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

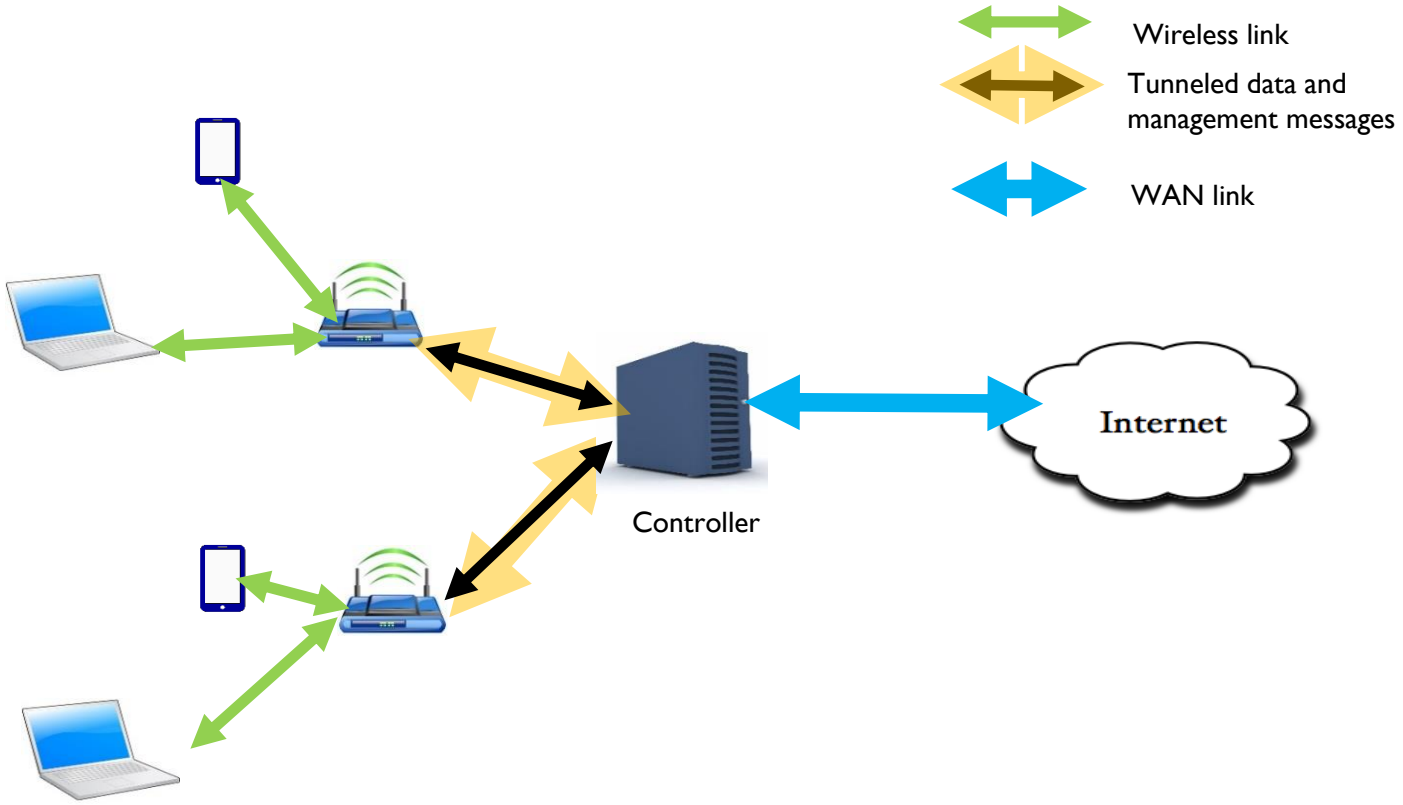
A Few Questions

- 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

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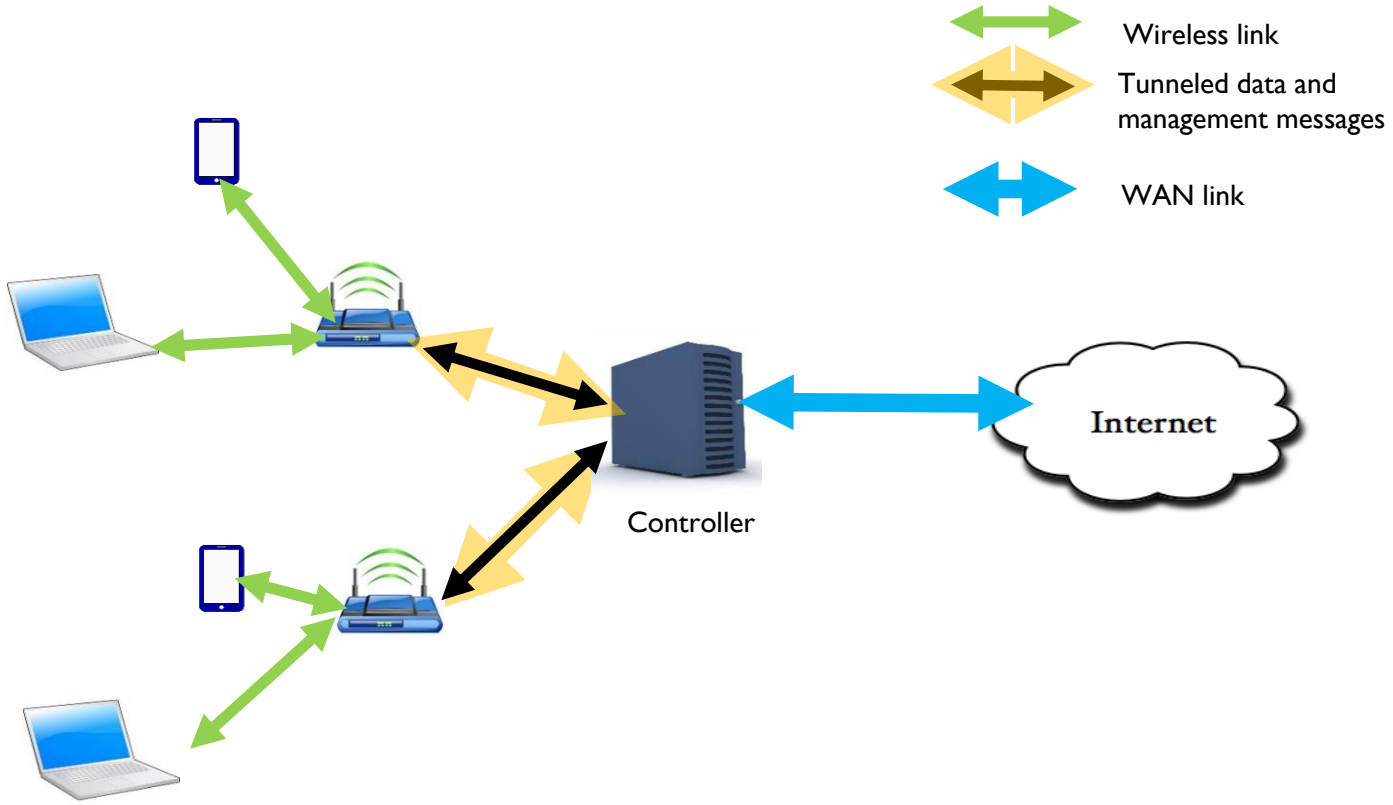

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THIS IS HOW EXACTLY IITB WIRELESS IS ALSO DEPLOYED

A Few-more Questions

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- 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

