

Testing of Automotive Systems (Part I)

Module 9 – Integration Testing

David Ludwig , Magna Steyr

FRS Function Release Step

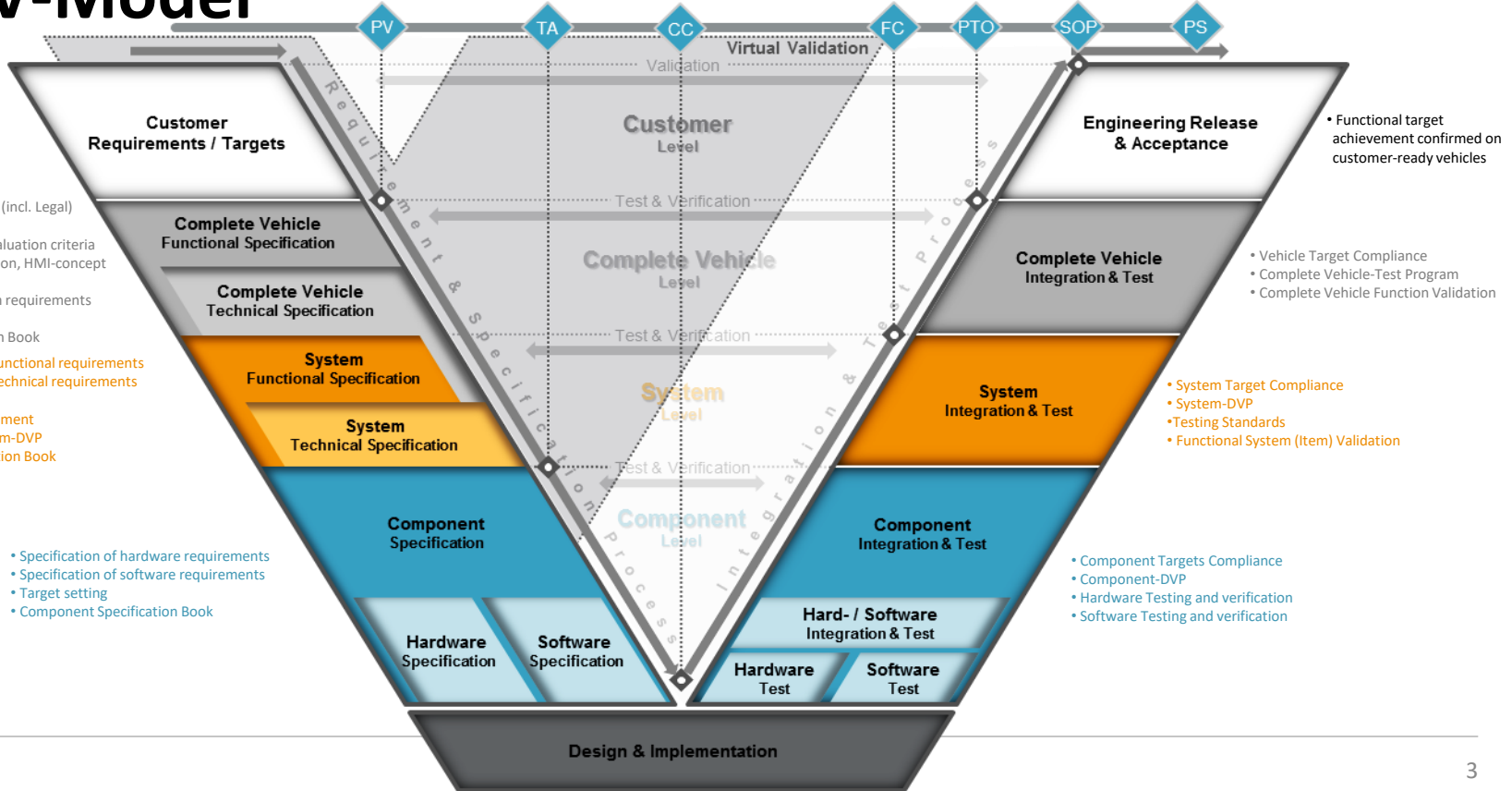
The V-Model

- Customer Market Profile
- Sales Markets
- Configuration List
- Feature und Function List
- Benchmarks
- Vehicle Profile Description

- Definition of CV requirements (incl. Legal)
- Target setting
- Derivation of measurable evaluation criteria
- Product & Functional description, HMI-concept
- Creation of CV-DVP
- Definition of Items and system requirements
- Item List
- Complete Vehicle Specification Book

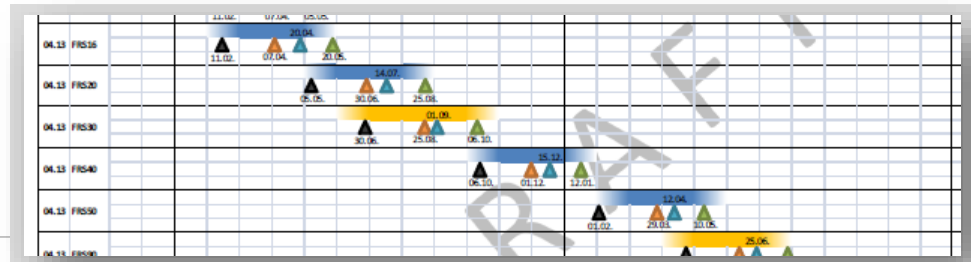
- Specification of functional requirements
- Specification of technical requirements
- Target Setting
- Functional assessment
- Creation of System-DVP
- System Specification Book
- Drawings
- Serial BOM

- Specification of hardware requirements
- Specification of software requirements
- Target setting
- Component Specification Book



The Art of Integration – Function Release Steps

- FRS are iterative steps
- Each FRS realizes an exactly defined function increase
- Several FRS can be nested into each other
- To serve the highly individual requirements of the project landscape
- FRS have no exactly predefined duration
- The overall numbers of FRS is not limited
- There is no „typical function increase“ for each FRS
- Integration team leader is the owner of the FRS process



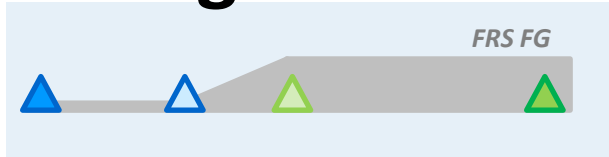
The goal of the FRS is ...

- ... to identify the strength and the weakness of the system and functions, not only error finding with a defined package (Verbund)
- ... to support upcoming build phases or special events (winter/summer testing) with a tested and frozen HW/SW package
- ... to provide an overview of the actual status of mechatronic function implementation (system and customer functions)
- ... to report an error status of the mechatronic customer and system functions
- ... to confirm the vehicle built from E/E perspective

The goal of the FRS is **NOT** ...

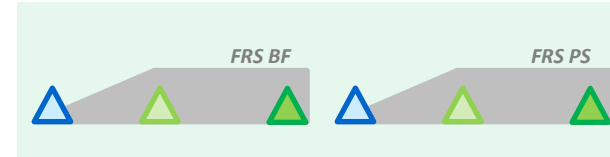
- ... to provide a complete vehicle status report
- ... to provide a full function parametrization and validation report

FRS - Timing



FRS with function increase

- Implementation of clearly defined list of functions by system suppliers and validation by MAGNA STEYR
- The goal of the FRS is function increase
- FRS with function increase start with end of concept phase (FRSCC) and end with FRS100 (typ. C-Samples)



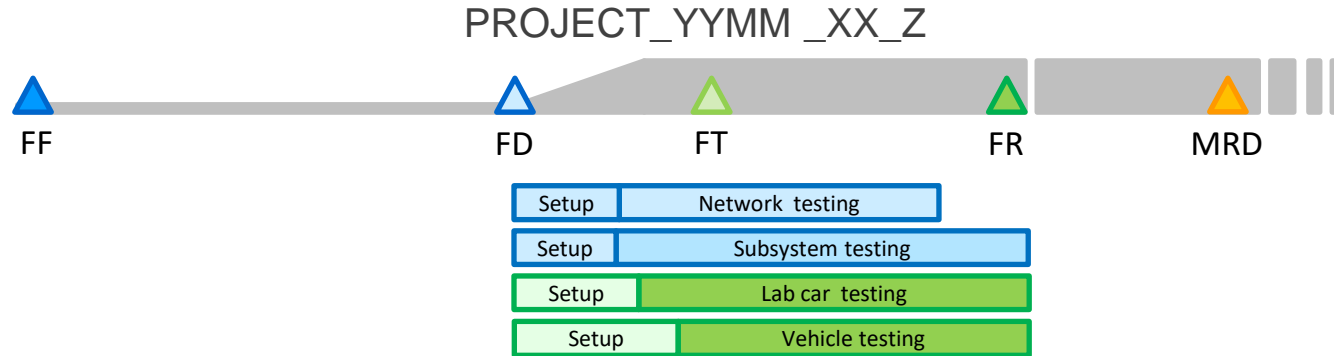
Bug fix FRS

- Individually short term planned for implementation of corrections

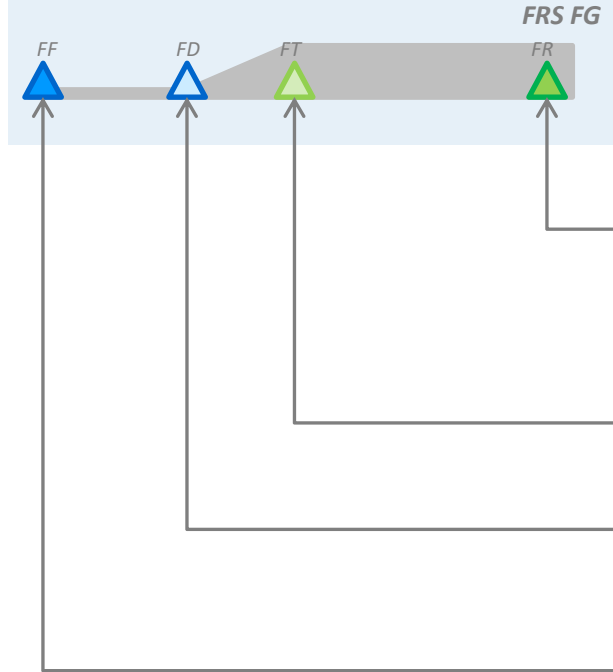
Data FRS PS

- Check of data packages
- No function increase
- Data FRS usually planned in last quarter of serial development

Generic FRS – test sequence



Generic Function Release Step - Milestones



- **FR – Function Release**

Validation tests completed. Quality of the tested systems is rated and risk evaluation for the implementation in the dedicated scenario can be done (e.g. winter testing)
Necessary corrections and changes are promoted to FEB
FRS release decision

- **FT – Function Test**

System is assembled and pre-tested. After this milestone bugfixes are prohibited.

