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Tech Notes

# Understanding and Configuring PPP CHAP Authentication

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## Introduction

The Challenge Handshake Authentication Protocol (CHAP) (defined in [RFC 1994](#) ) verifies the identity of the peer by means of a three-way handshake. These are the general steps performed in CHAP:

1. After the LCP (Link Control Protocol) phase is complete, and CHAP is negotiated between both devices, the authenticator sends a challenge message to the peer.
2. The peer responds with a value calculated through a one-way hash function (Message Digest 5 (MD5)).
3. The authenticator checks the response against its own calculation of the expected hash value. If the values match, the authentication is successful. Otherwise, the connection is terminated.

This authentication method depends on a "secret" known only to the authenticator and the peer. The secret is not sent over the link. Although the authentication is only one-way, you can negotiate CHAP in

both directions, with the help of the same secret set for mutual authentication.

For more information on the advantages and disadvantages of CHAP, refer to [RFC 1994](#) .

## Prerequisites

### Requirements

Readers of this document should have knowledge of these topics:

- How to enable PPP on the interface through the **encapsulation ppp** command.
- The **debug ppp negotiation** command output. Refer to [Understanding debug ppp negotiation Output](#) for more information.
- Ability to troubleshoot when the Link Control Protocol (LCP) phase is not in the open state. This is because, the PPP authentication phase does not begin until the LCP phase is complete and is in the open state. If the **debug ppp negotiation** command does not indicate that LCP is open, you need to troubleshoot this issue before you proceed.

**Note:** This document does not address MS-CHAP (Version 1 or Version 2). For more information on MS-CHAP, refer to the [MS-CHAP Support](#) and [MSCHAP Version 2](#) documents.

### Components Used

This document is not restricted to specific software and hardware versions.

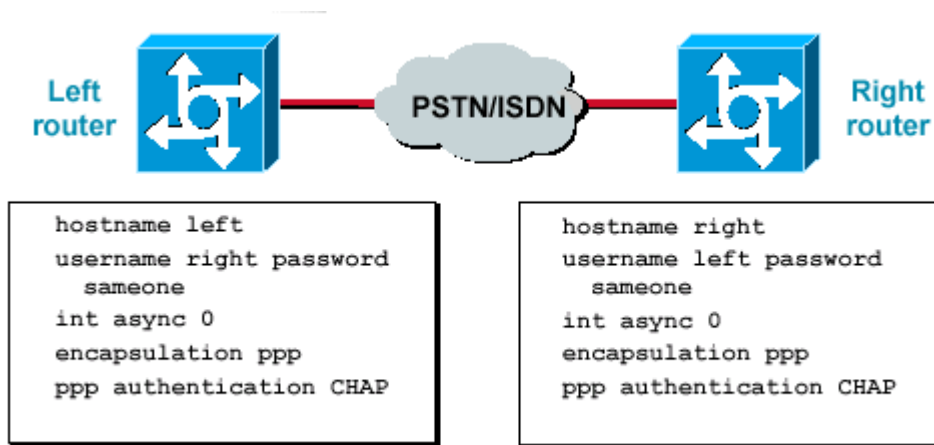
### Conventions

For more information on document conventions, see the [Cisco Technical Tips Conventions](#).

## Configure CHAP

The procedure to configure CHAP is fairly straightforward. For example, assume that you have two routers, left and right, connected across a network, as shown in [figure 1](#).

### Figure 1 – Two Routers Connected Across a Network



To configure CHAP authentication, complete these steps:

1. On the interface, issue the **encapsulation ppp** command.
2. Enable the use of CHAP authentication on both routers with the **ppp authentication chap** command.
3. Configure the usernames and passwords. To do so, issue the **username *username* password *password*** command, where *username* is the hostname of the peer. Ensure that:
  - o Passwords are identical at both ends.
  - o The router name and password are exactly the same, because they are case-sensitive.

**Note:** By default, the router uses its hostname to identify itself to the peer. However, this CHAP username can be changed through the **ppp chap hostname** command. Refer to [PPP Authentication Using the ppp chap hostname and ppp authentication chap callin Commands](#) for more information.

