Branch Office
EXTender™ 6000

Application Notes

Issue 2.1

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Notice

Every effort was made to ensure that the information in this book was complete and accurate at the time of printing. However, information is subject to change.

Your Responsibility for Your System's Security

Toll fraud is the use of your telecommunications system by an unauthorized party, for example, persons other than your company's employees, agents, subcontractors, or persons working on your company's behalf. Note that there may be a risk of toll fraud associated with your telecommunications system and, if toll fraud occurs, it can result in substantial additional charges for your telecommunications services.

Trademarks

EXTender 6000 is a registered trademark of MCK Communications.
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1. Application Overview

Overview

The Branch Office **EXT**ender™ 6000 extends the power of your PBX/KSU to any branch office, no matter where that office is located. A pair of EXTender 6000s can extend up to 8 digital phones out to a branch office, using as little as a 128K of network bandwidth. This provides your branch office employees with the full features of your corporate PBX/KSU including conference, transfer, 4-digit dialing, and even ACD capabilities.

The EXTender 6000 consists of:

a Switch module located at the PBX site
and a Remote module at the branch office.

The Switch module attaches to the PBX/KSU and the Remote module connects to the digital phones. The connection between the two units can be one of a variety of network circuits, but typically some form of digital leased line is optimal. A T1 or Fractional T1 TDM circuit is most common. (See Diagram A, below)

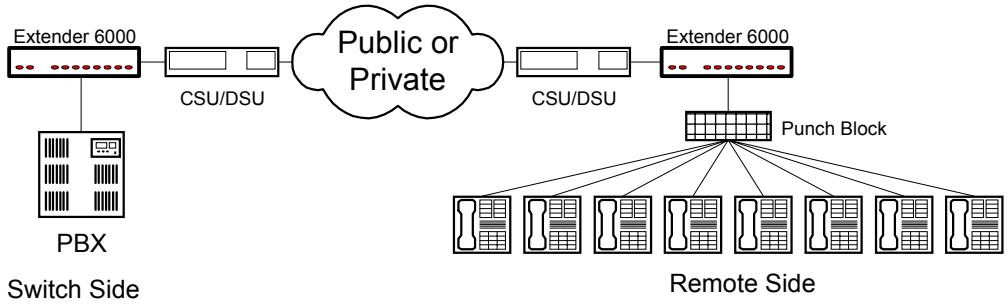

Diagram A

EXTender 6000 Network Connectivity

The EXTender 6000 is designed to interoperate with a variety of network termination equipment and types of networks. By using standard V.35, RS-232, or RS-530 synchronous, serial signaling, the EXTender 6000 can interface with standard CSU/DSUs and Terminal Adapters to communicate across a variety of network circuits. This includes a circuit that may already be in place for branch office data connectivity. Commonly, a branch office may provision a leased line T1 or Frac T1 to the corporate office. A multi-port CSU/DSU can be used to terminate the network link and provide one data port to an Ethernet router and another data port to the EXTender 6000. (See Diagram B). Some channels (i.e., DS0s) will be dedicated to the router and some will go to the EXTender 6000. This allows the branch office access to the corporate network and the PBX/KSU over a single leased line, without one function interfering with the other.

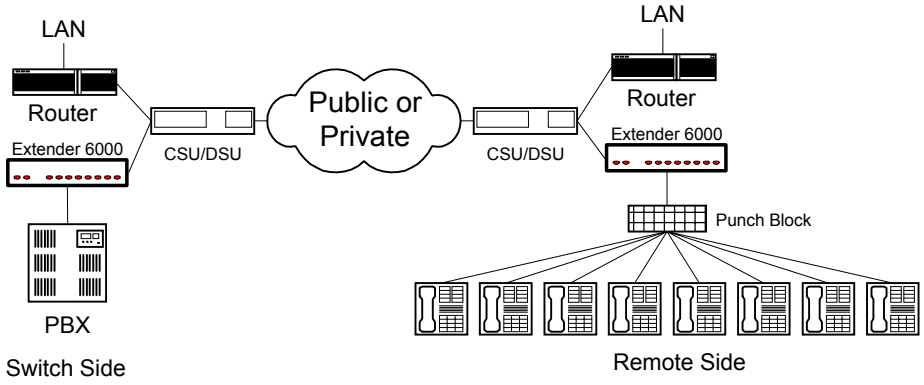

Diagram B

Network Bandwidth Requirements

The default setup for the EXTender 6000 allows all eight phones to simultaneously function over 384 Kbps of bandwidth. This translates into six 64K DS0 channels. However, the EXTender 6000 can handle all eight phones over as little as 128 Kbps of network bandwidth. The necessary bandwidth is totally dependent on the voice compression method selected and the number of phones in use simultaneously.

(For more information on bandwidth management, please refer to Chapter 2, *Establishing Required Data Bandwidth* and Chapter 3, *EXTender WAN Setup*, in this guide).

2. Establishing Required Data Bandwidth

Overview

One of the most important factors in the success of your EXTender 6000 is to determine the necessary network bandwidth needed for your application. If you do not select enough bandwidth, users could be blocked (i.e., fast busy signal) when attempting to place a call. Or if not configured properly, your users could experience data loss resulting in poor audio quality on phone conversations. This chapter will explain how to determine the size of the required bandwidth that will be used in your application of the EXTender 6000 units. Determining the appropriate bandwidth is a function of two factors:

1. Number of Users (Phones)
2. Voice Compression Method selected for Each User

Number of Users

The number of users is the number of *simultaneous* users (digital PBX/KSU phones) that will be extended at any given branch location. Physically, there can be up to eight *simultaneous* users for one EXTender 6000 pair.

Voice Compression Method

The EXTender 6000 employs voice compression in order to extend multiple users across fewer data channels. The EXTender 6000 supports the following industry-standard voice compression algorithms: 32 Kbps ADPCM, 24 Kbps ADPCM and G.729A. Depending on the voice compression algorithm selected, you may need anywhere from 16 Kbps (G.729A) up to 40 Kbps (ADPCM32) per user. This takes into account the actual voice plus signaling required.

