SDN Fundamentals & Techniques

Chapter 5 - Demo 3 - Using ONOS RESTful API to filter, mirror, and forward networking traffic based on ONOS's Intents framework

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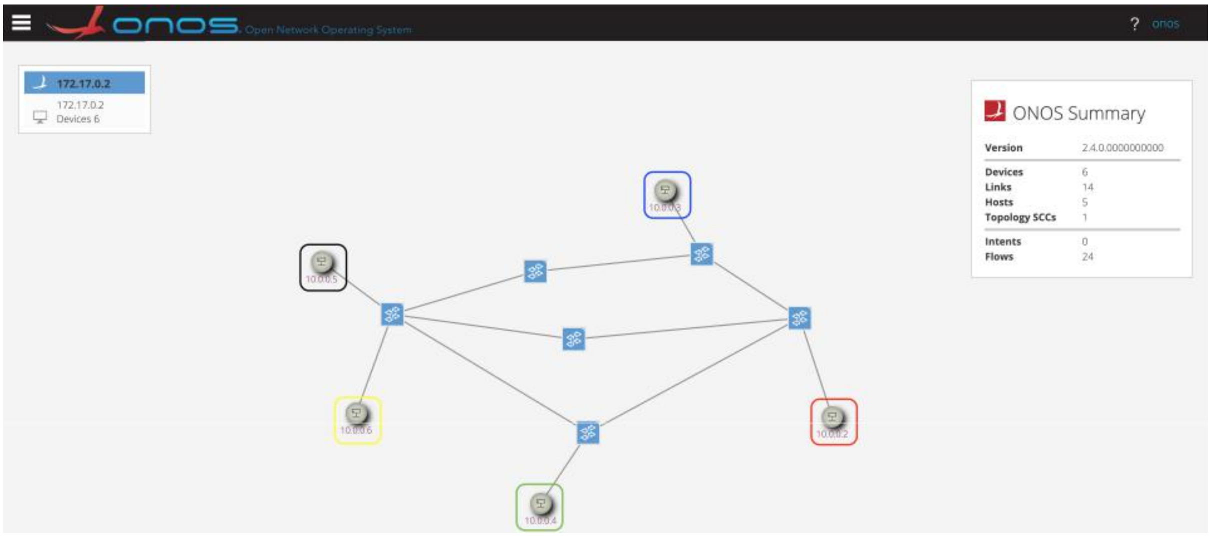
1. TASK



ONOS Summary

Version	2.4.0.0000000000
Devices	6
Links	14
Hosts	5
Topology SCCs	1
Intents	0
Flows	24

1.1 Create a series of point-to-point Intents, using Python-based codes and ONOS RESTful API, to allow communication between the “RED" network namespace and the “BLACK" network namespace.

Code

```
#!/usr/bin/env python3
"""
# ID for br-1 is "of:00000e3378f32342" and port "4" is connected with red
# curl -u onos:rocks -X POST --header "Content-Type: application/json" --header
"Accept: application/json" -d '{"type": "PointToPointIntent", "appId":
"org.onosproject.cli", "priority": 100, "ingressPoint": {"device":
"of:00000e3378f32342", "port": "4"}, "egressPoint": {"device":
"of:0000fef25cfa7740", "port": "3"}}' http://100.109.0.1:8181/onos/v1/intents
# ID for br-3 is "of:0000fef25cfa7740" and port "3" is connected with blue
# curl -u onos:rocks -X POST --header "Content-Type: application/json" --header
"Accept: application/json" -d '{"type": "PointToPointIntent", "appId":
"org.onosproject.cli", "priority": 100, "ingressPoint": {"device":
"of:0000fef25cfa7740", "port": "3"}, "egressPoint": {"device":
"of:00000e3378f32342", "port": "4"}}' http://100.109.0.1:8181/onos/v1/intents
"""
import requests, json
from requests.auth import HTTPBasicAuth

if __name__ == "__main__":
   headers = {"Content-type": "application/json", "Accept": "application/json"}
   rule0 = {"type": "PointToPointIntent", "appId": "org.onosproject.cli",
"priority": 100, "ingressPoint": {"device": "of:00000e3378f32342", "port": "4"},
"egressPoint": {"device": "of:0000fef25cfa7740", "port": "3"}}
```

```
   rule1 = {"type": "PointToPointIntent", "appId": "org.onosproject.cli",
"priority": 100, "ingressPoint": {"device": "of:0000fef25cfa7740", "port": "3"},
"egressPoint": {"device": "of:00000e3378f32342", "port": "4"}}
   res0 = requests.post("http://100.109.0.1:8181/onos/v1/intents",
json.dumps(rule0), headers = headers, auth = HTTPBasicAuth('onos', 'rocks'))
   res1 = requests.post("http://100.109.0.1:8181/onos/v1/intents",
json.dumps(rule1), headers = headers, auth = HTTPBasicAuth('onos', 'rocks'))
```

