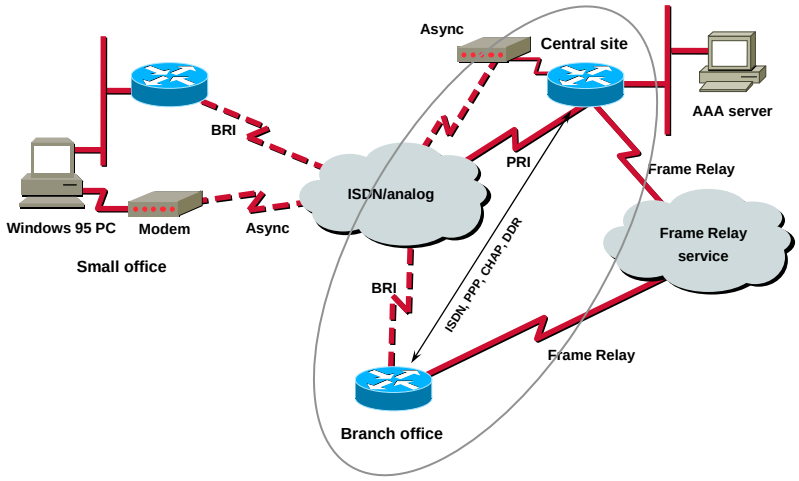
Chapter 4: Using ISDN and DDR Technologies to Enhance Remote Connectivity

Objectives

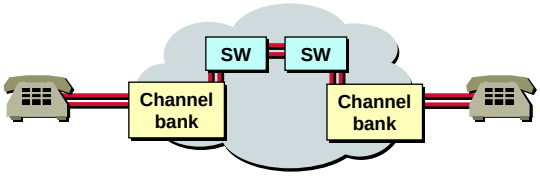
Upon completion of this chapter, you will be able to complete the following tasks:

- **Select BRI or PRI service for a particular application**
- **Identify Q.921 and Q.931 signaling and call sequences**
- **Configure ISDN BRI**
- **Configure ISDN PRI**
- **Configure ISDN DDR**