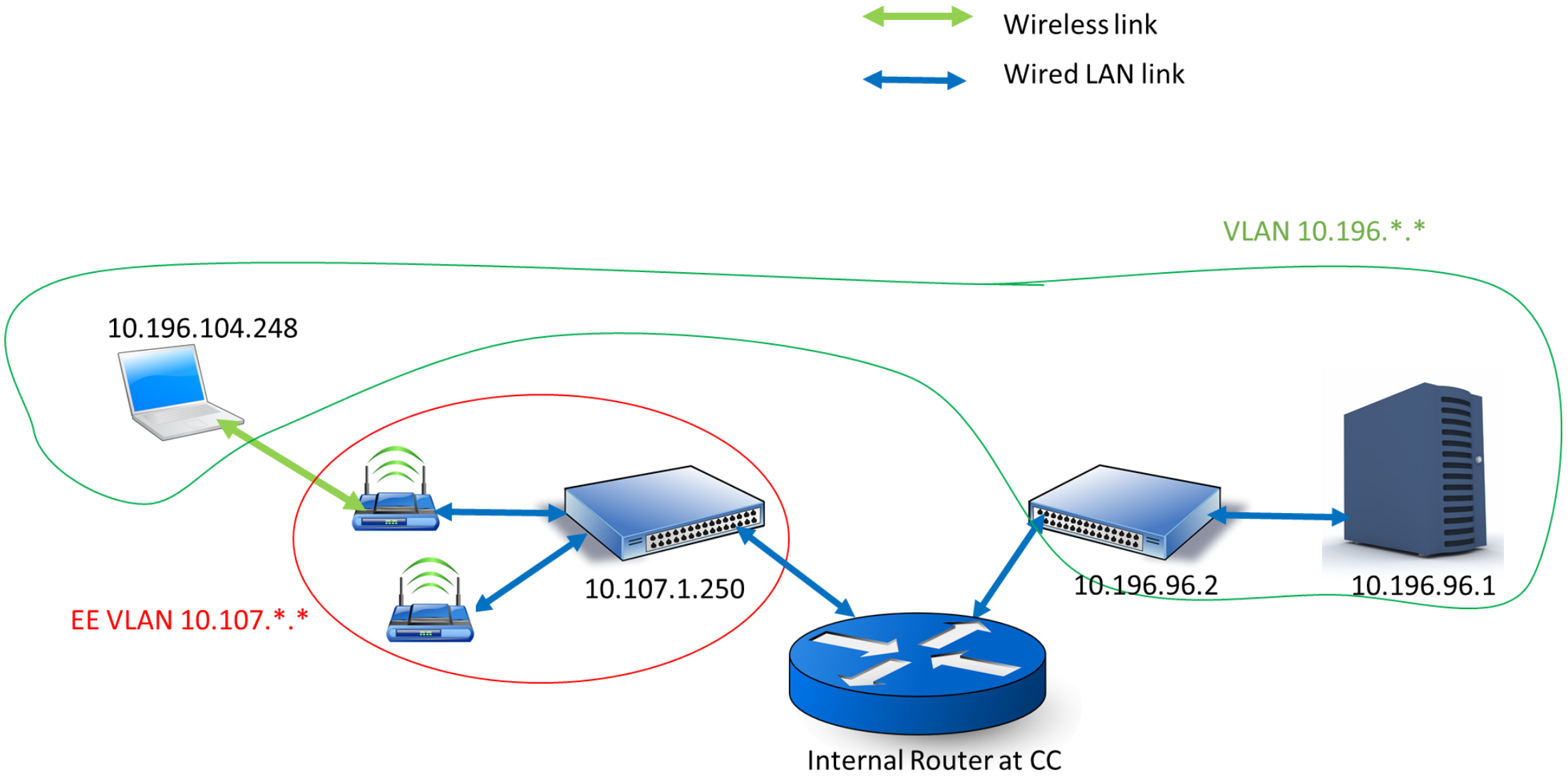
- How are different wireless networks hosted on single radio card?
  - Each radio card/interface has a base MAC-ID
  - Multiple virtual interfaces created on the card
    - MAC-ID will be increment of base MAC-ID
    - Every network is identified with SSID (Network name) and BSSID (which is MAC of interface)

- 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

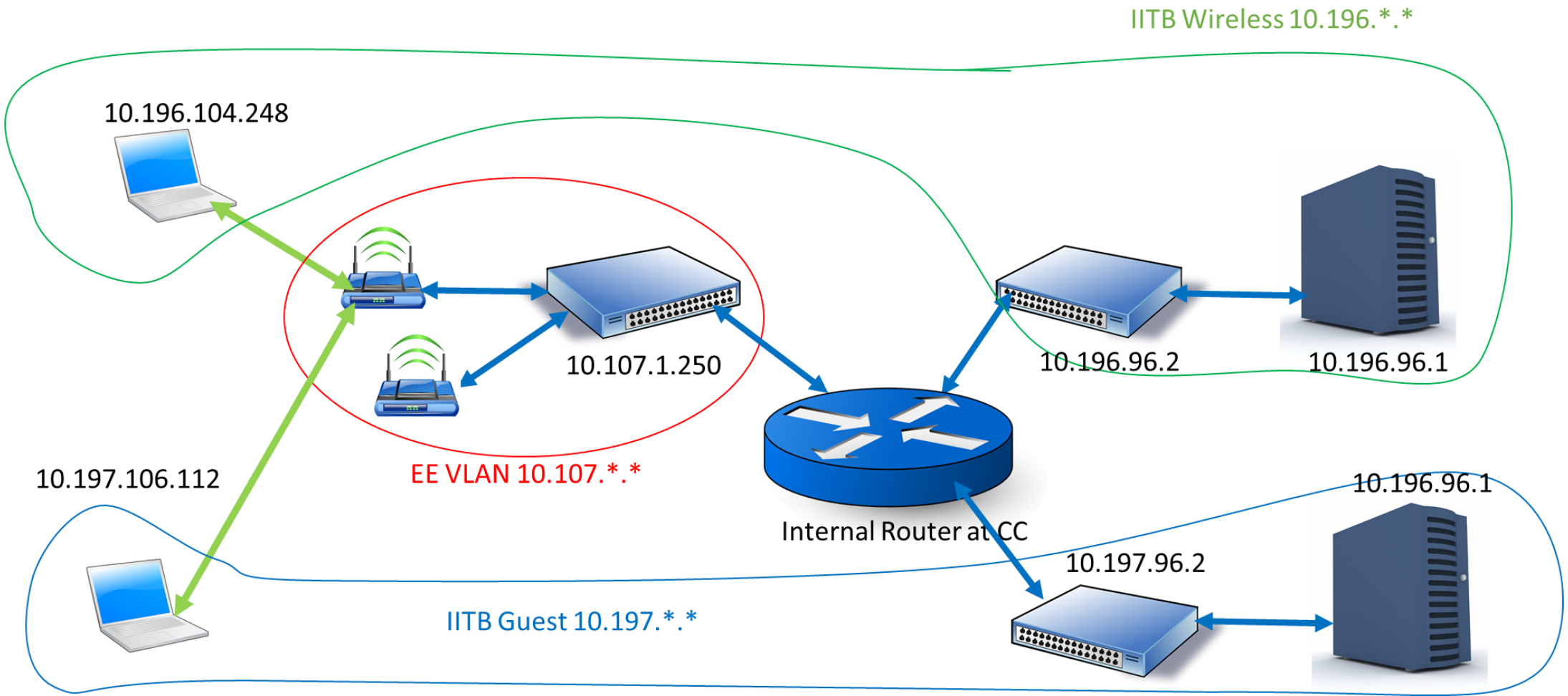
- What is the IP address of AP?
- What IP address do I get when I connect to IITB Wireless?
- Do they lie in same Subnetwork?

