CASNAV

CENTRO DE ANÁLISES DE SISTEMAS NAVAIS

24th ICCRTS 2019

Command and Control Interoperability Middleware Architecture

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Command and Control Interoperability Middleware Architecture

Tomás de Aquino
Manoel Pedro Sá
Anderson Ferreira

Brazilian Navy
CASNAV

Tomás de Aquino Tinoco Botelho – Col (Ret)

e-mail: *tomas.aquino@marinha.mil.br*

BtlArtFuzNav

Computer Engineer
Master Degree Systems and Computation

BtlCmdoCtFuzNav

CASNAV
INTERC2

- CASNAV Representative at the Brazilian Navy Command and Control Forum;
- CCIB – Brazilian Navy Representative (Brazil – EUA);
- IC2I – Associated Member;
- Professor of Software Engineering at Infnet College

AGENDA

Introduction

Interoperability

C2 Interoperability standards

Patterns and Technology

Interoperability among Simulators

Future Planned Interoperability

Conclusion and Opportunities of Innovation

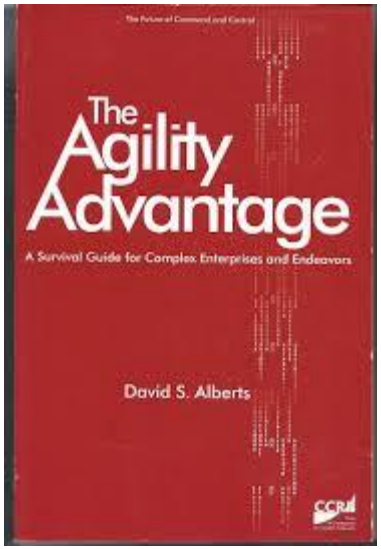
INTRODUCTION

Leading context

Agility, the basis for modern military operations, is a way of dealing with the combined effects of **complexity and uncertainty**.

Modern military operations require precise and timely information shared on a secure and need-to-know basis.

Distributed Command and Control (C2) exchanges from a Country's Forces and its Allies require interoperability among Information Systems (IS).



INTRODUCTION

The Joint Programme Interc2

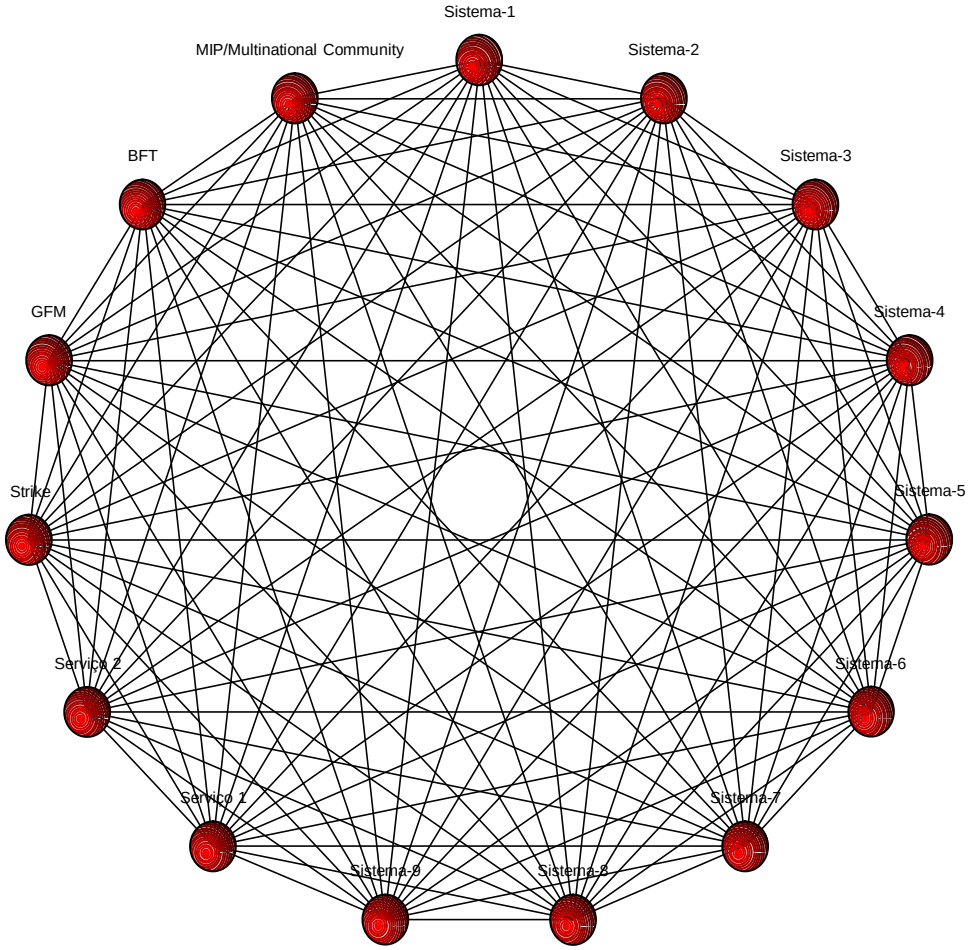
In Brazil, those concepts were met by the Command and Control Interoperability project (INTERC2).

A joint program between Brazil's Ministry of Defense (MD) and Brazilian Armed Forces to achieve C2 Interoperability among C2 Information Systems (C2IS).

