Fault-Tolerant SDN Solution for Cybersecurity Applications

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Introduction & Motivation

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Motivation

- Computer Networks have scaled up and are now entrusted to perform complex tasks successfully.
- Software Defined Networking (SDN) simplifies the management and control functions of networks
- SDN though introduces challenges as well.
  - High availability
  - Visual tools

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Contribution

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Contribution of our Work

- Design a high availability SDN solution suitable for a wide range of networks.
- Design and integrate a Synchronization Service to assist the master election process.
- Design and implement a web-based Dashboard and assist administrators in monitoring the network and enforce policies.

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Background

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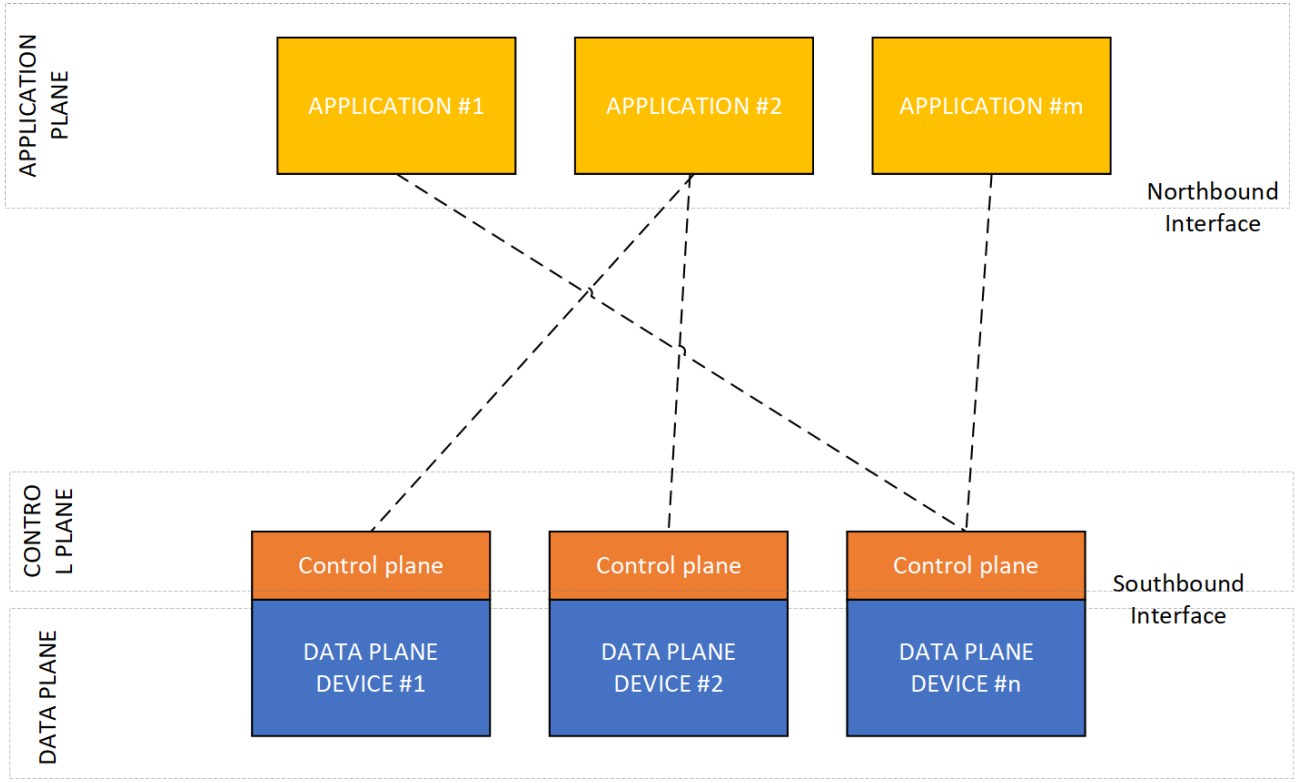
Traditional Networking

- Data plane and control planes are intertwined.
- Communication with data plane devices is not well-defined
- Data plane devices are task-specific and vendor locked
  - E.g., firewall, load-balancer, router



