SWINBURNE UNIVERSITY OF TECHNOLOGY

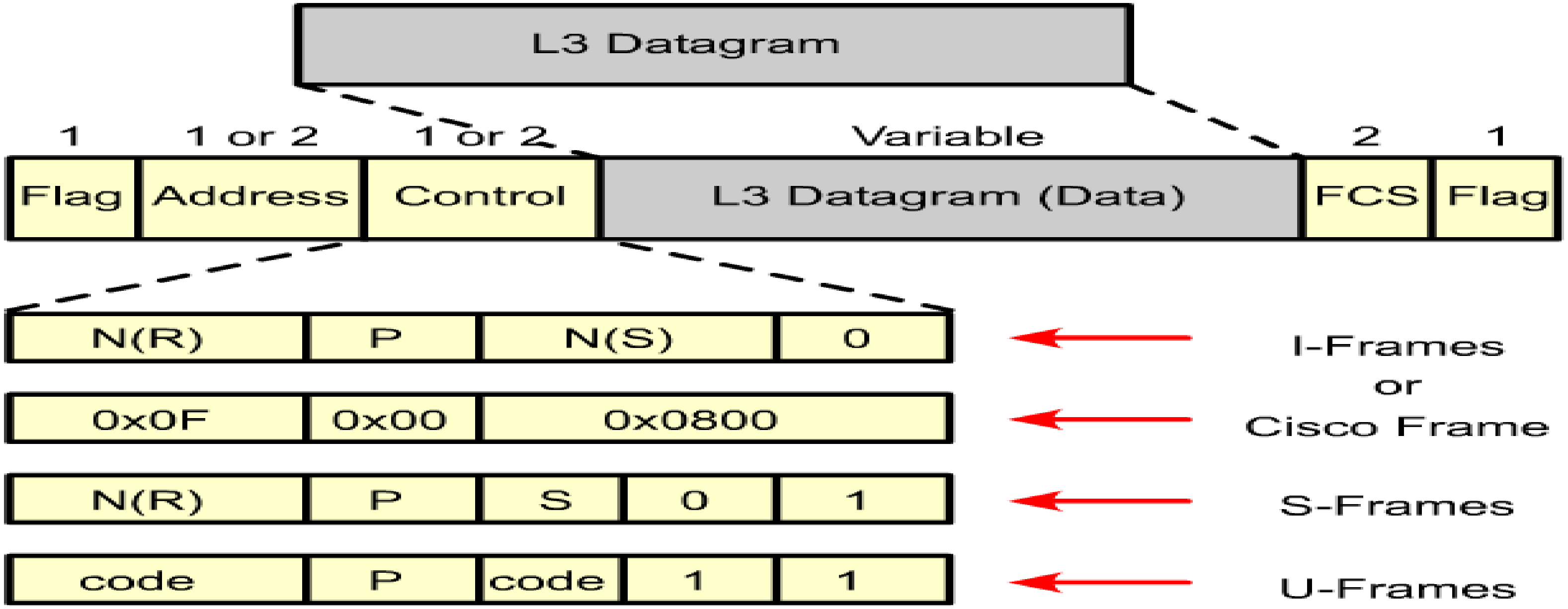
TNE20002 / TNE70003

PPP and CHAP
V1.1

SWINBURNE UNIVERSITY OF TECHNOLOGY

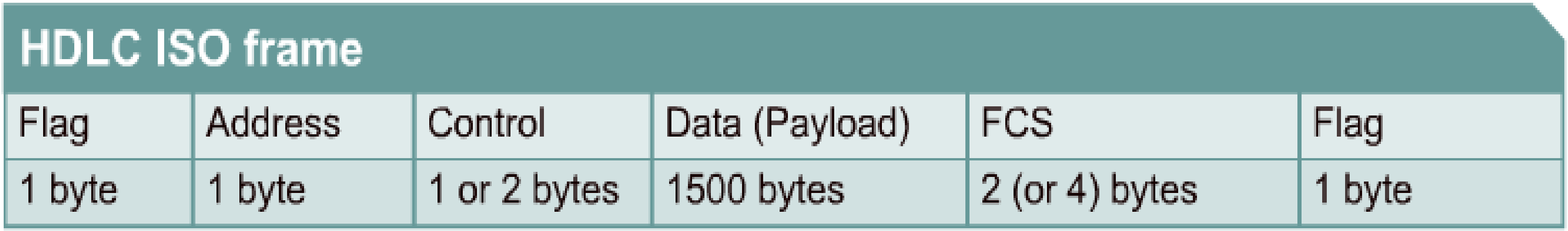
PPP – Point to Point Protocol

HDLC Encapsulation 1979



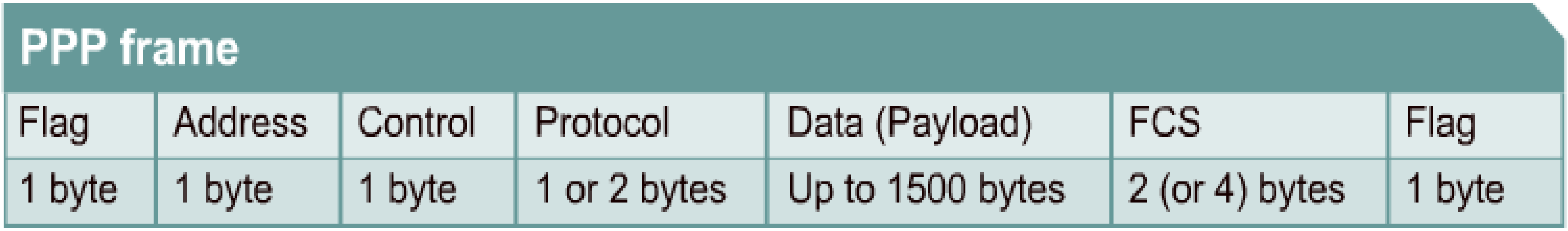
- In **1979**, the ISO agreed on HDLC as a standard bit-oriented **data link layer protocol** that encapsulates data on synchronous serial data links.
- Since **1981**, ITU-T has developed a series of HDLC derivative protocols.
- The following **examples of derivative protocols** are called link access protocols:
  - □ Link Access Procedure, Balanced (LAPB) for X.25
  - □ Link Access Procedure on the D channel (LAPD) for ISDN
  - □ Link Access Procedure for Modems (LAPM) and **PPP** for modems **< -------------**
  - □ Link Access Procedure for Frame Relay (LAPF) for Frame Relay

HDLC and PPP Encapsulation



HDLC ISO frame

Flag	Address	Control	Data (Payload)	FCS	Flag
1 byte	1 byte	1 or 2 bytes	1500 bytes	2 (or 4) bytes	1 byte

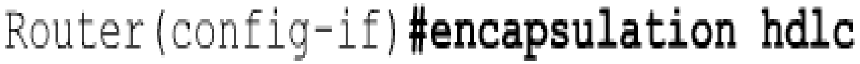


PPP frame

Flag	Address	Control	Protocol	Data (Payload)	FCS	Flag
1 byte	1 byte	1 byte	1 or 2 bytes	Up to 1500 bytes	2 (or 4) bytes	1 byte

