THINK 2018

SESSION 7697
A VISION FOR MODEL BASED LIFECYCLE SYSTEM ENGINEERING

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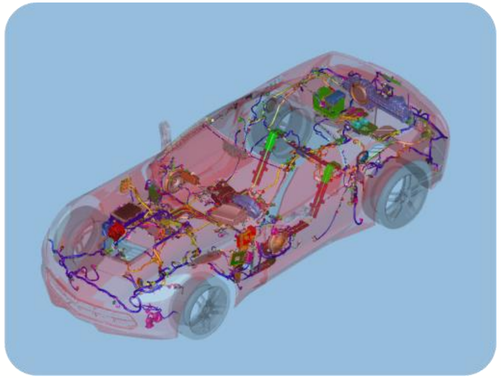
GENERAL MOTORS

GENERAL MOTORS ENGINEERING CONTEXT



Modern Automobile

1,000,000s of product instances

100,000s of product variants

10,000s parts

100s Electronic Control Units

10,000,000s Lines of Code

10s Networks

10,000s Network Signals

10,000s Engineers

INTRODUCTION

Model Based Systems Engineering (MBSE) has held the promise of both improved quality and efficiency in the engineering of large complex systems

It has rarely been a reality

Ease of use and accessibility of the modeled data have long been weakness in model based tool chains

GM is using large scale model based methods today, we have been tackling the challenges of usability and data access and usage.

Today we will introduce what GM has accomplished and what we see as the next step to realize the promise of a Model Based methodology supporting the full engineering lifecycle

THE DEFINING MODEL OF MBSE – THE SYSTEM MODEL

The System Model is the central connecting model of a MBSE methodology

In general it represents the decomposition structure of the engineered system (functional, logical, physical) and the relationships between engineering information and entities

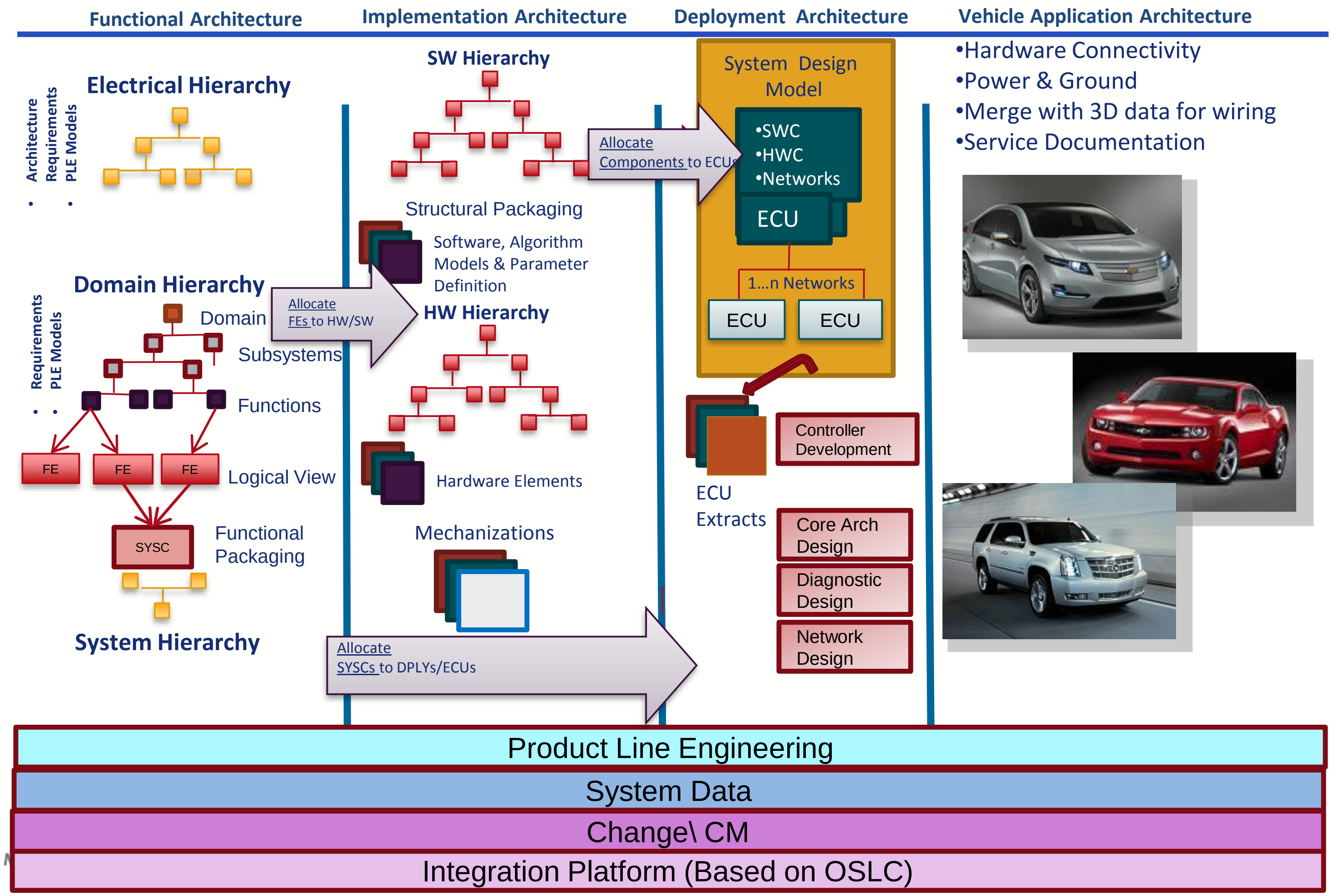
At GM we have a full system model of our electrical systems and are working to expand that practice to all disciplines

Some activities performed with our Model Based methodologies:

- Multiple allocation patterns of reusable requirements to different design solutions
- Derivation of required interface and network content based on deployment pattern
- Connection of software level detailed designs to system level architecture designs

SYSTEM ENGINEERING DEVELOPMENT LIFECYCLE - ELECTRICAL

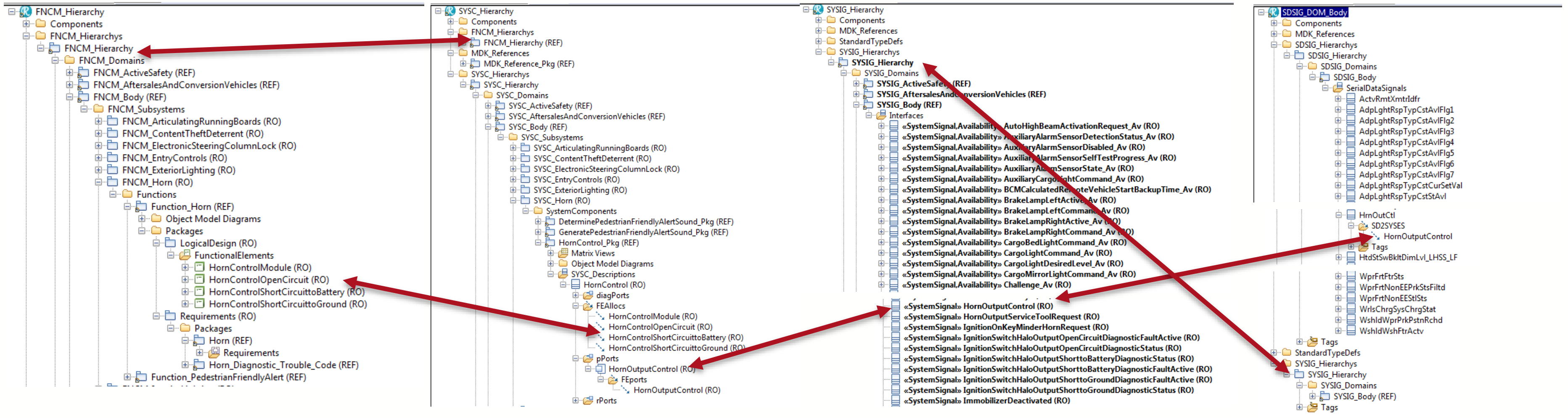
Traceability Relates the Elements



FUNCTIONAL ARCHITECTURE

A FUNCTIONAL DECOMPOSITION; REQUIREMENTS ALLOCATED TO SYSTEM ELEMENTS USED TO DRIVE INTERFACES

Functions | System Components | System Signals | Serial Data Signals



Functions:

```
FNCM_Hierarchy
  Components
  FNCM_Hierarchys
    FNCM_Hierarchy
      FNCM_Domains
        FNCM_ActiveSafety (REF)
        FNCM_AftersalesAndConversionVehicles (REF)
        FNCM_Body (REF)
          FNCM_Subsystems
            FNCM_ArticulatingRunningBoards (RO)
            FNCM_ContentTheftDeterrent (RO)
            FNCM_ElectronicSteeringColumnLock (RO)
            FNCM_EntryControls (RO)
            FNCM_ExteriorLighting (RO)
            FNCM_Horn (RO)
              Functions
                Function_Horn (REF)
                  Object Model Diagrams
                  Packages
                    LogicalDesign (RO)
                      FunctionalElements
                        HornControlModule (RO)
                        HornControlOpenCircuit (RO)
                        HornControlShortCircuittoBattery (RO)
                        HornControlShortCircuittoGround (RO)
                    Requirements (RO)
                      Packages
                        Horn (REF)
                          Requirements
                        Horn_Diagnostic_Trouble_Code (REF)
                Function_PedestrianFriendlyAlert (REF)
```

System Components:

```
SYSC_Hierarchy
  Components
  FNCM_Hierarchys
    FNCM_Hierarchy (REF)
  MDK_References
    MDK_Reference_Pkg (REF)
  SYSC_Hierarchys
    SYSC_Hierarchy
      SYSC_Domains
        SYSC_ActiveSafety (REF)
        SYSC_AftersalesAndConversionVehicles (REF)
        SYSC_Body (REF)
          SYSC_Subsystems
            SYSC_ArticulatingRunningBoards (RO)
            SYSC_ContentTheftDeterrent (RO)
            SYSC_ElectronicSteeringColumnLock (RO)
            SYSC_EntryControls (RO)
            SYSC_ExteriorLighting (RO)
            SYSC_Horn (RO)
              SystemComponents
                DeterminePedestrianFriendlyAlertSound_Pkg (REF)
                GeneratePedestrianFriendlyAlertSound_Pkg (REF)
                HornControl_Pkg (REF)
                  Matrix Views
                  Object Model Diagrams
                  SYSC_Descriptions
                    HornControl (RO)
                      diagPorts
                      FEAllocs
                        HornControlModule (RO)
                        HornControlOpenCircuit (RO)
                        HornControlShortCircuittoBattery (RO)
                        HornControlShortCircuittoGround (RO)
                      pPorts
                        HornOutputControl (RO)
                          FEports
                            HornOutputControl (RO)
                      rPorts
```

