

Network System Capstone @CS.NCTU

Emulation and Simulation

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Introduction to Network Simulations

- A **software** program models the behavior of a network
- Calculate the interaction between the different network entities
 - Routers, switches, nodes, access points, links, etc.
- Event-based simulations
 - Process a queue of sequential arriving events
- Tutorial
 - http://www-sop.inria.fr/members/Giovanni.Neglia/ns_course/slides/lec5.pdf

ns-3

- [Discrete event](#) network simulators
- Completely abandon backward-compatibility with ns-2
- Built using C++ and Python with scripting capability
 - ns library is wrapped by Python
 - ns models and core are implemented by C++
- Workflow
 - Topology definition
 - Model development (UDP, IPv4, applications, etc.)
 - Node and link configurations
 - Execution
 - Performance analysis
 - Visualization

ns-3 Tutorial

- Tutorial
 - <https://www.nsnam.org/docs/tutorial/html/>
- Installation
 - <https://www.nsnam.org/wiki/Installation>
- Documents
 - <https://www.nsnam.org/documentation/>
 - <https://www.nsnam.org/docs/release/3.33/tutorial/ns-3-tutorial.pdf>
- Tutorial
 - <https://www.nsnam.org/tutorials/simutools08/ns-3-tutorial-slides.ppt>
 - <https://www.nsnam.org/docs/ns-3-overview-july-2014.pdf>

Emulation

- Hardware or software that enables a network system
- Test a network design over a **virtual network** built upon a single (or multiple) physical NIC
- Packets are actually sent and received through real NICs
- (Usually) communications between two virtual NICs without a physical link
- Real traffic from applications
- Tools: Mininet
 - https://www.slideshare.net/MominaMasood1/mininet-demo?from_action=save
 - https://www.slideshare.net/e2m/mininet-basics?from_action=save

P4

- Programming language for controlling packet forwarding planes in networking devices, such as routers and switches
- P4 targets
 - Execution machine
 - P4 can be compiled for CPUs, FPGAs, SoCs, network processors and ASICs (Tofino)
- Tutorial
 - <https://github.com/p4lang/tutorials>
 - <https://wiki.onosproject.org/pages/viewpage.action?pageId=16122675>
 - <https://olivermichel.github.io/doc/p4.pdf>

Bmv2: P4 Software Switch

- Reference P4 software switch (Emulator)
- Written in C++11
- Take as input a JSON file generated from your P4 program by a [P4 compiler](#)
- Interpret it to implement the packet-processing behavior specified by that P4 program
- <https://github.com/p4lang/behavioral-model>

Traffic Generation

- Commodity tools
 - Iperf
 - Support [client](#) and [server](#) functionality
 - Support both TCP and UDP
 - Scapy
 - Packet manipulation tool
 - Forge or decode [packets](#)
 - Support packet injection, custom packet formats and scripting
- Tutorial of Scapy
 - https://scapy.net/conf/scapy_pacsec05.pdf
 - https://guedou.github.io/talks/2019_BHUSA/Scapy.slides.html

Traffic Generation Model

- Stochastic model of the traffic flows or data sources in a packet-switched network
- Can be used to evaluate the performance of a network system
- Types of models
 - Poisson traffic model
 - Long-tail traffic model
 - Standardized Internet traffic models
- Introduction to queueing theory
 - <https://web.mit.edu/modiano/www/6.263/lec5-6.pdf>

Mobility Models

- Characterize the movements of mobile users with respect to their location, velocity and direction over a period of time
- Allow a simulator to simulate the behaviors of users
- Type of patterns
 - Random patterns
 - Realistic patterns
- Well-known models
 - Random way point model
 - Random walk
- Tutorial
 - <https://www.cise.ufl.edu/~helmy/Helmy-Mobility-Tutorial-IWCMC-1.ppt>
<https://slideplayer.com/slide/4774735/>