Compaq SANworks™

Application Note
Data Replication Manager over an ATM Link
Supporting OSG Version 2.2.5

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About This Document

This Application Note provides an overview of the ATM (Asynchronous Transfer Mode) link and its effect on performance when used with the Data Replication Manager (DRM). The DRM is a storage-based data replication and workload migration solution that copies data online and in real time to remote locations via an extended Storage Area Network (SAN). The ATM link has not been qualified for configurations other than Data Replication Manager. This document supports the following configurations:

■ Data Replication Manager configurations with combinations of up to 4 storage systems and up to 12 servers (per local and remote sites).

■ Any combination of storage systems and servers, up to the maximum amounts described above. Configuration cannot exceed the total amount of ports on a Fibre Channel switch.

■ Non-cascaded Fibre Channel switches on the local or remote sites.

■ Open System Gateway revision level 2.2.5.

■ Fibre Channel switch version 2.1.7 or higher.

For complete details on Data Replication Manager, refer to the *Compaq SANworks Data Replication Manager HSG80 ACS Version 8.5P Operations Guide* for the appropriate platform. This Application Note contains the following sections:

■ Introduction to DRM with ATM Transport

 ❑ Fibre-Channel-to-ATM Gateway

 ❑ Open Systems Gateway Interface

■ ATM Link Topologies

 ❑ Dual Links

 ❑ Shared Virtual Channel Links

 ❑ Fractional Virtual Channel Links

 ❑ ATM Inverse Multiplexing

 ❑ Encryption

■ Case Study

 ❑ Example Criteria

 ❑ DRM Requirements

 ❑ Obtaining Best Performance

■ Installation and Configuration

 ❑ Fibre Channel Switch Setup

 ❑ Service Kit

 ❑ Open Systems Gateway Setup

■ Websites

 ❑ Compaq

 ❑ ATM Forum

■ Disclaimer

■ Glossary

Introduction to Data Replication Manager with ATM Transport

During normal data processing, data is written to initiator (local) and target (remote) sites. While copies of data reside at both sites, host data access occurs through the initiator site, unless there is a failure or catastrophe that disables processing at that site. In the event of an initiator failure, another site can continue processing data in the interim.

Data Replication Manager provides rapid data access recovery and continued data processing after the loss of one or more components. Data Replication Manager uses the peer-to-peer remote copy function of the HSG80 controller to achieve data replication. HSG80 controller pairs at the initiator site are connected to their partner HSG80 controller pairs at the target site.

Data Replication Manager can replicate data up to 100 kilometers (approximately 62 miles) through an extended storage area network over direct Fibre Channel links or extend over greater distances with Fibre-Channel-to-ATM Gateways.
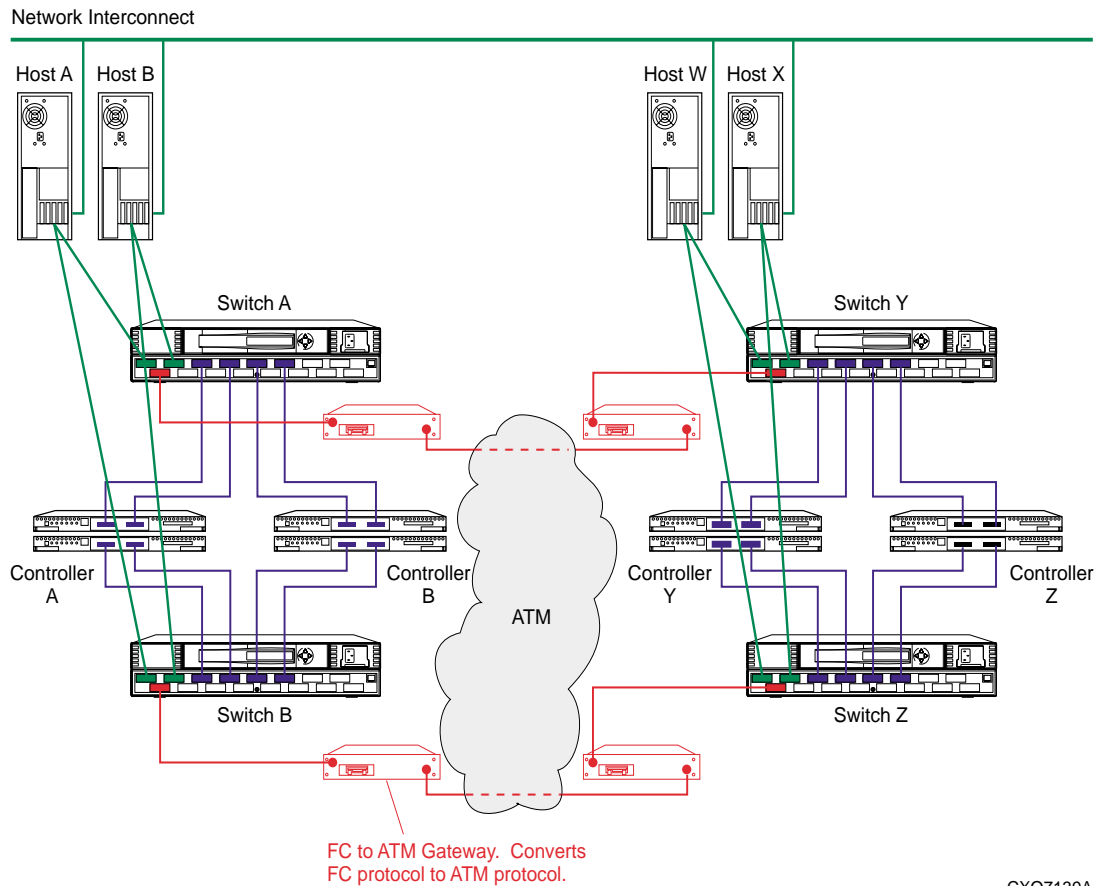
Fibre-Channel-to-ATM Gateway

Fibre-Channel-to-ATM gateways, referred to as Open Systems Gateways (OSGs), provide ATM connectivity into telecommunication networks for the *Compaq SANworks* extended SAN/DRM solution. ATM connectivity is ideal, where contingency sites are required to be very long distances away, to protect against wide area disasters or where dark fiber connectivity is unavailable.

