Repeatable Unit Testing of Distributed Interactive Simulation (DIS) Protocol Behavior Streams using Web Standards

Tobias Brennenstuhl
tobias.brennenstuhl.gy@nps.edu

Thesis advisor: Dr. Don Brutzman

2 December 2019

THE MOVES INSTITUTE

Problem Statement

- It is hard for simulation systems to interconnect, especially with partner nations and C2 systems
- Utilizing open-source Web Technology is a valuable resource that can help numerous systems regardless of classification
- Partnerships with NATO partners can improve shared understanding of mutual goals and challenges
- M&S is not relevant to active warfighting unless we can achieve interoperability between Live, Virtual and Constructive (LVC) simulations, robot telemetry, and Command and Control (C2)

Research Questions

- Stability of IEEE DIS specs and capabilities of MOVES LVC Lab offer excellent new opportunities for broad interoperation
  - Open-source codebase by Mike Bailey offers entire vocabulary
  - Curt Blais dissertation work on Rich Semantic Track (RST)
  - How can these best be adapted and applied?
- How to promote DIS behavior streams as first-class media type?
  - Coherent data streams for collaboration, simulation, telemetry
  - Unit testing of recorded streams for adaptable repeatability
  - Establish archivable annotated records of simulation activity

NPS PRAESTANTIA PER SCIENTIAM 1909

THE MOVES INSTITUTE

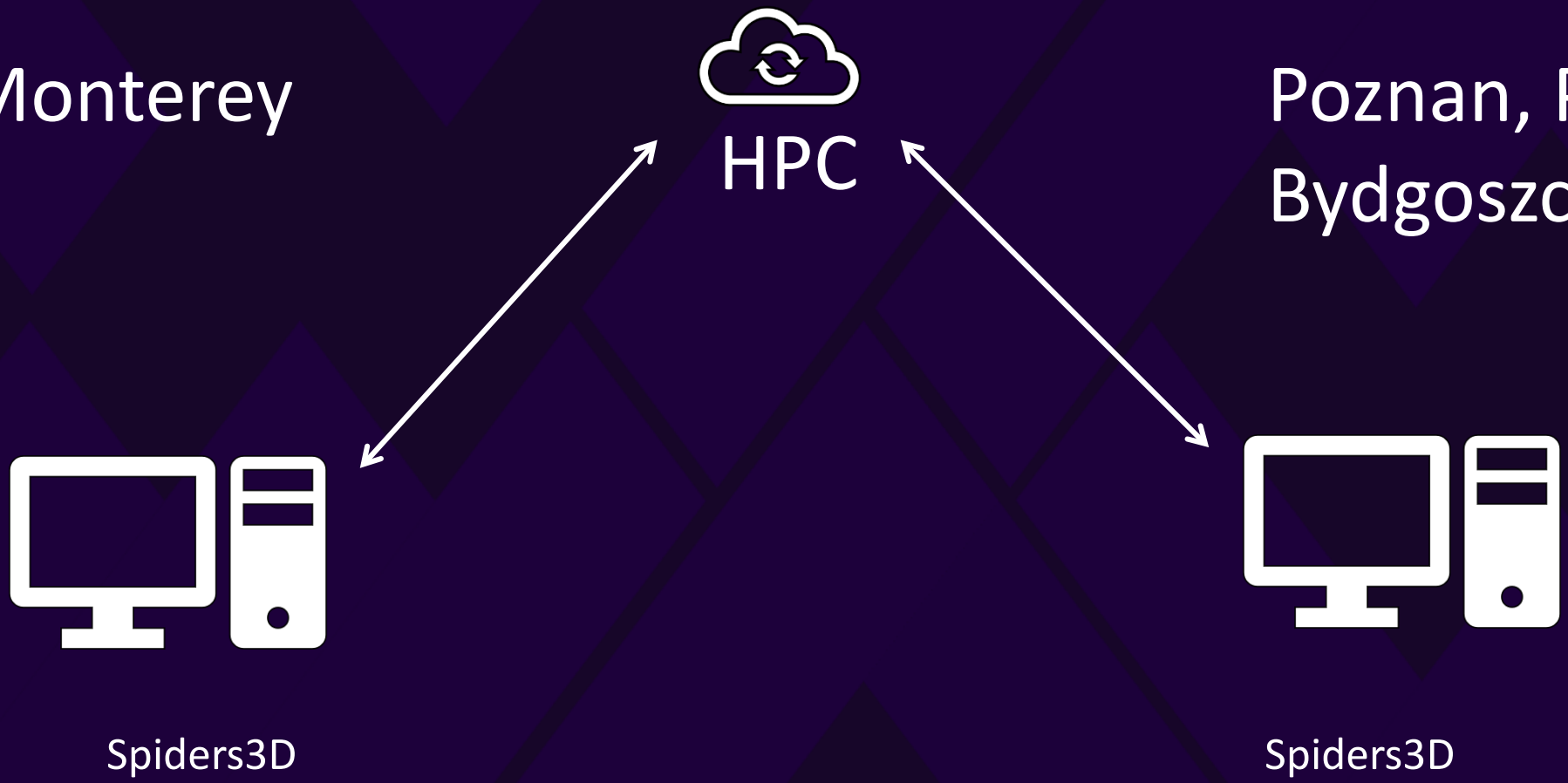
2019

Basic Premises

- Multiple open-source codebases available, initially Java with more languages to follow (JavaScript, Python, XML, JSON, etc.)
- X3D Graphics standard allows dynamic 3D in any Web browser
  - Install Spiders3D on a local web server for experimentation
  - Record remote animation of a model using PDUs
  - Distill concise first-order linear interpolators from streams
- A stream is a stream, at rest in a file or in motion over the network
  - Playback recorded manipulation of a model using PDUs
  - Stream manipulation of models using OpenDIS library

