

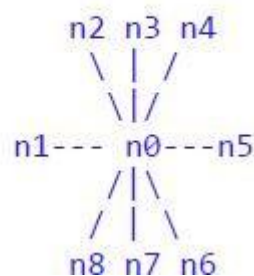
EXPERIMENT 5**BUILDING TOPOLOGIES IN NS-3 (STAR TOPOLOGY)****OBJECTIVE:**

- Implement the star network topology

BACKGROUND:

You have implemented point to point, CSMA and Wi-Fi topologies. In today's lab we are going to strengthen those skills with implementation of the Star topology shown in figure 5.1:

Star Network topology

**Figure 5.1: Star Network**

Each link is a point to point link. The central node (n0) is the packet sink. The other nodes generate traffic, which is sent to the sink. The code for this topology is in the examples folder (examples/tcp/star.cc). In this particular example, pcap tracing has been enabled, while logging is not enabled. Enable logging by inserting the following lines of code in the beginning of main:

```

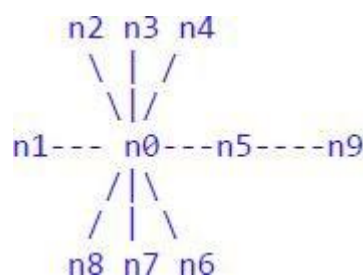
LogComponentEnable ("Star", LOG_LEVEL_INFO);
LogComponentEnable ("PacketSink", LOG_LEVEL_INFO);
LogComponentEnable ("OnOffApplication", LOG_LEVEL_INFO);
NS_LOG_INFO ("Star Topology Simulation");

```

Now running the code will show transmission and reception of packets in the terminal window.

TASK:

Modify the above topology as shown below in figure 5.2:



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Figure 5.2: Modified Star Network

Do not install any applications on nodes 0 and 5. Make node 9 (n9) the packet sink and send all packets (from n1-n4 and n6-n8) to this sink. All links are point to point links.

```
#include "ns3/applications-module.h"
#include "ns3/core-module.h"
#include "ns3/internet-module.h"
#include "ns3/netanim-module.h"
#include "ns3/network-module.h"
#include "ns3/point-to-point-layout-module.h"
#include "ns3/point-to-point-module.h"

using namespace ns3;

NS_LOG_COMPONENT_DEFINE("Star");

int main(int argc, char* argv[])
{
    LogComponentEnable("Star", LOG_LEVEL_INFO);
    LogComponentEnable("PacketSink", LOG_LEVEL_INFO);
    LogComponentEnable("OnOffApplication", LOG_LEVEL_INFO);
    NS_LOG_INFO("Modified Star Topology Simulation");

    Config::SetDefault("ns3::OnOffApplication::PacketSize", UintegerValue(137));
    Config::SetDefault("ns3::OnOffApplication::DataRate", StringValue("14kb/s"));

    uint32_t nSpokes = 7;

    CommandLine cmd(__FILE__);
    cmd.AddValue("nSpokes", "Number of nodes to place in the star", nSpokes);
    cmd.Parse(argc, argv);

    PointToPointHelper pointToPoint;
    pointToPoint.SetDeviceAttribute("DataRate", StringValue("5Mbps"));
    pointToPoint.SetChannelAttribute("Delay", StringValue("2ms"));

    // Build star
    PointToPointStarHelper star(nSpokes, pointToPoint);

    // Create extra node n9 and connect to n5

    NodeContainer extra;
    extra.Create(2); // n5 and n9

    InternetStackHelper internet;
    star.InstallStack(internet);
    internet.Install(extra);

    NetDeviceContainer d0n5 = pointToPoint.Install(star.GetHub(), extra.Get(0));

    NetDeviceContainer d5n9 = pointToPoint.Install(extra.Get(0), extra.Get(1));

    // Assign addresses
    star.AssignIpv4Addresses(Ipv4AddressHelper("10.1.1.0", "255.255.255.0"));

    Ipv4AddressHelper address1, address2;
    address1.SetBase("10.2.1.0", "255.255.255.0");
    Ipv4InterfaceContainer if0n5 = address1.Assign(d0n5);

    address2.SetBase("10.2.2.0", "255.255.255.0");
    Ipv4InterfaceContainer if5n9 = address2.Assign(d5n9);
```

