Transitioning OMG UPDM to ISO Unified Architecture Framework (UAF)

With Emphasis on Architecture Views
and on International Standardization

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INCOSE Maryland Chapter
(at JHU APL, Columbia, MD)
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Acknowledgments

- **This briefing is based on discussions held at the Object Management Group at the UPDM / UAF Group, the C4I Domain Task Force, the Government Information Sharing Task Force, the Systems Engineering Domain Special Interest Group, the Architecture Board (AB), and the AB's Liaison Subcommittee.**
- **Specific acknowledgment is given to various developers of UPDM & UAF. In chief, they are Matthew Hause of PTC, Graham Bleakley of IBM UK, Aurelijus Morkevicius of No Magic, Fatma Dandashi of MITRE Corp., and Lars-Olof Kihlström of Syntell Sweden.**
- **Walt Okon, Professor at Northern Virginia Community College, contributed as a former Systems Engineer at the DoD-CIO, Architecture and Engineering.**

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Agenda

- What was
- What is, and
- What will be
- Current status
- Conclusions
- Questions?
- Backup
  - Updated example model

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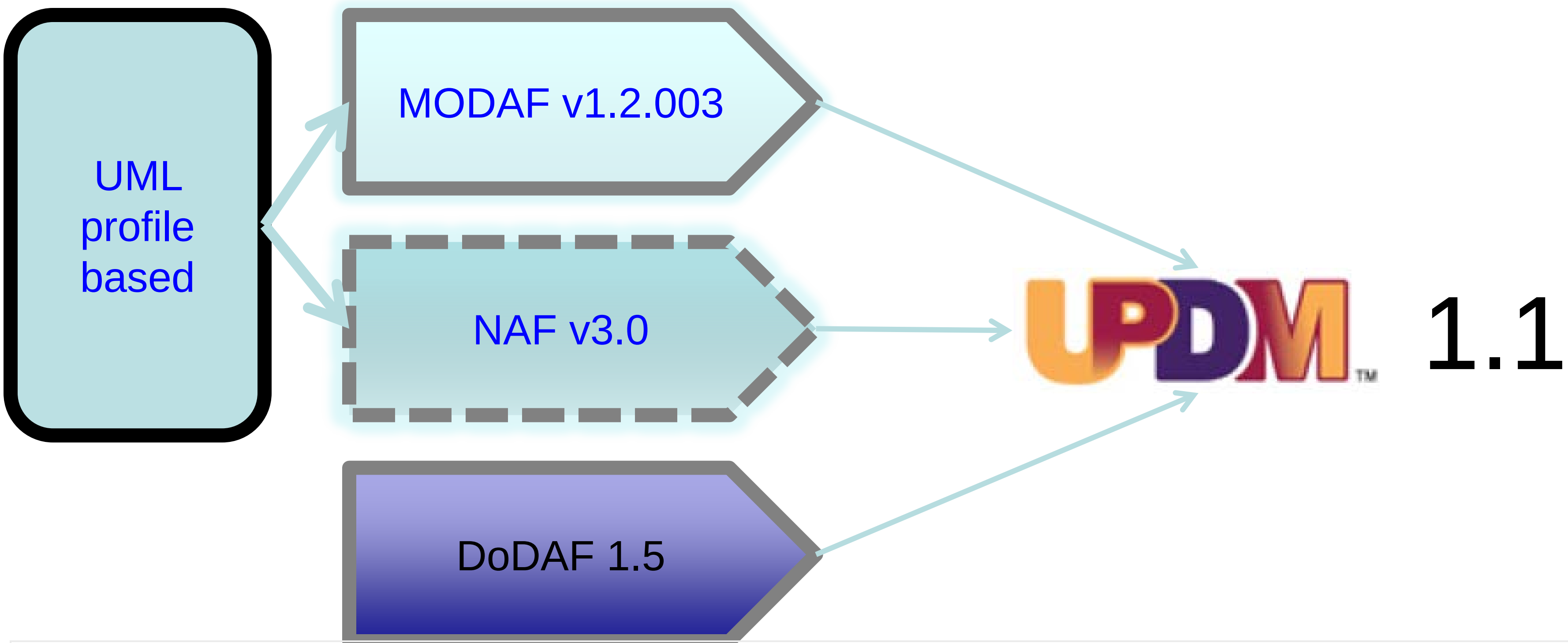
What was

UPDM version 1



- Meta model coherence
  - Same meta-model,
  - Different presentation layers
- Took an MBSE approach
- UPDM could choose between a pure UML or UML and SysML approach.
- UPDM contained both a profile and a domain meta-model

Why Model Based Systems Engineering

- **Pictures paints a thousand words**
  - Visio is good at this
  - Language is not controlled
- **Modeling languages add semantics and constraints**
  - Control what is being said and how it is said
- **MBSE is a common language of expression that captures**
  - Structure
  - Behavior
  - Requirements
    - Functional
    - Non Functional
- **Models can be quantifiable and executable**

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What is

Current UPDM V 2.1

- **UPDM is the Unified Profile for DoDAF and MODAF + NAF (starting v2)**
- UPDM is **NOT** a new Architectural Framework
- UPDM is **NOT** a methodology or a process
- UPDM is a graphical **enterprise modeling language**
- UPDM was developed by members of the OMG with help from industry and government domain experts

- DOD (US)
- MOD (UK)
- SWAF (Swedish Armed Forces)
- DND (Canada)

- MITRE
- Raytheon
- Lockheed Martin
- General Dynamics
- L3

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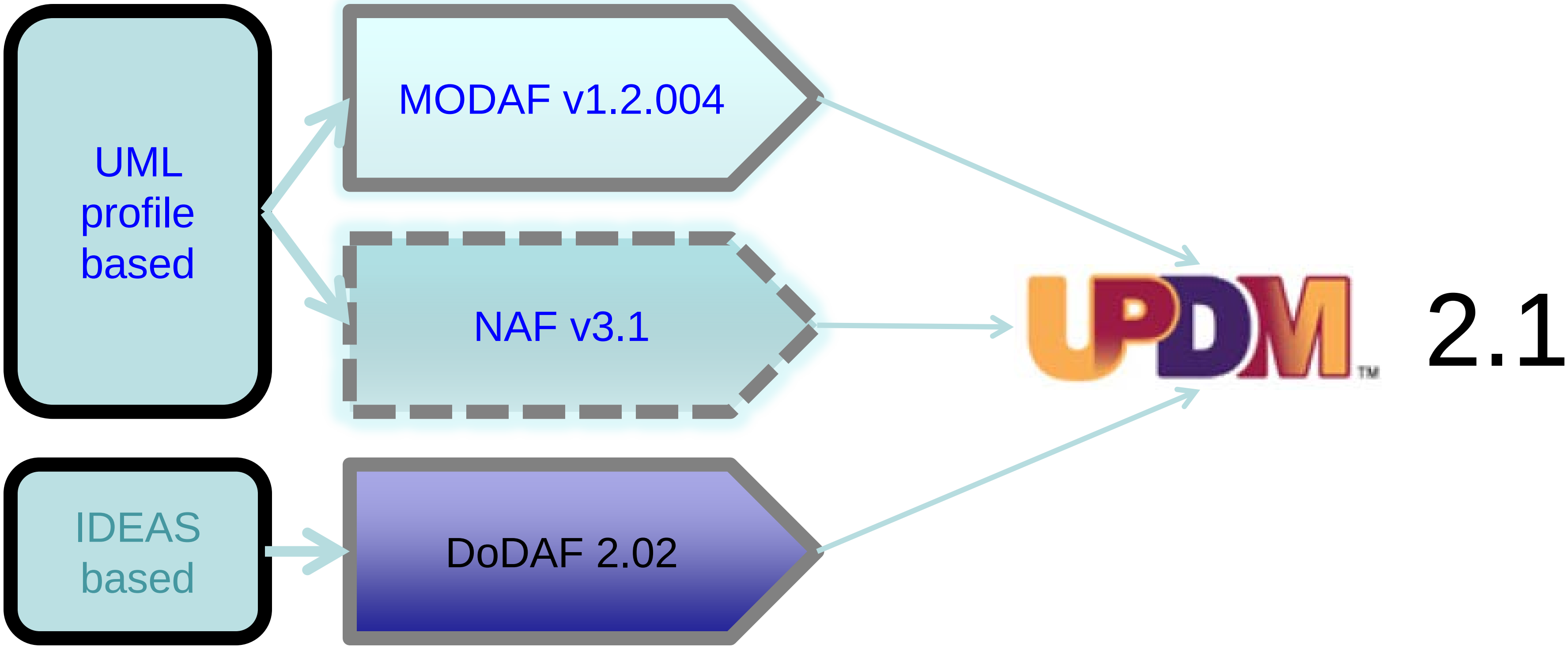
UPDM version 2 (2012-present day)



- IDEAS is a formal way for defining a metamodel
  - Allows you to reason across the information

IDEAS – International Defence Enterprise Architecture Specification
Supported by US, UK, SW, Australia, Canada

Unification with UPDM 2

- Common metamodel to build DoDAF, MODAF, and NAF models
  - Viewpoints (e.g.
    Capability (DoDAF & NAF) vs.
    Strategic (MODAF))
  - Views (e.g.
    OV-2 Operational Resource Flow Description (DoDAF) vs.
    OV-2 Operational Node Relationship Description (MODAF) vs.
    NOV-2 Operational Node Connectivity Description (NAF))
  - Concepts (e.g.
    Performer (DoDAF) vs.
    Node (MODAF & NAF))
- Infrastructure for tools to be able to provide different environments for DoDAF, MODAF, NAF – underlying metamodel is the same
  - Common Meta-model, different presentation layers
- Easy transition among DoDAF, MODAF, and NAF models

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MBSE and Engineering Analysis

Why UPDM is popular with practitioners of MBSE?

- No standardized frameworks for MBSE
- Integration with existing OMG standards, e.g. SysML
  - **Common repository (Integrated Architecture Repository)**
  - **Application of engineering analysis methods**
    - Impact Analysis
    - Coverage Analysis
    - Trade-off Analysis
    - Behavioral execution
    - Requirements compliance analysis
    - Model-based testing
  - **Interoperability**

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Adoption

- Tool Vendors: UPDM was adopted by majority of UML, SysML tool vendors.
- Defense:
  - Used by DOD and its contractors on various MBSE and IT projects
  - Being picked up outside of the US
    - Used in Europe, Australia, Asia, S. America
- Industry (external to Defense):
  - European research projects (DANSE)
  - Starting to be looked at by European industrial companies familiar with MBSE
  - Industry needs:
  - Commercialized/Industrialized whilst keeping features used by current users
  - Wider scope (SoS Lifecycle, Human System Integration, Risk etc.)

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International Standardization

- OMG UPDM 2.1 has been submitted to ISO/IEC/JTC1 as a publicly available specification.
- Without change it is now known as Draft International Standard 19513 (ISO DIS 19513)
- Majority of JTC1 National Bodies voted to accept.
- However, there were minor modifications suggested by one National Bodies.
- OMG is in process of responding.
- Still expect full International Standard (IS) by end of calendar year 2016.

