Conflict Resolution in SDN: Over-viewing Approaches and ONOS Intent Framework Usage on a Study Case

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Intelligent Networks, PPGCC, ICEx, UFMG

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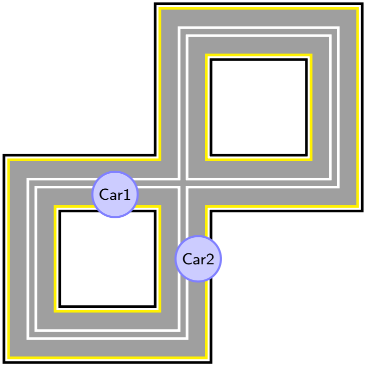
What is Conflict? How to Model? How to Resolve?



Two Cars need to use the same crossroad.

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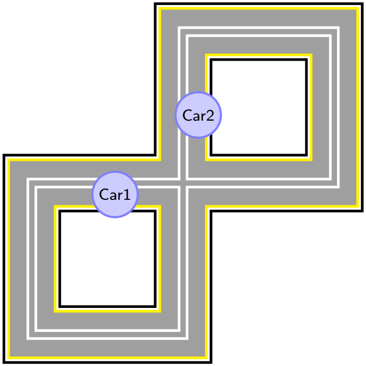

Who is on the right should go first.

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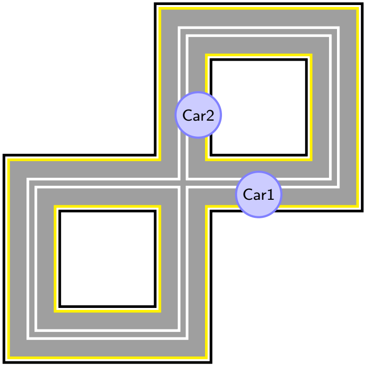

A simple rule ends the conflict.

Conflict Resolution in SDN

RESERVE *n*

App1 wants RESERVE 10 and App2 asks for RESERVE 30.

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WAYPOINT / AVOID

App1 intends to WAYPOINT *IP* and App2 desires AVOID the same *IP*.

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DENY/ALLOW

App1 may wish to DENY traffic to TCP port 80, while another App2 may require such traffic be ALLOWed.

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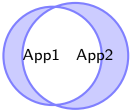

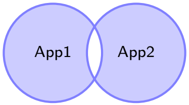

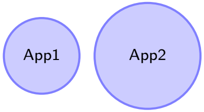

Two Apps overlap when the intersection of their respective demands is not empty, i.e., there are some flows that match both.

Over-viewing Approaches

PANE [FGL+13]

Provides a way for the network to solicit and react to such conflict needs automatically, dynamically, and at a finer timescale than with human input.
Participatory Networking, **Policy Atoms**, **Policy Tree**

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ONOS - Intent Framework [OnL14]

is a subsystem that allows applications to specify their network control desires in form of policy rather than mechanism.
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PGA [PLT+15]

Network policies to be expressed simply and independently, and leverage the graph structure to detect and resolve policy conflicts efficiently.
Policy Graph Abstraction, **Conflict-free Composed Chains**

Intent Framework Based on [OnL14]

- Policy rather than Mechanism

[1] actionable operations on the network environment

[2] such as tunnel links being provisioned, flow rules being installed on a switch, or optical lambdas (wavelengths) being reserved

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- Intents can be added dynamically at run-time

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Immutable model object that describes an application's request to the ONOS core to alter the network's behavior.

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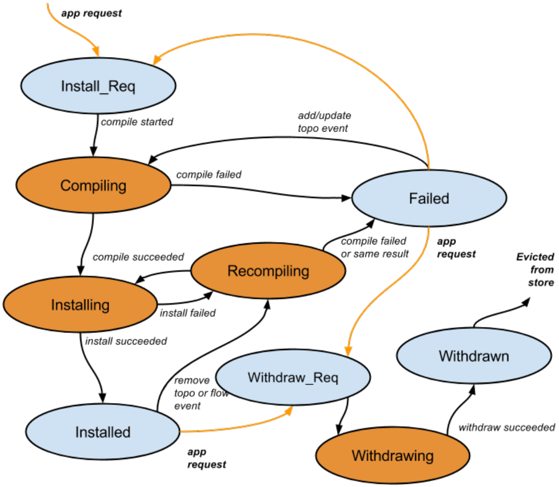
Identification

Identified by both the **ApplicationId** of the application that submitted it, and a unique **IntentId**, generated at creation.