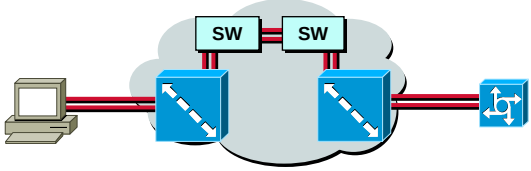
Chapter Activities



Asynchronous Versus ISDN

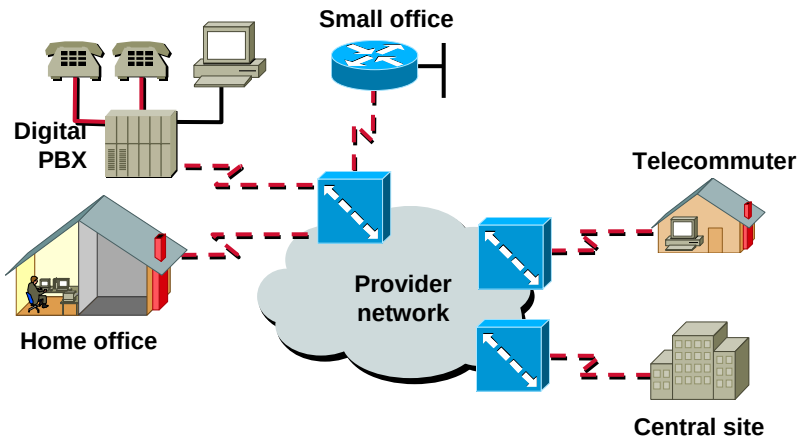


- Analog converted to digital and back



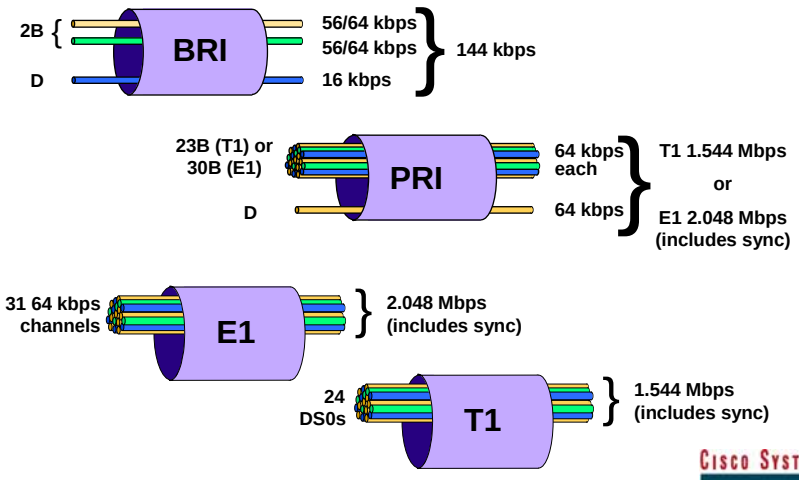
- Digital end-to-end

Integrated Services

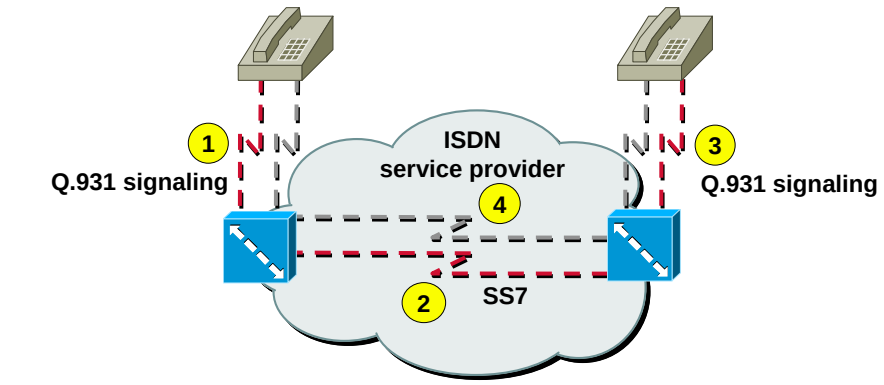


- Voice, data, video, and special services

ISDN Services and Channelized E1 and T1



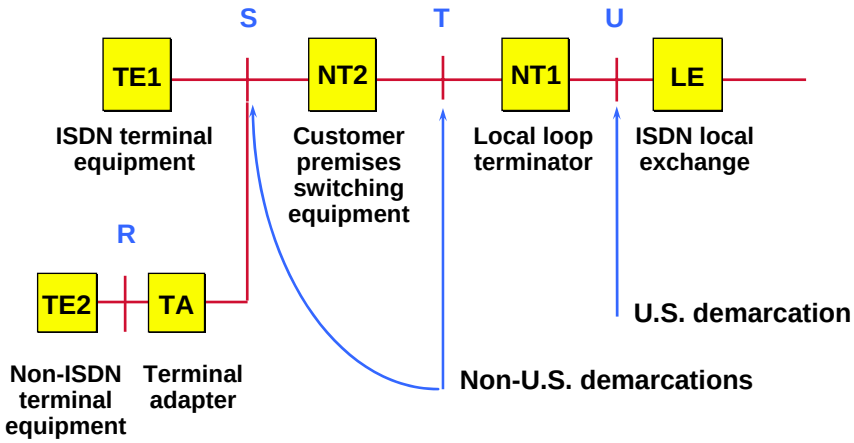
BRI Call Processing



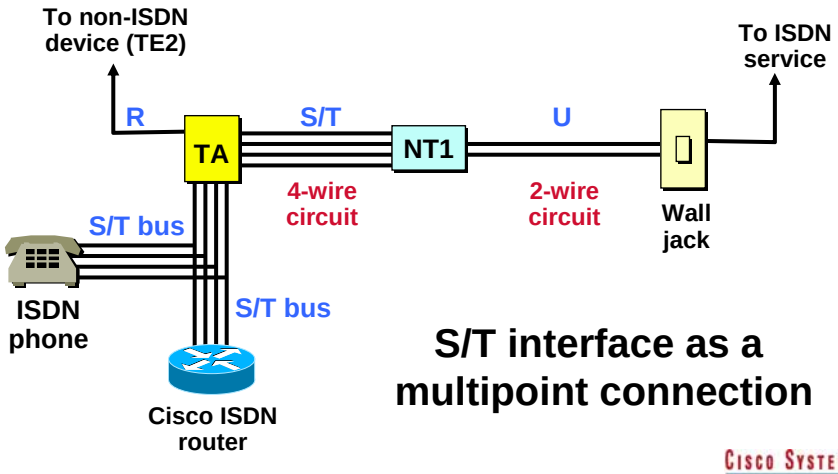
B channel

D channel/SS7 signaling

BRI Functional Groups and Reference Points

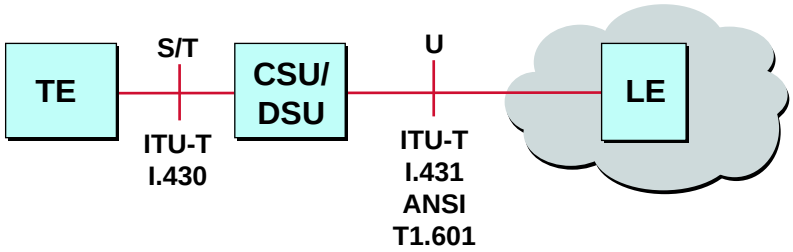


Physical Representation of BRI Reference Points



S/T interface as a multipoint connection

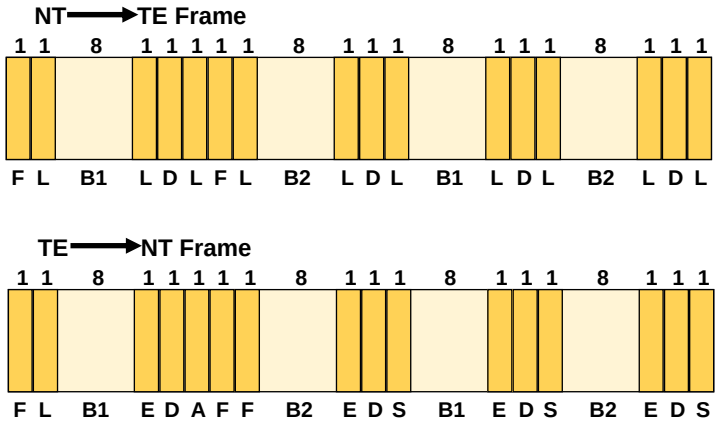
PRI—Layer 1 Standards and Reference Points



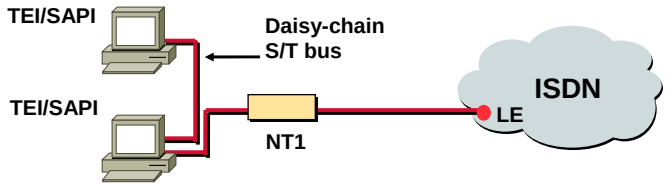
ISDN Protocol Layers

	D Channel	B Channel
Layer 3	DSS1 (Q.931)	IP/IPX
Layer 2	LAPD (Q.921)	HDLC/PPP/FR/ LAPB
Layer 1	I.430/I.431/ANSI T1.601	