ATM is a communications networking technology that carries information (voice, video, and data) in 53-byte cells. The fixed-length cell allows a network to carry any type of information within the cell and also to provide stringent service qualities that can differ by application.

Each virtual connection in an ATM network has a service category. The performance of the connection is measured by the established *Quality of Service* (QoS) parameters. *Constant Bit Rate* (CBR) is the service category used by the current DRM solution over ATM. The only requirement for CBR is *Peak Cell Rate* (PCR). This value is determined by performance requirements.

The DRM solution uses virtual connections in an ATM network that are predefined and permanently in place. These configurations are referred to as a *Permanent Virtual Circuit* (PVC). The 53-byte cell includes a 5-byte header that contains all the information to transport the cell from the source to the destination. Every cell header contains an address identifier used by the ATM switches to track how cells move from one physical link to the next. Before any communication exchanges take place, the connectivity information stored in the switches must be loaded manually. The network administrator must select the end points that require connectivity to set up PVCs. These address identifiers are known as VPIs and VCIs (*Virtual Path Identifiers* and *Virtual Channel Identifiers*).

DRM requires two ATM links, each running at a Public Line Rate between 1.544 megabits per second (193 kilobytes per second) and 144 megabits per second (18.06 megabytes per second). See Figure 1.

Figure 1 Data Replication Manager configured over an ATM link

Open Systems Gateway Interface

The Open Systems Gateway (OSG) interface supports:

- 50-micron multi-mode fiber, up to 500 meters (Fibre Channel and ATM sides)

- 62.5-micron multi-mode fiber, up to 200 meters (Fibre Channel and ATM sides)

- Performance target data rate from 1.554 megabits per second to 144 megabits per second over an ATM OC-3 link

- Point-to-point connectivity only (no alternate routing supported at present)

- Fibre Channel Class 3 traffic

- Frame data field size of 2048 bytes

The OSG interface does not support Class F frames.

ATM Link Topologies

Dual Links

The most disaster tolerant of the ATM link configurations, dual links, provide protection if one link becomes unavailable. No ATM switch is required. Each link has diverse routing to increase survivability. Figure 2 shows a dual-link configuration.

CXO7201A
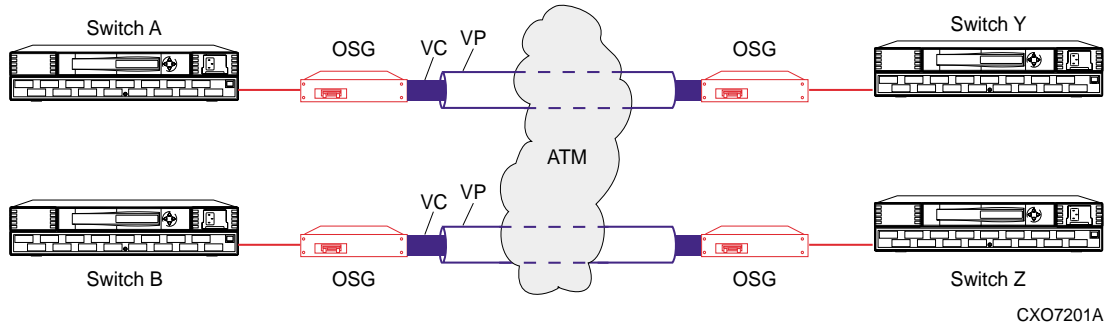
Figure 2 Dual-link configuration

Shared Links

A shared link, like that shown in Figure 3, allows for one telecommunication link between sites, with the line bandwidth divided between the two Fibre Channel fabrics. The data rate is shared according to the Peak Cell Rate allocation. Because there is only one link, this configuration has less survivability than dual links.

CXO7202A
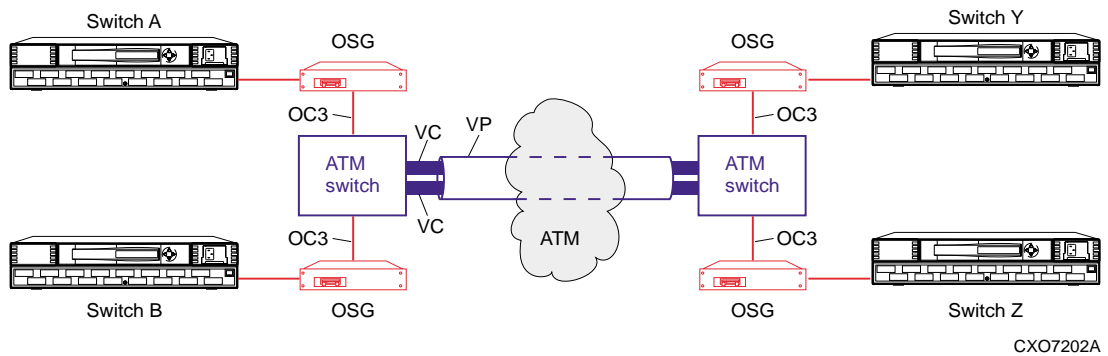
Figure 3 Shared virtual channel link configuration