Networking in IITB Wireless



Networking in IITB Wireless

Wireless link Wired LAN link



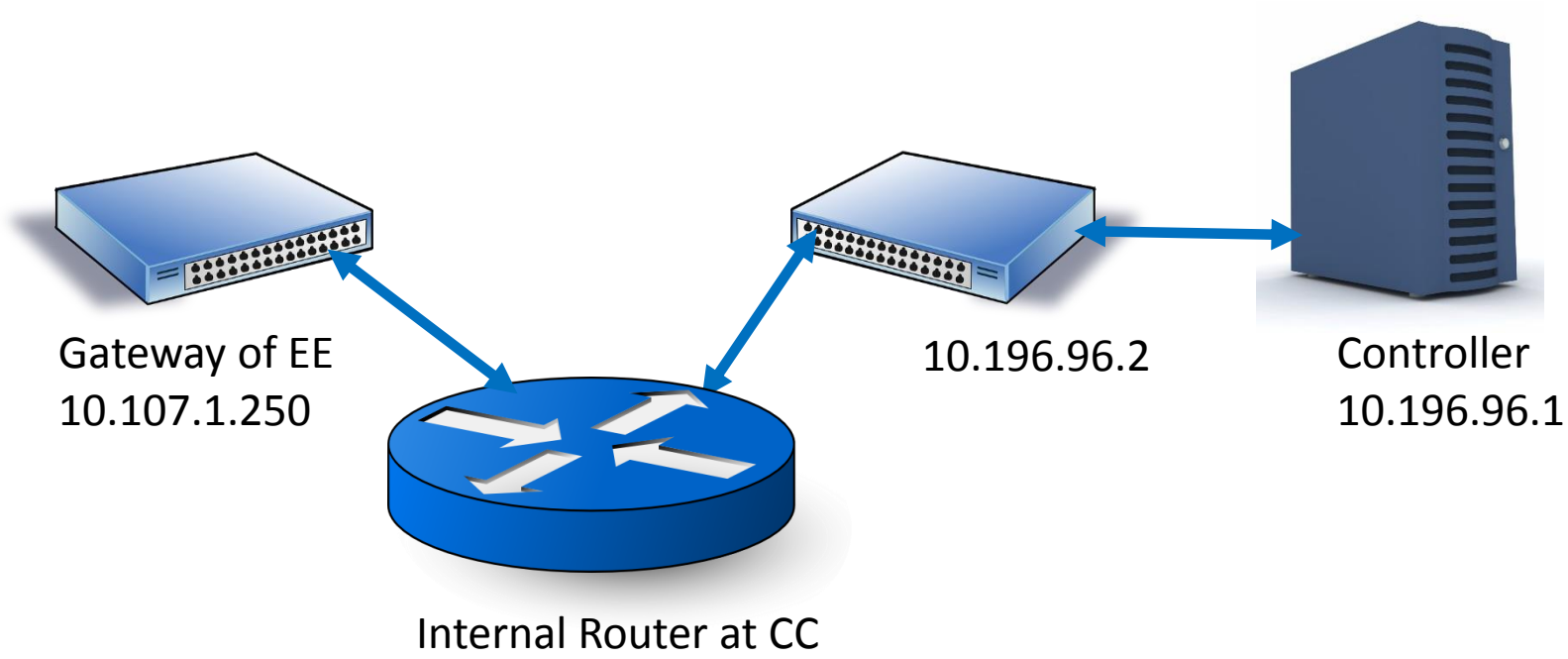
Networking in IITB Wireless

- 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

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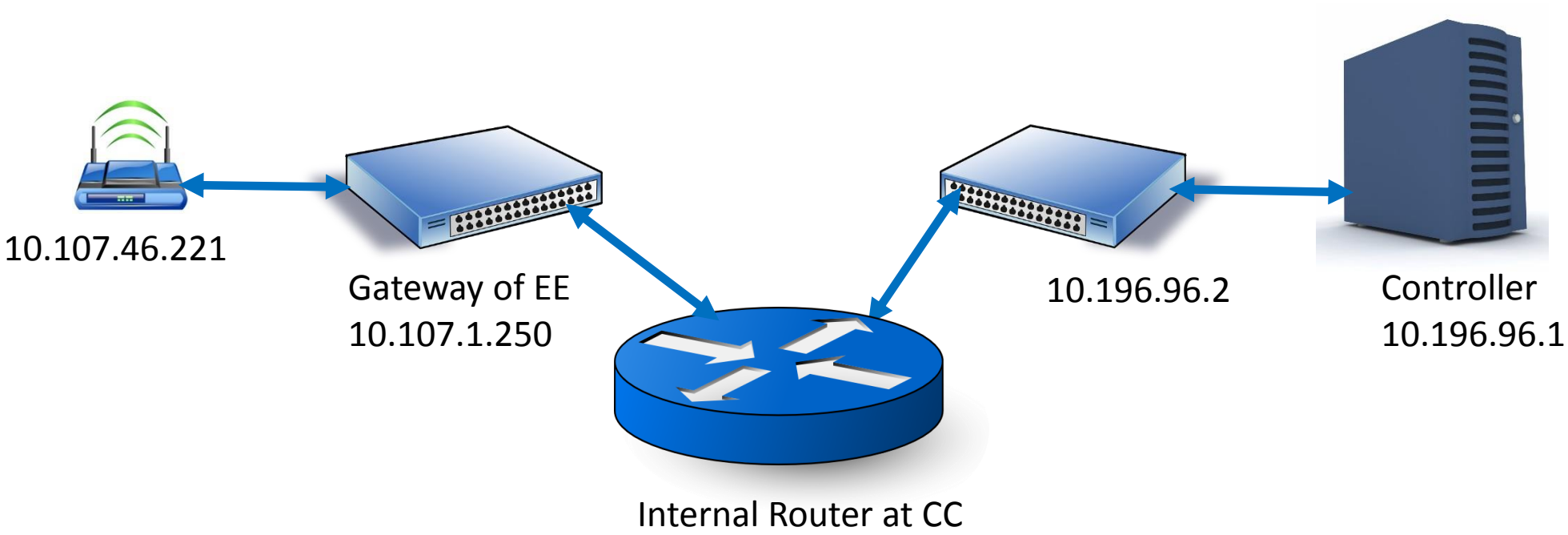
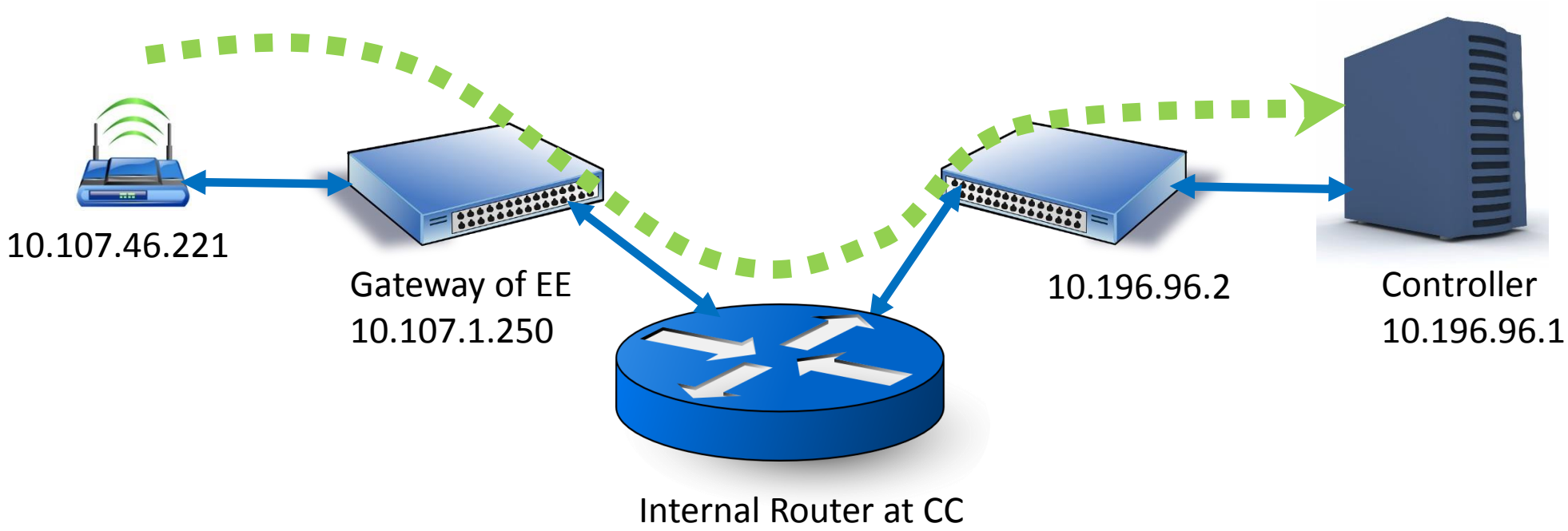


