



Let's shape a new
era of mobility. Together.

Let's move #LikeABosch

COSEDA UserGroup Meeting 2024

Half year experience with virtualGTM in COSIDE® 3.2

ME-IC/PRM-IPP Jürgen Hanisch | December 5th, 2024

Half year experience with virtualGTM in COSIDE® 3.2

Agenda

1. What is the GTM IP and where is it used
2. What is the virtualGTM
3. What happened since Coseda User Group Meeting 2023
4. What will come next?

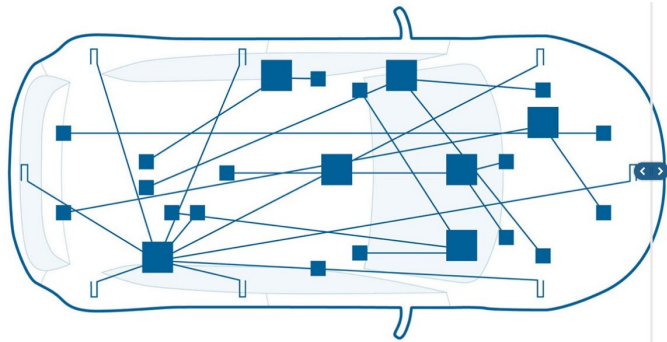
01

What is the GTM IP and where is it used

Half year experience with virtualGTM in COSIDE® 3.2

What is the GTM IP and where is it used

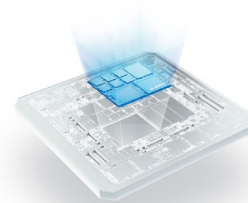
Multiple ECUs are built in cars to fulfill all necessary functions



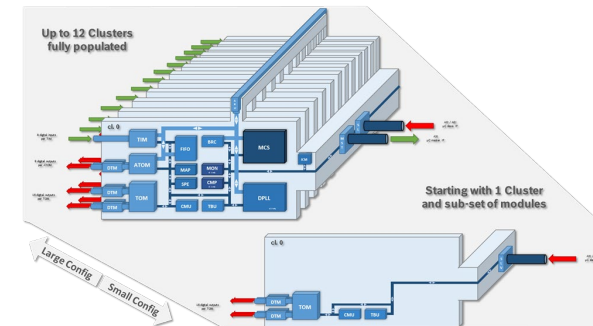
ECUs are typically built up with one/ multiple microcontrollers



An automotive microcontroller can embed one/ multiple GTM IP units

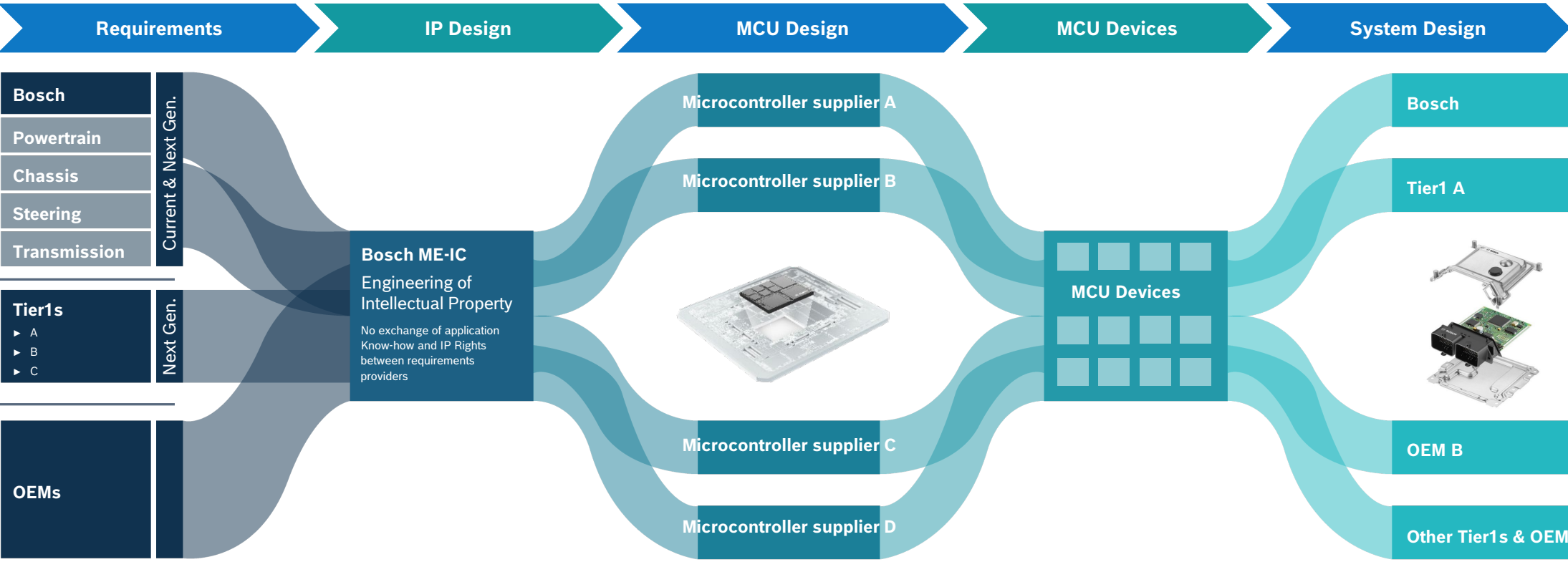


GTM IP functionality can scale depending on application usage



GTM IP – Legal Framework

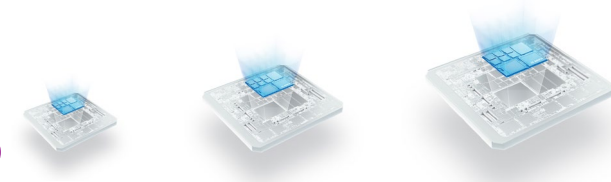
From requirements to solutions



Protection by contract and/or NDA Bosch ME-IC distributes right of the requirements provider to S/C suppliers

