EXHIBIT D-9

Quicker Connections LLC v. Cisco Systems, Inc., 2:24-cv-1074-JRG

Claim Chart for U.S. Patent No. 7,061,859 | Cisco
DDM-2000 FiberReach Multiplexer, DDM-2000 OC-3 Multiplexer, DDM-2000 OC-12 Multiplexer, and FT-2000 OC-48 Multiplexer Products (collectively, the "Lucent 2000 Product Family")

As shown in the chart below, all Asserted Claims of the '859 Patent are invalid under (1) 35 U.S.C. §§ 102 (a) and (b) because the Lucent DDM 2000 Product Family meets each element of those claims, (2) 35 U.S.C. §§ 102 (a) and (b) because the references describing the Lucent DDM 2000 Product Family discloses each element of those claims, and/or (3) 35 U.S.C. § 103 because the references describing the Lucent 2000 Product Family render those claims obvious either alone, or in combination with the knowledge of a person having ordinary skill in the art, and in further combination with the references specifically identified below and in the following claim chart and/or one or more references identified in Defendant's Preliminary Invalidity Contentions. The following quotations and diagrams come from documents that show the Lucent 2000 Product Family, in invalidating configurations, were publicly available by at least 2001, and describe the relevant functionality of those switches:

- DDM-2000 Multiplexer Datasheet, Lucent Technologies, 1999 ("DDM-2000 Datasheet")
- DDM-2000 OC-3 Multiplexer Software Release Description, Release 11.1.3, Lucent Technologies, July 2000 ("DDM-2000 Software Release 11.1.3")
- DDM-2000 OC-3 Multiplexer, TARP Release 13 and Later, User/Service Manual (TOP) Volume II, Lucent Technologies, June 2001 ("DDM-2000 TARP Release 13")
- DDM-2000 OC-3 Multiplexer Releases 8.0 through 11.1, User/Service Manual – Volume I, Lucent Technologies, Issue 4, April 1998 ("DDM-2000 User/Service Manual")
- SONET Synchronous Optical Networking Technical Overview, Lucent Technologies, January 1999 ("SONET White Paper")
- DDM-2000 FiberReach Multiplexer Wideband/Narrowband Shelf Release 2.2, User/Service Manual, Lucent Technologies, April 1998 ("DDM-2000 FiberReach Manual")
- DDM-2000 OC-3/OC-12 Multiplexer Circuit Pack Options, Lucent Technologies, February 2000
- DDM-2000 OC-3 Multiplexer Software Release Description, TARP Release 15.0.4, Lucent Technologies, August 2001
- DDM-2000 OC-3 and OC-12 Multiplexers Applications, Planning, and Ordering Guide, Lucent Technologies, April 2002

- Alcatel-Lucent 1665 Data Multiplexer (DMX) | Release 9.1 Applications and Planning Guide, Alcatel-Lucent, November 2011

Motivations to combine the disclosures in Lucent 2000 Product Family with disclosures in other publications known in the art, as explained in this chart, include at least the similarity in subject matter between the references to the extent they concern methods of fault protection in ring networks, and specifically to methods and systems for routing data flows based on available network segments. Insofar as the references cite other patents or publications, or suggest additional changes, one of ordinary skill in the art would look beyond a single reference to other references in the field.

These invalidity contentions are based on Defendant's present understanding of the asserted claims, and Quicker Connections' apparent construction of the claims in its March 12, 2025 Disclosure of Asserted Claims and Infringement Contentions Pursuant to P.R. 3-1, (Quicker Connections' "Infringement Disclosures"), which are deficient at least insofar as it fails to cite any documents or identify accused structures, acts, or materials in the Accused Products with particularity. Defendant does not agree with Quicker Connections' application of the claims, or that the claims satisfy the requirements of 35 U.S.C. § 112. Defendant's contentions herein are not, and should in no way be seen as, admissions or adoptions as to any particular claim scope or construction, or as any admission that any particular element is met by any accused product in any particular way. Defendant objects to any attempt to imply claim construction from this chart. Defendant's prior art invalidity contentions are made in a variety of alternatives and do not represent Defendant's agreement or view as to the meaning, definiteness, written description support for, or enablement of any claim contained therein.

The following contentions are subject to revision and amendment pursuant to Federal Rule of Civil Procedure 26(e), the Local Rules, and the Orders of record in this matter subject to further investigation and discovery regarding the prior art and the Court's construction of the claims at issue.

Claim Element	Lucent 2000 Product Family
1[pre] In a bidirectional ring network, in which nodes are mutually connected by network segments, a method of fault protection, comprising:	Lucent 2000 Product Family discloses in a bidirectional ring network, in which nodes are mutually connected by network segments, a method of fault protection, comprising. For example, Lucent 2000 Product Family discloses bidirectional ring networks, including bidirectional line switched rings that are comprised of multiple nodes connected by links, e.g., in a bidirectional ring network, in which nodes are mutually connected by network segments. Lucent 2000 Product Family discloses the implementation of fault protection methods, including the drop and continue dual-feed mechanism, e.g., a method of fault protection. DDM-2000 TARP Release 13 at 1053-1064

Claim Element	Lucent 2000 Product Family
	Make VT1.5 (DS1) or STS1 (DS3) Cross-Connections Using CIT Dual Ring Interworking Configuration 1. NOTE: This procedure assumes that the "drop and continue" feature will be used to interconnect two rings at two locations to support service between nodes in each ring. The two rings interface through EC-1 or OC-3 connections at two interworking nodes. NOTE: If you are not familiar with doing cross-connections using the CIT commands, it is strongly suggested that you read Cross-Connection Provisioning in the Administration and Provisioning section of this manual. Also, read the description of the following commands in the Commands and Reports section of this manual: `ent-crs-sts1`, `ent-crs-vt1`, `rtrv-crs-sts1`, `rtrv-crs-vt1`, `dlt-crs-sts1`, and `dlt-crs-vt1`. NOTE: You will have to login to more than one node in each ring to get a complete map of the network using the `rtrv-map-network` and `rtrv-map-neighbor` command. If a drawing of the network is not provided with the work order, it is recommended that you draw a simple schematic of the network before making cross-connections. List the TID of each node and how they are connected to each other. Figure 1 shows an example of a simple schematic.

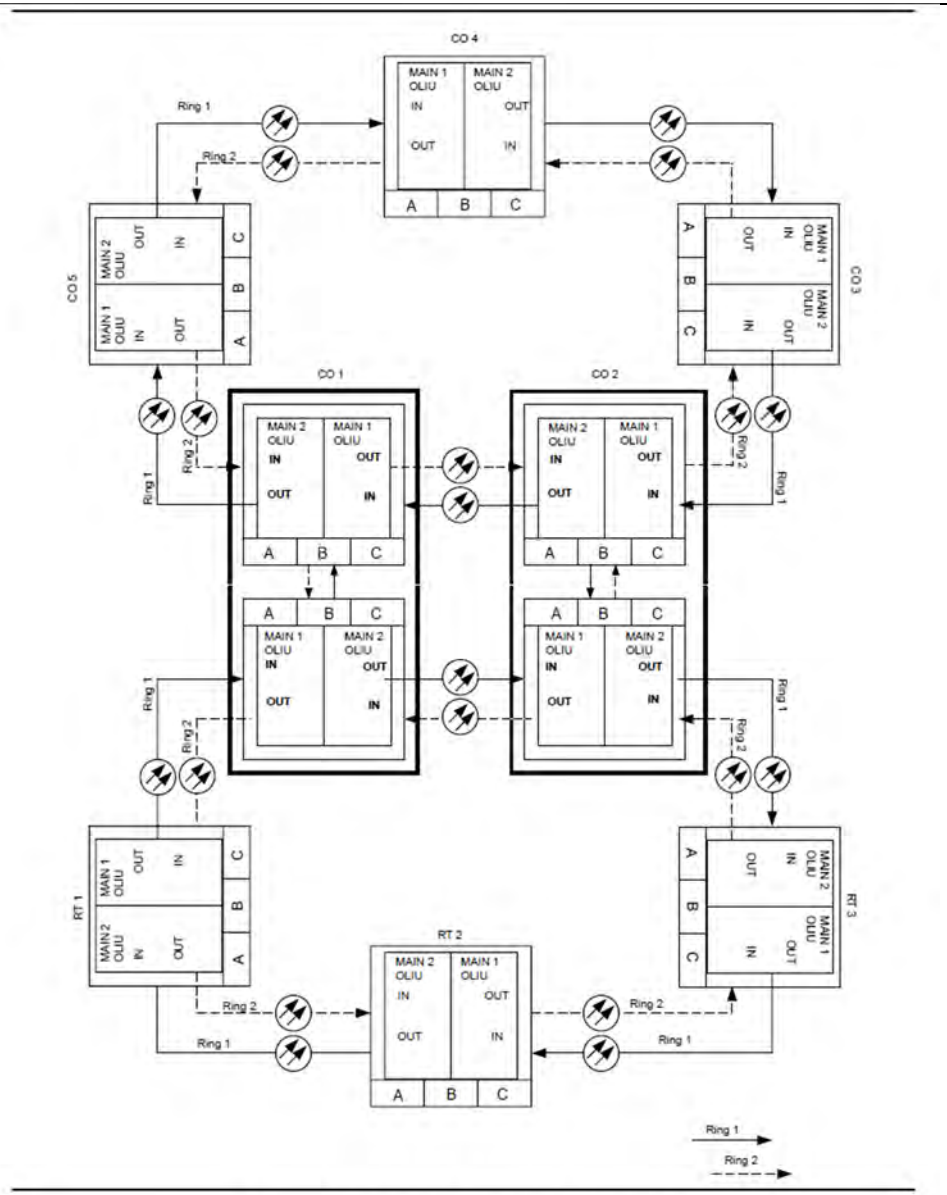


Figure 1 – Sample Network Schematic

Claim Element	Lucent 2000 Product Family

	Log in to any node in each ring in the network and use the **rtrv-map-network** and **rtrv-map-neighbor** command to retrieve a map of the network which lists all the systems and how they are connected to each other.
	
	Sample output reports are shown in Figures 2, 3, and 4:
	
	`/* Network Map for Site6NE1`
	`==========`
	`TID Product Type Level 2 IS`
	`NSAP`
	`==========`
	`Site6NE1 DDM-2000 OC-3`
	`39 840F 80 000000 0000 0000 0000 08006alad06e 00`
	
	`R5`
	`39 840F 80 000000 0000 0000 0000 00000e3a0273 00`
	
	`R6`
	`39 840F 80 000000 0000 0000 0000 08006alad07f 00`
	
	`R7`
	`39 840F 80 000000 0000 0000 0000 00000e3a0732 00`
	
	`Site3NE1 Y`
	`39 840F 80 000000 0000 0000 0000 00000e3a0372 00`
	
	`Site7NE1`
	`39 840F 80 000000 0000 0000 0000 08006alad06f 00`
	
	`*/`
	
	Figure 2 – Sample Report From rtrv-map-network Command

```
/* Neighbor Map for Site6NE1
   ================================================================
   TID                Connected Thru   Product Type     Level 2 IS
    NSAP
   ================================================================
   Site6NE1                            DDM-2000 OC-3
   39 840F 80 000000 0000 0000 0000 08006alad06e 00

   Site7NE1               main-1                            Y
   39 840F 80 000000 0000 0000 0000 08006alad06f 00

   Site5NE1               main-2
   39 840F 80 000000 0000 0000 0000 00000e3a0372 00

*/
```

Figure 3 – Sample Report From `rtrv-map-neighbor` Command (R13)

```
/* Neighbor Map for Site6NE1
   ================================================================
   TID            Connected Thru   Product Type     Level 2 IS  DCC
    NSAP
   ================================================================
   Site6NE1                          DDM-2000 OC-3      Y
   39 840F 80 000000 0000 0000 0000 08006alad06e 00

   Site7NE1               main-1                                 N
   39 840F 80 000000 0000 0000 0000 08006alad06f 00

   Site5NE1               main-2
   39 840F 80 000000 0000 0000 0000 00000e3a0372 00

*/
```

Figure 4 – Sample Report From `rtrv-map-neighbor` Command (R15)

2. Verify system configuration is same as specified on work order or circuit order.
3. From work order or circuit order, determine the terminating (drop) nodes for the service being established.

4. NOTE:
In dual ring configurations, cross-connections consist of "drop and continue" connections in addition to pass-through and terminating cross-connections. For example in Figures 5 through 8, drop and continue connections are made at the four nodes in CO 1 and CO 2 located between the two rings. Also, cross-connections must be made in all interconnected rings, including other DDM-2000 OC-3 rings, DDM-2000 OC-12 rings, and FT-2000 OC-48 rings, as required.

NOTE:
In ring configurations, you should use the following rules in establishing cross-connections in each ring:

1. All drop connections (including DRI, if present) from the same STS-1 timeslot must be provisioned the same, either all VT1.5 or STS-1.
2. If all 28 VT1.5s (DS1s) in an STS-1 are being passed through at a node in a VT1.5 path-switched ring, then the cross-connection may be provisioned as either a pass-through STS-1 or VT1.5. However, if you anticipate dropping VT1.5s from the pass-through node in the future, you should provision the pass-throughs as VT1.5 cross-connections. Also, provisioning now as a VT1.5 cross-connect will avoid a hit on traffic if the STS-1 cross-connect has to be converted (`cnvt-crs`) to 28 VT1.5 cross-connects to drop DS1s at a later time.
3. On STS-1 path-switched rings, all nodes in the ring must be provisioned as STS-1 cross-connections.

From work order, circuit order, and the sketch made in Step 1, determine the pass-through nodes for the service being established.

5. Use the `rtrv-eqpt:` command at each node to verify that each shelf is properly equipped for the service being established. For example, is the group or slot being used for service at the terminating ends equipped with the proper **MXRVO** and/or **DS1/DS1PM** circuit packs if DS1 service is being established?

6. NOTE:
Cross-connections supporting DS3 services are STS1 cross-connections. Cross-connections supporting DS1 services may be either STS1 or VT1.5 cross-connections. Use VT1.5 cross-connections for DS1 services if you expect to cross-connect only a portion of the VT1.5 signals in the STS-1 channel. If STS1 cross-connections are made at a shelf, there is a fixed mapping of all 28 VT1.5 cross-connections to a specific shelf group (see `ent-crs-sts1` command).

NOTE:
The following commands may be used to delete, enter, and retrieve cross-connections: `dlt-crs-vt1`, `ent-crs-sts1`, `ent-crs-vt1`, `ent-crs-sts1`, and `rtrv-crs-vt1`. and `rtrv-crs-sts1`. See the Commands and Reports section of this manual for a description of commands.

From work order or circuit order, determine the cross-connections (STS-1 or VT1.5) to be made at each node associated with the kind of service being established.

7. Starting at one of the terminating nodes for the DS1/DS3 circuit being established, use the `rtrv-crs-( ):` command at each node in the ring to verify that the cross-connections specified on the work order or circuit order may be made. For example, if the DS1 #3 low speed port in the **DS1/DS1PM** circuit pack in slot #2 of **LOW SPEED GROUP A** (a-2-3) is to be connected to timeslot m-1-2-3 and the `rtrv-crs-vt1` command shows that the cross-connection is already established, you should determine from office records if this port is already in-service before continuing with this procedure.

   If cross-connections are already assigned or improperly assigned, refer trouble to the organization responsible for facility design. Improperly assigned cross-connections may have to be deleted using the `dlt-crs-( )` commands.

8. NOTE:
   Channel state provisioning provides IS, AUTO, and NMON states for VT and STS channels similar to the port states for DS1 and DS3 ports. When a cross-connection is made to a point of termination the channel is in the AUTO state and alarming is disabled. The channel must receive a good signal from either ring to cause the channel to transition to in-service (IS).

   At all nonterminating nodes in the network, use the `ent-crs-vt1:` or `ent-crs-sts1:` command to provision pass-through connections. [For example, to make the DS1 pass-through cross-connection for channel m-1-2-3, use the `ent-crs-vt1:m-1-2-3,m-1-2-3:cct=twoway` command. To make pass-through cross-connections for STS-1 #1, use the `ent-crs-sts1:m-1,m-1:cct=twoway` command.]

9. At the terminating (drop) nodes of the circuit being established, use the **`ent-crs-vt1:`** or **`ent-crs-sts1:`** command to make the terminating cross-connections (for example, **`ent-crs-vt1:m-1-2-3,a-2-3:cct=twoway`**) or **`ent-crs-sts1:m-1,b:cct=twoway`**)

10. From work order or circuit order, determine the dual ring interworking node sites where the two rings are being interconnected.

11. From work order or circuit order at each dual ring interworking node, determine the "drop and continue" cross-connections to be made at each node.

12. At the dual ring interworking node sites, make or verify proper backplane EC-1 cable connections **[J38-J39** (**FUNCTION UNITS A**), **J40-J41** (**FUNCTION UNITS B**), **J42-J43** (**FUNCTION UNITS C**)] between **FUNCTION UNITS** groups used for service being provided. See CO 1 and CO 2 in Figure 5.

13. NOTE:
Ring 1 is the ring being received on the **MAIN 1 OLIU**. Ring 2 is the ring being received on the **MAIN 2(P) OLIU**. The ***`ring`*** parameter of the **`ent-crs`** commands is used to identify which ring rotation will be continued as well as dropped at a node. For example, if Ring 2 continues to the next node, then ***`ring`***=*m2*

At the dual ring interworking node sites, determine the ring (Ring 1 or Ring 2) rotation that will be continued to each node. For example, in Figure 5, note that at CO 1 in the top ring configuration, Ring 2 is continued to CO 2. In the bottom ring configuration, Ring 1 is continued from CO 1 to CO 2.

14. NOTE:
If VT1.5 cross-connections in the same STS-1 are made at a dual ring interworking node site, all VT1.5 "drop and continue" cross-connections at that node must be made in the same direction.

At the dual ring interworking node sites, make proper "drop and continue" cross-connections. For example, at the top node at CO 1 if STS-1 #1 in **MAIN OLIU** (m-1) is to be cross-connected to function group B (b) then the command **`ent-crs-sts1:m-1,b:cct=dc,ring=m2`** would be used to make the cross-connection. This command makes both the drop cross-connection as well as the continue cross-connection. If FT-2000 is a part of the DRI configuration, use 365-575-103, *FT-2000 OC-48 Lightwave System, Release 8.1 Through 9.1, User/Service Manual*, to make FT-2000 DRI cross-connections.

Claim Element	Lucent 2000 Product Family
	15. Use the `rtrv-crs-vt1:` or `rtrv-crs-sts1:` command to verify that the proper connection has been made. If an improper cross-connection is made, use the `dlt-crs-vt1:` or `dlt-crs-sts1:` command to delete the improper cross-connection and reenter the cross-connection. 16. At OC-12 terminating nodes equipped with **BBG11B 3DS3** circuit packs, use the `set-trace-sts1` command to verify the proper cross-connect path of a STS-1 cross-connected STS-1 signal. 17. After all cross-connections are made, use the `rtrv-alm:` command to verify no alarms are present. 18. If DS3 cross-connections have been established and the terminating nodes are equipped with **BBG4B DS3** circuit packs, use `set-trace-sts1` command to check integrity of cross-connect path. Reference: **DLP-563** 19. If `ne-acty`, `inc. VT AIS`, `inc. STS1 AIS`, `inc. VT unequipped`, or `inc. STS1 unequipped` alarms are present, look for missing or improperly made cross-connections. Use **TAP-120** to locate missing cross-connections, if required.

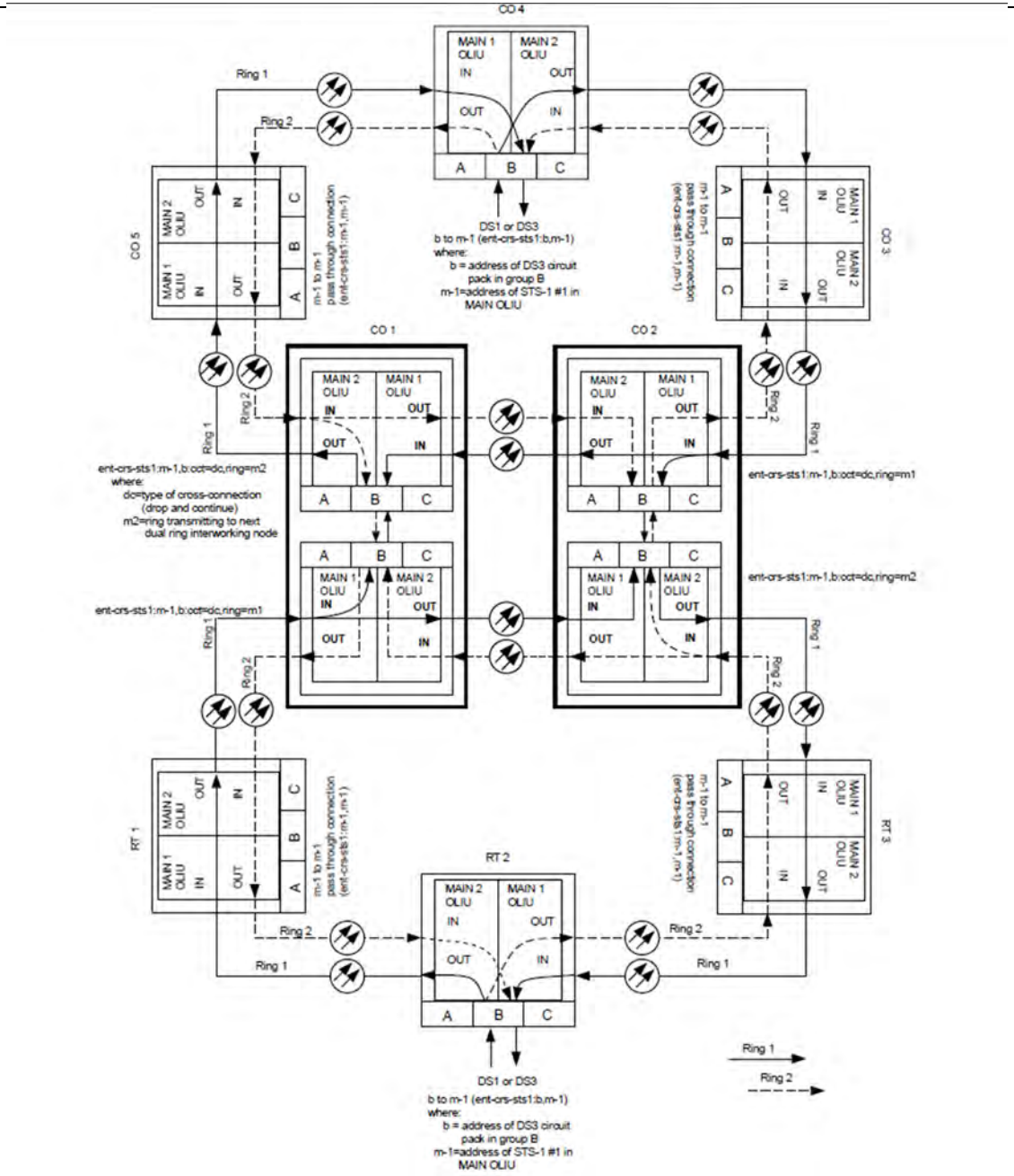


Figure 5 – Example of Dual Ring Interworking (OC-3) Cross-connections

DDM-2000 OC-3 MULTIPLEXER

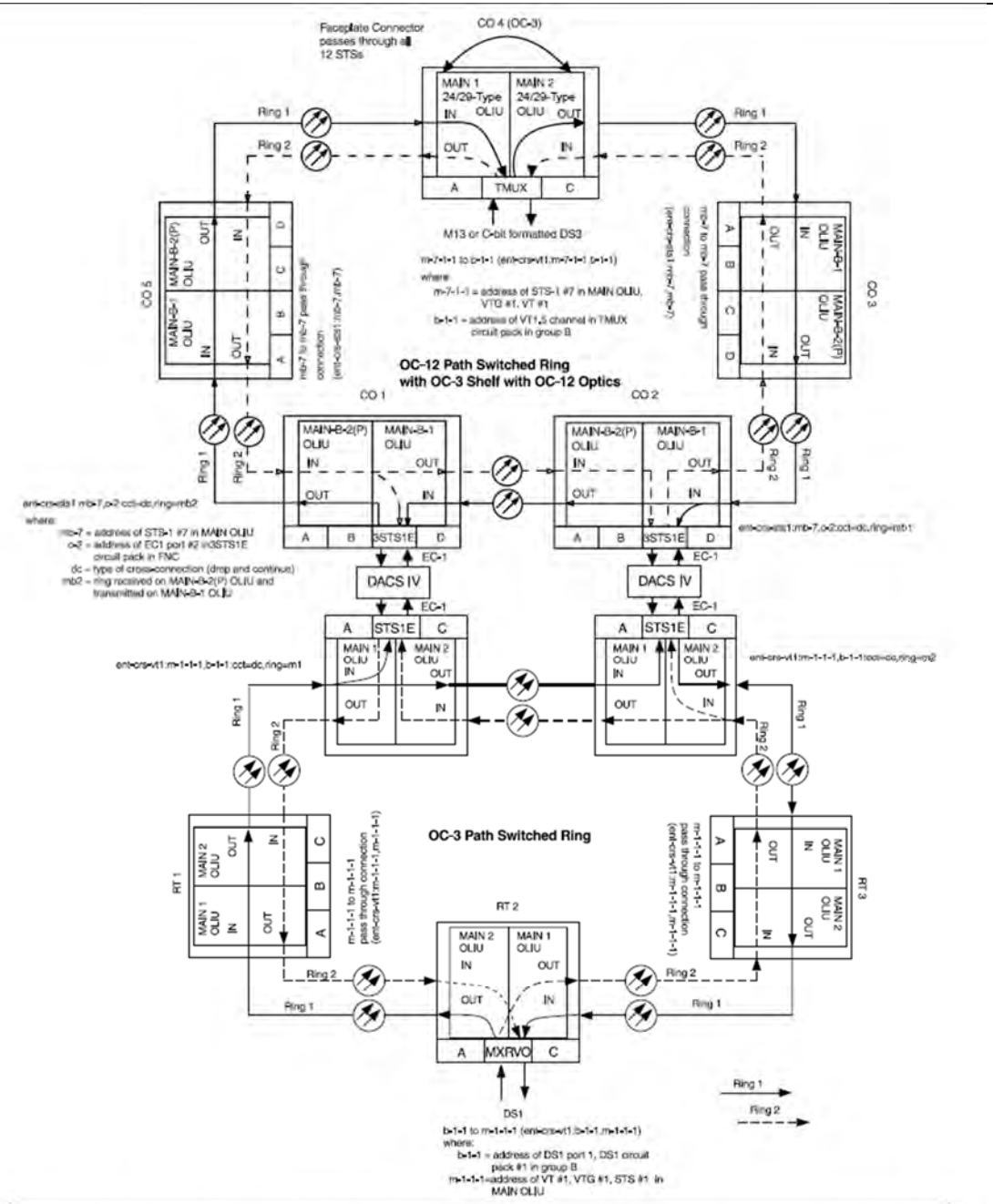


Figure 6 – Dual Ring Interworking Cross-connections (OC-3 with TMUX, OC-12 Optics)

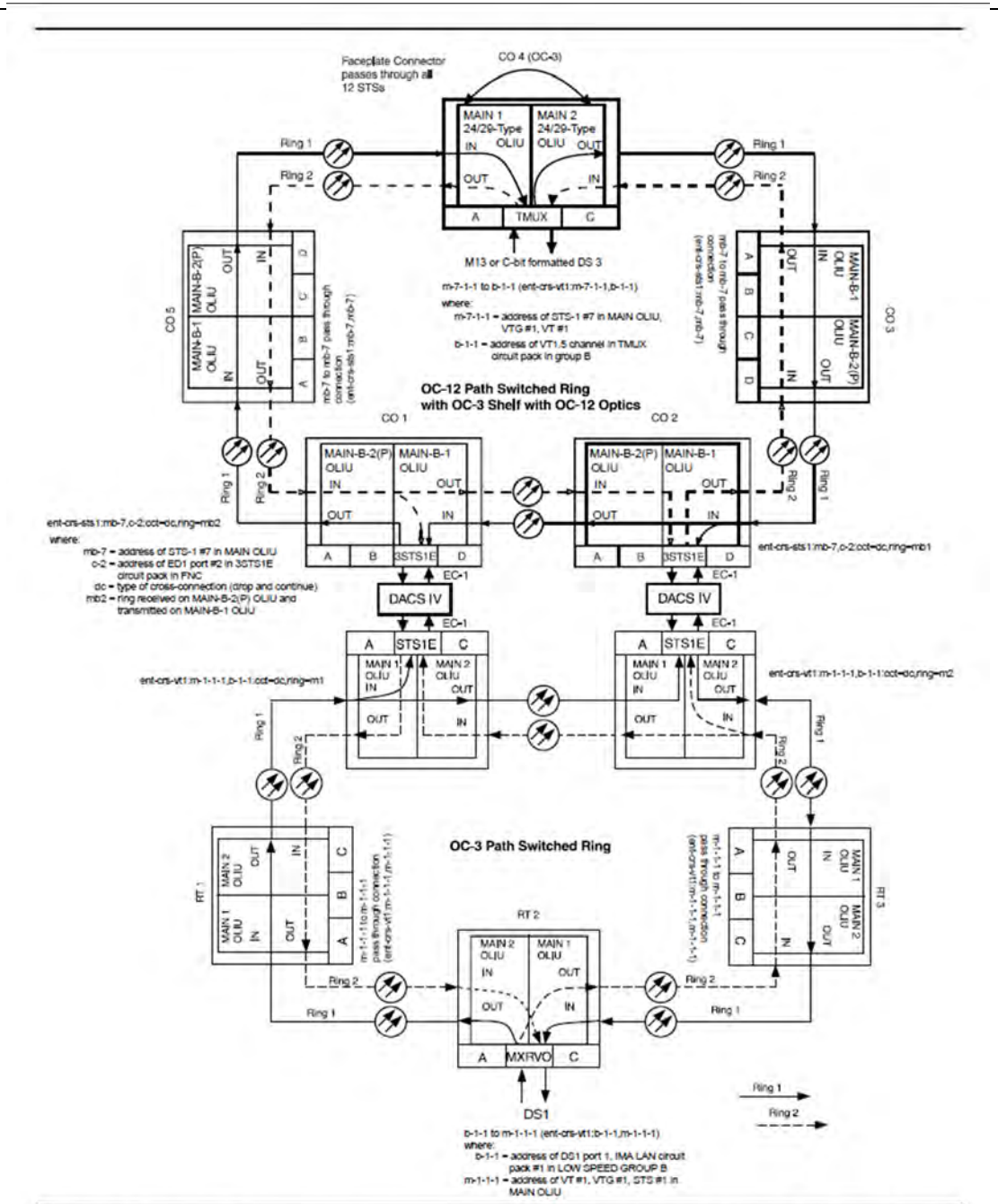


Figure 7 – Dual Ring Interworking Cross-Connections (LAN to TMUX) (OC-3 with OC-12 Optics)

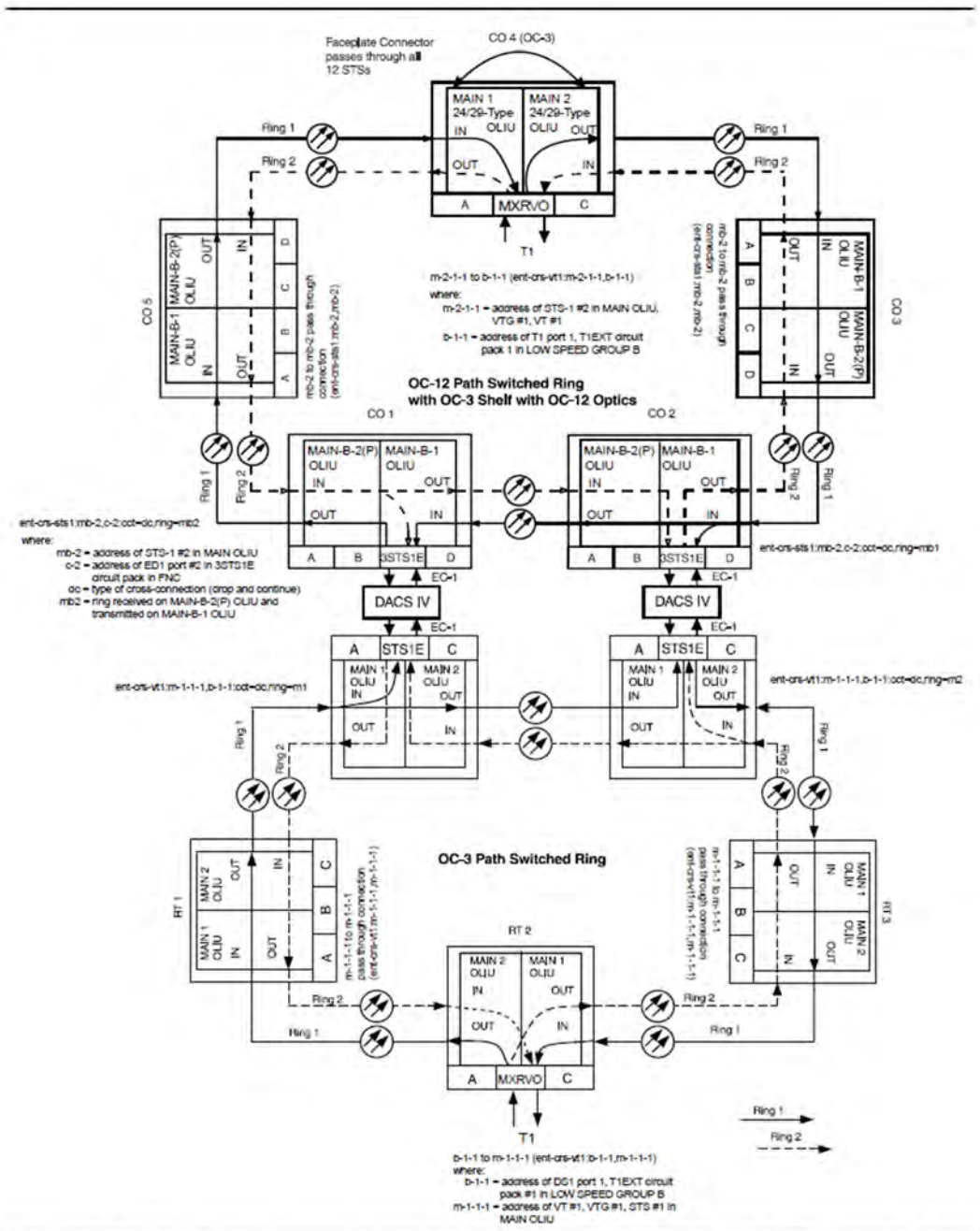
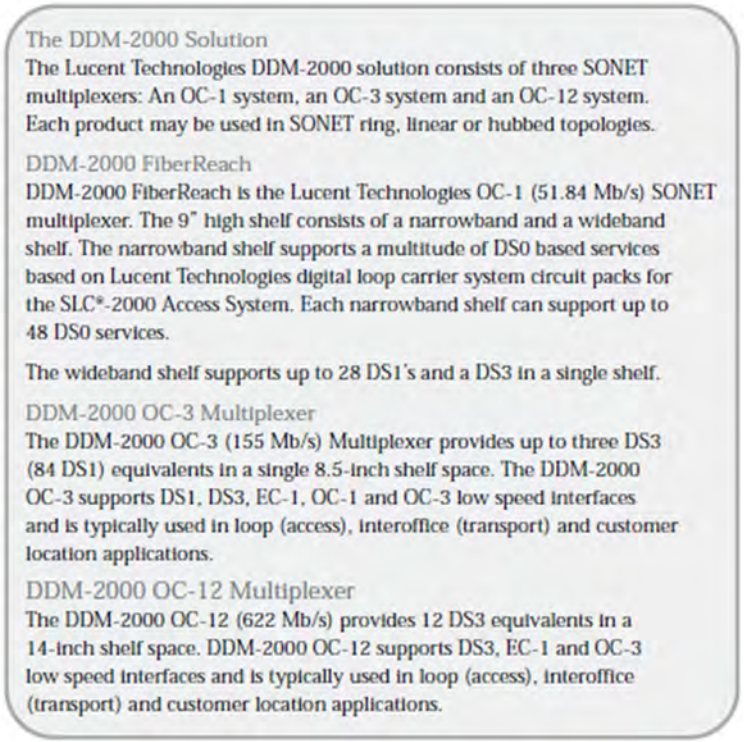


Figure 8 – Dual Ring Interworking Cross-Connections (T1EXT to TMUX) (OC-3 with OC-12 Optics)

Claim Element	Lucent 2000 Product Family
	DDM-2000 Datasheet at 3  DDM-2000 Software Release 11.1.3 at 1

Claim Element	Lucent 2000 Product Family
	1. Overview **1.01** The purpose of this software release description (SRD) is to provide information about Software Release 11.1.3 and its interaction with the DDM-2000 OC-3 System. This practice contains the following parts: ▪ Software Release 11.1.3 Features: This part provides a description of the features provided by Release 11.1.3. ▪ Operating Issues Resolved: This part provides the list of issues (problems) which existed in previous software releases that were resolved with this issue of software. ▪ Operating Issues: This part provides information about the existing issues (problems) in Release 11.1.3 that may become evident during the operation of the DDM-2000 OC-3 System. ▪ DDM-2000 Interworking: This part provides a description of the optical connections that are supported between OC-3, OC-12, and FiberReach shelves and the software releases that can coexist in the same subnetwork. ▪ DDM-2000 OC-3 Multiplexer DRI Software Compatibility: This part provides the dual ring interworking (DRI) software compatibility table for the DDM-2000 OC-3 Multiplexer for both EC-1 and OC-3/IS-3 interfaces. ▪ Inservice Upgrades: This part provides the information required to upgrade the DDM-2000 OC-3 System software to Release 11.1.3. ▪ Implementation Procedure: This part provides the information required to install the DDM-2000 OC-3 System software, Release 11.1.3. Important new information has been added to the "Software Installation and Upgrade Procedure" section. DDM-2000 Software Release 11.1.3 at 12-13

5. DDM-2000 Interworking

NOTE:
Interworking between products (DDM-2000, FT-2000, and DACS IV-2000, etc.) is evolving with EC-1, OC-3, IS-3, and DS3 interfaces. Care must be taken to check correct software releases and to check interface provisioning. For **OLIU** interfaces, care must be taken to ensure that both ends of a span are provisioned/equipped for the same protection mode (1+1 or dual 0x1, for example).

5.01 Table A lists the software compatibility within a subnetwork for the DDM-2000 OC-3 and OC-12 Multiplexers. All configurations listed support SEO. The table lists all possible software combinations. Combinations not listed are not supported.

Table A. DDM-2000 OC-3 and OC-12 Software Compatibility

OC-3 Release (Note 1)	OC-12 Release (Note 1)	Interconnection Method (Note 2)	Notes
9.0*	5.0	22-Type†, 21G-Type, or 21D-Type‡ OLIU	Supports OC-3/OC-12 interworking, 0x1 interfaces, and DRI
9.1 *	5.0	22-Type†, 21G-Type, or 21D-Type‡ OLIU	Supports OC-3/OC-12 interworking, 0x1 interfaces, and DRI
9.1 *	5.1	22-Type†, 21G-Type, or 21D-Type‡ OLIU	Supports OC-3/OC-12 interworking, 0x1 interfaces, and DRI
11.0 *	5.1	22-Type†, 21G-Type, or 21D-Type‡ OLIU	Supports OC-3/OC-12 interworking, 0x1 interfaces, and DRI
11.1 *	5.1	22-Type†, 21G-Type, or 21D-Type‡ OLIU	Supports OC-3/OC-12 interworking, 0x1 interfaces, and DRI
11.0 *	5.2	22-Type†, 21G-Type, 21D-Type‡, or 24G-U§ OLIU	Supports OC-3/OC-12 interworking, 0x1 interfaces, and DRI
11.1 *	5.2	22-Type†, 21G-Type, 21D-Type‡, or 24G-U§ OLIU	Supports OC-3/OC-12 interworking, 0x1 interfaces, and DRI

See Notes on Next Page.

Claim Element	Lucent 2000 Product Family
	Table A. DDM-2000 OC-3 and OC-12 Software Compatibility (Contd) ***Notes:*** (1) All NEs in a ring network, which may be part of a larger network, must be running the same software. Similarly, all NEs in a linear network, which may be part of a larger network, must be running the same software. In a subnetwork, which may consist of a mixture of ring and linear networks, all NEs must be running compatible software according to the table. (2) The OLIU types referenced in Table A are as follows: 21D-Type - 21D and 21D-U, 21G-Type - 21G, 21G-U, and 21G2-U, 22F-Type - 22F, 22F-U, and 22F2-U, 22G-Type - 22G-U, 22G2-U, and 22G3-U, 22D-U, and 24G-U. * 22-Type OLIUs must be used in DDM-2000 OC-3 ring shelves in **MAIN** and **FUNCTION UNITS** slots for optical extensions. 21-Type OLIUs used in OC-12. † The 22-Type OLIUs can only be used in the DDM-2000 OC-3 shelf. ‡ The 21D-Type OLIU can be used in the DDM-2000 OC-12 shelf in place of the 21G-Type OLIU for short reach applications. § The 24G-U OLIU can only be used in the **MAIN** slots of DDM-2000 OC-3 shelf. DDM-2000 Software Release 11.1.3 at 16

Claim Element	Lucent 2000 Product Family

6. DDM-2000 OC-3 Multiplexer DRI Software Compatibility

6.01 Table D lists the dual ring interworking (DRI) software compatibility for the DDM-2000 OC-3 Multiplexer for both EC-1 and OC-3 interfaces. The table lists all possible software combinations. Combinations not listed are not supported.

Table D. DDM-2000 OC-3 Multiplexer DRI Software Compatibility

DDM-2000 OC-3	DDM-2000 OC-12 and FT-2000	Notes
Release 7.2	OC-12 Release 5.X and FT-2000 Releases 4.1, 5.0, 6.0, and 7.X	FT-2000 Releases 4.1 and 5.0 have no DCC connectivity.
Release 9.0	OC-12 Release 5.0 and FT-2000 Releases 4.1, 5.0, 6.0, and 7.0	FT-2000 Releases 4.1 and 5.0 have no DCC connectivity.
Release 9.1	OC-12 Releases 5.X and FT-2000 Releases 7.X	
Release 11.0	OC-12 Releases 5.1/5.2 and FT-2000 Releases 7.1 and 7.2	
Release 11.1	OC-12 Releases 5.1/5.2 and FT-2000 Releases 7.1 and 7.2	

See 824-102-147, *Lucent Technologies 2000 Product Family Operations Interworking Guide* for more information on operations interworking.

Claim Element	Lucent 2000 Product Family
	DDM-2000 TARP Release 13 at 5-6

TOP Section Organization

The **Acceptance** tab covers procedures to check the shelf or system after the shelf has been equipped or after the system has been established.

The **System Turnup/Circuit Order** tab includes procedures for the following:

a. Equipping (turning up) a shelf in a looped back condition for the first time.

b. Establishing an end-to-end system after all shelves have been equipped.

c. Establishing initial end-to-end DS1, DS3, EC-1, OC-3c, TMUX DS3 to DS1, HDSL, T1, or LAN service.

d. Adding, converting, or discontinuing DS1, DS3, EC-1, TMUX DS3, HDSL, T1, or LAN service to an in-service system.

e. Adding new shelves or spans to existing configurations.

f. Upgrading software to a new release.

g. Converting or upgrading an OC-3 system to an OC-12 system.

h. Upgrading an OC-3 point-to-point system to path switched ring.

i. Establishing OC-3/IS-3 dual ring interworking (DRI) OC-3 to OC-12 or FT-2000 OC-48.

j. Upgrading OC-3/FT-2000 OC-48 DRI from EC-1 to OC-3.

k. Establishing single-homed or dual-homed FiberReach access via Release 15 DDM-2000 OC-3 or OC-12 backbone ring.

l. Establishing single-homed or dual-homed OC-3 access via Release 7 DDM-2000 OC-12 backbone ring.

m. Establishing single-homed or dual-homed OC-3 access via Release 15 DDM-2000 OC-12 backbone ring.

Claim Element	Lucent 2000 Product Family

n. Establishing single-homed or dual-homed Release 15 OC-3 or OC-12 access via FT-2000 OC-48 backbone ring.

o. Establishing single-homed or dual-homed Release 15 OC-3 or OC-12 access via WaveStar TDM 2.5G OC-48 backbone ring.

p. Establishing stand-alone FiberReach access via DDM-2000 OC-3 host.

q. Establishing OC-3 optical span extensions between FT-2000 OC-48, DDM-2000 OC-3, or DDM-2000 OC-12 Rings.

r. Establishing Release 15 OC-3 or OC-12 linear extensions between FT-2000 OC-48 and DDM-2000 OC-3 or DDM-2000 OC-12 Rings.

s. Establishing Release 15 OC-3 or OC-12 linear extensions between WaveStar TDM 2.5G OC-48 and DDM-2000 OC-3 or DDM-2000 OC-12 Rings.

t. Upgrading DDM-2000 OC-3/OC-12 dual ring interworking from EC-1 to OC-3/IS-3.

u. Upgrading DDM-2000 OC-3 ring network to OC-12 ring network to OC-12 ring network using OC-3 shelves.

v. Upgrading DDM-2000 OC-3 ring network to OC-12 ring network to OC-12 ring network using OC-3/OC-12 shelves.

w. Upgrading DDM-2000 OC-12 ring by removing OC-12 shelf and replacing with existing single-homed OC-3 shelf.

x. Upgrading DDM-2000 OC-12 ring network using 24-type OLIUs to OC-12 ring network using 29-type OLIUs.

The **Operation** tab covers procedures for operating the system such as connecting and using the craft interface terminal (CIT), displaying alarm and status conditions, installing a new generic program, etc.

The **Trouble Clearing** tab covers alarms and trouble reports.

The **Detailed Level Procedures** (DLP) tab contains all of the DLPs, beginning with DLP-500, used in this manual.

DDM-2000 TARP Release 13 at 58

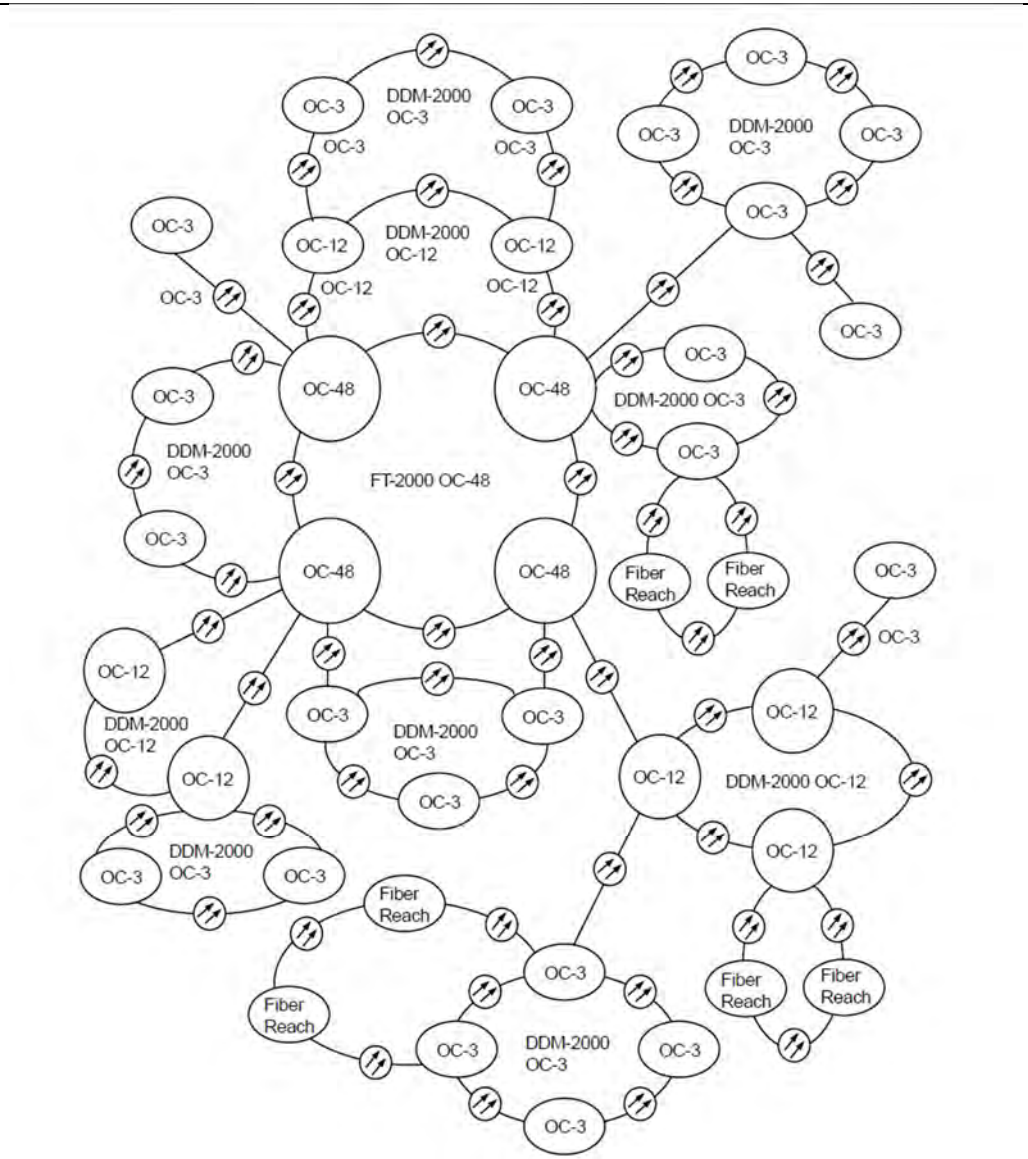


Figure 1 – DDM-2000/FT-2000 Large Network Configurations

Claim Element	Lucent 2000 Product Family
	DDM-2000 TARP Release 13 at 62

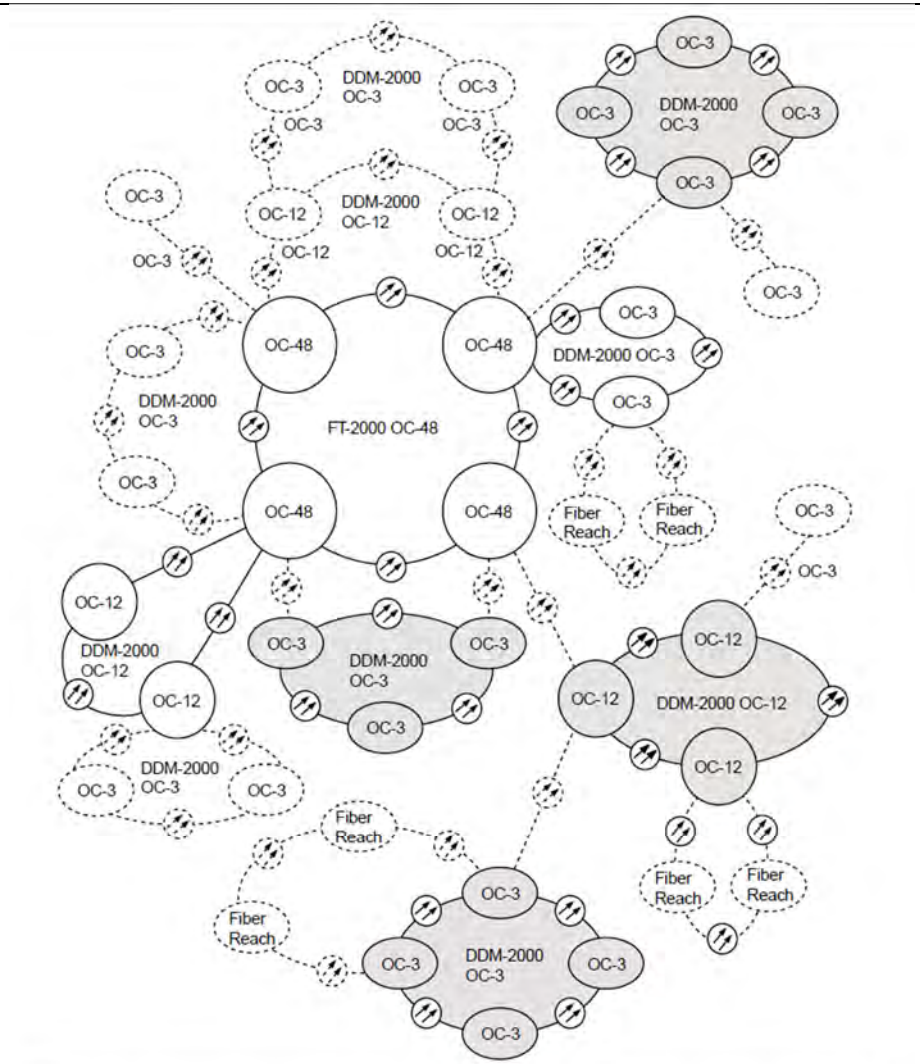


Figure 5 – DDM-2000/FT-2000 Large Network Configurations — DDM-2000 OC-3 or OC-12 Path Switched Ring

DDM-2000 OC-3 MULTIPLEXER

Claim Element	Lucent 2000 Product Family
	DDM-2000 TARP Release 13 at 70

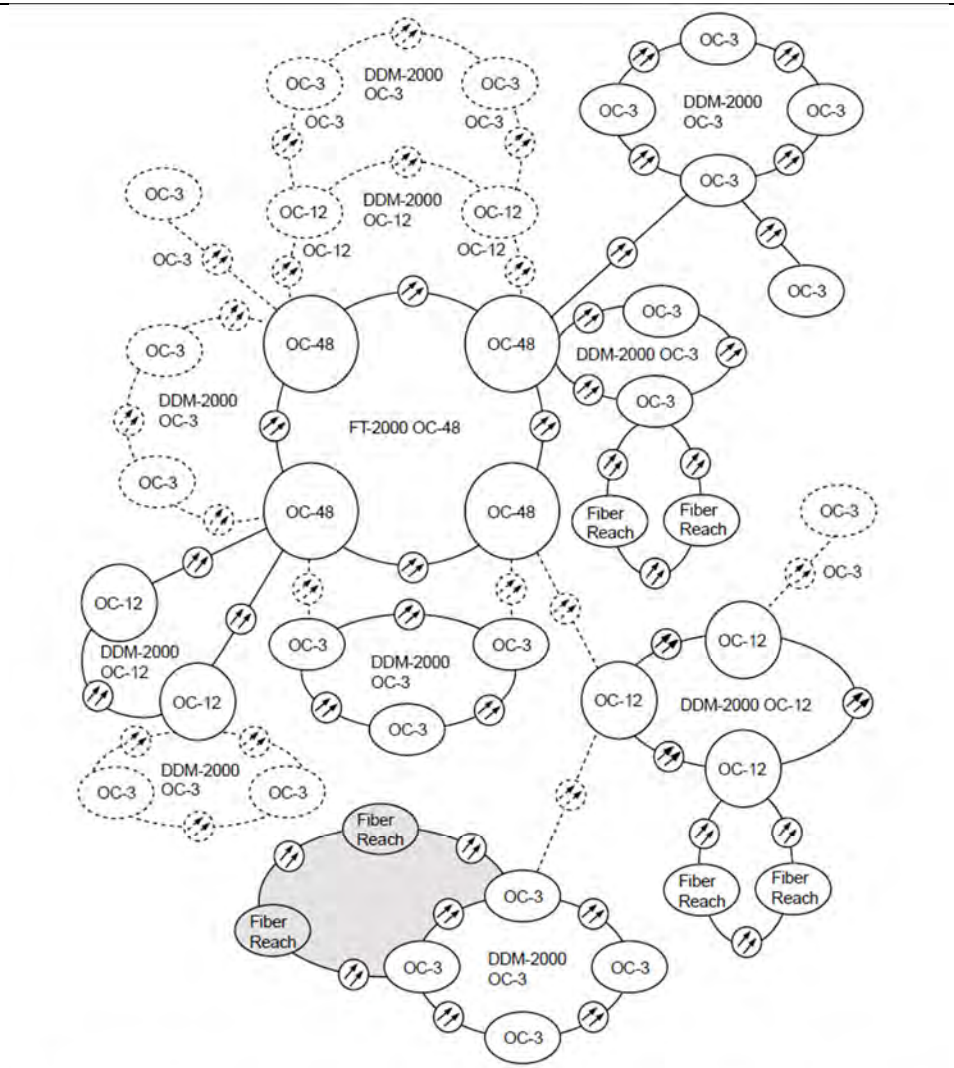


Figure 13 – DDM-2000/FT-2000 Large Network Configurations — Dual Homed FiberReach Access via DDM-2000 OC-3 or OC-12 Backbone Ring

DDM-2000 OC-3 MULTIPLEXER

Claim Element	Lucent 2000 Product Family
	DDM-2000 TARP Release 13 at 78

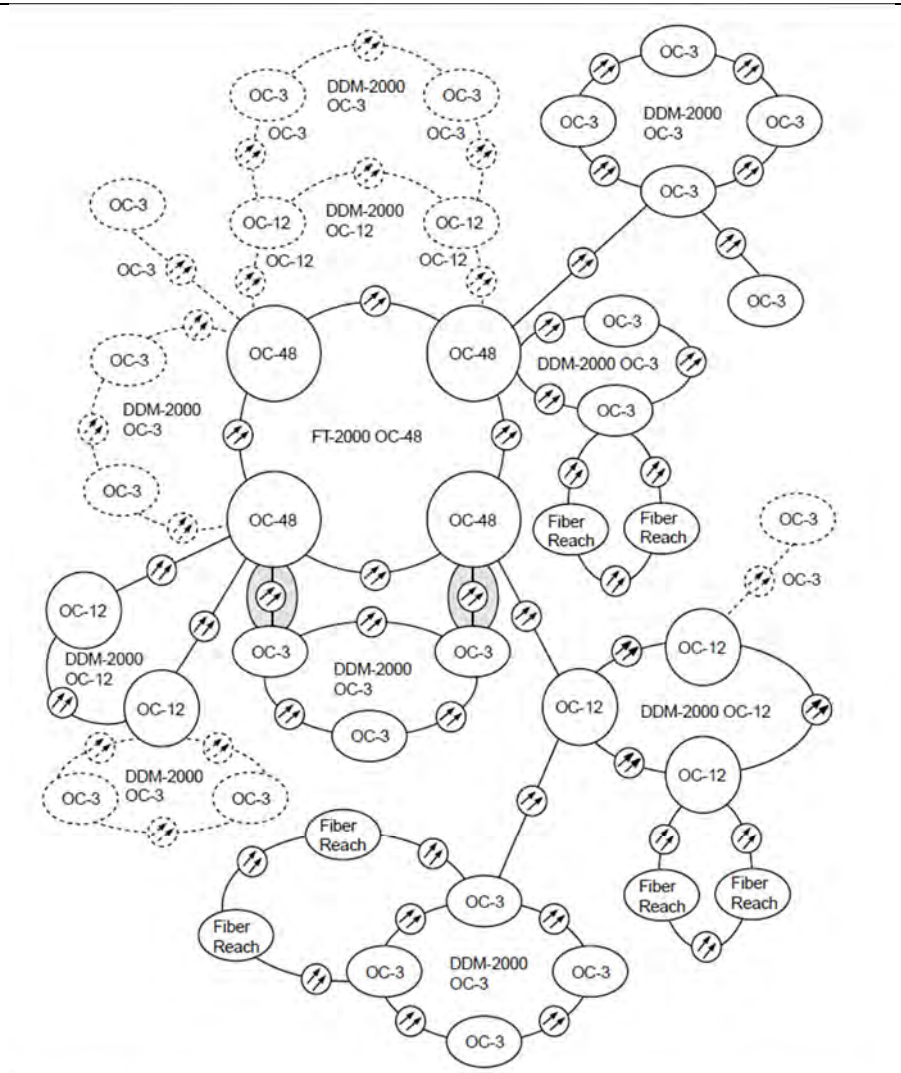


Figure 21 – DDM-2000/FT-2000 Large Network Configurations — OC-3/IS-3 Dual Ring Interworking Between DDM-2000 OC-3 Ring and FT-2000 OC-48

DDM-2000 OC-3 MULTIPLEXER

Claim Element	Lucent 2000 Product Family
	DDM-2000 TARP Release 13 at 134

Claim Element	Lucent 2000 Product Family
	DO ITEMS BELOW IN ORDER LISTED . . . . .FOR DETAILS, GO TO 4. NOTE: Ring releases support only manual VT1.5 and STS-1 cross-connections. Manual STS-1 and/or DS1 cross-connections have to be made at each shelf to configure the transmission path for each DS3/DS1 circuit being established. Either terminating (drop) cross-connections or "drop and continue" cross-connections are made at terminating nodes and pass-through cross-connections are made at intermediate nodes. NOTE: In ring configurations, you should use the following rules in establishing cross-connections in each ring: 1. All drop connections (including DRI, if present) from the same STS-1 timeslot must be provisioned the same, either all VT1.5 or STS-1. 2. If all 28 VT1.5s (DS1s) in an STS-1 are being passed through at a node in a VT1.5 path-switched ring, then the cross-connection may be provisioned as either a pass-through STS-1 or VT1.5. However, if you anticipate dropping VT1.5s from the pass-through node in the future, you should provision the pass-throughs as VT1.5 cross-connections. Also, provisioning now as a VT1.5 cross-connect will avoid a hit on traffic if the STS-1 cross-connect has to be converted to 28 VT1.5 cross-connects to drop DS1s at a later time. NOTE: On STS-1 path-switched rings, all nodes in the ring must be provisioned as STS-1 cross-connections.

Claim Element	Lucent 2000 Product Family
	DDM-2000 TARP Release 13 at 400-401

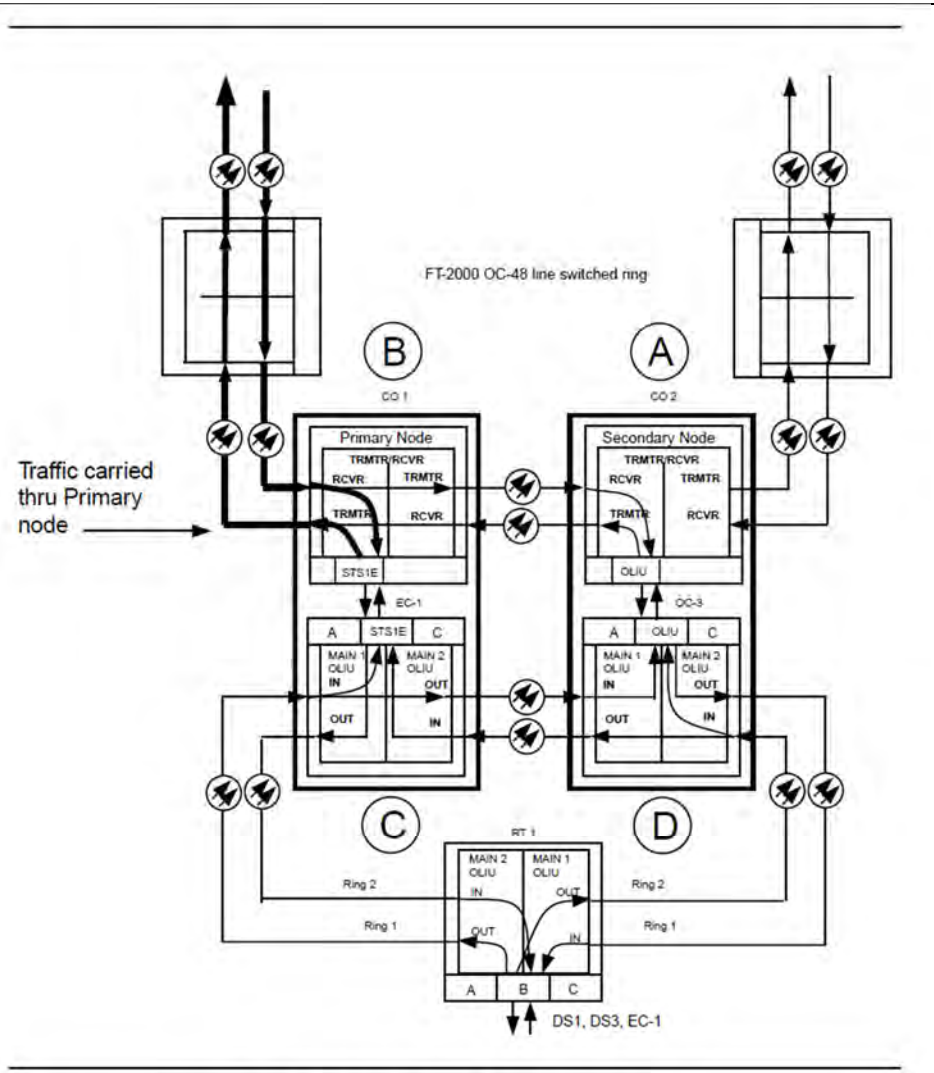


Figure 1 – OC-3/OC-48 DRI Interworking

DDM-2000 OC-3 MULTIPLEXER

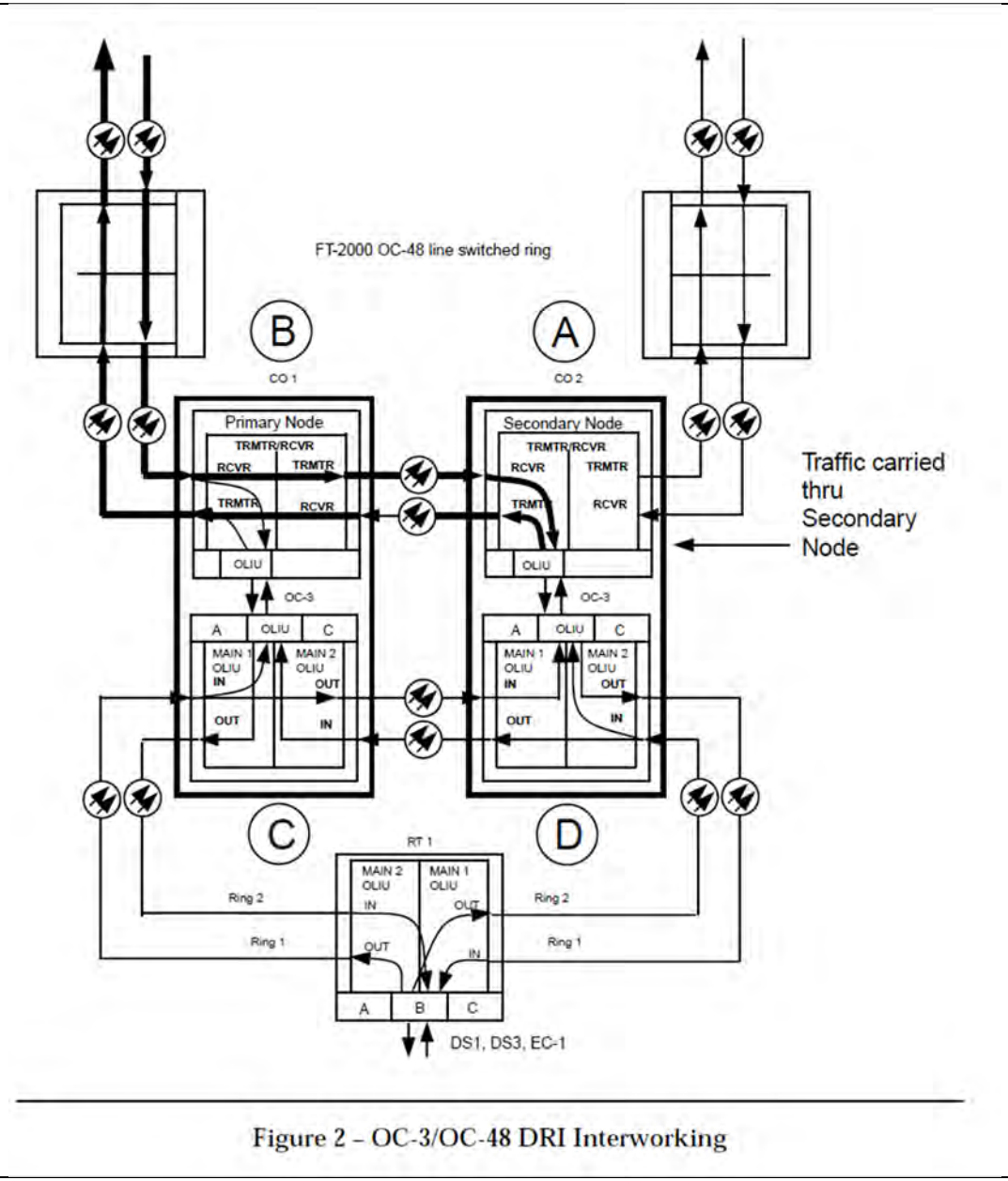


Figure 2 – OC-3/OC-48 DRI Interworking

Claim Element	Lucent 2000 Product Family
	DDM-2000 TARP Release 13 at 759-760

Install STS1E Circuit Packs

1. ⚠ **CAUTION:**
   Take care to avoid damaging the LEDs that protrude through the opening in the faceplate of the **BBG6 STS1E**.

   NOTE:
   BBG6 STS1E circuit packs may be installed in **FUNCTION UNITS** group slots **A**, **B**, or **C**. Service **BBG6 STS1E** circuit packs are installed in slots labeled **FUNCTION UNITS ( ) 1**. Protection **BBG6 STS1E** circuit packs are installed in slots labeled **FUNCTION UNITS ( ) 2(P)**.

   Determine which **FUNCTION UNITS** group slots (**A**, **B**, or **C**) are to be equipped with **BBG6 STS1E** circuit packs.

2. Determine from office records the length of the STS1E cabling between the DDM-2000 and the STSX cross-connect point.

3. Refer to Table A and Figure 1. Install the STS1E option jumpers per Table A.

4. NOTE:
   The **BBG6 STS1E** circuit pack provides bidirectional transport of one EC-1 signal through the DDM-2000 Multiplexer. **STS1E** high speed mode interfaces with the **DS1** circuit packs in a **FUNCTION UNITS** group at the VT-G rate. **STS1E** low speed mode interfaces with the **OLIU** circuit packs at the STS-1 rate.

   Set switch **S1** to mode of operation required (HIGH-SPEED MODE or LOW-SPEED MODE).

Table A – STS1E LBO Settings

Cable Length (Ft)		
734A Cable	**735A Cable**	**LBO Setting**
0 to 225	0 to 125	LBO IN
>225 to 450	>125 to 250	LBO OUT

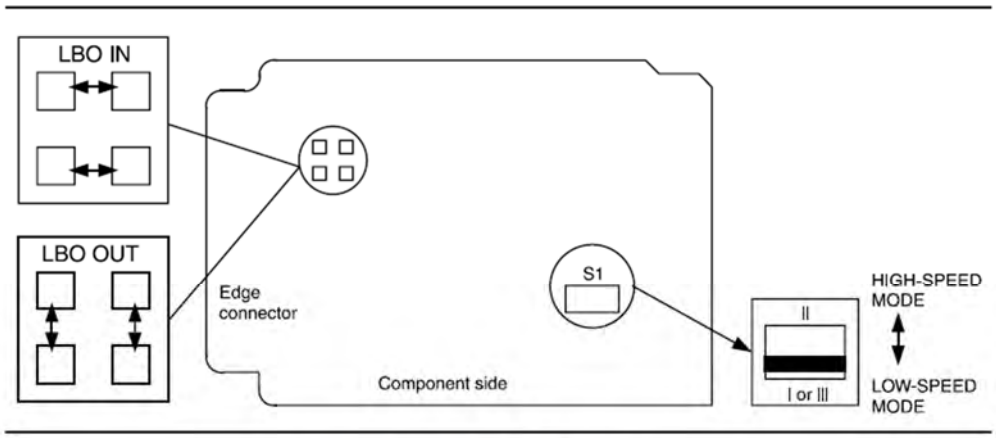


Figure 1 – BBG6 STS1E Option Settings

5. NOTE:
   If the response is not correct in the following procedures, replace the **BBG6 STS1E** circuit pack.

   Seat a **BBG6 STS1E** circuit pack in **FUNCTION UNITS** group slot **A-1**, **B-1**, or **C-1**.

   Response: **FAULT** LED on the **STS1E** lights for about 20 seconds then goes off. **ACTIVE** LED lights on the first **BBG6 STS1E** circuit pack of the pair installed.

6. If required, seat a second (protection) **BBG6 STS1E** circuit pack in **FUNCTION UNITS** group slot **A-2(P)**, **B-2(P)**, or **C-2(P)** of the same **FUNCTION UNITS** group.

   Response: **FAULT** LED on the **STS1E** lights for about 20 seconds then goes off. **ACTIVE** LED remains off.

7. Repeat this procedure from Step 1 for each pair of **BBG6 STS1E** circuit packs to be installed.

8. **STOP. YOU HAVE COMPLETED THIS PROCEDURE.**

Claim Element	Lucent 2000 Product Family
	DDM-2000 TARP Release 13 at 836

BBG6 STS1E

23. Determine from office records the length of the STS1E cabling between the DDM-2000 and the STSX cross-connect point.

24. Install the **STS1E** option jumpers per Table L and Figure 7.

25. NOTE:
The **STS1E** circuit pack provides bidirectional transport of one EC-1 signal through the DDM-2000 Multiplexer. **STS1E** high speed mode interfaces with the **DS1/DS1PM** circuit packs in a function unit group at the VT-G rate. **STS1E** low speed mode interfaces with the **OLIU** circuit packs at the STS-1 rate.

Determine **STS1E** mode of operation (high speed or low speed).

26. Set switch **S1** to mode of operation required (**HIGH-SPEED MODE** or **LOW-SPEED MODE**).

27. **STOP. YOU HAVE COMPLETED THIS PROCEDURE.**

Table L – STS1E LBO Settings

Cable Length (Ft)		
734A Cable	735A Cable	LBO Setting
0 to 225	0 to 125	LBO IN
>225 to 450	>125 to 250	LBO OUT

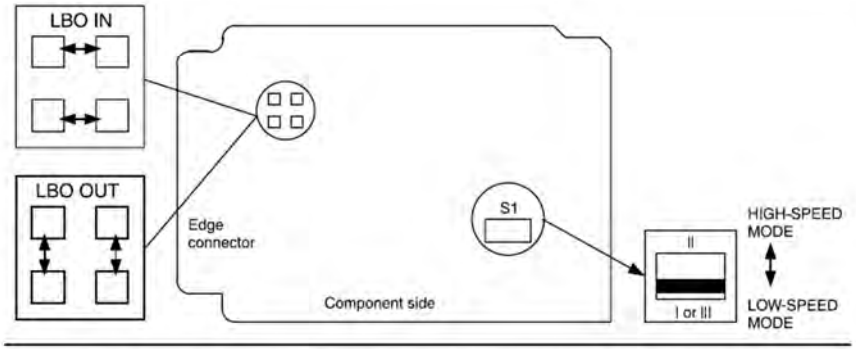


Figure 7 – BBG6 STS1E Line Build-Out Jumpers and Mode Switch

DDM-2000 OC-3 MULTIPLEXER

Claim Element	Lucent 2000 Product Family
	DDM-2000 TARP Release 13 at 1073

Perform DS3 Transmission Test
Dual Ring Interconnection

Overview: This procedure is performed on one or more out-of-service circuits to test the dual ring interconnections (DRI) from a DDM-2000 ring network to another DDM-2000 ring network or to an FT-2000 ring network. Numerous configurations are possible when interconnecting DDM-2000 networks. Therefore, this procedure provides you with typical examples and explanations of some of the possible configurations and instructs you on the procedures used in testing these configurations.

1. NOTE:
This procedure may be used to perform DS3 transmission tests for a Dual Ring Interconnection (DRI) between DDM-2000 networks and FT-2000 ring networks. When this procedure is being used to perform end-to-end DS3 tests, it is assumed that the complete end-to-end systems have already been tested and that only a particular DS3 channel is being tested at this time.

NOTE:
A CIT is required for this test to make/verify cross-connections and to switch paths of the DS3 being tested. The transmission test can be performed either with a CIT and the automated test command `test-trmsn-t3:` or with a DS3 test set.

NOTE:
The DS3 circuit being tested is assumed to originate at equipment external to the DDM-2000 source node and is carried around the DDM-2000 ring to the dual ring interconnection nodes where it is connected to the corresponding DDM-2000 DRI nodes or to the primary and secondary FT-2000 DRI nodes. The DS3 is then carried around the next ring network to the final destination node where it is terminated on external equipment. If more than two rings are interconnected, the DS3 signal may be passed through another set of DRI nodes.

