Lucent Technologies
Bell Labs Innovations

WaveStar™ DACS 4/4/1 Release 3.0

Application and Planning Guide

365-367-500
Issue 1
June 2001

Notice

Every effort was made to ensure that the information in this document was complete and accurate at the time of printing. However, information is subject to change.

European CE Mark

The CE Mark affixed to this equipment means that it conforms to the European Union Electromagnetic Compatibility Directive 89/336/EEC, and the Hazardous Voltage and Safety Directive 73/23/EEC.

Class 1 Laser Product

WaveStar™ DACS 4/4/1 is a class 1 laser product (IEC-825, 1993).

Trademarks

Microsoft, Windows NT, and *Excel* are trademarks or registered trademarks of Microsoft Corporation.

WaveStar is a trademark of Lucent Technologies.

ITM-NM is a registered trademark of Lucent Technologies.

American Express is a registered trademark of American Express Company.

MasterCard is a registered trademark of Mastercard International Incorporated.

VISA is a registered trademark of VISA International Service Association.

Ordering Information

The ordering number for this document is 365-367-500. Refer to the section *How to order documentation* for additional ordering information.

Developed by Lucent Technologies Customer Training and Information Products.

Lucent Technologies values your comments!

Lucent Technologies
Bell Labs Innovations

WaveStar DACS 4/4/1, Release 3.0, Application and Planning Guide

365-367-500 Issue 1 June 2001

Lucent Technologies welcomes your comments on this information product. Your opinion is of great value and helps us to improve.

1. Was the information product:

	Yes	*No*	*Not applicable*
In the language of your choice?	☐	☐	☐
In the desired media (paper, CD-ROM, etc.)?	☐	☐	☐
Available when you needed it?	☐	☐	☐

Please provide any additional comments:

_____

_____

2. Please rate the effectiveness of this information product:

	Excellent	*More than satisfactory*	*Satisfactory*	*Less than satisfactory*	*Unsatisfactory*	*Not applicable*
Ease of use	☐	☐	☐	☐	☐	☐
Level of detail	☐	☐	☐	☐	☐	☐
Readability and clarity	☐	☐	☐	☐	☐	☐
Organization	☐	☐	☐	☐	☐	☐
Completeness	☐	☐	☐	☐	☐	☐
Technical accuracy	☐	☐	☐	☐	☐	☐
Quality of translation	☐	☐	☐	☐	☐	☐
Appearance	☐	☐	☐	☐	☐	☐

If your response to any of the above questions is "*Less than satisfactory*" or "*Unsatisfactory,*" please explain your rating.

_____

_____

3. If you could change one thing about this information product, what would it be?

_____

_____

4. Please write any other comments about this information product:

_____

_____

Please complete the following if we may contact you for clarification or to address your concerns:

Name: _____ Date: _____

Company/organization: _____ Telephone number: _____

Address: _____

Email address: _____ Job function: _____

If you choose to complete this form online, go to http://www.lucent-info.com/comments
Otherwise fax to 407 767 2760 (U.S.) or +1 407 767 2760 (outside the U.S.) or email comments to ctiphotline@lucent.com

Contents

3 Applications

4 System Description

5 Operations, Administration, Maintenance, and Provisioning

6 Cross-Product Interworking

7 Physical Design

About This Document

Purpose

This document describes the *WaveStar*™ DACS 4/4/1, Release 3.0 equipment, features, and applications. Information about system planning, engineering, technical specifications, and product quality and reliability is also provided.

How to Use This Document

This document contains the following chapters and appendixes:

- Chapter 1, Introduction

  Provides an overview of the system.
- Chapter 2, Benefits and Features

  Describes benefits and features of the *WaveStar* DACS 4/4/1.
- Chapter 3, Applications

  Describes various uses of the *WaveStar* DACS 4/4/1.
- Chapter 4, System Description

  Presents a high-level functional description of the system.
- Chapter 5, Operations, Administration, Maintenance, and Provisioning

  Describes operations, administration, maintenance, and provisioning capabilities and interfaces, and fault detection, isolation, and reporting.
- Chapter 6, Cross-Product Interworking

  Describes how the *WaveStar* DACS 4/4/1 works with other Lucent Technologies SDH equipment.
- Chapter 7, Physical Design

  Describes the physical design of the system hardware.

- Chapter 8, System Planning and Engineering

  Contains information about system planning, synchronisation, and equipment configuration rules. It also contains information about system floor plans, the recommended amount of space between rows of equipment and above equipment racks, and floor loading.
- Chapter 9, Technical Specifications

  Provides technical specifications for transmission interfaces, power, physical specifications, environmental requirements, electromagnetic compatibility, timing and synchronisation, and overhead processing.
- Chapter 10, Quality and Reliability

  Describes *WaveStar* DACS 4/4/1 quality and reliability.
- Chapter 11, Product Support

  Provides product support information.
- Appendix A, Differences Between NTT MSP and ITU MSP
- Appendix B, Performance Monitoring Parameters
- Glossary
- Index.

1 Introduction

Purpose

This chapter provides an overview of the *WaveStar* DACS 4/4/1. It describes the system's key characteristics, transmission interfaces, types of cross connections, and other capabilities.

Overview

The *WaveStar* DACS 4/4/1 is a large-capacity cross-connect system that provides flexible bandwidth management in a Synchronous Digital Hierarchy (SDH) environment. The system can be equipped with various transmission interfaces and supports cross connections at broadband and wideband rates. The system also supports grooming and restoration capabilities.

Key characteristics

The *WaveStar* DACS 4/4/1 has the following key characteristics:

- 512 STM-1 equivalent capacity
- SDH network compatibility
- Cross connections at the AU-4-4c, AU-4, AU-3, TU-3, and TU-12 rates
- Fully-nonblocking, full-broadcast cross-connect matrix.

Transmission interfaces

The following transmission interfaces are available:

- STM-16 long-haul optical
- STM-4 short-haul optical
- STM-1 long-haul optical
- STM-1 short-haul optical
- STM-1 electrical
- STM-1 optical designed to Nippon Telegraph and Telephone (NTT) specifications.

For information about SONET compatibility of the transmission interfaces, see “SONET compatibility” in Chapter 9.

Cross connections

The following types of cross connections are available (see Figure 1-1):

- Unidirectional
- Bidirectional
- Multi-point
- Loopback.

Multi-point and loopback cross connections are special types of unidirectional cross connections.

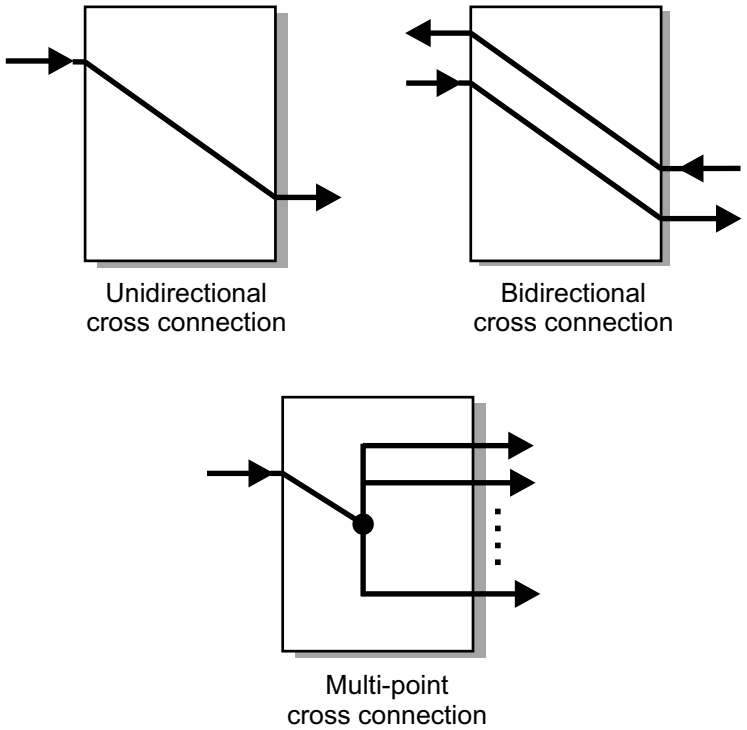

Figure 1-1 WaveStar DACS 4/4/1 Cross Connections

Other capabilities

WaveStar DACS 4/4/1 also provides the following capabilities:

- A duplicated Main Controller is available
- The cross-connect matrix has 2:8 equipment protection and can be switched glitchlessly (without errors)
- 1:8 equipment protection is available for STM-1 electrical interfaces
- 1+1 Multiplex Section Protection (MSP) line protection is available for all transmission interfaces
- Sub-Network Connection Protection with inherent or nonintrusive monitoring

- Automatic laser shutdown for STM-16 and STM-4 transmission interfaces
- ETSI compliant physical design and Network Equipment - Building Systems Zone 4 earthquake protection
- Operations, Administration, Maintenance, and Provisioning (OAM&P) activities can be performed locally or remotely from a personal computer running the XC-CIT application software, or from an element management system such as Lucent Technologies' ITM-SC. All OAM&P connections use the TCP/IP protocol.
- ITU-T G.826 compliant performance monitoring for RS, MS, VC-4-4c, VC-4, VC-3, and VC-12 trails
- ITU-T G.812 Type I clock with holdover mode
- As many as four prioritised timing references can be provisioned for the system clock. System timing can be derived from any transmission port including ports provisioned for MSP, or from a 2048 kHz or 64 kHz clock source.
- Supervisory unequipped generators and detectors for AU-4-4c, AU-4, and AU-3 path continuity checking
- Fibre-optic cabling that allows the Port racks to be located up to 50 cable metres away from the Matrix and Control and Matrix and Synchronisation racks.

2 Benefits and Features

Purpose This chapter describes benefits and features of the *WaveStar* DACS 4/4/1.

Benefits

Compact and cost effective

WaveStar DACS 4/4/1 was designed with state-of-the-art technology and design tools. Using the latest ASICs, optics, and packaging techniques, *WaveStar* DACS 4/4/1 has achieved a significant increase in circuit pack and equipment densities. A Port rack equipped with PSC subracks can be configured with up to 256 STM-1 equivalents of STM-16 or STM-4 transmission interfaces. The result is a very compact and flexible product that supports up to 512 STM-1 equivalents. The footprint for a 512 STM-1 equivalents configuration can be as small as 2400 mm by 600 mm.

Increased network reliability and availability

At best, facility outages are expensive and inconvenient; at worst, they can be catastrophic for network providers and their customers. The *WaveStar* DACS 4/4/1 contains the latest digital circuitry — circuitry known for its high quality and reliability. *WaveStar* DACS 4/4/1 also uses optical interconnections between the transmission ports and cross-connect components.

WaveStar DACS 4/4/1 reliability is further enhanced by redundant components incorporated into the hardware architecture. The cross-connect matrix has 2:8 equipment protection and can be switched glitchlessly (without errors).

Should a problem arise, the *WaveStar* DACS 4/4/1 generates alarm messages to alert maintenance personnel that a problem has been detected, and lights LEDs on failed units. Redundant and reliable system components and the alarm strategy ensure an extremely low number of service outages.

Rapid network rerouting

If a cable is cut, it is very important to reroute the affected network traffic as rapidly as possible. A network composed of *WaveStar* DACS 4/4/1s can be engineered to allow route restoration from a centralised operations and maintenance centre equipped with a network management system such as Lucent Technologies' *WaveStar* Network Management System (NMS).

When service outages or service degradation are detected (and cannot be resolved through self-healing capabilities such as equipment or facility protection), the centralised operations and maintenance centre can initiate a circuit reconfiguration. The backup circuit can either be established during service provisioning, or can be determined in real time when the service is impaired or threatened. Pre-established backup circuits can be selected manually by an operator or automatically. Furthermore, for AU4-4c, AU-4, and AU-3 paths, the Higher Order Supervisory Unequipped signal capability can be used to verify path continuity before switching service to a backup circuit.

Rapid response to network changes

The ability to rapidly implement network changes increases availability, improves customer satisfaction, and shortens the time it takes for new service orders to begin generating revenue. Deploying *WaveStar* DACS 4/4/1 in a network dramatically improves the time it takes to implement network changes. Once a facility is connected to the *WaveStar* DACS 4/4/1, its signal can be cross connected to any other facility connected to the *WaveStar* DACS 4/4/1. Unlike a manual cross-connect frame, technicians do not have to be on-site to change cross connections. No cables have to be moved or reconnected — this reduces the likelihood of errors or service disruption.

WaveStar DACS 4/4/1 and Lucent Technologies' Integrated Transport Management system - Subnetwork Controller (ITM-SC) bring fast provisioning to wideband and broadband networks. With fast provisioning, service providers can respond quickly to changing customer needs. The *WaveStar* DACS 4/4/1 and ITM-SC combination means network changes can be made from a central location. So, provisioning is not only fast, it can be done at a lower cost.

See Chapter 6 for more information about Lucent Technologies' ITM products.

Broadband and wideband grooming

WaveStar DACS 4/4/1 provides AU-4-4c, AU-4, AU-3, TU-3, and TU-12 grooming. Broadband and wideband grooming can be used to increase bandwidth usage and the cost effectiveness of the network.

24-hour monitoring

Network nodes that may have previously been unattended for all or part of the day can now be monitored around the clock. A single technician can monitor several *WaveStar* DACS 4/4/1s from a centralised network management system.

Smooth, efficient, in-service growth

Network providers can purchase *WaveStar* DACS 4/4/1 capacity as they need it. The *WaveStar* DACS 4/4/1's highly modular architecture makes this possible. Modular design permits cost effective start-up and ensures smooth, efficient in-service growth towards the system's maximum capacity. Additional port capacity can be added without affecting existing traffic.

Flexible physical arrangements

Some stations may have limited space for new equipment. The remote Port rack capability allows the flexibility to accommodate future growth for almost any office arrangement. *WaveStar* DACS 4/4/1 uses optical fibre cables to connect Port racks to the Matrix and Control and Matrix and Synchronisation racks. These cables can be up to 50 metres long (see Figure 2-1).

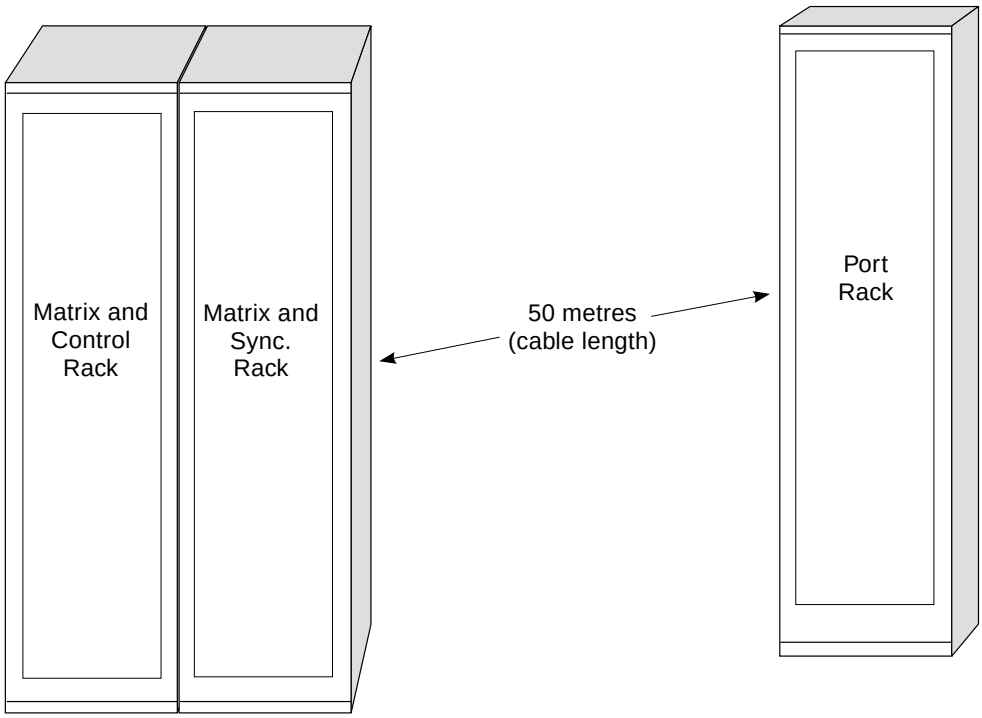

Figure 2-1 Remote Port Racks

Features

New features for Release 3.0

The following features are new for *WaveStar* DACS 4/4/1 Release 3.0:

- Sub-Network Connection Protection with inherent or nonintrusive monitoring
- Performance monitoring for VC-3 as AU-3, VC-3 as TU-3, and VC-12 trails (in addition to VC-4-4c as AU-4-4c and VC-4 as AU-4 which were available in earlier releases)

Sub-Network Connection Protection

Sub-Network Connection Protection (SNCP) is a transmission protection feature that provides protection of all or part of a trail through a network. The SNCP feature complies with ITU-T Recommendations G.841 and G.842.

At the head end of the protected subnetwork connection, a bridge is created. The bridge sends two identical copies of the protected trail toward the tail end over different routes. The tail end selects which copy of the trail to take as input based on manual and automatic switching criteria.

When SNCP is provisioned for a trail, the system monitors the trail for Trail Signal Fail (TSF) and Trail Signal Degrade (TSD) conditions. When a TSF or TSD condition occurs, service is switched away from the failed or degraded trail.

An SNCP group can be provisioned as either revertive or nonrevertive, and the monitoring that triggers protection switching can be provisioned as inherent or nonintrusive.

For Sub-Network Connection Protection with nonintrusive monitoring (SNCP/N), the automatic switching criteria are based on nonintrusive monitoring of server layer and client layer defects. For Sub-Network Connection Protection with inherent monitoring (SNCP/I), the automatic switching criteria are based on server layer defects.

SNCP bridge and selector configurations

The following SNCP bridge and selector configurations are available for this release:

- Bidirectional SNCP
- Unidirectional VC-trail protection
- Drop and continue working
- Drop and continue protection

Bidirectional SNCP configuration

Figure 2-2 shows a bidirectional connection with and without protection.

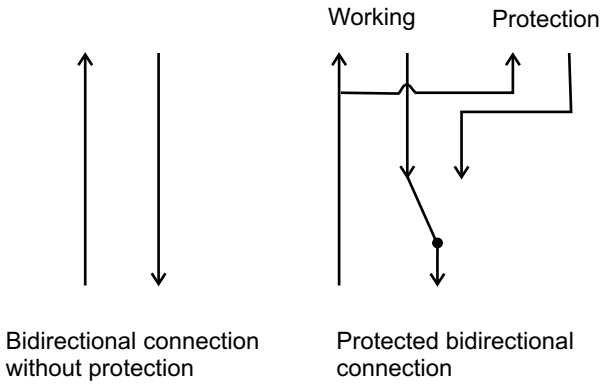

Figure 2-2 Bidirectional SNCP Bridge and Selector Configuration

Bidirectional SNCP operates with incoming and outgoing traffic on the working port. Each end of the connection provides both the head end (bridging) and the tail end (selector) capability. The working trail is the primary trail, and the protection trail is the secondary trail.

As shown in Figure 2-3, the bidirectional SNCP configuration also applies to multi-point connections (bridge or broadcast).

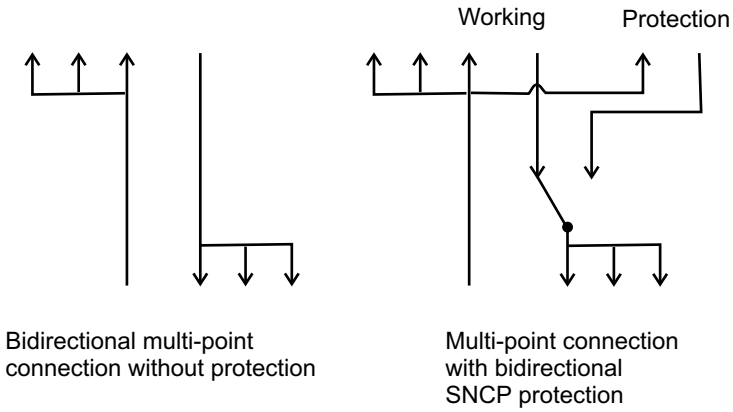

Figure 2-3 Multi-point Cross Connects with Bidirectional SNCP

Ring using bidirectional SNCP

Figure 2-4 shows an example of a ring that uses bidirectional SNCP.

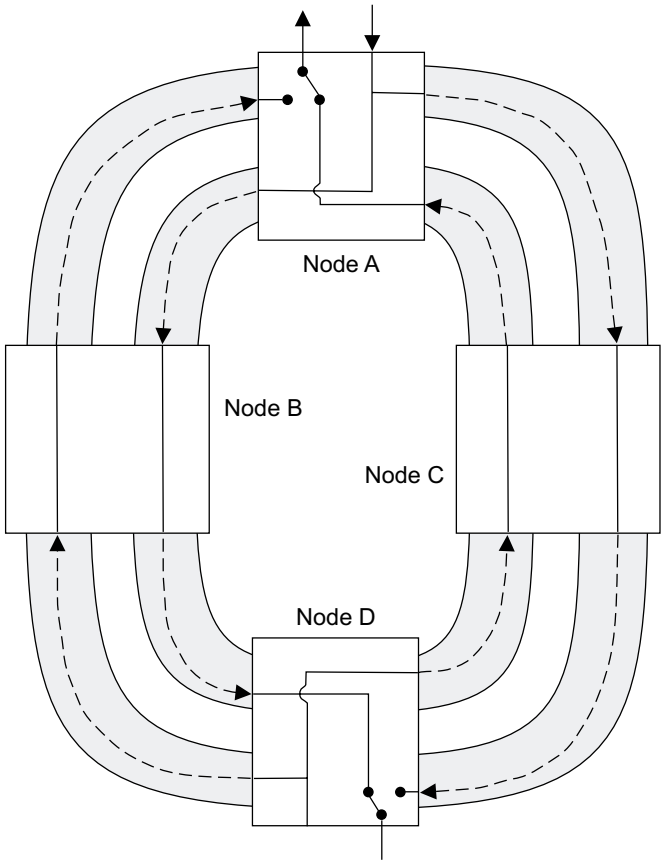

Figure 2-4 Ring Using Bidirectional SNCP

Nodes A and D both have a head end bridge and a tail end selector. Nodes B and C both have bidirectional cross connects.

Unidirectional VC-trail selector configuration

Figure 2-5 shows a unidirectional connection with and without protection. The unidirectional VC-trail selector configuration creates a unidirectional selector on the incoming direction of a port. As with the bidirectional SNCP configuration, the VC-trail selector configuration also applies to multi-point connections. The working trail is the primary trail, and the protection trail is the secondary trail.

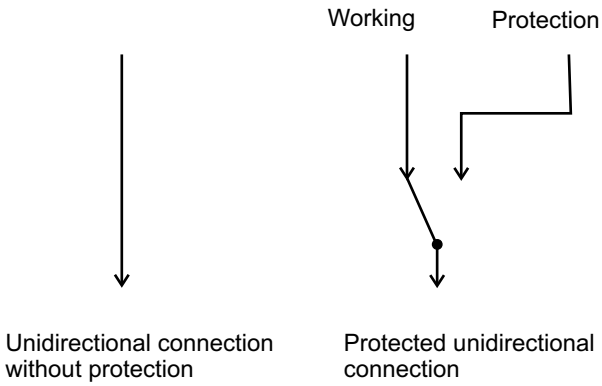

Figure 2-5 Unidirectional VC-Trail Selector Configuration

Drop and continue working configuration

The drop and continue working configuration is used at the primary interconnection node in rings with dual node interconnections. Figure 2-6 shows the selector for the drop and continue working configuration.

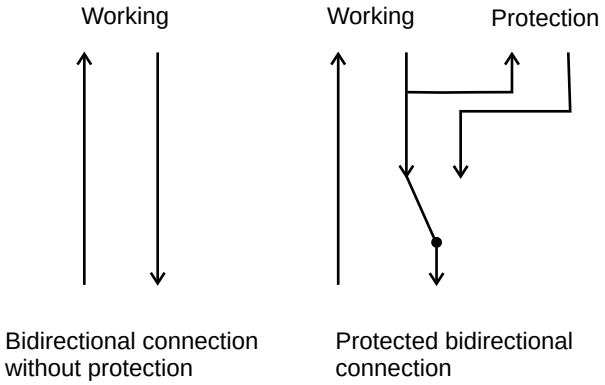

Figure 2-6 Selector for the drop and continue working configuration

This configuration provides the same selector on the incoming direction as the bidirectional SNCP configuration. However, the outgoing signal is sent only to working trail, and the incoming signal on the working trail is bridged to the outgoing signal on the protection trail. The working trail is the primary trail, and the protection trail is the secondary trail.

Drop and continue protection configuration

The drop and continue protection configuration is used at the secondary interconnection node in rings with dual node interconnections. Figure 2-7 shows the selector for the drop and continue protection configuration.

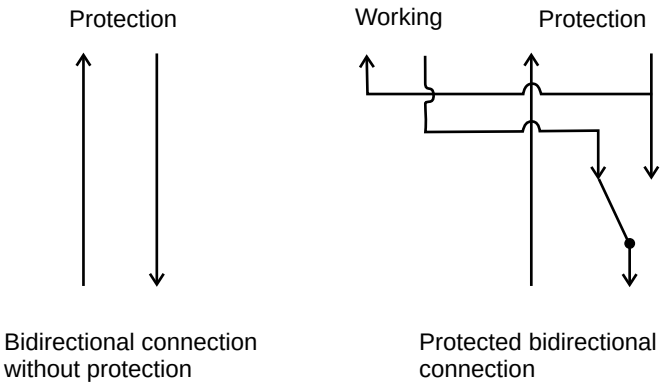

Figure 2-7 Selector for the drop and continue protection configuration

This configuration provides the same selector on the incoming direction as the bidirectional SNCP configuration. However, the outgoing signal is sent only to protection trail, and the incoming signal on the protection trail is bridged to the outgoing signal on the working trail. The protection trail is the primary trail, and the working trail is the secondary trail.

Dual node interconnections between SNCP rings

Figure 2-8 shows an example of dual node interconnections between SNCP rings that use bidirectional transmission.

