Nortel Networks Multiservice Switch

7400/15000/20000

Operations: Inverse Multiplexing for ATM

NN10600-730

Nortel Networks Multiservice Switch 7400/15000/20000

Operations: Inverse Multiplexing for ATM

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General availability. Contains information on Nortel Networks Multiservice Switch 7400, 15000, and 20000 for the PCR6.1 release.

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About this document

The purpose of NN10600-730 *Nortel Networks Multiservice Switch 7400/15000/20000 Inverse Multiplexing for ATM Operations* is to provide customers with information on the inverse multiplexing for ATM (IMA) feature available from Nortel Networks Multiservice Switch systems.

Who should read this document and why

This document is for persons working on Nortel Networks Multiservice Switch system's inverse multiplexing for ATM feature. It is specifically written for persons who perform the following tasks with Multiservice Switch IMA application:

- installing and configuring
- provisioning
- operating and maintaining
- troubleshooting

What you need to know

You need to have a basic understanding of the following:

- how ATM functions in Nortel Networks Multiservice Switch systems

  See NN10600-700 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Technology Fundamentals*.

- how to configure and monitor ports
  - NN10600-120 *Nortel Networks Multiservice Switch 15000/20000 Hardware Description*
  - NN10600-175 *Nortel Networks Multiservice Switch 7400 Hardware Installation, Maintenance, and Upgrade*
  - NN10600-130 *Nortel Networks Multiservice Switch 15000/20000 Hardware Installation, Maintenance, and Upgrade*
  - NN10600-550 *Nortel Networks Multiservice Switch 7400/15000/20000 Common Configuration Procedures*
  - NN10600-050 *Nortel Networks Multiservice Switch 7400/15000/20000 Command Reference*
- how to configure and monitor Multiservice Switch nodes using the command line interface or Nortel Networks Multiservice Data Manager.

  See 241-6001-023 *Nortel Networks Multiservice Data Manager Configuration Management Tools for Multiservice Switch*.

How this document is organized

This document contains the following sections:

What's new in this document

There were no new features added to this document.

Other changes made to this document include the following:

- The terms Passport and PVG have been rebranded in conjunction with the new Nortel Networks' brand simplified naming format. Passport is now referred to as the Nortel Networks Multiservice Switch, and PVG is now Media Gateway 7480/15000. For more information on the product rebranding, refer to NN10600-000 *Nortel Networks Multiservice Switch 7400/15000/20000 What's New in PCR6.1*.

Text conventions

This document uses the following text conventions:

- `nonproportional spaced plain type`

  Nonproportional spaced plain type represents system generated text or text that appears on your screen.

- **`nonproportional spaced bold type`**

  Nonproportional spaced bold type represents words that you should type or that you should select on the screen.

- *italics*

  Statements that appear in italics in a procedure explain the results of a particular step and appear immediately following the step.

  Words that appear in italics in text are for naming.

- `[optional_parameter]`

  Words in square brackets represent optional parameters. The command can be entered with or without the words in the square brackets.

- `<general_term>`

  Words in angle brackets represent variables which are to be replaced with specific values.

- UPPERCASE, lowercase

  Nortel Networks Multiservice Switch node commands are not case-sensitive and do not have to match commands and parameters exactly as shown in this document, with the exception of string options values (for example, file and directory names) and string attribute values.

- |

  This symbol separates items from which you may select one; for example, ON|OFF indicates that you may specify ON or OFF. If you do not make a choice, a default ON is assumed.

- ...

  Three dots in a command indicate that the parameter may be repeated more than once in succession.

The term absolute pathname refers to the full specification of a path starting from the root directory. Absolute pathnames always begin with the slash (/) symbol. A relative pathname takes the current directory as its starting point, and starts with any alphanumeric character (other than /).

Related documents

In addition to the documents listed in “What you need to know” (page 16), see the following documents for related information:

- NN10700-005 *Nortel Networks Multiservice Provider Edge 9500 Hardware Operations*
- NN10600-030 *Nortel Networks Multiservice Switch 7400/15000/20000 Overview*
- NN10600-270 *Nortel Networks Multiservice Switch 7400/15000/20000 Software Installation*
- NN10600-550 *Nortel Networks Multiservice Switch 7400/15000/20000 Common Configuration Procedures*
- NN10600-060 *Nortel Networks Multiservice Switch 7400/15000/20000 Component Reference*

- NN10600-420 *Nortel Networks Multiservice Switch 7400/15000/20000 Operations: Trunking*
- NN10600-500 *Nortel Networks Multiservice Switch 6400/7400/15000/20000 Alarms Reference*
- NN10600-702 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Routing and Signalling Fundamentals*
- NN10600-705 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Traffic Management Fundamentals*
- NN10600-706 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Traffic Shaping and Policing Fundamentals*
- NN10600-707 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Queuing and Scheduling Fundamentals*
- NN10600-708 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM CAC and Bandwidth Fundamentals*

The following documents provide additional information on inverse multiplexing for ATM:

- ATM Forum AF-PHY-0086.000, *Inverse Multiplexing for ATM (IMA) Specification*, Version 1.0.

  Note: When this specification is referred to throughout the rest of this document, it is assumed that the version is Version 1.0, unless otherwise stated.

- ATM Forum AF-PHY/95-1121R5, *Inverse Multiplexing for ATM (IMA) Specification*, Baseline Text, October 1996.

How to get more help

For information on training, problem reporting, and technical support, see the "Nortel Networks support services" section in *NN10600-030 Nortel Networks Multiservice Switch 7400/15000/20000 Overview*.

Chapter 1
IMA provisioning

Provision IMA on Nortel Networks Multiservice Switch devices, or upgrade IMA groups to the ATM Forum IMA protocol.

> ***Note:*** Succession Networks customers must use the templates in 241-6001-011 *Nortel Networks Multiservice Data Manager Fault Management Tools* to configure IMA.

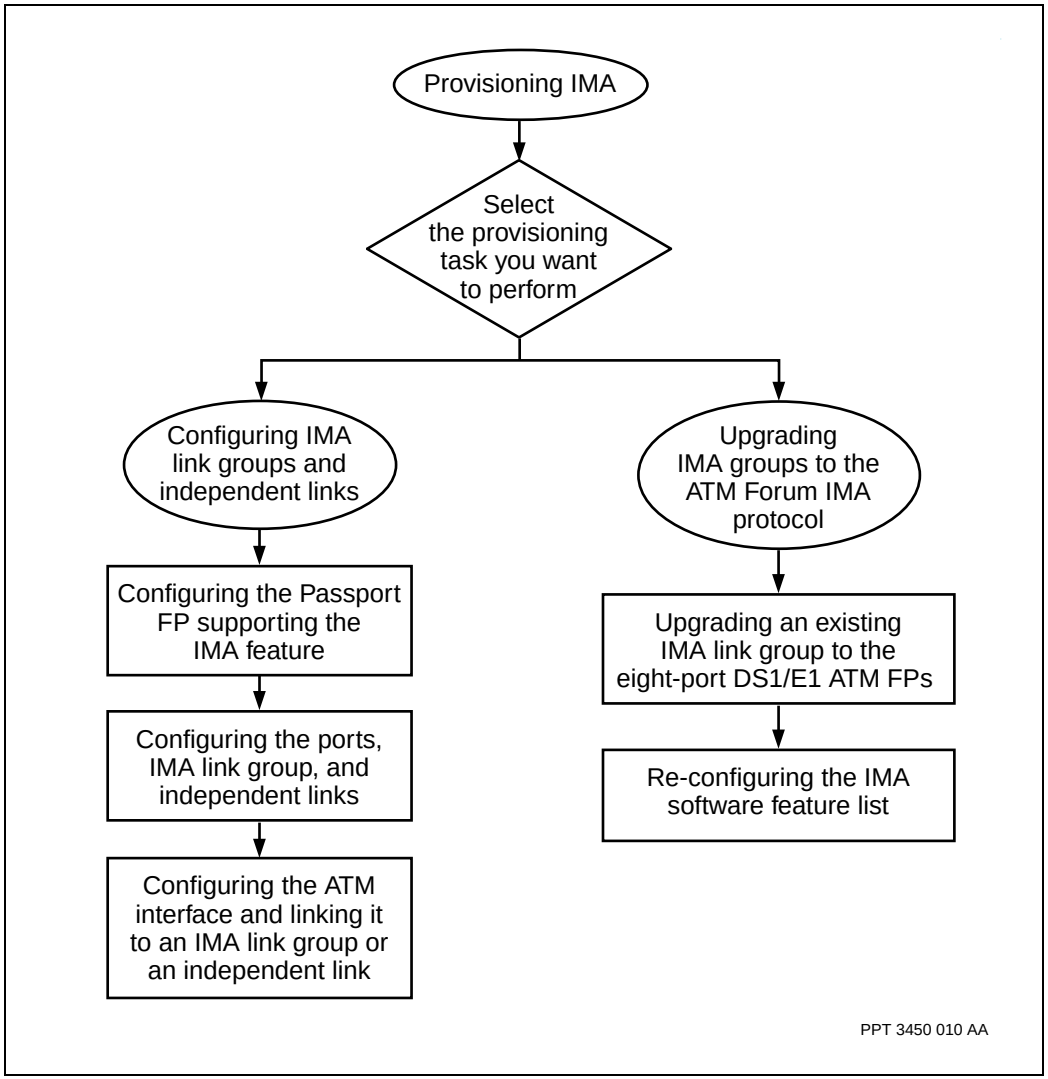
Prerequisites to IMA provisioning

- Before performing the procedures in this section, see “Prerequisites to configuring IMA” (page 129)
- Before configuring IMA, see “IMA configuration considerations” (page 130)

IMA provisioning flow

This taskflow shows you the sequence of procedures you perform to provision IMA. To link to any procedure, go to “Task navigation” (page 22).

Figure 1
Configuring IMA task flow



Task navigation

- “Configuring the FP supporting the IMA feature” (page 24)

- “Configuring the ports, IMA link groups, and independent links” (page 26)
- “Configuring the ATM interface and linking it to an IMA link group or an independent link” (page 32)
- “Upgrading an existing IMA link group to the 8-port DS1/E1 ATM FPs” (page 34)
- “Re-configuring the IMA software features list” (page 36)

Configuring the FP supporting the IMA feature

Configure the function processor that will be used to support the IMA feature.

Procedure steps

1. Enter configuring mode.

   ```
   start Prov
   ```

2. Configure the FP to run IMA.

   ```
   add Shelf Card/<Card>
   ```

3. Set the *cardType* attribute.

   ```
   set Shelf Card/<Card> cardType <IMA_FP>
   ```

4. Configure a new logical processor type by adding a *LogicalProcessorType* (*Lpt*) component.

   ```
   add Sw Lpt/imaFp
   ```

5. Configure the appropriate features on the *Lpt* component.

   ```
   set Sw Lpt/imaFp featureList <feature>
   ```

   The applications that you plan to use determine what other features you must add to the *ImaFp featureList*. For a complete list of applications and service combinations on an *imaFp*, see Nortel Networks Multiservice Switch Release Notes.

6. Add a *LogicalProcessor* (*Lp*) component.

   ```
   add Lp/<Lp>
   ```

7. Link the *LogicalProcessor* to the FP running IMA by setting the *mainCard* attribute.

   Note: To facilitate node monitoring and troubleshooting, the instance number of the *Lp* and its associated *Card* component are usually set to the same value.

   ```
   set Lp/<Lp> mainCard Shelf Card/<Card>
   ```

8. Set the *logicalProcessorType* attribute of the Lp with the name of the appropriate *Lpt* component.

   ```
   set Lp/<Lp> Lpt Sw Lpt/imaFp
   ```

9. Perform a semantic check on the configured data.

   ```
   check Prov
   ```

10 Activate the configured data.

```
activate Prov
```

Note: The editing view becomes the current view when this command is used.

11 Confirm the activation.

```
confirm Prov
```

Variable definitions

Variable	Value
<Card>	The instance number of the function processor providing IMA capability.
<feature>	The name of the feature you want to set.
<IMA_FP>	The function processor supporting IMA. To find the values for <IMA_FP> refer to NN10600-551 *Nortel Networks Multiservice Switch 7400/15000/20000 FP Configuration Reference*.
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.

Configuring the ports, IMA link groups, and independent links

Configure the ports, IMA link groups and independent links that will be used to support Nortel Networks Multiservice Switch IMA service.

Prerequisites

- Refer to the figure “IMA feature components and configurable attributes” (page 132), before performing the following procedures.
- Ensure that you have performed the prerequisite tasks defined in “Configuring the FP supporting the IMA feature” (page 24).
- The 8-port DS1/E1 ATM FPs, the 32-port DS1/E1 Multiservice Access (MSA) FPs, 4-port DS3Ch ATM FPs and the 2-port STM1 FPs support only the ATM Forum IMA protocol. The ATM Forum IMA protocol is available if you choose the *imaAtmForum* feature. With the exception of the 2-port STM1 FPs, the default setting for all Multiservice Switch FPs supporting IMA is atmForum10. For more information, see“IMA protocols” (page 96).
- When using the 2-port STM-1 electrical channelized CES/ATM/IMA FPs, there is no need to explicitly set the protocol, because the ATM IMA protocol 1.1 is automatically provisioned for this FP.
- The CTC mode is available only on the ATM Forum IMA protocol and is supported by on the 8-port DS1/E1 ATM FPs and the 32-port DS1/E1 MSA FPs.
- If you are using the ATM Forum IMA protocol on the 8-port DS1/E1 ATM FPs or the 32-port DS1/E1 MSA FPs, use CTC mode if all the links in a group use transmit clocking sources derived from the same reference.
- The default value is itc for all Multiservice Switch function processors.
- See NN10600-060 *Nortel Networks Multiservice Switch 7400/15000/20000 Component Reference* for further information concerning the attributes of the *Ima* component.

Procedure steps

1 Add a port to the *LogicalProcessor* (*Lp*) component.

For Multiservice Switch 7400 nodes use the following command:

```
add Lp/<Lp> <port_type>/<port_number>
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

```
add Lp/<Lp_15000> DS3/<DS3_15000> DS1/<DS1_15000>
```

2 For the 2-port STM-1 electrical channelized CES/ATM/IMA FPs, add the Vc12 component.

```
add Lp/<Lp> sdh/<port_number2> Vc4/0 Vc12/k,l,m
```

Note: Subcomponents e1, chan/0 are automatically created. Within the channel all timeslots except for timeslot 16 are created (default).

3 For the 32-port DS1/E1 Multiservice Access (MSA) FPs, add the AtmCell (*Cell*) component.

```
add Lp/<Lp_MSA32> <port_type>/<port_number> Chan/0
Cell
```

4 For the 32-port DS1/E1 MSA FPs, set the timeslots under the Channel (*Chan*) component.

For the 32-port DS1 MSA FP:

```
set Lp/<Lp_MSA32> DS1/<port_number> Chan/0 timeslots !
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
22 23 24
```

For the 32-port E1 MSA FP:

```
set Lp/<Lp_MSA32> E1/<port_number> Chan/0 timeslots !
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 17 18 19 20 21 22
23 24 25 26 27 28 29 30 31
```

5 Add an IMA link group to the *Lp* component.

For Multiservice Switch 7400 nodes use the following command:

```
add Lp/<Lp> Ima/<Ima>
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

```
add Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000>
```

6 Add a link (*Link* (*Lk*) component) to the IMA link group.

For Multiservice Switch 7400 nodes use the following command:

add Lp/<Lp> Ima/<Ima> Lk/<Lk>

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

add Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000> Lk/<Lk_15000>

7 Associate each IMA link with the *Channel* (*Chan*) subcomponent of a port. Channel 0 is recommended even though other values are allowed.

For Multiservice Switch 7400 nodes use the following command. Repeat the command for each IMA link. Each IMA link must be associated with a DS1or E1 physical link. No more than one link can be associated with any port. No more than one port can be associated with any link.

set Lp/<Lp> Ima/<Ima> Lk/<Lk> interfaceName Lp/<Lp> <port_type>/<port_number> Chan/0

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command. Repeat the command for each IMA link. Each IMA link must be associated with one DS1 logical link. An Ima link group under a DS3 port must be linked to a DS1 link under the same DS3 port: it cannot be linked to a DS1 link under another DS3 port. No more than 28 links can be associated with any port.No more than one port can be associated with any link.

set Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000> Lk/<Lk> interfaceName Lp/<Lp_15000> DS3/<DS3> DS1/<DS1> chan/0

8 Set the IMA *protocol* attribute.

For Multiservice Switch 7400 nodes use the following command:

set Lp/<Lp> Ima/<Ima> protocol <type>

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

set Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000> protocol atmForum10

9 Set the IMA *transmitClockMode* attribute.

For Multiservice Switch 7400 nodes use the following command:

set Lp/<Lp> Ima/<Ima> transmitClockMode <mode>

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command.

```
set Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000>
transmitClockMode <mode_15000>
```

10 Set the IMA link group attributes as required (optional).

For Multiservice Switch 7400 nodes use the following command. Repeat the command for each attribute you wish to add.

```
set Lp/<Lp> Ima/<Ima> <Ima_attribute>
<attribute_value>
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command. Repeat the command for each attribute you wish to add.

```
set Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000>
<Ima_attribute> <attribute_value>
```

Variable definitions

Variable	Value
<attribute value>	The value of the *Ima* component attribute
<DS1_15000>	The instance number of the DS1 tributary, having a value between 1 and 28 inclusive.
<DS3_15000>	The instance number of the DS3 port, having a value between 0 and 3 inclusive.
<Ima>	The instance number of the IMA link group, having a value of 0 to 7 inclusive for the 8-port DS1/E1 ATM FPs, or a value of 0 to 31 inclusive for the 32-port DS1/E1 MSA FPs. ***Note:*** For the 8-port DS1/E1 ATM FPs, if the *perVcQueueInterfaces* attribute under an LP's *Arc* subcomponent is set to a non-zero value, then traffic shaping (per-Vc queuing) is enabled. If traffic shaping is enabled on an LP, then the instances of IMA groups and independent links can have values from 0 to 3. If traffic shaping is disabled, then the instances of IMA link groups and independent links can have values from 0 to 7.
<Ima_15000>	The instance number of the IMA link group, having a value between 0 and 13.
<Ima_attribute>	The name of the *Ima* component attribute.

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Variable	Value
<Lk>	The instance number of the link and has a value of 0 to 31inclusive. For ease of configuring, monitoring and troubleshooting, each link number usually corresponds to the same port number. With the 8-port DS1/E1 ATM FPs, you may configure a total of eight links in an IMA link group. For example, an FP running IMA with a full complement of eight links forming an IMA link group may include links with any combination of identifiers, such as: • links 0, 1, 2, 3, 4, 5, 6, 7 or • links 0, 5,14, 23, 24, 25, 27, 31 With the 32-port DS1/E1 Multiservice FPs, you can configure a total of eight links in an IMA link group, with each link having an instance number between 0 and 15 inclusive. Note that each IMA link group must be associated with a port in the range 0 to 15 inclusive, or the range 16 to 31 inclusive: all ports within an IMA link group must fall within one of these two ranges. An IMA link group can include links 30 and 31 if the link group instance number (*Ima* component instance number) is in the range 16 to 29.
<Lk_15000>	The instance number of the link and has a value of 0 to 31 inclusive. For ease of configuring, monitoring and troubleshooting, each link number usually corresponds to the same port number. For Multiservice Switch 15000 and Multiservice Switch 20000 4-port DS3Ch ATM FPs, you can configure upwards to a total of 28 links in an IMA link group.
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.
<Lp_15000>	The instance number of the logical processor associated with the function processor providing IMA capability.

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Variable	Value
<Lp_MSA32>	The instance number of the 32-port DS1 or E1 MSA FP providing IMA capability. ***Note:*** For the 8-port DS1/E1ATM FP, the 4-port DS3Ch ATM FP, and the 2-port STM-1e channelized FP, a single channel, Chan/0, is automatically created with all available timeslots allocated. Use of Chan/0 (the default value) is recommended even though other values are allowed. These timeslots cannot be changed and only one *Channel* subcomponent per port is permitted. For the 32-port DS1/E1 MSA FPs, you must configure timeslots under the *Channel* component. See step 4 for the command used to configure timeslots for the 32-port DS1/E1 MSA FPs.
<mode>	The clock mode setting. If you have configured the 8-port DS1/E1 ATM FPs, the 32-port DS1/E1 MSA FPs, the 4-port DS3Ch ATM FPs, or the 2-port STM-1 e channelized FPs using the ATM Forum IMA protocol, you can set the mode clock setting as either ctc or itc.
<mode_15000>	The clock mode setting which can have two values: itc for independent transmit clock mode ctc for common transmit clock mode
<port_number>	The instance number of the port.
<port_type>	Ds1, E1, or Sdh. To determine the value to enter for the FP you are configuring, see NN10600-551 *Nortel Networks Multiservice Switch 7400/15000/20000 FP Configuration Reference*.
<port_number2>	The instance number of the sdh port, and k,l,m are the TUG-3 (values 1 to 3), TUG-4 (values 1 to 7), and TUG-12 (values 1 to 3) respectively.
<type>	The IMA protocol. For the 8-port DS1/E1 ATM FPs, 4-port DS3Ch ATM FPs, and the 32-port DS1/E1 ATM FPs, the value is atmForum10. For the 2-port STM-1 FPs, the value is atmForum11.

(Sheet 3 of 3)

Configuring the ATM interface and linking it to an IMA link group or an independent link

To support IMA, you must configure an ATM interface and link it to a Nortel Networks Multiservice Switch IMA link group or independent link.

Note: An *AtmIf* component is configured for each ATM interface. It manages the set of ATM connections that terminate or traverse the interface. For more information, see NN10600-700 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Technology Fundamentals*.

Prerequisites

- Refer to the figure "IMA feature components and configurable attributes" (page 132), before performing the following procedures.

Procedure steps

1 Add an ATM interface for each IMA link group.

For Multiservice Switch 7400 nodes use the following command:

```
add AtmIf/<AtmIf>
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

```
add AtmIf/<AtmIf_15000>
```

2 Link each IMA link group to an ATM interface.

For Multiservice Switch 7400 nodes use the following command:

```
set AtmIf/<AtmIf> interfaceName Lp/<Lp> Ima/<Ima>
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

```
set AtmIf/<AtmIf_15000> interfaceName Lp/<Lp_15000>
DS3/<DS3_15000> Ima/<Ima_15000>
```

3 Link each independent link to an ATM interface.

For Multiservice Switch 7400 nodes use the following command:

```
set AtmIf/<AtmIf> interfaceName Lp/<Lp> <port_type>/
<port_number> Chan/0
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

```
set AtmIf/<AtmIf_15000> interfaceName Lp/<Lp_15000>
DS3/<DS3_15000> DS1/<DS1_15000> Chan/0
```

Variable definitions

Variable	Value
<AtmIf>	The instance of the *AtmIf* component using a particular IMA link group and it can be any number between 1 and 1 024.
<AtmIf_15000>	The instance of the *AtmIf* component using a particular IMA link group and it can be any number between 1 and 65 535.
<DS3_15000>	The instance number of the DS3 port, having a value between 0 and 3 inclusive.
<Ima>	The instance number of the IMA link group. The instance numbers of IMA link groups and independent links must be unique in a mixed configuration (The independent link instance number is the same as the *DS1* or *E1* subcomponent).
<Ima_15000>	The instance number of the IMA link group, having a value between 0 and 13. The instance numbers of IMA link groups and independent links must be unique in a mixed configuration (The independent link instance number is the same as the *DS1* or *E1* subcomponent).
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.
<Lp_15000>	The instance number of the logical processor associated with the function processor providing IMA capability.
<port_number>	The instance number of the port.
<port_type>	Ds1, E1, or Sdh. To determine the value to enter for the FP you are configuring, see NN10600-551 *Nortel Networks Multiservice Switch 7400/15000/20000 FP Configuration Reference*.