Result

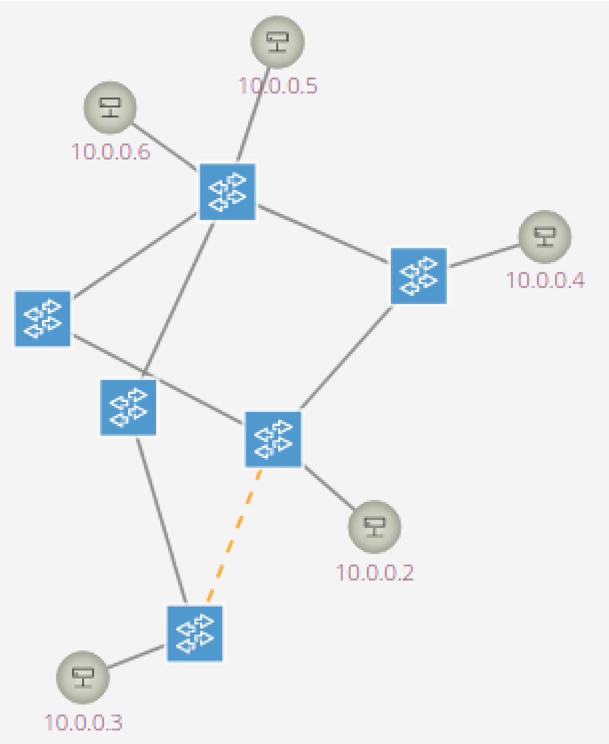
```
# curl -u onos:rocks -X GET http://100.109.0.1:8181/onos/v1/intents/
{"intents":[]}

# python task11.py

# curl -u onos:rocks -X GET http://100.109.0.1:8181/onos/v1/intents/
{"intents":[{"type":"PointToPointIntent","id":"0xd","key":"0xd","appId":"org.onospr
oject.cli","resources":[],"state":"INSTALLED"},{"type":"PointToPointIntent","id":"0
xc","key":"0xc","appId":"org.onosproject.cli","resources":[],"state":"INSTALLED"}]}

# curl -u onos:rocks -X GET
http://100.109.0.1:8181/onos/v1/intents/org.onosproject.cli/12
{"type":"PointToPointIntent","id":"0xc","key":"0xc","appId":"org.onosproject.cli","
resources":[],"state":"INSTALLED","selector":{"criteria":[]},"treatment":{"instruct
ions":[{"type":"NOACTION"}],"deferred":[]},"priority":100,"constraints":[],"ingress
Point":{"port":"4","device":"of:00000e3378f32342"},"egressPoint":{"port":"3","devic
e":"of:0000fef25cfa7740"}}root@elxa9698s73:/home/ejinyna/Desktop/SDN/chapter5_demo3
_scripts#

# curl -u onos:rocks -X GET
http://100.109.0.1:8181/onos/v1/intents/org.onosproject.cli/13
{"type":"PointToPointIntent","id":"0xd","key":"0xd","appId":"org.onosproject.cli","
resources":[],"state":"INSTALLED","selector":{"criteria":[]},"treatment":{"instruct
ions":[{"type":"NOACTION"}],"deferred":[]},"priority":100,"constraints":[],"ingress
Point":{"port":"3","device":"of:0000fef25cfa7740"},"egressPoint":{"port":"4","devic
e":"of:00000e3378f32342"}}
```