Intent States Based on [OnL14]



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- Intent States: Submission [3] $\rightarrow$ Compiling $\rightarrow$ Installing $\rightarrow$ Installed

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  - Impact the viability of a successfully compiled and installed intent
    Loss of throughput or connectivity

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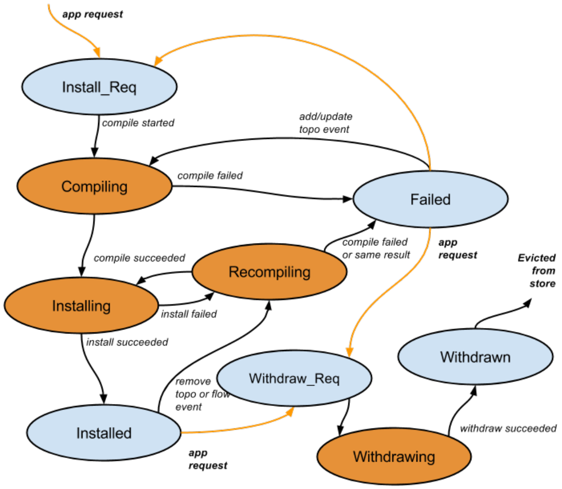
Intent Compilation Based on [OnL14]



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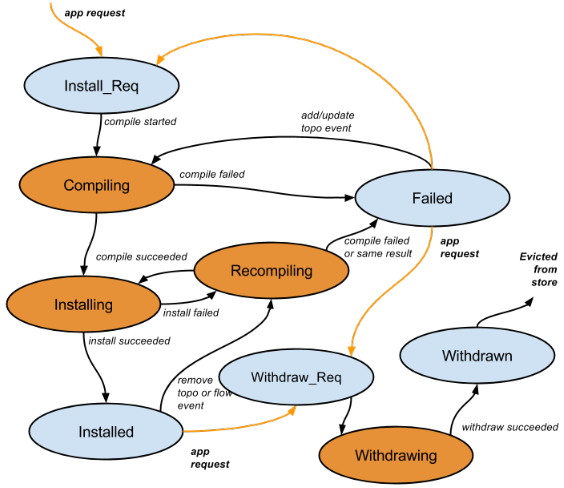

- States depicted in orange are transitional (brief amount of time)
- The rest of the states are parking states (more time is spent there)

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Intents are ultimately compiled down into a set of **FlowRule** model objects.

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The **IntentManager** coordinates the compilation and installation of **FlowRules** by managing the invocation of available **IntentCompilers** and **IntentInstallers**

Intent FlowRule Installation Based on [OnL14]

FlowRuleBatchOperations are handed off to the **FlowRuleManager** to be written down as protocol-specific messages.

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In the case of *OpenFlow*, the *OpenFlowRuleProvider* is responsible for generating *OFFlowMod* messages from **FlowRules**, and sending it to the appropriate network switch.

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In the case of *OpenFlow*, the *OpenFlowRuleProvider* is responsible for generating *OFFlowMod* messages from **FlowRules**, and sending it to the appropriate network switch.

It relies on the *OpenFlow* subsystem for its message factories and *OpenFlowSwitch* references for this task.

