VOLVO

Shift Happens:
How Volvo Cars Got Into Rust

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“Technology from the past come to save the future from itself”

- Graydon Hoare

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My Automotive Take:

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My Automotive Take:

“The Nemesis of Our Past Comes to Save Us From Our Future”

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About Me

Julius Gustavsson

- System Architect and Team Lead, LP (Low Power Processor)
  - Automotive Industry's first Rust based ECU
- Volvo Cars since 2017
  - Opinions are my own
- Over 20 years in SW development in different industries

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IMHO:

- Rust is the biggest deal in our industry, during my carrier!

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Programming Languages I've Used

- C
- C++
- Python
- Java
- Ruby
- Elixir
- Perl
- Erlang
- Lisp
- Scheme
- Go
- Kotlin
- Zig

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The Past

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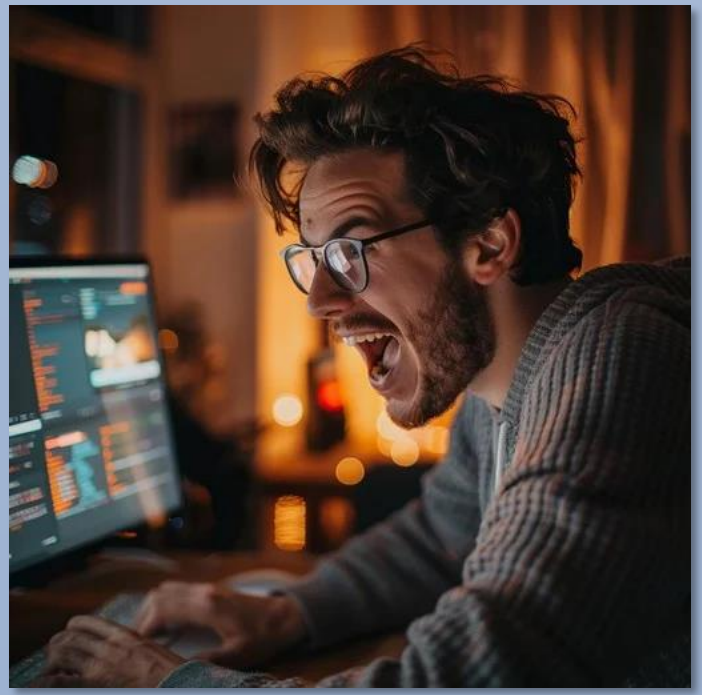

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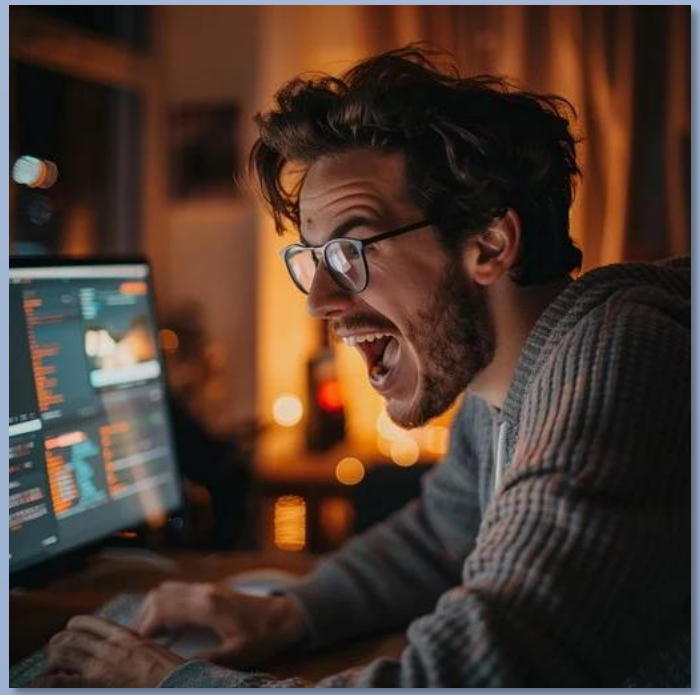

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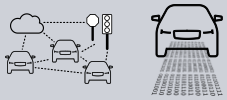
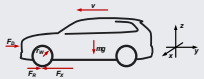
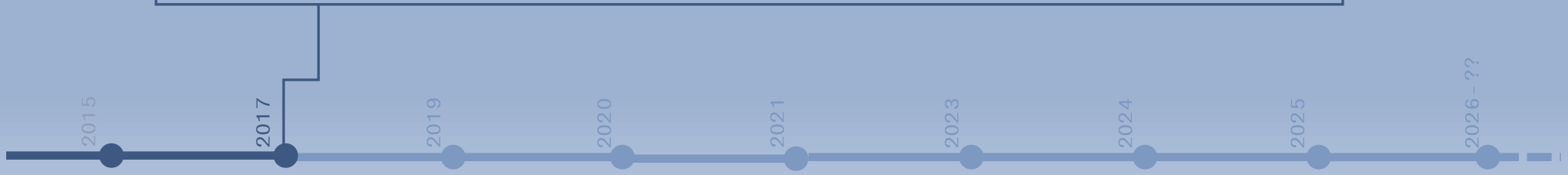
Functional Area	Expected Growth	CPU	GPU	NPU	ISP etc
Communications (Internal & External) 		+			
Traditional Functions 		+	?		?
Infotainment and HMI 		++	++		++
ADAS & Autonomy 		+++	+++	+++	+++
Other & Unknown 		?	?	?	?



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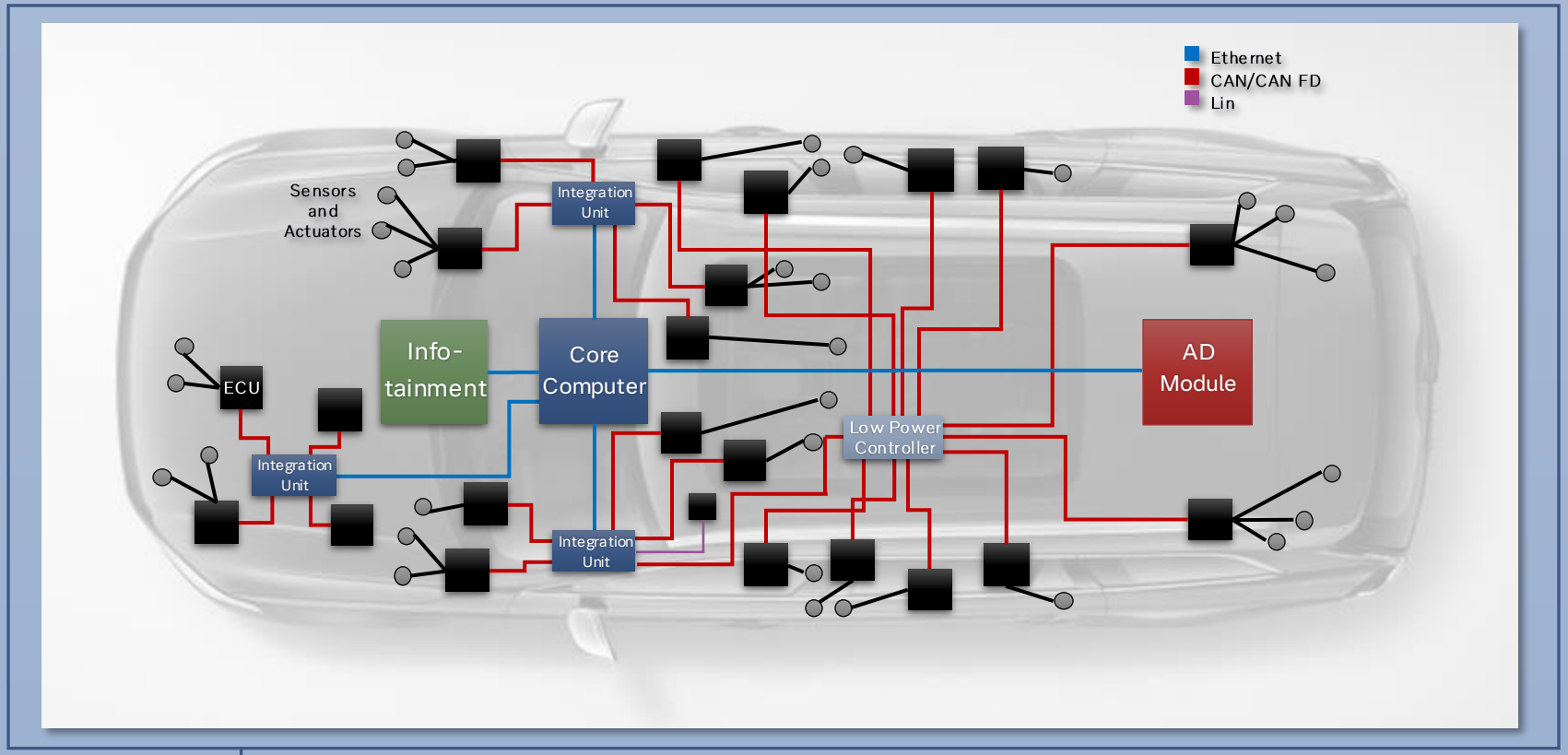

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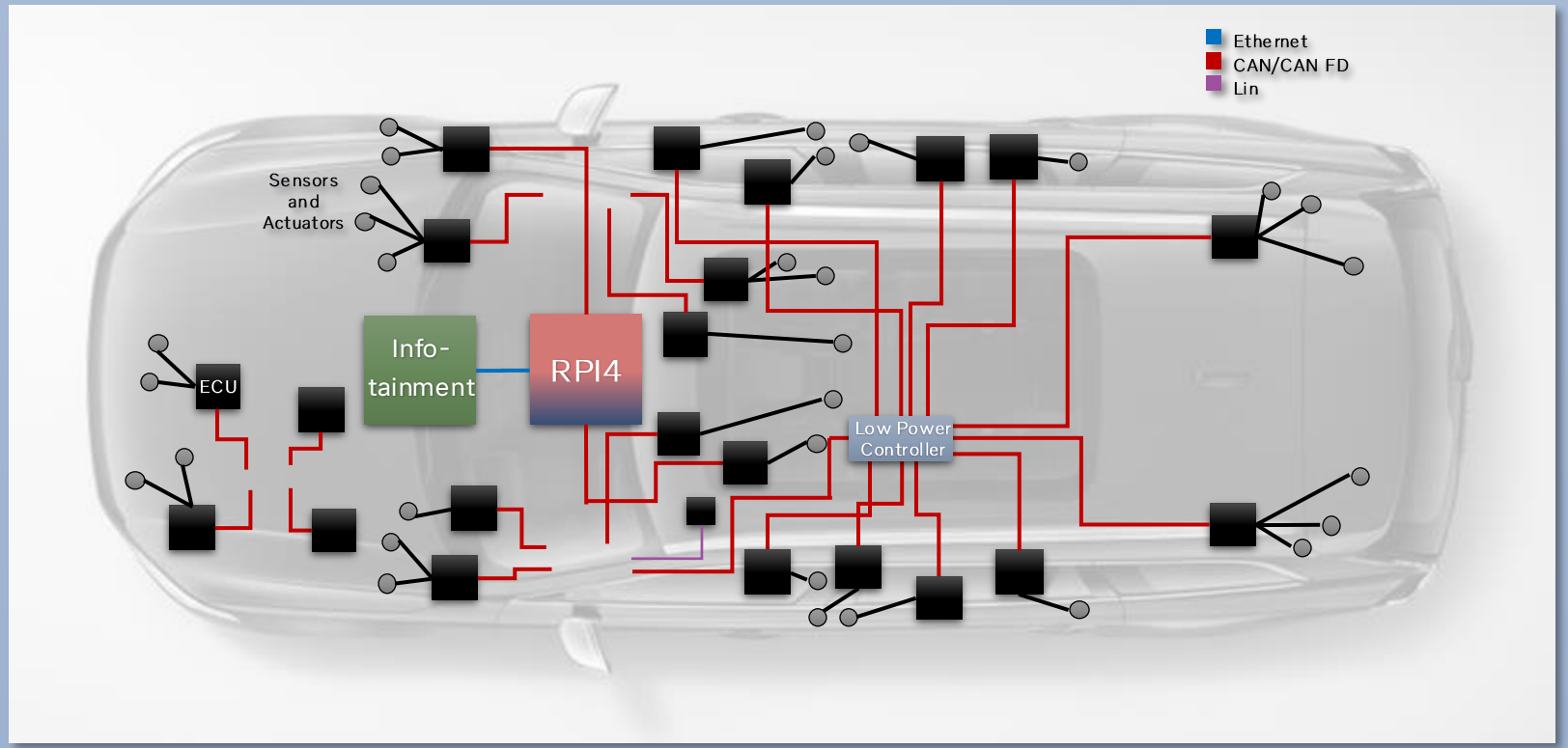

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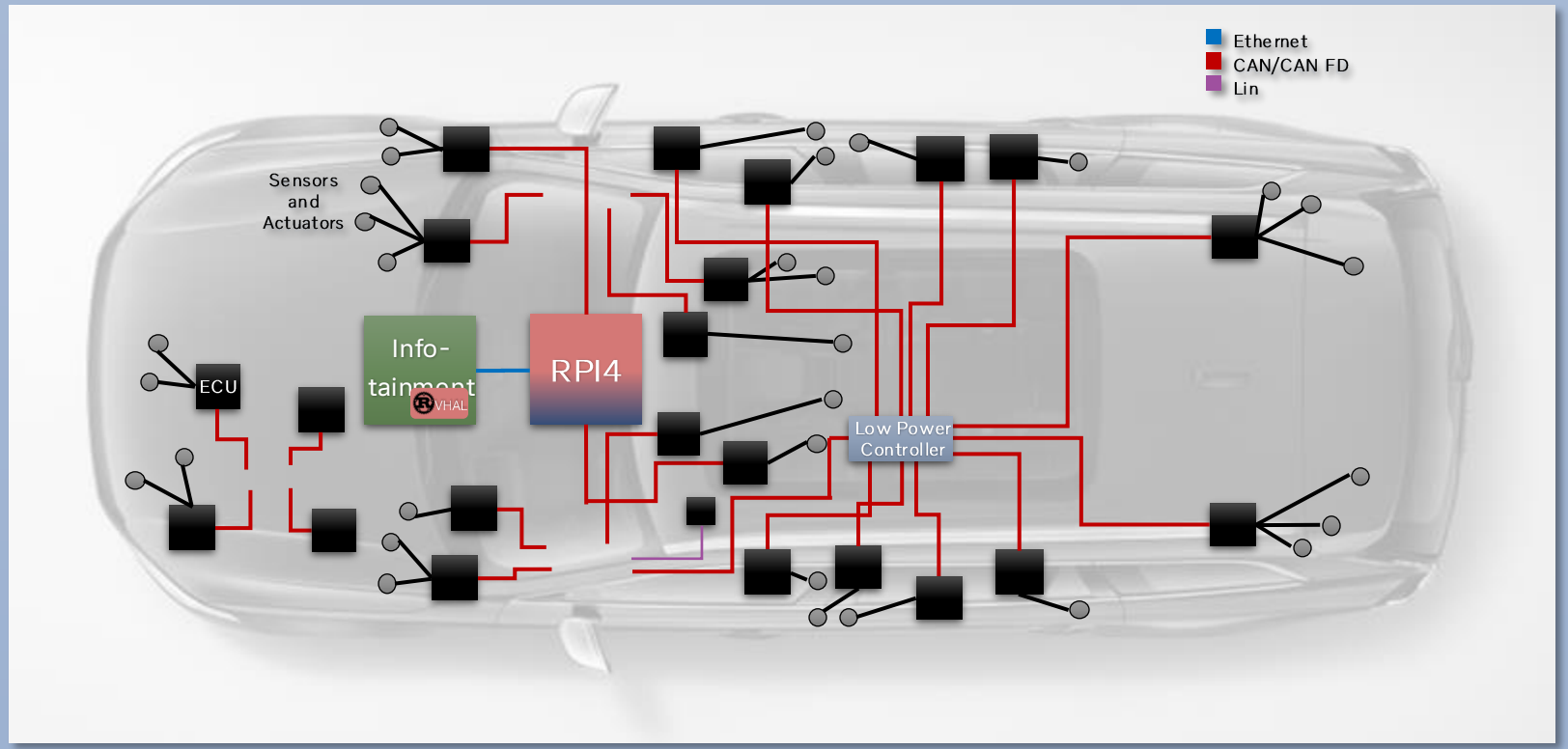

