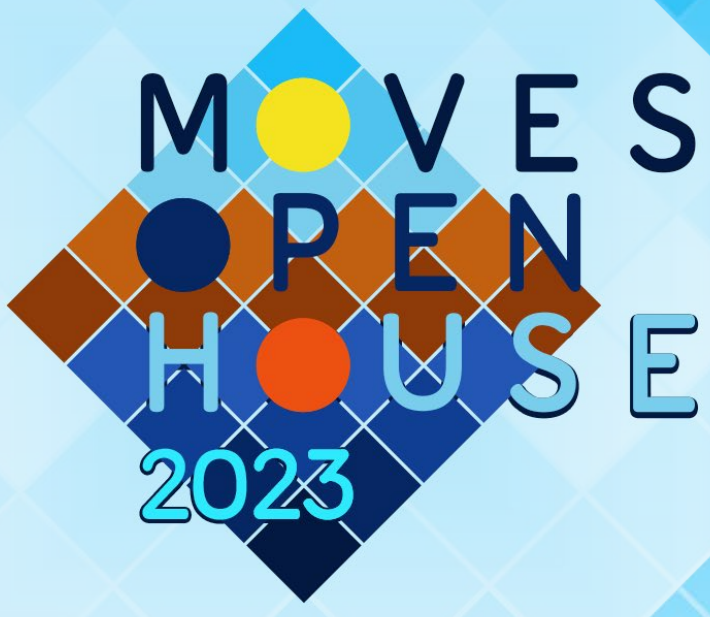


Robot Data Strategy and DFDL Parsing of Telemetry to Visualize NPS Field Experimentation (FX)

Don Brutzman and Terry Norbraten

24 May 2023

Motivation: Network Optional Warfare (NOW)

Gap: Modeling and Simulation is not part of C2 for warfighters

Network-Optional Warfare (NOW)

- ***Major vulnerabilities are commonplace:*** **naval forces conducting constant communications lack stealth and become dependent on continuous data exchange.**
- ***Agile EMCON:*** **"Radio silence" emissions control with judicious use of low-probability of intercept (LPI) communication channels, such as optical.**
- ***Messaging maturity:*** **efficient compression and a coherently defined signal book, aiding remote command initiative and operational freedom of action.**
- ***Ethical Control of Unmanned Systems:*** **allow unmanned systems with potential for lethal force to operate reliably at a distance, directed by humans to follow same tasking + constraints as any other trusted participant.**

Network-Centric Warfare (NCW)

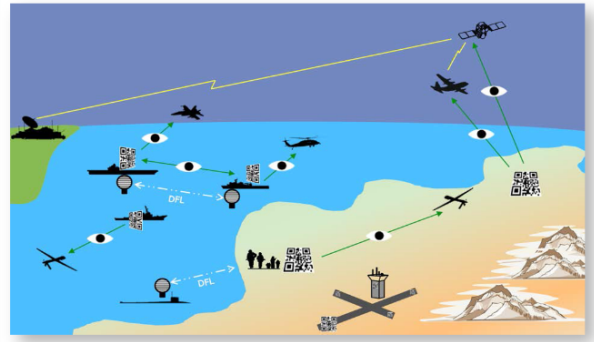
- **"Seeks to translate an information advantage, enabled in part by information technology, into a competitive advantage through the robust networking of well-informed geographically dispersed forces."**
- **"This networking—combined with changes in technology, organization, processes, and people—may allow new forms of organizational behavior."**
- **Source: Network-Centric Warfare, Wikipedia**

Precepts and Pillars

Network-Optional Warfare (NOW) precepts for deliberate, stealthy, minimalist tactical communications include multiple technical arenas for naval opportunity.

- **Data Strategy for Unmanned Systems**
- **Efficient Messaging**
- **Ethical Control of Unmanned Systems**
- **Optical Signaling**
- **Rich Semantic Track (RST)**
- **Semantic Coherence**

This work includes applied efforts in Field Experimentation (FX), Modeling, Simulation, and Analysis using open standards for scalability.



Operational View (OV-1) shows line-of-sight (LOS) optical signaling via Quick Reaction (QR) codes and Digital Flashing Light (DFL). Only two radio frequency (RF) lightning bolts!

Data Strategy for Autonomous Systems Field Experimentation (FX), Simulation and Analysis (link)

Abstract. Data collection and analysis techniques for robot experiments are haphazard and incomplete. Building best-practice workflows for data and metadata from unmanned systems can leverage both field experimentation (FX) and simulation to support archival data re-use and repeatable analysis. Reusable end-to-end data workflows are needed. Building on multiple open standards, open-source tools, and authoritative data formats, ongoing NPS CRUSER work is focused on applying Data Format Description Language (DFDL) techniques to archival recording/playback of mission orders, recorded telemetry and sensor streams. This necessary capability may enable an even-larger context, namely a Data Strategy for Unmanned Systems field experimentation (FX), modeling and simulation (M&S) supporting Live-Virtual-Constructive (LVC) synthesis, data repositories, and repeatable analysis. A full end-to-end toolchain built using open capabilities has the potential to address these important needs. This memorandum describes component technologies that together might establish such an information infrastructure. Failure to implement a shared data strategy blocks necessary interoperability of human-machine teams.

Approach

	Schema data design: value types and metadata
	Operator defines mission plan, records summary
	Robot collects, records sensor data
	Relay, transfer data to intermediate storage
	Archive all data: telemetry, imagery, video, 3D
Daffodil	Convert telemetry to Rich Semantic Track via Data Format Description Language DFDL
	Operators verify mission logs, narrative, links
	Publish catalog entries to Calhoun for search
	Query, compose, analytics mashups, re-use, etc.

Robodata Workflow: collection and storage of data enables recording, replay, smoothing and visualization of robot tracks.

Course: MV3500 Networked Simulation (link)

Savage > NetworkedGraphicsMV3500 > **Repository**

master | NetworkedGraphicsMV3500 / **README.md** | Find file | Blame | History | Permalink

typo
Brutzman, Don authored 1 week ago

40161231

README.md 3.45 KiB | Open in Web IDE | Replace | Delete

MV3500 Distributed Simulation Fundamentals Course

An introduction to distributed communications in simulation applications. Topics include introduction to the TCP/IP protocol stack, socket communications including TCP/UDP unicast/multicast and essential protocol design issues. Follow-on emphasis is Distributed Interactive Simulation (DIS) Protocol application programming, with side looks at High Level Architecture (HLA). Course activity focuses on creation and testing of network programming network code and web-browser applications.

This course archive contains a variety of original assets for assignments, examples, presentations, and specifications.

Key course pages:

- MV3500 Course Syllabus
- NPS CLE Sakai site for MV3500 course
- NPS GitLab site: NetworkedGraphicsMV3500

- opendis7-java Distribution Products

opendis7-java Distribution Products (link)

opendis7-java Distribution Products

Get ready...