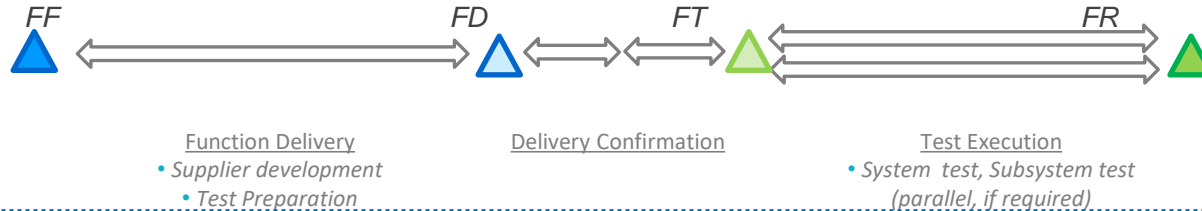
- **FD – Function Delivery**

All planned components are delivered (SW, HW, mechanics). Assembly and check during delivery confirmation phase. Only mandatory bugfixes intended

- **FF – Function Freeze**

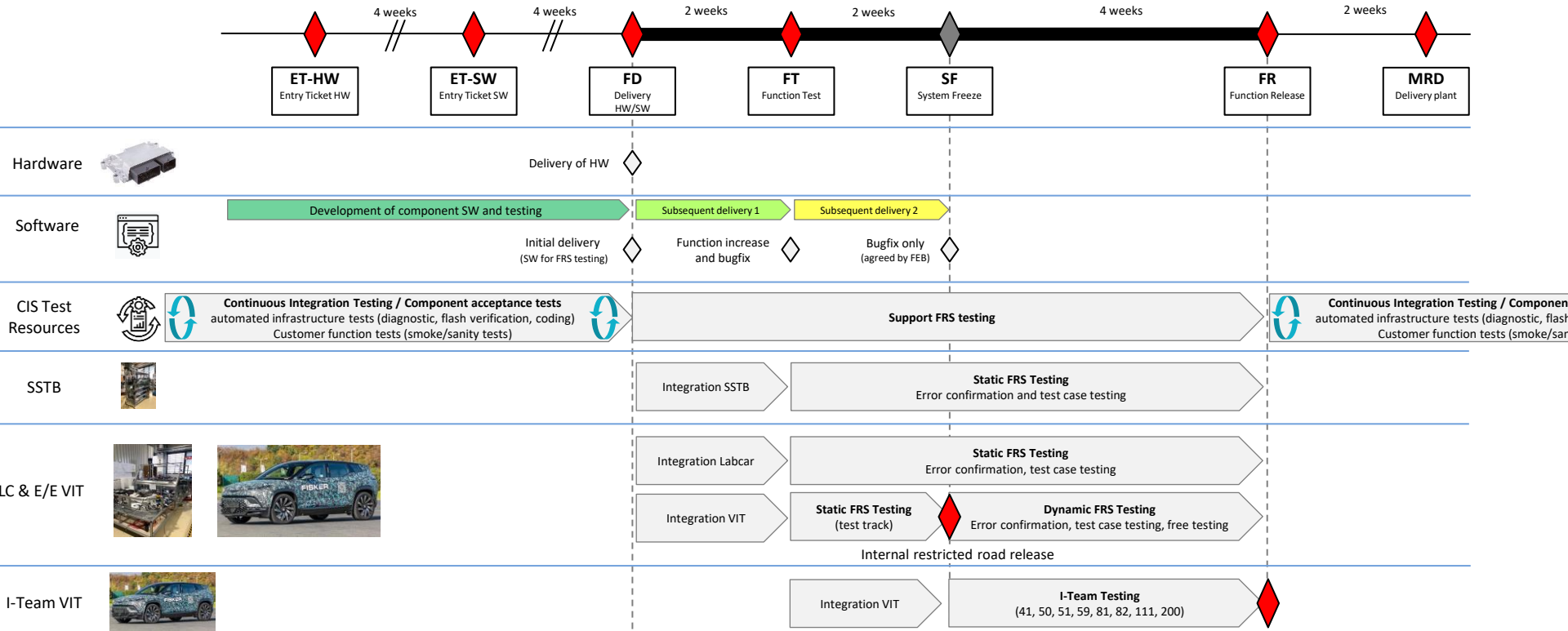
Agreement about scope of work (functions, corrections, changes) with all involved suppliers

FRS- The Phases



- Basically each phase is flexible in duration, overall FRS highly dependent on OEM and development task
- During function delivery the supplier's development process is tracked by means of metrics
- Delivery confirmation between FD and FT can be realized individually based on the implementation volume
- Step by step (first subsystem, then system) or
- Only one of both steps (depending on validation goal)
- Test Execution combines different types of integration testing
- Subsystem test (including variants)
- Network Test bench Test
- Lab car test
- VIT (Vehicle intensive test)

FRS Overview



Function release Step - Milestones

<i>ET HW Entry Ticket Hardware</i>	<ul style="list-style-type: none"> Latest at this milestone, a possible HW Change, relevant for procurement of new test parts for all test resources, has to be announced in FEB meeting to ER-PM (Part manager). Part demands are collected and forwarded to purchasing department.
<i>ET SW – Entry Ticket Software</i>	<ul style="list-style-type: none"> ET SW for all ECU parts to be raised. ET to be introduced and confirmed in FEB meeting. Function content for desired function release step must be defined until this date and must be agreed with all suppliers. All functional deviations to previous integration loop must be introduced and confirmed in FEB meeting.
<i>FD – Function Delivery</i>	<ul style="list-style-type: none"> Delivery of HW/SW, Diagnostic, Coding data, Component Test reports and Flash/Commissioning instructions. Agreed Functions (Hardware/Software) ready for system integration testing, must be in house at that date. Start of integration to test resources by MAGNA (Component acceptance test). Function increase and bugfix possible until FT if confirmed in FEB meeting.
<i>FT – Function Test</i>	<ul style="list-style-type: none"> The system under test is pre-tested and first start up of system is finished. Start of main test execution phase. Bugfix delivery only possible when necessary and aligned with project.
<i>SF – System Freeze</i>	<ul style="list-style-type: none"> Start of complete system testing.
<i>FR – Function Release</i>	<ul style="list-style-type: none"> Complete system release from complete vehicle based on test results of I-Teams (41, 50 51, 59, 81, 82, 111, 140, 200) is done. Risks and limitation for build and complete vehicle testing process are described. Problem landscape is presented.
<i>MRD – Material required Date</i>	<ul style="list-style-type: none"> Hardware and software must be available for vehicle build process.

Software maturity

Function implementation planning

FRS Maturity

O	Open, Not implemented
B	Functionality is available as backup to enable first testing (e.g. to enable Mule testing)
F	Firstly implemented. Test at test bench should be possible, vehicle tests may be possible. Generally functionality should be 100% available but smaller deviations can occur. Functional restrictions shall be agreed with Integration teams.
P	100% functionality is available for prototype vehicle tests. Basic parameterization available. Functional restrictions shall be agreed with Integration teams.
C	100% functionality is available, parameters are defined and verified. Parametrization process finished and customer maturity is achieved.

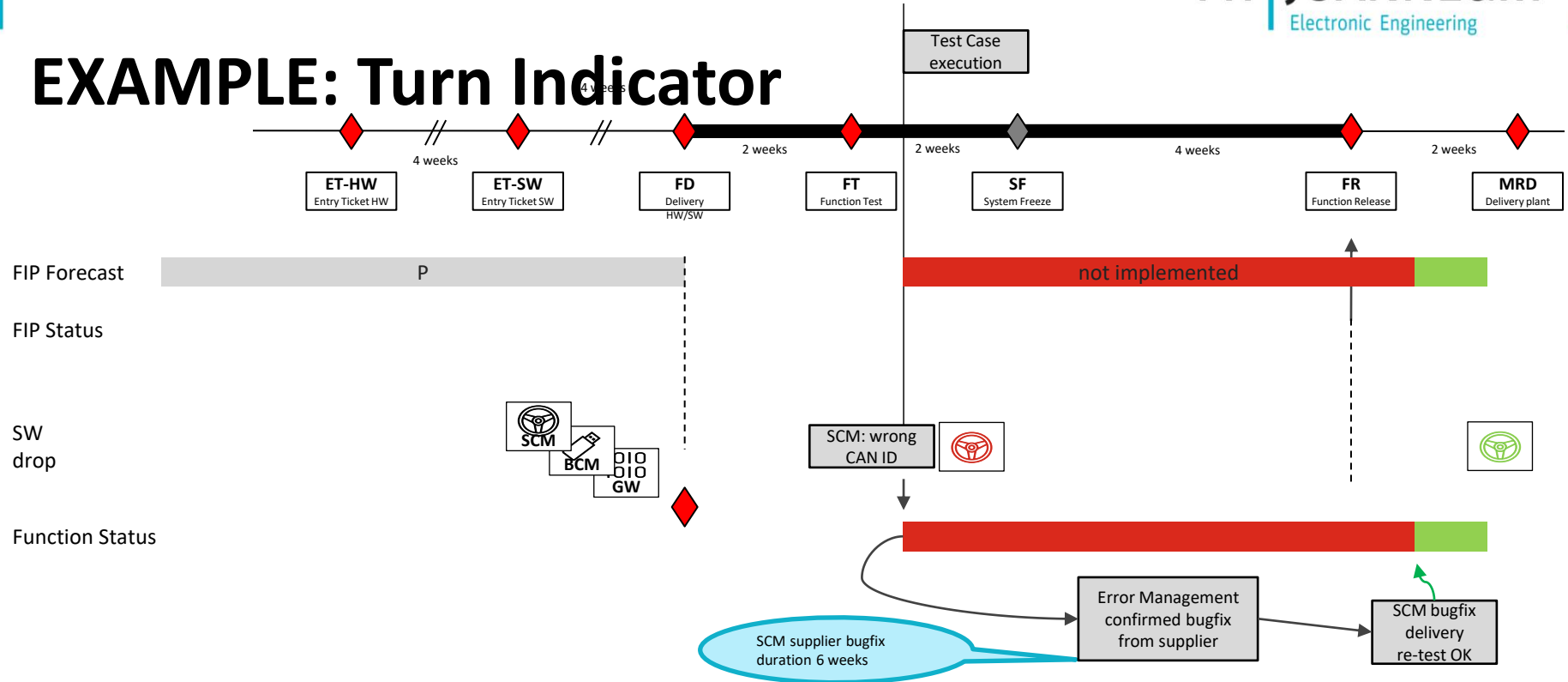
Continuous integration step (CIS)

Challenges and current situation

- Current FRS process not respected by project and supplier (SW delivery dates, test reports, ...)
- Multiple SW deliveries with bad quality, lot of redelivery's (untested) no functional check prior to FRS testing
- HW availability for FRS testing (ECU's, sensors and wiring harness)



EXAMPLE: Turn Indicator



Bugfix late for FRS, therefore no possibility to implement/correct functionality.