What will be UPDM 3-> UAF 1.0

From the Preface of UAF

- “The scope of Unified Architecture Framework Profile (UAFP) includes the
- language extensions to enable the extraction of specified and custom models from
- an integrated architecture description (AD).
- The models describe a system from a set of stakeholders’ concerns such as security or information through a set of predefined viewpoints and associated views.
- Models can also be developed to reflect custom viewpoints or to develop more formal extensions for new viewpoints…”

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From the Preface of UAF

- The profile conforms to terms defined in the ISO/IEC/IEEE 42010 (2011) standard for architecture description,
  - where the terms: *architecture, architecture description (AD), architecture framework, architecture view, architecture viewpoint, concern, environment, model kind, stakeholder*
- UAFP builds upon the widely used Systems Modeling Language (SysML).

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UAFP Capabilities

- “UAFP v 1.0 will support the capability to:
  - model architectures for a broad range of complex systems, which may include hardware, software, data, personnel, and facility elements;
  - model consistent architectures for system-of-systems (SoS) down to lower levels of design and implementation;
  - support the analysis, specification, design, and verification of complex systems; and
  - improve the ability to exchange architecture information among related tools that are SysML based and tools that are based on other standards.“

UAFP Intended Users

- The profile enables the modeling of strategic capabilities; business/operational activities, nodes and their interfaces, measures of effectiveness; services, their interfaces, levels of agreement and measures of performance; system resources, their functions, ports, protocols, interfaces, measures of performance; security including cyber security controls; human interactions with systems to support business operations; information and data schemas; and project planning. In addition, the profile enables the modeling of related architecture concepts such as System of Systems (SoS), information exchanges

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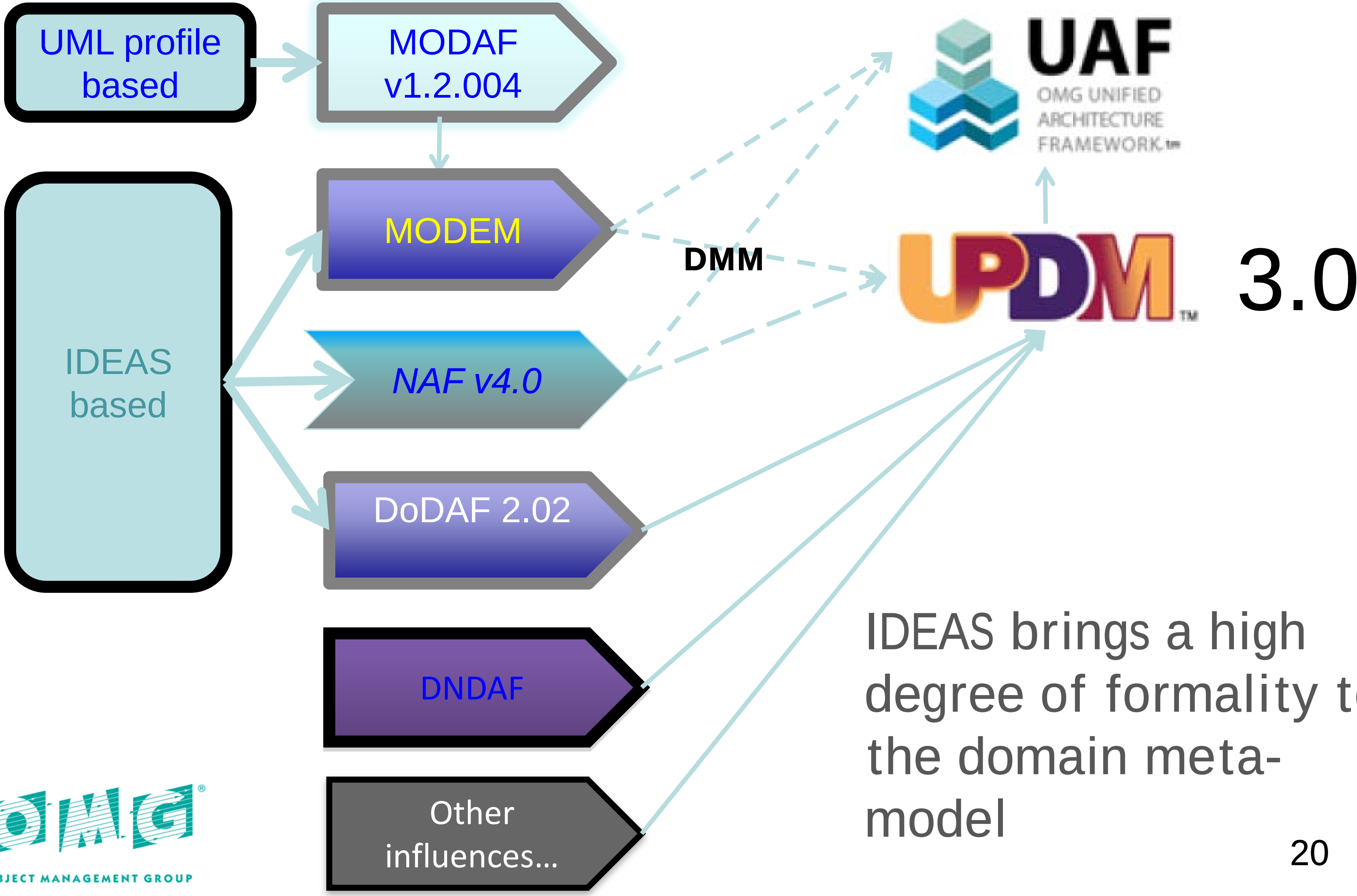
Framework developments

- UPDM RFP requirement: ” The UPDM V3.0 domain metamodel shall be derived from MODEM and DM2, both of which are based upon the International Defence Enterprise Architecture Specification Foundation [IDEAS].”
  - **Mandatory requirements (excerpt):**
    - Provide Domain Metamodel derived from MODEM and DM2 ✔
    - An Architecture Framework Profile Using SysML ✔
    - Supports BPMN 2.0 ✔
    - Use of SysML Requirements Elements and Diagrams ✔
    - Use of SysML Parametrics Elements and Diagrams Mapped to Measurements ✔
    - Traceability Matrix to Supported Frameworks ✔
  - **Non mandatory features (excerpt):**
    - UML Profile for NIEM ✔
    - Information Exchange Packaging Policy Vocabulary (IEPPV) ✔
    - Viewpoints in Support of SoS Life Cycle Processes and Analyses ✔
    - Support for Fit for Purpose Viewpoints beyond those defined in DoDAF, MODAF/ MODEM, NAF, and the Security Viewpoint from DNDAF. ✔
    - Human Systems Integration (HSI) ✔

UAF



IDEAS brings a high degree of formality to the domain meta-model

Why a Unified Architecture Framework

- Proliferation of frameworks that UPDM was being asked to support
- Need to support industry and federal usage as well as military
  - Commercialization, whilst still supporting Warfighter needs
- Ability to support other frameworks
  - By Extension
  - By Mapping
- IDEAS based format for DMM Allows implementation by non-SysML based tools
  - Same format as DoDAF 2.02

Grid Approach

				Behaviour					
	Classification	Structure	Connectivity	Processes	States	Sequences	Information	Constraints	Programme
Enterprise	E1 Capability Taxonomy NAV-2, NCV-2 AV-2, StV-2	E2 Enterprise Vision NCV-1 StV-1	E3 Capability Dependencies NCV-4 StV-4	E4 Standard Processes NCV-6 StV-6	E5 Effects		E7 Performance Parameters NCV-1 StV-1	E8 Planning Assumptions	Ep Capability Phasing NCV-3 StV-3
	E1-S1 (NSOV-3)								
Service	S1 Service Taxonomy NAV-2, NSOV-1 AV-2, SOV-1		S3 Service Interfaces NSOV-2 SOV-2	S4 Service Functions NSOV-3 SOV-5	S5 Service States NSOV-4b SOV-4b	S6 Service Interactions NSOV-4c SOV-4c	S7 Service I/F Parameters NSOV-2 SOV-2	S8 Service Policy NSOV-4a SOV-4a	Sp Service Delivery
Logical	L1 Node Types NAV-2 AV-2	L2 Logical Scenario NOV-2 OV-2	L3 Node Interactions NOV-2, NOV-3 OV-2,OV-3	L4 Logical Activities NOV-5 OV-5	L5 Logical States NOV-6b OV-6b	L6 Logical Sequence NOV-6c OV-6c	L7 Logical Data Model NSV-11a OV-7	L8 Logical Constraints NOV-6a OV-6a	Lp Lines of Development NPV-2 AcV-2
				L4-R4 (NSV-5)					
Resources	R1 Resource Types NAV-2, NSV-9 AV-2, SV-9	R2 Resource Structure NOV-4,NSV-1 OV-4, SV-1	R3 Resource Connectivity NSV-2, NSV-6 SV-2, SV-6	R4 Resource Functions NSV-4 SV-4	R5 Resource States NSV-10b SV-10b	R6 Resource Sequence NSV-10c SV-10c	R7 Physical Data Model NSV-11b SV-11	R8 Resource Constraints NSV-10a SV-10a	Rp Configuration Management NSV-8 SV-8
Deployed	D1 Master Data NAV-2 AV-2	D2 Deployed Resources NCV-5, NOV-4 StV-5, OV-4							Dp Deployment Schedule NCV-5 StV-5
Architecture	A1 Meta-Data Definitions NAV-3 AV-1/2	A2 Architecture Products	A3 Architecture Correspondance ISO42010	A4 Methodology Used NAF Ch3	A5 Architecture Status NAV-1 AV-1	A6 Architecture Versions NAV-1 AV-1	A7 Architecture Meta-Data NAV-1/3 AV-1	A8 Standards NTV-1/2 TV-1/2	Ap Architecture Plan