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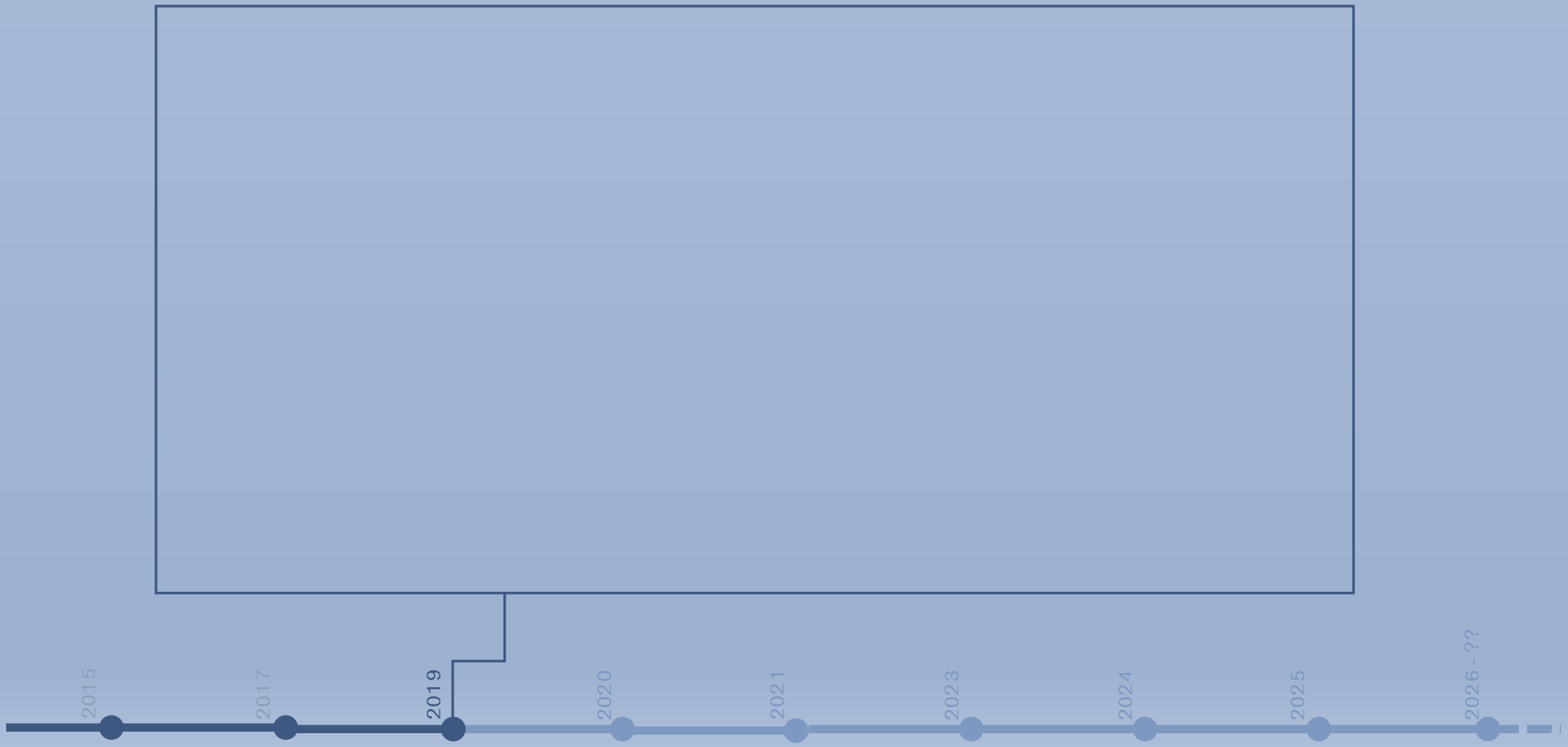

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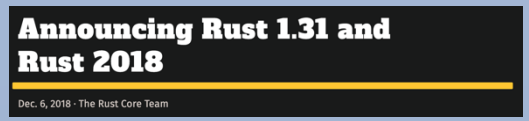
End of 2018:

- First Rust Talk at Volvo Cars
- Key people on board
- 

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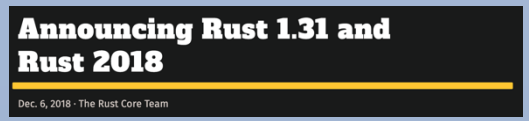
- 

2019:

- Got the green light to try out Rust
- Identified the Low Power Processor as an ideal target
- oxidize
- First Rust Master's Thesis – Showed viability of Rust `no_std`
- Rust team formed by the end of the year (4 people at first)

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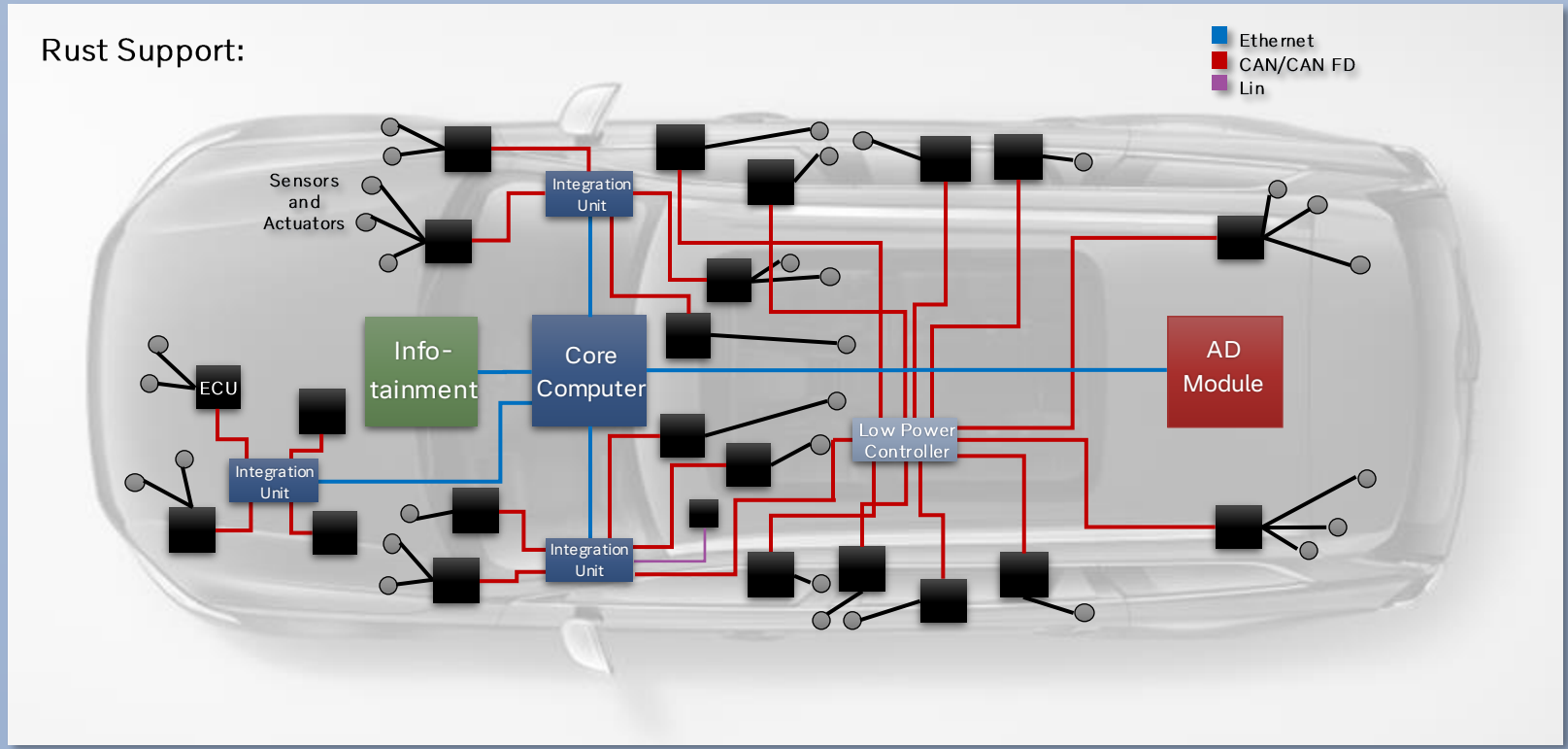
Rust Support:



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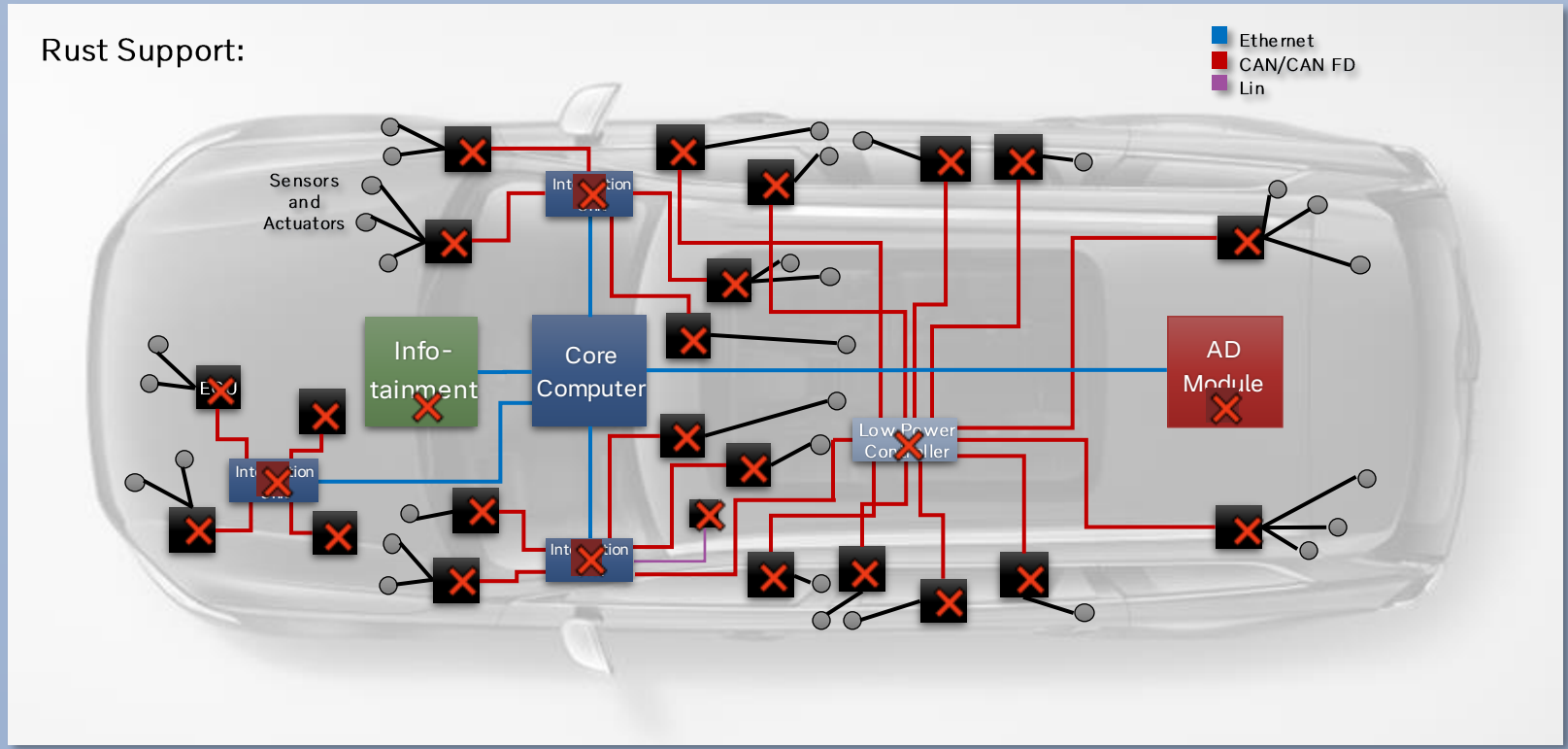

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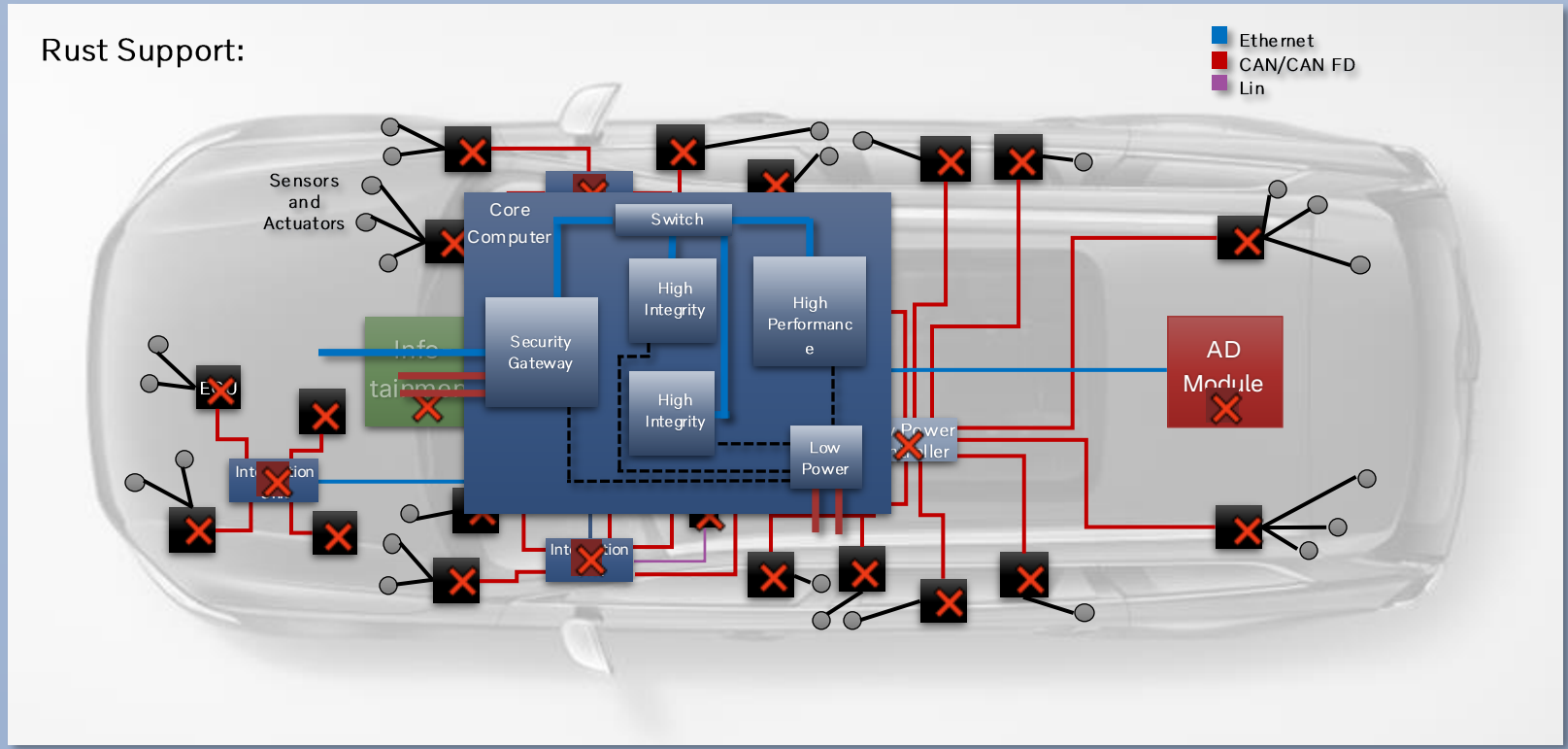

