Event-Driven Network Programming

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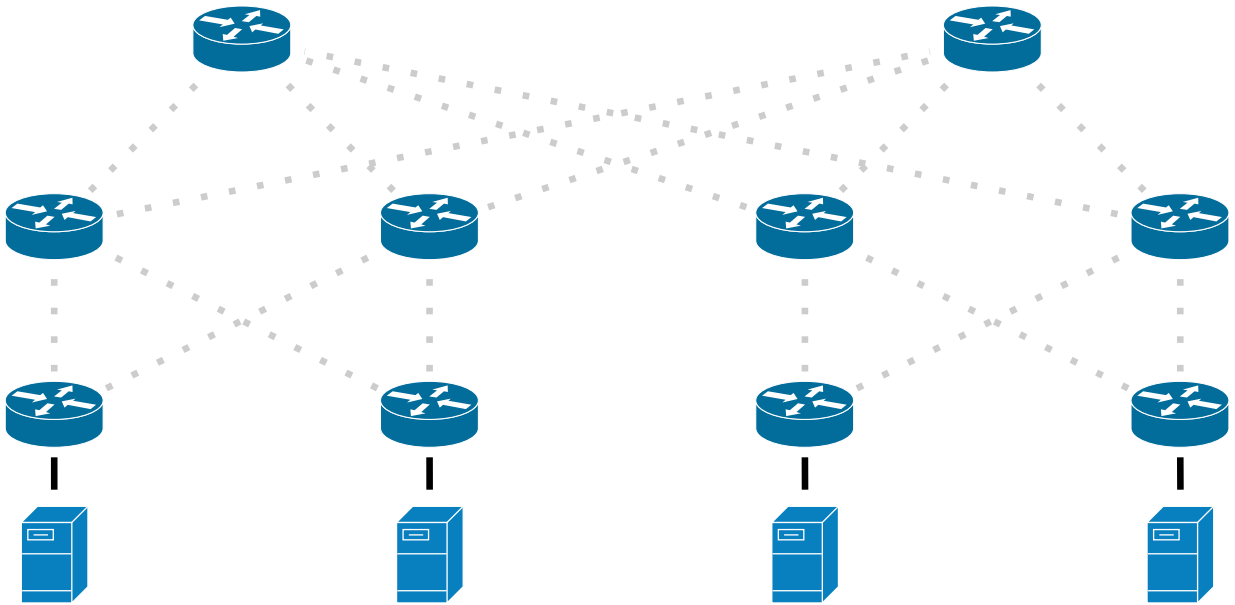
June 16th, 2016
(PLDI 2016)

Network Programming



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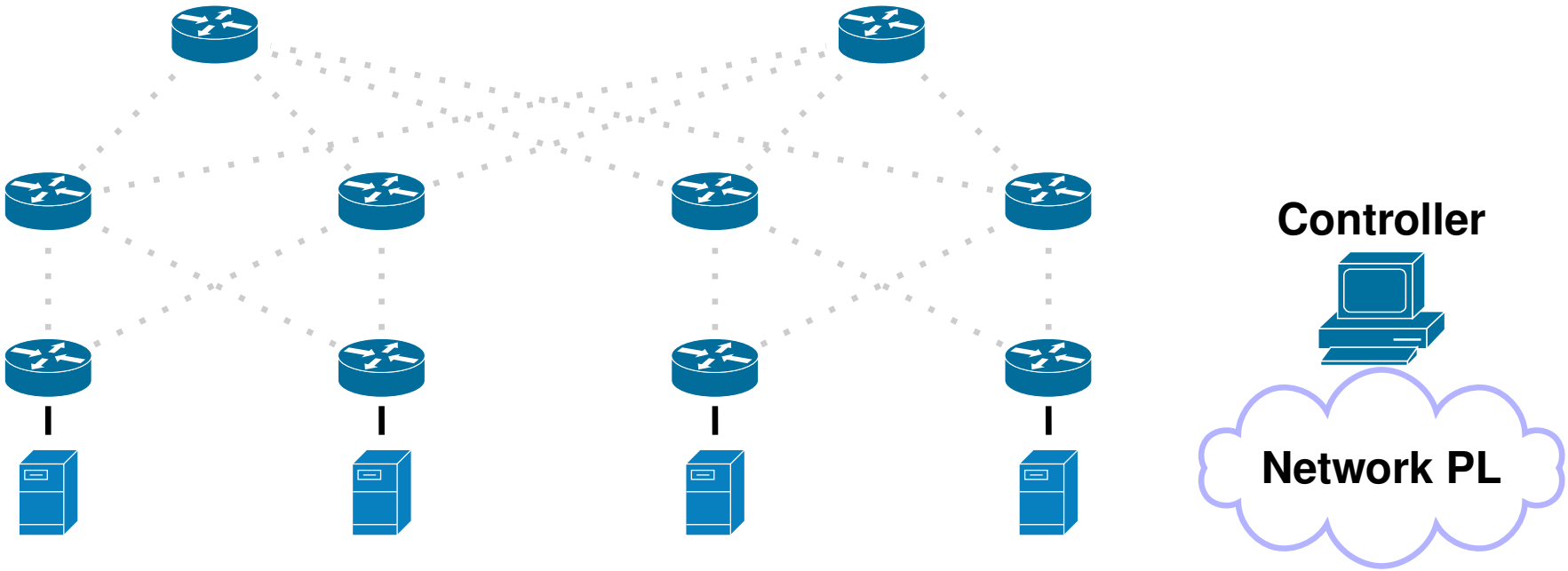

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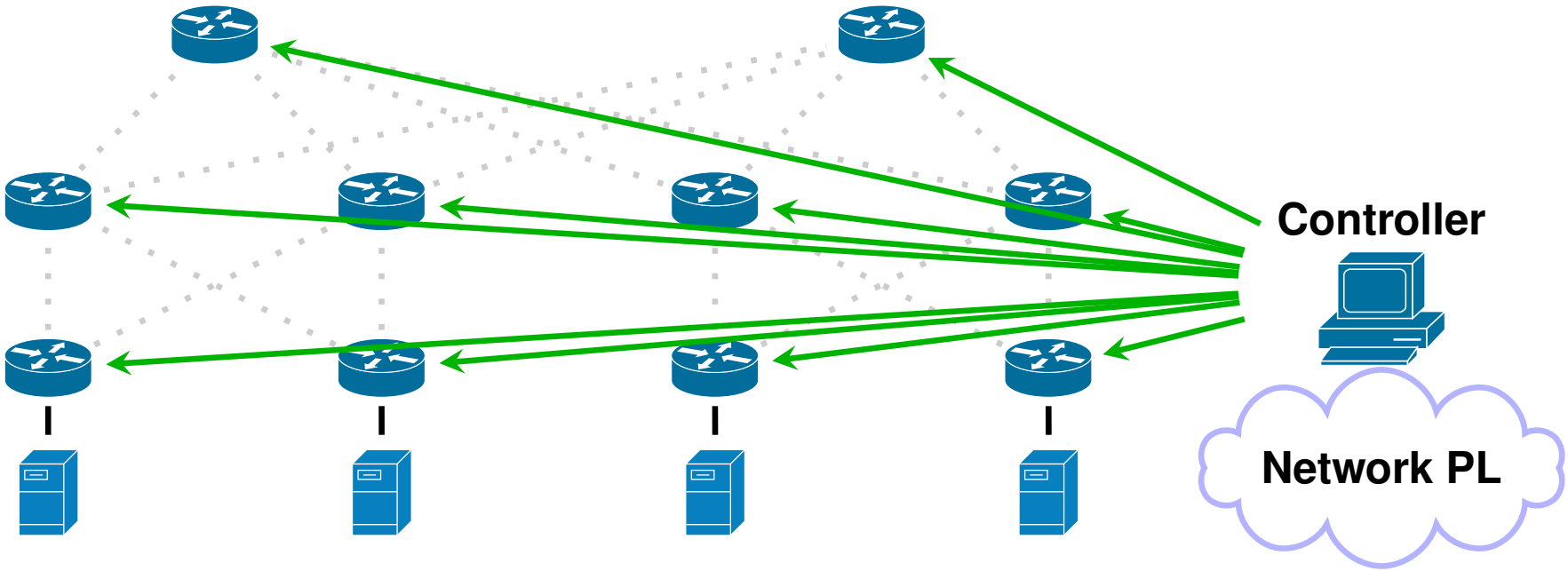

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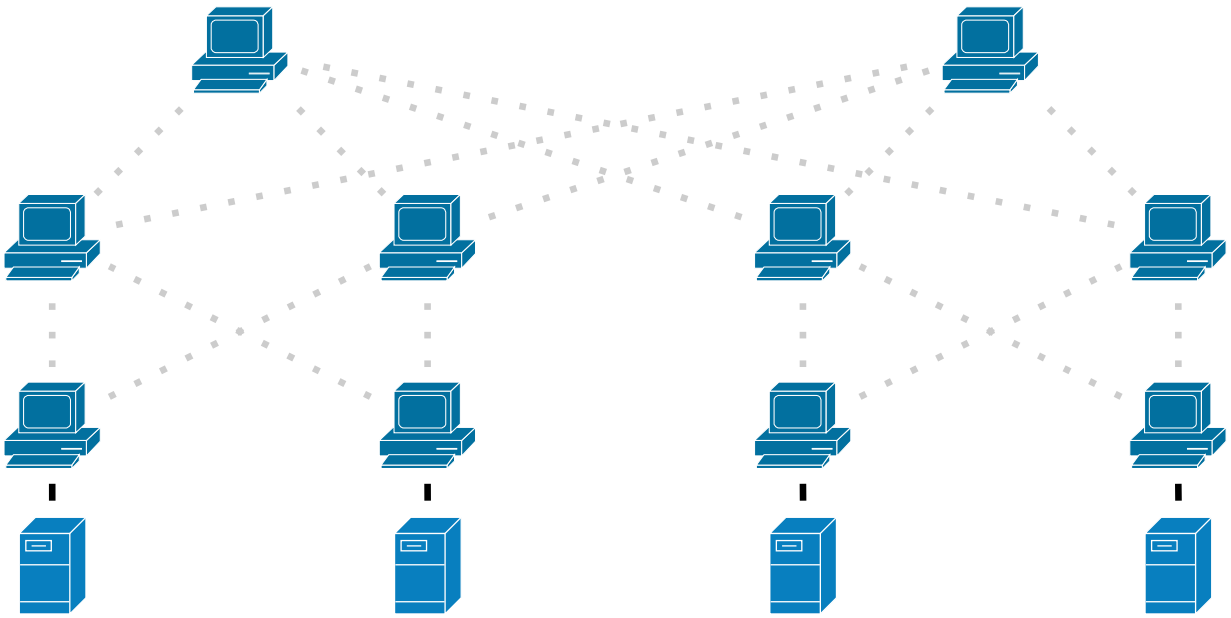

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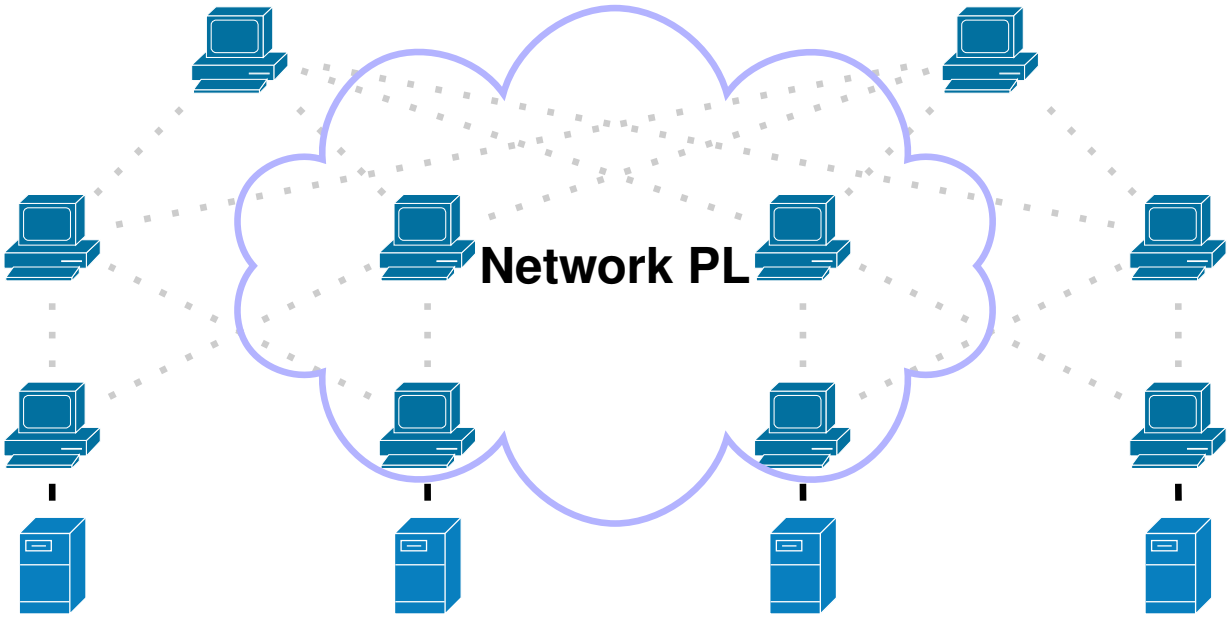

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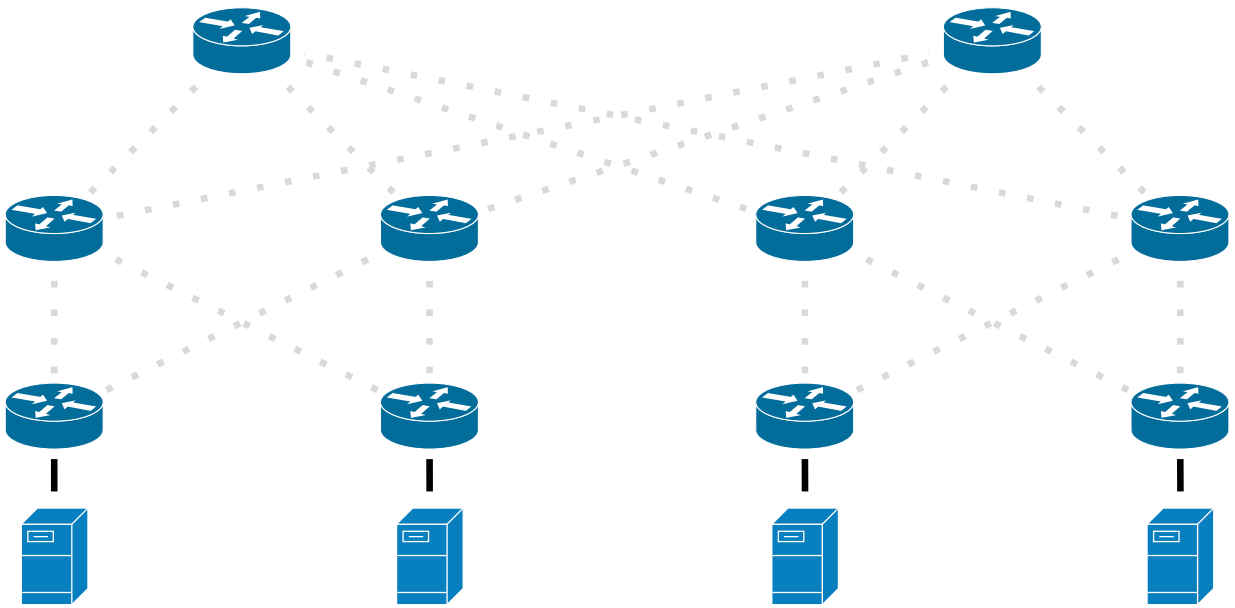
- There are many languages for this (NetKAT [POPL'14], etc.)
- SDN devices are becoming more programmable: mutable state, responding to events, etc.
- Writing programs for these *dynamic* networks is difficult: handling shared state in a distributed system, etc.