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	Taxonomy Tx	Structure Sr	Connectivity Cn	Processes Pr	States St	Interaction Scenarios Is	Information If	Constraints Ct	Roadmap Rm	Traceability Tr
Metadata Md	Metadata Taxonomy Md-Tx	Architecture Viewpoints [a] Md-Sr	Metadata Connectivity Md-Cn	Metadata Processes [a] Md-Pr	-	-		Metadata Constraints [a] Md-Ct		Metadata Traceability Md-Tr
Strategic St	Strategic Taxonomy St-Tx	Strategic Structure St-Sr	Strategic Connectivity St-Cn	-	Strategic States St-St	-		Strategic Constraints St-Ct	Strategic Deployment, St-Rm Stategic Phasing St-Rm	Strategic Traceability St-Tr
Operational Op	Operational Taxonomy Op-Tx	Operational Structure Op-Sr	Operational Connectivity Op-Cn	Operational Processes Op-Pr	Operational States Op-St	Operational Interaction Scenarios Op-Is	If	Operational Constraints Op-Ct	-	-
Services Sv	Service Taxonomy Sv-Tx	Service Structure Sv-Sr	Service Connectivity Sv-Cn	Service Processes Sv-Pr	Service States Sv-St	Service Interaction Scenarios Sv-Is	Conceptual Data Model,	Service Constraints Sv-Ct	Service Roadmap Sv-Rm	Service Traceability St-Tr
Personnel Pr	Personnel Taxonomy Pr-Tx	Personnel Structure Pr-Sr	Personnel Connectivity Pr-Cn	Personnel Processes Pr-Pr	Personnel States Pr-St	Personnel Interaction Scenarios Pr-Is	Logical Data Model,	Competence, Drivers, Performance Pr-Ct	Personnel Availability, Personnel Evolution, Personnel Forecast Pr-Rm	Personnel Traceability Pr-Tr
Resources Rs	Resource Taxonomy Rs-Tx	Resource Structure Rs-Sr	Resource Connectivity Rs-Cn	Resource Processes Pr-Rs	Resource States Rs-St	Resource Interaction Scenarios Rs-Is		Resource Constraints Rs-Ct	Resource evolution, Resource forecast Rs-Rm	Resource Traceability Rs-Tr
Security Sc	Security Taxonomy Sc-Tx	Security Structure Sc-Sr	Security Connectivity Sc-Cn	Security Processes Sc-Rs	-	-	Physical schema, real world results	Security Constraints Sc-Cn	-	-
Projects Pr	Project Taxonomy Pr-Tx	Project Structure Pr-Sr	Project Connectivity Pr-Cn	-	-	-		-	Project Roadmap Pr-Rm	Project Traceability Pr-Tr
Standards Sd	Standard Taxonomy Sd-Tx	Standards Structure Sd-Sr	-	-	-	-		-	Standards Roadmap Sr-Rm	Standards Traceability Sr-Tr
Actuals Resources Ar	Actual Resources Taxonomy Ar-Tx	Actual Resources Structure, Ar-Sr	Actual Resources Connectivity, Ar-Cn	Simulation [b]				Parametric Execution/Evaluation [b]	-	-
Dictionary *										
Summary & Overview										
Requirements										

a These viewpoints are not defined as part of the UAF but are architectural artifacts that can contribute to being successful in the definition and development of an architecture

b To be able to evaluate architecture behavior and constraints (i.e. non functional requirements) it is necessary to define actual instances of the architectural elements. It is expected that the tool vendors intending to implement the UAF/P have capabilities native to their tools to enable behavioral simulation and the evaluation of measures and constraints through Parametric diagrams or a proprietary equivalent.

Technical Content

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- b To be able to evaluate architecture behavior and constraints (i.e. non functional requirements) it is necessary to define actual instances of the architectural elements.
- It is expected that the tool vendors intending to implement the UAF/P have capabilities native to their tools to enable behavioral simulation and the evaluation of measures and constraints through Parametric diagrams or a proprietary equivalent

Why the Grid ?

- **Demilitarizes UPDM**
  - Still the same underlying metamodel and view constructs that support:
    - **DoDAF**
    - **MODAF**
    - **NAF**
  - Different presentation layers
- **Very hard to manage the views with so many contributing frameworks**
  - Lead to very complex mapping tables
  - Unwieldy descriptions
- **Possible to map many other frameworks onto the MM**
  - HSI views and SoS views

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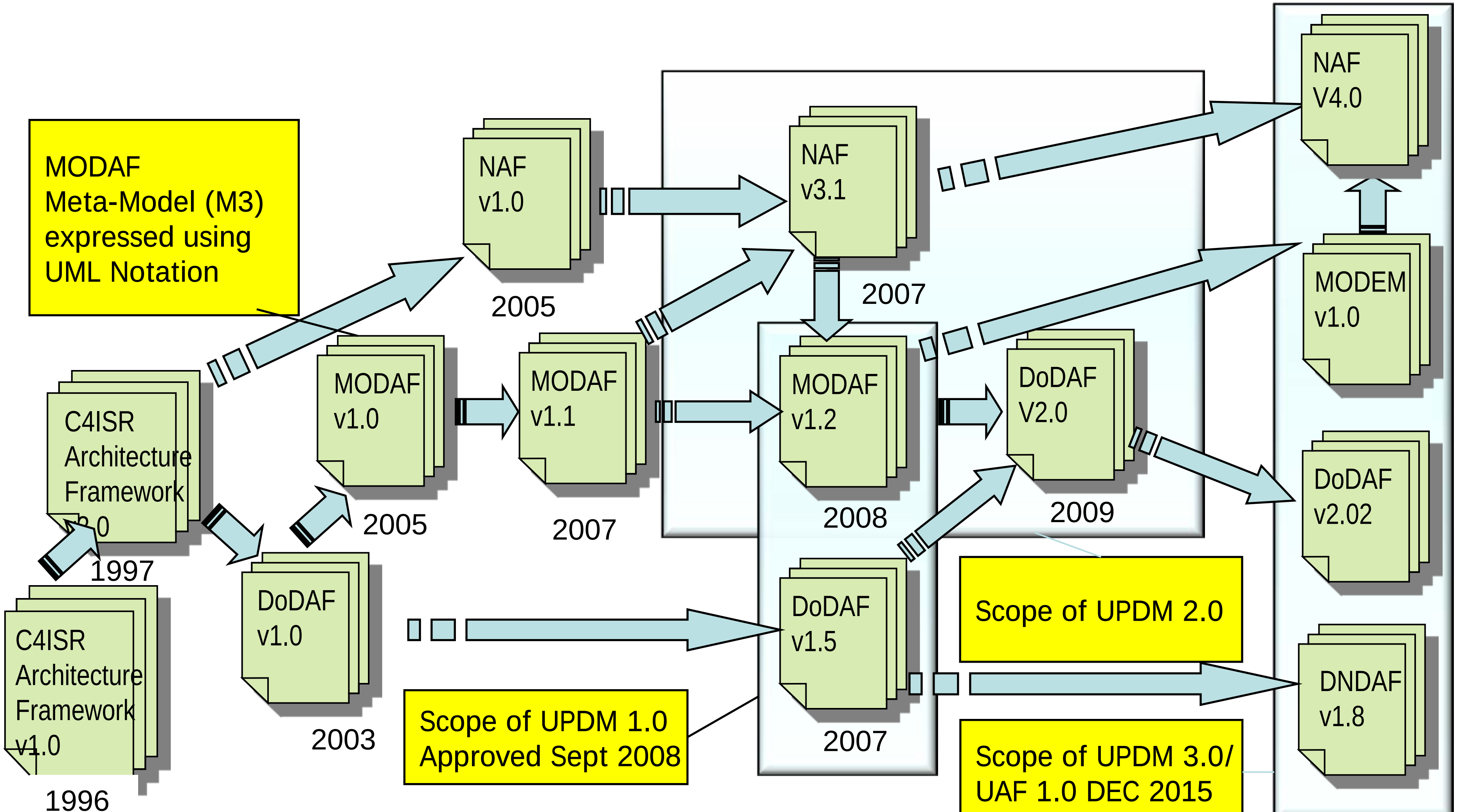
UAF Timetable



Role of the Sample Problem

1. **Show the prospective End-User of the Unified Architecture Framework Profile (UAFP) how to begin to produce an integrated Architecture Description of a relatively complex system that includes Mission (Use Case);**
2. **Address Senior Architects implementing this specification on a specific project.**
3. **Guide potential Tool Vendors toward conformance with this specification.**

Significant Changes

- Integration of parametrics to allow analysis
- Removal of UML and integration with SysML to ensure a technical engineering architecture
- Use of SysML proxy ports to define interfaces
- Integration of BPMN to provide business and technical architectures
- Support for human factors views
- Expanded example model to change configuration changes over time
- Name change to UAF to address expanded domain support
- Change from framework specific to grid names for views makes the framework independent
- IDEAS based meta-model provides an implementation-independent model
  - Can be implemented by non-UML tools

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International Standardization of UAF

- Expect OMG UAF to be publicly released by September 2017
- OMG UAF 1.0 could be submitted to ISO/IEC/JTC1 as a publicly available specification 3 months later (December 2017), or
- OMG could wait & submit UAF 1.1 to take into account feedback from vendors and users on UAF 1.0 (calendar year 2018)
- ISO UAF will probably be known as ISO 19513, as the successor to UPDM.
- Expect full International Standard (IS) during calendar year 2018.

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Conclusions

- UAF has the potential to improve communication, collaboration and interoperability between
  - Nations
  - Government and Industry
  - Industry to Industry
- Grid approach allows different industries to reuse, extend or create new views appropriate to them (Fit for purpose)
- New technologies can and will be applied to extend the use of UAF architectures to enable
  - Architecture Federation
  - Tool Federation
  - Improved interoperability
- Improving the discovery and reuse of architectural artifacts

Discussion

Questions?

BACKUP SLIDES

Backup Slides

The New Search and Rescue Model

The new SAR model

- The main purpose of the new SAR model has been to show proper use of services within the model.
- Services in UPDM 3 still acts as an isolating layer between the operational scenario (logical views) and the realization description (system view).
- They still trace to capabilities that they help to achieve.
- Operational activities that are part of nodes within the operational view can consume services.
- Nodes in the operational scenario cannot however provide them.
- System resources can implement services and can indicate that they implement the service interface that the service specification exposes.

The new SAR model

- The model contain three enterprise phases that show increasing levels of service use.

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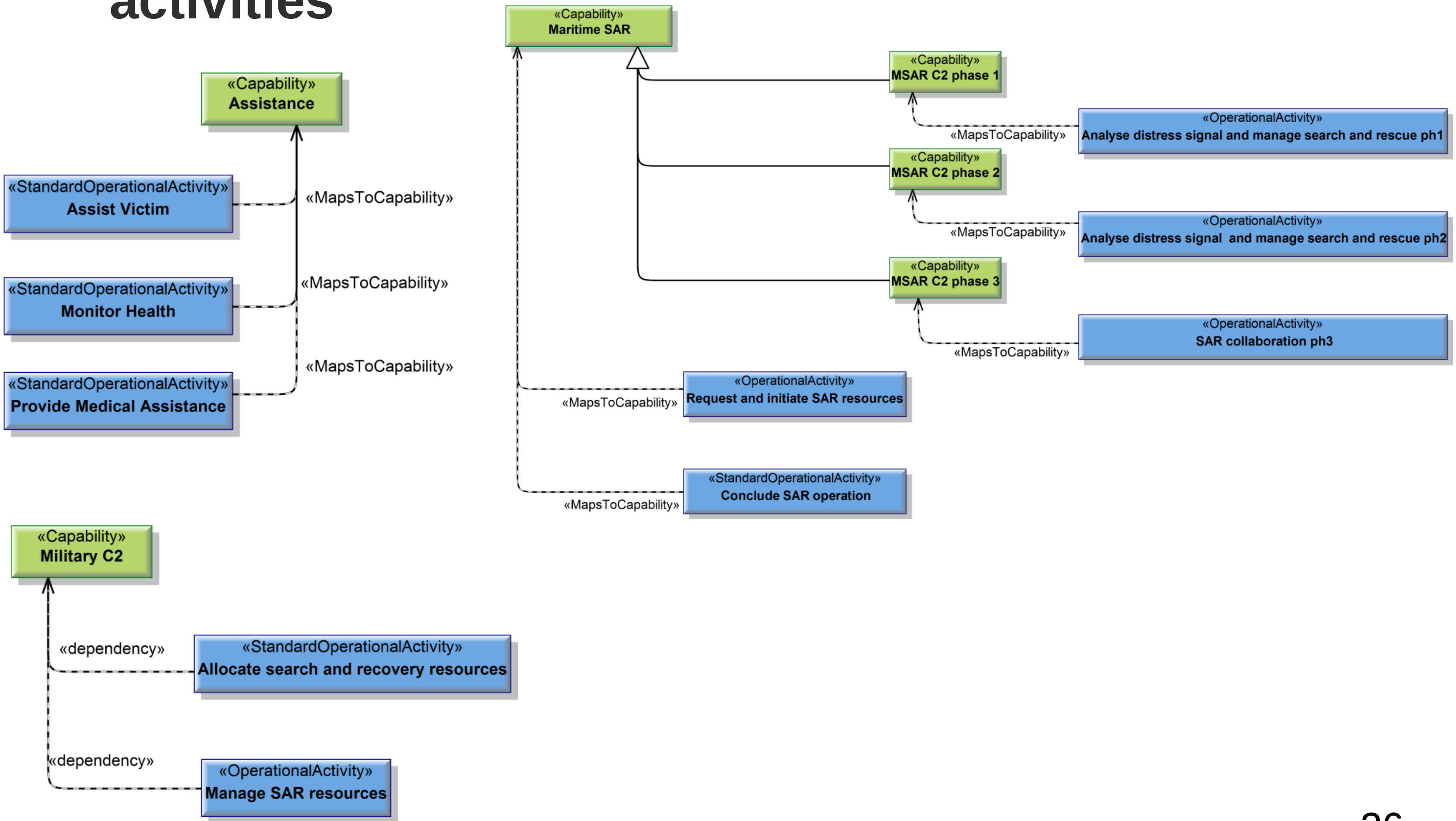
The new SAR model