GTM IP – Overview GTM Gen 1 – Gen 4

Delivered device configuration 2010 - 2023



GTM IP Deliveries

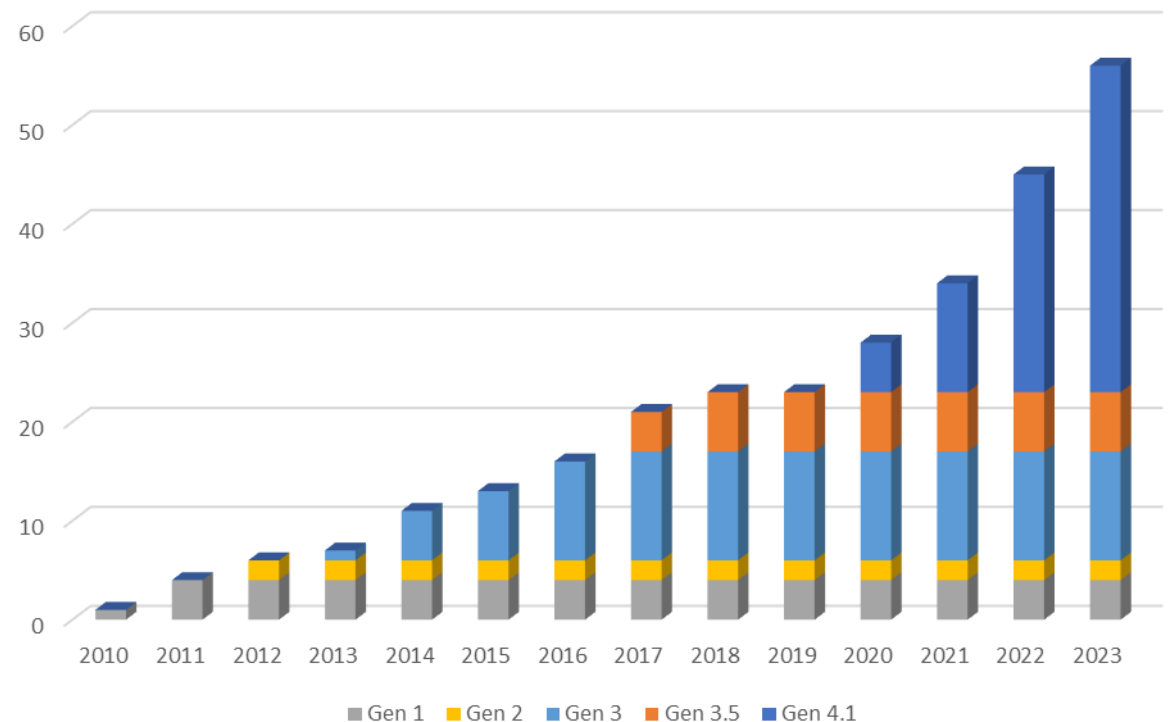
First GTM IP (Gen 1) delivered in 2010

Meanwhile more than 50 different configurations delivered to multiple semiconductor vendors

Delivery of GTM IP Gen 4 starting in 2020/21

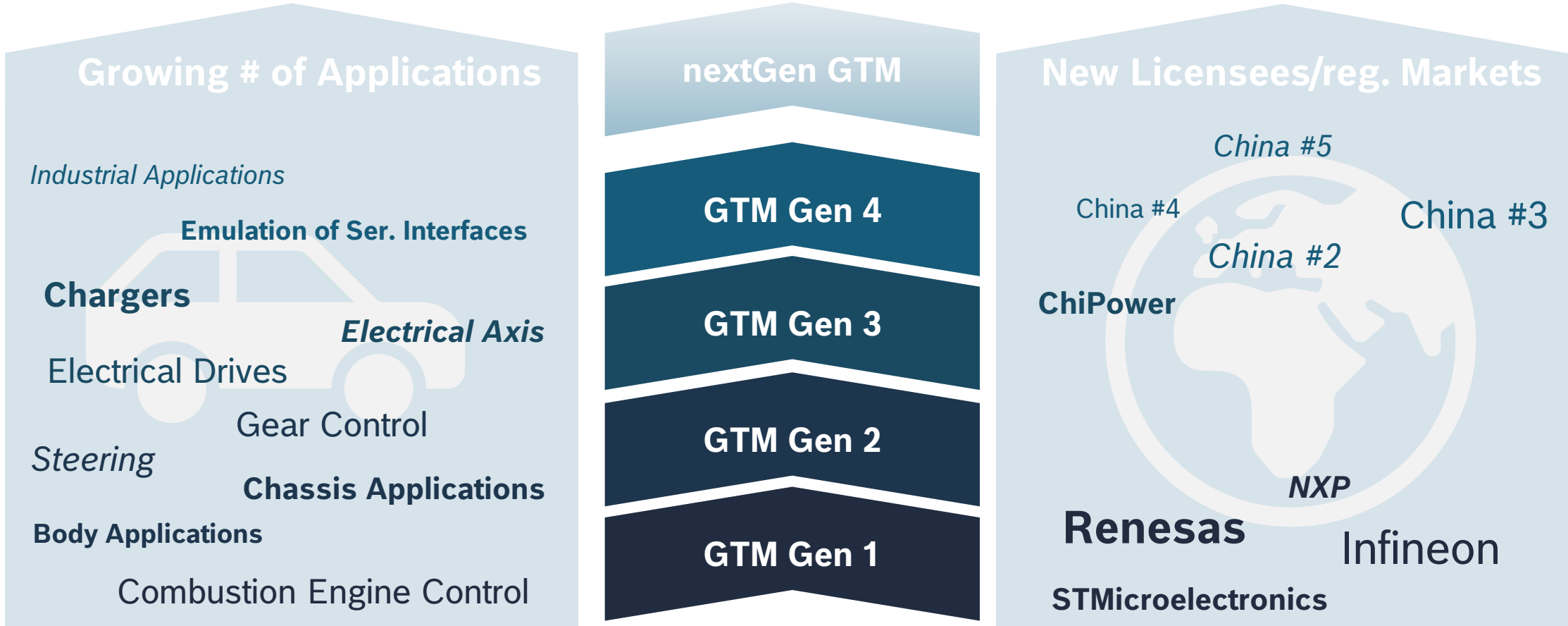
GTM Gen 4.1 devices dominating the list with more than Gen 3/3.5 in less than 2 years

Delivered GTM configurations
(by GTM IP Generation)



GTM IP – Status and Roadmap

New markets – application driven growth & new licensees



02

What is the virtualGTM

GTM IP – Architecture

virtualGTM – actual content

virtualGTM available for download:

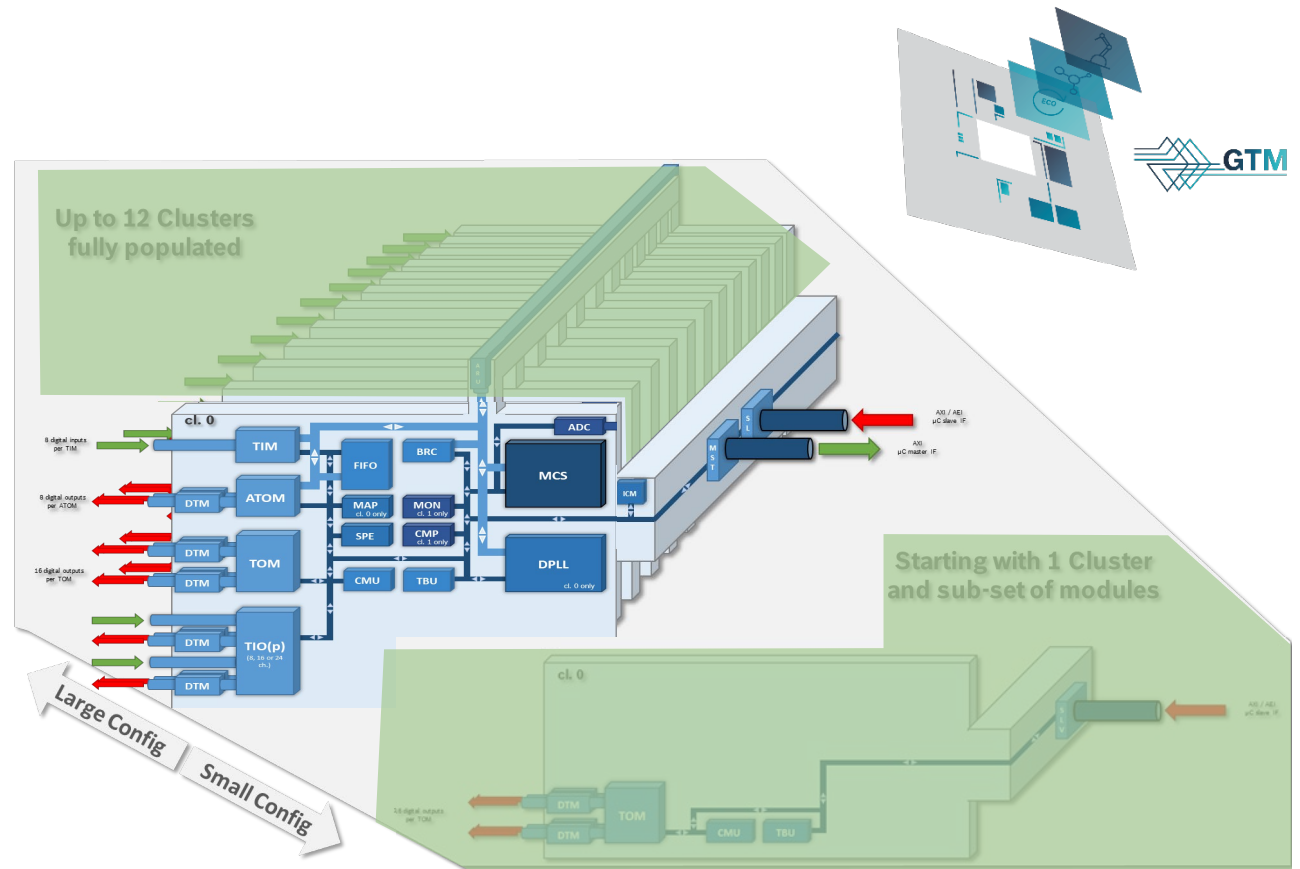
- Uses fully equipped 1 cluster GTM

01 Every GTM function available

02 Ideal suited for education/ training example

03 Complex applications using multiple GTM resources incl. MCS and ARU can be put in place

04 virtualGTM variants (more GTM resources/ clusters) can be made available on request

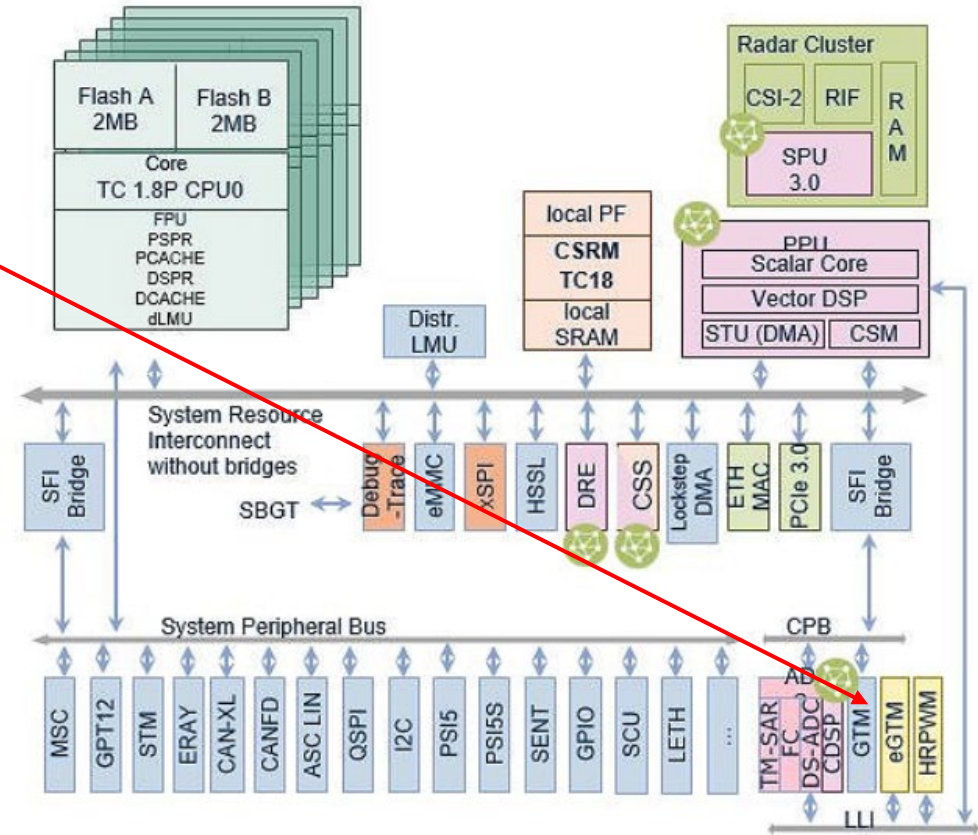


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Example for microcontroller with GTM

Example: IFX TC4xx

GTM is a sub unit in the micro controller system



https://www.infineon.com/export/sites/default/_images/product/microcontroller/Aurix/TAURIX-TC4x-Evolution.png_1016265805.png