MAIN REQUIREMENT

Develop and implement a Service Bus that allows interoperability between the Military Operational Planning System (SIPLOM) belonging to the Ministry of Defense and the C2 information systems belonging to the Military Forces in Joint and Combined Operations.

WITHOUT COMMUNICATION BUS



INTEROPERABILTY

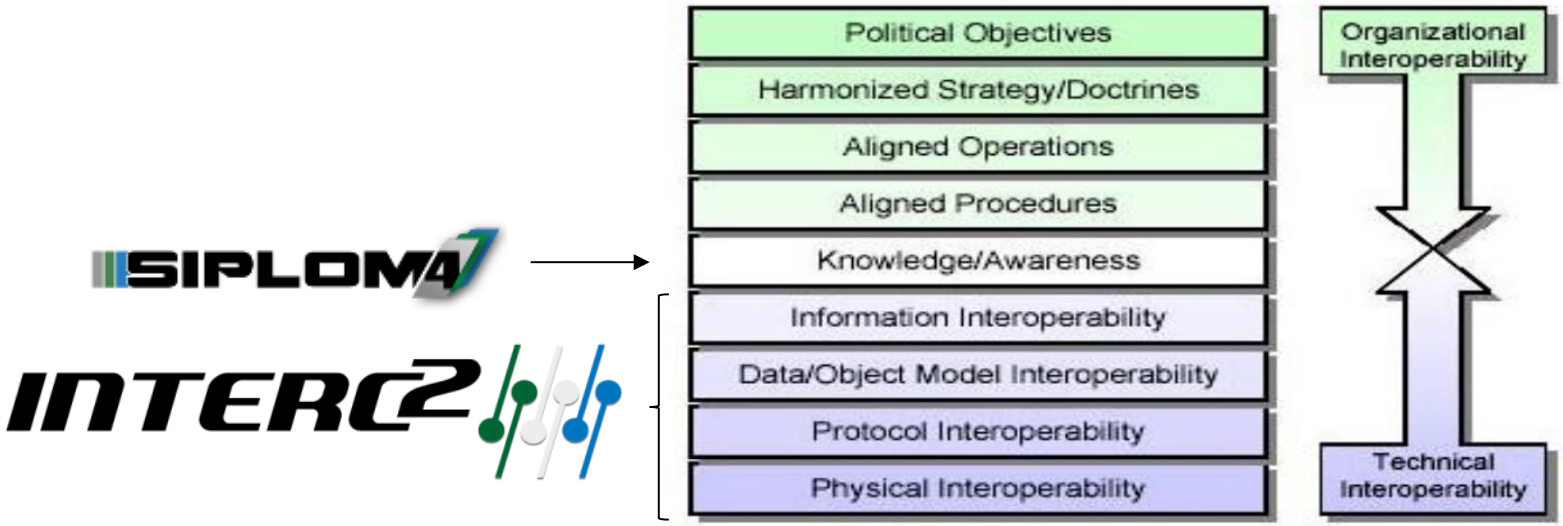
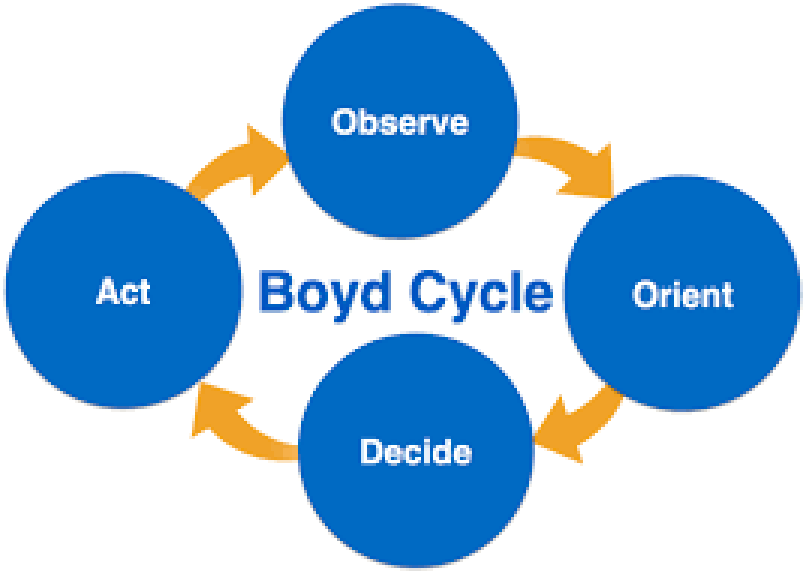


Figure 1— Levels of Organizational Interoperability

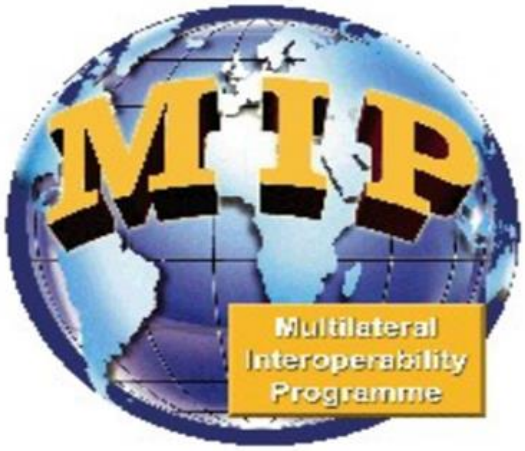
Rezaei, Reza, et al. "An Interoperability Model for Ultra Large Scale Systems." *Advances in Engineering Software*, vol. 67, 2014, pp. 22–46., doi:10.1016/j.advengsoft.2013.07.003.

