Note: Before using this information and the product it supports, read the information in “Notices” on page vii.

First Edition (June 2018)

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Preface

With the pressures to drive transaction processing 24/7 because of online banking and other business demands, IBM® zHyperLink on the IBM DS8880 is making it easy to accelerate transaction processing for the mainframe.

This IBM Redpaper™ publication helps you to understand the concepts, business perspectives, and reference architecture of installing, tailoring, and configuring zHyperLink in your own environment.

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Introduction

The business requirements for faster transactions and lower response times for applications drove new products that were designed to reduce latency that is related to retrieving data from backend storage, such as IBM Easy Tier® and flash storage. Although these solutions help to address the time that is required to read the data from your physical media, other parts of your I/O processing can also use valuable amount of time and affect your latency. This chapter provides an introduction to zHyperLink and use cases to demonstrate the benefits of the use of zHyperLink in your enterprise. Also included in this chapter are the hardware and software prerequisites that help to ensure a successful implementation.

This chapter includes the following topics:

▸ 1.1, “Introduction to zHyperLink” on page 2
▸ 1.2, “Use cases” on page 2
▸ 1.3, “zHyperLink prerequisites” on page 4
▸ 1.4, “Other considerations” on page 7
1.1 Introduction to zHyperLink

When an I/O request is performed by an application, several processes are performed to complete the request and affect the I/O latency. The I/O latency can be a significant part of application response time, where an I/O service time can represent up to 65% of the latency for an IBM Db2® transaction.

zHyperLink is designed to reduce the I/O latency by providing a fast, reliable, and direct communication path between the CPU and the I/O device. This goal is accomplished by installing zHyperLink adapters on the z/OS host and IBM DS8880 family hardware, and connecting the hardware by zHyperLink cables available. This configuration creates a point-to-point connection between the CPU and I/O device, which reduces the I/O response time by up to 10 times compared to z High-Performance FICON® (zHPF).

Such low response time is achieved by using synchronous I/O requests, which reduces the time that is required for some functions, such as I/O interrupts and z/OS dispatch time. The difference between synchronous and asynchronous I/O is explained next.

1.1.1 Sync versus Async I/O

Standard I/O processing that is available on technologies, such as zHPF, requires I/O operations to perform a series of time-consuming tasks, including the following examples:

- z/OS dispatching
- Interrupt handling
- CPU queue time
- Reload L1/L2 processor cache

These tasks and others that are required for I/O processing cause the I/O response time to be relatively long compared to transferring data within virtual storage, with response times of 130+ microseconds plus interrupt handling and CPU dispatch time.

When a synchronous I/O is performed, the CPU waits or “spins” until the I/O is completed, or the timeout value is reached. zHyperLink can significantly reduce the time that is required to complete the I/O because the dispatching, interrupt handling, CPU queue time, and CPU cache reload activities are no longer necessary.

To achieve superior response times, synchronous I/O operations are performed on random 4 KB read requests only, when the data is in the DS8880 cache. If the data is not in cache, a notification is returned to the host, and the heritage asynchronous I/O is performed. In the meantime, the requested information is pre-fetched, which might reduce the response time for the asynchronous I/O operation.

1.2 Use cases

You can benefit from the use zHyperLink in several situations. In this section, several examples are provided that show how the implementation of zHyperLink can introduce new business opportunities, or reduce your application design complexity.
1.2.1 Avoid Financial Losses

Mainly in financial sectors, fraud attempts occur daily that affect a broad range of businesses. Insurance, government agencies, and financial services are the main targets of fraud activities, which makes security a high priority for those companies. With such relevant risk to the core business, every transaction must be checked and validated. In this case, time matters.

Data mining applications and statistics help to anticipate and quickly detect fraud, take immediate action to minimize losses, and reduce risks. However, those efforts can increase response time. If the I/O does not complete within the time that is expected by the core business application, it might abandon the validation process, which increases the risks of processing fraudulent operations.

z/HyperLink enables much faster read operation with synchronous I/O and low latency access to the databases with fraud detection rules. This ability allows an effective fraud detection process with high I/O performance.

1.2.2 Grow business opportunities

With numerous channels available to create business every day, industries cannot lose a new opportunity to offer more services to their clients. It must be instantly efficient. The number of transactions in e-commerce increased significantly and the reason why it increased also changed. Because more customers are influenced by online advertising, that advertising is structured with fresh data from the customers, which makes it that much more effective.

To offer faster and smarter services, zHyperLink improves I/O response time expressively. This ability allows companies to process transactions much faster, which gives them enough time to process data from the clients and deliver more services or advertisements.

Providing these services or advertisements creates business opportunities. For example, a financing company might use zHyperLink advantages to show more favorable mortgage refinancing options to a client while they are checking their account balance without affecting response time.

1.2.3 Better client experience and revenue

Poor load speeds and inadequate performance on online services usually lead users to not wait for a transaction to complete, which affects critical financial business and negatively affects your brand. Clients who are dissatisfied with online services might take their business elsewhere. As a result, you are not losing only one customer, but possibly a customer whenever your company’s performance is affected. This situation can become worse and more frequent during peak time periods, which limits and compromise your marketing campaign.

Driven by market requirements, zHyperLink delivers the leading I/O latency for transaction processing on Db2 for z/OS applications. It also improves customer satisfaction, which often generates revenue and new business opportunities.
1.2.4 Faster recovery from outages

Hardware and software outages usually drive recovery processes to run. Recovery is not considered complete while every pending transaction in the work queue is not fully processed.

zHyperLink enables a synchronous I/O for that operation and allows the work queue to be reduced much more quickly than heritage FICON I/O. This ability significantly improves the Mean Time to Recovery (MTTR).

1.2.5 Workload growth without redesigning applications

The growth in amount of data that is generated by social media, analytics, mobile applications, security requirements, and cloud drive new requirements to run transactions with improved level of service and an enterprise class quality of service.

Applications must constantly be redesigned to avoid performance degradation, while the core business must be running. However, any type of development or redesign work can be time-consuming and costly to the business.

Improving I/O latency mitigates the need to reengineer applications to improve scale as the transaction rates and business grow. zHyperLink provides lower risk than application development to realize better response times and keep business running.

1.2.6 Reducing data sharing overhead

Concurrent read and write operations can be done from different applications that are accessing the same data. Better I/O latency allows clients to save money by continuing to grow adding data sharing instances are added. When the I/O operation completes more quickly, it reduces the possibility of multiple accesses to the data, which mitigates or delays system upgrades.

1.3 zHyperLink prerequisites

Before you plan and deploy zHyperLink in your environment, you must understand the basic prerequisites that must be satisfied before zHyperLink is enabled. The hardware and software prerequisites are described next.

1.3.1 Hardware prerequisites

This section provides more information about the hardware requirements for zHyperLink. The IBM z14™ Central Processor Complex (CPC), zHyperLink connectivity, and the DS8880 subsystem (the storage control unit) are described.
zHyperLink is a point-to-point connection between the z14 and DS8880, which provides extreme low latency for random reads. A sample zHyperLink connection between a z14 and a DS8880, which is limited to a distance of 150 meters (492 feet), is shown in Figure 1-1.

![Figure 1-1 zHyperLink physical connectivity](image)

**zHyperLink Express** includes the following hardware requirements:
- z14 or z14 ZR1 with zHyperLink Express adapter (FC #0431) installed
- FICON channel as a driver
- At least two 24x MTP-MTP cables to connect to a DS8880
- DS8880 with I/O Bay Planar board and firmware level 8.3
- DS8880 zHyperLink adapters

The z14 zHyperLink Express adapter is a separate feature code (FC #0431) that is installed in the Peripheral Component Interconnect® Express (PCIe) I/O drawer. The zHyperLink Express feature directly connects the z14 Central Processor Complex (CPC) to the I/O Bay enclosure of the DS8880. The z14 Microcode must be on Driver 32L with at least bundle S21.

The IBM zHyperLink Express is a two-port feature in the PCIe I/O drawer. Up to 16 features with up to 32 zHyperLink Express ports are supported in a z14 CPC. The zHyperLink Express feature uses PCIe Gen3 technology, with x16 lanes that are bifurcated into x8 lanes for storage connectivity. It is designed to support a link data rate of 8 GB per second (GBps).

**Note:** The link data rates do not represent the link performance. The performance is dependent upon many factors, including latency through the adapters, cable lengths, and the type of workload.

For better availability and performance, zHyperLink connections are required to be configured in pairs.

zHyperLink connections work with FICON channels; they do not replace them. FICON channels are still required to “drive” zHyperLink to each storage system. FICON is required for IPL and for:
- Initialization of zHyperLink connection
- I/Os that are not eligible for zHyperLink
- Failback when a zHyperLink request fails (for example, cache miss and busy condition)
A 24x MTP-MTP cable is required for each port of the zHyperLink Express feature. It is a single 24-fiber cable with Multi-fiber Termination Push-on (MTP) connectors. Internally, the single cable houses 12 fibers for transmit and 12 fibers for receive. The following fiber type options are available with specifications that support different distances for zHyperLink Express:

- Up to 150 meters (492 feet): OM4 50/125 micrometer multimode fiber optic cable with a fiber bandwidth wavelength of 4.7 GHz-km @ 850 nm.
- Up to 100 meters (328 feet): OM3 50/125 micrometer multimode fiber optic cable with a fiber bandwidth wavelength of 2.0 GHz-km @ 850 nm.

zHyperLink Express is supported on DS8880 Storage systems with 12-core and higher processors. DS8884/F with six cores can be concurrently upgraded to 12 cores with feature code (FC #4425). DS8880 with I/O Bay Planar board and firmware level 8.3 plus the z-synergy Services license is required. Also, I/O Priority Manager must be disabled. The DS8880 microcode level must be at least 8.3.2 (88.32.6.0).

On the IBM DS8880 side, the fiber optic cable connects to a zHyperLink PCIe interface in I/O Bay enclosure. Each zHyperLink connection requires a zHyperLink I/O adapter to connect zHyperLink cable to the storage system. Each zHyperLink I/O adapter features one port, but you must order the adapters in sets of two. Depending on the system configuration, zHyperLink I/O adapters can be ordered in quantities of 2, 4, 6, and 8.

**Note:** The minimum requirement for zHyperLink Express connectivity between the z14 CPC and the DS8880 subsystem is two links.

Use the feature codes that are listed Table 1-1 to order zHyperLink I/O adapters for storage systems with 12-core and higher processors.

**Table 1-1  zHyperLink feature codes for storage systems with 12-core and higher processors**

<table>
<thead>
<tr>
<th>Feature code</th>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1303         | Gen2 I/O enclosure pair        | • High-Performance Flash Enclosure Gen2 support for models 980, 981, 982, 98B, 98E, and 98F  
• Required to support feature code 3500 |
| 1450         | zHyperLink cable               | • 40 m (131 ft), OM4 50/125 micrometer, multi mode, MTP connectors  
• Requires feature code 3500 for storage systems with 12-core and higher processors |
| 1451         | zHyperLink cable               | • 150 m (492 ft), OM4 50/125 micrometer, multi mode, MTP connectors  
• Requires feature code 3500 for storage systems with 12-core and higher processors |
| 3500         | zHyperLink I/O-adapter          | • For storage systems with 12-core and higher processors  
• Required for feature code 1450 and 1451 |
| 4235         | 256 GB system memory           | • 12-core  
• For model 980 |
| 4425         | 12-core IBM POWER8® processors  | • Requires feature code 4235  
• For model 980 |
1.3.2 Software requirements

zHyperLink includes the following software requirements:

- zHyperLink Express is supported on z/OS 2.1 or later. Plan for required z/OS software maintenance.
- The z/OS image must run in an LPAR, not as a guest under IBM z/VM®.
- zHyperLink requires IBM z High-Performance FICON (zHPF) to be enabled.
- The minimum required version for Db2 is version 12. Plan for required Db2 software maintenance.

Apart from software levels, updates to z/OS and Db2 system parameters are required for enablement and monitoring. For more information about maintenance and parameter requirements, see 2.4, “Software planning” on page 28.

1.4 Other considerations

In this section, the following considerations that are related to zHyperlink implementation, such as limitations and the use potential, are described:

- Site considerations
- IBM ECKD™
- DS8880 I/O Priority manager
- IBM FICON Utilization

1.4.1 Site considerations

zHyperLink hardware is designed for short distance communication of up to 150 meters (492 feet). Therefore, your DS8880 must be up to this distance from your z14 CPC. zHyperLink is a point-to-point connection; no switching is supported. The distance and point-to-point requirements along with your site availability strategy play a key role in implementing zHyperLink. For more information about planning zHyperlink implementation, see Chapter 2, “Planning” on page 13.

Each customer might use a different site configuration that is based on application and business requirements. For some clients, it might be suitable to use a single data center location while other business, such as finance companies, might be required by law to use multiple production and disaster recovery sites to ensure a high availability and prevent data loss.

In this IBM Redbooks publication, we consider the following main data center scenarios and describe how the applications can benefit from zHyperLink in each scenario:

- Single site
- Multi-site
- Multi-site with extended distance

These scenarios are described next.
**Single site**

A single site is a basic mainframe configuration in which all production data and the processing units are in the same physical location. In this scenario, a secondary copy of your data might exist. The secondary DASD controller can also be attached to the z/OS host by zHyperLink if the distance between the machines is less than 150 meters (492 feet).

A single site configuration with a secondary DASD controller is shown in Figure 1-2.

![Figure 1-2 Sample single site configuration](image)

For more information about the implementation of zHyperLink in a single-site environment, see Chapter 2, “Planning” on page 13.
Multi-site
Many customers find that a multi-site configuration provides many benefits to their business by allowing the workload to be spread across multiple sites, or by providing disaster recovery capabilities that allow near zero downtime or data loss.

These sites might be up to 10 km (6.21 miles) apart, which allows the use of synchronous write operations. In such scenarios, the benefits of zHyperLink depend on how your system is designed.

A two-site configuration with IBM HyperSwap® capabilities is shown in Figure 1-3.

For more information about the implementation of zHyperLink in a multi-site environment, see Chapter 2, “Planning” on page 13.
Multi-site with extended distance

Other customers might require extended recovery capabilities, including situations where a large area can be affected, such as earthquakes or flooding. These companies often opt to use a multi-site configuration with synchronous and asynchronous replication, which allows improved system performance while maximizing system availability and resilience.

