Checking path consistency and reachability in multipath networks using Batfish

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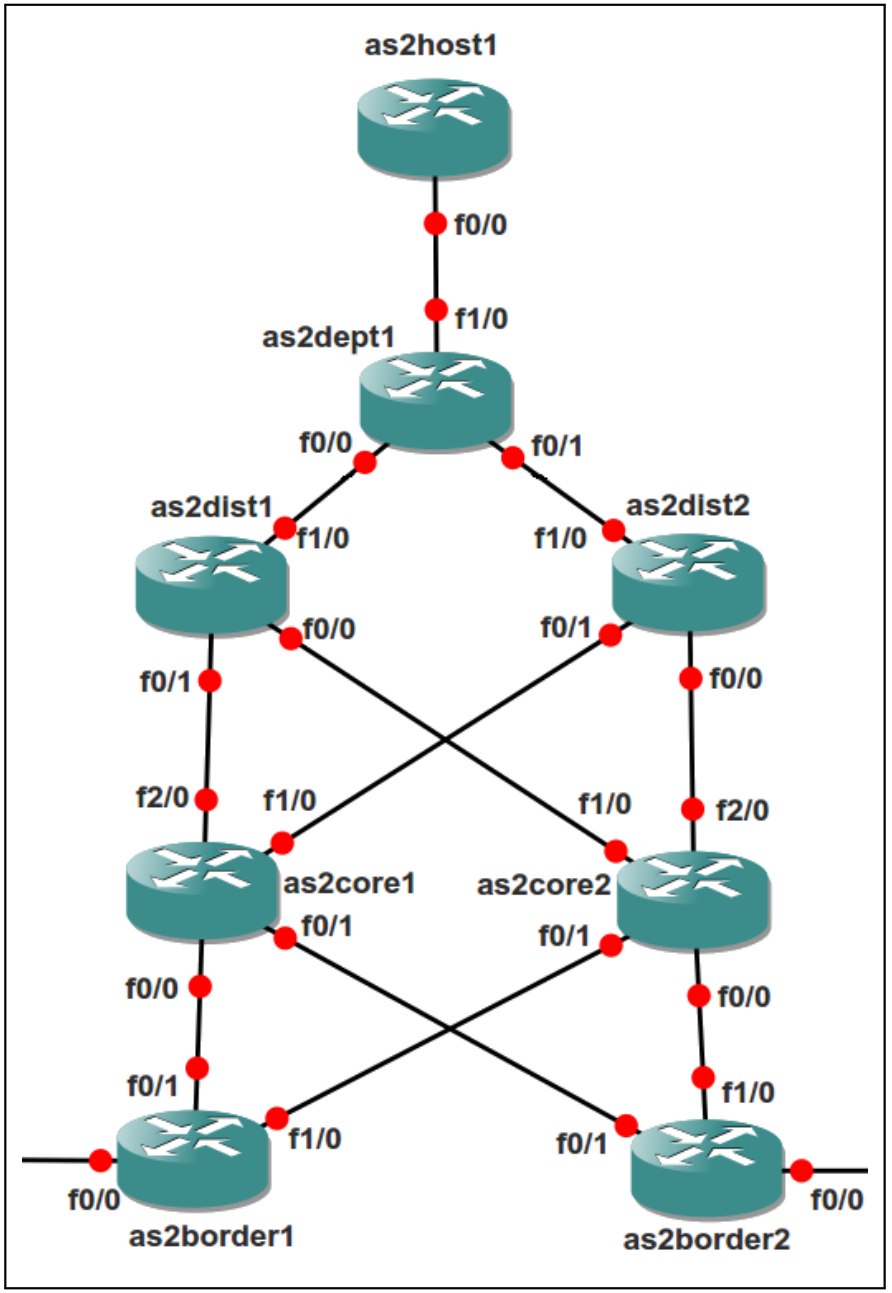
SoCal 2013

IP Networks

- IP Networks forward traffic from point A to point B
  - Implement policy
  - Forward desired traffic
  - Drop undesired traffic
  - Fault tolerance

