Obj1:

1.a

```
netman@netman:~$ ssh -2 -s vivek@198.51.100.5 netconf
Password:
<?xml version="1.0" encoding="UTF-8"?><hello><capabilities><capability>urn:ietf:params:netconf:base:1.0</capability><capability>urn:ietf:params:netconf:capability:writeable-running:
1.0</capability><capability>urn:ietf:params:netconf:capability:startup:1.0</capability><capability>urn:ietf:params:netconf:capability:url:1.0</capability><capability>urn:cisco:param
s:netconf:capability:pi-data-model:1.0</capability><capability>urn:cisco:params:netconf:capability:notification:1.0</capability></capabilities><session-id>1726571564</session-id></h
ello>]]>]]>
```

Apart from SSH, which other secure transport methods are supported by NETCONF?

The Secure transport layer provides a secure and reliable control between a client and a server.

1.b

```
R1#sh netconf session
Netconf Sessions: 1 open, maximum is 10
  Remote connection via SSH by user(vivek) from 198.51.100.2:49472, state connect
  Established at *20:12:49.375 UTC Mon Mar 28 2022
         Tx 556 bytes (1 msg), Tx 0 errors,
         Last message sent at *20:12:49.379 UTC Mon Mar 28 2022
         Rx 0 bytes (0 msg), 0 empty msg
         Last message received at never
Established at *20:12:49.375 UTC Mon Mar 28 2022
Last operation at *00:00:00.000 UTC Mon Jan 1 1900
Last successful operation at *20:12:49.375 UTC Mon Mar 28 2022
Session id:1726571564
Connection waiting for transactions
```

```
R1#sh netconf counters
NETCONF Counters
Connection Attempts:0: rejected:0 no-hello:0 success:0
Transactions
         total:1, success:1, errors:0
detailed errors:
         in-use 0         invalid-value 0          too-big 0
         missing-attribute 0      bad-attribute 0          unknown-attribute 0
         missing-element 0        bad-element 0    unknown-element 0
         unknown-namespace 0      access-denied 0          lock-denied 0
         resource-denied 0        rollback-failed 0        data-exists 0
         data-missing 0   operation-not-supported 0        operation-failed 0
         partial-operation 0
R1#
```

1.c

```
netman@netman:~$ ssh -2 -s vivek@198.51.100.5 netconf
Password:
Password:
<?xml version="1.0" encoding="UTF-8"?><hello><capabilities><capability>urn:ietf:params:netconf:base:1.0</capability><capability>urn:ietf:params:netconf:capability:writeable-running:
1.0</capability><capability>urn:ietf:params:netconf:capability:startup:1.0</capability><capability>urn:ietf:params:netconf:capability:url:1.0</capability><capability>urn:cisco:param
s:netconf:capability:pi-data-model:1.0</capability><capability>urn:cisco:params:netconf:capability:notification:1.0</capability></capabilities><session-id>1726567428</session-id></h
ello>]]>]]>
<?xml version="1.0" encoding="UTF-8"?>
<hello xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
   <capabilities>
      <capability>urn:ietf:params:netconf:base:1.0</capability>
   </capabilities>
</hello>]]>]]>
<?xml version="1.0" encoding="UTF-8"?>
<rpc xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" message-id="3">
  <get-config>
    <source>
       <running/>
    </source>
  </get-config>
</rpc>
]]>]]>
```

Running-config:

```
! Last configuration change at 20:15:26 UTC Mon Mar 28 2022
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
!
no aaa new-model
no ip icmp rate-limit unreachable
ip cef
!
!
!
!
!
!
no ip domain lookup
ip domain name vivek
no ipv6 cef
!
!
multilink bundle-name authenticated
!
!
!
!
!
!
!
username vivek privilege 15 secret 5 $1$0vaw$txGwJvvzq5AgK4K8GyJ3t1
!
!
ip tcp synwait-time 5
ip ssh version 2
!
```