A two-site configuration with synchronous replication within each site, and asynchronous replication between sites, is shown in Figure 1-4.

For more information about the implementation of zHyperLink an extended distance multi-site environment, see Chapter 2, “Planning” on page 13.

1.4.2 ECKD

zHyperLink supports only the traditional mainframe Extended Count Key Data (ECKD). The transport protocol is defined for accessing ECKD data records.

1.4.3 DS8880 I/O priority manager

The DS8880 I/O Priority Manager prioritizes access to system resources to achieve the wanted quality of service that is based on defined performance goals (high, medium, or low) for the volume or single I/O request. The Priority Manager constantly monitors and balances DS8880 system resources to help applications meet their performance targets automatically, without operator intervention.

DS8880 I/O Priority Manager works with z/OS Workload Manager to add more granularity that enables the I/O prioritization at single I/O operation level.
When enabling zHyperLink on the DS8880, I/O Priority manager must be turned off at disk subsystem level. This feature then is off for all data, even if the data is not eligible for zHyperLink. Therefore, I/O prioritization for IBM IMS™ data (and other data) might be effected.

### 1.4.4 FICON use

Considering that IBM zHyperLink does not replace zHPF but works with it instead, the workload that is transferred by zHPF reduces with zHyperLink implementation. zHyperLink Express is new PCIe connection and does not reduce the physical number of current zHPF connections.

An example in which zHPF is the only communication protocol handling 100% of I/Os is shown in Figure 1-5.

![Figure 1-5](image)

*Figure 1-5  zHPF is the only communication protocol handling 100% of I/Os*

How traffic on zHPF was directly affected after enabling zHyperLink is shown in Figure 1-6.

![Figure 1-6](image)

*Figure 1-6  How traffic on zHPF was directly affected after enabling zHyperLink*

**Note:** The numbers that are shown in Figure 1-5 and Figure 1-6 are for example purposes only.
Chapter 2. Planning

Every business industry has their own requirements and needs. Some applications might be designed to make heavy use of database read operations. Others require many inserts or updates to files. Some might be a mixture of both scenarios.

Understanding how your applications are designed and your business requirements is vital to benefit most from zHyperLink.

In this chapter, we describe the issues that must be considered when planning for zHyperLink.

This chapter includes the following topics:

- 2.1, “Identifying eligible workloads” on page 14
- 2.2, “Sizing sync I/O for zHyperLink” on page 20
- 2.3, “zHyperLink Hardware Planning” on page 22
- 2.4, “Software planning” on page 28
- , “For more information about how to configure your Db2 to explore zHyperLink, see this page of IBM Knowledge Center.” on page 32
- 2.6, “Monitoring” on page 36

Planning

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- , “For more information about how to configure your Db2 to explore zHyperLink, see this page of IBM Knowledge Center.” on page 32
- 2.6, “Monitoring” on page 36
2.1 Identifying eligible workloads

The first issue to consider when planning for zHyperLink is how your critical applications perform I/O operations. zHyperLink is not a substitute for other I/O protocols, such as z High Performance FICON (zHPF) because only a subset of all I/O operations is eligible for zHyperLink processing.

At the time of this writing, Db2 and VSAM reads can use zHyperLink to perform I/O operations. Therefore, systems that perform most Db2 and VSAM reads should benefit most from zHyperLink.

If DS8880 I/O Priority Manager is enabled, it must be disabled before zHyperLink can be enabled. In such cases, a further analysis of possible effects on applications that do not benefit from zHyperLink is also necessary.

By providing low latency disk access, zHyperLink improves application response time. This improvement reduces I/O sensitive workload response time by up to 50% without requiring application changes.

The improved performance of zHyperLink allows the z14 PU to make a synchronous request for the data that is in the DS8880 cache. This feature eliminates the undispach of the running request, the queuing delays to resume the request, and the PU cache disruption.

The following situations benefit most from zHyperLink enablement:

- **Db2 random reads**
  
  Db2 workloads are between the applications that can achieve extreme low latency times when zHyperLink is used. By eliminating time-consuming tasks, such as undispaching the running process, CPU queuing, and cache reload, you can achieve up to 10x better response time on cache hit read requests.

- **VSAM read requests on cache**
  
  You can also configure your system to use zHyperLink for VSAM read processing. zHyperLink can be used for all types of VSAM access (NSR, LSR, and RLS). Set your VSAM data sets that require low latency and perform many read I/Os to use zHyperLink.

Although zHyperLink can provide huge performance benefits to some types of I/O operations, cases exist in which its benefits are limited. The following examples are not good candidates for zHyperLink:

- **Read requests that are not likely to be in DASD cache**
  
  Because zHyperLink is designed to provide low response times, only data that is stored in the DASD cache is eligible for zHyperLink I/O processing. If your application data is not likely to be on DASD cache or the cache hit ratio is below 80%, the benefits from zHyperLink can be limited.

- **Read ahead or prestaging of data**
  
  When read ahead or prestaging are performed, several I/O requests are sent to the DASD controller before the data is required by the application. The extended wait time that is related to the multiple I/O requests result in an extended CPU spinning time while the operations are being processed. For that reason, read ahead and prestaging of data are not good candidates for zHyperLink processing.
2.1.1 zHyperLink in different site configurations

As described in 1.4, “Other considerations” on page 7, different site layouts can also affect the applicability and benefits that are delivered by zHyperlink. In this section, we describe three different site scenario examples and how they can benefit from zHyperLink.

Single-site

Single-site configurations are the simplest configurations available. In this scenario, all computing and storage devices are in a single physical location. No DASD replication to other remote sites occurs (synchronous nor asynchronous).

In a single-site configuration, a secondary DASD subsystem for replication and high availability can be included if a DASD subsystem failure occurs. zHyperLink can provide great benefits to your system in single site configurations. By connecting your Central Processor Complex (CPC) to the primary and secondary DASD subsystems by using zHyperLink, you can reduce eligible I/O response time latency by up to 10 times.

The sample implementation of zHyperLink in a single site configuration with a primary and secondary DASD subsystem is shown in Figure 2-1. In this case, zHyperLink connections to both DASD subsystems boxes exist, with which you can use zHyperLink if a planned or unplanned switch to secondary occurs.

![Physical location A](image)

**Figure 2-1** Sample single site configuration

**Note:** In the configuration that is shown in Figure 2-1, both DASD subsystems must be no more than 150 meters (492.12 feet) from the z14 CPC.
Multi-site with synchronous replication

To achieve higher levels of system availability and reduce recovery time to near zero, customers might run their systems in more than one physical location. The data also must be replicated between sites synchronously. These sites are apart from each other usually by no more than 10 kilometers (6.21 miles).

Although this configuration improves the system availability and reduces the delays that are related to CPU, it also limits the benefits of zHyperLink because the workload can be distributed between different sites.

Because zHyperLink is designed to work within a range of 150 meters (492 feet), the distance between the sites almost always prevents the remote CPC from being connected to the primary DASD subsystem by zHyperLink connections. Therefore, only the CPC that is in the same physical location of the production DASD subsystem can connect to it through zHyperLink. Also, only the workload that is running in this site benefits from lower I/O response times. This configuration can result in uneven application response times.

You can configure your environment so that the workloads that benefit most from zHyperLink run on the CPC that is connected to the primary DASD subsystem by zHyperLink adapters. You can plan to direct your zHyperLink eligible batch workload to the CPC close to the primary DASD subsystem, if the resources satisfy your batch needs.

A sample multi-site implementation in which each CPC is connected to the DASD subsystem in the same site by zHyperLink and FICON adapters, and to the remote site that is existing FICON only technology, is shown in Figure 2-2.

![Figure 2-2 Multi-site configuration with synchronous replication](image-url)
Multi-site with extended distances

Some enterprises require the highest levels of system availability to situations, such as a site or hardware device failure, or a natural disaster that can affect a large area. Such high levels of system availability are achieved by creating a multi-site environment with local and remote copies to ensure low recovery time objective (RTO) and minimize data loss or recovery point objective (RPO).

In the primary site, a primary and secondary DASD subsystem is replicated synchronously to provide high availability if a hardware failure occurs. The CPC system must have zHyperLink connectivity to primary and secondary DASD subsystems to ensure zHyperLink availability if a planned or unplanned switch to secondary DASD subsystem occurs.

The replication between the primary and secondary site is performed asynchronously to allow almost unlimited distances between both sites. This configuration reduces the risks of regional disasters that affect both sites.

At the second site, a primary and auxiliary storage subsystem can also be available to provide high availability capabilities at the secondary site. The replication between the primary and secondary DASD subsystems at the secondary site can be performed synchronously.

Plan for zHyperLink connectivity to primary and secondary DASD subsystems at the secondary site to ensure that your application response times are not affected if a disaster occurs at the primary site. A sample implementation of a multi-site configuration with extended distance between sites is shown in Figure 2-3. This configuration enables the full benefits from zHyperLink at the primary and secondary sites.

![Figure 2-3 Multi-site configuration with extended distances](image-url)
2.1.2 IBM z Batch Network Analyzer

The use of tools to identify workloads that can benefit from zHyperLink implementation can reduce the amount of time that is necessary to identify such workloads, and size the possible benefits.

By using IBM z Batch Network Analyzer (zBNA), you can see more information about I/O response times, including expected benefits from zHyperLink implementation. It is designed to help identify technology options (zEDC, DFSMS Encryption, CF Encryption, and zHyperLink) to reduce the batch window.

The zBNA is a PC-based productivity tool that provides a means of estimating the elapsed time for batch jobs solely based on the differences in CPU speeds for a base processor and a target processor, the number of engines on each system, and system capacities (data sharing is not considered). zBNA provides powerful, graphics-based demonstration of the z/OS batch window.

The zBNA tool requires the IBM CPS Java Runtime Environment v8 64-bit and runs on the Windows 7, 8, or 10 64-bit platform.

Input for the zBNA is SMF data that is extracted on the z/OS system by using the z/OS Data Extraction Program (CP3KEXTR). The CP3KEXTR program reads SMF records and extracts data that is needed as input to IBM's Processor Capacity Reference (zPCR) and zBNA tools.

The zBNA and CP3KEXTR programs are available for download at no charge from the IBM Techdocs website. The latest versions that must be used are zBNA version 1.8.2 and CP3KEXTR version 3.75.

A zBNA Users Guide and Education materials, including FAQs, a demonstration video, and lab exercises, also are available at the IBM Techdocs page for zBNA. A Users Guide for CP3KEXTR ia available on the IBM Techdocs page for CP3KEXTR.

zBNA was updated to support estimating benefits of zHyperLink by providing reports with text and graphics, including a list of top data sets candidates. Data can be filtered by date and time. It also includes support for aggregating zBNA LPAR results into CPC level views.

An example of the zBNA Average response time report that estimates the benefit of zHyperLink implementation for all data sets is shown in Figure 2-4 on page 19.
Because the output files from the CP3KEXTR extract tool can be large (even for a single day for one LPAR), the capability to terse the resulting output was added. We suggest to always use the terse option. zBNA automatically undersees the files. It also provides you with the option of saving the underse versions, which avoids the processing time to underse it again.

The process of SMF data being collected, underse, and transferred to the PC is shown in Figure 2-5.
Before collecting data, z/OS APAR OA52133 must be installed to perform the analysis. The following z/OS PTFs are related to the APAR:

- z/OS 2.1: UA93434
- z/OS 2.2: UA93435
- z/OS 2.3: UA93445

These PTFs are an enhancement to DFSMS Common Measurement Manager. They add the following components:

- DFSMS statistics for SMF Record type 42 SubType 5 Storage class response time
- VTOC data component I/O statistics
- VTOC index component I/O statistics
- VVDS component I/O statistics
- Type 42 SubType 6 Data Set I/O statistics

Db2 v12 also is a prerequisite for collecting data to be analyzed by using zBNA.

### 2.2 Sizing sync I/O for zHyperLink

In this section, we describe the maximum number of supported ports, how to determine the number of required zHyperLinks, and considerations for future growth.

#### 2.2.1 Number of connections

The IBM z14 zHyperLink Express (FC #0431) is a two-port feature in the PCIe I/O drawer. A total of up to 16 features with up to 32 zHyperLink Express ports are supported in a z14 and z14 ZR1 CPC.

On the DS8880 DASD subsystem, the number of zHyperLink ports that can be installed varies, depending on the number of cores per CPC that is available and the number of I/O bay enclosures. The number of zHyperLinks that can be installed based on the number of cores available is listed in Table 2-1.

<table>
<thead>
<tr>
<th>System/Model</th>
<th>Cores per CPC</th>
<th>zHyperLink support</th>
<th>Max zHyperLink connections (increments of 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS8884/DS8884F</td>
<td>6</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Yes</td>
<td>4</td>
</tr>
<tr>
<td>DS8886/DS8886F</td>
<td>8</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>Yes</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>Yes</td>
<td>12</td>
</tr>
<tr>
<td>DS8888/DS8888F</td>
<td>24</td>
<td>Yes</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>48</td>
<td>Yes</td>
<td>16</td>
</tr>
</tbody>
</table>
On the DS8880, DASD subsystems can have up to eight ports in a single frame, or 16 ports if an extension frame also exists. Each zHyperLink I/O adapter features one port, but you must order them in sets of two. Depending on the system configuration, zHyperLink I/O adapters can be ordered in quantities of 2, 4, 6, and 8. Each I/O Bay (Enclosure) can have two ports and are upgraded in pairs.

zHyperlink allows the following interconnections:

- One z14 to one DS8880 by using multiple zHyperLink connection pairs
- Multiple z14 CPCs to a single DS8880
- Multiple DS8880s to a single z14 CPC

Any interconnection between z14s and DS8880 is supported if connections are in pairs and within the maximum number of ports. A zHyperLink is a point-to-point connection, which means switching is not supported.

### 2.2.2 Sizing your system by using Resource Measurement Facility

The IBM Resource Measurement Facility™ (RMF™) provides a wide range of information about your system utilization, including I/O information that can be used to size your I/O system.