Compression Algorithms and Corresponding Required Bandwidth

ADPCM 32	ADPCM 24	G.729A
40 Kbps	32 Kbps	16 Kbps

Using the *Establishing Required Data Bandwidth Formula* in this chapter, you can determine the total bandwidth necessary to support your application. If you have excess bandwidth on your network circuit, your network terminating devices could allow you to use that bandwidth to connect to a router or even another EXTender 6000. In order to accomplish this, you must have multiple data ports on your CSU/DSU.

(For more information on your network terminating devices, please see Chapter 5, *Network Terminating Equipment,* in this guide).

Selecting the Proper Voice Compression

The highest voice quality is achieved by using the ADPCM 32 compression. The maximum quality comes at the expense of the highest utilization of network bandwidth. The highest voice compression is achieved by using the G.729A method. If you are using this method, you will significantly save on the bandwidth and still achieve voice quality that is regarded as near toll quality. However, if absolute conversation quality is your focus and bandwidth is no object, you probably want to select ADPCM 32. If you are bandwidth limited you will employ G.729A. The units come with ADPCM 32 selected as the default.

Note: Voice compression method is set through the "`Configuration->Port`" menu on the Management Interface (MI) of the EXTender 6000 Switch unit.

Voice Quality Expectations

Extenders use industry standard voice compression methods to allow multiple users to connect across fewer DS0 channels. While the voice quality should remain excellent in all circumstances, you may notice some minor affects depending on the voice compression selected. The person you are talking to on the other end should not notice these affects in most instances.

The G.729A algorithm only uses 8Kbps for its audio path. It therefore dramatically reduces the amount of network bandwidth required to extend multiple phones. It also provides excellent voice quality to all parties involved in a conversation. However, this algorithm is designed to optimize audio in the frequency range of the human voice. Tones outside of that range may sound muffled. Also, listening to audio that has already been compressed may sound slightly less clear. Here are some of the affects you may notice with compressed audio:

- Hold Music may sound less clear.
- Dial Tone, DTMF Tones, and phone Rings may sound garbled particularly on speakerphone. They still should function properly 100% of the time.
- May experience some minor echo and reduced audio clarity when calling some Cell phones. They often already compress audio.
- May hear some echo and notice minor delay in the conversation if calling internationally. This is caused by the delay in providing compressed audio with the fact that calling internationally may already introduce some delay.

If you are experiencing any of these problems and feel that it is not presenting you with adequate voice quality, we recommend making sure that you are using the ADPCM 32 voice compression method. While it requires more network bandwidth, it uses less voice compression and therefore minimizes the chances of any of these affects from ever occurring.

Establishing Required Data Bandwidth in My Application

Please use the following formula to establish your aggregate data bandwidth needs.

(_____ x 16) + (_____ x 32) + (_____ x 40) = _____
number of G.729A users | number of ADPCM 24 users | number of ADPCM 32 users | Kbps Bandwidth required

Multiply the number of ports (i.e. phones) using G.729A with the required bandwidth. Do the same for the other two compression methods. Add all three numbers and you are done. This is the necessary network bandwidth that needs to be available between your branch office EXTender and your PBX/KSU. This result will be useful when provisioning lines or setting up network terminating equipment. In the box provided underneath, write down your bandwidth requirement for future reference.

IMPORTANT NOTE: Before you proceed to the next chapter of this manual, make sure that you have established your network bandwidth requirement. You will use this information in the next few chapters of this guide.

Total Bandwidth Requirement | |

3. EXTender WAN Set up

Overview

When you are selecting your voice compression method to use with each phone port, you are affecting the amount of data traffic that will flow between the two EXTender units. Since this data needs to get across your network circuit (WAN), establishing your data bandwidth actually defines what the WAN bandwidth needs to be. You established your data bandwidth requirements in the previous chapter. The EXTender 6000 WAN set up will be covered in this chapter. It is important to set up the EXTender 6000 units to satisfy your bandwidth needs and to match bandwidth with your network terminating equipment.

EXTender WAN Configuration

You can set the network bandwidth of the EXTender 6000 by configuring the two available WAN ports (although most applications will only require one WAN port). Each WAN port's bandwidth can be configured in either 64 or 56 Kbps increments. Notice that these numbers are related to the bandwidth size of DS0 time slots. The maximum configurable port bandwidth is 30 X 64 or 1920 Kbps. This far exceeds the bandwidth necessary to extend eight digital phones.

The WAN ports of the EXTender 6000 directly connect to the data ports on the network terminating equipment (i.e. CSU/DSU). The WAN port's bandwidth on the EXTender 6000 should exactly match the data port bandwidth configured on the network terminating equipment. This is extremely important because of the timing issues between the EXTender units and the network.

If the bandwidth between the EXTenders and the CSU/DSUs is not properly synchronized, you will be wasting bandwidth or creating conditions for dropped voice packets.

Setting the EXTender's WAN ports below the CSU/DSUs data port wastes bandwidth, while setting it too high leaves the possibility for dropped voice packets.

Configurable Bandwidth per WAN Port

Number of DS0s	1	2	3	4	5	6	……	30
56K increments	56	112	168	224	280	336	……	1,680
64K increments	64	128	192	256	320	384	……	1,920

WAN Port Signaling

The WAN ports on the EXTender 6000 are capable of three types of serial signaling: RS-232, V.35, or RS-530. However, the performance of the EXTender 6000 units is unrelated to the type of signaling. The EXTender 6000 product supports multiple signaling so it can connect to many different types of terminal equipment. Remember that in all cases, the EXTender 6000 is expecting synchronous signaling with the clock to be provided by the network terminating device.

Please note that the RS-232 interfaces generally cannot run at higher than 224 Kbps. For higher bandwidth needs, you should use V.35 or RS-530 signaling. In addition, the EXTender 6000 WAN port signaling must match the data port signaling on the network terminating equipment. Both the Sync Rate (i.e. bandwidth) and the signaling are set through WAN configuration menu on the Management Interface of the EXTender 6000.

