facebook nsdi'21

# Running BGP in Data Centers at Scale

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# Motivation

# Facebook Data Center Growth

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Tremendous user growth

500 million in 2010

↓

2.5 billion in 2020

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Tremendous user growth

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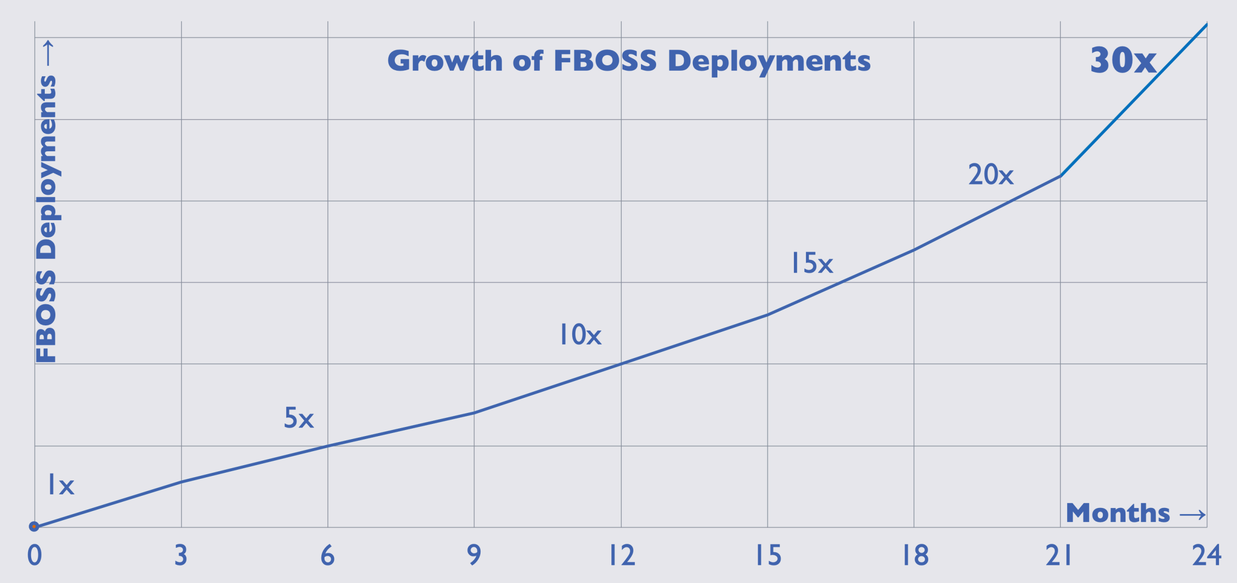
2.5 billion in 2020

Our data center networks have grown to meet with user demand




Source: FBOSS: Building Switch Software at Scale, SIGCOMM 18

# Data Center Routing Requirements

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Scalable design to support quick growth

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Reliability, expecting failures to be common

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Scalable design to support quick growth

Reliability, expecting failures to be common

Operational efficiency to innovate rapidly while providing production reliability

# BGP as the DC routing protocol

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BGP (Border Gateway Protocol) is chosen for scalability, extensive policy control, and long-term stability.

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BGP on vendor devices helped grow our networks rapidly initially, compared to developing an SDN routing solution from scratch.

# BGP Challenges

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Problematic in the DC as well due to frequent failures and maintenance events

Vendor BGP software not able to support evolving routing requirements fast

# Our Solution

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Scalable BGP routing design adhering to the principles of configuration uniformity and operational simplicity

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Routing policies to achieve reliability of the network under failures

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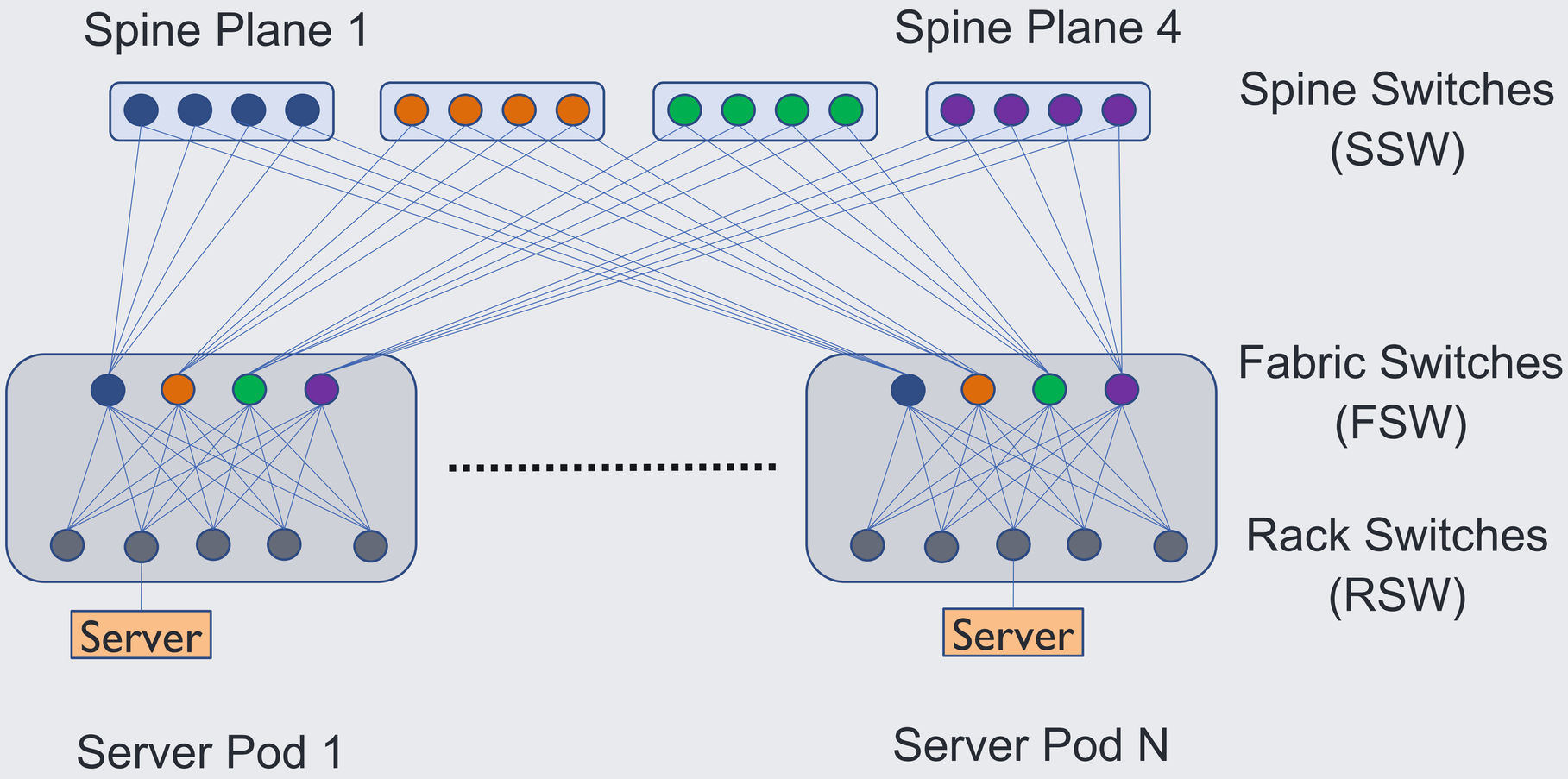
Scalable BGP routing design adhering to the principles of configuration uniformity and operational simplicity