Consistency

- There are programming approaches for SDN which provide consistency in the form of an *atomic* construct



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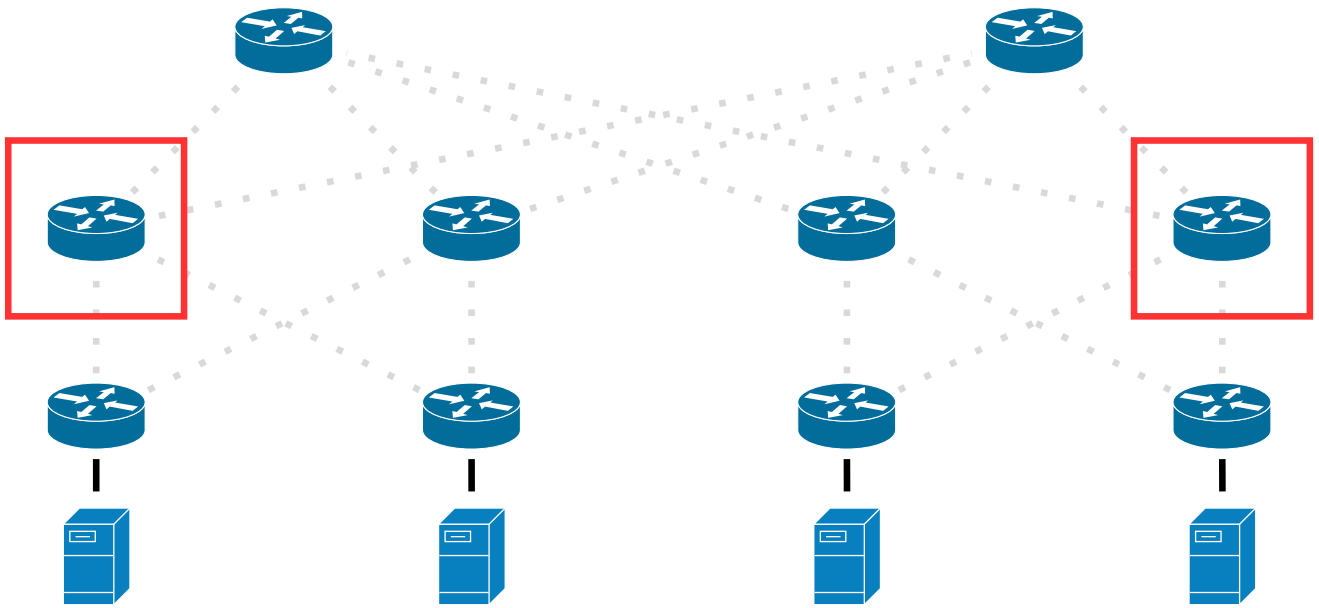

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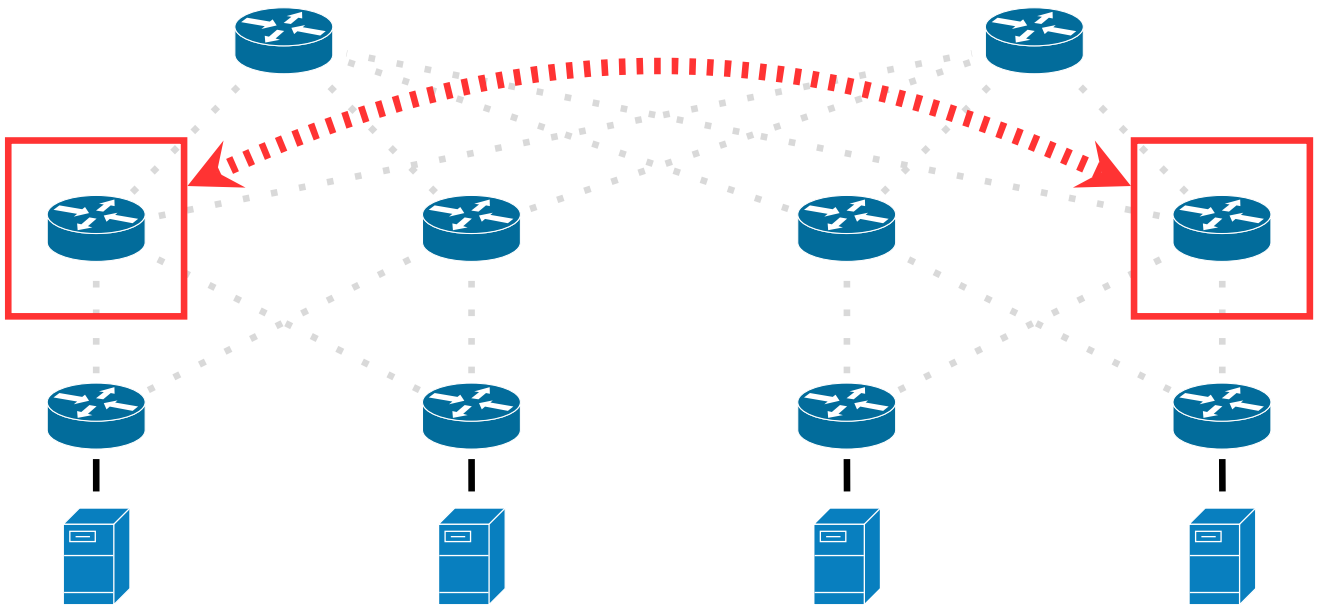

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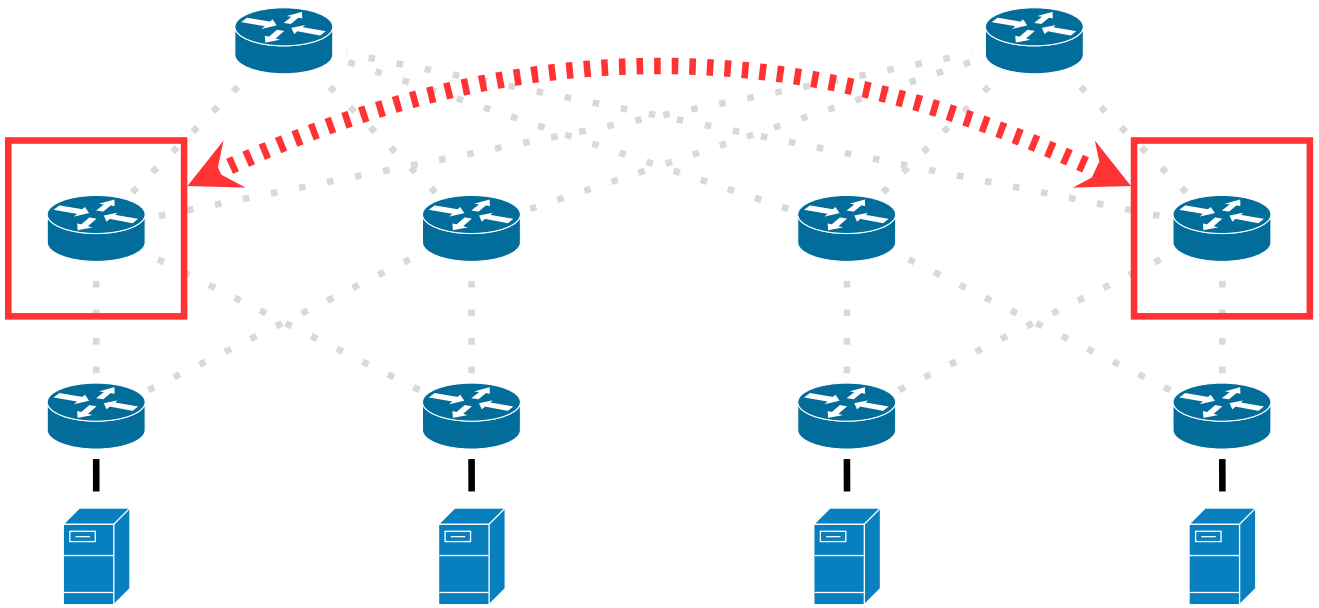

- We want to provide a useful form of consistency while ensuring that *all programs are efficiently implementable*

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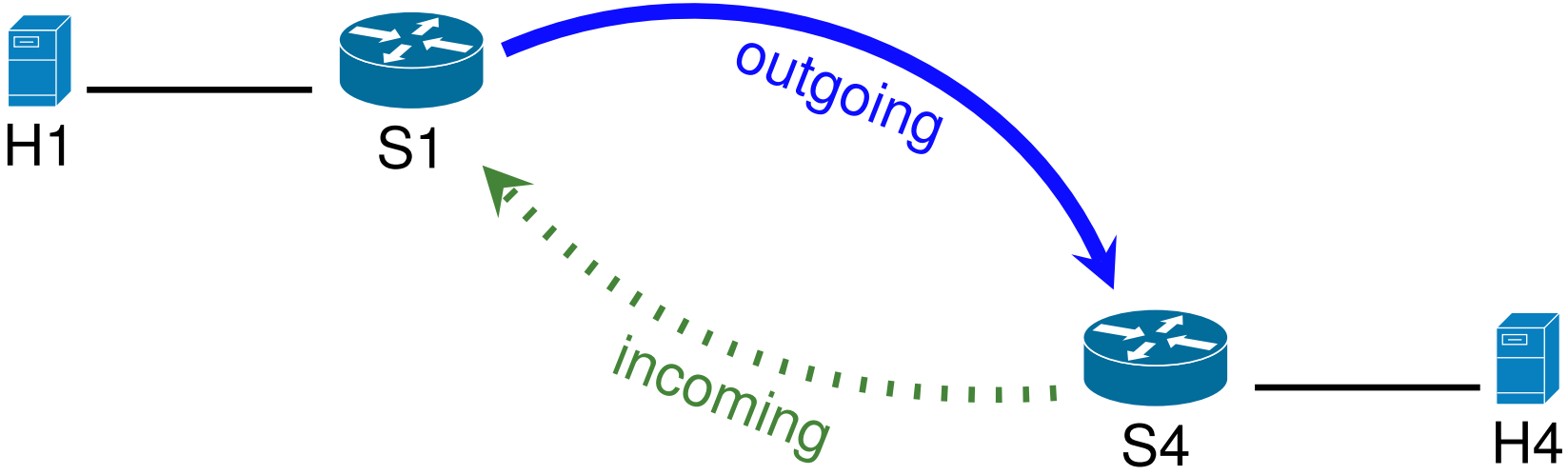

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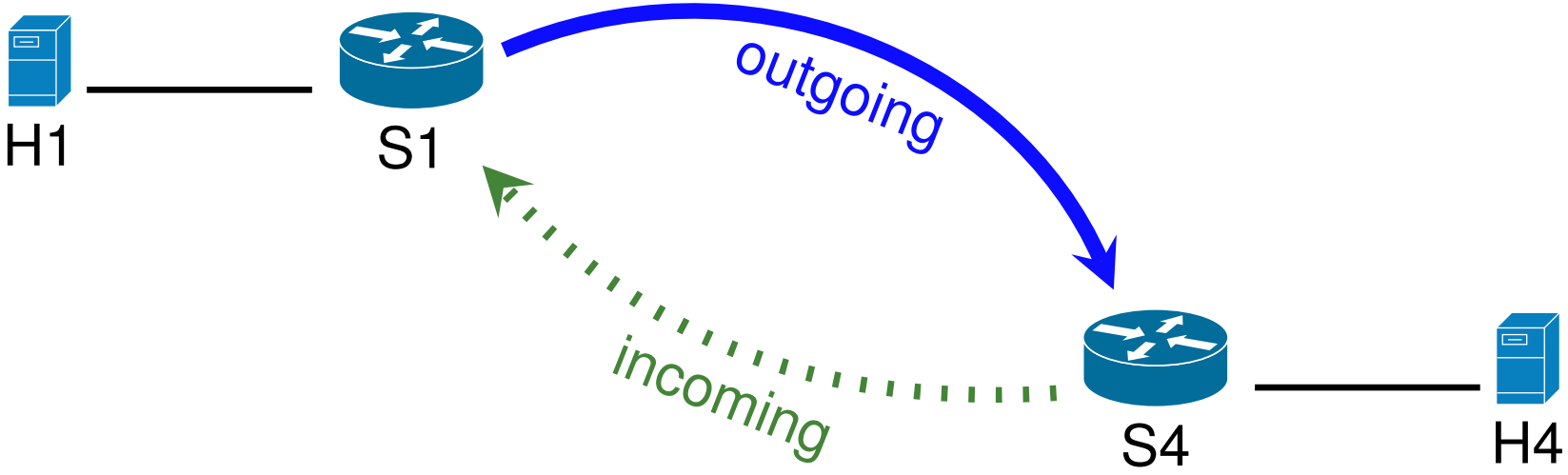

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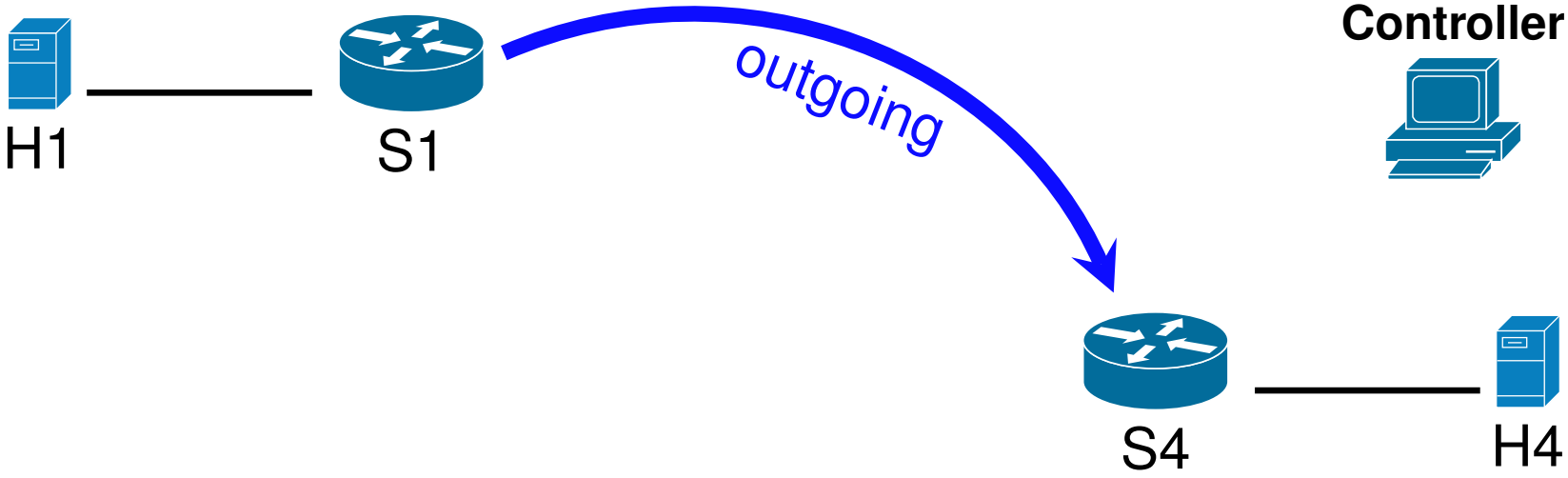

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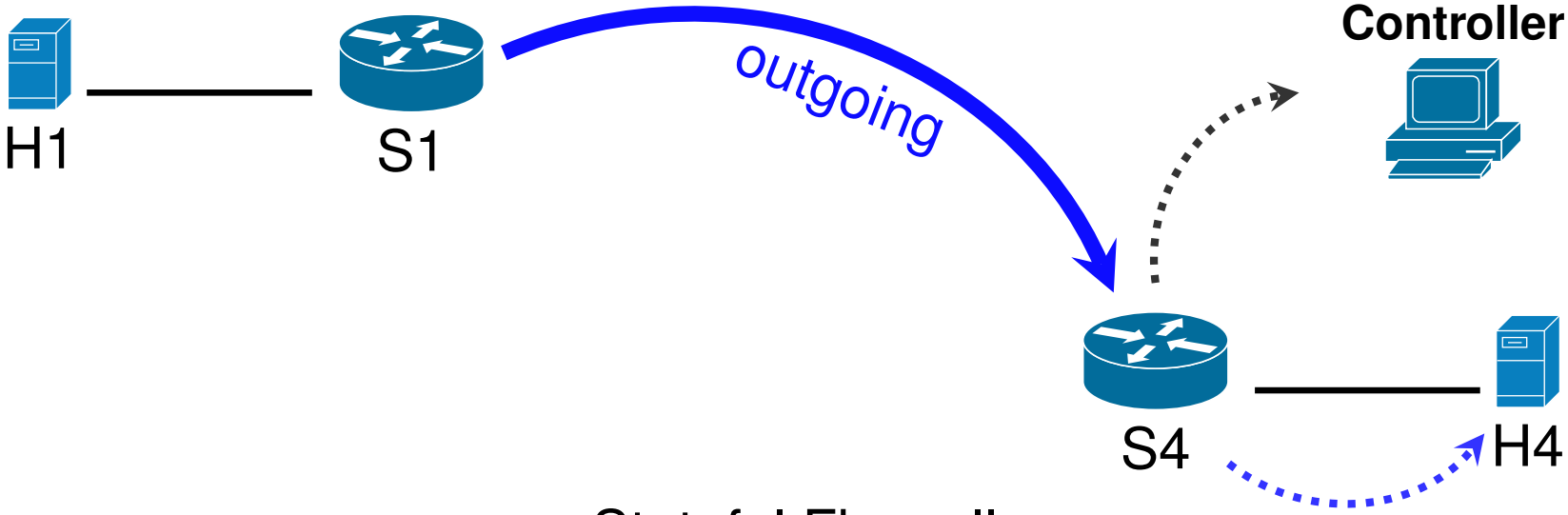

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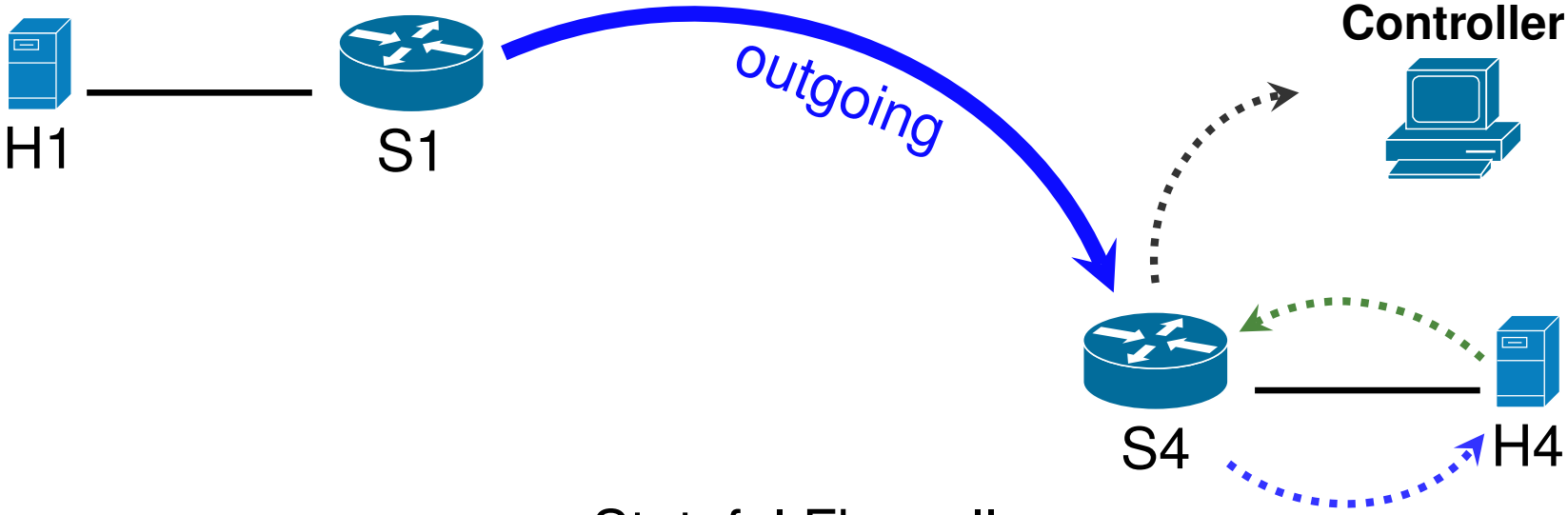

