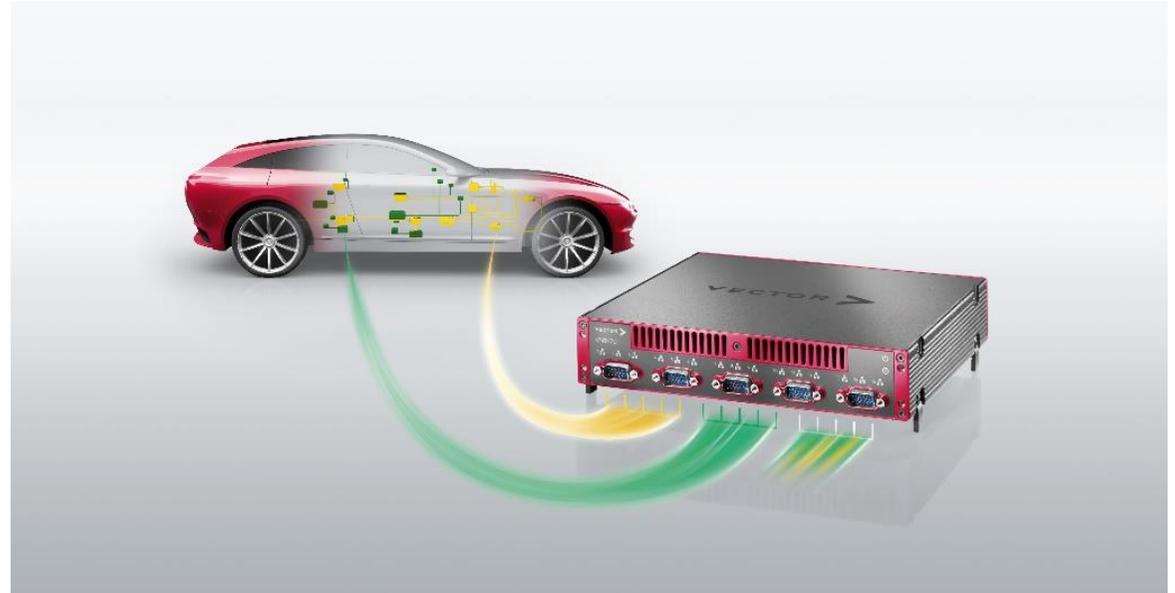


- ▶ The VN1641 is Vector's first dedicated CAN XL Network Interface (Planned Release April 2024)
  - ▶ It provides an appropriate, flexible and cost sensitive solution for analysis, test and simulation use cases
  - ▶ Full CAN XL support on all channels
    - > Protocol mode Error Signaling Enabled supported
    - > Protocol mode Error Signaling Disabled supported
  - ▶ CAN FD and CAN 2.0 Highspeed support on all channels with all latest features available
  - ▶ Time Synchronization
  - ▶ Digital / analog IOs: "simple IO" similar to VN1640A
    - > 2 Digital In, 1 Digital Out, 1 Analog In
  - ▶ Host connection
    - > USB 3.2 Gen. 1 with USB Type C connector with screw lock
    - > Ethernet Host Connection (Gigabit Ethernet 1000BASE-T)



## More Interfaces

- ▶ The VN1670 – Worldwide first CAN XL capable network interface
  - ▶ CAN XL available on 5 piggyback channels
  - ▶ Same feature set as VN1641
  - ▶ Additionally
    - > 5 onboard CAN/CAN FD channels
    - > 5 onboard LIN channels
- ▶ Overall: 15 channels
- ▶ Supported with CANoe/CANalyzer 17
- ▶ Vector Driver Setup 23.20





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## CAN Transceiver Technologies

## ▶ CAN XL Transceivers – A wide range of opportunities

	CAN High Speed 	CAN FD 	CAN SIC 	CAN SIC XL 
<b>Max. Bit-Rate in Mbit/s</b>	1	2 (5)	5 (8)	Up to 20
<b>Topology</b>	Linear bus, bus with stubs, stars	Linear bus, (peer-to-peer)	Linear bus, bus with stubs, stars, (peer-to-peer)	Linear bus, bus with stubs, stars
<b>Description</b>		Improved bit symmetry. Required for higher bit rates in FD data phase.	Supports ringing suppression.	Supports ringing suppression in arbitration phase. Supports mode change to use a push/pull mode in the data phase.
<b>Vector Product</b>	CANpiggy 1057Gcap	CANpiggy 1057Gcap	CANpiggy 1462BT	<i>In development</i>



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2. CAN XL Network Interfaces

