

Accelerating Automotive Ethernet validation by leveraging Synopsys Virtualizer with TraceCompass

Ashish Gandhi

Praveen Kumar Kondugari

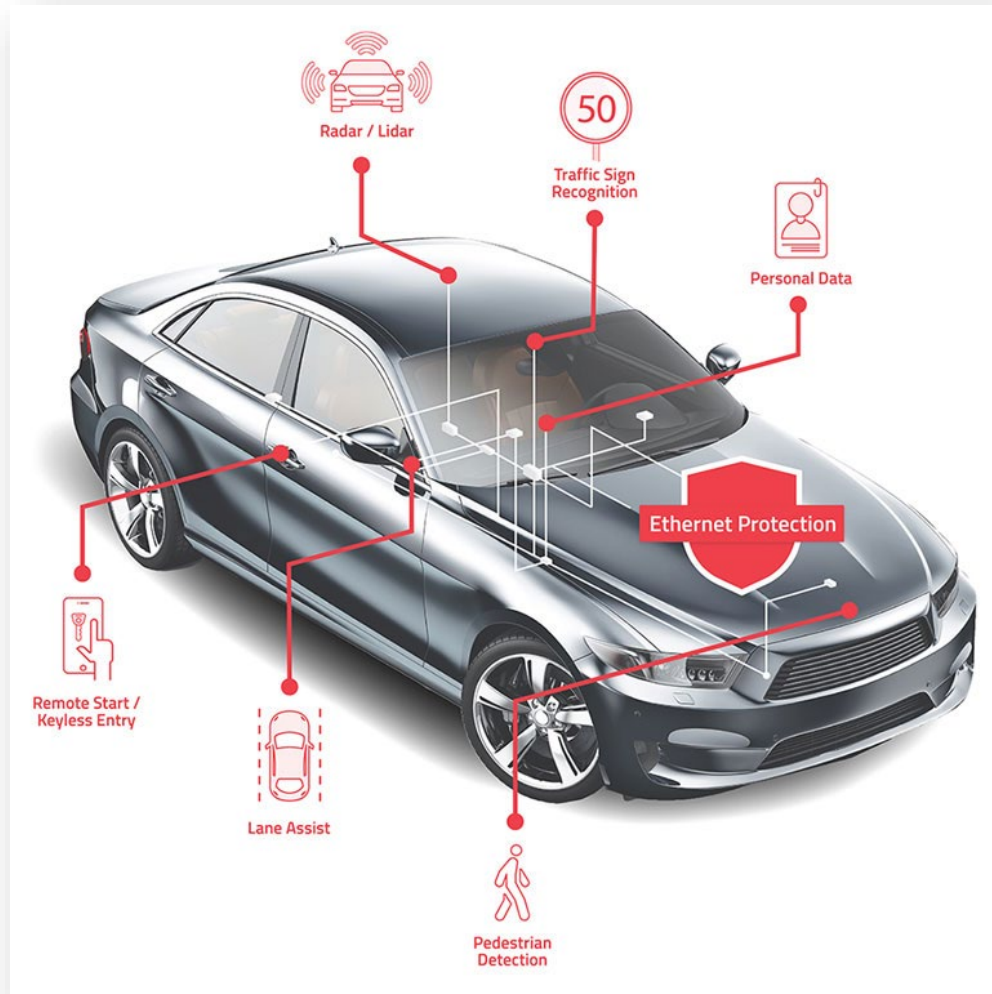
Sam Tennent

SYNOPSYS[®]

Overview

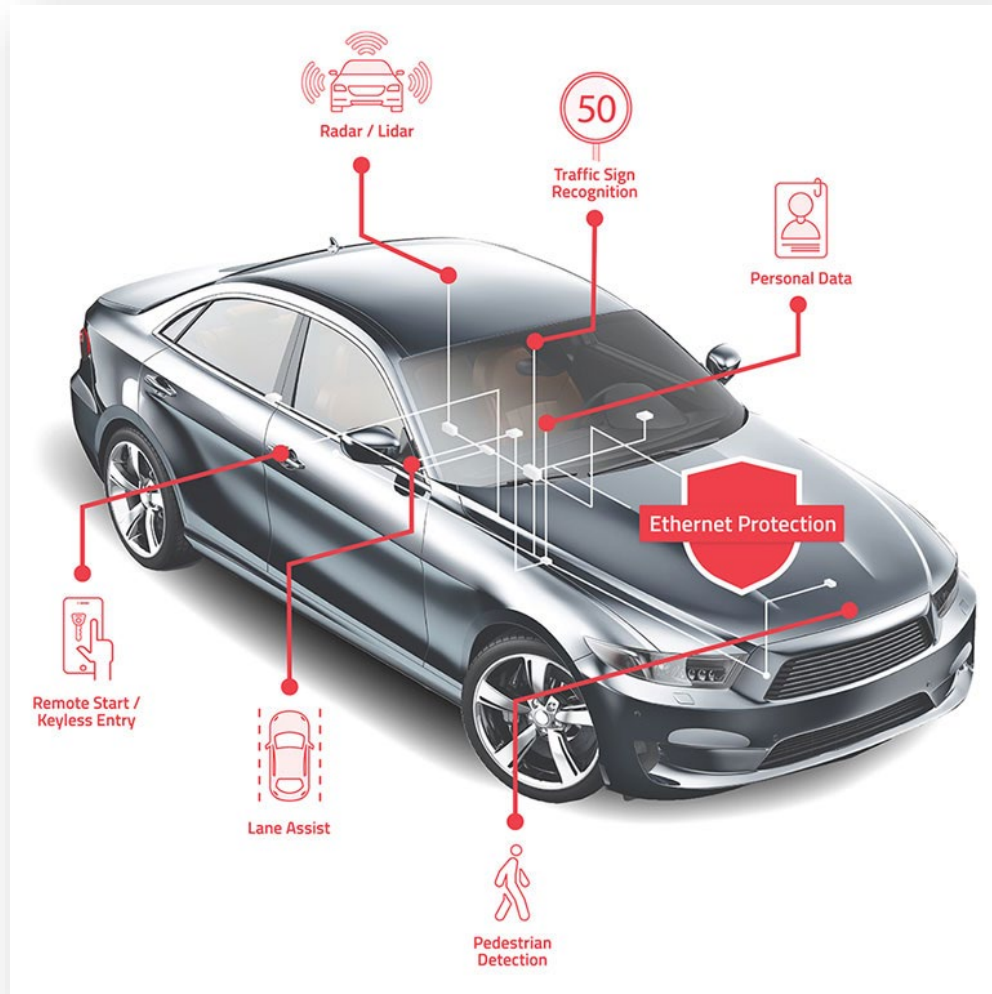
- What is Automotive Ethernet?
- Role of Virtual Prototyping
- Synopsys Virtualizer
- Challenges in debugging and current solutions
- TraceCompass
- Integrating TraceCompass with Virtualizer
- Experiments and Results
- Conclusions