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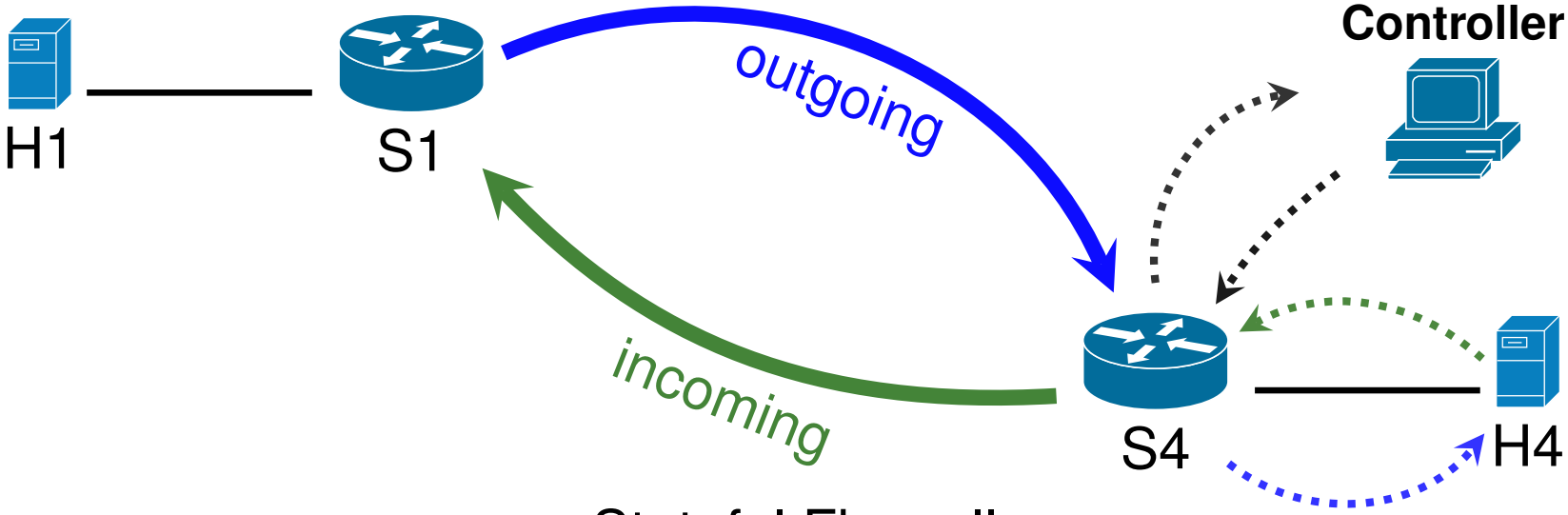

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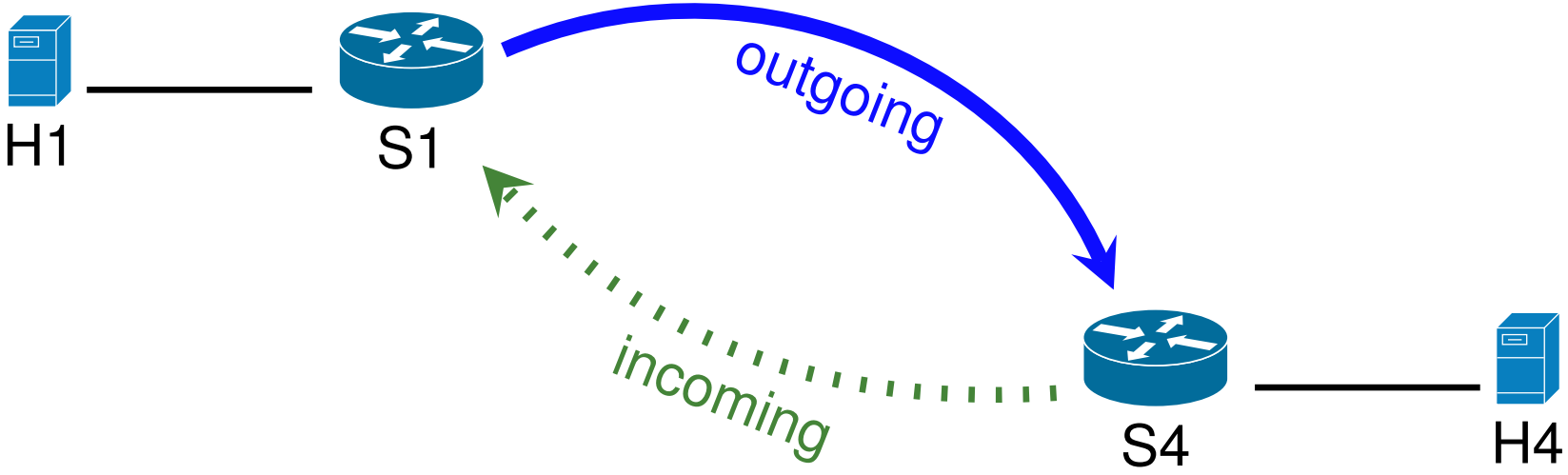

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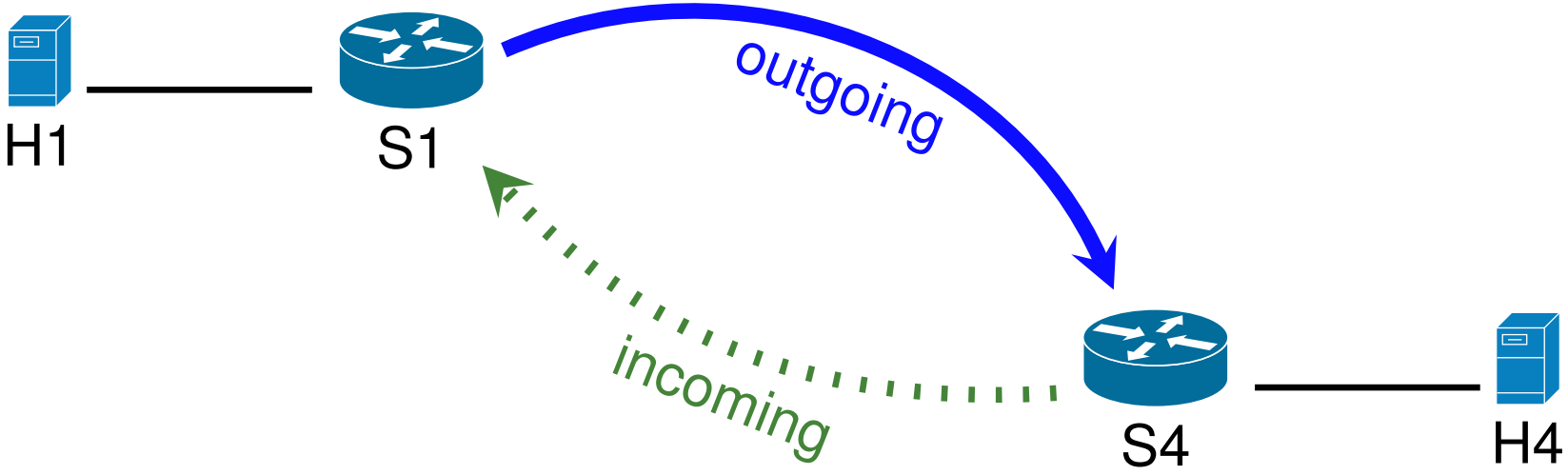

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- We need stronger guarantees about *when* configurations change with respect to events
- *Don't respond to an event too late (and don't respond too early)!*

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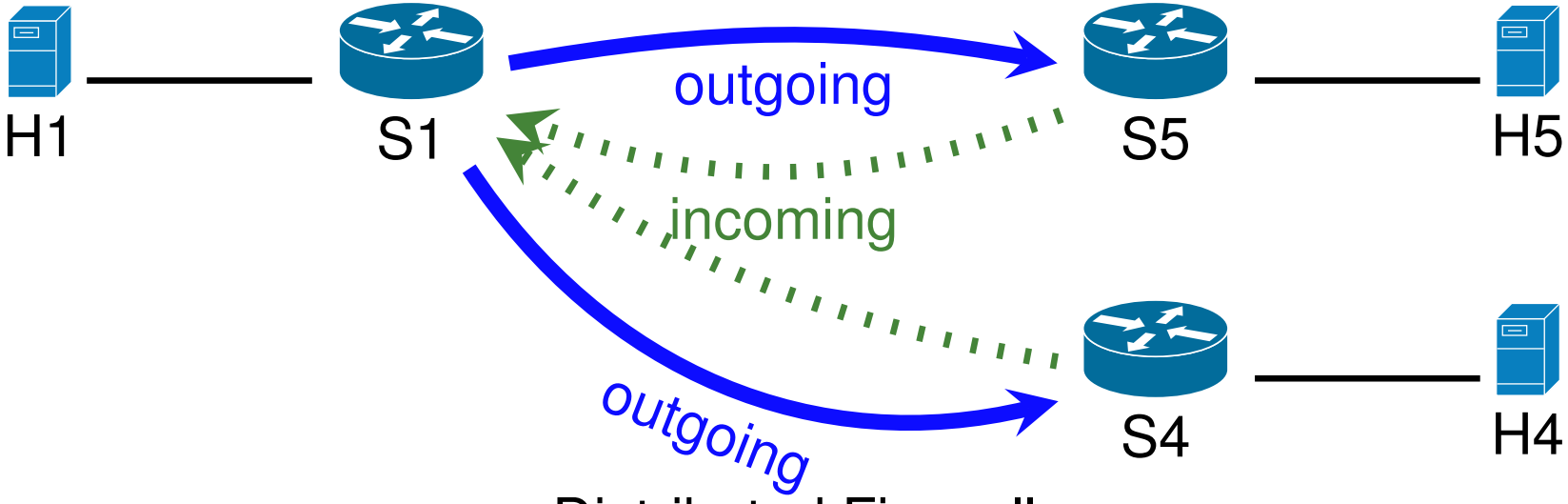

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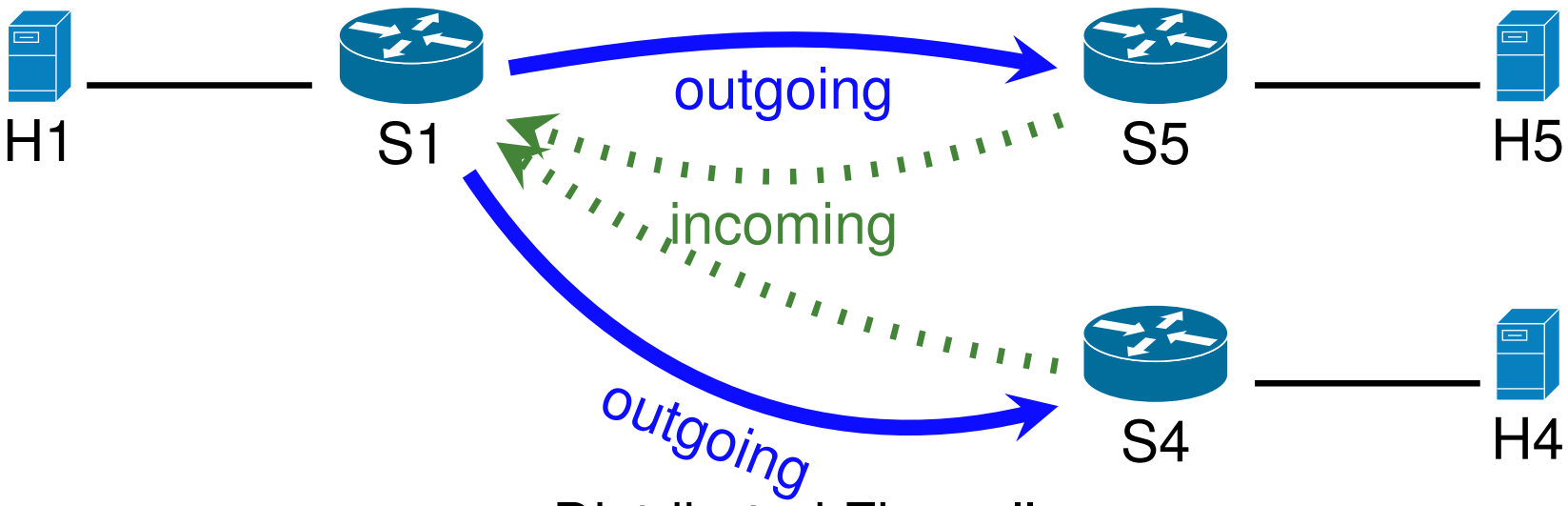

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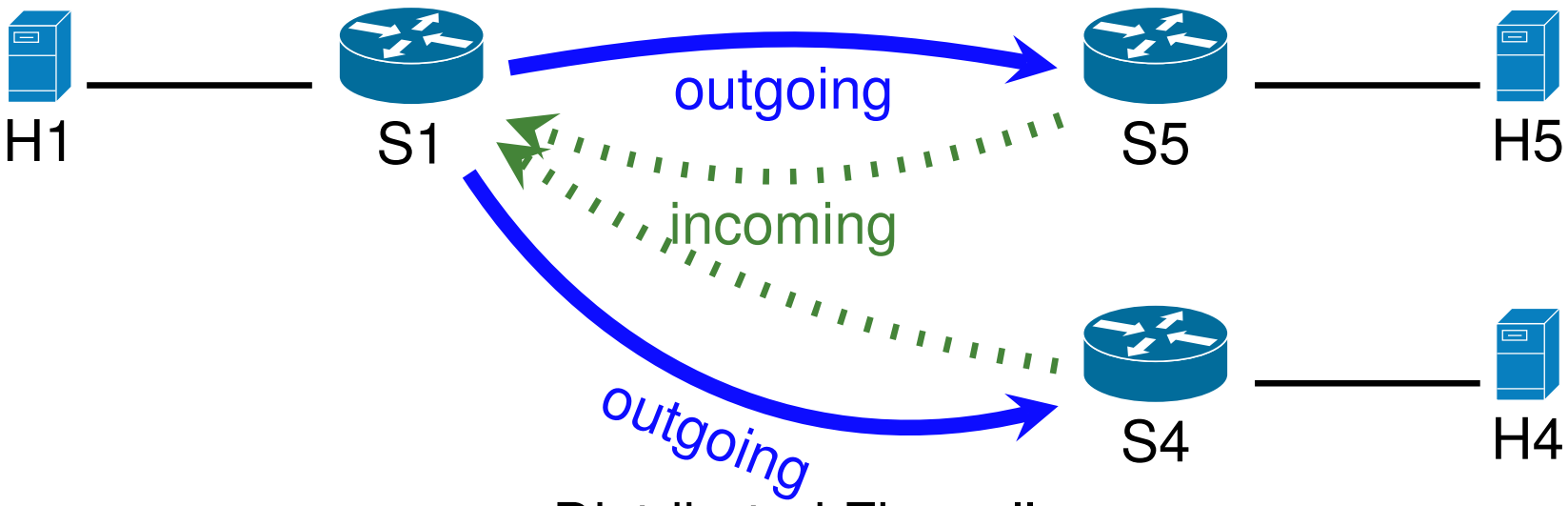

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- *This program cannot be implemented efficiently!*

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   - We provide a *locality condition* that guarantees efficient implementability

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$$
\begin{array}{rcll}
f & \in & \mathit{Field} & \textit{(header-field name)} \\
n & \in & \mathbb{N} & \textit{(numeric value)} \\
a, b & ::= & \textbf{true} \mid \textbf{false} \mid f = n \mid \textbf{state}(n) = n \mid a \vee b \mid a \wedge b \mid \neg a & \textit{(test)} \\
p, q & ::= & a \mid f \leftarrow n \mid p + q \mid p \,;\, q \mid p* \mid (n{:}n) \rightarrowtriangle (n{:}n) & \textit{(command)} \\
 & \mid & \textbf{state}(n) \leftarrow n &
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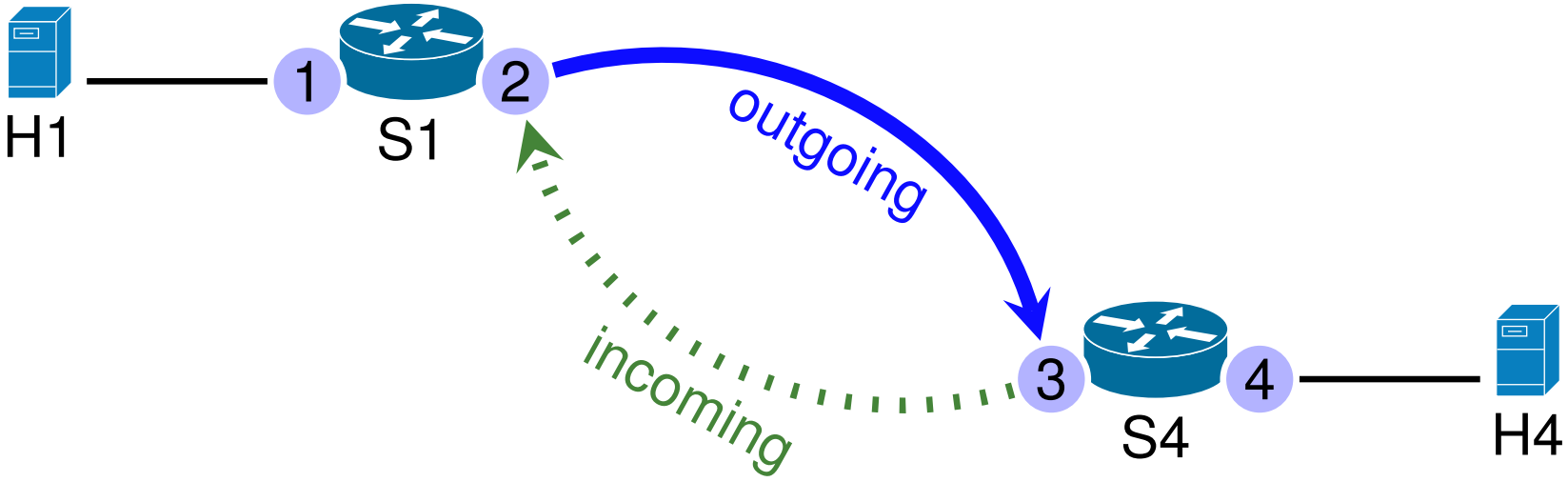