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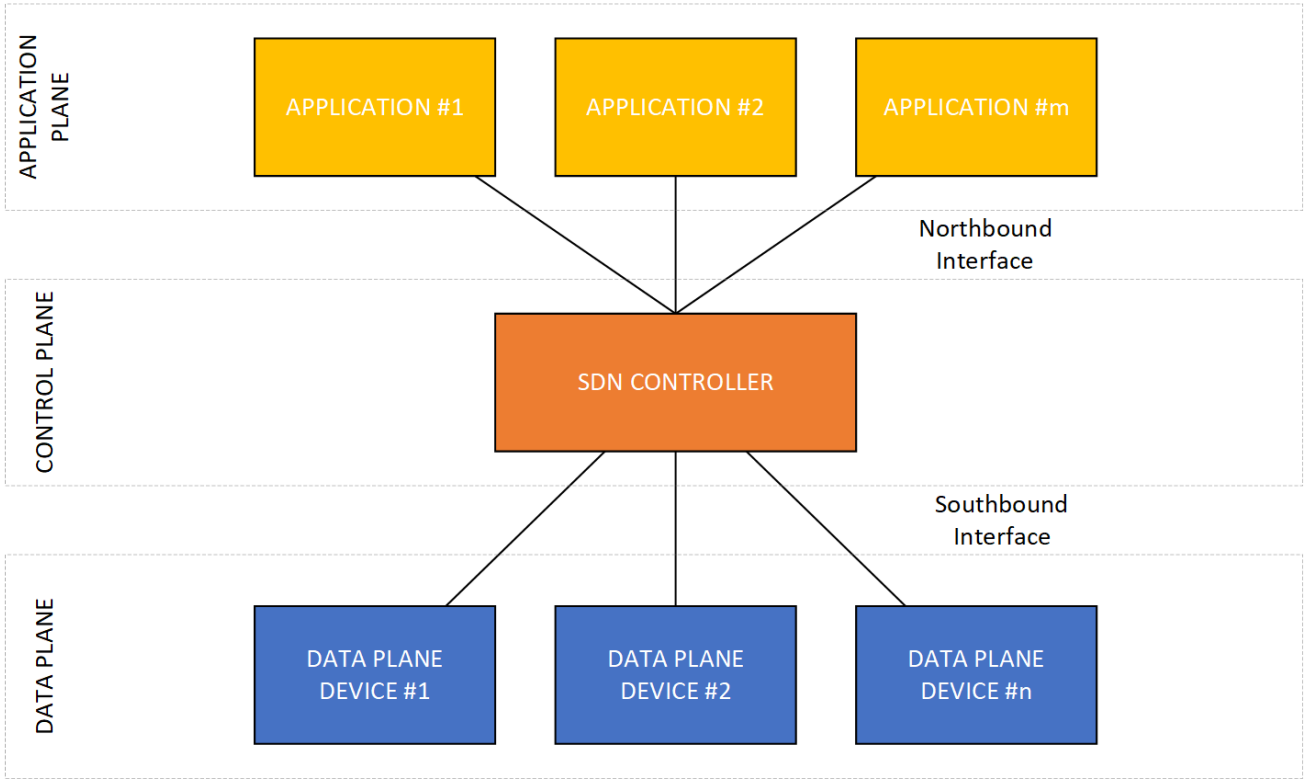
Software Defined Networking

- SDN decouples data plane and control plane
- Offers a logically centralized control point (the SDN Controller)
- High-level policies are translated to low level device specific instructions
- Efficient Monitoring of network
- Well defined communication interfaces



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Proposed System Architecture