Fractional Links

Fractional lines allow for leasing the exact bandwidth or access speeds needed to support a user's requirements (see Figure 4). This topology may also consist of shared links.
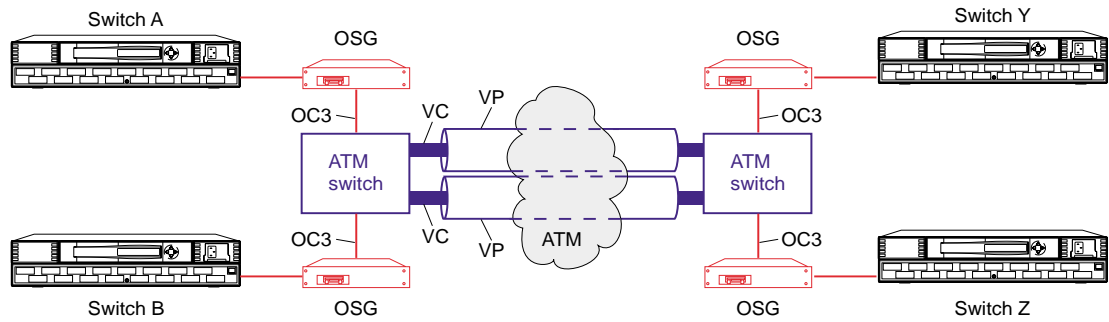
Figure 4 Fractional virtual channel link configuration

ATM Inverse Multiplexing

Multiple ATM T1/E1 speed circuits provide aggregate bandwidth when higher bandwidth is not available or when faster access rates are unnecessary (see Figure 5).
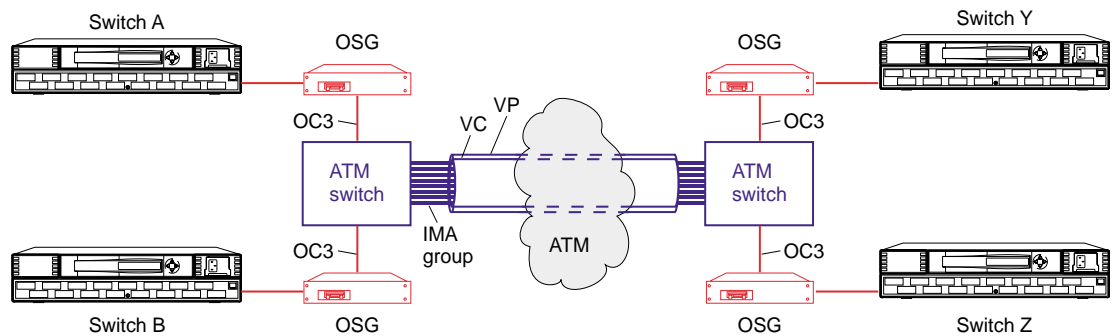
Figure 5 ATM inverse multiplexing configuration

Encryption

Encryption is for customers who require strong confidentiality, authentication, and access control to ensure network and information security (see Figure 6).

CXO7388A
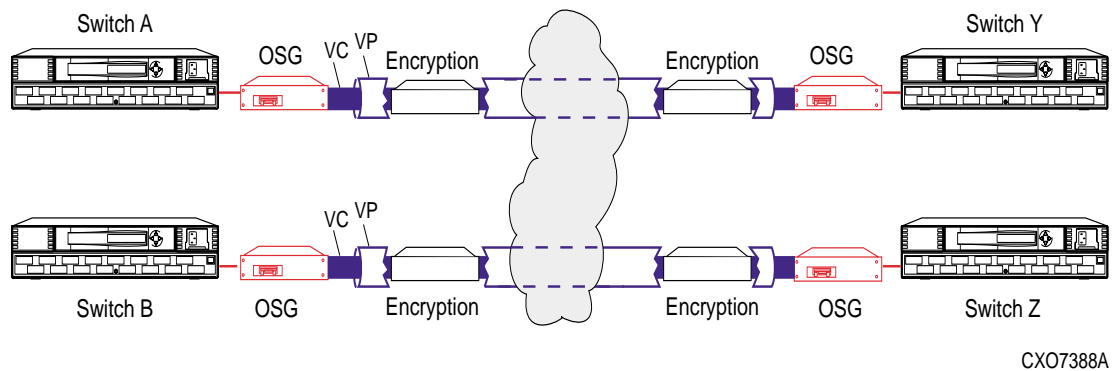
Figure 6 Encryption

Case Study

Example Criteria

- Distance between sites: 150 miles (241.35 kilometers)
- Write percentage: 30%
- I/O size: 8 kilobytes

DRM Requirements

DRM requires two separate PVCs. The telecommunications provider must supply VPIs and VCIs through their network for each PVC.

Obtaining Best Performance

When setting up a DRM configuration, changing the operational mode between synchronous and asynchronous can have a significant effect on performance as seen by the user. Unfortunately, there are no hard and fast rules to determine which setting is best. The best setting depends on a combination of the I/O workload, the type of intersite communication, and the distance of the intersite link.

This section provides the background information necessary to obtain the best performance over a DRM connection with an ATM link.

Workload profile

In normal operation, read requests from the host are satisfied from the local storage system. Read performance is, therefore, similar to performance in a non-DRM environment. Write operations, however, must be replicated to the remote site. This replication, which uses different communication transports over varying distances, introduces performance variations.