The IEEE Distributed Interactive Simulation (DIS) protocol is a formal standard for conducting real-time platform-level wargaming across multiple host computers and is used worldwide, especially by military organizations.

- Distributed Interactive Simulation (DIS) 101 Tutorial: The Basics, Interservice Industry Training, Simulation Education Conference (IITSEC), 29 November - 3 December 2021, Orlando Florida USA.

This page offers distribution products created from the latest build of the opendis7-java project source code.

---

opendis7-java jars and documentation

Get set...

- IEEE DIS7 PDU color figures illustrating PDU data structures
- opendis7-java Javadoc provides full documentation of classes and methods for Java programmers
- opendis7-full.jar is the latest recommended version for use. It is a "fat jar" (~210MB) which integrates all of the following:
  - opendis7-pdus-classes.jar, opendis7-pdus-javadoc.jar, opendis7-pdus-source.jar
  - opendis7-enumerations-classes.jar, opendis7-enumerations-javadoc.jar, opendis7-enumerations-source.jar

Experimental XML encoding for DIS Protocol version 7, enabling opportunities for further "big data" validation and conversion. Current work is testing and building upon these potential capabilities.

- XML Schema DIS_7_2012.autogenerated.xsd
- DIS7 PDU XML Schema Documentation
- generated from original XML for PDUs design templates by Don McGregor

Codebase design and production:

- Generating Distributed Interactive Simulation (DIS) Codebases using opendis7-source-generator, Simulation Interoperability Workshop (SIW) February 2022

MV3500 Networked Simulation course documentation

Go!

This NPS course is an introduction to distributed communications in simulation applications. Topics include introduction to the TCP/IP protocol stack, socket communications including TCP/UDP unicast/multicast and essential protocol design issues. Follow-on emphasis is Distributed Interactive Simulation (DIS) Protocol application programming, with side looks at High Level Architecture (HLA). Course activity focuses on creation and testing of network programming network code and web-browser applications.

- MV3500 Distributed Simulation course
  - course examples Javadoc (source code)
  - student assignments Javadoc (source code)

Example Simulation Program, Java (link)

Execution Flow Diagram for ExampleSimulationProgram.java

main() method controls program invocation

a. Handle command-line arguments
b. New ExampleSimulationProgram(), initialize()
c. runSimulationLoops()
d. tearDownNetworkInterface()
e. System.exit()

a.handleArguments()

Read, save new network address/port combination (if any, use default values if unspecified)

Provide warning usage message otherwise

b. constructor new ExampleSimulationProgram()

Initialize DIS channel parameters
Initialize simulation entities of interest
Join DIS channel for live network connection
Send CommentPdu as initial message

initialize()

initializeDisChannel()

Initialize network interface
Setup PDU recorder

initializeSimulationEntities()

Create PDU factory
Define each model of interest including names, platform IDs,network identifiers

Join DIS channel
Send CommentPDU as initial announcement

c. runSimulationLoops() runs each timestep loop of a simulation

Initialize loop counters, announce commencement on network

while (simulationLoopCount > MAX) // or other condition

Increment counters and timestep state variables

// ==========
// * your own simulation code goes here! **********

Are you listening for DIS PDUs from networked simulation channel?

Compute, set state variable whether termination condition is met

// ==========

Send outgoing DIS PDU messages to network channel for this loop

Thread sleep for real-time duration of simulation timestep

If termination condition met, break out of loop. Otherwise continue.

d. disChannel.tearDownNetworkInterface()

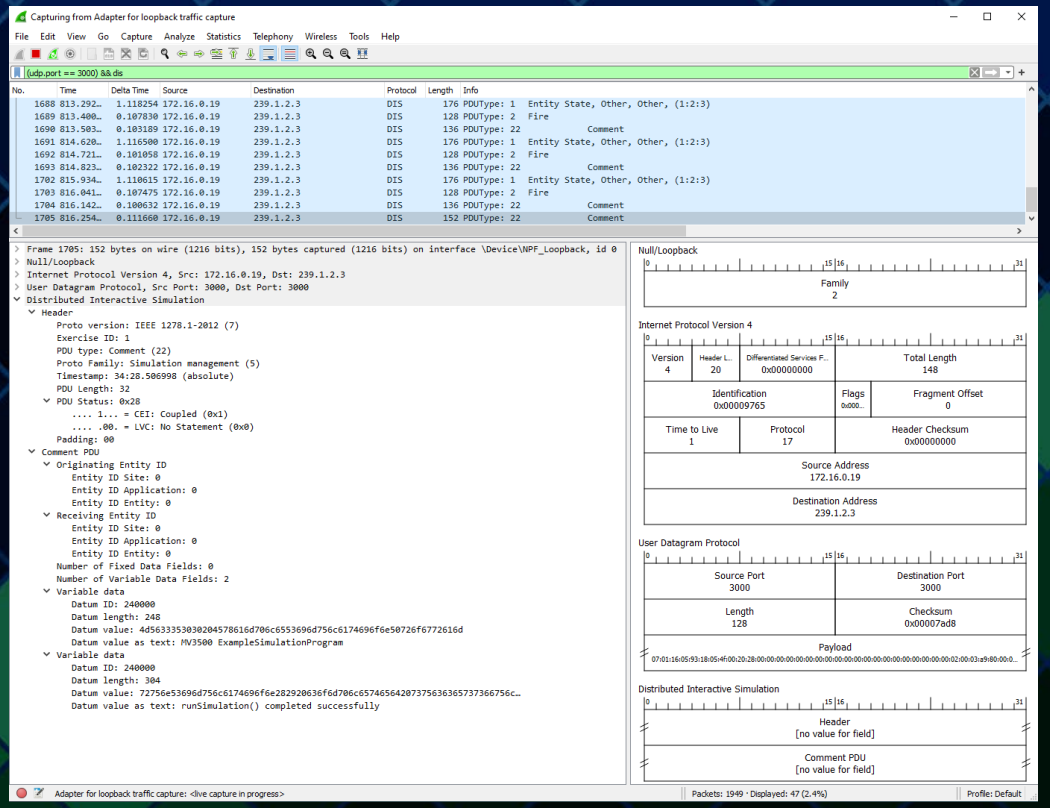
Clears all buffers
Closes pduRecorder
Shuts down threads
Releases network resources

