

# CE 40-443

# Computer Networks

## Software-Defined Networking

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<https://github.com/arshiarezai/course-net>

# Agenda

- Brief History
- Data centers
- Genesis of SDN
- Characteristics of SDN
- How SDN works
- SDN in data centers
- SDN in other environments
  - Wide Area networks
  - Service provider Networks
  - Campus Networks
  - Hospitality Networks
  - Mobile Networks
  - Optical Networks

# Acknowledgment

This presentation is influenced by the following university materials from similar courses

- John Hopkins University ,USA.

Thanks to :

- Dr. Mehdi Nobakht
- Dr. Farnaz Yousefi

**This presentation is a brief introduction to SDN, each title can be expanded into a chapter of a book, so you must study reference books to gain a correct , comprehensive and unbiased view of SDN.**

**More texts are placed in each slide for students future review.**

# Brief History

- Paul Baran argued about low survivability of telephone networks under enemy attack because of centralized architecture.
  - He proposed the packet-switching idea for the first time .
  - He demonstrate that if packets can be routed independently, the national voice communication system could still function even if 50% of forwarding switched were destroyed.
- Tim Berners-Lee invented WWW
  - Ever-growing datacenters rose dramatically

# Who's serving Web services? Datacenters



# A little calculation

- Guestimate # of servers in a modern data center :
- a modern data centers can accommodate 120,000 physical server.
- Each physical server host 20 VM.
- Conclusion :  $120,000 * 20 = 2,400,000$  host/datacenter

# Traffic Pattern in data centers

- East- West
- North-south

studies indicate that the majority of the traffic in current data centers is  
East- West traffic

- The mega-data centers differ from prior networks in a number of ways:
  - stability of topology
  - traffic patterns
  - sheer scale
- Old fashioned protocols require routers to spent more than 30% of their CPU clock cycle rediscovering and recalculating routes for a highly static network topology.
- services provided by these data centers require frequent reconfiguration

Legacy solutions can not be scaled well to this number of host in a data center.