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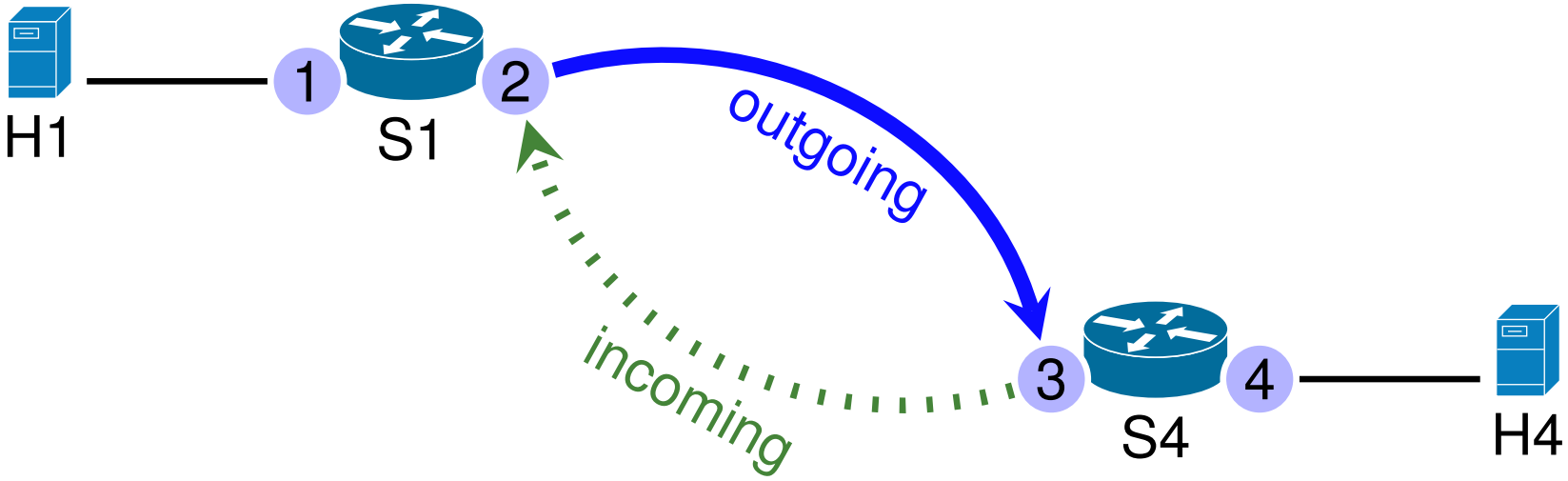

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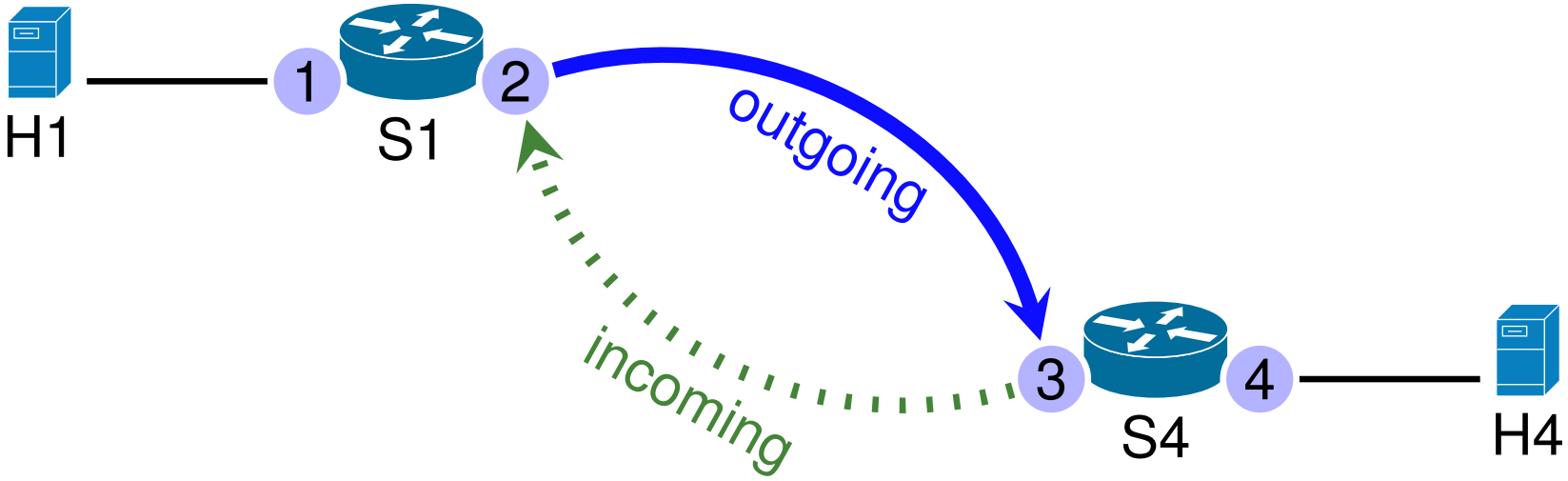

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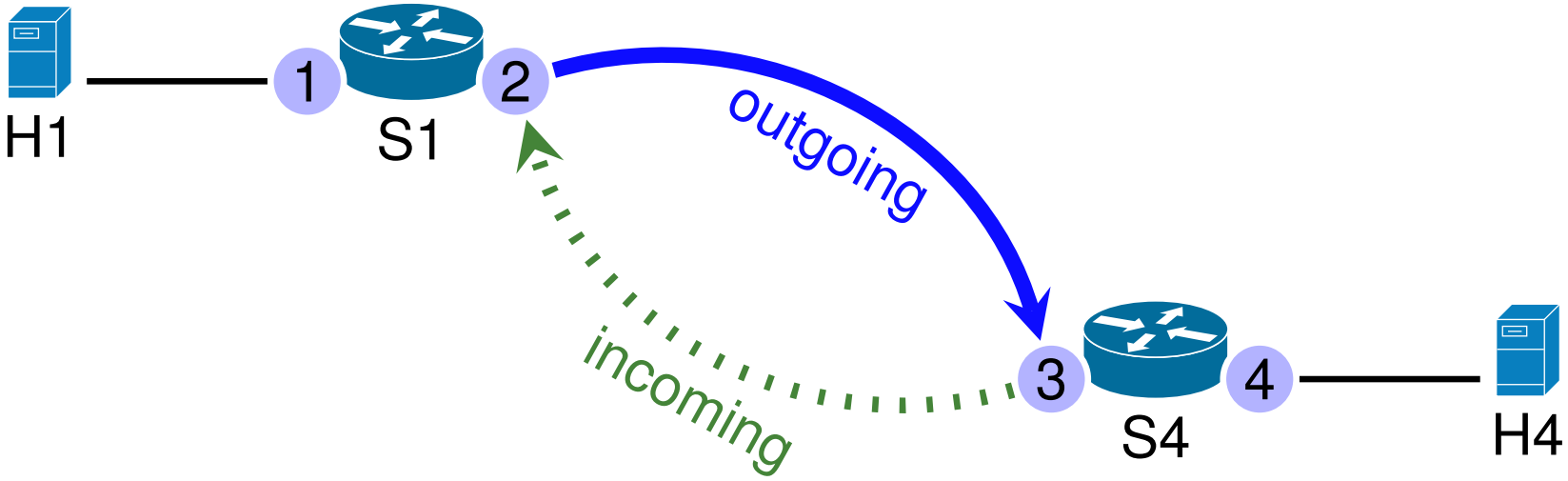

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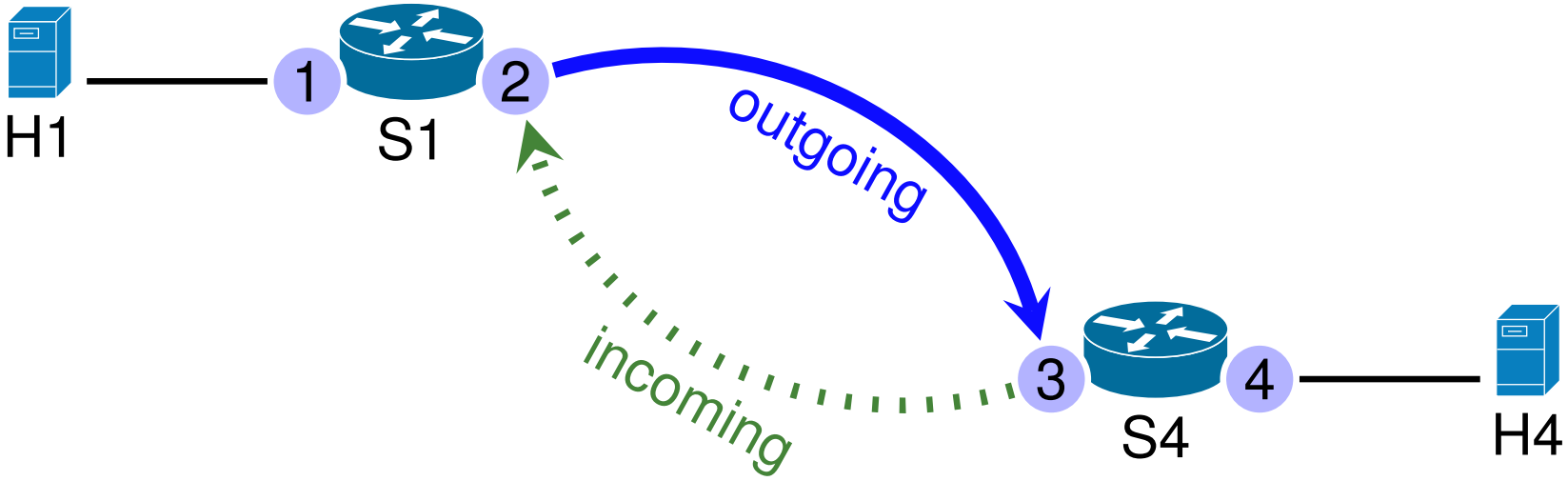

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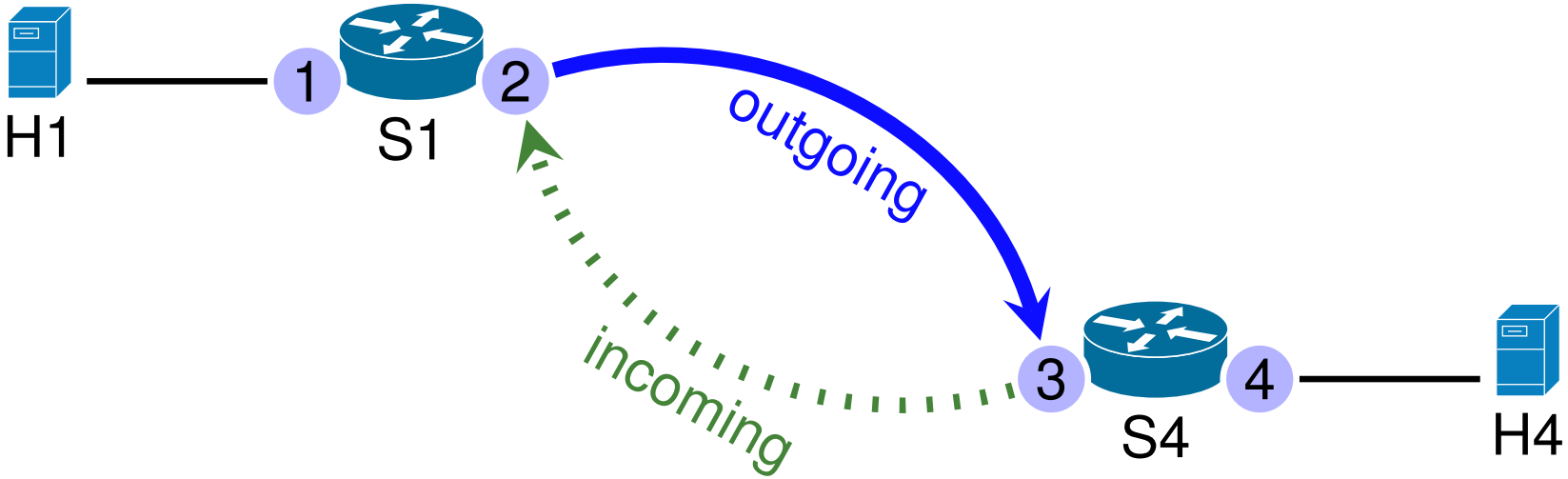

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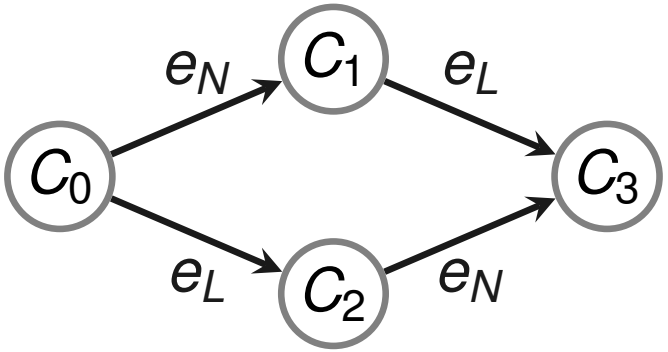

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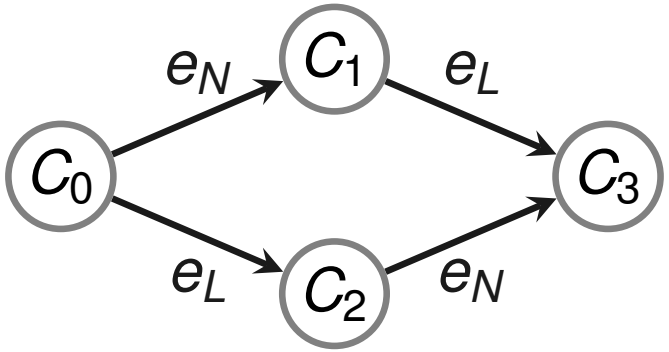

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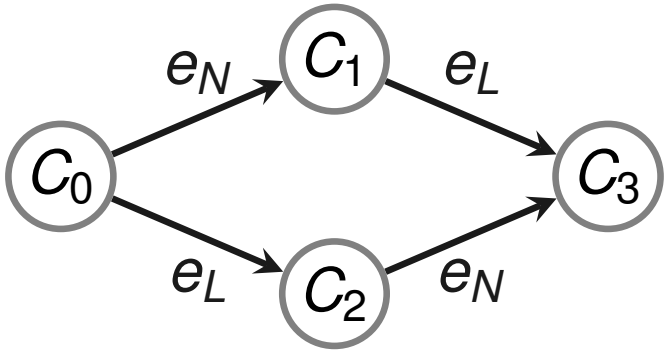

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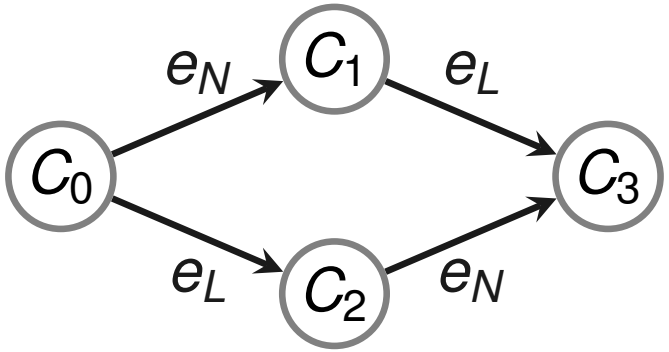

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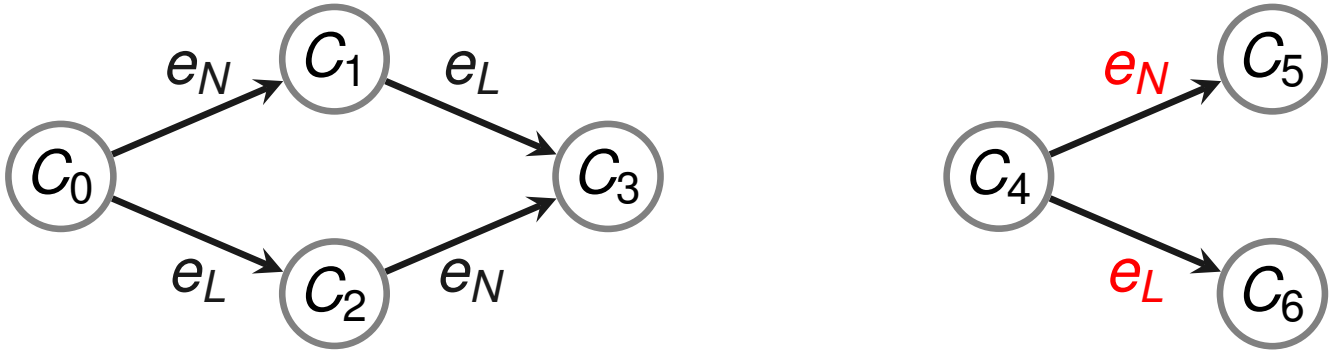

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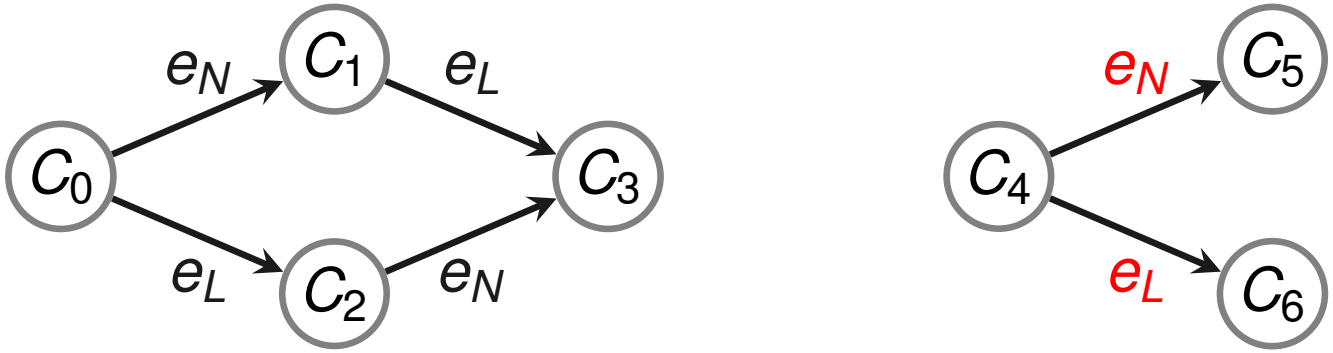

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- Problem: different switches could have different views of which events have occurred (conflicts!)

