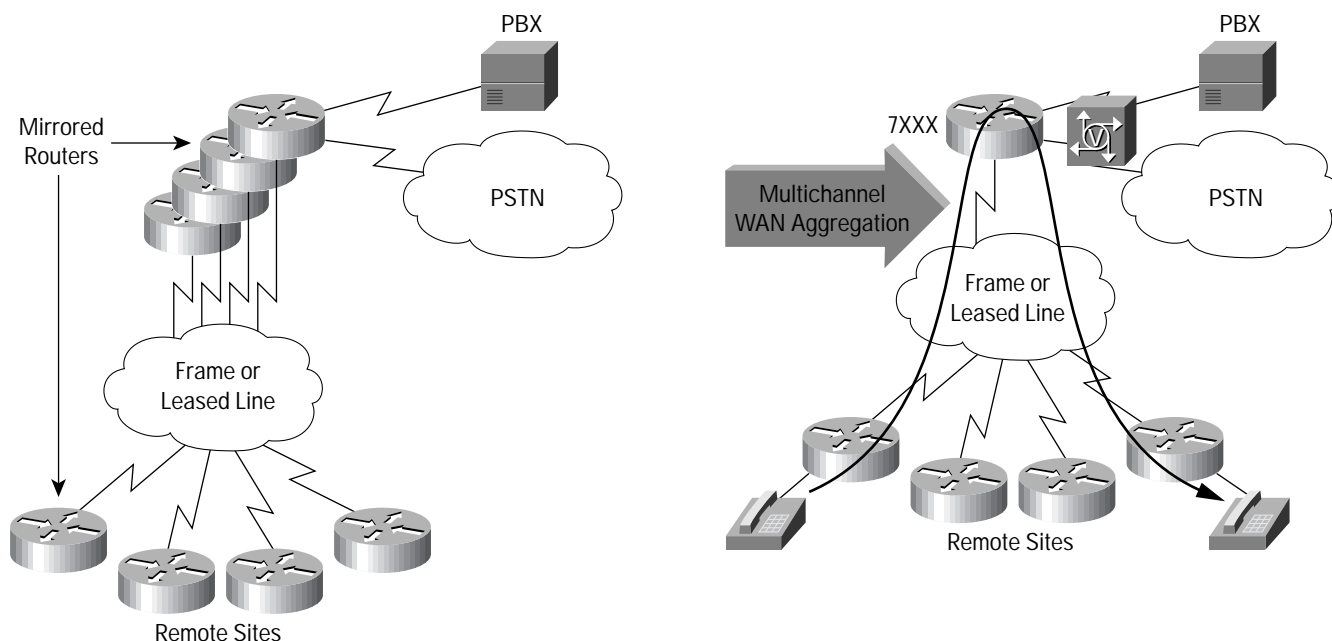


VoIP/VoFR Termination Using the Cisco 7200VxR

The Cisco 7200 is a multi-service router capable of aggregating voice over IP (VoIP) or voice over Frame Relay (VoFR) at the edge of the enterprise or service provider network. With the advent of the Time Division Multiplexing (TDM)-enabled voice port adapters PA-VXC-2TE1+ and the PA-VXB-2TE1+, the Cisco 7200VxR can now terminate VoIP or VoFR to the Public Switched Telephone Network (PSTN) or private branch exchange (PBX). This paper outlines the capabilities of these port adapters and their relevance to a multiservice VoIP solution.

Figure 1 Traditional Router Stacks at Central Site Can be Replaced by a Cisco 7200VxR as Shown Below



Traditionally, even when you had a Cisco 7200 or Cisco 7500 router aggregating VoFR traffic at a central site, you still needed stacks of 3810 or 3600 routers at the central site to terminate VoIP traffic to the PBX or PSTN. This meant many routers and many links coming into the central site. Using high-density, high-bandwidth interfaces on the Cisco 7200VxR, the number of routers and the number of incoming links can be reduced to just one. However, you would still need a voice gateway to terminate VoIP/VoFR traffic before it could go to the central PBX or PSTN. Using the newly released voice port adapters (PA-VXC-2TE1+) for the Cisco 7200, it is possible to connect the 7200VxR directly to the central site PBX or PSTN using digital T1 or E1.