Network Management changed to a nightmare 😱

# Genesis of SDN

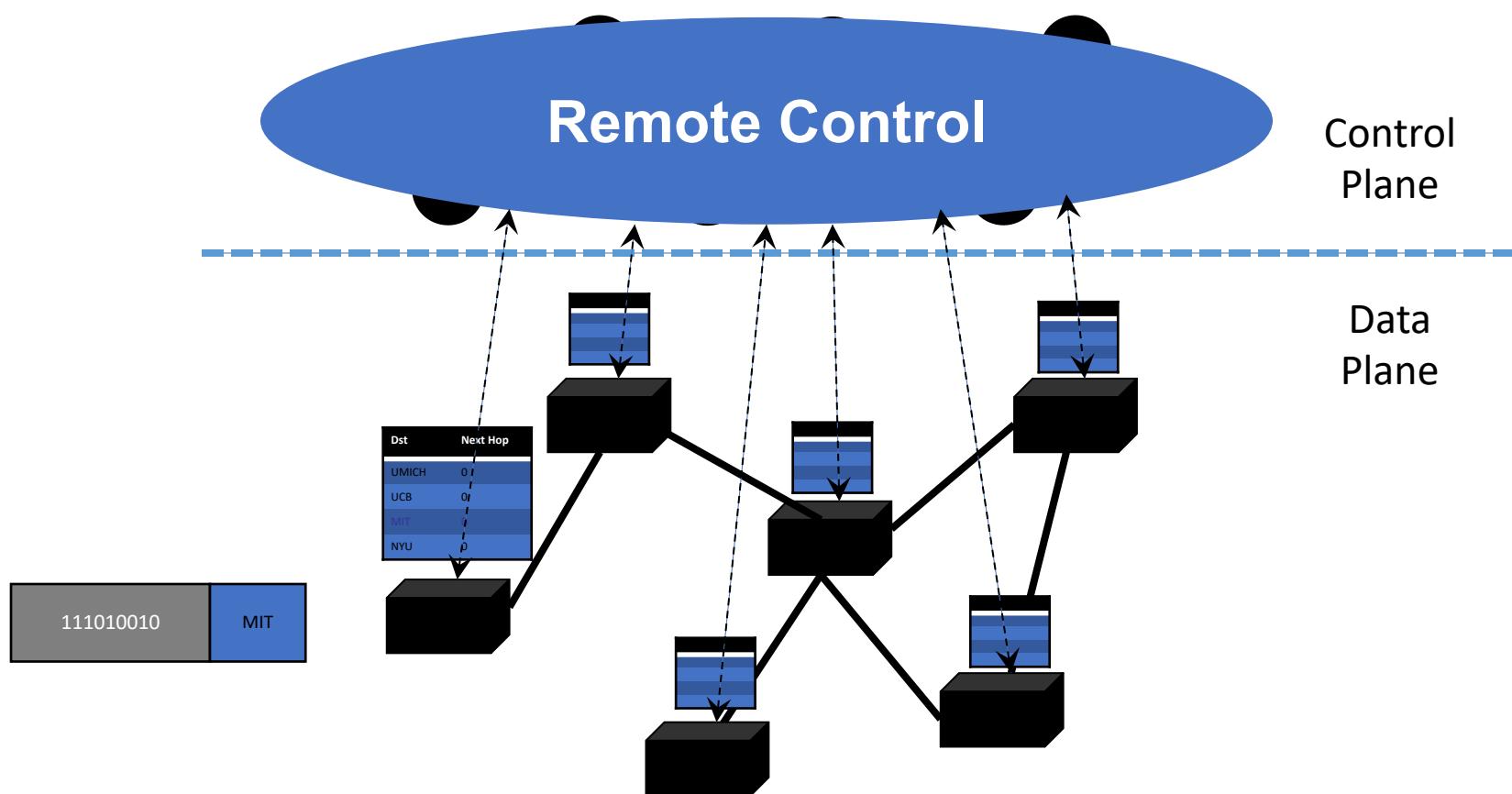
- Main idea:
  - Moving control OFF OF The Device

# Characteristics of SDN

- Plane separation
  - the control plane is moved off of the switching device and onto a centralized controller  
*how it results to loop prevention?* 🤔
- Simplified device and Centralized control
  - This software-based controller may then manage the network based on higher-level policies
- Network automation and virtualization
  - allows the programmer to specify the necessary forwarding behaviors without any knowledge of vendor-specific hardware
- Openness
  - interfaces should remain standard, well documented, and not proprietary.
  - facilitating research and experimentation.
  - open interfaces permit equipment from different vendors to interoperate

# Logically centralized control plane

- A distinct (typically remote) controller interacts with local control agents (CAs)



# Each goal is an app via specification abstraction

- What if an operator wants X?
- What if a customer wants to do weighted traffic splitting?
- ...
- There is an app for it!
  - Write your own routing protocol, load balancing algorithm, access control policies