Upgrading an existing IMA link group to the 8-port DS1/E1 ATM FPs

Upgrade, on the 8-port DS1/E1 ATM FPs, an existing IMA link group from the proprietary IMA protocol to the ATM Forum IMA protocol.

Prerequisites

- Ensure that you have Nortel Networks Multiservice Switch software release 5.0 or later on the nodes at both ends of the IMA link group.
- The 32-port Multiservice Access (MSA) FPs and the 4-port DS3Ch ATM FPs support only the ATM Forum protocol. See “IMA protocols” (page 96) for additional information.

Procedure steps

1. Change the setting of the *Ima* component *protocol* attribute to atmForum10 at both ends of the IMA link group.

   ```
   set Lp/<Lp> Ima/<Ima> protocol atmForum10
   ```

   Note: This step is a component critical change that causes the IMA link group to go out of service during the change-over.

2. Perform a semantic check on the configured data.

   ```
   check Prov
   ```

3. Save the new view to disk.

   ```
   save Prov
   ```

4. Activate the configured data.

   ```
   activate Prov
   ```

   This IMA link group is now operating with the ATM Forum protocol.

5. Confirm the activation.

   ```
   confirm Prov
   ```

6. Repeat this procedure for any other IMA link groups on the FP.

Variable definitions

Variable	Value
<Ima>	The instance number of the IMA link group, having a value of 0 to 7 inclusive.
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.

Re-configuring the IMA software features list

Use this optional procedure when all the IMA link groups on the FP are using the ATM Forum protocol.

Prerequisites

- Ensure that you have Nortel Networks Multiservice Switch software release 5.0 software or later on the nodes at both ends of the IMA link group.

Procedure steps

1 Ensure that other FPs are not using the LPT that you are about to re-configure.

2 When all IMA groups on an FP are using the ATM Forum protocol, re-configure the IMA feature selected on the LPT at both ends of the IMA link group.

```
set Sw Lpt/imaFp featureList ~ima imaAtmForum
```

Configuring the feature list to use the *imaAtmForum* feature avoids loading unnecessary software on the FP and results in memory savings.

Note: When this configured change is activated, the FP is reset to purge unnecessary software from memory.

Chapter 2
IMA feature monitoring

Monitor the condition of your IMA application in Nortel Networks Multiservice Switch systems by setting and interpreting the operational attributes available with IMA components.

Prerequisites to IMA feature monitoring

- For more complete information on IMA components and attributes, see NN10600-060 *Nortel Networks Multiservice Switch 7400/15000/20000 Component Reference*.
- For information on how to use Nortel Networks Multiservice Data Manager to monitor Multiservice Switch devices and services, see 241-6001-023 *Nortel Networks Multiservice Data Manager Configuration Management Tools for Multiservice Switch*.

IMA feature monitoring tasks

These tasks contain the procedures you perform to monitor IMA features:

Locking and unlocking a port component

Lock a port to temporarily discontinue active service of the component and generate internal diagnostics (self-tests). If the diagnostics pass, the administrative state of the component changes from locked to unlocked and the port or IMA startup procedure is executed. If the diagnostics fail, the component's administrative state remains locked and the test failure result is returned in an alarm.

Prerequisites

- If you lock a DS1 or E1 port that is actively part of an IMA link group, and if you have sufficient bandwidth, you will not lose user traffic if you are running the ATM Forum IMA protocol.
- If you lock a DS3 port on the 4-port DS3Ch ATM FP, you will lose all independent links and IMA link groups under that DS3 port.

Procedure steps

1 Lock a port component.

For Multiservice Switch 7400 nodes use the following command to lock a DS1 or E1 component:

```
lock Lp/<Lp> <port_type>/<port_number>
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command to lock a DS3 port:

```
lock Lp/<Lp_15000> DS3/<DS3_15000>
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command to lock a DS1 tributary component of a channelized DS3 port:

```
lock Lp/<Lp_15000> DS3/<DS3_15000> DS1/<DS1_15000>
```

2 Unlock a port component.

For Multiservice Switch 7400 nodes use the following command to unlock a DS1 or E1 component:

```
unlock Lp/<Lp> <port_type>/<port_number>
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command to unlock a DS3 port:

```
unlock Lp/<Lp_15000> DS3/<DS3_15000>
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command to unlock a DS1 tributary component of a channelized DS3 port:

unlock Lp/<Lp_15000> DS3/<DS3_15000> DS1/<DS1_15000>

Variable definitions

Variable	Value
<DS1_15000>	The instance number of the DS1 tributary, having a value between 1 and 28 inclusive.
<DS3_15000>	The instance number of the DS3 port, having a value between 0 and 3 inclusive.
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.
<Lp_15000>	The instance number of the logical processor associated with the function processor providing IMA capability.
<port_number>	The instance number of the port.
<port_type>	Ds1 or E1. To determine the value to enter for the FP you are configuring, see NN10600-551 *Nortel Networks Multiservice Switch 7400/15000/20000 FP Configuration Reference*.

Locking and unlocking an IMA component

Lock either an *Ima* component to temporarily discontinue active service of the component and generate internal diagnostics (self-tests). If the diagnostics pass, the administrative state of the component changes from locked to unlocked and the IMA startup procedure is executed. If the diagnostics fail, the component's administrative state remains locked and the test failure result is returned in an alarm.

Procedure steps

1. Lock an *Ima* component.

   For Multiservice Switch 7400 nodes use the following command:

   `lock Lp/<Lp> Ima/<Ima>`

   For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

   `lock Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000>`

2. Unlock an *Ima* component.

   For Multiservice Switch 7400 nodes use the following command:

   `unlock Lp/<Lp> Ima/<Ima>`

   For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

   `unlock Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000>`

Variable definitions

Variable	Value
<DS3_15000>	The instance number of the DS3 port, having a value between 0 and 3 inclusive.
<Ima>	The instance number of the IMA link group, having a value of 0 to 7 inclusive for the 8-port DS1/E1 ATM FPs, or a value of 0 to 29 inclusive for the 32-port DS1/E1 Multiservice Access (MSA) FPs. On the 2-port STM-1 electrical channelized CES/ATM/IMA FP, the link group values for port 0 should be less or equal to 56, and different than any independent ATMIF E1 number. The port 1 IMA group number (group number - 57) should be greater than 56 and less than or equal to 113, and different than an independent ATMIF E1 number.
<Ima_15000>	The instance number of the IMA link group, having a value between 0 and 13.
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.
<Lp_15000>	The instance number of the logical processor associated with the function processor providing IMA capability.

Performing a manual test on the IMA component

Perform a manual test on the IMA component by externally looping back the transmit signal to the port's receive path. This generates a test pattern at the transmit end of the IMA link group which will be distributed across all active links for transmission. The receive end of the IMA link recombines the data from the active links into a single stream and verifies the results of the transmission.

Prerequisites

- Refer to the figure "IMA feature components and operational attributes" (page 92), before performing the following procedures.
- If you are configuring a manual test, the *type* attribute for ports at the remote end must be set to *externalLoop*.
- For details about port tests, see NN10600-520 *Nortel Networks Multiservice Switch 7400/15000/20000 Fault and Performance Management: Troubleshooting*.

Procedure steps

1 Identify the type of test to be executed on the local *Ima* component.

For Multiservice Switch 7400 nodes use the following command:

```
set Lp/<Lp> Ima/<Ima> Test type manual
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

```
set Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000> Test
type manual
```

2 Specify the external loop test type on the port at the remote end.

For a Multiservice Switch 7400 DS1 port use the following command:

```
set Lp/<Lp> DS1/<DS1> Test type externalLoop
```

For a Multiservice Switch 7400 E1 port use the following command:

```
set Lp/<Lp> E1/<E1> Test type externalLoop
```

For a Multiservice Switch 7400 Sdh port use the following command:

```
set Lp/<Lp> Sdh/<Sdh> Test type externalLoop
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

set Lp/<Lp_15000> DS3/<DS3_15000> Test type externalLoop

3 Make sure the duration of the remote-end port test is longer than that configured for the IMA test. If necessary, set it to a new value.

For a Multiservice Switch 7400 DS1 port use the following command:

set Lp/<Lp> DS1/<DS1> Test duration <limit>

For a Multiservice Switch 7400 E1 port use the following command:

set Lp/<Lp> E1/<E1> Test duration <limit>

For a Multiservice Switch 7400 Sdh port use the following command:

set Lp/<Lp> Sdh/<Sdh> Test duration <limit>

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

set Lp/<Lp_15000> DS3/<DS3_15000> Test duration <limit>

4 Lock the port at the remote end.

For a Multiservice Switch 7400 DS1 port use the following command:

lock Lp/<Lp> DS1/<DS1>

For a Multiservice Switch 7400 E1 port use the following command:

lock Lp/<Lp> E1/<E1>

For a Multiservice Switch 7400 Sdh port use the following command:

lock Lp/<Lp> Sdh/<Sdh>

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

lock Lp/<Lp_15000> DS3/<DS3_15000>

5 Complete step 2 through step 4 for all ports at the remote end for the IMA group.

Note: Test data is sent (shared) over all the links in the IMA group; if you do not complete these step 2 through step 4 for all remote ports prior to initiating the test then errors in the test occur.

6 Use the start command to initiate the test on the port at the remote end.

For a Multiservice Switch 7400 DS1 port,use the following command:

start Lp/<Lp> DS1/<DS1> Test

For a Multiservice Switch 7400 E1 port use the following command:

start Lp/<Lp> E1/<E1> Test

For a Multiservice Switch 7400 Sdh port use the following command:

start Lp/<Lp> Sdh/<Sdh> Test

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

start Lp/<Lp_15000> DS3/<DS3_15000> Test

7 Complete step 2 through step 4 for all ports at the remote end for the IMA group. Test data is sent (shared) over all the links in the IMA group; if you do not complete these steps for all remote ports then errors in the test occur.

8 Lock the *Ima* component to be tested.

For Multiservice Switch 7400 nodes use the following command:

lock Lp/<Lp> Ima/<Ima>

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

lock Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000>

9 Use the start command to invoke the test on the *Ima* component.

For Multiservice Switch 7400 nodes use the following command:

start Lp/<Lp> Ima/<Ima> Test

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

start Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000> Test

10 Display the results of a test in progress.

For Multiservice Switch 7400 nodes use the following command:

display Lp/<Lp> Ima/<Ima> Test

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000> Test

11 If necessary, stop the test.

For Multiservice Switch 7400 nodes use the following command:

stop Lp/<Lp> Ima/<Ima> Test

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

stop Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000> Test

12 Unlock the *Ima* component when the test is complete.

For Multiservice Switch 7400 nodes use the following command:

unlock Lp/<Lp> Ima/<Ima>

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

unlock Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000>

13 If necessary, stop the test on the port at the remote end.

For a Multiservice Switch 7400 DS1 port use the following command:

stop Lp/<Lp> DS1/<DS1> Test

For a Multiservice Switch 7400 E1 port use the following command:

stop Lp/<Lp> E1/<E1> Test

For a Multiservice Switch 7400 Sdh port use the following command:

stop Lp/<Lp> Sdh/<Sdh> Test

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

stop Lp/<Lp_15000> DS3/<DS3_15000> Test

14 Unlock the port at the remote end when the test is complete.

For a Multiservice Switch 7400 DS1 port use the following command:

unlock Lp/<Lp> DS1/<DS1>

For a Multiservice Switch 7400 E1 port use the following command:

unlock Lp/<Lp> E1/<E1>

For a Multiservice Switch 7400 Sdh port use the following command:

unlock Lp/<Lp> Sdh/<Sdh>

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

unlock Lp/<Lp_15000> DS3/<DS3_15000>

Variable definitions

Variable	Value
<DS1>	The instance number of the DS1 port.
<DS3_15000>	The instance number of the DS3 port, having a value between 0 and 3 inclusive.
<E1>	The instance number of the E1 port.
<Ima>	The instance number of the IMA link group.
<Ima_15000>	The instance number of the IMA link group, having a value between 0 and 13.
<limit>	Specifies the maximum length of time (in minutes) that the test can run. The default value is 1.00.
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.
<Lp_15000>	The instance number of the logical processor associated with the function processor providing IMA capability.

Monitoring the status of the IMA application

Monitor the status of the IMA application by displaying a list of operational attributes and select the appropriate value.

Prerequisites

- Refer to the figure “IMA feature components and operational attributes” (page 92), before performing the procedure.

Procedure steps

1. Use the display command to determine the operational attributes of the IMA application.

   For Multiservice Switch 7400 nodes use the following command:

   `display Lp/<Lp> Ima/<Ima>`

   For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

   `display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000>`

Variable definitions

Variable	Value
<DS3_15000>	The instance number of the DS3 port, having a value between 0 and 3 inclusive.
<Ima>	The instance number of the IMA link group.
<Ima_15000>	The instance number of the IMA link group, having a value between 0 and 13.
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.
<Lp_15000>	The instance number of the logical processor associated with the function processor providing IMA capability.

Determining the status of an IMA link

Determine the status of an IMA link by displaying a list of operational attributes indicating the status of a *Link* subcomponent.

Prerequisites

- Refer to the figure "IMA feature components and operational attributes" (page 92), before performing the following procedures.

Procedure steps

1. Use the display command to determine the operational attributes of the link.

   For Multiservice Switch 7400 nodes use the following command:

   `display Lp/<Lp> Ima/<Ima> Lk/<Lk>`

   For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

   `display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000> Lk/<Lk_15000>`

Variable definitions

Variable	Value
<DS3_15000>	The instance number of the DS3 port, having a value between 0 and 3 inclusive.
<Ima>	The instance number of the IMA link group.
<Ima_15000>	The instance number of the IMA link group, having a value between 0 and 13.
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.
<Lp_15000>	The instance number of the logical processor associated with the function processor providing IMA capability.

Determine the status of all links in an IMA group based on statistical attributes

Determine the status of all links in an IMA group based on its statistical attributes as part of monitoring IMA links.

Prerequisites

- Refer to the figure “IMA feature components and operational attributes” (page 92), before performing the following procedures.

Procedure steps

1 Display the performance monitoring statistics provided for the links.

Note: Performance monitoring statistics are provided only if the ATM Forum IMA protocol is being used.

For Multiservice Switch 7400 nodes use the following command:

```
display Lp/<Lp> Ima/<Ima> Lk/* statistics
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodesuse the following command:

```
display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000>
Lk/* statistics
```

Variable definitions

Variable	Value
<DS3_15000>	The instance number of the DS3 port, having a value between 0 and 3 inclusive.
<Ima>	The instance number of the IMA link group.
<Ima_15000>	The instance number of the IMA link group, having a value between 0 and 13.
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.
<Lp_15000>	The instance number of the logical processor associated with the function processor providing IMA capability.

Determining the cause of the most recent OIF anomaly

Determine the cause of the most recent OIF anomaly. When an OIF (out of IMA frame) anomaly occurs on a link, the attribute value does not change until another OIF occurs with a different cause. The attribute *lastOifCause* is always set to *noOif* in this case.

Prerequisites

- Refer to the figure “IMA feature components and operational attributes” (page 92), before performing the following procedures.

Procedure steps

1 Display the cause of the most recent out of IMA frame (OIF) anomaly.

For Multiservice Switch 7400 nodes use the following command:

```
display Lp/<Lp> Ima/<Ima> Lk/* lastOifCause
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

```
display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000>
Lk/* lastOifCause
```

Variable definitions

Variable	Value
<DS3_15000>	The instance number of the DS3 port, having a value between 0 and 3 inclusive.
<Ima>	The instance number of the IMA link group.
<Ima_15000>	The instance number of the IMA link group, having a value between 0 and 13.
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.
<Lp_15000>	The instance number of the logical processor associated with the function processor providing IMA capability.

Determining the number of one-second intervals in which idle cells were received

Determine the number of one-second intervals in which one or more idle cells were received.

Prerequisites

- Refer to the figure “IMA feature components and operational attributes” (page 92), before performing the following procedures.

Procedure steps

1. Use the display command to determine the number of one second intervals in which one or more idle cells were received.

   For Multiservice Switch 7400 nodes use the following command:

   `display Lp/<Lp> Ima/<Ima> Lk/* idleCellSec`

   For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

   `display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000> Lk/* idleCellSec`

Variable definitions

Variable	Value
<DS3_15000>	The instance number of the DS3 port, having a value between 0 and 3 inclusive.
<Ima>	The instance number of the IMA link group.
<Ima_15000>	The instance number of the IMA link group, having a value between 0 and 13.
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.
<Lp_15000>	The instance number of the logical processor associated with the function processor providing IMA capability.

Determining if the IMA group is active

Determine whether or not the IMA group is active, the cause of failure if the group is inactive, and the remote defect indicator being received from IMA application at the remote end.

Prerequisites

- Refer to the figure “IMA feature components and operational attributes” (page 92), before performing the procedure.

Procedure steps

1 To determine whether or not the IMA group is active, use the command to examine the operational state of the IMA component.

If the operational state is enabled, the group is active. If the operational state is disabled, the group is inactive.

For Multiservice Switch 7400 nodes use the following command:

```
display Lp/<Lp> Ima/<Ima> operationalState
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

```
display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000>
operationalState
```

2 If the IMA is disabled, you can use the display command to determine why the group is inactive.

For Multiservice Switch 7400 nodes use the following command:

```
display Lp/<Lp> Ima/<Ima> failureCause
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

```
display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000>
failureCause
```

3 If the failure cause is due to a remote failure, you can use the display command to examine the remote defect indicator received from the remote IMA.

For Multiservice Switch 7400 nodes use the following command:

```
display Lp/<Lp> Ima/<Ima> remoteDefect
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000> remoteDefect

Variable definitions

Variable	Value
<DS3_15000>	The instance number of the DS3 port, having a value between 0 and 3 inclusive.
<Ima>	The instance number of the IMA link group.
<Ima_15000>	The instance number of the IMA link group, having a value between 0 and 13.
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.
<Lp_15000>	The instance number of the logical processor associated with the function processor providing IMA capability.

Determining the active and failed links in an IMA group

Determine which local links are active, which ones have failed, and the cause of failure (see the procedure "Determining the active and failed links in an IMA group" (page 55)).

Prerequisites

- Refer to the figure "IMA feature components and operational attributes" (page 92), before performing the following procedures.

Procedure steps

1. Display the operational state of the Link subcomponents to determine which links are active or failed.

   For Multiservice Switch 7400 nodes use the following command:

   display Lp/<Lp> Ima/<Ima> Lk/* operationalState

   For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

   display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000> Lk/* operationalState

2. Display the reason for a disabled condition of a link (link is inactive).

   For Multiservice Switch 7400 nodes use the following command:

   display Lp/<Lp> Ima/<Ima> Lk/<Lk> failureCause

   For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

   display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000> Lk/<Lk_15000> failureCause

3. In the case where the failureCause is remoteFailure, display the remoteDefect indicator to see why a link is inactive.

   For Multiservice Switch 7400 nodes use the following command:

   display Lp/<Lp> Ima/<Ima> Lk/<Lk> remoteDefect

   For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

   display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000> Lk/<Lk_15000> remoteDefect

Variable definitions

Variable	Value
<DS3_15000>	The instance number of the DS3 port, having a value between 0 and 3 inclusive.
<Ima>	The instance number of the IMA link group.
<Ima_15000>	The instance number of the IMA link group, having a value between 0 and 13.
<Lk>	The instance number of the link.
<Lk_15000>	The instance number of the link and has a value of 0 to 31 inclusive.
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.
<Lp_15000>	The instance number of the logical processor associated with the function processor providing IMA capability.

Determining which links in the IMA group are currently active and configured at the remote end

Determine which links in the IMA group have been activated by the IMA application at the remote end, and which links have been configured by the IMA application at the remote end (see the procedure “Determining which links in the IMA group are currently active and configured at the remote end” (page 57)).

Prerequisites

- Refer to the figure “IMA feature components and operational attributes” (page 92), before performing the following procedures.

Procedure steps

1. Display the remoteLidsActive attribute of the Ima component to determine which links have been configured by the remote IMA.

   For Multiservice Switch 7400 nodes use the following command:

   display Lp/<Lp> Ima/<Ima> remoteLidsConfig

   For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

   display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000> remoteLidsConfig

2. Display the remoteLidsActive attribute of the Ima component to determine which links have been activated by the remote IMA.

   For Multiservice Switch 7400 nodes use the following command:

   display Lp/<Lp> Ima/<Ima> remoteLidsActive

   For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

   display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000> remoteLidsActive

3. Display the remoteGid attribute of the Ima component to determine the IMA link group ID used by the remote IMA.

   For Multiservice Switch 7400 nodes use the following command:

   display Lp/<Lp> Ima/<Ima> remoteGid

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

`display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000> remoteGid`

Note: The remoteGid attribute is supported only if the ATM Forum IMA protocol is being used.

Variable definitions

Variable	Value
<DS3_15000>	The instance number of the DS3 port, having a value between 0 and 3 inclusive.
<Ima>	The instance number of the IMA link group.
<Ima_15000>	The instance number of the IMA link group, having a value between 0 and 13.
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.
<Lp_15000>	The instance number of the logical processor associated with the function processor providing IMA capability.

Determining the throughput available over an IMA group

Determine the throughput capacity currently available over an IMA link group.

Prerequisites

- Refer to the figure “IMA feature components and operational attributes” (page 92), before performing the following procedures.

Procedure steps

1 Use the display command to determine the throughput available over an IMA group.

Total throughput over an IMA link is the sum of the throughput available on each link, shown in cells per second.

For Multiservice Switch 7400 nodes use the following command:

```
display Lp/<Lp> Ima/<Ima> cellCapacity
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

```
display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000>
cellCapacity
```

Variable definitions

Variable	Value
<DS3_15000>	The instance number of the DS3 port, having a value between 0 and 3 inclusive.
<Ima>	The instance number of the IMA link group.
<Ima_15000>	The instance number of the IMA link group, having a value between 0 and 13.
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.
<Lp_15000>	The instance number of the logical processor associated with the function processor providing IMA capability.

