Opus Suite in LCC F126

Opus Suite Connect as part of the ILS IT Infrastructure of Project F126

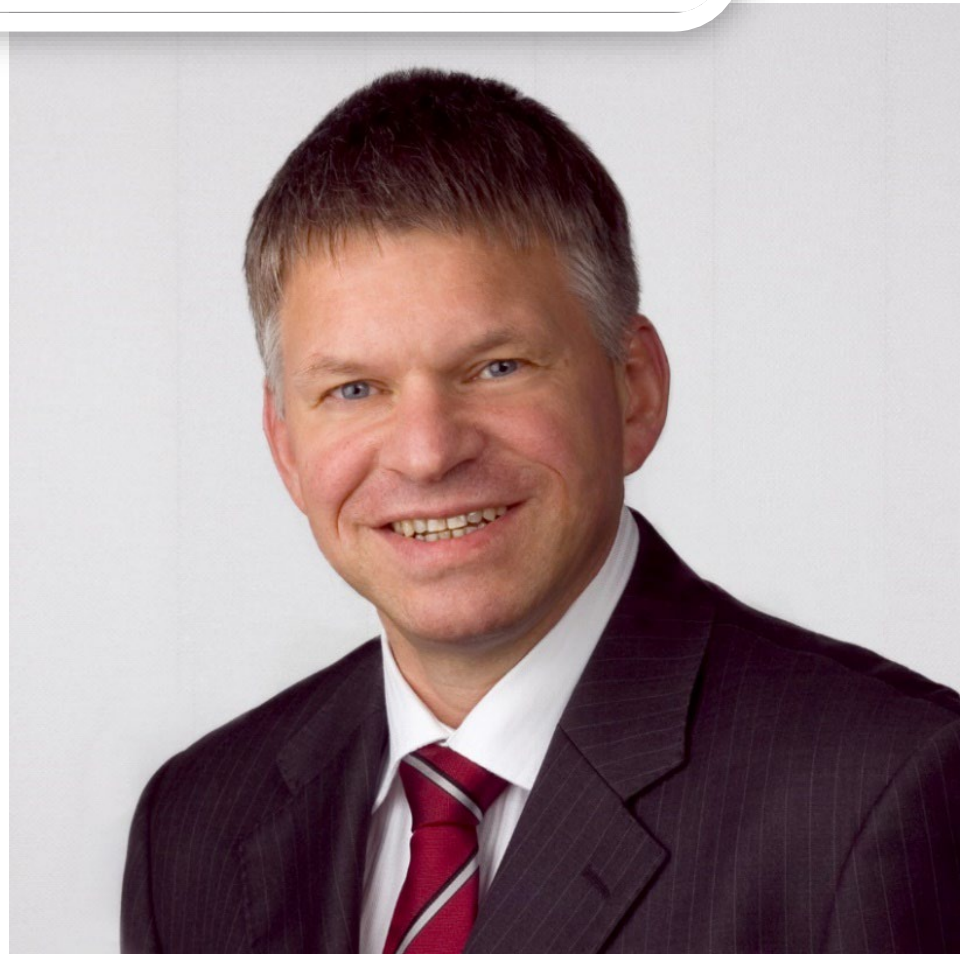
14.05.2024

Personal Introduction

Systecon
Deutschland Österreich Schweiz

Systecon Deutschland
aka AltenBachControl GmbH

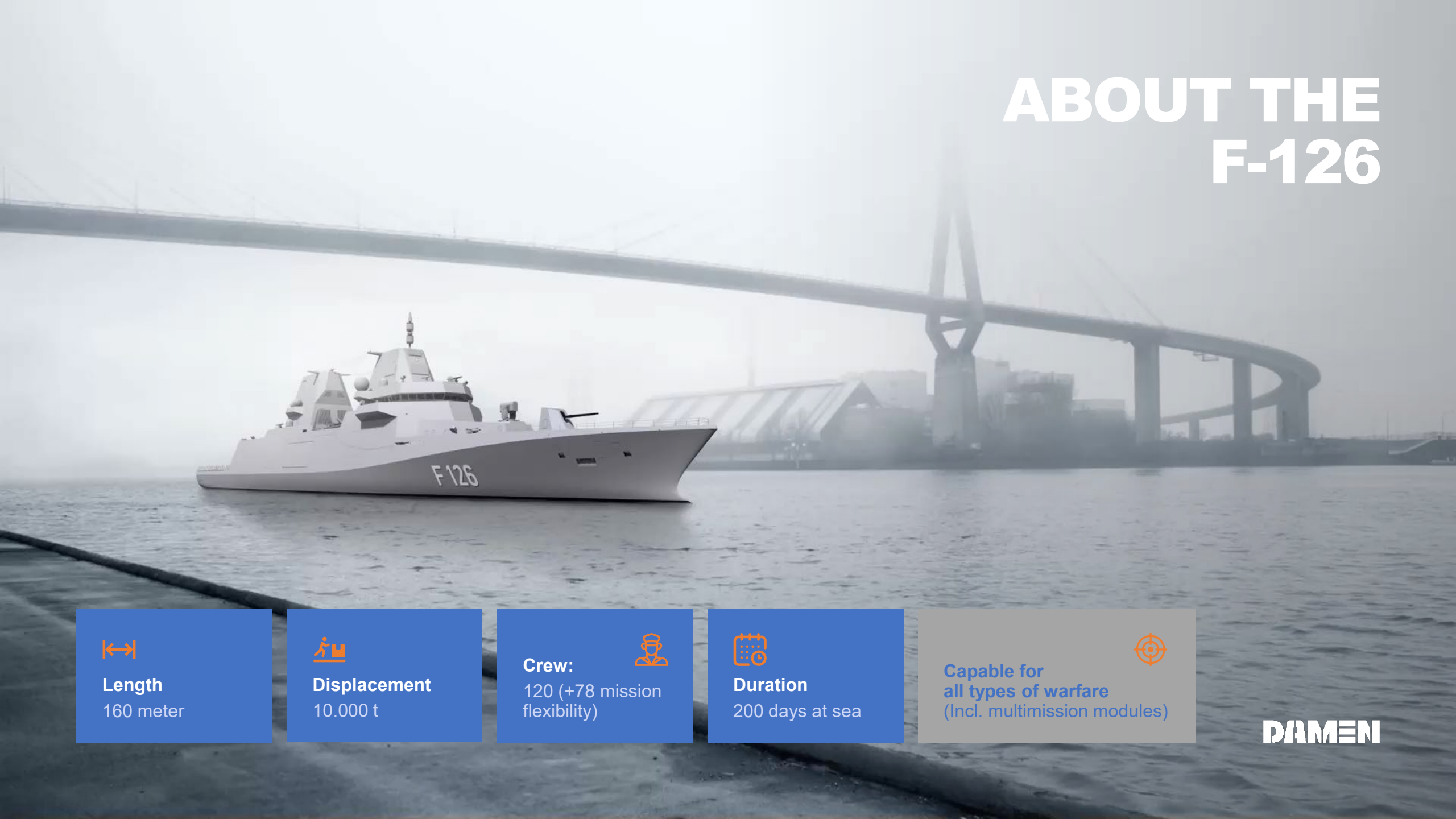
- Project support, consulting
- Cost estimation
- Life cycle cost management & optimizaiton
- Training & Workshops
- Region: D-A-CH military & non-transport customers
- Customer: military procurement agencies & armaments industry



Our agenda today

- Integration of OPUS10 / CATLOC into the project F126 at Damen Naval
- The role and use of Opus Suite Connect
- Lessons learned, achievements

ABOUT THE F-126



Length
160 meter

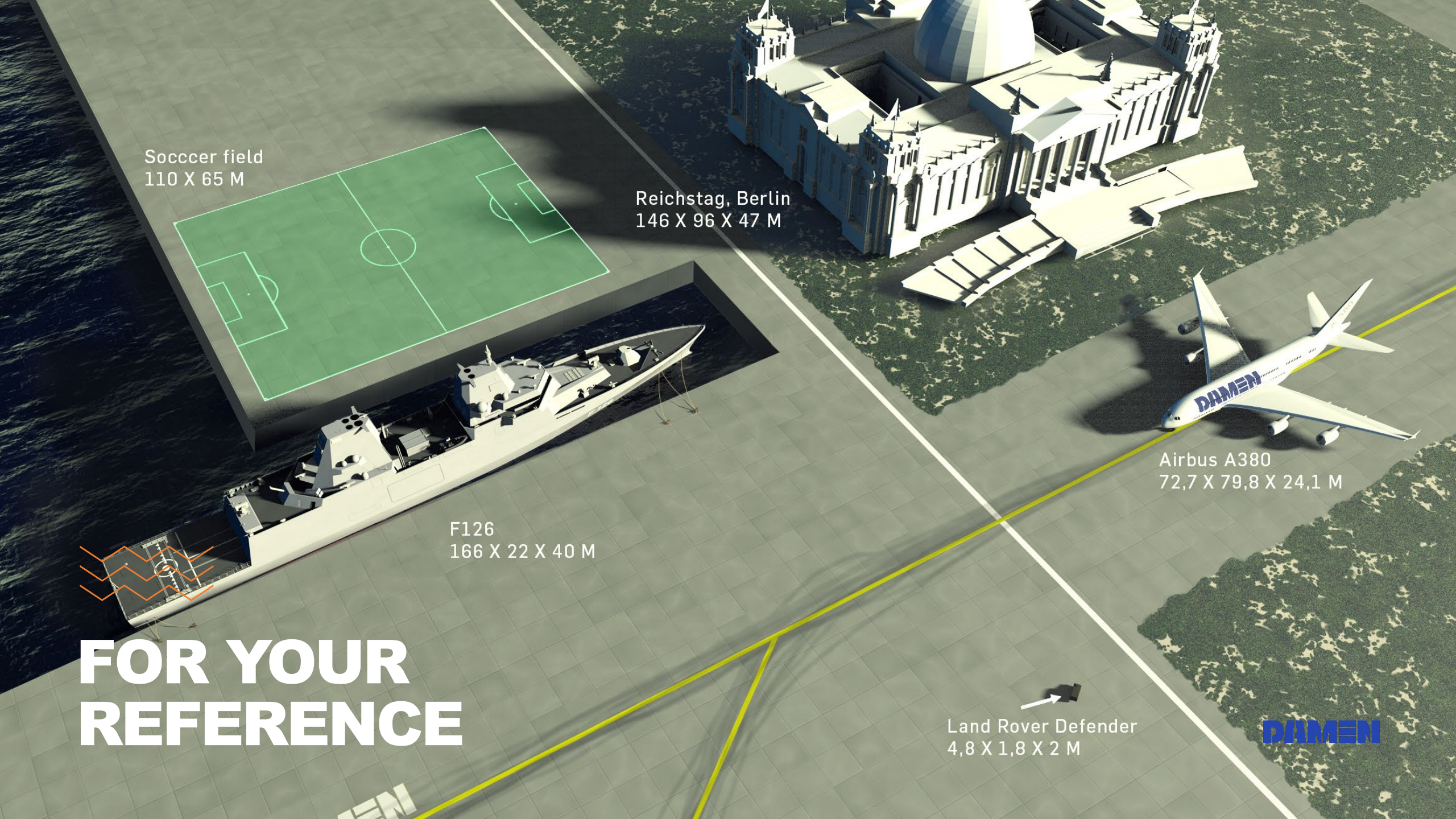
Displacement
10.000 t

Crew:
120 (+78 mission flexibility)

Duration
200 days at sea

Capable for all types of warfare
(Incl. multimission modules)