System Signals:

```
SYSIG_Hierarchy
  Components
  MDK_References
  StandardTypeDefs
  SYSIG_Hierarchys
    SYSIG_Hierarchy
      SYSIG_Domains
        SYSIG_ActiveSafety (REF)
        SYSIG_AftersalesAndConversionVehicles (REF)
        SYSIG_Body (REF)
          Interfaces
            «SystemSignal,Availability» AutoHighBeamActivationRequest_Av (RO)
            «SystemSignal,Availability» AuxiliaryAlarmSensorDetectionStatus_Av (RO)
            «SystemSignal,Availability» AuxiliaryAlarmSensorDisabled_Av (RO)
            «SystemSignal,Availability» AuxiliaryAlarmSensorSelfTestProgress_Av (RO)
            «SystemSignal,Availability» AuxiliaryAlarmSensorState_Av (RO)
            «SystemSignal,Availability» AuxiliaryCargoLightCommand_Av (RO)
            «SystemSignal,Availability» BCMCalculatedRemoteVehicleStartBackupTime_Av (RO)
            «SystemSignal,Availability» BrakeLampLeftActive_Av (RO)
            «SystemSignal,Availability» BrakeLampLeftCommand_Av (RO)
            «SystemSignal,Availability» BrakeLampRightActive_Av (RO)
            «SystemSignal,Availability» BrakeLampRightCommand_Av (RO)
            «SystemSignal,Availability» CargoBedLightCommand_Av (RO)
            «SystemSignal,Availability» CargoLightCommand_Av (RO)
            «SystemSignal,Availability» CargoLightDesiredLevel_Av (RO)
            «SystemSignal,Availability» CargoMirrorLightCommand_Av (RO)
            «SystemSignal,Availability» Challenge_Av (RO)
            «SystemSignal» HornOutputControl (RO)
            «SystemSignal» HornOutputServiceToolRequest (RO)
            «SystemSignal» IgnitionOnKeyMinderHornRequest (RO)
            «SystemSignal» IgnitionSwitchHaloOutputOpenCircuitDiagnosticFaultActive (RO)
            «SystemSignal» IgnitionSwitchHaloOutputOpenCircuitDiagnosticStatus (RO)
            «SystemSignal» IgnitionSwitchHaloOutputShorttoBatteryDiagnosticStatus (RO)
            «SystemSignal» IgnitionSwitchHaloOutputShorttoBatteryDiagnosticFaultActive (RO)
            «SystemSignal» IgnitionSwitchHaloOutputShorttoGroundDiagnosticFaultActive (RO)
            «SystemSignal» IgnitionSwitchHaloOutputShorttoGroundDiagnosticStatus (RO)
            «SystemSignal» ImmobilizerDeactivated (RO)
```

Serial Data Signals:

```
SDSIG_DOM_Body
  Components
  MDK_References
  SDSIG_Hierarchys
    SDSIG_Hierarchy
      SDSIG_Domains
        SDSIG_Body
          SerialDataSignals
            ActvRmtXmtrIdfr
            AdpLghtRspTypCstAvlFlg1
            AdpLghtRspTypCstAvlFlg2
            AdpLghtRspTypCstAvlFlg3
            AdpLghtRspTypCstAvlFlg4
            AdpLghtRspTypCstAvlFlg5
            AdpLghtRspTypCstAvlFlg6
            AdpLghtRspTypCstAvlFlg7
            AdpLghtRspTypCstCurSetVal
            AdpLghtRspTypCstStAvl
            HrnOutCtl
              SD2SYSES
                HornOutputControl
              Tags
            HtdStSwBkltDimLvl_LHSS_LF
            WprFrtFtrSts
            WprFrtNonEEPrkStsFiltd
            WprFrtNonEEStlSts
            WrlsChrgSysChrgStat
            WshldWprPrkPstnRchd
            WshldWshFtrActv
      Tags
  StandardTypeDefs
  SYSIG_Hierarchys
    SYSIG_Hierarchy
      SYSIG_Domains
        SYSIG_Body (REF)
      Tags
```

- Key Model Elements:
  - Functional Elements (FE)
  - Functional Interfaces
- Defines Requirement Allocation

- Key Model Elements:
  - System Components
  - System Interfaces
- Defines FE Allocation

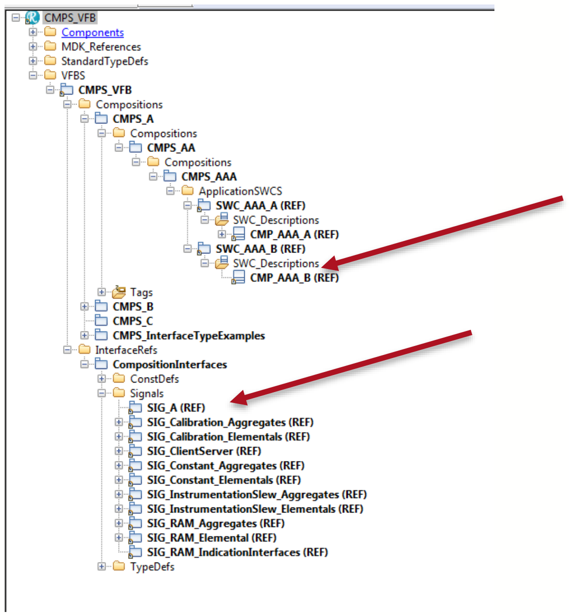
- Key Model Elements:
  - System Signals
- Abstract interface contract
- Bridge to other Architectures

- Key Model Elements:
  - Serial Data Signals
- Binds to System Signals

IMPLEMENTATION ARCHITECTURE

SOFTWARE DETAILED DESIGN INFORMATION CONNECTED TO SYSTEM LEVEL DESIGNS

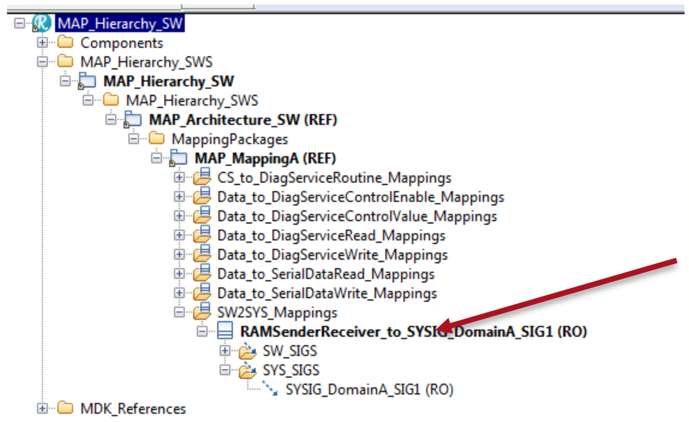
Software Components and Signals



```
CMPS_VFB
  Components
  MDK_References
  StandardTypeDefs
  VFBS
    CMPS_VFB
      Compositions
        CMPS_A
          Compositions
            CMPS_AA
              Compositions
                CMPS_AAA
                  ApplicationSWCS
                    SWC_AAA_A (REF)
                      SWC_Descriptions
                        CMP_AAA_A (REF)
                    SWC_AAA_B (REF)
                      SWC_Descriptions
                        CMP_AAA_B (REF)
          Tags
        CMPS_B
        CMPS_C
        CMPS_InterfaceTypeExamples
      InterfaceRefs
        CompositionInterfaces
          ConstDefs
          Signals
            SIG_A (REF)
            SIG_Calibration_Aggregates (REF)
            SIG_Calibration_Elementals (REF)
            SIG_ClientServer (REF)
            SIG_Constant_Aggregates (REF)
            SIG_Constant_Elementals (REF)
            SIG_InstrumentationSlew_Aggregates (REF)
            SIG_InstrumentationSlew_Elementals (REF)
            SIG_RAM_Aggregates (REF)
            SIG_RAM_Elemental (REF)
            SIG_RAM_IndicationInterfaces (REF)
          TypeDefs
```

- Key Model Elements:
  - Software Components (SWC)
  - Software Interfaces (SW Signals)

Software Mapping

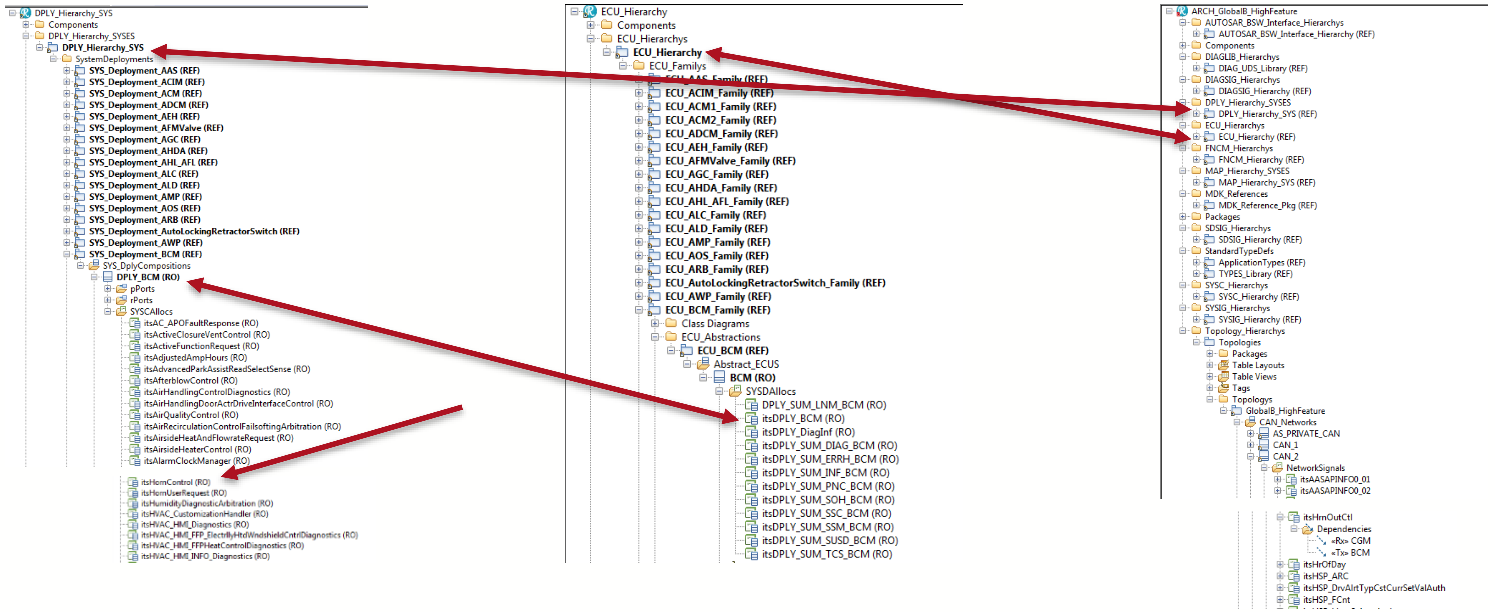


```
MAP_Hierarchy_SW
  Components
  MAP_Hierarchy_SWS
    MAP_Hierarchy_SW
      MAP_Hierarchy_SWS
        MAP_Architecture_SW (REF)
          MappingPackages
            MAP_MappingA (REF)
              CS_to_DiagServiceRoutine_Mappings
              Data_to_DiagServiceControlEnable_Mappings
              Data_to_DiagServiceControlValue_Mappings
              Data_to_DiagServiceRead_Mappings
              Data_to_DiagServiceWrite_Mappings
              Data_to_SerialDataRead_Mappings
              Data_to_SerialDataWrite_Mappings
              SW2SYS_Mappings
                RAMSenderReceiver_to_SYSIG_DomainA_SIG1 (RO)
                  SW_SIGS
                  SYS_SIGS
                    SYSIG_DomainA_SIG1 (RO)
  MDK_References
```