Bandwidth Management Chart and WAN Bandwidth Configuration

In Chapter 2, you determined your total network bandwidth requirement for your Branch Office EXTender application. However, the WAN ports of the EXTender 6000 and the data ports of your CSU/DSU need to be configured in 64K or 56K increments. If your DS0s on your CSU/DSUs are set for 56 Kbps time slots, use 56K increments. If they are set for 64 Kbps time slots, use 64K increments.

Note: If you do not know how your DS0s are configured, you may need to contact your network providers or your network equipment manufacturer for configuration instructions.

Table 1.0, below, is designed to simplify the determination of the number of DS0s needed for your application. **This Table only applies if all digital PBX/KSU phone ports are configured to run the same voice compression method.** The default is for all 8 phones to run ADPCM 32. If all phones run the same compression method, and you know the number of the phones that will be used plus the type of DS0 channels, circle the appropriate number in this chart. Then multiply that number by either 64,000 or 56,000. That is the number that should be entered for WAN port Sync Rate, and the data rate of your network terminating equipment's data port.

Number Of Users	Required Bandwidth in DS0, 64Kbps (56Kbps) according to compression technique		
	G.729A	ADPCM 32	ADPCM 24
1	1 (1)	1 (1)	1 (1)
2	1 (1)	2 (2)	1 (2)
3	1 (1)	2 (3)	2 (2)
4	1 (2)	3 (3)	2 (3)
5	2 (2)	4 (4)	3 (3)
6	2 (2)	4 (5)	3 (4)
7	2 (2)	5 (5)	4 (4)
8	2 (3)	5 (6)	4 (5)

Table 1.0 Bandwidth vs. Compression

Note: If you are employing different compression algorithms for various users, do not use Table 1.0 on the previous page, read the following paragraph.

Use the required bandwidth size that you have established in the Chapter 2. Depending on the size of your DS0 time slots (64K or 56K), divide the established bandwidth from the previous chapter by either 64 or 56. Round the number you obtain to the next higher digit.

Example: If you have established that your bandwidth requirement is 240 Kbps and you know that your DS0 channels are configured for 56 Kbps, divide the 240 by 56. You will get 4.29. By rounding it to the next higher digit, you will need to use 5 DS0s for your application. Multiply 5 times 56,000 and you get 280,000. This is the number that should be entered into the Sync Rate for WAN1 on your EXTender 6000 pair. This will need to match the data port of your network terminating device.

_____ / 64K or (56K) =_____ → _____
Required Bandwidth (from Chapter 2) | result | round off to the next higher integer (this is your required number of DS0's)

_____ X 64,000 or (56,000) = _____
required number of DS0s | WAN Port Sync Rate

Deliberately Undersourcing WAN Bandwidth

Deliberately undersourcing bandwidth means that you can deliberately set the WAN bandwidth lower than required to maintain all phones simultaneously.

Example: If you are running G.729A compression on all eight phones, you will need two 64K WAN channels. If you elect to use only one channel (for example a single 64K DDS circuit), you are undersourcing your WAN bandwidth. Based on the fact that not all users will be on the phone at the same time, you may be able to conserve bandwidth and still get excellent performance.

Blocking Calls that Exceed WAN Bandwidth

The most common method of preventing too many phones from going off-hook simultaneously is to give a fast busy signal whenever the bandwidth limitation is reached. This is referred to as "Blocking Calls." This is a useful and practical method and prevents degradation in audio quality due to inadequate network bandwidth. The benefit is that if you statistically believe that at any given time fewer than 8 users are actually on the phone simultaneously, you can reduce your bandwidth needs and save money. The drawback is that additional users looking to place or receive a call get a fast busy when they try to go off-hook. In addition, incoming calls will ring and then go into voice mail if all bandwidth has been exceeded.

To implement the Blocked Call method of preserving network bandwidth, simply under-allocate the bandwidth on the WAN port of the EXTender 6000 pair, and on the data ports of the network equipment. You should make sure that the EXTenders and the network equipment synchronous data rates still match. This setting is in the "`Configuration->WAN`" menu of the MI. In addition, you need to change the voice path to "Dynamic" instead of "Constant" which is the default voice path parameter found in the "`Configuration->Port`" menu of the MI on the Switch unit.

Using Additional WAN Ports

Most Branch Office EXTender 6000 applications only require the use of one WAN port. However, both ports can be used simultaneously or, more importantly, as a backup for one another. One reason to use both WAN ports is to provide enough bandwidth for 8 phones using a pair of leased line DDS circuits. Each DDS circuit might give you 64K of network bandwidth. By using two circuits and two CSU/DSUs, you can connect to both WAN ports and provide a total of 128K, which is enough to extend 8 phones using the G.729A voice compression method. Another reason for connecting both WAN ports is for network redundancy. If you have a fractional T1 connected through a CSU/DSU to WAN 1, you probably have enough bandwidth for all 8 phones. However, if something happens to that circuit at the Central Office of your provider, your branch office would be completely disconnected. To prevent this, you can provision a lower bandwidth 64K DDS or ISDN circuit for WAN 2. You might even provision it through an alternate network provider to ensure additional redundancy. This link will automatically be activated if, for any reason, the phones cannot communicate over WAN1. (See Diagram C, below)

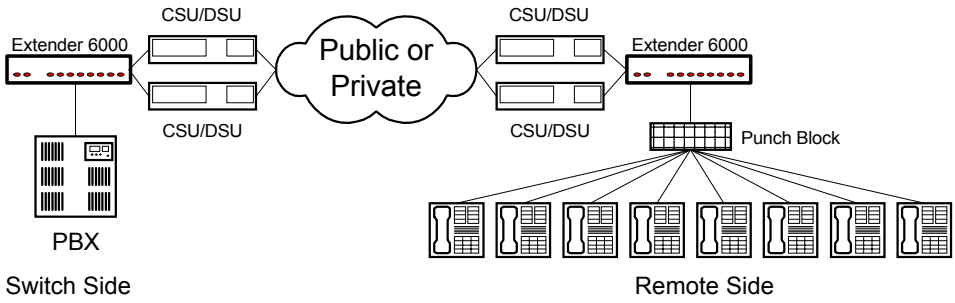

Diagram C

Activating multiple WAN ports is done through the WAN1 and WAN2 configuration screens of the EXTender 6000 Management Interface. Make sure to match the Synch Rate and Signaling method of your CSU/DSU or Terminal Adapter connected to each WAN port. You also need to add a secondary connection on the `"Configuration->Connect"` menu within the MI.

