Fleet: Defending SDNs from Misbehaving Administrators

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Motivation

- The Misbehaving Administrator Problem
  - Administrator affects SDN routing by misconfiguring a *correctly functioning* controller
- Human error is responsible for 50-80% of all network outages [1]
- Misconfigurations that do not cause outages can be difficult to detect

[1] Juniper Networks. What's behind network downtime? 2008.

Fleet's Approach

- The Fleet controller contributes:
  - Threshold signature functionality to switches
  - Resilience by voting on configurations
- Orthogonal Approaches
  - Diversity of hardware/software [2]
  - Policy-based flow rules [3, 4]

[2] Diego Kreutz, Fernando Ramos, and Paulo Verissimo. Towards secure and dependable software-defined networks. HotSDN '13.
[3] Philip Porras et al. A security enforcement kernel for OpenFlow networks. HotSDN '12.
[4] Ahmed Khurshid, et al. VeriFlow: Verifying network-wide invariants in real time. HotSDN '12.

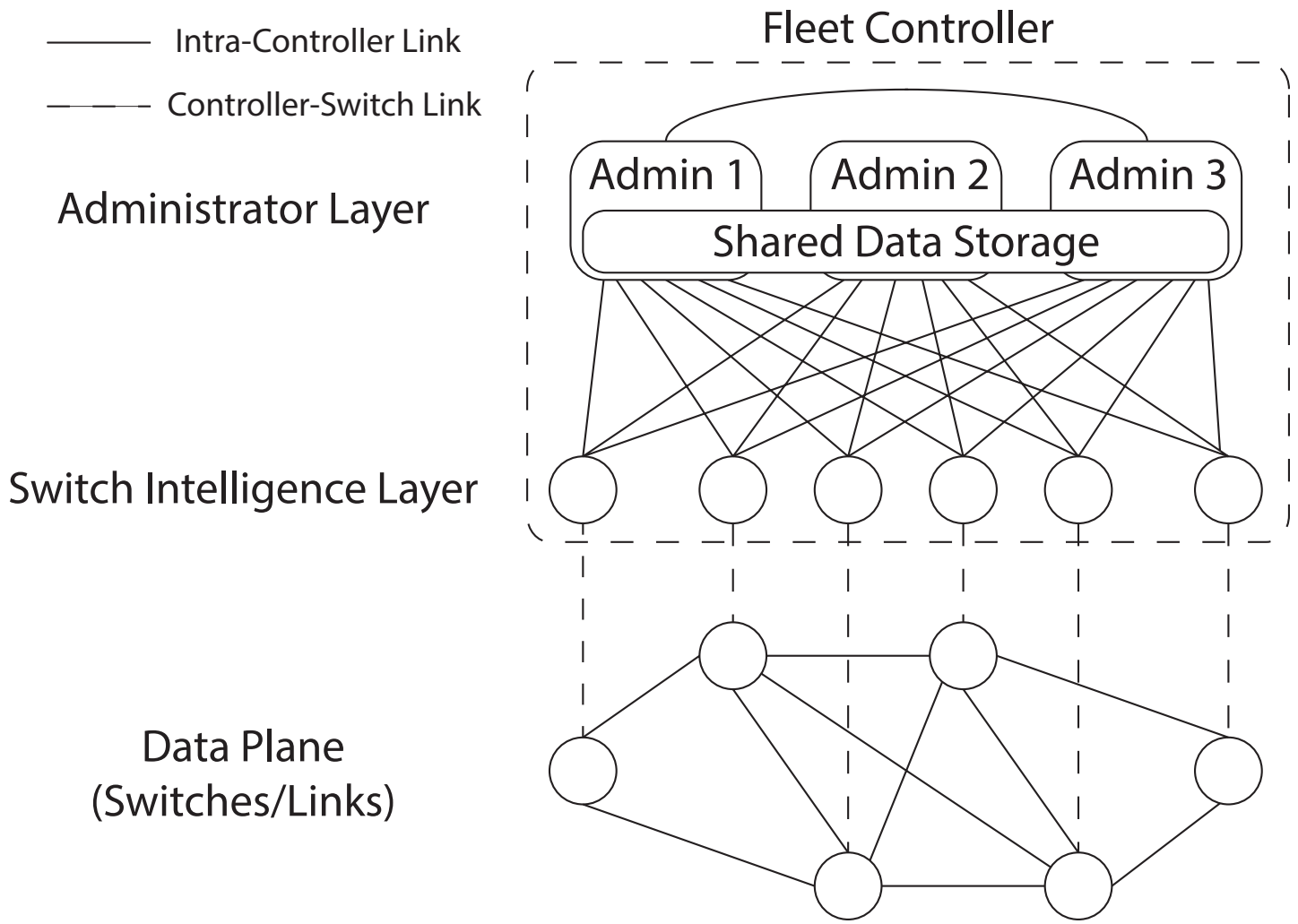
Adversary Model

- *k* misbehaving administrators (out of *n* total)
  - Network configured to desired level of resilience
  - In practice, *k* will be small (1 or 2)
- May create policies selecting undesired paths
- Cannot otherwise affect controller operation

Assumptions

- Switches pre-configured with necessary keys
- Administrators:
  - See the same network topology
  - Are loosely time-synchronized
  - Securely communicate out-of-band
  - Share the same routing policy if not malicious

