ChoiceNet Tutorial
Part I – Introduction to ChoiceNet

GEC 21

Welcome!

- Agenda
  - Part I ("Introduction"): (1:30 – 3:00)
    - **Overview** of ChoiceNet Project
    - **Implementation** on GENI
    - **Hands-on use**
  - Part II ("Advanced"): (3:30 – 5:00)
    - **Economics** of ChoiceNet
    - **Building a service** on ChoiceNet
    - **Hands-on use**

ChoiceNet People at Tutorial

- **Tilman Wolf**, UMass
- **Jim Griffioen**, UKY
- **Hussam Nasir**, UKY
- **Xinming Chen**, UMass
- **Onur Ascigil**, UKY
- **Thiago Teixeira**, UMass
- **Charles Carpenter**, UKY
- **Abhishek Dwaraki**, UMass

Hands-On Exercise

Hands-On Exercise

- Instructions:
  - http://groups.geni.net/geni/wiki/GEC21Agenda/ChoiceNet
  - Both source-routed and SDN-based services
- Please complete the following steps:
  1. Login and Pre-setup
  2. Configure and Install ChoiceNet Software
     - Step 3 takes a while – we'll continue with the presentation while we wait

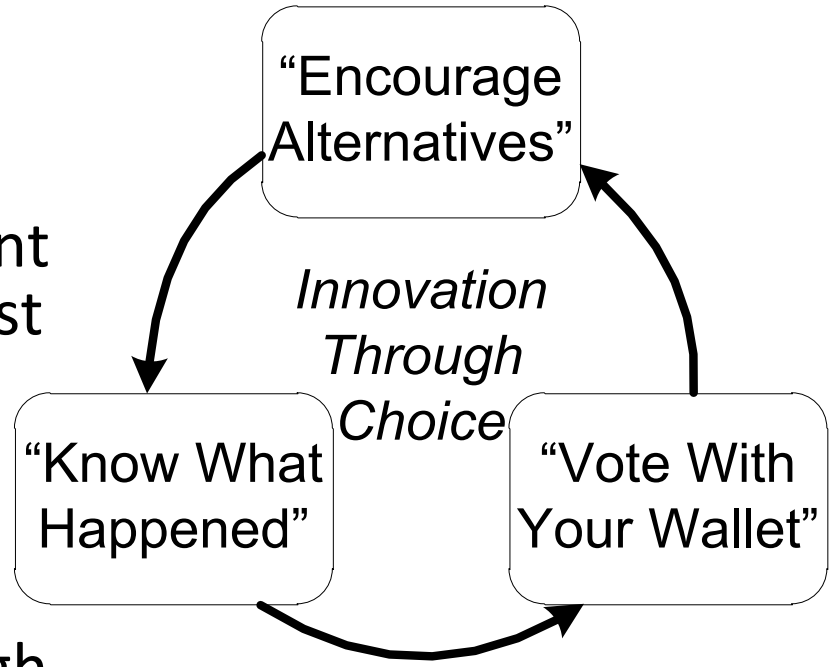
ChoiceNet Overview

ChoiceNet

- Motivation
  - End-users/apps have limited choices in the Internet
    - **Local network provider**(s) only
    - **No control** beyond 1st hop
  - Business transactions are for **long-term contracts**
  - Providers have **little incentive** to deploy new services
- ChoiceNet builds "economy plane" for Internet
  - **Marketplace**, where
    - Customers can choose providers
    - Providers have access to all customers
  - **Fine-grained contracts** for network services
  - **Competition** between providers drives innovation

ChoiceNet Principles

- Competition drives **innovation**
  - Users (or their applications) control choices
- "**Encourage alternatives**"
  - Provide services with different functionality, quality, and cost
- "**Know what happened**"
  - Evaluate service experience
- "**Vote with your wallet**"
  - Reward good services through continued use



- Focus today: **alternatives** and voting with **wallet**

Example: Video Streaming

- Choices for movie streaming
  - **Technical choices**:
    - Different connections, transport, caching, etc. ("experiences")
  - **Economic choices**:
    - Pay more or less for a particular video experience

- End-user interactions with ChoiceNet
  - **Select**, **pay for**, and **expect** a certain experience
- ChoiceNet infrastructure
  - Identifies choices, compose suitable offering
  - Distributes money among providers
  - Verifies performance

Aspects of Economy Plane

- **Services**
  - Network functionality in the broadest sense
    - Common specification format
    - Defined by end-points and operations
  - Possibly composed from other services
    - Everyone can sell/resell/aggregate services
- **Contracts**
  - Economic agreements for network service use
    - Trust through third-party intermediaries
    - Enforcement through verification (e.g., measurement)

Aspects of Economy Plane

- **Marketplaces**
  - Set of well-defined protocols
    - Advertisement of services
    - Transactions for service use
    - Use of service
  - Foundation for business relationships
  - Trusted intermediary between untrusted entities
- All **interactions** between customers and provider **require payment**
  - Use of some services is free
  - Some interactions not related to customers/provider

ChoiceNet Operation

- Providers **advertise services**
  - Identify services to be sold
  - Determine price
  - Advertise in marketplace
- User **starts application**
  - Available services are queried
  - User/app/OS chooses based on quality and price
- User **pays**
  - Payment is exchanged (we call it "consideration")
  - Service is set up/enabled for use
- Application **uses network service**
  - Data is transmitted
- **Multiple ways** of implementing these interactions

Example ChoiceNet Services

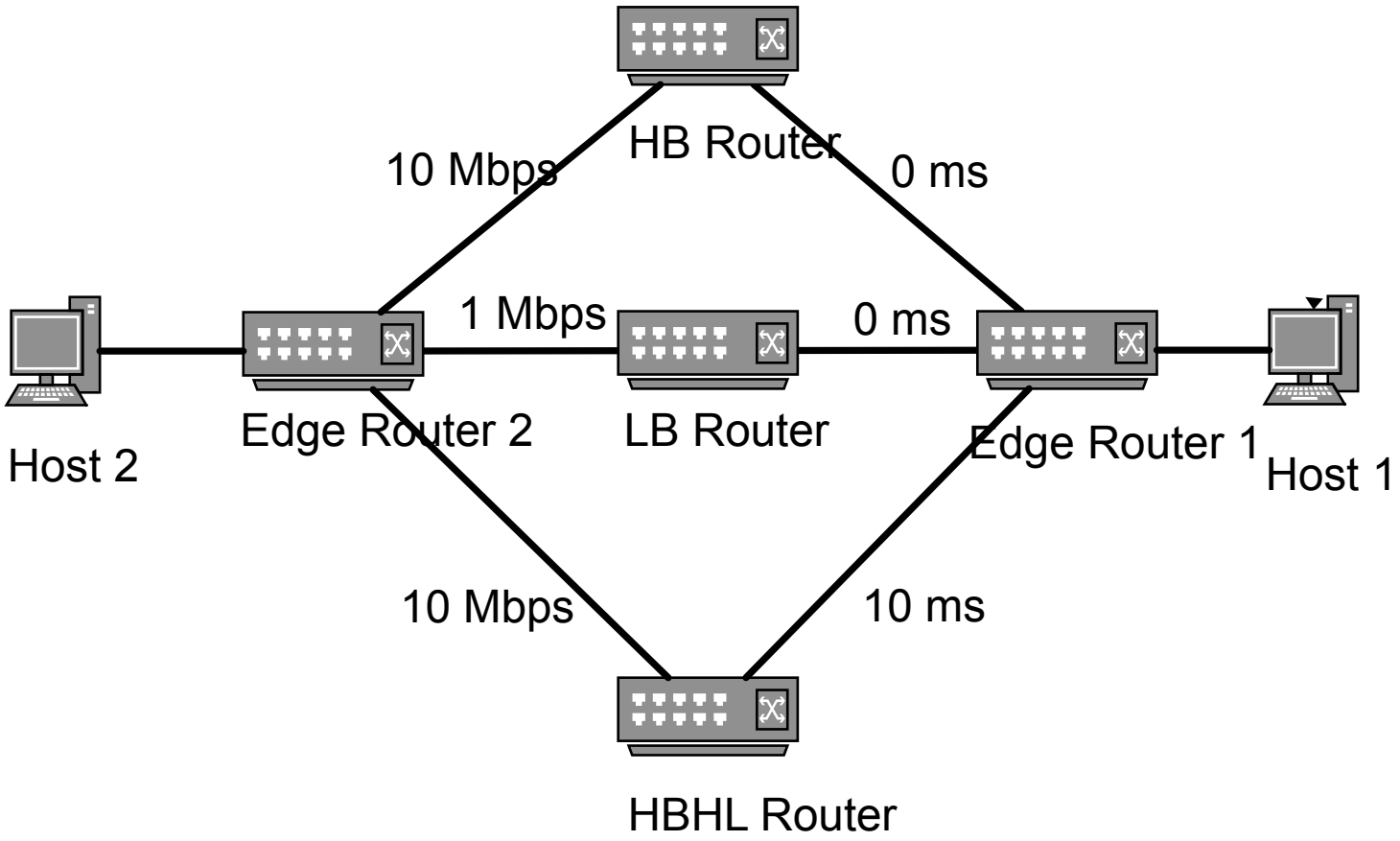
- Today: 2 different packet forwarding services
  - Different ways of realizing "choose-pay-use"
  - "**Source-routed**":
    - In-band signaling of choice and payment
    - Developed at University of Kentucky
  - "**SDN-based**":
    - SDN-based implementation with out-of-band setup
    - Developed at University of Massachusetts
- We will explain both
  - You will use both in the hands-on exercise

“Source-Routed” Implementation

Source-Routed Forwarding Service

- Packets contain source route a "proof of purchase" for every hop
- **Forwarding Service**
  - Verifies "proof of purchase" before forwarding packet to next hop
  - Implemented using Click
- **Path Service**
  - Accepts QoS advertisements from Forwarding Services
  - Computes a (ranked) set of paths that meet the requested QoS
    - Requires payment before giving out path
    - Returns paths with their "proof of purchase" tokens
- **ChoiceNet-enabled application (and wrapper)**
  - Any IPv6 application with a ChoiceNet library (replacing the socket calls)
    - Intercepts network socket-related calls
    - Contacts the Path Service to purchase a suitable path.
    - Consults a config file to know what type of path the user is willing to pay for.

Source-Routed ChoiceNet Operation



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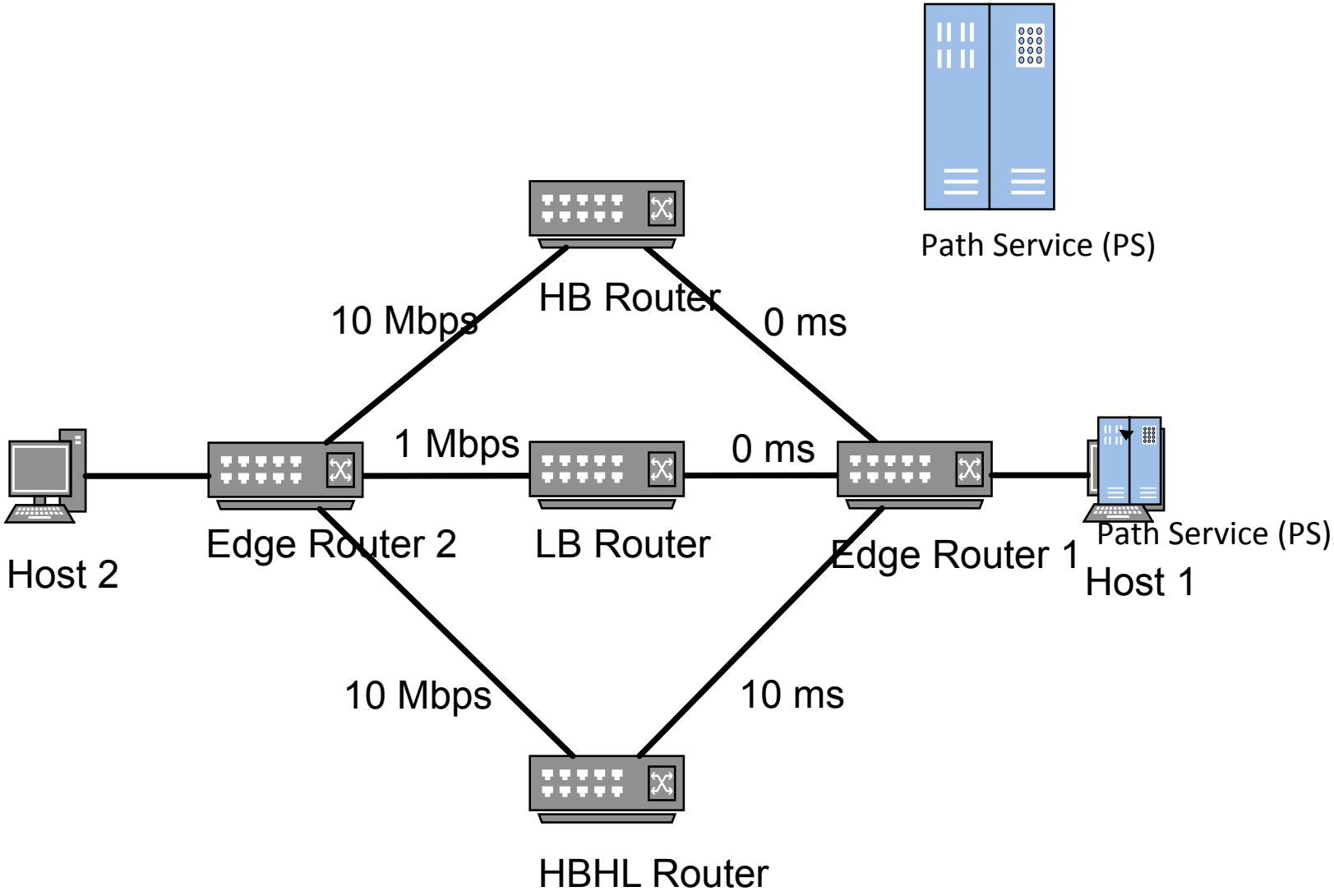