Note: Consult your EXTender 6000 System Administrator's Guide for more information.

4. External Network Set up

Overview

In the previous chapters, you established your required network bandwidth and the corresponding WAN configuration on the EXTender 6000 units. This chapter explains the network setup outside of your EXTender 6000 units required for successful deployment of your branch office application.

Data connectivity between the EXTender 6000 pair is handled through the facilities of a public network carrier. The public network allows the EXTender 6000 pair to transport its data across long distances. A public network, along with the accompanying network terminating equipment, also provides a synchronization clock source. Any public network that can be configured to comply with these EXTender 6000 requirements can be used for the WAN connection.

Types of Networks

- T1 or Frac T1 using TDM (Time Division Multiplexing)
- 56/64K DDS (Digital Data Service)
- ISDN

Although any of these networks can be configured for the EXTender 6000 connectivity, this guide currently focuses on TDM T1/Frac T1 and the 56/64K DDS applications.

Selecting a Network Circuit for your Branch Office

There are several factors to consider when selecting your network for your Branch Office EXTender 6000. We have already discussed bandwidth requirements in detail, and that is an extremely important selection criteria for your network. In addition, when selecting your network type, you should consider the reliability and the cost of the network service. The EXTender 6000s can only perform as well as your network performs. Before selecting your network, consider the reliability of the service.

T1 and Fractional T1 (TDM)

Point-to-point digital leased lines are generally the most reliable since they are dedicated circuits. Not only are they extremely reliable, but T1 and Fractional T1s have adequate bandwidth for both your extended phones and your data network connectivity. The only obstacle to providing a dedicated Frac T1 to a branch office can be cost. If you are extending a branch office that is physically far away from the PBX/KSU, it may not be cost effective to use a dedicated point-to-point circuit, particularly if it is a small office. (However, with a dedicated line, there are no usage charges since they are generally billed as a monthly flat rate.) Overall, T1 service is a very reliable way to extend phones AND provide data network connectivity to your branch office, at a fixed monthly cost.

Digital Data Service (DDS); 64/56K

A 64K or 56K digital leased line or DDS circuit (Digital Data Service), is also highly reliable, but bandwidth can be an issue. In order to extend all 8 phones simultaneously you will either have to provide 2 DDS circuits or undersource your bandwidth (see Chapter 3). If you can overcome bandwidth limitations, 2 DDS circuits can be a good choice as the monthly cost is usually less than a Frac T1. It is also a dedicated point-to-point circuit so reliability is high. In general, these circuits are billed at a monthly flat rate.

ISDN

ISDN may also be a cost-effective method to connect your Branch Office EXTender 6000 back to your PBX/KSU. If you bond the ISDN B-Channels you can get a 128K connection and extend up to 8 phones over a single ISDN line. In addition, you can use 2 ISDN lines connected to both EXTender 6000 WAN ports to get up to 256K for your application. Note that, ISDN is a switched circuit rather than a dedicated circuit. This means that you may be prone to intermittent connection problems. In addition, in many areas, ISDN has usage charges on a per minute basis, plus long distance charges if your branch office is out of the area. ISDN terminal adapters do not all support synchronous RS-232 mode, making your selection of network equipment somewhat limited. These factors can make ISDN less effective than the dedicated circuit approach to extending your phones, but an excellent back-up alternative to provide redundancy.

Combination of Network Services

It is possible to use a combination of any two network services to provide the necessary bandwidth for your EXTender 6000 application. While this may not be as cost-effective, it certainly has its advantages. This method's primary advantage is that you have network redundancy by providing alternate network paths for your EXTender 6000. If one network is suffering from problems, the Branch Office EXTender automatically rolls over to a secondary line. While the bandwidth would likely be reduced, it can provide excellent back-up. To provide this application, you would need to enable both WAN ports on your EXTender 6000 pair.

Connecting EXTenders Over Point-to-Point TDM T1/FT1

A point-to-point, TDM T1 line allows 24 bandwidth time slots per second. Each of these can carry either voice traffic (PBX/KSU) or network data (i.e. router). The type of traffic that is carried over the time slots is determined in your terminal equipment (CSU/DSU) and in the line provider's terminal equipment. For the purposes of provisioning the line from your network provider, they consider EXTender 6000 traffic as traditional data, not voice. The fact that it contains compressed voice within its data packets is irrelevant to them. Therefore make sure to specify you are using the lines for <u>data traffic,</u> not voice or PBX/KSU traffic. If you need assistance in setting up your access to the T1/FT1 line, please consult your line provider and/or Chapter 5, *Network Terminating Equipment*, and Chapter 6, *Configuring Common Customer Premise Equipment*, in this guide.

Note: *When connecting the EXTender 6000, the DS0 time slots must carry data.*

If you have a CSU/DSU that has multiple data ports, you could simultaneously plug your EXTender 6000 and your LAN router into the same network circuit. (Diagram D, below).

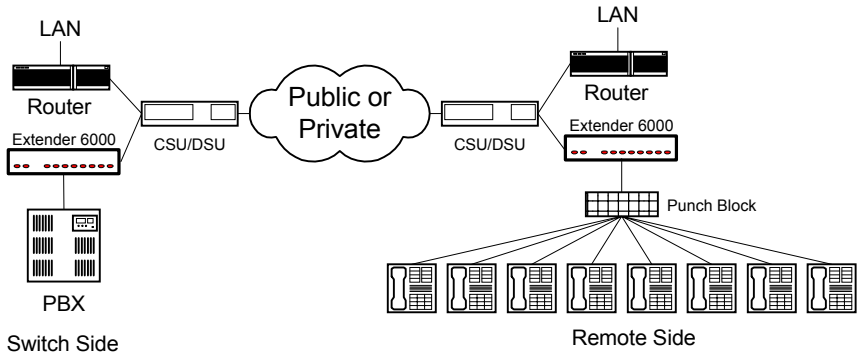

Diagram D

You could also plug multiple EXTender 6000 units into the same CSU/DSU and extend 16 phones or more. (Diagram E, below).

