Robotics in Space
The move to A.I.

Image courtesy of NASA.

Dr. Fredrik Bruhn,

Adjunct Professor in Robotics & Avionics

fredrik.bruhn@mdh.se

Embedded Systems @ MDH

- 15+17 professors
- 60 researchers (PhDs)
- 80 PhD students
- 14 cooperating research groups

Embedded systems (ES)

Future energy

Innovation and product realization

Embedded Systems Research

- Research volume 105 MSEK per year
- ~80% of research in co-production projects
- 200+ per reviewed publications per year
- 70 on-going projects
  - 80 industrial partners
  - 40 academic partners

One Environment – 6 Research Areas

Embedded Systems @ MDH

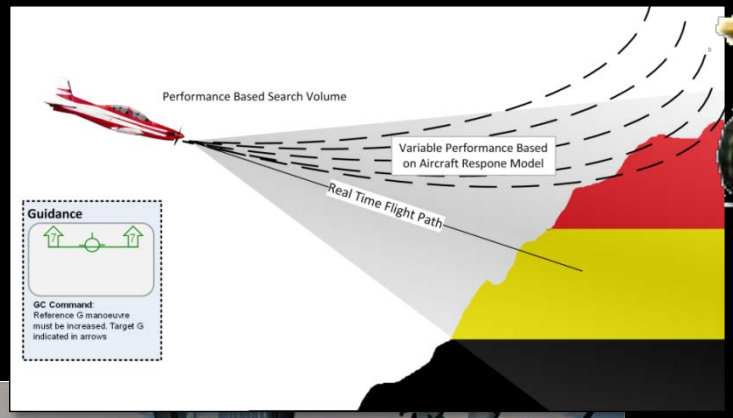
- Dependable systems
- Real-time systems
- Robotics and avionics
- Sensor systems and health
- Software engineering
- Verification and validation

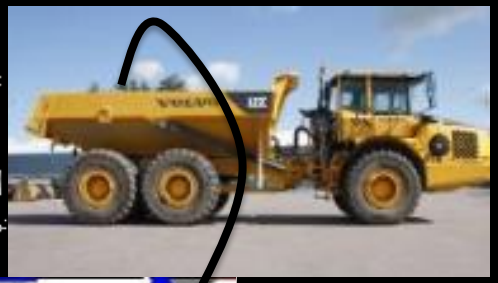
Project ”DPAC”