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```
// Install packet sink on n9
uint16_t port = 50000;
Address sinkLocalAddress(InetSocketAddress(Ipv4Address::GetAny(), port));
PacketSinkHelper sinkHelper("ns3::TcpSocketFactory", sinkLocalAddress);
ApplicationContainer sinkApp = sinkHelper.Install(extra.Get(1));
sinkApp.Start(Seconds(1.0));
sinkApp.Stop(Seconds(10.0));

OnOffHelper onOffHelper("ns3::TcpSocketFactory", Address());
onOffHelper.SetAttribute("OnTime", StringValue("ns3::ConstantRandomVariable[Constant=1]"));
onOffHelper.SetAttribute("OffTime", StringValue("ns3::ConstantRandomVariable[Constant=0]"));

ApplicationContainer spokeApps;

for (uint32_t i = 0; i < star.SpokeCount(); ++i)
{
    if (i == 5) continue; // skip n5 (forwarder only)

    AddressValue remoteAddress(InetSocketAddress(if5n9.GetAddress(1), port)); // sink at n9
    onOffHelper.SetAttribute("Remote", remoteAddress);
    spokeApps.Add(onOffHelper.Install(star.GetSpokeNode(i)));
}
spokeApps.Start(Seconds(1.0));
spokeApps.Stop(Seconds(10.0));

Ipv4GlobalRoutingHelper::PopulateRoutingTables();
pointToPoint.EnablePcapAll("star_forwarding");

Simulator::Run();
Simulator::Destroy();
return 0;
}
```

Output:

```

ubuntu@ubuntu24-04: ~/ns-allinone-3.40/ns-3.40$ ./ns3 run scratch/la5.cc
[0/2] Re-checking globbed directories...
ninja: no work to do.
Modified Star Topology Simulation
At time +1.09084s on-off application sent 137 bytes to 10.2.2.2 port 50000 total Tx 137 bytes
At time +1.09094s on-off application sent 137 bytes to 10.2.2.2 port 50000 total Tx 137 bytes
At time +1.09103s on-off application sent 137 bytes to 10.2.2.2 port 50000 total Tx 137 bytes
At time +1.09112s on-off application sent 137 bytes to 10.2.2.2 port 50000 total Tx 137 bytes
At time +1.09121s on-off application sent 137 bytes to 10.2.2.2 port 50000 total Tx 137 bytes
At time +1.09131s on-off application sent 137 bytes to 10.2.2.2 port 50000 total Tx 137 bytes
At time +1.09776s packet sink received 137 bytes from 10.1.1.2 port 49153 total Rx 137 bytes
At time +1.09806s packet sink received 137 bytes from 10.1.2.2 port 49153 total Rx 274 bytes
At time +1.09837s packet sink received 137 bytes from 10.1.3.2 port 49153 total Rx 411 bytes
At time +1.09868s packet sink received 137 bytes from 10.1.4.2 port 49153 total Rx 548 bytes
At time +1.09898s packet sink received 137 bytes from 10.1.5.2 port 49153 total Rx 685 bytes
At time +1.09929s packet sink received 137 bytes from 10.1.7.2 port 49153 total Rx 822 bytes
At time +1.16913s on-off application sent 137 bytes to 10.2.2.2 port 50000 total Tx 274 bytes
At time +1.16922s on-off application sent 137 bytes to 10.2.2.2 port 50000 total Tx 274 bytes
At time +1.16931s on-off application sent 137 bytes to 10.2.2.2 port 50000 total Tx 274 bytes
At time +1.16941s on-off application sent 137 bytes to 10.2.2.2 port 50000 total Tx 274 bytes
At time +1.1695s on-off application sent 137 bytes to 10.2.2.2 port 50000 total Tx 274 bytes
At time +1.16959s on-off application sent 137 bytes to 10.2.2.2 port 50000 total Tx 274 bytes
At time +1.17605s packet sink received 137 bytes from 10.1.1.2 port 49153 total Rx 959 bytes
At time +1.17635s packet sink received 137 bytes from 10.1.2.2 port 49153 total Rx 1096 bytes
At time +1.17666s packet sink received 137 bytes from 10.1.3.2 port 49153 total Rx 1233 bytes
At time +1.17696s packet sink received 137 bytes from 10.1.4.2 port 49153 total Rx 1370 bytes
At time +1.17727s packet sink received 137 bytes from 10.1.5.2 port 49153 total Rx 1507 bytes
At time +1.17757s packet sink received 137 bytes from 10.1.7.2 port 49153 total Rx 1644 bytes
At time +1.24741s on-off application sent 137 bytes to 10.2.2.2 port 50000 total Tx 411 bytes
At time +1.24751s on-off application sent 137 bytes to 10.2.2.2 port 50000 total Tx 411 bytes
At time +1.2476s on-off application sent 137 bytes to 10.2.2.2 port 50000 total Tx 411 bytes
At time +1.24769s on-off application sent 137 bytes to 10.2.2.2 port 50000 total Tx 411 bytes
At time +1.24779s on-off application sent 137 bytes to 10.2.2.2 port 50000 total Tx 411 bytes
At time +1.24788s on-off application sent 137 bytes to 10.2.2.2 port 50000 total Tx 411 bytes
At time +1.25433s packet sink received 137 bytes from 10.1.1.2 port 49153 total Rx 1781 bytes
At time +1.25464s packet sink received 137 bytes from 10.1.2.2 port 49153 total Rx 1918 bytes
At time +1.25494s packet sink received 137 bytes from 10.1.3.2 port 49153 total Rx 2055 bytes
At time +1.25525s packet sink received 137 bytes from 10.1.4.2 port 49153 total Rx 2192 bytes

```

POST LAB QUESTION:

Modify the star topology as below in the figure 5.3 and paste your code in the space given below.

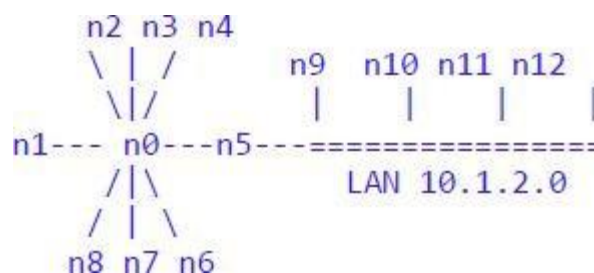


Figure 5.3

Do not install any application layer on n0 and n5. Make n12 packet sink and send all packets from n1n4 and n6-n11 to this sink.

```

#include "ns3/applications-module.h"
#include "ns3/core-module.h"
#include "ns3/csma-module.h"
#include "ns3/internet-module.h"
#include "ns3/netanim-module.h"
#include "ns3/network-module.h"
#include "ns3/point-to-point-layout-module.h"
#include "ns3/point-to-point-module.h"

using namespace ns3;

NS_LOG_COMPONENT_DEFINE("Star");

int main(int argc, char* argv[])
{
    LogComponentEnable("Star", LOG_LEVEL_INFO);
    LogComponentEnable("PacketSink", LOG_LEVEL_INFO);
    LogComponentEnable("OnOffApplication", LOG_LEVEL_INFO);
    NS_LOG_INFO("Star Topology Simulation");

    Config::SetDefault("ns3::OnOffApplication::PacketSize", UintegerValue(137));
    Config::SetDefault("ns3::OnOffApplication::DataRate", StringValue("14kb/s"));

    // Star has 8 spokes (n1-n8 around hub n0)

    uint32_t nSpokes = 8;

    CommandLine cmd(__FILE__);
    cmd.AddValue("nSpokes", "Number of spokes in the star", nSpokes);
    cmd.Parse(argc, argv);

