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Ensuring Fulfilment of End-to-End Timing Requirements in ADAS Projects

Olaf Schmidt
Business Development Manager

My Team Says That . . .

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"The CPUs do not have enough performance."

"We don't understand the root cause of the sporadic error."

"We need weeks for optimization."

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Our Experience from More Than 180 Projects is…

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Nearly 90% consider timing to later in their project.

Timing requirements are often unknown or imprecise.

Poor dynamic behavior design results in CPU underutilization.

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Agenda

Proven methodology

- *Model based design*
- *Simulation*
- *Virtual verification*
- *Test*
- *Continuous integration*

Leads to . . .

- *less stress.*
- *reduction in wasted time.*
- *fewer wasted resources.*

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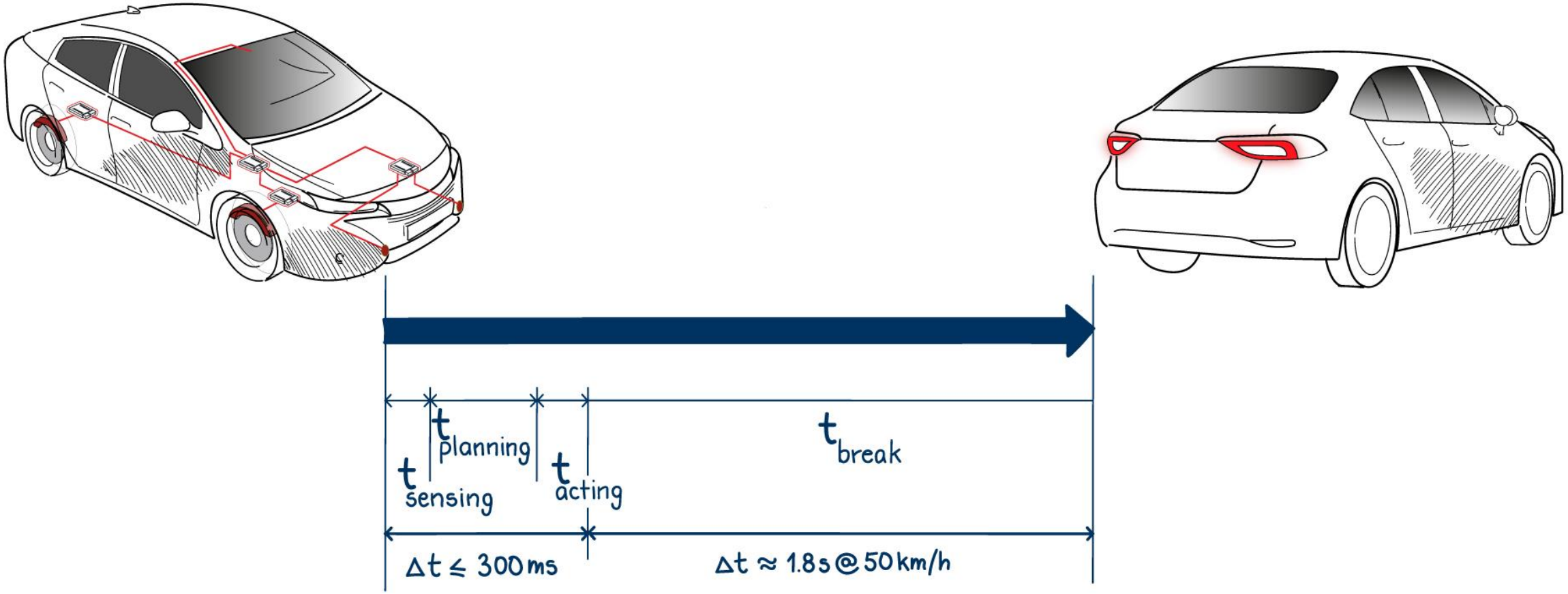
Advanced Emergency Braking System (AEB)



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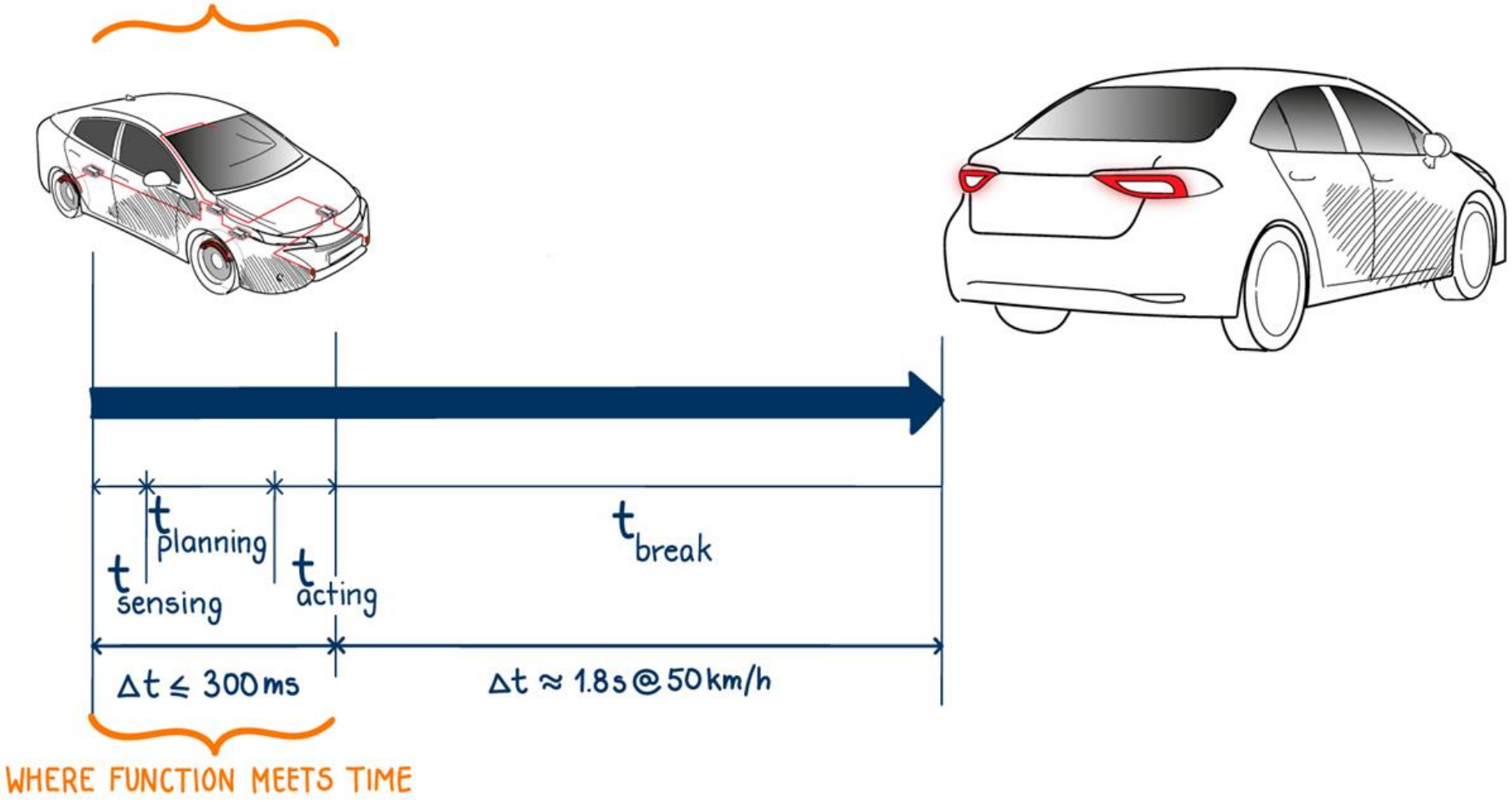
Advanced Emergency Braking System (AEB)