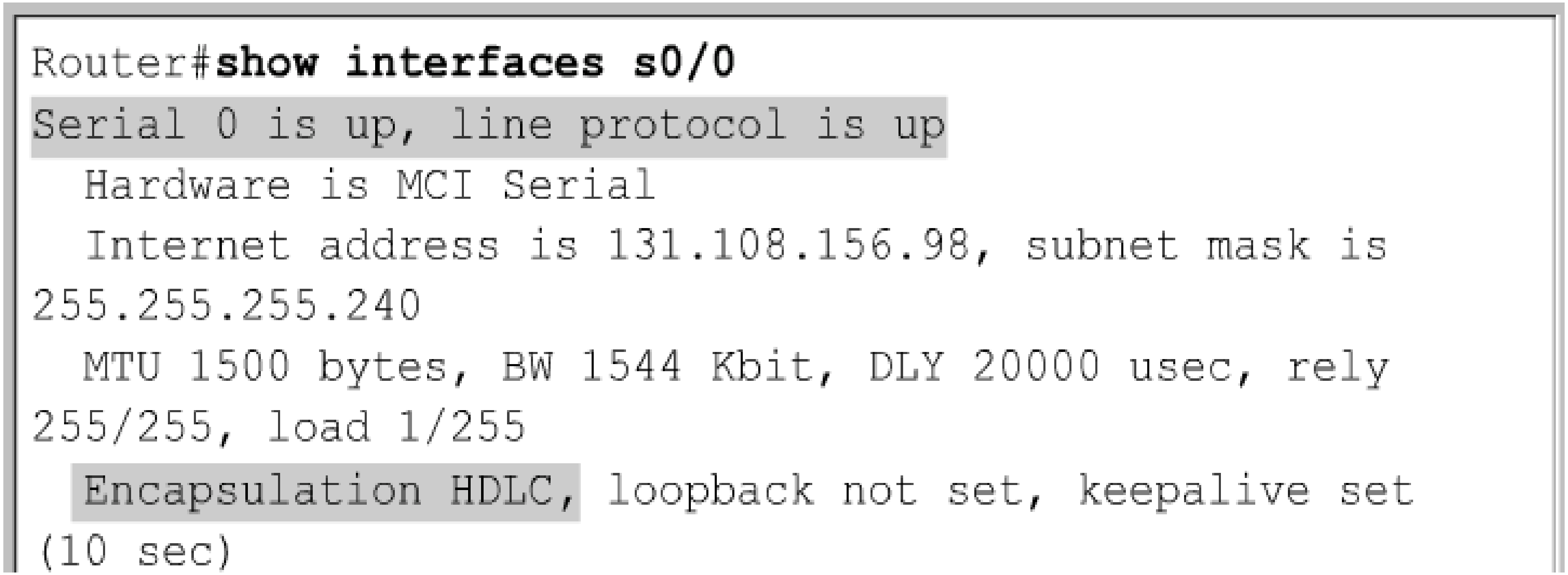
- HDLC is the default Layer 2 protocol for Cisco router serial interfaces
- HDLC does not have a way to indicate which layer 3 protocol is being carried.
- PPP frame has a Protocol field that indicates it is carrying either a layer 3 IPV4 packet or IPV6 packet

Configuring HDLC



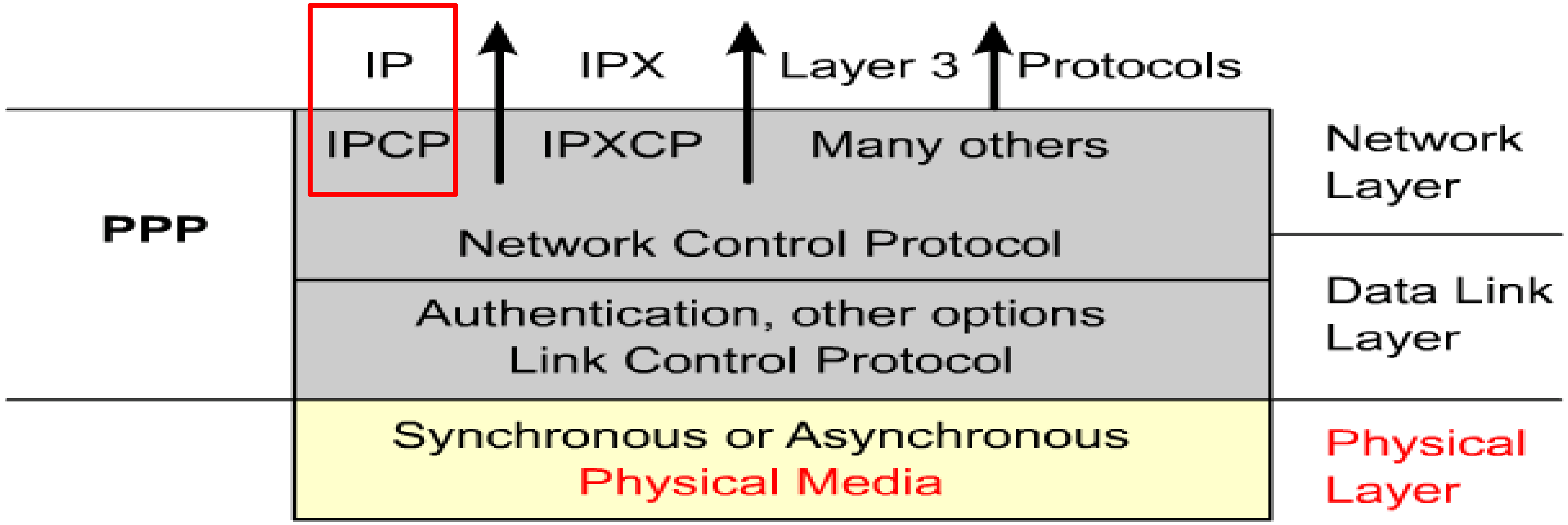
```
Router(config-if)#encapsulation hdlc
```

- The default encapsulation method used by Cisco devices on synchronous serial lines is Cisco HDLC.



```
Router#show interfaces s0/0
Serial 0 is up, line protocol is up
  Hardware is MCI Serial
  Internet address is 131.108.156.98, subnet mask is
255.255.255.240
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec, rely
255/255, load 1/255
  Encapsulation HDLC, loopback not set, keepalive set
(10 sec)
```

PPP layered architecture



- PPP contains two sub-protocols:

Network Control Protocol

□ Encapsulate and negotiate options for multiple network layer protocols

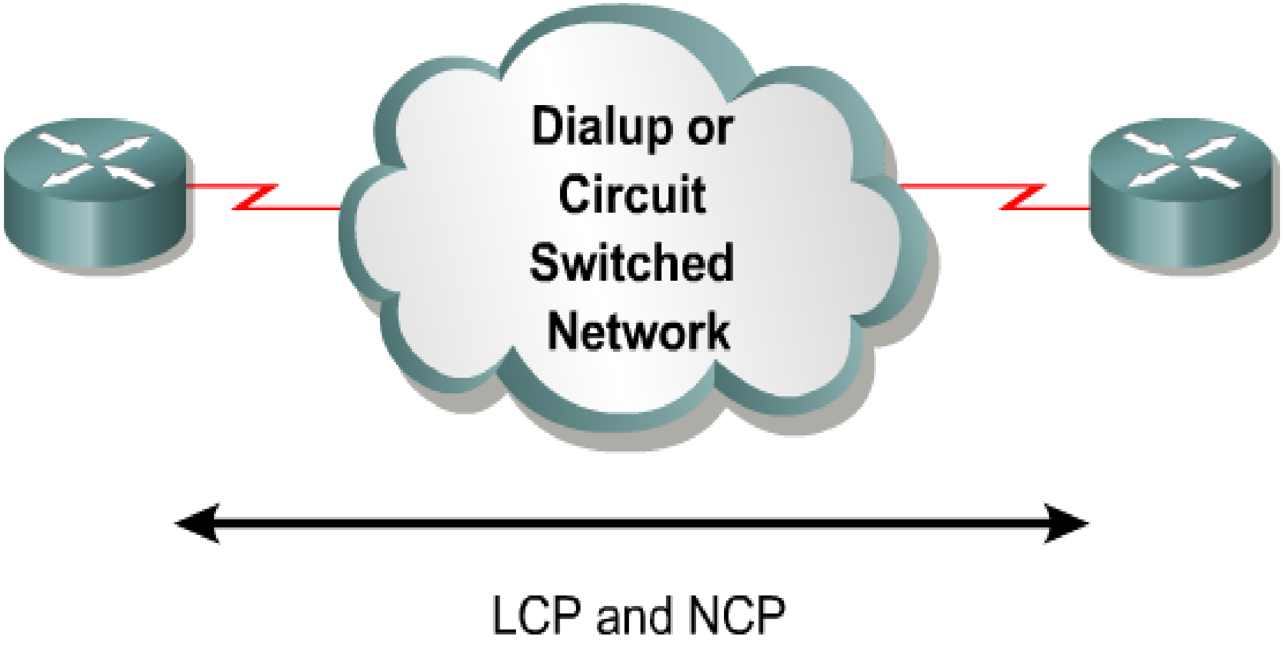
□ Responsible for configuring, enabling and disabling the network layer protocol

Link Control Protocol

□ Negotiate and setup control options on the WAN data link.