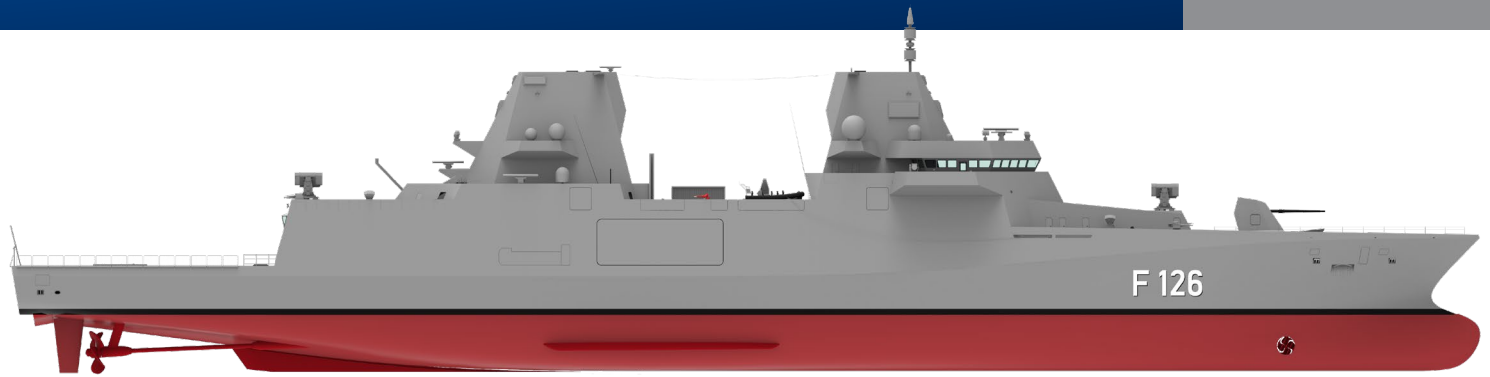
DAMEN



FOR YOUR REFERENCE

Main particulars

Length over all:	166,3 m
Beam:	21,7 m
Design Draught:	6,2 m



Configuration: CODLAD (COmbined Diesel ELectric And Diesel) with two independent drive trains

Main Engines:	2 x 12 MW, 20 Zylinder, 4-Takt
E-Drive:	2 x 3,7 MW im PTO-Mode
Propeller:	2x CPP (Dia 5100mm)
Diesel Generators:	4 x 3 MW
Energy Distribution:	Gleichspannungsnetz (DC-Grid)

FACTS

- Cable length per ship: 700.000 meter
- Quantity of pumps per ship: 150
- Fuel Capacity: >600 m^3
- I/O Sensors: 26.000

COMBAT SYSTEMS

WEAPONS

ASuW:	NSM Kongsberg
AAW:	ESSM Blk 2 (VLS Mk 41)
AAW:	RAM (2x)
Main Gun:	127 mm
Secondary Gun:	27 mm MLG RM
	12.7 mm RMW
	7.62 mm

SENSORS

Air Warning Radar:	TRS 4D
Fire Control Radar:	APAR Blk 2
ASW:	Variable Depth Sonar
Other:	ESSM
	Laser Warning
	Mirador 2x
	Gatekeeper
	AS Skeldar
	Non Lethal Effectors
	(Sound / light / water)

"Worldwide deployable (from Arctic to tropical waters), for all sorts of Operations (from Peer-to-peer Conflict to Humanitarian Aid)"

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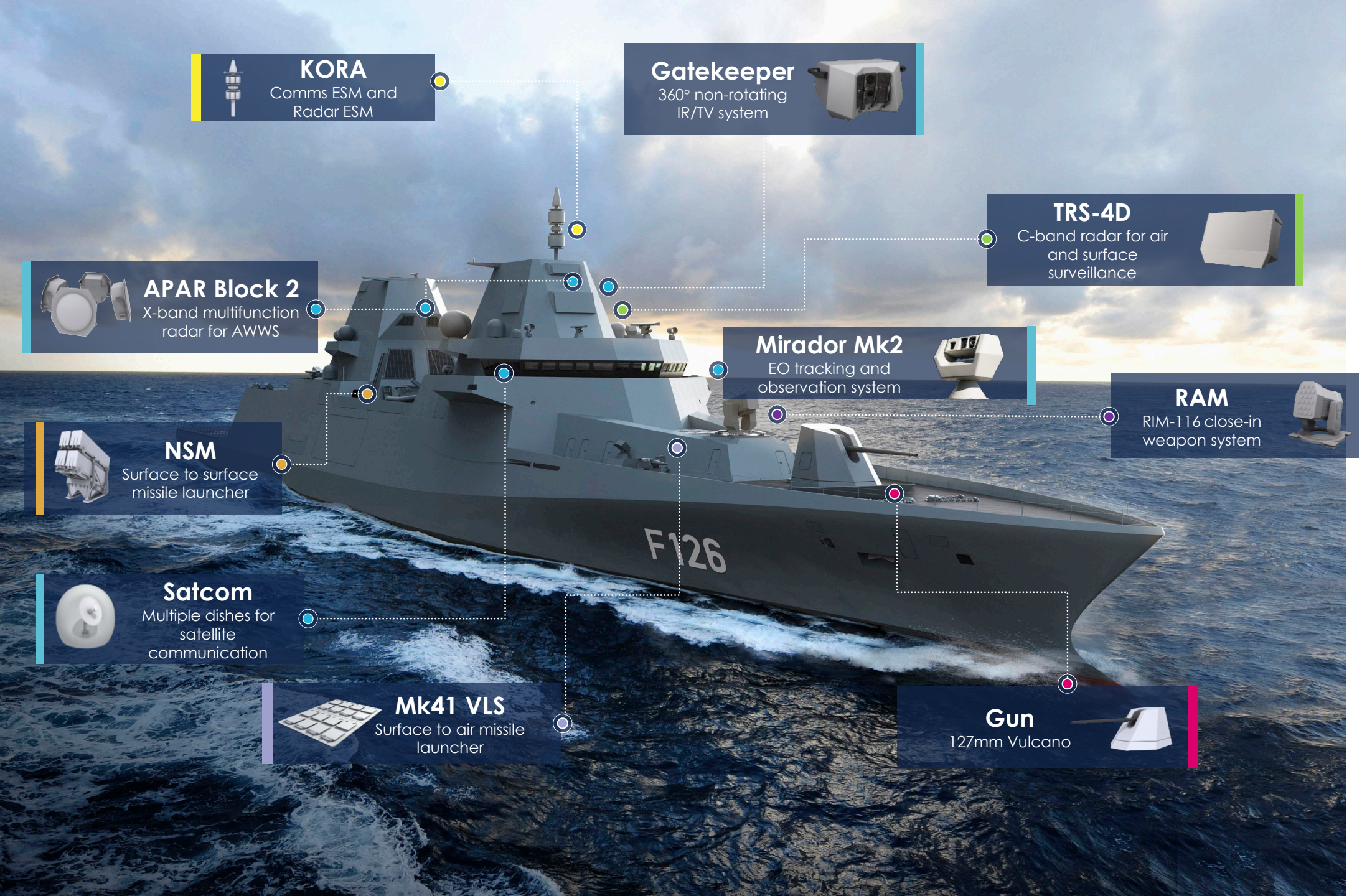

KORA
Comms ESM and Radar ESM
Gatekeeper
360° non-rotating IR/TV system
TRS-4D
C-band radar for air and surface surveillance
APAR Block 2
X-band multifunction radar for AWWS
Mirador Mk2
EO tracking and observation system
RAM
RIM-116 close-in weapon system
NSM
Surface to surface missile launcher
Satcom
Multiple dishes for satellite communication
Mk41 VLS
Surface to air missile launcher
Gun
127mm Vulcano
F126

DAMEN

OPUS10 / CATLOC in LCC F126

Why does DAMEN NAVAL use OPUS10 / CATLOC in project F126?

Reasons for application of Opus Suite

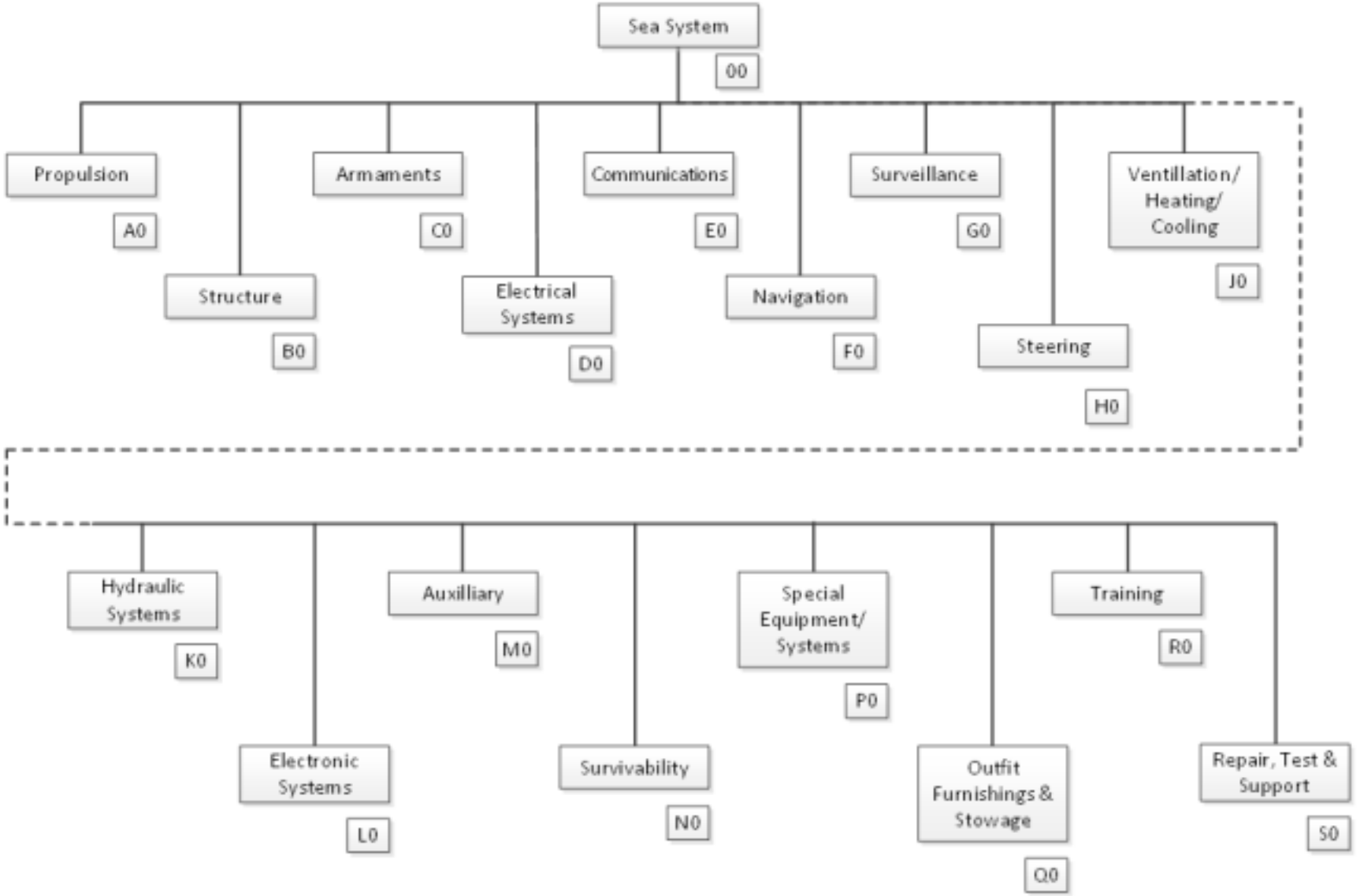
- Customer (BAAINBw) requirement: LCC management
  - *Monitor overall life cycle cost during construction & delivery*
  - *LCC reporting (yearly) from project to ministry*
  - *„May be later:“ project decisions influenced by LCC model analysis*

- DAMEN NAVAL objectives
  - *Life cycle optimization – cost drivers / availability bottleneck analysis*
  - *Spares recommendation (systems availability under normal conditions & w/o support)*
  - *Human resource utilization must match with crew size*

Shipbuilding is System Integration

TAS i.a.w. SNS 8.2.8 General Sea Vehicle – Model composed of individual subsystem models

