Real-Time Isn't Optional: How Zephyr Guarantees Safety at Racing Speeds

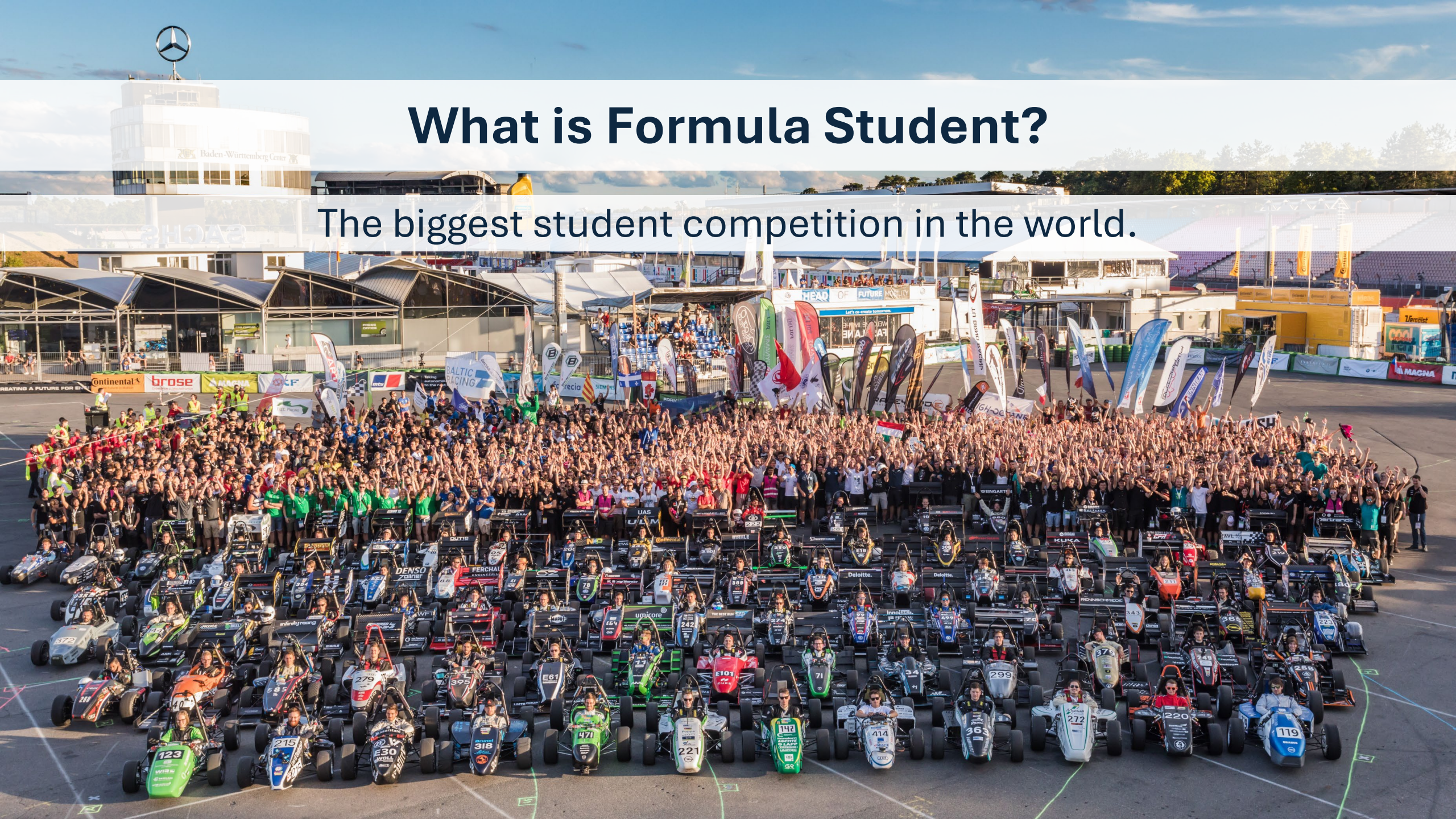
Jil Zerndt, ZURICH UAS Racing

ZURICH UAS RACING

zh aw School of Engineering
InES Institute of Embedded Systems

What is Formula Student?

