Red Hat Enterprise Linux

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Red Hat Car OS Approach

10th March 2021

The power of open

Red Hat

To face the **industry paradigm shift** …

The Advent of "CASE/ACES"

The software content of modern **Autonomous, Connected, Electrified and Shared vehicles** grows exponentially, making feature-rich & high-performance operating systems necessary.

New E/E in-vehicle architectures

OEMs are moving towards a centralized E/E architecture with **only a few powerful central computers** supplemented by **re-usable and rapidly integrated software components** that are driving standardization of the underlying platform.

New OS, middleware & cloud technologies

Virtualization and containerization are getting common within todays' OS. With the success of open source, **Linux** is getting traction in the Automotive Industry.

New tech players vs established OEMs

Nowadays, established OEMs are trying to **significantly expand the capabilities of their own vehicle software development**, following the example of new software-driven players like *Tesla*.

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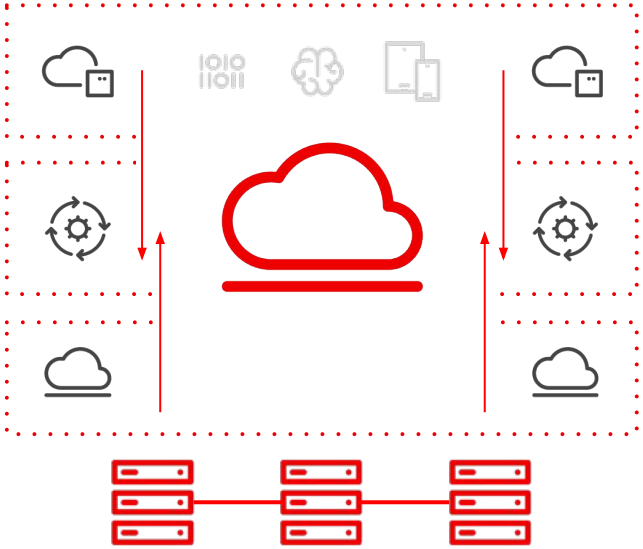
… **open source** and **open architectures** are recommended.

From **vertically integrated** dedicated point solutions…

Dedicated point solutions

…to continuous **open source & interoperable** innovation.



Continuous open source innovation

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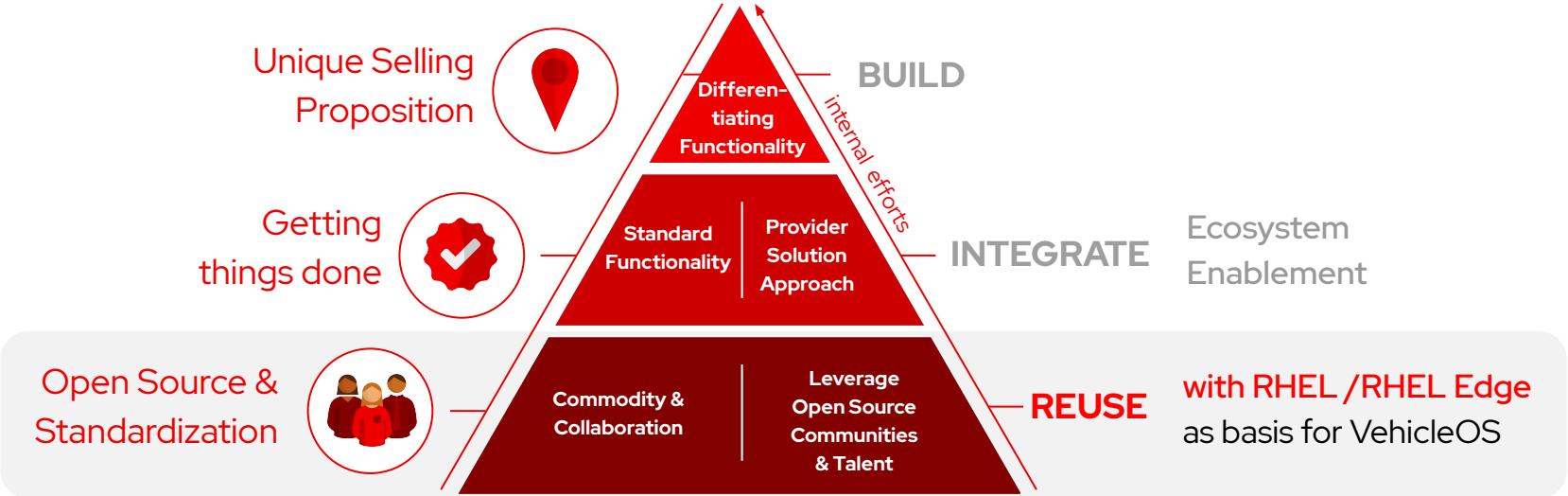
Our Open Source approach is a basis for **differentiating business functionality**