## One-Way and Two-Way Authentication

CHAP is defined as a one-way authentication method. However, you use CHAP in both directions to create a two-way authentication. Hence, with two-way CHAP, a separate three-way handshake is initiated by each side.

In the Cisco CHAP implementation, by default, the called party must authenticate the calling party (unless authentication is completely turned off). Therefore, a one-way authentication initiated by the called party is the minimum possible authentication. However, the calling party can also verify the identity of the called party, and this results in a two-way authentication.

One-way authentication is often required when you connect to non-Cisco devices.

For one-way authentication, configure the **ppp authentication chap callin** command on the calling router.

[Table 1](#) shows when to configure the callin option.

**Table 1 – When to Configure the Callin Option**

Authentication Type	Client (calling)	NAS (called)
One-way (unidirectional)	<b>ppp authentication chap callin</b>	<b>PPP authentication chap</b>
Two-way (bidirectional)	<b>ppp authentication chap</b>	<b>PPP authentication chap</b>

For more information on how to implement one-way authentication, refer to [PPP Authentication Using the ppp chap hostname and ppp authentication chap callin Commands](#).

## CHAP Configuration Commands and Options

[Table 2](#) lists the CHAP commands and options:

**Table 2 – CHAP Commands and Options**

Command	Description
<b>ppp authentication {chap   ms-chap   ms-chap-v2   eap   pap} [callin]</b>	This command enables local authentication of the remote PPP peer with the specified protocol.
<b>ppp chap hostname username</b>	This command defines an interface-specific CHAP hostname. Refer to <a href="#">PPP Authentication Using the ppp chap hostname and ppp authentication chap callin Commands</a> for more information.
<b>ppp chap password password</b>	This command defines an interface-specific CHAP password.
<b>ppp direction callin   callout   dedicated</b>	This command forces a call direction.  Use this command when a router is confused as to whether the call is incoming or outgoing (for example, when connected back-to-back or connected by leased lines and the Channel Service Unit or Data Service Unit (CSU/DSU) or ISDN Terminal Adapter (TA) are configured to dial).
	This command disables remote authentication by a peer (default

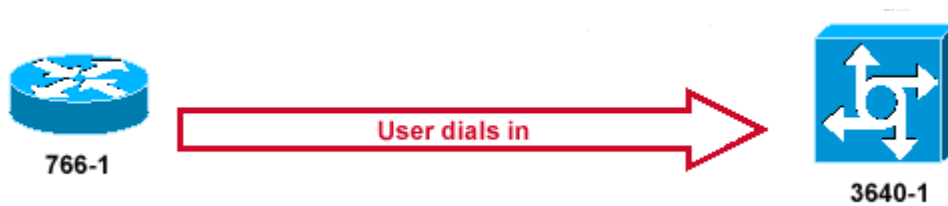
<p><b>ppp chap refuse</b> <i>[callin]</i></p>	<p>enabled). With this command, CHAP authentication is disabled for all calls, which means that all attempts by the peer to force the user to authenticate with the help of CHAP are refused.</p> <p>The callin option specifies that the router refuses to answer CHAP authentication challenges received from the peer, but still requires the peer to answer any CHAP challenges that the router sends.</p>
<p><b>ppp chap wait</b></p>	<p>This command specifies that the caller must authenticate first (default enabled).</p> <p>This command specifies that the router will not authenticate to a peer that requests CHAP authentication until after the peer has authenticated itself to the router.</p>
<p><b>ppp max-bad-auth</b> <i>value</i></p>	<p>This command specifies the allowed number of authentication retries (the default value is 0).</p> <p>This command configures a point-to-point interface not to reset itself immediately after an authentication failure, but instead to allow a specified number of authentication retries.</p>
<p><b>ppp chap splitnames</b></p>	<p>This hidden command allows different hostnames for a CHAP challenge and response (the default value is disabled).</p>
<p><b>ppp chap ignoreus</b></p>	<p>This hidden command ignores CHAP challenges with the local name (the default value is enabled).</p>

## Transactional Example

The diagrams in this section show the series of events that occur during a CHAP authentication between two routers. These do not represent the actual messages seen in the **debug ppp negotiation** command output. For more information, refer to [Understanding debug ppp negotiation Output](#).