Automotive Ethernet



[Reference Link](#)

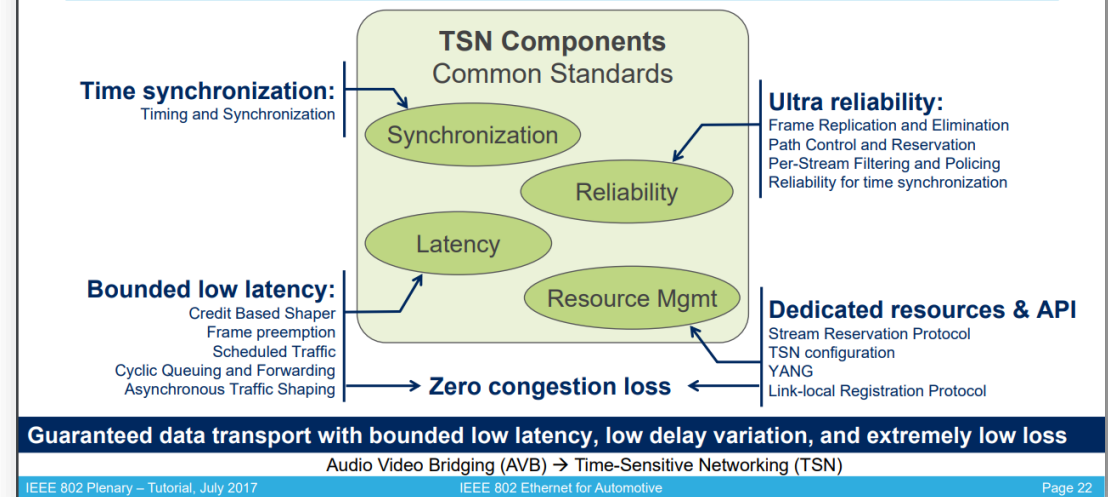
Automotive Ethernet



[Reference Link](#)

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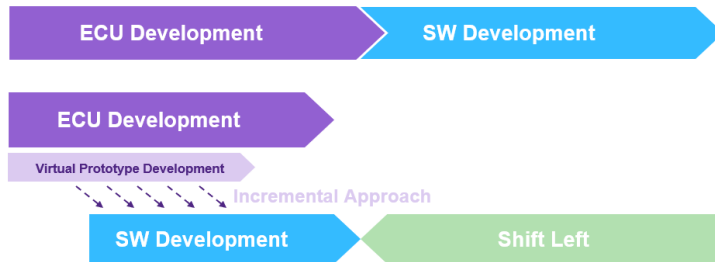
Time-Sensitive Networking (TSN)



[Reference Link](#)