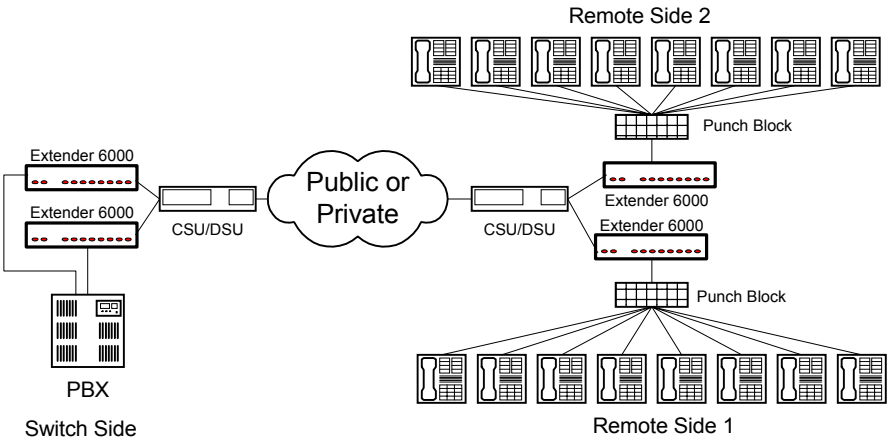

Diagram E

Connecting EXTender 6000 Over 56/64K Digital Data Service (DDS)

A digital data service line has only one data time slot. Because of the bandwidth constraint, this application is limited. If you are connecting your EXTender 6000 over DDS, you need a minimum of two DDS lines to use all eight phones simultaneously. You must use both WAN EXTender 6000 ports and the G.729A compression on all eight digital phone ports, unless you use undersourcing of bandwidth, from Chapter 3, *EXTender WAN Setup*. (Diagram F, below)

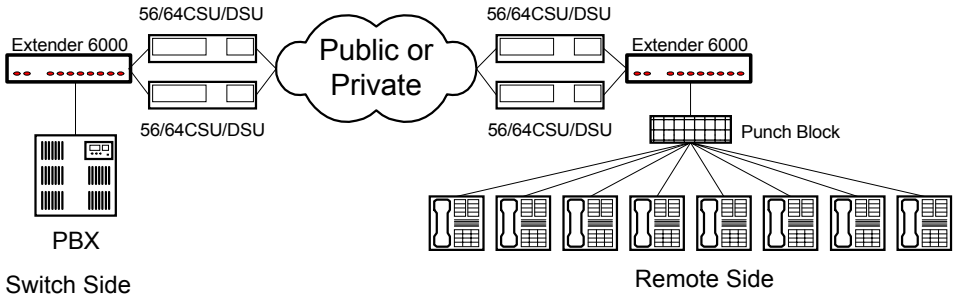

Diagram F

If Lines are not in Place

Before leasing a circuit to connect your EXTender 6000 pair, make sure to read the Establishing Required Data Bandwidth chapter of this manual. You want to make sure that you provision your network with enough bandwidth to support your application.

If Lines are in Place

If the line has already been installed, make sure that you have enough bandwidth to fulfill the EXTender 6000 requirements. If you have insufficient bandwidth, consult your line provider to obtain more.

(For further information, please refer to the Chapter 2, *Establishing Required Data Bandwidth.)*

Understanding Network Connectivity

When you are using the EXTender 6000 units over a point-to-point public circuit, you are essentially extending the serial connection between units over a public network. Unfortunately, the leased line providers cannot supply you with a serial cable connection that would span from your PBX/KSU location to a remote place. Instead, they can provide circuit switched, point-to-point TDM lines. These TDM lines require terminal equipment CSU/DSU at your premise. The conversion from serial signaling to a circuit switched protocol actually happens in your CSU/DSU. The signal is converted back to the serial signaling at the remote location CSU/DSU. Thus, the signal between the two EXTender 6000 units, over a leased line, flows back and forward in the 'serial/TDM/serial' format. (Diagram G, below)

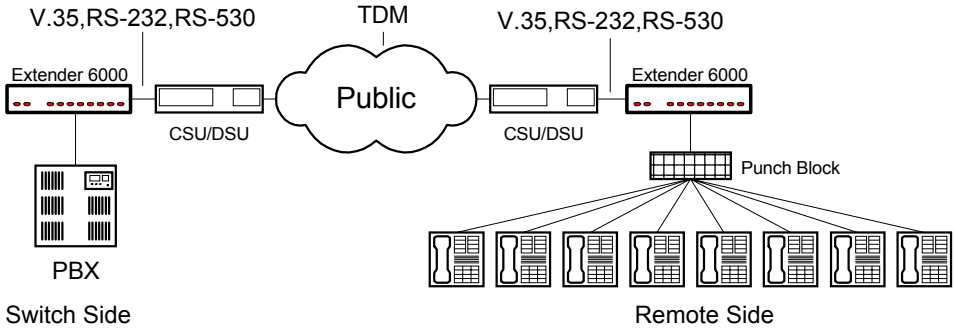

Diagram G

5. Network Terminating Equipment

Overview

In order to communicate over a public network circuit, the EXTender 6000 units require external network terminating devices. The type of network terminating equipment needed depends on the type of network and the number of devices that need to be connected to it. In the previous chapter, the network possibilities are described for the deployment of the EXTender 6000. This chapter will focus on the requirements of the network equipment to be used on those networks. This guide currently focuses most of its attention on network terminating devices that work with TDM circuits (i.e. T1/Frac T1). Those devices consist of CSU/DSU equipment.