- avoid **vendor lock-in** & **dependencies** → increase **flexibility** & **scalability**
- reduce **bottlenecks in resources** → increase **availability** & **attractiveness of talent**
- support **cooperation** and **handle antitrust law** → increase **standardization, reuse** & **efficiency**
- support digital transformation by **open source** → increase **innovation speed** by maintaining legacy integration

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We have a proven **Enterprise Subscription Model**.

Product Approach: What are we doing for you DOWNSTREAM?

Stable technology

- Hardened & tested enterprise software
- Kernel stability guarantee
- Quality engineering / Distributed CI

DevOps experience

- Technical support
- Award-winning customer portal
- Training

Safety & Security

- Security, stability, reliability
- Product safety
- Supply chain

Life cycle

- Subscription model
- 10+ years extended support
- Regular upgrades

Open Source Standardization: What are we doing for you UPSTREAM?

- Upstream leadership
- Advocacy for your requirements in the open source projects

- Ecosystem of hardware, software, cloud, & service partners
- Safety, security & compliance certifications

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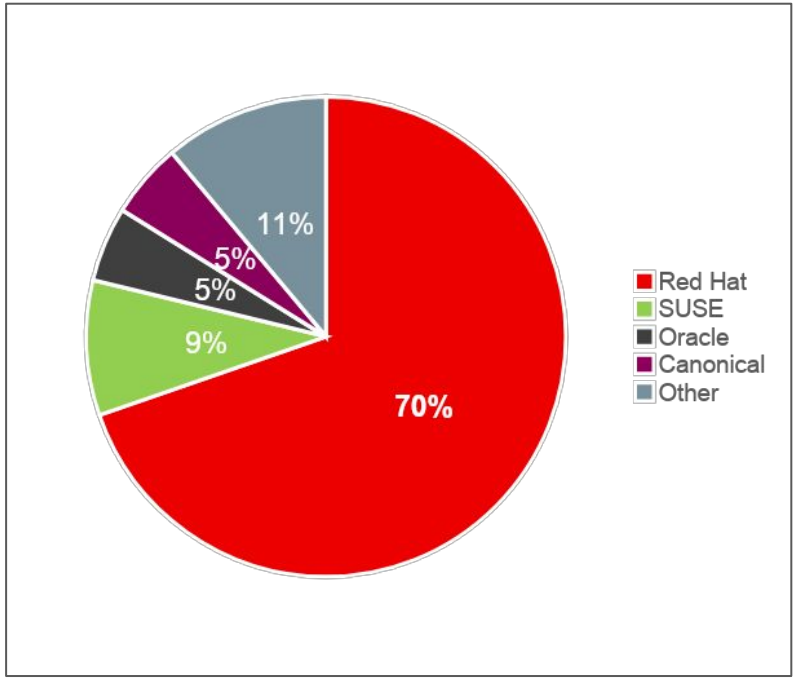
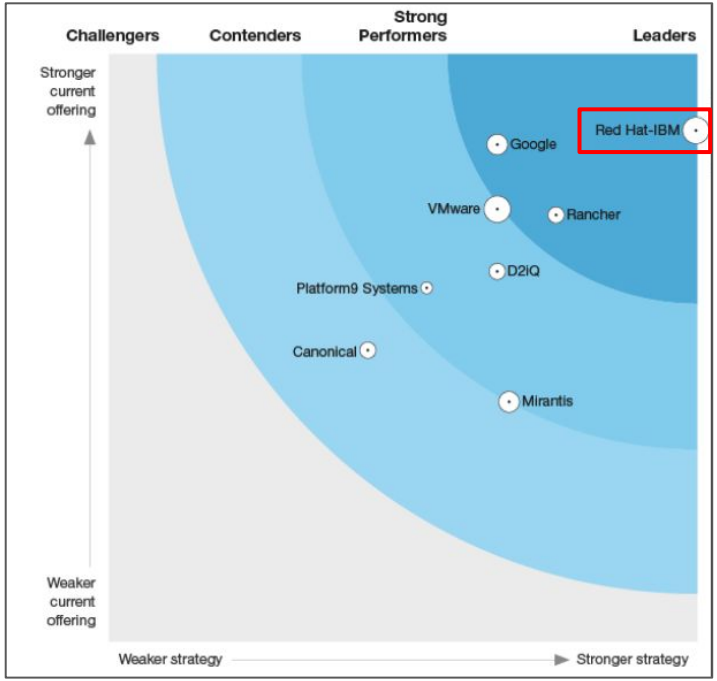
We are the **market leader** for linux & container platforms