- Capabilities can be mapped to operational activities



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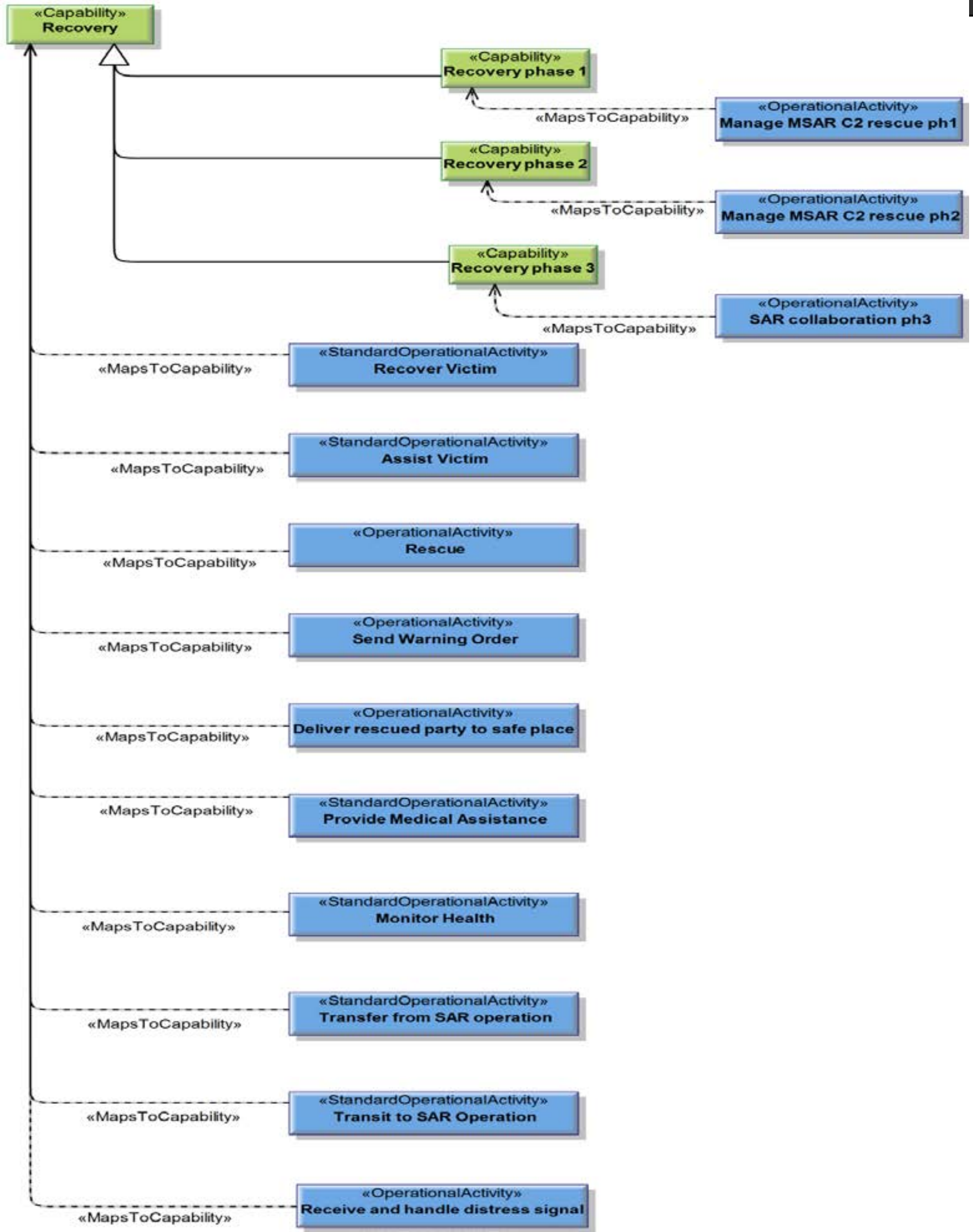
The new SAR model



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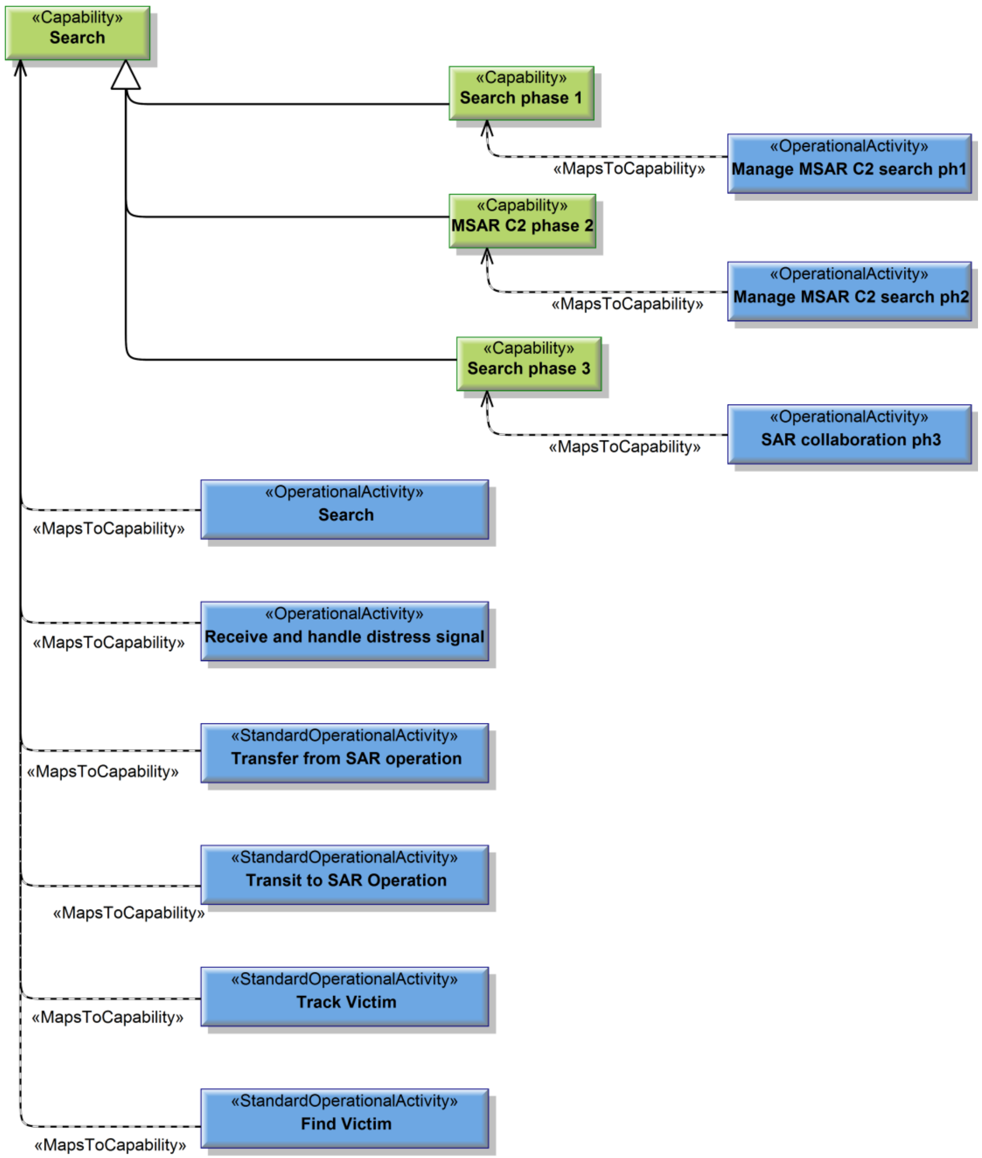
The new SAR model