Interface Type

The WAN, or the network, side of the EXTender 6000 units physically connects to the data port of the associated network termination device. The WAN ports provide a synchronous serial interface to that network termination device. The physical connector on the EXTender 6000 consists of a DB-25, but it is software selectable to support a variety of signaling such as RS-232, V.35, or even RS-530. To connect to a corresponding V.35 interface you may need a DB-25 to M34 adapter, although many CSU/DSUs support V.35 over DB-25 much like the EXTender 6000. See the System Administrator's Guide for details on the actual pin-outs for the EXTender 6000 WAN interface.

Note: It is necessary that the EXTender 6000 WAN port protocol match the data port protocol on the network terminating equipment.

Types of Network Terminating Devices

CSU/DSU – CSU/DSU equipment is usually used to terminate a T1 or Frac T1. In addition, DDS circuits (64K/56K leased lines) usually require CSU/DSU type of equipment although the network interface is very different. EXTender 6000 units can connect directly to a CSU/DSU which typically provides a V.35 synchronous interface. There is more information on CSU/DSU equipment later in this chapter.

Terminal Adapters – To operate across ISDN, you need to have an ISDN Terminal Adapter (TA). TAs can connect directly to the EXTender 6000 using a synchronous RS-232 interface. Make sure that your TA supports synchronous mode, as many only support asynchronous communication. In addition, the TA must support manual dialing from a front panel or DTR dialing rather than AT command dialing. To dial using a TA, the EXTender 6000 just sets DTR. It does not send AT commands.

Requirements for Network Terminating Equipment

In order to operate with the EXTender 6000, your selected network device must support the following:

Synchronous Serial Interface – As mentioned earlier, the EXTender 6000 has two WAN ports that operate as serial interfaces. They only support synchronous communication, so your network device must also support synchronous mode (many TA's do not). In addition, your network device must support V.35, RS-232, or RS-530 signaling.

Clock Source – The EXTender 6000 is externally clocked, so the network device connected to the WAN port must provide clock source to the EXTender 6000. This is necessary for synchronous communication to work.

Serial Communications Protocol – The EXTender 6000 communicates through its serial WAN interface as most devices do. It is a standard DTE (Data Terminal Equipment), and it expects to be connected to a standard DCE (Data Communications Equipment). The following describes the connection and data communication process that the EXTender 6000 expects:

EXTender raises DTR signal and then looks for the DSR signal.
EXTender waits for DCD signal.
EXTender raises RTS signal and then waits for the CTS signal.

In addition, the EXTender 6000 is externally clocked as mentioned above. Therefore, it assumes that the network device will provide clock source and will use the Receive Clock and Transmit Clock pins to do so.

Error Correction (not required) – It is important to note that the EXTender 6000 does NOT rely on the network device to do error correction. EXTender 6000 data packets are contained within HDLC frames, and handles its own error correction. In fact, in some instances, the network devices error correction scheme could interfere with the operation of the EXTender 6000.

Tips on Setting up Network Connection Using CSU/DSU over Leased Lines

Note: Before you deploy your CSU/DSU, please verify that your leased circuit is installed, configured and functioning properly on both ends of the leased line.

1. Consult your line provider about the fractional or full T1 line configuration.
2. Configure your CSU/DSU units to match your provider's line configuration. There are three things that you need to know: frame-format, line coding and idle channel coding. Ask your line provider to supply you with these.
3. If possible, have your line tested by conducting a remote loop line test. Many newer CSU/DSUs have these testing procedures built in. If your equipment does not have these capabilities, ask your line provider to conduct the tests.

Suggested Network Terminal Equipment Models

Make sure that you select the proper network terminating equipment. A list of tested equipment is provided, however it does not exclude non-tested equipment. Usually, if a manufacturer's equipment is listed, it means that the rest of the equipment by the same manufacturer will be applicable. The installation procedure for the non-listed models will likely vary only slightly from the listed models. In addition, any equipment that meets the requirements listed above should work with the EXTender 6000.

Network	Model	Manufacturer	Type
T1/FT1	ACCULINK 3160/3162/3164	Paradyne	CSU/DSU
T1/FT1	DataMAX T1/FT1	ADC Kentrox	CSU/DSU
T1/FT1	TSU LT	Adtran	CSU/DSU
T1/FT1	554 A	GDC	CSU/DSU
T1/FT1	926x/916x	Paradyne	Access MUX
56/64K DDS	D-SERV56/64	ADC Kentrox	CSU/DSU
56/64K DDS	3600 Series	Paradyne	CSU/DSU
ISDN	ISU 512	Adtran	Inverse Multiplexer
ISDN	ISU 2 X 64/128	Adtran	TA

Understanding CSU/DSU Equipment

The network terminating equipment for the TDM leased lines is actually a combination of two devices, the Channel Service Unit (CSU) and the Data Service Unit (DSU). Manufacturers, such as ADC Kentrox or Paradyne combine these units into single boxes. Many multiplexing and cross connecting devices also have the same type of functionality.

DDS CSU/DSUs versus T1/FT1 CSU/DSUs

There is a difference between the CSU/DSU device used in T1/Frac T1 applications and the device used in DDS (digital data service) applications. In order to ensure that your EXTender 6000 will function properly, you must originate and terminate the lines with the appropriate type of device. If you are using your EXTender 6000s over T1/Frac T1, you must use T1/Frac T1 CSU/DSUs on the Switch and on the Remote end of the circuit.

Detailed CSU/DSU Device Set up

For detailed instructions on how to set up the CSU/DSU devices, please refer to the factory manuals of the equipment that you are using.

(For the instructions on setting up typical CSU/DSU's, please refer to Chapter 6, *Configuring Common Customer Premise Equipment*).

6. Configuring Common CPE (Customer Premise Equipment)
Point to Point, TDM Connections
BACKGROUND
Point to point, Time Division Multiplexed, (TDM) connection usually terminates with either a Channel Service Unit, (CSU) or an essentially more capable CSU, commonly known as access multiplexer. A CSU receives and transmits signals from and to the Wide Area Network, (WAN) and provides a barrier for electrical interference between the WAN and the user sides. CSUs are also capable of echoing loopback signals from the service providing company. In the past, this loopback has been used for testing conducted by the provider companies. As of past few years, Customer Premise Equipment, (CPE) is becoming more sophisticated, allowing customers to perform tests and performance monitoring.

