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D5.4 Undergraduate/Master Curricula Implemented

Title of Course

Automotive Systems and Software Engineering

Title of the presentation

AUTOSAR - Automotive open system architecture 1

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Partnership for Promotion and Popularization of Electrical Mobility through Transformation and Modernization of WB HEIs Study Programs/PELMOB

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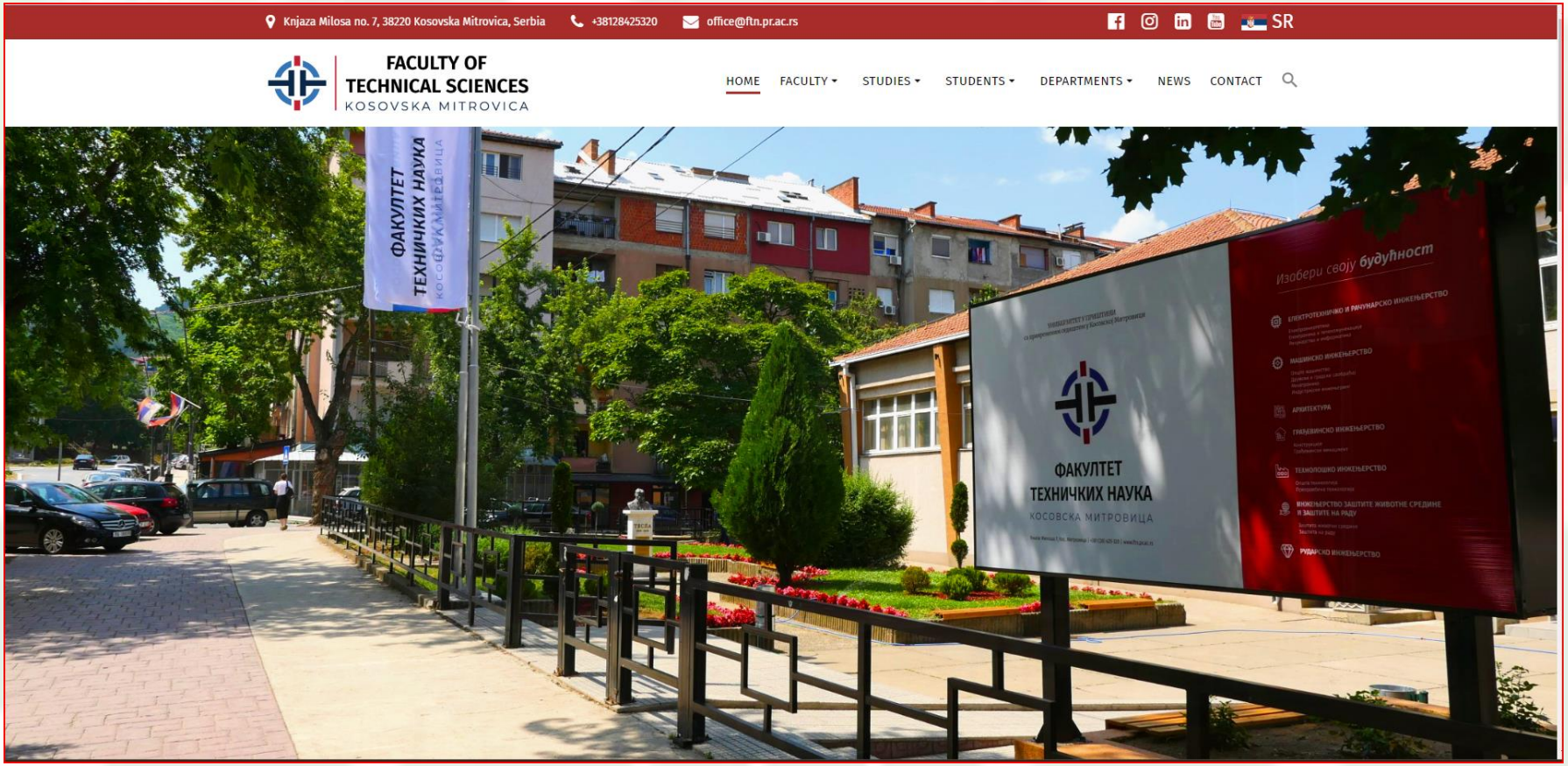