The PA-VXC-2TE1+ is a TDM-enabled 2T1/E1 voice port adapter (PA) with 30 DSPs (Digital Signaling Processors (DSPs) on board. These DSPs perform such routine functions as codec compression, voice-activity detection, and packetizing functions for VoIP calls. When a central-office aggregation router like the Cisco 7200VxR is equipped with one or more voice port adapters, it allows termination (conversion of VoIP/VoFR to pulse-code-modulation) so you can connect directly from the Cisco 7200VxR to a PBX or to the PSTN.¹

Capacity to Handle Voice Channels

The 30 DSPs on board the voice port adapter can compress voice channels using either high- or medium-complexity codecs. The 30 DSPs can compress either 60 channels of high-complexity codec (like G.723) or 120 channels of medium-complexity codecs. Examples of medium complexity would be G.729a, G.728 or G.726. The lowest bit rate possible is G.723.1 at 5.3 kbps.

Table 1 Capacity of voice port adapters

	High-Complexity codecs (for example, G.723)	Medium-complexity codecs (for example, G.729a)
PA-VXC-2TE 1+	48/60	48/60
PA-VXB-2TE 1+	24/24	48/48

Table 1 shows the number of calls that can be handled by each of the voice port adapters. The column on the left lists the two available voice port adapters for the Cisco 7200. The second column lists the number of calls for T1/E1 voice. For instance, 48/60 refers to the ability of the voice PA to handle up to two full T1 of voice or two full E1s of voice when high-complexity codecs are used.

Though the PA-VXC-2TE1+ is a TDM-enabled voice port adapter, it is also possible to use this port adapter on non-TDM platforms such as the older Cisco 7200 series routers. However, this means not having the advantages of TDM switching on the router’s chassis.

For those with a less dense requirement or no need for DSP farms, Cisco also provides a 12 DSP version of the voice port adapter called PA-VXB-2TE1+ that supports up to 24 channels of high-complexity voice or 48 channels of medium/low-complexity voice calls. This is more suited to T1 solutions since E1 links would normally involve 30 calls per E1.

Fax-Relay Capabilities

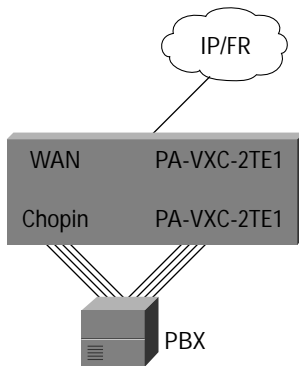
It is possible to have the DSPs on the voice port adapters demodulate fax signaling from a fax machine and convert it to IP packets for transmission over the IP data network. This allows fax transmissions to be transported over the IP infrastructure. This feature is commonly referred to as “Cisco fax relay” and is different from T.38 fax relay.

DSP Farm

The PA-VXC-2TE1+ has the DSP capacity to support up to 60 calls (DSOs) of medium complexity using the 30 DSPs on board. To utilize the full 12-channel processing capability (using medium-complexity voice codecs), Cisco introduces a new TDM-enabled 2/4/8 multichannel voice PA (project named “Chopin”) with no on-board DSPs but similar in all other respects to the earlier PA-VXC-2TE1+.

1. This family of port adapters includes the PA-VXC-2TE1+, PA-VXC-2TE1, PA-VXB-2TE1+ and PA-VXB-2TE1. Software requirement is Cisco IOS 12.0XE or 12.0T

Figure 2 The Chopin PA Will Share DSP Resources on Existing PA-VXC-2TE1+ Using the MIX Bus on the 7200VxR.



This is where the TDM-enabled chassis of the Cisco 7200VxR really shines. The MIX bus on the Cisco 7200VxR allows DS0 cross-connects from TDM-enabled (also known as MIX-enabled) port adapters (not necessarily voice port adapters). The TDM-enabled, multichannel 2/4/8 T1/E1 port adapter is one such case in point.²

Using the PA-MCX-family of TDM-enabled T1/E1 port adapters in conjunction with a PA-VXC-2TE1+ on the same Cisco 7200VxR, you could utilize all DSP resources on the latter PA. This is possible via a feature called DSP farms, which allows the unused DSP resources on the PA-VXC-2TE1+ to appear as a “farm” of DSPs to other PAs with no onboard DSP resources.³ The DS0 cross-connect is possible using the MIX bus on the Cisco 7200VxR. In addition to its wealth of features, the Cisco 7200VxR takes on some of the functions of a TDM multiplexer. Signaling is still terminated locally on the PA-MCX PA, and only the compression function is offloaded to the voice PA’s DSP farm.

