



Automatic generation of a complete model driven system reference database (SRDB) application



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SESP 2017 – ESTEC, 28th March 2017



European Space Agency

AGENDA



- The SRDB (System Reference DataBase)
 - ❑ SRDB Stakeholders needs
 - ❑ The challenge
 - ❑ The SRDB application

- The solution
 - ❑ Automatic generation of a complete model driven SRDB application

- Conclusions



System Reference DataBase (SRDB)



The SRDB mainly collects and maintains the **knowledge** related to spacecraft Monitoring and Control (M&C) such as Telemetries (TM) and Telecommands (TC) for allowing:

- On board SW development
- System AIT
- Delivery of data for in-flight operations

```
if(parameters.contains("page")){
    hql += " and P.page = " + page;
}
TypedQuery<Person> query = session.createQuery("select p from Person p where p.name contains(:name)");
```

```
166 var currentImage = "bigImage1";
167 var pages = Math.ceil(photos.length / 5);
168 updatePages();
169 updateAllImages();
170 // document.getElementById("bigImage1").src = currentImage;
171 // document.getElementById("bigImage1").alt = "Big Image 1";
172 changePhotoDescription("1");
173
174 function updatePages() {
175     var j = 0;
176
177     var html = '<table style="width: 100%; text-align: center;">';
178     if (page != 0) {
179         html = html + '<a href="#">';
180     }
181     html += '</td><td style="text-align: center;">';
182     if (pages > 7) {
```

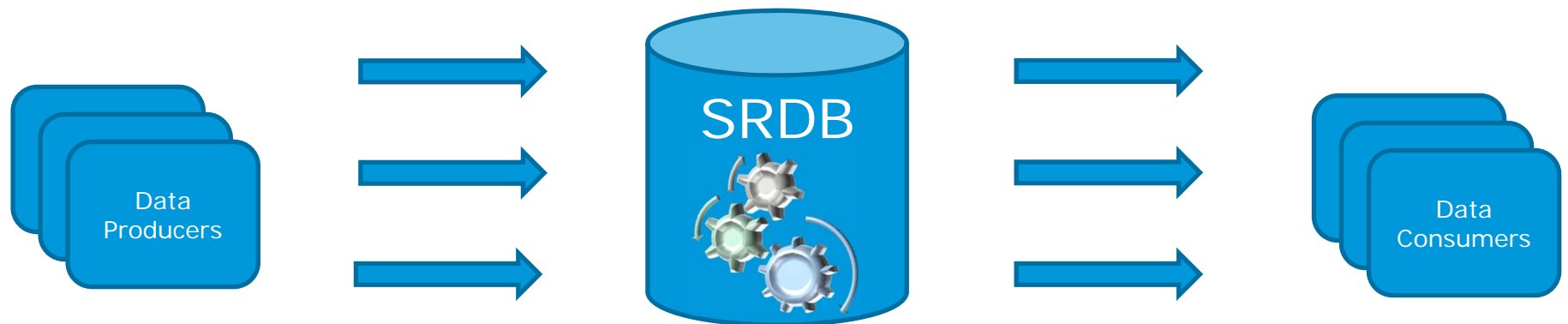


Data producer / consumer point of view



All stakeholders need to share the SSM knowledge at conceptual level:
all stakeholders concepts need to be mapped to the overall SSM conceptual data model (CDM)

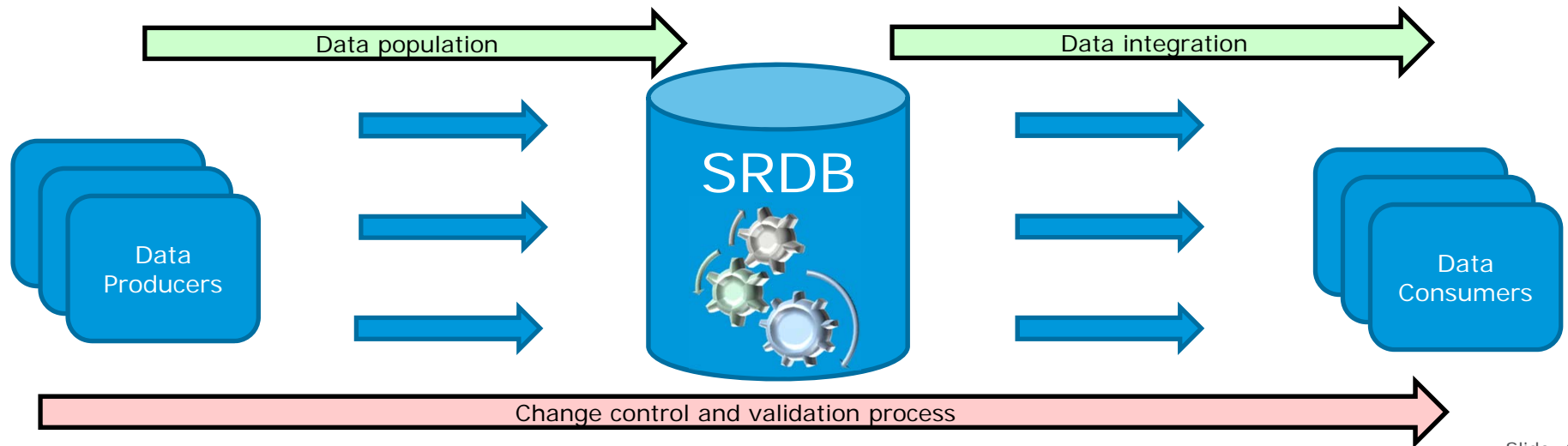
Objective: achieve the required **semantic interoperability** at space system level
(meaning effective and correct data exchange)



Data producer / consumer point of view

From a data producer point of view: timely population of the SRDB, fully integrated in the SRDB change control and validation processes.

From a data consumer point of view: timely integration and extension of the SRDB, fully integrated in the SRDB change control and validation processes.



