Robust fault-recovery in Software-Defined Networks

IBSDN: IGP as a Backup in SDN

June 2014 - Olivier Tilmans
Agenda

1. Software-Defined Networking
2. IBSDN
3. Evaluation
4. Discussion
5. Summary
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Software-Defined Networking

• Decouples the control-plane from the data-plane

• Brings programmability in networks
OpenFlow concepts

- Well-defined protocol and switch specifications
OpenFlow concepts (cont’d)

• Programmability via flow tables setup by the controller
Challenges

• Of the data-plane
  • Scalability
Challenges

• Of the data-plane
  • Scalability

• Of the controller
  • Consistency
  • Correctness
  • Capacity
Challenges

• Of the data-plane
  • Scalability

• Of the controller
  • Consistency
  • Correctness
  • Capacity

• Robustness
Impact of failures

• 3 sources of failures
Impact of failures

- 3 sources of failures
- Handling failures:
  - Reactively
  - Proactively
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Motivation

- Existing recovery schemes have inherent limitations
- Deployment of SDN in service-provider networks will co-exist with legacy hardware
Architecture
Requirements

1. Primary rules
2. Next-hop control rules
3. IGP-path control rule
4. Identifying IGP-forwarded packets
Operational model

Normal operation

Source

Destination
Operational model

Failure of the link R3-R4
Guarantees

• Connectivity is preserved for any combination of failures
Guarantees

• Connectivity is preserved for any combination of failures

• Restoration of connectivity does not involve the controller
Guarantees

• Connectivity is preserved for any combination of failures

• Restoration of connectivity does not involve the controller

• Safety
Implementation overview

- Controller built against the Ryu framework
- Nodes are Linux hosts
Implementation overview (cont’d)

- IGP-forwarded packets are tagged in their TOS byte
- Uses OpenFlow fast failover groups
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Benchmarks

- Micro benchmark
Benchmarks

- Micro benchmark
- Macro benchmark
Comparison with purely reactive SDN technique
Comparison with purely proactive SDN technique
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Benefits

- Robust against arbitrary set of failures
- Offers the expressiveness of SDN under normal operation
- Simplifies network design
Limitations

- IGP convergence
- Cannot enforce arbitrary policies with IGP
- Path stretch
Future work

• Reduce path-stretch
  • Remove U-turns

• Enforce some policies during the recovery process
  • Strict policies (do or drop)
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Summary

• Failure management is hard in pure SDN

• IBSDN adds an IGP beneath the SDN control-plane to deal with failures

• IBSDN ensures:
  • Maximal robustness
  • Scalability
  • Upper bound on restoration time