BRI Layer 1—I.430 Framing

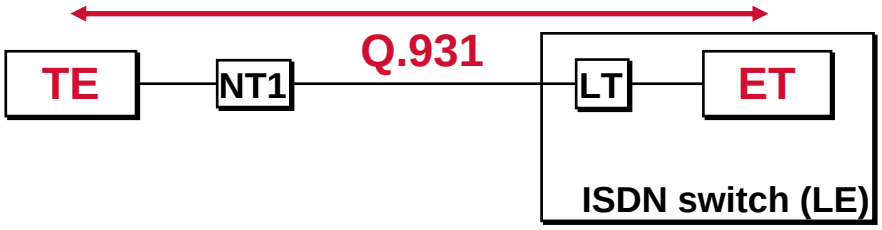


ISDN Layer 2



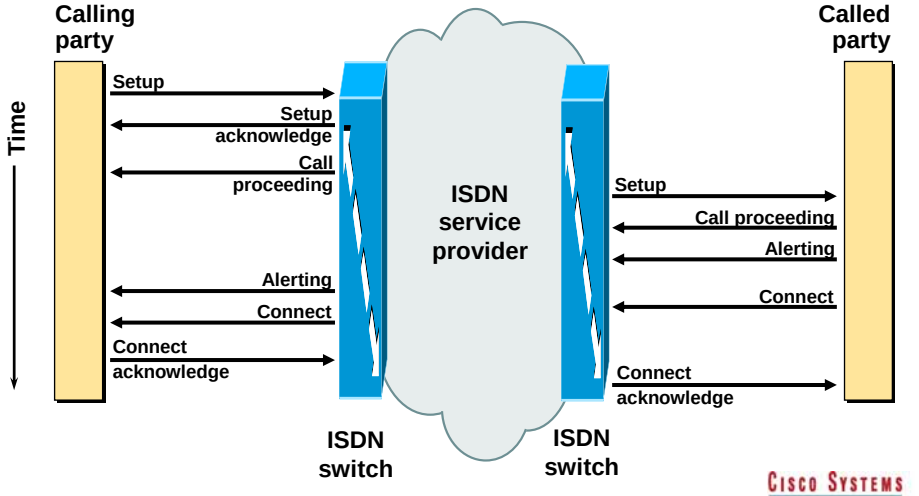
- ITU-T Q.920 and Q.921
- Defines logical link between TE/TA and NT2/LE
- Carries Layer 3 D-channel messages

ISDN Layer 3—D Channel Q.931

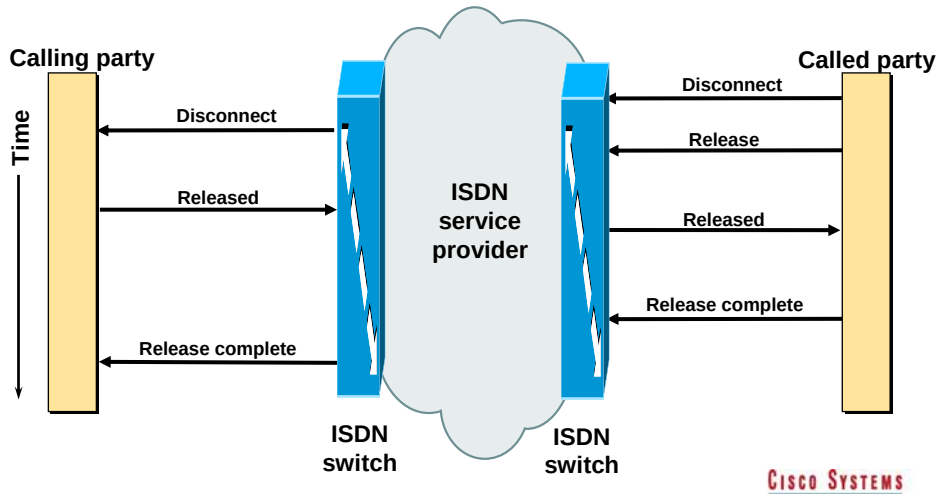


- Q.931 defines call control between the TE and local switch

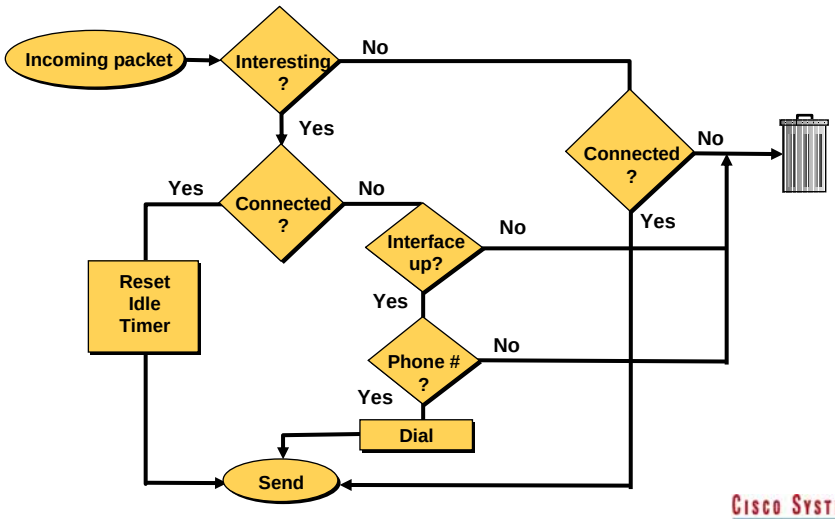
Q.931 Messaging—Call Setup Example



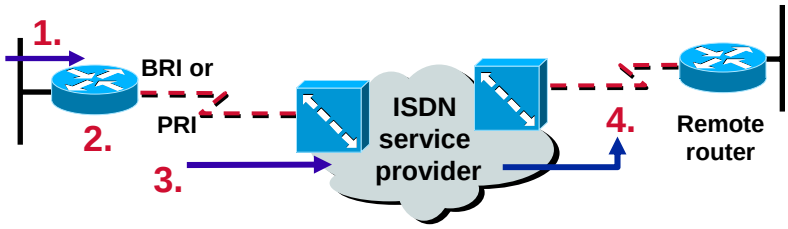
Q.931 Messaging—Call Teardown Example



DDR Operation



Using DDR with ISDN



1. Packet arrives
2. Switch packet to DDR interface, determine if interesting
3. If interesting, dial DDR destination via ISDN
4. Connect to remote router

