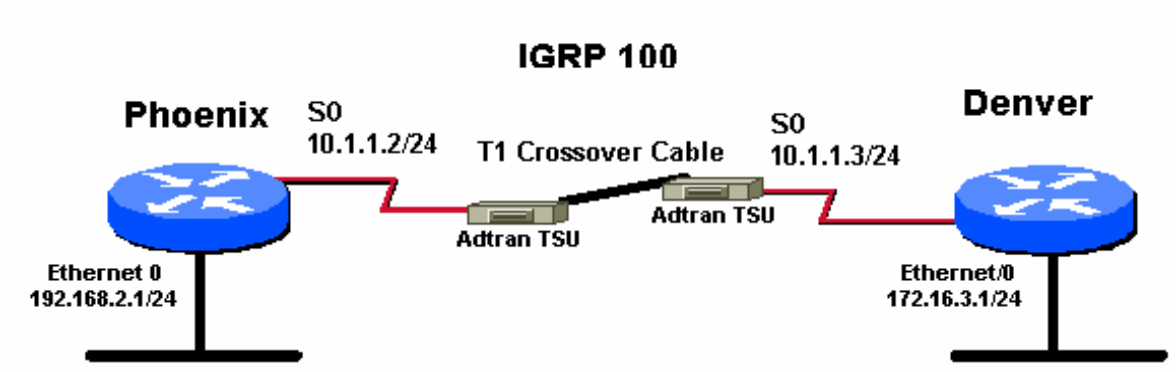
Cisco CCNA Optional Semester 4 Labs – Wide Area Networking

LAB 1 – T1 TSU WAN LINK – OVERVIEW - Instructor Guide

(Estimated time: 30 minutes)



Objectives:

- Understand the function of a T1 Service Unit (TSU) in network telecommunications
- Connect routers and TSUs to create a simulated Wide Area Network (WAN) with two sites
- Configure the routers to communicate across the WAN link through the TSUs
- Test connectivity over the WAN link using Ping and Telnet
- Become familiar with T-carrier and related telephone company (telco) terminology

Background:

In this lab you will create a T1 WAN link between routers using TSUs that will simulate a connection between two geographically separate sites. You will connect the routers and TSUs, configure the routers and then test your WAN link with basic TCP/IP utilities such as Ping and Telnet.

T1 Overview:

T1 digital communications technology was developed by Bell Labs as part of the North American T-carrier system (which also includes T3 and others). It has been used by telephone companies (telcos) for years primarily to carry voice traffic. A T1 allows 24 channels of 64 kilobits per second (Kbps) each to be multiplexed or combined over 2 pair of copper wire. This results in a capacity or "speed" of 1.544 megabits per second (Mbps). The signal is transmitted using Pulse Code Modulation (PCM) and Time Division Multiplexing (TDM). T1s were primarily used as trunk lines between Central Offices or COs (the T stands for Trunk). As corporate demands for voice and data communications grew, the telcos or "providers" began selling T1 service to businesses and other end users or "subscribers". It is now the most common form of high-speed digital communications used by larger organizations between multiple sites and for access to the Internet. Businesses, schools and Internet Service Providers (ISPs) are the biggest users of T1s. Many organizations have multiple T1s and for those who do not need a full T1, Fractional T1 (or FT1) service is also available from some providers. The most common form of FT1 local access is 56 Kbps.

T1 and the OSI Model:

T1 is an OSI layer 1 (physical layer) technology that links two locations as a transparent pipe through the Public Data Network (PDN). Layer 2 protocols such as HDLC and Frame Relay "ride on" T1 circuits (pipes) and layer 3 protocols such as IP and IPX can be passed over these pipes to link LANs together.

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The T1 Interface and TSU

The primary device used provide an interface to T1 (or FT1) service is a Channel Service Unit / Data Service Unit or CSU/DSU. Another term for a T1 CSU/DSU is TSU. The TSU allows access to the digital T-Carrier public network similar to the way a modem provides access to an analog line (local loop). The connection is provided by a Local Exchange Carrier (LEC) "the phone company" or an Inter-exchange Carrier (IXC) a "long distance company". The physical connection is usually located in a wiring closet or Main Distribution Facility (MDF) on the customer's premises. Most TSUs are about the size of an external modem. They can also be built-in or integrated into other devices such as routers. They can typically be configured to communicate from 64 Kbps (FT1) up to 1.544 Mbps (T1) in increments of 64 Kbps. A transmission rate of 64Kbps is known as a Digital Signal 0 (DS0). A T1 has 24 DS0s and is known as a DS1. T1s are commonly installed as dedicated point-to-point leased lines but may also be used to support Frame Relay and other packet switched networks.