Call Termination Capacity of the Cisco 7200VxR

The Cisco 7200VxR with six slots can accommodate up to six PA-VXC-2TE1s and allow termination of up to 12 T1/E1 worth of voice calls. In the case of the Cisco 7200VxR with the NPE-300 processor, termination of 12 T1/E1 worth of voice would result in 70 percent to 75 percent central processing unit (CPU) utilization. However, in practice the number of voice calls you choose to terminate on the router will depend upon how many other value-added services (such as quality of service) are to be enabled concurrently.

Signaling Support for the Cisco 7200VxR

In the past, PBXs connected via analog tie lines. The advent of digital links gave rise to the term Private Integrated Service Network Exchange (PINX) to include everything from PBXs and multiplexers to Centrex.

There are two ways a voice gateway could carry inter-PBX signaling:

- Point-to-point tunnel connections where the voice gateway (in this case the Cisco 7200) never looks into the tunnel. This is referred to as Transparent Common Channel Signaling (T-CCS). The advantage here is that it is a good way to transport proprietary inter-PBX signaling. On the negative side, the voice gateway doesn't understand the call so it is incapable of such functions as intelligent switch call routing. Consider a scenario where you have Nortel M1 PBXs, which support extensions to Q.931 to support proprietary features like Networked Mmail and Network ACD. If you wish to carry signaling related to these features through a Cisco 7200, then you would need to use T-CCS.
- Terminating the signaling at the voice gateway. Here, since the voice gateway understands the call, it actually routes the call to the correct destination. Information like caller-id might be forwarded from the originating voice gateway to the destination voice gateway in the case of Q.SIG and Integrated Services Digital Network (ISDN) Primary Rate Interface (PRI).

2. Cisco expects to release the TDM-enabled PA-MCX family with Cisco IOS[®] 12.1(3)E and Cisco IOS 12.1(4)T around August 2000. This family includes PA-MCX-2TE1, PA-MCX-4TE1 and PA-MCX-8TE1.

3. DSP farm functionality is expected in Cisco IOS 12.1(1)T

Q.SIG has emerged as the standard for inter-PINX signaling. As data routers became voice gateways, it became necessary for the data routers to support Q.SIG among other types of signaling.⁴ Q.SIG support is relevant when a Cisco 7200 voice gateway has to terminate/interpret signaling like Siemens Cornet NQ where T-CCS is relevant if you wish to transparently transport Siemens Cornet signaling.

Currently there exists support for T1 Channel Associated Signaling (CAS) as well as E1 CAS (some variations). In the latter part of the year, PRI Q.931 as well as PRI Q.931 network side and Q.SIG are expected to be supported along with support for T-CCS and R2 signaling.

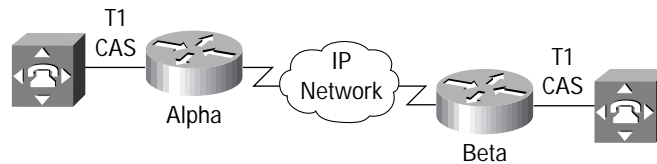
Table 2 Table of Cisco IOS releases supporting various signaling methods

T1 CAS	IOS 12.0(5)XE	Released
E1 CAS	IOS 12.0(5)XE5	Released
Q.SIG	IOS 12.1(2)T	Released
PRI user side	IOS 12.1(3)T	8/11/00
PRI network side	IOS 12.1(3)T	8/11/00
R-2 signaling	IOS 12.1(3)T	8/11/00
T-CCS	IOS 12.1(3)T	8/11/00
Feature Group D	IOS 12.1(3)T	8/11/00

Connection Trunk vs. T-CCS

Connection trunk refers to the ability to cross-connect packetized voice DS0s. So far we have referred to cross-connecting DS0s as a function of the MIX capability on the PA-VXC-2TE1/PA-VXB-2TE1 or on the chassis of the Cisco 7200VxR. Connection trunks take this a step farther and cross-connects packetized versions of these same voice DS0s.

