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DRIVING EMBEDDED EXCELLENCE

RTA-VRTE

Adaptive AUTOSAR Open Seminar

Overview

1. Adaptive AUTOSAR Overview
- Functional challenges to E/E Architectures
- Technical challenges
- Characteristics of ECUs
- Adaptive and Classic

2. Architecture
- Service Orientation
- Logical Architecture
- Functional Clusters
- APIs

3. Methodology
- Common Software Architecture
- Applications from development to deployment

4. Vehicle Computing with the Adaptive Platform
- Execution Management
- Communication Management

5. RTA-VRTE
- Motivation
- Early Access Programme
- Demonstration

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Adaptive AUTOSAR Overview

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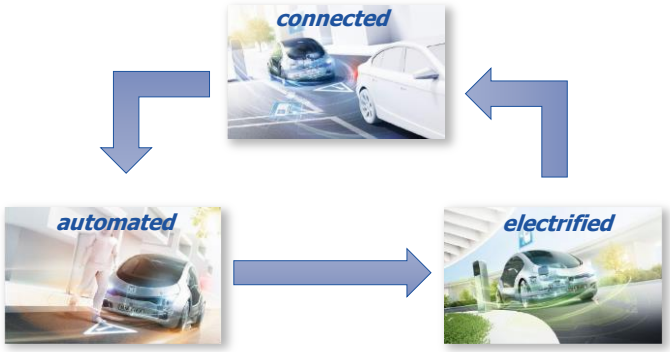
Automotive Software and its Unique Challenges – Trends Impacting the EE Architecture

- SW is critical to the modern vehicle
- AUTOSAR Classic Platform developed to support SW adoption
  - Hard Real-time, High Safety, Limited resource ECUs
- But we need more flexibility for tomorrow's challenges:
  - **C**onnectivity
  - Highly **A**utonomous driving
  - **S**hared ownership (mobility as a service)
  - **E**lectrification



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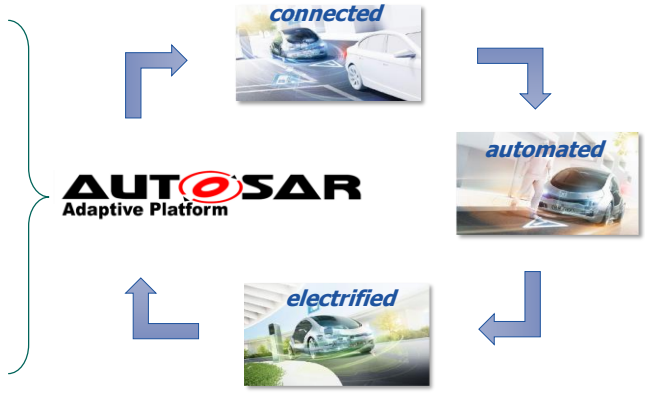
Addressing the Challenges – Adaptive AUTOSAR Platform

- High performance computing
  - Many core architectures
  - Intra-application parallelism
- High bandwidth (switched) communication
  - Ethernet
- Large data
  - External memory (file system)
- Heterogeneous architectures
  - Specialized co-processors



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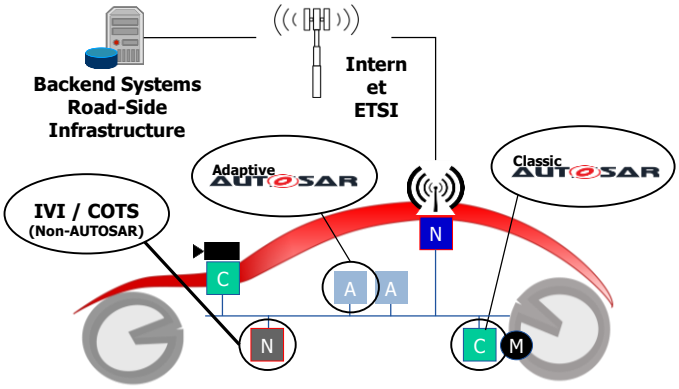
Adaptive and Classic – Coexistence Not Replacement

- Adaptive and Classic AUTOSAR will co-exist within a vehicle
  - Adaptive ECUs support dynamic SW change, highly parallel architectures
  - Classic ECUs for high safety, real-time SW within a severely resource constrained ECUs
- Adaptive ECUs <10% of ECUs within vehicle
  - A high-end vehicle might have ~120 ECUs of which 5-10 might use Adaptive ECUs



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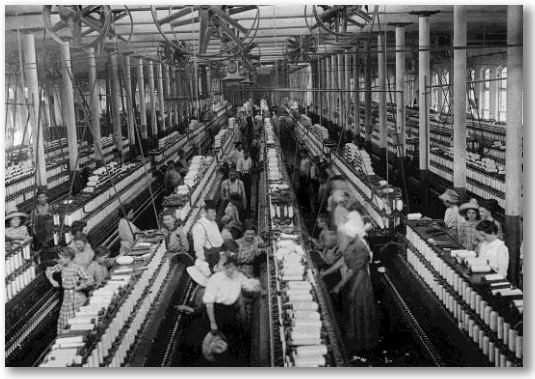
The Productivity Paradox… and Why It Means the AUTOSAR Adaptive Platform Exists



Magnolia Cotton Mills Spinning Room
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Jacquard Knitting Machines, SIVA
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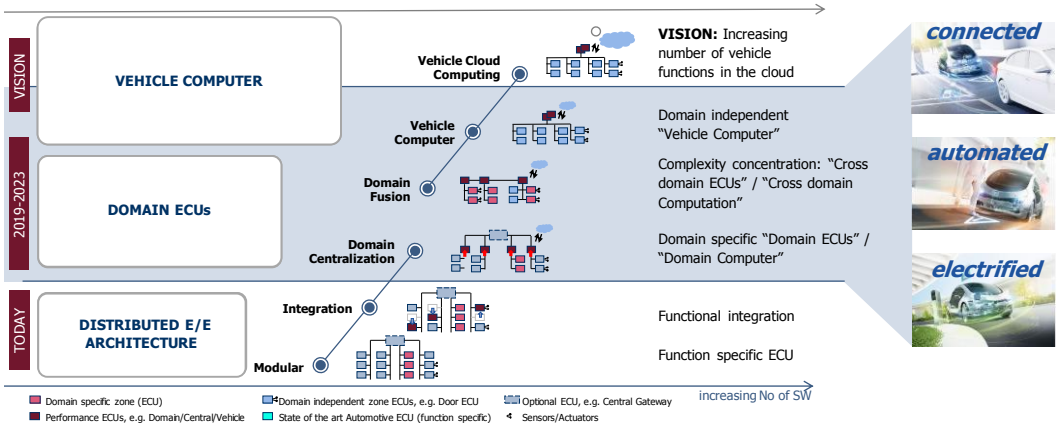
New Features Require New Architectures Require New ECU Designs



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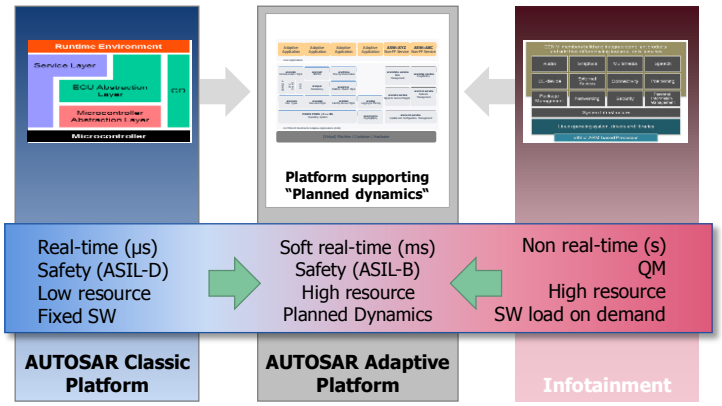
So Why Develop a new Platform?

- The **Adaptive AUTOSAR** Platform (AP) is designed to bridge the gap between Classic Platform (CP) and Infotainment

- AP Characteristics?
  - Soft real-time
    - Deadlines in ms range
  - Some safety requirements
    - ASIL-B
  - High resources
    - Micro-processor
    - Dynamic OS
  - SW Update
    - Planned Dynamics



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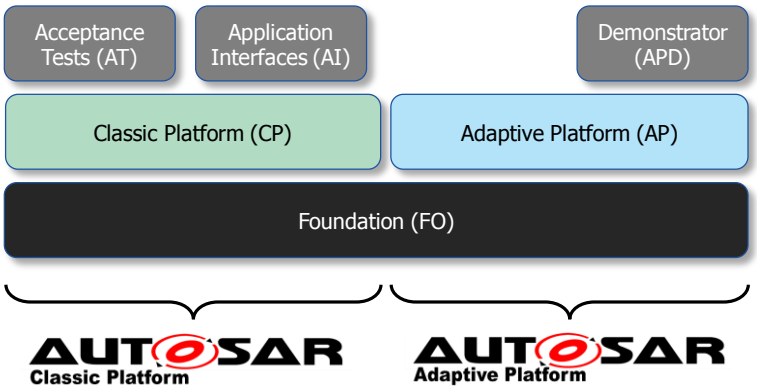
Adaptive and Classic Platforms

- Independent platforms with a common foundation (FO)

- Adaptive Platform (AP) does **not** replace Classic Platform (CP)

- Both CP and AP are in active development
  - Simultaneous release in October 2018.
  - AP18-10
  - R4.4.0
  - Further simultaneous release in 2019



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Foundation as Common Requirements

Requirement	Classic?	Adaptive ?	
[RS_Main_00001] … support deeply embedded systems	✓	✗	A "classic" automotive ECU
[RS_Main_00002] … support high performance computing platforms	✗	✓	A high performance ECU uses Adaptive AUTOSAR
[RS_Main_00400] … provide layered software architecture	✓	✗	The AUTOSAR architecture we know (and love?) is only applicable to the Classic platform
[RS_Main_00150] … support deployment and reallocation of Application Software	✓	✓	Both platform use same configuration language (ARXML) but different semantics
[RS_Main_00060] … provide standardized software interface for communication between Applications	✓	✓	The same requirement can be applicable to Classic and Adaptive but result in very different implementations