1.d:

```
<?xml version="1.0" encoding=\"UTF-8\"?>
<rpc message-id="101" xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
   <get-config>
      <source>
         <running/>
      </source>
      <filter>
         <config-format-text-cmd>
           <text-filter-spec> | inc interface </text-filter-spec>
         </config-format-text-cmd>
</filter>
   </get-config>
</rpc>]]>]]>
</cmd>version="1.0" encoding="UTF-8"?><rpc-reply message-id="101" xmlns="urn:ietf:params:netconf:base:1.0"><data><cli-config-data><cmd>interface FastEthernet0/0
</cmd>nterface FastEthernet1/0
</cmd>nterface FastEthernet1/1
</cmd>nterface FastEthernet2/0
</cmd>nterface FastEthernet2/1
</cmd></cli-config-data></data></rpc-reply>]]>]]>
```

1.e:

```
<?xml version="1.0" encoding=\"UTF-8\"?>
<rpc message-id="101" xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
   <get-config>
      <source>
         <running/>
      </source>
      <filter>
         <config-format-text-cmd>
         <text-filter-spec> interface FastEthernet1/0 </text-filter-spec>
      </config-format-text-cmd>
</filter>
   </get-config>
</rpc>]]>]]>
</cmd>version="1.0" encoding="UTF-8"?><rpc-reply message-id="101" xmlns="urn:ietf:params:netconf:base:1.0"><data><cli-config-data><cmd>!
</cmd>nterface FastEthernet1/0
</cmd>no ip address
</cmd>shutdown
</cmd>speed auto
</cmd>duplex auto
</cmd></cli-config-data></data></rpc-reply>]]>]]>
```

1.f

```
<?xml version="1.0" encoding="UTF-8"?>
<rpc message-id="101" xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
   <edit-config>
      <target>
         <running/>
      </target>
      <config>
         <cli-config-data>
<cmd>hostname Lab9Router</cmd>
           <cmd>interface Loopback10</cmd>
           <cmd>ip address 10.1.1.1 255.255.255.255</cmd>
</cli-config-data>
      </config>
   </edit-config>
</rpc>]]>]]>
<?xml version="1.0" encoding="UTF-8"?><rpc-reply message-id="101" xmlns="urn:ietf:params:netconf:base:1.0"><ok /></rpc-reply>]]>]]>
```

On Router:

```
interface Loopback10
 ip address 10.1.1.1 255.255.255.255
```

```
Lab9Router#
Lab9Router#
Lab9Router#
```

1.g:

```
<?xml version="1.0" encoding=\"UTF-8\"?>
<rpc message-id="101" xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
   <get-config>
      <source>
         <running/>
      </source>
      <filter>
          <config-format-text-cmd>
         <text-filter-spec> interface Loopback10</text-filter-spec>
      </config-format-text-cmd>
</filter>
   </get-config>
</rpc>]]>]]>
</cmd>version="1.0" encoding="UTF-8"?><rpc-reply message-id="101" xmlns="urn:ietf:params:netconf:base:1.0"><data><cli-config-data><cmd>!
</cmd>nterface Loopback10
</cmd>ip address 10.1.1.1 255.255.255.255
</cmd></cli-config-data></data></rpc-reply>]]>]]>
```

1.h:

```
<?xml version="1.0" encoding=\"UTF-8\"?>
<rpc xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" message-id="12">
    <copy-config>
        <target>
            <startup/>
         </target>
         <source>
           <running/>
         </source>
    </copy-config>
</rpc>
]]>]]>
<?xml version="1.0" encoding="UTF-8"?><rpc-reply message-id="12" xmlns="urn:ietf:params:netconf:base:1.0"><ok /></rpc-reply>]]>]]>
```

1.i:

```
<?xml version="1.0" encoding="UTF-8"?><hello><capabilities><capability>urn:ietf:params:netconf:base:1.0</capability><capability>urn:ietf:params:netconf:capability:writeable-running:
1.0</capability><capability>urn:ietf:params:netconf:capability:startup:1.0</capability><capability>urn:ietf:params:netconf:capability:url:1.0</capability><capability>urn:cisco:param
s:netconf:capability:pi-data-model:1.0</capability><capability>urn:cisco:params:netconf:capability:notification:1.0</capability></capabilities><session-id>1726567428</session-id></h
ello>]]>]]>
<?xml version="1.0" encoding="UTF-8"?>
<hello xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
    <capabilities>
        <capability>urn:ietf:params:netconf:base:1.0</capability>
```

It is not supported as seen from the screenshot above because it has nothing to say about datastores. If it supports it will send a specific message.