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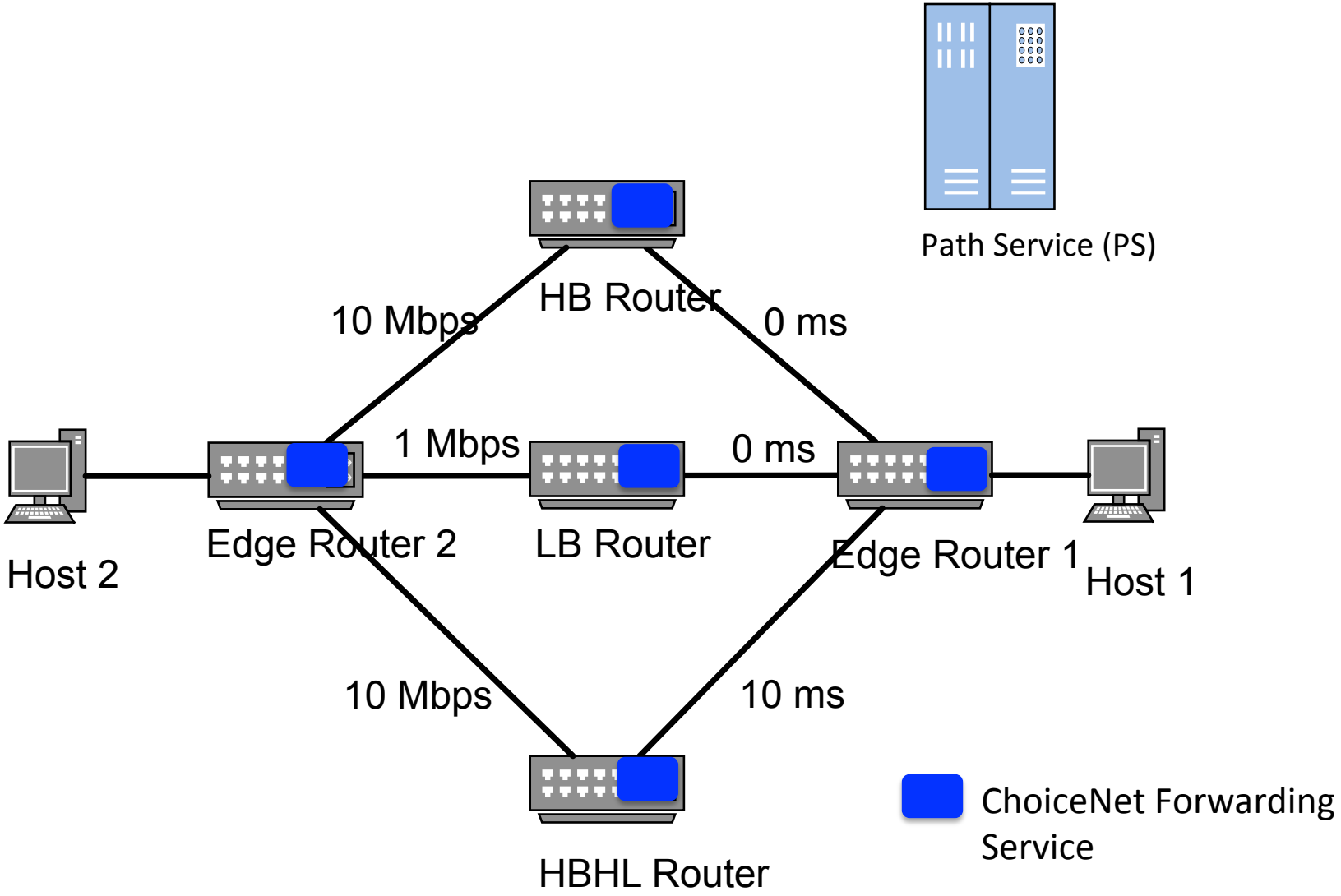
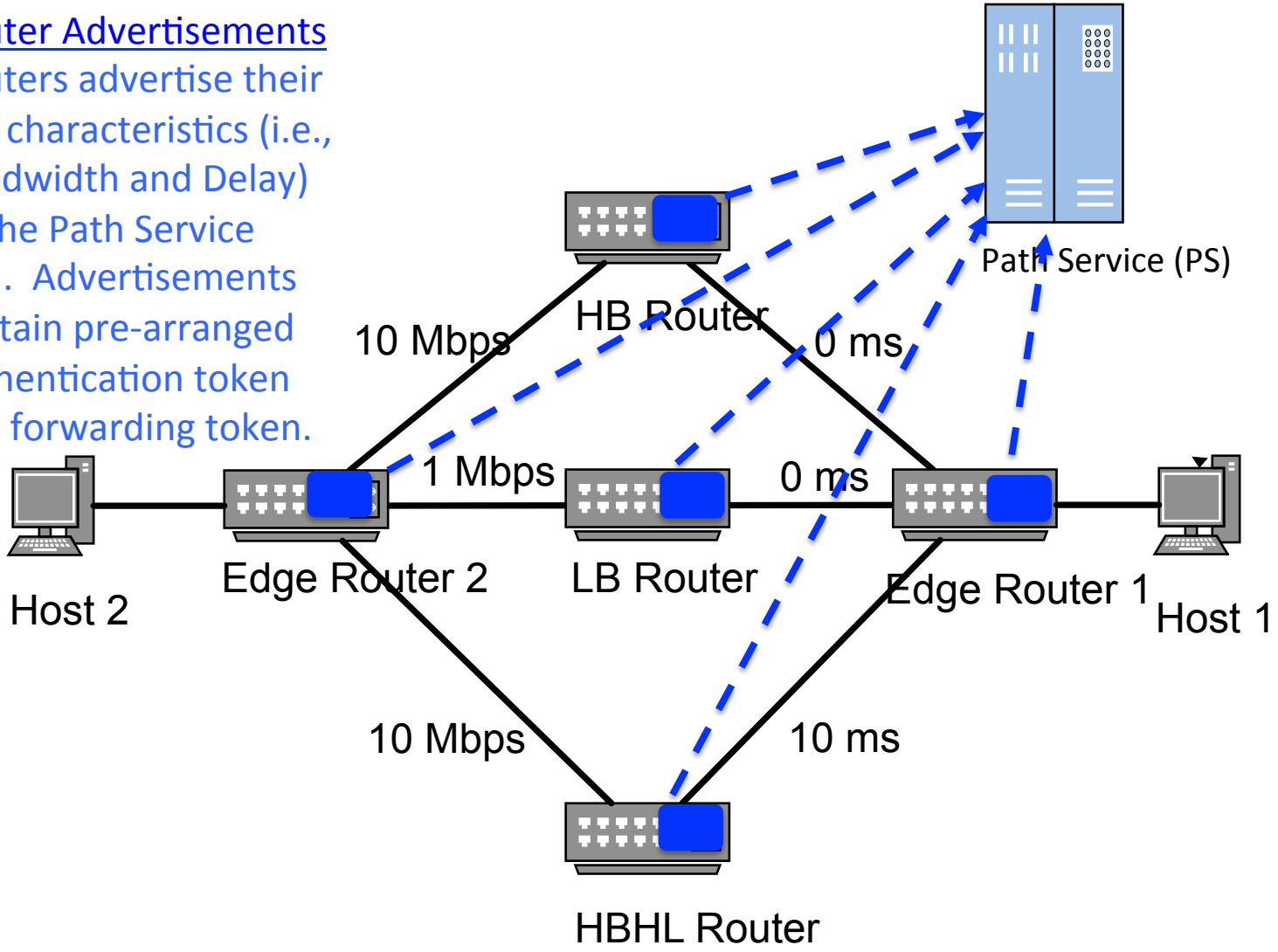


Source-Routed ChoiceNet Operation

Router Advertisements
Routers advertise their link characteristics (i.e., Bandwidth and Delay) to the Path Service (PS). Advertisements contain pre-arranged authentication token and forwarding token.



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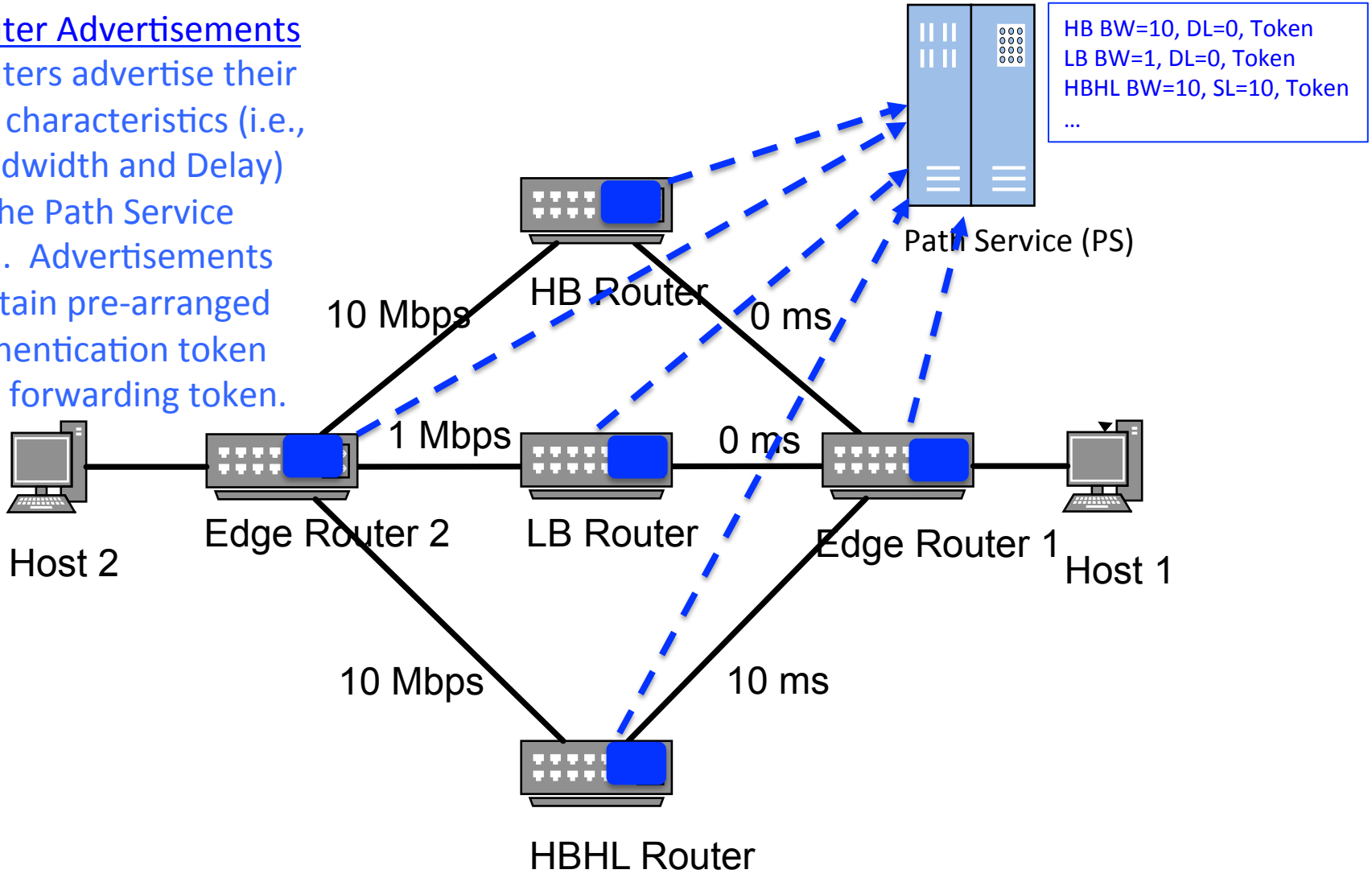

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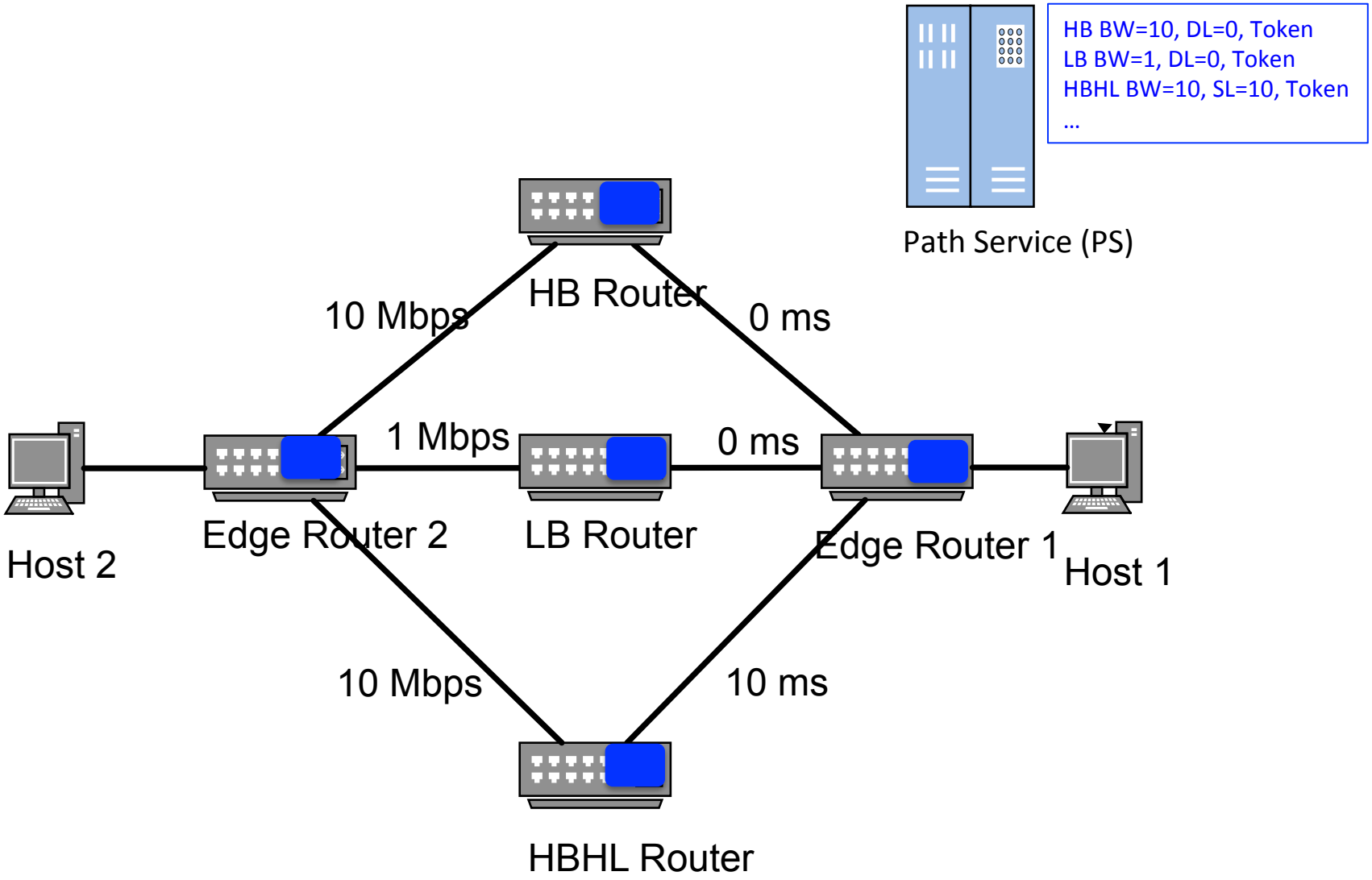