e. System.exit() // quit

MV3500 OpenDis7Examples ExampleSimulationProgramFlowDiagram.pdf

https://en.wikipedia.org/wiki/UML_state_machine

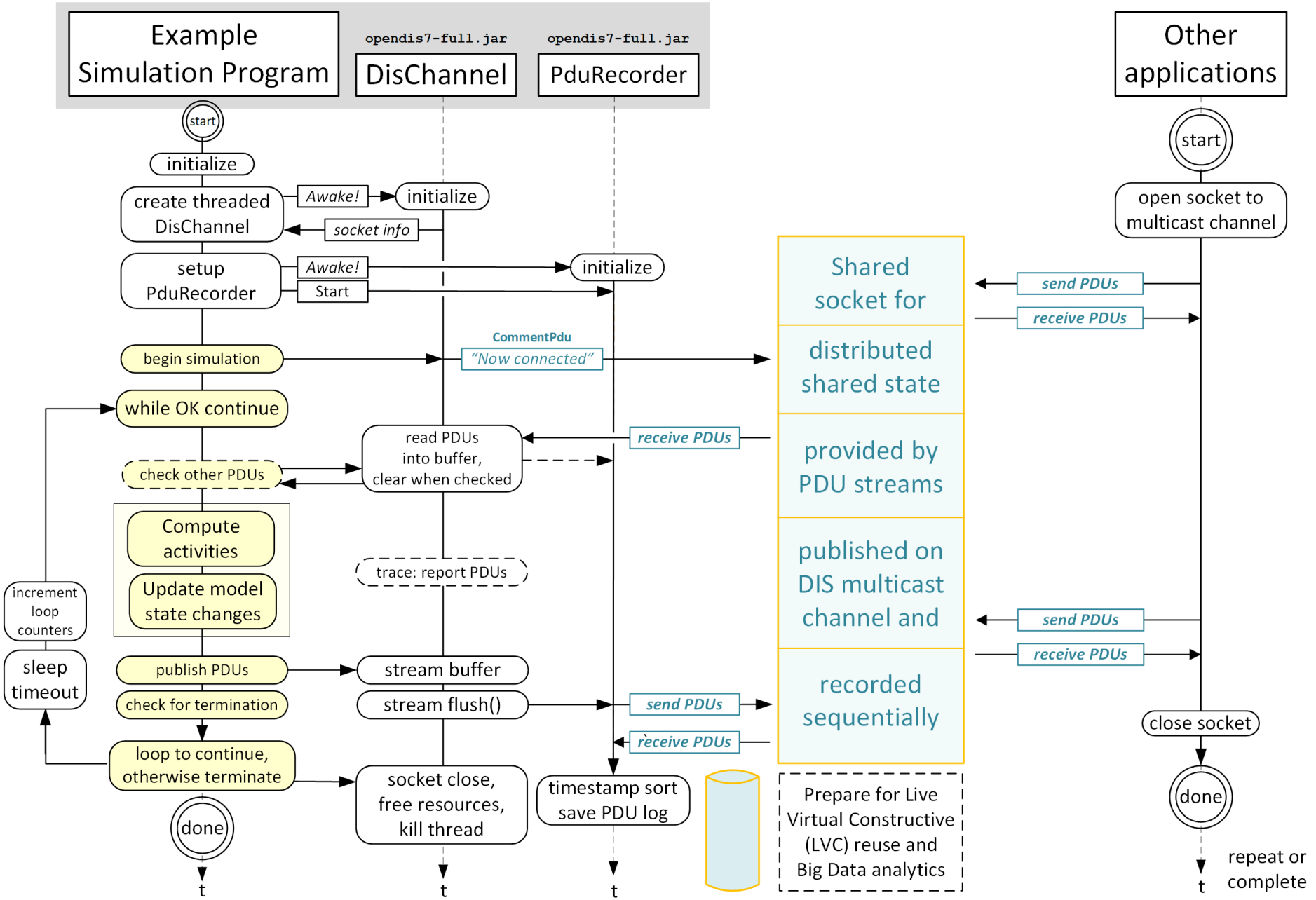
22 May 2023



A stream is a stream is a stream.

Recording, filtering, and playing back all manner of DIS streams offers path forward to achieve full LVC mashups, operational C2 integration.

ExampleSimulationProgram UML Timing Sequence Diagram



Predecisional: preparing an asynchronous Live Virtual Constructive (LVC) certificate

- Prerequisite: Java or Python programming ability
- MV3302 Discrete Event Simulation using Simkit (Buss)
- MV3500 Networked Simulation (Brutzman)
- MV4503 Simulation Interoperability (Fitzpatrick)
- integrate NATO/SISO C2SIM and Rich Semantic Track (Blais)
- Resident week, 40-hour LVC lab practical experience (all)

- Bonus course: MV4000 Hamming Learning to Learn

Web3D Consortium

Extensible 3D Graphics (X3D) 4.0 (link)

- Work complete by Web3D Consortium
- Final round of review, International Standards Organization
- Multiple validation tools, autogenerated APIs (Java, Python)
- XML, ClassicVRML, JSON, EXI, Turtle RDF encodings
- HTML5 integration
- glTF 2.0 rendering
- Web Audio API and MIDI
- Exploratory efforts with
- Metaverse Standards Forum

X3D Version 4 Overview

Tags: x3d x3dom X_ITE x3d4 x3dv4 X3D version 4

The X3D® version 4 (X3D4) Architecture Specification is a major upgrade to the Extensible 3D (X3D) Graphics International Standard that provides close support for the HTML5 Recommendation, Khronos glTF Physically Based Rendering (PBR), Web Audio API, and MIDI 2.0, along with numerous other features. **Humanoid Animation 2.0 (HAnim2)** is also fully supported, including BVH-style motion animation. This mature specification is a major update building on prior versions of X3D and Virtual Reality Modeling Language (VRML). This effort is driven by the X3D Graphics Working Group with many contributions from multiple working groups and daily community outreach.

- *Available.* X3D 4.0 Architecture approved by Web3D Consortium is online, ISO/IEC final editing and publication in progress April 2023.
- *Status.* X3D 4.0 Architecture successfully passed ISO ballot as Draft International Standard (DIS) by 12 nations in November 2022.
- *Features.* X3D4 Highlights provides a quicklook of major features including HTML5, glTF, Web Audio API, and MIDI 2.0 standards.
- *Release.* X3D4 Committee Draft (CD1) Specification for second-round balloting by national bodies in ISO/IEC, April 2022.
- *Update.* X3D4 Architecture Progress and Resources (with video) for Web3D 2021 Conference, Pisa Italy + online, 8-12 November 2021.
- *Progress.* X3D4 Specification Status Report during International Standards Organization (ISO) 4-week annual meeting July-August 2021.
- *Preview.* X3D Version 4 Draft: Ready for Early Adoption! for Web3D Webinars and SIGGRAPH conference, online August 2020.
- *Release.* X3D4 Committee Draft (CD) Specification for balloting by national bodies in International Standards Organization ISO/IEC.
- *Preview.* X3D4 Public Working Draft Specification for 25th-anniversary Web3D 2020 Conference and Web3D Consortium ballot.
- *Tracking.* X3D4 Implementations Progress Tracking provided numerous summary links tracking a variety of active ongong efforts.
- *Update.* **X3D Version 4 Draft: Released and Ready for Review!** presentation for Web3D 2020 Conference tutorial, online November 2020.
- *Update.* **X3D Version 4 Draft: Ready for Early Adoption!** presentation for Web3D Webinars and SIGGRAPH conference, online August 2020.
- *Rolling.* **X3D4 Draft is Moving In Fast: 3D Everywhere!** presentation from Web3D 2019 Conference, Los Angeles, 26-28 July 2019.
- *Aligning.* **X3D Futures: what is happening, how to get involved!** presentation from Web3D 2018 Conference, Poznan Poland, 22 June 2018.
- *Launch.* **Future of X3D** presentation and detailed notes from Web3D 2017 Conference, Brisbane Australia, 7 June 2017 (photograph).