The biggest student competition in the world.



And who are we?

ZURICH UAS
RACING

And who are we?

Dominic Odermatt

Jil Zerndt

ZURICH UAS
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Project and Bachelor's Thesis

Design and Implementation of the VCU for ZUR 06

Requirements:

- Real Time
- Safety Critical
- Event-driven
- Formula Student Rule Conform
- Car goes vroom

Pictured: ZUR 05 as ZUR 06 is currently under construction!

VCU: Vehicle Control Unit

State Machine

Hardware and Peripherals

Safety Guarantees:
Timeouts and Error Handling

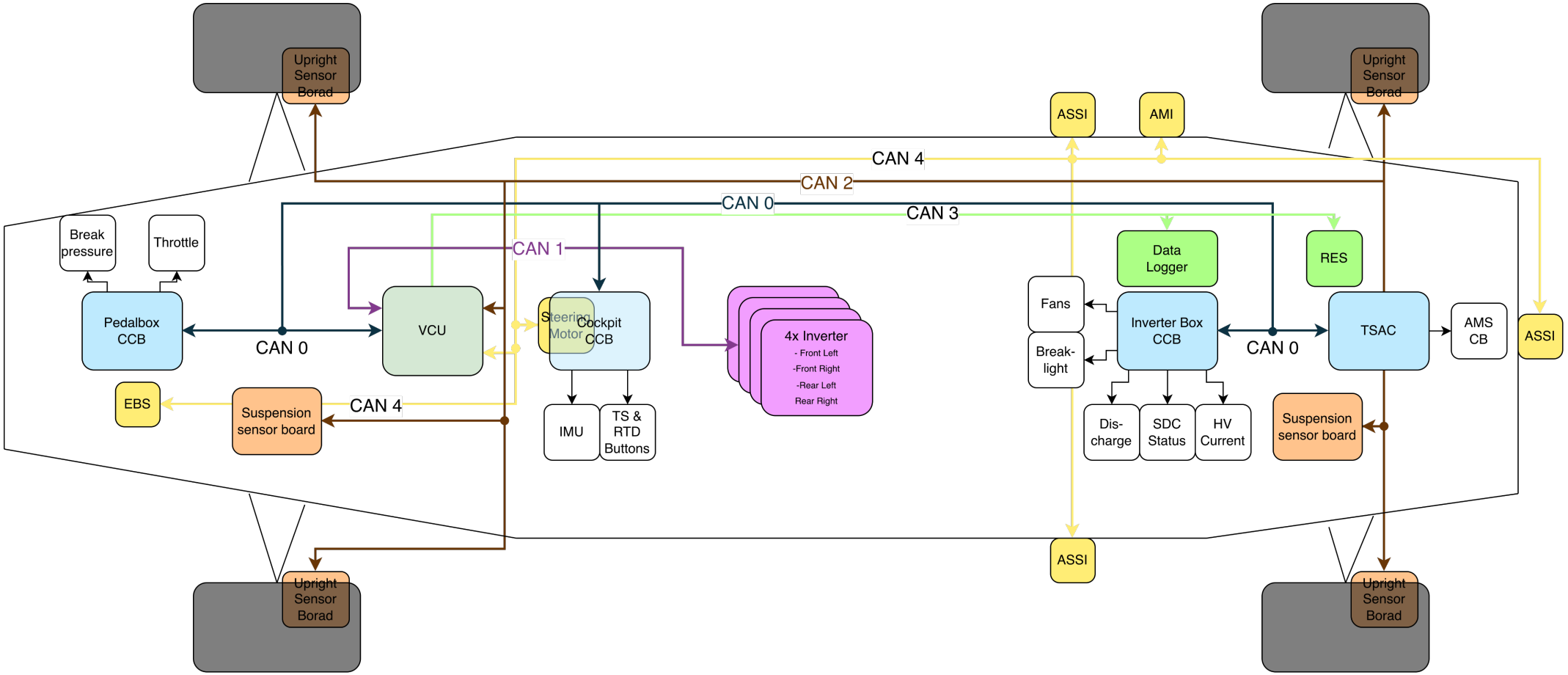
Threading and Scheduling

CAN Communication: OpenCyphal

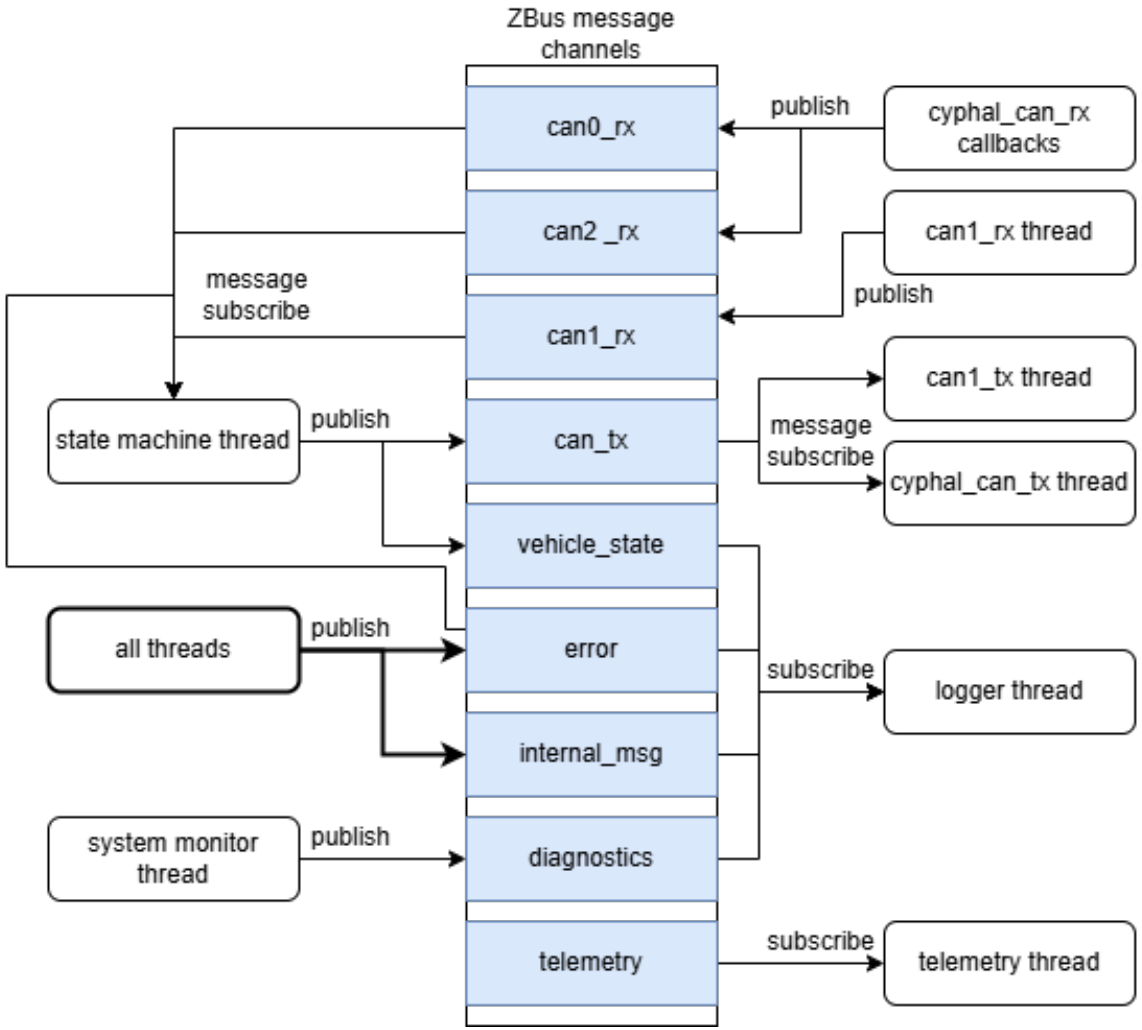
Inter-Thread communication: ZBus

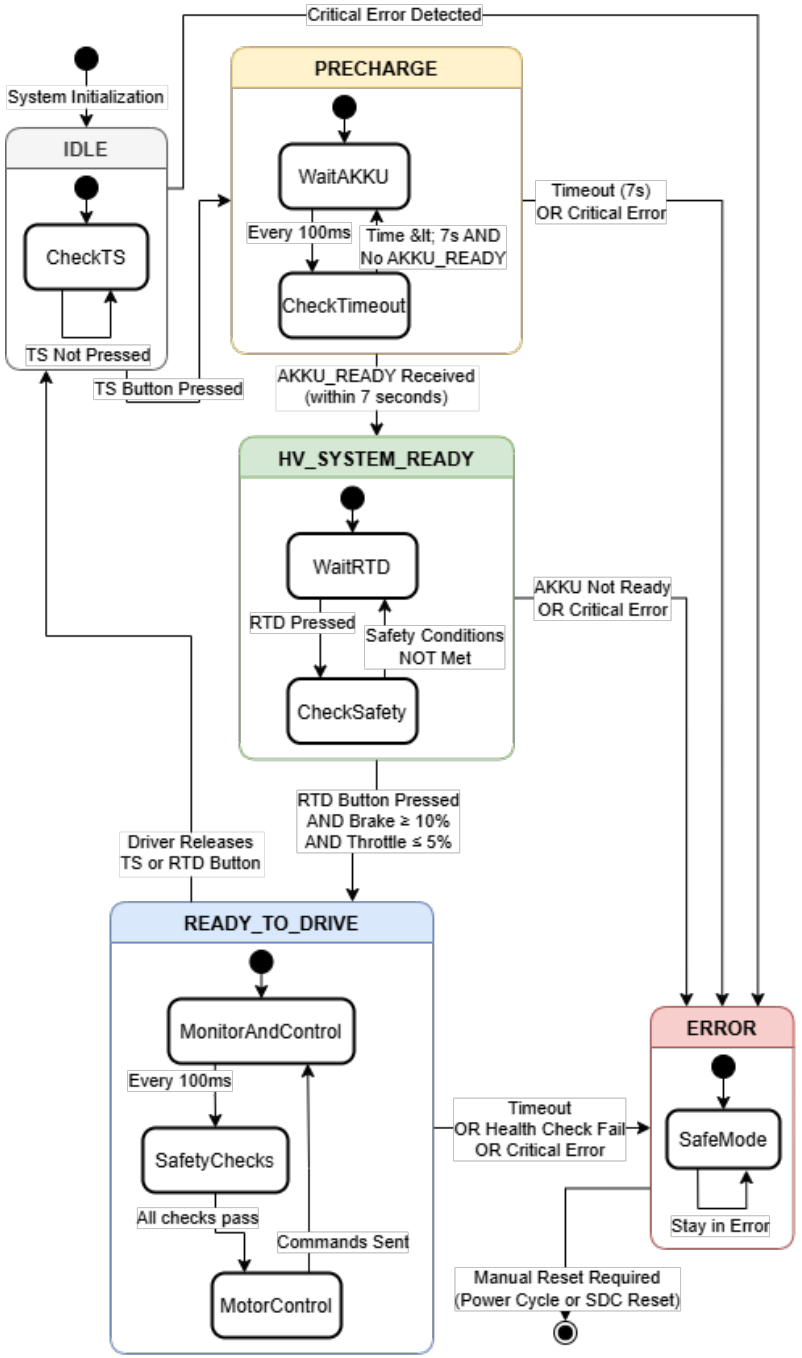
Pictured: ZUR 05 as ZUR 06 is currently under construction!

Hardware and Peripherals of the VCU



Implementation Details





Safety Guarantees on multiple Layers

- HW Watchdog and Shutdown Circuit
- Node Heartbeat and Timeout Monitoring OpenCyphal
- Timeout ZBus channels
- Error Channel
- Timeout State Machine
- FS26 Chip & lock step (NXP Board built-in Safety)

Conclusion

Why Zephyr?

- Real Time
- Scheduling
- Inter-Thread Communication
- Tool-Box
- Hardware Abstraction

Lessons learnt

- Zephyr offers incredible functionality
- Steep learning curve
- Cars are complex distributed systems
- Teamwork (100+ ZUR Members)

Future Development

- Additional sensors and functionality
- OpenCyphal UDP
- Integration testing
- Optimization
- Win the races
- Share Knowledge with future generations

Questions?

See you at the finish line!

*or at the Apéro :)