- Defines SW Signal to System Signal Mapping

DEPLOYMENT ARCHITECTURE

REUSABLE ELEMENTS IN DIFFERENT DESIGN PATTERNS



Deployment Compositions

```
DPLY_Hierarchy_SYS
  Components
  DPLY_Hierarchy_SYSES
    DPLY_Hierarchy_SYS
      SystemDeployments
        SYS_Deployment_AAS (REF)
        SYS_Deployment_ACIM (REF)
        SYS_Deployment_ACM (REF)
        SYS_Deployment_ADCM (REF)
        SYS_Deployment_AEH (REF)
        SYS_Deployment_AFMValve (REF)
        SYS_Deployment_AGC (REF)
        SYS_Deployment_AHDA (REF)
        SYS_Deployment_AHL_AFL (REF)
        SYS_Deployment_ALC (REF)
        SYS_Deployment_ALD (REF)
        SYS_Deployment_AMP (REF)
        SYS_Deployment_AOS (REF)
        SYS_Deployment_ARB (REF)
        SYS_Deployment_AutoLockingRetractorSwitch (REF)
        SYS_Deployment_AWP (REF)
        SYS_Deployment_BCM (REF)
          SYS_DplyCompositions
            DPLY_BCM (RO)
              pPorts
              rPorts
              SYSCAllocs
                itsAC_APOFaultResponse (RO)
                itsActiveClosureVentControl (RO)
                itsActiveFunctionRequest (RO)
                itsAdjustedAmpHours (RO)
                itsAdvancedParkAssistReadSelectSense (RO)
                itsAfterblowControl (RO)
                itsAirHandlingControlDiagnostics (RO)
                itsAirHandlingDoorActrDriveInterfaceControl (RO)
                itsAirQualityControl (RO)
                itsAirRecirculationControlFailsoftingArbitration (RO)
                itsAirsideHeatAndFlowrateRequest (RO)
                itsAirsideHeaterControl (RO)
                itsAlarmClockManager (RO)

                itsHornControl (RO)
                itsHornUserRequest (RO)
                itsHumidityDiagnosticArbitration (RO)
                itsHVAC_CustomizationHandler (RO)
                itsHVAC_HMI_Diagnostics (RO)
                itsHVAC_HMI_FFP_ElectrllyHtdWndshieldCntrlDiagnostics (RO)
                itsHVAC_HMI_FFPHeatControlDiagnostics (RO)
                itsHVAC_HMI_INFO_Diagnostics (RO)
```

ECUs

```
ECU_Hierarchy
  Components
  ECU_Hierarchys
    ECU_Hierarchy
      ECU_Familys
        ECU_AAS_Family (REF)
        ECU_ACIM_Family (REF)
        ECU_ACM1_Family (REF)
        ECU_ACM2_Family (REF)
        ECU_ADCM_Family (REF)
        ECU_AEH_Family (REF)
        ECU_AFMValve_Family (REF)
        ECU_AGC_Family (REF)
        ECU_AHDA_Family (REF)
        ECU_AHL_AFL_Family (REF)
        ECU_ALC_Family (REF)
        ECU_ALD_Family (REF)
        ECU_AMP_Family (REF)
        ECU_AOS_Family (REF)
        ECU_ARB_Family (REF)
        ECU_AutoLockingRetractorSwitch_Family (REF)
        ECU_AWP_Family (REF)
        ECU_BCM_Family (REF)
          Class Diagrams
          ECU_Abstractions
            ECU_BCM (REF)
              Abstract_ECUS
                BCM (RO)
                  SYSDAllocs
                    DPLY_SUM_LNM_BCM (RO)
                    itsDPLY_BCM (RO)
                    itsDPLY_DiagInf (RO)
                    itsDPLY_SUM_DIAG_BCM (RO)
                    itsDPLY_SUM_ERRH_BCM (RO)
                    itsDPLY_SUM_INF_BCM (RO)
                    itsDPLY_SUM_PNC_BCM (RO)
                    itsDPLY_SUM_SOH_BCM (RO)
                    itsDPLY_SUM_SSC_BCM (RO)
                    itsDPLY_SUM_SSM_BCM (RO)
                    itsDPLY_SUM_SUSD_BCM (RO)
                    itsDPLY_SUM_TCS_BCM (RO)
```

Network Topology

```
ARCH_GlobalB_HighFeature
  AUTOSAR_BSW_Interface_Hierarchys
    AUTOSAR_BSW_Interface_Hierarchy (REF)
  Components
  DIAGLIB_Hierarchys
    DIAG_UDS_Library (REF)
  DIAGSIG_Hierarchys
    DIAGSIG_Hierarchy (REF)
  DPLY_Hierarchy_SYSES
    DPLY_Hierarchy_SYS (REF)
  ECU_Hierarchys
    ECU_Hierarchy (REF)
  FNCM_Hierarchys
    FNCM_Hierarchy (REF)
  MAP_Hierarchy_SYSES
    MAP_Hierarchy_SYS (REF)
  MDK_References
    MDK_Reference_Pkg (REF)
  Packages
  SDSIG_Hierarchys
    SDSIG_Hierarchy (REF)
  StandardTypeDefs
    ApplicationTypes (REF)
    TYPES_Library (REF)
  SYSC_Hierarchys
    SYSC_Hierarchy (REF)
  SYSIG_Hierarchys
    SYSIG_Hierarchy (REF)
  Topology_Hierarchys
    Topologies
      Packages
      Table Layouts
      Table Views
      Tags
      Topologys
        GlobalB_HighFeature
          CAN_Networks
            AS_PRIVATE_CAN
            CAN_1
            CAN_2
              NetworkSignals
                itsAASAPINFO0_01
                itsAASAPINFO0_02

                itsHrnOutCtl
                  Dependencies
                    «Rx» CGM
                    «Tx» BCM
                itsHrOfDay
                itsHSP_ARC
                itsHSP_DrvAlrtTypCstCurrSetValAuth
                itsHSP_FCnt
```

- Key Model Elements:
  - Deployment Compositions
- Defines System Component Allocation
- Defines Software Component Allocation

- Key Model Elements:
  - ECUs
- Defines Deployment Composition Allocation

- Network Signals between ECUs determined by…
- System Component contracts to System Signals
- System Signal binding to Serial Data Signals

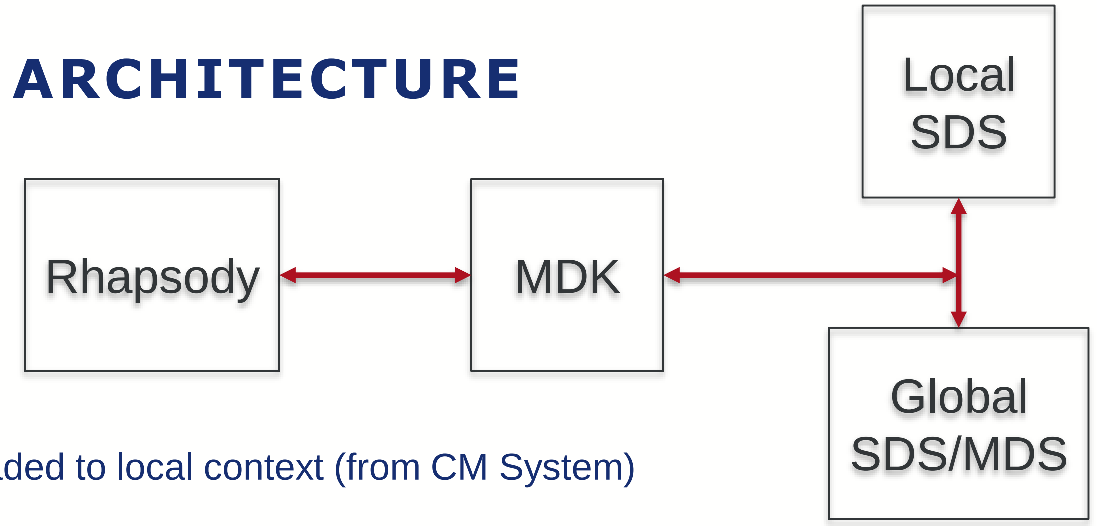
GENERAL MOTORS

MODEL DEVELOPMENT KIT(MDK) AND MODEL DEPENDENCY SERVER (MDS)

How GM is tackling the usability and data usage challenge today

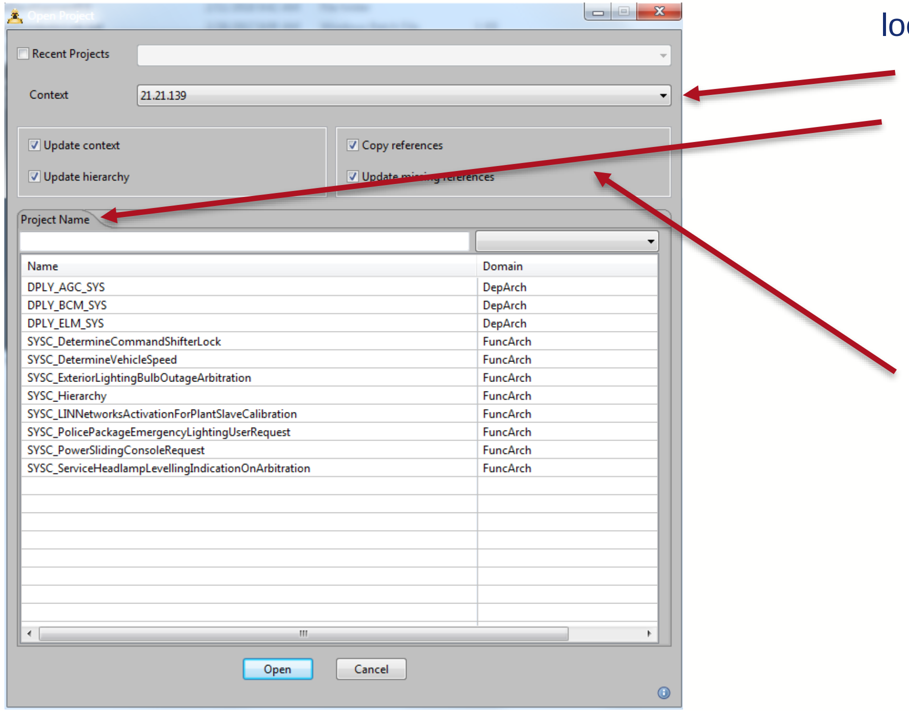
- MDK - leverages the Rhapsody Java APIs to automate creation of model elements
    - Makes creation of our Domain specific model elements and relationships far more efficient
    - Helps to enforce modeling guidelines
- MDS – keeps track of all relationships between the set of integrated data models
- The MDK works with the MDS to efficiently create local development environments