Obj2:

csv file parsed to get output in a form of table:

```
netman@netman:~/Downloads$ python3 obj2_lab9.py
+----------+---------------+----------+---------------+--------------------------+------+
| Hostname | loopback99 IP |  ip add  |  subnet mask  | OSPF network to advertise | area |
+----------+---------------+----------+---------------+--------------------------+------+
| Router1  |   loopback99  | 10.1.1.1 | 255.255.255.0 |     10.1.1.0 0.0.0.255   |  0   |
| Router2  |   loopback99  | 10.1.2.1 | 255.255.255.0 |     10.1.2.0 0.0.0.255   |  0   |
| Router3  |   loopback99  | 10.1.3.1 | 255.255.255.0 |     10.1.3.0 0.0.0.255   |  0   |
| Router4  |   loopback99  | 10.1.4.1 | 255.255.255.0 |     10.1.4.0 0.0.0.255   |  0   |
| Router5  |   loopback99  | 10.1.5.1 | 255.255.255.0 |     10.1.5.0 0.0.0.255   |  0   |
+----------+---------------+----------+---------------+--------------------------+------+
netman@netman:~/Downloads$
```

Obj3:

Successful Netconf into router after troubleshooting:

```
netman@netman:~$ ssh -2 -s vivek@198.51.100.1 netconf
The authenticity of host '198.51.100.1 (198.51.100.1)' can't be established.
RSA key fingerprint is SHA256:2EHV18z437pl7tZtnJcsbjyU8uEz6aUfNXfBUkszysc.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '198.51.100.1' (RSA) to the list of known hosts.
Password:
<?xml version="1.0" encoding="UTF-8"?><hello><capabilities><capability>urn:ietf:params:netconf:base:1.0</capability><capability>urn:ietf:params:netconf:capability:writeable-running:
1.0</capability><capability>urn:ietf:params:netconf:capability:startup:1.0</capability><capability>urn:ietf:params:netconf:capability:url:1.0</capability><capability>urn:cisco:param
s:netconf:capability:pi-data-model:1.0</capability><capability>urn:cisco:params:netconf:capability:notification:1.0</capability></capabilities><session-id>1740099052</session-id></h
ello>]]>]]>
```

Steps to make NETCONF working on the router are as given below:

1. The interface connected to tap0 was shut, so I made it no shut.
2. Removed IP access-group from the interface
3. Changed the IP address on the interface fa0/0 to the same subnet as of 198.51.100.0
4. Changed the access-list permissions to permit 198.51.100.0 network
5. Reconfigured the SSH again and made it to SSH version 2.
6. Configured the Netconf on the router.
7. Removed the IP route command as it was redundant since it is directly connected to the tap0.
8. I was able to ping from tap0 to fa0/0 and vice versa.
9. Also, I was able to make NETCONF working.

Obj4:

1.

```
RP/0/0/CPU0:Lab9_XR#sh netconf-yang clients
Tue Mar 29 01:11:58.875 UTC
Netconf clients
client session ID|     NC version|    client connect time|       last OP time|       last OP type|    <lock>|
      2498295776|        unknown|         0d  0h  1m  3s|                    |                   |        No|
RP/0/0/CPU0:Lab9_XR#
```

2.

Python code:

```python
from ncclient import manager
v=manager.connect(
    host='198.51.100.1',
    port=22,
    username='netman',
    password='netman',
    hostkey_verify=False,
    device_params={'name':'iosxr'})

def obj4():
  VIVEK= """
   <config>
   <rpc message-id="101" xmlns="urn:ietf:params:xml:ns:netconf:base:1:0>

   <config>
     <cli-config-data>

       <cmd> hostname Lab9_XR</cmd>
       <cmd> interface Loopback1</cmd>
       <cmd> ip add 10.11.12.13 255.255.255.255</cmd>
       <cmd> access-list 1 permit 198.51.100.2</cmd>
     </cli-config-data>
   </config>
 </rpc>]]>]]>"""

  k=v.edit_config(VIVEK,target='running')
  print(k)


if __name__ == "__main__":
  obj4()
```