From RMF, you can use the Channel Path Activity report (CHANNEL) to see information about all channel paths in the system. From this panel, you can access the following channel information:

- Percentage utilization
- Read (Bytes per second)
- Write (Bytes per second)
- FICON operations rate
- zHPF operations rate

To request the Channel Path Activity report, select 3 Monitor III from the primary menu and then, select 12 Channel in the Resource Report Selection menu. You also can use the CHANNEL command.

Locate the FICON channels that are used for the DS8880 disk subsystem in question and analyze the usage.

You should also analyze information regarding cache reads. You can run an RMF Postprocessor report that specifies REPORTS(CACHE(SUBSYS)) to extract cache read information. To request the postprocessor report, select 1 Postprocessor from the primary menu or run it by using a batch job of your own.

**Note:** CACHE must be enabled in the ERBRMFxx parmlib member.

For more information about zHyperLink and RMF, see 3.7, “Measuring after deployment” on page 63.
2.2.3 I/O connectivity planning

Standard recommendations for channels, such as FICON and OSA, also applies to zHyperLink. Ensure that connectivity is spread out on as many different I/O cards at the z14 and the DS8880. This configuration limits consequences that can result from component failures.

When planning zHyperLink implementation, plan for technology refresh and future growth at the z14 and the DS8880 side.

The IBM zHyperLink Express feature is a two-port feature. All other connectivity for z Series future updates or changes to the configuration should be considered when planning port allocation.

Connectivity should be spread out on the available cards. If you are connecting a z14 with four features to two DS8880s with four ports each, we suggest the use of one port at each z14 feature for the first DS8880 and the second port of each z14 feature for the second DS8880.

Consider ordering enough ports for future growth. If all installed ports are in use and you need to add two ports for connecting to a new DS8880 later, both of the new ports are on a single feature on the z14. This configuration causes a single point of failure (SPOF) situation, which can be avoided by adding ports or relocating connectivity for some on the current ports.

Note: Unlike FICON, swapping a zHyperLink within a CPC does not require I/O configuration updates. You can swap links by configuring them offline, swapping the physical cables, and then configuring them back online again. It is important to account for workload and verify the links after swapping them.

For more information about commands that are used for configuring online, offline, and verifying, see 4.1, “System commands” on page 70.

Also, ensure that your systems have enough zHyperLink connections to each box to manage possible maintenance activities, such as replacing a zHyperLink adapter on the CPC or the DASD subsystem.

2.3 zHyperLink Hardware Planning

In this section, we describe microcodes and how to plan for zHyperLink hardware updates, including microcode and ordering required features.

2.3.1 Microcode for zHyperLink

Planning for implementing zHyperLink include verifying the necessary levels of microcode at both ends of the point-to-point connection; that is, the z14 CPC and the DS8880 DASD subsystem. The microcode must be updated if it is not at the required level.

The following microcode levels are required:

- IBM z14TM (z14) mainframe is on Driver 32L with at least bundle S21
- DS8880 is at least 8.3.2 (88.32.6.0)

In addition to the DS8880 microcode level, the DS8880 z-synergy Services license is needed.
2.3.2 z14 Microcode change level

Regular installation of Microcode Change Levels (MCLs) is key for reliability, availability, and serviceability (RAS) and optimal performance. We recommend that the following tasks are performed:

- Install MCLs on a quarterly basis, at a minimum.
- Review hiper MCLs continuously to decide whether to wait for the next scheduled fix application session or to schedule one earlier based on risk assessment.

**Tip:** For the IBM z14, IBM Resource Link® provides access to the system information for your IBM Z® server according to the system availability data that is sent on a scheduled basis. It provides more information about the MCL status of your z14 servers.

For more information about accessing Resource Link, see the IBM Resource Link website.

**z14 Microcode terms**

The microcode features the following characteristics:

- The driver contains engineering change (EC) streams.
- Each EC stream covers the code for a specific component of z14 servers. It includes a specific name and an ascending number.
- The EC stream name and a specific number are one MCL.
- MCLs from the same EC stream must be installed in sequence.
- MCLs can include installation dependencies on other MCLs.
- Combined MCLs from one or more EC streams are in one bundle.
- An MCL contains one or more Microcode Fixes (MCFs).

A bundle is a set of MCLs that is grouped during testing and released as a group on the same date. You can install an MCL to a specific target bundle level.
The System Information window is enhanced to show a summary bundle level for the activated level, as shown in Figure 2-6.

![System Information: Bundle level](image)

**Figure 2-6  System Information: Bundle level**

### 2.3.3 IBM DS8880 Microcode change level

The DS8880 z-synergy Services license is required for zHyperLink. The initial enablement of any optional IBM DS8000® licensed function is a concurrent activity (assuming that the appropriate level of microcode is installed on the machine for the specific function).

When IBM releases new microcode for the DS8000, it is released in the form of a bundle. The term *bundle* is used because a new code release can include updates for various DS8000 components. These updates are tested together, and then the various code packages are bundled into one unified release.

In general, use the term *bundle* when referring to what code level is being used on a DS8000. Components within the bundle each feature their own revision levels.

For a DS8000 cross-reference table of code bundles, see [this website](#).

At the website, click **Documents → DS8800 Code Bundle Information**. The levels of code for currently released bundles are listed in the table on the web page. The information is updated as new code bundles are released. It is important to maintain a current version of the data storage command-line interface (DS CLI).
For the DS8000, the naming convention of bundles is PR.MM.FFF.E, where:

- **P**: Product (8 = DS8800)
- **R**: Release Major (X)
- **MM**: Release Minor (xx)
- **FFF**: Fix Level (xxx)
- **E**: EFIX level (0 is base, and 1.n is the interim fix build above base level.)

For more information about DS8880 Microcode updates, see *IBM System Storage DS8000: Architecture and Implementation*, SG24-8886.

### 2.3.4 z14 feature codes

The IBM zHyperLink Express is a two-port feature in the PCIe I/O drawer. You can install a maximum of 16 features with two 2 zHyperLink Express ports each on the IBM z14. The feature code to order is FC #0431. Installing PCIe zHyperLink features on an IBM z14 is a nondisruptive operation.

zHyperLink connections are required to be configured in pairs. Therefore, the minimum number of required features is two to avoid single point of failure (SPOF).

zHyperLink Express feature works as native PCIe adapter that can be shared by multiple LPARs. Each port can support up to 127 Virtual Functions (VFs), with one or more VFs/PFIDs being assigned to each LPAR. This configuration supports a maximum of 254 VFs per adapter. The maximum of 127 Virtual Functions means that a link can be shared by all LPARs on the z14 CPC.

### 2.3.5 DS8880 feature codes

zHyperLink feature on the DS8880 sits on the I/O Bay Enclosure. The feature includes two ports on an I/O Bay enclose and is always installed in pairs, which results in increments of four ports.

The DS8880 feature code for zHyperLink adapter is #3500. Depending on your configuration, other feature codes might be required; for example, FC #4235 for 256 GB system memory and FC #4425 for 12 core POWER8 processors.

Installing zHyperLink features on a DS8880 z14 is a nondisruptive operation.

The maximum number of zHyperlink #3500 features on a DS8880 is:

- 2 features (4 ports) on the DS8884
- 6 features (12 ports) on the DS8886
- 8 features (16 ports) on the DS8888

For more information about DS8880 zHyperLink features, see 1.3.1, “Hardware prerequisites” on page 4.

### 2.3.6 zHyperLink Cables

A 24x MTP-MTP cable is required for each port of the zHyperLink Express feature.

Cables can be ordered as features codes for the DS8880, which includes lengths of 40 meters (131.23 feet) or 150 meters (492.12 feet) and other options are available. The cables are identical to the cables that are used for the ICA SR z14 feature (FC #0172).
The HyperLink Express and ICA SR features are designed to drive distances up to 150 meters (492.12 feet) and support a link data rate of 8 GBps by using customer-supplied OM4 (4.7 GHz-Km @ 850 nm) fiber optic cables. With OM3 (2.0 GHz-Km @ 850 nm) fiber optic cables, zHyperLink Express and ICA SR distance drops to 100 meters (328.08 feet).

An OM4 24-fiber cable with Multi-fiber Terminated Push-on (MTP) connectors for zHyperlink is shown in Figure 2-7.

![Sample zHyperLink cable and connector](image)

The custom or standard cable lengths that are listed in Table 2-2 are available from IBM GTS or through other vendors. Similar lengths are available as OM3 options, although those lengths are limited to 100 meters (328.08 feet).

<table>
<thead>
<tr>
<th>P/N</th>
<th>Length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>00JA683</td>
<td>1.0</td>
</tr>
<tr>
<td>00JA684</td>
<td>2.0</td>
</tr>
<tr>
<td>00JA685</td>
<td>3.0</td>
</tr>
<tr>
<td>00JA686</td>
<td>5.0</td>
</tr>
<tr>
<td>00JA687</td>
<td>8.0</td>
</tr>
<tr>
<td>00LU282</td>
<td>10.0</td>
</tr>
<tr>
<td>00LU283</td>
<td>13.0</td>
</tr>
<tr>
<td>00JA688</td>
<td>15.0</td>
</tr>
<tr>
<td>00JA689</td>
<td>20.0</td>
</tr>
<tr>
<td>00LU284</td>
<td>40.0</td>
</tr>
<tr>
<td>00LU285</td>
<td>80.0</td>
</tr>
</tbody>
</table>
Chapter 2. Planning

For more information, see *IBM Z Planning for Fiber Optic Links (FICON/FCP, Coupling Links, Open Systems Adapters, and zHyperLink Express)*, GA23-1408.

*I/O configuration*

PCIe function for zHyperLink must also be defined to enable zHyperLink to work. Plan for updating the I/O configuration with zHyperLink. An example of Hardware Configuration Definition (HCD) panel is shown in Figure 2-8.

<table>
<thead>
<tr>
<th>P/N</th>
<th>Length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>00LU286</td>
<td>120.0</td>
</tr>
<tr>
<td>00LU287</td>
<td>150.0</td>
</tr>
<tr>
<td>00LU288</td>
<td>Custom</td>
</tr>
</tbody>
</table>

For more information, see *IBM Z Planning for Fiber Optic Links (FICON/FCP, Coupling Links, Open Systems Adapters, and zHyperLink Express)*, GA23-1408.

**Figure 2-8 Add PCIe function**

The number of simultaneous I/O operations that can be active on a zHyperLink is determined by the number of virtual functions that is defined in the I/O configuration for that link. The virtual function number is 1- to 3-digit number in the range 1-n (zHyperLink range is 1-127). zHyperLink adapters feature multiple ports and the virtual function values are on a port basis rather than an adapter basis.

We recommend defining four virtual functions for each link to obtain better results from zHyperLink.
An example of defined PCIe functions, including zHyperLink, is shown in Figure 2-9. Two ports are defined for each zHyperLink CHID.

![PCle Function List panel](image)

The IOCP definition for zHyperLink as in HCD defines both ports in a single zHyperLink card (same PCHID but different port numbers), as shown in Example 2-1.

**Example 2-1  Defining both ports in a single zHyperLink card**

```
FUNCTION FID=1001,VF=1,PCHID=140,                             *
PART=((LPZOSAPR),(LPZOSCDE,LPZOSDDE),TYPE=HYL,PORT=1
FUNCTION FID=1081,VF=1,PCHID=140,                             *
PART=((LPZOSAPR),(LPZOSCDE,LPZOSDDE),TYPE=HYL,PORT=2
```

zHyperLink includes the important specification that its connections cannot be used while I/O Priority Manager is enabled on storage system. However, I/O Priority Manager is disabled on DS8880 Storage Management only, and still can operate normally on z/OS through WLM.

### 2.4 Software planning

IBM zHyperLink is supported on native z/OS operating systems only. It is not supported on guest LPARS under z/VM or other operating systems. It was developed for IBM relational database Db2 for z/OS.

#### 2.4.1 Levels and requirements

The following software prerequisites must be met to enable zHyperLink:

- z/OS 2.1 or later and PTFs for the following components:
  - IOS, PCIe, System Trace, GTF, Supervisor
  - DFSMS Device Support
  - DFSMS Media Manager
  - zHyperLink Storage Class Granularity
2.4.2 Software activation plan for z/OS

By default, zHyperLink facility is disabled in z/OS. To enable z/OS for zHyperLink read processing, use the SETIOS MVS system command after IPL, or use the IECIOSxx PARMLIB member to enable zHyperLink processing during IPL.

**SETIOS MVS command**

The use of the SETIOS command that is shown in Example 2-2 specifies that the High Performance FICON for IBM z Systems® (zHPF) facility is enabled on the system. zHPF is a prerequisite for zHyperLink.

**Example 2-2  Dynamic zHPF enablement**

```
SETIOS ZHPF=YES
```

To dynamically enable zHyperLink read processing on the system after an IPL, enter the MVS command that is shown in Example 2-3.

**Example 2-3  Dynamic zHyperLink enablement**

```
SETIOS ZHYPERLINK,OPER=READ
```

This command specifies that zHyperLink facility should be enabled for read I/O requests.

More options are available for the OPER parameter, including ALL]WRITE|NONE. However, whether zHyperLink is used for an I/O request depends on if the I/O request meets the eligibility requirements.

When only read operations are currently available for zHyperLink, OPER=ALL and OPER=WRITE do not activate the function for writes. Instead, it keeps active for reads only. For more information, see 2.6, “Monitoring” on page 36.

For more information about the SETIOS MVS command, see Chapter 4. MVS system commands reference on z/OS MVS System Commands, SA38-0666.

**IECIOSxx Parmlib**

Before you implement zHyperLink, you must ensure that zHPF is enabled in your systems. You can enable zHPF by specifying the keyword that is shown in Example 2-4.

**Example 2-4  zHPF parm on IECIOSxx parmlib**

```
ZHPF=YES
```
To enable zHyperLink read processing during an IPL, include the statement that is shown in Example 2-5 in the IECIOSxx PARMLIB member on the system.

**Example 2-5  zHyperLink parm on IECIOSxx parmlib**

```
ZHYPERLINK,OPER=READ
```

The **ZHYPERLINK,OPER=READ** command specifies that zHyperLink facility is enabled on system for read I/O operations.