Claim Element	Lucent 2000 Product Family
	DDM-2000 TARP Release 13 at 1081-1092

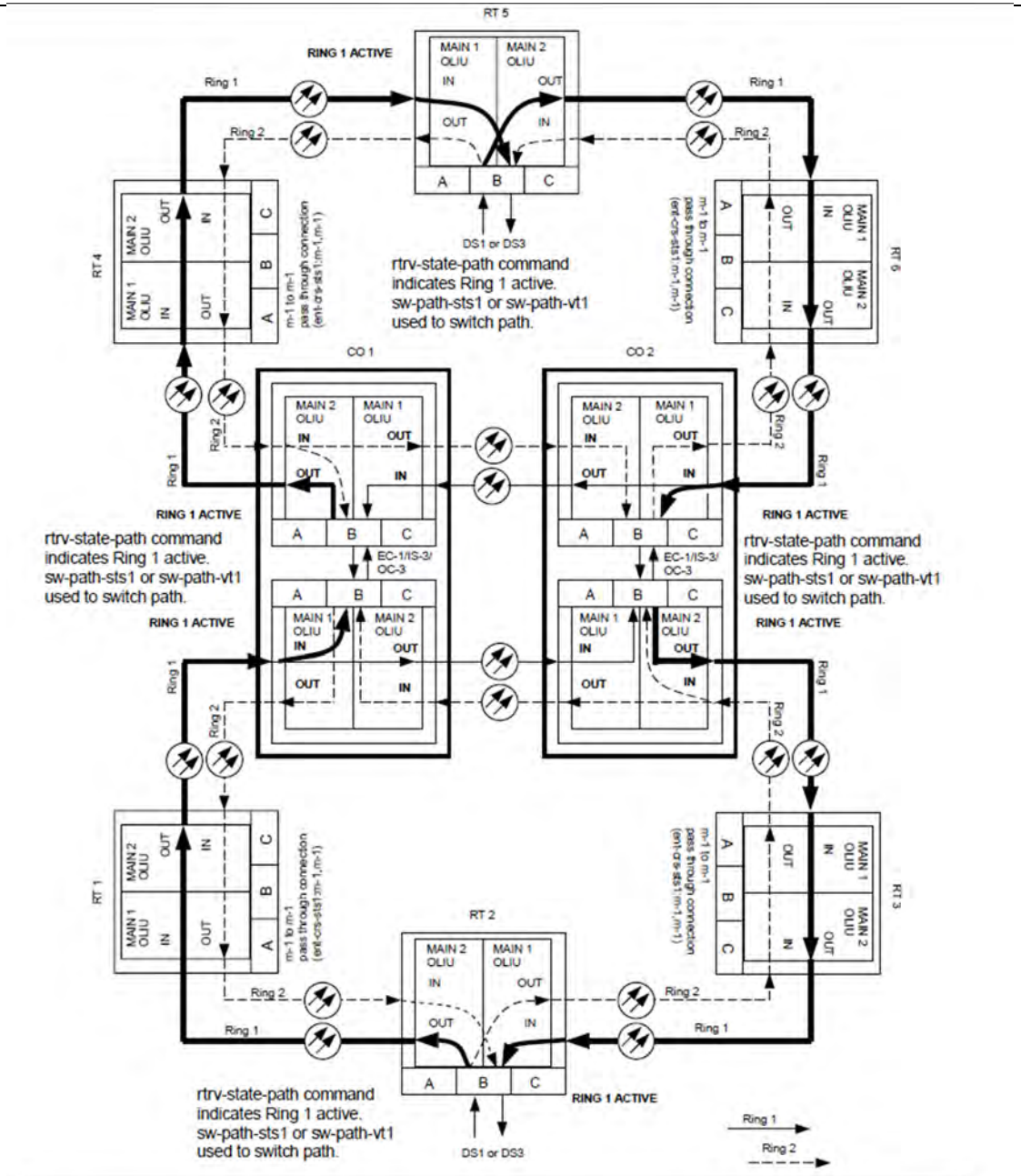


Figure 3 – Example of DS3 Transmission Test in Dual Ring Interworking Network

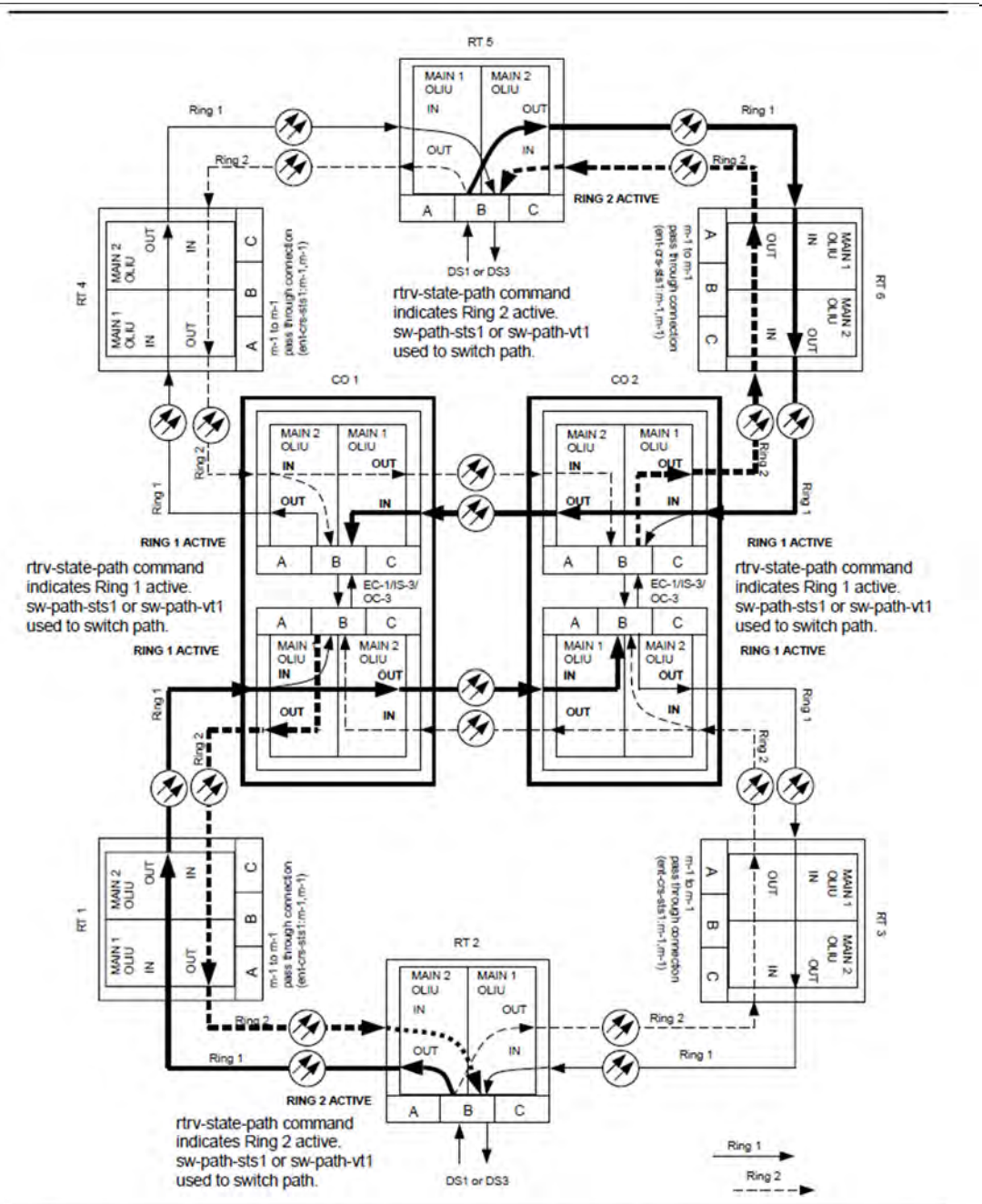


Figure 4 – Example of DS3 Transmission Test in Dual Ring Interworking Network

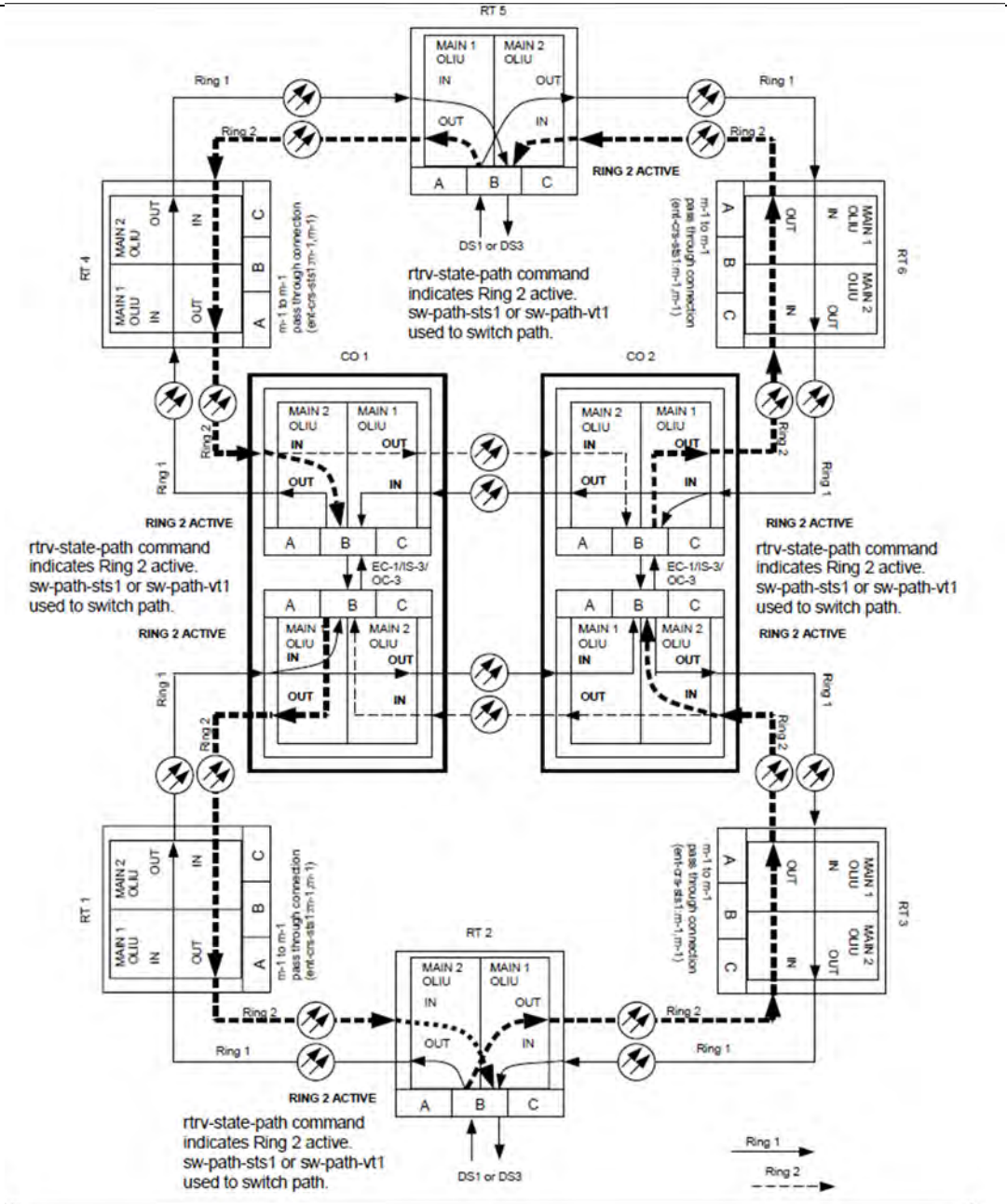


Figure 5 – Example of DS3 Transmission Test in Dual Ring Interworking Network

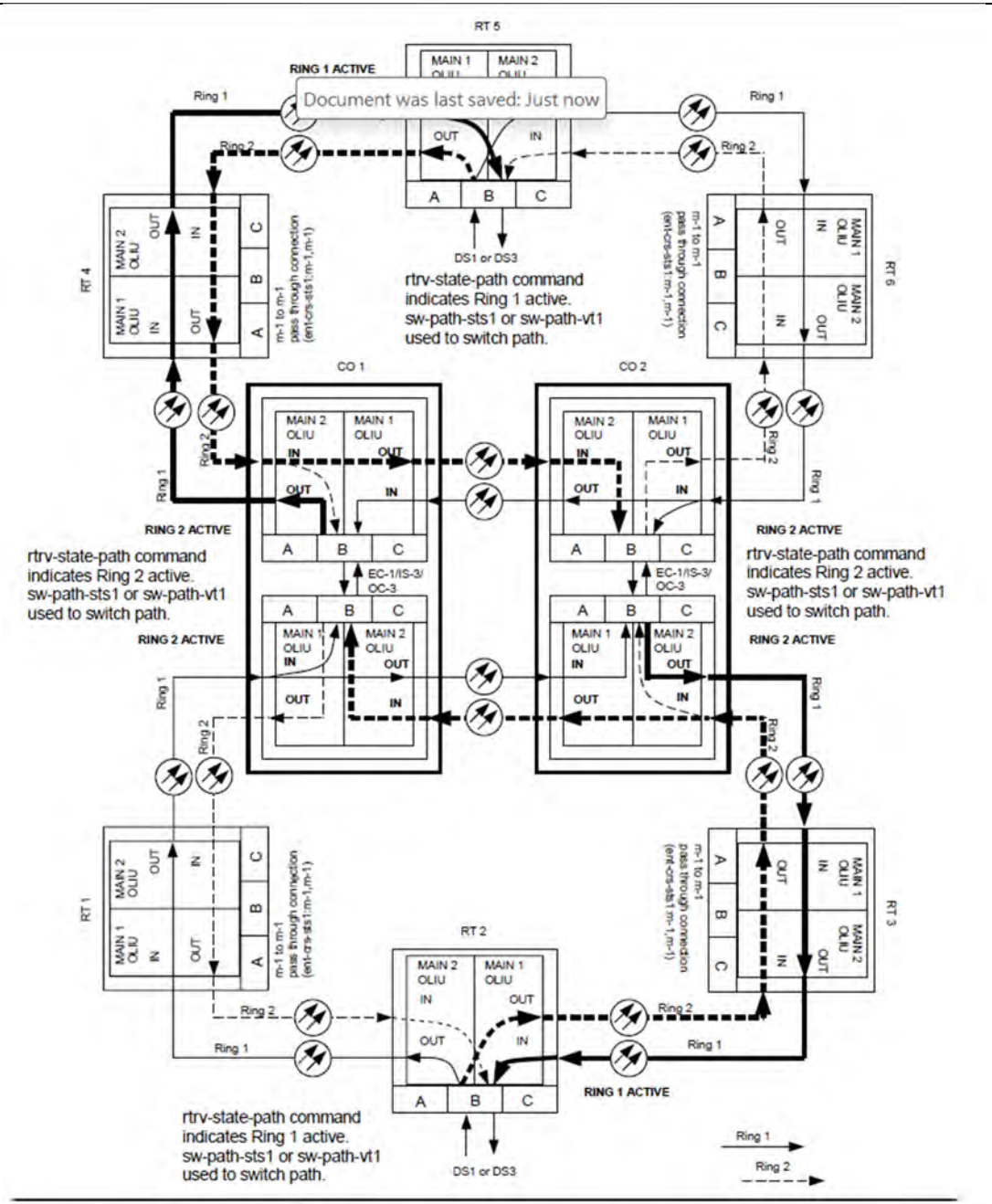


Figure 6 – Example of DS3 Transmission Test in Dual Ring Interworking Network

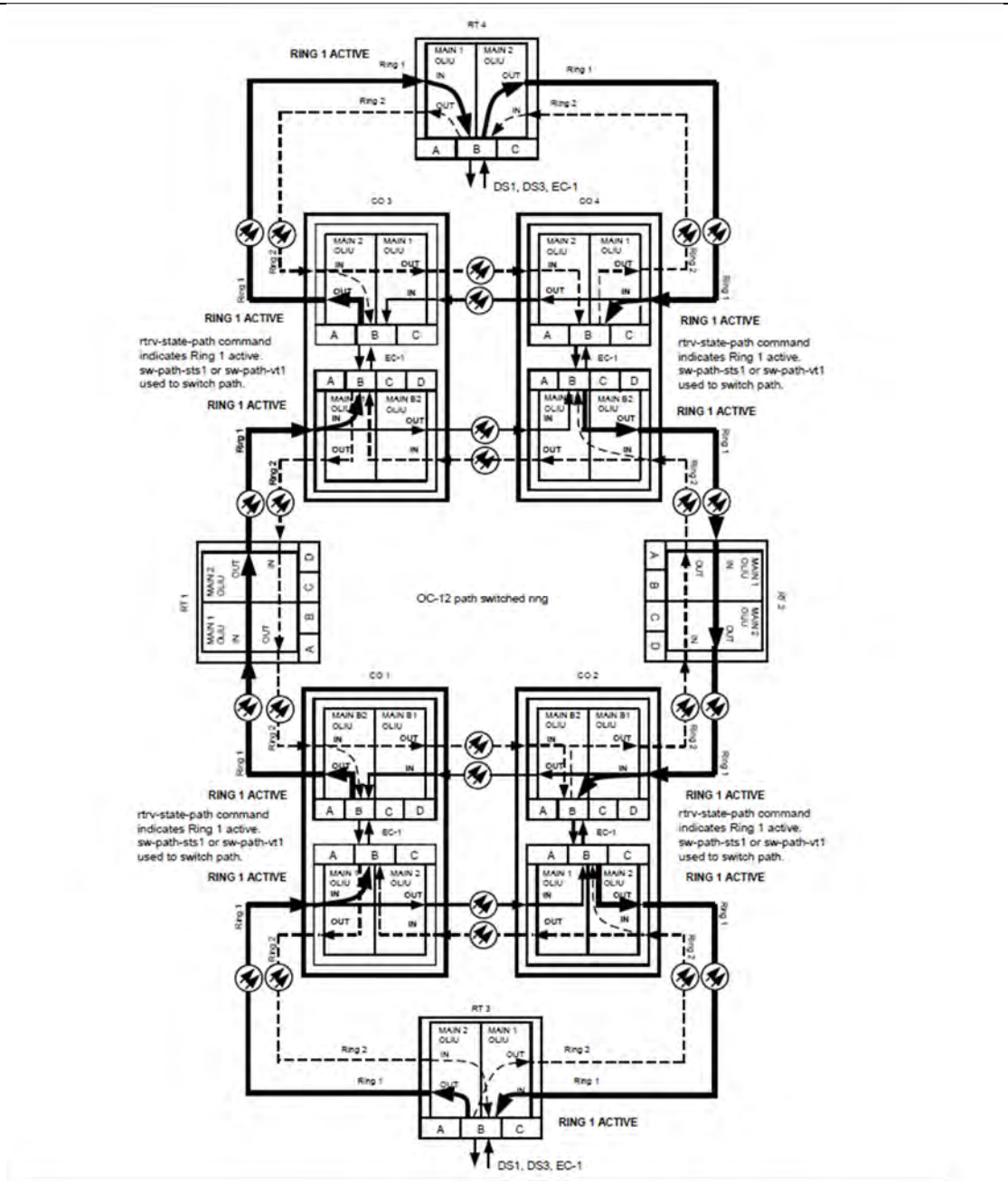


Figure 7 – Example of DS3 Transmission Test in Dual Ring Interworking Network

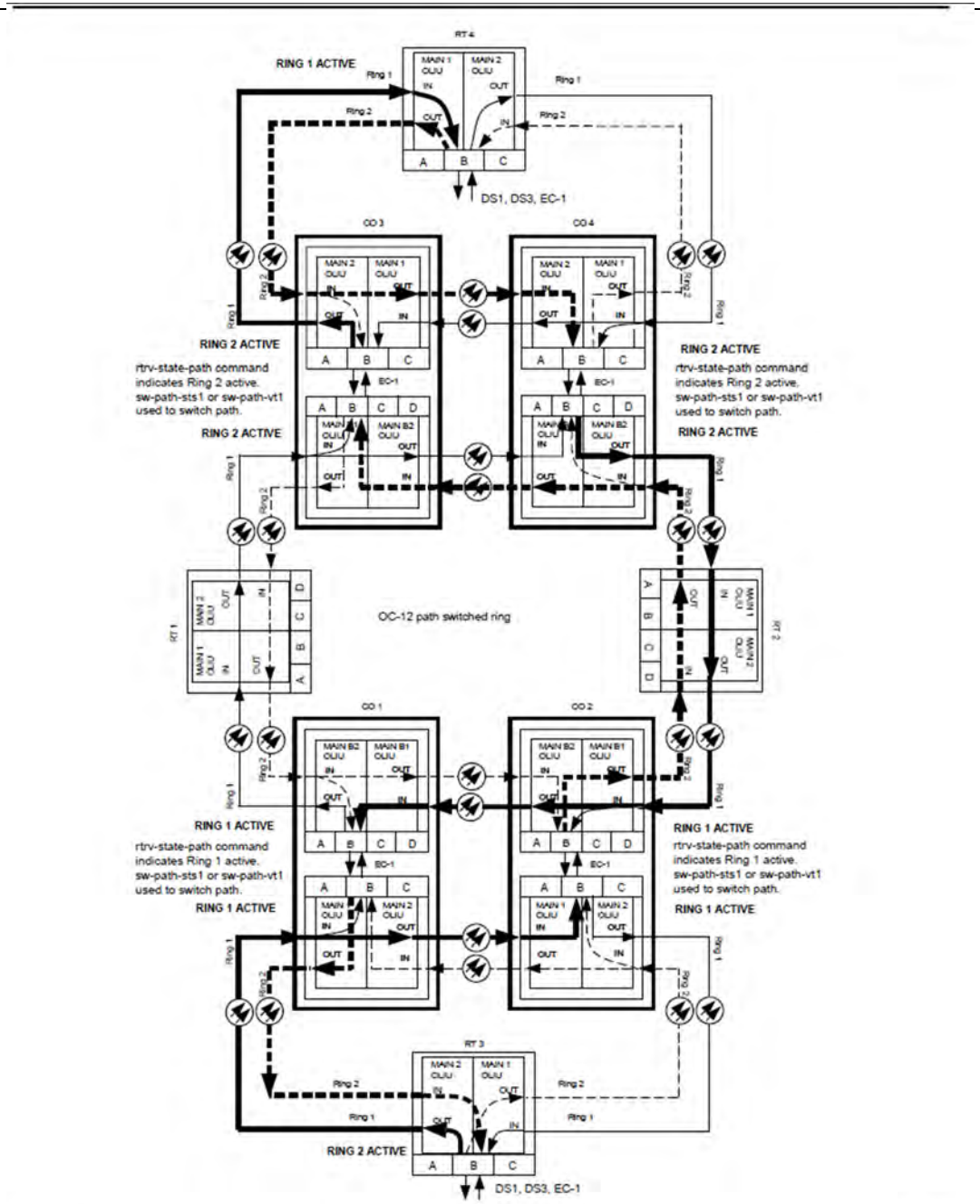


Figure 8 – Example of DS3 Transmission Test in Dual Ring Interworking Network

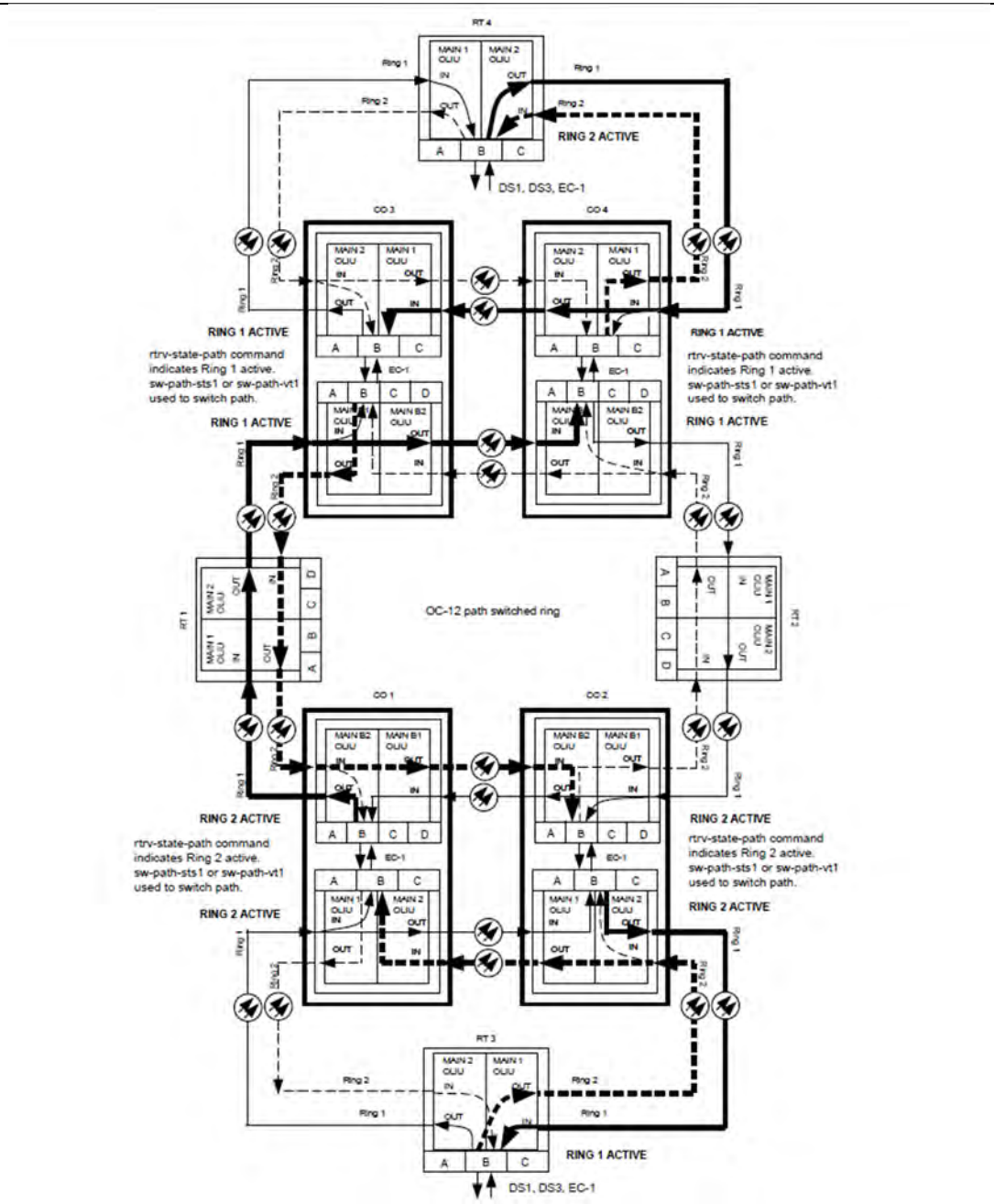


Figure 9 – Example of DS3 Transmission Test in Dual Ring Interworking Network

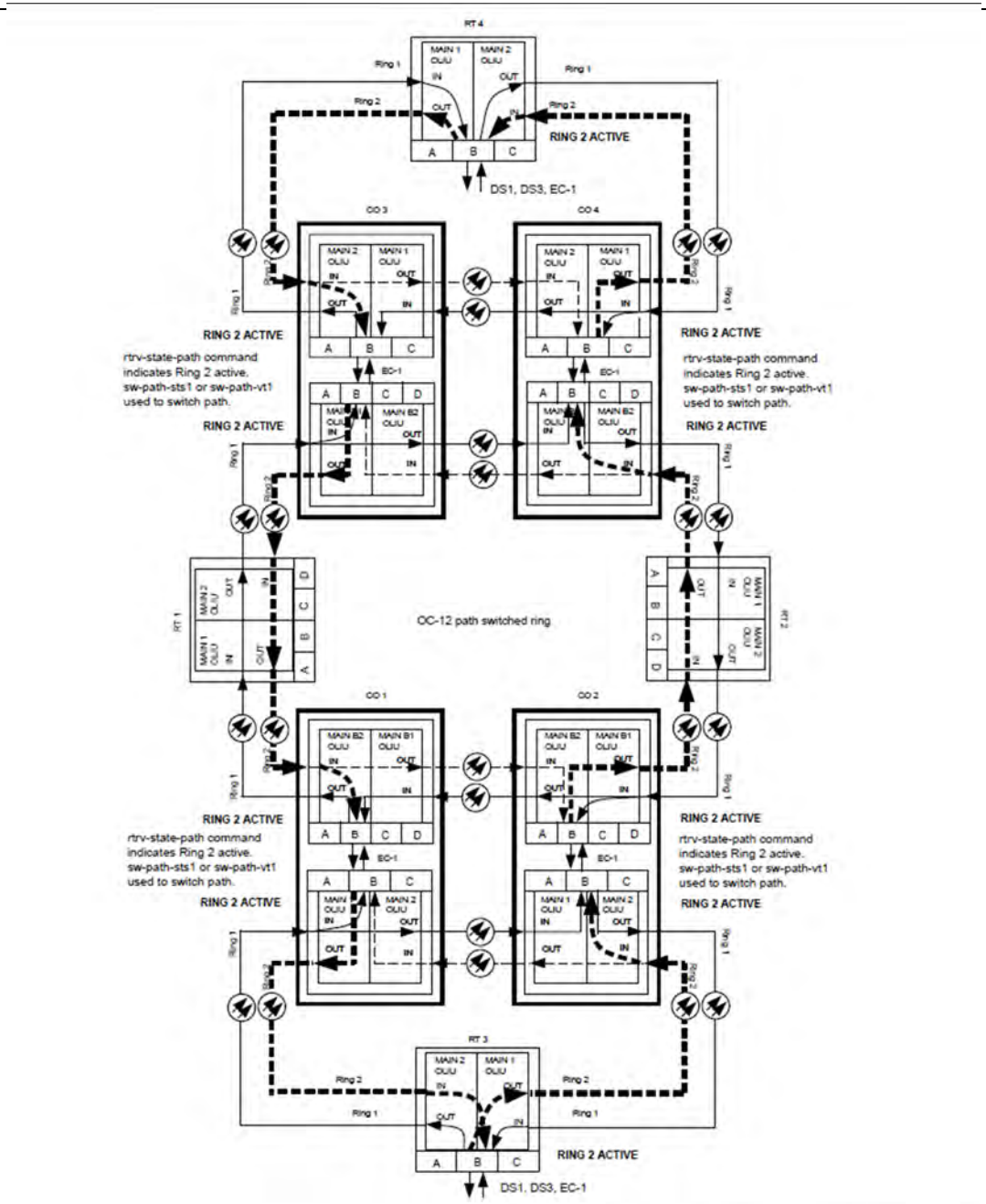


Figure 10 – Example of DS3 Transmission Test in Dual Ring Interworking Network

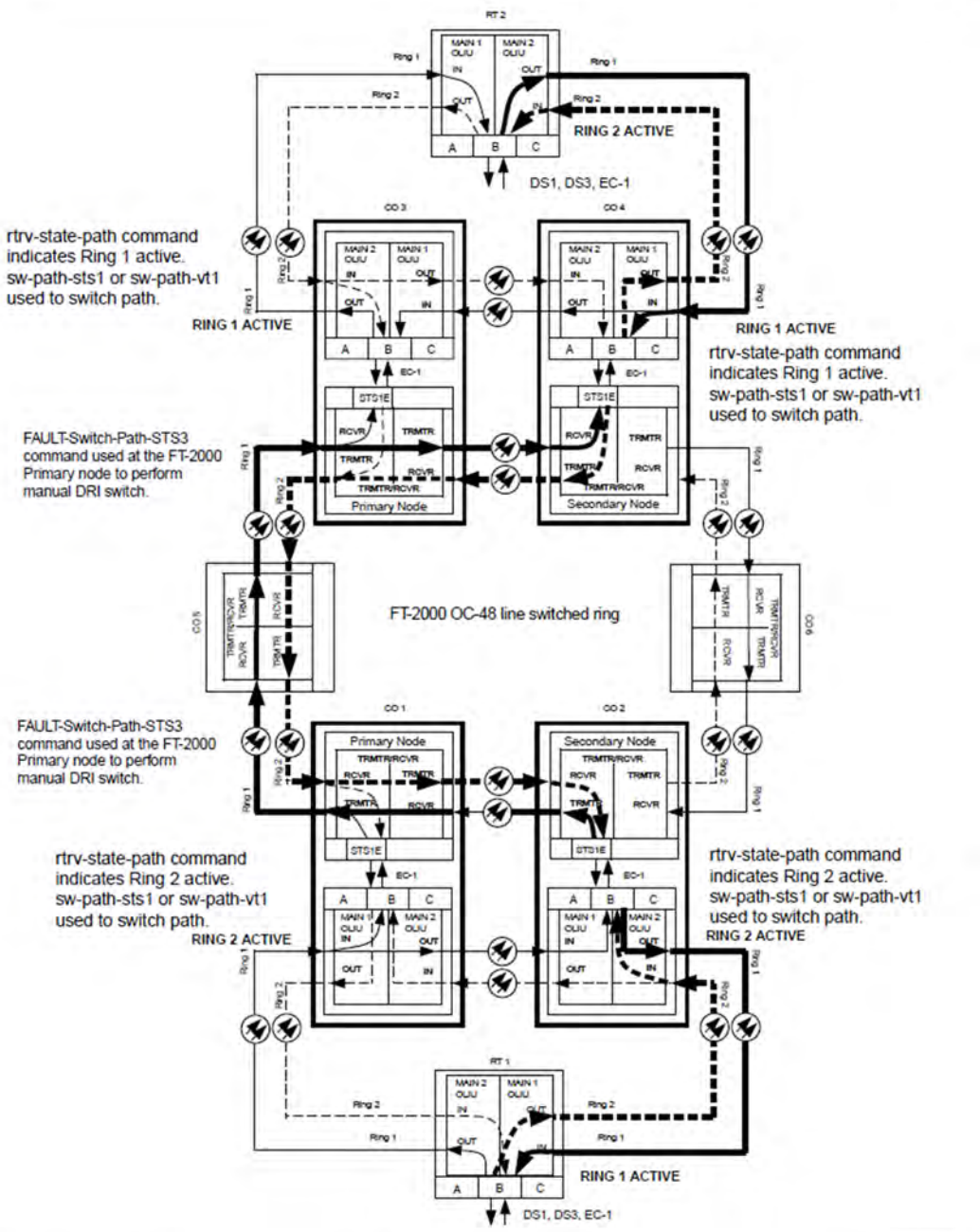


Figure 11 – Example of DS3 Transmission Test in Dual Ring Interworking Network

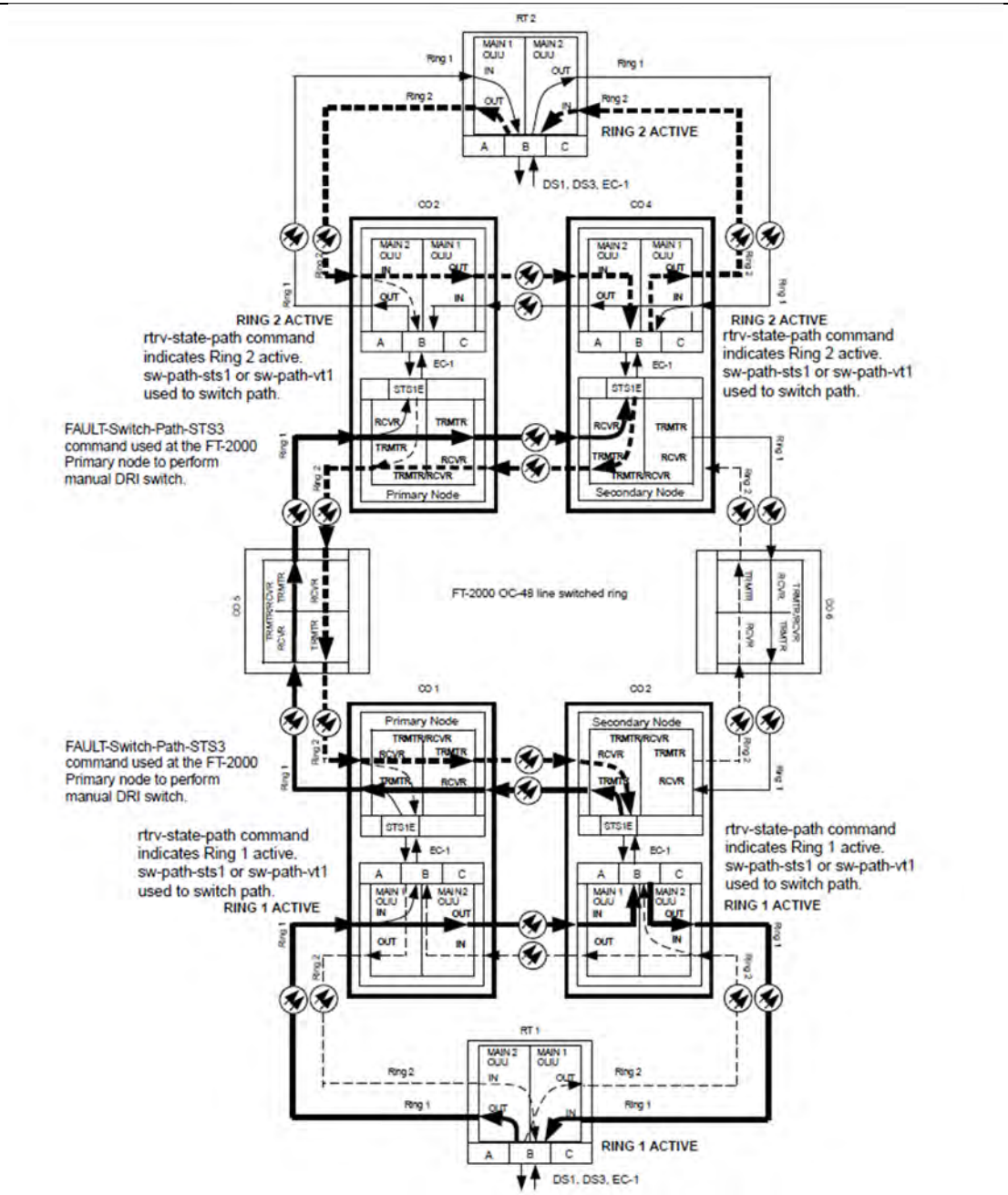


Figure 12 – Example of DS3 Transmission Test in Dual Ring Interworking Network

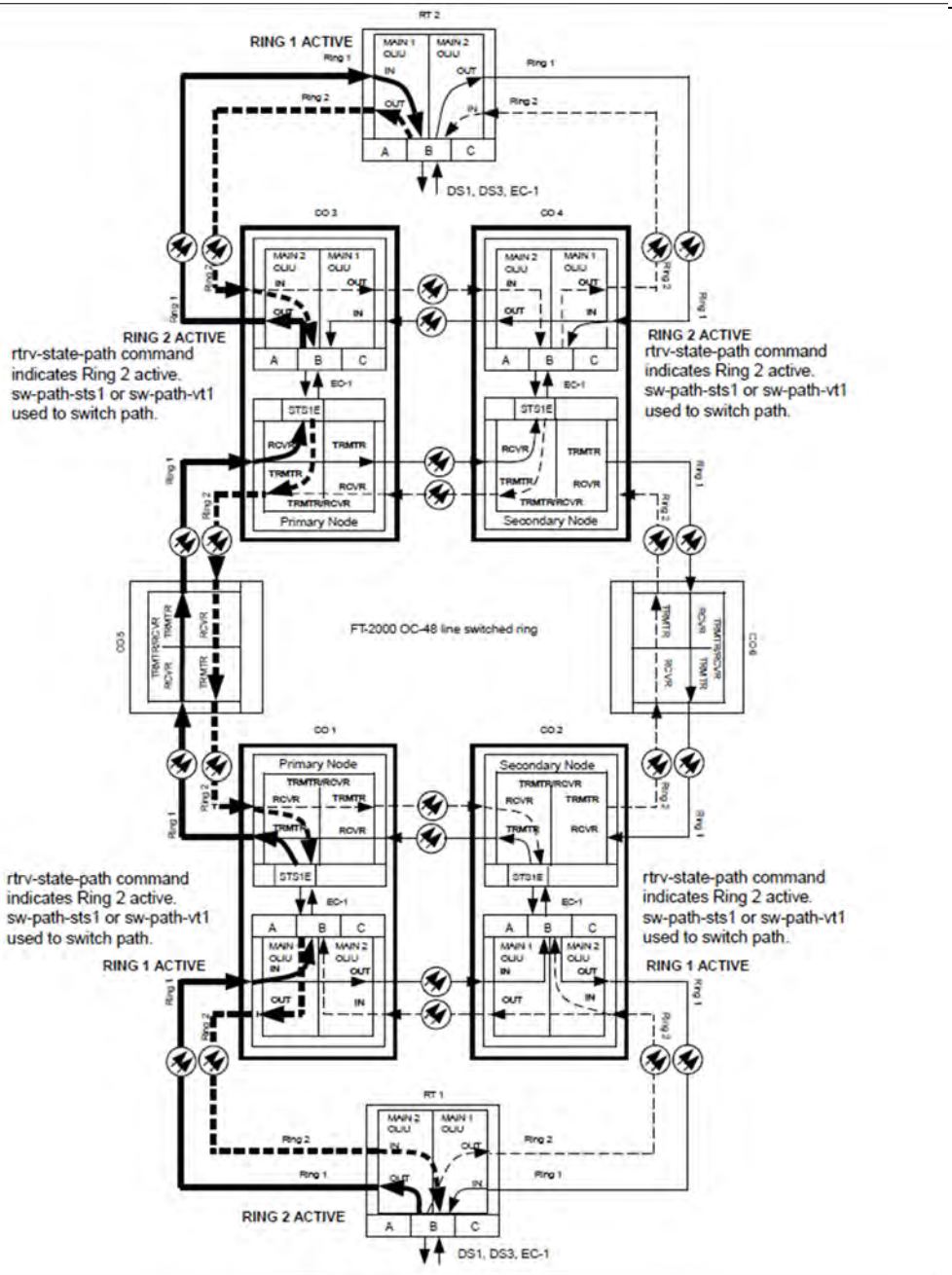


Figure 13 – Example of DS3 Transmission Test in Dual Ring Interworking Network

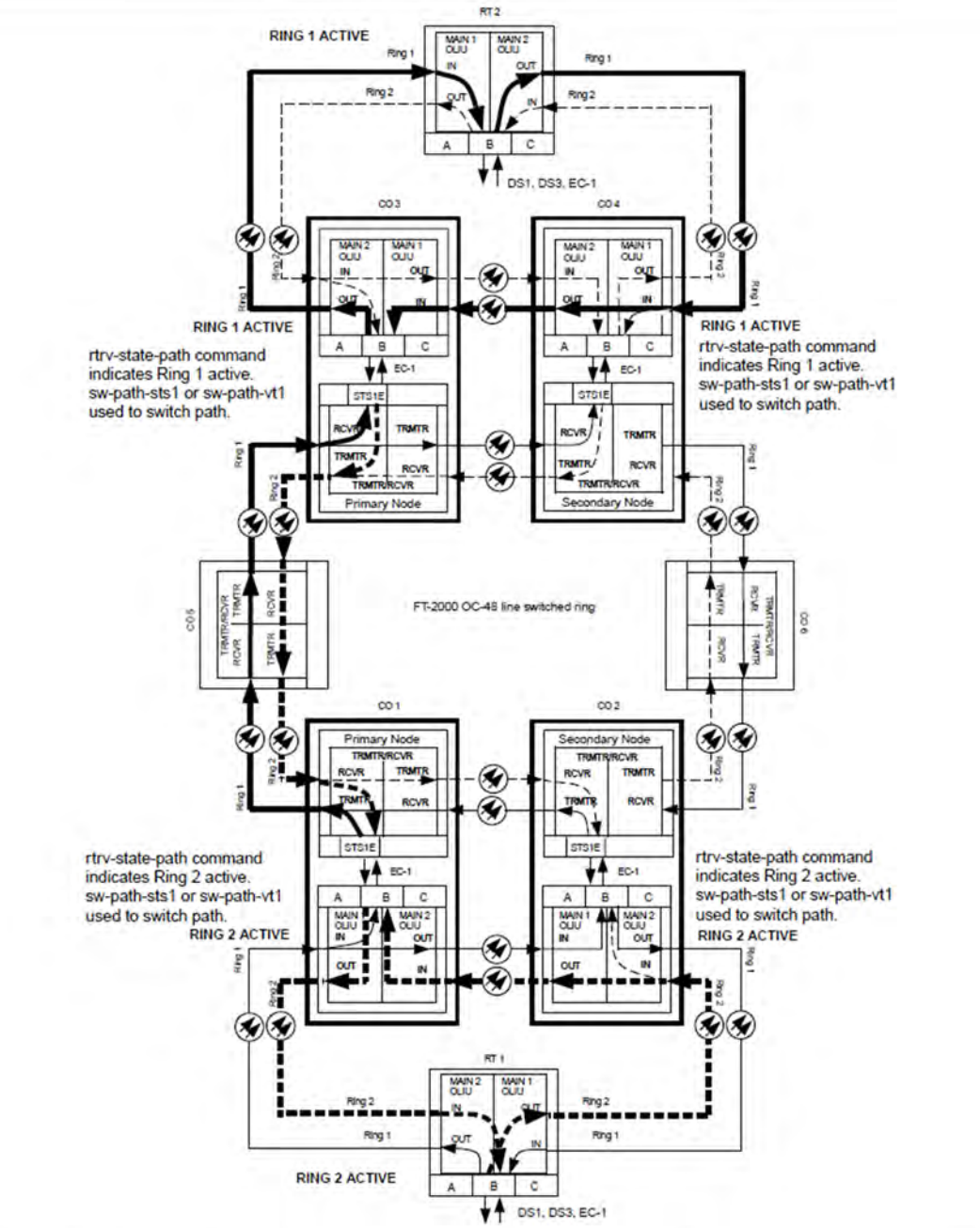


Figure 14 – Example of DS3 Transmission Test in Dual Ring Interworking Network

Claim Element	Lucent 2000 Product Family
	DDM-2000 TARP Release 13 at 1093-1113

Perform DS1 Transmission Test
Dual Ring Interconnection

Overview: This procedure is performed on one or more out-of-service circuits to test the dual ring interconnections (DRI) from a DDM-2000 ring network to another DDM-2000 ring network or through an FT-2000 ring network. Numerous configurations are possible when interconnecting DDM-2000 networks. Therefore, this procedure provides you with typical examples and explanations of some of the possible configurations and instructs you on the procedures used in testing these configurations.

1. NOTE:
This procedure may be used to perform DS1 transmission tests for a Dual Ring Interconnection (DRI) between DDM-2000 networks and FT-2000 ring networks. When this procedure is being used to perform end-to-end DS1 tests, it is assumed that the complete end-to-end systems have already been tested and that only a particular DS1 channel is being tested at this time.

NOTE:
A CIT is required for this test to make/verify cross-connections and to switch paths of the DS1 being tested. The transmission test can be performed either with a CIT and the automated test command `test-trmsn-t1:` or with a DS1 test set.

NOTE:
The DS1 circuit being tested is assumed to originate at equipment external to the DDM-2000 source node and is carried around the DDM-2000 ring to the dual ring interconnection nodes where it is connected to the corresponding DDM-2000 DRI nodes or to the primary and secondary FT-2000 DRI nodes. The DS1 is then carried around the next ring network to the final destination node where it is terminated on external equipment. If more than two rings are interconnected, the DS1 signal may be passed through another set of DRI nodes.

NOTE:
Proper cross-connections must be made at each shelf to establish the complete end-to-end path for the DS1 circuit being tested. TARP Release 13 has no default cross-connections and supports only manual VT1.5 and STS-1 cross-connections. See the description of the following commands in the Commands and Reports section of this manual: **cnvt-crs**, **dlt-crs-sts1**, **dlt-crs-vt1**, **ent-crs-sts1**, **ent-crs-vt1**, **rtrv-crs-sts1**, **rtrv-crs-vt1**, **cnvt-crs-sts1**, **set-ne**, and **rtrv-ne**. See Cross-Connection Provisioning in the Administration and Provisioning section of this manual for more information on cross-connection provisioning.

NOTE:
If one terminating end is equipped with **STS1E** circuit packs to provide EC-1 service and the other terminating end is equipped with **DS1/DS1PM** circuit packs, the DS1 transmission test is performed from the DS1 terminating end. If the CIT and **test-trmsn-t1:** command is being used to perform the test and you are at the EC-1 terminating end, you may be able to use the **rlgn** command to log into the DS1 end to perform the test using the **test-trmsn-t1:** command.

NOTE:
When both terminating ends are equipped with **STS1E** circuit packs, one end may be temporarily equipped with **DS1/DS1PM** and **MXRVO** circuits packs to perform the transmission tests. To perform transmission tests for this configuration, remove the **STS1E** at the near end, perform an update (**upd**), and install the **DS1/DS1PM** and **MXRVO** circuit pack(s). After the tests are completed, remove the temporary circuit packs, perform an update, and reinstall the **STS1E** circuit packs.

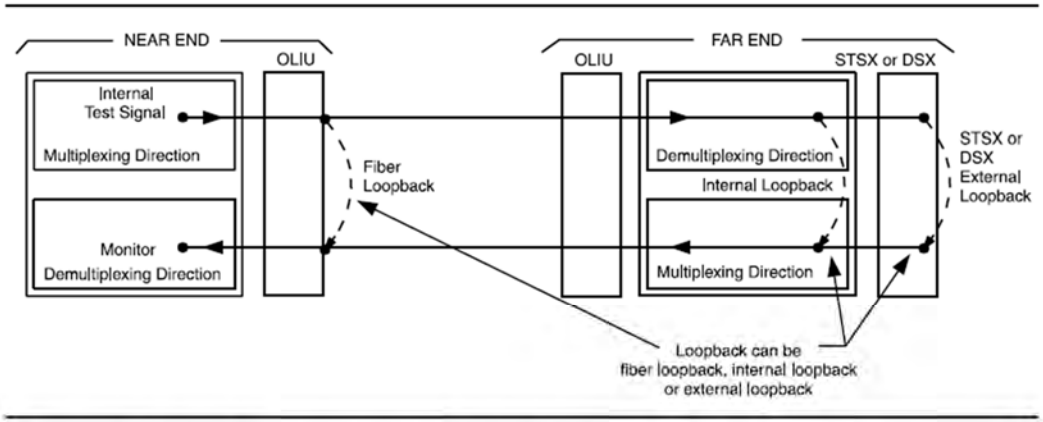
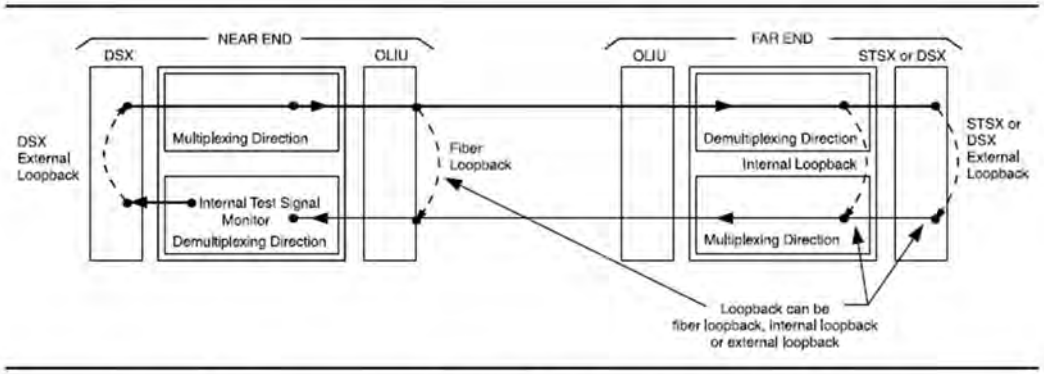
At the near-end **DDM-2000**, connect the CIT to the **CIT** jack on the User Panel, if required.

Reference: **DLP-521**

2. NOTE:
Work orders, office records, or CIT **ent-crs-sts1**, **ent-crs-vt1** or **rtrv-crs** commands may be used to make or verify STS-1 cross-connections.

At each shelf in the network, make/verify that proper pass-through, terminating, and "drop and continue" STS-1 cross-connections have been made for each DS1 channel being tested.

Claim Element	Lucent 2000 Product Family
	3. NOTE: Local tests cannot be performed in the DEMUX direction for **STS1E** circuit packs. See Figures 1 and 2. If local tests are being performed, the fiber loopbacks at the near-end **OLIU**s must be in place. If end-to-end tests are being performed, do ONE of the following: a. Connect a patch cord from the **OUT** jack to the **IN** jack at the far-end DSX-1 or STSX cross-connection associated with the DS1 channel to be tested. b. Log into the far-end terminal and use the **`opr-lpbk-t1:`***`address`* or **`opr-lpbk-ec1:`***`address`* command to loop back the DS1 or EC-1 port(s) at the far end. Use **`logout`** or **`toggle`** (ctrl t) command to return control of CIT to near end.

Claim Element	Lucent 2000 Product Family
	 **Figure 1 – Transmission Test of DS1 Signal in MUX Direction**  **Figure 2 – Transmission Test of DS1 Signal in DEMUX Direction**

4. **CAUTION:**
Execution of switch commands may affect service. Check local procedures before performing switch commands.

NOTE:
If this transmission test is to be performed for each path in the end-to-end network, the **`switch-path-sts1:`** or **`switch-path-vt1:`** command must be used at some of the DDM-2000 nodes to switch paths for each test. If FT-2000 is part of the network, the **`FAULT-Switch-Path-STS3`** command must be used at the FT-2000 Primary DRI node(s) if the FT-2000 secondary path and the DDM-2000 DRI connections to the FT-2000 secondary node are to be tested. Up to four tests may have to be performed for each DS1 circuit if all protection paths are required to be tested. See Figures 3 through 14.

NOTE:
For configurations not shown in the examples, local procedures should be developed to test the DS1 circuits being equipped. A sketch of the network may need to be made and the paths to be tested should be determined as shown in the examples in this procedure.

Use the necessary switch commands to set up the DS1 path being tested. [For example, if the configuration looks like Figure 3, use the **`switch-path-sts1:`** command for test 1 to make Ring 1 active at both terminating nodes and all DDM-2000 DRI nodes. Other DS1 path tests for the same configuration would be set up as follows (Figures 4 through 6)]:

Test	Terminating Nodes	DRI Nodes	Figure
Test 1	Ring 1 active	Ring 1 active	Figure 3
Test 2	Ring 2 active	Ring 1 active	Figure 4
Test 3	Ring 2 active	Ring 2 active	Figure 5
Test 4	Ring 1 active	Ring 2 active	Figure 6

5. Are you using CIT and **`test-trmsn-t1:`** command to perform this test?

If **YES**, then continue with **Step 6**.
If **NO**, then proceed to **Step 23**.

6. Are you doing this test in the mux or demux direction?

If **MUX** direction, then continue with **Step 7**.
If **DEMUX** direction, then proceed to **Step 9**.

7. At the near end DDM-2000, use the following command to perform a test of the DS1 loop in the fiber direction:
`test-trmsn-t1:address:dirn=mux:dur=( );`

   Where *address* = address identifier of the DS1 signal.

   dirn = direction of the test. If **dirn=mux**, direction is toward fiber.

   dur = duration of the test in minutes (1-120), default is 1.

8. Was the test successful (error free)?

   If **YES**, then continue with **Step 12**.
   If **NO**, then proceed to **Step 37**.

9. See Figure 2. At the near-end DSX-1 cross-connection associated with the DDM-2000 being tested, connect a patch cord from the **OUT** jack to the **IN** jack for the DS1 channel to be tested.

10. Use the following command to perform a DS1 transmission test in the demux direction to test the DS1 loop in the DSX direction:
`test-trmsn-t1:address:dirn=demux:dur=( );`

    Where *address* = address identifier of the DS1 signal.

    dirn = direction of the test. If **dirn=demux**, direction is toward DSX.

    dur = duration of the test in minutes (1-120), default is 1.

11. Was the test successful (error free)?

    If **YES**, then continue with **Step 12**.
    If **NO**, then proceed to **Step 37**.

12. Is this the first service being placed on the group and is a protection circuit pack installed?

    If **YES**, then continue with **Step 13**.
    If **NO**, then proceed to **Step 17**.

13. Use the following command to switch from service to protection circuit pack:
`switch-ls:address:pri=manual;`.

    Response: The green **ACTIVE** LED lights on the protection circuit pack.

14. Repeat the transmission test in the mux (or demux) direction using the following command:
`test-trmsn-t1:address:dirn=mux (or demux):dur=( );`.

15. Was the test successful (error free)?

    If **YES**, then continue with **Step 16**.
    If **NO**, then proceed to **Step 37**.

16. Use the following command to clear active switch requests on the protection circuit pack:
`switch-ls:address:pri=reset;`.

17. The **DS1** circuit path under test has passed the DS1 transmission test. Have all required paths been tested?

    If **NO**, then continue with **Step 18**.
    If **YES**, then proceed to **Step 19**.

18. Repeat this procedure from Step 4 for the next path to be tested.

19. Remove the looping patch cords from the cross-connect point. Use the `rls-lpbk-t1:` command to release loopback(s) at the far end, if required.

20. At the near-end (and the far-end) DDM-2000, momentarily depress the **UPD/INIT** button (or use the `upd` command) on the **SYSCTL** to update the **SYSCTL**.

21. Repeat this procedure from Step 2 for any additional DS1 circuits to be tested.

22. **STOP. YOU HAVE COMPLETED THIS PROCEDURE**.

23. At the cross-connection associated with the near-end DDM-2000, connect the DS1 test set to the **IN** and **OUT** jacks associated with the circuit under test.

24. Use the DS1 test set to test for error-free transmission.

25. Was the test successful (error free)?

    If **YES**, then continue with **Step 26**.
    If **NO**, then proceed to **Step 37**.

26. Is this the first service being placed on the group and is protection circuit pack installed?

    If **YES**, then continue with **Step 27**.
    If **NO**, then proceed to **Step 31**.

27. Unseat the service **DS1/DS1PM** circuit pack associated with the circuit under test.

28. Repeat the DS1 transmission test with the DS1 test set.

29. Was the test successful (error free)?

    If **YES**, then continue with **Step 30**.
    If **NO**, then proceed to **Step 37**.

30. Reseat the **DS1/DS1PM** circuit pack associated with the circuit under test.

31. The **DS1** circuit path under test has passed the DS1 transmission test. Have all required paths been tested?

    If **NO**, then continue with **Step 32**.
    If **YES**, then proceed to **Step 33**.

32. Repeat this procedure from Step 4 for the next path to be tested.

33. Remove the looping patch cords from the cross-connections.

34. At the near-end (and the far-end) DDM-2000, momentarily depress the **UPD/INIT** button on the **SYSCTL** to update the **SYSCTL**.

35. Repeat this procedure from Step 2 for any additional DS1 circuits to be tested.

36. **STOP. YOU HAVE COMPLETED THIS PROCEDURE.**

37. Check for line code (AMI/B8ZS) mismatch at near end and far end. If mismatch is found, set line code [**DLP-513**] to correct value and repeat this test. If no trouble is found, continue with the next step.

38. In some releases, if **dlc=yes** as set by the **set-t1:** command, loopbacks are not recognized (loopback not recognized) in this test. Use **rtrv-t1:** command to check if **dlc=yes**.

39. Is dlc set to yes?

    If **YES**, then continue with **Step 40**.
    If **NO**, then proceed to **Step 41**.

40. Use **set-t1:** command to temporarily set **dlc=no** and repeat this test. If the test fails again, continue with the next step.

41. Has the **DS1/DS1PM** circuit pack that failed the test been replaced?

    If **YES**, then proceed to **Step 44**.
    If **NO**, then continue with **Step 42**.

42. Replace the **DS1/DS1PM** circuit pack that failed the test.

    Reference: **DLP-523**

43. Repeat this procedure for the **DS1/DS1PM** circuit pack that failed.

44. Trouble may be in the DSX cross-connect wiring, VT1/STS1 cross-connections in the network (if ring configuration), or the shelf backplane. Use the rtrv-crs-( ) command to ensure proper VT1/STS1 cross-connections have been made at each shelf in the ring for the DS1 being tested. If no trouble found, check DSX cross-connect wiring and backplane connections. If other alarms or trouble indications are present, refer to **Trouble Clearing: IXL-001** to isolate the trouble. If no alarms or indications are present and a CIT is available, use the RETRIEVE commands (for example, **rtrv-alm**, **rtrv-hsty**, etc.) to check for other trouble indications.