    // Point-to-Point helper

    PointToPointHelper pointToPoint;
    pointToPoint.SetDeviceAttribute("DataRate", StringValue("5Mbps"));
    pointToPoint.SetChannelAttribute("Delay", StringValue("2ms"));

    // Build star
    PointToPointStarHelper star(nSpokes, pointToPoint);

    // Create LAN nodes: n9-n12

    NodeContainer csmaNodes;
    csmaNodes.Create(4);

    // Connect n5 (spoke index 4) to LAN gateway (csmaNodes.Get(0)) via P2P
    NodeContainer p2pLan;

    p2pLan.Add(star.GetSpokeNode(4), csmaNodes.Get(0)); // n5 + LAN gateway

    NetDeviceContainer p2pLanDevices = pointToPoint.Install(p2pLan);

    // CSMA LAN: n9-n12

    CsmHelper csma;
    csma.SetChannelAttribute("DataRate", StringValue("5Mbps"));
    csma.SetChannelAttribute("Delay", StringValue("2ms"));

    NetDeviceContainer csmaDevices = csma.Install(csmaNodes);

    // Install Internet stacks
    InternetStackHelper internet;
    star.InstallStack(internet);
    internet.Install(csmaNodes);

```

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```
// Assign IPs
// ->Subnet 1: star (n0 + n1-n7)

star.AssignIpv4Addresses(Ipv4AddressHelper("10.1.1.0", "255.255.255.0"));

// ->Subnet 2: P2P link (n5 ↔ LAN gateway)

Ipv4AddressHelper addressP2P;
addressP2P.SetBase("10.2.1.0", "255.255.255.0");

Ipv4InterfaceContainer ifP2P = addressP2P.Assign(p2pLanDevices);

// ->Subnet 3: CSMA LAN (n9-n12)

Ipv4AddressHelper addressLan;
addressLan.SetBase("10.2.2.0", "255.255.255.0");

Ipv4InterfaceContainer ifLan = addressLan.Assign(csmaDevices);

uint16_t port = 50000;
Address sinkLocalAddress(InetSocketAddress(Ipv4Address::GetAny(), port));
PacketSinkHelper sinkHelper("ns3::TcpSocketFactory", sinkLocalAddress);

ApplicationContainer sinkApp = sinkHelper.Install(csmaNodes.Get(3)); // sink at n12

sinkApp.Start(Seconds(1.0));
sinkApp.Stop(Seconds(10.0));

OnOffHelper onOffHelper("ns3::TcpSocketFactory", Address());