Routing policies to achieve reliability of the network under failures

In-house BGP agent coupled with automated testing and incremental deployment framework to achieve operational efficiency

# DC Routing Design with BGP

# Scalable Network Topology



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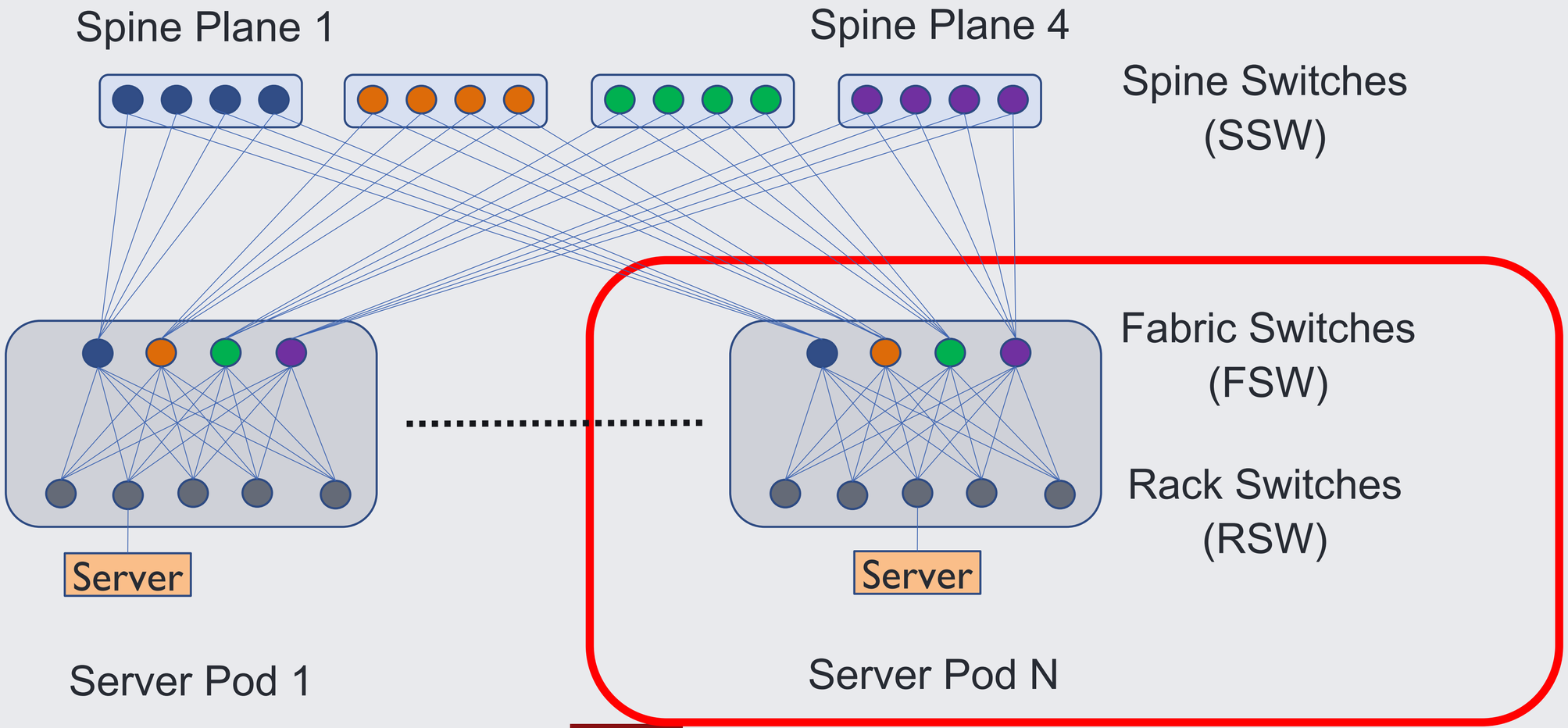

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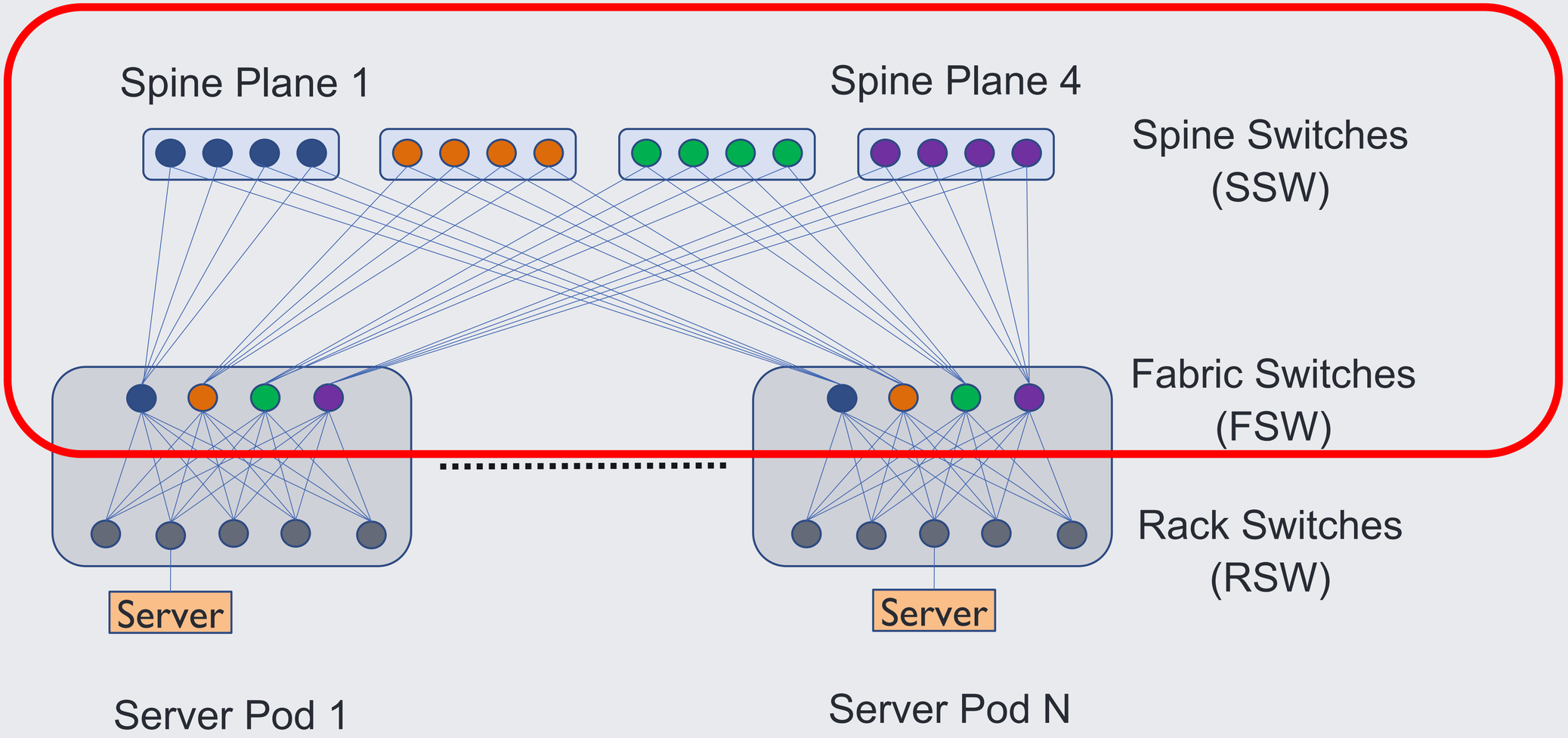