45. **STOP. YOU HAVE COMPLETED THIS PROCEDURE.**

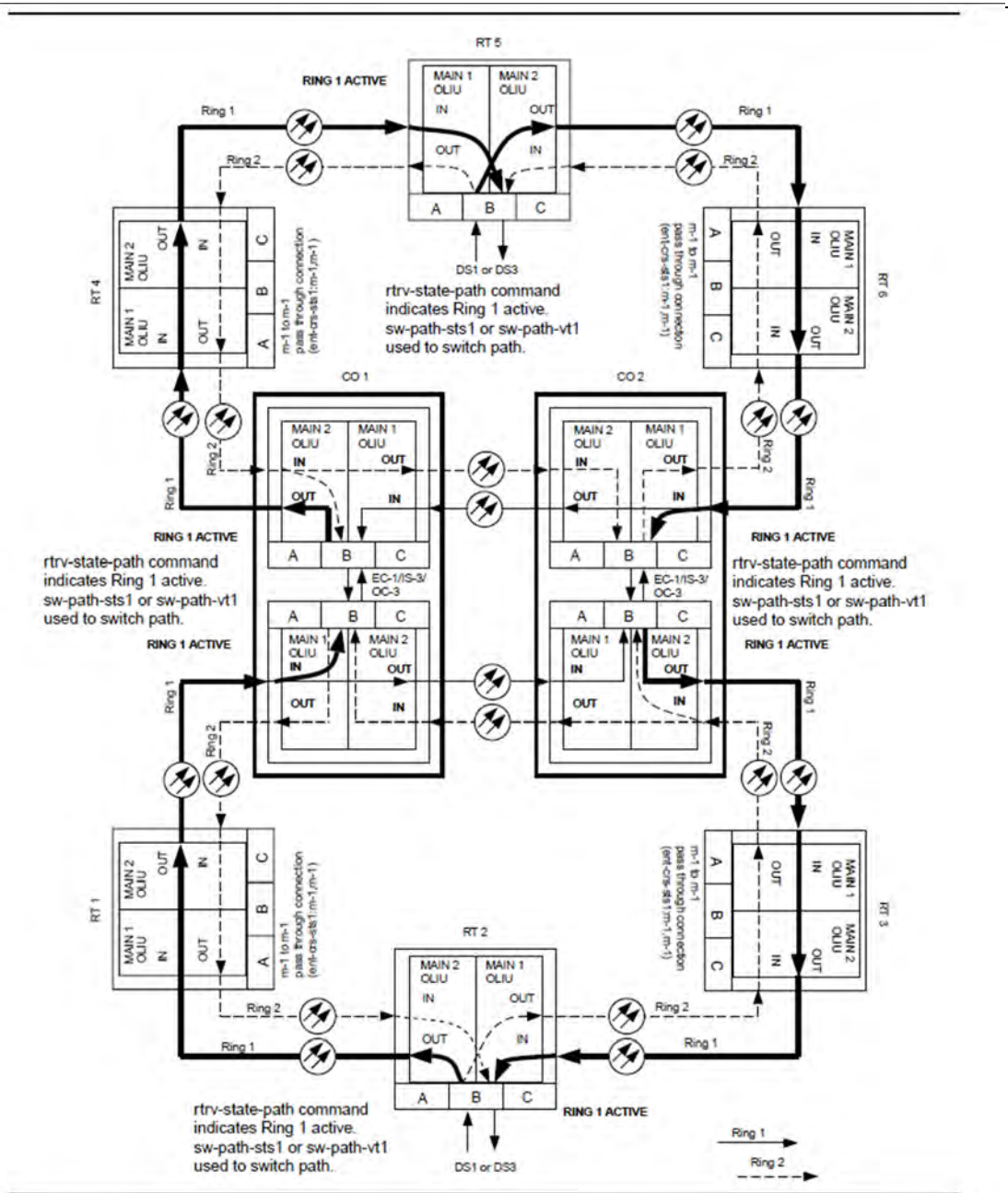


Figure 3 – Example of DS1 Transmission Test in Dual Ring Interworking Network

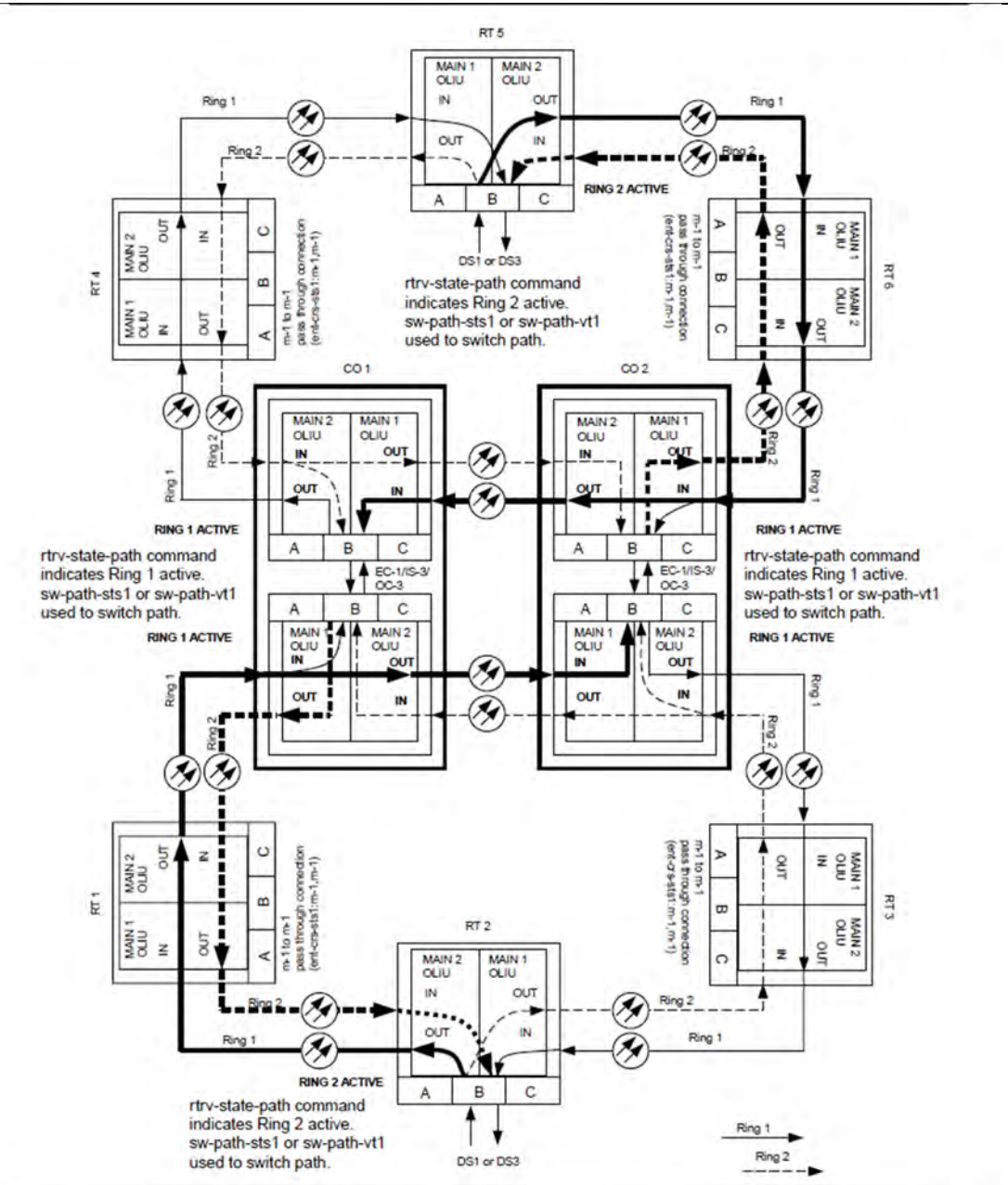


Figure 4 – Example of DS1 Transmission Test in Dual Ring Interworking Network

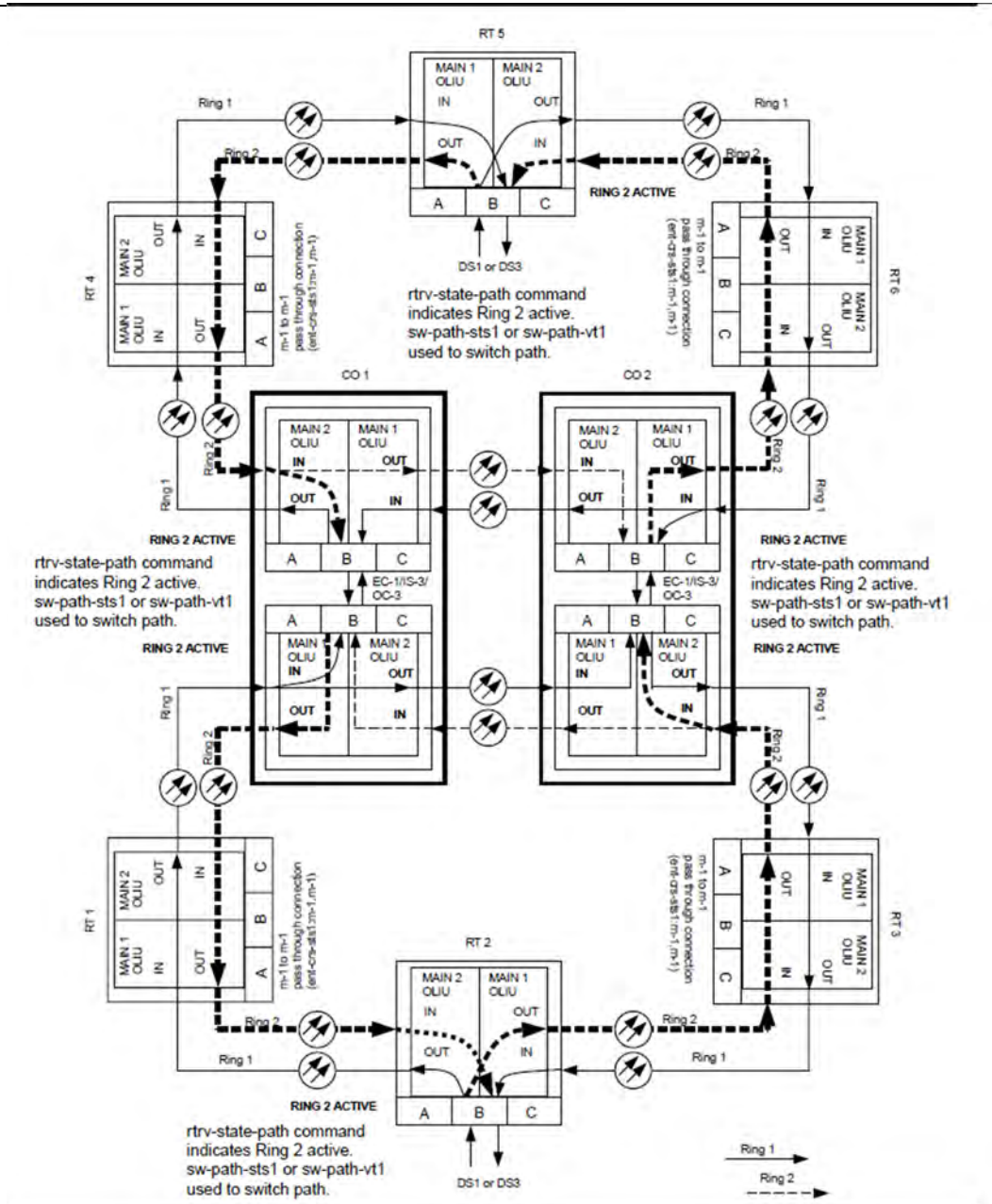


Figure 5 – Example of DS1 Transmission Test in Dual Ring Interworking Network

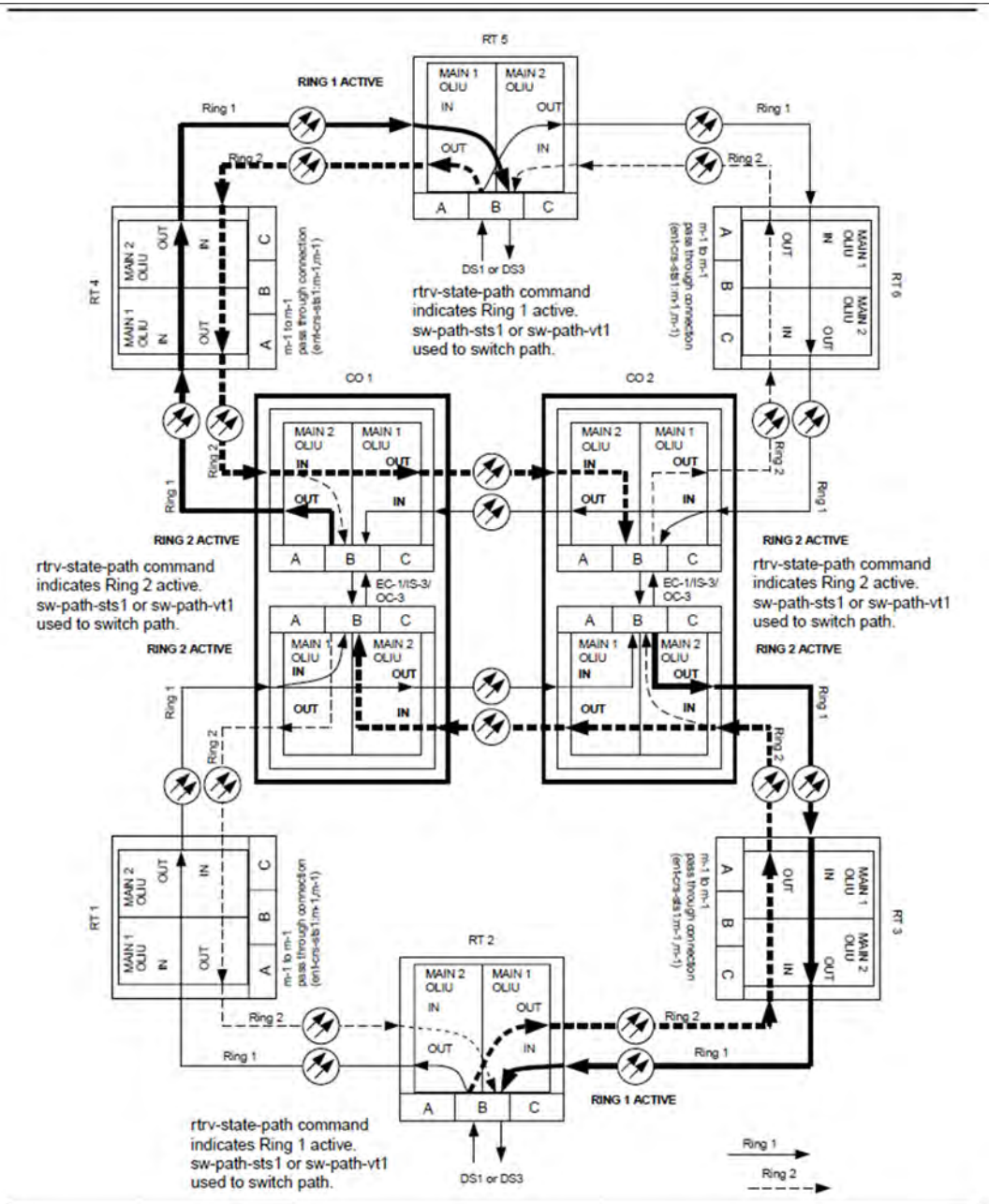


Figure 6 – Example of DS1 Transmission Test in Dual Ring Interworking Network

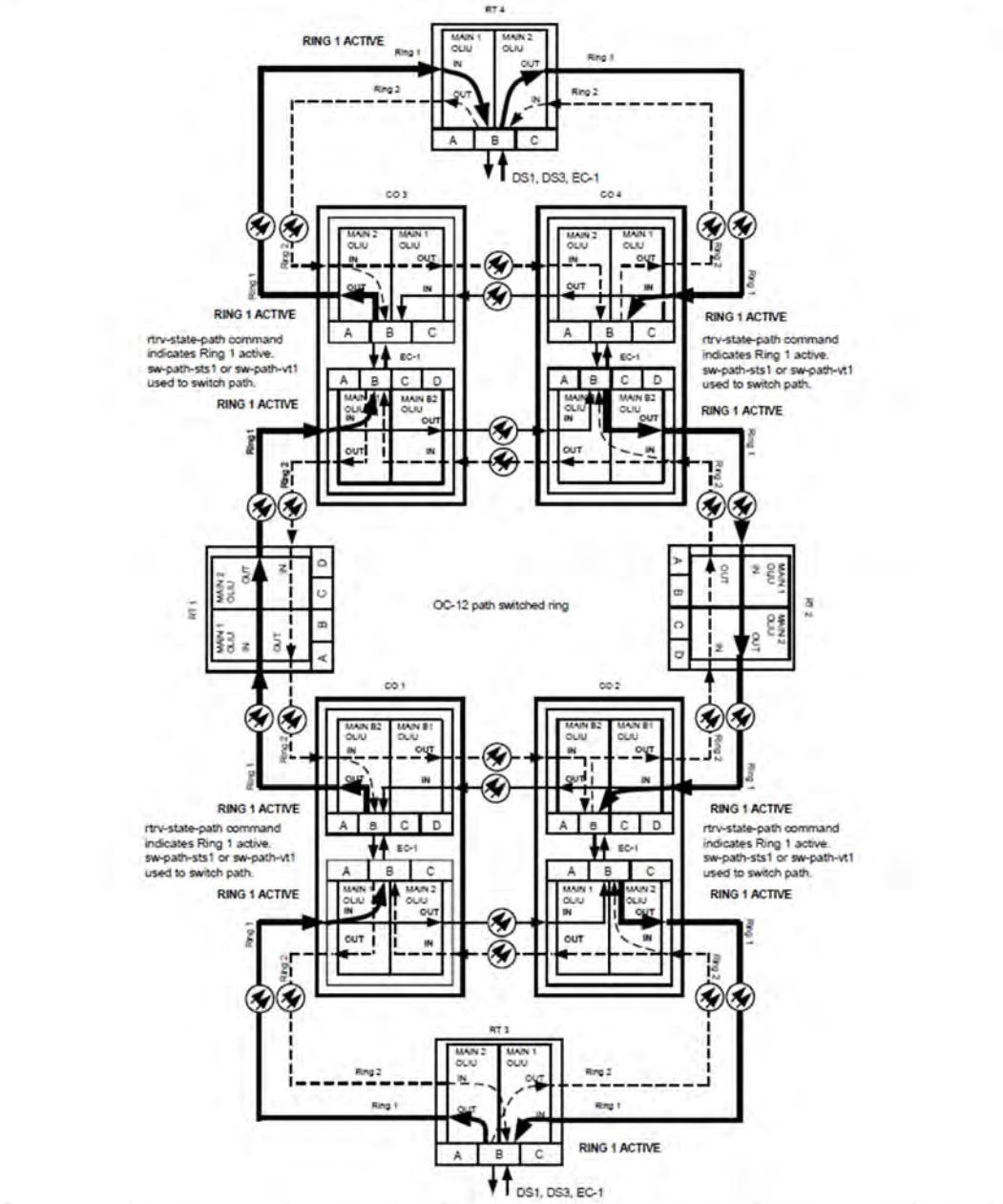


Figure 7 – Example of DS1 Transmission Test in Dual Ring Interworking Network

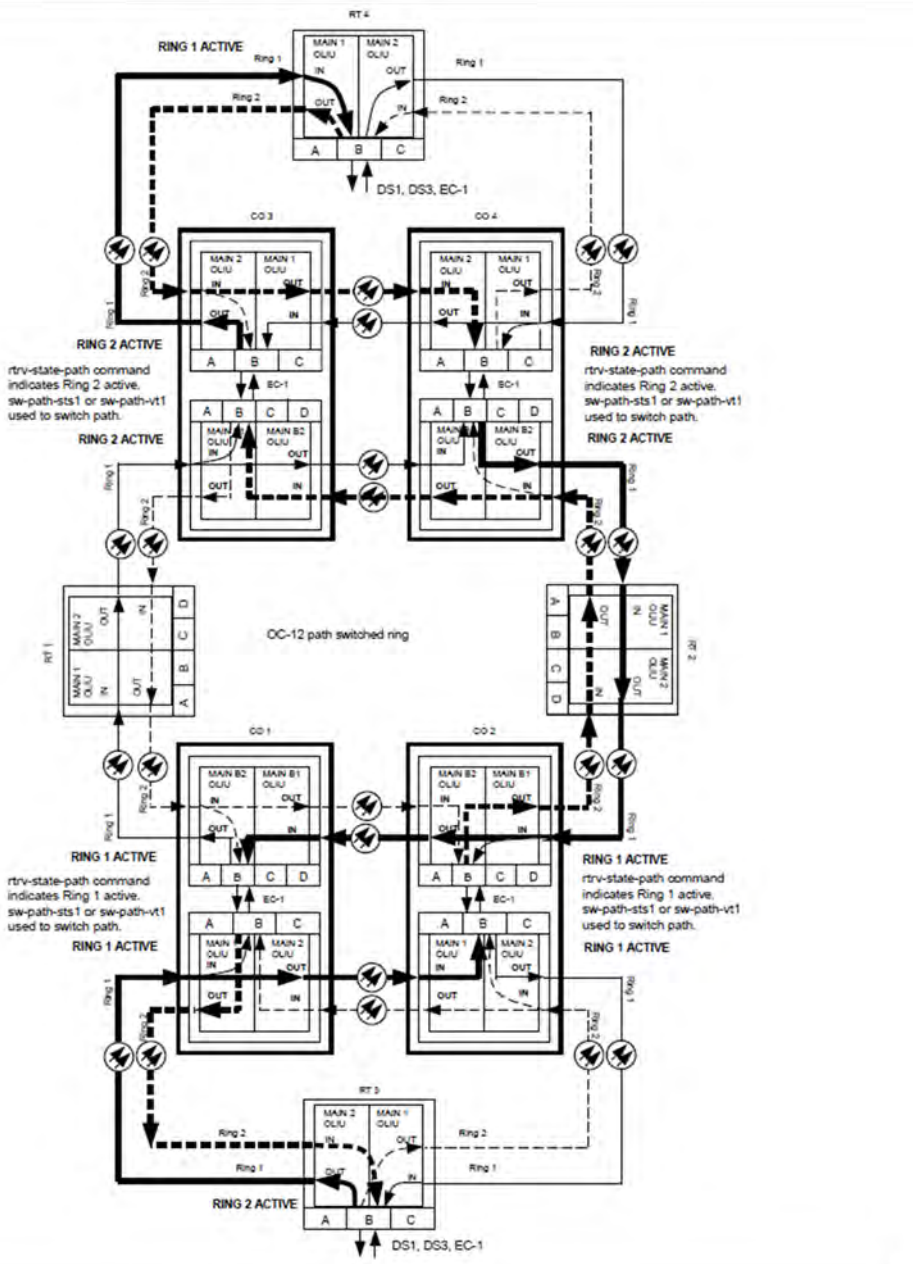


Figure 8 – Example of DS1 Transmission Test in Dual Ring Interworking Network

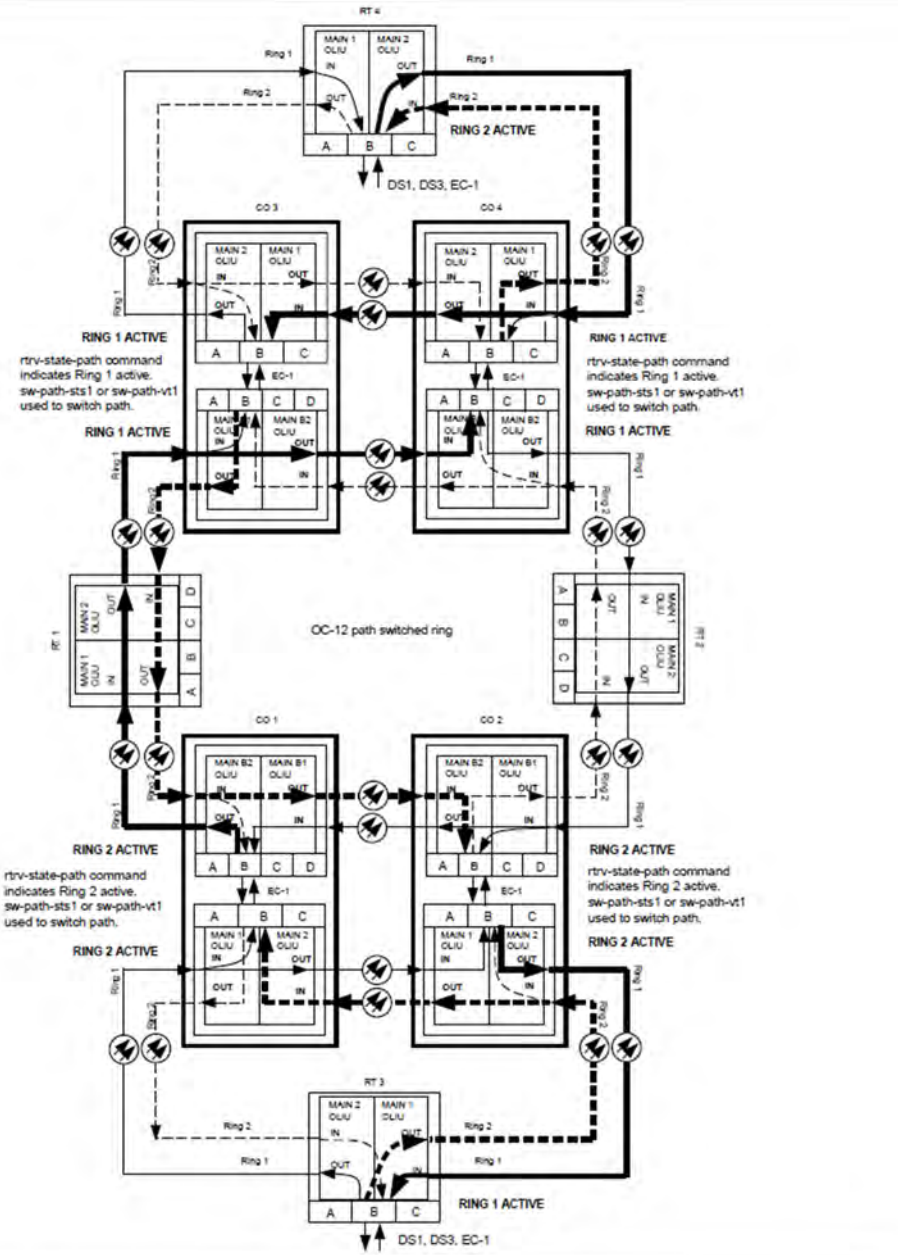


Figure 9 – Example of DS1 Transmission Test in Dual Ring Interworking Network

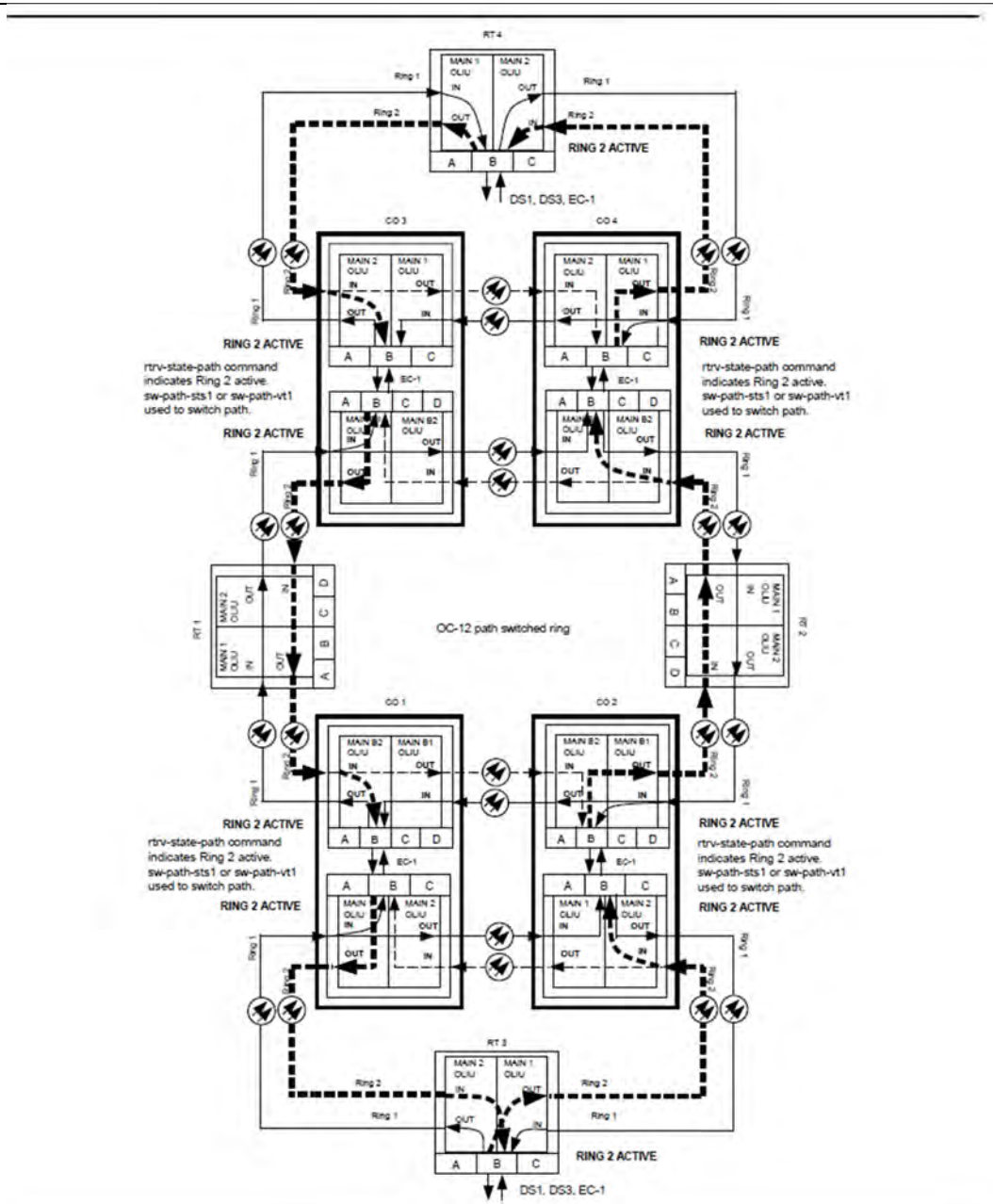


Figure 10 – Example of DS1 Transmission Test in Dual Ring Interworking Network

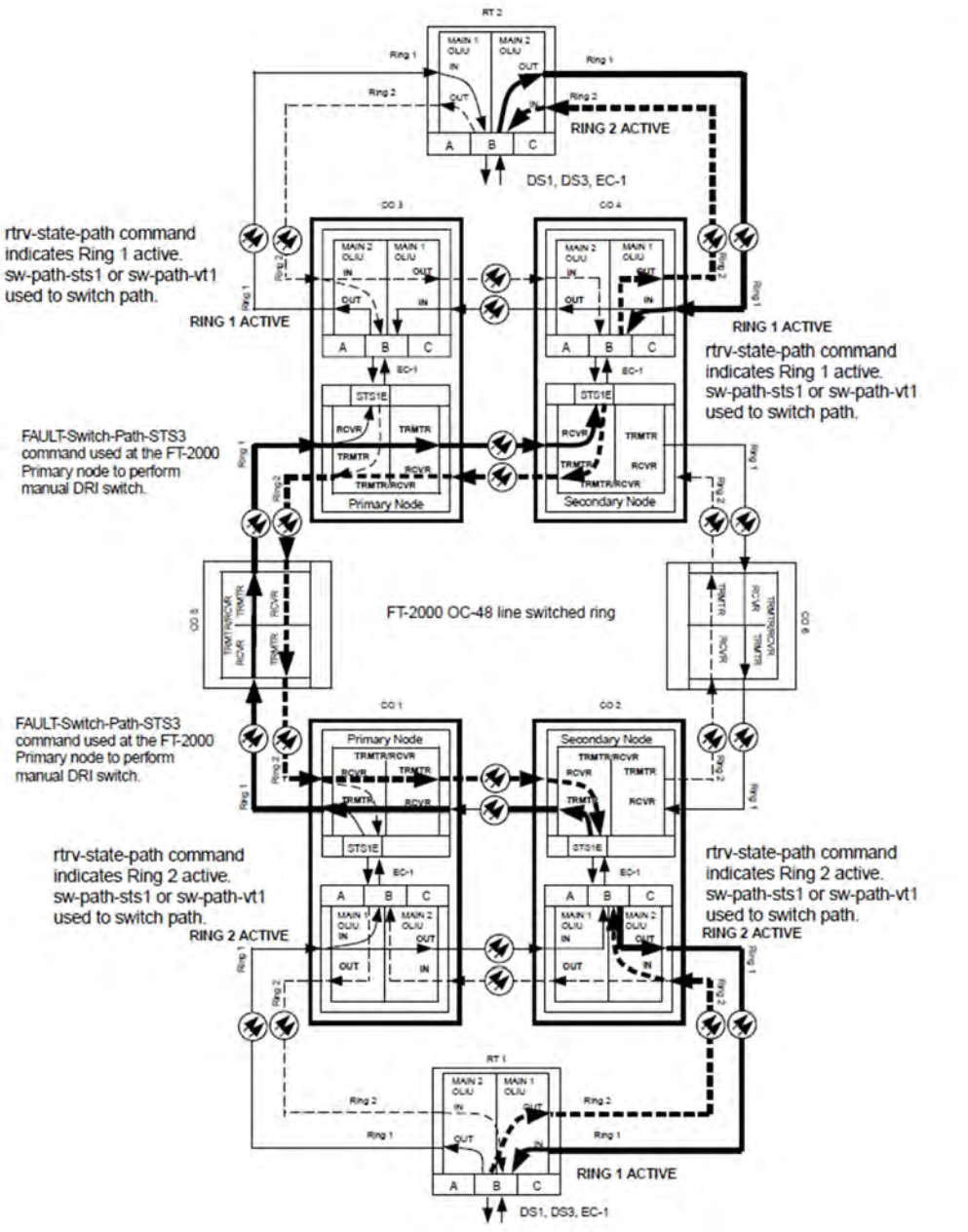


Figure 11 – Example of DS1 Transmission Test in Dual Ring Interworking Network

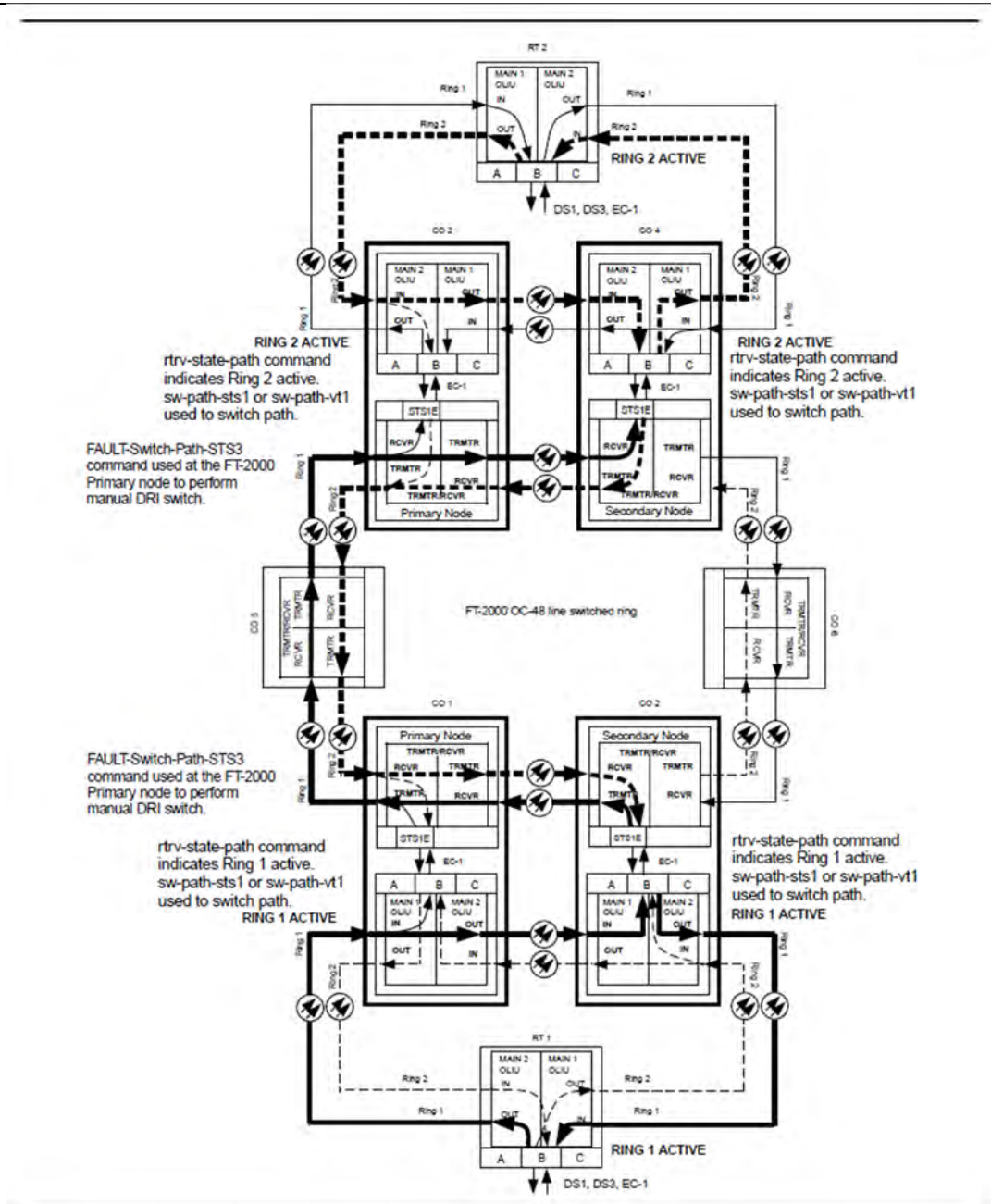


Figure 12 – Example of DS1 Transmission Test in Dual Ring Interworking Network

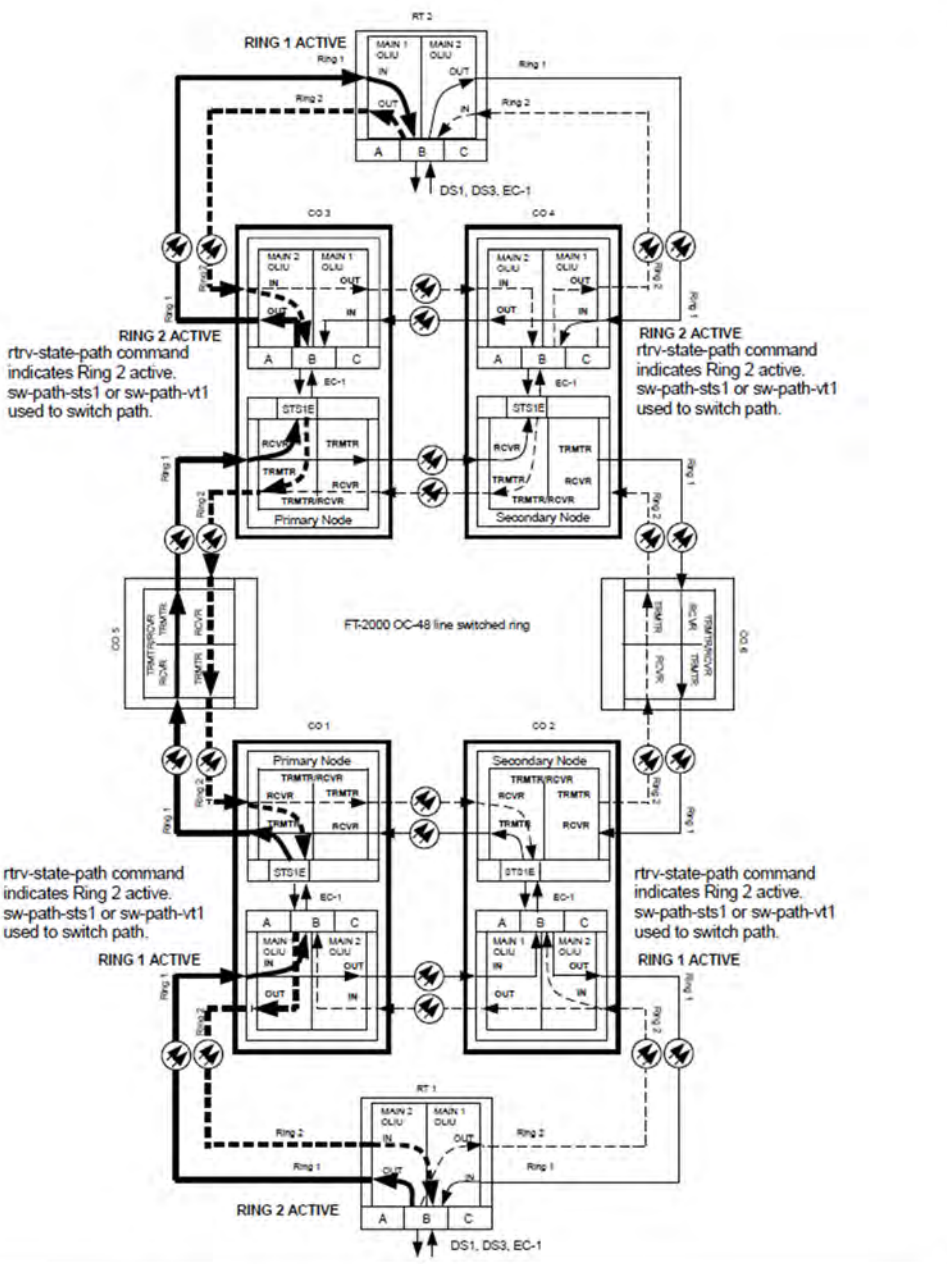


Figure 13 – Example of DS1 Transmission Test in Dual Ring Interworking Network

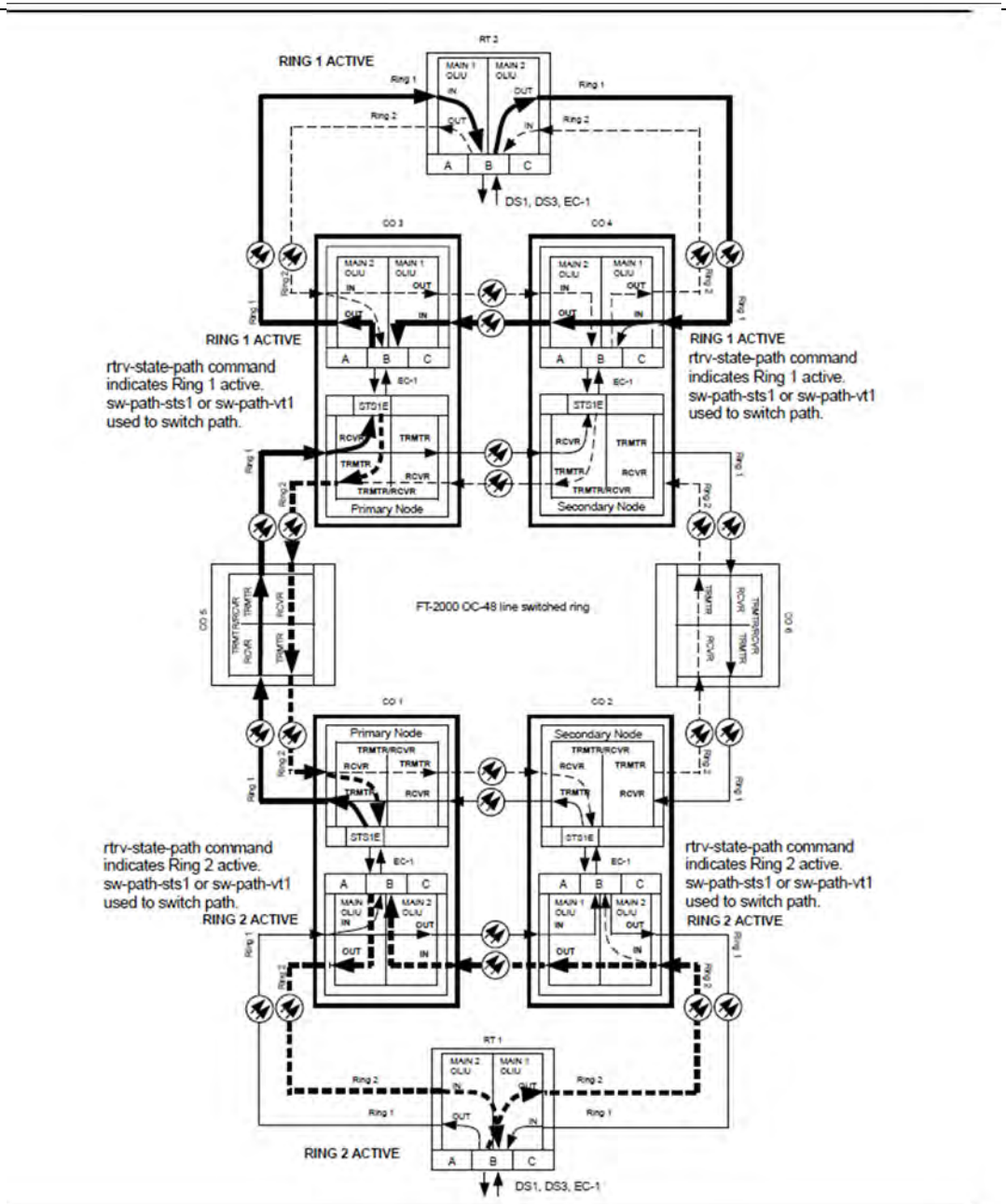


Figure 14 – Example of DS1 Transmission Test in Dual Ring Interworking Network

Claim Element	Lucent 2000 Product Family
	DDM-2000 User/Service Manual at 95-97

Release 6.0 supports linear applications with new features that include OC-3/ OC-12 interworking using the open systems interconnection (OSI) 7-layer protocol stack over the data communications channel (DCC). The OSI 7-layer protocol stack refers to the OSI reference model, a logical structure for network operations standardized by the international standards organization (ISO). Release 6.0 also includes an optional optical carrier level 3 concatenated (OC-3c) feature provided by the 21D or 21G OLIU. This OC-3c transport feature is used to interface with broadband terminals.

Release 6.0 includes one new circuit pack (and associated software): the BBG6 STS1E which provides a high-speed or low-speed EC-1 interface. The STS1E circuit packs are used in the Function Unit slots for EC-1 electrical multiplexer (high-speed) or EC-1 low-speed applications. The optional VT1.5 performance monitoring (PM) feature provides the PM of the V5 byte for errored seconds (ES), severely errored seconds (SES), and unavailable seconds (UAS). The optional DS1 PM feature allows measuring of near-end performance and the ESF far-end performance report of the incoming DS1 signal. This allows the service provider to determine the end-to-end performance of the DS1 signal. Enhanced security features include additional logins. The TL1 message-based interface, introduced in Release 2.0 and enhanced in subsequent releases, for centralized surveillance by NMA systems is enhanced in this release to allow Bellcore's OPS/INE system to provide centralized flow through provisioning of ports and cross-connections.

Release 6.2 replaces Release 6.1 and includes linear optical extensions from an OC-3 ring and an automatic synchronization reconfiguration feature. Automatic synchronization reconfiguration provides the ability to automatically select another synchronization source and to automatically reconfigure the synchronization provisioning in the event of a synchronization source failure or a synchronization change in the network, for example, a fiber cut. The feature can be enabled or disabled. Additional TL1 messages support provisioning, maintenance, testing, PM, and security functions.

Release 6.2 includes *SLC*-2000 Release 3.1 and 3.2 interworking and channel state provisioning. Channel state provisioning is a capability provided on DDM-2000 Multiplexers that suppresses reporting of alarms and events during provisioning by supporting multiple states (automatic, in-service, and not-monitored) for VT1.5 and STS-1 channels.

Release 7.0 is an enhanced ring release. Release 7.0 supports a "drop and continue" feature which is used with DRI applications and an automatic synchronization reconfiguration feature. Release 7.0 features include two new plug-ins (and associated software): the 22D-U and the 22G-U OLIUs. The 22D-U OLIU provides a short-reach IS-3 with TSI optical interface between colocated OC-3 and OC-12 and *SLC*-2000 ring shelves. The 22G-U OLIU has the same functionality of the 22F OLIU but with a 23 dB outside plant loss budget allowing for spans of up to 51 km. The 22D-U and 22G-U OLIUs support signal degrade protection switching. The "U" designation for the 22D-U and 22G-U OLIUs means

the OLIUs have universal optical connectors. These OLIUs have adapters that allow the use of *ST*®, SC, or FC connectors on the faceplates. The 22D-U and 22G-U OLIUs can be used in all releases that currently support 22F OLIUs (Release 3.1 and later).

Release 7.1 is an enhanced ring release featuring interworking with an OC-12 ring and interworking with *SLC*-2000 Release 3.1 and 3.2 in a ring. Release 7.1's new features include channel state provisioning, STS-1 signal degrade protection switching, OC-12 VT1.5 path switched ring (ring 0x1 low-speed interface) optical interconnections between DDM-2000 OC-3 and OC-12 ring shelves (OC-3/IS-3), enhanced DS3 PM, and additional TL1 commands and enhancements.

Channel state provisioning is a capability provided on DDM-2000 OC-3 and OC-12 Multiplexers that suppresses reporting of alarms and events during provisioning by supporting multiple states (automatic, in-service, and not-monitored) for VT1.5 and STS-1 channels. The STS-1 signal degrade feature requires the 22G-U or 22D-U OLIUs and measures the BIP-8 (B3) parity violations and causes a protection switch to the alternate path if the provisioned bit error rate threshold is crossed. The OC-12 VT1.5 path switched ring (ring 0x1 low-speed interface) OC-3/IS-3 interface offers a significant advantage over the 1+1 protected OC-3/IS-3 interface for VT1.5 path switched ring applications. Ring (0x1) low-speed interface means two service lines (no protection lines) are used between the OC-12 Multiplexer ring and the OC-3 Multiplexer ring. Switching is not done on the DDM-2000 OC-12 Multiplexer; rather VT1.5 or STS-1 level switching is done at the DDM-2000 OC-3 Multiplexer.

Enhanced DS3 PM provides a collection (from the fiber or high-speed interface) of the DS3 parity-bit (P-Bit) and frame and multiframe (F&M) bit ES, SES, and UAS to the already provided coding violations and severely errored frame seconds (SESF). The feature is mainly used for DS3 tariff verification.

Release 7.2 is a ring release that provides OC-3 operations interworking with the FT-2000 OC-48 Lightwave System. It also allows interworking between the old controllers (BBG5 and BBG7) and the new controllers (BBG8/BBG8B and BBG9). DDM-2000 FiberReach (OC-1) extensions can be added to Release 7.1 rings by upgrading the rings to Release 7.2 and adding a Release 9.0 OC-3 host node. Only OC-3 DDM-2000 FiberReach host nodes need Release 9.0 software and the new controllers.

- New applications:
  - — OC-3 operations interworking with FT-2000 OC-48 Lightwave System. Single-ended operations and DCC connectivity supported over OC-3 interfaces. Requires FT-2000 OC-48 Lightwave System Release 6.0 software.

- OC-3/IS-3 DRI with VT1.5/STS-1 drop and continue. Single-ended operations and DCC connectivity between DDM-2000 systems or DDM-2000 and FT-2000 OC-48 Lightwave Systems in DRI applications.
- Increased network size. A DDM-2000/*SLC*-2000/FT-2000 OC-48 Lightwave System subnetwork of 24 network elements (NE).

■ New features:

- Multiple OS Gateway Network Element (GNE). In DDM-2000/*SLC*-2000 networks, more than one NE can be physically connected to X.25 allowing OSs to automatically select an alternate GNE in case of primary GNE failure. The feature also allows different GNEs to support different OSs simultaneously.
- Provisionable X.25 packet size of 128 or 256 bytes.
- Enhanced PM. Enhancements to DS1 and DS3 line and path PM to further support tariff verification. Enhanced DS3 PM requires the new BBG4B DS3 circuit pack.
- CPro-2000 R3.0, 4.0, 5.0, and 6.0.

Release 8.0 is a linear release using the new BBG8/BBG8B system controller and BBG9 overhead controller circuit packs.

■ New applications:

- OC-3 operations interworking with FT-2000 OC-48 Lightwave System. Single-ended operations and DCC connectivity supported over OC-3 interfaces. Requires FT-2000 OC-48 Lightwave System Release 6.0 software.
- OC-3/IS-3 linear extensions from OC-12 rings. 1+1 linear OC-3 and IS-3 extensions from OC-12 rings.
- Increased subnetwork sizes. A DDM-2000/*SLC*-2000 subnetwork of 32 NEs. A mixed DDM-2000/*SLC*-2000/FT-2000 OC-48 Lightwave System/OC-3 Release 7.2 subnetwork of 24 to 32 NEs.

■ New features:

- Multiple Operations System (OS) Gateway Network Element (GNE). In DDM-2000/*SLC*-2000 networks, more than one NE can be physically connected to X.25 allowing OSs to automatically select an alternate GNE in case of primary GNE failure. The feature also allows different GNEs to support different OSs simultaneously.
- Additional X.25 switched virtual circuits. Nine virtual circuits can be provisioned in any combination of switched and permanent virtual circuits for connections to OSs.

Claim Element	Lucent 2000 Product Family
	DDM-2000 User/Service Manual at 136-145 Dual Ring Interworking (DRI) In an interconnected ring or DRI topology two rings are connected together at two geographically separate nodes. In addition to the facility and node failure protection that a single ring provides, the dual node interconnection between the rings provides an automatic alternate route in the event of a catastrophic failure at one of the interconnecting nodes. Typically, such a topology is used to interconnect a loop feeder access ring to a higher bandwidth interoffice ring, as shown in Figure 2-18. This architecture can withstand any single equipment or fiber failure in each of the rings or a failure (which could range from a CO shutdown in the case of fire, for example, or equipment failure, or failure of the facility connecting the two rings) of either of the two interconnecting nodes without losing service on either the access ring or the interoffice ring. Such a catastrophic failure would cause a service outage for a simple ring architecture.

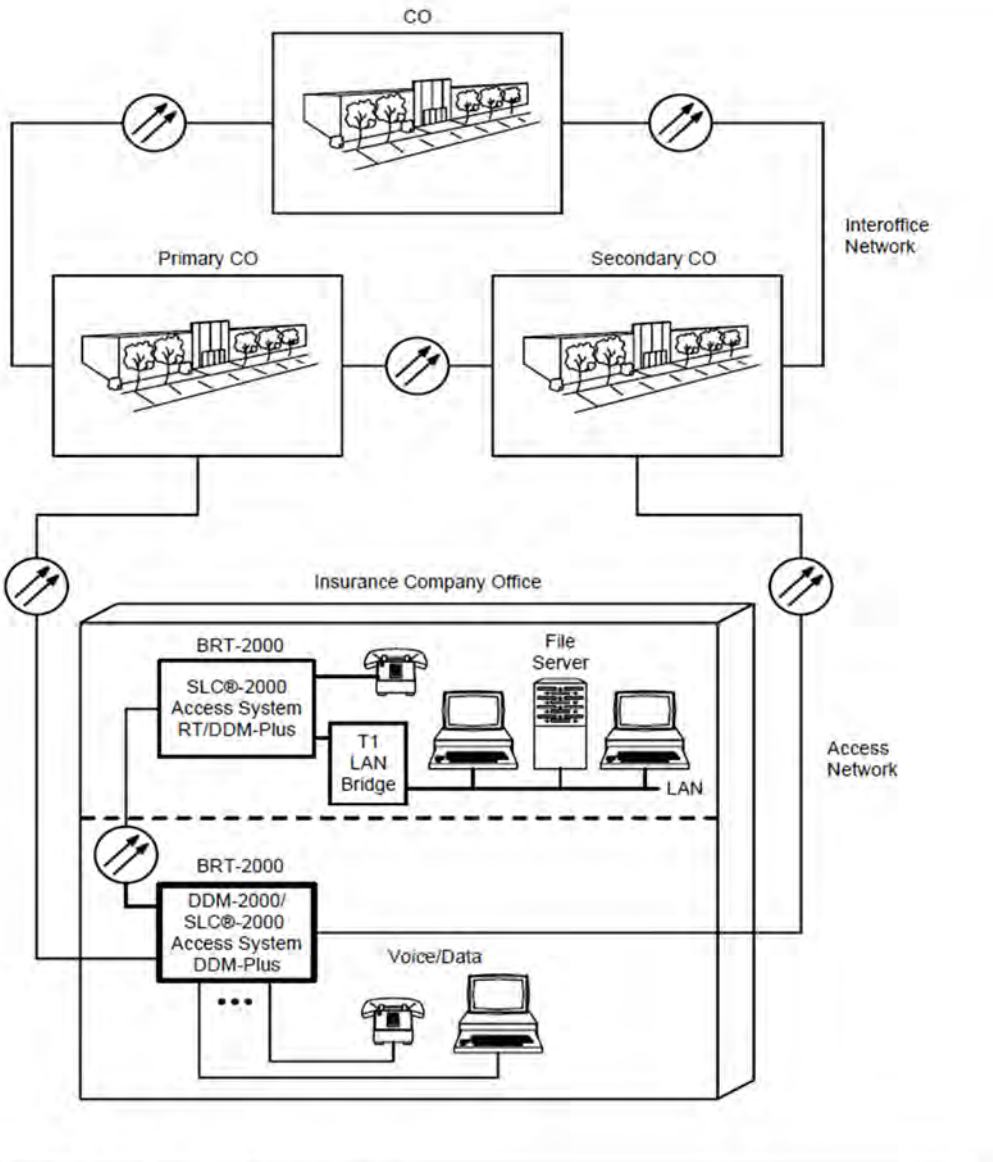
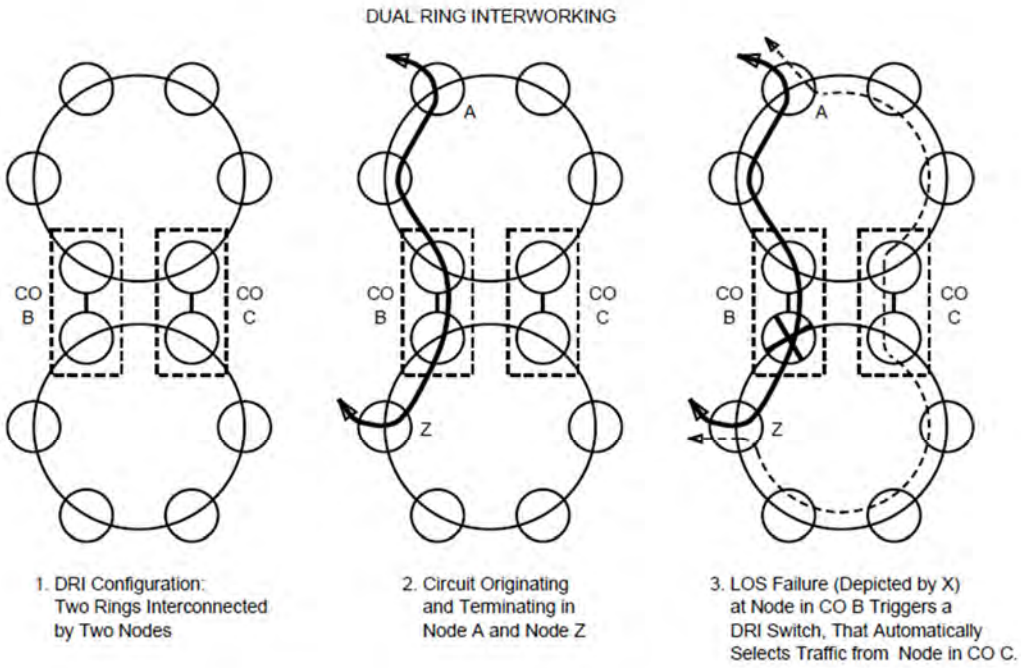
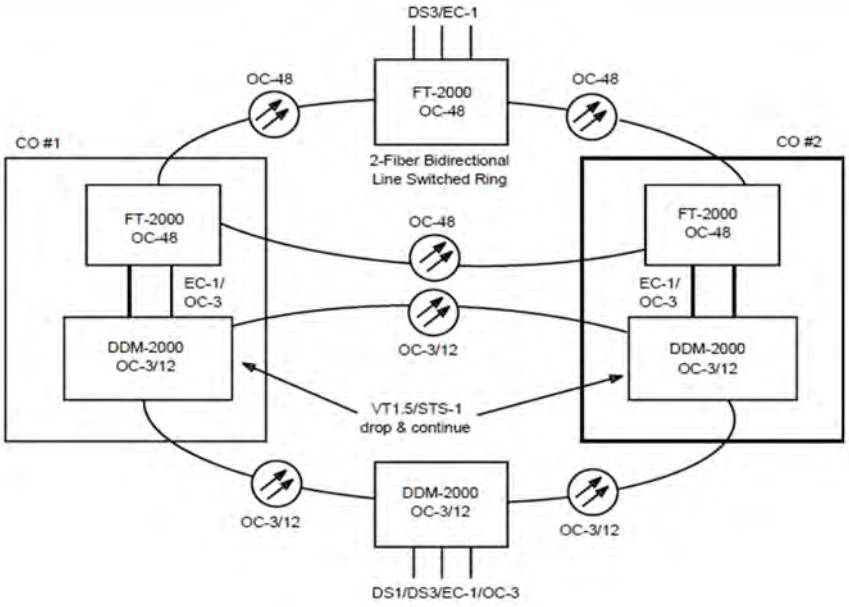


Figure 2-18. Dual Access Configuration

Claim Element	Lucent 2000 Product Family
	As Figure 2-19 shows, DRI allows a circuit (for instance, between nodes A and Z) with one termination in the upper ring and the other termination in the lower ring to survive a failure of the shared node that is currently carrying service for the circuit. The failure is depicted by an "X" in the figure. The two shared nodes are in CO B and CO C. Both nodes have the signal available to them at all times. When a failure occurs, the two terminating nodes and the two shared nodes switch so that traffic is carried through CO C and around the node failure.  Figure 2-19. Dual Ring Interworking Concepts

Claim Element	Lucent 2000 Product Family
	DDM-2000 OC-3, OC-12, and FT-2000 OC-48 Lightwave Systems can be configured to offer this topology. Often the DDM-2000 equipment is used for the loop feeder access ring, and the FT-2000 OC-48 Lightwave System equipment is used for the interoffice ring. Figure 2-20 shows a DDM-2000 OC-3 (or OC-12) path switched ring interworking with an FT-2000 OC-48 Lightwave System bidirectional line-switched ring. The DDM-2000 OC-12 Multiplexer also supports DS3 DRI in addition to the EC-1 and OC-3 interfaces. In the event of a DS3 failure, the OC-12 Multiplexer inserts an STS-1 AIS signal into the STS-1 ring channel used by the DS3 to activate the downstream STS path protection switch. In this application, the DDM-2000 provides an appearance of loop traffic at both the primary and secondary nodes by dropping traffic at the primary node and simultaneously continuing it on to the secondary node. This capability is called "drop-and-continue." The DDM-2000 OC-3 Multiplexer allows DS1 signals to be multiplexed for handoff at an economical EC-1 or OC-3 rate in the COs. Also, the DDM-2000 OC-3's flexible TSI can be used to prepackage all DRI protected DS1s into a single EC-1 for economical handoff to the OC-48 ring. This capability allows for the easy mixing of DRI and non-DRI services on the same ring network. In this way, only specially tariffed services need to be configured for the extra reliability that DRI provides. DS3/STS1 clear channel services are also supported. The companion FT-2000 OC-48 Lightwave System ring picks up the traffic at these two nodes and carries it to the destination node, unless a failure condition causes a protection switch to the secondary signal. In the reverse direction, a similar process is followed with the OC-48 ring handing off the two copies of the signal at the primary and secondary nodes and the OC-3 ring providing the switching at the destination node.

Claim Element	Lucent 2000 Product Family
	 Figure 2-20. OC-3/12 to FT-2000 OC-48 Lightwave System Dual Ring Interworking

Claim Element	Lucent 2000 Product Family
	The DDM-2000 drop-and-continue feature also finds an excellent application in interconnecting two rings via an intermediate transport network. In the example shown in Figure 2-21, DDM-2000 OC-3 Multiplexer access rings act as a DRI pair via an FT-2000 OC-48 Lightwave System and DACS IV-2000 interoffice network. The advantage of this network is the grooming for DRI traffic provided by the DACS IV-2000. Both DDM-2000 OC-3 rings provide drop and continue at each of their two duplicate COs. Both copies of the signal are transported as separate tributaries through the interoffice network, and path switching is implemented at the edges of the network. Signal redundancy is preserved on an end-to-end basis. In offices where SONET interconnections are not available, DS3 interfaces can be used between dual OC-12 offices. The DDM-2000 OC-12 Multiplexer also supports DS3 DRI in addition to the EC-1 and OC-3 interfaces. In the event of an incoming DS3 failure from the DSX-3, the OC-12 Multiplexer inserts an STS-1 AIS signal into the STS-1 ring channel used by the DS3 to activate the downstream STS path protection switch. It is recommended that SONET DRI interfaces (EC-1 or OC-3) be used if possible since the DS3 to STS-1 AIS translation feature is on the OC-12 Multiplexers only (R5.1 and later).

Claim Element	Lucent 2000 Product Family

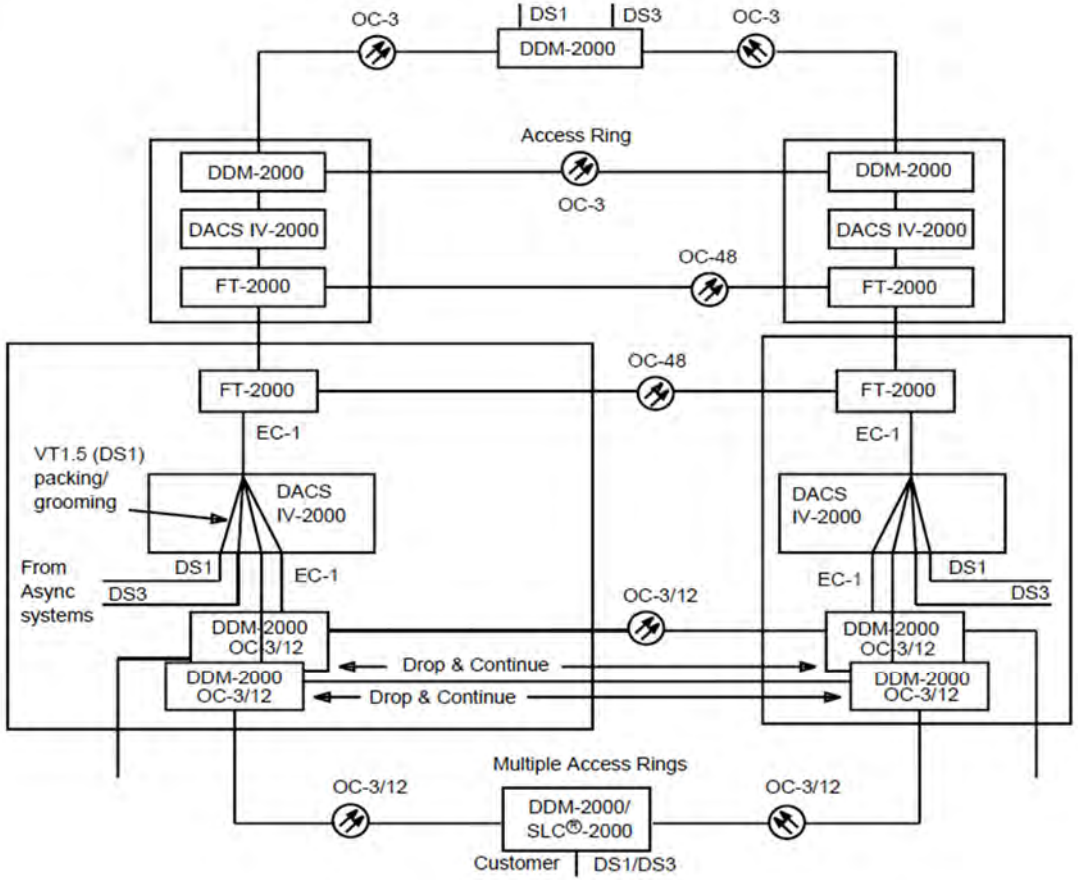


Figure 2-21. DDM-2000 Ring Interworking with FT-2000 OC-48 Lightwave System Transport and DACS IV-2000 Grooming

Claim Element	Lucent 2000 Product Family

Dual Homing with DRI

The survivability and networking benefits of Lucent's DRI solution are cost-effectively extended to smaller locations via DDM-2000 FiberReach dual-homing capabilities. Figure 2-22 shows an OC-3 feeder ring from duplicated wire centers with dual-homed DDM-2000 FiberReach extensions from selected feeder ring remote sites.

The host nodes and remote DDM-2000 FiberReach systems are configured just like the previously described dual-homing configuration with single 0x1 cross-connections employed by the host. In the dual wire center architecture, the access network is also protected from a catastrophic failure of one wire center, because the access and interoffice networks have duplicate points of interworking. The DDM-2000 OC-3 systems in the two wire centers employ the drop and continue cross-connection.

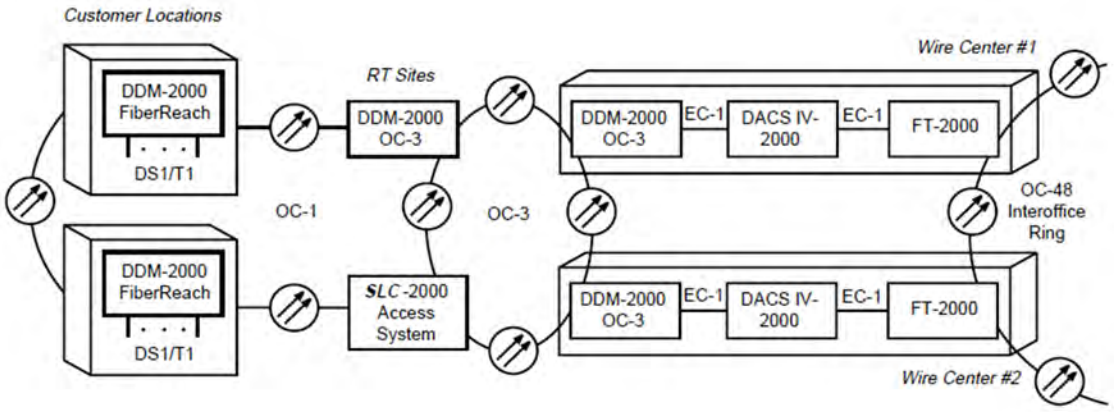


Figure 2-22. DDM-2000 FiberReach Ring Dual Homing to a DDM-2000 OC-3 Ring in a Dual Wire Center Application

Claim Element	Lucent 2000 Product Family
	DDM-2000 User/Service Manual at 170-173

FT-2000 OC-48 Lightwave System

Operations interworking (OI) provides the capability to access, operate, provision, and administer remote Lucent SONET NEs from any location in a SONET subnetwork or from a centralized OS.

OI is available among Lucent 2000 Product Family systems connected through the SONET DCC including:

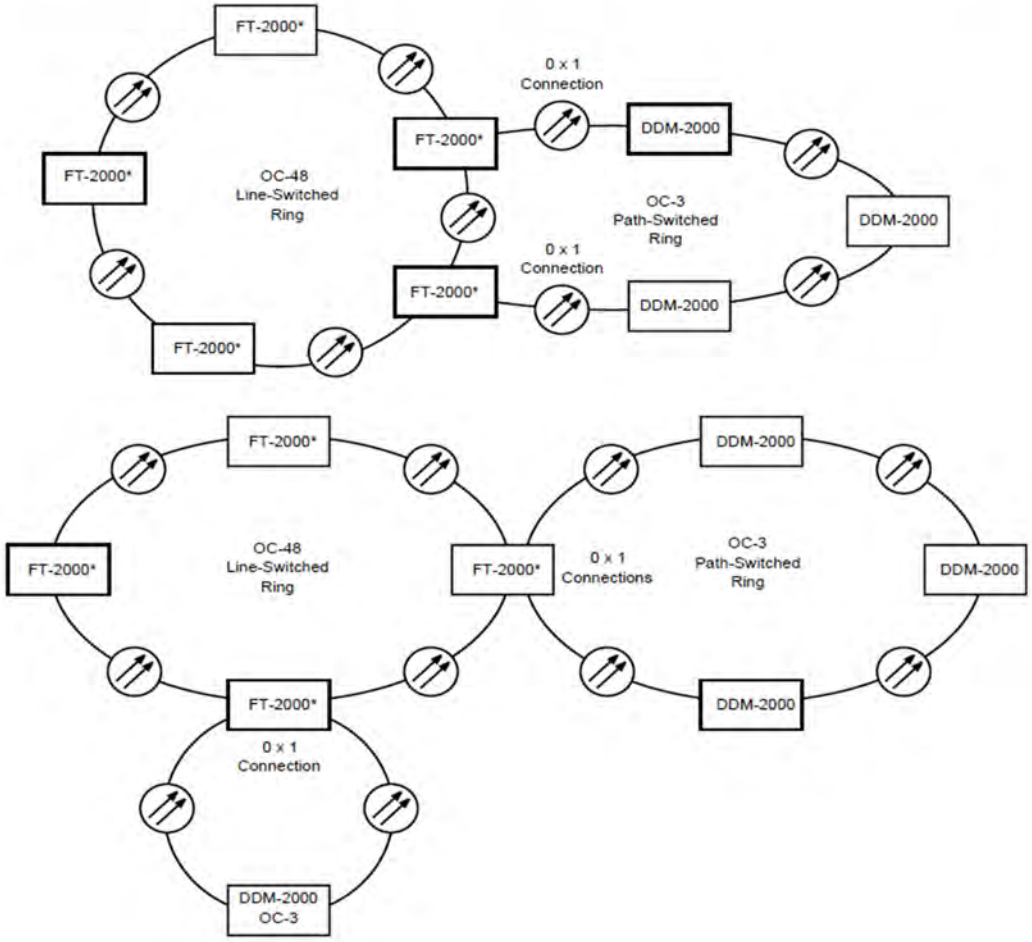
- FT-2000 OC-48 Lightwave System (Release 6.0 and later)
- DDM-2000 OC-3 Multiplexer (Release 7.2 and later).

The FT-2000 OC-48 Lightwave System equipped with Release 6.0 software supports OI applications with DDM-2000 OC-3 Multiplexers (Figure 2-44).

Messages carried on the SONET section DCC support the following interworking applications:

- Remote login
- GNE operation
- Remote NE status
- Remote software download and copy.
- **Remote login**: A user logged in locally to an FT-2000 OC-48 Lightwave System can remotely log in to a DDM-2000 OC-3 Multiplexer via the OC-3 DCC. However, a user logged in locally to a DDM-2000 OC-3 Multiplexer cannot remotely log in to the FT-2000 OC-48 Lightwave System. A user logged in locally to a DDM-2000 OC-3 Multiplexer can remotely log in to another DDM-2000 OC-3 Multiplexer through an FT-2000 OC-48 Lightwave System.
- **GNE operation**: One or more FT-2000 OC-48 Lightwave Systems can serve as a single interface to the local X.25 message-based operations system for the DDM-2000 OC-3 Multiplexers through the OC-3 DCC. The GNE also serves as a single interface for all FT-2000 OC-48 Lightwave Systems in the same ring network and in the same subnetwork. In a mixed DDM-2000 OC-3/FT-2000 OC-48 Lightwave System network, the FT-2000 OC-48 Lightwave System must serve as the GNE(s). Multiple GNEs are supported in a DDM-2000 OC-3 network.
- **Remote NE status**: The FT-2000 OC-48 Lightwave System can receive and transport alarm and status information from other FT-2000 OC-48 Lightwave Systems and DDM-2000 OC-3 Multiplexers that are in the same subnetwork. Within a subnetwork, NEs in the same alarm group (provisionable) exchange alarm and status information through at least one alarm gateway network element (AGNE). When an AGNE receives alarm and status information, it rebroadcasts the information to all the other NEs

- **Remote software download and copy**: An FT-2000 OC-48 Lightwave System can download (copy) software to remote FT-2000 OC-48 Lightwave Systems in the same network and across a DDM-2000 OC-3 network to another FT-2000 OC-48 Lightwave System in the same subnetwork. Similarly, a DDM-2000 OC-3 Multiplexer can download (copy) to another DDM-2000 OC-3 through an FT-2000 OC-48 Lightwave System network.



* FT-2000 OC-48 Add/Drop-Rings Terminal (Release 6 and later)

Figure 2-44. Operations Interworking Application

Figure 2-45 shows two types of OC-3 interface connections between FT-2000 OC-48 Lightwave System line switched rings and DDM-2000 OC-3 path switched rings.

- Linear (1+1). In this configuration (top figure of Figure 2-45), there is a 1+1 OC-3 interface connection to an FT-2000 OC-48 Lightwave System NE. A failure of the 1+1 OC-3 interface will trigger a DDM-2000 OC-3 line protection switch. Figure 2-46 shows a major application of this feature in a DRI application using optical OC-3/IS-3 interfaces.
- Ring (0x1). In this configuration (bottom figure of Figure 2-45), there are two 0x1 OC-3 interface connections to one FT-2000 OC-48 Lightwave System NE. A failure of one of the 0x1 OC-3 interfaces will trigger a DDM-2000 OC-3 path protection switch.

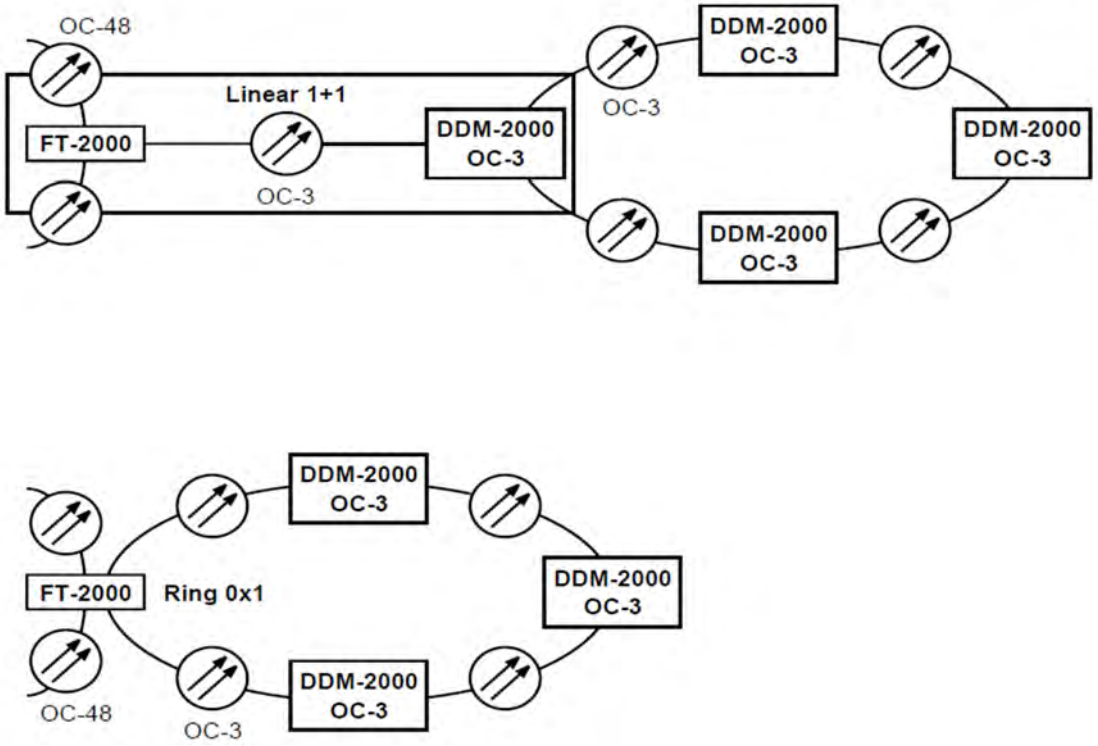
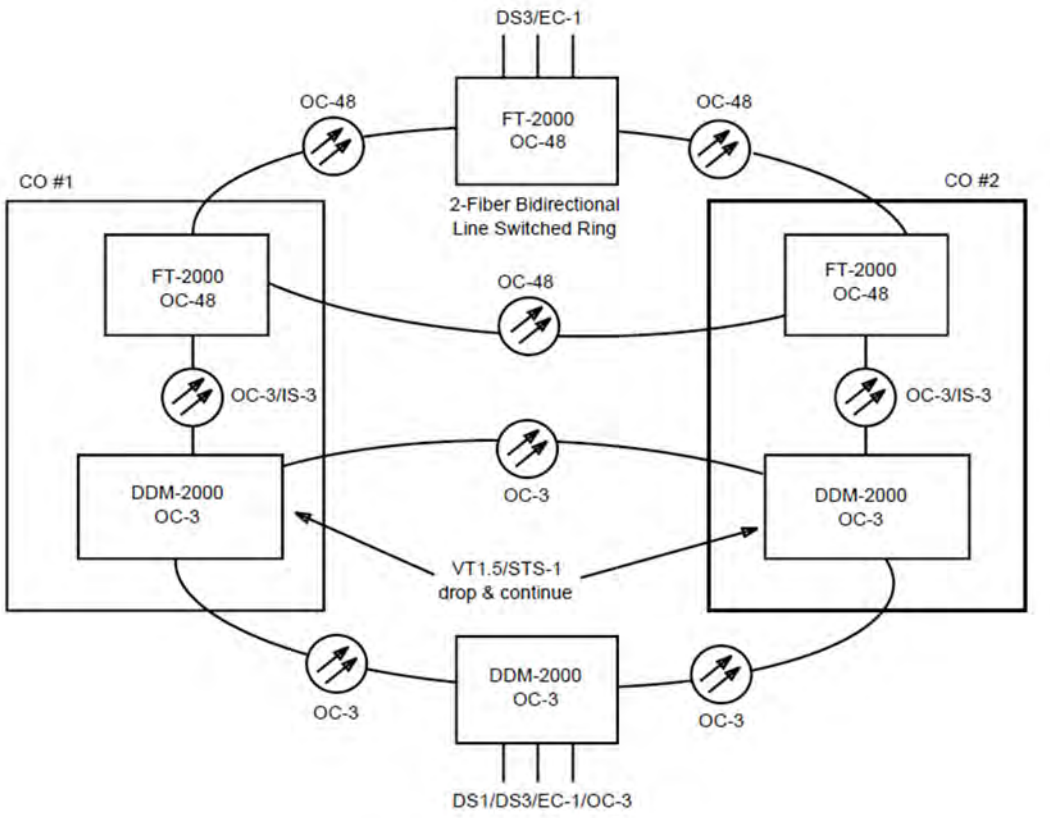


Figure 2-45. OC-3 Ring Interfaces with FT-2000 OC-48 Lightwave System

Claim Element	Lucent 2000 Product Family
	 Figure 2-46. DDM-2000 OC-3 to FT-2000 OC-48 Lightwave System Dual Ring Interface DDM-2000 User/Service Manual at 185

Claim Element	Lucent 2000 Product Family

Figure 2-55 also shows an optical drop/insert DS1 extension from the SONET rings implemented with RFL 9001 Intelligent Multiplexers. This extension is useful for serving low bandwidth sites remote from the SONET backbone. The figure shows a single host DDM-2000 interconnecting the rings, but the application could be a DRI to provide node survivability.

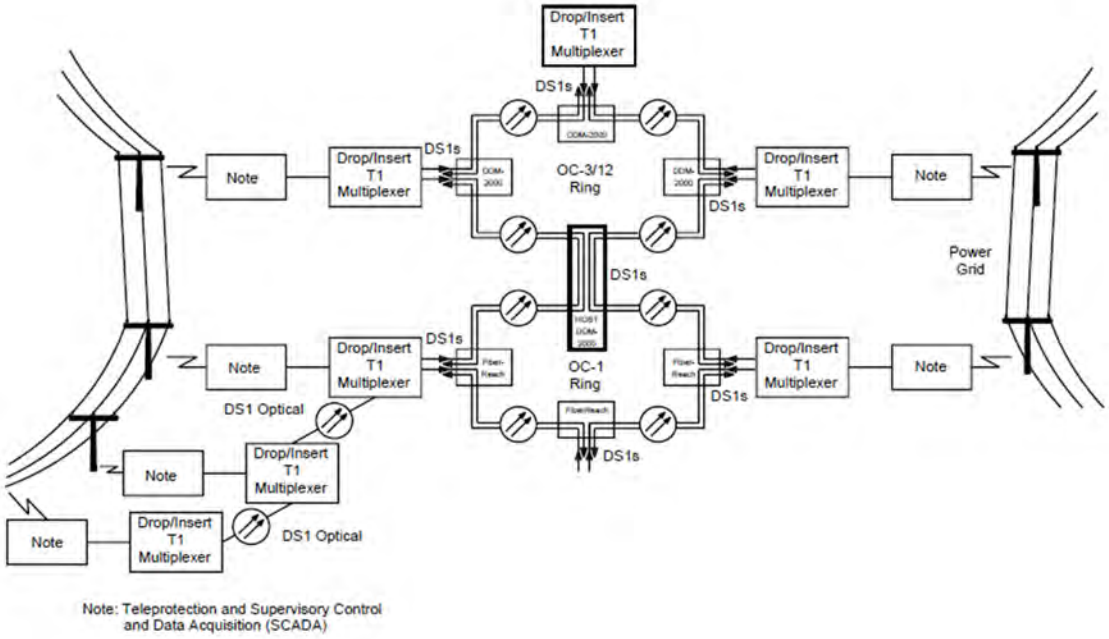


Figure 2-55. Teleprotection and SCADA Application

DDM-2000 User/Service Manual at 212

Claim Element	Lucent 2000 Product Family

OC-3 Dual Ring Interworking (DRI) Shelf

An example of an OC-3 DRI shelf is shown in Figure 3-10. The 22-type OLIU circuit packs are equipped in the main positions and can be equipped in function units A, B, or C. At least one pair of STS1E circuit packs must be equipped in at least one of the function unit slots. A DRI shelf can also support MXRVOs and DS3 interfaces for non-DRI circuits.

Starting with Release 7.2, DRI traffic can be interconnected using 22-type OLIU circuit packs in the function unit slots.

Beginning with Release 11.0, equipping the main slots with 24-type OLIUs allows the shelf to provide an OC-12 ring interface.

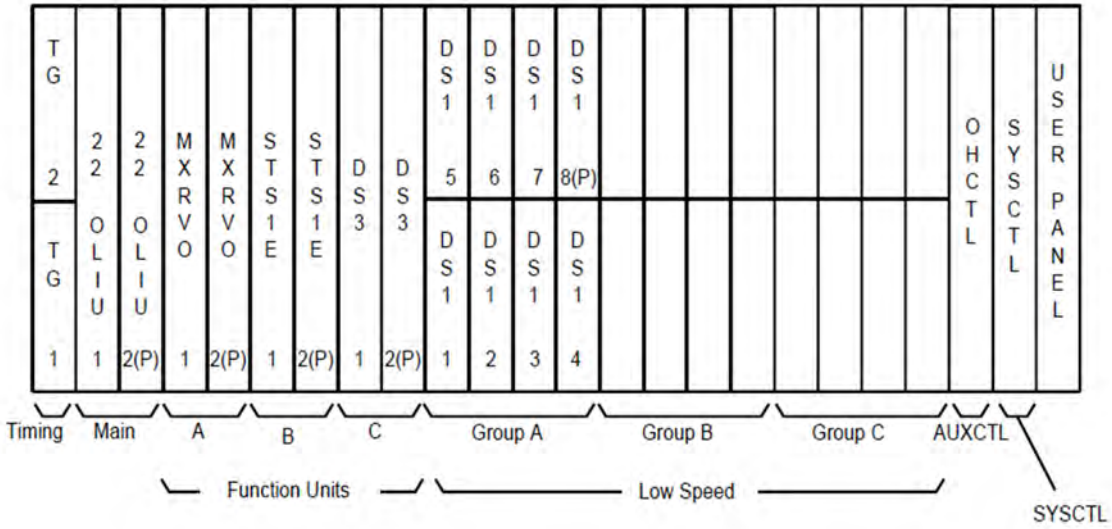


Figure 3-10. DDM-2000 OC-3 DRI Shelf

Claim Element	Lucent 2000 Product Family
	DDM-2000 User/Service Manual at 244 For the DS1 add/drop and ring application (Figure 5-5), the time slot interchange (TSI) feature of the 22-type OLIUs provides full flexibility in selecting traffic for each DS1, DS3, or EC-1 low-speed port from any high-speed time slot. The TSI function supports cross-connections across the full bandwidth of each OC-3 interface as well as to any low-speed port. Figure 5-5 is a block diagram of the DDM-2000 OC-3 Multiplexer VT1.5/STS-1 path switched ring application. The DDM-2000 OC-3 Multiplexer interfaces to the ring through the main slots at the OC-3 rate and uses the programmable VT1.5/ STS-1 TSI capability. Path switching can be done on VT1.5 paths, STS-1 paths, or a mixture of these. Up to 84 DS1s, 3 DS3s, 3 EC-1s, 1 OC-3/IS-3 1+1 linear optical extensions, or equivalent combination can be added/dropped from the DDM-2000 OC-3 Multiplexer self-healing ring at any node. Because of the ring's path protection scheme, time slots must be reserved all the way around the ring for all ring traffic, limiting the capacity of the ring to the OC-3 line rate. Like the add/drop topology, the TSI feature offers full flexibility in assigning signals between low-speed DS1, DS3, EC-1 or OC-3 ports and the high-speed interface at each shelf. The DDM-2000 OC-3 Multiplexer dual ring interworking (DRI) application uses the same shelf configuration as the OC-3 path switched ring (Figure 5-5). The main difference is that the VT1.5/STS-1 paths desired for DRI should be provisioned for drop and continue. As with the VT1.5/STS-1 path switched ring, path selection is at the VT1.5/STS-1 level. The DDM-2000 OC-3 and OC-12 Multiplexer path switched ring architecture allows mixing of drop and continue circuits with standard path switched circuits. TSI flexibility is also maintained in the assignment of low-speed ports to the high-speed interface. DDM-2000 User/Service Manual at 292-295

Claim Element	Lucent 2000 Product Family
	Dual-Homing DRI Synchronization Configurations OC-3 and FT-2000 OC-48 Lightwave System Figure 5-30 shows how OC-N timing can be distributed from an FT-2000 OC-48 Lightwave System line-switched ring to a DDM-2000 OC-3 path-switched ring using a dual-homing DRI configuration. The OC-3 DRI nodes are connected via OC-3 point-to-point links terminating in function unit C slots. The major characteristics of this configuration are: ■ The FT-2000 OC-48 Lightwave System nodes are through-timed and derive timing from different rotations of the OC-48 ring. ■ The FT-2000 OC-48 Lightwave System must be provisioned to write stratum 3 synchronization message to the K2 byte so the DDM-2000 ring can use synchronization messaging. ■ The two DDM-2000 OC-3 DRI nodes coordinate timing using synchronization status messages on the OC-3 ring so that all nodes will accept timing in the same direction. ■ The two DDM-2000 OC-3 DRI nodes must be provisioned for line-timing with timing derived from function unit C. Synchronization messaging on the OC-3 span between the two OC-3 DRI nodes must be disabled so timing loops are not formed. Synchronization messaging and automatic synchronization reconfiguration should be enabled on all other OC-3 interfaces on the DRI nodes. ■ All other OC-3 nodes must be provisioned for line-timing with synchronization messaging and automatic synchronization reconfiguration enabled.

Claim Element	Lucent 2000 Product Family

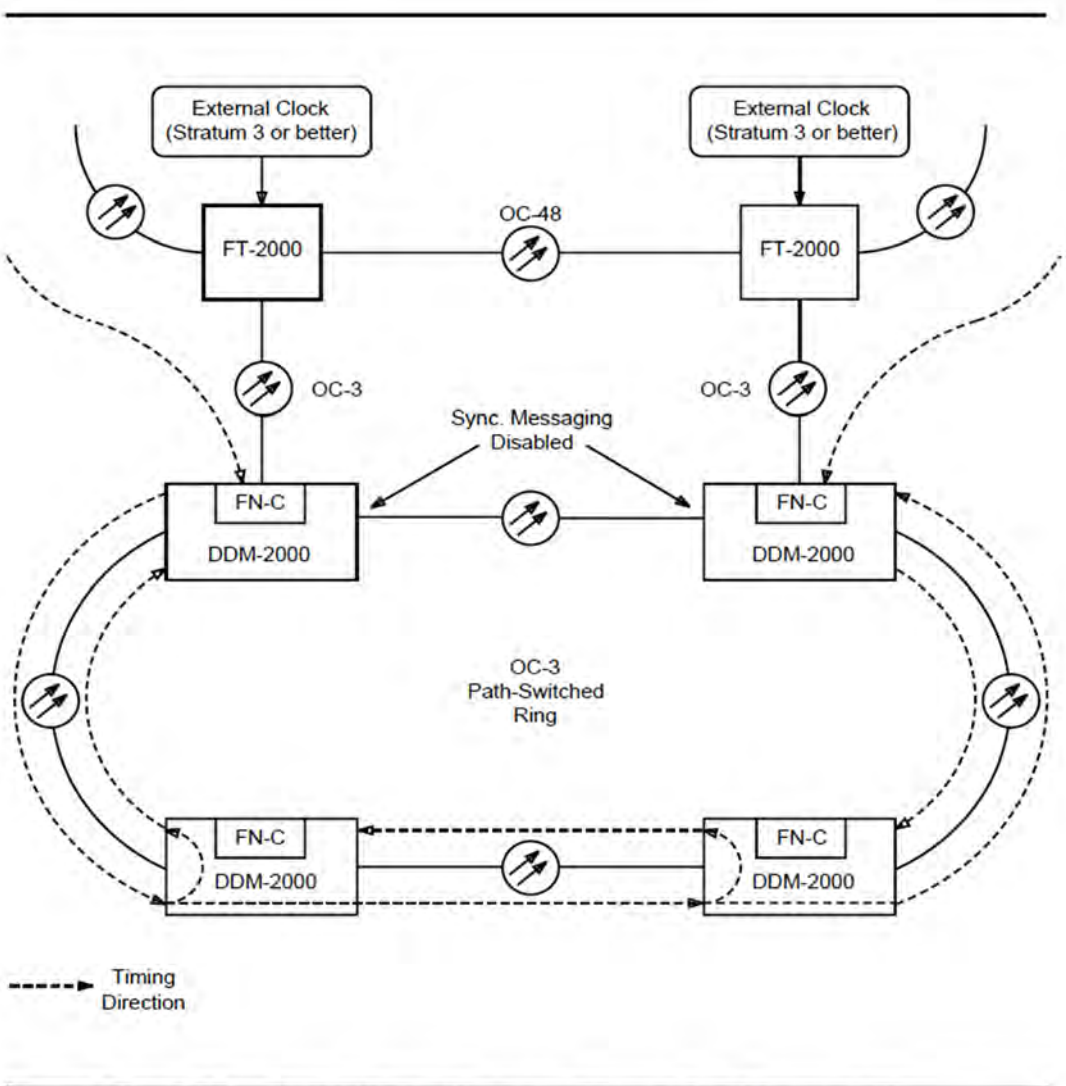
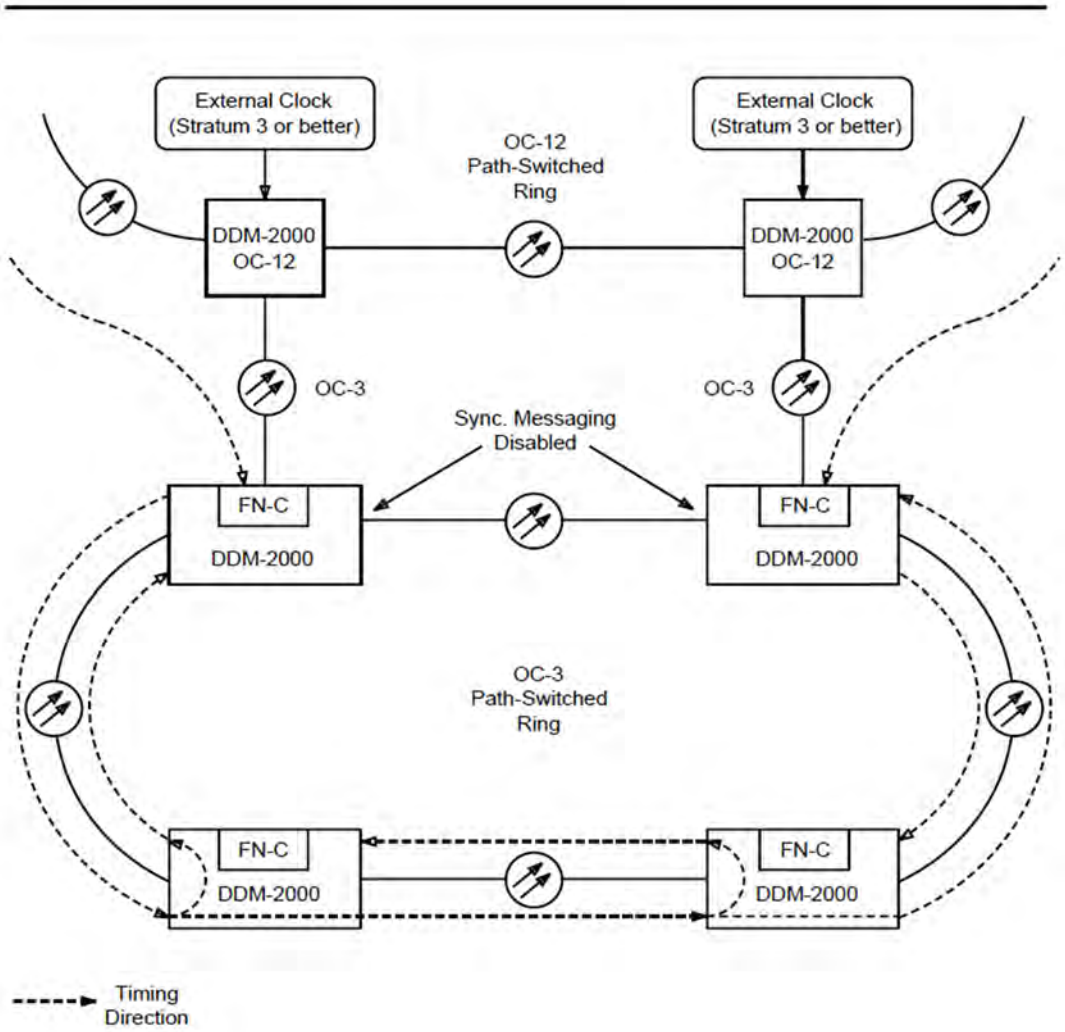


Figure 5-30. OC-3 and FT-2000 OC-48 Lightwave System Dual-Homing DRI Configuration

Claim Element	Lucent 2000 Product Family
	OC-3 and OC-12 Figure 5-31 shows how timing can be distributed from an OC-12 line-switched ring to a DDM-2000 OC-3 path-switched ring using a dual-homing DRI configuration. The OC-3 DRI nodes are connected via OC-3 point-to-point links terminating in function unit C slots. The major characteristics of this configuration are: ■ The OC-12 nodes are externally timed ■ The two DDM-2000 OC-3 DRI nodes coordinate timing using synchronization status messages on the OC-3 ring so that all nodes will accept timing in the same direction. ■ The two DDM-2000 OC-3 DRI nodes must be provisioned for line-timing with timing derived from function unit C. Synchronization messaging on the OC-3 span between the two OC-3 DRI nodes must be disabled so timing loops are not formed. Synchronization messaging and automatic synchronization reconfiguration should be enabled on all other OC-3 interfaces on the DRI nodes. ■ All other OC-3 nodes must be provisioned for line-timing with synchronization messaging and automatic synchronization reconfiguration enabled.

Claim Element	Lucent 2000 Product Family
	 Figure 5-31. OC-3 and OC-12 Dual-Homing DRI Configuration

Claim Element	Lucent 2000 Product Family
	DDM-2000 User/Service Manual at 400-401

The red FAULT LED lights by the SYSCTL on detection of BBG4/BBG4B DS3 circuit pack failure. In the event of an incoming DS3 signal failure, this LED will flash on and off. The green ACTIVE LED lights when the circuit pack is active (carrying service).

General Description of Operation

The BBG4/BBG4B DS3 circuit pack provides bidirectional transport of one DS3 signal through DDM-2000 OC-3 in either clear channel (CC) mode, violation monitor and removal (VMR) mode, or violation monitor (VM) mode, by mapping the DS3 into an STS-1 signal. The BBG4/BBG4B DS3 performs maintenance and provisioning functions associated with the STS-1 and DS3 signals and provides access to the STS-1 path overhead. It interfaces to the OLIU at the STS-1 rate, to the DSX-3, and to the SYSCTL, and receives timing signals traceable to the TG circuit pack. When provisioned for the CC mode, the DS3 can transport any DS3 rate signal that meets specified electrical interface requirements. When provisioned for the VMR or VM mode, the DS3 signal must meet both electrical and DS3 frame format requirements.

Detailed Description of Operation

Transmission Circuitry

Transmit Direction. Figure 7-26 provides an overall block diagram of the BBG4/BBG4B DS3 circuit pack. The transmit direction is the direction towards the STS-1 signal, and receive direction refers to the direction towards the DSX-3. In the transmit direction, the BBG4/BBG4B DS3 receives an incoming B3ZS encoded DS3 signal from the DSX-3. A closed protection relay contact routes the DS3 to a circuit that splits the signal and sends one output to the companion (standby) circuit pack and the other to its own receiver. The BBG4/BBG4B DS3 receiver performs equalization and clock recovery. The MUX circuitry performs B3ZS decoding, optional automatic DS3 AIS insertion, and a provisionable VMR function, then synchronizes and maps the DS3 to the STS-1 rate. The DS3 signal is then synchronized to the STS-1 payload rate, STS-1 path overhead is inserted, and an STS-1 rate signal is transmitted to an OLIU pair.

Receive Direction. The BBG4/BBG4B DS3 receives STS-1 data from both the active and standby OLIUs, selects one STS-1, performs pointer interpretation, processes and removes the path overhead, desynchronizes the embedded DS3, provides a provisionable VMR function, and then B3ZS encodes the signal for transmission to the DSX-3. A jumper allows the user to insert or remove an LBO network (225 ft. of 734A-type cable equivalent) to provide the required signal level and shape at the DSX-3.

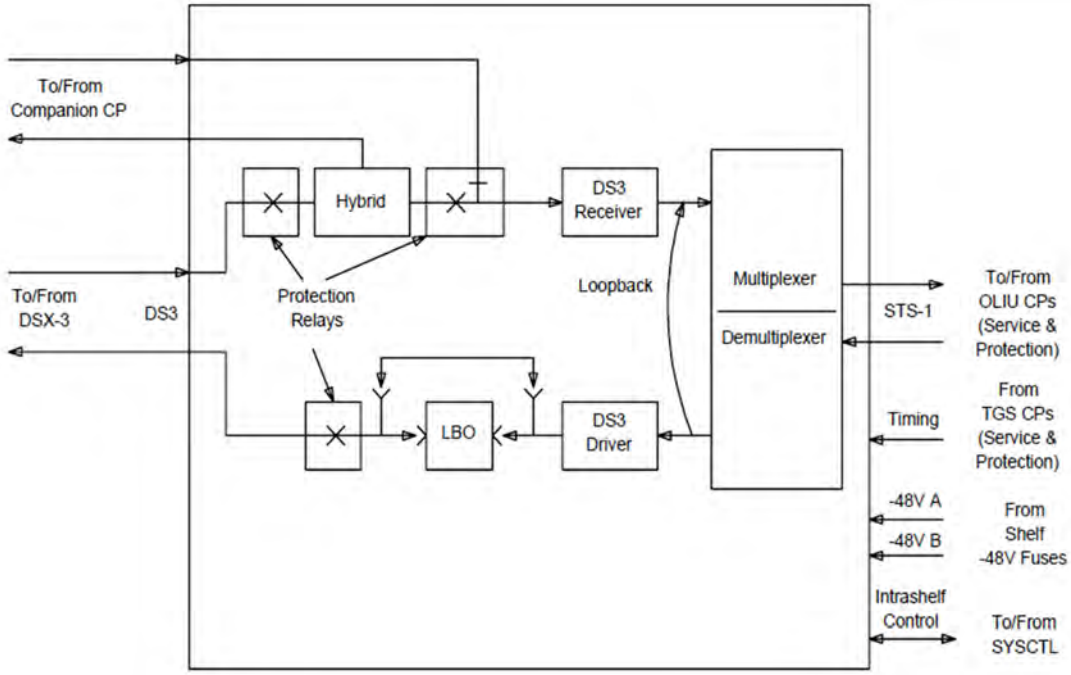


Figure 7-26. BBG4/BBG4B DS3 Circuit Pack Block Diagram

VMR Function

Before the DS3 signal is B3ZS-encoded (receive) or decoded (transmit), a VMR function can be provisioned via the control circuitry for one of three possible modes. These three modes are as follows:

- VMR with DS3 AIS insertion—default
- VM without removal of violations but with AIS insertion
- No violation monitoring CC mode with options for
  - AIS insertion
  - No AIS insertion.

Claim Element	Lucent 2000 Product Family
	DDM-2000 User/Service Manual at 524-545

Cross-Connection Provisioning

The DDM-2000 OC-3 Multiplexer can be provisioned for cross-connect routing of signals. In some applications, such as linear add/drop, drop, or hubbing, STS-1 or VT1.5 signal cross-connections may be established to route traffic in a specific manner. All cross-connections are bidirectional. Any STS-1 or VT1.5 signal may be cross-connected to a like signal with an available time slot, with some restrictions. Any STS-1 or VT1.5 signal between the main slot and any function unit slot may be cross-connected. Also, any single STS-1 or any VT1.5 channel in function units A or B may be cross-connected to any available time slots in function unit C when function unit C is equipped with OLIUs.

In ring applications, STS-1 and VT1.5 signals may be cross-connected in several ways. For bidirectional drop services, the normal (default) "two-way" cross-connection is used to connect a like signal in the high-speed main slot to any available time slot in any function unit equipped with low-speed STS1E, DS3, or DS1 circuit packs. For bidirectional hub applications at a ring node, the normal (default) "two-way" cross-connection is used to connect a like signal in the high-speed main slot to any available time slot in either the A, B, or C function unit, which has been equipped with OLIU circuit packs. The bidirectional pass-through service is used to connect the high-speed signal from one side of the ring to the other side. Both rings are connected using a single "two-way" (`ent-crs`) command. The high-speed time slot entering must be the same leaving in pass-through connections.

The "drop and continue" service provides, in a single command (`ent-crs`), the proper bidirectional cross-connection to "drop" a copy of the high-speed signal in the main slot to any available time slot in any function unit and to "continue" the signal on the high-speed channel to the next node. The same command also properly drops the signal from the opposite ring direction.

The DDM-2000 OC-3 Multiplexer has two cross-connect modes of operation, default and manual. On linear systems, this mode is "default" and can be provisioned to "manual." On ring systems, this mode is "manual" and cannot be changed. The cross-connect mode may be changed using the `set-ne` command and selecting the required `crs` mode. The cross-connect mode may be verified with the `rtrv-ne` command. Any cross-connect command may be implemented at each individual site in a network through the CIT connection or at any site via a remote login session from any other site.

Cross-Connection Types

DDM-2000 OC-3 Multiplexers have time slot interchange (TSI) features. This offers users flexibility in directing traffic in and out of these systems to support a wide variety and range of customer applications.

Cross-connections in DDM-2000 OC-3 Multiplexers are made by specifying the SONET rate (VT1.5 and STS-1), the end point addresses (access identifiers), the cross-connection type (two-way, drop and continue, etc.), and, in some cases, the ring direction (ring=m1, ring=m2, etc.). In DDM-2000 OC-3 Multiplexers, each single cross-connection command establishes a two-way cross-connection.

The basic type of cross-connection allows a low-speed port or channel to be cross-connected to a channel in the high-speed interface portion of the shelf. This is used in all linear add/drop applications where DS1, DS3, VT1.5, STS-1, and EC-1 low-speed signals are cross-connected to VT1.5 and STS-1 channels in the high-speed linear interfaces.

The next type of cross-connection allows a low-speed port or channel to be cross-connected to a channel in the high-speed ring interface. This is used in all path switched ring applications where DS1, DS3, VT1.5, STS-1, and EC-1 low-speed signals are cross-connected to VT1.5 or STS-1 channels in both rotations of the rings terminating on the high-speed interfaces. With this cross-connection, all added signals are bridged on to both rotations of the ring, and the better of the two signals received from the two rotations of the ring is dropped.

Another type of cross-connection allows a VT1.5 or STS-1 channel to be "passed-through" between two high-speed ring interfaces or between two OC-1 ring interfaces supported by 27G2-U OLIUs in function units. This is used in all path switched ring applications at nodes where traffic is not dropped. In path switched rings, pass-through grooming (passing a signal on a ring time slot that is different from the ring time slot on which it was received) is not supported.

End-to-end survivable service facilities need to cross multiple rings interconnected at multiple wire centers. To support these applications, a drop-and-continue cross-connection is provided for a signal from a high-speed channel to be dropped to a specified low-speed port or channel and continued on to the next node in the same direction while also adding a corresponding signal from the low-speed port or channel to the high-speed channel in the other rotation of the ring.

A variation of ring cross-connections, the "locked cross-connection," is supported at the VT1.5 level to lock the path selector to a specified rotation of the ring. With this cross-connection, a DS1 or VT1.5 signal from the low-speed interface is cross-connected to the specified VT1.5 channel in the high-speed interface in the specified direction; and any signal received in the same VT1.5 channel from the

Claim Element	Lucent 2000 Product Family

Locked cross-connections are a ring-to-non-ring type of cross-connection between a ring interface and a non-ring interface in which no path protection switching is provided (see Figure 8-1).

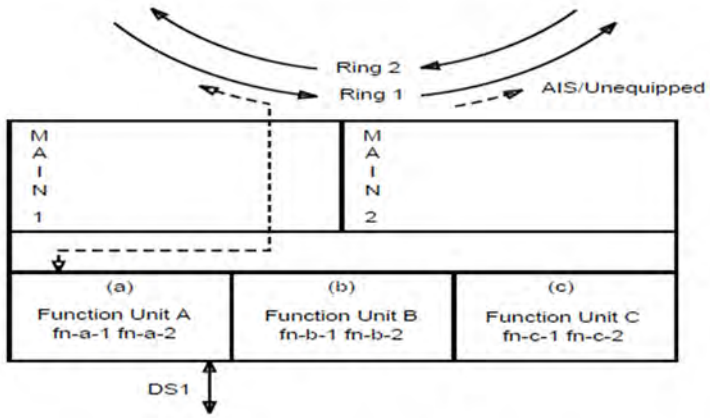


Figure 8-1. Locked Cross-Connection

A locked cross-connection configuration has the following characteristics:

- The signal received on a specified channel, for example, m-1-1-1 of the ring interface m1 from ring 1 in one direction around the ring is transmitted on a non-ring (DS1) interface.
- The signal received on the other ring interface (m2), using the other direction around the ring (ring 2), on the same channel (m-1-1-1) is ignored.
- A signal is transmitted from a non-ring interface (DS1 interface) through the specified channel (m-1-1-1) on ring 2 using ring interface m1.
- The provisioned AIS or unequipped signal is transmitted on the other direction around the ring (ring 1) using ring interface (m2). This signal will not cause any alarms at pass-through nodes and will only cause alarms at terminating nodes if cross-connections are provisioned.

"Hairpin" cross-connections allow local drop of signals, ring extensions supported by a ring host node, and allow passing traffic between two ring interfaces on a single host node. In this case, no high-speed channel is involved and the cross-connections are entirely within the interfaces in the function units.

In DDM-2000 OC-3 Release 9.0, VT1.5 signals from function units A or B can be cross-connected to VT1.5 signals in function unit C. The VT1.5 signals can be in any MXRVO, STS1E, or 22-type OLIU, with the exception that MXRVO-to-MXRVO hairpins are not allowed. Beginning in Release 9.1, VT1.5 and STS-1 signals terminating on 27G2-U OC-1 OLIUs in function units may be hairpin connected. The available interfaces are:

- DS1 to EC-1/OC-3
- EC-1 to OC-3
- EC-1 to EC-1
- OC-3 to OC-3
- OC-1 to OC-1
- STS-1 to STS-1

Table 8-5 lists the number of available VT1.5 cross-connections including hairpin cross-connections:

Table 8-5. DDM-2000 OC-3 Available VT1.5 Cross-Connections, Including Hairpin

Slot	Main	Fn-A	Fn-B	Fn-C
Main	84	56	56	84
Fn-A	56	0	0	56*
Fn-B	56	0	0	56*
Fn-C	84	56*	56*	0

* Hairpin cross-connections.

Table 8-6 lists the number of available STS-1 cross-connections including hairpin cross-connections:

Table 8-6. DDM-2000 OC-3 Available STS-1 Cross-Connections, Including Hairpin

Slot	Main	Fn-A	Fn-B	Fn-C
Main	3/12 *	2	2	3
Fn-A	2	0	0	2
Fn-B	2	0	0	2
Fn-C	3	2	2	0

* Any three of 12 when using a 24G-U OLIU.