MDK/MDS TOOLING ARCHITECTURE



- Only models that will be modified are loaded to local context (from CM System)
- MDK is used to open the model
  - Queries the MDS for all dependent model data
  - Downloads required model data from the Global Shared Data Server (SDS)
- MDK is also used to edit model
  - Custom UIs tailored to our model structure and processes
  - Automations driven by custom UI to improve efficiency and abstract model details
  - All model data is available to be added to the model from Global SDS
  - Referenced data is added automatically
  - Local SDS manages any local model changes (overrides Global SDS)

MDK/MDS EXAMPLE – OPEN PROJECT



Recent Projects

Context: 21.21.139

☑ Update context
☑ Update hierarchy
☑ Copy references
☑ Update missing references

Project Name

Name	Domain
DPLY_AGC_SYS	DepArch
DPLY_BCM_SYS	DepArch
DPLY_ELM_SYS	DepArch
SYSC_DetermineCommandShifterLock	FuncArch
SYSC_DetermineVehicleSpeed	FuncArch
SYSC_ExteriorLightingBulbOutageArbitration	FuncArch
SYSC_Hierarchy	FuncArch
SYSC_LINNetworksActivationForPlantSlaveCalibration	FuncArch
SYSC_PolicePackageEmergencyLightingUserRequest	FuncArch
SYSC_PowerSlidingConsoleRequest	FuncArch
SYSC_ServiceHeadlampLevellingIndicationOnArbitration	FuncArch

The MDK is used to open model projects and manage the required content of the local work area.

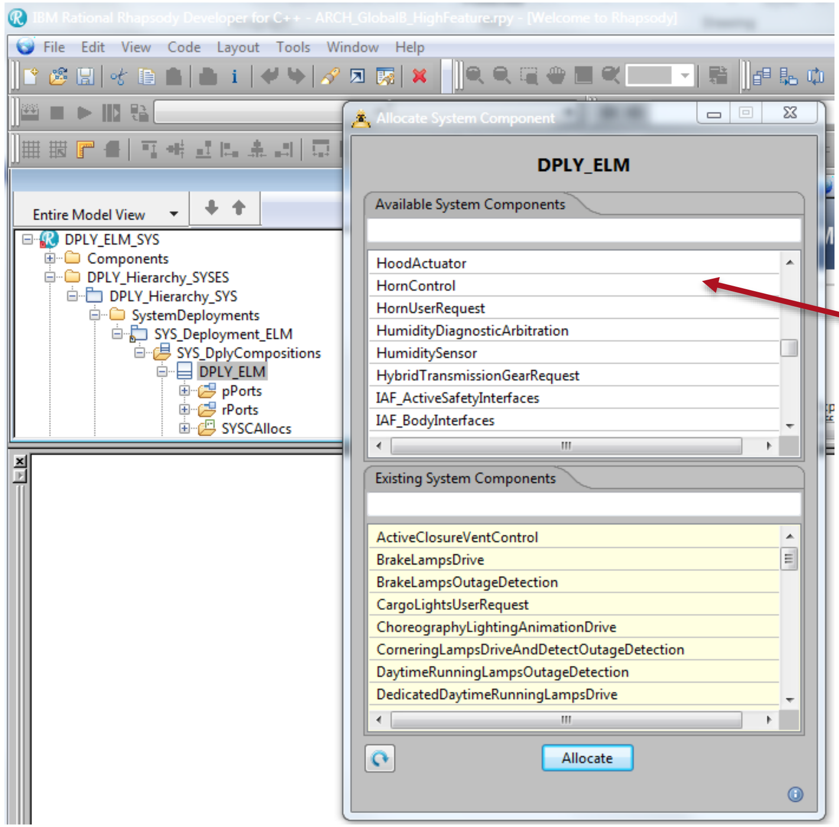
Select Local Work Area

Select Project from local work area

Based on check boxes MDK will use MDS and GSDS to:

- Update Context – Update all GSDS data to latest versions
- Update Hierarchy – Update referenced data hierarchy structure
- Copy references – Copy any referenced model data from the GSDS to the local work area
- Update missing references – Copy any missing referenced data from the GSDS to the local work area and reference into the model

MDK/MDS EXAMPLE – SYSC ALLOCATION


IBM Rational Rhapsody Developer for C++ - ARCH_GlobalB_HighFeature.rpy - [Welcome to Rhapsody]
File Edit View Code Layout Tools Window Help
Entire Model View
Allocate System Component
Allocate

DPLY_ELM_SYS
- Components
- DPLY_Hierarchy_SYSES
  - DPLY_Hierarchy_SYS
    - SystemDeployments
      - SYS_Deployment_ELM
        - SYS_DplyCompositions
          - DPLY_ELM
            - pPorts
            - rPorts
            - SYSCAllocs

DPLY_ELM

Available System Components

- HoodActuator
- HornControl
- HornUserRequest
- HumidityDiagnosticArbitration
- HumiditySensor
- HybridTransmissionGearRequest
- IAF_ActiveSafetyInterfaces
- IAF_BodyInterfaces

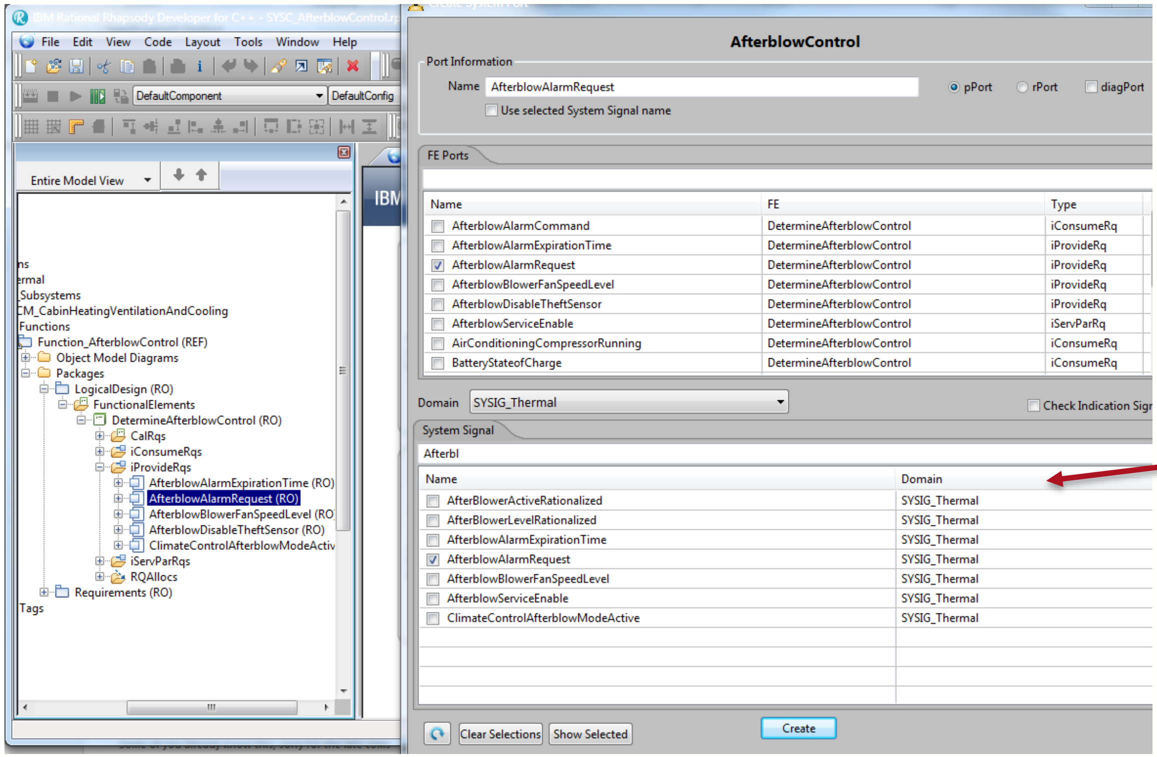
Existing System Components

- ActiveClosureVentControl
- BrakeLampsDrive
- BrakeLampsOutageDetection
- CargoLightsUserRequest
- ChoreographyLightingAnimationDrive
- CorneringLampsDriveAndDetectOutageDetection
- DaytimeRunningLampsOutageDetection
- DedicatedDaytimeRunningLampsDrive

The MDK is used to allocate System Components to Compositions. This creates an instance of the System Component under the Composition.

