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GTM TechDay

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Detroit, Michigan
www.bosch-gtm.com

GTM
enabler for flexibility and supply security

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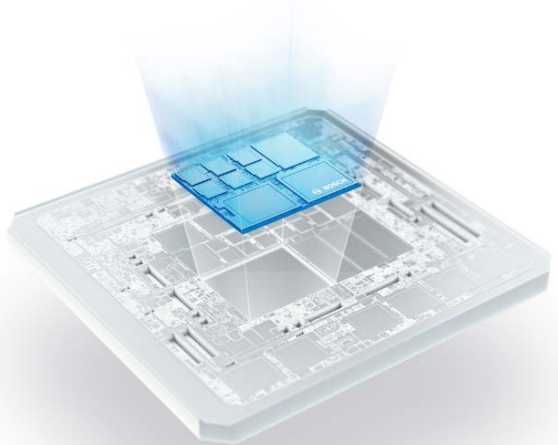
Agenda

1. GTM background and history
2. Bosch microcontroller strategy
3. GTM supporting fast exchangeability of microcontrollers
4. GTM – basic ideas
5. Summary and outlook



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GTM Background and History

- The Bosch GTM was derived from the Bosch Microcontroller strategy, benefiting the OEMs, Tier1 and semiconductor suppliers
- History:
  - Decision to start GTM development was made in 2009
  - Feature- and roadmap-alignment with OEM, Semiconductor suppliers started 2009
  - Concerns were raised in the industry if all required functionality would be covered
  - Complaints about GTM's contribution to chip-size, but:
    - Total cost of ownership approach in favor of GTM – it is more cost effective to have determinism and a dedicated time base than to spend the effort in customer projects later
    - Increased functionality compared to solutions with simple capture/compare approach extended by a small controller
  - First SOP with GTM 1.5 in 2014 with Infineon, ST, NXP (at that time: Freescale)
  - Simulation-based evaluation of enhancements started in 2015 (feature requestor can test the requested functionality on the simulation model)
  - 2017: GTM 3.1 SOP with much more functionality than any other timer available in the market

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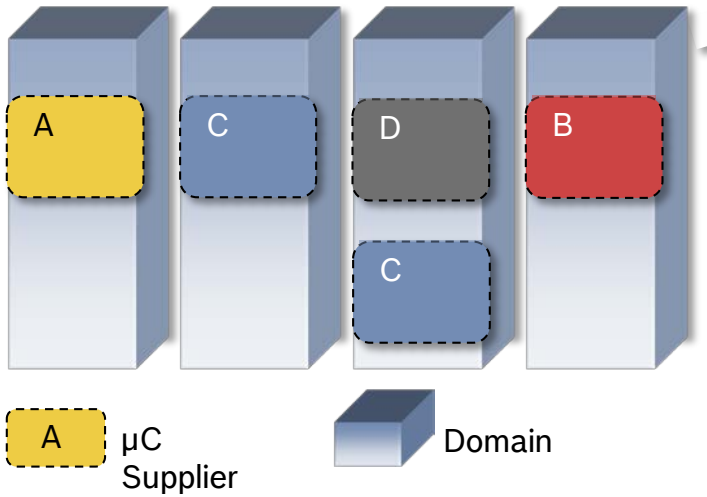
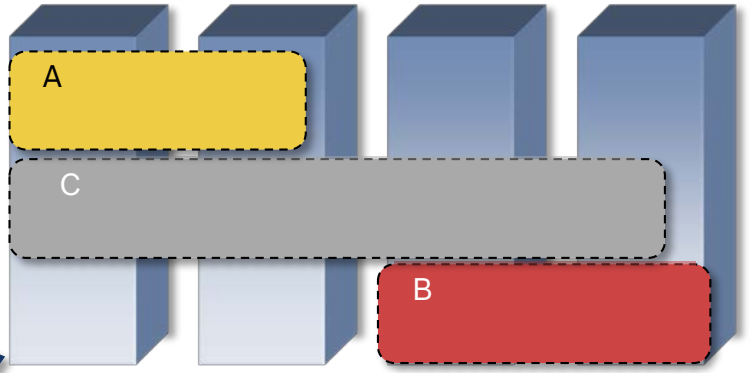
Bosch Microcontroller Strategy

"From individual sourcing of different µC for each domain to cross domain usage of the same µC families"

➡ Started with the MDG1 engine controller family in 2015





Goals:

- **Higher volumes** for each µC family
- Enabling of a **second source** concept
- **Cost reduction** by reuse of HW and SW
- **Quality improvement** due to focus on fewer µC families

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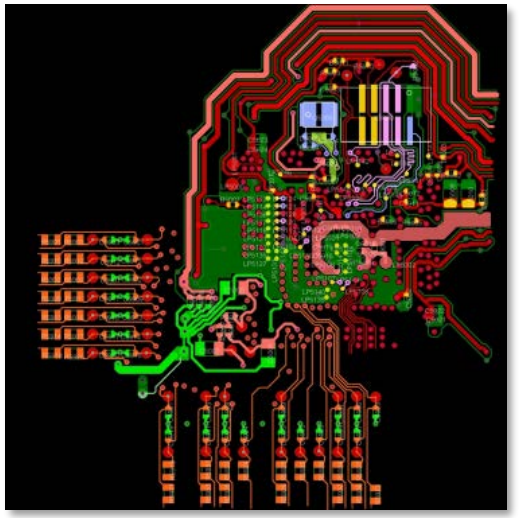
Bosch Microcontroller Strategy

- Increase production volumes
  - For better amortization of increasing development cost at suppliers
  - By usage of µC families across application domains
    - Usage of identical µC wherever possible (e.g. today for engine- and transmission control)
    - Alternative: same basic IP set for different applications
- Second source concept is a must to achieve supply security
  - Robustness against changes in the supply base
  - Robust supply due to geographically independent production sites
  - Requires fast exchangeability of microcontrollers



Device_3 BGA 292 module layout: can be used for IFX, FSL and ST 65/55nm and for the next generation

Usage of µC families across different domains will lead to higher volumes, reduced overall price and effort. Second source concept improves supply security.