ORDERING a TDM POINT to POINT CIRCUIT
Generally, when you order a point to point TDM connection, you will have to ask your local provider about the frame format and about the line coding. If possible, your line frame format should be Extended Super Frame ESF and your Line Coding should be B8ZS. If your provider equipment does not support these, you could settle for different frame formats and line coding types as long as your CSU/DSU equipment will support them.

DSU and CLOCK SOURCE
If you are using the EXTender 6000 over a point to point circuit, your CSU or access multiplexing equipment must have the Data Service Unit, (DSU) option. The DSU manages synchronized line control, and converts input and output between serial signal interfaces, RS-232, RS-520 or V.35 from the user side and the time-division multiplexed interfaces, on the WAN side. Since the clock source is drawn from the WAN side, CSU/DSUs must run in the 'slave to the WAN' clock mode. In turn, the Extender 6000 draws clock from the CSU/DSUs. Hence, Extenders indirectly draw clock from the WAN via CSU/DSUs.

MORE ABOUT CLOCKS
If you are running a typical installation of Extenders over a point to point, leased TDM circuit, you must set your CSU/DSUs to draw the clock from the WAN. This is done in the NET or the WAN menu. Whether the menu is referred to as WAN or NET, solely depends on a manufacturer's choice of labeling. Do not get confused. Although, there might be multiple places where you could set the clock in a CSU/DSU, you should only configure your CSU/DSU to draw the WAN clock. All other clocks will be automatically configured.

Note: CSU/DSUs can draw clock sources from individual data ports or if they have the Add/Drop option, from the DSX port. This option might be useful for some other applications, nonetheless, in the case of the Extender 6000, the data port clock source should always be set to internal. In reality, you will not have to worry about this setting since all CSU/DSUs are factory configured with this setting.

STEP BY STEP PROCEDURE in SETTING UP a CSU/DSU

1. Before you plug your CSU/DSU into the D mark plug, you should try to test your point to point line. This is either done by a professional testing equipment or in some instances by your own CSU/DSUs. The provider that installed the line may already have done this.
2. Plug your CSU/DSUs into the D mark installed by your WAN provider. If your CSU/DSU has built in loop back testing and diagnosis capabilities, you should try to run those tests. For details on how to run the tests, consult your CSU/DSU manual.
3. Usually, your CSU/DSUs will automatically synchronize with the WAN. If this is the case, proceed to step five.
4. If not, you must change options in the WAN or NET menu so that your CSU/DSU will synchronize with the WAN. Your WAN provider will inform you about your point to point circuit configuration.

   In a typical installation, there are three things that you may need to configure:

   - **Clock**
     As mentioned above, the WAN clock must be set to NET (slave to WAN or NET).
   - **Frame format**
     There are various types of TDM frame formats. Some typical ones are D4, Extended Super Frame, Ericsson etc.
   - **Line coding**
     Line coding could be typically set to either B8ZS or AMI (older version).

If after configuring these three common parameters, your WAN does not come up, consult your manual and your service provider on how to take further steps.

5. Now that you have configured your WAN side of the CSU/DSU, you need to configure your data port or the user side. Go into the DTE or the Data Port menu and configure the protocol to be V.35. That should be sufficient. Please consult your manual to determine if there are any additional steps that you need to take.
6. Finally, you need to route your DS0 channels to the appropriate data ports. This is usually done in the Channel Configuration menu. You must route the same DS0s to the data ports on both sides of the point to point connection. For example, if you route DS0s one through three on your switch side CSU/DSU to the Extender WAN port, you must do the same on the remote side CSU/DSU.
7. Now you should move on to configuring the Extenders.

Note: Visit our web site at: www.mck.com for more information on setting up network equipment. The site is updated regularly.

ISDN Connections

About the Supported Equipment

The list of presently supported equipment will always be updated. Please, be sure to review MCK's web site to find out about the latest updates. (www.mck.com)

Currently Supported Configuration **- Face Plate Dialing with Synchronous Clear Channel or Synchronous Bonding**

Background

Similarly to point to point TDM, ISDN B connections are time division multiplexed, however, all of the ISDN signaling is extracted into a separate D signaling channel. The added complexity of signaling also allows ISDN circuits to provide data service. Depending on the size of the access bandwidth required, ISDN circuits are dominantly delivered to customers in two flavors, PRI and BRI. The more common, BRI, is capable of 128Kbps of duplex data transfer. PRI data transfer extends to 23 B data channels or 1.472Mbps. Both BRI and PRI are suitable for use with the Extender 6000.

Much like in the case of a point to point TDM circuit, an ISDN circuit requires specific customer premise equipment. ISDN CPEs that terminate BRI circuits are called Terminal Adapters, TAs. In some instances, a customer might desire to have WAN access in excess of 128kbps but smaller than 1.47Mbps. This can be achieved by installing multiple BRI circuits. An ISDN CPE that terminates multiple BRI circuits is called inverse multiplexer. Finally, a PRI is terminated with a multiplexer or a CSU/DSU that is ISDN aware.

Both, TAs and Inverse multiplexers, perform similar functions to CSUs. A TA receives and transmits signals from and to the wide area network WAN and provides a barrier for electrical interference between the WAN and the user sides. Many TAs are also capable of echoing loopback signals generated by the service providing company. In addition to static connections, characteristic to traditional point to point TDM circuits, ISDN circuits are capable of multi-point links. Hence, when compared to CSUs, the TAs and inverse multiplexers have additional configuration options.

Ordering an ISDN line

Your ISDN line configuration will depend on the type of switch that your provider has in their nearest central office. If possible, you should order your ISDN line to support the National-1 protocol. Any other protocol will be switch related and it will function as long as your TAs would support it. In addition, you will need to obtain the SPID, DN and TEI information from your provider.

ISDN Complexity – How to distinguish what is important in an application?