SRDB stakeholders requirements



What do the stakeholders actually need?

An adequate SRDB tool, which fulfills a *minimum set of requirements*:

- ✓ Generation and instantiation of the project-specific database physical schema
- ✓ Data management editors (MMI)
- ✓ Import / export facility
- ✓ Data consistency checker
- ✓ Validation status awareness
- ✓ Impact analysis for non-regression tests
- ✓ Differences at concept level between two deliveries
- ✓ Generic script syntax and cross-check verification



The Main Challenge

Timely, efficiently and effectively support:

- The space system development, test and operation
- The space system knowledge sharing and management

in order to:

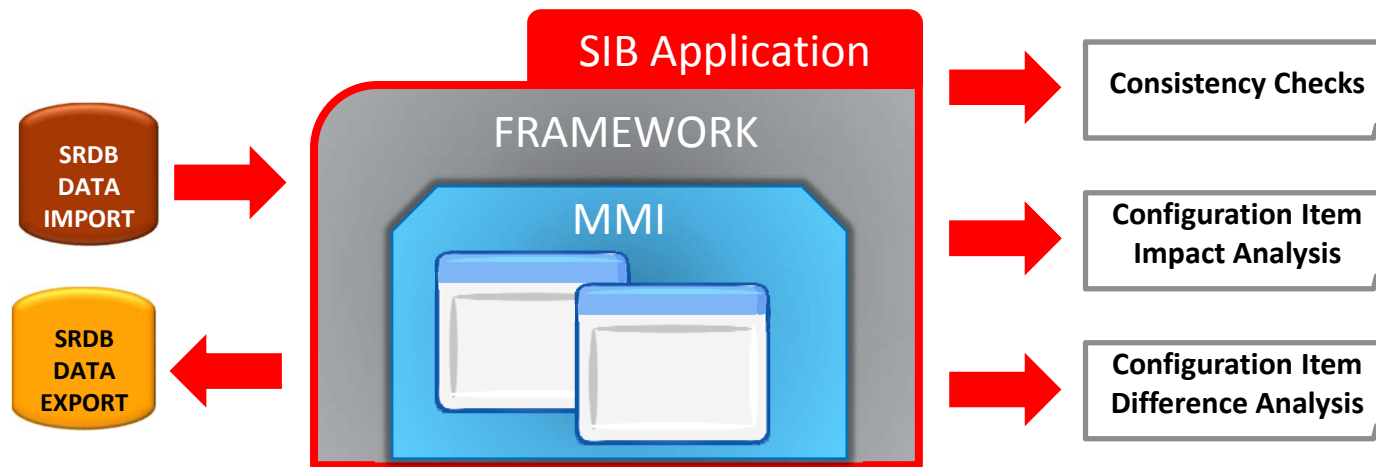
- Apply the data producer/consumer viewpoint to the complete Space System Model (SSM)
- Take into account the project specific SRDB data models needed to fulfil the project stakeholders data requirements



SIB Application



The **Space Information Base Application (SIB)** has been developed to fulfil the SRDB Application Requirements

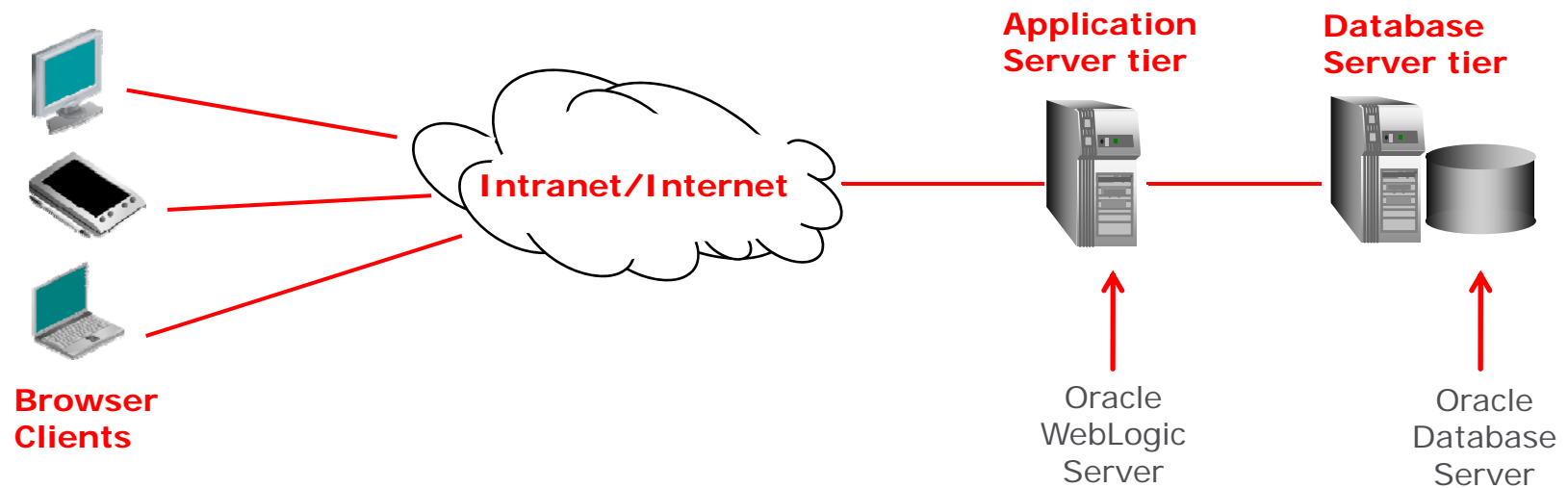


SIB Deployment



Classic three-tier deployment allowing:

- Seamless remote access
- No client installation (standard Internet browsers)
- Performance isolation and optimization on server tiers