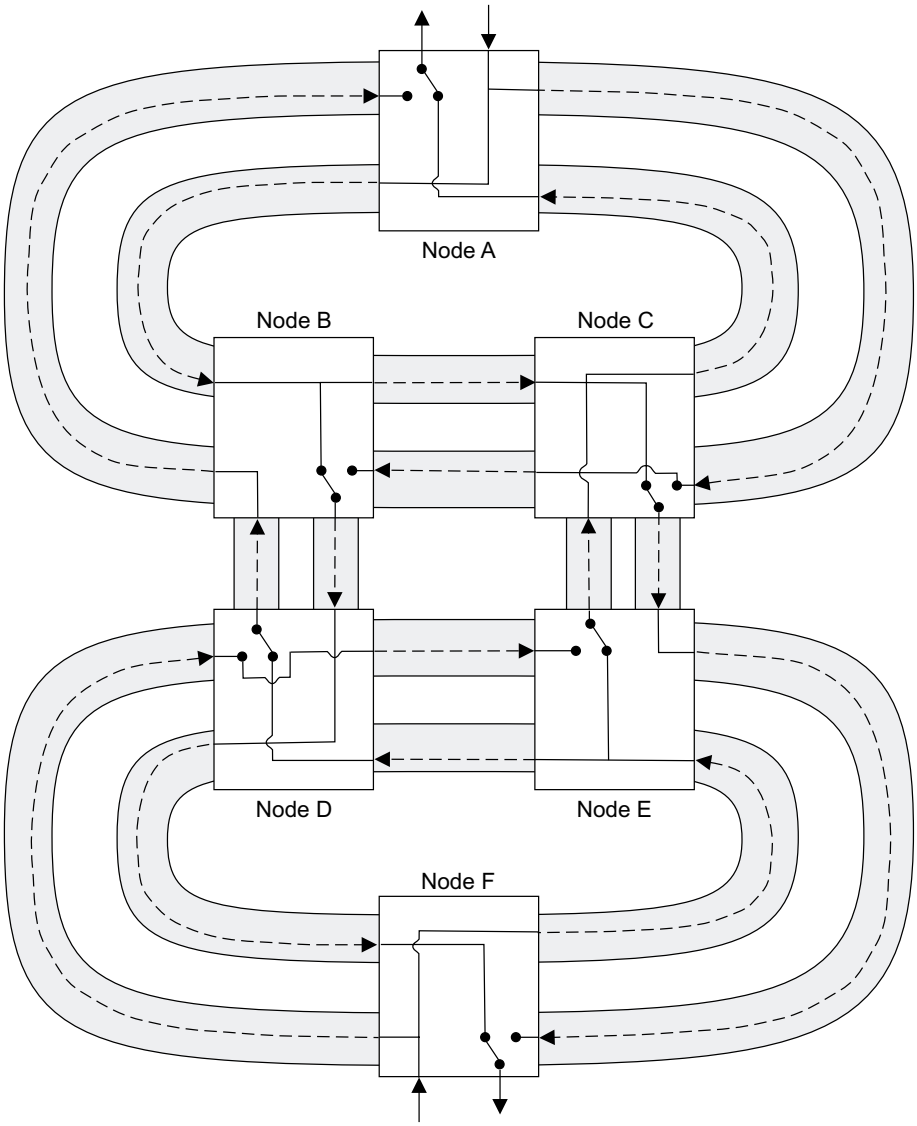

Figure 2-8 Dual Node Interconnections Between SNCP Rings

Node A has a bidirectional SNCP bridge and selector configuration. Node B is a primary interconnection node with a drop and continue working configuration, and a unidirectional cross connect. Node C is a secondary interconnection node with a drop and continue protection configuration, and a unidirectional cross connect. Node D is a secondary interconnection node with a drop and continue protection configuration, and a unidirectional cross connect. Node E is a primary interconnection node with a drop and continue working configuration, and a unidirectional cross connect. Node F has a bidirectional SNCP bridge and selector configuration.

Refer to ITU-T Recommendation G.842 for more information about how the drop and continue working, and the drop and continue protection

configurations work with SNCP rings that use dual node interconnections.

Performance monitoring

In releases before R2.0.2, VC-4 trails could be monitored for performance only if the VC-4 was terminated. That is, termination points had to be provisioned for the VC-4 signal at the TU-3 or TU-12 level. Beginning with Release 2.1, terminated and nonterminated (clear channel) VC-4-4c and VC-4 trails can be monitored.

Beginning with Release 3.0, nonterminated VC-3 as AU-3 trails and lower order VC trails can be provisioned for nonintrusive monitoring. Lower order VC trails include VC-3 as TU-3 and VC-12.

WaveStar DACS 4/4/1 provides performance monitoring (PM) of the following terminated trails:

- RS
- MS
- VC-4.

The system also provides nonintrusive monitoring of the following nonterminated trails:

- VC4-4c
- VC-4
- VC-3 as AU-3
- VC-3 as TU-3
- VC-12.

The system can monitor line quality, collect and store data on signal performance, and notify users by way of alarms, reports, and autonomous messages if a user-defined quality threshold is crossed. You can examine and modify threshold values and retrieve PM data or reports for a transmission port or a PM parameter.

Monitored overhead bytes

The system monitors overhead bytes for block errors as defined in ITU-T Recommendation G.826, then it calculates various PM parameters. Each parameter represents a certain level and/or duration of signal degradation.

For VC-4-4c, VC-4, and VC-3 trails, near end PM data are collected by monitoring the incoming B3 overhead byte. Far end PM data are collected by monitoring the G1 byte.

For RS trails, near end PM data are collected by monitoring the incoming B1 byte. Far end PM data are not collected for RS trails.

For MS trails, near end PM data are collected by monitoring the incoming B2 byte. Far end PM data are collected by monitoring the M1 byte.

For VC-12 trails, near end PM data are collected by monitoring the incoming V5 overhead byte, bits 1 and 2. Far end PM data are collected by monitoring the incoming V5 overhead byte, bit 8 for Remote Defect Indication (RDI), and bit 3 for Remote Error Indication (REI).

Performance Monitoring parameters

The system classifies PM data as current or recent, and collects data for 15-minute and 24-hour intervals. For each PM parameter, the system keeps the current and 96 most recent 15-minute counts, and one current and one recent 24-hour count. The current 24-hour count is updated at the end of each 15-minute interval.

You can set a threshold value for each parameter of each trail on each transmission port. After thresholds have been defined and PM counts have been enabled, the system automatically generates a Threshold Crossing Alert (TCA) message whenever a threshold is crossed.

The following PM parameters can be monitored for both the Near End of RS, MS, and VC-n paths and the Far End of MS and VC-n (where n equals 4-4C, 4, 3, and 12) paths:

- Background Block Error (BBE)
- Errored Second (ES)
- Severely Errored Second (SES)
- Unavailable Second (UAS).

See Appendix B for more information about PM parameters.

EOW and User channels

The new PSC subrack also provides access to the EOW (E1 or E2) and User channel (F1) overhead bytes. The E1 overhead byte provides a direct voice communication channel between regenerator section terminating equipment. The E2 overhead byte provides a direct voice communication channel between multiplex section terminating equipment. Typically, these voice channels are used for maintenance purposes. The F1 overhead byte provides a direct data channel between regenerator section terminating equipment.

Automatic laser shutdown

WaveStar DACS 4/4/1 has an automatic laser shutdown capability. The system can be provisioned to automatically shut down the laser in an STM-16 or STM-4 port unit as soon as the system detects an interruption in the optical signal.

Duplicated Main Controller

Beginning with Release 2.1, a duplicated Main Controller (MC) is available. The primary purpose of a duplicated MC is to increase system availability. The second (standby) MC accomplishes this by automatically taking control of the system if the active MC fails.

System capacity

Beginning with Release 2.0, *WaveStar* DACS 4/4/1 can be configured for a maximum cross-connect capacity of 512 STM-1 equivalents. Earlier releases of *WaveStar* DACS 4/4/1 had a maximum capacity of 256 STM-1 equivalents. Earlier releases of *WaveStar* DACS 4/4/1 can be upgraded to a maximum capacity of 512 STM-1 equivalents.

Cross-connect matrix

The system has a nonblocking, full-broadcast cross-connect matrix. The cross-connect matrix is compatible with both American National Standards Institute (ANSI) and International Telecommunications Union (ITU) transmission standards and the hardware is capable of cross connecting all tributaries defined by them.

Cross connections

The following types of cross connections are available at the AU-4-4c, AU-4, AU-3, TU-3, and TU-12 rates:

- Unidirectional
- Bidirectional
- Multi-point
- Loopback.

Multi-point and loopback are special types of unidirectional cross connections.

Multi-point cross connects have the following characteristics:

- Connect a single input to two or more outputs
- Provide bridging for restoration, testing, or broadcast
- Can be from any input to any available output signal
- Can be added to any existing service whether originally created as unidirectional or bidirectional
- Were previously called bridge and broadcast cross connects.

A loopback cross connection is a unidirectional cross connection that sends the signal from an input port back to the same input port.

Beginning with Release 3.0, Alarm Indication Signal (AIS) can be inserted as the output signal for any output port that is cross connected.

Transmission interfaces

The following transmission interfaces are available:

- STM-16 long-haul optical (one port per unit)
- STM-4 short-haul optical (four ports per unit)
- STM-1 long-haul optical (four ports per unit)
- STM-1 short-haul optical (four ports per unit)
- STM-1 electrical (four ports per unit)
- STM-1 optical designed to Nippon Telegraph and Telephone (NTT) specifications (four ports per unit).

For information about SONET compatibility of the transmission interfaces, see “SONET compatibility” in Chapter 9.

Equipment protection

Equipment protection is a redundancy arrangement in which one or more system components are backed up by one or more similar system components. The components in this arrangement are called a protection group.

WaveStar DACS 4/4/1 offers the following types of equipment protection:

- A duplicated Main Controller is available.
- The cross-connect matrix and internal transmission paths have a 2:8 protection architecture. Service is not affected even if two equipment failures occur before repairs can be made. Also, when no faults are present, user-initiated protection switching of the cross-connect matrix is glitchless (without errors).
- The Matrix and Synchronisation subrack has duplicated matrix control, and synchronisation and timing hardware.
- The Digital Timing Unit (DTU), which provides the timing for transmission interfaces in the port subracks, is duplicated.
- 1:8 equipment protection is available for STM-1 electrical interfaces.

1+1 Multiplex Section Trail Protection (MSP)

1+1 MSP is a redundancy arrangement in which the same signal is sent and received over two separate transmission facilities. These facilities terminate on separate transmission ports that are logically linked in software.

WaveStar DACS 4/4/1 supports the following types of MSP:

- ITU MSP — complies with ITU-T Recommendation G.783, Annex A.
- NTT MSP — complies with ITU-T Recommendation G.783, Annex B and a set of recommendations provided by Nippon Telegraph and Telephone (NTT).
- ANSI MSP — complies with American National Standards Institute (ANSI) T1-105.01.

ITU MSP

ITU MSP provides 1+1 unidirectional or bidirectional nonrevertive switching for STM-16, STM-4, and STM-1 optical interfaces, and for STM-1 electrical interfaces. Two lines carry identical payloads in a permanent bridged arrangement between network elements. The receivers on each end select which line to listen to based on local line conditions, manual protection switching commands, and requests passed between nodes over the Automatic Protection Switching (APS) channel.

The APS channel consists of the K1 and K2 bytes in the multiplex section overhead.

NTT MSP

NTT MSP provides 1+1 bidirectional nonrevertive switching for STM-1 optical and electrical interfaces. NTT MSP is similar to ITU MSP, the purpose is the same, but NTT MSP differs from ITU MSP in several ways. See Appendix A for information about the differences between NTT MSP and ITU MSP.

ANSI MSP

ANSI MSP provides 1+1 unidirectional nonrevertive switching for STM-16, STM-4, and STM-1 optical interfaces, and for STM-1 electrical interfaces. ANSI MSP is nearly identical to unidirectional ITU MSP, differing only in some information sent in the K bytes of the multiplex section overhead.

Transmission interface and protection mixing

A PSA subrack can be equipped with any combination of STM-1 electrical and optical transmission interfaces. ITU MSP, ANSI MSP, or NTT MSP can be provisioned on STM-1 electrical or optical interfaces. 1:8 equipment protection, for STM-1 electrical interfaces, can be mixed with any or all types of MSP on the same shelf of a PSA subrack.

Standards compliance

WaveStar DACS 4/4/1 complies with ITU-T and ETSI[1] recommendations on physical design, environmental requirements, and electromagnetic compatibility.

OAM&P

Operations, Administration, Maintenance, and Provisioning (OAM&P) activities can be performed locally or remotely from a personal computer running the XC-CIT application software, or from an element management system such as Lucent Technologies' ITM-SC. All OAM&P connections use the TCP/IP protocol.

Facility rolling

Facility rolling allows the transmission network to be reconfigured by moving traffic from one transmission facility to another with minimal service interruption. *WaveStar* DACS 4/4/1 provides the following types of facility rolling:

- Unidirectional roll of a unidirectional connection
- Unidirectional roll of a bidirectional connection
- Bidirectional roll of a bidirectional connection
- Rolling all output ports connected to a particular input port.

1 ITU-T is the Telecommunication Standardisation Sector of the International Telecommunications Union (formerly the International Telephone and Telegraph Consultative Committee [CCITT]). ETSI is the European Telecommunications Standards Institute.

Facility testing

WaveStar DACS 4/4/1 provides bridge and loopback cross connections. Signals can be monitored by bridging a signal to a test port for testing with external test equipment. Locally or remotely generated loopback cross connections simplify network fault isolation and repair activities.

On demand diagnostic tests

Diagnostic tests can determine the health of a specific unit, signal, or type of alarm indicator (End-of-Suite, Rack Top, User Panel, Station). You can run one test at a time and wait for the test result, or request multiple tests or the same test multiple times. If multiple tests are requested, they are run in the background; that is, other OAM&P tasks can be performed while the tests are running.

The system automatically notifies you when a test completes and stores the test results. Test results can be displayed for a specific unit or for a specific result type. That is, you can request a summary of tests that have passed, failed, partially passed, or errored. You can also request a list of tests that are in progress, and if necessary, cancel tests that have not been run yet.

AU-4-4c, AU-4, and AU-3 path continuity verification

Path continuity verification allows a centralised operations and maintenance centre such as the *WaveStar* NMS to perform connection validation and performance verification of a spare path before switching service to it. This feature provides the Higher Order Supervisory Unequipped (HSU) signal defined in ITU-T Recommendation G.783. The HSU functionality includes generation and monitoring of the supervisory unequipped signal for AU-4-4c, AU-4, and AU-3 paths.

System timing

WaveStar DACS 4/4/1 provides the following timing features:

- The system clock is an ITU-T G.812 Type I clock with holdover
- As many as four prioritised timing references can be provisioned.
- System timing can be derived from any transmission port including ports provisioned for MSP, or from a 2048 kHz or 64 kHz clock source
- Two 2048 kHz clock outputs that can be used as a timing source for other equipment.

The ITU-T G.812 Type VI clock that was available with releases 1.0 and 1.1 of *WaveStar* DACS 4/4/1 can be used with Release 2.0, Release 2.1, or Release 3.0 systems.

3 Applications

Purpose

This chapter describes various uses of the *WaveStar* DACS 4/4/1.

Hubbing and grooming

By designating certain nodes in a network to serve as hubs (points of concentration), network providers can reduce the number of point-to-point connections between nodes. Figure 3-1 shows the reduced number of facilities that result from using this strategy.

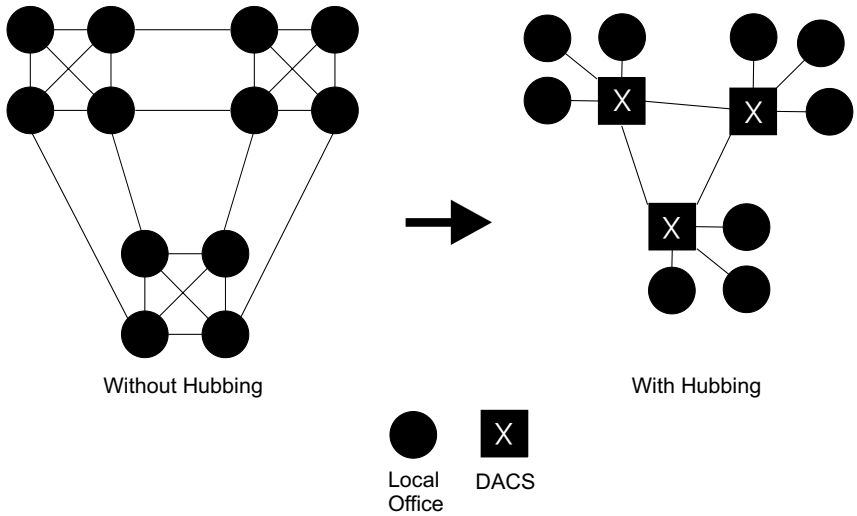

Figure 3-1 Establishing Hubs to Replace Point-to-Point Connections

Network growth is easier to accommodate in a network where hubbing is used. If the growth is small, perhaps all that would be required is a new node that could be connected to the nearest hub. If the growth involves several new nodes, then it might be wise to integrate a new hub into the network. In either case, far fewer facilities are required to bring the new service into a network with hubbing topology than would be required in a network with point-to-point topology.

Hubbing also offers these additional benefits:

- Sensitivity to forecast uncertainty is reduced, which results in simplified planning
- Cross-connect management is easier.

The *WaveStar* DACS 4/4/1 is an excellent tool for maximising the efficiency of a hubbing network. With the *WaveStar* DACS 4/4/1's drop/add capability, VC-12s or VC-3s that are bound for the same final or intermediate location can be added to a facility that has sufficient spare capacity and is also bound for the same location. This technique is called grooming (see Figure 3-2), and it ensures that spare capacity is put to use.

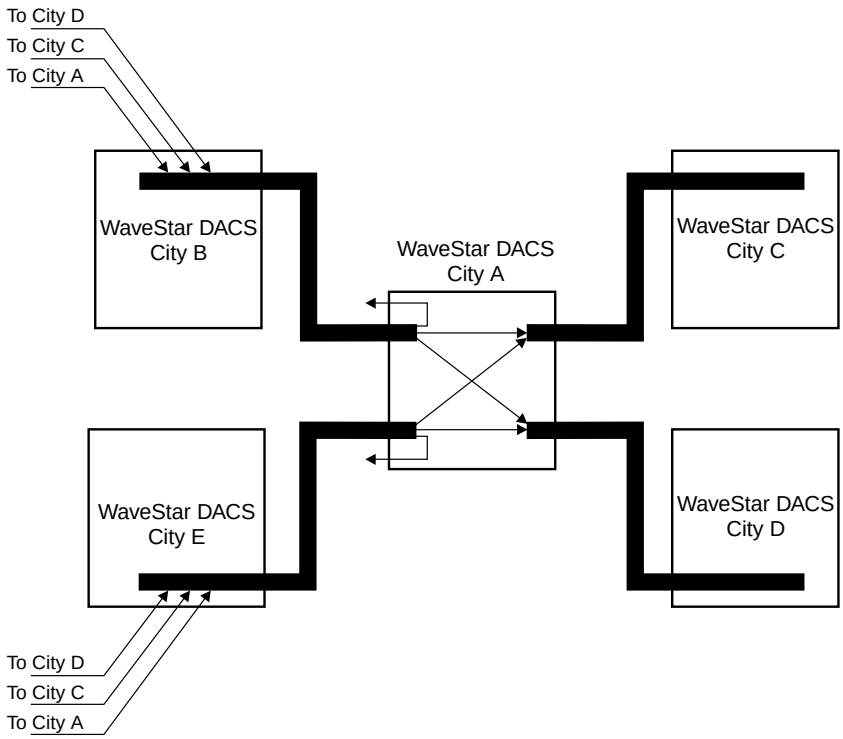

Figure 3-2 Grooming

Manual cross-connect replacement

The *WaveStar* DACS 4/4/1 replaces all functions of a manual cross-connect frame and offers the following advantages:

- After a facility is connected to a *WaveStar* DACS 4/4/1, it can be cross connected to any other facility connected to the frame without having to manually move or reconnect cable.
- Cross-connect management is done through a computer-based interface.
- Technicians at off-site locations can add and remove cross connections (remote provisioning).
- The *WaveStar* DACS 4/4/1 usually requires less space than the manual frames it replaces.

Centralised network OAM&P

WaveStar DACS 4/4/1 operations, administration, maintenance, and provisioning tasks can be performed from a remote location. The Integrated Transport Management system provides centralised management of a network composed of *WaveStar* DACS 4/4/1s and other SDH network elements. Centralised management makes the following activities possible:

- Remote provisioning — reduces operation costs and shortens waiting times between service order and service cutover.
- Bandwidth management — drop/add operations can be coordinated across several *WaveStar* DACS 4/4/1s to maximise bandwidth efficiency.
- Digital Cross-connect System (DCS)-based network restoration — to keep service outages to an absolute minimum, major network failures must be restored as soon as possible. DCS-based network restoration is a very efficient type of network restoration for major failures. For example, if a cable is cut, service can be restored within a matter of seconds or minutes, depending on the spare capacity available and the degree of automation designed into the network.
- Testing — the testing capabilities built into the *WaveStar* DACS 4/4/1 simplify network fault isolation and repair activities. By using the bridge capabilities, any transmission port — whether it is carrying live traffic or it is just being brought into service — can be connected to external equipment, and tested.
- Network status monitoring — a variety of alarm and administrative messages can be monitored from a central location. Personnel at that location can use this information to make and execute decisions about network operation.

4 System Description

Purpose

This chapter presents a high-level functional description of the *WaveStar* DACS 4/4/1.

Functional description

The *WaveStar* DACS 4/4/1 is a large-capacity cross-connect system that provides flexible bandwidth management in a Synchronous Digital Hierarchy (SDH) environment. The system can be equipped with various transmission interfaces and supports cross connections at broadband and wideband rates. The system also supports grooming and restoration capabilities. Figure 4-1 shows a block diagram of the *WaveStar* DACS 4/4/1 system.

The system has a fully-nonblocking, full-broadcast cross-connect matrix. The cross-connect matrix is compatible with both American National Standards Institute (ANSI) and International Telecommunications Union (ITU) transmission standards, and the hardware is capable of cross connecting all tributaries defined by them.

The cross-connect matrix and internal transmission paths have a 2:8 protection architecture. This architecture uses ten sets of components; eight working sets and two protection sets. Service is not affected even if two equipment failures occur before repairs can be made.

The system can be configured for a maximum capacity of 512 STM-1 equivalents. The system capacity determines the number of port subracks that can be provisioned. A 512 STM-1 equivalent system can have a maximum of 16 port subracks. The system can be also be configured for a maximum capacity of 256 STM-1 equivalents.

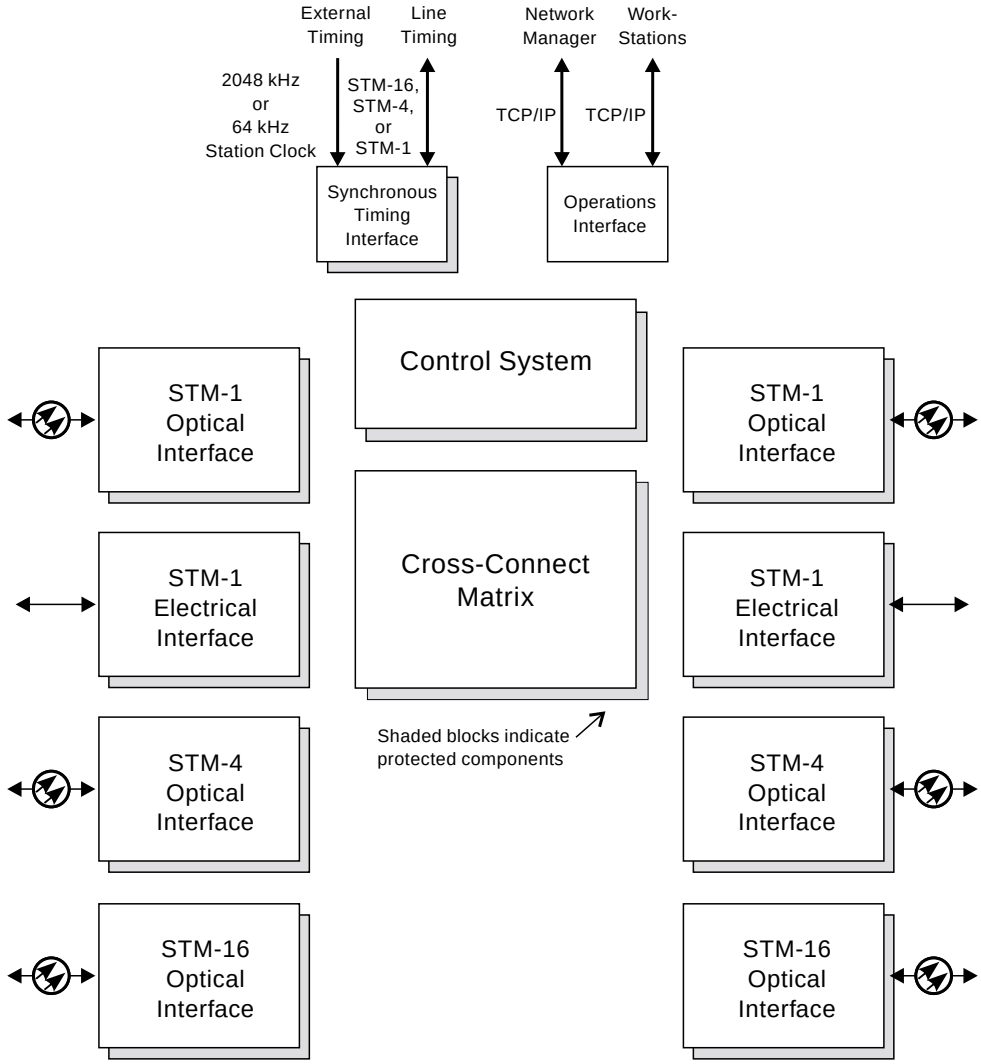

Figure 4-1 WaveStar DACS 4/4/1 System Diagram

Control architecture

WaveStar DACS 4/4/1 coordination and control is carried out by the following controllers (see Figure 4-2):

- Main controller — provides local and remote interfaces for operations, administration, maintenance, and provisioning. The main controller accepts commands from these interfaces and translates them into equipment level instructions that are sent to the subrack controllers.
- Subrack controllers — route messages to and from the Main Controller and the board controllers.
- Board controllers — perform control processing for most types of units (circuit packs). Functions performed by board controllers include executing commands received from subrack controllers and sending maintenance or performance data to subrack controllers.