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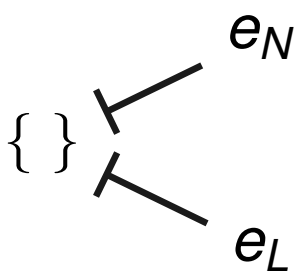

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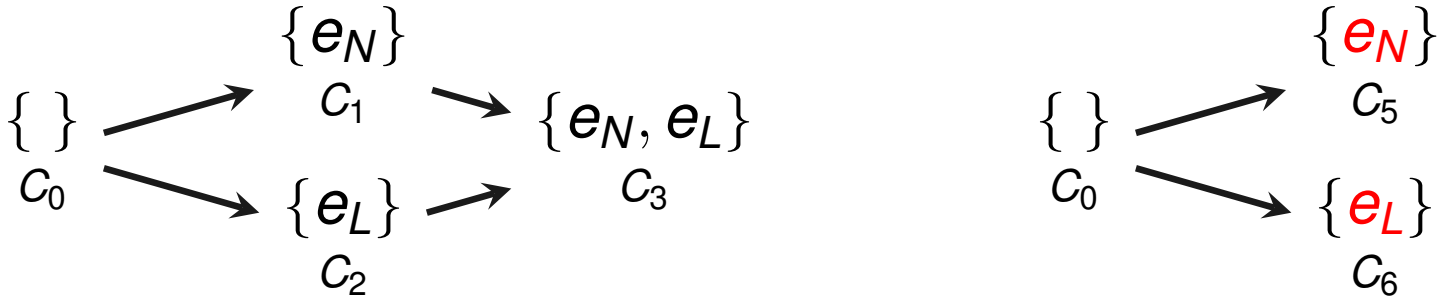

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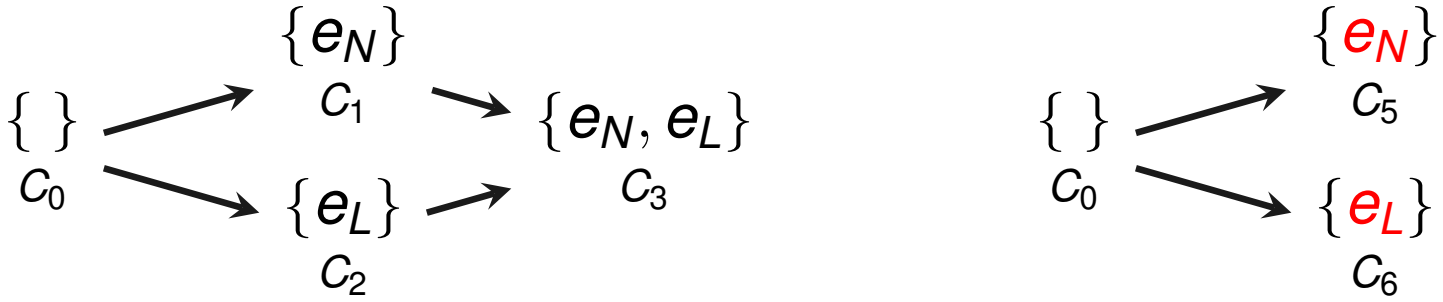

- **Locality condition:** we require incompatible events to occur at the same switch

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Lemma

In general, can't correctly implement an NES that does not satisfy the locality condition, unless availability can be sacrificed

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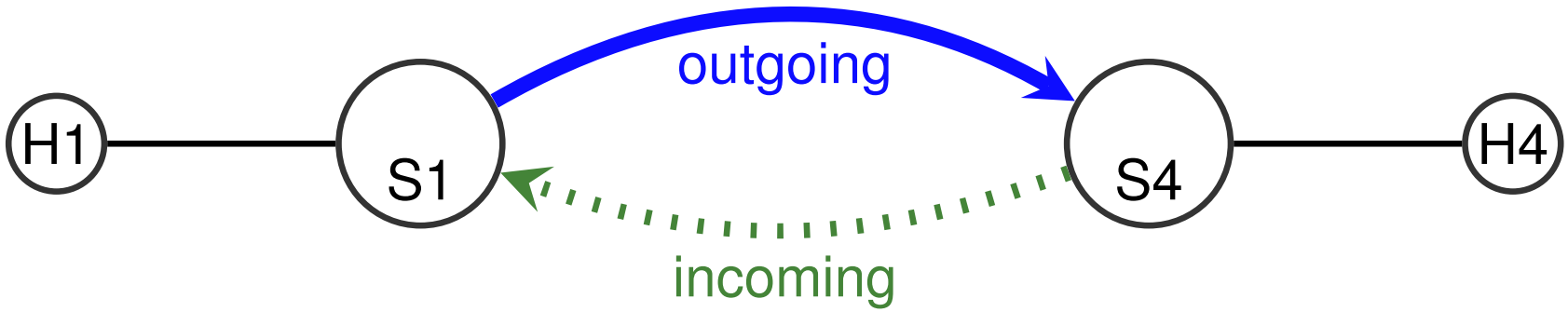

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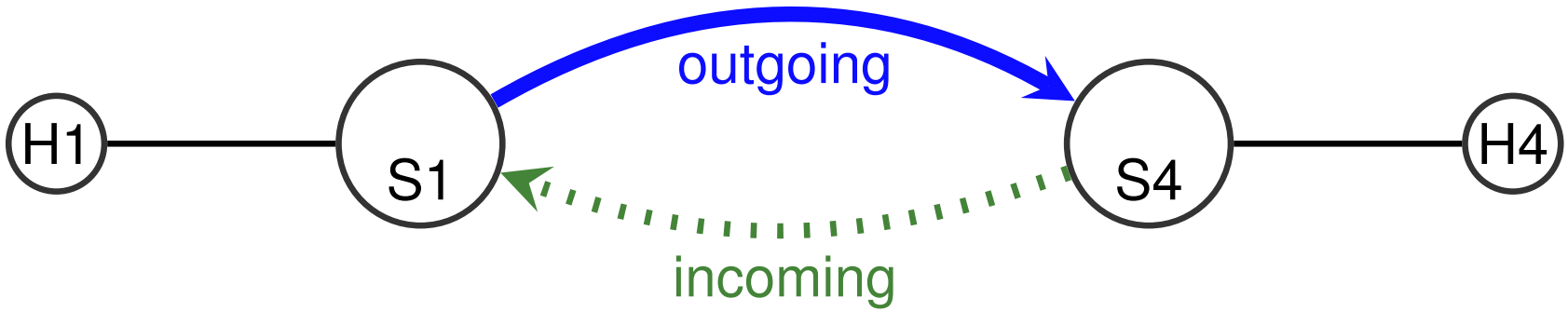

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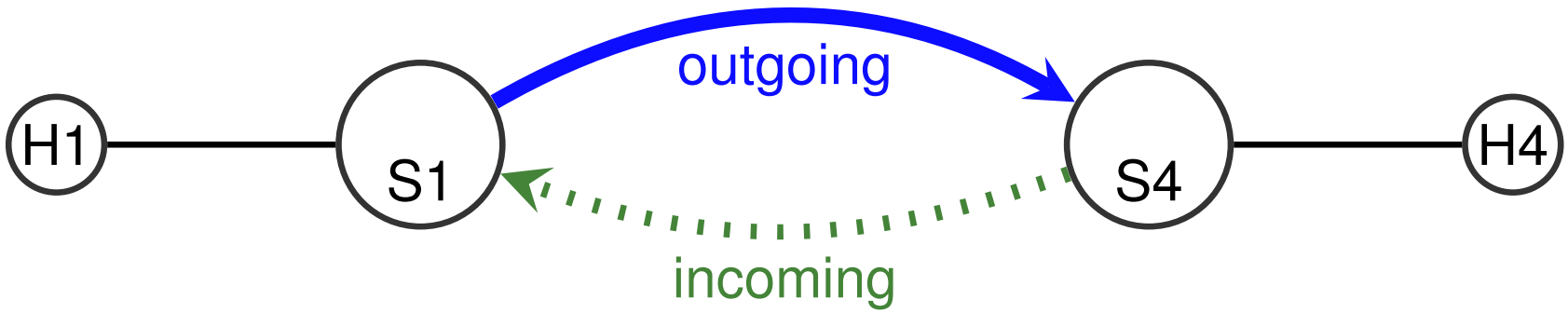

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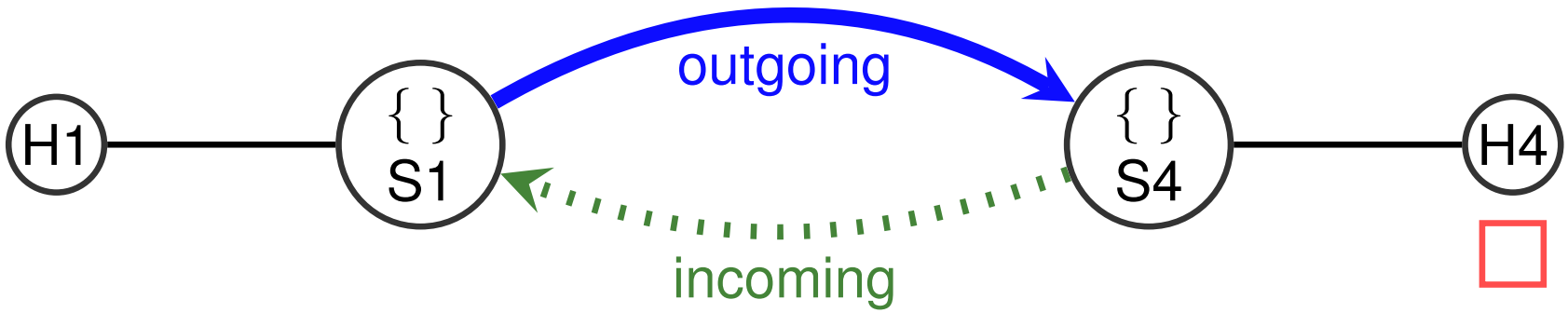

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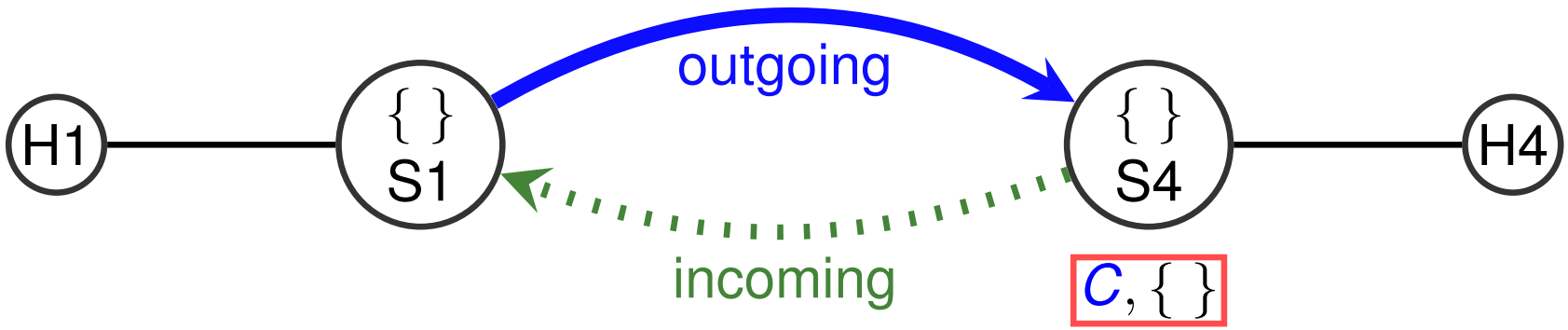

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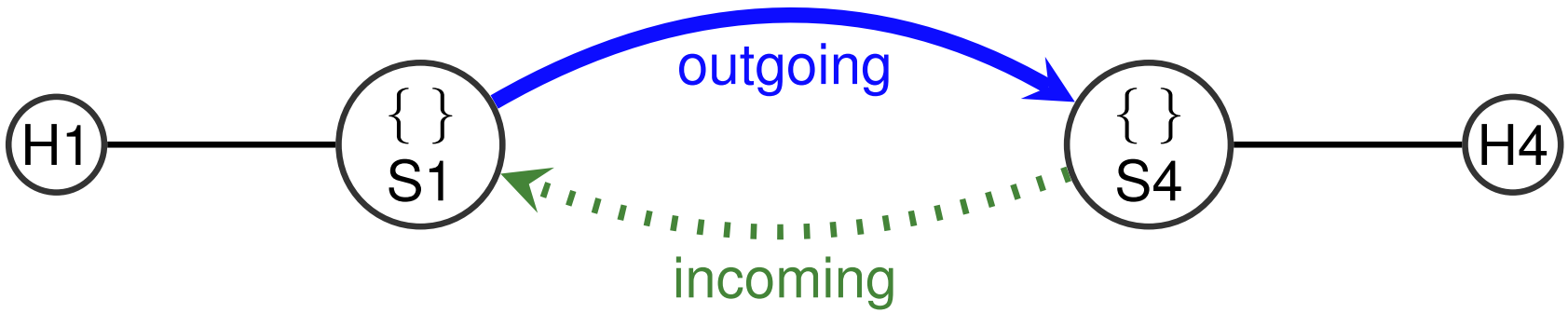

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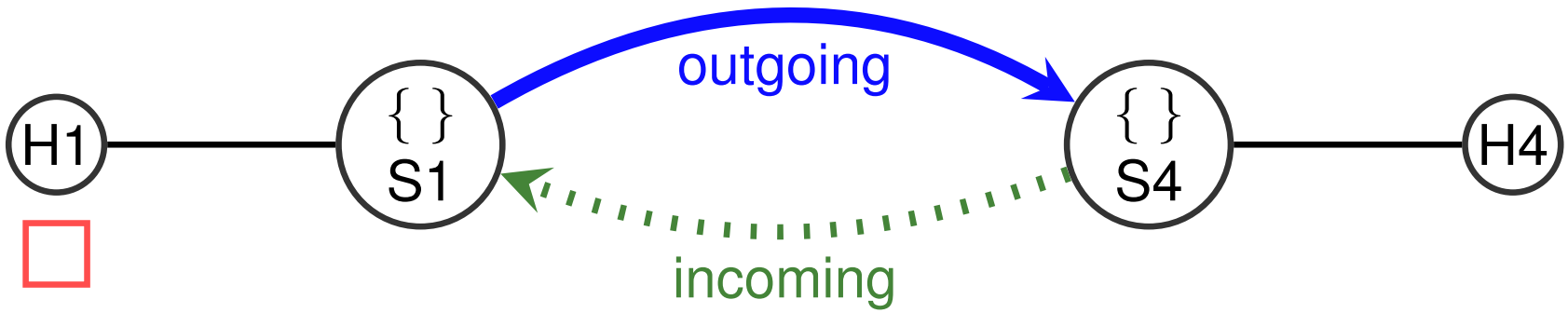

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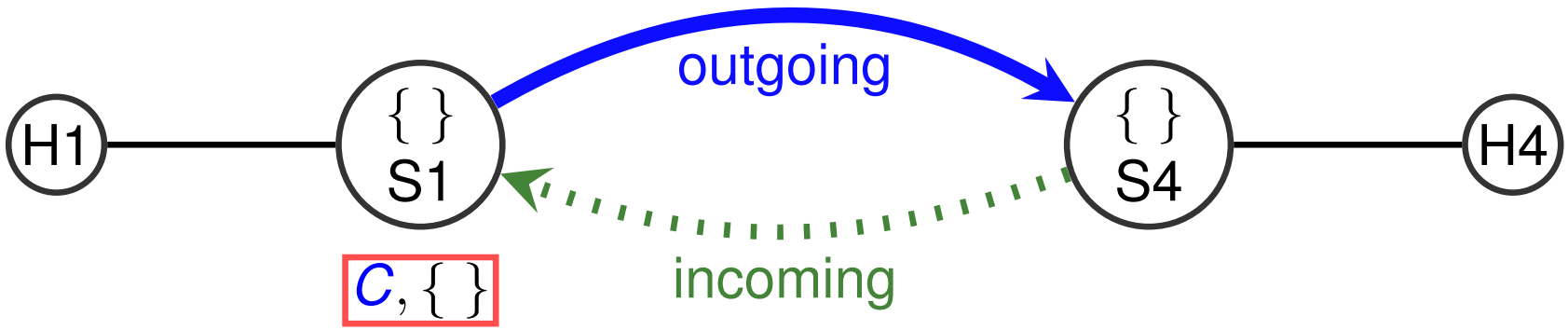

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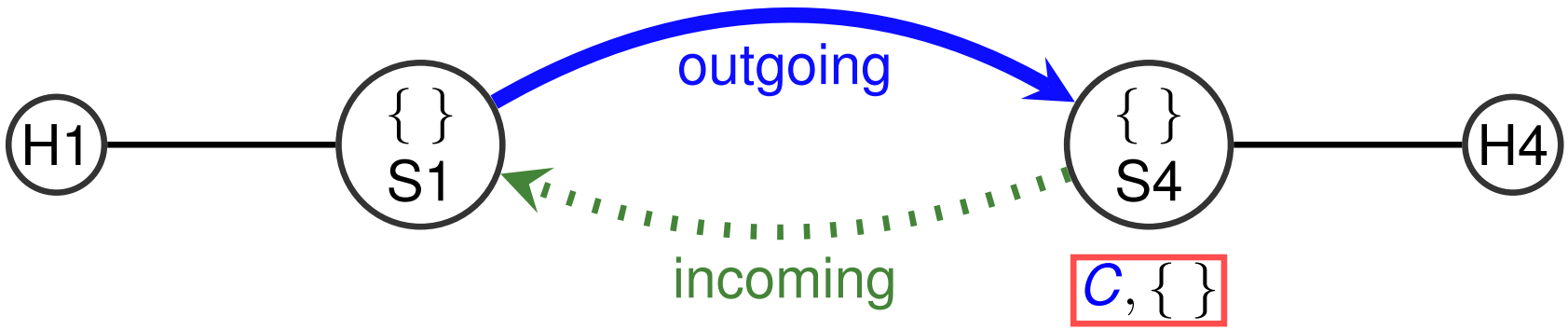