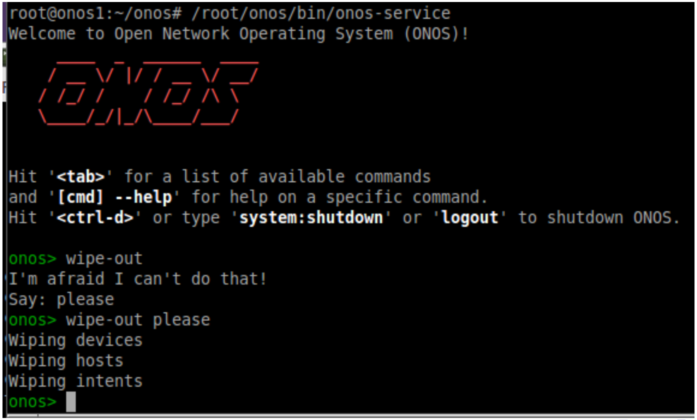
ONOS Intent Hands On

onos

Open Network Operating System

ONOS Intent Hands On Based On [Mar15]

$ docker run -td -p 8181:8181 -p 6633:6633 -h onos1 –name onos1 heitormotta/sci-onos:run
$ docker exec -ti onos1 bash
# ./bin/onos-service
onos>



```
root@onos1:~/onos# /root/onos/bin/onos-service
Welcome to Open Network Operating System (ONOS)!

Hit '<tab>' for a list of available commands
and '[cmd] --help' for help on a specific command.
Hit '<ctrl-d>' or type 'system:shutdown' or 'logout' to shutdown ONOS.

onos> wipe-out
I'm afraid I can't do that!
Say: please
onos> wipe-out please
Wiping devices
Wiping hosts
Wiping intents
onos>
```

ONOS Intent Hands On Based On [Mar15]

first contact

onos> app activate org.onosproject.drivers (to be possible access http://localhost:8181/onos/ui/index.html)

mininet topology

$ sudo mn –topo tree,2 –controller remote,$(ipdocker onos1),6633 –mac

mininet> pingall (no connectivity)

openflow and proxyarp

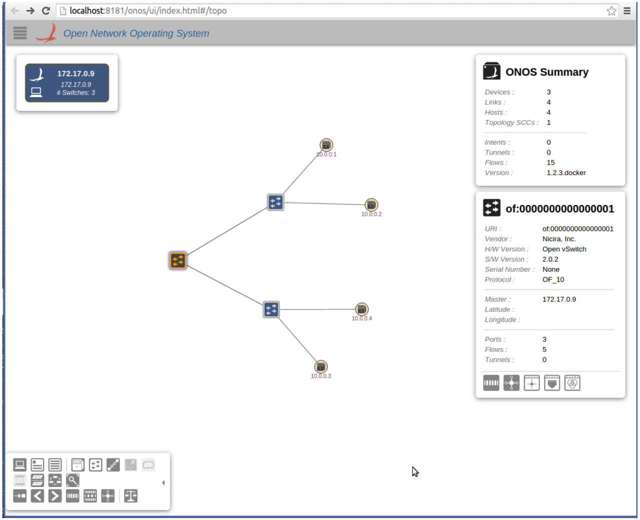
onos> app activate org.onosproject.openflow (to recognize devices)

onos> app activate org.onosproject.fwd

mininet

mininet> pingall (ok)
mininet> h1 ping h2

ONOS Intent Hands On Based On [Mar15]


localhost:8181/onos/ui/index.html#/topo
Open Network Operating System
10.0.0.1
10.0.0.2
10.0.0.3
10.0.0.4

172.17.0.9
172.17.0.9
Switches: 3

ONOS Summary

Devices :	3
Links :	4
Hosts :	4
Topology SCCs :	1
Intents :	0
Tunnels :	0
Flows :	15
Version :	1.2.3.docker

of:0000000000000001

URI :	of:0000000000000001
Vendor :	Nicira, Inc.
H/W Version :	Open vSwitch
S/W Version :	2.0.2
Serial Number :	None
Protocol :	OF_10
Master :	172.17.0.9
Latitude :	
Longitude :	
Ports :	3
Flows :	5
Tunnels :	0

ONOS Intent Hands On Based On [Mar15]

simple-switchl2-app

$ onos-app $(ipdocker onos1) install target/switchl2-app-1.0-SNAPSHOT.oar

onos> app deactivate org.onosproject.fwd (ping stop to work)

onos> app activate simple.switchl2.app (ping work again)

intent-switch-app

onos> app deactivate simple.switchl2.app (ping stop to work)

$ onos-app $(ipdocker onos1) reinstall! target/intent-switch-app-1.3.0-SNAPSHOT.oar