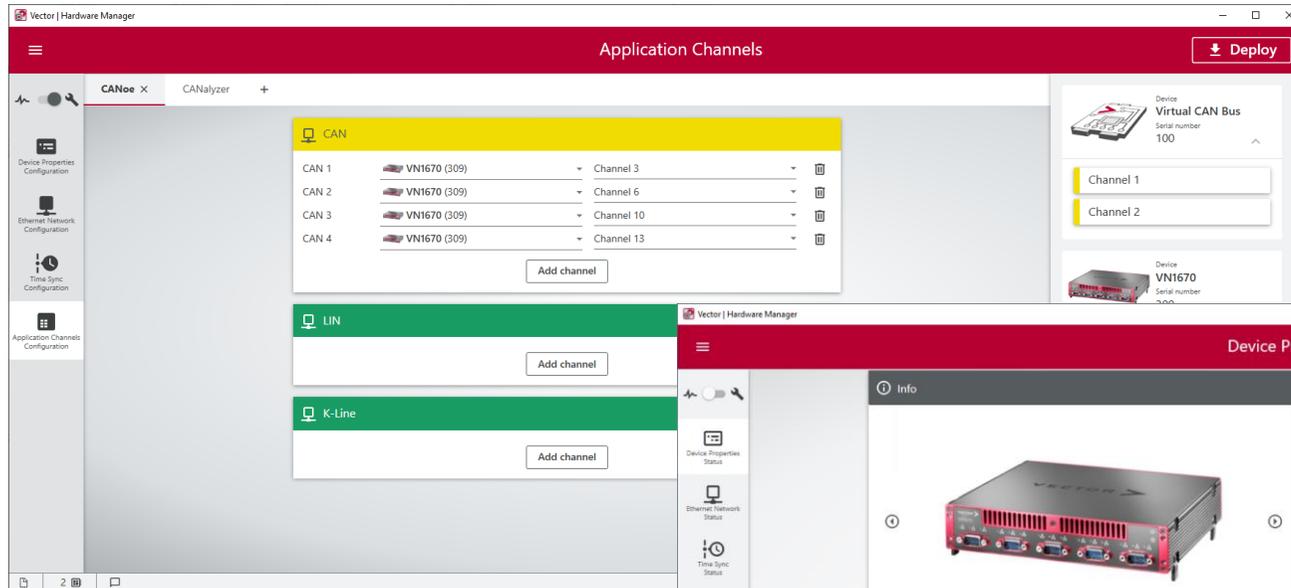
3. CAN XL Transceivers

4. **Vector CANoe and CAN XL**

# Vector CANoe and CAN XL Interface Configuration

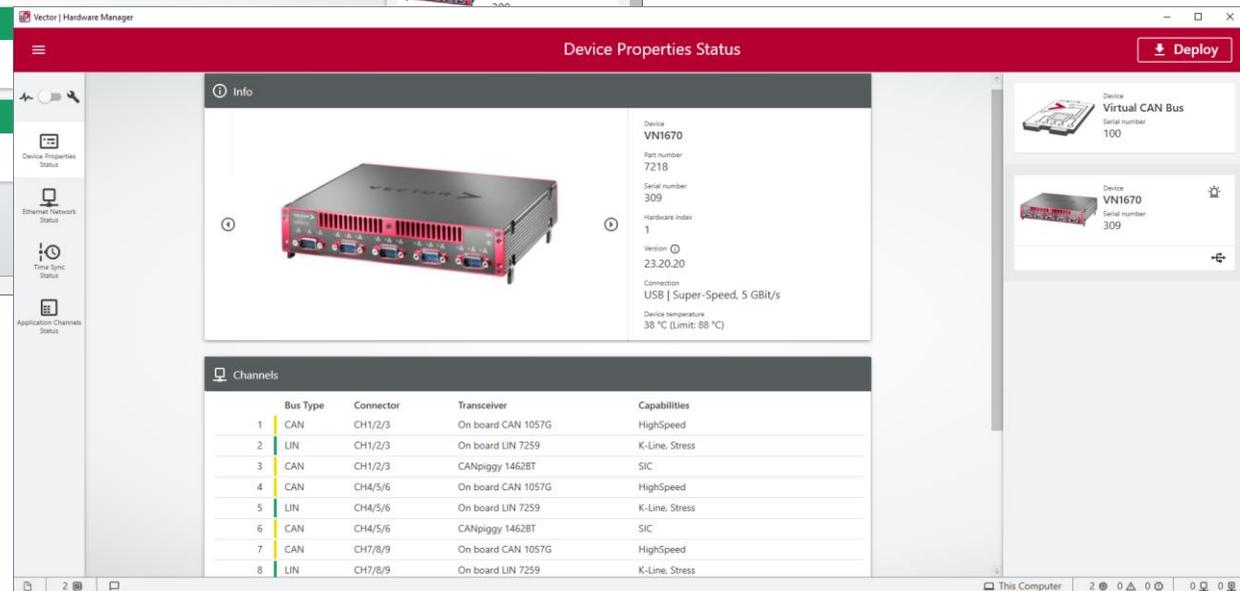


## ► Vector Hardware Manager



- Creation of configuration templates

- Configuration of Shared Medium Networks and Switched Networks
- Configuration of time synchronisation between interfaces