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Event Chains

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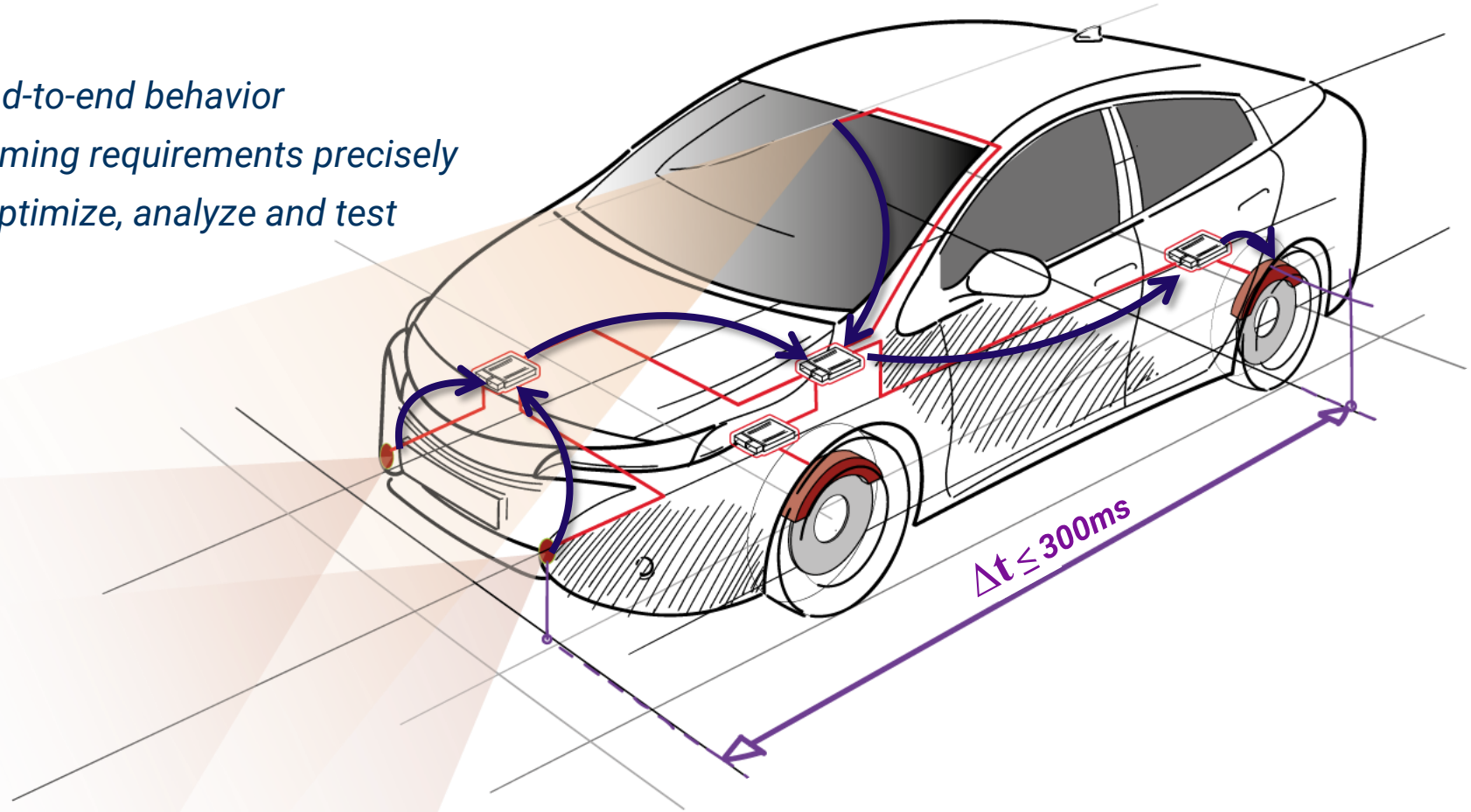
Concept to:

- *model end-to-end behavior*
- *specify timing requirements precisely*
- *design, optimize, analyze and test*



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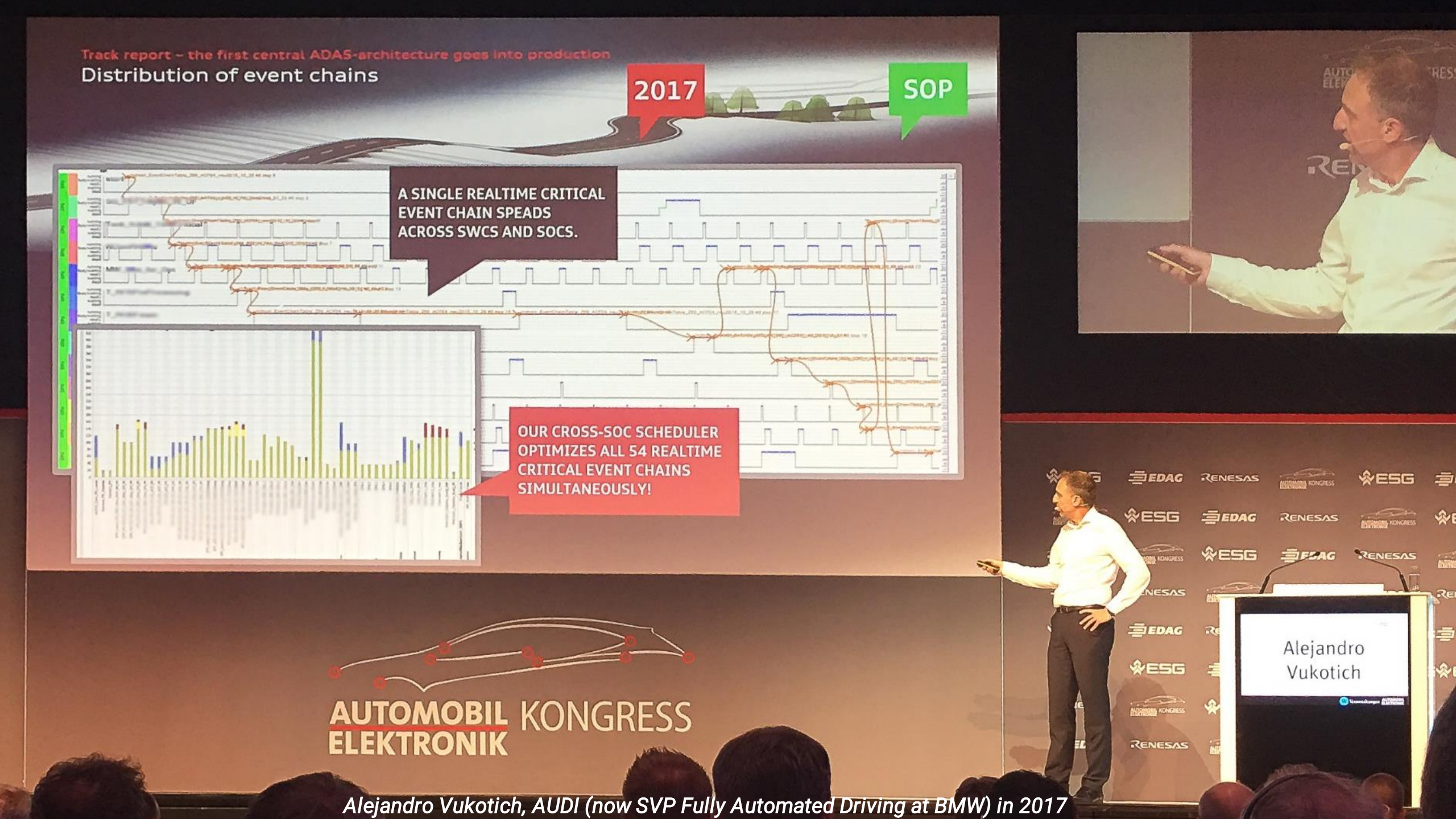

