Software Platforms for Automotive Systems

Tutorial 1: Basic Concepts

Sample Solution

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Cost Sensitiveness

1) The automotive domain is highly cost-sensitive. To illustrate this let us consider the following example: An OEM sells 100 million units of a given car model in a year.

a) If 10 cents can be saved up per unit. How much is the total saving of the OEM for a period of 10 years considering an annual interest rate of 2%? Hint: Assume the OEM disposes on the saving on a yearly basis.

b) Compare this with the case of the aeronautic industry where only 10,000 units are sold in a year.

c) How do costs increase as errors are detected later in a car’s life cycle? Consider the phases: i) design, ii) development, iii) production and iv) commercialization. Explain your answer.

Cost Sensitiveness

1.a) u=100 million, s=0.1 euros, y=10 years, r=0.02

$$s \times u \times \left(\sum_{i=0}^{y-1} (1+r)^i \right) = 109{,}5 \quad \text{million} \quad \text{euros}$$

1.b) u=10,000, s=0.1 euros, y=10 years, r=0.02

$$s \times u \times \left(\sum_{i=0}^{y-1} (1+r)^i \right) = 10{,}950 \quad \text{euros}$$

1.c) Cost increase exponentially as errors are detected later in the car's life cycle. Errors detected in the design phase have no cost whereas errors detected in the production phase are very costly. The reason is that it takes more time and effort to correct errors in the later phases.

State Automata

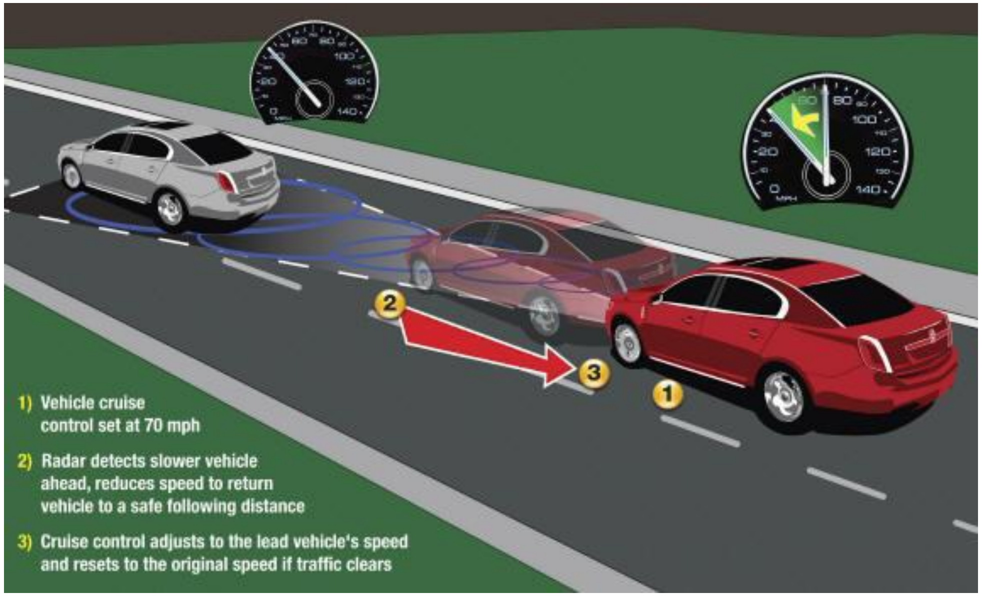
2) Let us consider the ACC (Adaptive Cruise Control) system. ACC keeps the car's speed at a desired constant value taking traffic flow into account.

Sketch a state automaton for ACC. For this consider the situation of the following picture with:

i) ACC set at 110 Km/h.