MAIN GOAL

Main goal of Interc2 Project is to seek agility in order to accelerate the OODA cycle!



PATTERNS AND TECNOLOGY



ADEM

Alternate Development and Exchange Method

PATTERNS AND TECHNOLOGY

The **Multilateral Interoperability Programme (MIP)** is an effort to deliver an assured capability for interoperability of information to support multinational, combined and joint operations.

The MIP goal is to support all levels from corps to battalion. MIP's focus is on command and control systems.

MIP is a consortium of 29 NATO and Non-NATO nations that meet quarterly to define interoperability specifications for the exchange information between their national Command and Control systems.

https://public.mip-interop.org/sites/mip/Pages/Home.aspx

https://en.wikipedia.org/wiki/Multilateral_Interoperability_Programme#JC3IEDM

INTERC2

PATTERNS AND TECHNOLOGY

The **Joint Command, Control and Consultation Information Exchange Data Model** (JC3IEDM), is first and foremost an information exchange data model.

The model can also serve as a coherent basis for other information exchange mechanisms, such as message formats, currently lacking a unified information structure.

https://public.mip-interop.org/Pages/Default.aspx

PATTERNS AND TECHNOLOGY

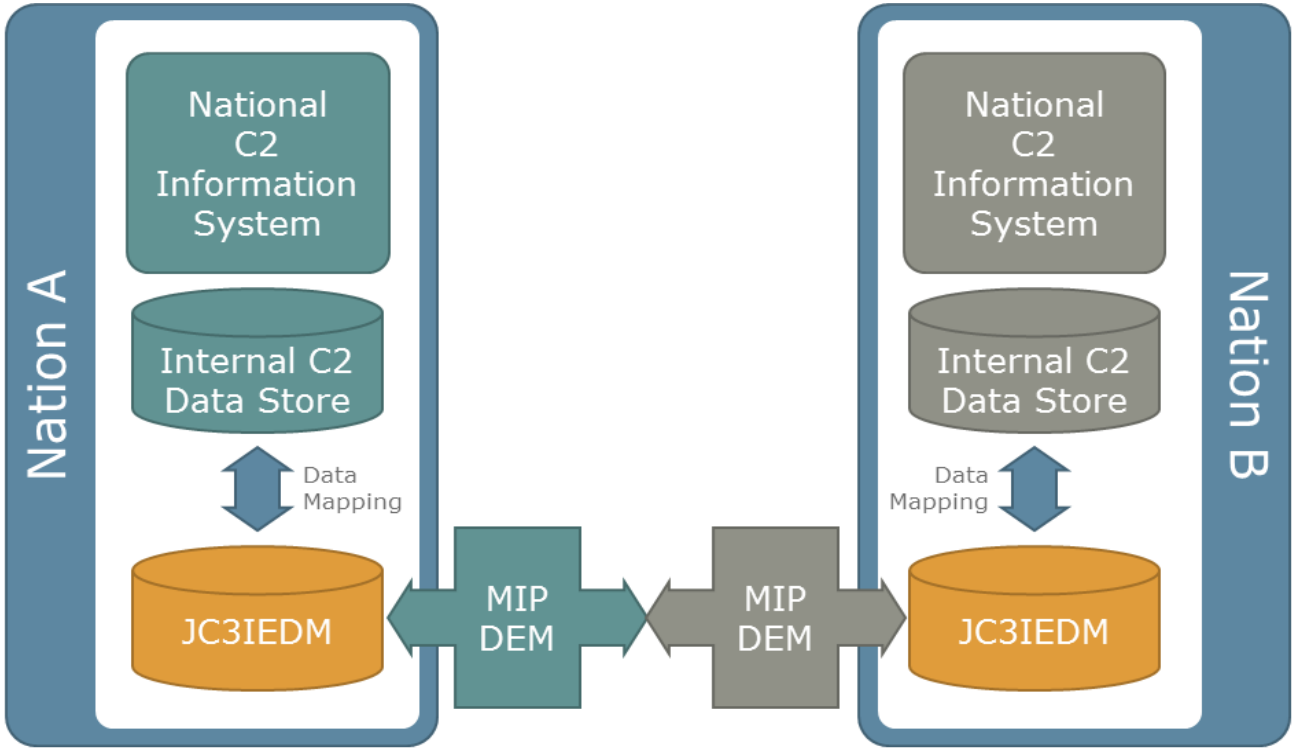
JC3IEDM is intended to represent the core of the data identified for exchange across multiple functional areas and multiple views of the requirements.