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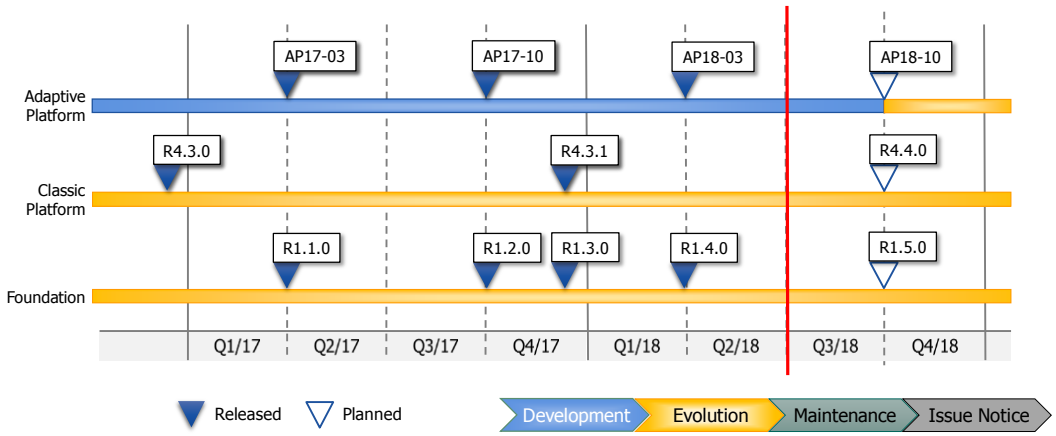
Independent Release Schedule



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Release History and Plans

- **Adaptive Platform specification(s)** are in development
- 2017-03 → First "draft" release
  - Subject to change based on experience and feedback
- 2017-10 → New Features
- 2018-03 → API Stability
- 2018-10 → First "full" release
  - First release with "non-draft" elements
  - Synchronized with CP R4.4
- **Adaptive Platform Demonstrator** developed in parallel with specifications
  - Same release cadence
  - Typically 1-month later
- Not a reference implementation!
  - Aid understanding
  - Validate specifications
  - Explore implications before specifications
- Exploit existing (non-automotive) technologies

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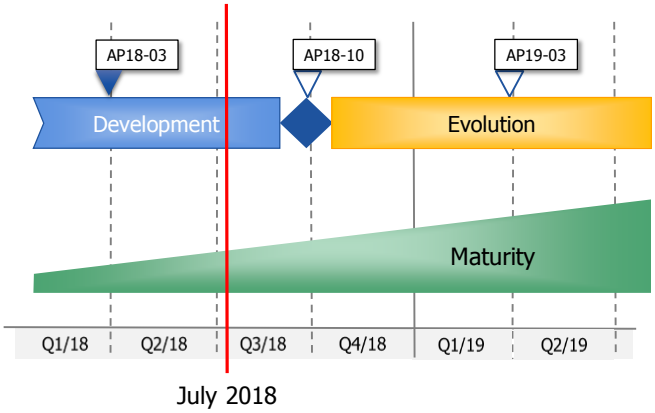
Adaptive Platform Maturity

- AP18-10 is the first "full" release of the Adaptive Platform
  - Synchronized with CP R4.4
- First release with "non-draft" specs
  - Mature concepts are "release"
  - Specification & implementation
- Specifications will continue to evolve
  - Bugs will be identified and fixed
  - Draft items will be released as their maturity improves
  - New concepts will be specified and implemented
- Process mirrors Classic Platform development process



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Adaptive Platform… Comparison with Classic

AUTOSAR Classic Platform	AUTOSAR Adaptive Platform
Single address space (MPU support for safety)	Virtual address space for each application (MMU support)
Statically configured signal-based communication (CAN, FlexRay)	Dynamically configured service-oriented communication
Based on OSEK	Based on POSIX (PSE51)
Execution of code directly from ROM	Application is loaded (on demand) from persistent memory into RAM
Statically defined task configuration	Support of multiple (dynamic) scheduling strategies
Specification	Specification as binding Standard, Code as Demonstrator

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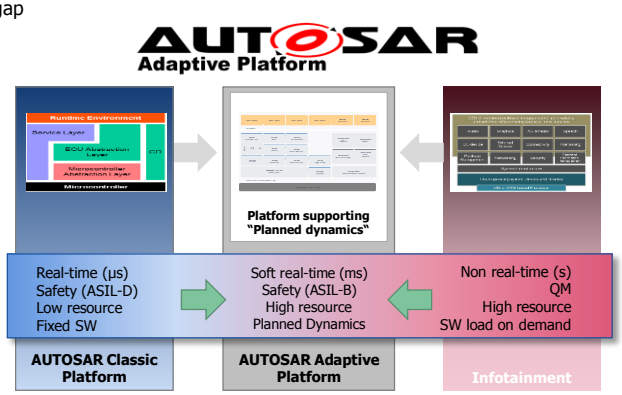
Summary

- AUTOSAR Adaptive Platform designed to bridge the gap between the Hard real-time classic and the non-RT infotainment worlds
- Planned Dynamics
  - Applications
  - Communication paths
- Service Oriented Communication
  - Offer, Discover, Call
- Adaptive and Classic co-exist
  - Common foundation
  - Simultaneous release (2018-10, 2019, …)



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Architecture

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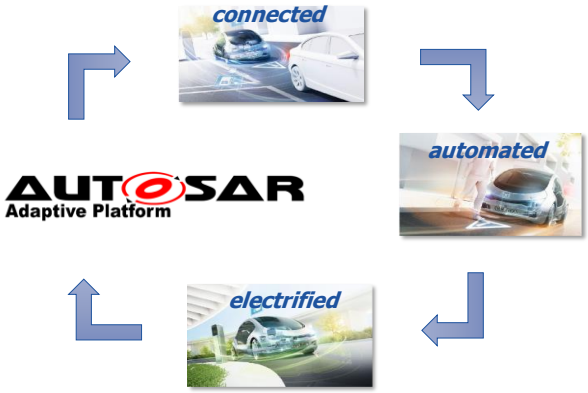
Architecture – Introduction

- In the previous session we saw how Adaptive is the new AUTOSAR platform for…
  - High performance computing
  - High bandwidth communication
  - Large data
  - Heterogeneous ECUs
- A new platform introduces new…
  - Core requirements
  - Fundamental assumptions

→ A new architecture!
  - For the Application
  - For the Platform



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Application Architecture

- There are two generally accepted principles of "good" application design:
  - Loose coupling
  - Strong cohesion
- Why are these "good" design principles?
  - Abstract away from, and hide, any unnecessary details
    - Improve ability to reason about a design
  - Split the problem into manageable units
- The Classic Platform adopts a **Component-based Architecture**
  - Compositions of multiple communicating SWCs
- The Adaptive Platform adopts a **Service-oriented Architecture**
  - Independent functional units
  - Formally defined interface

– "…the purpose of abstraction is not to be vague, but to create a new semantic level in which one can be absolutely precise …".
– **Edsger Dijkstra, 1972**

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Service-oriented Architecture

- In service-oriented architectures (SOA), application components provide services through a communication protocol over a network
- A service comprises a stand-alone unit of functionality available only via a formally defined interface
- A service can be accessed remotely, acted upon and updated independently
- The function provided by a service is in the general case the integration of distributed, separately-maintained and deployed software components.

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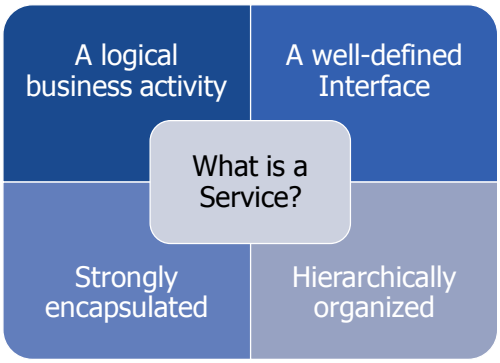
Properties of a Service

- It logically represents a **business activity** with a specified outcome
- Accessed through a **well-defined Interface**
  - Typically through an *Interface Definition Language* (IDL)
    - In AUTOSAR the IDL is ARXML
  - Distinct from the accessing programming language
- Provides **Strong Encapsulation**
  - A "black box" for its consumers
- Organized **Hierarchically**
  - It may consist of other underlying services
  - Different services can be used in conjunction to provide the functionality of a large software application
  - Technologies and standards enable components to communicate and cooperate over a network, e.g. IP network



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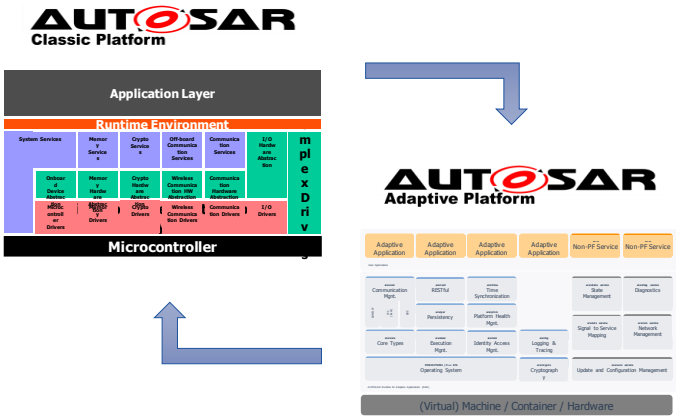
Logical Platform Architecture

- A logical architecture describes how the software is composed
  - Modules
  - Interfaces
- The Classic Platform has a **layered software architecture**
- The Adaptive Platform has a **modular software architecture**
- What are the differences? And why?