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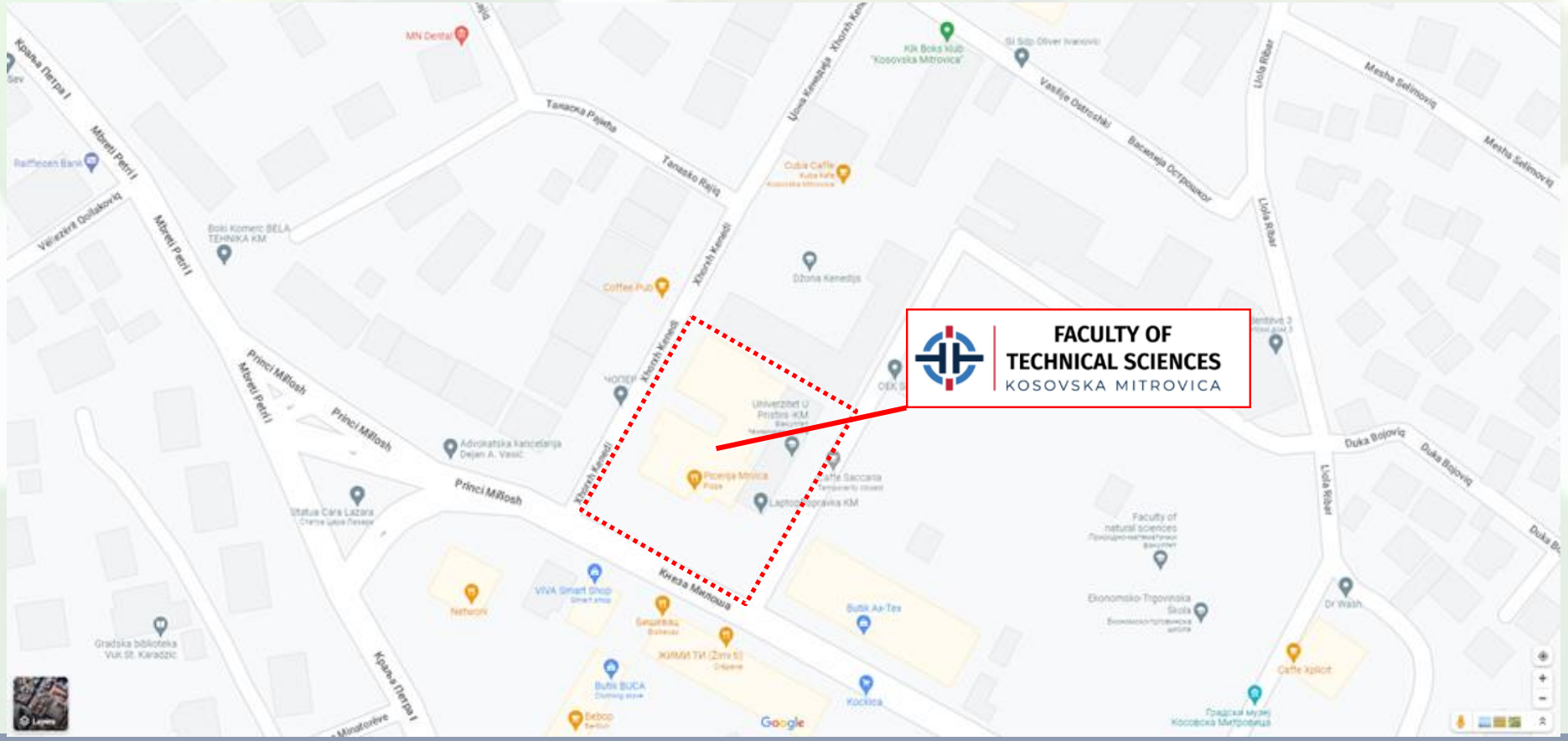

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AUTOSAR (Automotive Open System Architecture)

AUTOSAR

Overview

AUTOSAR is a **global development partnership** (founded in 2003) that standardizes software architecture for automotive ECUs. It enables interoperability, scalability, and modularity across vehicle systems.