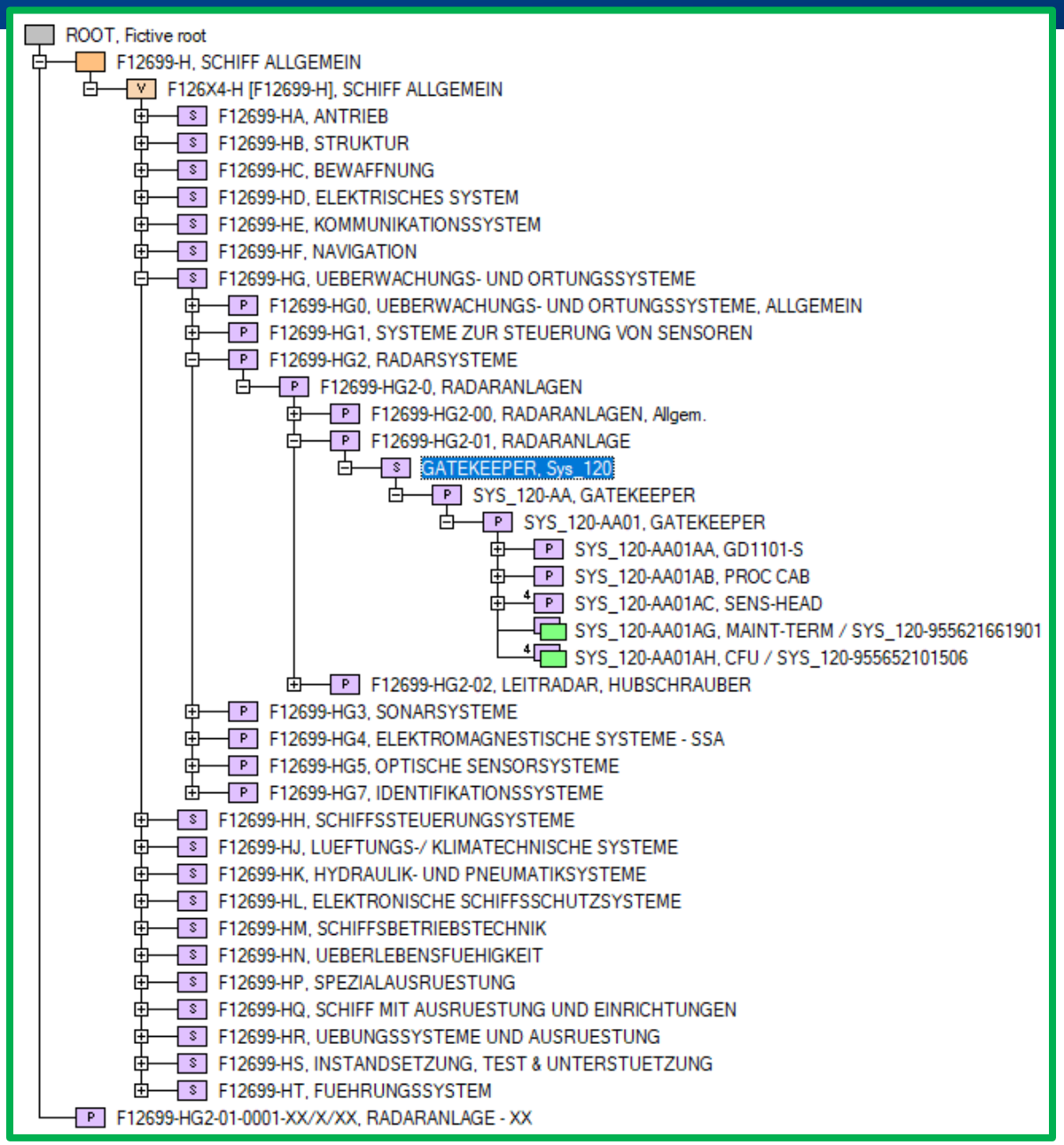
Top Level Breakdown for a General Sea Vehicle

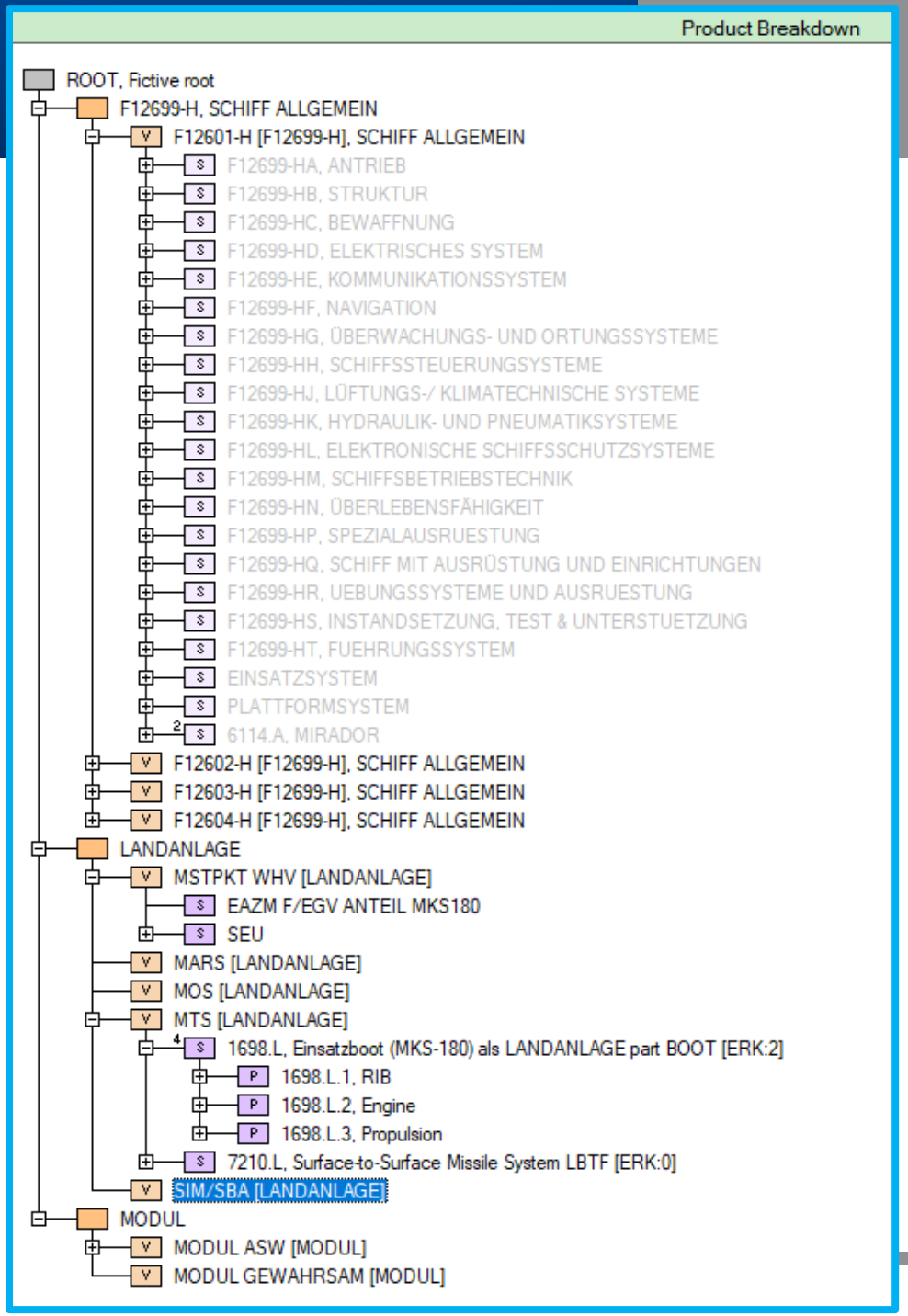


ICN-83007-0000000122-001-01

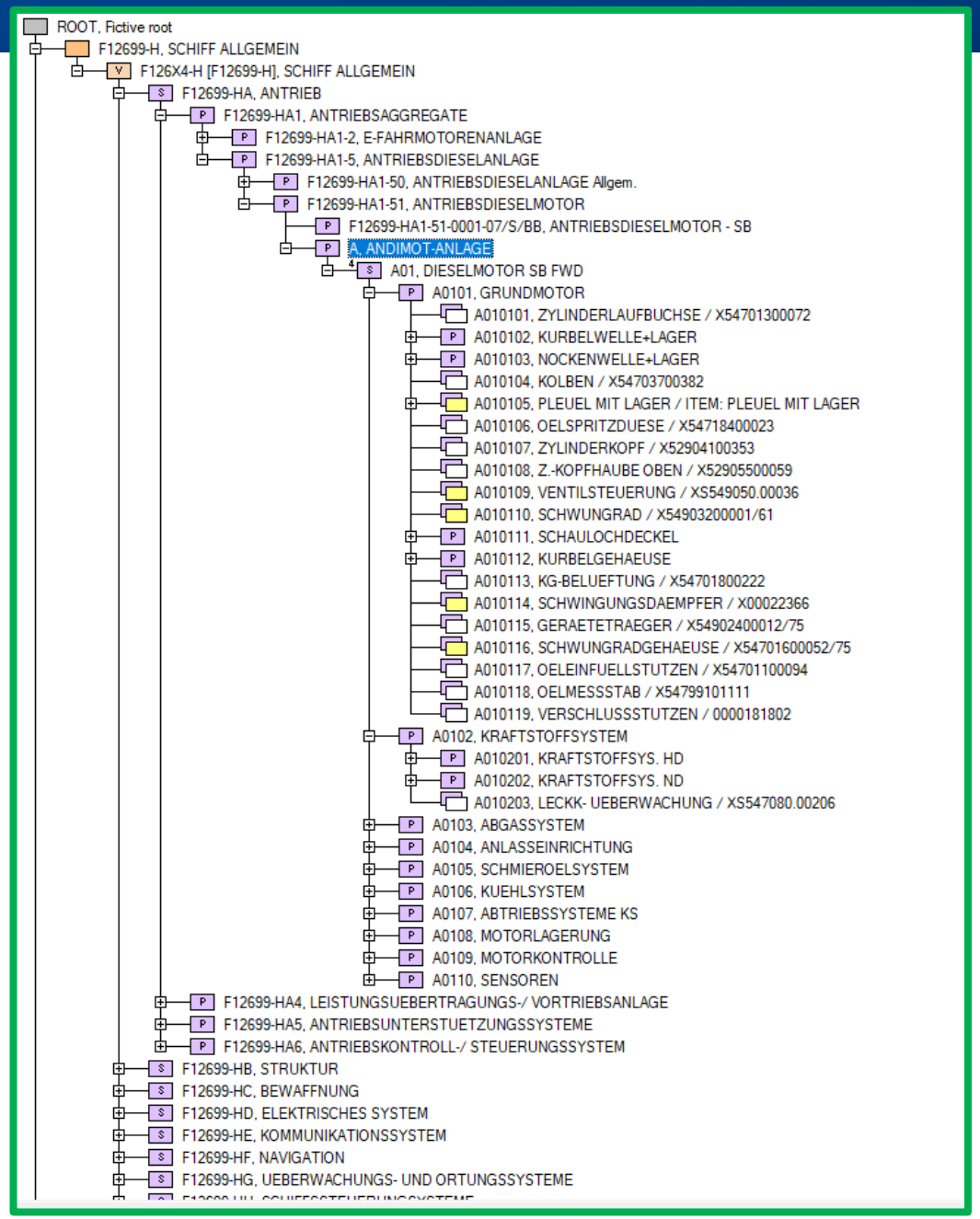
System	Title
A0	Propulsion, General
B0	Structure, General
C0	Armaments, General
D0	Electrical power, General
E0	Communications, General
F0	Navigation, General
G0	Surveillance, General
H0	Steering, General
J0	Ventilation and air conditioning, General
K0	Hydraulics and pneumatics, General
L0	Electronic systems, General
M0	Auxiliary, General
N0	Survivability, General
P0	Special equipment and systems, General
Q0	Outfit and furnishings, General
R0	Training, General
S0	Repair, test and support, General
T0	Management system
U0	Meteorological and oceanography system