As for the command, more values are available for the **OPER** parameter, including `OPER=ALL|READ|WRITE|NONE`. However, READ I/O is the only supported I/O operation for zHyperLink. Therefore, even with **OPER=ALL** set, only reads are available. Write I/O is not enabled to use zHyperLink.

The same issue occurs if **OPER=WRITE** is set. In this case, reads and writes are disabled for zHyperLink. For more information, see 2.6, “Monitoring” on page 36.

For more information about the IECIOSxx PARMLIB member, see Chapter 57. IECIOSxx (I/O related parameters) on *z/OS MVS Initialization and Tuning Reference*, SA23-1380.

### 2.4.3 zHyperLink Storage Class Granularity activation plan

Storage Class Granularity is a single policy that covers all users so that zHyperLink can be managed across all applications. It turns zHyperLink off and on for specific non-SMS data sets, and overrides zHyperLink specification for SMS-managed data sets.

By using Storage Class Granularity, the system administrator can enable or disable synchronous I/O to the data sets that are members of a storage class (SC), and enable or disable synchronous I/O for specific data sets by using an operator command. The ability to dynamically enable or disable zHyperLink also facilitates testing this facility.

With Storage Class Granularity support, two new Storage class attributes were added and can also be found in DCOLLECT Record Type ‘SC’. The Storage Class definition is shown in Figure 2-10.

```
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guaranteed Space</td>
<td>N (Y or N)</td>
</tr>
<tr>
<td>Guaranteed Synchronous Write</td>
<td>N (Y or N)</td>
</tr>
<tr>
<td>Multi-Tiered SG</td>
<td>(Y, N, or blank)</td>
</tr>
<tr>
<td>Parallel Access Volume Capability</td>
<td>N (R, P, S, or N)</td>
</tr>
<tr>
<td>CF Cache Set Name</td>
<td>(up to 8 chars or blank)</td>
</tr>
<tr>
<td>CF Direct Weight</td>
<td>(1 to 11 or blank)</td>
</tr>
<tr>
<td>CF Sequential Weight</td>
<td>(1 to 11 or blank)</td>
</tr>
<tr>
<td>CF Lock Set Name</td>
<td>(up to 8 chars or blank)</td>
</tr>
<tr>
<td>Disconnect Sphere at CLOSE</td>
<td>N (Y or N)</td>
</tr>
<tr>
<td>zHyperLink Eligible for read</td>
<td>Y (Y or N)</td>
</tr>
<tr>
<td>zHyperLink Eligible for write</td>
<td>N (Y or N)</td>
</tr>
</tbody>
</table>
```

**Figure 2-10  ISMF Storage Class panel**

Without requiring applications to restart, systems can start the use of synchronous I/O with zHyperLink for eligible data sets with Storage Class Granularity. Verify SMS-managed data sets that were unable to use zHyperLink and can now use zHyperLink after the storage class definition is activated.
This facility also provides a command that is used to toggle zHyperLink on an individual data set basis by using a **VARY SMS** command, as shown in the following example:

```
V SMS,DSNAME(dsname)
```

The use of this command overrides the storage class definition. Media Manager checks the eligibility flags, and after the command is issued, all current and subsequent opens use the new specified value.

**Note:** The use of the **VARY SMS** command is the only way to enable zHyperLink processing for a non-SMS data set.

The following examples describe how to dynamically activate or deactivate synchronous I/O(SIO) with the **VARY SMS** command:

- **VARY SMS,DSNAME(dsname),ZHLREAD=YES**
  Enables synchronous I/O reads for data set. After the vary command overwrites the Storage Class definition, the reads should use synchronous I/O, even if SC is not eligible for reads.

- **VARY SMS,DSNAME(dsname),ZHLREAD=NO**
  Overrides SC eligibility for reads and issues reads to the data set by using SIO. Reads should use zHPF because the data set is not enabled for Synchronous I/O reads.

### 2.4.4 Software activation plan for Db2

For activation of zHyperLink I/O protocol on Db2, the **ZHYPERLINK** subsystem parameter is specified to determine the default scope of zHyperLink I/O requests. The following values are acceptable for zHyperLink on Db2:

- **DISABLE**
  Db2 does not use zHyperLink for any I/O requests. This value is the default.

- **ENABLE**
  All eligible I/O requests that Db2 makes request the zHyperLink protocol.

- **DATABASE**
  Db2 requests the zHyperLink protocol only for database synchronous read I/Os.

The entries on the DSNTIPA3 panel define storage management preferences for the storage groups and data sets that are created during installation and migration. The zHyperLink parameter is included in that session, as shown in Figure 2-11 on page 32.
2.5 Performance Planning

In this section, we describe relevant performance considerations when zHyperLink is activated. System specialists must identify applications that can use zHyperLink and decide to explore it.

Good performance planning is helpful for the following reasons:

- The installation might determine that the potential incremental CPU cost that is associated with zHyperLink cannot be justified, even with the reduced latency that synchronous I/O provides.
- The installation might want to disable zHyperLink because the cache hit ratio for a class of data sets does not warrant its use.

Note: zHyperLink is supported on Db2 for up to 4 Kb page sizes, in multiples of 512 bytes.

For more information about how to configure your Db2 to explore zHyperLink, see this page of IBM Knowledge Center.
2.5.1 CPU considerations

zHyperLink can reduce transaction time by half. It is highly advised to be used when critical business depends on it. However, for some environments, the CPU cost is not neutral, which requires performance planning to project what customers might see with Db2 or VSAM.

As of this writing, the system settings allow any VSAM application or Db2 table space to read by using zHyperLink. By introducing fine-grained controls (for example, at the Db2 table space or a VSAM data set), customers choose the CPU response time tradeoff that they want.

2.5.2 Db2 performance considerations

Db2 APARS for performance adds new indicators on Db2, which improves performance capacity planning. The following counters were created on Instrumentation Facility Component Identifier (IFCID) 003 to represent DASD cache hits and successful zHyperlink read I/Os:

- QWACAWTD: Wait time for synchronous read I/O operations that resulted in disk cache hits
- QWACAWCD: Number of synchronous read I/O operations that resulted in disk cache hits

Messages DSNB455I and DSNB411I are changed to display statistics showing read I/O delays when zHyperlink is in use.

The DSNB411I message is the result of the DISPLAY BUFFERPOOL DETAIL command, which displays detailed information about the buffer pool, including synchronous I/O reads that are performed by zHyperLink. A sample output from the DISPLAY BUFFERPOOL DETAIL command is shown in Example 2-6.

Example 2-6  DISPLAY BUFFERPOOL DETAIL command output

| DSNB455I - SYNCHRONOUS I/O DELAYS - |
|------------------------------|---|
| AVERAGE DELAY                 | xx |
| MAXIMUM DELAY                 | xx |
| TOTAL PAGES                   | xx |

<table>
<thead>
<tr>
<th>SYNCHRONOUS I/O DELAYS WITH ZHYPERLINK</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVERAGE DELAY</td>
</tr>
<tr>
<td>MAXIMUM DELAY</td>
</tr>
<tr>
<td>TOTAL PAGES</td>
</tr>
</tbody>
</table>

| DSNB411I - RANDOM GETPAGE = xx       |
| SYNC READ I/O (R)                   | xx |
| SEQ. GETPAGE                        | xx |
| SYNC READ I/O (S)                   | xx |
| SYNC READ I/O (ZHL)                 | xx |
| DMTH HIT                            | xx |
| PAGE-INS REQ                        | xx |
| SEQUENTIAL                          | xx |
| VPSEQT HIT                          | xx |
| RECLASSIFY                          | xx |

Note: To reduce I/O latency, it is advised that I/Os are limited to a CI size of 4 Kb.
2.5.3 Measuring before deployment

In this section, we describe two ways of measuring current performance: RMF and the zBNA tool.

When implementing major updates to the system or configuration, performance should be measured before and after the update. A similar situation applies to implementing zHyperLink. However, because zHyperLink is intended to improve I/O reads, focus should be on the eligible workload and not the overall performance.

In general, performance comparisons should always be done on comparable workloads, such as the same day of the week and month or a batch window on the weekend.

**Note:** A zHyperLink can easily be turned on and off by using system commands; therefore, you can compare performance with and without zHyperLink many times, if needed. For more information about which commands to use, see 4.1, “System commands” on page 70.

Measuring by using RMF

We focus on measuring the DASD subsystem cache and the FICON Channel utilization. The Subsystem Cache is a focus because that is the target for future zHyperLink I/Os, and the FICON Channel utilization because it can detect the change that is caused by some I/Os being offloaded from FICON to zHyperLink.

RMF Monitor III offers the following reports that assist you in monitoring the performance of your cache subsystem. They present the combined I/O activity coming from any z/OS system (in the same or in different sysplexes) from/to the controller:

- Cache Summary Report (CACHSUM)
- Cache Detail Report (CACHDET)

By using the reports, you can analyze cache rates at the SSID and volume level.

An alternative to the interactive analysis with Monitor III is the RMF Postprocessor Cache Subsystem Activity Report. You can run the report by using the `REPORTS(CACHE(SUBSYS))` sysin statement. A JCL example is provided later in this section.

By using the z/OS Workload Manager (WLM), you can define a service and report class for each Db2 region. The use of a separate report class for the Db2 region for which you are about to implement zHyperLink helps you limit reporting to the workload that is to benefit from zHyperLink implementation. A similar report is available that uses the RMF Spreadsheet reporter.

The Workload Activity report (WLMGL) can be used to request various reports, including the Service Class report and the Report Class report, which are nearly identical. The WLMGL report shows the response time distribution and the goal versus actual.

The RMF WLMGL report is also available in XML output format. For more information about how to produce and view XML reports, see “How to work with Postprocessor XML reports” in the *IBM z/OS RMF Users Guide*, SC34-2664.
A sample JCL that is used to print a Workload Activity report is shown in Figure 2-12.

```
//RMFPP EXEC PGM=ERBRMFPP,REGION=0M
/*STEPLIB DD DISP=SHR,DSN=CEE.SCEERUN
//MFPINPUT DD DISP=SHR,DSN=*.RMFSORT.SORTOUT
//MFPMSGDS DD SYSOUT=* */
******RMF POSTPROCESSING OPTIONS GENERATED FROM
******POSTPROCESSOR OPTIONS PANEL INPUT ONLY.
******
//SYSIN DD *
SYSS(SYSOUT(0)
SYSRPTS(WLMGL(RCLASS(report_class)))
```

Figure 2-12 Sample JCL to print the RMF Workload Activity Report

Measure the FICON channel use for the DASD subsystem in question by using the RMF Channel Path Activity report (CHANNEL). This report provides more information about channel path activity for all channel paths that are in the system.

As with the Cache subsystem reporting, the alternative of the use of the RMF Postprocessor is available. Specify REPORTS(CHAN) as sysin for a Channel Activity Report.

For more information about RMF reporting, see Resource Measurement Facility Report Analysis, SC34-2665.

Measuring by using zBNA
The zBNA Average response Time Graph shows the current and estimated I/O response times. The report can be filtered by Service classes and job names.

The report provides a current time of Average Re-Dispatch and Response time, which is the sum of Average I/O Response and user-specified Re-Dispatch time. It also provides an estimate of zHyperLink Estimated Re-Dispatch and Response times. This report factors in zHyperLink Eligible DASD Cache Hits and the elimination of Re-Dispatch Time for those hits.

Another useful zBNA report is the zHyperLink I/O Rate report documenting I/Os per second for workload that uses zHyperlink and further eligible zHyperLink workload. The report also documents the highest potential I/O rate that is estimated to be achievable if all zHyperLink workload were enabled.

Use the reports for documenting current I/O response times and I/O rates before implementing zHyperLink.

**Note:** The zBNA tool is designed to estimate the potential effect that moving to new technologies can have on batch elapse time. It is not designed for measuring overall system performance. When creating a zBNA report multiple times, it cannot be guaranteed that all variables are the same for each report.

For more information about the zBNA tool, see 2.1, “Identifying eligible workloads” on page 14.
2.6 Monitoring

In this section, we describe how to monitor the operation of zHyperLink by using z/OS display commands, over the devices enabled for zHyperLink, PCIe adapters, Control Unit, and so on. This task is important after the system is activated and before production data is sent through zHyperLink.

2.6.1 Monitoring PCIe

In this section, we describe how to display and monitor PCIe adapters. Some important display commands and new information were added to display PCIe commands.

**D PCIE**

The **D PCIE** command shows the information that is registered for the device type with PCIe. It displays all PCIe devices, including zHyperLink. Each PCIe Function Id (PFID) is displayed in a single line, meaning that if you have multiple PFIDs that are defined for each physical connection, one line is displayed for each PFID.

This command also displays the device type name, status, ASID and JOBNAME that is allocating the connection, Channel Id, Virtual Function Number, and Port Number. For a more information about the fields, see 4.1, “System commands” on page 70.

**D PCIE,PFID=pfid**

The **D PCIE,PFID=pfid** command displays more detailed information about a single zHyperLink connection. This command includes information, such as software status, port state, and CU Node description. For more information about the fields that are available for the **D PCIE,PFID=pfid** command, see 4.1, “System commands” on page 70.

2.6.2 Monitoring devices

In this section, we describe how to monitor devices that are enabled for zHyperLink. We also describe how to display more information about those devices.

**D IOS,ZHYPERLINK**

The display IOS command with the **ZHYPERLINK** parameter shows if zHyperLink is ENABLED or DISABLED. When zHyperLink is ENABLED, it describes what I/O operation is available to use zHyperLink (READ|WRITE). In specific cases where hardware requirements were not met, it might display “NOT SUPPORTED BY THE PROCESSOR” instead.

For more information about the **D IOS,ZHYPERLINK** command, see 4.1, “System commands” on page 70.

**D M=DEV(devno)**

Use the **D M=DEV(devno)** command to display device-related information. The command output now also includes zHyperLink related information, and can be used to check the number and status of paths to the device, and the number of connections and status of zHyperLink.

You can also check the functions that are enabled for the device, including the zHyperLink options Read, Write, and All.
For more information about the **D M=DEV(devno)** command, see 4.1, “System commands” on page 70.

**D M=DEV(devno),ZHYPERLINK**
The **D M=DEV(devno),ZHYPERLINK** command displays more information that is related to zHyperLink. The information that is available in this command also includes information about what functions are enabled, or the reason why they are disabled.