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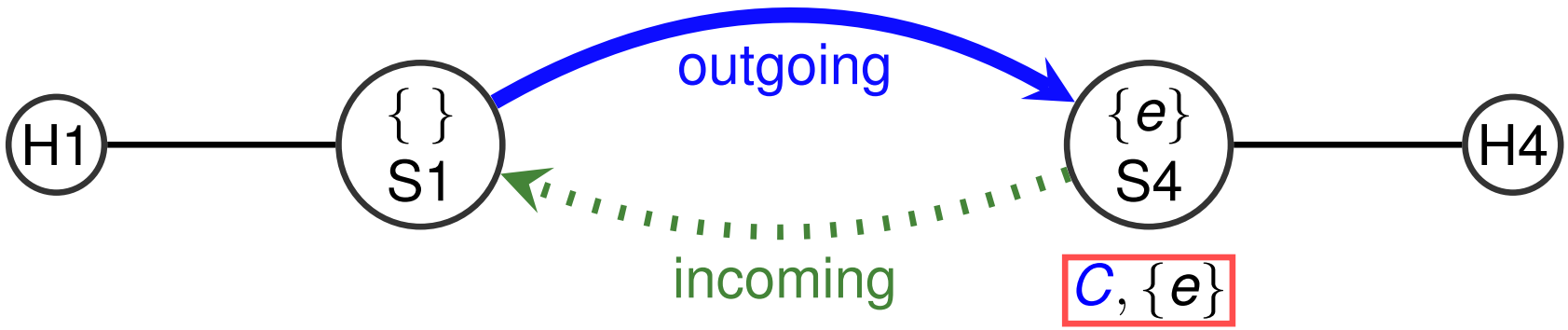

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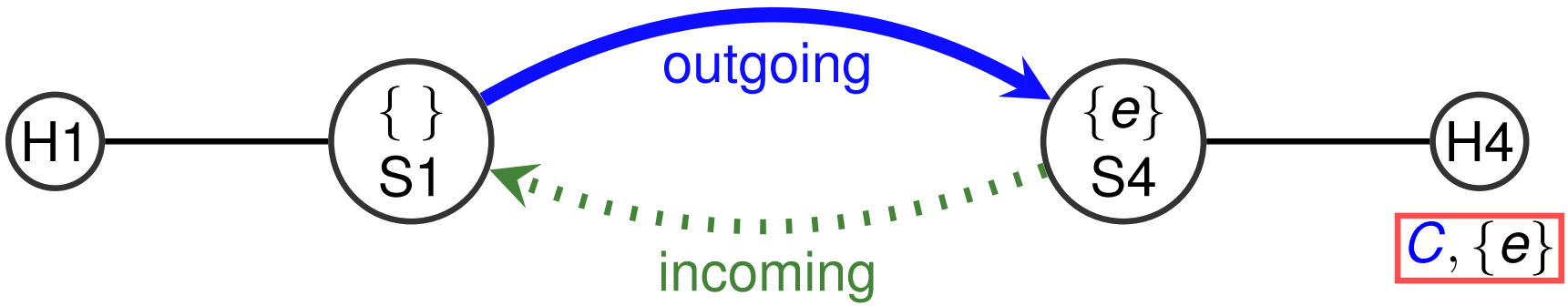

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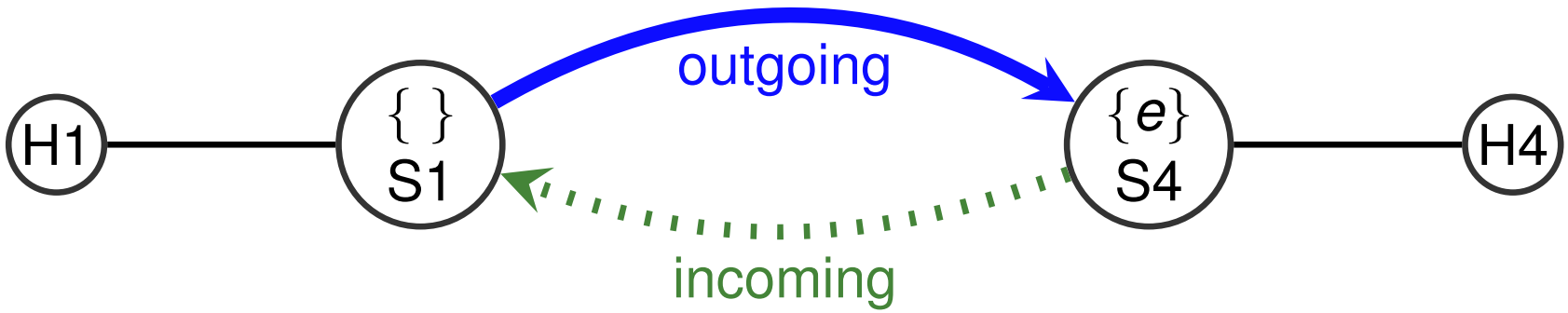

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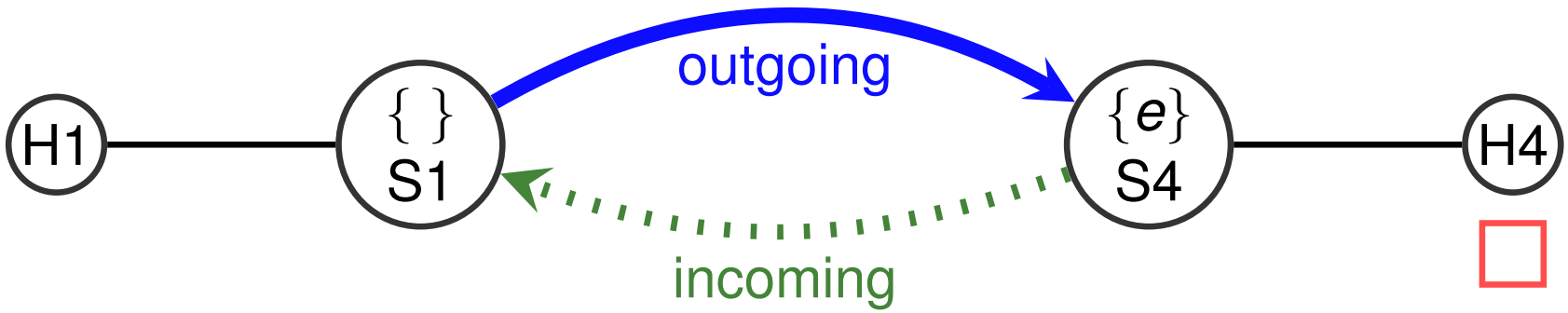

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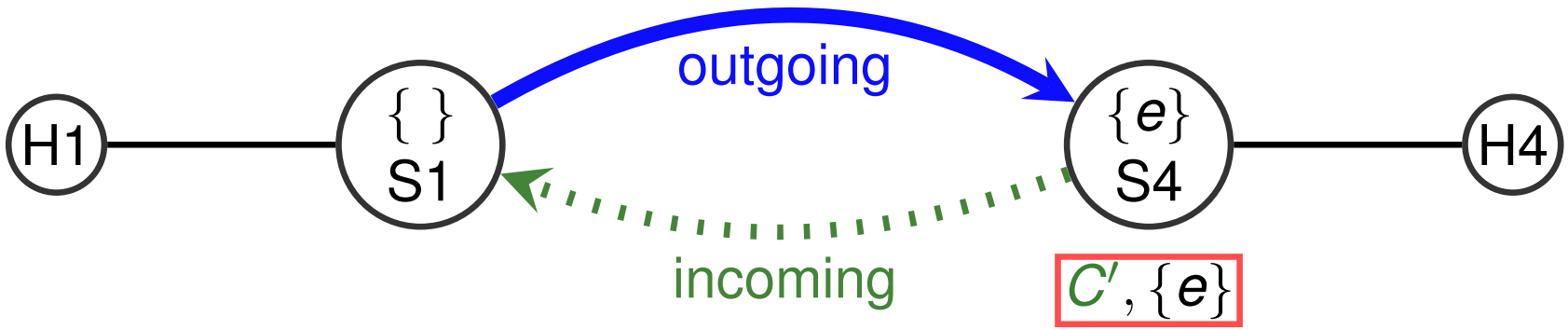

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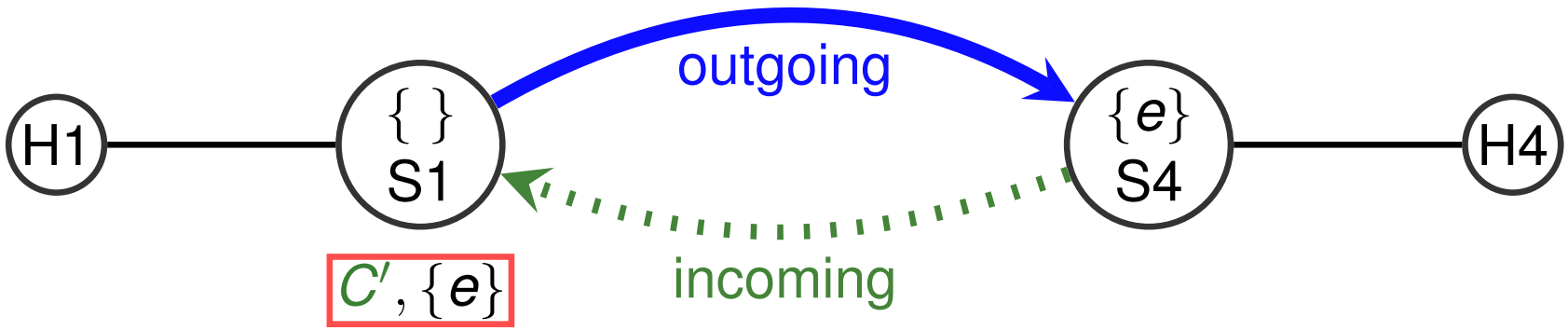

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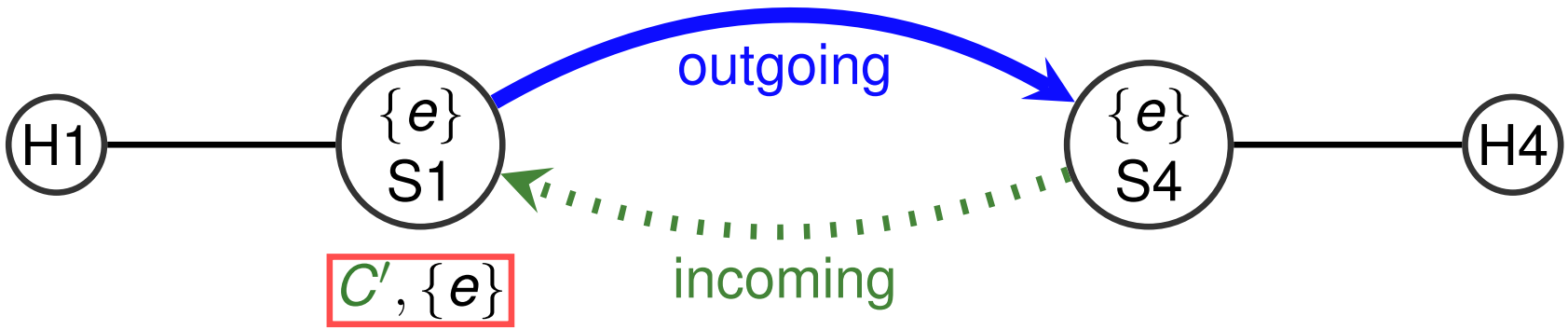

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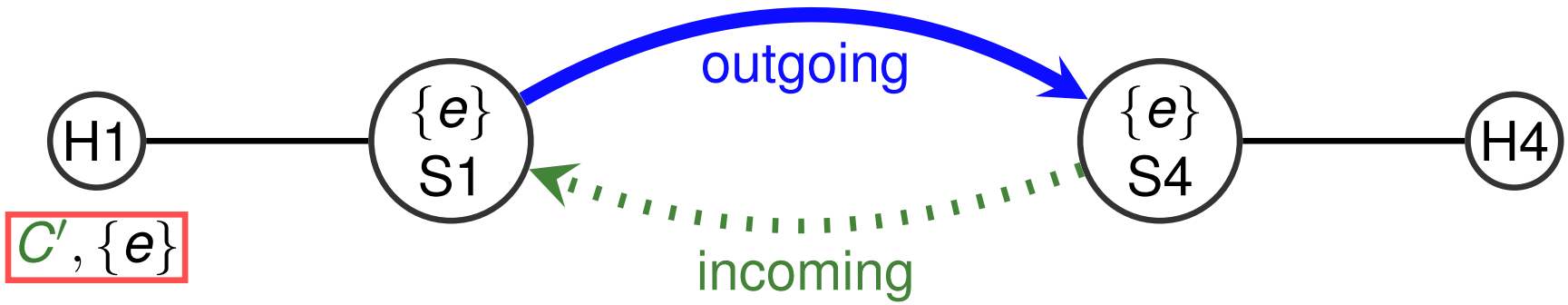

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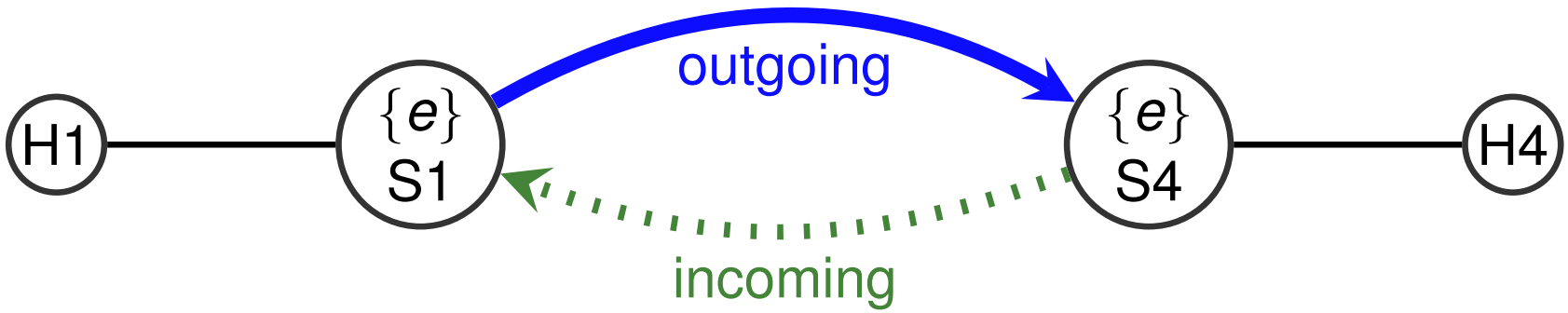

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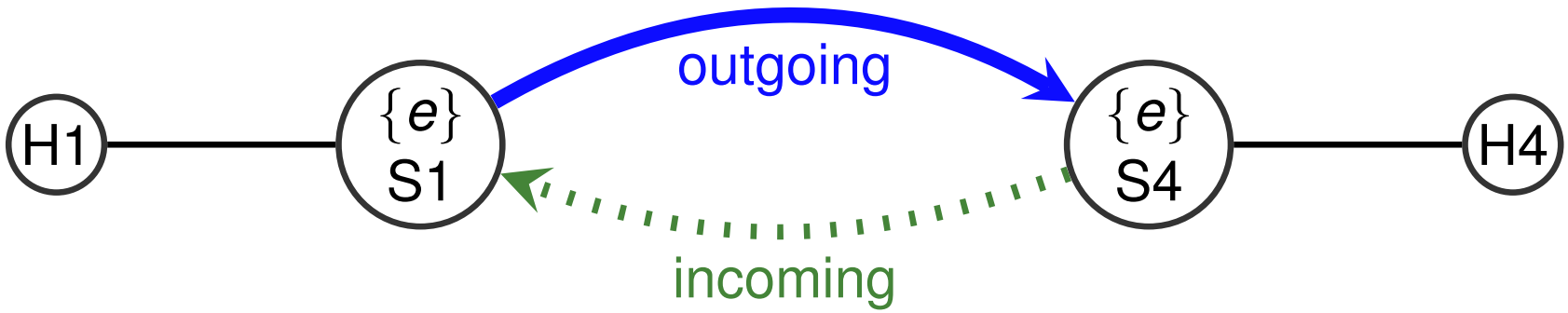

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Theorem (Correctness)

Implementing an event-driven program in this way guarantees:

- *event-triggered consistent update*
- *event structure consistency*

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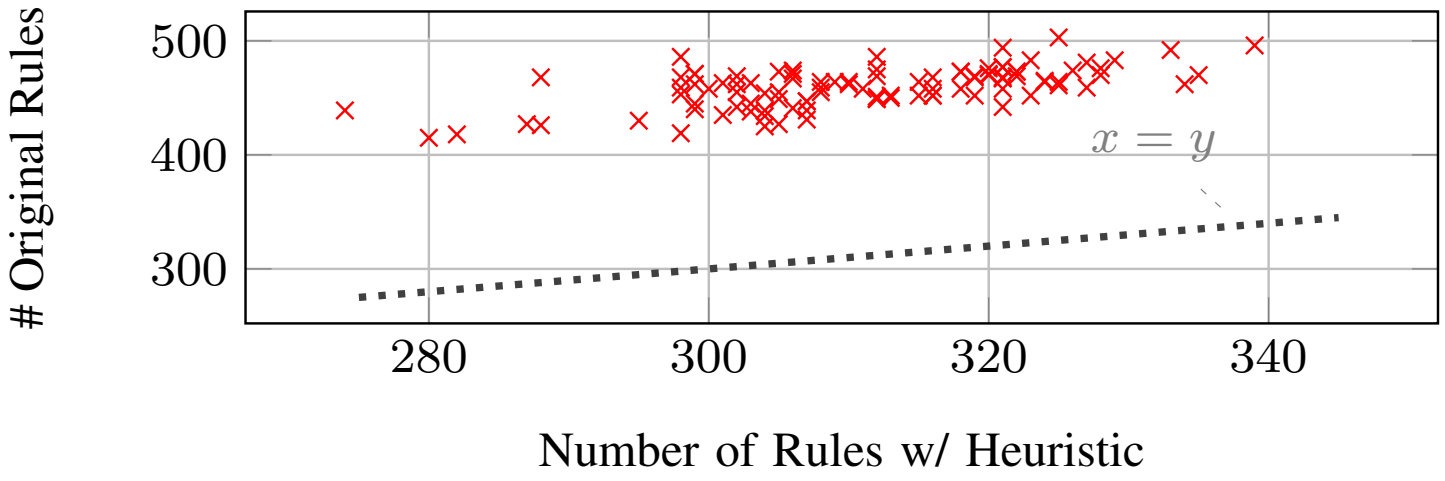