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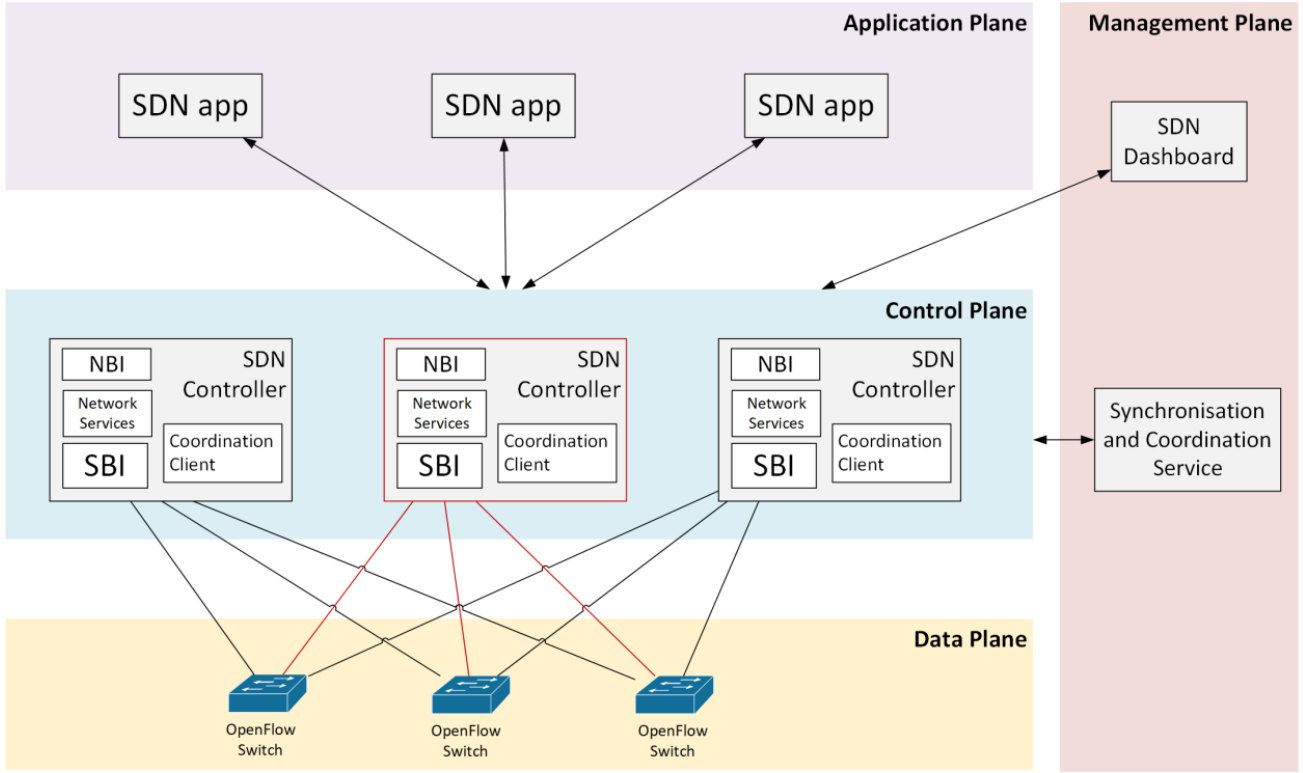
Proposed System Architecture: High level description

- Multiple SDN Controller instances
  - Ensure high availability
- Synchronization and Coordination Service (SCS)
  - Assists master controller election process
  - Ensures discovery of the master controller to SDN apps
- SDN Dashboard
  - Offers visual-based tools to the administrator



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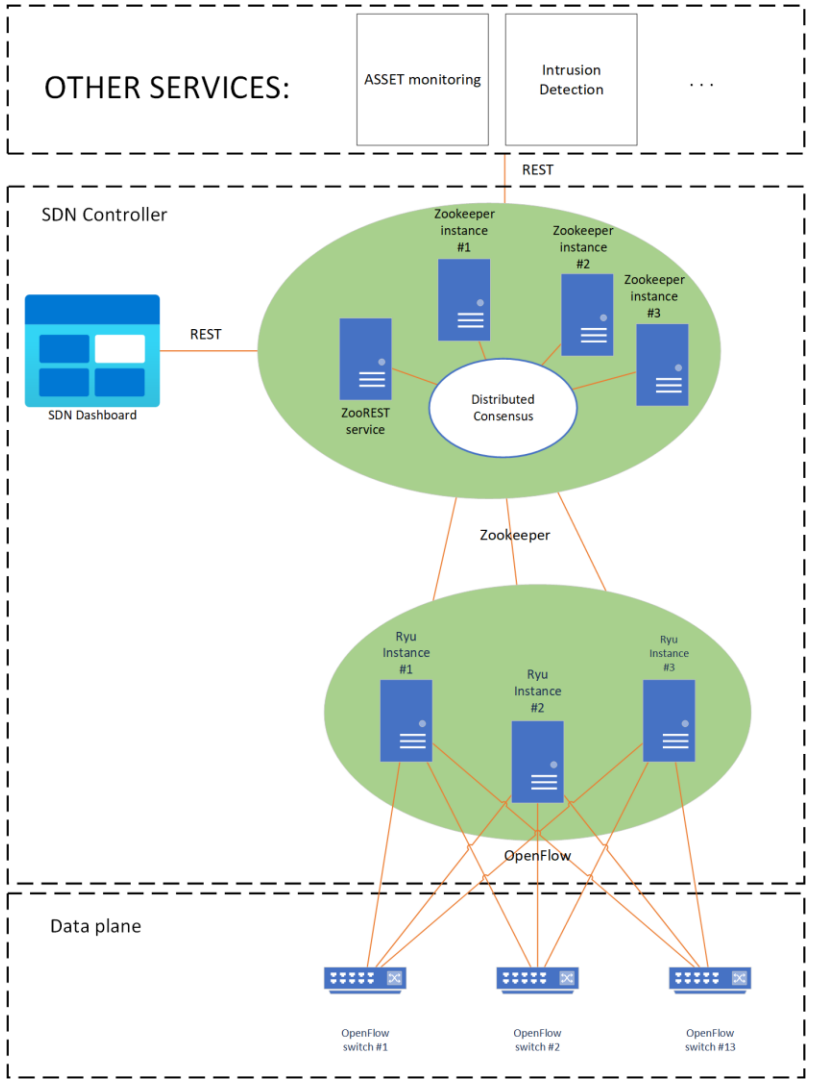
Proposed System Architecture: Technical details