1.2 Delete all the created Intents using Python-based code and ONOS RESTful API.

Code

```
#!/usr/bin/env python3
import requests, json
from requests.auth import HTTPBasicAuth

if __name__ == "__main__":
   headers = {"Content-type": "application/json", "Accept": "application/json"}
   res0 = requests.get("http://100.109.0.1:8181/onos/v1/intents/", auth =
HTTPBasicAuth('onos', 'rocks'))
   # Get all intent rules and store in a list and print
   for index, value in enumerate(res0.json()["intents"]):
       requests.delete("http://100.109.0.1:8181/onos/v1/intents/%s/%s" %
(value["appId"], value["id"]), auth = HTTPBasicAuth('onos', 'rocks'))
```

Result

```
# curl -u onos:rocks -X GET http://100.109.0.1:8181/onos/v1/intents/
{"intents":[{"type":"PointToPointIntent","id":"0x25","key":"0x25","appId":"org.onos
project.cli","resources":[],"state":"INSTALLED"},{"type":"PointToPointIntent","id":
"0x24","key":"0x24","appId":"org.onosproject.cli","resources":[],"state":"INSTALLED
"}]}

# python task12.py

# curl -u onos:rocks -X GET http://100.109.0.1:8181/onos/v1/intents/
{"intents":[]}
```

1.3 Create a Host-to-Host Intent to allow communication between the “RED" network namespace and the “BLACK" network namespace.

Code

```
#!/usr/bin/env python3
"""
# red: 42:d9:7b:37:82:81; blue: f2:3d:13:6d:df:13
# curl -u onos:rocks -X POST --header "Content-Type: application/json" --header
"Accept: application/json" -d
'{"type":"HostToHostIntent","appId":"org.onosproject.cli","resources":["42:D9:7B:37
:82:81/None","F2:3D:13:6D:DF:13/None"],"selector":{"criteria":[]},"treatment":{"ins
tructions":[{"type":"NOACTION"}],"deferred":[]},"priority":100,"constraints":[{"inc
lusive":false,"types":["OPTICAL"],"type":"LinkTypeConstraint"}],"one":"42:D9:7B:37:
82:81/None","two":"F2:3D:13:6D:DF:13/None"}'
http://100.109.0.1:8181/onos/v1/intents
"""
import requests, json
from requests.auth import HTTPBasicAuth

if __name__ == "__main__":
   headers = {"Content-type": "application/json", "Accept": "application/json"}
   rule0 =
{"type":"HostToHostIntent","appId":"org.onosproject.cli","resources":["42:D9:7B:37:
82:81/None","F2:3D:13:6D:DF:13/None"],"selector":{"criteria":[]},"treatment":{"inst
ructions":[{"type":"NOACTION"}],"deferred":[]},"priority":100,"constraints":[{"incl
usive":"false","types":["OPTICAL"],"type":"LinkTypeConstraint"}],"one":"42:D9:7B:37
:82:81/None","two":"F2:3D:13:6D:DF:13/None"}
   res0 = requests.post("http://100.109.0.1:8181/onos/v1/intents",
json.dumps(rule0), headers = headers, auth = HTTPBasicAuth('onos', 'rocks'))
```