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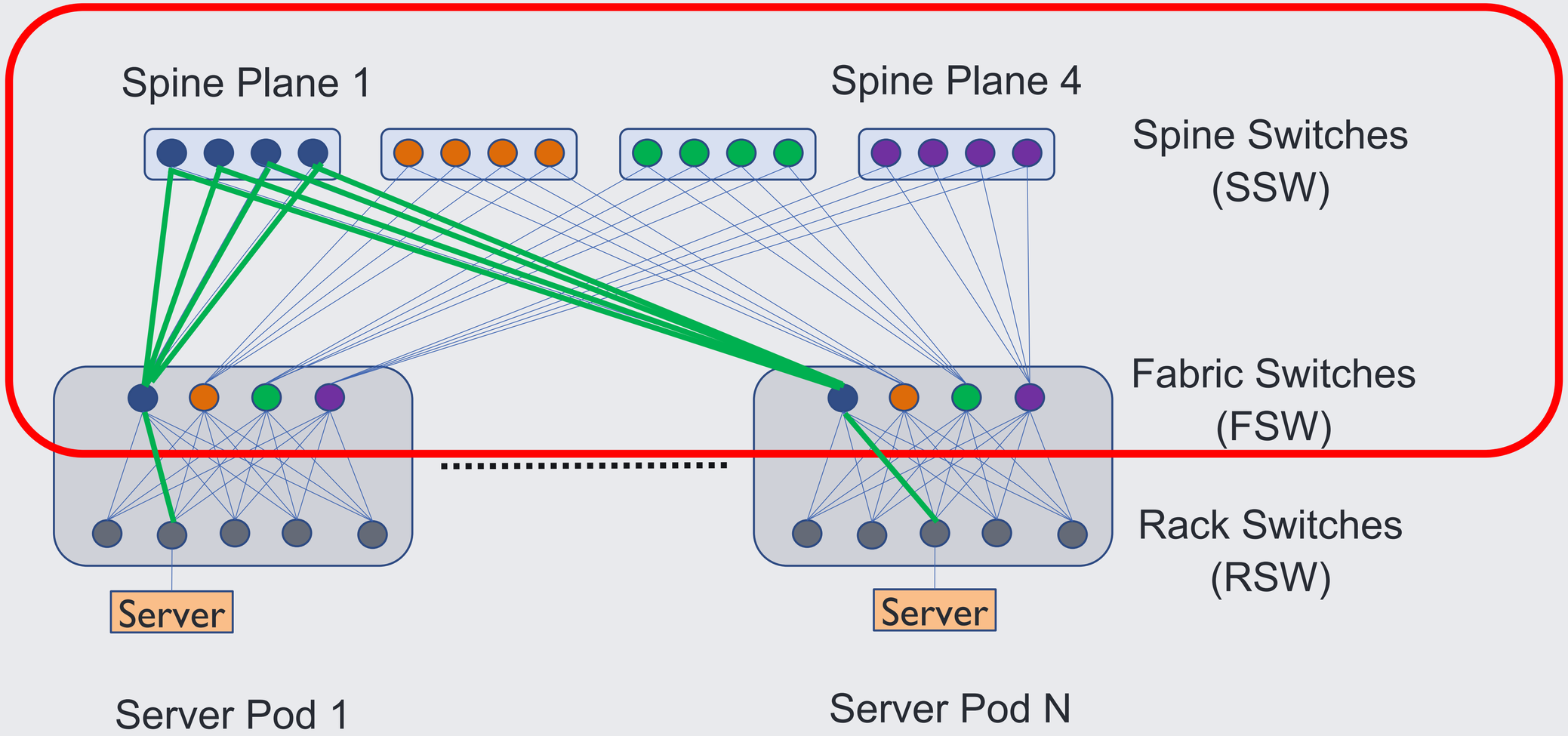