Toward that end, it lays down a common approach to describing the information to be exchanged in a command and control (C2) environment.

https://public.mip-interop.org/Pages/Default.aspx

INTEROP

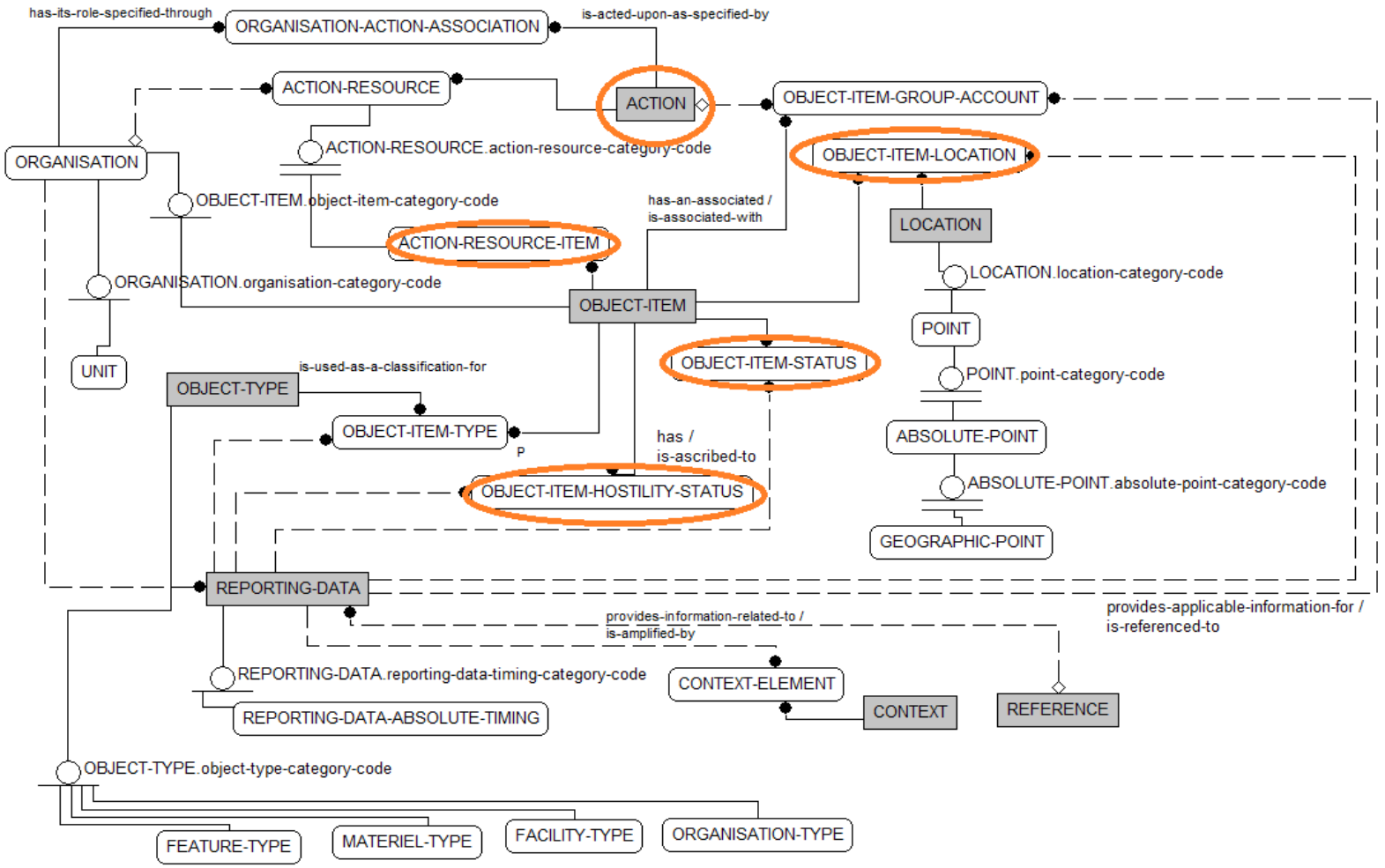
PATTERNS AND TECHNOLOGY



NATO degree 4.a interoperability
NATO level 5 interconnectivity

https://systematic.com/defence/capabilities/c2/interoperability/mip/

PATTERNS AND TECHNOLOGY



PATTERNS AND TECHNOLOGY

Alternate Development and Exchange Method

The ADEM specification provides the means to exchange the Current Situation using the semantics of the Joint Consultation, Command and Control Information Exchange Data Model (**JC3IEDM**).

ADEM enables simple and extensible information exchange using existing open standards (Web Services) while remaining faithful to the proven utility of the **JC3IEDM** information model

https://public.mip-interop.org/Public%20Document%20Library/10-Programme-Mgmt/White-Papers/20150917_ADEM%20White%20Paper.pdf

EXAMPLE MESSAGE (DATA)