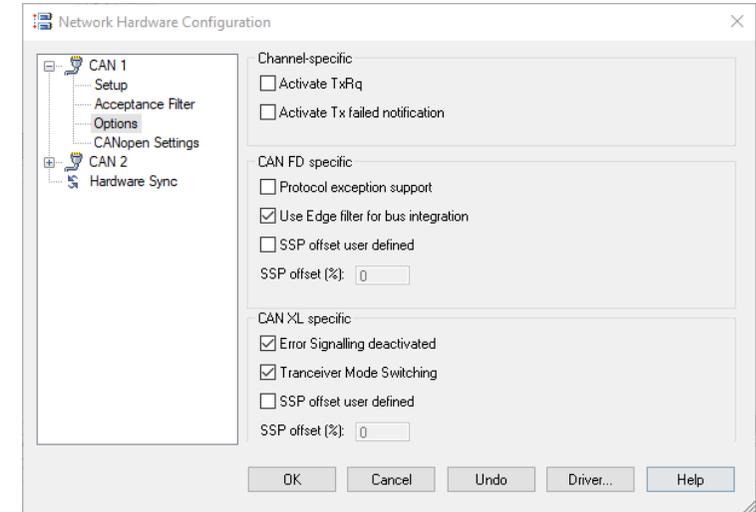
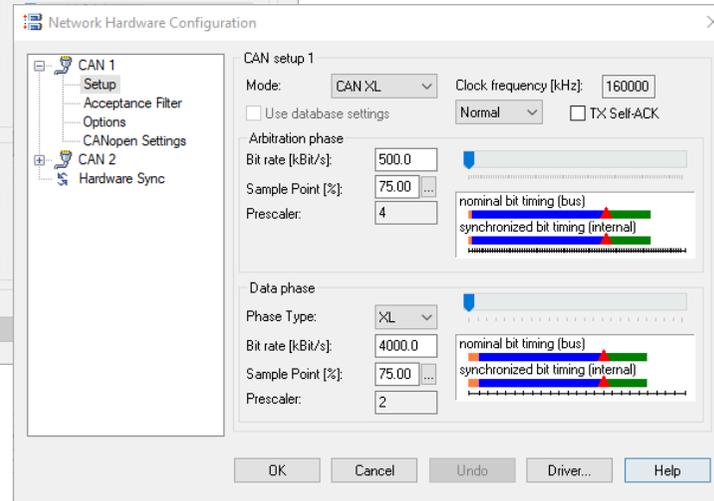
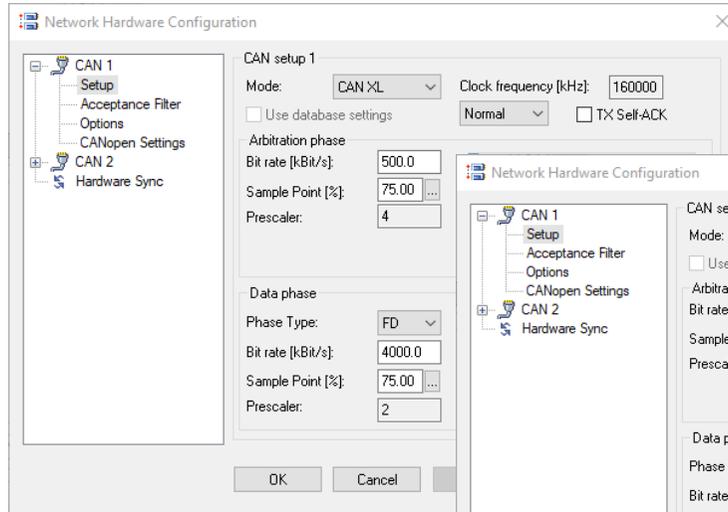
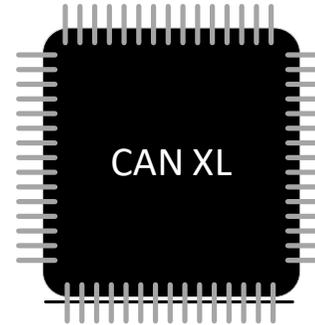


# Vector CANoe and CAN XL

## The CANoe CAN concept



- ▶ CANoe models CAN quite simple:
- ▶ Just like a controller ...



### ▶ Optional parameters

- Protocol Exception Event
- Errors Signaling On/Off
- Tranceiver Mode Switching

# Vector CANoe and CAN XL

## The CANoe CAN concept



- ▶ This concept is also followed in CANoes application language CAPL

```
variables
{
  // A CAN frame with ID 0
  message 0x0 canXL;
}

on key 'c'
{
  // transmit a CAN CC frame
  output(canXL);
}

on key 'a'
{
  // transmit a CAN FD frame with switched bitrate
  canXL.FDF = 1;
  canXL.BRS = 1;
  output(canXL);
}

on key 'n'
{
  // transmit a CAN XL frame
  canXL.FDF = 1;
  canXL.XLF = 1;
  output(canXL);
}
```

```
on message 0x0
{
  if (canXL.FDF == 0)
  {
    write("Received CAN CC frame. FDF: %d", this.FDF);
  }
  else if (canXL.FDF == 1 && canXL.XLF == 0)
  {
    write("Received CAN FD frame. FDF: %d XLF: %d", this.FDF, this.XLF);
  }
  else if (canXL.FDF == 1 && canXL.XLF == 1)
  {
    write("Received CAN XL frame. FDF: %d XLF: %d", this.FDF, this.XLF);
  }

  // Reset frame object to CAN CC
  canXL.FDF = 0;
  canXL.XLF = 0;
  canXL.BRS = 0;
}
```