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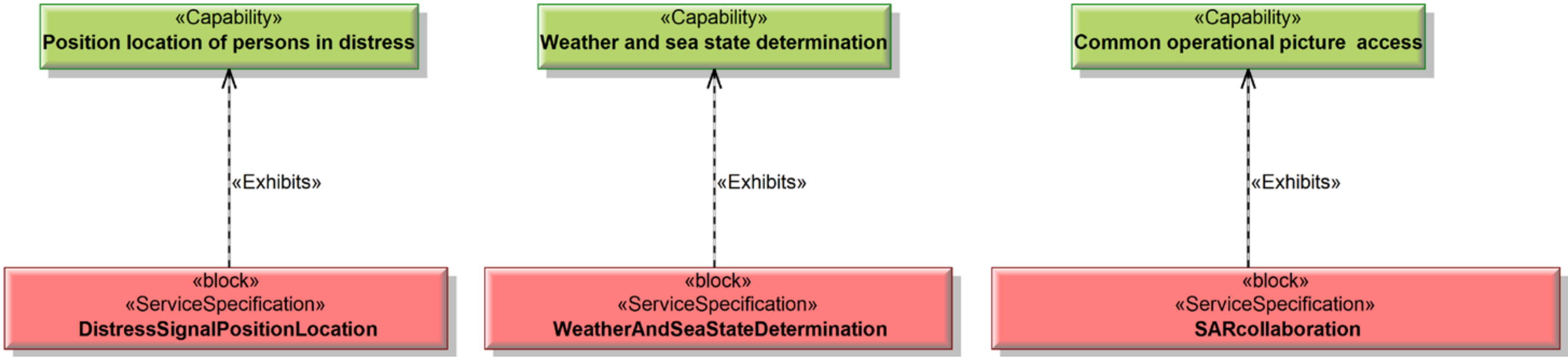
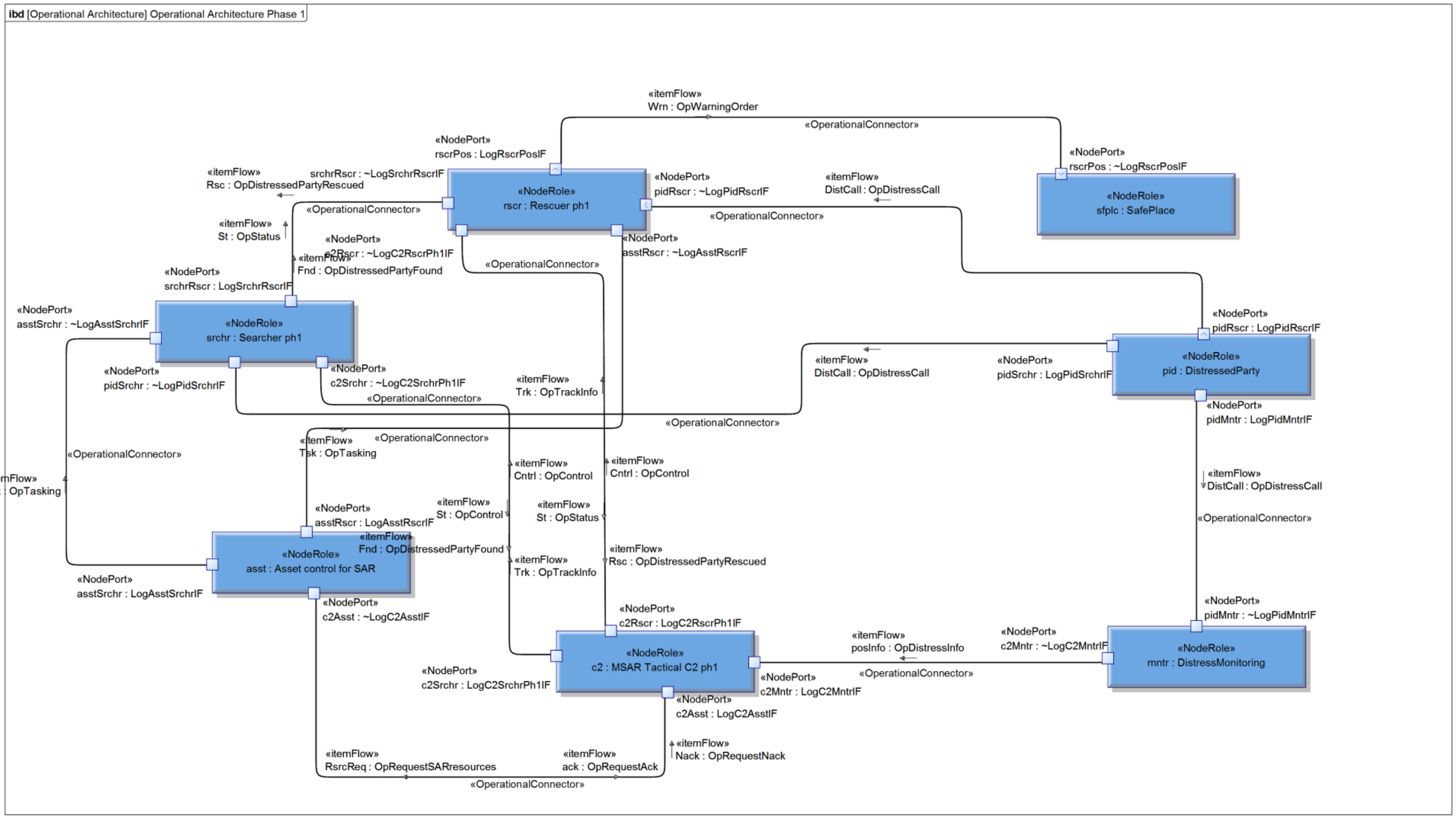
The new SAR model

- **Services can be mapped to capabilities**



The new SAR model: phase 1

- **For each of the three phases slightly different operational architectures can be defined.**



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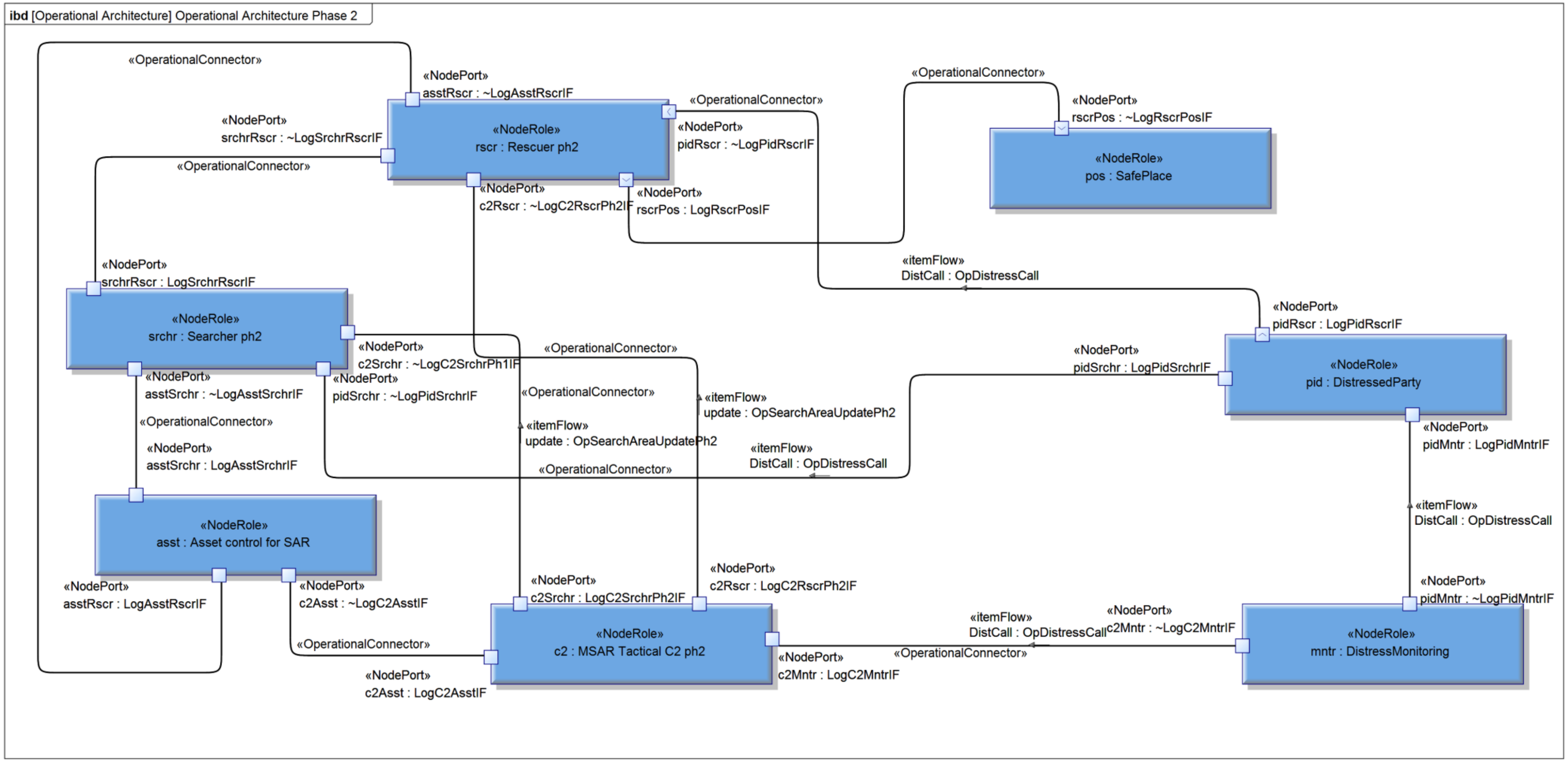
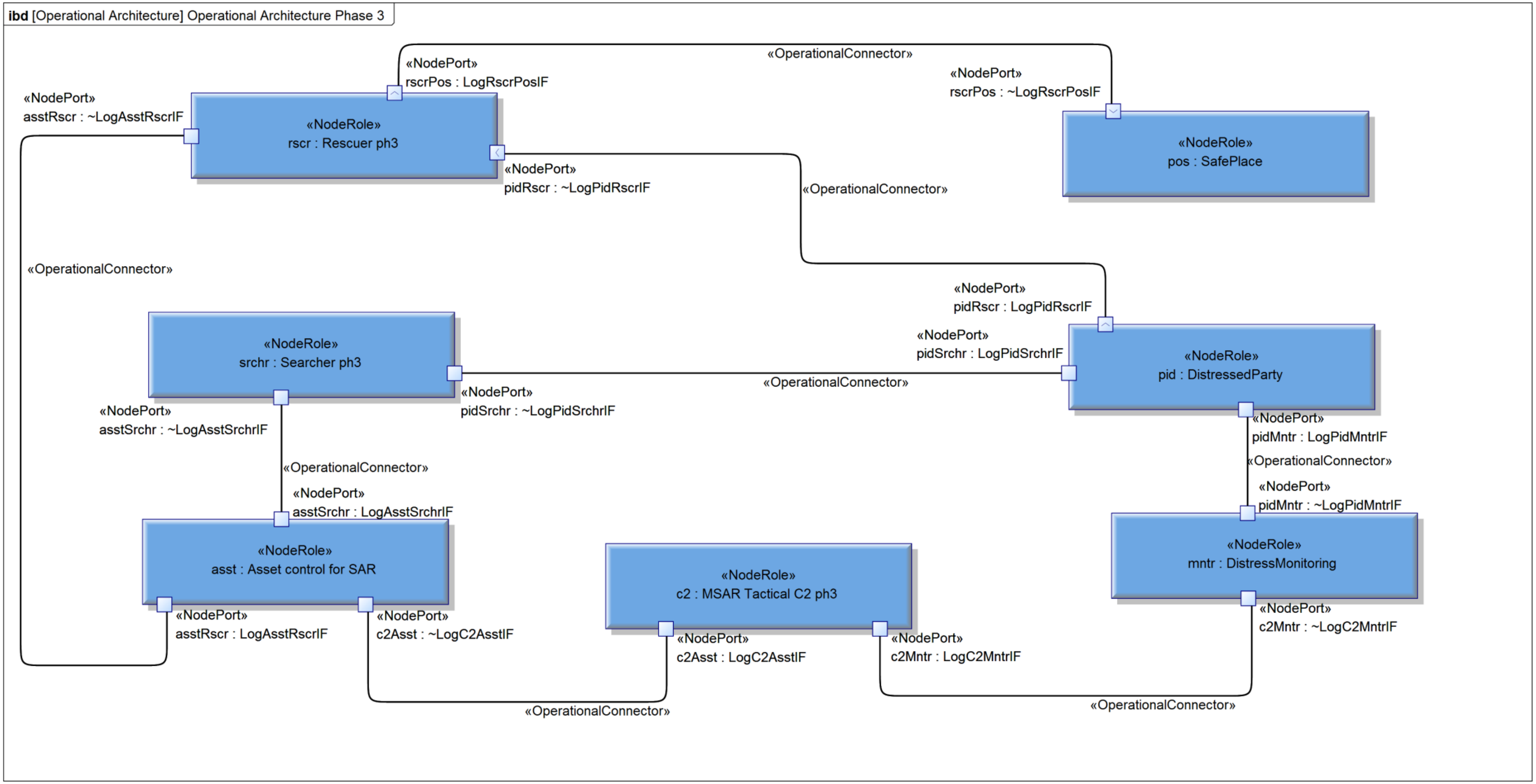
The new SAR model: phase 2