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Linear Application Default Cross-Connection Mode

In the default cross-connection mode, STS-1 cross-connections are automatically set up. The default cross-connections are determined according to the circuit pack equipage of the DDM-2000 OC-3 Multiplexer. No VT1.5 cross-connections are made in the default mode. If slots are unequipped, then no cross-connection is made.

For some applications, such as a point-to-point configuration, the default mode may provide all the necessary cross-connections required.

DDM-2000 linear systems support a fixed mapping between STS-1 signals embedded in the OC-3 line signal and the STS-1s associated with signals dropped on the shelf. This "default" STS-1 signal mapping is shown in Table 8-7. When the **crs** parameter is "default," attempts to enter or delete cross-connections are denied. When the value of the **crs** parameter is "manual," cross-connections are not created or deleted automatically. Even if a circuit pack is inserted into an empty slot, the system waits for the user to provision the cross-connection before the port is put into service. Likewise, a circuit pack (CP) cannot be removed until the cross-connection to the circuit pack is deleted.

Table 8-7. DDM-2000 OC-3 Default STS-1 Cross-Connections (Termination)

From		To	"To" CP Type (Note)	CIT Command
m-1	<-->	a	MXRVO, STS1E, DS3	-not required-
m-2	<-->	b	MXRVO, STS1E, DS3	-not required-
m-3	<-->	c	MXRVO, STS1E, DS3	-not required-
m-1	<-->	a-1	OLIU	-not required-
m-2	<-->	b-2	OLIU	-not required-
m-3	<-->	c-3	OLIU	-not required-

Note: The STS1E circuit pack hardware switch must be set to "low-speed" to support cross-connections.

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	Manual Cross-Connections If the default cross-connections do not provide the necessary connections, then a manual cross-connection mode may be selected by entering the **set-ne** command and changing the **crs** parameter to manual. In the manual cross-connections mode, the cross-connections can be changed using the following commands: ■ **ent-crs-sts1** (Enter Cross-Connection STS-1)—This command creates STS-1 signal cross-connections. ■ **dlt-crs-sts1** (Delete Cross-Connection STS-1)—This command deletes STS-1 signal cross-connections. ■ **ent-crs-vt1** (Enter Cross-Connection VT1.5)—This command creates VT1.5 signal cross-connections. The 22-type OLIU circuit packs must be used to establish VT1.5 cross-connections. ■ **dlt-crs-vt1** (Delete Cross-Connection VT1.5)—This command deletes VT1.5 signal cross-connections. ■ **cnvt-crs** (Convert Cross-Connection)—This command converts an existing STS-1 cross-connection to 28 individual VT1.5 cross-connections with the same endpoints as the STS-1 cross-connection. VT1.5 signals carried within the original STS-1 appear in the same time slots in the upstream or downstream DDM-2000 OC-3 before and after the conversion takes place. 22-type OLIU circuit packs must be used to convert cross-connections. The **cnvt-crs** command has the unique ability to convert an existing STS-1 signal into its component 28 VT1.5 signals. This conversion enables an easy upgrade of existing STS-1 drop networks to DS1 add/drop networks. No inverse capability is available to convert 28 VT1.5 signals back to a single STS-1 cross-connection. DDM-2000 OC-3 systems provide flexible routing of STS-1 and VT1.5 signals between high-speed and function unit interfaces for ring, hubbing, and add/drop applications. These "manual" cross-connections are entered using the CIT and are shown in Table 8-11 through Table 8-24. The **crs** parameter must be set to "manual" to enter flexible STS-1 and VT1.5 cross-connections.

Allowable Cross-Connects

Table 8-8 through Table 8-10 list main and function unit circuit packs and their allowed cross-connect functionality. It also lists the earliest software release the cross-connect was available.

The following list defines the cross-connect types listed in Table 8-8 through Table 8-10.

- **Two-Way**: A two-way cross-connection between two non-ring interfaces is a bidirectional cross-connection between two ports, two channels, or one port and one channel. This type of cross-connection can be used in both "linear" and "ring" generics; when used in a "ring" generic, it is sometimes referred to as a "hairpin" cross-connection.
- **Add/Drop**: A two-way cross-connection add/drop to/from a ring interface is a bidirectional cross-connection between a channel on a path-protection switched ring and a port or channel on a non-ring interface.
- **Dual 0x1**: A two-way dual 0x1 cross-connection between two ring interfaces is a bidirectional cross-connection between channels on each of two different ring interfaces (no path switching). This type of cross-connection is used in "single homing" network configurations.
- **Intra-FN Dual 0x1**: A two-way intra-FN dual 0x1 cross-connection between two ring interfaces is a bidirectional cross-connection between channels on the two different ring interfaces supported by a pair of dual-port OLIUs in the same function unit (no path switching). This type of cross-connection is used in "single homing" network configurations.
- **Dual 0x1 NR**: A two-way dual 0x1 cross-connection between a ring interface and a non-ring interface is a bidirectional cross-connection between a channel on a ring interface and a port on a non-ring interface (no path switching). Also referred to as "Locked DS3." This type of cross-connection is used in "single homing" network configurations.
- **Pass-Through**: A two-way pass-through cross-connection on a ring interface is a bidirectional cross-connection on a single ring interface.
- **Single 0x1**: A two-way single 0x1 ring to ring cross-connection is a bidirectional cross-connection between channels on each of two different ring interfaces. This type of cross-connection is used in "dual homing" network configurations (no path switching).
- **Intra-FN Single 0x1**: A two-way intra-FN single 0x1 ring to ring cross-connection is a bidirectional cross-connection between channels on the two different ring interfaces supported by a pair of dual-port OLIUs in the same function unit. This type of cross-connection is used in "dual homing" network configurations (no path switching).
- **Single 0x1 NR**: A two-way single 0x1 cross-connection between a ring interface and a non-ring interface is a bidirectional cross-connection between a channel on a ring interface and a port on a non-ring interface. Also referred to as "Locked DS3." This type of cross-connection is used in "dual homing" network configurations (no path switching).

- **Drop/Continue**: A drop and continue cross-connection is a bidirectional cross-connect between a ring and an non-ring interface which also continues on the ring.
- **Unprotected Video Broadcast**: An unprotected video broadcast source cross-connection on a ring interface is an asymmetric bidirectional cross-connection from a broadcast source onto an OC-N ring.
- **Locked VT:** A ring (0x1) VT locked cross-connection between low-speed and high-speed time slots, locking ring traffic onto a designated ring rotation.

Table 8-8. DDM-2000 OC-3 Ring Cross-Connect Types Allowable (Main to Main)

From MAIN		To MAIN		
Circuit Pack	Cross Connect Type	22-type	24G-U	27-type
22-type	Pass-Through STS	5.1		
	Pass-Through VT	5.0		
	Drop/Continue STS	7.0		
	Drop/Continue VT	7.0*		
24G-U	Pass-Through STS		11.0	
	Pass-Through STS-3C		11.0	
	Pass-Through VT		11.0	
	Drop/Continue STS		11.0	
	Drop/Continue VT		11.0	
27-type	Pass-Through STS			9.0
	Pass-Through VT			9.0
	Drop/Continue STS			9.0
	Drop/Continue VT			9.0*

* All VT1.5 drop and conitnue cross-connections in a system must be in the same direction, i.e. from the same ring (m1 or m2).

Table 8-9. DDM-2000 OC-3 Ring Cross-Connect Types Allowable (Main to Function Unit)

From MAIN		To FUNCTION UNIT							
Circuit Pack	Cross-Connect Type	22-type*	26G2-U	27G-U	27G2-U	DS3	STS1E†	MXRVO	TMUX
22-type	Add/Drop STS	7.0‡ 9.0§				5.1 ¶	5.1	5.1	11.1
	Add/Drop VT	7.0‡ 9.0§					5.1	5.0	11.1
	Dual 0x1 STS		11.1 §§	9.0	9.0 ¶¶				
	Dual 0x1 VT		11.1 §§	9.0	9.0 ¶¶				
	Dual 0x1 NR STS (Locked DS3)					11.0 **			
	Single 0x1 STS		11.1 ††§§	9.0 ††	9.0 ††¶¶				
	Single 0x1 VT		11.1 ††§§	9.0 ††	9.0 ††¶¶				
	Single 0x1 NR STS (Locked DS3)					11.0 **			
	Drop/Continue STS	7.2					7.0		
	Drop/Continue VT	7.2 ‡‡					7.0 ‡‡		
	Locked VT							9.0	11.1
27-type	Add/Drop STS	9.0				9.0 ¶	9.0	9.0	11.1
	Add/Drop VT	9.0					9.0	9.0	11.1
	Dual 0x1 STS		11.1	9.0	9.0				
	Dual 0x1 VT		11.1	9.0	9.0				
	Dual 0x1 NR STS					11.0 **			
	Single 0x1 STS		11.1 ††	9.0 ††	9.0 ††				
	Single 0x1 VT		11.1 ††	9.0 ††	9.0 ††				
	Single 0x1 NR STS					11.0 **			
	Drop/Continue STS	9.0				9.0 ¶	9.0		

From MAIN		To FUNCTION UNIT							
Circuit Pack	Cross-Connect Type	22-type*	26G2-U	27G-U	27G2-U	DS3	STS1E†	MXRVO	TMUX
27-type (cont'd)	Drop/Continue VT	9.0 ‡‡					9.0 ‡‡		
	Locked VT							9.0	11.1
24-type	Add/Drop STS	11.0				11.0	11.0	11.0	11.1
	Add/Drop VT	11.0					11.0	11.0	11.1
	Dual 0x1 STS		11.1 §§	11.0	11.0 ¶¶				
	Dual 0x1 VT		11.1 §§	11.0	11.0 ¶¶				
	Dual 0x1 NR STS					11.0 **			
	Single 0x1 STS		11.1 §§	11.0	11.0 ¶¶				
	Single 0x1 VT		11.1 §§	11.0	11.0 ¶¶				
	Single 0x1 NR STS					11.0 **			
	Drop/Continue STS	11.0					11.0		
	Drop/Continue VT	11.0					11.0		
	Locked VT							11.0	11.1

* A 22-type OLIU in a function unit is in "linear" (unprotected or 1+1 line protected), not a ring configuration.

† This table refers to only "low-speed" STS-1 interfaces.

‡ Only FN-B and/or FN-C can be equipped with 22-type OLIUs in this release.

§ FN-A, FN-B and/or FN-C can be equipped with 22-type OLIUs in this release.

¶ This entry valid for DS3 circuit packs except the BBG19 front-access pack.

** This entry valid for the BBG19 front-access DS3 circuit pack.

†† One of the pair of function unit slots will be empty.

‡‡ All VT1.5 drop and continue cross-connections in a system must be in the same direction, i.e. from the same ring (m1 or m2).

§§ The mixing of 0x1, Pass-Through, and local Add/Drop cross-connects is supported beginning with R11.1.

¶¶ The mixing of 0x1, Pass-Through, and local Add/Drop cross-connects is supported beginning with R11.0.

Table 8-10. DDM-2000 OC-3 Ring Cross-Connect Types Allowable (Function Unit to Function Unit)

From FUNCTION UNIT		To FUNCTION UNIT						
Circuit Pack	Cross-Connect Type	22-type*	26G2-U	27G2-U	DS3	STS1E†	MXRVO	TMUX
22-type	Two-Way STS	11.1			11.1	11.1		
	Two-Way VT	9.0				9.0	9.0	11.1
	Add/Drop STS		11.1	11.0				
	Add/Drop VT		11.1	11.0				
26G2-U	Add/Drop STS	11.1 ‡‡				11.1	11.1 §‡‡	11.1
	Add/Drop VT	11.1 ‡‡	11.1 ‡,‡‡			11.1	11.1 §‡‡	11.1
	Dual 0x1 STS		11.1 ¶‡‡	11.1 ¶‡‡				
	Dual 0x1 VT		11.1 ¶‡‡	11.1 ¶‡‡				
	Pass-Through STS		11.1 ‡‡					
	Pass-Through VT		11.1 ‡‡					
	Single 0x1 STS		11.1 ¶**‡‡	11.1 ¶**‡‡				
	Single 0x1 VT		11.1 ¶**‡‡	11.1 ¶**‡‡				
27G2-U	Add/Drop STS	11.0 §§				11.0	11.0 §§	11.1
	Add/Drop VT	11.0 §§				11.0	11.0 §§	11.1
	Dual 0x1 STS		11.1 ¶§§	9.1 ¶§§				
	Dual 0x1 VT		11.1 ¶§§	9.1 ¶§§				
	Intra-FN Dual 0x1 VT			9.1 ††				
	Pass-Through STS			9.1 §§				
	Pass-Through VT			9.1 §§				

From FUNCTION UNIT		To FUNCTION UNIT						
Circuit Pack	Cross-Connect Type	22-type*	26G2-U	27G2-U	DS3	STS1E†	MXRVO	TMUX
27G2-U (cont'd)	Single 0x1 STS		11.1 ¶**§§	9.1 ¶**§§				
	Single 0x1 VT		11.1 ¶**§§	9.1 ¶**§§				
	Intra-FN Single 0x1 VT			9.1 ††**				
STS1E	Two-Way VT	9.0				9.0	9.0	11.1
	Two-Way STS	11.1			11.1	11.1		
	Add/Drop STS		11.1	11.0				
	Add/Drop VT		11.1	11.0				
MXRVO	Two-Way VT	9.0				9.0		
	Add/Drop STS		11.1 §‡‡	11.0 §§				
	Add/Drop VT		11.1 §‡‡	11.0 §§				
TMUX	Two-Way VT	11.1				11.1		
	Add/Drop STS		11.1 §	11.1				
	Add/Drop VT		11.1 §	11.1				

* A 22-type OLIU in a function unit is in "linear" (unprotected or 1+1 line protected), not a ring configuration.

† This table refers to only "low-speed" STS-1 interfaces.

‡ This entry represents the hairpin local drop cross-connection between a channel on an OC-1 ring terminating on a pair of 26G2-U OLIUs and a DS1 port in the low-speed group associated with the 26G2-U OLIUs. The MXRVO functionality on the 26G2-U OLIUs is used. Note that it is NOT possible to connect between a channel on an OC-1 ring terminating on a pair of 26G2-U OLIUs and a 26G2-U/DS1 combination in a different function unit.

§ MXRVO functionality within the 26G2-U OLIU is NOT used. Rather, a separate pair of MXRVOs in a different FN group are used.

¶ Cross-connections from one OC-1 ring to a different OC-1 ring in a different function unit.

** One of the pair of function unit slots will be empty.

†† Cross-connections from one OC-1 ring to a different OC-1 ring in the same function unit.

‡‡ The mixing of 0x1, Pass-Through, and local Add/Drop cross-connects is supported beginning with R11.1.

§§ The mixing of 0x1, Pass-Through, and local Add/Drop cross-connects is supported beginning with R11.0.

Table 8-11 through Table 8-24 lists the various types of cross-connections supported. After the tables are descriptions of applications and the types of cross-connections each application requires.

Table 8-11. Linear or Ring Manual STS-1 Cross-Connections (Termination/Drop)

From *		To	"To" CP Type (Note)	CIT Command
m-{1-3}	<-->	a	MXRVO, STS1E, DS3, TMUX	ent-crs-sts1:m-1,a
m-{1-3}	<-->	b	MXRVO, STS1E, DS3, TMUX	ent-crs-sts1:m-2,b
m-{1-3}	<-->	c	MXRVO, STS1E, DS3, TMUX	ent-crs-sts1:m-3,c
m-{1,2}†	<-->	a	MXRVO, STS1E, DS3, TMUX	ent-crs-sts1:m-1,a
m-{1,2}†	<-->	b	MXRVO, STS1E, DS3, TMUX	ent-crs-sts1:m-2,b
m-{1,2}†	<-->	c	MXRVO, STS1E, DS3, TMUX	ent-crs-sts1:m-3,c

Notes:

The STS1E circuit pack hardware switch must be set to "low-speed" to support cross-connections.

* Whenever 24-type OLIUs are installed in main the range of STS-1s will be from 1 to 12. Example: m-{1-12}.

† Ring cross-connection; 27-type OLIU in main.

Table 8-12. Linear or Ring Manual STS-1 Cross-Connections (Hub/Drop)

From *		To	"To" CP Type	CIT Command
m-{1-3}	<-->	a-{1,2}	OLIU	ent-crs-sts1:m-1,a-1
m-{1-3}	<-->	b-{1,2}	OLIU	ent-crs-sts1:m-2,b-2
m-{1-3}	<-->	c-{1,3}	OLIU	ent-crs-sts1:m-3,c-3
m-{1,2}†	<-->	{a,b}-{1-2}	22-type OLIU	ent-crs-sts1:m-1,a-1
m-{1,2}†	<-->	{c}-{1-3}	22-type OLIU	ent-crs-sts1:m-1,a-1

Notes:

* Whenever 24-type OLIUs are installed in main the range of STS-1s will be from 1 to 12. Example: m-{1-12}.

† Ring cross-connection; 27-type OLIU in main.

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Table 8-13. Linear Manual STS-1 Cross-Connections (Add)

From		To	"From" CP Type (Note)	CIT Command
a	<-->	c-{1,3}	MXRVO, STS1E, DS3	ent-crs-sts1:a,c-1
b	<-->	c-{1,3}	MXRVO, STS1E, DS3	ent-crs-sts1:b,c-3
a-{1,2}	<-->	c-{1,3}	OLIU	ent-crs-sts1:a-1,c-1
b-{1,2}	<-->	c-{1,3}	OLIU	ent-crs-sts1:b-1,c-1

Note:

The STS1E circuit pack hardware switch must be set to "low-speed" to support cross-connections.

Table 8-14. Ring Manual STS-1 Cross-Connections (Pass-Through)

From *		To	"To" CP Type (Note)	CIT Command
m-1	<-->	m-1	OLIU	ent-crs-sts1:m-1,m-1
m-2	<-->	m-2	OLIU	ent-crs-sts1:m-2,m-2
m-3	<-->	m-3	OLIU	ent-crs-sts1:m-3,m-3
{a,b,c}-{1-2}	<-->	{a,b,c}-{1-2}	27G2-U OLIU	ent-crs-sts1:a-1,a-1
m-{1,2}†	<-->	m-{1,2}	22-type OLIU	ent-crs-sts1:m-1,m-1

Notes:

Address on the left side MUST BE identical to the address on the right side. There is no interchange function for "pass-through" signals.

* Whenever 24-type OLIUs are installed in main the range of STS-1s will be from 1 to 12. Example: m-{1-12}.

† Ring cross-connection; 27-type OLIU in main.

Table 8-15. Ring Manual STS-1 Cross-Connections (Drop and Continue)

From *		To	"To" CP Type (Note)	CIT Command
m-{1-3}	<-->	a	STS1E	ent-crs-sts1:m-1,a:cct=dc,ring=m1
m-{1-3}	<-->	b	STS1E	ent-crs-sts1:m-2,b:cct=dc,ring=m1
m-{1-3}	<-->	c	STS1E	ent-crs-sts1:m-3,c:cct=dc,ring=m2
m-{1-3}	<-->	a-{1,2}	OLIU	ent-crs-sts1:m-1,a-1
m-{1-3}	<-->	b-{1,2}	OLIU	ent-crs-sts1:m-2,b-2
m-{1-3}	<-->	c-{1,3}	OLIU	ent-crs-sts1:m-3,c-3
m-{1,2}†	<-->	{a,b,c}	STS1E	ent-crs-sts1:m-1,a:cct=dc,ring=m1
m-{1,2}†	<-->	{a,b}-{1,2}	22-type OLIU	ent-crs-sts1:m-1,a-1
m-{1,2}†	<-->	c-{1-3}	22-type OLIU	ent-crs-sts1:m-1,c-3

Notes:

The STS1E circuit pack hardware switch must be set to "low-speed" to support cross-connections. The "ring" parameter defines the ring carrying the continue signal. This ring directly connects to the other drop and continue shelf.

* Whenever 24-type OLIUs are installed in main the range of STS-1s will be from 1 to 12. Example: m-{1-12}.

† Ring cross-connection; 27-type OLIU in main.

Table 8-16. Linear or Ring Manual VT1.5 Cross-Connections (Termination/Drop)

From *		To	"To" CP Type (Note)	CIT Command
m-{1-3}-{1-7}-{1-4}	<-->	a-{1-7}-{1-4}	MXRVO, STS1E, TMUX	ent-crs-vt1:m-1-1-1,a-1-1
m-{1-3}-{1-7}-{1-4}	<-->	b-{1-7}-{1-4}	MXRVO, STS1E, TMUX	ent-crs-vt1:m-2-3-4,b-3-4
m-{1-3}-{1-7}-{1-4	<-->	c-{1-7}-{1-4}	MXRVO, STS1E, TMUX	ent-crs-vt1:m-3-3-3,c-3-3
m-{1,2}-{1-7}-{1-4}†	<-->	{a,b,c}-{1-7}-{1-4}	MXRVO, STS1E	ent-crs-vt1:m-1-1-1,a-1-1

Notes:

The STS1E circuit pack hardware switch must be set to "low-speed" to support cross-connections.

* Whenever 24-type OLIUs are installed in main the range of STS-1s will be from 1 to 12. Example: m-{1-12}.

† Ring cross-connection; 27-type OLIU in main.

Table 8-17. Linear or Ring Manual VT1.5 Cross-Connections (Hub/Drop)

From *		To	"To" CP Type	CIT Command
m-{1-3}-{1-7}-{1-4}	<-->	a-{1,2}-{1-7}-{1-4}	OLIU	ent-crs-vt1:m-1-1-1,a-1-1-1
m-{1-3}-{1-7}-{1-4}	<-->	b-{1,2}-{1-7}-{1-4}	OLIU	ent-crs-vt1:m-2-2-2,b-2-2-2
m-{1-3}-{1-7}-{1-4}	<-->	c-{1-3}-{1-7}-{1-4}	OLIU	ent-crs-vt1:m-3-3-3,c-3-3-3
m-{1,2}-{1-7}-{1-4}†	<-->	{a,b}-{1,2}-{1-7}-{1-4}	22-type OLIU	ent-crs-vt1:m-1-1-1,a-1-1-1
m-{1,2}-{1-7}-{1-4}†	<-->	c-{1-3}-{1-7}-{1-4}	22-type OLIU	ent-crs-vt1:m-2-2-2,c-3-3-3

Notes:

* Whenever 24-type OLIUs are installed in main the range of STS-1s will be from 1 to 12. Example: m-{1-12}.

† Ring cross-connection; 27-type OLIU in main.

Table 8-18. Ring Manual STS-1 Cross-Connections (Hairpin)

From	"From" CP Type		To	"To" CP Type	CIT Command
{a,b}-{1-2}	27G2-U OLIU	<-->	c-{1-2}	27G2-U OLIU	ent-crs-sts1:a-1,c-2
{a,b}-{1-2}	27G2-U OLIU	<-->	c-{1-3}	22-type OLIU	ent-crs-sts1:a-1,c-3
{a,b}-{1-2}	22-type OLIU	<-->	c-{1-2}	27G2-U OLIU	ent-crs-sts1:a-1,c-2
{a,b}-{1-2}	27G2-U OLIU	<-->	c	MXRVO,TMUX, STS1E	ent-crs-sts1:a-1,c
{a,b}	MXRVO,TMUX,STS1E	<-->	c-{1-2}	27G2-U OLIU	ent-crs-sts1:a,c-2
{a,b}-{1}	26G2-U OLIU	<-->	c-{1-3}	22-type OLIU	ent-crs-sts1:a-1,c-3
{a,b}-{1-2}	22-type OLIU	<-->	c-{1}	26G2-U OLIU	ent-crs-sts1:a-1,c-1
{a,b}-{1}	26G2-U OLIU	<-->	c	MXRVO,TMUX, STS1E	ent-crs-sts1:a-1,c
{a,b}	MXRVO,TMUX,STS1E	<-->	c-{1}	26G2-U OLIU	ent-crs-sts1:a,c-1
{a,b}	DS3, STS1E	<-->	c-{1-3}	22-type OLIU	ent-crs-sts1:a,c-3
{a,b}-{1-2}	22-type OLIU	<-->	c	DS3, STS1E	ent-crs-sts1:a-1,c
{a,b}-{1-2}	22-type OLIU	<-->	c-{1-3}	22-type OLIU	ent-crs-sts1:a-1,c-3
{a,b}	DS3, STS1E	<-->	c	STS1E	ent-crs-sts1:a,c

Note:

Refer to the **`ent-crs-sts1`** command for software release information.

Table 8-19. Ring Manual VT1.5 Cross-Connections (OC-1 Hub/Drop)

From *		To	"To" CP Type	CIT Command
m-{1-3}-{1-7}-{1-4}	<-->	a-{1,2}-{1-7}-{1-4}	27G-U OLIU	ent-crs-vt1:m-1-1-1,a-1-1-1
m-{1-3}-{1-7}-{1-4}	<-->	b-{1,2}-{1-7}-{1-4}	27G-U OLIU	ent-crs-vt1:m-2-2-2,b-2-2-2
m-{1-3}-{1-7}-{1-4}	<-->	c-{1-2}-{1-7}-{1-4}	27G-U OLIU	ent-crs-vt1:m-3-3-3,c-2-3-3
m-{1,2}-{1-7}-{1-4}†	<-->	{a,b,c}-{1,2}-{1-7}-{1-4}	27G-U OLIU	ent-crs-vt1:m-1-1-1,a-1-1-1
m-{1-3}-{1-7}-{1-4}	<-->	a-{1}-{1-7}-{1-4}	26G2-U OLIU	ent-crs-vt1:m-1-1-1,a-1-1-1
m-{1-3}-{1-7}-{1-4}	<-->	b-{1}-{1-7}-{1-4}	26G2-U OLIU	ent-crs-vt1:m-2-2-2,b-1-2-2
m-{1-3}-{1-7}-{1-4}	<-->	c-{1}-{1-7}-{1-4}	26G2-U OLIU	ent-crs-vt1:m-3-3-3,c-1-3-3
m-{1,2}-{1-7}-{1-4}†	<-->	{a,b,c}-{1}-{1-7}-{1-4}	26G2-U OLIU	ent-crs-vt1:m-1-1-1,a-1-1-1

Notes:

* Whenever 24-type OLIUs are installed in main the range of STS-1s will be from 1 to 12. m-{1-12}.

† Ring cross-connection; 27-type OLIU in main.

Table 8-20. Ring Manual VT1.5 Cross-Connections (Drop and Continue)

From *		To	"To" CP Type (Note)	CIT Command
m-{1-3}-{1-7}-{1-4}	<-->	a-{1-7}-{1-4}	STS1E	ent-crs-vt1:m-1-1-1,a-1-1:cct=dc,ring=m1
m-{1-3}-{1-7}-{1-4}	<-->	b-{1-7}-{1-4}	STS1E	ent-crs-vt1:m-2-3-4,b-3-4:cct=dc,ring=m1
m-{1-3}-{1-7}-{1-4}	<-->	c-{1-7}-{1-4}	STS1E	ent-crs-vt1:m-3-3-3,c-3-3:cct=dc,ring=m2
m-{1-3}-{1-7}-{1-4}	<-->	a-{1,2}-{1-7}-{1-4}	OLIU	ent-crs-vt1:m-1-1-1,a-1-1-1:cct=dc,ring=m1
m-{1-3}-{1-7}-{1-4}	<-->	b-{1,2}-{1-7}-{1-4}	OLIU	ent-crs-vt1:m-2-2-2,b-2-2-2:cct=dc,ring=m1
m-{1-3}-{1-7}-{1-4}	<-->	c-{1-3}-{1-7}-{1-4}	OLIU	ent-crs-vt1:m-3-3-3,c-3-3-3:cct=dc,ring=m2
m-{1,2}-{1-7}-{1-4}*	<-->	{a,b,c}-{1-7}-{1-4}	STS1E	ent-crs-vt1:m-1-1-1,a-1-1:cct=dc,ring=m1
m-{1,2}-{1-7}-{1-4}†	<-->	a-{1,2}-{1-7}-{1-4}	22-type OLIU	ent-crs-vt1:m-1-1-1,a-1-1-1:cct=dc,ring=m1
m-{1,2}-{1-7}-{1-4}†	<-->	b-{1,2}-{1-7}-{1-4}	22-type OLIU	ent-crs-vt1:m-2-2-2,b-2-2-2:cct=dc,ring=m1
m-{1,2}-{1-7}-{1-4}†	<-->	c-{1-3}-{1-7}-{1-4}	22-type OLIU	ent-crs-vt1:m-3-3-3,c-3-3-3:cct=dc,ring=m2

Notes:

The STS1E circuit pack hardware switch must be set to "low-speed" to support cross-connections. The "ring" parameter defines the ring carrying the continue signal. This ring directly connects to the other drop and continue shelf.

* Whenever 24-type OLIUs are installed in main the range of STS-1s will be from 1 to 12. m-{1-12}.

† Ring cross-connection; 27G-U OLIU in main.

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Table 8-21. Linear Manual VT1.5 Cross-Connections (Add)

From		To	"To" CP Type (Note)	CIT Command
a-{1-7}-{1-4}	<-->	c-{1-3}-{1-7}-{1-4}	MXRVO, STS1E	ent-crs-vt1:a-1-1,c-1-1-1
b-{1-7}-{1-4}	<-->	c-{1-3}-{1-7}-{1-4}	MXRVO, STS1E	ent-crs-vt1:b-2-2,c-2-2-2
a-{1,2}-{1-7}-{1-4}	<-->	c-{1-3}-{1-7}-{1-4}	OLIU	ent-crs-vt1:a-2-2-2,c-2-2-2
b-{1,2}-{1-7}-{1-4}	<-->	c-{1-3}-{1-7}-{1-4}	OLIU	ent-crs-vt1:b-2-2-2,c-3-3-3

Note:

The STS1E circuit pack hardware switch must be set to "low-speed" to support cross-connections.

Table 8-22. Ring Manual VT1.5 Cross-Connections (Pass-Through)

From *		To	"To" CP Type (Note)	CIT Command
m-1-{1-7}-{1-4}	<-->	m-1-{1-7}-{1-4}	OLIU	ent-crs-vt1:m-1-1-2,m-1-1-1
m-2-{1-7}-{1-4}	<-->	m-2-{1-7}-{1-4}	OLIU	ent-crs-vt1:m-2-3-4,m-2-3-4
m-3-{1-7}-{1-4}	<-->	m-3-{1-7}-{1-4}	OLIU	ent-crs-vt1:m-3-5-3,m-3-5-3
{a,b,c}-{1-2}	<-->	{a,b,c}-{1-2}	27G2-U OLIU	ent-crs-vt1:a-1-1-1,a-1-1-1
m-1-{1-7}-{1-4}†	<-->	m-1-{1-7}-{1-4}	22-type OLIU	ent-crs-vt1:m-1-1-2,m-1-1-2
m-2-{1-7}-{1-4}†	<-->	m-2-{1-7}-{1-4}	22-type OLIU	ent-crs-vt1:m-2-3-4,m-2-3-4

Notes:

Address on the left side MUST BE identical to the address on the right side. There is no interchange function for "pass-through" signals.

* Whenever 24-type OLIUs are installed in main the range of STS-1s will be from 1 to 12. Example: m-{1-12}.

† Ring cross-connection; 27G-U OLIU in main.

Table 8-23. Ring Manual VT1.5 Cross-Connections (Locked)

From *		To	"To" CP Type	CIT Command
m-{1-3}-{1-7}-{1-4}	<-->	a-{1-7}-{1-4}	MXRVO	ent-crs-vt1:m-1-1,a-1-1-1:cct=locked,ring=m1
m-{1-3}-{1-7}-{1-4}	<-->	b-{1-7}-{1-4}	MXRVO	ent-crs-vt1:m-2-2,b-2-2-2:cct=locked,ring=m1
m-{1-3}-{1-7}-{1-4}	<-->	c-{1-7}-{1-4}	MXRVO	ent-crs-vt1:m-3-3,c-3-3-3:cct=locked,ring=m1
m-{1,2}-{1-7}-{1-4}†	<-->	{a,b,c}-{1-7}-{1-4}	MXRVO	ent-crs-vt1:m-1-1,a-1-1-1:cct=locked,ring=m1

Notes:

* Whenever 24-type OLIUs are installed in main the range of STS-1s will be from 1 to 12. m-{1-12}.

† Ring cross-connection; 27G-U OLIU in main.

Table 8-24. Ring Manual VT1.5 Cross Connections (Hairpin)

From	"From" CP Type		To	"To" CP Type	CIT Command
{a,b}-{1-2}-{1-7}-{1-4}	27G2-U OLIU	<-->	c-{1-2}-{1-7}-{1-4}	27G2-U OLIU	ent-crs-vt1:a-1-1-1,c-2-1-1
a-{1-2}-{1-7}-{1-4}*	27G2-U OLIU	<-->	a-{1-2}-{1-7}-{1-4}*	27G2-U OLIU	ent-crs-vt1:a-1-1-1,a-2-1-1
b-{1-2}-{1-7}-{1-4}*	27G2-U OLIU	<-->	b-{1-2}-{1-7}-{1-4}*	27G2-U OLIU	ent-crs-vt1:b-1-1-1,b-2-1-1
c-{1-2}-{1-7}-{1-4}*	27G2-U OLIU	<-->	c-{1-2}-{1-7}-{1-4}*	27G2-U OLIU	ent-crs-vt1:c-1-1-1,c-2-1-1
{a,b}-{1-2}-{1-7}-{1-4}	22-type OLIU	<-->	c-{1-7}-{1-4}	STS1E/MXRVO	ent-crs-vt1:a-1-1,c-1-2
c-{1-3}-{1-7}-{1-4}	22-type OLIU	<-->	{a,b}-{1-7}-{1-4}	STS1E/MXRVO	ent-crs-vt1:c-1-1,b-1-2
{a,b}-{1-2}-{1-7}-{1-4}	22-type OLIU	<-->	c-{1-3}-{1-7}-{1-4}	22-type OLIU	ent-crs-vt1:a-1-1-1,c-1-1-1
{a,b}-{1-7}-{1-4}	STS1E	<-->	c-{1-7}-{1-4}	STS1E/MXRVO TMUX	ent-crs-vt1:a-1-1,c-1-1
c-{1-7}-{1-4}	STS1E	<-->	{a,b}-{1-7}-{1-4}	MXRVO/TMUX	ent-crs-vt1:c-1-1,b-1-1
{a,b}-1-{1-7}-{1-4}	26G2-U OLIU	<-->	c-{1-3}-{1-7}-{1-4}	22-type OLIU	ent-crs-vt1:a-1-1-1,c-1-1-1
{a,b}-{1-2}-{1-7}-{1-4}	22-type OLIU	<-->	c-1-{1-7}-{1-4}	26G2-U OLIU	ent-crs-vt1:a-1-1-1,c-1-1-1
{a,b}-1-{1-7}-{1-4}	26G2-U OLIU	<-->	c-{1-7}-{1-4}	STS1E/TMUX/ MXRVO	ent-crs-vt1:a-1-1-1,c-1-1
{a,b}-{1-7}-{1-4}	STS1E/TMUX/ MXRVO	<-->	c-1-{1-7}-{1-4} }	26G2-U OLIU	ent-crs-vt1:a-1-1-1,c-1-1
{a,b,c}-1-{1-7}-{1-4}	26G2-U OLIU	<-->	{a,b,c}-1-{1-7}-{1-4}	26G2-U OLIU	ent-crs-vt1:a-1-1-1,c-1-1-1

* STS-1 number must be different in 'from' and 'to' addresses.

Optical Point-to-Point Application

This is a linear application with two NEs. Valid mapping is provided by termination cross-connections. Either "default" or "manual" mode is supported per shelf. DS1 services are supported either by STS-1 signal mapping to 28 VT1.5 signals as described under default cross-connections or by manual VT cross-connections. VT cross-connections are allowed only if the OLIU circuit pack is a 22-type and the **crs** mode is "manual."

Optical Drop Application

This is a linear application with multiple NEs in a chain. Function unit "C" of intermediate nodes is equipped with OLIUs to transport signals to the next NE. Valid mapping is provided by termination and drop cross-connections. Either "default" or "manual" mode is supported per shelf. Intermediate drop nodes may require "manual" cross-connections. DS1 services are supported either by STS-1 signal mapping to 28 VT1.5 signals as described under default cross-connections or by manual VT cross-connections. VT cross-connections are allowed only if the OLIU circuit pack is a 22-type and the **crs** mode is "manual."

Optical Hubbing Application

This is a linear application with multiple NEs in a hub/chain. Hub NEs function units can be equipped with OLIUs to transport signals to the next NE. Valid mapping is provided by termination, hub, and drop cross-connections. Either "default" or "manual" mode is supported per shelf. Intermediate hub nodes may require "manual" cross-connections. DS1 services are supported either by STS-1 signal mapping to 28 VT1.5 signals as described under default cross-connections or by manual VT cross-connections. VT cross-connections are allowed only if the OLIU circuit pack is a 22-type and the **crs** mode is "manual."

Optical Add/Drop Application

This is a linear application with multiple NEs in a chain. Function unit "C" of intermediate nodes is equipped with OLIUs to transport signals to the next NE. Valid mapping is provided by termination, add, and drop cross-connections. Either "default" or "manual" mode is supported per shelf.

Intermediate drop nodes may require "manual" cross-connections. Intermediate add/drop nodes require "manual" cross-connections and an OLIU circuit pack, a 22-type, that supports add/drop cross-connections.

DS1 services are supported either by STS-1 signal mapping to 28 VT1.5 signals as described under default cross-connections or by manual VT cross-connections. VT cross-connections are allowed only if the OLIU circuit pack is a 22-type and the **crs** mode is "manual."

Claim Element	Lucent 2000 Product Family
	Electrical EC-1 Multiplexer Application This is an application with one NE. Valid cross-connections are provided by the shelf and depend on the equipage. DS1 services are supported by EC-1 (STS-1) signal mapping to 28 VT1.5 signals as described under default cross-connections. The STS1E circuit pack must be hardware-provisioned for the "high-speed" mode. **OC-3/OC-12/OC-1 Path Protected Ring Application** This is a path protected ring application with multiple NEs in a two-fiber ring. The main optical units of each node in the ring are equipped with ring OLIU circuit packs, the 22-type, 24-type, or 27-type to transport signals to the next NE as well as drop signals at the NE. Valid mapping is provided by termination and pass-through cross-connections. Only the "manual" cross-connect mode is supported. **OC-3/OC-12 Path Protected Ring Drop and Continue Application** This is a path protected ring application with multiple NEs in a two-fiber ring. All but two nodes are normal ring application nodes (see previous application). Two nodes are defined to be the drop and continue nodes and are neighbors. They function to provide two copies of each service on the ring to another ring (dual ring interworking) or to wire centers (dual wire center service). Special drop and continue cross-connections are used to support this feature. The STS1E low-speed circuit pack is used to transport traffic between rings or to the wire centers. This feature provides node failure survival functionality. These two special nodes can also provide normal ring functionality at the same time. **OC-3/OC-12 Path Protected Ring Optical Extension Application** This is a path protected ring application with multiple NEs in a two-fiber ring and OLIU circuit packs in function units A, B, and/or C of an NE. This application allows services to exit the ring on OC-3 interfaces to other NEs. Mixed network topologies (ring and linear) are possible but require compatibility between the ring and linear software releases. See the software compatibility tables in Section 9, "Maintenance Description."

Claim Element	Lucent 2000 Product Family
	Manual Cross-Connection Procedure The DDM-2000 OC-3 system has a per-shelf parameter called **crs**, which determines if the shelf uses automatic "default" STS-1 signal routing or requires the user to enter and delete all cross-connections. Manual mode (**crs=manual**) disables the "default" routing and unlocks the cross-connect table for editing by the user. The following procedure reprovisions linear systems from default to manual: a. From the CIT, issue the command **set-ne:crs=manual** to put the shelf into "manual" mode. On linear systems, any existing "default" cross-connections" made by the shelf will still be active but are now "manual." b. All cross-connections entered by the user are "manual" connections and must be deleted by the user to change service. c. All commands to change signal routings (enter or delete) may be service affecting. A warning and confirmation for the request is issued as explained in Section 11, "Commands and Reports," for the **ent-crs** and **dlt-crs** commands. d. Manual routing requires that slots be equipped. The **ent-crs** routing command will check if the slot is equipped and display an error message denying illegal requests. e. Manual routing requires that slots be equipped. Therefore, if the last circuit pack of a protected pair is removed from the slot even if there is no signal on the circuit pack, the action is alarmed. The "Update" command will be denied. The manual routing must be deleted before the circuit pack can be removed and the slot becomes unequipped using the "Update" command. f. The **rtrv-crs** commands display the cross-connect routing table. g. In function slots A, B, and C, more than one STS-1 signal or 28 VT1.5 signals can be manually routed to them. This is invalid for MXRVO, STS1E, and DS3 circuit packs. If a routing command is issued and the circuit pack type is wrong, the command is denied. h. In linear systems, to put the shelf back into "default" cross-connect mode requires that the existing cross-connections be STS-1 and be valid defaults (see Table 8-7). The user is required to reset the cross-connections to meet these rules. If the cross-connect table is not valid, the **set-ne:crs=default** command is denied. DDM-2000 User/Service Manual at 559-564

Claim Element	Lucent 2000 Product Family
	DS3/EC-1 Ring Network Cross-Connection Example DS3/EC-1 ring network provisioning follows the same procedure as the DS1 ring provisioning example except that function unit B is involved. For example, in Figure 8-7, replacing the MXRVO and DS1 circuit packs at Node 1, function unit B, and at Node 6, function unit B with DS3 or STS1E circuit packs, converts the figure to a DS3 path protected ring. The following cross-connections would then be made: Node — Cross-Connection 2, 3, 4, and 5 — ent-crs-sts1:m-2,m-2 1 — ent-crs-sts1:m-2,b 6 — ent-crs-sts1:m-2,b **OC-3/OC-12 Ring Drop and Continue Cross-Connection Provisioning** All the information on "Ring Cross-Connection Provisioning" applies to "Ring Drop and Continue Cross-Connection Provisioning." Please review "Ring Cross-Connection Provisioning" as that information is not repeated here. Only the new provisioning information is presented here. This information applies to both STS-1 and VT1.5 traffic. Only the cross-connection addresses are different. A mixed traffic ring of STS-1 and VT1.5 drop and continue services is supported. Two nodes are defined to be drop and continue nodes in a ring subnetwork and are the exit points where "two" copies of the same service are available. By making two copies of the same service available at two nodes, the network is protected from failure of a node (for example, a CO) that affects all traffic on the ring. For rings that carry drop and continue services, the drop and continue nodes are neighbors and all "drop and continue" traffic must be continued on the ring connecting the two nodes.

Claim Element	Lucent 2000 Product Family
	In Figure 8-8 (one half of a drop and continue DRI application) CO 1 and CO 2 are drop and continue nodes. Traffic continued at CO 1 uses Ring 2 which is the fiber connecting CO 1 to CO 2. Likewise, continued traffic at CO 2 uses Ring 1, which is the fiber connecting CO 2 to CO 1. When a new service is added to the ring, use the normal procedures to add service to all nodes of a ring except to the drop and continue nodes. Before a drop and continue cross-connection can be made to a low-speed function unit, the slots must be equipped with either STS1E low-speed circuit packs or OC-3 OLIUs. This circuit pack type is the interface for drop and continue applications. The cross-connection command for drop and continue at CO 1 (see Figure 8-8) has two additional parameters. They are cross-connection type (**cct**) and ring identification (**ring**). The **cct** is **dc** for drop and continue. The parameter **ring** for the **ent-crs-sts1** or **ent-crs-vt1** command defines the direction of the continued signal. The counterclockwise ring is called **m2** because it is always connected to main-2 OLIU. Similarly, the clockwise ring is called **m1** because it is always connected to main-1 OLIU. At CO 1 the parameter for **ring** is **m2**, which means to continue the signal on Ring 2 toward CO 2. For VT1.5 cross-connections, once the first VT drop and continue cross-connection defines the ring direction, all other VT drop and continue cross-connections at that node are forced to use that ring rotation. Similarly at CO 2, the other drop and continue node, the cross-connection command requires the same two parameters. The **cct** parameter is **dc** and the value for **ring** is **m1**, which means to continue the signal on Ring 1 toward CO 1.

Claim Element	Lucent 2000 Product Family

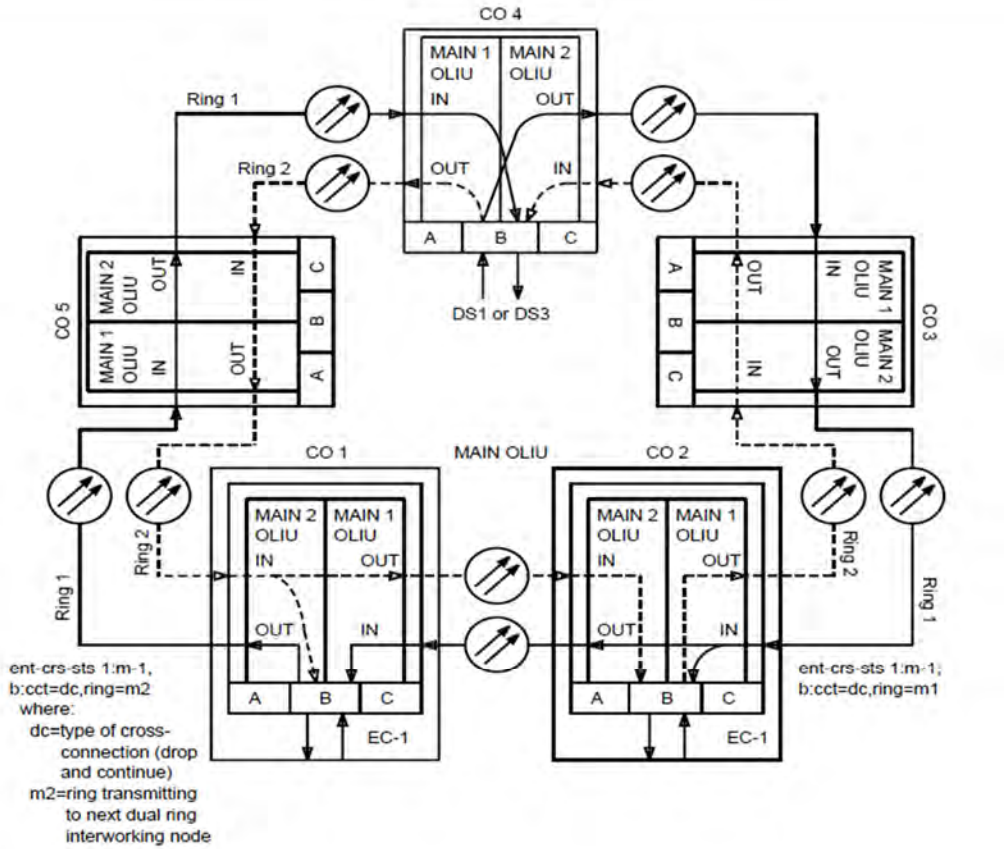


Figure 8-8. Drop and Continue Nodes

OC-3/OC-12 Ring Network Drop and Continue Cross-Connection Example

Figure 8-9 shows a DRI network.

1. The user wants to provision a fully protected service using drop and continue cross-connections in this dual ring topology. The service is a DS3 at RT2 (bottom node in figure) to CO 4 (top node in figure).
2. All nodes in both rings require 22-type or 24-type OLIUs in the main slots and all nodes require the same release of drop and continue ring software. The two terminating nodes (CO 4 and RT2) require low-speed DS3 circuit packs in a function unit as defined by the work order.
3. The site CO 1 has two NEs, one is part of the upper ring subnetwork and the other is a part of the lower subnetwork. They are connected by EC-1 signals provided by STS1E low-speed circuit packs. The figure shows these connections in function unit B of both NEs but any available function unit can be used.
4. Note in the figure the identification of Ring 1 (clockwise) and Ring 2 (counterclockwise). This identification is a key to correct provisioning and needs to be checked before cross-connections are made.
5. The work order will specify the low-speed channel of the DS3 service, the available high-speed channel on the lower ring, and the low-speed channel assigned at the drop and continue nodes. While it is not required by DDM-2000 that the low-speed channel of the drop and continue nodes be the same, it is recommended to simplify record keeping.
6. For this example, the cross-connections are:

   ent-crs-sts1:b,m-1 at RT2 (two-way drop)
   ent-crs-sts1:m-1,m-1 at RT3 and RT1 (pass-through)
   ent-crs-sts1:m-1,b:cct=dc,ring=m1 at CO 1 (lower NE)
   ent-crs-sts1:m-1,b:cct=dc,ring=m2 at CO 2 (lower NE).

   The continued signal at CO 1 must be assigned to Ring 1 ("m1"), and the continued signal at CO 2 must be assigned to Ring 2 ("m2").
7. In a similar manner, the upper ring is provisioned according to the work order. The high-speed and low-speed addresses do not have to be the same as the ones used in the lower ring, but they must follow the rules for rings, which is to assign a single high-speed channel to all nodes for this DS3 service.

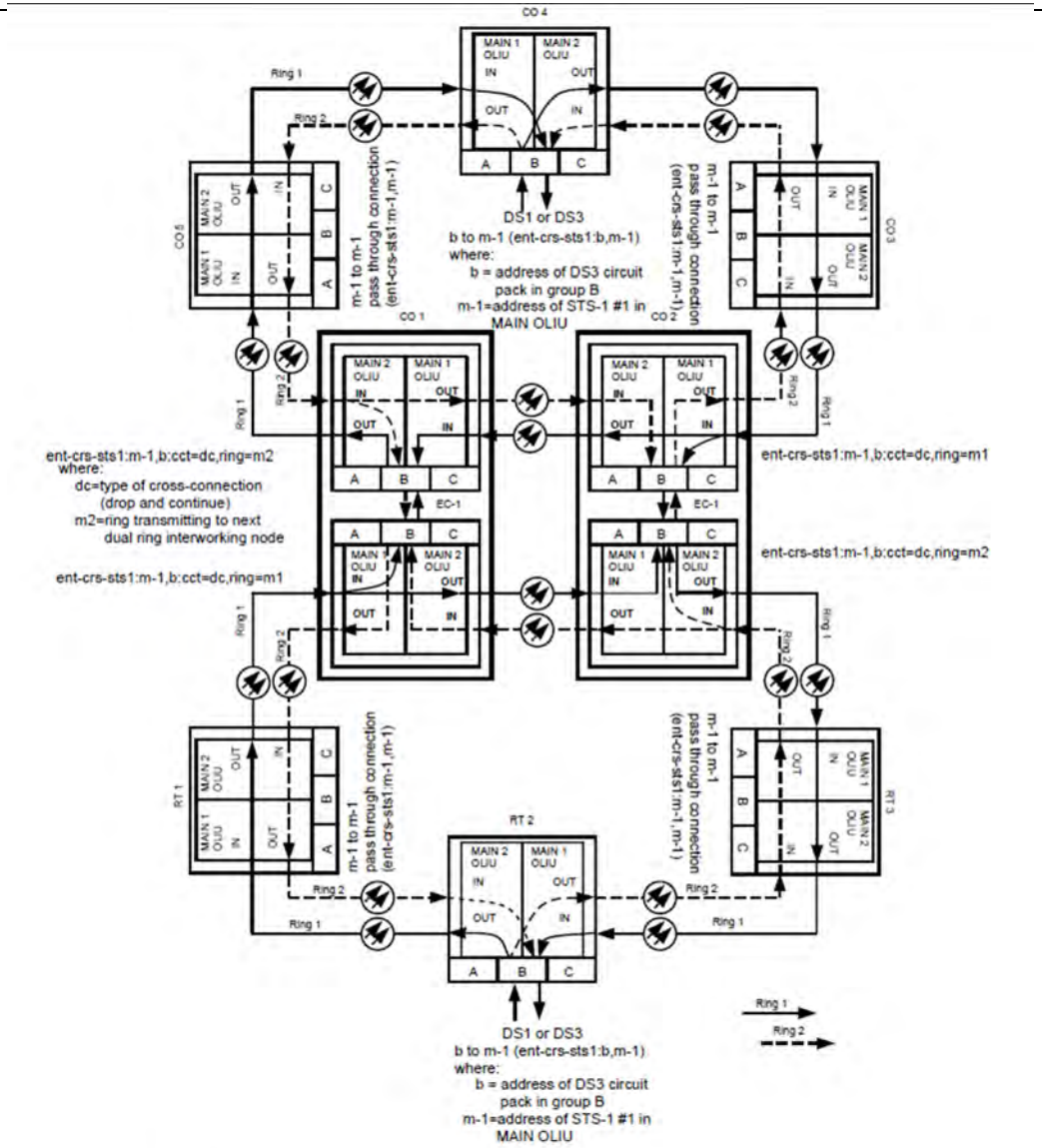


Figure 8-9. Example Dual Ring Configuration Cross-Connections

For this example, the cross-connections are:

ent-crs-sts1:m-1,b:cct=dc,ring=m2—at CO 1 (upper NE)
ent-crs-sts1:m-1,b:cct=dc,ring=m1—at CO 2 (upper NE)
ent-crs-sts1:m-1,m-1—at CO 3 and CO 5 (pass-through)
ent-crs-sts1:b,m-1—at CO 4 (two-way drop).

The continued signal at CO 1 must be assigned to Ring 2 ("m2"), and the continued signal at CO 2 must be assigned to Ring 1 ("m1").

8. Cross-connections supporting DS3 services are STS-1 cross-connections. Cross-connections supporting DS1 services may be either STS-1 or VT1.5 cross-connections. VT1.5 drop and continue services use the same procedure except that the addresses and channels used are VT. The interface between the two rings at the drop and continue nodes is still the STS1E circuit pack, which can support VT1.5 cross-connections as well as STS-1 cross-connections. See the TOP section of this manual (Volume II) for procedures.

OC-3/OC-12 VT1.5 Path Switched Ring (0x1) Single Homing

Figure 8-10 shows an example of an OC-12 VT1.5 path switched ring (0x1) single homing application. The figure is placed after the example explanation and can be removed for reference.

The DDM-2000 OC-12 ring supports 0x1 OC-3/IS-3 interfaces in its function unit slots. These interfaces must be provisioned as 0x1. Signals pass through the DDM-2000 OC-12 transport ring and exit to the DDM-2000 OC-3 ring. OC-12 function unit slot FN(x)-1 is connected to OC-3 main-1, and OC-12 function unit slot FN(x)-2 is connected to OC-3 main-2. Switching is not done on the DDM-2000 OC-12 Multiplexer on these lines or paths on these lines; rather VT1.5 or STS-1 level path switching is done on the DDM-2000 OC-3 Multiplexer. This allows DDM-2000 OC-3 nodes running ring software to interface with DDM-2000 nodes of an OC-12 ring in such a way as to provide ring-on-ring architecture. Each OC-3 ring so supported occupies up to three STS-1 time slots on the OC-12 ring. Each OC-12 node can provision the same STS-1 time slots as other OC-12 nodes to drop to the OC-3 shelf (to share STS-1s among several OC-3 shelves) or the OC-12 node can provision different STS-1s at different sites. When 0x1 is used, the OC-12 ring passes the contents of these STS-1 time slots between the low-speed OC-3/IS-3 lines and OC-12 high-speed lines without terminating them or performing any path protection switching on them. Up to four OC-3 rings can be supported in this fashion by an OC-12 ring to maximize the OC-12 bandwidth utilization. This allows access to any and all VT1.5 signals at an OC-12 site. Since the high-speed signals from the OC-3 ring(s) are sent as two copies (one clockwise, the other counter-clockwise) on the OC-12 ring, the OC-12 ring capacity is limited to the OC-12 line rate.

Claim Element	Lucent 2000 Product Family
	DDM-2000 User/Service Manual at 615-622

Path Protection Switching (Path Switched Rings)

The path switched ring application is based on the Bellcore TR-TSY-000496/ GR-1400 path protection switching scheme. The DDM-2000 OC-3 Multiplexer must be equipped with 22-type, 24-type (OC-12) or 27-type (OC-1) OLIUs in the main slots for ring applications. The 22G-U, 22G2-U, 22F2-U, and 22D-U OLIUs support path protection switching based on STS/VT unequipped and STS/VT signal degrade, and are recommended for OC-3 ring applications.

The path protection switched ring has two single-fiber counter-rotating rings as shown in Figure 9-14. This architecture has distinct advantages over a linear architecture. Each node on the ring terminates four fibers: a transmit and receive fiber in each direction. Eight fibers are needed to connect the same NE in a nonterminal position of a linear add/drop 1+1 protected arrangement: two transmit and two receive in each direction, without providing the same level of protection that the ring provides. The architecture of the ring is designed to protect against any single point of failure, including a node failure, single fiber cut, or dual fiber cut. Node failure or dual fiber failure in a linear network affects traffic to all downstream nodes. A node failure in a ring only affects traffic dropped at the failed node.

The signal that enters the ring is protected on a SONET path basis as switching is performed independently for each path. Because of the ring's unidirectional operation, time slots must be reserved all the way around the ring for all ring traffic, limiting the capacity of the ring to the OC-N line rate. DDM-2000 OC-3 can provide both VT1.5 and/or STS-1 path protection, and DDM-2000 OC-12 can provide STS-1 path protection. A single DDM-2000 OC-3 shelf can support a mix of STS-1 and VT1.5 path switched rings. VT1.5 path protection is available at the OC-12 rate by using DDM-2000 OC-3 systems colocated with a DDM-2000 OC-12 system.

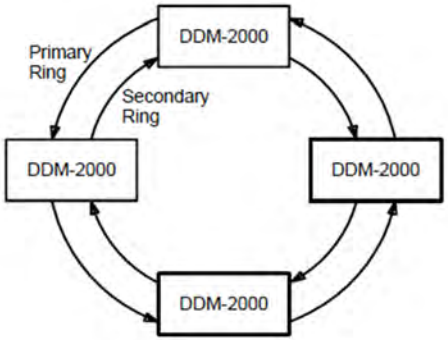


Figure 9-14. Two-Fiber Unidirectional Ring

Path Protection Scheme

Path protection rings feed a SONET payload (STS or VT) from the ring entry point, simultaneously in both rotations of the ring, to the signal's ring drop or exit point as shown by traffic AC and CA in Figure 9-15(a). This duplication of the signal that enters the ring is called a "head-end bridge." The node that drops the signal from the ring monitors both ring rotations and is responsible for selecting the signal that has the highest quality based on LOS/LOF, path AIS, LOP, STS/VT unequipped, and STS/VT path BER performance. This function at the ring exit point is called a "tail-end switch." Path switching is non-revertive. All detected hard failures (LOS, LOF, LOP, line AIS, or STS-1 path AIS) and in VT path switched rings, an STS-1 path signal failure based on BER or an STS path unequipped results in path AIS insertion in the outgoing signals. This allows the drop node to detect VT path failures and select the good path.

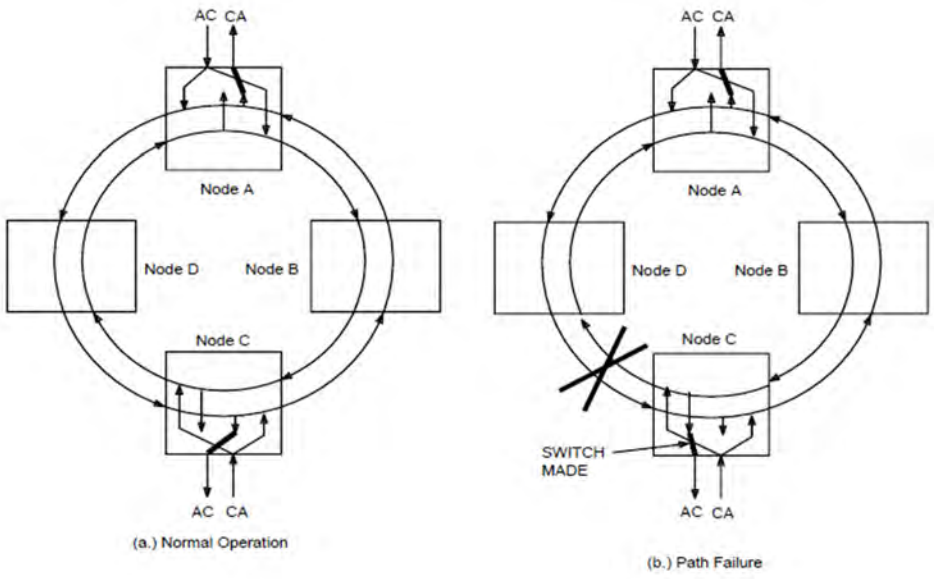
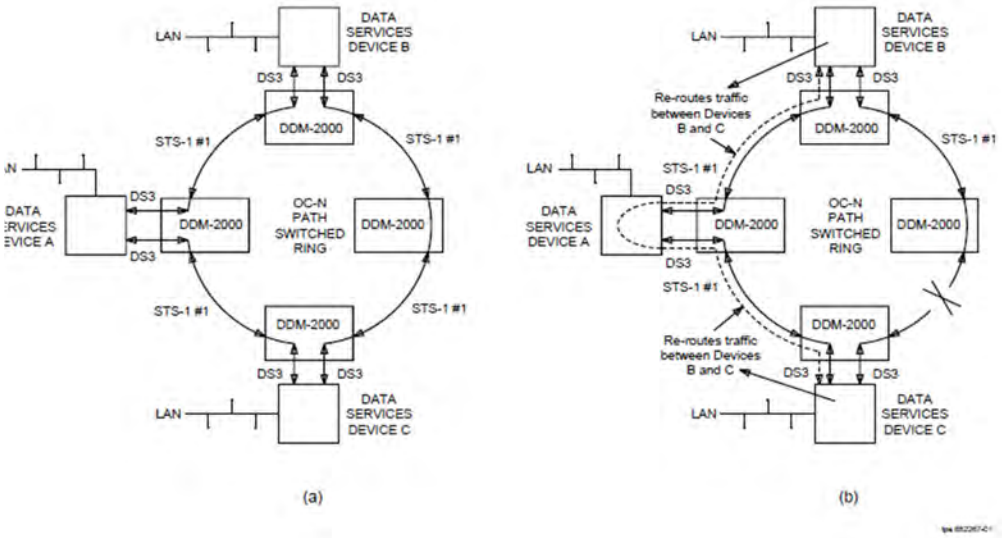


Figure 9-15. Path Protection Switching

Claim Element	Lucent 2000 Product Family
	The user can set a VT1.5 signal degrade threshold using the **set-vt1** and **rtrv-vt1** commands at a **drop** node on a VT path protected ring. Similarly, the user can set an STS-1 signal degrade threshold using the **set-sts1** and **rtrv-sts1** commands at a **drop** node on an STS path protected ring. Note that although previous equipage-based restrictions on the provisioning of these parameters have been removed, the signal degrade threshold will only be active on OLIUs that support it (22D-U, 22G-U/22G2-U, 27G-U/27G2-U, 22F2-U, 24G-U). Under normal conditions, both incoming SONET path signals to the switch selection point are of high quality, and the signal can be selected from either ring. A failure or a transmission degradation on one of the rings requires that the other ring path be selected, and requirements specify that this path selection must occur within 60 milliseconds after a hard failure condition. Figure 9-15(b) shows how traffic is switched when a dual-fiber cut occurs. Ring releases provide nonrevertive switching to minimize the impact on critical customer services by giving the service provider control when, and if, the critical service should revert to a particular ring. A manual path protection switching command allows switching back to the original path for ease of ring maintenance. Refer to the **switch-path-vt1** or **switch-path-sts1** commands in Section 11, "Commands and Reports."

Claim Element	Lucent 2000 Product Family
	Path Protection - Locked DS3 Cross-Connect Figure 9-16(a) illustrates path-switched protection for a locked DS3 cross-connect. In this example, full multimedia data services, such as Ethernet, Token Ring, ATM, etc., are routed around the ring and through each Data Services Device on STS-1 #1. In the event of a service interruption, as indicated by the "X" in Figure 9-16(b), Data Services Device A reroutes traffic between itself and Data Services Devices B and C.  Figure 9-16. Locked DS3 Cross-Connect Path Protection Switching

Claim Element	Lucent 2000 Product Family
	Dual Ring Interworking (DRI) The DDM-2000 OC-3 Multiplexers support DRI which provides end-to-end protection from loss of service on traffic traveling over interconnected rings. This is achieved by connecting the two rings at two dual-homing offices and by provisioning the multiplexers at these nodes to "drop and continue" all necessary paths. This provides a redundant path in case of a catastrophic failure at one of the two DRI offices or one of the nodes in each DRI office. The end nodes perform standard path protection switching on the signals from these two redundant paths. **Dual Ring Interworking (DRI) Path Protection Scheme** Figure 9-17 shows DRI path protection switching. Note that the upper ring could be an FT-2000 OC-48 Lightwave System bidirectional line switched ring. In the receive direction, a DRI node that passes a signal between rings performs two steps: 1. The VT1.5 and/or STS-1 signals to be passed between rings are "dropped and continued." This means the signal is dropped at that node and simultaneously copied into the OC-3 signal in the outgoing direction of the same ring rotation. 2. The VT1.5 and/or STS-1 signal that was dropped in Step 1 and the corresponding VT1.5 and/or STS-1 signal incoming from the other ring direction are compared, and the signal with the highest quality is selected as in single ring topologies. In the transmit direction, a DRI node feeds VT1.5 or STS-1 signals in the direction opposite to the "continue" portion of the drop and continue signal (Step 1 previously) to only one rotation of the ring as shown in Figure 9-14. This routing is to only one rotation as distinguished from how an ordinary path switched ring bridges incoming low-speed traffic onto both rotations. The drop and continue routing necessary for DRI is established with a cross-connection command.

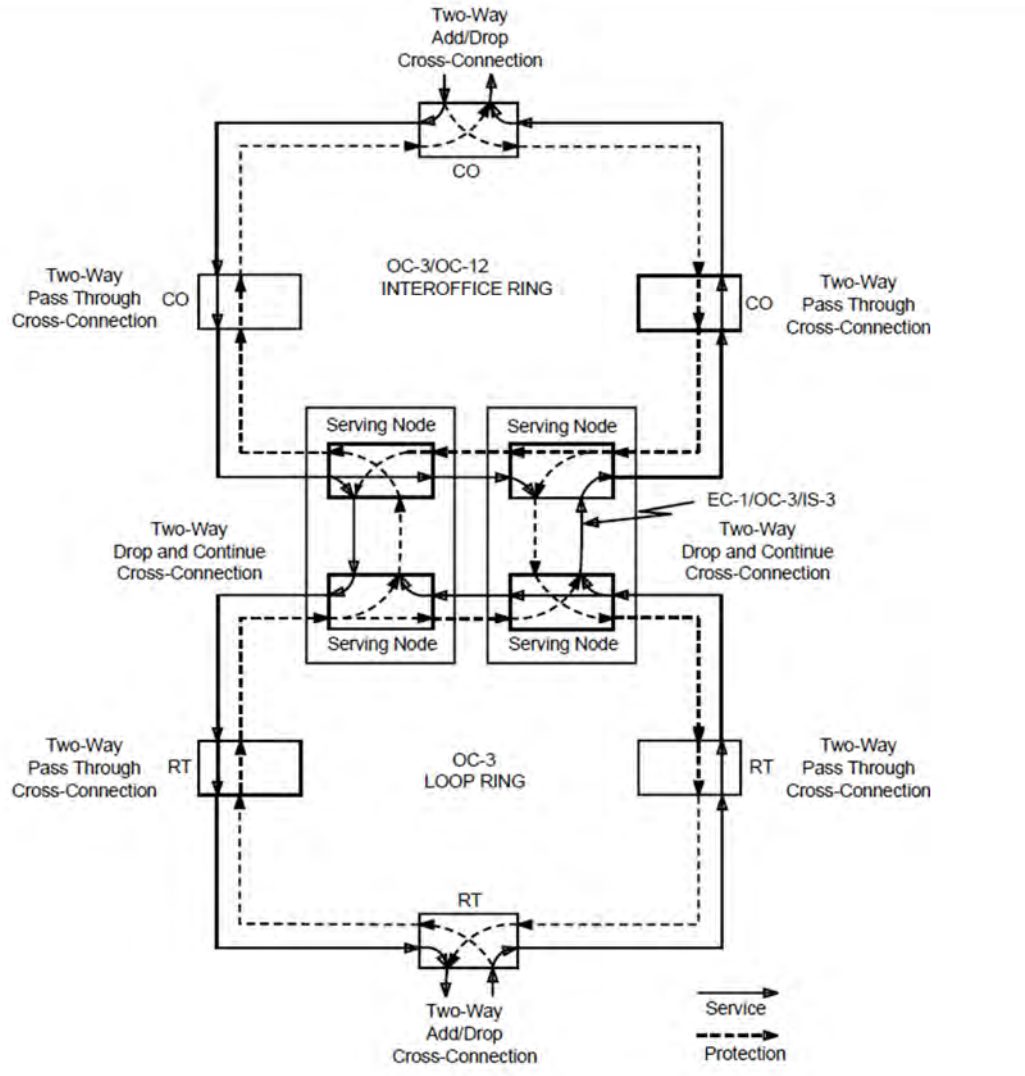


Figure 9-17. DRI Path Protection Switching

OC-3/OC-12 Path Switched Ring (0x1)

A DDM-2000 OC-3 ring shelf can function in a ring-on-ring application using the 0x1 interface capability of the OC-12 or FT-2000 OC-48 Lightwave System ring. The OC-3 shelf functions in the normal path switched ring mode. VT/STS path protection switching is done on the OC-3 shelf as previously described for an OC-3 ring.

In single homing, the OC-3 ring shelf interconnects through its main-1/main-2 ring interface either directly or through another OC-3 ring shelf to the low-speed OC-3 0x1 interface on a single OC-12 or FT-2000 OC-48 Lightwave System shelf.

In dual homing, the OC-3 ring shelf interconnects directly or through another OC-3 ring shelf with the OC-3 interfaces on two separate and normally non-colocated OC-12 or FT-2000 OC-48 Lightwave System shelves.

OC-3/OC-1 Path Switched Ring (0x1)

The OC-3/OC-1 path switched ring is similar to the OC-3/OC-12 ring-on-ring. A DDM-2000 FiberReach shelf interconnects with a DDM-2000 OC-3 ring host shelf through low-speed OC-1 interfaces on the OC-3 ring shelf. VT/STS path protection switching is done on the DDM-2000 FiberReach shelf.

In single homing, the DDM-2000 FiberReach ring interconnects through a pair of low-speed OC-1 0x1 interfaces on the OC-3 shelf.

In dual homing, the OC-1 ring interconnects through the low-speed OC-1 0x1 interfaces on two separate and normally non-colocated OC-3 shelves.

Status of ACTIVE LED on Rings

In all ring applications, ACTIVE LEDs on each main OLIU are always lit because it is not known if a signal on that OLIU is currently being selected by a far-end NE.

Equipment Protection

The DS3, MXRVO, STS1E, and TG circuit packs are 1×1 protected and use nonrevertive switching. Green ACTIVE LEDs are provided on the faceplates of these circuit packs to indicate which ones are active (carrying service).

The DS1 circuit packs are 1×7 protected and use revertive switching. To prevent frequent protection switches caused by intermittent failures of a DS1 circuit pack, the system provides an "automatic lock" feature. If four automatic protection switches are done on the same DS1 circuit pack within a 10-minute interval, traffic

Claim Element	Lucent 2000 Product Family
	is automatically locked onto the protection DS1 circuit pack, and the automatic lock is reported as a minor alarm. The automatic lock can be reset manually using the **switch-ls** command. It resets automatically at midnight or if the affected DS1 circuit pack is replaced. The DDM-2000 OC-3 Multiplexer supports unprotected equipment configurations. The DS1 protection circuit pack is automatically provisioned with the same user-settable options as the service DS1 circuit pack it protects except for the line build-out (LBO) value which is set by hardware switches (not by CIT or TL1). **Synchronization Reference Protection** In external timing and line timing modes, the synchronization references are 1×1 protected. If neither reference is available, the system automatically switches to "holdover" timing mode. When the TG is provisioned for synchronization messaging, the system can determine the quality of the line timing references by reading the synchronization messages in the OC-N transport overhead bytes. If the quality is not adequate, the TG will switch to holdover until manually switched to a good reference. If automatic synchronization reconfiguration is enabled, the TG will automatically select the highest quality reference. See "Synchronization Messaging" in Section 5 and, "Transmission and Synchronization Interfaces" and the **set-sync** command in Section 11, "Commands and Reports." The system can be provisioned to revertive or nonrevertive timing mode switching. The default is revertive. If provisioned for revertive mode switching, the system automatically switches from holdover mode to the provisioned timing mode (external timing or line timing) when an unprotected timing reference failure clears. If provisioned for nonrevertive mode switching, the system must be manually switched from holdover mode to the provisioned timing mode (external timing or line timing) when an unprotected timing reference failure clears. Refer to the **rtrv-sync**, **set-sync** and **switch-sync** commands in Section 11, "Commands and Reports."

Claim Element	Lucent 2000 Product Family
	SONET White Paper at 8-11

7.4 Self-Healing Ring Configuration

In a Self-Healing Ring configuration, a mechanism referred to as Automatic Protection Switching is employed. There are two types of protection ring topologies. The first is UPSR (unidirectional Path Switched Ring), the other is BLSR (Bi-directional Line Switched Ring). Each of these ring topologies is discussed later in this section of this document. The Self-Healing Ring configuration is the most commonly deployed SONET topology in mission critical government and enterprise backbones, due to its survivability characteristics.

Automatic Protection Switching is a mechanism provided within the SONET specification that is designed to provide duplicate finer span paths. In this configuration, a backup fiber span (protection ring) is enabled when and if there is a failure within the fiber span currently carrying traffic on a SONET network. It should be noted that during normal operating conditions, both fiber spans are always active, and a SONET multiplexer selects which fiber span to receive traffic, based on an internal algorithm (e.g. based on which fiber module was installed in the multiplexer first). The SONET standard specifies that the protection ring should automatically become the fiber span (ring) the SONET multiplexer receives traffic from within 60 milliseconds (unnoticeable to the user) in the event of a failure on the other fiber span (see figure 5).

There are three main types of operational problems that can occur where the protection ring will take over and become the fiber span (ring):

- A break in the fiber cable
- Signal failure (e.g. laser problem)
- Signal degrade (which can happen when an old laser fail due to age)
- Node failure

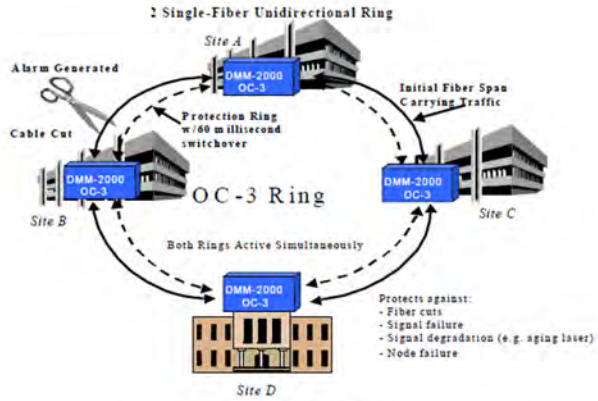


Figure 5
Automatic Protection Switching Ring

7.4.1 Bi-directional Line Switched Self-Healing Ring (BLSR)

A network configuration known as a Bi-Directional Line Switched Self-Healing Ring (BLSR) is another means of creating a survivable SONET network. This type of configuration uses a closed-loop transport design that implements duplicate, geographically diverse paths for each SONET service. The closed-loop design implements bi-directional fiber spans, where each dual fiber span handles one direction of SONET traffic. Each direction of SONET traffic carries a duplicate copy of the traffic, one on the working ring and the other on the protection ring. The integrity the SONET signal is compared at each multiplexer along its path. When cable cuts, signal failures or signal degrades are detected, a BLSR configuration automatically switches traffic to the surviving fiber span. BLSR configurations are typically deployed in interoffice applications where distributed meshed or linear node-to-node configurations are implemented. Figure 6 shows a BLSR configuration.

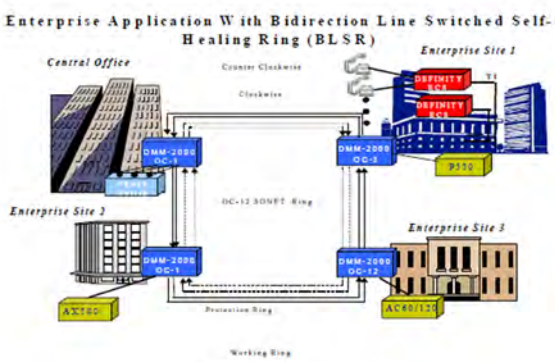


Figure 6

7.4.2 Unidirectional Path-Switched Ring (UPSR)

Some SONET multiplexers (e.g. DDM-2000) support the Unidirectional Path Switched Ring (UPSR) configuration to support critical ring applications. UPSR ensures network survivability by using a closed-loop transport that automatically protects against cable cuts, signal failure, or signal degrades by implementing duplicate, geographically diverse paths for each SONET service. A UPSR configuration is made up of a single fiber optic pair that interconnects neighboring SONET multiplexers. Traffic flows in one direction for the working path, while traffic on the protection path flows in the opposite direction. Traffic on each path is continuously monitored by a SONET multiplexer. When there is a fiber failure – or signal degradation is detected on the working fiber path – traffic is automatically diverted to the backup fiber protection path. UPSR configurations are typically implemented in SONET access networks where traffic is terminated at a central office. Figure 7 depicts an enterprise network where UPSR is enabled.

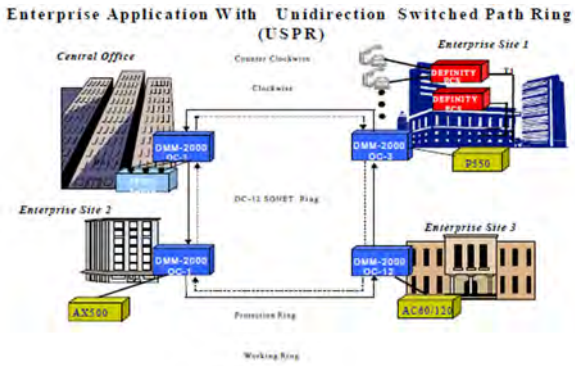


Figure 7

7.5 Dual Ring Interconnection (DRI)

The Dual Ring Interworking configuration allows multiple rings sharing traffic to be resilient from a SONET multiplexer node failure. If a catastrophe takes out a SONET multiplexer system, traffic will be routed through the operational SONET multiplexer. The benefit to the user is that continuous network operation is maintained, and business continues as usual even though a failure has occurred. This is all transparent to the user. This type of configuration is typically deployed in central office topologies. Figure 8 see illustrates a DRI configuration.

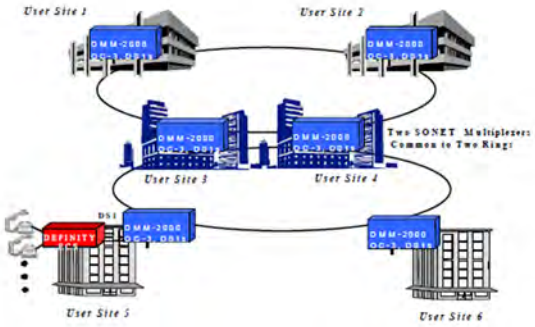


Figure 8

7.6 Folded Rings

When route diversity is not available, a two-fiber span path switched ring can be configured in what is known as a SONET folded ring configuration. A folded ring is a single path ring that provides simplicity and minimizes equipment costs. Figure 9 illustrates a SONET folded ring configuration.

Enterprise Connected in a SONET Folded Ring (UPSR)

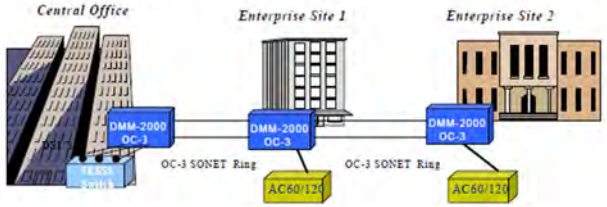


Figure 9

Claim Element	Lucent 2000 Product Family
	SONET White Paper at 18 **12.0 SONET SYNCHRONIZATION AND TIMING** **12.1 Importance of Synchronized Timing** Network timing between SONET devices is an integral part of maintaining accurate information transmitted over a SONET network. In the earlier days of networking, the method used in timing was Asynchronous. In Asynchronous timing each switch runs its own clock. In Synchronous timing, switches can use a single common clock to maintain timing. This single common clock is referred to as a Primary Reference Source (PRS) or Master Clock. Synchronous timing maintains better accuracy than Asynchronous timing because it uses a single common clocking scheme to maintain timing. This accurate timing often becomes important to government and enterprise applications, particularly when they are running time sensitive applications (e.g. video streaming applications). There are three methods typically used in obtaining synchronous timing in SONET multiplexers (e.g. Lucent DDM-2000 Multiplexer), they include: • Timing from an onboard internal oscillator • Timing from an incoming optical signal from a high-speed interface • Timing from an external source coming from a DS1 timing reference that can be stratum 3 or higher clocking DDM-2000 FiberReach Manual at 75-78

Applications

2

Overview

The DDM-2000 FiberReach Multiplexer can support a range of applications with maximum economy and efficiency. This chapter highlights the ways the DDM-2000 FiberReach Multiplexer, along with other members of the 2000 Product Family, meets these diverse network needs.

DDM-2000 FiberReach Applications Summary

Lucent Technologies' 2000 Product Family has set the standard for networking flexibility. The newest member of this family, the DDM-2000 FiberReach Multiplexer, extends the benefits of the DDM-2000 Multiplexer and *SLC*®-2000 Access System to end users whose capacity needs may be small but still demand the cutting edge services and support of the larger customers. Targeting the diverse needs of business carrier access, residential fiber-in-the-loop, and private network applications, DDM-2000 FiberReach will deliver a full range of services using the Narrowband and Wideband shelf as follows:

- Narrowband Shelf
  - — telephony,
  - — DS0 specials
  - — Integrated Services Digital Network (ISDN).

- Wideband Shelf
  - — DS1 services (via DSX-1 or T1 carrier access)
  - — video transport.

DDM-2000 FiberReach interworks with DDM-2000 OC-3/OC-12 and *SLC*-2000 Access System hosts via an exceptional variety of networking options, including single-homed OC-1 path-switched ring extensions and fully survivable dual-homing topologies. In every application, DDM-2000 FiberReach offers a thorough set of operations features with a look and feel that matches the other acclaimed DDM-2000 Multiplexer systems. Remote operation is via the data communications channel (DCC), while a user panel and craft interface terminal port support local operations needs. Complete performance-monitoring (PM) features, including DS1 path PM, permit the service provider to verify the quality-of-service terms of key tariffs.

DDM-2000 FiberReach will extend the service provider's investment in Synchronous Optical NETwork (SONET) networks by supporting broadband capabilities such as two-way moving picture experts group (MPEG 2) videoconferencing transport within standard SONET signal formats. Thus, new broadband services can be created by pairing the bandwidth of DDM-2000 FiberReach with the network survivability and resultant revenue-generating potential of path protection switching and dual wire center architectures.

Three types of DDM-2000 FiberReach applications are offered:

- **Business Carrier Access**: Premium-tariffed telecommunications services (via DS1 or T1 carrier extensions) supplied by public network providers to business customers
- **Fiber in the Loop**: Cost-effective basic telephony, as well as emerging video and data services
- **Private Networks**: Privately held networks that supply the internal communication needs of large corporations, organizations, and institutions.

While DDM-2000 FiberReach applications are quite flexible and easy to use, aspects like bandwidth, facility management, and operations subnetwork design require some more detailed consideration. Where appropriate, this section will provide a high-level overview and refer you to Section 6, "System Planning and Engineering," for further details.