- Pulls up all potential SYSCs from both the local and Global Servers
- Will automatically reference in the model data into the proper reference hierarchy
- Generates the allocation instance(s) of selected System Components

MDK/MDS EXAMPLES – SYSC PORT CREATION


IBM Rational Rhapsody Developer for C++ - SYSC_AfterblowControl.rp
File Edit View Code Layout Tools Window Help
DefaultComponent
DefaultConfig
Entire Model View
IBM

ns
ermal
Subsystems
CM_CabinHeatingVentilationAndCooling
Functions
Function_AfterblowControl (REF)
Object Model Diagrams
Packages
LogicalDesign (RO)
FunctionalElements
DetermineAfterblowControl (RO)
CalRqs
iConsumeRqs
iProvideRqs
AfterblowAlarmExpirationTime (RO)
AfterblowAlarmRequest (RO)
AfterblowBlowerFanSpeedLevel (RO
AfterblowDisableTheftSensor (RO)
ClimateControlAfterblowModeActiv
iServParRqs
RQAllocs
Requirements (RO)
Tags

AfterblowControl

Port Information

Name: AfterblowAlarmRequest — [✓ pPort] rPort ☐ diagPort

☐ Use selected System Signal name

FE Ports

	Name	FE	Type
☐	AfterblowAlarmCommand	DetermineAfterblowControl	iConsumeRq
☐	AfterblowAlarmExpirationTime	DetermineAfterblowControl	iProvideRq
✓	AfterblowAlarmRequest	DetermineAfterblowControl	iProvideRq
☐	AfterblowBlowerFanSpeedLevel	DetermineAfterblowControl	iProvideRq
☐	AfterblowDisableTheftSensor	DetermineAfterblowControl	iProvideRq
☐	AfterblowServiceEnable	DetermineAfterblowControl	iServParRq
☐	AirConditioningCompressorRunning	DetermineAfterblowControl	iConsumeRq
☐	BatteryStateofCharge	DetermineAfterblowControl	iConsumeRq

Domain: SYSIG_Thermal — ☐ Check Indication Sigr

System Signal

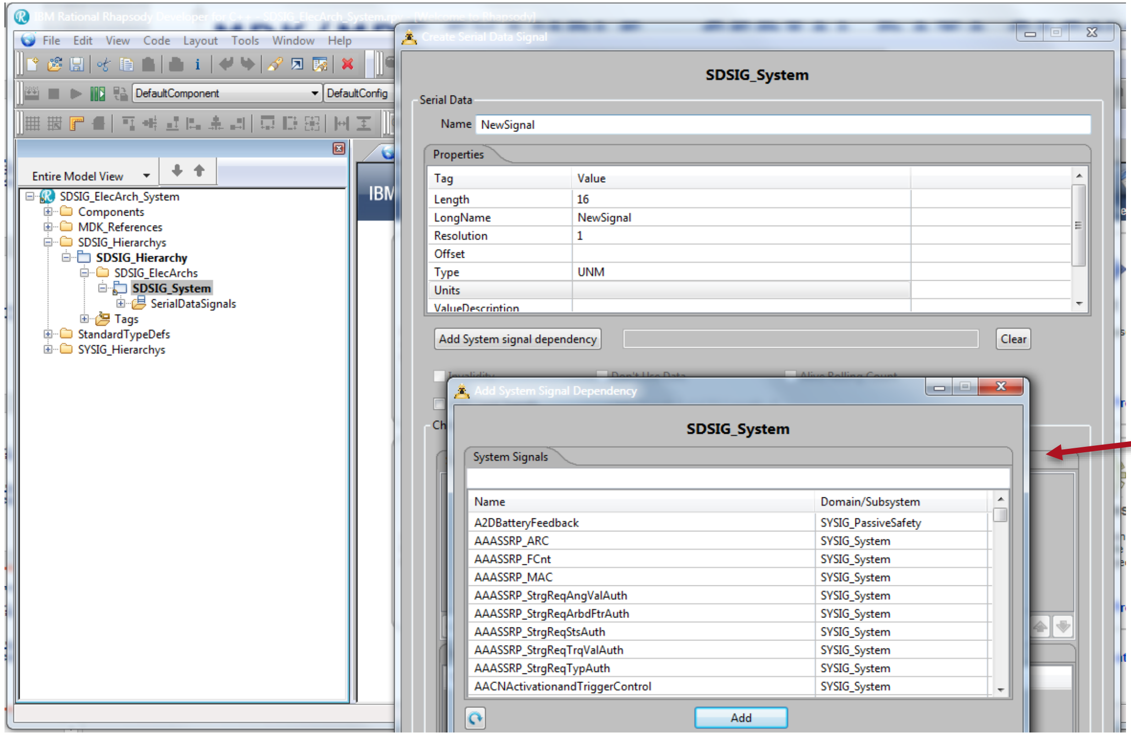
Afterbl

	Name	Domain
☐	AfterBlowerActiveRationalized	SYSIG_Thermal
☐	AfterBlowerLevelRationalized	SYSIG_Thermal
☐	AfterblowAlarmExpirationTime	SYSIG_Thermal
✓	AfterblowAlarmRequest	SYSIG_Thermal
☐	AfterblowBlowerFanSpeedLevel	SYSIG_Thermal
☐	AfterblowServiceEnable	SYSIG_Thermal
☐	ClimateControlAfterblowModeActive	SYSIG_Thermal

The MDK is used to create System Component Ports. These ports are created with a relationship to an FE port and a port contract to a System Signal (Interface)

- Pulls up local FE content
- Pulls up all potential System Signals from both the local and Global Servers
- Will automatically reference in the model data into the proper reference hierarchy
- Generates the port with the FE relationship and System Signal contract

MDK/MDS EXAMPLES – SERIAL DATA SIGNAL CREATION



File Edit View Code Layout Tools Window Help
DefaultComponent
DefaultConfig
Entire Model View
IBM
Create Serial Data Signal
Add System Signal Dependency

SDSIG_ElecArch_System
- Components
- MDK_References
- SDSIG_Hierarchys
  - SDSIG_Hierarchy
    - SDSIG_ElecArchs
      - SDSIG_System
        - SerialDataSignals
    - Tags
- StandardTypeDefs
- SYSIG_Hierarchys

SDSIG_System

Serial Data

Name: NewSignal

Properties

Tag	Value
Length	16
LongName	NewSignal
Resolution	1
Offset	
Type	UNM
Units	
ValueDescription	

Add System signal dependency | Clear

SDSIG_System

System Signals

Name	Domain/Subsystem
A2DBatteryFeedback	SYSIG_PassiveSafety
AAASSRP_ARC	SYSIG_System
AAASSRP_FCnt	SYSIG_System
AAASSRP_MAC	SYSIG_System
AAASSRP_StrgReqAngValAuth	SYSIG_System
AAASSRP_StrgReqArbdFtrAuth	SYSIG_System
AAASSRP_StrgReqStsAuth	SYSIG_System
AAASSRP_StrgReqTrqValAuth	SYSIG_System
AAASSRP_StrgReqTypAuth	SYSIG_System
AACNActivationandTriggerControl	SYSIG_System

Add

The MDK is used to define Serial Data Signals and create a relationship to an associated System Signal (Interface)

- Pulls up all potential System Signals from both the local and Global Servers
- Will automatically reference in the model data into the proper reference hierarchy
- Generates the Serial Data signal as defined with a relationship to the selected System Signal

CURRENT ACHIEVEMENTS

The previous slides provide a very brief overview of the capabilities GM has put in place. With them GM has achieved:

- Ability to **generate** network and architecture configurations
- Ability to **generate** middleware software
- Ability to **generate** allocation based requirements specifications
- Ability to **generate** full architecture analysis and reports

With tailored user experience to our specific product and language

But…

OPPORTUNITIES FOR EXPANDED INTEGRATION

The System model provides an **abstracted** authoring environment that identifies the content of a system and the relationships between those elements

Many engineering operations and tools provide the authoring environment for defining the **details** of system content and relationships

GM, through the use of our extensions, has started to allow the abstracted model definition to assist in preforming the detailed operations, but there is significant opportunity for additional integrations

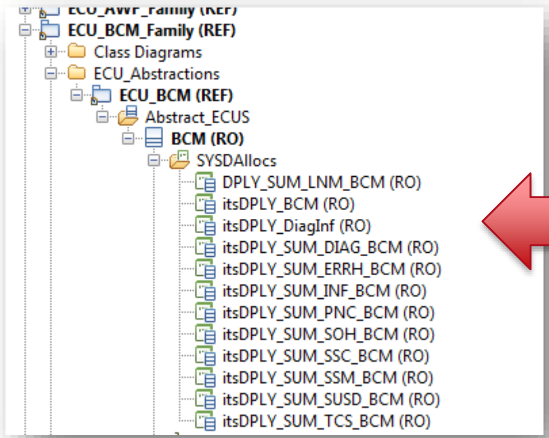
Some examples follow:

MODEL CONTENT AND GLOBAL CONFIG CONTENT

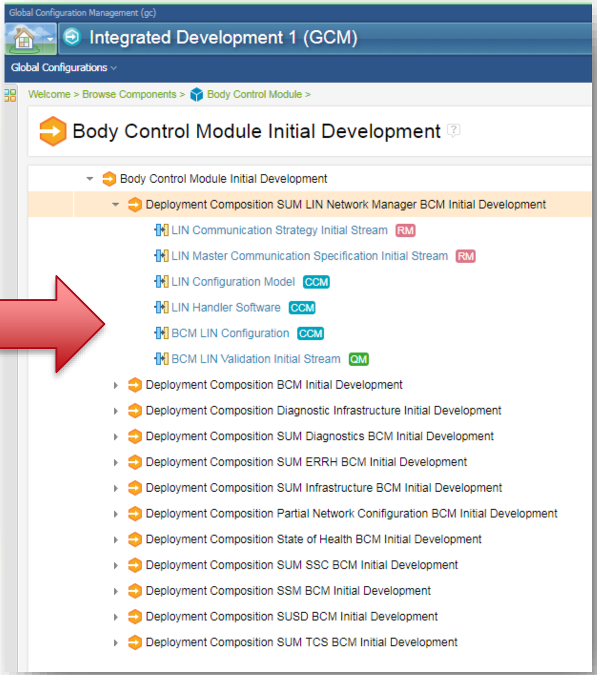
A System Model will inherently include a representation of the system content

The Global Config Structure will also include a representation of the system content

These should be connected to prevent duplication of effort and mismatches



```
ECU_AWF_Family (REF)
ECU_BCM_Family (REF)
  Class Diagrams
  ECU_Abstractions
    ECU_BCM (REF)
      Abstract_ECUS
        BCM (RO)
          SYSDAllocs
            DPLY_SUM_LNM_BCM (RO)
            itsDPLY_BCM (RO)
            itsDPLY_DiagInf (RO)
            itsDPLY_SUM_DIAG_BCM (RO)
            itsDPLY_SUM_ERRH_BCM (RO)
            itsDPLY_SUM_INF_BCM (RO)
            itsDPLY_SUM_PNC_BCM (RO)
            itsDPLY_SUM_SOH_BCM (RO)
            itsDPLY_SUM_SSC_BCM (RO)
            itsDPLY_SUM_SSM_BCM (RO)
            itsDPLY_SUM_SUSD_BCM (RO)
            itsDPLY_SUM_TCS_BCM (RO)
```



Global Configuration Management (gc)

Integrated Development 1 (GCM)

