



CISCO NETWORKING ACADEMY PROGRAM



IP Telephony v1.0

Instructor Guide

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I. Welcome

Welcome to the IP Telephony v1.0 Instructor Guide. Cisco Worldwide Education (WWE) has developed this guide to provide a helpful resource for instructors. This introduction will emphasize four themes:

- Student-centered, instructor-facilitated model
- One size does not fit all
- Hands-on, skills-based learning
- Global community of educators

Student-Centered, Instructor-Facilitated

The IP Telephony curriculum has not been designed as a standalone e-learning or distance-learning course. The teaching and learning model of the Cisco Networking Academy® Program is based on instructor facilitation.

One Size Does Not Fit All

The Cisco Networking Academy Program serves hundreds of thousands of students in almost 150 countries. Students range from early teens to mature adults and from advanced middle school students to undergraduate engineering students.

One curriculum cannot fit the needs of all students. WWE relies on local instructors to make the program work and to help their students achieve the learning goals of the program. There are three fixed reference points for each program that provide flexibility for the instructors:

- The mission of WWE to educate and train
- The requirements of the IP Telephony or related certification exams
- The hands-on skills that help prepare students for the industry and further education

The WWE policy allows instructors to "add anything, but subtract nothing" from the curriculum. WWE supports in-class differentiation, which is used to provide additional support for students who need it and additional challenges for advanced students. WWE also allows instructors to decide how much time to spend on various topics. Some topics can be skimmed, while others may need to be emphasized for different audiences. The local instructor must decide how to balance the need for hands-on labs with the realities of the local student-to-equipment ratio and time schedule. This Guide can be used to facilitate the preparation of lesson plans and presentations. Instructors are encouraged to research and use external sources to develop additional labs and exercises.

Hands-On, Skills-Based

The core of the IP Telephony experience is the sequence of hands-on labs. Labs are designated as either essential or optional. Essential labs include information that is fundamental to the Cisco Networking Academy student experience. This course was not designed to prepare students for a specific certification exam but it can help students gain background information for various voice exams, succeed in job situations, and develop their cognitive abilities. In IP Telephony, students will learn about the following elements:

- Basic setup for the Cisco CallManager Express (CME) Router
- Basic setup for a switch in the voice enabled network
- Installing and configuring Cisco CME Software
- Configuring basic Cisco CME features
- Configuring advanced Cisco CME features
- Configuring Cisco CME for deployment over a WAN

Global Community

WWE instructors are members of a global community of educators. There are over 10,000 instructors that teach the same eight CCNA and CCNP courses in the program. Although the IP Telephony curriculum is new many of the skills learned from CCNA and CCNP courses will be useful in this course. WWE is committed to the improvement of the curriculum, assessment model, and instructional resources such as this guide.

Guide Overview:

Section II provides a scope and sequence overview of the course. Section III summarizes the most important learning objectives, target indicators, and labs, and offers teaching suggestions and background information. Section IV provides a case study related to network design, implementation, and troubleshooting. Instructors can also devise their own case studies. Section V includes four appendices:

- Cisco online tools and utilities
- Assessment guidelines (IP Telephony v1.0 doesn't include formal assessments)
- Evidence-centered design of assessment tasks in the Networking Academy program
- Instructional best practices

II. Course Overview

Target Audience

The target audience is anyone who desires a practical and technical introduction to the field of networking. This includes high school, community college, and lifelong-learning students who are interested in careers as network technicians, network engineers, network administrators, and network help-desk staff.

Prerequisites

The successful completion of this course recommends the following:

- Reading age level of 13 or higher
- Successful completion of CCNA

The following prerequisites are beneficial, but not required:

- Prior experience with computer hardware and command line interfaces

- Background in computer programming

Course Description

The Cisco IP Telephony version 1.0 course provides an introduction to converged voice and data networks as well as challenges faced by its various technologies. The course presents Cisco solutions and implementation considerations to address those challenges.