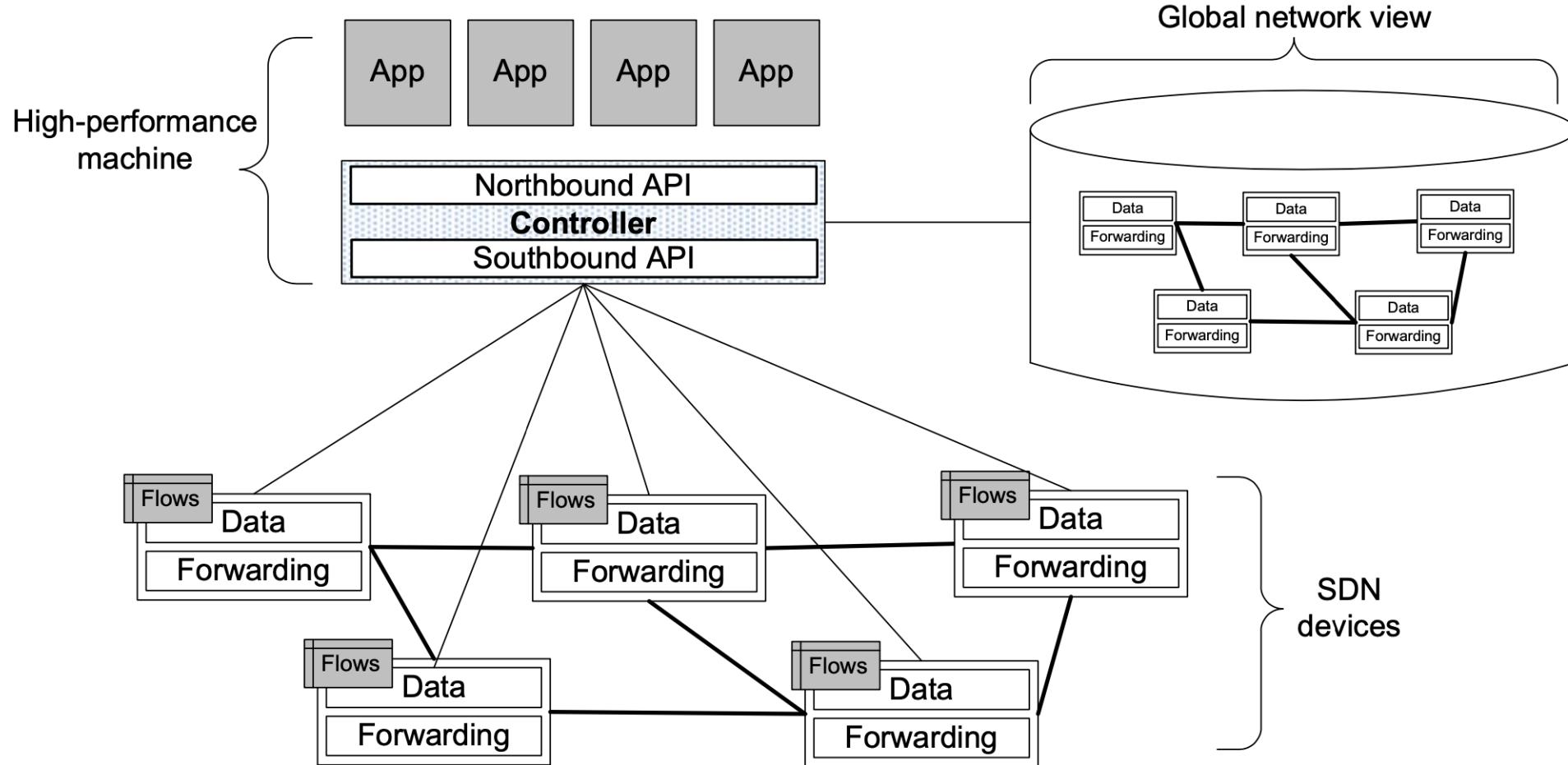
# Reason about each app via network state abstraction

- Now that the network is not distributed anymore and is a simple graph, we can **verify** whether whatever we specified...
  - ...makes sense
  - ...likely to work
  - ...likely to work with the rest
- No more *umm-I don't no-maybe*