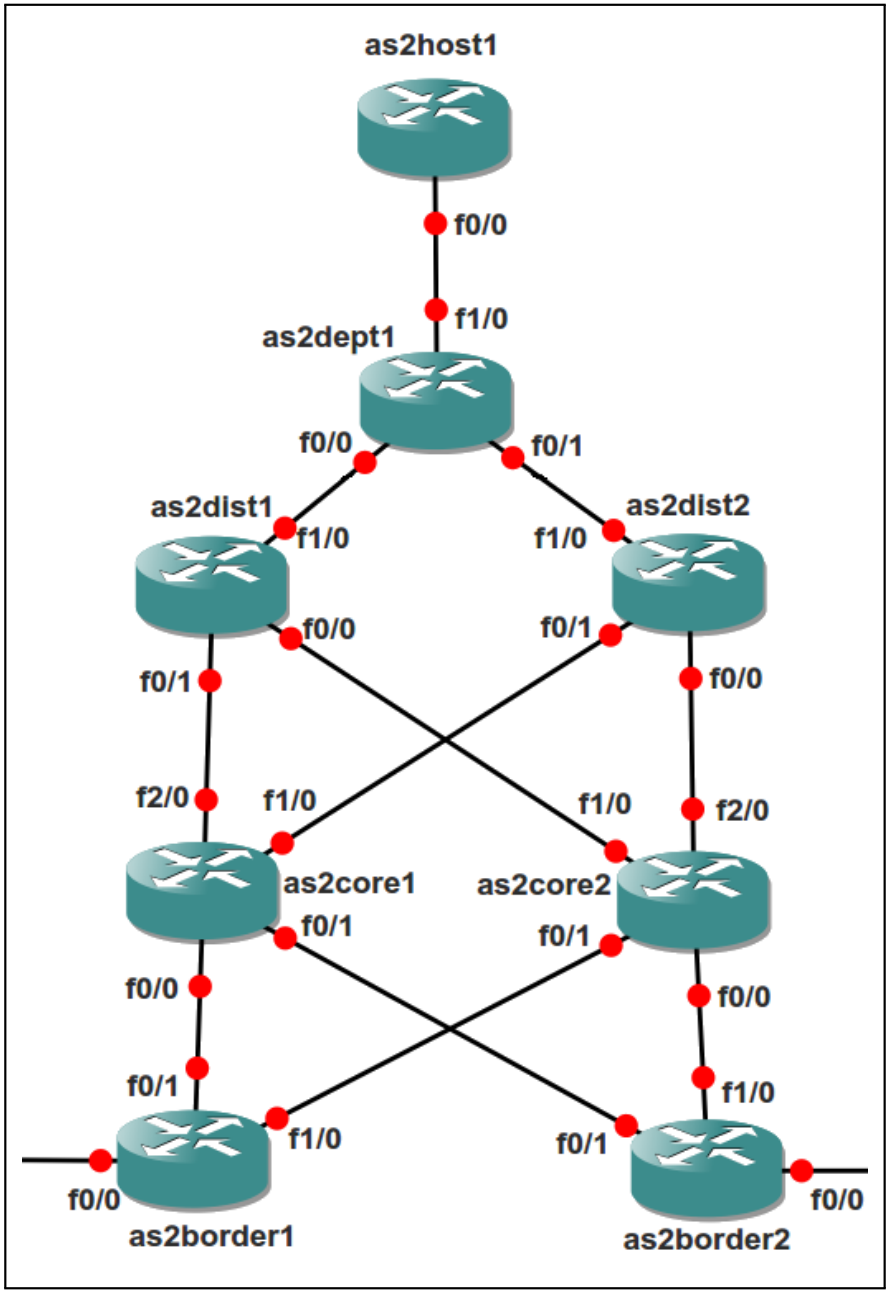
Router-based networks



Router-based network paradigm:

- Decentralized configurations (per-node)
- Configuration is program in DSL
- Routing protocols run to fixed point, compute forwarding tables
- Most commonly deployed

Network Abstraction: Data Plane



Data Plane

- Runtime forwarding state of network
- Dynamically computed
- Dictates what to do with received traffic
- Partitioned into forwarding tables at each node

Problem Characterization

Policy violations correspond to bad runtime forwarding state

- Can be detected by analyzing dynamic snapshot
- Easy given snapshot
- Dynamic snapshot expensive to obtain
- Dynamic snapshot may not have converged
- Can only find problems that are already present

Better Approach, New Challenges

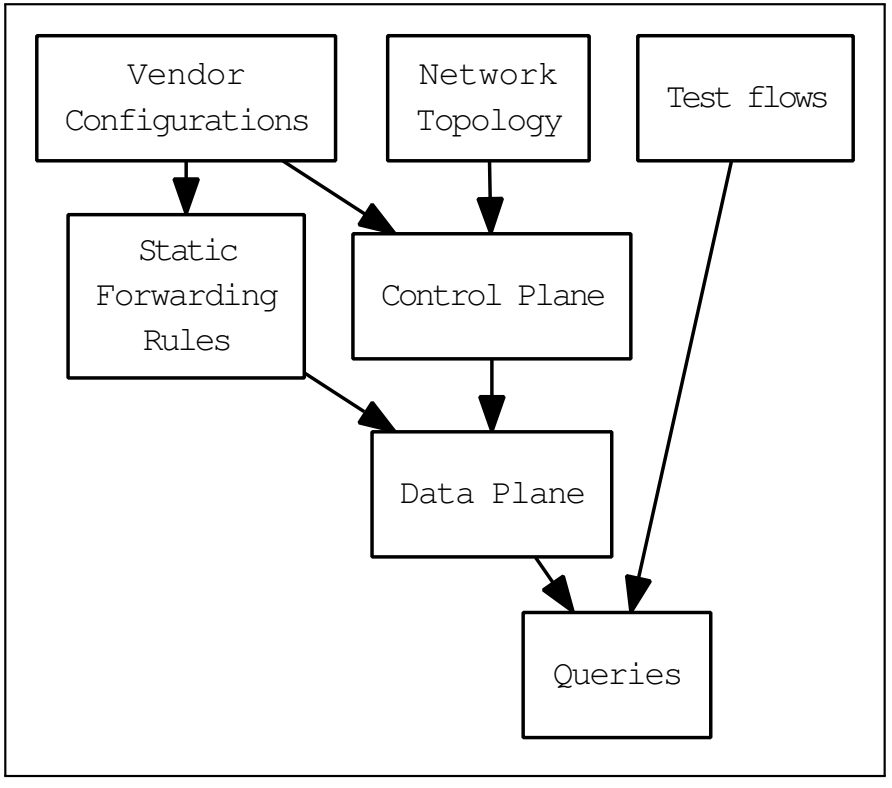
We want to find problems before they occur