ISDN Configuration Tasks

- Global configuration
  - Select switch type
  - Specify traffic to trigger DDR call
- Interface configuration
  - Select interface specifications
  - Configure ISDN addressing
- Optional feature configuration

ISDN Configuration Commands

- Set global parameters with this command:
  - isdn switch-type
- Set interface parameters with these commands:
  - encapsulation ppp (CHAP and Multilink PPP)
  - ip address
  - isdn spid1

Selecting the ISDN Switch Type

```
Router(config)#isdn switch-type switch-type
```

```
Router(config-if)#isdn switch-type switch-type
```

- Specifies the type of ISDN switch with which the router communicates
- Global or interface command

Setting Interface Protocols

```
Router(config-if)#encapsulation {ppp | hdlc}
```

- Selects framing for that ISDN BRI

```
Router(config-if)#ppp authentication
                          {pap | chap | ms-chap}
```

- Selects PPP authentication type

Setting SPIDs if Necessary

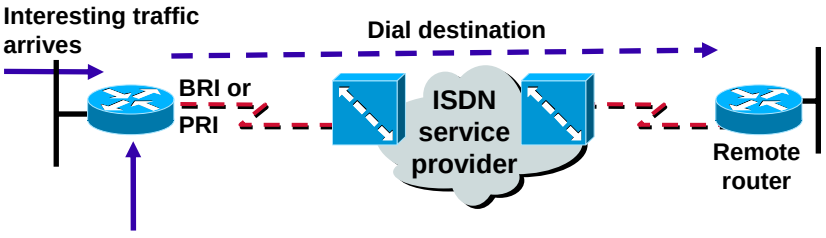
```
Router(config-if)#isdn spid1 spid-number [ldn]
```

- Sets a B channel SPID(Service Provider ID) required by many service providers

```
Router(config-if)#isdn spid2 spid-number [ldn]
```

- Sets an SPID for the second B channel

DDR Configuration Tasks



1. Define interesting traffic
2. Assign interesting traffic definition to ISDN interface
3. Define destination
4. Define call parameters

Defining Interesting Traffic

```
Router(config)#dialer-list dialer-group-number
   protocol protocol-name {permit | deny}
   list access-list-number
```

- Defines interesting packets for DDR
- Associated with the dialer group assigned to the interface

```
Router(config-if)#dialer-group group-number
```

- Assigns an interface to the dialer access group specified in the *dialer-list* command

Using Access Lists for DDR

```
Router(config)#access-list access-list-number {permit|deny}
  {protocol | protocol-keyword }
  {source source-wildcard | any}
  {destination destination-wildcard | any}
  [protocol-specific-options] [log]
```

- Gives tighter control over “interesting” traffic and uses standard or extended access lists

```
Router(config)#dialer-list dialer-group list access-list-
  number
```

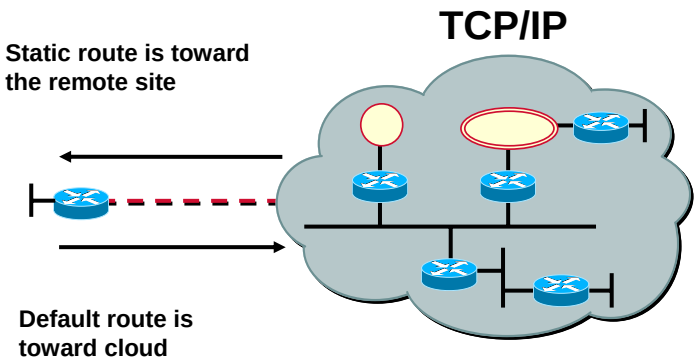
- Associates an access list with a dialer access group

Defining Destination Parameters

```
Router(config-if)#dialer map protocol next-hop-address
   [name hostname] [broadcast] dial-string
```

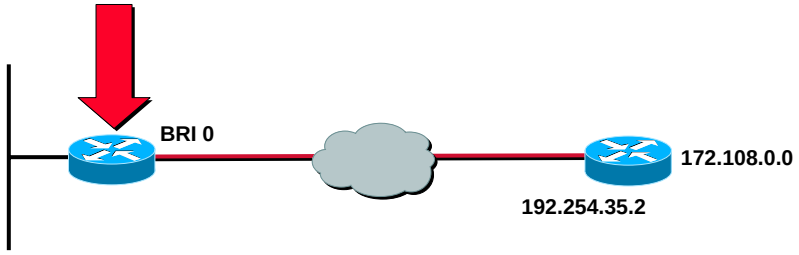
- Defines how to reach a remote ISDN destination

