15. PPP and Frame relay in small network

PPP and Frame relay are protocols operating at data link layer used in segment of private WAN connection. PPP enable establish communication through serial link between cisco and noncisco device where can not be used proprietary HDLC cisco encapsulation. Frame relay networks offer packet switched technology in providers network. This article will focus on simple implementation of PPP serial link and Frame relay link in office environment.

About PPP (basics)

Is nonproprietary data link protocol carefully designed for compatibility with common HW devices. Enabled are these connection establishments:

- *serial cables*
- *phone lines*
- *trunk lines*
- *cellular telephones*
- *fiber optic links*

Extend features supported on serial links as quality management and PAP or CHAP authentication mechanism.

Main components of protocol are:

1. HDLC protocol for encapsulation over point to point link
2. Link control protocol – establish link connection
3. Network control protocols (NCPs) – for establishing and configuration different network layer protocol

PPP configuration step by step

1) **Enable PPP on interface**

R #config t

R(config)#interface serial 0/0/0

R(config-if)#encapsulation ppp

2) **Configure authentication**

- PAP – **older and unsecure**, password is send as clear text
  ppp authentication pap
  ppp pap sent-username My_name password PSWD
- **CHAP – based on 3 way handshake mechanism using message digest** – preferred if can be used
  ppp authentication chap

3) Optionally configure compression with compress command

4) Optionally enable link quality monitoring

   ppp quality 80 (1 to 100) – if link does not meet quality requirements then goes down

5) Optionally enable load balancing across link with ppp multilink

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About Frame relay

All frame relay networks *are build on 3 main components*: DTE equipment at each end of connection (FRAD device of user), DCE (telephony company CO) and middle components (frame relay switches in operator network).

In frame relay networks our routers act as DTE devices and serial connection T1/E1 leased lines connect router to FR

switch in POP (point of presence) our ISP (internet service provider). Frame relay switches on other end act as DCE devices.

DLCI – *is local meaning number that identify link connection* (but in opposite of IP address have only local meaning).

Frame relay address mapping is important for knowing how map which DLCI map to L3 address of remote destination. Mapping can be configured as dynamic or static. (for beginners is it a bit confusing in configuration and in CCNA eLearning materials). For configuration easier way is relay on dynamic mapping that use inverse arp. For static mapping must be used frame-relay map command.

Frame relay configuration step by step

1) *Enable frame relay on interface*

   encapsulation frame-relay

and set encapsulation options cisco /ietf, cisco is on cisco devices default. IETF use only in multivendor environment when second end is non cisco device.

2) Configure bandwidth (does not affect real bandwidth) that is important for EIGRP and OSPF metric calculation

3) Set appropriateLMI type (cisco, q933a or ansi)

4) Optionally disable inverse arp for frame-relay DLCI mapping and configure appropriate static frame-relay map commands (important in end-to-end reachability in hub and spoke networks when spoke to spoke reachability is expected).

For training and hardening skills before CCNA examination we introduce next configuration scenario that can be as preconfigured downloaded from here.