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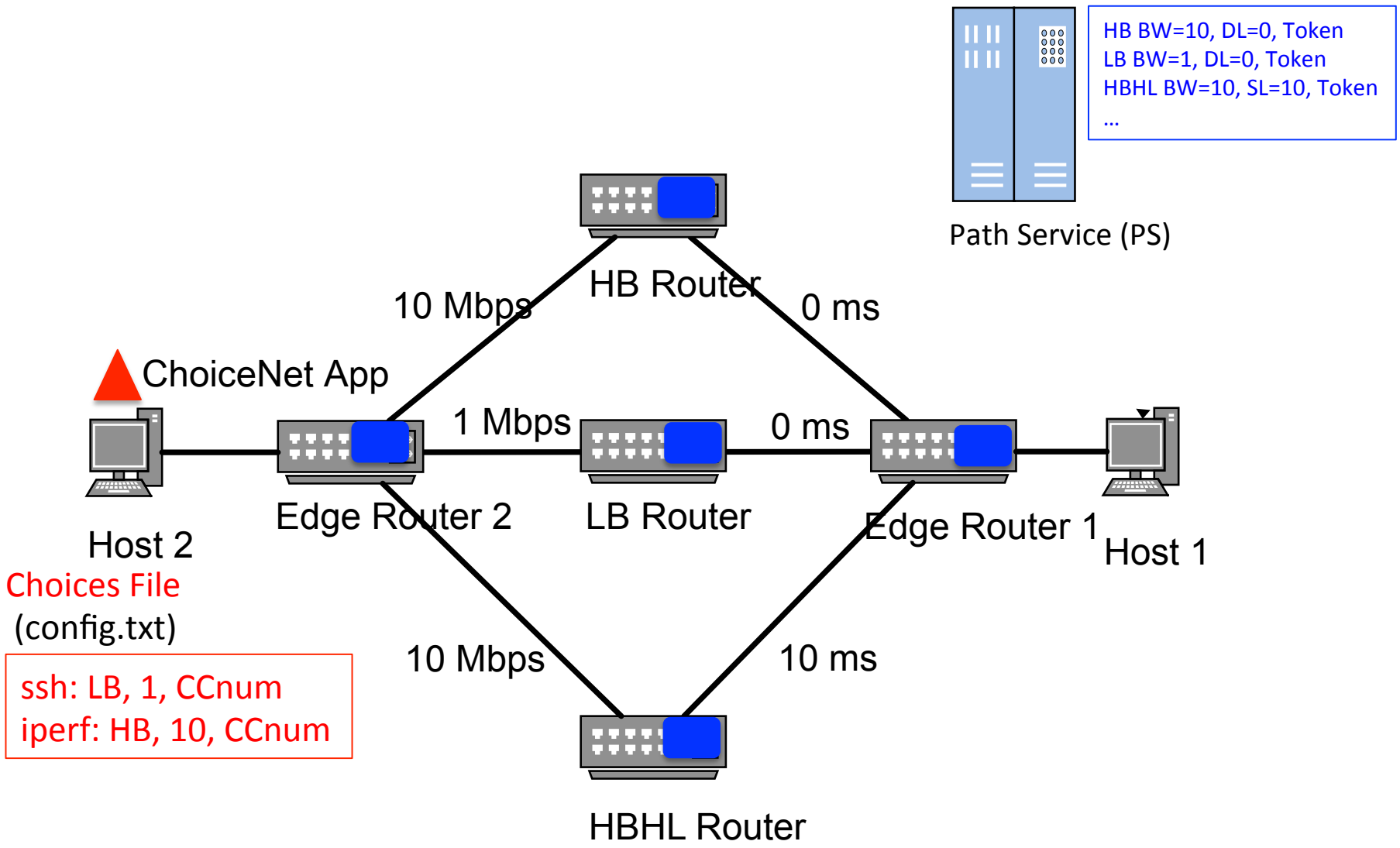

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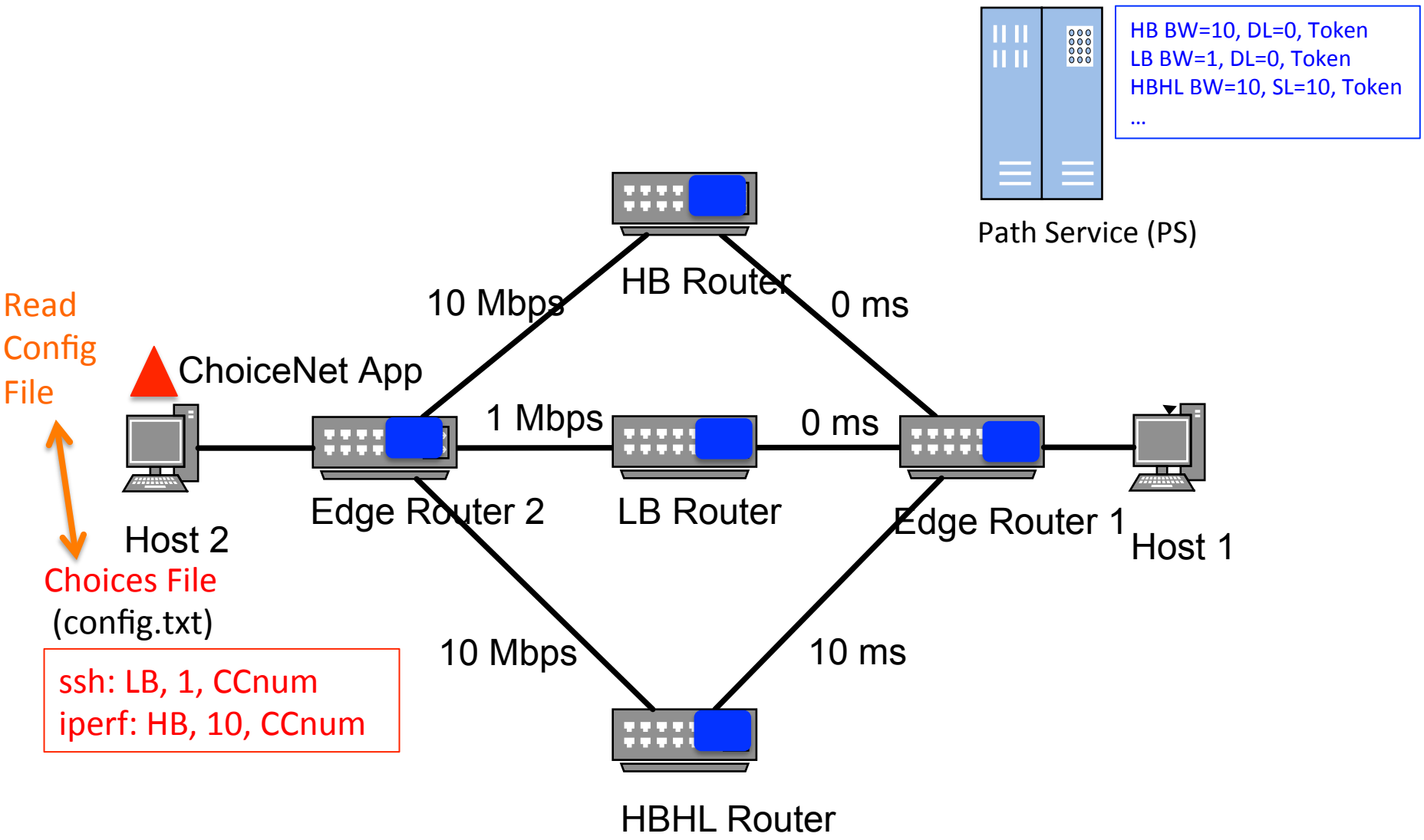

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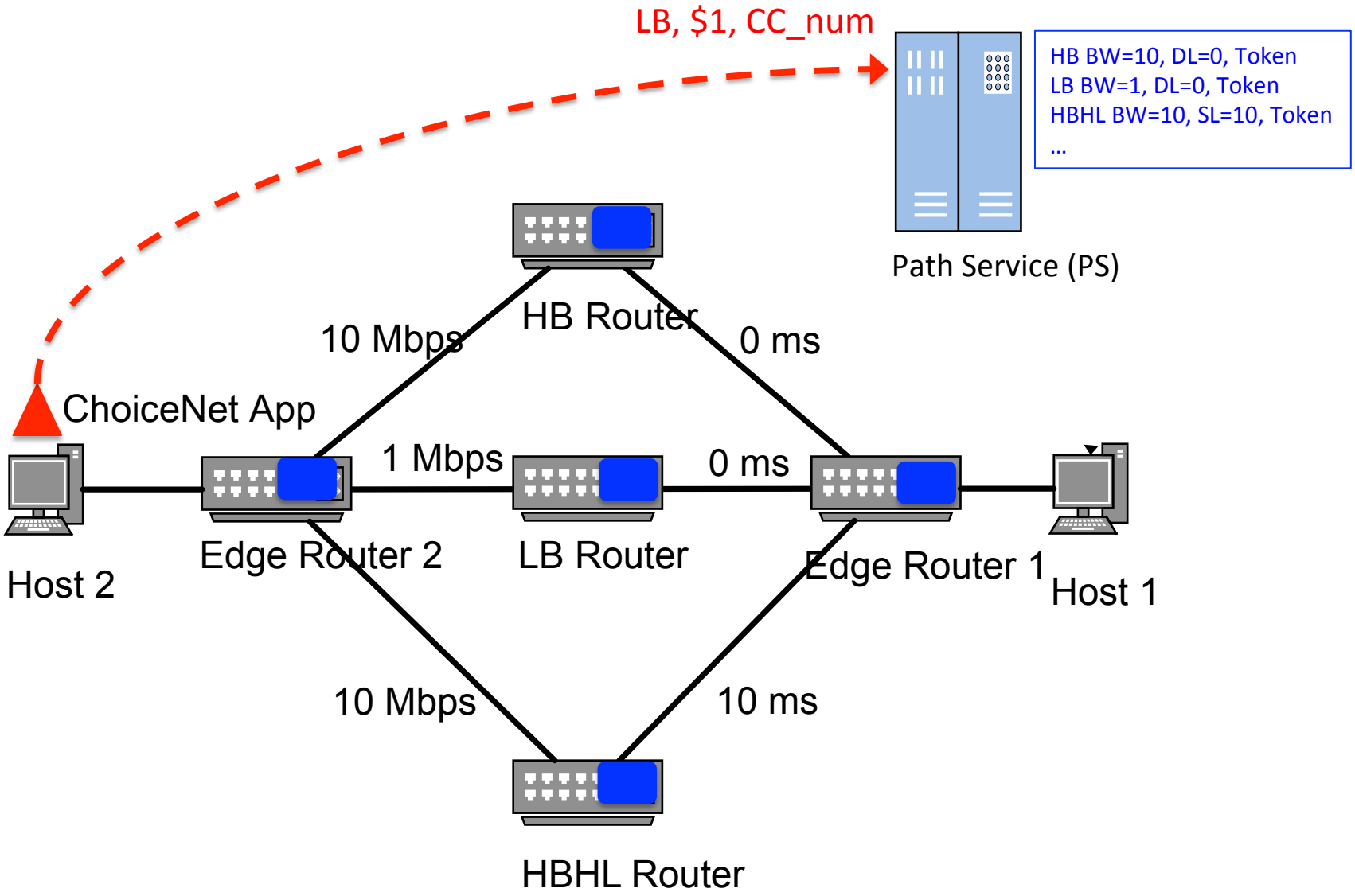

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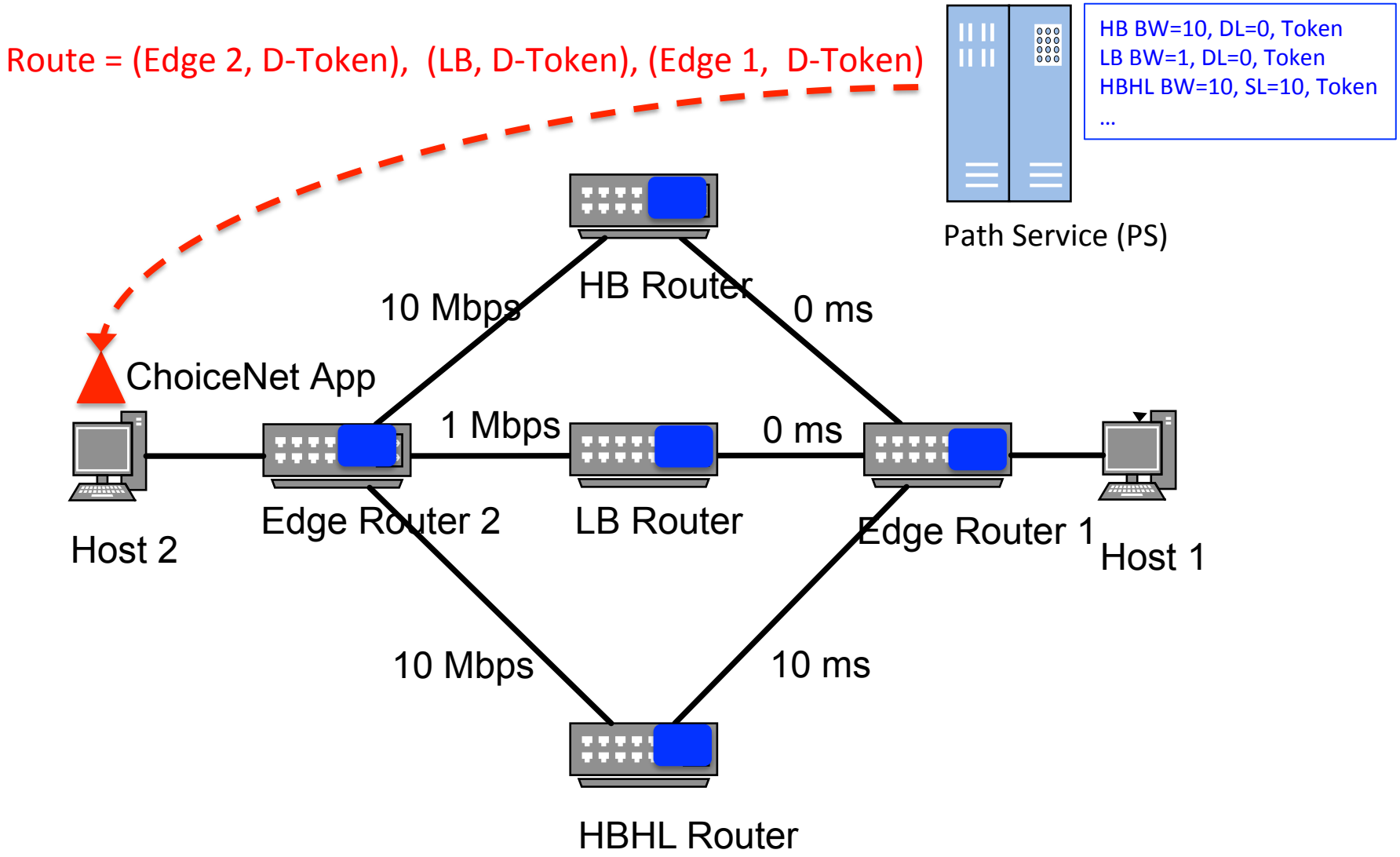