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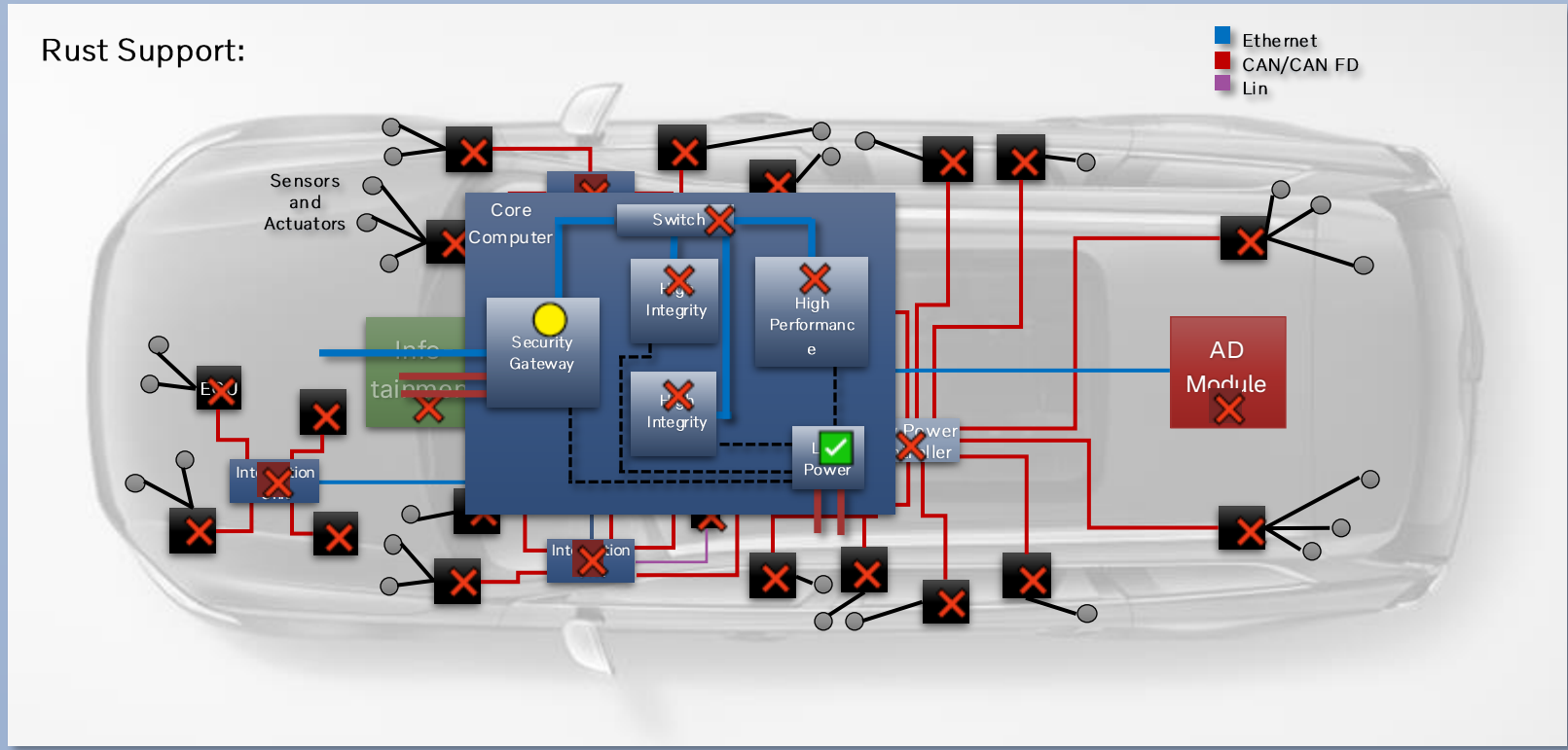

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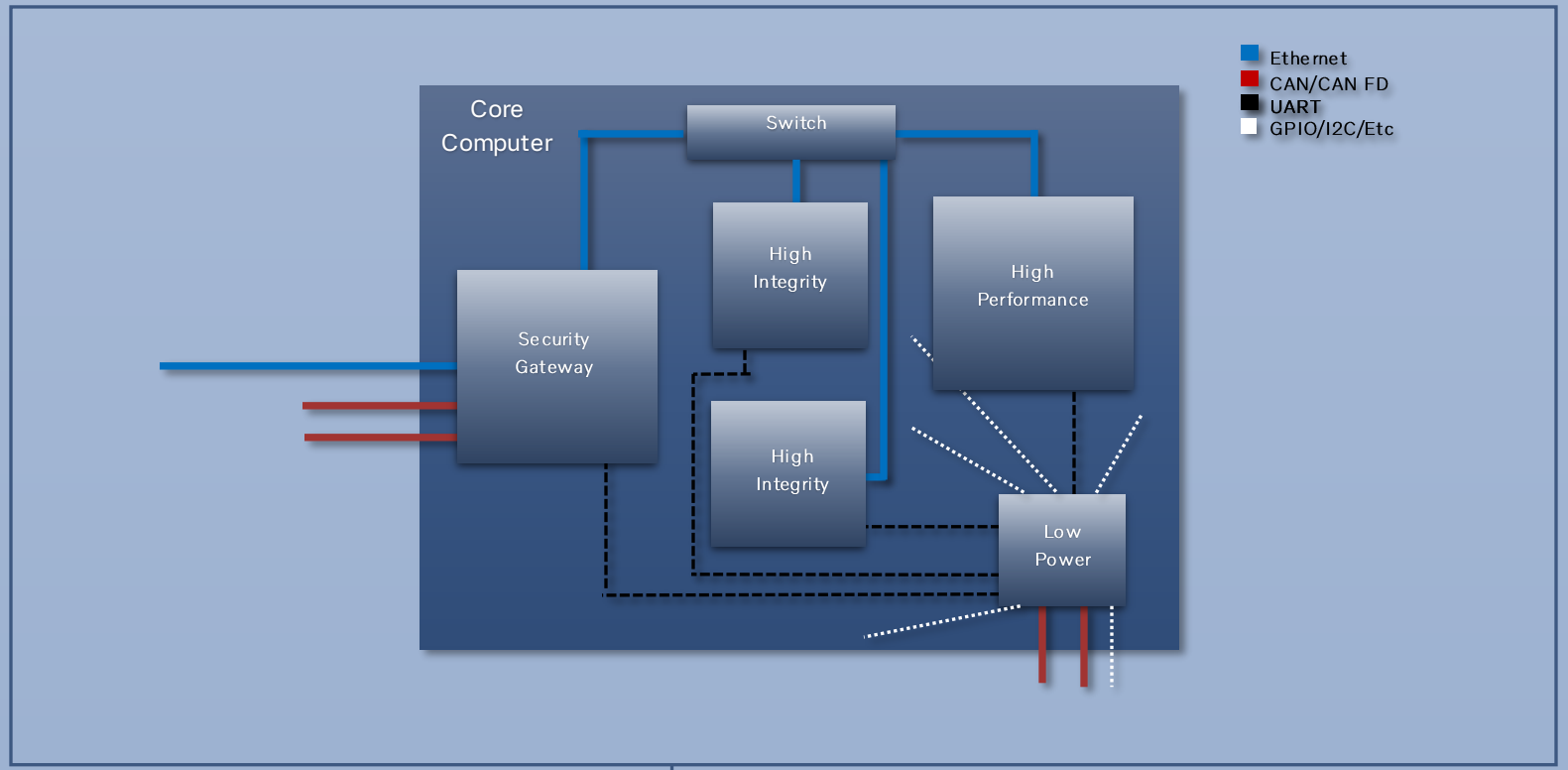

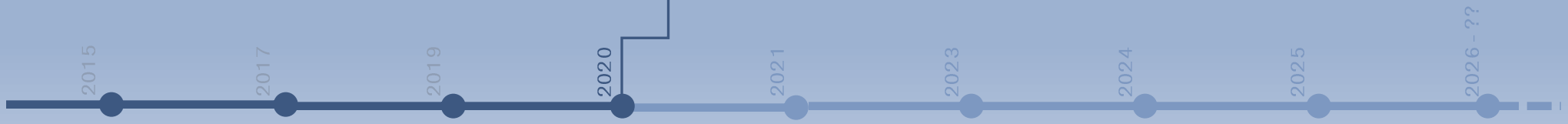

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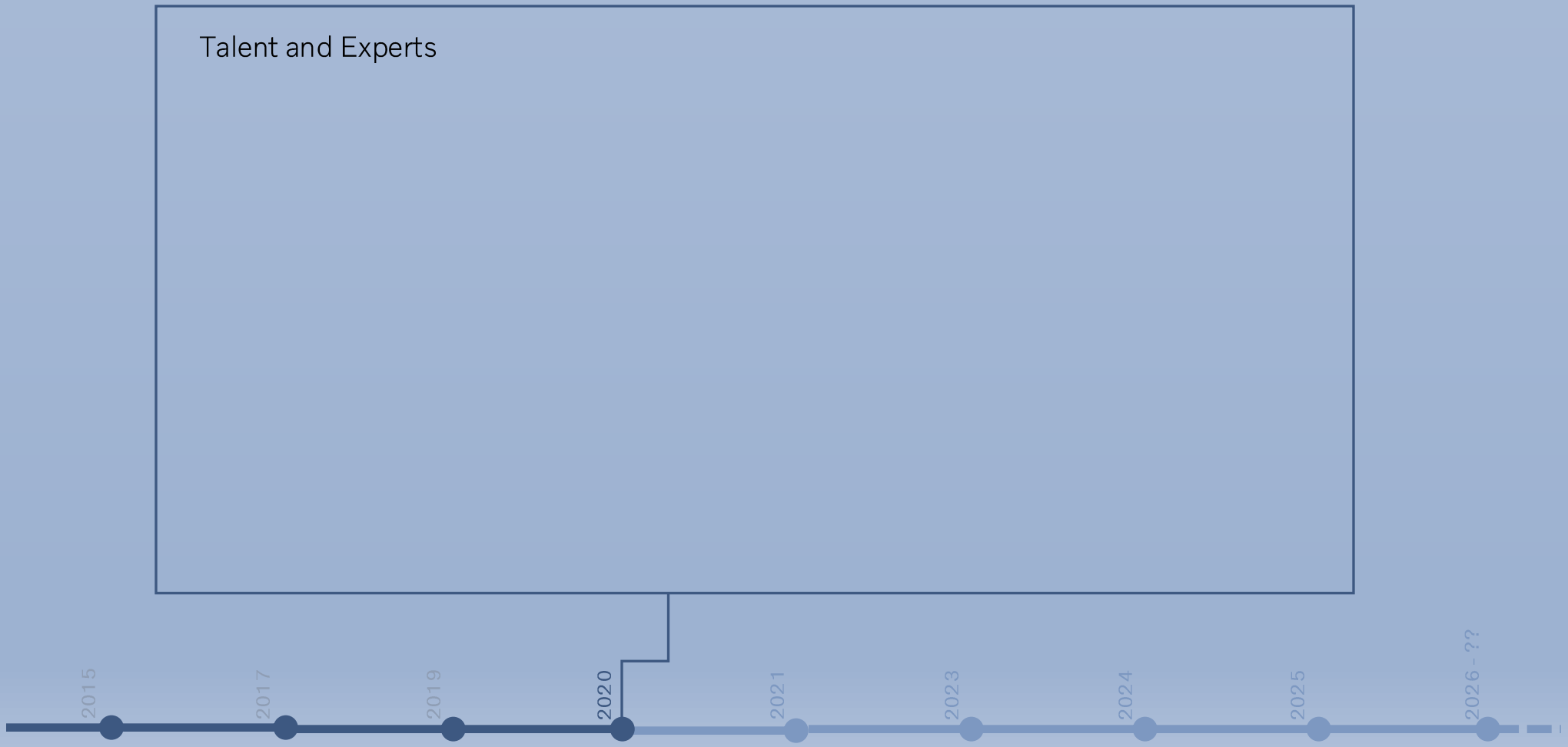

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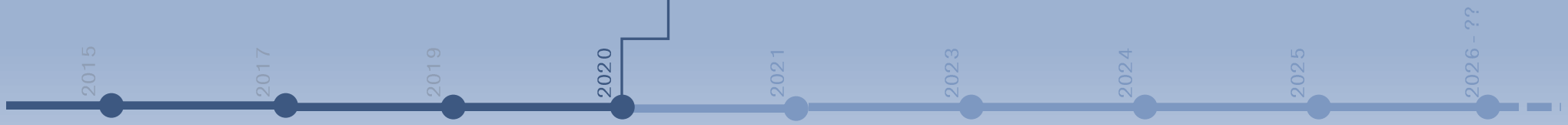
Talent and Experts

- Four developers initially
- Senior engineers but little to no Rust experience



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- Got help from external experts early on

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- Senior engineers but little to no Rust experience
- Got help from external experts early on
  - ➢ Highly recommended!

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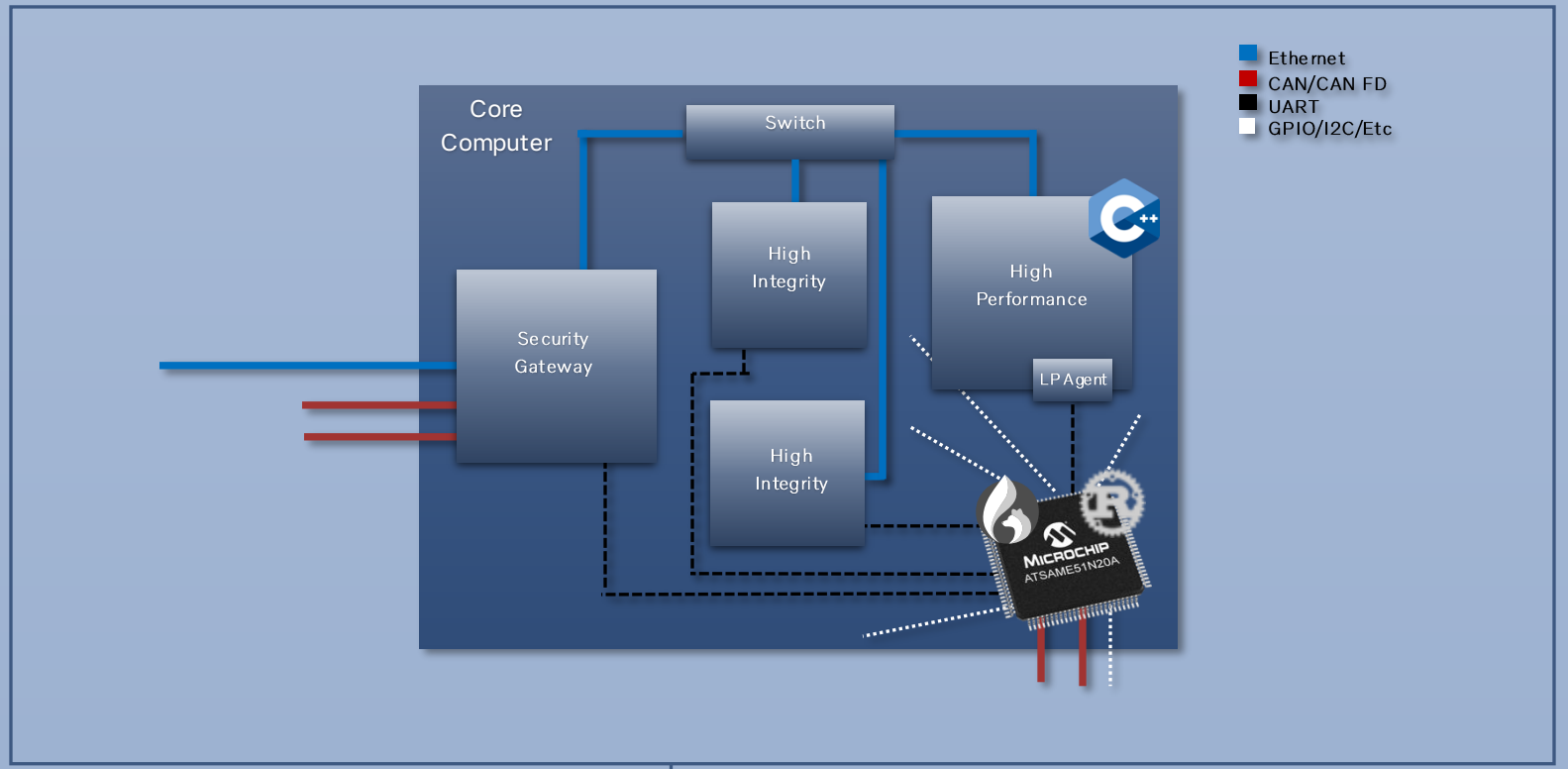