The basic TSUs used with this lab will have two interfaces; one to the router and one to the public network provided by the phone company. The cable between the router and the TSU is attached to a DB60 synchronous serial port (S0 or S1) at the router and the other end is attached to the TSU high-speed serial Nx56/64 interface with a V.35 connector. A special T1 crossover cable, which simulates the phone company, is connected to the Network Interface (NI) ports between the two TSUs using RJ45 connectors. The T1 signal framing format and line encoding method may vary from one service provider to another so it is necessary to verify what they are using. Extended Superframe (ESF) framing and binary 8 zero substitution (B8ZS) line coding are common today.

Tools / Preparation:

Prior to starting the lab, the teacher or lab assistant should select a pair of 2500 or 1600 series routers. The Routers and TSUs should be connected as indicated in the diagram. The TSUs should already be configured and will provide the DCE clock for the routers. Work in teams of 2 or more. The following is a list of resources required.

- 2 Cisco routers (2500 or 1600 series) with at least IOS 11.2 (preferably 12.0)
- 2 ADTRAN T1 TSUs configured for ESF framing and B8ZS coding (1 will provide clock)
- 2 WAN Serial Cables – DB60 Male to V.35 Male DTE
- 1 specially wired CAT5 T1-crossover cable to connect the two network ports on the TSUs
- Workstation connected to the router console port for configuration
- Optional: two workstations (one on each router's Ethernet LAN) to test connectivity across the WAN from workstation to workstation.

Web Site Resources:

- **Terms and acronyms** - http://www.cisco.com/univercd/cc/td/doc/cisintwk/ita/index.htm
- **IP routing protocol IOS command summary -** http://www.cisco.com/univercd/cc/td/doc/product/software/ios120/12cgcr/rbkixol.htm
- **Introduction to WAN technologies -** http://www.cisco.com/univercd/cc/td/doc/cisintwk/ito_doc/introwan.htm
- **ADTRAN TSU ACE Information -**

http://www.adtran.com/data_sheets/html/61200/295/l1-8/index.html

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LAB 1 – T1 / TSU WAN LINK – ANSWERS

Step 1 – Examine the TSUs.

1. Look at the back of one of the TSUs and fill in the interface information in the following table:

Interface / Port Name	Interface connection / Cable type	Purpose / Function
Network	RJ45 / CAT5 UTP	Network Interface (NI) Connects to the provider's T-carrier network
V.35 Nx56/64	V.35 Female / DB60 to V.35 Male	Connection to router serial interface (S0 or S1)

Step 2 – Connect the Routers and TSUs

Start with all equipment turned off. Attach each router to a corresponding TSU V.35 Nx56/64 port using the V.35 DTE cables. Connect the two TSUs together using a special T1 crossover cable between the network ports to simulate the telco (A regular cable comes with the TSU for attachment to a rea1 T1 connection).

Step 3 – Configure the Phoenix Router

Configure the Phoenix router for connection to the TSU according to the diagram. One of the TSUs will provide the DCE clock so it is not necessary to set the clock rate on the serial interface.

2. What routing protocol will be used? **IGRP, autonomous system 100**

Use the show interface (abbrev: sh int) command to answer the following questions:

Phoenix# show interface

3. What is the IP address and subnet mask of interface Ethernet 0? **192.168.2.1 / 255.255.255.0**
4. What is the encapsulation for interface Ethernet 0? **ARPA**
5. What is the IP address and subnet mask of interface Serial 0? **10.1.1.2 / 255.255.255.0**
6. What is the encapsulation for interface Serial 0? **HDLC**
7. What is the default bandwidth (BW) for interface Serial 0? **1544 Kbit (or 1.544 Mbps)**

Step 4 – Configure the Denver Router

Configure the Denver router for connection to the TSU according to the diagram. One of the TSUs will provide the DCE clock so it is not necessary to set the clock rate on the serial interface.