Paid Server OS Revenue Share -
Paid Linux (2019) $2.7B[1]



The Forrester Wave Study Q3/2020
Multi Cloud Container Development Platforms[2]



> 2600 OpenShift customers

Sources:

1. Gartner Forecast: Infrastructure Software Markets, Worldwide 2019 Q4
2. Forrester Research Inc Study Q3: https://www.redhat.com/en/resources/forrester-wave-multicloud-container-platform-analyst-material

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We leverage the **experience from the telco industry** bringing custom hardware and disparate systems to a single, open platform.

Custom hardware

Monolith application

Custom ASIC
Custom RTOS
Monolithic app
(dozens per car)

Meteorcomm
Interoperable positive train control communication system

Network appliance

Monolith application

Semi-custom SoC
OS diversity
Monolithic app
(dozens per car)

Verizon
launches an industry-leading large OpenStack NFV deployment

Virtua-lization

Monolith app with virtual machines

Semi-custom SoC
OS diversity - Modular app components
(10-20 per car)

Rakuten Mobile
E2E cloud-native mobile network with open source tech

Software Defined Networking / Network Function Virtualization

WE ARE HERE

Private cloud with virtual machines

Virtual machines

Standard SoC
RHEL ecosystem
Containerized apps
(2-12 per car)

Private or public cloud

Microservices in containers

Standard SoC
RHEL + OCP
Containerized apps

We can do that again, faster. Automotive already primed with Linux demand, but lacks standardization.

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We start with the customer-centric **Connected Car Vision**

"An **enterprise-hardened open source layer** to run workloads spanning from offboard to onboard, by using a **light container management solution on a CarOS**."

Vehicle Onboard			Vehicle Offboard and Cloud		
ADAS/AD	Infotainment	Real Time AI	Backend	Ecosystem	Applications

Linux, Containers, Middleware & Microservices

Vehicle HW Platforms | Edge | Public Clouds | Private Cloud | On Prem

BUILD ONCE. DEPLOY ANYWHERE.

onboard or cloud related application enables **new kind of services** and their **scalability** across any **workload** – any **footprint** – any **location** - any **provider.**

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Edge computing is an integral part of our open hybrid cloud strategy