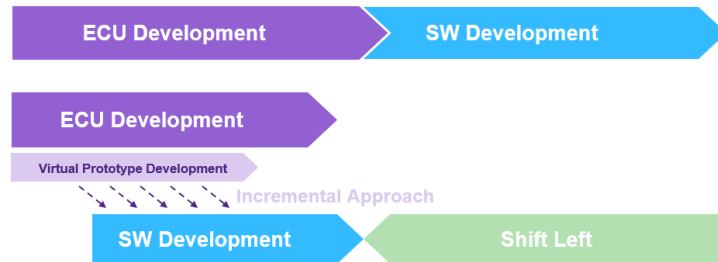
Role of Virtual Prototyping

- Pre-silicon, Software Development
- Front-load Test Development

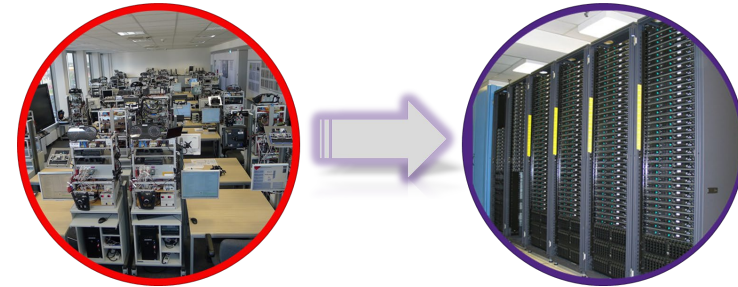


Role of Virtual Prototyping

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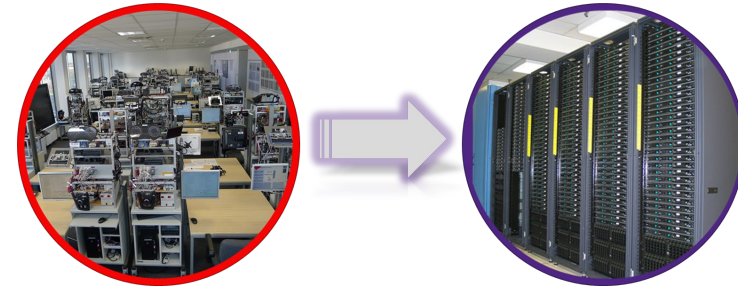
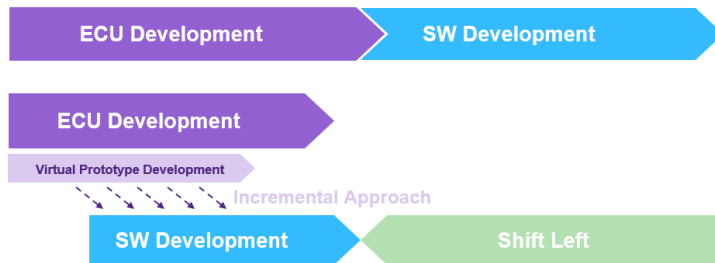