Small topology with PPP and FR interconnections
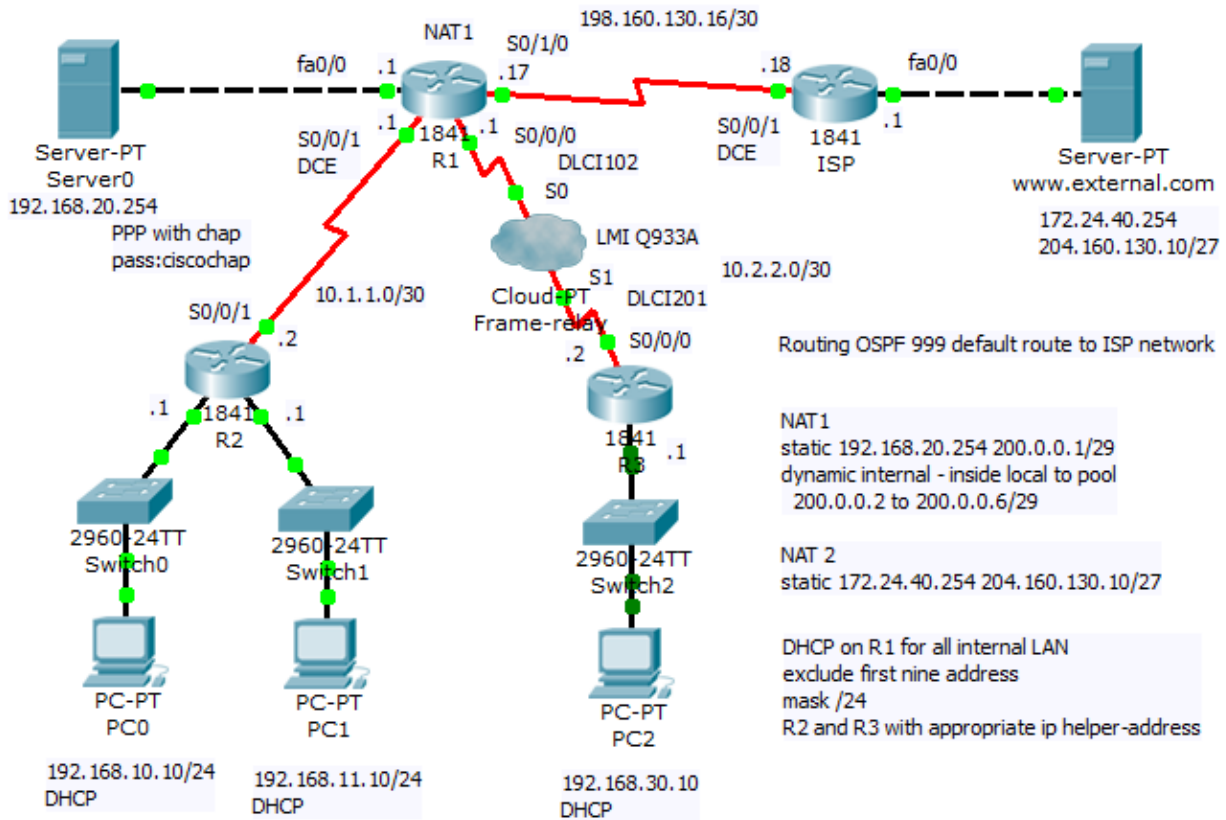
Scenario include PPP and frame relay configuration, subnetting and dynamic routing using OSPF routing protocol with ID 999. Office network use private addressing space with subnets 192.168.10.0/24, 192.168.11.0/24, 192.168.30.10 and 10.0.0.0/8 (10.1.1.0/30 and 10.2.2.0/30 VLSM subnets). On router R1 is configured NAT with PAT for private client address space and static nat translation for remote access to internal servers.

For PPP link configuration on R2 and R1 router we use

username R1 password 0 ciscochap	username R2 password 0 ciscochap

interface Serial0/0/1 ip address 10.1.1.2 255.255.255.252 encapsulation ppp ppp authentication chap	interface Serial0/0/1 bandwidth 2048 ip address 10.1.1.1 255.255.255.252 encapsulation ppp ppp authentication chap ip nat inside clock rate 2000000

For Frame relay configuration at R1 FRAD and R3 FRAD we used (configuration of FR switch is beyond scope of our training but Packet Tracer offer Cloud-PT simulation object that we will introduce in one of our next article).

R1	R3
interface Serial0/0/0.102 point-to-point ip address 10.2.2.1 255.255.255.252 frame-relay interface-dlci 102 ip nat inside clock rate 2000000	interface Serial0/0/0.201 point-to-point ip address 10.2.2.2 255.255.255.252 frame-relay interface-dlci 201 clock rate 2000000

For examination of frame-relay open state and mapping remote address to local DLCI can be used this show commands:

- show frame-relay pvc
- show frame-relay map
- show frame-relay lmi
- show interface

