

Generating Distributed Interactive Simulation (DIS) Codebases using opendis7-source-generator

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SISO Simulation Interoperability Workshop (SIW)
7 February 2022

Topics

1. Overview and Design, opensis7-source-generator Architecture
2. Codebases for opensis7-java and opensis7-python
3. Examples and Testing
4. DIS Streaming, Logging and File Encodings
5. Live Virtual Constructive (LVC) Archiving
6. Track Interoperability, C2SIM
7. Planned Future Work
8. Conclusions and Recommendations

Design principles

Open source for unrestricted use, no hidden dependencies

Specification compliance

Data definitions for repeatable autogeneration of source code

Quality Assurance (QA) through repeatable unit testing

Adopt, refine “best practices” for each programming language

Build community: public scrutiny, testing, improvements

opendis7-source-generator Architecture

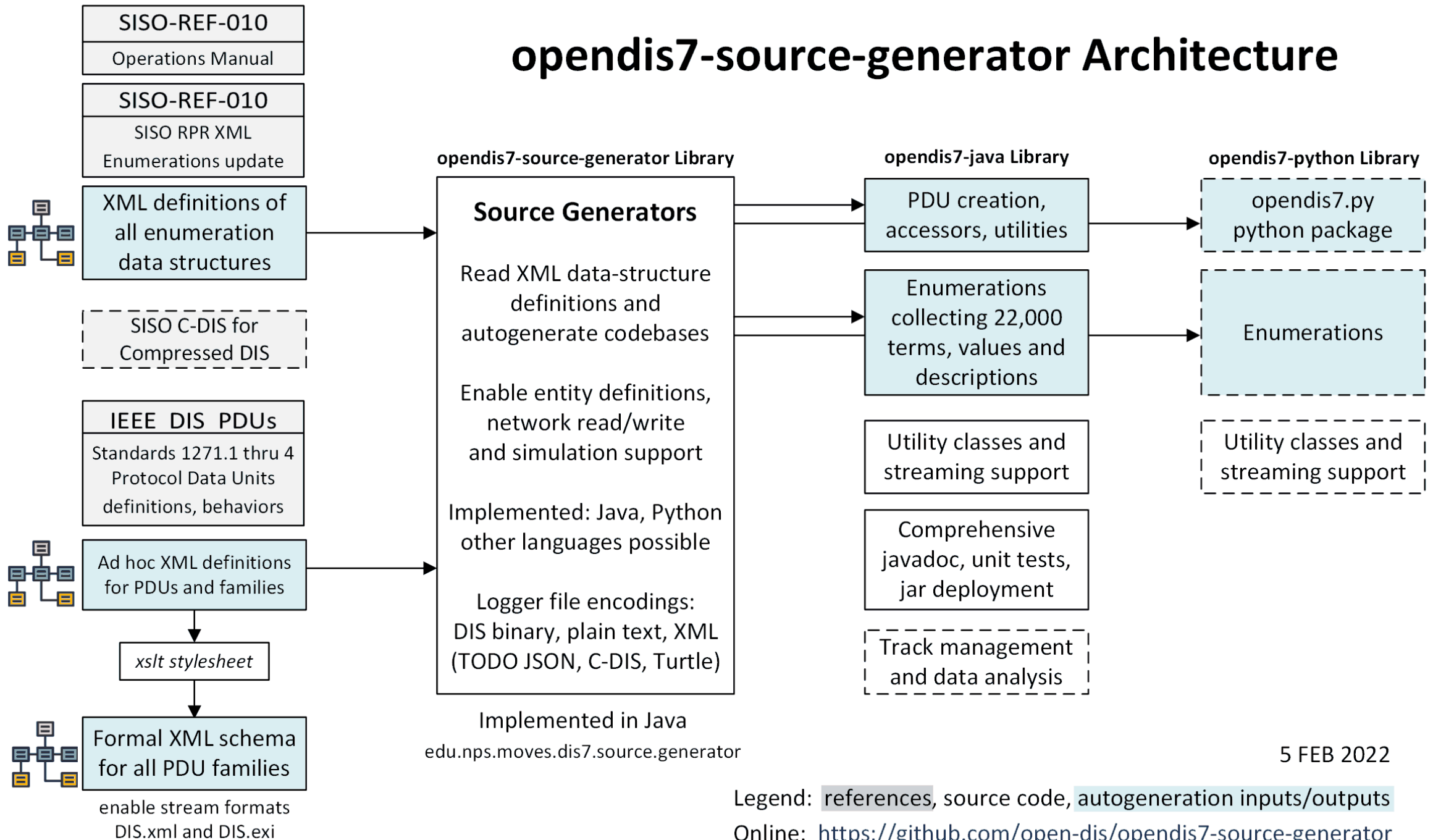
Strict adherence to publicly defined specifications

Autogeneration inputs: locally defined XML data structures for IEEE DIS Protocol Data Units (PDUs) and published XML for SISO-REF-010 Enumerations

Autogeneration of multiple production outputs

- codebases for PDU handling
- Enumeration classes for names/numbers/descriptions
- Utility classes for programmer support: networking, I/O, etc.

opendis7-source-generator Architecture



PDU definition: all about the data

Data structures for all 72 IEEE DIS PDUs defined in .xml

- Further transformed as formal XML Schema for DIS documents

Enumeration types defined by SISO in .pdf .xlsx and .xml

- Updated frequently, approved annually, working group process

Entity State PDU (ESPDU)

HDR	Proto Ver	Compat Ver	Exercise ID	PDU Type	PDU Status	HDR Len	PDU Length	
	Timestamp							
BODY	Entity ID						Sequence Number	
	Entity Type							
	Padding							
	Entity Appearance				Entity Capabilities			
	Entity Location							
	Entity Orientation							
					Force ID	DRA	Num Variable Records (N)	
Var Rec 1	Record Type = 2001 (Attached Parts Variable record)				Record Length		Padding	Num Parts
	Array of Attached Part record							
Variable Record 2	Record Type = 2010 (Dead Reckoning Variable record)				Record Length		Padding	
	Entity Linear Velocity							
	Entity Linear Acceleration							
	Entity Angular Velocity							
					Padding			
	Variable Record 3							
	...							
	Variable Record N							

Array

Array

File Edit Project XML JSON DTD/Schema Schema design XSL/XQuery Authentic DB Convert View Browser WSDL SOAP XBRL Tools Window Help

Project

open-dis7-source-generator

DIS schema

build.xml

DIS_7_2012.autogenerated.xsd

MergeOpenDisTemplatesIntoDis7S

README.md

PDU representations

DIS_7_2012.xml

DistributedEmissionsFamilyPdu.xml

EntityInformationFamilyPdu.xml

EntityManagementFamilyPdu.xml

InformationOperationsFamilyPdu.x

LiveEntityFamilyPdu.xml

LogisticsFamilyPdu.xml

MinefieldFamilyPdu.xml

RadioCommunicationsFamilyPdu.x

README.md

SimulationManagementFamilyPdu

SimulationManagementWithReliabi

SyntheticEnvironmentFamilyPdu.xr

WarfareFamilyPdu.xml

SISO REF-010 enumerations

SISO-REF-010.xml

SISO-REF-010.xsd

Info

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<class name="EntityInformationInteractionFamilyPdu" id="1" abstract="true" inheritsFrom="PduBase" comment="Section 5.3.3. Common superclass for EntityState, Collision, collision-elastic, and entity state update PDUs.">