□ The LCP sits on top of the physical layer and is used to establish, configure, and test the data link connection.

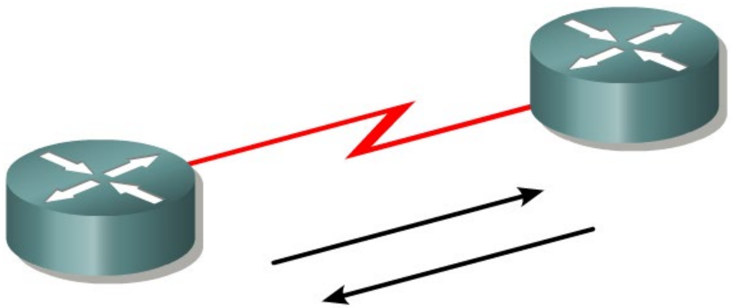
PPP Session Establishment – 3 Phases



PPP Session Establishment

- Link Establishment Phase
- **Authentication/Link Quality Phase**
- Network Layer Protocol Phase

Phase 1 – Link establishment



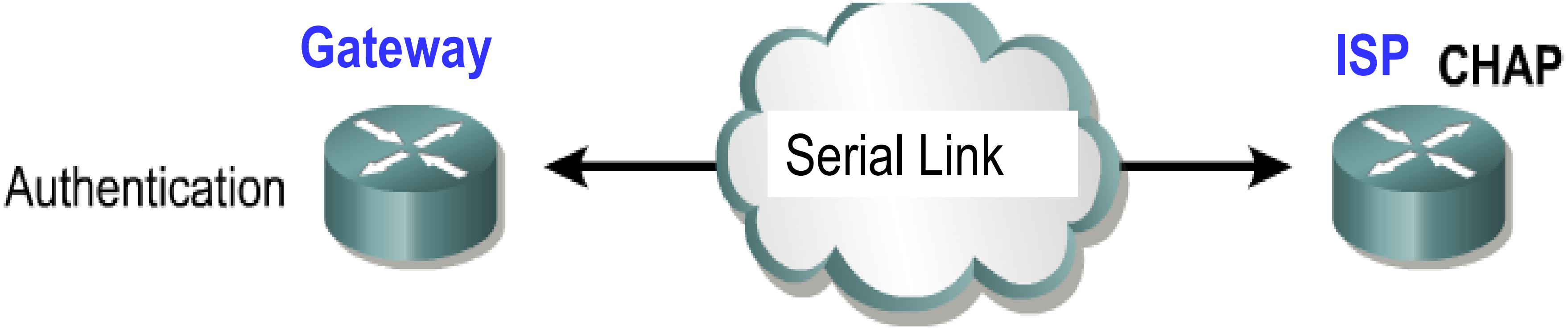
- In this phase each PPP device sends **LCP frames** to **configure and test the data link.**

- LCP frames contain a configuration option field that allows devices to negotiate the use of options such as:
  - □ the **maximum transmission unit** (**MTU**),
  - □ **compression** of certain PPP fields,
  - □ the **link-authentication** protocol.

- Before any network layer packets can be exchanged, LCP must first **open the connection and negotiate the configuration parameters**.

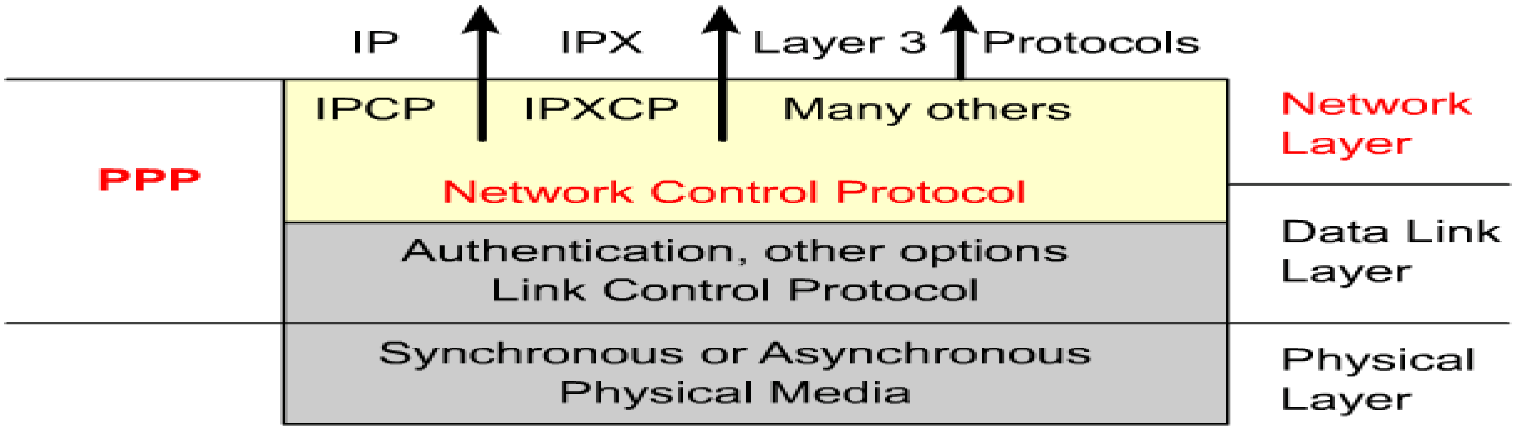
- This phase is complete when a configuration ACK frame has been sent and received.

Phase 2 - Authentication | Link Quality



- After the link has been established and the **CHAP authentication protocol decided** on, the peer will be authenticated.
- Authentication, if used, takes place before the network layer protocol phase is entered.
- As part of this phase, LCP also allows for an **optional link quality determination test.**
  - □ The link is tested to determine whether the link quality is good enough to bring up network layer protocols

Phase 3 - Network Layer Protocol

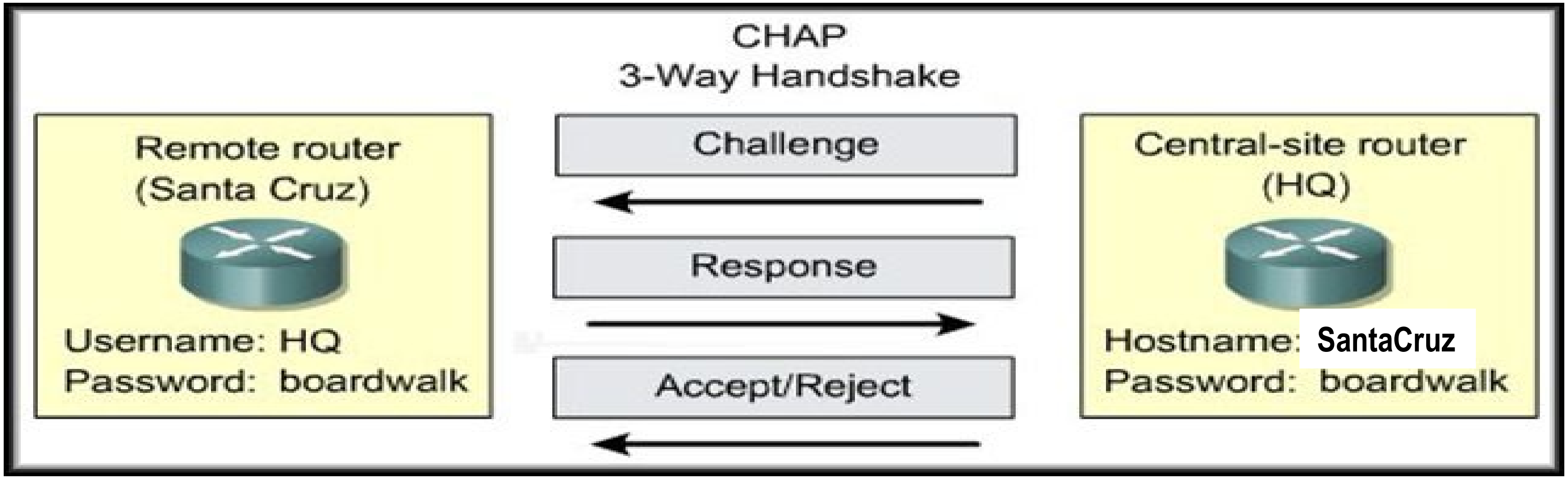


- In this phase the PPP devices send **NCP frames** to choose **either the IPv4 or IPv6 network layer protocol**.
- When the network layer protocol has been configured, packets can be sent over the link.
- The **show interfaces** command reveals the LCP and NCP states under PPP configuration.
- The PPP link remains configured for communications until LCP or NCP frames close the link or until an inactivity timer expires or a user intervenes.

