Bosch IP TechDay 2024

Advantages and Benefits of the GTM IP

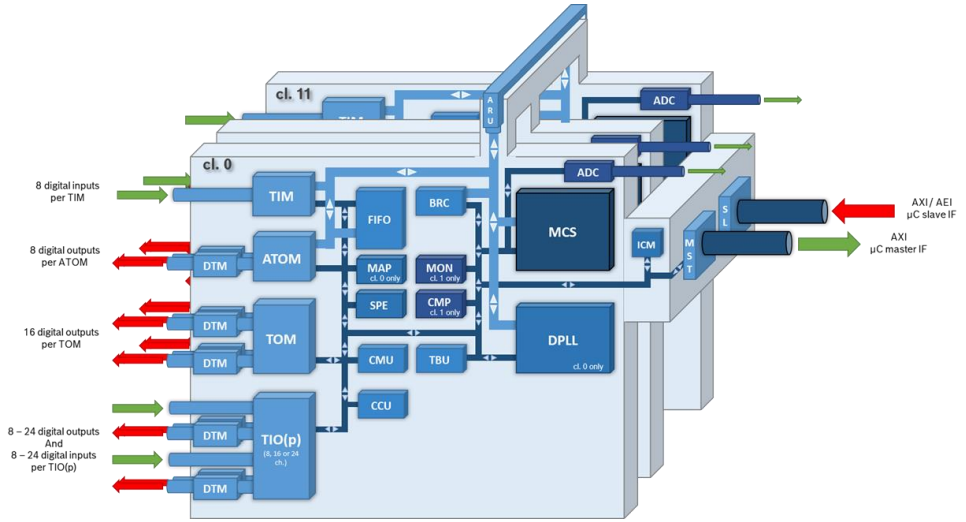
ME-IC/PRM-IP | March 14th, 2024

IP TechDay
We enable possibilities

BOSCH

Agenda

1. GTM Introduction
2. GTM – Markets, Configs, Eco-system
3. GTM Applications
4. GTM IP

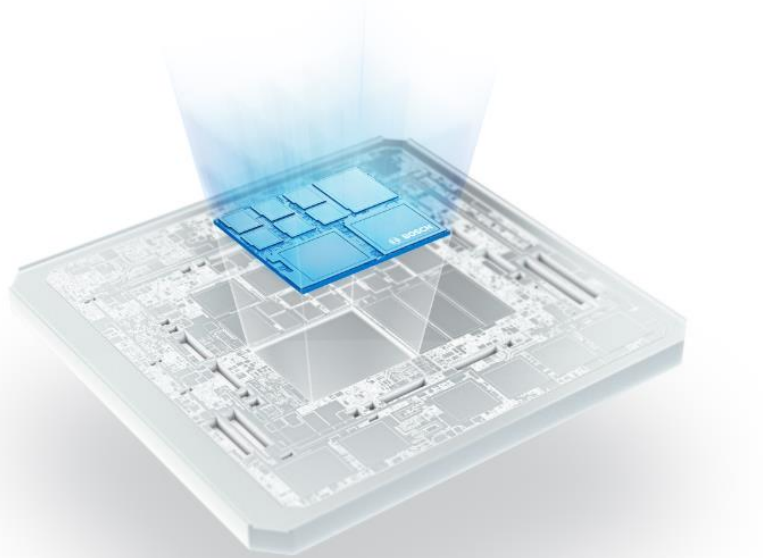


1

GTM Introduction

BOSCH

GTM-IP
GTM – Generic Timer Module



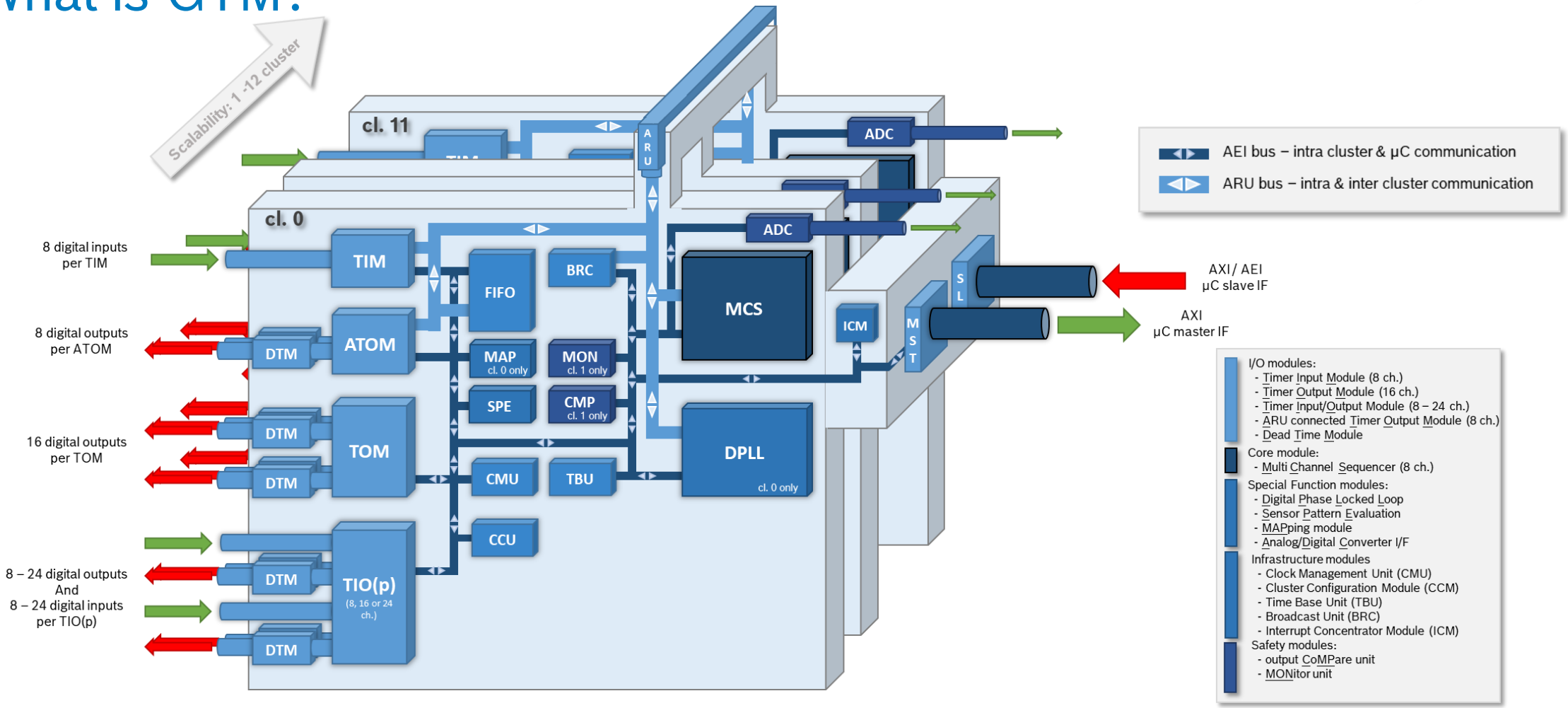
- **Timer:**
  - digital input data (e.g. capturing sensor data)
  - digital output data (e.g. PWMs for actor control)

- **GTM is a realtime, standardized oriented I/O co-processor**
  - digital input data processing (e.g. capturing sensor data and process these)
  - digital output data generation (e.g. PWMs for actor control, with close-loop control)

- **Offloading real-time critical I/O workloads from µC cores to a specialized I/O co-processor with massive parallel thread handling capabilities**