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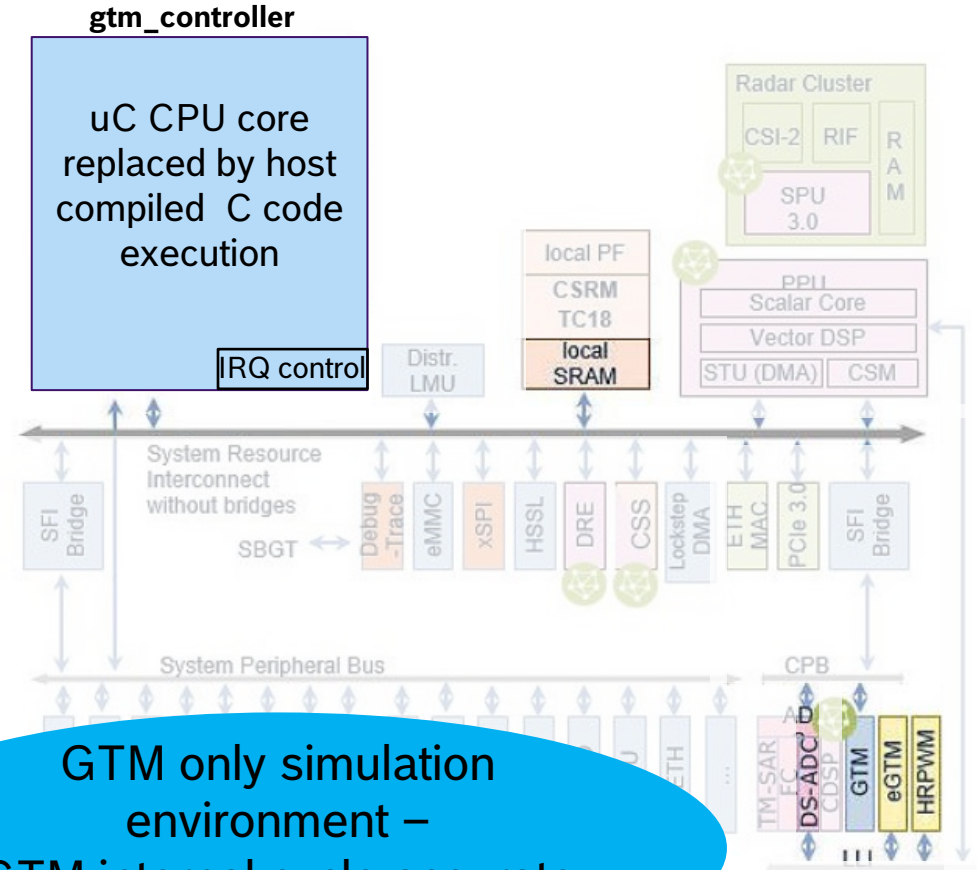
GTM only simulation environment

What will be available for use in COSIDE® simulation

virtualGTM: Cycle accurate SystemC model of GTM IP

GTM IP is embedded in Coside module, which models simplified uC- functionalities:

- CPU with interrupt controller
- Local memory
- ADC's
- Analog functionality for High Resolution PWM



03

What happened since Cosedda User Group Meeting 2023

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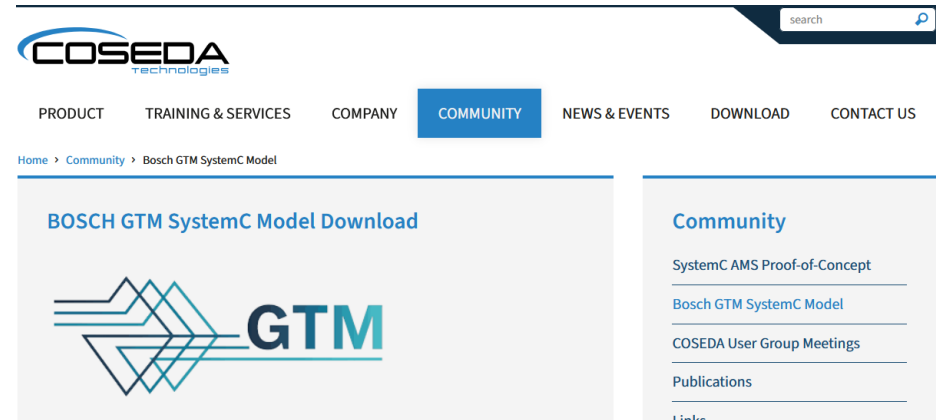
What happened since Coseda User Group Meeting 2023

December 2023: COSEDA UGM 2023

- virtualGTM accessible on download page for COSIDE® 3.1
 - Collected first experience and feedback from
 - COSIDE® users
 - COSEDA staff
 - Bosch GTM team
 - Interested people so far not using COSIDE®

February 2024:

- Decision by COSEDA and Bosch GmbH to make the virtualGTM available in the upcoming COSIDE® 3.2 release



Half year experience with virtualGTM in COSIDE® 3.2

What happened since Coseda User Group Meeting 2023

March 2024: Bosch IP TechDay Asia Shanghai

- presentations, talks
 - GTM IP ECO environment partner contributions
 - COSEDA, Lauterbach, Tasking, Hightec
 - <https://www.bosch-semiconductors.com/ip-modules/gtm-platform/ip-techday-asia-2024/>
- ~200 participants

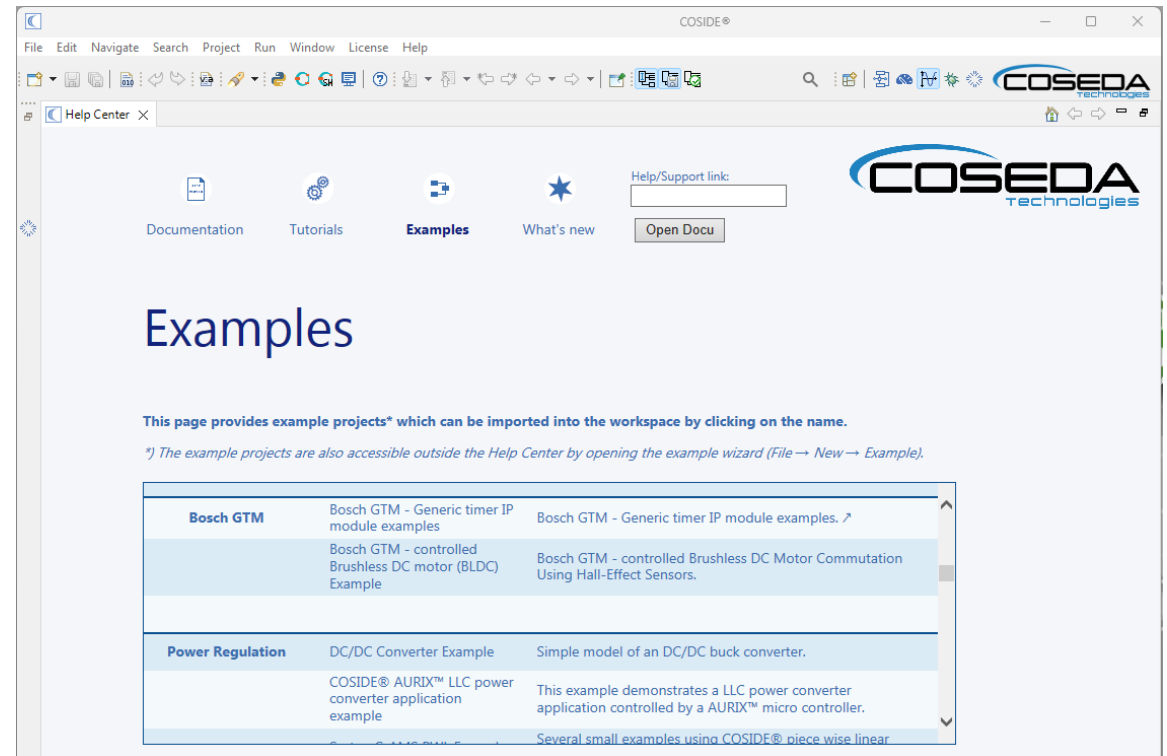


Half year experience with virtualGTM in COSIDE® 3.2

What happened since Coseda User Group Meeting 2023

April 2024: Launch of COSIDE 3.2

- virtualGTM included
 - Examples accessible by the Help Center
- COSEDA/ Bosch GmbH staff:
 - Train interested customers on using virtualGTM