Develop once, deploy anywhere	Meet diverse use cases	Consistent operations

Red Hat Product Portfolio

Red Hat OpenShift

Red Hat Enterprise Linux

Red Hat Ansible Automation

Vehicle

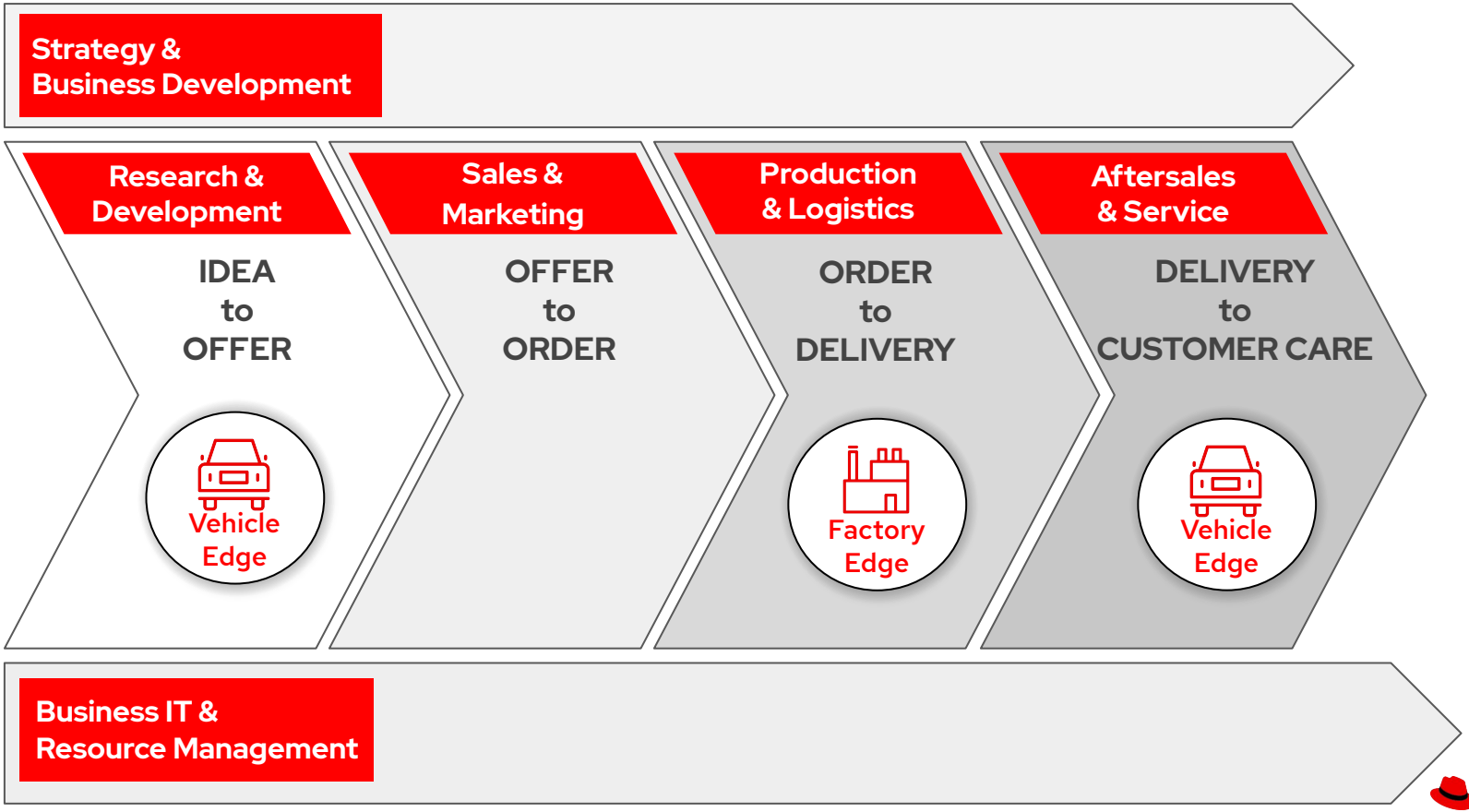
Bare metal cluster

Infrastructure virtualization

Public/private cloud

Source: https://www.redhat.com/en/topics/edge-computing/approach

Automotive Value Chain



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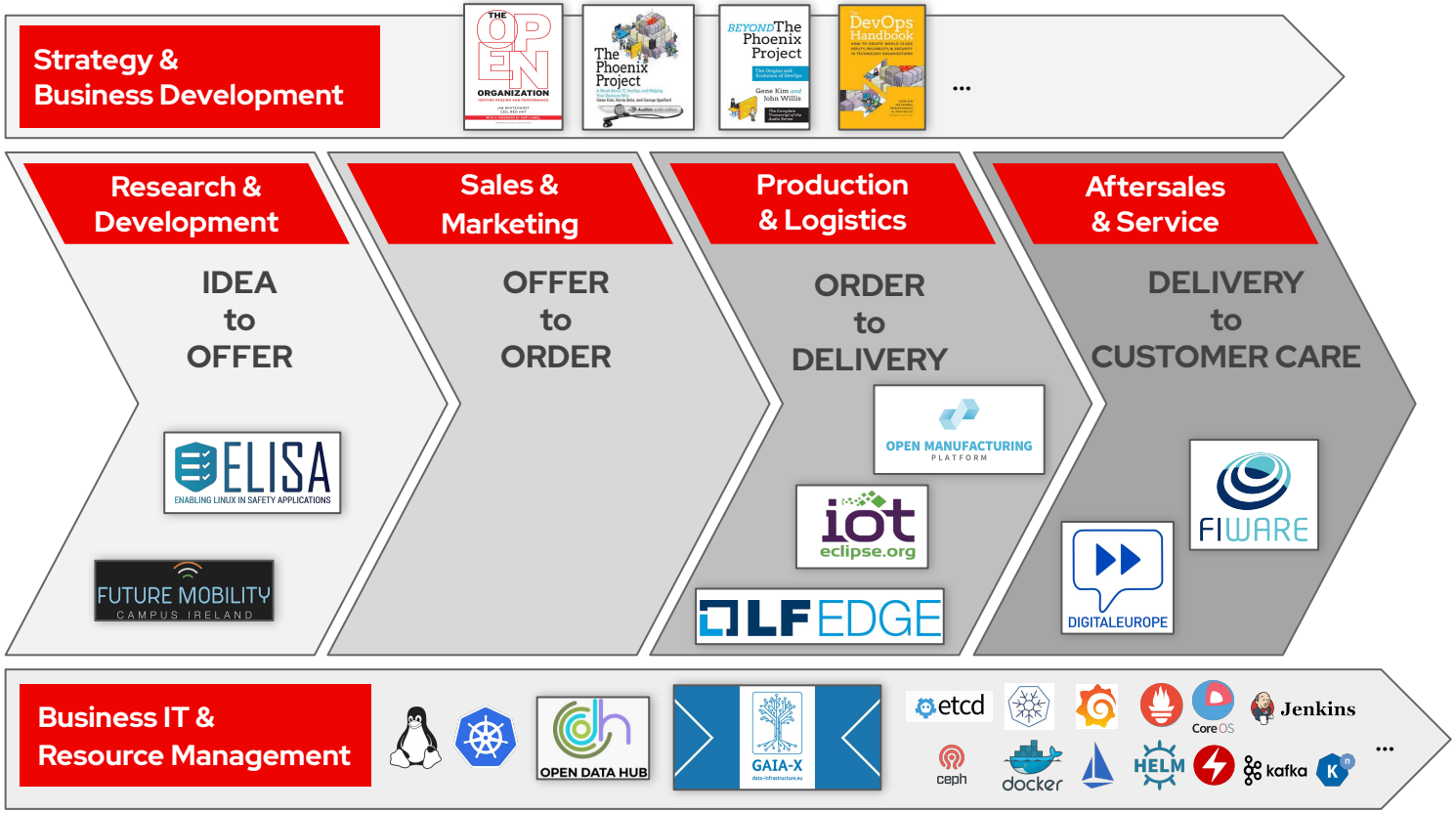
Open Source Standardization within Automotive Chain



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Automotive Value Chain with Success Stories

Strategy & Business Development

Research & Development

IDEA to OFFER

ZF
ADAS Platform

Sales & Marketing

OFFER to ORDER

Production & Logistics

ORDER to DELIVERY

Aftersales & Service

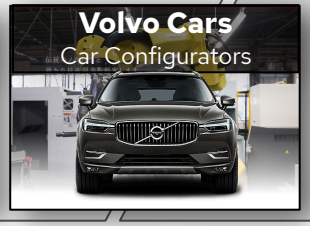
DELIVERY to CUSTOMER CARE

Omnitracs
Fleet Management

BMW Group
Autonomous Driving

Volkswagen
Virtual Testing

Volvo Cars
Car Configurators



VW Plant Zwickau
Plant Service Bus

Asahi Tekko
Production Optimization

Corporate IT & Resource Management

BMW
Cloud Native Platform

BOSCH
Private/ Hybrid Cloud

FORD
Hybrid Cloud

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Overview of Red Hat Automotive Use Cases