Dependable Platforms for Autonomous systems and Control

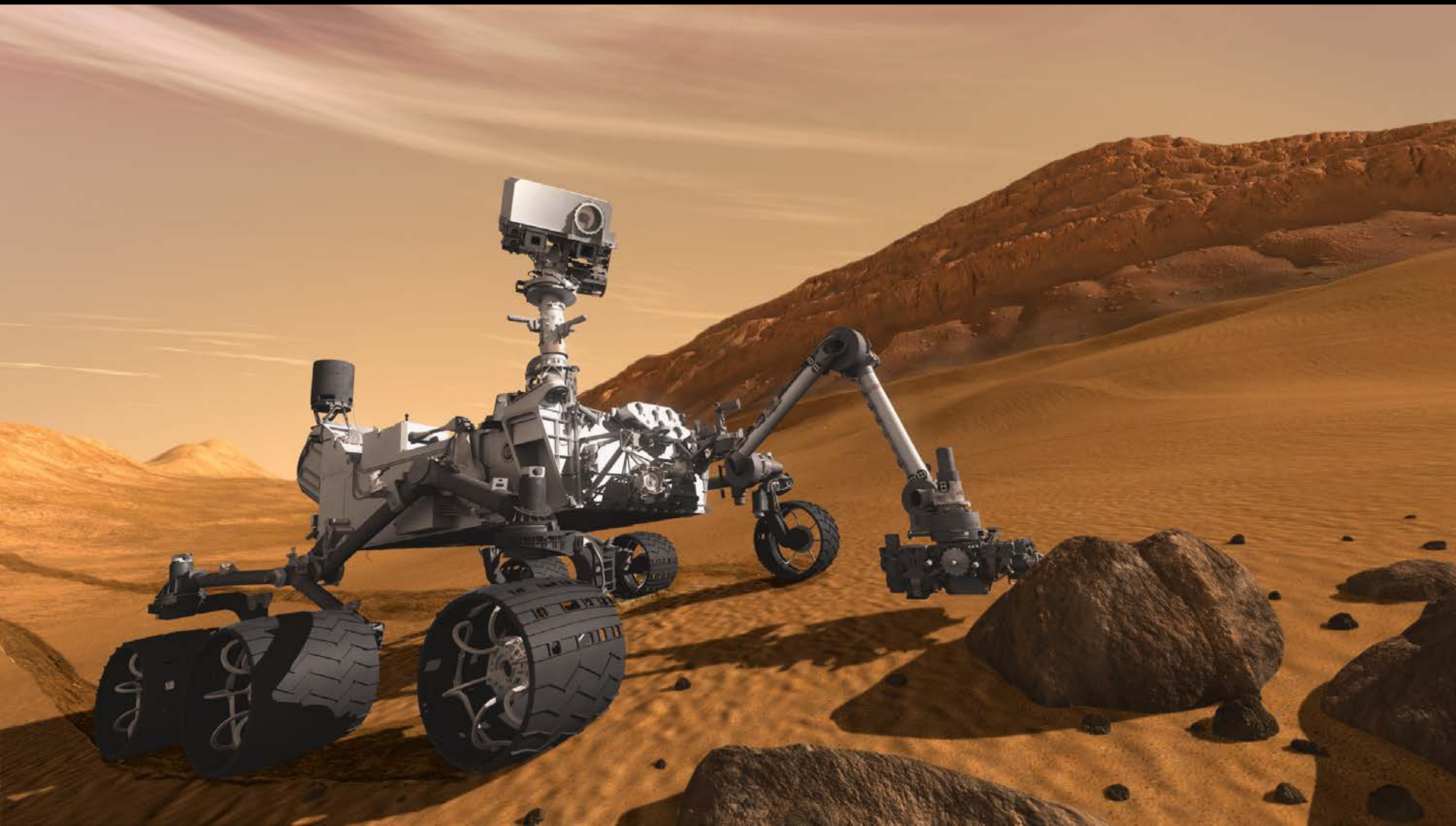
- 8 years, 108 MSEK
- 4 research groups
  - 25 researchers
- 3 sub-project topics
  - *Predictability and dependability in parallel architectures*
  - *Autonomous systems and control*
  - *Design methodologies*

