13(C). Multilink PPP (MLPPP)

PPP has the ability to combine multiple physical links into a single virtual interface that can be used just like any other kind of interface.

Configuration—Within a single router, the same number (highlighted) must be used for the multilink group commands and the number of the multilink interface itself. They don't need to match on opposite ends of the serial lines (different routers). You'll need to configure the virtual multilink interface [Lines 1-4] before you can reference its group number on the serial lines [Lines 9, 17].

	R1	R2
1	`interface Multilink 1`	`interface Multilink 2`
2	` ppp multilink`	` ppp multilink`
3	` ppp multilink group 1`	` ppp multilink group 2`
4	` ip address 10.12.0.1 255.255.255.252`	` ip address 10.12.0.2 255.255.255.252`
5	`!`	`!`
6	`interface Serial0/2/0`	`interface Serial0/2/0`
7	` encapsulation ppp`	` encapsulation ppp`
8	` ppp multilink`	` ppp multilink`
9	` ppp multilink group 1`	` ppp multilink group 2`
10	` bandwidth 128`	` bandwidth 128`
11	` no shutdown`	` clock rate 128000`
12	`!`	` no shutdown`
13	`!`	`!`
14	`interface Serial0/2/1`	`interface Serial0/2/1`
15	` encapsulation ppp`	` encapsulation ppp`
16	` ppp multilink`	` ppp multilink`
17	` ppp multilink group 1`	` ppp multilink group 2`
18	` bandwidth 64`	` bandwidth 64`
19	` no shutdown`	` clock rate 64000`
20		` no shutdown`

Command Locations—You *can* put a bandwidth command on the multilink interface, but if you put it on the individual serial lines instead [Lines 10,18], that allows the multilink bandwidth to be automatically adjusted as individual component links go up and down (128+64=192). Typing "encapsulation ppp" on the multilink interface is harmlessly ignored by IOS.

Command	Serial Interface	Multilink
`ip address …`		•
`encapsulation ppp`	•	
`ppp multilink`	•	•
`ppp multilink group <#>`	•	•
(ppp authentication configuration)	•	
`no shutdown`	•	(automatic)
`clock rate …`	•	
`bandwidth …`	•	(optional or calculated)

Using PPP to combine multiple serial lines into one virtual link at OSI layer 2 gives several benefits:

- One L3 address for the combined link
- Simpler Routing Table—each network at the distant site has a single routing table entry rather than one for each individual serial line
- More Stable Routing Table—The combined link stays up as long as even one of the component lines is working
- Better Traffic Burst Handling—by default, IOS load-balances per-destination, meaning that with separate links, all traffic to one destination would go over only one of the serial lines, even if the other(s) were unused at the time. PPP actually splits an individual packet into fragments to fully utilize the available links and provide a speed multiple. The fragments are reassembled at the other end. Since this happens at L2 (PPP), L3 (IP) is completely unaware
- Simplified routing protocol neighbor relationships and reduced hello traffic across the link

VERIFYING MLPPP CONFIGURATION

```
R2# show ppp multilink

Multilink2
  Bundle name: R1
  Remote Endpoint Discriminator: [1] R1
  Local Endpoint Discriminator: [1] R2
  Bundle up for 00:47:48, total bandwidth 128, load 1/255
  Receive buffer limit 24000 bytes, frag timeout 1500 ms
    0/0 fragments/bytes in reassembly list
    0 lost fragments, 1 reordered
    0/0 discarded fragments/bytes, 0 lost received
    0x54 received sequence, 0x4C sent sequence
  Member links: 2 active, 0 inactive (max 255, min not set)
    Se0/2/1, since 00:47:48
    Se0/2/0, since 00:06:27
No inactive multilink interfaces
```

You can use the normal "show interfaces" command on a multilink, just like any other interface.

```
R2# show interfaces multilink 2
Multilink2 is up, line protocol is up
  Hardware is multilink group interface
  Internet address is 10.12.0.2/30
  MTU 1500 bytes, BW 128 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, LCP Open, multilink Open
  Open: IPCP, CDPCP, loopback not set
                        Lots omitted, but it's the same as any other interface
```

If there are problems with one member link not participating (listed as inactive), you can still use the normal troubleshooting commands, like "show interfaces" and "show controllers" on that physical interface.

USING A MULTILINK INTERFACE

Once a multilink interface is running, it's treated just like any other interface. All of your OSI layer 3 configs, like IP addresses, go on the multilink instead of the underlying physical interfaces. And all L3 functions, like routing and routing protocols, use it as well.

```
R2# show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
GigabitEthernet0/0         unassigned      YES NVRAM  administratively down down
GigabitEthernet0/1         unassigned      YES NVRAM  administratively down down
Serial0/2/0                unassigned      YES NVRAM  up                    up
Serial0/2/1                unassigned      YES NVRAM  up                    up
Multilink2                 10.12.0.2       YES manual up                    up
```

```
R2# show ip route
                    Legend omitted
Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
C        10.12.0.0/30 is directly connected, Multilink2
C        10.12.0.1/32 is directly connected, Multilink2
L        10.12.0.2/32 is directly connected, Multilink2
      192.168.1.0/32 is subnetted, 1 subnets
O        192.168.1.1 [110/782] via 10.12.0.1, 00:21:44, Multilink2
```

```
R2# show ip ospf interface brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Mu2          2     0               10.12.0.2/30       781   P2P   1/1
```