Setting Default/Static Routes



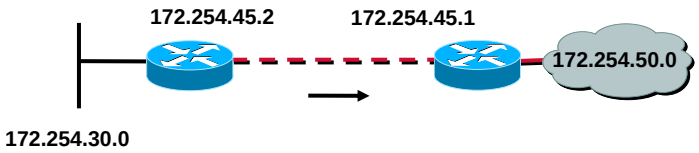
Setting Static Routes

```
Router(config)#ip route 172.108.0.0 255.255.0.0 192.254.35.2
```

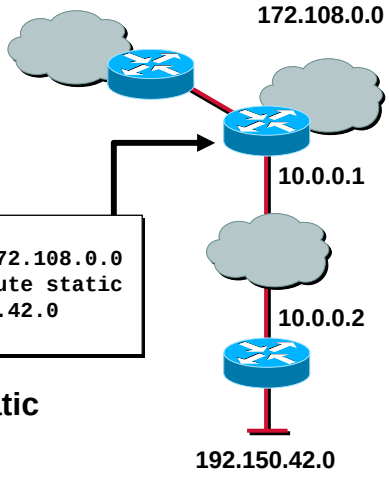


Setting Default Routes

```
Router(config)#ip route 172.254.50.0 255.255.255.0 172.254.45.1
Router(config)#ip default-network 172.254.50.0
Router(config)#ip route 0.0.0.0 0.0.0.0 172.254.45.1
```



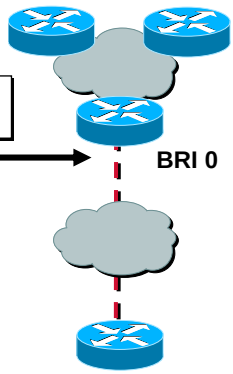
Setting Route Redistribution




```
Router(config)#router igrp 109
Router(config-router)#network 172.108.0.0
Router(config-router)#redistribute static
Router(config)#ip route 192.150.42.0
       255.255.255.0 10.0.0.2
```

- This router advertises static routes to other routers

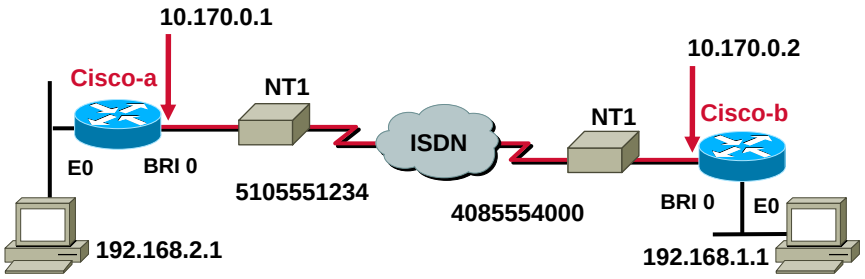
Deactivating Routing Updates on an Interface




```
Router(config)#router igrp 100
Router(config-router)#passive-interface bri0
```

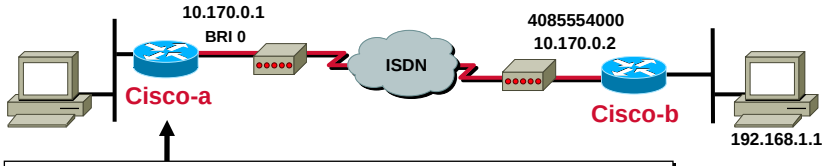
- Does not broadcast routes on that interface

Configuring a Simple ISDN Call



- Use PPP encapsulation
- All IP traffic to destination triggers ISDN call
- Carrier uses a 5ESS basic rate switch
- Service provider assigns connection parameters

Configuration Example, Cisco-a

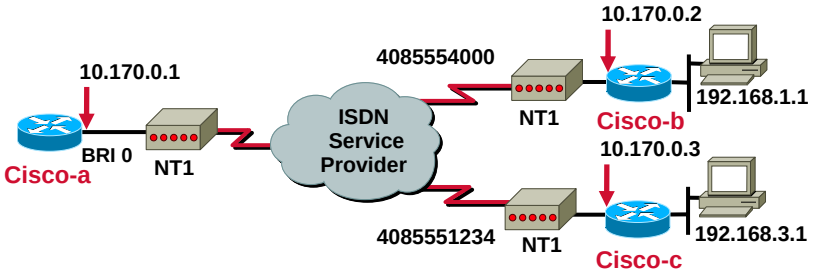



```
hostname Cisco-a
isdn switch-type basic-5ess
username Cisco-b password samepass
interface bri 0
 ip address 10.170.0.1 255.255.0.0
 encapsulation ppp
 dialer idle-timeout 300
 dialer map ip 10.170.0.2 name Cisco-b 4085554000
 dialer-group 1
 ppp authentication chap
!
ip route 192.168.1.0 255.255.255.0 10.170.0.2
dialer-list 1 protocol ip permit
```

Configuration Example, Cisco-b

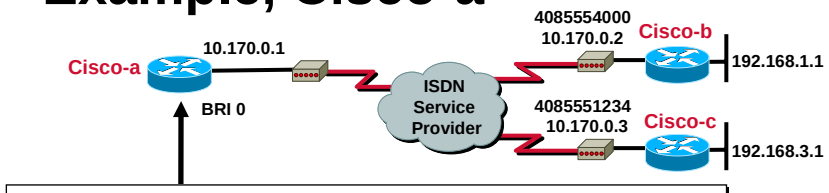

```
hostname Cisco-b
isdn switch-type basic-5ess
username Cisco-a password samepass
interface bri 0
 ip address 10.170.0.2 255.255.0.0
 encapsulation ppp
 dialer idle-timeout 300
 dialer map ip 10.170.0.1 name Cisco-a 5105551234
 dialer-group 1
 ppp authentication chap
!
ip route 192.168.2.0 255.255.255.0 10.170.0.1
dialer-list 1 protocol ip permit
```