Script output on Cisco_Ios_XR using ncclient library:

```
netman@netman:~/Downloads$ python3 vivek.py
<?xml version="1.0"?>
<rpc-reply message-id="urn:uuid:9790d5b2-6f0f-45a2-b216-aa8e88350426" xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0" xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
 <data>
  <aaa xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-aaa-locald-admin-cfg">
   <usernames>
    <username>
     <name>netman</name>
     <usergroup-under-usernames>
      <usergroup-under-username>
       <name>root-system</name>
      </usergroup-under-username>
     </usergroup-under-usernames>
     <secret>$1$Wmu2$vuXb1iG6T1t.wbLPpsanL.</secret>
    </username>
   </usernames>
  </aaa>
  <crypto xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-crypto-sam-cfg">
   <ssh xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-crypto-ssh-cfg">
    <server>
     <v2></v2>
     <netconf>831</netconf>
     <netconf-vrf-table>
      <vrf>
       <vrf-name>red</vrf-name>
       <enable></enable>
      </vrf>
      <vrf>
       <vrf-name>green</vrf-name>
       <enable></enable>
      </vrf>
```

Hostname and Loopback IP configured on router:

```
</netconf-yang>
<host-names xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-shellutil-cfg">
 <host-name>Lab9_XR</host-name>
</host-names>
<interfaces xmlns="http://openconfig.net/yang/interfaces">
 <interface>
  <name>Loopback1</name>
  <config>
   <name>Loopback1</name>
   <type xmlns:idx="urn:ietf:params:xml:ns:yang:iana-if-type">idx:softwareLoopback</type>
   <enabled>true</enabled>
  </config>
  <subinterfaces>
   <subinterface>
    <index>0</index>
    <ipv4 xmlns="http://openconfig.net/yang/interfaces/ip">
     <address>
      <ip>10.11.12.13</ip>
      <config>
       <ip>10.11.12.13</ip>
       <prefix-length>32</prefix-length>
      </config>
     </address>
    </ipv4>
```

IP address configuration on g0/0/0:

```
<active>act</active>
<interface-name>GigabitEthernet0/0/0/0</interface-name>
<ipv4-network xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-ipv4-io-cfg">
 <addresses>
  <primary>
   <address>198.51.100.1</address>
   <netmask>255.255.255.0</netmask>
  </primary>
 </addresses>
</ipv4-network>
</interface-configuration>
<interface-configuration>
```

Access-list configuration :

```
<ipv4-acl-and-prefix-list xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-ipv4-acl-cfg">
 <accesses>
  <access>
   <access-list-name>vivek</access-list-name>
   <access-list-entries>
    <access-list-entry>
     <sequence-number>1</sequence-number>
     <grant>permit</grant>
     <source-network>
      <source-address>198.51.100.0</source-address>
     </source-network>
     <sequence-str>1</sequence-str>
    </access-list-entry>
   </access-list-entries>
  </access>
  <access>
   <access-list-name>v4-ingress</access-list-name>
   <access-list-entries>
    <access-list-entry>
     <sequence-number>1</sequence-number>
     <grant>permit</grant>
     <source-network>
      <source-address>198.51.100.2</source-address>
     </source-network>
     <sequence-str>1</sequence-str>
    </access-list-entry>
```

Obj 5:

In your opinion, what are the advantages of using data models such as YANG or YAML in network automation?

1. YANG is used widely by bodies such as IETF to create a broad range of rich YANG models.
2. It models both the configuration and state of key layers of network.
3. Enables automated operations and policies.
4. Reinforces a solid foundation for automation and SDN.

Out of all the network automation tools you used (Netmiko, NAPALAM, Ansible, NETCONF, etc.), which one is your favorite and why?

My favorite network automation tool is Ansible over all the other tools because of the below reasons:

1. It is open source
2. It is very simple to setup and use
3. It is agentless
4. It is efficient.
5. It automates the cumbersome repetitive task by creating a ansible playbook and automating it using python script.