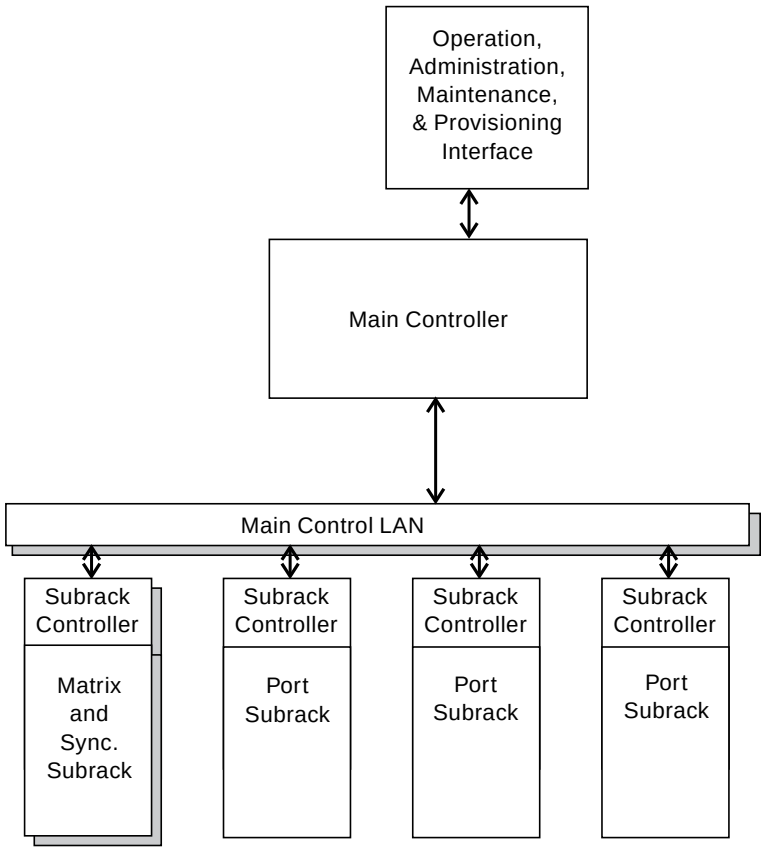

Figure 4-2 WaveStar DACS 4/4/1 Control Structure

New software releases

New software releases can be installed without interrupting service.

Network management

The *WaveStar* DACS 4/4/1 software is designed to evolve with Telecommunications Management Network standards and is fully compatible with Lucent Technologies' *WaveStar* Network Management System (NMS). *WaveStar* NMS can provide centralised control over a network composed of *WaveStar* DACS 4/4/1s and other SDH network elements.

Transmission interfaces

The following transmission interfaces are available:

- STM-16 long-haul optical (one port per unit)
- STM-4 short-haul optical (four ports per unit)
- STM-1 long-haul optical (four ports per unit)
- STM-1 short-haul optical (four ports per unit)
- STM-1 electrical (four ports per unit)
- STM-1 optical designed to Nippon Telegraph and Telephone (NTT) specifications (four ports per unit).

1:8 equipment protection is available for STM-1 electrical interfaces. 1+1 Multiplex Section Protection (MSP) and Sub-Network Connection Protection (SNCP) are available for all transmission interfaces.

For information about SONET compatibility of the transmission interfaces, see "SONET compatibility" in Chapter 9.

System timing

The *WaveStar* DACS 4/4/1 has duplicated synchronisation and timing hardware. The system clock is an ITU-T G.812 Type I clock with holdover. As many as four prioritised timing references can be provisioned. System timing can be derived from any transmission port including ports provisioned for MSP, or from an external 2048 kHz or 64 kHz composite clock source.

Operations, administration, maintenance, and provisioning interfaces

Operations, Administration, Maintenance, and Provisioning (OAM&P) activities can be performed locally or remotely from a personal computer running the XC-CIT application software, or from an element management system such as Lucent Technologies' ITM-SC. All OAM&P connections use the TCP/IP protocol. See Chapter 5 for more information about OAM&P interfaces.

5 Operations, Administration, Maintenance, and Provisioning

Purpose

This chapter describes *WaveStar* DACS 4/4/1 Operations, Administration, Maintenance, and Provisioning (OAM&P) capabilities, and fault detection, isolation, and reporting.

OAM&P capabilities

The following OAM&P capabilities are available:

- Provision
  - Cross Connects
  - Monitoring Control
  - Equipment
  - Transmission (multiplexing structure of transmission signals)
  - Protection Switching
  - Performance Monitoring
  - Alarm Settings
  - Synchronisation and Timing
  - System ID
- Alarms
  - View Current Alarms
  - Station Alarm Control
  - Display Alarm Panel
- Reports
  - Autonomous Messages (including alarm messages)
  - Performance Monitoring
  - User Transactions
  - Defects

- Protection
  - Equipment
  - Transmission
- Maintenance
  - Controller Maintenance
  - Execute Tests
  - View Test Results
  - Background Tests
  - Clear Test History Records
  - Automatic Laser Shutdown
- Utilities
  - Backup Database
  - Change Password
  - Login Administration
  - Date and Time Administration
  - Autonomous Message Indicator
  - Fibre Assignments
- Help
  - Help Topics
  - About.

OAM&P interfaces

Figure 5-1 shows the Operations, Administration, Maintenance, and Provisioning (OAM&P) interfaces that are described in this section.

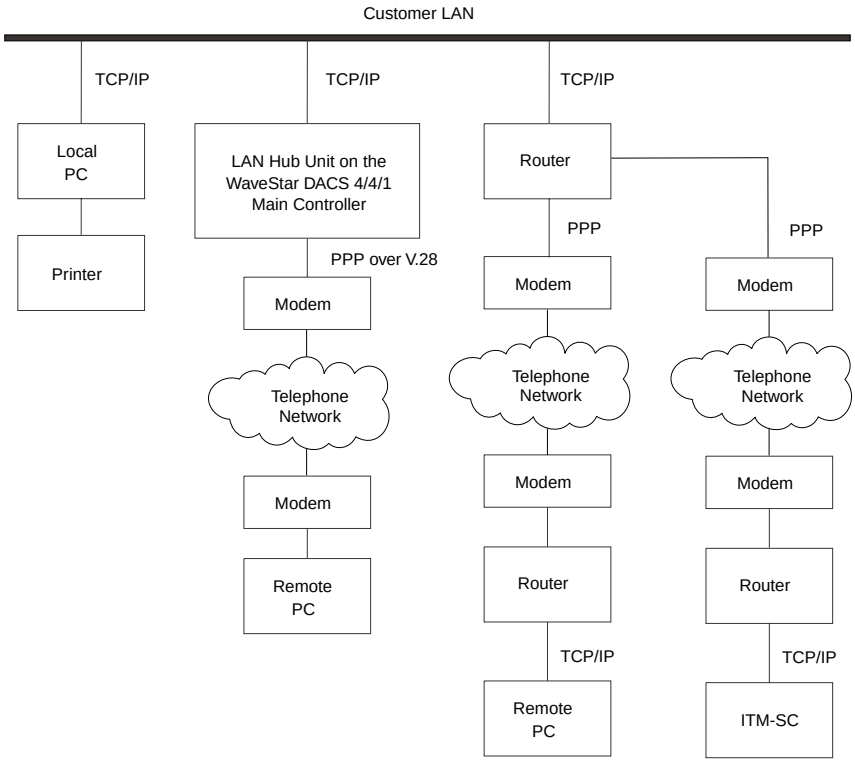

Figure 5-1 OAM&P Interfaces

The software application that provides the graphical user interface for OAM&P capabilities is called the XC-CIT. The following guidelines apply to the XC-CIT application:

- As many as six XC-CIT applications can be connected to a *WaveStar* DACS 4/4/1 simultaneously.
- The XC-CIT application can run on a local or a remote Personal Computer (PC).
- More than one XC-CIT application can run on each PC.
- If a PC is on a LAN that contains more than one *WaveStar* DACS 4/4/1, each XC-CIT application can connect to any *WaveStar* DACS 4/4/1 on the LAN.
- More than one XC-CIT application can connect to the same *WaveStar* DACS 4/4/1 (see Figure 5-2).

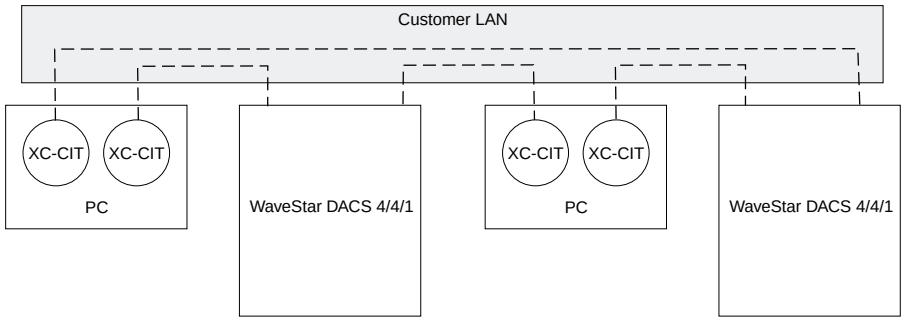

Figure 5-2 Multiple XC-CIT Applications Connected to a WaveStar DACS 4/4/1

Local or remote access

OAM&P capabilities can be accessed locally or remotely from a PC connected to the Main Controller by way of an Ethernet 10baseT LAN. A local or remote PC can be used for all the OAM&P capabilities listed at the beginning of this chapter. The communication protocol for this connection is Transmission Control Protocol/Internet Protocol (TCP/IP). The PC and the Main Controller are nodes on a customer-provided LAN. The LAN Hub ports are located on the LAN Hub Unit (LHU), which is on the back of the Main Controller subrack.

OAM&P capabilities can also be accessed remotely through a V.28 DTE interface. This interface is provided through the WS1 connector, which is located on the User Panel.

A PC that meets the requirements listed in *OAM&P PC requirements* is required for local or remote access.

Remote management interface

WaveStar DACS 4/4/1 can be managed remotely by an element management system such as Lucent Technologies' Integrated Transport Management system - Subnetwork Controller (ITM-SC). As many as four connections can be established. This interface is provided through PORT 2 on the Serial TM, which is on the back of the Main Controller subrack. The communication protocol is TCP/IP.

OAM&P PC requirements

The following are the minimum requirements for a personal computer used for local or remote access to OAM&P capabilities:

- *Microsoft Windows NT* [1] 4.0 or later operating system with Service Pack 4
- Pentium III 600 MHz/512 K cache processor
- 19-inch colour monitor

1 Microsoft and Windows NT are trademarks or registered trademarks of Microsoft Corporation.

- 256 Mbytes ECC, EDO DIMM, SDRAM
- 13.5 Gbyte hard disk, IDE or SCSI
- 32x CD-ROM drive, IDE
- 1.44 Mbyte diskette drive
- 16-bit sound card
- Matrox Millennium 2D or equivalent graphics card
- Network controller capable of operating in a 10Base-T, 10Base 2, or 100Base-TX environment
- Interfaces: 2 serial, 1 parallel, 1 keyboard, 1 mouse, 1 microphone, 1 headphone
- A modem is required if the PC will be used for a remote dial-up connection
- Optional: *Microsoft Office 97* [2] or higher if you want to modify reports.

The memory specified above (256 Mbytes) is for optimal performance for one or two XC-CIT applications running on a PC concurrently with other applications open. If you will be running more than two XC-CIT applications on a single PC, the memory should be increased by 32 Mbytes per additional XC-CIT application.

Using the XC-CIT

The XC-CIT application has a point-and-click graphical user interface that makes OAM&P tasks like provisioning a cross connection or printing a report easy to perform. You point and click to select values or options, then point and click to apply them. If a value or option that you have selected applies to only a subset of the items on a window, the items that do not apply are grayed out and cannot be selected. A system message warns you if you select a value or option that is not valid for the current system configuration.

If you need help to complete a task, easy to use on-line help is available.

Reports and other information can be sent to a printer connected to the OAM&P PC or to other printers on the customer LAN, if the PC is set up to do this. Reports can also be saved and modified using *Microsoft Excel*[3].

Access security

WaveStar DACS 4/4/1 requires a login and password before you can perform OAM&P tasks, including database queries. The PC can be set

2 Microsoft and Office 97 are trademarks or registered trademarks of Microsoft Corporation.

3 Microsoft and Excel are trademarks or registered trademarks of Microsoft Corporation.

up to lock after a user-defined period of no activity. You must re-enter your password to unlock the PC.

The system provides four access classes with the following capabilities:

- Operator — Can suppress alarms and query all system data except login and password information.
- Supervisor — Can suppress alarms, control all network element functions, and query and modify all system data except login and password information.
- Administrator — Can suppress alarms, control all network element functions, and query and modify all system data including login and password information.
- TL1 All — Allows access from a remote management system and has the same capabilities as the Supervisor access class.

Fault detection, isolation, and reporting

WaveStar DACS 4/4/1 collects information about transmission and equipment failures or degraded performance and determines what actions should be taken.

Observed defects are correlated to determine the source of the trouble. If one problem causes defects to be detected by multiple parts of the system, defect correlation tries to find the real cause and to suppress any side-effect causes. After a defect has been correlated, the system initiates the consequent action(s) defined for that defect. Consequent actions are actions that return the system to proper operation, prevent faults from propagating through the network, or both. One example of a consequent action is protection switching; switching from the equipment providing service to standby (protection) equipment.

If a defect persists, it is declared a failure, and the system raises an alarm and activates alarm indicators. You can provision a defect-to-alarm delay interval, which is the amount of time the system waits (after a defect occurs) before declaring a failure and reporting it.

Alarm indicators leave a *trail of lights* that identifies the suite (aisle), rack, and unit on which the failure occurred. Alarm indicators are turned on or off by solid-state relays located on the Alarm Relay Unit (ARU) in the Main Controller subrack. When the condition that caused the alarm ends, the system clears the alarm and turns off the alarm indicators. You can provision an alarm-clear delay interval, which is the number of seconds that the system waits (after an equipment or transmission alarm has cleared) before turning off the associated alarm indicators and generating an alarm-clear message.

The system logs information about transmission and equipment defects and alarms. You can examine the log or print a report from a local or remote OAM&P PC.

Alarm Panel

You can view alarm tallies and other alarm information from the Alarm Panel (see Figure 5-3). The Alarm Panel can be accessed through a local or remote OAM&P PC.

Alarm tallies are the current number of prompt, deferred, and information alarms for the system. Information about current alarms and autonomous events can also be displayed from the Alarm Panel. Autonomous events are actions that the system initiates automatically, for example, protection switching events or system clock reference changes.

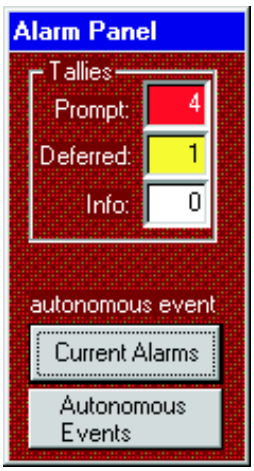

Figure 5-3 Alarm Panel

Service-affecting conditions

Any condition that will or could disrupt customer traffic is considered service affecting including the following:

- Protection is not available for the alarmed entity.
- The alarmed entity is still providing service and cannot be protected.
- For control functions, any condition that can cause a cross-connect command to be denied.

All other conditions are considered nonservice affecting.

Failure conditions

Failure conditions are classified as either equipment or transmission failures.

Equipment failures

Equipment failures indicate problems that originate inside the system. If a failure is detected, an alarm is generated and, if the problem is serious, Alarm Indication Signal (AIS) and Remote Defect Indication (RDI) can be inserted in the transmission path. The system also attempts to restore service through equipment protection switching, if it is provisioned to do so.

Transmission failures

Transmission (signal) failures indicate problems that originate outside the system. If a failure is detected, an alarm is generated and, if the problem is serious, AIS and RDI can be inserted in the transmission path. AIS and RDI notify downstream and upstream Network Elements that a failure has been detected (see Figure 5-4). The system also attempts to restore service through MSP, SNCP, or both types of protection switching, if it is provisioned to do so.

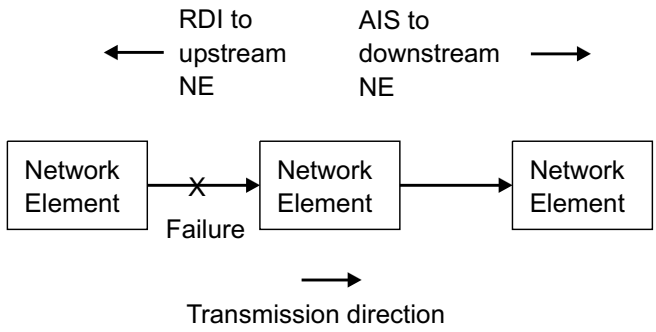

Figure 5-4 Network Alarms

Alarm severity levels

WaveStar DACS 4/4/1 provides alarm severity levels that comply with ITU-T Recommendation M.20, Alarm Information Categories. The alarm severity levels are as follows:

- Prompt — indicates that maintenance personnel must immediately replace the defective equipment or take whatever corrective action is necessary to restore good service. Alarms for service-affecting conditions are always classified as prompt.
- Deferred — indicates one, or both, of the following:
  - A performance-degrading condition exists, but the condition is not service affecting.
  - Change over to standby equipment has been used to restore service. Maintenance personnel must take immediate action, but they must resolve any prompt alarms first.
- Information — indicates that new maintenance event information is available. No immediate action is required. Maintenance personnel can perform the required actions on a scheduled basis or after an accumulation of maintenance events. Information alarms are indicated only on the User Panel. Maintenance event information can be retrieved using a local or remote OAM&P PC.

User Panel alarm indicators and controls

The User Panel is located on the front of the Main Controller (MC) subrack and displays general status and alarm information. It has the following alarm indicators and controls:

- POWER — not used in this release.

- PROMPT — a red LED that indicates that an alarm classified as prompt exists in the system.
- DEFERRED — a red LED that indicates that an alarm classified as deferred exists in the system.
- INFORMATION — a yellow LED that indicates that an alarm classified as information exists in the system.
- ABNORMAL — not used in this release.
- SUPPRESSED and DISCONNECT — two push-button switches that allow you to suppress or disconnect alarm indications. The yellow LED next to the SUPPRESSED switch indicates that alarm indications are suppressed. The yellow LED next to the DISCONNECT switch indicates that alarm indications are disconnected.

End-of-suite alarm indicators

WaveStar DACS 4/4/1 provides relays for end-of-suite alarm indicators. Typically, end-of-suite alarm indicators (Prompt and Deferred) are located at the end of an equipment aisle, and are activated when the system detects a fault in that equipment aisle. End-of-suite alarm indicators can be disconnected or suppressed at the User Panel or from a local or remote OAM&P PC.

Rack-top alarm indicators

Rack-top alarm indicators (Prompt and Deferred) are located at the top of each rack and are activated when the system detects a fault in that rack. Rack-top alarm indicators can be suppressed but cannot be disconnected.

Station alarm indicators

Station alarm indicators are alarm indicators that the customer can design to ring or light to draw attention to an alarm condition. These alarm indicators can be located in the equipment room or in other parts of the office. *WaveStar* DACS 4/4/1 provides relays for disconnectable and nondisconnectable station alarm indicators.

Typically, disconnectable station alarm indicators are connected to audible alarms, and nondisconnectable station alarm indicators are connected to visual alarms. Therefore, if station alarm indicators are disconnected, audible alarms are silenced, but visual alarms remain active until the failure has cleared.

Disconnectable station alarm indicators can be disconnected or suppressed on a system-wide basis. Nondisconnectable station alarm indicators cannot be disconnected, but can be suppressed on a system-wide basis. Station alarm indicators can be disconnected or suppressed from the User Panel or from a local or remote OAM&P PC.

Miscellaneous discrete alarm indicators

WaveStar DACS 4/4/1 provides miscellaneous discrete alarm inputs and outputs that the customer can use to detect external alarm conditions and

to drive external devices. The alarm inputs can sense a change of state in an external, customer-provided contact.

Unit indicators

Unit indicators provide alarm and status information. They are visible only when the rack doors are open. Unit indicators cannot be disconnected or suppressed; they remain lit until the alarm is cleared.

The red LED lights continuously whenever one of the following conditions occurs:

- An equipment failure has been detected on the unit
- The unit temperature is higher than normal
- The unit is being initialised
- The wrong unit was installed, or the unit cannot be initialised
- A diagnostic test is being run on the unit.

The red LED flashes whenever one of the following failures occurs, or if the cause of the failure (equipment or transmission) cannot be determined:

- Transmission failures such as Loss Of Signal (LOS)
- Station clock input reference failures.

MPU, BSC, and DTU units have two indicators. A continuously lit red (yellow on the MPU) LED indicates an equipment failure on the unit. A continuously lit green LED indicates that the unit is active. If a unit or group of units is protected, the green LED indicates which unit is active.

The green or red LED will not light if the unit is not accessible by the controller, or if the LED is damaged.

Suppressing and disconnecting alarms

When alarms are disconnected or suppressed, the corresponding alarm indications (visual or auditory notification that an alarm has been raised) are turned off. However, information about disconnected or suppressed alarms can still be accessed through a local or remote OAM&P PC. The yellow LED next to the DISCONNECT or SUPPRESSED button on the User Panel indicates that alarm indications are disconnected or suppressed.

Disconnecting alarm indications is a system-wide and permanent condition. Alarms that occur after alarm indications have been disconnected will not be indicated until the disconnection is removed.

Suppressing alarm indications is a system-wide and temporary condition. Only current alarm indications, for alarm indicators that are provisioned as suppressible, are turned off. Any subsequent alarms will light the alarm indicators. When alarm indications are suppressed, the SUPPRESSED indicator on the User Panel remains lit until the fault that caused the alarm has cleared.

You can provision station, rack-top, end-of-suite, and user-panel alarm indicators as suppressible or nonsuppressible.

Alarm logging

The system logs information about transmission (signal) and equipment defects and alarms. You can examine the log or print a report from a local or remote OAM&P PC.

The log contains the following information:

- The address of the unit or signal that caused the alarm
- The failure condition that caused the alarm
- The alarm category (transmission or equipment)
- The severity of the alarm (prompt, deferred, or information)
- The status of the alarm (nonservice affecting or service affecting)
- The date and time the alarm occurred
- If the alarm has cleared, the date and time the alarm cleared.

6 Cross-Product Interworking

Purpose

This chapter describes Lucent Technologies' Synchronous Digital Hierarchy (SDH) products that interwork with the *WaveStar*™ DACS 4/4/1. For information about *WaveStar* DACS 4/4/1 applications, see Chapter 3.

Lucent Technologies' SDH product family

The SDH product family is well suited for Plesiochronous Digital Hierarchy (PDH) and SDH network applications serving line rates ranging from 2 Mbit/s to 2.5 Gbit/s. The internal architecture of these products is based on SDH standards, but at the same time, compatibility with PDH networks has been maintained. This allows members of the SDH product family to serve as gateways between PDH and SDH networks. Network providers who are interested in migrating from PDH to SDH will find this capability particularly useful.

To ensure that members of the SDH product family work together, Lucent Technologies does extensive cross-product testing. The result is a family of products that work together flawlessly.

Network elements

The following table describes the network elements that interwork with the *WaveStar* DACS 4/4/1:

Product	Description
WaveStar Bandwidth Manager	A modular networking system integrating a broadband cross-connect fabric with access and interoffice transport facilities.
WaveStar ADM 16/1	A high capacity multiplexer and transport system that multiplexes standard PDH or SDH signals (2, 24, 45, 51, 140, 155, and 620 Mbit/s) into a 155 Mbit/s (STM-1), 620 Mbit/s (STM-4), or 2.5 Gbit/s (STM-16) signal.
WaveStar ADM 4/1	A synchronous access multiplexer that multiplexes standard PDH or SDH signals into one or two STM-1 or STM-4 signals.
WaveStar OLS 1.6T	A Time Division Multiplexer (TDM) used in different network configurations as an add/drop multiplexer, a terminal multiplexer, and a regenerator.
WaveStar OLS 40G and OLS 80G	Lightwave systems comprised of end terminals that multiplex digitally-encoded information (contained in up to 16 different wavelengths) on one end, transmit the resulting combined signal through the optical fibres, and then demultiplex the information at the other end.
WaveStar AM 1 PLUS	A multiplexer and transport system that multiplexes a broad range of plesiochronous and data signals into 620 Mbit/s (STM-4) or 155 Mbit/s (STM-1) signals.
WaveStar TDM 10G OC-192 2F	A SONET system that multiplexes asynchronous DS3 and synchronous EC1, OC-3, OC-12, and OC-48 traffic onto the OC-192 BLSR for transport to distant OC-192 multiplexers on the BLSR.
WaveStar LambdaUnite	A 10G and 40G optical switch that can support Ethernet services from one network element in both ring and meshed topologies.

Related information

For more information about these products, see one of the following sites:

- For non-Lucent employees — www.lucent.com
- For Lucent employees — http://optical.web.lucent.com/products/

Network managers

WaveStar NMS

The *WaveStar* Network Management System (NMS) offers full 4/4/1 integrated network-level management. It can manage all other members of Lucent Technologies' SDH product family as well as network elements from other vendors, which makes it an ideal tool for centralised network management. *WaveStar* NMS also works with ITM-SC to provide element management for multiplexers and digital cross-connect systems.

The *WaveStar* NMS integrates software from Lucent Technologies and other vendors into a unified set of processes. Processes are integrated across technology domains such as: SDH optical terminal and cross-connect systems, functional domains such as fault, performance, and configuration management, and vendor domains by interpreting and responding to standard messages.

WaveStar NMS can also administer spare capacity on 140 Mbit/s and STM-1 links and can execute alternate-routing commands and restoration plans for end-to-end paths on 2 Mbit/s, 34 Mbit/s, 45 Mbit/s, 140 Mbit/s, and VC-4 level signals.

ITM-SC

The Integrated Transport Management system Subnetwork Controller (ITM-SC) is an element management system for *WaveStar* ADM 16/1, *WaveStar* ADM 4/1, and *WaveStar* DACS 4/4/1 Release 2.1 or later. It provides fault management, configuration management, performance management, and node backup and restoration capabilities.