Access Lists and DDR for ISDN



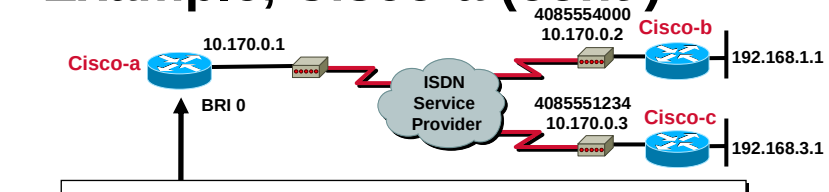
- Cisco-a allows all IP traffic except Telnet and FTP to trigger ISDN calls to Cisco-b, and access subnet 192.168.1.0

Access List Configuration Example, Cisco-a




```
hostname Cisco-a
isdn switch-type basic-dms100
username Cisco-b password samepass
username Cisco-c password samepass
interface bri 0
 ip address 10.170.0.1 255.255.0.0
 encapsulation ppp
dialer idle-timeout 300
dialer map ip 10.170.0.2 name Cisco-b 4085554000
dialer map ip 10.170.0.3 name Cisco-c 4085551234
dialer-group 2
ppp authentication chap
(continued on next figure)
```


Access List Configuration Example, Cisco-a (cont.)

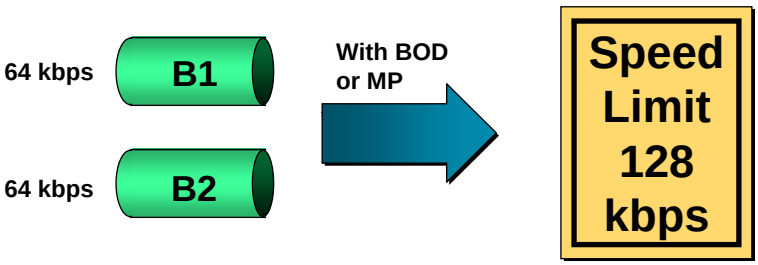



```
ip route 192.168.1.0 255.255.255.0 10.170.0.2
ip route 192.168.3.0 255.255.255.0 10.170.0.3
access-list 101 deny tcp any any eq ftp
access-list 101 deny tcp any any eq telnet
access-list 101 permit ip any any
dialer-list 2 protocol ip list 101
```

Optional ISDN Configurations

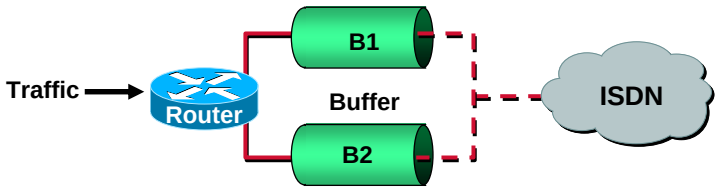
- Specify Multilink PPP or BOD
- Enable caller ID screening
- Configure rate adaptation
- Called number answer

B Channel Aggregation



- Available on all Cisco IOS platforms with ISDN
- Accomplished via Cisco proprietary BOD or Multilink PPP

Cisco Proprietary BOD




```
Router(config)#int bri0
Router(config-if)#dialer load–threshold load
```

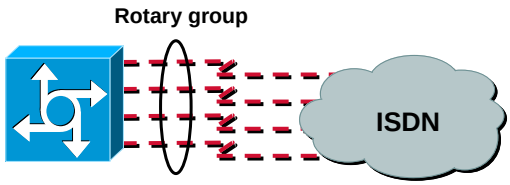

B Channel Aggregation Using Multilink PPP


```
Router(config)#int bri0
Router(config-if)#dialer load-threshold load [inbound | outbound | either]
Router(config-if)#ppp multilink
```

Configuring Multilink PPP

- MLP can be configured on:
  - Asynchronous serial interfaces
  - Synchronous serial interfaces
  - Basic Rate Interfaces (BRI)
  - Primary Rate Interfaces (PRI)

Configuring Multilink PPP (cont.)



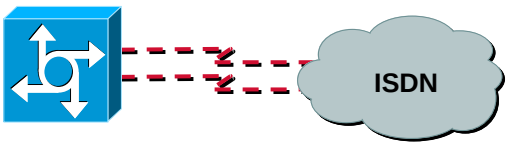

```
Router(config-if)#ppp multilink
```

- Enables Multilink PPP on a dialer rotary group

```
Router(config-if)#dialer load-threshold load
          [outbound | inbound | either]
```

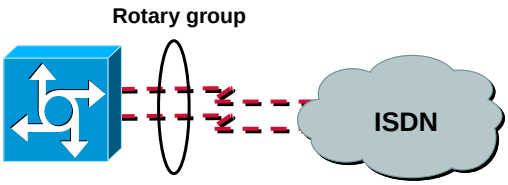
- Defines the threshold to bring up another link

Configuring Multilink PPP (cont.)