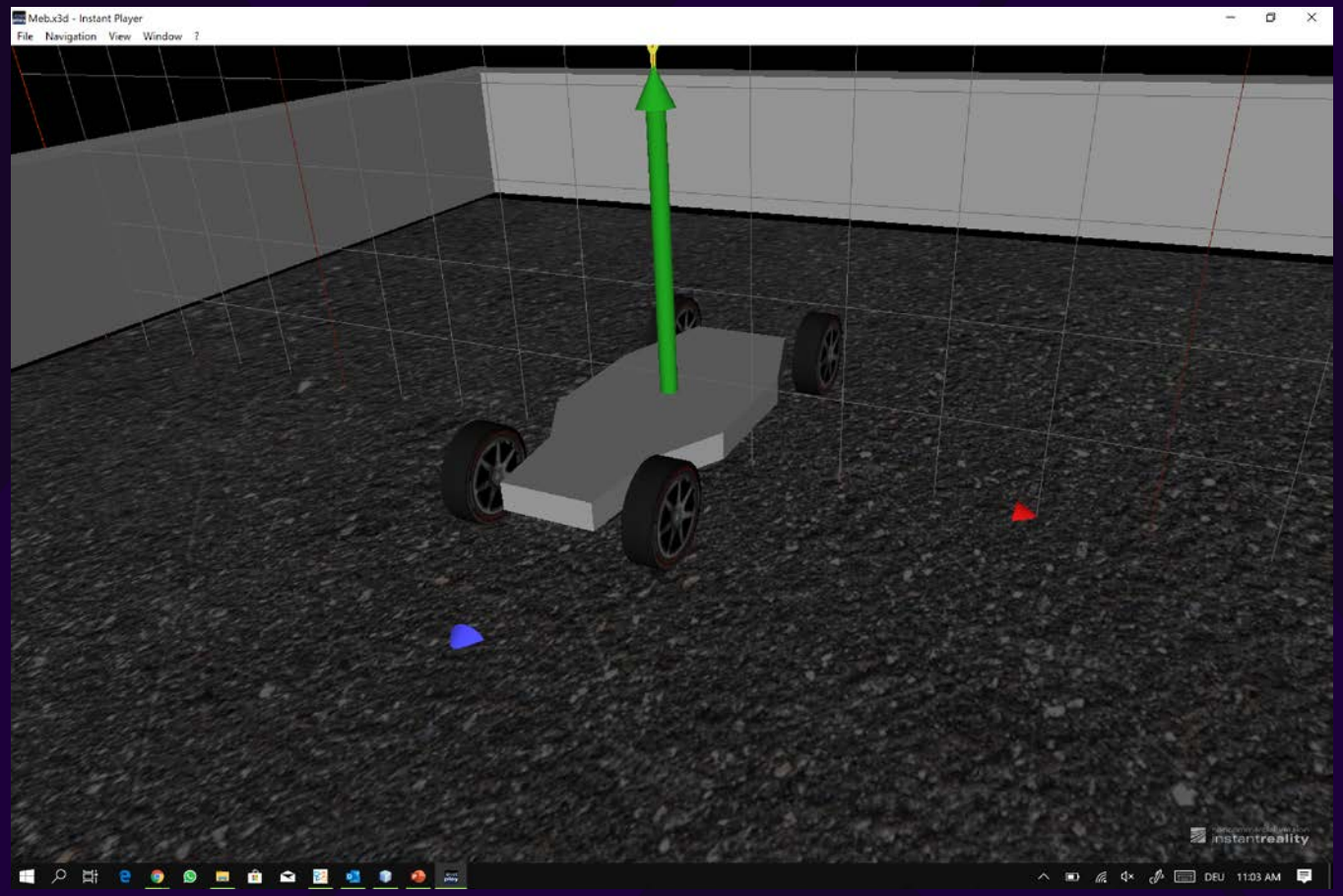
THE MOVES INSTITUTE

Use Case: Long-Haul DIS for Collaboration



Achievements:

- Taking MV3204 Introduction to X3D Graphics



Way Ahead

- ~~Taking MV3204 Introduction to X3D Graphics~~ Half complete
- Further test Java implementation, then create JavaScript
- Contact teams producing open-source X3D players:
  - Fraunhofer X3dom.org and Create3000.de/x_ite
- Inspect Spiders3D JavaScript Virtual Environment Web Server
- Collaborate on distributed LVC models and simulations
  - Take advantage of campus-wide Multicast capability
  - Explore possible HPC network connection to Germany
  - Consider NATO C2SIM and CWIX 2020/2021 participation

