

Header Space Analysis: Static Checking for Networks

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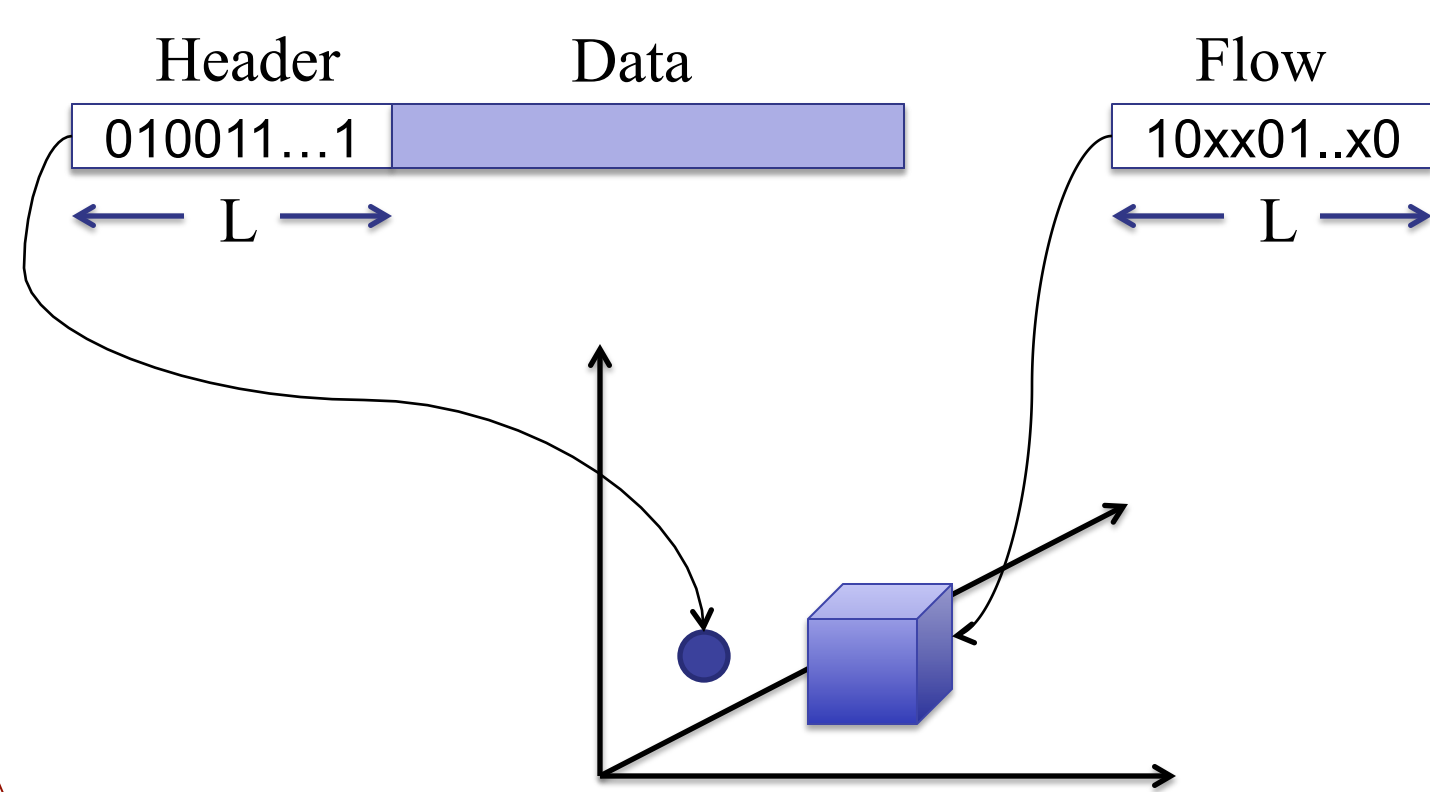
Goals

- Statically check networks to:
 - Detect failures such as **Forwarding Loops** and **Reachability Failures**.
 - Ensure **Isolation of Slices** created on a network.
 - Create a set of test packets for **Runtime Self-Testing** of networks to detect problems such as Link Failure, Congestion or Security Holes.

