教育部智慧聯網技術與應用人才培育計畫 -- 智慧製造電子應用聯盟

軟體定義無線網路
(Software-Defined Wireless Networks)

電子工程系
曾柏軒 (Po-Hsuan Tseng)
History of Software-Defined Networking

• OpenFlow, the major protocol used in Software Defined Networking (SDN), was introduced in ACM SIGCOMM 2008 [1].

• OpenFlow is considered as the enabler of SDN.

• In 2011, the InformationWeek magazine introduced OpenFlow as the biggest thing since Ethernet was developed by Robert Metcalfe in 1973.

History of Software-Defined Networking

For years, computer scientists have dreamed up ways to improve networks' speed, reliability, energy efficiency, and security. But their schemes have generally remained lab projects, because it's been impossible to test them on a large scale.

http://www2.technologyreview.com/news/412194/tr10-software-defined-networking/

http://video.mit.edu/watch/tr10-software-defined-networking-541/
What is SDN?

• Software-defined networking (SDN) is an approach to computer networking
  - allows network administrators to programmatically initialize, control, change, and manage network behavior
dynamically via open interfaces and abstraction of lower-level functionality.
• SDN architectures decouple network control and forwarding functions
  - enabling network control to become directly programmable
  - the underlying infrastructure to be abstracted from applications and network services.
What is SDN?

- With the addition of **controller** and **OpenFlow** protocol to separate
  - control plane
  - forwarding/data plane
### What is SDN?

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<th>API</th>
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<td>Controller</td>
<td>Open Network Operating System (ONOS)</td>
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<td>EstiNet MT198T legacy/SDN hybrid switch</td>
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Why SDN?

• Google deployed OpenFlow in its datacenters since 2010, and later announced many benefits and great improvement of utilization in ONS 2012.
What is Network Function Virtualization (NFV)?

• Network-function virtualization (NFV) is a network architecture concept
  • proposes using the technologies of IT virtualization to virtualize entire classes of network node functions into building blocks
    • that may be connected, or chained, to create communication services.
教材來源

• 教育部行動寬頻尖端技術人才培育計畫 SDN/NFV 課程
  - SDN/NFV Core Network by Prof. Meng-Hsun Tsai in National Cheng Kung University  http://mbat-cctu.nsysu.edu.tw

• Other Courses
  - Software Defined Networking, by Prof. Nick Feamster in Princeton University  https://www.coursera.org/course/sdn1

• Book

• Research Paper
  - “Software Defined Wireless Networks” series, IEEE Communications Magazine, November 2015
課程網頁: 個人網頁

108-1 軟體定義無線網路 四子四甲、四乙、四丙、電子所

最新消息
- 9/27(五)因老師出差攔會，停課一週。
- 9/30 課程訊息已公布。

課程資訊
Fri. 5, 6, 7 (教室 104)
Office hour: Thur. 4, 5, 6, 7, 8, 9，綜合科學 207-3 室
助教：黃其蓉 stu5012 AT gmail.com / 李明儒 stube680646 AT gmail.com
綜合科學 210 室

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https://myweb.ntut.edu.tw/~phtseng/#SDN
網路討論區

GitLab 社群: 程式碼託管，會依據使用狀態評分
課程資訊 (1/2)

• 授課時間
  - Fri. 5.6.7 (綜科 104)

• 評分方式: 實驗作業與期末專題需放在 GitLab 上供所有同學觀摩
  - 實驗 45%
  - 期末專題 25%
  - 期末考 25%
  - 出席率 5%
課程資訊 (2/2)

• 助教資訊:
  - 楊其峰 stu92012@gmail.com
    - 綜合科館 210 室
    - 若要約時間請以 email 聯絡。
  - 李陞陽 stube0806450@gmail.com

• Office Hour
  - 禮拜四 11:00 - 18:00。
  - 綜合科館 207-3 室
  - phtseng@ntut.edu.tw
上課方式

• 上課地點在物聯網實驗室 (綜科 104) 上課
• 一般課程 5 weeks
• 實驗課 6 weeks
  - 兩人一組進行實驗
  - 助教講解基本操作，回答問題並展示結果
  - 每組配有兩張 Raspberry Pi Model 3B+、無線網卡，(搭配 AP)
• 業師授課 2 weeks
  - 研華：介紹工業物聯網平台
• 期末考/期末報告
一般課程規劃

• Wireless SDN 概念課程:
  - 參照成大蔡孟勳教授的教材，加入 SDN for IoT/SDN/NFV for 5G System 論文的討論
    ✓ 1. Introduction of SDN;
    ✓ 2. The Road To SDN: Introduction of Computer Networking;
    ✓ 4. Controller
    ✓ 5. Network Function Virtualization (NFV);
    ✓ 6. SDN for Internet of Things (IoT) and SDN/NFV for 5G System
實驗課程設計

- **SDN Basic**  
  - Understand the protocol for control/forwarding separation
    ✓ OpenFlow Protocol
  - Simulate the performance of SDN
    ✓ Mininet
    ✓ EstiNet: use EstiNet MT198T legacy/SDN hybrid switch
  - Setup a controller
    ✓ ONOS or RYU
  - Setup a SDN switch
    ✓ Open vSwitch (OVS)
      ➢ Setup using Mininet and Raspberry PI

- **SDN Applications**
  - SDN for WiFi clients using hostapd
  - SDN using meter-table
  - SDN for IoT using Mesh Networks (bonus/final project reference)
實驗課程 (1/3)

• 実験課:
  - LAB 0: Linux Basics
    ✓ Linux installation on VM
    ✓ Linux basic instructions
  - LAB 1: Mininet installation
    ✓ Mininet installation
    ✓ Setup network topology in Mininet
  - LAB 2: Controller on Mininet
    ✓ OVS installation, how to use OVS
    ✓ ONOS/RYU controller installation
    ✓ Observe the topology in Web GUI
    ✓ Perform a complete SDN simulation
- LAB 3: WiFi + Open vSwitch (OVS) on Raspberry PI
  ✓ OVS installation, how to use OVS
  ✓ OVS bridge combined with Hostapd
  ✓ ONOS Controller on Ubuntu/VM

OVS on Raspberry PI

SDN switch

(Demo) 兩台裝置(手機)連上 Hostapd, 利用 flow 阻擋 其中一台裝置上網。

利用 Flow 阻擋特定封包 類似防火牆
乙太網路連接外網 並達到上網功能

e.g., eth0

e.g., wlan0

此介面使用 TP-LINK 無線上網卡 開啟 Hostapd

Lab210
- LAB 4: Software Defined Wireless Mesh Network [OPTIONAL]

- Wireless mesh network to support **wireless backbone** for Internet-of-Things (IoT)
  - SDN introduces Flexibility of Wireless Mesh Network
- OLSR installation to set up a mesh network
- OVS bridge for wired and wireless connection
業師授課

• 工業物聯網
  - from 研華
105-2 學生專題分享

- Service Dedicated Line (by 陳惇介, 鄭坤名)
  - 因應遠端控制、監控與近年來發展的物聯網需求，利用這些網路需求僅需固定頻寬、穩定連線的特性，本專案依服務為其提供特權專線，確保服務穩定。
Q&A