CAN frame object

CAN frame handler

# Vector CANoe and CAN XL

## Analyzing CAN XL



### ► What's up on the network?

Start of Frame	Time	Chn	ID	Event Type	Dir	DLC	Data length	Data	SEC	SDT	VCID	AF	Frame Duration
22.107420	22.109796	CAN 1	401	CAN XL Frame	Tx	1036	1037	49 E8 6D 83 D1 2C 03 F5 EF B5 93 BF 55 D4 46 .. 0	FF	AA	29a	2.383 ms (9286 bits)	
22.207420	22.211660	CAN 1	561	CAN XL Frame	Tx	1884	1885	F4 C2 C5 28 F2 0B B4 71 6F FB 65 31 A0 38 8D .. 0	FF	AA	29a	4.246 ms (16747 bits)	
22.307420	22.307746	CAN 1	381	CAN XL Frame	Tx	104	105	0F 7A 0E 08 A1 17 0F 58 28 CA F9 08 22 79 9D .. 0	FF	AA	29a	0.332 ms (1084 bits)	
22.407420	22.408459	CAN 1	361	CAN XL Frame	Tx	429	430	DC 89 04 16 99 F4 23 19 16 7D 10 9E 6F A4 39 .. 0	FF	AA	29a	1.045 ms (3943 bits)	
22.507420	22.509517	CAN 1	281	CAN XL Frame	Tx	909	910	4A 48 08 D4 C6 B4 89 FD 85 76 80 C7 0D 63 E0 .. 0	FF	AA	29a	2.103 ms (8168 bits)	
22.607420	22.609062	CAN 1	1A1	CAN XL Frame	Tx	703	704	1D 6F DA 6F 87 3D 45 50 23 28 DD 87 BE 87 B3 .. 0	FF	AA	29a	1.648 ms (6355 bits)	
22.707420	22.709064	CAN 1	421	CAN XL Frame	Tx	704	705	E1 CA 76 DE 7F BF 27 84 82 E9 A2 10 F3 A2 D2 .. 0	FF	AA	29a	1.650 ms (6363 bits)	
22.807420	22.808281	CAN 1	421	CAN XL Frame	Tx	348	349	CF C6 AD D1 23 F8 CD F2 24 82 AA 0B 06 D9 A1 .. 0	FF	AA	29a	0.867 ms (3231 bits)	
22.907420	22.908056	CAN 1	701	CAN XL Frame	Tx	245	246	24 4D 33 4E 9B E8 B3 A2 40 26 89 E9 D1 F1 8B .. 0	FF	AA	29a	0.642 ms (2325 bits)	
23.007420	23.009739	CAN 1	361	CAN XL Frame	Tx	1011	1012	DC BE B4 F8 EB 6C 54 B5 DA 4D D8 8C C7 7C 2D .. 0	FF	AA	29a	2.326 ms (9065 bits)	
23.107420	23.110201	CAN 1	1C1	CAN XL Frame	Tx	1220	1221	F6 72 45 D9 85 CD 31 7C F0 07 4F 41 AC 13 10 .. 0	FF	AA	29a	2.788 ms (10905 bits)	
23.207420	23.209352	CAN 1	201	CAN XL Frame	Tx	834	835	B2 62 10 DF 61 52 FA 71 4E DB A7 16 BF 53 49 .. 0	FF	AA	29a	1.938 ms (7508 bits)	
23.307420	23.310071	CAN 1	201	CAN XL Frame	Tx	1161	1162	B9 3E DA 0C 47 59 D5 5A 4D CC 3B 1B 7D 81 A1 .. 0	FF	AA	29a	2.658 ms (10386 bits)	
23.407420	23.408043	CAN 1	601	CAN XL Frame	Tx	239	240	FF 1D A9 7F C9 F3 45 36 03 65 15 77 5F 69 51 .. 0	FF	AA	29a	0.629 ms (2272 bits)	
23.507420	23.511253	CAN 1	81	CAN XL Frame	Tx	1698	1699	1A 2C 01 4B D1 15 FA 8D 86 68 99 F6 72 A1 95 .. 0	FF	AA	29a	3.839 ms (15112 bits)	
23.607420	23.608694	CAN 1	5C1	CAN XL Frame	Tx	535	536	BC 05 26 8A 56 6E 5E 6C F4 C8 92 64 03 82 45 .. 0	FF	AA	29a	1.280 ms (4877 bits)	
23.707420	23.707777	CAN 1	41	CAN XL Frame	Tx	117	118	6E FB FF E3 94 2C 44 A5 56 40 AF B7 04 C9 F2 .. 0	FF	AA	29a	0.363 ms (1200 bits)	
23.807420	23.811913	CAN 1	1	CAN XL Frame	Tx	1997	1998	7D A4 D3 FE D8 C3 98 C9 81 76 D7 E9 02 51 71 .. 0	FF	AA	29a	4.499 ms (17744 bits)	
23.907420	23.909849	CAN 1	681	CAN XL Frame	Tx	1060	1061	2C 84 93 BF 74 7B F5 E4 1D A9 8D 76 30 F6 63 .. 0	FF	AA	29a	2.436 ms (9497 bits)	
24.007420	24.008430	CAN 1	281	CAN XL Frame	Tx	415	416	56 A1 43 E9 F1 07 70 55 D4 56 8A BE 14 A9 CD .. 0	FF	AA	29a	1.016 ms (3821 bits)	
24.107420	24.109755	CAN 1	201	CAN XL Frame	Tx	1017	1018	A8 F1 56 BD BD 4F 58 66 DB 47 E5 9B DB F8 51 .. 0	FF	AA	29a	2.341 ms (9119 bits)	
24.207420	24.207896	CAN 1	61	CAN XL Frame	Tx	172	173	7C 0F 67 27 C3 F2 F1 F9 DA 00 A1 AD 5A B9 B8 .. 0	FF	AA	29a	0.482 ms (1683 bits)	
24.307420	24.310181	CAN 1	1	CAN XL Frame	Tx	1210	1211	E6 3B 3E C3 BD 3B DA FB 89 AE C3 BE 69 47 .. 0	FF	AA	29a	2.768 ms (10818 bits)	
24.407420	24.408916	CAN 1	781	CAN XL Frame	Tx	636	637	14 AC C2 FE 74 8F 80 32 A6 8E C5 8D F8 9F 16 .. 0	FF	AA	29a	1.503 ms (5766 bits)	
24.507420	24.510958	CAN 1	141	CAN XL Frame	Tx	1564	1565	CA 93 10 7E F3 5B D0 ED E1 9D B3 9F 7A 38 C7 .. 0	FF	AA	29a	3.544 ms (13932 bits)	