- Accelerate test cycles in regression
- Anytime, anywhere availability

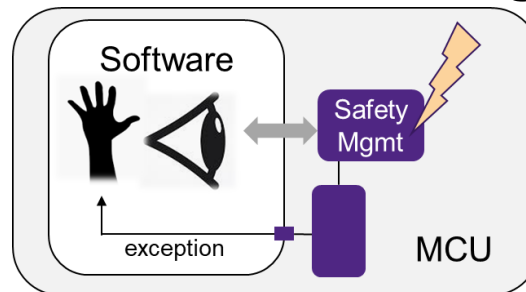


Role of Virtual Prototyping

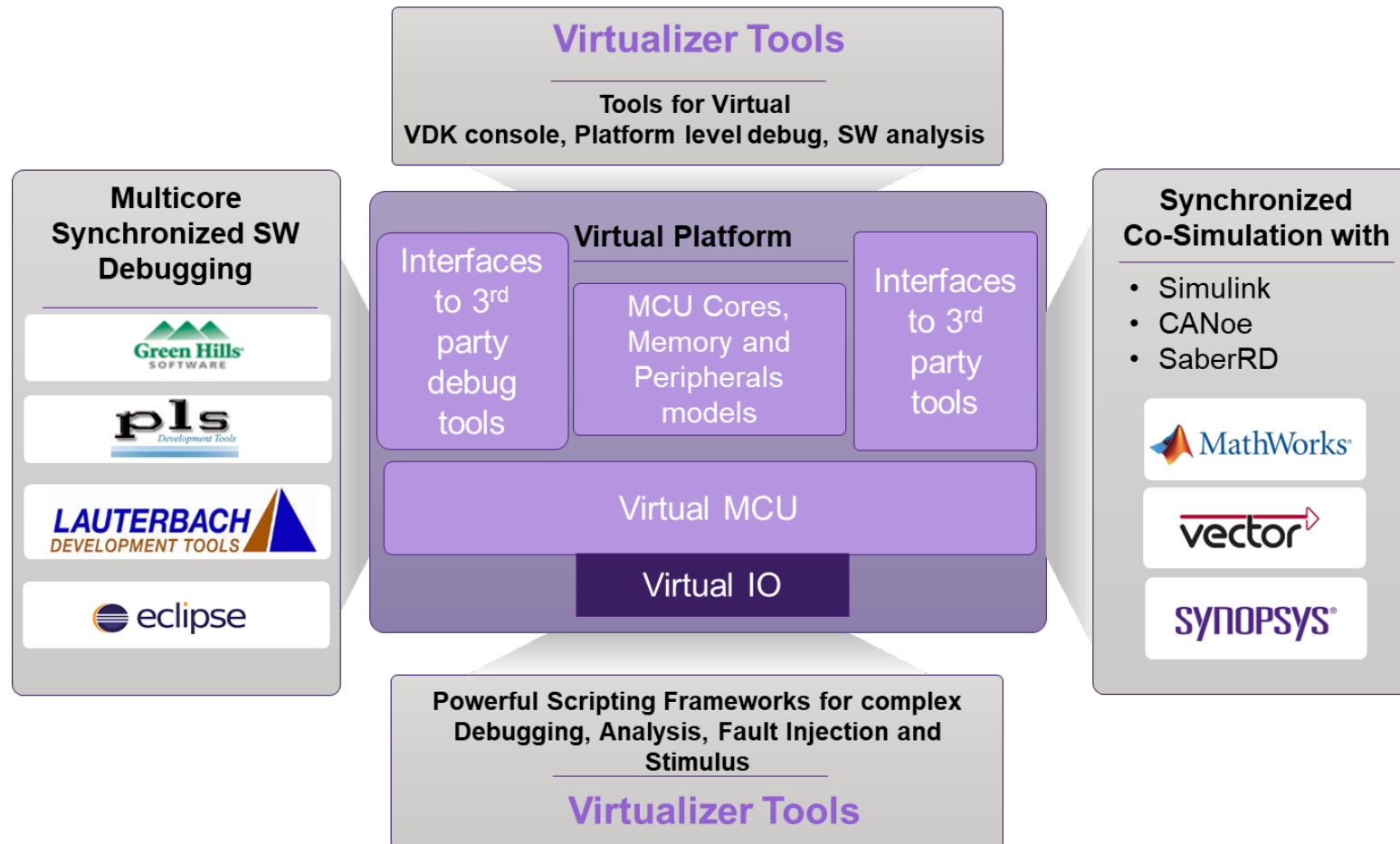
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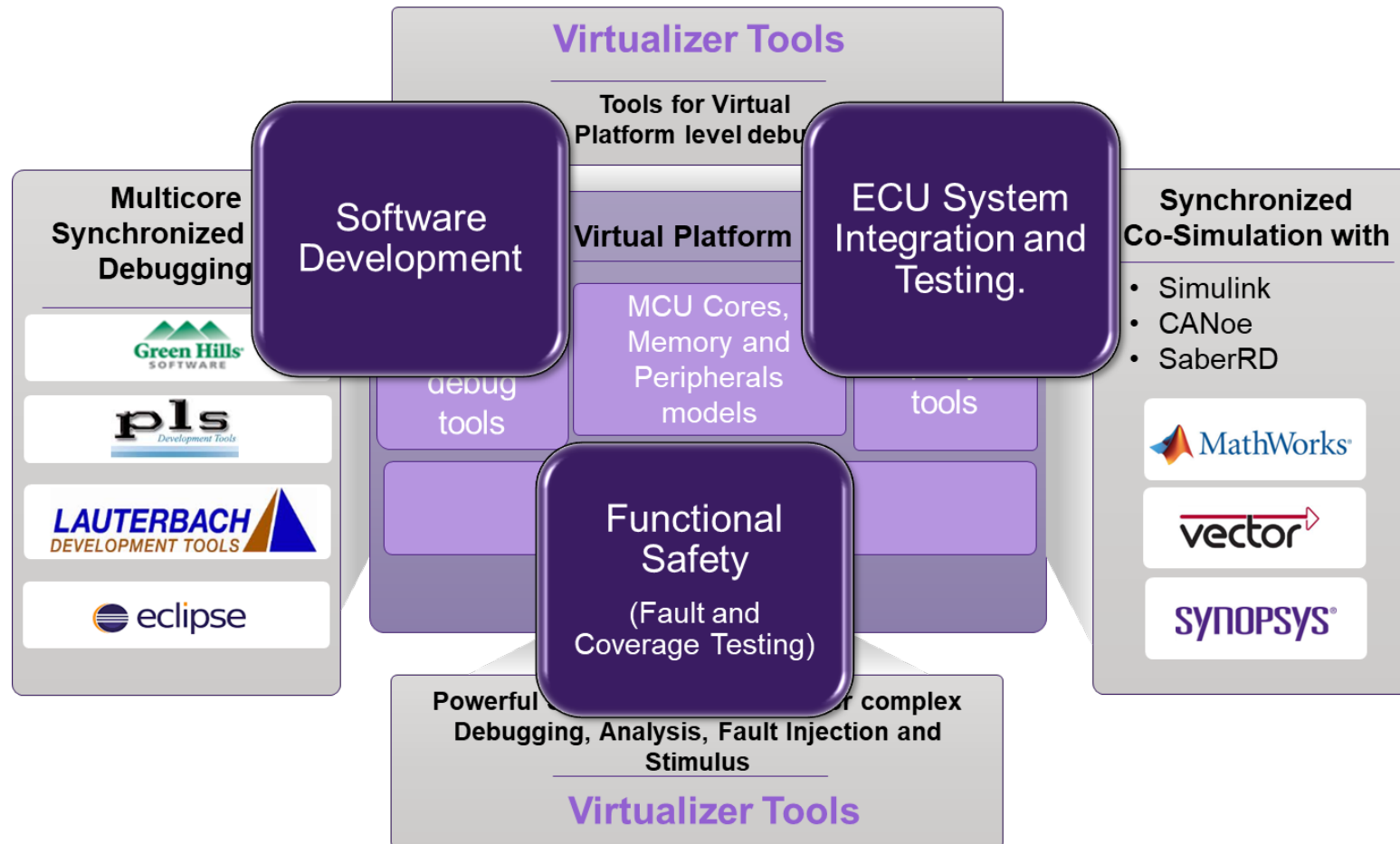
- Increase fault & coverage testing



Synopsys Virtualizer™



Synopsys Virtualizer™



Challenges in debugging and current solutions

- Challenges
 - Huge amount of ethernet traffic
 - Missing holistic view of Ethernet transactions
 - Manual mapping of ethernet transactions with other hardware and software events