AUTOSAR is the **backbone of modern automotive software**, enabling innovation while ensuring reliability.

Automotive open system architecture (AUTOSAR) is a plug-and-play platform architecture that allows vehicle original equipment manufacturers (OEMs) and Tier 1 provider to increase electronic control unit (ECU) programming efficiency, reduce development costs

AUTOSAR (Automotive Open System Architecture)

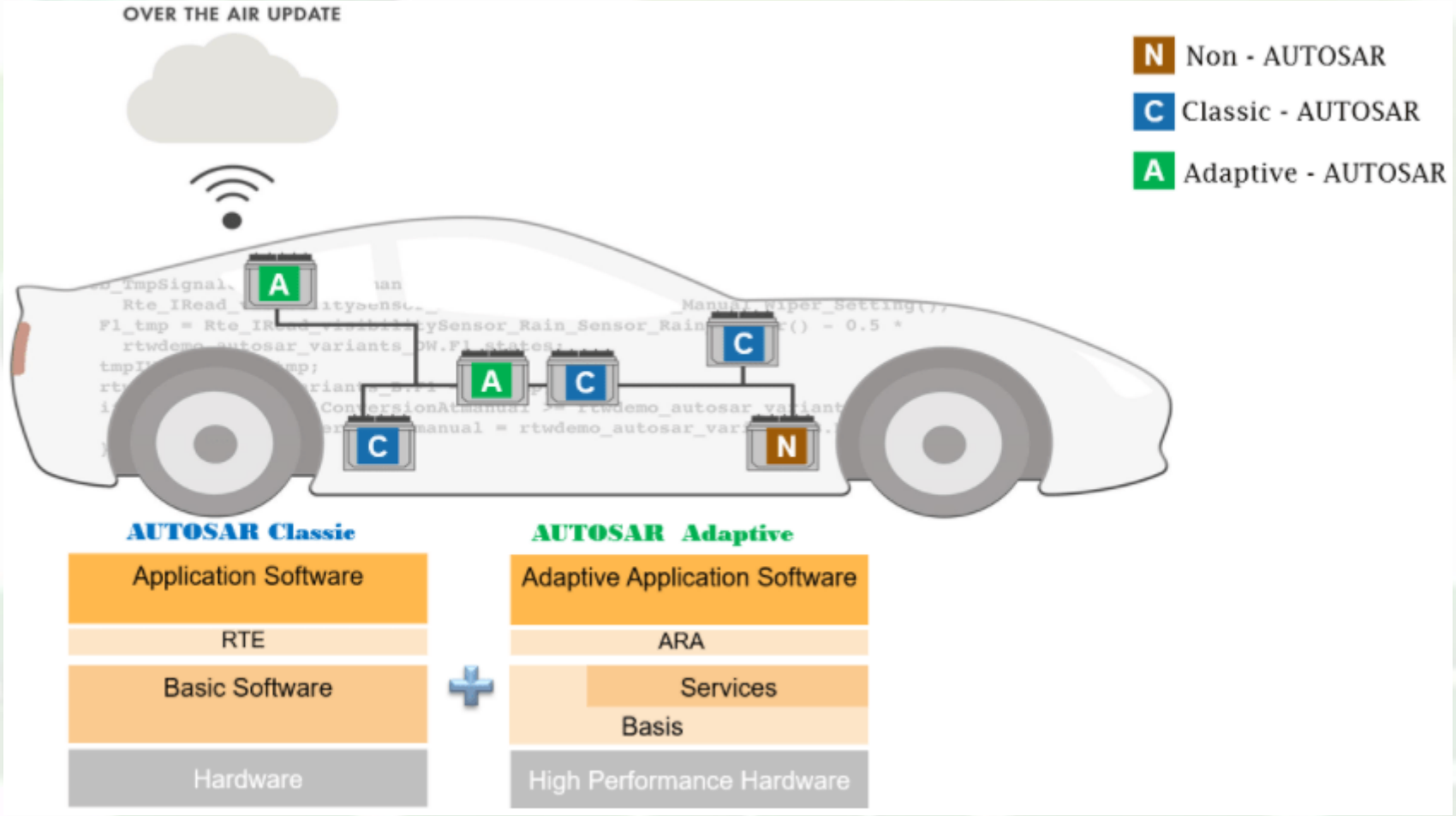
The AUTOSAR standard provides two platforms to support the current and future generations of automotive electronic control units (ECUs):