<initialValue name="protocolFamily" value="DISProtocolFamily.ENTITY_INFORMATION_INTERACTION"/>

</class>

<class name="EntityStatePdu" id="1" inheritsFrom="EntityInformationInteractionFamilyPdu" comment="7.2.2. Represents the position and state of one entity in the world. See 5.3.2.">

<initialValue name="pduType" value="DisPduType.ENTITY_STATE"/>

<attribute name="entityID" comment="Unique ID for an entity that is tied to this state information">

<classRef name="EntityID"/>

</attribute>

<attribute name="forceId" comment="What force this entity is affiliated with, eg red, blue, neutral, etc">

<sisoenum type="ForceID" comment="uid 6"/>

</attribute>

<attribute name="numberOfVariableParameters" hidden="true" comment="How many variable parameters are in the variable length list. In earlier versions of DIS these were known as articulation parameters">

<primitive type="uint8"/>

</attribute>

<attribute name="entityType" comment="Describes the type of entity in the world">

<classRef name="EntityType"/>

</attribute>

<attribute name="alternativeEntityType">

<classRef name="EntityType"/>

</attribute>

<attribute name="entityLinearVelocity" comment="Describes the speed of the entity in the world">

<classRef name="Vector3Float"/>

</attribute>

<attribute name="entityLocation" comment="describes the location of the entity in the world">

<classRef name="Vector3Double"/>

</attribute>

<attribute name="entityOrientation" comment="describes the orientation of the entity, in euler angles with units of radians">

<classRef name="EulerAngles"/>

</attribute>

Text

NEW

Grid

Schema

WSDL

XBRL

Authentic

Browser

SISO-REF-010.xml

EntityInformationFamilyPdu.xml

DIS_7_2012.autogenerated.xsd

MergeOpenDisTemplatesIntoDis7Schema.xslt

build.xml

DIS_7_2012.xml

NPS-defined XML

data structures

for DIS

https://github.com/open-dis/opendis7-source-generator/tree/master/xml/dis_7_2012

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Project

open-dis7-source-generator

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SimulationManagementFamilyPdu.xml

SimulationManagementWithReliabilityFamilyPdu.xml

SyntheticEnvironmentFamilyPdu.xml

WarfareFamilyPdu.xml

SISO REF-010 enumerations

SISO-REF-010.xml

SISO-REF-010.xsd

Info

Enable Extended Schema Validation...

No Schema Rule files assigned

element

DIS

ann:

element

head

ann:

element

meta

ann:

complexType

rootType

ann:

comment

EntityInformationFamilyPdu.xml contains 7 classes

complexType

AttributeRecordSetType

ann:

element

AttributePdu

ann:

element

CollisionElasticPdu

ann:

element

CollisionPdu

ann:

complexType

EntityInformationInteractionFamilyPduType

ann:

element

EntityStatePdu

ann:

element

EntityStateUpdatePdu

ann:

comment

WarfareFamilyPdu.xml contains 5 classes

element

DetonationPdu

ann:

element

DirectedEnergyFirePdu

ann:

element

EntityDamageStatusPdu

ann:

element

FirePdu

ann:

complexType

WarfareFamilyPduType

ann:

comment

LogisticsFamilyPdu.xml contains 7 classes

complexType

LogisticsFamilyPduType

ann:

element

RepairCompletePdu

ann:

element

RepairResponsePdu

ann:

element

ResupplyCancelPdu

ann:

element

ResupplyOfferPdu

ann:

element

ResupplyReceivedPdu

ann:

element

ServiceRequestPdu

ann:

comment

SimulationManagementFamilyPdu.xml contains 13 classes

Attributes

Identity constraints

Name	Type	Use	Default	Fixed
protocolVersion	xs:string			
exercisID	xs:unsignedByte			
pduType	xs:string			
timestamp	xs:unsignedLong			
length	xs:unsignedShort			
protocolFamily			DISProtocolFamily.ENTITY_INFORMATION_INTERACTION	
family				EntityInformationInteractionFamilyPduType
forceld	xs:string			
numberOfVariableParameters	xs:unsignedByte			

Text

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DIS_7_2012.xml

Autogenerated XML Schema for DIS documents

https://savage.nps.edu/open-dis7-java/xml/DIS_7_2012.autogenerated.xsd

SISO-REF-010-DRAFT

**Reference for
Enumerations for Simulation
Interoperability**

Version 30

29 January 2022

SAC Approved: XX/XX/XXXX

EXCOM Approved: XX/XX/XXXX

Prepared by:

**Standards Activity Committee Special Working Group
Reference for Enumerations for Simulation
(SAC SWG Enumerations)**

SISO-REF-10.1-2019

**Reference for
Standards Activities Committee
Special Working Group
Enumerations for Simulation
Operations Manual**

Version 08

01 January 2018

SAC Approved: 04/16/2019

EXCOM Approved: 4/30/2019

Prepared by:

**Standards Activity Committee Special Working Group
Reference for Enumerations for Simulation
(SAC SWG Enumerations)**

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SyntheticEnvironmentFamilyPdus.xml

WarfareFamilyPdus.xml

SISO REF-010 enumerations

SISO-REF-010.xml

SISO-REF-010.xsd

Info

1<?xml version="1.0" encoding="utf-8"?>

2<?xml-stylesheet type="text/xsl" href="SISO-REF-010-spreadsheetml.xsl" title="SpreadsheetML" alternate="yes"?>

3<?xml-stylesheet type="text/xsl" href="SISO-REF-010-c99h.xsl" title="C99 Header" alternate="yes"?>

4<ebv xmlns="http://www.sisostds.org/schemas/SISO-REF-010/2.6" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://www.sisostds.org/schemas/SISO-REF-010/2.6 SISO-REF-010.xsd" title="SISO-REF-010-v30-DRAFT-20220129-d11" release="" date="2022-01-29" href="http://www.sisostds.org/doclib/doclib.cfm?SISO_RID_1003262" description="Enumerations for Simulation Interoperability" organisation="Simulation Interoperability Standards Organization">

5<copyright><![CDATA[

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25]]></copyright>

26<revisions uid="1" name="Revision History">...</revisions>

958<dict uid="2" name="Acronyms">...</dict>

2723<enum uid="3" name="DIS-Protocol Version" size="8">...</enum>

2740<enum uid="4" name="DIS-PDU Type" size="8">...</enum>

2832<enum uid="5" name="DIS-Protocol Family" size="8">...</enum>

2857<enum uid="6" name="Force ID" size="8">...</enum>

2890<enum uid="7" name="Entity Kind" size="8">...</enum>

2902<enum uid="8" name="Platform Domain" applicability="1,3-5,7-9" size="8">...</enum>