Output from this commands show next pictures

```
!
!
line con 0
line vty 0 4
 login
!
!
!
end


R1#show frame
R1#show frame-relay ?
  lmi   show frame relay lmi statistics
  map   Frame-Relay map table
  pvc   show frame relay pvc statistics
R1#show frame-relay map
Serial0/0/0.102 (up): point-to-point dlci, dlci 102, broadcast, status defined,
active
R1#show frame-relay lmi
LMI Statistics for interface Serial0/0/0 (Frame Relay DTE) LMI TYPE = CCITT
 Invalid Unnumbered info 0        Invalid Prot Disc 0
 Invalid dummy Call Ref 0         Invalid Msg Type 0
 Invalid Status Message 0         Invalid Lock Shift 0
 Invalid Information ID 0         Invalid Report IE Len 0
 Invalid Report Request 0         Invalid Keep IE Len 0
 Num Status Enq. Sent 1962        Num Status msgs Rcvd 1961
 Num Update Status Rcvd 0         Num Status Timeouts 16

LMI Statistics for interface Serial0/0/0.102 (Frame Relay DTE) LMI TYPE = CCITT
 Invalid Unnumbered info 0        Invalid Prot Disc 0
 Invalid dummy Call Ref 0         Invalid Msg Type 0
 Invalid Status Message 0         Invalid Lock Shift 0
 Invalid Information ID 0         Invalid Report IE Len 0
 Invalid Report Request 0         Invalid Keep IE Len 0
 Num Status Enq. Sent 0           Num Status msgs Rcvd 0
 Num Update Status Rcvd 0         Num Status Timeouts 16

R1#show frame-relay pvc 102

PVC Statistics for interface Serial0/0/0 (Frame Relay DTE)
DLCI = 102, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0/0/0.102


input pkts 14055       output pkts 32795       in bytes 1096228
out bytes 6216155      dropped pkts 0          in FECN pkts 0
in BECN pkts 0         out FECN pkts 0         out BECN pkts 0
in DE pkts 0           out DE pkts 0
out bcast pkts 32795   out bcast bytes 6216155

R1#
```

Output from show frame-relay lmi supply us with statistic information about link. LMI as management build in mechanism

can be used for link state monitoring. As frame relay lmi standard can be selected cisco, q933a and ansi. As it is discussed in this topics http://www.tek-tips.com/viewthread.cfm?qid=402209, 21.3.2012 most important thing to consider is that both end must support apropriate type of LMI.

Output from show ip interface brief contain physical link and data link up state. If link state is down you need check clock rate command on DCE end of link, encapsulation command and authentication mechanism if used (optionally compression and other optional config).

```
R1#show ip int brief
Interface              IP-Address      OK? Method Status              Protocol

FastEthernet0/0        192.168.20.1    YES manual up                  up

FastEthernet0/1        unassigned      YES unset  administratively down down

Serial0/0/0            unassigned      YES unset  up                  up

Serial0/0/0.102        10.2.2.1        YES manual up                  up

Serial0/0/1            10.1.1.1        YES manual up                  up

Serial0/1/0            198.160.130.17  YES manual up                  up

Serial0/1/1            unassigned      YES unset  administratively down down

Vlan1                  unassigned      YES unset  administratively down down
R1#show interface s0/0/0.102
Serial0/0/0.102 is up, line protocol is up (connected)
  Hardware is HD64570
  Internet address is 10.2.2.1/30
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation FRAME-RELAY
  Last clearing of "show interface" counters never
```

Next pictures show output from show interface on interfaces participating in PPP encapsulation. As you can see from output of command encapsulation is PPP and both LCP and appropriate NCP (IPCM and CDPCP) are in open state.

```
 R1                                                        ─ □ X

 Physical    Config    CLI

                    IOS Command Line Interface

   Num Status Enq. Sent 0        Num Status msgs Rcvd 0
   Num Update Status Rcvd 0      Num Status Timeouts 16

 R1#show interface s0/0/1
 Serial0/0/1 is up, line protocol is up (connected)
   Hardware is HD64570
   Internet address is 10.1.1.1/30
   MTU 1500 bytes, BW 2048 Kbit, DLY 20000 usec,
      reliability 255/255, txload 1/255, rxload 1/255
   Encapsulation PPP, loopback not set, keepalive set (10 sec)
   LCP Open               LCP open state
   Open: IPCP, CDPCP
   Last input never, 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  0/0/256 (active/max active/max total)
      Reserved Conversations 0/0 (allocated/max allocated)
      Available Bandwidth 1536 kilobits/sec
   5 minute input rate 58 bits/sec, 0 packets/sec
   5 minute output rate 56 bits/sec, 0 packets/sec
      411 packets input, 28264 bytes, 0 no buffer
      Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
      0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
      404 packets output, 28156 bytes, 0 underruns
      0 output errors, 0 collisions, 0 interface resets
      0 output buffer failures, 0 output buffers swapped out
      0 carrier transitions
      DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
 R1#

                                            Copy      Paste
```