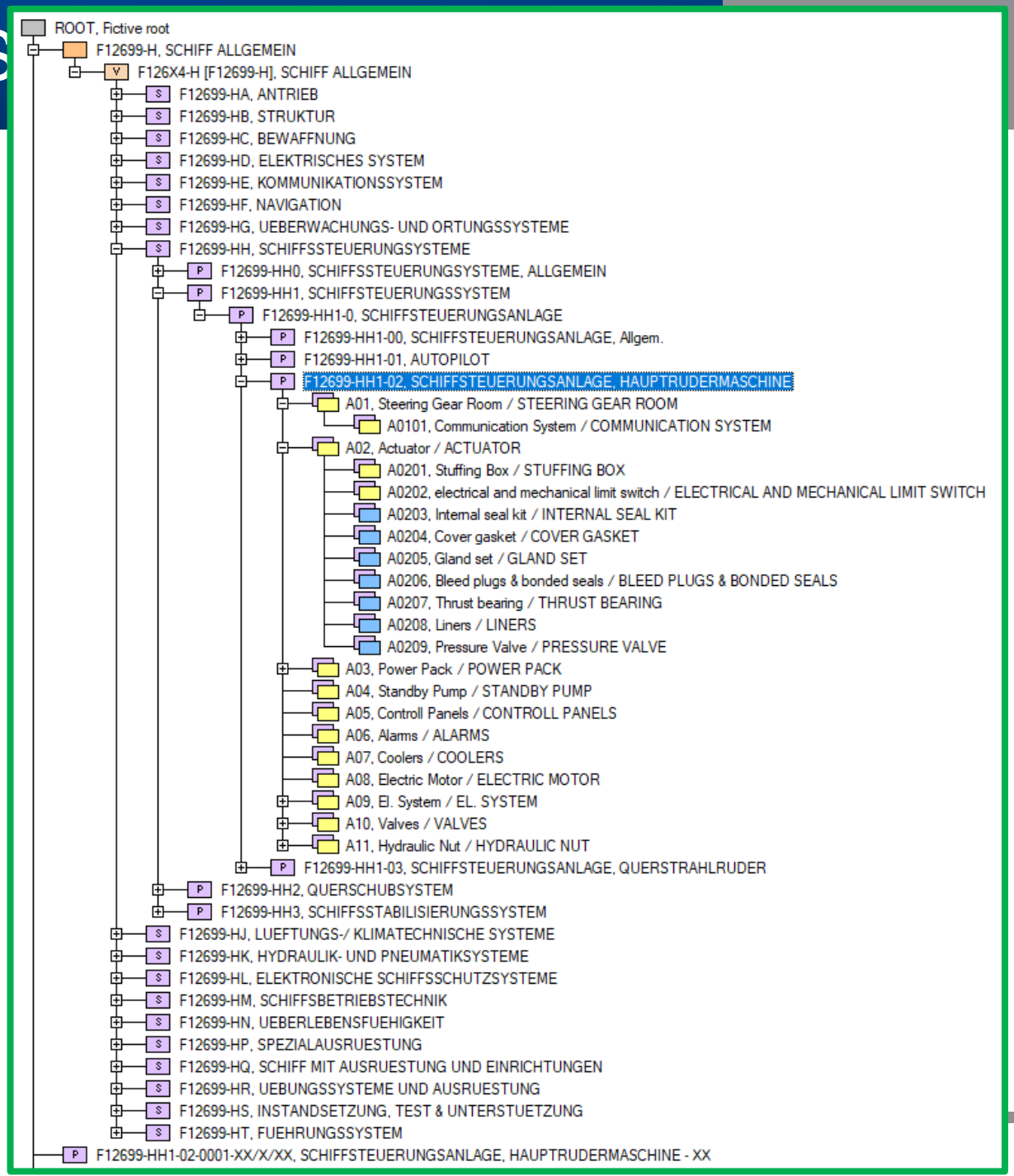
Product Breakdown iaw. SNS





Product Breakdown iaw. SNS





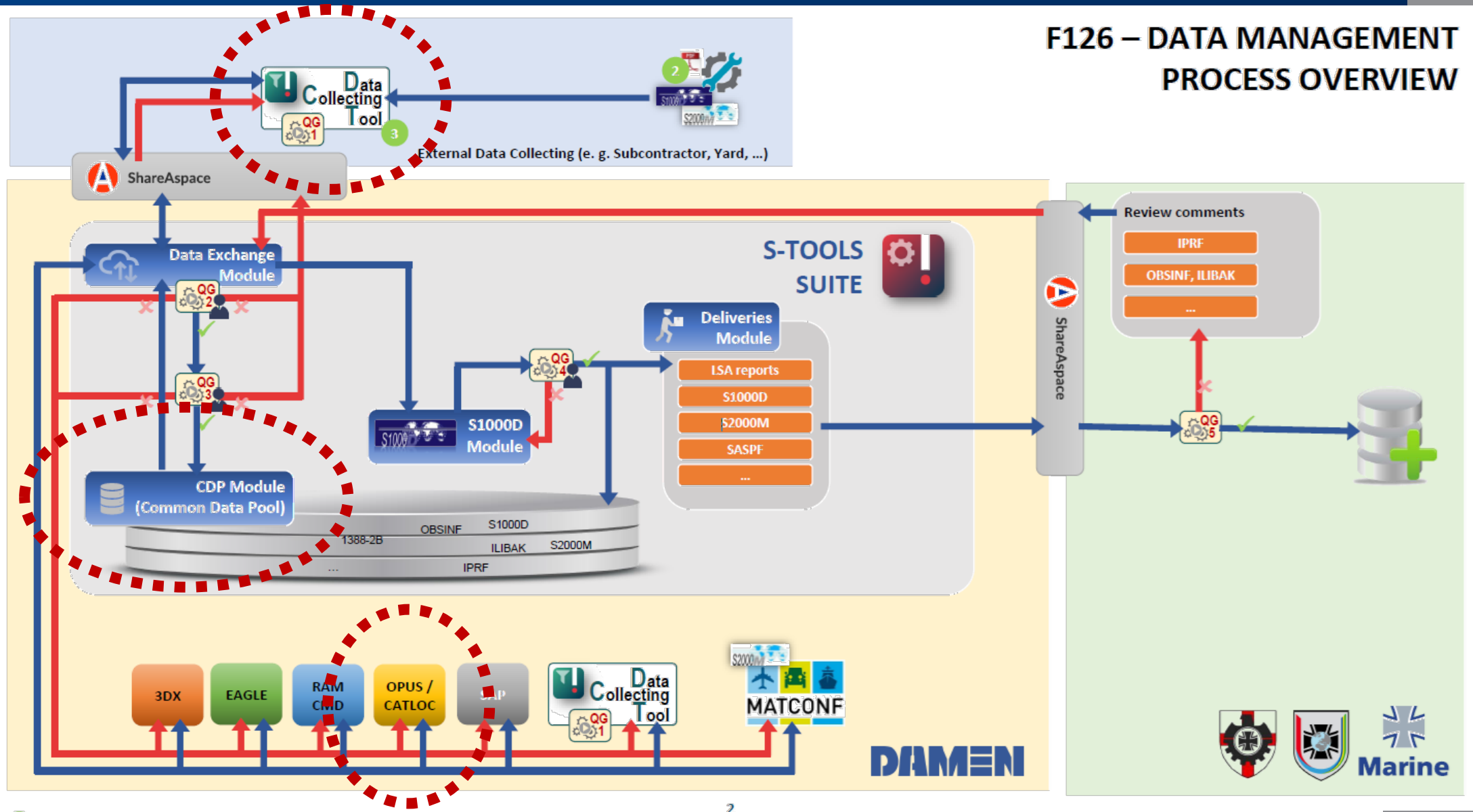
Challenges adressed by Opus Suite Connect

- Create subsystem models from supplier data / LSA
- Merge subsystem models into overall system model
  - Arrange for unique LCN numbering in overall model
  - When subsystem occurs 2+ times in system, subsystem LCN‘s need to be adapted
- update an existing model from actual LSA data
  - even when model has been manually changed
- Traceability of model updates

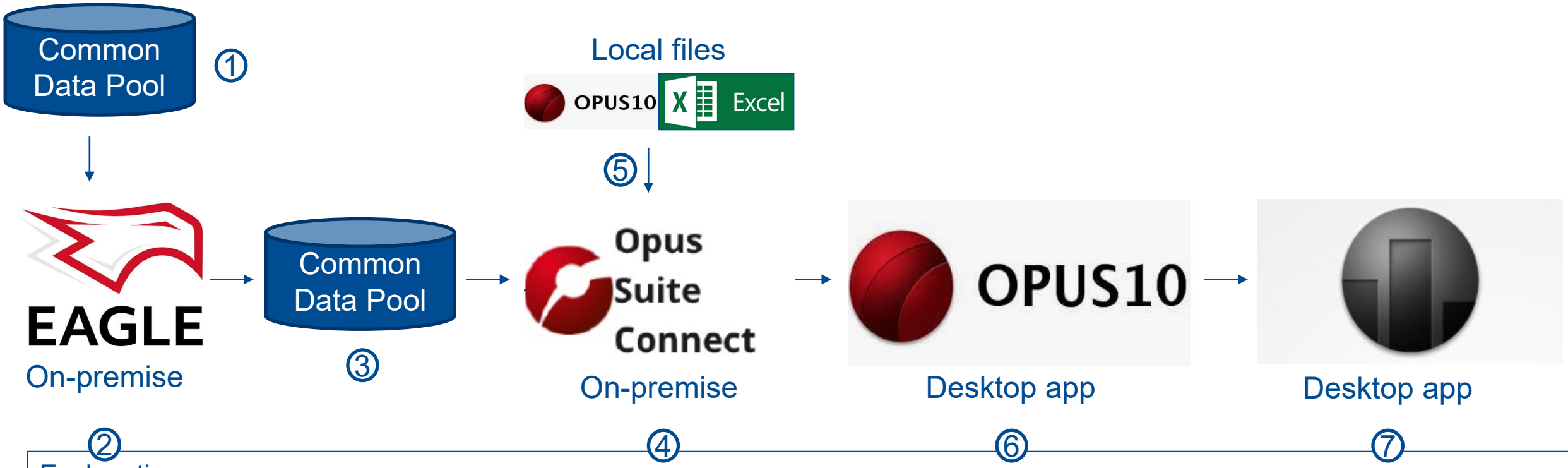
Shipbuilding is System Integration – ILS is, too

How is OPUS10 / CATLOC / CONNECT integrated into the project?

ILS data management process overview



ILS data from supplier via LSA to Opus Suite



Explanation

1. This is Damen Naval's Common Data Pool (internal database), which contains data from suppliers
2. Data flows from the Common Data Pool to EAGLE (on-premise)
3. Data is being transformed in EAGLE and flows back to the Common Data Pool
4. Opus Suite Connect (on-premise) connects to the Common Data Pool (via ODBC ??)
5. Data from .opi- or .xlsx-files can be merged together with Common Data Pool data into one OPUS model
6. From Opus Suite Connect an export can be done to enable opening the OPUS model in the desktop application
7. CATLOC (desktop application) can be connected to the OPUS model

Interfacing with F126 ILS IT-Infrastructure

How will Opus Suite Connect be integrated?