As the percentage of writes increases, the amount of data sent to the remote site also increases, potentially reducing performance. The first step in assessing the effect of DRM is to analyze the existing I/O workload. In particular, the percentage of writes, the size of these writes, the write request rate, and the existing write response time should be determined. With this information you can predict the resulting performance using DRM under different configurations with a reasonable degree of accuracy.

Distance considerations

When data is transferred from the local to remote sites, the SCSI protocol, encapsulated into Fibre Channel frames, requires a minimum of four trips over the path. These are conceptually:

1. Ask the remote site if it is ready to receive data.

2. Wait for the response from the remote site.

3. Send the data to the remote site.

4. Wait for acknowledgment from the remote site.

When sending data over fiber, the transmission time is approximately 5 microseconds per kilometer. Since a minimum of four trips is required for each SCSI data transfer, this translates to 20 microseconds per kilometer, or about 32.2 microseconds per mile. For example, if a remote site is located 150 miles away from the local site, the total time will be 4830 microseconds for every data transfer. Since a typical I/O operation on a non-DRM configuration with write-back cache takes approximately 500 microseconds, long distances can have a significant effect on performance.

Communication type

The specific type of communication may also have a significant effect on performance. When using ATM over an OC-3 link, the data rate is limited to a maximum of 155 megabits per second. Straight Fibre Channel, on the other hand, has a native speed slightly over 1 billion bits (Gb) per second. If the communications link is ATM, the hardware that translates between Fibre Channel and ATM protocol introduces an additional latency of about 2.41 milliseconds combined for all four trips. The effects of these different transport mechanisms must also be taken into account when considering performance.

In the previous example of 150 miles (4.83 milliseconds), the addition of ATM increases the latency by 2.41 milliseconds to a total of 7.24 milliseconds. The maximum data rate is also lowered from the Fibre Channel maximum of 100 megabytes per second to approximately 13 megabytes per second (taking protocol overhead into account).

Synchronous operation

In the synchronous mode of operation, command completion is not returned to the host until the data has been stored on both the local and remote sites. If the host computer issues multiple write requests at the same time, all of these requests are pipelined (multiple requests on the connection at the same time). Even though multiple commands may be outstanding, completion for each command is returned only when all data for that command has been received and acknowledged by the remote site. Since the commands are pipelined, there is very little queuing, so the response time of each request is determined by the total time for the four trips. This means that the length and type of the communications path is the primary factor for the response time of each command.

The maximum number of commands that may be outstanding simultaneously is controlled by the OUTSTANDING_IO parameter on the controller. If the number of commands issued by the host exceeds this value, those commands are queued internally by the local controller for later transmission.

Asynchronous operation

To reduce response times, asynchronous operation returns I/O completion to the host as soon as the data is sent to the local controller, but before it is received by the remote system. The result is that the host computer sees only the response time associated with the local system. The time delays associated with data replication are masked because the replication is accomplished in the background.

Because completion of the transfer is returned to the host, the host may send additional requests, confident that the previous data is safely written. Because of this, the controller must ensure that all data that was previously acknowledged as being complete, but that is currently "in transit" to the remote system, is delivered in the correct order. This is accomplished by allowing only one data transfer at a time (for a particular association set) to be sent to the remote site. Any additional data transfer commands are queued internally within the controller and sent one at a time as the previous transfers complete.

Because the host sees a very fast response time, it may issue I/O requests at a rapid rate. The replication, on the other hand, proceeds at the rate dictated by the intersite link. As a result, a large queue of requests that are waiting for replication may build within the controller.

The number of queue requests is limited by the OUTSTANDING_IO parameter. The number of requests that have been acknowledged to the host by the controller as being completed, but have not yet been sent (or acknowledged) by the remote site, is compared to the value of OUTSTANDING_IO. If the number of requests is greater, then subsequent requests sent by the host are not acknowledged as completed until they are sent to and acknowledged by the remote site.

A simple example may help to clarify this:

Assume that OUTSTANDING_IO is set to a value of 5 and that a host issues a request, waits for completion from the controller, then immediately issues another request. Assume also that the DRM configuration is on ATM over a very long distance, requiring a significant amount of time to perform replication. In asynchronous mode, each request issued by the host is acknowledged as completed by the controller very quickly. As a result, the host issues five requests before the remote site has completed the first request. If the host then issues another (sixth) request, this exceeds the value of OUTSTANDING_IO. The local controller does not return completion of this request to the host, but queues it behind the previous requests that are awaiting replication. Completion of the sixth request is not returned until all five preceding requests have been sent to and acknowledged by the remote site, and the sixth request itself has been sent and acknowledged. The result is that the host sees a response time for the first five requests equal to the time taken by the local controller, while the sixth request has a response time equal to the sum of the transit times from local to remote controller for all preceding requests.

Assume that the time for the local controller is 500 microseconds, while the total time for replication to the remote controller is 5 milliseconds. In this case, the host sees a response time of 500 microseconds for each of the first five requests, since completion is returned immediately. The sixth request has a response time slightly less than 30 milliseconds because it must wait for all previous requests to be completed by the remote site. In other words, the sixth request has a response time 60 times greater than the first five.

Performance analysis

Taking the preceding information into account, the performance picture becomes quite complex, since there are so many factors that interact. To analyze the performance of a DRM configuration and select the optimum parameters, all of the contributing factors must be fully quantified. This analysis requires a multiple step procedure, requiring detailed knowledge of the I/O workload and proposed DRM configuration.