Figure 3 Application for Connection Trunk



A typical application for connection trunk is shown in Figure 3. In the above case, the router named “Alpha” could in practice be a Cisco 7200VxR and the one named “Beta” could be a Cisco 3660. If there is a situation where the T-1 connected to LHS PBX were to fail, then it is possible to have a busy back signal to the T-1 port on the remote 3600 provided one has configured an option called “busy out monitor.”⁵

Yet another case where connection trunk applies would be where you have a large number of Cisco 2600/3600 routers at branch offices and a Cisco 7200VxR at the head-end. If your requirement is that calls roll over to the PSTN when E&M ports are not available at the remote sites, then you could configure connection trunks between the 2600/3600s and the central site Cisco 7200VxR.

T-CCS on the other hand refers to the ability to carry D-channel signaling between two PBXs via a Cisco 7200VxR. These two features are used together to provide an efficient “tie-line replacement” solution.

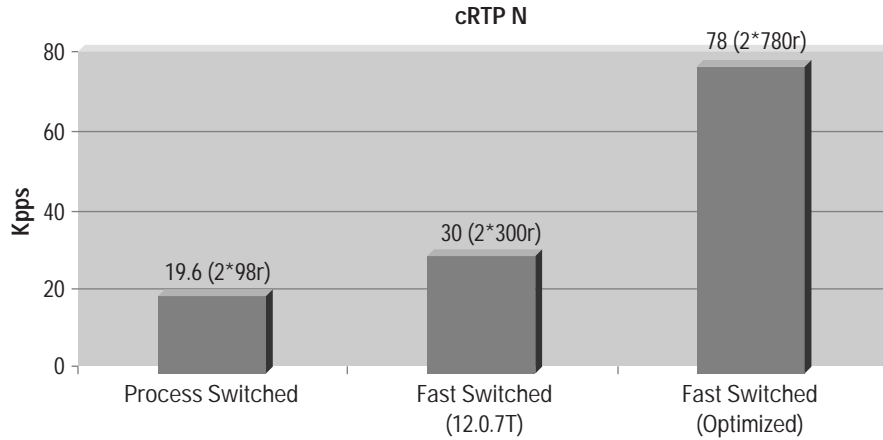
4. Q.SIG will be supported on the Cisco 7200VxR in Cisco IOS 12.0(7)XK and IOS 12.1(2)T

5. For more information on connection trunk please refer to the URL:

<http://www.cisco.com/univercd/cc/td/doc/product/software/ios121/121newft/121t/121t1/voip72.htm>

However, the longer-term solution is hardware-accelerated CRTP where the CRTP compression and un-compression could be offloaded from the central processor of the router to a hardware-acceleration component like the Parallel Express Forwarding (PXF) based NSE-1 for the Cisco 7200VxR.

Figure 6 CRTP Performance on a Cisco 7200VxR



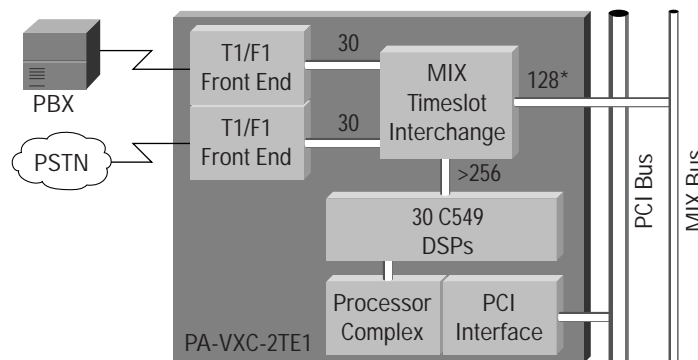
In Figure 6, NDR refers to No-Drop-Rate, the rate at which we can sustain traffic without packet drops. CRTP can even be used over asynchronous transfer mode (ATM) networks provided you introduce an intermediate layer like Point-to-Point Protocol (PPP). This way you could have the benefits of CRTP over PPP over ATM AAL-5.