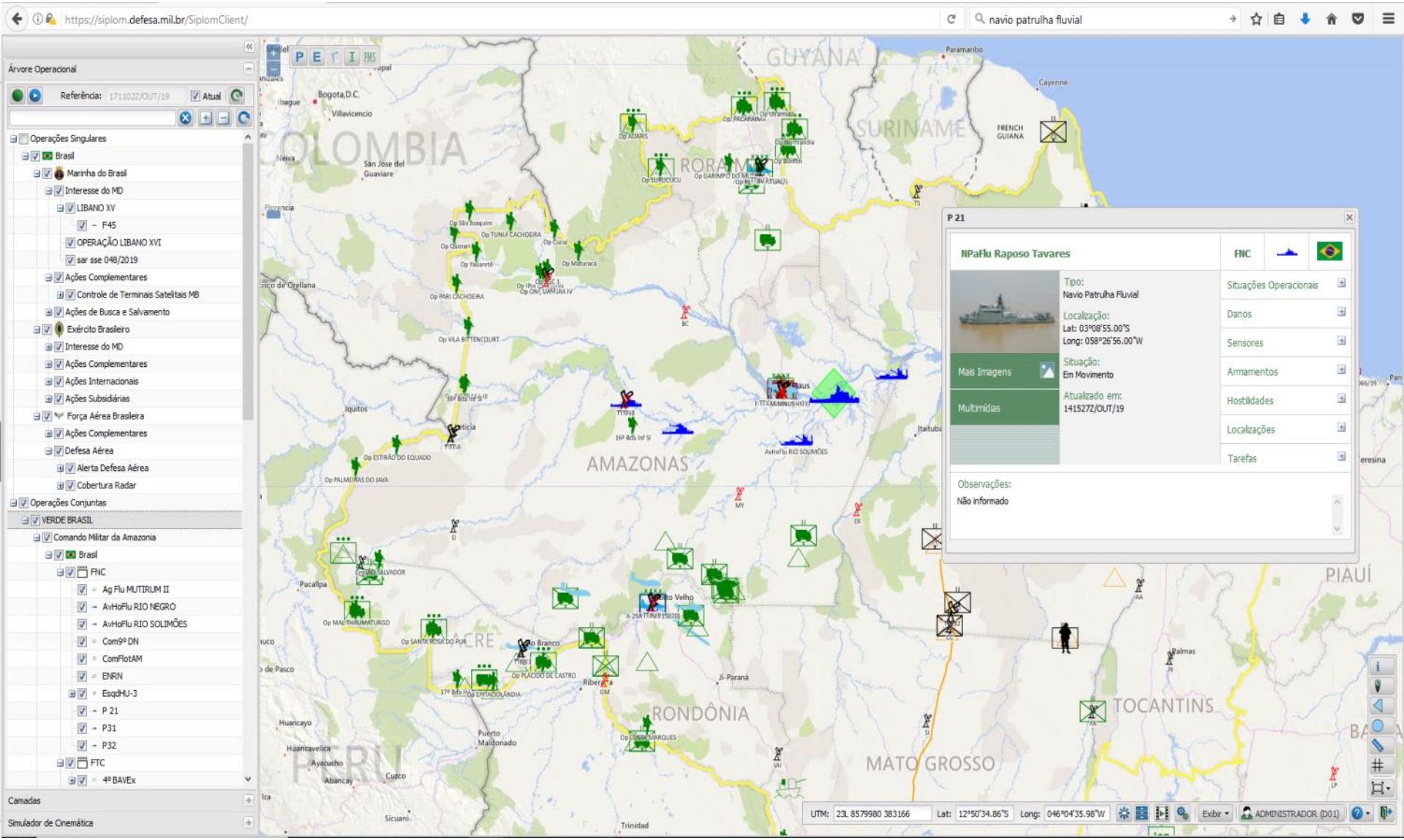
- Information source: Navy (Brazilian Navy);
- Obj. of interest kind: SurfaceVessel (Ship);
- Obj. of interest name: Fragata Defensora;
- Hostility: Friend (FR);
- Color: GREY;
- Hull Nr.: F41;
- Operacional status: OPR;
- Class: Frigate (FFL).

ADEM EXAMPLE MSG (XML)

```
<?xml version="1.0"?>
<soap:Envelope xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
  <soap:Body>
    <ns3:SurfaceVessel xmlns="http://mipinterop.org/schemas/ADEM/2014/04/11/Jc3Types.xsd"
          xmlns:ns2="http://mipinterop.org/schemas/ADEM/2014/04/11/Jc3Common.xsd"
          xmlns:ns3="http://mipinterop.org/schemas/ADEM/2014/04/11/Jc3Materiel.xsd"
          xmlns:ns4="http://mipinterop.org/schemas/ADEM/2014/04/11/Jc3Location.xsd"
          xmlns:ns5="urn:br:mil:md:sc1:interc2:types" Source="MB" uri="urn:uuid:17f2d995-fe23-
4cdb-b397-3da2daadb766">
          <ns2:CommentText>test Wed Nov 26 15:32:25 BRST 2014</ns2:CommentText>
          <ns3:NameTxt>F Defensora</ns3:NameTxt>
          <ns3:Hostility>FR</ns3:Hostility>
          <ns3:BodyColourCode>GREY</ns3:BodyColourCode>
          <ns3:OperatStatCode>OPR</ns3:OperatStatCode>
          <ns3:HullNoTxt>F41</ns3:HullNoTxt>
          <ns3:SurfVesselTypeCatCode>FFL</ns3:SurfVesselTypeCatCode>
    </ns3:SurfaceVessel>
  </soap:Body>
</soap:Envelope>
```