NPS FRAESTANTIA PER SCIENTIAM

THE MOVES INSTITUTE

SPIDERS3D Virtual Environment (link)

README.md

Spiders3dPublic

This project area is for selected release of unrestricted public assets related to SPIDERS3D Collaborative Virtual Environment.

Now available:

a. SPIDERS3D Program Overview and Collaboration Walkthrough for latest demonstration video and multiple related references.

> This demonstration shows remote Web-based collaboration capabilities using the SPIDERS3D distributed virtual environment.

b. SPIDERS3D Virtual Sand Table (VST) project slideset describes a new 3D printing/display capability.

> SPIDERS3D Virtual Sand Table enables hands-on group collaboration through vertical display and 3D printing of X3D models.

c. Collaborative 3D Visualization for Ashore, Afloat and Expeditionary Readiness Workshop is external resource providing many relevant information assets.

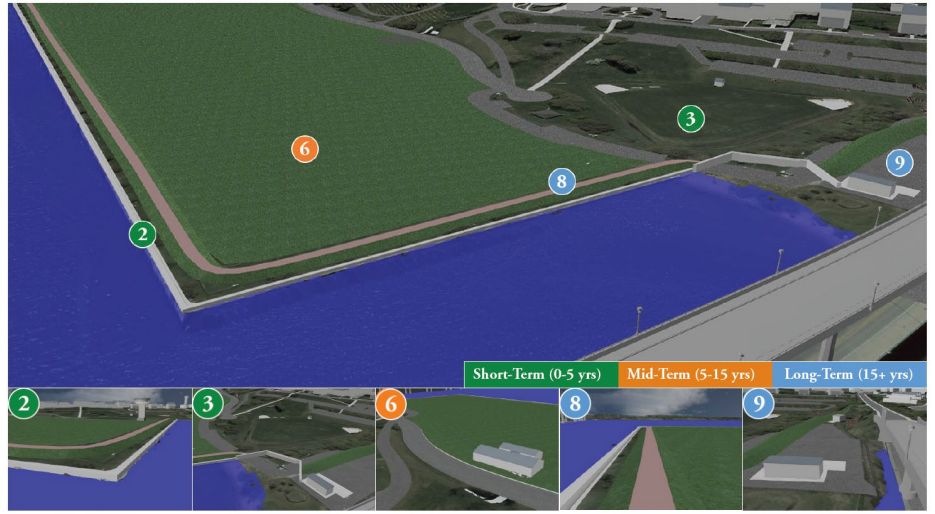
> In December 2019, Virginia Tech and Web3D Consortium hosted a one-day workshop to provide presentations to Naval enterprise leaders on the use of collaborative Web-based #X3D visualization techniques by Government, Academia and Industry practitioners. Annual workshops have followed.

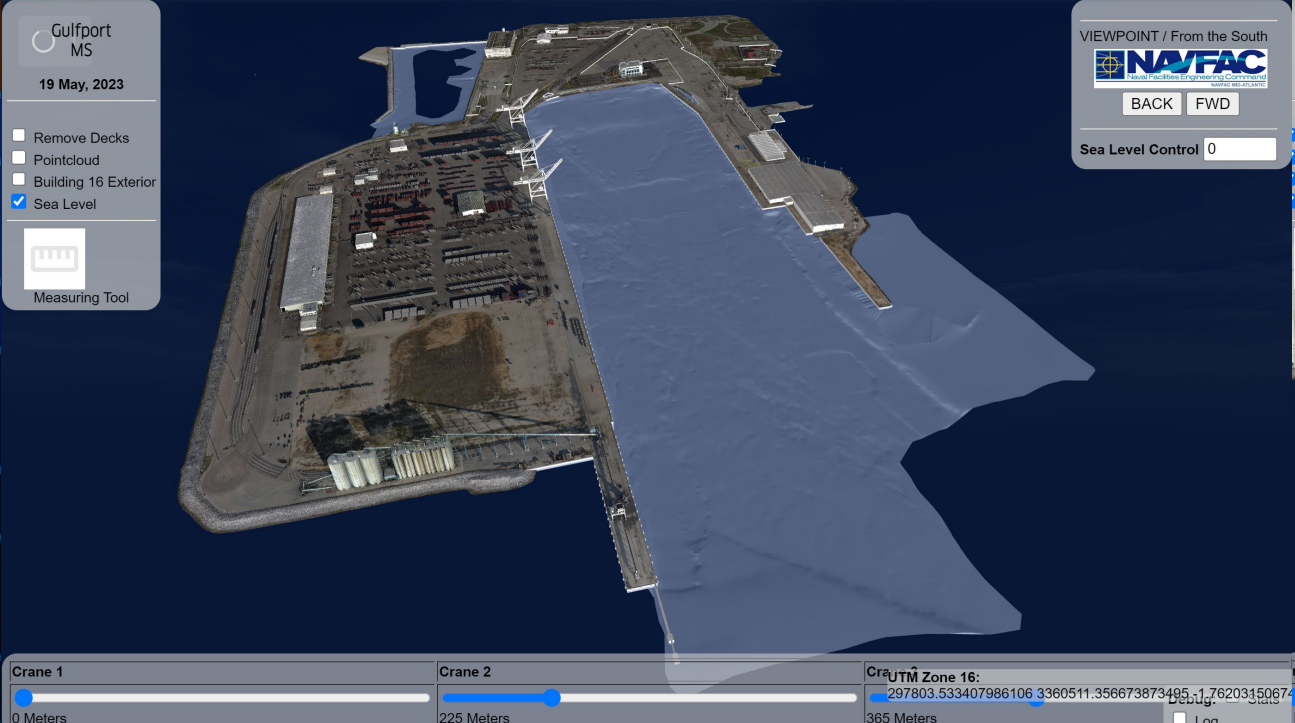
Virtual USNA: climate change planning

USNA 40-year infrastructure plan raising seawalls 2.5 feet based on NAVFAC briefing on climate impacts

