



WW-02

OTA Stimulation of Automotive Radar

Helmut Schreiber^{1,3}, Wolfgang Bösch¹,
Michael Gadringer¹, Steffen Metzner²

¹ Institute of Microwave and Photonics Engineering,
Graz University of Technology

² AVL List GmbH, Graz

³ helmut.schreiber@tugraz.at



The 15th European Radar Conference

Goals and Ambition

- Testing sensor
- Testing automation functionalities of vehicles and autonomous driving functions in the laboratory



SIL/HIL



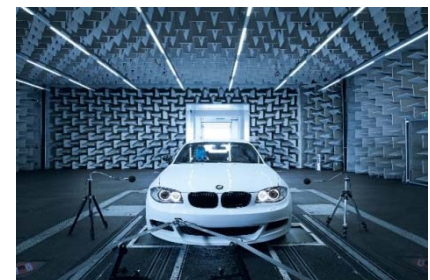
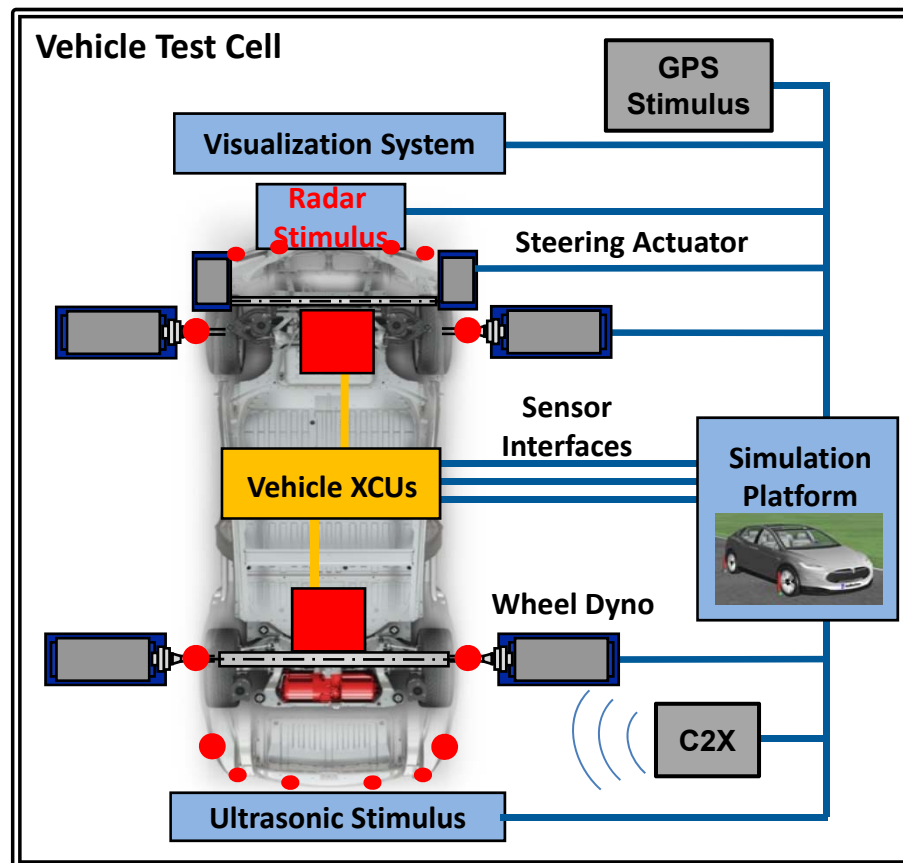
AVL DrivingCube™



Driving Simulator

Vehicle stimulation

- Torque
- Ultrasonic sensors
- Steering actuator
- Camera
- Car2X
- GPS
- Radar sensor
- LiDAR



© AVL

The Challenge

- Radar stimulation has to be coherent
 - ⇒ It has to modify the transmitted signal to create a echo similar to the real target's.
- Over-the-Air (OTA) stimulation
- Radar is „unknown“: stimulation should work with as little a-priori knowledge about the radar as possible
- Short distance (starting from 2 metres)
- Complex scenarios with many targets (≥ 4)

Coherent Stimulation

- Generate the echo in real-time from the radar's transmitted signal

OR

- Use a recording of the transmitted waveform

Analog vs. digital

- Hardware complexity vs. processing speed
- Digital real time processing down to about a range of 30 m (implementation dependent)

Why OTA?