2910<enum uid="9" name="Platform-Land Category" applicability="1.1.X" size="8">...</enum>

3054<enum uid="10" name="Platform-Air Category" applicability="1.2.X" size="8">...</enum>

3137<enum uid="11" name="Platform-Surface Category" applicability="1.3.X" size="8">...</enum>

3224<enum uid="12" name="Platform-Subsurface Category" applicability="1.4.X" size="8">

3225<enumrow value="0" description="Other" uuid="c2eabb18-5269-11df-a1c6-080069138b88" />

3226<enumrow value="1" description="SSBN (Nuclear Ballistic Missile)" uuid="c2ebc436-5269-11df-9f4f-080069138b88" />

3227<enumrow value="2" description="SSGN (Nuclear Guided Missile)" uuid="c2ecd59c-5269-11df-a951-080069138b88" />

3228<enumrow value="3" description="SSN (Nuclear Attack - Torpedo)" uuid="c2ede806-5269-11df-91d5-080069138b88" />

3229<enumrow value="4" description="SSG (Conventional Guided Missile)" uuid="c2eef200-5269-11df-b7f8-080069138b88" />

3230<enumrow value="5" description="SS (Conventional Attack - Torpedo, Patrol)" uuid="c2f00780-5269-11df-b0b6-080069138b88" />

3231<enumrow value="6" description="SSAN (Nuclear Auxiliary)" uuid="c2f1136e-5269-11df-827f-080069138b88" />

Text NEW Grid Schema WSDL XBRL Authentic Browser

SISO-REF-010.xml EntityInformationFamilyPdus.xml DIS_7_2012.autogenerated.xsd MergeOpenDisTemplatesIntoDis7Schema.xslt build.xml DIS_7_2012.xml

5. SISO-REF-010-2020: Reference for Enumerations for Simulation Interoperability

https://www.sisostds.org/ProductsPublications/ReferenceDocuments.aspx

(scroll down to bottom of page)

Abstract. SISO-REF-010 specifies numerical values and associated definitions for fields that are identified as enumerations in SISO Standards Products and SISO-sponsored standards published by IEEE for High Level Architecture (HLA) and Distributed Interactive Simulation (DIS). Enumerations for simulations may be applied in other architectures, such as the Test and Training Enabling Architecture (TENA).

Resources include SISO-REF-010-2020 distribution, enumerations PDF and Operations Manual (OPMAN)

SISO

Simulation Interoperability Standards Organization

Simulation Interoperability & Reuse through Standards™

https://raw.githubusercontent.com/open-dis/opendis7-source-generator/master/xml/SISO/SISO-REF-010.xml

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Javadoc

[JDK 17 Javadoc Documentation](#) describes Java interfaces in detail, providing online documentation and context-sensitive help

Be sure to update or add Javadoc entries in your programs.
Having Javadoc available greatly aids understanding and will often uncover flaws that might otherwise go unnoticed.

Guidance: [How to Write Doc Comments for the Javadoc Tool](#)

open-dis7 Javadoc

🔗 The open-dis7-java🔗 library provides a complete type-safe Java implementation of both the DIS Protocol version 7 (IEEE 1278.1-2012) and SISO-REF-010 Enumerations specifications, interfaces and objects, all as open source.

- Over 22,000 SISO-REF-010 enumeration values are provided.
- edu.nps.moves.dis7.pdus package contains IEEE DIS Protocol Data Unit (PDU) packet-definition classes.
- edu.nps.moves.dis7.utilities package contains network interface and data-conversion utilities.
- edu.nps.moves.dis7.utilities.stream package contains stream utilities for DIS file saving, conversions and playback.
- Experimental DIS XML schema🔗 and documentation🔗 assist with data-centric processing of DIS streams.

Distribution binary available at open-dis7-full.jar🔗. Further examples, presentations and projects are provided in Networked Graphics MV3500🔗 course archive by the Modeling, Virtual Environments, Simulation (MOVES) Institute🔗 of the Naval Postgraduate School (NPS)🔗.



Packages	
Package	Description
edu.nps.moves.dis7.entities	The entities packages provide a large number of autogenerated utility classes for world entities of interest.
edu.nps.moves.dis7.entities.afg.lifeform.land	Afghanistan (AFG) LIFE_FORM LAND typed classes for world entities defined by SISO-REF-010-v30-DRAFT-20220129-d11 (2022-01-29) enumerations.
edu.nps.moves.dis7.entities.afg.platform.land	Afghanistan (AFG) PLATFORM LAND typed classes for world entities defined by SISO-REF-010-v30-DRAFT-20220129-d11 (2022-01-29) enumerations.
edu.nps.moves.dis7.entities.alb.platform.surface	Albania (ALB) PLATFORM SURFACE typed classes for world entities defined by SISO-REF-010-v30-DRAFT-20220129-d11 (2022-01-29) enumerations.
edu.nps.moves.dis7.entities.are.platform.air	United Arab Emirates (ARE) PLATFORM AIR typed classes for world entities defined by SISO-REF-010-v30-DRAFT-20220129-d11 (2022-01-29) enumerations.
edu.nps.moves.dis7.entities.are.platform.surface	United Arab Emirates (ARE) PLATFORM SURFACE typed classes for world entities defined by SISO-REF-010-v30-DRAFT-20220129-d11 (2022-01-29) enumerations.
edu.nps.moves.dis7.entities.arg.munition.antiship	Argentina (ARG) MUNITION ANTI_SHIP typed classes for world entities defined by SISO-REF-010-v30-DRAFT-20220129-d11 (2022-01-29) enumerations.
edu.nps.moves.dis7.entities.arg.platform.air	Argentina (ARG) PLATFORM AIR typed classes for world entities defined by SISO-REF-010-v30-DRAFT-20220129-d11 (2022-01-29) enumerations.
edu.nps.moves.dis7.entities.arg.platform.subsurface	Argentina (ARG) PLATFORM SUBSURFACE typed classes for world entities defined by SISO-REF-010-v30-DRAFT-20220129-d11 (2022-01-29) enumerations.
edu.nps.moves.dis7.entities.arg.platform.surface	Argentina (ARG) PLATFORM SURFACE typed classes for world entities defined by SISO-REF-010-v30-DRAFT-20220129-d11 (2022-01-29) enumerations.

3108/3894MB

Projects - open-dis7, MV3500 Networ... Files x Favorites

...3d ExampleSimulationProgram.java x SimulationManager.java x build.xml [MV3500 pdu capture logs] x AllPduReceiverLog.txt x ExampleSimulationProgramLog.txt...