United States Naval Academy
Installation Resilience Plan

Upper Yard Project Portfolio

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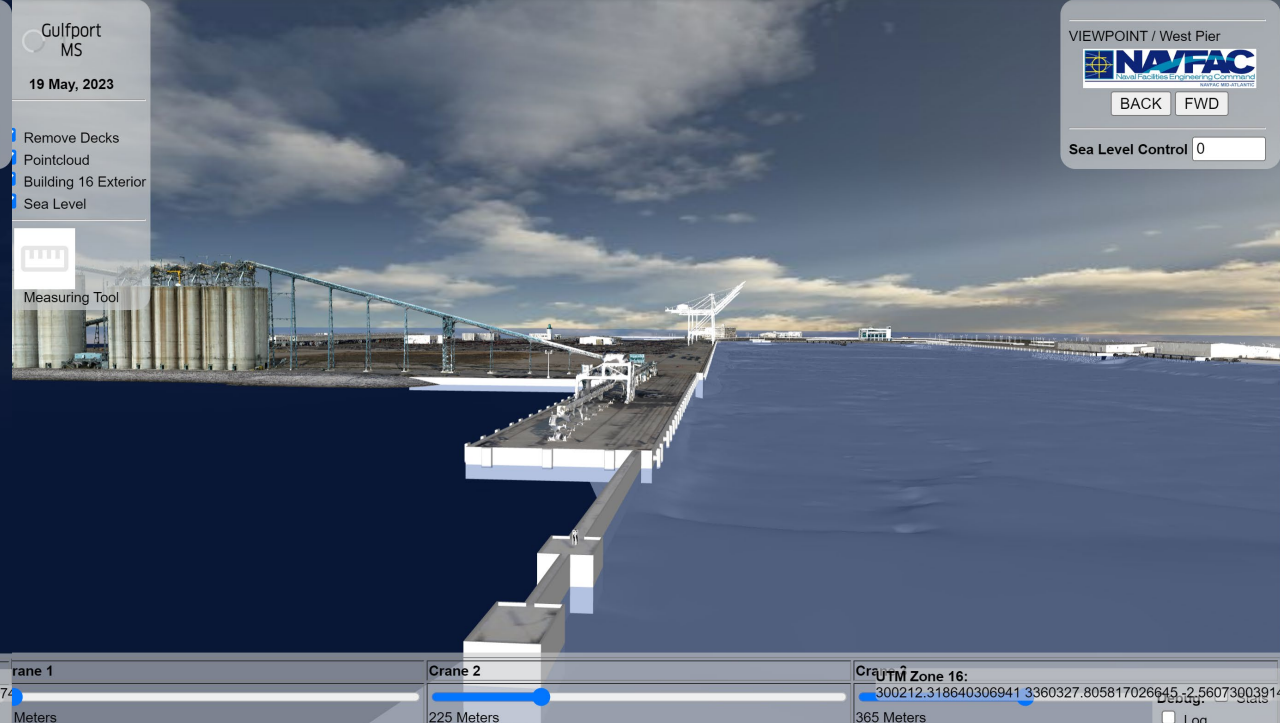
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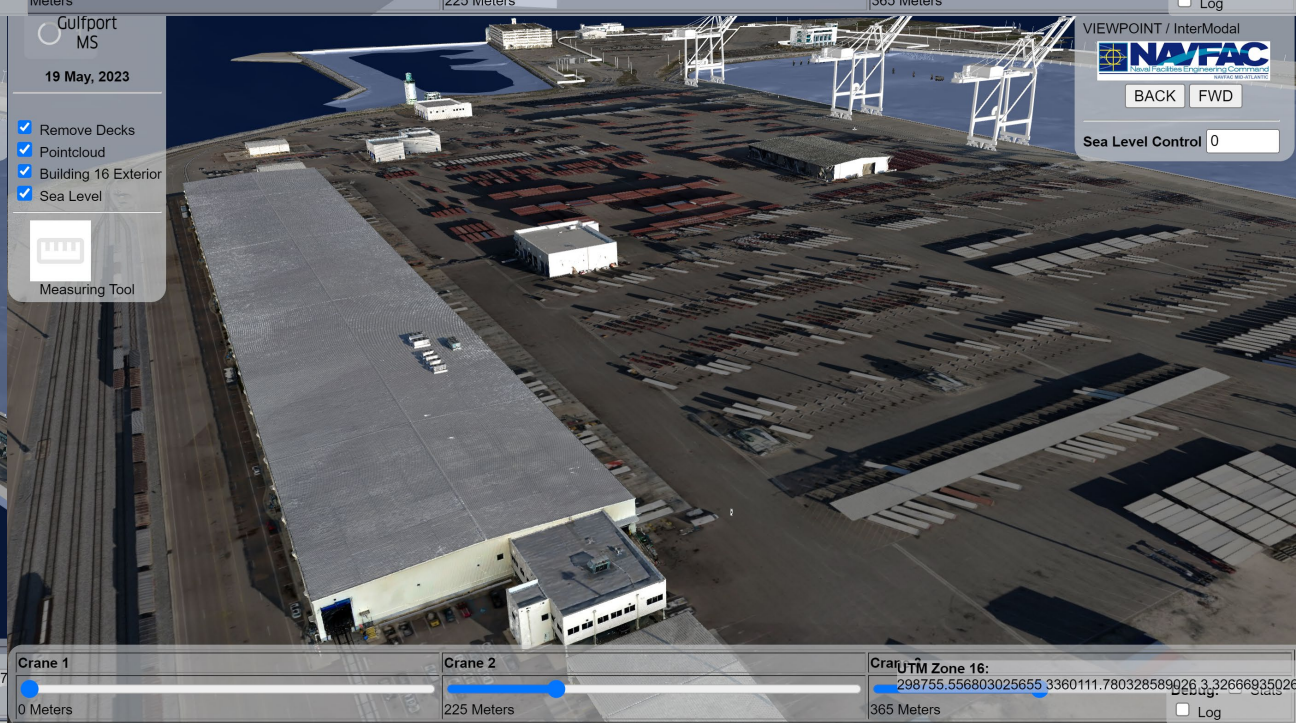