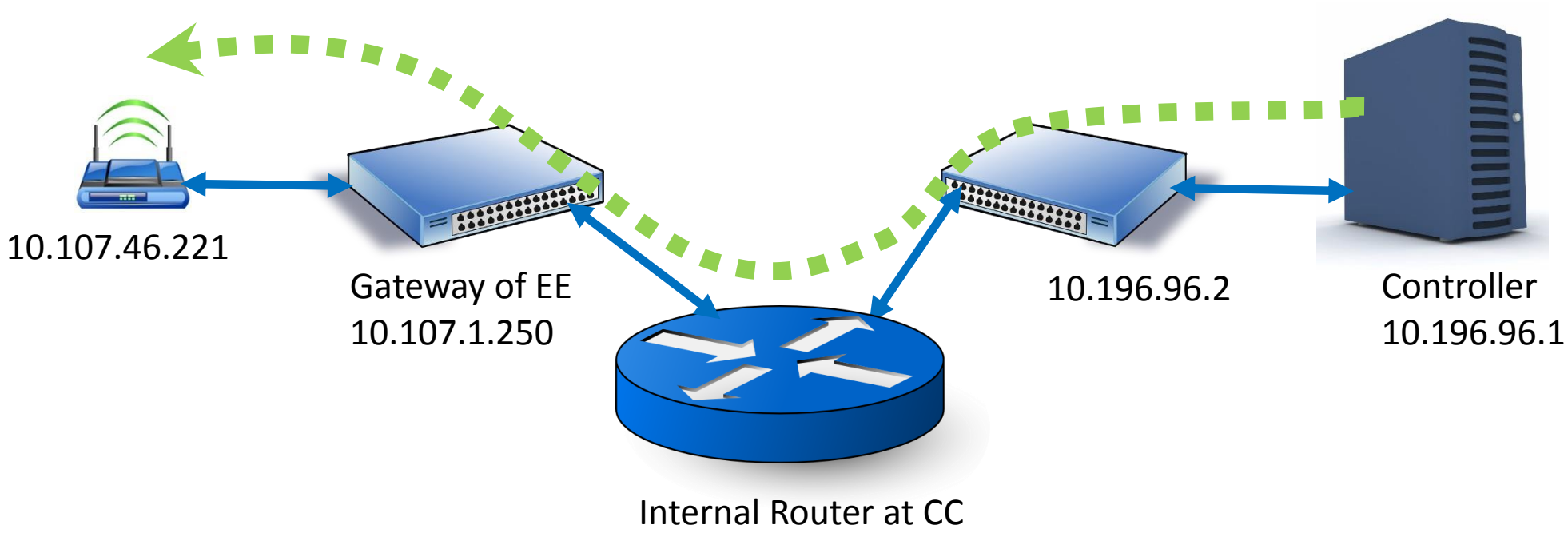
Tunnel setup

- AP configured with controller address. Contacts the controller



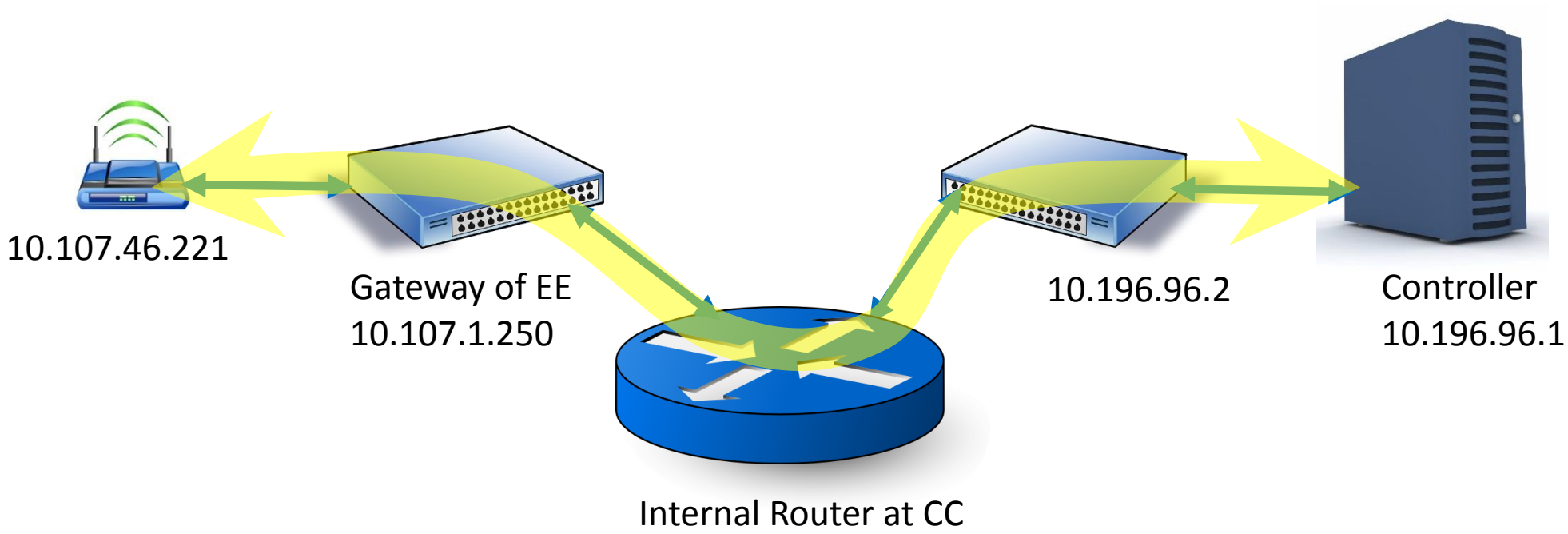
Tunnel setup

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



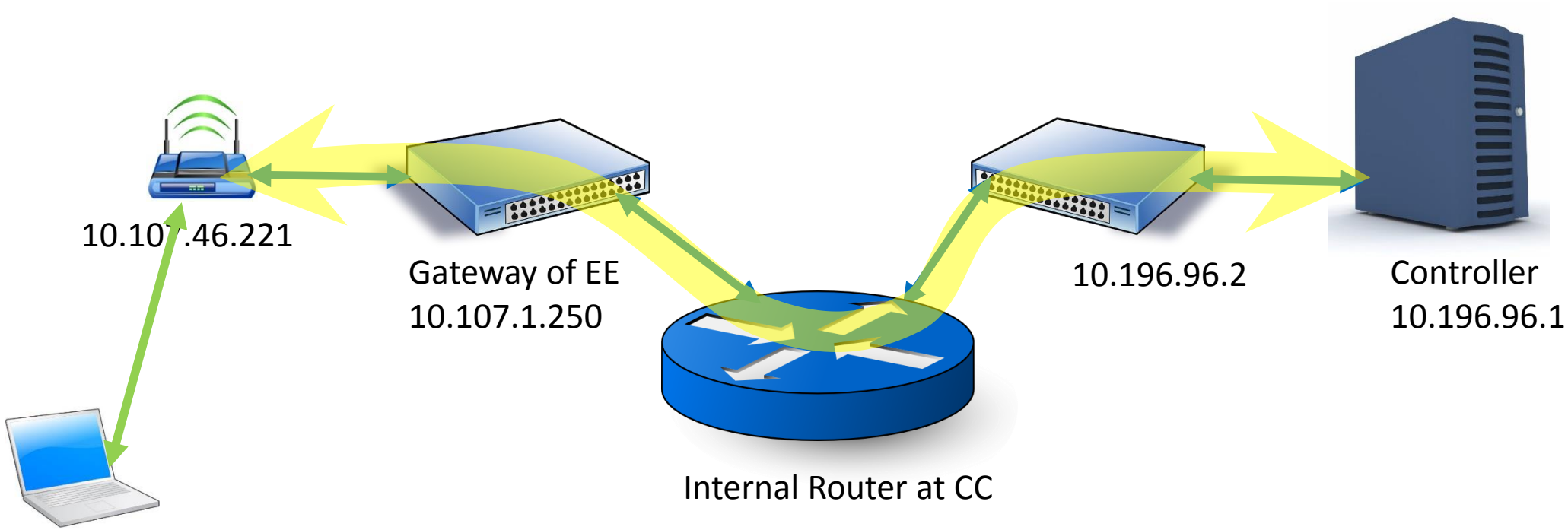
Tunnel setup

- 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

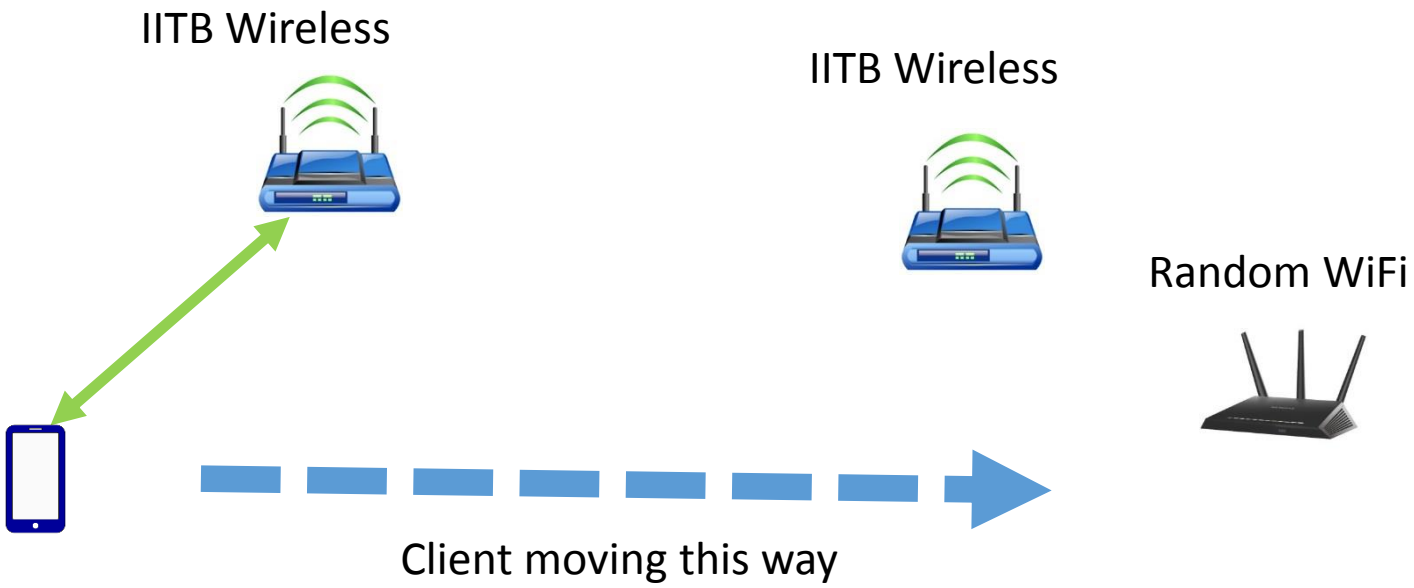
