What is Network Programming?

Software Defined Networking Webinar Series

Speakers: Serges Nanfack
Hostess: Kara Sullivan
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Welcome to the 1st session of the **Software Defined Networking** webinar series!

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Software Defined Networking Series

NEXT SESSION:

Intro to SDN

📅 29 November, 2016 – 7:00 A.M. PST

Register at: bit.ly/SDNSeries
What We are Going to Cover

1. Today’s network
2. What is network programming?
3. Why do we need Programmable networks?
4. Technologies that enable programmable networks
Today’s Network
Point-of-Sale

Taxi

Hotel

Bookstore

Print Advertising

Car

Music
Digitization Is Changing The World

- Bookstore
- Taxi
- Music
- Hotel
- Print Advertising
- Car
- Point-of-Sale
Digitization Is Changing The World

- Bookstore: Amazon
- Taxi: Uber
- Music: Spotify and Pandora
- Hotel: Airbnb
- Print Advertising: Google
- Car: Tesla
- Point-of-Sale: Square
Digital Disruptors

Social  Mobile  Data  Cloud
Today’s IT Model – Complex, Not Fast Enough

Box by Box
Manual Configuration

Security      QoS      Path Optimization
Today’s Passive Networks

• Dumb store-and-forward network
  Smart end hosts implement key functions
  Simple routers store and forward packets
  Limited network processing (e.g., routing, forwarding, buffering, and packet scheduling)

• Packet header used in a simple way
  Common, standardized format
  Causes one of a small set of operations to occur
  Packet forwarded or dropped based on those rules
  Network (largely) ignores higher-layer headers

Enable experimentation and innovation inside the networks?
Evolution of the Server Configuration

1990’s:
- Server
- CD
- Ethernet cable (or)

Today:
- Data center
- Chef
- Puppet Labs
- UCS Manager
- OpenStack
What is Network Programming?
Network Virtualization

Traditional

Virtualized

Forwarding instructions are sent by the controller to each device.
Control Plane and Data Plane

- A network device contains the following planes:

- **Control plane** - This is typically regarded as the brains of a device.
  - Used to make forwarding decisions.
  - Contains Layer 2 and Layer 3 route forwarding mechanisms, such as:
    - Routing protocol neighbor tables and topology tables
    - IPv4 and IPv6 routing tables
    - STP
    - ARP table

- **Data plane (forwarding plane)** – Typically the switch fabric connecting the various network ports on a device.
  - The data plane of each device is used to forward traffic flows.

Cisco Express Forwarding (CEF) is an advanced, Layer 3 IP switching technology that enables forwarding of packets to occur at the data plane without consulting the control plane.
Programmable Networks

• Packet == data + code
  Smart hosts, as before
  Active nodes that can execute code on the data
  Active packets that carry code to active nodes

• Postscript analogy
  Contains both your data, and the program the printer runs to print your data

• Active networks
  allow an individual user, or groups of users, to inject customized programs into the nodes of the network.
Programmable Routers

- What is programmable

- Who can program

configuration  policy based routing  code per packet

OS upgrade  off-line download

manufacturer  owner  end user

authorized contractor  “big” users
Why Programmable Network?
Motivation for Programmable Networks

- **High-level goal**
  
  Leverage computation in the network

- **User pull**
  
  Automatically adaptive streaming
  
  Data aggregation to reduce data volumes
  
  Computation closer to users to reduce latency

- **Industry push**
  
  Ad-hoc collection of middleboxes emerging
  
  Replace with generic, multi-purpose active nodes
  
  Otherwise, proliferation of active components will happen anyway, without any common framework
Motivation for Programmable Networks

• Big mismatch in rates of innovation
  Applications change quickly (e.g., Web, P2P, IM)
  The network changes slowly

• Deploying new network technology is hard
  Delay for standardization (at the IETF)
  Additional delays for vendors to implement and service providers to deploy the new technology

• Better to decouple services from hardware
  Minimize the amount of global agreement
  Load new services on demand
What Enables Network Programming?
Enabling Technologies for Programmable Networks

• Component-based software engineering
  Building blocks for composing software

• Code mobility (e.g., Java)
  Previously between end hosts, not network nodes
  Innovation in safe and efficient code mobility

• Field-programmable gate arrays (FPGAs)
  Enabling higher speed of packet processing

• Research in programming languages
  And PL folks’ interest in networking
Two Models of Programmable Networks

• Active networks are active in two ways
  Switches run code on data flowing through them
  Individuals can inject programs into the network

• Programmable switches: discrete ANs
  Separation of program loading and execution
  E.g. program loading only by network operator
  Packet is demultiplexed to the right program

• Capsules: integrated ANs
  Every packet is a program, and carries its code
  Perhaps in a restricted programming language
Three Parts to a Programmable Network

• Execution environment
  - Virtual machine with access to node resources
  - General, Turing-complete vs. restricted models

• Active applications
  - Provide an end-to-end, customized service
  - Load code on to the routers to program the VM

• Node operating system
  - Support multiple execution environments at once
  - Provide safety between execution environments
Join the Next Session: Software Defined Networking

- Network Programmability concepts
- SDN architecture
- Type of SDNs
- Open flow Protocol
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