ISDN was designed to perform anything that covers the integration of voice and data traffic. Hence the name ISDN, Integrated Service Digital Network. A detailed examination of ISDN service, its network topology and organization can be found in any generic ISDN book. The information provided in these paragraphs is greatly simplified and it only covers the most common ISDN application, relevant to the use with the Extender 6000. The provided, step by step instructions are based on the following assumptions*:*

General

- Single BRI circuit application
- TA has integrated NT-1

Provider Specific

- Provided U interface
- National 1 switch protocol
- Dynamic TEI assignment
- Dial line configuration

Protocol Specific

Dialing: Front plate dialing

Protocol: Synchronous data transfer with either clear channel or bonded mode

Any other ISDN application that goes beyond these assumptions will be provided in custom data notes and it will be available on www.mck.com.

General and Provider Specific

The U interface on a BRI service, at a customer premise is common in North America. Usually, the U interfaces are terminated with a Network Termination-1 NT-1 type of equipment. The purpose of an NT-1 is to provide the S/T reference point for the Terminating Equipment TE-1. However, if the Terminating Equipment has legacy interface such as serial RS-232 or V.35, a separate device, called Terminal Adapter TA will interface the S/T with the legacy interfaces. In ISDN terminology, the equipment with legacy interfaces is referred to as Terminal Equipment 2 TE-2. Many common ISDN TAs actually have two components, the NT-1 and the TE-2. An example of such device is Adtran ISU 2X64. In addition to these components, this Adtran unit also supports front plate dialing.

Protocol Specific -Front Plate Dialing with Synchronous Clear Channel or Synchronous Bonding

There are many ways in which the Extenders 6000 could operate when connected to an ISDN network/ISDN TAs. There are two distinctive configurations concerning the connection between the TAs and the Extender 6000. Depending on the type of TA, **dialing** can be configured as front plate, DTR or other software protocol dialing using AT commands. Other configuration between the TAs and the Extenders is related to the actual **protocol** that occurs between the TA and the Extender and the protocol between the two TAs connected over an ISDN WAN.

The provided step by step procedure will assume the simplest mode of operation:

- front plate dialing from the face of a terminal adapter
- clear channel synchronous or synchronous bonding operation

Before you begin configuring your ISDN adapters

Consult your ISDN provider to obtain:

1. Switch type / Line Protocol
2. Service Profile Identifier SPID, Terminal Endpoint Identifiers TEI (if not automatic) and Directory Numbers DN, if necessary.

This information is always contained in the ISDN service contract and the installation sheet. Before you start your installation, make sure that you have these.

Configuring Switch Type

1. Boot your TA
2. Select the CONFIG menu.
3. Select the SWITCH submenu
4. According to the information you have gathered from your ISDN provider (contract and installation sheets), select the switch type. In most cases, within the US and Canada, your ISDN provider will require that the switch type actually is the NATIONAL ISDN1 line protocol. Naturally, if your ISDN provider is suggesting otherwise, please make the adequate selection.
5. Now that you have configured your Switch Type / Line Protocol, you should configure the service profile identifier SPID, terminal endpoint identifiers TEI and the local directory DN numbers.

Configuring SPID, TEI and DN numbers
About TEI

In most cases, you will not have to address the configuration of terminal endpoint identifiers TEI, for these are almost always assigned dynamically. However, in some instances, depending on the type of the switch that your provider is using, you might need to assign the TEIs. If that is the case, your ISDN provider will deliver the necessary information. Since the TEI assignment is rare, this sheet will not demonstrate this configuration.

Configuring SPID and DN numbers

In some instances, you might not even have to provision your local directory numbers. In any case, the following instructions will assist you in setting up the SPID and the LDN numbers.

1. Depending on your TA, select either LINE IDENTIFICATION or DTE IDENTIFICATION menu
2. Configure your SPID
3. Enter the DN configuration and make adequate changes.

Note: On a TA, each SPID and the corresponding DN are related to a DTE port. You must never cross the SPID and the DN from one DTE to another. If you start with the first SPID on DTE#1, you must enter the corresponding DN to that same DTE#1 and so on.

PROTOCOL Clear Channel Synchronous or Synchronous Bonding

By using ISDN as your network bandwidth service, you could connect your Extender 6000 over either one or two serial ports. If you connect your Extender 6000 over one port, you could use it in two modes. You could provision your network bandwidth over one B channel (64K) or via two B channels (128k). In the second case, you must set your TA to function in BONDING mode. In both cases, however, the protocol needs to be set to **synchronous**.

1. Select the CONFIGURATION menu.
2. Select the Protocol submenu.
3. Depending on your application, select either CLEAR CHANNEL or BONDING mode.
4. Find the DTE options menu.
5. Select the Protocol submenu and choose Synchronous Transfer.
6. Find the Bit Rate submenu and select either 64 or 128K. This naturally depends on your application.
7. Go to Connector type menu and Select the V.35 option.

Now you are ready to dial.

1. At the main menu, select the Dial option.
2. Select the Dial number option.
3. Enter the number and hit the Dial button.

If you are using BONDING, be sure that the remote ISDN TA is also configured in this mode. If you have any additional setup requirements, please refer to the TAs OEM manual and consult your ISDN provider.

Currently Supported Configuration

There are three ways ISDN terminal adapters can call one another. They are using AT commands issued by a DTE, face plate dialing, and DTR dialing. The EXTender 6000 does not support AT command dialing at all. In addition, our findings are that DTR dialing is suspect with many TA. Therefore, we recommend TAs that support face plate dialing.

What is DTR Dialing?

Some terminal adapters are capable of detecting the DTR signal that the Extender 6000 provides. These terminal adapters can be configured to automatically dial upon the detection of this signal. While this can work, it can be problematic and is not currently recommended.

Currently Supported ISDN TA

Adtran ISU 2X64
Adtran ISU 128
Adtran ISU 512 *

* This product is an inverse multiplexer that can support up to four simultaneous ISDN BRI lines, or 8-B channels providing up to 512kbps.

Custom Configuration - DTR Dialing

The alternate configuration of using the Extender 6000 with terminal adapters involves DTR signal dialing. The TAs that will be used in this mode must support either synchronous clear channel or synchronous bonding ISDN protocols.

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