- Ryu SDN Controller framework
  - ✓ Python-based
  - ✓ easy to deploy
  - ✓ REST API as Northbound Interface
  - ✓ Multiple Southbound Interfaces (incl. OpenFlow)



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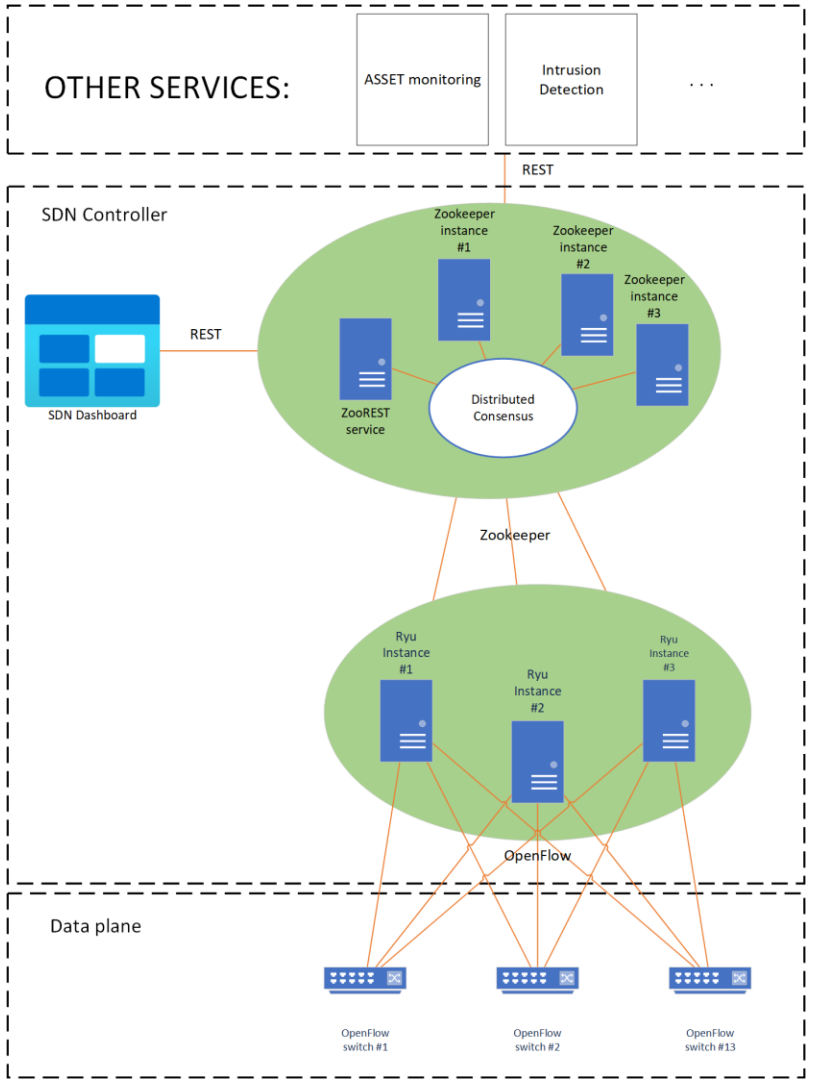
Proposed System Architecture: Technical details

- Apache Zookeeper as the SCS
  - ✓ provides distributes service coordination
  - ✓ exposes a simple REST API for other services
  - ✓ offers a master election process