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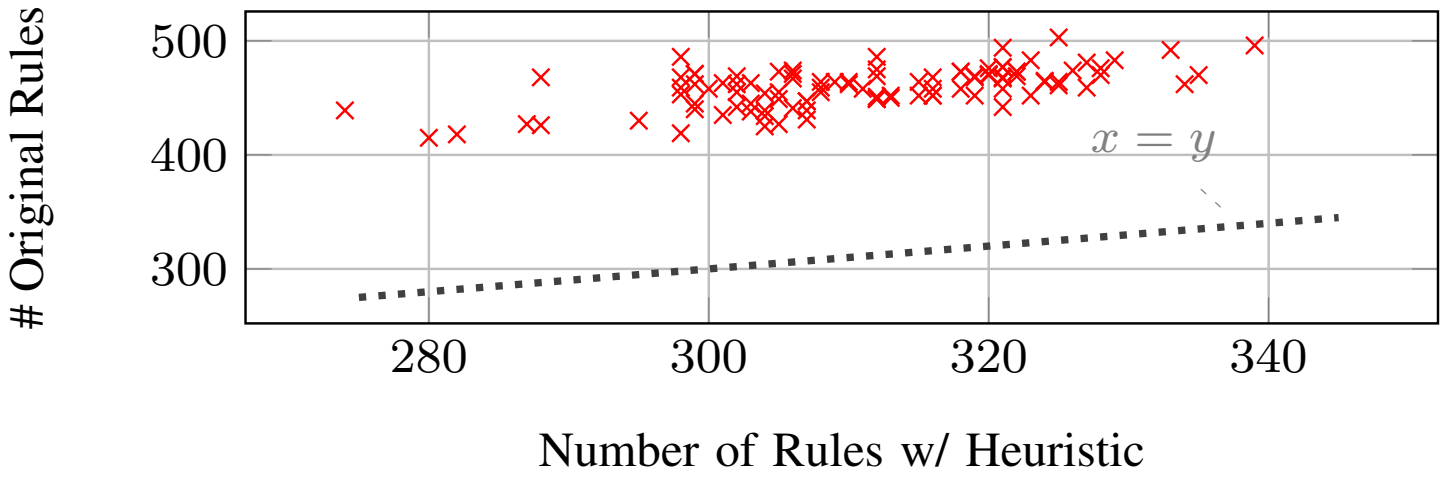

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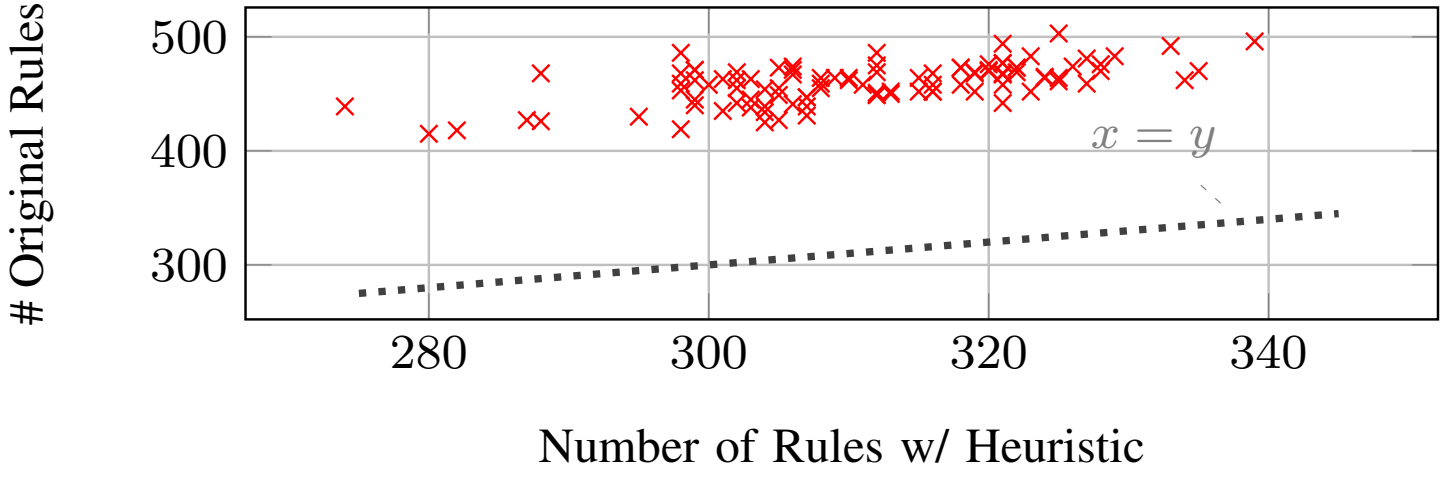

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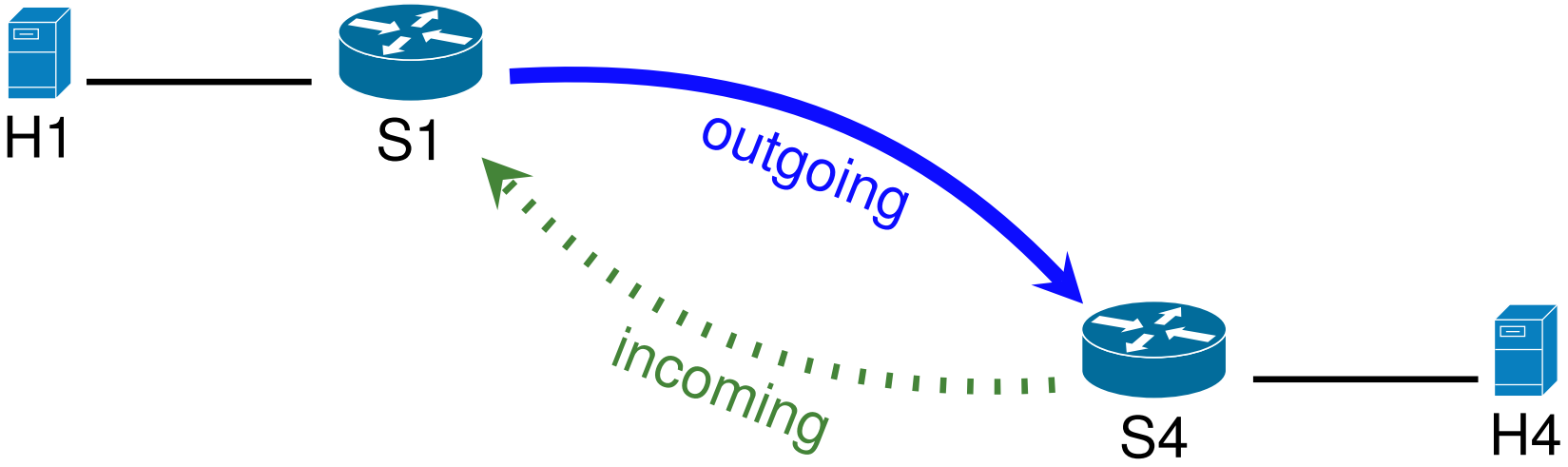

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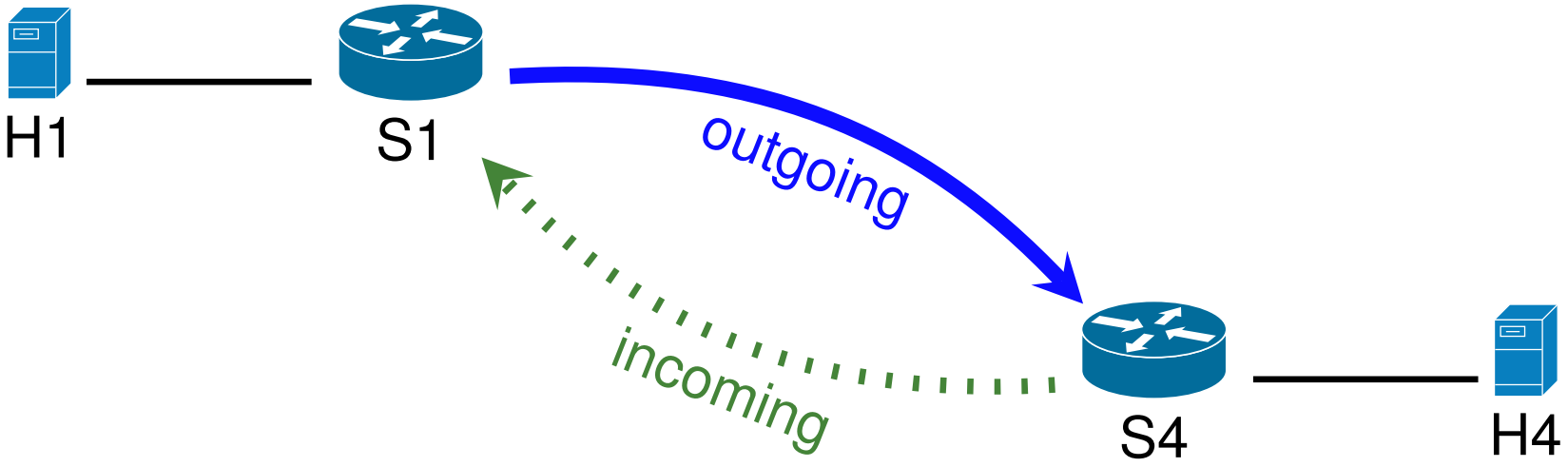

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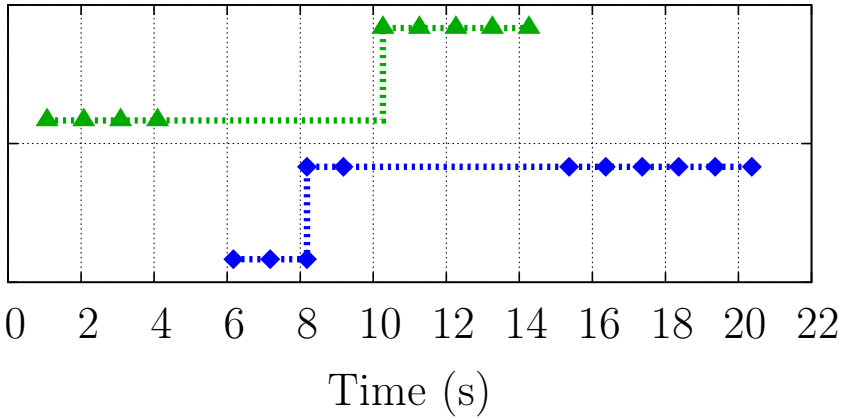

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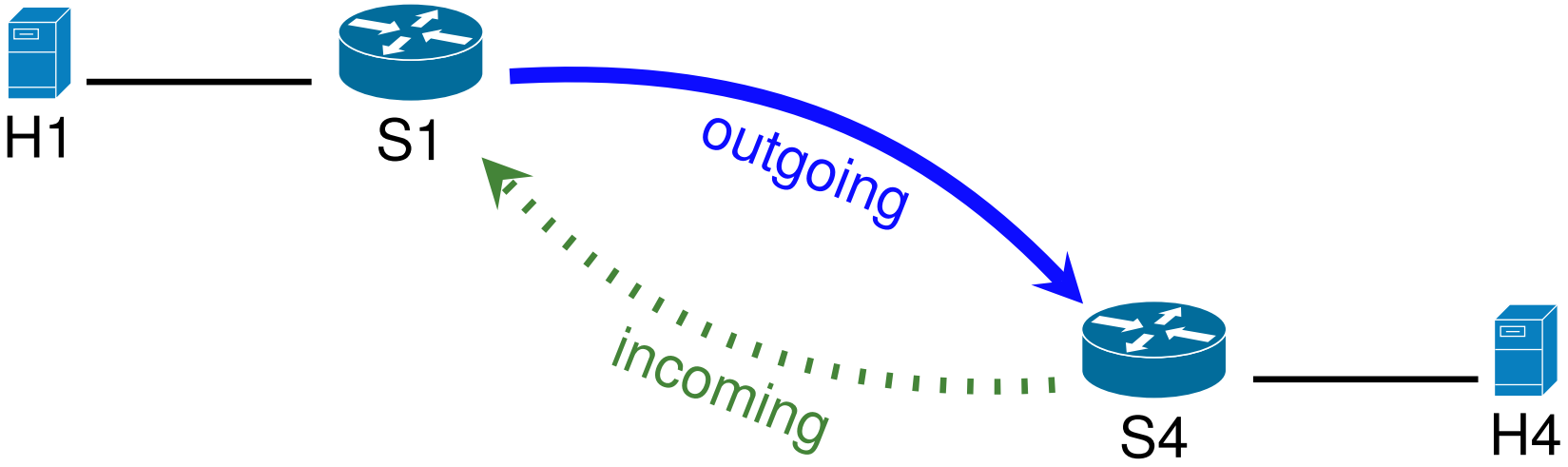

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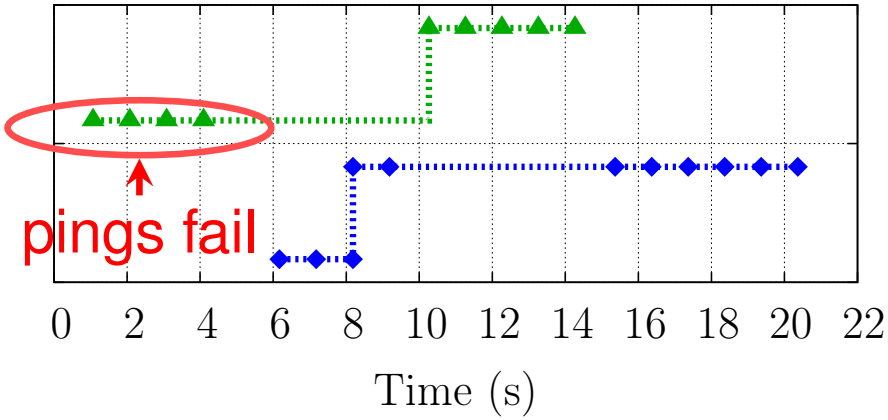

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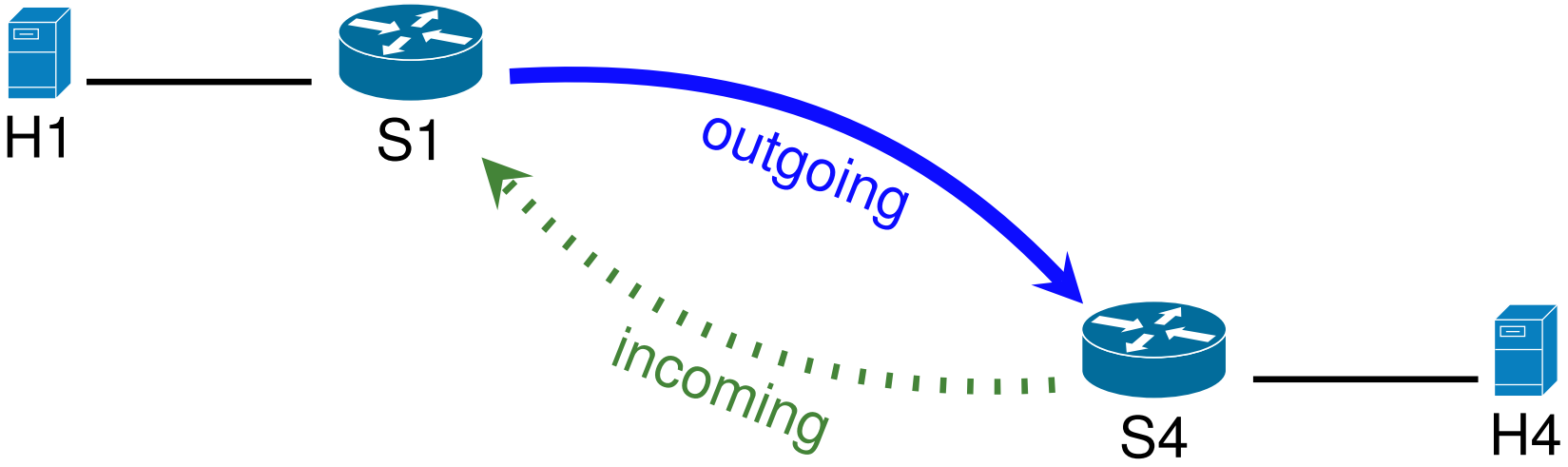

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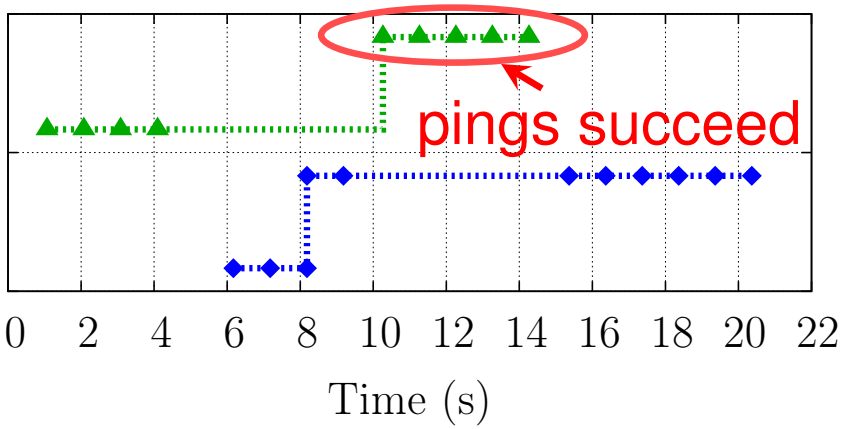

