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ATTESTATION CAPABLE PROGRAMMABLE SOFTWARE SWITCH
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Programmability in Switches

• A shift from Fixed function ASICs to Programmable ASICs.
• Flexibility in packet protocols, quick prototyping, and fast time to deploy.
• **Programmable nature of switch introduces security concerns.**
• Corruption of packets, dropping packets or modifying the dataplane.

Identifying a compromised network
What you'll see in the demo

1. Setup resources in FABRIC and start the Switch.
2. Send packets from Sender to Receiver hosts via the Switch.
3. Show the Switch generating evidence based on look-up table contents ("rules").
4. Add and modify rules and display how the Attester's (i.e., Switch) evidence changes accordingly.
5. Show performance (throughput) of the prototype switch.

Define constants

```python
from ipaddress import ip_address, IPv4Address, IPv6Address, IPv4Network, IPv6Network

# Slice
slice_name = 'BMv2_newesttopo'

# Switches
s1_name = "s1"

switch_cores = 8
```
switch_ram = 16
switch_disk = 100

# Hosts
h1_name = "h1"
h2_name = "h2"

h1_subnet = IPv6Network('fec0:db8:0:f000::/64')
h1_addr = IPv6Address('fec0:db8:0:f000::10')

h2_subnet = IPv6Network('fec0:db8:0:f001::/64')
h2_addr = IPv6Address('fec0:db8:0:f001::100')

host_cores = 2
host_ram = 8
host_disk = 10

net_h1_name = 'net_h1'
net_h2_name = 'net_h2'

net_h1_s1_name = 'net_h1_s1'
net_h2_s1_name = 'net_h2_s1'

# All node properties
image = 'default_ubuntu_20'

Setting up slice and submission

[]: try:
    #Create Slice
    slice = fablib.new_slice(name=slice_name)

    # Add switch node s1
    s1 = slice.add_node(name=s1_name, image=image,
                        cores=switch_cores, ram=switch_ram, disk=switch_disk)
    s1.set_capacities(cores=switch_cores, ram=switch_ram, disk=switch_disk)
    s1_iface_h1 = s1.add_component(model='NIC_Basic', name="s1_local_nic1").
                ▼ get_interfaces()[0]
    s1_iface_h2 = s1.add_component(model='NIC_Basic', name="s1_local_nic2").
                ▼ get_interfaces()[0]

    # Add host node h1
    h1 = slice.add_node(name=h1_name, image=image,
                        cores=host_cores, ram=host_ram, disk=host_disk)
    h1 iface = h1.add_component(model='NIC_Basic', name="h1 nic").
                ▼ get_interfaces()[0]
# Add host node h2
h2 = slice.add_node(name=h2_name, image=image,
      cores=host_cores, ram=host_ram, disk=host_disk)
h2_iface = h2.add_component(model='NIC_Basic', name="h2_nic")

#Add host networks
host_net1 = slice.add_l2network(name=net_h1_s1_name,
      interfaces=[s1_iface_h1, h1_iface])
host_net2 = slice.add_l2network(name=net_h2_s1_name,
      interfaces=[s1_iface_h2, h2_iface])

#Submit Slice Request
slice.submit()
except Exception as e:
    print(f"Error: {e}")
    traceback.print_exc()

[4]:

config_threads = {}

Download libraries and tools from repository

[ ]:

host_config_script = "sudo apt update -y -qq && sudo apt install -y
      build-essential && sudo apt install -y net-tools && sudo apt install -y
      iperf3"
switch_config_script = "sudo apt update -y -qq && sudo apt install -y
      build-essential && sudo apt install -y net-tools && sudo apt install -y
      python3-pip"

try:
    h1 = slice.get_node(name=h1_name)
    print(h1)
    if type(ip_address(h1.get_management_ip())) is IPv6Address:
        #h1.execute("sudo sed -i '/nameserver/d' /etc/resolv.conf \\n        echo nameserver 2a00:1098:2c::1 >> /etc/resolv.conf \\n        nameserver 2a01:4f8:c2c:123f::1 >> /etc/resolv.conf")
        h1.execute("sudo sh -c 'echo nameserver 2a00:1098:2b::1 >> /etc/resolv.conf'")
    h1_os_iface = h1.get_interface(network_name=net_h1_s1_name)
    h1_os_iface.ip_addr_add(addr=h1_addr, subnet=h1_subnet)
    config_threads[h1] = h1_config_thread

h2 = slice.get_node(name=h2_name)
if type(ip_address(h2.get_management_ip())) is IPv6Address:
    h2.execute("sudo sed -i '/nameserver/d' /etc/resolv.conf \&\& sudo sh -c "
    "echo nameserver 2a00:1098:2c::1 >> /etc/resolv.conf \&\& sudo sh -c 'echo"
    
