ARCHITECTURE & SAFETY-CRITICAL SOFTWARE FOR NEXT GENERATION VEHICLES

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BACKGROUND

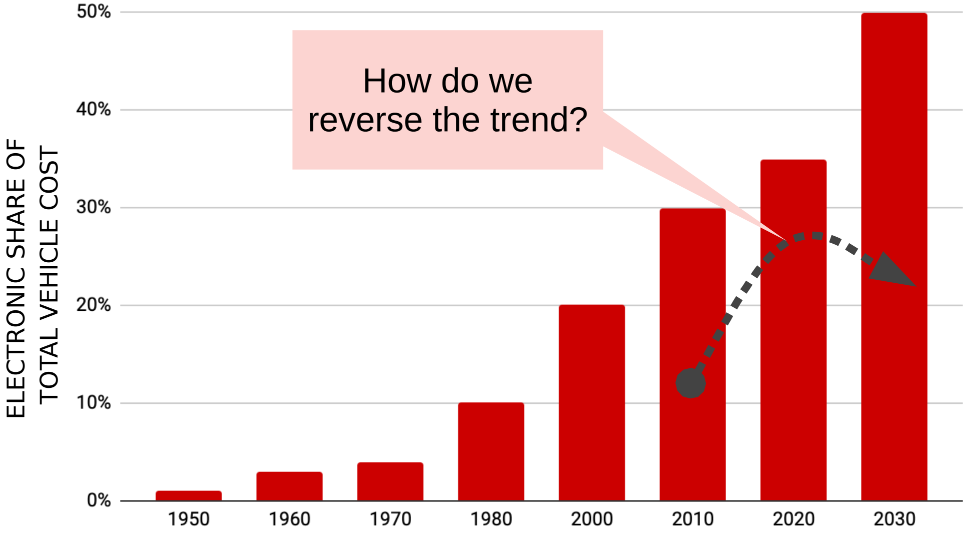
VEHICLE GROWTH IN ELECTRONICS

- Electric vehicles, ADAS, IVI, V2X driving up cost and complexity of electronics

- Modern luxury vehicles have 50-150 ECUs
  source: Strategy Analytics, IHS Markit

- Global ECU market $63.6 billion (2018)
  source: grandriewresearch.com

- Electronic share of total vehicle cost is rising exponentially



source: Statista 2017

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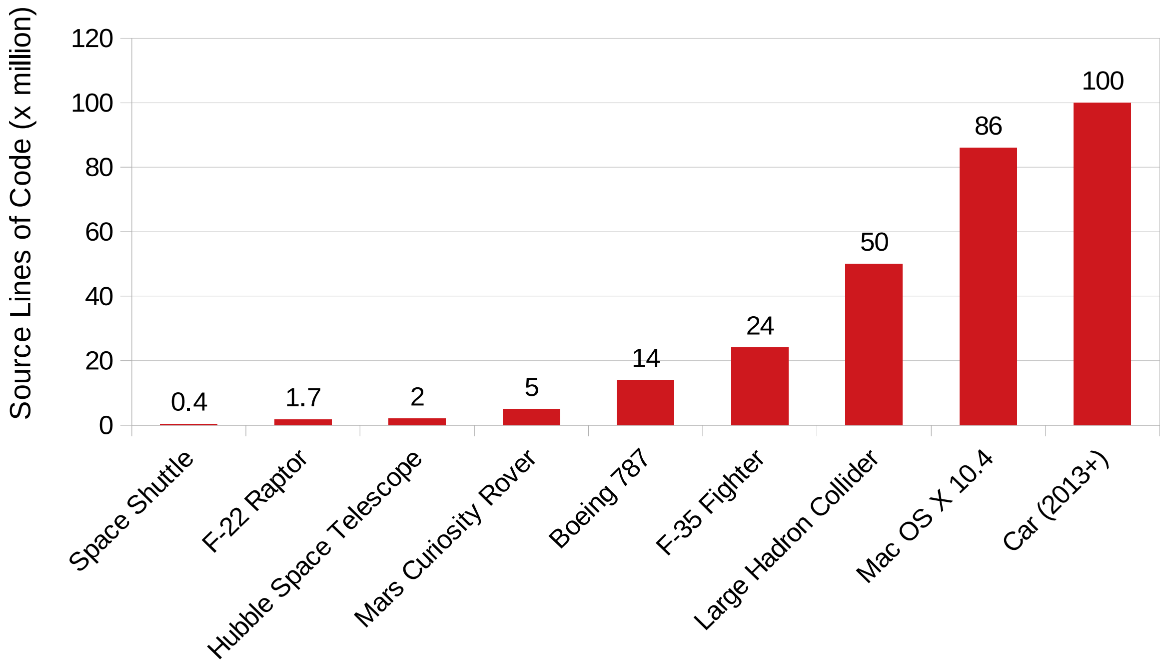
AUTOMOTIVE SOFTWARE COMPLEXITY