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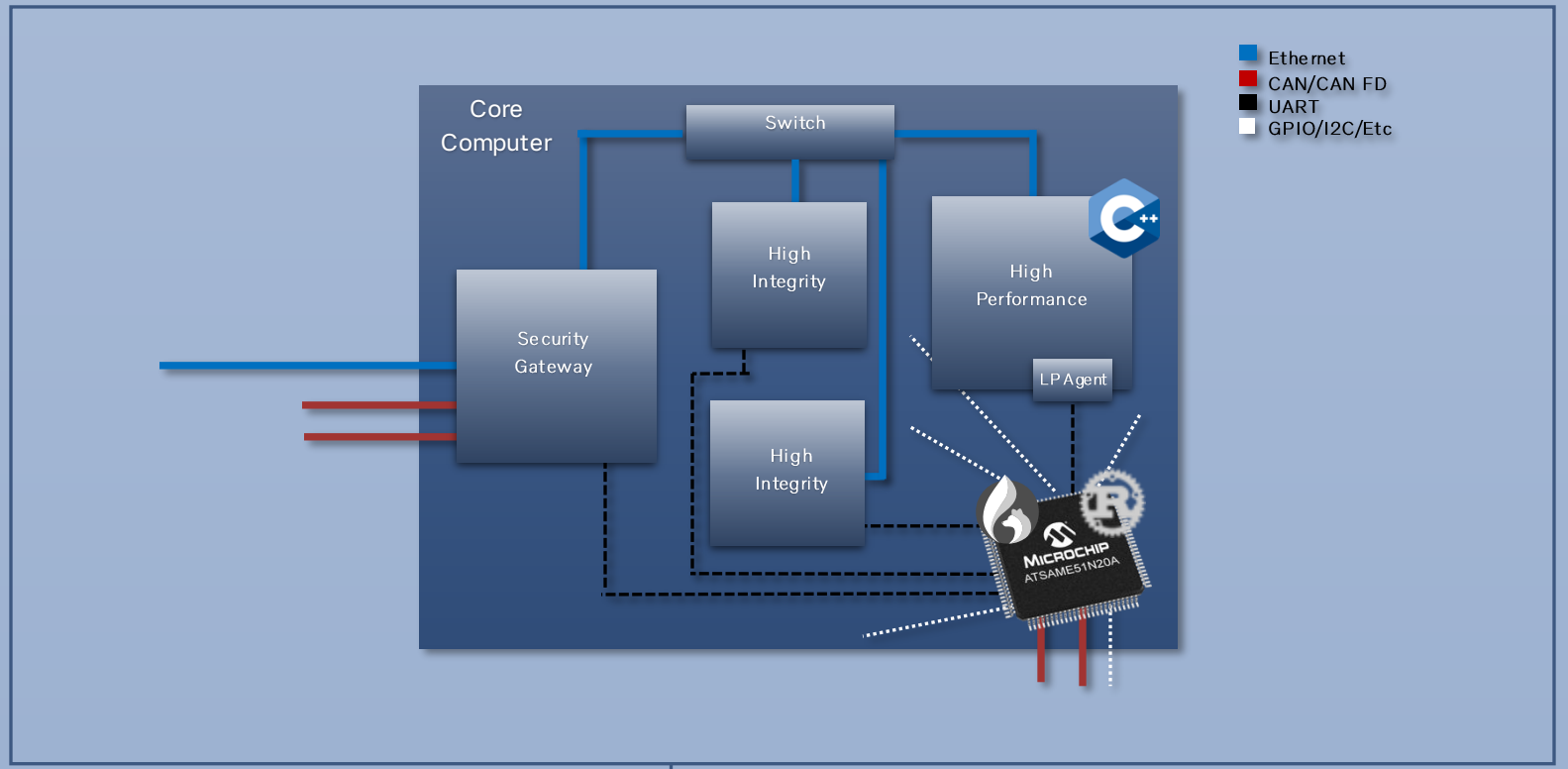

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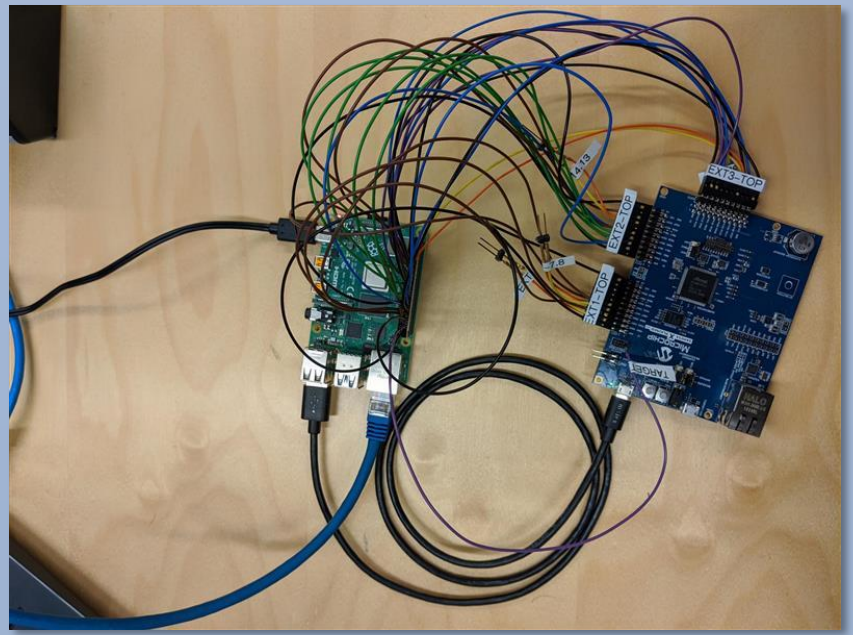

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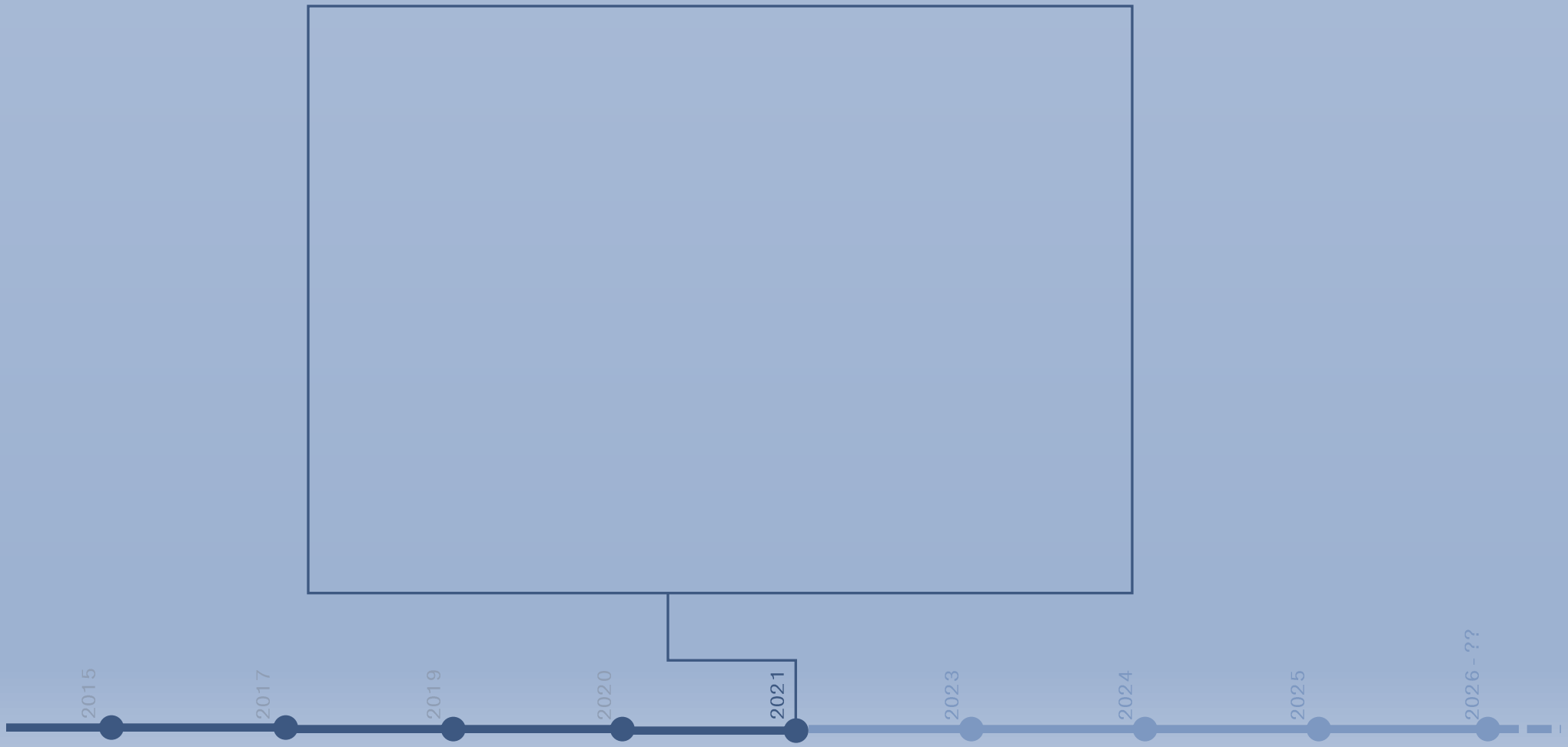

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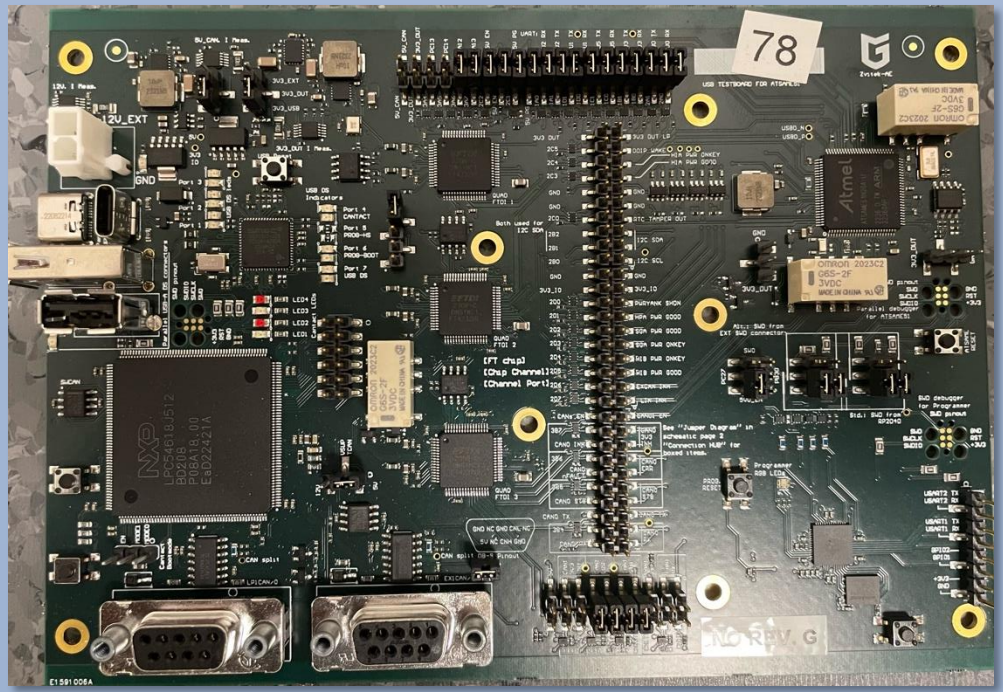

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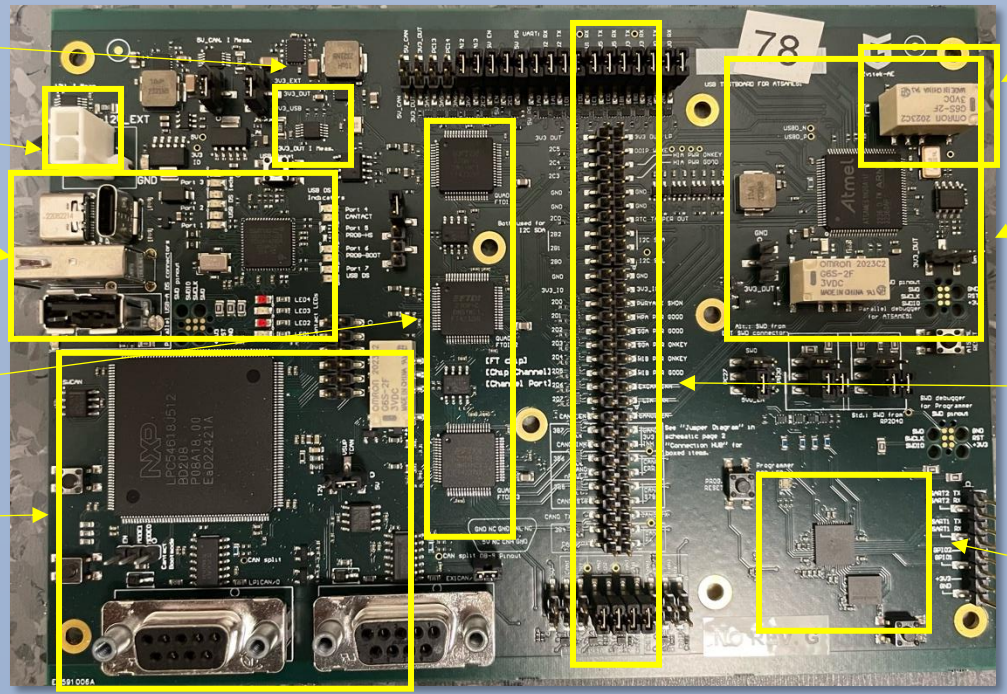

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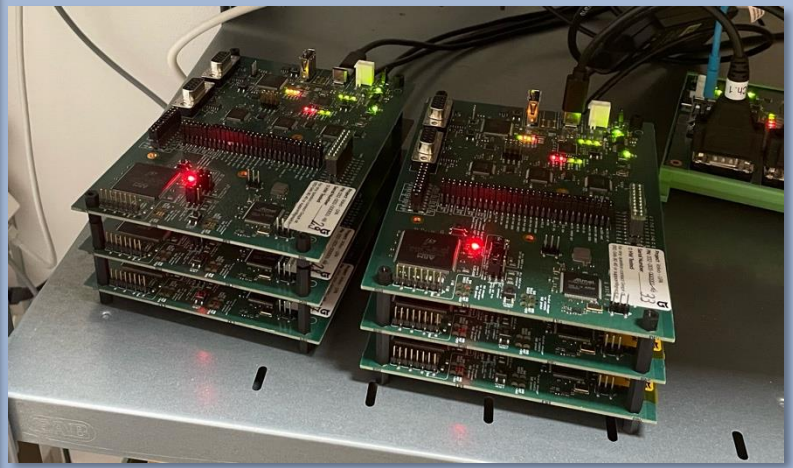
CI Setup



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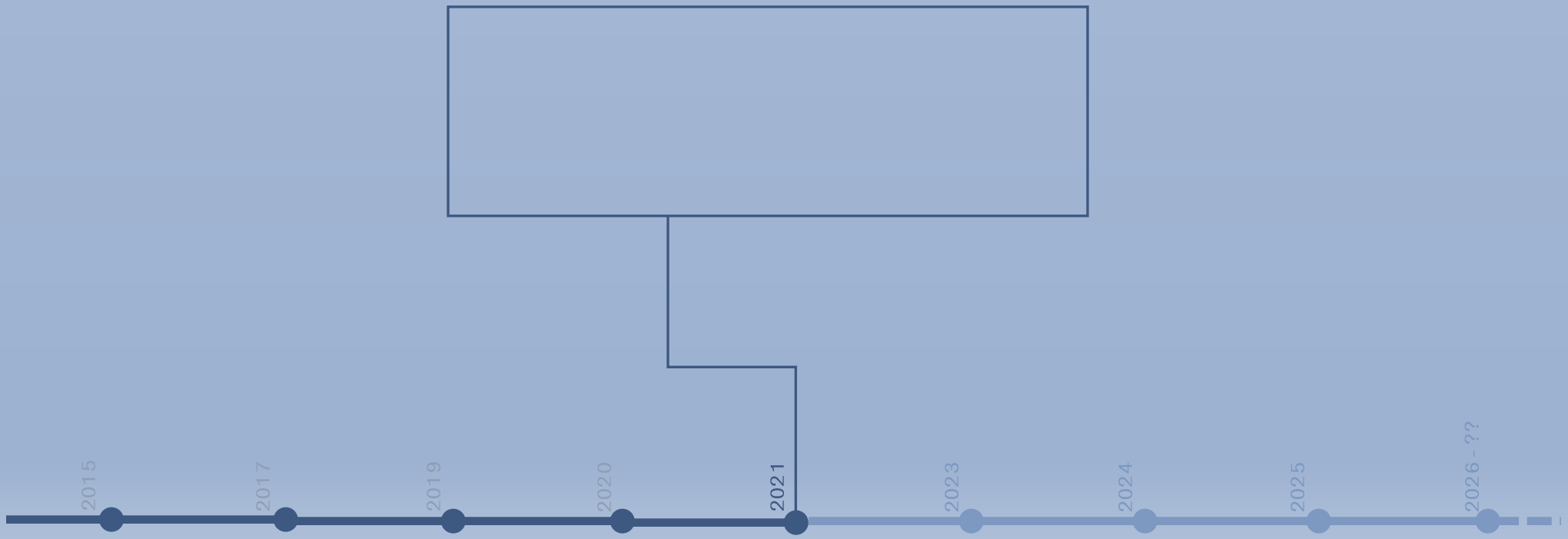

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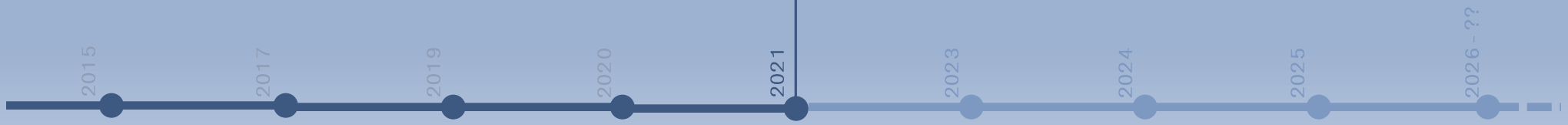
First UDS Server Released

- The rest of the organisation can receive our deliveries using standard tools



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1.0 Release

- All mandatory cyber security and basetech requirements in place
- Green light for production signing

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First Production Release!