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The solution



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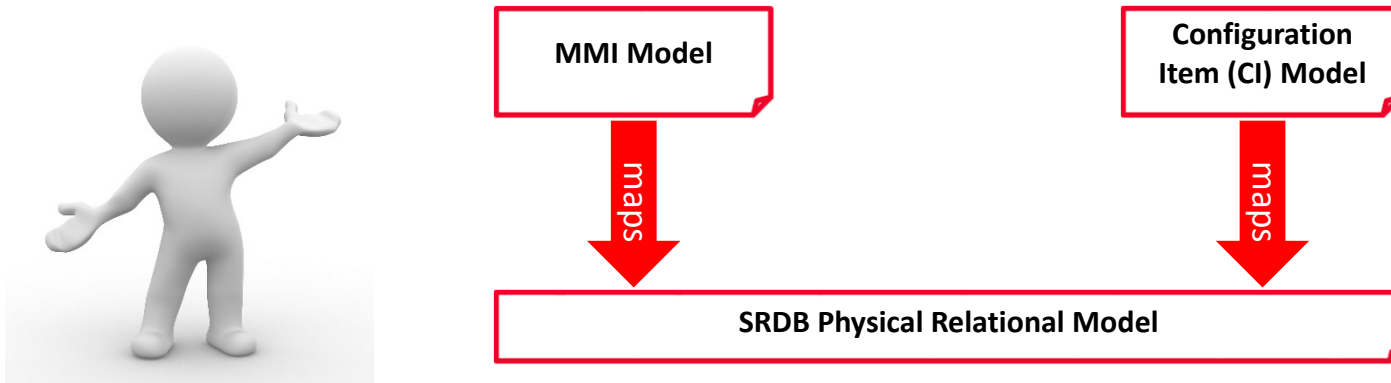
The challenge:

Timely, efficiently and effectively support

- The space system development, test and operation
- The space system knowledge sharing and management

The solution:

100% model driven Space System Information Base (SIB) application in compliance with the *project specific data model requirements*



SIB: Model Driven Approach



The SIB application generation is performed by using two different model injection approaches:

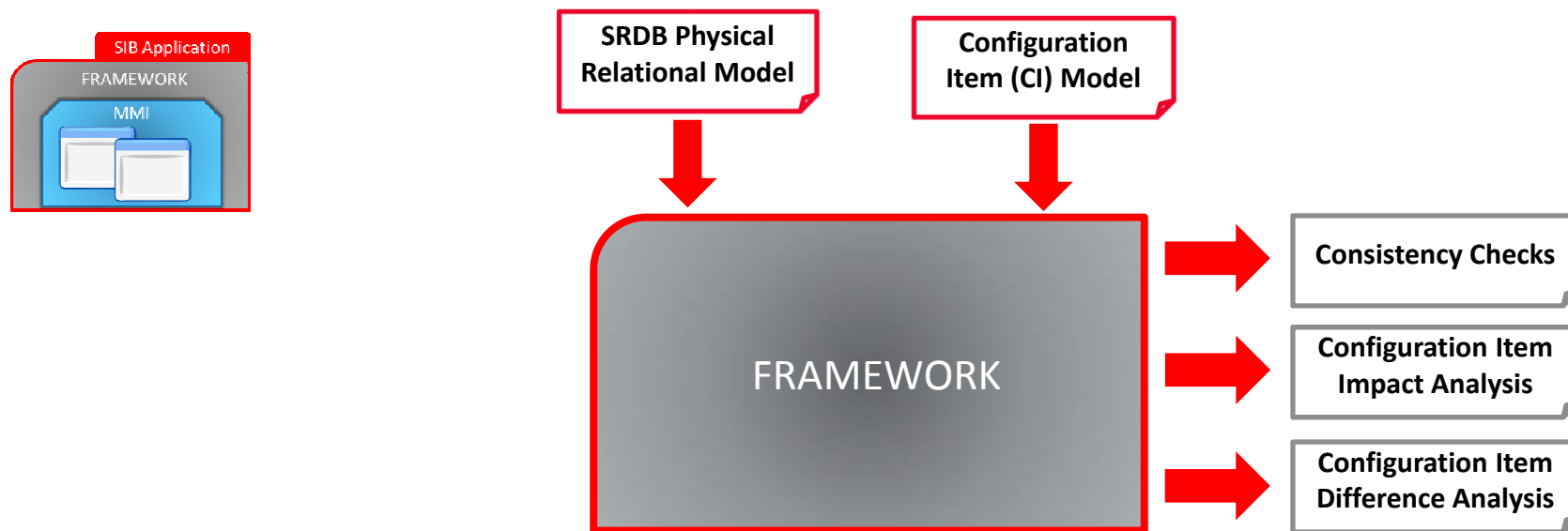
- **Run-time model awareness**, where the application software has a different behaviour at run-time depending on the input models specification.
- **Model driven code generation**, meaning that the application code is first generated by using a code generator and then deployed in the application server.