Course Objectives

In this course, students will learn Cisco CallManager Express (CME) architecture, components, functionality and features as they configure Cisco. They will learn some Voice over IP (VoIP) and Quality of Service (QoS) technologies and apply them to Cisco CME environment. The focus of this course is:

- CallManager Express (Windows-based call manager is not taught at this time)
- Connecting a PSTN network
- Connecting from one router across the WAN to another router running CME
- Connecting from one CME enabled router to another CME enabled router

Lab Requirements

Please refer to the IP Telephony equipment bundle spreadsheets on the Cisco Academy Connection website.

Certification Alignment

The IP Telephony curriculum is not designed to align with any specific certification. Many of the components in this curriculum can be used to prepare for voice related certifications.

Course Overview

The course has been designed for approximately 40 contact hours. Approximately 30 hours will be designated to lab activities and 10 hours for curriculum content. Case studies and other instructional material will be developed by the instructor community. The format and timing should be determined by the Local Academy.

III. Guide for Each Module

Module 1: Introduction to Packet Voice Technologies

Overview

This module provides an overview of the basic telephony functions and devices, including PBXs, switching functions, call signaling, and multiplexing techniques. It also reviews basic components of the Packet Telephony Network and identifies the different requirements in campus, enterprise, and service provider environments. Together, these concepts and techniques provide a solid introduction to the VoIP arena.

This module describes the various analog and digital connections, introduces quality issues, describes common compression schemes, and concludes with a description of fax-over-IP voice networks.

This module includes the following lessons:

- Traditional Telephony
- Packetized Telephony Networks
- IP Telephony Applications
- Analog Voice Basics
- Analog-to-Digital Voice Encoding
- Signaling Systems

Module 2: Introduction to VoIP

Overview

Voice over IP (VoIP) enables a voice-enabled router to carry voice traffic, such as telephone calls and faxes, over an IP network. The module introduces the fundamentals of VoIP, bandwidth requirements using different coder-decoders (codecs) and data links, and implementation solutions. The role of gateways and their use in integrating VoIP with traditional voice technologies is explained.

This module includes the following lessons:

- Requirements of Voice in an IP Internetwork
- Gateway and their Roles
- Encapsulating Voice in IP Packets
- Calculating Bandwidth Requirements

Module 3: Configuring Cisco CallManager Express

Overview

Cisco CME is an integrated call-processing solution based on Cisco midrange access routers using Cisco IOS software that delivers telephony services for up to 120 users in small offices. This allows customers to take advantage of the benefits of IP communications, without the higher costs and complexity of deploying a server-based solution. Because the solution is based on the Cisco access router and Cisco IOS software, it is simple to deploy and manage, especially for customers who already use Cisco IOS software products.

This module includes the following lessons:

- Overview of Cisco CME
- Differences between Traditional Telephony and VoIP
- Challenges and Solutions in VoIP
- Cisco CME Features and Functionality
- Cisco CME Network Parameters
- IP Phone Registration
- Ephone-dn and Ephone
- Cisco CME Files
- Initial Phone Setup

Module 4: Voice Dial Plans, Configuring Voice Interfaces and Dial Peers

Overview

Configuring dial peers is the key to setting up dial plans and implementing voice over a packet network. This module discusses dial-peer configuration, hunt groups, digit manipulation, and special-purpose connections. In this module you will also learn basic configuration of analog and digital voice ports, the function and basic configuration of various analog and digital voice connections, dial peers, and class of restriction (COR).

This module includes the following lessons:

- Call Establishment Principles
- Configuring Dial Peers
- Special-Purpose Connections
- Building a Scalable Numbering Plan
- Configuring Voice Ports
- Adjusting Voice Quality

- Analog and Digital Voice Interfaces
- Configuring Analog and Digital Voice Interfaces
- Dial Peers
- Call Setup and Digit Manipulation
- Class of Restriction

Module 5: Configuring CME Additional Features

Overview

This module describes the additional features that can be installed and configured to enhance a basic Cisco CallManager Express (CME).

Many of the features presented will be necessary to a successful deployment of Cisco CME. These features include ways for a system administrator, customer administrator and user to interact with the Cisco CME in a web-based graphical user interface (GUI).

Critical features that many installations will need to configure include the auto attendant, music on hold, call transfer, and call forward features.