    "nameserver 2a01:4f8:c2c:123f::1 >> /etc/resolv.conf' \&\& sudo sh -c 'echo"
    
    "nameserver 2a00:1098:2b::1 >> /etc/resolv.conf'"
    h2_os_iface = h2.get_interface(network_name=net_h2_s1_name)
    h2_os_iface.ip_addr_add(addr=h2_addr, subnet=h2_subnet)
    h2_config_thread = h2.execute_thread(host_config_script)
    config_threads[h2] = h2_config_thread
    
    s1 = slice.get_node(name=s1_name)

if type(ip_address(s1.get_management_ip())) is IPv6Address:
    s1.execute("sudo sh -c 'echo nameserver 2a00:1098:2c::1 >> /etc/resolv.
    conf' \&\& sudo sh -c 'echo nameserver 2a01:4f8:c2c:123f::1 >> /etc/resolv.
    conf' \&\& sudo sh -c 'echo nameserver 2a00:1098:2b::1 >> /etc/resolv.conf'"
    s1_config_thread = s1.execute_thread(switch_config_script)
    config_threads[s1] = s1_config_thread
    
except Exception as e:
    print(f"Error: {e}")
    traceback.print_exc()

[ ]: try:
    slice = fablib.get_slice(name=slice_name)
    for node in slice.get_nodes():
        print(f"{node.get_name()}: {node.get_ssh_command()}"
    except Exception as e:
        print(f"Exception: {e}")

Copy scripts to the host VMs

[ ]:
    h1_ssh = ""
    h2_ssh = ""
    s1_ssh = ""
    h1_scp = ""
    h2_scp = ""
    s1_scp = ""
    script_h1 = "ip6_bringup_h1.sh"
    script_h2 = "ip6_bringup_h2.sh"
    script_s1 = "switch_script.sh"
    script_export_mac = "export_mac.sh"
    script_addrule = "add_rules.sh"
```
out_file = "ascript.sh"

try:
    slice = fablib.get_slice(name=slice_name)
    h1_ssh = slice.get_node(name=h1_name).get_ssh_command()
    h2_ssh = slice.get_node(name=h2_name).get_ssh_command()
    s1_ssh = slice.get_node(name=s1_name).get_ssh_command()
    
    # creating appropriate scp command for host h1
    h1_param = h1_ssh.split('ssh ')[1]
    h1_scp = "scp " + h1_param
    scp_addr = h1_scp.split('@')[1]
    scp_config = h1_scp.split('@')[0]
    scp_addr_brkted = ["" + scp_addr + "]"
    h1_scp = scp_config + '"' + scp_addr_brkted
    h1_scp = h1_scp.split('ubuntu')[0] + " " + script_h1 + " ubuntu" + h1_scp.

    print(h1_scp)
    # h1.execute(h1_scp)
    
    # creating appropriate scp command for host h2
    h2_param = h2_ssh.split('ssh ')[1]
    h2_scp = "scp " + h2_param
    scp_addr = h2_scp.split('@')[1]
    scp_config = h2_scp.split('@')[0]
    scp_addr_brkted = ["" + scp_addr + "]"
    h2_scp = scp_config + '"' + scp_addr_brkted
    h2_scp = h2_scp.split('ubuntu')[0] + " " + script_h2 + " ubuntu" + h2_scp.

    print(h2_scp)

    # creating appropriate scp command for switch s1
    s1_param = s1_ssh.split('ssh ')[1]
    s1_scp = "scp " + s1_param
    scp_addr = s1_scp.split('@')[1]
    scp_config = s1_scp.split('@')[0]
    scp_addr_brkted = ["" + scp_addr + "]"
    s1_scp = scp_config + '"' + scp_addr_brkted
    s1_scp = s1_scp.split('ubuntu')[0] + " " + script_s1 + " ubuntu" + s1_scp.

    print(s1_scp)

    s1_param1 = s1_ssh.split('ssh ')[1]
```
s1_scp1 = "scp " + s1_param1
scp_addr = s1_scp1.split('@')[1]
scp_config = s1_scp1.split('@')[0]
shcp_addr_brkted = "[" + scp_addr + "]"