Use the show interface (abbrev: sh int) command to answer the following questions:

Denver# show interface

8. What is the IP address and subnet mask of interface Ethernet 0? **172.16.3.1 / 255.255.255.0**
9. What is the encapsulation for interface Ethernet 0? **ARPA**
10. What is the IP address and subnet mask of interface Serial 0? **10.1.1.3 / 255.255.255.0**
11. What is the encapsulation for interface Serial 0? **HDLC**
12. What is the default bandwidth (BW) for interface Serial 0? **1544 Kbit (or 1.544 Mbps)**

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Step 5 – Test the WAN Connection between the routers

13. From a console connection on the Phoenix router, Ping the IP address of the Serial 0 interface on the Denver Router. What was the result of the ping command? **Should be Successful**

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14. From a console connection on the Phoenix router, Telnet to the IP address of the Serial 0 interface on the Denver Router. What was the result of the Telnet command? **Should be successful**

Step 6 (Optional) Test Connection Between Workstations

If two Windows or comparable workstations are available, connect one to a hub on the Ethernet LAN off of each router. Workstation A should be connected to the LAN off the Phoenix router and workstation B connected to the LAN off of the Denver router. Connect each router's Ethernet interface to the corresponding hub.

15. Ping from the workstation A to the Denver router's Ethernet IP address. What was the result of the ping command? **Should be successful if workstation IP addresses are compatible**

16. Ping from the workstation A to workstation B's IP address. What was the result of the ping command? **Should be successful if workstation IP addresses are compatible**

17. Telnet from the workstation A to the Denver router's Ethernet IP address. What was the result of the Telnet command? **Should be successful if workstation IP addresses are compatible**

18. Telnet from the workstation A to workstation B's IP address. What was the result of the command? **Should NOT be successful. A Workstation can be a Telnet client but not a Telnet server (no Telnet daemon).**

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Instructor Notes – TSU and Router Configuration

Step 1 – Configure Framing and Line Coding on Both TSUs
Use the TSU LCD menu to configure (or verify) that the network interface (NI) for each TSU is configured to support Extended Superframe (ESF) framing and Binary Eight Zero Substitution (B8ZS) line coding. The main menu has 4 options: **1) STATUS, 2) CONFIG, 3) UTIL and 4) TEST.** Perform the following for each TSU.

a. Turn on the power switch on the back of the TSU.
b. Press the **DOWN** button until main menu item **2) CONFIG** is selected and press **ENTER.**
c. Press **ENTER** to select menu option **1) NETWORK (NI)**
d. Verify that option **1) FORMAT:** (framing) is set to **ESF (**the default is **AUTO).**
   If it is not, press **ENTER** while on option 1 and then press the **DOWN** button until you see **ESF** and then press **ENTER** again (you may press **CANCEL** to ignore a setting)
e. Verify that option **2) CODING:** (line coding) is set to **B8ZS (**the default is **B8ZS).**
   If it is not, press the **DOWN** arrow until you get to option **2) CODING** and then press **ENTER.** Then press the **DOWN** button until you see B8ZS and the press **ENTER** again. (You may press **CANCEL** to ignore a setting)
f. To return to a prior menu, press **CANCEL** when the cursor is on a menu item number.

Step 2 – Configure the Phoenix TSU to Provide Clock Signal
Configure (or verify) that the network interface (NI) for only ONE of the TSUs (Phoenix) is configured to provide an internal click signal for the DTE devices (routers) across the WAN.

a. Turn on the TSU
b. Press the **DOWN** button until menu item **2) CONFIG** is selected and then press **ENTER.**
c. Press **ENTER** to select menu option **1) NETWORK (NI)**
d. Press the **DOWN** button to get to option **5) CLOCK SOURCE**
e. Verify that option **5) CLOCK SOURCE:** is set to **INTERNAL** (the default is **NETWORK**)
f. If it is not, press **ENTER** while on option 5 and then press the **DOWN** button until you see **INTERNAL** and then press **ENTER** again (you may press **CANCEL** to ignore a setting)
g. To return to a prior menu, press **CANCEL** when the cursor is on a menu item number.

Step 3 – Configure the Denver TSU to Use the Phoenix TSU Clock Signal
Configure (or verify) that the network interface (NI) on the Denver TSU is configured to use the network clock signal (the default) generated by the Phoenix TSU.

a. Turn on the TSU
b. Press the **DOWN** button until menu item **2) CONFIG** is selected and then press **ENTER.**
c. Press **ENTER** to select menu option **1) NETWORK (NI)**
d. Press the **DOWN** button to get to option **5) CLOCK SOURCE**
e. Verify that option **5) CLOCK SOURCE:** is set to **NETWORK** (the default)
f. If it is not, press **ENTER** while on option 5 and then press the **DOWN** button until you see **NETWORK** and then press **ENTER** again (you may press **CANCEL** to ignore a setting)

g. To return to a prior menu, press **CANCEL** when the cursor is on a menu item number.