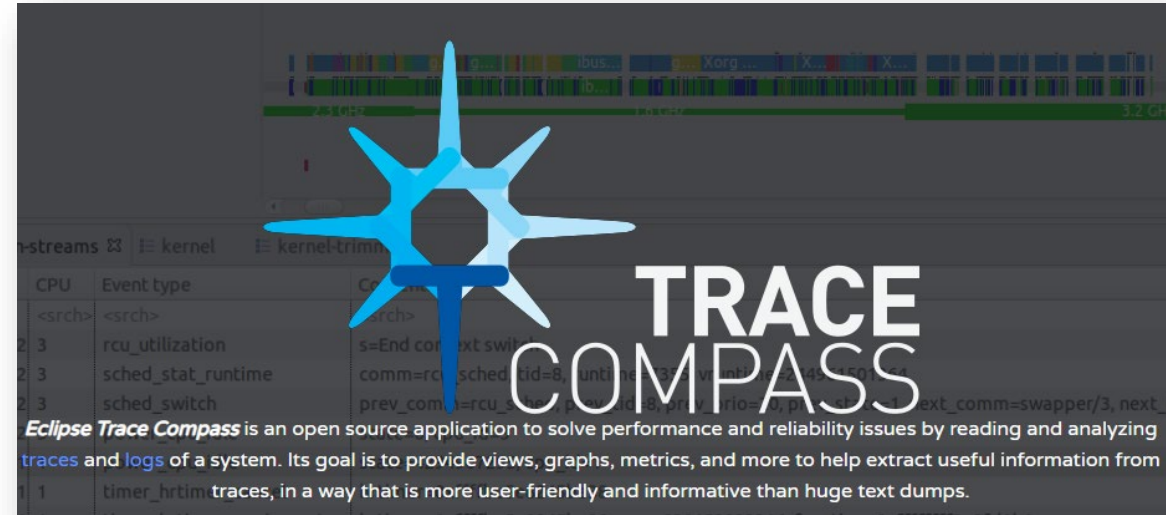
Challenges in debugging and current solutions

- Challenges
 - Huge amount of ethernet traffic
 - Missing holistic view of Ethernet transactions
 - Manual mapping of ethernet transactions with other hardware and software events
- Current solutions
 - Virtualizer
 - ✓ pcap capture with timestamping
 - ✓ analyze ethernet and platform events
 - ✗ analyze ethernet traffic
 - Wireshark
 - ✓ analyze single pcap
 - ✗ analyze multiple pcap
 - ✗ correlate other platform events
 - TraceCompass
 - ✓ analyze multiple pcap
 - ✗ correlate other platform events

TraceCompass

Network Tracing

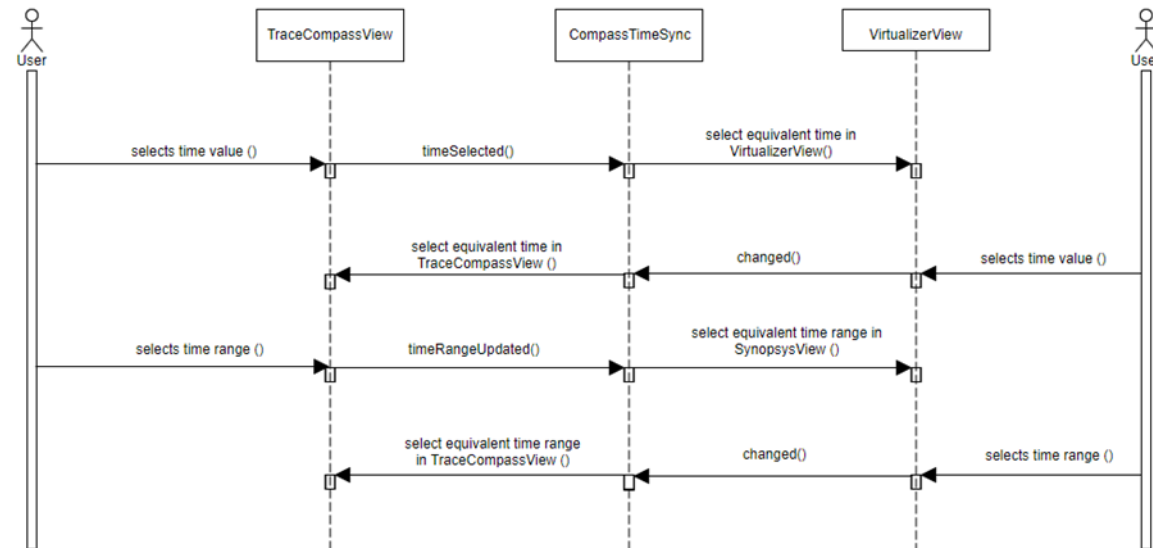
- Visualize multiple pcap files
- Time-Synchronous analysis views
 - Pcap Trace Viewer, TimeChart
 - Histogram, State System Explorer
- Other statistical analysis views and options
 - Stream List, Statistics, Filters, Colors, merge pcap traces into single view



[Reference Link](#)

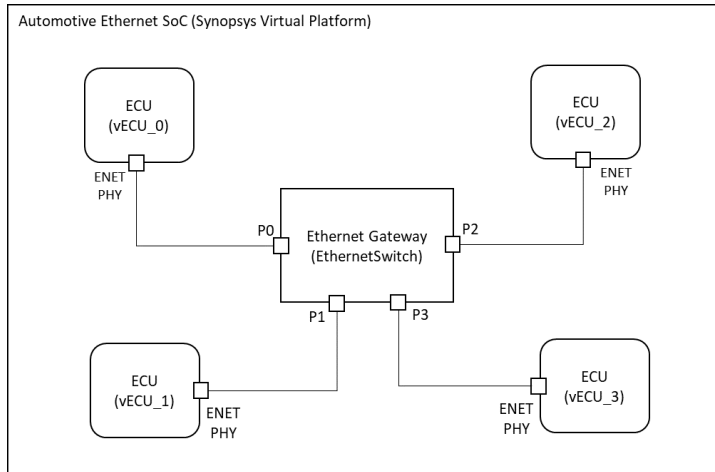
Integrating TraceCompass with Virtualizer

- Combines the TraceCompass multi-node pcap analysis capabilities with Virtualizer's tracing analysis
- User interactions with TraceCompass views synchronized with Virtualizer views