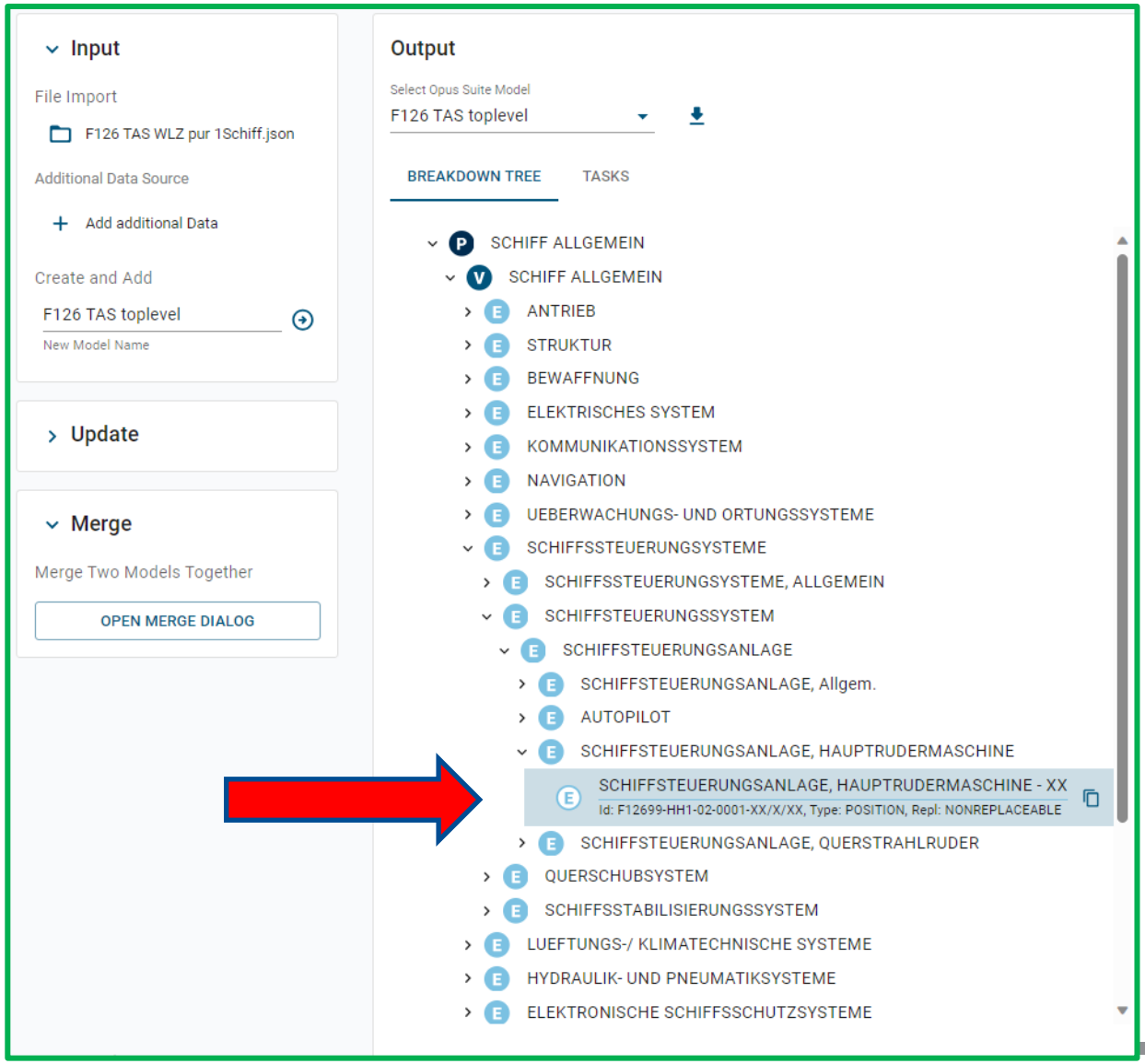
Opus Suite Connect – Web Interface / **Top-level System Model**

When data extract from LSA into Connect complies to standard (GEIA-STD-0007)

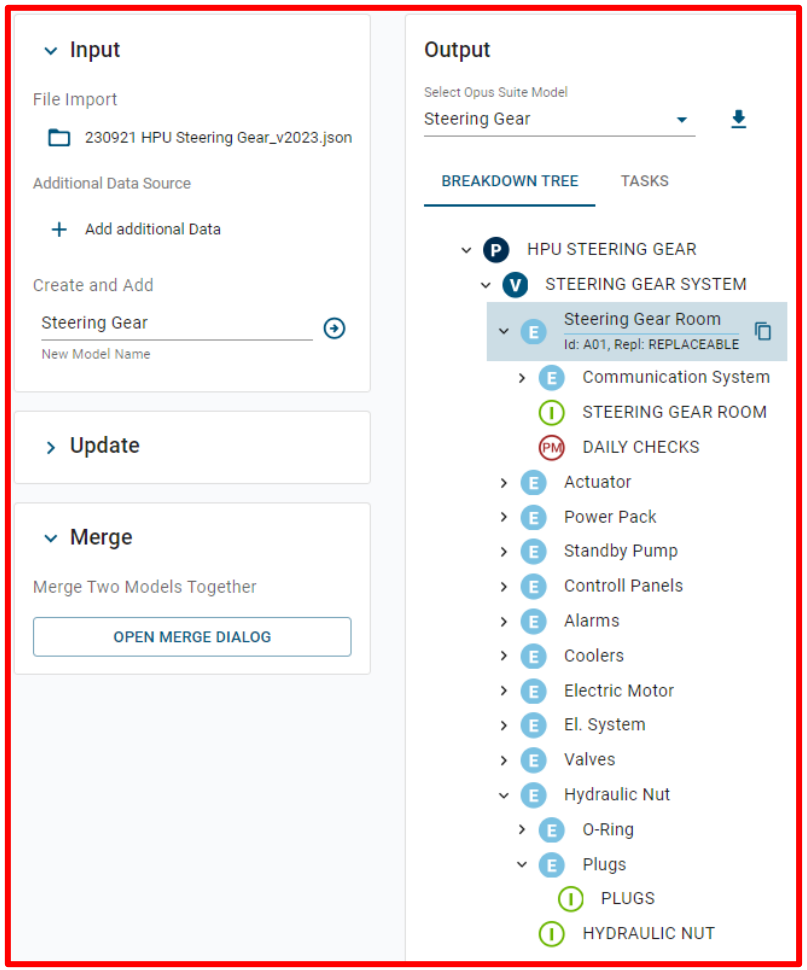
- generate a new model
- integrate a new model into an existing model
- actualize an existing (earlier created) model
- review data and identify anomalities
- transfer data into OPUS10 import format