Method: Header Space Analysis

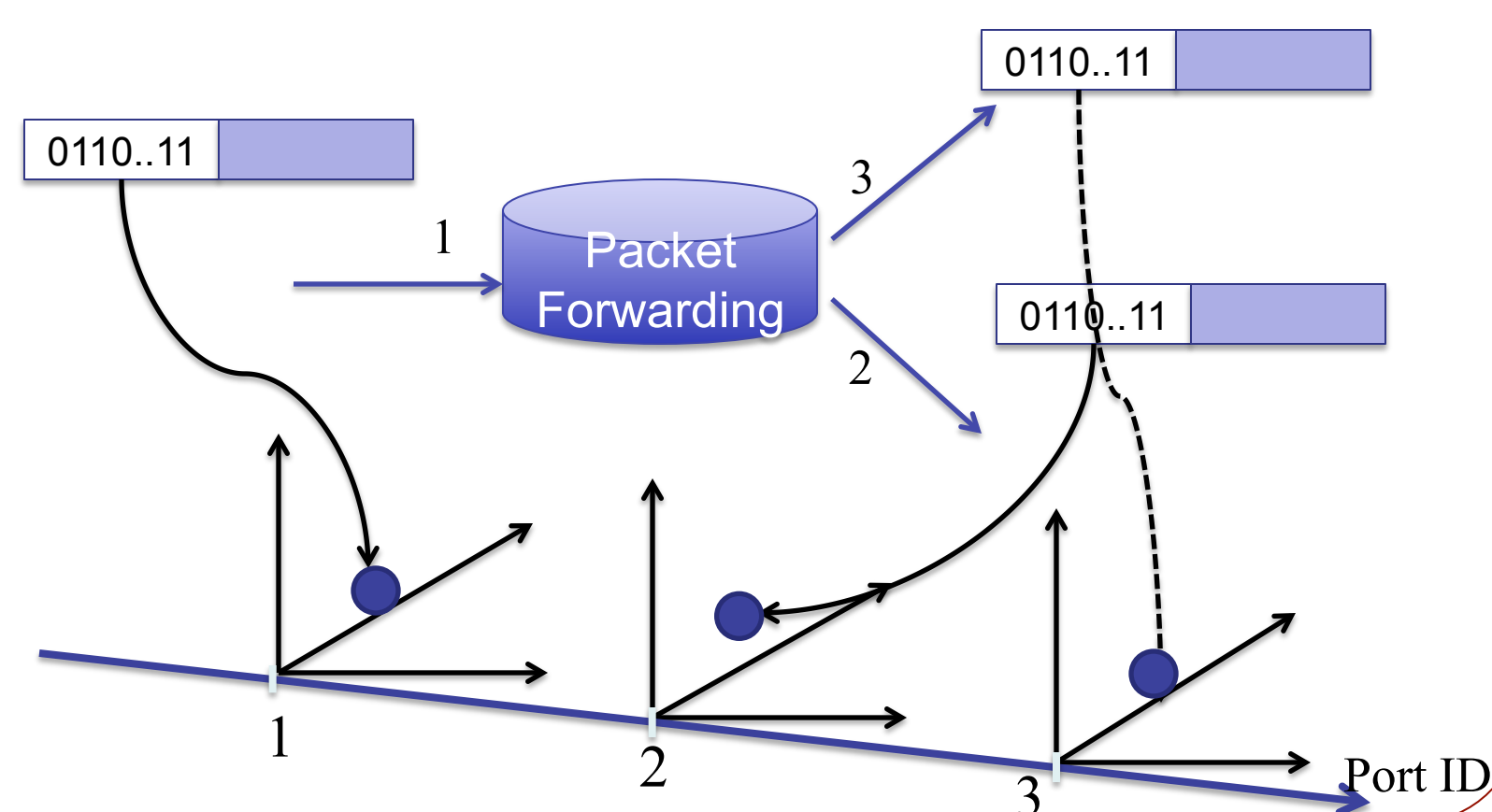
STEP 1

Model packet header as a point in $\{0,1\}^L$ space
The Header Space



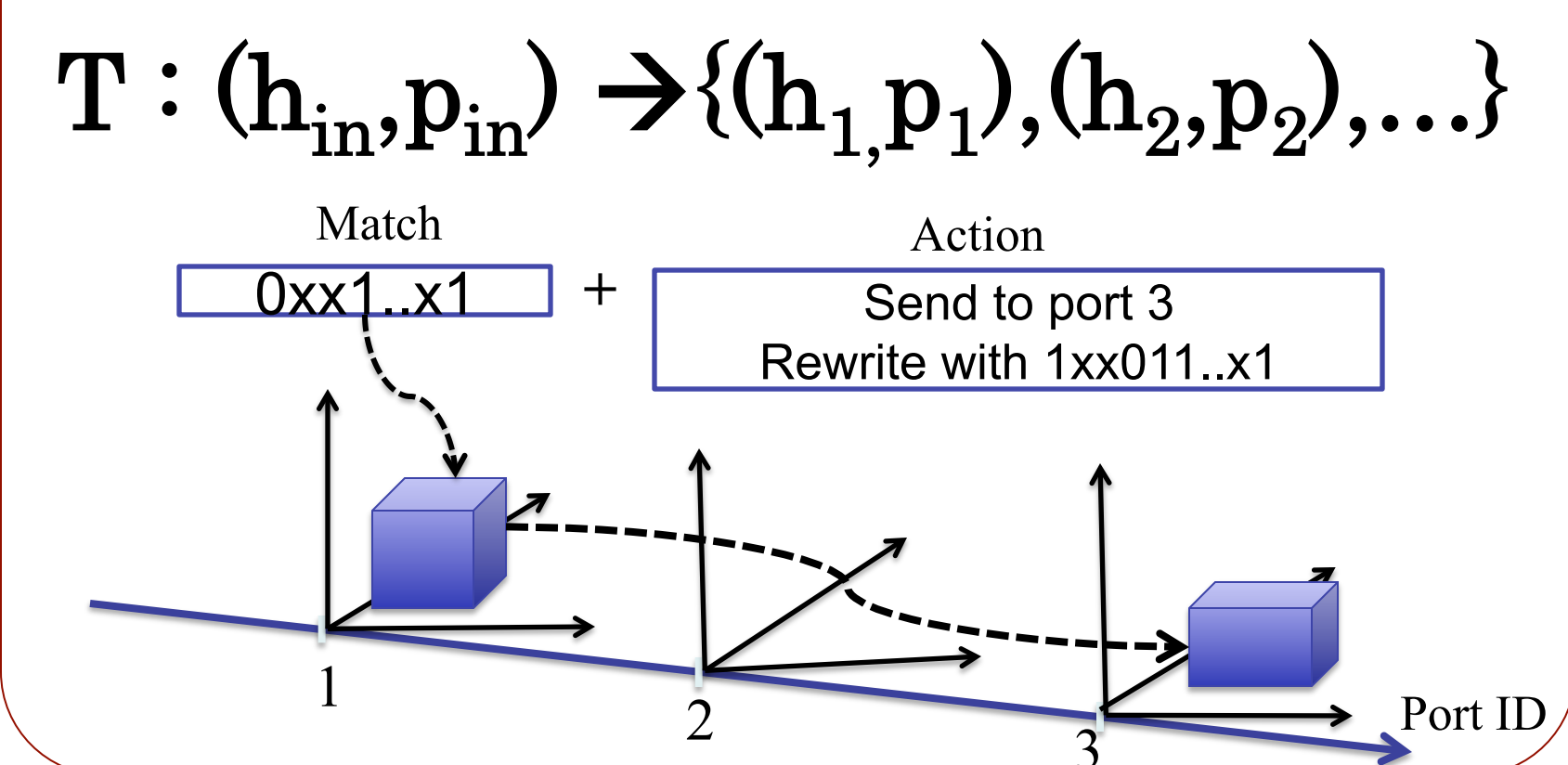
STEP 2

Add a unique port id as an extra dimension to the space
The Network Space



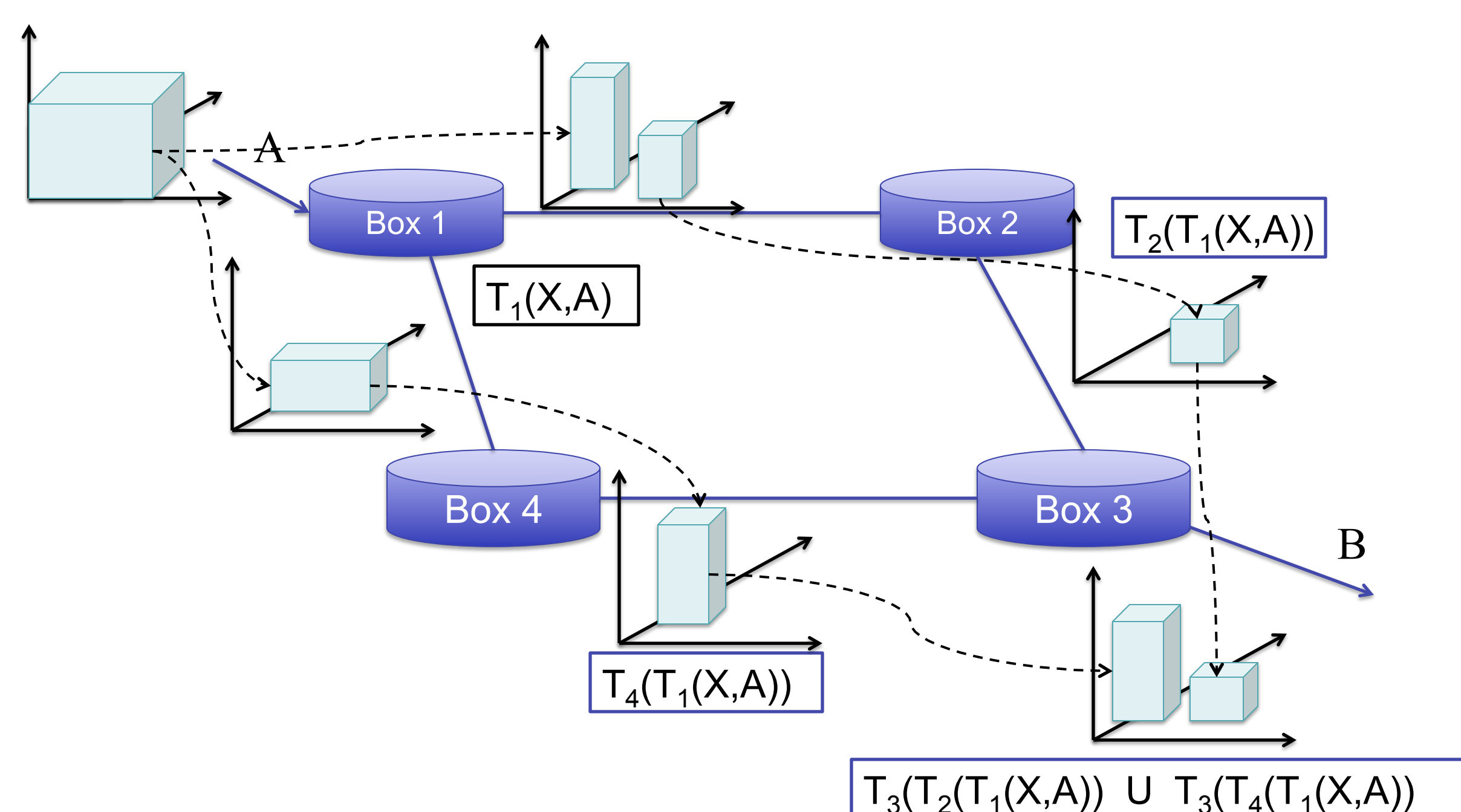
STEP 3

Model each box as a transformer of network space
The Transfer Function



Two Examples

Reachability



Calculating Reachability:

- Method 1)** Compose transfer functions along the paths that connects A to B
- Method 2)** Inject an all-x packet from A and follow the packet until it reaches B

Runtime Self-Testing

Goal: Pick a set of test packets and injection ports to exercise maximum number of possible rules in the network.

Method:

- Find the all-way reachability from every available terminal port.
- Keep track of the transfer function rules that each flow exercises along the paths.
- Pick a set of flows and one representative packet from each flow to cover maximum number of rules.

What can be detected?

- Link or port down.
- Performance degradation such as congestion.
- Routing errors.
- Security holes.