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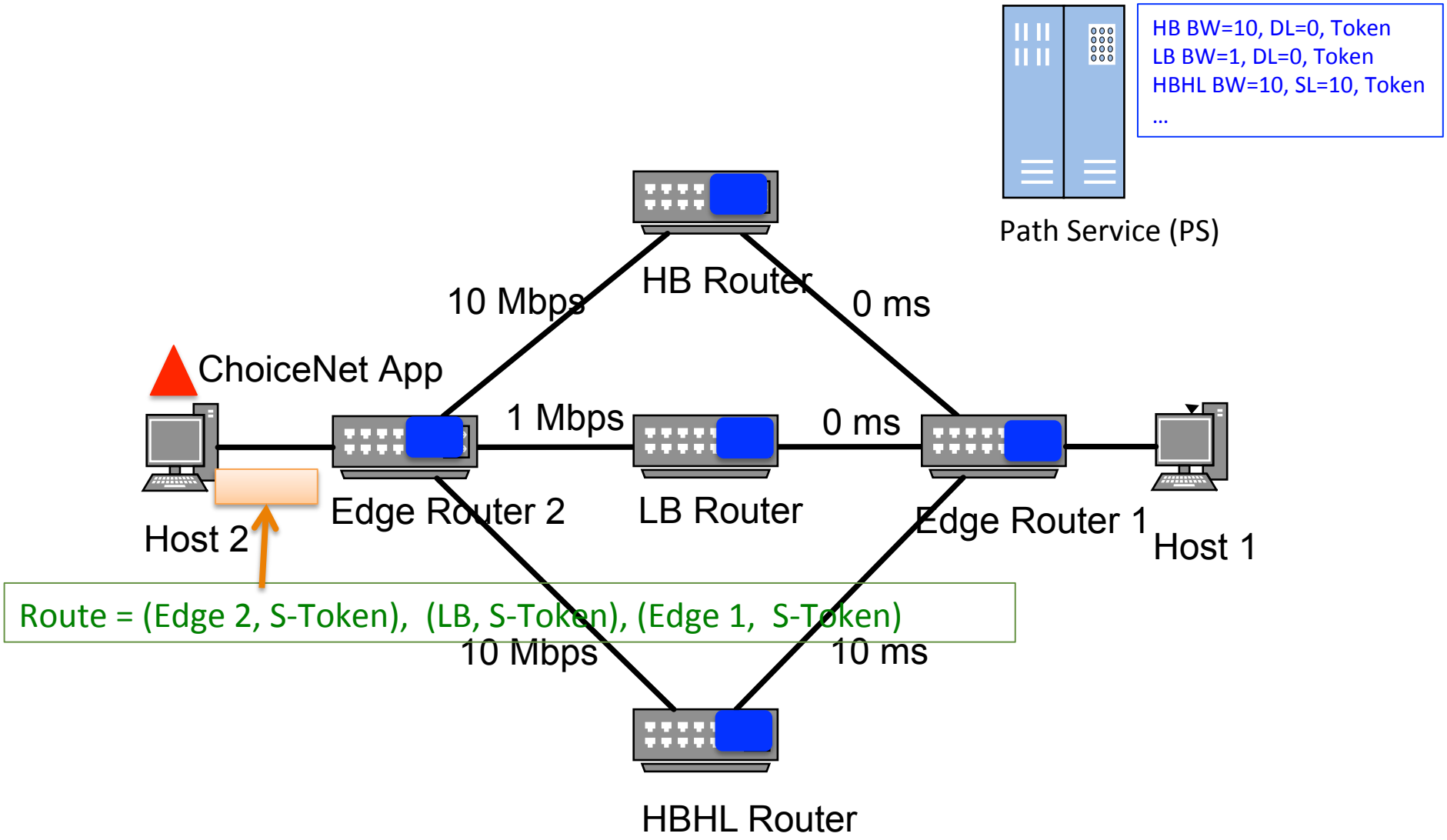

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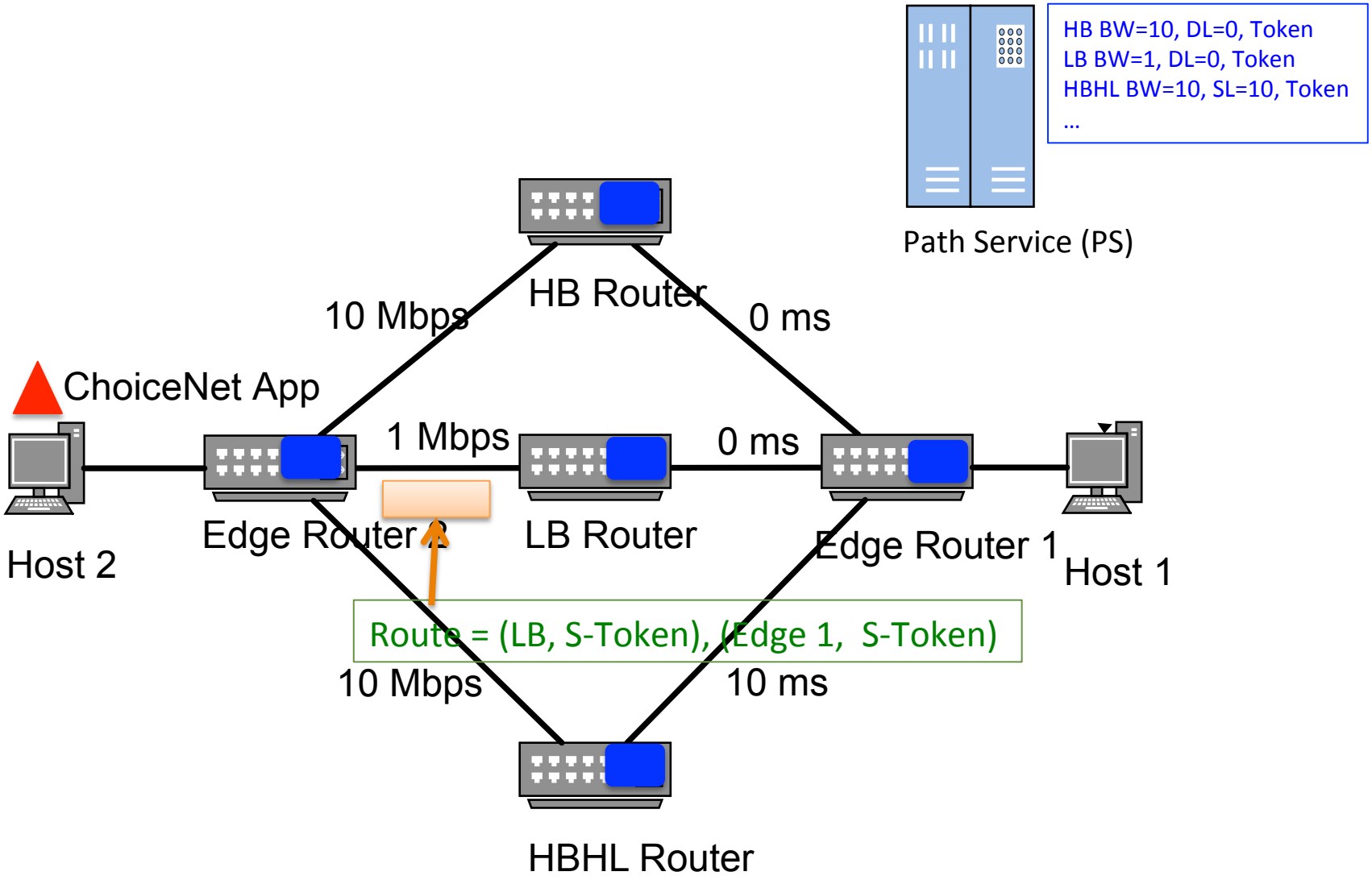

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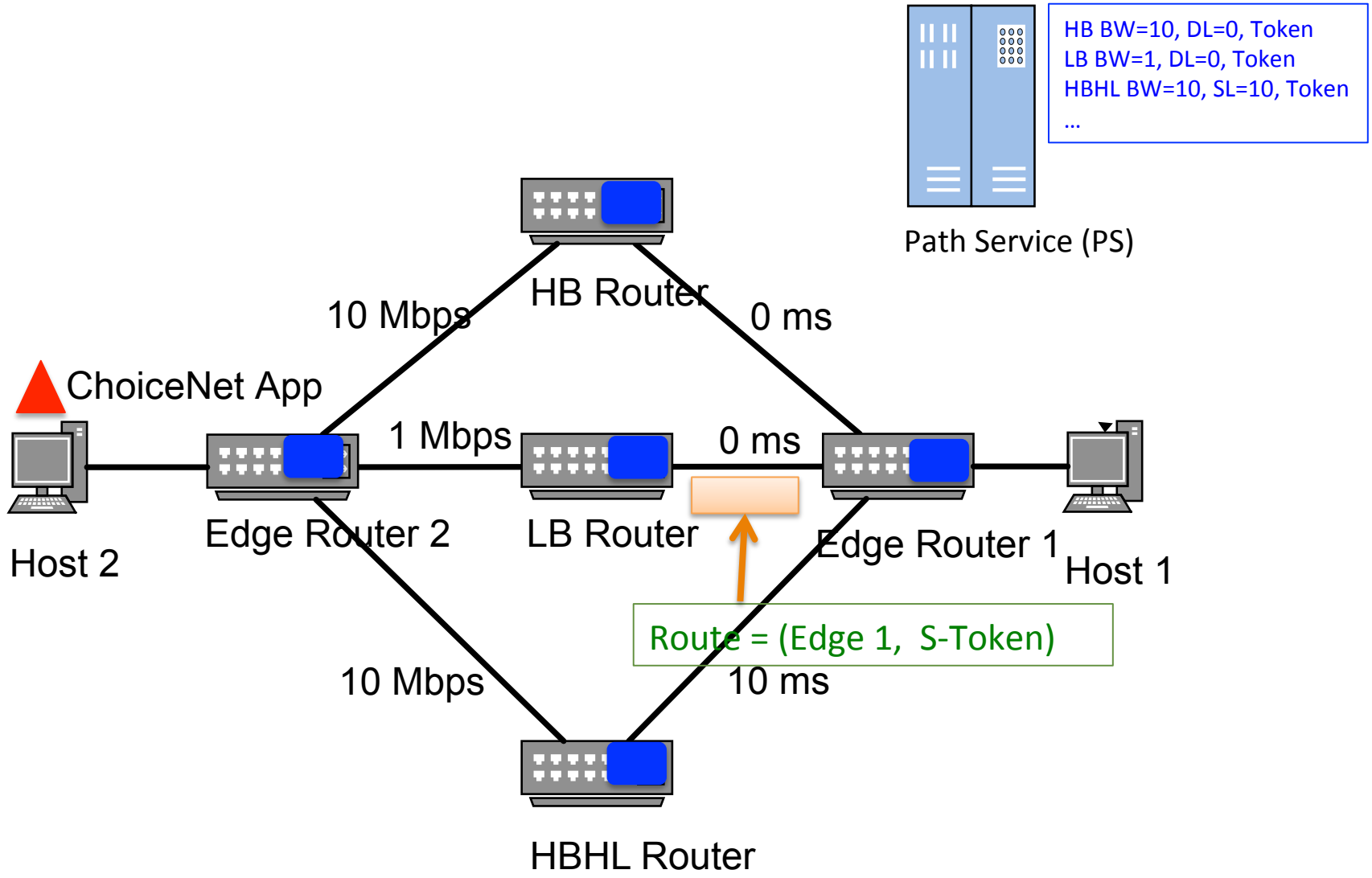