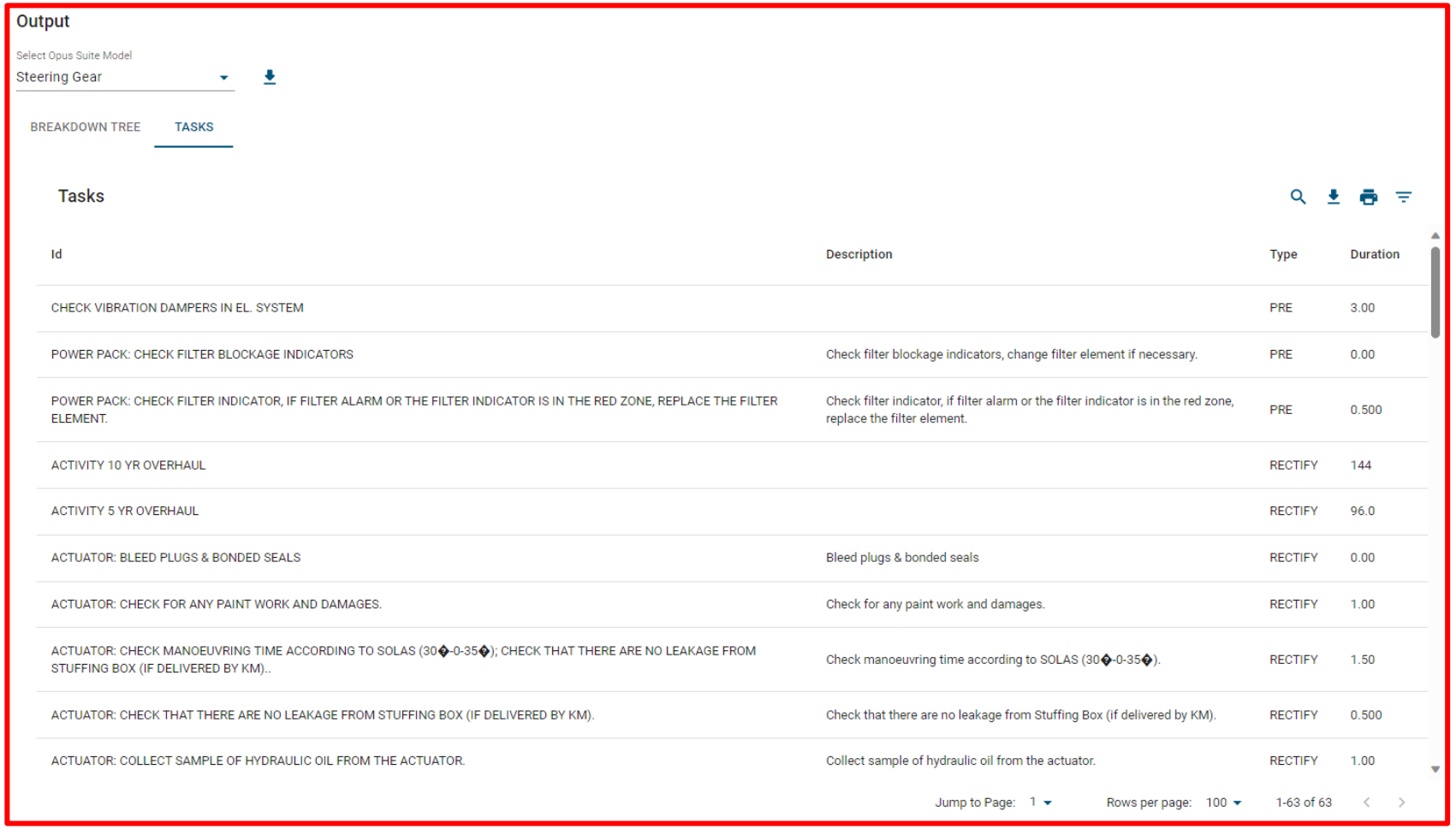
download/export to a .JSON file

import into an OPUS10 model on desktop/laptop OPUS10 application



Generate subsystem model from CDP or LSA-DB data





Merge subsystem into top-level system model at given Breakdown Element

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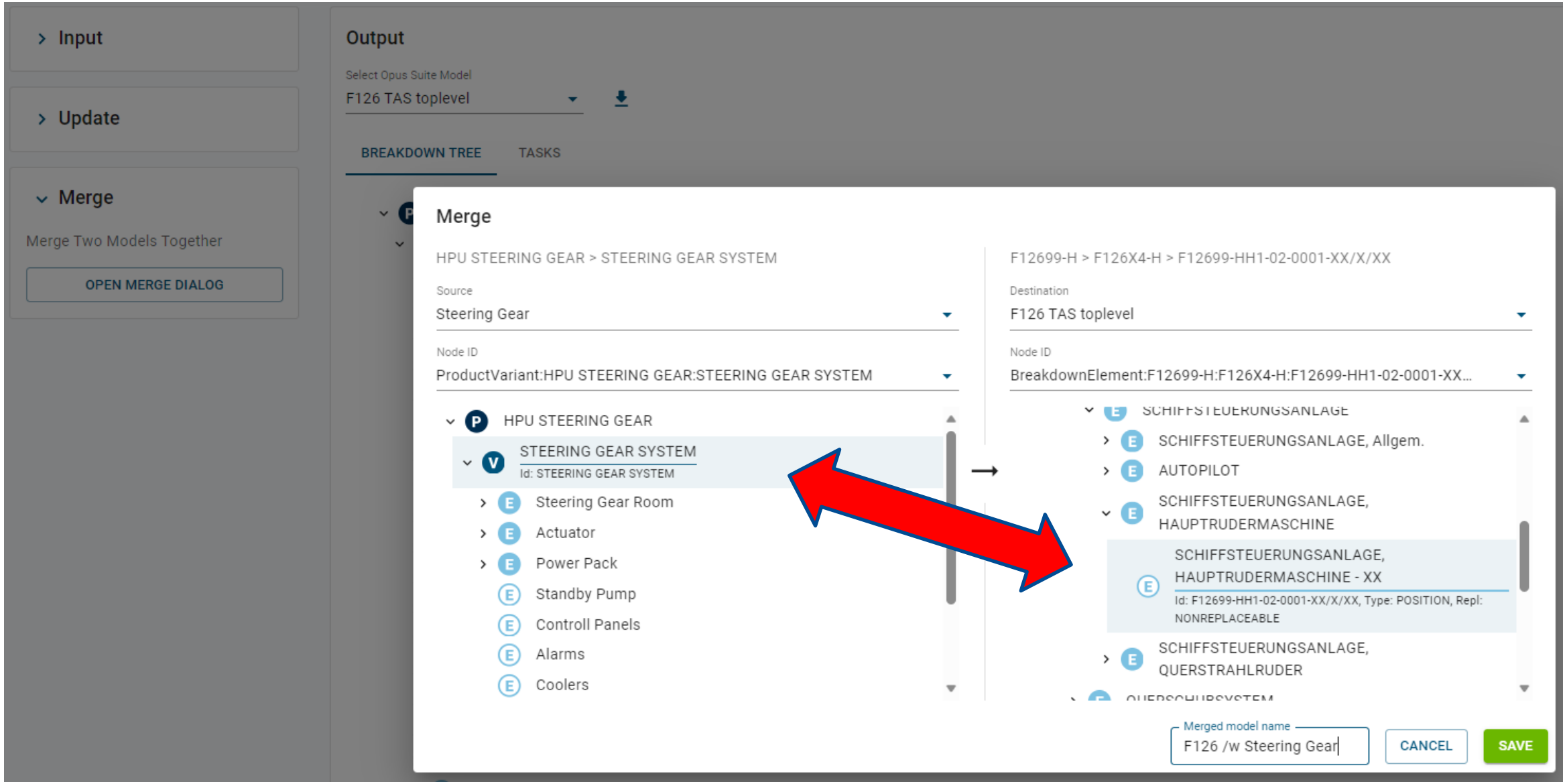
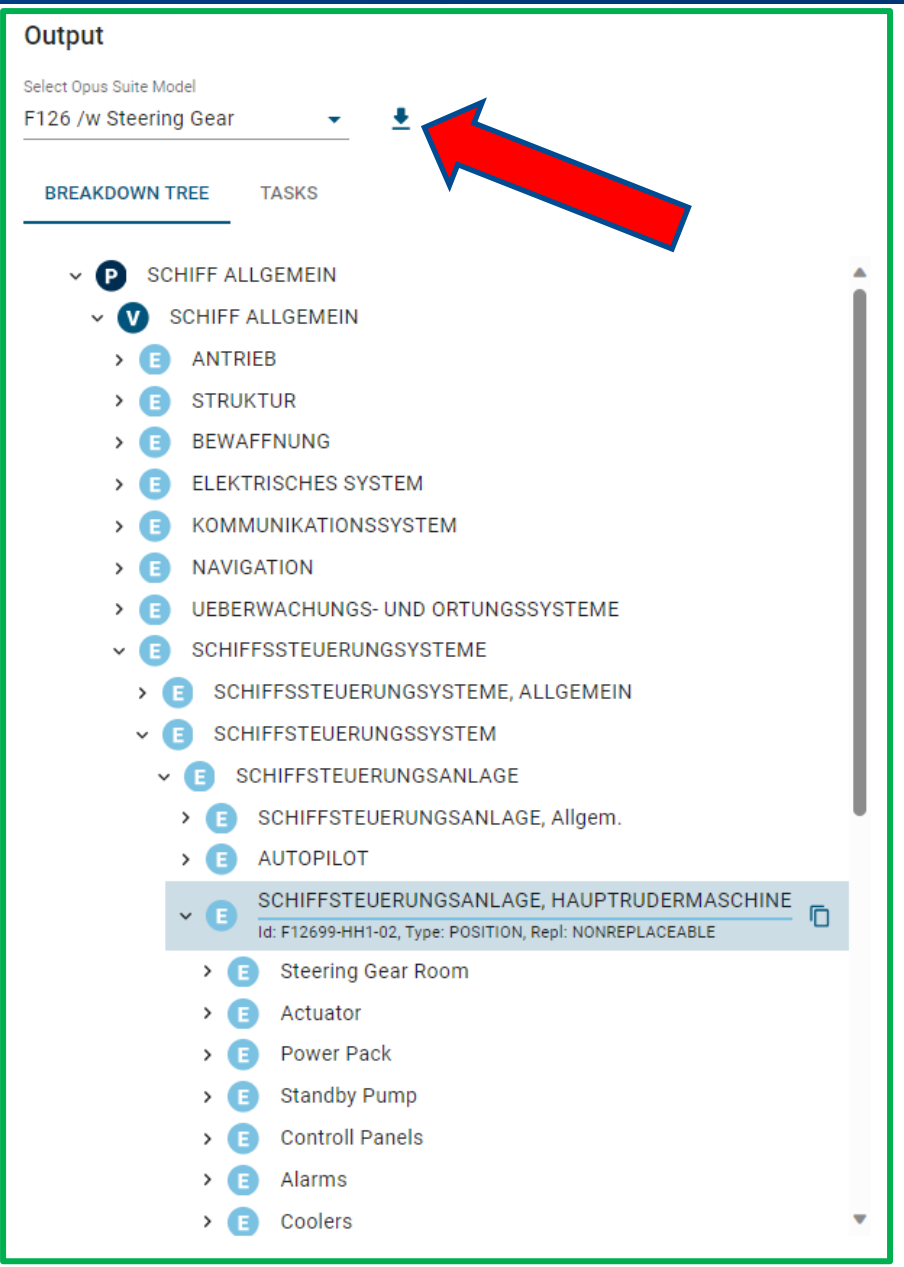
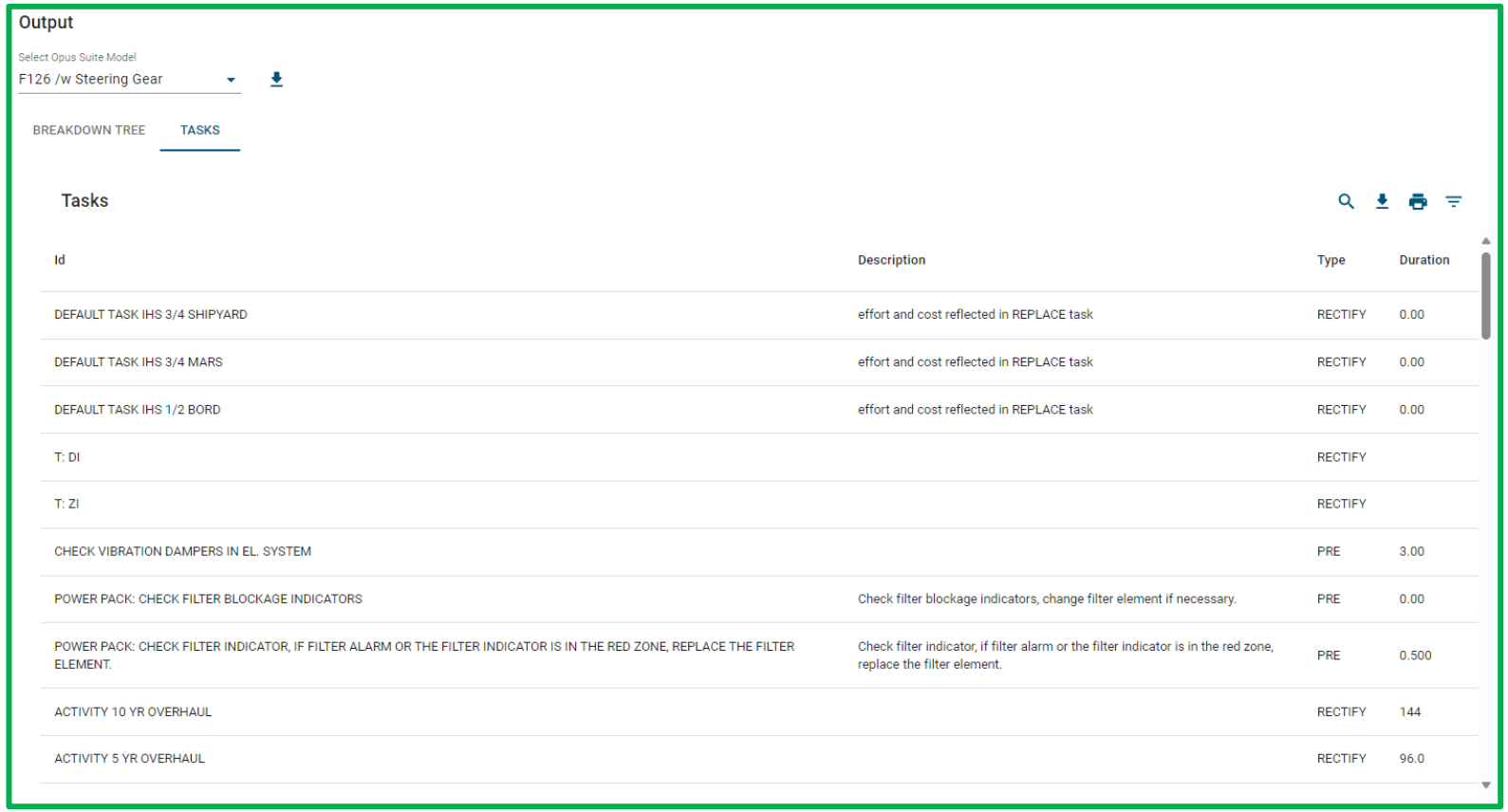
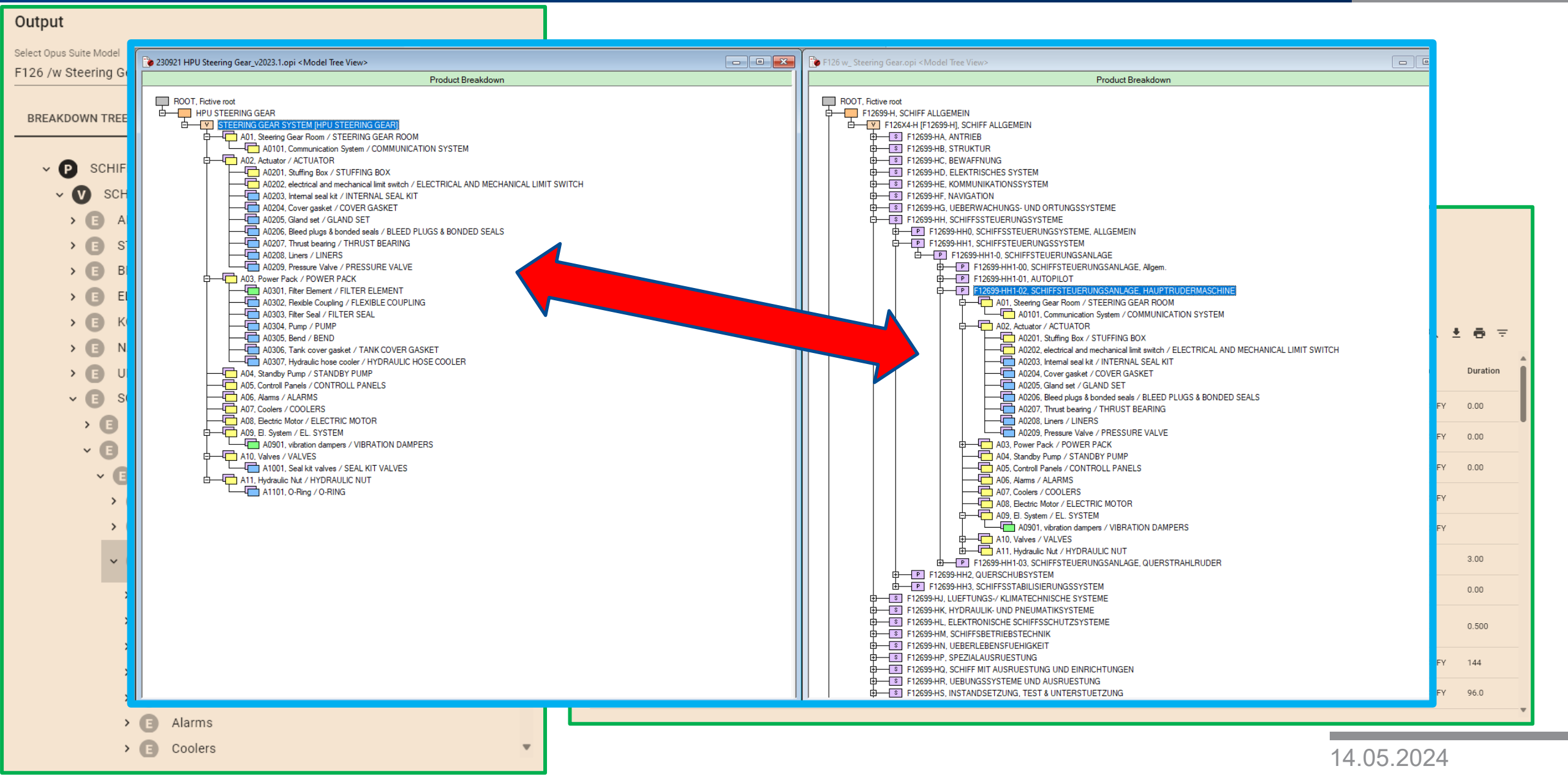