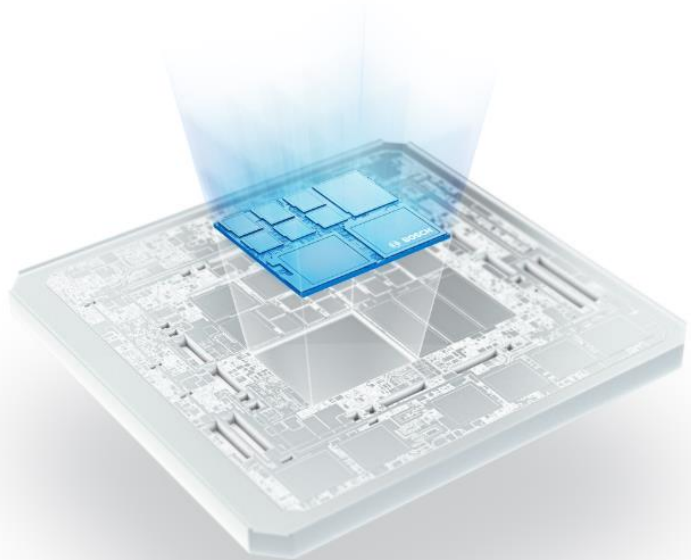
GTM-IP – Architecture

What is GTM?



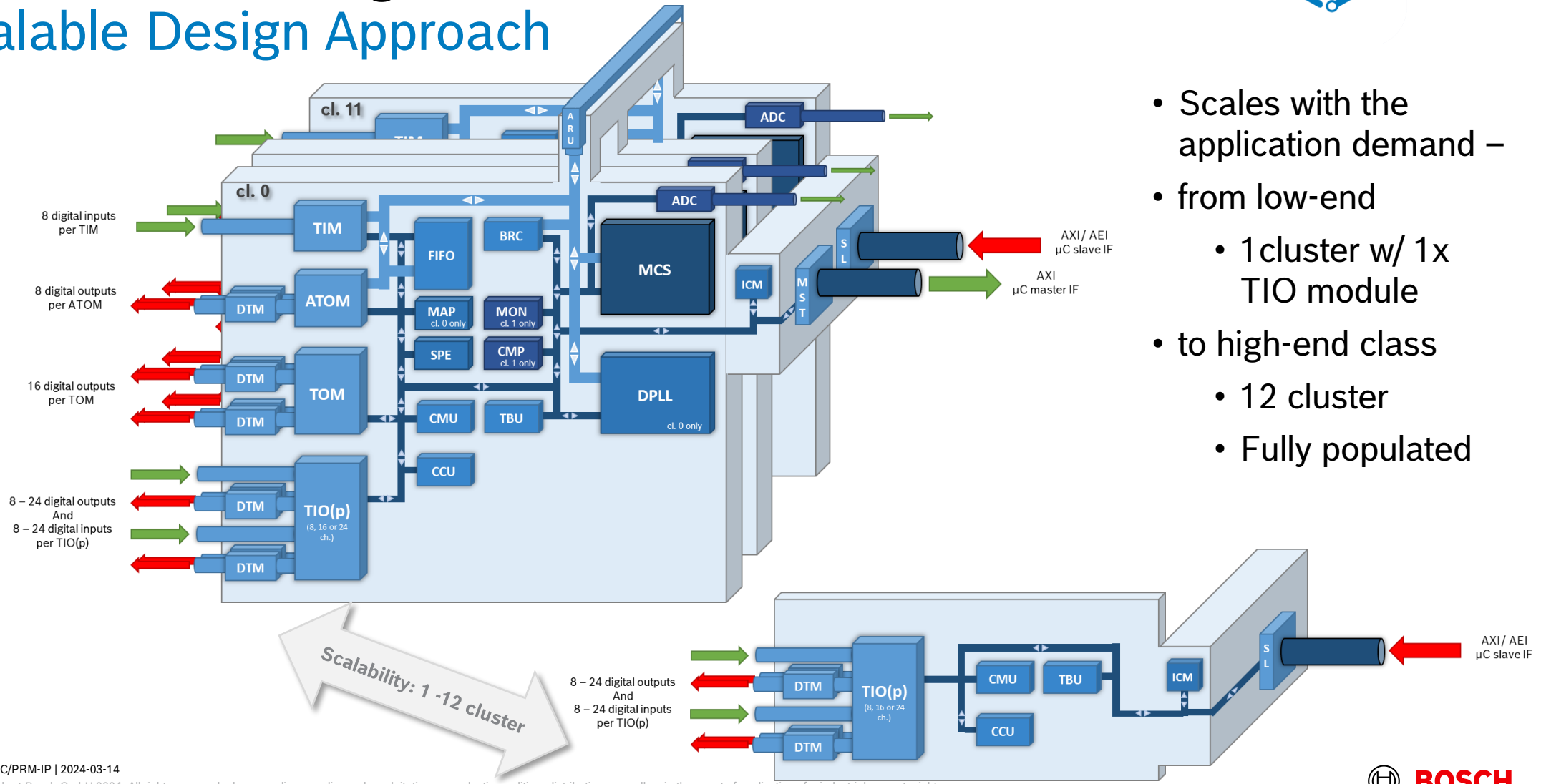
GTM-IP
Benefits of a standardized I/O co-processors