Interworking examples

ADM 16/1 with 2 Mbit/s access

Figure 6-1 shows an interworking arrangement in which *WaveStar* ADM 16/1s provide 2 Mbit/s access to the *WaveStar* DACS 4/4/1. Each *WaveStar* ADM 16/1 in this configuration can be equipped with as many as 378 2-Mbit/s interfaces. STM-1 lines connect the *WaveStar* ADM 16/1 to the *WaveStar* DACS 4/4/1.

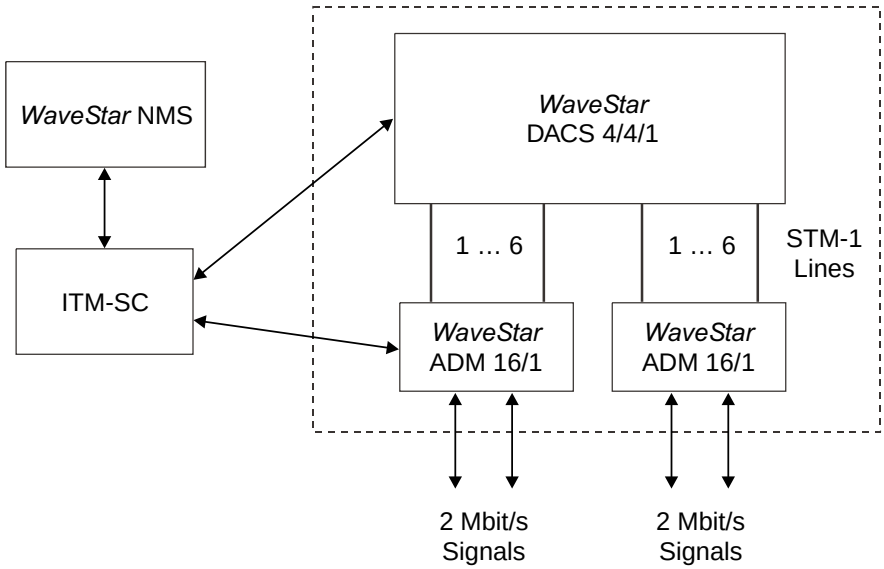

Figure 6-1 2 Mbit/s Access with the WaveStar ADM 16/1

ADM 16/1 with 2 Mbit/s access ring

Figure 6-2 shows an interworking arrangement in which *WaveStar* ADM 16/1s in a ring structure provide 2 Mbit/s access to the *WaveStar* DACS 4/4/1. The ring can operate at the STM-1, STM-4, or STM-16 rate. Each *WaveStar* ADM 16/1 in this configuration can be equipped with as many as 504 2-Mbit/s interfaces. STM-1 lines connect the *WaveStar* ADM 16/1 to the *WaveStar* DACS 4/4/1.

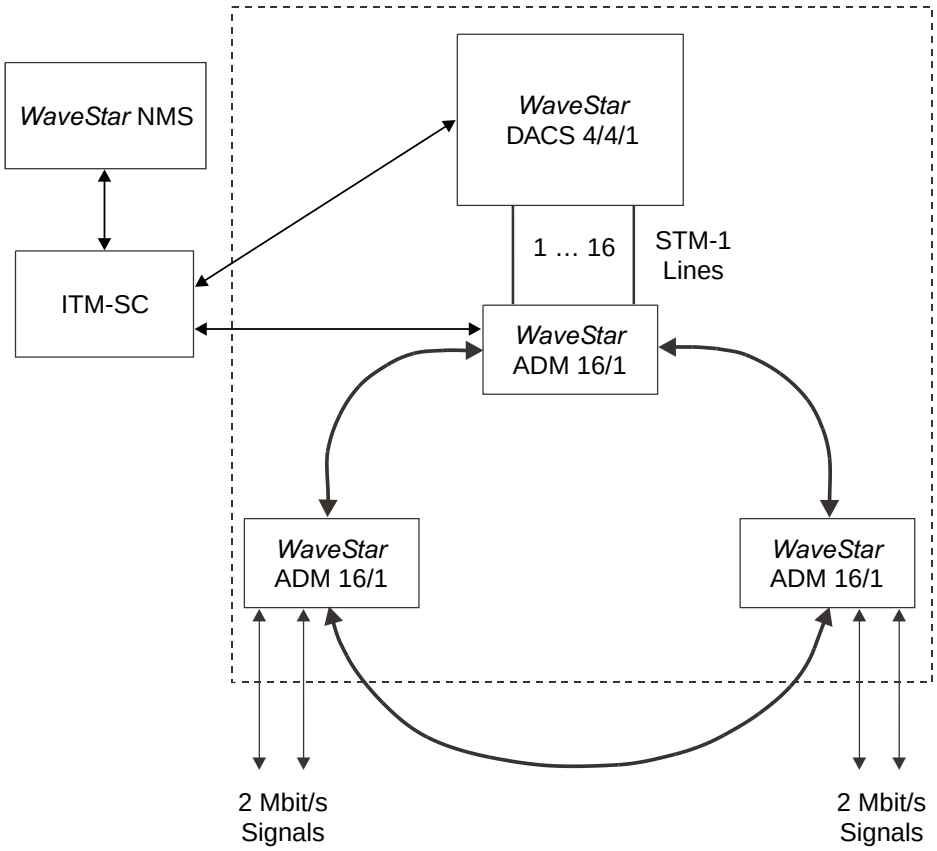

Figure 6-2 2 Mbit/s Access Ring with the WaveStar ADM 16/1

ADM 4/1 with 2, 34, or 45 Mbit/s access

Figure 6-3 shows an interworking arrangement in which *WaveStar* ADM 4/1s provide 2 Mbit/s, 34 Mbit/s, or 45 Mbit/s access to the *WaveStar* DACS 4/4/1. *WaveStar* ADM 4/1 provides a high density PDH access solution (up to 756 2-Mbit/s interfaces, or up to 30 34-Mbit/s or 45-Mbit/s interfaces). STM-1 lines connect the *WaveStar* ADM 4/1 to the *WaveStar* DACS 4/4/1.

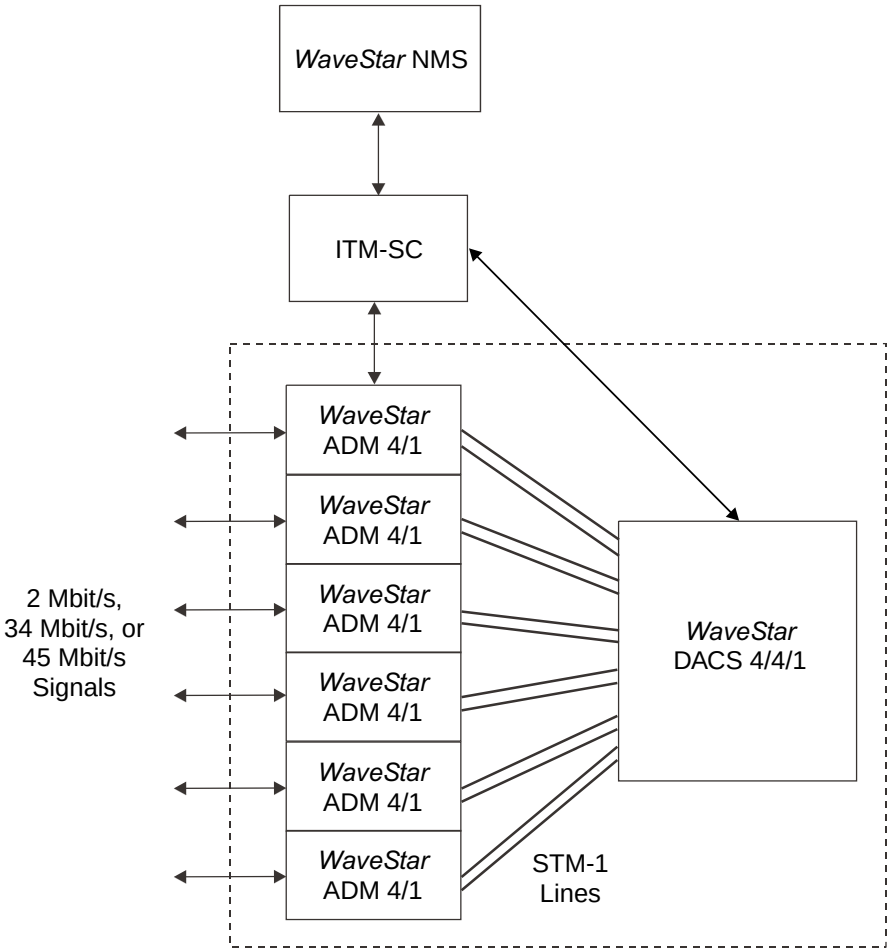

Figure 6-3 2 Mbit/s, 34 Mbit/s, or 45 Mbit/s Access with the WaveStar ADM 4/1

7 Physical Design

Purpose

This chapter describes the physical design of the *WaveStar* DACS 4/4/1 hardware.

Introduction

WaveStar DACS 4/4/1 is a subrack-based system that always contains a Matrix and Synchronisation subrack, a Main Controller subrack, and one or more port subracks. Figure 7-1 shows a minimum system configuration.

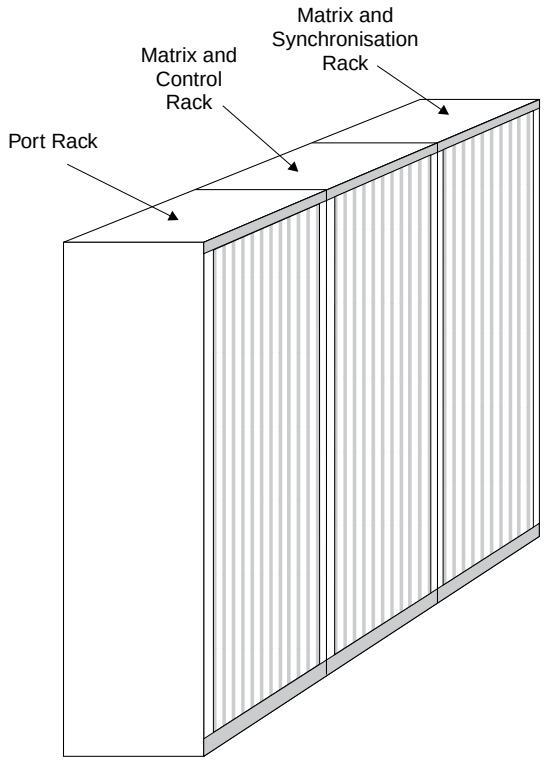

Figure 7-1 WaveStar DACS 4/4/1 Minimum System Configuration

Equipment racks

The physical design of the *WaveStar* DACS 4/4/1 equipment racks conforms to European Telecommunications Standards Institute (ETSI) equipment practices for transmission products. Furthermore, the racks have been designed to withstand the most severe (zone 4) earthquakes.

The equipment racks are 2200 mm tall, 600 mm wide, and 600 mm deep. A rack extender kit is available to extend the height of a rack to 2600 mm.

WaveStar DACS 4/4/1 subracks as well as standard ETSI subracks from other Lucent Technologies products such as the *WaveStar*™ ADM 4/1, or from other vendors can be mounted in *WaveStar* DACS 4/4/1 equipment racks.

Racks must be installed so that they can be accessed from the front and the back. Racks can be fastened to the equipment room floor or ceiling, or to an overhead cable tray. Cables can be routed through the top or the bottom of a rack.

The doors on the front and back of each rack swing open for access to the subracks, and if necessary, the doors can be removed from the rack.

Except for the fans in the Main Controller subrack, the system equipment racks are designed for natural convection cooling.

Subracks

An equipment rack can accommodate one or two subracks. Subracks house plug-in units (circuit packs) that contain the circuitry for the *WaveStar* DACS 4/4/1. All subracks conform to ETSI equipment practices for transmission products.

WaveStar DACS 4/4/1 subracks have a midplane that separates the front and rear sections of the subrack. Units plug into both sides of the midplane. The midplane interconnects the units in the subrack and reduces the number of cables that are typically used in this type of equipment.

Matrix and Synchronisation rack

Description The Matrix and Synchronisation rack is an ETSI standard rack that houses the Matrix and Synchronisation subrack and five Bit Slice Switch Units (cross-connect matrix components).

Illustration, front view Figure 7-2 shows a front view of the Matrix and Synchronisation rack.

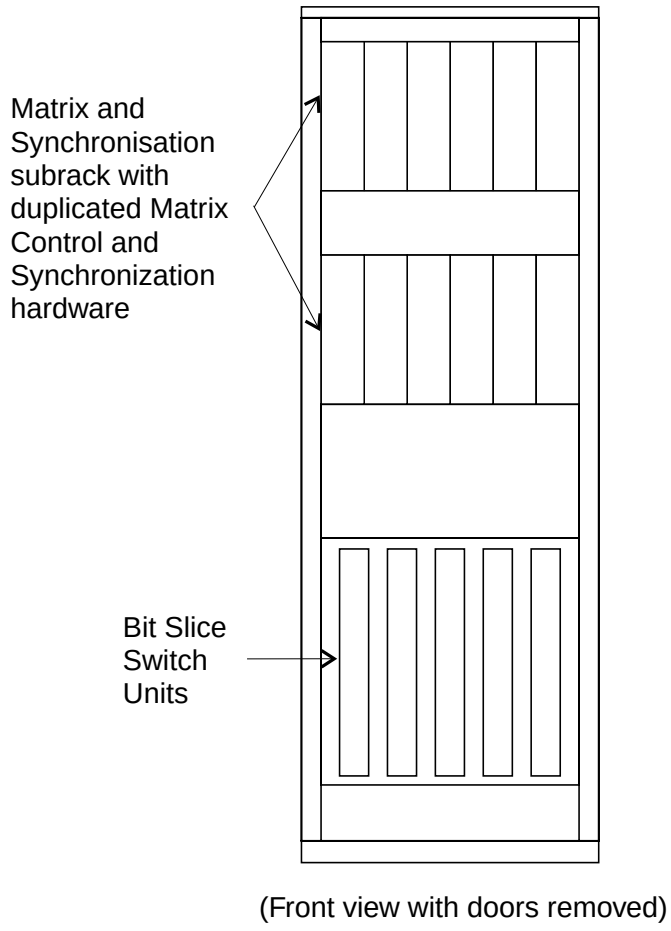

Figure 7-2 Matrix and Synchronisation Rack

Matrix and Synchronisation subrack

Description

The Matrix and Synchronisation (MS) subrack has two shelves with front and rear sections that are partitioned for plug-in units (circuit packs). Each shelf is equipped with the same set of matrix control and synchronisation and timing hardware. The units plug into a midplane that separates the front and rear sections and provides the interconnections between units.

Illustration, front view

Figure 7-3 shows a front view of the MS subrack.

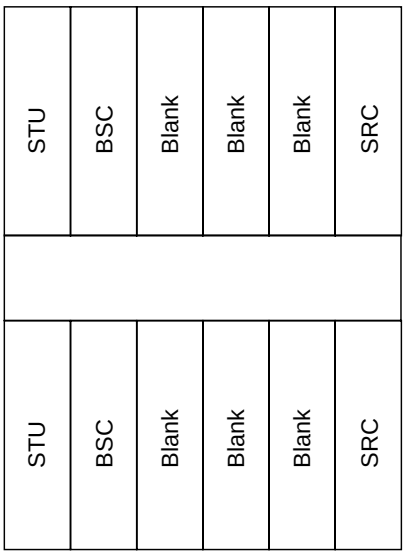

Figure 7-3 Matrix and Synchronisation Subrack - Front View

Unit descriptions, front

The following units plug into the front of each shelf in the MS subrack:

- **STU — System Timing Unit**

  The STU provides system timing and synchronisation.

- **BSC — Bit Slice Controller**

  The BSC works with the STU to provide timing signals for internal transmission paths and control information for the BSSUs (cross-connect matrix components).

- **SRC — Subrack Controller**

  The SRC routes messages back and forth from the Main Controller to units in the subrack.

Illustration, rear view Figure 7-4 shows a rear view of the MS subrack.

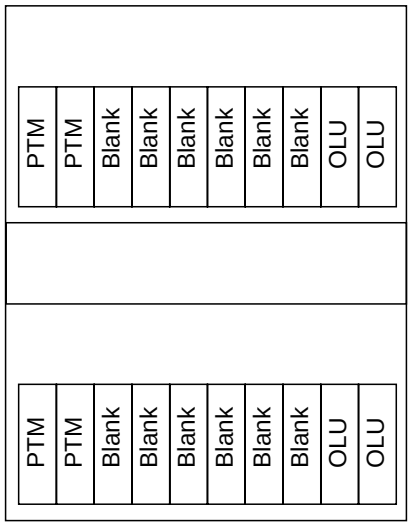

Figure 7-4 Matrix and Synchronisation Subrack - Rear View

Unit descriptions, rear The following units plug into the back of each shelf in the MS subrack:

- **PTM — Power Terminal Module**

  The PTM filters incoming station power from two separate power lines and distributes it across the subrack midplane.

- **OLU — Optical Link Unit**

  The OLU is part of the internal transmission path. It provides interfaces for the optical-fibre cables that carry transmission data between the BSCs and the BSSUs. The OLU also provides interfaces for the optical-fibre cables that carry timing information between the duplicated BSCs in the Matrix and Synchronisation subrack.

Bit Slice Switch Unit (BSSU)

Description The Bit Slice Switch Units (BSSUs) are cross-connect matrix components. Five BSSUs are located in the bottom of the Matrix and Synchronisation rack, and five BSSUs are located in the bottom of the Matrix and Control rack.

Matrix and Control rack

Description The Matrix and Control rack is an ETSI standard rack that houses the Main Controller subrack, User Panel, and five Bit Slice Switch Units (cross-connect matrix components).

Illustration, front view Figure 7-5 shows a front view of the Matrix and Control rack.

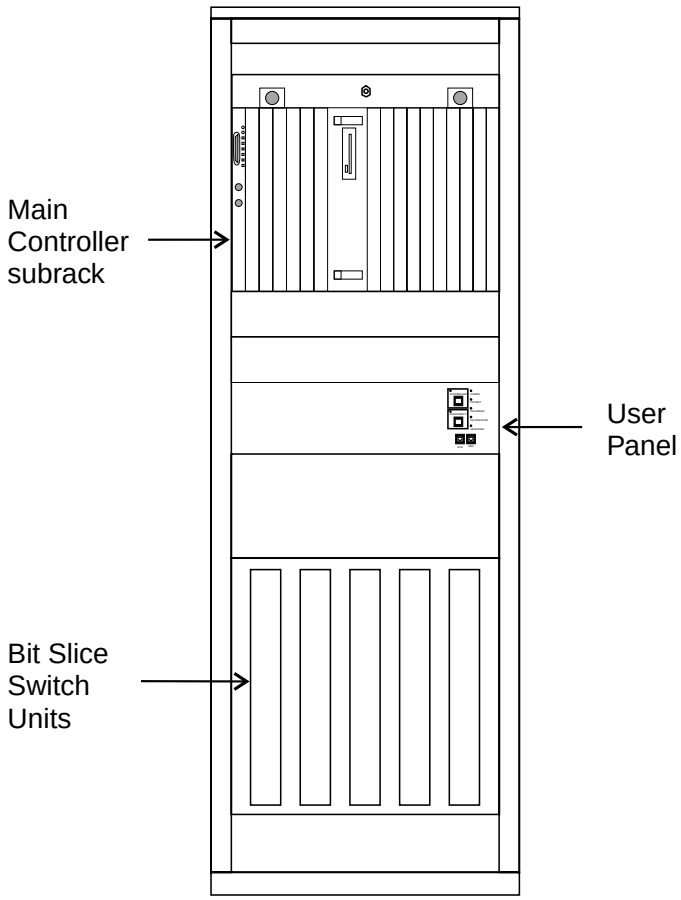

Figure 7-5 Matrix and Control Rack

Main Controller subrack

Description

The Main Controller (MC) subrack has a card cage, a fan tray, and a power supply. The card cage has front and rear sections that are partitioned for plug-in units and transition modules. Units and transition modules plug into a midplane that separates the front and rear sections of the card cage and provides the interconnections between units and transition modules.

Beginning with Release 2.1, a duplicated Main Controller is available.

Illustration, front view

Figure 7-6 shows a front view of the MC subrack with a duplicated Main Controller.

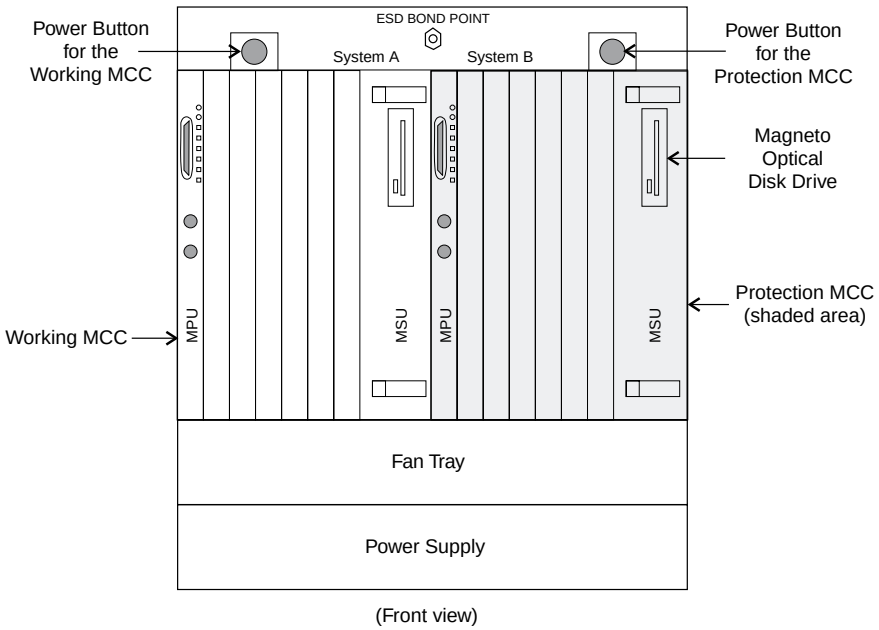

Figure 7-6 Main Controller Subrack - Front View

Unit descriptions, front

The following units plug into the front of the MC subrack:

- **MPU — Main Processor Unit**

  The MPU provides the following:

  – Central processing function

  – Control of the ARU and the LHU

  – A narrow Small Computer System Interface (SCSI-2) to the MSU.

- **MSU — Mass Storage Unit**

  The MSU contains a fixed-medium hard disk drive and a removable-medium optical disk drive.

Illustration, rear view

Figure 7-7 shows a rear view of the MC subrack with a duplicated Main Controller.

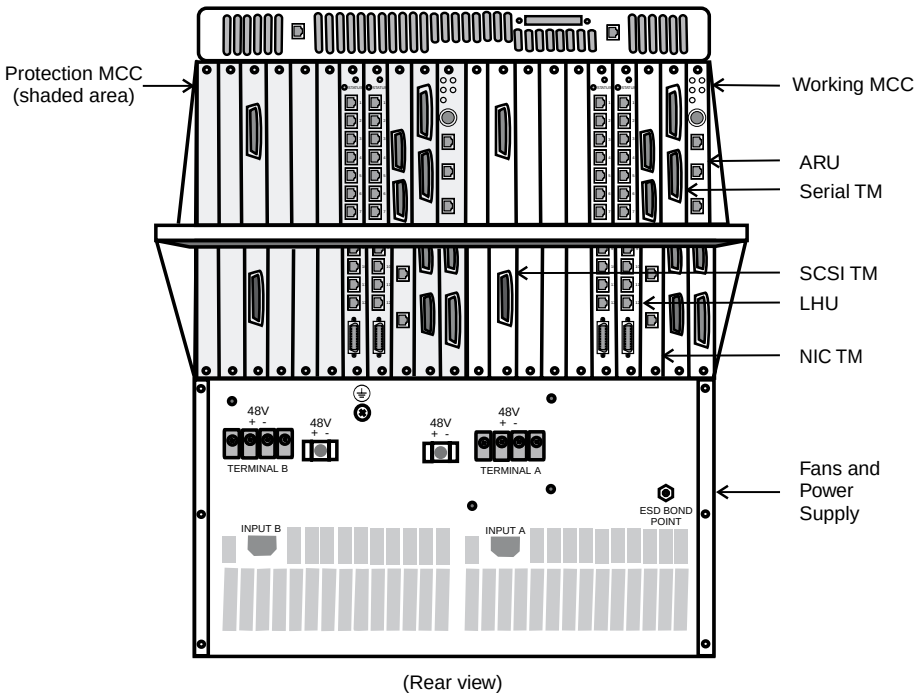

Figure 7-7 Main Controller Subrack - Rear View

Unit descriptions, rear

The following units and Transition Modules (TMs) plug into the back of the MC subrack:

- **ARU — Alarm Relay Unit**

  The ARU provides interfaces to the system alarm indicators, a network interface to the LHU, and a narrow Small Computer Interface-2 (SCSI-2) to the MSU.

- **LHU — LAN Hub Unit**

  The LHU provides the hub ports necessary for the LAN connections in the system.

- **NIC TM — Network Interface Chip Transition Module**

  The NIC TM provides LAN access to the MPU.

- **SCSI TM — SCSI Transition Module**

  The SCSI TM provides a narrow SCSI-2 interface between the MPU and the MSU.

- **Serial TM — Serial Transition Module**

  The Serial TM provides serial access to the MPU.

User Panel

Description The User Panel provides system status information.

Illustration, front view Figure 7-8 shows a front view of the User Panel.

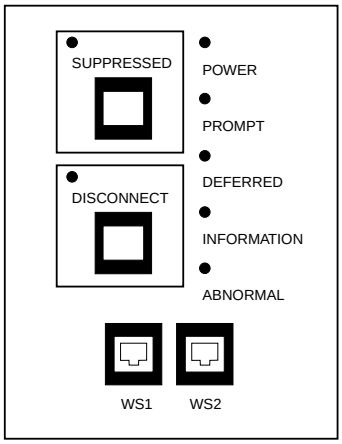

Figure 7-8 User Panel

Components The User Panel has the following alarm indicators, controls, and connectors:

- POWER — not used in this release.
- PROMPT — a red LED that indicates that an alarm classified as prompt exists in the system.
- DEFERRED — a red LED that indicates that an alarm classified as deferred exists in the system.
- INFORMATION — a yellow LED that indicates that an alarm classified as information exists in the system.
- ABNORMAL — not used in this release.
- SUPPRESSED and DISCONNECT — two push-button switches that allow you to suppress or disconnect alarm indications. The yellow LED next to the SUPPRESSED switch indicates that alarm indications are suppressed. The yellow LED next to the DISCONNECT switch indicates that alarm indications are disconnected.
- WS1 and WS2 — V.28 DCE 8-pin modular connectors. WS1 is used to connect a terminal or a modem to the working Main Controller for local or remote OAM&P activities. WS2 is used to connect a terminal or a modem to the protection Main Controller for local or remote OAM&P activities. WS2 can be used only if the system has a duplicated Main Controller.