CHAP

Challenge
Handshake
Authentication
Protocol

Challenge Handshake Authentication Protocol - CHAP



- CHAP is used at the startup of a link and periodically verifies the identity of the remote Host using a three-way handshake.
- After the PPP link establishment phase is complete, the local router sends a "challenge" message to the remote Host.
- The remote Host responds with a value calculated using a one-way hash function, which is typically Message Digest 5 (MD5).
- This response is based on the password and challenge message.
- The local Host checks the response against its own calculation of the expected hash value.
- If the values match, the authentication is acknowledged, otherwise the connection is immediately terminated.

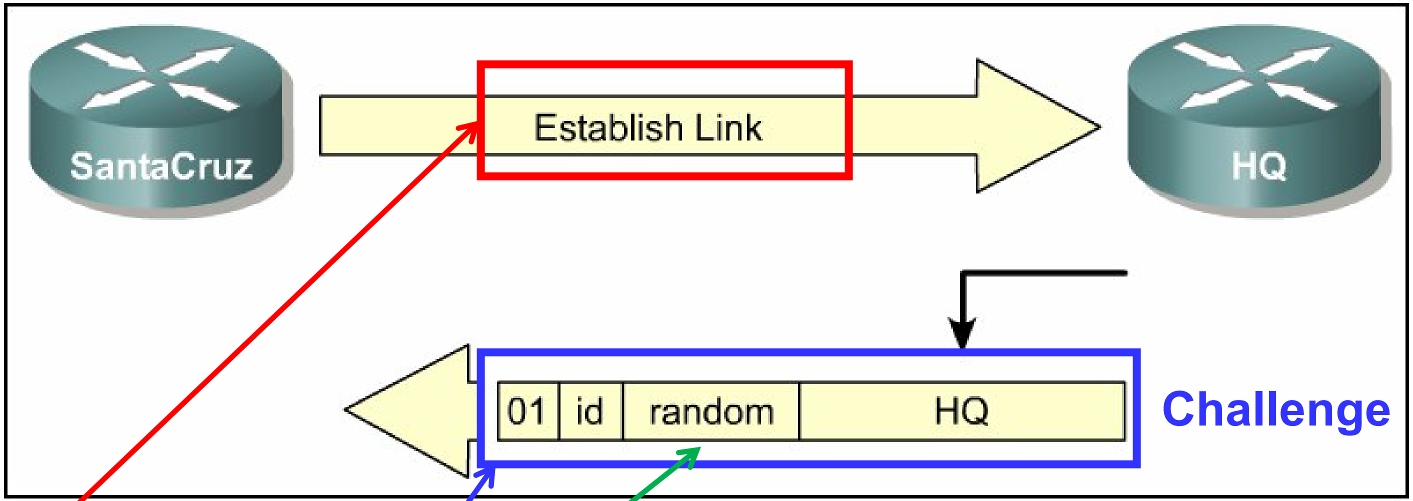
Challenge Handshake Authentication Protocol (CHAP)

- CHAP provides protection against playback (relay) attack through the use of a variable challenge value that is unique and unpredictable.
  - □ Playback attack:
    A breach of security in which information is stored without authorization and then retransmitted to trick the receiver into unauthorized operations such as false identification or authentication or a duplicate transaction.

- Since the challenge is unique and random, the resulting hash value will also be unique and random.

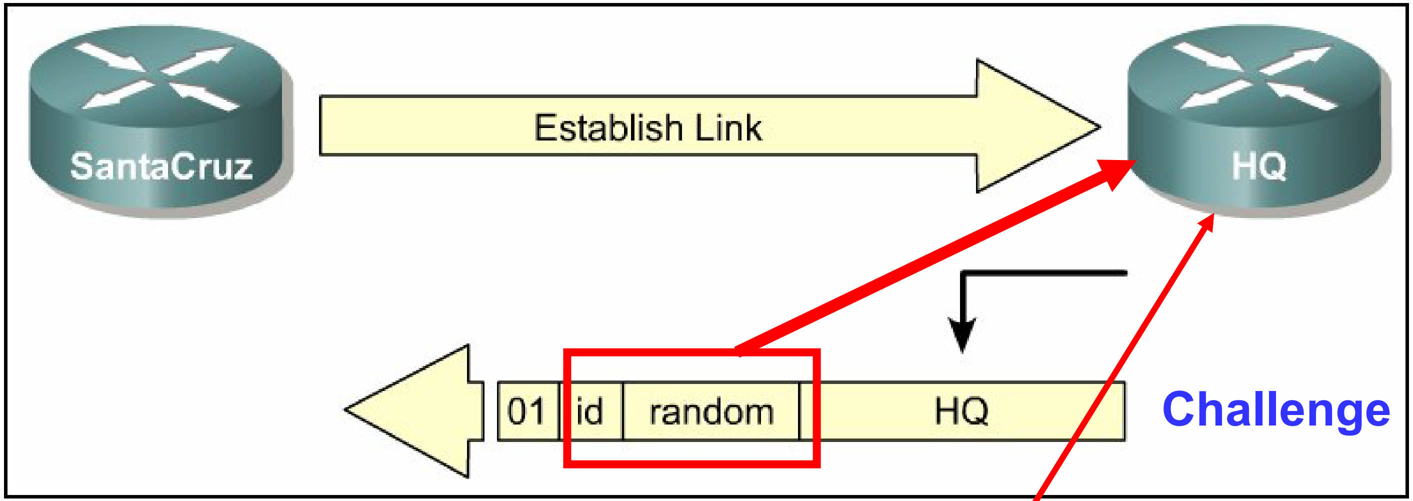
- The local host or a third-party authentication server is in control of the frequency and timing of the challenges.

1. PPP Authentication – SantaCruz calls HQ



- SantaCruz **calls** HQ to establish a PPP link.
- HQ router sends a **CHAP challenge packet** with the following details:
  - □ **01** = challenge packet type identifier.
  - □ **ID** = sequential number that identifies the challenge.
  - □ **random** = a random value generated by the **HQ** router.
  - □ **HQ** = the authentication name of the challenger.