Source History

ExampleSimulationProgram.java

```
1  /**
2   * Copyright (c) 2008-2022, MOVES Institute, Naval Postgraduate School (NPS). All rights reserved.
3   * This work is provided under a BSD open-source license, see project license.html and license.txt
4   * @author brutzman@nps.edu
5   */
6   package OpenDis7Examples;
7
8   import ...13 lines
9
10
11
12
13
14
15
16
17
18
19
20
21
22  /** The purpose of this inheritable class is to provide an easily modifiable example simulation program
23   * that includes DIS-capable entities performing tasks of interest, and then reporting activity via PDUs
24   * to the network.
25   * Default program initialization includes PDU recording turned on by default.
26   * @see <a href="https://gitlab.nps.edu/Savage/NetworkedGraphicsMV3500/-/blob/master/examples/src/OpenDis7Examples/ExampleSimulat
27   */
28
29  public class ExampleSimulationProgram
30  {
31      protected boolean verboseComments = true;
32      static final String NETWORK_ADDRESS_DEFAULT = "239.1.2.3";
33      static final int NETWORK_PORT_DEFAULT = 3000;
34      String networkAddress = NETWORK_ADDRESS_DEFAULT;
35      int networkPort = NETWORK_PORT_DEFAULT;
36      String thisHostName = "localhost";
37      String DEFAULT_OUTPUT_DIRECTORY = "./pduLog";
38
39      /** seconds for real-time execution (not simulation time, which may or may not be the same) */
40      double currentTimeStep = 1.0; // seconds
41      /** initial simulation time */
42      double initialTime = 0.0;
43      /** current simulation time */
44      double simulationTime;
45
46      /**
47       * Output prefix to help with logging by identifying this class (overridden in subclass).
48       */
49      protected static String TRACE_PREFIX;
```

ExampleSimulationProgram.java - Navigator

Members

<empty>

- ExampleSimulationProgram
- ExampleSimulationProgram()
- ExampleSimulationProgram(String address, int port)
- getNetworkAddress() : String
- getNetworkPort() : int
- getTimestampStyle() : TimestampStyle
- handleArgs(String[] args)
- initializeSimulationEntities()
- isVerboseComments() : boolean
- main(String[] args)
- runSimulationLoops()
- sendAllPduForLoopTimestep(EntityStatePdu entityState)
- sendCommentPdu(VariableRecordType commentType,
- sendSinglePdu(Pdu pdu)
- setNetworkAddress(String newNetworkAddress)
- setNetworkPort(int newNetworkPort)
- setTimestampStyle(TimestampStyle newTimestampStyle)
- setUpNetworkInterface()
- setVerboseComments(boolean newVerboseComments)
- tearDownNetworkInterface()