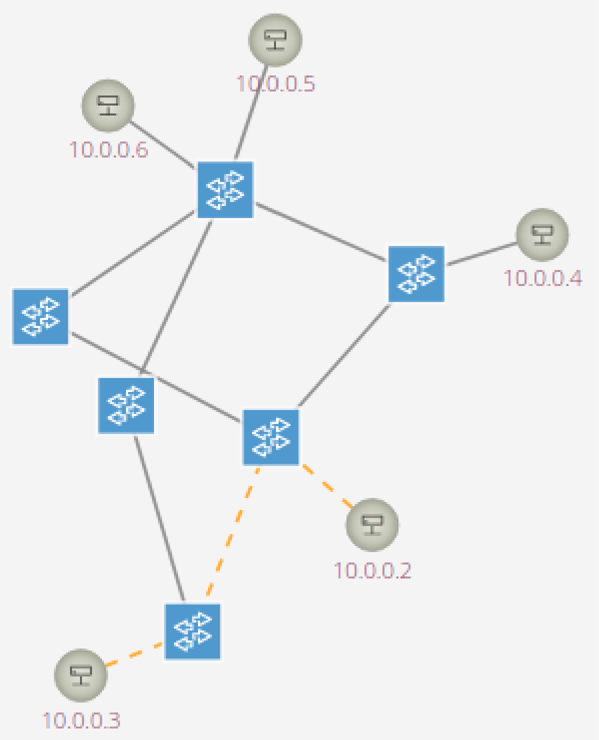
Result

```
# curl -u onos:rocks -X GET http://100.109.0.1:8181/onos/v1/intents/
{"intents":[]}

# python task13.py

# curl -u onos:rocks -X GET http://100.109.0.1:8181/onos/v1/intents/
{"intents":[{"type":"HostToHostIntent","id":"0x49","key":"0x49","appId":"org.onospr
oject.cli","resources":["42:D9:7B:37:82:81/None","F2:3D:13:6D:DF:13/None"],"state":
"INSTALLED"}]}

# curl -u onos:rocks -X GET
http://100.109.0.1:8181/onos/v1/intents/org.onosproject.cli/0x49
{"type":"HostToHostIntent","id":"0x49","key":"0x49","appId":"org.onosproject.cli","
resources":["42:D9:7B:37:82:81/None","F2:3D:13:6D:DF:13/None"],"state":"INSTALLED",
"selector":{"criteria":[]},"treatment":{"instructions":[{"type":"NOACTION"}],"defer
red":[]},"priority":100,"constraints":[{"inclusive":false,"types":["OPTICAL"],"type
":"LinkTypeConstraint"}],"one":"42:D9:7B:37:82:81/None","two":"F2:3D:13:6D:DF:13/No
ne"}
```



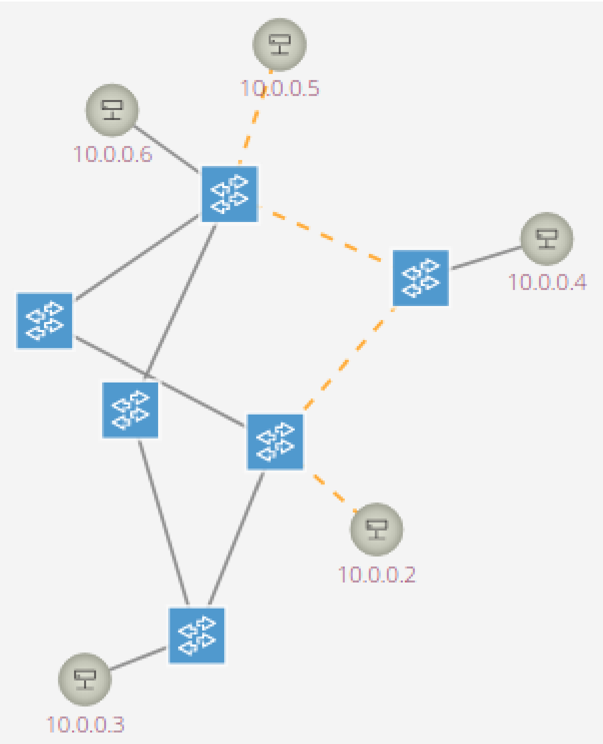
1.4 Is the Host-to-Host Intent an abstraction of the Point-to-Point Intents? Your answer must be provided with explanations.

No.
As far as I can see from task 1.1 and task 1.3, Point-to-Point intent rule is created in Task 1.1, which mainly operates the ports of OVS switches and connects the OVS

switches, Host-to-Host intent rule is created in Task 1.3, which mainly operates the hosts and connects the hosts.

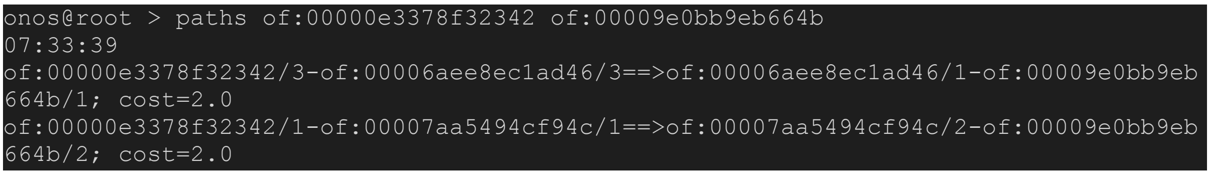
1.5 What path is selected by the Host-to-Host Intent for enabling the communication between the “RED" network namespace and the “BLACK" network namespace?