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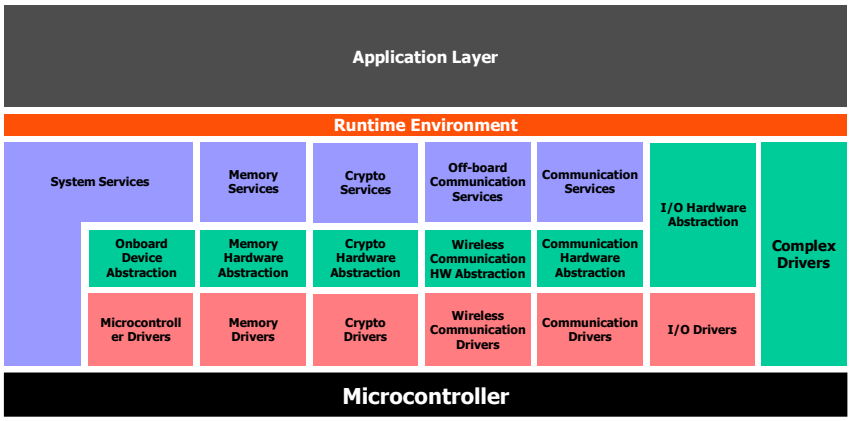
Classic Platform Layered Software Architecture (AR4.3)



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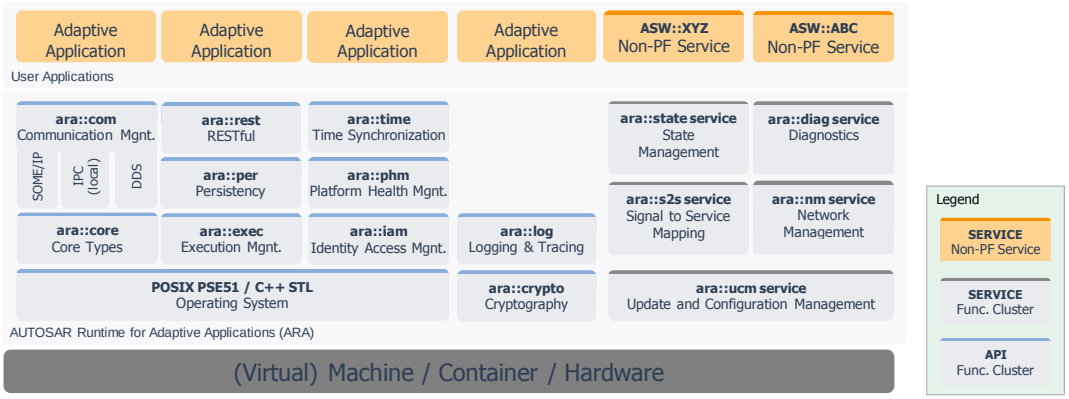
Adaptive Platform Architecture



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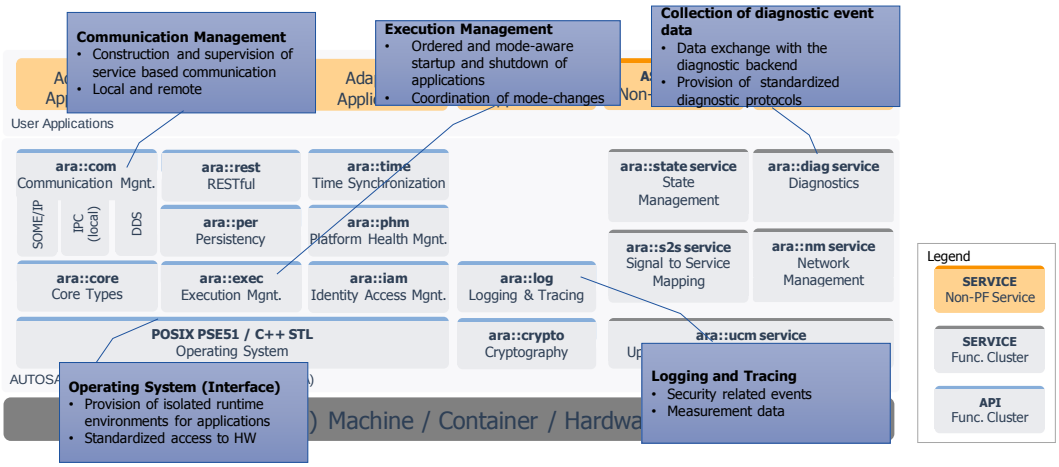

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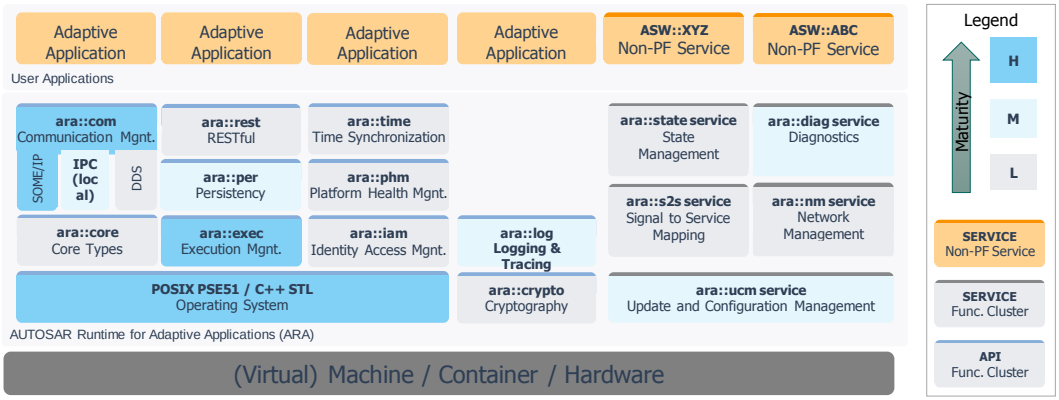
Adaptive Platform Architecture – Maturity



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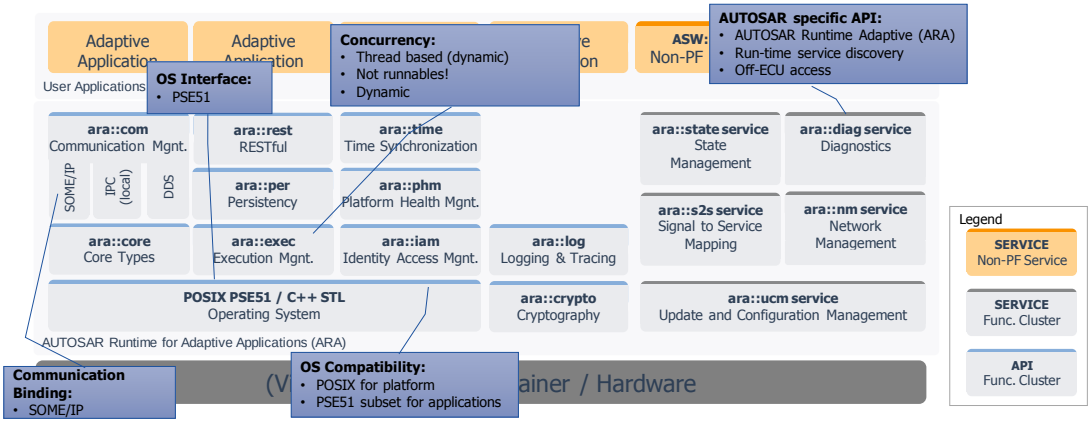
Adaptive Platform Architecture – APIs



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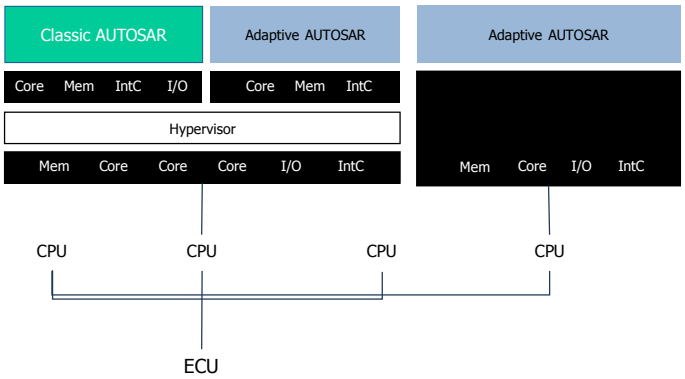
AUTOSAR Platform – Machine View

- A **Machine** supports a single **Software Platform Instance**
  - Classic
  - Adaptive
- Hypervisor
  - Creates multiple **virtual machines**
  - Classic and Adaptive on same CPU!



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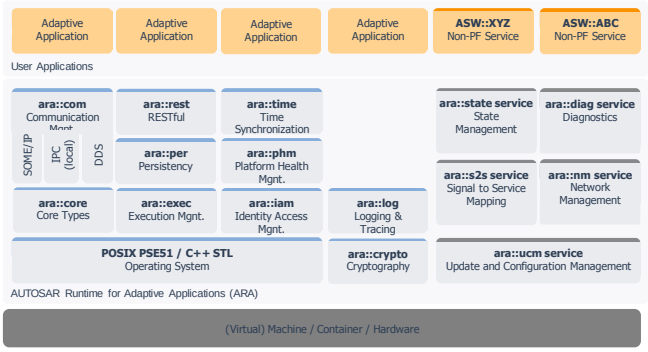
Summary

- AP addresses need for new HPC and communication requirements
- Functional clusters
  - Not just a module, also the concepts behind it
- Promotes incremental change
  - Dynamic software set
  - Service-oriented architecture
  - Dynamic communication protocols
- Manifest for deployment



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Methodology

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What is the Adaptive AUTOSAR Methodology?

- The Adaptive AUTOSAR methodology describes …
  - The **main activities** that are required to build an Adaptive AUTOSAR System
    - Use-cases
    - Tasks
    - Work products
  - The **relationships** between activities and work-products
- What is it not?
  - Not a complete process description
    → Other, project specific, steps are permitted
  - Not a prescriptive ordering
    → Describes a general order but iterations and side-steps are permitted.