Alejandro Vukotich, AUDI (now SVP Fully Automated Driving at BMW) in 2017

Use Cases

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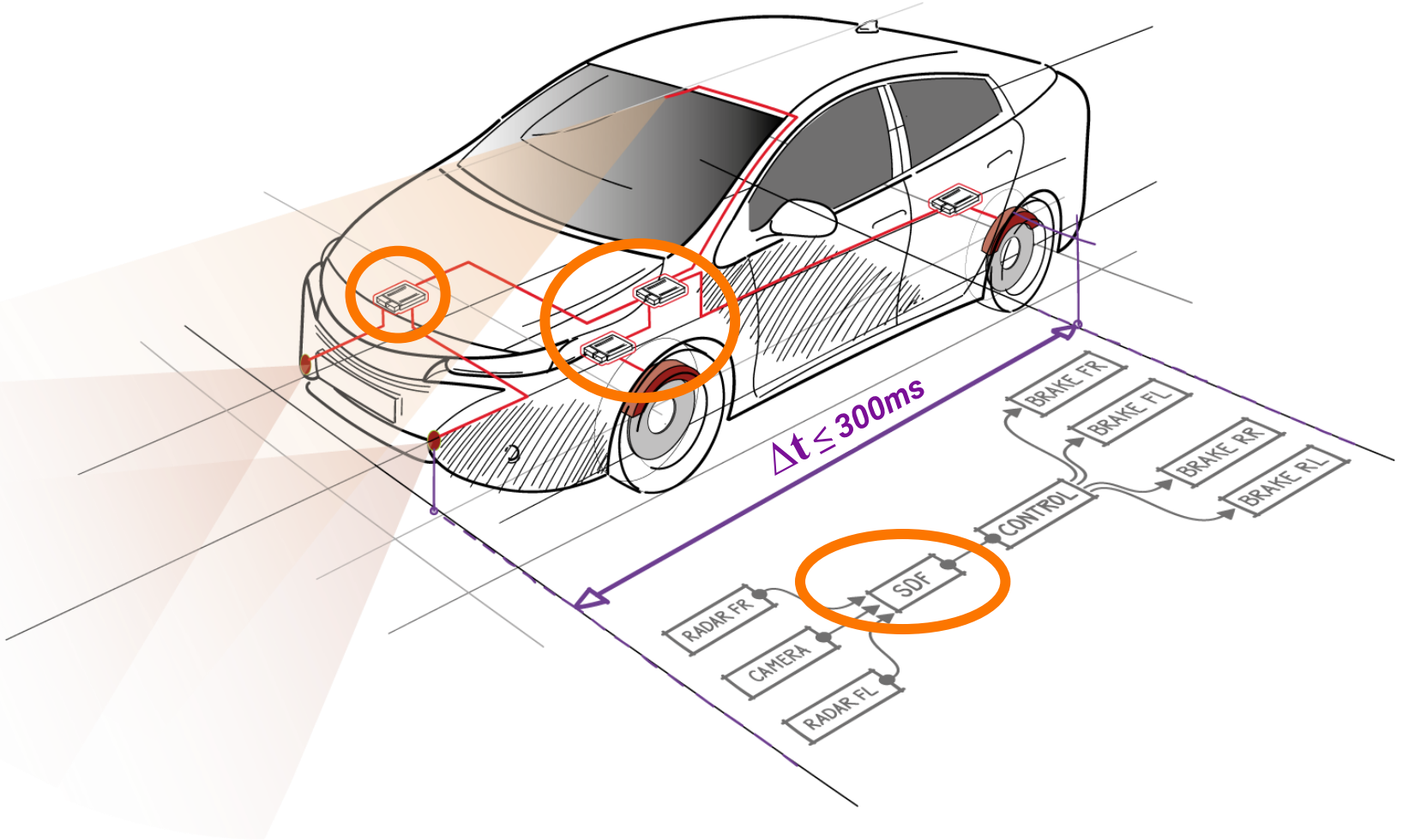

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Sensor Data Fusion in High Performance Domain Controllers

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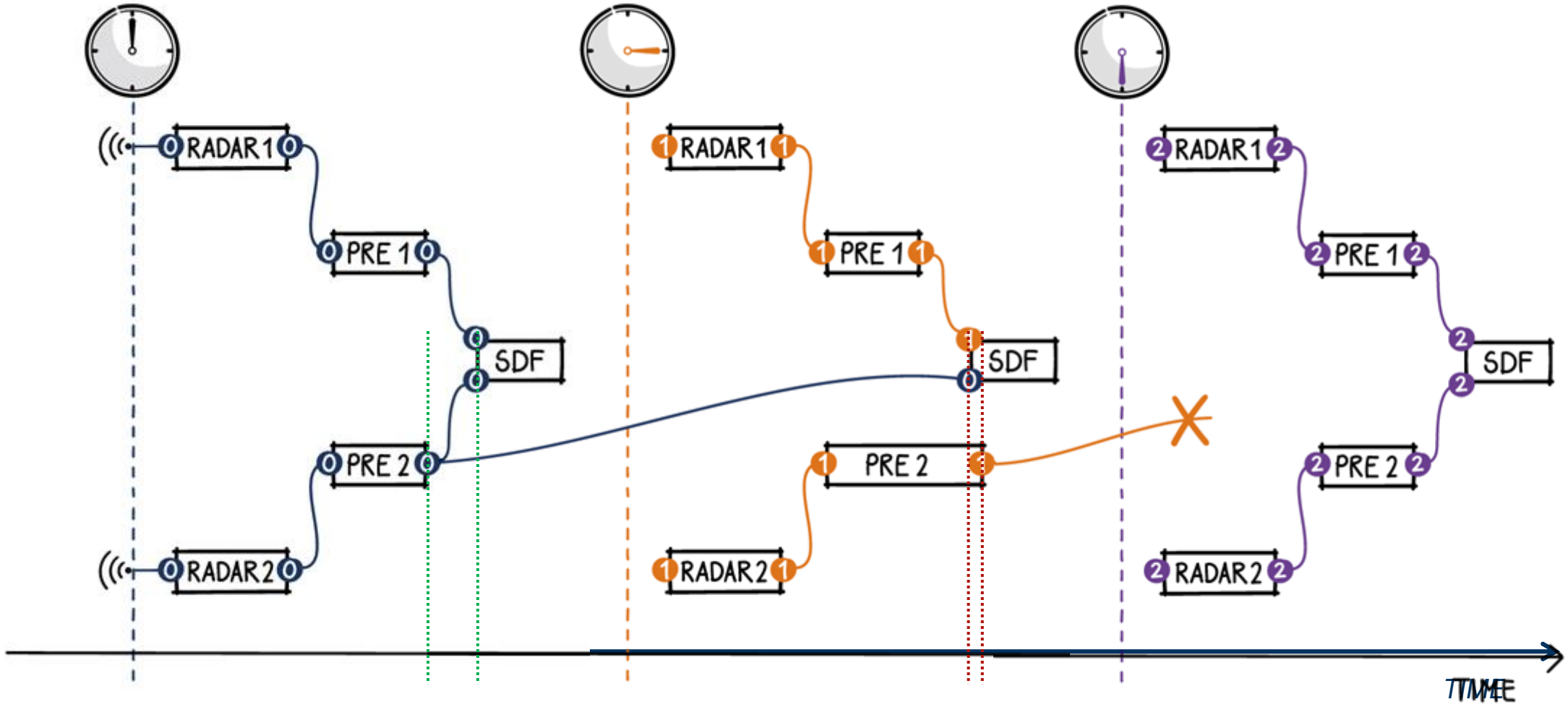