br-1(of:00000e3378f32342)->br-4(of:00006aee8ec1ad46)->br-6(of:00009e0bb9eb664b)



1.6 After specifying the path, you are asked to provide a hypothesis on how the Host-to-Host Intent selects paths.

The hypothesis on how the Host-to-Host intent selects paths is based on the distance /cost of the path, which means “shortest distance first”.
So in Task 1.5, the path could be
br-1(of:00000e3378f32342)->br-4(of:00006aee8ec1ad46)->br-6(of:00009e0bb9eb664b)
Also could be
br-1(of:00000e3378f32342)->br-2(of:00007aa5494cf94c)->br-6(of:00009e0bb9eb664b)



```
onos@root > paths of:00000e3378f32342 of:00009e0bb9eb664b
07:33:39
of:00000e3378f32342/3-of:00006aee8ec1ad46/3==>of:00006aee8ec1ad46/1-of:00009e0bb9eb
664b/1; cost=2.0
of:00000e3378f32342/1-of:00007aa5494cf94c/1==>of:00007aa5494cf94c/2-of:00009e0bb9eb
664b/2; cost=2.0
```

1.7 Using Host-to-Host Intents, enable the communication between all network namespaces in the topology.

Code

```
#!/usr/bin/env python3
"""
# red: 42:d9:7b:37:82:81; blue: f2:3d:13:6d:df:13; green: 72:24:6c:5d:17:b2;
yellow: aa:df:25:c8:92:49; black: 2e:b9:5b:d4:52:eb
"""
import requests, json
from requests.auth import HTTPBasicAuth

if __name__ == "__main__":
   headers = {"Content-type": "application/json", "Accept": "application/json"}
   red_blue =
{"type":"HostToHostIntent","appId":"org.onosproject.cli","resources":["42:D9:7B:37:
82:81/None","F2:3D:13:6D:DF:13/None"],"selector":{"criteria":[]},"treatment":{"inst
ructions":[{"type":"NOACTION"}],"deferred":[]},"priority":100,"constraints":[{"incl
usive":"false","types":["OPTICAL"],"type":"LinkTypeConstraint"}],"one":"42:D9:7B:37
:82:81/None","two":"F2:3D:13:6D:DF:13/None"}
   red_blue_res = requests.post("http://100.109.0.1:8181/onos/v1/intents",
json.dumps(red_blue), headers = headers, auth = HTTPBasicAuth('onos', 'rocks'))
   red_green =
{"type":"HostToHostIntent","appId":"org.onosproject.cli","resources":["42:D9:7B:37:
82:81/None","72:24:6C:5D:17:B2/None"],"selector":{"criteria":[]},"treatment":{"inst
ructions":[{"type":"NOACTION"}],"deferred":[]},"priority":100,"constraints":[{"incl
usive":"false","types":["OPTICAL"],"type":"LinkTypeConstraint"}],"one":"42:D9:7B:37
:82:81/None","two":"72:24:6C:5D:17:B2/None"}
   red_green_res = requests.post("http://100.109.0.1:8181/onos/v1/intents",
json.dumps(red_green), headers = headers, auth = HTTPBasicAuth('onos', 'rocks'))
   red_yellow =
{"type":"HostToHostIntent","appId":"org.onosproject.cli","resources":["42:D9:7B:37:
82:81/None","AA:DF:25:C8:92:49/None"],"selector":{"criteria":[]},"treatment":{"inst
ructions":[{"type":"NOACTION"}],"deferred":[]},"priority":100,"constraints":[{"incl
usive":"false","types":["OPTICAL"],"type":"LinkTypeConstraint"}],"one":"42:D9:7B:37
:82:81/None","two":"AA:DF:25:C8:92:49/None"}
   red_yellow_res = requests.post("http://100.109.0.1:8181/onos/v1/intents",
json.dumps(red_yellow), headers = headers, auth = HTTPBasicAuth('onos', 'rocks'))
   red_black =
{"type":"HostToHostIntent","appId":"org.onosproject.cli","resources":["2E:B9:5B:D4:
52:EB/None","42:D9:7B:37:82:81/None"],"selector":{"criteria":[]},"treatment":{"inst
ructions":[{"type":"NOACTION"}],"deferred":[]},"priority":100,"constraints":[{"incl
usive":"false","types":["OPTICAL"],"type":"LinkTypeConstraint"}],"one":"2E:B9:5B:D4
:52:EB/None","two":"42:D9:7B:37:82:81/None"}
   red_black_res = requests.post("http://100.109.0.1:8181/onos/v1/intents",
