

Getting Students' Hands Dirty With Clean-Slate Networking

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Our Current Thinking: Network as Artifact

“There is a tendency in our field to **believe that everything we currently use is a paragon of engineering, rather than a snapshot of our understanding at the time.** We build great myths of spin about how what we have done is the only way to do it to the point that our universities now teach the flaws to students (and professors and textbook authors) who don't know better.”

-- John Day

Instead: Could we change the *network* as easily as applications?

TCP/IP Header in Lego Format.



Problem

- Conventional networking courses teach today's protocols and mechanisms as fixed artifacts
- **Question:** Can students be taught to think critically about network architecture?
 - Clean slate thinking
 - Hands-on experience analyzing, building, etc.
- How to structure the course without the familiar “scaffolding” of the network stack?

Syllabus Organization

- Organize around **problems**, rather than layers
- Network management problems
 - Network configuration
 - Traffic engineering
 - Network security
 - Network troubleshooting
- For each task, consider the division of labor

Programming Assignments

- Goals
 - Help students develop an arsenal of tools
 - Teach domain details (learn by doing)
 - Teach thinking across layer boundaries
- Assignment Domains
 - Enterprise networks
 - Wide-area networks

Enterprise Network Assignments

- Layer-two configuration
 - Click, Emulab, Quagga
 - Set up topology as simple, switched LAN
 - Relying on Emulab infrastructure, and using Click
- Hubs, switches, and routers
 - NOX/Mininet
 - Different network elements perform similar rules on packets (matching/actions)
 - Uses same platform to study all network elements

Wide-Area Network Assignments

- Connecting a virtual network to the Internet (using Transit Portal)
 - Set up virtual network of choice
 - Connect to Internet with BGP (advertise prefix)
 - Experiment with rate limiting
- Analyzing measurement data (using NetFlow and BGP data)
 - BGP convergence behavior
 - Routing table properties

Discussion and Lessons

- Alternate organizations may work better (e.g., around types of networks)
- More novelty, less grunt work
- New course modules
 - Home networks
 - Mobile and cellular networks

Conclusion

- Networking technologies, concepts, and tools are evolving rapidly
- No longer makes sense to discuss network as an artifact
 - Instead, teach students to address problems
 - Give them the tools for implementing their solutions to problems