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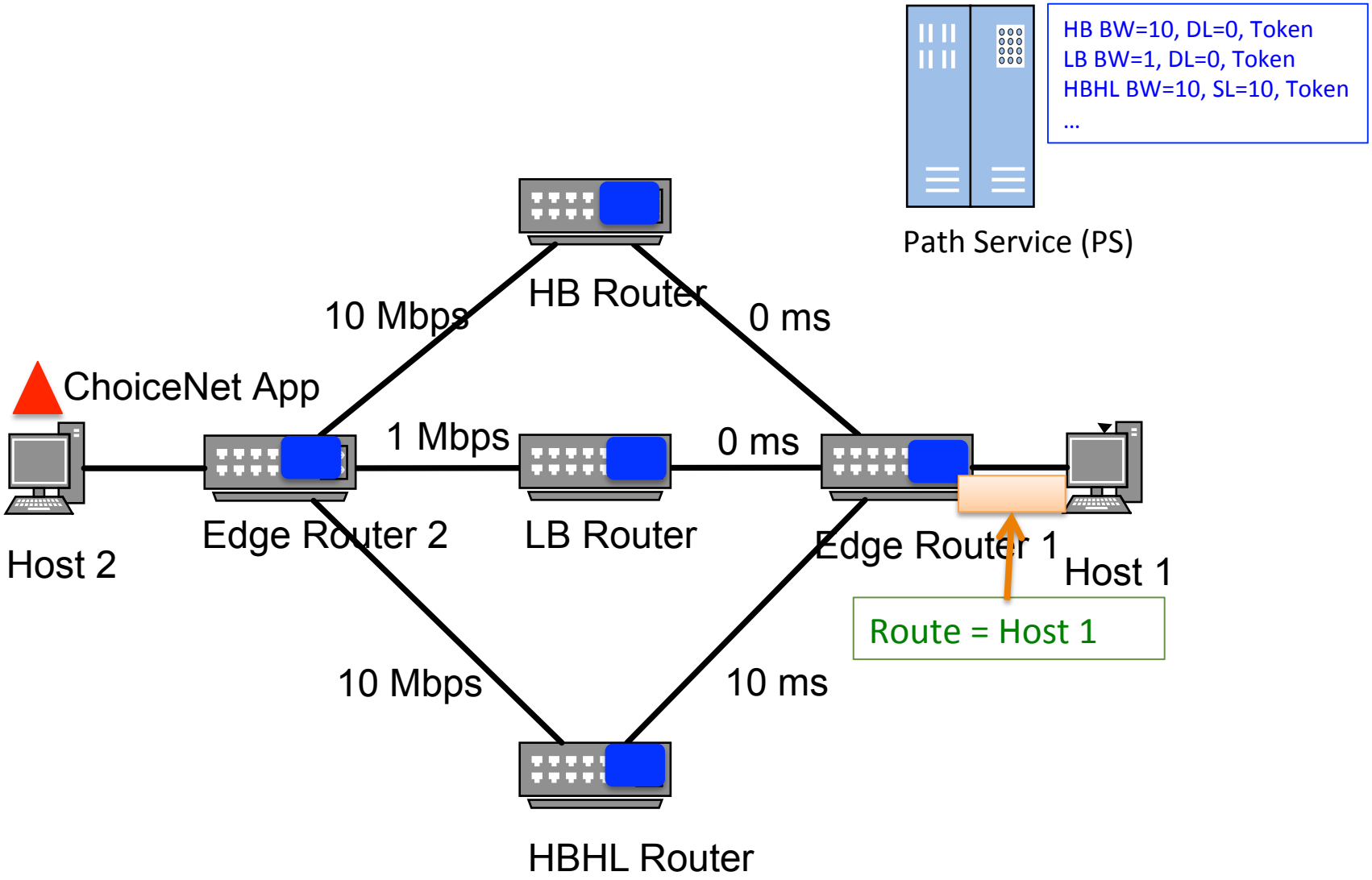
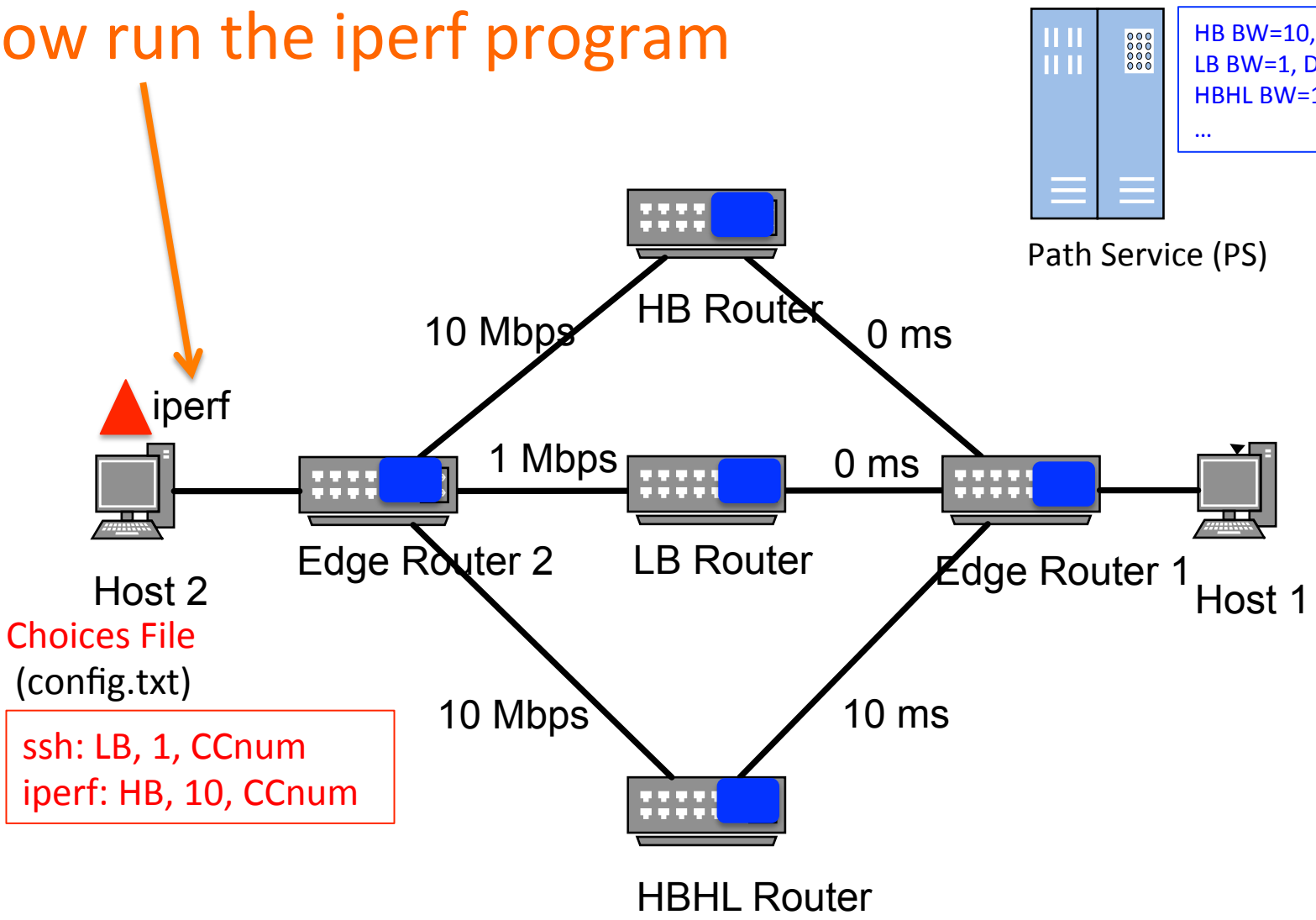


Source-Routed ChoiceNet Operation

Now run the iperf program



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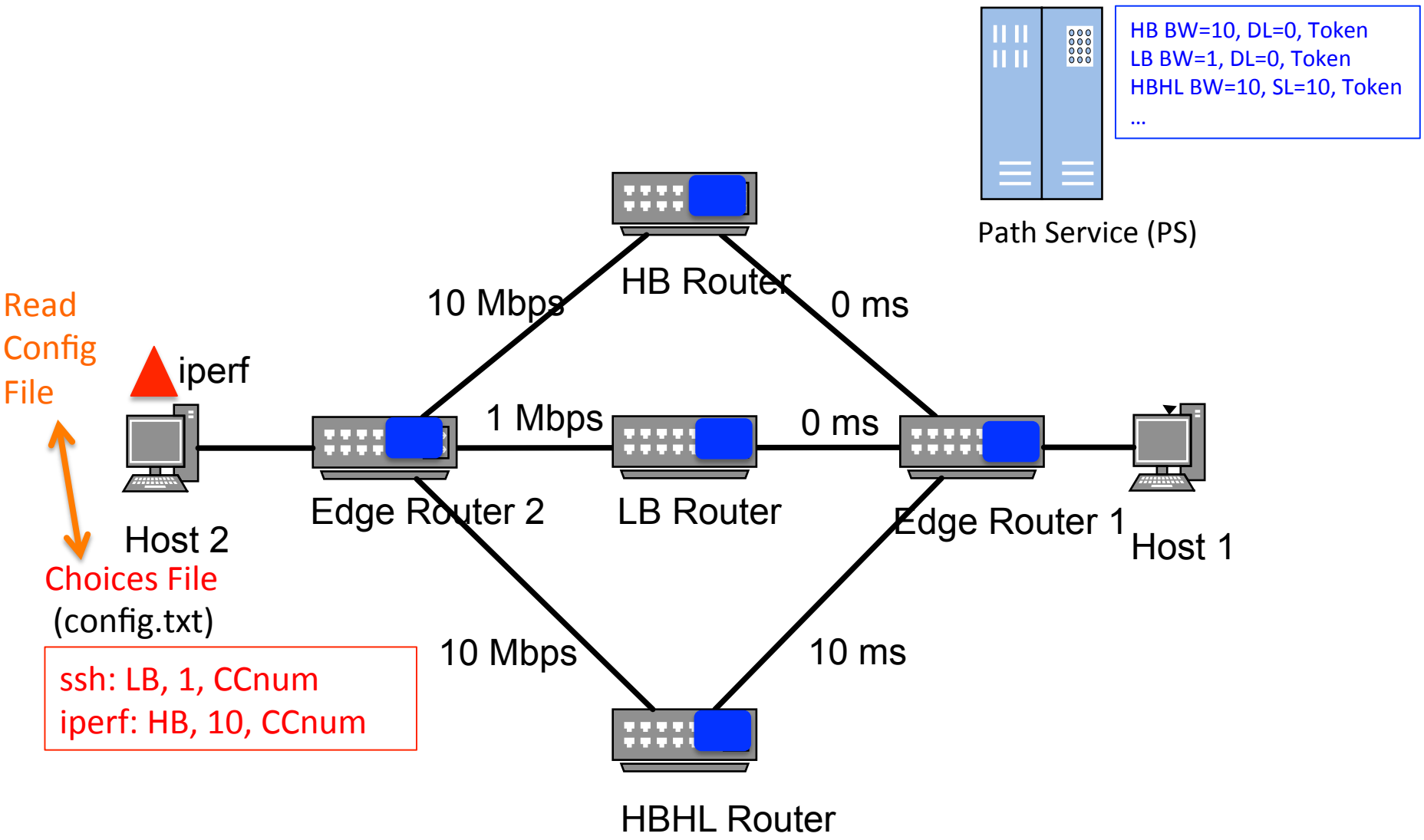

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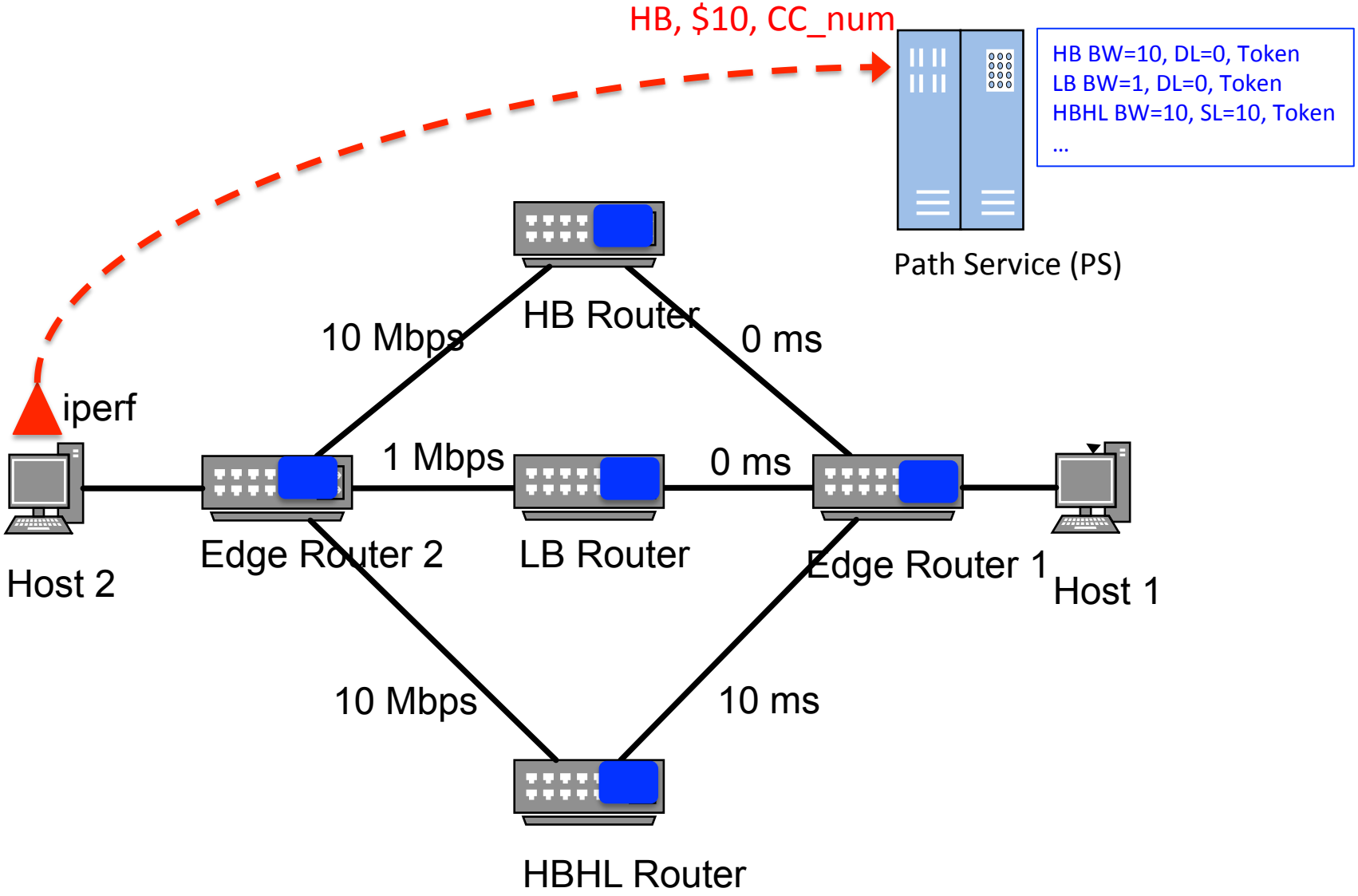