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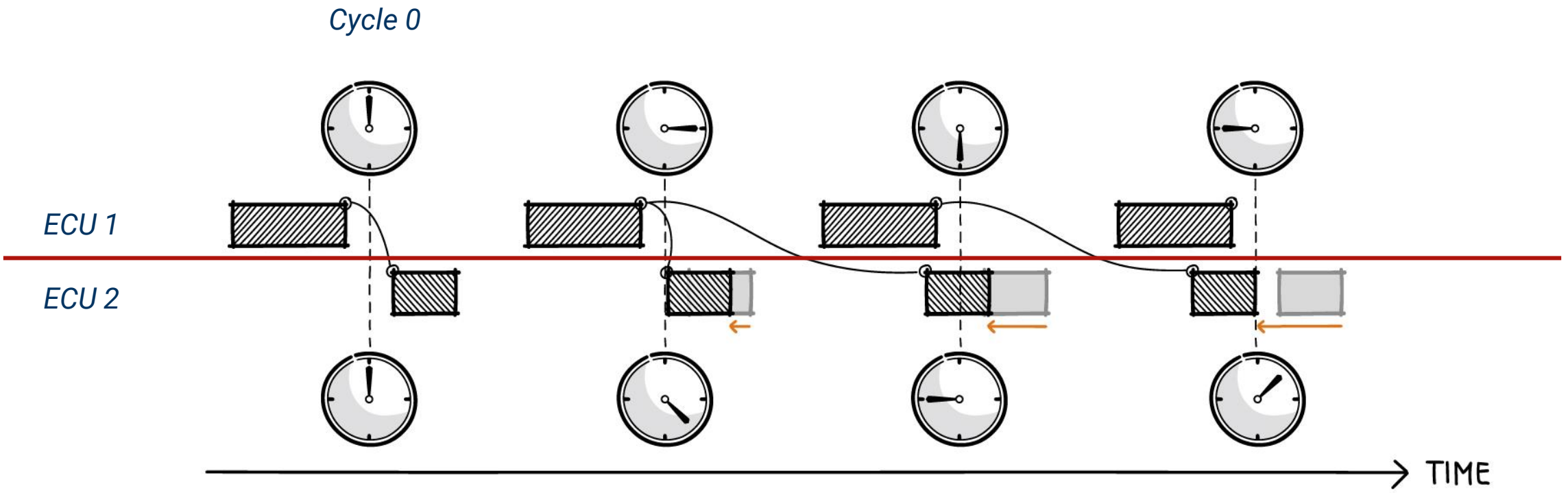
Clock Drift and Asynchronicity



Occurs in ECU/ECU, Sensor/CPU, CPU/CPU scenarios

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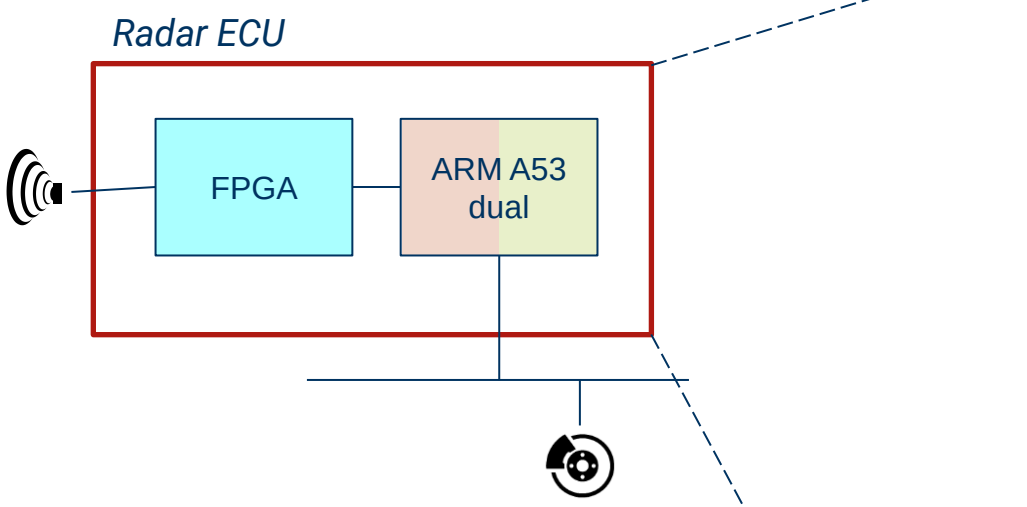
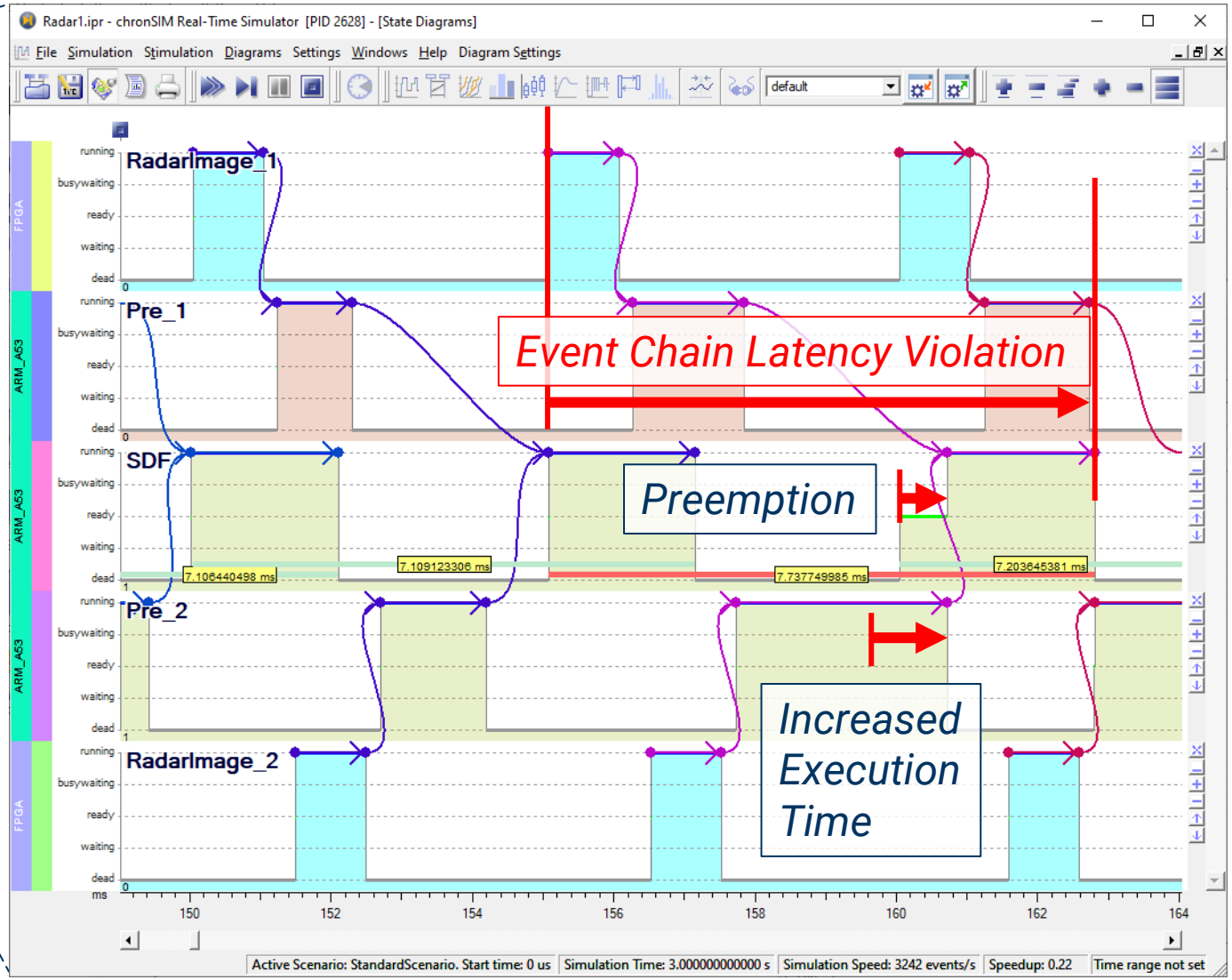
Multi-Core and Scheduling