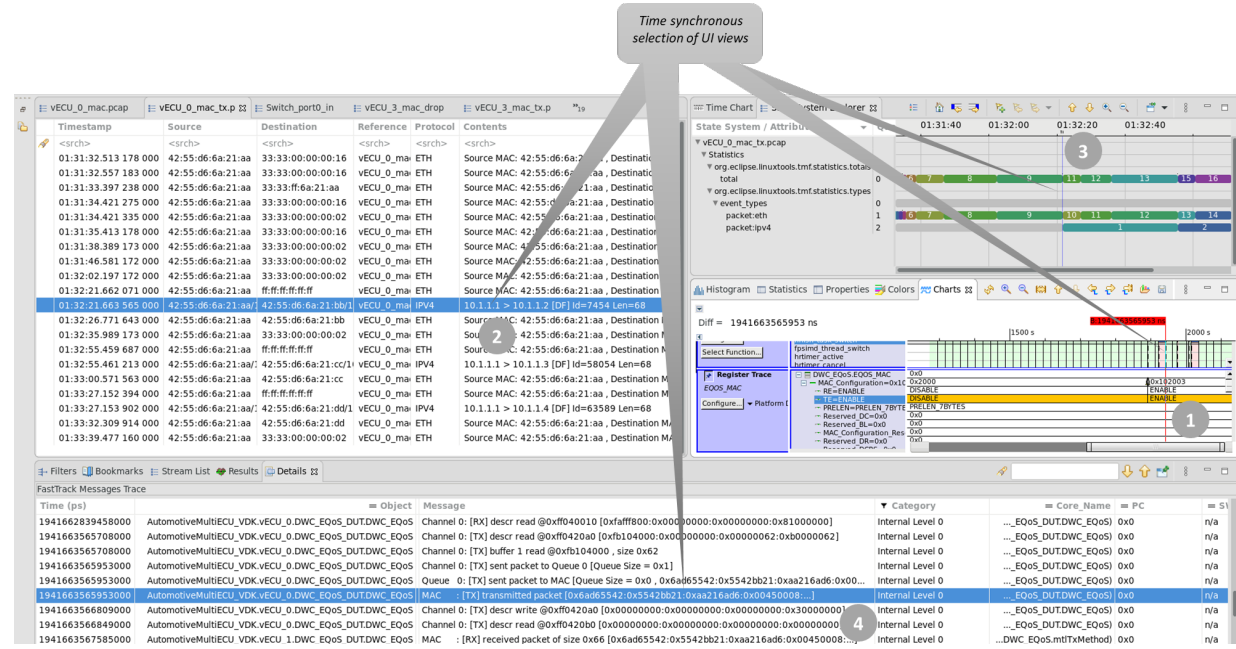
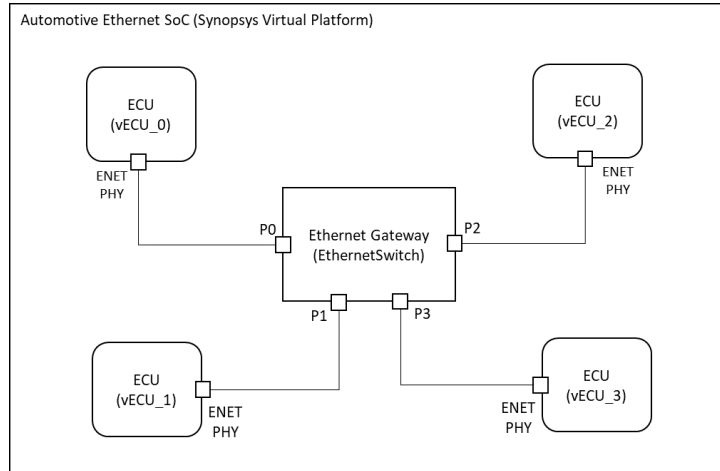
Experiments and Results

- An Automotive Ethernet scenario
 - Typical Automotive platform with 4x Virtual ECUs connected via Ethernet Switch
 - ping executed across ECUs and analyzed successfully using the integrated solution