DPAC example challenges

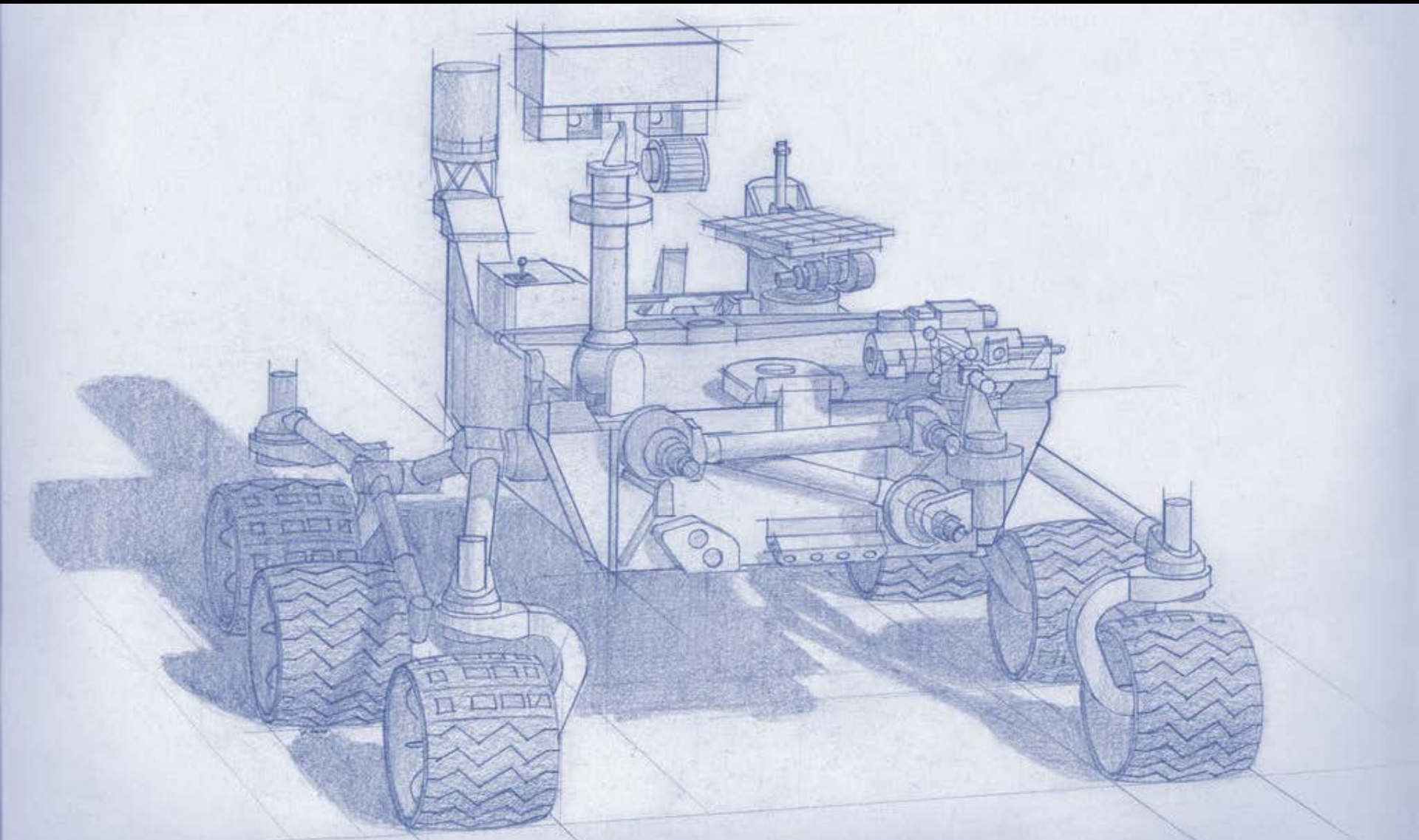




Mars Science Laboratory - Curiosity



Mars 2020 Rover



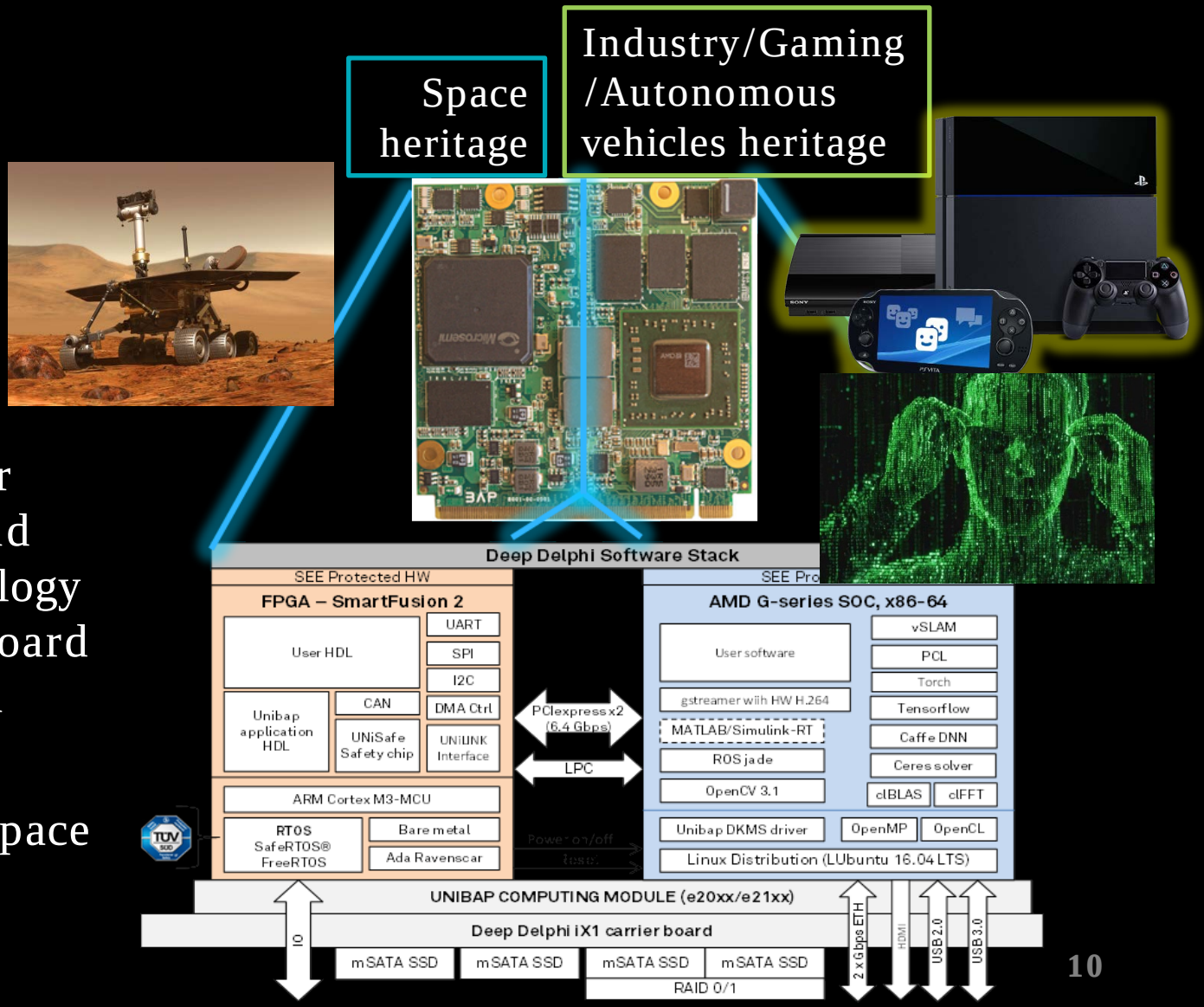
Taking the next step… How?

- Truly autonomous and collaborative systems
- Management of autonomy, mission- path planners
- Reinforced machine learning (AI/Deep Learning)
- Spin-in

0.14 km/h **400x improvement** **55 km/h**

Core technology - Processing

- Successful merger between Space and Industrial technology for advanced onboard processing shown
- TRL-9, flying in space since May 2016.



Choice of 100-1000 GFLOP processing parts

- 17 Mrad! Not a typo
- Commercial semiconductor process
- Enterprise ECC (error correction) through server hardware heritage
- Good for space by co-incidence.
- 100 and above GFLOPs massive computing performance

NASA

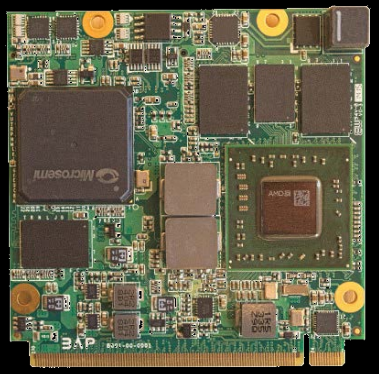
Advanced Micro Devices (AMD) Processor: Radiation Test Results

Kenneth A. LaBel, Martin A. Carts – NASA Goddard Space Flight Center
Robert A. Gigliuto – MEI Technologies
Carl M. Szabo, Jr. – Dell Services Federal Government
Matt Kay, Tim Sinclair, Matt Gadlage, Adam Duncan, Dave Ingalls – NAVSEA Crane