The new SAR model: Phase 3



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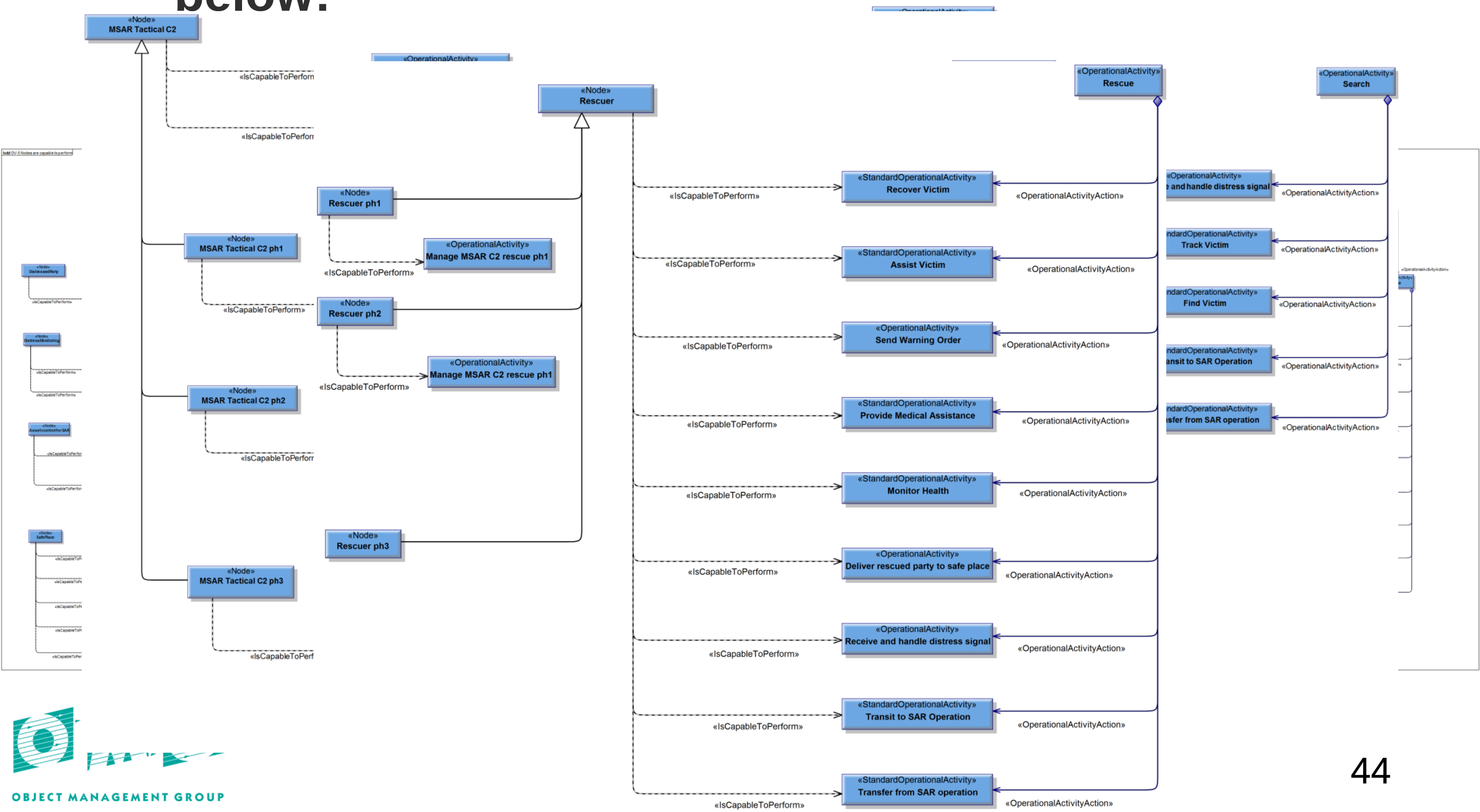
The new SAR model

- The difference between the architectures is due to the different abilities to access services.
- In phase 1 there are no services.
- In phase 2 there are two services that can be accessed from the tactical SAR centre resulting in changes to the information flow towards the search and rescue nodes.
- In phase 3 services can be accessed by the tactical centre as well as the search and rescue nodes giving an even larger change in the operational architecture.

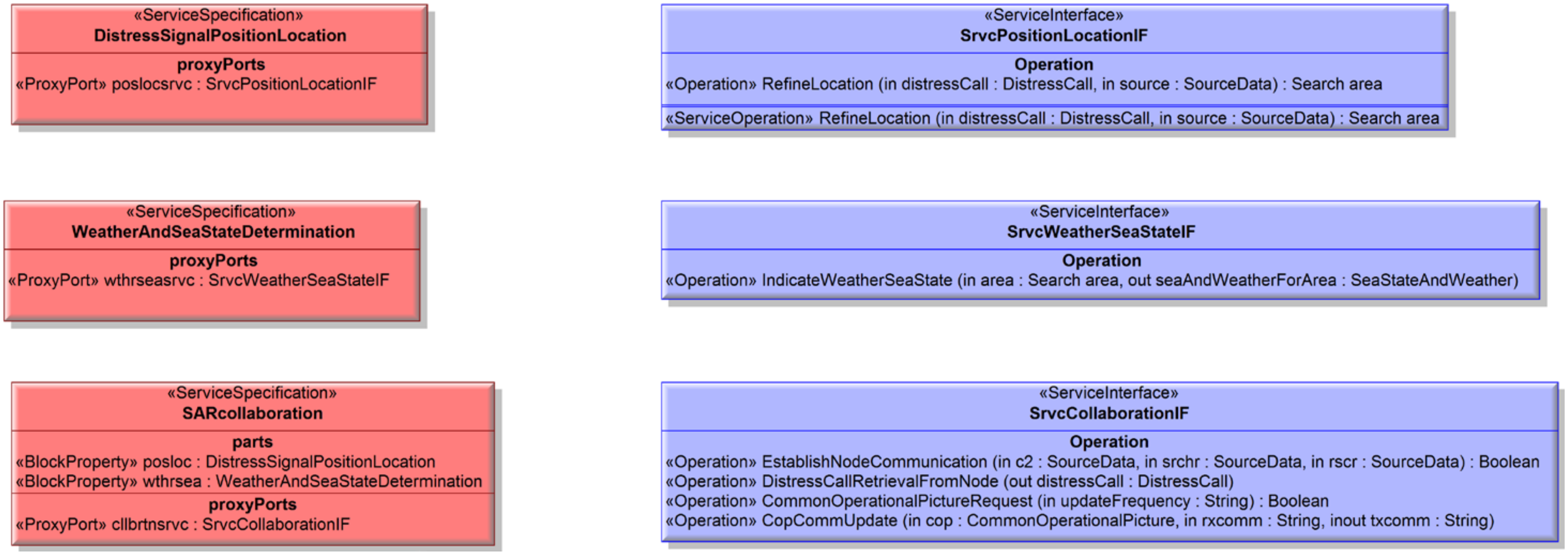
The new SAR model

- **The activities performed by each node is shown below:**



The new SAR model

- **The service specifications themselves:**



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The new SAR model

- **The two first services are available as part of phase 2.**
- **The third service is much more advanced and available from phase 3.**
- **Two of the operations defined for the third service implies the service invoking a remote operation from the consuming node.**
- **The third service makes use of the two preceding ones as internal parts from a specification point of view, i.e. the SAR collaboration service specification indicates that it will not specify the kind of handling already specified in the two previous services but references them instead. This has no implication as far as the implementation of the service is concerned.**

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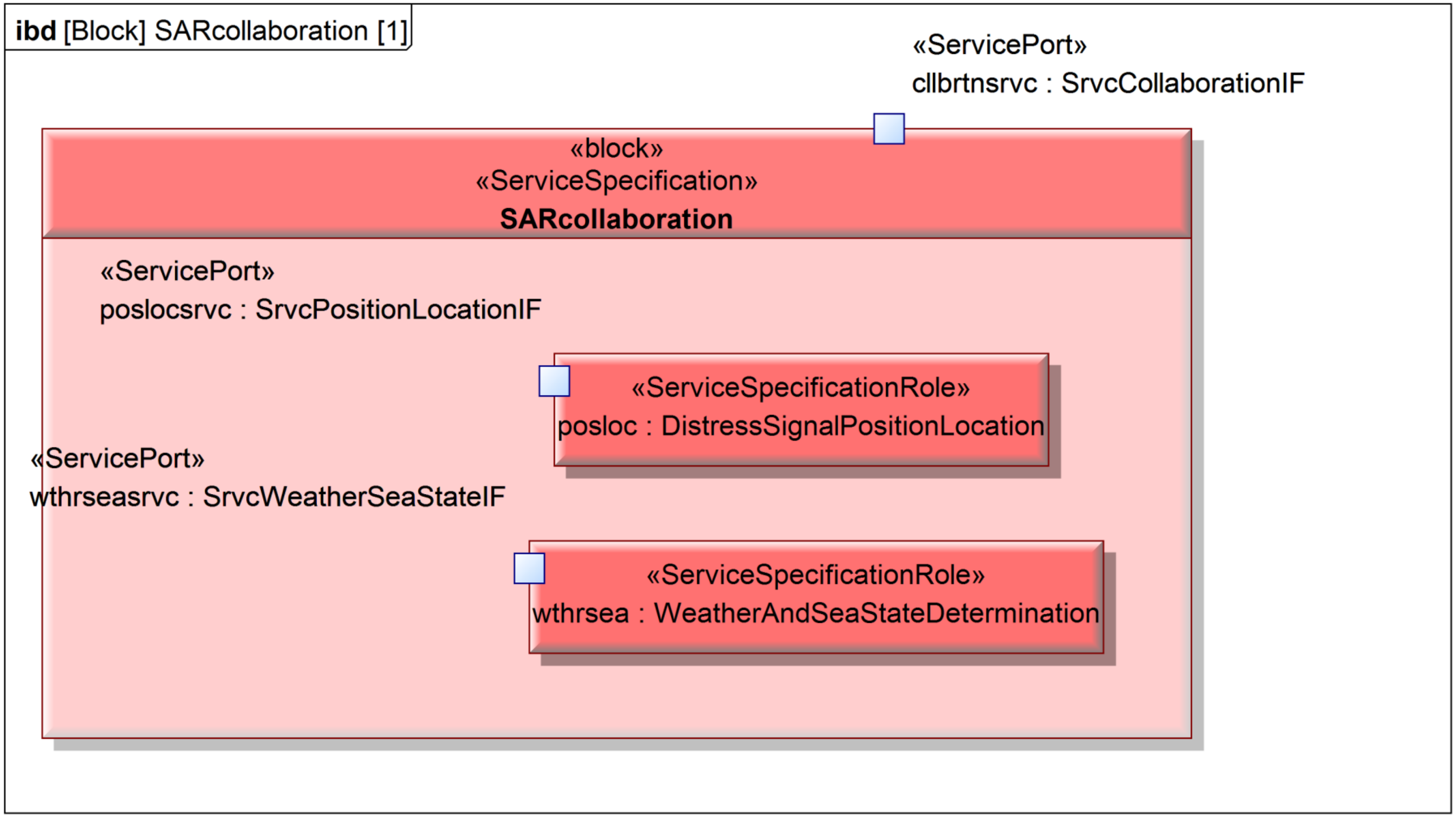
The new SAR model