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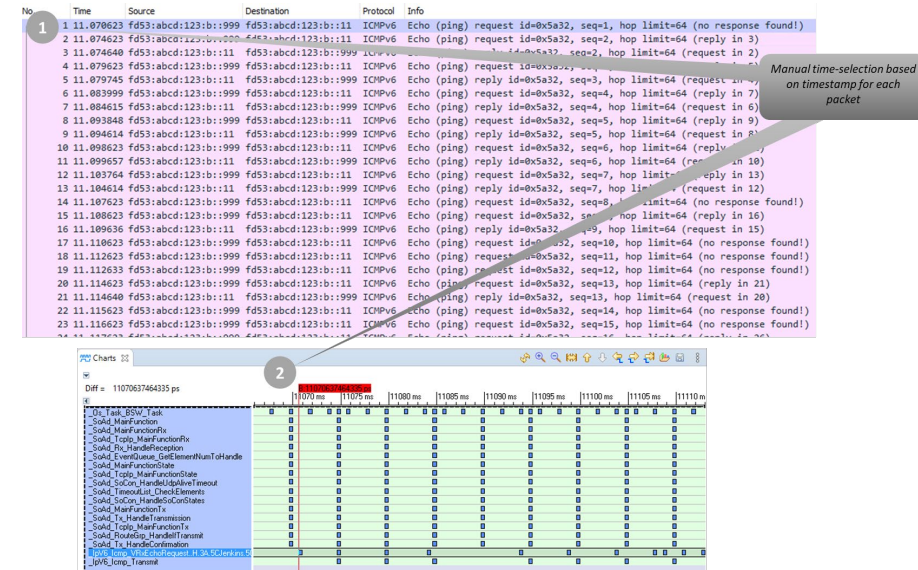
```
agandhi@automotive-platform:~$ ping6 -w4000 -I tap0.14 fd53:abcd:123:b::11 -c20
PING fd53:abcd:123:b::11 (fd53:abcd:123:b::11) from fd53:abcd:123:b::999 tap0.14: 56 data bytes
64 bytes from fd53:abcd:123:b::11: icmp_seq=2 ttl=64 time=192 ms
64 bytes from fd53:abcd:123:b::11: icmp_seq=3 ttl=64 time=200 ms
64 bytes from fd53:abcd:123:b::11: icmp_seq=4 ttl=64 time=57.5 ms
64 bytes from fd53:abcd:123:b::11: icmp_seq=5 ttl=64 time=84.8 ms
64 bytes from fd53:abcd:123:b::11: icmp_seq=6 ttl=64 time=311 ms
64 bytes from fd53:abcd:123:b::11: icmp_seq=7 ttl=64 time=153 ms
64 bytes from fd53:abcd:123:b::11: icmp_seq=9 ttl=64 time=683 ms
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64 bytes from fd53:abcd:123:b::11: icmp_seq=25 ttl=64 time=218 ms
64 bytes from fd53:abcd:123:b::11: icmp_seq=26 ttl=64 time=980 ms
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--- fd53:abcd:123:b::11 ping statistics ---
35 packets transmitted, 20 received, 42% packet loss, time 34413ms
rtt min/avg/max/mdev = 57.578/430.846/1024.878/291.081 ms, pipe 2
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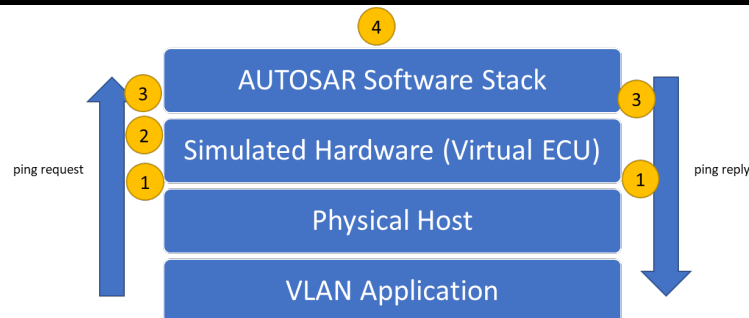


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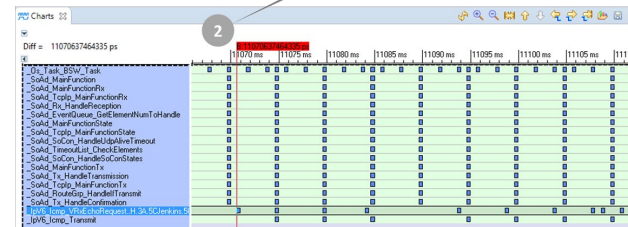
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No.	Time	Source	Destination	Protocol	Info
1	11.070623	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=1, hop limit=64 (no response found!)
2	11.074623	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=2, hop limit=64 (reply in 3)
3	11.074640	fd53:abcd:123:b::11	fd53:abcd:123:b::999	ICMPv6	Echo (ping) reply id=0x5a32, seq=2, hop limit=64 (request in 2)
4	11.079623	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=3, hop limit=64 (reply in 7)
5	11.079745	fd53:abcd:123:b::11	fd53:abcd:123:b::999	ICMPv6	Echo (ping) request id=0x5a32, seq=4, hop limit=64 (reply in 7)
6	11.083999	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=5, hop limit=64 (request in 8)
7	11.084615	fd53:abcd:123:b::11	fd53:abcd:123:b::999	ICMPv6	Echo (ping) reply id=0x5a32, seq=4, hop limit=64 (request in 6)
8	11.093848	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=6, hop limit=64 (reply in 9)
9	11.094614	fd53:abcd:123:b::11	fd53:abcd:123:b::999	ICMPv6	Echo (ping) reply id=0x5a32, seq=5, hop limit=64 (request in 8)
10	11.098623	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=6, hop limit=64 (reply in 10)
11	11.099657	fd53:abcd:123:b::11	fd53:abcd:123:b::999	ICMPv6	Echo (ping) reply id=0x5a32, seq=6, hop limit=64 (request in 10)
12	11.103764	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=7, hop limit=64 (reply in 13)
13	11.104614	fd53:abcd:123:b::11	fd53:abcd:123:b::999	ICMPv6	Echo (ping) request id=0x5a32, seq=7, hop limit=64 (request in 12)
14	11.107623	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=8, hop limit=64 (no response found!)
15	11.108623	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=9, hop limit=64 (reply in 16)
16	11.109636	fd53:abcd:123:b::11	fd53:abcd:123:b::999	ICMPv6	Echo (ping) reply id=0x5a32, seq=9, hop limit=64 (request in 15)
17	11.110623	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=10, hop limit=64 (no response found!)
18	11.112623	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=11, hop limit=64 (no response found!)
19	11.112633	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=12, hop limit=64 (no response found!)
20	11.114623	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=13, hop limit=64 (reply in 21)
21	11.114640	fd53:abcd:123:b::11	fd53:abcd:123:b::999	ICMPv6	Echo (ping) reply id=0x5a32, seq=13, hop limit=64 (request in 20)
22	11.115623	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=14, hop limit=64 (no response found!)
23	11.116623	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=15, hop limit=64 (no response found!)

Manual time-selection based on timestamp for each packet



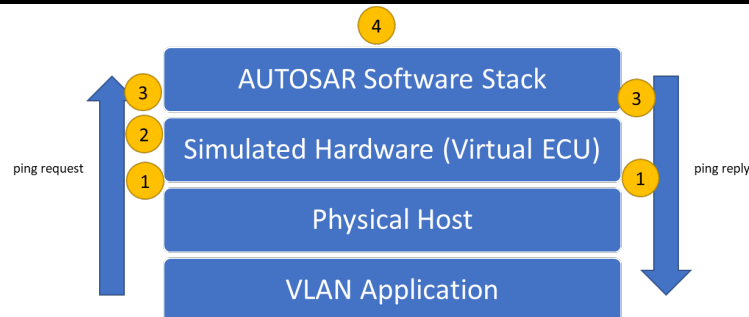
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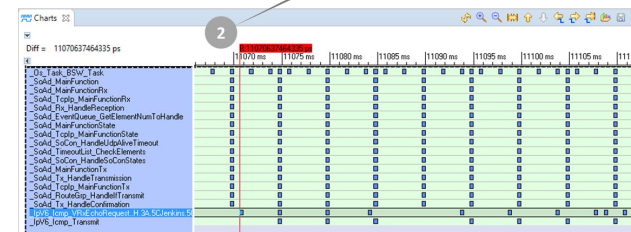


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11	11.099657	fd53:abcd:123:b::11	fd53:abcd:123:b::999	ICMPv6	Echo (ping) reply id=0x5a32, seq=6, hop limit=64 (request in 10)
12	11.103764	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=7, hop limit=64 (reply in 13)
13	11.104614	fd53:abcd:123:b::11	fd53:abcd:123:b::999	ICMPv6	Echo (ping) reply id=0x5a32, seq=7, hop limit=64 (request in 12)
14	11.107623	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=8, hop limit=64 (no response found!)
15	11.108623	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=9, hop limit=64 (reply in 16)
16	11.109636	fd53:abcd:123:b::11	fd53:abcd:123:b::999	ICMPv6	Echo (ping) reply id=0x5a32, seq=9, hop limit=64 (request in 15)
17	11.110623	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=10, hop limit=64 (no response found!)
18	11.112623	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=11, hop limit=64 (no response found!)
19	11.112633	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=12, hop limit=64 (no response found!)
20	11.114623	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=13, hop limit=64 (reply in 21)
21	11.114640	fd53:abcd:123:b::11	fd53:abcd:123:b::999	ICMPv6	Echo (ping) reply id=0x5a32, seq=13, hop limit=64 (request in 20)
22	11.115623	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=14, hop limit=64 (no response found!)
23	11.116623	fd53:abcd:123:b::999	fd53:abcd:123:b::11	ICMPv6	Echo (ping) request id=0x5a32, seq=15, hop limit=64 (no response found!)

Manual time-selection based on timestamp for each packet



Function	Self (%)	TISP	TISCP	Called	Instructions
_SoAd_MainFunction	1.858	2762058	191644332	51	663
_SoAd_EventQueue_GetElemen...	14.862	22096...	22096464	255	5304
_Ip_Os_Task_BSW_Task	29.475	43822...	7715840...	0	10519
_IpV6_Icmp_VRxEchoRequest....	5.786	8602790	29745240	35	2065
_IpV6_Icmp_Transmit	1.289	1916360	232071196	20	460

Experiments and Results

- Ethernet packet loss analysis in an Automotive platform using AUTOSAR



- Manual analysis v/s integrated solution analysis compared
- Significant time saved in reaching to the root cause of the issue

Experiments and Results

- Software Bug analysis for faster debug
 - stmmac bug analysis speedup using integrated solution