Top-level System with subsystem merged at given BDE

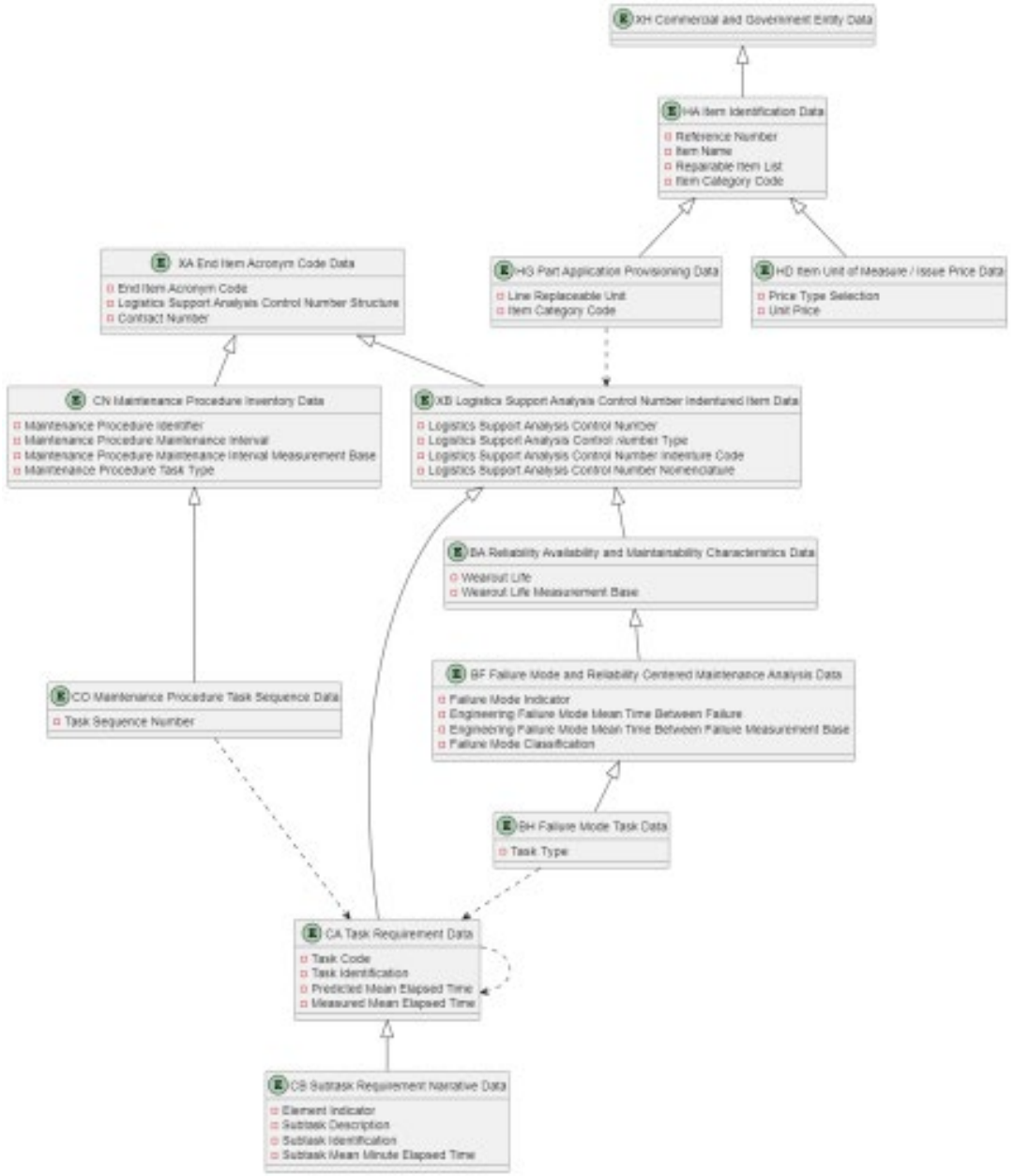




Import generated JSON file into empty OPUS10 model template



Interface requirements – GEIA 0007 entities (tables)



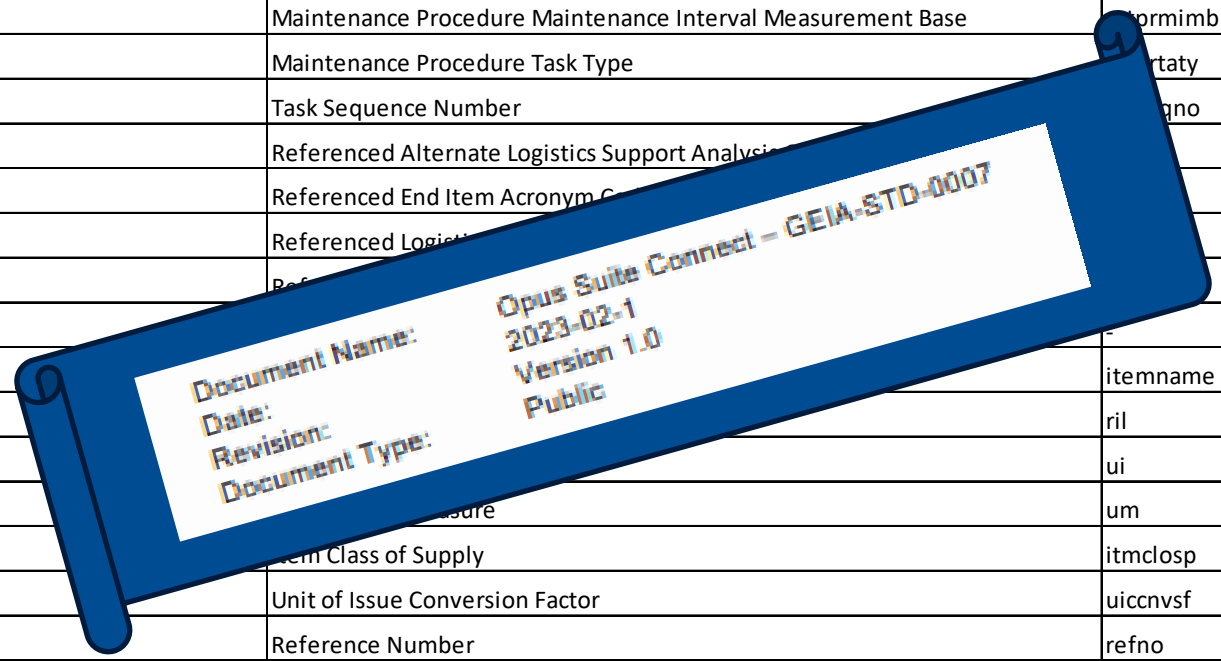
- Entity BF Failure Mode and Reliability Centered Maintenance Analysis Data
- Entity BH Failure Mode Task Data
- Entity BD
- Entity CA Task Requirement Data
- Entity CB Subtask Requirement Narrative Data
- Entity CN Maintenance Procedure Inventory Data
- Entity CO Maintenance Procedure Task Sequence Data
- Entity HA Item Identification Data
- Entity HD Item Unit of Measure Issue Price Data
- Entity HG Part Application Provisioning Data
- Entity XA End Item Acronym Code Data
- Entity XB Logistics Support Analysis Control Number Indentured Item Data

Opus Suite Connect – GEIA-STD-0007

Entity	Entity Code	Element Name	DATA ATTRIBUTE / ELEMENT NAME	SHORT NAME	STATUS
Entity XA	XA	End Item Acronym Code Data	End Item Acronym Code	eiac	SUPPORTED
Entity XA	XA	End Item Acronym Code Data	Logistics Support Analysis Control Number Structure	lcnstr	SUPPORTED
Entity XA	XA	End Item Acronym Code Data	Contract Number	contrno	SUPPORTED
Entity XB	XB	Logistics Support Analysis Control Number Indentured Item Data	Logistics Support Analysis Control Number	lcn	SUPPORTED
Entity XB	XB	Logistics Support Analysis Control Number Indentured Item Data	Logistics Support Analysis Control Number Type	lcntype	SUPPORTED
Entity XB	XB	Logistics Support Analysis Control Number Indentured Item Data	Logistics Support Analysis Control Number Indenture Code	lcnidcd	SUPPORTED
Entity XB	XB	Logistics Support Analysis Control Number Indentured Item Data	Logistics Support Analysis Control Number Nomenclature	lcnnomen	SUPPORTED
Entity BA	BA	Reliability Availability and Maintainability Characteristics Data	Wearout Life	wearoutl	UNDER CONSIDERATION
Entity BA	BA	Reliability Availability and Maintainability Characteristics Data	Wearout Life Measurement Base	weartlmb	UNDER CONSIDERATION
Entity BF	BF	Failure Mode and Reliability Centered Maintenance Analysis Data	Failure Mode Indicator	fmindctr	SUPPORTED
Entity BF	BF	Failure Mode and Reliability Centered Maintenance Analysis Data	Engineering Failure Mode Mean Time Between Failure	efmmtbf	PLANNED
Entity BF	BF	Failure Mode and Reliability Centered Maintenance Analysis Data		efmtbfmb	PLANNED
Entity BF	BF	Failure Mode and Reliability Centered Maintenance Analysis Data		fmclass	UNDER CONSIDERATION
Entity BH	BH	Failure Mode Task Data	Task Type	tasktype	PLANNED
Entity CA	CA	Task Requirement Data	Task Code	taskcode	SUPPORTED
Entity CA	CA	Task Requirement Data	Task Identification	taskid	SUPPORTED
Entity CA	CA	Task Requirement Data		prdmnelt	PLANNED
Entity CA	CA	Task Requirement Data	Predicted Mean Man Hours	prdmnmhr	PLANNED
Entity CA	CA	Task Requirement Data	Measured Mean Elapsed Time	msdmnelt	PLANNED
Entity CA	CA	Task Requirement Data	Measured Mean Man Hours	msdmnmhr	SUPPORTED
Entity CB	CB	Subtask Requirement Narrative	Data Subtask Number	subtano	SUPPORTED
Entity CB	CB	Subtask Requirement Narrative	Data Element Indicator	elind	UNDER CONSIDERATION
Entity CB	CB	Subtask Requirement Narrative	Data Subtask Description	subtdesc	SUPPORTED

Opus Suite Connect – GEIA-STD-0007

Entity	Entity Code	Element Name	DATA ATTRIBUTE / ELEMENT NAME	SHORT NAME	STATUS
Entity CB	CB	Subtask Requirement Narrative	Data Subtask Description	subtdesc	SUPPORTED
Entity CB	CB	Subtask Requirement Narrative	Data Subtask Identification	subtaid	SUPPORTED
Entity CB	CB	Subtask Requirement Narrative	Subtask Mean Minute Elapsed Time	subtmmet	SUPPORTED
Entity CN	CN	Maintenance Procedure Inventory Data	Maintenance Procedure Identifier	mtpridtf	PLANNED
Entity CN	CN	Maintenance Procedure Inventory Data	Maintenance Procedure Maintenance Interval	mtprmtin	PLANNED
Entity CN	CN	Maintenance Procedure Inventory Data	Maintenance Procedure Maintenance Interval Measurement Base	prmimb	PLANNED
Entity CN	CN	Maintenance Procedure Inventory Data	Maintenance Procedure Task Type	rtaty	PLANNED
Entity CO	CO	Maintenance Procedure Task Sequence Data	Task Sequence Number	qno	PLANNED
Entity CO	CO	Maintenance Procedure Task Sequence Data	Referenced Alternate Logistics Support Analysis		PLANNED
Entity CO	CO	Maintenance Procedure Task Sequence Data	Referenced End Item Acronym C		PLANNED
Entity CO	CO	Maintenance Procedure Task Sequence Data	Referenced Logist		PLANNED
Entity CO	CO	Maintenance Procedure Task Sequence Data	Ref		PLANNED
Entity CO	CO	Maintenance Procedure Task Sequence Data		-	SUPPORTED
Entity HA	HA	Item Identification Data		itemname	SUPPORTED
Entity HA	HA	Item Identification Data		ril	UNDER CONSIDERATION
Entity HA	HA	Item Identification Data		ui	PLANNED
Entity HA	HA	Item Identification Data	sure	um	PLANNED
Entity HA	HA	Item Identification Data	tem Class of Supply	itmclosp	UNDER CONSIDERATION
Entity HA	HA	Item Identification Data	Unit of Issue Conversion Factor	uiccnvsf	PLANNED
Entity HA	HA	Item Identification Data	Reference Number	refno	SUPPORTED
Entity HA	HA	Item Identification Data	Item Name	itemname	SUPPORTED
Entity HG	HG	Part Application Provisioning Data	Line Replaceable Unit	lru	UNDER CONSIDERATION
Entity HG	HG	Part Application Provisioning Data	Item Category Code	icc	UNDER CONSIDERATION
Entity HG	HG	Part Application Provisioning Data	Quantity per Assembly	qpa	SUPPORTED
Entity HD	HD	Item Unit of Measure Issue Price Data	Price Type Selection	prctypsl	PLANNED
Entity HD	HD	Item Unit of Measure Issue Price Data	Unit Price	unitprc	SUPPORTED