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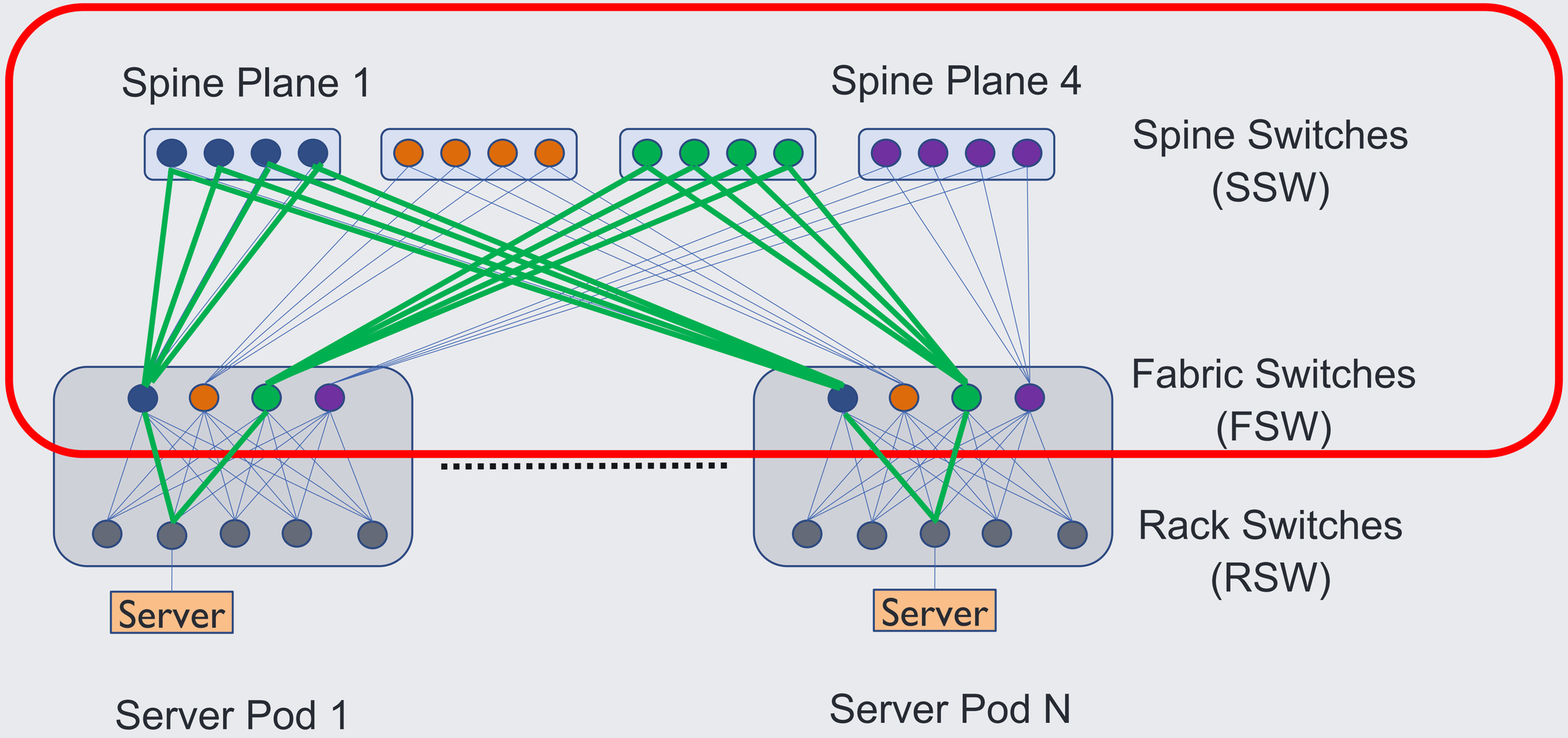

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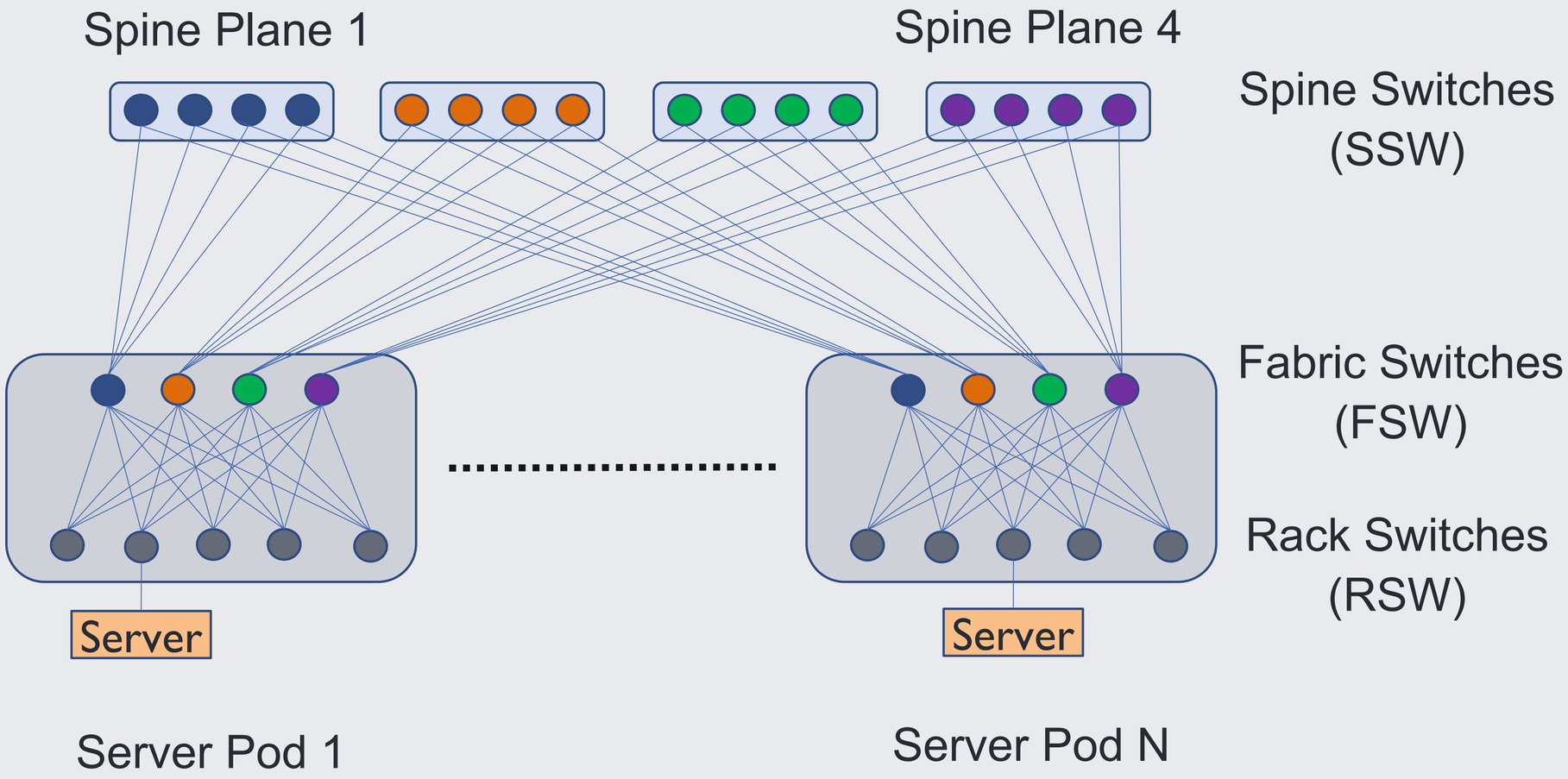
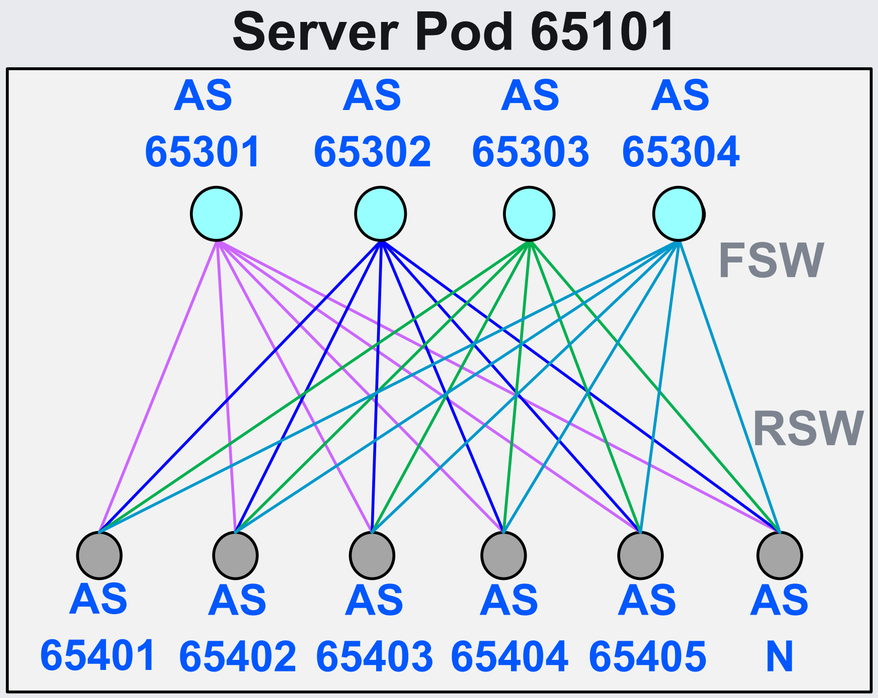
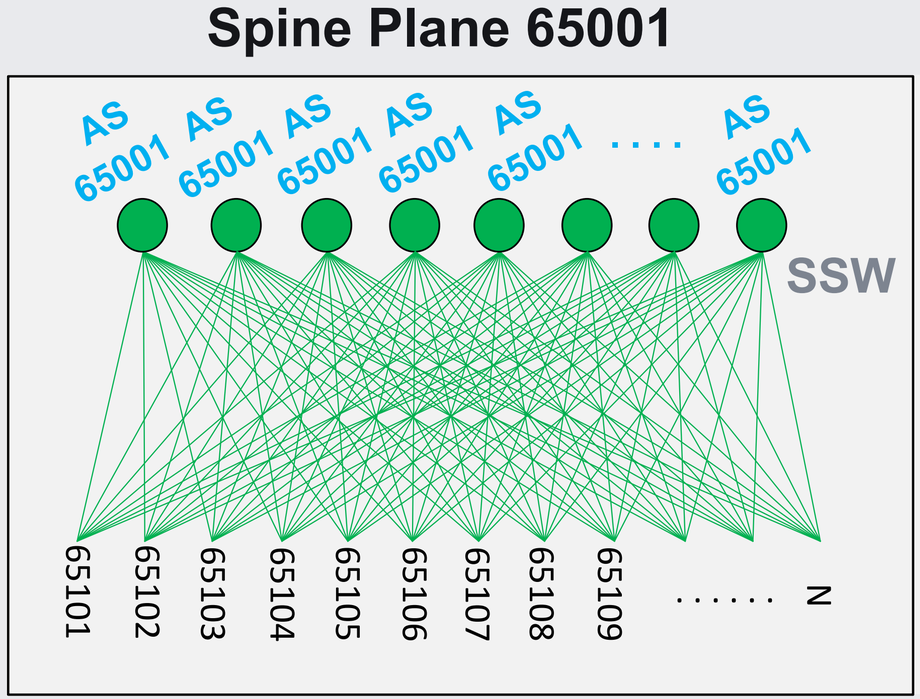