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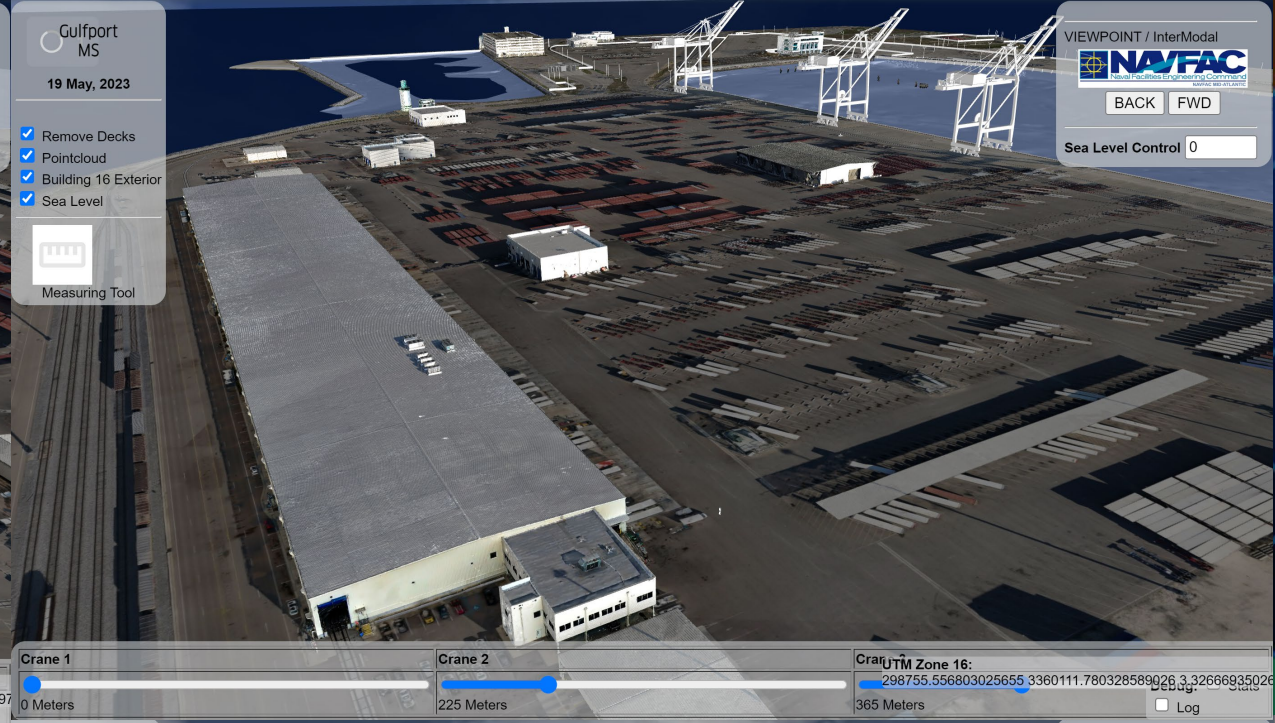
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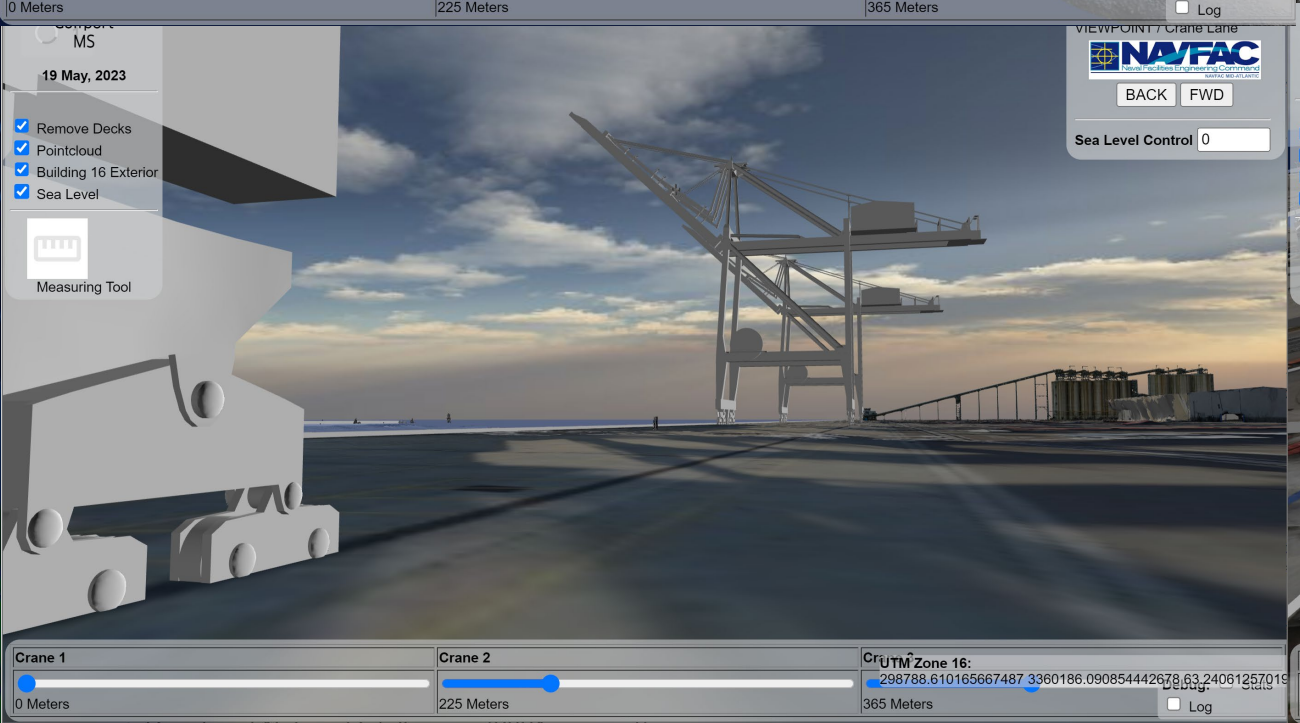