- **The SAR collaboration service is shown below**



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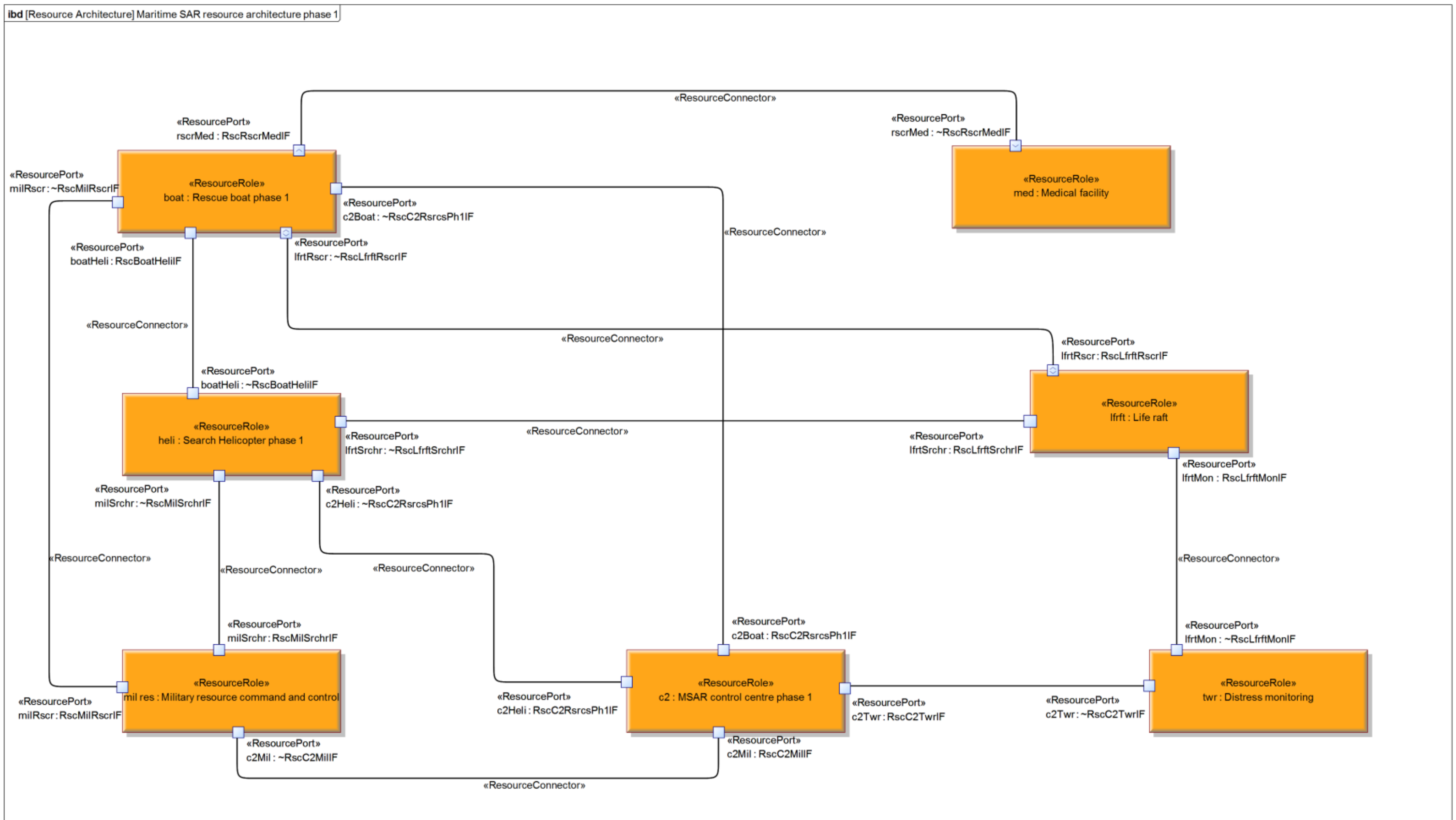
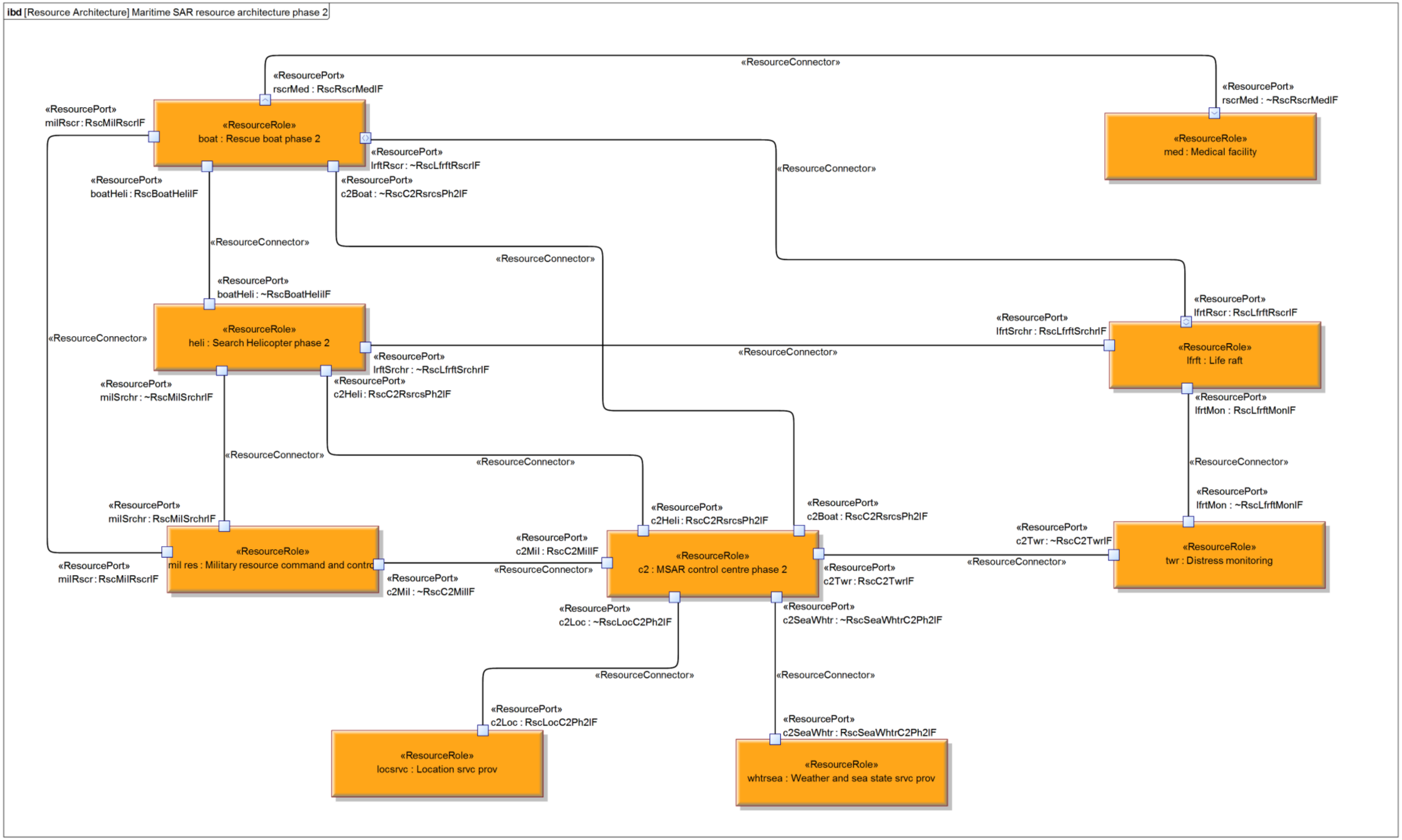
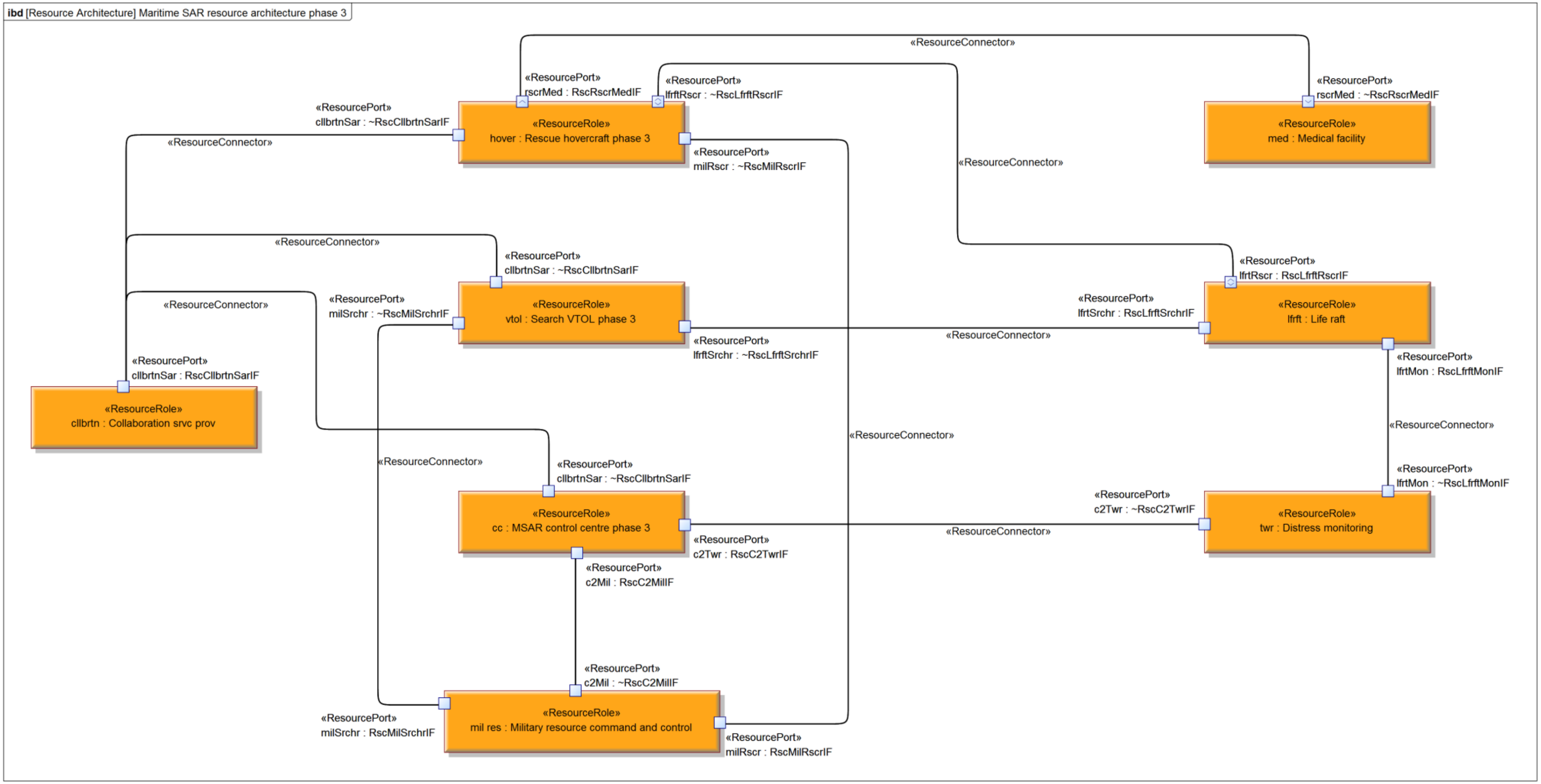
Resource architectures: Phase 1

