lecture 12:
dynamic control

5590: software defined networking

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TTLMAN 401B, R 17:30-20:00

Kinetic

dynamics

network conditions are dynamic, but current approaches to (re)configure the network are NOT

example: dynamic net config

University of Illinois

- an instructed class, 4 restricted classes
- downgrade a user's traffic to a different class based on past usage

current approach

- complex instrumentation
- "wrapper" that dynamically change low-level net config

Kinetic

goals

- capture dynamics, automatically verifies temporal properties

Kinetic language

- dynamic policy as finite state machine (FSM)
- states: distinct forwarding behavior
- transition: triggering network events

Kinetic handler listens to events

- triggers transition in a policy
- update the data plane

the state explosion challenge

dynamic policy defined over a state space *exponential* in the number of

- hosts, flows, …
- N hosts $\longrightarrow$ 2^N FSM states

a monolithic FSM

- built from N small FMSs, each with a_i states
- $\prod a_i$ states

technical contribution

introduce located packet equivalence class (LPEC)

- divide the state space into isolated FSMs

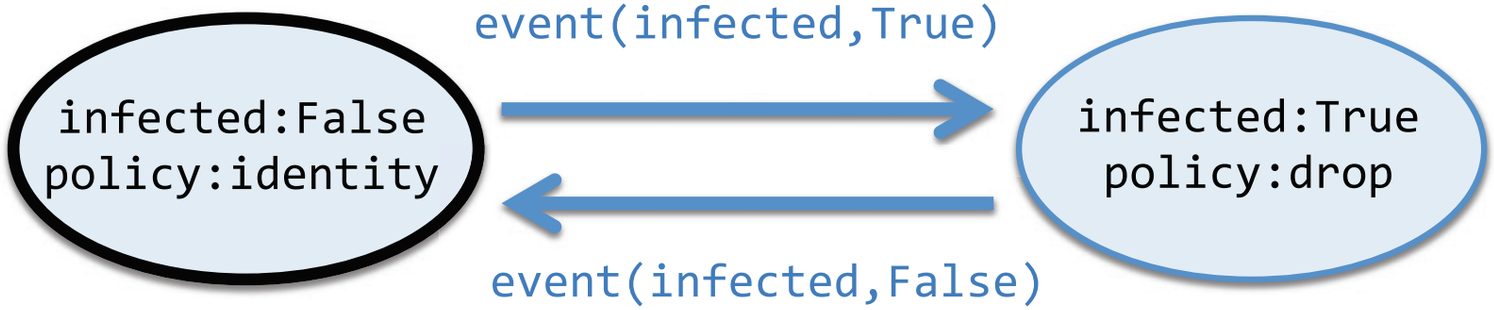
use Pyretic composition

- prevent FSM production
- express large FSMs as smaller ones

dynamic policy as FSM

FSM specifies how a (Pyretic) policy evolves in response to events

- FSM state contains a policy
- FSM transition corresponds to net events