2. HQ CHAP Challenge sent to SantaCruz

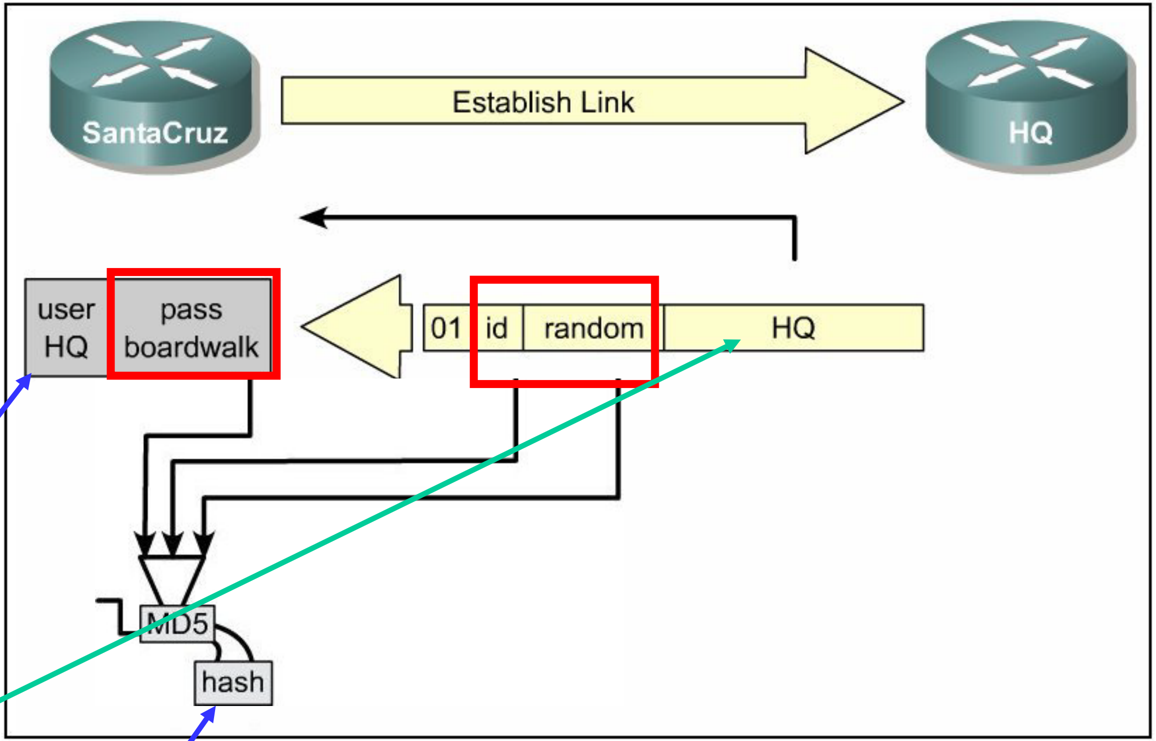


- The challenge packet is sent to the *calling* (SantaCruz) router.
- The **ID** and **random** values are kept in a **table** on the HQ router.
- A list of outstanding challenges is maintained in **table** on HQ router.

3.SantaCruz receives CHAP Challenge

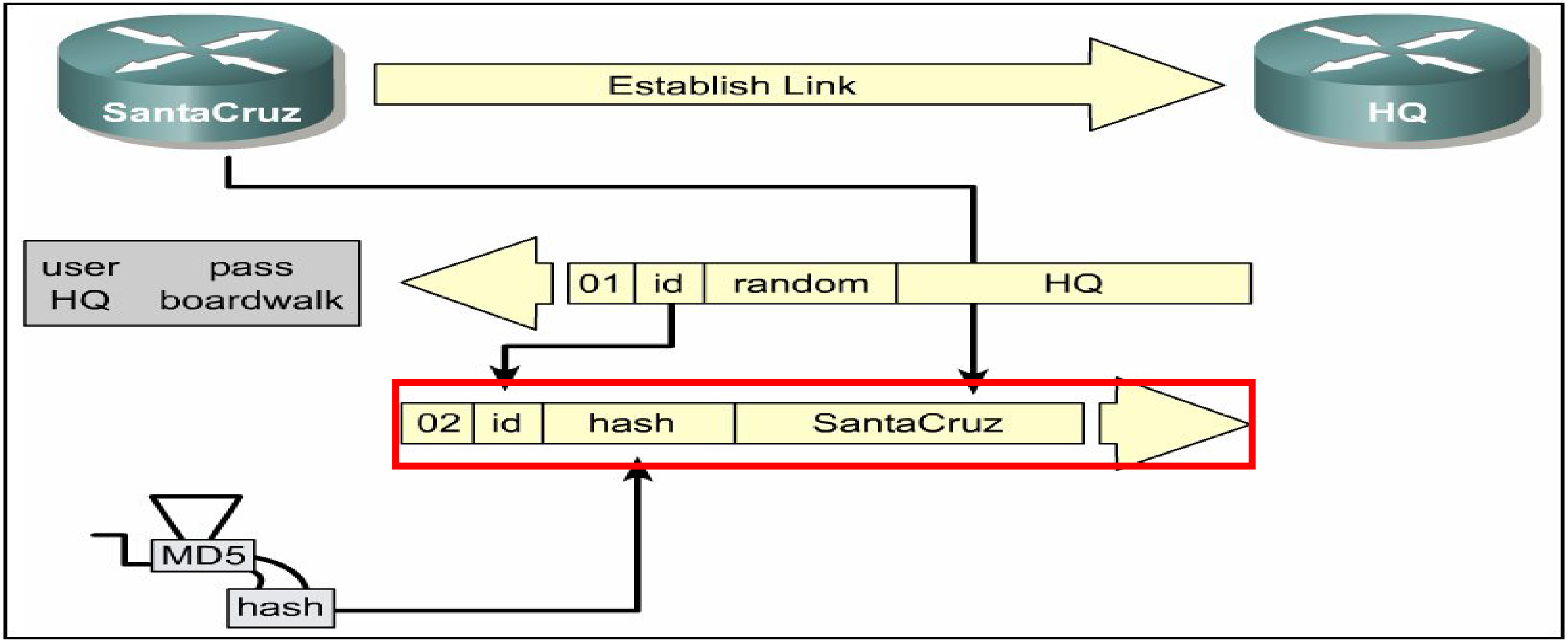
Receive CHAP Challenge

Table of User/Password



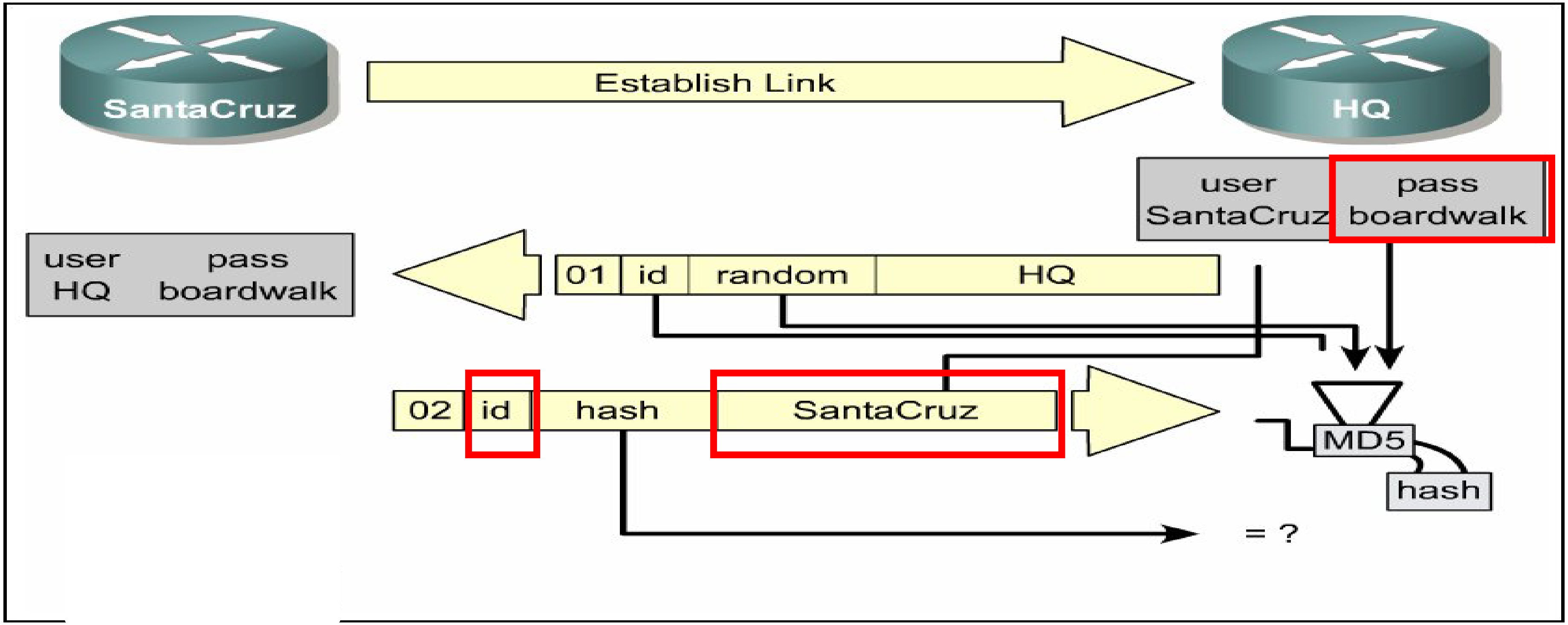
- The name HQ is used to look up the password.
- The ID value, the random value and the password are fed into the MD5 hash generator.
- The result is the one-way MD5-hashed CHAP challenge that will be sent back in the CHAP response.