You can plan to periodically issue this command to monitor your zHyperLink status. For more information about the status, see 4.1, “System commands” on page 70.

**D M=CU(cuno)**
The **D M=CU(cuno)** command includes output that is similar to the **D M=DEV(devno)** command. It also includes zHyperLink function information, including the PFID, PCHID, LinkId, Software, and Port status.

For more information about each field, see 4.1, “System commands” on page 70.
Deployment

This chapter describes the deployment considerations when implementing zHyperLink. It also covers monitoring system availability and measuring the benefits of implementing zHyperLink.

This chapter includes the following sections:
- 3.1, “Hardware deployment” on page 40
- 3.2, “Software upgrade and maintenance” on page 52
- 3.3, “zHyperLink enablement” on page 54
- 3.4, “Monitoring” on page 59
- 3.5, “Activating zHyperLink for VSAM data sets” on page 60
- 3.6, “Activating zHyperLink for Db2” on page 62
- 3.7, “Measuring after deployment” on page 63
3.1 Hardware deployment

In this section, we explain how to implement the hardware part of zHyperLink on the z14 and on the DS8880. The physical hardware components, DS8880 settings, and z14 I/O configuration also are covered.

To start, we suggest ordering the features first.

3.1.1 Ordering features

Order features for the z14 and the DS8880 plus cables at your IBM support representative.

For the z14, the IBM zHyperLink Express is a two-port feature in the PCIe I/O drawer. You can install a maximum of 16 features with two zHyperLink Express ports each (FC #0431). Because zHyperLink connections are required to be configured in pairs, the minimum number of required features is two to avoid a single point of failure (SPOF).

For the DS8880, the feature includes one port on an I/O Bay enclosure, and is always installed in pairs. Also, two I/O Bay enclosures are updated at a time, which results in increments of four ports. The DS8880 feature code for the zHyperLink adapter is FC #3500. Depending on your configuration, other feature codes might be required (for example, FC #4235 for 256 GB system memory, and FC #4425 for 12 core POWER8 processors).

Order 24x MTP-MTP cables for connecting the z14 to the DS8880. Cables are available as OM3 and OM4 fiber optic cables.

Note: Cables up to a length of 150 meters (492 feet) are supported. Because the cable length affects latency, cables are generally ordered as short as possible.

After ordering the features, configuration files for the future update of z14 and DS8880 are available. You need the configuration files for ordering connection of cables as described in 3.1.4, “Installing features” on page 42, and for the I/O configuration update as described in 3.1.6, “Updating I/O configuration” on page 43.

For more information about feature codes and cables, see 2.3, “zHyperLink Hardware Planning” on page 22.

3.1.2 Updating microcode

The microcode at both ends of the point-to-point connection (the z14 CPC and the DS8880 DASD subsystem) must be updated to support zHyperLink. If the microcode is not at the required level, contact your IBM support representative and request the microcode update.

The following microcode levels are required:

- IBM z14TM (z14) mainframe on Driver 32L with at least bundle S21
- DS8880 at a minimum of 8.3.2 (88.32.6.0)

Updating microcode on z14 and the DS8880 are nondisruptive activities.
3.1.3 Enabling the DS8880 zHyperLink feature

The DS8880 z-synergy Service License must be available on the DS8880. You can obtain your license activation codes from the IBM data storage feature activation (DSFA) website, or contact your IBM support representative and request that the license is enabled.

Note: The DS8880 z-synergy Service License also include parallel access volumes (PAVs), HyperPAV, Transparent Cloud Tiering, and other functions; therefore, it is likely to be available on your DS8880 if you are implementing zHyperLink on a DASD subsystem that is in use for z Series.

Then, verify that the zHyperLink feature is enabled on the DS8880. Feature enablement is done by using the GUI or the DS8000 Series command-line interface (DS CLI). In the following example, we use the GUI for verifying enablement of the zHyperLink function on the DS8880. Complete the following steps:

1. Access the GUI by using your browser and pointing to the GUI URL https://<HMC_IP>, where <HMC_IP> is the DS8880 Hardware Management Console (HMC) IP address. This Storage Management GUI URL is configured by the IBM support representative during the installation process.

2. Log on by using your login credentials.

3. After logging on, select the Settings menu and then, the System option.

4. Select the Licensed Functions tab, which brings you to the list of functions as shown in Figure 3-1. The IBM Z Synergy function must be enabled.

Making the DS8880 Z Synergy Service license available and enabling the Z Synergy Function are nondisruptive activities.
For more information about the GUI, see the *DS8880 Architecture and Implementation Guide, SG24-8323.*

### 3.1.4 Installing features

When the ordered features are delivered, the IBM service representative installs the features. Detailed instructions for installing the features are provided for the IBM service representative as part of the feature delivery.

After installing the features in the z14 and the DS8880, cables can be connected. Make sure to avoid SPOFs when deciding which ports to use on the z14 and the DS8880. Spread connections over as many different cards on both devices as possible.

**Tip:** Documenting the specific ports that each cable is connected to at both ends makes future troubleshooting and updates to the setup easier.

Installing the features and connecting the cables are nondisruptive activities.

### 3.1.5 Activating zHyperLink on the DS8880

Complete the following steps to enable the zHyperLink option on the DS8880 DASD subsystem before enabling it on the z/OS side:

1. Log on to the DS8000 Storage Management GUI with administrator privileges.
2. Select the **Settings** menu and then, the **System** option.
3. Select the **Advanced** tab.
4. Disable the I/O Priority Manager mode (Function setting) and verify that the CUIR support (under IBM System z®) is enabled, as shown in Figure 3-2.

![DS8000 GUI Advanced System Settings](image)

**Figure 3-2** DS8000 GUI Advanced System Settings

If I/O Priority Manager is enabled on your storage system, you cannot use a zHyperLink connection. CUIR enablement is needed for maintenance and for adding zHyperLink features by way of a miscellaneous equipment specification (MES).
5. Select the **zHyperLink** tab and then, select the **I/O Read Enabled** option, as shown in Figure 3-3.

![Figure 3-3 DS8000 GUI zHyperLink](image)

For more information about the DS8000 Storage Management GUI, see the *DS8880 Architecture and Implementation Guide*, SG24-8323.

### 3.1.6 Updating I/O configuration

In this section, we describe how to define and implement the I/O Configuration updates for zHyperLink PCIe features on the z14 processor.

Because zHyperLinks are not defined on the control unit, you can continue to define up to eight CHPIDs per logical control unit (LCU). zHyperLink does not reduce that number. Association between the z14 firmware and the DS8880 storage subsystem is discovered during link initialization. z/OS associates zHyperLinks with devices at IPL or vary online time.

#### Updating I/O definition file

Review the CFReport file that is supplied by your IBM support representative after ordering the features that are installed on your z14 CPC. The file contains information about the Channel IDs (CHIDs) for the installed zHyperLinks features.

In this example, we define two PCIe zHyperLink (HYL) features, which are shared by two partitions on the CPC. On each of the two features, we define four virtual functions on port 1 for both partitions, for a total of 16 virtual functions (because they cannot be shared). The process that is used to define virtual functions for port 2 is similar, but not included in the example.
We use Hardware Configuration Definition (HCD) for the definitions, but Hardware Configuration Manager (HCM) can also be used.

The zHyperLink part of the resulting IOCDS from this example is listed in Appendix B, “Sample IOCDS” on page 97.

**Note:** Unlike non-PCIe channels, such as OSA and FICON, PCIe functions are defined at the processor level, not at the Logical Channel Subsystem (LCSS) level.

To start the process, complete the following steps:

1. Select option 3, Processors on the Define, Modify, or View Configuration Data panel. The Processor List panel opens.
2. Select Work with PCIe functions by using the F line-command.
3. To define the zHyperLink PCIe function, press F11 on the PCIe Function List panel.

Figure 3-4 shows the Add PCIe Function panel.

![Figure 3-4 HCD Add PCIe Function panel](image)

The following values are displayed on the panel:

- **Function ID (FID):** Similar to the control unit ID that you define when devices were added to an OSA or FICON channel. It is the identifier of the channel and virtual function ID.
- **Type:** Identifies the PCIe function type; in this case, ZHYPERLINK.
- **Channel ID:** The zHyperLink function channel ID that is documented in the CFReport; similar to a PCHID for an OSA or FICON channel.
- **Port:** Can be 1 or 2 for a zHyperLink PCIe feature. In this example, we define port 1 only.
– Virtual Function ID: A number in the range of 1 to 127 because the maximum number of virtual functions for a zHyperLink feature is 254. Two ports with a maximum of 127 virtual functions each.

**Note:** The virtual function number must be unique at the feature port level, and cannot be shared by multiple partitions.

– Number of virtual functions: The number of simultaneous I/O operations that can be active on a zHyperLink. We recommend defining four virtual functions for a zHyperLink port per LPAR.

– UID: The User Defined Identifier that can be used for PCIe functions for partitions with the attribute (flag), which enables or disables UID-checking for a logical partition. Not applicable to zHyperLink.

– Description: The optional description of the definition. Consider specifying information on the DS8880 to which the zHyperLink is connected and the partition.

4. Press Enter. The Define Access List panel opens, as shown in Figure 3-5. Use this panel to select the partition that can access the virtual functions.

```
Select one partition for the access list.

Function ID . . . . : 1001

/ CSS ID Partition Name Number Usage Description
/ 0    LPZOSAPR    A  OS   ZOS-A Production
/ 0    LPZOSBPR    B  OS   ZOS-B Production
/ 0    LPZOSCDE    C  OS   ZOS-1 Development
/ 0    LPZOSDDE    D  OS   ZOS-2 Development
/ 0    LPZOSETS    E  OS   ZOS-8 Test
/ 0    LPZOSFTS    F  OS   ZOS-9 Test
```

Figure 3-5  HCD Define Access List panel

A virtual function cannot be shared between partitions; therefore, you can select a single partition only.

5. Press Enter. The Define Candidate List opens. Optionally select one or more partitions.
6. Press Enter. Four virtual functions for the LPZOSAPR partition are defined, as shown in Figure 3-6.

![Figure 3-6 HCD PCIe Function List panel](image)

You can update the Access List and Candidate Access List by scrolling right, the same way as you can for channels like OSA and FICON.

Next, we define another four virtual functions for the same Channel ID and port, but assigned to another partition. Complete the following steps:

1. Use the A line-command next to one of the Function IDs that are shown in Figure 3-6. The Add PCIe Function panel opens and the values that you specified for the first partition are displayed.

   Figure 3-7 shows the Add PCIe Function panel.

![Figure 3-7 HCD Add PCIe Function panel](image)
The following values are changed or unchanged as indicated:

- Function ID (FID) must be updated because it is unique (as with a control unit ID).
- Type, Channel ID, and Port are unchanged because we are still defining virtual functions for the first Channel ID and port.
- Virtual Function ID must be unique at the feature port level. We used numbers 1 - 4 for the first partition; in this example, we continue by using the values of 5 - 8.

**Note:** The virtual function number must be unique at feature port level and cannot be shared by multiple partitions.

- Number of virtual functions is unchanged at the value of 4 and Description is updated to specify another partition.

2. Press Enter. The Define Access List panel opens, as shown in Figure 3-8. Use this panel to select the partition that can access the virtual functions.

```
Figure 3-8   HCD Define Access List panel
```

The next partition is selected. HCD does not prevent you from selecting the same partition as for the first four virtual functions. In that case, eight virtual functions are on a single port and for a single partition.

**Note:** We strongly suggest defining only four virtual functions on a single port per LPAR. A higher number can result in device busy conditions.

3. Press Enter. The Define Candidate List opens. Optionally select one or more partitions.
4. Press Enter. Four virtual functions for the LPZOSBPR partition are now defined, as shown in Figure 3-9.

![PCIe Function List panel]

Select one or more PCIe functions, then press Enter. To add, use F11.

Processor ID . . . .: CETUS         Cetus

<table>
<thead>
<tr>
<th>FID</th>
<th>CHID+</th>
<th>P+</th>
<th>VF+</th>
<th>Type+</th>
<th>UID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1001</td>
<td>140</td>
<td>1</td>
<td>1</td>
<td>ZHYPERLINK</td>
<td>DS8880 0175-FCC41 LPZOSAPR</td>
<td></td>
</tr>
<tr>
<td>1002</td>
<td>140</td>
<td>1</td>
<td>2</td>
<td>ZHYPERLINK</td>
<td>DS8880 0175-FCC41 LPZOSAPR</td>
<td></td>
</tr>
<tr>
<td>1003</td>
<td>140</td>
<td>1</td>
<td>3</td>
<td>ZHYPERLINK</td>
<td>DS8880 0175-FCC41 LPZOSAPR</td>
<td></td>
</tr>
<tr>
<td>1004</td>
<td>140</td>
<td>1</td>
<td>4</td>
<td>ZHYPERLINK</td>
<td>DS8880 0175-FCC41 LPZOSAPR</td>
<td></td>
</tr>
<tr>
<td>1005</td>
<td>140</td>
<td>1</td>
<td>5</td>
<td>ZHYPERLINK</td>
<td>DS8880 0175-FCC41 LPZOSBPR</td>
<td></td>
</tr>
<tr>
<td>1006</td>
<td>140</td>
<td>1</td>
<td>6</td>
<td>ZHYPERLINK</td>
<td>DS8880 0175-FCC41 LPZOSBPR</td>
<td></td>
</tr>
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<td>ZHYPERLINK</td>
<td>DS8880 0175-FCC41 LPZOSBPR</td>
<td></td>
</tr>
<tr>
<td>1008</td>
<td>140</td>
<td>1</td>
<td>8</td>
<td>ZHYPERLINK</td>
<td>DS8880 0175-FCC41 LPZOSBPR</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3-9 HCD PCIe Function List panel

5. Repeat steps 1 - 4 when you are defining Functions IDs for the other Channel ID.

The following values are used when defining Function IDs:

- Function ID (FID): For the next channel ID, the example uses the starting value of 1101. The Function ID must be unique within the I/O Configuration Definition File (IODF).
- Type: Identifies the PCIe function type; in this case, ZHYPERLINK.
- Channel ID: The zHyperLink function channel ID that is documented in the CFReport, which is similar to a PCHID for an OSA or FICON channel. In the example configuration, the other zHyperLink Channel ID is 1A8.
- Port: The example includes port 1 only.
- Virtual Function ID: Because we are now defining the second Channel ID, we can use the same Virtual Functions IDs as we did for the first Channel ID; that is, 1-4 and 5-8.
- Number of virtual functions: Define four virtual functions for a zHyperLink port as for the first channel ID.
- UID: Still not used.
- Description: Similar to the text that we used for the first Channel ID.
6. After defining Function IDs for the second Channel ID, the list of defined Functions is as shown in Figure 3-10.