# Logically centralized control plane

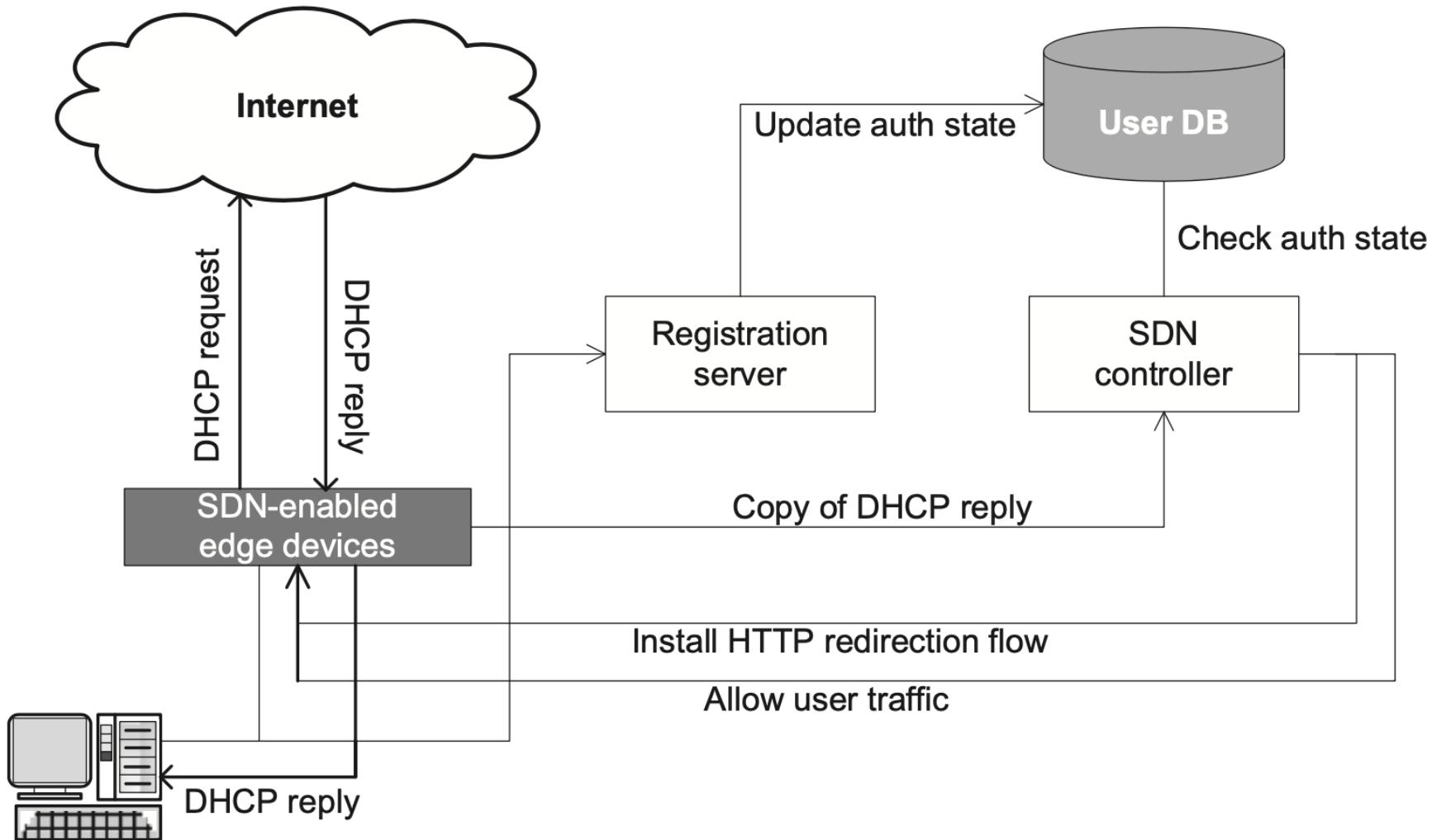
- A distinct (typically remote) controller interacts with local control agents (CAs)
- Each router contains a **flow table**.
- Each entry of the flow table defines a **match-action rule**
- Entries of the flow table is computed and distributed by the (logically) centralized controller

# SDN Operation



- The terms *northbound* and *southbound* are often used to distinguish whether the interface is to the applications or to the devices .
- The SDN controller is responsible for abstracting the network of SDN devices it controls and presenting an abstraction of these network resources to the SDN applications running above
- A flow describes a set of packets transferred from one network endpoint (or set of endpoints) to another endpoint (or set of endpoints)
  - Flow is unidirectional

# SDN ON CAMPUS



# References

- Internet Hall of Fame. Paul Baran. Retrieved from: [link](#).
- Software Defined Networks, A Comprehensive Approach, 2th edition.
  - Paul Göransson , Chuck Black , Timothy Culver

Thank You! 

any question ?