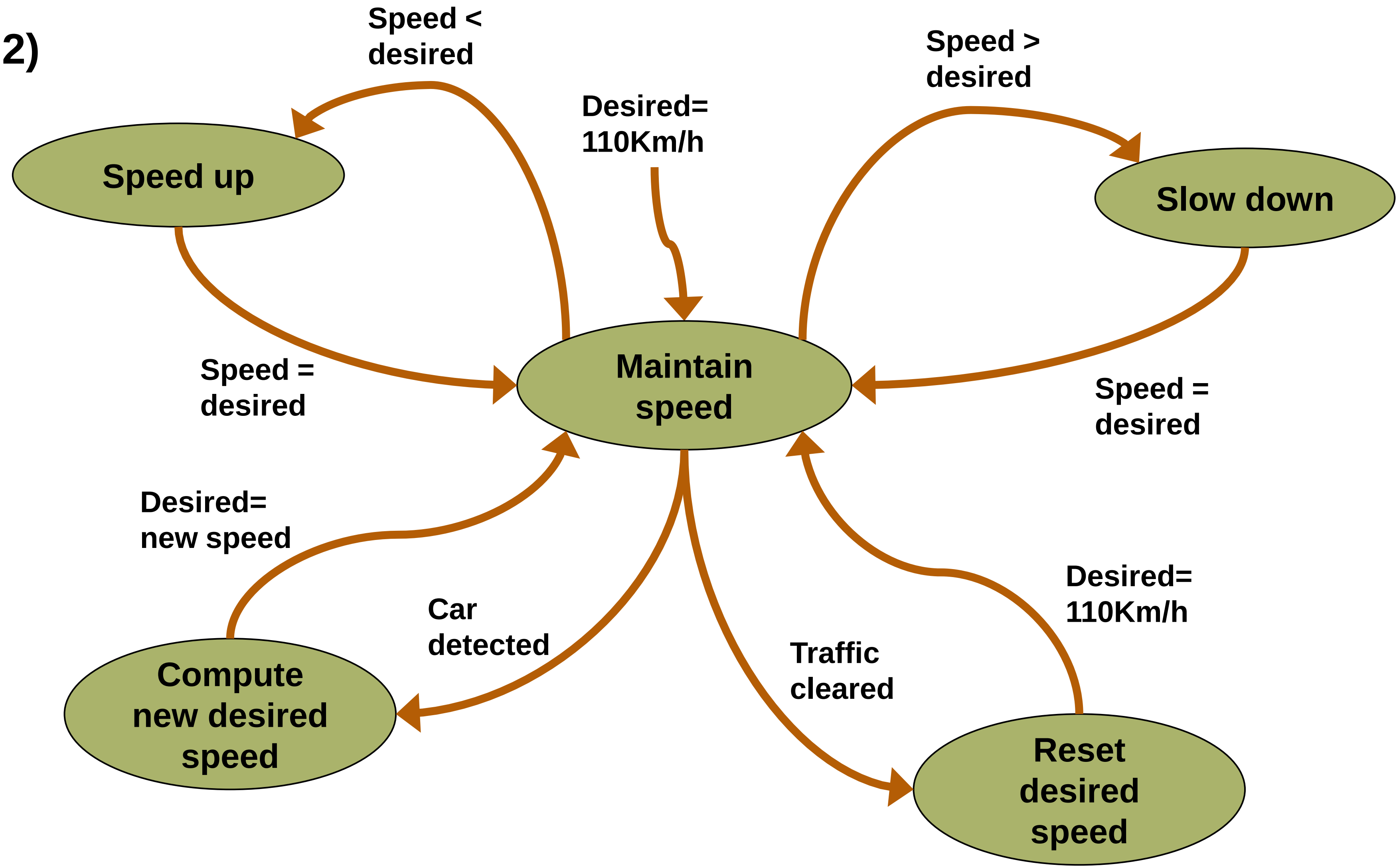
ii) ACC detects a car.

iii) If speed of leading car less than own speed, then ACC adapts its speed to keep a safe distance, and it resets to the configured speed if traffic clears.



State Automata

2)



Logical and Technical Architecture

3) Different modules/ECUs need to integrated in order to achieve the desired behavior of ACC. Sketch the logical and technical architecture of the system. Consider that the modules/ECUs involved are as follows:

i) ACC: This ECU takes RADAR sensor data to determine the distance and speed of the leading car. It receives the desired speed from the driver and controls other modules/ECUs.

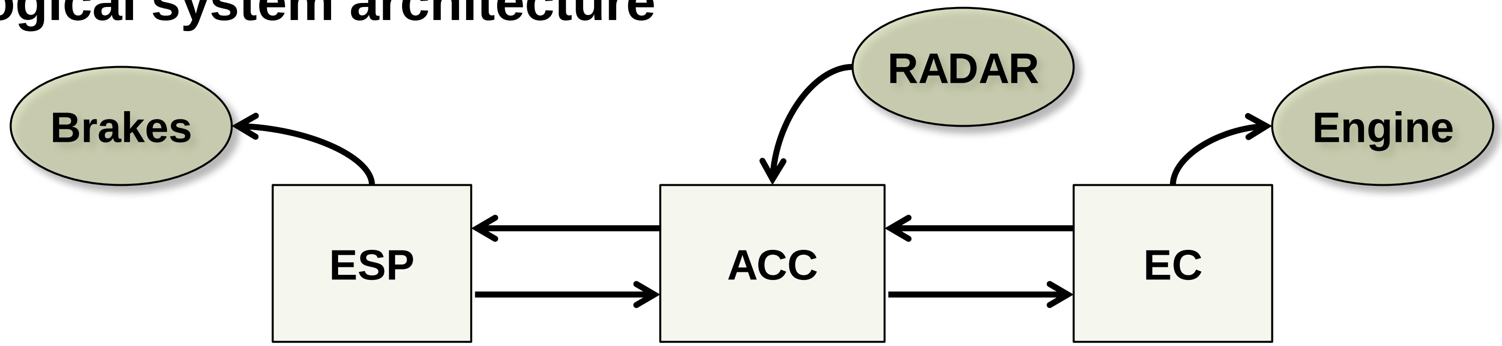
ii) ESP (Electronic Stability Program): This ECU controls the brakes and wheels. It provides ACC with the current speed.

iii) EC (Engine Control): This ECU controls the engine functions including speed.