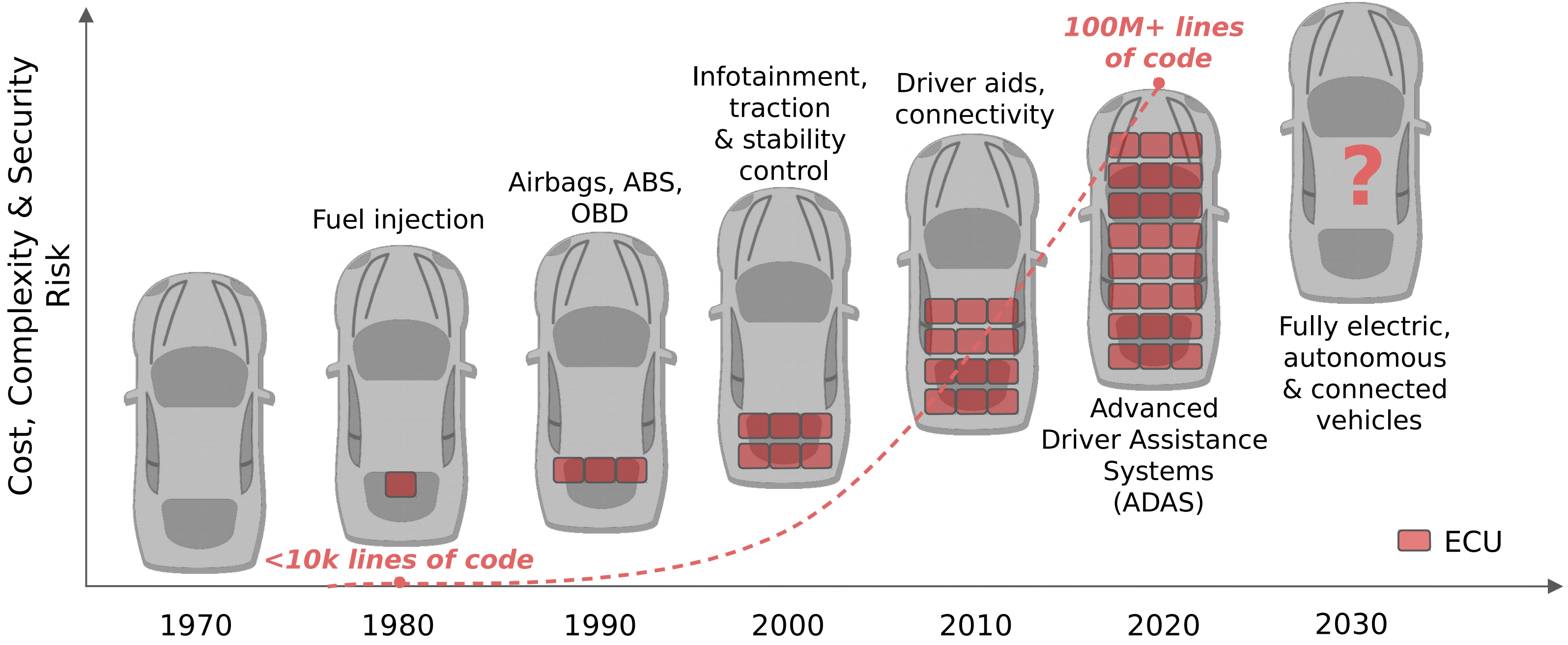
- Growth in automotive electronics has given rise to growth in software complexity



Source: https://informationisbeautiful.net/visualizations/million-lines-of-code/

SOFTWARE EXPLOSION

- Software growth driven by increased vehicle functionality + increased ECU count



HARDWARE & OS EVOLUTION

AUTOMOTIVE DOMAIN

- 8→ 16→ 32 bit microcontrollers
- 1-3 cores, often single function
- Typically 10s-100s MHz
- Freescale PowerPC, Infineon TriCore …
- Integrated CAN, GPIOs, ADCs

Simple RTOS

- OSEK, FreeRTOS, Tresos, ECOS ...

PC DOMAIN

- 64-bit CPUs, integrated GPUs
- Multicore, multiple tasks
- GHz clock speed, hardware virtualization
- Intel & AMD x86, ARM
- USB, PCIe, Ethernet, WiFi

Complex General Purpose OS

- Windows, Mac OS, Linux

AUTOMOTIVE SYSTEM CHALLENGES

Reduce electronic costs

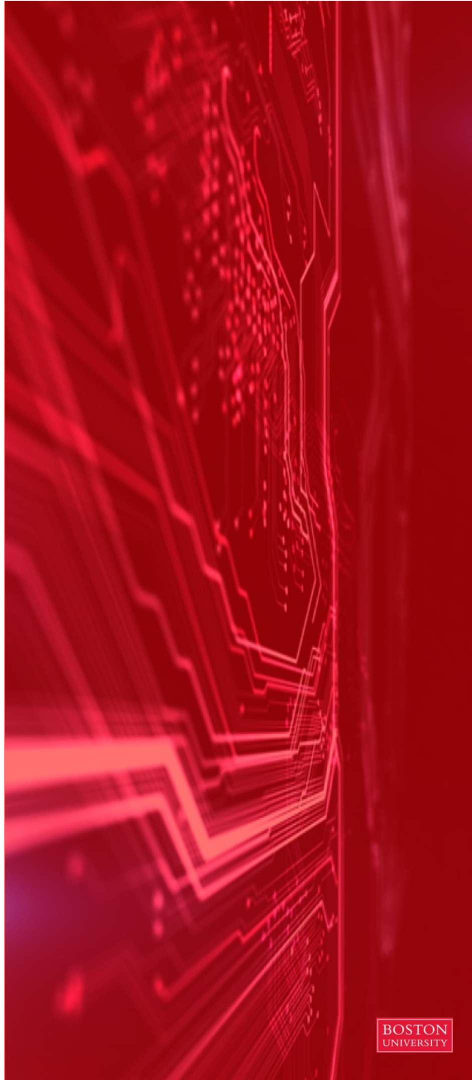
- Replace ECUs with multicore PC-class processors
- Consolidate ECU functions as software tasks

...but...

