Hows of a Campus WiFi Network: Case study of IITB Wireless

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A Few Questions

• What is a Campus WiFi?
  • Deployment of many WiFi APs across the campus
  • Have a mode of management and configuration

• How did it come up? And what is the need?
  • Started as auxiliary/secondary internet source.
  • With faster technologies and increased online activities, became more prominent.
  • Easier deployment, covers wide range of users (compared to Ethernet)
  • As HOTSPOTS: for additional capacity and coverage
A Few Questions

• How is Management of large/medium scale deployment done?

  • Can’t be manual
    • Configuring/ Re-configuring individual APs is a pain and may not be consistent.
  • Centralized management is a good option.
    • Gives a global view and flexibility.
  • Controller talks to APs about configuration, connections etc...
    • Needs a protocol of communication and connection to be setup.
A Few Questions

• Is IITB Wireless centrally managed? What features does IITB Wireless provide?

  • Yes.
    • It is a centrally managed deployment by ARUBA Networks.
  • Provides
    • Multiple networks: IITB Wireless, eduroam, IITB Guest.
    • Roaming
    • Can host temporary networks for conferences, workshops etc.
    • AND LOT MORE....
A Typical Centrally Managed WiFi Deployment

• Controller
  • Communicates to AP about connections, configurations and various other things

• Pre Configured APs
  • Like identifying controller, what data to forward to controller, what data to accept from it etc.

• A Protocol
  • For communication and setting up the deployment
A Typical Centrally Managed WiFi Deployment

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- **Pre Configured APs**
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- **A Protocol**
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**THIS IS HOW EXACTLY IITB WIRELESS IS ALSO DEPLOYED**
A Few-more Questions

• How does a IITB Wireless AP look like? What all does it have?
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  • This is how it looks like:
A Few-more Questions

• How does a IITB Wireless AP look like? What all does it have?
  • This is how it looks like:

- It has 2 dual band radio cards and a PoE port (Ethernet)
- On each card it hosts 3 networks eduroam, IITB-Wireless, IITB-Guest
- The deployment uses non overlapping channels 1,6 and 11 respectively in neighborhood.
A Few-more Questions

• How are different wireless networks hosted on single radio card?
  • Each radio card/interface has a base MAC-ID
  • Multiple virtual interfaces created on the card
    • MAC-ID will be increment of base MAC-ID
    • Every network is identified with SSID (Network name) and BSSID (which is MAC of interface)

• How are connections to IITB Wireless, IITB Guest, eduroam different?
  • These networks are on different logical/virtual interfaces, equivalent to different APs
  • Connections to each one of them is managed independently
Networking in IITB Wireless

• What is the IP address of AP?
• What IP address do I get when I connect to IITB Wireless?
• Do they lie in same Subnetwork?
Networking in IITB Wireless
Networking in IITB Wireless

Wireless link

Wired LAN link

IITB Wireless 10.196.*.*

10.196.104.248

10.107.1.250

EE VLAN 10.107.*.*

Internal Router at CC

10.197.96.2

10.196.96.2

10.196.96.1

10.197.106.112

IITB Guest 10.197.*.*
Networking in IITB Wireless

• What is the IP address of AP and what IP address do I get when I connect to IITB Wireless? Do they lie in same Subnetwork?
  • IP to you (your device) is given by the DHCP server of central WiFi controller.
  • The wireless connection belongs to the VLAN in which controller is present and not the VLAN of department. AP belongs to the VLAN where it is located.
  • There is a tunnel (IP in IP tunnel or a transport layer connection) from AP to Controller

• How is this tunnel setup?
Tunnel setup

• Connect a Pre-configured AP
Tunnel setup

• Connect a Pre-configured AP

10.107.46.221
Gateway of EE 10.107.1.250
10.196.96.2
Controller 10.196.96.1
Tunnel setup

• AP configured with controller address. Contacts the controller
Tunnel setup

• Controller authenticates the AP and sends a reply and permission to setup tunnel
Tunnel setup

• AP setups the tunnel with controller. May be a persistent connection
Tunnel setup

• Any client trying to connect to this AP, data will be forwarded to controller and controller manages the connection
Roaming in IITB Wireless

• How does the connection continue when I move from one floor to another?
• How does the connection switch to another AP automatically?
Roaming in IITB Wireless

• Basic Service Set and Extended Service Set

• In ESS
  • Many APs are configured to have same SSID and security credentials
  • Different APs are differentiated based on BSSID (MAC)

  BSSID – SSID MAP

• In WiFi switching connection is always client decision
  • Avoided as much as possible by client
  • Can be forced by controller by disconnecting client from certain AP
  • Faster handoffs have non standard key caching techniques or support IEEE 802.11
Roaming in IITB Wireless

Client moving this way
Roaming in IITB Wireless

- Client switches to another AP within same ESS preferentially.
- Even if signal strength of Random WiFi is more than IITB Wireless, client prefers switching to IITB Wireless
Deficiencies in Existing Deployment

- Can different APs be deployed in this setup
  - Entire setup is proprietary deployment by ARUBA
  - The tunnel and protocol are not standard
- Is the deployment scalable?
  - Difficult beyond a point, as all data goes to controller
Addressing interoperability

• Standard protocols are developed
  • CAPWAP - Control And Provisioning of Wireless Termination Points
    • By IETF
    • UDP based protocol - RFC 5415
    • Bindings are written for 802.11 WLAN Networks RFC 5416
    • Protocol to configure CPE (Customer Premise Equipment) from remote ACS (Auto Configuration Server)
    • http/SOAP based protocol for configuration
Addressing Interoperability

- A CAPWAP tunnel is setup between AC and WTP
- Applications are written on these main threads for CAPWAP 802.11 bindings
  - An application to set configurations
  - An applications to retrieve statistics
Addressing Scalability

• Why should all the data be tunneled?
  • There are 3 kind of frames in IEEE 802.11 networks
    • Control frames
    • Management frames
    • Data frames
  • Data frames can be locally bridged.
  • Forward only control and management frames

• Does multiple controllers help?
  • Local controller to manage real time activities like roaming
  • Global controller to manage global activities like authentication
Addressing Scalability

- Wireless link
- Wired LAN link
- WAN link
- Control Plane
Addressing Scalability

- Wireless link
- Wired LAN link
- WAN link
- Control Plane

Global Controller

Local Controller

Internet
• What is SDN? How does it help
  • SDN: Software Defined Networking. Enables dynamic programming of network
  • Separates Control plane and data plane
  • Provides standard interfaces or APIs for features. Implementation may differ below this level

• Is it really needed?
  • Yes. It makes APs light radios that forward data
  • Gives global view, uniform policy management
  • Enables interoperability by providing standard interface.

• Is the solution scalable?
  • Yes. As the controller is not loaded with data.

• Existing work?
  • Odin, OpenFlow wireless or OpenRoads, ethanol etc.
Proposed Architecture for SDN Controller

Hierarchical Controller Architecture
- Time critical operations in local controller
- Global policy management in cloud controller

Access technology independent protocol
- Manage Wi-Fi, Wi-Max deployments using same controller
- Same controller to manage TVWS backhaul and also WLAN deployment

Standard Interfaces
- Enables interoperability
Proposed Architecture for SDN Controller

Controller and switches: **OpenFlow** protocol

Controller and APs: TCP based protocol
(Proposed for standardization)
  - Wireless technology independent protocol
  - Bindings written to support specific wireless technology

Controller to controllers: Openflow forwarded by flow visor
THANK YOU