Next possibility to correct → Next FRS

Solution: Addition CIS

Process Solution

Implementation of CIS (continuous integration steps)

Ensure strengthen FRS milestone reporting within project and line organization

Ensure test resources for ER-C/ER-I to check SW (Component Acceptance Test, Smoke/Sanity testing)

Enhance FRS process with component test possibility

Change mindset of FRS process and release

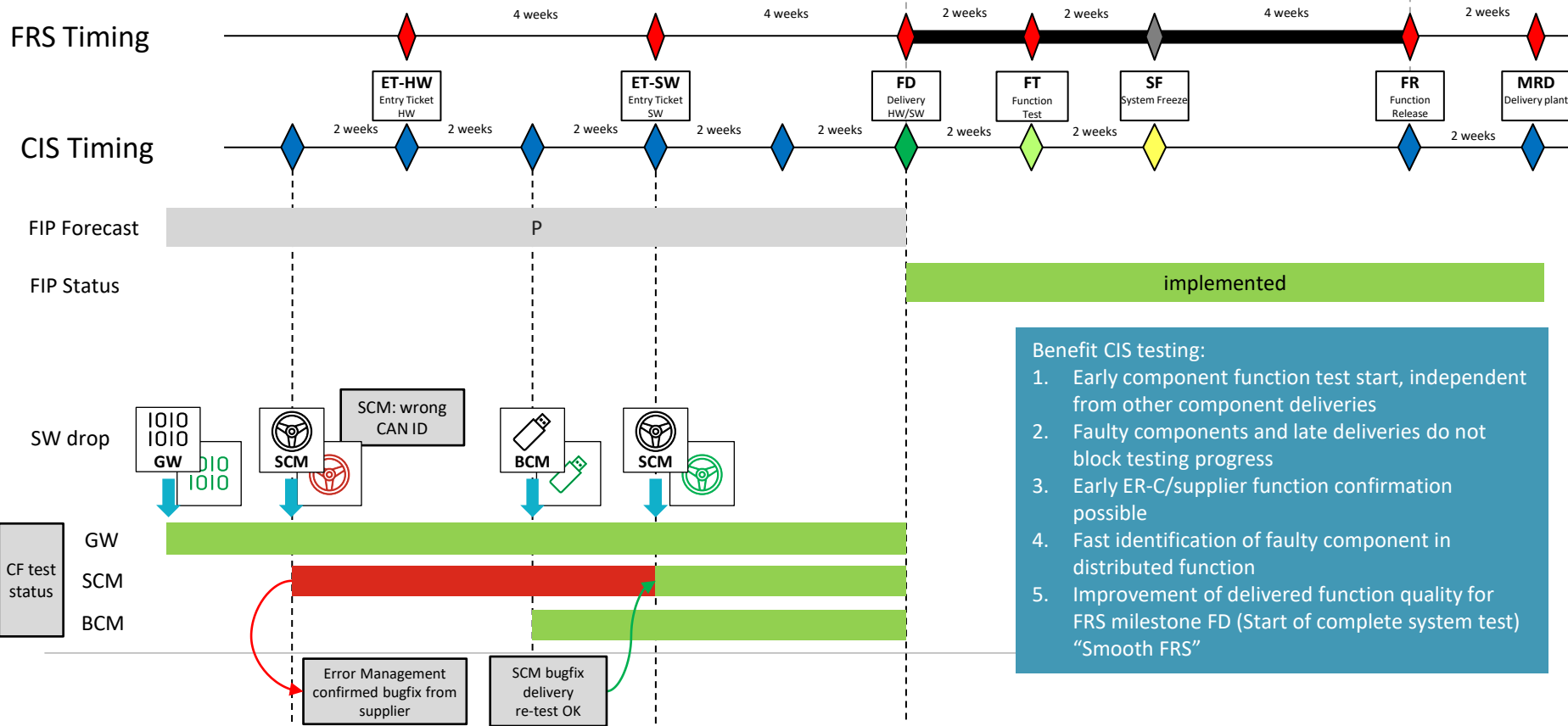
Technical Solution

Improve Automation level especially for system tests (diagnosis, flashing, ...)

Generate generic work products (test cases, test benches reports, ...)

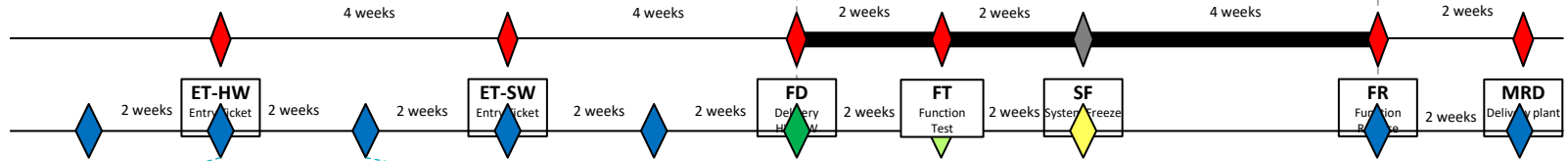


EXAMPLE: Turn Indicator

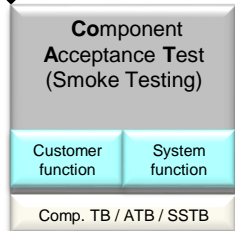


CIS - Timing

FRS Timing



CIS loop detail

SW Drop
@MAGNA
Test facility

Confirmation of
component function
implementation
for further FRS complete
system test

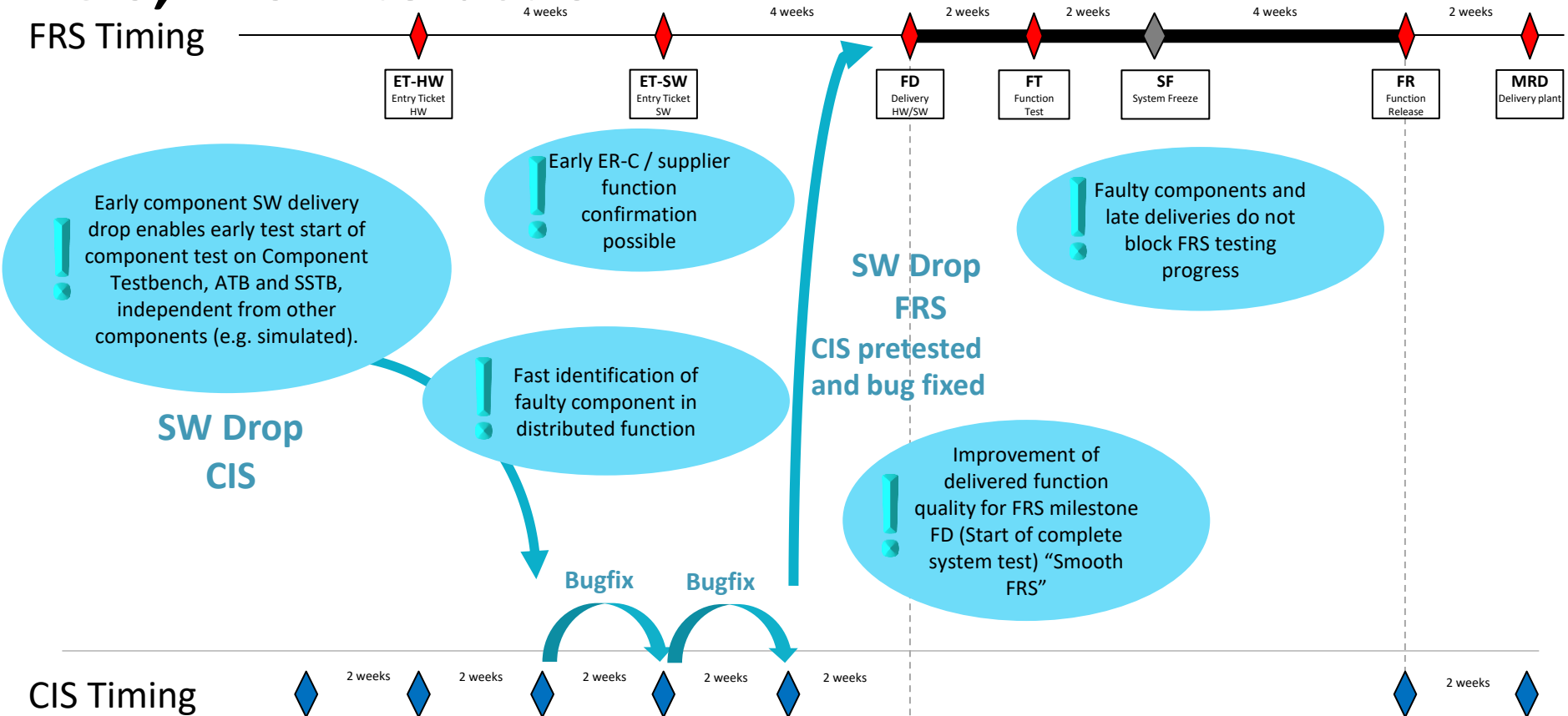
CIS Test

Function implementation check and bugfix confirmation
Focus on component integration test supported by ER-C