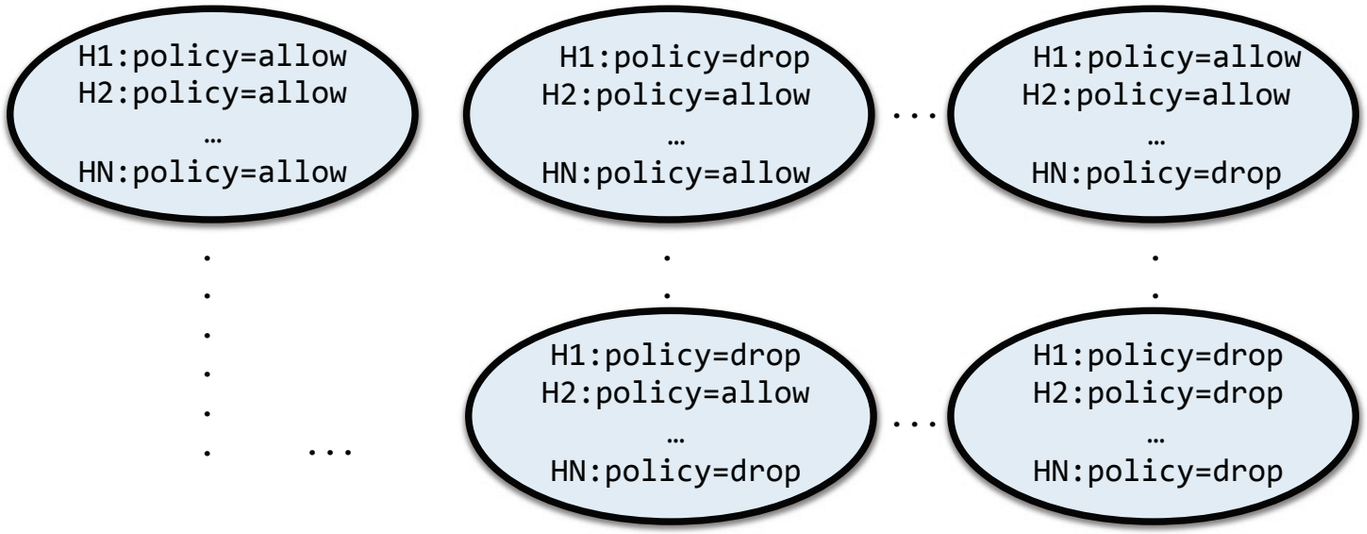
N hosts ⟶ 2^N states

located packet equivalence class

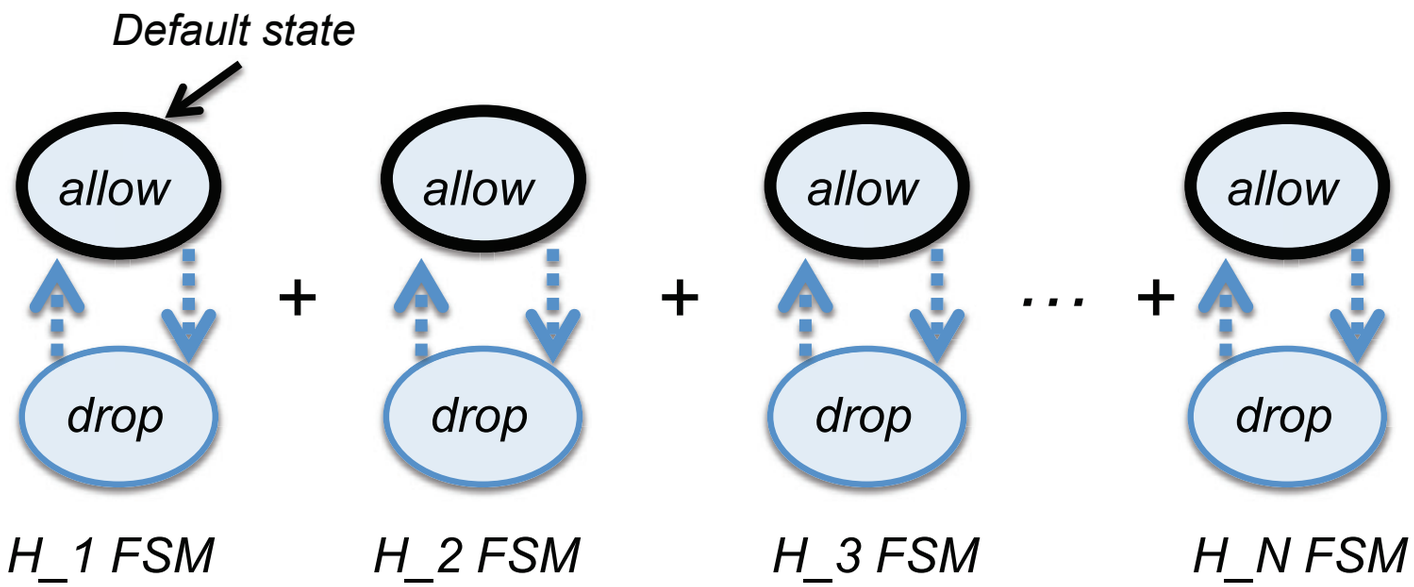
2^N states

N LPEC

N isolated FSMs



# of hosts: N	Total # of states: 2^N	Total # of transitions: 2^{2N} (omitted for cleaner look)



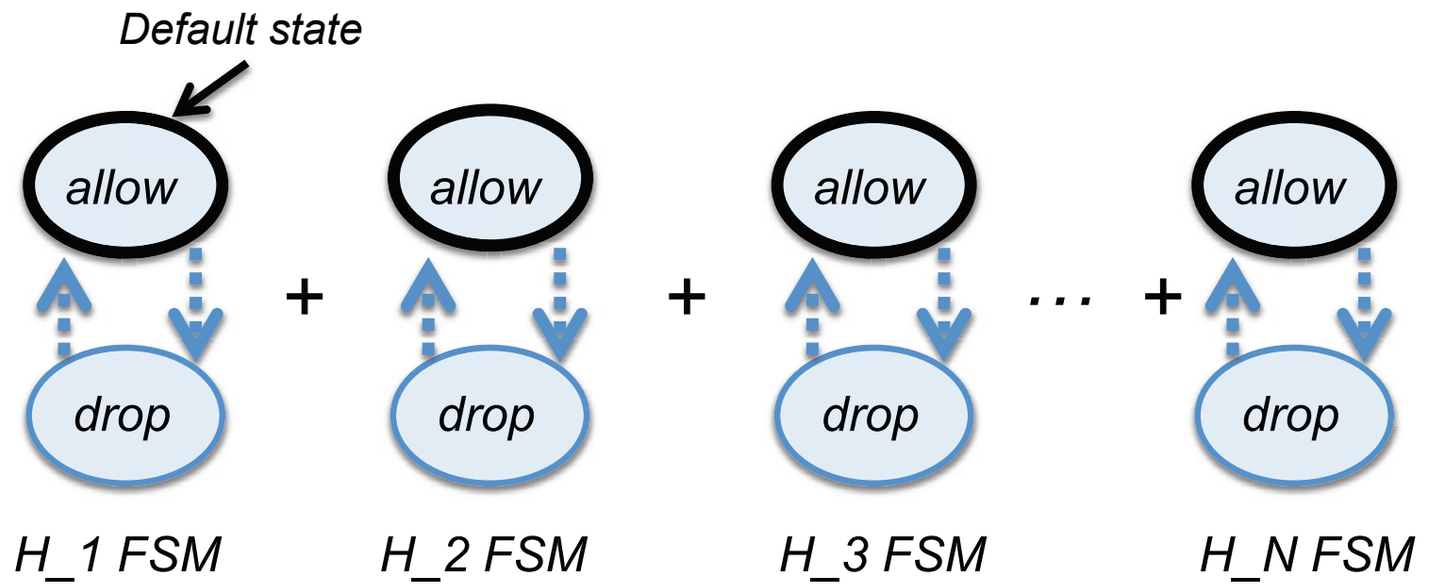
# of hosts: N	Total # of states: 2N	Total # of transitions: 2N

located packet equivalence class

LPEC: packets always in the same FSM state

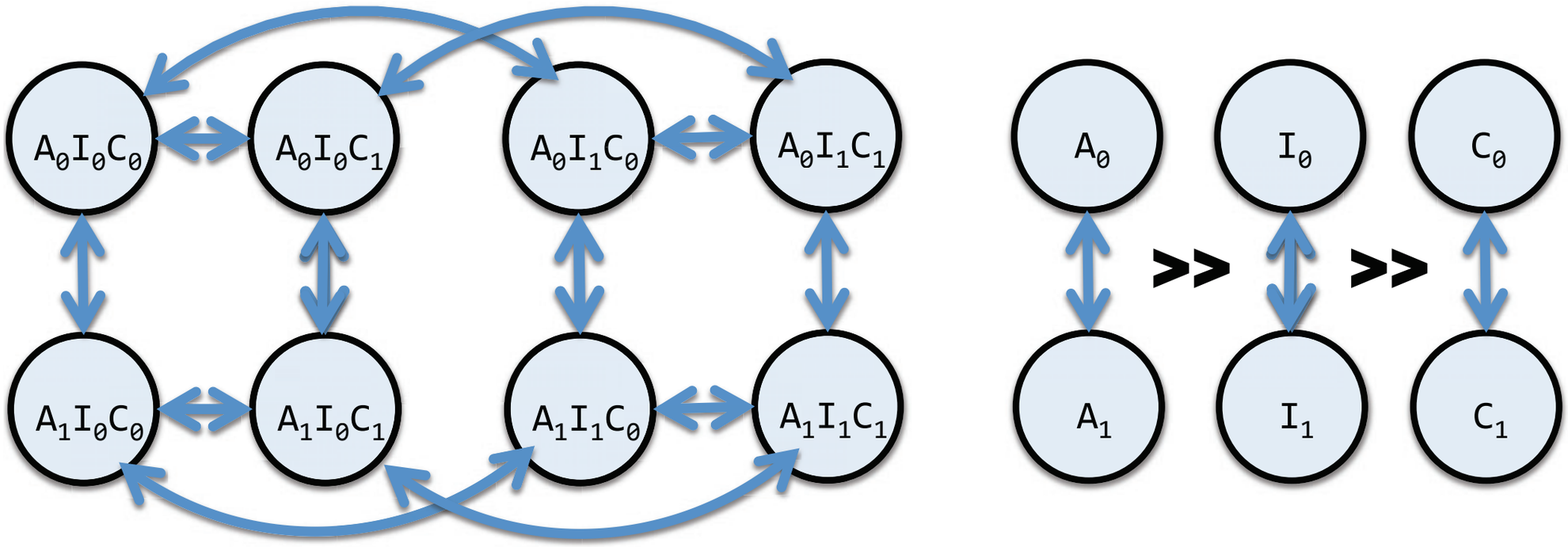
- dynamics for each LPEC defined by an isolated FSM
- for each LPEC:
  - events ⟶ FSM transition ⟶ Pyretic recompilation ⟶ switch update

N isolated FSMs



FSM composition

A_0:Authenticated	I_0:Infected	C_0:Capped
A_1:Unauthenticated	I_1:Clean	C_1:Uncapped



$\prod a_i$

$\sum a_i$