DTN-based Formula Student Rule Enforcement

Sebastian Schildt, Wolf-Bastian Pöttner, Johannes Morgenroth, Bennet Sartori, Lars Wolf, Willem Almstedt, Hendrik Heine, Sandra Hesse, Eduardo Jiminez, Tim Lüdtke, Vinh Tran, Daniel Mazur, Tobias Michaels, Christoph Stamprath, Nicolas Steinwand

Formula Student Germany

- In one year students design, construct und build a prototype race car seating one person.

- The only limitations in proving their creativity and knowledge are some safety restrictions in compliance to Formula Student rules.

- The Competition is the climax and the reward for the students' hard work.

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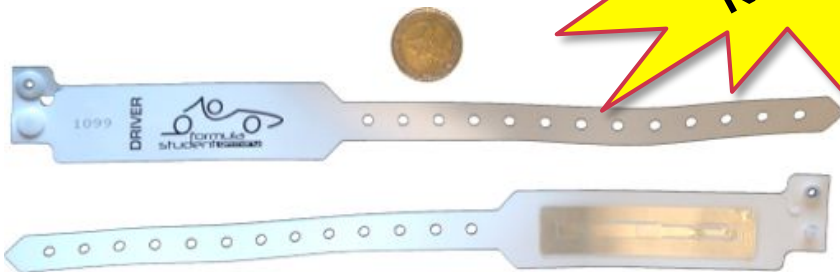# Formula Student Germany

Driver Management

Safety and Fairness

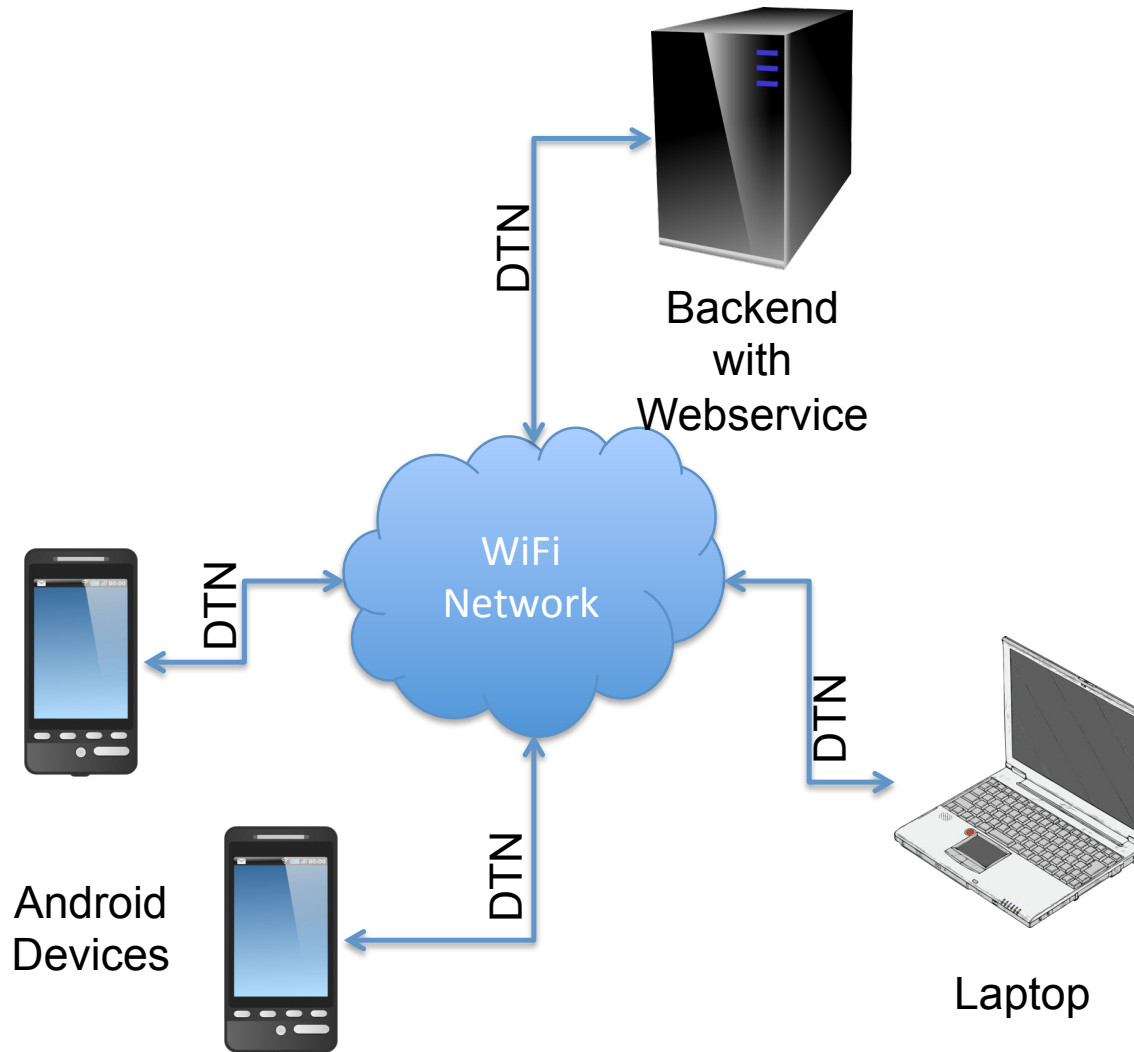In order to attend a dynamic competition, a driver