- How does the connection continue when I move from one floor to another?
- How does the connection switch to another AP automatically?

Roaming in IITB Wireless

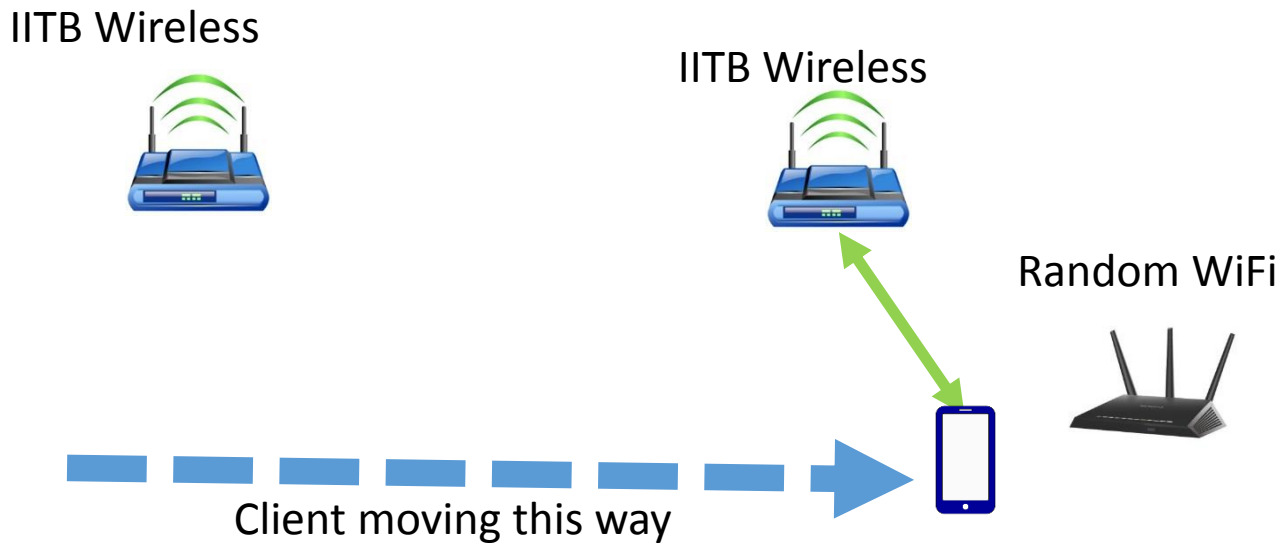
- Basic Service Set and Extended Service Set
- In ESS
  - Many APs are configured to have same SSID and security credentials
  - Different APs are differentiated based on BSSID (MAC)