Unclassified

Three generations of mission critical heterogeneous computing solutions

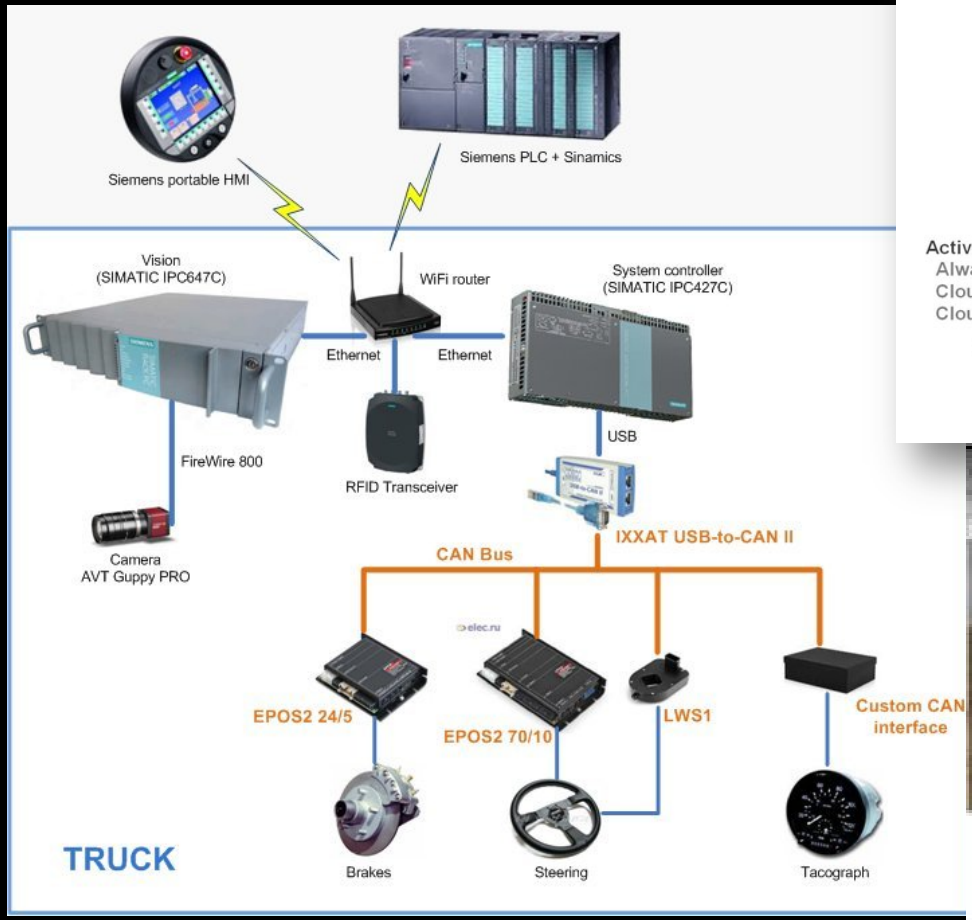
AMD G-series SOC “kabini”, FT3
Microsemi SmartFusion2
Interconnect PCIe x2 v2.0 (10 GT/s)
AMGGPU (CIK=y)