The steps required to configure a DRM solution for optimum performance consist of both preinstallation and postinstallation analyses. The preinstallation phase consists of measuring the current I/O workload on the units to be replicated, calculating the minimum transport bandwidth required to support the existing I/O load, and predicting the response times for the DRM system for both synchronous and asynchronous replication. Once the system is installed, additional steps may be taken to tune the configuration for maximum performance.

The preinstallation phase consists of the following steps:

1. Determine the I/O workload parameters that are relevant to DRM. These parameters should be measured only on those units that are to be replicated, since non-DRM units are irrelevant to this analysis.

   The parameters to be measured for each unit include:

   - Transfer size of writes

   - Request rate of writes

   - Either the average response time or the average queue depth of writes

   - Either the average response time or the average queue depth of reads (for a later, more comprehensive analysis)

   - Transfer size and request rate of reads (for a later, more comprehensive analysis)

   The data may be measured with existing operating system utilities (such as the Windows NT Performance Monitor) or third party utilities (such as ViewPoint from Datametrics). It is important to gather this data during both typical and critical periods. Because the data gathered is used for later analysis, the results of the analysis depend on the quality of the collected information. If there are several distinct I/O phases (such as interactive and batch), data should be collected separately for each phase and the resulting data analyzed independently.

2. Determine the minimum transport bandwidth required. The bandwidth required is the product of the write request rates and the write transfer sizes for all replicated units. For example, if the busiest period shows a total write request rate of 150 requests per second with an average transfer size of 8 kilobytes, the required bandwidth is 1200 kilobytes per second, or 1.2 megabytes per second, so neither ATM nor straight Fibre Channel would impose significant bottlenecks. Note that due to other considerations, this rate may not be maintainable. This step is merely to ensure the minimum bandwidth required to meet the existing data rate.

3. The latency for synchronous replication may be calculated once the distance between the local and remote site is known. For straight Fibre Channel, the latency in milliseconds is the distance in miles multiplied by 0.0322 (distance in kilometers must be multiplied by 0.02). If ATM is used, 2.41 milliseconds must be added to this figure to account for the ATM protocol conversions. For a 150 mile distance, for example, the fiber latency is 4.83 milliseconds (7.24 milliseconds for ATM as shown in the section "Communication type" on page 9).

   Although large latencies may be associated with synchronous replication, the ability to send multiple requests from the host simultaneously allows a very high request rate to be supported.

4. For asynchronous replication, the host sees very little latency, since completion is returned when the local controller receives the data. Only one data transfer may be outstanding between the local and remote site in asynchronous replication mode however, so the maximum request rate is dependent on the amount of time taken for that replication. The maximum rate can be calculated by taking the reciprocal of the latency calculated in step 3. Using 4.83 milliseconds (0.00483 seconds) for example, 1 divided by 0.00483 equals about 207 requests per second. If the connection is made through ATM, the latency from step 3 of 7.24 milliseconds results in a maximum request rate of about 138 requests per second.

    The calculated rate is the maximum rate that can be supported while retaining full asynchronous response times. If the rate rises above the calculated value, then more requests are arriving at the controller every second than can be sent sequentially over the communications link. This results in queues of requests building at the local site and, when the number of requests exceeds the value of OUTSTANDING_IO, the request is delayed for a significant time (as shown in the section "Asynchronous operation" on page 10), resulting in a large increase in response time.

    It is important to note that most I/O is quite bursty. Although the average arrival rate may be below the thresholds calculated in this step, bursts of I/O requests may cause an instantaneous peak rate and lengthy response times.

    A rule of thumb is to aim for an average rate of no more than 80% of the rates calculated in this step. From the examples given, an average write rate of more than 165 requests per second (fiber) or 110 write requests per second (ATM) may result in long response times. Once the maximum write request rates have been calculated, the minimum transport bandwidth should (once again) be determined. As explained in step 2, this determination is accomplished by multiplying the average write transfer size by the write request rate. For the examples given, a maximum rate of 165 write requests per second yields a data rate of 1.32 megabytes per second. For a rate of 110 on ATM, the minimum required bandwidth is 880 kilobytes per second.

5. If the data gathered in step 1 indicates that the write request rate for an association set exceeds the maximum request rate for asynchronous requests calculated in step 4, then better performance can be realized by setting the operation mode to synchronous. On the other hand, if the request rate from step 1 is less than the maximum rate for asynchronous, then setting the operation mode to asynchronous provides the best response time.

6. The optimum value of OUTSTANDING_IO depends on both the type of unit and the spatial locality of requests sent to individual units.

    For JBOD units, if there is a possibility that two or more requests might be sent rapidly to the same location on the unit, the value of OUTSTANDING_IO should be set fairly low. A value of 10 or less is recommended.

    For RAID-5 sets, if there is a possibility that two or more requests might be sent rapidly to the same strip, the value of OUTSTANDING_IO should also be set fairly low. To calculate the size of a strip, multiply the chunk size of the RAID-5 set by one less than the number of members in the set. For a six-member RAID-5 set with a chunk size of 256, for example, the size of a strip would be 256 times 5, or 1280.

    In any event, performance of the unit should be monitored with tools such as VTDPY and DSTAT, and the value of OUTSTANDING_IO adjusted as required to attain the maximum throughput.

7. Once the preceding calculations are complete, it may be of interest to calculate the overall maximum request rate. Since all calculations are based on only the write request rate, the combined request rate is determined by dividing the write request rate by the fraction of writes. The result is the maximum request rate that this configuration supports.

For example, if the write fraction is 0.3 (30%), then a write rate of 165 per second for fiber results in a maximum request rate of 165 divided by 0.3, or 550 requests per second. For a write rate of 110 on ATM, the maximum request rate is 367 requests per second.