    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

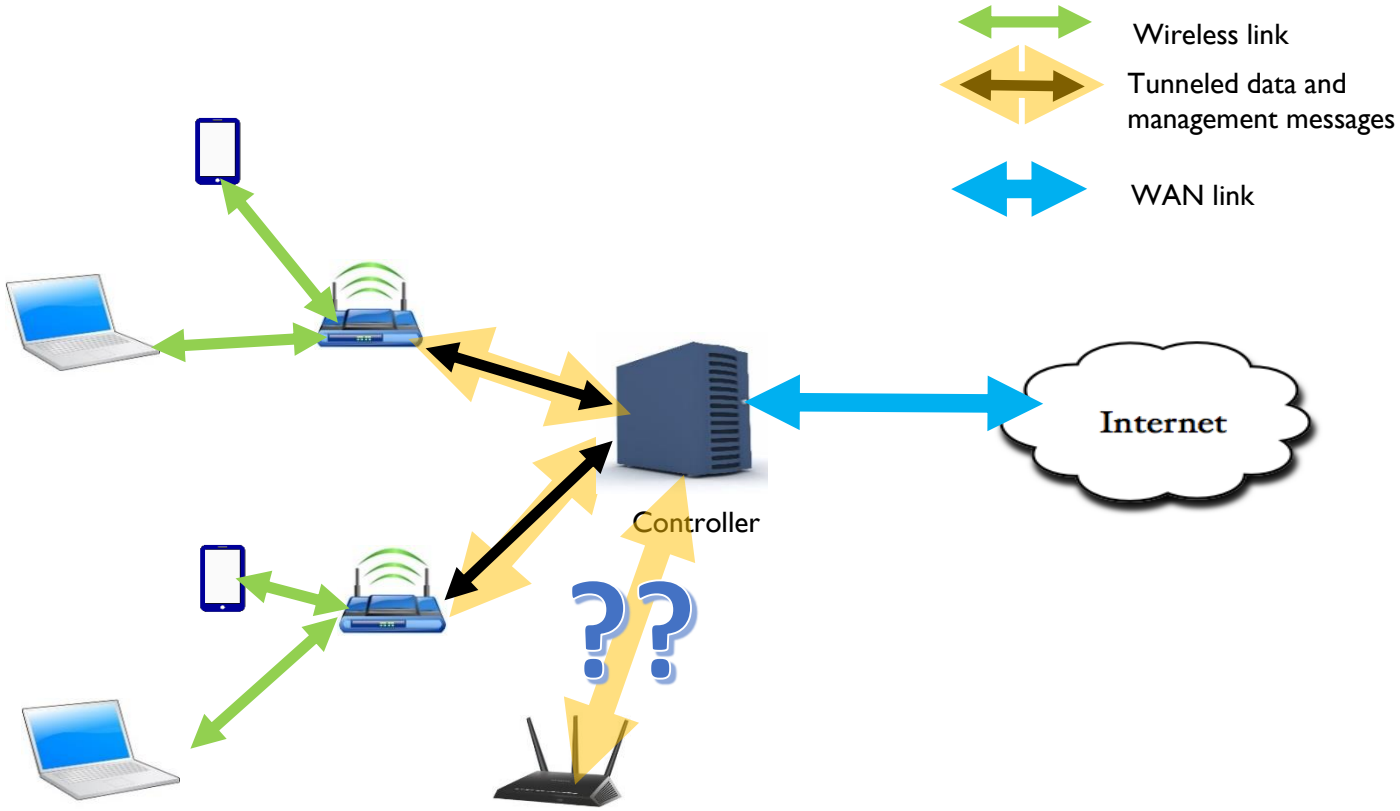


Roaming in IITB Wireless



- 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

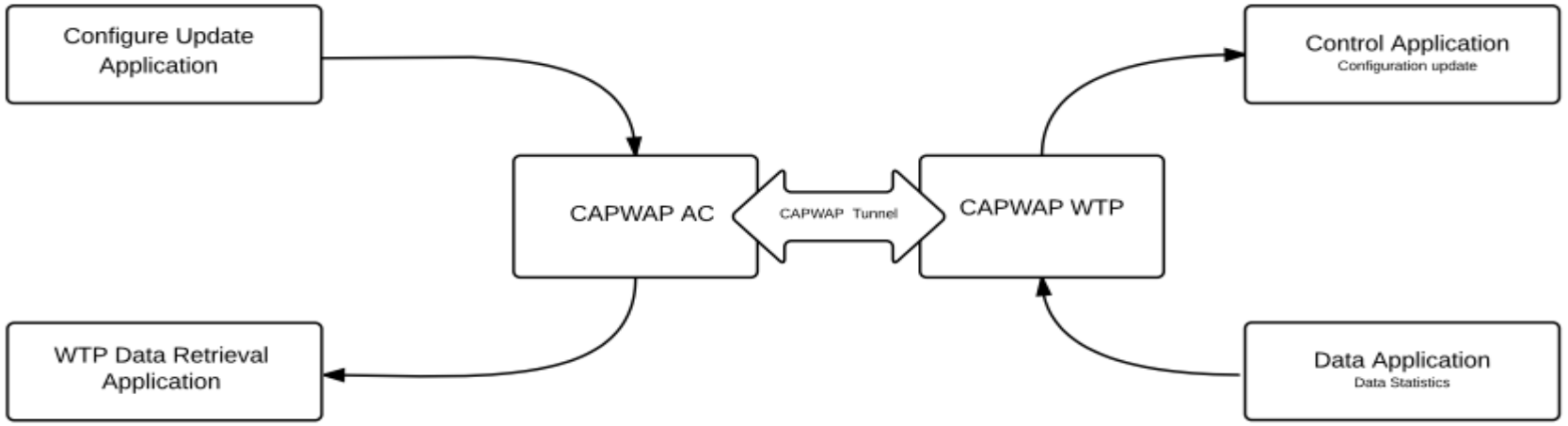


- Can different APs be deployed in this setup
  - Entire setup is proprietary deployment by ARUBA
  - The tunnel and protocol are not standard
- Is the deployment scalable?
  - Difficult beyond a point, as all data goes to controller

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
  - TR069 – Technical Report 69; CWMP – CPE WAN Management Protocol by Broadband Forum
    - Protocol to configure CPE (Customer Premise Equipment) from remote ACS (Auto Configuration Server)
    - http/SOAP based protocol for configuration

Addressing Interoperability



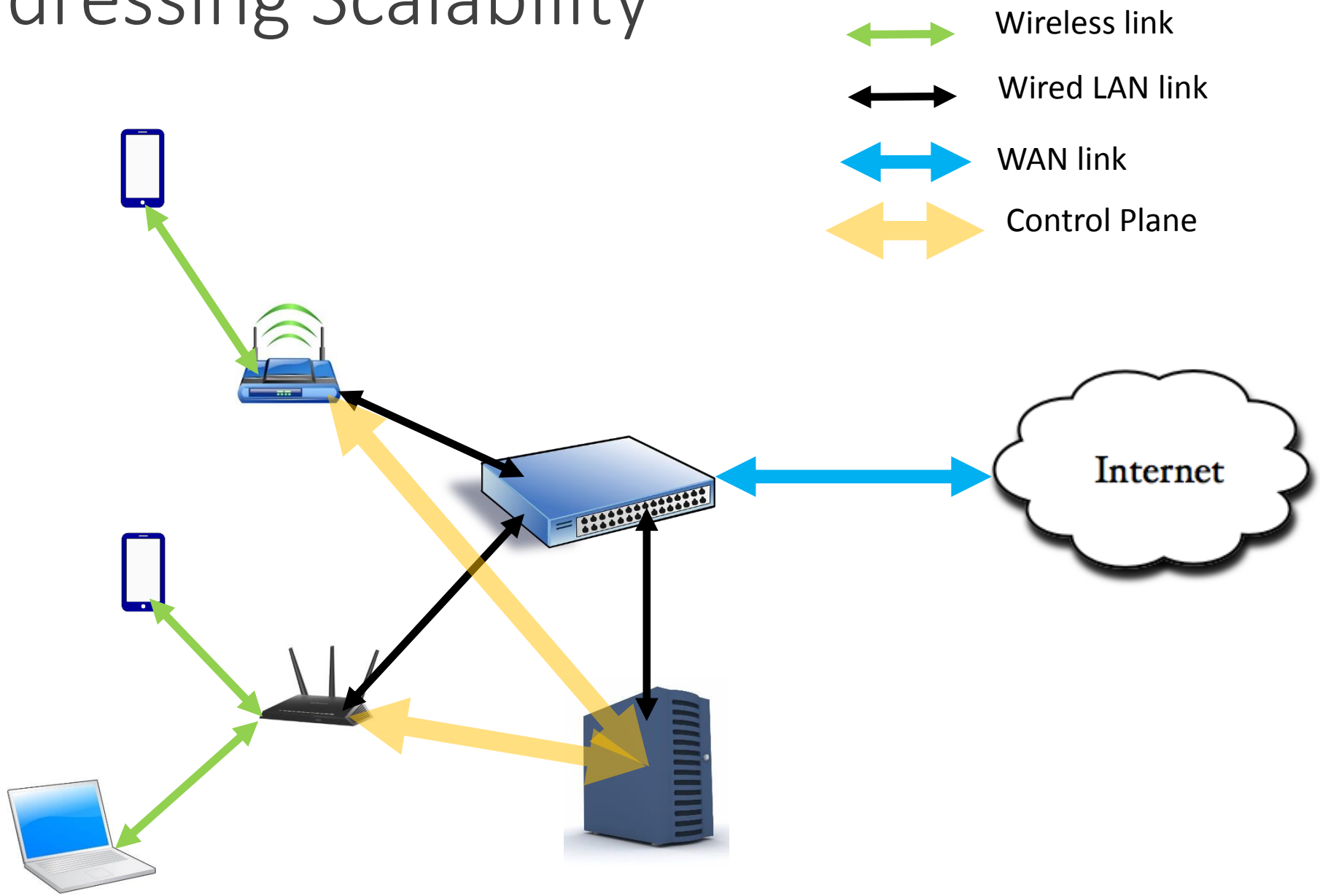
Architecture of CAPWAP based WLAN controller