```
index : kernel/git/netdev/net-next.git
Netdev Group's -next networking tree

about summary refs log tree | commit | diff stats
path: root/drivers/net/ethernet/stmmac/stmmac_main.c

author   Jose Abreu <Jose.Abreu@synopsys.com>      2018-08-08 09:04:35 +0100
committer David S. Miller <davem@davenloft.net>    2018-08-09 11:16:28 -0700
commit   7d96c5afab6fb932acae99311448b876911c (patch)
tree     12e739411c1c4a6928966e7abfc2ea2f2c0457b /drivers/net/ethernet/stmmac/stmmac_main.c
parent   4bb7aff96d0f92483f27ec04683efc2fda42d25 (diff)
download net-next-7d96c5afab6fb932acae99311448b876911c.tar.gz

net: stmmac: Integrate XGMAC into main driver flow

Now that we have all the XGMAC related callbacks, lets start integrating
this IP block into main driver.

Also, we corrected the initialization flow to only start DMA after
setting descriptors length.

Signed-off-by: Jose Abreu <joabreu@synopsys.com>
Cc: David S. Miller <davem@davenloft.net>
Cc: Joao Pinto <jpinto@synopsys.com>
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Cc: Alexandre Torgue <alexandre.torgue@st.com>
Cc: Andrew Lunn <andrew@lunn.ch>
Signed-off-by: David S. Miller <davem@davenloft.net>
```

- Enhanced Scheduling Traffic (EST) visualization for Time Sensitive Networking

Conclusions

- Successful holistic visualization of ethernet transactions in Virtual Platform
- Expedite ethernet software debugging and analysis
- Leveraging TraceCompass with Virtualizer is valuable to accelerate Automotive Ethernet validation
- TraceCompass' network protocol support can be extended for broader usage

Questions