Comp. TB / ATB / SSTB

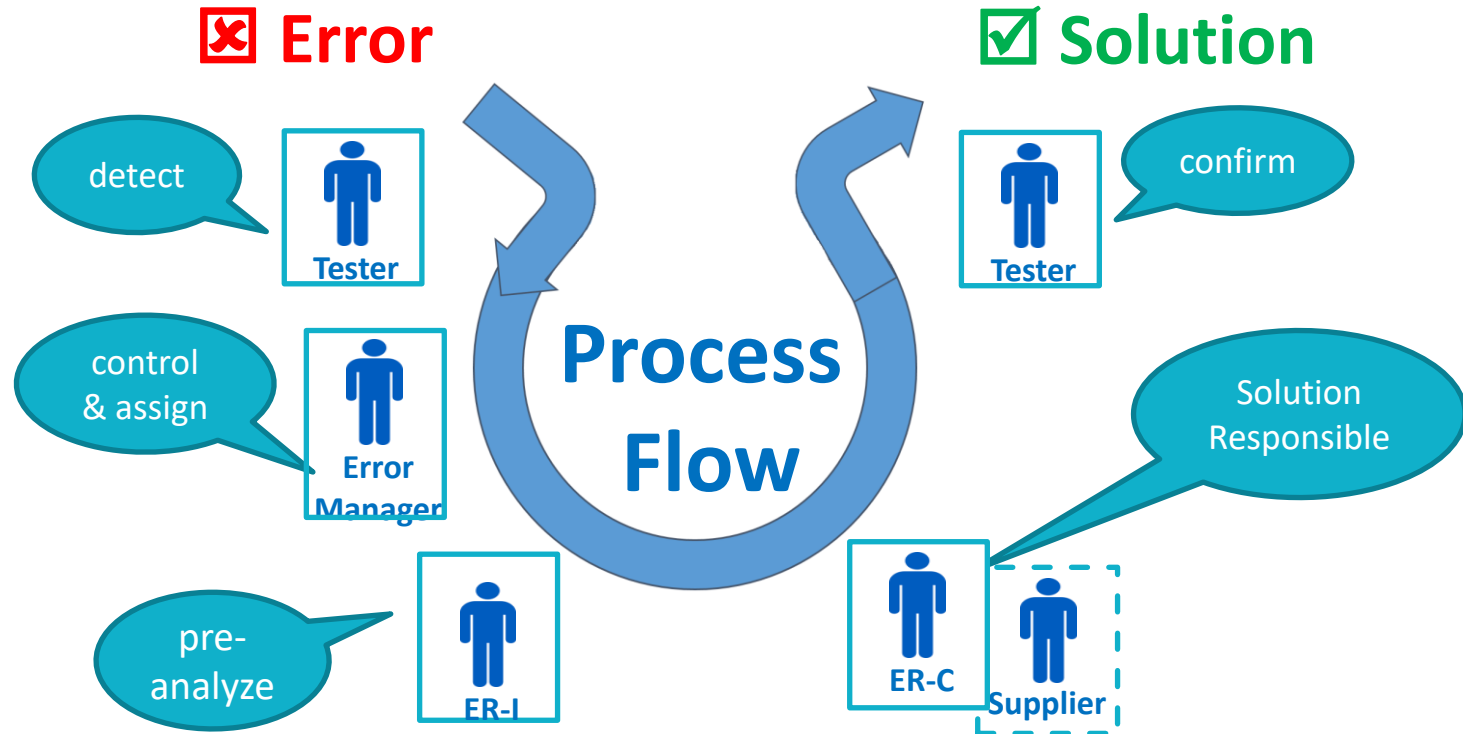
- ◆ Regular CIS delivery (changes tested by supplier)
- ◆ FRS delivery (fully tested)
- ◆ Subsequent delivery 1 (feature & bugfix)
- ◆ Subsequent delivery 2 (bugfix only)

FRS Timing

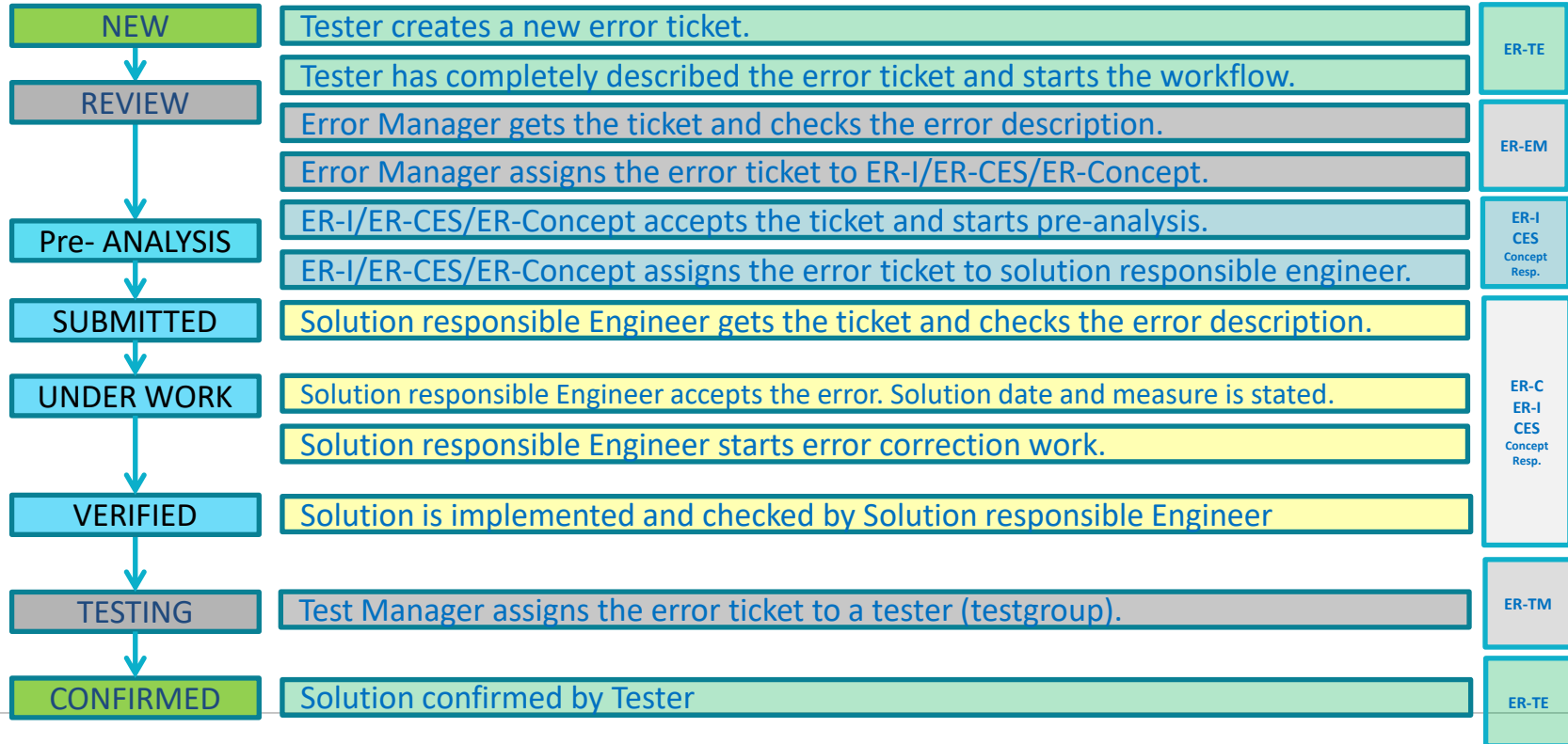


Error management

Process Flow - Overview



Error management workflow



Role Tester (ER-TEE)

ER-TEE

Rights:

- Create new error tickets
- Add attachments to existing tickets
- Reject suggested solutions („error not confirmed“)

Obligations:

- Describe the error clearly with all necessary information (traces, pictures, videos)
- Upfront information and clarification with CRE, ER-I if necessary is preferred.
- Observe error tickets “under observation”
- Test error solutions
- Confirm announced error tickets

Role Error Manager (ER-EM)

ER-EM

Rights:

- Assign new tickets to ER-I for pre-ANALYSIS or to Solution Responsible to start the corrective action.
- Reject new error tickets
- Assign the status OBSERVATION, CANCELLED, CLOSED or QUALITY
- Interfere during each error ticket workflow
- Reject suggested solutions („solution not accepted“)

Obligations:

- Assign a Solution responsible for each error ticket
- Check new error tickets regarding its information, sense and completeness.
- Decide further measures for rejected error tickets
- Observe the progress during each error ticket workflow
- Evaluate the error solving process and report it

Role Item-, CES-, Concept - Responsible

ER-I
CES Resp.
Concept
Resp.

Rights:

- Assign the status UNDER WORK and VERIFIED
- Reject assigned error tickets (“error description”, „no error“ and „not reproducible“)

Obligations:

- Accept the ticket and start pre-analysis
- Clearly identify affected component and ITEM function
- Assign ticket to Solution responsible
- Check correctness of Test case
- Assign ticket to test case writer for correction and review result
- Check and correct requirement definition of Item function and Distributed function

Role Solution Responsible (Supplier, ER-C, ER-I, CES Responsible)

ER-C
Supplier
ER-I,
CES-Resp.

Rights:

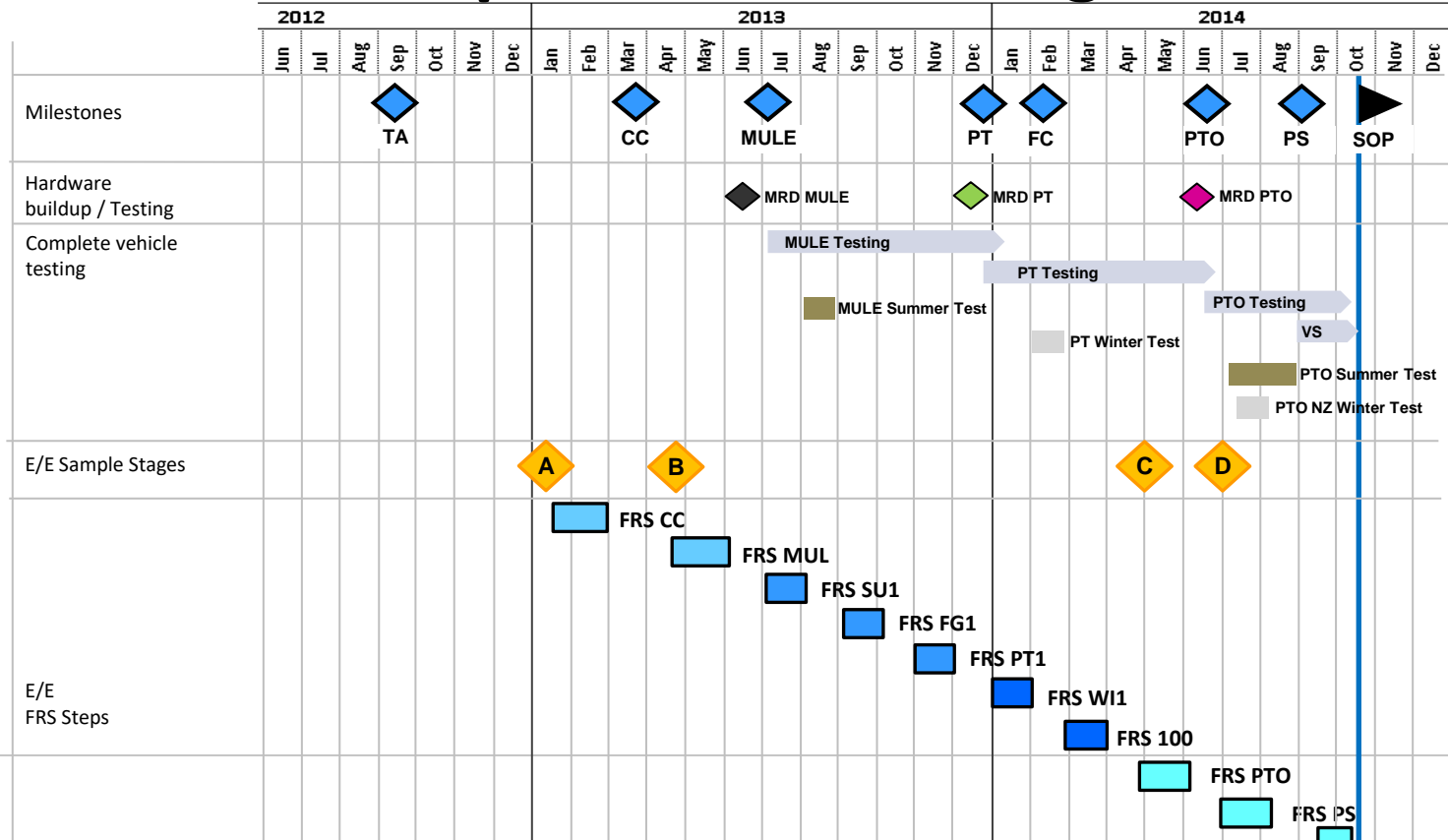
- Assign the status UNDER WORK and VERIFIED
- Reject assigned error tickets (“error description”, „no error“, „not responsible“ and „not reproducible“)
- Create new error tickets
- Add attachments to existing tickets