OPUS10 model populated from LSA data

Table	Column	Source entity
Product	PID	XA
Product	DESCR	XA
BreakdownElement	BEID	XB
BreakdownElement	DESCR	XB
BreakdownElement	ATYPE	XB
BreakdownElement	REPL	XB
ProductVariant	PVID	XC
ProductVariant	BPID	XA
ProductVariant	DESCR	XC
ProductBreakdown	PVID	XF
ProductBreakdown	BDSID	XF
ProductBreakdown	BDMID	XF
ProductBreakdown	QTYPM	XF
ProductBreakdown	TID	CA
ProductRealization	PVID	HO
ProductRealization	BDEID	HO
ProductRealization	IID	HO
Item	IID	HA
Item	DESCR	HA
Item	PRICE	HD
ItemStructure	IID	XB
ItemStructure	MID	XB
ItemStructure	QTYPM	XB
ItemStructure	REPL	XB
Failure	FRID	BF
Failure	DESCR	BF
Failure	BDEID	BF
Failure	IID	BF
Failure	REPAB	HG HA
FailureRate	FRID	BF
FailureRate	OPID	BF
FailureRate	FRT	BF
Repair	FRID	BH
Repair	MAID	BH
Task	TID	CA
Task	DESCR	CA
Task	TYPE	CA
Task	DURN	CA
MaintenanceActivity	MAID	CA
MaintenanceActivityContent	MAID	CA CB
MaintenanceActivityContent	COID	CA CB
MaintenanceActivityContent	SMAID	CA CB
TaskPackage	TPID	CA
TaskPackageContent	TPID	CA CB
TaskPackageContent	TID	CA CB
TaskBreakdown	TID	CA CB
TaskBreakdown	SEQ	CA CB
TaskBreakdown	SUTID	CA CB
TaskBreakdown	DURN	CA CB
SubTaskType	SUTID	CA CB
PMPlan	PMID	CA
PMPlan	BDEID	XB
PMPlan	IID	HG
PMSchedule	PMID	CV
PMSchedule	SEQ	CV
PMSchedule	MAID	CV
PMInterval	PMID	CV
PMInterval	SEQ	CV
PMInterval	OPID	CV

Product, Variants & Breakdown

Item & Item Structure

Product Realization

Failures
(ID, Rates, Repair)

Preventive Maintenance
(Plans, Schedule, Intervals)

Maintenance Activities

Task Package & Task

Task Breakdown w/ Subtasks

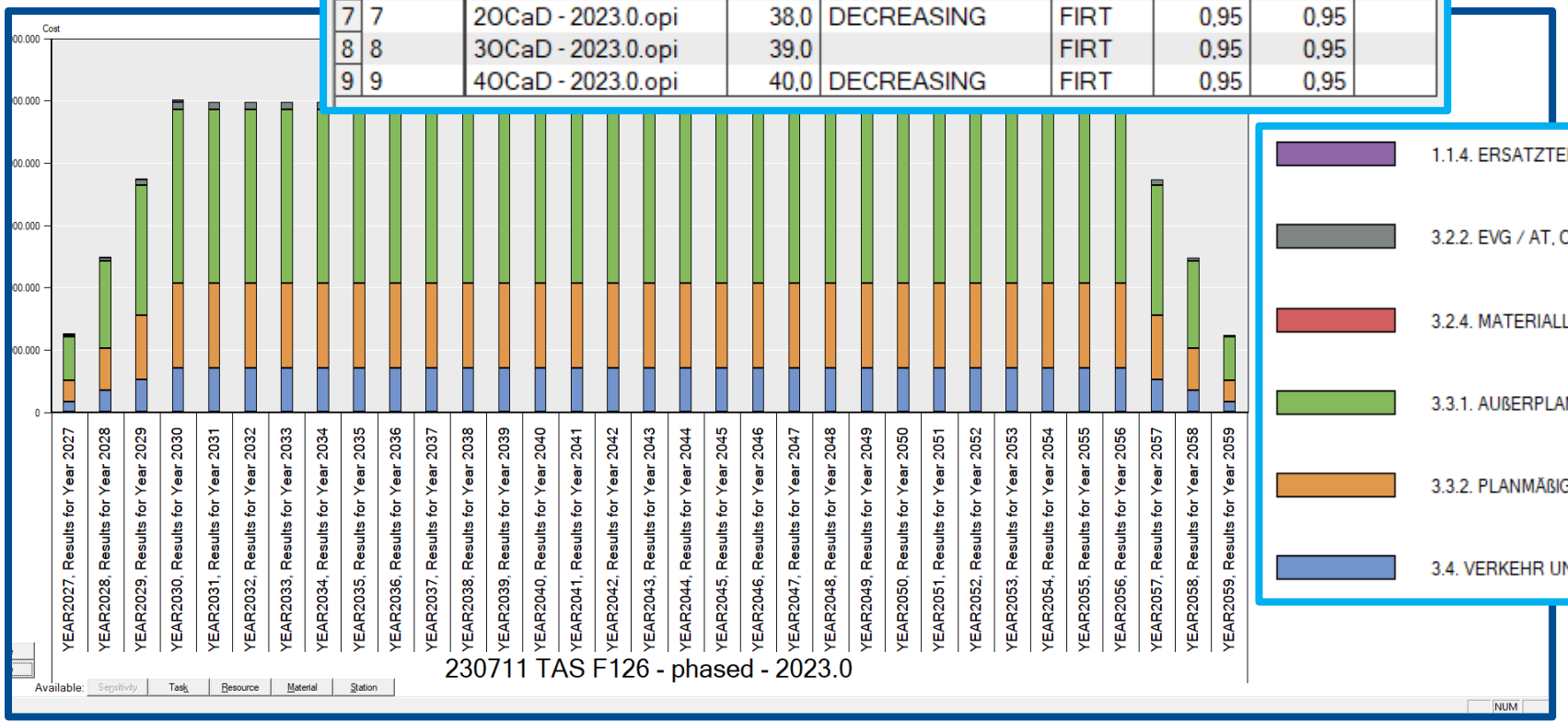
- An overall model and a phased model
  - CATLOC transfers cost to GAF cost structure
- Results contribute periodically to system design report
- 6-monthly LCC reports to contracting agency BAAINBw

Opus Suite use

Phased model ⇨ transferred to GeMoD cost structure

Phases

	PHID Phase identifier	PHFN Phase file name	PHTIM Phase start time [Years] <0,0>	PHDIR Phase spares direction <UNRESTRICTED>	PHMOE Phase MoE <A>	PHMIN Phase minimal MoE	PHMAX Phase maximal MoE	NOTE User note
1	1	Phase 0 - 2023.0.opi	0,0	INCREASING	FIRT	0,95	0,95	
2	2	FOC - 2023.0.opi	7,0	INCREASING	FIRT	0,95	0,95	
3	3	2OC - 2023.0.opi	8,0	INCREASING	FIRT	0,95	0,95	
4	4	3OC - 2023.0.opi	9,0	INCREASING	FIRT	0,95	0,95	
5	5	4OC - 2023.0.opi	10,0	INCREASING	FIRT			
6	6	FOCaD - 2023.0.opi	37,0	DECREASING	FIRT	0,95	0,95	
7	7	2OCaD - 2023.0.opi	38,0	DECREASING	FIRT	0,95	0,95	
8	8	3OCaD - 2023.0.opi	39,0		FIRT	0,95	0,95	
9	9	4OCaD - 2023.0.opi	40,0	DECREASING	FIRT	0,95	0,95	



230711 TAS F126 - phased - 2023.0

- 1.1.4. ERSATZTEILERSTBEDARF, CIID + CIIP + CIIR
- 3.2.2. EVG / AT, CNDD + CNOD + CNDP + CNOP (discardables + partially repairables: consumption + reordering costs)
- 3.2.4. MATERIALLAGERUNG, CNSD + CNSP + CNSR (discardables, partially repairables, repairables)
- 3.3.1. AUßERPLANMÄßIGE INSTANDHALTUNG, CNCP + CNCR + CNCS (repairables, partially repairables, systems)
- 3.3.2. PLANMÄßIGE INSTANDHALTUNG, CNPP + CNPR + CNPS (repairables, partially repairables, systems)
- 3.4. VERKEHR UND TRANSPORT, CNTD + CNTP + CNTR + CNTS

Contribution of LCC to System Design Proces

System Description ⇔ Model Object Identifier MOI
Subsystem is part of the F126 LCC model in OPUS10

- **LCCM contribution** = observation of anomality of the subsystem within the overall LCC model:
  - Bottlenecks (Availability ☹)
  - Large spares requirements, e.g. circulation reserve on board
  - Significantly high resource utilization, esp. Maintenance personell on board
  - Significantly high failure rates or item demand rates
  - Preventive maintenance plan that does not fit to operations profile

- **Results**
  - System adaptation
  - Support System adaptation
    - *Resources, Capabilities (→LOR(A))*
  - Maintenance adaptation
    - *PM, CM, Maintenance Level*
  - (no consequence)

Project practice

Lessons learned, achievements

Challenges & Lessons Learned

LSA/LCC timing

Data after subcontracts closed

ILS data from subcontractors run in late

LSA works start late

Availability of data for LCC modelling even later

LSA data correctness

Indenture levels MUST reflect breakdown correctly

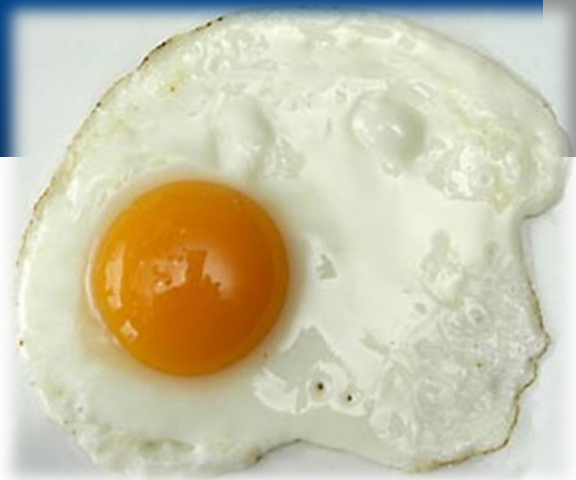
Breakdown of identical system components MUST be reflected identically

Items MUST be positioned correctly in breakdown (accumulations)

Equipment & consumables NOT to be included in breakdown

Uom (unit of measure) requires close attention (AOR, MTBF etc.)

Sunny side up!



Shipbuilding is systems integration

- Damen integrates >>100‘s of subsystems into F126 and land installations

- ILS F126 needs to handle subsystem data from >>100‘s of subsystem suppliers in LSA… processes

➢ Opus Suite Connect allows for „industrialized“ integration of subsystem models into overall ship / project LCC model (OPUS10 / CATLOC)

Thank you for your attention!