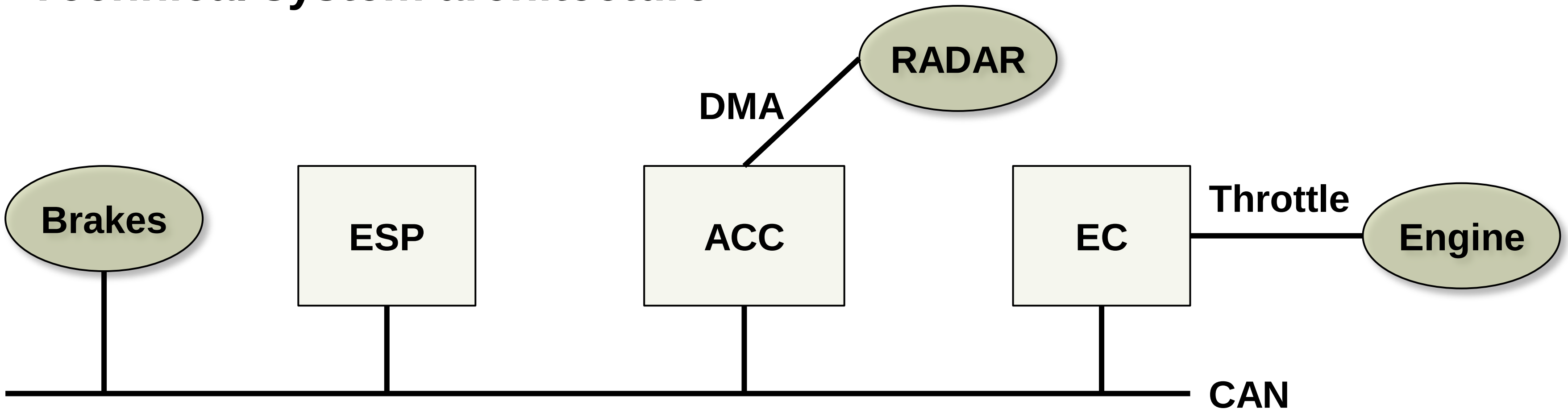
Logical and Technical Architecture

3)

Logical system architecture



Technical system architecture



Logical and Technical Architecture

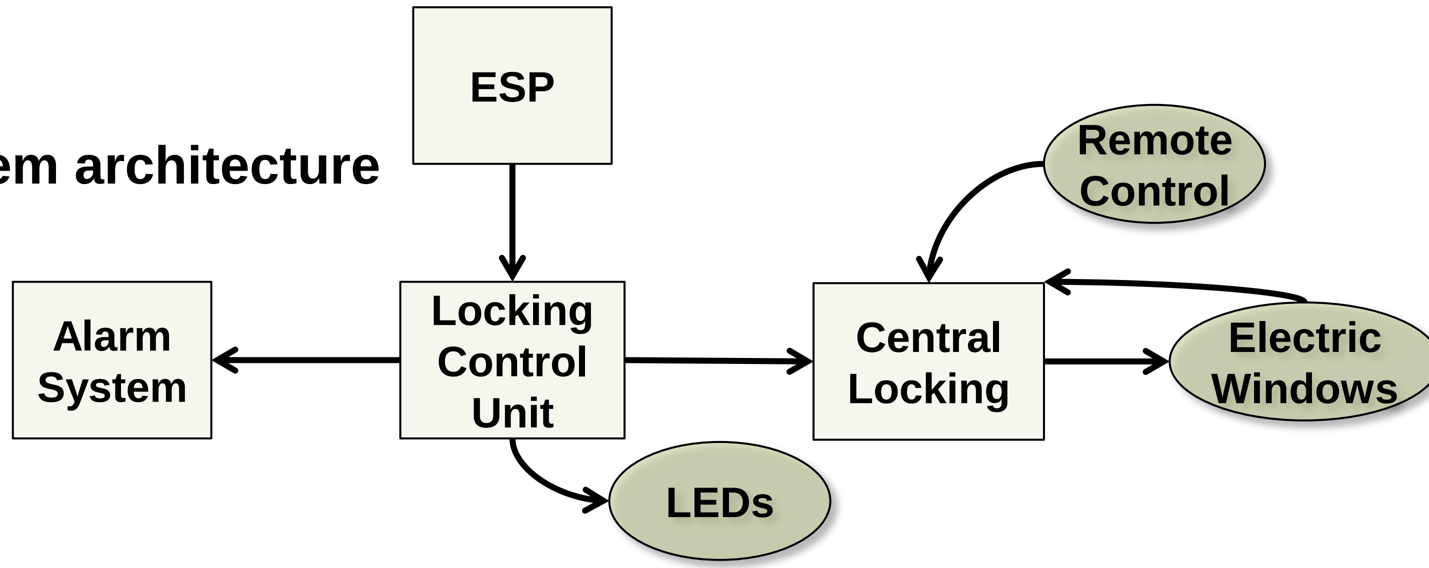
4) Sketch the logical and technical architecture for following comfort electronics consisting of alarm system, central locking, remote control, electric windows, and locking control unit:

- **i) The alarm system should be activated when doors are forced to open.**
- **ii) The central locking system should close and open doors on demand**
- **iii) The remote control allows for a remote acti-vation of the central locking system.**
- **iv) Electric windows are closed automatically when car is closed by central locking.**
- **v) The locking control unit activates the alarm when car‘s speed is zero and the driver leaves it unlocked. It locks doors automatically when speed is greater than a given threshold. It turns on the LEDs signalizing that doors are open/closed and that the alarm is engaged or disengaged.**

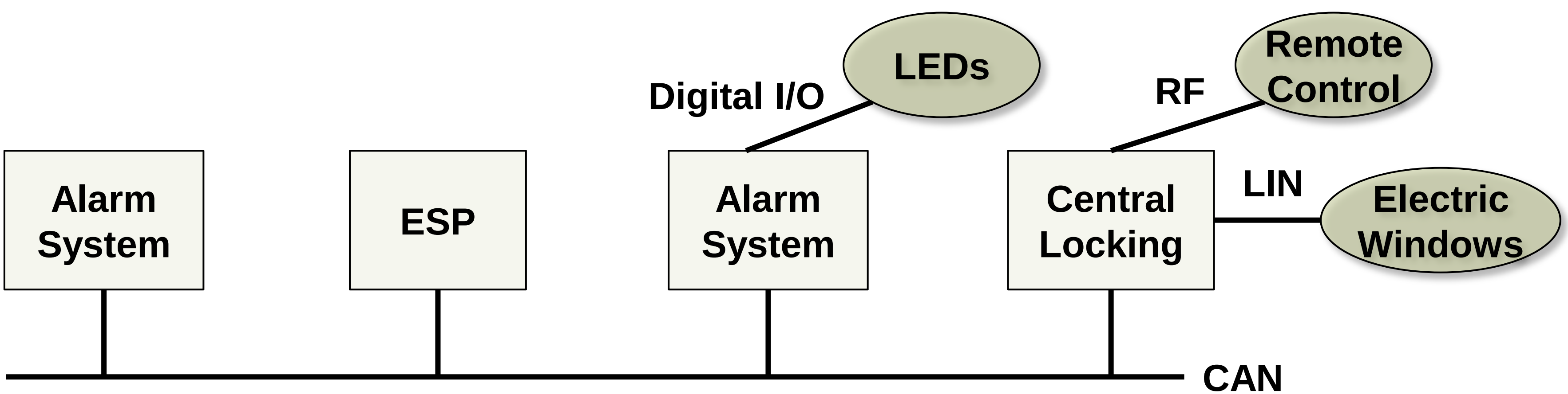
Logical and Technical Architecture

4)

Logical system architecture



Technical system architecture



Automotive Domains

5) Automotive applications are typically divided into different domains according to their functions.

a) **How many automotive domain are there? Explain them briefly.**

b) **Which are the safety-critical domains in the automotive industry? Explain why?**

c) **What is the different between passive and active safety? Mention examples of passive- and active-safety systems.**

d) **Into which domain can we classify ACC?**

Automotive Domains

5.a) There are 6 domains: Power Train, Chassis, Safety (passive), Body/Comfort, Multimedia/Telematics and Man Machine Interface.

5.b) Power Train, Chassis, and Safety are safety-critical domains. Error of applications in this domain might put human life in danger.

5.c) Active safety involves applications that try to avoid accidents (ESP, ABS, etc.). Passive safety involves applications that try to mitigate the consequences of an accident (seat belts, airbags, etc.)

5.d) ACC is a cross-domain application involving functions from power train and chassis, etc.