Need new vehicle OS

- To manage 100s of tasks on multiple cores

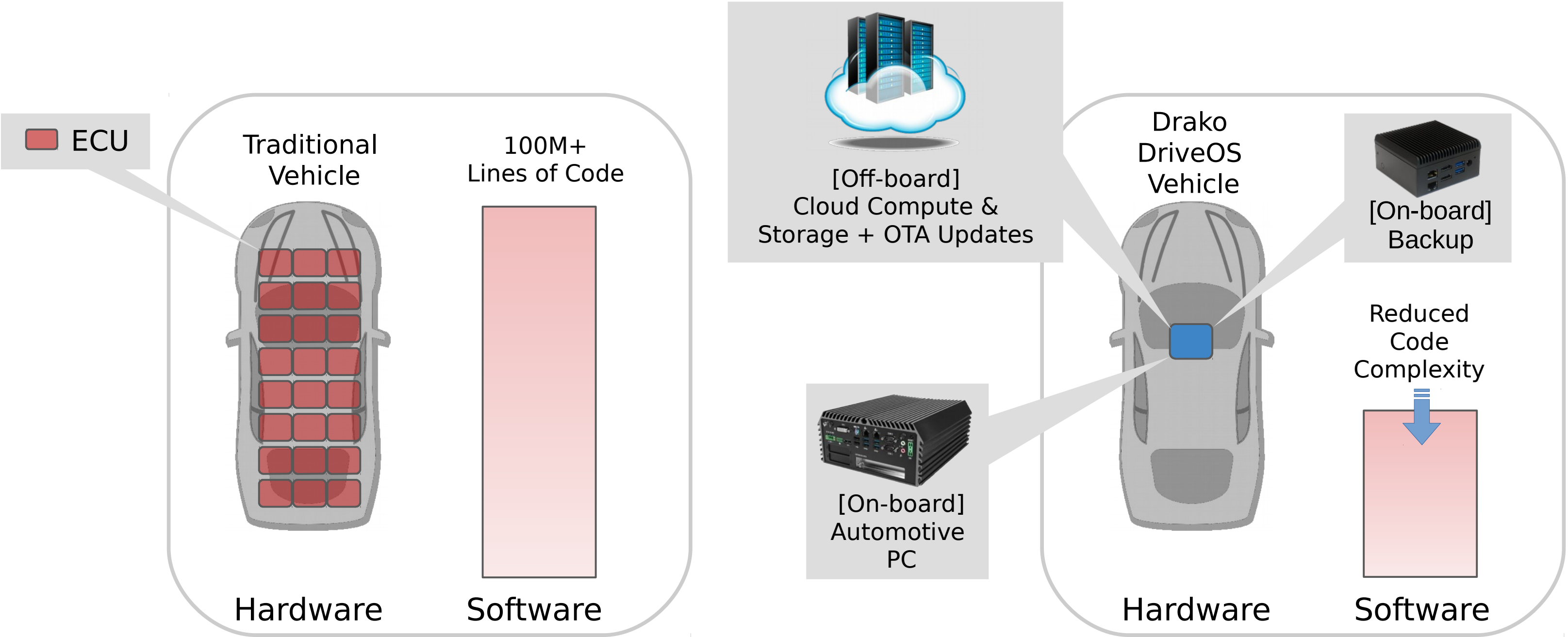
- Too complex to write new OS from scratch
- Combine real-time with legacy code
- Safety (ISO26262), security, predictability
- Mixed-criticality-aware (ASIL A-D)
- Fast critical reboot (current PC-based OSes too slow)



MOVING FORWARD: DriveOS

DRAKO DriveOS

DriveOS supports traditional hardware functions as software tasks running on a multicore virtualized platform