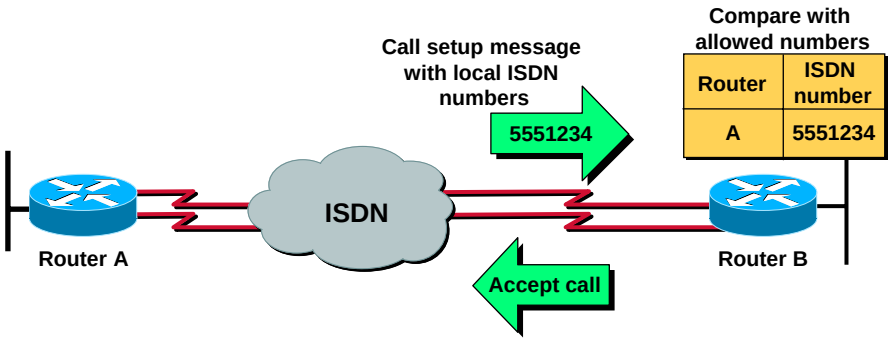

```
Router(config)#interface bri0
Router(config-if)#no ip address
Router(config-if)#encapsulation ppp
Router(config-if)#ppp multilink
Router(config-if)#dialer idle-timeout 30
Router(config-if)#dialer load-threshold 128 either
```


Configuring Multilink PPP (cont.)




```
Router(config)#interface dialer1
Router(config-if)#ip address 10.10.10.7 255.255.255.0
Router(config-if)#encapsulation ppp
Router(config-if)#dialer idle-timeout 30
Router(config-if)#dialer map ip 10.10.10.8 name Router 81012345678901
Router(config-if)#dialer load-threshold 128 either
Router(config-if)#dialer-group 1
Router(config-if)#ppp authentication chap
Router(config-if)#ppp multilink
```

Caller Identification Screening



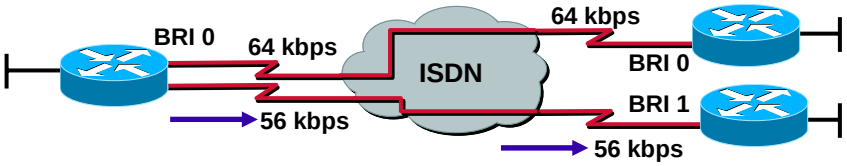
- Extra level of call management
- Call not set up (or charged) until acceptance
- An alternative: PPP encapsulation and CHAP

Configuring Caller ID Screening

```
Router(config-if)#isdn caller number
```

- Enables caller ID screening

Selecting ISDN Rate Adaptation



- Configured for outgoing calls
- Requested lower speed from call is honored
- Assigned on a per-destination basis

Configuring Rate Adaptation

```
Router(config-if)#dialer map protocol next-hop-address
  [name name] [speed speed] [broadcast] [dial-string]
```

- Negotiates speed for calls to a destination

Configuring Called-Number Answer

```
Router(config-if)#isdn answer1 [called-party-number]
```

or

```
Router(config-if)#isdn answer2 [called-party-number]
```

- Sets the number to allow the interface to respond/answer

Monitoring PPP on BRI

```
BranchF#sh int bri 0 1
BRI0:1 is up, line protocol is up
  Hardware is BRI
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation PPP, loopback not set, keepalive set (10 sec)
  LCP Open
  Open: IPCP, CDPCP
  Last input 00:00:02, output 00:00:02, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0 (size/max/drops); Total output drops: 0
  Queueing strategy: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
     Conversations  0/1/256 (active/max active/max total)
     Reserved Conversations 0/0 (allocated/max allocated)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     45 packets input, 1448 bytes, 0 no buffer
     Received 45 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     45 packets output, 1444 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     3 carrier transitions
```

Monitoring ISDN BRI D Channel

```
BranchF#sh int bri 0
BRI0 is up, line protocol is up (spoofing)
  Hardware is BRI
  Internet address is 10.155.0.1/24
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation PPP, loopback not set
  Last input 00:00:04, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0 (size/max/drops); Total output drops: 0
  Queueing strategy: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
     Conversations  0/1/256 (active/max active/max total)
     Reserved Conversations 0/0 (allocated/max allocated)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     680 packets input, 3651 bytes, 0 no buffer
     Received 223 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     680 packets output, 3697 bytes, 0 underruns
     0 output errors, 0 collisions, 5 interface resets
     0 output buffer failures, 0 output buffers swapped out
     3 carrier transitions
```


Monitoring ISDN BRI B Channels

```
BranchF#sh int bri 0 1 2
BRI0:1 is up, line protocol is up
  Hardware is BRI
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation PPP, loopback not set, keepalive set (10 sec)
  LCP Open
  Open: IPCP, CDPCP
  Last input 00:00:01, output 00:00:01, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0 (size/max/drops); Total output drops: 0
  Queueing strategy: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
     Conversations  0/1/256 (active/max active/max total)
     Reserved Conversations 0/0 (allocated/max allocated)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     82 packets input, 2844 bytes, 0 no buffer
     Received 82 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     82 packets output, 2838 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     5 carrier transitions
(output omitted)
```

Monitoring ISDN BRI

```
Router#show isdn status
The current ISDN Switchtype = basic-5ess
ISDN BRI0 interface
    Layer 1 Status:
        ACTIVE
    Layer 2 Status:
        TEI = 65, State = MULTIPLE_FRAME_ESTABLISHED
    Layer 3 Status:
        1 Active Layer 3 Call(s)
    Activated dsl 0 CCBs = 1
        CCB:callid=2, sapi=0, ces=1, B-chan=1
    Total Allocated ISDN CCBs = 1
```


Verifying Multilink PPP

```
Router#show ppp multilink
Bundle rudder, 3 members, first link is BRI0: B-Channel 1
0 lost fragments, 8 reordered, 0 unassigned, sequence 0x1E/0x1E rcvd/sent
Bundle dallas, 4 members, first link is BRI2: B-Channel 1
0 lost fragments, 28 reordered, 0 unassigned, sequence 0x12E/0x12E rcvd/sent
```