SIB: Run-time model awareness

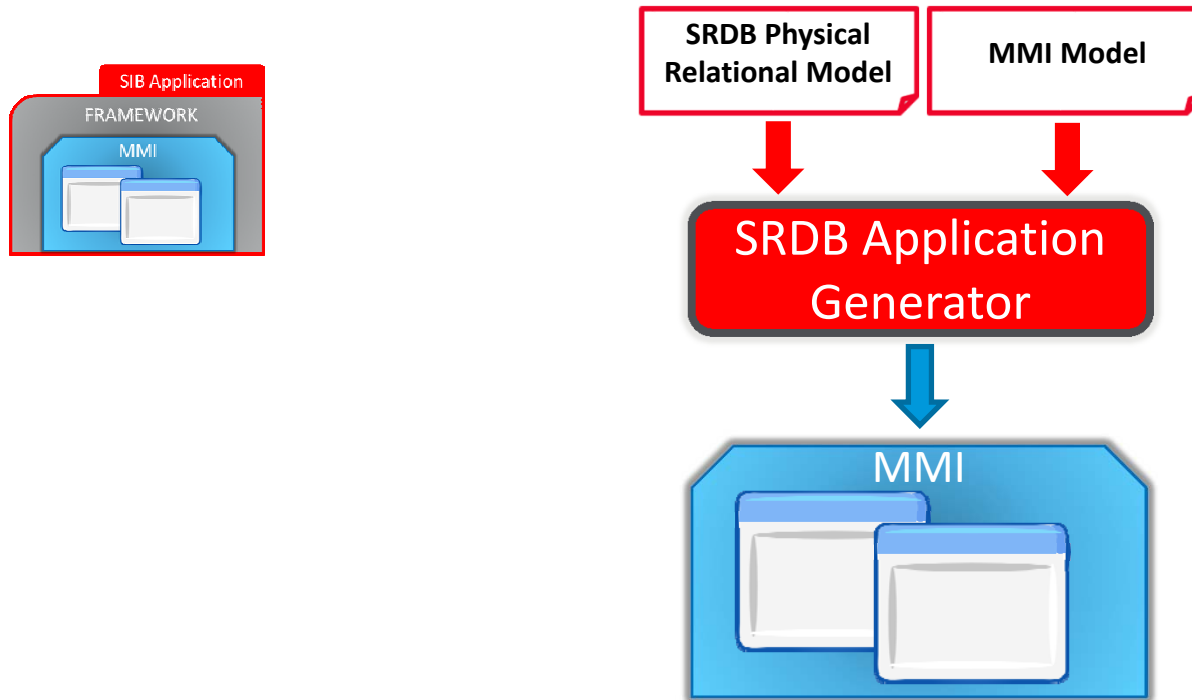


The **SIB application framework** component has been developed by using the runtime model awareness approach in order to fulfil the requirements concerning the physical model management and instantiation, the validation rules engine, the difference report generator and the impact analysis engine.



SIB: Model driven code generation

The model driven code generation approach has been used to *automatically* generate the **SIB MMI product editor**

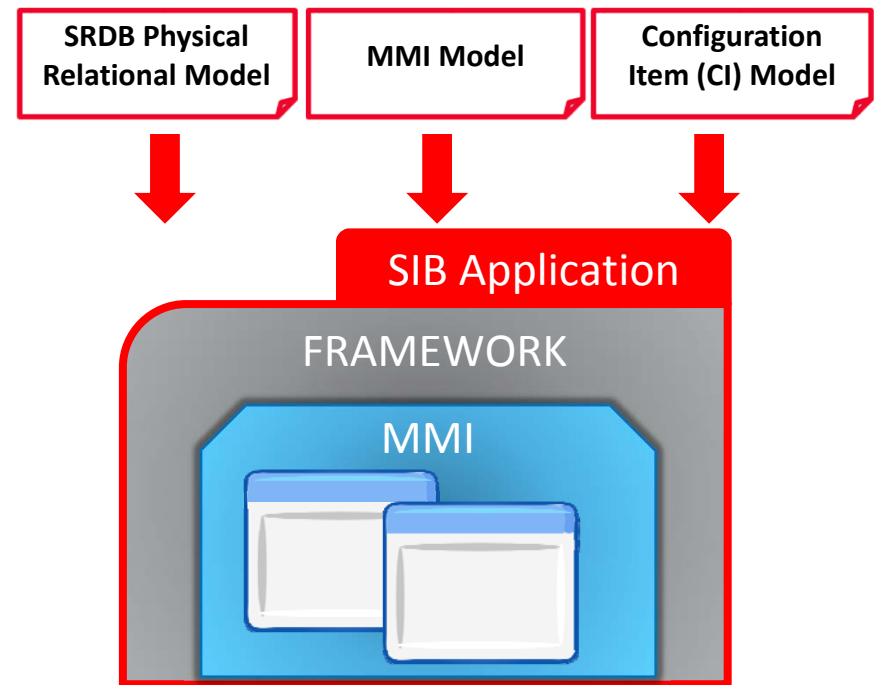


SIB: Models overview

- SRDB Physical Relational Model
 - ❑ Database Schema
 - ❑ Validation Rules Definition

- MMI Model
 - ❑ Menu Layout
 - ❑ Configuration Item View

- Configuration Item Model
 - ❑ "Part of" Definition
 - ❑ Impact Analysis Definition
 - ❑ Difference Analysis Definition



SRDB PHYSICAL RELATIONAL MODEL: Validation Rules Definition



Validation Rules

Filter By: Table Name

Action View Format Freeze Detach Wrap

Icd Version	Table Name	Constraint Id	Constraint Type	Class	Severity
MIB6.9.1	PCFREC	PCFREC_03F	Cross Check	MIB	Error
MIB6.9.1	PCF	PCF_01A	Primary Key	MIB	Error
MIB6.9.1	PCF	PCF_01B	Field Check	MIB	Error
MIB6.9.1	PCF	PCF_01C	Field Check	MIB	Editorial
MIB6.9.1	PCF	PCF_01D	Field Check	MIB	Error
MIB6.9.1	PCF	PCF_01E	Cross Check	MIB	Error
MIB6.9.1	PCF	PCF_02A	Field Check	MIB	Warning
MIB6.9.1	PCF	PCF_03A	Unique Key	MIB	Error
MIB6.9.1	PCF	PCF_03B	Field Check	MIB	Error
MIB6.9.1	PCF	PCF_05A	Field Check	MIB	Error

Validation Rules

Filter By: Table Name

Action View Format Freeze Detach Wrap

Icd Version	Table Name	Constraint Id	Constraint Type	Class	Severity
MIB6.9.1	PCF	PCF_07A	Field Check	MIB	Error
MIB6.9.1	PCF	PCF_08A	Record Check	MIB	Error
MIB6.9.1	PCF	PCF_08B	Foreign Key	MIB	Error
MIB6.9.1	PCF	PCF_08C	Field Check	MIB	Editorial
MIB6.9.1	PCF	PCF_08D	Record Check	MIB	Editorial
MIB6.9.1	PCF	PCF_08E	Cross Check	MIB	Error
MIB6.9.1	PCF	PCF_08F	Cross Check	MIB	Error
MIB6.9.1	PCF	PCF_08G	Cross Check	MIB	Error
MIB6.9.1	PCF	PCF_09A	Record Check	MIB	Error
MIB6.9.1	PCF	PCF_09B	Foreign Key	MIB	Error

Description: PCF_NAME shall be unique (i.e. PK).