NPS PRAESTANTIA PER SCIENTIAM 1909

THE MOVES INSTITUTE

2019

DIS Unit Testing to Confirm Protocol Correctness

Define all 72 IEEE DIS PDU data structures in XML, Java

stream

Simulation program generates PDU traffic

stream

Visual sim playback

stream

New stream PDU log file

IEEE DIS Specifications for packet values, meanings and PDU interaction sequences

Git version control

Authoritative repeatable validatable test results

Reference image, video

Reference PDU log file

"Hello world" unit test

Define simple behavior example as scenario table

- Create entites A, B
- A shoots, misses B
- B shoots, hits A
- Predefined time delays, consistent repeatability

stream

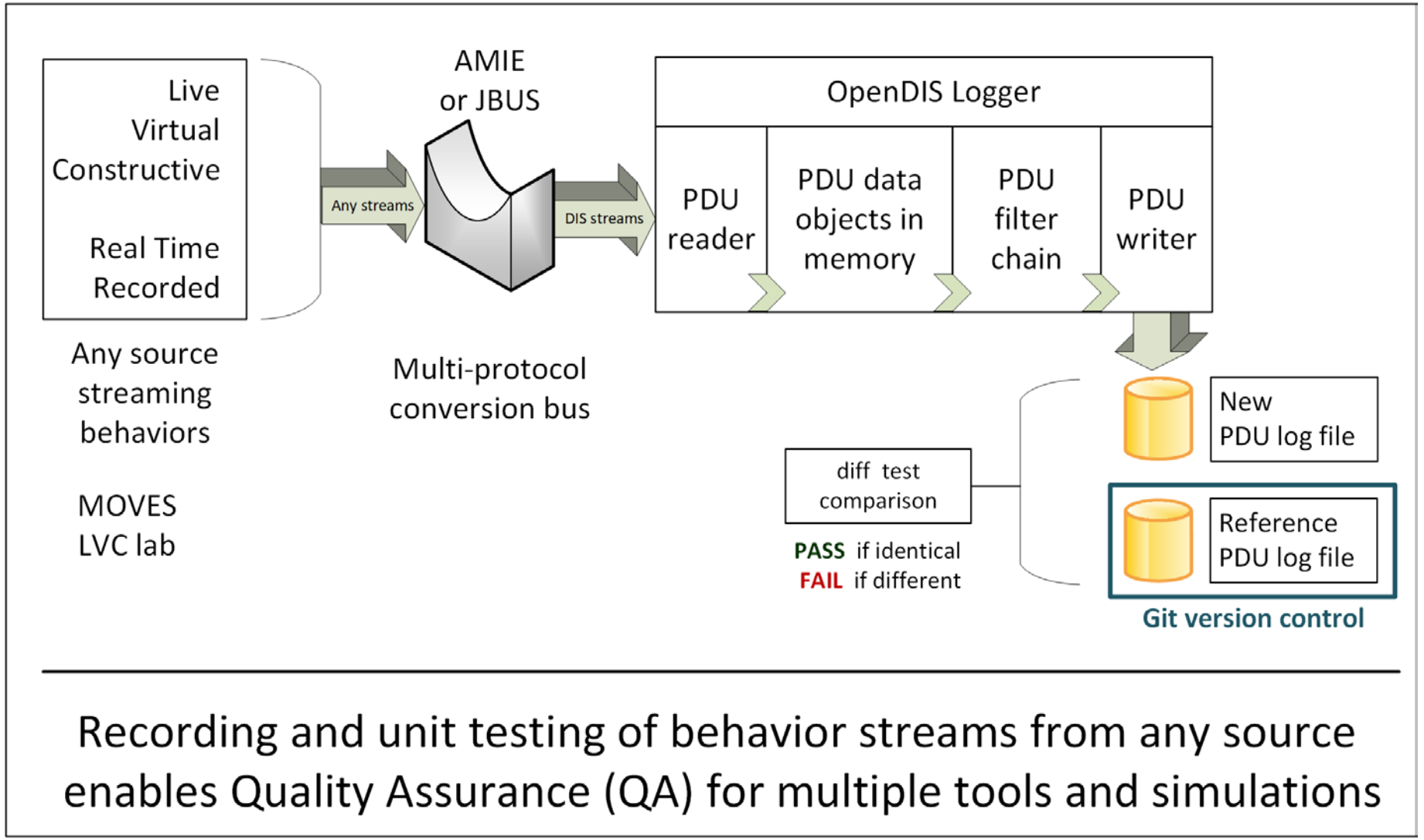
stream

Comparable results

- Inspectable by Wireshark,
- Repeatable by multiple tools,
- Validatable using OpenDIS,
- Visually confirmable

Once process is established, build comprehensive suite of DIS reference scenarios with matching unit-test results

LVC Behavior Streams Unit Testing Implementation Pattern



Recording and unit testing of behavior streams from any source enables Quality Assurance (QA) for multiple tools and simulations