- 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

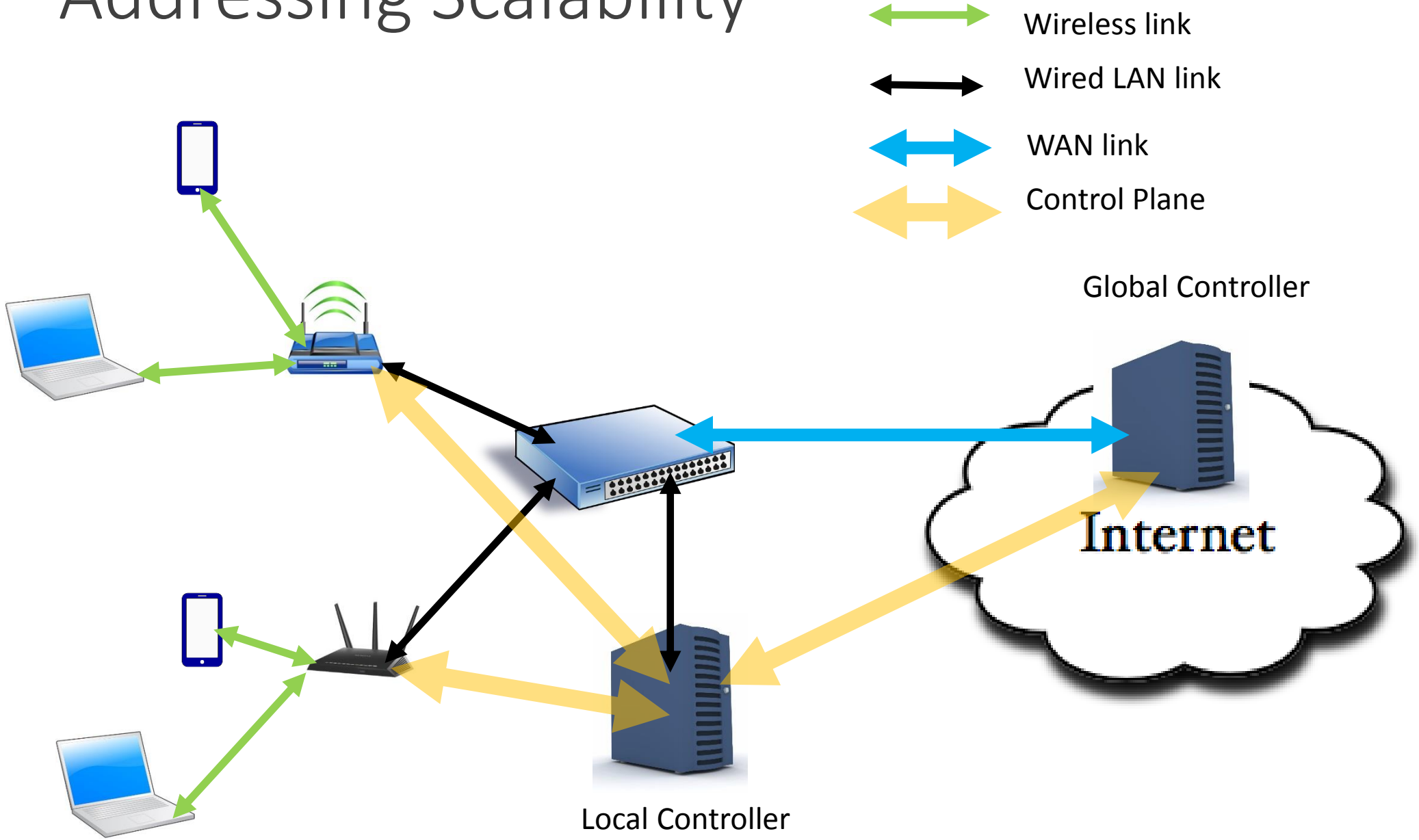
Addressing Scalability

- 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

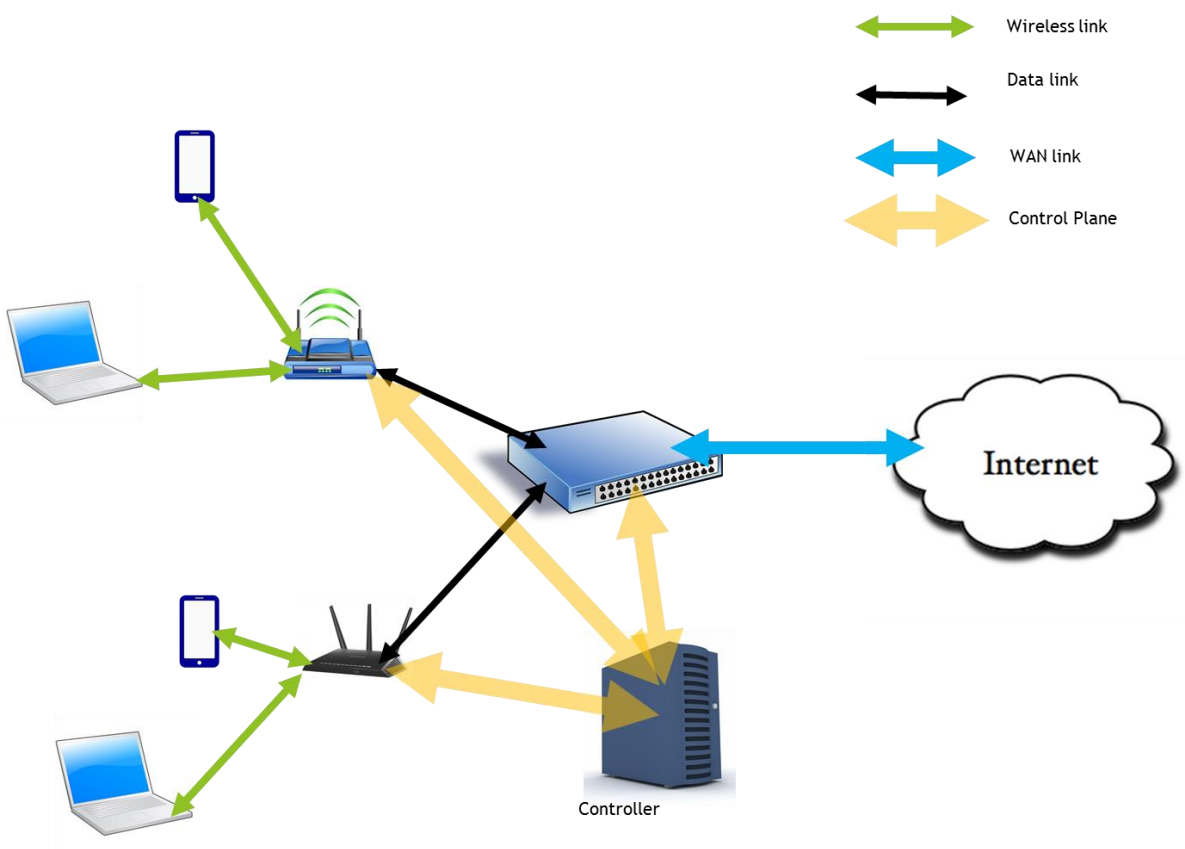
Addressing Scalability



Addressing Scalability

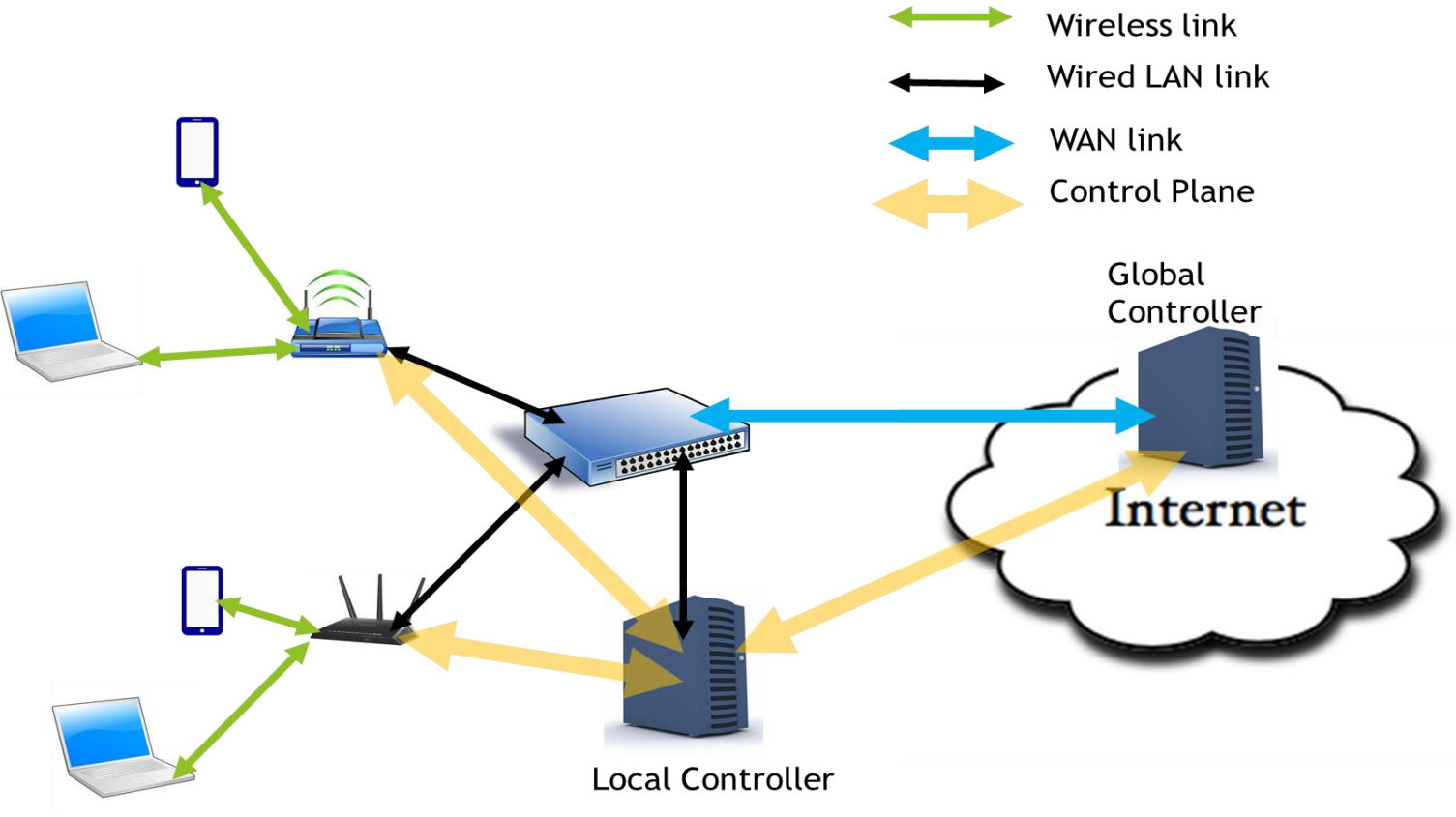


