Project Description

Figure 1: "virtual bootcamp challenge" – collage

Challenge for the Virtual Bootcamp:

A. main assignment for the virtual bootcamp session

You navigate your train remotely (see "The Virtual Bootcamp") from Linz train station, where the Infineon offices are located and where you have spent some time learning about the **Infineon Radar Sensor**[1], to Vienna train station where you will be welcomed by the Thales Austria company and learn more about ETCS (see "Fact Sheet").

Using the **Infineon radar sensor** together with Arduino Hardware or a Raspberry Pi, you programmed your train to detect its relative position on the train route at all time. When your train passes a yellow beacon it checks its current position as derived from the radar sensor against the fixed and known location of the beacon with respect to the coordinate frame on the railway map. Even in case of a deviation in position between the measured and the actual value, your system is able to pinpoint the error margin approximately and deliver a good estimate of the actual position.

For your journey you display position data on the train by means of an lcd screen. However you let both your coworkers from Infineon in Linz and your colleagues at Thales in Vienna monitor the train's position in "real time" through a program running on their device of choice (cross-platform app). There is no limit to how sophisticated your User Interface looks.

[1] **Sense2GoL**, 24GHz sensor development kit utilizing Infineon BGT24LTR11 RF transceiver and XMC1300 32-bit ARM® Cortex®-M0 MCU series: https://www.infineon.com/sense2goL

B. extensions for the virtual bootcamp session and on-site development

You have succeded with the main challenge as a group and want to take on number a), b) or c) in this list. You have relevant skills and experience with Matlab, RTOS, Qt or 3D printing and choose to focus on the task c), d), e) or f) respectively right from the start.

a. Develop on the story in the main assignment, create new scenarios and test cases – then conquer the challenges.

b. Let's say the operation of your radar sensor is halted due to some unpredicted event. The train is a safety-critical system. We are expecting to receive reliable position data at all times. Think about compensating for interruptions in general. Additional sensors can be deployed on the test setup for registering motion data (e.g. an IMU).

c. It is possible that someone, ill intentioned, has placed false beacons which resemble the original ones in the center line of the tracks or that there are foreign objects placed along the track. Your system registers and deals with such events. Additional sensors can be deployed on the test setup.

d. ***topic*****:** MATLAB/ SIMULINK for IoT
Notes**:** Please plan with the Thales & Infineon Bootcamp coordinators for testing hardware and software configurations ahead of time if you like to work on this topic. For point II schedule an on-site working session.

I. Link yourself into the main assignment and extension b) using Matlab for Sensor fusion (e.g. Sensor Fusion and Tracking Toolbox).
II. Improve the speed control of the brushed DC motors which was designed making use of the Matlab Control System Toolbox (on-site[2] option working on the model train setup of the Bootcamp).

e. ***topic*****:** RTOS/freeRTOS for Arduino/avr programming and embedded c
special prerequisites: i) can only be done provided there is a big enough group working on the main assignment. For ii) you will be given a separate set of tasks and some additional code.
Notes**:** If you're interested in working on this topic you need to plan with the Thales Bootcamp coordinators ahead of time for testing hardware and software configurations and for studying supplementary references.

I. You will learn about RTOS programming by developing the program for the main challenge on Arduino hardware, making use of RTOS tasks.
II. You are experienced with freeRTOS and want to take on the challenge of managing the integrity and complexity of all components of the train system together.

[2] location t.b.a

f. ***topic*****:** Qt

Notes**:** Please plan with the Thales & Infineon Bootcamp coordinators for testing hardware and software configurations ahead of time if you like to work on this topic.

You are extending on a basic template created so far, developing the cross-platform application described in the main assignment for visualising data. You can add warning elements to the dash board, create a digital twin, bring the user experience to a new level by making user interactions both comprehensive and appealing and futhermore push data into a cloud.

g. ***topic:*** 3D printing / Solidworks

Notes**:** If you're interested in working on this task, please schedule an on-site working session with Thales & Infineon Bootcamp coordinators (on-site option[3], working on the model train setup of the Bootcamp).

You enjoy designing and will give the application the group develops in this project a functional "outer shell". You transform it to an eye catcher for when the results will be presented at the bootcamp and later on at the Best of #IMM2020 event. You reckognise the needs, set constrains and functionalites for your 3D-printed model. You share your design digitally with all teammates so everyone can get them 3D-printed remotely for their own home-setup.

[3] location t.b.a.

Fact Sheet

Since the train is locked onto the track, we might think that with building a rail line from Vienna to Linz, the train will not depend on Google Maps for navigating between the two places. While to some extend this is correct, being bound to a predefined pathway at all times brings about real challenges:

Just as cars can find themselves in a traffic jam during commuting periods, the main east-west rail corridor connecting Vienna and Linz can get very busy at times, accomodating a large number of local, intercity and international, both passenger and freight trains. However, the possibilities for a train to overtake or give way to another train are scarce and evasive manoeuvres in case of emergencies (e.g. for avoiding a collision) are not an option.

It is therefore imperative that the trains run in a well coordinated manner, guided by a mastermind who processes information coming from each and every train, from track-side systems, monitoring environmental data and from post-analytical computational evaluations. This mastermind infrastructure comprises multiple entities, i.e. radio block centres, train control centres and path coordination systems. The task we face, in an ongoing manner all through the foreseeable future, is to provide these controlling systems with **more diverse, more accurate and more reliable information - safe, available at all times and from every location**.