onOffHelper.SetAttribute("OnTime", StringValue("ns3::ConstantRandomVariable[Constant=1]"));
onOffHelper.SetAttribute("OffTime", StringValue("ns3::ConstantRandomVariable[Constant=0]"));

ApplicationContainer sourceApps;

// Install on star spokes except hub (n0) and forwarder (n5)
for (uint32_t i = 0; i < star.SpokeCount(); ++i)
{
    if (i == 4) continue; // skip n5

    AddressValue remoteAddress(InetSocketAddress(ifLan.GetAddress(3), port)); // sink at n12
    onOffHelper.SetAttribute("Remote", remoteAddress);
    sourceApps.Add(onOffHelper.Install(star.GetSpokeNode(i)));
}

// Install on LAN nodes except sink (n12)
for (uint32_t j = 0; j < 3; ++j) // n9-n11
{
    AddressValue remoteAddress(InetSocketAddress(ifLan.GetAddress(3), port)); // sink at n12
    onOffHelper.SetAttribute("Remote", remoteAddress);
    sourceApps.Add(onOffHelper.Install(csmaNodes.Get(j)));
}

sourceApps.Start(Seconds(1.0));
sourceApps.Stop(Seconds(10.0));

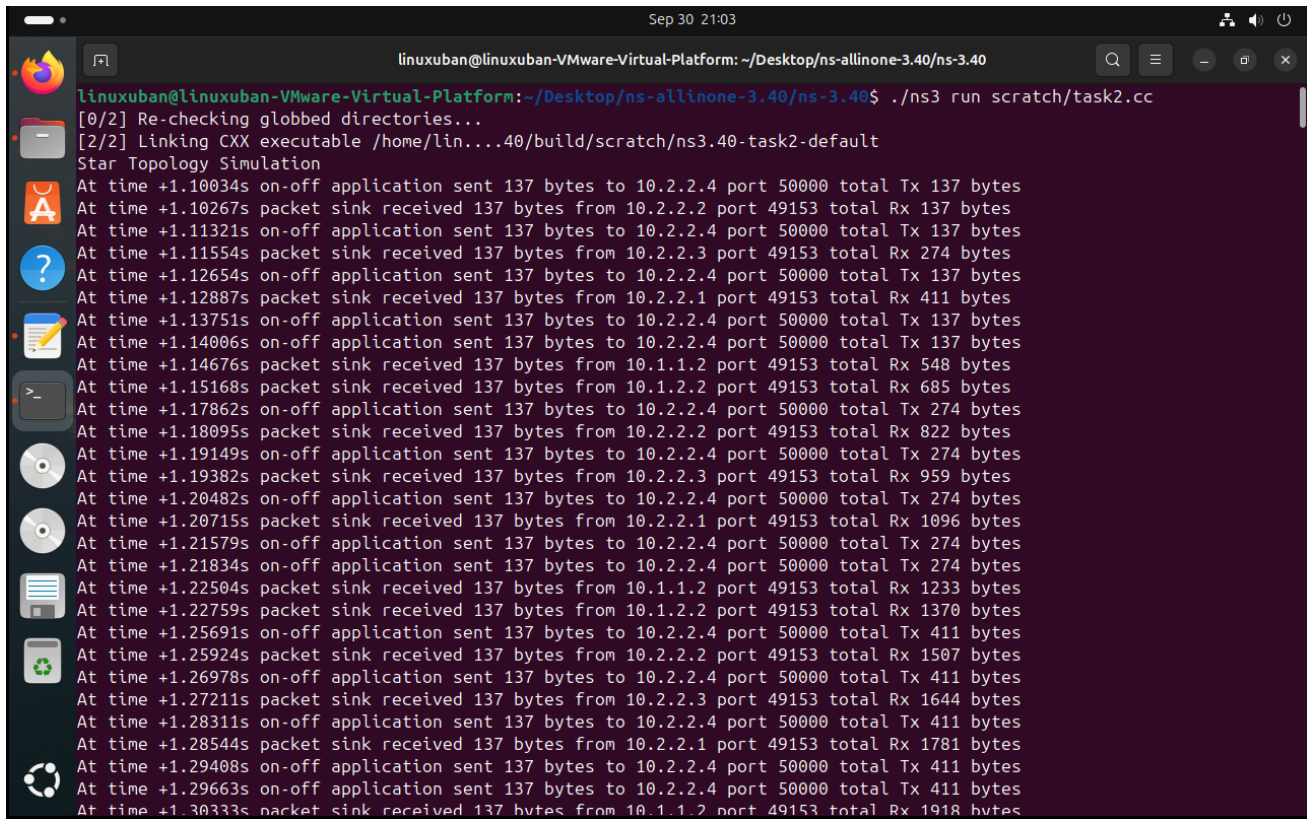
Ipv4GlobalRoutingHelper::PopulateRoutingTables();

// Tracing

pointToPoint.EnablePcapAll("star_forwarding");
csma.EnablePcap("lan", csmaDevices.Get(0), true);
```

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```
Simulator::Run();  
Simulator::Destroy();  
return 0;  
}
```



The screenshot shows a terminal window titled 'linuxubun@linuxubun-VMware-Virtual-Platform: ~/Desktop/ns-allinone-3.40/ns-3.40'. The user has executed the command './ns3 run scratch/task2.cc'. The output shows the simulation setup and a series of log messages for a 'Star Topology Simulation'. The messages include timestamps, event types (on-off application sent, packet sink received), and data flow statistics (total Tx and Rx bytes) for various IP addresses and ports. The simulation appears to be running successfully, with data being sent and received between different nodes in the network.