Update 2021

Strategy & Business Management

- Digital Leadership
- Open Innovation
- IT and Cloud Strategy
- Open Source Strategy
- New Business Opportunities

Research & Development

- Advanced Driver Assistance Systems, Autonomous Driving
- Virtual Testing for Automotive Dev
- Engineering Lifecycle Mgmt
- Software defined vehicle and Embedded IT
- Engineering Workplace
- High Performance Computing

Sales & Marketing

- 360° Customer Journey, Multichannel
- Car Configurators
- Global Ordering Platform
- Dealer Management Systems and Workplace

Production & Logistics

- Factory Edge, IoT Platform
- Manufacturing Execution System
- Plant Service Bus
- Smart Logistics and Supply Chain

Aftersales & (Mobility) Services

- Connected Car Services (Backend)
- On Demand Mobility
- Fleet Management
- Vehicle Over-the-Air-Update and predictive maintenance

Information Technology

OPS:
- IaaS
- CaaS, PaaS
- Hybrid, Multi Cloud
- Linux Platform
- Identity Platform
- IT Auto-mation

DEV:
- App, Legacy Modernization
- Next Gen Architectures
- SAP Trans-formation
- DevOps Efficiency
- Middleware & Integration
- API Management

- Artificial Intelligence, ML
- Data Analytics and Platforms
- Cyber Security
- Blockchain

Resource Management (e.g. Finance, HR, Procurement)

- Open Source Contribution Policy
- Free Open Source SW Compliance
- Robot Process Automation
- Finance Solutions and Leasing

Agile Trans-for-mation

Biz Dev Ops

Open Culture

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We see synergies between **Vehicle Onboard and Offboard**

Vehicle Onboard

Customer Touch Points
(mobile, website, call center, dealer, third party, ...)

In-Vehicle Platform

Infotain-ment | ADAS/ AD | ... | Basis Central

Basis for Vehicle OS as part of Software Platform

Hardware platform

Focus for today based on **Red Hat** Enterprise Linux

podman

Connected Vehicle Network Edge

Edge Services Platforms
(owned by 3rd Parties, Telecoms, ...)

Red Hat Middleware
AMQ, FUSE, ...

APACHE Camel

kafka

Vehicle Offboard and Cloud (runs on AWS, Azure, Alibaba, ...)

Vehicle Operation & Security Center

Vehicle Services Platforms
(customer centric)

OEM Apps | Supplier Apps | 3rd Party Apps

Connected Vehicle Platform(s)
(vehicle centric)

Multi Cloud Management

Basis for flexible & distributed services

Engineering Platform & Software Factory
collaboration & communication with Tier 1, .., n

Requirements & Systems Engineering	System & Software Testing
DevOps & Continuous Integration	Artificial Intelligence in Engineering
ELM & Integration to PLM	Data Management (for ADAS/AD)

Enterprise IT & other Business Lines

Red Hat OpenShift

Red Hat Quay

Red Hat Advanced Cluster Management

RED HAT CODEREADY

okd

Project QUAY

ditto

Jenkins

argo

OPEN DATA HUB

...