Ring Topologies

The need to prevent service outage caused by network failure has created a new class of applications. The 2000 Product Family offers a wide range of self-healing network features that automatically protect against service outage caused by cable cuts and equipment failures, which in turn protect customers and generate increased revenue. These self-healing features include flexible DACS-based restoration with the *ITM XM* controller, *SLC*®-2000 two- and four-fiber rings,

Claim Element	Lucent 2000 Product Family
	DDM-2000 OC-3 and OC-12 virtual tributary 1.5 (VT1.5) and STS-1 path switched rings, *SLC*-2000 Access System path switched rings, and DDM-2000 FiberReach VT1.5 path-switched rings. DDM-2000 FiberReach, DDM-2000 OC-3, DDM-2000 OC-12, and *SLC*-2000 Access System self-healing rings offer the performance and administrative benefits demonstrated by the successful Lucent FT Series G Ring Diversity Switch. Since the DDM-2000 FiberReach, OC-3, OC-12, and FT-2000 path switched rings operate in an integrated, single-ended fashion, complex network-level coordination is not necessary to restore traffic. This means restoration is faster and more reliable. Furthermore, bandwidth administration and network reconfigurations (for example, adding or deleting nodes) can be easier. The DDM-2000 FiberReach, OC-3, and OC-12, and *SLC*-2000 path-switched rings operate as shown in Figure 2-1(a). Traffic entering a path switched ring node is sent onto both rotations of the ring. At the receiving node, the signal having the highest integrity (based on SONET path information) is selected and dropped as outgoing traffic. At intermediate nodes, the traffic is "passed-through" without changing the SONET path information. The DDM-2000 time slot interchange (TSI) capabilities make the provisioning of add/drop and pass-through traffic quick and easy. The self-healing nature of the path switched ring is shown in Figure 2-1(b). In this case, the fiber failure between nodes B and C causes node B to switch from the counterclockwise ring to the clockwise ring, thus maintaining service between nodes A and C.

Claim Element	Lucent 2000 Product Family

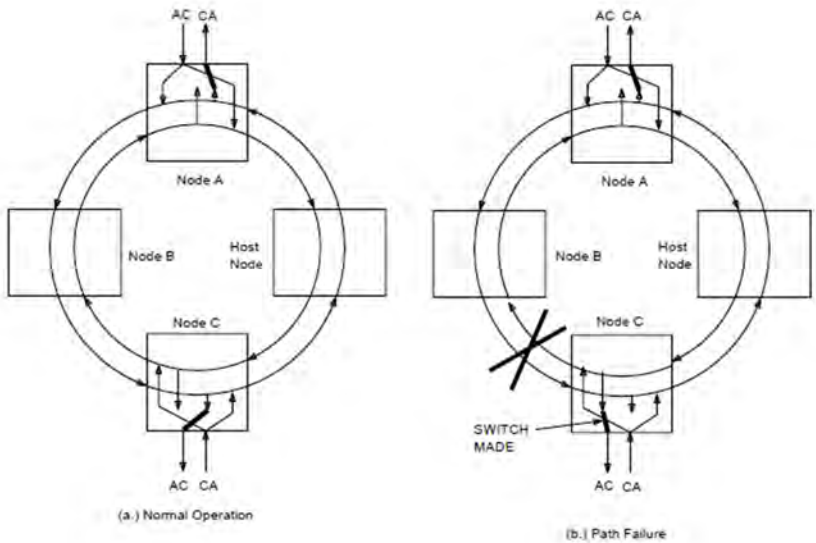


Figure 2-1. Path Switched Ring

A network which requires the bulk of its traffic to be dropped at a single node is an ideal application for path switched rings. A typical loop feeder network, where most traffic is between the subscriber loop to a central office (CO), fits this mold. Such an application calls for the delivery of protected DS1 and DS3 service to customer locations. In many cases, where the network serves only voice traffic and DS1s, a DDM-2000 FiberReach/OC-3/*SLC*-2000 path switched ring is a perfect fit. If DS3 service or a mixture of DS1 and DS3 service is needed, one or more OC-3 rings may be necessary. Cost, fiber availability, and bandwidth flexibility all play a part in determining whether a single OC-1 or OC-3 ring, multiple OC-1 or OC-3 rings, or an OC-12 ring will be the best network solution.

DDM-2000 FiberReach Manual at 85

Claim Element	Lucent 2000 Product Family

Integration with Dual Wire Center Applications

The survivability and networking benefits of Lucent's dual ring interworking (DRI) solution are cost-effectively extended to smaller locations via DDM-2000 FiberReach dual-homing capabilities. Figure 2-5 shows an OC-3 feeder ring from duplicated wire centers, with dual-homed DDM-2000 FiberReach extensions from selected feeder ring remote sites.

The host nodes and remote DDM-2000 FiberReach systems are configured just like the previously described dual-homing configuration with single 0x1 cross-connections (ring 0x1 low speed interface) employed by the host. In the dual wire center architecture, the access network is also protected from a catastrophic failure of one wire center, because the access and interoffice networks have duplicate points of interworking. The DDM-2000 OC-3 systems in the two wire centers employ the drop and continue cross-connection. (For more details on the dual wire center application, see LTP 363-206-200, *DDM-2000 Multiplexer Applications, Planning, and Ordering Guide*.)

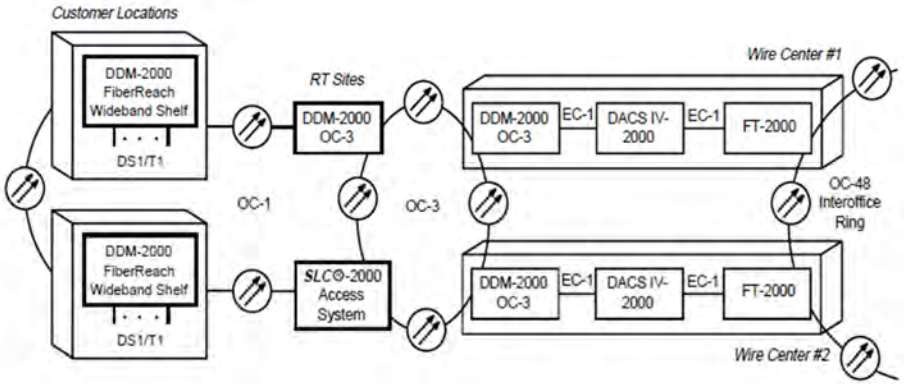


Figure 2-5. DDM-2000 FiberReach Ring Dual Homing to a DDM-2000 OC-3 Ring in a Dual Wire Center Applications

Claim Element	Lucent 2000 Product Family
	DDM-2000 FiberReach Manual at 169-176

Synchronization Messaging

The DDM-2000 FiberReach Multiplexers provide a synchronization messaging feature to ensure the integrity of network synchronization during both normal and abnormal conditions. With synchronization messaging, the current quality of the timing source can be conveyed from one DDM-2000 FiberReach Multiplexer to the next. This capability allows the DDM-2000 FiberReach Multiplexers to automatically change their timing reference in order to always maintain the highest quality timing available.

Applications

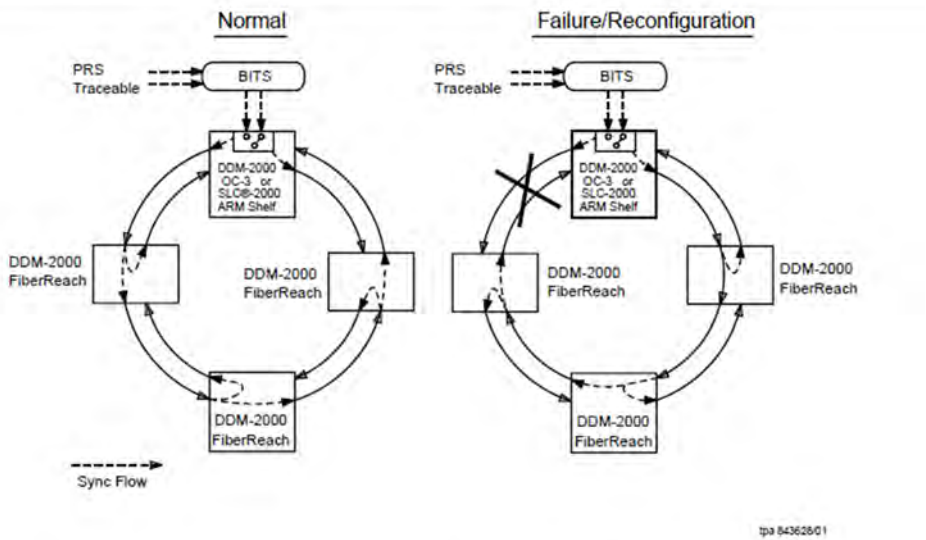
The applications that are currently supported with the synchronization messaging feature can be divided into two categories:

1. Automatic synchronization reconfiguration
2. Synchronization provisioning integrity.

Automatic Synchronization Reconfiguration

SONET was designed to operate optimally in a synchronous environment. Although plesiosynchronous and asynchronous operation can be supported by pointer adjustments, transmission quality is affected by the generation of additional jitter and wander due to pointer adjustments. Because of this, it is desirable to maintain synchronous operation whenever possible. With synchronization messages, the quality of the different timing references can be made available at each DDM-2000 FiberReach Multiplexer. The DDM-2000 FiberReach Multiplexer shelf can always determine the best timing reference available to it and switch to that reference. Through this mechanism, the synchronous operation of the subnetwork can be maintained. The switching of timing references is hitless, and the synchronization messages also allow it to be done without creating timing loops in the process.

Consider the access ring network in Figure 5-7. Under normal operation, the ring has one DDM-2000 Multiplexer externally timed and the other FiberReach multiplexers line-timed in the counterclockwise direction. If a fiber failure occurs between the host DDM-2000 and the DDM-2000 FiberReach Multiplexers, the synchronization autoreconfiguration feature will cause the DDM-2000 FiberReach Multiplexers to change their line timing directions to clockwise. The result is that the ring is again operating synchronously. The ring already provides self-healing of the traffic; so it is especially important to maintain synchronous operation during this type of failure to prevent service degradation due to increased jitter and wander.

Claim Element	Lucent 2000 Product Family
	 Figure 5-7. Synchronization Failure and Reconfiguration

Synchronization Provisioning Integrity

A welcome byproduct of synchronization messaging is the prevention of provisioning errors. Provisioned timing loops on the DDM-2000 FiberReach Multiplexers will be quickly detected through the synchronization messaging algorithm and prevented by forcing a shelf into holdover. The system can then be reprovisioned correctly.

Feature Details and Options

As mentioned previously, SONET synchronization messaging is used to communicate the quality of the subnetwork timing throughout the subnetwork. This is done using bits 1 through 3 of the K2 byte found in the SONET overhead. If a DDM-2000 FiberReach system is deriving timing from a given OC-*N* interface and synchronization messaging is enabled on that interface (Kbyte messages are enabled using the **`set-ocn`** user interface command or **`ent-rr`** TL1 command), the system interprets the received message to determine its internal timing status. The DDM-2000 FiberReach system also transmits over the particular OC-*N* interface, and all other OC-*N* interfaces that are enabled for synchronization messaging, the appropriate message indicating the quality of its timing and its active timing mode. Table 5-1 lists the associated internal timing status that is associated with synchronization messages received from the OC-*N* interface when synchronization messaging is enabled. The table lists the messages from low to high quality.

Table 5-1. Synchronization Messages Using K2 Byte

Received Message	Active Timing Mode
Don't Use	Holdover
Timing Looped Back (TLB)	Holdover
Stratum 4*	Holdover
Internal Clock (IC)	OK to use
Stratum 3*	OK to use
Stratum 2*	OK to use
Sync Quality Unknown (SQU)	OK to use
Stratum 1*	OK to use

* Presently, DDM Multiplexers cannot generate these messages, but they could be transmitted and supported for auto-reconfiguration if any of these are received by DDM-2000 Multiplexer.

Claim Element	Lucent 2000 Product Family
	The "Don't use" message is sent when the system determines that its timing is not suitable for synchronization; for example, due to failure. When the DDM-2000 FiberReach system is in holdover mode, the Internal Clock message will be sent on all OC-1 interfaces. When the DDM-2000 FiberReach system is configured for line timing, the Timing Looped Back message will be sent on the OC-N interfaces towards the network element from which the timing is being derived. The message received on the OC-N interface will be sent on all other OC-N interfaces where synchronization messaging is enabled. With automatic synchronization reconfiguration, the DDM-2000 FiberReach Multiplexer systems use and compare the incoming synchronization messages on the OC-1 interfaces available for line timing to select the highest quality synchronization reference available. If the received quality levels are the same on the references available for timing, the existing line timing reference takes precedence. This feature guarantees the nonrevertive operation of reconfiguration. The line timing reference is provisioned by the **`set-sync`** command. The existence of automatic synchronization reconfiguration does not change the system's behavior on traditional line failures; for example, loss of frame (LOF), loss of pointer (LOP), loss of signal (LOS), and others. Examples In this section, some detailed examples are given to show specifically how the synchronization messages propagate through the DDM-2000 FiberReach network and assist in the recovery from a fiber failure. Through these examples, one can extend the same concept to any other network that may include different topologies, number of sites, failure locations, and number of BITS clocks.

Claim Element	Lucent 2000 Product Family

Table 5-2. Synchronization Messages using S1 Byte *

Received Message	Active Timing Mode†
Don't Use	Holdover
Traceable SONET Clock	OK to use
Traceable Stratum 3‡	OK to use
Traceable Stratum 2‡	OK to use
Sync Trace Unknown	OK to use
PRS Traceable‡	OK to use

* This table is applicable when an OC-3 OLIU is in the main slots.

† This column applies only when provisioned for line timing mode.

‡ Presently, DDM-2000 FiberReach Multiplexers cannot generate these messages, but they could be transmitted and supported for autoreconfiguration if any of these are received by DDM-2000 FiberReach Multiplexer.

nchronization messaging using the SONET K2 byte and S1 byte can be disabled on a per
)-N interface using the **set-ocn** command. (See Table 5-2.) Zeros will be transmitted on
s 1-3 of the K2 byte if this is done; all ones will be transmitted on bits 5-8 of the S1 byte if
s is done. The timing and synchronization status of a shelf can be determined using the
rv-sync command.

Synchronization Reconfiguration in an Access Ring

Figure 5-8a shows the access ring operating in its normal configuration. The DDM-2000 Multiplexer at the central office (CO) is externally timed, and each of the other DDM-2000 FiberReach Multiplexers are line-timed in a counterclockwise direction. The sync quality unknown (SQU) message is sent to indicate where timing is traceable to an external BITS and where it is valid to be used. The timing looped back (TLB) message is sent on the interface that is being used as the line timing reference and, thus, where using that timing would create a timing loop.

In Figure 5-8b, a fiber has been cut between sites A and B. Immediately, the DDM-2000 FiberReach Multiplexer at site B enters holdover and sends out the internal clock (IC) message to site C. The DDM-2000 FiberReach Multiplexer at site B cannot switch to line time from site C because it is receiving the TLB message on that interface.

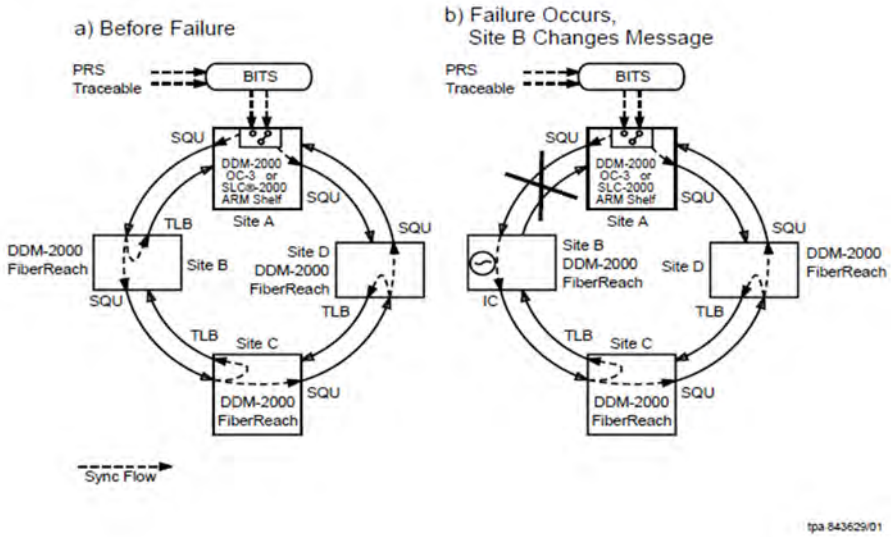


Figure 5-8. Synchronization Reconfiguration — Access Ring (Sheet 1 of 3)

Claim Element	Lucent 2000 Product Family

In Figure 5-8c, the DDM-2000 FiberReach Multiplexer at site C detects the incoming IC message and sends out the IC message to site D. The DDM-2000 FiberReach Multiplexer at site C cannot switch to line time from the other rotation because it is receiving the TLB message on that interface.

In Figure 5-8d, the DDM-2000 FiberReach Multiplexer at site D detects the incoming IC message. Because this DDM-2000 FiberReach Multiplexer is receiving the SQU message from site A, it will switch to line time from site A because SQU is higher quality than IC. After the switch occurs, the TLB message is sent back to site A and the SQU message is retransmitted to site C.

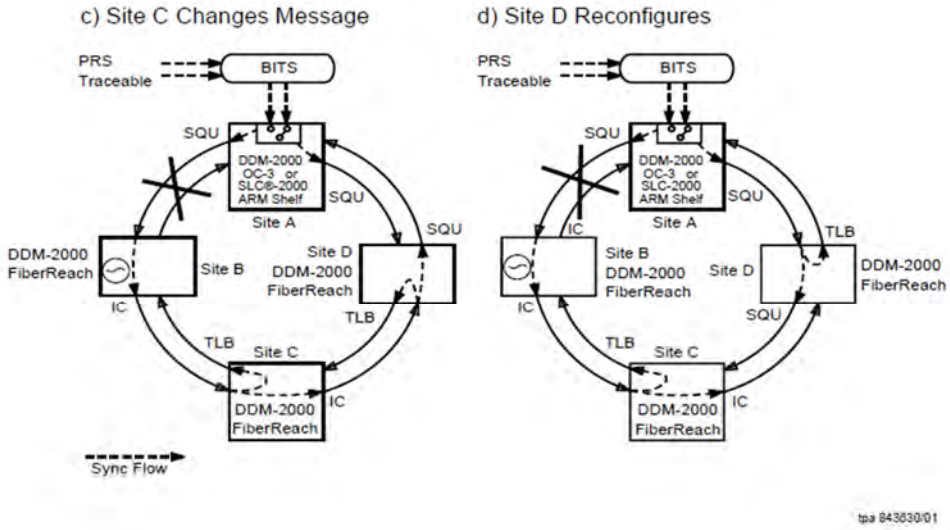


Figure 5-8. Synchronization Reconfiguration — Access Ring (Sheet 2 of 3)

Claim Element	Lucent 2000 Product Family

In Figure 5-8e, the DDM-2000 FiberReach Multiplexer at site C detects the incoming SQU message from site D. The SQU message is a better quality message than the IC message being received from site B, so the DDM-2000 FiberReach Multiplexer at site C switches to line time from site D. After the switch occurs, the TLB message is sent back to site D, and the SQU message is retransmitted to site B.

In Figure 5-8f, the DDM-2000 FiberReach Multiplexer at site B detects the incoming SQU message from site C. The SQU message is a better quality message than the internal holdover capability, so the DDM-2000 FiberReach Multiplexer at site B switches to line time from site C. After the switch occurs, the TLB message is sent back to site C, and the SQU message is forwarded to site A. When the failure clears, the synchronization remains in the new configuration unless it is manually switched back.

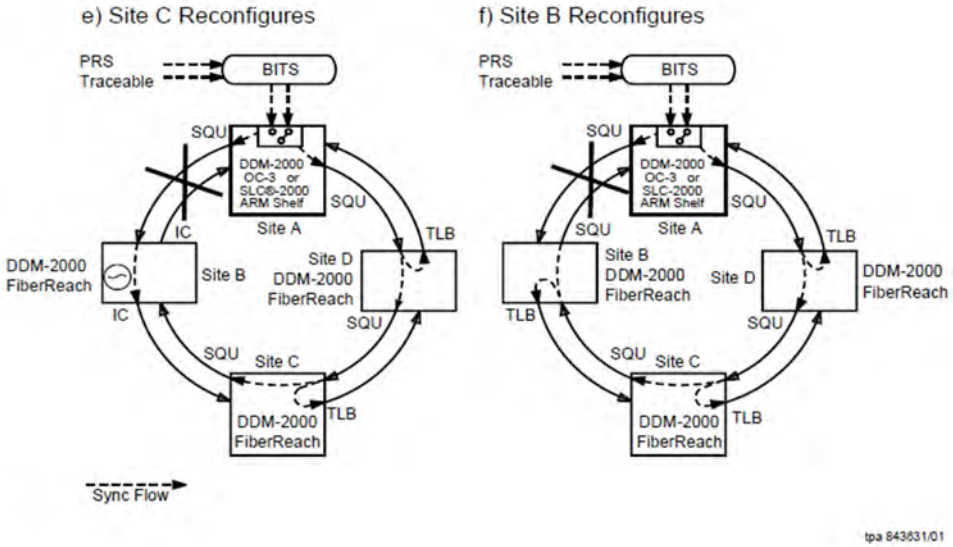


Figure 5-8. Synchronization Reconfiguration — Access Ring (Sheet 3 of 3)

Claim Element	Lucent 2000 Product Family
	DDM-2000 FiberReach Manual at 219 General Description of Operation The DS1 circuit pack terminates four bidirectional DS1 lines complying with standard DSX-1 signal specifications. The DS1 circuit pack interfaces to the OLIU circuit pack at the VT-G rate (6.912 MHz) and to the SYSCTL. Detailed Description of Operation Transmission Circuitry **Transmit Direction.** Figure 7-7 provides an overall block diagram of the DS1 circuit pack. The transmit direction points towards the VT-G, and the receive direction points toward the DS1s. In the transmit direction, the DS1 receives four balanced DS1 bipolar signals. Each of these signals passes through a relay to a DS1 interface circuit that converts it to unipolar nonreturn to zero (NRZ) format, recovers its clock, and sends it to the multiplexer (MUX) circuit. The MUX circuit converts each DS1 rate input into a 1.728 Mb/s VT1.5 signal, and then byte interleaves the four VT1.5s to create a VT-G signal that it sends to the OLIU pack using the frame sync and clock received from the OLIU. **Receive Direction.** The DS1 receives a VT-G with clock and frame information from the OLIU and demultiplexes the VT-G into four unique VT1.5 signals. Each VT1.5 passes through circuitry that performs pointer interpretation, removes the VT path overhead bits, the fixed stuff bits, and the overhead communications channel bits, and desynchronizes the embedded DS1. The DS1 rate signal is AMI or B8ZS encoded, preequalized with a selectable line build out (LBO). It is then sent as a balanced signal to a DSX-1 that may be located up to 655 feet from the system, or to a DS1 termination located up to 1310 feet from the system. DDM-2000 FiberReach Manual at 289-290

2000 FiberReach Multiplexers offers users flexibility in directing traffic in and out of these systems to support a wide variety and range of customer applications.

In a hairpin application, no cross-connection using high speed interfaces are needed on the node in the hosting ring because no signal is transported through the high-speed interfaces in the host ring.

For the DDM-2000 Multiplexers, cross-connections of both ring paths are entered with a single command entry per shelf. This minimizes the possibility of provisioning a circuit without a protection channel. A DDM-2000 OC-1 ring has 28 VT1.5 channels. The ring channels are always carried within the 26G2-U OLIU circuit packs in the main 1 and main 2 slots. Cross-connections in DDM-2000 Multiplexers are made by specifying the SONET rate (VT1.5), the end point addresses (access identifiers), the cross-connection type (two way, locked, etc.) and, in some cases, the ring direction (ring=m1, ring=m2, etc.). In DDM-2000 Multiplexers, each single cross-connection command establishes a bidirectional cross-connection. There is no need to identify ring channels in Main 1 as different from Main 2 because both rings are always provisioned with the same information.

Table 8-3. Ring Manual STS-1 Cross-Connections (Pass-Through) for the 26G-U

From *		To	"To" CP Type (Note)	CIT Command
m-1	<-->	m-1	OLIU	ent-crs-sts1:m-1,m-1

Notes:

Address on the left side MUST BE identical to the address on the right side. There is no interchange function for "pass-through" signals.

Table 8-4. Ring Manual STS-1 Cross-Connections (Pass-Through) for the 28G-U

From *		To	"To" CP Type (Note)	CIT Command
m-1	<-->	m-1	OLIU	ent-crs-sts1:m-1,m-1
m-2	<-->	m-2	OLIU	ent-crs-sts1:m-2,m-2
m-3	<-->	m-3	OLIU	ent-crs-sts1:m-3,m-3

Notes:

Address on the left side MUST BE identical to the address on the right side. There is no interchange function for "pass-through" signals.

* Whenever 28G-U OLIUs are installed in main the range of STS-1s will be from 1 to 3.

Claim Element	Lucent 2000 Product Family

There are three different VT1.5 cross-connection types for the DDM-2000 FiberReach Multiplexer: termination/drop, pass-through, and locked.

Termination/Drop Cross-Connection

The termination/drop cross-connection is used in all path-switched ring applications for DDM-2000 FiberReach, where DS1 low-speed signals are cross-connected to VT1.5 channels in both rotations of the rings terminating on the high-speed interfaces. With this cross-connection, all added signals are bridged on to both rotations of the ring; the better of the two signals received from the two rotations of the ring is dropped.

As shown in Table 8-5 and Table 8-6, at the entry and exit points, the VT channels are cross-connected to the low-speed ports (for example, **{ls group}-{slot#}-{port# on slot}, a-1-4**). These are called "drop" connections. For example, the command **ent-crs-vt1:m-1-3-4,b-1-4** connects the fourth low-speed port associated with slot 1 of low-speed group B to the fourth VT1.5 within the third VT group within the first (and only) STS-1 of both OC-1 rings.

Table 8-5. DDM-2000 FiberReach Manual VT1.5 Cross Connections (Termination/Drop) in a 1 x 1 Configuration

	From*		To	"To" CP Type	Example Commands
1x1	m-1-{1-7}-{1-4}	<-->	a-1-{1-4}	DS1,DS1PM	ent-crs-vt1:m-1-1-1,a-1-1
	m-1-{1-7}-{1-4}	<-->	b-1-{1-4}	DS1,DS1PM	ent-crs-vt1:m-1-3-4,b-1-4
	m-1-{1-7}-{1-4}	<-->	c-1-{1-4}	DS1,DS1PM	ent-crs-vt1:m-1-3-3,c-1-3
	m-1-{1-7}-{1-4}	<-->	d-1-{1-4}	DS1,DS1PM	ent-crs-vt1:m-1-3-3,d-1-3
	m-1-{1-7}-{1-4}	<-->	a-1-{1-2}	T1EXT, HDSL	ent-crs-vt1:m-1-1-1,a-1-2
	m-1-{1-7}-{1-4}	<-->	b-1-{1-2}	T1EXT, HDSL	ent-crs-vt1:m-1-3-4,b-1-2
	m-1-{1-7}-{1-4}	<-->	c-1-{1-2}	T1EXT, HDSL	ent-crs-vt1:m-1-3-3,c-1-1
	m-1-{1-7}-{1-4}	<-->	d-1-{1-2}	T1EXT, HDSL	ent-crs-vt1:m-1-3-3,d-1-1

* Whenever 28G-U OLIUs are installed in the Main slot, the range of STS-1s will be from 1 to 3.

DDM-2000 FiberReach Manual at 304

Claim Element	Lucent 2000 Product Family
	Path protection switching is employed for dual-homed applications, just like in single-homed applications. That is, path switching is supplied by the remote DDM-2000 FiberReach nodes and the DDM-2000 OC-3 systems in the wire center. However, the OC-3 host node configuration is different from single homing. Since an OC-3 host node terminates only one leg of the OC-1 extension, it employs a 0x1 low-speed interface to the OC-1 ring extension. The dual OC-1 circuit pack can be unprotected in a dual-homed application. Dual- and single-homed extensions can also be mixed at a host node, allowing the access network to be tailored efficiently to different groups of customers. **Example Cross-Connections** The cross-connect commands at each node in Figure 8-7 are as follows: ■ At RT1 and RT2: `ent-crs-vt1:m-1-2-3,m-1-2-3:cct=twoway;` The VT signal in the ring is only passing through these sites, so two-way cross-connections with identical addresses are provisioned here. ■ At RT3 and RT4: `ent-crs-vt1:m-1-2-3,b-1-4-7:cct=twoway;` At these sites, the VT1.5 signal is routed between a timeslot on the OC-3 ring and a timeslot on the OC-1 ring. ■ At FiberReach: `ent-crs-vt1:m-1-4-7,c-1-4:cct=twoway;` At this site, the signal is routed from a DS1 interface to the same timeslot on both rotations of the OC-1 ring. In the other direction, the VT1.5 signals received from both rotations of the OC-1 ring are monitored, path protection switching is provided, and the selected signal is routed to the DS1 interface. ■ At CO: `ent-crs-vt1:m-1-2-3,b-1-1:cct=twoway;` At this site, the signal is routed from a DS1 interface to the same timeslot on both rotations of the OC-3 ring. In the other direction, the VT1.5 signals received from both rotations of the OC-3 ring are monitored, path protection switching is provided, and the selected signal is routed to the DS1 interface. DDM-2000 FiberReach Manual at 334-341

and a fixed 15-second clear delay. Yellow signals are not subject to holdoff or clear delays. Circuit pack failures (except control circuit pack failures) are subject to the provisionable holdoff and clear delays. Refer to the **set-attr-alm** and **rtrv-attr-alm** commands in Chapter 11, "Commands and Reports."

Protection Switching

The DDM-2000 FiberReach Multiplexer provides equipment protection switching of all transmission circuit packs, and SONET standard path protection switching for OC-1 lines. Installation of protection equipment is optional. Protection switches are caused by automatically detected faults in the circuit packs or OC-1 lines, and by external commands from a CIT or telemetry byte-oriented serial (TBOS) interface. Refer to the **switch-ls**, and **switch-sync** commands in Chapter 11, "Commands and Reports."

Path Protection Switching (Path Switched Rings)

The path switched ring application is based on the Bellcore's TR-TSY-000496/GR-1400 path protection switching scheme.

The path protection switched ring has two single-fiber counter-rotating rings as shown in Figure 9-5. Each node on the ring terminates four fibers: a transmit and receive fiber in each direction. The architecture of the ring is designed to protect against any single point of failure, including a node failure, single fiber cut, or dual fiber cut. A node failure in a ring affects only traffic dropped at the failed node.

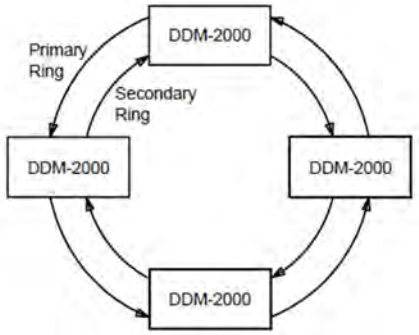


Figure 9-5. Two-Fiber Unidirectional Ring

The signal that enters the ring is protected on a SONET path basis as switching is performed independently for each path. Because of the ring's unidirectional operation, time slots must be reserved all the way around the ring for all ring traffic, limiting the capacity of the ring to the OC-N line rate. DDM-2000 FiberReach can provides VT1.5 path protection.

Path protection switched rings feed a SONET payload from the ring entry point, simultaneously in both rotations of the ring, to the signal's ring drop or exit point as shown by traffic AC and CA in Figure 9-6a. This duplication of the signal that enters the ring is called a "head-end bridge." The node that drops the signal from the ring monitors both ring rotations and is responsible for selecting the signal that has the highest quality based on LOS/LOF, path alarm indication signal (AIS), and path bit error rate (BER) performance. This function at the ring exit point is called a "tail-end switch." The system provides nonrevertive switching. All detected hard failures (LOS, LOF, LOP, line AIS, STS-1 or VT1.5 path AIS, or STS-1 path signal failure or signal degrade based on BER for path protected rings) result in AIS insertion in the outgoing signals. This allows the drop node to detect path failures and to select the good path.

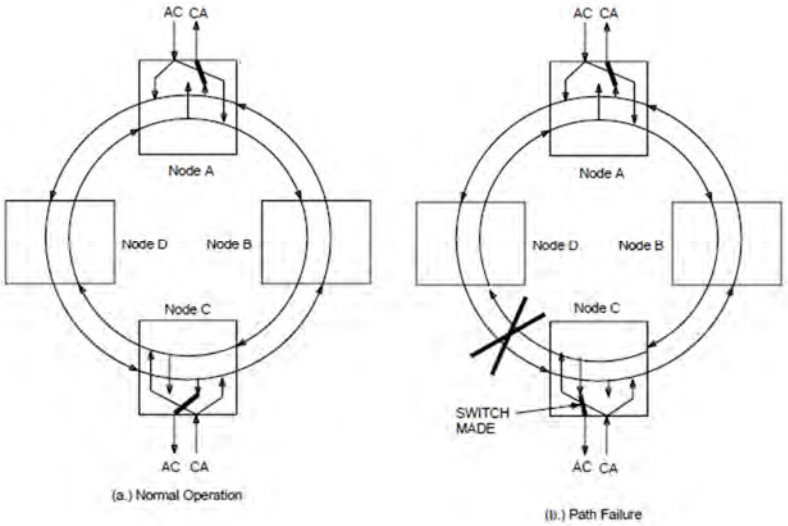


Figure 9-6. Path Protection Switching

Claim Element	Lucent 2000 Product Family
	The user can set STS-1 and VT1.5 signal degrade thresholds using the **set-sts1**, **set-vt1**, **rtrv-sts1**, and **rtrv-vt1** commands at a *drop* node on a protected ring. Under normal conditions, both incoming SONET path signals to the switch selection point are of high quality, and the signal can be selected from either ring. A failure or a transmission degradation on one of the rings requires that the other ring path be selected; path selection occurs within 60 milliseconds after a hard failure condition. Figure 9-6b shows how traffic is switched when a dual-fiber cut occurs. The system provides nonrevertive switching to minimize the impact on critical customer services by giving the service provider control when, and if, the critical service should revert to a particular ring. A manual path protection switching command allows switching back to the original path for ease of ring maintenance. Refer to the **switch-path-vt1** command in Chapter 11, "Commands and Reports." OC-3/OC-1 Ring Interworking The DDM-2000 OC-3 Multiplexers support both dual-homed and single-homed FiberReach ring interworking applications to provide end-to-end protection from loss of service on traffic traveling over interconnected rings. The dual-homed configuration provides two points (nodes) of interconnection between the OC-3 Multiplexer ring and the FiberReach OC-1 ring to insure a continuation of service between rings, should one interconnecting node fail. The DDM-2000 OC-3 ring interconnects with the FiberReach ring through 0x1 interfaces. The 0x1 interface on the DDM-2000 OC-3 Multiplexer passes traffic from one direction of the OC-3/ OC-1 ring to one direction of the FiberReach ring. There is no bridging of traffic onto both rings at the 0x1 interface as there is at a ring drop point. Also, no path protection switching or line protection switching is performed on the OC-3 for traffic connected to the 0x1 interface. Path protection switching is performed on the FiberReach nodes and on the DDM-2000 OC-3 nodes at the traffic exit (drop) points.

Single-Homed Interworking Application

Figure 9-7 shows a single-homed FiberReach configuration. A single DDM-2000 OC-3 shelf provides the point of interconnection between the two rings. On the OC-3 shelf, traffic from one ring is cross-connected through a 0x1 interface to one direction on the other ring. The OC-3 shelf requires two OC-1 OLIUs in a function unit to interface both sides of the FiberReach ring. No line or path protection switching is performed for the 0x1 interface. Path protection switching is performed at the exit points as in the simple ring application previously discussed.

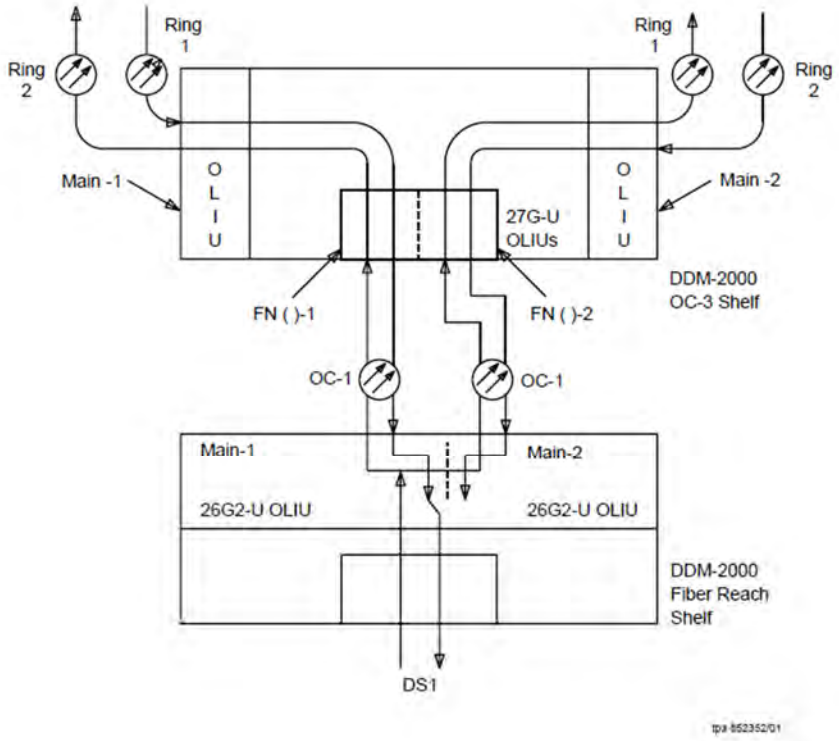
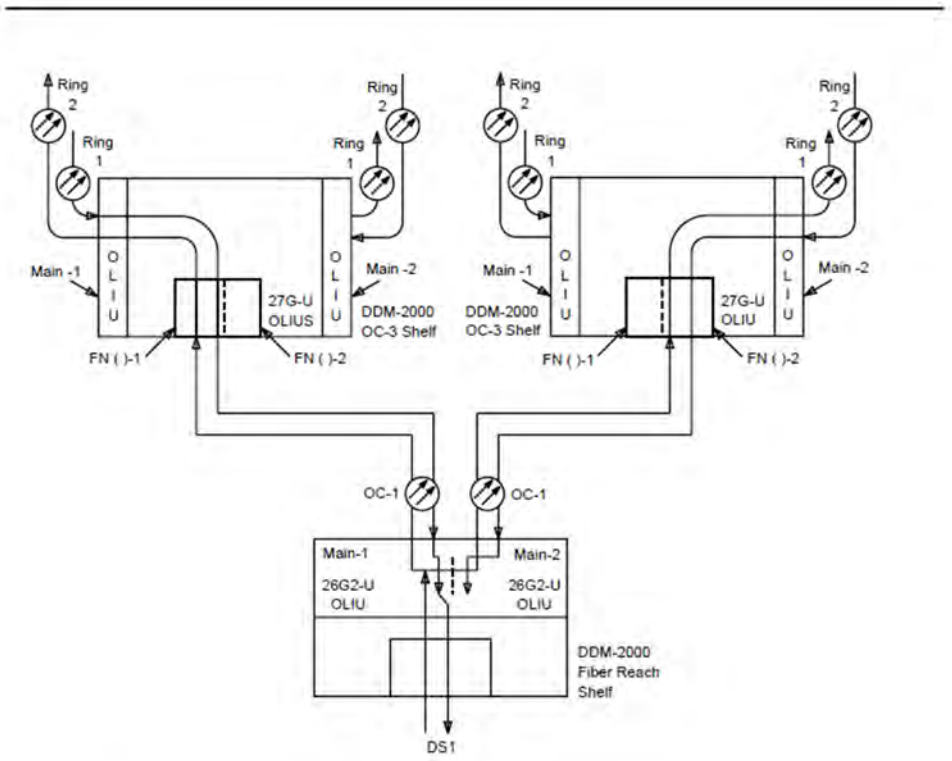


Figure 9-7. Single-Homed Ring Interworking Application

Claim Element	Lucent 2000 Product Family
	Dual-Homed Ring Interworking Application Figure 9-8 shows a dual-homed FiberReach configuration. This application requires two DDM-2000 OC-3 Multiplexers to provide redundant points of interconnection between the FiberReach and the DDM-2000 OC-3 ring. The same 0x1 interface is used as for the single-homed application. However for the dual-homing application, only one 27-type OLIU is required in the DDM-2000 OC-3 function unit to interface one side of the FiberReach ring. Another FiberReach extension can use the remaining -1 or -2 slots, as long as the bandwidth is not violated. For instance, assume you had a dual homed application where one OC-3 shelf is hosting and terminating one rotation of the subtending OC-1 ring through OC-1 port # 1 on the dual OC-1 (27-type OLIU) in FN-A-1, and another OC-3 shelf is hosting and terminating the other rotation of the subtending OC-1 ring through the OC-1 port #1 on the dual OC-1 (27-type). As a result, both 27-type OLIU circuit packs located in FN-A-1 of one OC-3 shelf and FN-A-2 of the other OC-3 shelf still have one OC-1 port available (OC-1 #2) to be used for another dual-homed application to host another OC-1 ring, or this OC-1 port can be used to host a single-homed application, which in this case requires the presence of another 27-type OLIU in FN-A-2.

Claim Element	Lucent 2000 Product Family
	 Figure 9-8. Dual-Homed Ring Interworking Application

Single-Homed Interworking Application for FiberReach to a DDM-2000 OC-12

Figure 9-9 shows a single-homed FiberReach configuration. A single DDM-2000 OC-12 shelf provides the point of interconnection between the two rings. On the OC-12 shelf, traffic from one ring is cross-connected through a 0x1 interface to one direction on the other ring. The OC-12 shelf requires two OC-3 OLIUs in a function unit to interface both sides of the FiberReach ring. No line or path protection switching is performed for the 0x1 interface. Path protection switching is performed at the exit points as in the simple ring application previously discussed.

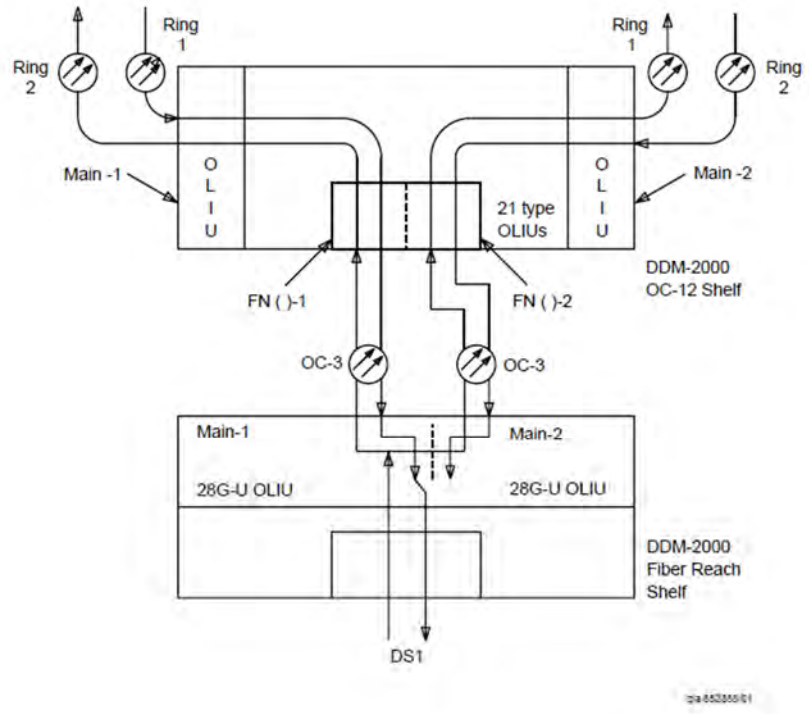


Figure 9-9. Single-Homed Ring Interworking Application for FiberReach to DDM-2000 OC-12

Dual-Homed Ring Interworking Application for FiberReach to DDM-2000 OC-12

Figure 9-10 shows a dual-homed FiberReach configuration. This application requires two DDM-2000 OC-12 Multiplexers to provide redundant points of interconnection between the FiberReach and the DDM-2000 OC-12 ring. The same 0x1 interface is used as for the single-homed application. However for the dual-homing application, only one 21-type OLIU is required in the DDM-2000 OC-12 function unit to interface one side of the FiberReach ring.

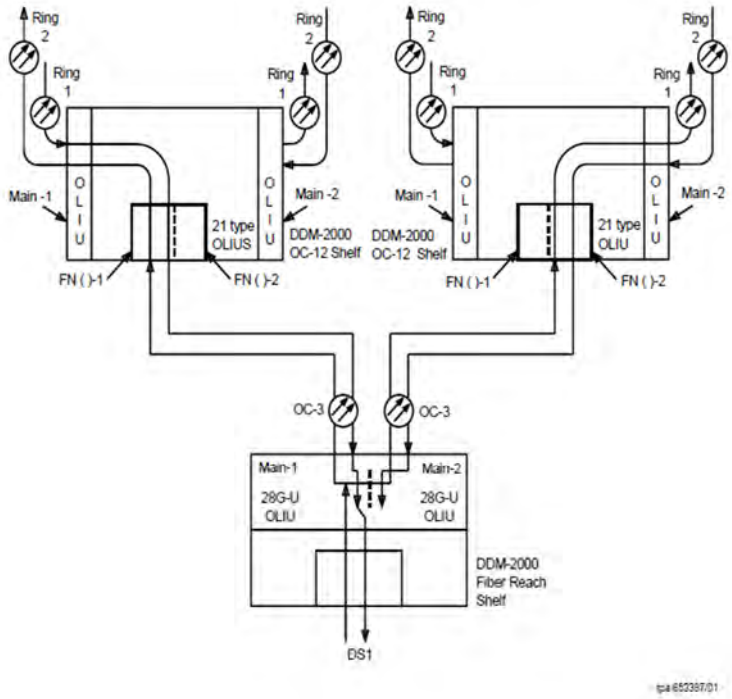


Figure 9-10. Dual-Homed Ring Interworking Application for FiberReach to DDM-2000 OC-12

Claim Element	Lucent 2000 Product Family
	DDM-2000 FiberReach Manual at 385

Synchronization

Optical Line Interface Unit (26G-Type)

The 26G-Type OLIU circuit pack meets the specifications of TR-253, SONET Transport Systems Generic Criteria. The OLIU circuit pack supports a line-timing mode which locks to a recovered clock from an OC-1 signal. A free-running mode will be supported in a future software release.

Holdover mode is entered on failure of the line-timing reference, providing a temperature stability of ±8.8 ppm (–40°C to +75°C). Holdover capability for 24 hours will be better than ±4.6 ppm.

Protection Switching

Ring Networks

Path protection rings feed a SONET payload (STS or VT) from the ring entry point, simultaneously in both rotations of the ring, to the signal's ring exit point. The node that terminates the signal from the ring monitors both ring rotations and is responsible for selecting the signal that has the highest quality based on loss of signal (LOS), path alarm indication signal (AIS), and path bit error rate (BER) performance. On pass-through paths, all detected hard failures (LOS, LOF, LOP, line AIS, STS-1 path AIS, or STS-1 path signal failure based on BER) result in VT AIS insertion in the outgoing signals. This allows the terminating node to be aware of the failure and to switch to protection. Protection switching is completed within 50 milliseconds of failure detection. Similarly, for dropped nonterminated paths, if both incoming STS-1s have any of the previous failures, VT AIS will be inserted in the dropped signal.

Under normal conditions, both incoming SONET path signals to the switch selection point are of high quality, and the signal can be selected from either ring. A failure or a transmission degradation on one of the rings requires that the other ring path be selected. DDM-2000 FiberReach provides nonrevertive switching to minimize the impact on critical customer services by giving the service provider control when, and if, the critical service should revert to a particular ring. A manual path protection switching command allows switching back to the original path for ease of ring maintenance, if desired.

Claim Element	Lucent 2000 Product Family
	DDM-2000 FiberReach Manual at 784

Claim Element	Lucent 2000 Product Family

DO ITEMS BELOW IN ORDER LISTED . . . . FOR DETAILS, GO TO

6. From office records or by using the `rtrv-crs-vt1:all` command at any site, determine the existing cross-connections.

7.

CAUTION:
Critical or Major alarms will be generated if pass-through cross-connections are not made on the new shelf before splicing it into the network.

NOTE:
In ring configurations, you should use the following rules in establishing cross-connections in each ring:

1. All drop connections (including DRI, if present) from the same STS-1 timeslot must be provisioned the same, either all VT1.5 or STS-1.
2. If all 28 VT1.5s (DS1s) in an STS-1 are being passed through at a node in a VT1.5 path-switched ring, then the cross-connection may be provisioned as either a pass-through STS-1 or VT1.5. However, if you anticipate dropping VT1.5s from the pass-through node in the future, you should provision the pass-throughs as VT1.5 cross-connections. OC-3 ring Releases 7.0 and earlier do not support the command (`cnvt-crs`) for converting an STS-1 to a VT1.5 cross-connect. Also, provisioning now as a VT1.5 cross-connect will avoid a hit on traffic if the STS-1 cross-connect has to be converted to 28 VT1.5 cross-connects to drop DS1s at a later time.
3. On STS-1 path-switched rings, all nodes in the ring must be provisioned as STS-1 cross-connections.

Claim Element	Lucent 2000 Product Family
	DDM-2000 FiberReach Manual at 1443

0x1
See Ring (0x1) Low Speed Interface.

1+1
The 1+1 protection switching architecture protects against failures of the optical transmit/receive equipment and their connecting fiber facility. One bidirectional interface (two fibers plus associated OLIUs on each end) is designated "service", and the other is designated "protection". In each direction, identical signals are transmitted on the service and protection lines ("dual-fed"). The receiving equipment monitors the incoming service and protection lines independently, and selects traffic from one line (the "active" line) based on performance criteria and technician/OS control. In 1+1 both service and protection lines could be active at the same time. Also referred to as linear (1+1) low speed interface.

1xN, 1x1
1xN protection switching pertains to circuit pack protection that provides a redundant signal path through the DDM-2000 (it does not cover protection switching of an optical facility; see "1+1"). In 1xN switching, a group of N service circuit packs share a single spare protection circuit pack. 1x1 is a special case of 1xN, with N=1. In 1x1 only one is active at a time.

A

ABN
Abnormal (status condition)

ACO
Alarm Cutoff — A pushbutton switch available on the user panel that can be used to retire an audible office alarm.

ACO/TST
Alarm Cutoff and Test — The name of a pushbutton on the user panel.

Active
Active identifies a 1+1 protected OC-N line which is currently selected by the receiver at either end as the payload carrying signal or a 1x1 or 1xn protected circuit pack that is currently carrying service. (See Standby.)

ADM
Add/Drop Multiplexer.

AIS
Alarm Indication Signal — A code transmitted downstream in a digital network that shows that an upstream failure has been detected and alarmed.

Claim Element	Lucent 2000 Product Family
	DDM-2000 FiberReach Manual at 1447

DACS IV-2000
Digital Access and Cross-Connect System that provides electronic DS3/STS-1 or DS1/VT1.5 cross-connect capability, eliminating the need for manual DSXs.

DCC
Data Communications Channel — The embedded overhead communications channel in the DCE Data Communications Equipment — In a data station, the equipment that provides the signal conversion and coding between the data terminal equipment (DTE) and the line. The DCE may be separate equipment or an integral part of the DTE or of intermediate equipment. A DCE may perform other functions usually performed at the network end of the line.

DDM-1000
Lucent's Dual DS3 Multiplexer — A digital multiplexer that multiplexes DS1, DS1C, or DS2 signals into a DS3 signal or a 90 Mb/s or 180 Mb/s optical signal.

DDM-2000
Lucent's next generation network multiplexers that multiplex DS1, DS3, or EC-1 inputs into EC-1, OC-1, OC-3, or OC-12 outputs.

Default Provisioning
The parameter values that are preprogrammed as shipped from the factory.

Demultiplexing
A process applied to a multiplexed signal for recovering signals combined within it and for restoring the distinct individual channels of these signals.

DEMUX
Demultiplexer - "the DEMUX direction" is from the fiber toward the DSX.

Digital Multiplexer
Equipment that combines by time-division multiplexing several digital signals into a single composite digital signal.

DLC
Digital Loop Carrier

DPLL
Digital Phase-Locked Loop

DRI
Dual Ring Interworking. Two ring networks interconnected at two common nodes.

Drop and Continue
A technique that allows redundant signal appearances at two central offices in a DRI network, allowing protection against central office failures.

DS1
Digital Signal Level 1 (1.544 M/bs)

DS1 Circuit Pack
The DS1 interface circuit pack interfaces to the DSX-1 panel.

DS3
Digital Signal Level 3 (44.736 M/bs)

Claim Element	Lucent 2000 Product Family

1[a] constructing a general mask indicating which of the segments are reachable in the event of a fault in the network by assigning a respective general mask bit to each segment, indicating whether the segment is reachable following occurrence of the fault;	Lucent 2000 Product Family discloses constructing a general mask indicating which of the segments are reachable in the event of a fault in the network by assigning a respective general mask bit to each segment, indicating whether the segment is reachable following occurrence of the fault. For example, Lucent 2000 Product Family discloses discloses K bytes and S bytes, which indicate whether a particular action needs to be taken to route network traffic, including whether a failure has occurred. Thus, at least under the claim scope alleged by Quicker Connection's Infringement Disclosures, this limitation is met. To the extent that Lucent 2000 Product Family is not found to meet this limitation, it would have been obvious to a person of ordinary skill in the art as explained below. DDM-2000 User/Service Manual at 1-11 **Release 8.1** is a linear release supporting *MegaStar*® 2000 SONET Radio. Release 8.1 requires the BBG8/BBG8B SYSCTL system controller and BBG9 or new BBG10 OHCTL overhead controller. Release 8.1 may be used for non-*MegaStar* 2000 applications when S1 byte synchronization messaging is desired. Release 8.1 will interwork with Releases 7.2 or 9.0. ■ New Applications: — *MegaStar* 2000 SONET Radio. Part of Lucent Technologies and Harris-Farinon *MegaStar* 2000 Radio system supporting mixed fiber and radio topologies. *MegaStar* applications require the BBG10 OHCTL. ■ New Features: — S1 Byte synchronization messaging. Uses the S1 byte of the SONET overhead to pass timing status information to different nodes in a loop-timed network. Synchronization messaging mode (S1 byte or K2 byte) is provisionable on a per OC-N basis. — CPro-2000, ITM SNC. Release 8.1 is supported by CPro-2000 Releases 5.0, 6.0, and ITM SNC Release 4.0. DDM-2000 User/Service Manual at 1-14

- New Features:
  - S1-byte Synchronization Messaging. Uses the S1 byte of the SONET overhead to pass timing status information to different nodes in a loop-timed network. Synchronization messaging mode (S1 byte or K2 byte) is provisionable on a per-OC-3 basis.
  - Enhanced DS1 PM. Provides 15 minute bins for DS1 path and line PM data.
  - Fourth Level of Security. A new Maintenance security level, which allows access to Reports and some maintenance activities is provided in addition to the three current levels of privileged, general, and reports-only.
  - Quad-DS1 electrical loopbacks. Provides an electrical facility loopback of four DS1 interfaces from a given BBF1B or BBF3 DS1 circuit pack.
  - Large networks. Supports DDM-2000 and FiberReach networks of up to 50 nodes.
  - CPro-2000, ITM SNC support. Release 9.1 is supported by CPro-2000 Releases 5.0 and 6.0, and ITM SNC Releases 2.2 and 4.0.
  - 27G2-U OLIU. The new 27G2-U OLIU supports the new cross-connects necessary to provide enhanced FiberReach topologies.

DDM-2000 User/Service Manual at 5-45-5-48

Feature Details and Options

As mentioned previously, SONET synchronization messaging is used to communicate the quality of the subnetwork timing throughout the subnetwork. This is done using bits 1-3 of the K2 byte found in the SONET overhead. In OC-3 Release 9.1 and later releases, synchronization messaging can also be done using bits 5-8 of the S1 byte in the SONET overhead (not supported on OC-1 links). If a DDM-2000 OC-3 system is deriving timing from a given OC-N interface and synchronization messaging is enabled on that interface (Kbyte messages and Sbyte messages in OC-3 Release 9.1 and later are provisioned using the `set-ocn` command), the system interprets the received message to determine its internal timing status. The system also determines the state of the DS1 output, if the DS1 output is enabled. The DDM-2000 OC-3 system also transmits over the particular OC-N interface and all other OC-N interfaces that are enabled for synchronization messaging, the appropriate message indicating the quality of its timing, and its active timing mode. Table 5-3 and Table 5-4 list the associated internal timing status and DS1 output states that are associated with synchronization messages received from the OC-N interface when synchronization messaging is enabled. The tables list the messages from low- to high-quality.

Table 5-3. Synchronization Messages using K2 Byte

Received Message	Active Timing Mode *	Default DS1 Output State	Quality Level
Don't Use	Holdover	AIS	7
Timing Looped Back (TLB)	Holdover	AIS	7
Stratum 4 †	Holdover	AIS	6
Internal Clock (IC)	OK to use	AIS	5
Stratum 3 †	OK to use	Good	4
Stratum 2 †	OK to use	Good	3
Sync Quality Unknown (SQU)	OK to use	Good	2
Stratum 1 †	OK to use	Good	1

* This column applies only when provisioned for line-timing mode.

† Presently, DDM-2000 OC-3 Multiplexers cannot generate these messages, but they could be retransmitted and supported for auto-reconfiguration if any of these are received by a DDM-2000 OC-3 Multiplexer.

Table 5-4. Synchronization Messages using S1 Byte*

Received Message	Active Timing Mode †	Default DS1 Output State	Quality Level
Don't Use	Holdover	AIS	7
Traceable SONET minimum Clock	OK to use	AIS	5
Traceable Stratum 3 ‡	OK to use	Good	4
Traceable Stratum 2 ‡	OK to use	Good	3
Sync Trace Unknown	OK to use	Good	2
PRS Traceable ‡	OK to use	Good	1

* S1 byte not supported on OC-1 links.

† This column applies only when provisioned for line-timing mode.

‡ Presently, DDM-2000 OC-3 Multiplexers cannot generate these messages, but they could be retransmitted and supported for autoreconfiguration if any of these are received by a DDM-2000 OC-3 Multiplexer.

Synchronization messaging using the SONET K2 byte and S1 byte can be disabled on a per OC-N interface using the **`set-ocn`** command (not supported by OC-1). Zeros will be transmitted on bits 1-3 of the K2 byte if this is done; all ones will be transmitted on bits 5-8 of the S1 byte if this is done. The timing and synchronization status of a shelf can be determined using the **`rtrv-sync`** command.

The "Don't Use" message is sent when the system determines that its timing is not suitable for synchronization; for example, due to failure.

When the DDM-2000 OC-3 system is configured for external timing and its DS1 output port is provisioned for MULT mode, the message Sync Quality Unknown (SQU) for K byte, or Sync Trace Unknown (STU) for S byte, is sent on all the OC-N interfaces where synchronization messaging is provisioned. When the capability of communicating with a BITS clock over the DS1 overhead exists, the quality of the reference signal will be transmitted instead; for example, Stratum 1.

When the DDM-2000 OC-3 system is configured for external timing and its DS1 output port is provisioned for SYNC OUT mode, the Timing Looped Back (TLB) message for K byte, or "Don't Use" message for S byte, will be sent on the OC-N interfaces towards the NE from which the DS1 timing output is being derived. The SQU message for K byte or STU for S byte will be sent on all other OC-N interfaces where synchronization messaging is provisioned. If the DS1 output is generating AIS while the system is configured in this way, the message SQU for K byte, or STU for S byte, will be transmitted on all OC-N interfaces.

When the DDM-2000 OC-3 system is configured for free run or is in holdover mode, the Internal Clock message for K byte or Traceable SONET Clk for S byte

will be sent on all OC-N interfaces where synchronization messaging is provisioned.

When the DDM-2000 OC-3 system is configured for line timing, the TLB message for K byte and "Don't Use" for S byte will be sent on the OC-N interfaces towards the NE from which the timing is being derived. The message received on the OC-N interface will be sent on all other OC-N interfaces where synchronization messaging is provisioned.

With automatic synchronization reconfiguration, the DDM-2000 OC-3 Multiplexer systems use and compare the incoming synchronization messages on the OC-N interfaces available for line timing to select the highest quality synchronization reference available. If the received quality levels are the same on the references available for timing, the existing line timing reference take precedence. This feature guarantees the non-revertive operation of reconfiguration. The line timing reference is provisioned by the **`set-sync`** command.

The existence of automatic synchronization reconfiguration does not change the system's behavior on traditional line failures; for example, LOF, LOP, LOS, and others.

There are synchronization references in the DDM-2000 OC-3 system that can be provisioned as network timing sources but are not considered as timing sources for automatic synchronization reconfiguration. Examples of these are the linear extensions off of a DDM-2000 OC-3 ring. This type of interface is considered a linear interface, and the system treats it as such with regards to synchronization.

Table 5-5 lists the synchronization references available on DDM-2000 OC-3 and OC-12 system topologies.

Table 5-5. Available Synchronization References

System	Manually Provisionable	Automatically Reconfigurable
OC-3 Linear	Main, Fn-C	Main, Fn-C
OC-3 Rings	Main-1, Main-2, Fn-C	Main-1, Main-2, Fn-C
OC-12 Linear	Main-B	Not applicable
OC-12 Rings	Main-B-1, Main-B-2	Main-B-1, Main-B-2

Function unit C, when equipped with an OC-3/IS-3 OLIU, can be selected as an option for automatic synchronization reconfiguration. This is useful in DRI networks where an OC-3 ring is connected through an OC-3/IS-3 optical interface to an OC-12 or FT-2000 OC-48 Lightwave System ring.

In OC-3 Release 9.1 and later ring releases, the sending of DS1 AIS on the output of the BBF2B circuit pack can be provisioned by using the **set-sync** command. Depending on the quality level of the incoming sync messages, this new parameter can be provisioned to send DS1 AIS upon receiving level 5 (default), level 4, level 3, or level 2. Refer to Table 5-3 and Table 5-4 for definitions of quality levels. AIS will be sent as long as the received message is at the provisioned or greater in quality level number.

Examples

In this part, some detailed examples are given to show specifically how the synchronization messages propagate through the DDM-2000 OC-3 network and assist in the recovery from a fiber failure. Through these examples, one can extend the same concept to any other network that may include different topologies, number of sites, failure locations, and number of BITS clocks.

NOTE:
All nodes in a ring using automatic synchronization reconfiguration must have the synchronization messaging and automatic synchronization reconfiguration features enabled to prevent alarms.

In all of the following examples, if the sync message parameter within the **set-oc3** command has been provisioned to "S byte" for an optical interface, then the equivalent S byte message will be transmitted from that optical interface. The following are equivalent messages:

K2: Sync Quality Unknown is the same as, S1: Sync Trace Unknown

K2: Timing Looped Back is the same as, S1: Don't Use

K2: Internal Clock is the same as, S1: Traceable SONET minimum Clock

K2: Stratum 3 is the same as, S1: Traceable Stratum 3.

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Dual-Homing DRI Synchronization Configurations

OC-3 and FT-2000 OC-48 Lightwave System

Figure 5-30 shows how OC-N timing can be distributed from an FT-2000 OC-48 Lightwave System line-switched ring to a DDM-2000 OC-3 path-switched ring using a dual-homing DRI configuration. The OC-3 DRI nodes are connected via OC-3 point-to-point links terminating in function unit C slots. The major characteristics of this configuration are:

- The FT-2000 OC-48 Lightwave System nodes are through-timed and derive timing from different rotations of the OC-48 ring.
- The FT-2000 OC-48 Lightwave System must be provisioned to write stratum 3 synchronization message to the K2 byte so the DDM-2000 ring can use synchronization messaging.
- The two DDM-2000 OC-3 DRI nodes coordinate timing using synchronization status messages on the OC-3 ring so that all nodes will accept timing in the same direction.
- The two DDM-2000 OC-3 DRI nodes must be provisioned for line-timing with timing derived from function unit C. Synchronization messaging on the OC-3 span between the two OC-3 DRI nodes must be disabled so timing loops are not formed. Synchronization messaging and automatic synchronization reconfiguration should be enabled on all other OC-3 interfaces on the DRI nodes.
- All other OC-3 nodes must be provisioned for line-timing with synchronization messaging and automatic synchronization reconfiguration enabled.

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SONET Overhead Bytes

The DDM-2000 OC-3 Multiplexer currently uses the K2 byte in the SONET format for synchronization signaling. The reserved V4 byte in the VT1.5 superframe is used for internal fault detection in a DDM-2000 OC-3 Multiplexer shelf. This internal usage of the V4 byte may cause the value of the transmitted V4 byte to vary.

The DDM-2000 OC-3 Multiplexer does not depend on, and always ignores, the value of the V4 byte received from another DDM-2000 or other shelf with an OC-3 interface.

Performance

Wander/Jitter

- For SONET optical interfaces, the maximum time interval error (MTIE) does not exceed 60 nanoseconds phase variation when timed with a wander-free reference
- Jitter transfer, tolerance, and generation requirements are met as specified in GR-253-CORE and GR-499-CORE
- The SONET interfaces meet the T1.101 OC-N output short-term stability mask.

Signal Performance

The following specifications apply given the standard networks defined in GR-499-CORE.

- For systems interfacing at the DS1 rate, the number of errored seconds, during a 2-hour, one-way loopback test, is less than 10
- For systems interfacing at the DS3 rate, the number of errored seconds, during a 2-hour, one-way loopback test, is less than 72
- The BER is less than 10^{-9} for both the DS1 and DS3 rates. Burst-errored seconds are excluded
- The frequency of burst-errored seconds, other than those caused by protection switching induced by hard equipment failures, averages less than four per day.

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	`Kbyte Message` The valid values for this parameter are `enabled`, indicating that proprietary Sync messages are used, and `disabled`, indicating that proprietary Sync messages are not used. The Sync messages use the K2 byte in the SONET overhead to determine synchronization quality. These values are set by the **`set-oc3`** command. `Sync Message` Beginning with OC-3 Releases 8.1 and 9.1, this parameter indicates the type of synchronization messaging that has been provisioned for that OC-3 optical interface by the **`set-oc3`** command. The valid values for this parameter are `Kbyte` (default value), `Sbyte`, and `disabled`. The sync messages use the K2 byte or the S1 byte in the SONET line overhead to determine synchronization quality. `Concat Mode` This parameter is used in linear releases only. This report parameter is visible only if the STS3c mode is enabled via the **`set-feat`** command. This indicates if the addressed line is concatenated or not. The valid values are `enabled` and `disabled`. For OC-3, only function unit C slots can report concatenated values. `Radio` This parameter is avaliable with linear releases only and is reported if this a *MegaStar* 2000 system. It has a value of **`yes`** or **`no`**, and it indicates whether there is a Radio Frequency Unit (RFU) connected to the SONET subsystem through an IS-3 interface. `AIS Alarm` This parameter specifies the alarm level of a non-service-affecting OC-3 line AIS failure condition. The valid values are: **`cr`** Critical alarm **`mj`** Major alarm **`mn`** Minor alarm **`na`** Not alarmed, but reported (default). **RELATED COMMANDS** rtrv-sync DDM-2000 User/Service Manual at 11-197

The output parameters are:

`Line Address` Address of the OC-12 line.

`Signal Degrade Threshold`
This is the bit error rate (BER) threshold as a logarithm to the base 10. The value of *n* is an integer with a range of -5 through -9 corresponding to BERs of 10^{-5} through 10^{-9}. If a slot is empty or equipped with something other than an OC-12 optical unit, a hyphen (-) will appear in this column.

`Sync Message` For OC-3 Release 11.0 and later ring releases, this parameter indicates the type of synchronization messaging that has been provisioned for that OC-12 optical interface by the **`set-oc12`** command. The valid values for this parameter are `Kbyte` (default value), `Sbyte`, and `disabled`. The sync messages use the K2 byte or the S1 byte in the SONET line overhead to determine synchronization quality.

`AIS Alarm` This parameter specifies the alarm level of a non-service-affecting OC-12 line AIS failure condition. The valid values are

- **`cr`** Critical alarm
- **`mj`** Major alarm
- **`mn`** Minor alarm
- **`na`** Not alarmed, but reported (default)

RELATED COMMANDS

set-oc3

set-oc12

DDM-2000 User/Service Manual at 11-277

the `src` parameter is set to `fn-c` and the DS1 synchronization output is provisioned for `SYNC OUT` mode.

In addition to the condition mentioned above, in OC-3 Release 9.1 and future ring releases, DS1 Output Mode will not be reported when `Sync Autoreconfiguration` parameter is enabled. This will prevent any confusion in reading the report when the autoreconfiguration forces the `Active Reference/Line` parameter to switch to a better source.

`AIS Threshold`

In OC-3 Release 9.1 and later ring releases, this parameter indicates the provisioned sync message quality level and its equivalent sync message phrase for the active reference at which, or greater incoming quality level numbers, DS1 AIS will be transmitted on the sync output of the BBF2B TGS or BBF4 TG3 circuit pack. If the `syncmsg` parameter within the **`set-oc3`** or **`set-oc12`** command is set to `disabled`, then the word `disabled` will be reported with the provisioned value of this parameter. It may be set to one of the following options:

`level5`	default value. (K2: Internal Clock, S1: Traceable SONET Clk, or disabled)
`level4`	(K2: Stratum 3, S1: Traceable Stratum 3, or disabled)
`level3`	(K2: Stratum 2, S1: Traceable Stratum 2, or disabled)
`level2`	(K2: Sync Quality Unknown, S1: Sync Trace Unknown, or disabled)

For a definition of quality levels, refer to the Sync Message Information section of this command pages.

`DS1 Output State`

The output state is the status of the DS1 output when in the *`sync out`* mode, and may be one of the following:

`good`	This status indicates that the DS1 output is traceable to the incoming OC-1 (Release 9.1 and later), OC-3 signal, or OC-12 (if Main unit slots are equipped with 24G-U OLIU packs). line.

	DDM-2000 User/Service Manual at 11-339

For ring releases, the signal degrade value for addresses of main-1 and main-2 *must* be the same. Therefore, any change to signal degrade for one address will automatically be made to the other by the software.

kbyte

NOTE:
This parameter is only applicable to Releases 8.0 and 9.0. This parameter is no longer be used for DDM-2000 OC-3 Releases 8.1, 9.1, and later releases. For later releases, the **syncmsg** parameter is used in place of the **kbyte** parameter.

Kbyte specifies the usage of the K byte overhead for Sync Messages. Both the sending and receiving messages are affected. If Kbyte is `enabled`, proprietary Sync Messages are used. If Kbyte is `disabled`, proprietary Sync Messages are not used. The default value is `enabled`. For main slots m1 and m2 in ring applications, the kbyte value could be different on both rotations of the ring.

syncmsg This parameter is available in OC-3 Releases 8.1, 9.1, and later releases. Synchronization messaging allows timing to be reconfigured in a network upon a node or fiber failure. This parameter has one of the following values:

`Kbyte` This is the default value. When this option is selected, both K2 and S1 byte sync messages are transmitted, but only K2 byte is received and interpreted for sync messaging.

`Sbyte` When this option is selected, only the S1 byte is sent and received for sync messaging. K2 byte will always send a "Don't Use" message.

NOTE:
To minimize the amount of time that DDM-2000 is in holdover mode when upgrading a ring network from **Kbyte** to **Sbyte** messages, it is recommended that the user first upgrade the nodes farthest away from the external timing source, and then proceed to nodes closer to the timing source.

`disabled` When this option is selected, interpretation of both K2 and S1 bytes will be disabled and hence a "Don't Use" message will be transmitted on both bytes at all times.

	DDM-2000 User/Service Manual at 11-345

syncmsg This parameter is available in OC-3 Release 11.0 and later rings releases. Synchronization messaging allows timing to be reconfigured in a network upon a node or fiber failure. Parameter value is one of the following:

- `Kbyte` This is the default value. When this option is selected, both K2 and S1 byte sync messages are transmitted, but only K2 byte is received and interpreted for sync messaging.
- `Sbyte` When this option is selected, only the S1 byte is sent and received for sync messaging. K2 byte will always send a "Don't Use" message.
- `disabled` When this option is selected, interpretation of both K2 and S1 bytes will be disabled and hence a "Don't Use" message will be transmitted on both bytes at all times.

aisalm For ring releases, the AIS alarm values for Main-1 and Main-2 (when using the 24-type OLIU circuit packs in the Main unit slots) must be the same. Any change to one address will also be made automatically to the other by the software. Alarm is the provisioned alarm level of the non-service affecting (NSA) OC-12 line AIS and has the following values:

- `cr` Critical alarm
- `mj` Major alarm
- `mn` Minor alarm
- `na` Not alarmed, but reported (default)

If an attempt is made to execute this command, when a mix of incompatible OLIU packs exists in Main, the request will be denied with the following message:

```
SNVS
/* Status, Not in Valid State */
/* Both main slots must be equipped with compatible OLIU packs. */
```

DDM-2000 User/Service Manual at 11-406

BBF2B TGS circuit packs. As long as the incoming quality level number is at or greater than the provisioned level, AIS will be transmitted. This parameter is listed in ascending quality order and may have one of the following values:

level5 This is the default value. Send DS1 AIS for incoming quality level 5 (K2: Internal Clock, S1: Traceable SONET Clk) or greater (that is, quality level 6 or 7).

level4 Send DS1 AIS for incoming quality level 4 (K2: Stratum 3, S1: Traceable Stratum 3) or greater.

level3 Send DS1 AIS for incoming quality level 3 (K2: Stratum 2, S1: Traceable Stratum 2) or greater.

level2 Send DS1 AIS for incoming quality level 2 (K2: Sync Quality Unknown, S1: Sync Trace Unknown) or greater.

auto SyncAutoreconfiguration allows the system to choose the best timing source to use when it is provisioned for Line Timing. The synchronization source selection is based on the synchronization messages received from the available timing (synchronization) sources. Automatic Protection Switching takes place to the standby timing source when the active source fails. The switch is nonrevertive, and there will not be an automatic switch back to the former timing reference.

When SyncAutoreconfiguration is enabled, the system automatically reconfigures between line timing sources **main** and **fn-c** in linear systems and **main-1** and **main-2** in ring systems.
In ring releases, **fn-c** will also be a source option. Use the **switch-sync** command to manually switch to the other timing source.

enabled SyncAutoreconfiguration is active.

disabled SyncAutoreconfiguration is not active (default).

If hardware provisioning switches are set for FreeRunning timing mode, execution of this command will be denied with the following message:

```
SNVS
/* Status, Not in Valid State */
/* System provisioned for free-running. */
```

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Each SONET layer has a set of overhead bytes as shown in Figure A-4. These bytes carry information used by various network elements.

- **Section Overhead** contains information that is used by all SONET equipment including repeaters.
- **Line Overhead** is used by all SONET equipment except repeaters.
- **Path Overhead** is carried within the payload envelope.
  - **STS-1 path overhead** remains with the STS-1 SPE until its asynchronous signal is extracted (for example, DS-3) or until its individual VT1.5 signals are demultiplexed.
  - **VTN (N= 1.5, 2, 3, or 6) path overhead** remains with the VTN until its asynchronous signal is extracted.

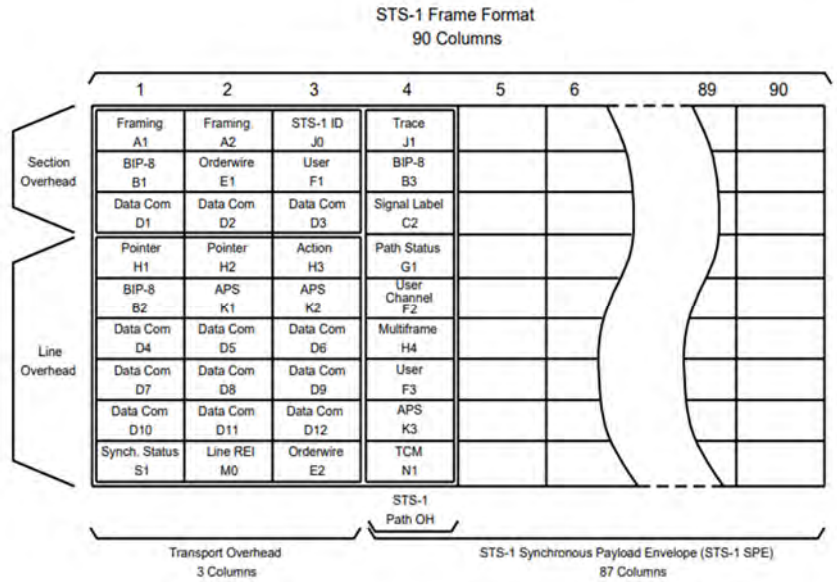


Figure A-4. SONET Frame Format

SONET Frame Structure

The following pages provide more detailed information on the function of various overhead bytes for each SONET layer.

Section Overhead

- Framing (A1, A2)
  - Provides framing for each STS-1.
- STS-1 ID (J0)
  - Provides the order of appearance in a byte-interleaved STS-*N* frame; for example, STS-1 #1, STS-1 #2.....STS-1 #48. In future applications, this byte will provide a section trace function. For information on STS-*N* signals, see the "Higher Rate Transport" part of this section.
- Section Bit-Interleaved Parity (BIP-8) (B1)
  - Provides SECTION performance monitoring and is calculated over all bits of the previous STS-*N* frame. Defined only for STS-1 #1 of an STS-*N* signal.
- Section Order Wire (E1)
  - Provides a local order wire for voice communication channel between section terminating network elements, such as repeaters. Defined only for STS-1 #1 of an STS-*N* signal.
- Section User Channel (F1)
  - Set aside for the user's purpose. Defined only for STS-1 #1 of an STS-*N* signal.
- Section Data Communications Channel (D1, D2, D3)
  - Is a 192 kb/s message-based channel. Used for alarms, maintenance, control, monitoring, and other communication needs between section terminating equipment. Defined only for STS-1 #1 of an STS-*N* signal.

Line Overhead

- Line Pointer (H1, H2)
  - Two bytes indicate the offset in bytes between the pointer action byte (H3) and the first byte (J1) of the STS-1 synchronous payload envelope (SPE).
- Pointer Action (H3)
  - One byte is allocated for frequency justification.
- Line Bit-Interleaved Parity (BIP-8) (B2)
  - This byte is for line performance monitoring. This byte is provided in all STS-1 signals within an STS-*N* signal.
- Line Automatic Protection Switching (APS) (K1, K2)
  - Two bytes used for APS signaling between line level entities. In addition, bits 6, 7, and 8 of K2 are used for line alarm indication signal (AIS) and line far-end receive failure (FERF). Defined only for STS-1 #1 of an STS-*N* signal.
- Line Data Communications Channel (D4 - D12)
  - Is a 576 kb/s message-based channel.
- Synch. Status (S1)
  - In STS-1 #1, the S1 byte is for synchronization status messages, and only bits 5 through 8 are used.
- Line REI (M0)
  - The M0 byte is for STS-1 line far-end block error (FEBE), and only bits 5 through 8 are used.
- Line Orderwire (E2). Defined only for STS-1 #1 of an STS-*N* signal.
  - One byte is allocated to be used as an express orderwire between line terminating equipment.

Path Overhead

There are two types of path overheads:

- STS-1 path overhead
- VT path overhead.

STS-1 Path Overhead

The STS-1 path overhead is assigned to and remains with the STS-1 SPE until the payload is extracted and is used for functions that are necessary to transport all synchronous payload envelopes.

- STS-1 Path Trace (J1)
  - Repetitively transmits a 64 byte, fixed length, string so that an STS-1 path receiving terminal can verify its continued connection to the intended transmitter.
- STS-1 Path Bit-Interleaved Parity (BIP-8) (B3)
  - Provides each STS-1 path performance monitoring. This byte is calculated over all bits of the previous STS-1 SPE before scrambling.
- STS-1 Path Signal Labels (C2)
  - Indicates the construction of the STS-1 SPE. A value of 00000000 indicates an unequipped STS-1 SPE. Values for various payload mappings are defined in TR-NWT-000253, Issue 2.
- STS-1 Path Status (G1)
  - Conveys the STS-1 path terminating status, far end block errors (FEBE), and yellow alarm signal conditions back to an originating STS-1 path terminating equipment.
- STS-1 Path User Channel (F2, F3)
  - User communication channel between Path elements.
- VT Multiframe Indicator (H4)
  - Provides a general multiframe indicator for VT-structured payloads.
- STS-1 Path Automatic Protection Switching (K3)
  - Path Automatic Protection Switching
- TCM - Tandem Connection Maintenance (N1)
  - Bits 1-4 used for incoming error monitoring. Bits 5-8 used as communications channel.

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Protection Line

As defined by the SONET standard, the protection line is the pair of fibers (one transmit and one receive) that carry the SONET APS channel (K1 and K2 bytes in the SONET line overhead). On a DDM-2000 OC-3 system, a *protection* line is a pair of fibers that terminate on an OLIU circuit pack in the `main-2`, `fn-a-2`, `fn-b-2`, or `fn-c-2` slot. (See "Service Line.")

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Unidirectional

A protection switching mode in which the system at each end of an optical span monitors both service and protection lines and independently chooses the best signal (unless overridden by an equipment failure or by an external request, such as a forced switch or lockout). In a system that uses unidirectional line switching, both the *service* and *protection* lines may be *active* simultaneously, with one line carrying traffic in one direction and the other line carrying traffic in the other direction. The K1 and K2 bytes in the SONET line overhead are used to convey to the far end which line the near end receiver has chosen, so that an "active" indication may be made at the far end.