Definition: PCF_NAME

Encoding: [PCF].[PCF_NAME]

Description: PCF_NAME should be uppercased.

Definition: PCF_NAME=UPPER(PCF_NAME)

Encoding: [PCF].[PCF_NAME=UPPER(PCF_NAME)]

Description: IF PCF_USCON='Y' then shall exist at least one CVE entry having CVE_PARNAM=PCF_NAME.

Definition: [nv(PCF_USCON,'#') = 'Y'] implies [exists (select 1 from CVE where CVE_PARNAM = PCF_NAME)]

Encoding: [PCF].[exists (select 1 from CVE where CVE_PARNAM = PCF_NAME) OR NOT (nv(PCF_USCON,'#') = 'Y')]

Description: PCF_PID shall be unique.

Definition: PCF_PID

Encoding: [PCF].[PCF_PID]

Description: PCF_VALID shall point to a PCF entry having PCF_NAME = PCF_VALID.

Definition: PCF_VALID -> PCF_NAME

Encoding: [PCF].[PCF].[PCF_VALID.PCF_NAME]

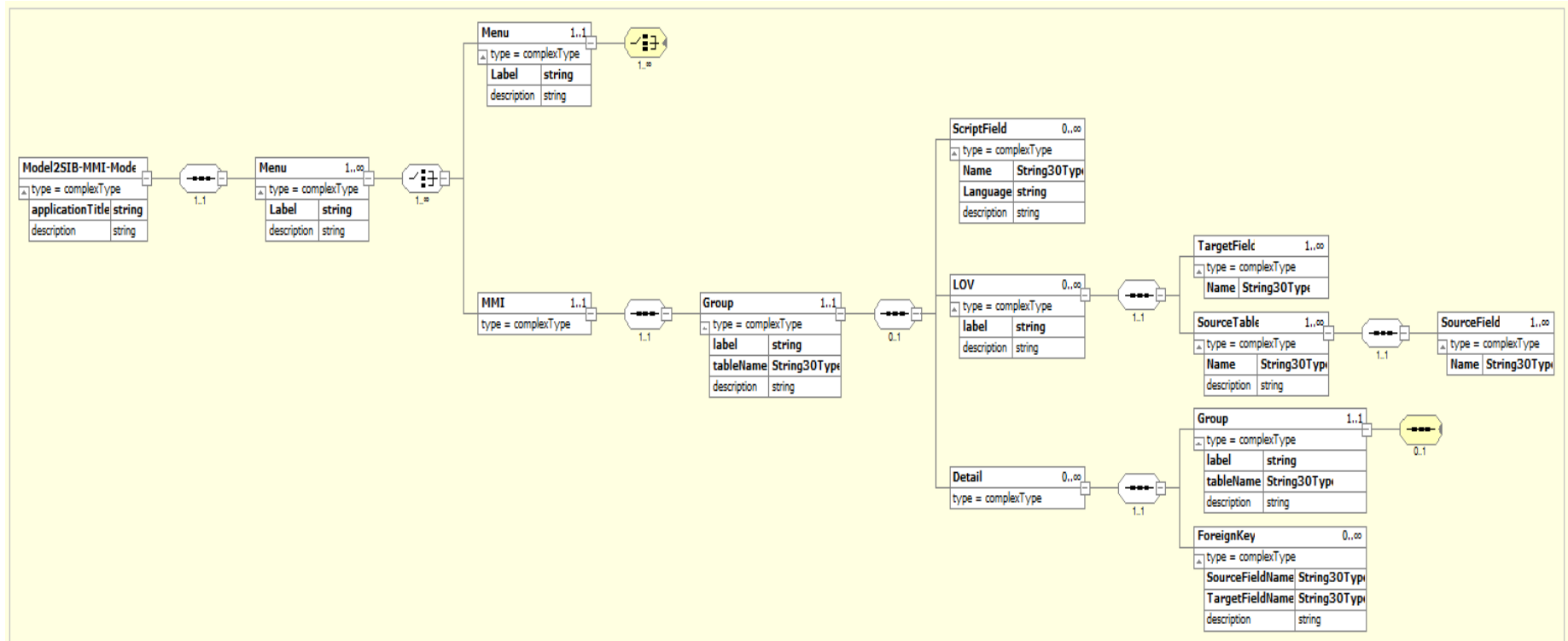
Description: IF PCF_VALPAR is not null then PCF_VALID is not null.

Definition: (PCF_VALPAR is not null) implies (PCF_VALID is not null)

Encoding: [PCF].[PCF_VALID is not null] OR NOT (PCF_VALPAR is not null)



MMI Model



MMI Model: Menu Layout (example)