Summary

When choosing between synchronous and asynchronous replication, the best performance depends on a variety of workload factors. Since the setting of this parameter is dynamic, it is relatively easy to switch between the two operational modes and view the resulting performance change. Guidelines for setting the mode are not intended to be hard and fast rules, but rather should be considered a starting point.

Note that as workload conditions change over time, changes may be needed in the operation mode to maintain optimum performance.

Installation and Configuration

Fibre Channel Switch Setup

Set up the Fibre Channel switch as required in the Compaq SANworks *Data Replication Manager HSG80 ACS Version 8.5P Operations Guide* for your platform.

The Fibre Channel switch configuration must be modified to correctly communicate with the OSGs. Verify or change the following as appropriate:

1. Open a telnet session and log into the Fibre Channel switch.

2. Type version and then press **Enter**. You will see a display similar to the example below.

    ```
    Kernel:      5.3.1
    Fabric OS:   v2.1.8_rc2
    Made on:     Fri Jun 23 13:40:45 PDT 2000
    Flash:       Fri Jun 23 13:41:17 PDT 2000
    BootProm:    Tue Dec 29 17:32:38 PST 1998
    ```

    Verify that the switch (Fabric OS) is running version 2.1.7 or greater.

3. Type licenseshow and then press **Enter**. You will see a display similar to the example below.

    ```
    Web license
         Zoning license
         SES license
    RdSebdezQ9SeTfcQ:
         Web license
         Zoning license
         SES license
         QuickLoop license
         Fabric license
         Remote Switch license
    ```

    Verify that the remote switch license is loaded.

    If the switch license is not present, load the license by typing licenseadd "license-key", then press **Enter**. To obtain the license key, refer to the Remote Switch Option Kit provided with your Fibre Channel switches. Repeat step 3 to verify that the license has been added.

4. Configure the switch for E-port connectivity with OSGs by entering the following:

    a. Type switchdisable and then press **Enter**.

b. Type configure and then press **Enter**. You will see a display similar to the example below.

```
Configure...
Fabric parameters (yes, y, no, n): [no]
```

Type yes and then press **Enter.**

c. Press **Enter** several times until you see a display similar to the following:

```
E_D_TOV: (1000..5000) [5000]
```

Type 5000 for this value and then press **Enter.**

d. You will see a display similar to the following:

```
Data field size: (256..2112) [2048]
```

Type 2048 for this value and then press **Enter**.

e. Press **Enter** several times until you see a display similar to the following:

```
Suppress Class F Traffic: (0..1) [1]
```

Type 1 for this value and then press **Enter.**

f. For fabric OS V2.1.9g and later, press **Enter** several times until you see a display similar to the following:

```
SNYC IO mode: (0..1) [0]
```

Type 1 for this value and then press **Enter**.

g. Press **Enter** several times until you see a display similar to the following and you are back to the telnet prompt. Configure process is complete:

```
Virtual Channel parameters (yes, y, no, n): [no]
  Arbitrated Loop parameters (yes, y, no, n): [no]
  System services (yes, y, no, n): [no]
No changes.
```

h. Type switchenable and then press **Enter**. Switch setup is now complete.

Service Kit

The Service Kit is required for remote service and to configure the Open Systems Gateway through a modem. The kit consists of a Western Telematics (WTI) switch and necessary RJ-45 cables.

The WTI switch is a 16-port, asynchronous switch that mounts in a standard 19-inch rack along with the Open Systems Gateway (OSG). To enable remote servicing of the OSG, a customer-supplied modem must be installed. You must obtain a local phone number from your telecommunications provider for this modem.

The kit does not supply the cables required to connect locally to a server or terminal device. See your CNT hardware Installation User Guide for remote and local connectivity options.

Open Systems Gateway Setup

To configure the OSGs, the Fibre-Channel-to-Backbone (FC-BB) Wizard must be run. Prior to beginning the FC-BB Wizard, collect the following information from the telecommunications provider:

❏ PVC1 VPI: _____ VCI: _____ Public Line Rate: _____ CDVT: _____ (min 3000 microseconds)

❏ PVC2 VPI: _____ VCI: _____ Public Line Rate: _____ CDVT: _____ (min 3000 microseconds)

The VPI and VCI values will be used by the Wizard. The Public Line Rate must be calculated based on bandwidth required. When provisioning the PVCs, the telecommunications provider must set the CDVT value. This value must be at least 3000 microseconds to avoid cell loss.

Use the FC-BB Configuration Wizard to set up all gateways. For additional information on the FC-BB Configuration Wizard, see Appendix C of the *UltraNet Open Systems Gateway Hardware Installation Manual*.

After initial power on of the gateway, and prior to running the FC-BB Configuration Wizard, verify from the console that the message "active received" has been displayed. The "active received" may take several minutes.

From the Wizard's directory type:

```
wizards1.0x6>run fcbb
```

The following banner and question lines will be displayed. Follow these conventions in the question lines:

■ The item in the square brackets is the default response to the question. If you wish to accept the default response, press **Enter** to move to the next item.

■ The items in the parentheses are the possible responses to the question:

❏ "<" indicates "back to previous question"

❏ "?" invokes the Help system

❏ "." ends the Wizard session

■ The item in the angle brackets is the format or syntax of the expected response.

```
(Banner) FC-BB wizard initializing...
(Banner) Current 2 slot configuration:
(Banner)    Slot  1 - Type: PowerPC, PCI bus interfaces: 2
(Banner)              PCI bus I/O 1: FibreChannel
(Banner)              PCI bus I/O 2: ATM
(Banner)              Compression board: No
(Banner)    Slot  2 - Type: unknown
```

(Question) Do you wish to change the above hardware configuration? [no]
(yes, no, ?, .) <yes/no>:

Type no. There should be no reason to change the hardware configuration. If the configuration does not look like the one above, it is probably because the "active received" console message has not been displayed. To restart this process, power down the OSG and then power it back up again.