- First factory release for Polestar 3
- 2024Q1 – 3.5 years since first Rust bringup

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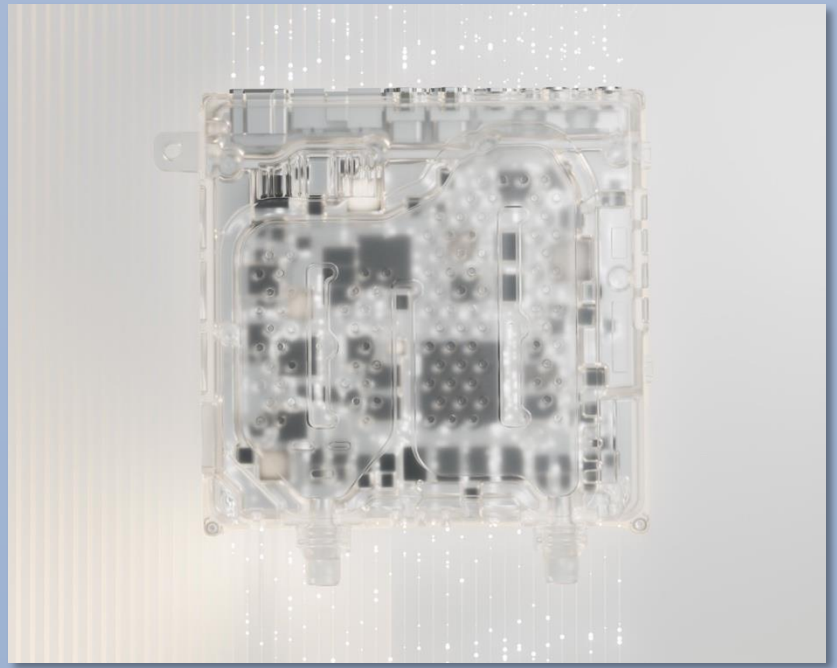

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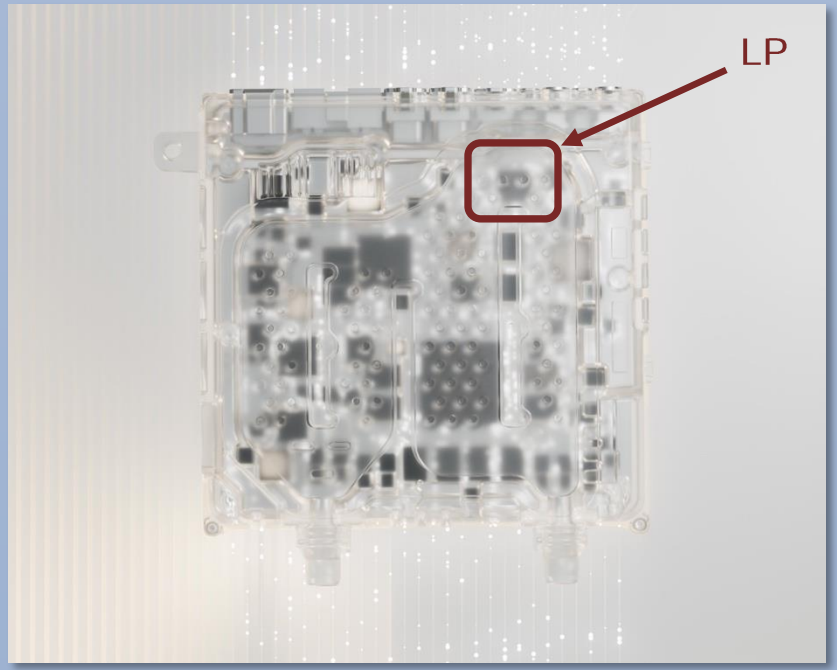

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The Present

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Where are we now?

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Where are we now?

- Finalizing the last features
- Wrapping up and preparing for maintainance mode
- Scouting for new Rust opportunities in upcoming projects

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Results:

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Results:

- First Rust ECU in Production!
- 6-10 Developers
- 170+ KLOC
  Rust: ~90KLOC (+ ~70 3rd party crates)
  C++: ~30KLOC
  Tests and Support: ~50KLOC
- Designed and built our own development HW
- Maintain our own CI

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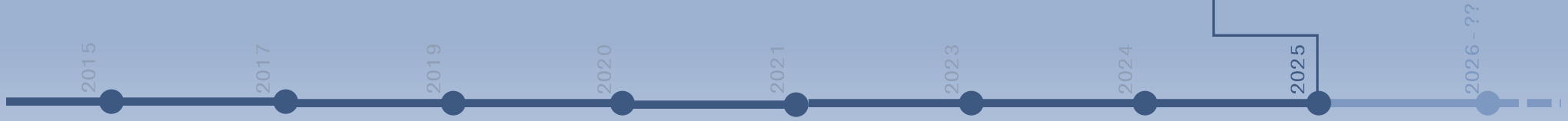
Developed From Scratch:

- Most HALs and Drivers (together with the **`atsamd`** project)
- Bootloaders
- Protocols for UART Communication
- CAN Communication Stack (including **`mcan`** HAL)
- ISO14229 Compliant Diagnostic Stack
- Diagnostic Monitor Framework
- Cybersecurity Mechanisms
- Persistent Storage
- Requirement Tracking and Tracing
- SBOM generation
- etc, etc
- Plus the actual LP Functionality



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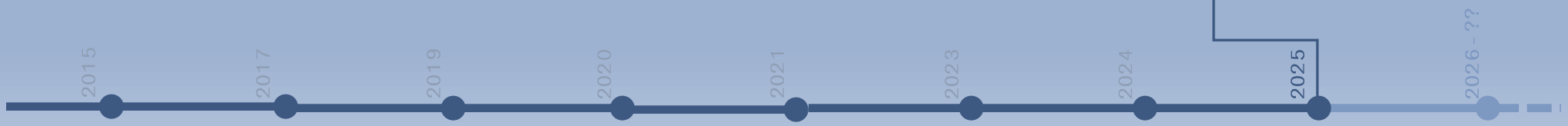
Productivity, Quality & Maintainance

Findings from Google (Rust Nation ‘24):



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- Higher confidence in correctness
- Code is easier to review
- Higher confidence in individual contributions

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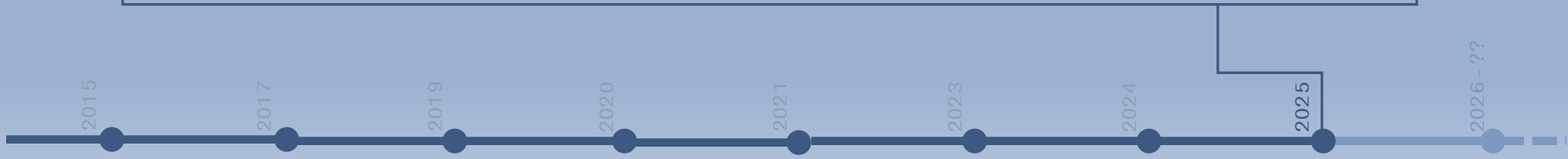

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Volvo Cars:

✅ 2-4X!

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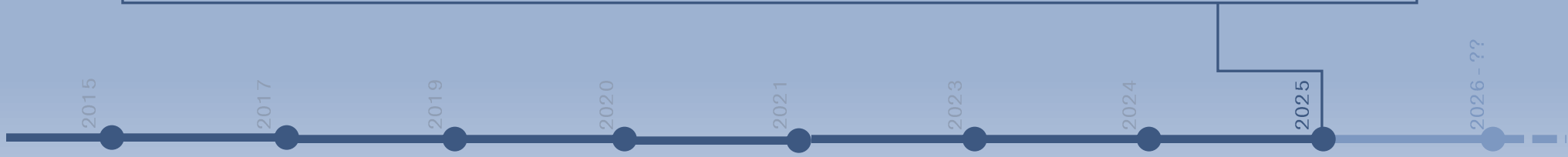

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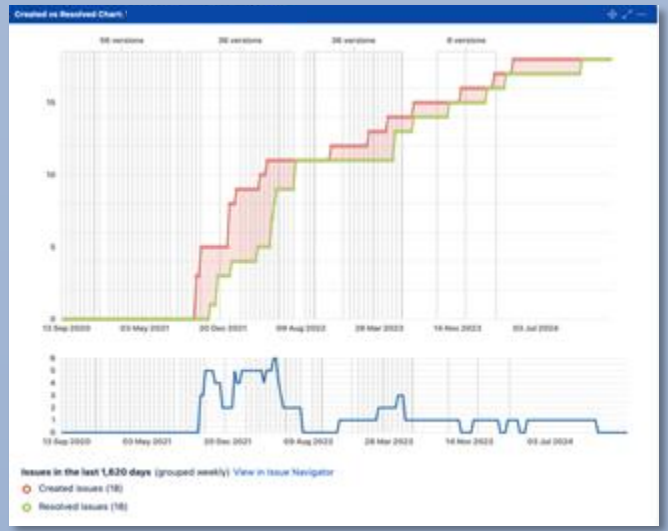

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✅

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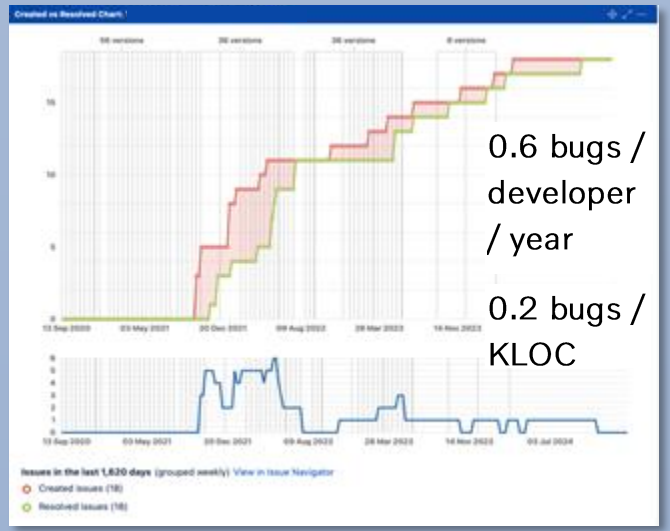

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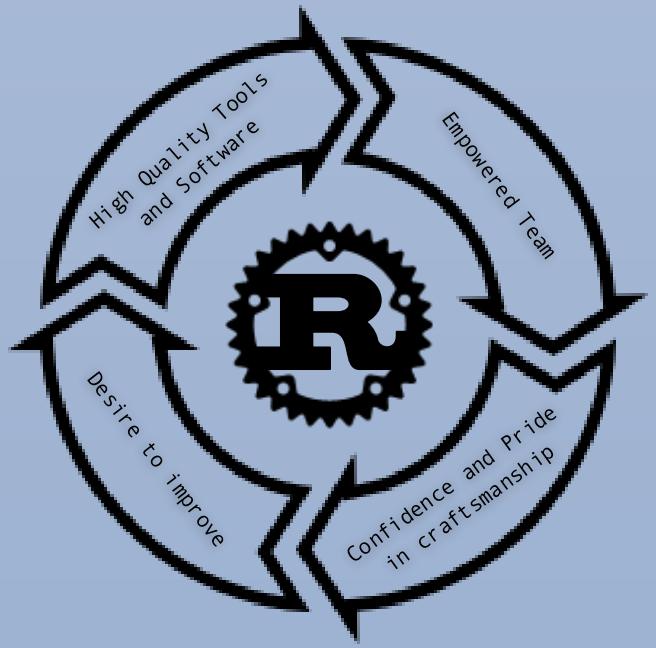

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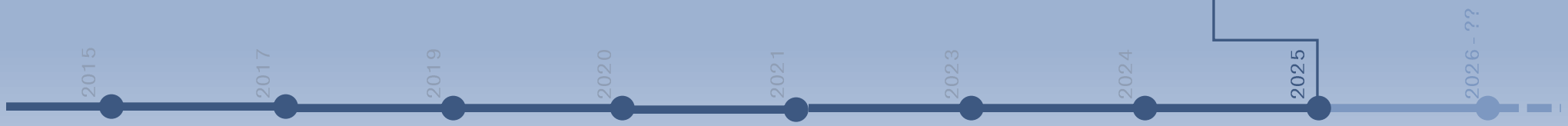
Over-Selling It?



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Over-Selling It?

- The learning curve is real
  - *But not nearly as bad as many claim*
- Rust automotive ecosystem is still young
  - *We might have to build the library ourselves*
- Fair amount of cogntive load
  - *The compiler only accepts provably correct code*
  - *Time spent with code not compiling*
  - *“Type Tetris” can be frustrating at times*

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  - *“Type Tetris” can be frustrating at times*
- Build times could be better
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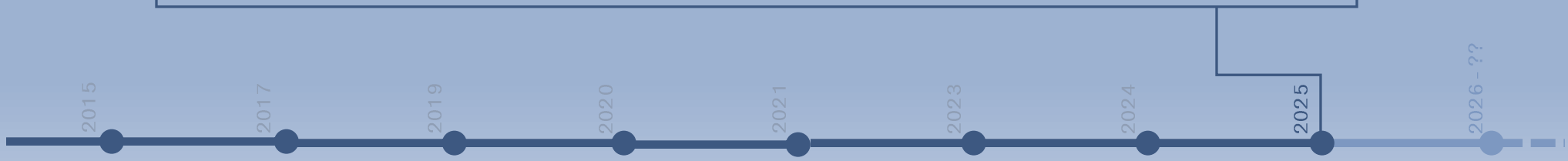

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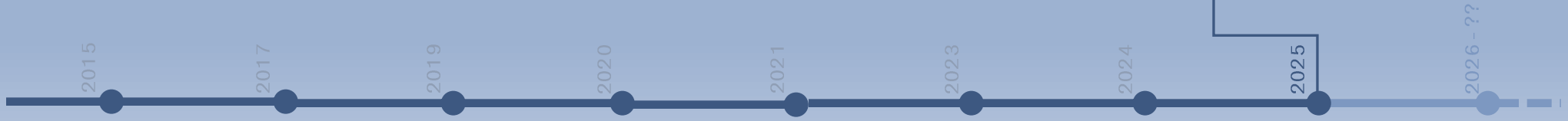
➢ **The positives still far outweigh the negatives**



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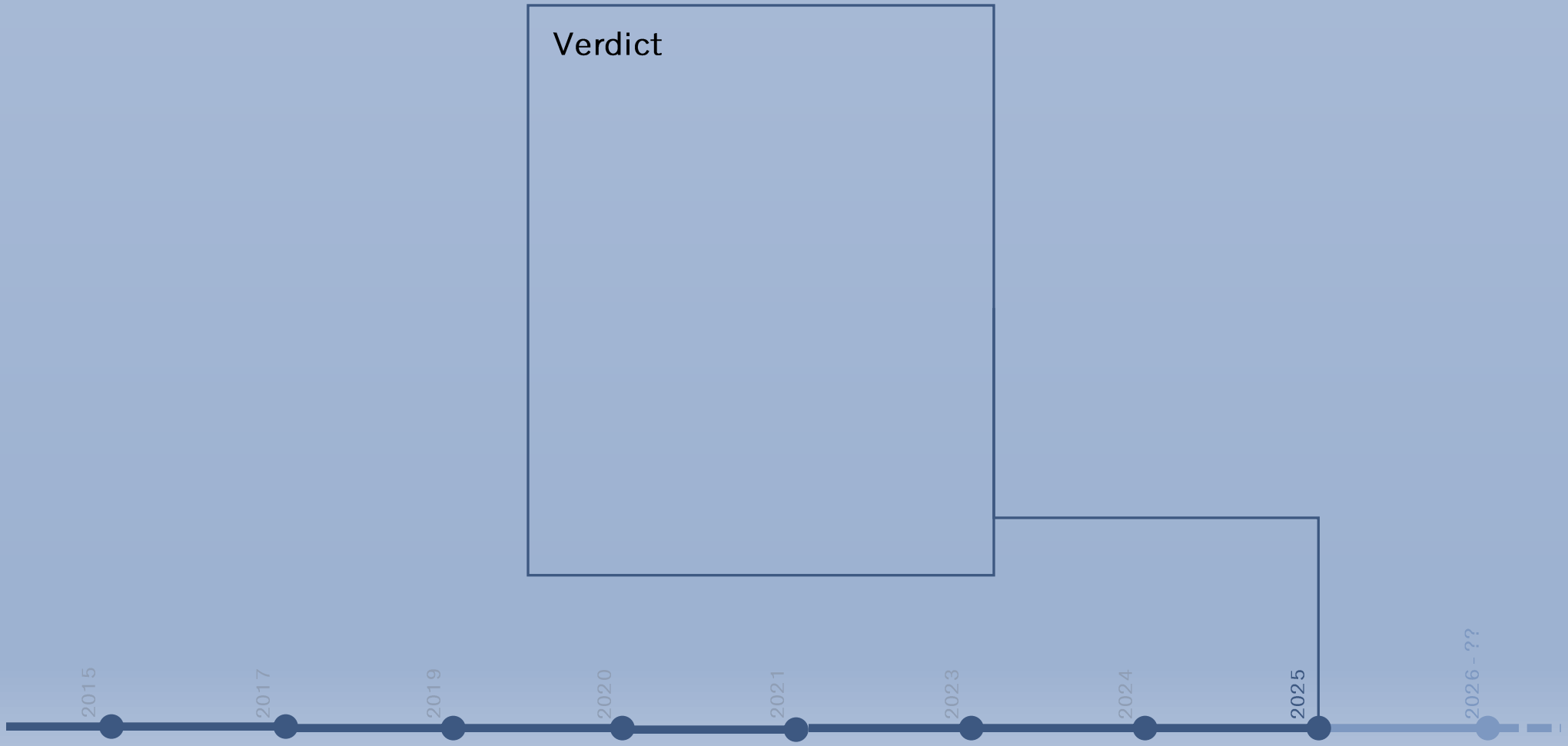

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Verdict

HUGE SUCCESS!