MMI Model: Configuration Item View (example)



```

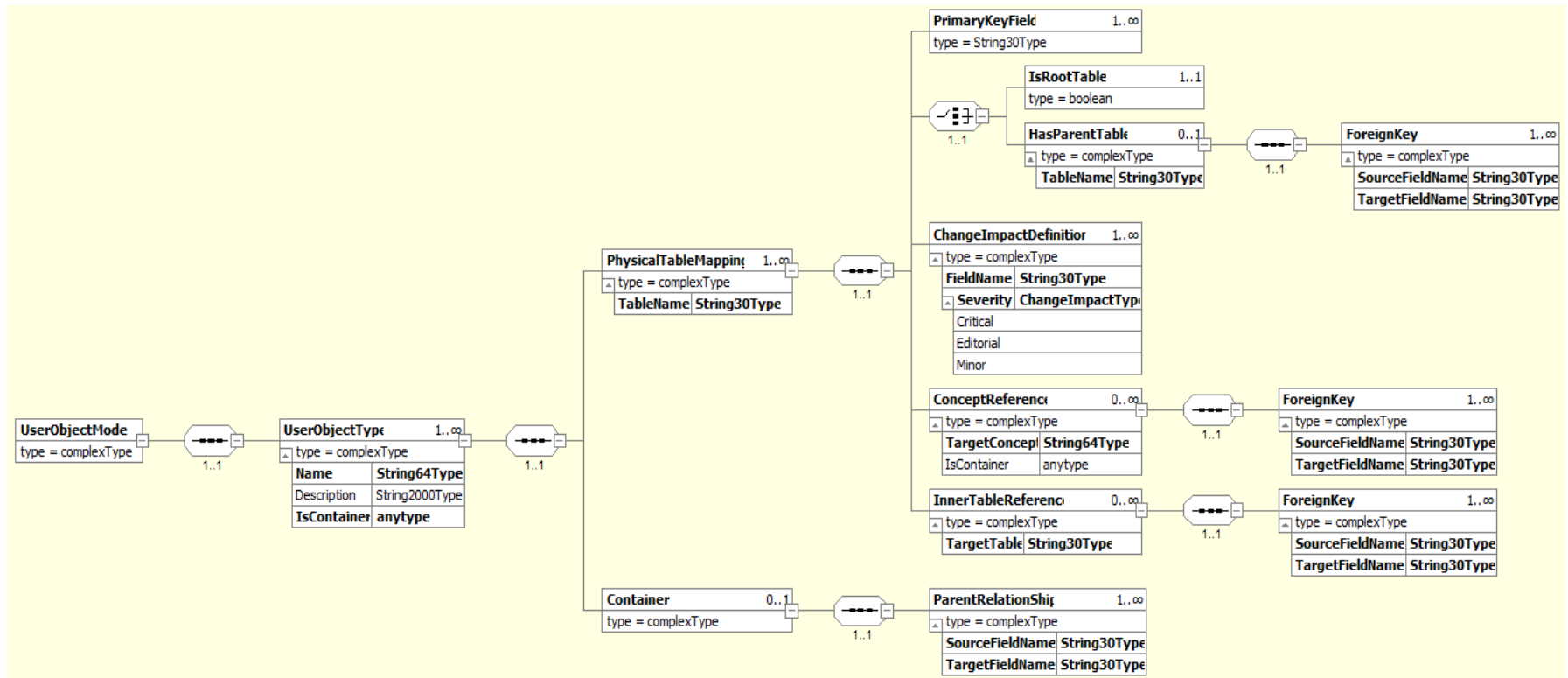
</Menu>
<Menu Label="Monitoring Data" description="Monitoring Data">
  <MMI>
    <Group label="Pcf - TM Parameters" tableName="PCF" description="Pcf - TM Parameters">
      <Detail>
        <Group label="Pcfrec - Compound Parameter " tableName="PCFREC" description="Pcfrec - Compound Parameter">
          </Group>
        </Detail>
      <Detail>
        <Group label="Ocf - Monitoring check" tableName="OCF" description="Ocf - Monitoring check">
          <Detail>
            <Group label="Ocp - Monitoring check data" tableName="OCP" description="Ocp - Monitoring check data">
              </Group>
            </Detail>
          </Group>
        </Detail>
      <Detail>
        <Group label="Cur - Calibration conditional selection" tableName="CUR" description="Cur - Calibration conditional selection">
          </Group>
        </Detail>
      </Group>
    </MMI>
  </Menu>
  <Menu Label="Interpretation Function" description="Interpretation Function">

```

The screenshot displays the configuration interface for 'Pcf - TM Parameters'. It includes a table with columns: Pcf_name, Pcf_descr, Pcf_pid, Pcf_unit, Pcf_ptc, Pcf_pfc, Pcf_width, Pcf_valid, Pcf_related, Pcf_catg, Pcf_natur, and Pcf_o. A row is visible for PRA2015 with Pcf_descr 'RAFS_R_LOOK_INLE' and Pcf_pid '2031'. Below the table is a 'Referenced By' section listing various parameters like CAP0, TRF1, MCF0, etc. Further down, there are sections for 'Pcfrec - Compound Parameter' and 'Ocf - Monitoring check', each containing a table and a 'Referenced By' list. The 'Ocp - Monitoring check data' table has columns: Ocp_name, Ocp_pos, Ocp_type, Ocp_hulu, Ocp_hulu, Ocp_rchk, and Ocp_valpe. A row is visible for PRA2015 with Ocp_pos '1', Ocp_type 'H', and Ocp_valpe 'NO ERROR'. The 'Cur - Calibration conditional selection' section is partially visible at the bottom.



Configuration Item Model



Configuration Item Model (example)

```

<UserObjectType Name="Alphanumeric Display" Description="AND" IsContainer="False">
  <PhysicalTableMapping TableName="DPF">
    <PrimaryKeyField>DPF_NUMBE</PrimaryKeyField>
    <IsRootTable>true</IsRootTable>
    <ChangeImpactDefinition FieldName="DPF_HEAD" Severity="Editorial"/>
    <ChangeImpactDefinition FieldName="DPF_NUMBE" Severity="Critical"/>
    <ChangeImpactDefinition FieldName="DPF TYPE" Severity="Editorial"/>
  </PhysicalTableMapping>
  <PhysicalTableMapping TableName="DPC">
    <PrimaryKeyField>DPC_NUMBE</PrimaryKeyField>
    <PrimaryKeyField>DPC_FLDN</PrimaryKeyField>
    <HasParentTable TableName="DPF">
      <ForeignKey SourceFieldName="DPF_NUMBE" TargetFieldName="DPC_NUMBE"/>
    </HasParentTable>
    <ConceptReference TargetConcept="Reporting Data">
      <ForeignKey SourceFieldName="PCF_NAME" TargetFieldName="DPC_NAME"/>
    </ConceptReference>
    <ChangeImpactDefinition FieldName="DPC_COMM" Severity="Critical"/>
    <ChangeImpactDefinition FieldName="DPC_FLDN" Severity="Minor"/>
    <ChangeImpactDefinition FieldName="DPC_FORM" Severity="Minor"/>
    <ChangeImpactDefinition FieldName="DPC_MODE" Severity="Critical"/>
    <ChangeImpactDefinition FieldName="DPC_NAME" Severity="Critical"/>
    <ChangeImpactDefinition FieldName="DPC_NUMBE" Severity="Critical"/>
    <ChangeImpactDefinition FieldName="DPC_TEXT" Severity="Minor"/>
  </PhysicalTableMapping>
</UserObjectType>