4.SantaCruz sends CHAP Response



- The response packet is assembled and sent.
  - □ **02** = CHAP response packet type identifier.
  - □ **ID** = copied from the challenge packet.
  - □ **hash** = the output from the MD5 hash generator.
  - □ **SantaCruz** = the hostname of the responding device.

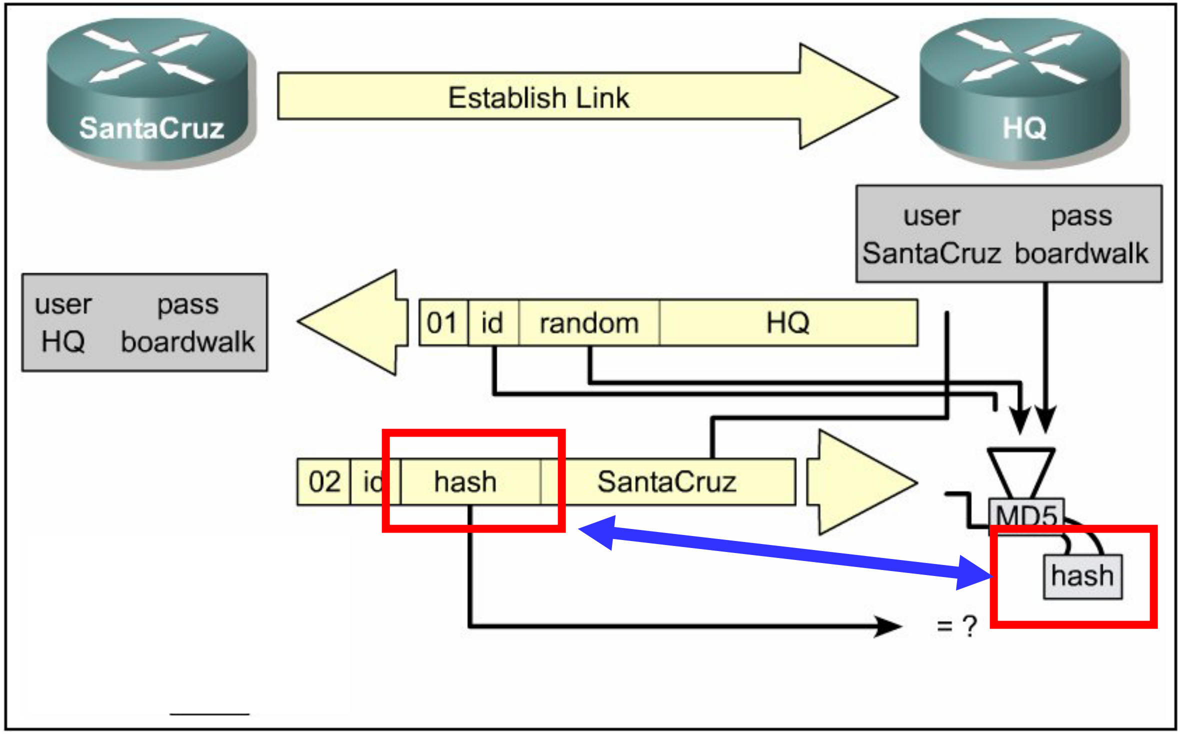
5. HQ receives CHAP Response



- The ID is used to find the original challenge packet in table.
- The name is used to look up the password from a configured name or a security server.
- The original ID, the original random value and the password are fed into the MD5 hash generator.

6. HQ Compares

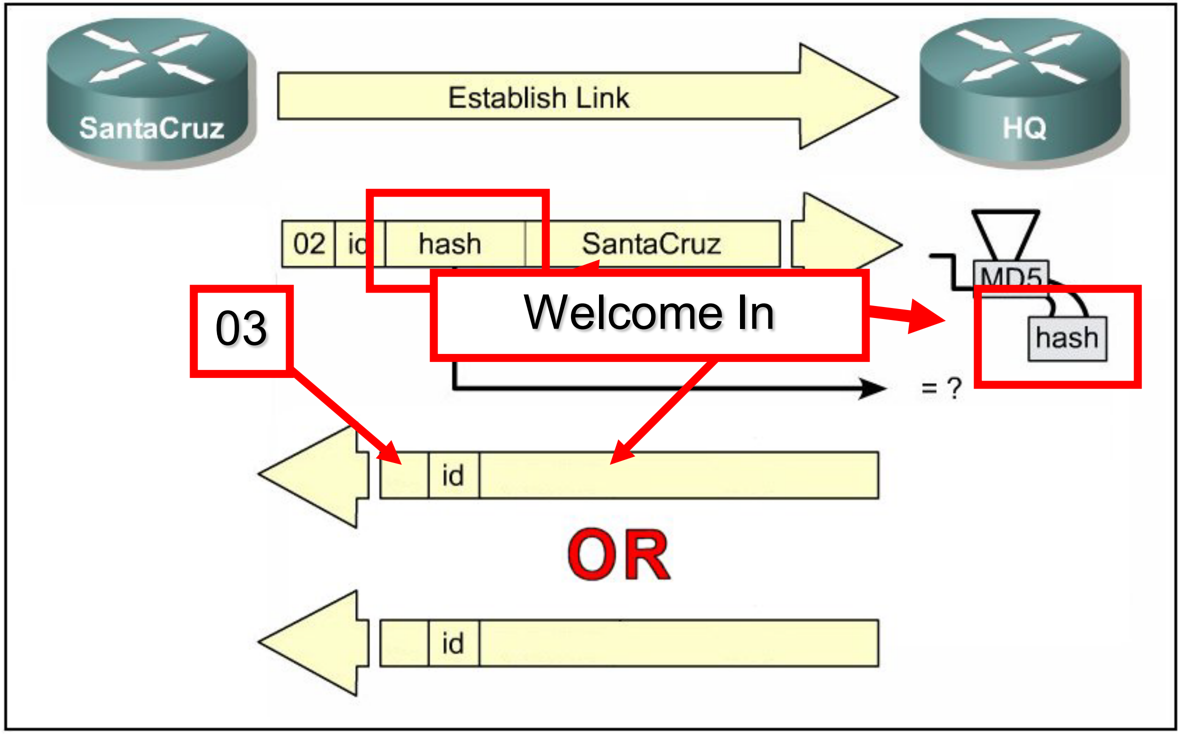
Receive CHAP Response



- The hash value received in the response packet from SantaCruz is then *compared with the MD5 hash value calculated* by HQ.
- CHAP authentication succeeds if the calculated and the received hash values are equal.