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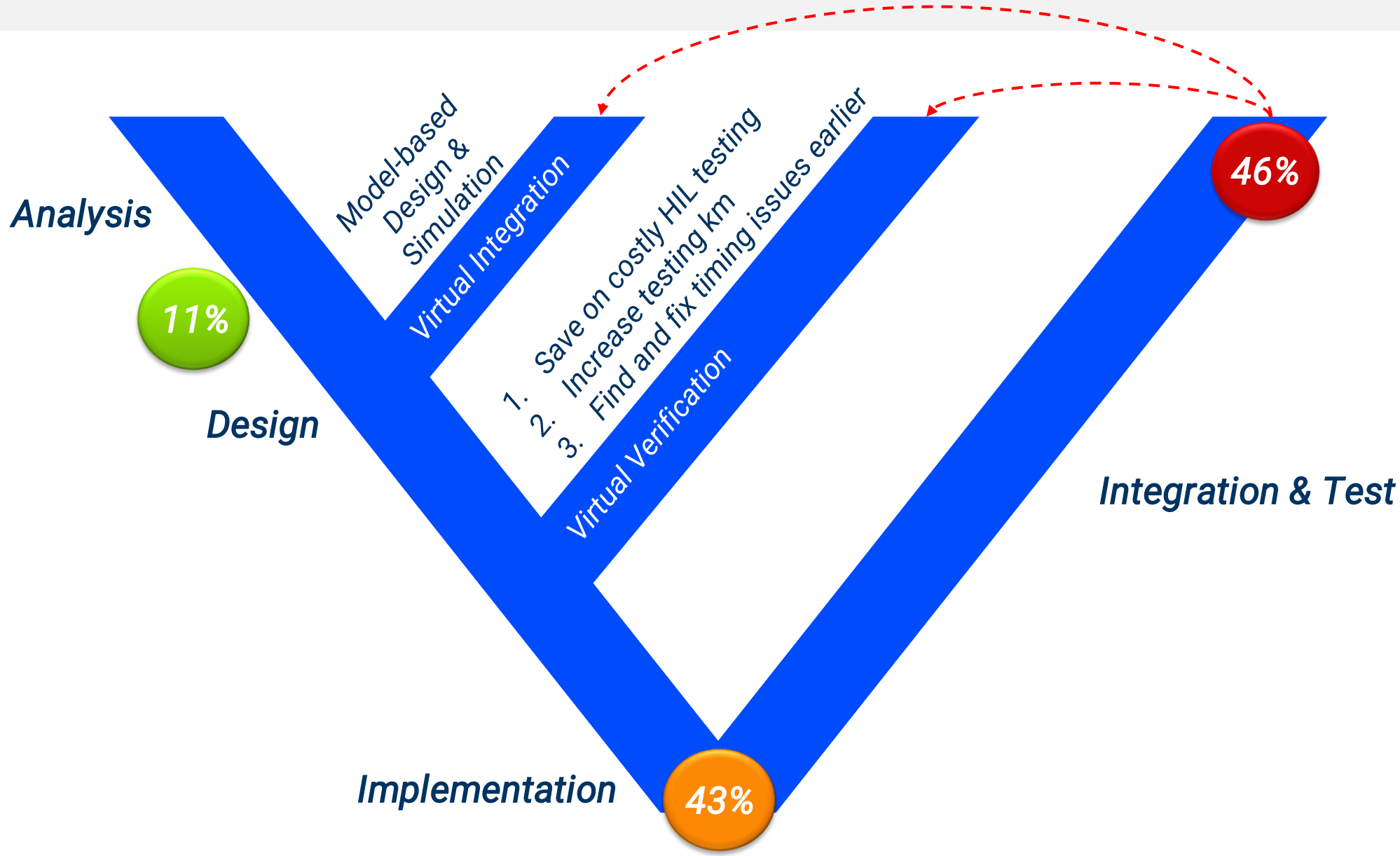
Workflow



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Increase Efficiency by Examining Timing Early

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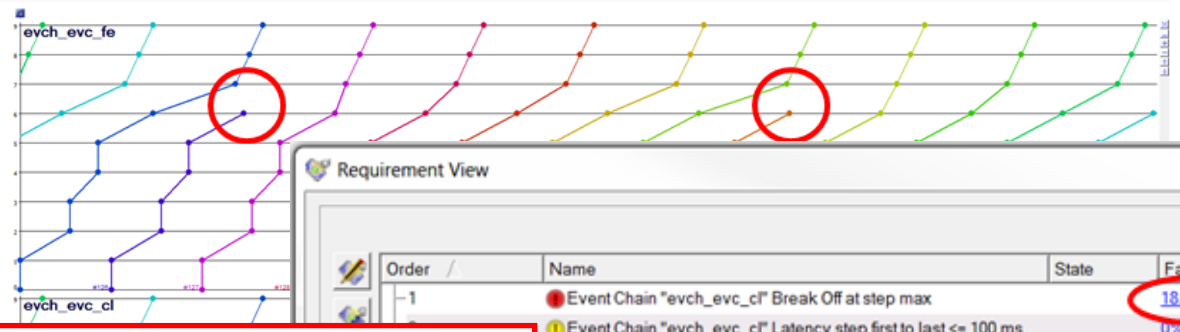
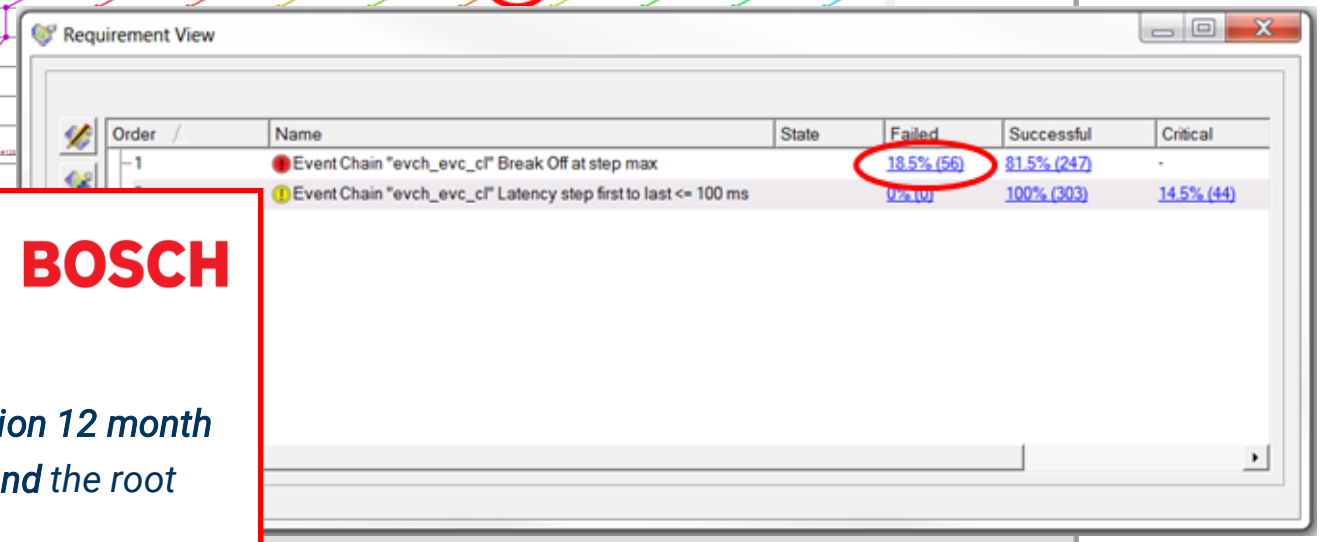
Modellbasierte Architekturentwicklung und Simulation