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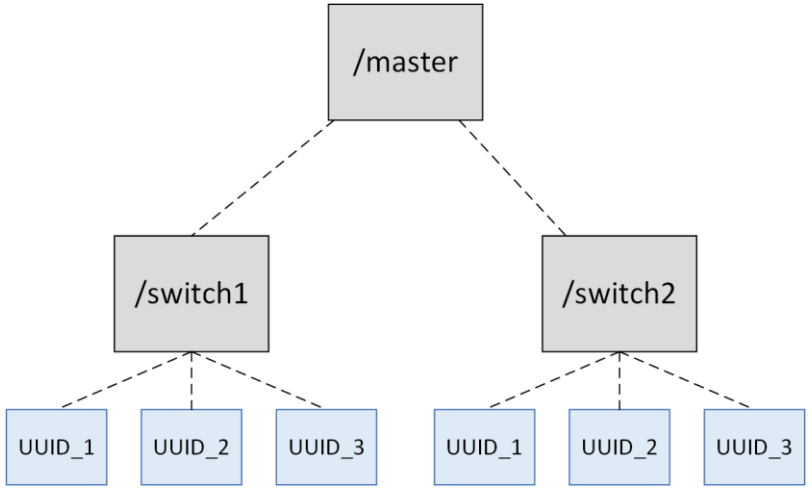
Master controller election process

✓Based on Zookeeper Election Process.

1. An SDNC registers a switch as a node (if not registered already)
2. The SDNC registers itself (UUID) as an ephemeral Zookeeper node (znode).
   1. The node obtains a unique ID
   2. The node is bound to the connection state
3. The znode with the lowest UUID value is elected as master