- Needs to be registered as driver

- Need to attend a daily driver briefing

- Is only allowed to compete in a subset of disciplines
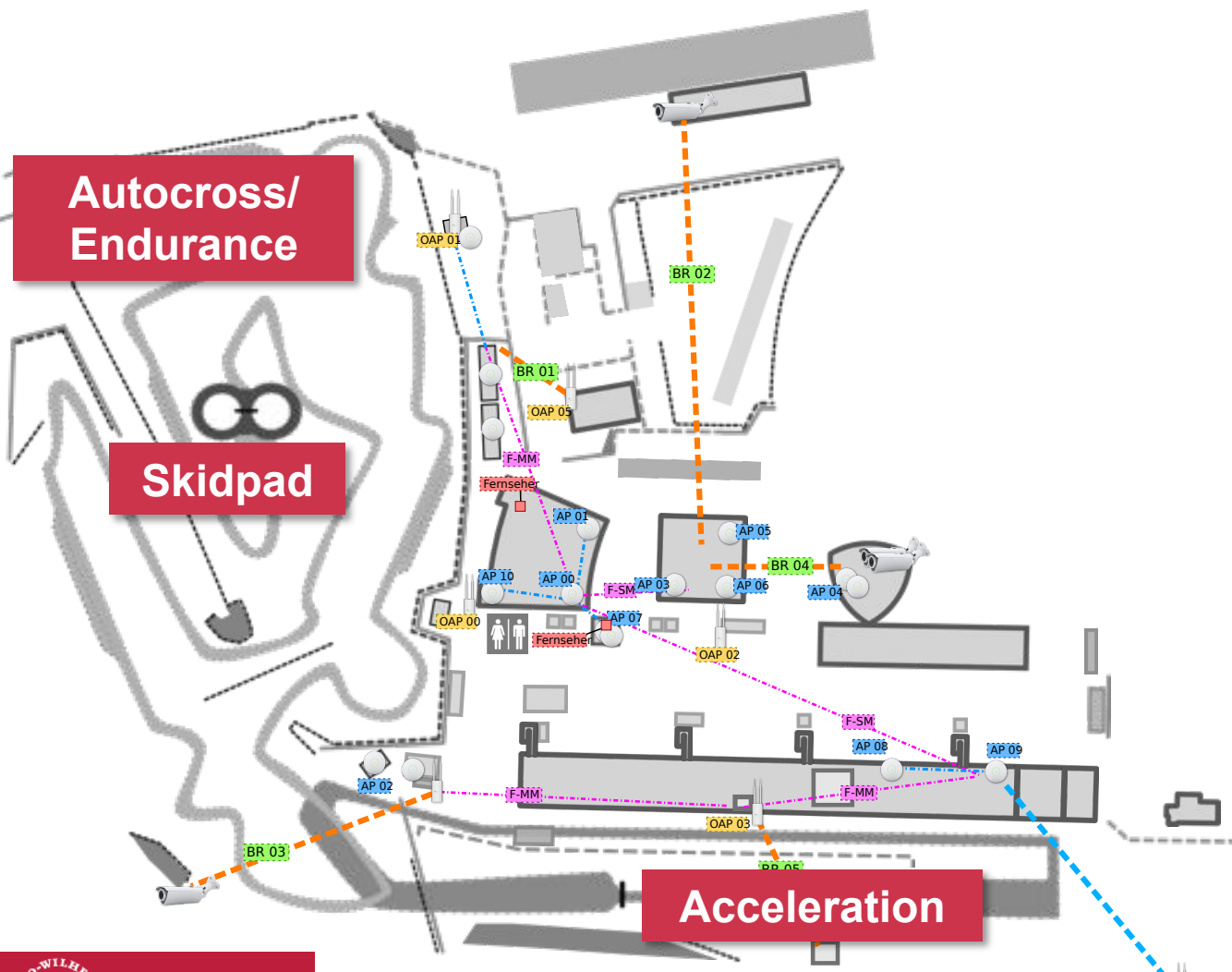
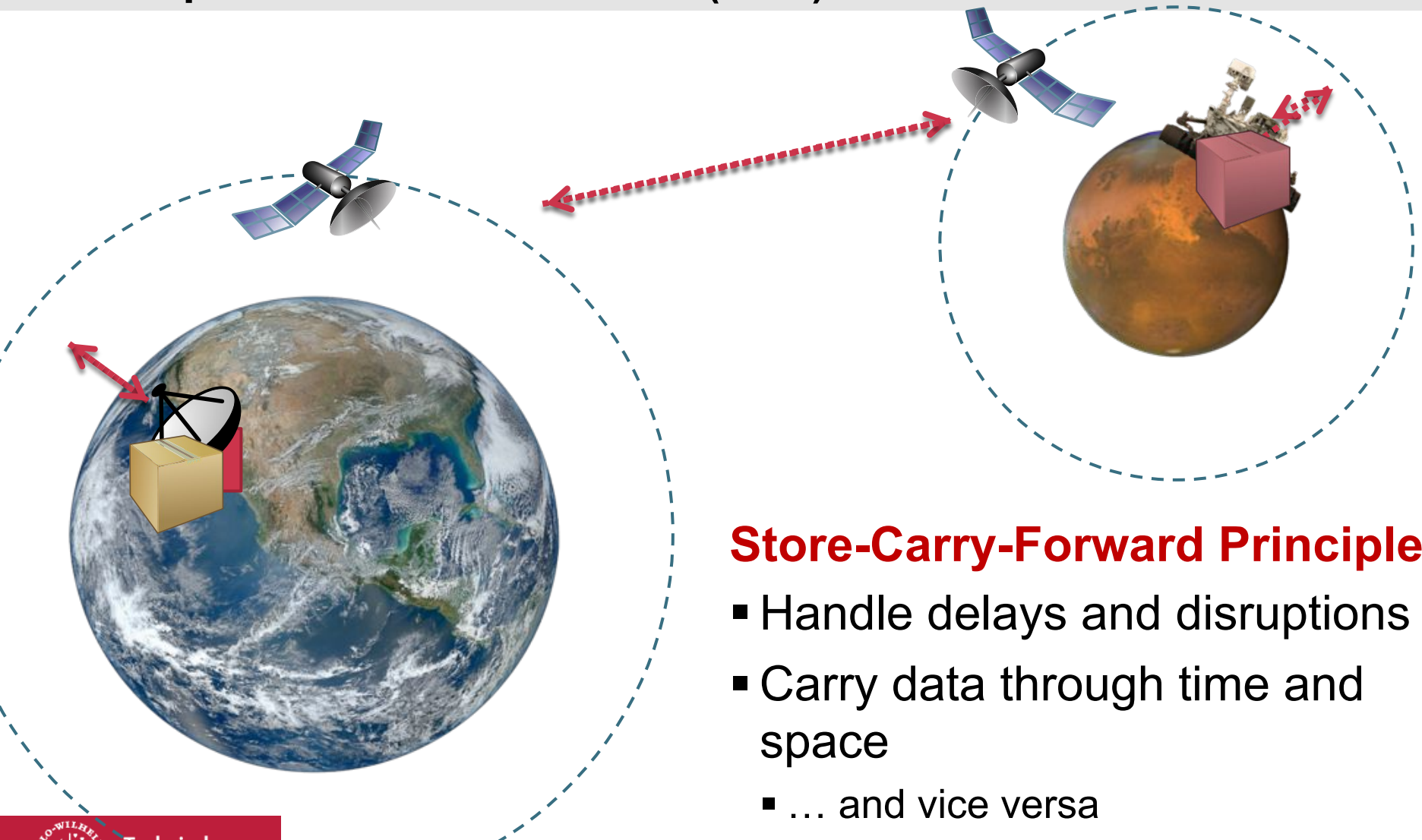## Legacy System