Global Configurations

Welcome > Browse Components > Body Control Module >

Body Control Module Initial Development

```
Body Control Module Initial Development
  Deployment Composition SUM LIN Network Manager BCM Initial Development
    LIN Communication Strategy Initial Stream RM
    LIN Master Communication Specification Initial Stream RM
    LIN Configuration Model CCM
    LIN Handler Software CCM
    BCM LIN Configuration CCM
    BCM LIN Validation Initial Stream QM
  Deployment Composition BCM Initial Development
  Deployment Composition Diagnostic Infrastructure Initial Development
  Deployment Composition SUM Diagnostics BCM Initial Development
  Deployment Composition SUM ERRH BCM Initial Development
  Deployment Composition SUM Infrastructure BCM Initial Development
  Deployment Composition Partial Network Configuration BCM Initial Development
  Deployment Composition State of Health BCM Initial Development
  Deployment Composition SUM SSC BCM Initial Development
  Deployment Composition SSM BCM Initial Development
  Deployment Composition SUSD BCM Initial Development
  Deployment Composition SUM TCS BCM Initial Development
```

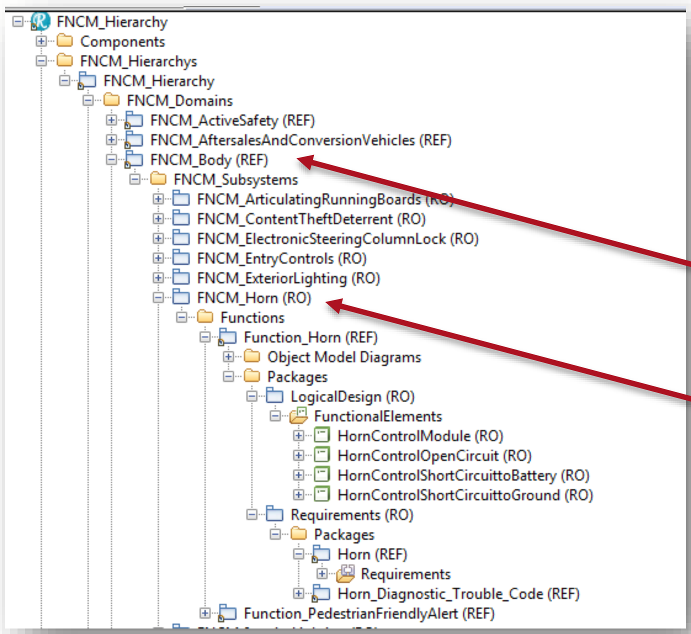
GC ALIGNMENT TO MODEL CONTENT

GCs only have representation of components (collections of content) so the model is likely to have much more detail

This is the general issue, the model will not fully align with other environments

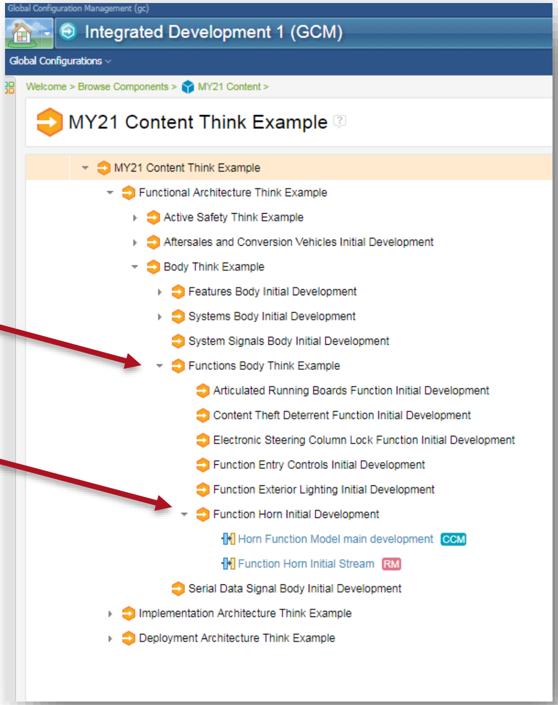
A transform is required between representations

Model



FNCM_Hierarchy
- Components
- FNCM_Hierarchys
  - FNCM_Hierarchy
    - FNCM_Domains
      - FNCM_ActiveSafety (REF)
      - FNCM_AftersalesAndConversionVehicles (REF)
      - FNCM_Body (REF)
        - FNCM_Subsystems
          - FNCM_ArticulatingRunningBoards (RO)
          - FNCM_ContentTheftDeterrent (RO)
          - FNCM_ElectronicSteeringColumnLock (RO)
          - FNCM_EntryControls (RO)
          - FNCM_ExteriorLighting (RO)
          - FNCM_Horn (RO)
            - Functions
              - Function_Horn (REF)
                - Object Model Diagrams
                - Packages
                  - LogicalDesign (RO)
                    - FunctionalElements
                      - HornControlModule (RO)
                      - HornControlOpenCircuit (RO)
                      - HornControlShortCircuittoBattery (RO)
                      - HornControlShortCircuittoGround (RO)
                  - Requirements (RO)
                    - Packages
                      - Horn (REF)
                        - Requirements
                      - Horn_Diagnostic_Trouble_Code (REF)
              - Function_PedestrianFriendlyAlert (REF)

Global Config



Global Configuration Management (gc)

Integrated Development 1 (GCM)

Global Configurations

Welcome > Browse Components > MY21 Content >

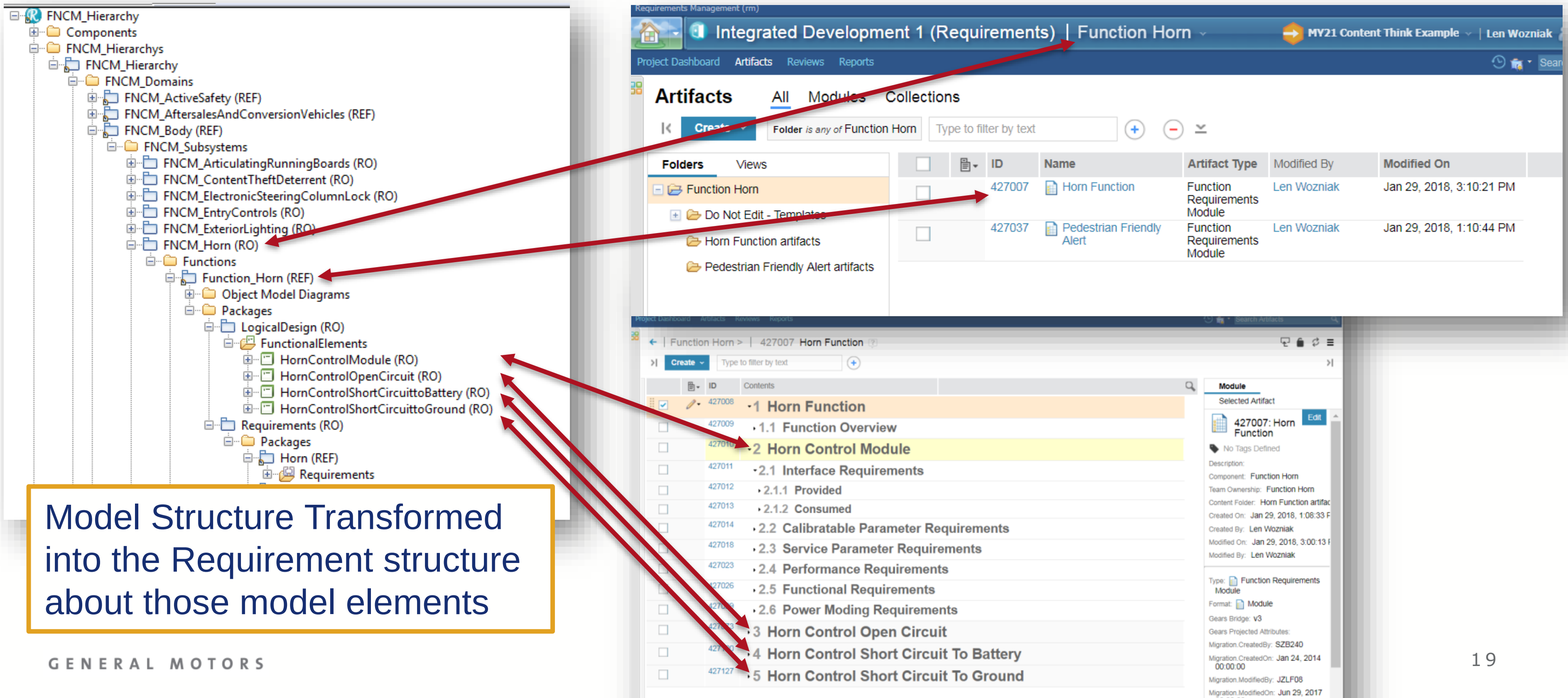
MY21 Content Think Example

- MY21 Content Think Example
  - Functional Architecture Think Example
    - Active Safety Think Example
    - Aftersales and Conversion Vehicles Initial Development
    - Body Think Example
      - Features Body Initial Development
      - Systems Body Initial Development
      - System Signals Body Initial Development
      - Functions Body Think Example
        - Articulated Running Boards Function Initial Development
        - Content Theft Deterrent Function Initial Development
        - Electronic Steering Column Lock Function Initial Development
        - Function Entry Controls Initial Development
        - Function Exterior Lighting Initial Development
        - Function Horn Initial Development
          - Horn Function Model main development CCM
          - Function Horn Initial Stream RM
      - Serial Data Signal Body Initial Development
  - Implementation Architecture Think Example
  - Deployment Architecture Think Example

FUNCTION MODEL TO REQUIREMENTS OVERLAP

Model

Requirements



FNCM_Hierarchy
- Components
- FNCM_Hierarchys
  - FNCM_Hierarchy
    - FNCM_Domains
      - FNCM_ActiveSafety (REF)
      - FNCM_AftersalesAndConversionVehicles (REF)
      - FNCM_Body (REF)
        - FNCM_Subsystems
          - FNCM_ArticulatingRunningBoards (RO)
          - FNCM_ContentTheftDeterrent (RO)
          - FNCM_ElectronicSteeringColumnLock (RO)
          - FNCM_EntryControls (RO)
          - FNCM_ExteriorLighting (RO)
          - FNCM_Horn (RO)
            - Functions
              - Function_Horn (REF)
                - Object Model Diagrams
                - Packages
                  - LogicalDesign (RO)
                    - FunctionalElements
                      - HornControlModule (RO)
                      - HornControlOpenCircuit (RO)
                      - HornControlShortCircuittoBattery (RO)
                      - HornControlShortCircuittoGround (RO)
                  - Requirements (RO)
                    - Packages
                      - Horn (REF)
                        - Requirements

Requirements Management (rm)

Integrated Development 1 (Requirements) | Function Horn — MY21 Content Think Example | Len Wozniak

Project Dashboard · Artifacts · Reviews · Reports

Artifacts — All · Modules · Collections

Create · Folder *is any of* Function Horn · Type to filter by text

Folders · Views
- Function Horn
  - Do Not Edit - Templates
  - Horn Function artifacts
  - Pedestrian Friendly Alert artifacts