COMMUNICATION BUS

SIPLOM USER INTERFACE



SIPLOM RECEIVES A SURFACE VESSEL LOCATION

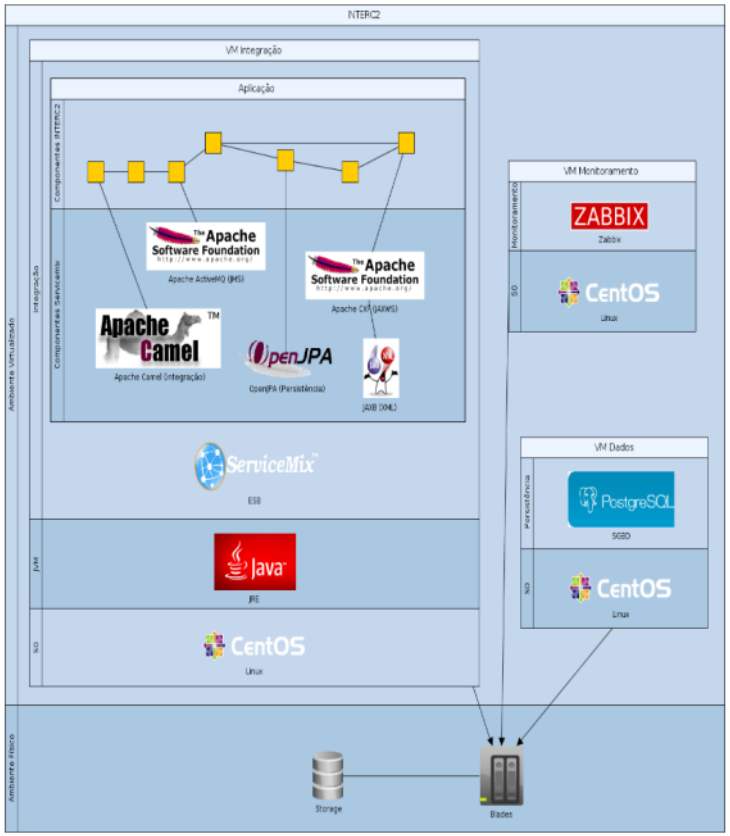
SOFTWARE TECHNOLOGY

Open source is the Motto!

In order to fulfill CB requirements without incurring major software infrastructure costs, INTERC2 team adopted:

- The Apache ServiceMix Portfolio;

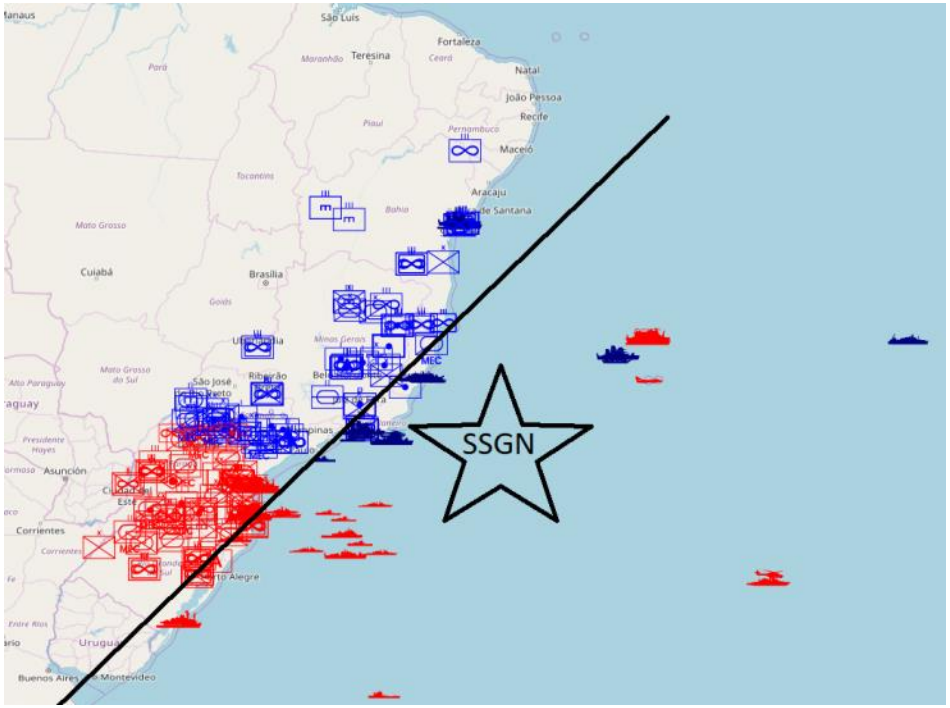
- A SOA-based open source Enterprise Service Bus (ESB) to leverage library requirements.



Software Assets in a Modular View

NAVAL WAR SIMULATION SYSTEM (SSGN)

Building on the knowledge gained in project research and development and by determination of the Deputy Chief of Command and Control, a new version of the Communication Bus has been developed to integrate military operations simulators.