- Develop Service Interfaces
- Design CP/AP interoperability
- Design Machine
- Create Diagnostic Mapping

- User-level
- Platform level

- Integrate SW
- Configure Machine
- Create Application Manifest
- Configure Service Instances

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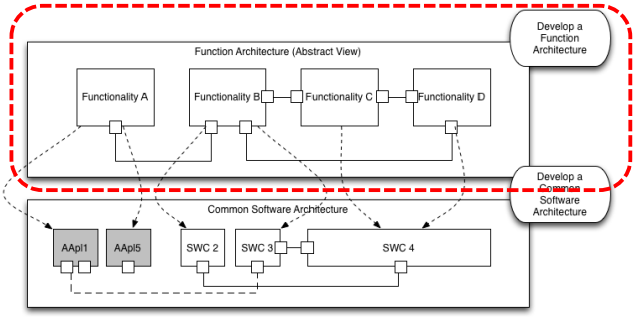
Architecture and Design: Step 1 – Develop Function Architecture

- **What?**
  - Develop a Function Architecture
- **Why?**
  - Evaluate features and requirements necessary for a specific E/E vehicle project
- **How?**
  - Form an appropriate Function Architecture comprising functional blocks, their interfaces and connections



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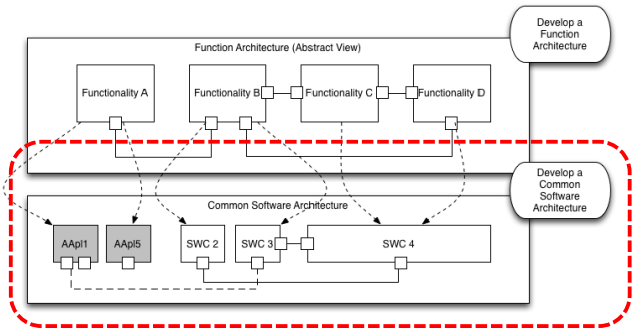
Architecture and Design: Step 2 – Derive Common Software Architecture from Function Architecture

- **What?**
  - Derive a Common Software Architecture (CSA) from the Function Architecture
- **Why?**
  - SW Architect designs realization of functional blocks.
- **How?**
  - Design SWCs for Classic and Applications for Adaptive platforms
  - Consider how SWCs and Applications interact.
  - Develop Service Interface descriptions
    - (which may be between SWCs and Adaptive Applications)



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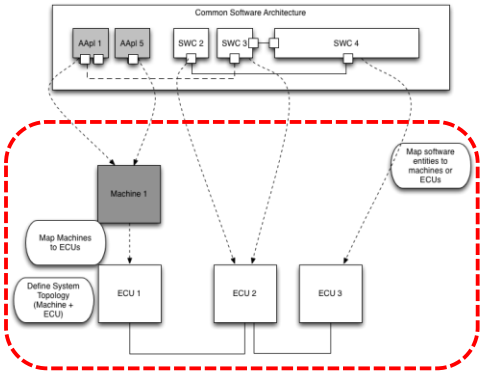
Architecture and Design: Step 3 – Map Common Software Architecture to ECUs and Machines

- **What?** Develop System – combining Classic and Adaptive ECUs
- **Why?** Map Common Software Architecture to the realizing ECUs/Machines.
- **How?**
  - Define ECUs (Classic)
  - Define Machines (Adaptive)
  - Deploy Applications to machines
  - Map SWCs to ECUs



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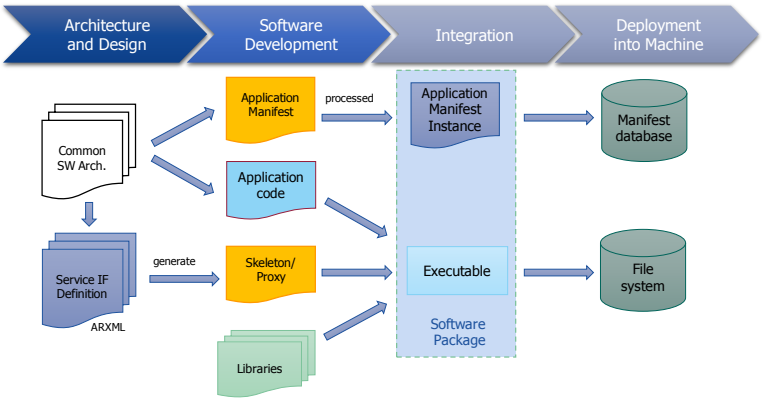
Adaptive Application Development Workflow: Design, Development and Integration



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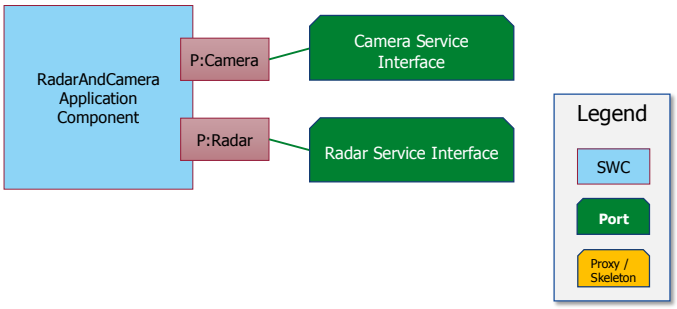
AUTOSAR Platform – Application

- A specific type of SWC models an Adaptive Application
- Analogous to SWC in Classic
- Provide/require Ports
- Port Interface defines services
- Modelled in ARXML
  - The AUTOSAR System models both AP and CP



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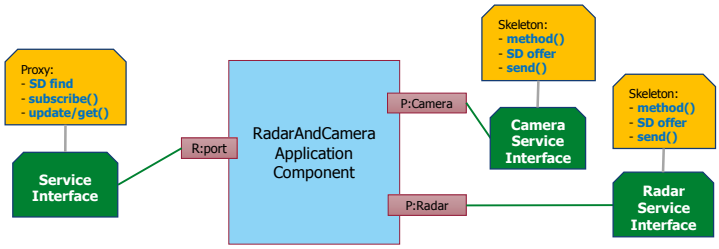
AUTOSAR Platform – Workflow for Application (1)

- **Generate application component header** files based on Service Definition
  - Skeletons for service discovery (offer, register, …)
  - Proxy for service discovery (discovery, subscribe,…)
  - Proxy for method calls and event reception (client)
  - Skeletons for method calls and event publishing (server)
- Implement and compile software components
  - This step is independent of the definition of service instances
- Develop main function of executable



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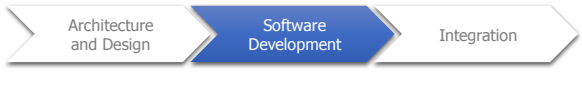
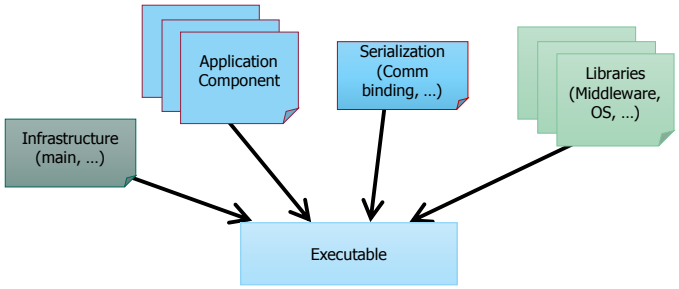
AUTOSAR Platform – Workflow for Application (2)

- **Configure and generate serialization code** for Adaptive Platform

- Application Executable
  - Software component code,
  - Infrastructure code (main function, etc.)
  - Serialization code, and
  - Middleware libraries (platform code)





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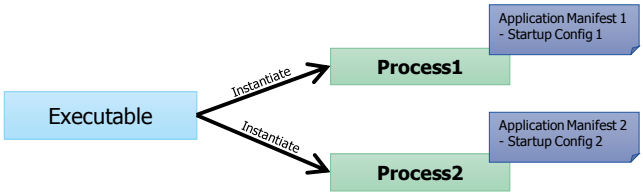
AUTOSAR Platform – Workflow for Application (3)

- Define processes
  - Executables can be instantiated in several ways in terms of processes
  - Startup behavior can be defined depending on machine state
- **Application Manifest** describes process and startup configuration
  - Per-process
- Includes
  - Command-line parameters
  - Environment (R18-10)
  - Execution Dependencies
  - Valid States



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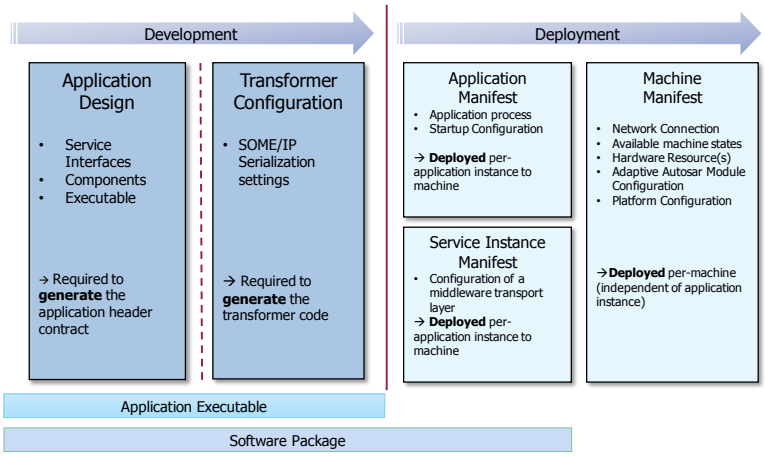
AUTOSAR Adaptive – Methodology Review