```
linuxubun@linuxubun-VMware-Virtual-Platform: ~/Desktop/ns-allinone-3.40/ns-3.40$ ./ns3 run scratch/task2.cc  
[0/2] Re-checking globbed directories...  
[2/2] Linking CXX executable /home/lin...40/build/scratch/ns3.40-task2-default  
Star Topology Simulation  
At time +1.10034s on-off application sent 137 bytes to 10.2.2.4 port 50000 total Tx 137 bytes  
At time +1.10267s packet sink received 137 bytes from 10.2.2.2 port 49153 total Rx 137 bytes  
At time +1.11321s on-off application sent 137 bytes to 10.2.2.4 port 50000 total Tx 137 bytes  
At time +1.11554s packet sink received 137 bytes from 10.2.2.3 port 49153 total Rx 274 bytes  
At time +1.12654s on-off application sent 137 bytes to 10.2.2.4 port 50000 total Tx 137 bytes  
At time +1.12887s packet sink received 137 bytes from 10.2.2.1 port 49153 total Rx 411 bytes  
At time +1.13751s on-off application sent 137 bytes to 10.2.2.4 port 50000 total Tx 137 bytes  
At time +1.14006s on-off application sent 137 bytes to 10.2.2.4 port 50000 total Tx 137 bytes  
At time +1.14676s packet sink received 137 bytes from 10.1.1.2 port 49153 total Rx 548 bytes  
At time +1.15168s packet sink received 137 bytes from 10.1.2.2 port 49153 total Rx 685 bytes  
At time +1.17862s on-off application sent 137 bytes to 10.2.2.4 port 50000 total Tx 274 bytes  
At time +1.18095s packet sink received 137 bytes from 10.2.2.2 port 49153 total Rx 822 bytes  
At time +1.19149s on-off application sent 137 bytes to 10.2.2.4 port 50000 total Tx 274 bytes  
At time +1.19382s packet sink received 137 bytes from 10.2.2.3 port 49153 total Rx 959 bytes  
At time +1.20482s on-off application sent 137 bytes to 10.2.2.4 port 50000 total Tx 274 bytes  
At time +1.20715s packet sink received 137 bytes from 10.2.2.1 port 49153 total Rx 1096 bytes  
At time +1.21579s on-off application sent 137 bytes to 10.2.2.4 port 50000 total Tx 274 bytes  
At time +1.21834s on-off application sent 137 bytes to 10.2.2.4 port 50000 total Tx 274 bytes  
At time +1.22504s packet sink received 137 bytes from 10.1.1.2 port 49153 total Rx 1233 bytes  
At time +1.22759s packet sink received 137 bytes from 10.1.2.2 port 49153 total Rx 1370 bytes  
At time +1.25691s on-off application sent 137 bytes to 10.2.2.4 port 50000 total Tx 411 bytes  
At time +1.25924s packet sink received 137 bytes from 10.2.2.2 port 49153 total Rx 1507 bytes  
At time +1.26978s on-off application sent 137 bytes to 10.2.2.4 port 50000 total Tx 411 bytes  
At time +1.27211s packet sink received 137 bytes from 10.2.2.3 port 49153 total Rx 1644 bytes  
At time +1.28311s on-off application sent 137 bytes to 10.2.2.4 port 50000 total Tx 411 bytes  
At time +1.28544s packet sink received 137 bytes from 10.2.2.1 port 49153 total Rx 1781 bytes  
At time +1.29408s on-off application sent 137 bytes to 10.2.2.4 port 50000 total Tx 411 bytes  
At time +1.29663s on-off application sent 137 bytes to 10.2.2.4 port 50000 total Tx 411 bytes  
At time +1.30333s packet sink received 137 bytes from 10.1.1.2 port 49153 total Rx 1918 bytes
```