Multicore is the way forward

Software easier to reconfigure, upgrade, and extend

Machine virtualization provides safe isolation of cores

Hardware & software redundancy for fault recovery

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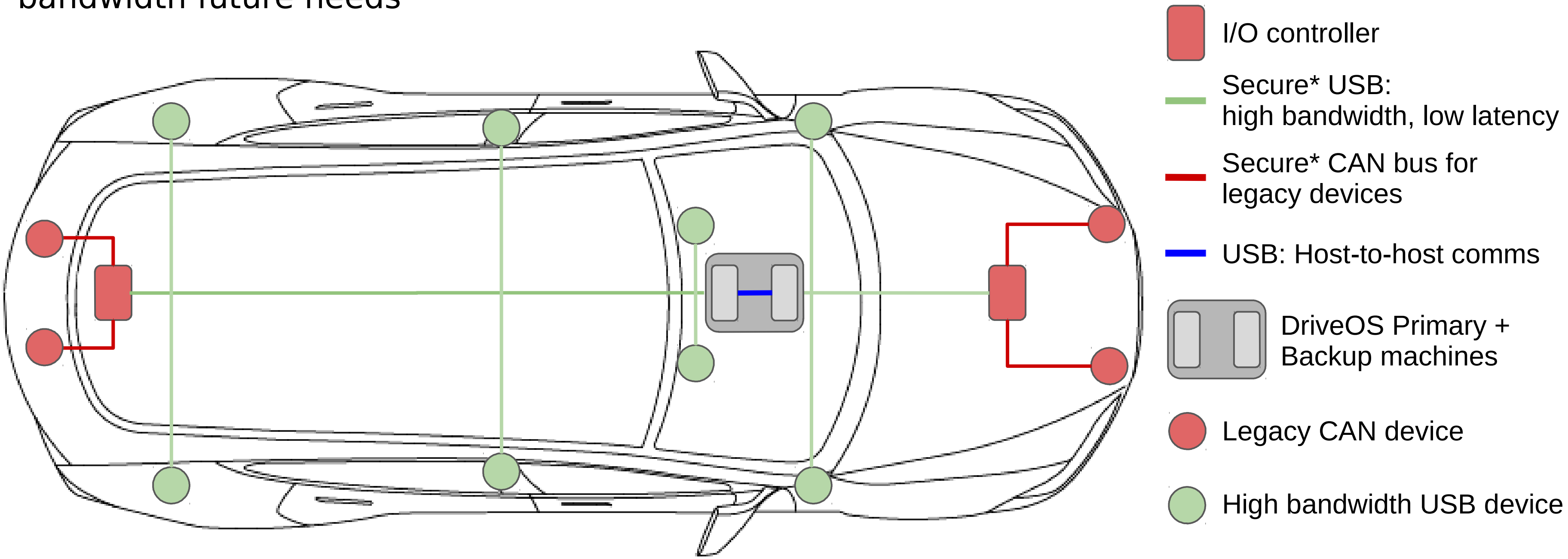
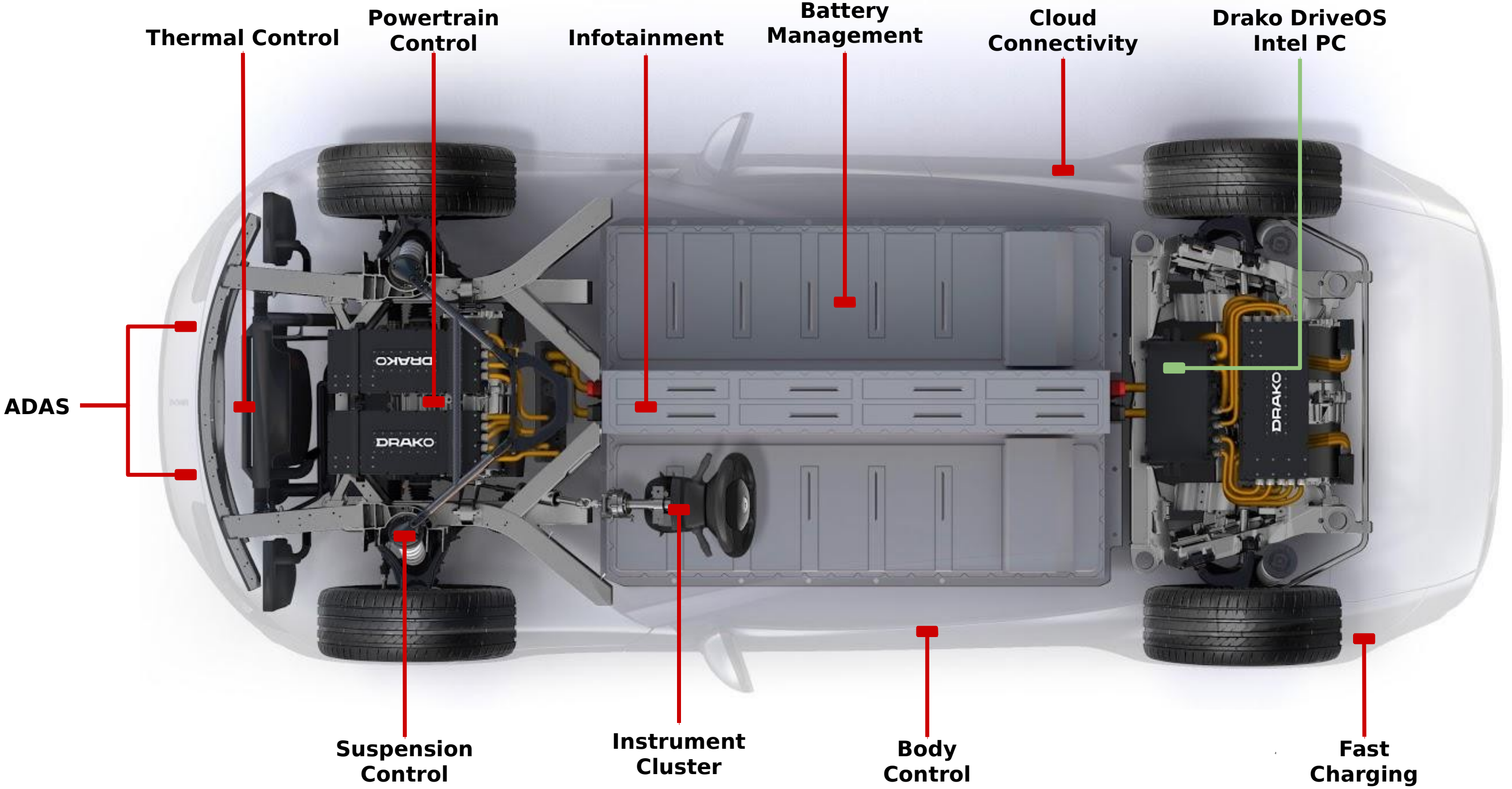
DRAKO DriveOS I/O