- Can ask what-if questions
- Perform static analysis by looking at configurations

Configuration analysis is complicated and difficult:

- Have to model multiple routing protocols, intricacies
- Often heterogeneous devices, configuration languages, firmware versions, etc. (e.g. UCLA)
- Dissimilar configuration paradigms across vendors

Batfish



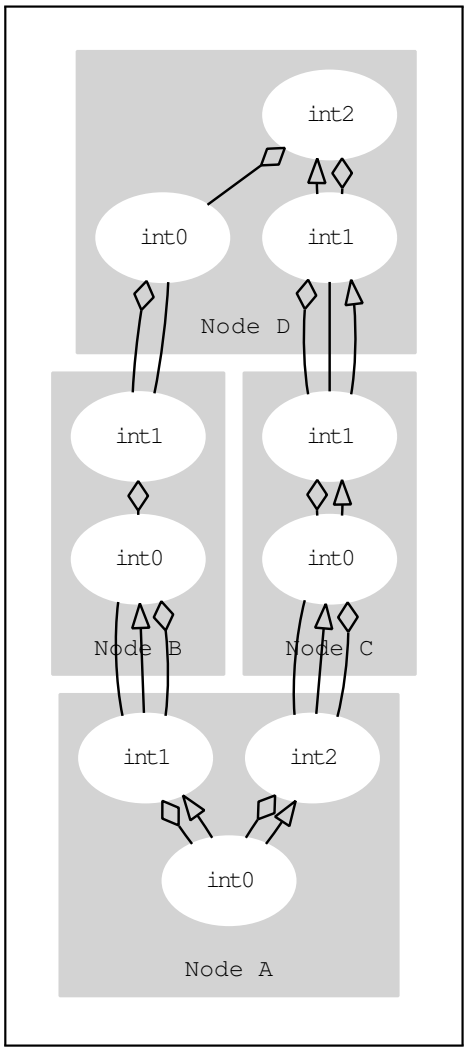
Introducing: Batfish

- Static analysis tool
- Compiles configs into vendor-independent representation
- Implements control plane declaratively using LogiQL
  - Naturally express fixed-point logic
  - Modular
  - Easy to construct queries

Network Problems

- Misconfigurations cause deviation from policy
  - Black holes
  - Firewall leaks
  - Forwarding loops
- Multipath routing
  - Multiple paths to destination
  - Path choice unpredictable
  - Policy deviations may be path-specific

Path Consistency



Want to ensure *Path Consistency*:

- Delivery of flow not contingent on path taken
- Every flow always dropped or always arrives
- Defined in terms of per-flow reachability, loops
- Desired property of multipath networks
  - Single-path networks trivially path-consistent

Related Work

- Dynamic analysis
  - Header space (Hassel) [Kazemian et al., NSDI 2012]
  - Anteater [Mai et al., SIGCOMM 2011]
    - Check reachability, etc. for data plane snapshot
- Static analysis
  - rcc [Feamster and Balakrishnan, NSDI 2005]
    - checks configs for inconsistencies
  - C-BGP [Quoitin and Uhlig, Network, IEEE 19, 6 (2005)]
    - limited control plane model
    - single paths only

Summary

- Batfish can statically analyze networks
- Declarative model for control plane
- Introduce and decide Path Consistency for multipath networks.

- Future Work
  - Run on real, large-scale networks
  - Automatically generate interesting test flows

Questions

Questions?

Paper:
Checking path consistency and reachability in multipath networks using Batfish
`http://www.cs.ucla.edu/~arifogel/papers/wqe-f2013-batfish.pdf`

Slides:
`http://www.cs.ucla.edu/~arifogel/papers/socal-2013-batfish-slides.pdf`

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