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Step 4 – Build a T1 Crossover Cable

A T1-crossover cable must be used to connect the network interface (NI) ports between the TSUs to simulate the phone company. The T1-Crossover cable is made from CAT5 with RJ45 connectors. Use the following pin outs to build the cable (refer to the ADTRAN TSU manual for details of each pin's function):

Pin 1 to Pin 4
Pin 2 to pin 5
Pin 4 to pin 1
Pin 5 to pin 2

Step 5 – Set TSU password and lock keypad (Optional - Instructors only)

A passcode can be set and the keypad locked on the ADTRAN TSUs to prevent tampering with the configuration settings or creating an unknown passcode. Setting the passcode will require that it be known to lock and unlock the keypad. To set the password and lock the keypad perform the following steps:

a. Turn on the TSU
b. Press the **DOWN** button until menu item **3) UTIL** is selected and then press **ENTER.**
c. Press the **DOWN** button to get to option **5) SET PASSCODE**
d. Press **ENTER** to select option **5) SET PASSCODE.** The passcode is 4-digit numeric and is set to 0000 as a default which requires no passcode.. Press the **UP** or **DOWN** buttons to change the numbers. Pressing **ENTER** accepts a number and moves to the next one. **Set the passcode to 9999 and press ENTER.**
e. Press the **DOWN** button to get to option **6) KEYPAD**. The default is **LOCKED.**
   Note: The keypad may be locked without setting a passcode
f. Press **ENTER** to select option **6) KEYPAD**
g. Press the **DOWN** button to lock or unlock the keypad.
h. Press **ENTER** to lock the keypad. Once the keypad is locked the passcode displays as **????** and no settings may be changed without unlocking the keypad.
i. To unlock the keypad. Press **ENTER** on the **KEYPAD** option and press the **DOWN** button to select **UNLOCK**. When you attempt to unlock the keypad you will be prompted for the passcode.
j. NOTE: If the correct passcode is entered and the keypad is unlocked the passcode may be changed.

Step 5 – Reset TSU to Factory Setting (Optional - Instructors only)

a. Turn on the TSU
b. Press the **DOWN** button until menu item **3) UTIL** is selected and then press **ENTER.**
c. Press the **DOWN** button to get to option **7) FACT RESTORE**
d. Press **ENTER** to restore the TSU settings to the factory defaults. It the keypad is locked you will not be able to reset the defaults. The keypad must be unlocked and the passcode (if set) must be known.

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Instructor Notes – TSU and Router Configuration

Phoenix Router Configuration

The following output is a sample running config from the Phoenix router (Cisco 2514 with IOS 12.0). This configuration was created using the SETUP utility. Your configuration may vary.

```
Phoenix#sh run
Building configuration...
Current configuration:
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Phoenix
!
enable secret 5 $1$RzSl$h7YbTdpxwWl7bizbWmxk51
enable password cisco
!
ip subnet-zero
!
interface Ethernet0
 ip address 192.168.2.1 255.255.255.0
 no ip directed-broadcast
 no mop enabled
!
interface Ethernet1
 no ip address
 no ip directed-broadcast
 shutdown
!
interface Serial0
 ip address 10.1.1.2 255.255.255.0
 no ip directed-broadcast
 no ip mroute-cache
!
interface Serial1
 no ip address
 no ip directed-broadcast
 shutdown
!
ip classless
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 password cisco
 login
!
end
```

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Instructor Notes – TSU and Router Configuration

Denver Router Configuration

The following output is a sample running config from the Denver router (Cisco 2501 with IOS 12.0) This configuration was created using the SETUP utility. Your configuration may vary.

```
Denver#sh run
Building configuration...
Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Denver
!
enable secret 5 $1$.VLQ$HV/pERwdNIXVJusJqzF.W0
enable password cisco
!
ip subnet-zero
!
interface Ethernet0
 ip address 172.16.3.1 255.255.255.0
 no ip directed-broadcast
 no mop enabled
!
interface Serial0
 ip address 10.1.1.3 255.255.255.0
 no ip directed-broadcast
 no ip mroute-cache
 no fair-queue
!
interface Serial1
 no ip address
 no ip directed-broadcast
 shutdown
!
router igrp 100
 redistribute connected
 network 10.0.0.0
 network 172.16.0.0
!
ip classless
!
line con 0
 transport input none
line aux 0
line vty 0 4
 password cisco
 login
!
end

Denver#
```