CHAP Challenge

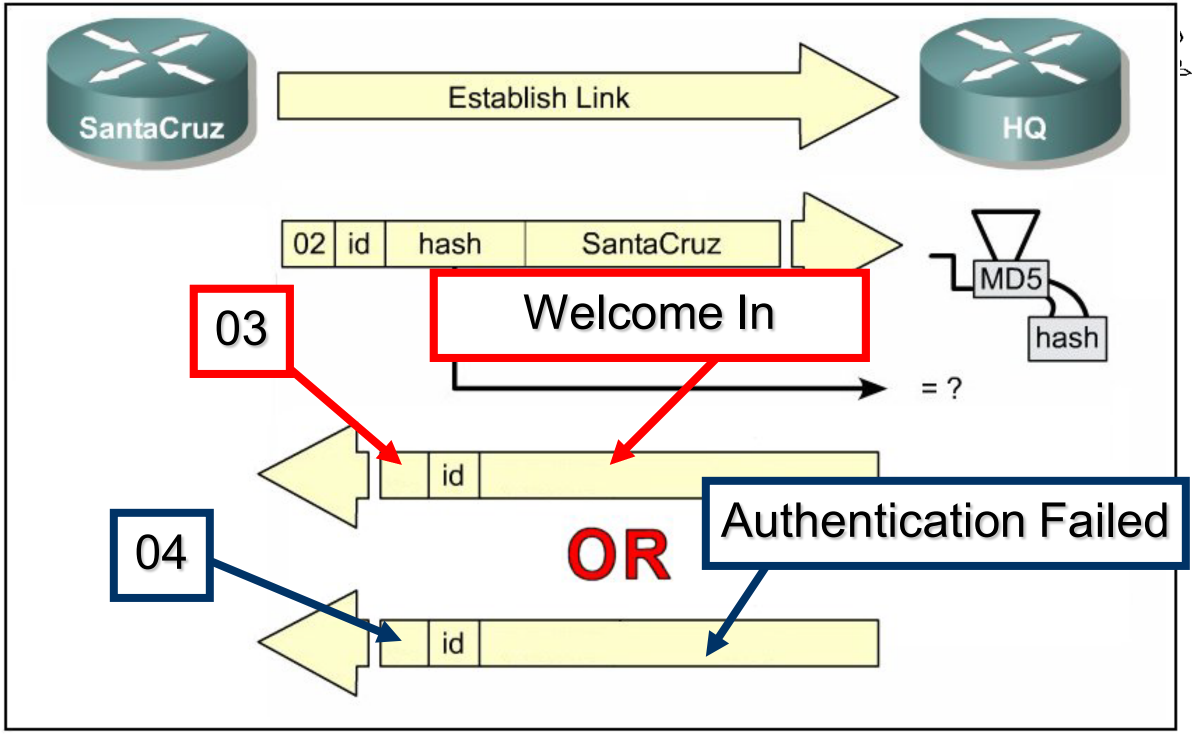
Success
OR
Failure



- If authentication is **successful**, a CHAP success packet is built from the following components:
  - □ 03 = CHAP success message type.
  - □ ID = copied from the response packet.
  - □ “Welcome In” is simply a text message providing a user-readable explanation.

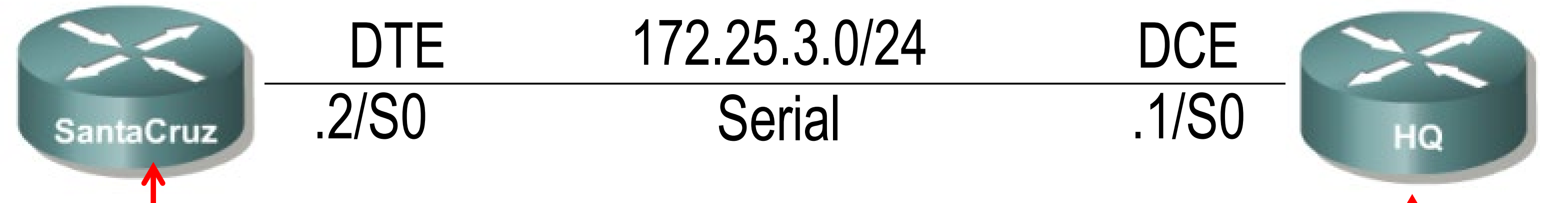
CHAP Challenge

Success
OR
Failure



- If authentication **fails**, a CHAP failure packet is built from the following components:
  - □ 04 = CHAP failure message type.
  - □ ID = copied from the response packet.
  - □ "Authentication failure" or other text message, providing a user-readable explanation.

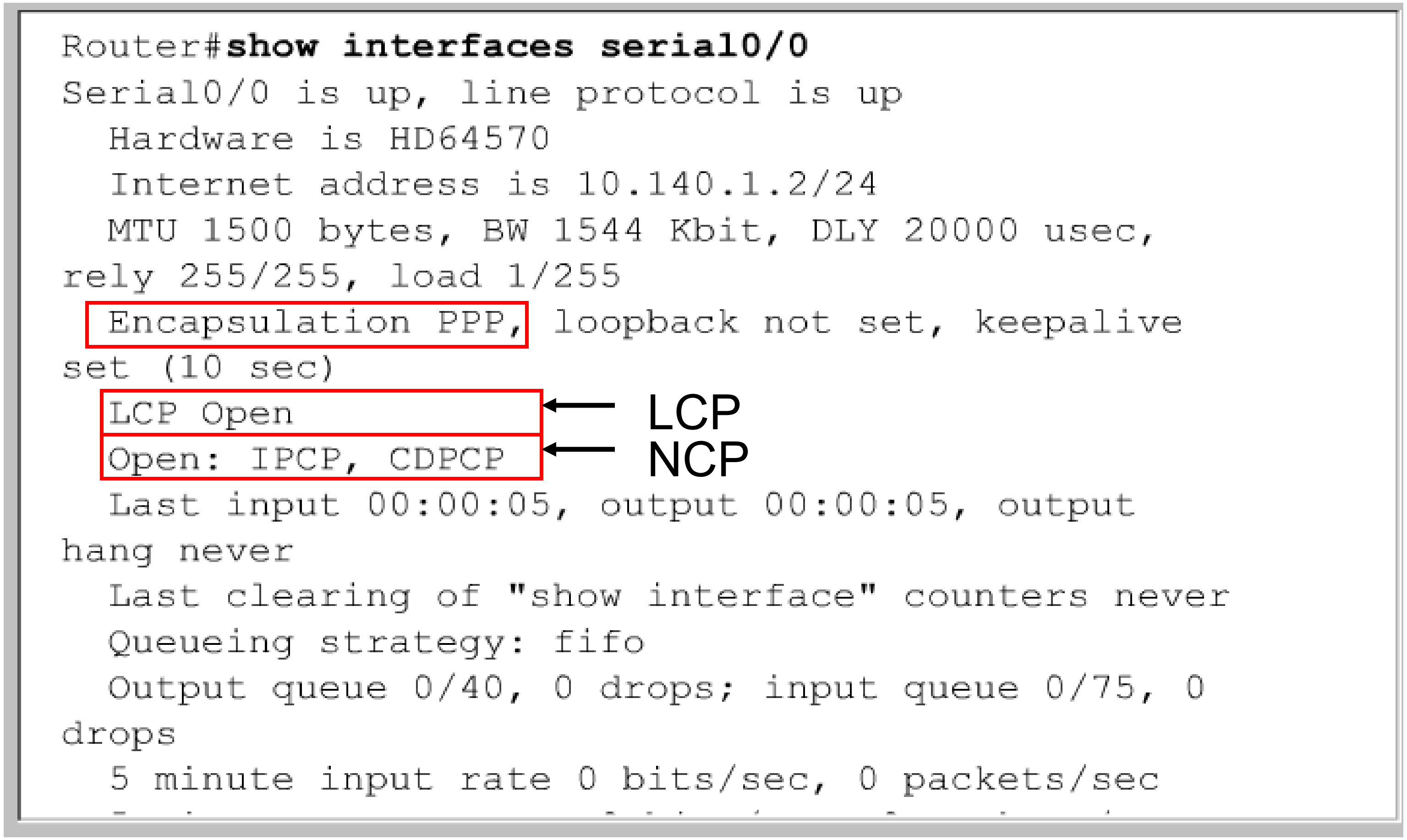
Configuring CHAP



```
username HQ password cisco
interface Serial0
  ip address 172.25.3.2 255.255.255.0
  encapsulation ppp
  ppp authentication chap
```

```
username SantaCruz password cisco
interface Serial0
    ip address 172.25.3.1 255.255.255.0
    encapsulation ppp
    ppp authentication chap
```