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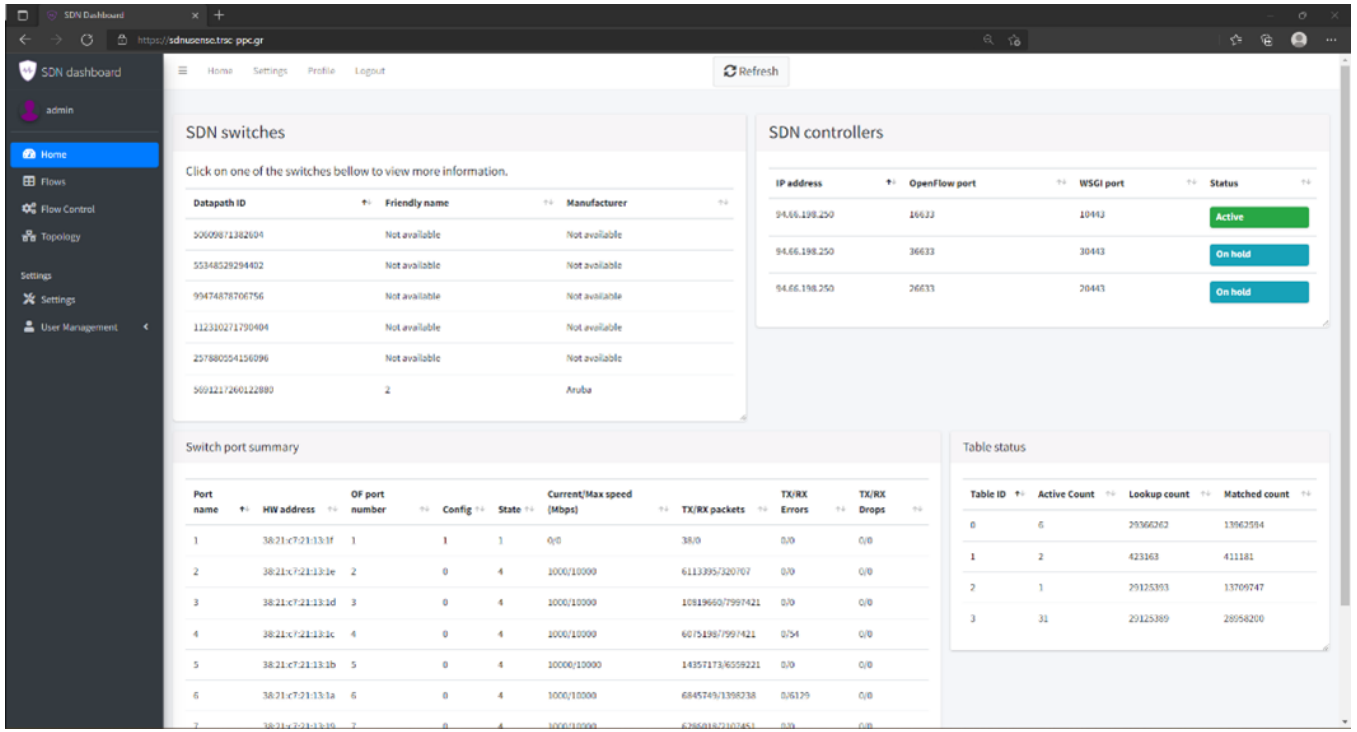
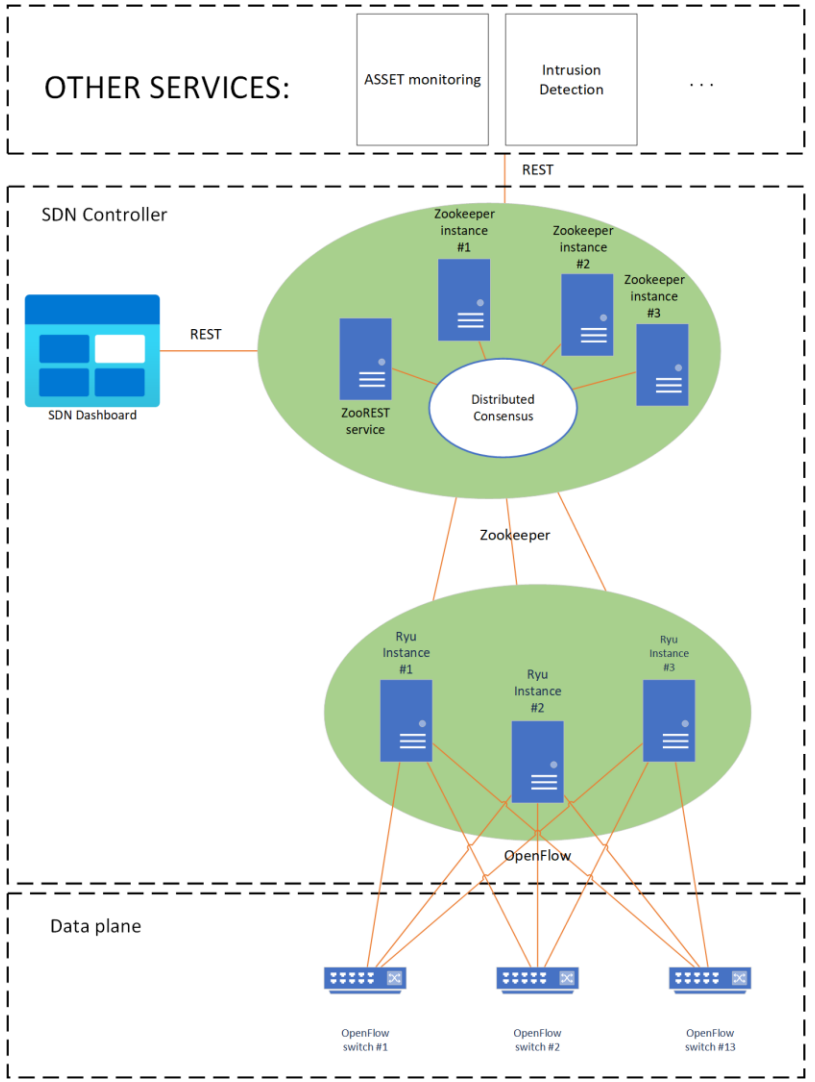
Proposed System Architecture: Technical details

- SDN Dashboard
  - ✓Django-based application
  - ✓Offer the administrator a visual-based interface for monitoring/control





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SDN-based Applications

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SDN-based Applications: SDN-enabled Devices

- Plethora of devices are hard to integrate
  - Security concerns
  - Peculiar behaviour regarding the network

- SDN-based infrastructure can:
  - ✓Assist the organization integrate these devices
  - ✓Enforce strict security policies
  - ✓Monitor the devices

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SDN-based Applications: Risk Assessment

- Estimating the risk of a device can become a complex task
- Timely detection and mitigation of malicious actions is important for many use cases

- SDN technology can:
  - ✓Offer fine-grained statistics
  - ✓Provide details on communication behaviour of hosts
  - ✓Enrich risk evaluation processes with data plane measurements