Determining the current cell utilization of an IMA group

Determine the current cell utilization of an IMA group as a percentage of the current capacity. Cell utilization is averaged over a one-minute sliding window.

Prerequisites

- Refer to the figure “IMA feature components and operational attributes” (page 92), before performing the following procedures.

Procedure steps

1. Use the display command to determine the current cell utilization as a percentage of the current capacity of an IMA group. (Utilization is averaged over a one-minute sliding window.)

   For Multiservice Switch 7400 nodes use the following command:

   `display Lp/<Lp> Ima/<Ima> receiveCellUtilization, transmitCellUtilization`

   ForMultiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

   `display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000> receiveCellUtilization, transmitCellUtilization`

Variable definitions

Variable	Value
<DS3_15000>	The instance number of the DS3 port, having a value between 0 and 3 inclusive.
<Ima>	The instance number of the IMA link group.
<Ima_15000>	The instance number of the IMA link group, having a value between 0 and 13.
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.
<Lp_15000>	The instance number of the logical processor associated with the function processor providing IMA capability.

Monitoring relative link delays

Monitor relative link delays by displaying the link (or links) with the least delay in an IMA link group, and the last-measured delay of the remaining links relative to the link (or links) with the least delay in the group.

Prerequisites

- Refer to the figure “IMA feature components and operational attributes” (page 92), before performing the procedure.
- If connectivity to the remote link is not available (for example, due to a LIF, LCD, LOF or LOS or condition), the ICP cells cannot provide the correct values for the *remoteDefect* and *remoteLid* attributes. The value for the *relativeDelay* attribute is meaningless when the link is down.

Procedure steps

1 Use the display command to determine the relative delay between each of the links in an IMA group.

For Multiservice Switch 7400 nodes use the following command:

```
display Lp/<Lp> Ima/<Ima> Lk/* relativeDelay
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

```
display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000>
Lk/* relativeDelay
```

Variable definitions

Variable	Value
<DS3_15000>	The instance number of the DS3 port, having a value between 0 and 3 inclusive.
<Ima>	The instance number of the IMA link group.
<Ima_15000>	The instance number of the IMA link group, having a value between 0 and 13.

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Variable	Value
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.
<Lp_15000>	The instance number of the logical processor associated with the function processor providing IMA capability.
(Sheet 2 of 2)	

Determining remote link configuration

Determine remote link configuration by displaying the logical link ID used by the remote IMA for each link.

Prerequisites

- Refer to the figure “IMA feature components and operational attributes” (page 92), before performing the procedure.
- If connectivity to the remote link is not available (for example, due to a LIF, LCD, LOF or LOS or condition), then the *remoteLid* has a value of 0.

Procedure steps

1 Use the display command to determine the remote logical link ID of the links in an IMA group.

For Multiservice Switch 7400 nodes use the following command:

```
display Lp/<Lp> Ima/<Ima> Lk/* remoteLid
```

For Multiservice Switch 15000 and Multiservice Switch 20000 nodes use the following command:

```
display Lp/<Lp_15000> DS3/<DS3_15000> Ima/<Ima_15000>
Lk/<Lk_15000> remoteLid
```

Variable definitions

Variable	Value
<DS3_15000>	The instance number of the DS3 port, having a value between 0 and 3 inclusive.
<Ima>	The instance number of the IMA link group.
<Ima_15000>	The instance number of the IMA link group, having a value between 0 and 13.
<Lp>	The instance number of the logical processor associated with the function processor providing IMA capability.
<Lp_15000>	The instance number of the logical processor associated with the function processor providing IMA capability.

Determining if the IMA group provides adequate bandwidth

Determine if the IMA link group provides adequate bandwidth. An IMA link group may not always have enough bandwidth to support all ATM connections associated with the ATM interface. When some physical links on the IMA group have failed, some bandwidth non-elastic connections may have to be released and some bandwidth elastic connections may have to reduce their bandwidth consumption.

See NN10600-708 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM CAC and Bandwidth Fundamentals* for details on

- dynamic bandwidth management for ATM connections
- how to monitor ATM connections and dynamic bandwidth

Chapter 3
Troubleshooting IMA

This section provides information on how to troubleshoot the IMA feature. It contains the following sections:

Multiservice Switch alarms

On-switch alarms are generated asynchronously by Nortel Networks Multiservice Switch components and are displayed on the user interface to indicate faults or failure conditions on a Multiservice Switch node. When an alarm occurs, it indicates that a component needs to be serviced or that it has detected a fault elsewhere on the node. Alarm text descriptions contain information to assist you in monitoring and troubleshooting your Multiservice Switch network. Alarms specifically indicate one of the following:

- degradation/quality-of-service conditions

  (for example, when a threshold is reached)

- processing error

  (for example, protocol violations)

- failures/out-of-service conditions

  (for example, hardware failures)

- administrative conditions

  (for example, issuing the lock command)

- security violations

The interface can be either a VT100 terminal or Nortel Networks Multiservice Data Manager workstation. For information on Multiservice Data Manager tools, see 241-6001-023 *Nortel Networks Multiservice Data Manager Configuration Management Tools for Multiservice Switch*.

Alarms contain information that can assist you in monitoring the node and the network. The figure "Example of an IMA alarm appearing on the text interface" (page 66) provides an example of an alarm. For complete information on alarms, see NN10600-500 *Nortel Networks Multiservice Switch 6400/7400/15000/20000 Alarms Reference*.

Figure 2
Example of an IMA alarm appearing on the text interface