- Minimize invasive changes: Ready to drive car to be used on the test-bed
 - in complete virtual environment
 - in all driving situations up to the limits
 - in all functional and non-functional conditions
 - in highly efficient and automatized testing operations
 - Safe operation

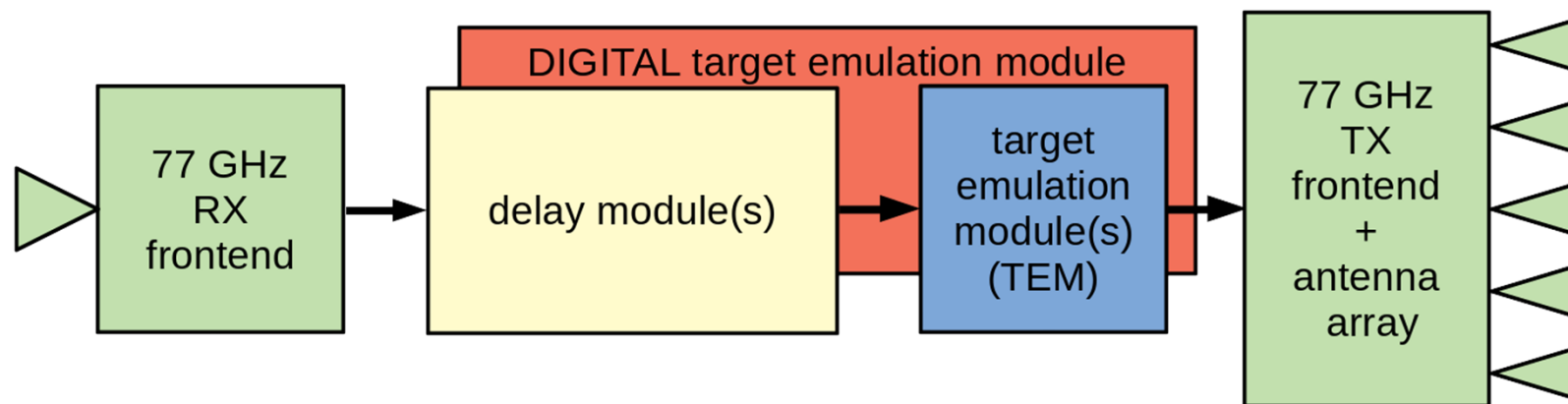


Target Stimulation

- Target parameters:
 - Range
 - Direction
 - Velocity
 - Radar cross-section (RCS)
- Stimulator has to set:
 - Delay
 - Direction-of-arrival (DOA)
 - Doppler shift
 - Amplitude

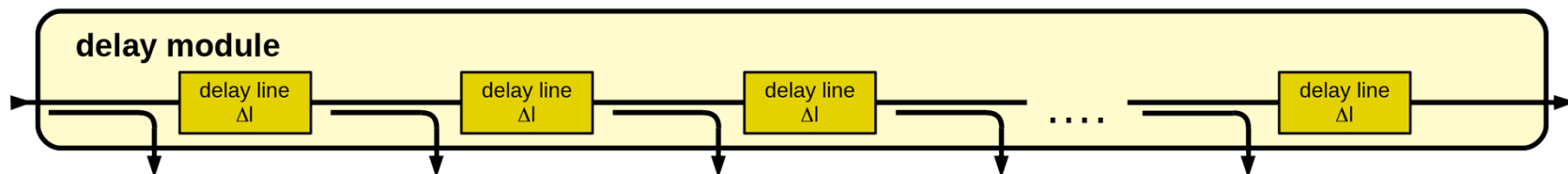
Basic Concept

- Processing at intermediate frequency (2 GHz)
- Modular design
- Scalability



Concept - Delay Line

- Provides multiple coarse delays
- Tapped delay-line instead of switched delay
 - Is able to provide ALL possible delays simultaneously
 - Enables stimulation of multiple targets at different ranges
 - Higher complexity since all delay elements have the same SHORT length