Port rack

Description

The Port rack is an ETSI standard rack. It can be equipped with two PSA subracks, two PSC subracks, or one PSA subrack and one PSC subrack. The PSB subrack, for STM-0 interfaces, has been discontinued.

Illustration, front view

Figure 7-9 shows a front view of a Port rack equipped with two PSA subracks.

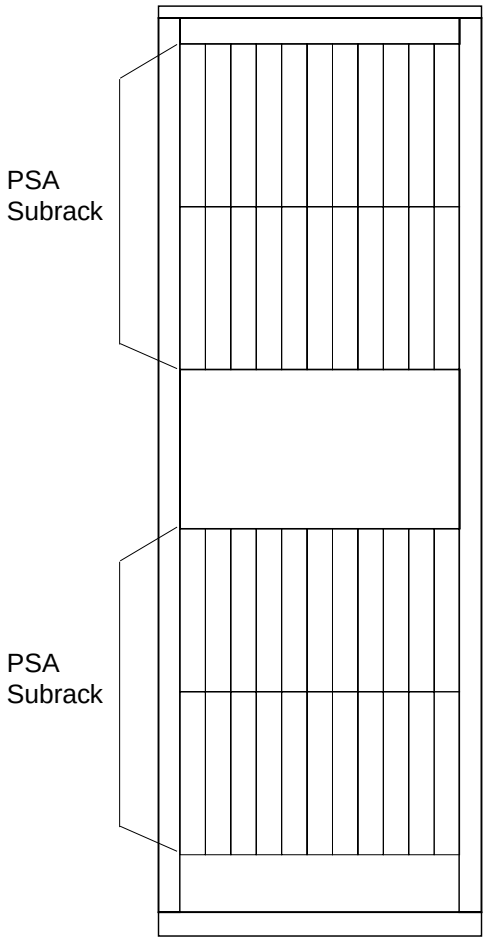

Figure 7-9 Port Rack Equipped with PSA Subracks

Port Subrack A (PSA)

Description

The Port Subrack A (PSA) has front and rear sections that are partitioned for plug-in units. The units plug into a midplane that separates the front and rear sections and provides the interconnections between units.

The PSA subrack can be equipped with up to 64 unprotected or equipment protected STM-1 electrical ports (4 ports per unit), or up to 32 STM-1 optical or electrical ports with 1+1 Multiplex Section Protection (MSP).

Illustration, front view

Figure 7-10 shows a front view of a PSA subrack equipped with STM-1 electrical port units that are configured for 1:8 equipment protection. When configured for MSP, the STM1 P (protection) unit is replaced by an apparatus blank.

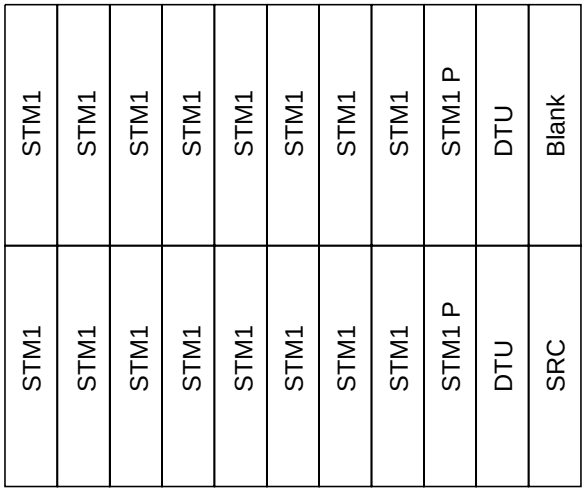

Figure 7-10 PSA Subrack - Front View

Unit descriptions, front

The following units plug into the front of the PSA subrack:

- **STM1 — STM-1 Port Unit**

  The STM-1 port unit has four STM-1 ports. Each STM-1 port provides 155.52 Mbit/s transmission.

- **DTU — Digital Timing Unit**

  The DTU provides timing for the transmission units in the subrack.

- **SRC — Subrack Controller**

  The SRC routes messages back and forth from the Main Controller to units in the subrack.

Illustration, rear view

Figure 7-11 shows a rear view of a PSA subrack.

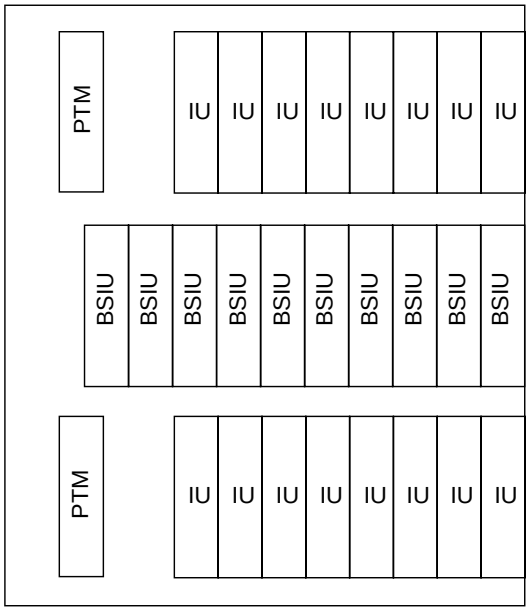

Figure 7-11 PSA Subrack - Rear View

Unit descriptions, rear

The following units plug into the back of the PSA subrack:

- **PTM — Power Terminal Module**

  The PTM filters incoming station power from two separate power lines and distributes it across the subrack midplane.

- **BSIU — Bit Slice Interface Unit**

  The BSIU is part of the internal transmission path. It transports data between the BSSUs and the port units. The BSIU also monitors the transmission data and provides Automatic Protection Switching for hardware failures.

- **IU — STM-1 Interface Unit**

  The STM-1 interface unit (IU) provides the SDH Physical Interface (SPI) function for STM-1 electrical or optical signals. The IU provides four STM-1 interfaces. The following STM-1 IUs all work with the STM-1 port unit:

  – STM-1 short-haul optical interface unit designed to ITU specifications

  – STM-1 long-haul optical interface unit designed to ITU specifications

  – STM-1 electrical interface unit

  – STM-1 optical interface unit designed to Nippon Telegraph and Telephone (NTT) specifications.

Port Subrack C (PSC)

Description

The Port Subrack C (PSC) has front and rear sections that are partitioned for plug-in units. The units plug into a midplane that separates the front and rear sections and provides the interconnections between units.

The PSC can be equipped with STM-16 or STM-4 optical port units. For this release, STM-16 and STM-4 port units cannot be mixed in the same PSC subrack.

As many as 8 unprotected STM-16 optical ports (1 port per unit), or 4 STM-16 optical ports with 1+1 Multiplex Section Protection (MSP) can be provisioned. As many as 32 unprotected STM-4 optical ports (4 ports per unit), or 16 STM-4 optical ports with 1+1 MSP can be provisioned.

Illustration, front view

Figure 7-12 shows a front view of a PSC subrack equipped with STM-16 optical port units.

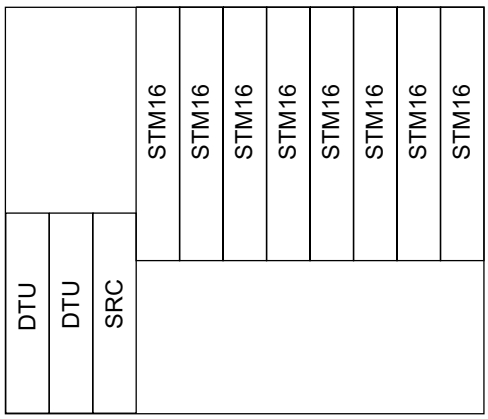

Figure 7-12 PSC Subrack - Front View

Unit descriptions, front

The following units plug into the front of the PSC subrack:

- **STM16 — STM-16 Port Unit**

  The STM-16 port unit has 1 STM-16 port. The STM-16 port provides 2.5 Gbit/s transmission.

- **STM4 — STM-4 Port Unit**

  The STM-4 port unit has 4 STM-4 ports. Each STM-4 port provides 622 Mbit/s transmission.

- **DTU — Digital Timing Unit**

  The DTU provides timing for the transmission units in the subrack.

- **SRC — Subrack Controller**

  The SRC routes messages back and forth from the Main Controller to units in the subrack.

Illustration, rear view

Figure 7-13 shows a rear view of a PSC subrack. Unlike STM-1 port units, the STM-16 and STM-4 port units do not have separate Interface Units that provide the SDH Physical Interface (SPI) function. The SPI function is built into the STM-16 and STM-4 port units.

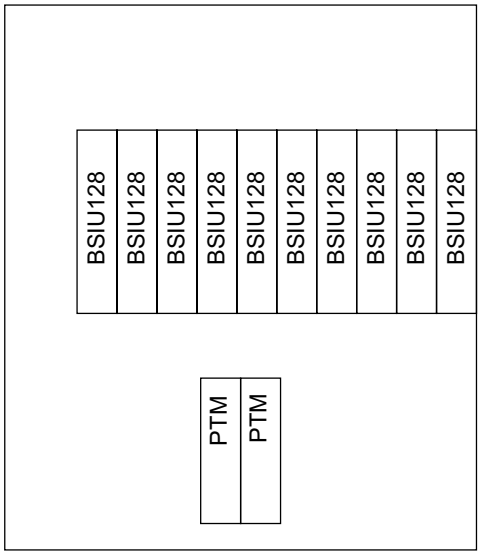

Figure 7-13 PSC Subrack - Rear View

Unit descriptions, rear

The following units plug into the back of the PSC subrack:

- **PTM — Power Terminal Module**

  The PTM filters incoming station power from two separate power lines and distributes it across the subrack midplane.

- **BSIU128 — Bit Slice Interface Unit**

  The BSIU128 is part of the internal transmission path. It transports data between the BSSUs and the port units. The BSIU128 also monitors the transmission data and provides Automatic Protection Switching for hardware failures. The BSIU128s in the PSC subrack can transport twice the bandwidth, up to 128 STM-1 equivalents, compared to the BSIUs in the PSA subrack, which can transport up to 64 STM-1 equivalents.

8 System Planning and Engineering

Purpose This chapter contains information about the following:

- System planning
- Synchronisation
- Equipment configuration rules
- System floor plans
- The recommended amount of space between rows of equipment and above equipment racks
- Floor loading.

System planning

Many factors must be considered when planning for a new *WaveStar* DACS 4/4/1 system, or expanding an existing system. The following items should be included in the plan:

- Synchronisation
- System capacity
- Equipment and facility protection
- Span length
- Equipment interconnection
- Cabling
- Floor plan layout
- Environmental requirements
- Power requirements.

Synchronisation and timing

Overview

The *WaveStar* DACS 4/4/1 complies with ITU-T Recommendations G.812 and G.783 for synchronisation and timing. The system has duplicated synchronisation and timing hardware that provides the following capabilities:

- The system clock is an ITU-T G.812 Type I clock with holdover mode. The pull-in and pull-out range for the system clock is ± 5.0 ppm.
- System clock input references can be derived from any transmission port, including ports provisioned for MSP, or from external references (station clock inputs)
- External references can be derived from 2048 kHz timing inputs or from 64 kHz composite clock inputs.
- Reference source and timing mode selection are based on user-assigned priorities.
- System clock distribution to transmission hardware within the system.
- A 2048 kHz station clock output port on each System Timing Unit (STU) that can be used as a timing source for other equipment.
- When no faults are present, user-initiated protection switching of the synchronisation and timing hardware is glitchless.

Figure 8-1 shows a diagram of the synchronisation and timing hardware.

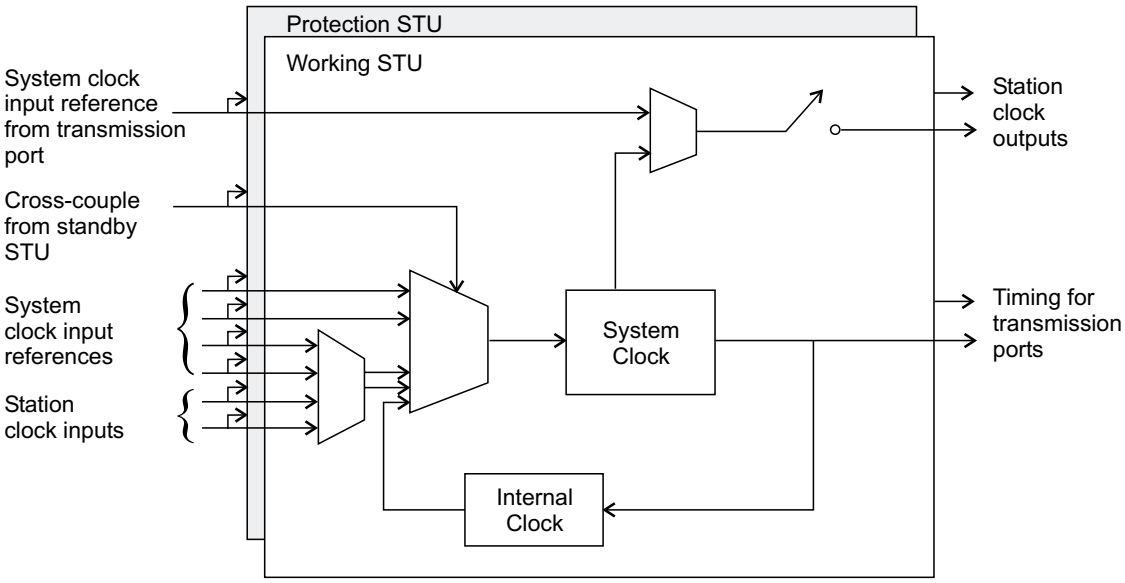

Figure 8-1 Synchronisation and Timing Diagram

Timing modes

WaveStar DACS 4/4/1 offers the following timing modes:

- Free-Running — The system operates in free-running mode when it is initially put into service. In free-running mode, system timing is provided by the internal clock. The accuracy of the internal clock in free-running mode is 2048 kHz ± 2.5 ppm (cumulative measure).

  Free-running mode is used during installation and testing before timing references are provisioned. After the system has been phase locked to a timing reference, it will not return to free-running mode.
- Phase locked — Phase-locked mode is the normal mode of operation. In this mode, the system clock is slaved to a timing reference (transmission port or station clock input).
- Holdover — Holdover mode is a backup operational mode that the system switches to automatically if all provisioned timing references have failed. In holdover mode, the internal system clock simulates the timing that occurred during a previous period in phase-locked mode. Before switching to holdover mode, the system should be phase locked to a good timing reference for at least 30 minutes. The system can enter holdover mode after a shorter phase-lock interval, but transmission performance requirements may not be satisfied.

  Holdover performance complies with ITU-T Recommendation G.812 for a Type I clock, which specifies an initial frequency offset of 0.5×10^{-9} and a frequency drift of 2×10^{-10}/day.

  An alarm is raised whenever the system enters holdover mode.

Timing inputs

Two types of STU are available; one STU accepts 2048 kHz station clock inputs, and the other STU accepts 64 kHz station clock inputs. Both types of STU have two station clock input ports.

Timing inputs (references) should meet the requirements of ITU-T Recommendations G.703 and G.825. System clock input references can be derived from traffic-carrying lines (STM-16, STM-4, or STM-1 ports or MSP pairs) or from external references (station clock inputs). As many as four prioritised input references can be provisioned for the system clock. If no references are provisioned, the system operates in free-running or holdover timing mode.

No special cables are required for line-derived timing. Timing information is sent from the port unit to the STU through internal data transmission paths.

External references can be derived from one or two 2048 kHz timing inputs or from one or two 64 kHz composite clock inputs. When the input reference for the system clock is derived from an external reference, the station clock input ports on the working and protection Matrix and Synchronisation subracks should be connected to the same

external reference (see Figure 8-2). The connectors for the station clock inputs are located on the back of the Matrix and Synchronisation subrack.

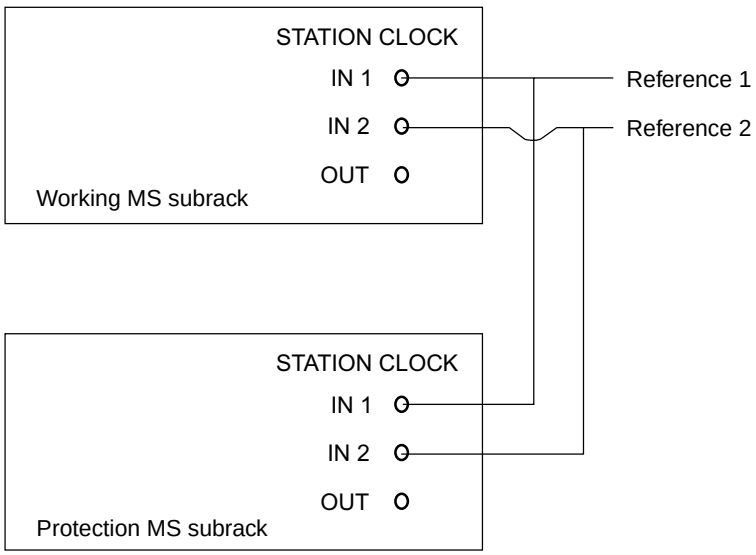

Figure 8-2 Input Timing References

Limits for timing references

There is a limit of one timing reference per port unit. If MSP is provisioned, only one port per MSP pair can be a timing reference, and the port must be on the working unit. If SNCP is provisioned, the working or protection port unit can be provisioned as a timing reference.

As many as two timing references can be provisioned for a single-fibre port subrack. As many as four timing references can be provisioned for dual-fibre or quad-fibre port subracks.

The limits for line-derived timing references apply to both system clock input references and station clock input references. For example, if four STM-1 ports in a dual-fibre port subrack are provisioned as system clock input references, a fifth STM-1 port in the same port subrack cannot be provisioned as a station clock input reference. Also, if a port on an STM-1 port unit is provisioned as a system clock input reference, another port on the same unit cannot be provisioned as a station clock input reference.

Timing outputs

The *WaveStar* DACS 4/4/1 provides two 2048 kHz timing output ports, called station clock output ports. The station clock output ports, one output port on each STU, can be used as a timing source for other equipment. The input timing reference for the station clock output ports can be derived from the system clock or from a transmission port, including ports provisioned for MSP or SNCP.

The timing output signal complies with ITU-T Recommendation G.703, and is squelched (no signal is transmitted) if the STU has a hardware failure that prevents a valid signal from being transmitted. If timing is

derived from a transmission port, a signal failure will also cause the output to be squelched.

If the input timing reference used for the station clock outputs is a transmission port, the port can be one of the transmission ports used as an input reference for the system clock, or the port can be different from any of the transmission ports used as an input reference for the system clock. Because both station clock output ports get their input from the same timing source, the output signals are not independent. A failure of the timing source affects both station clock output ports.

Timing reference selection

A priority can be assigned to each input timing reference. The STU monitors the status (good or failed) of each provisioned timing reference and selects the active reference based on its status and priority. Only a reference whose status is good will be selected as the active reference.

The priority assigned to timing references determines whether reference selection (switching) is revertive or nonrevertive. If timing references are assigned different priority values, reference selection is revertive. If the highest priority reference is active and fails, the STU selects the next highest priority reference whose status is good. However, if the status of the highest priority reference becomes good, the STU switches back (reverts) to that reference. If all the provisioned timing references are assigned equal priority values, reference selection is nonrevertive.

The selection of a particular reference can be forced by assigning it a priority that is higher than other provisioned references. Or, a reference can be locked out (preventing the system from selecting that reference) by assigning it the priority “None.”

Timing mode selection

The default priority for holdover mode (internal clock) is lower than any of the priorities that can be assigned to input timing references. Consequently, under normal circumstances, the system will go into holdover timing mode only if all provisioned timing references have failed. The system can, however, be forced into holdover mode by assigning the internal clock a higher priority than any of the provisioned timing references.

Glitchless switching

A cross-couple link between the active and standby synchronisation and timing hardware enables the standby hardware to maintain the same frequency and phase as the active hardware. Consequently, when no faults are present, no bit errors, also called hits or glitches, are caused by manual switching of the synchronisation and timing hardware.

Equipment configuration rules

All *WaveStar* DACS 4/4/1 systems contain a Matrix and Control rack, a Matrix and Synchronisation rack, and one or more Port racks. When the system is configured for a maximum capacity of 512 STM-1 equivalents, as many as 16 port subracks can be provisioned.

Matrix and Synchronisation rack

The Matrix and Synchronisation rack is an ETSI standard rack that houses the Matrix and Synchronisation subrack and Bit Slice Switch Units (cross-connect matrix components). Table 8-1 lists Matrix and Synchronisation rack equipment.

Table 8-1 Matrix and Synchronisation Rack Equipment List

Description	Quantity
Matrix and Synchronisation rack	1
Power and Alarm Distribution Panel	2
Matrix and Synchronisation subrack	1
Bit Slice Switch Unit (BSSU)	5

Matrix and Synchronisation subrack

The Matrix and Synchronisation (MS) subrack has two shelves with front and rear sections that are partitioned for plug-in units. Each shelf is equipped with identical units in identical physical positions.

Units

Table 8-2 lists the description and quantity for each unit in the Matrix and Synchronisation subrack.

Table 8-2 Matrix and Synchronisation Subrack — Unit List

Description	Quantity per subrack
System Timing Unit (STU)	2
Bit Slice Controller (BSC)	2
Subrack Controller Unit (SRC)	2
Power Terminal Module (PTM)	4
Optical Line Unit (OLU)	4

BSFI cables

Bit Slice Fibre Interface (BSFI) cables are 4.5 metre, optical fibre cables that carry timing and control information between the BSCs and the BSSUs. The BSFI cables connect from the BSSUs to the OLUs in the Matrix and Synchronisation subrack.

ECI cables

Equipment Core Interface (ECI) cables are optical fibre cables that provide the transmission interface between the BSSUs in the Matrix and Control and Matrix and Synchronisation racks and the BSIUs in the port subracks. Table 8-3 lists the ECI cable lengths. ECI cable lengths may vary within the same system; however, the cables to each port subrack must be the same length. The 12-metre cables are used for a contiguous system layout. The 50-metre cables are used for a noncontiguous system layout (remote Port racks).

Table 8-3 ECI Cable Lengths

Description
ECI optical cable, 12 metres
ECI optical cable, 50 metres

Matrix and Control rack

The Matrix and Control rack is an ETSI standard rack that houses the Main Controller subrack, the User Panel, and Bit Slice Switch Units (cross-connect matrix components). Table 8-4 lists Matrix and Control rack equipment.

Table 8-4 Matrix and Control Rack Equipment List

Description	Quantity
Matrix and Control rack	1
Main Controller subrack	1
Power and Alarm Distribution Panel	1
Power, Alarm, and Fuse Panel	1
User Panel	1
Bit Slice Switch Unit (BSSU)	5

Main Controller subrack

The Main Controller (MC) subrack has front and rear sections that are partitioned for plug-in units. The MC subrack can be equipped with one or two Main Controllers (MCs). Each MC is equipped with the same set of plug-in units. The Main Processor Unit and the Mass Storage Unit plug into the front of the subrack. The Alarm Relay Unit, NIC TM, SCSI TM, and Serial TM plug into the back of the subrack.

Units

Table 8-5 lists the description and quantity for each unit in the MC subrack.

Table 8-5 Main Controller Subrack — Unit List

Description	Quantity per subrack	
	1 MC	2 MCs
Alarm Relay Unit (ARU)	1	2
LAN Hub Unit (LHU)	2	4
Main Processor Unit (MPU)	1	2
Mass Storage Unit (MSU)	1	2
NIC TM	1	2
SCSI TM	1	2
Serial TM	1	2

Configuration rules

The Main Control LAN (MCLAN) provides the control interface between the Main Controller subrack and other system subracks (Matrix and Synchronisation subrack and port subracks). For systems with a single MC, each subrack in the system requires one MCLAN connection. For systems with a duplicated MC, each subrack in the system requires two MCLAN connections. The connectors for the MCLAN ports are located on the LAN Hub Unit (LHU). Each LHU has twelve LAN Hub.

LAN cables

LAN cables connect the MCLAN ports to the MCLAN W (working) and MCLAN P (protection) connectors on the back of each subrack.

Table 8-6 lists the LAN cable lengths. LAN cable lengths may vary within the same system. The 7.6 metre cables are used between the Main Controller subrack and Matrix and Synchronisation subrack. The 15.0 metre cables are used between the Main Controller subrack and port subracks for a contiguous system layout. The 30.5 and 61.0 metre cables are used for a noncontiguous system layout (remote Port racks).

Table 8-6 LAN Cable Lengths

Description
LAN cable, 7.6 metres
LAN cable, 15.0 metres
LAN cable, 30.5 metres
LAN cable, 61.0 metres

Port rack

The Port rack is an ETSI standard rack that houses port subracks. Table 8-7 lists Port rack equipment.

Table 8-7 Port Rack Equipment List

Description	Quantity
Port rack	1
PSA subrack or PSC subrack	1 or 2
Power and Alarm Distribution Panel	1

Port Subrack A (PSA)

The Port Subrack A (PSA) has two shelves with front and rear sections that are partitioned for plug-in units. STM-1 port units, Digital Timing Units, and the Subrack Controller Unit plug into the front of the subrack. Power Terminal Modules, Bit Slice Interface Units, and STM-1 interface units plug into the back of the subrack.

Units

Table 8-8 lists the description and quantity for each unit in the PSA subrack.

Table 8-8 PSA Subrack — Unit List

Description	Quantity per subrack
STM-1 Port Unit	1 to 18
Port Unit apparatus blank	0 to 17
Digital Timing Unit (DTU)	2
Subrack Controller Unit (SRC)	1
Power Terminal Module (PTM)	2
Bit Slice Interface Unit (BSIU)	10
STM-1 Electrical Interface Unit or STM-1 Optical Interface Unit (NTT) or STM-1 Short-Haul Optical Interface Unit (ITU) or STM-1 Long-Haul Optical Interface Unit (ITU)	1 to 16
Interface Unit apparatus blank	0 to 15

Configuration rules

The following units are always required in a PSA subrack:

- Two DTUs
- One SRC
- Two PTMs
- 10 BSIUs.