This module includes the following lessons:

- Cisco CME GUI Features
- Configuring Phone Features

Module 6: VoIP Signaling and Call Control

Overview

To provide voice communication over an IP network, Real-Time Protocol (RTP) sessions are created. These sessions are dynamically created and facilitated by one of several call control procedures. Typically, these procedures also embody mechanisms for signaling events during voice calls and for managing and collecting statistics about the voice calls. This module focuses on two protocols that offer call control support for Voice over IP (VoIP): H.323 and the Media Gateway Control Protocol (MGCP).

This module includes the following lessons:

- Need for Signaling and Call Control
- Configuring H.323
- Configuring MGCP

Module 7: Improving and Maintaining Voice Quality

Overview

When human speech is converted to analog electrical signals and then digitized and compressed, some of the qualitative components are lost. This module explores the components of voice quality that you must maintain, the methods that you can use to measure voice quality, and the effective QoS tools that you can implement to improve voice quality.

This module includes the following lessons:

- IP QoS Mechanisms
- Implementing AutoQoS
- Comparing Voice Quality Measurement Standards
- VoIP Challenges
- QoS and Good Design
- Jitter
- Delay
- Apply QoS in the Campus
- QoS Tools in the WAN
- Configuring QoS in the WAN
- Configuring CAC
- Voice Bandwidth Engineering

IV. Case Study

Overview and Objectives

These case studies allow students to implement new IP Telephony designs. Students will use the skills that have already been developed to use, make, and connect the proper cabling to the appropriate devices.

It is crucial to read and understand the scenarios to make sure that all requirements are fulfilled. Each scenario guides the student through the proper steps to ensure that the project is completed properly.

V. Appendices:

A) Cisco Online Tools and Utilities

Appendix A: Cisco Online Tools and Utilities

Cisco Systems offer a wide range of online documents and tools to assist in the configuration, troubleshooting, and optimization of routers and switches. These resources can be found on the Cisco Technical Assistance Center (TAC) website at <http://www.cisco.com/tac>. To learn more about the Cisco TAC website visit http://www.cisco.com/public/news_training/tac_overview.html. This document introduces ten valuable resources that are available to users at cisco.com.

A cisco.com user ID and password is required to access all of the tools on the Cisco TAC website. A user ID and password can be obtained with a valid Cisco service contract at <http://tools.cisco.com/RPF/register/register.do>.

1 Output Interpreter

The screenshot shows the Cisco Systems website's 'Output Interpreter' page. At the top, there is a navigation bar with the Cisco logo, a search bar, and links for Home, Logged In, Profile, Contacts & Feedback, Help, and Site Map. Below this is a secondary navigation bar with 'Technical Support' and a 'GO' button. The main content area is titled 'Output Interpreter' and features a yellow callout box with the text: 'Check out this new functionality! Now you can paste your PIX show tech-support or running configuration into Output Interpreter to automatically convert 'conduct', 'outbound' or 'apply' statements to 'access-list' statements.' Below the callout, there is a paragraph explaining the tool's purpose: 'The Output Interpreter is a troubleshooting tool that will report potential problems by analyzing supported show command output. View an [example of results generated](#) by this tool.' This is followed by a note: 'Not all commands are supported by Output Interpreter. Look up supported commands relevant to your issue in the following lists:' and two bullet points: 'List of Supported "Show" Commands' and 'Problem to Command Mappings'. At the bottom of the main content area, there is a form titled 'Enter "show" command(s) output from your device for analysis.' with instructions to paste output or upload a file. The form includes a large text area for pasting and a 'Browse...' button for file uploads. On the right side of the page, there is a search bar, a 'Toolkit' section with icons for various tools, and a 'Related Tools' section with links to 'TAC Case Open', 'Command Lookup Tool for Cisco IOS', and 'Bug Toolkit'.

Output Interpreter is a Web-based application that provides a troubleshooting analysis and a course of action for a router, switch, or PIX device. Output Interpreter uses a collection of **show** command output to perform the analysis. Users paste the output of one or more supported commands into Output Interpreter to receive a report that includes errors, warnings, and relevant troubleshooting information. The report also includes crash analysis and error message decodes, which were previously supported by the Stack Decoder and the Error Message Decoder tools.