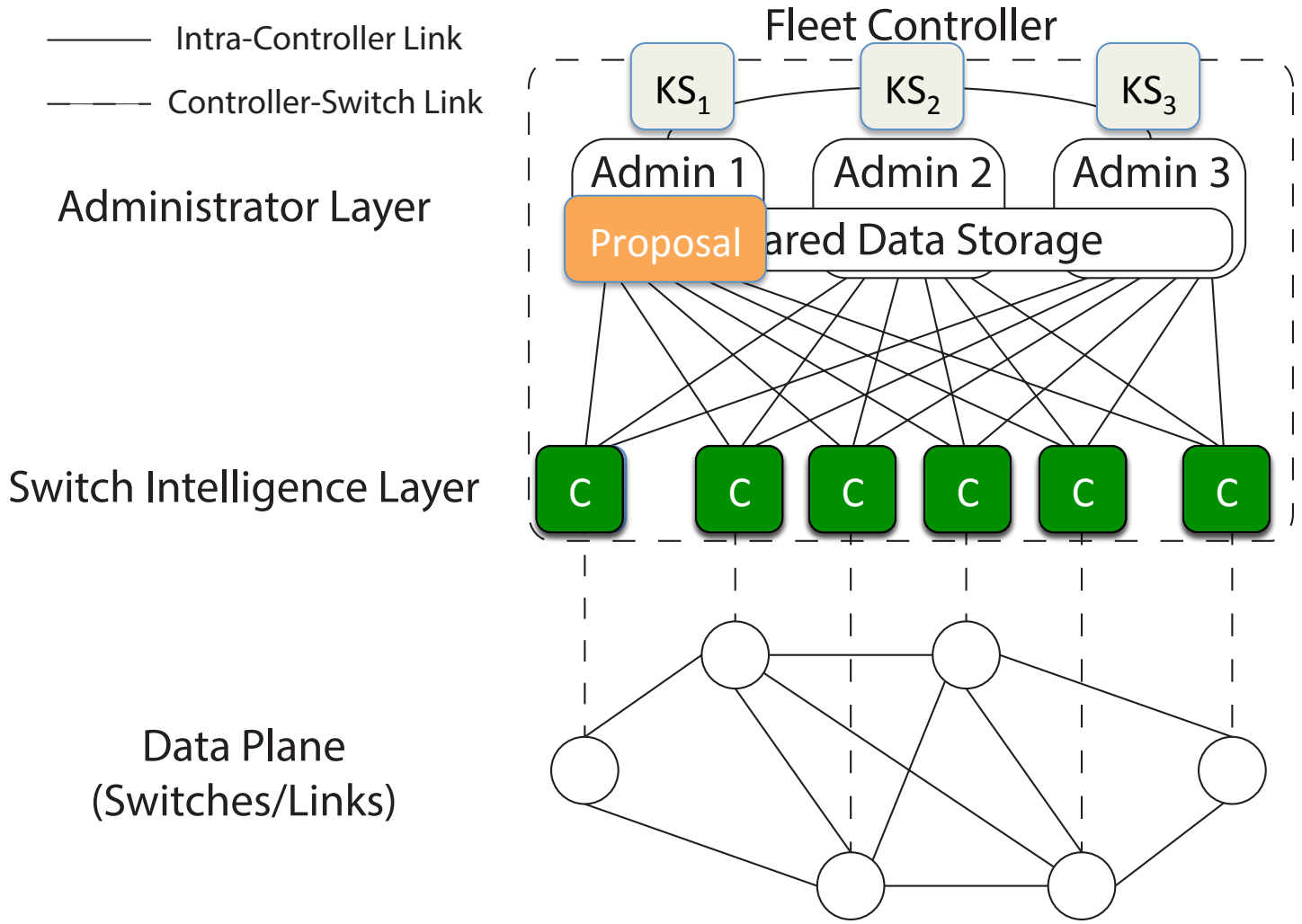
Fleet Controller Architecture



Routing with the Fleet Controller

- Single-configuration
  - Voting protocol using threshold signatures
- Multi-configuration (details in paper)
  - Sources or ingress switches can select per-flow routes