For further reference about connected serial cable and clocking of link you can use show controllers serial – interface s0/0/1 on R1 router act as DCE end with configured clock rate command.
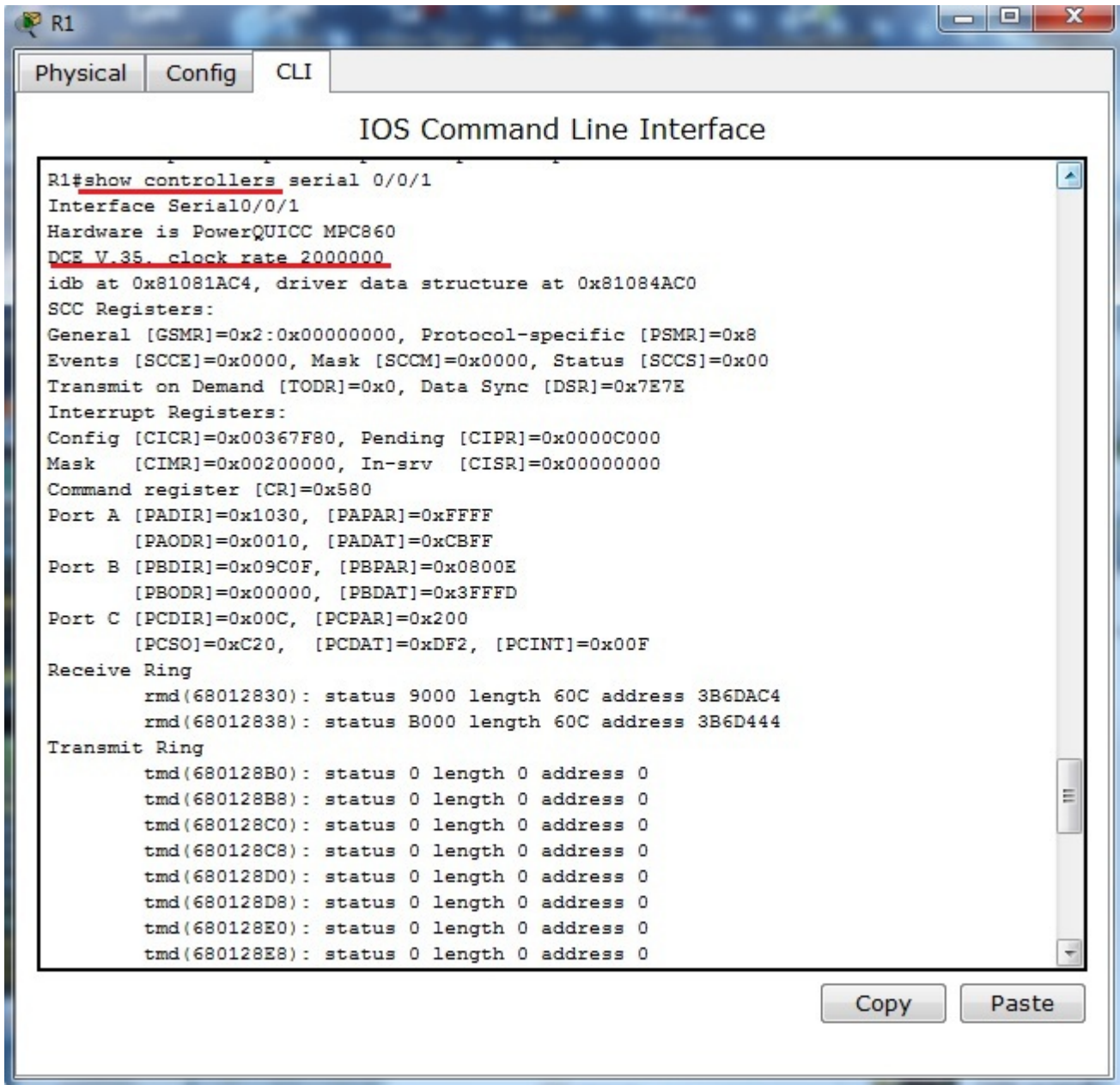
Last two pictures show Frame-relay simulation device available in Cisco Packet tracer.