- **Common architecture across multiple semiconductors**
  - Development of software/applications independent of selected MCU
- **Generic architecture**
  - Covering a wide range of application domains and areas (powertrain, traction control, chassis control, xEV, inverter, converter PFC, industry, ...)
- **Open to 3rd parties to contribute to nextGen requirements**
- **Growing Eco-Environment**
  - Enables development of a rich set of tools and compilers



GTM-IP – Advantage & Benefits

Scalable Design Approach



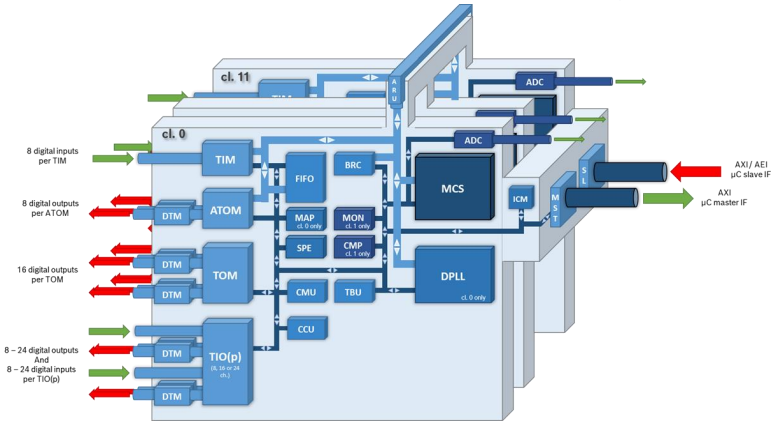
- Scales with the application demand –
- from low-end
  - 1cluster w/ 1x TIO module
- to high-end class
  - 12 cluster
  - Fully populated

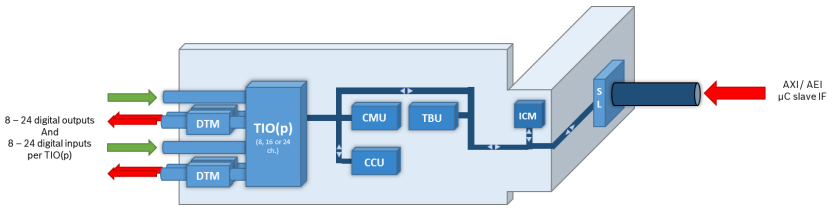
GTM-IP – Architecture

Key features and structures

Real-time oriented I/O co-processor

1. **Modular design approach**
   - tailorable to the target application
2. **Rich set of multi-purpose and specialized modules**
3. **RISC-based internal cores with 8x multi-threading**
4. **Two levels of GTM internal bus systems to connect sub-modules**
   - intra- and inter-cluster communication
5. **µC bus master interface**
   - enables offloading of workloads from µC cores to GTM
6. **Programmability by external CPUs**