Tracing CAN XL traffic

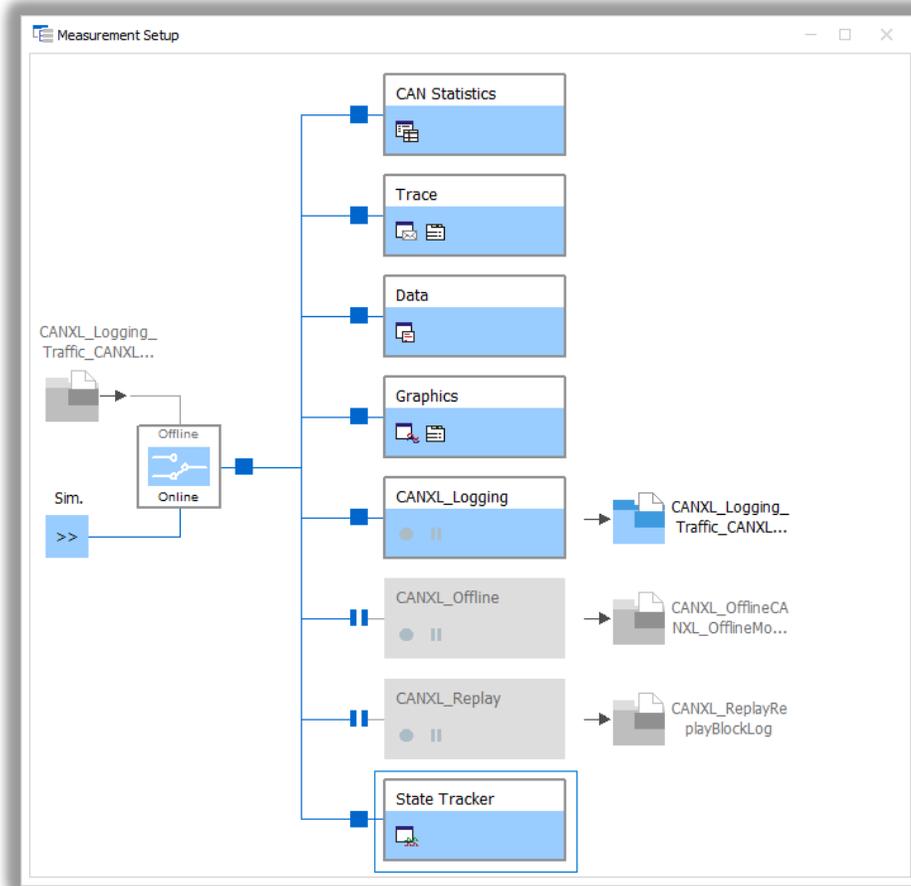
Interpretation of CAN XL specific frame fields