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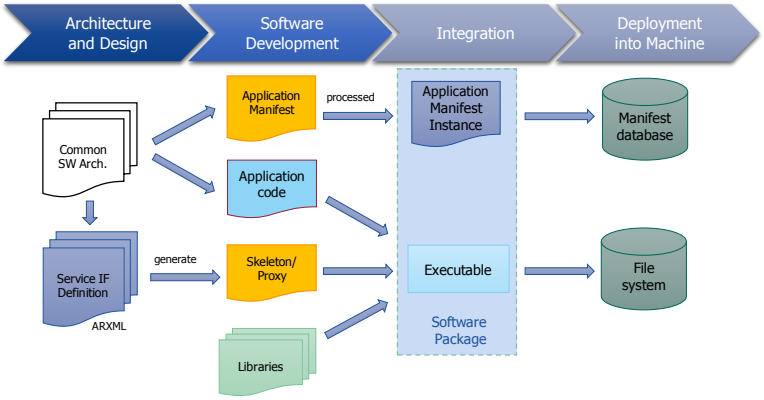
Summary

- Methodology promotes incremental change
  - Dynamic SW set
  - Service-Oriented communication
  - Discovery protocols
- Manifest for deployment



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Vehicle Computing with the Adaptive Platform

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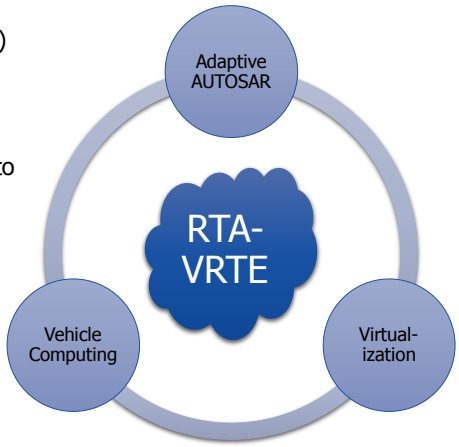
RTA-VRTE and Adaptive AUTOSAR

- Adaptive AUTOSAR doesn't address all issues (yet)
  - Vehicle computation
  - Domain controller ECUs
- ETAS, together with Bosch, is building RTA-VRTE to address these additional challenges
  - Adaptive AUTOSAR
    - Standardized applications
  - Hypervisor for virtualization
    - Multiple safety and functional domains
  - Vehicle computing support
    - Lifecycle management
    - Update management
    - Personalization



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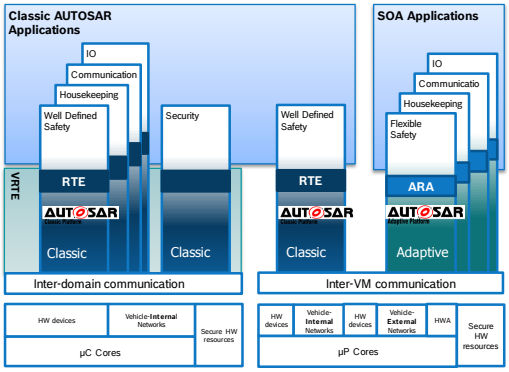
RTA-VRTE

- The RTA-VRTE product will…
  - …include support for…
    - Adaptive Platform Service-Oriented Architecture
    - Micro-processor based Vehicle Computer
      - x86/ARM architecture
      - Optional micro-controller support
    - Multiple operating systems (e.g. Linux, QNX)
      - Depending on functional safety requirements
  - …is being developed according to ISO26262 and IT-Security criteria
  - …provide multiple protection domains
    - Hypervisor enables multiple instances to be hosted on the same Vehicle Computer
  - …support software update over the air



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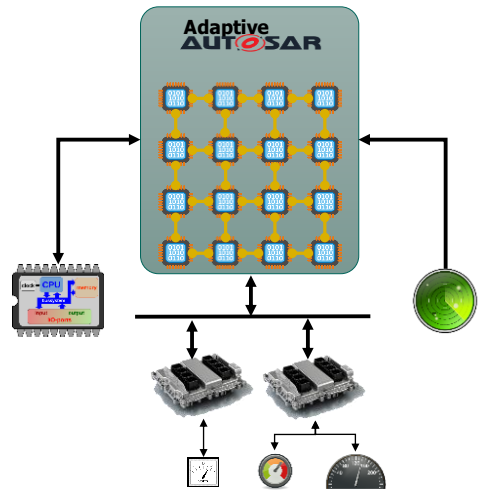
What is Vehicle Computing?

- Centralized computing resource
  - Centralized functionality, e.g. decision making
  - High Performance
  - COTS processor
- Adaptive Platform architecture supports new E/E requirements for autonomy, high-bandwidth communication and incremental SW change
  - Sensor fusion
  - Image processing
  - Generation real-world object models
- Key Functional Clusters
  - Execution Management and OS Interface
  - Communication Management



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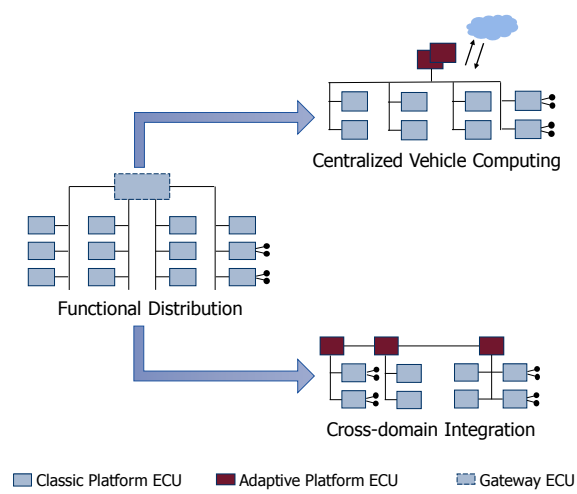
Decision Centralized Architectures

- The Adaptive Platform is the enabler for supporting CASE motivators
  - Incremental SW updates for continuous improvement
  - Parallel applications for scalability
  - Dynamic connectivity to reduced coupling
- The Adaptive Platform's support for high performance and strong isolation enables environmental change
  - Cross-Domain ECUs integrating related functionality
  - Vehicle computation nodes providing centralized computing resources



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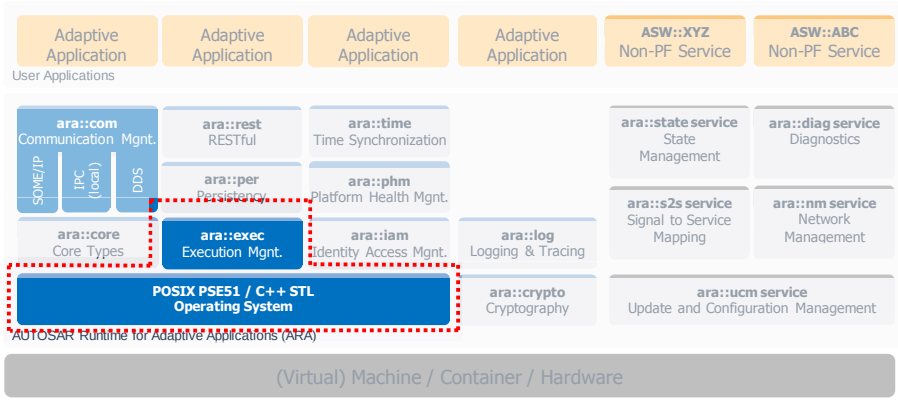
Vehicle Computing – Execution and Communication Management



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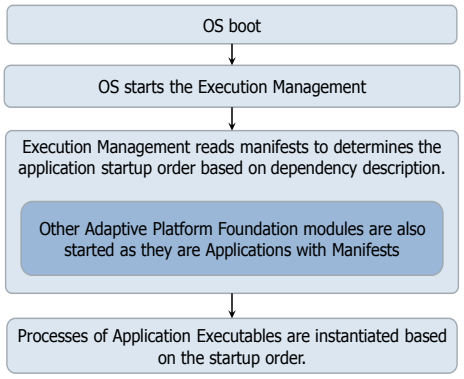
Adaptive Platform – Execution Management

- Fundamental task of Execution Management is the ordered startup and shutdown of the **Adaptive Platform instance**
- Platform Startup – OS starts Execution Management as the "init" process
  - Starts Platform-level applications
  - Starts User-level applications
- Run-time Monitoring and State Management
  - Error handling and Recovery actions
  - Machine state change → start/stop applications
- Platform Shutdown - Initiated by Execution Management
  - Based on startup dependencies



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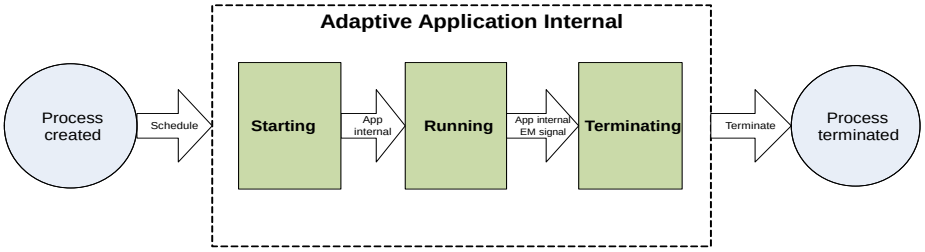
Execution Management – Managing the Application Lifecycle

- Execution Management starts application based on information from the **Application Manifest**
  - Execution Management manages process state
- Each Application (process instance) has independent state
  - Managed internally by the application



- **Starting** Application establishes
- **Running** Application initialization complete
- **Terminating** EM terminating process. Flush data to persistent store

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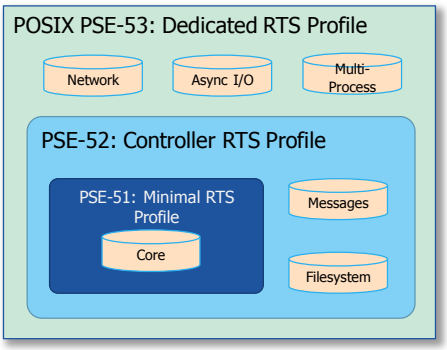
The Adaptive Platform Operating System

- The Classic Platform adopted and extended OSEK OS
- The Adaptive Platform defines the OS interface
  - Platform applications – POSIX API
  - User applications – PSE-51 subset [*IEEE Std 1003.13]*