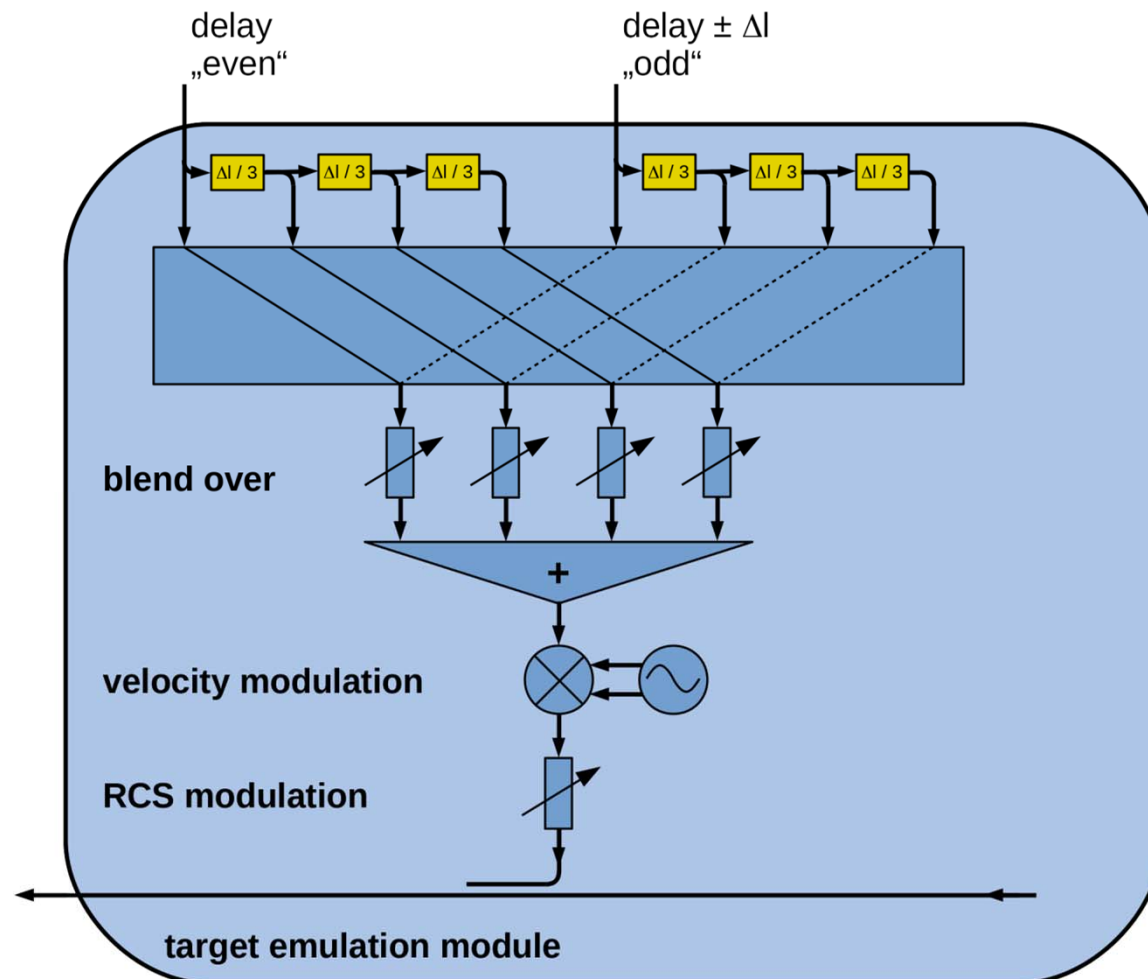


Concept - TEM

- That is the point where a single virtual target is created:
 - Doppler spectrum
 - RCS
- Additionally the TEM provides fine increments for the delay