<table>
<thead>
<tr>
<th>Processor ID . . . .: CETUS Cetus</th>
</tr>
</thead>
<tbody>
<tr>
<td>/ FID  CHID+  P+  VF+  Type+         UID   Description</td>
</tr>
<tr>
<td>_ 1001  140    1   1    ZHYPERLINK    ____  DS8880 0175-FCC41 LPZOSAPR</td>
</tr>
<tr>
<td>_ 1002  140    1   2    ZHYPERLINK    ____  DS8880 0175-FCC41 LPZOSAPR</td>
</tr>
<tr>
<td>_ 1003  140    1   3    ZHYPERLINK    ____  DS8880 0175-FCC41 LPZOSAPR</td>
</tr>
<tr>
<td>_ 1004  140    1   4    ZHYPERLINK    ____  DS8880 0175-FCC41 LPZOSAPR</td>
</tr>
<tr>
<td>_ 1005  140    1   5    ZHYPERLINK    ____  DS8880 0175-FCC41 LPZOSBPR</td>
</tr>
<tr>
<td>_ 1006  140    1   6    ZHYPERLINK    ____  DS8880 0175-FCC41 LPZOSBPR</td>
</tr>
<tr>
<td>_ 1007  140    1   7    ZHYPERLINK    ____  DS8880 0175-FCC41 LPZOSBPR</td>
</tr>
<tr>
<td>_ 1008  140    1   8    ZHYPERLINK    ____  DS8880 0175-FCC41 LPZOSBPR</td>
</tr>
<tr>
<td>_ 1101  1A8    1   1    ZHYPERLINK    ____  DS8880 0175-FCC41 LPZOSAPR</td>
</tr>
<tr>
<td>_ 1102  1A8    1   2    ZHYPERLINK    ____  DS8880 0175-FCC41 LPZOSAPR</td>
</tr>
<tr>
<td>_ 1103  1A8    1   3    ZHYPERLINK    ____  DS8880 0175-FCC41 LPZOSAPR</td>
</tr>
<tr>
<td>_ 1104  1A8    1   4    ZHYPERLINK    ____  DS8880 0175-FCC41 LPZOSAPR</td>
</tr>
<tr>
<td>_ 1105  1A8    1   5    ZHYPERLINK    ____  DS8880 0175-FCC41 LPZOSBPR</td>
</tr>
<tr>
<td>_ 1106  1A8    1   6    ZHYPERLINK    ____  DS8880 0175-FCC41 LPZOSBPR</td>
</tr>
<tr>
<td>_ 1107  1A8    1   7    ZHYPERLINK    ____  DS8880 0175-FCC41 LPZOSBPR</td>
</tr>
<tr>
<td>_ 1108  1A8    1   8    ZHYPERLINK    ____  DS8880 0175-FCC41 LPZOSBPR</td>
</tr>
</tbody>
</table>

*Note:* Port 2 was not included in the example. When you define zHyperLink for port 2, the Function ID still must be unique within the IODF; however, the Virtual Function IDs are identical to the IDs that were defined for port 1. Function IDs for port 2 can be assigned to the same or different partitions as the IDs that were defined for port 1.

**Implementing input/output definition file**

After updating the I/O definition file (IODF), follow your standard procedure for building and implementing the new production IODF.

The zHyperLink PCIe functions do not include updates to the Operating System Configuration part of the IODF.

**3.1.7 Verifying zHyperLink cables**

Verify zHyperLink cable connections after implementing the hardware, as described in 3.1, “Hardware deployment” on page 40. Start the verification process by issuing system commands on the z/OS system, and then, continue by verifying on the HMC.
**Verifying zHyperLink cables on z/OS**

Complete the following steps to verify the zHyperLink cables on the z/OS system:

1. Display PCIE functions by using the `D PCIE` system command. Consider the following points:
   - The PFID column represents the Function ID and the PN column represents the port.
   - The device Type name is 8 GB zHyperLink.
   - At this stage, the Status column should display `STNBY` because the functions are not yet online.

2. Configure the Function online by using the `CF PFID(xxxx),ON` system command.

3. Display PCIE functions again by using the `D PCIE` system command. The Status is changed to `CFNG`. After enabling zHyperLink at the z/OS level later, zHyperLink is allocated or in use, and the Status is then `ALLC`.

**Verifying on HMC**

Complete the following steps to verify on the HMC:

1. Log on to the HMC by using your browser and pointing to the HMC URL, `https://<HMC_IP>`.

2. Select the processor and **Single Object Operations** task, which brings you to the Support Element.

3. At the Support Element, select the processor and **Channels**. Locate the first Channel ID for zHyperLink.

4. Select the **Channel** and the **Advanced Facilities** task. Select **Card Specific Advanced Facilities** and then, **View Port Parameters**.

5. Select the port number.
A sample HMC Advanced facilities window for a zHyperLink channel 0140 port 1 is shown in Figure 3-11.

![IBM Support Element]

**View Port Parameters - PCHID0140**

Channel ID: 0140
Port: 1

Link state: Operational

<table>
<thead>
<tr>
<th>Lane</th>
<th>Receiver (dBm)</th>
<th>Transmitter (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-2.6336</td>
<td>0.0207</td>
</tr>
<tr>
<td>1</td>
<td>-2.881</td>
<td>-0.2077</td>
</tr>
<tr>
<td>2</td>
<td>-2.5833</td>
<td>0.2897</td>
</tr>
<tr>
<td>3</td>
<td>-2.5076</td>
<td>-0.4725</td>
</tr>
<tr>
<td>4</td>
<td>-2.7901</td>
<td>-0.5119</td>
</tr>
<tr>
<td>5</td>
<td>-2.0809</td>
<td>-0.1475</td>
</tr>
<tr>
<td>6</td>
<td>-2.7942</td>
<td>0.0945</td>
</tr>
<tr>
<td>7</td>
<td>-2.3025</td>
<td>0.6230</td>
</tr>
</tbody>
</table>

Figure 3-11  HMC Advanced Facilities window

6. Verify that a Remote worldwide node name (WWNN) is displayed. The WWNN is displayed if the WWNN was read when a path first came online to the LCU.

   The Remote Link ID should display the physical zHyperLink port ID on the DS8880.

   The remove Link Speed should be GEN3. If the Remote Link speed is GEN1 or GEN2, the link speed was degraded.

7. Verify the dBm values for the eight receiver lanes. A valid range for the Optics Receiver is -9.5 dBm - +2.4 dBm.

8. Verify the dBm values for the eight transmitter lanes. A valid range for the Optics Transmitter is -7.6 dBm - +2.4 dBm.

Repeat these steps for all installed zHyperLink Channel IDs and ports.
3.2 Software upgrade and maintenance

In this section, we describe deployment steps for zHyperLink concerning the software requirements as described in Chapter 2, “Planning” on page 13. We also describe the process of requesting the products and fixes that are required for zHyperLink.

3.2.1 Product upgrades

When products for z/OS platform are to be installed or upgraded, the preferred method for ordering the product and maintenance is through internet orders. When internet orders is used, the package is immediately available for download after the order is processed.

To use the internet delivery option, you must place your order by using IBM ShopzSeries (Shopz). If you are not a Shopz user, an account must be created.

For more information, see the ShopzSeries website.

Ensure that you have the appropriate network connectivity and firewall set-up to use the Internet Delivery option. To verify your system setup for internet delivery of orders, see the Connectivity Test for SW Download Readiness website.

You can always choose a physical delivery on Tape or DVD option. If you prefer to receive your ServerPac by using tapes, for example, you must select the highest tape density that is supported by your driving system.

The required space for your order in the download file system is provided on the Shopz download page in the Required information for ServerPac Dialog file. The download page can be found on the My Orders tab of the ShopzSeries website.

The ServerPac provides you with the following libraries:

- Distribution libraries (DLIBs)
- Target libraries (TLIBs)
- System Management Program Extended (SMP/E) libraries

For more information about Shopz, see the Shopz User's Guide.

ServerPac is available in a compacted (TERSED) file format. After downloading the ServerPac, an UNTERSE job must be run to unpack it.

Two programs are available to UNTERSE files: AMATERSE and TRSMAIN. A sample JCL to UNTERSE the IBMUSER.SERVRPAC.TERSED file by using the TRSMAIN program is shown in Example 3-1.

Example 3-1  Sample UNTERSE job

```plaintext
//UNTERSEQ JOB (,) REGION=0M NOTIFY=&SYSUID,CLASS=A
//******************************************************************************
//UNTERSEQ EXEC PGM=TRSMAIN,PARM=UNPACK
//SYSPRINT DD SYSOUT=* 
//INFILE DD DSN=IBMUSER.SERVRPAC.TERSED, DISP=SHR
//OUTFILE DD DSN=IBMUSER.SERVRPAC.UNTERSED,
//         DISP=(NEW,CATLG),
//         SPACE=(CYL,(1,1))
```
References to **AMATERSE** can be found in IBM Knowledge Center under the **AMATERSE: Pack and unpack a data set** topic.

With **UNTERSE** being complete, you can start performing **RECEIVE**, **CHECK**, and **APPLY** processes to your SMPE libraries.

The **SMPE RECEIVE** command takes a SYSMOD currently outside of SMP/E and stages it into the SMP/E library domain. Some examples of **SMPE RECEIVE** can be found in IBM Knowledge Center under the **SET command Examples** topic.

When **RECEIVE** is complete, **APPLY CHECK** is advised before doing the actual **APPLY**. The **CHECK** command verifies whether any error occurs when SYSMOD is applied in your **APPLY** command. This step simulates an **APPLY**; however, the target system libraries are not updated.

After completion of the **APPLY CHECK** process, the actual **APPLY** can be run. It specifies which previously received SYSMODs are to be installed in the target libraries. SMP/E ensures that all SYSMODs that are set as prerequisites were installed or are being installed concurrently in the correct order. Examples of **APPLY JCL** can be found in IBM Knowledge Center under the **APPLY command Examples** topic.

For more information about syntax for SMPE commands, see IBM Knowledge Center under the **SMP/E for z/OS commands Syntax and notation rules** topic.

When **APPLY** is completed, all of the previously downloaded SYSMODs are installed in your target libraries, and customization for zHyperLink can be started.

### 3.2.2 Product maintenance

The use of the **MISSINGFIX** report is required to determine whether any APARs exist that are applicable, and are not yet installed. The **REPORT MISSINGFIX** command checks the zones that are specified on the **ZONES** operand and determines whether any missing fixes exist based on the fix categories of interest.

Run the **SMP/E REPORT MISSINGFIX ZONES (<your zone names>) FIXCAT (IBM.Function.zHyperLink)** command and install all the maintenance listed. Example 3-2 shows a sample **MISSINGFIX JCL**.

**Example 3-2  Sample SMP/e control cards with FIXCAT option**

```
SET BOUNDARY (GLOBAL).
REPORT MISSINGFIX ZONES (<your zone names>)
FIXCAT (IBM.Function.zHyperLink).
```

**Note:** You can also consider checking IBM.Device.Server.z14-3906* for z14 and IBM.Device.Server.z14-3906.zHighPerformanceFicon for zHPF.
3.3 zHyperLink enablement

This section describes what should be checked before enabling zHyperLink, the updates that are required on system PARMLIB members, and commands that are used to activate zHyperLink in your z/OS environment.

3.3.1 Verifications before activation

Some checks must be made before zHyperLink is enabled.

Check whether the devices attached to the DS8880 with zHyperLinks are supporting zHyperLink at the z/OS side through z/OS display matrix (D M=DEV) command (see Example 3-3).

Example 3-3  Sample D M=DEV command

D M=DEV(9200)
IEE174I 15.34.07 DISPLAY M 493
DEVICE 09200 STATUS=ONLINE
CHP 48 4A 59 5B
ENTRY LINK ADDRESS 0117 0111 0218 0212
DEST LINK ADDRESS 0101 0120 0205 0222
PATH ONLINE Y Y Y Y
CHP PHYSICALLY ONLINE Y Y Y Y
PATH OPERATIONAL Y Y Y Y
MANAGED N N N N
CU NUMBER 0230 0230 0230 0230
INTERFACE ID 0033 0230 0331 0330
MAXIMUM MANAGED CHPID(S) ALLOWED: 0
DESTINATION CU LOGICAL ADDRESS = 30
SCP CU ND = 002107.981.IBM.75.00000000FCC41.0230
SCP TOKEN NED = 002107.900.IBM.75.00000000FCC41.3000
SCP DEVICE NED = 002107.900.IBM.75.00000000FCC41.3000
WWNN = 5005076306FFD699
HYPERPAV ALIASES CONFIGURED = 16
ZHYPERLINKS AVAILABLE = 2
FUNCTIONS ENABLED = MIDAW, ZHPF, ZHYPERLINK(R)

Confirm that both functions are enabled, zHPF and zHyperLink. For more information about each field, see 4.1, “System commands” on page 70.

Check the devices that are attached to your storage subsystem, and use the z/OS display command to have more information about the I/O operation that is supported by them. The command that is shown in Example 3-4 provides more information about what was enabled for a specific device.

Example 3-4  Sample D M=DEV(dev),ZHYPERLINK

D M=DEV(9200),ZHYPERLINK
IEE587I 15.53.51 DISPLAY M 502
DEVICE 09200 STATUS=ONLINE
DEVICE IS ENABLED FOR ZHYPERLINK
READ OPERATIONS ARE ENABLED
WRITE OPERATIONS ARE DISABLED FOR THE FOLLOWING REASON(S):
ZHYPERLINK WRITES ARE DISABLED FOR THE SYSTEM
CONTROL UNIT DOES NOT SUPPORT ZHYPERLINK WRITES

When an I/O operation is not supported by zHyperLink, the system displays the reasons through the IEE587I message. For more information about possible reasons, see 4.1, “System commands” on page 70.