# Vector CANoe and CAN XL

## Analyzing CAN XL

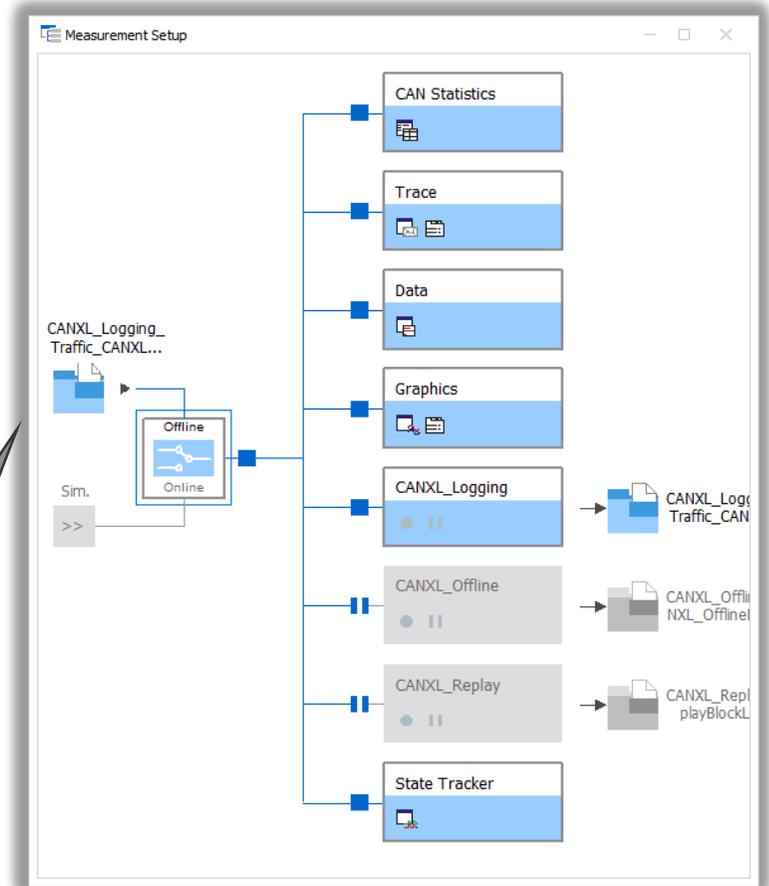


- ▶ Logging and offline analyzes for CAN XL



CAN logging

CAN offline

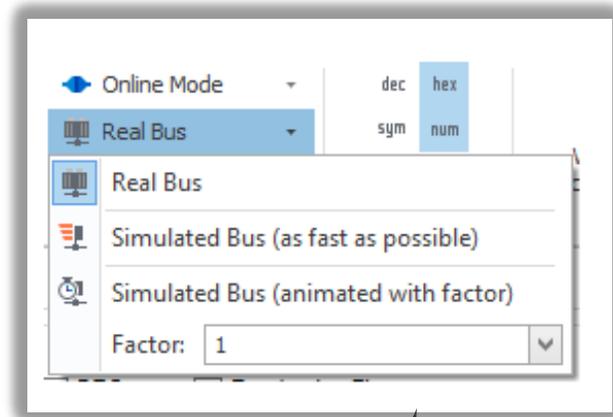


# Vector CANoe and CAN XL

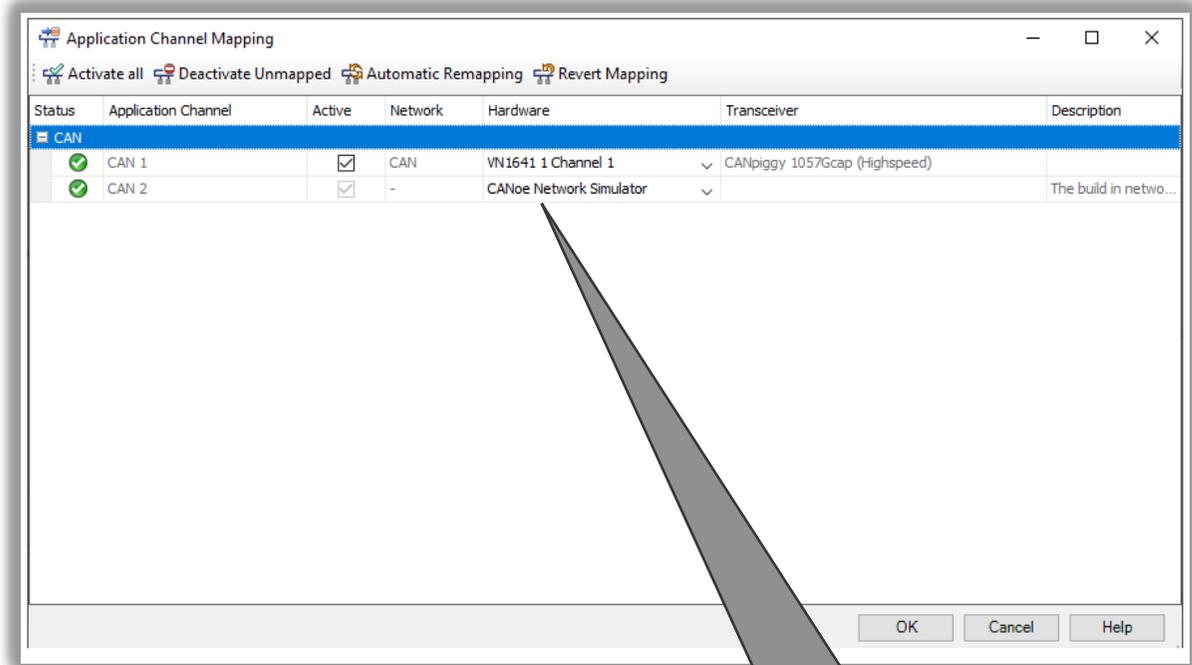
## Simulating CAN XL



- ▶ Simulated Mode and simulation per channel



Simulation of entire network configuration

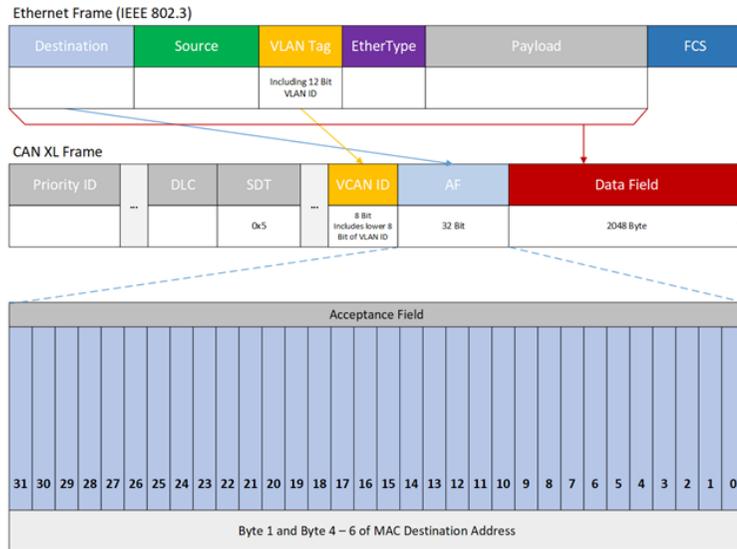


Simulation of a single network

# Vector CANoe and CAN XL Ethernet Tunneling

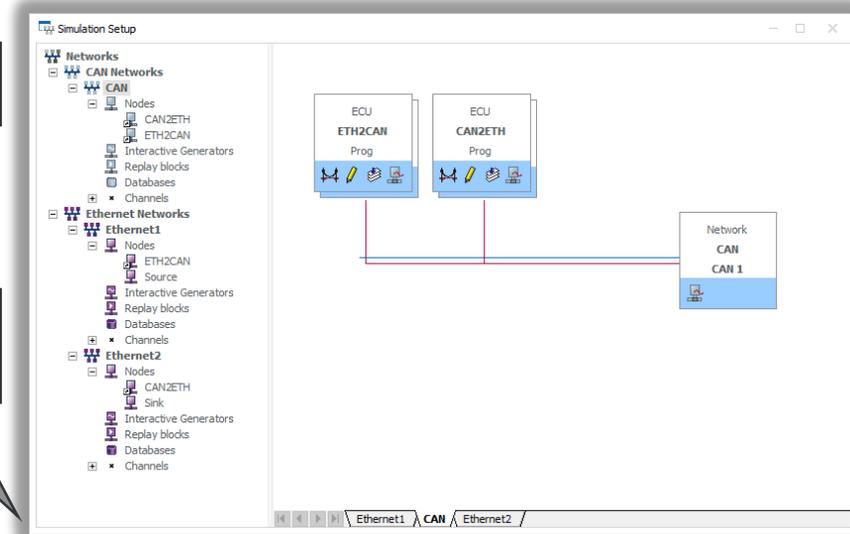


## ► CAN XL and IP? No Problem ...



CAN XL - ETH  
Frame mapping

Implementing  
ETH tunneling in  
CANoe



Trace

Time	Event Type	Dir	DLC	Data length	Data	VLAN	VCID	Destination MAC	AF	SDT
4.174334	Ethernet packet	Rx	50		C5 D7 C7 04 AA C4 E5 B8 6F 8D 7F 21 5C F7 68 F6 D0 64 71 78 F9 D5 C8 01 9F 42 8A 19 15 32 D2 58 30 51 CE 2C E4 5D 92 EF D6 A0 82 97 12 E3 D2 6F 80 81	4D2		02:84:CF:38:BE:04		
4.174335	Ethernet packet	Tx	50		C5 D7 C7 04 AA C4 E5 B8 6F 8D 7F 21 5C F7 68 F6 D0 64 71 78 F9 D5 C8 01 9F 42 8A 19 15 32 D2 58 30 51 CE 2C E4 5D 92 EF D6 A0 82 97 12 E3 D2 6F 80 81	4D2		02:84:CF:38:BE:04		