EM → Acts as OS "Init" process
- Configure the OS based on Application Manifest information
- Start/Stop executables – process creation and scheduling policy

OS → Run-time process management
- Scheduling of processes and threads
- Inter-process communication, shared memory, etc.
- Resource management; run-time detection of overuse



POSIX: Portable Operating System Interface for UNIX [IEEE Std 1003.1]

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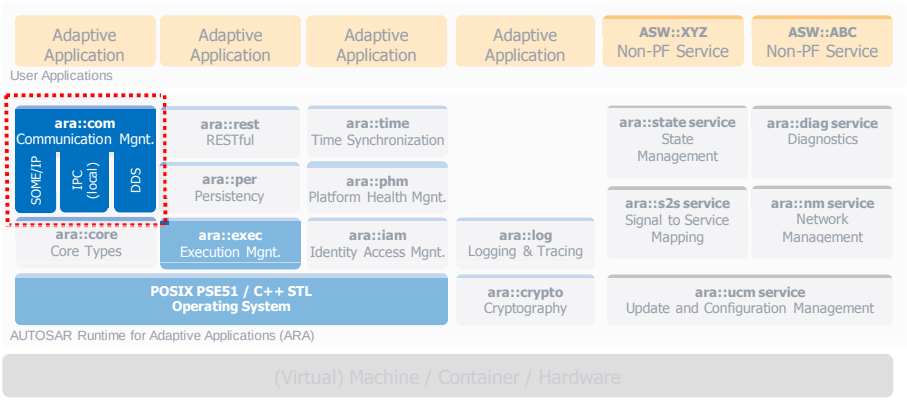
Vehicle Computing – Execution and Communication Management



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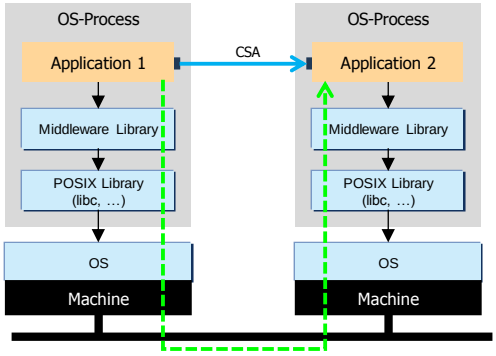
Adaptive Platform – Adaptive Communication

- The Classic Platform uses **signal-based** communication
  - Source and destination are statically configured.
- The Adaptive Platform uses **service-oriented** communication
  - Interfaces defined in Common SW Architecture (CSA) define provided and required services
  - At run-time clients and services are connected using the Adaptive Platform
- The Adaptive Platform provides the **middleware** that implements communication over the CSA



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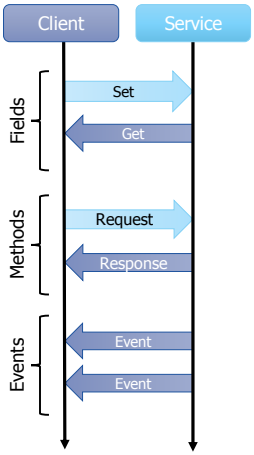
AUTOSAR Adaptive Services and the Discovery Protocol

- Is identified by a service **type identifier**. E.g. "DoorLock"
- Can be instantiated a number of times (0 to n)
  - Each instance has unique **instance identifier**. E.g. "FrontLeft", "RearRight"
- Is a collection of:
  - **Events**. E.g. "LockStatus"
  - **Methods**. E.g. "LockCommand", "UnlockCommand"
  - **Fields**. E.g. "Get(LockStatus)"
- Can be **discovered** on the network using the unique identifier
  - Users of the service may subscribe to the elements (events, methods or fields) of a service instance



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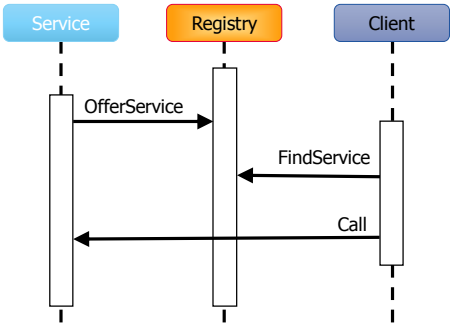
Adaptive Platform – Adaptive Communication

- Communication paths can be established programmatically using the Adaptive Platform's **Discovery Protocol**
  - **Offer** service with Adaptive Platform
  - **Find** all registered services and bind to the selected service
  - **Call** the bound service
- The AUTOSAR Adaptive platform provides **middleware** functionality
  - Communication binding provides implementation independence
- Registry can be per-process or per-platform



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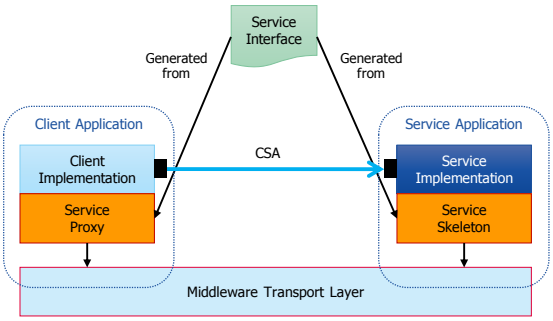
Distributed Communication – Service Proxy and Skeleton

- Service and client may not be on the same machine
- The **service interface definitions** defined within the CSA
  - Generate application infrastructure to provide or consume a service
- Infrastructure generated from service interfaces
  - **skeleton** → provide data and implement methods
  - **proxy** → consume data and call methods
- Standardized by the `ara::com` specification
  - Implements the AP discovery protocol
  - Supports location independence for Applications
  - Platform vendor independent development



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Vehicle Computing with RTA-VRTE

- AUTOSAR Adaptive Platform exists to support new E/E demands
  - Connectivity, Autonomy, Shared Ownership, Electrification
  - High Performance Computation, High bandwidth Applications
- Functional Clusters are key components of Adaptive Platform
  - Applications are isolated for safety and security
  - Methodology supports incremental change
  - Dynamic SW sets and communication paths
- Vehicle Computing for centralized computation
  - Execution Management → platform startup and run-time control
  - Communication Management → dynamic high-bandwidth communication

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Early Access Programme

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What is the Early Access Programme?

- RTA-VRTE Early Access Programme provides a "ready-to-go" Adaptive AUTOSAR environment
  - A host VM containing RTA-VRTE configuration and build tools
    - AUTOSAR editor
    - Proxy/skeleton generator
    - Service interface editor (for inclusion in Q3'18)
  - Target VMs for experimentation: QNX, Linux
- AUTOSAR Adaptive Platform support
  - Execution Management, Communication Management, …
  - Multiple target OS (QNX 7.0.1 – separate licence required, Linux)
- Includes free access to RTA-VRTE development releases for 12-months (3-monthly updates)
  - Flexible tools licencing (licence for business-unit)
  - Support and consultancy (including on-site)
  - Adaptive AUTOSAR training (using RTA-VRTE, on-site)

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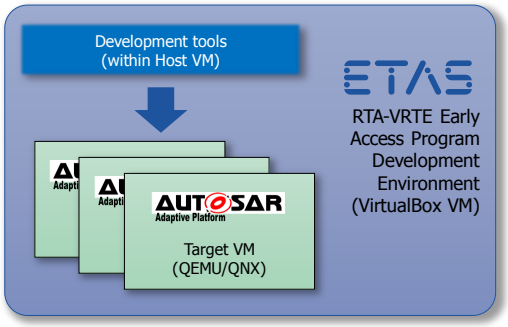
RTA-VRTE Development Environment

- RTA-VRTE Early Access Programme provides a complete "ready-to-go" development environment
- Host VM (Linux) using VirtualBox
  - Simple one-step installation for Windows PC
  - Complete tools and build installation
- Target VM (QNX 7.0 or Linux) using QEMU
  - Core Adaptive AUTOSAR modules
  - Execution Management
  - Communication Management
- Example Applications
  - Step-by-step "Hello World" tutorial
  - Communicating client/server Adaptive Applications



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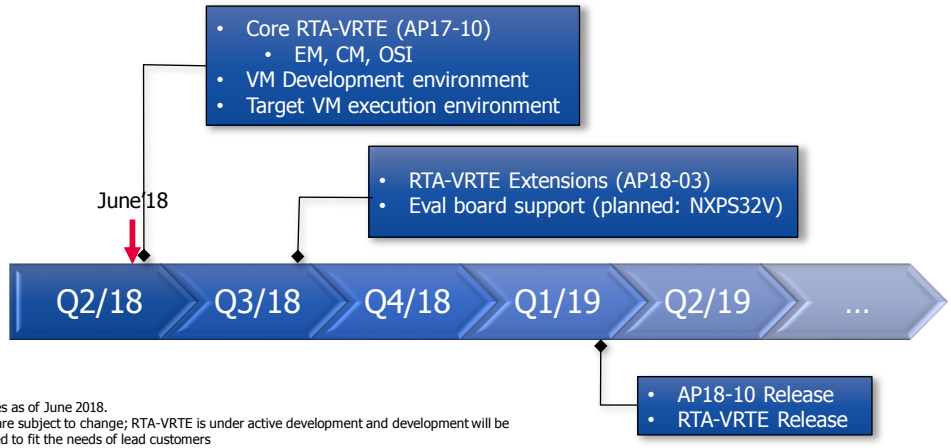
Early Access Programme Release Plan (June 2018)



All dates as of June 2018.
Dates are subject to change; RTA-VRTE is under active development and development will be adjusted to fit the needs of lead customers
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RTA-VRTE Early Access Programme

RTA-VRTE Development Plan (June 2018)

		Q3'18	Q4'18	Q1'19	Q2'19
Communication Management	API Compliance	AP18-03		AP18-10	
	Signal-2-Service		Prototype	Feature Complete	
	SOME/IP	Prototype	Feature Complete		Production
	Inter-ECU (Ethernet)	Prototype	Feature Complete		Production
	Intra-ECU (shared memory)	Prototype	Feature Complete		Production
Development support	Log & Trace API	Prototype	Feature Complete		Production
	Data log and trace	Prototype	Feature Complete		Production
	XCP	Feature Complete		Production	