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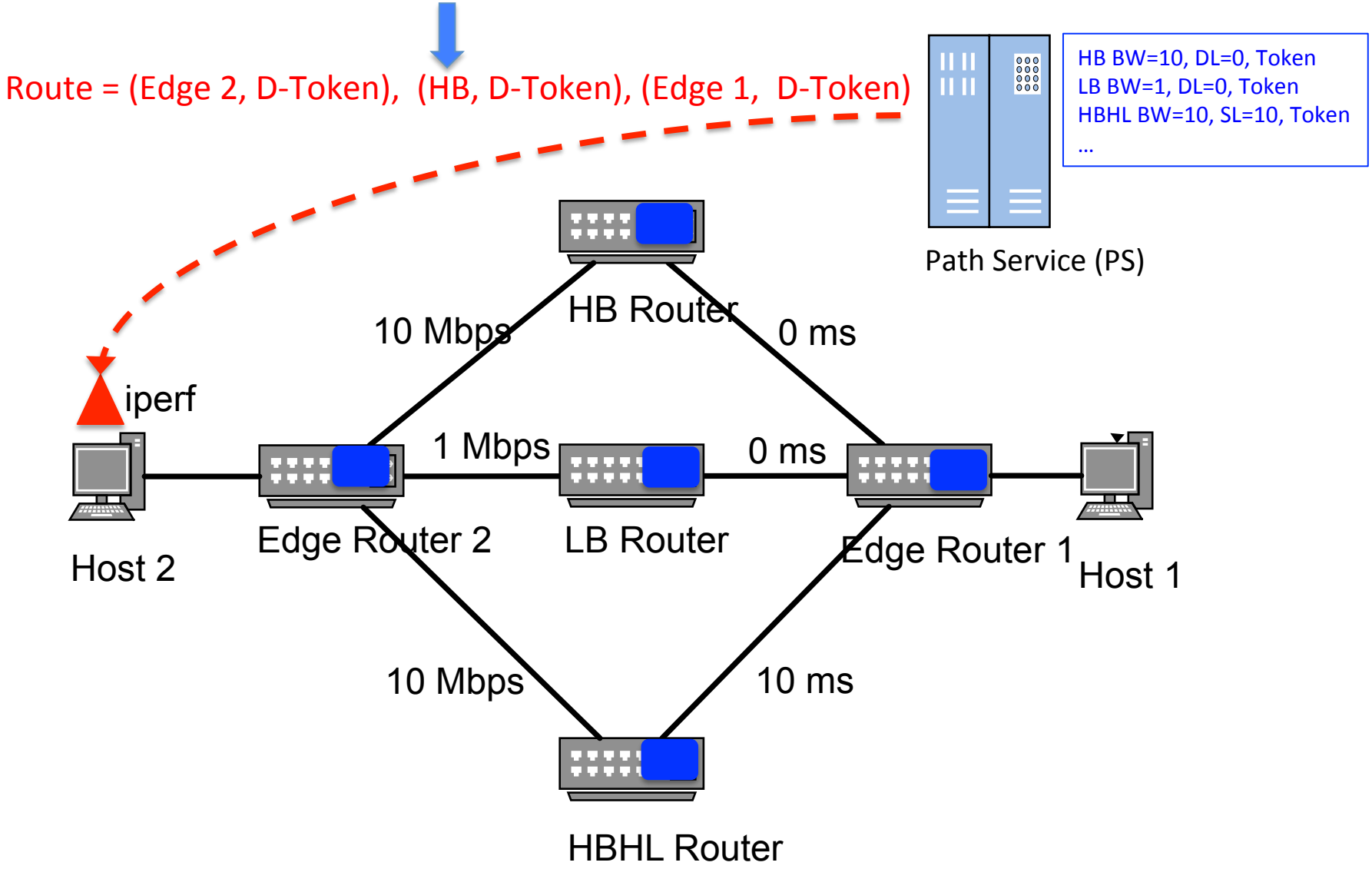

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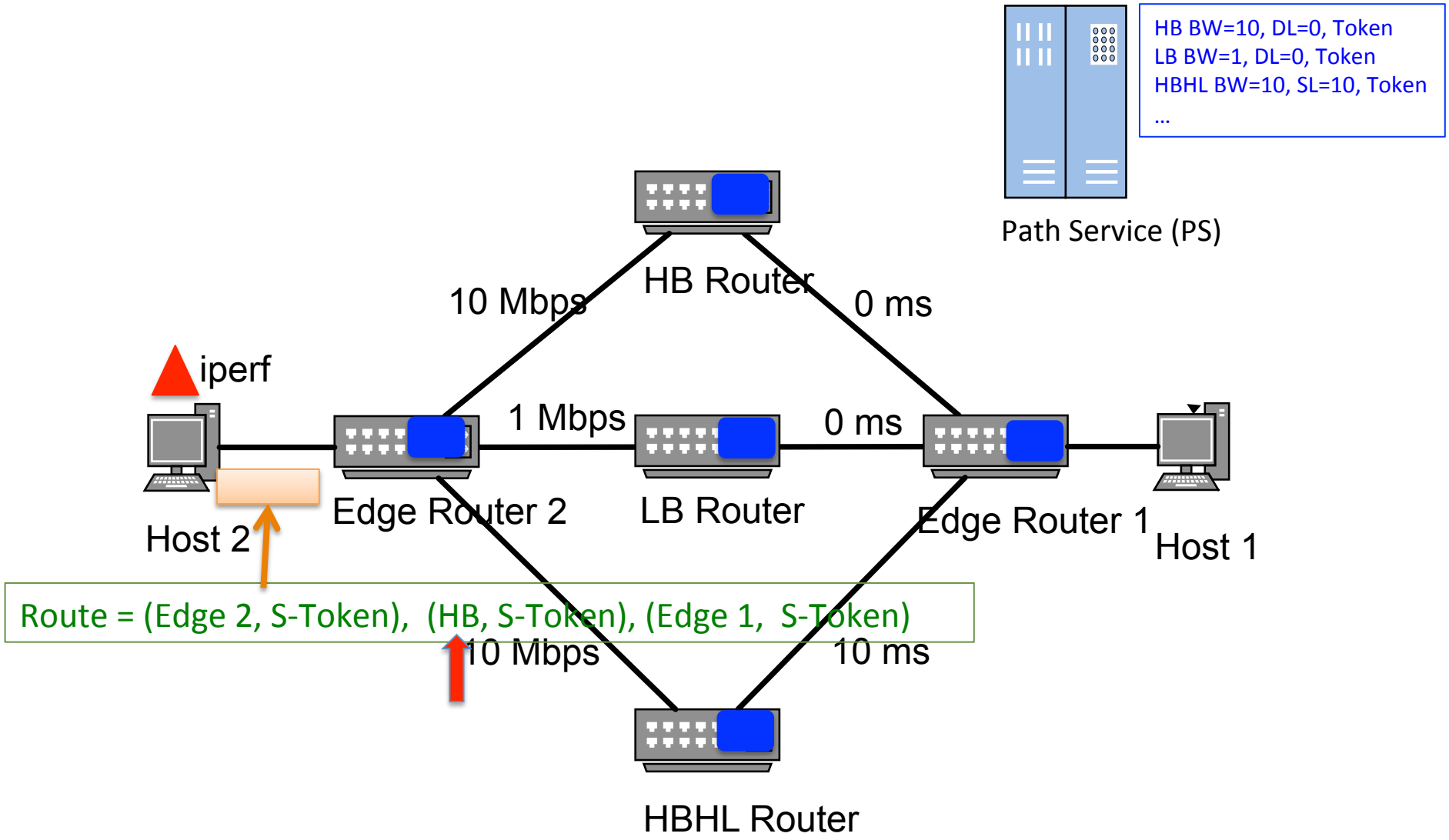

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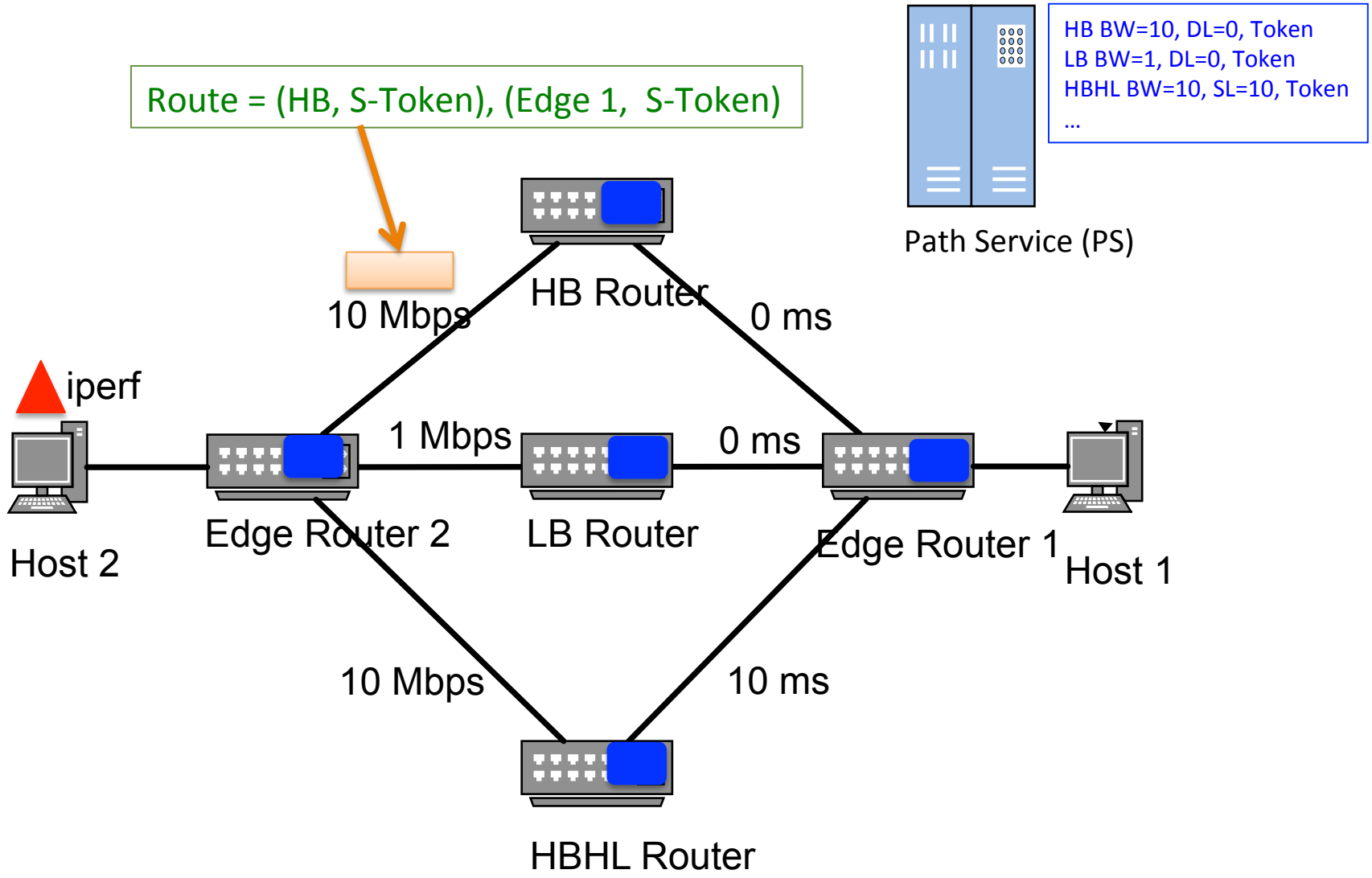

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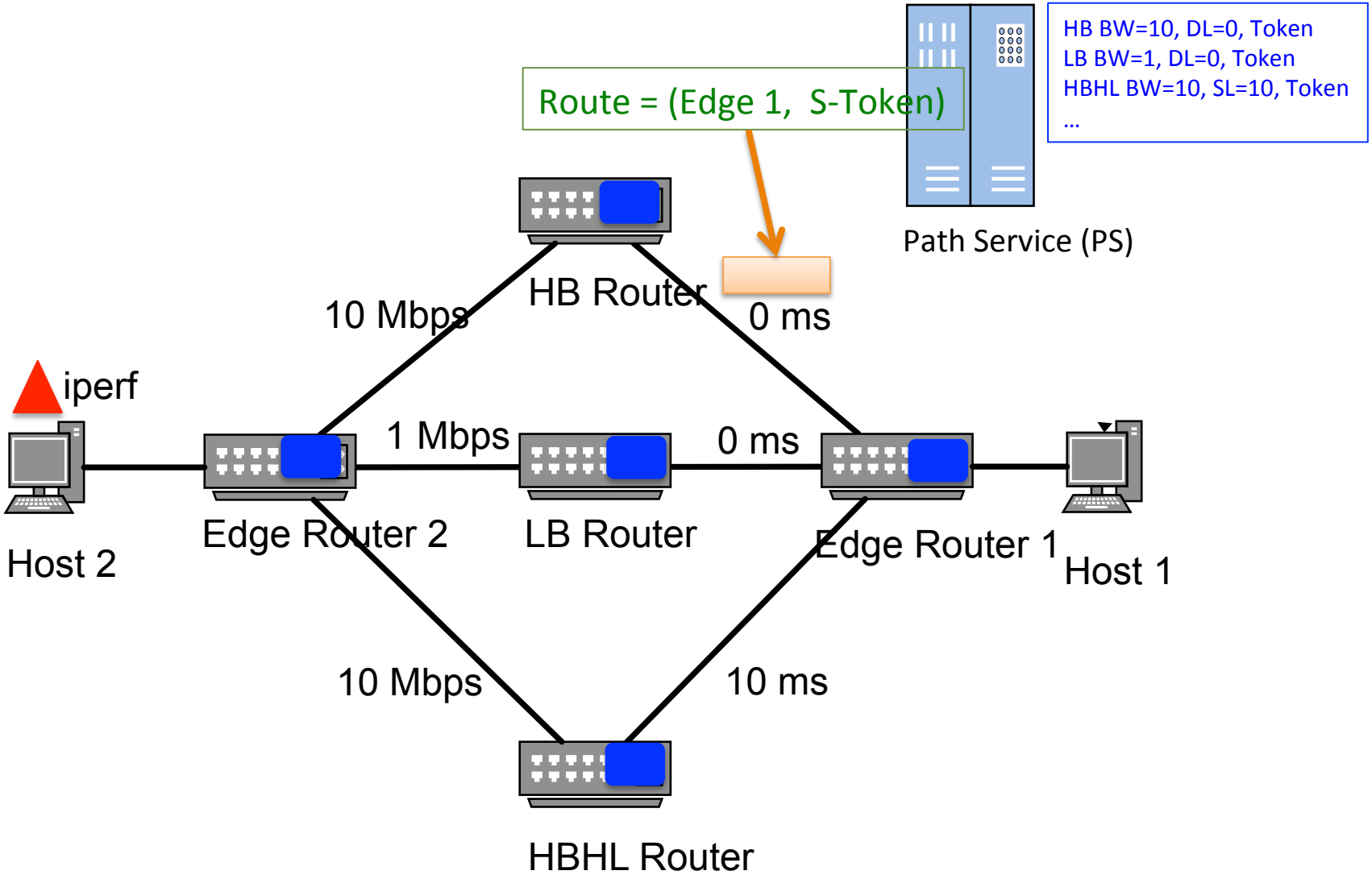