4.174587	CAN XL Frame	Tx	67	68	02 84 CF 38 BE 04 02 84 CF 38 BE 03 00 81 D2 24 23 F1 C5 D7 C7 04 AA C4 E5 B8 6F 8D 7F 21 5C F7 68 F6 D0 64 71 78 F9 D5 C8 01 9F 42 8A 19 15 32 D2 58 30 51 CE 2C E4 5D 92 EF D6 A0 82 97 12 E3 D2 6F 80 81		D2		23bbe04	05
4.174588	Ethernet packet	Rx	50		C5 D7 C7 04 AA C4 E5 B8 6F 8D 7F 21 5C F7 68 F6 D0 64 71 78 F9 D5 C8 01 9F 42 8A 19 15 32 D2 58 30 51 CE 2C E4 5D 92 EF D6 A0 82 97 12 E3 D2 6F 80 81	4D2		02:84:CF:38:BE:04		
4.174589	Ethernet packet	Tx	50		C5 D7 C7 04 AA C4 E5 B8 6F 8D 7F 21 5C F7 68 F6 D0 64 71 78 F9 D5 C8 01 9F 42 8A 19 15 32 D2 58 30 51 CE 2C E4 5D 92 EF D6 A0 82 97 12 E3 D2 6F 80 81	4D2		02:84:CF:38:BE:04		

# Vector CANoe and CAN XL Testing CAN XL



IP TechDay  
We enable possibilities



- ▶ Testing CAN XL? Just wait ...
  - ▶ Vector's vTESTstudio provides a table driven concept

Kommando	Überschrift
<b>Test Tree</b>	
▼ Test Case	Test CaseCheckCANXLSignal
▶ CAPL Inline	Stimulate ECU