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RTA-VRTE Development Plan (June 2018)

		Q3'18	Q4'18	Q1'19	Q2'19
Diagnostics	Transport (DoIP/UDS)		Prototype	Feature Complete	
	Server		Prototype	Feature Complete	
Execution Management	API Compliance	AP18-03		AP18-10	
	Application start/stop	Feature Complete		Production	
	Function Groups		Prototype	Feature Complete	Production
	Resource Management		Prototype	Feature Complete	Production
	Recovery Framework		Prototype	Feature Complete	Production

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RTA-VRTE Development Plan (June 2018)

		Q3'18	Q4'18	Q1'19	Q2'19
Persistency	API Compliance	AP18-03		AP18-10	
	Database			Prototype	Feature Complete
	File access	NFS		Optimized prototype	Feature Complete
Platform Health Monitoring (Safety)	API Compliance	AP18-03		AP18-10	
	Error Management		Prototype	Prototype	Feature Complete
	SW Lockstep		Prototype	Prototype	Feature Complete
	SW Watchdog		Prototype	Prototype	Feature Complete

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RTA-VRTE Development Plan (June 2018)

		Q3'18	Q4'18	Q1'19	Q2'19
Security	API Compliance	AP18-03		AP18-10	
	Symmetric/asymmetric crypto	Prototype			Feature Complete
	Key Management	Prototype			Feature Complete
Update	A/B Partition (intermediate)	Prototype			
	Update Domain		Prototype		Feature Complete
	New Domain			Prototype	
	Single application				Prototype

All dates as of June 2018.
Dates are subject to change; RTA-VRTE is under active development and development will be adjusted to fit the needs of lead customers
Please contact ETAS for updated release information.

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RTA-VRTE – Adaptive AUTOSAR Open Seminar

Early Access Programme Contents

- The RTA-VRTE Early Access Programme comprises
  - Access to ETAS Adaptive AUTOSAR expertise
    - 200-hrs support & consultancy (of which, up to 40-hrs can be on-site)
  - Adaptive AUTOSAR Training (based on the RTA-VRTE Early Access Programme SW)
    - Two days, on-site
    - Covers Adaptive AUTOSAR principles, configuration and use
    - Provided on-site, max 8 participants
  - Free access to RTA-VRTE development releases for 12-months (3-monthly updates)
    - Access to new and updated VRTE/AUTOSAR modules included within the core RTA-VRTE product
    - Support for new HW platforms (as released as part of EAP)

- The RTA-VRTE Early Access Programme is intended for pre-development
  - Virtualization enables experimentation without HW requirements
  - Provides a migration path to RTA-VRTE for production

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RTA-VRTE – Adaptive AUTOSAR Open Seminar

Adaptive AUTOSAR Training Agenda

Day 1	Day 2
Adaptive AUTOSAR Overview • Why the Adaptive AUTOSAR initiative exists • Core concepts • How Adaptive and Classic AUTOSAR are connected	**Communication Management (Part 2)** • SOME/IP
Architecture and Methodology • What are the "modules" that form the Adaptive Platform • How an Adaptive Application interactions with the Platform • How to work with the Adaptive Platform	**Adaptive Foundation** • Persistency Functional Cluster • Log & Trace Functional Cluster
Execution Management Functional Cluster • Machine and Adaptive Application lifecycles • State Management • Dynamic behavior	**Adaptive Services** • Diagnostics Functional Cluster • Interoperability between Classic and Adaptive Platforms
Communication Management Functional Cluster (Part 1) • Service-oriented communication paradigm • What is a Service? • How to implement a service	**Wrap-up** • Look ahead for the Adaptive Platform

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RTA-VRTE – Adaptive AUTOSAR Open Seminar

Summary

- RTA-VRTE Early Access Programme is a complete "ready-to-go" Adaptive AUTOSAR development environment
  - Host VM (Linux/VirtualBox)
    - Simple installation on Windows
    - RTA-VRTE development tools and build system
  - Target VM (QNX 7.0/QEMU)
    - Core Adaptive AUTOSAR modules
- Example Applications
  - From a simple "Hello World" through to communicating Adaptive Applications
- RTA-VRTE EAP Package
  - Consultancy/support (200hrs inc. 40hrs on-site)
  - Adaptive AUTOSAR Training (2-days, on-site)
- QNX 7.0 Licencing
  - Customer provided
- Other licencing
  - RTA-VRTE EAP software is licenced for single team use
  - Not valid for production purposes

RTA-VRTE early access program: A Cost-effective starter-kit for AUTOSAR Adaptive

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RTA-VRTE – Adaptive AUTOSAR Open Seminar

RTA-VRTE Demonstration

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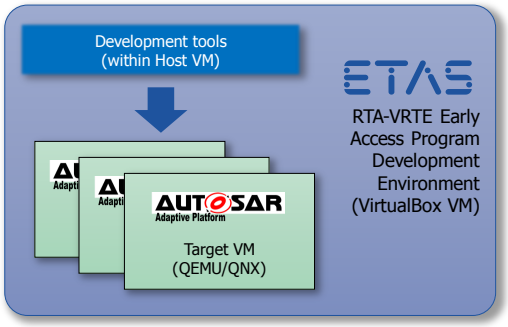
Introduction

- The EAP Demonstrator is packaged as a VirtualBox Xubuntu 18.04 virtual machine
  - Compressed into a zip file!
- Installation
  - Unzip to a convenient folder and open the `.vbox` file using a recent version of VirtualBox;
    - E.g. VirtualBox Version 5.2.6 r120293 (QT5.6.2)
- System requirements
  - 8GB RAM
  - 35GB HDD
  - Dual core processor
  - More memory/cores can be configured if available



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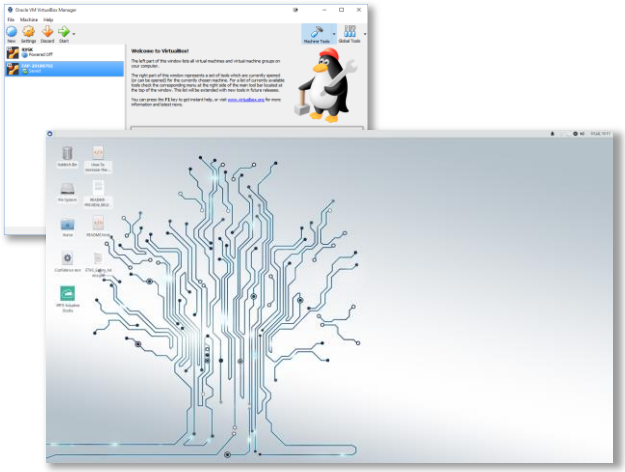
RTA-VRTE Early Access Programme Startup

- Pre-requisites
  - VirtualBox Extension Pack
- Double-click `rvsk.vbox` to start the demonstrator
- When the Host VM is started, it will automatically log in the user `developer` and present an `xfce` desktop.
- The password is required for example if you log out or need to do some system operations;
  - Set to `dev12345` when shipped.



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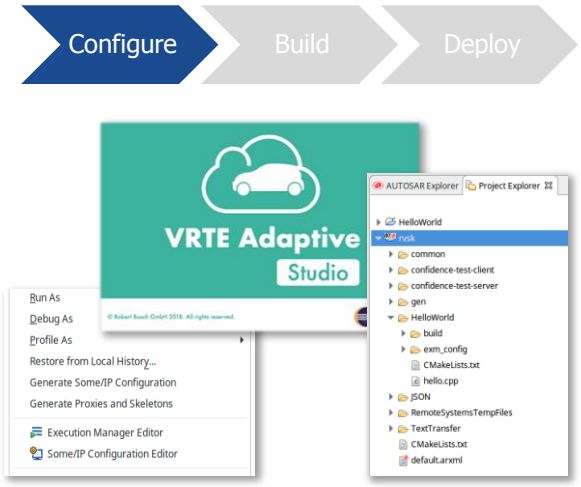
Configuration



- **VRTE Adaptive Studio**
  - Pre-installed in EAP
  - Double-click the icon to start
- Includes all demonstration projects
  - Default workspace (`~/workspace`)
- Supports creation of all aspects of RTA-VRTE Projects…
  - Containing multiple Adaptive Applications
  - Application source
  - Proxy/Skeleton generation
  - Application Design Editor (prototype)
  - Execution Management Editor (prototype)
  - SOME/IP Configuration (prototype)

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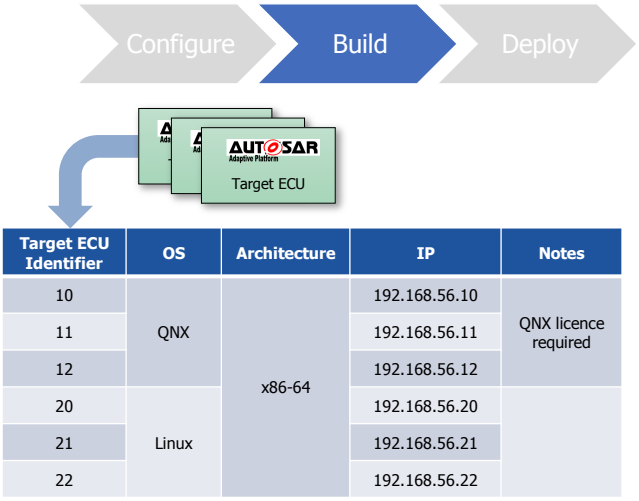
Development Environment



- RTA-VRTE EAP runs inside a VirtualBox VM
  - Network of six Target ECUs
  - Each Target ECU is a virtual machine
- Host VM → Build and Configuration
- Target ECU → Execution
- Target ECUs use QEMU within Host VM
  - QNX OS
  - Linux OS
- Target ECUs identified by VM Number
  - Part of machines IP address
  - Type of VM (QNX, Linux, …)