Single-Configuration Approach

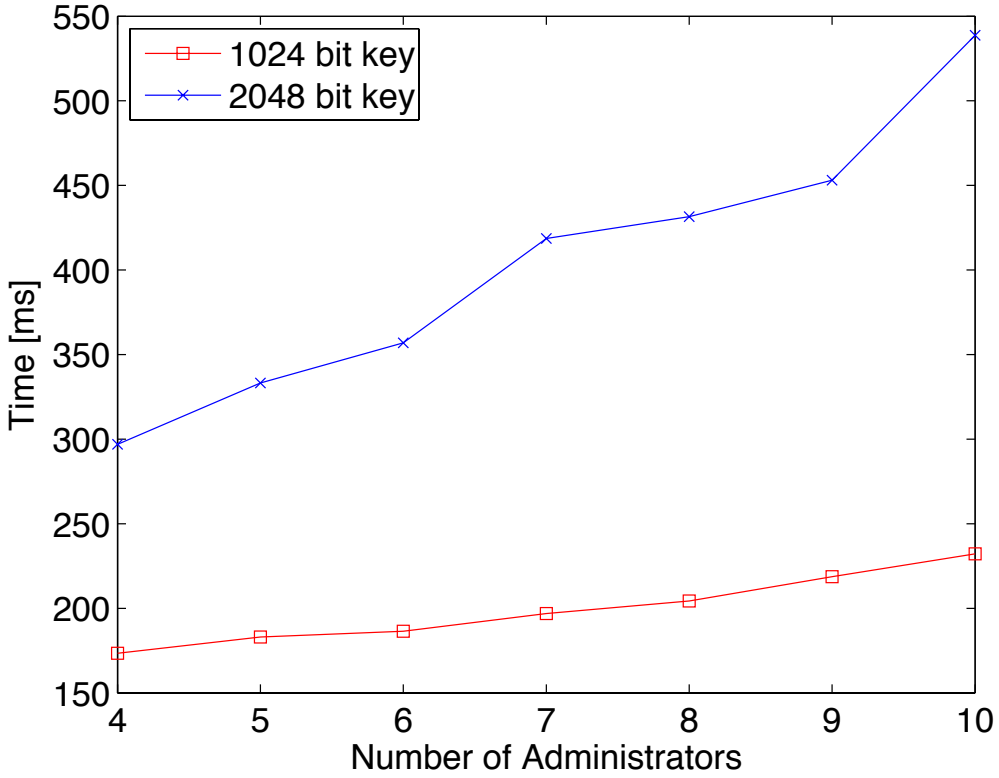


Evaluation

- Prototype implementation in Python-based POX controller and Mininet SDN framework
- Tested on random topologies of 20 switches and 50 hosts
- Main question: what dominates recovery time?