▶ Await Value Match	Check Signal PlaybackStatus==1 Wait until CAN XL Transmitter::CANXL::MediaReceiver::MediaClientPDU::PlaybackStatus==1 with timeout 100 ms

Run tests in CANoe

Wait functions allow for asynchronous programming

Title	Verdict	Runtime	Test Unit
Test CAN XL	✓	0.044s	TestUnitCANXL
TestUnitCANXL	✓	0.005s	
Test CaseCheckCANXLSignal	✓	0.004s	

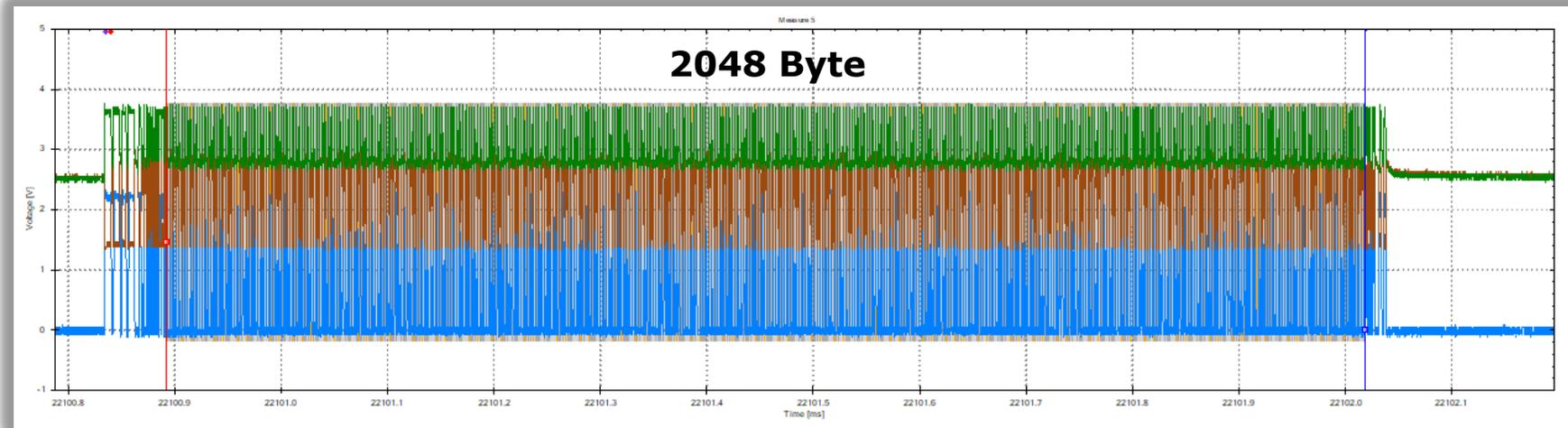
  

Name	Value	Data Type	Test Units	Dependencies
------	-------	-----------	------------	--------------

executed: 1 of 1    00:00:00    not passed: 0    **Passed**

## Testing CAN XL

- ▶ Getting physical – CANoe Option Scope



- ▶ **Physical layer analysis of CANXL protocol**

- ▶ Make usage of trigger conditions for CAN XL
  - ▶ Trigger on entire standard frame id range
  - ▶ Trigger very fast on waveform of CAN XL differential signal
  - ▶ Trigger on error frames
- ▶ Use advantages of full protocol decode of CAN XL frame format.
  - ▶ Protocol interpretation matches to voltage signal.



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**Thank you for your Attention!**

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