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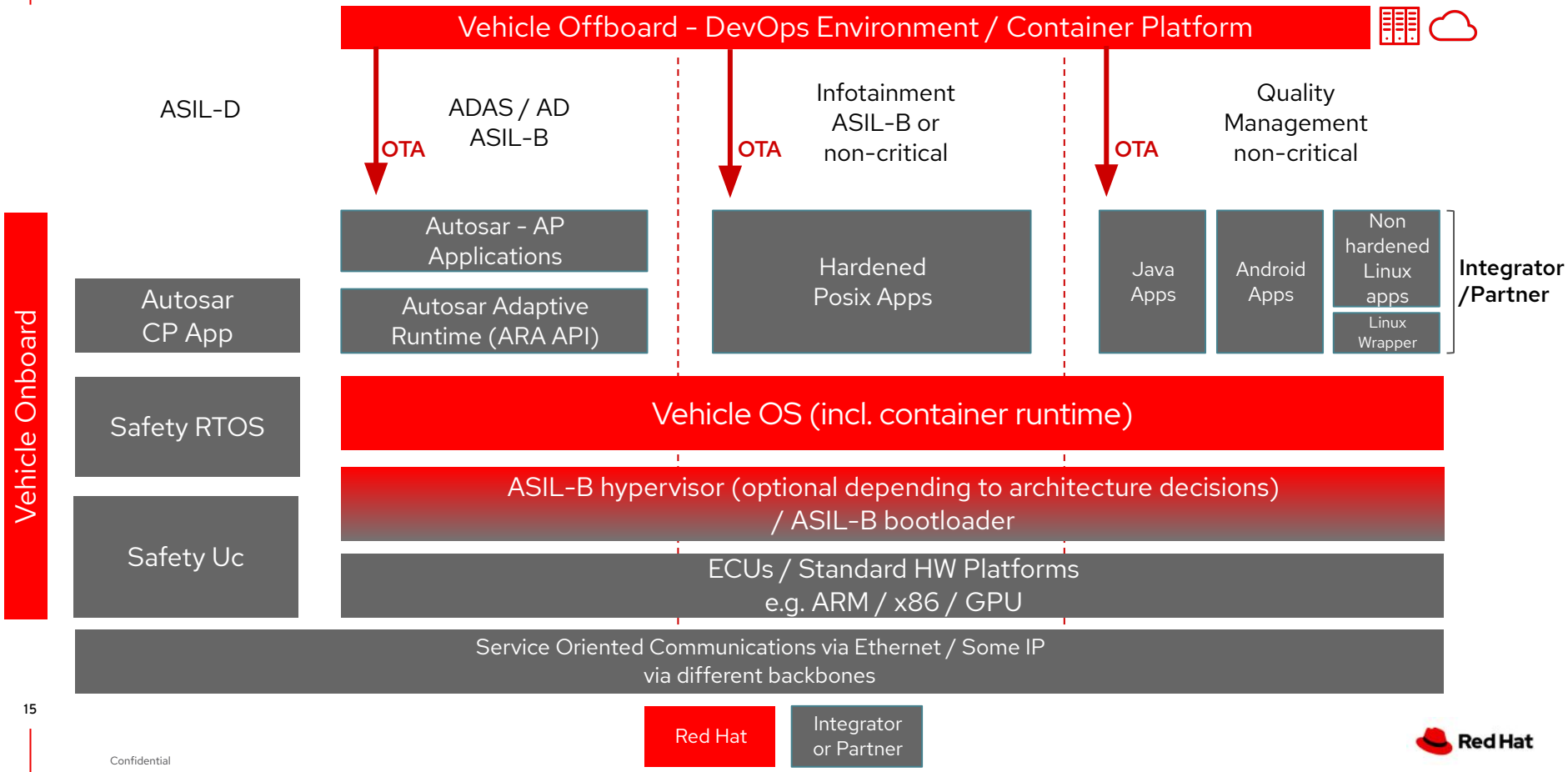
Vehicle Onboard Overview



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Four dimensions of the Red Hat Car OS Approach

1. Technical / Base System

- Platform Standards (Linux Kernel, Glibc, ...)
- Smaller Footprint, Realtime, faster boot time, ...
- Hardware Support (ARM, x86, ...)
- Container Usage (lightweight approaches)
- ...

2. Qualification (incl. certification)

- Functional Safety ASIL-B, ISO 26262
- Cybersecurity / ISO 21434
- ASPICE / Process Qualification
- Certification Bodies
- ...