A PSA subrack can be configured with one or two optical fibre connections to each BSSU. A single-fibre subrack supports up to 32 STM-1 equivalents. A dual-fibre subrack supports up to 64 STM-1 equivalents.

Single-fibre subrack

A single-fibre PSA subrack can be equipped with STM-1 port units and any combination of STM-1 optical or electrical interface units. Each unequipped slot on the front and back of the subrack must be equipped with an apparatus blank.

Single-fibre PSA subracks are best suited for MSP. However, the port units in a single-fibre PSA subrack can be configured in any of the following ways:

- Unprotected
- 1:8 equipment protection
- Multiplex Section Protection (MSP)
- Both 1:8 equipment protection and MSP.

MSP can be assigned to a pair of ports on adjacent port units. The working port is on an odd-numbered port unit, and the protection port is the port with the same number on the even-numbered port unit to the right of the working port (see Figure 8-3). For example, port 1 on port unit 1 is the working port, and port 1 on port unit 2 is the protection port.

ITU MSP, ANSI MSP, or NTT MSP can be used on any combination of STM-1 port units and electrical or optical interface units. MSP can be used on a shelf that also uses STM-1 electrical equipment protection.

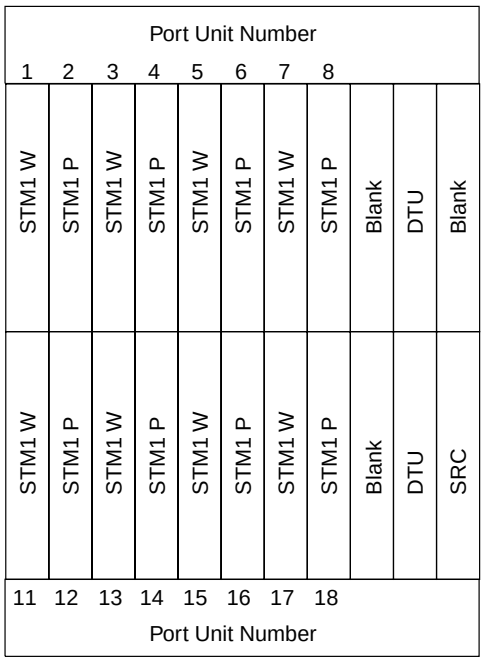

Figure 8-3 PSA Subrack — STM-1 Interfaces with MSP

Because the single-fibre subrack is designed to be used with MSP, bandwidth is not allocated to the even-numbered port units in the subrack. Consequently, cross connections can be provisioned only for ports on odd-numbered port units.

1:8 equipment protection can be configured on a per-shelf basis. An equipment protection group is created automatically when port unit 9 or 19 is inserted into the subrack (see Figure 8-4).

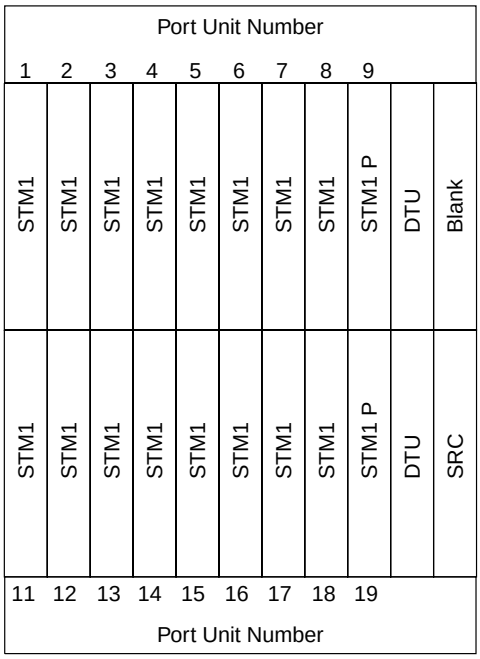

Figure 8-4 PSA Subrack — STM-1 Electrical Interfaces with 1:8 Equipment Protection

The protection unit can substitute for any port unit in the same shelf if the following conditions are met:

- The port unit has an electrical interface unit.
- No ports on the unit have MSP provisioned.

Dual-fibre subrack

A dual-fibre PSA subrack can be equipped with STM-1 port units and any combination of STM-1 optical or electrical interface units. Each unequipped slot on the front and back of the subrack must be equipped with an apparatus blank.

Dual-fibre PSA subracks are best suited for 1:8 equipment protection or for unprotected port units. However, the port units in a dual-fibre PSA subrack can be configured in any of the following ways:

- Unprotected
- 1:8 equipment protection
- Multiplex Section Protection (MSP)
- Both 1:8 equipment protection and MSP.

1:8 equipment protection can be configured on a per-shelf basis. An equipment protection group is created automatically when port unit 9 or 19 is inserted into the subrack.

The protection unit can substitute for any port unit in the same shelf if the following conditions are met:

- The port unit has an electrical interface unit.
- No ports on the unit have MSP provisioned.

Because the dual-fibre subrack is designed to be used with 1:8 equipment protection or unprotected port units, bandwidth is allocated to all port units in the subrack except port units 9 and 19, which are the protection units for 1:8 equipment protection. When MSP is assigned in a dual-fibre subrack, the overall system bandwidth is reduced. Bandwidth is reduced because MSP uses two physical ports, but only carries the bandwidth of one port.

Port Subrack C (PSC)

The Port Subrack C (PSC) has front and rear sections that are partitioned for plug-in units. STM-16 or STM-4 port units, Digital Timing Units, and the Subrack Controller Unit plug into the front of the subrack. Power Terminal Modules and Bit Slice Interface Units plug into the back of the subrack.

Units

Table 8-9 lists the description and quantity for each unit in the PSC subrack.

Table 8-9 PSC Subrack — Unit List

Description	Quantity per subrack
STM-16 Port Unit	1 to 8
STM-4 Port Unit	1 to 8
Port Unit apparatus blank	0 to 7
Digital Timing Unit (DTU)	2
Subrack Controller Unit (SRC)	1
Power Terminal Module (PTM)	2
Bit Slice Interface Unit 128 (BSIU128)	10

Configuration rules

The following units are always required in a PSC subrack:

- Two DTUs
- One SRC
- Two PTMs
- 10 BSIUs.

A PSC subrack can be configured with one, two, or four optical fibre connections to each BSSU. A single-fibre subrack supports up to 32 STM-1 equivalents. A dual-fibre subrack supports up to 64 STM-1 equivalents. A quad-fibre subrack supports up to 128 STM-1 equivalents.

Single-fibre subrack

A single-fibre PSC subrack can be equipped with STM-16 or STM-4 port units. Each unequipped slot on the front of the subrack must be equipped with an apparatus blank. Seven port unit apparatus blanks are shipped with each PSC subrack.

A single-fibre PSC subrack has bandwidth allocated only to port units 1 and 3. No bandwidth is allocated to port units 2, 4, 5, 6, 7, and 8 and consequently, cross connections cannot be made to ports on these port

units. Ports on port units 2 and 4 will carry traffic only if they are provisioned for Multiplex Section Protection (MSP). Ports on port units 5, 6, 7, and 8 will never carry traffic.

The single-fibre PSC subrack is best suited for applications that require only a small number of STM-16 or STM-4 interfaces. Ports in a single-fibre PSC subrack can be unprotected, or MSP can be provisioned on port units 1, 2, 3, and 4.

MSP can be assigned to a pair of ports on adjacent port units. The working port is on an odd-numbered port unit, and the protection port is the port with the same number on the even-numbered port unit to the right of the working port. For example, port 1 on port unit 1 is the working port, and port 1 on port unit 2 is the protection port. ITU MSP or ANSI MSP can be used on STM-16 or STM-4 ports.

Dual-fibre subrack

A dual-fibre PSC subrack can be equipped with STM-16 or STM-4 port units. Each unequipped slot on the front of the subrack must be equipped with an apparatus blank. Seven port unit apparatus blanks are shipped with each PSC subrack.

Dual-fibre PSC subracks are best suited for MSP, because bandwidth is allocated only to odd-numbered port units. Port units in a dual-fibre PSC subrack can be unprotected. However, because bandwidth is not allocated to the even-numbered port units, cross connections can be provisioned only for ports on odd-numbered port units.

MSP can be assigned to a pair of ports on adjacent port units. The working port is on an odd-numbered port unit, and the protection port is the port with the same number on the even-numbered port unit to the right of the working port. ITU MSP or ANSI MSP can be used on STM-16 or STM-4 ports.

Quad-fibre subrack

A quad-fibre PSC subrack can be equipped with STM-16 or STM-4 port units. Each unequipped slot on the front of the subrack must be equipped with an apparatus blank. Seven port unit apparatus blanks are shipped with each PSC subrack.

Quad-fibre PSC subracks are best suited for unprotected port units, because bandwidth is allocated to all port units in the subrack. MSP can be provisioned in a quad-fibre PSC subrack, but overall system bandwidth is reduced. Bandwidth is reduced because MSP uses two physical ports, but only carries the bandwidth of one port.

Equipment room recommendations

This section contains information about system floor plans, the recommended amount of space between rows of equipment and above equipment racks, and floor loading.

Contiguous layout

Figure 8-5 shows a floor plan for a minimum system configuration with a contiguous layout. A maintenance aisle must be provided in front of and behind the equipment racks.

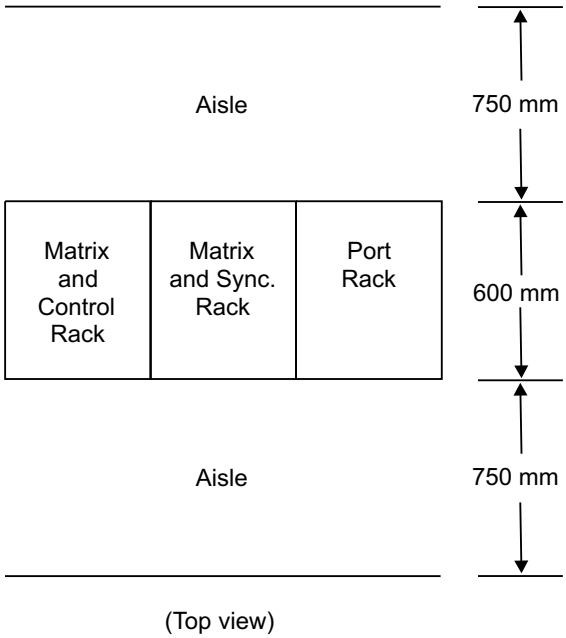

Figure 8-5 Floor Plan for Minimum System Configuration

Noncontiguous layout

Figure 8-6 shows a floor plan for a system with a noncontiguous layout. This illustration also shows one of the possible configurations for a 512 STM-1 equivalent system.

WaveStar DACS 4/4/1 uses optical fibre cables to connect Port racks to the Matrix and Control and Matrix and Synchronisation racks. These cables can be up to 50 metres long.

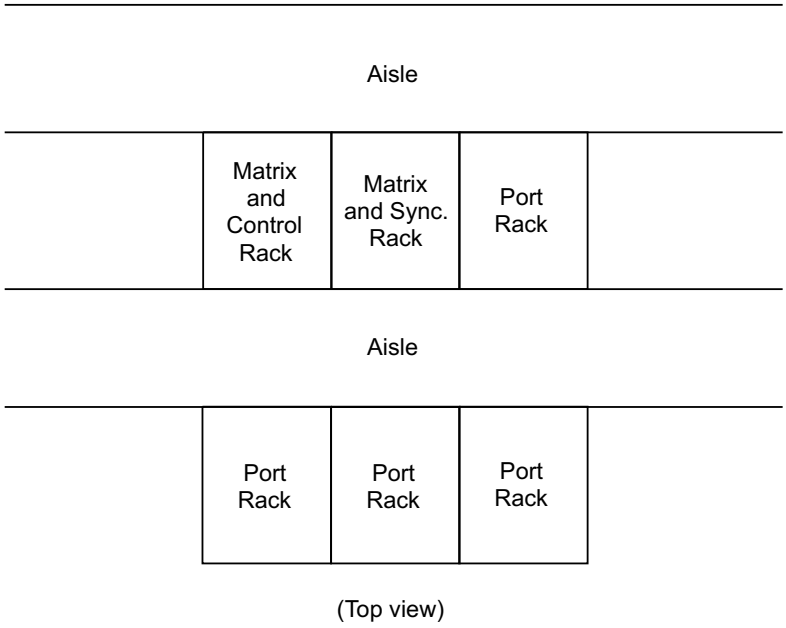

Figure 8-6 Floor Plan for a System with a Noncontiguous Layout

Aisle width

ETSI *Equipment Practices for Station Telephone Equipment* recommends an aisle width of 750 mm.

Rack overhead space

Because most *WaveStar* DACS 4/4/1 equipment racks use convection cooling, it is very important that the equipment room has adequate space for air to exit from the top of the racks. The recommended amount of overhead space is 200 mm. This 200-mm space is measured from the top of a rack to the bottom of an overhead cable tray or to the ceiling (see Figure 8-7). Furthermore, if system cabling is routed overhead, it should be routed straight up through the cable outlets at the top of the racks and into the overhead cable trays.

CAUTION

Cable, or anything else lying on top of the racks, interferes with ventilation and could cause heat induced equipment failures.

Floor loading

The system meets ETSI requirements (ETS 300 119-2 and -3 dated October 1992) for floor loading. The limit for floor loading is 540 kg for racks with a footprint of 600 mm by 600 mm.

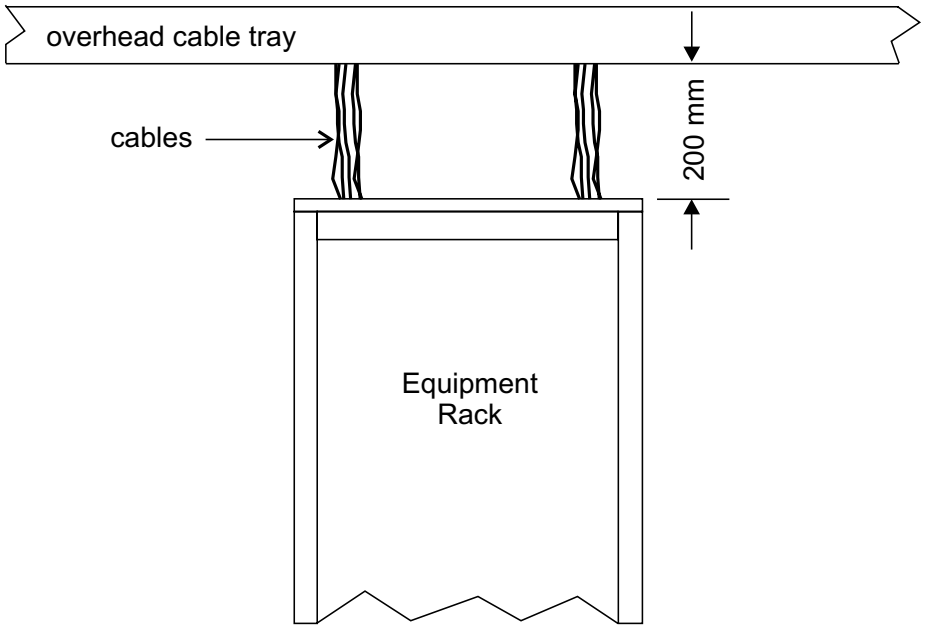

Figure 8-7 Rack Overhead Space

9 Technical Specifications

Purpose This chapter contains technical specifications for the following:

- Transmission interfaces
- Power
- Physical specifications
- Environmental requirements
- Electromagnetic compatibility
- Timing and synchronisation
- Overhead processing.

Transmission interfaces

STM-16 long-haul optical interface

The STM-16 port unit (LAC8) provides long-haul optical transmission at the STM-16 rate. It is designed to ITU-T Recommendation G.957 specifications for STM-16 long-haul optical interfaces (L-16.1). Each STM-16 port unit has one STM-16 port. The STM-16 port unit provides the following capabilities:

- Synchronous Physical Interface (SPI)
- Regenerator Section Termination (RST)
- Multiplex Section Termination (MST)
- Multiplex Section Adaptation (MSA), which includes higher order pointer processing
- Higher order Path Termination (HPT) for VC-4 and VC-3
- Supervisory Unequipped for AU-4 and AU-3
- Higher order Path Monitoring (HPM) for VC-4-4c, VC-4, and VC-3
- Higher order Path Adaptation (HPA)
- Lower order Path Monitoring (LPM) for VC-3 and VC-12
- 2.5 Gbit/s optical transmission
- Non-Return to Zero (NRZ) line coding
- LC optical connectors (LC to SC and LC to FC adaptors are also available)
- Standard mappings that comply with ITU-T Recommendation G.707.

See Table 9-17 for a summary of termination and adaptation functions for the STM-16 long-haul optical interface.

Table 9-1 shows the optical parameters for an STM-16 long-haul optical interface.

Table 9-1 STM-16 Long-Haul Optical Interface Parameters

Description	Value
Bit Rate	2.5 Gbit/s
Format/Code	Scrambled Binary NRZ
Wavelength	1310 (-30, +25) ηm
Bit Error Rate	≤ 1 x 10^{-10} /regenerator section*
Mean launched power (min. - max.)	-2 dBm to +3 dBm
Minimum extinction ratio	8.2 dB

* The specified Bit Error Rate assumes worst-case optical path attenuation and dispersion conditions.

STM-4 short-haul optical interface

The STM-4 port unit (LAC6) provides short-haul optical transmission at the STM-4 rate. It is designed to ITU-T Recommendation G.957 specifications for STM-4 short-haul optical interfaces (S-4.1). Each STM-4 port unit has 4 STM-4 ports. The STM-4 port unit provides the following capabilities:

- Synchronous Physical Interface (SPI)
- Regenerator Section Termination (RST)
- Multiplex Section Termination (MST)
- Multiplex Section Adaptation (MSA), which includes higher order pointer processing
- Higher order Path Termination (HPT) for VC-4 and VC-3
- Supervisory Unequipped for AU-4 and AU-3
- Higher order Path Monitoring (HPM) for VC-4-4c, VC-4, and VC-3
- Higher order Path Adaptation (HPA)
- Lower order Path Monitoring (LPM) for VC-3 and VC-12
- 622.08 Mbit/s optical transmission
- Non-Return to Zero (NRZ) line coding
- LC optical connectors (LC to SC and LC to FC adaptors are also available)
- Standard mappings that comply with ITU-T Recommendation G.707.

See Table 9-17 for a summary of termination and adaptation functions for the STM-4 short-haul optical interface.

Table 9-2 shows the optical parameters for an STM-4 short-haul optical interface.

Table 9-2 STM-4 Short-Haul Optical Interface Parameters

Description	Value
Bit Rate	622.08 Mbit/s
Format/Code	Scrambled Binary NRZ
Wavelength	1310 (-36, +46) ηm
Bit Error Rate	≤ 1 x 10^{-10} /regenerator section*
Mean launched power (min. - max.)	-15 dBm to -8 dBm
Minimum extinction ratio	8.2 dB

* The specified Bit Error Rate assumes worst-case optical path attenuation and dispersion conditions.

STM-1 electrical interface

The STM-1 port unit (LAH201) works with an electrical interface unit (IME1) to provide electrical transmission at the STM-1 rate. The STM-1 port unit and the electrical interface unit are designed to ITU specifications. Each STM-1 port unit has 4 STM-1 ports.

The STM-1 port unit and the electrical interface unit provide the following capabilities:

- Synchronous Physical Interface (SPI)
- Regenerator Section Termination (RST)
- Multiplex Section Termination (MST)
- Multiplex Section Adaptation (MSA), which includes higher order pointer processing
- Higher order Path Termination (HPT) for VC-4 and VC-3
- Higher order Path Monitoring (HPM) for VC-4 and VC-3
- Supervisory Unequipped for AU-4 and AU-3
- Higher order Path Adaptation (HPA)
- Lower order Path Monitoring (LPM) for VC-3 and VC-12
- 155.52 Mbit/s electrical transmission
- Coded Mark Inversion (CMI) line coding
- 75-ohm BNC connectors
- Standard mappings that comply with ITU-T Recommendation G.707.

See Table 9-17 for a summary of termination and adaptation functions for the STM-1 electrical interface.

STM-1 short-haul optical interface

The STM-1 port unit (LAH201) works with an optical interface unit to provide short-haul optical transmission at the STM-1 rate. Each STM-1 port unit has 4 STM-1 ports.

Two short-haul optical interface units are available. One interface unit (IMO5) is designed to ITU-T Recommendation G.957 specifications for STM-1 short-haul optical interfaces (S-1.1). The other interface unit (IMO1) is designed to Nippon Telegraph and Telephone (NTT) specifications.

The STM-1 port unit and the optical interface units provide the following capabilities:

- Synchronous Physical Interface (SPI)
- Regenerator Section Termination (RST)
- Multiplex Section Termination (MST)
- Multiplex Section Adaptation (MSA), which includes higher order pointer processing
- Higher order Path Termination (HPT) for VC-4 and VC-3
- Higher order Path Monitoring (HPM) for VC-4 and VC-3
- Supervisory Unequipped for AU-4 and AU-3
- Higher order Path Adaptation (HPA)
- Lower order Path Monitoring (LPM) for VC-3 and VC-12
- 155.52 Mbit/s optical transmission
- Non-Return to Zero (NRZ) line coding
- SC optical connectors (SC to LC and SC to FC adaptors are also available)
- Standard mappings that comply with ITU-T Recommendation G.707.

See Table 9-17 for a summary of termination and adaptation functions for the STM-1 short-haul optical interface.

Table 9-3 shows the optical parameters for an STM-1 short-haul optical interface designed to ITU specifications.

Table 9-3 STM-1 Short-Haul Optical Interface Parameters — ITU

Description	Value
Bit Rate	155.52 Mbit/s
Format/Code	Scrambled Binary NRZ
Wavelength	1310 (-49, +50) ηm
Bit Error Rate	≤ 1 x 10^{-10} /regenerator section*
Mean launched power (min. - max.)	-15 dBm to -8 dBm
Minimum extinction ratio	8.2 dB

* The specified Bit Error Rate assumes worst-case optical path attenuation and dispersion conditions.

Table 9-4 shows the optical parameters for an STM-1 optical interface designed to NTT specifications.

Table 9-4 STM-1 Short-Haul Optical Interface Parameters — NTT

Description	Value
Bit Rate	155.52 Mbit/s
Format/Code	Scrambled Binary NRZ
Wavelength	1310 (-49, +50) ηm
Transmission Length	0 to 400 m
Cable Type	Single Mode Fibre
Minimum Received Power	≤ -23 dBm
Maximum Received Power	≥ -11 dBm
Bit Error Rate	≤ 1 x 10^{-10} /regenerator section*
Average Optical Output Power	-17 to -11 dBm
Minimum extinction ratio	11 dB

* The specified Bit Error Rate assumes worst-case optical path attenuation and dispersion conditions.

STM-1 long-haul optical interface

The STM-1 port unit (LAH201) works with an optical interface unit (IMO9) to provide long-haul (L-1.2) optical transmission at the STM-1 rate. The STM-1 port unit and the long-haul optical interface unit are designed to ITU-T Recommendation G.957 specifications. Each STM-1 port unit has 4 STM-1 ports.

The STM-1 port unit and the long-haul optical interface unit provide the following capabilities:

- Synchronous Physical Interface (SPI)
- Regenerator Section Termination (RST)
- Multiplex Section Termination (MST)
- Multiplex Section Adaptation (MSA), which includes higher order pointer processing
- Higher order Path Termination (HPT) for VC-4 and VC-3
- Higher order Path Monitoring (HPM) for VC-4 and VC-3
- Supervisory Unequipped for AU-4 and AU-3
- Higher order Path Adaptation (HPA)
- Lower order Path Monitoring (LPM) for VC-3 and VC-12
- 155.52 Mbit/s optical transmission
- Non-Return to Zero (NRZ) line coding
- LC optical connectors (LC to SC and LC to FC adaptors are also available)
- Standard mappings that comply with ITU-T Recommendation G.707.

See Table 9-17 for a summary of termination and adaptation functions for the STM-1 long-haul optical interface.

Table 9-5 shows the optical parameters for an STM-1 long-haul optical interface.

Table 9-5 STM-1 Long-Haul Optical Interface Parameters

Description	Value
Bit Rate	155.52 Mbit/s
Format/Code	Scrambled Binary NRZ
Wavelength	1550 (-70, +30) ηm
Bit Error Rate	≤ 1 x 10^{-10} /regenerator section*
Mean launched power (min. - max.)	-5 dBm to 0 dBm
Minimum extinction ratio	10 dB

* The specified Bit Error Rate assumes worst-case optical path attenuation and dispersion conditions.

SONET compatibility

The SDH transmission interfaces described in this chapter are compatible with the Synchronous Optical Network (SONET) transmission interfaces listed in Table 9-6.

Table 9-6 SDH and SONET Interface Correspondence

SDH Interface	SONET Interface
STM-1 optical	OC-3
STM-4 optical	OC-12
STM-16 optical	OC-48

Table 9-7 lists SDH cross-connect rates that are supported by the system and the corresponding SONET cross-connect rate.

Table 9-7 SDH and SONET Cross-Connect Rate Correspondence

SDH Rate	SONET Rate
AU4-4c	STS-12c
AU-4	STS-3c
AU-3	STS-1
VC-2	VT-6
Not Supported	VT-3
VC-12	VT-2
VC-11	VT-1.5

Power

Input power

The *WaveStar* DACS 4/4/1 operates using -48 volt DC station power. The system can accept power from two separate DC sources. To ensure that power unit protection operates correctly, these two sources must be at potentials that are within the range -40.5 to -57 volts DC.

Wiring

The *WaveStar* DACS 4/4/1 power, ground, and alarm wiring complies with the following standards:

- ETSI ETS 300 253
- ITU-T Recommendation K.27.

Power consumption

Table 9-8 shows the power consumption for fully-equipped racks.

Table 9-8 Power Consumption — Racks

Rack	Typical (Watts at -48V)
Matrix and Synchronisation	413
Matrix and Control	395
Port equipped with two PSA subracks	1065
Port equipped with two PSC subracks	1180

Table 9-9 shows the power consumption for units.