(Question) Do you wish to include Snmp support? [yes]
(yes, no, ?, .) <yes/no>:

Type yes.

(Question) Enter the number of Snmp trap destinations: [1]
(0..6, ?, .) <Decimal>:

Type the numeric value 1.

(Question) Enter 1st trap destination's IP address: [16.82.80.162]
(<, ?, .) <IpAddress>:

Type the numeric value of the IP address for the SNMP Manager. Enter appropriate SNMP trap information, if required.

(Question) Enter local CNT node number: [06]
(0x00..0xFF, ?, .) <Hex>: 06

Type the numeric value 06 (arbitrary node number). This number must be 2 digits in length.

(Banner) FC-BB wizard now configuring PowerPC (Zap) in slot 1...

(Question) Do you wish to set slot 1's ATM interface IP address? [no]
(yes, no, <, ?, .) <yes/no>:

Type no. This gateway does not support IP traffic over ATM.

(Question) Do you wish to set slot 1's on-board Ethernet IP address? [yes]
(yes, no, <, ?, .) <yes/no>:

Type yes.

(Question) Enter slot 1's on-board Ethernet IP address: [10.0.0.6]
(<, ?, .) <IpAddress>:

Type the numeric value of the IP address assigned to this OSG.

(Question) Enter slot 1's on-board Ethernet subnetwork mask: [255.0.0.0]
(<, ?, .) <IpAddress>:

Type the numeric value of the subnet mask assigned to this OSG. The IP information should correspond to customer network.

(Question) Will the physical layer of slot 1's 1st ATM interface provide the clocking? [yes]
(yes, no, ?, .) <yes/no>:

Type no. Set all gateways to no unless back-to-back gateway connections are needed. In this case, set only one of the gateways in the pair to yes.

(**Question) Enter number of Active VCI bits: [10]**
(12, 11, 10, 4, ?, .) <Decimal>:

Type the numeric value 10. Set Active VCI bits based on VPI and VCI values provided by the telecommunications provider. See Table 1 for the correct setting.

Table 1 ActiveVciBits Values		
ActiveVciBits	**VPI Range**	**VCI Range**
12	0	0- 4095
11	0-1	0- 2048
10	0-3	0-1023
4	0-255	0-15

```
(Question) Enter the PVC's VCI number: [101]
(0..1023, ?, .) <Decimal>:
```

Type the numeric value 101.

```
(Question) Enter the PVC's VPI number: [0]
(0..3, <, ?, .) <Decimal>:
```

Type the numeric value 0. This is the VCI and VPI value given by the telecommunications provider for this PVC.

```
(Question) Enter the PVC's quality of service: [cbr]
(UBR, CBR, VBR, <, ?, .) <String>:
```

Type cbr. This QoS, with the associated PVC's Line Rate values, must be purchased from the telecommunications provider.

```
(Question) Enter the PVC's peak cell rate: [1300]
(1..135000, <, ?, .) <Decimal>:
```

Type the numeric value 1300. This value is the PCR of the gateway and is expressed in kilobits per second. It is also defined as the Premise Line Rate. Its value is given in kilobits per second. Type a value in the acceptable range of 1544 to 126000 kilobits per second. The value required for this field is the result of a performance analysis similar to the one described in the previous Case Study.

Efficiency values to be considered when specifying Line Rate with the telecommunications provider are as follows:

- SONET efficiency = 150.336 megabits per second / 155.52 megabits per second = 0.967

- ATM efficiency = 48 cells / 53 cells = 0.9

- Fibre Channel 8b/10b encoding = 8 bits / 10 bits = 0.80

- Fibre Channel efficiency = 2048 bytes / (2048 + 48 bytes) = 0.977

These values, as well as any additional telecommunication-specific values, must be used when calculating the bandwidth that the telecommunications provider must furnish to ensure the required DRM bandwidth.

As in the Case Study, if the required data rate is 880 kilobytes per second (7040 kilobits per second), then the following values must be used for correct Premise and Public Line Rate setup (see Table 2):

- Premise Line Rate = 8 * 880 / (0.8 * 0.977) = 9007 kilobits per second (PVC Peak Cell Rate)

■ Public Line Rate = 8 * 880 / (0.967 * 0.9 * 0.8 * 0.977) = 10350 kilobits per second

Table 2 Example - Premise and Line Rate Setting vs. Data Rate

Max Data Rate (Based on No Delay) (Kbps)	Premise Line Rate (PVC Peak Cell Rate) (Kbps)	Public Line Rate (cells per sec)	Public Line Rate (Mbps)
1050	1344	3499	1.544 (ATM T1)
1393	1782	4642	2.048 (ATM E1)
3401	4352	11332	5
6802	8703	22664	10
13605	17406	45328	20
20407	26109	67992	30
23378	29910	77892	34.368 (ATM E3)
27209	34812	90656	40
30431	38934	101390	44.736 (ATM T3)
34011	43515	113320	50
40814	52218	135984	60
47616	60921	158648	70
54418	69624	181313	80
61220	78327	203977	90
68023	87030	226641	100
81627	104436	271969	120
95232	121842	317297	140
98289	125754	327484	144.495 (ATM OC-3)

```
(Question) Do you wish to set a static route IP address? [no]
(yes, no, ?, .) <yes/no>:
```
Type no. Static routing is not supported.

```
(Question) Do you wish to set a default gateway IP address? [yes]
(yes, no, ?, .) <yes/no>:
```
Type yes.

```
(Question) Enter default gateway's IP address: [10.0.0.100]
(<, ?, .) <IpAddress>:
```

