

MV3500 Distributed Simulation Fundamentals (3-2)

March-June 2023

Synopsis	An introduction to distributed communications in simulation applications. Topics covered previously this quarter include CS3502 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. Prerequisites: CS2173 or equivalent (Java programming).		
Instructor	Don Brutzman Office Watkins 270 Office hours are anytime available, as indicated by my online schedule in Outlook/Teams. Make an appointment if you want to be sure to see me. If needed please call me directly.	brutzman@nps.edu http://faculty.nps.edu/brutzman	1.831.656.2149 work 1.831.402.____ cell
Schedule	We meet Monday-Tuesday-Wednesday 11-1200 and as needed. Projects, assignments and demo dates are announced in advance. Savage Lab in Watkins 267 is available to use.		
Course Sites	NPS version control: https://gitlab.nps.edu/Savage/NetworkedGraphicsMV3500 Prior site CLE Sakai: MV3500 Internetwork Communications and Simulation MS Teams, references: Savage – MV3500 channel, Files > MV3500 Wikipedia References		
Software	Savage Developers Guide : Apache NetBeans 17, Java Development Kit (OpenJDK) 19, and Wireshark Network Analyzer Open-DIS Project, https://github.com/open-dis : open-dis7-java , open-dis7-source-generator X3D-Edit Authoring Tool, https://savage.nps.edu/X3D-Edit (use sourceforge prerelease)		
Optional Textbooks	<ol style="list-style-type: none"> 1. Networked Graphics: Building Networked Games and Virtual Environments, Anthony Steed and Manuel Fradinho Oliveira, Elsevier, 536 pages, 2009. Chapter 7 discusses X3D graphics, X3D-Edit authoring tool, and IEEE DIS networking protocol. 2. Networked Virtual Environments, Sandeep Singhal and Michael Zyda, ACM Press SIGGRAPH Series, Addison Wesley, 2009. 3. Modeling and Simulation: Linking Entertainment and Defense, National Research Council (NRC), 1997, Michael Zyda chair and editor. 4. X3D for Web Authors, Don Brutzman and Leonard Daly, Morgan Kaufmann, 2007. 5. IEEE/SISO Distributed Interactive Simulation (DIS) Protocol Standards. 		
Guidelines	<ol style="list-style-type: none"> 1. You must devote time to reading and coding in order to succeed in this course. 2. Students are encouraged to work together. However all submitted assignment must include your own work. Group solutions to project assignments are acceptable when so credited. As in any endeavor, individual integrity is essential. If in doubt, ask. 3. This course has potential to significantly help you in your thesis and other courses. Thus your comments, questions and suggestions are worthwhile and always welcome. 4. Most course communications are in our Teams channel. For course email, please include “MV3500” in the subject line so that email filters can locate it satisfactorily. 		

Course Objectives

1. Understand network programming strengths and limitations for distributed simulation.
2. Improve your programming skills, becoming sufficiently competent to knowledgeably supervise programming teams in future assignments.
3. Support your **thesis work** and projects in other classes, especially MOVES practicum course.
4. Use tools, techniques and a repeatable methodology that can help you later in your career.

Class Policy and Study Recommendations

8. You are learning new ideas and a new vocabulary. Thinking and writing in a new language requires fluency. Don't be reluctant to think new thoughts or work hard. Persistence pays.
2. Discussion and dialog will make class material a lot more immediate.
3. Projects make up your entire grade, just like real world. Exams are *boring* (harsh label).
4. Grading is based on merit and performance. I expect everyone to work hard and get an A.
5. You learn how to program solutions to problems by doing. Thus we do lots of coding and projects. The key for me is to see that you are progressing steadily through hands-on experience. Your final project should pass the "quantitatively cool" test among all of us.
6. Students are expected to check in projects on time. It is your responsibility to contact me in advance for assistance if you are unable to meet an assignment date. If your work is unfinished at deadline, check it in and keep working. If needed: finalize and fix something even if late, since spiral improvement is much better than waterfall crashing.
7. The highest levels of honesty and professional integrity are expected of all military leaders. See [NPS Academic Honor Code NPSINST 5370.4D](#) for a description of your responsibilities.

Candidate Projects

- Ordinarily as the course progresses, we consider a variety of projects that can contribute to shared live virtual constructive (LVC) scenarios that utilize distributed virtual environments.
- For this abbreviated offering, we will primarily focus on IEEE Distributed Interactive Simulation (DIS) Protocol and potential interoperability running with Simkit applications.
- What are your challenges of interest, for your thesis and for your career? Let's discuss it, there are many opportunities available, and I am always happy to help.

MV3500 Distributed Simulation Fundamentals 2023

Week	Dates	Topics	Notes
1	MAR 27-31	1. Course introduction , get started TCP/IP networking	Shared-state interoperability across programming languages; installation of Netbeans , Java OpenJDK
2	APR 3-7	2. Simulation Networking Standards and the Web DIS applications for Live Virtual Constructive (LVC)	Assignment 1 when ready, I can assist your setup.
3	APR 10-14	3. TCP/IP Sockets in Java	
4	APR 17-21	4. TCP Sockets in Java Curt Blais: Rich Semantic Track (RST)	Install/run Wireshark using guidance , watch video Create UML sequence diagram with Visio
5	APR 24-28	5. Java Input/Output (I/O) "Cheat Sheet" presentation 6. User Datagram Protocol (UDP)	Assignment 2 due (unicast) TBD: testing argon VPN
6	MAY 1-5	7. Network Scalability Considerations 8. Distributed Interactive Simulation (DIS) Protocol: DIS101 Tutorial IITSEC 2021 and opendis7 SIW 2022	Assignment 3: DIS comms by adapting OpenDis7Examples - ExampleSimulationProgram
7	MAY 8-12	9. High-Level Architecture (HLA) snapshot	Prepare Open House demo: two cranes operating, network choreography, presentation/poster plan
8	MAY 15-19	11. Network Security: XML, certificates , PKI , etc., Simulation as a Service (SAAS) , Cloud virtualization	Using DIS PDU recorder and playback utilities. Final project design sessions with Simkit examples
9	MAY 22-26	Curt Blais, Rich Semantic Track (RST) MOVES Open House, 23-25 May 2023 10. Test and Training Enabling Architecture (TENA)	Assignment 4: Enumerations examples, DIS assessment. Future: OpenDIS Servlet.
10	MAY 29 -JUN 2	Loren Peitso: Defeating lag in networked physics VEs Project testing, additional coverage of interest.	Debugging, troubleshooting, agile development. Look at selected theses by prior students.
11	JUN 5-9	Exam period occurs during graduation week	Final project demos: elaborations or independence!