2

GTM – Markets, Configs, Eco-system

BOSCH

GTM-IP – Status and Roadmap
New markets – application driven growth

IP TechDay
We enable possibilities

Growing # of Applications

Industrial Applications

Emulation of Ser. Interfaces

Chargers

Electrical Axis

Electrical Drives

Gear Control

Steering

Chassis Applications

Body Applications

Combustion Engine Control

nextGen GTM

GTM Gen 4

GTM Gen 3

GTM Gen 2

GTM Gen 1

New Licensees/reg. Markets

China #5

China #4

China #3

China #2

ChiPower

NXP

Renesas

Infineon

STMicroelectronics

ME-IC/PRM-IP | 2024-03-14

BOSCH

GTM-IP – Overview GTM Gen 1 – Gen 4
Delivered device configuration 2010 - 2023

IP TechDay
We enable possibilities

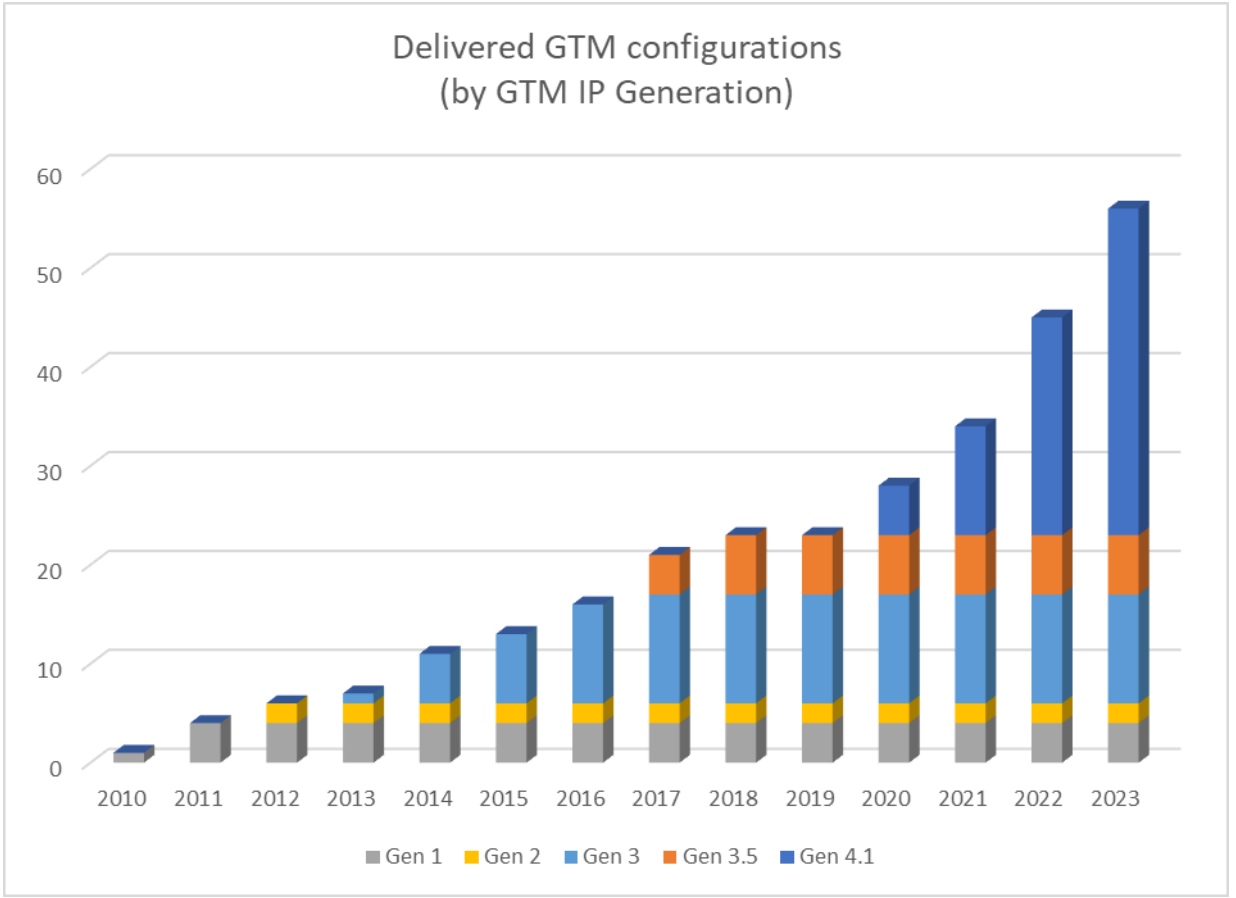
GTM IP Deliveries

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 then Gen 3/3.5 in less then 2 years