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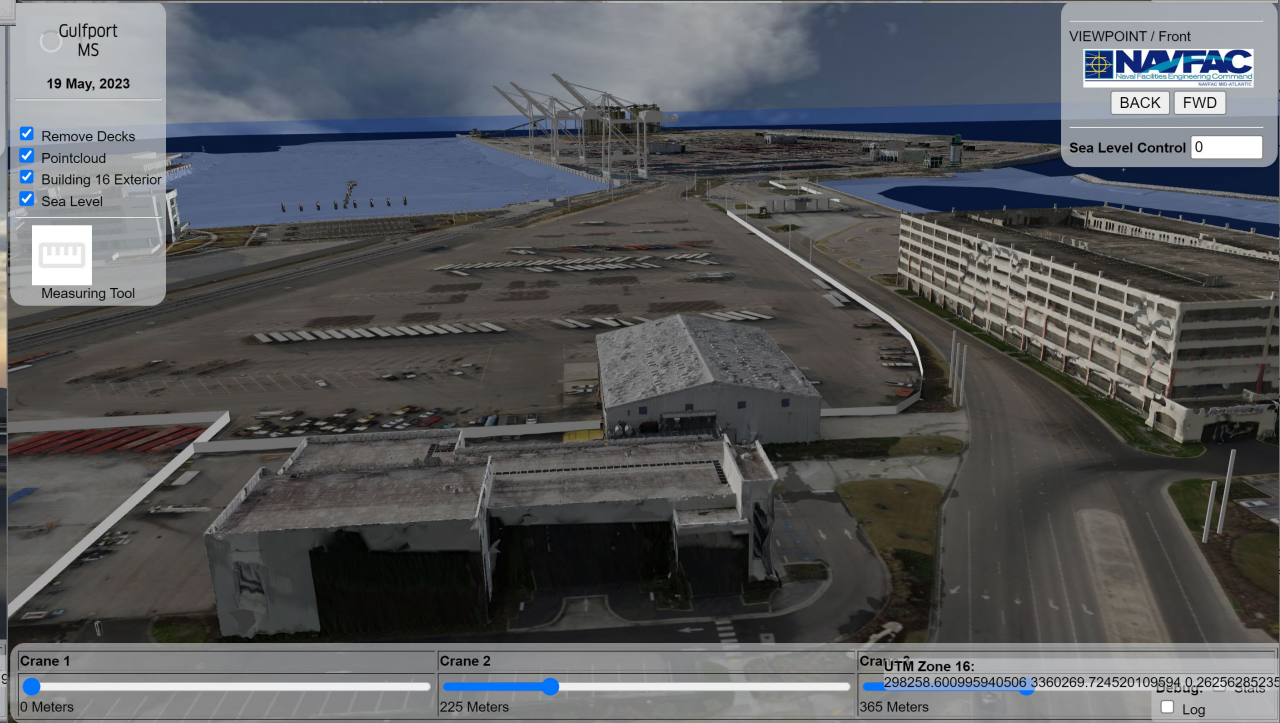
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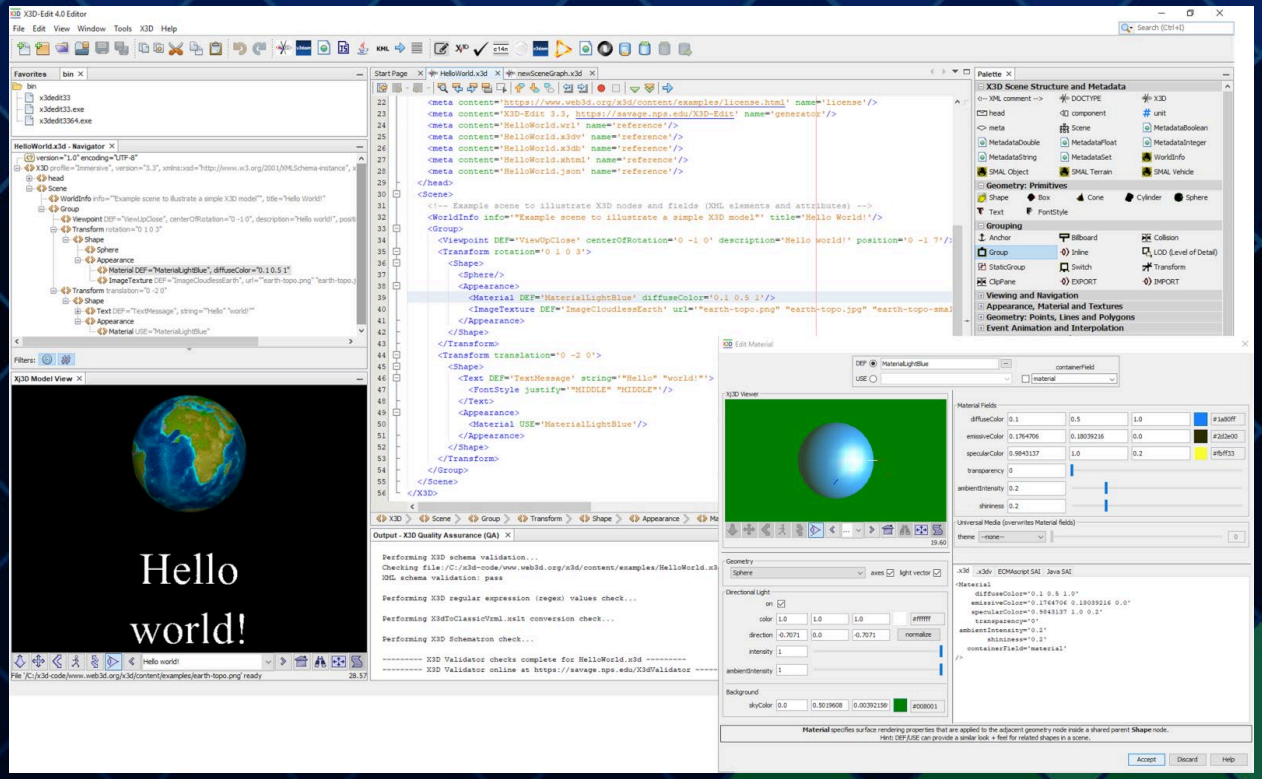
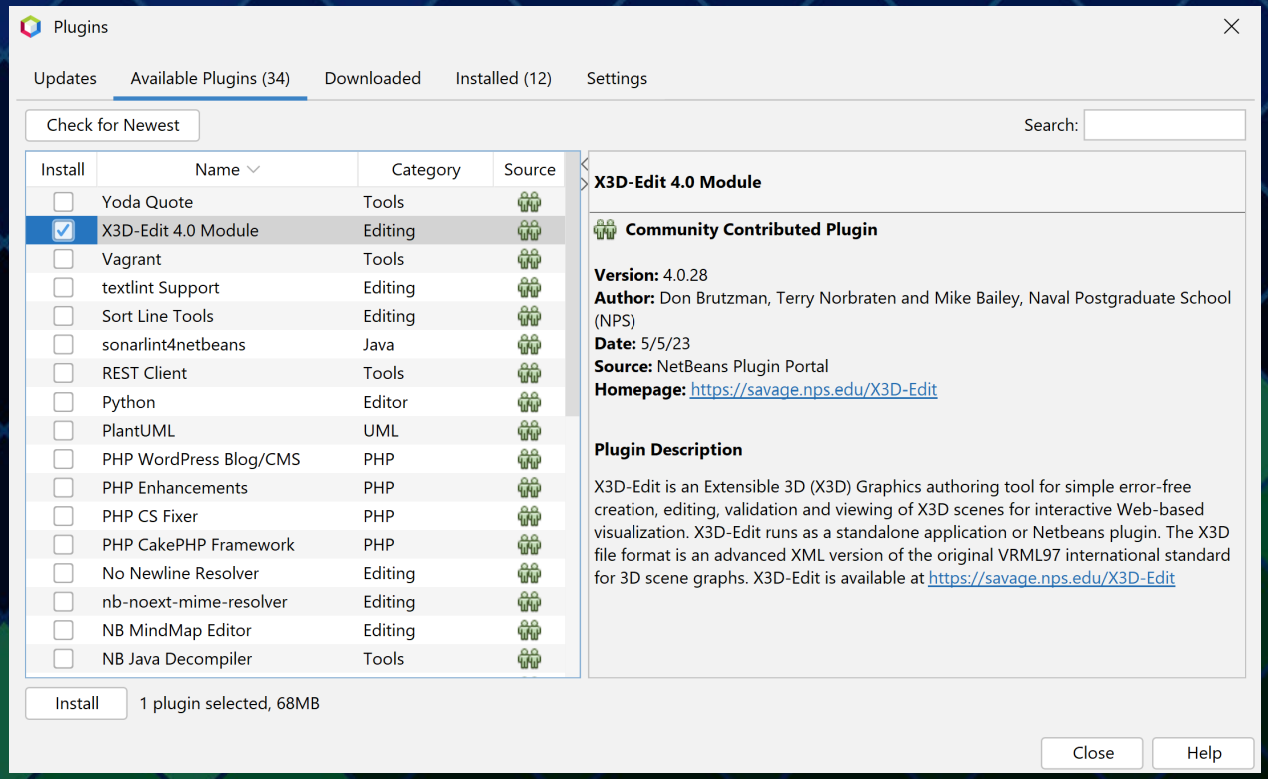
X3D-Edit now a trusted plugin for NetBeans