<http://www.cisco.com/cgi-bin/Support/OutputInterpreter/home.pl>

2 Error Message Decoder

The screenshot shows the Cisco Error Message Decoder web page. At the top, there is a navigation bar with the Cisco Systems logo on the left and links for Home, Logged In, Profile, Contacts & Feedback, Help, and Site Map on the right. Below the navigation bar is a search bar with a dropdown menu set to 'Technical Support' and a 'GO' button. A secondary search bar is located on the right side of the page, with a 'GO' button and a dropdown menu set to 'Search All Cisco.com'. The main content area is titled 'Error Message Decoder' and contains the following text:

This tool will help you research and resolve error messages for Cisco IOS Software, Catalyst Switches Software, and Cisco Secure PIX Firewall Software. Follow the steps below to receive a description, recommended action, and related resources for your one- or two-line error message.

Standard error messages have the following structure :
%FACILITY-SEVERITY-MNEMONIC : Message-text (Ex: %SYS-2-MALLOCFAIL).

Other console messages (like debugs or router crashes) are not supported by this tool. Please check the [help](#) file for more information.

Copy the error message from your device, paste it here, then click Submit.

Paste Error Message:

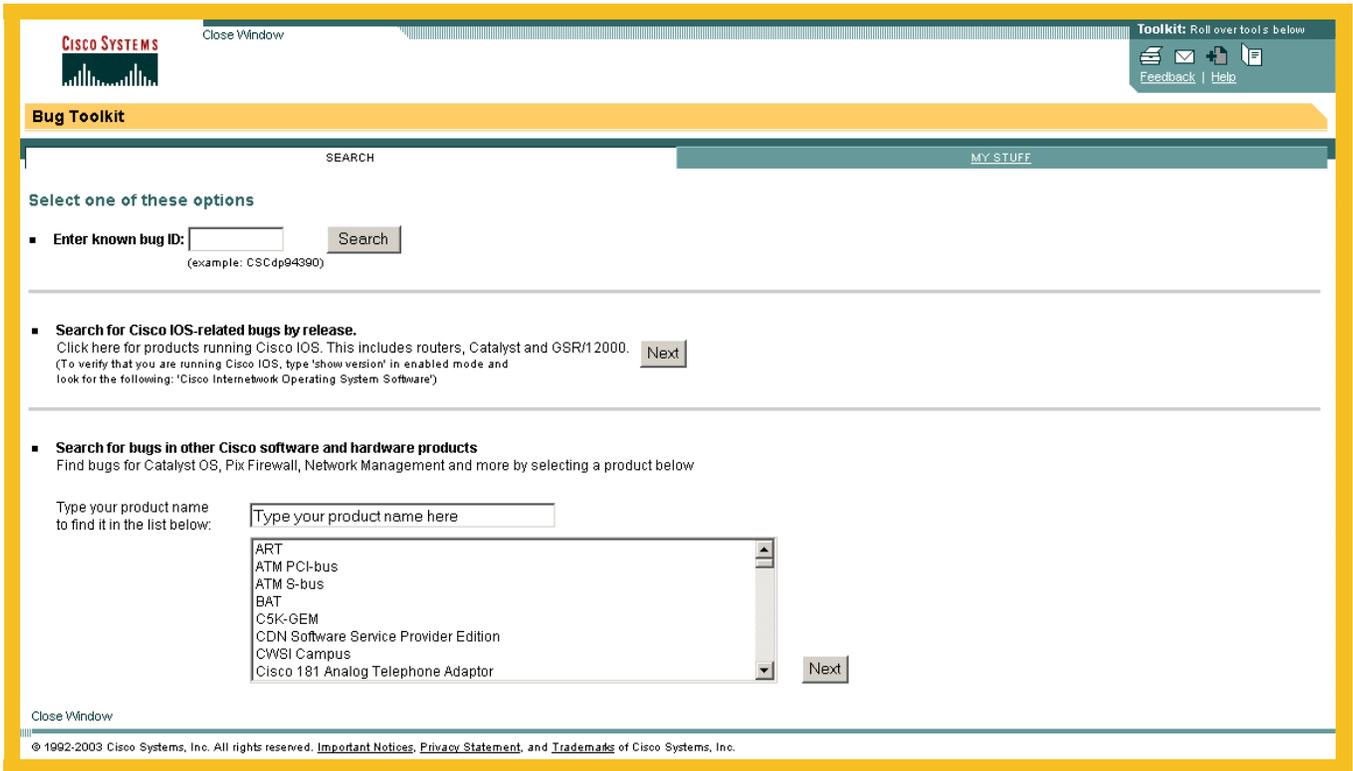
suggest related documents within results