(ping work again)

proactive-firewall-app

$ onos-app $(ipdocker onos1) reinstall! target/proactive-firewall-1.0-SNAPSHOT.oar

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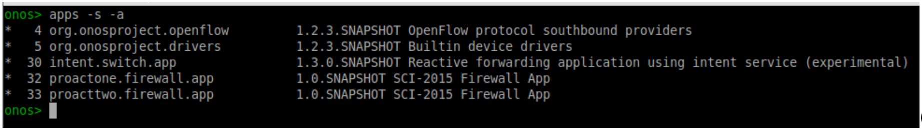

```
onos> apps -s -a
*   4 org.onosproject.openflow        1.2.3.SNAPSHOT OpenFlow protocol southbound providers
*   5 org.onosproject.drivers         1.2.3.SNAPSHOT Builtin device drivers
*  30 intent.switch.app               1.3.0.SNAPSHOT Reactive forwarding application using intent service (experimental)
*  32 proactone.firewall.app          1.0.SNAPSHOT SCI-2015 Firewall App
*  33 proacttwo.firewall.app          1.0.SNAPSHOT SCI-2015 Firewall App
onos>
```

Cl

proactive-firewall in proactone-firewall and proacttwo-firewall

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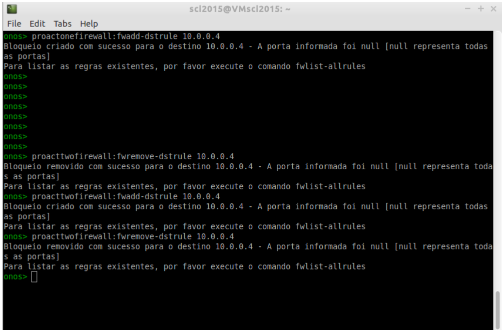

```
onos> proactonefirewall:fwadd-dstrule 10.0.0.4
Bloqueio criado com sucesso para o destino 10.0.0.4 - A porta informada foi null [null representa todas
as portas]
Para listar as regras existentes, por favor execute o comando fwlist-allrules
onos>
onos>
onos>
onos>
onos>
onos>
onos>
onos>
onos> proacttwofirewall:fwremove-dstrule 10.0.0.4
Bloqueio removido com sucesso para o destino 10.0.0.4 - A porta informada foi null [null representa toda
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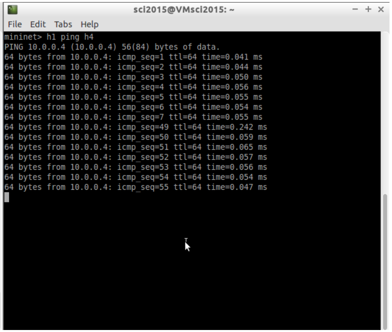