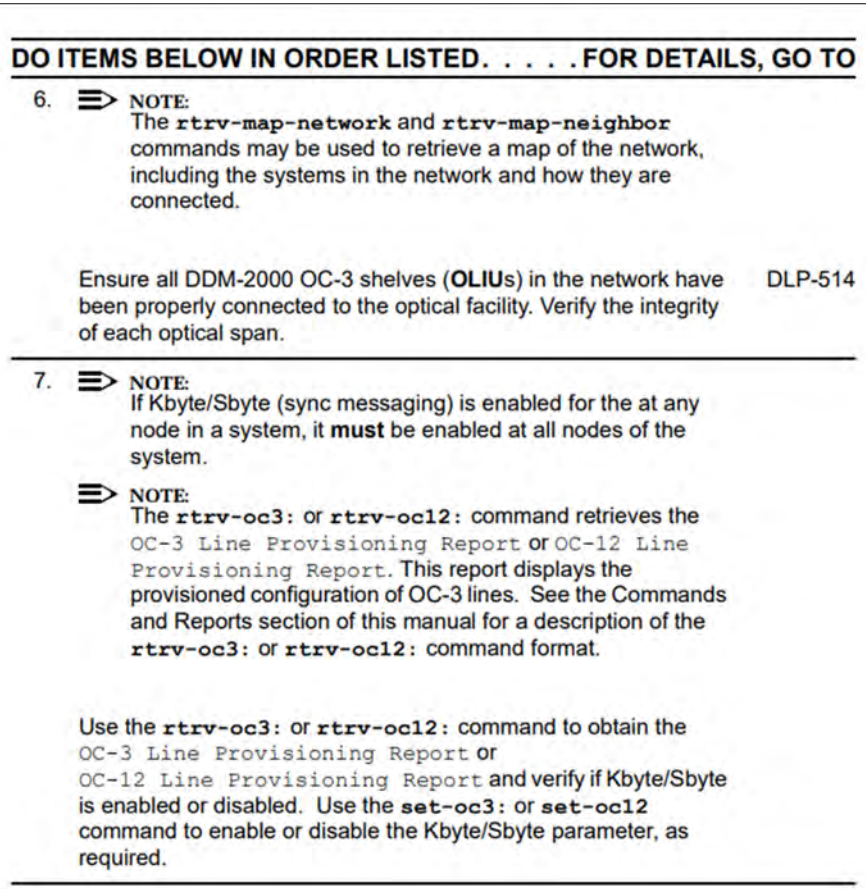
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Table A – DDM-2000 OC-3 Parameters Provisionable Via the CIT

Parameter	Range	Default (Note 1)	Command (Note 2)
Date	current value	70-01-01	set-date
Time	current value	00:00:00	set-date
Target ID (system name)	20 characters	LT-DDM-2000	set-ne
Remote NE Status	enabled,disabled		set-ne
Alarm Group	1-255	255	set-ne
Alarm Gateway NE	yes,no	no	set-ne
Shelf number	1-8	1	set-ne
Idle channel signal	STS Uneqpd./AIS insert	AIS	set-ne
	VT Uneqpd./AIS insert	AIS	
CO/RT select	CO, RT	RT	set-ne
CIT page length	0 (pager off), 3-150 rows	24	set-link
PM thresholds	See PM Table	-	set-pmthres
Alarm holdoff delay	0-30 sec	2	set-attr-alm
Alarm clear delay	0-30 sec	15	set-attr-alm
Power minor almn. level	MN, MJ	MN	set-attr-alm
OC1 degrade threshold	10^{-5} to 10^{-9}	10^{-6}	set-oc1
AIS almn. level of NSA OC-1			
Line AIS	CR, MJ, MN, NA	NA	set-oc1
OC3 degrade threshold	10^{-5} to 10^{-9}	10^{-6}	set-oc3
Sync messaging	K byte, S byte, disabled	K byte	set-oc3
AIS almn. level of NSA OC-3			
Line AIS	CR, MJ, MN, NA	NA	set-oc3
DccMode	distinct,identical	distinct	set-oc3
Application	0x1,1+1	1+1	set-oc3
OC12 degrade threshold§§§	10^{-5} to 10^{-9}	10^{-6}	set-oc12
Sync messaging§§§	K byte, S byte, disabled	K byte	set-oc12
AIS almn. level of NSA OC-12			
Line AIS§§§	CR, MJ, MN, NA	NA	set-oc12
DccMode	distinct,identical	distinct	set-oc12
STS-1 path signal			
degrade threshold†††	10^{-5} to 10^{-9}	10^{-6}	set-sts1
Signal fail alarm threshold	10^{-3} to 10^{-6}	10^{-3}	set-sts1
NSA STS-1 path AIS			
alarm level	MN, NR	MN	set-sts1
SA STS-1 path AIS			
alarm level	CR, MN, NA, NR	MN	set-sts1
STS-1 channel state***	NMON, AUTO‡	AUTO	set-state-sts1
OC-1 line state‡‡‡	NMON, IS	IS	set-state-oc1

See notes and footnotes at end of table.

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DO ITEMS BELOW IN ORDER LISTED. . . . . FOR DETAILS, GO TO

6. ⇒ **NOTE:**
The **rtrv-map-network** and **rtrv-map-neighbor** commands may be used to retrieve a map of the network, including the systems in the network and how they are connected.

Ensure all DDM-2000 OC-3 shelves (**OLIUs**) in the network have been properly connected to the optical facility. Verify the integrity of each optical span. DLP-514

7. ⇒ **NOTE:**
If Kbyte/Sbyte (sync messaging) is enabled for the at any node in a system, it **must** be enabled at all nodes of the system.

⇒ **NOTE:**
The **rtrv-oc3:** or **rtrv-oc12:** command retrieves the `OC-3 Line Provisioning Report` or `OC-12 Line Provisioning Report`. This report displays the provisioned configuration of OC-3 lines. See the Commands and Reports section of this manual for a description of the **rtrv-oc3:** or **rtrv-oc12:** command format.

Use the **rtrv-oc3:** or **rtrv-oc12:** command to obtain the `OC-3 Line Provisioning Report` or `OC-12 Line Provisioning Report` and verify if Kbyte/Sbyte is enabled or disabled. Use the **set-oc3:** or **set-oc12** command to enable or disable the Kbyte/Sbyte parameter, as required.

	DO ITEMS BELOW IN ORDER LISTED . . . . .FOR DETAILS, GO TO 8. NOTE: If Sync Autoreconfiguration is enabled, Kbyte/Sbyte must also be enabled. NOTE: The **rtrv-sync:** command retrieves the Synchronization Report. This report displays the provisioning and operational information on the synchronization attributes of the DDM-2000. See the Commands and Reports section of this manual for a description of the **rtrv-sync:** command format. Use the **rtrv-sync:** command to obtain the Synchronization Report and verify if Sync Autoreconfiguration is enabled or disabled. Use the **set-sync:** command to enable or disable the Sync Autoreconfiguration parameter, as required. 9. NOTE: The section data communication channel (DCC), used for far end communications, must be enabled at each network element (shelf) for the end-to-end line test to work. Default condition for the DCC channel is "enabled". If it has been disabled, use the **set-fecom:** command **at each shelf** to enable far end communications. NOTE: The **rlgn** command can be used to log in to each shelf at optical span being tested. Perform end-to-end line test on all optical spans. Report any failures to the organization that installed the DDM-2000. DLP-515 10. Perform end-to-end DS1 transmission test in the **Mux** direction for each function unit group, if required. A. DS1 Single Ring Test in **Mux** Direction DLP-510 B. DS1 Dual Ring (DRI) Test in **Mux** Direction DLP-554 C. DS1 Single/Dual Homing Test in **Mux** Direction DLP-510 DDM-2000 TARP Release 13 at 223

DO ITEMS BELOW IN ORDER LISTED. . . . . FOR DETAILS, GO TO

22. **NOTE:**
If Sync Autoreconfiguration is enabled, Kbyte/Sbyte must also be enabled.

NOTE:
If Sync Autoreconfiguration is enabled at any line-timed OC-3 node in a ring, it **must** be enabled at all line-timed OC-3 nodes of a ring.

NOTE:
The **rtrv-sync:** command retrieves the `Synchronization Report`. This report displays the provisioning and operational information on the synchronization attributes of the DDM-2000. See the Commands and Reports section of 363-206-295, *DDM-2000 OC-12 Multiplexer, TARP Release 7, User/Service Manual—Volume I*, and 363-206-285, *DDM-2000 OC-3 Multiplexer, TARP Release 13 and Later, User/Service Manual—Volume I*, for a description of the **rtrv-sync:** command format.

Use the **rtrv-sync:** command to obtain the `Synchronization Report` and verify if Sync Autoreconfiguration is enabled or disabled. Use the **set-sync:** command to enable or disable the Sync Autoreconfiguration parameter, as required.

23. **NOTE:**
Two or more shelves in the same network **cannot** have the same system name or TID (set by the **set-ne:** command).

Verify no duplicate TID settings exist. The **rtrv-ne:** command may be used at each shelf in the network to display settings. If duplicates exist, determine new settings and use the **set-ne** command to make new settings.

DDM-2000 TARP Release 13 at 254-255

DO ITEMS BELOW IN ORDER LISTED. . . . . FOR DETAILS, GO TO

Use the **ent-crs-vt1:** or **ent-crs-sts1:** command at the new shelf to make all required *pass-through* cross-connections (for example, **ent-crs-vt1:m-1-1-1,m-1-1-1** or **ent-crs-sts1:m-1,m-1**). Pass-through cross-connections must be made at the new shelf to correspond to each terminating cross-connection present on every shelf in the ring network. (See Figure 1.)

9. **NOTE:**
If Kbyte or Sbyte (sync messaging) is enabled for the **main-1** and **main-2** optical interfaces at any node in a ring, it **must** be enabled at all nodes of the ring.

NOTE:
The **rtrv-oc3:** or **rtrv-oc12:** command retrieves the `OC-3 Line Provisioning Report` or `OC-12 Line Provisioning Report`. This report displays the provisioned configuration of OC-3 or OC-12 lines. See the Commands and Reports section of this manual for a description of the **rtrv-oc3:** or **rtrv-oc12:** command format.

Use the **rtrv-oc3:** or **rtrv-oc12:** command to obtain the `OC-3 Line Provisioning Report` or `OC-12 Line Provisioning Report` and verify if Kbyte/Sbyte is enabled or disabled. Use the **set-oc3:** or **set-oc12:** command to enable or disable the Kbyte/Sbyte parameter, as required.

DO ITEMS BELOW IN ORDER LISTED . . . . .FOR DETAILS, GO TO

10. **NOTE:**
If Sync Autoreconfiguration is enabled, Kbyte/Sbyte must also be enabled.

NOTE:
If Sync Autoreconfiguration is enabled at any line-timed node in a ring, it **must** be enabled at all line-timed nodes of a ring.

NOTE:
The **`rtrv-sync:`** command retrieves the `Synchronization Report`. This report displays the provisioning and operational information on the synchronization attributes of the DDM-2000. See the Commands and Reports section of this manual for a description of the **`rtrv-sync:`** command format.

Use the **`rtrv-sync:`** command to obtain the `Synchronization Report` and verify if Sync Autoreconfiguration is enabled or disabled. Use the **`set-sync:`** command to enable or disable the Sync Autoreconfiguration parameter, as required.

11. **WARNING:**
Unterminated optical connectors may emit invisible laser radiation. Eye damage may occur if beam is viewed directly or with improper optical instruments. Avoid direct exposure to the beam.

CAUTION:
An automatic protection switch service hit may occur when the correct optical fibers are cut. Cutting the wrong fiber lines will cause a service interruption.

At the point where the new DDM-2000 shelf will be added, use local procedures to cut the two fiber lines connecting existing shelves and condition the fiber for connection to the new shelf.

DDM-2000 TARP Release 13 at 814

set-oc3	Sets the characteristics of an OC-3 line pair. Sets the signal degrade threshold of the OC-3 line as a bit error rate (BER). Specifies if sync message signaling uses kbyte or sbyte or is enabled or disabled. Specifies if the concatenation mode (concat) of the OC-3 line is to be independent STS-1 channels or an sts-3c channel.
set-oc12	Sets the characteristics of an OC-12 line pair. Sets the signal degrade threshold of the OC-12 line as a bit error rate (BER). Specifies if sync message signaling uses kbyte or sbyte or is enabled or disabled.
set-ow	Sets the orderwire routing for the network element.
set-state-oc1	Sets the state of OC-1 line(s) to be monitored (IS) for a good signal or not monitored (NMON).
set-state-ec1	Sets the state of a low-speed EC-1 port to be automatically monitored (AUTO) for a good signal or not monitored (NMON).
set-state-t1	Sets the state of a low-speed port to be automatically monitored (AUTO) for a good signal or not monitored (NMON).
set-state-t3	Sets the state of a DS3 port to be automatically monitored (AUTO) for a good signal or not monitored (NMON).
set-state-sts1	Sets the state of a STS-1 channel to be automatically monitored (AUTO) for a good signal or not monitored (NMON).
set-state-vt1	Sets the state of a VT1.5 channel to be automatically monitored (AUTO) for a good signal or not monitored (NMON).
set-sts1	Sets the signal degrade characteristics of an STS-1 channel.
set-t1	Sets the characteristics of a DS1 port.
set-t3	Sets the characteristics of a DS3 port.
set-vt1	Sets the signal degrade characteristics of a VT1.5 channel.
set-x25	Sets the packet size of X.25 link to either 128 or 256.

DDM-2000 TARP Release 13 at 1209-1212

Sync Messaging
Change Kbyte to Sbyte

1. NOTE:
   This procedure may be used to change Kbyte sync messaging to Sbyte sync messaging.

   Use **rtrv-alm:** command to verify that there are no alarms or protection switches present on the system.

2. NOTE:
   To minimize the amount of time that DDM-2000 shelves are in holdover mode when upgrading a ring network from Kbyte to Sbyte messages, it is recommended that you first upgrade the node(s) farthest away from the external timing source, then proceed to nodes closer to the timing source. For example, if all the line timed nodes in the network shown in Figure 1 had their *Sync Source (src)* set to *main1*, the farthest node from the external timing source would be Node D.

   NOTE:
   Note that in Figure 2, if Node B is changed to Sbyte first, then Node C will go into holdover. Note that in Figure 3, if Node D is changed to Sbyte first, then Node C and Node B, none of the nodes will go into holdover.

   Use the **rtrv-sync:/set-sync:** command at each node in the network to display/set the synchronization source.

3. Use **rtrv-oc3:/set-oc3:** command to verify/enable sync messaging (kbyte) at each node.

4. Determine the farthest node from the external timing source.

5. Use **set-oc3:syncmsg=***Sbyte* command to enable Sbyte sync messaging at each node, starting from the node furthest from the external timing source.

6. Use the **rtrv-sync:** command to display the provisioning and operational information of the synchronization interface.

7. **STOP. YOU HAVE COMPLETED THIS PROCEDURE.**

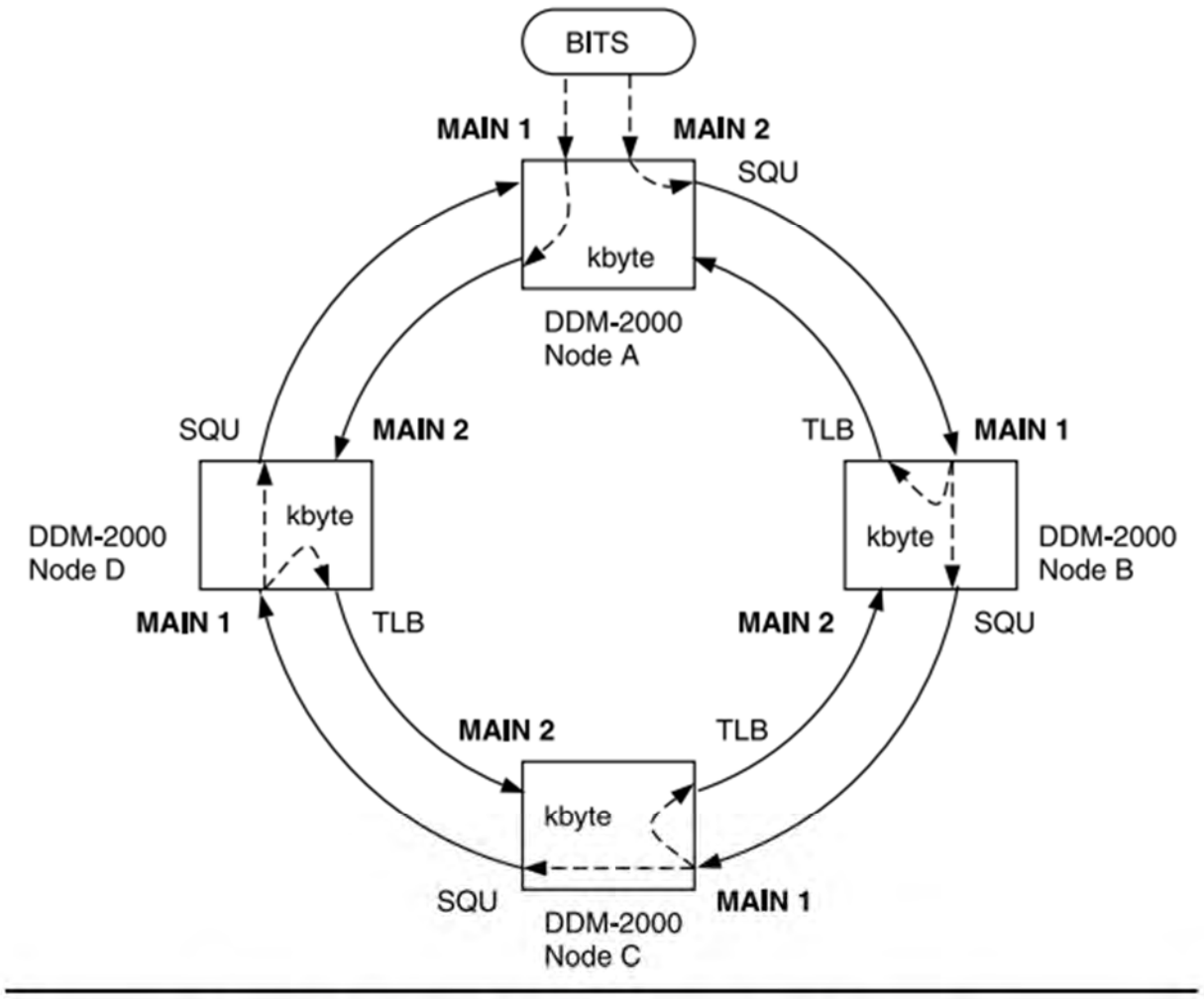


Figure 1 – Normal OC-3 Ring Using Kbyte Messaging

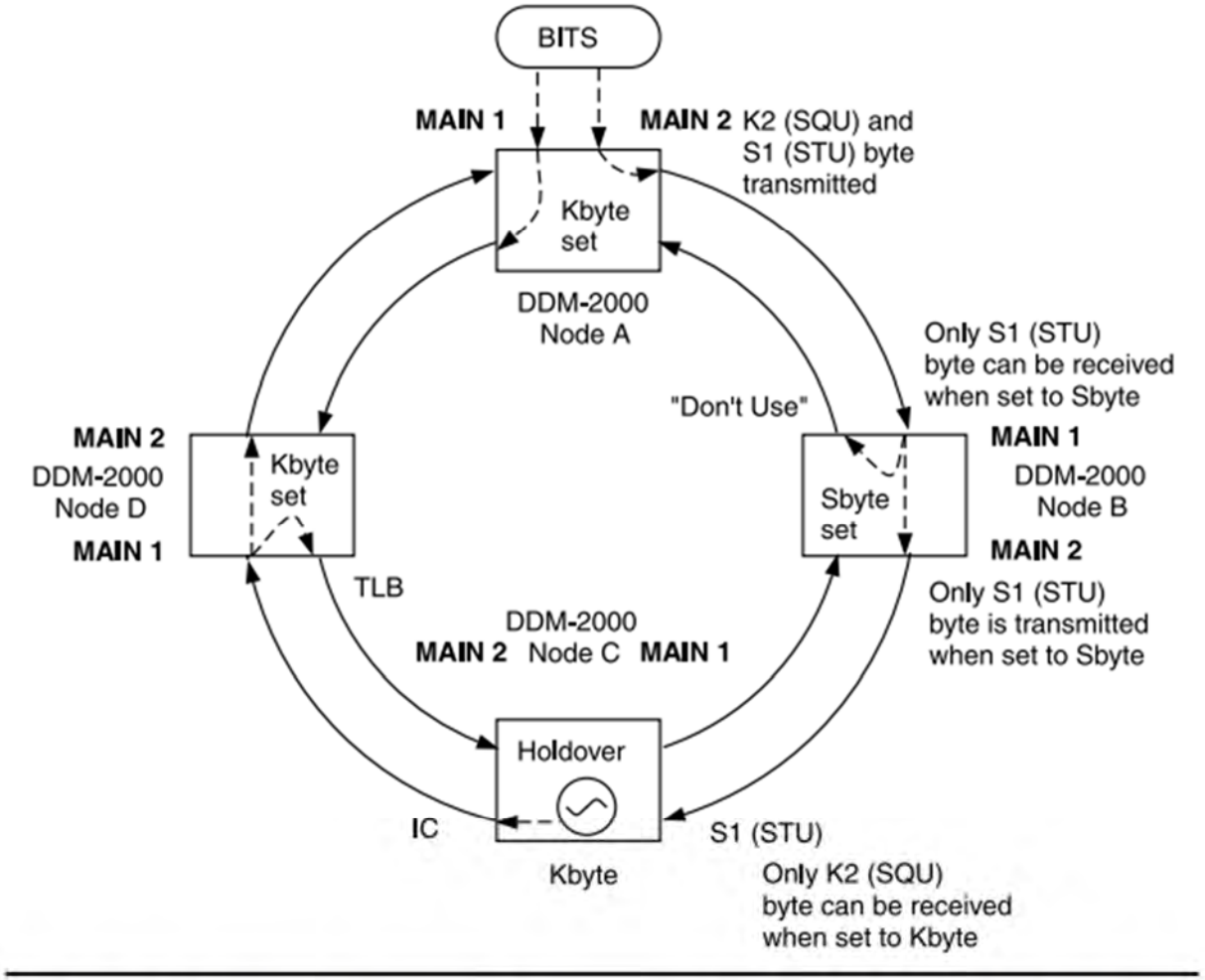


Figure 2 – Abnormal Sequence of Changing Kbyte to Sbyte - One Node in Holdover

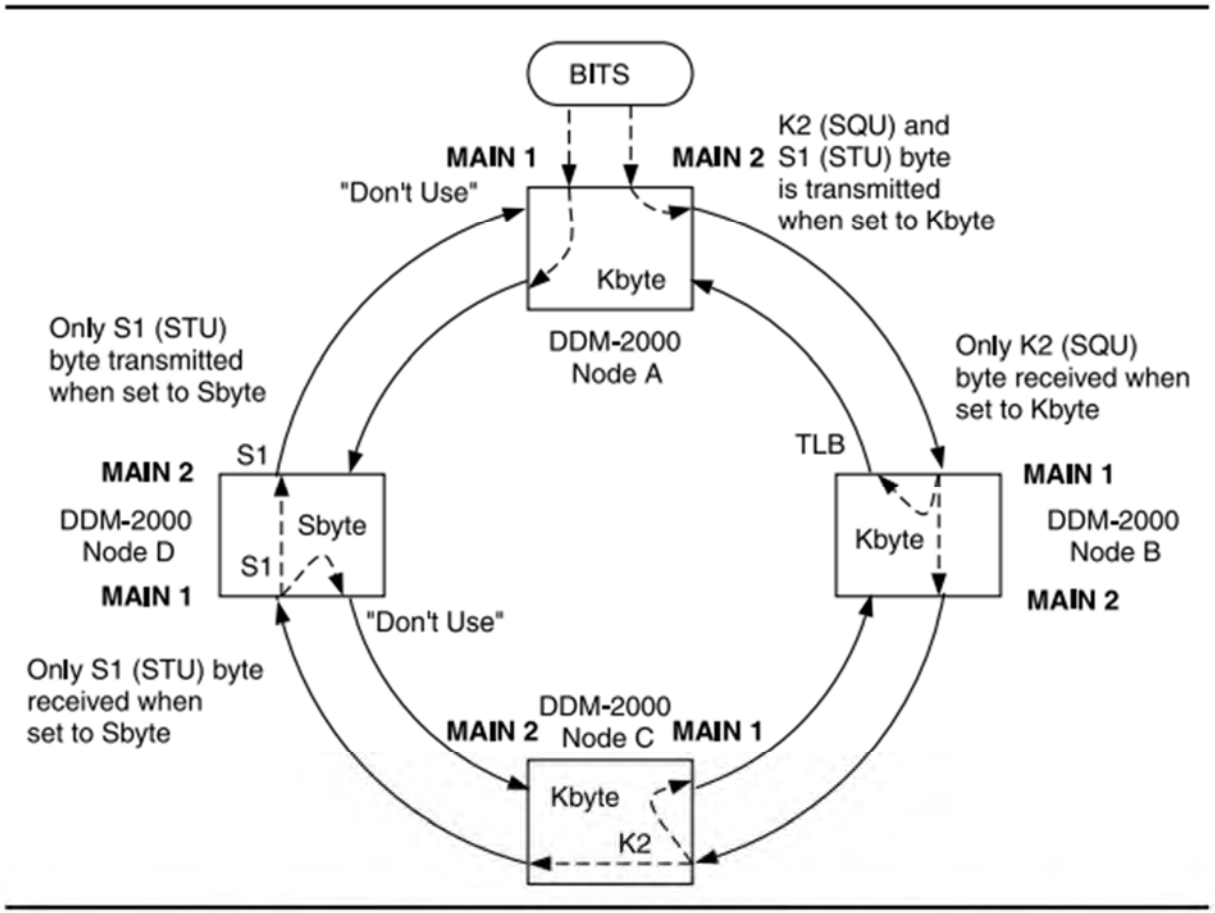


Figure 3 – Normal Sequence of Changing Kbyte to Sbyte

DDM-2000 FiberReach Manual at 535

The output parameters are:

`Line Address` Address of the OC-3 line.

`Signal Degrade Threshold`
This is the bit error rate (BER) threshold shown as a logarithm to the base 10. The value of *n* is an integer with a range of -5 through -9 corresponding to BERs of 10^{-5} through 10^{-9}, respectively.

`Sync Message` This parameter indicates the type of synchronization messaging that has been provisioned for that OC-3 optical interface by the **set-oc3** command. The valid values for this parameter are `Kbyte` (default value), `Sbyte`, and `disabled`. The sync messages use the K2 byte or the S1 byte in the SONET line overhead to determine synchronization quality.

`AIS Alarm` This parameter specifies the alarm level of a non-service-affecting OC-3 line AIS failure condition. The valid values are:

cr Critical alarm

mj Major alarm

mn Minor alarm

na Not alarmed, but reported (default).

RELATED COMMANDS

rtrv-sync

set-oc3

DDM-2000 FiberReach Manual at 589-590

`Sync Message Information`

This heading identifies the section of the report where input and output messages used to determine the timing source quality are listed. This section of the report is available only if the `kbyte` message parameter is set to **`enabled`**.

When the shelf is equipped with 28-type OLIUs (in FiberReach Release 2.2 and later), this section of the report is available only if any of the optical interfaces have been provisioned for `kbyte` (default) or `Sbyte` sync messaging (using the **`set-oc3`** command if equipped with 28-type OLIUs in Main unit slots).

`OC-N Line`

This parameter identifies the addresses of optical interfaces that can carry sync messages.

`Input Message`

`disabled`	Indicates that the field is not applicable (for example, if synchronization messaging is disabled).
`?`	Indicates that the message is not readable (for example, due to a line failure).

This column identifies the `Kbyte` input message received on each optical interface line, and may have one of the following values:

`Don't Use`	The interface is not suitable for synchronization timing (Quality Level 7).
`Timing Looped Back`	The network element connected to this interface is line-timed from it (Quality Level 7).
`Stratum 4`	The interface is receiving timing from a Stratum 4 clock source (Quality Level 6).
`Internal Clock`	This interface is receiving timing from a system in holdover or free running (Quality Level 5).
`Stratum 3`	The interface is receiving timing from a Stratum 3 clock source (Quality Level 4).

`Stratum 2` The interface is receiving timing from a Stratum 2 clock source (Quality Level 3).

`Sync Quality Unknown` This interface is receiving timing from a good quality clock source (Quality Level 2).

`Stratum 1` The interface is receiving timing from a Stratum 1 clock source (Quality Level 1).

`Output Message`
This identifies the output message sent out on each OC-N interface line. The valid values for this parameter are the same as those listed for `Input Message`.

`Type` In FiberReach Release 2.2 (if equipped with 28-type OLIUs in Main unit slots) and later releases, this column identifies the type of sync messaging the optical interface was provisioned for using the **`set-oc3`** command. The valid values are:

`Kbyte`

`Sbyte`

`disabled`

NOTE:
For OC-1 interfaces, this column will only display `Kbyte`.

`Sync Autoreconfiguration`
This capability allows the system to choose the best timing source to use when it is provisioned for line timing. The valid values are **`enabled`** and **`disabled`**.

DDM-2000 FiberReach Manual at 632-633

NAME

set-oc3: Set OC-3 Characteristics

INPUT FORMAT

set-oc3::*Address*[:**dgr=***SignalDegradeThreshold*]
[,**syncmsg=***SynchronizationMessaging*][,**aisalm=***Alarm*];

DESCRIPTION

This command sets several characteristics (parameters) of a specified OC-3 line or line pair, using the 28-type OLIU. The 28-type OLIU is available in FiberReach Release 2.2 and later releases.

The input parameters are:

Address Address identifies the OC-3 line(s) or line pair(s).

If the shelf is equipped with 28-type OLIUs in Main unit slots (available in Release 2.2 and later), the only OC-3 valid addresses are:
main-{1,2,all}, all

dgr SignalDegradeThreshold specifies the signal degrade threshold as a BER in terms of a logarithm to the base 10. When this threshold is crossed, an alarm will be raised and automatic protection switching of the service line will be initiated. The value of this parameter has a range of -9 to -5. The default value is -6.
For ring releases, the signal degrade value for addresses of main-1 and main-2 *must* be the same. Therefore, any change to signal degrade for one address will automatically be made to the other by the software.

syncmsg Synchronization messaging allows timing to be reconfigured in a network upon a node or fiber failure. This parameter has one of the following values:

Kbyte This is the default value. When this option is selected, both K2 and S1 byte sync messages are transmitted, but only K2 byte is received and interpreted for sync messaging.

Sbyte When this option is selected, only the S1 byte is sent and received for sync messaging. K2 byte will always send a "Don't Use" message.

NOTE:
To minimize the amount of time that DDM-2000 is in holdover mode when upgrading a ring network from **Kbyte** to **Sbyte** messages, it is recommended that the user first upgrade the nodes farthest away from the external timing

source, and then proceed to nodes closer to the timing source.

`disabled` When this option is selected, interpretation of both K2 and S1 bytes will be disabled and hence a "Don't Use" message will be transmitted on both bytes at all times.

aisalm Alarm is the provisioned alarm level of the NSA OC-3 line AIS and has the following values:

- `cr` Critical alarm
- `mj` Major alarm
- `mn` Minor alarm
- `na` Not alarmed, but reported (default).

If an attempt is made to execute this command, when a mix of incompatible OLIU packs exists in Main, the request will be denied with the following message:

```
SNVS
/* Status, Not in Valid State */
/* Both main slots must be equipped with compatible OLIU packs. */
```

When input, this command will cause the following confirmation request to be displayed:

```
/* Caution! Alarm or maint. thresholds and sync messages
   are affected by this command.
   You have selected the set-oc3 command with these parameters:

   Address = x
   SignalDegradeThreshold = -n
   NonServiceAffectingAIS= value

Execute? (y/n or CANcel/DELete to quit) =
```

DDM-2000 FiberReach Manual at 171

Synchronization Provisioning Integrity

A welcome byproduct of synchronization messaging is the prevention of provisioning errors. Provisioned timing loops on the DDM-2000 FiberReach Multiplexers will be quickly detected through the synchronization messaging algorithm and prevented by forcing a shelf into holdover. The system can then be reprovisioned correctly.

Feature Details and Options

As mentioned previously, SONET synchronization messaging is used to communicate the quality of the subnetwork timing throughout the subnetwork. This is done using bits 1 through 3 of the K2 byte found in the SONET overhead. If a DDM-2000 FiberReach system is deriving timing from a given OC-*N* interface and synchronization messaging is enabled on that interface (Kbyte messages are enabled using the **`set-ocn`** user interface command or **`ent-rr`** TL1 command), the system interprets the received message to determine its internal timing status. The DDM-2000 FiberReach system also transmits over the particular OC-*N* interface, and all other OC-*N* interfaces that are enabled for synchronization messaging, the appropriate message indicating the quality of its timing and its active timing mode. Table 5-1 lists the associated internal timing status that is associated with synchronization messages received from the OC-*N* interface when synchronization messaging is enabled. The table lists the messages from low to high quality.

Table 5-1. Synchronization Messages Using K2 Byte

Received Message	Active Timing Mode
Don't Use	Holdover
Timing Looped Back (TLB)	Holdover
Stratum 4*	Holdover
Internal Clock (IC)	OK to use
Stratum 3*	OK to use
Stratum 2*	OK to use
Sync Quality Unknown (SQU)	OK to use
Stratum 1*	OK to use

* Presently, DDM Multiplexers cannot generate these messages, but they could be transmitted and supported for auto-reconfiguration if any of these are received by DDM-2000 Multiplexer.

DDM-2000 FiberReach Manual at 900-901

DO ITEMS BELOW IN ORDER LISTED . . . . . FOR DETAILS, GO TO

9.

NOTE:
If Kbyte or Sbyte (sync messaging) is enabled for the OC-3 **MAIN 1** and **MAIN 2(P)** optical interfaces at any node in the OC-3 ring, it **must** be enabled at all nodes in the OC-3 ring and in the **FUNCTION UNITS** slots of the host OC-12 shelf.

NOTE:
The **rtrv-oc3:** command retrieves the `OC-3 Line Provisioning Report`. This report displays the provisioned configuration of OC-3 lines. See the "Commands and Reports" section of 363-206-290, *DDM-2000 OC-12 Multiplexer, Release 5 and Higher, User/Service Manual — Volume I* and 363-206-280, *DDM-2000 OC-3 Multiplexer, Release 8 and Higher, User/Service Manual — Volume I* for a description of the **rtrv-oc3:** command format.

Use the **rtrv-oc3:** command to obtain the `OC-3 Line Provisioning Report` and verify if Kbyte/Sbyte is enabled or disabled. Use the **set-oc3:** command to enable or disable the Kbyte/Sbyte parameter, as required.

DO ITEMS BELOW IN ORDER LISTED . . . . FOR DETAILS, GO TO

10.

NOTE:
If Sync Autoreconfiguration is enabled, Kbyte/Sbyte must also be enabled.

NOTE:
If Sync Autoreconfiguration is enabled at any line-timed OC-3 node in a ring, it **must** be enabled at all line-timed OC-3 nodes of a ring.

NOTE:
The **rtrv-sync:** command retrieves the Synchronization Report. This report displays the provisioning and operational information on the synchronization attributes of the DDM-2000. See the "Commands and Reports" section of 363-206-290, *DDM-2000 OC-12 Multiplexer, Release 5 and Higher, User/Service Manual — Volume I*) and 363-206-280, *DDM-2000 OC-3 Multiplexer, Release 8 and Higher, User/Service Manual — Volume I*) for a description of the **rtrv-sync:** command format.

Use the **rtrv-sync:** command to obtain the Synchronization Report and verify if Sync Autoreconfiguration is enabled or disabled. Use the **set-sync:** command to enable or disable the Sync Autoreconfiguration parameter, as required.

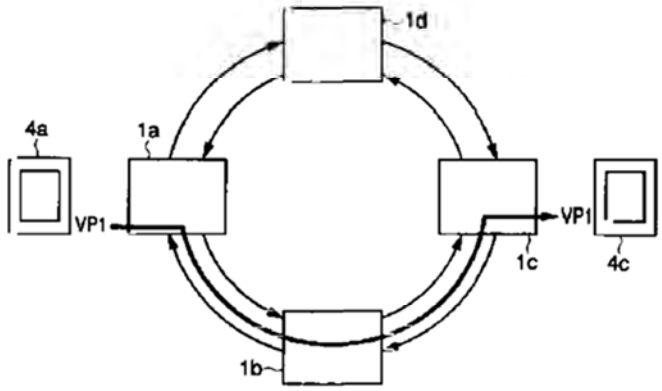
	Under at least the apparent claim scope alleged by Quicker Connections' Infringement Disclosures, Lucent 2000 Product Family in combination with (1) the knowledge of a person of ordinary skill in the art, alone or in further combination with (2) each (individually, as well as one or more together) of the references identified in element 1[a] of Exhibit D and F charts renders the claim, including the present limitation, obvious. Below are examples of such references. Omichi at Claim 2 ("The bifurcation insertion node according to claim 1, further comprising: processing means for determining whether or not a virtual path is affected by a ring link fault based on a location of the ring link where a fault has occurred stored in the first table, a ring link to be used as a working path set in the second table, and a route direction set in the route switching flag, and for causing the ring link communication means to transmit information in an opposite direction if the virtual path is affected, wherein the route selection method includes a first table provided for each virtual path for storing the location of the ring link where the fault has occurred, a second table provided for each virtual path and in which the ring link to be used as the working path is set, and a route switching flag provided for each virtual path and set to switch the direction of the route to be used as the working path.") Omichi at Claim 3 ("The bifurcation insertion node according to claim 2, wherein the second table and route switching flags of some virtual paths are set with all bits inverted.") Omichi at Claim 4 ("The bifurcation insertion node according to claim 2 or 3, wherein the numbers of the ring links used as working paths set in the second table are set to non-consecutive discrete numbers.") Omichi at [0012] ("[Means for Solving Problem] The bifurcation insertion node according to claim 1 is provided with a branch line link communication means for communicating information over the branch line link; ring link communication means for communicating information via the ring link, and route selection method for receiving notification of a ring link fault via the ring link communication means, and for causing the ring link communication means to transmit information in the opposite direction to a virtual path affected by the ring link fault.") Omichi at [0031]-[0032] ("[0031] FIG. 4 is a diagram explaining the virtual path protection path. A protection path is a virtual path that is used to avoid a fault that occurs on the ring network. In FIG. 4, a fault occurs in the

	ring link 2b between the bifurcation insertion node 1b and the bifurcation insertion node 1c, so a virtual path VP1, which is a protection path that does not pass through the ring link 2b, is used. [0032] A fault occurring in this ring link 2b is detected by the bifurcation insertion node 1b or 1c, and the occurrence of the fault is notified to the other bifurcation insertion nodes. The bifurcation insertion node 1a receiving the notification of the fault checks the virtual paths affected by the fault among the virtual paths from the branch line node 4a connected to the bifurcation insertion node itself, and transmits a frame 5 or an ATM cell 6 to the ring link 2d in the opposite direction for the virtual path affected by the fault to avoid the fault. That is, the bifurcation insertion node 1a avoids the fault by switching the route of the virtual path VP1 from the counterclockwise direction (working path) illustrated in FIG. 3 to the clockwise direction (protection path) illustrated in FIG. 4. The details of switching to the protection path will be described later.") Omichi at [0036]-[0038] ("[0036] FIG. 6(a) to FIG. 6(c) are diagrams for explaining the tables stored in the route information unit 9. The ring link fault table illustrated in FIG. 6(a) is a table for holding information on whether or not a fault has occurred in a ring link. This ring link fault table has a bit width equal to the maximum number of ring links in the ring network, and the bit numbers correspond to the ring link numbers. Each bit indicates that the corresponding ring link is not faulty when it is "0" and indicates that the corresponding ring link is faulty when it is "1." Therefore, when there is no fault, all bits in the ring link fault table are "0", but when a fault occurs in a ring link, the bifurcation insertion nodes 1a to 1d that receive the fault notification sets the content of the bit number corresponding to the ring link number where the fault occurred to "1." [0037] The used ring link table illustrated in FIG. 6(b) is a table set for each virtual path, and indicates the ring link to be used as the working path. This ring link table in use has a bit width equal to the maximum number of ring links in the ring network, and the bit number corresponds to the number of the ring link. Each bit indicates that the corresponding ring link is used as a protection path when it is "0", and indicates that the corresponding ring link is used as a working path when it is "1." [0038] The route switching flag illustrated in FIG. 6(c) is a flag that is set for each virtual path, and indicates whether the working path is clockwise or counterclockwise. When this route switching flag is "0", it indicates that the working path is clockwise, and when it is "1", it indicates that the working path is counterclockwise.") Omichi at [0044] ("[0044] When the ring link fault is removed, the bifurcation insertion node which detects that the fault has been removed notifies other bifurcation insertion nodes that the fault has been removed. The bifurcation insertion node that receives the notification of the fault removal sets the corresponding bit in the ring link fault table to "0." When all the bits in the ring link fault table are cleared, the virtual path that has

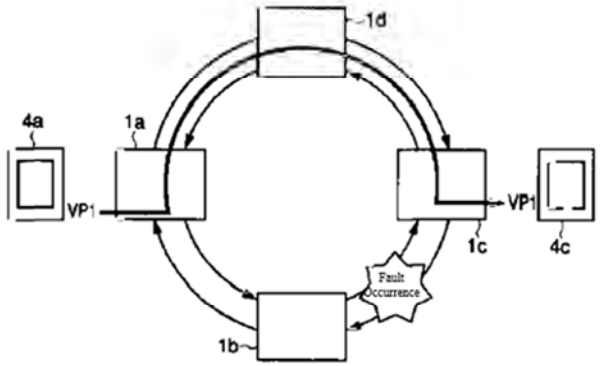
been switched to the protection path and is now in operation is switched to the working path, and the ring network operates as if it were completely fault-free.")

Omichi at Figure 3 and 4

[FIG. 3]

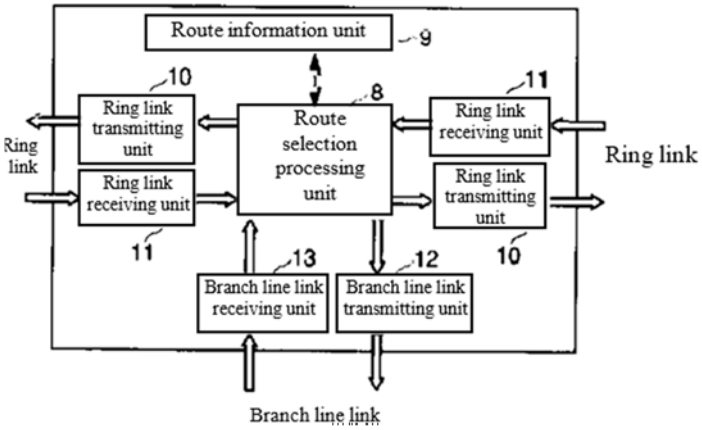


[FIG. 4]



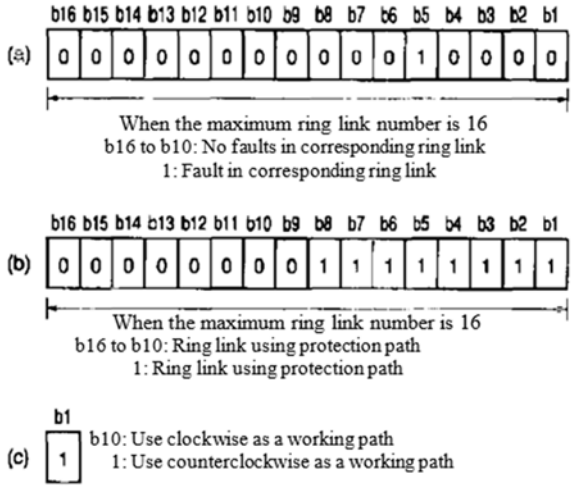
Omichi at Figure 5

[FIG. 5]



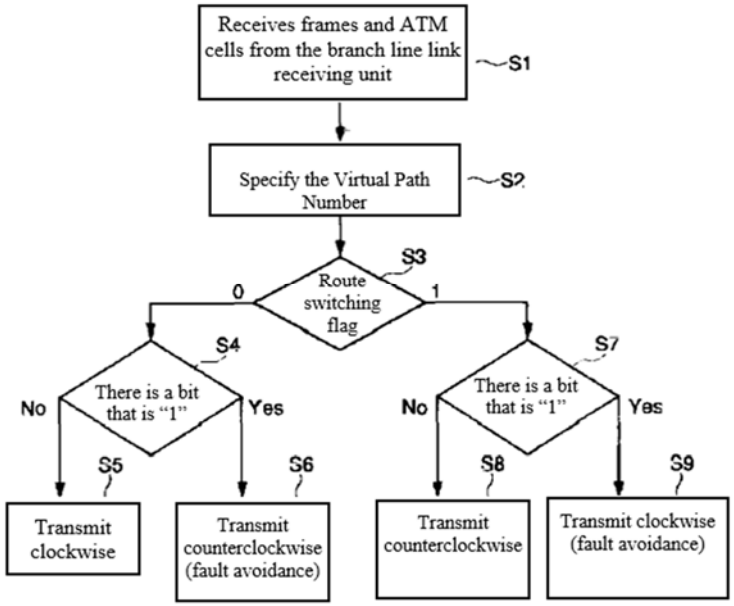
Omichi at Figure 6

[FIG. 6]



Omichi at 7

[FIG. 7]



Killat at Abstract ("The invention relates to a method, a structure and a communications network for transporting data packets, receive addresses being contained in said data packets. The communications network consists of linked bi-directional rings with so-called multi-nodes which switch between adjacent rings, and so-called single nodes which are arranged along the periphery of a ring as so-called add-drop multiplexers. The network is provided with a tree structure during initialization. The multi-nodes are the nodes of said tree structure and each branch consists of two segments which accommodate the add-drop multiplexers (2, 3, 5). All of the data packets follow the shortest paths in relation to said tree structure, and the routing information provided at the initialization stage is sufficient so that in the case of a breakdown in one segment only the single nodes of the segment and the at most two adjacent multi-nodes have to make new routing decisions. A multi-node is able to do so just from knowing the port connected to the defective segment, and the

	single node concerned is able to do so just from knowing which single nodes can still be reached in the direction of the defect.") Killat at 1 ("The invention relates to a method for constructing and operating a communications network according to the preamble of Claim 1, in which data packets are routed through the network together with receiver addresses in order to ultimately be removed from the network by the receiver by evaluating the receiver addresses. The invention further relates to a redundant communications network for transporting data packets according to the preamble of Claim 17. State-of-the-art routing algorithms assume that network nodes exchange information about the shortest routes to other nodes, if known, or the status of the connected lines. Based on this information, each node calculates the minimum distances to all possible destination nodes and the corresponding output port (cf. D.E. Comer: Internetworking with TPC/IP, Vol. 1, 3rd ed., Prentice Hall (1995)). Since the information is exchanged approximately every 30 seconds, the network can adapt to the failure of lines or nodes within this time horizon. It would be better to find a method that can consider and bridge failures in much shorter time intervals (~ 1 msec).") Killat at 2 ("The object of this invention is to provide a method for operating a communications network and a corresponding network which, when the network is initialized, already distributes all information on how data packets are to be routed in normal operation and in the event of an error. The main aim is to ensure that routing information does not have to be distributed in the network every time a connection is established or terminated. The invention minimizes connection setup times for connections under normal conditions as well as reconfiguration times in the event of an error.") Killat at 2 ("Along all lines, also called "segments", there are "single" nodes, which are designed as "add-drop" multiplexers: they can send in both directions of their segment and receive from both directions. They also feature a receive/transmit port for a terminal device to be connected. A single node removes a packet from the network if it recognizes an address assigned to it in the recipient address. To send, it refers to a routing table (or recognizes from the structure of the recipient address) to see which output port it should send the packet to.

	The multi-nodes that link the rings are assigned an address on each adjacent segment, via which the multi-node can be addressed. The multi-nodes must also be informed in the form of rules or tables to which segment a received packet should be forwarded. Multi-nodes can be used to switch redundant paths if a section of the route or one or more single nodes in a segment failed.") Killat at 3 ("During initialization, a table is created for each multi-node that specifies the output port through which a specific destination address can be reached. According to the invention, the routing is defined in such a way that – regardless of any meshing – the routing is always carried out along the tree structure. Since it is a tree structure with double lines, if one segment fails, this strategy only needs to be slightly modified by the two adjacent multi-nodes and the single stations of the affected segment, using the second intact segment of the same branch.") Killat at 3-4 ("Fig. 3 Single node (with segment prefix SP0 and suffix SS0) in normal operation; NP: user port; BP: leaf port; WP: root port; Fig. 4 Single node (with segment prefix SP0 and suffix SS0) and a failed segment SP0; not reachable: SSX > SS0 (SSX < SS0), where the information in parentheses in the diagrams refers to the case: SSx < SS0; Fig. 5 Multi-node, failed segment with prefix SPX; SB: segment bit, PP: port prefix, SP: segment prefix, SS: segment suffix. The index o refers to the multi-node in question. WP: root port, NP: user port.") Killat at Figure 3

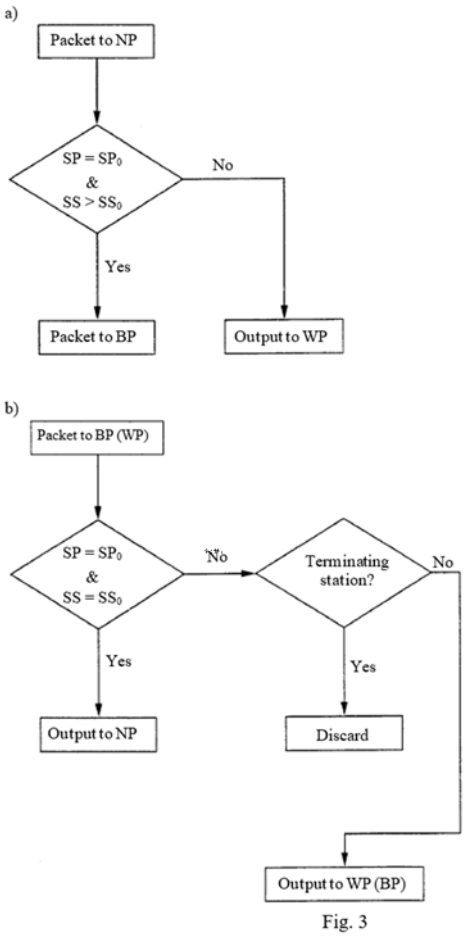


Fig. 3

Killat at Figure 4

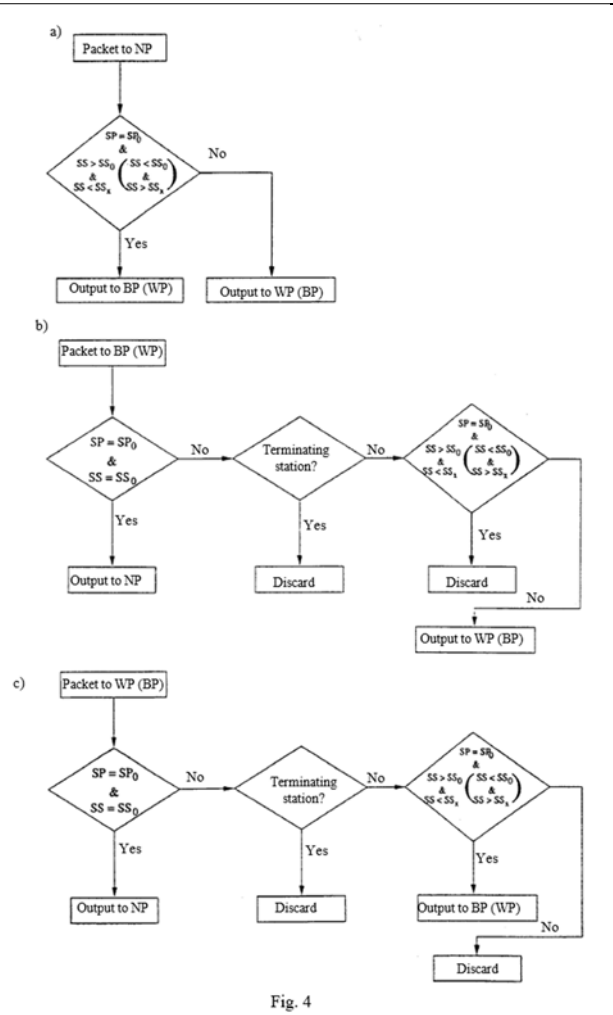


Fig. 4

Killat at Figure 5

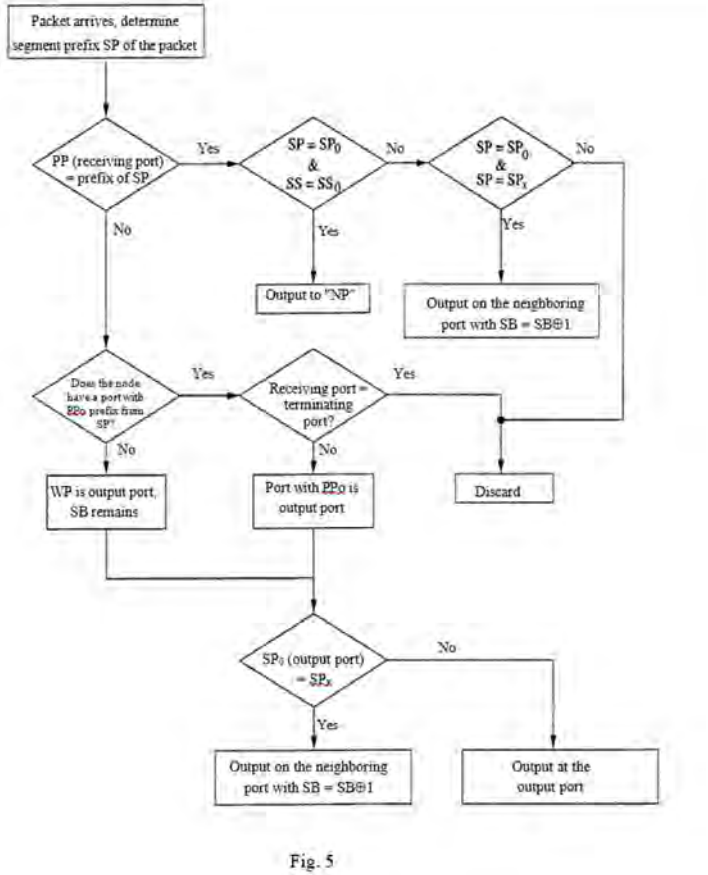


Fig. 5

Killat at 4 ("In the preferred version of the invention, the addresses are assigned in such a way that routing tables can be omitted because the address structure reflects the tree structure of the network. This situation is shown in Fig. 2, where the first 7 bits of the address of the single stations connected to this segment are indicated along the segments. This part of a node address (9 in Fig. 2), called the segment prefix SP, uniquely identifies a segment, for example segment 10. The first bit of an address, the segment bit SB, indicates whether the corresponding station is located on the left or right segment of a branch. Because of this left/right marking, neighboring multi-nodes must have a different sense of rotation when assigning address values, see Fig. 2:

multi-nodes with an even placing have the same direction of rotation as the root node, those with an odd placing, e.g. at positions 5 and 6, have the opposite direction.")

Killat at Figure 2

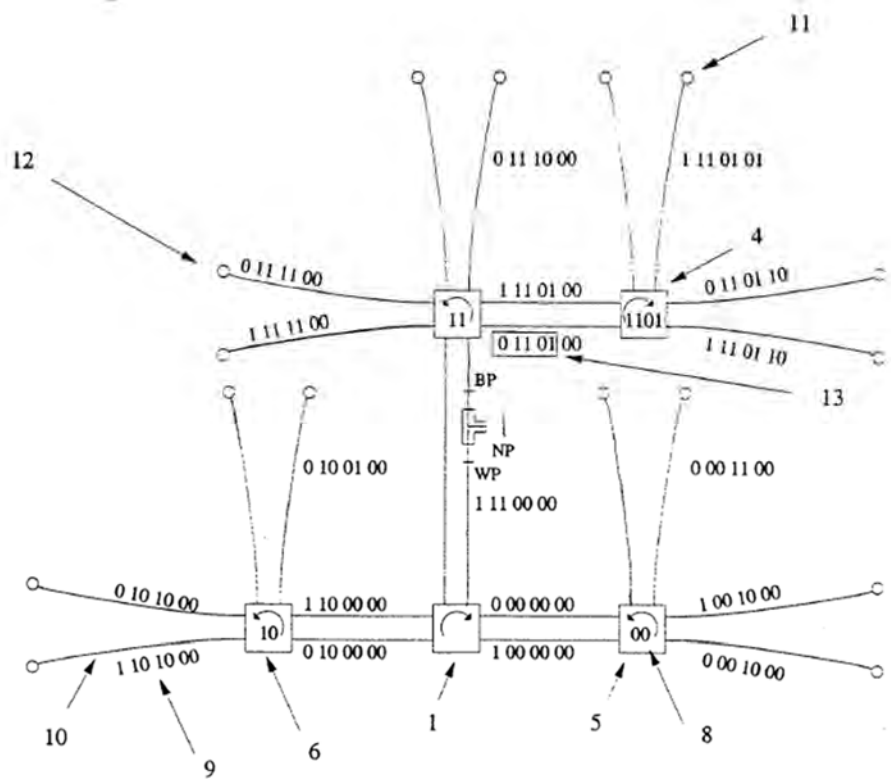


Fig. 2

Killat at 5-6 ("If there is a failure on the segment in question, two stations adjacent to the failure area register the loss of communication capability.
They communicate this loss to the network management using a special message. The network management informs the adjacent multi-nodes and the single nodes of the affected segment about the failure, which leads to the behavior outlined in Fig. 4 for the single nodes.

	One possible variant is that the affected stations could already receive and interpret the information addressed to the network management. This saves a delay equivalent to the duration of a signal round-trip.") Killat at 6 ("The port prefix PP (13 in Fig. 2) at a multi-node is the bit sequence consisting of the segment bit SB, the node identifier K resulting from the tree structure (cf. 8 in Fig. 2) and the Idn bit port identifier. Port prefix PP and prefix of the connected segment SP differ for nodes of non-maximum order by low-order zeros.") Killat at 7 ("The routing decisions to be made, which are described in Fig. 3-5 , can be implemented using simple comparator circuits that check subaddresses for equality or "greater than" relationships. Another implementation compatible with the present invention would be to create a routing table in the form of a RAM (random access memory) in which the correct output port is entered for each conceivable receiving address according to the rules laid down in Fig. 3-5. A further implementation under the invention would consist in identifying each connection by a connection identifier, communicating the relationship between the connection identifier and the destination address to all the nodes or all the nodes involved in the connection in a signaling phase, whereupon the nodes, after analyzing the destination address constructed according to the invention, would independently complete the routing table according to the specified rules.") Killat at 7-8 ("In ATM networks with a network structure according to the invention, the header field contains segment prefix SP, station suffix SS and a connection identifier of length r, whereby the maximum number of connections that can be processed via a single station is 2r. In an alternative implementation variant, the method is as described in Section 3, final paragraph : the network works with connection identifiers VPIs/VCIs (Virtual Path Identifier / Virtual Circuit Identifier). In a signaling phase, the relationship between VPI/VCI and the invention address reflecting the topology, is revealed so that the nodes can make the entries in the routing tables for VPIs/VCls according to the rules in Fig. 3-5.") Killat at Claim 1 ("1. Method for constructing and operating a communications network for transporting data packets, each of which contains receiver addresses that can be evaluated by a terminal device addressed by them, the network having networked bidirectional rings with multi-nodes connecting the rings to one another and single nodes arranged along the periphery of the network, characterized in that during initialization the network is formed in a tree structure in which the multi-nodes, which contain root ports directed towards a root

	node and one or more leaf ports, are designed as nodes of the tree structure and each branch of the tree structure consists of two segments receiving the single nodes, the single nodes containing a root port, a leaf port and one or more user ports, that in the event of a failure in a segment the routing decisions for the data packets are made by the single node of the segment and the multi-nodes immediately adjacent to the segment, the routing decision of a multi-node being made from the knowledge of the failed segment and the routing decision of a single node being made from the knowledge of the single nodes that can still be reached in the direction of the failure.") Killat at Claim 2 ("2. Method according to claim 1, characterized in that the routing decision of a multi-node is made solely from the knowledge of the failed segment and/or the routing decision of a single node is made solely from the knowledge of the single nodes still reachable in the failure direction.") Killat at Claim 4 ("4. Method according to claim 3, characterized in that the segment prefix has a substructure predetermined by the number of node levels of the tree underlying the network, the segment prefix indicating how to reach the address in question starting from the root node of the tree.") Killat at Claim 17 ("17. Communications network for transporting data packets, each of which contains receiver addresses that can be evaluated by an end device addressed by them, the network having networked bidirectional rings with multi-nodes connecting the rings to one another and single nodes arranged along the periphery of the network, in particular to implement a method under claim 1, characterized in that the network is formed in a tree structure in which the multi-nodes, which contain root ports directed towards a root node and one or more leaf ports, are designed as nodes of the tree structure and each branch of the tree structure consists of two segments receiving the single nodes, the single nodes containing a root port, a leaf port and one or more user ports, so that single nodes of a segment and the multi-nodes immediately adjacent to the segment are formed in such a way that, in the event of a segment failure, the routing decisions for the data packets are made by the single node of the segment and the multi-nodes immediately adjacent to the segment, the routing decision of a multi-node being made from the knowledge of the failed segment and the routing decision of a single node being made from the knowledge of the single nodes that can still be reached in the direction of the failure.") Killat at Claim 20 ("20. Network according to claim 19, characterized in that the segment prefix has a substructure predetermined by the number of node levels of the tree underlying the network, the segment prefix indicating how to reach the address in question starting from the root node of the tree.")

	Killat at Claim 22 (“22. Network according to claims 17, 18 or 19, characterized in that the addresses are supplemented by a connection identifier which allows different connections to a destination station to be distinguished.”)

1[b] for a given data flow to be conveyed through the network from a source node to a destination node, constructing a specific mask indicating the segments on a desired path of the flow by assigning a respective specific mask bit to each of the segments, indicating whether the flow was to be conveyed over the segment had occurrence of the segment been operational before the fault; and	Lucent 2000 Product Family discloses for a given data flow to be conveyed through the network from a source node to a destination node, constructing a specific mask indicating the segments on a desired path of the flow by assigning a respective specific mask bit to each of the segments, indicating whether the flow was to be conveyed over the segment had occurrence of the segment been operational before the fault. For example, Lucent 2000 Product Family discloses K bytes and S bytes, which indicate whether a particular action needs to be taken to route network traffic, including whether a failure has occurred. Thus, at least under the claim scope alleged by Quicker Connection's Infringement Disclosures, this limitation is met. To the extent that Lucent 2000 Product Family is not found to meet this limitation, it would have been obvious to a person of ordinary skill in the art as explained below. DDM-2000 User/Service Manual at 1-11 **Release 8.1** is a linear release supporting *MegaStar*® 2000 SONET Radio. Release 8.1 requires the BBG8/BBG8B SYSCTL system controller and BBG9 or new BBG10 OHCTL overhead controller. Release 8.1 may be used for non-*MegaStar* 2000 applications when S1 byte synchronization messaging is desired. Release 8.1 will interwork with Releases 7.2 or 9.0. ■ New Applications: — *MegaStar* 2000 SONET Radio. Part of Lucent Technologies and Harris-Farinon *MegaStar* 2000 Radio system supporting mixed fiber and radio topologies. *MegaStar* applications require the BBG10 OHCTL. ■ New Features: — S1 Byte synchronization messaging. Uses the S1 byte of the SONET overhead to pass timing status information to different nodes in a loop-timed network. Synchronization messaging mode (S1 byte or K2 byte) is provisionable on a per OC-N basis. — CPro-2000, ITM SNC. Release 8.1 is supported by CPro-2000 Releases 5.0, 6.0, and ITM SNC Release 4.0. DDM-2000 User/Service Manual at 1-14

- New Features:
  - S1-byte Synchronization Messaging. Uses the S1 byte of the SONET overhead to pass timing status information to different nodes in a loop-timed network. Synchronization messaging mode (S1 byte or K2 byte) is provisionable on a per-OC-3 basis.
  - Enhanced DS1 PM. Provides 15 minute bins for DS1 path and line PM data.
  - Fourth Level of Security. A new Maintenance security level, which allows access to Reports and some maintenance activities is provided in addition to the three current levels of privileged, general, and reports-only.
  - Quad-DS1 electrical loopbacks. Provides an electrical facility loopback of four DS1 interfaces from a given BBF1B or BBF3 DS1 circuit pack.
  - Large networks. Supports DDM-2000 and FiberReach networks of up to 50 nodes.
  - CPro-2000, ITM SNC support. Release 9.1 is supported by CPro-2000 Releases 5.0 and 6.0, and ITM SNC Releases 2.2 and 4.0.
  - 27G2-U OLIU. The new 27G2-U OLIU supports the new cross-connects necessary to provide enhanced FiberReach topologies.

DDM-2000 User/Service Manual at 5-45-5-48

Feature Details and Options

As mentioned previously, SONET synchronization messaging is used to communicate the quality of the subnetwork timing throughout the subnetwork. This is done using bits 1-3 of the K2 byte found in the SONET overhead. In OC-3 Release 9.1 and later releases, synchronization messaging can also be done using bits 5-8 of the S1 byte in the SONET overhead (not supported on OC-1 links). If a DDM-2000 OC-3 system is deriving timing from a given OC-N interface and synchronization messaging is enabled on that interface (Kbyte messages and Sbyte messages in OC-3 Release 9.1 and later are provisioned using the `set-ocn` command), the system interprets the received message to determine its internal timing status. The system also determines the state of the DS1 output, if the DS1 output is enabled. The DDM-2000 OC-3 system also transmits over the particular OC-N interface and all other OC-N interfaces that are enabled for synchronization messaging, the appropriate message indicating the quality of its timing, and its active timing mode. Table 5-3 and Table 5-4 list the associated internal timing status and DS1 output states that are associated with synchronization messages received from the OC-N interface when synchronization messaging is enabled. The tables list the messages from low- to high-quality.

Table 5-3. Synchronization Messages using K2 Byte

Received Message	Active Timing Mode *	Default DS1 Output State	Quality Level
Don't Use	Holdover	AIS	7
Timing Looped Back (TLB)	Holdover	AIS	7
Stratum 4 †	Holdover	AIS	6
Internal Clock (IC)	OK to use	AIS	5
Stratum 3 †	OK to use	Good	4
Stratum 2 †	OK to use	Good	3
Sync Quality Unknown (SQU)	OK to use	Good	2
Stratum 1 †	OK to use	Good	1

* This column applies only when provisioned for line-timing mode.

† Presently, DDM-2000 OC-3 Multiplexers cannot generate these messages, but they could be retransmitted and supported for auto-reconfiguration if any of these are received by a DDM-2000 OC-3 Multiplexer.

Table 5-4. Synchronization Messages using S1 Byte*

Received Message	Active Timing Mode †	Default DS1 Output State	Quality Level
Don't Use	Holdover	AIS	7
Traceable SONET minimum Clock	OK to use	AIS	5
Traceable Stratum 3 ‡	OK to use	Good	4
Traceable Stratum 2 ‡	OK to use	Good	3
Sync Trace Unknown	OK to use	Good	2
PRS Traceable ‡	OK to use	Good	1

* S1 byte not supported on OC-1 links.

† This column applies only when provisioned for line-timing mode.

‡ Presently, DDM-2000 OC-3 Multiplexers cannot generate these messages, but they could be retransmitted and supported for autoreconfiguration if any of these are received by a DDM-2000 OC-3 Multiplexer.

Synchronization messaging using the SONET K2 byte and S1 byte can be disabled on a per OC-N interface using the **`set-ocn`** command (not supported by OC-1). Zeros will be transmitted on bits 1-3 of the K2 byte if this is done; all ones will be transmitted on bits 5-8 of the S1 byte if this is done. The timing and synchronization status of a shelf can be determined using the **`rtrv-sync`** command.

The "Don't Use" message is sent when the system determines that its timing is not suitable for synchronization; for example, due to failure.

When the DDM-2000 OC-3 system is configured for external timing and its DS1 output port is provisioned for MULT mode, the message Sync Quality Unknown (SQU) for K byte, or Sync Trace Unknown (STU) for S byte, is sent on all the OC-N interfaces where synchronization messaging is provisioned. When the capability of communicating with a BITS clock over the DS1 overhead exists, the quality of the reference signal will be transmitted instead; for example, Stratum 1.

When the DDM-2000 OC-3 system is configured for external timing and its DS1 output port is provisioned for SYNC OUT mode, the Timing Looped Back (TLB) message for K byte, or "Don't Use" message for S byte, will be sent on the OC-N interfaces towards the NE from which the DS1 timing output is being derived. The SQU message for K byte or STU for S byte will be sent on all other OC-N interfaces where synchronization messaging is provisioned. If the DS1 output is generating AIS while the system is configured in this way, the message SQU for K byte, or STU for S byte, will be transmitted on all OC-N interfaces.

When the DDM-2000 OC-3 system is configured for free run or is in holdover mode, the Internal Clock message for K byte or Traceable SONET Clk for S byte

will be sent on all OC-N interfaces where synchronization messaging is provisioned.

When the DDM-2000 OC-3 system is configured for line timing, the TLB message for K byte and "Don't Use" for S byte will be sent on the OC-N interfaces towards the NE from which the timing is being derived. The message received on the OC-N interface will be sent on all other OC-N interfaces where synchronization messaging is provisioned.

With automatic synchronization reconfiguration, the DDM-2000 OC-3 Multiplexer systems use and compare the incoming synchronization messages on the OC-N interfaces available for line timing to select the highest quality synchronization reference available. If the received quality levels are the same on the references available for timing, the existing line timing reference take precedence. This feature guarantees the non-revertive operation of reconfiguration. The line timing reference is provisioned by the **`set-sync`** command.

The existence of automatic synchronization reconfiguration does not change the system's behavior on traditional line failures; for example, LOF, LOP, LOS, and others.

There are synchronization references in the DDM-2000 OC-3 system that can be provisioned as network timing sources but are not considered as timing sources for automatic synchronization reconfiguration. Examples of these are the linear extensions off of a DDM-2000 OC-3 ring. This type of interface is considered a linear interface, and the system treats it as such with regards to synchronization.

Table 5-5 lists the synchronization references available on DDM-2000 OC-3 and OC-12 system topologies.

Table 5-5. Available Synchronization References

System	Manually Provisionable	Automatically Reconfigurable
OC-3 Linear	Main, Fn-C	Main, Fn-C
OC-3 Rings	Main-1, Main-2, Fn-C	Main-1, Main-2, Fn-C
OC-12 Linear	Main-B	Not applicable
OC-12 Rings	Main-B-1, Main-B-2	Main-B-1, Main-B-2

Function unit C, when equipped with an OC-3/IS-3 OLIU, can be selected as an option for automatic synchronization reconfiguration. This is useful in DRI networks where an OC-3 ring is connected through an OC-3/IS-3 optical interface to an OC-12 or FT-2000 OC-48 Lightwave System ring.

In OC-3 Release 9.1 and later ring releases, the sending of DS1 AIS on the output of the BBF2B circuit pack can be provisioned by using the **set-sync** command. Depending on the quality level of the incoming sync messages, this new parameter can be provisioned to send DS1 AIS upon receiving level 5 (default), level 4, level 3, or level 2. Refer to Table 5-3 and Table 5-4 for definitions of quality levels. AIS will be sent as long as the received message is at the provisioned or greater in quality level number.

Examples

In this part, some detailed examples are given to show specifically how the synchronization messages propagate through the DDM-2000 OC-3 network and assist in the recovery from a fiber failure. Through these examples, one can extend the same concept to any other network that may include different topologies, number of sites, failure locations, and number of BITS clocks.

NOTE:
All nodes in a ring using automatic synchronization reconfiguration must have the synchronization messaging and automatic synchronization reconfiguration features enabled to prevent alarms.

In all of the following examples, if the sync message parameter within the **set-oc3** command has been provisioned to "S byte" for an optical interface, then the equivalent S byte message will be transmitted from that optical interface. The following are equivalent messages:

K2: Sync Quality Unknown is the same as, S1: Sync Trace Unknown

K2: Timing Looped Back is the same as, S1: Don't Use

K2: Internal Clock is the same as, S1: Traceable SONET minimum Clock

K2: Stratum 3 is the same as, S1: Traceable Stratum 3.

DDM-2000 User/Service Manual at 5-56

Dual-Homing DRI Synchronization Configurations

OC-3 and FT-2000 OC-48 Lightwave System

Figure 5-30 shows how OC-N timing can be distributed from an FT-2000 OC-48 Lightwave System line-switched ring to a DDM-2000 OC-3 path-switched ring using a dual-homing DRI configuration. The OC-3 DRI nodes are connected via OC-3 point-to-point links terminating in function unit C slots. The major characteristics of this configuration are:

- The FT-2000 OC-48 Lightwave System nodes are through-timed and derive timing from different rotations of the OC-48 ring.
- The FT-2000 OC-48 Lightwave System must be provisioned to write stratum 3 synchronization message to the K2 byte so the DDM-2000 ring can use synchronization messaging.
- The two DDM-2000 OC-3 DRI nodes coordinate timing using synchronization status messages on the OC-3 ring so that all nodes will accept timing in the same direction.
- The two DDM-2000 OC-3 DRI nodes must be provisioned for line-timing with timing derived from function unit C. Synchronization messaging on the OC-3 span between the two OC-3 DRI nodes must be disabled so timing loops are not formed. Synchronization messaging and automatic synchronization reconfiguration should be enabled on all other OC-3 interfaces on the DRI nodes.
- All other OC-3 nodes must be provisioned for line-timing with synchronization messaging and automatic synchronization reconfiguration enabled.

DDM-2000 User/Service Manual at 10-38

SONET Overhead Bytes

The DDM-2000 OC-3 Multiplexer currently uses the K2 byte in the SONET format for synchronization signaling. The reserved V4 byte in the VT1.5 superframe is used for internal fault detection in a DDM-2000 OC-3 Multiplexer shelf. This internal usage of the V4 byte may cause the value of the transmitted V4 byte to vary.

The DDM-2000 OC-3 Multiplexer does not depend on, and always ignores, the value of the V4 byte received from another DDM-2000 or other shelf with an OC-3 interface.

Performance

Wander/Jitter

- For SONET optical interfaces, the maximum time interval error (MTIE) does not exceed 60 nanoseconds phase variation when timed with a wander-free reference
- Jitter transfer, tolerance, and generation requirements are met as specified in GR-253-CORE and GR-499-CORE
- The SONET interfaces meet the T1.101 OC-N output short-term stability mask.

Signal Performance

The following specifications apply given the standard networks defined in GR-499-CORE.

- For systems interfacing at the DS1 rate, the number of errored seconds, during a 2-hour, one-way loopback test, is less than 10
- For systems interfacing at the DS3 rate, the number of errored seconds, during a 2-hour, one-way loopback test, is less than 72
- The BER is less than 10^{-9} for both the DS1 and DS3 rates. Burst-errored seconds are excluded
- The frequency of burst-errored seconds, other than those caused by protection switching induced by hard equipment failures, averages less than four per day.

DDM-2000 User/Service Manual at 11-195

	Kbyte Message — The valid values for this parameter are `enabled`, indicating that proprietary Sync messages are used, and `disabled`, indicating that proprietary Sync messages are not used. The Sync messages use the K2 byte in the SONET overhead to determine synchronization quality. These values are set by the **`set-oc3`** command. Sync Message — Beginning with OC-3 Releases 8.1 and 9.1, this parameter indicates the type of synchronization messaging that has been provisioned for that OC-3 optical interface by the **`set-oc3`** command. The valid values for this parameter are `Kbyte` (default value), `Sbyte`, and `disabled`. The sync messages use the K2 byte or the S1 byte in the SONET line overhead to determine synchronization quality. Concat Mode — This parameter is used in linear releases only. This report parameter is visible only if the STS3c mode is enabled via the **`set-feat`** command. This indicates if the addressed line is concatenated or not. The valid values are `enabled` and `disabled`. For OC-3, only function unit C slots can report concatenated values. Radio — This parameter is avaliable with linear releases only and is reported if this a *MegaStar* 2000 system. It has a value of **`yes`** or **`no`**, and it indicates whether there is a Radio Frequency Unit (RFU) connected to the SONET subsystem through an IS-3 interface. AIS Alarm — This parameter specifies the alarm level of a non-service-affecting OC-3 line AIS failure condition. The valid values are: **`cr`** Critical alarm **`mj`** Major alarm **`mn`** Minor alarm **`na`** Not alarmed, but reported (default). **RELATED COMMANDS** rtrv-sync DDM-2000 User/Service Manual at 11-197

The output parameters are:

`Line Address` Address of the OC-12 line.

`Signal Degrade Threshold`
This is the bit error rate (BER) threshold as a logarithm to the base 10. The value of *n* is an integer with a range of -5 through -9 corresponding to BERs of 10^{-5} through 10^{-9}. If a slot is empty or equipped with something other than an OC-12 optical unit, a hyphen (-) will appear in this column.

`Sync Message` For OC-3 Release 11.0 and later ring releases, this parameter indicates the type of synchronization messaging that has been provisioned for that OC-12 optical interface by the **`set-oc12`** command. The valid values for this parameter are `Kbyte` (default value), `Sbyte`, and `disabled`. The sync messages use the K2 byte or the S1 byte in the SONET line overhead to determine synchronization quality.

`AIS Alarm` This parameter specifies the alarm level of a non-service-affecting OC-12 line AIS failure condition. The valid values are

- **`cr`** Critical alarm
- **`mj`** Major alarm
- **`mn`** Minor alarm
- **`na`** Not alarmed, but reported (default)

RELATED COMMANDS

set-oc3

set-oc12

DDM-2000 User/Service Manual at 11-277

the `src` parameter is set to `fn-c` and the DS1 synchronization output is provisioned for `SYNC OUT` mode.

In addition to the condition mentioned above, in OC-3 Release 9.1 and future ring releases, DS1 Output Mode will not be reported when `Sync Autoreconfiguration` parameter is enabled. This will prevent any confusion in reading the report when the autoreconfiguration forces the `Active Reference/Line` parameter to switch to a better source.

`AIS Threshold`

In OC-3 Release 9.1 and later ring releases, this parameter indicates the provisioned sync message quality level and its equivalent sync message phrase for the active reference at which, or greater incoming quality level numbers, DS1 AIS will be transmitted on the sync output of the BBF2B TGS or BBF4 TG3 circuit pack. If the `syncmsg` parameter within the **`set-oc3`** or **`set-oc12`** command is set to `disabled`, then the word `disabled` will be reported with the provisioned value of this parameter. It may be set to one of the following options:

`level5`	default value. (K2: Internal Clock, S1: Traceable SONET Clk, or disabled)
`level4`	(K2: Stratum 3, S1: Traceable Stratum 3, or disabled)
`level3`	(K2: Stratum 2, S1: Traceable Stratum 2, or disabled)
`level2`	(K2: Sync Quality Unknown, S1: Sync Trace Unknown, or disabled)

For a definition of quality levels, refer to the Sync Message Information section of this command pages.

`DS1 Output State`

The output state is the status of the DS1 output when in the *`sync out`* mode, and may be one of the following:

`good`	This status indicates that the DS1 output is traceable to the incoming OC-1 (Release 9.1 and later), OC-3 signal, or OC-12 (if Main unit slots are equipped with 24G-U OLIU packs). line.

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For ring releases, the signal degrade value for addresses of main-1 and main-2 *must* be the same. Therefore, any change to signal degrade for one address will automatically be made to the other by the software.

kbyte

NOTE:
This parameter is only applicable to Releases 8.0 and 9.0. This parameter is no longer be used for DDM-2000 OC-3 Releases 8.1, 9.1, and later releases. For later releases, the **syncmsg** parameter is used in place of the **kbyte** parameter.

Kbyte specifies the usage of the K byte overhead for Sync Messages. Both the sending and receiving messages are affected. If Kbyte is `enabled`, proprietary Sync Messages are used. If Kbyte is `disabled`, proprietary Sync Messages are not used. The default value is `enabled`. For main slots m1 and m2 in ring applications, the kbyte value could be different on both rotations of the ring.

syncmsg This parameter is available in OC-3 Releases 8.1, 9.1, and later releases. Synchronization messaging allows timing to be reconfigured in a network upon a node or fiber failure. This parameter has one of the following values:

`Kbyte` This is the default value. When this option is selected, both K2 and S1 byte sync messages are transmitted, but only K2 byte is received and interpreted for sync messaging.

`Sbyte` When this option is selected, only the S1 byte is sent and received for sync messaging. K2 byte will always send a "Don't Use" message.

NOTE:
To minimize the amount of time that DDM-2000 is in holdover mode when upgrading a ring network from **Kbyte** to **Sbyte** messages, it is recommended that the user first upgrade the nodes farthest away from the external timing source, and then proceed to nodes closer to the timing source.

`disabled` When this option is selected, interpretation of both K2 and S1 bytes will be disabled and hence a "Don't Use" message will be transmitted on both bytes at all times.

	DDM-2000 User/Service Manual at 11-345

syncmsg This parameter is available in OC-3 Release 11.0 and later rings releases. Synchronization messaging allows timing to be reconfigured in a network upon a node or fiber failure. Parameter value is one of the following:

- `Kbyte` This is the default value. When this option is selected, both K2 and S1 byte sync messages are transmitted, but only K2 byte is received and interpreted for sync messaging.
- `Sbyte` When this option is selected, only the S1 byte is sent and received for sync messaging. K2 byte will always send a "Don't Use" message.
- `disabled` When this option is selected, interpretation of both K2 and S1 bytes will be disabled and hence a "Don't Use" message will be transmitted on both bytes at all times.

aisalm For ring releases, the AIS alarm values for Main-1 and Main-2 (when using the 24-type OLIU circuit packs in the Main unit slots) must be the same. Any change to one address will also be made automatically to the other by the software. Alarm is the provisioned alarm level of the non-service affecting (NSA) OC-12 line AIS and has the following values:

- `cr` Critical alarm
- `mj` Major alarm
- `mn` Minor alarm
- `na` Not alarmed, but reported (default)

If an attempt is made to execute this command, when a mix of incompatible OLIU packs exists in Main, the request will be denied with the following message:

```
SNVS
/* Status, Not in Valid State */
/* Both main slots must be equipped with compatible OLIU packs. */
```

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BBF2B TGS circuit packs. As long as the incoming quality level number is at or greater than the provisioned level, AIS will be transmitted. This parameter is listed in ascending quality order and may have one of the following values:

level5 This is the default value. Send DS1 AIS for incoming quality level 5 (K2: Internal Clock, S1: Traceable SONET Clk) or greater (that is, quality level 6 or 7).

level4 Send DS1 AIS for incoming quality level 4 (K2: Stratum 3, S1: Traceable Stratum 3) or greater.

level3 Send DS1 AIS for incoming quality level 3 (K2: Stratum 2, S1: Traceable Stratum 2) or greater.

level2 Send DS1 AIS for incoming quality level 2 (K2: Sync Quality Unknown, S1: Sync Trace Unknown) or greater.

auto SyncAutoreconfiguration allows the system to choose the best timing source to use when it is provisioned for Line Timing. The synchronization source selection is based on the synchronization messages received from the available timing (synchronization) sources. Automatic Protection Switching takes place to the standby timing source when the active source fails. The switch is nonrevertive, and there will not be an automatic switch back to the former timing reference.

When SyncAutoreconfiguration is enabled, the system automatically reconfigures between line timing sources **main** and **fn-c** in linear systems and **main-1** and **main-2** in ring systems.
In ring releases, **fn-c** will also be a source option. Use the **switch-sync** command to manually switch to the other timing source.

enabled SyncAutoreconfiguration is active.

disabled SyncAutoreconfiguration is not active (default).

If hardware provisioning switches are set for FreeRunning timing mode, execution of this command will be denied with the following message:

```
SNVS
/* Status, Not in Valid State */
/* System provisioned for free-running. */
```

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Each SONET layer has a set of overhead bytes as shown in Figure A-4. These bytes carry information used by various network elements.

- **Section Overhead** contains information that is used by all SONET equipment including repeaters.
- **Line Overhead** is used by all SONET equipment except repeaters.
- **Path Overhead** is carried within the payload envelope.
  - **STS-1 path overhead** remains with the STS-1 SPE until its asynchronous signal is extracted (for example, DS-3) or until its individual VT1.5 signals are demultiplexed.
  - **VTN (N= 1.5, 2, 3, or 6) path overhead** remains with the VTN until its asynchronous signal is extracted.