```

- "Part of" Definition
- Impact Analysis Definition
- Difference Analysis Definition

Standard features of generated MMI



Full SIB MIB ICD 6.9 (Model2ADF generated - Copyright dottcb-consulting.it, 2014)

Logged In application : SIB_SRDB/MYDATASET SIB Designer Logout

Monitoring parameters

Pcf

Transaction commit / rollback Save Cancel

Advanced Search **Advanced search area** Quick Search

Match All Any
Case Sensitive?

Name: _____ Width: _____ Inter: _____ Sptype: _____
 Descr: _____ Valid: _____ Uscon: _____ Corr: _____
 Pid: _____ Related: _____ Decim: _____ Obtid: _____
 Unit: _____ Categ: _____ Parval: _____ Darc: _____
 Ptc: _____ Natur: _____ Subsys: _____ Endian: _____
 Pfc: _____ Curtx: _____ Valpar: _____ Simval: _____

Search Reset

Hide advanced search area

Action View Format En.Cons. Dis.Cons. Freeze Detach Wrap Toolbar

Name	Descr	Pid	Unit	Ptc	Pfc	Width	Valid	++	Related	++	Categ
ACSP095_	PPR_CSSNORMLIM	131,293		5	2						N
ACSP096H	PPR_CSSSUMBRAMAX	131,294	5	5	2						N
ACSP230_	ADS_CSSBLENDK	131,295		5	2						N
ACSP422_	FDIR_CSSCCT	131,296		5	2						N
ACSPF09_	FDIR_CSSAMSG	135,082		2	1						S

9469

Columns Frozen 2

group: Monitoring parameters: pcf

Referenced By

Hyperlinks to referenced records

CDF 1 CUR 0 CUR 0 CVE 0 DPC 1 GPC 0 GRPA 0 OCF 0 OCP 0 PCF 0 PCF 0 PCFREC 0 PCFREC 0 PLF 1 PPC 0 PTV 0 SPC 0 VPD 0

> Clob columns

> Ocf

> Cur

> Pcfrec

Collapse panel widget



Configuration Item View MMI



Monitoring parameters

Pcf

Filter By: Pcfname Advanced Search

Action View Format En.Cons. Dis.Cons. Freeze Detach Wrap

Name	Descr	Rid	Unit	Ptc	Pfc	Width	Valid	++	Related	++	Categ	Natur	Curbs
PMI35975	MI_CL_RS_E_ER	1,876		2	1	8		++	++	S	R	PPP	

Columns Frozen: 2

Referenced By

CDF0 CUR0 CUE0 DPC1 GPC0 GRPA0 OCF1 CCP1 PCF0 PCF0 PCFREC0 PCFREC0 PJF2 PFC0 PTV0 SPC0 VPD0

OCb columns

OCf

Action View Format En.Cons. Dis.Cons. Freeze Detach Wrap

Name	++	Nbchck	Nbool	Inter	Codin
PMI35975	++	3	1	C	A

Columns Frozen: 2

Referenced By

OCF1

Ocp

Action View Format En.Cons. Dis.Cons. Freeze Detach Wrap

Name	++	Pos	Type	units	Hvals	RI-hk	++	Valpar
PMI35975	++	1	H	VAI1D			++	1

Columns Frozen: 1

Cur

Action View Format En.Cons. Dis.Cons. Freeze Detach Wrap

Pname	++	Pos	RI-hk	++	Valpar	Select
No rows found						

Columns Frozen: 4

Pcfrec

Slide 25



Flat Table MMI



Pcf

Filter By: PcfName Advanced Search

Save Cancel

Action View Format En.Cons. Dis.Cons. Freeze Detach Wrap

Name	Descr	Pid	Unit	Ptc	Pfc	Width	Valid	++	Related	++	Categ	Natur	Curtx
AESAI11S	ESA_INHIBIT_CH_1			2	1	8		++		++	S	D	AES_TCHI
AESAI12S	ESA_INHIBIT_CH_1			2	1	8		++		++	S	D	AES_TCHI
AESAI32S	ESA_INHIBIT_CH_3			2	1	8		++		++	S	D	AES_TCHI
AESASM1S	ESA_SCAN_MODE			2	1	8		++		++	S	D	AES_TSCA
AESB131S	ESB_INHIBIT_CH_3			2	1	8		++		++	S	D	AES_TCHI
AESBSM1S	ESB_SCAN_MODE			2	1	8		++		++	S	D	AES_TSCA
AAAXS20S	CS_USABLE			2	1			++		++	N	D	
AAAXS28S	ES_CH1_POLES_BLI			2	1			++		++	N	D	
AMT2AAVI	MT2AVCURRENTA		MA	5	2			++		++	N	D	
AMT2BAVI	MT2AVCURRENTB		MA	5	2			++		++	N	D	
AMT1AAVI	MT1AVCURRENTA		MA	5	2			++		++	N	D	
AMT1BAVI	MT1AVCURRENTB		MA	5	2			++		++	N	D	
ESDXSP1D	POT_STEP_TO_DEG		DEG	5	1			++		++	N	D	
CDUPMAOS	PM A PWR STATUS			1	0			++		++	S	D	CDU_T_OF
CDUPMBOS	PM B PWR STATUS			1	0			++		++	S	D	CDU_T_OF