SDN for WLAN Management



- 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

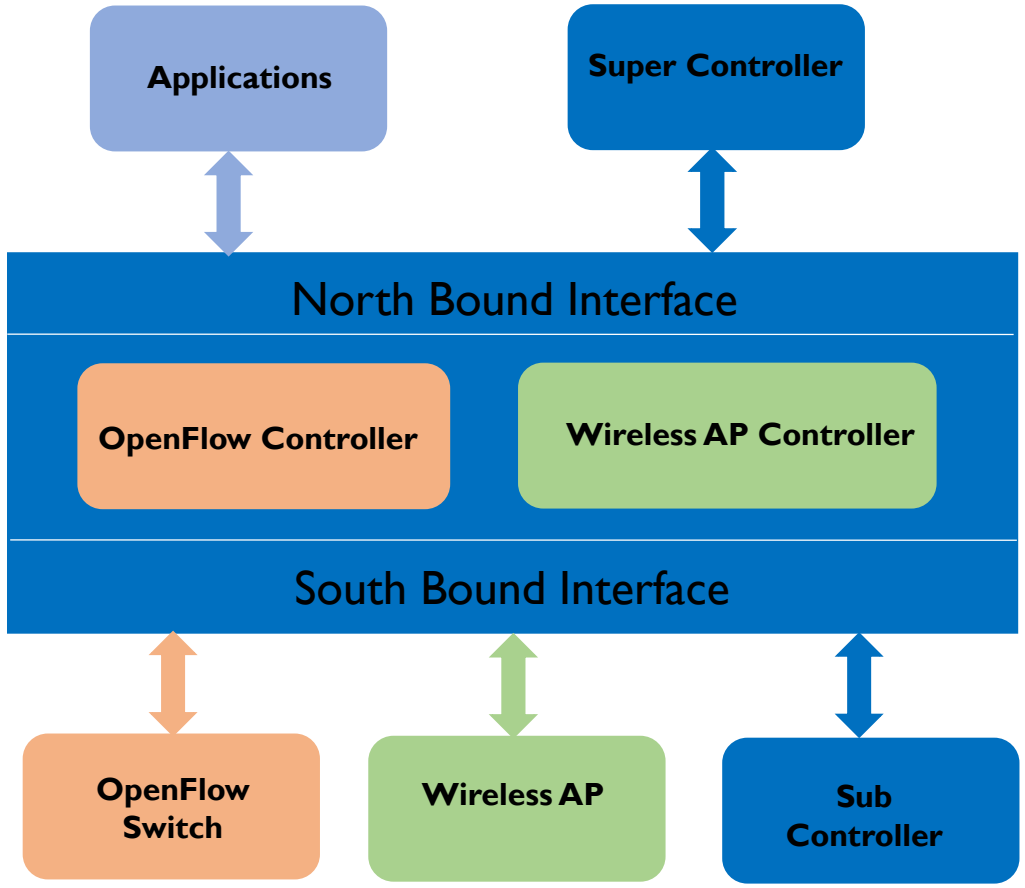


Hierarchical Controller Architecture
- Time critical operations in local controller
- Global policy management in cloud controller

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