TEM ... Target Emulation Module

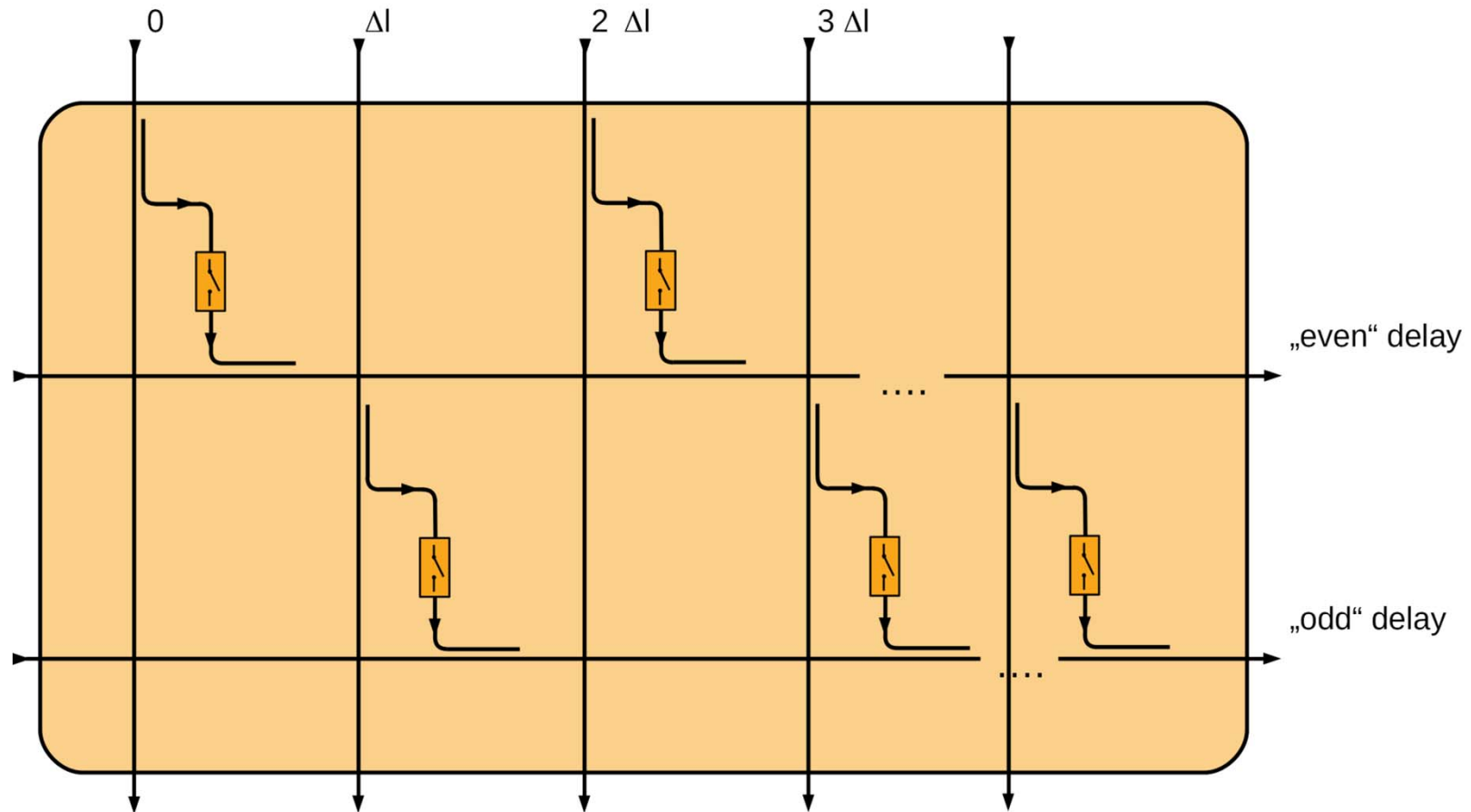
TEM



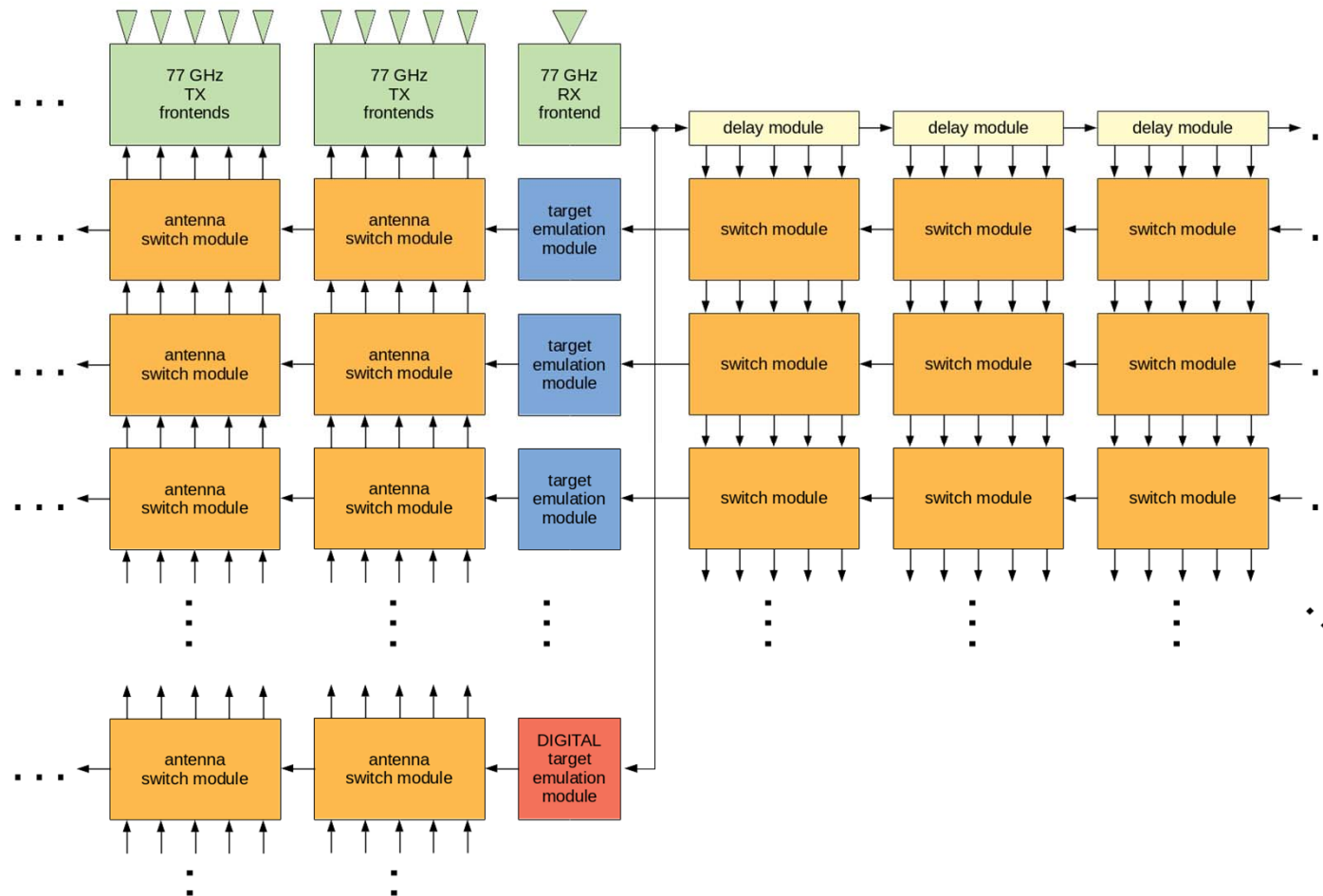
Concept - Switch Matrix

- Needed to set the distance (= time delay) of a target
 - Connects the corresponding output of the delay-line to a TEM
 - „Cold switching“ due to 2 parallel lines (even & odd delays)

Switch Matrix



Overall Concept



Demo on a Dyno test-bed

Future Challenges

- Multi-target objects to trigger object classification of the radar sensor
- New waveforms (OFDM, ...)
- Frequency & bandwidth
- MIMO:
 - Needs to model each channel (path)
 - Each element of the receive array has to be stimulated independently

Any questions ?