# Reusable BGP ASN Allocation



# Route Summarization

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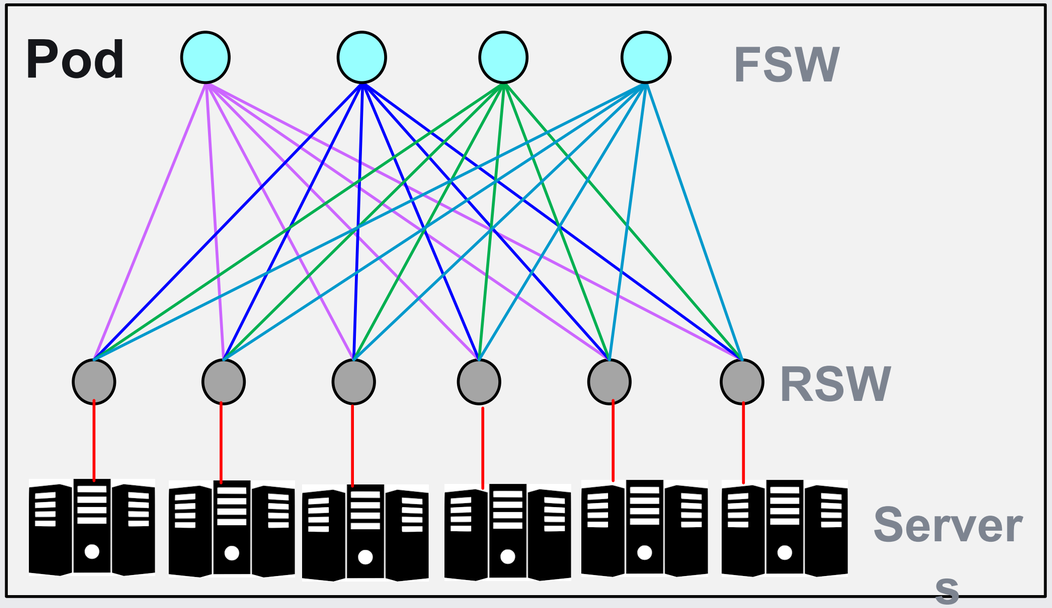
Example of Production routes, reflecting topology hierarchy