Half year experience with virtualGTM in COSIDE® 3.2

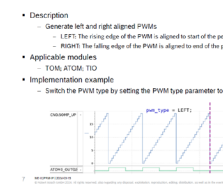
What happened since Coseda User Group Meeting 2023

May 2024 – now

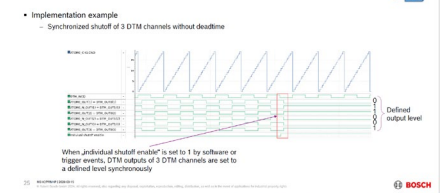
■ GTM IP FAE Team:

- Establish virtualGTM with COSIDE® as primary solution on sharing executable GTM IP example code in a virtual simulation environment with any user
- Set up training examples
- Set up application examples
- Assist COSIDE® customers in using virtualGTM

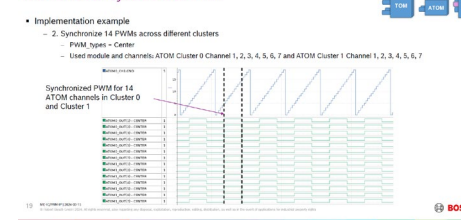
Using GTM-IP in Electric Vehicles Edge-Aligned PWM



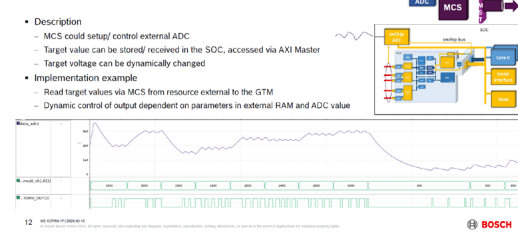
Using GTM-IP in Electric Vehicles Fast shut off functionality using DTM



Using GTM-IP in Electric Vehicles Multi channel synchronous PWM



Example Code for GTM IP functions Access to GTM external resources

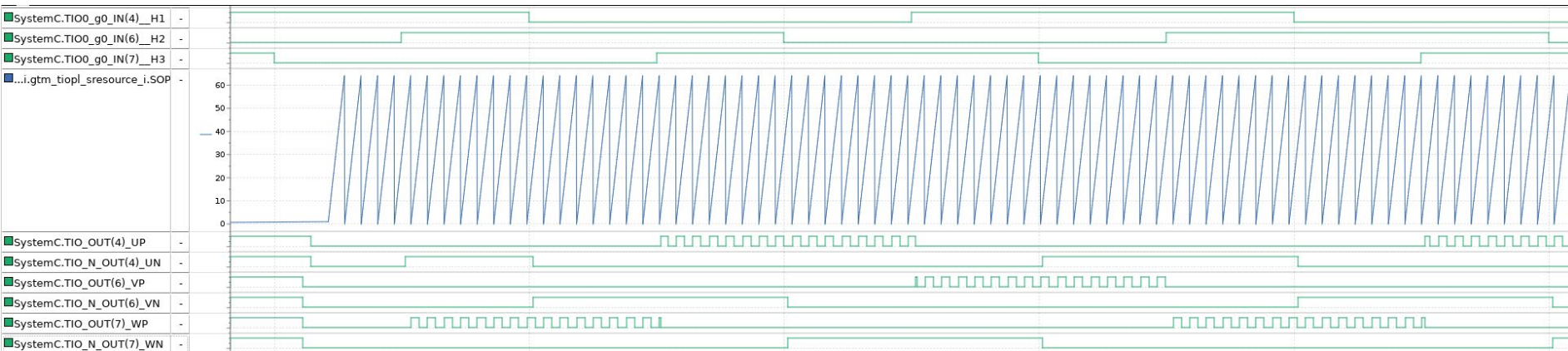
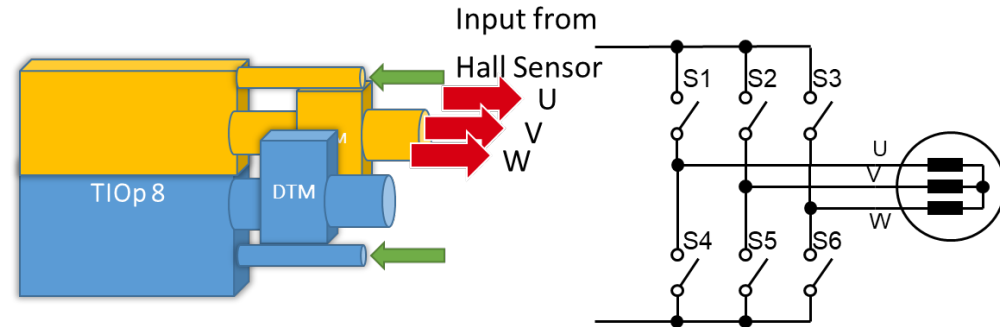


Half year experience with virtualGTM in COSIDE® 3.2

TIO BLDC control – application example



- Description
 - TIO controlling a Brushless DC motor
- Applicable modules
 - TIOp8, DTM
- Implementation example
 - 4 TIO channels with DTM shutoff capability in use
 - Hall decoding with speed determination supported



Half year experience with virtualGTM in COSIDE® 3.2

TIO BLDC example – applied in system testbench

Testbench allows:

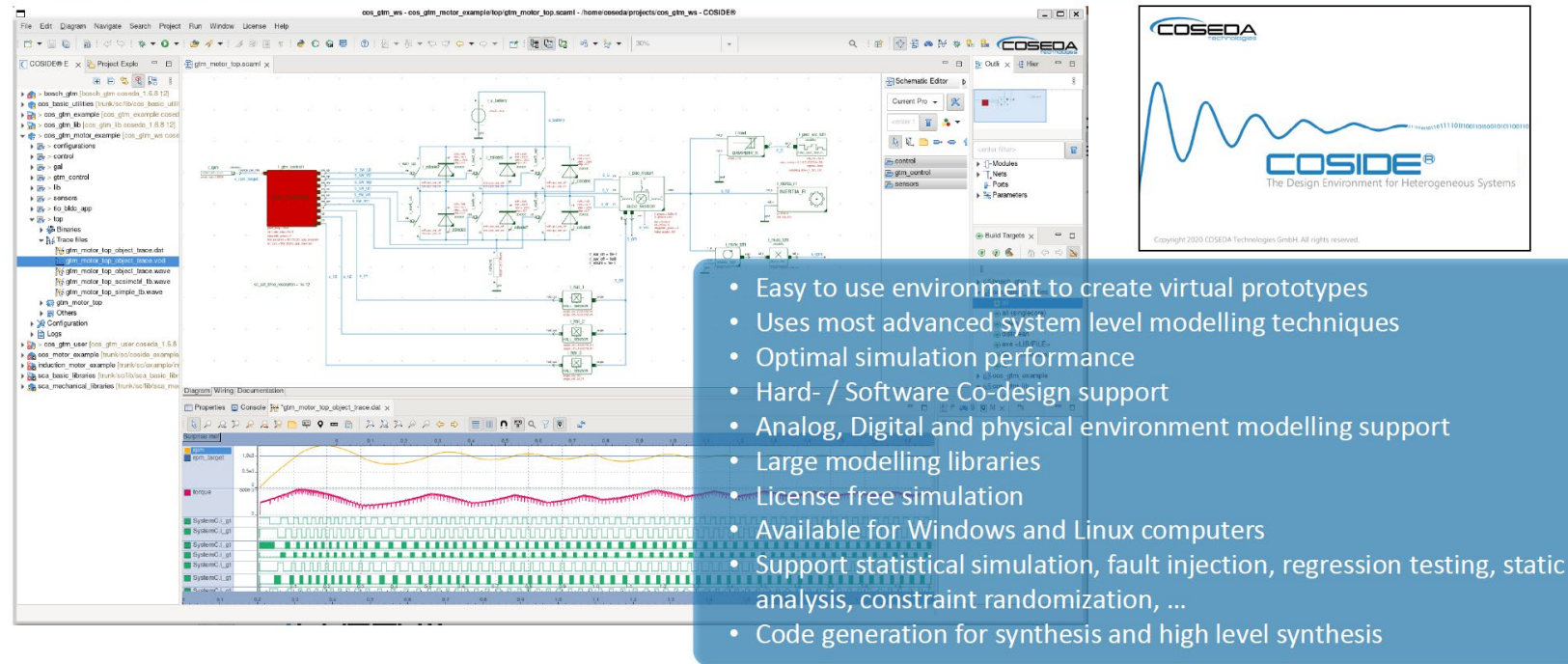
- Closed loop simulation

Includes:

- 3 phase motor
- Hall sensors
- Power switches
- PWM generation by GTM

COSIDE® for Virtual Prototyping

用于虚拟样机的COSIDE®



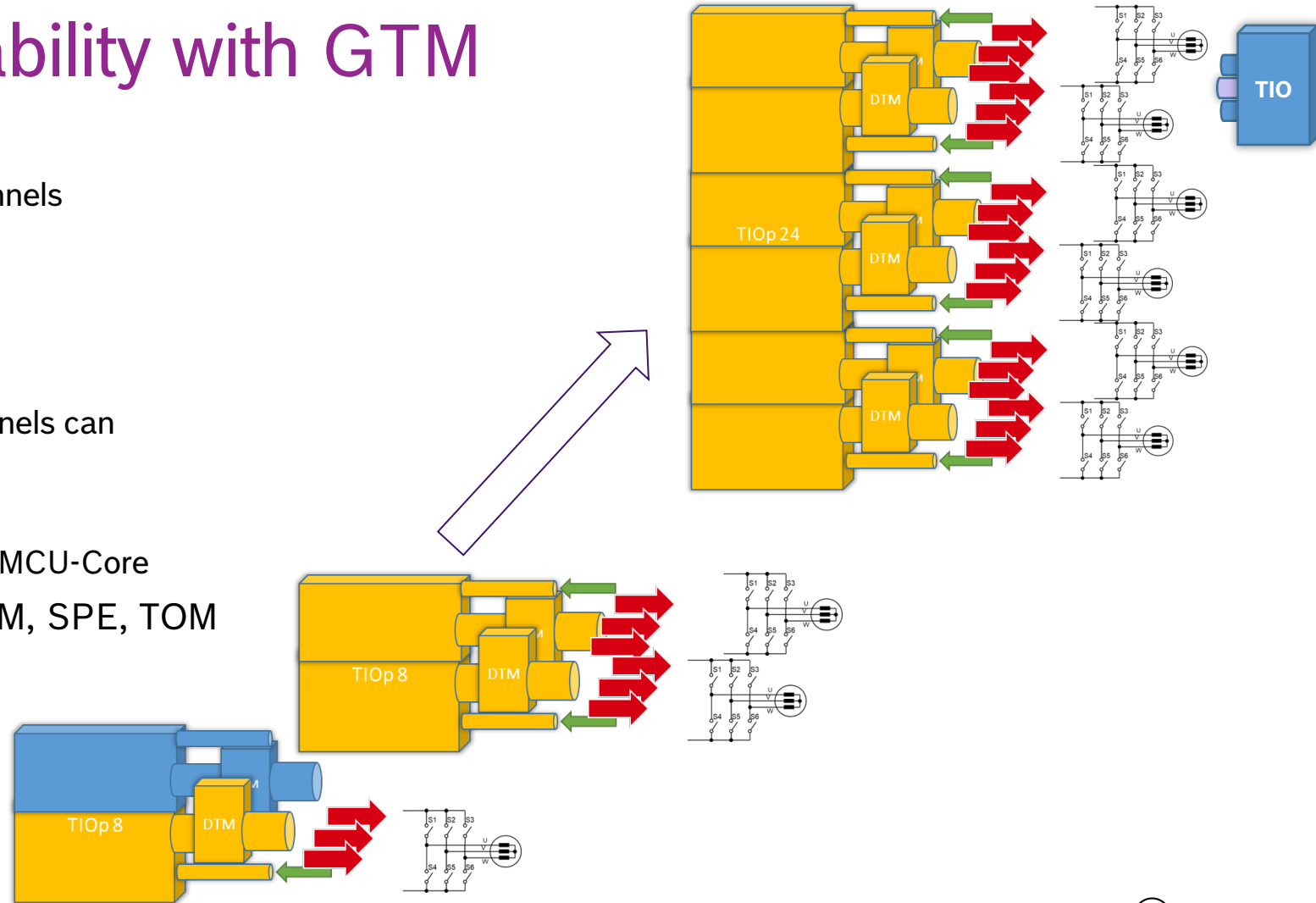
The screenshot displays the COSIDE software environment. The main window shows a detailed circuit schematic of a BLDC motor system, including a three-phase inverter bridge, a motor, and various control and sensor blocks. A project explorer on the left lists the components. Below the schematic, a simulation waveform shows the motor's performance over time, with multiple signals plotted. A blue overlay box on the right contains a list of features:

- Easy to use environment to create virtual prototypes
- Uses most advanced system level modelling techniques
- Optimal simulation performance
- Hard- / Software Co-design support
- Analog, Digital and physical environment modelling support
- Large modelling libraries
- License free simulation
- Available for Windows and Linux computers
- Support statistical simulation, fault injection, regression testing, static analysis, constraint randomization, ...
- Code generation for synthesis and high level synthesis

Half year experience with virtualGTM in COSIDE® 3.2

TIO BLDC – scalability with GTM

- Description
 - Functional scalability 4 - 24 channels
- Applicable modules
 - TIOp 24 channels, DTM
- Implementation example
 - One TIOp instance with 24 channels can support 6 brushless DC motors
 - All operating fully independent
 - Control can be done by MCS or MCU-Core
- Lesser resources needed than TIM, SPE, TOM approach (needs 6 clusters)



Half year experience with virtualGTM in COSIDE® 3.2

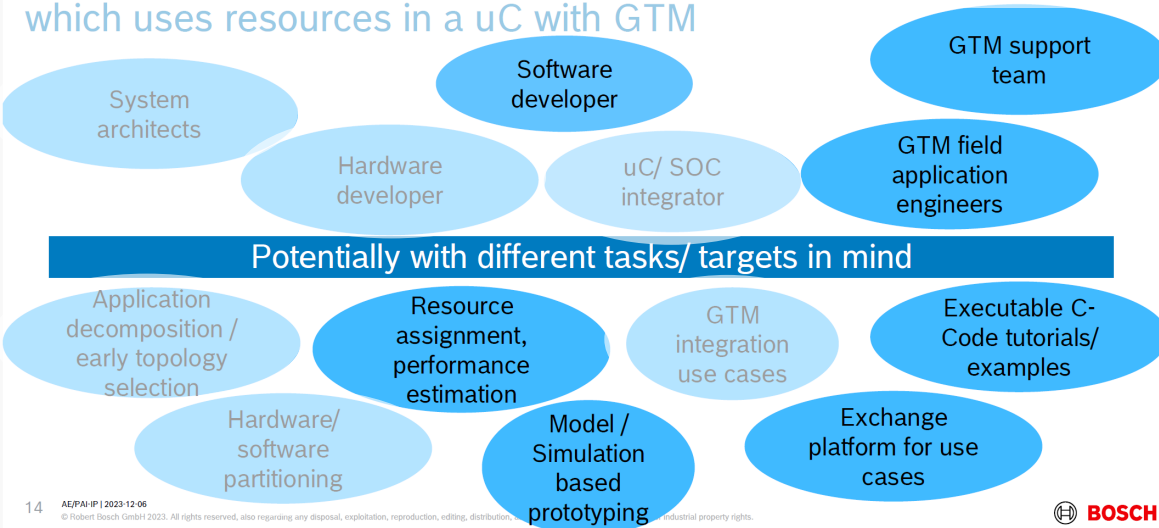
Expectations from Coseda User Group Meeting 2023

First experience with COSIDE® 3.2 gathered by/ on following tasks

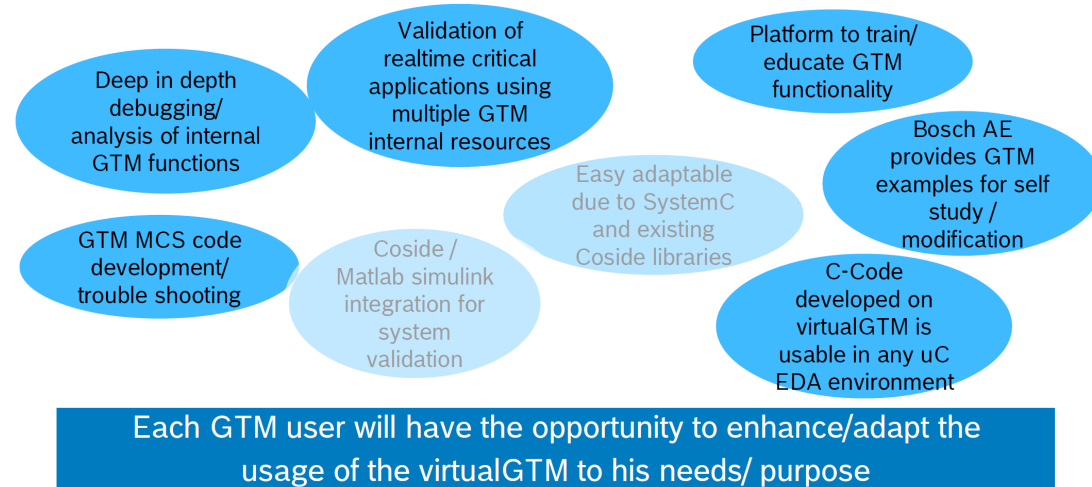
- Light blue marked are users/ tasks which we did not get requests concerning virtualGTM yet
 - We assume, they will approach us
 - it will take some more month

Who should know/ use the virtualGTM ?

Anybody who is concepting, designing, programming applications which uses resources in a uC with GTM



Opportunities of/ with virtualGTM



04

What will come next?

Half year experience with virtualGTM in COSIDE® 3.2

Make ECO environment for virtualGTM usable too

GTM users, mainly implement code for their applications on existing microcontroller hardware

- Using Tool chains with tools of different vendors
 - Tools:
 - GTM Debugger
 - MCS Assembler
 - MCS C-Compiler
- COSEDA/ Bosch GmbH/ Tool partners are working on
 - Using Debugger software for debugging of virtualGTM in COSIDE®
 - See COSEDA/ PLS presentations on COSEDA UserGroup Meeting 2024
 - Using GTM Hardware abstraction layer to implement unique C-code which can be compiled to any CPU host core or MCS core