Homework Assignments and Grading Criteria

Percent	Task	Summary
	Student professional background and goals	Describe your thesis, warfare community and specialization area. What are your goals for this course, your major, and your career?
20%	Assignment 1	Update unicast sockets sender/receiver, modifying provided code. Demonstrate ability to build, run and document Java programs in course examples that perform networking tasks.
20%	Assignment 2	Modify provided code for unicast/multicast sockets sender/receiver (possibly trusted Argon VPN). Demonstrate proficiency to build, run and document software that performs networking tasks.
15%	Assignment 3	Shared communications examples using NPS campus network, using OpenDIS ExampleSimulationProgram PDU example. Modify provided code, run with streams recorded/saved/replayed using opendis7-java capabilities and Wireshark.
15%	Assignment 4 Class Project	Shared Source Code, Demo Presentation for MOVES Open House Combine DIS, Simkit programs for simple meaningful behaviors. Include DIS enumerations for specific player platforms of interest. Document behavior and save the stream for possible future re-use.
15%	Thought Essay	DIS assessment essay: how might shared distributed state within a virtual environment help your potential research topic of interest?
15%	Project and Presentation	Suggested: thesis prototype demo, example DIS enumerations use, HTTP servlet with DIS protocol, etc. Individual effort or two-person teams. Your choices for topics. <i>Project Attributes</i> are listed on next page. You are undergoing “peer review” with your current and future classmates. We expect your presented, recorded, repeatable work is <i>quantitatively cool!</i>
100%	gitlab version control for persistent progress	Durable outcomes: this work helps you perform future duties as a MOVES graduate and helps efforts in follow-on practicum course. Due diligence also helps future students “look over your shoulder” to observe good practices and continue building lessons learned.

Candidate Course Projects

This quarter's shared course emphasis:

- **Produce DIS PDU outputs from a Simkit program, creating a logged simulation narrative.**
- **Adept recording and playback of DIS PDU streams as necessary step for LVC simulations.**

Project attributes:

- Project preparation plans and progress reports are given in class, as announced. Be ready!
- Source code checked into course gitlab version control as another regular NetBeans project.
- README.md description and directions, includes Javadoc for classes and methods.
- Simple slideset presentation including key points and generous use of screenshots.
- Class demonstration, 15-20 minutes. Include list of accomplishments plus future TODO items.
- Repeatable and useful ideas, for your own theses and for future students. Quantitatively cool!

Additional candidate project choices. Direct continuation of course homework is a good starting point.

Multicast DIS bridge between LANS (2 people)

- a. Connect two LANS via unicast socket.
- b. Read multicast DIS PDUs from each side, send to other side.
- c. Maintain list of passed PDUs, filter duplicates to prevent infinite loops.
- d. Create a recording of the stream, sorted and filtered. Report simple statistics.

Improve test cases to provide unit tests (2 people)

- e. Extend homework3/OpenDisPduSender to set example values for each available PDU method.
- f. Confirm visually using X3D-Edit, WireShark, Java that values are passed (round-trip testing).
- g. Create recording files for each test set, again using X3D-Edit PDU Player-Recorder.
- h. Establish DIS "unit test" by checking results into git so that variations are detectable.

Improve OpenDIS documentation "Missing Manual"

- i. <https://github.com/open-dis/DISTutorial> in Markdown format.
- j. Editorial corrections, note problems and list suggestions for future work.
- k. Build script automated download provide the latest IEEE DIS specification as a reference.
- l. Upgrade Wireshark configuration to support all IEEE DIS PDUs, match OpenDIS build

More elaborate, tactically interesting scenario for generating PDU packets

- m. Prepare for Chris Fitzpatrick practicum, Live Virtual constructive (LVC) network modeling.
- n. Areas of interest: Monterey Bay, Camp Pendleton, Rota Spain, etc.

Advanced projects extending repertoire shown in course:

Assess use cases, add PDUs to John Furr's Forward Observer (FO) thesis Java source code
Adapt a Unity or other program to emit PDUs using Open-DIS C# binding. Caveat programmer!
Read a GPS data file and generate ESPDU stream
Read a different data file (in a commonly used format) and generate ESPDU stream.
Refresh, test demonstration programs using GoogleMaps, OpenStreetMap using HTML/Javascript.
Refresh, update X3DOM OpenDIS example by Byron Harder using HTML/X3D/JavaScript.

- Note separate research progress on this capability is leading to SPIDERS3D updates.

Support future practicum efforts: AIS streams to DIS, exemplar for SIMC2 NATO work, etc.
X3D Position/Orientation Interpolator smoothing/distillation/compression for stream playback.
"Your project here"... work supporting your thesis or professional interests is especially welcome.