USB-centric solution: works with legacy devices + supports higher bandwidth future needs

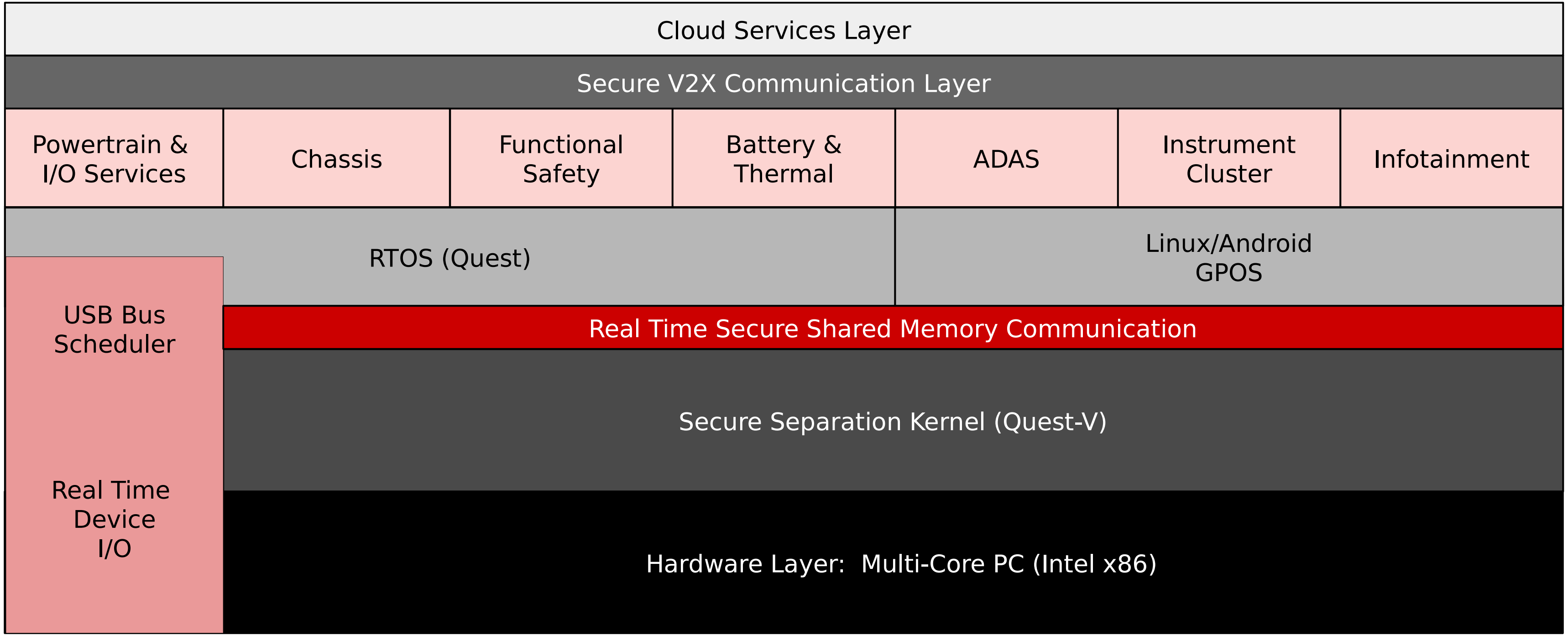


*Secure access to USB + CAN mediated by trusted I/O sandbox in DriveOS

REFERENCE DESIGN: DRAKO GTE DriveOS

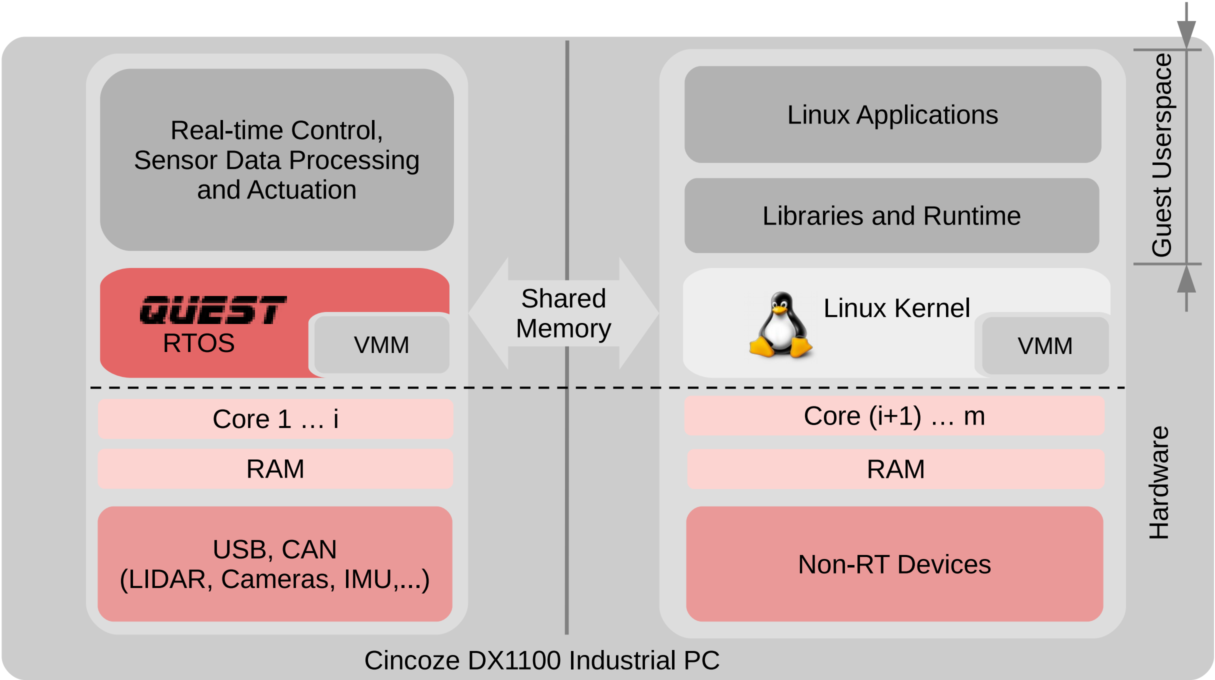


DRAKO DriveOS REFERENCE STACK



EXAMPLE: Quest-V for DriveOS