Validierung der Ergebnisse

- Fehlverhalten tritt genügend oft auf
- Bei verschiedenen Wirkketten zu unterschiedlichen Zeiten





Thomas Jäger
Architect, ADAS

BOSCH

*„We have found **errors in simulation 12 month earlier** and were able to **understand** the root cause and to **fix it efficiently**“*

9

BOSCH

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***Model based architectural** development and **simulation** – practical example driver assistance systems with **AMALTHEA** and **chronSIM**, Proceedings of Embedded Software Engineering Congress, Nov. 2015.*

Precise Specification of Timing Requirement

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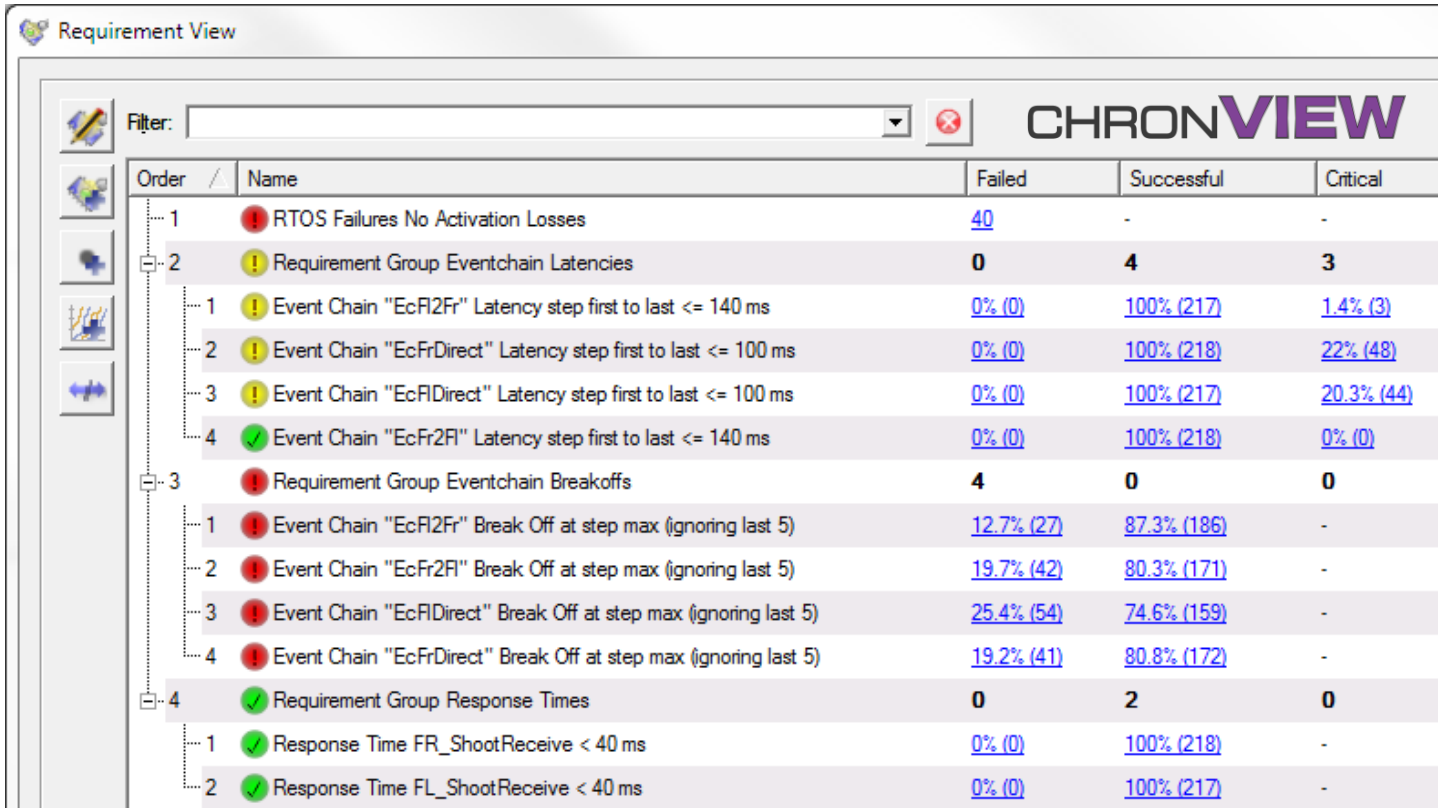
Simulation-based requirement evaluation

Real-Time Requirements

- CPU, Core and Bus Load
- Event Chain Latencies
- Event Chain Synchronization
- Date Synchronization
- Response Time
- Runnable‘s Execution Rate and Order
- Start-to-Start Jitter
- IRQ’s Loss or Blocking
- Net Execution Time of SW Functions
- RTOS events



Order	Name	Failed	Successful	Critical
1	RTOS Failures No Activation Losses	40	-	-
2	Requirement Group Eventchain Latencies	**0**	**4**	**3**
1	Event Chain "EcFl2Fr" Latency step first to last <= 140 ms	0% (0)	100% (217)	1.4% (3)
2	Event Chain "EcFrDirect" Latency step first to last <= 100 ms	0% (0)	100% (218)	22% (48)
3	Event Chain "EcFlDirect" Latency step first to last <= 100 ms	0% (0)	100% (217)	20.3% (44)
4	Event Chain "EcFr2Fl" Latency step first to last <= 140 ms	0% (0)	100% (218)	0% (0)
3	Requirement Group Eventchain Breakoffs	**4**	**0**	**0**
1	Event Chain "EcFl2Fr" Break Off at step max (ignoring last 5)	12.7% (27)	87.3% (186)	-
2	Event Chain "EcFr2Fl" Break Off at step max (ignoring last 5)	19.7% (42)	80.3% (171)	-
3	Event Chain "EcFlDirect" Break Off at step max (ignoring last 5)	25.4% (54)	74.6% (159)	-
4	Event Chain "EcFrDirect" Break Off at step max (ignoring last 5)	19.2% (41)	80.8% (172)	-
4	Requirement Group Response Times	**0**	**2**	**0**
1	Response Time FR_ShootReceive < 40 ms	0% (0)	100% (218)	-
2	Response Time FL_ShootReceive < 40 ms	0% (0)	100% (217)	-

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Understand the Dynamic Behavior of Your Embedded System

