Teaching Network Protocol Concepts in an Open-Source Simulation Environment

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Overview

• Philosophy behind Network Workbench
• Teaching network protocols using simulation
• Java Network Workbench 2
  • Features
  • Structure
  • Available exercises
• JNW2 and constructivism
• Grade outcomes/conclusion
Philosophy behind Network Workbench

• We’ve been using simulation as a teaching tool for network protocols since 1993

• Students learn more by solving problems
  • Specifically how network protocols work
  • We provide scaffolding for all the “busy work” of programming
  • They program the core algorithms
  • Simulation provides reproducible results

• Java Network Workbench 2 (JNW2) replaces Network Workbench (which was C++ based)
  • Open source software for teaching
JNW2 and Constructivism

JNW2 is rooted in constructivist philosophy as laid out by Savery and Duffy (1995):

- Anchor all learning activities to a larger task or problem
- Support the learner in developing ownership for the overall problem or task
- Design an authentic task
- Design the task and the learning environment to reflect the complexity of the environment they should be able to function in at the end of learning
- Give the learner ownership of the process used to develop the solution
- Design the learning environment to support and challenge the learner’s thinking
- Encourage testing ideas against alternative views and alternative contexts
- Provide opportunity for and support reflection on both the content learned and the learning process
What is Provided in JNW2

• Overall environment packaged for NetBeans
  • Also usable in Eclipse
  • Java offers lower complexity and student familiarity
• At the heart, a Discrete Event Simulation (DES) engine
  • All activity has known time (or distribution)
  • Each event can trigger another event
• Java classes to support all functions
  • Good quality programming
  • Stack patterned after the Internet Protocol Suite
  • In the middle of key stack layers, place for student to add code
  • With algorithm to be implemented, in comments
  • Must interoperate with open-source code provided
• Example data “email” and network structure
Java Network Workbench 2 Features

• Like the Internet, node addresses have a local and global part
  • And there is a Data Link layer underneath

• DES steps through the simulation visibly, in “ticks”
  • `nextEvent()` pulls next scheduled action from list

• Stochastic option: an event can have predictable time or last for time drawn at random from a distribution
  • But the random number generator seed always follows the same pattern so the outcome is predictable

• Network can be viewed graphically
Java Network Workbench 2 Structure
Mark Pullen Teaching Network Protocol Concepts in an Open Source Simulation Environmnet
Java Network Workbench 2 Exercises

• Data Link Layer
  • *bit stuffing/unstuffing*
  • *error detection*
  • *Carrier Sense Multiple Access with Collision Detection*

• Network Layer
  • *topology matrices*
  • *network layer routing*

• Transport Layer
  • *reliable transport layer*
  • *slow-start sending end window*
More Exercises Planned

- token passing local area networks?
- network layer routing information distribution
- multicast networking
- network security
- application layer message handling
- mixture of traffic types
Grade Outcomes and Conclusion

• ABET requirements stimulated collecting outcomes; students score a letter grade higher on JNW2-related exam questions

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• Students enjoy the projects and learn more
• JNW2 is available http://netlab.gmu.edu/JNW2
  • Solutions available by faculty request on department letterhead