2015 2017 2019 2020 2021 2023 2024 2025 2026 - ??

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But, Remember
Betamax?

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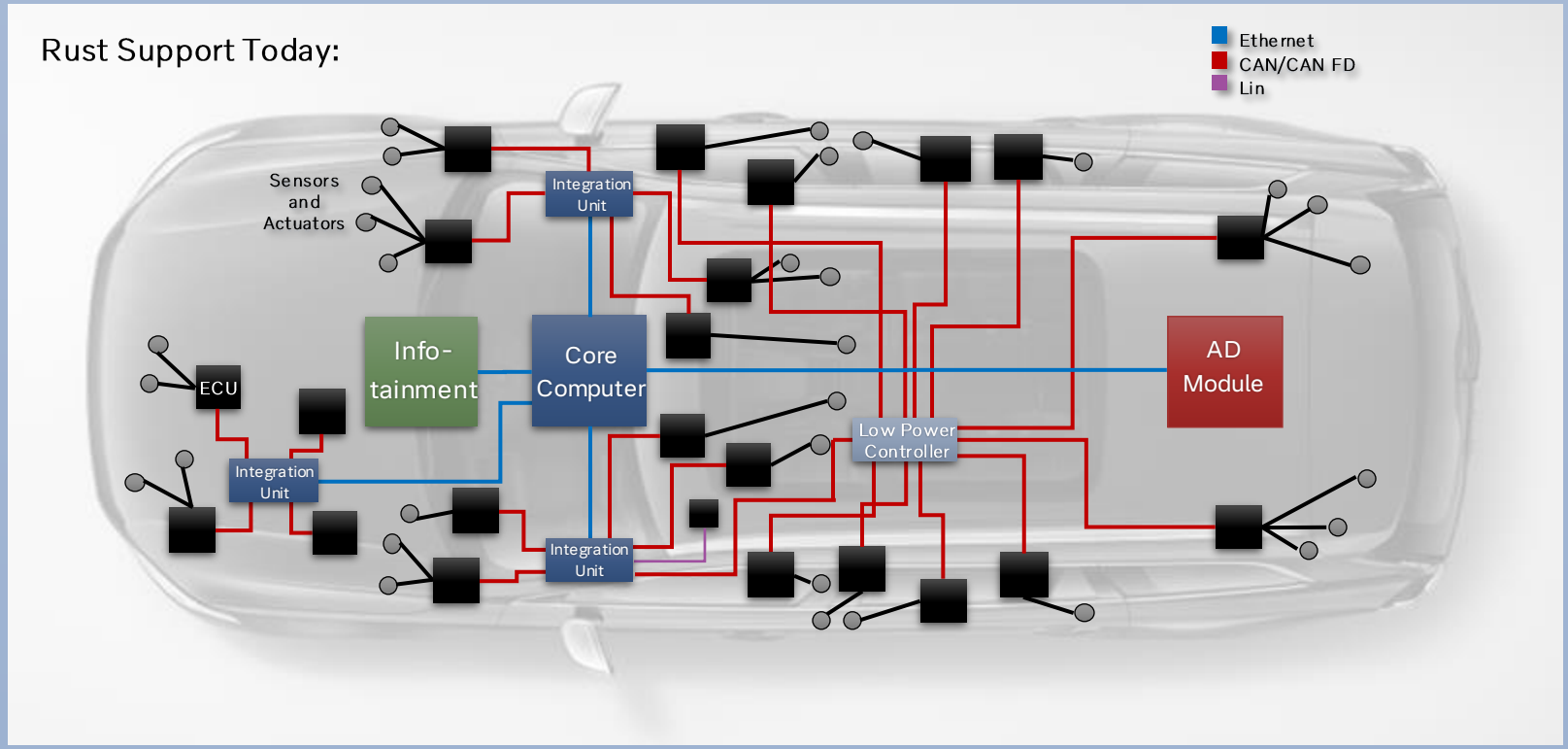
Rust Support Today:



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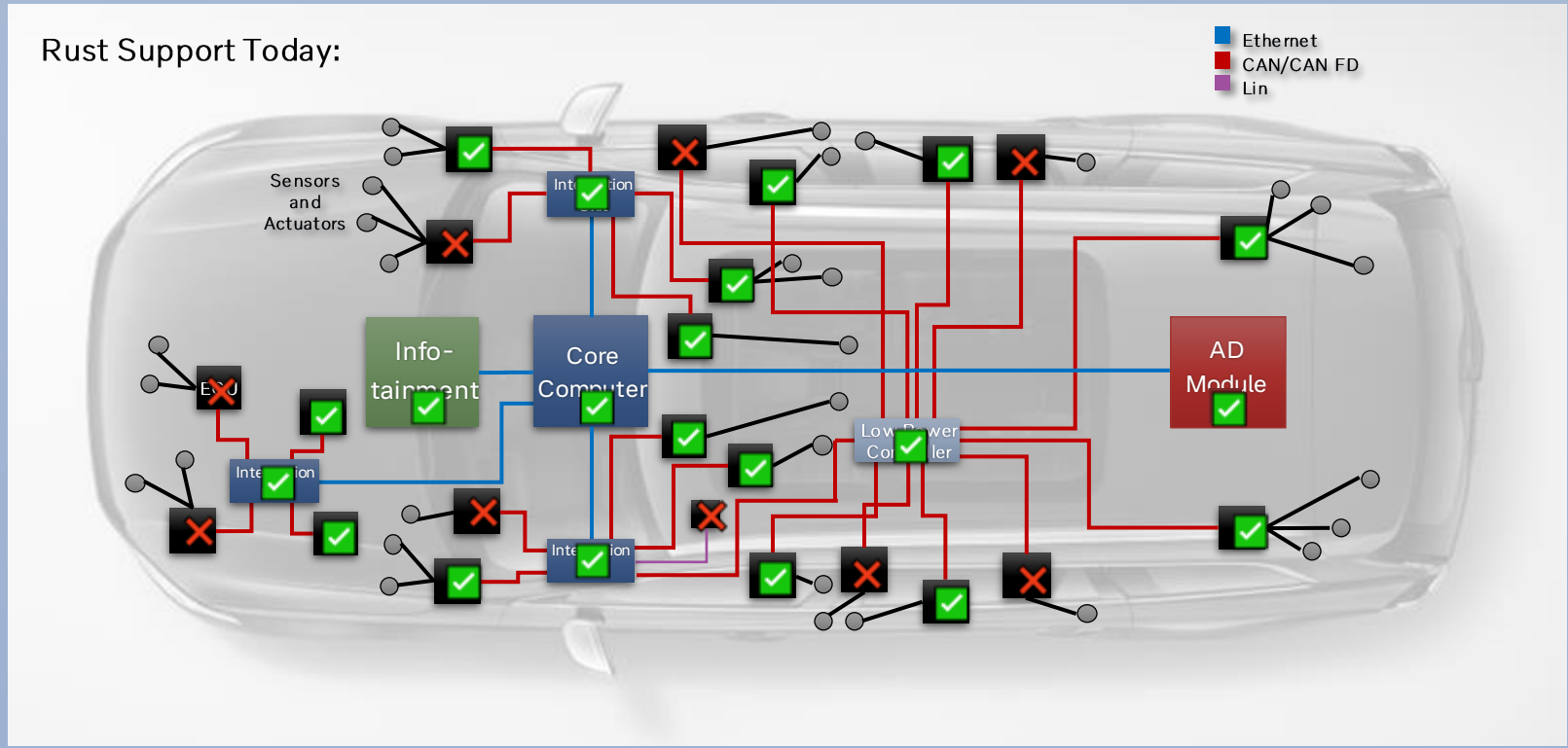

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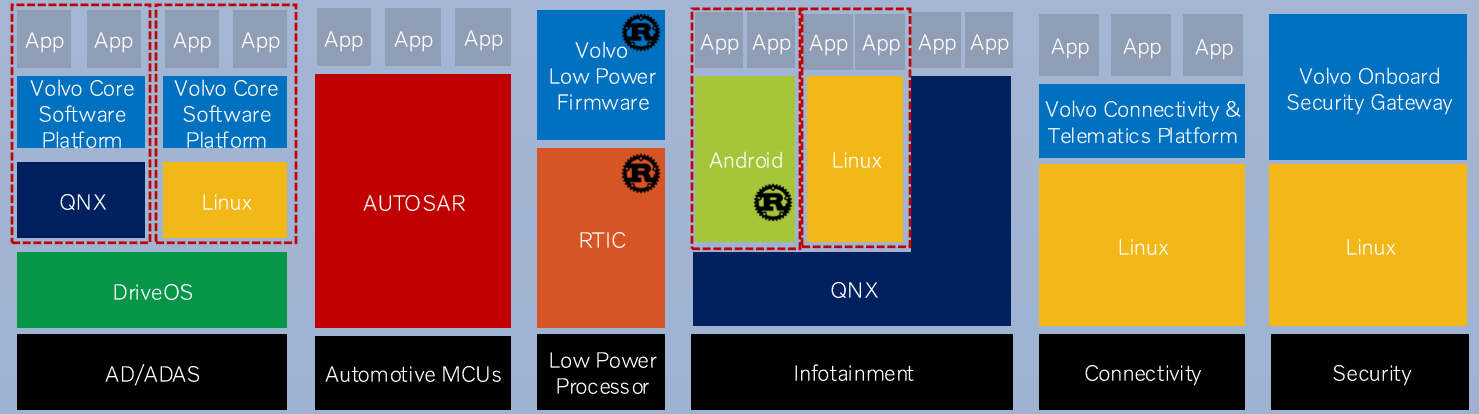
Volvo Onboard SW Platforms



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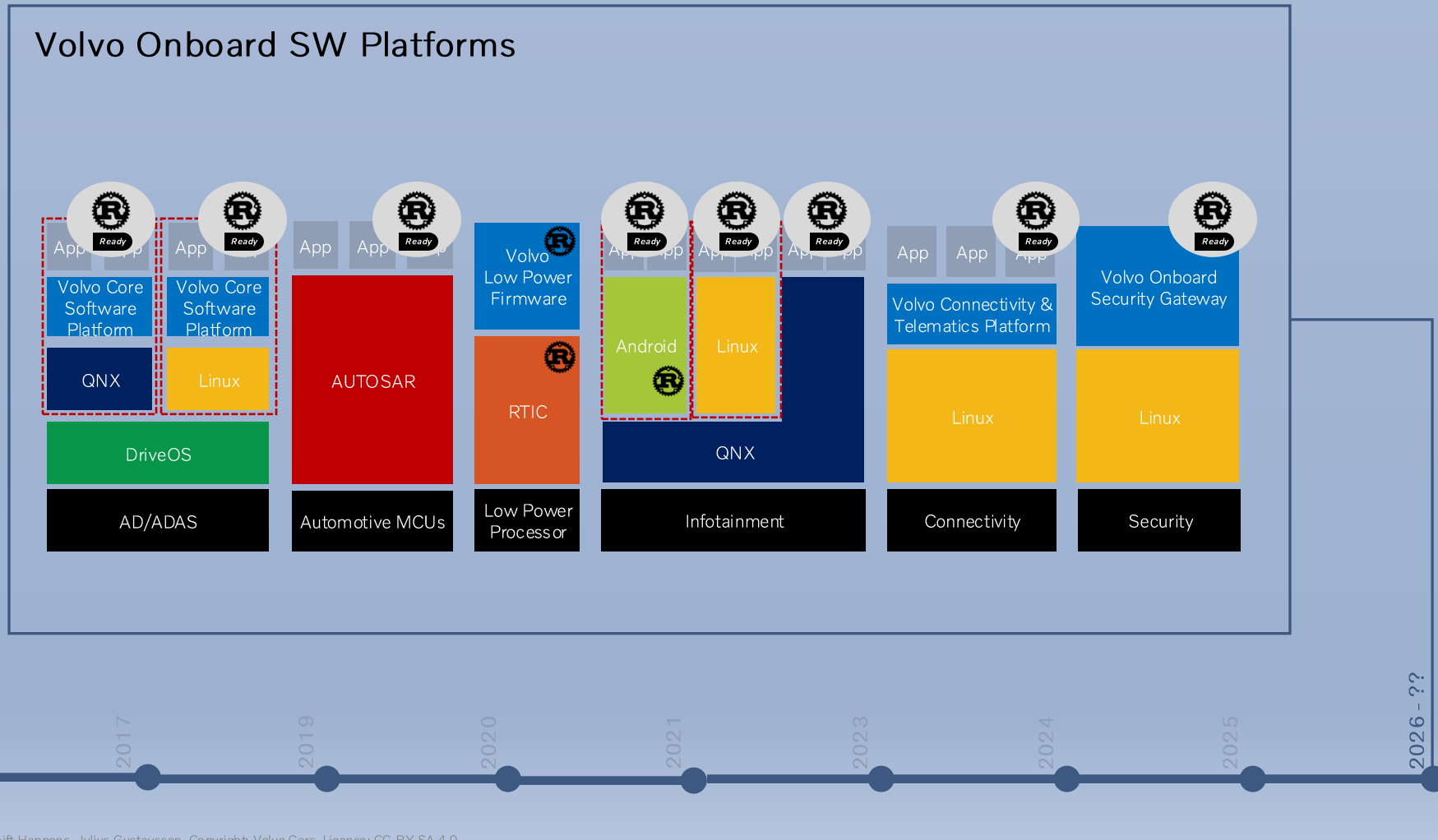