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Fast Exchangeability of Microcontrollers

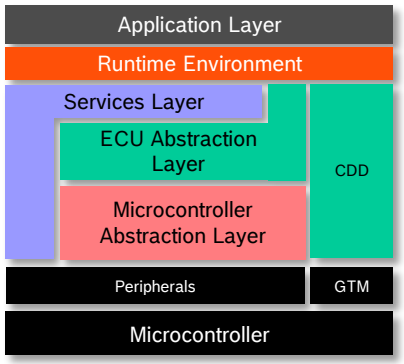
Applied Measures for fast exchangeability

HW

- Implementation of configurable digital core modules to use same printed circuit board (PCB) for the µCs of different suppliers 

Software

- AUTOSAR layers cover standard peripherals (SPI, Ports, …) 
- The timer needs a different solution due to complexity, tight interaction with application software and different timers on the market. Bosch approach:
  - Use common timer for all suppliers to run time-critical functionality there **➔ Solution: GTM!**
  - Other parts of the complex driver (CDD) run on µC with significantly reduced timing constraints
  - Application Layer has no direct access to Hardware



Result: Switching of µC suppliers can be accomplished in about 6 weeks.

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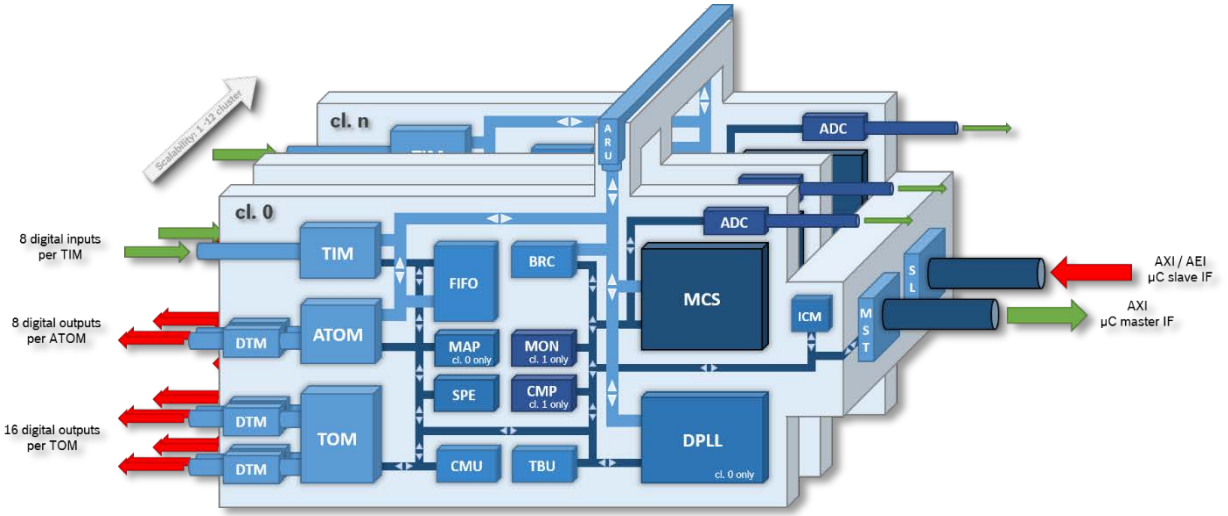
How to get a common Timer Module?

- First approach: Bosch asked main semiconductor companies to license their timer – result:
  - **All** of them agreed to license to competitors
  - **None** of them accepted to use a competitor's timer

- As a result, the GTM was born
  - As an extension of an ARU (Advanced Routing Unit) based system in another market
  - And finally accepted by nearly all suppliers



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GTM – Basic Ideas

- Basic ideas of GTM design:
  - Unload main core from interrupt load – e.g. SPI, flywheel, SENT, ...
  - Determinism – to allow calibration engineers worldwide to adapt their functionality without consideration of the other functionality running on the GTM (Bosch experienced some expensive learning cycles because of such interferences in the past)
  - Spend timer resources to avoid late changes of the PCBs of OEM ECU-projects. Using e.g. MIOS or GPTA: in case other actuator with different PWM time base is connected, the PCB has to be changed

- Additional benefit of the combination: Configurable core modules on PCB, Autosar and GTM: Shorter time to market through risk mitigation
  - Devices from former generations can be used as risk mitigation measure if problems with the new generation arise (e.g. 65nm instead of 40nm device)
  - Ramp up can be planned and done much faster because the exchangeability minimizes the technical project risks

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GTM – The Future

- GTM development is an ongoing process to cover future needs for several application areas

- Next versions:
  - GTM 3.5 with µC bus master capability and industry standard interface (AXI – Advanced eXtensible Interface) support
  - Enhancements targeted for GTM 4.0 include
    - Enhanced electric vehicle control functionality
    - Improved scalability for better support of low- and mid-range µCs for automotive and non-automotive applications
    - Extended ability to shift applications from main cores to GTM real-time cores
    - Efficiency, performance and debug-ability optimized MCS compute power
    - Additional safety features to better support ASIL D setup

- In 2020 GTM will run in more than one hundred projects in different domains (powertrain, body, chassis)