- Separation kernel (a.k.a. partitioning hypervisor)
- Partitions CPU cores, RAM, I/O devices among guests
- Each sandbox runs its own OS



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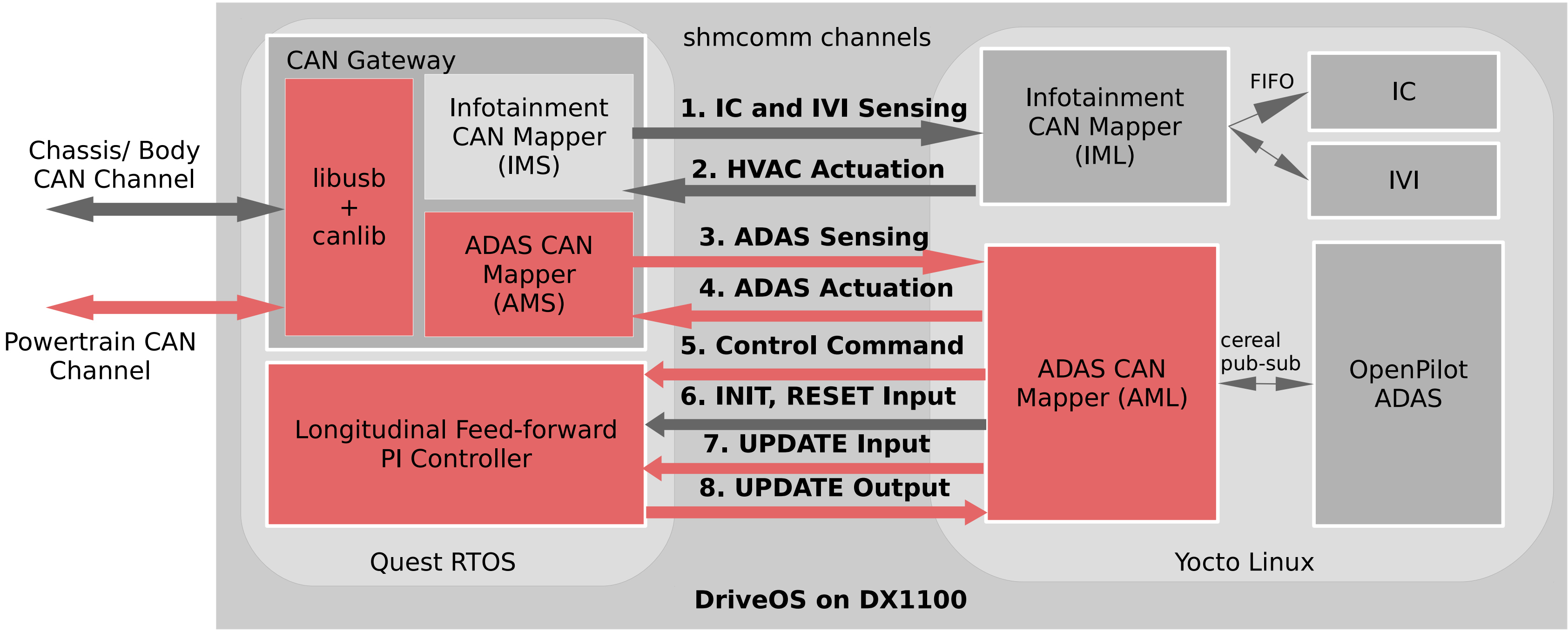
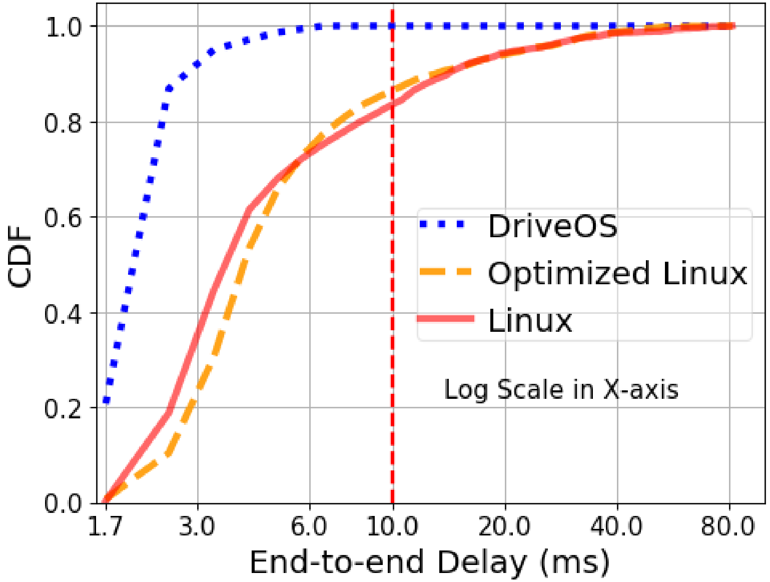
DRIVEOS: EXAMPLE OpenPilot ADAS + IC + IVI