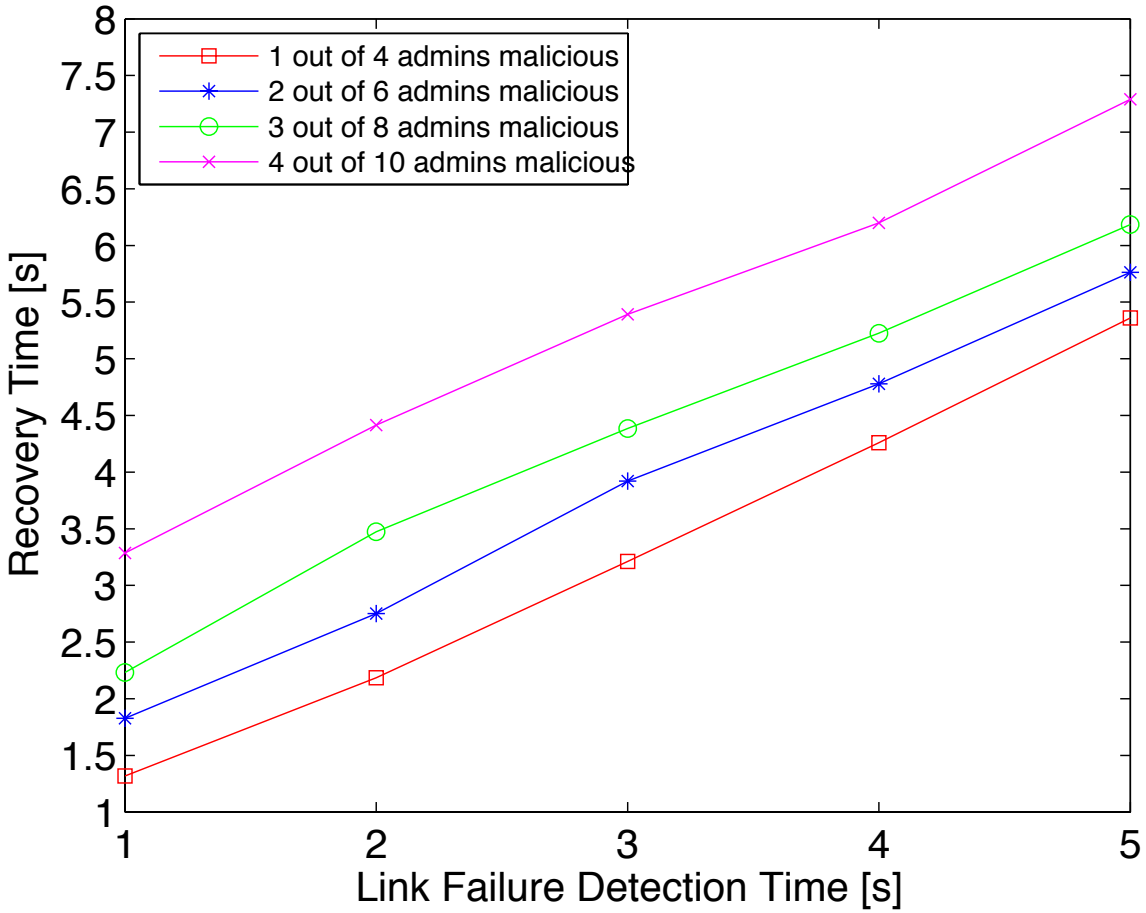
Evaluation

- Key size affects voting protocol length
- Successful vote takes less than 1s



Evaluation

- Link failure detection time dominates recovery



Conclusions

- Fleet protects against misconfigurations with little overhead
- Switch intelligence enables useful switch functionality, such as threshold signatures
- Companies can expand their networks to locations where admins may not be as trusted

Thank you! Questions?