- Multiple wristbands
- Paper-based lists

New:
RFID-system

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System Components

Intermittent WiFi Connectivity

Disruption Tolerant Networks (DTN)

Store-Carry-Forward Principle

- Handle delays and disruptions
- Carry data through time and space
  - … and vice versa

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DTN vs. Classical (Wireless) Networking

Argh, those dreaded mobility! Always a big headache with nodes moving around getting out of range and stuff!

What a wonderful thing mobility is. It helps me spreading data.

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DTN vs. Classical (Wireless) Networking

Links and routes can fail anytime. Luckily I am prepared for this horrible incidents by using sophisticated route recovery and repair mechanisms!

You are a "Horrible incident". Links will fail all the time. That's just the way wireless networks are.

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DTN vs. Classical (Wireless) Networking

I have so many powerful ways of routing. I can find shortest paths, most reliable paths, use location, interest and much more to make your data arrive!

I can do all that. And if even with all those measures I can't deliver your packet directly, I will travel into the future to deliver it!

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DTN vs. Classical (Wireless) Networking

I am the standard. The whole internet builds on my principles. After all, most networks, even wireless ones are more or less reliable and connected, and this is my domain!

Networks for sissies? I am just as good as you in those networks!

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DTN vs. Classical (Wireless) Networking

Ordinary Networking	DTN Networking
Mobility is a challenge	Mobility is exploited
Link failures are handled as accidents	Failing links are considered as normal
Routing through space	Routing through space and time
The Standard	Superset of ordinary networking

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All data on Wristbands

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Manufacturer reserved															
MAC Pt. 1															
MAC Pt. 2															
Type	Driver					Team				Class		Car		Name	
Given Name															
Given Name												Driver			

Registration Sector

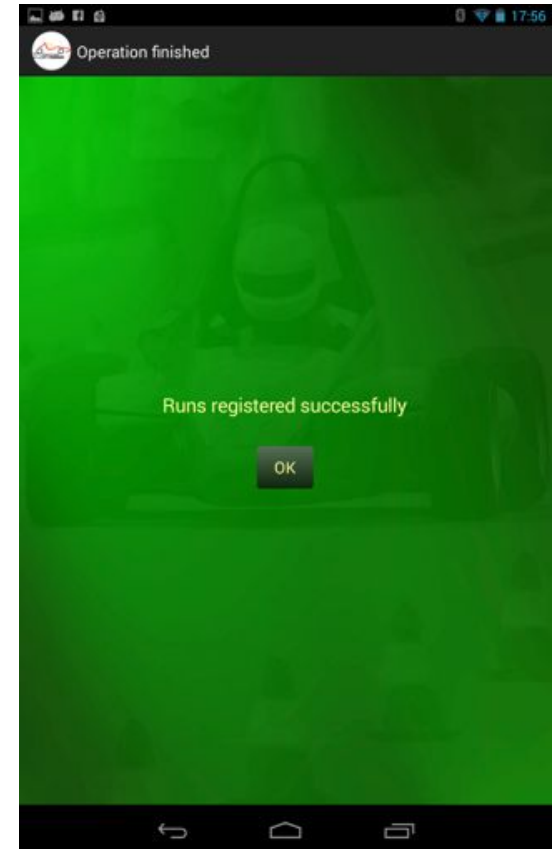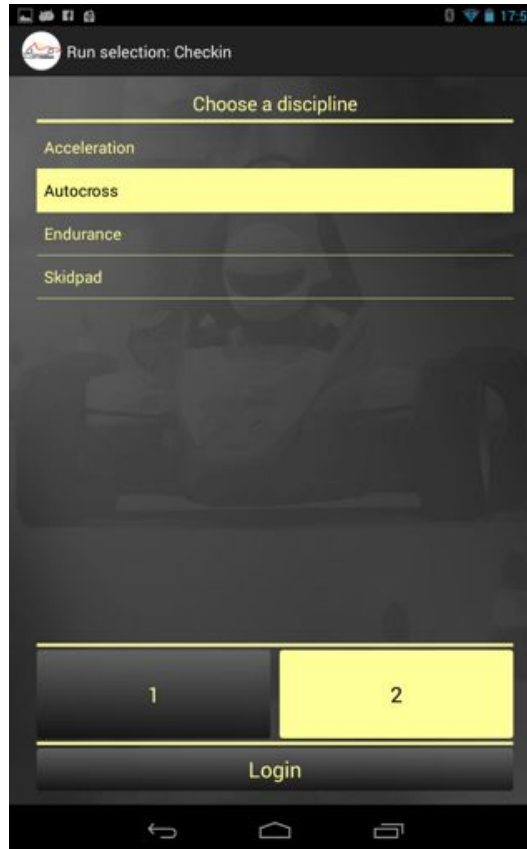| 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Type	Login	Timestamp				Reader									
MAC Pt. 1															
MAC Pt. 2															