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```

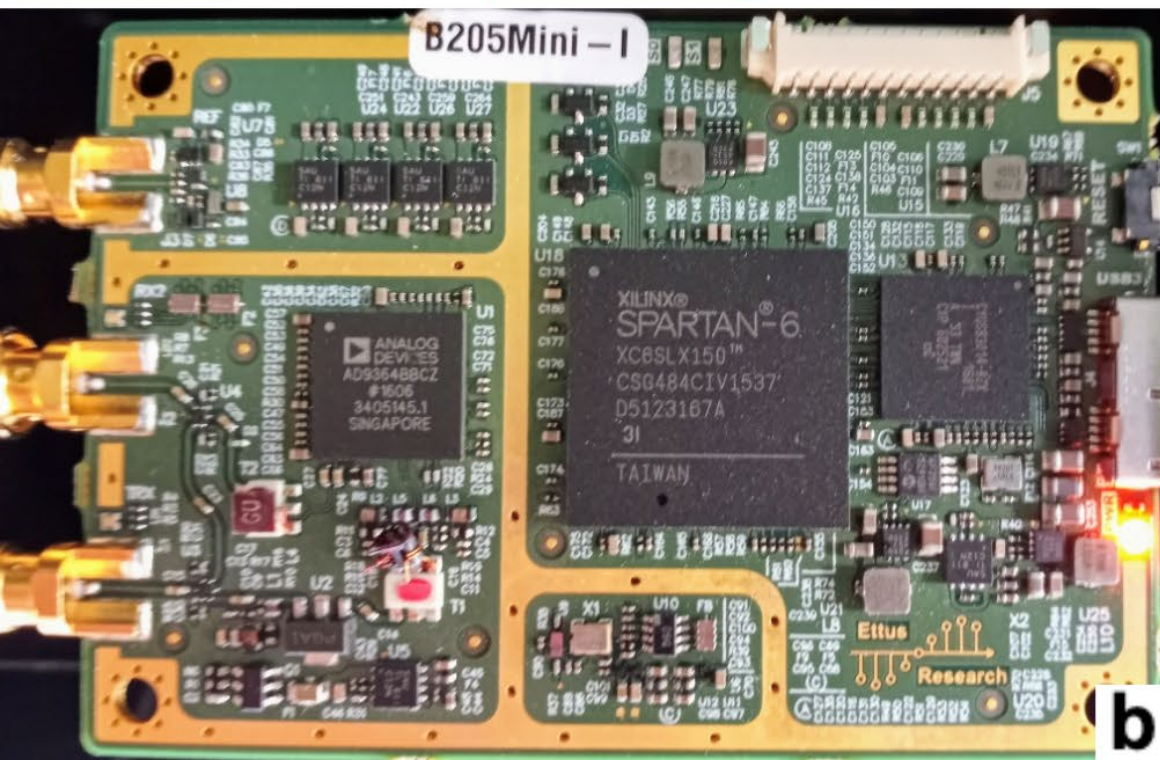
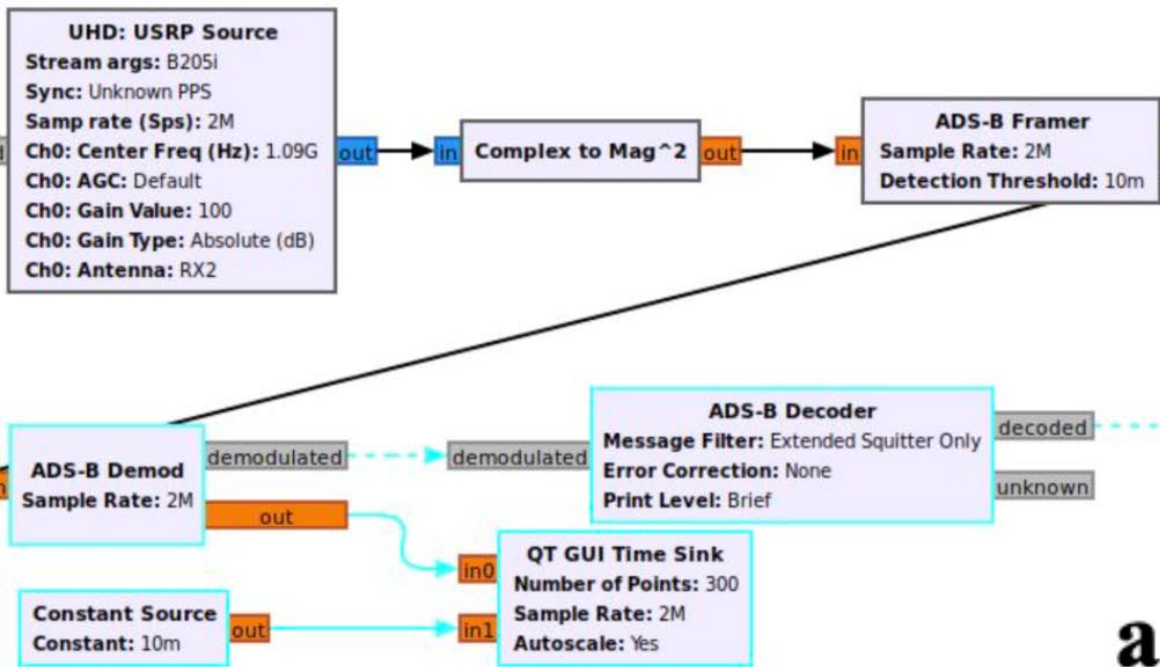
67 public void initializeSimulationEntities()
68 {
69     // Your model setup: define participants.  who's who in this zoo?
70     // Assuming you keep track of entity objects...  here is some support for for Entity 1.
71
72     // PDU objects are already created, now set their values.
73     entityID_1.setSiteID( pSiteID: 1).setApplicationID( pApplicationID: 2).setEntityID( pEntityID: 3); // made-up example ID;
74
75     entityID_2.setSiteID( pSiteID: 1).setApplicationID( pApplicationID: 2).setEntityID( pEntityID: 4); // made-up example ID;
76     // TODO someday, use enumerations; is there a unique site triplet for MOVES Institute?
77
78     entityStatePdu_1.setEntityID( pEntityID: entityID_1);
79     entityStatePdu_1.setForceId( pForceId: ForceID.FRIENDLY);
80     entityStatePdu_1.setEntityType( new _001Poseidon()); // note import statement above
81     entityStatePdu_1.setMarking( newMarking: "Entity #1");
82     entityStatePdu_1.getMarkingString(); // check
83
84     entityStatePdu_2.setEntityID( pEntityID: entityID_2);
85     entityStatePdu_2.setForceId( pForceId: ForceID.OPPOSING);
86     entityStatePdu_2.setEntityType( new _002Triton()); // note import statement above
87     entityStatePdu_2.setMarking( newMarking: "Entity #2");
88
89     // TODO how should we customize this munition?  what is it for your simulation?
90     munitionDescriptor1.setQuantity( pQuantity: 1);
91     firePdu_1a.setDescriptor( pDescriptor: munitionDescriptor1).setRange( pRange: 1000.0f);
92
93     // TODO simulation management PDUs for startup, planning to design special class support
94     // simulationManager.addEntity();
95     simulationManager.setDescriptor( newDescriptor: "ExampleSimulationProgram");
96     simulationManager.addHost( newHost: thisHostName);
97     simulationManager.setDisThreadedNetworkInterface( disThreadedNetworkInterface: disNetworkInterface);
98 }
99
100 /**
101  * This runSimulationLoops() method is for you, a customizable programmer-modifiable
102  * code block for defining and running a new simulation of interest.
103  */

```

opendis Python project

Testing legacy python DIS using a software-defined radio.

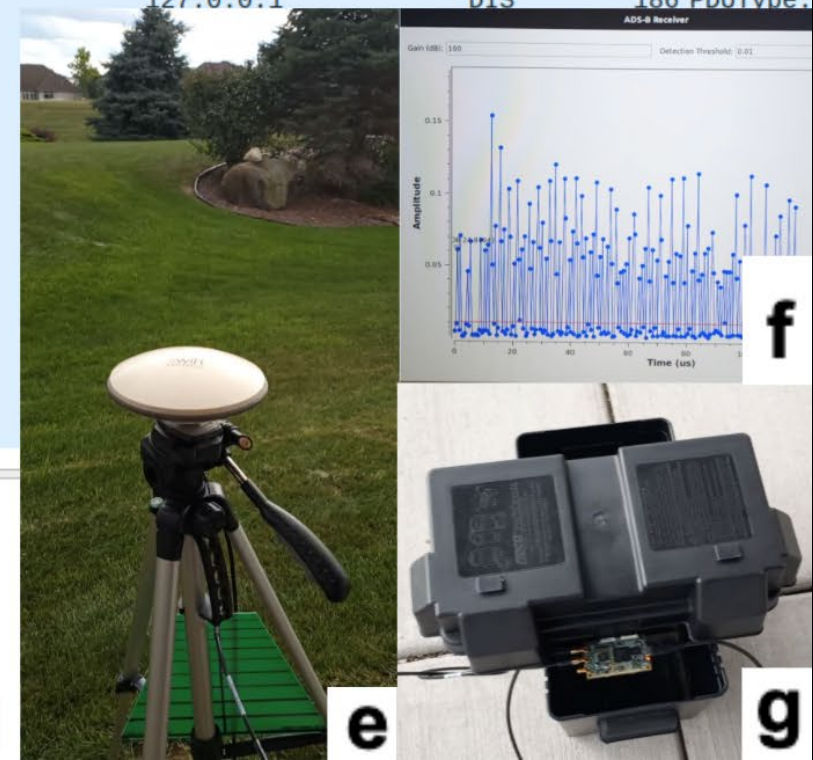
- (a) GNU Radio block diagram,
- (b) Ettus Research USRP B205mini-i Software Defined Transceiver,
- (c) ADS-B PDU Encoder console output,
- (d) Wireshark UDP network capture of ADS-B messages,
- (e) backyard antenna position,
- (f) demodulated signal response,
- (g) radio transceiver box with USB connection.