```
    Lp/1 Ima/2 Lk/11; 1998-03-20 14:19:40.08
SET critical communications
commProtocolError                              7011  1210
    ADMIN: unlocked     OPER: disabled      USAGE: idle
    AVAIL:              PROC:               CNTRL:
    ALARM: critical     STBY: notSet        UNKNW: false
    Id: 01000064  Rel:
    Com: Loss of Ima Framing (LIF) has been detected.
        Check the last OIF cause of the link.
    Int: 1/0/2/8499; ImaAFLinkHandler_Actor.cc; 2202; p5.0d.30
```

IMA-specific alarms

Nortel Networks Multiservice Switch alarms indicating the following state changes can be generated by IMA feature.

Note: The text "(A)" denotes that the alarm applies to the ATM Forum IMA protocol.

- 7011 1100 - IMA group failure. There are no links active in the group.
- 7011 1210 (A) - IMA link failure. A loss of IMA frame (LIF) defect has occurred on a link.
- 7011 1211 (A) - IMA link failure. The link is experiencing a loss of delay synchronization (LODS) condition.
- 7011 1212 (A) - IMA link failure. The link has been misconnected.
- 7011 1213 (A) - IMA link failure. The system has detected a remote failure indicator (RFI) alarm condition.
- 7011 1214 (A) - IMA link failure. The system has detected a fault alarm condition on the link.
- 7011 1215 (A) - IMA link failure. The remote link has gone into an unusable state.
- 7011 1216 (A) - IMA link failure. The system has detected a protocol error alarm condition on the link

For details on these alarms, see NN10600-500 *Nortel Networks Multiservice Switch 6400/7400/15000/20000 Alarms Reference*.

IMA group alarms

IMA group alarms are set and cleared in response to conditions causing the group to go out of service. There is one alarm at the IMA group level (7011 1100).

When the ATM Forum IMA protocol is used, the alarm text provides an indication of the cause of the alarm. The following are potential causes:

- The IMA group IDs received in the ICP cells on all candidate links (remaining after the transmit test procedure) involved in IMA group start-up do not match.

- The IMA frame lengths received in the ICP cells on all candidate links involved in IMA group start-up do not match the value supported by the IMA group. (Nortel Networks Multiservice Switch IMA supports only a frame length of 128.)
- The logical link IDs received in the ICP cells on all candidate links (remaining after the transmit test procedure) involved in IMA group start-up are not unique.
- The IMA group symmetry received in the ICP cells on all candidate links involved in IMA group start-up is not supported. (Multiservice Switch IMA supports only symmetrical configuration.)
- An expected state transition expected from the far end did not take place during IMA group start-up.
- The far end rejects the IMA frame length being used by the near end during IMA group start-up.
- The far end rejects the group symmetry being used by the near end during IMA group start-up.
- The far end aborts for a reason other than bad frame length or symmetry during IMA group start-up.
- No links can be activated during IMA group start-up, or the number of active links is reduced to zero during normal operation.
- During IMA group start-up, or in normal operation, the Group Status field in ICP cells received on candidate or active links indicates that the remote IMA has insufficient links.
- The far end enters start-up while the near end is not in start-up and is unlocked.

IMA link alarms

IMA link alarms are set and cleared in response to conditions causing the link to go out of service. Some link alarms are set immediately when an error condition is detected and cleared immediately when the error condition is no longer present. Other link alarms are set when a defect is present for a period of time. These alarms are cleared when the defect is absent for a period of time. In some cases, intermittent defects can also lead to alarms.

Link alarms for the ATM Forum IMA protocol

A number of alarm types are defined at the IMA link level when the ATM Forum IMA protocol is being used in Nortel Networks Multiservice Switch systems. These alarm types are

- loss of IMA frame (LIF) defect on the link
- loss of delay synchronization (LODS) on the link
- the link is misconnected
- remote failure indicator (RFI) condition has occurred
- a fault condition has occurred indicating an invalid value
- remote link is unusable
- protocol error has occurred on the link

The troubleshooting process

The objective of effective troubleshooting is to

- identify the problem quickly
- isolate the cause
- resolve the fault as quickly as possible in order to minimize disruption in service or loss of data

A summary of troubleshooting actions is summarized in the remainder of this section.

Tools for troubleshooting IMA

You can perform a manual external loopback test on the *Ima* component. For instructions on performing this test, see “Performing a manual test on the IMA component” (page 43). You can also monitor the condition of your IMA application by performing a number of other commands (see “IMA feature monitoring” (page 37) for details).

You can avoid having to manually set up the external loopback for an IMA test by using the following steps:

1 Perform the external loopback test on the port components at the remote end. For instructions, see NN10600-520 *Nortel Networks Multiservice Switch 7400/15000/20000 Fault and Performance Management: Troubleshooting*.

2 Perform the IMA test. See “Performing a manual test on the IMA component” (page 43).

Troubleshooting using Nortel Networks Multiservice Data Manager

Nortel Networks Multiservice Data Manager offers a comprehensive set of fault management tools for detecting and isolating problems. When using Multiservice Data Manager to troubleshoot the IMA feature, use the integrated alarms display to view alarms and the integrated command console for access to IMA operational attributes.

For details on the scope and use of Multiservice Data Manager interface and software tools, see 241-6001-023 *Nortel Networks Multiservice Data Manager Configuration Management Tools for Multiservice Switch*.

Handling problems

The table “Handling problems” (page 71) provides guidelines on how to respond to problems that may occur with an IMA application. Problems that occur when your IMA application is operating may not be confined to IMA components only.

Note: The text “(A)” denotes that an alarm or value applies to the ATM Forum IMA protocol.

Table 1
Handling problems

Problems that may occur	Probable causes	Corrective measures
IMA group alarm is set 7011 1100	Value indicated for *failureCause* attribute of the *Ima* component:	
	noGoodLinksInStartup - No links could be activated during IMA group startup	Check the operational attributes of the *Link* subcomponents. Ensure that the associated physical ports are enabled. Verify that they are connected to ports being used by a properly configured remote IMA group.
	badGidInStartup - Different group IDs were received from the remote links during IMA group startup	Ensure that the links in the group are connected to links under a single remote *Ima* component.
	badLidInStartup - Duplicate logical link IDs were received from the remote links during IMA group startup	Ensure that the links in the group are connected to links under a single remote *Ima* component.
	unsupportedFrameLengthInStartup - An IMA frame length other than 128 cells was received from one or more of the remote links during IMA group startup (p)	Ensure that the remote IMA group uses a frame length supported by your local IMA group.
	An IMA frame length other than 128 cells was received from all of the remote links during IMA group startup (A)	

(Sheet 1 of 11)

Table 1 (continued)
Handling problems

Problems that may occur	Probable causes	Corrective measures
	timeoutInStartup - The remote IMA application failed to enter IMA startup within the expected amount of time	Examine the operational attributes of the remote *Ima* component. Ensure that the component is not locked and that its associated ports are enabled. ***Note:*** Often the *remoteDefect* attribute of the *Ima* component provides an indication of the cause of failure at the remote end; however, under some circumstances this defect indicator cannot be received, so it is always best to examine the remote end directly.
	noGoodLinks - The group was active, but all links have become disabled (p) All links have become disabled or failed to become enabled while the IMA group was not in startup state (A)	Check the operational attributes of the *Link* subcomponents. Ensure that the associated physical ports are enabled. Examine the operational attributes of the remote *Ima* component to determine if it has caused the problem.
	remoteFailure - The *Ima* component at the remote end has a problem	Examine the operational attributes of the remote *Ima* component. ***Note:*** The *remoteDefect* attribute of the *Ima* component often provides an indication of the cause of failure at the remote end; however, under some circumstances this defect indicator cannot be received, so it is always best to examine the remote end directly.
(Sheet 2 of 11)		

Table 1 (continued)
Handling problems

Problems that may occur	Probable causes	Corrective measures
	unsupportedSymmetryInStartup - The symmetry proposed by the far end IMA group is not supported on the local IMA group. This occurs when the local IMA group is running ATM Forum protocol and the far end proposes a group symmetry other than “symmetric configuration and operation” (A)	Ensure that the remote IMA group uses a group symmetry supported by your local IMA group. Reprovision the far-end IMA group to use the ATM Forum protocol.
IMA link alarm is set 7011 1200 (p), or the *Link* component is disabled	If the value of the *availabilityStatus* attribute of the *Link* component is depend and the physical interface is out of service (the *operationalState* attribute of the *Chan* component being used by the link is disabled)	Correct the problem that has caused the physical interface to go out of service. See the procedures for troubleshooting problems with function processors in NN10600-520 *Nortel Networks Multiservice Switch 7400/15000/20000 Fault and Performance Management: Troubleshooting*.
	If the *availabilityStatus* of the *Link* component is offLine, the parent *Ima* component is locked (*adminState* attribute of the *Ima* component is “locked”) Value indicated for *failureCause* attribute of the *Link* component:	Unlock the parent *Ima* component
(Sheet 3 of 11)		

Table 1 (continued)
Handling problems

Problems that may occur	Probable causes	Corrective measures
	interfaceDown - The physical interface is out of service.	Correct the problem that has caused the physical interface to go out of service or become unusable. See the procedures for troubleshooting problems with function processors in NN10600-520 *Nortel Networks Multiservice Switch 7400/ 15000/20000 Fault and Performance Management: Troubleshooting*.
	lif - The link is in a “loss of IMA frame” state.	Check the cabling at the associated port to ensure that it is properly connected to a port associated with a *Link* component on the remote IMA group. Then, check the status of the remote port to see if it is enabled.
(Sheet 4 of 11)		

Table 1 (continued)
Handling problems

Problems that may occur	Probable causes	Corrective measures
	lods - The differential delay of this link exceeds the configured value for the *maxDiffDelay* attribute for the *Ima* component given its configured *linkSelectionCriterion* attribute	Display the *relativeDelay* operational attributes of all the Links under the *Ima* component to determine their differential delays relative to the link with the least delay. If the provisioned *maxDiffDelay* attribute is not at its maximum value and an increased transmission delay can be tolerated, increase the value of the *maxDiffDelay* attribute to activate this link. Otherwise do one of the following: • Remove one or more of the other links from the group to reduce the differential delay of this link such that it is activated. • Replace the physical facility used by this link with one exhibiting a lower differential delay.
(Sheet 5 of 11)		

Table 1 (continued)
Handling problems

Problems that may occur	Probable causes	Corrective measures
	protocolError - A violation of the IMA startup or link addition protocol occurred which prevented this link from being activated	If the *operationalState* attribute of the parent *Ima* component is disabled, the problem occurred during group startup. Examine the operational attributes of the *Ima* component to troubleshoot the problem. If the *operationalState* attribute of the parent *Ima* component is enabled, the problem occurred during link addition. A fault may have occurred with the IMA group ID, frame length, or logical link ID received on this link, or the remote IMA application may not be responding to attempts to add this link. Check the cabling at the associated port to ensure that it is correctly connected to a port associated with a *Link* component on the remote IMA group. Then, check the status of the remote port to ensure that it is enabled.
(Sheet 6 of 11)		

Table 1 (continued)
Handling problems

Problems that may occur	Probable causes	Corrective measures
	remoteFailure - The *Link* component at the remote end has a problem	Examine the operational attributes of the corresponding link at the remote end to troubleshoot its problem. ***Note:*** Often the *remoteDefect* attribute provides an indication of the cause of failure at the remote end; however, under some circumstances this defect indicator cannot be received, so it is always best to examine the remote end directly.
IMA link alarm is set 7011 1210 (A) The alarm is due to a loss of IMA frame (LIF) failure	The link is incorrectly connected or incorrectly configured.	Check the *lastOifCause* operational attribute of the link to obtain an indication of the cause of the problem. Check that the physical port is properly connected at the local and remote ends and that all port alarms are clear. Check the configuration of the *Link* components on the local and remote ends.
(Sheet 7 of 11)		

Table 1 (continued)
Handling problems

Problems that may occur	Probable causes	Corrective measures
IMA link alarm is set 7011 1211 (A) A loss of delay synchronization (LODS) condition is present on the link.	The transit delay experienced on the link is such that the link is no longer in link delay synchronization (LDS).	Check the *relativeDelay* operational attribute of the link to determine its differential delay. If an increase in the maximum differential delay across the IMA group is acceptable, increase the setting of the *maxDiffDelay* attribute of the parent *Ima* component. Alternatively, change the setting of the *linkSelectionCriterion* attribute of the parent *Ima* component This may force the IMA group to select a different reference link. ***Note:*** This action may cause other links to experience an LODS condition. If the problem persists, replace the physical facility used by this link with one that has a transit delay closer to that of the reference link.
IMA link alarm is set 7011 1212 (A) The link is misconnected.	The link is incorrectly connected or incorrectly configured.	Check that the physical port is properly connected at the local and remote ends. Check the configuration of the *Link* components on the local and remote ends.

Table 1 (continued)
Handling problems

Problems that may occur	Probable causes	Corrective measures
IMA link alarm is set 7011 1213 (A) A remote failure indicator (RFI) alarm condition has occurred.	The remote IMA link has experienced a persistent defect.	Check the configuration of the *Link* components on the local and remote ends. Display the operational attributes of the remote IMA *Link* component.
IMA link alarm is set 7011 1214 (A) A fault alarm condition has occurred on the link.	The link is incorrectly connected or incorrectly configured.	Check that the physical port is properly connected at the local and remote ends. Check the *failureCause* attribute of the IMA *Link* components. Check the configuration of the *Link* components on the local and remote ends.
IMA link alarm is set 7011 1215 (A) The remote link has gone to the unusable state.	The remote IMA link has gone to the Unusable state. (For example, the remote port is down.)	Display the operational attributes of the *Link* component at the remote end to determine why the link has entered the unusable state.
IMA link alarm is set 7011 1216 (A) A protocol error alarm condition has occurred on the link. The link could not be activated within the prescribed time-out period.	The remote link is not changing state as quickly as the local link.	Display the operational attributes of the remote IMA *Link* component. Check the configuration of the *Link* components on the local and remote ends.

(Sheet 9 of 11)

Table 1 (continued)
Handling problems

Problems that may occur	Probable causes	Corrective measures
Occasional loss of traffic but no alarms issued	If certain Cell statistics (such as *uncorrectableHecErrors*) or Port statistics (such as *sevErroredSec*) are increasing, this indicates a problem with the physical facility connecting the near-end and far-end IMA groups. (For more information about these statistics, see NN10600-060 *Nortel Networks Multiservice Switch 7400/15000/20000 Component Reference*.)	Verify the physical links connecting the two IMA groups and replace them if they are not providing the required quality. Do a port test on the local and remote ends to determine if there is any faulty equipment and replace a card if required.
	If the *idleCellSec* operational attribute of an IMA *Link* component is increasing, this means that idle cells are being received on the link.	Check the IMA clocking mode at the far-end and the clock sources for the physical ports that are part of the IMA group. Display the *clockingModeMismatch* operational attribute of the IMA *Link*. If its value is on, this means that both ends of the IMA group are not using the same clocking mode. Although this is a valid configuration, ensure that this is the expected result. Ensure that there is a bit transparent link to the remote IMA. For example, if the two IMA groups are connected through a cell-relay network, this will cause idle cells to be inserted. Check the equipment at the far-end.

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Table 1 (continued)
Handling problems

Problems that may occur	Probable causes	Corrective measures
	If one of the *icpViolations*, *sevErroredSec,* or *unavailSec* operational attributes of an IMA *Link* component is increasing, this means that the link is occasionally losing IMA framing.	Check the *lastOifCause* attribute of the IMA *Link* components. Do an Ima loopback test on local and remote IMA groups to determine if there is faulty equipment and replace a card if required. (See "Performing a manual test on the IMA component" (page 43).)