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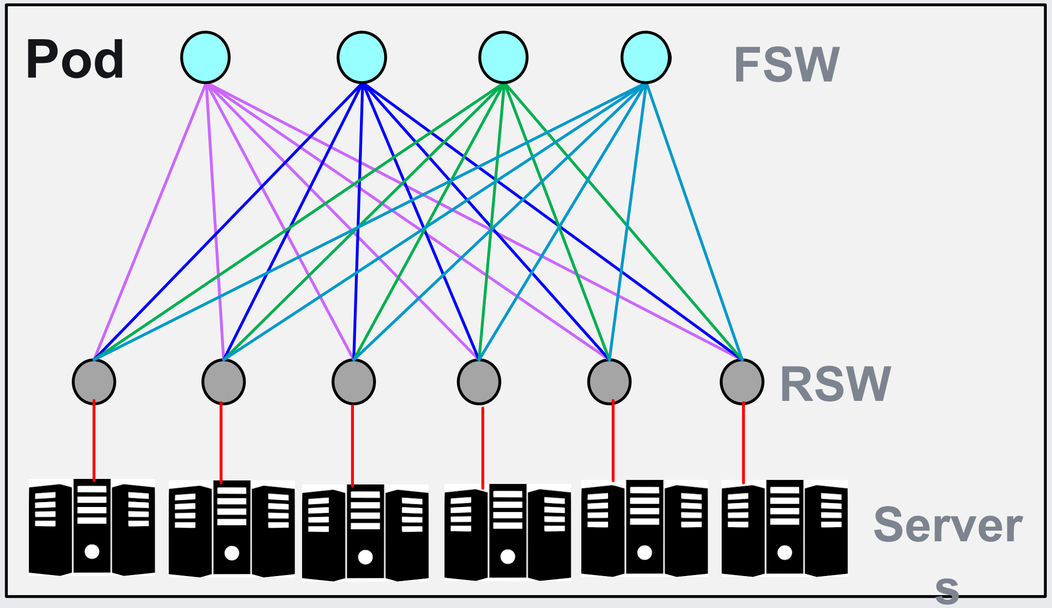


Server IP addresses
face:b00c::1:0/128

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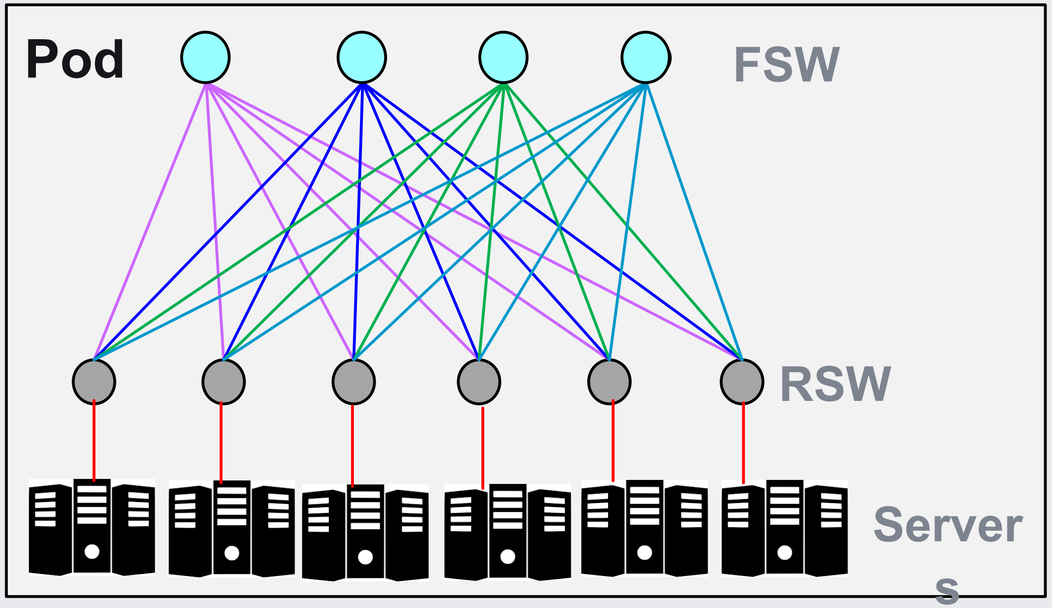


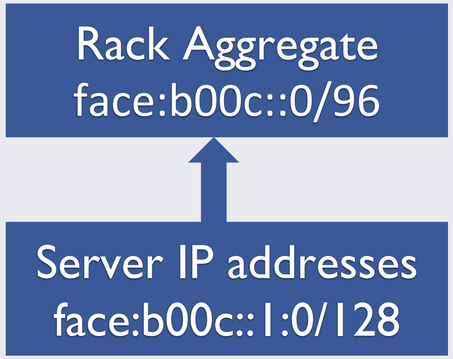

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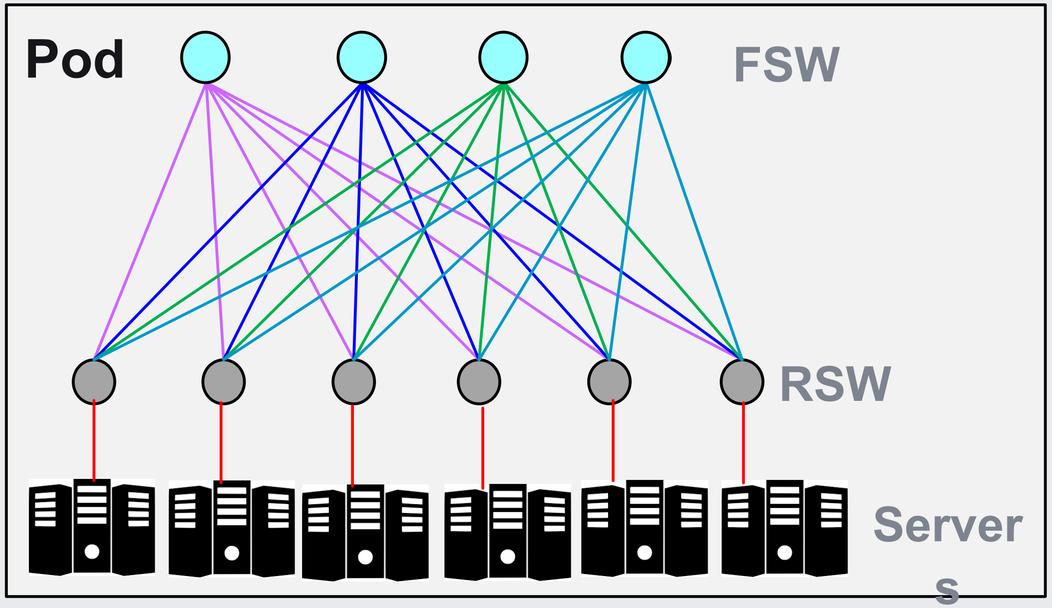