Time	ICAO	Callsign	Alt	Climb	Speed	Hdng	Latitude	Longitude
			ft	ft/m	kt	deg	deg	deg
20:30:10	ac08fa	SKW5025	11150	-1280	398	-74	42.8322950	-89.2147391
20:30:10	a3e936	N351HC	-1	128	164	-25	43.0989990	-89.3877038
20:30:10	a3a0cc		24100	-960	441	-26	42.5952976	-89.9870336
20:30:10	aa8b74			128	413	-169		
20:30:10	a43b04	N3718T	8050	192	135	-154	43.1376801	-89.5318674
20:30:10	a2d8db	N2828B	40225	-3392	580	-30	42.9291237	-89.0175738
20:30:10	a05225	N12JD	21000	64	285	-2	42.9336090	-89.5163461
20:30:10	a16862	N190CE	2200	-192	135	-159	43.1164856	-89.4494061
20:30:10	a35e3c	N316MP	3225	-448	99	169	43.0941514	-89.3744332
20:30:10	a54501		3125	128	122	-68	43.1247253	-89.614
20:30:10	a36e61	ASA1014et24025o		0	443	-26		
20:30:10	a5ff57	N486ER	-1	1024	95	15	43.1620245	-89.314

No.	Time	Source	Destination	Protocol	Length	Info
26971	1196.4973536...	127.0.0.1	127.0.0.1	DIS	186	PDType:
26972	1196.4978965...	127.0.0.1	127.0.0.1	DIS	186	PDType:
26973	1196.4980517...	127.0.0.1	127.0.0.1	DIS	186	PDType:
26974	1196.4982870...	127.0.0.1	127.0.0.1	DIS	186	PDType:
26975	1196.4987409...	127.0.0.1	127.0.0.1			
26976	1196.4988770...	127.0.0.1	127.0.0.1			
26977	1196.4990076...	127.0.0.1	127.0.0.1			
26978	1196.4995425...	127.0.0.1	127.0.0.1			
26979	1196.4997723...	127.0.0.1	127.0.0.1			
26980	1196.4999055...	127.0.0.1	127.0.0.1			
26981	1196.5000341...	127.0.0.1	127.0.0.1			
26982	1196.5003034...	127.0.0.1	127.0.0.1			
26983	1196.5004986...	127.0.0.1	127.0.0.1			
26984	1196.5006301...	127.0.0.1	127.0.0.1			
26985	1196.5007579...	127.0.0.1	127.0.0.1			
26986	1196.5008794...	127.0.0.1	127.0.0.1			
26987	1196.5010054...	127.0.0.1	127.0.0.1			
26988	1196.5011609...	127.0.0.1	127.0.0.1			

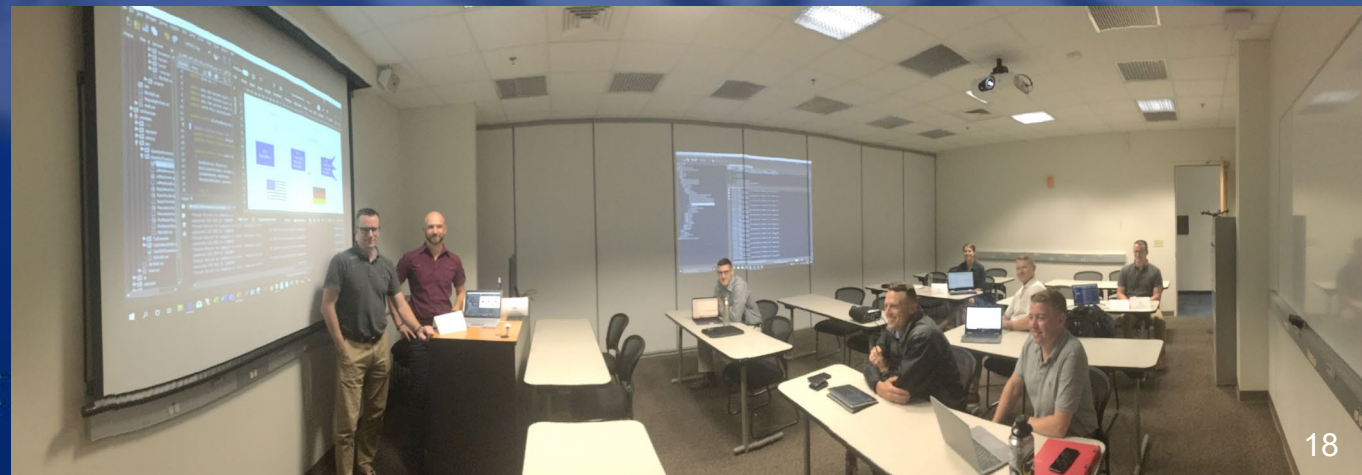
Extra: 0
 ▾ Entity Linear Velocity
 X: 543
 Y: 0
 Z: 0
 ▾ Entity Location
 X: 42.9538429
 Y: -90.6040519
 Z: 29000



NPS course MV3500 Networked Graphics Simulation

The screenshot shows the GitLab web interface for the repository `NetworkedGraphicsMV3500`. The browser address bar shows `https://gitlab.nps.edu/Savage/NetworkedGraphicsMV3500`. The left sidebar contains navigation links: Project information, Repository, Issues (0), Merge requests (0), CI/CD, Security & Compliance, Deployments, Monitor, and Infrastructure. The main content area displays the repository name with a globe icon, Project ID 1563, and statistics: 2,439 Commits, 1 Branch, 0 Tags, 795.5 MB Files, and 795.5 MB Storage. A warning banner at the top states: "Please review any and all PUBLIC repositories, groups, and associated files. These allow anyone on the Internet to access without authentication. Repository and group owners are responsible for their content and permission settings. Go to your project(s), click on Settings > General and expand the 'Visibility, project features, permissions' to change this setting." At the bottom of the repository view, there are buttons for History, Find file, Web IDE, and a Clone button.