When one physical link goes out of service, it causes two IMA links to go down.	The transmit and receive wires of a port are not connected to the same port at the remote end.	Display the *remoteLid* operational attribute of the IMA links at both ends. Make sure the values match the expected ones.
IMA link states are going up and coming down repeatedly. Some link states are incorrect (either down or disabled).	The number of links has exceeded the total number of links allowed for each port block/port grouping.	Reconfigure the total number of links so that they are less than or equal to the total number of links allowed per maker/port grouping.
Note: The text "(A)" denotes that an alarm or value applies to the ATM Forum IMA protocol.		
(Sheet 11 of 11)		

Chapter 4
IMA conceptual overview

This chapter provides an overview of inverse multiplexing for ATM (IMA) in Nortel Networks Multiservice Switch systems and includes the following:

For a detailed description of IMA functionality, see "Understanding IMA" (page 101)

What is IMA?

Inverse multiplexing for asynchronous transfer mode (ATM), or IMA, is a feature available in Nortel Networks Multiservice Switch systems that supports the transparent transmission of ATM cell data over an IMA link group. Depending upon the function processor in use, IMA transparently

distributes a single stream of ATM layer cell traffic onto one or more physical links for transmission across the links. IMA then combines the traffic back into the original ATM layer cell sequence at the remote end.

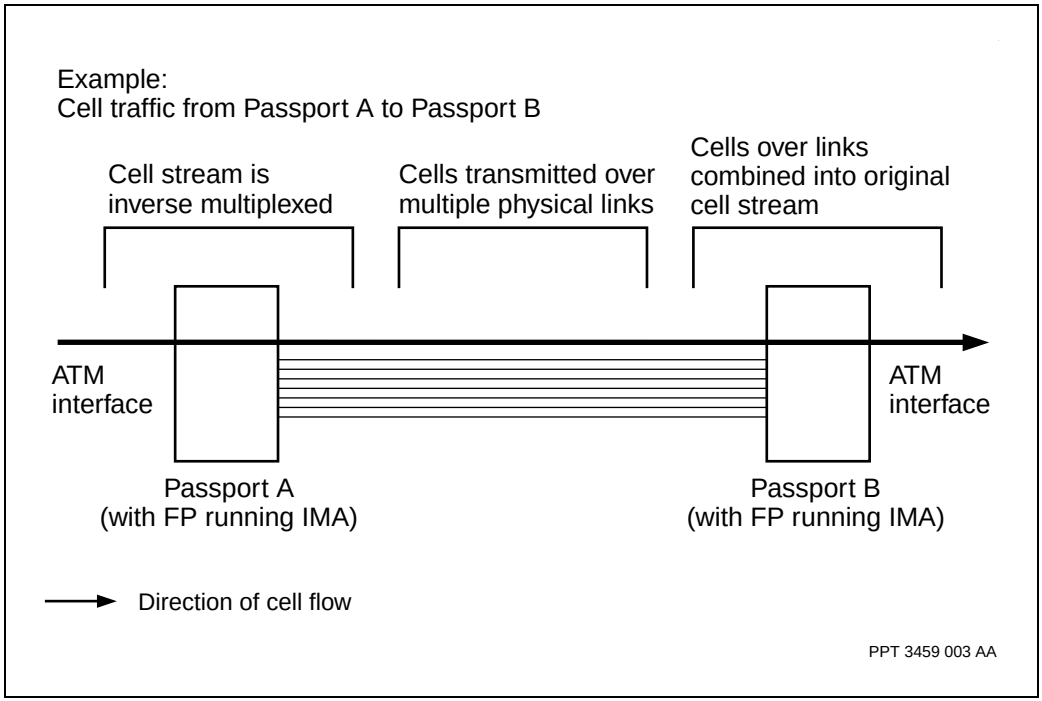
For information on which function processors support IMA, see NN10600-551 *Nortel Networks Multiservice Switch 7400/15000/20000 FP Configuration Reference*.

How does IMA work?

IMA groups multiple DS1 or E1 physical links or logical links (depending on the type of function processor) to form a single high-speed ATM link. This link is called an IMA link group. The figure "The concept of inverse multiplexing (unidirectional example) illustrated using the 8-port DS1/E1 ATM FP" (page 85) shows an example of two Nortel Networks Multiservice Switch 7400 nodes with function processors (FPs) running IMA. In this example, eight DS1 or E1 lines are grouped together to form one IMA link group.

The number of IMA link groups and the number of DS1 or E1 physical links or logical links forming the IMA link groups are determined by the particular node's function processors and by the provisioning decisions. See "Cell transport functionality using IMA" (page 103) for details.

Figure 3
The concept of inverse multiplexing (unidirectional example) illustrated using the 8-port DS1/E1 ATM FP



Network implementations of IMA

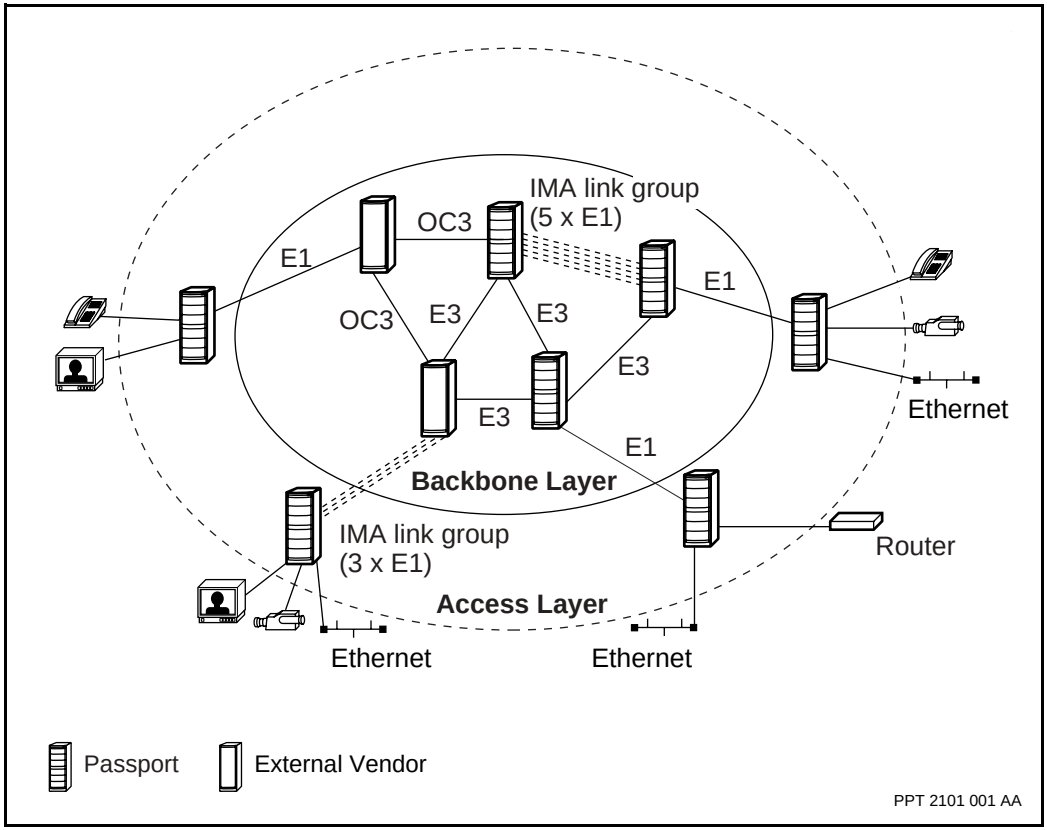
An IMA link group can be used in various network implementations. For example, an IMA link group can be used within a Nortel Networks Multiservice Switch network, or to access an external ATM network.

The figure "Example of using IMA link groups (Multiservice Switch 7400) in an ATM network" (page 87) shows an example of how an IMA link group can be used to provide higher speed links between access and backbone layer nodes. In this example, the link group speed is three times the E1 rate, or 5.715 Mbit/s. The ATM Forum protocol is being used, in this case, by the node in the access layer. This allows interoperability with the external vendor equipment in the backbone layer, based on the ATM Forum *Inverse Multiplexing for ATM (IMA) Specification*.

In Nortel Networks Multiservice Switch 7400 nodes, IMA can also be used to provide high speed access between backbone nodes at rates between E1 and E3. In this example, the link group speed is five times the E1 rate, or 9.525 Mbit/s. One of the benefits of IMA is that existing hardware can be used to access higher line rates.

Note: It is possible to transport an IMA cell stream over a bit transparent medium, such as leased DS1/E1 lines or the AAL1 circuit emulation system supported on Multiservice Switch. However, due to the format required by IMA control protocol (ICP) cells, it is not possible to transport the IMA cell stream over an ATM network between nodes running ATM bearer service (cell relay). For details on ICP cells, see “IMA framing and control” (page 109).

Figure 4
Example of using IMA link groups (Multiservice Switch 7400) in an ATM network



Terminology specific to IMA

Inverse multiplexing for ATM refers to the transparent transport of a single ATM cell stream over one or more physical links, and the combining and reordering of cells back into the original stream at the receiving end.

An IMA *link group* refers to the combination of one or more physical or logical links (depending on the type of function processor) that use the inverse multiplexing process to transmit traffic across these links. (This may also be referred to as an *IMA group*.) An IMA link group is presented as a single link to the ATM layer. A link group originates on one FP running the IMA feature and terminates on another FP running the IMA feature (typically these FPs are on two different Nortel Networks Multiservice Switch nodes).

Channelization refers to a function processor's ability to group DS1 access onto a DS3 line. For example, on Multiservice Switch 15000 and Multiservice Switch 20000 node's DS3 channelized ATM FP, 28 individual DS1 channels (lines or ATM UNIs) are multiplexed and demultiplexed on each of four DS3 cell streams (112 DS1 channels or 112 ATM UNIs).

An *independent link* refers to a single DS1/E1 physical link or DS1 logical link that is used directly by the ATM layer, without being part of an IMA link group.

> ***Note:*** An IMA link group is capable of using the IMA protocol over a single DS1/E1 physical link or DS1 logical link (depending of the type of function processor). This is useful when the current requirement may only warrant the use of a single physical link or logical link, but anticipated growth will require additional links. Physical or logical links can be added to the IMA link group as the need for additional bandwidth arises.

Supported ATM features and services

IMA accommodates cell level ATM layer traffic and is compatible with the full range of associated Nortel Networks Multiservice Switch ATM features. IMA supports fully integrated functionality, including

- ATM traffic management for different service categories within an ATM interface

- Multiservice Switch routing system for the efficient handling of link failures

The following table shows additional features that closely interwork with IMA in Multiservice Switch systems. These features are described elsewhere in the Nortel Networks Multiservice Switch documentation suite.

Table 2
IMA and related features

Feature	Document with feature description	Feature description
Inverse multiplexing for ATM	NN10600-730 *Nortel Networks Multiservice Switch 7400/15000/ 20000 Inverse Multiplexing for ATM Operations*	Describes IMA feature, benefits, functionality, provisioning, monitoring, troubleshooting
Core services' connection bandwidth control (CBC)	NN10600-700 *Nortel Networks Multiservice Switch 7400/15000/ 20000 ATM Technology Fundamentals*	Describes how the CBC algorithm controls the response of different ATM connections that are part of an ATM interface to a change in bandwidth over an IMA link group
Dynamic trunk speed changes	NN10600-420 *Nortel Networks Multiservice Switch 7400/15000/ 20000 Operations: Trunking*	Describes the speed changes on ATM trunks required to maintain a direct logical trunk connection on a permanent single hop PVC when a bandwidth change occurs on an IMA link group
Point-to-multipoint connections	NN10600-700 *Nortel Networks Multiservice Switch 7400/15000/ 20000 ATM Technology Fundamentals*	Describes CBC requirements for point-to-multipoint connections

IMA fully supports the orderly and predictable allocation of bandwidth within a link group using ATM quality of service as outlined in the existing traffic management contract. For more information see the following documents:

- NN10600-705 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Traffic Management Fundamentals*
- NN10600-706 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Traffic Shaping and Policing Fundamentals*
- NN10600-707 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Queuing and Scheduling Fundamentals*
- NN10600-708 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM CAC and Bandwidth Fundamentals*

IMA supports existing ATM features and services. For example:

- ATM bearer service
- ATM logical trunks (AAL5), including ATM direct adjacent trunks
- Circuit Emulation (AAL1)
- ATM multiprotocol encapsulation (MPE)
- Frame Relay over ATM

IMA includes support for

- Multiservice Switch services that can be carried over ATM (Services related to voice transport, voice networking, and transparent data are supported by Multiservice Switch 7400, Multiservice Switch 15000, and Multiservice Switch 20000 nodes.)
- ATM connections such as PVCs, soft PVCs, and SVCs.

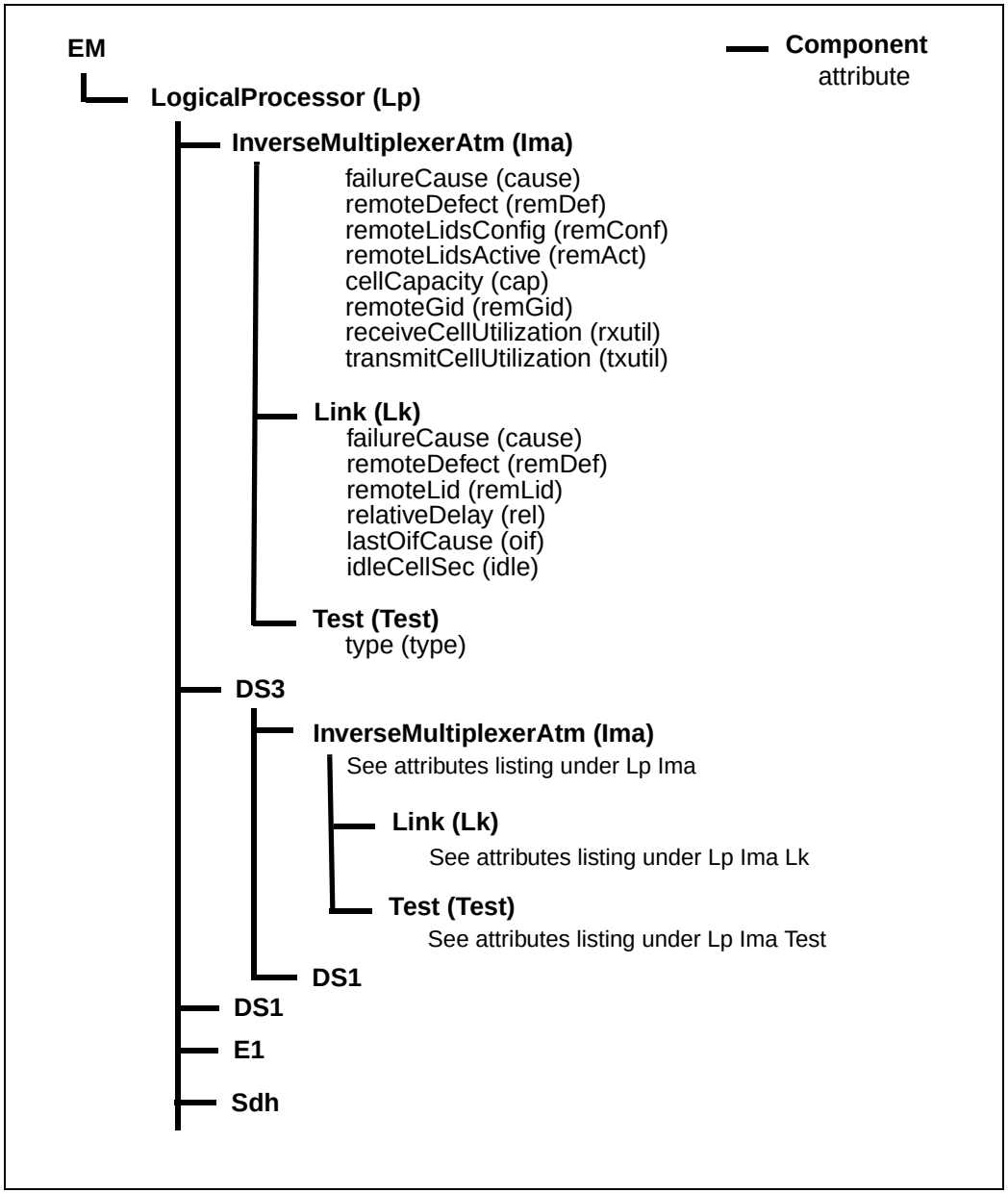
Note: These lists of features supported by IMA are not comprehensive. Features are added in each Multiservice Switch release.

IMA components and operational attributes

The IMA feature components and operational components are shown in the figure “IMA feature components and operational attributes” (page 92). The *Ima* subcomponents of the *Lp* component and the *Lp DS3* subcomponent

permit access to an IMA group and contains a number of operational attributes. *Link* and *Test* are sub-components of the *Lp Ima* and *Lp DS3 Ima* subcomponents. The figure also shows the operational attributes of the *Ima* subcomponent of the *Lp* component. A complete listing of the Ima feature attributes are in NN10600-060 *Nortel Networks Multiservice Switch 7400/ 15000/20000 Component Reference*.

Figure 5
IMA feature components and operational attributes



Function processors supporting IMA

For information on which FPs support IMA, see NN10600-551 *Nortel Networks Multiservice Switch 7400/15000/20000 FP Configuration Reference*.

IMA link groups and independent links

The individual ports on some Nortel Networks Multiservice Switch FPs and the DS1 logical links on other FPs can be configured for IMA functionality as follows:

- IMA links (part of an IMA link group), or
- independent (stand-alone) links

When using independent links, each individual link must be associated with an *AtmIf* component. When using IMA, one *AtmIf* component is defined for each IMA link group. See “IMA provisioning” (page 21) for details on how to configure IMA link groups, and a mixed configuration of IMA link groups and independent physical links.

No traffic losses occur with ATM Forum IMA when you add physical or logical links. In the case of removal of such links, if there is sufficient bandwidth on the remaining links, there will be no traffic loss. Likewise, you can remove or add physical or logical links without tearing down the link group or the ATM interface being served by the IMA link group. The failure of one physical or logical link has no effect on the remaining links in the IMA link group (if there is sufficient bandwidth on the remaining physical or logical links), except that overall throughput is reduced over the IMA link group. In addition, you can engineer an IMA link group such that if a physical link fails, service over many ATM connections served by the link can be maintained at a reduced capacity. Specifically, you can designate ATM direct logical trunks using single hop permanent virtual connections (PVCs) as *elastic* connections that continue service if the capacity available to the connection changes due to a change in IMA group capacity. If IMA bandwidth is reduced, you can configure a direct trunk connection to continue at the reduced throughput or be released.

For information on the provisioning configurations for the function processors, see the following sections:

- "Provisioning configurations for the 8-port DS1/E1 ATM function processors" (page 94)
- "Provisioning configurations for the 32-port DS1/E1 Multiservice Access function processors" (page 94)
- "Provisioning configurations for the 4-port DS3Ch ATM function processor" (page 96)
- "Provisioning configurations for the 2-port STM-1 electrical channelized CES/ATM/IMA function processor" (page 96)

Provisioning configurations for the 8-port DS1/E1 ATM function processors

The 8-port DS1/E1 ATM FPs for Nortel Networks Multiservice Switch 7400 nodes support

- up to eight IMA link groups per FP with each link group servicing a separate ATM interface
- up to eight physical links per IMA link group
- up to eight independent links per FP
- a mixture of IMA groups and independent links running simultaneously on an FP

Provisioning configurations for the 32-port DS1/E1 Multiservice Access function processors

For the purpose of IMA configuration, consider the 32 ports as divided into two 16-port blocks. The lower port block includes ports 0 through 15, and the upper port block includes ports 16 through 31.

Characteristics and special considerations for configuring IMA on MSA32 are provided in the following points.

- On the 32-port DS1 Multiservice Access (MSA32) function processors (FPs), a maximum of 15 ports can be used for IMA in each port block, if the number of IMA link groups on that port block is 7 or less.

- On the E1 MSA32 FPs, a maximum of 14 ports can be used for IMA in each port block, if the number of IMA link groups on that port block is 7 or less.
- On the DS1 and E1 MSA32 a maximum of 13 ports can be used for IMA in each port block, if each IMA port is in its own IMA link group (13 ports in 13 groups). Note it is supported but not typical to have single-link IMA groups.
- When IMA is deployed in a port block, other services (for example, frame relay and circuit emulation) should not be used on that port block.
- Each IMA link group may have up to eight ports.
- All ports in an IMA link group must be in the same port block.
- In the lower port block, any combination of ports can be included in an IMA link group; the link instance to which each port is associated is in the range of 0 through 15.
- In the upper port block, any combination of ports can be included in a link group; the link instance to which each port is associated is in the range of 0 through 15.
- Interoperability with IMA features in Nortel Networks Multiservice Switch Release 5.0 and later, is supported.

When configuring IMA on 32-port FPs, you can make considerations for the following:

- the number of IMA groups per port block basis
- the number of link groups across the entire FP regardless of port blocks
- the number of IMA groups for DS1 compared to E1

In general, there are no semantic limits imposed through software and configuration checks. That is, Multiservice Switch systems will not disallow provisioning 16 IMA ports per block, but that configuration will not work; some ports will fail. The network operator must be aware of and follow the above rules, such as maximum 14 E1 or 15 DS1 IMA ports per port block.

Provisioning configurations for the 4-port DS3Ch ATM function processor

The 4-port DS3Ch ATM FP for Nortel Networks Multiservice Switch 15000 and Multiservice Switch 20000 nodes support

- up to four physical links per FP
- up to 28 DS1 logical links per DS3 port
- up to 14 IMA link groups per DS3 port
- up to 56 IMA link groups per channelized FP (14 IMA link groups x 4 ports)
- up to 112 independent links (28 DS1 channels for each of the four DS3 ports) per channelized FP
- a mixture of IMA link groups and independent links running simultaneously on an FP

Provisioning configurations for the 2-port STM-1 electrical channelized CES/ATM/IMA function processor

The 2-port STM-1 electrical channelized CES/ATM/IMA FP for Nortel Networks Multiservice Switch 7400 nodes supports

- up to 2 physical links per FP
- transport of ATM cell streams at rates between E1 and 32 x E1
- link group sizes in the range of 1 to 32 E1 links
- up to 57 IMA link groups per port
- a mixture of IMA link groups and independent links running simultaneously on an FP

IMA protocols

Multiservice Switch IMA software supports the ATM Forum IMA protocol.

Applicability

For the 8-port DS1/E1 function processors, Nortel Networks Multiservice Switch systems support the ATM Forum IMA. Multiservice Switch IMA services running on the 32-port DS1/E1 Multiservice Access (MSA32) FP, 2-port STM-1 electrical channelized CES/ATM/IMA FP, and the 4-port DS3Ch ATM FP, support only the ATM Forum IMA protocol 1.1.

ATM Forum IMA protocol

The ATM Forum IMA protocol, supported in Nortel Networks Multiservice Switch release 5.0 and later, provides interoperability with equipment compliant with the ATM Forum *Inverse Multiplexing for ATM (IMA) Specification*. Future enhancements to Multiservice Switch system's IMA product will be based on the ATM Forum IMA protocol.

All Multiservice Switch function processors that provide IMA services support the ATM Forum IMA protocol.

Bandwidth options using ATM

Nortel Networks Multiservice Switch system's IMA feature permits the transfer of ATM layer cell traffic between FPs as summarized in the table "Method of transferring ATM layer cell traffic between function processors" (page 97).

Table 3
Method of transferring ATM layer cell traffic between function processors

Function processor	Product	Method
8-port DS1 ATM FP	Multiservice Switch 7400	multiple DS1 physical links
8-port E1 ATM FP	Multiservice Switch 7400	multiple E1 physical links
32-port DS1 MSA FP	Multiservice Switch 7400	multiple DS1 physical links
32-port DS1 MSA FP	Multiservice Switch 7400	multiple E1 physical links
4-port DS3Ch ATM FP	Multiservice Switch 15000 and Multiservice Switch 20000	multiple DS1 logical links on a DS3 channelized interface
2-port STM-1e Ch CES/ ATM/IMA FP	Multiservice Switch 7400	multiple E1 logical links on an STM1 channelized interface

Typically, the FPs are on different nodes. IMA on the 8-port DS1/E1 ATM FPs and the 32-port DS1/E1 MSA FPs bridges the gap between the throughput of a DS1/E1 ATM link and a DS3/E3 ATM link. This is useful where DS3/E3 facilities (or those with higher line speeds) are not available or cannot be justified due to cost or the volume of ATM traffic.

IMA link group capacity on the 8-port DS1/E1 ATM FPs

For Nortel Networks Multiservice Switch system's IMA feature on the 8-port DS1/E1 ATM FPs, ATM layer cell traffic between the FPs can be transferred across one to eight DS1 or E1 physical links. Bandwidth can be added to (or removed from) IMA link groups up to a maximum of eight DS1 or E1 physical links, as per network requirements. For more information, see "Provisioning configurations for the 8-port DS1/E1 ATM function processors" (page 94).

IMA technology also greatly increases the number of DS1 or E1 physical links that a Multiservice Switch 7400 node can support. Instead of up to eight ATM interfaces over eight physical links between nodes, one ATM interface can operate over eight physical links in an IMA link group. If you use four 8-port DS1/E1 ATM FPs, then you can operate up to 32 physical links (minimum of four IMA link groups) between two Multiservice Switch 7400 nodes using IMA.