ID	Name	Artifact Type	Modified By	Modified On
427007	Horn Function	Function Requirements Module	Len Wozniak	Jan 29, 2018, 3:10:21 PM
427037	Pedestrian Friendly Alert	Function Requirements Module	Len Wozniak	Jan 29, 2018, 1:10:44 PM

Function Horn > | 427007 Horn Function

Create · Type to filter by text

ID	Contents
427008	1 Horn Function
427009	1.1 Function Overview
427010	2 Horn Control Module
427011	2.1 Interface Requirements
427012	2.1.1 Provided
427013	2.1.2 Consumed
427014	2.2 Calibratable Parameter Requirements
427018	2.3 Service Parameter Requirements
427023	2.4 Performance Requirements
427026	2.5 Functional Requirements
[illegible]	2.6 Power Moding Requirements
[illegible]	3 Horn Control Open Circuit
[illegible]	4 Horn Control Short Circuit To Battery
427127	5 Horn Control Short Circuit To Ground

Module · Selected Artifact

427007: Horn Function (Edit)

No Tags Defined

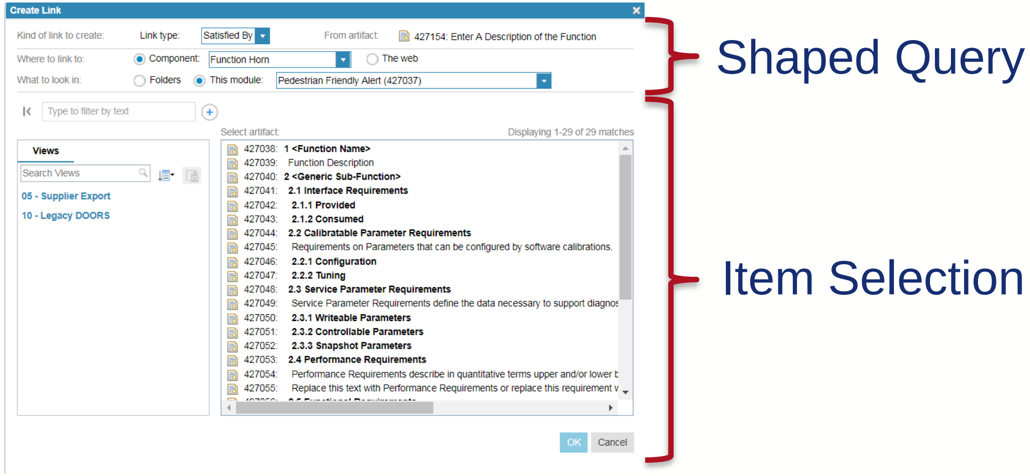
Description:
Component: Function Horn
Team Ownership: Function Horn
Content Folder: Horn Function artifac
Created On: Jan 29, 2018, 1:08:33 P
Created By: Len Wozniak
Modified On: Jan 29, 2018, 3:00:13 P
Modified By: Len Wozniak

Type: Function Requirements Module
Format: Module
Gears Bridge: v3
Gears Projected Attributes:
Migration.CreatedBy: SZB240
Migration.CreatedOn: Jan 24, 2014 00:00:00
Migration.ModifiedBy: JZLF08
Migration.ModifiedOn: Jun 29, 2017

Model Structure Transformed into the Requirement structure about those model elements

DIALOGS

In general a dialog is a shaped query followed by a item selection



Kind of link to create: Link type: Satisfied By From artifact: 427154: Enter A Description of the Function

Where to link to: [✓ Component:] Function Horn ( ) The web

What to look in: ( ) Folders [✓ This module:] Pedestrian Friendly Alert (427037)

05 - Supplier Export

10 - Legacy DOORS

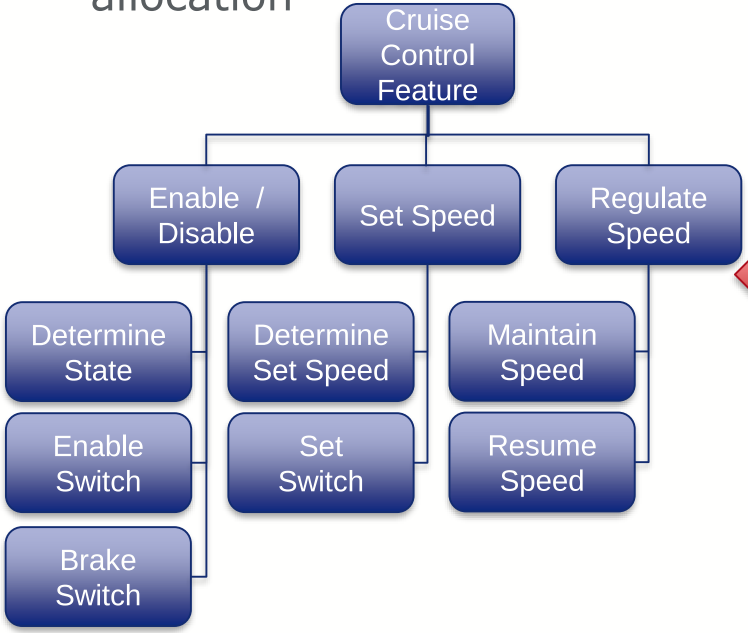
Select artifact: Displaying 1-29 of 29 matches

```
427038:  1 <Function Name>
427039:   Function Description
427040:  2 <Generic Sub-Function>
427041:   2.1 Interface Requirements
427042:    2.1.1 Provided
427043:    2.1.2 Consumed
427044:   2.2 Calibratable Parameter Requirements
427045:    Requirements on Parameters that can be configured by software calibrations.
427046:    2.2.1 Configuration
427047:    2.2.2 Tuning
427048:   2.3 Service Parameter Requirements
427049:    Service Parameter Requirements define the data necessary to support diagnos
427050:    2.3.1 Writeable Parameters
427051:    2.3.2 Controllable Parameters
427052:    2.3.3 Snapshot Parameters
427053:   2.4 Performance Requirements
427054:    Performance Requirements describe in quantitative terms upper and/or lower b
427055:    Replace this text with Performance Requirements or replace this requirement v
```

Out of the Box dialogs use general tool shapes, but much more effective queries exist using system model data

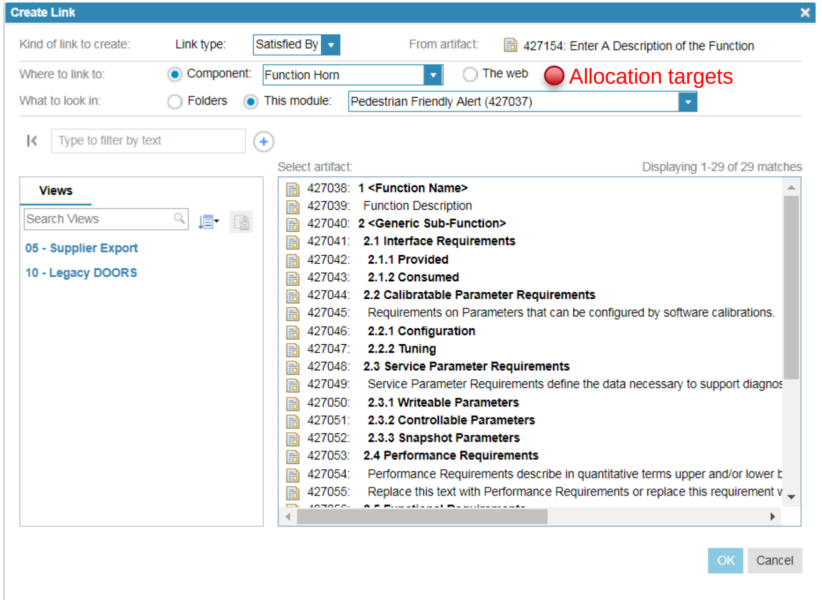
DECOMPOSITION AND FUNCTION ALLOCATION AND REQUIREMENTS LINKS

We use the system model to abstract the requirements allocation



Use the abstract relationship to guide the detailed work

A dialog query shaped with knowledge from the engineering data



Create Link

Kind of link to create: Link type: Satisfied By From artifact: 427154: Enter A Description of the Function

Where to link to: [✓ Component:] Function Horn ○ The web ● Allocation targets

What to look in: ○ Folders [✓ This module:] Pedestrian Friendly Alert (427037)

Type to filter by text

Views

Search Views

05 - Supplier Export

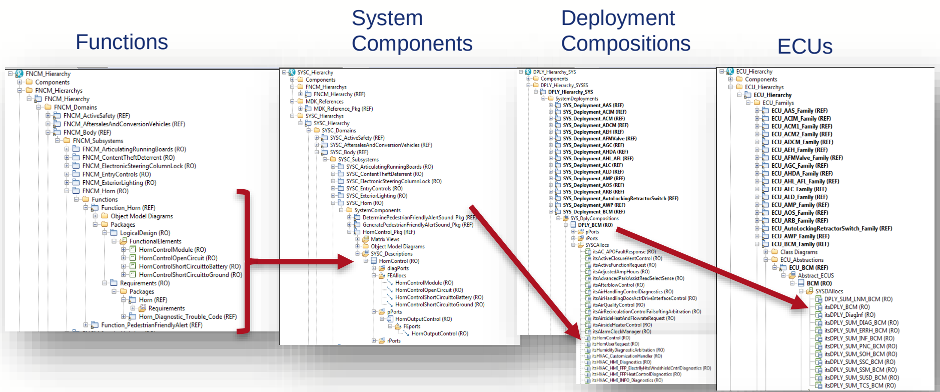
10 - Legacy DOORS

Select artifact: Displaying 1-29 of 29 matches

427038: **1 <Function Name>**
427039: Function Description
427040: **2 <Generic Sub-Function>**
427041: **2.1 Interface Requirements**
427042: **2.1.1 Provided**
427043: **2.1.2 Consumed**
427044: **2.2 Calibratable Parameter Requirements**
427045: Requirements on Parameters that can be configured by software calibrations.
427046: **2.2.1 Configuration**
427047: **2.2.2 Tuning**
427048: **2.3 Service Parameter Requirements**
427049: Service Parameter Requirements define the data necessary to support diagnos
427050: **2.3.1 Writeable Parameters**
427051: **2.3.2 Controllable Parameters**
427052: **2.3.3 Snapshot Parameters**
427053: **2.4 Performance Requirements**
427054: Performance Requirements describe in quantitative terms upper and/or lower b
427055: Replace this text with Performance Requirements or replace this requirement v