BOSCH

GTM-IP
GTM IP 4.1 microcontrollers

IP TechDay
We enable possibilities

Microcontrollers from semiconductor companies

- **Chipower THA6** (GTM 3)
- **Infineon Aurix TC4x family**
- **NXP S32Z2 / S32E2**
- **Renesas RH850/U2B**
- **ST Microelectronics Stellar G/P family**

紫光同芯微电子有限公司
TONGXIN MICROELECTRONICS CO., LTD.

RENESAS

Increasing number of MCUs with GTM 4.1 will be launched in the next years

BOSCH

MCS Assembler
Tools and services from Bosch and partners

IP TechDay
We enable possibilities

Continuously growing Eco-Environment

- Rich set of tools and compilers supporting application development including assembler and C compilers
- GTM System C reference model support and integration in various MCU prototypes
- Virtual Prototyping
- Software drivers and application-based library support
- Debugger support for efficient development and analysis of GTM applications
- GTM training and application notes

BOSCH

3

GTM Applications

BOSCH

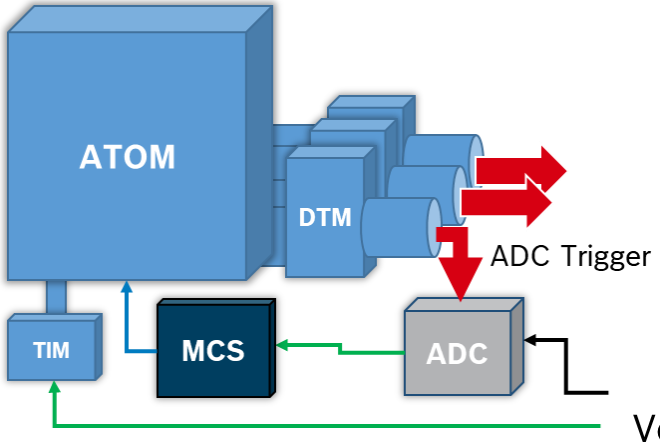
GTM Applications
Example Application

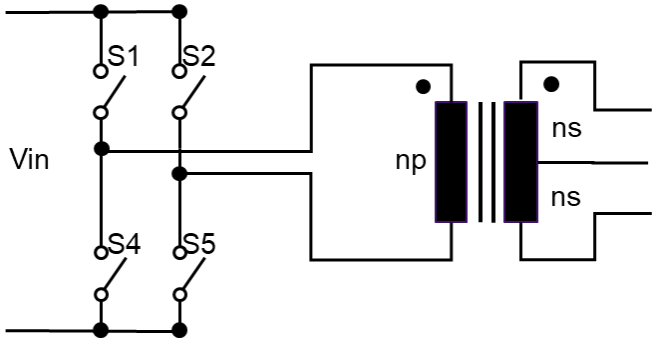
- Electric Powertrain
  - Inverter, motor control, sensor, …
- Gasoline Powertrain
  - injection control, fuel pump, sensor,…
- Converter
  - DC/DC, AC/DC, PFC,
- Inverter
  - DC/AC,
- Breaks
- Steering

- Motor Control,
  - BLDC (Brush Less DC)
  - FOC (Field Oriented Control), …
- Emulation of serial I/F
  - SPI, UART ,LIN ,I2C, I3C
- Control of Display
- Replacing external complex logic to reduce BOM cost
- and many other application