For information on IMA link group capacity on the 8-port DS1/E1 ATM FPs, contact your Nortel Networks account representative.

IMA link group capacity on the 32-port DS1/E1 Multiservice Access FPs

For Nortel Networks Multiservice Switch system's IMA feature on the 32-port DS1/E1 Multiservice Access (MSA32) FPs, ATM layer cell traffic between the FPs can be transferred across all 32 DS1 or E1 physical links. Bandwidth can be added to (or removed from) IMA link groups up to a maximum of eight DS1 or E1 physical links, as per network requirements.

Note: These capabilities are subject to specific characteristics. See "Provisioning configurations for the 32-port DS1/E1 Multiservice Access function processors" (page 94) for more information.

For more information, see "Provisioning configurations for the 32-port DS1/E1 Multiservice Access function processors" (page 94). For information on IMA link group capacity on the MSA32 FP, contact your Nortel Networks account representative.

IMA link group capacity on the 4-port DS3Ch ATM FP

For Nortel Networks Multiservice Switch system's IMA feature on the 4-port DS3Ch ATM FPs, ATM layer cell traffic can be transferred across a maximum of 28 DS1 logical links on one DS3 port. For more information, see "Provisioning configurations for the 4-port DS3Ch ATM function processor" (page 96).

For information on IMA link group capacity on the 4-port DS3Ch ATM FP, contact your Nortel Networks account representative.

IMA link group capacity on the 2-port STM-1 electrical channelized CES/ATM/IMA FP

For Nortel Networks Multiservice Switch system's IMA feature on the 2-port STM1eCh CES/ATM/IMA FPs, ATM layer cell traffic can be transferred across a maximum of 32 E1 logical links on one SDH port. For more information, see "Provisioning configurations for the 2-port STM-1 electrical channelized CES/ATM/IMA function processor" (page 96).

Chapter 5
Understanding IMA

This section describes how inverse multiplexing for ATM (IMA) functions in Nortel Networks Multiservice Switch systems, including the key concepts associated with this feature. The functionality presented in this chapter applies to the ATM Forum IMA protocol (supported on Multiservice Switch 7400, Multiservice Switch 15000, and Multiservice Switch 20000 nodes). For more information, see “IMA protocols” (page 96).

This section specifically describes the following aspects of IMA:

- “IMA configuration considerations” (page 130)

IMA in the ATM layer reference model

The figure “IMA in the ATM layer reference model” (page 103) shows how IMA fits into a standard ATM layer reference model. For speed and efficiency, IMA functionality is accomplished entirely at the physical layer. The transmission convergence sublayer handles the interaction between the ATM layer and IMA. This sublayer is divided into the IMA specific part and the interface specific part; these parts interwork with the physical medium dependent sublayer to perform full IMA functionality.

- IMA specific part (transmission convergence sublayer) - controls the actual inverse multiplexing functionality, such as the distributing and combining of the ATM cell stream, cell rate decoupling, IMA synchronization, compensation for differential delay, and physical link monitoring and control

  Note: The process used by IMA to transmit the ATM cell stream is transparent to the ATM layer

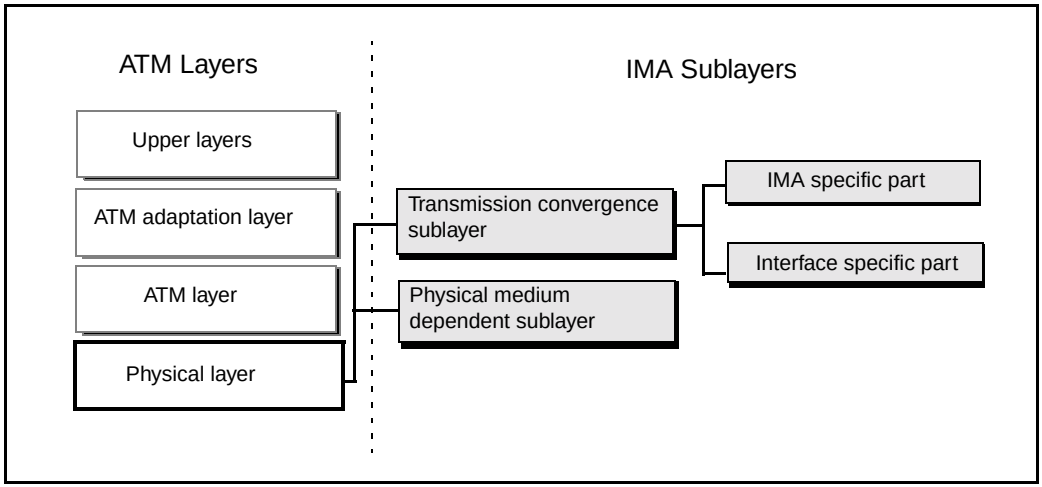
- interface specific part (transmission convergence sublayer) - controls the ATM-specific functions of the DS1 or E1 or DS3 physical interface, such as header error control (HEC), cell delineation and cell scrambling/de-scrambling
- physical medium dependent sublayer - controls the transmission of data on the E1/DS1 or DS3 physical links

IMA specific functionality is performed in a cell processing logic block called the IMA cell machine, available in FPs that support the IMA feature. The IMA cell machine

- handles the sequencing of cells when the links are active
- detects any link failures or status changes and reports them to the software
- generates ICP, filler and stuff cells

IMA software configures each individual link in an IMA link group and determines those recognized by the IMA application at the far end FP as being part of that IMA link group.

Figure 6
IMA in the ATM layer reference model



Cell transport functionality using IMA

The figures “An IMA link group between two 8-port DS1/E1 ATM FPs supporting IMA (Multiservice Switch 7400 node)” (page 104) and “IMA link groups between two 4-port DS3Ch ATM FPs supporting IMA (Multiservice Switch 15000 and Multiservice Switch 20000 nodes)” (page 105), illustrate the concept of inverse multiplexing. In each figure, a FP running IMA in Multiservice Switch A receives a single stream of cell traffic from the ATM layer and transparently distributes the individual cells in a round-robin fashion along multiple links within an IMA link group or groups. The FP running IMA in Multiservice Switch B re-aggregates the cell stream at the receiving end of the link group on a cell-by-cell basis, preserving the original cell order and format.

Figure 7
An IMA link group between two 8-port DS1/E1 ATM FPs supporting IMA (Multiservice Switch 7400 node)

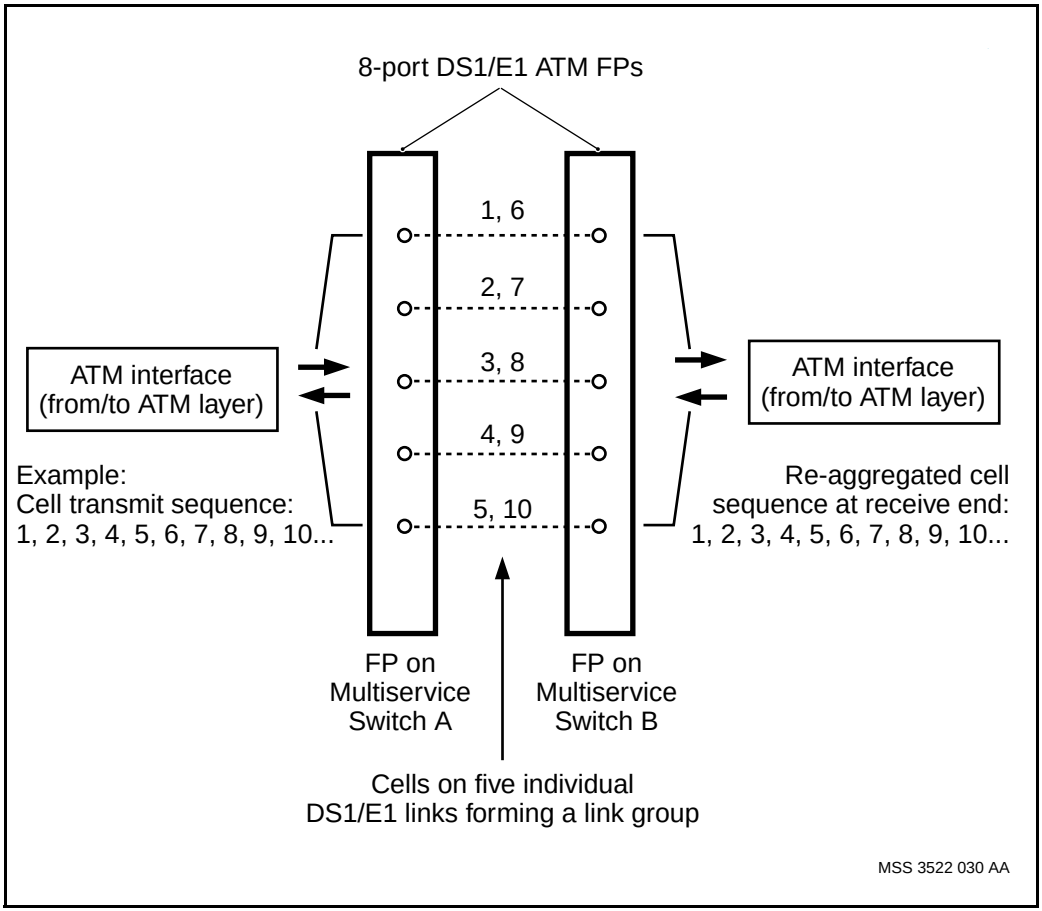
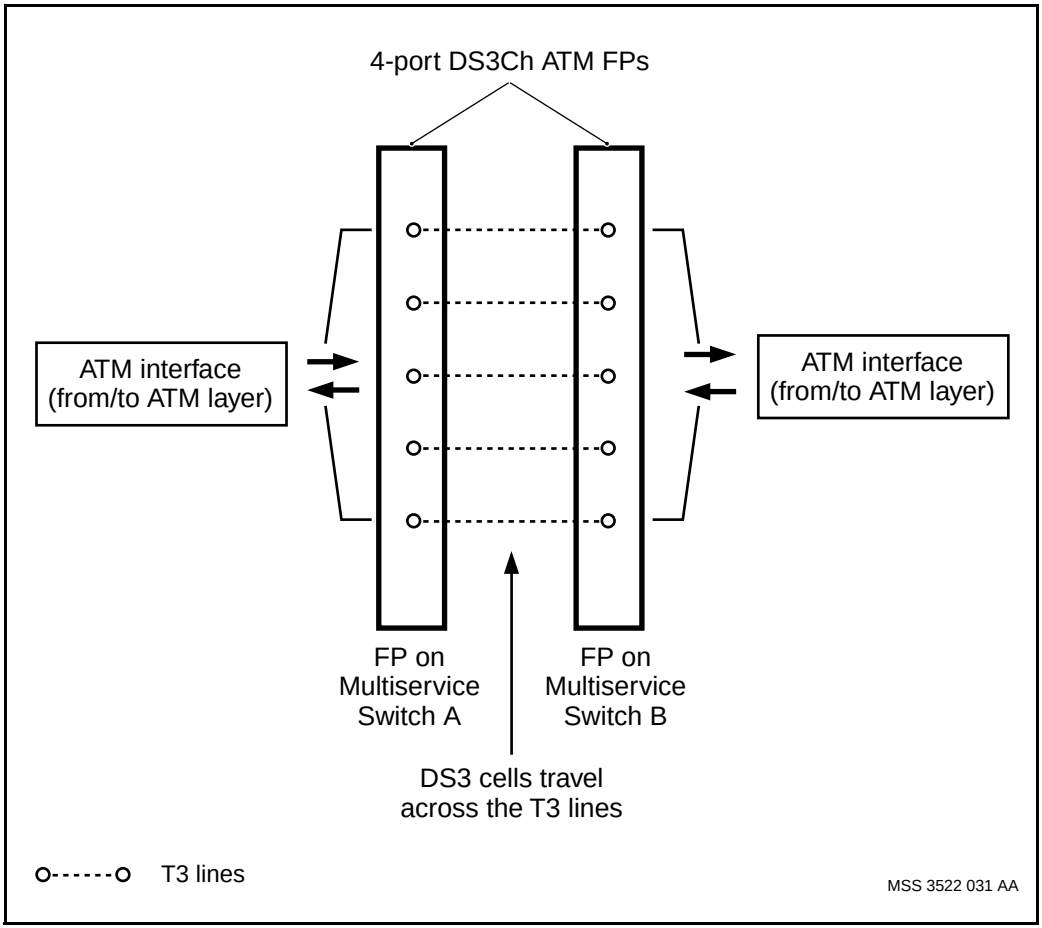


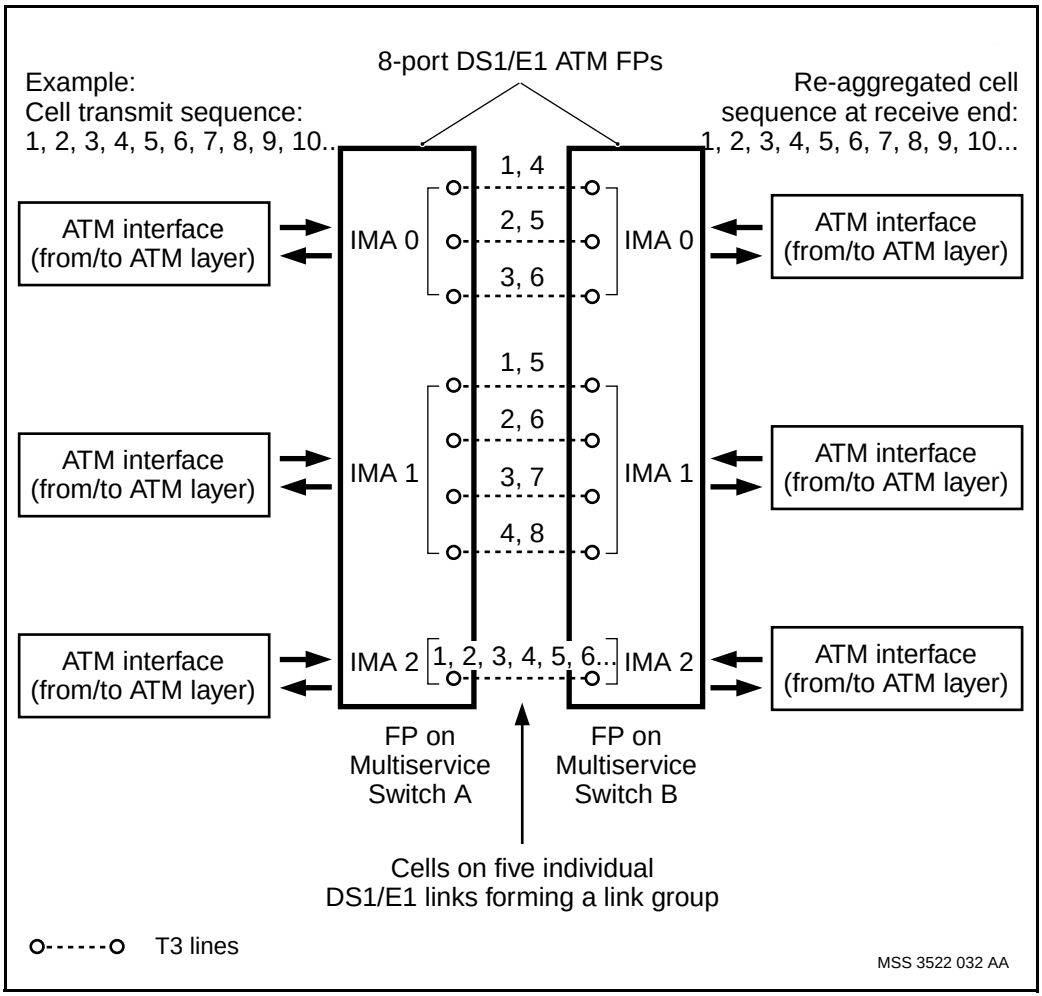
Figure 8
IMA link groups between two 4-port DS3Ch ATM FPs supporting IMA (Multiservice Switch 15000 and Multiservice Switch 20000 nodes)



The figure “Detailed view of multiple IMA link groups between two 8-port DS1/E1 ATM FPs (Multiservice Switch 7400 node)” (page 106) illustrates how the IMA feature distributes and combines an ATM layer cell sequence over multiple IMA link groups. Each IMA link group is associated with an ATM interface. The stream of cell traffic is distributed in a round-robin fashion over each physical link in the IMA link group. For example, the cell

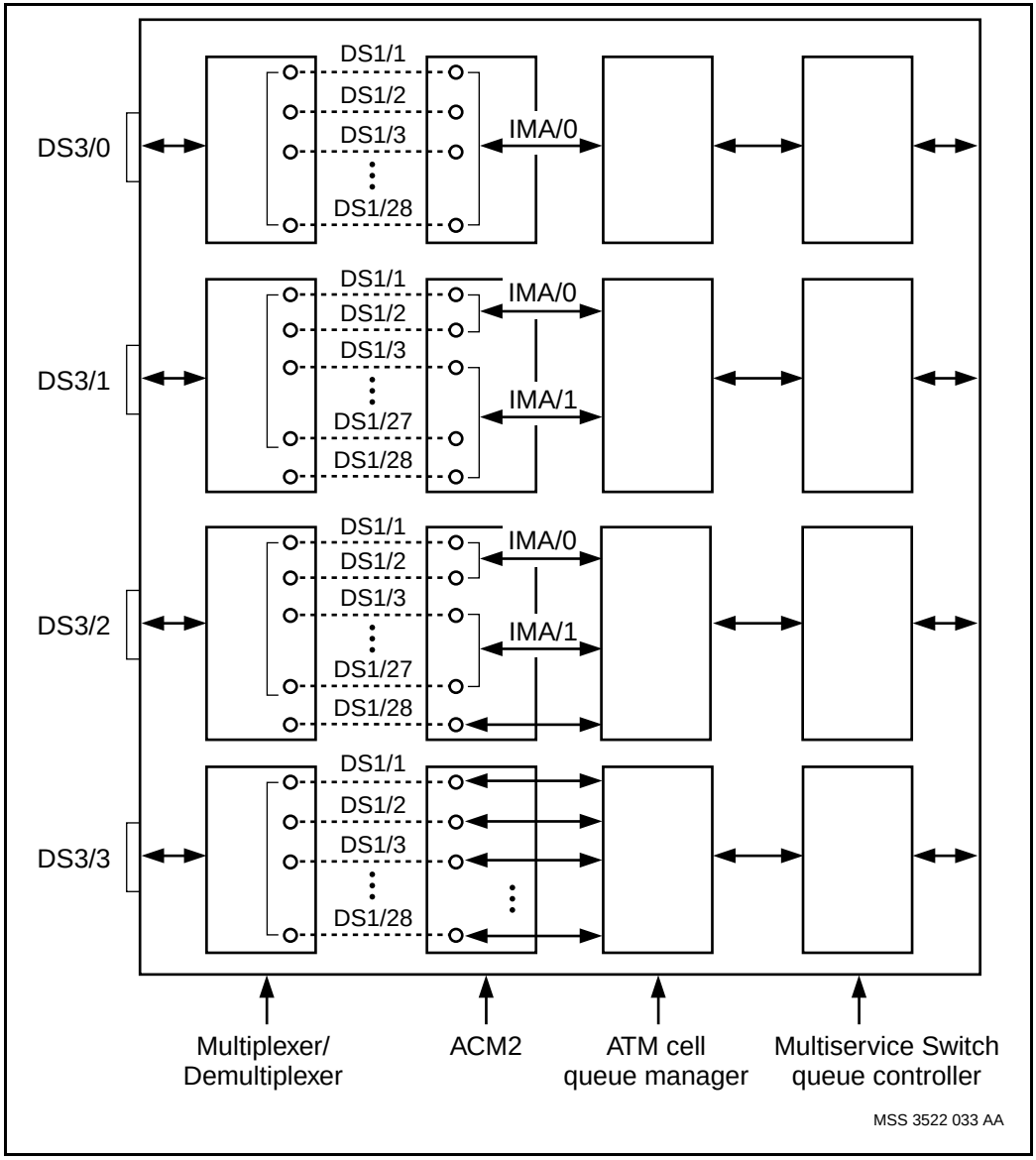
stream for IMA link group 0 is distributed over the three links in its group. IMA link group 2 contains only one physical link; therefore, its cell sequence is unchanged from the incoming transmit sequence.

Figure 9
Detailed view of multiple IMA link groups between two 8-port DS1/E1 ATM FPs (Multiservice Switch 7400 node)



The figure “Detailed view of multiple IMA link groups and independent links forming in a 4-port DS3Ch ATM FP (Multiservice Switch 15000 and Multiservice Switch 20000 nodes)” (page 108) illustrates how the IMA feature distributes and combines ATM layer cell sequences over multiple IMA link groups and independent links. Cell traffic from the ACM2 processor running IMA is multiplexed from DS1 to DS3 format and is shunted out of the FP on the DS3 ports. The flow is bidirectional: in the opposite direction, cell traffic is demultiplexed from DS3 to DS1 format.

Figure 10
Detailed view of multiple IMA link groups and independent links forming in a 4-port DS3Ch ATM FP (Multiservice Switch 15000 and Multiservice Switch 20000 nodes)



IMA framing and control

IMA control protocol (ICP) cells, one of two types of operations and maintenance (OAM) cells used with IMA, control the distribution of ATM cells over an IMA link group.

ICP OAM cells perform two basic functions:

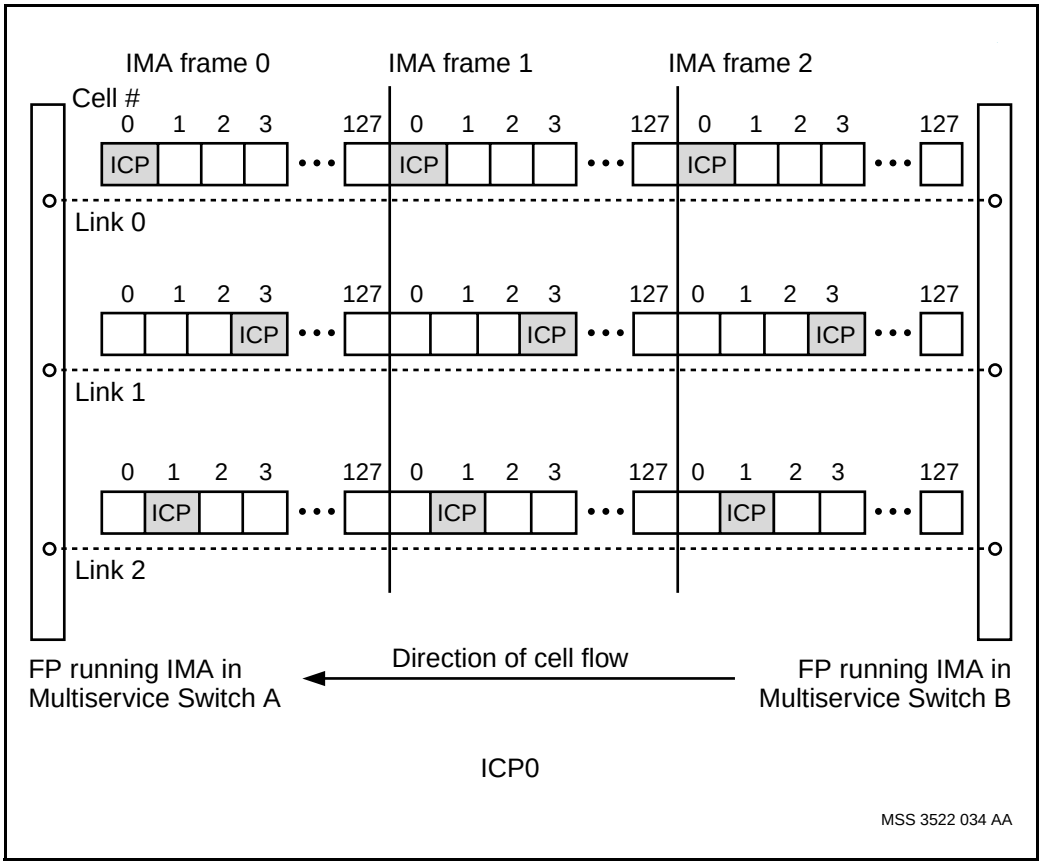
- maintain synchronization on a link and facilitate the determination of differential delay between links
- convey IMA configuration and status information

ATM cells being transmitted over a link are apportioned into frames containing 128 cells, permitting the insertion of one ICP cell within each frame on a physical link. Each ICP cell appears in a different position within a frame on different links within the IMA link group, but in the same position from frame-to-frame on any given link.

ICP cell distribution

The figure “Example of IMA framing and ICP cell distribution on a link group” (page 110) shows an example of the distribution of ICP cells over different physical links or logical links within an IMA link group. To simplify the example, the transmission of cells is shown only from Multiservice Switch B to Multiservice Switch A. For example, on link 0 in the figure “Example of IMA framing and ICP cell distribution on a link group” (page 110), the ICP cell always appears as the first cell in each frame; on link 1, the ICP cells always appear as the fourth cell in each frame.

Figure 11
Example of IMA framing and ICP cell distribution on a link group

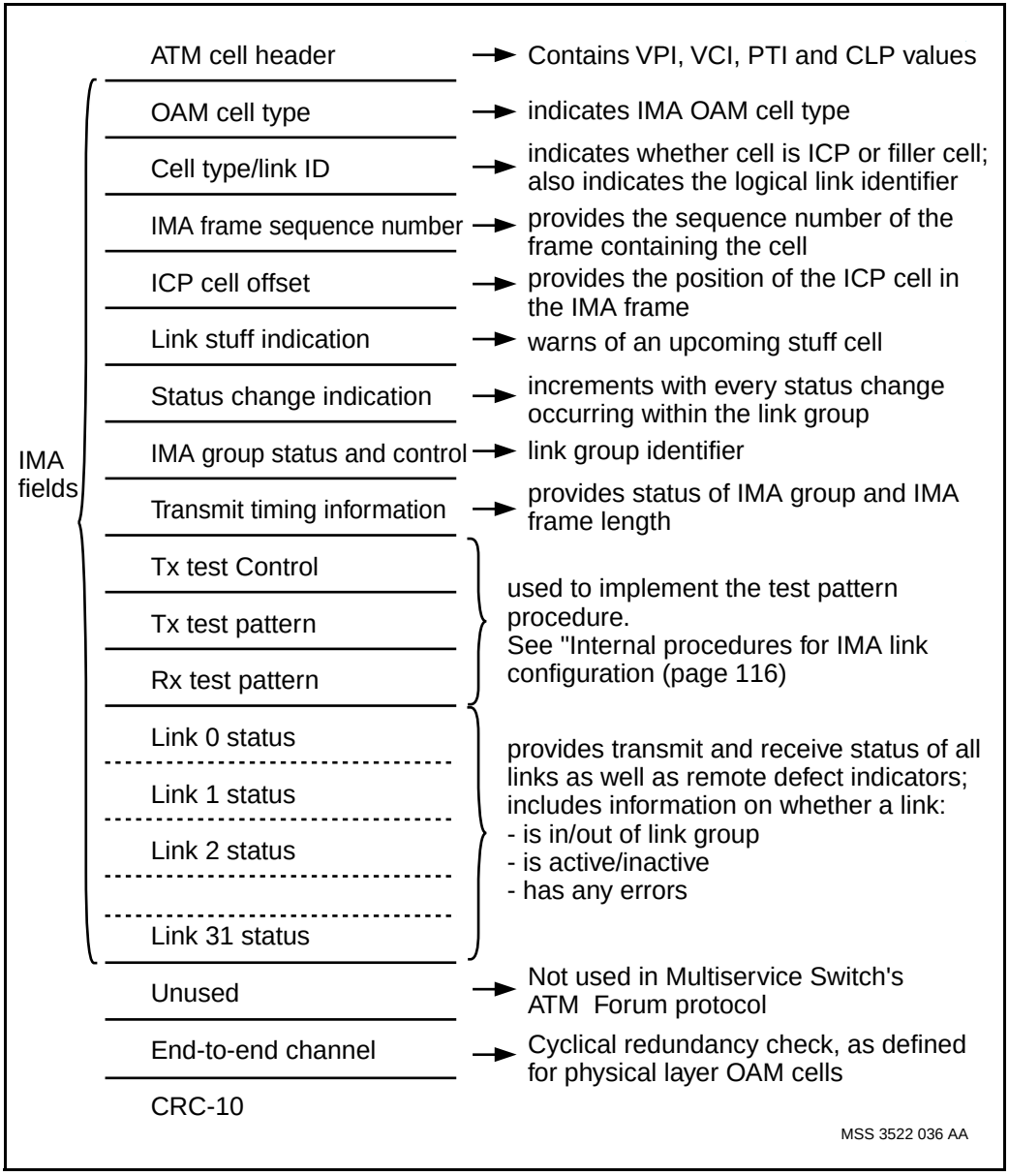


ICP cell contents

ICP cells contain information on the cell, the IMA frame, the physical link, the IMA link group, and the individual links. Two ICP cell formats appear in this section. For IMA services on the 1-port STM1 ATM FPs, 8-port DS1/E1 ATM FPs, the 32-port DS1/E1 Multiservice Access (MSA32) FPs, and the 4-port DS3Ch ATM FP, Multiservice Switch systems support only the ATM Forum IMA protocol. For more information on IMA protocols, see “IMA protocols” (page 96).

The figure “Contents of an ATM Forum IMA protocol ICP cell on all Multiservice Switch FPs supporting IMA” (page 112) shows the contents of an ATM Forum protocol ICP cell

Figure 12
Contents of an ATM Forum IMA protocol ICP cell on all Multiservice Switch FPs supporting IMA



Cell rate decoupling using filler cells

Cell rate decoupling guarantees that the physical links in an IMA link group continue to transmit cells when there are not enough user cells available to saturate the links. The decoupling process injects an OAM type filler cell to satisfy the cell rate requirement on each physical link. These filler cells are required any time there is a cell transmit opportunity on a physical link, but no cells are available from the ATM interface.

Note: Filler cells are the IMA equivalent to physical layer idle cells.

The IMA cell machine generates filler cells at the transmit side of a link and removes them on the receive side. Filler cells are actually blank ICP cells; the cell type and link ID field indicates whether an ICP cell is a filler cell or not. If a cell is a filler cell, then the remaining ICP fields are empty.

Link capacity within an IMA link group

The process of IMA framing and control slightly reduces the capacity of individual physical links in an IMA link group to transmit cells. Also, link capacity can differ between IMA link groups depending on the IMA protocol used.

For more information on IMA link group capacity, contact your Nortel Networks account representative.

IMA link states

IMA groups on different nodes communicate link status information by using ICP cells to signal to the far-end IMA link group. Communication between IMA groups is established by a handshaking sequence that occurs between both ends of the link group. For details, see “Internal procedures for IMA link configuration” (page 114). The figure “Contents of an ATM Forum IMA protocol ICP cell on all Multiservice Switch FPs supporting IMA” (page 112) show the link status fields in an ICP cell.

Internal procedures for IMA link configuration

This section summarizes the link configuration procedures that are defined internally to the IMA process, based on how IMA is configured at both ends of a link group. They are executed transparently to users after configuring IMA on Nortel Networks Multiservice Switch FPs at the near and far end of the IMA link group:

- IMA link group startup - a handshaking sequence occurring between the two ends of a link group; permits each end of the link to resolve their respective link identifiers (LIDs) and verify connectivity
- link addition (to an IMA link group) - as a result of provisioning at both ends of a link group
- link deletion (from an IMA link group) - as a result of provisioning at either end of a link group
- link deactivation (from an IMA link group) - due to a fault on a link or a violation of the IMA protocol

  For example, the differential delay of one link relative to its peers in a IMA link group may increase such that the link must be removed from the link group (See “Compensating for differential delay” (page 121).)

- link reactivation (as part an IMA link group) - due to the recovery of a link from a fault on the link or from a violation of the IMA protocol

  For example, the differential delay of one link relative to its peers in a link group may decrease such that the link can be re-admitted to the link group.

Only the ATM Forum IMA protocol uses the test pattern procedure as specified in *Inverse Multiplexing for ATM (IMA) Specification*. This procedure is used during link group startup, link addition and link reactivation to determine if there are any links in the IMA link group that are misconnected. If a link is determined to be misconnected, it is not activated in the IMA link group.

Adding inactive links to an IMA link group

The IMA application incorporates a process to determine how often it will attempt to admit inactive links to an IMA link group. A user can control the amount of time that the IMA application waits between attempts to add inactive links to a link group by setting the *linkRetryTimeout* attribute. This attribute can be assigned a value anywhere between 0 and 1000 seconds, with the default value of 10 seconds. The process of attempting to add inactive links itself takes a few seconds because of the protocol involved.

> ***Note:*** The *linkRetryTimeout* attribute is not a configurable attribute when using the 32-port DS1/E1 Multiservice Access (MSA32) function processor (FP). It is always set to the default value, 1 second.

The different conditions specified in the following list determine the response of the IMA application when there are inactive links in an IMA link group:

- after the startup procedure
- when the IMA link group is functioning
- after the link addition and reactivation procedure

After the startup procedure

If the Startup procedure is successful but not all links in an IMA link group are active, the IMA application waits the amount of time specified by the *linkRetryTimeout* attribute before invoking the link addition and reactivation procedure for all inactive links in the link group.

When the IMA link group is functioning

If an IMA link group is functioning with all configured links active, the IMA application will initiate the link addition and reactivation procedure when

- a link fails; this may occur due to the physical link going down, a loss of IMA frame (LIF) failure, or a remote link failure.
- a loss of delay synchronization (LODS) failure occurs in an IMA link group (for details, see “Ongoing monitoring of differential delay” (page 123))
- a configuration change is made that either
  - — adds or deletes links, or

— modifies the provisionable attributes *maxDiffDelay* or *linkSelectionCriterion*

For details on these attributes, see NN10600-060 *Nortel Networks Multiservice Switch 7400/15000/20000 Component Reference*. For a discussion of differential delay, see “Compensating for differential delay” (page 121).

After the link addition and reactivation procedure

If not all links in the IMA link group are active upon the completion of the link addition and reactivation procedure (whether a link has been added or not), the IMA application waits the amount of time specified by the *linkRetryTimeout* attribute before invoking the link addition and reactivation procedure for all inactive links in the link group.

Compensating for asynchronous physical links

Cell stuffing is a technique used to maintain IMA synchronization in link groups containing asynchronous physical links. Line clock rates over different links that derive their clock from different sources can vary up to 100 ppm due to the frequency tolerance of clock generators permitted in the DS1/E1physical layer standards.

Note 1: This is not the same issue as differential delay discussed in “Compensating for differential delay” (page 121).

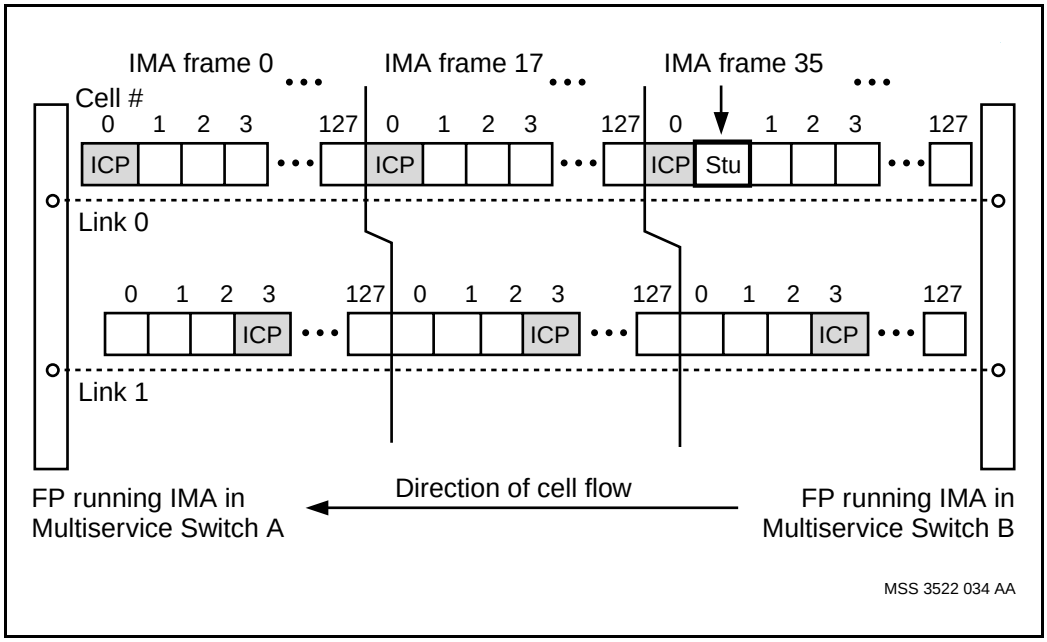
Note 2: Cell stuffing to compensate for asynchronous physical links is used by IMA link groups in independent transmit clock (ITC) mode only. For details on clock mode and IMA link groups, see “Transmit clock mode” (page 117).

To prevent the physical link from being starved of ATM cells, stuff cells are inserted on physical links in an IMA link group that are operating at a faster clock rate than the slowest link. Stuff cells are added by the IMA cell machine on an FP running IMA after round-robin cell distribution has occurred at the transmit side of a link group. A stuff cell is merely a copy of an ICP cell and always follows immediately after an ICP cell in an IMA frame. The “link stuff indication” field of an ICP cell indicates to the remote end the location of the stuff cell (see the figure “Contents of an ATM Forum IMA protocol ICP cell on all Multiservice Switch FPs supporting IMA” (page 112)).

Cell stuffing prevents the physical layer interface from inserting idle cells to compensate for differences in clock synchronization, which would disrupt the IMA process.

For example, in the figure "Example of cell stuffing to preserve the order of cells over links running at different speeds" (page 117), physical links 0 and 1 are part of the same IMA link group. It is evident by IMA frame 17 that link 0 is running slightly faster than link 1. By frame 35, a stuff cell is added to re-synchronize the cells on the two links. Cell stuffing occurs as required to align the cells on different links in a link group.

Figure 13
Example of cell stuffing to preserve the order of cells over links running at different speeds



Transmit clock mode

There are two modes of transmit clocking on IMA link groups, as specified in *Inverse Multiplexing for ATM (IMA) Specification*:

- Common transmit clock (CTC) mode
- Independent transmit clock (ITC) mode

In CTC mode, the same transmit clock reference is used for all physical links in the IMA link group. In ITC mode, the transmit clock may be derived from different references on one or more physical links in the IMA link group. The following table "Transmit clock mode supported by the IMA protocol in Multiservice Switch systems" (page 118) indicates the transmit clock modes supported by the ATM Forum protocol.

Table 4
Transmit clock mode supported by the IMA protocol in Multiservice Switch systems

Function processor	Product	Transmit clock mode supported by: ATM Forum IMA protocol
8-port DS1 ATM FP	Multiservice Switch 7400	• CTC mode • ITC mode
8-port E1 ATM FP	Multiservice Switch 7400	• CTC mode • ITC mode
2-port STM1eCh CES/ ATM/IMA FP	Multiservice Switch 7400	• CTC mode
32-port DS1 MSA FP	Multiservice Switch 7400	• CTC mode • ITC mode
32-port E1 MSA FP	Multiservice Switch 7400	• CTC mode • ITC mode
4-port DS3Ch ATM FP	Multiservice Switch 15000 and Multiservice Switch 20000	• CTC mode • ITC mode
Note 1: Multiservice Switch system's implementation of ITC mode using the ATM Forum protocol differs from that specified in *Inverse Multiplexing for ATM (IMA) Specification*. For details, see *"Multiservice Switch implementation of ITC mode" (page 120)*.		