•**AUTOSAR Classic Platform** — This platform supports traditional internal applications such as powertrain, chassis, body, and interior electronics.

•**AUTOSAR Adaptive Platform** — This platform supports service-based applications such as automated driving, Car-to-X, software updates over-the-air (OTA), and vehicles as part of the Internet of Things (IoT).

AUTOSAR Classic, AUTOSAR Adaptive, and Non-AUTOSAR ECUs can interoperate within a single car.

AUTOSAR (Automotive Open System Architecture)



AUTOSAR (Automotive Open System Architecture)

AUTOSAR

The Benefits of AUTOSAR

1. **Standardization**: AUTOSAR provides a common framework and standardized interfaces, promoting interoperability and reusability of software components across different vehicle models and manufacturers.
2. **Scalability**: The modular structure of AUTOSAR allows for easy scaling of software components to accommodate the increasing complexity of modern vehicles.
3. **Reduced Development Time**: By offering pre-defined software modules and interfaces, AUTOSAR accelerates software development, reducing time-to-market for new vehicle features.
4. **Enhanced Diagnostics**: AUTOSAR includes standardized diagnostic features, making it easier to detect and address issues in vehicle systems, enhancing overall safety and reliability.
5. **Future-Proofing**: With the automotive industry rapidly evolving towards autonomous and connected vehicles, AUTOSAR provides a flexible framework that can adapt to new technologies and requirements.

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AUTOSAR (Automotive Open System Architecture)

AUTOSAR

AUTOSAR in Practice

1.ECU Integration: AUTOSAR facilitates the integration of various ECUs within a vehicle. Each ECU runs AUTOSAR-compliant software, allowing for seamless communication and cooperation between different components. This interoperability is essential for functions like engine control, braking, and infotainment systems to work harmoniously.

2.Over-the-Air (OTA) Updates: With the rise of connected vehicles, OTA updates have become commonplace. AUTOSAR's standardized interfaces and modular architecture make it easier for automakers to implement OTA updates, ensuring that vehicles can receive new features and security patches remotely.

3.Advanced Driver Assistance Systems (ADAS): ADAS features, such as adaptive cruise control and lane-keeping assist, rely on complex software and sensor integration. AUTOSAR simplifies the development and integration of these systems, making vehicles safer and more capable of assisting drivers.

4.Electrification and Hybridization: As vehicles shift towards electrification and hybridization, AUTOSAR helps manage the complex software systems that control electric powertrains. This includes battery management, energy recuperation, and electric motor control.

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AUTOSAR (Automotive Open System Architecture)

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AUTOSAR Tooling and Development

1.A UTOSAR Tool Chains: Various vendors offer AUTOSAR-compliant tool chains that assist in designing, configuring, and generating AUTOSAR software components. These tools help manage the complexity of the architecture and ensure compliance with the standard.

2. Code Generators: Code generators are used to convert high-level descriptions of software components into executable code. This automation streamlines the development process and reduces the risk of errors.

3. Configuration Tools: Configuring the numerous parameters and settings in an AUTOSAR project can be daunting. Configuration tools simplify this process by providing a user-friendly interface for defining software components and their interactions.

4. Testing and Validation: Thorough testing and validation are crucial in automotive software development to ensure safety and reliability. AUTOSAR tools support testing by enabling developers to simulate and analyze the behavior of software components.