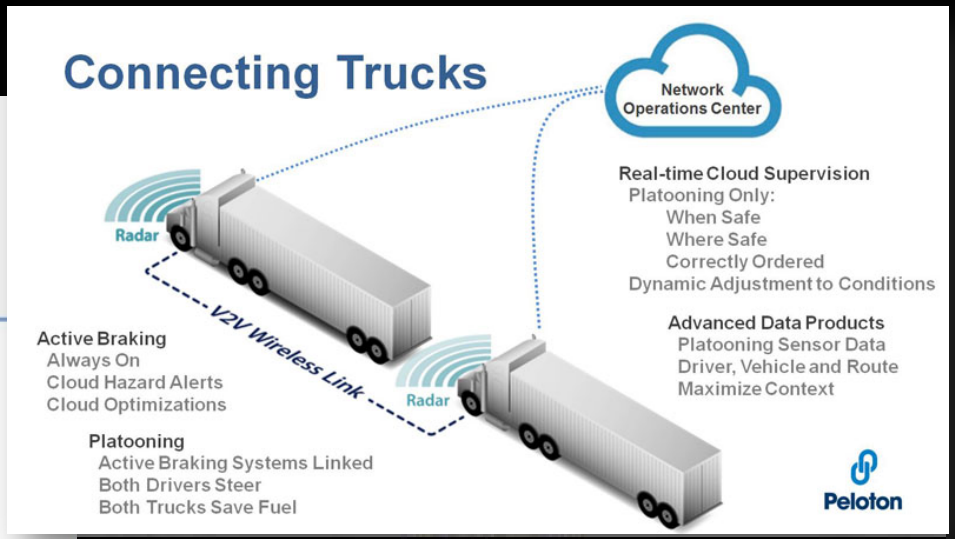


AMD G-series SOC “Steppe Eagle”, FT3b
Microsemi SmartFusion2
Interconnet PCIe x2 v2.0 (10 GT/s)
IOMMU, SVM, AMDKFD, AMDGPU (CIK=y)

AMD R-series SOC “Merlin Falcon”, FP4
Altera Cyclone V GT
Interconnect PCIe x4 v2.0 (20 GT/s)
IOMMU, SVM, AVX2, HSA 1.0