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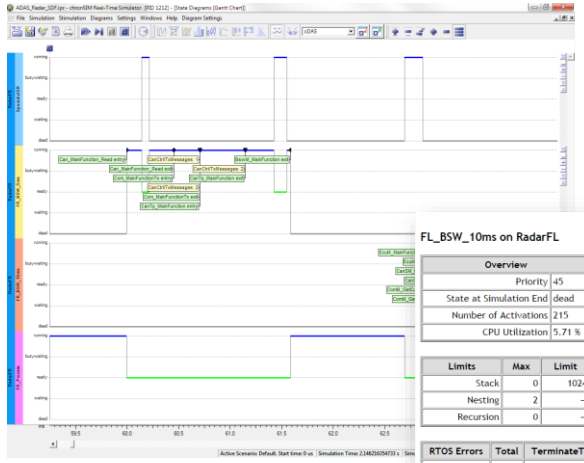
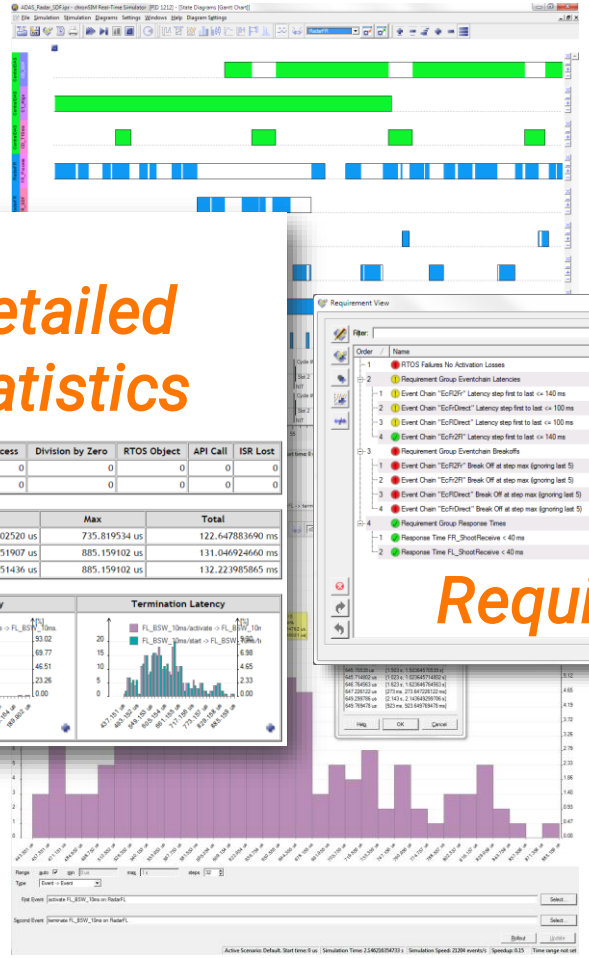
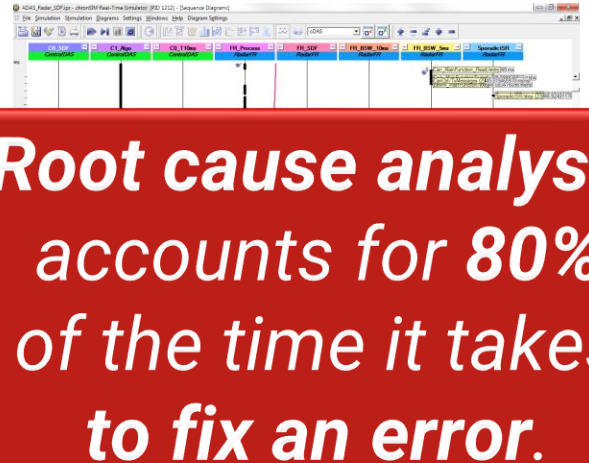
State view



Gantt view

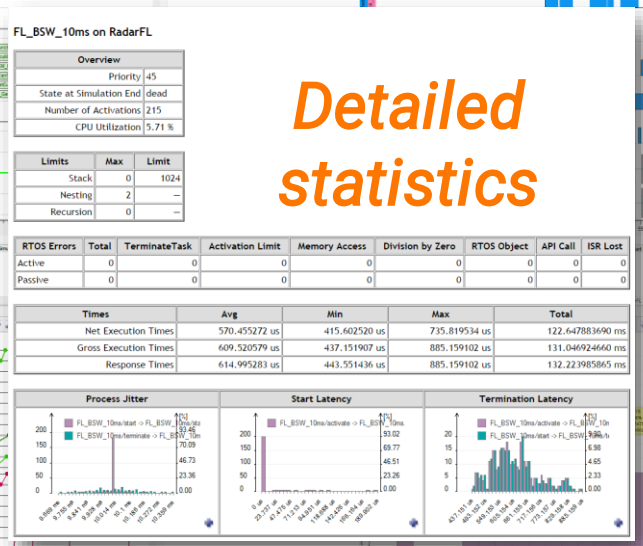


Trace view

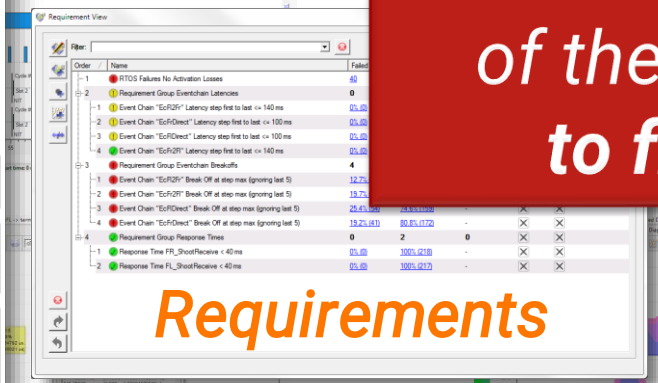


Root cause analysis *accounts for* **80%** *of the time it takes* ***to fix an error.***