All course assets are online
Students use version control



Wireshark is useful network monitoring tool for DIS

<https://www.wireshark.org>

The image displays the Wireshark network protocol analyzer interface. The main window is titled '*Ethernet 7' and shows a list of captured packets. The selected packet is 1062, which is a User Datagram Protocol (UDP) packet from 172.20.223.70 to 239.1.2.3. The packet details pane shows the following information:

- Frame 1062: 732 bytes on wire (5856 bits), 732 bytes captured (5856 bits) on interface \Device\NPF_{C83E7248-F10F-4805-867B-22B46B0AF06E}, id 0
- Ethernet II, Src: 02:50:41:00:00:01 (02:50:41:00:00:01), Dst: IPv4mcast_01:02:03 (01:00:5e:01:02:03)
- Internet Protocol Version 4, Src: 172.20.223.70, Dst: 239.1.2.3
- User Datagram Protocol, Src Port: 3000, Dst Port: 3000

The packet details pane also shows the following information:

- Header
- Proto version: IEEE 1278.1-2012 (7)
- Exercise ID: 0
- POU type: Entity State (1)
- Proto Family: Entity information / Interaction (1)
- Timestamp: 00:00.000000 (relative)
- PDU Length: 0
- PDU Status: 0x00
- Padding: 00
- Entity State PDU
- Entity ID
- Entity ID Site: 0
- Entity ID Application: 0
- Entity ID Entity: 0
- Force ID: 0
- Number of Articulation Parameters: 0
- Entity Type, (0:0:0:0:0:0)
- Alternative Entity Type, (0:0:0:0:0:0)
- Entity Linear Velocity
- Entity Location
- Entity Orientation
- Appearance: 0x00000000
- Dead Reckoning Parameters
- Entity Marking
- Capabilities: 0

The packet bytes pane shows the raw data of the packet, which is a User Datagram Protocol (UDP) packet. The packet is 732 bytes long and is captured on interface \Device\NPF_{C83E7248-F10F-4805-867B-22B46B0AF06E}. The packet details pane shows the following information:

- Header
- Entity ID
- Force ID: 0
- Number of Articulation Parameters: 0
- Entity Type, (0:0:0:0:0:0)
- Kind: Other (0)
- Domain: Other (0)
- Country: Other (0)
- Category: 0
- Subcategory: 0
- Specific: 0
- Extra: 0
- Alternative Entity Type, (0:0:0:0:0:0)
- Entity Linear Velocity
- Entity Location
- Entity Orientation
- Appearance: 0x00000000
- Dead Reckoning Parameters
- Entity Marking
- Capabilities: 0

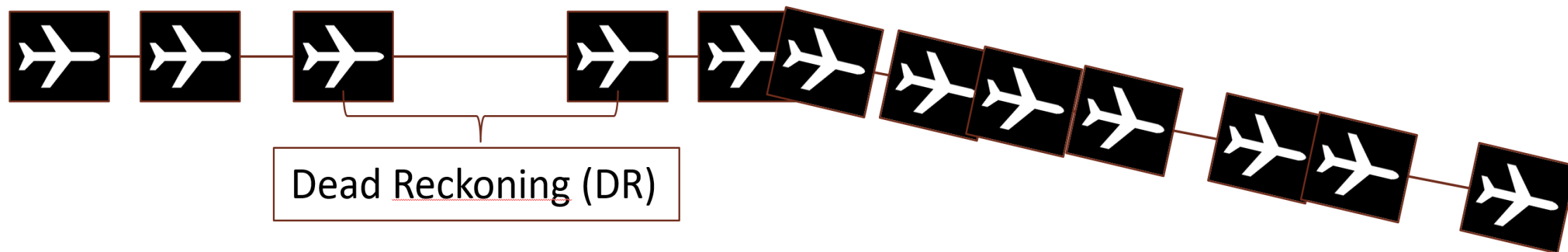
The packet bytes pane shows the raw data of the packet, which is a User Datagram Protocol (UDP) packet. The packet is 732 bytes long and is captured on interface \Device\NPF_{C83E7248-F10F-4805-867B-22B46B0AF06E}. The packet details pane shows the following information:

- Header
- Entity ID
- Force ID: 0
- Number of Articulation Parameters: 0
- Entity Type, (0:0:0:0:0:0)
- Kind: Other (0)
- Domain: Other (0)
- Country: Other (0)
- Category: 0
- Subcategory: 0
- Specific: 0
- Extra: 0
- Alternative Entity Type, (0:0:0:0:0:0)
- Entity Linear Velocity
- Entity Location
- Entity Orientation
- Appearance: 0x00000000
- Dead Reckoning Parameters
- Entity Marking
- Capabilities: 0

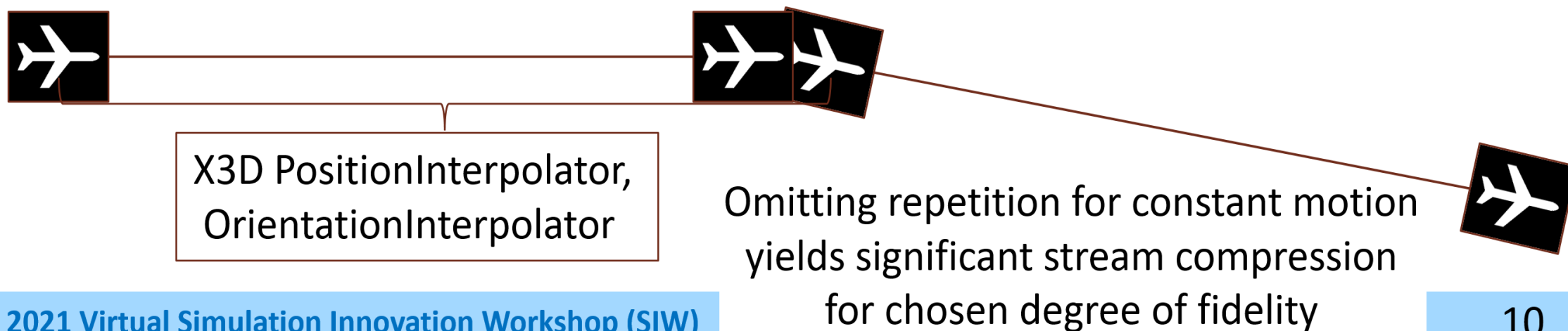


Test Scenario for Playback Compression

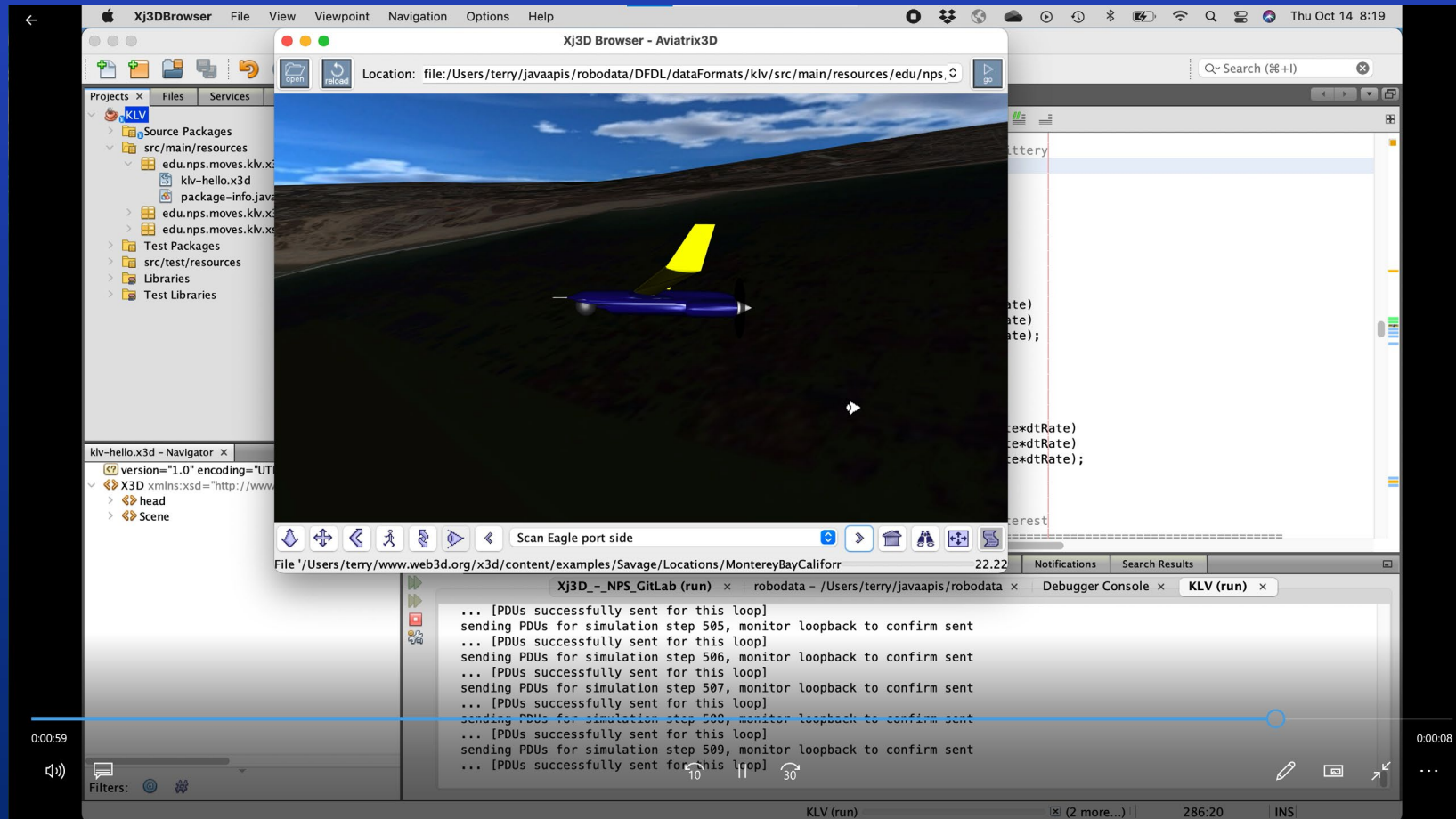
Raw DIS PDU Data from Simulation or Live Streaming:



Sliding Window Interpolator for X3D Animation Playback:



LVC playback Scan Eagle telemetry



Track distillation, replay, visualization

Now working to refine processes for linear-regression curve fits and track distillation to encourage further analytic assessment

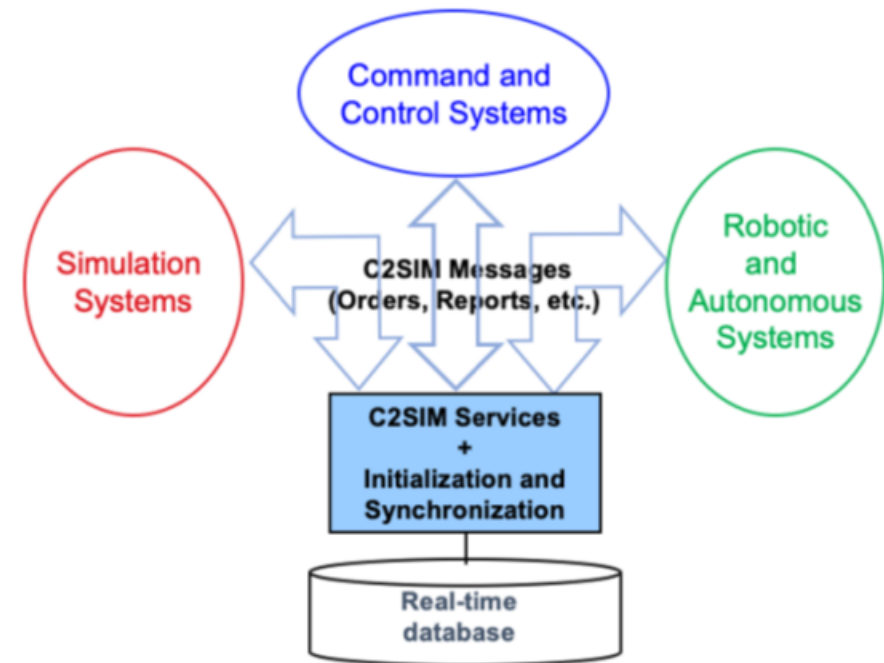
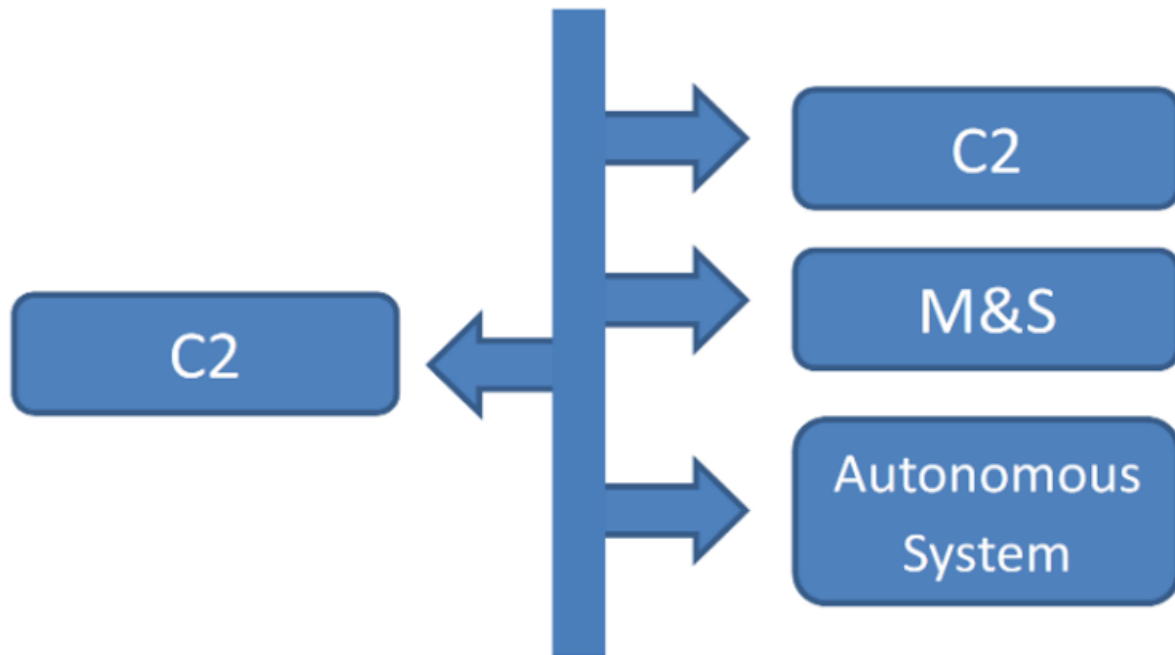
Treating Track as a first-class media type, augmenting with KML waypoints and X3D interpolators is valuable for gaining insight and understanding

Adjusting timestamp epoch to commencement is enabler for LVC

Adding COMMENT PDUs as narrative, plus diversity of DIS PDUs, provides rich capabilities for recording/analyzing simulations with real-world experimentation

C2SIM: Command and Control for Simulation

SISO standard, NATO interoperability experimentation, much activity.
DIS seems to be a good complement for state updates.



Future work: lots

Compressed DIS (C-DIS) PDU encoding and DIS version 8

Unit testing suites might lead to conformance criteria

Multiple encodings tested: DIS binary, plain text, XML, EXI, JSON

PDU track classes for scenario analytics

Conformance tests for specified DIS behaviors

Publishing libraries of repeatable examples and tests

Your project here...

Conclusions and Recommendations

opendis7 source generator is working and repeatable
opendis7-java is working and ready for broad use
opendis7-python testing and refinement has begun

Now that stable design is achieved, much greater presence in github forums is planned, all participation is welcome

DIS offers opportunity for mainstreaming M+S in many ways

Availability

OpenDIS on github

- <https://github.com/open-dis>
- <https://github.com/open-dis/opendis7-source-generator>
- <https://github.com/open-dis/opendis7-java>
- <https://github.com/open-dis/opendis7-python>

MV3500 Networked Graphics Simulation course

- <https://gitlab.nps.edu/Savage/NetworkedGraphicsMV3500>
with [IITSEC DIS 2021 Tutorial](#)

Contact

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