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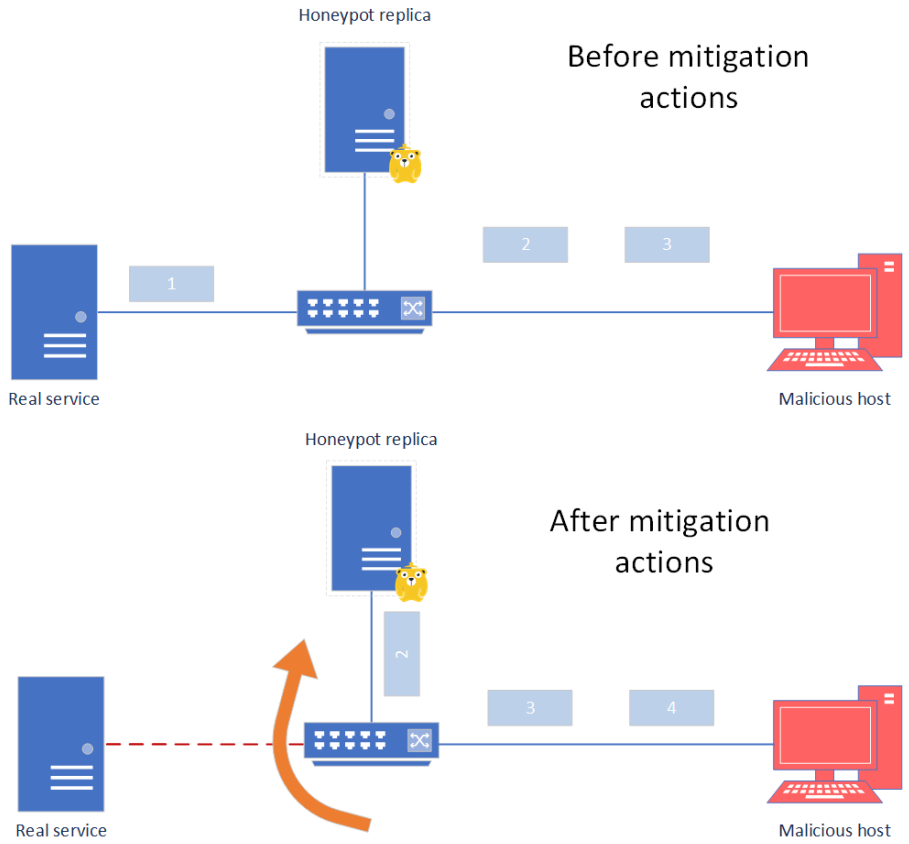
SDN-based Applications: SDN-based Honeypots

- What are Honeypots?
  - Software instances that emulate the behaviour of real assets/services
  - Based on their level of interaction: low, medium high
  - Based on their operation field: production, research
  - Based on their locations: server, client, hybrid



- Taking advantage of SDN honeypots can:
  - ✓Blend honeypot instances in production environments
  - ✓Redirect malicious actors to honeynets
  - ✓Ensure minimal network disruptions