At the bottom of the page, there is a footer with links for BUSINESS INDUSTRIES & SOLUTIONS, NETWORKING SOLUTIONS, PRODUCTS & SERVICES, TECHNOLOGIES, ORDERING, TECHNICAL SUPPORT, LEARNING & EVENTS, PARTNERS & RESELLERS, and ABOUT CISCO. Below these links are the same navigation links as in the top bar, followed by the copyright notice: © 1992-2003 Cisco Systems, Inc. All rights reserved. [Important Notices](#), [Privacy Statement](#), and [Trademarks](#) of Cisco Systems, Inc.

Explanations for console error message strings are listed in the Cisco Software System Messages guide.

<http://www.cisco.com/cgi-bin/Support/Errordecoder/home.pl>

3 Software Bug Toolkit



The Software Bug Toolkit is a Web-based resource that is used to search for software bugs based on version and feature sets. The toolkit can be used to determine why a feature does not work.

http://www.cisco.com/cgi-bin/Support/Bugtool/launch_bugtool.pl

4 IP Subnet Calculator

The screenshot shows the Cisco IP Subnet Calculator web page. At the top left is the Cisco Systems logo. The navigation bar includes links for Home, Logged In, Profile, Contacts & Feedback, Help, and Site Map. A search bar is located in the top right corner. The main content area is titled "IP Subnet Calculator" and features four tabs: HOME, SUBNETS, SUPERNETS (CIDR), and VLSM. The SUBNETS tab is currently selected. Below the tabs, there is a brief description of the tool and three sections: "Subnets", "Supernet (CIDR)", and "VLSM", each with a short description of its function. On the right side, there is a "Search" box, a "Toolkit" section with icons for various tools, and a "Related Tools" section with links to "TAC Case Open", "TAC Case Query", and "2600/3600/3700 Memory Calculator". The footer contains a list of links for various Cisco services and a copyright notice for 1992-2003 Cisco Systems, Inc.

IP Subnet Calculator is a Web-based resource that is used to calculate the subnet mask based on several variables. This tool can be used to verify network settings.

<http://www.cisco.com/cgi-bin/Support/IpSubnet/home.pl>

5 Password Recovery Procedures

[Solutions](#) [Products](#) [Ordering](#) [Support](#) [Partners](#) [Training](#) [Corporate](#)

Tech Notes

Password Recovery Procedures

Document ID: 6130

Please provide your [feedback](#) on this document.

This page is the index of password recovery procedures for Cisco products.

Note: For security reasons, the password recovery procedures described here require physical access to the equipment.

High-End Routers

Cisco 12000 Series Routers	Cisco 7100 Series Routers	Cisco uBR7200	Cisco AGS
Cisco 7000 Series Routers	Cisco uBR7100	Cisco 7500 Series Routers	Route Processor Module
Cisco 7000 Series Route Switch Processor (RSP7000)	Cisco 7200 Series Routers	Cisco uBR10000	

LAN Switches

EtherSwitch/FastSwitch/FastHub	Catalyst 2100 Series Switches	Catalyst 2950 Series Switches	Catalyst 5500/5000/2926G/2926 Series Switches
Catalyst 1200 Series Switches	Catalyst 2600 Series	Catalyst 3000/3100/3200	Catalyst 6000 Series

This Web page is the source for Cisco password recovery procedures. The password recovery procedure for every Cisco device can be found here.