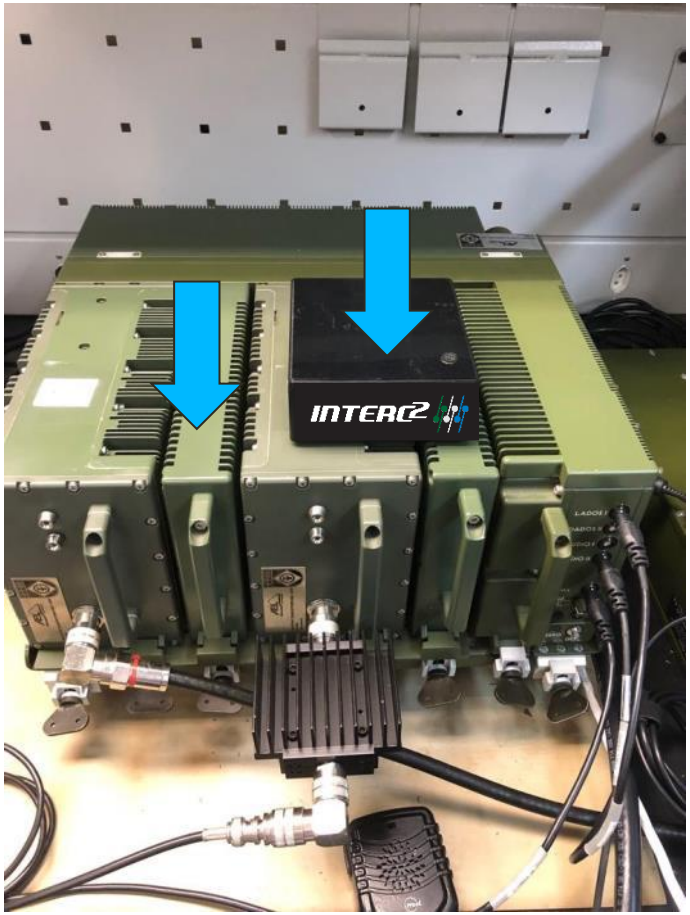
NAVAL WAR SIMULATOR SYSTEM

MD-ROD

EMBEDDED INTEROPERABILITY

(2018)

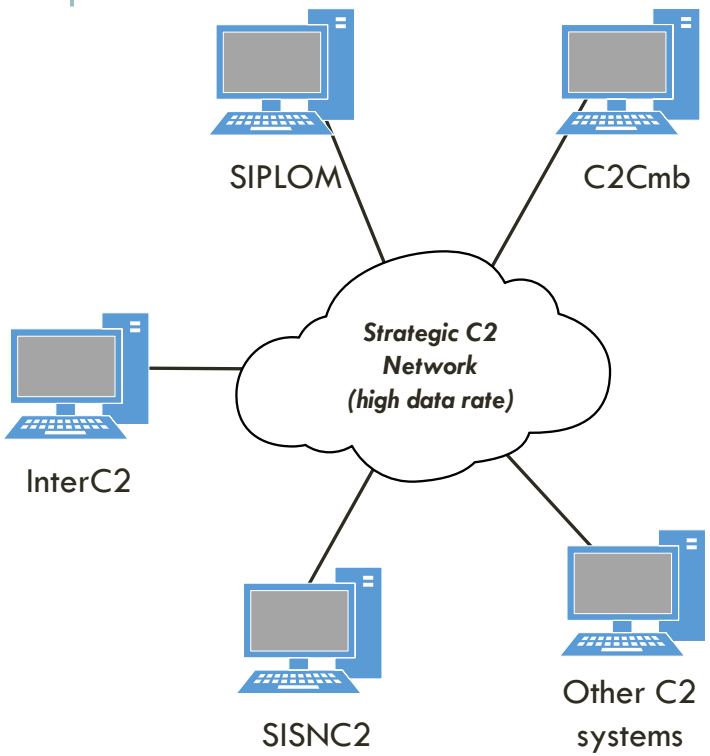
EMBEDDED INTEROPERABILITY



Building on the knowledge gained in the research and development of the project and by determination of the Deputy Chief of Command and Control, a new version is being developed to be employed at the tactical level.