148

Columns Frozen 2

Referenced By

CDF 0 CUR 0 CUR 0 CVE 0 DPC 0 GPC 0 GRPA 0 OCF 0 OCP 0 PCF 2 PCF 0 PCFREC 0 PCFREC 0 PLF 0 PPC 0 PTV 0 SPC 0 VPD 0

Clob columns

PcfSyn

Use PM B power status acquired by TTR A if TM Encoder A is active and PM B power status acquired by TTR B if TM Encoder B is active

```
VAR_PMBOnStatus := ((CDUTMEAS.raw == 1 and CDUPBATS.raw == 1) or (CDUTMEAS.raw == 0 and CDUPBATS.raw == 1));
```

return(VAR_PMBOnStatus);

Check Script

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Conclusions:
current achievements and next challenge



Slide 27



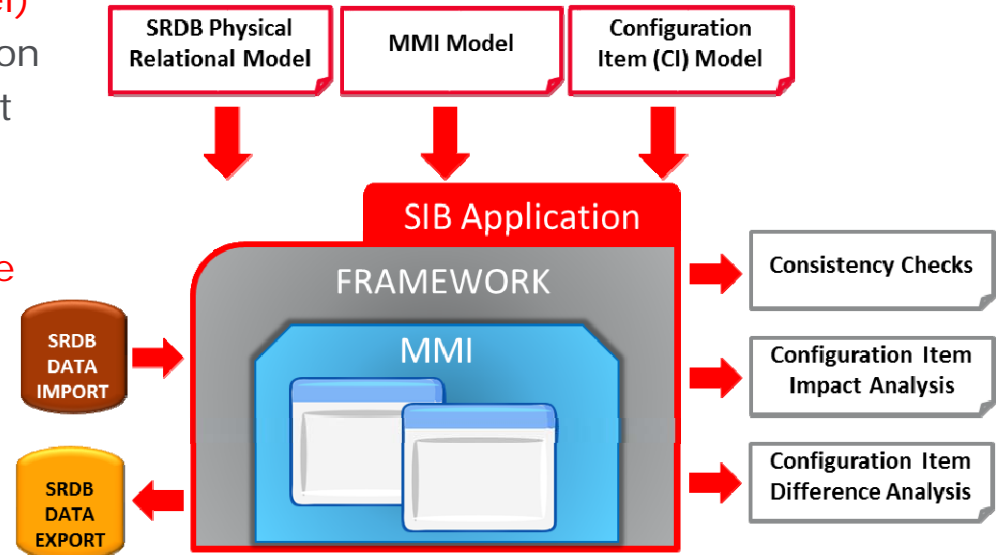
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Current Achievements



100% Model Driven SRDB Application:

- Fulfilled Requirements:
 - Import/Export Interface (corresponding to the SRDB Physical Relational model)
 - Consistency Checks & script verification
 - Impacts Analysis & Differences Report
 - MMI for Data & Violations Navigation
 - Flat MMI
 - Configuration Item MMI (based on the master-detail pattern)
- Input Models:
 - SRDB Physical Relational Model
 - MMI Model
 - Configuration Item Model
- Three-tier Deployment



Next challenge

100% Model Driven SRDB Application:

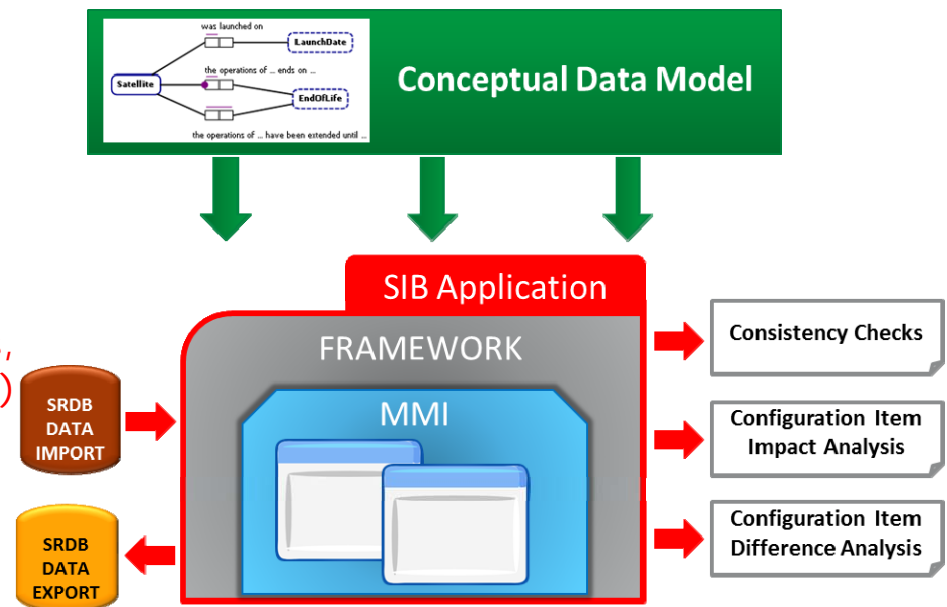
➤ Fulfilled Requirements:

- Import/Export interfaces (based on the user specific ICD models)
- Consistency Checks & script verification
- Impacts Analysis & Differences Report
- MMI for Data & Violations Navigation
- Flat MMI
- Configuration Item MMI (enhancements, e.g. seamless UUID, Overflow areas, ...)

➤ Input Model:

- Conceptual Data Model

➤ Three-tier Deployment



Automatic generation of a complete model driven system reference database (SRDB) application



Thank you!

... any questions



Feel free to contact us if you need any further information!

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SESP 2017 – ESTEC, 28th March 2017



European Space Agency