With accessibility to real time motion profiles and performance parameters of trains, control and signalling systems can be optimized towards administering larger volumes of traffic on rail tracks and thus an increased number of connections.

Figure 2: balises (source: Vortok Balisen Mounts ERTMS October 2008)

In the status quo railway infrastructure, the very basic (ETCS-level 1) position tracking elements are yellow beacons (balises, see Figure 1) anchored sectionally into the center line of the tracks. These are equipped with transponders and (amongst other data) communicate their location to the train through telegrams so that the train can determine its instantaneous position within the railway-map reference frame. A comprehensive description of the on-field train position tracking mechanisms, commonly and currently employed all across Europe, is part of the European Train Control System (ETCS)[4].

For our experiment, yellow rectangular slips of paper are substituted for the balises.

[4] suggestions for literature:

- http://www.styria-mobile.at/home/Austro-SwissRailwaySignalling/asr/desigazsetcsl2.html
- https://fahrweg.dbnetze.com/resource/blob/4119016/461729e9fed0107df85271ba1bbddf8b/etcsbroschuere_2018-data.pdf

The Virtual Bootcamp

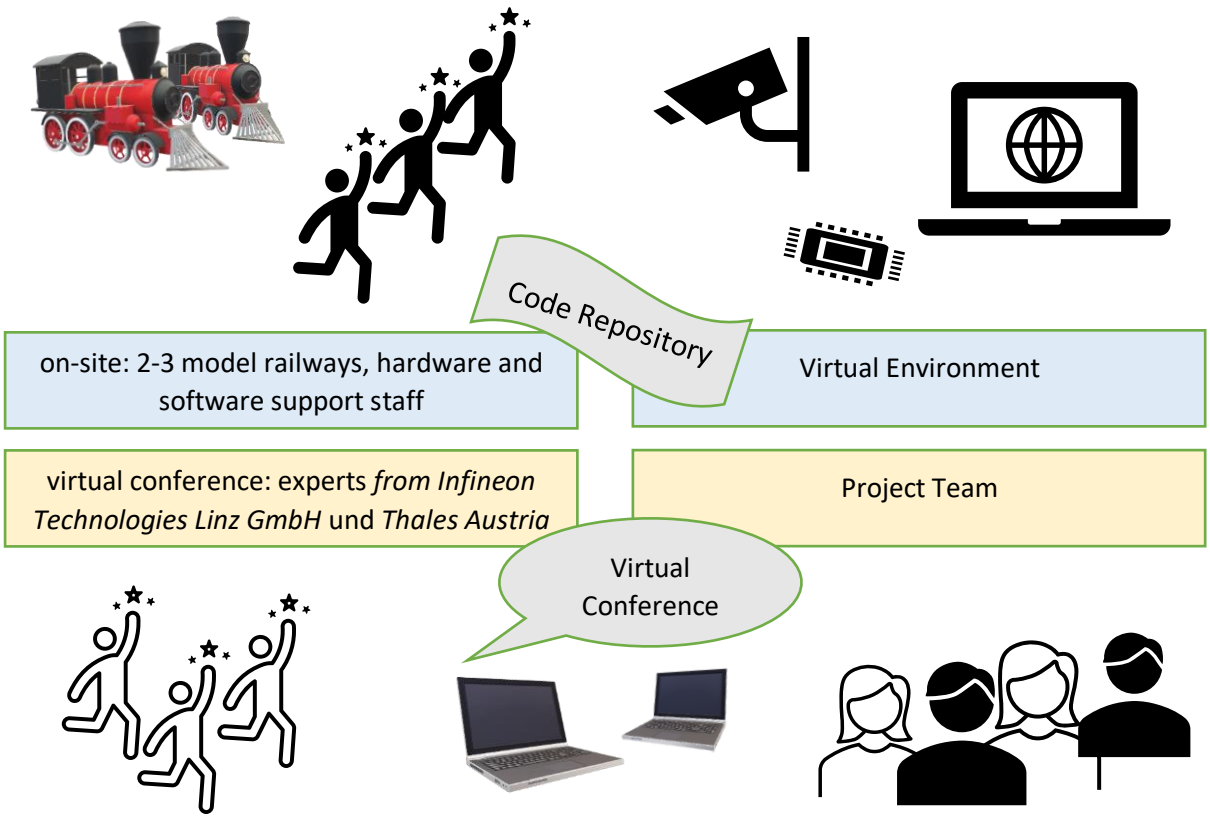

Figure 3: how we set up our workspace

Depending on the needs of the team, the "on-site[5]" model trains can run different sets of hardware and software components.

1. Our group of experts invites you to get into contact with us prior to the event. We will answer your questions and assist with the team building process.
2. If you decided to be part of our project team, code resources, UML- or sequence diagrams, system architecture diagrams and notes about the software deployed will be made available to you two weeks in advance.
3. If you have a model railway at home (e.g. a Lego Train), you might be able to use your own train-setup for some tasks of this challenge. Please plan with the Thales & Infineon Bootcamp coordinators ahead of time.

All participants are encourgage to adapt and reuse the code developed in this Bootcamp for their own IoT-purposes. We offer on-going support and also welcome your initatives for a post-Bootcamp collaboration.

[5] location t.b.a.