BriefingSector

Security Features

- ## We use MiFare Classic
  - MiFare Classic Crypto has been thoroughly broken

- ## Blocks are permanently write protected
  - Can only add to a band
  - Reader always checks sequence of all blocks
  - Later blocks can invalidate earlier ones

- ## HMAC Authentication (SHA-1)
  - Secret key
  - All block data and Tag ID (unique) as input

- ## **Consistency checking in the backend**

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Android App used on Track

Used on track. Android based. We used Nexus7 tablets with extra battery

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Experience: Driver Registration

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- ## No trouble with broken WiFi connections in the field

  - ○ Volunteers neither noticed nor cared whether there was WiFi or not

  - ○ Data eventually arrived at the backend

- ## Reading distance for proximity tags is really short

  - ○ Sometimes need to move the tags on the drivers hand

- ## Achieved at least the same throughput as the old system

  - ○ 22 cars per 10 minutes (27 s/car) for Acceleration

  - ○ RFID check is not the bottleneck

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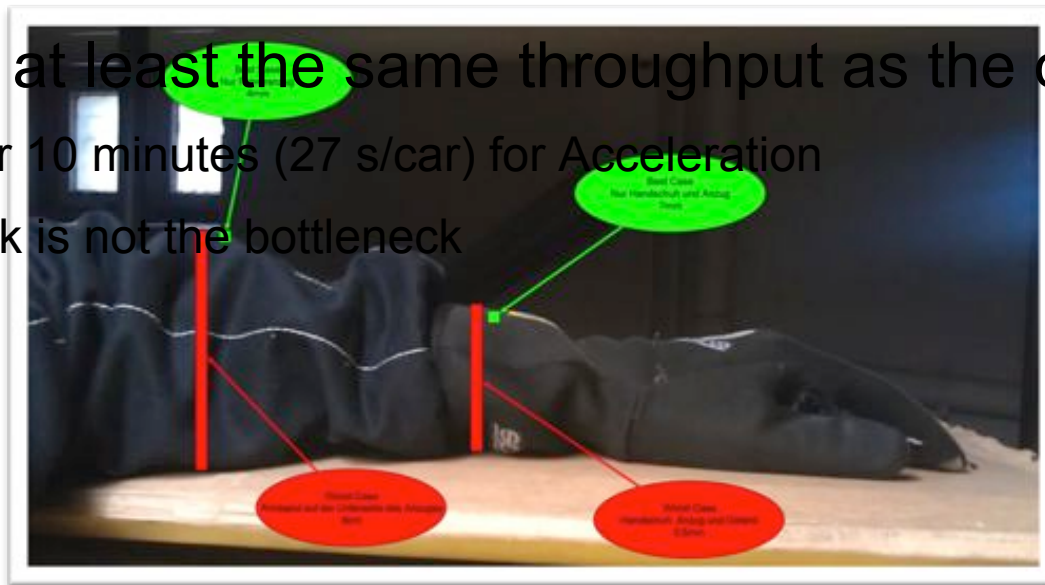
Experiment: Custom Reader

Better antenna and custom FDM printed case for better usability

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Thank you. Questions?

https://www.formulastudent.de

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