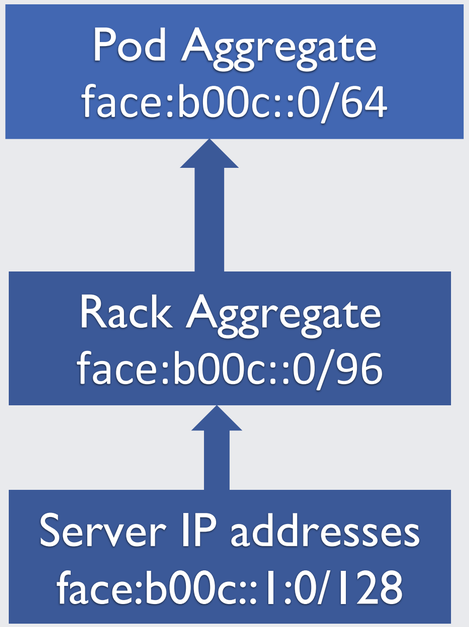

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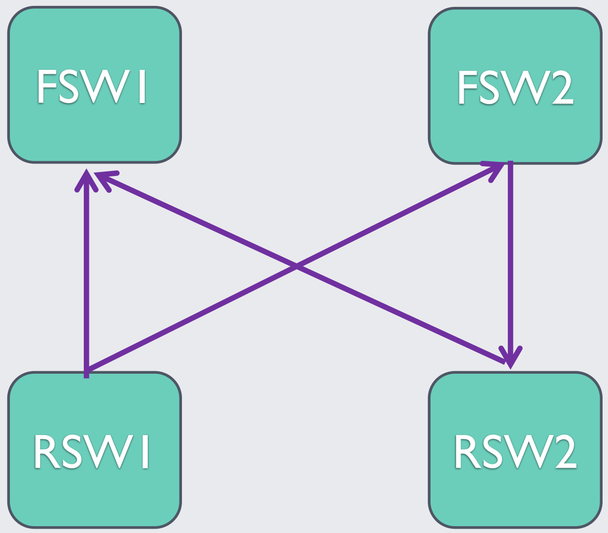
| Scalability | Enforce route summarization<br>Avoid backup path explosion |
| Maintainability | Isolate/remediate problematic nodes without disrupting traffic |
| Service reachability | Avoid service disruptions when instances of services are added/removed/migrated |

# Reliability

## Predefine backup paths for link failure




During BGP Route Convergence

# Reliability

## Predefine backup paths for link failure

RSW1's rack_prefix:
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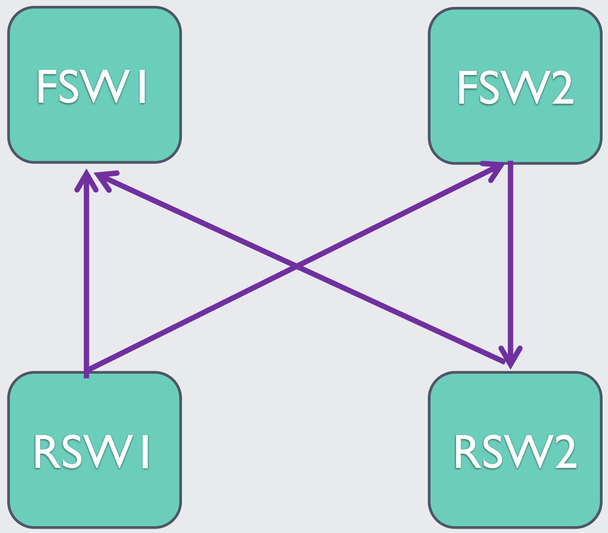


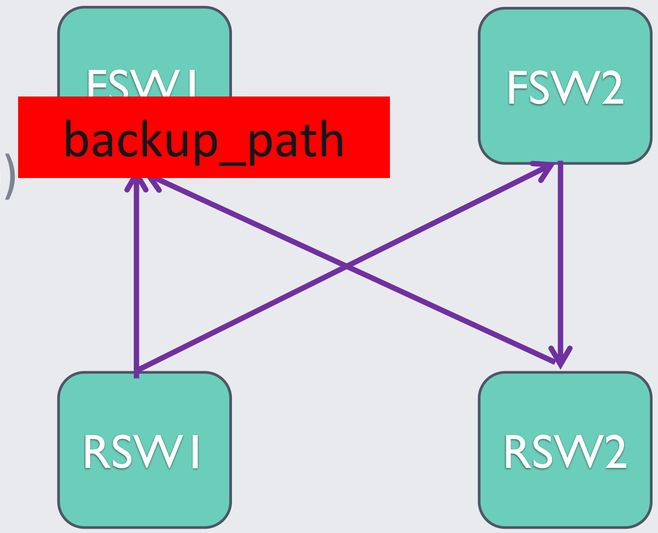

action: add tag
'rack_prefix'

During BGP Route Convergence

# Reliability

## Predefine backup paths for link failure

RSW1's rack_prefix:
-> RSW1 (best)
-> RSW2--FSW2--RSW1 (backup)




**match:** 'rack_prefix'
**action:** add tag 'backup_path'

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**match:** 'backup_path'
action: allow

During BGP Route Convergence

# Reliability

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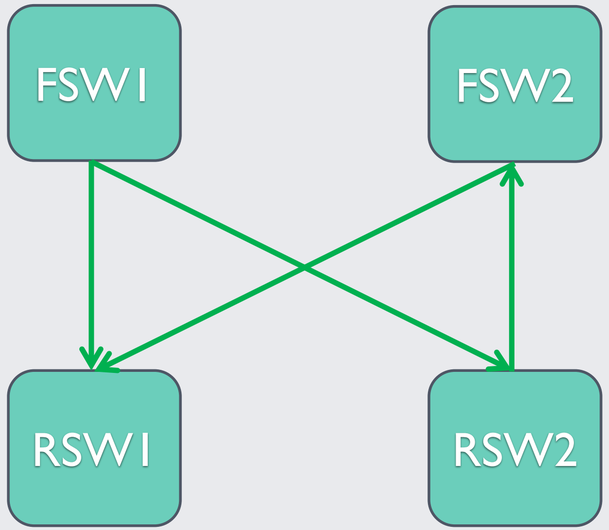