Target ECU Identifier	OS	Architecture	IP	Notes
10	QNX	x86-64	192.168.56.10	QNX licence required
11			192.168.56.11	
12			192.168.56.12	
20	Linux		192.168.56.20	
21			192.168.56.21	
22			192.168.56.22	

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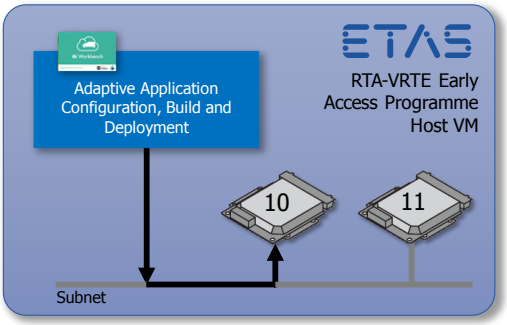
Deployment

- Target VMs always start from the same state
  - Root file system remains unchanged
- The NFS share for each machine persist between runs
  - Accessible from Host VM
- Adaptive Applications are deployed to Target ECU
  - Automatically by build system
  - Copied to NFS share
- Similar approach will be adopted for HW
  - Accessible from same subnet



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Working with Target VMs

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RTA-VRTE Early Access Programme – Demonstrator

Host VM Startup

- Start VirtualBox
- Start Host VM
- Open a Terminal
  - Change font size
- Close Host VM
  - Save state for next session

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Demonstrator – First Application

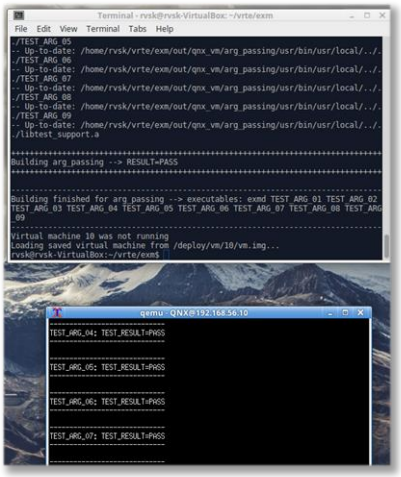
Start a Terminal
- In the Host VM, right-click on desktop
- Select "Open Terminal Here"

Switch to the project folder

```
cd ~/vrte/exm/project
```

Build and deploy to target VM

```
build -d <APP> 10
```



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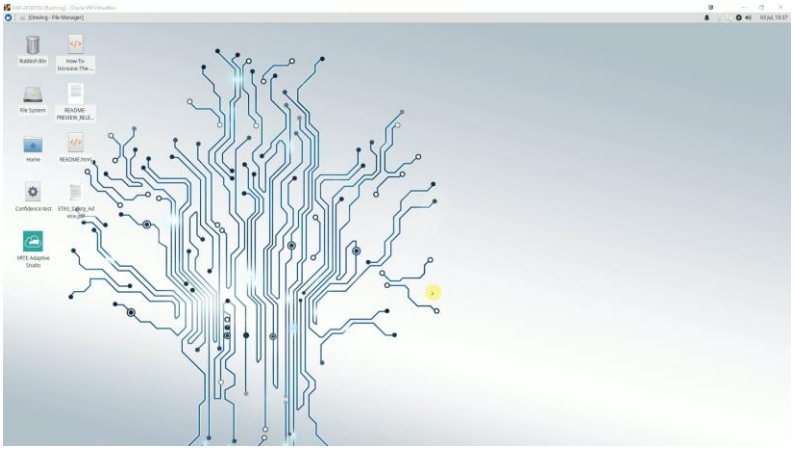
RTA-VRTE Early Access Programme – Demonstrator

Build and Deploy a Simple Adaptive Application

- Change to project directory
- Build an Adaptive Application and deploy to Linux Target ECU 20
- Execute Adaptive Application (under control of Execution Management)
- Explore source code of a simple application



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TextTransfer – Client-server Communication

- `TextTransfer` Application demonstrates
  - Inter-process communication (Client, Server)
  - Multiple executables within the same project
- Same build process as simple example
- Open two terminals to the Target ECU
  - Enables different executables to show output
- In the terminal windows, type (one per window!) start the server and client

```
> cd ~/vrte/exm/project
> build -Fsqc -d TextTransfer 10

> sshvm 10
> sshvm 10

> /opt/vrte/usr/bin/texttransfer_server
> /opt/vrte/usr/bin/texttransfer_client
```

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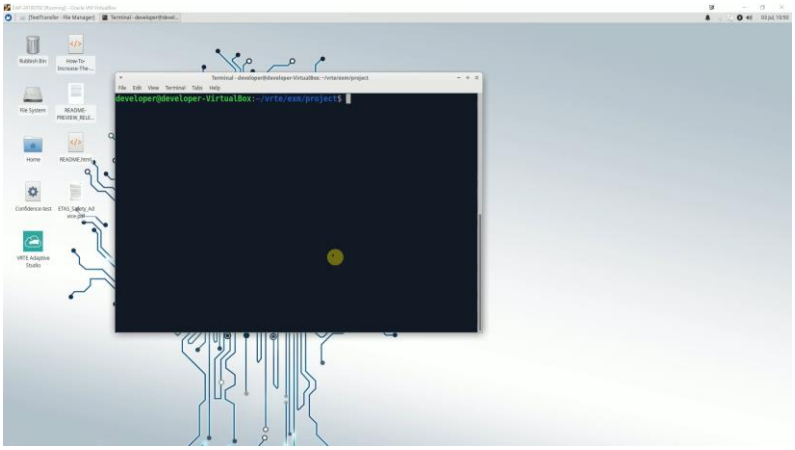
Build and Deploy Communicating Adaptive Applications

- Build an Adaptive Application(s) and deploy to Linux Target ECU
  - Server
  - Client
- Open SSH terminals for interaction
  - Execute Adaptive Application(s)
  - Send text
- Explore source code



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Adaptive Studio – Application Design Editor

- Application Design Editor
  - A Domain Specific Language (DSL) to abstract ARXML files with a text–based format.
- Adaptive AUTOSAR elements:
  - ARPackage
  - AdaptiveApplicationSwComponentType
  - ServiceInterface
  - ImplementationDataType `struct` and `array`
- Automatic compilation of "`.adesign`" file into ARXML

```
package MyPackage {
    interface MyInterface namespace Etas {
        event Event1 of float64
    }
}
```

```
<?xml version="1.0" encoding="UTF-8"?>
<AUTOSAR xmlns="http://autosar.org/schema/r4.0" xmlns:xsi="http://www.w3.org/26
  <AR-PACKAGES>
    <AR-PACKAGE>
      <SHORT-NAME>MyPackage</SHORT-NAME>
      <ELEMENTS>
        <SERVICE-INTERFACE>
          <SHORT-NAME>MyInterface</SHORT-NAME>
          <NAMESPACES>
            <SYMBOL-PROPS>
              <SHORT-NAME>Etas</SHORT-NAME>
              <SYMBOL>Etas</SYMBOL>
            </SYMBOL-PROPS>
          </NAMESPACES>
          <EVENTS>
            <VARIABLE-DATA-PROTOTYPE>
              <SHORT-NAME>Event1</SHORT-NAME>
              <TYPE-TREF DEST="IMPLEMENTATION-DATA-TYPE">/float64</TYPE-TREF>
            </VARIABLE-DATA-PROTOTYPE>
          </EVENTS>
        </SERVICE-INTERFACE>
      </ELEMENTS>
    </AR-PACKAGE>
  </AR-PACKAGES>
</AUTOSAR>
```

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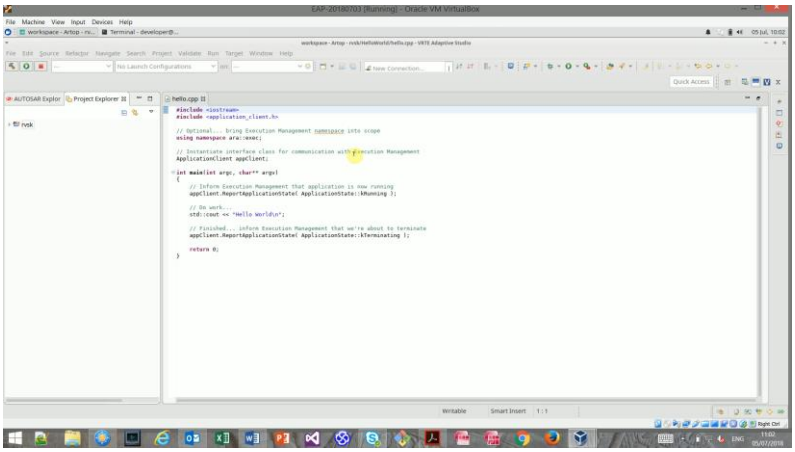
RTA-VRTE – Adaptive AUTOSAR Open Seminar

Using Application Design Editor

- Create a new AUTOSAR project Adaptive using VRTE Adaptive Studio
- Create a new `.adesign` file
  - AUTOSAR DSL
  - Service Interface
  - Event
- Automatically create equivalent ARXML



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RTA-VRTE – Adaptive AUTOSAR Open Seminar

Summary

- Adaptive AUTOSAR starts from the solid foundation offered by Classic
  - Dynamic machines → Incremental software change, platform updates
  - Dynamic applications → Parallelism, Determinism
  - Dynamic communication → Run-time partnerships
- Adaptive AUTOSAR is the enabler for change… and RTA-VRTE addresses the areas AUTOSAR does not cover!
  - Design for change → Service orientation
  - Encapsulate → Parallelism, Errors, Trust, Change
  - Adapt → Self-calibrating, self-correcting software
  - Safety → Layers, "swiss cheese" model
- Adaptive AUTOSAR in development
  - First release of Adaptive AUTOSAR Standards: 2018-10
  - RTA-VRTE "Early Access Programme" from ETAS: Now!

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Thank you

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