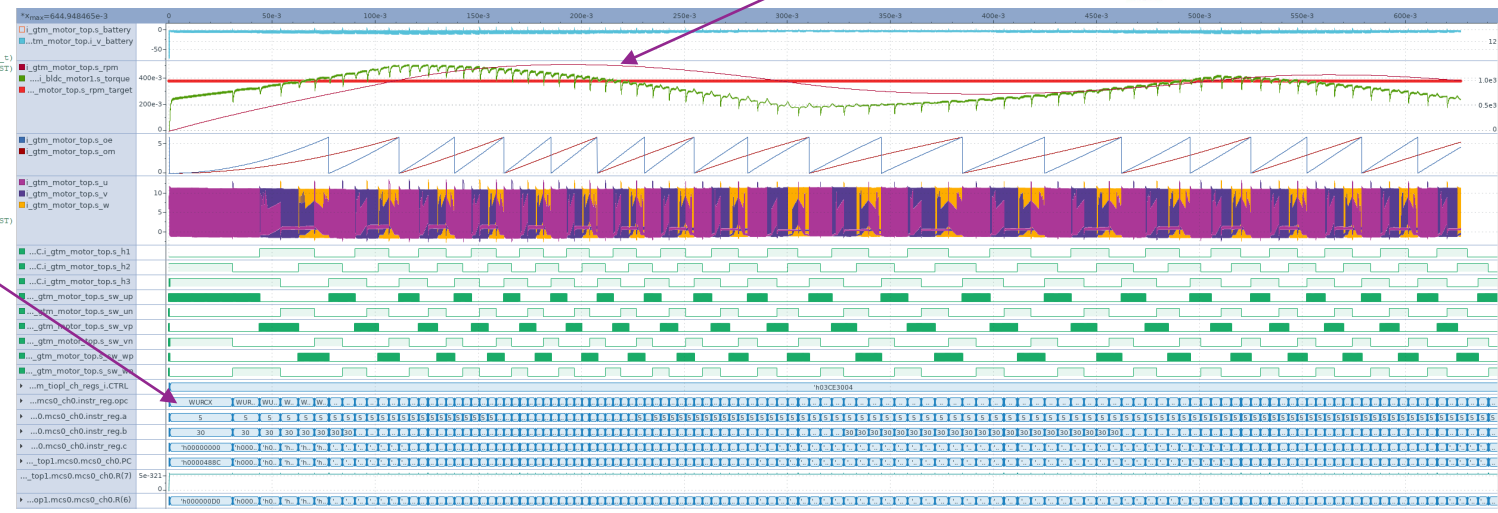
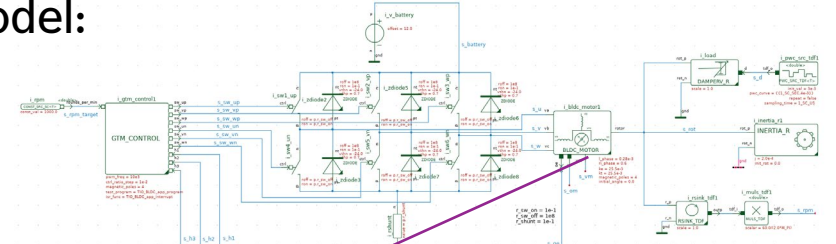
Half year experience with virtualGTM in COSIDE® 3.2

TIO BLDC example system testbench – controlled by MCS

C code compiled (TASKING) for MCS executed in virtualGTM

Motor model:
rpm

```
.._TIO_driver.c 82 wr_val = (_ae1_t) (( cr_val ) | ( mask ) & ( val ));
mcd r4,cr_val
mov r5,mhb
.L1423:
mcd r6,val
mov r2,mhb
andl r6,#0097200
andl r2,#255
.L1424:
or r4,r6
or r5,r2
.L1425:
andl r5,#255
mov mhb,r5
mov r4,wr_val
.L1426:
.._TIO_driver.c 83
.._TIO_driver.c 84
mov mhb,r5
bwl r4,r1
.L1427:
.._TIO_driver.c 85
.._TIO_driver.c 86
.._TIO_driver.c 87
.._TIO_driver.c 88
mcd r5,r5,#0
mhl r5,#10
add r5,r0
mcd r4,r4,r5,#12
mhl r4,#6
add r4,r5
.L1428:
addl r4,r32
.L1429:
movl r0,#0
movl mhb,#59
bwl r5,r4
.L1429:
.._TIO_driver.c 89
mcd r8,r8,#0
mhl r8,#10
add r8,r0
mcd r2,r2,r8,#12
mhl r2,r8
```

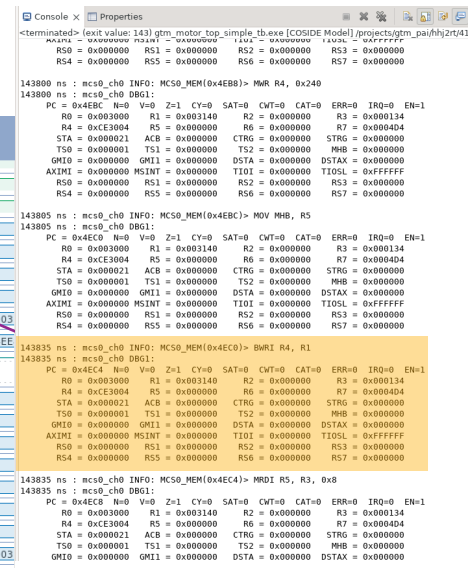
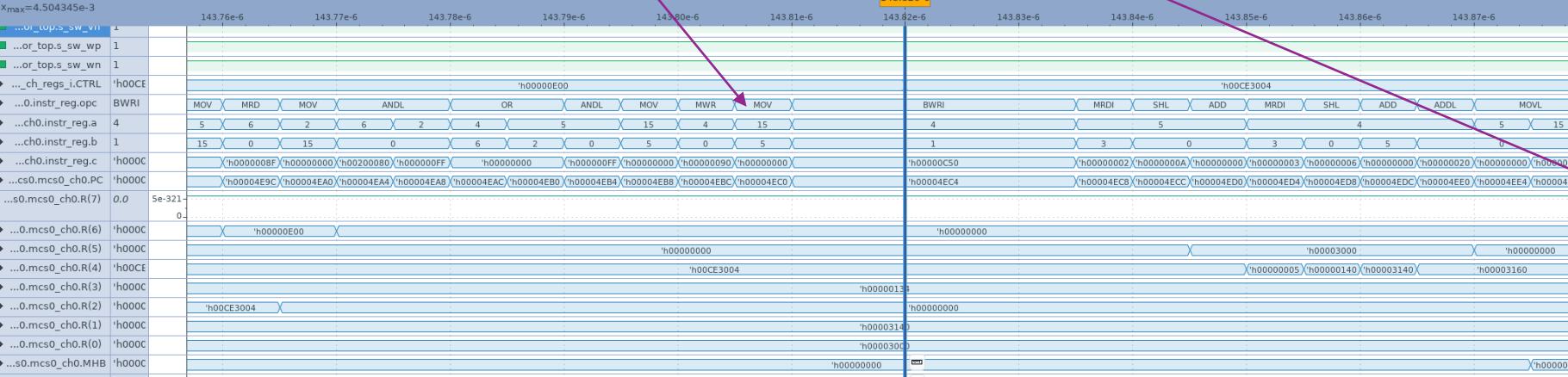


Half year experience with virtualGTM in COSIDE® 3.2

TIO BLDC example system testbench – controlled by MCS

Application can be inspected on:

- textual MCS traces
- graphical wave forms



A decorative header consisting of a series of overlapping, colorful triangles and polygons in shades of red, purple, blue, cyan, and green, creating a vibrant, abstract pattern.

Thank you for your attention!

Jürgen Hanisch, ME-IC/PRM-IPP; December 5th 2024