TDM Hair-Pinning

Historically, the term “hair pin” refers to the ability to send a call in the direction from which it came. At the system level, on a Cisco 7200VxR, you can take a voice DS0 coming in on one T1 of the voice port adapter PA-VXC-2TE1+ and cross-connect it to another T1 on the same voice port adapter. The idea is that you could re-route a call coming in, off say a PBX, and send it back to the PSTN.

Since the Cisco 7200VxR supports TDM switching on the chassis, it is possible to cross-connect a voice DS0 from a T1 on the first voice port adapter and connect it to a T1 on a second voice port adapter, in effect using the chassis of the 7200VxR as a TDM switch.

Figure 7 TDM Hair-Pinning Between T1s on the Same Voice Port Adapter



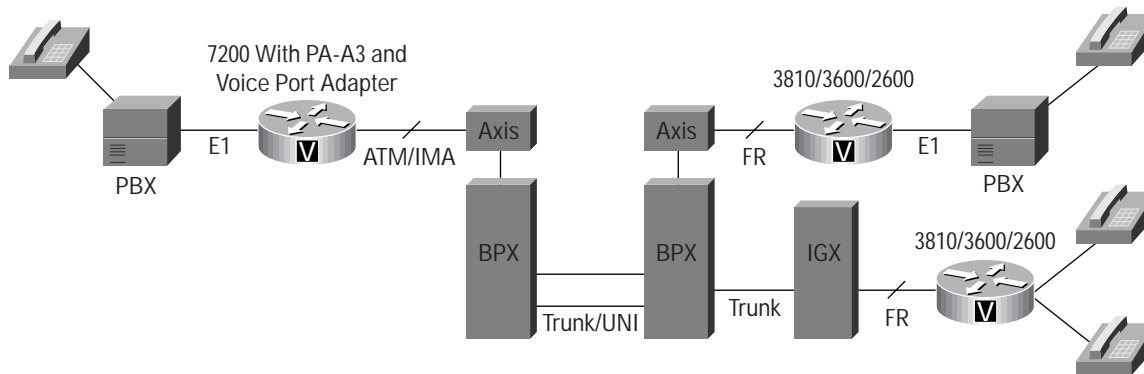
On a non-VXR chassis like the traditional Cisco 7200, you can still achieve the same end result of cross-connecting a voice DS0 from the first T1 to the second T1 (on the same voice PA), but you would accomplish this at a higher layer, typically at the VoIP dial-peer.

In the future, TDM hair-pinning may be activated based upon detection of congestion in the IP network.

VoIP Over ATM (FRF.11 Over AAL5)

VoIP over ATM (AAL5) can be done using the Cisco PA-A3 and tuning the queue limits on this PA to provide lower latency to voice traffic. This is a Cisco proprietary solution that interworks between remote office Cisco 3810s, Cisco 2600s and Cisco 3600s when connected to a central site that uses a Cisco 7200VxR equipped with PA-A3 ATM Deluxe Port Adapters or Inverse Multiplexing for ATM (IMA) PAs.

Figure 8 Voice Over AAL5 Using FRF.11



The caveat here is that data should not be on the same VC as FRF.11 over AAL5 traffic. In other words, you need to have two VCs between the remote office and central site, one carrying data the other carrying voice traffic. The advantage to this solution is that one can now rely on the robust voice quality of service (QoS) provided by ATM.

Management of 7200 Voice

CVM 2.0 can be used to centrally manage a whole range of voice gateways including the Cisco 1750, Cisco 2600, Cisco 3600, Cisco AS5300, and the Cisco 7200.⁸ Management includes the ability to manage dial plans on the 7200 voice gateway plus the ability to provision voice ports to simplify issues from a numbering perspective.

Figure 9 UI of CiscoWorks2000 Cisco Voice Manager



In conclusion, the Cisco 7200VxR is a versatile TDM-enabled platform capable of aggregating voice traffic (VoIP, VoFR, and VoATM) at a central site as well as terminating voice to a central-site PBX. Its strengths are in scaling CRTP for VoIP traffic and in scaling QoS for voice. With newer developments under way to provide inter-connectivity with carrier SS7 networks, the Cisco 7200VxR will be an ideal OC-3 level connectivity platform for service providers and enterprise customers alike.

8. CVM 2.0 will support the Cisco 7200 voice gateway in Cisco IOS 12.0(7)XK

For More Information

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