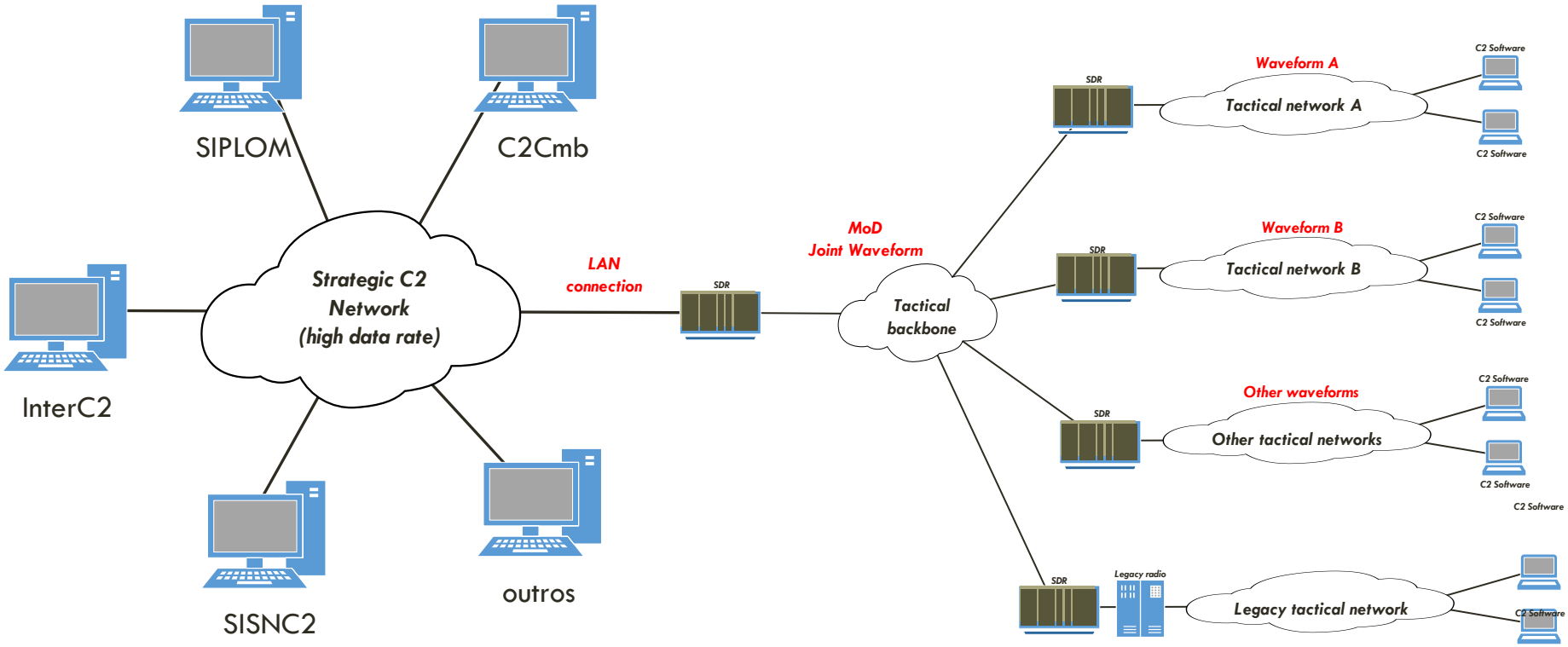
INTERC2

INTEROPERABILITY SDR – INTERC2



- Today strategic C2 Systems are accessed through high data rate networks
- SDR will connect tactical networks between themselves and to the strategic networks
  - high distance data links
  - mobile stations
  - low data rates
  - high delay
  - data loss
  - will connect different tactical networks

INTEROPERABILITY SDR – INTERC2 AND MULTIPROTOCOL DATA LINK

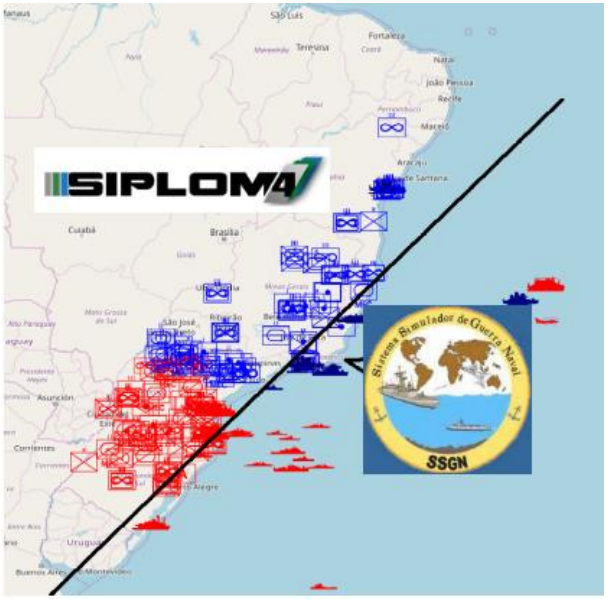


CONCLUSION AND INOVATION OPPORTUNITIES

CONCLUSION AND INOVATION OPPORTUNITIES

Mil Ops

Simulation



Tactical - SDR

INTERC2

REFERENCES

[1] "DOCTRINE OF JOINT OPERATIONS 1st VOLUME" ("DOUTRINA DE OPERAÇÕES CONJUNTAS 1º VOLUME." *Ministério da Defesa* in Portuguese). *Brazilian Ministry of Defense,* www.defesa.gov.br/arquivos/legislacao/emcfa/publicacoes/doutrina/md30_m_01_volume_1.pdf, 2011.

[6] "THE JOINT C3 INFORMATION EXCHANGE DATA MODEL JC3IEDM Main". *MULTILATERAL INTEROPERABILITY PROGRAMME*, public.mip-interop.org/Public Document Library/04-Baseline_3.1/Interface-Specification/JC3IEDM/JC3IEDM-Main-3.1.4.pdf.

[7] "Alternate Development Exchange Method (ADEM) Concept of Operations", *MULTILATERAL INTEROPERABILITY PROGRAMME*, 1 June 2019, public.mip-interop.org/Public Document Library/05-ADEM/ADEM_v1.0.8rev1.zip.

[8] "Welcome to the MIM." *Welcome - Welcome to the MIM - MIP Information Model*, www.mimworld.org/portal.

[9] "Extensible Markup Language." *Wikipedia*, Wikimedia Foundation, 31 May 2018, en.wikipedia.org/wiki/Extensible_Markup_Language.

REFERENCES

[10] "XML Schema (W3C)." *Wikipedia*, Wikimedia Foundation, 30 Apr. 2019, en.wikipedia.org/wiki/XML_Schema_(W3C).

[11] "Web Services Description Language." *Wikipedia*, Wikimedia Foundation, 15 May 2019, en.wikipedia.org/wiki/Web_Services_Description_Language.

[23] "Enterprise Runtime Everywhere." *Apache Karaf - Enterprise Runtime Everywhere*, karaf.apache.org/.

[24] "ActiveMQ." *ActiveMQ*, activemq.apache.org/.

[26] "Apache Camel: Index." *Apache Camel: Index*, camel.apache.org/.

[27] "Apache CXF" *Apache CXF*, cxf.apache.org/.

[28] "Apache OpenJPA." *Apache OpenJPA*, openjpa.apache.org/.

REFERENCES

[30] Rezaei, Reza, et al. "An Interoperability Model for Ultra Large Scale Systems." *Advances in Engineering Software*, vol. 67, 2014, pp. 22–46., doi:10.1016/j.advengsoft.2013.07.003.