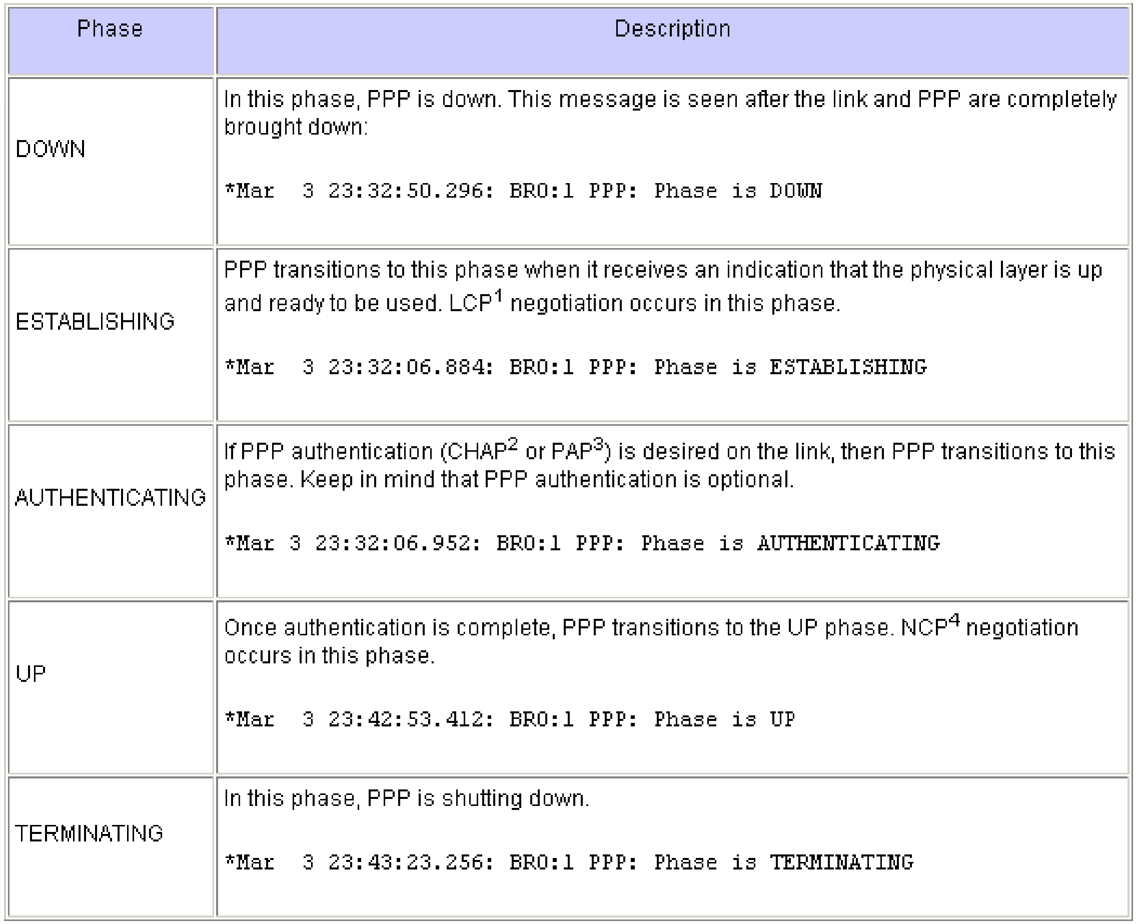
Verifying PPP



```
Router#show interfaces serial0/0
Serial0/0 is up, line protocol is up
  Hardware is HD64570
  Internet address is 10.140.1.2/24
  MTU 1500 bytes, BW 1544 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 00:00:05, output 00:00:05, output
hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0
drops
  5 minute input rate 0 bits/sec, 0 packets/sec
```

debug ppp negotiation

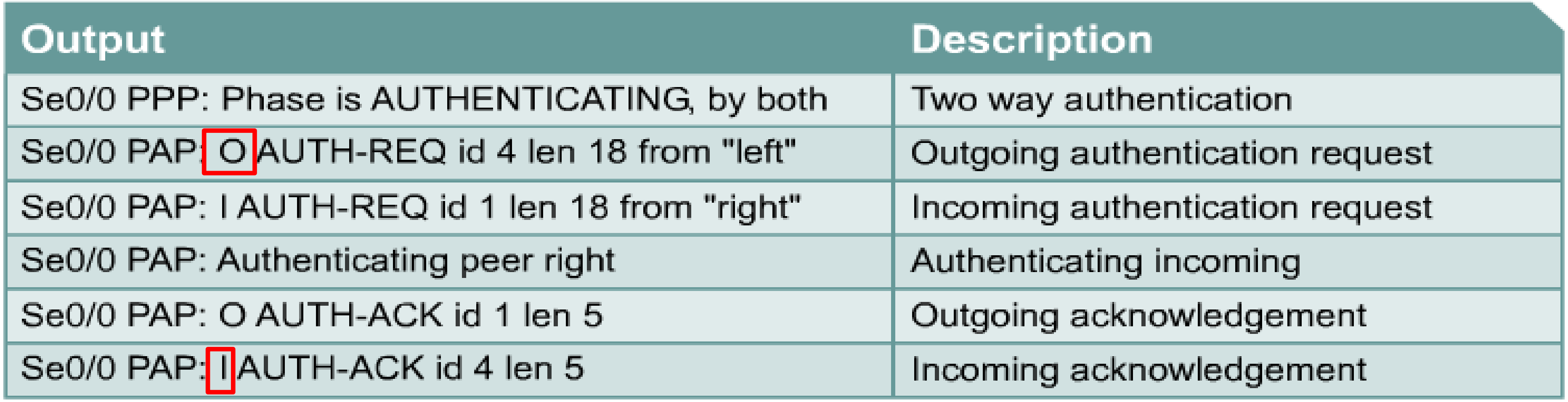
```
Router#debug ppp negotiation
PPP protocol negotiation
   debugging is on
. . .
BR0:1 LCP: State is Open
. . .
PPP: Phase is AUTHENTICATING
. . .
BR0:1 IPCP: State is Open
. . .
```



Phase	Description
DOWN	In this phase, PPP is down. This message is seen after the link and PPP are completely brought down: `*Mar  3 23:32:50.296: BRO:1 PPP: Phase is DOWN`
ESTABLISHING	PPP transitions to this phase when it receives an indication that the physical layer is up and ready to be used. LCP[1] negotiation occurs in this phase. `*Mar  3 23:32:06.884: BRO:1 PPP: Phase is ESTABLISHING`
AUTHENTICATING	If PPP authentication (CHAP[2] or PAP[3]) is desired on the link, then PPP transitions to this phase. Keep in mind that PPP authentication is optional. `*Mar 3 23:32:06.952: BRO:1 PPP: Phase is AUTHENTICATING`
UP	Once authentication is complete, PPP transitions to the UP phase. NCP[4] negotiation occurs in this phase. `*Mar  3 23:42:53.412: BRO:1 PPP: Phase is UP`
TERMINATING	In this phase, PPP is shutting down. `*Mar  3 23:43:23.256: BRO:1 PPP: Phase is TERMINATING`

- The **debug ppp negotiation** command enables you to view the PPP negotiation transactions, identify the problem or stage when the error occurs, and develop a resolution.
- During PPP negotiation, the link goes through several phases, as shown above.
- The end result is that PPP is either up or down.

debug ppp authentication



Output	Description
Se0/0 PPP: Phase is AUTHENTICATING, by both	Two way authentication
Se0/0 PAP: O AUTH-REQ id 4 len 18 from "left"	Outgoing authentication request
Se0/0 PAP: I AUTH-REQ id 1 len 18 from "right"	Incoming authentication request
Se0/0 PAP: Authenticating peer right	Authenticating incoming
Se0/0 PAP: O AUTH-ACK id 1 len 5	Outgoing acknowledgement
Se0/0 PAP: I AUTH-ACK id 4 len 5	Incoming acknowledgement

- The `debug ppp authentication` command displays the authentication exchange sequence.
- With two-way authentication configured, each router authenticates the other.
- Messages appear for both the authenticating process and the process of being authenticated.

The End

PAP, CHAP, and MS-CHAP - CompTIA Security+ SY0-501 - 4.2 - YouTube

1. Intro to the Point to Point Protocol PPP - YouTube