### Call

#### Figure 2 – The Call Comes In

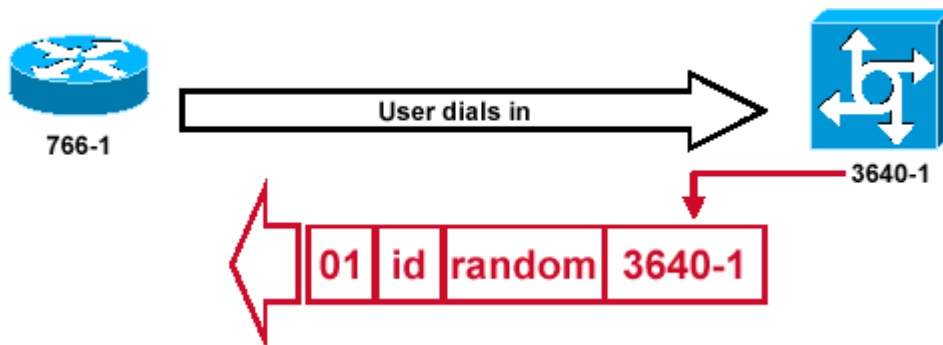


[Figure 2](#) shows these steps:

1. The call comes in to 3640-1. The incoming interface is configured with the **ppp authentication chap** command.
2. LCP negotiates CHAP and MD5. For more information on how to determine this, refer to [Understanding the debug ppp negotiation Output](#).
3. A CHAP challenge from 3640-1 to the calling router is required on this call.

## Challenge

**Figure 3 – A CHAP Challenge Packet is Built**



[Figure 3](#) illustrates these steps in the CHAP authentication between the two routers:

1. A CHAP challenge packet is built with these characteristics:
  - 01 = challenge packet type identifier.
  - ID = sequential number that identifies the challenge.
  - random = a reasonably random number generated by the router.
  - 3640-1 = the authentication name of the challenger.
2. The ID and random values are kept on the called router.
3. The challenge packet is sent to the calling router. A list of outstanding challenges is maintained.

## Response

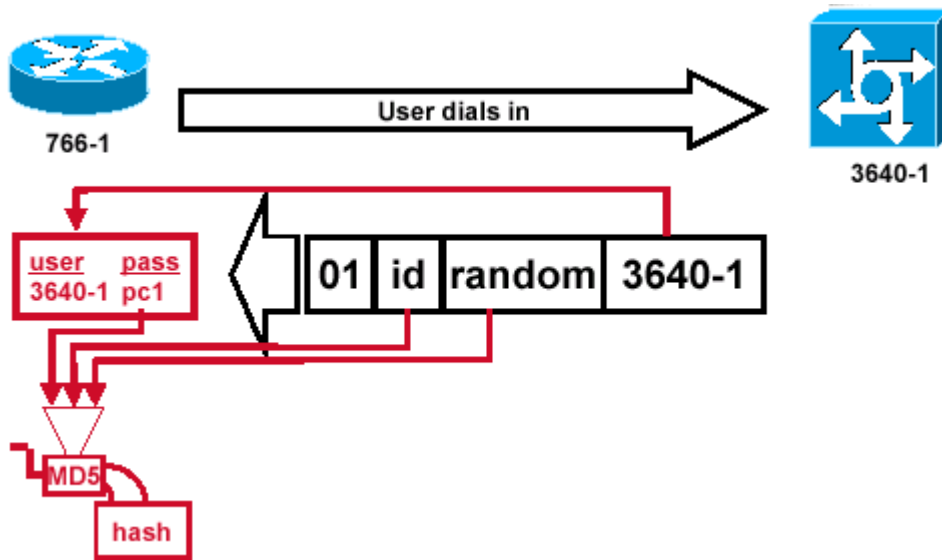
**Figure 4 – Receipt and MD5 Processing of the Challenge Packet from the Peer**

Figure 4 illustrates how the challenge packet is received from the peer, and processed (MD5). The router processes the incoming CHAP challenge packet in this way:

1. The ID value is fed into the MD5 hash generator.
2. The random value is fed into the MD5 hash generator.
3. The name 3640-1 is used to look up the password. The router looks for an entry that matches the username in the challenge. In this example, it looks for:

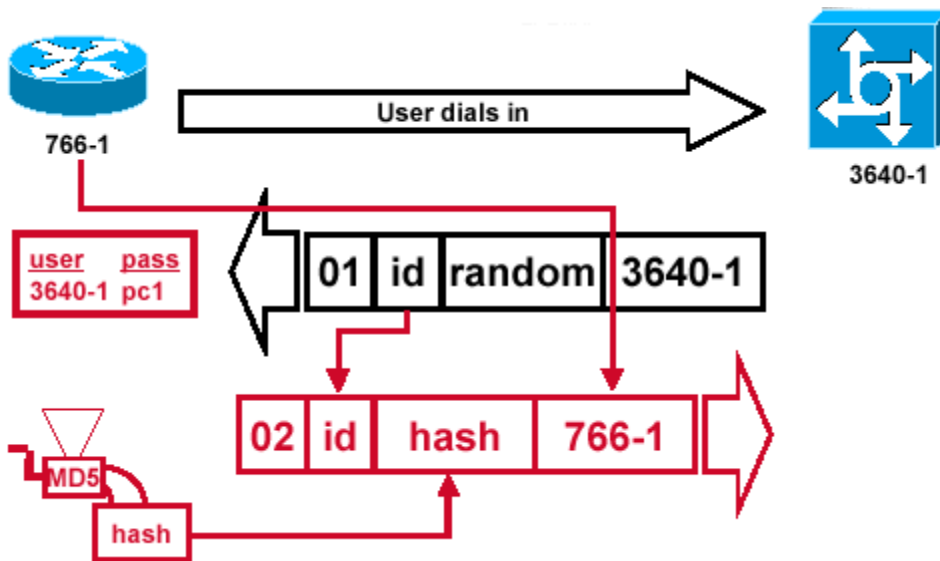
```
username 3640-1 password pc1
```

4. The password is fed into the MD5 hash generator.

The result is the one-way MD5-hashed CHAP challenge that is sent back in the CHAP response.

### Response (continued)

**Figure 5 – The CHAP Response Packet Sent to the Authenticator is Built.**



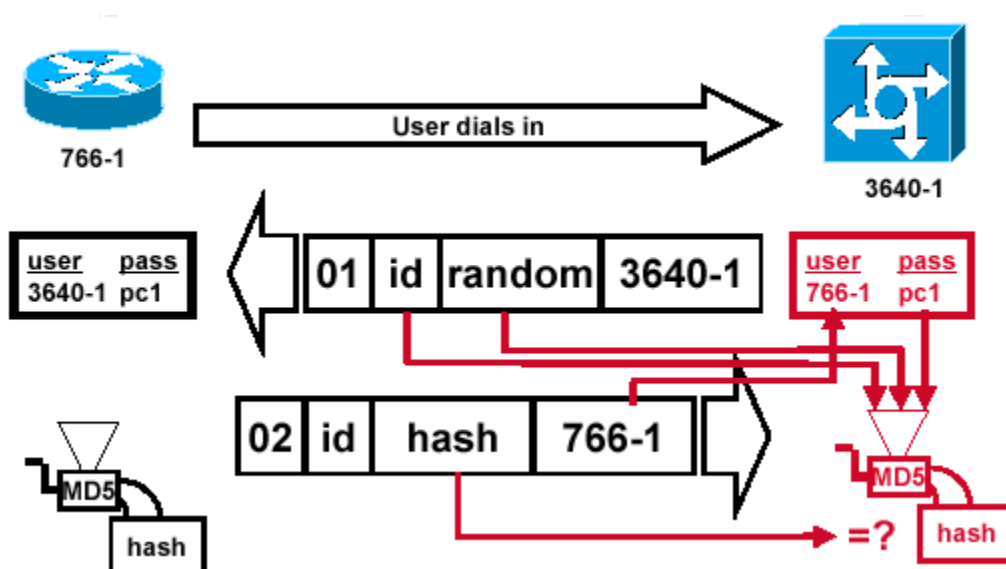
[Figure 5](#) illustrates how the CHAP response packet sent to the authenticator is built. This diagram shows these steps:

1. The response packet is assembled from these components:
  - 02 = CHAP response packet type identifier.
  - ID = copied from the challenge packet.
  - hash = the output from the MD5 hash generator (the hashed information from the challenge packet).
  - 766-1 = the authentication name of this device. This is needed for the peer to look up the username and password entry needed to verify identity (this is explained in more detail in the [Verify CHAP](#) section).
2. The response packet is then sent to the challenger.