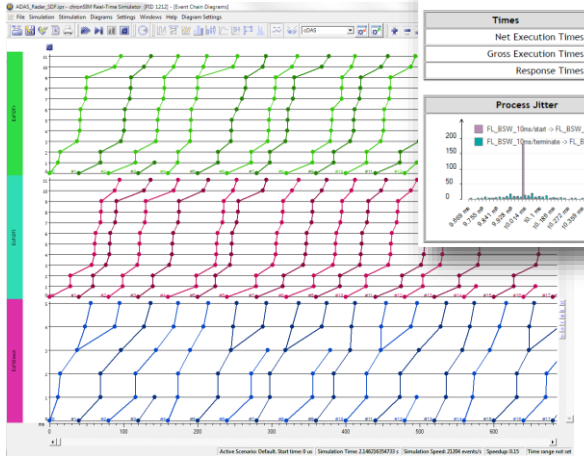
Detailed statistics



Requirements

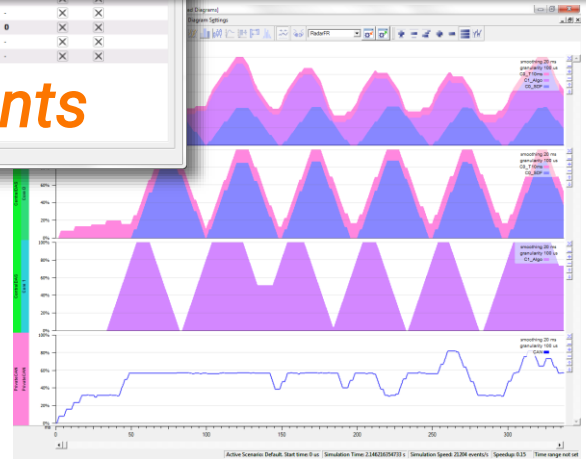


Event chains



Histogram

Load view



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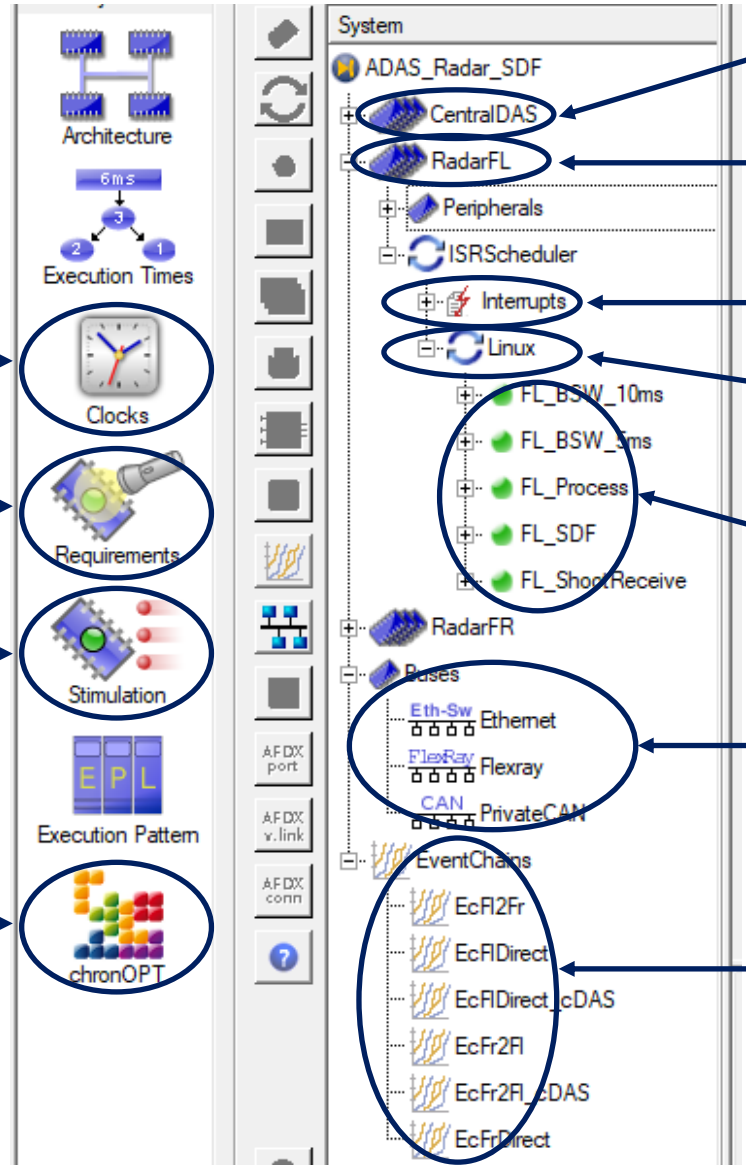
***Clocks**: drift, start offset, etc*

***Requirement** specification*

***Activation:** ISRs, Tasks/Threads*

*Architectural **optimization***



***SoC**: multi-CPU, HW accelerator, memory*

*ECU, **multi-core, memory***

Interrupts

***Scheduler/RTOS**: FP, RR, EDF, FCFS, TDMA; AUTOSAR OS, OSEK, POSIX*

Tasks, Threads, Processes
Functions/Runnables

***Busses/Networks**:*
CAN, Ethernet, FlexRay, LIN

***Event chain** specification*

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Event Chain Focused Design – at Different Levels

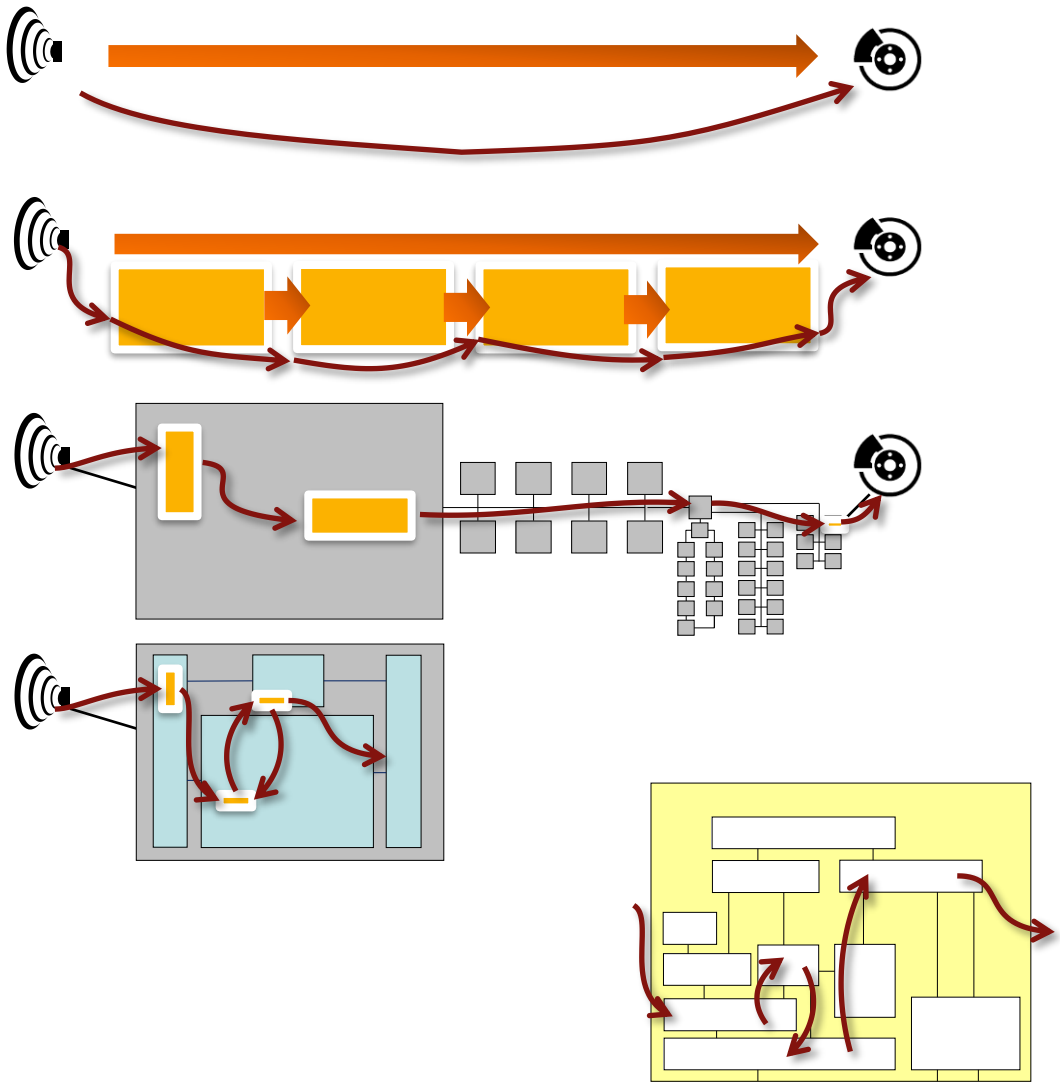
I. *Customer function*

II. *Functional net / logical architecture*

III. *System architecture - OEM view*

IV. *System architecture - ECU view*

V. *Software architecture*



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Customer Statements

Andreas Wolfram
Team Lead Software

"The feasibility of such **change requests** can now be analyzed in **1/3 of the usual time**. This saves time and money, allows fast **feedback to** the **customer** and gives **more confidence in the modified system**."

Dr. Jan Meyer
PMT

"Real-time simulation with **chronSIM** supports and **improves the development process**. We detect **timing errors** in **early development phases**. In addition we have more trust because of **improved system under-standing**."

Thomas Jäger
Architect ADAS

„Through **simulations**, we **found errors 12 months earlier** than usual, and were able to **understand** the **root causes** and **solve** them **efficiently**. "

Bernhard Augustin
Driver Assistance Systems

"Up to now we identified **timing** and performance **problems** only during series development. Next time we will do this **systematically** right from the start - already in the **concept phase**."

Markus Breitenberger
System & Application Group Leader

chronSIM is a **valuable tool**. Without, several problems fixed would still be present in our system today.

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Excellence in Real-Time Delivers…

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✓ *High quality products*

- *Robust and scalable **dynamic architecture***
- *Verified **timing requirements***
- *Optimized use of **hardware resources***
- *Reduced number of **sporadic timing errors***

✓ *Efficient processes*

- *Handle **complexity** efficiently and reduce risk of failures*
- ***Early detection** and correction of timing errors*
- *Smooth **collaboration** between OEM and Tier-1*

✓ *Savings in time and money.*

Reduction in stress.

LinkedIn

Questions?

schedule meeting with Olaf

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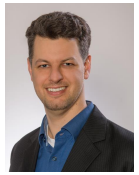
Thank you



Olaf Schmidt
olaf.schmidt@inchron.com
Phone +49-331-2797892-53
Get in touch!