json.dumps(red_black), headers = headers, auth = HTTPBasicAuth('onos', 'rocks'))
   blue_green =
{"type":"HostToHostIntent","appId":"org.onosproject.cli","resources":["72:24:6C:5D:
17:B2/None","F2:3D:13:6D:DF:13/None"],"selector":{"criteria":[]},"treatment":{"inst
ructions":[{"type":"NOACTION"}],"deferred":[]},"priority":100,"constraints":[{"incl
usive":"false","types":["OPTICAL"],"type":"LinkTypeConstraint"}],"one":"72:24:6C:5D
:17:B2/None","two":"F2:3D:13:6D:DF:13/None"}
   blue_green_res = requests.post("http://100.109.0.1:8181/onos/v1/intents",
json.dumps(blue_green), headers = headers, auth = HTTPBasicAuth('onos', 'rocks'))
   blue_yellow =
{"type":"HostToHostIntent","appId":"org.onosproject.cli","resources":["AA:DF:25:C8:
92:49/None","F2:3D:13:6D:DF:13/None"],"selector":{"criteria":[]},"treatment":{"inst
ructions":[{"type":"NOACTION"}],"deferred":[]},"priority":100,"constraints":[{"incl
usive":"false","types":["OPTICAL"],"type":"LinkTypeConstraint"}],"one":"AA:DF:25:C8
:92:49/None","two":"F2:3D:13:6D:DF:13/None"}
   blue_yellow_res = requests.post("http://100.109.0.1:8181/onos/v1/intents",
json.dumps(blue_yellow), headers = headers, auth = HTTPBasicAuth('onos', 'rocks'))
   blue_black =
{"type":"HostToHostIntent","appId":"org.onosproject.cli","resources":["2E:B9:5B:D4:
```

```
52:EB/None","F2:3D:13:6D:DF:13/None"],"selector":{"criteria":[]},"treatment":{"inst
ructions":[{"type":"NOACTION"}],"deferred":[]},"priority":100,"constraints":[{"incl
usive":"false","types":["OPTICAL"],"type":"LinkTypeConstraint"}],"one":"2E:B9:5B:D4
:52:EB/None","two":"F2:3D:13:6D:DF:13/None"}
   blue_black_res = requests.post("http://100.109.0.1:8181/onos/v1/intents",
json.dumps(blue_black), headers = headers, auth = HTTPBasicAuth('onos', 'rocks'))
   green_yellow =
{"type":"HostToHostIntent","appId":"org.onosproject.cli","resources":["72:24:6C:5D:
17:B2/None","AA:DF:25:C8:92:49/None"],"selector":{"criteria":[]},"treatment":{"inst
ructions":[{"type":"NOACTION"}],"deferred":[]},"priority":100,"constraints":[{"incl
usive":"false","types":["OPTICAL"],"type":"LinkTypeConstraint"}],"one":"72:24:6C:5D
:17:B2/None","two":"AA:DF:25:C8:92:49/None"}
   green_yellow_res = requests.post("http://100.109.0.1:8181/onos/v1/intents",
json.dumps(green_yellow), headers = headers, auth = HTTPBasicAuth('onos', 'rocks'))
   green_black =
{"type":"HostToHostIntent","appId":"org.onosproject.cli","resources":["2E:B9:5B:D4:
52:EB/None","72:24:6C:5D:17:B2/None"],"selector":{"criteria":[]},"treatment":{"inst
ructions":[{"type":"NOACTION"}],"deferred":[]},"priority":100,"constraints":[{"incl
usive":"false","types":["OPTICAL"],"type":"LinkTypeConstraint"}],"one":"2E:B9:5B:D4
:52:EB/None","two":"72:24:6C:5D:17:B2/None"}
   green_black_res = requests.post("http://100.109.0.1:8181/onos/v1/intents",
json.dumps(green_black), headers = headers, auth = HTTPBasicAuth('onos', 'rocks'))
   yellow_black =
{"type":"HostToHostIntent","appId":"org.onosproject.cli","resources":["2E:B9:5B:D4:
52:EB/None","AA:DF:25:C8:92:49/None"],"selector":{"criteria":[]},"treatment":{"inst
ructions":[{"type":"NOACTION"}],"deferred":[]},"priority":100,"constraints":[{"incl
usive":"false","types":["OPTICAL"],"type":"LinkTypeConstraint"}],"one":"2E:B9:5B:D4
:52:EB/None","two":"AA:DF:25:C8:92:49/None"}
   yellow_black_res = requests.post("http://100.109.0.1:8181/onos/v1/intents",
json.dumps(yellow_black), headers = headers, auth = HTTPBasicAuth('onos', 'rocks'))
```