Table 9-9 Power Consumption — Units

Unit	Typical (Watts at -48V)
BSC	26
BSIU	6.5
BSIU128	13
BSSU	53
DTU	13.5
OLU	7.5
PTM	~0
SRC	16.4
STM-1 Port Unit	16
STM-1 Electrical Interface	8.5
STM-1 Optical Interface	4.2
STM-4 Port Unit	45
STM-16 Port Unit	50
STU	16.4

Rack and subrack dimensions

Table 9-10 shows the dimensions of *WaveStar* DACS 4/4/1 racks and subracks. Rack and subrack dimensions comply with European Telecommunications Standards Institute (ETSI) ETS 300 119 part 2.

Table 9-10 Rack and Subrack Dimensions

	Height (mm)	Width (mm)	Depth (mm)
Rack	2200	600	600
Rack	2600	600	600
Subrack	≤ 1000	450	545

Rack and subrack weights

Table 9-11 shows the weights of fully-equipped *WaveStar* DACS 4/4/1 racks and subracks.

Table 9-11 Rack and Subrack Weights

Description	Weight (kg)	Weight (lbs.)
Matrix and Synchronisation Rack	195	429
Matrix and Control Rack	177	389
Port Rack with one PSA Subrack	154	339
Port Rack with two PSA Subracks	208	458
Port Rack with one PSC Subrack	150	330
Port Rack with two PSC Subracks	200	440
PSA Subrack	54	119
PSC Subrack	50	109
Rack Extender Kit (for 2600 mm rack)	4.5	9.95

Environmental characteristics

Operating conditions

The diagram in Figure 9-1 shows the climatic operating limits. The boundaries of the diagram are determined not only by the maximum and minimum temperature and relative humidity, but also by the absolute humidity. The following terms are used in the diagram:

- Normal Operating Conditions — the temperature and humidity limits within which the equipment will operate correctly.
- Exceptional Operating Conditions — the conditions under which the equipment is not guaranteed to operate correctly. Alarm activation errors, connection errors, and signalling errors could occur. However, the equipment will not sustain permanent damage under these conditions. Operation under these conditions should be limited to short periods of time.
- 90 Percent Distribution Limits — these limits identify a range within which the temperature and relative humidity values should remain 90 percent of the time. Compliance will reduce the number of circuit failures.

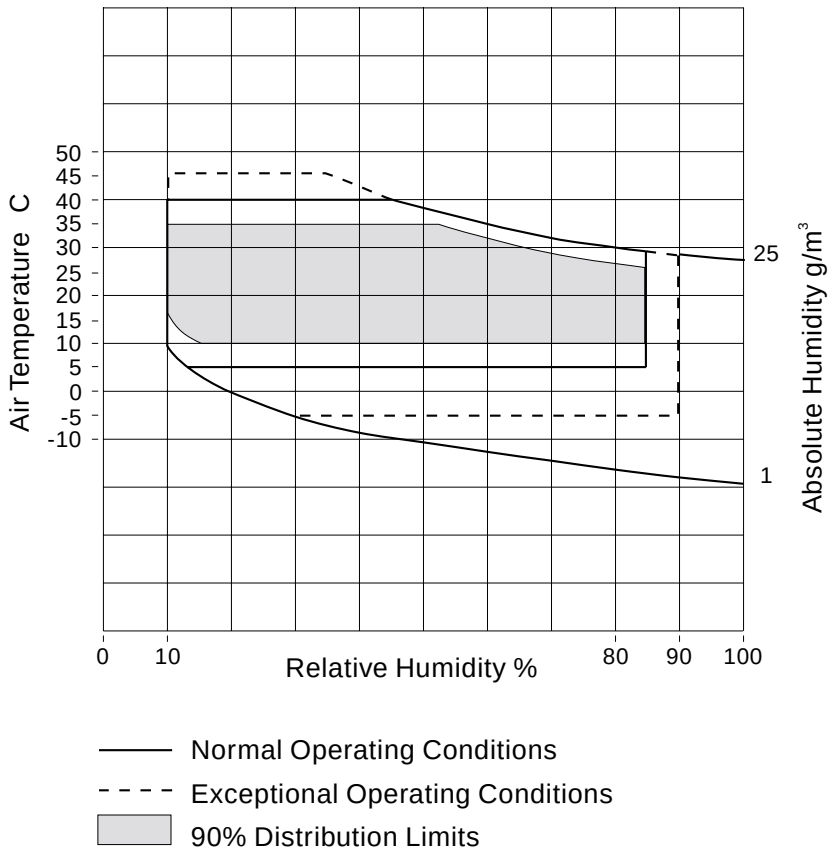

Figure 9-1 Climatic Specifications — Operating Conditions

Storage conditions

WaveStar DACS 4/4/1 will operate after being stored in an environment that is within the tolerances specified in ETSI Storage Class 1.2 (ETS 300 019-1-[0-3]).

Figure 9-2 shows a climatogram for Storage Class 1.2.

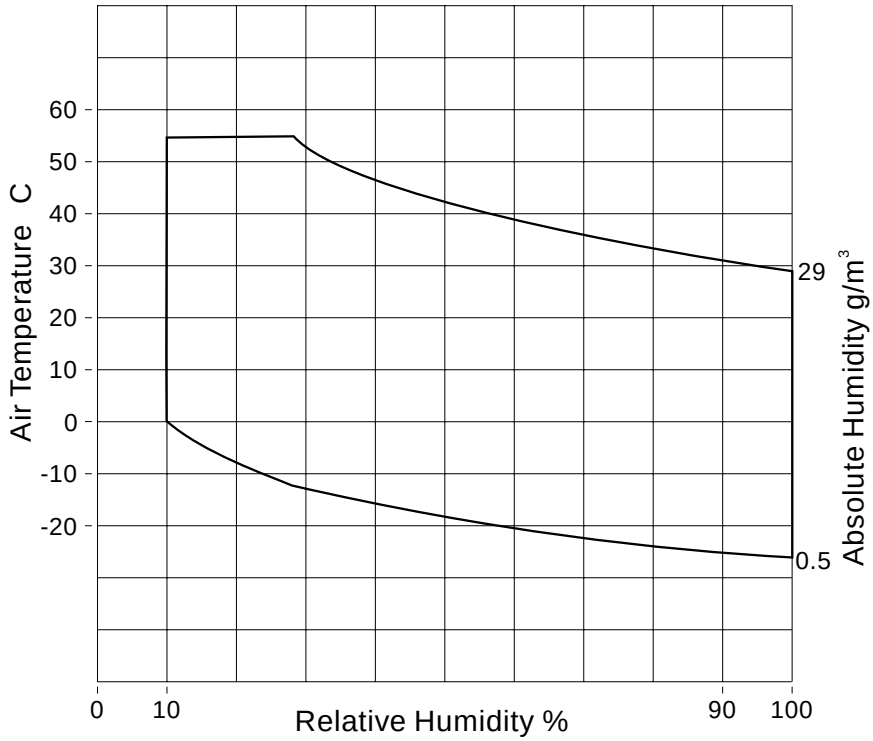

Figure 9-2 Climatic Specifications — Storage Conditions

Transport conditions

WaveStar DACS 4/4/1 will operate after being exposed to an environment that is within the tolerances specified in ETSI Transportation Class 2.3 (ETS 300 019-1-[0-3]).

The system will operate after being transported at altitudes between 3000 metres above sea level and 60 metres below sea level.

System cooling

System cooling conforms to ETSI ETS 300 119-2, section 6.1.

Standards compliance

Electromagnetic compatibility

The *WaveStar* DACS 4/4/1 meets electromagnetic compatibility (EMC) requirements for CE marking, radiated emission, conducted emission, radiated immunity, conducted immunity, and electrostatic discharge.

This requires compliance with the following regulatory requirements:

- European Low Voltage Directive 73/23/EEC

  To meet this directive the product must comply with the following standards:

  – EN60950:1992 including amendments A1:1993, A2:1993, and A3:1995 (Specification for Safety of information technology equipment, including electrical business equipment)

  – EN60825-1:1994 including amendment A11:1996 (Safety of laser products).

- European Union (EU) EMC directive 89/336/EEC and amendment to the EMC directive 92/31/EEC

  To meet the above directives, the equipment must be tested and must comply with the following standards:

  – EN55022:1995 Class A (Limits and methods of measurement of radio disturbance characteristics of information technology equipment)

  – EN50082-1:1992 (Electromagnetic compatibility - Generic immunity standard).

- CE Marking amending directive 93/68/EEC.

CE marking

The system conforms to all requirements necessary to obtain the CE marking.

Radiated emission

The system complies with Class A limits for radiated emission as specified in IEC Publication CISPR 22.

Conducted emission

The system complies with Class A limits for conducted emission as specified in IEC Publication CISPR 22.

Radiated immunity

The system is tested for radiated immunity according to IEC Publication 1000 PT 4-3, with an extended frequency range from 80 MHz to 1000 MHz. The equipment can withstand severity level 2.

Conducted immunity

The system complies with the following standards for conducted immunity:

- For Electrical Fast Transient, the system is tested according to IEC Publication 1000 PT 4-4. The equipment can withstand severity level 4.
- For Continuous Wave, the system complies with IEC Publication 1000 PT 4-6. The equipment can withstand severity level 2.

Electrostatic discharge

The system complies with IEC Publication 1000 PT 4-2 for the following electrostatic discharge (ESD) requirements:

- With EMC boundary intact (rack doors closed), for direct and indirect ESD, the system complies with severity levels 1 through 4.
- With EMC boundary not intact (rack doors open), for direct ESD, the system complies with a 500 Volt level contact discharge. This applies to the subrack frame, door edges, inner door surfaces, faceplates, latches, LEDs, and switches. It does not apply to midplane/backplane or components on units. For indirect ESD, the system complies with severity level 1.

Units are designed to minimise the risk of electrostatic shock when removed from the equipment, provided that normal electrostatic handling precautions are taken. Before touching a unit (circuit pack), connect an anti-static wrist strap to the ESD jack located on the subrack mounting bracket.

User safety

WaveStar DACS 4/4/1 meets the requirements for user safety as stated in IEC Publications 825 and 950.

Under normal operating conditions with the rack doors closed, all parts of the equipment that carry voltages greater than 42 volts DC are protected against direct touching as defined in IEC Publication 950.

The temperature rise of touchable parts complies with IEC Publication 950.

WaveStar DACS 4/4/1 is a class 1 laser product. According to IEC Publication 825, no laser shutdown facilities are required for class 1 lasers. However, maintenance personnel should be careful when disconnecting optical-fibre cables from optical interface units, because invisible laser radiation may be emitted.

WaveStar DACS 4/4/1 has an automatic laser shutdown capability. The system can be provisioned to automatically shuts down the laser in an STM-16 or STM-4 port unit as soon as the system detects an interruption in the optical signal.

Fire resistance

The system design conforms to the fire resistance criteria stated in EN 60950 (IEC Publication 950) and IEC Publication 332.

Earthquake protection

The system complies with Bellcore Network Equipment-Building Systems (NEBS) Earthquake Risk Zone 4 criteria, and complies with Pacific Bell static testing specifications.

Robustness

All in-station electrical interfaces meet the overvoltage protection requirement of ITU-T Recommendation G.703, Annex B. The test voltage is 100 volts.

Insertion or removal of any unit does not damage the unit or any other unit. Insertion or removal of any unit other than the active System Timing Unit affects only traffic carried by that unit.

OAM&P PC requirements

Operations, Administration, Maintenance, and Provisioning (OAM&P) activities can be performed from a local or remote personal computer running the XC-CIT application software, or from an element management system such as Lucent Technologies' ITM-SC.

The following are the minimum requirements for a personal computer used for local or remote access to OAM&P capabilities:

- *Microsoft Windows NT* [1] 4.0 or later operating system with Service Pack 4
- Pentium III 600 MHz/512 K cache processor
- 19-inch colour monitor
- 256 Mbytes ECC, EDO DIMM, SDRAM
- 13.5 Gbyte hard disk, IDE or SCSI
- 32x CD-ROM drive, IDE
- 1.44 Mbyte diskette drive
- 16-bit sound card
- Matrox Millennium 2D or equivalent graphics card
- Network controller capable of operating in a 10Base-T, 10Base 2, or 100Base-TX environment
- Interfaces: 2 serial, 1 parallel, 1 keyboard, 1 mouse, 1 microphone, 1 headphone
- A modem is required if the PC will be used for a remote dial-up connection
- Optional: *Microsoft Office 97* [2] or higher if you want to modify reports.

The memory specified above (256 Mbytes) is for optimal performance for one or two XC-CIT applications running on a PC concurrently with other applications open. If you will be running more than two XC-CIT applications on a single PC, the memory should be increased by 32 Mbytes per additional XC-CIT application.

1 Microsoft and Windows NT are trademarks or registered trademarks of Microsoft Corporation.

2 Microsoft and Office 97 are trademarks or registered trademarks of Microsoft Corporation.

Synchronisation and timing

General

WaveStar DACS 4/4/1 has an ITU-T G.812 Type I clock with holdover mode and duplicated synchronisation and timing hardware. The pull-in and pull-out range for the system clock is ± 5.0 ppm. As many as four prioritised timing references can be provisioned. System timing can be derived from any transmission port including ports provisioned for MSP, or from a 2048 kHz or 64 kHz clock source. The system also provides two timing output ports that can be used as a timing source for other equipment. The timing output signal complies with ITU-T Recommendation G.703.

Jitter and wander performance

WaveStar DACS 4/4/1 complies with ITU-T Recommendations G.783 and G.825 for jitter and wander performance.

Protection and redundancy

Every *WaveStar* DACS 4/4/1 has 2:8 protection for the cross-connect matrix and internal transmission paths and duplicated matrix control and synchronisation and timing hardware.

The following optional protection features are available:

- Duplicated Main Controller
- 1+1 MSP for all transmission interfaces
- SNCP for all transmission interfaces
- 1:8 equipment protection for STM-1 electrical interfaces.

Overhead processing

All unused, undefined, and national use bytes except for the unscrambled bytes in the first row of the section overhead are generated as all ones. The unscrambled bytes in the first row of the section overhead are generated as a suitable bit pattern to ensure one's density. None of the unused, undefined, and national use bytes are processed in the receive direction.

Table 9-12 lists the section overhead bytes that are supported by *WaveStar* DACS 4/4/1.

Table 9-12 Section Overhead

Byte	Description	STM-1E STM-1O ITU STM-1O NTT	STM-16 STM-4
A1, A2	Framing	Yes	Yes
J0	RS Trace	Not precluded*	Not precluded
B1	RS BIP	Yes	Yes
E1	Orderwire	No	Yes
F1	User channel	No	Yes
D1-D3	RS DCC	No	Not precluded
B2	MS BIP	Yes	Yes
K1, K2	APS	Yes	Yes
K2	MS AIS	Yes	Yes
K2	MS RDI	Yes	Yes
D4-D12	DCC	No	Not precluded
S1	Sync. status	Not precluded	Not precluded
M1	MS REI	Yes	Yes
E2	Orderwire	No	Yes

* Not precluded means that this capability is not available is this release, but the system has been designed so that the capability could be added in a future release.

Table 9-13 lists the overhead bytes for monitored VC-4-4c, VC-4 as AU-4, and VC-3 as AU-3 signals.

Table 9-13 VC-4-4c, VC-4, and VC-3 Overhead Bytes for Monitored Paths

Byte	Description	STM-16 STM-4 STM-1E STM-1O ITU STM-1O NTT
J1	VC Path Trace	Yes
B3	VC BIP	Yes
C2	VC Signal Label	Yes
G1	VC Path Status	Yes
F2	User channel	No
H4	Multiframe Indication	No
F3	User channel	No
K3	APS (b1-b4)	Not precluded*
N1	TCM	Not precluded

* Not precluded means that this capability is not available is this release, but the system has been designed so that the capability could be added in a future release.

Table 9-14 lists the VC-4-4c, VC-4, and VC-3 overhead bytes for Higher-order Supervisory Unequipped Signal (HSUT).

Table 9-14 VC-4-4c, VC-4, and VC-3 Overhead Bytes for Higher-Order Supervisory Unequipped Signal (HSUT)

Byte	Description	STM-1E STM-1O ITU STM-1O NTT	STM-16 STM-4
J1	VC Path Trace	Yes	Yes
B3	VC BIP	Yes	Yes
C2	VC Signal Label	Yes	Yes
G1	VC Path Status	Yes	Yes
F2	User channel	No	No
H4	Multiframe Indication	No	No
F3	User channel	No	No
K3	APS (b1-b4)	Not precluded*	Not precluded
N1	TCM	Not precluded	Not precluded

* Not precluded means that this capability is not available is this release, but the system has been designed so that the capability could be added in a future release.

Table 9-15 lists the overhead bytes for monitored VC-3 as TU-3 signals.

Table 9-15 VC-3 as TU-3 Overhead Bytes for Monitored Paths

Byte	Description	STM-16 STM-4 STM-1E STM-1O ITU STM-1O NTT
J1	VC Path Trace	Yes
B3	VC BIP	Yes
C2	VC Signal Label	Yes
G1	VC Path Status	Yes
F2	User channel	No
H4	Multiframe Indication	No
F3	User channel	No
K3	APS (b1-b4)	Not precluded*
N1	TCM	Not precluded

* Not precluded means that this capability is not available is this release, but the system has been designed so that the capability could be added in a future release.

Table 9-16 lists the overhead bytes for monitored VC-12 signals.

Table 9-16 VC-12 Overhead Bytes for Monitored Paths

Byte	Description	STM-16 STM-4 STM-1E STM-1O ITU STM-1O NTT
V5	VC Signal Label	Yes
V5	VC Path Status	Yes
V5	VC BIP	Yes
J2	VC Path Trace	Yes
N2	TCM	Not precluded*
K4	b1-b4	Not precluded

* Not precluded means that this capability is not available is this release, but the system has been designed so that the capability could be added in a future release.

Termination and adaptation functions

Table 9-17 summarises the termination and adaptation functions for the available transmission interfaces.

Table 9-17 Summary of Termination and Adaptation Functions

Function	Interface
	STM-16 STM-4 STM-1E STM-1O ITU STM-1O NTT
Regenerator Section (RS) Termination (STMn)	Yes
Multiplex Section (MS) Termination (STMn)	Yes
MS Adaptation (VC-4 as AU-4-STMn)	Yes
MS Adaptation (VC-3 as AU-3-STMn)	Yes
Higher-order Supervisory Unequipped (HSU) Termination (VC-4)	Yes
HSU Termination (VC-3 as AU-3)	Yes
Higher-order Path (HP) Overhead Monitor (VC-4)	Yes
HP Overhead Monitor (VC-3 as AU-3)	Yes
HP Termination (VC-4)	Yes
HP Adaptation (TU3-TUG3-VC4)	Yes
HP Adaptation (TU12-TUG2-TUG3-VC4)	Yes
Lower-order Path (LP) Overhead Monitor (VC-3)	Yes
LP Overhead Monitor (VC-12)	Yes

Supervision and alarms

Plug-in units

Transmission units show failures as follows:

- LED continuously lit indicates an equipment failure or high-temperature condition
- LED flashing indicates a transmission-signal failure.

User Panel

The User Panel LEDs indicate the following conditions:

- Power failure
- Prompt alarm
- Deferred alarm
- Information alarm
- Station alarms are suppressed
- Station alarms are disconnected.

10 Quality and Reliability

Overview

At best, facility outages are expensive and inconvenient; at worst, they can be catastrophic for network providers and their customers. Fortunately, the *WaveStar* DACS 4/4/1 contains the latest digital circuitry — circuitry known for its high quality and reliability. *WaveStar* DACS 4/4/1 reliability is further enhanced by redundant components incorporated into the hardware architecture. Should problems arise, the *WaveStar* DACS 4/4/1 generates alarm messages to alert maintenance personnel that a problem has been detected, and lights LEDs on failed units. Redundant and reliable system components plus the alarm strategy ensure an extremely low number of service outages.

Fault-tolerant design

Every *WaveStar* DACS 4/4/1 has 2:8 protection of the cross-connect matrix and internal transmission paths and duplicated matrix control and synchronisation and timing hardware. The matrix and internal transmission paths consist of ten sets of components; eight working sets and two protection sets. Service is not affected even if two equipment failures occur before repairs can be made.

The following optional protection features can further reduce the chance of service interruption:

- Duplicated Main Controller
- 1+1 MSP for all transmission interfaces
- SNCP for all transmission interfaces
- 1:8 equipment protection for STM-1 electrical interfaces.

Reliability

The overall system reliability varies as a function of system configuration, interface mix, and protection options. The amount of time that a transmission interface is unavailable increases as the number of unprotected interfaces increases. With protected equipment or interfaces,

a primary failure causes a protection switch rather than a service outage. If the primary failure is repaired before a secondary failure occurs, there is no service outage.

The likelihood of a connection-affecting failure can be kept at a very low level by using the protection-switching arrangements available with *WaveStar* DACS 4/4/1. The average outage due to double failures (a secondary failure occurs before the primary failure is repaired) can be reduced with maintenance procedures that keep the mean time to repair to a minimum. The mean time to repair starts when a primary failure occurs and ends when the primary failure is repaired.

The system reliability data in this section are derived according to AT&T Reliability Information Notebook version 6. The Failure In Time (FIT) data comes from the Merrimack Valley FIT-95 database and other sources and estimates.

The system reliability data in this section is the most recent data available at the time of printing. Your account representative may have more recent or more complete reliability data.

Unit reliability

Table 10-1 lists Failure In Time (FIT) and Mean Time Between Failure (MTBF) data for *WaveStar* DACS 4/4/1 units. One FIT is equal to one failure in 10^9 hours of operation. An equipment room air temperature of 25 degrees Centigrade, an air temperature between units of 40 degrees Centigrade, and a Mean Time To Repair of 2 hours were used for all calculations. Because many units operate in an environment that has an air temperature less than 40 degrees Centigrade, the FIT numbers are conservative.

Table 10-1 Unit Reliability

Unit	Code	FITs	MTBF (hours)	MTBF (years)
Generic Units				
PTM	IME1	284	3,521,127	401.7
SRC	LAH49	3,154	317,058	36.2

Table 10-1 Unit Reliability (Contd)

Unit	Code	FITs	MTBF (hours)	MTBF (years)
Main Controller Subrack				
MPU		5,263	190,000	21.7
MSU		21,000	47,619	5.4
LHU	LAA45	1,520	657,895	75.1
ARU		505	1,980,198	225.9
NIC TM		301	3,322,259	379.0
Serial TM		85	11,764,706	1342.1
SCSI TM		35	28,571,429	3,259.3
PSP (Power Supply)		10,000	100,000	11.4
Fans		25,642	38,999	4.4
Matrix and Synchronisation Subrack				
BSC256 (upgrade only)	LAH101	2,872	348,189	39.7
BSC512	LAH107	3057	327,164	37.3
STU (2 MHz station clock)	LAH102	4,130	242,131	27.6
STU (64 KHz station clock)	LAH103	4,130	242,131	27.6
OLU	IMO4	1,473	678,887	77.4
BSSU256 (upgrade only)	LAC4	6,780	147,493	16.8
BSSU512	LAC5	3,929	254,518	29.0
Port Subrack				
BSIU	IMO3	1,388	720,461	82.2
BSIU128	LAL65	2,602	384,320	43.8
DTU	LAH100	4,130	242,131	27.6
STM-1 Port Unit	LAH201	3,854	259,471	29.6
STM-1 Electrical Interface Unit	IME1	245	4,081,633	465.6
STM-1 Optical Interface Unit (NTT)	IMO1	416	2,403,846	274.2
STM-1 Short-Haul Optical Interface Unit (ITU)	IMO5	416	2,403,846	274.2
STM-4 Port Unit	LAC6	5,196	192,456	22.0
STM-16 Port Unit	LAC8B	4,892	204,415	23.3

Matrix unavailability

Table 10-2 shows matrix unavailability calculations for the *WaveStar* DACS 4/4/1. The calculations are based on a triple slice failure. A 2-hour Mean Time To Repair was used for all calculations.

Table 10-2 Matrix Unavailability

	Matrix Unavailability (Seconds per year)
One connection at 64 ports	0.000004
Any connection at 64 ports	0.000004
One connection at 512 ports	0.000181
Any connection at 512 ports	0.000090

Full unavailability

Table 10-3 shows full unavailability calculations for the *WaveStar* DACS 4/4/1. The calculations are based on other failures, such as a double STU failure, that can cause full unavailability. A 2-hour Mean Time To Repair was used for all calculations.

Table 10-3 Full Unavailability

	Full Unavailability (Seconds per year)
One connection at 64 ports	0.022276
Any connection at 64 ports	0.022276
One connection at 512 ports	0.020300
Any connection at 512 ports	0.020210

Port unavailability

Table 10-4 shows port unavailability calculations for the *WaveStar* DACS 4/4/1. The calculations are based on all port subrack failures except a double DTU failure for a 64-port configuration. A double DTU failure is included in the full unavailability numbers for a 64-port configuration (Table 10-3). A 2-hour Mean Time To Repair was used for all calculations.

Table 10-4 Port Unavailability

		Port Unavailability (Seconds per year)
STM-1 Optical with MSP	One connection at 64 ports	0.0058
	One connection at 512 ports	0.0101
	Any connection at 64 ports	0.0231
	Any connection at 512 ports	0.1010
STM-1 Electrical with 1:8 equipment protection	One connection at 64 ports	14.5478
	One connection at 512 ports	14.5521
	Any connection at 64 ports	247.4602
	Any connection at 512 ports	989.8494

Total unavailability

Table 10-5 shows total unavailability calculations for the *WaveStar* DACS 4/4/1. The calculations include all components of outage in the matrix and port subracks, and represent the actual connection availability for the *WaveStar* DACS 4/4/1. A 2-hour Mean Time To Repair was used for all calculations.

Table 10-5 Total Unavailability

		Port Unavailability (Seconds per year)
STM-1 Optical with MSP	One connection at 64 ports	0.0281
	One connection at 512 ports	0.0304
	Any connection at 64 ports	0.0454
	Any connection at 512 ports	0.1212
STM-1 Electrical with 1:8 equipment protection	One connection at 64 ports	14.5701
	One connection at 512 ports	14.5724
	Any connection at 64 ports	247.4825
	Any connection at 512 ports	989.8696

11 Product Support

Introduction

Product support is an important part of the total product offering. Lucent Technologies offers services for the planning, implementation, and operation of networks that use our SDH products. Network planning services include network planning and design, as well as, economic and technical support. Product implementation services include: site surveys, engineering, installation and testing, acceptance support, database preparation, and project management. Operations services such as field support, repair and exchange services, product introduction services, and emergency recovery services can also be provided.