<http://www.cisco.com/warp/public/474/>

6 TAC Case Collection

The screenshot shows the Cisco Technical Support website's TAC Case Collection page. The page has a yellow header with the Cisco Systems logo and navigation links (Home, Logged In, Register, Contacts & Feedback, Help, Site Map). Below the header is a search bar with 'Technical Support' entered and a 'GO' button. A sidebar on the left contains 'TECHNICAL SUPPORT' and 'TAC Case Collection'. The main content area features a description of the TAC Case Collection tool, a 'Note' about browser support, and several categorized links with 'NEW!' badges: ATM Media Support, Dial (Access), Frame Relay, IP Routing Protocols, LAN Switching, Hardware Troubleshooting, Router and IOS Architecture, and Security. A right sidebar includes a search box, a 'Toolkit' section with icons for various tools, and a 'Related Tools' section with links for TAC Case Open, TAC Case Query, and Error Message Decoder.

CISCO SYSTEMS Home | Logged In | Register | Contacts & Feedback | Help | Site Map

Technical Support Select a Location / Language

TECHNICAL SUPPORT + TECHNICAL SUPPORT

TAC Case Collection **TAC Case Collection**

The TAC Case Collection, an evolution of the Troubleshooting Assistant tool, helps you interactively identify and troubleshoot common problems involving hardware, configuration, and performance issues. These solutions, provided directly by TAC engineers, have resolved actual networking problems. Please select a technology or product area from the list below to begin troubleshooting.

Note: New knowledge bases only support browser versions IE 5.5 and later or Netscape 6.x and later.

ATM Media Support
ATM link level access

Dial (Access)
DDR & non-DDR callout using external modem, CAS T1/E1, PRI, or BRI, Local and AAA server based authentication and authorization, LCP and NCP negotiations, authentication failure, link stability, and routing packets

Frame Relay
PVCs, SVCs, Traffic Shaping, dial-backup, PPP over Frame Relay, configuration, performance and connectivity issues

IP Routing Protocols
Common issues on configuration, routes missing from routing table, route not being redistributed, network not being advertised, neighbor not forming or flapping, Internet and network connectivity, NAT, PBR, HSRP and error messages. Routing protocols covered include EIGRP, OSPF, BGP and RIP

LAN Switching
Configuration, connectivity, VLANs, trunking, autonegotiation, passwords and catalyst hardware issues

Hardware Troubleshooting
Catalyst switches (2900XL, 3500XL, 2948G-L3/4908G-L3, 4000/4912G/2980G/2948G, 5000/5500/2926G/2926, 6000/6500), MSFC/MSFC2, access servers (AS5200/5300, AS5350/5400, AS5800), and MC3810 Access Concentrator

Router and IOS Architecture
Router crashes, upgrades, installation, password recovery, error messages, memory, hardware, and booting problems for Cisco routers (800, 1600, 2500, 2600, 3600, 3700, 4000, 4500, 4700, 7200, uBR 7200 & 7500), modules (7500 RSP, VIP, FEIP & GEIP), and access servers (AS5200, AS5300 & AS5800)

Security
Connectivity, hardware, software features and upgrades, licensing, password recovery for the PIX and VPN 3000 Concentrator, and VPN client installation

Search:

Toolkit: Roll over tools below

Related Tools

[TAC Case Open](#)
[TAC Case Query](#)
[Error Message Decoder](#)

The TAC Case Collection, is an evolution of the Troubleshooting Assistant tool. It allows users to interactively identify and troubleshoot common problems that involve hardware, configuration, and performance issues. These solutions, which are provided directly by TAC engineers, help resolve networking problems.

http://www.cisco.com/kobayashi/support/tac/tsa/launch_tsa.html

7 Software Advisor

The screenshot shows the Cisco Software Advisor web application. At the top left is the Cisco Systems logo. The page has a yellow header bar with the text "Software Advisor". Below this is a navigation bar with three tabs: "HOME", "SOFTWARE SUPPORT FOR FEATURES", and "SOFTWARE SUPPORT FOR HARDWARE". The main content area contains the following text:

Want to try out what's new in Software Advisor? If you have one of the following supported products:

Switch Series: 4000, 4500, 5000, 5500, 6000, 6500

.... You can [try it now](#).

For each entry point below, you have the option to search for applicable software bugs using the Bug Toolkit.