## Verify CHAP

This section provides tips on how to verify your configuration.

### Figure 6 – The Challenger Processes the Response Packet

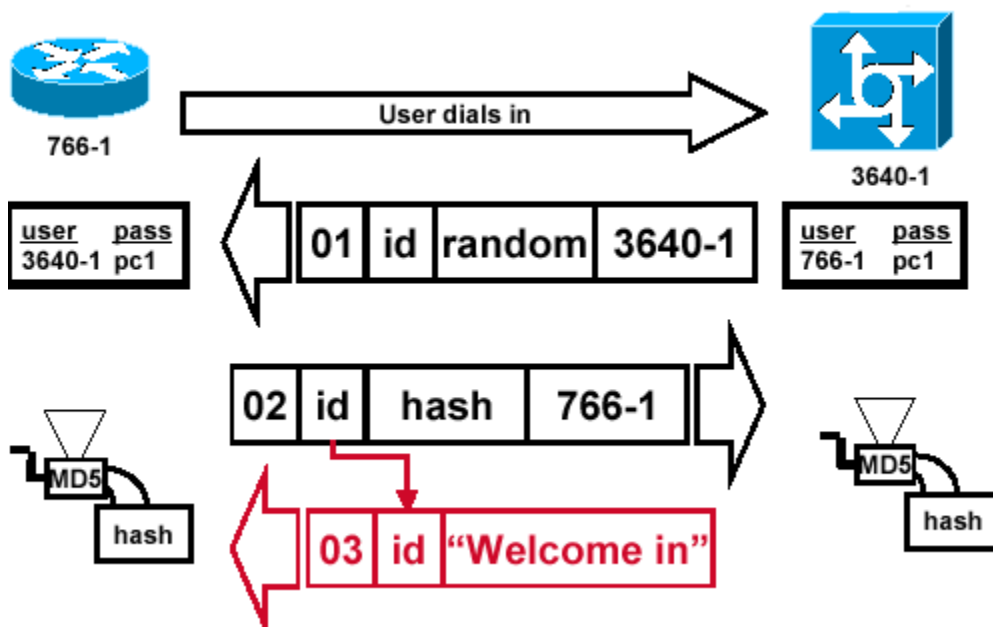


[Figure 6](#) shows how the challenger processes the response packet. Here are the steps involved when the CHAP response packet is processed (on the authenticator):

1. The ID is used to find the original challenge packet.
2. The ID is fed into the MD5 hash generator.
3. The original challenge random value is fed into the MD5 hash generator.
4. The name 766-1 is used to look up the password from one of these sources:
  - o Local username and password database.
  - o RADIUS or TACACS+ server.
5. The password is fed into the MD5 hash generator.
6. The hash value received in the response packet is then compared with the calculated MD5 hash value. CHAP authentication succeeds if the calculated and the received hash values are equal.

## Result

### Figure 7 – Success Message is Sent to the Calling Router



[Figure 7](#) illustrates the success message sent to the calling router. It involves these steps:

1. If authentication is successful, a CHAP success packet is built from these components:
  - o 03 = CHAP success message type.
  - o ID = copied from the response packet.
  - o "Welcome in" is simply a text message that provides a user-readable explanation.
2. If authentication fails, a CHAP failure packet is built from these components:
  - o 04 = CHAP failure message type.
  - o ID = copied from the response packet.
  - o "Authentication failure" or other text message, that provides a user-readable explanation.
3. The success or failure packet is then sent to the calling router.

**Note:** This example depicts a one-way authentication. In a two-way authentication, this entire process is repeated. However the calling router initiates the initial challenge.

## Troubleshoot CHAP

Refer to [Troubleshooting PPP Authentication](#) for information on how to troubleshoot issues.

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## Related Information

- [Understanding debug ppp negotiation Output](#)
- [Troubleshooting PPP Authentication](#)
- [PPP Authentication Using the ppp chap hostname and ppp authentication chap callin Commands](#)
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