Verifying Multilink PPP (cont.)

```
Router# show interface bri0 1
BRI0: B-Channel 1 is up, line protocol is up
  Hardware is BRI
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation PPP, loopback not set, keepalive not set
  lcp       = OPEN      multilink = OPEN
  ipcp      = OPEN
  Last input 0:05:51, output 0:05:52, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0 (size/max/drops); Total output drops: 0
  Output queue: 0/64/0 (size/threshold/drops)
     Conversations  0/1 (active/max active)
     Reserved Conversations 0/0 (allocated/max allocated)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     15 packets input, 804 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     14 packets output, 806 bytes, 0 underruns
     0 output errors, 0 collisions, 19 interface resets, 0 restarts
     0 output buffer failures, 0 output buffers swapped out
     1 carrier transitions
```

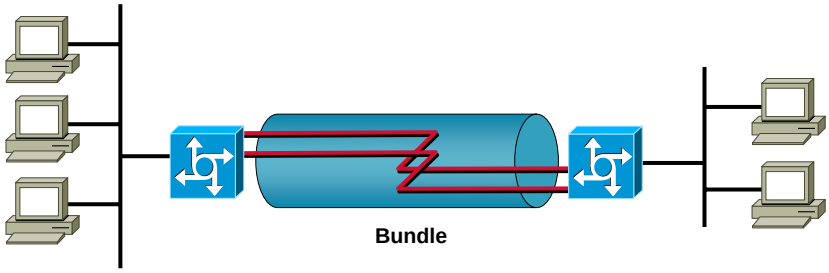

Troubleshooting Multilink PPP

```
BranchF#debug dialer
BranchF#ping 10.115.0.135

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.115.0.135, timeout is 2 seconds:

BRI0: Dialing cause ip (s=10.155.0.1, d=10.115.0.135)
BRI0: Attempting to dial 6000
%LINK-3-UPDOWN: Interface BRI0:2, changed state to up
dialer Protocol up for BR0:2.
%LINEPROTO-5-UPDOWN: Line protocol on Interface BRI0:2, changed state to
up!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 32/34/36 ms
BranchF#
BRI0: rotary group to 6000 overloaded (1)
BRI0: Attempting to dial 6000
%ISDN-6-CONNECT: Interface BRI0:2 is now connected to 6000 CentralF
```

Troubleshooting Multilink PPP (cont.)



- CHAP/PAP/caller ID on answering router?
- Dialer load threshold on one router?
- Fair queuing turned on?

ISDN *debug* Commands

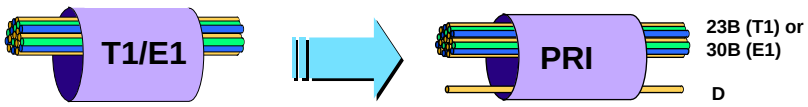
```
Router#debug isdn q921
```

- Shows data link layer messages (Layer 2) on the D channel between the access router and the ISDN switch

```
Router#debug isdn q931
```

- Shows call setup and teardown of ISDN network connections (Layer 3) between the access router and the ISDN switch

Configuration Tasks for PRI



- Select the PRI switch type
- Specify T1/E1 controller, framing, and line coding for the facility
- Set PRI group timeslots for T1/E1 and indicate the speed used
- Specify the interface on the router that you will configure for DDR

ISDN PRI Configuration

```
Router(config)#isdn switch-type switch-type
```

- Configures the ISDN PRI switch type

```
Router(config)#controller {t1 | e1}
          {slot/port | unit-number}
```

- Configures the ISDN PRI controller

T1/E1 Controller Parameters

```
Router(config-controller)#framing
 {sf | esf | crc4 | no-crc4}
```

- Selects the framing type on the controller

```
Router(config-controller)#linecode
 {ami | b8zs | hdb3}
```

- Selects the line-code type on the controller

```
Router(config-controller)#clock source
  {line [primary | secondary] | internal}
```

- Specifies the T1 clock source

Additional ISDN PRI Configuration Parameters

```
Router(config-controller)#pri-group [timeslots range]
```

- Specifies ISDN PRI on the T1 or E1 controller

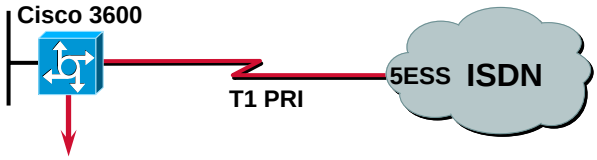
```
Router(config)#interface serial {slot/port: | unit:}{23 | 15}
```

- Specifies the serial port for the PRI D channel

```
Router(config-if)#isdn incoming-voice modem
```

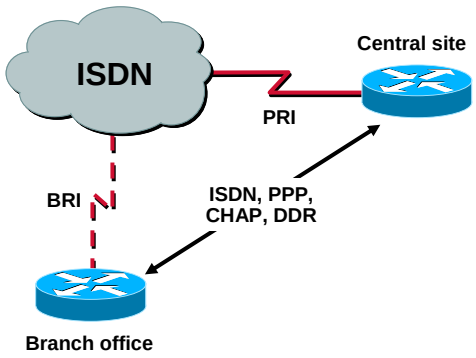
- Switches incoming analog calls to internal modems

PRI Configuration Example




```
isdn switch-type primary-5ess
!
controller t1 0/0
pri-group timeslots 1-24
framing esf
linecode b8zs
clock source line
!
interface serial 0/0:23
ip address 192.168.11.2  255.255.255.0
isdn incoming-voice modem
```


Laboratory Exercise: Visual Objective



Summary

After completing this chapter, you should be able to perform the following tasks:

- **Select BRI or PRI service for a particular application**
- **Identify Q.921 and Q.931 signaling and call sequences**
- **Configure ISDN BRI**
- **Configure ISDN PRI**
- **Configure ISDN DDR**

Review Questions

- **Compare ISDN BRI with ISDN PRI.**
- **If you are not sure what your ISDN switch type is, where would you obtain this information?**
- **What are Q.921 and Q.931?**