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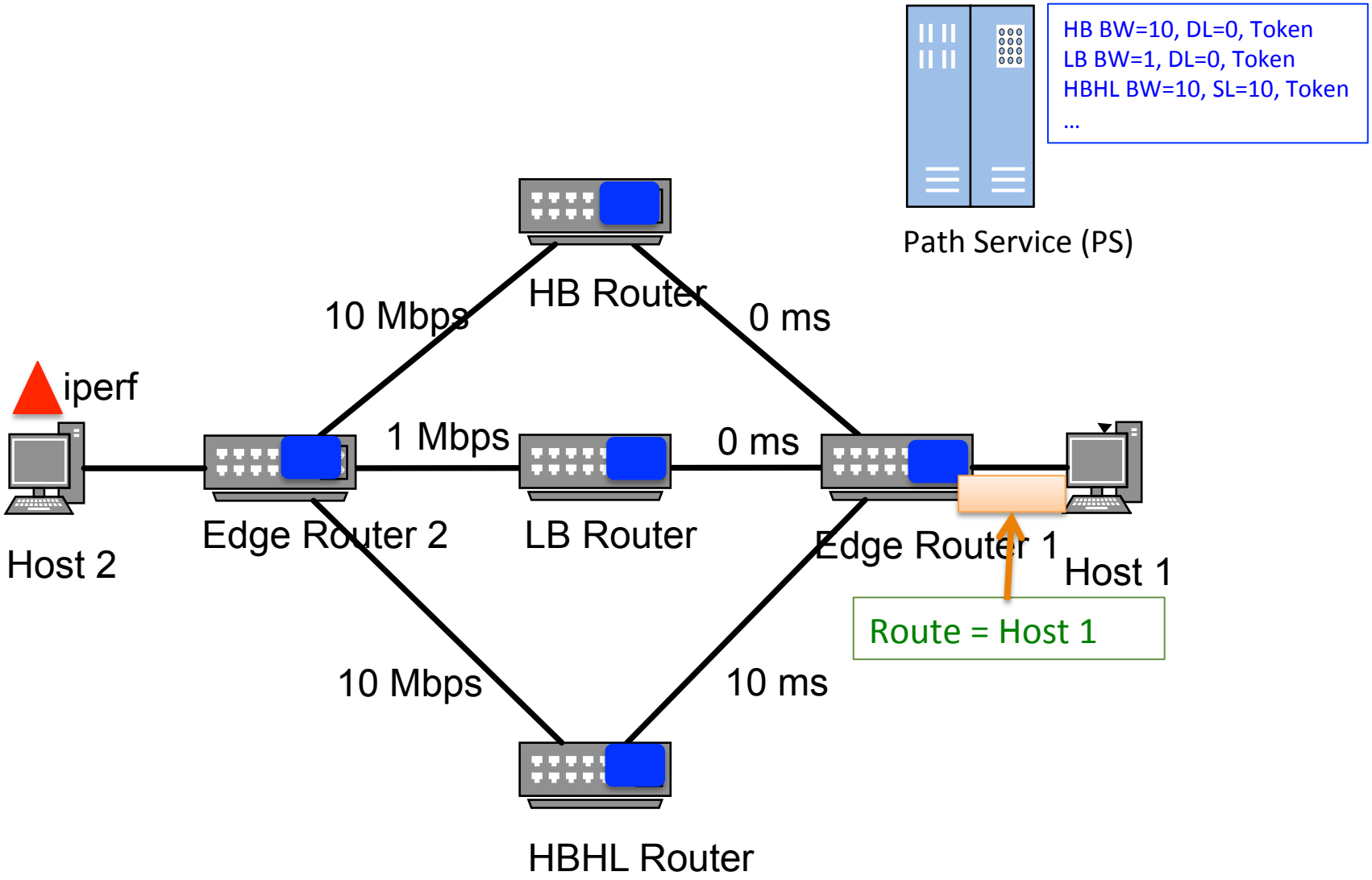


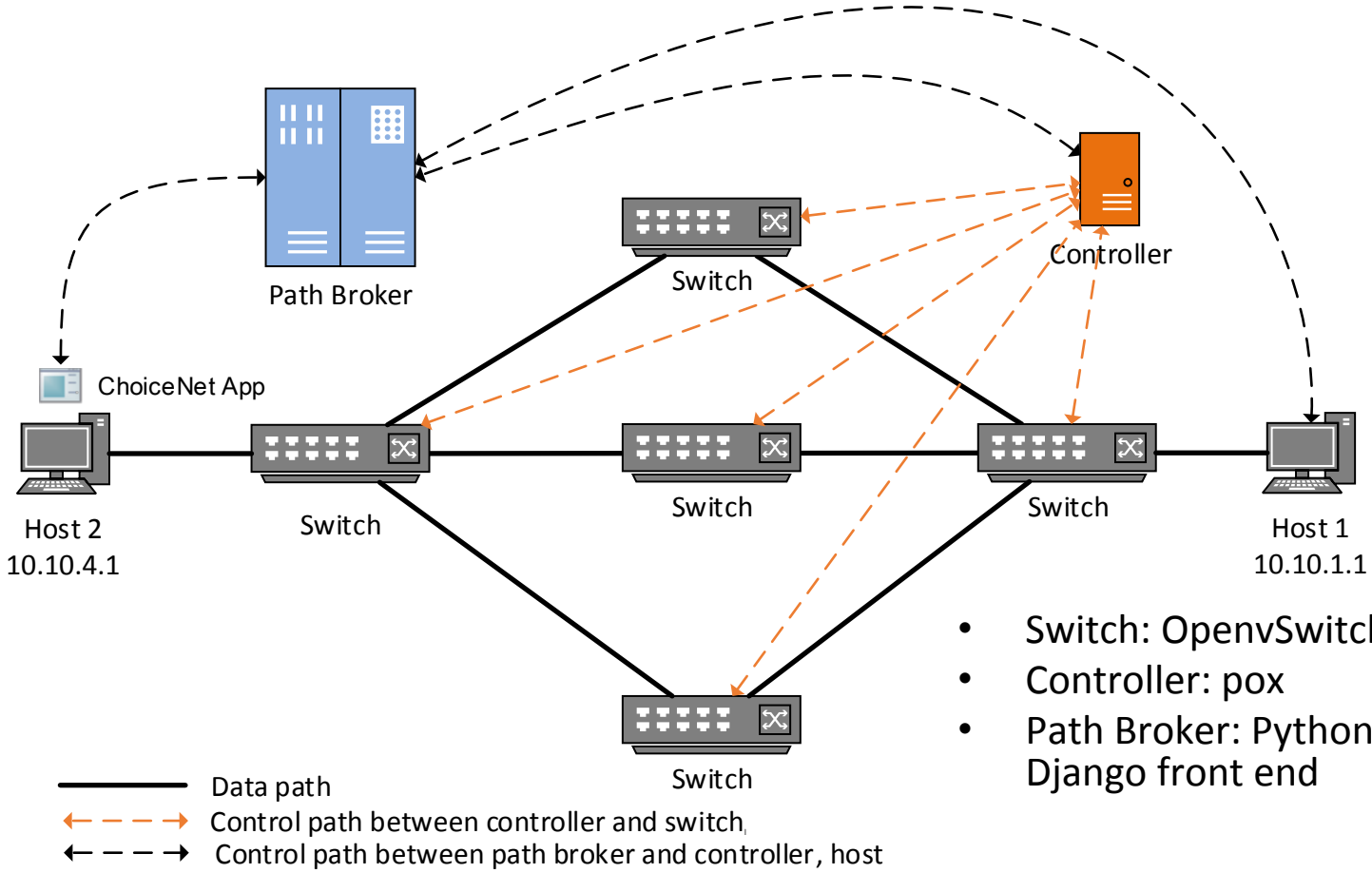
“SDN-Based” Implementation

“SDN-Based” Implementation

- Software Defined Network (SDN) implements per-flow routing
- **Forwarding Service**
  - SDN-enabled switches, accepting setup commands from Controller
- **Path Service**
  - Controller
    - Computes Intra-AS routes
    - Sends advertisements to Path Broker
  - Path Broker
    - Computes Inter-AS routes
    - Has a web front-end for payments
- **ChoiceNet-enabled application**
  - Network traffic intercepted using netfilter
  - Separate ChoiceNet app as interface between user and path broker

SDN-Based ChoiceNet Operation

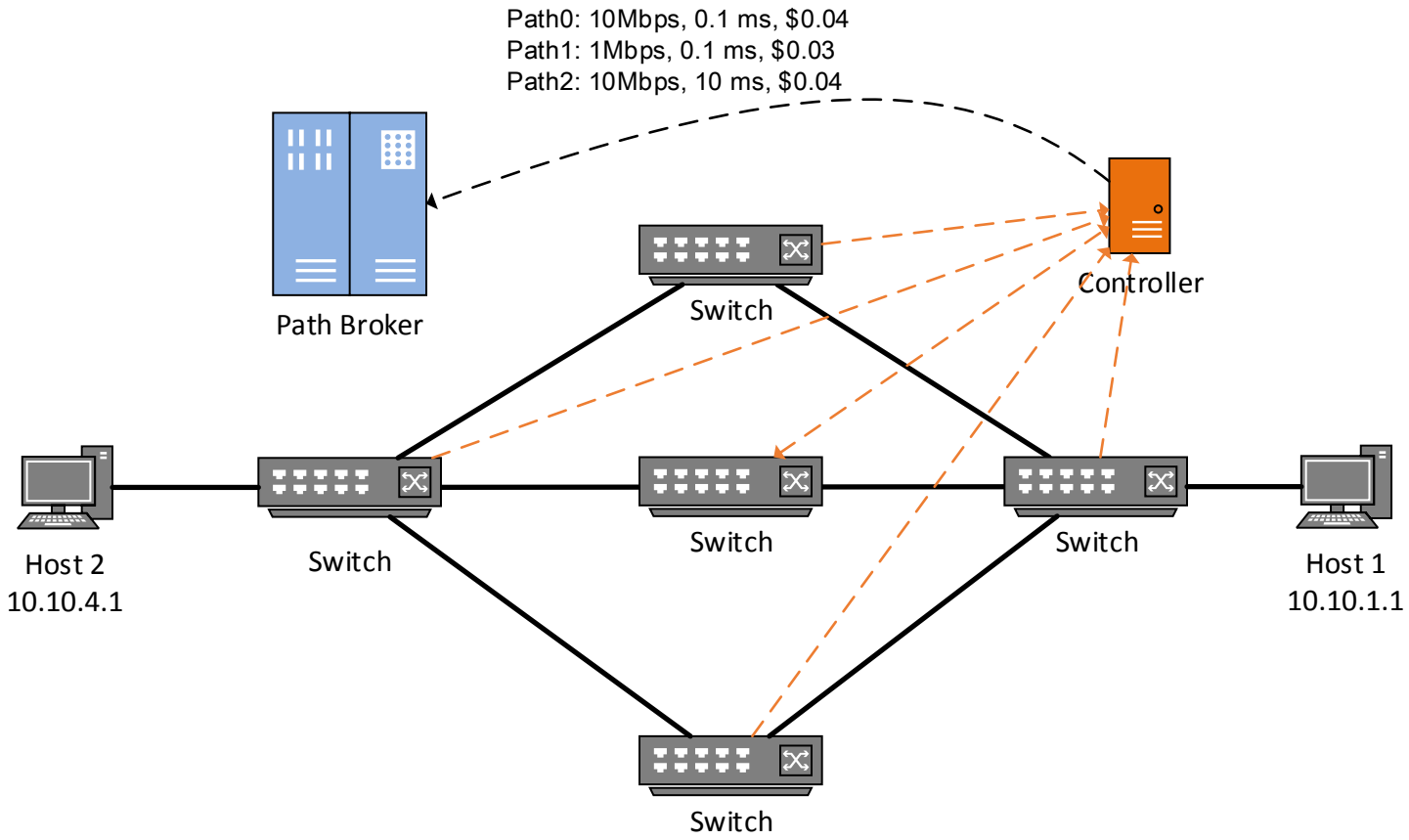
- Path Broker at core of interactions



- Switch: OpenvSwitch
- Controller: pox
- Path Broker: Python server, Django front end