OK Cancel

ANOTHER EXAMPLE
TEST COLLECTION LINKS AND REQUIREMENTS ALLOCATION

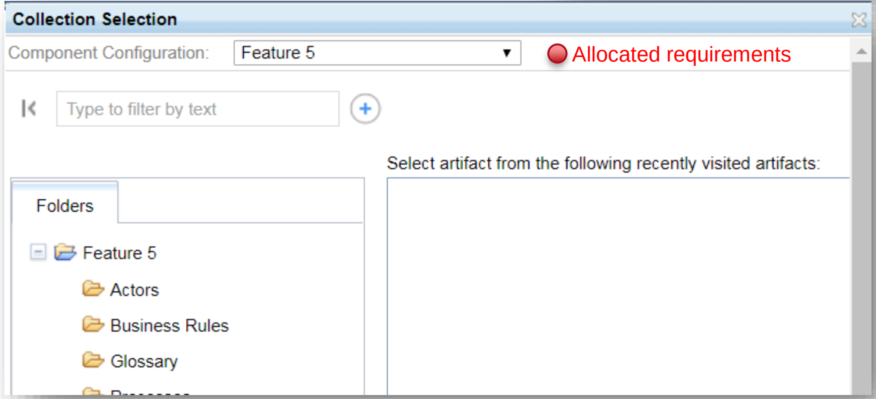


```
FNCM_Hierarchy
  Components
  FNCM_Hierarchys
    FNCM_Hierarchy
      FNCM_Domains
        FNCM_ActiveSafety (REF)
        FNCM_AftersalesAndConversionVehicles (REF)
        FNCM_Body (REF)
          FNCM_Subsystems
            FNCM_ArticulatingRunningBoards (RO)
            FNCM_ContentTheftDeterrent (RO)
            FNCM_ElectronicSteeringColumnLock (RO)
            FNCM_EntryControls (RO)
            FNCM_ExteriorLighting (RO)
            FNCM_Horn (RO)
              Functions
                Function_Horn (REF)
                  Object Model Diagrams
                  Packages
                    LogicalDesign (RO)
                      FunctionalElements
                        HornControlModule (RO)
                        HornControlOpenCircuit (RO)
                        HornControlShortCircuittoBattery (RO)
                        HornControlShortCircuittoGround (RO)
                    Requirements (RO)
                      Packages
                        Horn (REF)
                          Requirements
                        Horn_Diagnostic_Trouble_Code (REF)
                Function_PedestrianFriendlyAlert (REF)
```

```
SYSC_Hierarchy
  Components
  FNCM_Hierarchys
    FNCM_Hierarchy (REF)
  MDK_References
    MDK_Reference_Pkg (REF)
  SYSC_Hierarchys
    SYSC_Hierarchy
      SYSC_Domains
        SYSC_ActiveSafety (REF)
        SYSC_AftersalesAndConversionVehicles (REF)
        SYSC_Body (REF)
          SYSC_Subsystems
            SYSC_ArticulatingRunningBoards (RO)
            SYSC_ContentTheftDeterrent (RO)
            SYSC_ElectronicSteeringColumnLock (RO)
            SYSC_EntryControls (RO)
            SYSC_ExteriorLighting (RO)
            SYSC_Horn (RO)
              SystemComponents
                DeterminePedestrianFriendlyAlertSound_Pkg (REF)
                GeneratePedestrianFriendlyAlertSound_Pkg (REF)
                HornControl_Pkg (REF)
                  Matrix Views
                  Object Model Diagrams
                  SYSC_Descriptions
                    HornControl (RO)
                      diagPorts
                      FEAllocs
                        HornControlModule (RO)
                        HornControlOpenCircuit (RO)
                        HornControlShortCircuittoBattery (RO)
                        HornControlShortCircuittoGround (RO)
                      pPorts
                        HornOutputControl (RO)
                          FEports
                            HornOutputControl (RO)
                      rPorts
```

```
DPLY_Hierarchy_SYS
  Components
  DPLY_Hierarchy_SYSES
    DPLY_Hierarchy_SYS
      SystemDeployments
        SYS_Deployment_AAS (REF)
        SYS_Deployment_ACIM (REF)
        SYS_Deployment_ACM (REF)
        SYS_Deployment_ADCM (REF)
        SYS_Deployment_AEH (REF)
        SYS_Deployment_AFMValve (REF)
        SYS_Deployment_AGC (REF)
        SYS_Deployment_AHDA (REF)
        SYS_Deployment_AHL_AFL (REF)
        SYS_Deployment_ALC (REF)
        SYS_Deployment_ALD (REF)
        SYS_Deployment_AMP (REF)
        SYS_Deployment_AOS (REF)
        SYS_Deployment_ARB (REF)
        SYS_Deployment_AutoLockingRetractorSwitch (REF)
        SYS_Deployment_AWP (REF)
        SYS_Deployment_BCM (REF)
          SYS_DplyCompositions
            DPLY_BCM (RO)
              pPorts
              rPorts
              SYSCAllocs
                itsAC_APOFaultResponse (RO)
                itsActiveClosureVentControl (RO)
                itsActiveFunctionRequest (RO)
                itsAdjustedAmpHours (RO)
                itsAdvancedParkAssistReadSelectSense (RO)
                itsAfterblowControl (RO)
                itsAirHandlingControlDiagnostics (RO)
                itsAirHandlingDoorActrDriveInterfaceControl (RO)
                itsAirQualityControl (RO)
                itsAirRecirculationControlFailsoftingArbitration (RO)
                itsAirsideHeatAndFlowrateRequest (RO)
                itsAirsideHeaterControl (RO)
                itsAlarmClockManager (RO)
                itsHornControl (RO)
                itsHornUserRequest (RO)
                itsHumidityDiagnosticArbitration (RO)
                itsHVAC_CustomizationHandler (RO)
                itsHVAC_HMI_Diagnostics (RO)
                itsHVAC_HMI_FFP_ElectrllyHtdWndshieldCntrlDiagnostics (RO)
                itsHVAC_HMI_FFPHeatControlDiagnostics (RO)
                itsHVAC_HMI_INFO_Diagnostics (RO)
```

```
ECU_Hierarchy
  Components
  ECU_Hierarchys
    ECU_Hierarchy
      ECU_Familys
        ECU_AAS_Family (REF)
        ECU_ACIM_Family (REF)
        ECU_ACM1_Family (REF)
        ECU_ACM2_Family (REF)
        ECU_ADCM_Family (REF)
        ECU_AEH_Family (REF)
        ECU_AFMValve_Family (REF)
        ECU_AGC_Family (REF)
        ECU_AHDA_Family (REF)
        ECU_AHL_AFL_Family (REF)
        ECU_ALC_Family (REF)
        ECU_ALD_Family (REF)
        ECU_AMP_Family (REF)
        ECU_AOS_Family (REF)
        ECU_ARB_Family (REF)
        ECU_AutoLockingRetractorSwitch_Family (REF)
        ECU_AWP_Family (REF)
        ECU_BCM_Family (REF)
          Class Diagrams
          ECU_Abstractions
            ECU_BCM (REF)
              Abstract_ECUS
                BCM (RO)
                  SYSDAllocs
                    DPLY_SUM_LNM_BCM (RO)
                    itsDPLY_BCM (RO)
                    itsDPLY_DiagInf (RO)
                    itsDPLY_SUM_DIAG_BCM (RO)
                    itsDPLY_SUM_ERRH_BCM (RO)
                    itsDPLY_SUM_INF_BCM (RO)
                    itsDPLY_SUM_PNC_BCM (RO)
                    itsDPLY_SUM_SOH_BCM (RO)
                    itsDPLY_SUM_SSC_BCM (RO)
                    itsDPLY_SUM_SSM_BCM (RO)
                    itsDPLY_SUM_SUSD_BCM (RO)
                    itsDPLY_SUM_TCS_BCM (RO)
```



Collection Selection

Component Configuration: Feature 5

● Allocated requirements

Type to filter by text

Select artifact from the following recently visited artifacts:

Folders

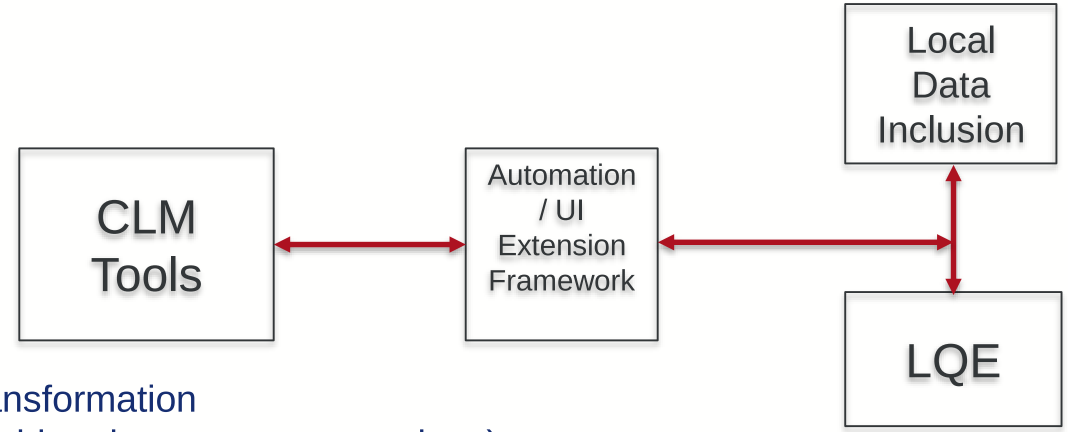
- Feature 5
  - Actors
  - Business Rules
  - Glossary

We already showed our requirements traceability to developed content

Requirement collections for validation should be supported by identifying the element under test and limiting the requirements selection to requirements actually allocated to that element

This is not always the correct selection method, but very useful for some levels of test in complex products

GENERIC SOLUTION



- Automation / UI Extension Framework
  - Automations for data sharing with transformation
  - UI manipulation (have to be able to add and remove menu options)
  - Allows for query driven dialogs with custom query shapes and presentations
- LQE
  - All indexed data is already available
  - Requires capability to add query support for custom dialogs
  - Requires improved data model controls
    - Turn implicit relationships to explicit to improve query performance
    - Easy inclusion of specific data needed for your process
- Local Data Inclusion
  - Need to ensure indexing is fast enough for served data to respond to changes being made by the user
  - Need to ensure local modified data (if it exists) gets included in results

'One size fits all' does not work

We all have our own process and data shape

Need is for the extension framework, not the extensions

CONCLUSION

- In a Model Based System Lifecycle Engineering methodology, the model is not something created in addition to traditional engineering tasks
    - The Models are created in support of / as alternative to traditional engineering tasks
- A key to success is freeing the model data to be used in support of all lifecycle tasks
- This is possible today, but is too hard
- Improved capabilities are needed to leverage the infrastructure that is already there
    - Focus needs to be on extensible frameworks, not fixed integrations and capabilities