s1_scp1 = scp_config + "@" + scp_addr_brkted
s1_scp1 = s1_scp1.split('ubuntu')[0] + " " + script_export_mac + " ubuntu"
scp_addr_brkted = "[" + scp_addr + "]"

s1_scp2 = scp_config + "@" + scp_addr_brkted
s1_scp2 = s1_scp2.split('ubuntu')[0] + " " + script_addrule + " ubuntu"

print(s1_scp1)

print(s1_scp2)

with open(out_file, "w") as out:
    out.write("#!/bin/bash

")
    out.write(h1_scp + "\n")
    out.write(h2_scp + "\n")
    out.write(s1_scp + "\n")
    out.write(s1_scp1 + "\n")
    out.write(s1_scp2 + "\n")
    out.close()

except Exception as e:
    print(f"Exception: {e}"

[ ]: 
chmod u+x ascript.sh
./ascript.sh

[ ]: 
thrift_nnpy_script = "cd ~/behavioral-model/ci; chmod u+x install-nanomsg.sh && install-nanomsg.sh install-thrift.sh; ./install-nanomsg.sh && ./install-nanomsg.sh && ./install-thrift.sh"
bmv2_build = "cd behavioral-model/ ; ./autogen.sh && ./configure 'CXXFLAGS=-g -O3' 'CFLAGS=-g -O3' --disable-logging-macros --disable-elogger && make -j2 && sudo make install"

try:
    s1 = slice.get_node(name=s1_name)
    s1.execute_thread(thrift_nnpy_script)
    s1.execute_thread(bmv2_build)

except Exception as e:
    print(f"Exception: {e}"

[39]: 
ra_build = "cd ~/bmv2-remote-attestation/ ; ./autogen.sh && ./configure 'CXXFLAGS=-g -O3' 'CFLAGS=-g -O3' --disable-logging-macros --disable-elogger && make -j2"
ra_to_base = "cd ~/bmv2-remote-attestation/ ; mv /usr/share/p4c/p4include/v1model.p4 /usr/share/p4c/p4include/v1model_orig.p4 & & sudo ./ra_to_base.sh"

try:
    s1 = slice.get_node(name=s1_name)
    s1.execute_thread(ra_build)
    s1.execute_thread(ra_to_base)
except Exception as e:
    print(f'Exception: {e}')

Execute copied scripts

script_h1 = "ip6_bringup_h1.sh"
script_h2 = "ip6_bringup_h2.sh"
script_s1 = "switch_script.sh"
script_export_mac = "export_mac.sh"

try:
    s1 = slice.get_node(name=s1_name)
    h1_s1_iface = s1.get_interface(network_name=net_h1_s1_name)
    h2_s1_iface = s1.get_interface(network_name=net_h2_s1_name)
    h1_s1_mac = h1_s1_iface.get_mac()
    h2_s1_mac = h2_s1_iface.get_mac()
    print(h1_s1_mac)
    print(h2_s1_mac)

    h1 = slice.get_node(name=h1_name)
    h1_iface = h1.get_interface(network_name=net_h1_s1_name)
    h1_ifname = h1_iface.get_device_name()
    h1_mac = h1_iface.get_mac()
    print(h1_ifname)
    h1.execute("chmod u+x " + script_h1)
    h1.execute_thread("./" + script_h1 + " " + h1_ifname + " " + h1_s1_mac)

    h2 = slice.get_node(name=h2_name)
    h2_iface = h2.get_interface(network_name=net_h2_s1_name)
    h2_ifname = h2_iface.get_device_name()
    h2_mac = h2_iface.get_mac()
    print(h2_ifname)
    h2.execute("chmod u+x " + script_h2)
    h2.execute_thread("./" + script_h2 + " " + h2_ifname + " " + h2_s1_mac)

    s1.execute("chmod u+x " + script_export_mac)
s1.execute("./script_export_mac + " + h1_mac + " + h2_mac + " + h1_s1_mac + " + h2_s1_mac")

except Exception as e:
    print(f'Exception: {e}')

HBH extension format

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<td>RA – Switch Tables</td>
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<td>RA – Switch Program</td>
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<td>RA – Path Program</td>
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Feel free to get in touch if you would like to know more or have any questions, email me at nshyamkumar@iit.edu