Lucent Technologies also offers comprehensive product training courses and documentation.

Training

Contact the Customer Training and Information Products organisation at 1-888-LUCENT8 (1-888-582-3688) for course information or to enroll in training courses. The following *WaveStar* DACS 4/4/1 courses are available:

- DG3204 — *WaveStar* DACS 4/4/1 Overview
- TR3562 — *WaveStar* DACS 4/4/1 Administration, Provisioning, and Maintenance.

The following related courses are available:

- TR5951 — Synchronous Digital Hierarchy (SDH) Introduction
- TR9204 — SDH Transmission Products Overview
- TR3630 — Integrated Transport Management - Network Module/ Cross-Connect Module (ITM-NM/XM).

Product documents

The following *WaveStar* DACS 4/4/1 documents are available:

Document Number	Title
365-367-500	*WaveStar* DACS 4/4/1 Application and Planning Guide
365-367-512	*WaveStar* DACS 4/4/1 Provisioning Guide
365-367-513	*WaveStar* DACS 4/4/1 Administration and Maintenance Guide
365-367-503	*WaveStar* DACS 4/4/1 Quick Reference Guide

If you would like more information, please contact your Lucent Technologies representative.

How to order documentation

The ordering number for this document is 365-367-500. To order by mail, write to:

Lucent Technologies Customer Information Center
Attention: Order Entry Section
2855 N. Franklin Road
P.O. Box 19901
Indianapolis, Indiana, U.S.A. 46219

Place telephone orders Monday through Friday. To order by telephone, call:

From the U.S.A.: 1-888-582-3688
FAX: +1-800-566-9568

From outside the U.S.A.: +1-317-322-6416
FAX: +1-317-322-6699

A check, money order, purchase order number, or charge number *VISA*[1] bank card, *American Express*[2] card services, or *MasterCard*[3] bank card is required with all orders. Make checks payable to Lucent Technologies.

1 *VISA* is a registered trademark of VISA International Service Association.
2 *American Express* is a registered trademark of American Express Company.
3 *Mastercard* is a registered trademark of Mastercard International Incorporated.

A Differences Between NTT MSP and ITU MSP

Purpose This appendix describes the differences between Nippon Telegraph and Telephone (NTT) 1+1 Multiplex Section Trail Protection (MSP) and International Telecommunications Union (ITU) MSP. The differences are as follows:

- NTT MSP is bidirectional, and switching is nonrevertive. ITU MSP is unidirectional or bidirectional, and switching is nonrevertive.
- NTT MSP may have either the working or protection line as the preferred line. The ITU MSP protocol is designed with a tendency to keep service on the working line — always treating the working line as the preferred line.
- NTT MSP lockout is not reflected in transmitted K bytes (K1 and K2). ITU MSP transmits and acknowledges a lockout condition using the K bytes.
- The NTT MSP protocol transmits K bytes on both the working and protection lines and, depending on the state of the lines, receives K bytes from either line. Line status and protocol state determine the line on which the K bytes will be received and interpreted. ITU MSP never interprets K bytes received on the working line.
- The NTT MSP protocol waits 1 second for an acknowledgment from the far end before giving up on a manual protection-switch request. ITU MSP waits for 2.5 seconds.
- For NTT MSP, the failure of protocol alarm (MScFOP) is not declared for an acknowledgment time-out, but *is* declared if the K1 and K2 channel numbers are incorrect, the request is invalid, or if bit 5 in the K2 byte is not 0. For ITU MSP, the failure of protocol alarm is raised for an acknowledgment time-out, incorrect channel number, invalid request, or if bit 5 in the K2 byte is not 0.

- NTT MSP supports only forced switch operations. ITU MSP supports both forced switch and manual switch operations.
- The NTT and ITU MSP protocols have several differences in K-byte format including the following:
  - Different channel numbering schemes
  - NTT MSP does not use the K2 channel number as an acknowledgment, ITU MSP does
  - NTT MSP does not use the DNR (Do Not Revert) request, ITU MSP does.

B Performance Monitoring Parameters

Purpose

This appendix describes and lists performance monitoring parameters.

The following performance monitoring (PM) terms appear in this appendix.

- **Parameter** — the output of the PM calculation process; for example, Near End Errored Seconds.
- **Trail** — the transmission path between two path termination points.
- **Near End** — the error or degraded performance was detected at the local network element, which is the near end of the transmission path.
- **Far End** — the error or degraded performance was detected at a remote network element, which is the far end of the transmission path.
- **Background Block Error** — the number of errored blocks that were detected.
- **Estimator** — a value that is used in the PM calculation process. It is the error rate (errored blocks/second) at which the errored seconds become severely-errored seconds.
- **Errored Second** — the number of one-second intervals in which *one or more* errored blocks occur.
- **Severely-Errored Second** — the number of one-second intervals in which the number of errored blocks *equals or exceeds* the estimator value.
- **Unavailable Second** — the number of one-second intervals in which PM data is unavailable due to a prolonged severely-errored condition. The Unavailable Second count begins when ten or more consecutive Severely-Errored Second (SES) intervals are detected;

these SES intervals are counted as an Unavailable Second. The Unavailable Second count stops when ten or more consecutive non-SESs are detected. All other counts stop during an Unavailable Second.

Table B-1 lists the PM parameters for VC-4-4c, VC-4, and VC-3 trails and the range of Threshold Crossing Alert (TCA) values for 15-minute and 24-hour counts.

Table B-1 Performance Monitoring Parameters for VC-4-4c, VC-4, and VC-3 Trails

Trail Type	Parameter	15-Minute TCA Range	24-Hour TCA Range
VC-4-4c, VC-4, VC-3	**Near End Thresholds**		
	Background Block Error	1 - 7,200,000	1 - 691,200,000
	Errored Second	1 - 900	1 - 86,400
	Severely-Errored Second	1 - 900	1 - 86,400
	Unavailable Second	1 - 900	1 - 86,400
	Far End Thresholds		
	Background Block Error	1 - 7,200,000	1 - 691,200,000
	Errored Second	1 - 900	1 - 86,400
	Severely-Errored Second	1 - 900	1 - 86,400
	Unavailable Second	1 - 900	1 - 86,400

Table B-2 lists the PM parameters for VC-12 trails and the range of Threshold Crossing Alert (TCA) values for 15-minute and 24-hour counts.

Table B-2 Performance Monitoring Parameters for VC-12 Trails

Trail Type	Parameter	15-Minute TCA Range	24-Hour TCA Range
VC-12	**Near End Thresholds**		
	Background Block Error	1 - 1,800,000	1 - 172,800,000
	Errored Second	1 - 900	1 - 86,400
	Severely-Errored Second	1 - 900	1 - 86,400
	Unavailable Second	1 - 900	1 - 86,400
	Far End Thresholds		
	Background Block Error	1 - 1,800,000	1 - 172,800,000
	Errored Second	1 - 900	1 - 86,400
	Severely-Errored Second	1 - 900	1 - 86,400
	Unavailable Second	1 - 900	1 - 86,400

Table B-3 lists the PM parameters for RS trails and the range of TCA values for 15-minute and 24-hour counts.

Table B-3 Performance Monitoring Parameters for RS Trails

Trail Type	Parameter	15-Minute TCA Range	24-Hour TCA Range
RS	**Near End Thresholds**		
	Background Block Error	1 - 7,200,000	1 - 691,200,000
	Errored Second	1 - 900	1 - 86,400
	Severely-Errored Second	1 - 900	1 - 86,400
	Unavailable Second	1 - 900	1 - 86,400

Table B-4 lists the PM parameters for MS trails and the range of TCA values for 15-minute and 24-hour counts.

Table B-4 Performance Monitoring Parameters for MS Trails

Trail Type	Parameter	15-Minute TCA Range	24-Hour TCA Range
MS1 (STM-1)	**Near End Thresholds**		
	Background Block Error	1 - 2,160,000	1 - 207,360,000
	Errored Second	1 - 900	1 - 86,400
	Severely-Errored Second	1 - 900	1 - 86,400
	Unavailable Second	1 - 900	1 - 86,400
	Far End Thresholds		
	Background Block Error	1 - 2,160,000	1 - 207,360,000
	Errored Second	1 - 900	1 - 86,400
	Severely-Errored Second	1 - 900	1 - 86,400
	Unavailable Second	1 - 900	1 - 86,400
MS4 (STM-4)	**Near End Thresholds**		
	Background Block Error	1 - 86,400,000	1 - 8,294,400,000
	Errored Second	1 - 900	1 - 86,400
	Severely-Errored Second	1 - 900	1 - 86,400
	Unavailable Second	1 - 900	1 - 86,400
	Far End Thresholds		
	Background Block Error	1 - 86,400,000	1 - 8,294,400,000
	Errored Second	1 - 900	1 - 86,400
	Severely-Errored Second	1 - 900	1 - 86,400
	Unavailable Second	1 - 900	1 - 86,400

Table B-4 Performance Monitoring Parameters for MS Trails (Contd)

Trail Type	Parameter	15-Minute TCA Range	24-Hour TCA Range
MS16 (STM-16)	**Near End Thresholds**		
	Background Block Error	1 - 345,600,000	1 - 33,177,600,000
	Errored Second	1 - 900	1 - 86,400
	Severely-Errored Second	1 - 900	1 - 86,400
	Unavailable Second	1 - 900	1 - 86,400
	Far End Thresholds		
	Background Block Error	1 - 345,600,000	1 - 33,177,600,000
	Errored Second	1 - 900	1 - 86,400
	Severely-Errored Second	1 - 900	1 - 86,400
	Unavailable Second	1 - 900	1 - 86,400

Glossary

A

Abnormal alarm

Abnormal alarm is a yellow LED located on the User Panel that indicates that self tests, manual tests, or maintenance operations are in progress. For example, a user manually switching the timing to holdover mode will cause an abnormal alarm. This feature is not yet available.

Active

When an entity is duplicated, one of the duplicated entities (the active entity) is currently providing service, while the other is in standby. Either the working or protection entity could be active at any time.

Active and standby

These terms refer to the operational states of entities that are part of a protection group. An active entity is one that is currently providing service; a standby entity substitutes for an active entity if necessary.

Administrative Unit

An Administrative Unit (AU) is the information structure that provides adaptation between the higher order path layer and the Multiplex Section layer. The AU consists of a higher order Virtual Container information payload and an AU pointer. The AU pointer indicates the offset of the payload frame start relative to the Multiplex Section frame start. An AU-4 consists of a VC-4 plus an AU pointer. An AU-3 consists of a VC-3 plus an AU pointer.

Administrative Unit Group

An Administrative Unit Group (AUG) consists of one or more byte-interleaved AUs. For an STM-1, an AUG can be either a single AU-4 or three byte-interleaved AU-3s.

AIS

The Alarm Indication Signal (AIS) is a signal that is sent downstream to indicate that an upstream failure has been detected and alarmed. AIS is transmitted by the Network Element that detected the failure to prevent downstream failures being declared and alarms being raised.

Alarm delay
Alarm delay is the amount of time the system waits after a failure occurs before activating an alarm.

Alarm indicator
An alarm indicator is a visual or audible indication that an alarm is active. One example of an alarm indicator is the red LED on a unit. The red LED lights if a unit fails.

AU
See Administrative Unit.

AU-3
An AU-3 (Administrative Unit 3) consists of a VC-3 (Virtual Container 3) plus an AU pointer.

AU-4
An AU4 (Administrative Unit 4) consists of a VC-4 (Virtual Container 4) plus an AU pointer.

AU-4-4c
An AU-4-4c (Administrative Unit 4-4c) consists of four concatenated AU-4s. Concatenated means linked together in a series.

AUG
See Administrative Unit Group.

Auto-provisioning
Auto-provisioning is the system's ability to automatically provision equipment.

Autonomous
An autonomous action is initiated by the system without direction by a user.

Autonomous messages
Autonomous messages are messages generated automatically by the system.

B Background Block Errors

Background Block Errors (BBEs) are the number of Errored Blocks that were detected. A block is a set of consecutive bits associated with the path; each bit belongs to only one block. An Errored Block is a block in which one or more bits are in error.

Backup
Backup refers to the duplicate hardware, software, or data that can be used in case of failure or when the primary system is unavailable.

Bridge cross connect
A bridge cross connect is a unidirectional cross connect that can be added to an existing unidirectional or bidirectional cross connect. One direction of a signal is bridged to another port while the original cross connect is left untouched. Typically, bridge cross connects are used to monitor signals or to prepare for a roll.

C

Circuit pack
See Unit.

CIT
Craft Interface Terminal. A computer terminal used for provisioning and maintenance activities.

Controller
Controller is another name for the SRC and MPU units. Controllers administer the units on their respective subracks.

Cross connects
Cross connects are the hardware and software used to connect line-terminating equipment, multiplexers, and other equipment.

D

Default
A default is a value the system automatically provides if the user does not specify a value.

Defect
A defect is a fault that interrupts a specific function. A defect does not affect the performance of a function. See Failure.

Deferred
An alarm category or severity. An alarm classified as Deferred indicates one, or both, of the following:

- *A performance-degrading condition exists, but the condition does not affect service*
- *A change over to standby equipment has been used to restore service.*

Maintenance personnel must take immediate action, but they must resolve any Prompt alarms first.

Degradation
Degradation pertains to the reduced service level available from a computer system when one or more of its component parts is unavailable due to malfunction or maintenance.

Diagnostic test
Tests the internal hardware on a unit.

Downstream

The downstream signal points at or towards the destination of the transmission stream. In other words, the downstream signal looks in the direction of transmission.

DTU

The Digital Timing Unit (DTU) provides the timing reference for transmission interfaces. Each port subrack has both a working and a protection DTU.

E Electrostatic Discharge

Electrostatic Discharge (ESD) is the sudden release of the charge associated with static electricity. Static charge is generated whenever two materials come into contact with each other and are then separated.

Entity

Entity is a term used to generically refer to a piece of equipment or to a signal.

Errored Seconds

Errored Seconds (ES) refers to the number of one-second periods in which one or more Errored Blocks occur.

Estimator value

The estimator value is a value that is used in the performance-monitoring calculation process. The estimator value is the error rate, Errored Blocks per second, at which the Errored Seconds become Severely-Errored Seconds.

ETSI

The European Telecommunications Standards Institute (ETSI) is a committee designed to provide inter-vendor and inter-operator compatibility of SDH equipment.

F Failure

A failure is a defect that has persisted long enough to be considered a permanent condition. A failure can affect the performance of a specific function.

Far end

Far end refers to the *remote* network element. For performance monitoring, the system collects performance-monitoring data on the local network element from anomalies detected in the incoming signal by the remote (far-end) network element.

Free-running mode

The system operates in free-running mode when it is initially put into service. In free-running mode, the system timing is provided by the internal clock. After the system has been phaselocked to a timing reference, the system will not return to free-running mode.

G **G.xxx**

G.xxx refers to ITU Standards documents.

Grooming

The process of adding, dropping, and switching payloads among network facilities to improve the fill. When properly done, grooming minimises spare capacity on network facilities.

H **Holdover mode**

Holdover mode is a backup operational mode that the system enters automatically if all provisioned timing references have failed. In holdover mode, the internal system clock simulates the timing that occurred during a previous period in freerunning mode or phaselocked mode. An alarm is raised whenever the system enters holdover mode.

I **Information**

An alarm category or severity. An alarm classified as Information means that the alarm requires no immediate action. Maintenance personnel can perform the required actions on a scheduled basis or after an accumulation of maintenance events. Information alarms are indicated only on the User Panel.

International Telecommunications Union — Transmission

The International Telecommunications Union — Transmission (ITU) is an international consultative committee that studies technical, operating, and tariff questions and issues recommendations on them with a view to standardising telecommmunications on a worldwide basis. The ITU was formerly called the Consultative Committee for International Telegraph and Telephone (CCITT).

ITM-SC

Integrated Transport Management system - Subnetwork Controller is an element manager for ISM, SLM, *WaveStar* ADM 16/1, *WaveStar* ADM 4/1, and *WaveStar* DACS 4/4/1.

ITU MSP

ITU MSP provides 1+1 nonrevertive switching for STM-16, STM-4, and STM-1 optical interfaces, and for STM-1 electrical interfaces. Two transmission lines carry identical payloads in a permanent bridged arrangement between network elements.

ITU-T

See International Telecommunications Union — Transmission.

J **Jitter**

Short-term variations in properties of a digital signal.

K

Kbit/s

Kbit/s is an abbreviation for Kilobits per second.

L

Line restore time

Line restore time applies only to NTT MSP. Line restore time is the number of minutes that the system waits, after a failure condition that caused a protection switch clears, before switching to the line that is not carrying service (the line where the fault cleared).

Line-derived timing

Line-derived timing means that the system timing is derived from the signal received from a transmission port.

Loopback cross connect

A loopback cross connect is a unidirectional cross connect that sends the signal from an input port back to the same input port. If the input port is cross connected to an output port, the signal is bridged and sent back to the input port. Loopback cross connects are typically used to isolate facility trouble.

M

Magneto Optical disks

A Magneto Optical (MO) disk is a removable storage medium. MO disks are used for backing up the system database and for loading software onto the system.

Main Controller subrack

The Main Controller subrack contains the main processor, memory, Local Area Network (LAN) hubs, hard disk, removable optical disk, alarm unit, main connector panel, and User Panel.

Matrix and Control rack

The Matrix and Control (MC) rack is an equipment rack that contains the Main Controller subrack and five Bit Slice Switch Units (BSSUs).

Matrix and Synchronisation rack

The Matrix and Synchronisation (MS) rack is an equipment rack that contains the Matrix and Synchronisation subrack and five Bit Slice Switch Units (BSSUs).

Matrix and Synchronisation subrack

The mechanical assembly that houses the matrix control and synchronisation and timing units.

Mbit/s

Mbit/s is an abbreviation for Megabits per second.

MCLAN
The Main Controller Local Area Network (MCLAN) is a LAN used by the system for inter-processor communication between the Main Controller (MC) subrack and other system subracks.

MSP
MSP provides 1+1 switching for transmission lines. Two lines carry identical payloads in a permanent bridged arrangement between network elements.

MSP group
An MSP group is a pair of associated ports on a pair of physically-adjacent transmission units. An MSP group, also called an MSP pair, provides transmission line protection between network elements.

Multiplex Section
Multiplex Section (MS) is the trail between, and including, two multiplex section trail termination functions.

Multiplexing
Multiplexing combines multiple data channels onto a single transmission medium.

Multi-point cross connect
A multi-point cross connect is a special type of unidirectional cross connect. It connects a single input to two or more outputs.

N

Near end
Near end refers to the *local* network element. For performance monitoring, the system collects performance-monitoring data on the local network element from anomalies detected in the incoming signal by the local (near-end) network element.

Network element
A network element is any piece of equipment that forms part of the transmission path for a traffic-bearing signal.

Nonrevertive
Nonrevertive is a protection switching architecture type. When a protection group is nonrevertive, the protection entity will continue to operate as the active entity even after a failure clears on the working entity.

Nontransparent loopbacks
A nontransparent loopback replaces the incoming data stream with the outgoing data stream and also replaces the outgoing stream with AIS. See Transparent loopback.

NTT MSP
NTT MSP provides 1+1 bidirectional nonrevertive switching for STM-1 optical and electrical interfaces. Two transmission lines carry identical payloads in a permanent bridged arrangement between network elements.

O

Overhead
Overhead (OH) is the term for the auxiliary bytes in Synchronous Digital Hierarchy (SDH) signals used for anything but customer payload.

P

Pack
See Unit.

Parameter
Parameters are the output of the performance-monitoring calculation process. For example: background block errors, errored seconds, severely-errored seconds, and unavailable seconds are all parameters.

Password
A word or code that is used to control access to the system.

Path Trace Identifier
The purpose of the Path Trace Identifier (PTI) is to transmit a path access point identifier so that a receiving terminal can verify that the receiving terminal is connected to the intended transmitter.

Phaselocked mode
Phaselocked mode is the normal mode of operation. In this mode, the system clock is slaved to an external timing reference such as a transmission port or a Station Clock input.

Plug-in
See Unit.

Prompt
An alarm category or severity. An alarm classified as Prompt indicates that maintenance personnel must repair the defective equipment or take whatever corrective action is necessary to restore good service. Alarms for conditions that affect service are always classified as Prompt.

Protection
When an entity is duplicated, one of the duplicated entities is designated as the protection entity, while the other is designated as the working entity. If the status of the protection entity changes from standby to active, the entity still retains its designation as the protection entity.

Protocol
Rules governing transmitting and receiving of data.

R

Rack
A rack is a mechanical assembly that houses the system hardware.

Revertive
Revertive is a protection switching architecture type. When a protection group is revertive, the system will automatically switch service from the protection entity back to the working entity when a failure clears and the Wait To Restore time has elapsed.

Rollover (Roll)
A roll is used to replace the input of an existing cross connect. All outputs in the original connection are moved to the new input. You can roll a unidirectional cross connect, one or both directions of a bidirectional cross connect, or a cross connect with a bridged connection.

S

SCSI
See Small Computer System Interface.

Severely-Errored Seconds
Severely-Errored Seconds (SES) are the number of one-second periods in which the number of Errored Blocks equals or exceeds the estimator value.

Slot
A slot is the space that is designed to hold a unit in a subrack.

Small Computer System Interface
A hardware interface that allows for the connection of peripheral devices to a computer.

SNCP
See Sub-Network Connection Protection.

Sub-Network Connection Protection
Sub-Network Connection Protection (SNCP) is a transmission protection feature that provides protection of all or part of a trail through a network.

Synchronous Digital Hierarchy
Synchronous Digital Hierarchy (SDH) is a hierarchical set of digital transport structures, standardised for the transport of suitably-adapted payloads over physical transmission networks.

Squelch
A squelched signal means that no signal is being transmitted.

Standby
When an entity is duplicated, one of the duplicated entities, the active entity, is currently providing service while the other entity is in standby. Either the working or protection entity can be in standby at any time.

Station alarm
A station alarm is an alarm that appears visually or audibly anywhere other than on the User Panel or on a unit.

Station clock input
The station clock input can be either 2048 kHz or 64 kHz, depending on the type of System Timing Unit (STU) that is installed in the system.

Synchronous Transport Module, level 1
Synchronous Transport Module, level 1 (STM-1) is a 155.52-Megabit per second data stream in a Synchronous Digital Hierarchy (SDH) frame format. This is the lowest level SDH signal.

Subrack
A subrack is a mechanical assembly that houses plug-in units, also referred to as circuit packs, that contain the circuitry for the system. All subracks conform to ETSI equipment practices for transmission products. Subracks have a midplane or a backplane that interconnects the units in the subrack.

Suite
A suite is an equipment aisle or set of equipment racks.

Synchronous
Synchronous is a method of transmitting data in which discrete signal elements are transmitted at a fixed and continuous rate. Synchronous data transmission requires that the timing of the transmission be synchronised between the sending and receiving devices.

System
System refers to groups of software and hardware that operate as a whole.

System clock input reference
System clock input references can be derived from transmission ports, including ports provisioned for MSP, or from external timing references (station clock inputs).

T

TCA
See Threshold Crossing Alert.

TCP/IP
A communication protocol for data transport.

Threshold
A threshold is the level of a parameter count at which the system sends a Threshold Crossing Alert.

Threshold Crossing Alert
The system reports a Threshold Crossing Alert (TCA) whenever a performance-monitoring parameter exceeds a specified threshold.

Trail
A trail is the logical transmission path between two path termination points.

Transparent loopback
A transparent loopback replaces the incoming data stream with the outgoing data stream and leaves the outgoing stream as is. Transparent loopbacks do not affect the outgoing data. See Nontransparent loopback.

Tributary Unit
A Tributary Unit (TU) is an information structure that provides adaptation between the lower order path layer and the higher order path layer. A TU consists of an information payload, also referred to as a lower order Virtual Container, and a TU pointer. The TU pointer indicates the offset of the payload frame start relative to the higher order Virtual Container frame start.

Tributary Unit Group
A Tributary Unit Group (TUG) consists of one or more TUs occupying fixed, defined positions in a higher order Virtual Container payload.

TU
See Tributary Unit.

TU12
A TU12 (Tributary Unit 12) consists of a VC12 (Virtual Container 12) plus a TU pointer.

TU3
A TU3 (Tributary Unit 3) consists of a VC3 (Virtual Container 3) plus a TU pointer.

TUG
See Tributary Unit Group.

TUG-2
A TUG-2 is 12 columns of an STM-1 frame that can contain four TU-11s, three TU-12s, or one TU-2.

TUG-3

A TUG-3 is 86 columns of an STM-1 frame that can contain either one TU-3 or seven TUG-2s.

U

Unavailable Seconds

Unavailable Seconds (UAS) is the number of one-second periods when performance-monitoring data is unavailable due to prolonged severely-errored conditions. The Unavailable Seconds count begins when the system detects ten or more consecutive Severely-Errored Seconds. The system will count these Severely-Errored Seconds as Unavailable Seconds instead. The Unavailable Seconds count stops when the system detects ten or more consecutive, nonseverely errored seconds. All other counts stop during Unavailable Seconds.

Unit

A unit is the hardware that is inserted into an equipment shelf. A unit is also called a plug-in, circuit pack, or pack.

Upstream

The upstream signal points at or towards the source of the transmission stream. In other words, the upstream signal looks in the direction opposite to the direction of transmission.

V

Virtual Container

A Virtual Container (VC) is the information structure used to support path layer connections in the SDH. A VC is defined for each signal type. A VC-11 contains a 1.544 Mbit/s (DS1) signal. A VC-12 contains a 2.048 (E1) Mbit/s signal. A VC-2 contains a 6.312 Mbit/s (DS2) signal. A VC-3 contains either a 34.368 Mbit/s (P31) signal or a 44.736 Mbit/s (DS3) signal. A VC-4 contains a 139.264 Mbit/s (P41) signal.

W

WaveStar Network Management System

WaveStar Network Management System is a network-level management system for a Data Communications Network (DCN).

Working

When an entity is duplicated, one of the duplicated entities is designated as working, while the other is designated as the protection entity. If the status of the working entity changes from active to standby, the entity still retains its designation as the working entity. The working entity is the preferred active entity.

Index