The technique of cell stuffing to compensate for asynchronous physical links is used only by IMA link groups in independent transmit clock (ITC) mode. When common transmit clock (CTC) mode is used, there are no differences in the clock rate used by different physical links. Therefore, no cell stuffing is required to maintain clock synchronization. However, to comply with the *Inverse Multiplexing for ATM (IMA) Specification*, cell stuffing occurs in CTC mode every 2 048 cells transmitted on each link in the IMA link group.

Common transmit clock (CTC) mode

CTC mode is supported on the ATM Forum IMA protocol for IMA services provided through the 8-port DS1/E1 FP, the 32-port DS1/E1 Multiservice Access (MSA32) FP, and the 2-port STM-1 electrical channelized CES/ATM/IMA FP (see the table "Transmit clock mode supported by the IMA protocol in Multiservice Switch systems" (page 118)). When using this mode, the operator must ensure that all links in the IMA link group use the same transmit clock. For example, all physical links could use a clocking source of

- module
- line (if the transmit clocks at the far end are all derived from the same source)

If you are using CTC mode, and not all links in an IMA link group use the same transmit clock reference, corruption or loss of data may occur. If you use the module clocking source, clocking will be synchronous across all ports.

Nortel Networks Multiservice Switch systems insert a stuff event after every 2 048 cells transmitted on each link in an IMA link group using CTC mode, as described in ATM Forum *Inverse Multiplexing for ATM (IMA) Specification*. Cell stuffing to compensate for timing differences between links is suppressed in CTC mode.

> ***Note:*** For information on network clock synchronization, see NN10600-550 *Nortel Networks Multiservice Switch 7400/15000/20000 Common Configuration Procedures*.

Independent transmit clock (ITC) mode

IMA services on any Nortel Networks Multiservice Switch function processor providing IMA capability supports the ITC mode on the ATM Forum IMA protocol. See the table “Transmit clock mode supported by the IMA protocol in Multiservice Switch systems” (page 118)).

If ITC mode is used, links in the IMA link group may use the same or different transmit clock references, provided the clock tolerance on each link is within 50 ppm (the maximum specified by the DS1). IMA link groups configured to operate in ITC mode use cell stuffing as a technique for maintaining IMA synchronization. For a description of cell stuffing, see “Compensating for asynchronous physical links” (page 116)

In a typical ITC mode configuration, all physical links use a clocking source of line and the clocks on the incoming links are derived from different references.

> ***Note:*** For information on network clock synchronization, see NN10600-550 *Nortel Networks Multiservice Switch 7400/15000/20000 Common Configuration Procedures*.

Multiservice Switch implementation of ITC mode

Nortel Networks Multiservice Switch system implementation of ITC mode is different from what is specified in the ATM Forum *Inverse Multiplexing for ATM (IMA) Specification*. The specification states that a stuff event is to be inserted on the transmit reference link after every 2 048 cells transmitted on the link. Stuff events are inserted on the other links in an IMA link group, as required, to keep them synchronized with the transmit reference link.

In ITC mode, Multiservice Switch systems do not insert stuff events on the transmit reference link after every 2 048 cells. Instead, it synchronizes all links in the IMA link group to the slowest link in the link group (see “Compensating for asynchronous physical links” (page 116)). Since the slowest link is used as the reference, no stuffing is required on that link. Stuff events are inserted on the other links as required to keep them synchronized with the slowest link. For signalling purposes, Multiservice Switch nodes select one of the active links as the transmit reference link.

Interoperability considerations using ITC mode

While Multiservice Switch node-to-Multiservice Switch node interoperability is guaranteed in ITC mode, there may be some issues for interoperability with non-Multiservice Switch equipment in this mode. Interoperability may not be possible if the receive IMA on the non-Multiservice Switch equipment requires stuff events on the transmit reference link after every 2 048 cells for proper operation.

The Multiservice Switch IMA receiver is capable of operation with an IMA transmitter that uses either the Multiservice Switch ITC implementation or an ITC mode implementation compliant with the ATM Forum specification.

Guidelines for transmit clock mode

The following guidelines apply to the transmit clock mode used in Nortel Networks Multiservice Switch systems:

- If all links in the IMA link group use the same transmit clock, use CTC mode. This guarantees interoperability with equipment compliant to the ATM Forum *Inverse Multiplexing for ATM (IMA) Specification*.
- If links in the IMA link group use different transmit clocks, then you must use ITC mode. Interoperability with non-Multiservice Switch equipment must be determined on a case-by-case basis.
- The transmit clock mode does not need to be the same at each end of the link.

Compensating for differential delay

Physical links within an IMA link group may encounter different cell transfer delays that can also vary over time on each individual link. Cells transmitted over different links in a given order may not be received in the same order at the far end due to differential delay. In fact, a cell transmitted before other cells in the original stream may arrive at the receiving end after those cells it had originally preceeded.

> ***Note:*** This is not the same issue as variations in transmit clock tolerance discussed in “Compensating for asynchronous physical links” (page 116).

Differential delay is a factor of the length of time that cells may spend on different links due to the length of the transmission path, the use of transmission media (such as satellite technology) or delays introduced by intermediate equipment. “Lagging” physical links (ones with a longer cell transit time) store more cells on a link than the “leading” links (those with the shortest cell transit time).

Using cell buffers to maintain link delay synchronization

The IMA cell machine in the FP at the receiving end of an IMA link group must be able to re-establish the cell order of the original stream. To do so, this device

1 measures differential delay over the various links

2 buffers cells received on each link based on the measured differential delay, thereby equalizing the differential delay before recombining the cells into the original stream

Buffers impose an equal transit time on all links. The “leading” link in a link group (the link with the shortest delay) has the longest cell buffer, and the most “lagging” link (the one with the longest delay) has the shortest buffer. When the receiving end of an IMA link group has measured and compensated for the differential delay over a physical link, then the link is considered to be in link delay synchronization (LDS).

Measuring differential delay during IMA link group startup

In the process of establishing communication with the FP at the far end of a link during IMA link group startup or link addition and reactivation (see “Internal procedures for IMA link configuration” (page 114)), the IMA feature measures the differential delay over each physical link at the receive end. There can be one of two results:

- If the delay over a link relative to other links is *within* a specified maximum value, then the link is considered to be in LDS and can be included as an active member of the IMA link group.
- If the delay over a link relative to other links *exceeds* the maximum value, then the link is not in LDS and is rejected as an active member of the IMA link group.

When both ends of an IMA link group agree on which links are within LDS, they can start exchanging user cells.

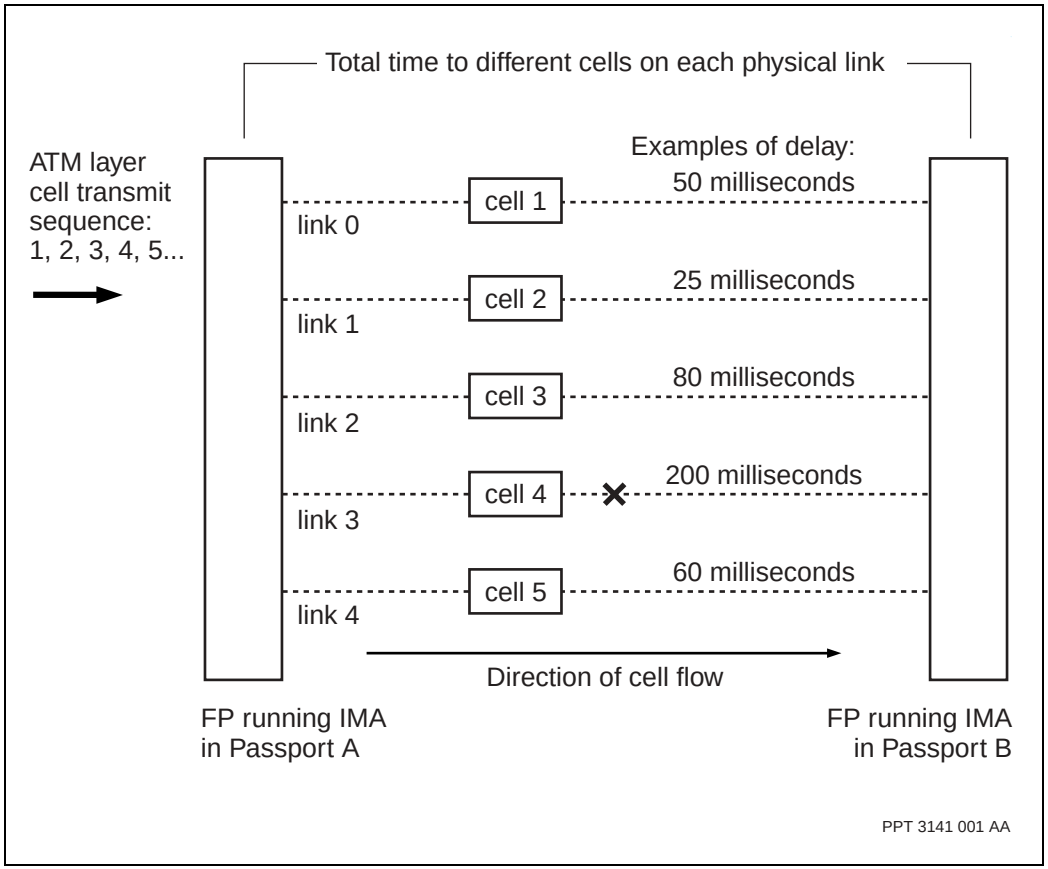
Ongoing monitoring of differential delay

The IMA feature continually monitors and compensates for the differential delay of links within a link group. If the delay on a link changes such that it exceeds the specified maximum differential delay plus one millisecond, the link is considered to have lost its delay synchronization; that is, the link has experienced a loss of delay synchronization (LODS), and is deactivated from the IMA link group. A link is removed from an IMA link group immediately when a LODS state is detected.

For example, in the figure "Measuring differential delay over links in an IMA link group" (page 124), cell 4 is experiencing a delay of 200 milliseconds over link 3. If the differential delay is set to 100 milliseconds (the maximum), then links 0, 1, 2 and 4 can remain in the link group, while link 3 must be removed.

> ***Note:*** The ATM hardware is designed to tolerate a differential delay of 1 millisecond greater than the maximum provisioned for the attribute *maxDiffDelay*. For example, you may see a delay of 26 milliseconds when the provisioned maximum is 25 milliseconds.

Figure 14
Measuring differential delay over links in an IMA link group



Link selection criteria

When not all of the links in an IMA link group conform to the maximum differential delay, you can choose one of the following criteria for selecting which links should be deactivated and which ones should remain active:

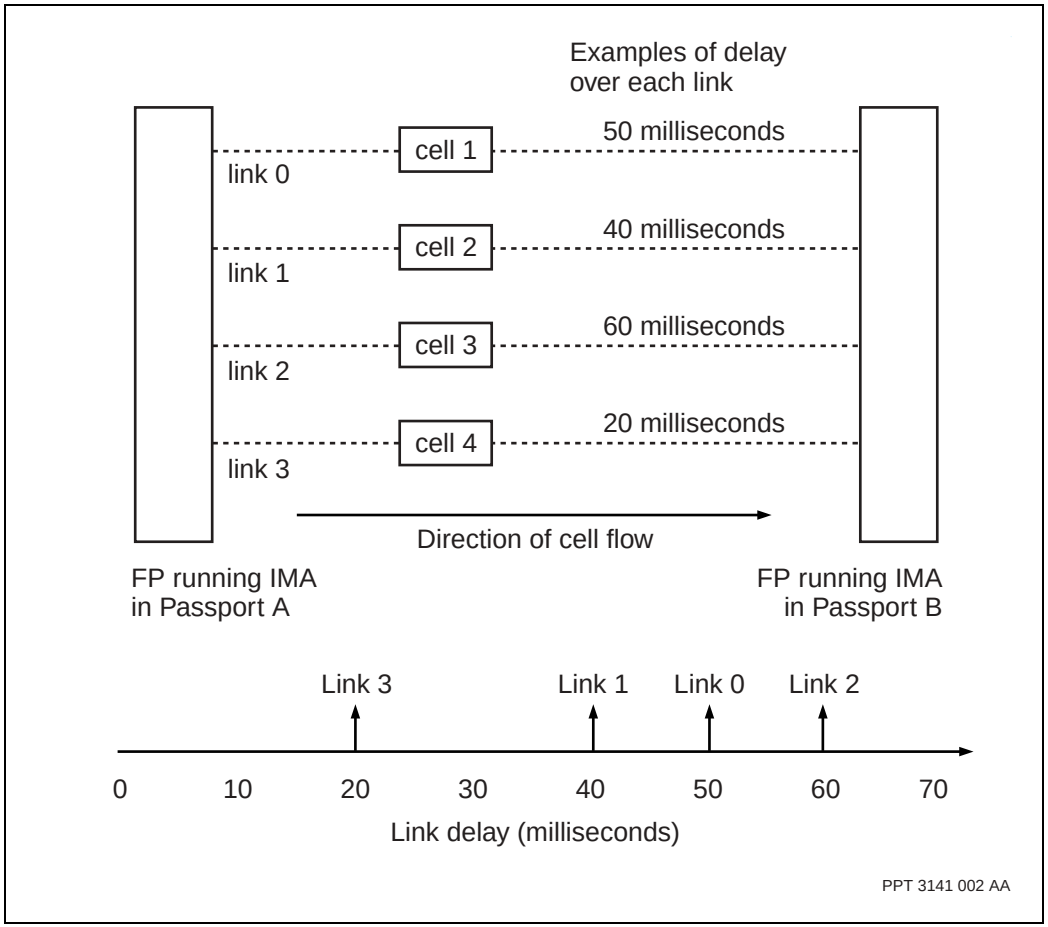
- maximum bandwidth
- minimum delay

Note: The 32-port DS1/E1 Multiservice Access (MSA32) FP only supports link selection based on minimum delay. For this FP only, the link selection criterion minimum delay is the value of the *Ima* attribute *linkSelectionDelay leastDelay*.

The default is maximum bandwidth. The figure “Example of an IMA link group illustrating different link selection criteria” (page 126) provides an example illustrating the two selection criteria. If you configure a maximum differential delay of 20 milliseconds for the IMA link group, then two different sets of links would be activated depending on the link selection criteria:

- If you have chosen to minimize delay, then links 1 and 3 would be selected.
- If you have chosen to maximize bandwidth links 0, 1 and 2 would be selected.

Figure 15
Example of an IMA link group illustrating different link selection criteria



ATM IMA service reliability on Multiservice Switch for Succession Networks

Note: This feature is not generally available. Contact Nortel Networks for more information on this feature.

In Nortel Networks Multiservice Switch for Succession Networks, the IMA ATM feature (imaAtmForumHot) offers hitless equipment protection and software migration for ATM services running over IMA in one-for-one equipment protected scenarios on the 4-port DS3 Ch Atm FP.

The following ATM services offer a hitless service:

- PVCs (VCCs and VPCs)
- point-to-point SVCs
- source and destination SPVCs
- point-to-point SVPs
- source and destination SPVPs
- nailed-up relay points
- switched relay points

The ATM hitless services can be offered on up to:

- 56 ATM interfaces per FP (UNI and PNNI) in non-associated signalling configurations
- 5500 ATM connections per FP
  - — 2600 SVCs for voice calls
  - — 2600 PVCs/SPVCs/SVCs for DSL or voice calls
  - — 300 PVCs/SPVCs/SVCs for internal control purposes
- 28 DS1s per IMA group
- 56 IMA groups per FP

Hot standby applications and features can run uninterrupted, even when the hardware providing that service changes. This means they can offer hitless services during equipment protection switchover and hitless software migration. This is done by operating with a standby instance of the software that is fully synchronized with the active instance of the software. Hot standby applications and features use equipment sparing of FPs to incur a minimal

interruption of cell forwarding and maintain any connections that are established. This ability reduces service down time and increases service reliability.

The IMA ATM feature (imaAtmForumHot) provides hot standby functionality only when it is provisioned on a one-for-one (1:1) spared 4pDS3ChAtm LP and using a 1:1 sparing panel.

For information on:

- hitless ATM services on Nortel Networks Multiservice Switch 15000 Multiservice Switch 20000 and nodes, see NN10600-702 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Routing and Signalling Fundamentals*
- hitless software migration on Multiservice Switch 15000 and Multiservice Switch 20000 nodes, see NN10600-272 *Nortel Networks Multiservice Switch 7400/15000/20000 Upgrading Software*
- hitless services and hot, warm, and cold standby applications and features, see NN10600-550 *Nortel Networks Multiservice Switch 7400/15000/20000 Common Configuration Procedures*.

  Note: Succession Networks customers must use the templates in 241-6001-011 *Nortel Networks Multiservice Data Manager Fault Management Tools* to configure IMA.

ATM control channel failure on IMA

ATM control channels, which include signaling, ILMI, and RCC are subject to the CBC algorithm on IMA links. If a link in the IMA group fails, a bandwidth reduction occurs and one or more of the control channels may be torn down if there is insufficient bandwidth available. The control channels will not reestablish until the link recovers or other connections are released, freeing bandwidth and allowing the control channels to be admitted.

Prerequisites to configuring IMA

Several prerequisites must be fulfilled before you can begin configuring IMA on a Nortel Networks Multiservice Switch node.

- You must have one of the FPs supporting IMA installed on your Multiservice Switch node. Refer to NN10600-551 *Nortel Networks Multiservice Switch 7400/15000/20000 FP Configuration Reference* for information on which FPs support IMA).
- You can configure the ports with independent ATM links or as a mixed configuration containing both independent links and IMA links. For more information about configuring the port components for independent links, see NN10600-710 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Configuration Management*. Also, see "Mixed configurations" (page 137).
- The customer equipment cables consisting of the actual physical connections between Multiservice Switch nodes must be in place and properly connected to the termination panel, which is in turn connected to the physical connector ports on the FP. See the following documents for details on the cabling connections for the FPs that run IMA:
  - NN10600-170 *Nortel Networks Multiservice Switch 7400 Hardware Description*
  - NN10600-120 *Nortel Networks Multiservice Switch 15000/20000 Hardware Description*
  - NN10600-175 *Nortel Networks Multiservice Switch 7400 Hardware Installation, Maintenance, and Upgrade*
  - NN10600-130 *Nortel Networks Multiservice Switch 15000/20000 Hardware Installation, Maintenance, and Upgrade*
- You should have access to all necessary configuring information. See NN10600-060 *Nortel Networks Multiservice Switch 7400/15000/20000 Component Reference* for information on the configurable attributes for IMA.
- Be aware of the configuration options for ports on the FPs supporting IMA. See NN10600-551 *Nortel Networks Multiservice Switch 7400/15000/20000 FP Configuration Reference* for details.

- For information on configuring trunks for IMA, see NN10600-420 *Nortel Networks Multiservice Switch 7400/15000/20000 Operations: Trunking*.
- Use the procedures in NN10600-270 *Nortel Networks Multiservice Switch 7400/15000/20000 Software Installation* to install the base software, before configuring IMA.

  Note: See "IMA protocols" (page 96) for information regarding Multiservice Switch releases supporting the IMA feature.

- The procedures provided in this section assume that you are configuring in edit mode. For introductory discussions on configuring and configuration views, see NN10600-030 *Nortel Networks Multiservice Switch 7400/15000/20000 Overview*.
- MSA32 has special considerations when deploying IMA. See "Provisioning configurations for the 32-port DS1/E1 Multiservice Access function processors" (page 94).

IMA configuration considerations

The following sections contains considerations that apply to configuring IMA:

IMA and the ATM interface

To transmit user cells, the Nortel Networks Multiservice Switch node must have access to an ATM interface to link to an IMA link group. The table "Where to find information on ATM connection types that can be transported over an IMA link group on Multiservice Switch nodes" (page 131) lists the ATM features and services and shows where you can find information in the Multiservice Switch documentation suite.

Table 5
Where to find information on ATM connection types that can be transported over an IMA link group on Multiservice Switch nodes

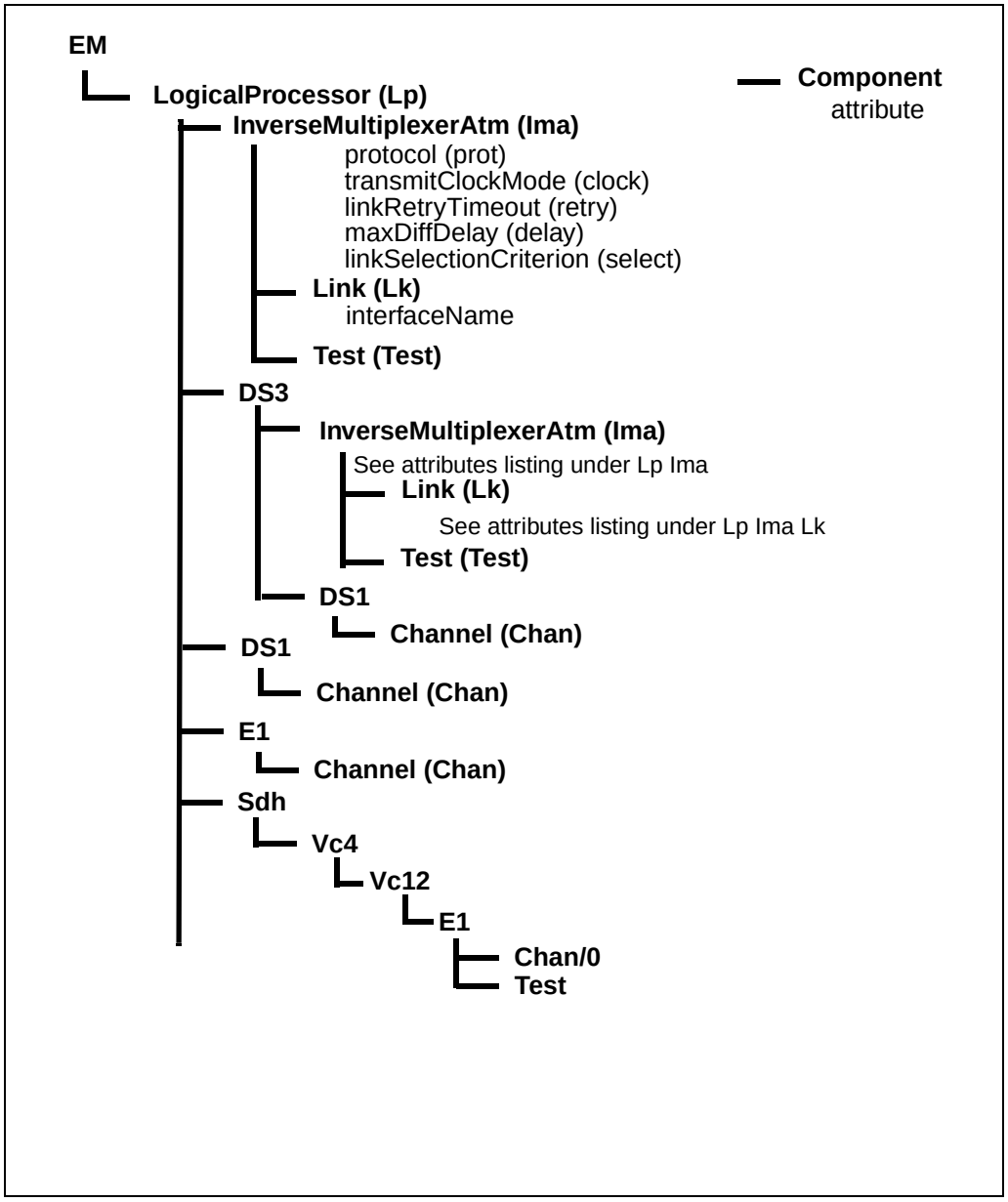
Feature/service	Document
ATM bearer service	NN10600-700 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Technology Fundamentals*
ATM direct and logical trunks (AAL5)	NN10600-420 *Nortel Networks Multiservice Switch 7400/15000/20000 Operations: Trunking*
Circuit Emulation (AAL1)	NN10600-720 *Nortel Networks Multiservice Switch 7400/15000/20000 AAL1 Circuit Emulation Operations*
ATM multiprotocol encapsulation (MPE)	NN10600-800 *Nortel Networks Multiservice Switch 7400/15000/20000 IP Technology Fundamentals*
Frame relay over ATM	NN10600-920 *Nortel Networks Multiservice Switch 7400/15000/20000 Operations: Frame Relay to ATM Interworking*

IMA components and configurable attributes

This section summarizes the components and configurable attributes reflecting IMA on Nortel Networks Multiservice Switch system's component administration system (CAS). It also includes a description of the configuring links required for IMA.

The IMA component tree is shown in the figure "IMA feature components and configurable attributes" (page 132). The *Ima* subcomponents of the *Lp* component and the *Lp DS3* subcomponent allow configuring access to an IMA link group. *Link* and *Test* are sub-components of the *Lp Ima* and *Lp DS3 Ima* subcomponents.

Figure 16
IMA feature components and configurable attributes



A background description of the role of several key configurable attributes under the *Ima* component is available in the following sections:

- *maxDiffDelay*: “Compensating for differential delay” (page 121)
- *linkSelectionCriterion*: “Link selection criteria” (page 124)
- *linkRetryTimeout*: “Adding inactive links to an IMA link group” (page 115)
- *transmitClockMode*: “Transmit clock mode” (page 117)
- *protocol*: “IMA protocols” (page 96)

A complete description of the IMA components and attributes is provided in NN10600-060 *Nortel Networks Multiservice Switch 7400/15000/20000 Component Reference*.

IMA configuring links