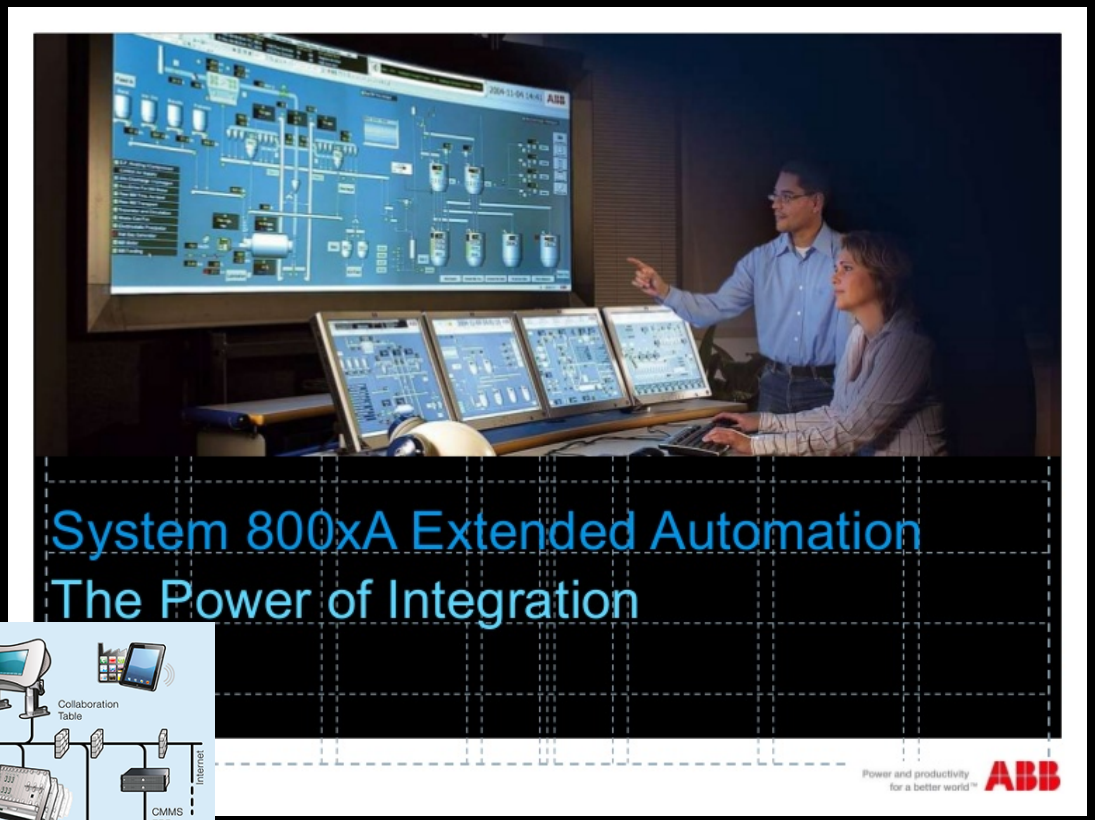
ADAS spin-in

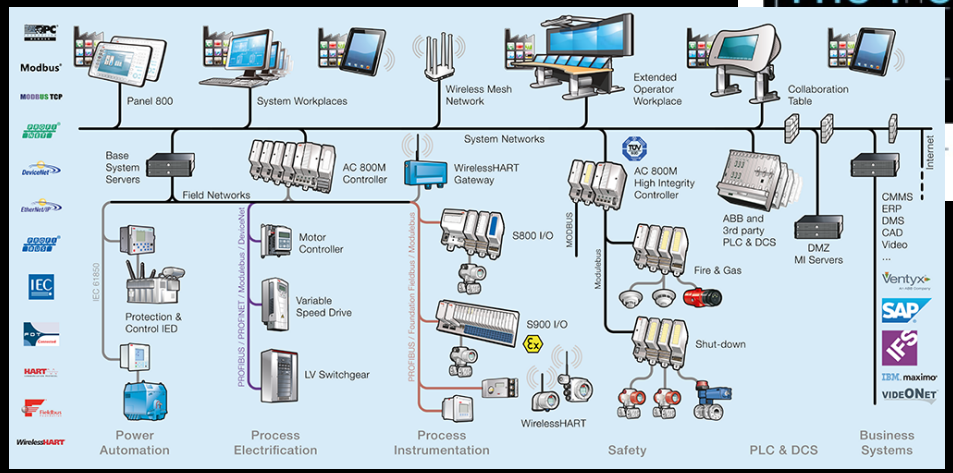

Siemens portable HMI
Siemens PLC + Sinamics
Vision
(SIMATIC IPC647C)
WiFi router
System controller
(SIMATIC IPC427C)
Ethernet
Ethernet
FireWire 800
RFID Transceiver
USB
Camera
AVT Guppy PRO
IXXAT USB-to-CAN II
CAN Bus
EPOS2 24/5
EPOS2 70/10
LWS1
Custom CAN
interface
TRUCK
Brakes
Steering
Tacograph


Connecting Trucks
Network
Operations Center
Real-time Cloud Supervision
Platooning Only:
When Safe
Where Safe
Correctly Ordered
Dynamic Adjustment to Conditions
Advanced Data Products
Platooning Sensor Data
Driver, Vehicle and Route
Maximize Context
Radar
V2V Wireless Link
Radar
Active Braking
Always On
Cloud Hazard Alerts
Cloud Optimizations
Platooning
Active Braking Systems Linked
Both Drivers Steer
Both Trucks Save Fuel
Peloton


RoadNex v2.2 Desert track

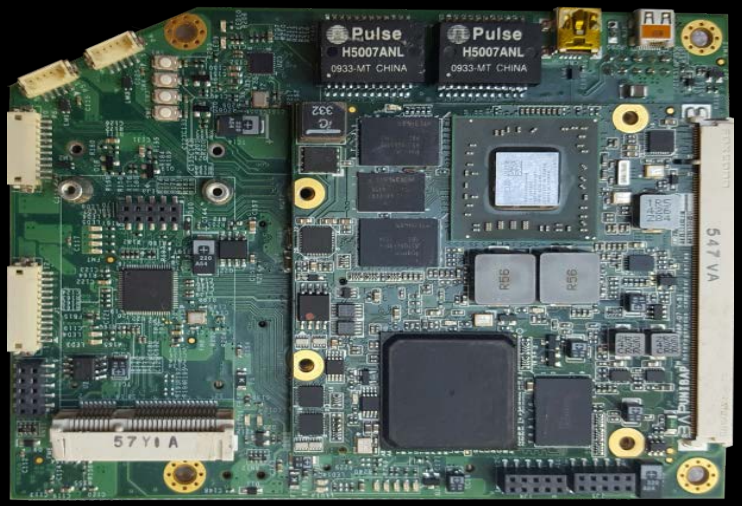
Control technology spin-in





Collaborative robotics spin-in

Derived A.I. solutions in LEO



25 Mpixel CMOS
32 object tracking

- Data extraction in orbit
- Data mining in orbit

MÄLARDALENS HÖGSKOLA
ESKILSTUNA VÄSTERÅS

Are we moving? 2024?

Thank you!

Questions ?

fredrik.bruhn@mdh.se