As a result of the use of the display device command, you have Control Unit (CU) number information, which is CU NUMBER 0230 in Example 3-3 on page 54.

Use the D M=CU(<number>) command to display zHyperLinks stats on Control Unit, as shown in Example 3-5.

Example 3-5   Sample D M=CU(0230)

D M=CU(0230)
  IEE174I 16.11.24 DISPLAY M 523
  CONTROL UNIT 0230
  CHP 48 4A 59 5B
  ENTRY LINK ADDRESS 0117 0111 0218 0212
  DEST LINK ADDRESS 0101 0120 0205 0222
  CHP PHYSICALLY ONLINE Y Y Y Y
  PATH VALIDATED Y Y Y Y
  MANAGED N N N N
  ZHPF - CHPID Y Y Y Y
  ZHPF - CU INTERFACE Y Y Y Y
  INTERFACE ID 0033 0230 0331 0330
  MAXIMUM MANAGED CHPID(S) ALLOWED = 0
  DESTINATION CU LOGICAL ADDRESS = 30
  CU ND = 002107.981.IBM.75.0000000FCC41.0230
  CU NED = 002107.981.IBM.75.0000000FCC41.3000
  TOKEN NED = 002107.900.IBM.75.0000000FCC41.3000
  WWNN = 5005076306FFD699
  FUNCTIONS ENABLED = ZHPF, ZHYPERLINK(R)
  DEFINED DEVICES
     09200-0926F
  DEFINED PAV ALIASES
     19270-1927F

ZHYPERLINKS

<table>
<thead>
<tr>
<th>PFID</th>
<th>PCHID</th>
<th>Port</th>
<th>LinkId</th>
<th>S/W St</th>
<th>Port St</th>
</tr>
</thead>
<tbody>
<tr>
<td>00000101</td>
<td>0140</td>
<td>01</td>
<td>0080</td>
<td>Alloc</td>
<td>Oper</td>
</tr>
<tr>
<td>00000201</td>
<td>0140</td>
<td>02</td>
<td>0180</td>
<td>Alloc</td>
<td>Oper</td>
</tr>
</tbody>
</table>

The command that is shown in Example 3-5 provides information about the Control Unit. More information (highlighted in bold in Example 3-5) was added to the IEE174I message in support of zHyperLink.

The ZHYPERLINKS section on the command output includes processor-side information (PCHID and Port data), and control-unit side information (LinkId).

Only the online PFIDs are displayed, regardless of whether the link is usable. Offline (standby) PFIDs are not included in the command output.

For more information about the message output and a description of the displayed fields, see 4.3, “System messages” on page 79.
3.3.2 Activating zHyperLink

After completing the verification steps as described in 3.3.1, “Verifications before activation” on page 54, you are ready to start the deployment process.

The steps that are described in this section are required to activate zHyperLink on z/OS. In this section, we describe the process of enabling the zHyperLink facility, and the messages that are expected as response to the activation.

Static activation
This section describes system parameter updates and parameter checks that are required to support zHyperLink.

LOADxx
As described in 2.4.2, “Software activation plan for z/OS” on page 29, LOADxx member at z/OS PARMLIB must be checked before you start using zHyperLink. The transactional-execution facility must be enabled for zHyperLink to work.

MACHMIG is an optional parameter that identifies facilities that you do not want z/OS to use after migration to another processor or z/OS version. How to code the MACHMIG statement is listed in Table 3-1.

<table>
<thead>
<tr>
<th>Column</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-7</td>
<td>MACHMIG</td>
</tr>
<tr>
<td>10-72</td>
<td>A list of facilities not to use. When more than one facility is listed, separate each from the previous by one or more blanks or commas.</td>
</tr>
</tbody>
</table>

The following facilities can be specified in upper, lower, or mixed case:
- EDAT2 (the hardware-based enhanced-DAT facility 2)
- TX (the hardware-based transactional-execution facility)
- RI (a hardware-based facility that is reserved for IBM use only)
- VEF (the hardware-based vector extension facility)

To allow zHyperLink to work, MACHMIG must not contain the TX statement value in the LOADxx member. The following example shows an MACHMIG definition where transactional-execution facility and enhanced DAT facility 2 are set not to be used:

```
----+----1----+----2
MACHMIG  TX, EDAT2
```

The TX statement is preventing zHyperLink enablement, and must be removed from the MACHMIG definition to implement zHyperLink and support synchronous I/O.

If MACHMIG TX is not specified and the default value is None; that is, the system does not prevent zHyperLink use.

IECIOSxx
The PARMLIB member (IECIOSxx) must be customized to support zHyperLink. The IECIOSxx member contains records that are created on installation to accomplish I/O requests.

An important requirement for zHyperLink is High Performance FICON for IBM z Systems (zHPF) to be enabled. It is defined at the IECIOSxx PARMLIB member with a ZHPF parameter.
The `ZHPF` parameter defines the condition of the `ZHPF` function. If no `ZHPF` statement is specified, the `ZHPF` facility is disabled in the system by default and zHyperLink is not supported.

The following options are available for the `ZHPF` parameter:

- `ZHPF=YES`
- `ZHPF=NO`

When the `YES` statement is defined, zHPF is activated in the system after an IPL. This activation of `ZHPF` supports the use of zHyperLink.

If `NO` is defined, zHPF is disabled, which avoids support to zHyperLink.

Example 3-6 shows a sample IECIOSxx that defines zHPF and zHyperLink.

```
Example 3-6   Sample IECIOSxx

BROWSE    SYS1.PARMLIB(IECIOS00) - 01.18           Line 0000000000 Col 001 080
Command ===>                                                  Scroll ===> PAGE
********************************* Top of Data **********************************
HYPERPAV=YES
ZHPF=YES
ZHYPERLINK,OPER=READ
******************************** Bottom of Data ********************************
```

The `ZHYPERLINK` statement at the IECIOSxx PARMLIB member is required to enable the zHyperLink facility. If no `ZHYPERLINK` statement is specified, the zHyperLink facility is disabled on the system by default, as shown in the following example:

```
ZHYPERLINK OPER=ALL|READ|WRITE|NONE
```

The defined value on the `zHyperLink` statement specifies whether the zHyperLink facility is enabled on the following operations:

- **ALL** I/O operations
- **Read** I/O operations
- **Write** I/O operations
- **Disabled** for all I/O operations

When **OPER=ALL** is defined, it activates zHyperLink for **READ** I/Os. Write I/O requests are not supported by zHyperLink. In this case, all write I/Os are done asynchronously through zHPF protocol, while read requests are done synchronously through zHyperLink.

When **OPER=READ** is defined, you activate zHyperLink for **READ** I/O requests.

**OPER=WRITE** defines that only write I/Os are enabled for the system. Write I/Os are not supported by zHyperLink; therefore, zHyperLink remains disabled.

Example 3-6 also includes a sample IECIOS00 member and the setup for activating zHyperLink for **READ** I/Os on the z/OS PARMLIB.

For more information about syntax rules for IECIOSxx, see IBM Knowledge Center.

**Remember:** The IOS system parameter updates that are done through `PARMLIB` require an IPL to take effect.
Dynamic activation
The use of z/OS system commands allow you to dynamically activate zHyperLink on z/OS systems. In this section, we describe the available commands for zHyperLink activation.

**SETOIS ZHPF**
Another option to activate zHyperLink is by dynamically using z/OS system commands. By using SETIOS system commands, you can dynamically set the values for ZHPF and ZHYPERLINK without the need of an IPL.

The following syntax for the SETIOS command changes the zHPF operation mode:

```
SETIOS ZHPF={YES|NO}
```

Next, the following command enables zHPF:

```
SETIOS ZHPF=YES
```

In response to the SETIOS command, the system displays the following message:

```
IOS090I SETIOS. ZHPF UPDATE(S) COMPLETE
```

You can verify the zHPF status by issuing the display IOS command:

```
D IOS,ZHPF
```

In response to the display zHPF command, the system replies with an IOS630I message:

```
IOS630I hh.mm.ss ZHPF FACILITY 485
HIGH PERFORMANCE FICON FACILITY IS ENABLED
```

**SETOIS ZHYPERLINK**
As described in this section, the SETIOS command specifies the operation mode of zHyperLink in the system.

As in the IEClOSSxx specification, four different values are available for the OPER parameter in the SETIOS ZHYPERLINK command, as shown in the following example:

```
SETIOS ZHYPERLINK,OPER={ALL|READ|WRITE|NONE}
```

The value that is defined on the zHyperLink statement specifies whether the zHyperLink facility is enabled on the following operations:

- ALL I/O operations
- Read I/O operations
- Write I/O operations
- Disabled for all I/O operations.

The following values are currently suitable for the OPER statement if you must activate zHyperLink:

- ALL
- READ

Whether zHyperLink is used for an I/O request depends on if this request meets the eligibility requirements. Only read operations are supported by zHyperLink. OPER=ALL and OPER=WRITE do not activate the facility for write I/Os; it keeps active only for reads, depending on the value defined.

If SETIOS ZHYPERLINK,OPER=WRITE is issued, it does not activate the zHyperLink function. In this case, zHyperLink remains disabled.
**SETIOS ZHYPERLINK, OPER=ALL** activates zHyperLink for READ I/Os as expected. Write I/O requests are not supported by zHyperLink. In this case, write I/Os continue to be asynchronous by way of the zHPF protocol, while read requests are eligible for synchronous I/O through zHyperLink.

The following example shows how to activate read I/Os for zHyperLink and what is expected as the command result:

**SETIOS ZHYPERLINK, OPER=READ**

Message IOS090I is displayed in response to the **SETIOS ZHYPERLINK** command:

IOS090I SETIOS. ZHYPERLINK UPDATE(S) COMPLETE

For more information about the **SETIOS ZHYPERLINK** command, see 4.1, “System commands” on page 70.

**Remember:** All system parameters that are changed dynamically are valid until the system is started. To keep your updates permanent, you must update your system parameters in the PARMLIB. For more information, see “Static activation” on page 56.

### 3.4 Monitoring

Monitoring your systems is vital to ensure system availability and meet required service level agreement (SLA) levels. The following sections describe some of the available options to monitor zHyperLink, and identify possible errors and interventions that might be required.

In addition to the options available here, we encourage you to check for other monitoring options that might be useful in your site and are not described here. Some options can include creating tailored report jobs, user programs, and other reporting tools.

#### 3.4.1 System automation

The use of system automation tools to monitor and report any relevant messages on z/OS systems were widely adopted by customers around the world. These tools relieve operators to focus on activities that cannot be automated and require manual intervention. It permits immediate reaction to any serious alert. The operations team can even use system automation tools to assist them in performing specific tasks, or creating alerts that are based on defined system messages.

zHyperLink introduced and updated a set of messages that can be used by your system automation tool to monitor zHyperLink states. An example of an error message IOS637E that states that zHyperLink task terminated is shown in Figure 3-12.

**Figure 3-12  Error message IOS637E example**
Figure 3-13 shows that the IOS639E message is displayed if the zHyperLink PCIe function failed recovery.

![Error message IOS639E example](image)

For more information about IOS system messages, see 4.3, “System messages” on page 79.

### 3.5 Activating zHyperLink for VSAM data sets

zHyperLink can be activated at the data set level, which provides options for granularity. In this section, we describe the two available options to activate zHyperLink for VSAM data sets.

#### 3.5.1 zHyperLink for SMS data sets

Storage Class Granularity turns zHyperLink off and on for specific non-SMS data sets, and to override the zHyperLink specification for SMS-managed data sets.

With Storage Class Granularity, the system administrator can enable and disable synchronous I/O to the data sets that are members of a storage class (SC), and enable or disable synchronous I/O for specific data sets by operator command. The ability to dynamically enable or disable zHyperLink also facilitates the testing of this facility.

Through Interactive Storage Management Facility (ISMF), you can define or alter a storage class to enable Storage Class Granularity in support of zHyperLink. An example of storage class definition is shown in Figure 3-14.

![Storage Class panel with zHyperLink options](image)

Two other options are added for zHyperLink. The specified values take effect when the SMS configuration is activated.
A Storage Class display on the ISMF panel is shown in Figure 3-15.

```
CDS Name . . . . . . : SYS1.STPPLEX.SCDS
Storage Class Name : SCZHPLNK

Guaranteed Space . . . . . . . . : NO
Guaranteed Synchronous Write . : NO
Multi-Tiered SGs . . . . . . . . : 
Parallel Access Volume Capability : NOPREF
Cache Set Name . . . . . . . . . : 
CF Direct Weight . . . . . . . . : 
CF Sequential Weight . . . . . : 
Lock Set Name . . . . . . . . . : 
Disconnect Sphere at CLOSE . . . : NO
zHyperLink Eligible for read . . : YES
zHyperLink Eligible for write . : NO
```

Figure 3-15  ISMF panel with zHyperLink option

### 3.5.2 zHyperLink for non-SMS data sets

The `VARY SMS` command is the only option to enable zHyperLink for a non-SMS data set. This command provides an option to switch zHyperLink I/O status on an individual data set basis.

The `VARY` command overrides the storage class definition. After the command is issued, all current and subsequent opens use the specified value. It is the only option for non-SMS data sets to use zHyperLink:

- `VARY SMS,DSNAME(dsname),ZHLREAD=YES`  
  Enables synchronous I/O reads for the data set. When the vary command overwrites Storage Class definition, the reads are successful even if SC is not eligible for reads.

- `VARY SMS,DSNAME(dsname),ZHLREAD=NO`  
  Override SC eligibility for reads. Issue reads to the data set by using Synchronous I/O.

Reads should use zHPF because the data set is not enabled for Synchronous I/O reads.

After varying SMS and enabling zHyperLink to the required datasets, check the status of zHyperLink in your datasets by using the following display SMS command:

```
D SMS,DSNAME(datasetname|ALL),ZHL
```

For more information about this command in 4.1, “System commands” on page 70.