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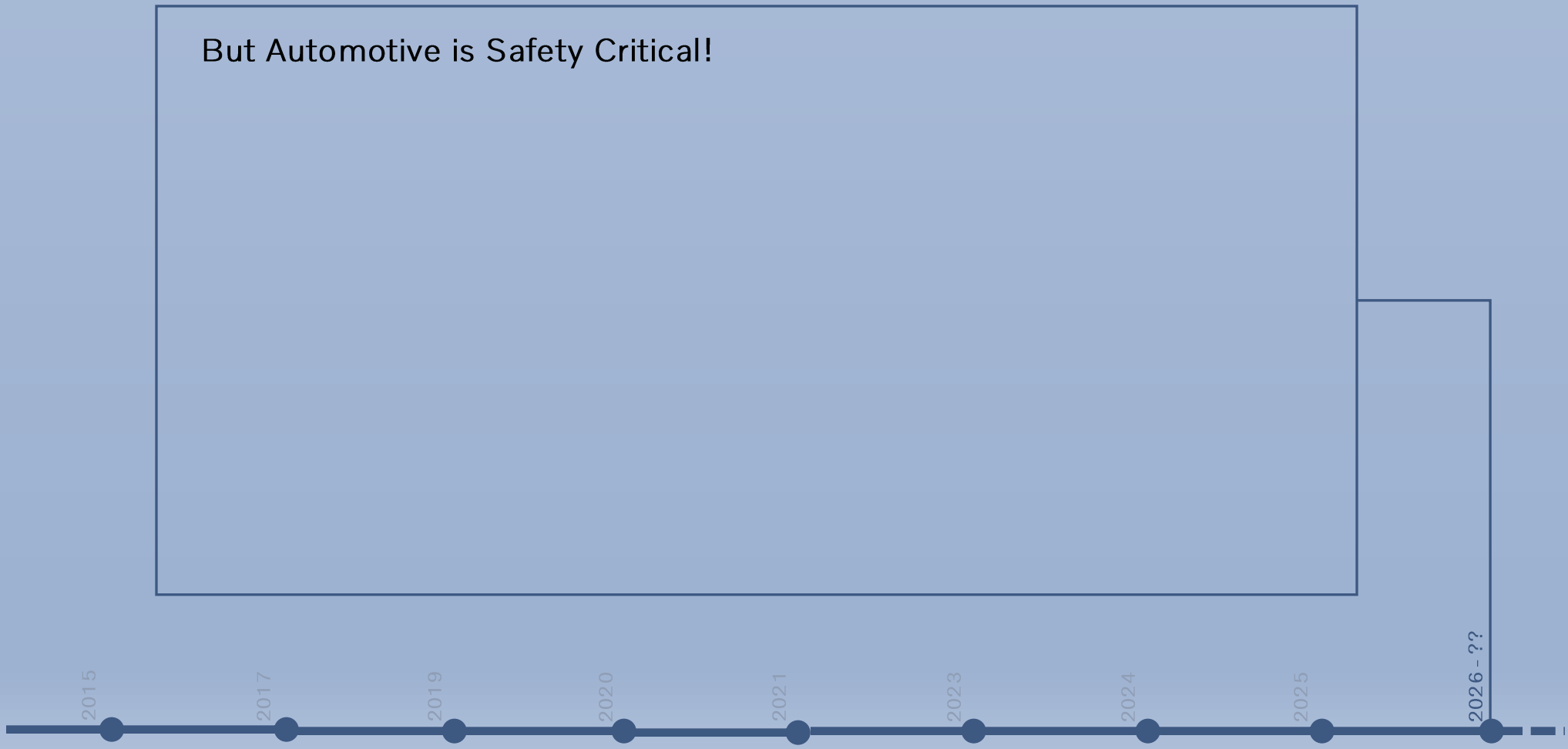
But Automotive is Safety Critical!



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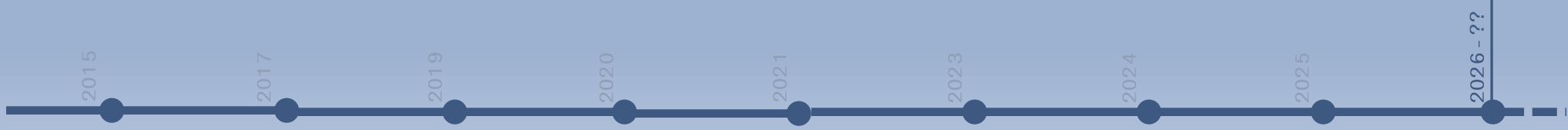
But Automotive is Safety Critical!

State of FuSa in 2025:	Status
Safety Critical Consortium	✅
Compiler Toolchain	✅
Unofficial Specification	✅
Official Specification	Coming Soon!
Official Coding Guidelines for Safety	🟡
Runtime Libraries	🟡
Other Tooling	🟡



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Will 2026 be the year of Safety Critical Rust in Cars?

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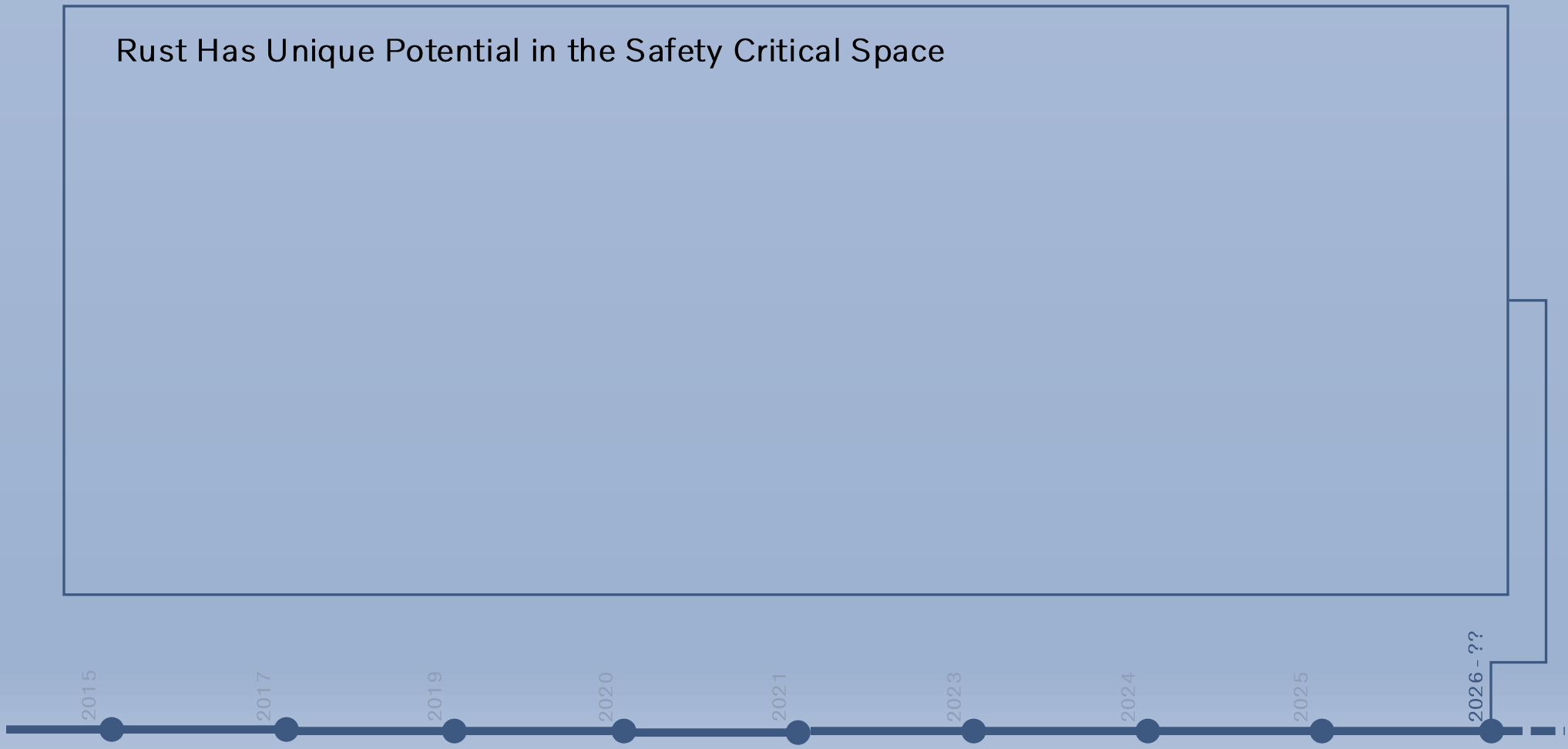
Rust Has Unique Potential in the Safety Critical Space



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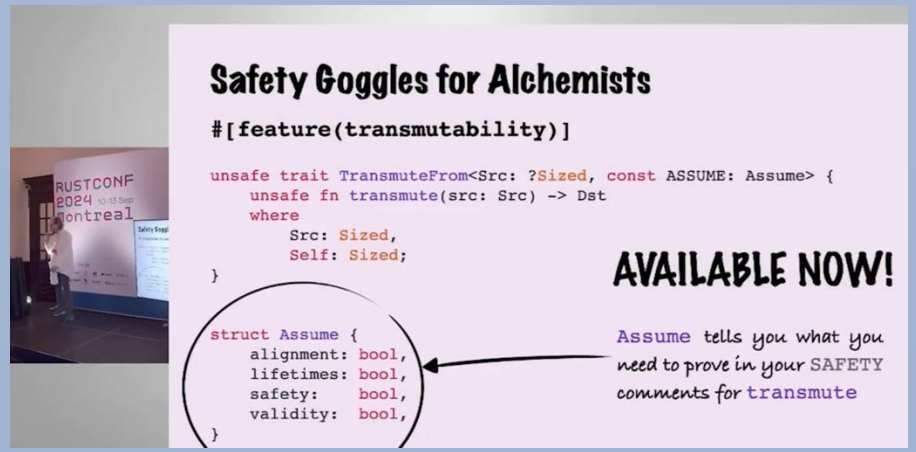

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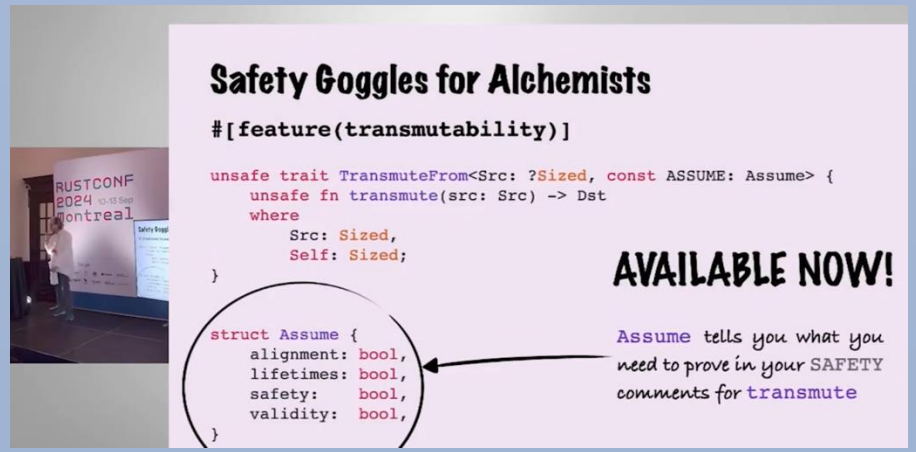

"Correct By Construction"

2015 2017 2019 2020 2021 2023 2024 2025 2026 - ??

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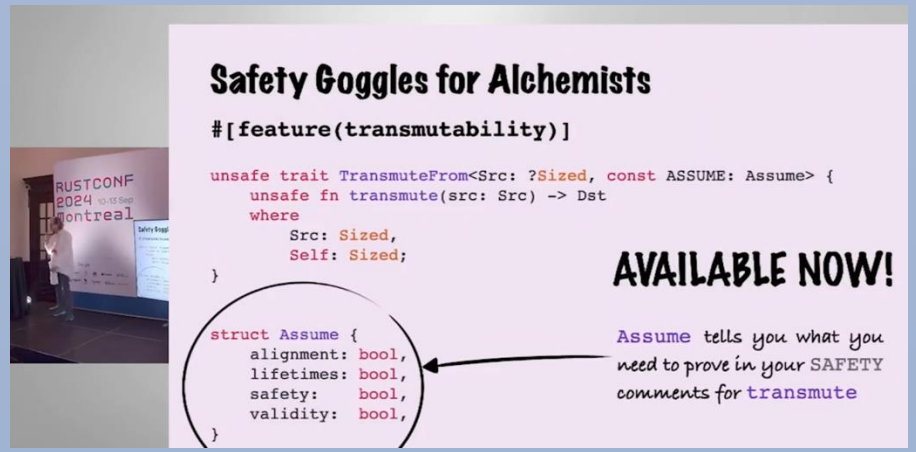

How about:

“Compliant By Construction”?

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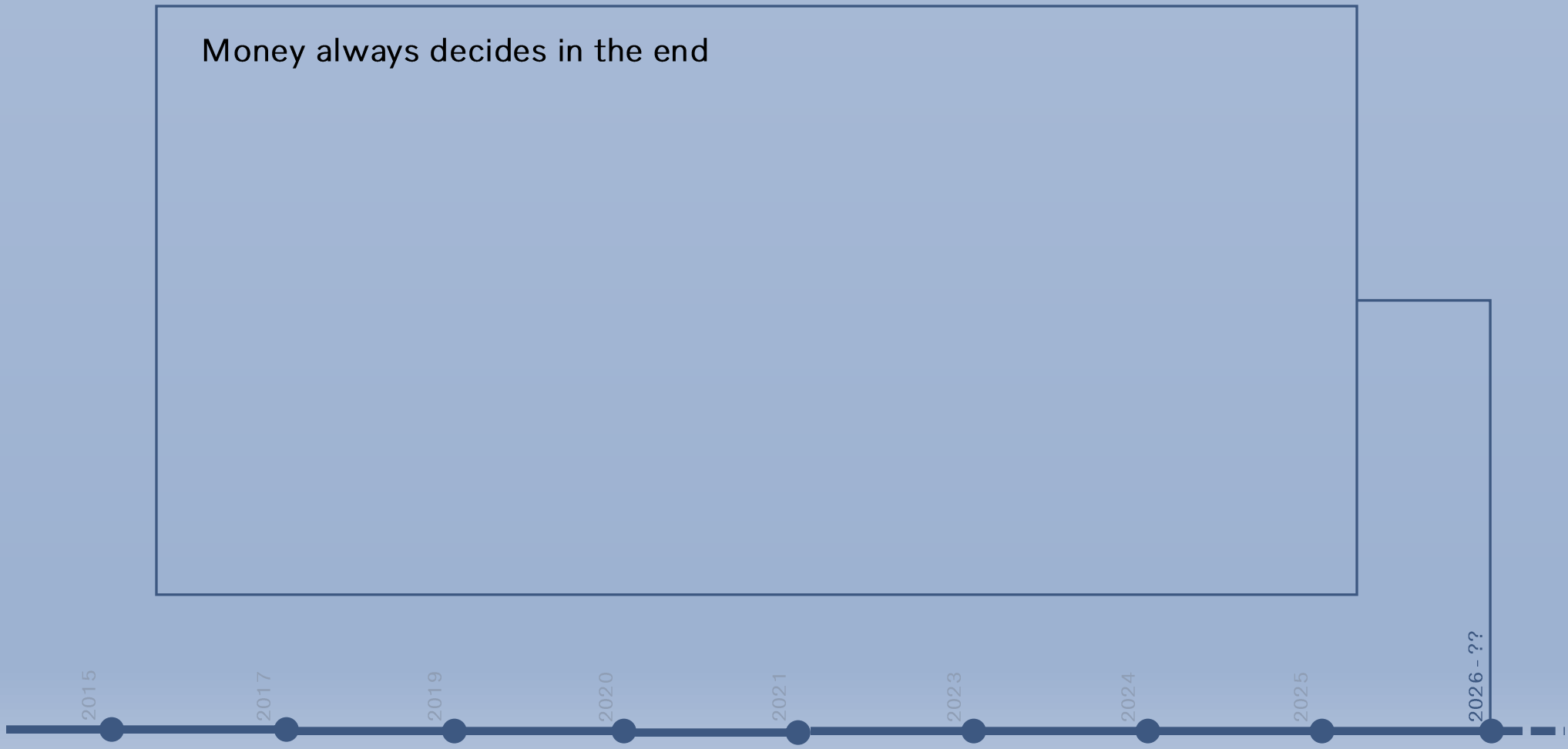
Money always decides in the end



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~90% of development effort is spent on verification

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Car industry spends 2% of revenue on warranty costs per year

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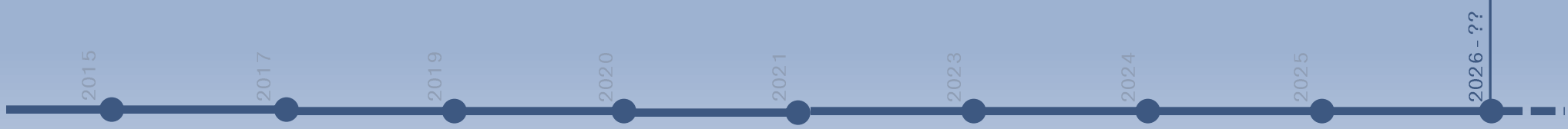
Any improvement on these could mean
€Billions in savings!