Obligations:

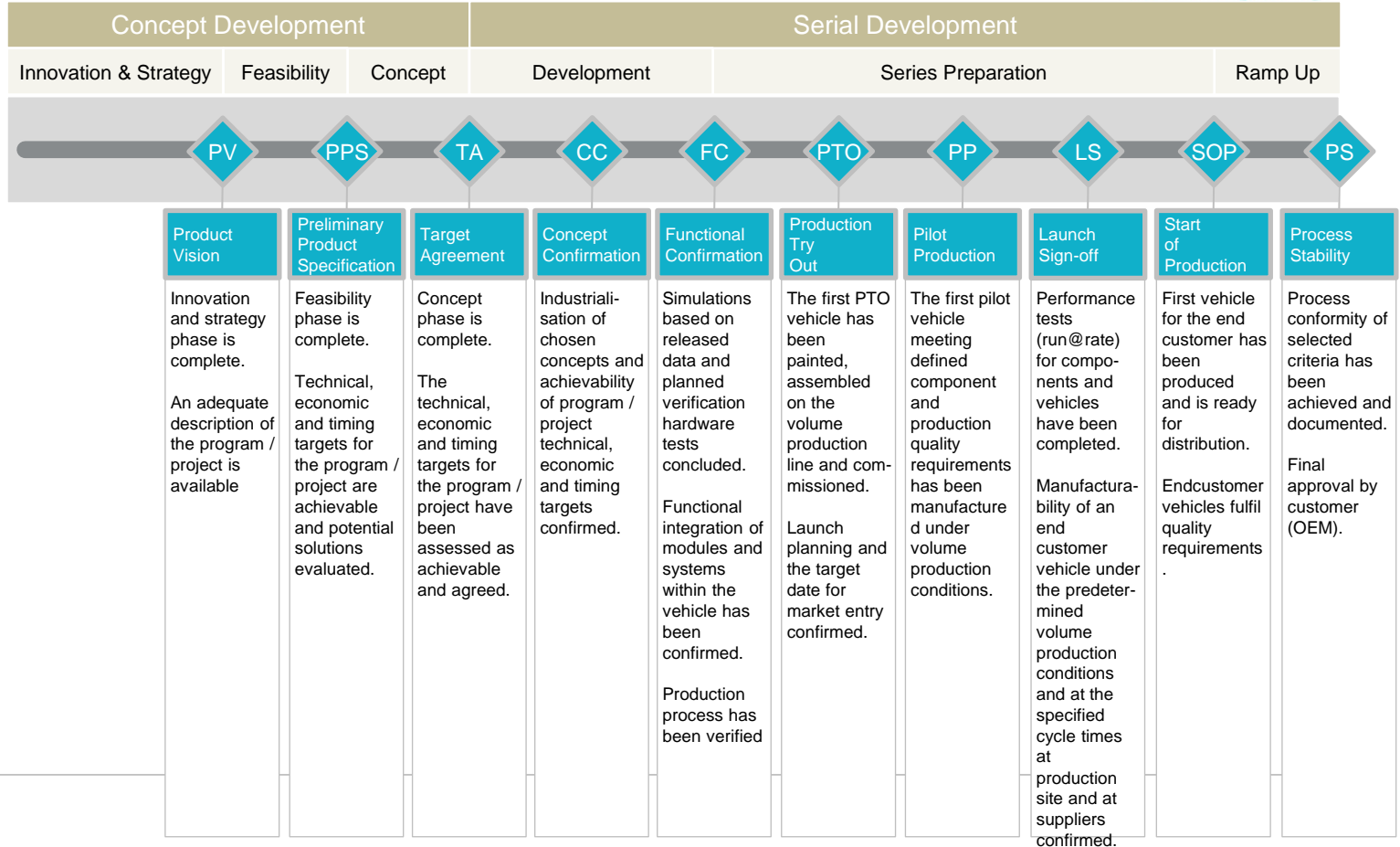
- Inform, Lead and support the supplier during the error solving process.
- Present a solution for the assigned error ticket within time limit.
- Check assigned error tickets regarding its information, sense and completeness.
Contact and support Tester if error behaviour needs further analysis.
- Detailed error root cause analysis has to be done by supplier, not by Tester.