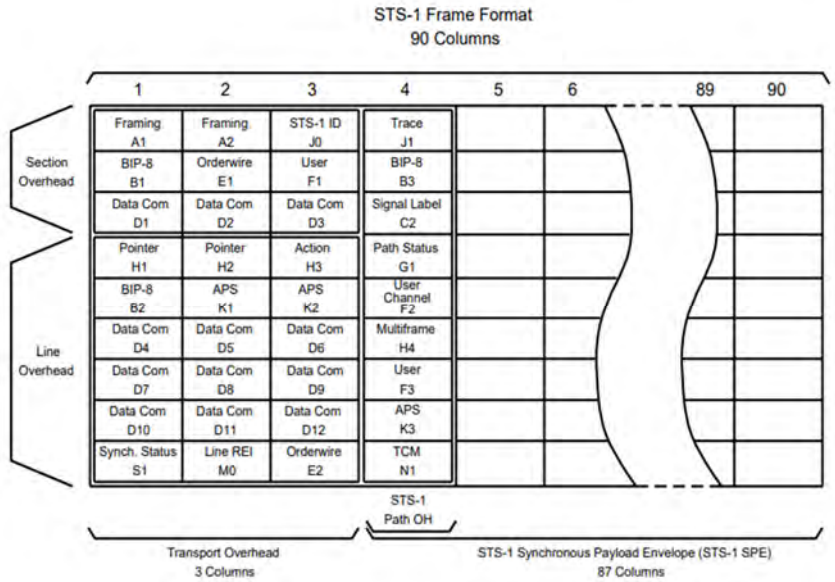


Figure A-4. SONET Frame Format

SONET Frame Structure

The following pages provide more detailed information on the function of various overhead bytes for each SONET layer.

Section Overhead

- Framing (A1, A2)
  - Provides framing for each STS-1.
- STS-1 ID (J0)
  - Provides the order of appearance in a byte-interleaved STS-*N* frame; for example, STS-1 #1, STS-1 #2.....STS-1 #48. In future applications, this byte will provide a section trace function. For information on STS-*N* signals, see the "Higher Rate Transport" part of this section.
- Section Bit-Interleaved Parity (BIP-8) (B1)
  - Provides SECTION performance monitoring and is calculated over all bits of the previous STS-*N* frame. Defined only for STS-1 #1 of an STS-*N* signal.
- Section Order Wire (E1)
  - Provides a local order wire for voice communication channel between section terminating network elements, such as repeaters. Defined only for STS-1 #1 of an STS-*N* signal.
- Section User Channel (F1)
  - Set aside for the user's purpose. Defined only for STS-1 #1 of an STS-*N* signal.
- Section Data Communications Channel (D1, D2, D3)
  - Is a 192 kb/s message-based channel. Used for alarms, maintenance, control, monitoring, and other communication needs between section terminating equipment. Defined only for STS-1 #1 of an STS-*N* signal.

Line Overhead

- Line Pointer (H1, H2)
  - Two bytes indicate the offset in bytes between the pointer action byte (H3) and the first byte (J1) of the STS-1 synchronous payload envelope (SPE).
- Pointer Action (H3)
  - One byte is allocated for frequency justification.
- Line Bit-Interleaved Parity (BIP-8) (B2)
  - This byte is for line performance monitoring. This byte is provided in all STS-1 signals within an STS-*N* signal.
- Line Automatic Protection Switching (APS) (K1, K2)
  - Two bytes used for APS signaling between line level entities. In addition, bits 6, 7, and 8 of K2 are used for line alarm indication signal (AIS) and line far-end receive failure (FERF). Defined only for STS-1 #1 of an STS-*N* signal.
- Line Data Communications Channel (D4 - D12)
  - Is a 576 kb/s message-based channel.
- Synch. Status (S1)
  - In STS-1 #1, the S1 byte is for synchronization status messages, and only bits 5 through 8 are used.
- Line REI (M0)
  - The M0 byte is for STS-1 line far-end block error (FEBE), and only bits 5 through 8 are used.
- Line Orderwire (E2). Defined only for STS-1 #1 of an STS-*N* signal.
  - One byte is allocated to be used as an express orderwire between line terminating equipment.

Path Overhead

There are two types of path overheads:

- STS-1 path overhead
- VT path overhead.

STS-1 Path Overhead

The STS-1 path overhead is assigned to and remains with the STS-1 SPE until the payload is extracted and is used for functions that are necessary to transport all synchronous payload envelopes.

- STS-1 Path Trace (J1)
  - Repetitively transmits a 64 byte, fixed length, string so that an STS-1 path receiving terminal can verify its continued connection to the intended transmitter.
- STS-1 Path Bit-Interleaved Parity (BIP-8) (B3)
  - Provides each STS-1 path performance monitoring. This byte is calculated over all bits of the previous STS-1 SPE before scrambling.
- STS-1 Path Signal Labels (C2)
  - Indicates the construction of the STS-1 SPE. A value of 00000000 indicates an unequipped STS-1 SPE. Values for various payload mappings are defined in TR-NWT-000253, Issue 2.
- STS-1 Path Status (G1)
  - Conveys the STS-1 path terminating status, far end block errors (FEBE), and yellow alarm signal conditions back to an originating STS-1 path terminating equipment.
- STS-1 Path User Channel (F2, F3)
  - User communication channel between Path elements.
- VT Multiframe Indicator (H4)
  - Provides a general multiframe indicator for VT-structured payloads.
- STS-1 Path Automatic Protection Switching (K3)
  - Path Automatic Protection Switching
- TCM - Tandem Connection Maintenance (N1)
  - Bits 1-4 used for incoming error monitoring. Bits 5-8 used as communications channel.

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Protection Line

As defined by the SONET standard, the protection line is the pair of fibers (one transmit and one receive) that carry the SONET APS channel (K1 and K2 bytes in the SONET line overhead). On a DDM-2000 OC-3 system, a *protection* line is a pair of fibers that terminate on an OLIU circuit pack in the `main-2`, `fn-a-2`, `fn-b-2`, or `fn-c-2` slot. (See "Service Line.")

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Unidirectional

A protection switching mode in which the system at each end of an optical span monitors both service and protection lines and independently chooses the best signal (unless overridden by an equipment failure or by an external request, such as a forced switch or lockout). In a system that uses unidirectional line switching, both the *service* and *protection* lines may be *active* simultaneously, with one line carrying traffic in one direction and the other line carrying traffic in the other direction. The K1 and K2 bytes in the SONET line overhead are used to convey to the far end which line the near end receiver has chosen, so that an "active" indication may be made at the far end.

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Table A – DDM-2000 OC-3 Parameters Provisionable Via the CIT

Parameter	Range	Default (Note 1)	Command (Note 2)
Date	current value	70-01-01	set-date
Time	current value	00:00:00	set-date
Target ID (system name)	20 characters	LT-DDM-2000	set-ne
Remote NE Status	enabled,disabled		set-ne
Alarm Group	1-255	255	set-ne
Alarm Gateway NE	yes,no	no	set-ne
Shelf number	1-8	1	set-ne
Idle channel signal	STS Uneqpd./AIS insert	AIS	set-ne
	VT Uneqpd./AIS insert	AIS	
CO/RT select	CO, RT	RT	set-ne
CIT page length	0 (pager off), 3-150 rows	24	set-link
PM thresholds	See PM Table	-	set-pmthres
Alarm holdoff delay	0-30 sec	2	set-attr-alm
Alarm clear delay	0-30 sec	15	set-attr-alm
Power minor almn. level	MN, MJ	MN	set-attr-alm
OC1 degrade threshold	10^{-5} to 10^{-9}	10^{-6}	set-oc1
AIS almn. level of NSA OC-1			
Line AIS	CR, MJ, MN, NA	NA	set-oc1
OC3 degrade threshold	10^{-5} to 10^{-9}	10^{-6}	set-oc3
Sync messaging	K byte, S byte, disabled	K byte	set-oc3
AIS almn. level of NSA OC-3			
Line AIS	CR, MJ, MN, NA	NA	set-oc3
DccMode	distinct,identical	distinct	set-oc3
Application	0x1,1+1	1+1	set-oc3
OC12 degrade threshold§§§	10^{-5} to 10^{-9}	10^{-6}	set-oc12
Sync messaging§§§	K byte, S byte, disabled	K byte	set-oc12
AIS almn. level of NSA OC-12			
Line AIS§§§	CR, MJ, MN, NA	NA	set-oc12
DccMode	distinct,identical	distinct	set-oc12
STS-1 path signal			
degrade threshold†††	10^{-5} to 10^{-9}	10^{-6}	set-sts1
Signal fail alarm threshold	10^{-3} to 10^{-6}	10^{-3}	set-sts1
NSA STS-1 path AIS			
alarm level	MN, NR	MN	set-sts1
SA STS-1 path AIS			
alarm level	CR, MN, NA, NR	MN	set-sts1
STS-1 channel state***	NMON, AUTO‡	AUTO	set-state-sts1
OC-1 line state‡‡‡	NMON, IS	IS	set-state-oc1

See notes and footnotes at end of table.

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DO ITEMS BELOW IN ORDER LISTED. . . . . FOR DETAILS, GO TO

6. ⇒ NOTE:
The **rtrv-map-network** and **rtrv-map-neighbor** commands may be used to retrieve a map of the network, including the systems in the network and how they are connected.

Ensure all DDM-2000 OC-3 shelves (**OLIUs**) in the network have been properly connected to the optical facility. Verify the integrity of each optical span. DLP-514

7. ⇒ NOTE:
If Kbyte/Sbyte (sync messaging) is enabled for the at any node in a system, it **must** be enabled at all nodes of the system.

⇒ NOTE:
The **rtrv-oc3:** or **rtrv-oc12:** command retrieves the `OC-3 Line Provisioning Report` or `OC-12 Line Provisioning Report`. This report displays the provisioned configuration of OC-3 lines. See the Commands and Reports section of this manual for a description of the **rtrv-oc3:** or **rtrv-oc12:** command format.

Use the **rtrv-oc3:** or **rtrv-oc12:** command to obtain the `OC-3 Line Provisioning Report` or `OC-12 Line Provisioning Report` and verify if Kbyte/Sbyte is enabled or disabled. Use the **set-oc3:** or **set-oc12** command to enable or disable the Kbyte/Sbyte parameter, as required.

DO ITEMS BELOW IN ORDER LISTED . . . . .FOR DETAILS, GO TO

8. **NOTE:**
If Sync Autoreconfiguration is enabled, Kbyte/Sbyte must also be enabled.

NOTE:
The **rtrv-sync:** command retrieves the Synchronization Report. This report displays the provisioning and operational information on the synchronization attributes of the DDM-2000. See the Commands and Reports section of this manual for a description of the **rtrv-sync:** command format.

Use the **rtrv-sync:** command to obtain the Synchronization Report and verify if Sync Autoreconfiguration is enabled or disabled. Use the **set-sync:** command to enable or disable the Sync Autoreconfiguration parameter, as required.

9. **NOTE:**
The section data communication channel (DCC), used for far end communications, must be enabled at each network element (shelf) for the end-to-end line test to work. Default condition for the DCC channel is "enabled". If it has been disabled, use the **set-fecom:** command **at each shelf** to enable far end communications.

NOTE:
The **rlgn** command can be used to log in to each shelf at optical span being tested.

Perform end-to-end line test on all optical spans. Report any failures to the organization that installed the DDM-2000. DLP-515

10. Perform end-to-end DS1 transmission test in the **Mux** direction for each function unit group, if required.

A.	DS1 Single Ring Test in **Mux** Direction	DLP-510
B.	DS1 Dual Ring (DRI) Test in **Mux** Direction	DLP-554
C.	DS1 Single/Dual Homing Test in **Mux** Direction	DLP-510

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DO ITEMS BELOW IN ORDER LISTED. . . . . FOR DETAILS, GO TO

22. ⇒ **NOTE:**
If Sync Autoreconfiguration is enabled, Kbyte/Sbyte must also be enabled.

⇒ **NOTE:**
If Sync Autoreconfiguration is enabled at any line-timed OC-3 node in a ring, it **must** be enabled at all line-timed OC-3 nodes of a ring.

⇒ **NOTE:**
The **rtrv-sync:** command retrieves the `Synchronization Report`. This report displays the provisioning and operational information on the synchronization attributes of the DDM-2000. See the Commands and Reports section of 363-206-295, *DDM-2000 OC-12 Multiplexer, TARP Release 7, User/Service Manual—Volume I*, and 363-206-285, *DDM-2000 OC-3 Multiplexer, TARP Release 13 and Later, User/Service Manual—Volume I*, for a description of the **rtrv-sync:** command format.

Use the **rtrv-sync:** command to obtain the `Synchronization Report` and verify if Sync Autoreconfiguration is enabled or disabled. Use the **set-sync:** command to enable or disable the Sync Autoreconfiguration parameter, as required.

23. ⇒ **NOTE:**
Two or more shelves in the same network **cannot** have the same system name or TID (set by the **set-ne:** command).

Verify no duplicate TID settings exist. The **rtrv-ne:** command may be used at each shelf in the network to display settings. If duplicates exist, determine new settings and use the **set-ne** command to make new settings.

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DO ITEMS BELOW IN ORDER LISTED. . . . . FOR DETAILS, GO TO

Use the **ent-crs-vt1:** or **ent-crs-sts1:** command at the new shelf to make all required *pass-through* cross-connections (for example, **ent-crs-vt1:m-1-1-1,m-1-1-1** or **ent-crs-sts1:m-1,m-1**). Pass-through cross-connections must be made at the new shelf to correspond to each terminating cross-connection present on every shelf in the ring network. (See Figure 1.)

9. **NOTE:**
If Kbyte or Sbyte (sync messaging) is enabled for the **main-1** and **main-2** optical interfaces at any node in a ring, it **must** be enabled at all nodes of the ring.

NOTE:
The **rtrv-oc3:** or **rtrv-oc12:** command retrieves the `OC-3 Line Provisioning Report` or `OC-12 Line Provisioning Report`. This report displays the provisioned configuration of OC-3 or OC-12 lines. See the Commands and Reports section of this manual for a description of the **rtrv-oc3:** or **rtrv-oc12:** command format.

Use the **rtrv-oc3:** or **rtrv-oc12:** command to obtain the `OC-3 Line Provisioning Report` or `OC-12 Line Provisioning Report` and verify if Kbyte/Sbyte is enabled or disabled. Use the **set-oc3:** or **set-oc12:** command to enable or disable the Kbyte/Sbyte parameter, as required.

DO ITEMS BELOW IN ORDER LISTED . . . . .FOR DETAILS, GO TO

10. **NOTE:**
If Sync Autoreconfiguration is enabled, Kbyte/Sbyte must also be enabled.

NOTE:
If Sync Autoreconfiguration is enabled at any line-timed node in a ring, it **must** be enabled at all line-timed nodes of a ring.

NOTE:
The **`rtrv-sync:`** command retrieves the `Synchronization Report`. This report displays the provisioning and operational information on the synchronization attributes of the DDM-2000. See the Commands and Reports section of this manual for a description of the **`rtrv-sync:`** command format.

Use the **`rtrv-sync:`** command to obtain the `Synchronization Report` and verify if Sync Autoreconfiguration is enabled or disabled. Use the **`set-sync:`** command to enable or disable the Sync Autoreconfiguration parameter, as required.

11. **WARNING:**
Unterminated optical connectors may emit invisible laser radiation. Eye damage may occur if beam is viewed directly or with improper optical instruments. Avoid direct exposure to the beam.

CAUTION:
An automatic protection switch service hit may occur when the correct optical fibers are cut. Cutting the wrong fiber lines will cause a service interruption.

At the point where the new DDM-2000 shelf will be added, use local procedures to cut the two fiber lines connecting existing shelves and condition the fiber for connection to the new shelf.

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set-oc3	Sets the characteristics of an OC-3 line pair. Sets the signal degrade threshold of the OC-3 line as a bit error rate (BER). Specifies if sync message signaling uses kbyte or sbyte or is enabled or disabled. Specifies if the concatenation mode (concat) of the OC-3 line is to be independent STS-1 channels or an sts-3c channel.
set-oc12	Sets the characteristics of an OC-12 line pair. Sets the signal degrade threshold of the OC-12 line as a bit error rate (BER). Specifies if sync message signaling uses kbyte or sbyte or is enabled or disabled.
set-ow	Sets the orderwire routing for the network element.
set-state-oc1	Sets the state of OC-1 line(s) to be monitored (IS) for a good signal or not monitored (NMON).
set-state-ec1	Sets the state of a low-speed EC-1 port to be automatically monitored (AUTO) for a good signal or not monitored (NMON).
set-state-t1	Sets the state of a low-speed port to be automatically monitored (AUTO) for a good signal or not monitored (NMON).
set-state-t3	Sets the state of a DS3 port to be automatically monitored (AUTO) for a good signal or not monitored (NMON).
set-state-sts1	Sets the state of a STS-1 channel to be automatically monitored (AUTO) for a good signal or not monitored (NMON).
set-state-vt1	Sets the state of a VT1.5 channel to be automatically monitored (AUTO) for a good signal or not monitored (NMON).
set-sts1	Sets the signal degrade characteristics of an STS-1 channel.
set-t1	Sets the characteristics of a DS1 port.
set-t3	Sets the characteristics of a DS3 port.
set-vt1	Sets the signal degrade characteristics of a VT1.5 channel.
set-x25	Sets the packet size of X.25 link to either 128 or 256.

DDM-2000 TARP Release 13 at 1209-1212

Sync Messaging
Change Kbyte to Sbyte

1. **NOTE:**
   This procedure may be used to change Kbyte sync messaging to Sbyte sync messaging.

   Use **rtrv-alm:** command to verify that there are no alarms or protection switches present on the system.

2. **NOTE:**
   To minimize the amount of time that DDM-2000 shelves are in holdover mode when upgrading a ring network from Kbyte to Sbyte messages, it is recommended that you first upgrade the node(s) farthest away from the external timing source, then proceed to nodes closer to the timing source. For example, if all the line timed nodes in the network shown in Figure 1 had their *Sync Source (src)* set to *main1*, the farthest node from the external timing source would be Node D.

   NOTE:
   Note that in Figure 2, if Node B is changed to Sbyte first, then Node C will go into holdover. Note that in Figure 3, if Node D is changed to Sbyte first, then Node C and Node B, none of the nodes will go into holdover.

   Use the **rtrv-sync:/set-sync:** command at each node in the network to display/set the synchronization source.

3. Use **rtrv-oc3:/set-oc3:** command to verify/enable sync messaging (kbyte) at each node.

4. Determine the farthest node from the external timing source.

5. Use **set-oc3:syncmsg=***Sbyte* command to enable Sbyte sync messaging at each node, starting from the node furthest from the external timing source.

6. Use the **rtrv-sync:** command to display the provisioning and operational information of the synchronization interface.

7. **STOP. YOU HAVE COMPLETED THIS PROCEDURE.**

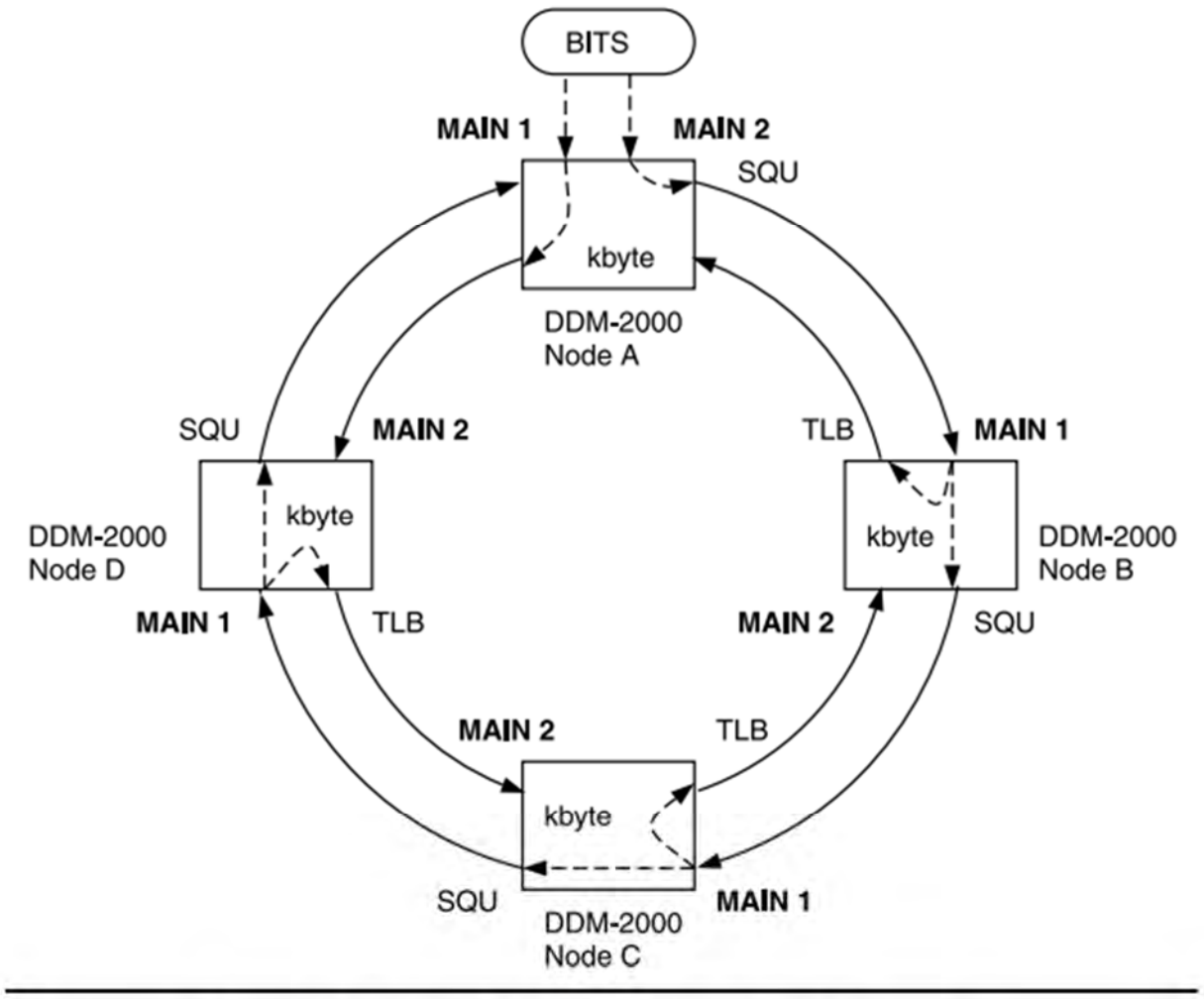


Figure 1 – Normal OC-3 Ring Using Kbyte Messaging

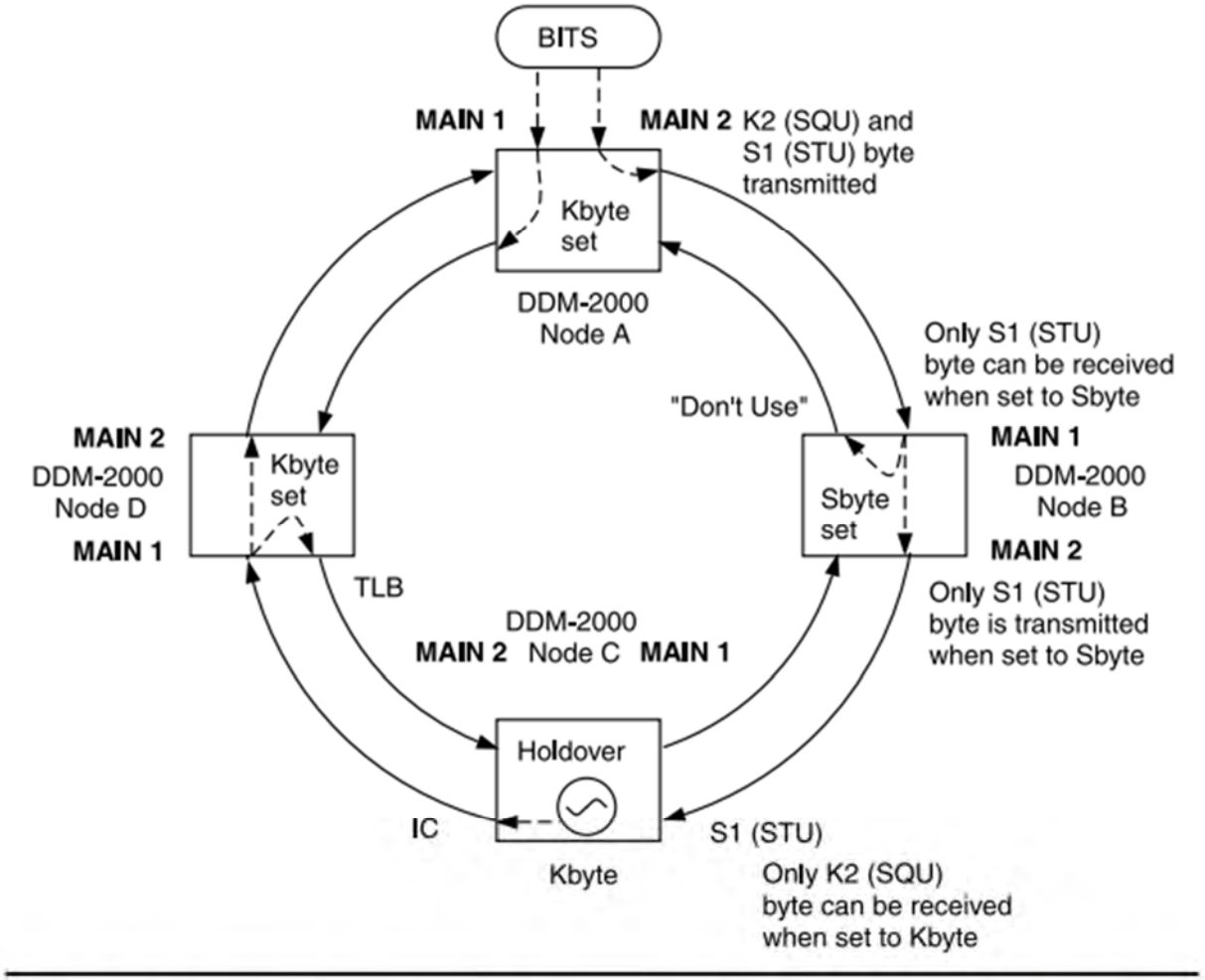


Figure 2 – Abnormal Sequence of Changing Kbyte to Sbyte - One Node in Holdover

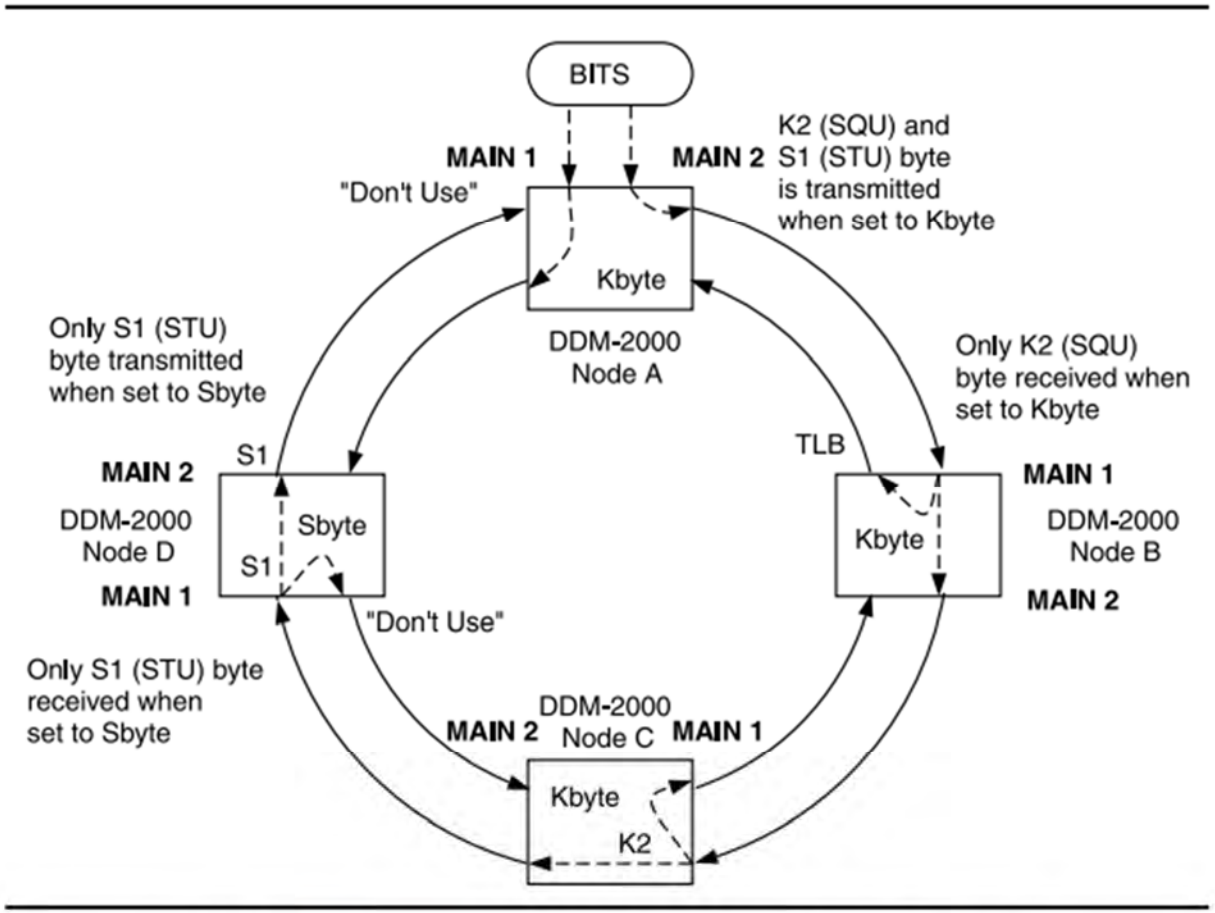


Figure 3 – Normal Sequence of Changing Kbyte to Sbyte

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The output parameters are:

`Line Address`	Address of the OC-3 line.
`Signal Degrade Threshold`	This is the bit error rate (BER) threshold shown as a logarithm to the base 10. The value of *n* is an integer with a range of -5 through -9 corresponding to BERs of 10^{-5} through 10^{-9}, respectively.
`Sync Message`	This parameter indicates the type of synchronization messaging that has been provisioned for that OC-3 optical interface by the **`set-oc3`** command. The valid values for this parameter are `Kbyte` (default value), `Sbyte`, and `disabled`. The sync messages use the K2 byte or the S1 byte in the SONET line overhead to determine synchronization quality.
`AIS Alarm`	This parameter specifies the alarm level of a non-service-affecting OC-3 line AIS failure condition. The valid values are:

`cr`	Critical alarm
`mj`	Major alarm
`mn`	Minor alarm
`na`	Not alarmed, but reported (default).

RELATED COMMANDS

rtrv-sync

set-oc3

DDM-2000 FiberReach Manual at 589-590

`Sync Message Information`
This heading identifies the section of the report where input and output messages used to determine the timing source quality are listed. This section of the report is available only if the `kbyte` message parameter is set to **`enabled`**.

When the shelf is equipped with 28-type OLIUs (in FiberReach Release 2.2 and later), this section of the report is available only if any of the optical interfaces have been provisioned for `kbyte` (default) or `Sbyte` sync messaging (using the **`set-oc3`** command if equipped with 28-type OLIUs in Main unit slots).

`OC-N Line`
This parameter identifies the addresses of optical interfaces that can carry sync messages.

`Input Message`

`disabled`	Indicates that the field is not applicable (for example, if synchronization messaging is disabled).
`?`	Indicates that the message is not readable (for example, due to a line failure).

This column identifies the `Kbyte` input message received on each optical interface line, and may have one of the following values:

`Don't Use`	The interface is not suitable for synchronization timing (Quality Level 7).
`Timing Looped Back`	The network element connected to this interface is line-timed from it (Quality Level 7).
`Stratum 4`	The interface is receiving timing from a Stratum 4 clock source (Quality Level 6).
`Internal Clock`	This interface is receiving timing from a system in holdover or free running (Quality Level 5).
`Stratum 3`	The interface is receiving timing from a Stratum 3 clock source (Quality Level 4).

	`Stratum 2` The interface is receiving timing from a Stratum 2 clock source (Quality Level 3).
	`Sync Quality Unknown` This interface is receiving timing from a good quality clock source (Quality Level 2).
	`Stratum 1` The interface is receiving timing from a Stratum 1 clock source (Quality Level 1).
	`Output Message` This identifies the output message sent out on each OC-N interface line. The valid values for this parameter are the same as those listed for `Input Message`.
	`Type` In FiberReach Release 2.2 (if equipped with 28-type OLIUs in Main unit slots) and later releases, this column identifies the type of sync messaging the optical interface was provisioned for using the **`set-oc3`** command. The valid values are:
	`Kbyte`
	`Sbyte`
	`disabled`
	NOTE: For OC-1 interfaces, this column will only display `Kbyte`.
	`Sync Autoreconfiguration` This capability allows the system to choose the best timing source to use when it is provisioned for line timing. The valid values are **`enabled`** and **`disabled`**.
	DDM-2000 FiberReach Manual at 632-633

NAME

set-oc3: Set OC-3 Characteristics

INPUT FORMAT

set-oc3::*Address*[:**dgr=***SignalDegradeThreshold*]
[,**syncmsg=***SynchronizationMessaging*][,**aisalm=***Alarm*];

DESCRIPTION

This command sets several characteristics (parameters) of a specified OC-3 line or line pair, using the 28-type OLIU. The 28-type OLIU is available in FiberReach Release 2.2 and later releases.

The input parameters are:

Address Address identifies the OC-3 line(s) or line pair(s).

If the shelf is equipped with 28-type OLIUs in Main unit slots (available in Release 2.2 and later), the only OC-3 valid addresses are:
main-{1,2,all}, all

dgr SignalDegradeThreshold specifies the signal degrade threshold as a BER in terms of a logarithm to the base 10. When this threshold is crossed, an alarm will be raised and automatic protection switching of the service line will be initiated. The value of this parameter has a range of -9 to -5. The default value is -6.
For ring releases, the signal degrade value for addresses of main-1 and main-2 *must* be the same. Therefore, any change to signal degrade for one address will automatically be made to the other by the software.

syncmsg Synchronization messaging allows timing to be reconfigured in a network upon a node or fiber failure. This parameter has one of the following values:

Kbyte This is the default value. When this option is selected, both K2 and S1 byte sync messages are transmitted, but only K2 byte is received and interpreted for sync messaging.

Sbyte When this option is selected, only the S1 byte is sent and received for sync messaging. K2 byte will always send a "Don't Use" message.

NOTE:
To minimize the amount of time that DDM-2000 is in holdover mode when upgrading a ring network from **Kbyte** to **Sbyte** messages, it is recommended that the user first upgrade the nodes farthest away from the external timing

source, and then proceed to nodes closer to the timing source.

`disabled` When this option is selected, interpretation of both K2 and S1 bytes will be disabled and hence a "Don't Use" message will be transmitted on both bytes at all times.

aisalm Alarm is the provisioned alarm level of the NSA OC-3 line AIS and has the following values:

- `cr` Critical alarm
- `mj` Major alarm
- `mn` Minor alarm
- `na` Not alarmed, but reported (default).

If an attempt is made to execute this command, when a mix of incompatible OLIU packs exists in Main, the request will be denied with the following message:

```
SNVS
/* Status, Not in Valid State */
/* Both main slots must be equipped with compatible OLIU packs. */
```

When input, this command will cause the following confirmation request to be displayed:

```
/* Caution! Alarm or maint. thresholds and sync messages
   are affected by this command.
   You have selected the set-oc3 command with these parameters:

   Address = x
   SignalDegradeThreshold = -n
   NonServiceAffectingAIS= value

Execute? (y/n or CANcel/DELete to quit) =
```

DDM-2000 FiberReach Manual at 171

Synchronization Provisioning Integrity

A welcome byproduct of synchronization messaging is the prevention of provisioning errors. Provisioned timing loops on the DDM-2000 FiberReach Multiplexers will be quickly detected through the synchronization messaging algorithm and prevented by forcing a shelf into holdover. The system can then be reprovisioned correctly.

Feature Details and Options

As mentioned previously, SONET synchronization messaging is used to communicate the quality of the subnetwork timing throughout the subnetwork. This is done using bits 1 through 3 of the K2 byte found in the SONET overhead. If a DDM-2000 FiberReach system is deriving timing from a given OC-*N* interface and synchronization messaging is enabled on that interface (Kbyte messages are enabled using the **`set-ocn`** user interface command or **`ent-rr`** TL1 command), the system interprets the received message to determine its internal timing status. The DDM-2000 FiberReach system also transmits over the particular OC-*N* interface, and all other OC-*N* interfaces that are enabled for synchronization messaging, the appropriate message indicating the quality of its timing and its active timing mode. Table 5-1 lists the associated internal timing status that is associated with synchronization messages received from the OC-*N* interface when synchronization messaging is enabled. The table lists the messages from low to high quality.

Table 5-1. Synchronization Messages Using K2 Byte

Received Message	Active Timing Mode
Don't Use	Holdover
Timing Looped Back (TLB)	Holdover
Stratum 4*	Holdover
Internal Clock (IC)	OK to use
Stratum 3*	OK to use
Stratum 2*	OK to use
Sync Quality Unknown (SQU)	OK to use
Stratum 1*	OK to use

* Presently, DDM Multiplexers cannot generate these messages, but they could be transmitted and supported for auto-reconfiguration if any of these are received by DDM-2000 Multiplexer.

DDM-2000 FiberReach Manual at 900-901

DO ITEMS BELOW IN ORDER LISTED . . . . . FOR DETAILS, GO TO

9.

NOTE:
If Kbyte or Sbyte (sync messaging) is enabled for the OC-3 **MAIN 1** and **MAIN 2(P)** optical interfaces at any node in the OC-3 ring, it **must** be enabled at all nodes in the OC-3 ring and in the **FUNCTION UNITS** slots of the host OC-12 shelf.

NOTE:
The **rtrv-oc3:** command retrieves the `OC-3 Line Provisioning Report`. This report displays the provisioned configuration of OC-3 lines. See the "Commands and Reports" section of 363-206-290, *DDM-2000 OC-12 Multiplexer, Release 5 and Higher, User/Service Manual — Volume I* and 363-206-280, *DDM-2000 OC-3 Multiplexer, Release 8 and Higher, User/Service Manual — Volume I* for a description of the **rtrv-oc3:** command format.

Use the **rtrv-oc3:** command to obtain the `OC-3 Line Provisioning Report` and verify if Kbyte/Sbyte is enabled or disabled. Use the **set-oc3:** command to enable or disable the Kbyte/Sbyte parameter, as required.

DO ITEMS BELOW IN ORDER LISTED . . . . FOR DETAILS, GO TO

10.

NOTE:
If Sync Autoreconfiguration is enabled, Kbyte/Sbyte must also be enabled.

NOTE:
If Sync Autoreconfiguration is enabled at any line-timed OC-3 node in a ring, it **must** be enabled at all line-timed OC-3 nodes of a ring.

NOTE:
The **rtrv-sync:** command retrieves the Synchronization Report. This report displays the provisioning and operational information on the synchronization attributes of the DDM-2000. See the "Commands and Reports" section of 363-206-290, *DDM-2000 OC-12 Multiplexer, Release 5 and Higher, User/Service Manual — Volume I*) and 363-206-280, *DDM-2000 OC-3 Multiplexer, Release 8 and Higher, User/Service Manual — Volume I*) for a description of the **rtrv-sync:** command format.

Use the **rtrv-sync:** command to obtain the Synchronization Report and verify if Sync Autoreconfiguration is enabled or disabled. Use the **set-sync:** command to enable or disable the Sync Autoreconfiguration parameter, as required.

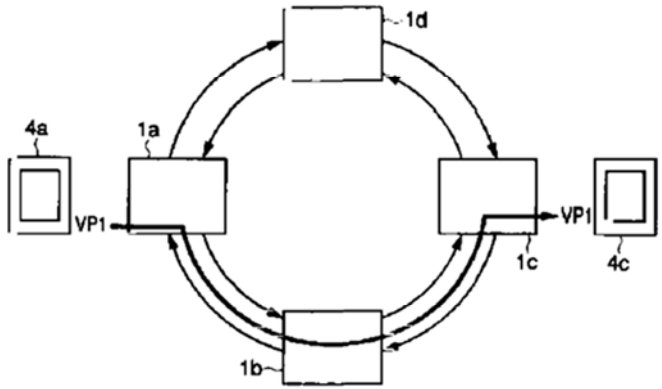
	Under at least the apparent claim scope alleged by Quicker Connections' Infringement Disclosures, Lucent 2000 Product Family in combination with (1) the knowledge of a person of ordinary skill in the art, alone or in further combination with (2) each (individually, as well as one or more together) of the references identified in element 1[b] of Exhibit D and F charts renders the claim, including the present limitation, obvious. Below are examples of such references. Omichi at Claim 2 ("The bifurcation insertion node according to claim 1, further comprising: processing means for determining whether or not a virtual path is affected by a ring link fault based on a location of the ring link where a fault has occurred stored in the first table, a ring link to be used as a working path set in the second table, and a route direction set in the route switching flag, and for causing the ring link communication means to transmit information in an opposite direction if the virtual path is affected, wherein the route selection method includes a first table provided for each virtual path for storing the location of the ring link where the fault has occurred, a second table provided for each virtual path and in which the ring link to be used as the working path is set, and a route switching flag provided for each virtual path and set to switch the direction of the route to be used as the working path.") Omichi at Claim 3 ("The bifurcation insertion node according to claim 2, wherein the second table and route switching flags of some virtual paths are set with all bits inverted.") Omichi at Claim 4 ("The bifurcation insertion node according to claim 2 or 3, wherein the numbers of the ring links used as working paths set in the second table are set to non-consecutive discrete numbers.") Omichi at [0012] ("[Means for Solving Problem] The bifurcation insertion node according to claim 1 is provided with a branch line link communication means for communicating information over the branch line link; ring link communication means for communicating information via the ring link, and route selection method for receiving notification of a ring link fault via the ring link communication means, and for causing the ring link communication means to transmit information in the opposite direction to a virtual path affected by the ring link fault.")

	Omichi at [0028]-[0030] ("[0028] FIG. 2(a) is a diagram illustrating an example of a virtual path used as a virtual information communication path. Virtual paths VP1 to VP4 respectively indicate the route from branch line node 4a to branch line node 4c, the route from branch line node 4a to branch line node 4d, the route from branch line node 4d to branch line node 4a, and the route from branch line node 4d to branch line node 4c. In this way, the ring links 2a to 2d and the branch line links 3a to 3d make it possible to accommodate a plurality of virtual paths on one transmission line. [0029] A virtual path is set between branch line nodes 4a to 4d via the ring network, and serves as a communication path for variable-length frames containing information or fixed-length ATM cells. FIG. 2(b) and FIG. 2(c) are diagrams illustrating the configurations of a frame and an ATM cell. As illustrated in FIG. 2(b), frame 5 includes a 4-byte header unit including a virtual path number, and an information unit in which information of 60 to 1518 bytes is stored. As illustrated in FIG. 2(c), ATM cell 6 includes a 5-byte header unit containing the virtual path number and an information unit containing 48 bytes of information. [0030] FIG. 3 is a diagram explaining the working path of a virtual path. A working path is a virtual path that is normally used, and in FIG. 3, virtual path VP1 which is a route from branch line node 4a to branch line node 4c is illustrated as an example.") Omichi at [0036]-[0038] ("[0036] FIG. 6(a) to FIG. 6(c) are diagrams for explaining the tables stored in the route information unit 9. The ring link fault table illustrated in FIG. 6(a) is a table for holding information on whether or not a fault has occurred in a ring link. This ring link fault table has a bit width equal to the maximum number of ring links in the ring network, and the bit numbers correspond to the ring link numbers. Each bit indicates that the corresponding ring link is not faulty when it is "0" and indicates that the corresponding ring link is faulty when it is "1." Therefore, when there is no fault, all bits in the ring link fault table are "0", but when a fault occurs in a ring link, the bifurcation insertion nodes 1a to 1d that receive the fault notification sets the content of the bit number corresponding to the ring link number where the fault occurred to "1." [0037] The used ring link table illustrated in FIG. 6(b) is a table set for each virtual path, and indicates the ring link to be used as the working path. This ring link table in use has a bit width equal to the maximum number of ring links in the ring network, and the bit number corresponds to the number of the ring link. Each bit indicates that the corresponding ring link is used as a protection path when it is "0", and indicates that the corresponding ring link is used as a working path when it is "1." [0038] The route switching flag illustrated in FIG. 6(c) is a flag that is set for each virtual path, and indicates whether the working path is clockwise or counterclockwise. When this route switching flag is "0", it indicates that the working path is clockwise, and when it is "1", it indicates that the working path is counterclockwise.")

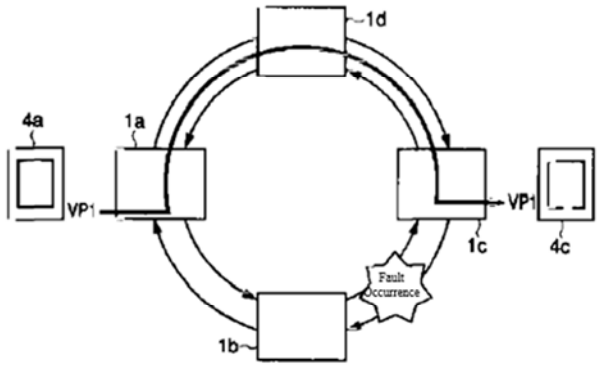
	Omichi at [0039]-[0043] ("[0039] FIG. 7 is a flow chart explaining the processing procedure of the bifurcation insertion node in this embodiment. First, when the route selection processing unit 8 receives a frame 5 or an ATM cell 6 from the branch line link receiving unit 13 (S1), it refers to the header of the frame 5 or the ATM cell 6 to identify its virtual path number (S2). [0040] Next, the route selection processing unit 8 judges whether or not the route switching flag corresponding to the virtual path number identified in step S2 is "0" (S3). If the route switching flag is "0" (S3, 0), the used ring link table corresponding to the virtual path number specified in step S2 is compared with the ring link fault table to determine whether or not there are bits with the same bit number and both bits set to "1" (S4). If there are no bits with the same bit number and both bits are set to "1" (S4, No), either there is no fault in the ring network, or even if there is a fault, the ring link in which the fault occurs is not included in the working path, so the ring link transmitting unit 10 is made to transmit the frame 5 or ATM cell 6 in a clockwise direction (S5). [0041] Furthermore, if there are bits with the same bit number and both bits are set to "1" (S4, Yes), the working path includes a ring link in which a fault has occurred, so the ring link transmitting unit 10 is caused to transmit the frame 5 or ATM cell 6 in a counterclockwise direction. That is, the frame 5 or ATM cell 6 is transmitted using the protection path (S6). [0042] Furthermore, if the route switching flag is "1" in step S3 (S3, 1), the used ring link table corresponding to the virtual path number identified in step S2 is compared with the ring link fault table to determine whether there is a bit whose contents are both "1" (S7). If there are no bits with the same bit number and both bits are set to "1" (S7, No), either there is no fault in the ring network or the working path does not include the faulty ring link even if a fault has occurred, therefore, the ring link transmitting unit 10 is made to transmit frame 5 or ATM cell 6 in a counterclockwise direction (S8). [0043] Furthermore, if there are bits with the same bit number and both bits are set to "1" (S7, Yes), the ring link includes a ring link whose working path has a fault, so the ring link transmitting unit 10 is instructed to transmit frame 5 or ATM cell 6 in a clockwise direction. That is, frame 5 or ATM cell 6 is transmitted using the protection path.") Omichi at [0046]-[0047] ("[0046] In the ring network of embodiment 1, for all of the virtual path usage ring link tables, a "0" indicates that the corresponding ring link is used as a protection path, and a "1" indicates that the corresponding ring link is used as a working path. When the route switching flag was "0", it indicated that the working path was clockwise, and when it was "1", it indicated that the working path was counterclockwise.

	[0047] In the ring network of this embodiment, the used ring link tables and route switching flags of some virtual paths are set in the same manner as the used ring links and route switching flags in the first embodiment. For the other virtual paths, the ring link tables used, and the route switching flags, the values of each bit are set by inverting them. For example, in the ring link table illustrated in FIG. 6(b), the bits b16 to b9 are set to "1" to be used as the working path, and the bits b8 to b1 are set to "0" to be used as the protection path. Also, the route switching flag illustrated in FIG. 6(c) is set to "0" to use the clockwise direction.") Omichi at [0049] ("[0049] In the initial stage of using a ring network, it is expected that the number of ring links actually used will often be smaller than the maximum number of ring links. In this embodiment, non-consecutive discrete numbers are set as the ring link numbers. In setting the ring link table for each virtual path of the bifurcation insertion node, the bit corresponding to the ring link number to be used is set to "1", and the bits between the bits set to "1" are also set to "1" in advance. When a new bifurcation insertion node is added to this ring network, the number of the new ring link is set to be between the ring link numbers on both sides of the insertion position.") Omichi at Figure 3 and 4

[FIG. 3]

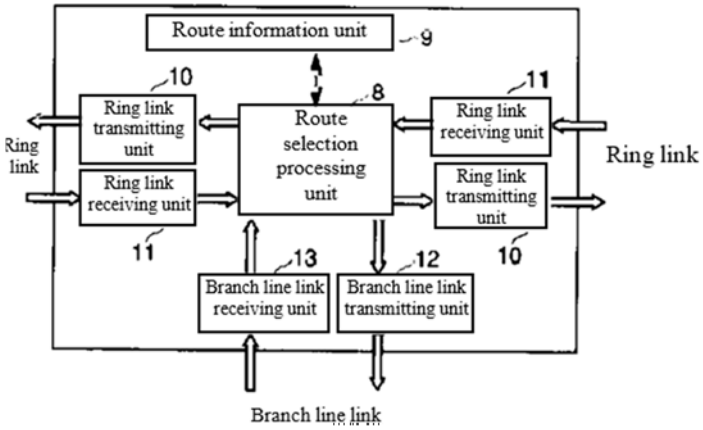


[FIG. 4]



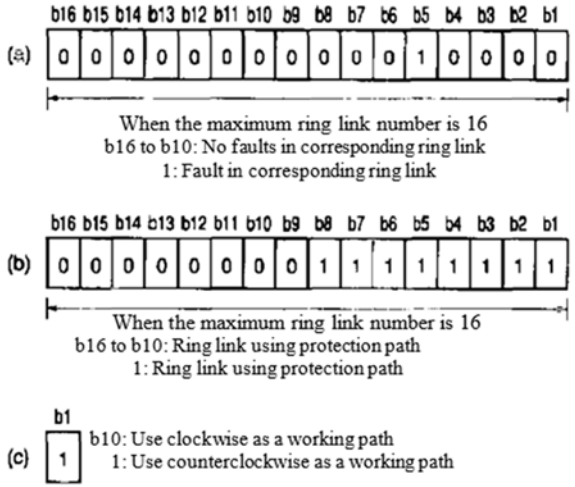
Omichi at Figure 5

[FIG. 5]



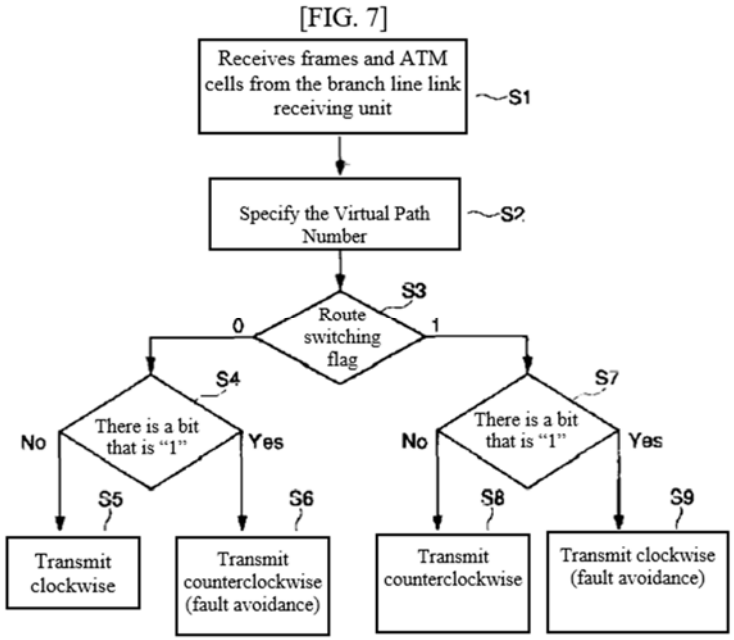
Omichi at Figure 6

[FIG. 6]



Omichi at 7

[FIG. 7]



Killat at Abstract ("The invention relates to a method, a structure and a communications network for transporting data packets, receive addresses being contained in said data packets. The communications network consists of linked bi-directional rings with so-called multi-nodes which switch between adjacent rings, and so-called single nodes which are arranged along the periphery of a ring as so-called add-drop multiplexers. The network is provided with a tree structure during initialization. The multi-nodes are the nodes of said tree structure and each branch consists of two segments which accommodate the add-drop multiplexers (2, 3, 5). All of the data packets follow the shortest paths in relation to said tree structure, and the routing information provided at the initialization stage is sufficient so that in the case of a breakdown in one segment only the single nodes of the segment and the at most two adjacent multi-nodes have to make new routing decisions. A multi-node is able to do so just from knowing the port connected to the defective segment, and the

	single node concerned is able to do so just from knowing which single nodes can still be reached in the direction of the defect.”) Killat at 1 (“The invention relates to a method for constructing and operating a communications network according to the preamble of Claim 1, in which data packets are routed through the network together with receiver addresses in order to ultimately be removed from the network by the receiver by evaluating the receiver addresses. The invention further relates to a redundant communications network for transporting data packets according to the preamble of Claim 17. State-of-the-art routing algorithms assume that network nodes exchange information about the shortest routes to other nodes, if known, or the status of the connected lines. Based on this information, each node calculates the minimum distances to all possible destination nodes and the corresponding output port (cf. D.E. Comer: Internetworking with TPC/IP, Vol. 1, 3rd ed., Prentice Hall (1995)). Since the information is exchanged approximately every 30 seconds, the network can adapt to the failure of lines or nodes within this time horizon. It would be better to find a method that can consider and bridge failures in much shorter time intervals (~ 1 msec).”) Killat at 2 (“The object of this invention is to provide a method for operating a communications network and a corresponding network which, when the network is initialized, already distributes all information on how data packets are to be routed in normal operation and in the event of an error. The main aim is to ensure that routing information does not have to be distributed in the network every time a connection is established or terminated. The invention minimizes connection setup times for connections under normal conditions as well as reconfiguration times in the event of an error.”) Killat at 2 (“Along all lines, also called "segments", there are "single" nodes, which are designed as "add-drop" multiplexers: they can send in both directions of their segment and receive from both directions. They also feature a receive/transmit port for a terminal device to be connected. A single node removes a packet from the network if it recognizes an address assigned to it in the recipient address. To send, it refers to a routing table (or recognizes from the structure of the recipient address) to see which output port it should send the packet to.

	The multi-nodes that link the rings are assigned an address on each adjacent segment, via which the multi-node can be addressed. The multi-nodes must also be informed in the form of rules or tables to which segment a received packet should be forwarded. Multi-nodes can be used to switch redundant paths if a section of the route or one or more single nodes in a segment failed.") Killat at 3 ("During initialization, a table is created for each multi-node that specifies the output port through which a specific destination address can be reached. According to the invention, the routing is defined in such a way that – regardless of any meshing – the routing is always carried out along the tree structure. Since it is a tree structure with double lines, if one segment fails, this strategy only needs to be slightly modified by the two adjacent multi-nodes and the single stations of the affected segment, using the second intact segment of the same branch.") Killat at 3-4 ("Fig. 3 Single node (with segment prefix SP0 and suffix SS0) in normal operation; NP: user port; BP: leaf port; WP: root port; Fig. 4 Single node (with segment prefix SP0 and suffix SS0) and a failed segment SP0; not reachable: SSX > SS0 (SSX < SS0), where the information in parentheses in the diagrams refers to the case: SSx < SS0; Fig. 5 Multi-node, failed segment with prefix SPX; SB: segment bit, PP: port prefix, SP: segment prefix, SS: segment suffix. The index o refers to the multi-node in question. WP: root port, NP: user port.") Killat at Figure 3

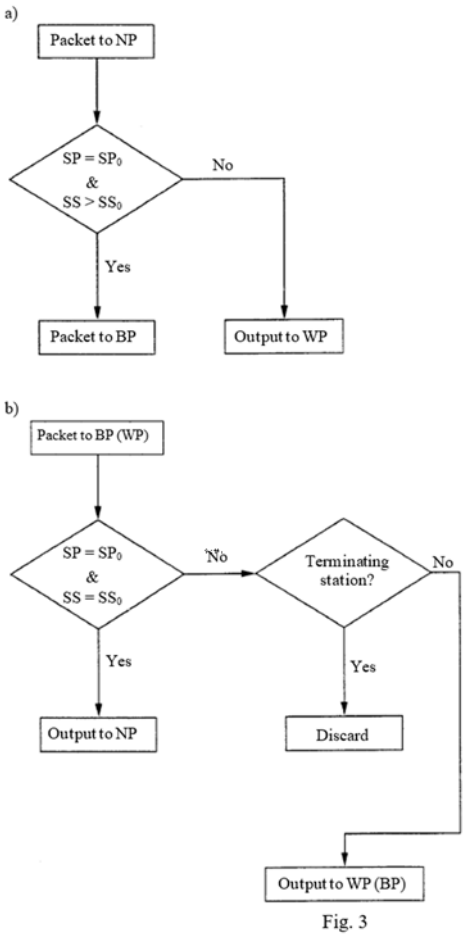


Fig. 3

Killat at Figure 4

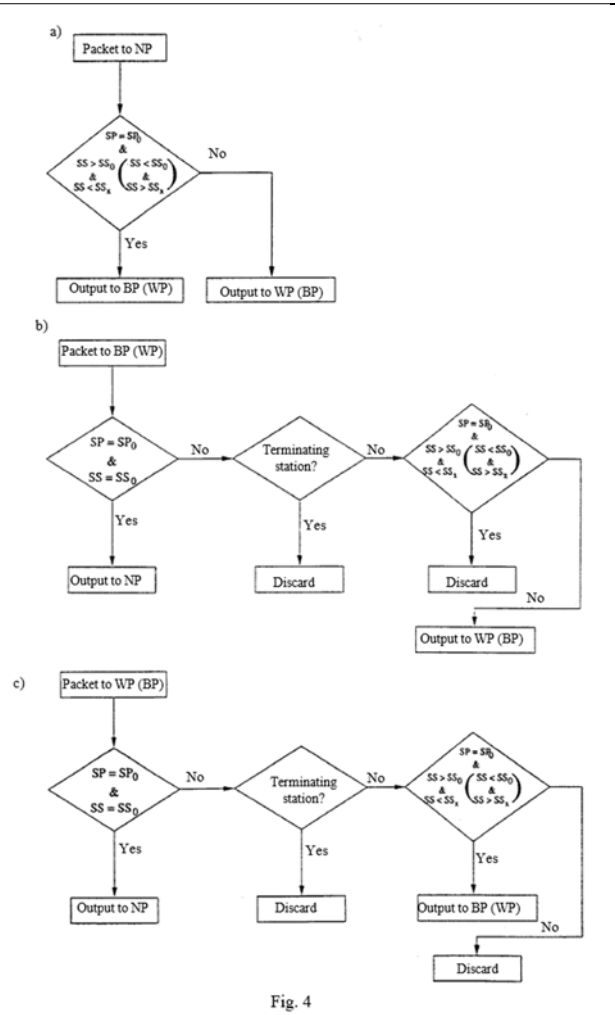


Fig. 4

Killat at Figure 5

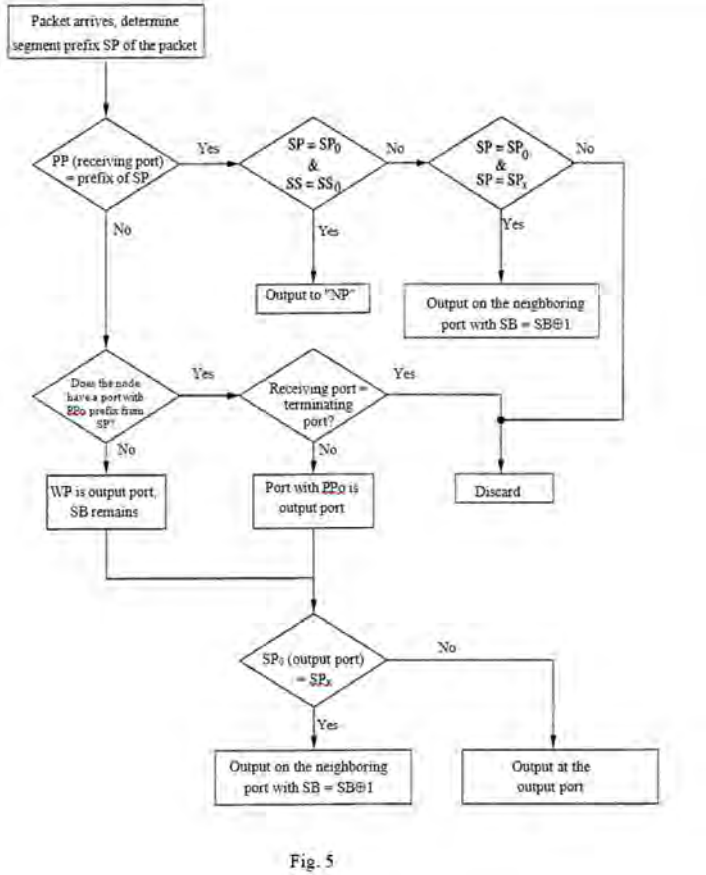
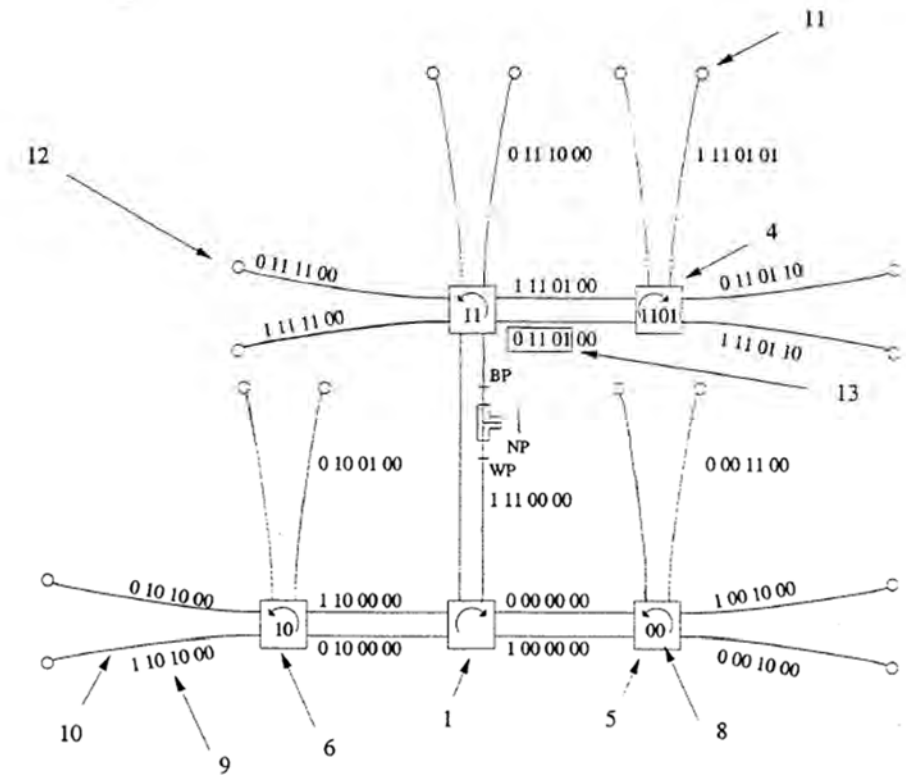


Fig. 5

Killat at 4 (“In the preferred version of the invention, the addresses are assigned in such a way that routing tables can be omitted because the address structure reflects the tree structure of the network. This situation is shown in Fig. 2, where the first 7 bits of the address of the single stations connected to this segment are indicated along the segments. This part of a node address (9 in Fig. 2), called the segment prefix SP, uniquely identifies a segment, for example segment 10. The first bit of an address, the segment bit SB, indicates whether the corresponding station is located on the left or right segment of a branch. Because of this left/right marking,

	neighboring multi-nodes must have a different sense of rotation when assigning address values, see Fig. 2: multi-nodes with an even placing have the same direction of rotation as the root node, those with an odd placing, e.g. at positions 5 and 6, have the opposite direction.") Killat at Figure 2  Fig. 2 Killat at 5 ("In addition to the user port NP, each single node has two network-side ports, which are referred to as the root port WP and the leaf port BP according to their location. The routing rules for the three ports in the undisturbed normal case are shown in Fig. 3. In the case that the station suffices do not increase monotonically,

	it must be recorded for all stations (= single nodes) of a segment whether they can be reached via the root port or the leaf port.") Killat at 5-6 ("If there is a failure on the segment in question, two stations adjacent to the failure area register the loss of communication capability. They communicate this loss to the network management using a special message. The network management informs the adjacent multi-nodes and the single nodes of the affected segment about the failure, which leads to the behavior outlined in Fig. 4 for the single nodes. One possible variant is that the affected stations could already receive and interpret the information addressed to the network management. This saves a delay equivalent to the duration of a signal round-trip. Killat at 6 ("The port prefix PP (13 in Fig. 2) at a multi-node is the bit sequence consisting of the segment bit SB, the node identifier K resulting from the tree structure (cf. 8 in Fig. 2) and the Idn bit port identifier. Port prefix PP and prefix of the connected segment SP differ for nodes of non-maximum order by low-order zeros.") Killat at 7 ("The routing decisions to be made, which are described in Fig. 3-5 , can be implemented using simple comparator circuits that check subaddresses for equality or "greater than" relationships. Another implementation compatible with the present invention would be to create a routing table in the form of a RAM (random access memory) in which the correct output port is entered for each conceivable receiving address according to the rules laid down in Fig. 3-5. A further implementation under the invention would consist in identifying each connection by a connection identifier, communicating the relationship between the connection identifier and the destination address to all the nodes or all the nodes involved in the connection in a signaling phase, whereupon the nodes, after analyzing the destination address constructed according to the invention, would independently complete the routing table according to the specified rules.") Killat at 7-8 ("In ATM networks with a network structure according to the invention, the header field contains segment prefix SP, station suffix SS and a connection identifier of length r, whereby the maximum number of connections that can be processed via a single station is 2r. In an alternative implementation variant, the method is as described in Section 3, final paragraph : the network works with connection identifiers VPIs/VCIs (Virtual Path Identifier / Virtual Circuit Identifier). In a signaling

	phase, the relationship between VPI/VCI and the invention address reflecting the topology, is revealed so that the nodes can make the entries in the routing tables for VPIs/VCls according to the rules in Fig. 3-5.") Killat at Claim 1 ("1. Method for constructing and operating a communications network for transporting data packets, each of which contains receiver addresses that can be evaluated by a terminal device addressed by them, the network having networked bidirectional rings with multi-nodes connecting the rings to one another and single nodes arranged along the periphery of the network, characterized in that during initialization the network is formed in a tree structure in which the multi-nodes, which contain root ports directed towards a root node and one or more leaf ports, are designed as nodes of the tree structure and each branch of the tree structure consists of two segments receiving the single nodes, the single nodes containing a root port, a leaf port and one or more user ports, that in the event of a failure in a segment the routing decisions for the data packets are made by the single node of the segment and the multi-nodes immediately adjacent to the segment, the routing decision of a multi-node being made from the knowledge of the failed segment and the routing decision of a single node being made from the knowledge of the single nodes that can still be reached in the direction of the failure.") Killat at Claim 2 ("2. Method according to claim 1, characterized in that the routing decision of a multi-node is made solely from the knowledge of the failed segment and/or the routing decision of a single node is made solely from the knowledge of the single nodes still reachable in the failure direction.") Killat at Claim 4 ("4. Method according to claim 3, characterized in that the segment prefix has a substructure predetermined by the number of node levels of the tree underlying the network, the segment prefix indicating how to reach the address in question starting from the root node of the tree.") Killat at Claim 17 ("17. Communications network for transporting data packets, each of which contains receiver addresses that can be evaluated by an end device addressed by them, the network having networked bidirectional rings with multi-nodes connecting the rings to one another and single nodes arranged along the periphery of the network, in particular to implement a method under claim 1, characterized in that the network is formed in a tree structure in which the multi-nodes, which contain root ports directed towards a root node and one or more leaf ports, are designed as nodes of the tree structure and each branch of the tree structure consists of two segments receiving the single nodes, the single nodes containing a root port, a leaf port and one or more user ports, so that single nodes of a segment and the multi-nodes immediately adjacent to the segment are formed in such a way that, in the event of a segment failure, the routing decisions for the data packets are

	made by the single node of the segment and the multi-nodes immediately adjacent to the segment, the routing decision of a multi-node being made from the knowledge of the failed segment and the routing decision of a single node being made from the knowledge of the single nodes that can still be reached in the direction of the failure.") Killat at Claim 20 ("20. Network according to claim 19, characterized in that the segment prefix has a substructure predetermined by the number of node levels of the tree underlying the network, the segment prefix indicating how to reach the address in question starting from the root node of the tree.") Killat at Claim 22 ("22. Network according to claims 17, 18 or 19, characterized in that the addresses are supplemented by a connection identifier which allows different connections to a destination station to be distinguished.")

1[c] superimposing the general and specific masks in order to determine a disposition of the flow.	Lucent 2000 Product Family discloses superimposing the general and specific masks in order to determine a disposition of the flow. For example, Lucent 2000 Product Family discloses K bytes and S bytes, which indicate whether a particular action needs to be taken to route network traffic, including whether a failure has occurred. Thus, at least under the claim scope alleged by Quicker Connection's Infringement Disclosures, this limitation is met. To the extent that Lucent 2000 Product Family is not found to meet this limitation, it would have been obvious to a person of ordinary skill in the art as explained below. DDM-2000 User/Service Manual at 1-11 **Release 8.1** is a linear release supporting *MegaStar*® 2000 SONET Radio. Release 8.1 requires the BBG8/BBG8B SYSCTL system controller and BBG9 or new BBG10 OHCTL overhead controller. Release 8.1 may be used for non-*MegaStar* 2000 applications when S1 byte synchronization messaging is desired. Release 8.1 will interwork with Releases 7.2 or 9.0. ■ New Applications: — *MegaStar* 2000 SONET Radio. Part of Lucent Technologies and Harris-Farinon *MegaStar* 2000 Radio system supporting mixed fiber and radio topologies. *MegaStar* applications require the BBG10 OHCTL. ■ New Features: — S1 Byte synchronization messaging. Uses the S1 byte of the SONET overhead to pass timing status information to different nodes in a loop-timed network. Synchronization messaging mode (S1 byte or K2 byte) is provisionable on a per OC-N basis. — CPro-2000, ITM SNC. Release 8.1 is supported by CPro-2000 Releases 5.0, 6.0, and ITM SNC Release 4.0.

DDM-2000 User/Service Manual at 1-14

- New Features:
  - S1-byte Synchronization Messaging. Uses the S1 byte of the SONET overhead to pass timing status information to different nodes in a loop-timed network. Synchronization messaging mode (S1 byte or K2 byte) is provisionable on a per-OC-3 basis.
  - Enhanced DS1 PM. Provides 15 minute bins for DS1 path and line PM data.
  - Fourth Level of Security. A new Maintenance security level, which allows access to Reports and some maintenance activities is provided in addition to the three current levels of privileged, general, and reports-only.
  - Quad-DS1 electrical loopbacks. Provides an electrical facility loopback of four DS1 interfaces from a given BBF1B or BBF3 DS1 circuit pack.
  - Large networks. Supports DDM-2000 and FiberReach networks of up to 50 nodes.
  - CPro-2000, ITM SNC support. Release 9.1 is supported by CPro-2000 Releases 5.0 and 6.0, and ITM SNC Releases 2.2 and 4.0.
  - 27G2-U OLIU. The new 27G2-U OLIU supports the new cross-connects necessary to provide enhanced FiberReach topologies.

DDM-2000 User/Service Manual at 5-45-5-48

Feature Details and Options

As mentioned previously, SONET synchronization messaging is used to communicate the quality of the subnetwork timing throughout the subnetwork. This is done using bits 1-3 of the K2 byte found in the SONET overhead. In OC-3 Release 9.1 and later releases, synchronization messaging can also be done using bits 5-8 of the S1 byte in the SONET overhead (not supported on OC-1 links). If a DDM-2000 OC-3 system is deriving timing from a given OC-N interface and synchronization messaging is enabled on that interface (Kbyte messages and Sbyte messages in OC-3 Release 9.1 and later are provisioned using the `set-ocn` command), the system interprets the received message to determine its internal timing status. The system also determines the state of the DS1 output, if the DS1 output is enabled. The DDM-2000 OC-3 system also transmits over the particular OC-N interface and all other OC-N interfaces that are enabled for synchronization messaging, the appropriate message indicating the quality of its timing, and its active timing mode. Table 5-3 and Table 5-4 list the associated internal timing status and DS1 output states that are associated with synchronization messages received from the OC-N interface when synchronization messaging is enabled. The tables list the messages from low- to high-quality.

Table 5-3. Synchronization Messages using K2 Byte

Received Message	Active Timing Mode *	Default DS1 Output State	Quality Level
Don't Use	Holdover	AIS	7
Timing Looped Back (TLB)	Holdover	AIS	7
Stratum 4 †	Holdover	AIS	6
Internal Clock (IC)	OK to use	AIS	5
Stratum 3 †	OK to use	Good	4
Stratum 2 †	OK to use	Good	3
Sync Quality Unknown (SQU)	OK to use	Good	2
Stratum 1 †	OK to use	Good	1

* This column applies only when provisioned for line-timing mode.

† Presently, DDM-2000 OC-3 Multiplexers cannot generate these messages, but they could be retransmitted and supported for auto-reconfiguration if any of these are received by a DDM-2000 OC-3 Multiplexer.

Table 5-4. Synchronization Messages using S1 Byte*

Received Message	Active Timing Mode †	Default DS1 Output State	Quality Level
Don't Use	Holdover	AIS	7
Traceable SONET minimum Clock	OK to use	AIS	5
Traceable Stratum 3 ‡	OK to use	Good	4
Traceable Stratum 2 ‡	OK to use	Good	3
Sync Trace Unknown	OK to use	Good	2
PRS Traceable ‡	OK to use	Good	1

* S1 byte not supported on OC-1 links.

† This column applies only when provisioned for line-timing mode.

‡ Presently, DDM-2000 OC-3 Multiplexers cannot generate these messages, but they could be retransmitted and supported for autoreconfiguration if any of these are received by a DDM-2000 OC-3 Multiplexer.

Synchronization messaging using the SONET K2 byte and S1 byte can be disabled on a per OC-N interface using the **`set-ocn`** command (not supported by OC-1). Zeros will be transmitted on bits 1-3 of the K2 byte if this is done; all ones will be transmitted on bits 5-8 of the S1 byte if this is done. The timing and synchronization status of a shelf can be determined using the **`rtrv-sync`** command.

The "Don't Use" message is sent when the system determines that its timing is not suitable for synchronization; for example, due to failure.

When the DDM-2000 OC-3 system is configured for external timing and its DS1 output port is provisioned for MULT mode, the message Sync Quality Unknown (SQU) for K byte, or Sync Trace Unknown (STU) for S byte, is sent on all the OC-N interfaces where synchronization messaging is provisioned. When the capability of communicating with a BITS clock over the DS1 overhead exists, the quality of the reference signal will be transmitted instead; for example, Stratum 1.

When the DDM-2000 OC-3 system is configured for external timing and its DS1 output port is provisioned for SYNC OUT mode, the Timing Looped Back (TLB) message for K byte, or "Don't Use" message for S byte, will be sent on the OC-N interfaces towards the NE from which the DS1 timing output is being derived. The SQU message for K byte or STU for S byte will be sent on all other OC-N interfaces where synchronization messaging is provisioned. If the DS1 output is generating AIS while the system is configured in this way, the message SQU for K byte, or STU for S byte, will be transmitted on all OC-N interfaces.

When the DDM-2000 OC-3 system is configured for free run or is in holdover mode, the Internal Clock message for K byte or Traceable SONET Clk for S byte

will be sent on all OC-N interfaces where synchronization messaging is provisioned.

When the DDM-2000 OC-3 system is configured for line timing, the TLB message for K byte and "Don't Use" for S byte will be sent on the OC-N interfaces towards the NE from which the timing is being derived. The message received on the OC-N interface will be sent on all other OC-N interfaces where synchronization messaging is provisioned.

With automatic synchronization reconfiguration, the DDM-2000 OC-3 Multiplexer systems use and compare the incoming synchronization messages on the OC-N interfaces available for line timing to select the highest quality synchronization reference available. If the received quality levels are the same on the references available for timing, the existing line timing reference take precedence. This feature guarantees the non-revertive operation of reconfiguration. The line timing reference is provisioned by the **`set-sync`** command.

The existence of automatic synchronization reconfiguration does not change the system's behavior on traditional line failures; for example, LOF, LOP, LOS, and others.

There are synchronization references in the DDM-2000 OC-3 system that can be provisioned as network timing sources but are not considered as timing sources for automatic synchronization reconfiguration. Examples of these are the linear extensions off of a DDM-2000 OC-3 ring. This type of interface is considered a linear interface, and the system treats it as such with regards to synchronization.

Table 5-5 lists the synchronization references available on DDM-2000 OC-3 and OC-12 system topologies.

Table 5-5. Available Synchronization References

System	Manually Provisionable	Automatically Reconfigurable
OC-3 Linear	Main, Fn-C	Main, Fn-C
OC-3 Rings	Main-1, Main-2, Fn-C	Main-1, Main-2, Fn-C
OC-12 Linear	Main-B	Not applicable
OC-12 Rings	Main-B-1, Main-B-2	Main-B-1, Main-B-2

Function unit C, when equipped with an OC-3/IS-3 OLIU, can be selected as an option for automatic synchronization reconfiguration. This is useful in DRI networks where an OC-3 ring is connected through an OC-3/IS-3 optical interface to an OC-12 or FT-2000 OC-48 Lightwave System ring.

In OC-3 Release 9.1 and later ring releases, the sending of DS1 AIS on the output of the BBF2B circuit pack can be provisioned by using the **set-sync** command. Depending on the quality level of the incoming sync messages, this new parameter can be provisioned to send DS1 AIS upon receiving level 5 (default), level 4, level 3, or level 2. Refer to Table 5-3 and Table 5-4 for definitions of quality levels. AIS will be sent as long as the received message is at the provisioned or greater in quality level number.

Examples

In this part, some detailed examples are given to show specifically how the synchronization messages propagate through the DDM-2000 OC-3 network and assist in the recovery from a fiber failure. Through these examples, one can extend the same concept to any other network that may include different topologies, number of sites, failure locations, and number of BITS clocks.

NOTE:
All nodes in a ring using automatic synchronization reconfiguration must have the synchronization messaging and automatic synchronization reconfiguration features enabled to prevent alarms.

In all of the following examples, if the sync message parameter within the **set-oc3** command has been provisioned to "S byte" for an optical interface, then the equivalent S byte message will be transmitted from that optical interface. The following are equivalent messages:

K2: Sync Quality Unknown is the same as, S1: Sync Trace Unknown

K2: Timing Looped Back is the same as, S1: Don't Use

K2: Internal Clock is the same as, S1: Traceable SONET minimum Clock

K2: Stratum 3 is the same as, S1: Traceable Stratum 3.

DDM-2000 User/Service Manual at 5-56

Dual-Homing DRI Synchronization Configurations

OC-3 and FT-2000 OC-48 Lightwave System

Figure 5-30 shows how OC-N timing can be distributed from an FT-2000 OC-48 Lightwave System line-switched ring to a DDM-2000 OC-3 path-switched ring using a dual-homing DRI configuration. The OC-3 DRI nodes are connected via OC-3 point-to-point links terminating in function unit C slots. The major characteristics of this configuration are:

- The FT-2000 OC-48 Lightwave System nodes are through-timed and derive timing from different rotations of the OC-48 ring.
- The FT-2000 OC-48 Lightwave System must be provisioned to write stratum 3 synchronization message to the K2 byte so the DDM-2000 ring can use synchronization messaging.
- The two DDM-2000 OC-3 DRI nodes coordinate timing using synchronization status messages on the OC-3 ring so that all nodes will accept timing in the same direction.
- The two DDM-2000 OC-3 DRI nodes must be provisioned for line-timing with timing derived from function unit C. Synchronization messaging on the OC-3 span between the two OC-3 DRI nodes must be disabled so timing loops are not formed. Synchronization messaging and automatic synchronization reconfiguration should be enabled on all other OC-3 interfaces on the DRI nodes.
- All other OC-3 nodes must be provisioned for line-timing with synchronization messaging and automatic synchronization reconfiguration enabled.

DDM-2000 User/Service Manual at 10-38

SONET Overhead Bytes

The DDM-2000 OC-3 Multiplexer currently uses the K2 byte in the SONET format for synchronization signaling. The reserved V4 byte in the VT1.5 superframe is used for internal fault detection in a DDM-2000 OC-3 Multiplexer shelf. This internal usage of the V4 byte may cause the value of the transmitted V4 byte to vary.

The DDM-2000 OC-3 Multiplexer does not depend on, and always ignores, the value of the V4 byte received from another DDM-2000 or other shelf with an OC-3 interface.

Performance

Wander/Jitter

- For SONET optical interfaces, the maximum time interval error (MTIE) does not exceed 60 nanoseconds phase variation when timed with a wander-free reference
- Jitter transfer, tolerance, and generation requirements are met as specified in GR-253-CORE and GR-499-CORE
- The SONET interfaces meet the T1.101 OC-N output short-term stability mask.

Signal Performance

The following specifications apply given the standard networks defined in GR-499-CORE.

- For systems interfacing at the DS1 rate, the number of errored seconds, during a 2-hour, one-way loopback test, is less than 10
- For systems interfacing at the DS3 rate, the number of errored seconds, during a 2-hour, one-way loopback test, is less than 72
- The BER is less than 10^{-9} for both the DS1 and DS3 rates. Burst-errored seconds are excluded
- The frequency of burst-errored seconds, other than those caused by protection switching induced by hard equipment failures, averages less than four per day.

DDM-2000 User/Service Manual at 11-195

	Kbyte Message — The valid values for this parameter are `enabled`, indicating that proprietary Sync messages are used, and `disabled`, indicating that proprietary Sync messages are not used. The Sync messages use the K2 byte in the SONET overhead to determine synchronization quality. These values are set by the **`set-oc3`** command. Sync Message — Beginning with OC-3 Releases 8.1 and 9.1, this parameter indicates the type of synchronization messaging that has been provisioned for that OC-3 optical interface by the **`set-oc3`** command. The valid values for this parameter are `Kbyte` (default value), `Sbyte`, and `disabled`. The sync messages use the K2 byte or the S1 byte in the SONET line overhead to determine synchronization quality. Concat Mode — This parameter is used in linear releases only. This report parameter is visible only if the STS3c mode is enabled via the **`set-feat`** command. This indicates if the addressed line is concatenated or not. The valid values are `enabled` and `disabled`. For OC-3, only function unit C slots can report concatenated values. Radio — This parameter is avaliable with linear releases only and is reported if this a *MegaStar* 2000 system. It has a value of **`yes`** or **`no`**, and it indicates whether there is a Radio Frequency Unit (RFU) connected to the SONET subsystem through an IS-3 interface. AIS Alarm — This parameter specifies the alarm level of a non-service-affecting OC-3 line AIS failure condition. The valid values are: **`cr`** Critical alarm **`mj`** Major alarm **`mn`** Minor alarm **`na`** Not alarmed, but reported (default). **RELATED COMMANDS** rtrv-sync DDM-2000 User/Service Manual at 11-197

The output parameters are:

`Line Address` Address of the OC-12 line.