Software Support for Features:

- [Search by Features](#)
Create your list of Cisco IOS or CatOS features. What software releases support them?
- [Search by Release](#)
Select your Cisco IOS or CatOS release. Which software features does it support?
- [Compare Releases](#)
Select two Cisco IOS releases. Which software features are unique to each, and which do they have in common?

Software Support for Hardware:

- [Cisco IOS, PIX OS, or WAN Switching Supported Hardware](#)
Create a list of hardware products. Which minimum software releases are compatible with it?
- [CatOS Supported Hardware](#)
Populate your Catalyst chassis with CatOS hardware. Which CatOS release will support all the installed hardware?

Note: The Catalyst 4000, 5000, and 6000 Series have both Cisco IOS and CatOS supported hardware.

At the bottom of the page, there is a "Close Window" button and a copyright notice: "© 1992-2003 Cisco Systems, Inc. All rights reserved. [Important Notices](#), [Privacy Statement](#), and [Trademarks](#) of Cisco Systems, Inc."

The Software Advisor helps users choose the appropriate software for network devices. Users can match software features to Cisco IOS and CatOS releases, compare IOS releases, or find out which software releases support their hardware.

<http://www.cisco.com/cgi-bin/Support/CompNav/Index.pl>

8 Feature Navigator II

The screenshot shows the Cisco Feature Navigator II web application. At the top, there is a navigation bar with the Cisco Systems logo, a search bar, and links for Home, Logged In, Profile, Contacts & Feedback, Help, and Site Map. Below the navigation bar, there is a sidebar menu with categories like PRODUCTS & SERVICES, CISCO IOS SOFTWARE, and GENERAL INFORMATION. The main content area is titled "CISCO IOS SOFTWARE" and "Cisco Feature Navigator II". It includes a search bar, a "Toolkit" section with icons for various tools, and a "Related Tools" section with links to Solution Finder for Modular Routers, Dynamic Configuration Tool, Bug Toolkit, and MIB Locator. The main content area also features a section titled "What Took Hours Now Takes Minutes" with a description of the application and several links for searching, comparing releases, and learning about Release 12.3. A small image of a person using a laptop is visible on the right side of the main content area. At the bottom right, there is a prominent banner for "CISCO IOS SOFTWARE RELEASE 12.3T".

Cisco Feature Navigator II is a Web-based application that allows users to quickly find the right Cisco IOS Software release for the features they want to run on their networks. Users can search by feature, search by release, or compare two different releases.

<http://tools.cisco.com/ITDIT/CFN/jsp/index.jsp>

9 TAC Advanced Search

The screenshot shows the Cisco TAC Advanced Search interface. At the top, there's a navigation bar with the Cisco logo and links for Home, Logged In, Register, Contacts & Feedback, Help, and Site Map. Below this is a 'Technical Support' dropdown menu and a 'GO' button. The main content area is titled 'TAC Advanced Search' and includes a search bar with a 'GO' button and a 'Search All Cisco.com' dropdown. The 'Look in' section has radio buttons for 'TAC Technical Documentation' (selected), 'TAC Data Collections', 'all of www.cisco.com', and 'NetPro search'. The 'Find' section has search criteria: 'with all of the words', 'with the exact phrase', 'with at least one of the words', and 'without the words'. The 'Type of File' section has radio buttons for 'All TAC Document Types' (selected), 'Case Studies', 'Configuration Examples', 'Field Notices', 'Networking Solutions', 'Password Recovery', 'QandAs', 'Security Advisories', 'Tech Notes', and 'White Papers'. The 'Results per page' section has radio buttons for '10' (selected), '25', and '100'. A 'Search' button is at the bottom center. The right sidebar contains 'Search' and 'Toolkit' sections, along with 'Related Tools' and 'Related Links'.

TAC Advanced Search can be used to access the same resources used by TAC. Users can search the entire TAC database for technical documents published by the Cisco TAC, for TAC technical support tools, for documents that are located on <http://www.cisco.com/>, or for entries in the Networking Professionals Connection discussion forums.

http://www.cisco.com/kobayashi/support/tac/s_tac.shtml