GATES

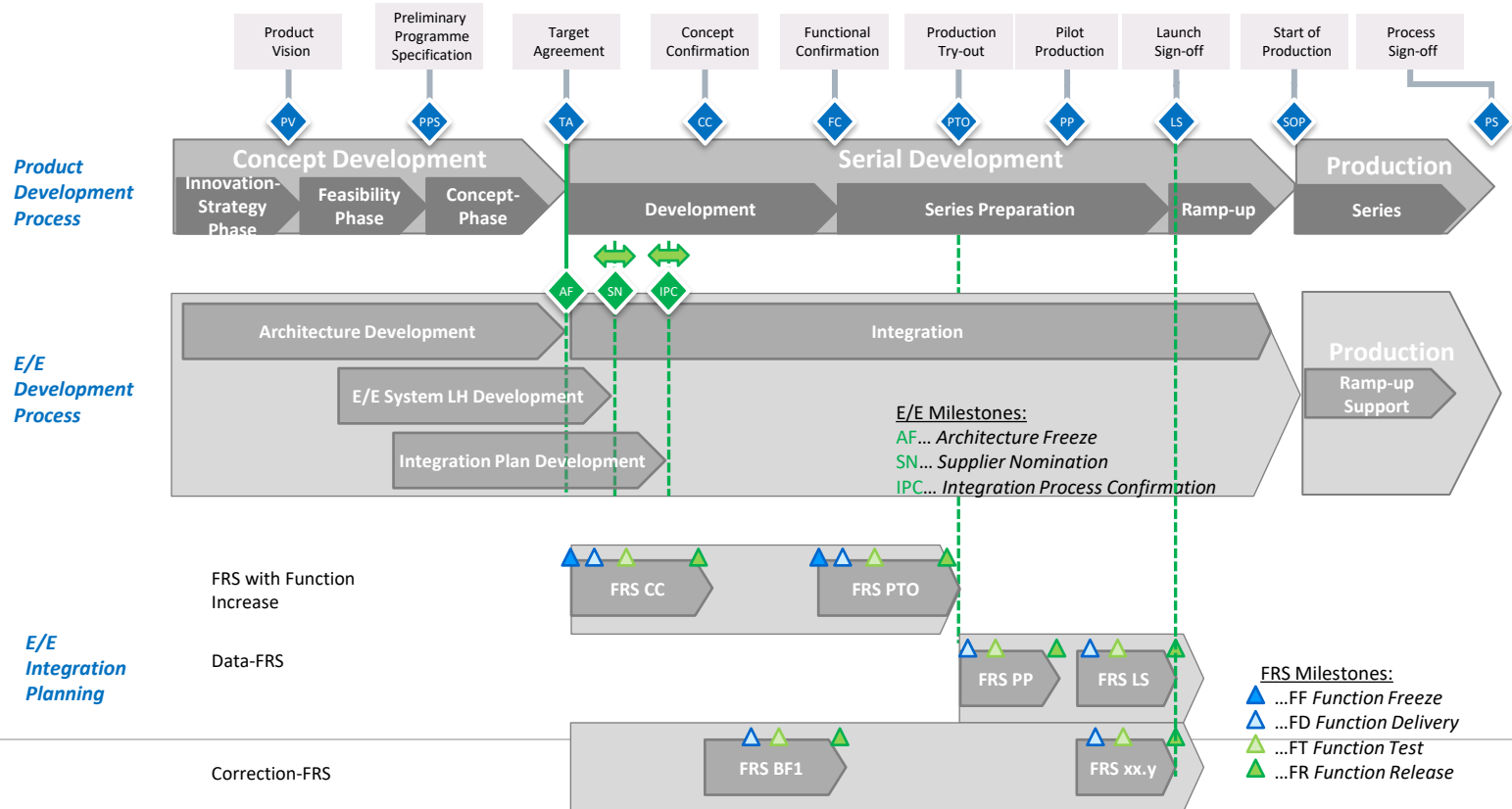
Project xx – Example Master Timing



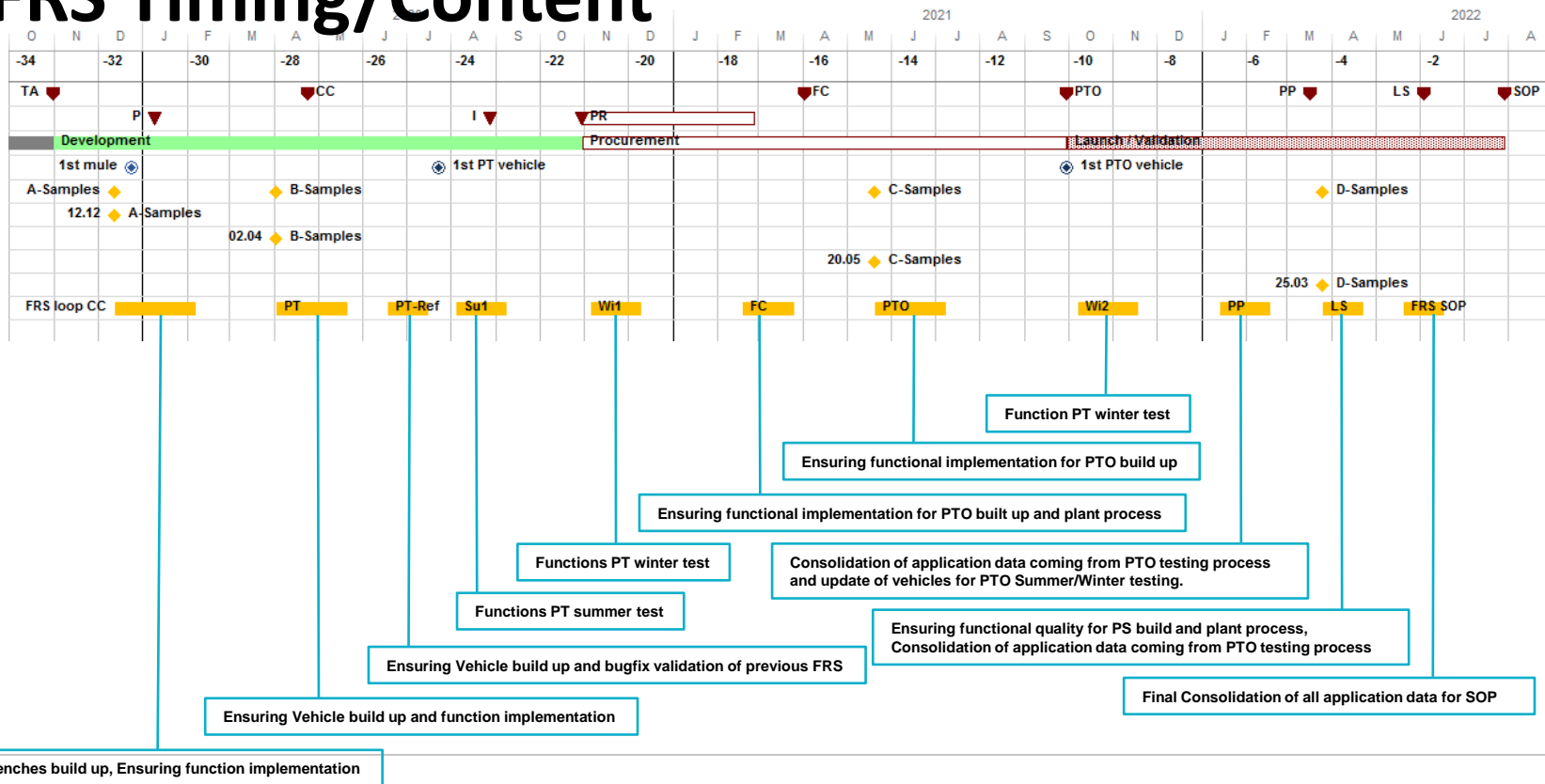
Gates



Process Overview

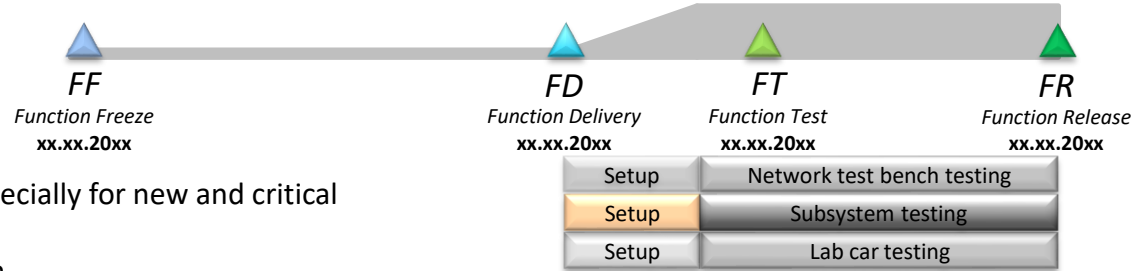


FRS Timing/Content

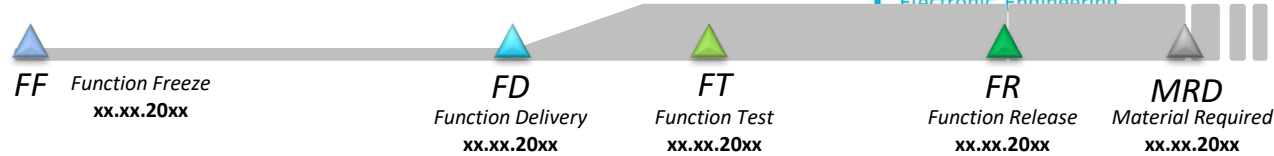


FRS CC

- Goal: Concept confirmation
- First build up (all ECU's, sensors and actuators)
- Functional confirmation of electrical system especially for new and critical
- Functional content defined in concept phase
- Testing of network functions of electrical system
- Wiring harness testing: Pinning, color mapping, connector coding, checking of fuse concept
- Confirmation of system function: network communication, bus load, clamp control
- Testing done on static test resources: lab car, network test bench and sub system test bench
- Requirements:
 - Customer functions
 - Implementation quality minimum "F" (Firstly implemented)
 - System functions:
 - Diagnostics: HW/SW identification and basic functionality like reading and deleting error memory entries should be at least possible with special supplier tools.
 - Variant coding: At least possible with special supplier tools.
 - Flash programming: At least possible with special developer tools or via CAN.
 - Energy management: Implementation of basic network functionality (Power down)
 - Required HW sample level: A-sample

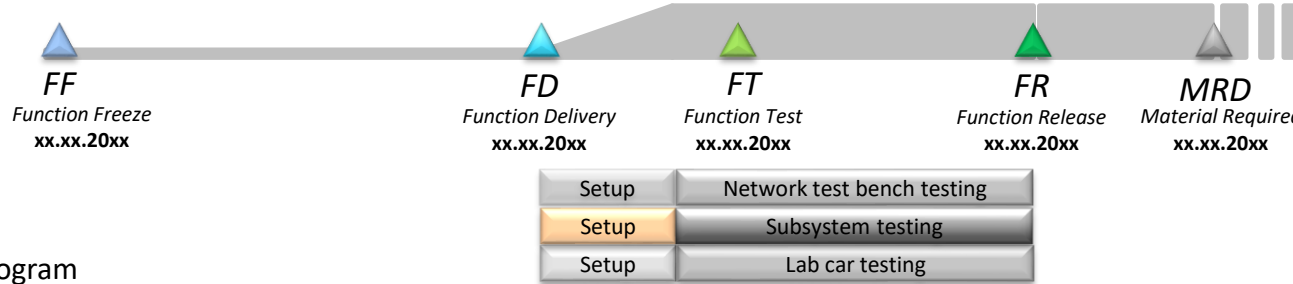


FRS MUL



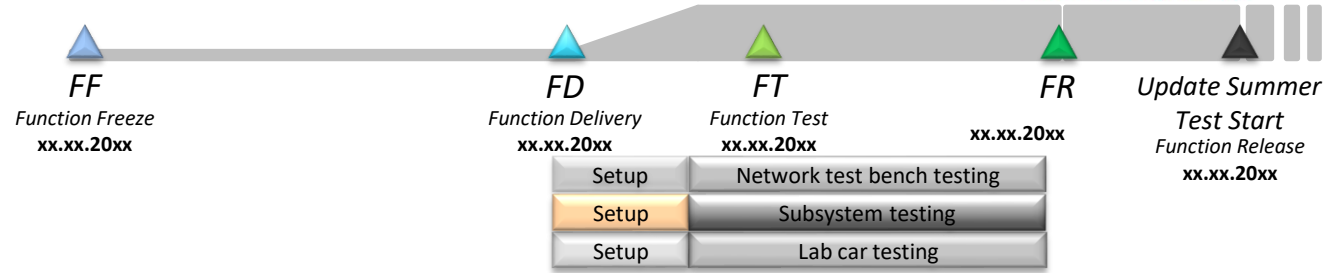
- Goal: Function testing for MULE build program
- Ensuring functional implementation for MULE build and vehicle test program
- Confirmation of system functions: network communication, bus load, clamp control
- Wiring harness testing: Pinning, color mapping, connector coding, fuse concept
- Customer function implementation: Focus on basic functionality necessary to enable a conformable dynamic vehicle test program
- Testing done on static test resources: labcar, network and subsystem test bench
- Requirements:
 - Customer functions: Implementation quality minimum “P” (Prototype testing relevant implemented) for all functions needed for MULE vehicle testing
 - System functions:
 - Bus communication: All signals implemented according to definition in message catalog.
 - Diagnostics: Basic diagnostic functionality implemented and managed by common diagnostic development tool
 - Implemented diagnostic jobs must support vehicle first startup process. Provision of corresponding diagnostic description data
 - Variant coding: At least possible with common development tool
 - Flash programming: At least possible with common development tool
 - Energy management: Basic network functionality, power down functionality and quiescent current requirements must be implemented
- Required HW sample level: B-sample

FRS PT



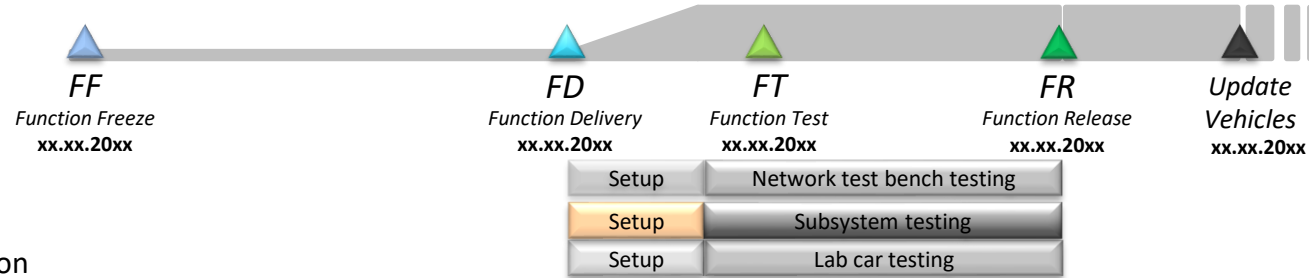
- Goal: Function testing for PT build program
- Testing of basic customer functionality and corresponding functions according agreed implementation planning for PT build and vehicle test program.
- Customer function implementation: Focus on basic functionality necessary to enable a conformable dynamic vehicle test program.
- Monitoring of function growth according to function implementation plan. ~90% of functions should be implemented.
- Requirements:
- Customer functions: Implementation quality minimum “P” (Prototype testing relevant implemented) for all functions needed for PT vehicle testing.
- System functions:
- Bus communication: All signals implemented according to definition in message catalog.
- Diagnostics: Implementation of all jobs necessary for variant coding and flash programming process. Realization of jobs for power down, energy saving, ECU reset needed. Usage of common development tool for Vehicle first startup process.
- Variant coding: Possible with common development tool.
- Flash programming: Possible with common development tool.
- Energy management: Basic network functionality, power down functionality and quiescent current requirements
- Required HW sample level: B-sample