Type the numeric value 10.0.0.100. This IP information should correspond to customer network.

```
(Banner) Writing configuration files...
Thu Oct  5 14:11:05  DEBUG: CNT0:sm_dlp:1:7:0 starting dynamic linking
parser version 1.0.

(Banner) FC-BB wizard configuration completed.
wizards1.0x6>Thu Oct  5 14:11:42  NOTICE: CNT506:sm_cfgd:1:5:0 Set 'active'
received.
```

Note the `active received` console message. This message must appear after completion of the Wizard and prior to initiating the `ABORT` command. The message may take several minutes to display.

Execute the `ABORT` command from the root level. The OSGs will reboot and all new configuration information will be loaded.

Websites

Compaq

Check the Compaq website for more information on the complete line of Fibre Channel storage products, product certification, technical information, updates, and documentation. This information can be accessed through our website at:

http://www.compaq.com/products/storageworks/

ATM Forum

Over 600 organizations belong to the ATM Forum, an international standards organization that promotes the use of ATM products and services. The ATM Forum can be accessed at the following website:

http://www.atmforum.com/

Disclaimer

Compaq does not warrant third party products, which customers may purchase in the making of a DRM solution. These products are used on an "as is" basis unless otherwise specified in the Third Party's Warranty Attributes. Third party products may be warranted by the third party as specified in the documentation provided with the third party products.

Glossary

ATM (*Asynchronous Transfer Mode*)	A communications networking technology for both LANs and WANs that carries information in fixed-size cells. ATM uses logical connections to provide quality of service guarantees that enable disparate traffic such as data, voice, and video to be carried over the same local or wide area network.
CBR (*Constant Bit Rate*)	A category of ATM service. Supports a constant or guaranteed data rate. CBR is designed to support applications that need a highly predictable transmission rate.
CDVT (*Cell Delay Variation Tolerance*)	The amount of delay, expressed in microseconds, that a cell can be delayed from its actual delivery time.
Data Rate	The bandwidth required without any protocol overhead (8-bit bytes).
Default Gateway	The default path that a computer or router uses to forward and route data between two or more networks that have different protocols.
Fibre Channel	Technology for very high-speed switching-based serial transmissions.
IP address	The numeric address that identifies a particular computer on the internet.
Latency	The amount of time required for a transmission to reach its destination.
OC-3	An optical carrier that provides high-speed bandwidth at 155 megabits per second.
PCR (*Peak Cell Rate*)	The maximum transmission speed of a virtual connection. PCR is a required parameter for the CBR service category.
Premise Line Rate	The speed of the link between the premise edge device and user equipment.
Premise Network	All transmission connections between user equipment and edge devices to the public network.
Public Line Rate	The speed of the link between the premise and public networks.
PVC (*Permanent Virtual Circuit*)	Logical connection manually defined by the network administrator. The PVC is created by specifying the VPI and VCI.
Public Network	All transmission connections supplied by the telecommunications provider, terminating at a customer edge device.
QoS (*Quality of Service*)	Each virtual connection in an ATM network has a service category. The performance of the connection is measured by the established QoS parameters, which are outlined by the ATM Forum. Performance issues include data rate, cell loss rate, cell delay, and delay variation (jitter). Categories of ATM service are Constant Bit Rate (CBR), Variable Bit Rate-Real Time (VBR-RT), Variable Bit Rate- Non-Real Time (VBR-NRT), Available Bit Rate (ABR), and Unspecified Bit Rate (UBR).
SCSI (*Small computer system interface*)	A processor-independent standard protocol for system-level interfacing between a computer and intelligent devices including hard drives, floppy disks, CD-ROMs, printers, scanners, and others.

SDH	European version of SONET.
SONET	A standard optical interface for transmission systems. SONET is a synchronous protocol and is the physical layer for ATM LANs operating over fiber at 155 Mbps or higher. **Note:** OSGs default to SONET. If SDH is required, edit the ATMOC3 configuration file.
Speed of light through fiber	Approximately 200,000 kilometers per second or 5 microseconds per kilometer.
Subnet mask (also known as *address mask*)	A subnet is an IP network that can be reached through a single IP address. All the members of the subnet share the mask value. Members of the subnet can then be referenced more easily. A subnetwork is a network that is part of another network, connected through a gateway, bridge, or router.
UBR (*Unspecified Bit Rate*)	A category of ATM service. UBR supports connections that have no performance requirements.
UltraNet Wizard *Fibre-Channel-to-ATM Configuration Wizard*	An *UltraNet* application that lets the user designate the default configuration settings for Fibre-Channel-ATM on the Open Systems Gateway.
VCC (*Virtual Channel Connection*)	Defines a logical networking path between two endpoints on the network. ATM cells travel over this connection.
VCI (*Virtual Channel Identifier*)	The field of the cell header that stores the virtual channel address.
VPC (*Virtual Path Connection*)	A series of virtual paths joined together to form the logical groups of circuits defined for each link of the network. The VPC moves traffic from one link to another.
VPI (*Virtual Path Identifier*)	The field of the cell header that stores the virtual path address.
WTI Switch	A 16-port serial switch that can be used to configure or service the OSG unit locally or remotely. The Western Telematics (WTI) switch must be installed to set up and service the ATM gateway.