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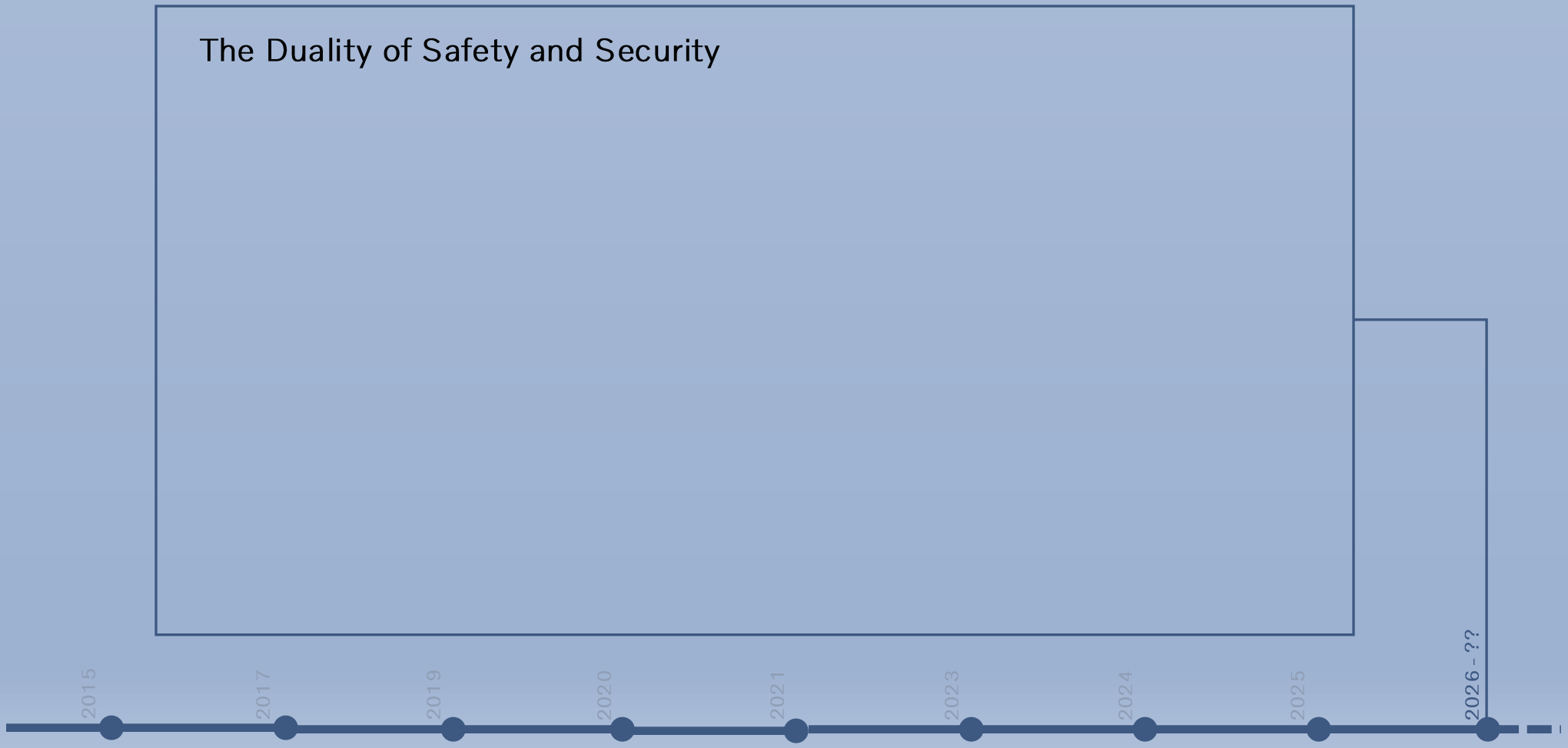

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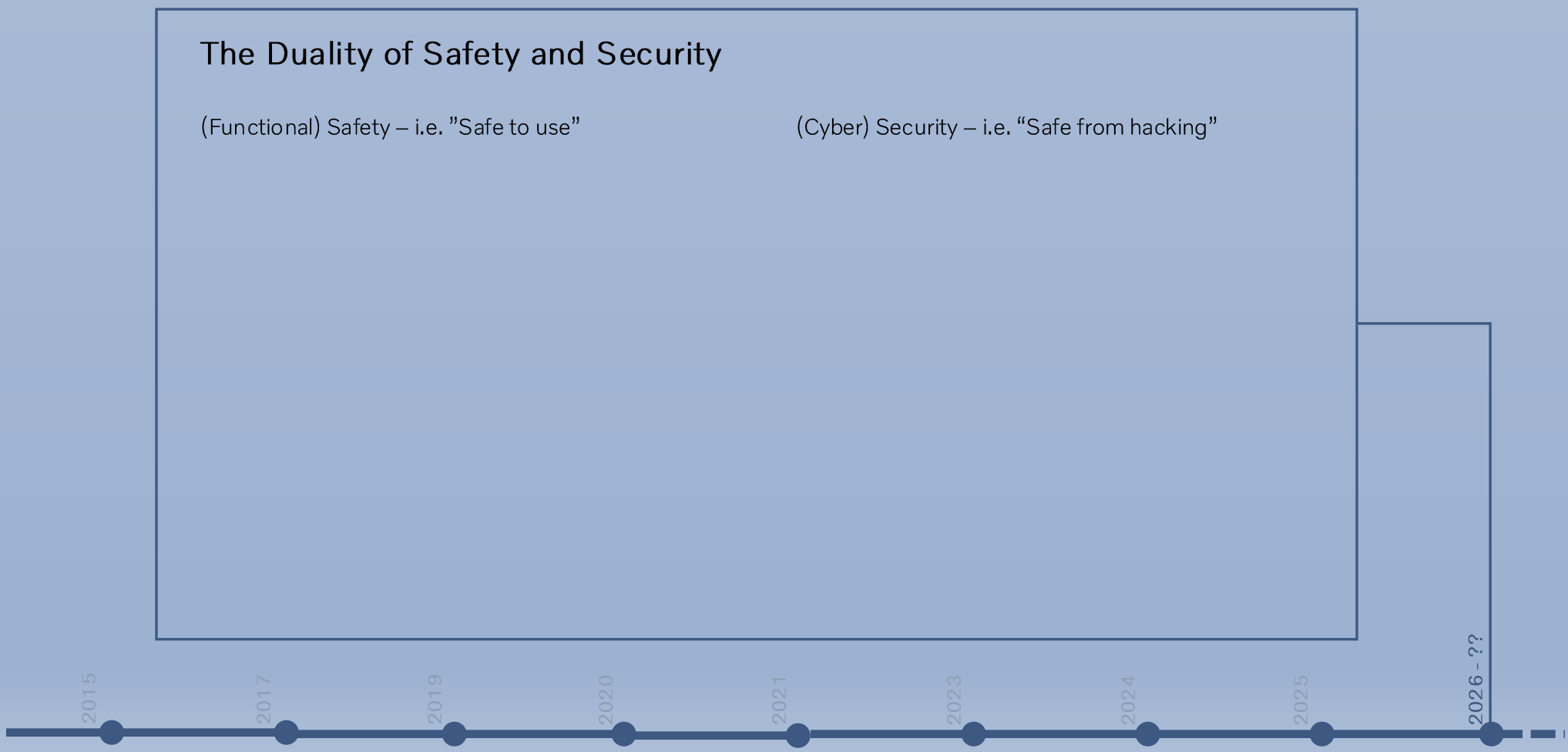
The Duality of Safety and Security

(Functional) Safety – i.e. ”Safe to use”

(Cyber) Security – i.e. “Safe from hacking”



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The Duality of Safety and Security

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- Peform Hazard Analysis (HARA) and employ necessary mitigations
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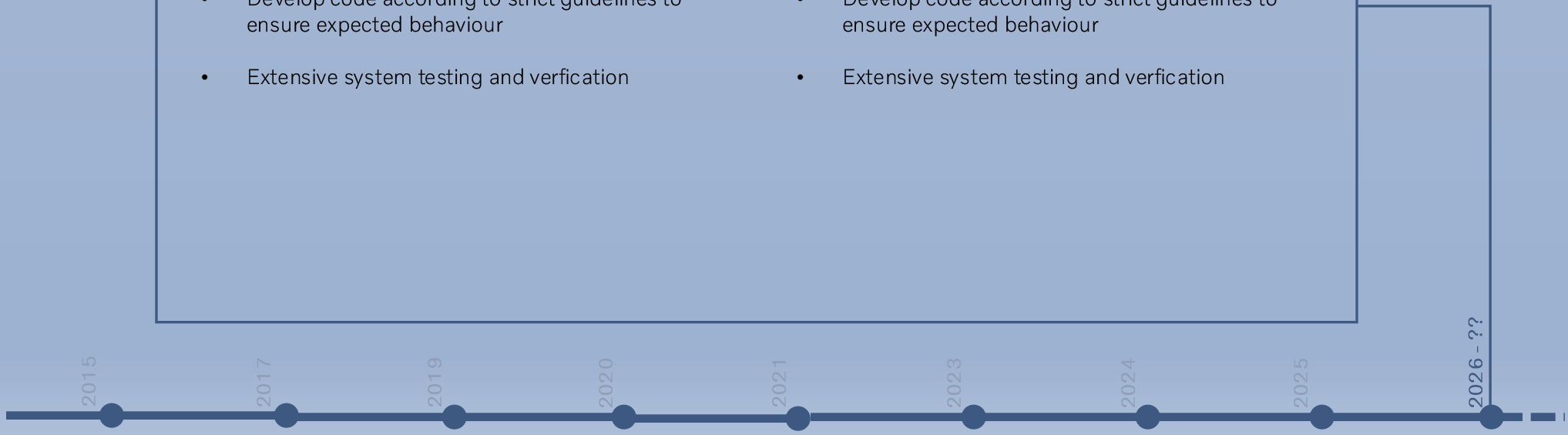

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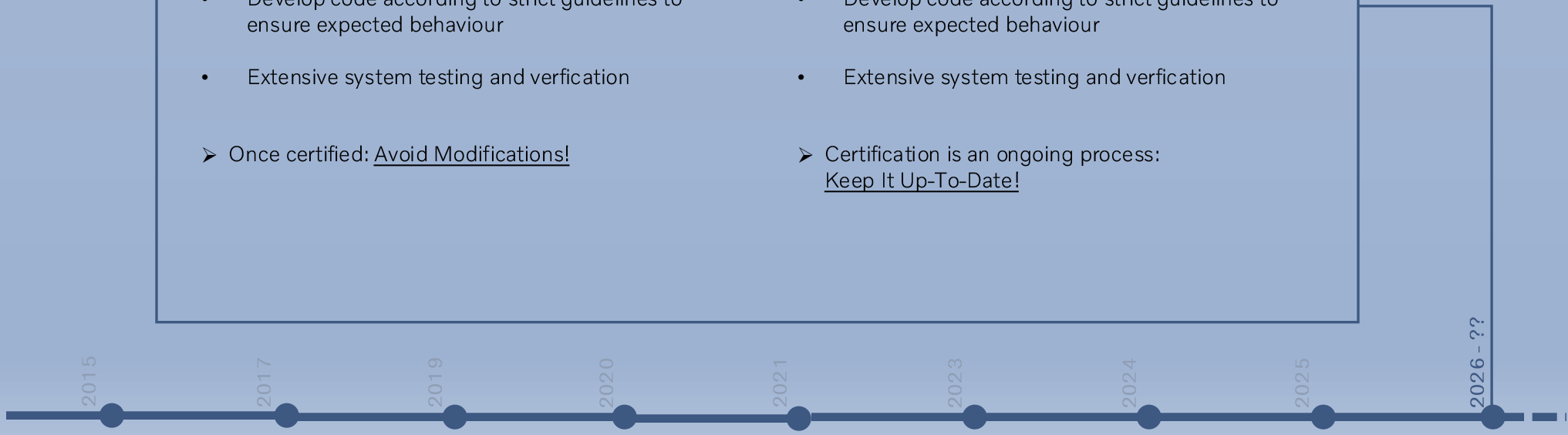

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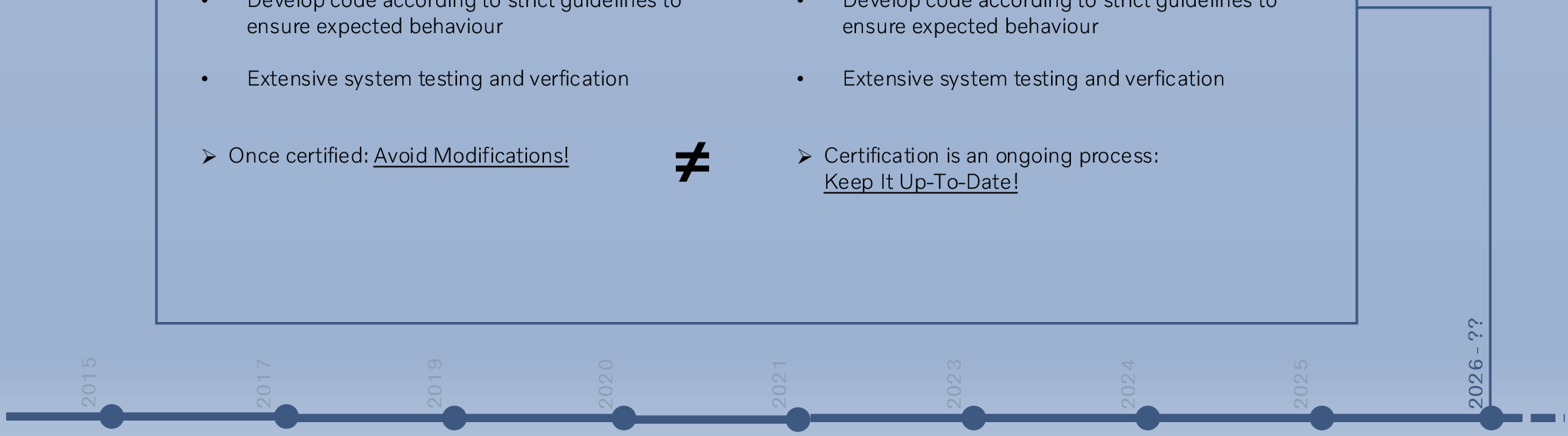

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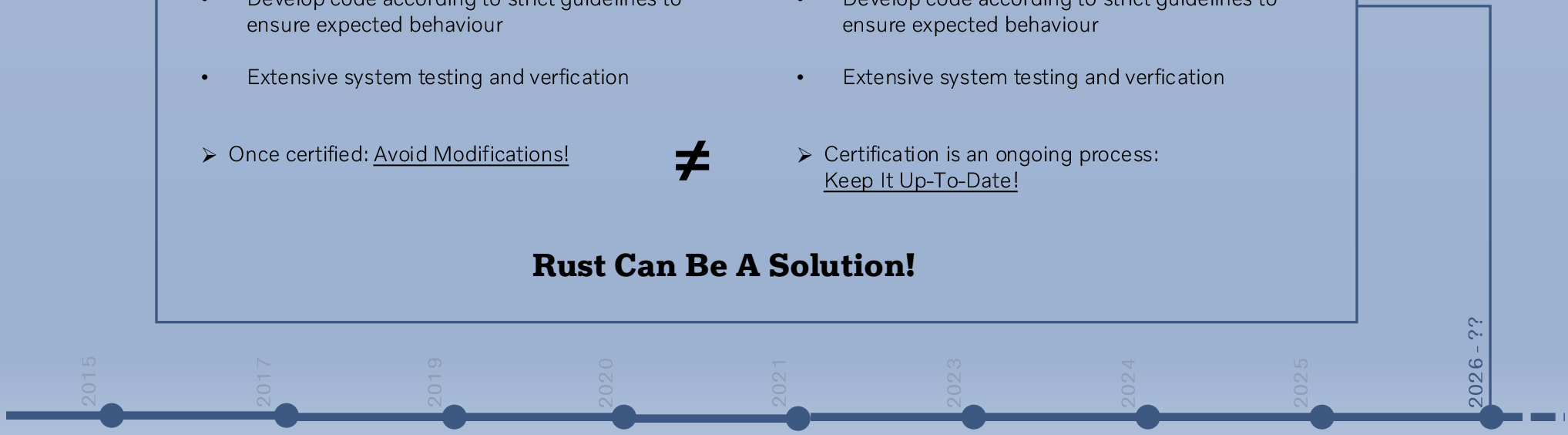

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THE FUTURE FOR RUST IN CARS IS BRIGHT!


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Thank You!