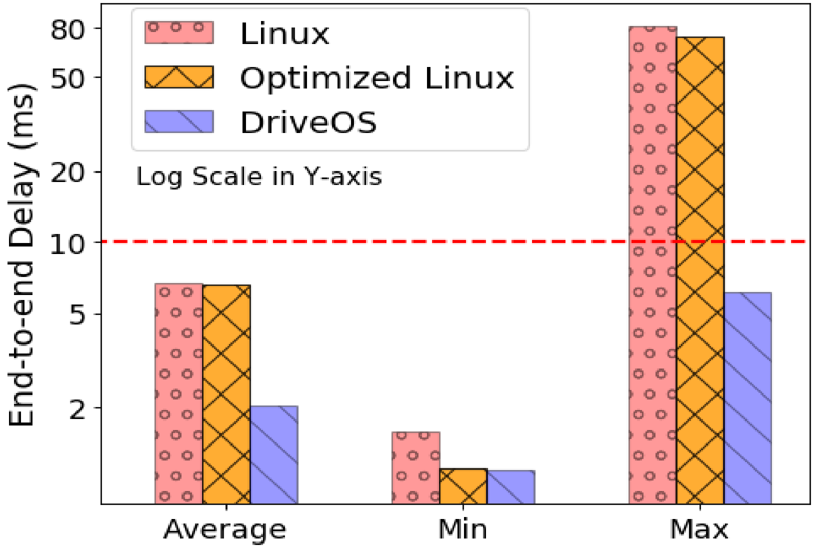


DriveOS: OpenPilot CONTROL LOOP LATENCY

- ADAS Control Loop End-to-end Latency in presence of background Linux tasks

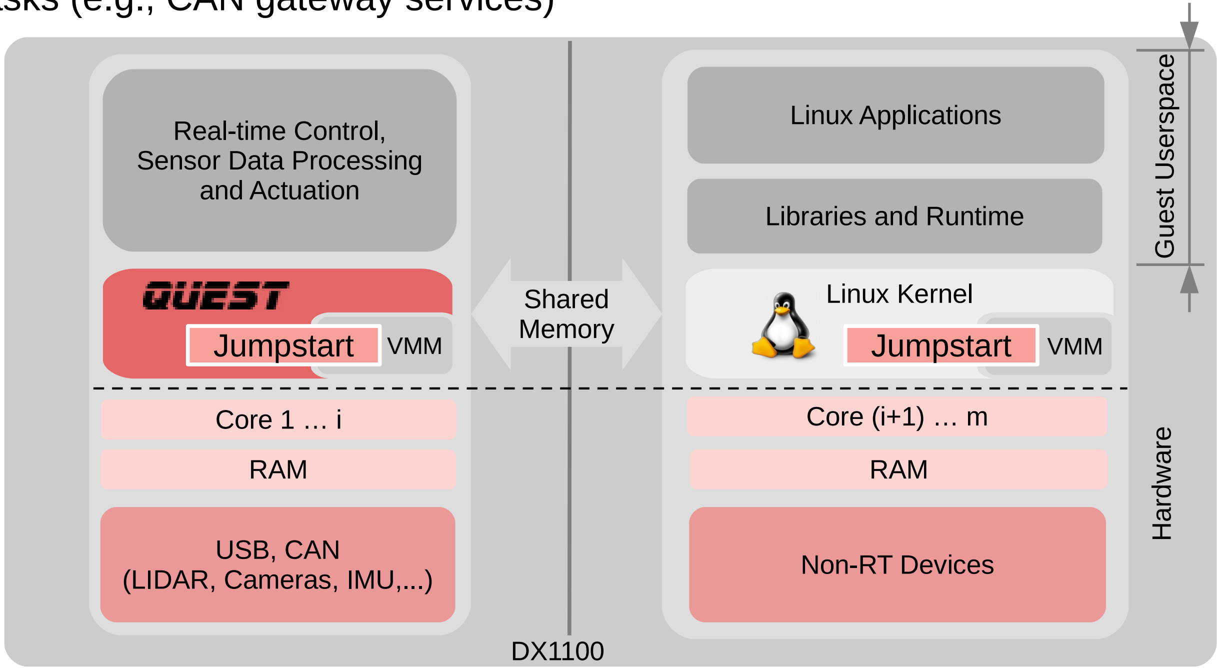
  Target bound = 10ms





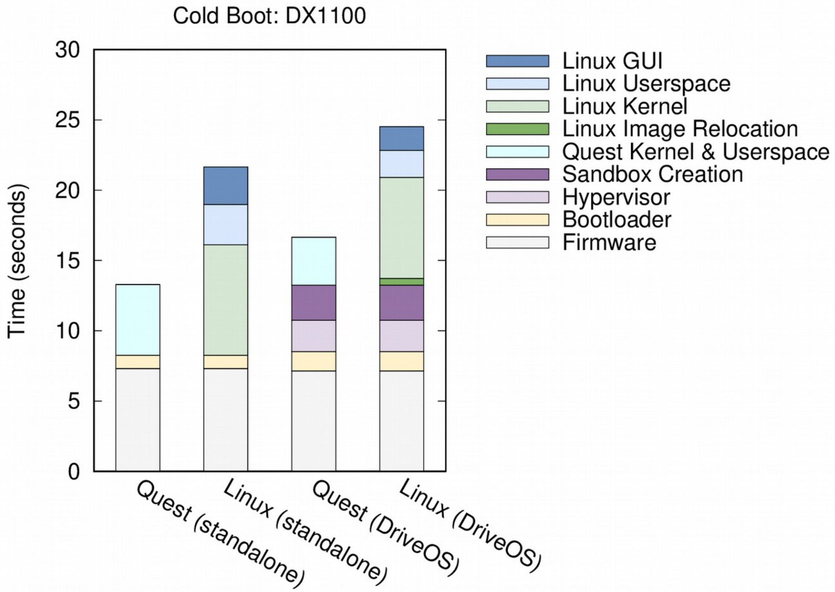
Jumpstart POWER MANAGEMENT

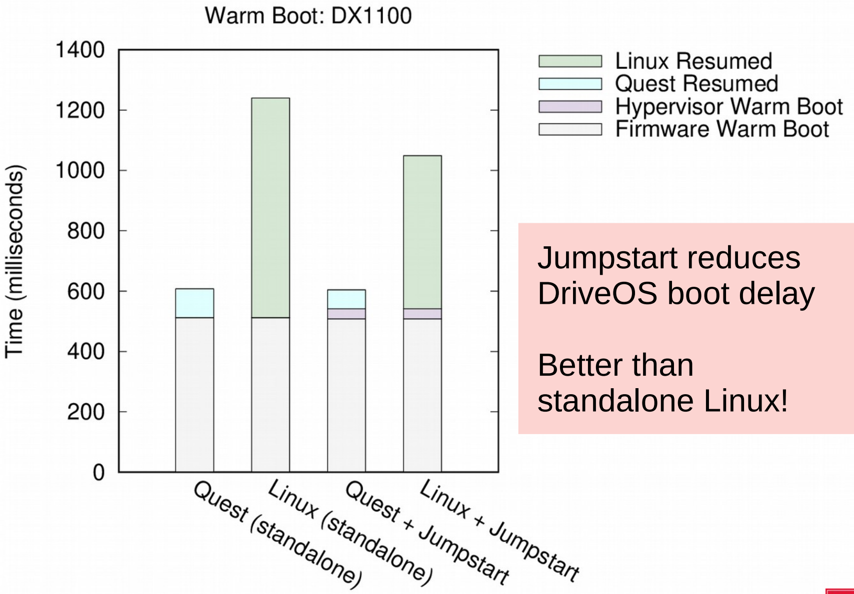
- PC hardware requires Firmware POST, bootloader, device & service initialization to boot OS
- DriveOS uses Jumpstart ACPI S3 suspend-to-RAM & resume-from-RAM for low latency restart of critical tasks (e.g., CAN gateway services)



Jumpstart POWER MANAGEMENT

- Jumpstart services span all guests
  - RTOS coordinates suspension but enables parallel reboot
- Potential for ACPI S4 suspend-to-disk using non-volatile memory (e.g., Intel Optane)
  - Eliminates system power usage during suspension





Jumpstart reduces DriveOS boot delay

Better than standalone Linux!

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CONCLUSIONS

Now is the time to look to alternative hardware + OS automotive solutions

DriveOS uses hardware virtualization for real time temporal and spatial isolation of software functions

+ Multicore PC-class platform replaces ECUs with software tasks
+ Symbiosis between RTOS & legacy OS
+ Real-time I/O & task pipeline processing
+ Fast reboot of critical services on PC-class hardware

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QUESTIONS