3. Tooling & Process for Safety App Dev

- Joint agile development / DevOps sprint cycles
- Open Source Software [OSS] Governance
- Release Management Process & Traceability
- Establish Test Framework
- Integration/Handling of existing tools (e.g. Yocto)

4. Business Model & Go to Market

- Ecosystem
- Partners
- Legal & Liability
- Pricing
- Business Case & Marketing

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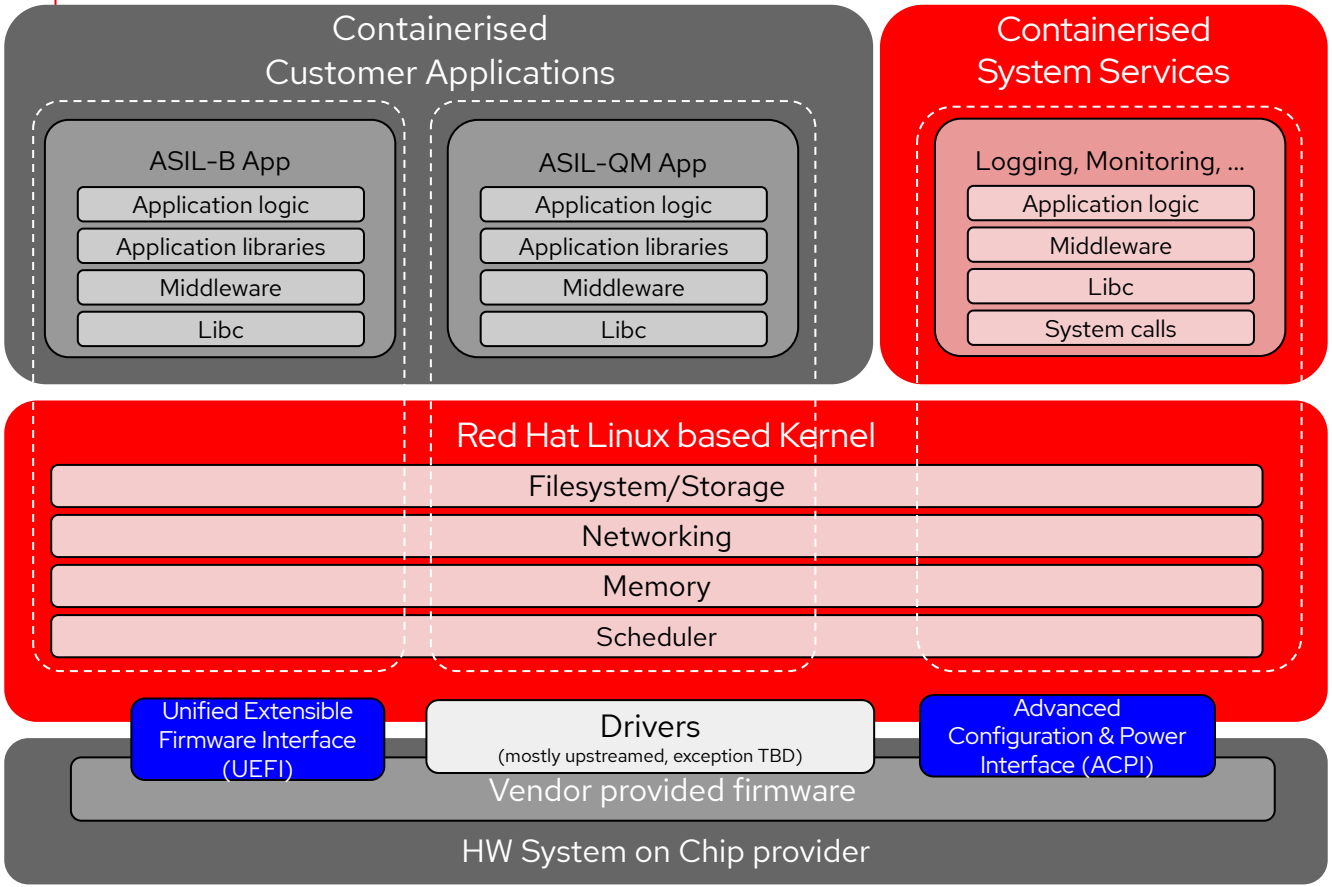

- Applications are isolated using containers. Those technologies are cross cutting across Kernel and resources it manages (memory, networking, etc.)
- All needed dependencies, including Red Hat provided runtime libraries, third party MW and application specific libraries are packaged in containers
- System related services, both ASIL-B and ASIL-QM, are also packaged as containers. Those will have access to system calls and might have more privileges depending on purpose and use.
- The interfaces for system services (events monitoring and such) closely connected to HW have to be described and standardized

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