GTM Applications

Application Example

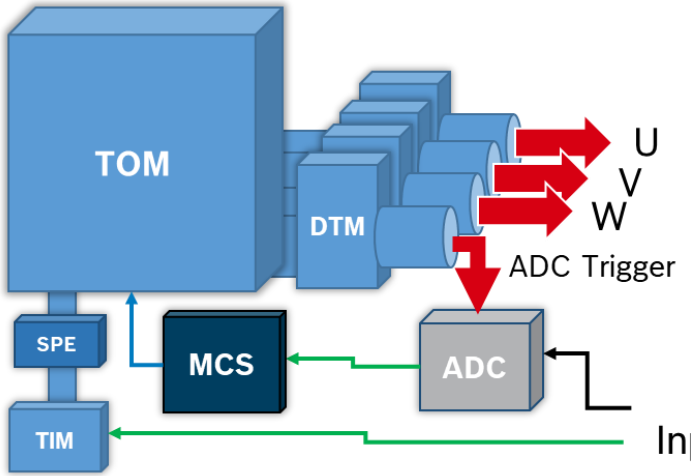


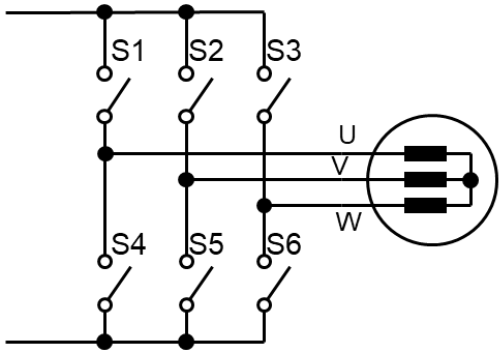


Example: Full Bridge PFC (Power Factor Correction)

Voltage, Current, etc. …

Example: BLDC (Brushless DC) Motor





Input from Hall Sensor, Voltage, Current,, etc. …

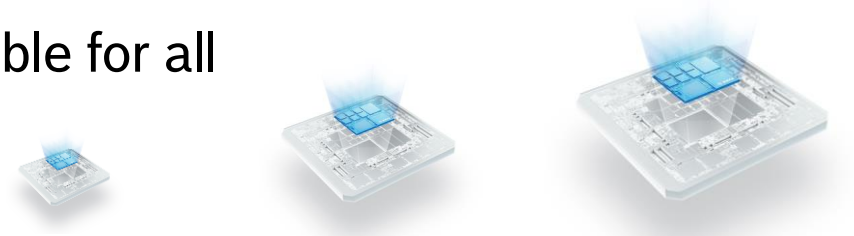
4

GTM 4.1 IP

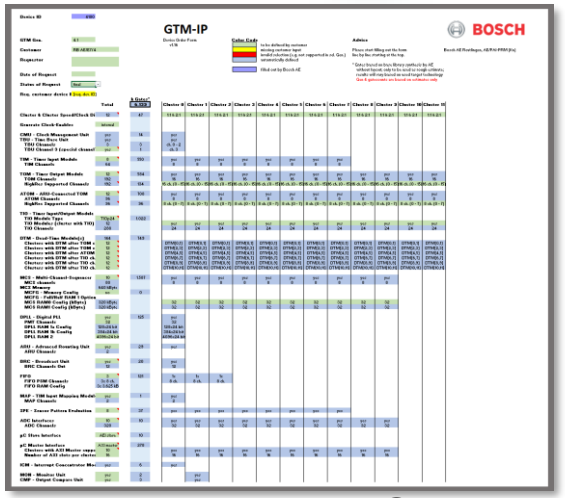
BOSCH

GTM 4.1 IP
Standard & Customer tailored GTM IP configurations

- GTM Standard Configs
  - 8 standard configurations available
  - Well defined standard configuration which are suitable for all kind off application
  - Available off the shelf



- GTM Customer defined
  - Tailored GTM configuration for customers need
    - Excel-based order sheet to allow customers to tailor the GTM IP configuration towards the customers needs



GTM-IP
GTM IP 4.1

Revision 0130

Release November 2022

Deliverables per each GTM 4.1 device configuration

- ▶ Documentation
  - Readme file
  - GTM Spec 4.1 and Appendix
  - Module Integration Guide
- ▶ Design
  - DFT results
  - Spyglass reports
  - Synthesis constraints
- ▶ Safety
  - Safety Manual & Safety Certificate
  - FMEDA and DFA

Thank you!

Gregor Sunderdiek, Product Manager