`Signal Degrade Threshold`
This is the bit error rate (BER) threshold as a logarithm to the base 10. The value of *n* is an integer with a range of -5 through -9 corresponding to BERs of 10^{-5} through 10^{-9}. If a slot is empty or equipped with something other than an OC-12 optical unit, a hyphen (-) will appear in this column.

`Sync Message` For OC-3 Release 11.0 and later ring releases, this parameter indicates the type of synchronization messaging that has been provisioned for that OC-12 optical interface by the **`set-oc12`** command. The valid values for this parameter are `Kbyte` (default value), `Sbyte`, and `disabled`. The sync messages use the K2 byte or the S1 byte in the SONET line overhead to determine synchronization quality.

`AIS Alarm` This parameter specifies the alarm level of a non-service-affecting OC-12 line AIS failure condition. The valid values are

- **`cr`** Critical alarm
- **`mj`** Major alarm
- **`mn`** Minor alarm
- **`na`** Not alarmed, but reported (default)

RELATED COMMANDS

set-oc3

set-oc12

DDM-2000 User/Service Manual at 11-277

the `src` parameter is set to `fn-c` and the DS1 synchronization output is provisioned for `SYNC OUT` mode.

In addition to the condition mentioned above, in OC-3 Release 9.1 and future ring releases, DS1 Output Mode will not be reported when `Sync Autoreconfiguration` parameter is enabled. This will prevent any confusion in reading the report when the autoreconfiguration forces the `Active Reference/Line` parameter to switch to a better source.

`AIS Threshold`

In OC-3 Release 9.1 and later ring releases, this parameter indicates the provisioned sync message quality level and its equivalent sync message phrase for the active reference at which, or greater incoming quality level numbers, DS1 AIS will be transmitted on the sync output of the BBF2B TGS or BBF4 TG3 circuit pack. If the `syncmsg` parameter within the **`set-oc3`** or **`set-oc12`** command is set to `disabled`, then the word `disabled` will be reported with the provisioned value of this parameter. It may be set to one of the following options:

`level5`	default value. (K2: Internal Clock, S1: Traceable SONET Clk, or disabled)
`level4`	(K2: Stratum 3, S1: Traceable Stratum 3, or disabled)
`level3`	(K2: Stratum 2, S1: Traceable Stratum 2, or disabled)
`level2`	(K2: Sync Quality Unknown, S1: Sync Trace Unknown, or disabled)

For a definition of quality levels, refer to the Sync Message Information section of this command pages.

`DS1 Output State`

The output state is the status of the DS1 output when in the *`sync out`* mode, and may be one of the following:

`good`	This status indicates that the DS1 output is traceable to the incoming OC-1 (Release 9.1 and later), OC-3 signal, or OC-12 (if Main unit slots are equipped with 24G-U OLIU packs). line.

	DDM-2000 User/Service Manual at 11-339

For ring releases, the signal degrade value for addresses of main-1 and main-2 *must* be the same. Therefore, any change to signal degrade for one address will automatically be made to the other by the software.

kbyte

NOTE:
This parameter is only applicable to Releases 8.0 and 9.0. This parameter is no longer be used for DDM-2000 OC-3 Releases 8.1, 9.1, and later releases. For later releases, the **syncmsg** parameter is used in place of the **kbyte** parameter.

Kbyte specifies the usage of the K byte overhead for Sync Messages. Both the sending and receiving messages are affected. If Kbyte is `enabled`, proprietary Sync Messages are used. If Kbyte is `disabled`, proprietary Sync Messages are not used. The default value is `enabled`. For main slots m1 and m2 in ring applications, the kbyte value could be different on both rotations of the ring.

syncmsg This parameter is available in OC-3 Releases 8.1, 9.1, and later releases. Synchronization messaging allows timing to be reconfigured in a network upon a node or fiber failure. This parameter has one of the following values:

`Kbyte` This is the default value. When this option is selected, both K2 and S1 byte sync messages are transmitted, but only K2 byte is received and interpreted for sync messaging.

`Sbyte` When this option is selected, only the S1 byte is sent and received for sync messaging. K2 byte will always send a "Don't Use" message.

NOTE:
To minimize the amount of time that DDM-2000 is in holdover mode when upgrading a ring network from **Kbyte** to **Sbyte** messages, it is recommended that the user first upgrade the nodes farthest away from the external timing source, and then proceed to nodes closer to the timing source.

`disabled` When this option is selected, interpretation of both K2 and S1 bytes will be disabled and hence a "Don't Use" message will be transmitted on both bytes at all times.

	DDM-2000 User/Service Manual at 11-345

syncmsg This parameter is available in OC-3 Release 11.0 and later rings releases. Synchronization messaging allows timing to be reconfigured in a network upon a node or fiber failure. Parameter value is one of the following:

- `Kbyte` This is the default value. When this option is selected, both K2 and S1 byte sync messages are transmitted, but only K2 byte is received and interpreted for sync messaging.
- `Sbyte` When this option is selected, only the S1 byte is sent and received for sync messaging. K2 byte will always send a "Don't Use" message.
- `disabled` When this option is selected, interpretation of both K2 and S1 bytes will be disabled and hence a "Don't Use" message will be transmitted on both bytes at all times.

aisalm For ring releases, the AIS alarm values for Main-1 and Main-2 (when using the 24-type OLIU circuit packs in the Main unit slots) must be the same. Any change to one address will also be made automatically to the other by the software. Alarm is the provisioned alarm level of the non-service affecting (NSA) OC-12 line AIS and has the following values:

- `cr` Critical alarm
- `mj` Major alarm
- `mn` Minor alarm
- `na` Not alarmed, but reported (default)

If an attempt is made to execute this command, when a mix of incompatible OLIU packs exists in Main, the request will be denied with the following message:

```
SNVS
/* Status, Not in Valid State */
/* Both main slots must be equipped with compatible OLIU packs. */
```

DDM-2000 User/Service Manual at 11-406

BBF2B TGS circuit packs. As long as the incoming quality level number is at or greater than the provisioned level, AIS will be transmitted. This parameter is listed in ascending quality order and may have one of the following values:

level5 This is the default value. Send DS1 AIS for incoming quality level 5 (K2: Internal Clock, S1: Traceable SONET Clk) or greater (that is, quality level 6 or 7).

level4 Send DS1 AIS for incoming quality level 4 (K2: Stratum 3, S1: Traceable Stratum 3) or greater.

level3 Send DS1 AIS for incoming quality level 3 (K2: Stratum 2, S1: Traceable Stratum 2) or greater.

level2 Send DS1 AIS for incoming quality level 2 (K2: Sync Quality Unknown, S1: Sync Trace Unknown) or greater.

auto SyncAutoreconfiguration allows the system to choose the best timing source to use when it is provisioned for Line Timing. The synchronization source selection is based on the synchronization messages received from the available timing (synchronization) sources. Automatic Protection Switching takes place to the standby timing source when the active source fails. The switch is nonrevertive, and there will not be an automatic switch back to the former timing reference.

When SyncAutoreconfiguration is enabled, the system automatically reconfigures between line timing sources **main** and **fn-c** in linear systems and **main-1** and **main-2** in ring systems.
In ring releases, **fn-c** will also be a source option. Use the **switch-sync** command to manually switch to the other timing source.

enabled SyncAutoreconfiguration is active.

disabled SyncAutoreconfiguration is not active (default).

If hardware provisioning switches are set for FreeRunning timing mode, execution of this command will be denied with the following message:

```
SNVS
/* Status, Not in Valid State */
/* System provisioned for free-running. */
```

DDM-2000 User/Service Manual at A-5 – A-8

Each SONET layer has a set of overhead bytes as shown in Figure A-4. These bytes carry information used by various network elements.

- **Section Overhead** contains information that is used by all SONET equipment including repeaters.
- **Line Overhead** is used by all SONET equipment except repeaters.
- **Path Overhead** is carried within the payload envelope.
  - **STS-1 path overhead** remains with the STS-1 SPE until its asynchronous signal is extracted (for example, DS-3) or until its individual VT1.5 signals are demultiplexed.
  - **VTN (N= 1.5, 2, 3, or 6) path overhead** remains with the VTN until its asynchronous signal is extracted.

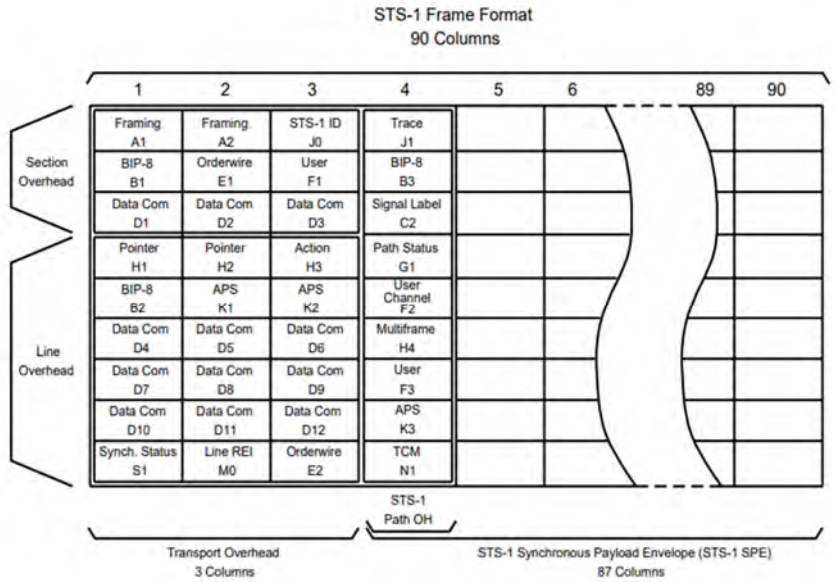


Figure A-4. SONET Frame Format

SONET Frame Structure

The following pages provide more detailed information on the function of various overhead bytes for each SONET layer.

Section Overhead

- Framing (A1, A2)
  - Provides framing for each STS-1.
- STS-1 ID (J0)
  - Provides the order of appearance in a byte-interleaved STS-*N* frame; for example, STS-1 #1, STS-1 #2.....STS-1 #48. In future applications, this byte will provide a section trace function. For information on STS-*N* signals, see the "Higher Rate Transport" part of this section.
- Section Bit-Interleaved Parity (BIP-8) (B1)
  - Provides SECTION performance monitoring and is calculated over all bits of the previous STS-*N* frame. Defined only for STS-1 #1 of an STS-*N* signal.
- Section Order Wire (E1)
  - Provides a local order wire for voice communication channel between section terminating network elements, such as repeaters. Defined only for STS-1 #1 of an STS-*N* signal.
- Section User Channel (F1)
  - Set aside for the user's purpose. Defined only for STS-1 #1 of an STS-*N* signal.
- Section Data Communications Channel (D1, D2, D3)
  - Is a 192 kb/s message-based channel. Used for alarms, maintenance, control, monitoring, and other communication needs between section terminating equipment. Defined only for STS-1 #1 of an STS-*N* signal.

Line Overhead

- Line Pointer (H1, H2)
  - Two bytes indicate the offset in bytes between the pointer action byte (H3) and the first byte (J1) of the STS-1 synchronous payload envelope (SPE).
- Pointer Action (H3)
  - One byte is allocated for frequency justification.
- Line Bit-Interleaved Parity (BIP-8) (B2)
  - This byte is for line performance monitoring. This byte is provided in all STS-1 signals within an STS-*N* signal.
- Line Automatic Protection Switching (APS) (K1, K2)
  - Two bytes used for APS signaling between line level entities. In addition, bits 6, 7, and 8 of K2 are used for line alarm indication signal (AIS) and line far-end receive failure (FERF). Defined only for STS-1 #1 of an STS-*N* signal.
- Line Data Communications Channel (D4 - D12)
  - Is a 576 kb/s message-based channel.
- Synch. Status (S1)
  - In STS-1 #1, the S1 byte is for synchronization status messages, and only bits 5 through 8 are used.
- Line REI (M0)
  - The M0 byte is for STS-1 line far-end block error (FEBE), and only bits 5 through 8 are used.
- Line Orderwire (E2). Defined only for STS-1 #1 of an STS-*N* signal.
  - One byte is allocated to be used as an express orderwire between line terminating equipment.

Path Overhead

There are two types of path overheads:

- STS-1 path overhead
- VT path overhead.

STS-1 Path Overhead

The STS-1 path overhead is assigned to and remains with the STS-1 SPE until the payload is extracted and is used for functions that are necessary to transport all synchronous payload envelopes.

- STS-1 Path Trace (J1)
  - Repetitively transmits a 64 byte, fixed length, string so that an STS-1 path receiving terminal can verify its continued connection to the intended transmitter.
- STS-1 Path Bit-Interleaved Parity (BIP-8) (B3)
  - Provides each STS-1 path performance monitoring. This byte is calculated over all bits of the previous STS-1 SPE before scrambling.
- STS-1 Path Signal Labels (C2)
  - Indicates the construction of the STS-1 SPE. A value of 00000000 indicates an unequipped STS-1 SPE. Values for various payload mappings are defined in TR-NWT-000253, Issue 2.
- STS-1 Path Status (G1)
  - Conveys the STS-1 path terminating status, far end block errors (FEBE), and yellow alarm signal conditions back to an originating STS-1 path terminating equipment.
- STS-1 Path User Channel (F2, F3)
  - User communication channel between Path elements.
- VT Multiframe Indicator (H4)
  - Provides a general multiframe indicator for VT-structured payloads.
- STS-1 Path Automatic Protection Switching (K3)
  - Path Automatic Protection Switching
- TCM - Tandem Connection Maintenance (N1)
  - Bits 1-4 used for incoming error monitoring. Bits 5-8 used as communications channel.

DDM-2000 User/Service Manual at GL-16

Protection Line

As defined by the SONET standard, the protection line is the pair of fibers (one transmit and one receive) that carry the SONET APS channel (K1 and K2 bytes in the SONET line overhead). On a DDM-2000 OC-3 system, a *protection* line is a pair of fibers that terminate on an OLIU circuit pack in the `main-2`, `fn-a-2`, `fn-b-2`, or `fn-c-2` slot. (See "Service Line.")

DDM-2000 User/Service Manual at GL-21

Unidirectional

A protection switching mode in which the system at each end of an optical span monitors both service and protection lines and independently chooses the best signal (unless overridden by an equipment failure or by an external request, such as a forced switch or lockout). In a system that uses unidirectional line switching, both the *service* and *protection* lines may be *active* simultaneously, with one line carrying traffic in one direction and the other line carrying traffic in the other direction. The K1 and K2 bytes in the SONET line overhead are used to convey to the far end which line the near end receiver has chosen, so that an "active" indication may be made at the far end.

DDM-2000 TARP Release 13 at 815

Table A – DDM-2000 OC-3 Parameters Provisionable Via the CIT

Parameter	Range	Default (Note 1)	Command (Note 2)
Date	current value	70-01-01	set-date
Time	current value	00:00:00	set-date
Target ID (system name)	20 characters	LT-DDM-2000	set-ne
Remote NE Status	enabled,disabled		set-ne
Alarm Group	1-255	255	set-ne
Alarm Gateway NE	yes,no	no	set-ne
Shelf number	1-8	1	set-ne
Idle channel signal	STS Uneqpd./AIS insert	AIS	set-ne
	VT Uneqpd./AIS insert	AIS	
CO/RT select	CO, RT	RT	set-ne
CIT page length	0 (pager off), 3-150 rows	24	set-link
PM thresholds	See PM Table	-	set-pmthres
Alarm holdoff delay	0-30 sec	2	set-attr-alm
Alarm clear delay	0-30 sec	15	set-attr-alm
Power minor almn. level	MN, MJ	MN	set-attr-alm
OC1 degrade threshold	10^{-5} to 10^{-9}	10^{-6}	set-oc1
AIS almn. level of NSA OC-1			
Line AIS	CR, MJ, MN, NA	NA	set-oc1
OC3 degrade threshold	10^{-5} to 10^{-9}	10^{-6}	set-oc3
Sync messaging	K byte, S byte, disabled	K byte	set-oc3
AIS almn. level of NSA OC-3			
Line AIS	CR, MJ, MN, NA	NA	set-oc3
DccMode	distinct,identical	distinct	set-oc3
Application	0x1,1+1	1+1	set-oc3
OC12 degrade threshold§§§	10^{-5} to 10^{-9}	10^{-6}	set-oc12
Sync messaging§§§	K byte, S byte, disabled	K byte	set-oc12
AIS almn. level of NSA OC-12			
Line AIS§§§	CR, MJ, MN, NA	NA	set-oc12
DccMode	distinct,identical	distinct	set-oc12
STS-1 path signal degrade threshold†††	10^{-5} to 10^{-9}	10^{-6}	set-sts1
Signal fail alarm threshold	10^{-3} to 10^{-6}	10^{-3}	set-sts1
NSA STS-1 path AIS alarm level	MN, NR	MN	set-sts1
SA STS-1 path AIS alarm level	CR, MN, NA, NR	MN	set-sts1
STS-1 channel state***	NMON, AUTO‡	AUTO	set-state-sts1
OC-1 line state‡‡‡	NMON, IS	IS	set-state-oc1

See notes and footnotes at end of table.

DDM-2000 TARP Release 13 at 46 -47

DO ITEMS BELOW IN ORDER LISTED. . . . . FOR DETAILS, GO TO

6. ⇒ NOTE:
The **rtrv-map-network** and **rtrv-map-neighbor** commands may be used to retrieve a map of the network, including the systems in the network and how they are connected.

Ensure all DDM-2000 OC-3 shelves (**OLIUs**) in the network have been properly connected to the optical facility. Verify the integrity of each optical span. DLP-514

7. ⇒ NOTE:
If Kbyte/Sbyte (sync messaging) is enabled for the at any node in a system, it **must** be enabled at all nodes of the system.

⇒ NOTE:
The **rtrv-oc3:** or **rtrv-oc12:** command retrieves the `OC-3 Line Provisioning Report` or `OC-12 Line Provisioning Report`. This report displays the provisioned configuration of OC-3 lines. See the Commands and Reports section of this manual for a description of the **rtrv-oc3:** or **rtrv-oc12:** command format.

Use the **rtrv-oc3:** or **rtrv-oc12:** command to obtain the `OC-3 Line Provisioning Report` or `OC-12 Line Provisioning Report` and verify if Kbyte/Sbyte is enabled or disabled. Use the **set-oc3:** or **set-oc12** command to enable or disable the Kbyte/Sbyte parameter, as required.

DO ITEMS BELOW IN ORDER LISTED . . . . .FOR DETAILS, GO TO

8. **NOTE:**
If Sync Autoreconfiguration is enabled, Kbyte/Sbyte must also be enabled.

NOTE:
The **rtrv-sync:** command retrieves the Synchronization Report. This report displays the provisioning and operational information on the synchronization attributes of the DDM-2000. See the Commands and Reports section of this manual for a description of the **rtrv-sync:** command format.

Use the **rtrv-sync:** command to obtain the Synchronization Report and verify if Sync Autoreconfiguration is enabled or disabled. Use the **set-sync:** command to enable or disable the Sync Autoreconfiguration parameter, as required.

9. **NOTE:**
The section data communication channel (DCC), used for far end communications, must be enabled at each network element (shelf) for the end-to-end line test to work. Default condition for the DCC channel is "enabled". If it has been disabled, use the **set-fecom:** command **at each shelf** to enable far end communications.

NOTE:
The **rlgn** command can be used to log in to each shelf at optical span being tested.

Perform end-to-end line test on all optical spans. Report any failures to the organization that installed the DDM-2000. DLP-515

10. Perform end-to-end DS1 transmission test in the **Mux** direction for each function unit group, if required.

A.	DS1 Single Ring Test in **Mux** Direction	DLP-510
B.	DS1 Dual Ring (DRI) Test in **Mux** Direction	DLP-554
C.	DS1 Single/Dual Homing Test in **Mux** Direction	DLP-510

DDM-2000 TARP Release 13 at 223

DO ITEMS BELOW IN ORDER LISTED. . . . . FOR DETAILS, GO TO

22. ⇒ **NOTE:**
If Sync Autoreconfiguration is enabled, Kbyte/Sbyte must also be enabled.

⇒ **NOTE:**
If Sync Autoreconfiguration is enabled at any line-timed OC-3 node in a ring, it **must** be enabled at all line-timed OC-3 nodes of a ring.

⇒ **NOTE:**
The **rtrv-sync:** command retrieves the `Synchronization Report`. This report displays the provisioning and operational information on the synchronization attributes of the DDM-2000. See the Commands and Reports section of 363-206-295, *DDM-2000 OC-12 Multiplexer, TARP Release 7, User/Service Manual—Volume I*, and 363-206-285, *DDM-2000 OC-3 Multiplexer, TARP Release 13 and Later, User/Service Manual—Volume I*, for a description of the **rtrv-sync:** command format.

Use the **rtrv-sync:** command to obtain the `Synchronization Report` and verify if Sync Autoreconfiguration is enabled or disabled. Use the **set-sync:** command to enable or disable the Sync Autoreconfiguration parameter, as required.

23. ⇒ **NOTE:**
Two or more shelves in the same network **cannot** have the same system name or TID (set by the **set-ne:** command).

Verify no duplicate TID settings exist. The **rtrv-ne:** command may be used at each shelf in the network to display settings. If duplicates exist, determine new settings and use the **set-ne** command to make new settings.

DDM-2000 TARP Release 13 at 254-255

DO ITEMS BELOW IN ORDER LISTED. . . . . FOR DETAILS, GO TO

Use the **ent-crs-vt1:** or **ent-crs-sts1:** command at the new shelf to make all required *pass-through* cross-connections (for example, **ent-crs-vt1:m-1-1-1,m-1-1-1** or **ent-crs-sts1:m-1,m-1**). Pass-through cross-connections must be made at the new shelf to correspond to each terminating cross-connection present on every shelf in the ring network. (See Figure 1.)

9. **NOTE:**
If Kbyte or Sbyte (sync messaging) is enabled for the **main-1** and **main-2** optical interfaces at any node in a ring, it **must** be enabled at all nodes of the ring.

NOTE:
The **rtrv-oc3:** or **rtrv-oc12:** command retrieves the `OC-3 Line Provisioning Report` or `OC-12 Line Provisioning Report`. This report displays the provisioned configuration of OC-3 or OC-12 lines. See the Commands and Reports section of this manual for a description of the **rtrv-oc3:** or **rtrv-oc12:** command format.

Use the **rtrv-oc3:** or **rtrv-oc12:** command to obtain the `OC-3 Line Provisioning Report` or `OC-12 Line Provisioning Report` and verify if Kbyte/Sbyte is enabled or disabled. Use the **set-oc3:** or **set-oc12:** command to enable or disable the Kbyte/Sbyte parameter, as required.

DO ITEMS BELOW IN ORDER LISTED . . . . .FOR DETAILS, GO TO

10. **NOTE:**
If Sync Autoreconfiguration is enabled, Kbyte/Sbyte must also be enabled.

NOTE:
If Sync Autoreconfiguration is enabled at any line-timed node in a ring, it **must** be enabled at all line-timed nodes of a ring.

NOTE:
The **`rtrv-sync:`** command retrieves the `Synchronization Report`. This report displays the provisioning and operational information on the synchronization attributes of the DDM-2000. See the Commands and Reports section of this manual for a description of the **`rtrv-sync:`** command format.

Use the **`rtrv-sync:`** command to obtain the `Synchronization Report` and verify if Sync Autoreconfiguration is enabled or disabled. Use the **`set-sync:`** command to enable or disable the Sync Autoreconfiguration parameter, as required.

11. **WARNING:**
Unterminated optical connectors may emit invisible laser radiation. Eye damage may occur if beam is viewed directly or with improper optical instruments. Avoid direct exposure to the beam.

CAUTION:
An automatic protection switch service hit may occur when the correct optical fibers are cut. Cutting the wrong fiber lines will cause a service interruption.

At the point where the new DDM-2000 shelf will be added, use local procedures to cut the two fiber lines connecting existing shelves and condition the fiber for connection to the new shelf.

DDM-2000 TARP Release 13 at 814

set-oc3	Sets the characteristics of an OC-3 line pair. Sets the signal degrade threshold of the OC-3 line as a bit error rate (BER). Specifies if sync message signaling uses kbyte or sbyte or is enabled or disabled. Specifies if the concatenation mode (concat) of the OC-3 line is to be independent STS-1 channels or an sts-3c channel.
set-oc12	Sets the characteristics of an OC-12 line pair. Sets the signal degrade threshold of the OC-12 line as a bit error rate (BER). Specifies if sync message signaling uses kbyte or sbyte or is enabled or disabled.
set-ow	Sets the orderwire routing for the network element.
set-state-oc1	Sets the state of OC-1 line(s) to be monitored (IS) for a good signal or not monitored (NMON).
set-state-ec1	Sets the state of a low-speed EC-1 port to be automatically monitored (AUTO) for a good signal or not monitored (NMON).
set-state-t1	Sets the state of a low-speed port to be automatically monitored (AUTO) for a good signal or not monitored (NMON).
set-state-t3	Sets the state of a DS3 port to be automatically monitored (AUTO) for a good signal or not monitored (NMON).
set-state-sts1	Sets the state of a STS-1 channel to be automatically monitored (AUTO) for a good signal or not monitored (NMON).
set-state-vt1	Sets the state of a VT1.5 channel to be automatically monitored (AUTO) for a good signal or not monitored (NMON).
set-sts1	Sets the signal degrade characteristics of an STS-1 channel.
set-t1	Sets the characteristics of a DS1 port.
set-t3	Sets the characteristics of a DS3 port.
set-vt1	Sets the signal degrade characteristics of a VT1.5 channel.
set-x25	Sets the packet size of X.25 link to either 128 or 256.

DDM-2000 TARP Release 13 at 1209-1212

Sync Messaging
Change Kbyte to Sbyte

1. **NOTE:**
   This procedure may be used to change Kbyte sync messaging to Sbyte sync messaging.

   Use **`rtrv-alm:`** command to verify that there are no alarms or protection switches present on the system.

2. **NOTE:**
   To minimize the amount of time that DDM-2000 shelves are in holdover mode when upgrading a ring network from Kbyte to Sbyte messages, it is recommended that you first upgrade the node(s) farthest away from the external timing source, then proceed to nodes closer to the timing source. For example, if all the line timed nodes in the network shown in Figure 1 had their *`Sync Source (src)`* set to *`main1`*, the farthest node from the external timing source would be Node D.

   NOTE:
   Note that in Figure 2, if Node B is changed to Sbyte first, then Node C will go into holdover. Note that in Figure 3, if Node D is changed to Sbyte first, then Node C and Node B, none of the nodes will go into holdover.

   Use the **`rtrv-sync:/set-sync:`** command at each node in the network to display/set the synchronization source.

3. Use **`rtrv-oc3:/set-oc3:`** command to verify/enable sync messaging (kbyte) at each node.

4. Determine the farthest node from the external timing source.

5. Use **`set-oc3:syncmsg=`***`Sbyte`* command to enable Sbyte sync messaging at each node, starting from the node furthest from the external timing source.

6. Use the **`rtrv-sync:`** command to display the provisioning and operational information of the synchronization interface.

7. **STOP. YOU HAVE COMPLETED THIS PROCEDURE.**

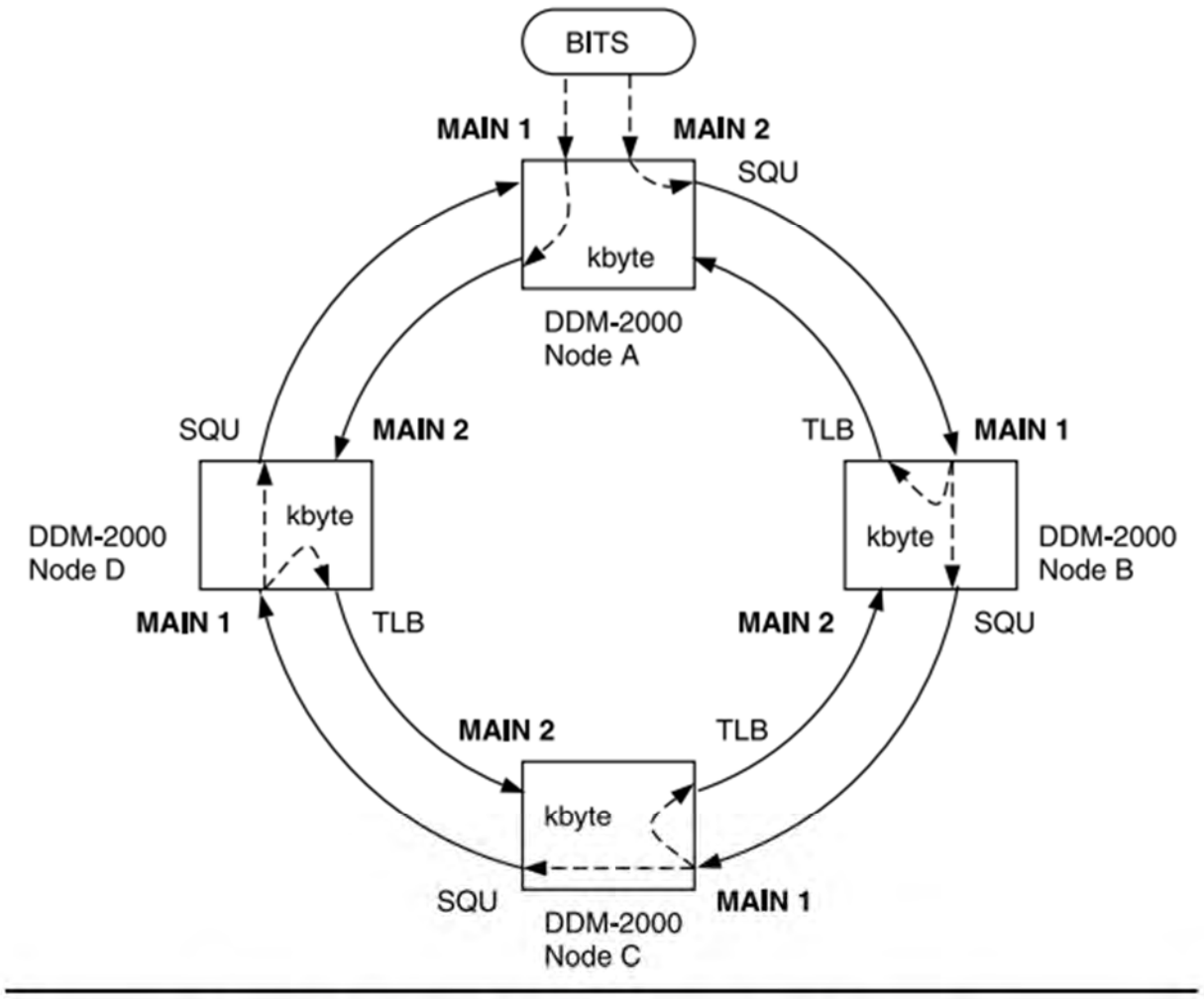


Figure 1 – Normal OC-3 Ring Using Kbyte Messaging

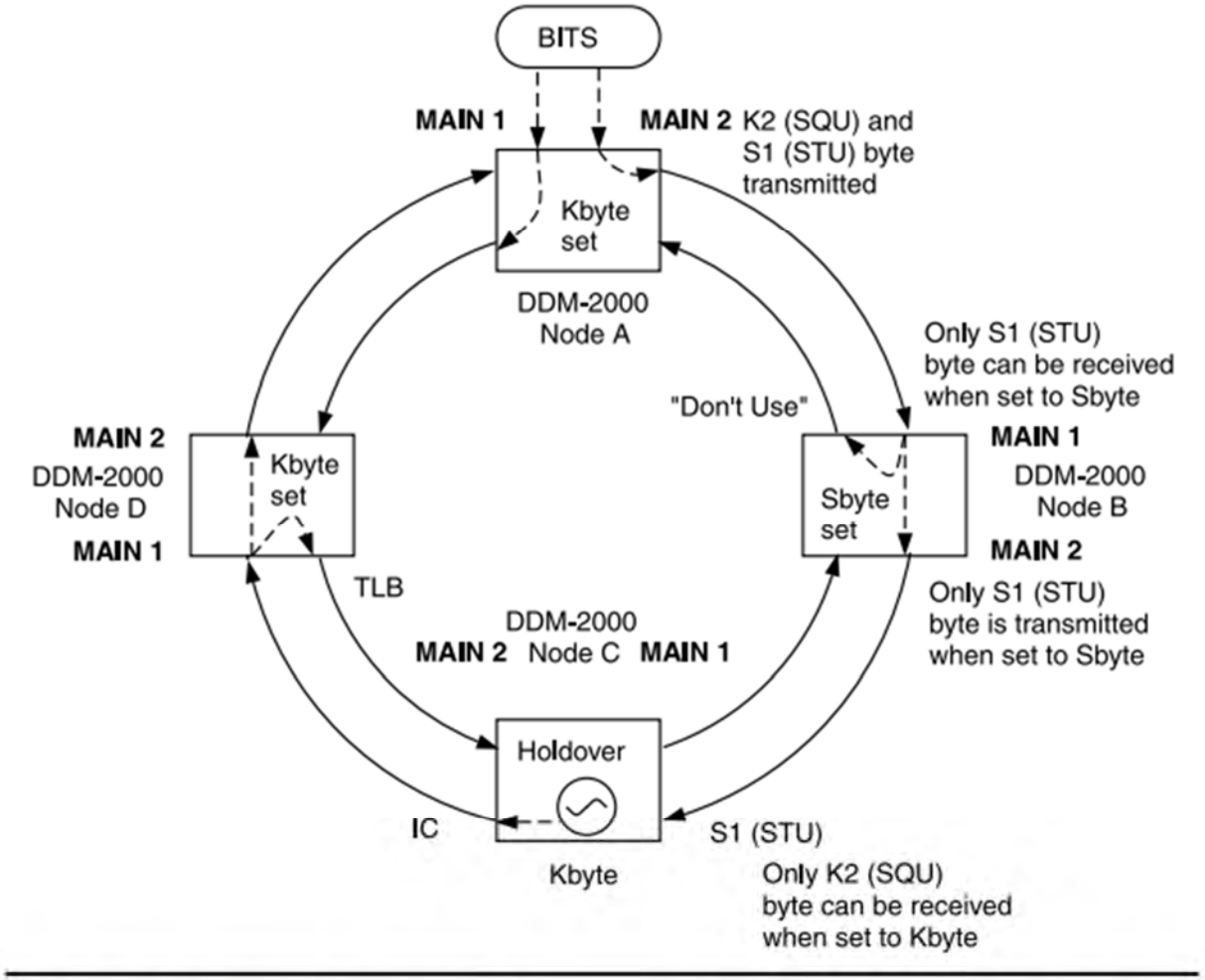


Figure 2 – Abnormal Sequence of Changing Kbyte to Sbyte - One Node in Holdover

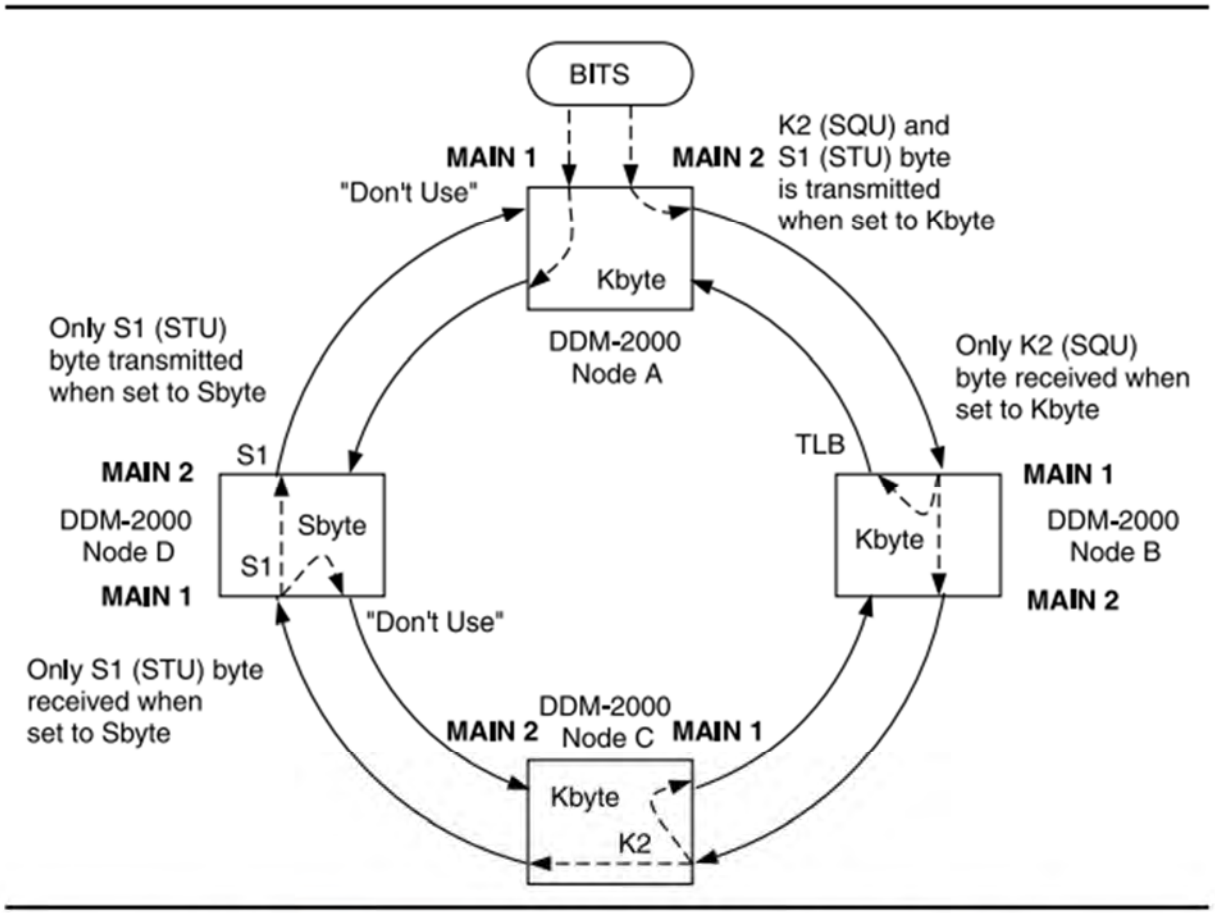


Figure 3 – Normal Sequence of Changing Kbyte to Sbyte

DDM-2000 FiberReach Manual at 535

The output parameters are:

`Line Address`	Address of the OC-3 line.
`Signal Degrade Threshold`	This is the bit error rate (BER) threshold shown as a logarithm to the base 10. The value of *n* is an integer with a range of -5 through -9 corresponding to BERs of 10^{-5} through 10^{-9}, respectively.
`Sync Message`	This parameter indicates the type of synchronization messaging that has been provisioned for that OC-3 optical interface by the **set-oc3** command. The valid values for this parameter are `Kbyte` (default value), `Sbyte`, and `disabled`. The sync messages use the K2 byte or the S1 byte in the SONET line overhead to determine synchronization quality.
`AIS Alarm`	This parameter specifies the alarm level of a non-service-affecting OC-3 line AIS failure condition. The valid values are:

cr	Critical alarm
mj	Major alarm
mn	Minor alarm
na	Not alarmed, but reported (default).

RELATED COMMANDS

rtrv-sync

set-oc3

DDM-2000 FiberReach Manual at 589-590

`Sync Message Information`

This heading identifies the section of the report where input and output messages used to determine the timing source quality are listed. This section of the report is available only if the `kbyte` message parameter is set to **`enabled`**.

When the shelf is equipped with 28-type OLIUs (in FiberReach Release 2.2 and later), this section of the report is available only if any of the optical interfaces have been provisioned for `kbyte` (default) or `Sbyte` sync messaging (using the **`set-oc3`** command if equipped with 28-type OLIUs in Main unit slots).

`OC-N Line`

This parameter identifies the addresses of optical interfaces that can carry sync messages.

`Input Message`

`disabled`	Indicates that the field is not applicable (for example, if synchronization messaging is disabled).
`?`	Indicates that the message is not readable (for example, due to a line failure).

This column identifies the `Kbyte` input message received on each optical interface line, and may have one of the following values:

`Don't Use`	The interface is not suitable for synchronization timing (Quality Level 7).
`Timing Looped Back`	The network element connected to this interface is line-timed from it (Quality Level 7).
`Stratum 4`	The interface is receiving timing from a Stratum 4 clock source (Quality Level 6).
`Internal Clock`	This interface is receiving timing from a system in holdover or free running (Quality Level 5).
`Stratum 3`	The interface is receiving timing from a Stratum 3 clock source (Quality Level 4).

	`Stratum 2` The interface is receiving timing from a Stratum 2 clock source (Quality Level 3).
	`Sync Quality Unknown` This interface is receiving timing from a good quality clock source (Quality Level 2).
	`Stratum 1` The interface is receiving timing from a Stratum 1 clock source (Quality Level 1).
	`Output Message` This identifies the output message sent out on each OC-N interface line. The valid values for this parameter are the same as those listed for `Input Message`.
	`Type` In FiberReach Release 2.2 (if equipped with 28-type OLIUs in Main unit slots) and later releases, this column identifies the type of sync messaging the optical interface was provisioned for using the **`set-oc3`** command. The valid values are:
	`Kbyte`
	`Sbyte`
	`disabled`
	NOTE: For OC-1 interfaces, this column will only display `Kbyte`.
	`Sync Autoreconfiguration` This capability allows the system to choose the best timing source to use when it is provisioned for line timing. The valid values are **`enabled`** and **`disabled`**.
	DDM-2000 FiberReach Manual at 632-633

NAME

set-oc3: Set OC-3 Characteristics

INPUT FORMAT

set-oc3::*Address*[:**dgr=***SignalDegradeThreshold*]
[,**syncmsg=***SynchronizationMessaging*][,**aisalm=***Alarm*];

DESCRIPTION

This command sets several characteristics (parameters) of a specified OC-3 line or line pair, using the 28-type OLIU. The 28-type OLIU is available in FiberReach Release 2.2 and later releases.

The input parameters are:

Address Address identifies the OC-3 line(s) or line pair(s).

If the shelf is equipped with 28-type OLIUs in Main unit slots (available in Release 2.2 and later), the only OC-3 valid addresses are:
main-{1,2,all}, all

dgr SignalDegradeThreshold specifies the signal degrade threshold as a BER in terms of a logarithm to the base 10. When this threshold is crossed, an alarm will be raised and automatic protection switching of the service line will be initiated. The value of this parameter has a range of -9 to -5. The default value is -6.
For ring releases, the signal degrade value for addresses of main-1 and main-2 *must* be the same. Therefore, any change to signal degrade for one address will automatically be made to the other by the software.

syncmsg Synchronization messaging allows timing to be reconfigured in a network upon a node or fiber failure. This parameter has one of the following values:

Kbyte This is the default value. When this option is selected, both K2 and S1 byte sync messages are transmitted, but only K2 byte is received and interpreted for sync messaging.

Sbyte When this option is selected, only the S1 byte is sent and received for sync messaging. K2 byte will always send a "Don't Use" message.

NOTE:
To minimize the amount of time that DDM-2000 is in holdover mode when upgrading a ring network from **Kbyte** to **Sbyte** messages, it is recommended that the user first upgrade the nodes farthest away from the external timing

source, and then proceed to nodes closer to the timing source.

`disabled` When this option is selected, interpretation of both K2 and S1 bytes will be disabled and hence a "Don't Use" message will be transmitted on both bytes at all times.

aisalm Alarm is the provisioned alarm level of the NSA OC-3 line AIS and has the following values:

- `cr` Critical alarm
- `mj` Major alarm
- `mn` Minor alarm
- `na` Not alarmed, but reported (default).

If an attempt is made to execute this command, when a mix of incompatible OLIU packs exists in Main, the request will be denied with the following message:

```
SNVS
/* Status, Not in Valid State */
/* Both main slots must be equipped with compatible OLIU packs. */
```

When input, this command will cause the following confirmation request to be displayed:

```
/* Caution! Alarm or maint. thresholds and sync messages
   are affected by this command.
   You have selected the set-oc3 command with these parameters:

   Address = x
   SignalDegradeThreshold = -n
   NonServiceAffectingAIS= value

Execute? (y/n or CANcel/DELete to quit) =
```

DDM-2000 FiberReach Manual at 171

Synchronization Provisioning Integrity

A welcome byproduct of synchronization messaging is the prevention of provisioning errors. Provisioned timing loops on the DDM-2000 FiberReach Multiplexers will be quickly detected through the synchronization messaging algorithm and prevented by forcing a shelf into holdover. The system can then be reprovisioned correctly.

Feature Details and Options

As mentioned previously, SONET synchronization messaging is used to communicate the quality of the subnetwork timing throughout the subnetwork. This is done using bits 1 through 3 of the K2 byte found in the SONET overhead. If a DDM-2000 FiberReach system is deriving timing from a given OC-*N* interface and synchronization messaging is enabled on that interface (Kbyte messages are enabled using the **`set-ocn`** user interface command or **`ent-rr`** TL1 command), the system interprets the received message to determine its internal timing status. The DDM-2000 FiberReach system also transmits over the particular OC-*N* interface, and all other OC-*N* interfaces that are enabled for synchronization messaging, the appropriate message indicating the quality of its timing and its active timing mode. Table 5-1 lists the associated internal timing status that is associated with synchronization messages received from the OC-*N* interface when synchronization messaging is enabled. The table lists the messages from low to high quality.

Table 5-1. Synchronization Messages Using K2 Byte

Received Message	Active Timing Mode
Don't Use	Holdover
Timing Looped Back (TLB)	Holdover
Stratum 4*	Holdover
Internal Clock (IC)	OK to use
Stratum 3*	OK to use
Stratum 2*	OK to use
Sync Quality Unknown (SQU)	OK to use
Stratum 1*	OK to use

* Presently, DDM Multiplexers cannot generate these messages, but they could be transmitted and supported for auto-reconfiguration if any of these are received by DDM-2000 Multiplexer.

DDM-2000 FiberReach Manual at 900-901

DO ITEMS BELOW IN ORDER LISTED . . . . . FOR DETAILS, GO TO

9.

NOTE:
If Kbyte or Sbyte (sync messaging) is enabled for the OC-3 **MAIN 1** and **MAIN 2(P)** optical interfaces at any node in the OC-3 ring, it **must** be enabled at all nodes in the OC-3 ring and in the **FUNCTION UNITS** slots of the host OC-12 shelf.

NOTE:
The **rtrv-oc3:** command retrieves the `OC-3 Line Provisioning Report`. This report displays the provisioned configuration of OC-3 lines. See the "Commands and Reports" section of 363-206-290, *DDM-2000 OC-12 Multiplexer, Release 5 and Higher, User/Service Manual — Volume I* and 363-206-280, *DDM-2000 OC-3 Multiplexer, Release 8 and Higher, User/Service Manual — Volume I* for a description of the **rtrv-oc3:** command format.

Use the **rtrv-oc3:** command to obtain the `OC-3 Line Provisioning Report` and verify if Kbyte/Sbyte is enabled or disabled. Use the **set-oc3:** command to enable or disable the Kbyte/Sbyte parameter, as required.

DO ITEMS BELOW IN ORDER LISTED . . . . FOR DETAILS, GO TO

10.

NOTE:
If Sync Autoreconfiguration is enabled, Kbyte/Sbyte must also be enabled.

NOTE:
If Sync Autoreconfiguration is enabled at any line-timed OC-3 node in a ring, it **must** be enabled at all line-timed OC-3 nodes of a ring.

NOTE:
The **rtrv-sync:** command retrieves the Synchronization Report. This report displays the provisioning and operational information on the synchronization attributes of the DDM-2000. See the "Commands and Reports" section of 363-206-290, *DDM-2000 OC-12 Multiplexer, Release 5 and Higher, User/Service Manual — Volume I*) and 363-206-280, *DDM-2000 OC-3 Multiplexer, Release 8 and Higher, User/Service Manual — Volume I*) for a description of the **rtrv-sync:** command format.

Use the **rtrv-sync:** command to obtain the Synchronization Report and verify if Sync Autoreconfiguration is enabled or disabled. Use the **set-sync:** command to enable or disable the Sync Autoreconfiguration parameter, as required.

	Under at least the apparent claim scope alleged by Quicker Connections' Infringement Disclosures, Lucent 2000 Product Family in combination with (1) the knowledge of a person of ordinary skill in the art, alone or in further combination with (2) each (individually, as well as one or more together) of the references identified in element 1[c] of Exhibit D and F charts renders the claim, including the present limitation, obvious. Below are examples of such references. Omichi at Abstract ("[Problem] To provide a bifurcation insertion node that can quickly recover from a fault when the fault occurs on a ring network. [Resolution Means] The bifurcation insertion node includes a branch line link transmitting unit 12 and a branch line link receiving unit 13 that communicate information via a branch line link, a ring link transmitting unit 10 and a ring link receiving unit 11 that communicate information via a ring link, and a route selection processing unit 8 that receives notification of a ring link fault via the ring link receiving unit 11 and causes the ring link transmitting unit 10 to transmit information in the opposite direction to a virtual path affected by the ring link fault. The route selection processing unit 8 causes the ring link transmission unit 10 to transmit information in the opposite direction to the virtual path affected by the ring link fault, thereby enabling rapid recovery from the fault.") Omichi at Claim 1 ("A bifurcation insertion node constituting a ring network, comprising: branch line link communication means for communicating information via the branch line link; ring link communication means for communicating information via the ring link, and route selection method for receiving notification of a ring link fault via the ring link communication means, and for causing the ring link communication means to transmit information in the opposite direction to a virtual path affected by the ring link fault.") Omichi at Claim 2 ("The bifurcation insertion node according to claim 1, further comprising: processing means for determining whether or not a virtual path is affected by a ring link fault based on a location of the ring link where a fault has occurred stored in the first table, a ring link to be used as a working path set in the second table, and a route direction set in the route switching flag, and for causing the ring link communication means to transmit information in an opposite direction if the virtual path is affected, wherein the route selection method includes a first table provided for each virtual path for storing the location

	of the ring link where the fault has occurred, a second table provided for each virtual path and in which the ring link to be used as the working path is set, and a route switching flag provided for each virtual path and set to switch the direction of the route to be used as the working path.") Omichi at Claim 5 ("A ring network, comprising: a plurality of branch line nodes, a plurality of bifurcation insertion nodes connected to each of the plurality of branch line nodes via a branch line link, and a ring link connecting the plurality of bifurcation insertion nodes in a ring shape, wherein each of the plurality of bifurcation insertion nodes includes a branch line link communication means for communicating information via the branch line link, ring link communication means for communicating information over the ring link, and route selection method for receiving notification of the occurrence of a ring link fault via the ring link communication means and causing the ring link communication means to transmit information in the opposite direction to the virtual path affected by the ring link fault.") Omichi at Claim 6 ("A ring network fault recovery method including a plurality of branch line nodes, a plurality of bifurcation insertion nodes connected to each of the plurality of branch line nodes via a branch line link, and a ring link connecting the plurality of bifurcation insertion nodes in a ring shape, comprising: a step of causing a bifurcation insertion node receive notification of a fault in a ring link; and a step of causing the bifurcation insertion node to transmit information in an opposite direction for a virtual path affected by the ring link fault.") Omichi at [0012] ("[Means for Solving Problem] The bifurcation insertion node according to claim 1 is provided with a branch line link communication means for communicating information over the branch line link; ring link communication means for communicating information via the ring link, and route selection method for receiving notification of a ring link fault via the ring link communication means, and for causing the ring link communication means to transmit information in the opposite direction to a virtual path affected by the ring link

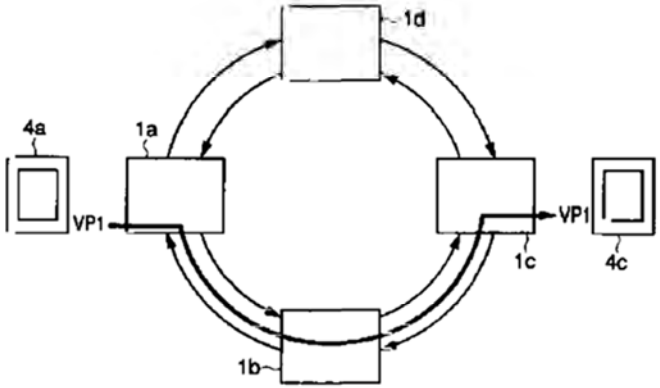
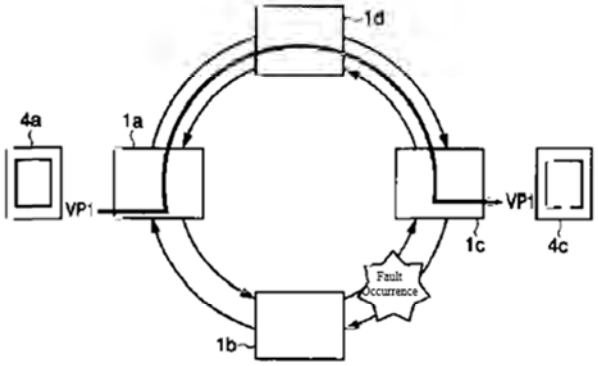
	fault.") Omichi at [0014]-[0023] ("[0014] The bifurcation insertion node of claim 2 is the bifurcation insertion node of claim 1, wherein processing means for determining whether or not a virtual path is affected by a ring link fault based on a location of the ring link where a fault has occurred stored in the first table, a ring link to be used as a working path set in the second table, and a route direction set in the route switching flag, and for causing the ring link communication means to transmit information in an opposite direction if the virtual path is affected, wherein route selection method includes a first table provided for each virtual path for storing the location of the ring link where the fault has occurred, a second table provided for each virtual path and in which the ring link to be used as the working path is set, and a route switching flag provided for each virtual path and set to switch the direction of the route to be used as the working path. [0015] The processing means determine whether or not a virtual path is affected by a ring link fault based on the first table, the second table, and the value set in the route switching flag, so that it is possible to quickly determine whether or not a virtual path is affected by a ring link fault, enabling rapid recovery from the fault. [0016] The bifurcation insertion node according to claim 3 is the bifurcation insertion node of claim 2, wherein the second table and route switching flags of some virtual paths are set with all bits inverted. [0017] Since the second table and route switching flags of some virtual paths are set with all bits inverted, the traffic in the ring network can be reduced and more virtual paths can be accommodated. [0018] The bifurcation insertion node of claim 4 is the bifurcation insertion node of claim 2 or 3, wherein the numbers of the ring links used as working paths set in the second table are set to non-consecutive discrete numbers. [0019] The numbers of the ring links used as working paths set in the second table are set to non-consecutive discrete numbers, so that when adding a bifurcation insertion node, there is no need to change the settings of the second table of an existing bifurcation insertion node, making it possible to add a bifurcation insertion node in a short period of time.

	[0020] The ring network described in claim 5 is a ring network including a plurality of branch line nodes, a plurality of bifurcation insertion nodes connected to each of the plurality of branch line nodes via a branch line link, and a ring link connecting the plurality of bifurcation insertion nodes in a ring shape, wherein each of the plurality of bifurcation insertion nodes includes a branch line link communication means for communicating information via the branch line link, ring link communication means for communicating information over the ring link, and route selection method for receiving notification of the occurrence of a ring link fault via the ring link communication means and causing the ring link communication means to transmit information in the opposite direction to the virtual path affected by the ring link fault. [0021] The route selection method receives notification of a ring link fault via the ring link communication means and causes the ring link communication means to transmit information in the opposite direction to the virtual path affected by the ring link fault, thus enabling rapid fault recovery. [0022] The ring network fault recovery method according to claim 6 is a ring network fault recovery method including a plurality of branch line nodes, a plurality of bifurcation insertion nodes connected to each of the plurality of branch line nodes via a branch line link, and a ring link connecting the plurality of bifurcation insertion nodes in a ring shape, being provided with a step of having a bifurcation insertion node receive notification of a fault in a ring link and a step of causing the bifurcation insertion node to transmit information in an opposite direction for a virtual path affected by the ring link fault. [0023] By having the bifurcation insertion node transmit information in the opposite direction to the virtual path affected by the ring link fault, rapid fault recovery is possible.") Omichi at [0031]-[0032] ("[0031] FIG. 4 is a diagram explaining the virtual path protection path. A protection path is a virtual path that is used to avoid a fault that occurs on the ring network. In FIG. 4, a fault occurs in the ring link 2b between the bifurcation insertion node 1b and the bifurcation insertion node 1c, so a virtual path VP1, which is a protection path that does not pass through the ring link 2b, is used. [0032] A fault occurring in this ring link 2b is detected by the bifurcation insertion node 1b or 1c, and the occurrence of the fault is notified to the other bifurcation insertion nodes. The bifurcation insertion node 1a

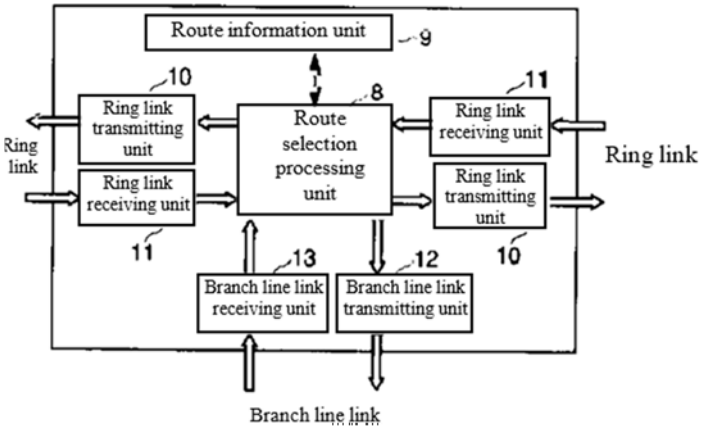
	receiving the notification of the fault checks the virtual paths affected by the fault among the virtual paths from the branch line node 4a connected to the bifurcation insertion node itself, and transmits a frame 5 or an ATM cell 6 to the ring link 2d in the opposite direction for the virtual path affected by the fault to avoid the fault. That is, the bifurcation insertion node 1a avoids the fault by switching the route of the virtual path VP1 from the counterclockwise direction (working path) illustrated in FIG. 3 to the clockwise direction (protection path) illustrated in FIG. 4. The details of switching to the protection path will be described later.") Omichi at [0035] ("When the route selection processing unit 8 receives a frame 5 or an ATM cell 6 from the ring link receiving unit 11 or the branch line link receiving unit 13, it determines the transmission direction of the frame 5 or the ATM cell 6 by referring to the information stored in the route information unit 9, and causes the ring link transmitting unit 10 or the branch line link transmitting unit 12 to transmit the frame 5 or the ATM cell 6.") Omichi at [0036]-[0038] ("[0036] FIG. 6(a) to FIG. 6(c) are diagrams for explaining the tables stored in the route information unit 9. The ring link fault table illustrated in FIG. 6(a) is a table for holding information on whether or not a fault has occurred in a ring link. This ring link fault table has a bit width equal to the maximum number of ring links in the ring network, and the bit numbers correspond to the ring link numbers. Each bit indicates that the corresponding ring link is not faulty when it is "0" and indicates that the corresponding ring link is faulty when it is "1." Therefore, when there is no fault, all bits in the ring link fault table are "0", but when a fault occurs in a ring link, the bifurcation insertion nodes 1a to 1d that receive the fault notification sets the content of the bit number corresponding to the ring link number where the fault occurred to "1." [0037] The used ring link table illustrated in FIG. 6(b) is a table set for each virtual path, and indicates the ring link to be used as the working path. This ring link table in use has a bit width equal to the maximum number of ring links in the ring network, and the bit number corresponds to the number of the ring link. Each bit indicates that the corresponding ring link is used as a protection path when it is "0", and indicates that the corresponding ring link is used as a working path when it is "1." [0038] The route switching flag illustrated in FIG. 6(c) is a flag that is set for each virtual path, and indicates

	whether the working path is clockwise or counterclockwise. When this route switching flag is “0”, it indicates that the working path is clockwise, and when it is “1”, it indicates that the working path is counterclockwise.”) Omichi at [0039]-[0043] (“[0039] FIG. 7 is a flow chart explaining the processing procedure of the bifurcation insertion node in this embodiment. First, when the route selection processing unit 8 receives a frame 5 or an ATM cell 6 from the branch line link receiving unit 13 (S1), it refers to the header of the frame 5 or the ATM cell 6 to identify its virtual path number (S2). [0040] Next, the route selection processing unit 8 judges whether or not the route switching flag corresponding to the virtual path number identified in step S2 is “0” (S3). If the route switching flag is “0” (S3, 0), the used ring link table corresponding to the virtual path number specified in step S2 is compared with the ring link fault table to determine whether or not there are bits with the same bit number and both bits set to “1” (S4). If there are no bits with the same bit number and both bits are set to “1” (S4, No), either there is no fault in the ring network, or even if there is a fault, the ring link in which the fault occurs is not included in the working path, so the ring link transmitting unit 10 is made to transmit the frame 5 or ATM cell 6 in a clockwise direction (S5). [0041] Furthermore, if there are bits with the same bit number and both bits are set to “1” (S4, Yes), the working path includes a ring link in which a fault has occurred, so the ring link transmitting unit 10 is caused to transmit the frame 5 or ATM cell 6 in a counterclockwise direction. That is, the frame 5 or ATM cell 6 is transmitted using the protection path (S6). [0042] Furthermore, if the route switching flag is “1” in step S3 (S3, 1), the used ring link table corresponding to the virtual path number identified in step S2 is compared with the ring link fault table to determine whether there is a bit whose contents are both “1” (S7). If there are no bits with the same bit number and both bits are set to “1” (S7, No), either there is no fault in the ring network or the working path does not include the faulty ring link even if a fault has occurred, therefore, the ring link transmitting unit 10 is made to transmit frame 5 or ATM

	cell 6 in a counterclockwise direction (S8). [0043] Furthermore, if there are bits with the same bit number and both bits are set to "1" (S7, Yes), the ring link includes a ring link whose working path has a fault, so the ring link transmitting unit 10 is instructed to transmit frame 5 or ATM cell 6 in a clockwise direction. That is, frame 5 or ATM cell 6 is transmitted using the protection path.") Omichi at [0046]-[0047] ("[0046] In the ring network of embodiment 1, for all of the virtual path usage ring link tables, a "0" indicates that the corresponding ring link is used as a protection path, and a "1" indicates that the corresponding ring link is used as a working path. When the route switching flag was "0", it indicated that the working path was clockwise, and when it was "1", it indicated that the working path was counterclockwise. [0047] In the ring network of this embodiment, the used ring link tables and route switching flags of some virtual paths are set in the same manner as the used ring links and route switching flags in the first embodiment. For the other virtual paths, the ring link tables used, and the route switching flags, the values of each bit are set by inverting them. For example, in the ring link table illustrated in FIG. 6(b), the bits b16 to b9 are set to "1" to be used as the working path, and the bits b8 to b1 are set to "0" to be used as the protection path. Also, the route switching flag illustrated in FIG. 6(c) is set to "0" to use the clockwise direction.") Omichi at [0049] ("[0049] In the initial stage of using a ring network, it is expected that the number of ring links actually used will often be smaller than the maximum number of ring links. In this embodiment, non-consecutive discrete numbers are set as the ring link numbers. In setting the ring link table for each virtual path of the bifurcation insertion node, the bit corresponding to the ring link number to be used is set to "1", and the bits between the bits set to "1" are also set to "1" in advance. When a new bifurcation insertion node is added to this ring network, the number of the new ring link is set to be between the ring link numbers on both sides of the

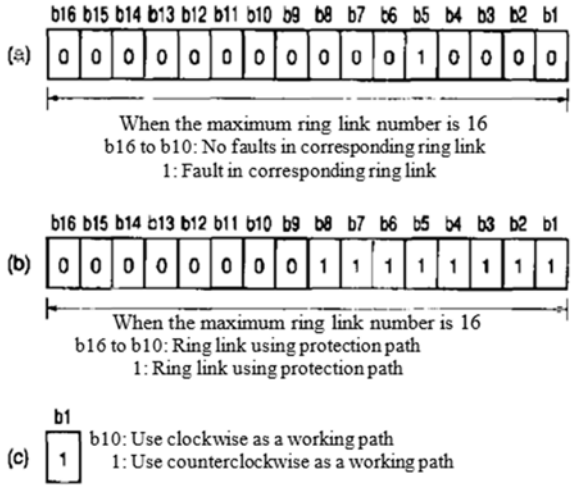
	insertion position.") Omichi at Figure 3 and 4 [FIG. 3]  [FIG. 4]  Omichi at Figure 5

[FIG. 5]



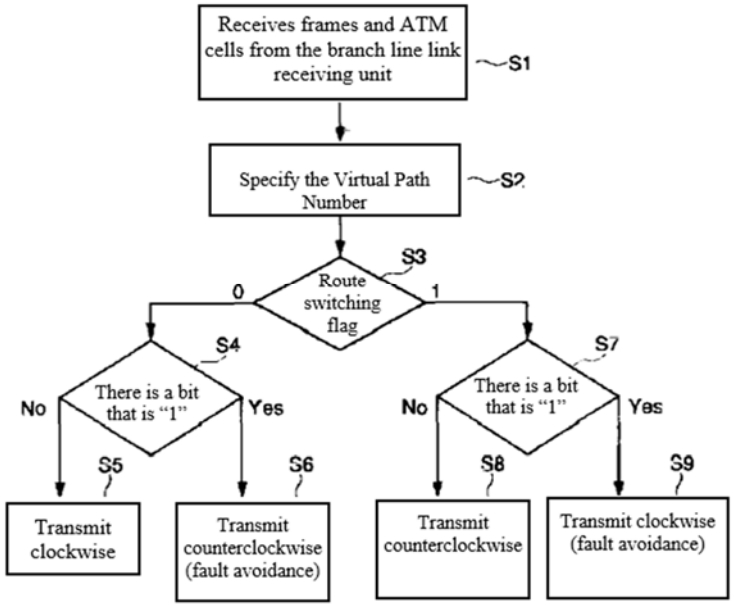
Omichi at Figure 6

[FIG. 6]



Omichi at 7

[FIG. 7]



Killat at Abstract ("The invention relates to a method, a structure and a communications network for transporting data packets, receive addresses being contained in said data packets. The communications network consists of linked bi-directional rings with so-called multi-nodes which switch between adjacent rings, and so-called single nodes which are arranged along the periphery of a ring as so-called add-drop multiplexers. The network is provided with a tree structure during initialization. The multi-nodes are the nodes of said tree structure and each branch consists of two segments which accommodate the add-drop multiplexers (2, 3, 5). All of the data packets follow the shortest paths in relation to said tree structure, and the routing information provided at the initialization stage is sufficient so that in the case of a breakdown in one segment only the single nodes of the segment and the at most two adjacent multi-nodes have to make new routing decisions. A multi-node is able to do so just from knowing the port connected to the defective segment, and the

	single node concerned is able to do so just from knowing which single nodes can still be reached in the direction of the defect.”) Killat at 1 (“The invention relates to a method for constructing and operating a communications network according to the preamble of Claim 1, in which data packets are routed through the network together with receiver addresses in order to ultimately be removed from the network by the receiver by evaluating the receiver addresses. The invention further relates to a redundant communications network for transporting data packets according to the preamble of Claim 17. State-of-the-art routing algorithms assume that network nodes exchange information about the shortest routes to other nodes, if known, or the status of the connected lines. Based on this information, each node calculates the minimum distances to all possible destination nodes and the corresponding output port (cf. D.E. Comer: Internetworking with TPC/IP, Vol. 1, 3rd ed., Prentice Hall (1995)). Since the information is exchanged approximately every 30 seconds, the network can adapt to the failure of lines or nodes within this time horizon. It would be better to find a method that can consider and bridge failures in much shorter time intervals (~ 1 msec).”) Killat at 2 (“The object of this invention is to provide a method for operating a communications network and a corresponding network which, when the network is initialized, already distributes all information on how data packets are to be routed in normal operation and in the event of an error. The main aim is to ensure that routing information does not have to be distributed in the network every time a connection is established or terminated. The invention minimizes connection setup times for connections under normal conditions as well as reconfiguration times in the event of an error.”) Killat at 2 (“Along all lines, also called "segments", there are "single" nodes, which are designed as "add-drop" multiplexers: they can send in both directions of their segment and receive from both directions. They also feature a receive/transmit port for a terminal device to be connected. A single node removes a packet from the network if it recognizes an address assigned to it in the recipient address. To send, it refers to a routing table (or recognizes from the structure of the recipient address) to see which output port it should send the packet to.

	The multi-nodes that link the rings are assigned an address on each adjacent segment, via which the multi-node can be addressed. The multi-nodes must also be informed in the form of rules or tables to which segment a received packet should be forwarded. Multi-nodes can be used to switch redundant paths if a section of the route or one or more single nodes in a segment failed.") Killat at 3 ("During initialization, a table is created for each multi-node that specifies the output port through which a specific destination address can be reached. According to the invention, the routing is defined in such a way that – regardless of any meshing – the routing is always carried out along the tree structure. Since it is a tree structure with double lines, if one segment fails, this strategy only needs to be slightly modified by the two adjacent multi-nodes and the single stations of the affected segment, using the second intact segment of the same branch.") Killat at 3-4 ("Fig. 3 Single node (with segment prefix SP0 and suffix SS0) in normal operation; NP: user port; BP: leaf port; WP: root port; Fig. 4 Single node (with segment prefix SP0 and suffix SS0) and a failed segment SP0; not reachable: SSX > SS0 (SSX < SS0), where the information in parentheses in the diagrams refers to the case: SSx < SS0; Fig. 5 Multi-node, failed segment with prefix SPX; SB: segment bit, PP: port prefix, SP: segment prefix, SS: segment suffix. The index o refers to the multi-node in question. WP: root port, NP: user port.") Killat at Figure 3

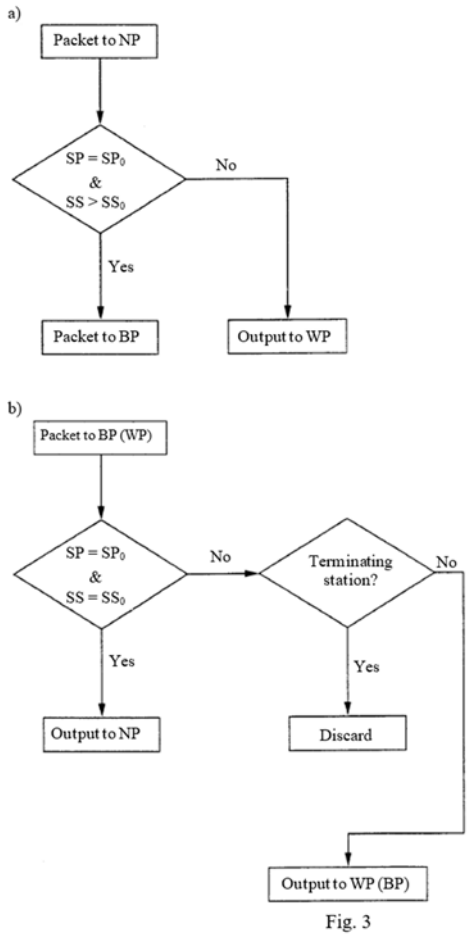


Fig. 3

Killat at Figure 4

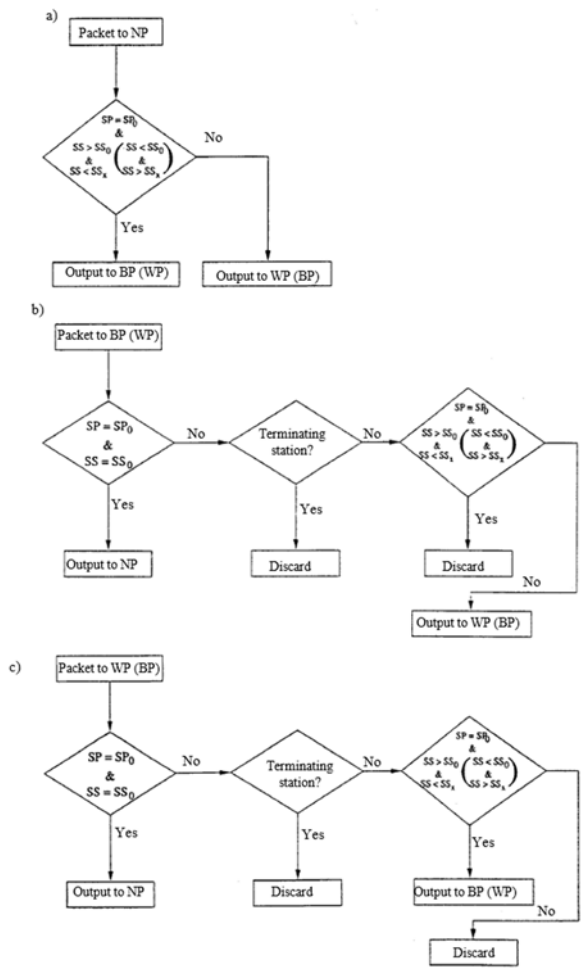


Fig. 4

Killat at Figure 5

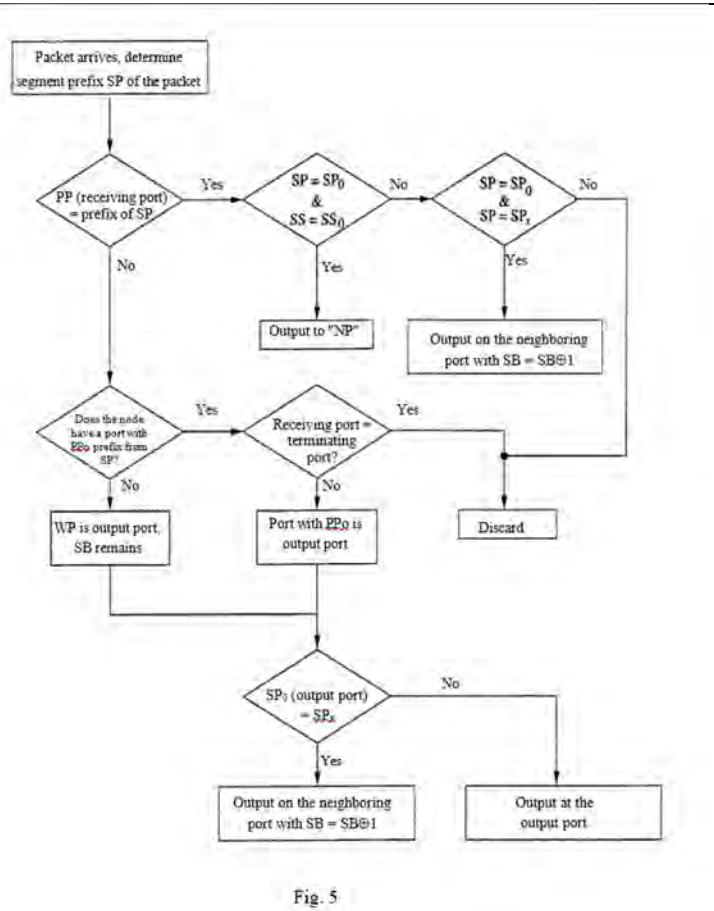


Fig. 5

Killat at 4 ("In the preferred version of the invention, the addresses are assigned in such a way that routing tables can be omitted because the address structure reflects the tree structure of the network. This situation is shown in Fig. 2, where the first 7 bits of the address of the single stations connected to this segment are indicated along the segments. This part of a node address (9 in Fig. 2), called the segment prefix SP, uniquely identifies a segment, for example segment 10. The first bit of an address, the segment bit SB, indicates whether the corresponding station is located on the left or right segment of a branch. Because of this left/right marking, neighboring multi-nodes must have a different sense of rotation when assigning address values, see Fig. 2:

multi-nodes with an even placing have the same direction of rotation as the root node, those with an odd placing, e.g. at positions 5 and 6, have the opposite direction.")

Killat at Figure 2

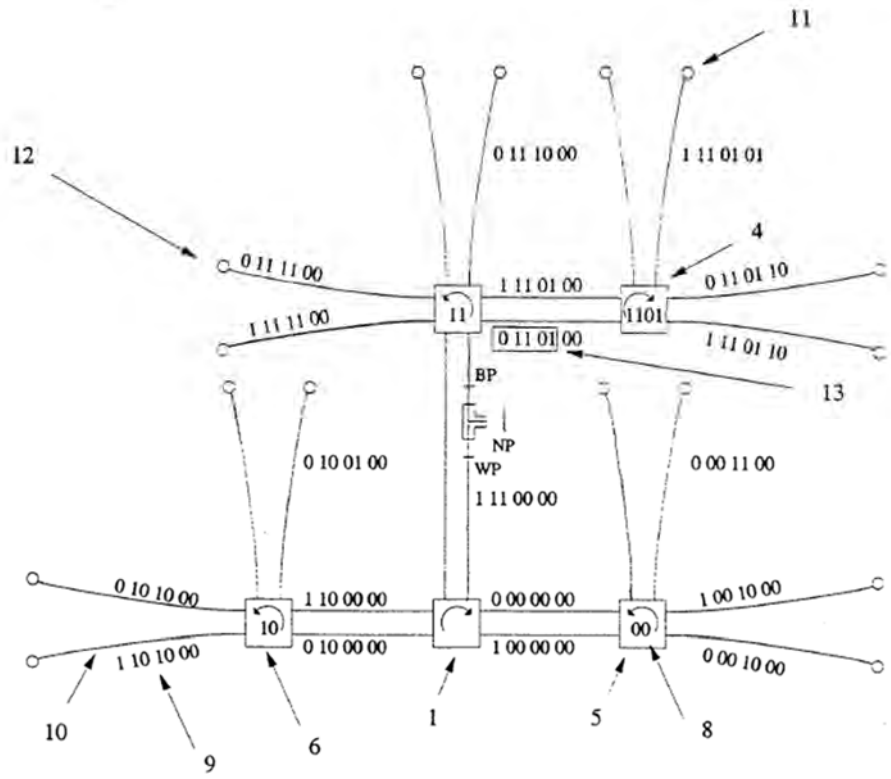


Fig. 2

Killat at 5 ("In addition to the user port NP, each single node has two network-side ports, which are referred to as the root port WP and the leaf port BP according to their location. The routing rules for the three ports in the undisturbed normal case are shown in Fig. 3. In the case that the station suffices do not increase monotonically,

	it must be recorded for all stations (= single nodes) of a segment whether they can be reached via the root port or the leaf port.") Killat at 5-6 ("If there is a failure on the segment in question, two stations adjacent to the failure area register the loss of communication capability. They communicate this loss to the network management using a special message. The network management informs the adjacent multi-nodes and the single nodes of the affected segment about the failure, which leads to the behavior outlined in Fig. 4 for the single nodes. One possible variant is that the affected stations could already receive and interpret the information addressed to the network management. This saves a delay equivalent to the duration of a signal round-trip. Killat at 6 ("The port prefix PP (13 in Fig. 2) at a multi-node is the bit sequence consisting of the segment bit SB, the node identifier K resulting from the tree structure (cf. 8 in Fig. 2) and the Idn bit port identifier. Port prefix PP and prefix of the connected segment SP differ for nodes of non-maximum order by low-order zeros.") Killat at 7 ("The routing decisions to be made, which are described in Fig. 3-5 , can be implemented using simple comparator circuits that check subaddresses for equality or "greater than" relationships. Another implementation compatible with the present invention would be to create a routing table in the form of a RAM (random access memory) in which the correct output port is entered for each conceivable receiving address according to the rules laid down in Fig. 3-5. A further implementation under the invention would consist in identifying each connection by a connection identifier, communicating the relationship between the connection identifier and the destination address to all the nodes or all the nodes involved in the connection in a signaling phase, whereupon the nodes, after analyzing the destination address constructed according to the invention, would independently complete the routing table according to the specified rules.") Killat at 7-8 ("In ATM networks with a network structure according to the invention, the header field contains segment prefix SP, station suffix SS and a connection identifier of length r, whereby the maximum number of connections that can be processed via a single station is 2r. In an alternative implementation variant, the method is as described in Section 3, final paragraph : the network works with connection identifiers VPIs/VCIs (Virtual Path Identifier / Virtual Circuit Identifier). In a signaling

	phase, the relationship between VPI/VCI and the invention address reflecting the topology, is revealed so that the nodes can make the entries in the routing tables for VPIs/VCls according to the rules in Fig. 3-5.") Killat at Claim 1 ("1. Method for constructing and operating a communications network for transporting data packets, each of which contains receiver addresses that can be evaluated by a terminal device addressed by them, the network having networked bidirectional rings with multi-nodes connecting the rings to one another and single nodes arranged along the periphery of the network, characterized in that during initialization the network is formed in a tree structure in which the multi-nodes, which contain root ports directed towards a root node and one or more leaf ports, are designed as nodes of the tree structure and each branch of the tree structure consists of two segments receiving the single nodes, the single nodes containing a root port, a leaf port and one or more user ports, that in the event of a failure in a segment the routing decisions for the data packets are made by the single node of the segment and the multi-nodes immediately adjacent to the segment, the routing decision of a multi-node being made from the knowledge of the failed segment and the routing decision of a single node being made from the knowledge of the single nodes that can still be reached in the direction of the failure.") Killat at Claim 2 ("2. Method according to claim 1, characterized in that the routing decision of a multi-node is made solely from the knowledge of the failed segment and/or the routing decision of a single node is made solely from the knowledge of the single nodes still reachable in the failure direction.") Killat at Claim 4 ("4. Method according to claim 3, characterized in that the segment prefix has a substructure predetermined by the number of node levels of the tree underlying the network, the segment prefix indicating how to reach the address in question starting from the root node of the tree.") Killat at Claim 13 ("13. Method according to one or more of claims 1-12, characterized in that the routing decisions are made with the aid of a series of comparators which carry out queries for "equal to" or "greater than" relationship.") Killat at Claim 17 ("17. Communications network for transporting data packets, each of which contains receiver addresses that can be evaluated by an end device addressed by them, the network having networked bidirectional rings with multi-nodes connecting the rings to one another and single nodes arranged along the periphery of the network, in particular to implement a method under claim 1, characterized in that the network is formed in a tree structure in which the multi-nodes, which contain root ports directed towards a root node

	and one or more leaf ports, are designed as nodes of the tree structure and each branch of the tree structure consists of two segments receiving the single nodes, the single nodes containing a root port, a leaf port and one or more user ports, so that single nodes of a segment and the multi-nodes immediately adjacent to the segment are formed in such a way that, in the event of a segment failure, the routing decisions for the data packets are made by the single node of the segment and the multi-nodes immediately adjacent to the segment, the routing decision of a multi-node being made from the knowledge of the failed segment and the routing decision of a single node being made from the knowledge of the single nodes that can still be reached in the direction of the failure.") Killat at Claim 20 ("20. Network according to claim 19, characterized in that the segment prefix has a substructure predetermined by the number of node levels of the tree underlying the network, the segment prefix indicating how to reach the address in question starting from the root node of the tree.") Killat at Claim 22 ("22. Network according to claims 17, 18 or 19, characterized in that the addresses are supplemented by a connection identifier which allows different connections to a destination station to be distinguished.") Killat at Claim 29 ("29. Network according to one or more of claims 17-28, characterized in that the routing decisions are made with the aid of a series of comparators which carry out queries for "equal to" or "greater than" relationship.")