Result

```
# python task17.py

# curl -u onos:rocks -X GET http://100.109.0.1:8181/onos/v1/intents/
{"intents":[{"type":"HostToHostIntent","id":"0xb7","key":"0xb7","appId":"org.onospr
oject.cli","resources":["42:D9:7B:37:82:81/None","F2:3D:13:6D:DF:13/None"],"state":
"INSTALLED"},{"type":"HostToHostIntent","id":"0xbd","key":"0xbd","appId":"org.onosp
roject.cli","resources":["2E:B9:5B:D4:52:EB/None","F2:3D:13:6D:DF:13/None"],"state"
:"INSTALLED"},{"type":"HostToHostIntent","id":"0xc0","key":"0xc0","appId":"org.onos
project.cli","resources":["2E:B9:5B:D4:52:EB/None","AA:DF:25:C8:92:49/None"],"state
":"INSTALLED"},{"type":"HostToHostIntent","id":"0xbe","key":"0xbe","appId":"org.ono
sproject.cli","resources":["72:24:6C:5D:17:B2/None","AA:DF:25:C8:92:49/None"],"stat
e":"INSTALLED"},{"type":"HostToHostIntent","id":"0xbf","key":"0xbf","appId":"org.on
osproject.cli","resources":["2E:B9:5B:D4:52:EB/None","72:24:6C:5D:17:B2/None"],"sta
te":"INSTALLED"},{"type":"HostToHostIntent","id":"0xb9","key":"0xb9","appId":"org.o
nosproject.cli","resources":["42:D9:7B:37:82:81/None","AA:DF:25:C8:92:49/None"],"st
ate":"INSTALLED"},{"type":"HostToHostIntent","id":"0xbc","key":"0xbc","appId":"org.
onosproject.cli","resources":["AA:DF:25:C8:92:49/None","F2:3D:13:6D:DF:13/None"],"s
tate":"INSTALLED"},{"type":"HostToHostIntent","id":"0xbb","key":"0xbb","appId":"org
.onosproject.cli","resources":["72:24:6C:5D:17:B2/None","F2:3D:13:6D:DF:13/None"],"
state":"INSTALLED"},{"type":"HostToHostIntent","id":"0xb8","key":"0xb8","appId":"or
g.onosproject.cli","resources":["42:D9:7B:37:82:81/None","72:24:6C:5D:17:B2/None"],
"state":"INSTALLED"},{"type":"HostToHostIntent","id":"0xba","key":"0xba","appId":"o
rg.onosproject.cli","resources":["2E:B9:5B:D4:52:EB/None","42:D9:7B:37:82:81/None"]
,"state":"INSTALLED"}]}
```

1.8 Without deleting the current Intents, you are asked to create a Single-to-Multi point Intent to allow communication between the “RED" network namespace and “BLACK", “BLUE", “GREEN" network namespaces. Only communication on port 4009 should be allowed. After creating this Intent students are requested to verify using “nc" utility or any similar program.