FRS SU/WI



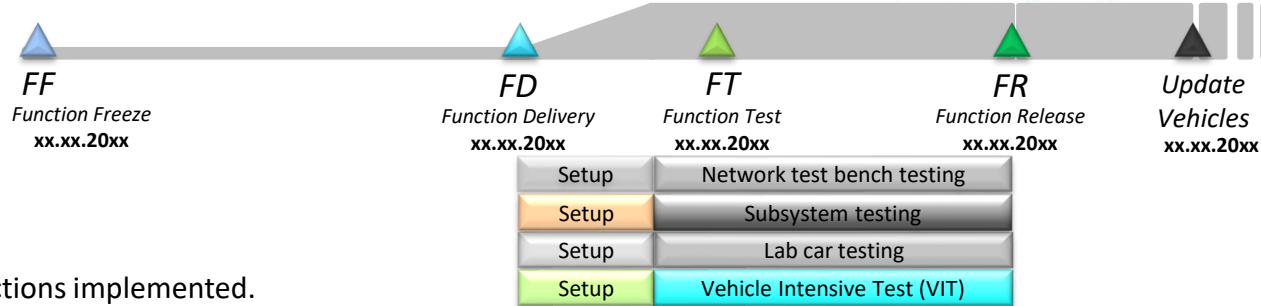
- Goal: Ensuring function implementation and update of MULE-vehicles for Summer/Winter Testing program.
- Realization of additional functions, requested by complete vehicle departments, to ensure update of MULE-vehicles for further test program progress.
- Main testing purpose is to ensure functional growth according definition in implementation planning.
- Requirements:
- Customer functions: Implementation quality minimum “P” (Prototype testing relevant implemented) for all functions needed for MULE vehicle testing.
- System functions:
- Bus communication: All signals implemented according to definition in message catalog.
- Diagnostics: Implementation of jobs necessary for vehicle update process. Usage of common development tool for Vehicle update process.
- Variant coding: At least possible with common development tool.
- Flash programming: At least possible with common development tool.
- Energy management: Basic network functionality, power down functionality and quiescent current requirements must be implemented.
- Required HW sample level: B-sample

FRS FC



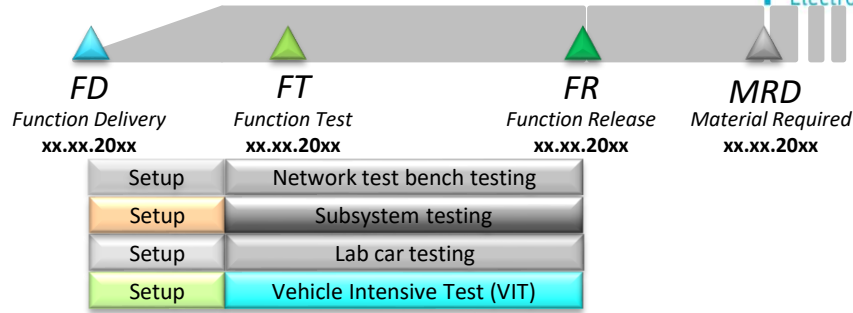
- Goal: Ensuring function confirmation
- Testing of basic customer functionality and corresponding functions according implementation planning for PT build and vehicle test program
- Main testing purpose is to ensure functional growth according definition in implementation planning specially with a view to upcoming PT-build program. ~80% of functions should be implemented
- Requirements:
- Customer functions: Implementation quality minimum “P” (Prototype testing relevant implemented) for all functions needed for upcoming PT vehicle testing
- System functions:
- Bus communication: All signals implemented according to definition in message catalog.
- Diagnostics: Implementation of all jobs necessary for variant coding and flash programming process. Realization of jobs for power down, energy saving, ECU reset. Usage of common development tool for Vehicle update process and upcoming first startup process in PT-build
- Variant coding: Possible with common development tool
- Flash programming: Possible with common development tool
- Energy management: Basic network functionality, power down functionality and quiescent current requirements implemented
- Required HW sample level: B-sample

FRS 100



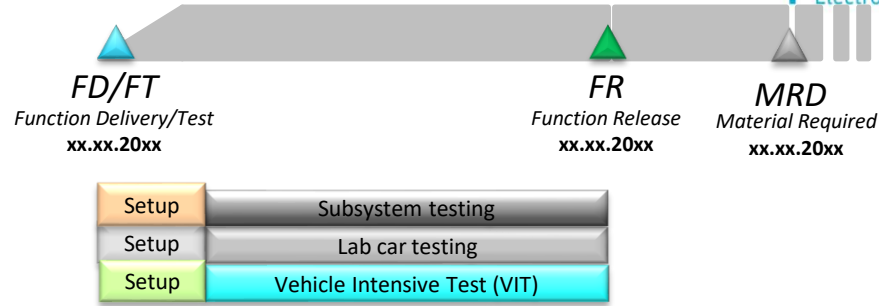
- Goal: 100% Customer and System functions implemented.
- 100% implementation of Customer and System functions according to implementation planning to fully concentrate on error reduction process until SOP.
- 100% implementation of System functions necessary to start tool evaluation process of production facility and aftersales.
- Requirements:
- Customer functions: Implementation quality minimum "C" (Customer relevant implemented) for all functions.
- System functions:
- Bus communication: All signals implemented according to definition in message catalog.
- Diagnostics: Realization of all Diagnostic jobs (also special jobs!) for development, production and aftersales. All necessary ECU data (diagnostic-, coding- and flash description data for development, production and aftersales has to be provided).
- Variant coding: Realization with production and aftersales tool.
- Flash programming: Realization with production and aftersales tool..
- Energy management: 100% Realization
- Required HW sample level: C-sample (partly B-samples possible)

FRS PTO



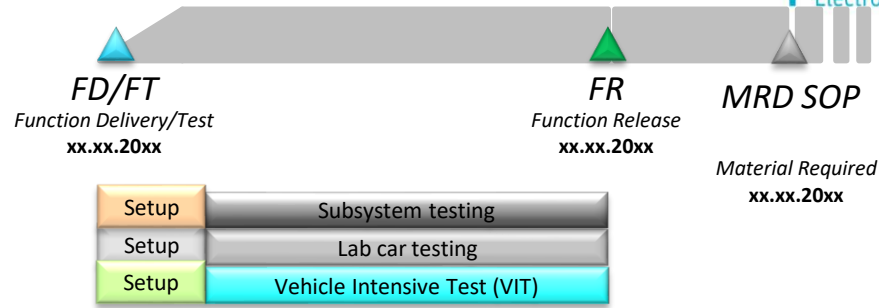
- Goal: Ensuring functional implementation for PTO build and plant process.
- 100% implementation of Customer and System functions according to implementation planning to fully concentrate on error reduction process until SOP.
- 100% implementation of System functions necessary to start tool evaluation process of production facility and aftersales.
- Requirements:
- Customer functions: Implementation quality minimum "C" (Customer relevant implemented) for all functions.
- System functions:
- Bus communication: All signals implemented according to definition in message catalog.
- Diagnostics: Realization of all Diagnostic jobs (also special jobs!) for development, production and aftersales. All necessary ECU data (diagnostic-, coding- and flash description data for development, production and aftersales has to be provided).
- Variant coding: Realization with production and aftersales tool.
- Flash programming: Realization with production and aftersales tool..
- Energy management: 100% Realization
- Required HW sample level: C-sample (from now on only SW changes allowed!)

FRS PP



- Goal: Ensuring functional quality for PP build and plant process. Consolidation of application data coming from PTO testing process
- 100% implementation of Customer and System functions according to implementation planning
- Ensuring error free vehicles and build quality
- Consolidation and Validation of all application data coming from PTO testing process.
- Validation and creation of SW data packages for Pre- series build.
- Requirements:
- Required HW sample level: D-sample

FRS SOP



- Goal: Final Consolidation of all application data for SOP.
- 100% implementation of Customer and System functions according to implementation planning
- Last chance for parameter delivery for serial build process in plant, starting with SOP.
- Consolidation and Validation of all application data coming from VS testing process. .
- Validation and creation of SW data packages for Series build.
- Requirements:
- Completion of function application data process and final data file delivery to system integration department.

Real life example

Program Grenadier E

- **Customer:** INEOS Automotive
- **Platform / Product:** NEW BEV
- **Market:** US EU CHN
- **Timing SOP:** EU 05/2026
- **Lifetime volume:** 335.000
- **Production Location:** MSF Graz
- **Magna Steyr project phases / timeline**
 - Pre-Feasibility Phase
 - Feasibility Phase
 - Concept development
 - Serial development
 - Procurement
 - Launch validation

04/2022 – 09/2022 (6 months)

09/2022 – 01/2023 (5 months)

02/2023 – 09/2023 (7,5 months)

09/2023 – 05/2024 (8,5 months)

05/2024 - 04/2025 (10,5 months)

04/2025 – 05/2026 (13 months until SOP EU) / US+ 4 months / CHN +4 months



Key Specs

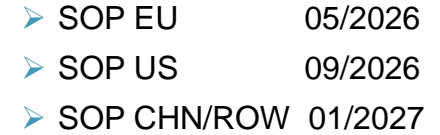
- **Unibody from Steel (No Frame)**
- **Ground Clearance** 250 mm
- **Curb Weight** 2740kg (EU regulation)
- **Battery Size** ~100kWh
- **Range** >=400km (WLTP)
- **Fast Charge Speed** >=200kW
- **Electric Engines** 2
- **Total Power** >360kW (~480hp)
- **Top Speed** 160km/h
- **Diff Locks:** Front + Rear + (Mid)
- **Wheel Travel** +-110mm (Front/Rear)
- **Wading** 650 mm
- **Suspension:** Double Wishbone (Front)
Multi-Link (Rear)