Traffic flow on link failure

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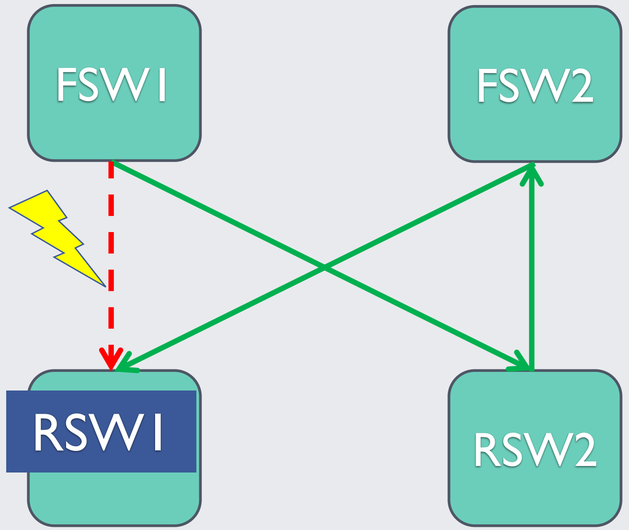
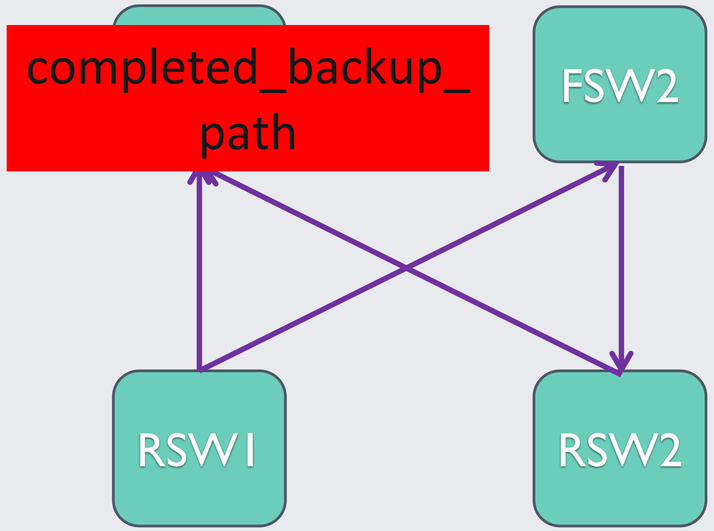



Traffic flow on link failure

# Scalability

## Enforce route summarization and avoid backup path explosion

match: ‘backup_path’
action: add tag ‘completed_backup_path’

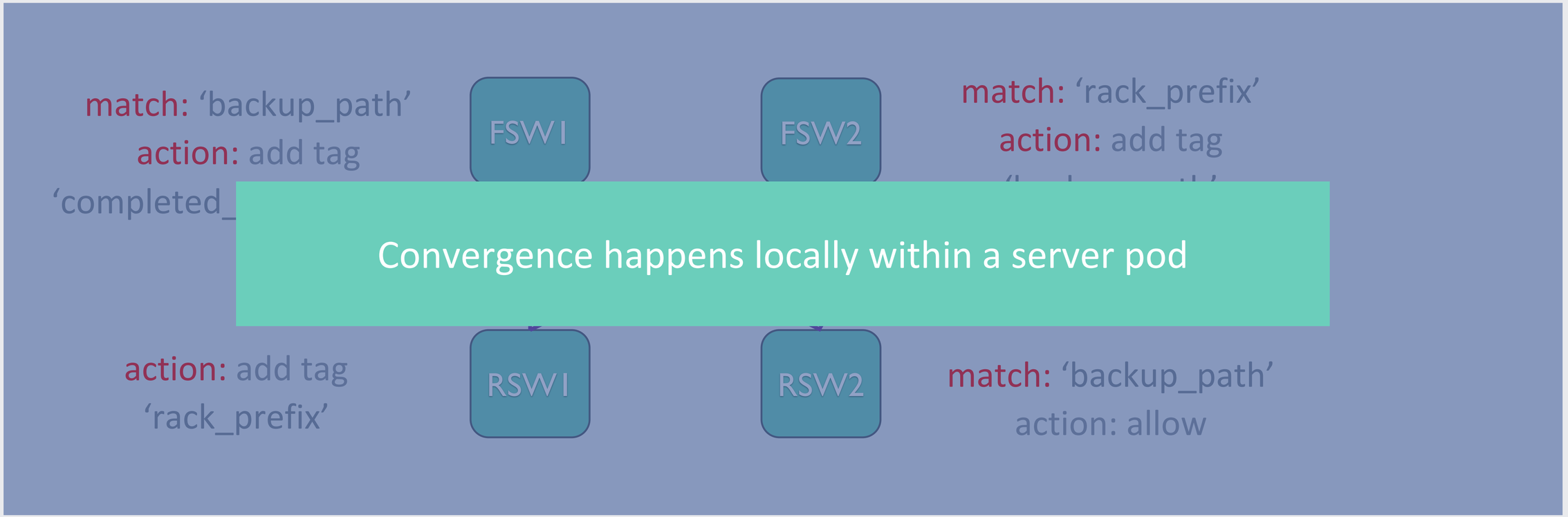



Routes with tag ‘completed_backup_path’ won’t be propagated to other devices.

During BGP Route Convergence

# Scalability

## Enforce route summarization and avoid backup path explosion

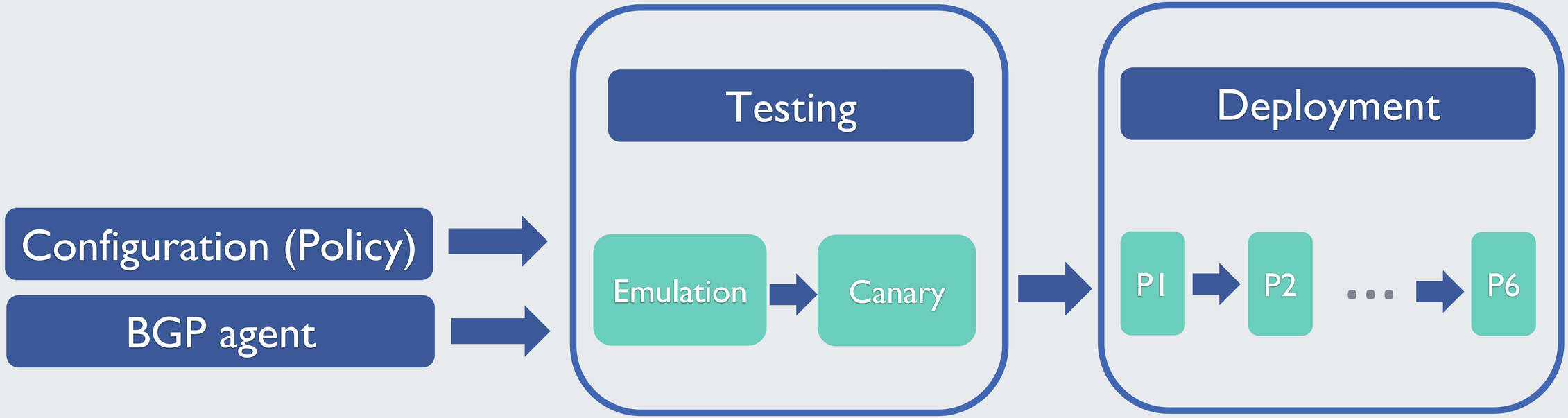



During BGP Route Convergence

# Operational Experience

# Built Operational Pipeline

Support BGP like any other SW, enabling fast incremental updates!



# Conclusion

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Scalable BGP-based routing design: Reusable ASN allocation and route summarization coupled with our scalable topology design

Reliable under failures: Routing policies such as predefined backup path

Operationally Efficient: Automated testing and incremental deployment framework for our in-house BGP implementation

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