Code

```
#!/usr/bin/env python3
"""
# red: 42:d9:7b:37:82:81; blue: f2:3d:13:6d:df:13; green: 72:24:6c:5d:17:b2;
yellow: aa:df:25:c8:92:49; black: 2e:b9:5b:d4:52:eb
{"type":"MultiPointToSinglePointIntent","id":"0x2","key":"0x2","appId":"org.onospro
ject.gui","resources":[],"state":"INSTALLED","selector":{"criteria":[{"type":"ETH_D
ST","mac":"2A:32:D4:A3:DB:A5"}]},"treatment":{"instructions":[{"type":"NOACTION"}],
"deferred":[]},"priority":100,"constraints":[],"ingressPoint":[{"port":"2","device"
:"of:00006a484895fe46"},{"port":"3","device":"of:0000def6c4216141"},{"port":"4","de
vice":"of:00006e5b1ef7624f"}],"egressPoint":{"port":"4","device":"of:00009a5d40ddc1
44"}}
"""
import requests, json
from requests.auth import HTTPBasicAuth

if __name__ == "__main__":
   headers = {"Content-type": "application/json", "Accept": "application/json"}
   rule =
{"type":"SinglePointToMultiPointIntent","appId":"org.onosproject.cli","resources":[
],"selector":{"criteria":[]},"treatment":{"instructions":[{"type":"NOACTION"}],"def
erred":[]},"priority":100,"constraints":[],
"ingressPoint":{"port":"4","device":"of:00006e5b1ef7624f"},
"egressPoint":[{"port":"3","device":"of:0000def6c4216141"},{"port":"2","device":"of
:00006a484895fe46"},{"port":"4","device":"of:00009a5d40ddc144"}]}
   res = requests.post("http://100.109.0.1:8181/onos/v1/intents", json.dumps(rule),
headers = headers, auth = HTTPBasicAuth('onos', 'rocks'))
```

Result

```
# python task18.py

# curl -u onos:rocks -X GET http://100.109.0.1:8181/onos/v1/intents/
{"intents":[{"type":"SinglePointToMultiPointIntent","id":"0xb","key":"0xb","appId":
"org.onosproject.cli","resources":[],"state":"INSTALLED"}]}

# curl -u onos:rocks -X GET
http://100.109.0.1:8181/onos/v1/intents/org.onosproject.cli/0xb
{"type":"SinglePointToMultiPointIntent","id":"0xb","key":"0xb","appId":"org.onospro
ject.cli","resources":[],"state":"INSTALLED","selector":{"criteria":[]},"treatment"
:{"instructions":[{"type":"NOACTION"}],"deferred":[]},"priority":100,"constraints":
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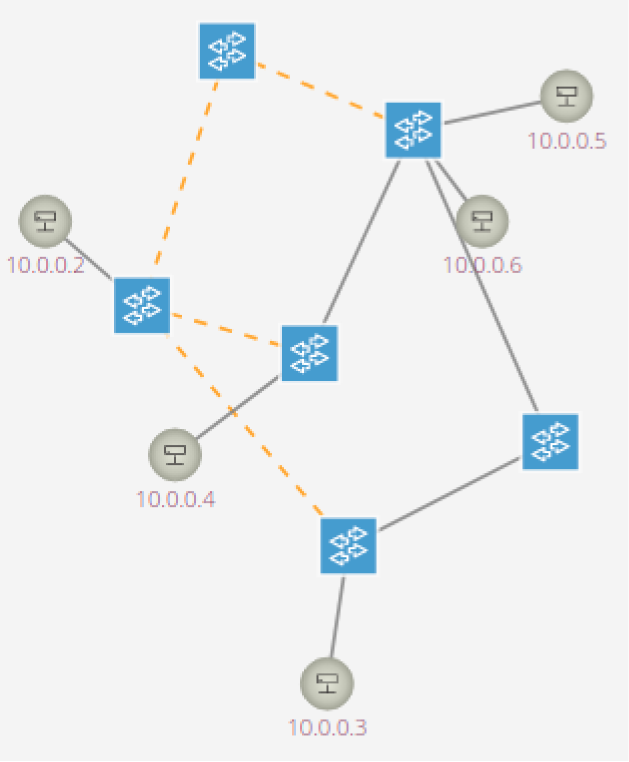

1.9 Explain the benefits brought by the use of Intent-based networking compared to Open-Flow flow rules.

With intent-based networking, the user doesn't need significant networking knowledge to describe the requirements for connectivity, which means, what the user needs to do is describe the abstracted intent of connectivity, and the intent-based networking will implement the connection details automatically.