```
mininet> h1 ping h4
PING 10.0.0.4 (10.0.0.4) 56(84) bytes of data.
64 bytes from 10.0.0.4: icmp_seq=1 ttl=64 time=0.041 ms
64 bytes from 10.0.0.4: icmp_seq=2 ttl=64 time=0.044 ms
64 bytes from 10.0.0.4: icmp_seq=3 ttl=64 time=0.050 ms
64 bytes from 10.0.0.4: icmp_seq=4 ttl=64 time=0.056 ms
64 bytes from 10.0.0.4: icmp_seq=5 ttl=64 time=0.055 ms
64 bytes from 10.0.0.4: icmp_seq=6 ttl=64 time=0.054 ms
64 bytes from 10.0.0.4: icmp_seq=7 ttl=64 time=0.055 ms
64 bytes from 10.0.0.4: icmp_seq=49 ttl=64 time=0.242 ms
64 bytes from 10.0.0.4: icmp_seq=50 ttl=64 time=0.059 ms
64 bytes from 10.0.0.4: icmp_seq=51 ttl=64 time=0.065 ms
64 bytes from 10.0.0.4: icmp_seq=52 ttl=64 time=0.057 ms
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64 bytes from 10.0.0.4: icmp_seq=54 ttl=64 time=0.054 ms
64 bytes from 10.0.0.4: icmp_seq=55 ttl=64 time=0.047 ms
```

proactonefirewall:fwadd-dstrule 10.0.0.4
proacttwofirewall:fwremove-dstrule 10.0.0.4 (fail)
proacttwofirewall:fwadd-dstrule 10.0.0.4
proacttwofirewall:fwremove-dstrule 10.0.0.4 (ok for few pings)

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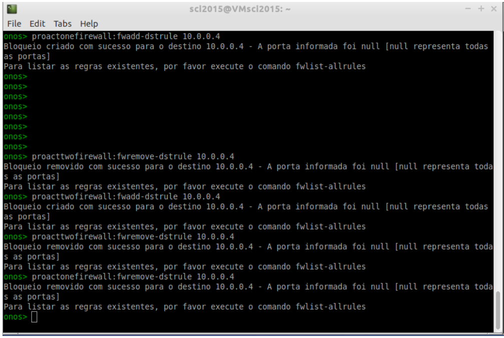

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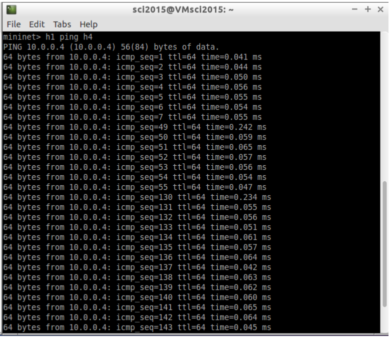

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64 bytes from 10.0.0.4: icmp_seq=5 ttl=64 time=0.055 ms
64 bytes from 10.0.0.4: icmp_seq=6 ttl=64 time=0.054 ms
64 bytes from 10.0.0.4: icmp_seq=7 ttl=64 time=0.055 ms
64 bytes from 10.0.0.4: icmp_seq=49 ttl=64 time=0.242 ms
64 bytes from 10.0.0.4: icmp_seq=50 ttl=64 time=0.059 ms
64 bytes from 10.0.0.4: icmp_seq=51 ttl=64 time=0.065 ms
64 bytes from 10.0.0.4: icmp_seq=52 ttl=64 time=0.057 ms
64 bytes from 10.0.0.4: icmp_seq=53 ttl=64 time=0.056 ms
64 bytes from 10.0.0.4: icmp_seq=54 ttl=64 time=0.054 ms
64 bytes from 10.0.0.4: icmp_seq=55 ttl=64 time=0.047 ms
64 bytes from 10.0.0.4: icmp_seq=130 ttl=64 time=0.234 ms
64 bytes from 10.0.0.4: icmp_seq=131 ttl=64 time=0.055 ms
64 bytes from 10.0.0.4: icmp_seq=132 ttl=64 time=0.056 ms
64 bytes from 10.0.0.4: icmp_seq=133 ttl=64 time=0.051 ms
64 bytes from 10.0.0.4: icmp_seq=134 ttl=64 time=0.061 ms
64 bytes from 10.0.0.4: icmp_seq=135 ttl=64 time=0.057 ms
64 bytes from 10.0.0.4: icmp_seq=136 ttl=64 time=0.064 ms
64 bytes from 10.0.0.4: icmp_seq=137 ttl=64 time=0.042 ms
64 bytes from 10.0.0.4: icmp_seq=138 ttl=64 time=0.063 ms
64 bytes from 10.0.0.4: icmp_seq=139 ttl=64 time=0.062 ms
64 bytes from 10.0.0.4: icmp_seq=140 ttl=64 time=0.060 ms
64 bytes from 10.0.0.4: icmp_seq=141 ttl=64 time=0.065 ms
64 bytes from 10.0.0.4: icmp_seq=142 ttl=64 time=0.064 ms
64 bytes from 10.0.0.4: icmp_seq=143 ttl=64 time=0.045 ms
```

proactonefirewall:fwremove-dstrule 10.0.0.4 (ok)

Conflict Resolution in SDN

- Over-view: Three Approaches

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- Study Case: ONOS Intent SwitchL2

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  - Problems → Protocols [MMKJA14]

Thanks! Questions?

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