Apache NetBeans Trusted Plugin (link)





https://savage.nps.edu/X3D-Edit

Additive Manufacturing (AM) and CAMRE: rewriting NPS X3D ModelExchange.nps.edu

Log in

NPS X3D Model Exchange

Welcome NPS Navy and Marine Makers!

Welcome | Discover | Examples | Preview | Upload | Developers | Engage | FAQs | Forums | Learn | Twitter | About | Account | Contact

Search website (updated hourly)

Tools

Forums

Welcome, NPS Navy and Marine Makers!

Welcome to the NPS X3D Model Exchange

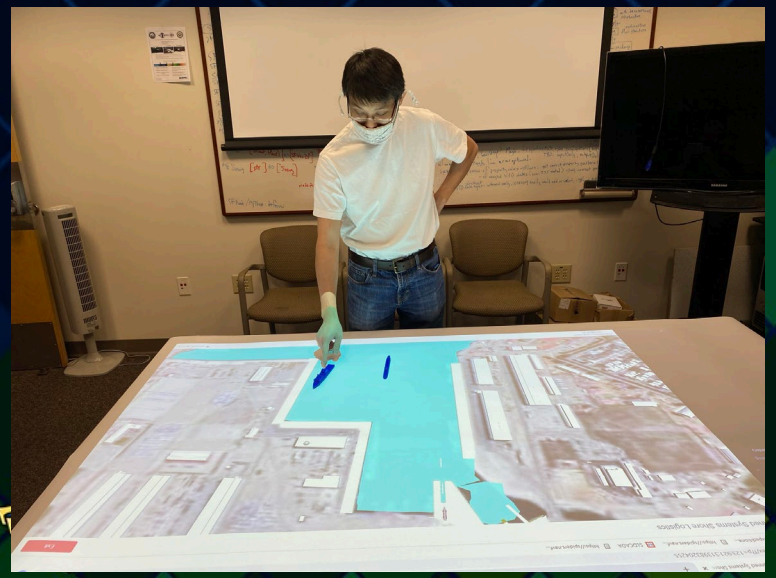
Additive Manufacturing (AM) will have major impacts on future Navy and Marine operations. The goal of the X3D Model Exchange is to help Navy and Marine Makers at NPS learn how to find, produce, share and print 3D models. The X3D Graphics International Standard enables archival publishing of geometric data with corresponding metadata for long-term use and re-use.

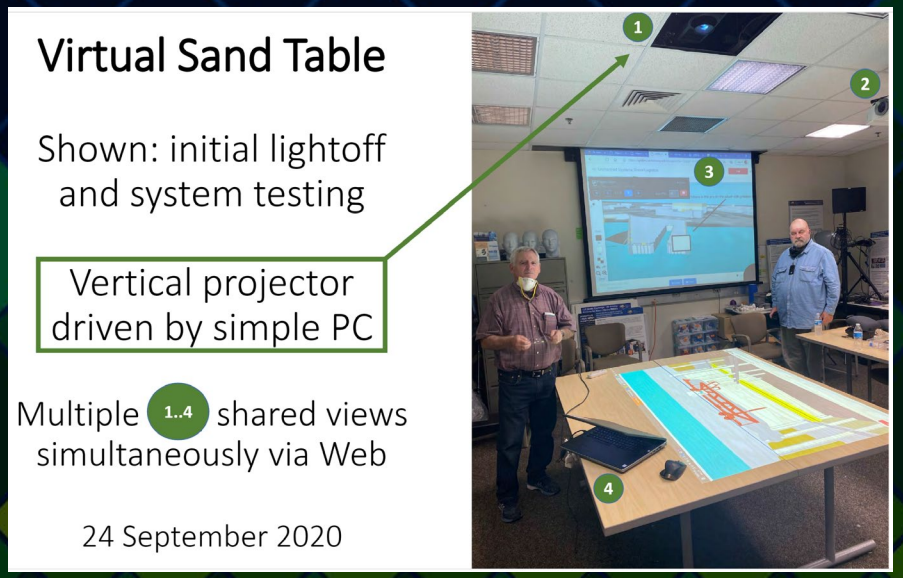
- Presentation: X3D Model Exchange Introduction
- Posters: X3D Model Exchange, NPS Additive Manufacturing, and Large-Scale Adoption
- Available: Naval Research Program (NRP) Project Report, NOV 2018.
- Continuing work: Milestone 2: Soft Launch capability testing.
- Contact Us, send a CAC request, or send email to makers@nps.edu.

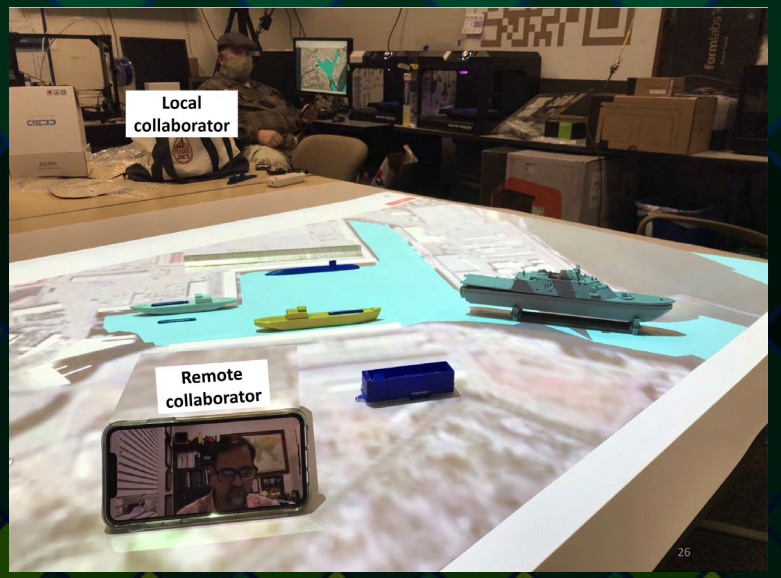
X3D Virtual Sand Table (link)

SPIDERS3D Virtual Sand Table (VST) enables hands-on group collaboration through vertical display and 3D printing of X3D models.

- SPIDERS3D is a Web-based collaborative virtual environment that connects multiple participants in a shared real-world location.
- X3D standard is used to publish 3D models and metadata originating from diverse sources, enabling consistent 3D viewing and printing.
- Individuals can create, cooperatively modify, save and share realistic Naval scenarios of interest.
- A vertical projector displays top-down views for direct team discussion and in-person interaction.
- SPIDERS3D Virtual Sand Table is a low-cost, repeatable new twist on a classic presentation technique.







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