- **Three different resource architectures result from this approach.**



Resource architecture: phase 2




ibd [Resource Architecture] Maritime SAR resource architecture phase 3
«ResourceConnector»
«ResourcePort»
rscrMed : RscRscrMedIF
«ResourcePort»
lfrftRscr : ~RscLfrftRscrIF
«ResourcePort»
rscrMed : ~RscRscrMedIF
«ResourcePort»
cllbrtnSar : ~RscCllbrtnSarIF
«ResourceRole»
hover : Rescue hovercraft phase 3
«ResourceRole»
med : Medical facility
«ResourceConnector»
«ResourcePort»
milRscr : ~RscMilRscrIF
«ResourceConnector»
«ResourceConnector»
«ResourcePort»
cllbrtnSar : ~RscCllbrtnSarIF
«ResourcePort»
lfrtRscr : RscLfrftRscrIF
«ResourceConnector»
«ResourcePort»
milSrchr : ~RscMilSrchrIF
«ResourceRole»
vtol : Search VTOL phase 3
«ResourcePort»
lfrtSrchr : RscLfrftSrchrIF
«ResourceRole»
lfrft : Life raft
«ResourceConnector»
«ResourcePort»
lfrftSrchr : ~RscLfrftSrchrIF
«ResourcePort»
lfrtMon : RscLfrftMonIF
«ResourcePort»
cllbrtnSar : RscCllbrtnSarIF
«ResourceRole»
cllbrtn : Collaboration srvc prov
«ResourceConnector»
«ResourceConnector»
«ResourceConnector»
«ResourcePort»
cllbrtnSar : ~RscCllbrtnSarIF
«ResourcePort»
lfrtMon : ~RscLfrftMonIF
«ResourcePort»
c2Twr : ~RscC2TwrIF
«ResourceRole»
cc : MSAR control centre phase 3
«ResourceConnector»
«ResourceRole»
twr : Distress monitoring
«ResourcePort»
c2Twr : RscC2TwrIF
«ResourcePort»
c2Mil : RscC2MilIF
«ResourcePort»
c2Mil : ~RscC2MilIF
«ResourceRole»
mil res : Military resource command and control
«ResourcePort»
milSrchr : RscMilSrchrIF
«ResourcePort»
milRscr : RscMilRscrIF

The new SAR model

- **In the resource architectures it is much easier to see the addition of services since the implementation resources that show the service make their appearance.**
- **The interfaces of the service specifications do not make an appearance directly in the diagrams since an implementation of a service may well require the exposure of parameters additional to the ones made visible in the specification interface, i.e. a more correct way of tracing the implies that the interfaces that deal with this are shown by means of an implementation association.**

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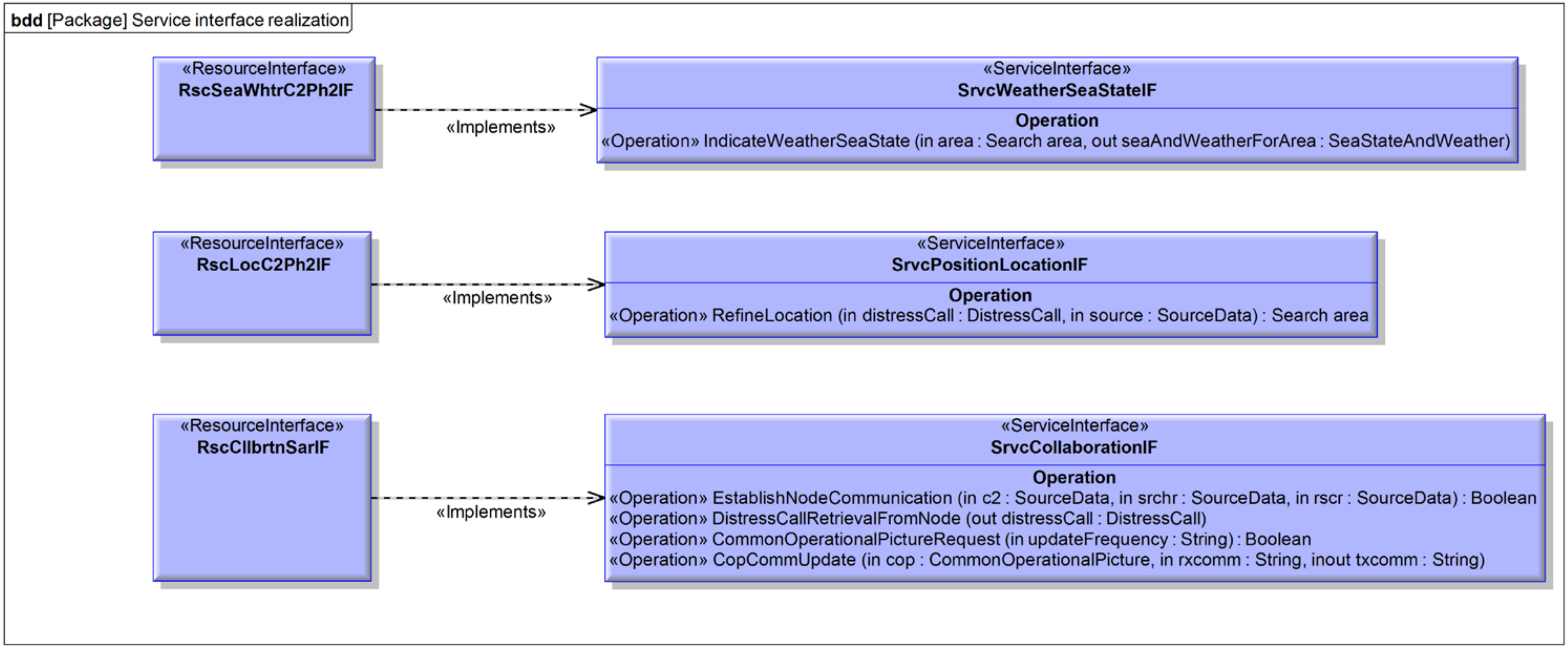
Service implementations



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The new SAR model

- The resources shown in the resource architectures can also be decomposed to indicate how different resources are used to make up the capability configuration in question.
- An example of this is shown on the next slide.

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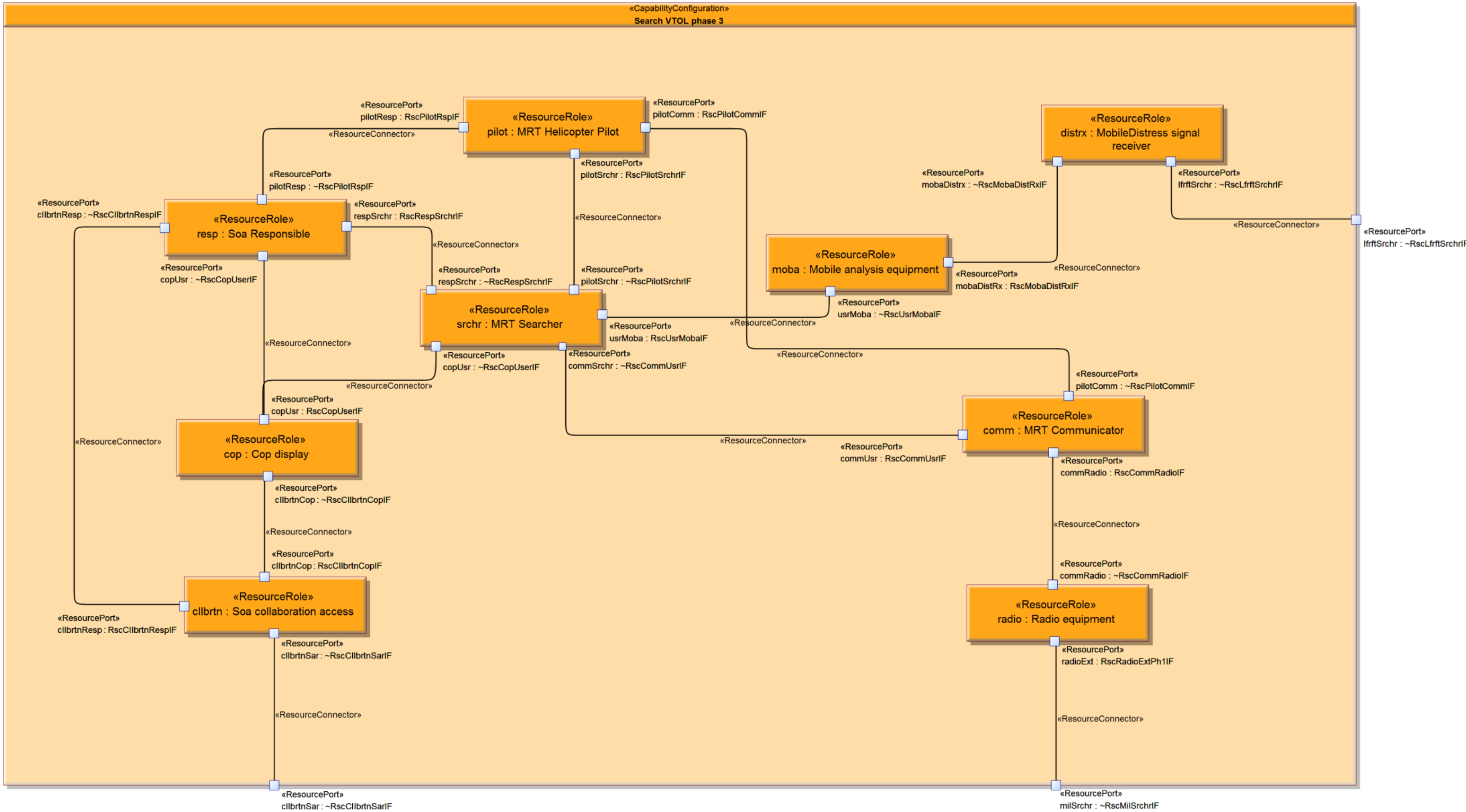
The new SAR model



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