There are three groups of components (or subcomponents) that are important to the IMA configuring process for Nortel Networks Multiservice Switch nodes using any of the function processors supporting the IMA application:

- IMA
- ATM port management
- ATM interface

The ATM port management and IMA subcomponents both exist under the *Lp* component. The logical processor used for IMA is linked to the *Card* subcomponent under the *Shelf* component; this specifies the location in the shelf where the function processor running IMA resides.

Through configuration, associate each IMA *Link* subcomponent with the *Channel* subcomponent of a unique instance of a E1 or DS1 link on the FP. Channel 0 (the default value) is recommended even though other values are allowed. Configure all timeslots for this channel.

The figure “Component hierarchy showing examples of configuring links required for IMA using the 8-port E1 ATM FP (Multiservice Switch 7400 node)” (page 135) shows the component hierarchy for the *Ima* feature on the 8-port E1 ATM FP, including the required configuring links.

Multiservice Switch systems can support a total of

- eight physical links in one link group on the 8-port DS1/E1 ATM FPs
- eight physical links in one link group on the 32-port DS1/E1 MSA FPs
- 28 logical links in one link group on the 4-port DS3Ch ATM FPs
- 32 logical links in one link group on the 2-port STM-1e channelized FPs

These links can have instance numbers within the range of 0 to 31. For example, an 8-port DS1/E1ATM FP with a full complement of eight links forming a link group may include links with any combination of identifiers, such as:

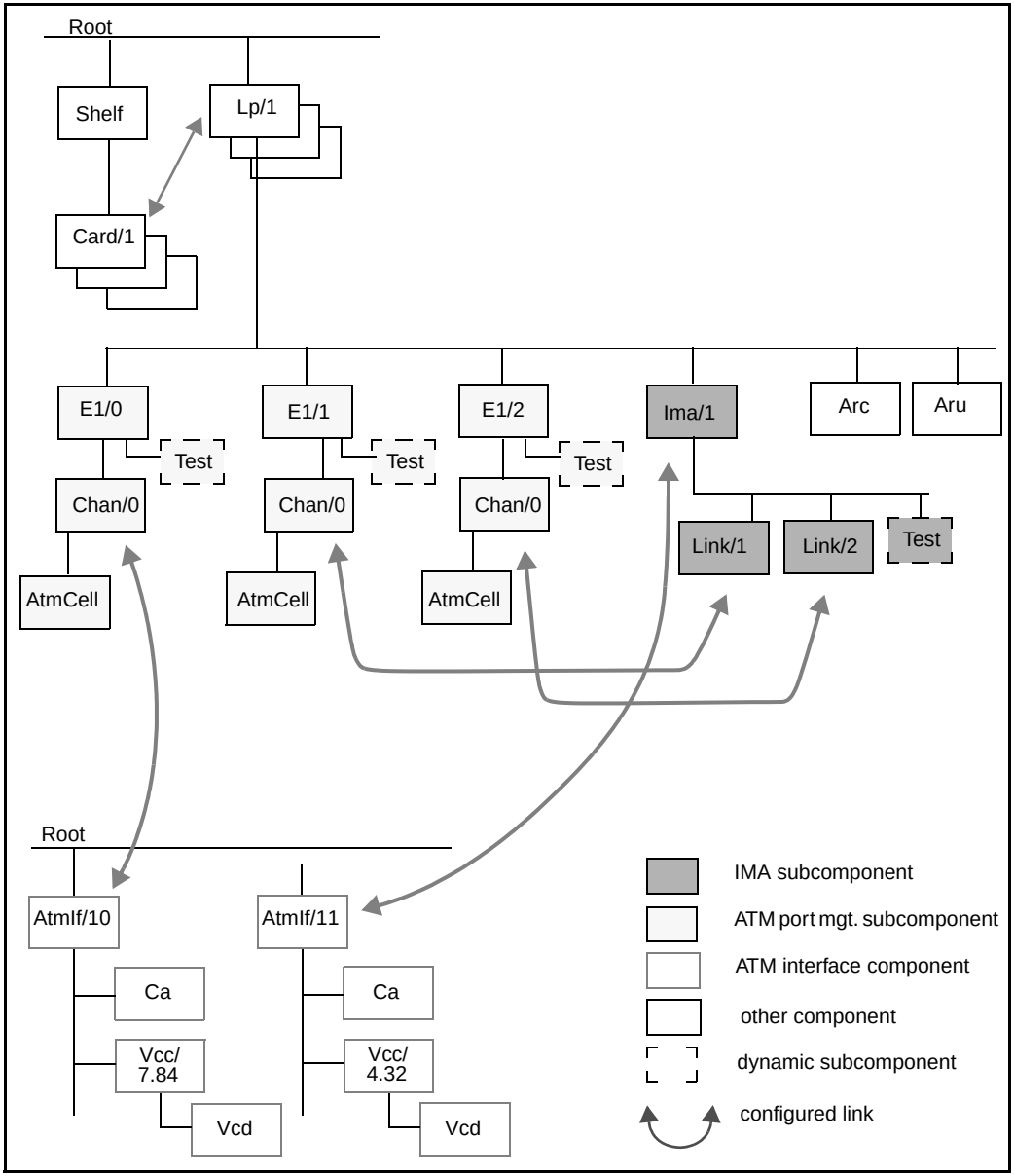
- links 0, 1, 2, 3, 4, 5, 6, 7 or
- links 0, 5, 14, 23, 24, 25, 27, 31

With the 32-port DS1/E1 ATM FPs, you can configure a maximum of eight physical links in an IMA link group, with the links having instance numbers between 0 and 15 inclusive. IMA link groups on the 32-port DS1/E1 ATM FPs must contain physical links associated with ports in the range 0 to 15 inclusive, or in the range 16 to 31 inclusive: all ports in an IMA link group must fall in one of these ranges.

With the 2-port STM-1 electrical channelized CES/ATM/IMA FP, the link group values for port 0 should be less or equal to 56, and different than any independent ATMIF E1 number. The port 1 IMA group number (group number - 57) should be greater than 56 and less than or equal to 113, and different than an independent ATMIF E1 number.

If you want to transmit user cells over an IMA link, the IMA link group (represented by the *Ima/1* subcomponent in the figure "Component hierarchy showing examples of configuring links required for IMA using the 8-port E1 ATM FP (Multiservice Switch 7400 node)" (page 135)) must be linked to an ATM interface (represented by the *AtmIf*). All connections associated with the ATM interface are transmitted over the IMA link group. Link instance numbers must be unique within one IMA link group, but do not have to be unique among different IMA groups.

Figure 17
Component hierarchy showing examples of configuring links required for IMA using the 8-port E1 ATM FP (Multiservice Switch 7400 node)



Notes about configuring IMA

For information on how to configure features on Nortel Networks Multiservice Switch nodes, see NN10600-270 *Nortel Networks Multiservice Switch 7400/15000/20000 Software Installation*:

For information on operator and configuration commands, see NN10600-050 *Nortel Networks Multiservice Switch 7400/15000/20000 Command Reference*.

Before you begin configuring the *Ima* feature, note the following

- The *Ima* features may be used on an LP only if the associated *cardType* is
  - 8pDS1Atm (for Multiservice Switch 7400 nodes)
  - 8pE1Atm (for Multiservice Switch 7400 nodes)
  - 32pDS1Msa (for Multiservice Switch 7400 nodes)
  - 32pE1Msa (for Multiservice Switch 7400 nodes)
  - 4pDS3ChAtm (for Multiservice Switch 15000 and Multiservice Switch 20000 nodes)
  - 2pSTM1eCh (for Multiservice Switch 7400 nodes)
- An *Ima* component can be added only to an LP with a feature set containing:
  - *ImaAtmForum* (for the 32-port Ds1/E1 MSA FPs, 4-port DS3Ch ATM FPs, 8-port DS1/E1 ATM FPs, and the 2-port STM-1e channelized CES/ATM/IMA FPs)
- An *Ima* component must have at least one *Link* subcomponent.
- An *Ima* component must be bound to an *AtmIf* component or not bound to anything at all.
- All *Link* subcomponents of an *Ima* component must be bound to *Chan* components residing on the same LP as the *Ima* component.
- For the 4-port DS3Ch ATM FP, all *DS1* components must have the same *clockingSource* attribute value as their parent *DS3* component. With a value of *sameAsDs3*, the *DS1* component will automatically use the *clockingSource* value specified by the parent *DS3*. The attribute value is set by default to *sameAsDs3* and is the only value permitted.

- For the 4-port DS3Ch ATM FP, if the *NetworkSynchronization* component is present, both values of the *clockingSource* attributes for *DS3* and *DS1* components must be module.
- The 8-port DS1/E1 ATM FPs allow the traffic shaping feature to be enabled or disabled. The ATM cell queue manager provides the traffic shaping ability for the 4-port DS3Ch ATM FP on Multiservice Switch 15000 and Multiservice Switch 20000 nodes. Similarly, traffic shaping on the 32-port MSA FP is provided automatically by the ATM cell queue manager.
- For the 2-port STM-1 electrical CES/ATM/IMA FPs, only the ATM Forum IMA protocol 1.1 is supported. For more information see "IMA protocols" (page 96).

  Note: It is not a prerequisite to link the IMA application to an ATM interface before configuring IMA. You can configure IMA and test the IMA application before configuring a link to an ATM interface (see the procedure "Configuring the FP supporting the IMA feature" (page 24)). The section "IMA feature monitoring" (page 37) provides details on manually testing the IMA application.

Mixed configurations

Nortel Networks Multiservice Switch FPs that provide IMA services, support a mixed configuration of independent ATM links and IMA link groups on the same FP. The following rules apply to configuring a mixed configuration:

- The instance number of IMA groups and independent links must be unique. For example an *Ima/0* and a *DS1/0* independent link cannot co-exist on the same FP.

  From a configuring perspective, an independent link is a DS1 or E1 link that is bound by its *Channel* subcomponent to an *AtmIf* component. The instance number of an independent link is the same as its DS1 or E1 component. For information about configuring DS1 or E1 or DS3 port components, see NN10600-550 *Nortel Networks Multiservice Switch 7400/15000/20000 Common Configuration Procedures*. For information about configuring an ATM interface, see NN10600-710 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Configuration Management*.

- For the Multiservice Switch 7400 node using the 8-port DS1/E1 ATM FP, if traffic shaping and per-Vc queuing are disabled on the LP, then the instances of IMA groups and independent links can have values from 0 to 7. If either traffic shaping or per-Vc queuing is enabled on Multiservice Switch 7400 node using the 8-port DS1/E1 ATM FP, then the instances of IMA groups and independent links can have values from 0 to 3.

  For the Multiservice Switch 7400 node using the 8-port DS1/E1 ATM FP, if traffic shaping and per-Vc queuing are disabled when there is no *Arc* subcomponent on the LP, or when the *Arc* subcomponent is present and its *perVcQueueInterfaces* attribute is set to zero. If the *perVcQueueInterfaces* attribute is set a non-zero value, then per-Vc queuing and traffic shaping are enabled.

  The value of the *Arc* component's *perVcQueueInterfaces* attribute also indicates which IMA groups or independent links can have per-Vc queuing and traffic shaping enabled:

  — If the *perVcQueueInterfaces* is set to one, then only instance zero (that is *IMA/0* or *DS1/0*) can have per-VC queuing and traffic shaping enabled.

  — If the *perVcQueueInterfaces* attribute is set to two, then instances zero and one can have per-Vc queuing and traffic shaping enabled.

  — If the *perVcQueueInterfaces* attribute is set to four, then instances zero to three can have per-Vc queuing and traffic shaping enabled.

- The ATM cell queue manager automatically provides traffic shaping on the 32-port MSA FP.

For more information about configuring traffic shaping, see the following documents:

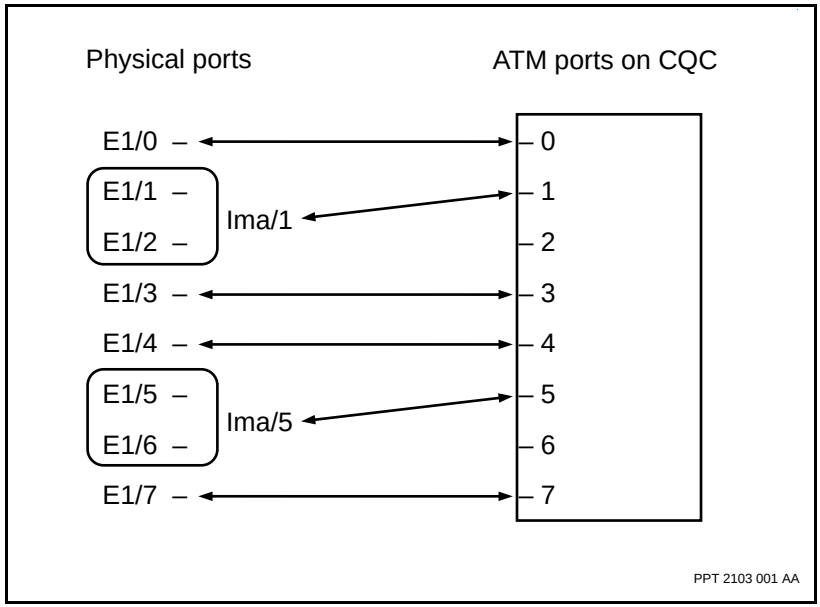
- NN10600-705 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Traffic Management Fundamentals*
- NN10600-706 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Traffic Shaping and Policing Fundamentals*
- NN10600-707 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Queuing and Scheduling Fundamentals*

Example of a mixed configuration without traffic shaping

The following figure "Example of a mixed configuration without traffic shaping on the 8-port E1 ATM FP (Multiservice Switch 7400 node)" (page 139) shows the relationship between the FP's physical ports and ATM ports. The ATM ports are part of the FP's cell queue controller (CQC), the ATM cell processor; these are the ports used by the ATM software.

This figure shows four independent links and two IMA link groups. The IMA groups (*Ima/1* and *Ima/5*) each combine two physical ports into IMA virtual ports.

Figure 18
Example of a mixed configuration without traffic shaping on the 8-port E1 ATM FP (Multiservice Switch 7400 node)



The example in the figure "Example of a mixed configuration without traffic shaping on the 8-port E1 ATM FP (Multiservice Switch 7400 node)" (page 139) illustrates the following configuring concepts:

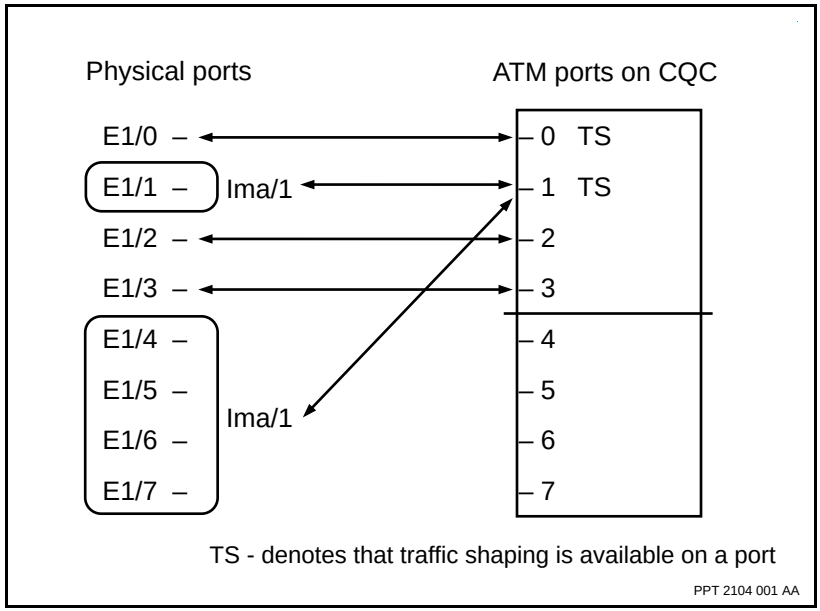
- When traffic shaping is not being used, all eight ATM ports are available.

- The instance numbers for each independent link match the ATM port number. Note that each physical port used as an independent link in the figure "Example of a mixed configuration without traffic shaping on the 8-port E1 ATM FP (Multiservice Switch 7400 node)" (page 139) matches the same ATM port number:
  - E1/0
  - E1/3
  - E1/4
  - E1/7
- Independent links and IMA groups cannot share the same instance numbers. Note the instance numbers shown in the figure "Example of a mixed configuration without traffic shaping on the 8-port E1 ATM FP (Multiservice Switch 7400 node)" (page 139):
  - E1/0
  - *Ima/1* (composed of physical links E1/1 and E1/2)
  - E1/3
  - E1/4
  - *Ima/5* (composed of physical links E1/5 and E1/6)
  - E1/7
- The configuration of IMA groups incorporate a high degree of flexibility, Specifically, the IMA groups can use, without restriction, any physical links that are not being used as independent links. For example, in the figure "Example of a mixed configuration without traffic shaping on the 8-port E1 ATM FP (Multiservice Switch 7400 node)" (page 139) the link groups Ima/1 and Ima/5 could use any combination of physical links available.

Example of a mixed configuration with traffic shaping

The following figure shows a mixed configuration of three independent links and one IMA link group with traffic shaping enabled on the 8-port E1 ATM FP. In this example, the *perVcQueueInterfaces* attribute is set to two, making traffic shaping available on ATM ports 0 and 1. Also, the IMA link group Ima/1 combines five physical ports into one virtual port.

Figure 19
Example of a mixed configuration with traffic shaping enabled on the 8-port E1 ATM FP (Multiservice Switch 7400 node)



The example in the figure "Example of a mixed configuration with traffic shaping enabled on the 8-port E1 ATM FP (Multiservice Switch 7400 node)" (page 141) illustrates the following configuration concepts for Multiservice Switch 7400 nodes:

- When traffic shaping is enabled, only four ATM ports are available (ports 0 to 3).
- Because the *perVcQueueInterfaces* attribute is set to two, two of the four ATM ports (instances 0 and 1) can use the traffic shaping feature. In the example in the figure "Example of a mixed configuration with traffic shaping enabled on the 8-port E1 ATM FP (Multiservice Switch 7400 node)" (page 141), the independent link E1/0 and the IMA link group Ima/1 can take advantage of the traffic shaping feature.
- As in the example in the figure "Example of a mixed configuration without traffic shaping on the 8-port E1 ATM FP (Multiservice Switch 7400 node)" (page 139), the instance numbers for each independent link and IMA link group matches the ATM port number.

- Independent links and IMA groups have distinct instance numbers.

Migrating software releases

The proprietary IMA protocol is not supported due to the ATM Forum standards for IMA. Therefore, the ATM Forum IMA protocol must be used henceforth. See “Upgrading an existing IMA link group to the 8-port DS1/E1 ATM FPs” (page 34) for more information.

Appendix Multiservice Switch IMA compliance to specification

This section identifies certain exceptions to full specification compliance for inverse multiplexing for ATM (IMA) in Nortel Networks Multiservice Switch systems. The specification for the IMA feature is the ATM Forum AF-PHY-0086.000, *Inverse Multiplexing for ATM (IMA) Specification*, Version 1.0.

IMA in Multiservice Switch networks fully complies with all mandatory requirements of the ATM Forum IMA Specification with the exception of the specific sections listed in the table "Multiservice Switch IMA mandatory specification compliance" (page 144). None of the remaining exceptions have any impact regarding the interoperability of Multiservice Switch devices with other ATM Forum compliant equipment.

IMA on Multiservice Switch devices fully complies with the optional requirements for ITC mode of the ATM Forum Specification, with the exception of the specific sections listed in the table "Multiservice Switch IMA optional specification compliance" (page 146). These exceptions may affect the interoperability of Multiservice Switch devices in ITC mode with other ATM Forum-compliant equipment.

The following terminology applies to statements regarding compliance with specification:

- **Noted**. This terminology applies where the specification provides clarification, non-specific information, or details that do not relate directly to Multiservice Switch IMA.

- **Fully complies with**. This terminology applies where Multiservice Switch IMA functionality fully complies with the text for this section.
- **Compliant with these exceptions**. This terminology applies where Multiservice Switch IMA does not completely comply with the text. Additional text explains specific exceptions.
- **Not supported**. This terminology applies where Multiservice Switch IMA does not support the functionality described in the text.

Table 6
Multiservice Switch IMA mandatory specification compliance

Section	Applicable requirement	Compliance
Section R-54	The IMA transmitter shall perform a check that an ATM Layer cell is available and accept that cell when the Tx IMA data cell clock (IDCC) ticks and only when the Tx IDCC ticks.	Compliant with these exceptions: Multiservice Switch does not implement the Tx IDCC clock exactly as specified. There is no impact regarding interoperability with specification-compliant equipment.
Section R-55	The transmit IMA shall derive the Tx IMA data cell rate (IDCR) from the selected TRL according to (EQ. 1).	Compliant with these exceptions: Multiservice Switch does not implement the Tx IDCR exactly as specified. There is no impact regarding interoperability with specification-compliant equipment.
Section R-61	The CDV attributed to the presence of ICP cells shall be removed by a behavior equivalent to providing a small smoothing buffer into which cells are placed after reordering and after removing ICP cells (including SICP cells), but not Filler cells.	Compliant with these exceptions: Multiservice Switch does not implement CDV smoothing at the IMA layer. There is no impact regarding interoperability with specification-compliant equipment.

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Table 6 (continued)
Multiservice Switch IMA mandatory specification compliance

Section	Applicable requirement	Compliance
Section R-62	If the TRL is in the Working state, the Rx IDCR made available to the ATM layer of the receiver shall be derived as specified in equation (EQ. 1) using the incoming link indicated by the FE IMA transmitter as the TRL in the "Transmit Timing Information" field in the ICP cell.	Compliant with these exceptions: Multiservice Switch does not implement the Rx IDCR exactly as specified. There is no impact regarding interoperability with specification-compliant equipment.
Section R-63	Zero or one cell only shall be made available to the ATM layer at an IMA data cell clock tick. The behavior of the IMA receiver shall be equivalent to following: when the IMA data cell clock at the receiver ticks, one cell shall be removed from the smoothing buffer.	Compliant with these exceptions: Multiservice Switch does not implement the Rx IDCC clock exactly as specified. There is no impact regarding interoperability with specification-compliant equipment.
Section R-97	The default value of Alpha (a) shall be 2.	Compliant with these exceptions: Multiservice Switch implements Alpha = 1, which is within the optional range specified. There is no impact regarding interoperability with specification-compliant equipment.

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Table 6 (continued)
Multiservice Switch IMA mandatory specification compliance

Section	Applicable requirement	Compliance
Section R-133	In the case of the LODS failure alarm, the IMA shall support 2.5±0.5 seconds as a default persisting checking time to enter, and 10±0.5 seconds as a default persisting clearing time to exit.	Compliant with these exceptions: Multiservice Switch implements a hysteresis method to ensure that the LODS alarm does not toggle when the differential delay is near the maximum permitted level. There is no impact regarding interoperability with specification-compliant equipment.
Note 1: IMA on Multiservice Switch devices fully complies with all mandatory requirements in the ATM Forum IMA Specification with the exception of the specific sections listed in this table. ***Note 2:*** For a definition of the terms and acronyms used in the "Applicable requirement" column of this table, see ATM Forum AF-PHY-0086.000, *Inverse Multiplexing for ATM (IMA) Specification*, Version 1.0.		
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Table 7
Multiservice Switch IMA optional specification compliance

Section	Applicable requirement	Compliance
Section O-5 Section CR-4 Section CR-6	The transmit IMA may also support the ITC mode.	Compliant with these exceptions: Multiservice Switch systems's implementation of ITC mode is not exactly as specified. See "Transmit clock mode" (page 117) for details.
Note: For a definition of the terms and acronyms used in the "Applicable requirement" column of this table, see ATM Forum AF-PHY-0086.000, *Inverse Multiplexing for ATM (IMA) Specification*, Version 1.0.		

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