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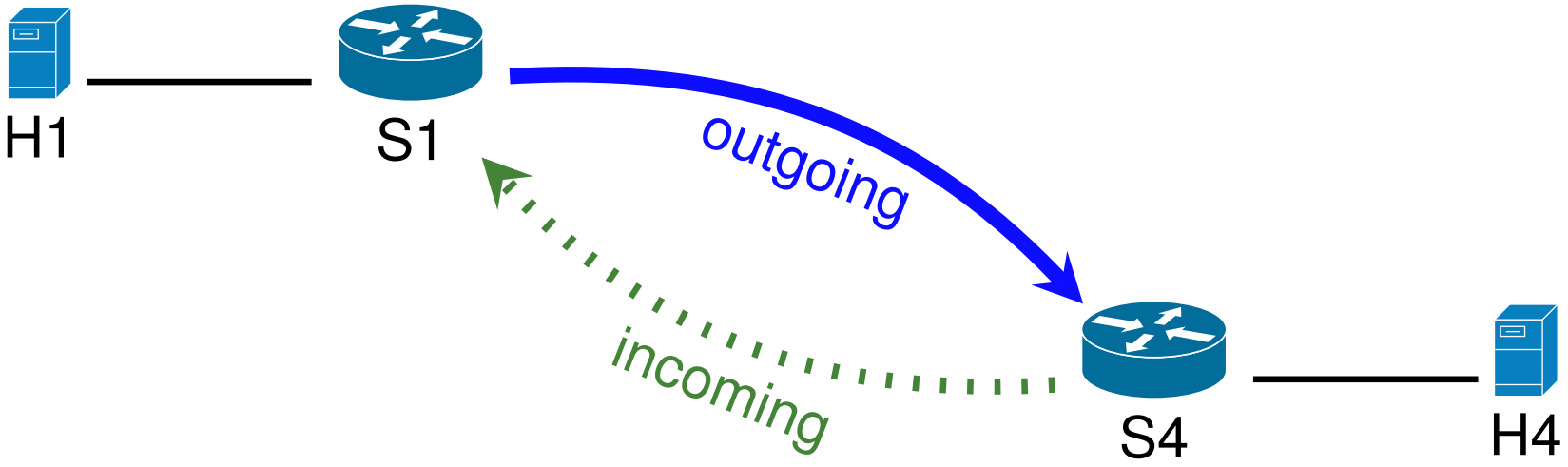

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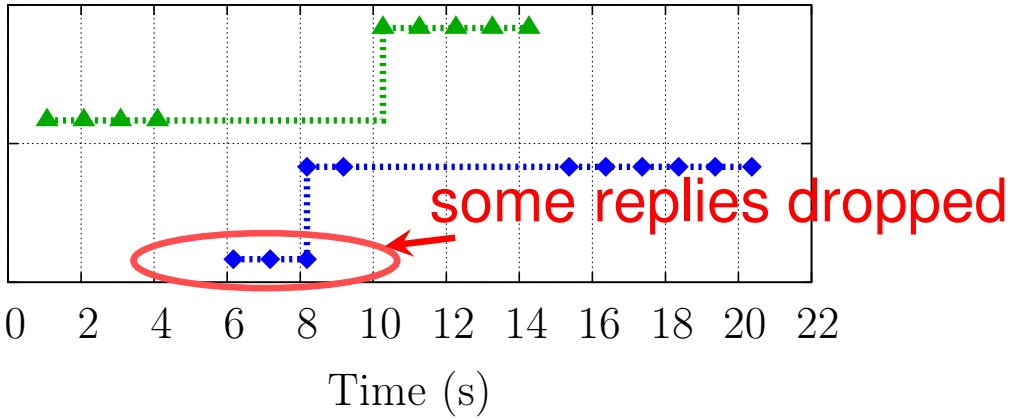

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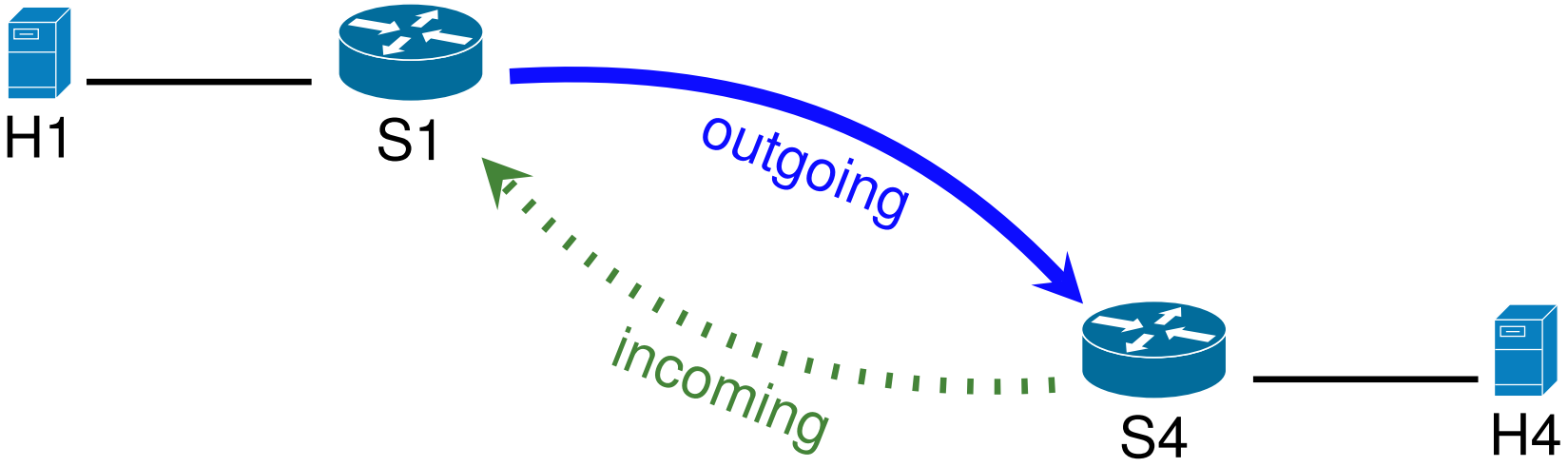

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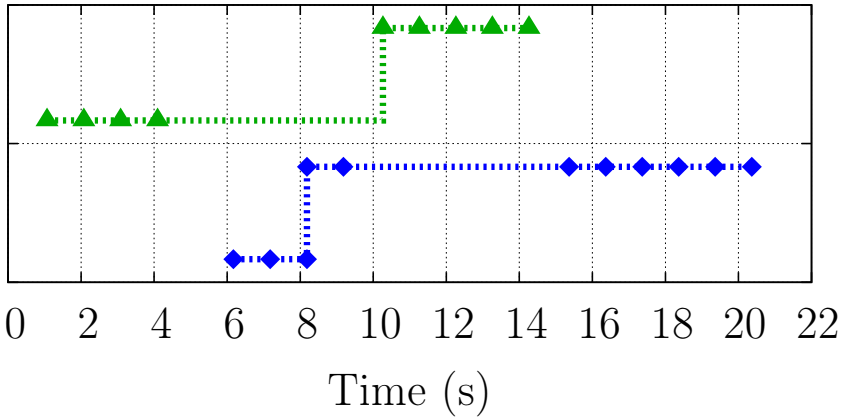

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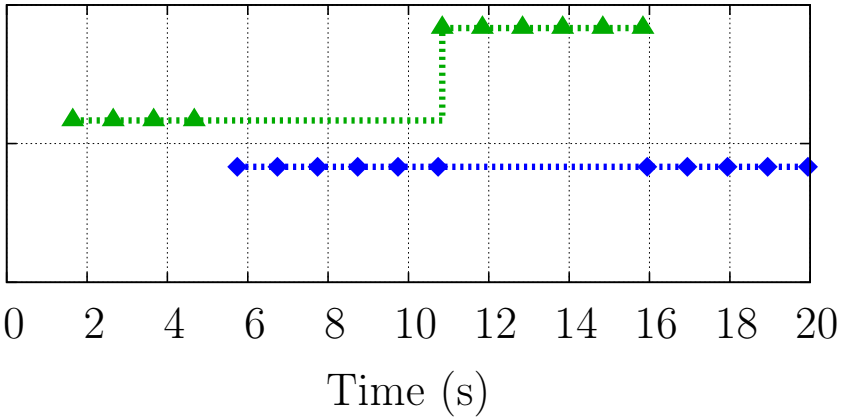

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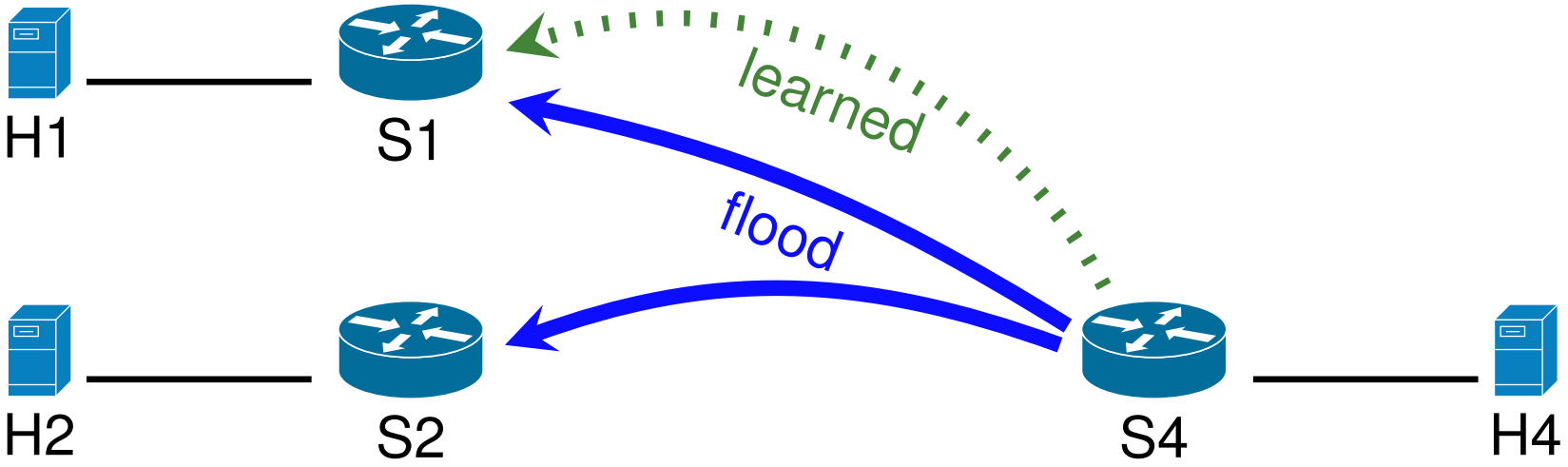

Learning Switch—Topology

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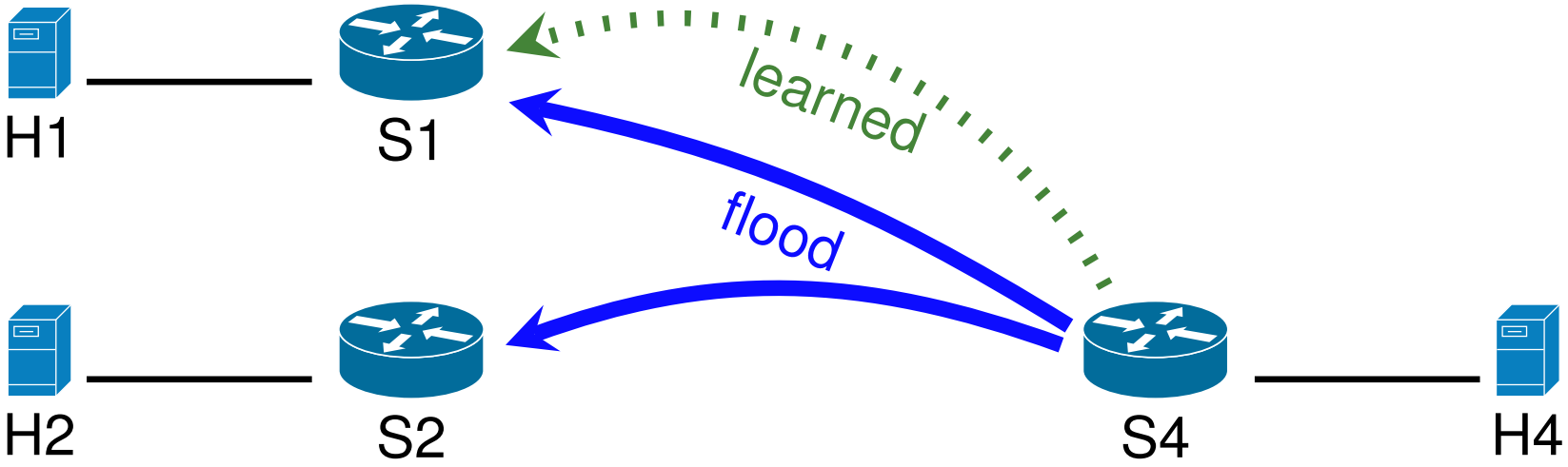
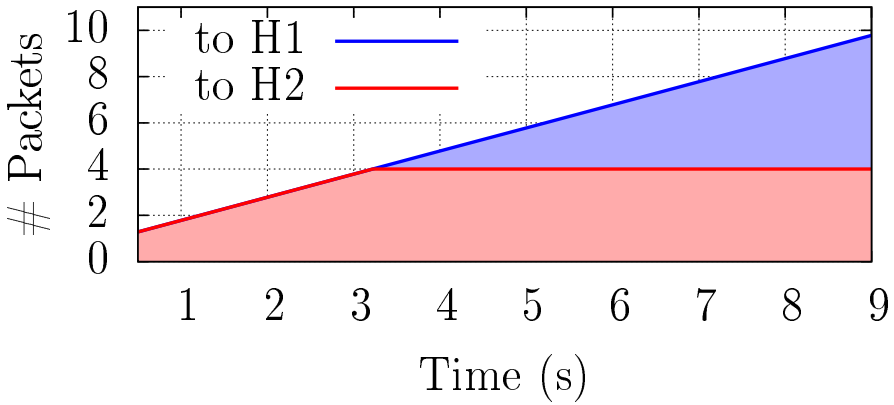


Learning Switch—Topology



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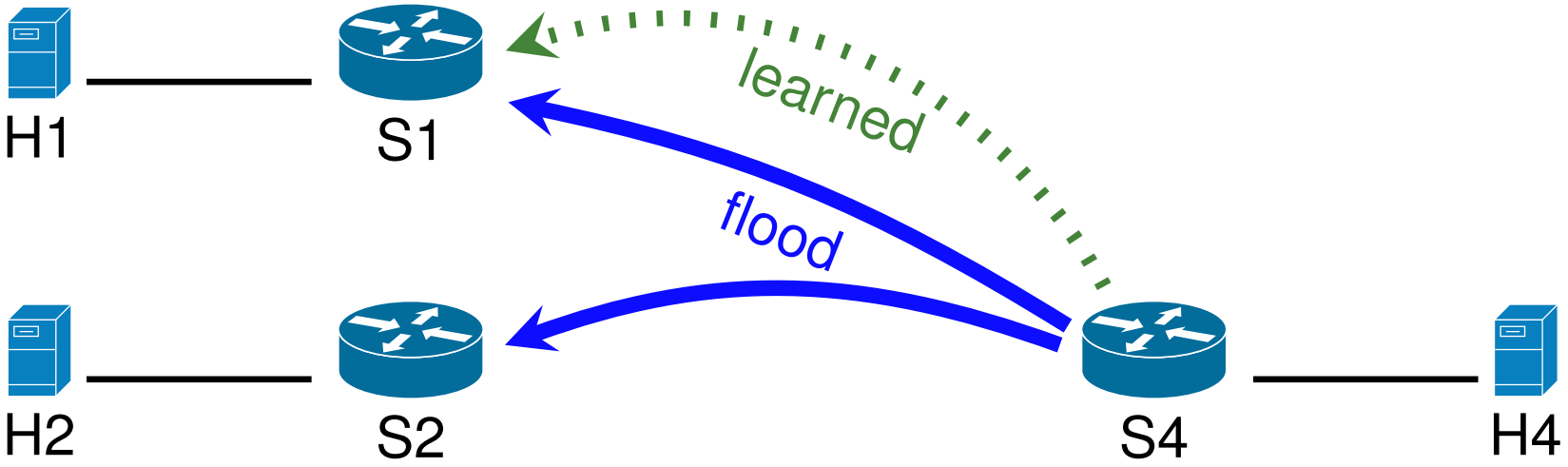

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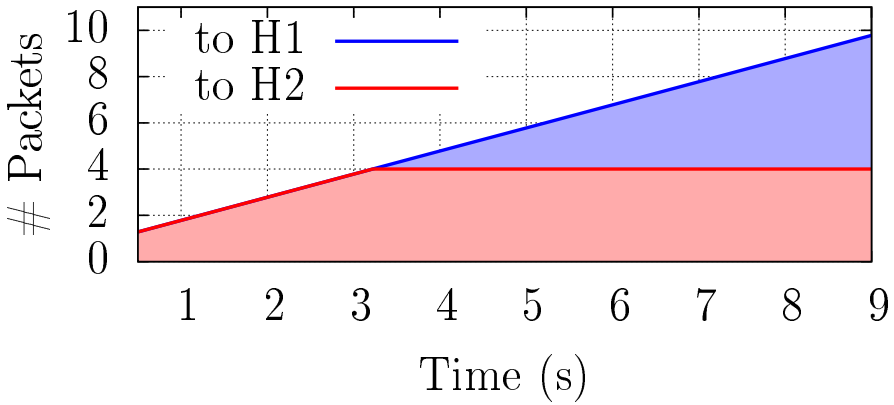

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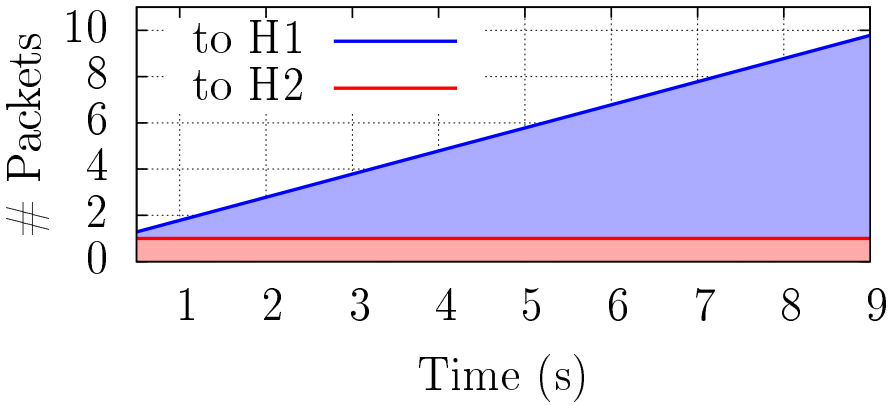

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Related Work

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  - Consistent Updates [SIGCOMM'12], Dionysus [SIGCOMM'14], CCG [NSDI'15], Update Synthesis [PLDI'15], Checking Beliefs [NSDI'15], NetEgg [CoNEXT'15]
- High-Level Network Functionality
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