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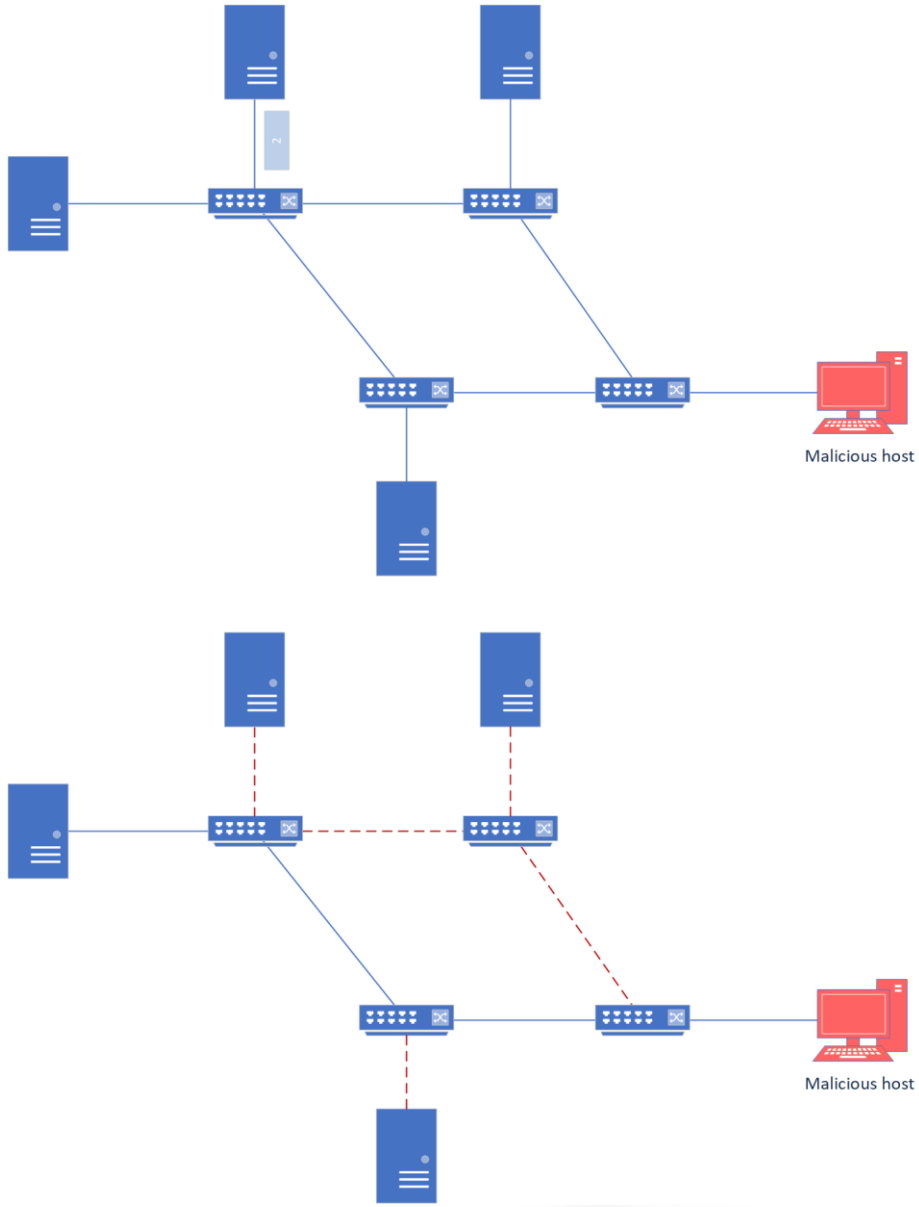
SDN-based Applications: Host isolation

- Malicious actions can lead to large disruptions
- Sensitive data leakage.

- Taking advantage of SDN an organization can:
  - ✓ deny communication access to specific hosts
  - ✓Isolate suspiciously behaving hosts
  - ✓Create levels of isolation



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SDN-based Applications: High Precision QoS

- Many application enforce strict QoS
- Delivery of content must be ensured

- Leveraging SDN organisations can:
  - ✓Closely monitor network state
  - ✓Retrieve fine grained, real-time statistics
  - ✓Timely reroute traffic

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Conclusion

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Conlusion

- SDN technology can assist other decision-making processing
- Enforce policies in a flexible manner
- Better utilize the underlying networking infrastructure

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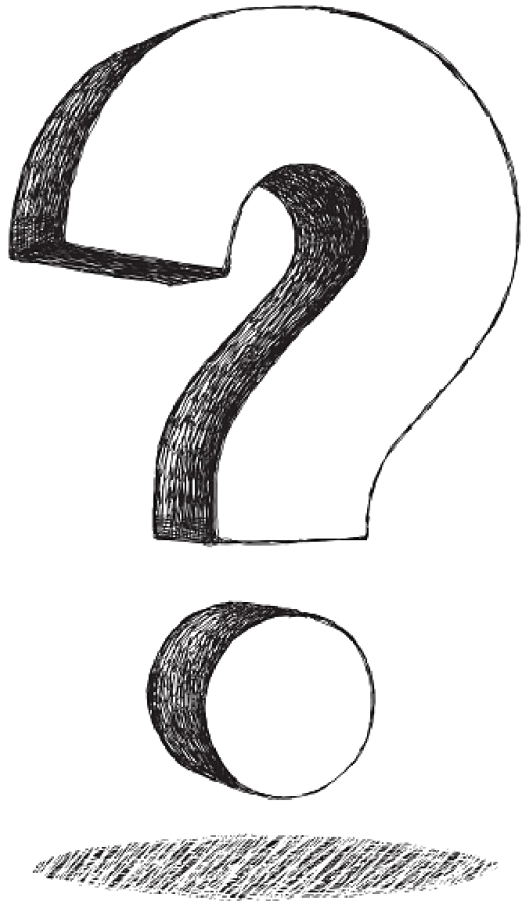
Thank you!



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