**TARGET VALUE VTS:**

Approach Angle >30°

Departure Angle >33°

Ramp Angle >20°

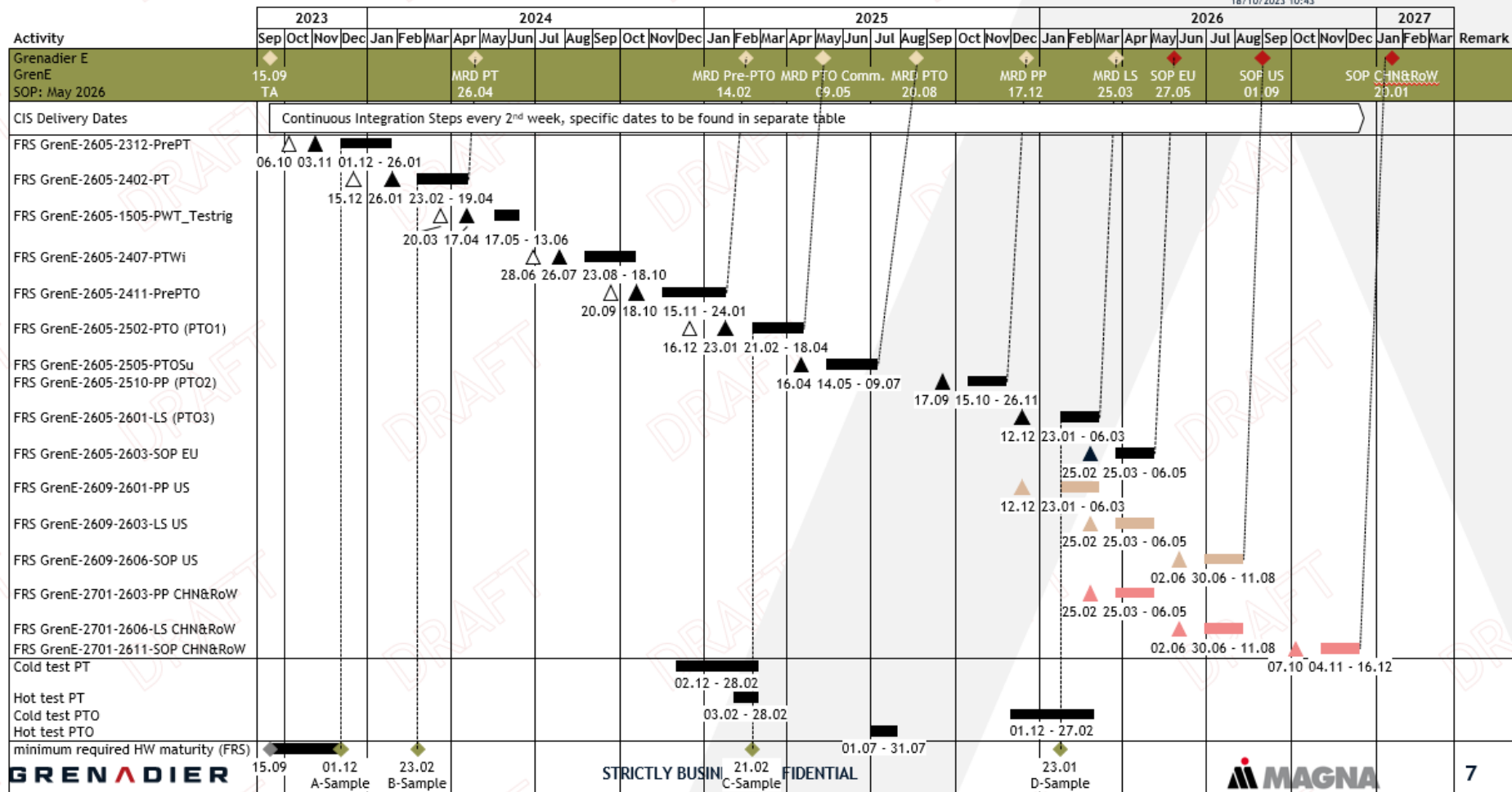


Virtual loops 3D Design (CAD) Datafreezes Simulation (CAE)													Brief overview: <ul style="list-style-type: none"> - Program duration 48 months - SOP 05/26 - PTO 08/25 - TA (Target agreement) 09/23 - PT / Planning Rel. 11/23 - 1st Hardware: PT 07/24 - PR (Proc. Rel.) 05/24
Procurement Releases Tooling LLP BIW													
HVB Battery samples MRD													
Physical validation Vehicle availability Vehicle Testing Summer/Winter													
Homologation													

FRS PLAN - OVERVIEW - GRENADIER E

FRS Plan v. 1.1

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Validation GrenE

Testbenches in GRENE

For FRS PrePT (01.12.2023)
following test benches planned:

- 1 NWTB
- 1 ATB
- 1 Body SSTB
- 1 HV/Powertrain

For FRS PT (23.02.2024)
all test benches planned.

I-Team	Department	Amount		
140	EE_SV	1	NWTB FV	
140	EE_SV	3	ATB Automated Test Bench	
140	EE_SV	1	SSTB Body /Comfort	
140	EE_SV	1	SSTB Infotainment/HMI	
140	EE_SV	1	SSTB Chassis / ADAS	
140	EE_HV	1	SSTB HV/ Powertrain	
140	EE_SV	1	NWTB Cyber Security	
140	EE_SV	1	NWTB OTA	
140	EE_SV	2	Labcar static	
140	EE_SV	1	Labcar dynamisch	
140	EE_SV	4	VIT vehicles	VIT: <ul style="list-style-type: none"> • PT2B_053 - M1 Lifestyle LHD EU • PT2B_054 - M1 Halo Offroad RHD EU • PT2B_055 - M1 Lifestyle LHD US • PT2B_056 - M1 Halo Offroad LHD EU Module vehicles: <ul style="list-style-type: none"> • PT2B_057 - M1 Lifestyle LHD China • PT2B_058 - M1 Lifestyle LHD US (HU Supplier) • PT2B_080 - M1 Entry LHD China • PT2B_059 - M1 Lifestyle LHD EU
59	EE_DF	1	SSTB ADAS (ADAS HIL)	
51	EC_FI2	1	SSTB Road to Rig	also used from I-Team 140

CIS Timing

Every 2 weeks CIS start since 15.09.2023

No ECU participation due to nomination status

Currently only residual bus simulation testing possible due to high effort on test bench frame sourcing.

GRENADIER E - CIS TIMING

FRS Plan v. 1.1

Grenadier E - Name	Start Date	End Date	Grenadier E - Name	Start Date	End Date	Grenadier E - Name	Start Date	End Date	Grenadier E - Name	Start Date	End Date
CIS 1	15.09.2023	28.09.2023	CIS 18	09.08.2024	22.08.2024	CIS 35	23.07.2025	05.08.2025	CIS 51	06.05.2026	19.05.2026
CIS 2	29.09.2023	12.10.2023	CIS 19*	23.08.2024	05.09.2024	CIS 36	06.08.2025	19.08.2025	CIS 52	20.05.2026	02.06.2026
CIS 3	13.10.2023	25.10.2023	CIS 20 *	06.09.2024	19.09.2024	CIS 37	20.08.2025	02.09.2025	CIS 53	03.06.2026	16.06.2026
CIS 4	27.10.2023	09.11.2023	2605-PTWi	23.08.2024	18.10.2024	CIS 38	03.09.2025	16.09.2025	CIS 54	17.06.2026	30.06.2026
CIS 5	10.11.2023	23.11.2023	CIS 22	18.10.2024	31.10.2024	CIS 39	17.09.2025	30.09.2025	CIS 55 *	01.07.2026	14.07.2026
CIS 6 *	24.11.2023	07.12.2023	CIS 23	02.11.2024	15.11.2024	CIS 40	01.10.2025	14.10.2025	CIS 56 *	15.07.2026	27.07.2026
CIS 7 *	08.12.2023	21.12.2023	CIS 24 *	16.11.2024	29.11.2024	CIS 41*	15.10.2025	28.10.2025	2609-SOP US	30.06.2026	11.08.2026
2605-PrePT	01.12.2023	26.01.2024	CIS 25 *	30.11.2024	13.12.2024	CIS 42 *	29.10.2025	11.11.2025	CIS 57	11.08.2026	24.08.2026
CIS 8	26.01.2024	08.02.2024	2605-PrePTO	15.11.2024	24.01.2025	2605-PP (PTO2)	15.10.2025	26.11.2025	CIS 58	25.08.2026	07.09.2026
CIS 9	09.02.2024	22.02.2024	CIS 26	24.01.2025	06.02.2025	CIS 43	26.11.2025	09.12.2025	CIS 59	08.09.2026	21.09.2026
CIS 10 *	23.02.2024	07.03.2024	CIS 27	07.02.2025	20.02.2025	CIS 44	10.12.2025	23.12.2025	CIS 60	22.09.2026	05.10.2026
CIS 11 *	08.03.2024	21.03.2024	CIS 28 *	21.02.2025	06.03.2025	CIS 45	10.01.2026	23.01.2026	CIS 61	06.10.2026	19.10.2026
2605-PT	23.02.2024	19.04.2024	CIS 29 *	07.03.2025	20.03.2025	CIS 46 *	24.01.2026	06.02.2026	CIS 62	20.10.2026	02.11.2026
CIS 12	19.04.2024	02.05.2024	2605-PTO (PTO1)	21.02.2025	18.04.2025	CIS 47*	07.02.2026	19.02.2026	CIS 63 *	03.11.2026	16.11.2026
CIS 13	03.05.2024	16.05.2024	CIS 30	18.04.2025	30.04.2025	2605-LS (PTO3)	23.01.2026	06.03.2026	CIS 64 *	17.11.2026	30.11.2026
2605-PWT_testrig	17.05.2024	13.06.2024	CIS 31	02.05.2025	15.05.2025	CIS 48	06.03.2026	19.03.2026	2701-SOP CHN&RoW	04.11.2026	16.12.2026
CIS 14	14.06.2024	27.06.2024	CIS 32 *	16.05.2025	29.05.2025	CIS 49 *	20.03.2026	02.04.2026			
CIS 15	28.06.2024	11.07.2024	CIS 33 *	30.05.2025	12.06.2025	CIS 50 *	03.04.2026	16.04.2026			
CIS 16	12.07.2024	25.07.2024	2605-PTOSu	14.05.2025	09.07.2025	2605-SOP EU	25.03.2026	06.05.2026			
CIS 17	26.07.2024	08.08.2024	CIS 34	09.07.2025	22.07.2025						

* Support of FRS testing (no additional function implementation allowed)

Validation GrenE

FRS GrenE-2605-2312-PrePT / FRS GrenE-2605-2402-PT

Function testing of all ECUs for PT build up.

Focus: System Functions Bus communication, Diagnose, Flashing, Coding, Energy and Network management.
FUSA and CS requirements to be implemented but show only result in a DTC entry.

FRS GRENE-2605-1505-PWT_Testtrig

Function testing of PWT Testtrig components to ensure PT commissioning.

Focus: HVB and HV environment, VCU, ESC, EDU EPS and iBooster.

FRS GrenE-2605-2407-PTWi

Function testing of all ECUs for PT test program (e.g., cold test).

Focus: Function Growth, E2E Protection, Security Access.

FRS GrenE-2605-2411-PrePTO

Function testing of all ECUs for PTO build up. Ensure function growth.

Focus: 100% Customer and System functions implemented, SecOC, FuSa, Signature Validation, OTA.

FRS GrenE-2605-2502-PTO (PTO1)

100% Customer and System functions implemented. Ensure function growth.

Focus: 100% Customer and System functions implemented, SecOC, FuSa, Signature Validation, OTA, Downgrade protection.

FRS GrenE-2605-2505-PTOSu

Function testing of all ECUs for PTO test program (e.g., hot test).

Focus: Bugfixing, Deactivation of Security Access and Signature Validation not allowed.

FRS GrenE-2605-2510-PP (PTO2)

Ensuring functional implementation for PP build and plant process.

Focus: Bugfixing, End2End Protection, Security Access, Signature Validation, SecOC, FuSa Functions and Downgrade Protection active. SecOC with Serial Keys.
(No deactivation possible anymore!)

FRS GrenE-2605-2601-LS (PTO3)

Ensuring functional quality for LS build and plant process. Consolidation of application data coming from
PTO/PP testing process.

Focus: Bugfixing

FRS GrenE-2605-2603-SOP EU

Final Consolidation of all application data for SOP EU.

Focus: Bugfixing