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Automotive Systems and Software Engineering

AUTOSAR - Automotive open system architecture

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Nine companies founded the AUTOSAR partnership

https://www.autosar.org/about/partners

BMW

BOSCH

Continental

Ford

gm

STELLANTIS

TOYOTA

VOLKSWAGEN GROUP

AUTOSAR (Automotive Open System Architecture)

AUTOSAR

Key Components

1.Classic Platform (CP)

1. For **safety-critical, real-time** functions (e.g., engine control, braking).
2. Uses **static configuration** (fixed at compile time).
3. Supports **OSEK/VDX** OS.

2.Adaptive Platform (AP)

1. For **high-performance, dynamic** systems (e.g., autonomous driving, infotainment).
2. Runs on **POSIX-based OS** (Linux, QNX).
3. Enables **OTA updates** and AI/ML integration.

3.Foundation (Shared Standards)

1. Common communication protocols (**CAN, Ethernet, SOME/IP**).
2. Unified diagnostics (**UDS, DTC**).
3. Security modules (**Cryptography, HSM**).

AUTOSAR (Automotive Open System Architecture)

AUTOSAR

Core Principles

- ✓ **Modularity** – Reusable software components (SWCs).
- ✓ **Standardization** – Vendor-agnostic interfaces.
- ✓ **Abstraction** – Hardware-independent software.
- ✓ **Collaboration** – 300+ partners (OEMs, Tier 1s, chipmakers).

Benefits

- ✓ **Reduced Development Costs** – Shared standards cut R&D time.
- ✓ **Plug-and-Play ECUs** – Easier integration across suppliers.
- ✓ **Future-Proofing** – Supports electrification, autonomy, and connectivity.

AUTOSAR (Automotive Open System Architecture)

AUTOSAR

Future of AUTOSAR

- ✓ **AI/ML Integration** – Adaptive Platform for autonomous driving.
- ✓ **Cybersecurity** – Enhanced encryption for OTA updates.
- ✓ **Mixed-Criticality Systems** – Combining CP and AP on single hardware.

AUTOSAR ECU Software Architecture

AUTOSAR

1. Application Layer- his layer is responsible for defining the application software that controls various vehicle functions. It includes the software components (SW-Cs) that interact with the vehicle's ECUs.

• Contains **SW Components (SWCs)** implementing vehicle functions (e.g., engine control, ADAS).

• **Interface**: Uses **Virtual Functional Bus (VFB)** for communication between SWCs.

2. Runtime Environment (RTE)

• Mediates communication between **Application Layer** and **Lower Layers**.

• Implements **AUTOSAR Interfaces** (Sender/Receiver, Client/Server).

3. System Services
This layer consists of standardized software modules responsible for hardware abstraction, communication, diagnostics, and other low-level functions. It provides a uniform interface for the application software.

ECU (Electronic Control U

3. System Services

Service Type	Examples
Memory Services	NVM (Non-Volatile Memory) management
Crypto Services	Encryption/authentication (e.g., SecOC)
Off-Board Comm. Services	Diagnostics (UDS), OTA updates
Communication Services	CAN, LIN, Ethernet stacks

AUTOSAR ECU Software Architecture

AUTOSAR

4. Hardware Abstraction Layer (HAL)

Abstraction Module	Function
I/O Hardware Abstraction	Sensor/actuator interfacing
Onboard Device Abstraction	ECU-internal peripherals
Memory HW Abstraction	Flash/EEPROM access
Crypto HW Abstraction	HSM (Hardware Security Module)
Wireless Comm. HW Abstraction	Wi-Fi/Bluetooth control
Communication HW Abstraction	CAN transceiver control

5. Complex Drivers

- **Vendor-specific code** (e.g., for legacy systems or performance-critical tasks).
- Bypasses AUTOSAR layers for direct hardware access.

6. Microcontroller (MCU) Layer

•**Drivers**:

- **MCU Drivers** (Clock, Watchdog)
- **Memory Drivers** (Flash, RAM)
- **Crypto Drivers** (AES, SHA acceleration)
- **Wireless Comm. Drivers** (Cellular, BLE)
- **Communication Drivers** (CAN, SPI, I2C)
- **I/O Drivers** (ADC, GPIO)