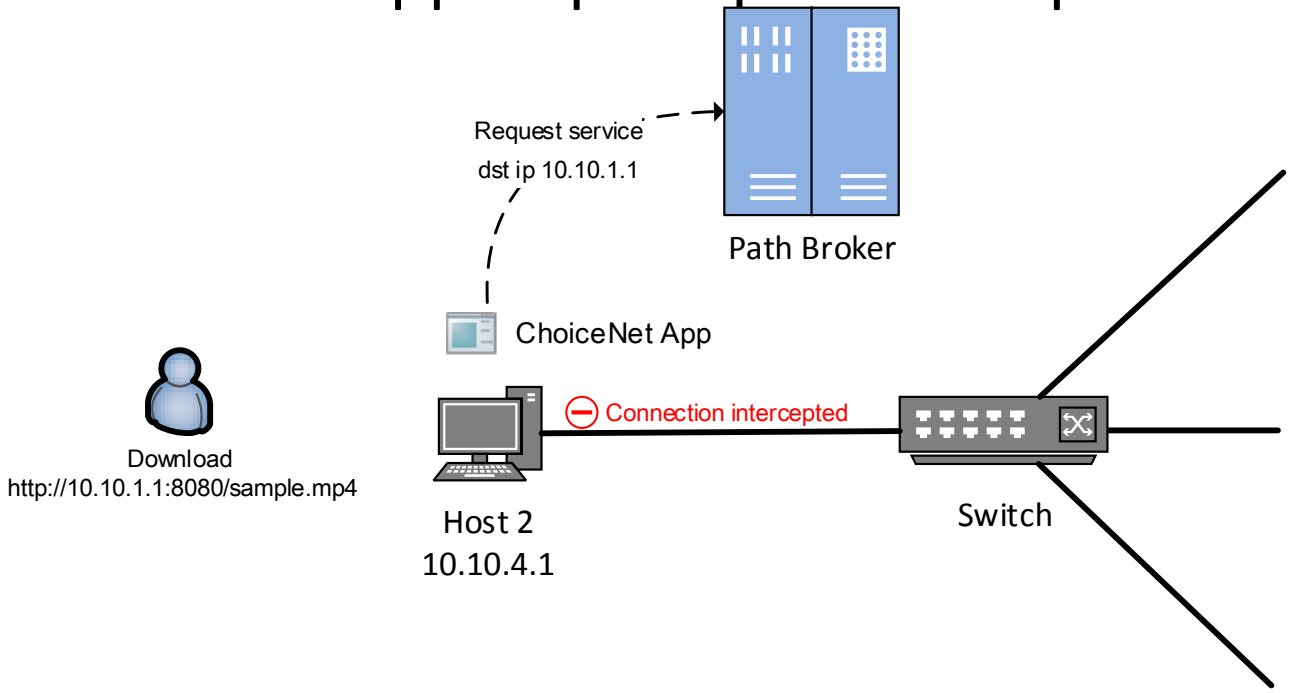
SDN-Based ChoiceNet Operation

- Controller detects paths and advertises them



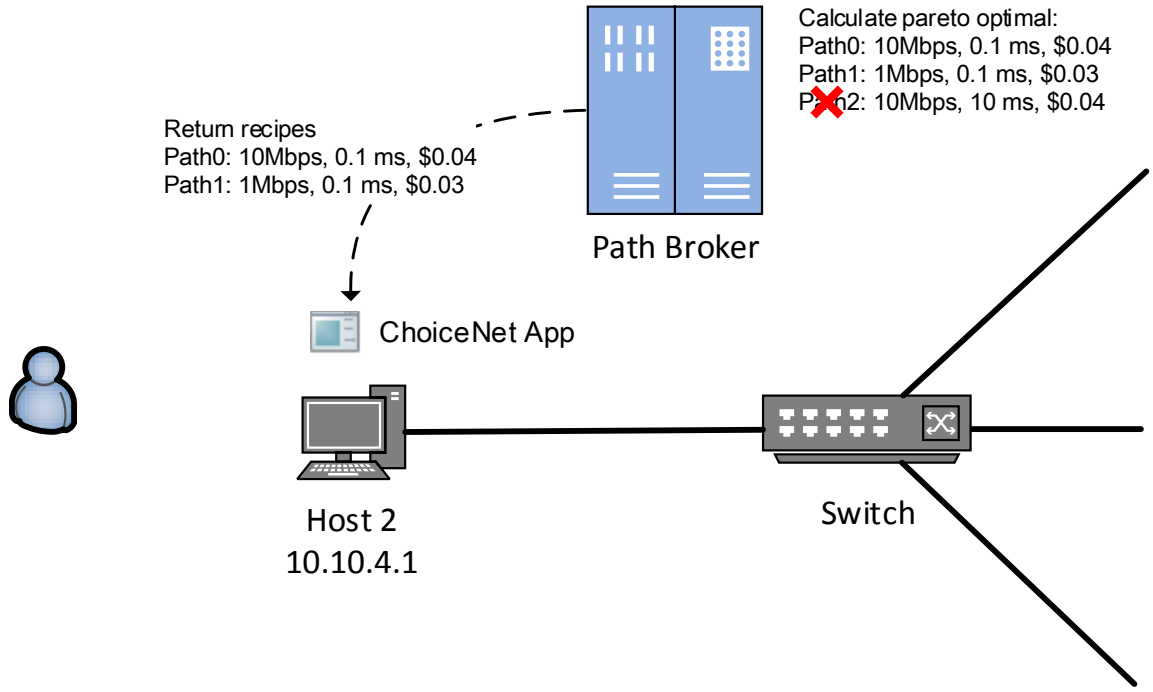
SDN-Based ChoiceNet Operation

- User/application starts a connection
  - OS intercepts connection request
  - ChoiceNet App request path from path broker



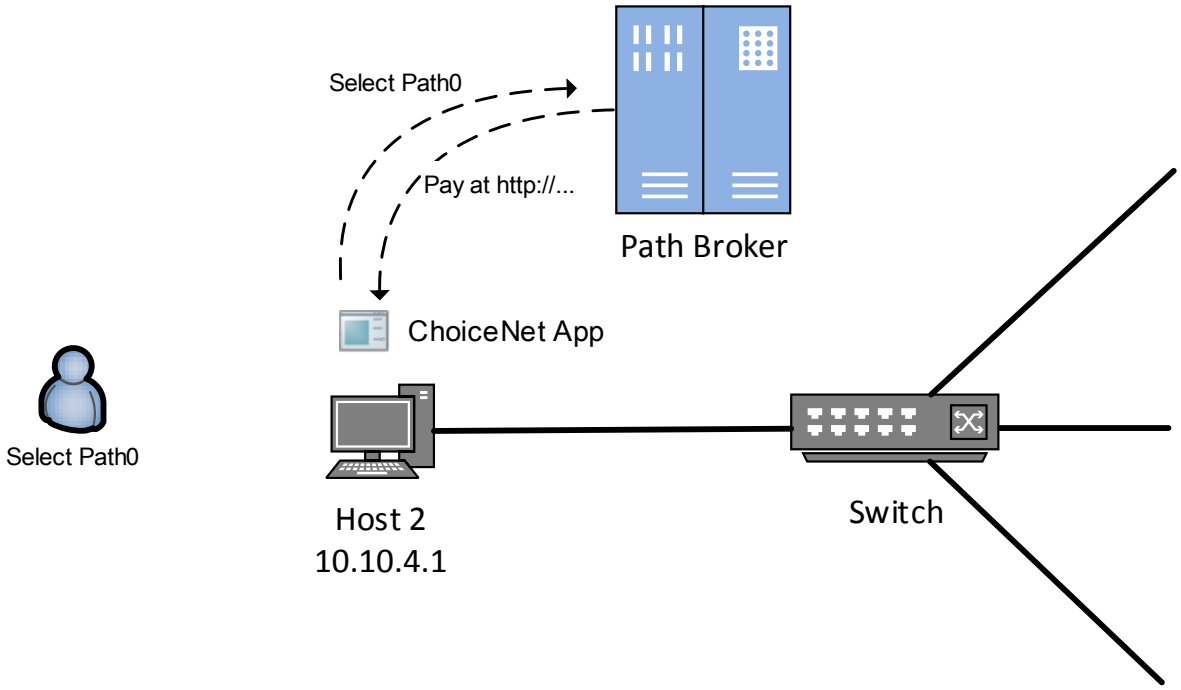
SDN-Based ChoiceNet Operation

- Path broker calculates Pareto-optimal paths
  - Returns offers to ChoiceNet app



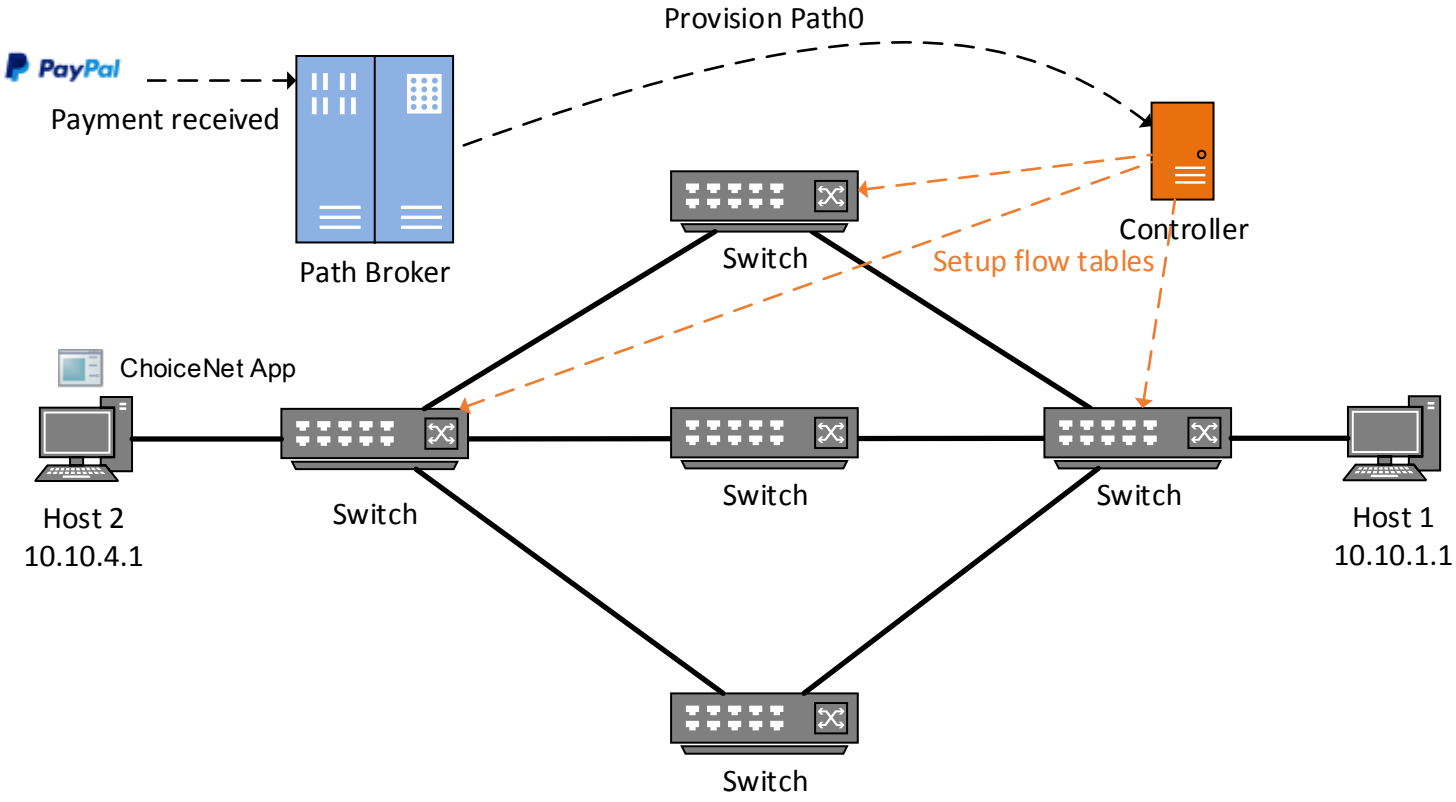
SDN-Based ChoiceNet Operation

- User/application selects on path
  - Path broker requests payment



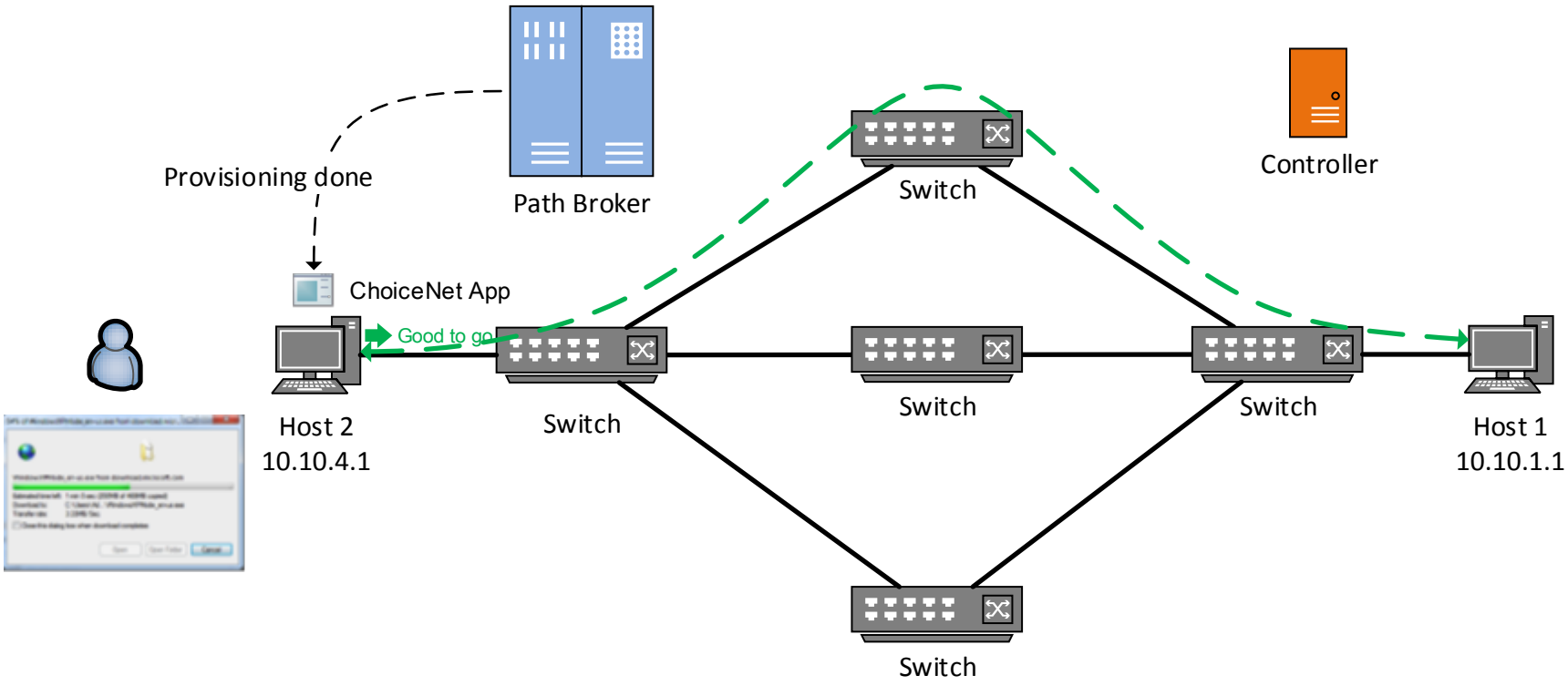
SDN-Based ChoiceNet Operation

- Payment issued via Paypal website
  - After receiving payment, broker provisions path



SDN-Based ChoiceNet Operation

- After provisioning, path broker informs App
  - Transmission begins



Hands-On Exercise

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  - Both source-routed and SDN-based services
- Complete remaining steps:
  3. Interacting with ChoiceNet Apps
  4. Run Apps in ChoiceNet (PART 1)
  5. Run Apps in ChoiceNet (PART 2)
- Parts 1 and 2 can be done in any order

Limitations

- Current services are only end-to-end paths
  - More complex services could be constructed
  - ChoiceNet allows processing and storage services
- No verification mechanism if service was good
  - External measurement to provide “insurance”
- No escrow for money
  - No recourse for customer

Acknowledgements

- All ChoiceNet collaborators:
  - **Ken Calvert**, UKY
  - **Rudra Dutta**, NC State
  - **George Rouskas**, NC State
  - **Ilya Baldine**, RENCI
  - **Anna Nagurney**, UMass
- Economic simulation:
  - **Luis Andres Marentes Cubillos**, Univ. de los Andes
- National Science Foundation
- GENI Project Office

ChoiceNet Travel Grant Awardees

- Please see Tilman Wolf during break!

Thank you!

More information about ChoiceNet:
http://choicenet.info