The `D SMS` command was updated to include the option to display zHyperLink attributes to a specific data set. You can use this command to display if SMS or non-SMS-managed data sets are zHyperLink eligible.
3.6 Activating zHyperLink for Db2

Before your Db2 applications can benefit from synchronous I/O operations, you must enable zHyperLink to your Db2 subsystem. You can activate zHyperLink from the installation and migration panel that is available on Db2. For more information about how to start the installation and migration panels, see *Db2 12 for z/OS Installation and migration*, GC27-8851.

From the DSNTIPA3 panel, you can see a new option to control zHyperLink utilization for Db2. A sample DSNTIPA3 panel is shown in Figure 3-16.

![Sample Db2 installation panel](image)

Db2 zHyperLinks SCOPE includes the following options:

- **DISABLE**
  - Db2 does not use zHyperLink for any I/O requests.

- **ENABLE**
  - All eligible I/O requests that are performed by Db2 use the zHyperLink protocol.

- **DATABASE**
  - Db2 request only the zHyperLink protocol for database synchronous read I/Os.

The entries on the DSNTIPA3 panel define storage management preferences for the storage groups and data sets that are created during installation and migration.

After you apply and save your changes, the changes are dynamically loaded on storage and no Db2 recycle is required.
3.7 Measuring after deployment

After you implement zHyperLink in your system, it is highly recommended that you create the means to measure the benefits from the synchronous I/O, and plan for future growth.

Input for Resource Monitoring Facility (RMF) and zBNA is based on SMF records. Therefore, you can run reports that are based on records from before and after zHyperLink implementation. This feature enables you to compare results and assess the benefits of zHyperLink. You also can disable and enable zHyperLinks at data set, storage class, and system levels, which provides you with options for granularity.

In general, performance comparisons always are done on comparable workloads.

3.7.1 Measuring by using Resource Monitoring Facility

After you install and enable zHyperLink in your systems, you can use RMF to measure zHyperLink utilization and benefits.

RMF panels
RMF was updated to include zHyperLink and synchronous I/O information. The information that is provided in RMF panels enables you to better view zHyperLink usage and efficiency. You can use the RMF panels or Postprocessor to gather zHyperLink and DASD-related information, including response time and cache hit ratio.

The RMF Monitor III PCIe Activity panel was updated to display information about zHyperLink PCIe cards, including information about the number of reads, usage, and success rates.

From the RMF main menu, you can select option 3, monitor III, and then, option 3, resource, and finally, option 14, PCIe, to display PCIe-related information, including zHyperLink functions. The updated PCIe Activity panel is shown in Figure 3-17.

Note: In addition to Db2 configuration, you must enable the VSAM data sets to use zHyperLink before your Db2 systems can benefit from synchronous I/O. For more information about how to set up zHyperLink for VSAM data sets, see 3.5, “Activating zHyperLink for VSAM data sets” on page 60.
From the PCIe Activity panel, you can place your cursor at the Function ID you want to measure, and press Enter. A new panel displays that includes more information about the Function ID. A sample panel with detailed zHyperLink information is shown in Figure 3-18.

```
RMF Synchronous I/O Link Activity
Press Enter to return to the Report panel.

More: +

Function ID : 0101    Alloc Time % : 100
Allocated : 14.03.32  on 05/11/18

Synchronous I/O Link
Port ID : 1
Type-Model : 002107-981
Serial Number : 0000000FCC41

This Function Link (CEC)
Adapter
Time Busy % : 0 0

Request
Rate : 0 0
Success % :

Transfer
Read Rate : 0 0
Read Ratio :
Write Rate : 0 0
Write Ratio :
```

Figure 3-18  RMF PCIe Activity panel

From the RMF panel, the following important fields must be reviewed:

- **Function ID**
  The hexadecimal identifier of the synchronous I/O link for which performance data is reported.

- **Alloc time %**
  Percentage of the reporting interval for which the synchronous I/O link was allocated or in the process of de-allocation.

- **Serial number**
  The serial number of the storage controller to which the synchronous I/O link connects.

- **Adapter Time busy %**
  - This function
    Time busy represents the percentage of time the PFID (Function) was busy processing synchronous I/O requests. If the function time busy is high, plan to define extra PFIDs for your zHyperLink adapters (we suggest up to four PFIDs per adapter port per LPAR by using zHyperLink to avoid link busy conditions).
– Link (CPC)

The percentage of time spent on synchronous I/O processing on the synchronous I/O link (physical connection). If the time busy percentage is high, plan to add zHyperLink adapters.

► Request rate

– This function

The number of total synchronous I/O requests per second for this function. This number includes requests that were rejected because of timeout conditions, cache failures, and link busy conditions.

– Link (CPC)

The number of total synchronous I/O requests per second for the synchronous I/O link on which this function is defined. This number includes requests that were rejected because of timeout conditions, cache failures, and link busy conditions.

► Success %

– This Function

The percentage of synchronous I/O requests that completed successfully for this function.

– Link (CPC)

The percentage of requests that completed successfully for the synchronous I/O link on which this function is defined.

► Read Rate:

– This Function

The number of megabytes per second that were read from the storage controller by this synchronous I/O function.

– Link (CPC)

The number of megabytes per second that were read from the storage controller on the synchronous I/O link on which this function is defined.

► Read Ratio:

– This Function

The number of megabytes read per request that was processed by this synchronous I/O function.

– Link (CPC)

The number of megabytes read per request that was processed on the synchronous I/O link on which this function is defined.

► Write Rate:

– This Function

The number of megabytes per second that were written to the storage controller by this synchronous I/O function.

– Link (CPC)

The number of megabytes per second that were written to the storage controller on the synchronous I/O link on which this function is defined.
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Write Ratio:
- This Function
  The number of megabytes written per request processed by this synchronous I/O function.
- Link (CPC)
  The number of megabytes written per request processed on the synchronous I/O link on which this function is defined.

RMF batch reports
You can also create the same report by running a batch job. A sample RMF job to extract PCIe information is shown in Example 3-7.

Example 3-7  Sample report PCIe JCL

```
//RMFPP EXEC PGM=ERBRMFPP,REGION=0M
//MFPINPUT DD DISP=(OLD,DELETE),DSN=*.RMFSORT.SORTOUT
//MFPMSDS DD SYOUT=*  
//XPRPTS DD PATH='/u/mysuer/rmfrpt/report1.xml',
//        PATHOPTS=(OWRONLY,OCREAT,OTRUNC),
//        PATHMODE=(SIRUSR,SIWUSR,SIRGRP),FILEDATA=TEXT
//XPXSRPTS DD PATH='/u/myuser/rmfrpt/report2.xml',
//        PATHOPTS=(OWRONLY,OCREAT,OTRUNC),
//        PATHMODE=(SIRUSR,SIWUSR,SIRGRP),FILEDATA=TEXT
//**************************************************************
//*        RMF POSTPROCESSING OPTIONS GENERATED FROM
//*        POSTPROCESSOR OPTIONS PANEL INPUT ONLY.
//**************************************************************
//SYSIN DD *
//SYOUT(0)  
//REPORTS(PCIE)
```

The batch report generates XML files with PCIe-related information. The XML reports include the same information that is available on the PCIe Activity panel, in addition to the Synchronous I/O Response Time Distribution field.

The Synchronous I/O Response Time Distribution field shows the percentage of synchronous I/O requests that was completed within a response time by PFID. The values range from below 20 microseconds to below 100 microseconds. You can use this information to compare PFID and adapter performance, and identify possible link degradation states.

Another option to measure your performance after zHyperLink enablement is based on the report DASD device that is available on RMF postprocessor. You can create a job to report your DASD environment and analyze synchronous and asynchronous response times.
A sample RMF job to report on DASD devices is shown in Example 3-8.

**Example 3-8   Sample report DASD JCL**

```plaintext
//RMFPP EXEC PGM=ERBRMFPP,REGION=0M
//MFPINPUT DD   DISP=SHR,DSN=*.RMFSORT.SORTOUT
//MFPMSGDS DD   SYSOUT=*  
//******************************************************************
//*        RMF POSTPROCESSING OPTIONS GENERATED FROM
//*        POSTPROCESSOR OPTIONS PANEL INPUT ONLY.
//*  
//******************************************************************
//SYSIN DD   *
SYSOUT(0)
REPORTS(DEVICE(DASD))
```

The output from the report device job is shown in Figure 3-19.

![Figure 3-19   Synchronous I/O Device Activity output](image)

The Synchronous I/O Device Activity report includes more information about devices for synchronous and asynchronous I/Os. Use the available information to check if the number of synchronous requests, cache miss, and synchronous response time meet application expectations.

For more information about the fields in the Synchronous I/O Device Activity report, see *IBM z/OS RMF Report Analysis*, SC34-2665.
3.7.2 Measuring using zBNA

The zBNA zHyperLink I/O Rate report documents I/Os per second (IOPS) for workloads that are using zHyperlink and eligible zHyperLink workload. The report also documents the highest potential I/O rate that is estimated to be achievable if all zHyperLink workloads were enabled.

You can use the report as input for evaluating whether zHyperLink was enabled for an optimal amount of data.

**Note:** The zBNA tool is designed to estimate the potential effect moving to new technologies can have for batch elapse time. It is not designed for measuring overall system performance. When a zBNA report is created multiple times, it cannot be guaranteed that all variables are the same for each report.

For more information about the zBNA tool, see 2.1, “Identifying eligible workloads” on page 14.
Operations

This chapter provides relevant information to daily operations after zHyperLink is implemented. This information can be used to create automation procedures, monitoring activities, and troubleshooting errors.

This chapter includes the following topics:

- 4.1, “System commands” on page 70
- 4.2, “System automation” on page 77
- 4.3, “System messages” on page 79
- 4.4, “Hardware Management Console” on page 85
- 4.5, “Troubleshooting” on page 88
4.1 System commands

This section documents system commands that are used for displaying and managing resources that are related to zHyperLink.

4.1.1 Display commands

In this section, we introduce some commands that can be used to display zHyperLink Peripheral Component Interconnect Express (PCIe) related information.

**D PCIE**

The use of the `D PCIE` command shows the information that is registered for the device type with PCIe. The example that is shown in Figure 4-1 shows two zHyperLink PCIe I/O cards with two ports each.

![Figure 4-1 Sample D PCIE command output](image)

```
IQP022I 00.17.04 DISPLAY PCIE 688
PCIE    0012 ACTIVE
PFID DEVICE TYPE NAME STATUS ASID JOBNAME CHID VFN PN
00000101  8GB zHyperLink ALLC 001A IOSAS 0140 0002 1
00000201  8GB zHyperLink ALLC 001A IOSAS 0140 0002 2
00000301  8GB zHyperLink ALLC 001A IOSAS 01A8 0002 1
00000401  8GB zHyperLink ALLC 001A IOSAS 01A8 0002 2
```

**D PCIE,PFID=pfid**

The use of the `D PCIE,PFID=pfid` command shows information about software and port states, as shown in Figure 4-2.

![Figure 4-2 Sample D PCIE,PFID=pfid command output](image)

```
IQP024I 00.32.25 DISPLAY PCIE 693
PCIE    0012 ACTIVE
PFID DEVICE TYPE NAME STATUS ASID JOBNAME CHID VFN PN
00000101  8GB zHyperLink ALLC 001A IOSAS 0140 0002 1

CLIENT ASIDS: NONE
CU WWNN: 5005076306FFD699  CU Link Id: 0080
S/W State: Allocated
Port State: Operational
CU Node Descriptor: 002107.981.IBM.75.0000000FC41
```

The output includes the following information:

- Worldwide node name of the storage system (CU) (if provided)
  - Displayed as **Not Available** if not provided (for example, synchronous I/O link was never operational). Information is residual for links that are not operational.
- CU link ID
  - Displayed as **Not Available** if not provided. Information is residual for links that are not operational.
Software State

State from the point of view of the sync I/O link manager (Unavailable, Allocated, Allocate Error, Error, or Intervention Required).

Node descriptor

If the WWNN is not provided, it is displayed as Not available. For example, this state can occur if the synchronous I/O link was never operational. Displaying the information regardless of whether the WWNN is provided enables the client to see the state of the link.

Port state

This state from the point of view of the firmware (None, Operational, Not Oper, or Undefined). Port states are listed in Table 4-1.

Table 4-1 Port states

<table>
<thead>
<tr>
<th>Summary state</th>
<th>Detailed State</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>None</td>
<td>No state information is available about the port.</td>
</tr>
<tr>
<td>Operational</td>
<td>None</td>
<td>The port is operational and running at full capacity. A port state qualifier of 01 means fully operational.</td>
</tr>
<tr>
<td>Operational</td>
<td>Link speed degraded</td>
<td>This port is operational, but is running in a degraded state because the link started at a speed less than the maximum capable speed (for example, Gen-2 instead of Gen-3).</td>
</tr>
<tr>
<td>Operational</td>
<td>Link width degraded</td>
<td>The port is operational, but is running in a degraded state because only a subset of the fibers (lanes) on the link is functional (for example, four out of eight lanes).</td>
</tr>
<tr>
<td>Not Operational</td>
<td>None</td>
<td>The port is not operational. No other information is provided. For example, the port might be in the process of starting.</td>
</tr>
<tr>
<td>Not Operational</td>
<td>Link down</td>
<td>The port is not operational because the link is down.</td>
</tr>
<tr>
<td>Not Operational</td>
<td>Control unit not responding</td>
<td>The link is up, but the control unit is not responding to the start sequence.</td>
</tr>
<tr>
<td>Not Operational</td>
<td>Fenced by processor</td>
<td>The port was fenced by the processor because the number of detected errors exceeded the internal threshold.</td>
</tr>
<tr>
<td>Not Operational</td>
<td>Fenced by control unit</td>
<td>The port was fenced by the control unit because the number of detected errors exceeded the threshold.</td>
</tr>
<tr>
<td>Not Operational</td>
<td>Processor side in service mode</td>
<td>The port is not operational because the local (processor) side of the link is in service mode (for example, CE testing or replacing the optics).</td>
</tr>
<tr>
<td>Not Operational</td>
<td>Control unit side in service mode</td>
<td>The port is not operational because the remote (control unit) side of the link is in service mode.</td>
</tr>
</tbody>
</table>
CF PFID(pfid),ON/OFF
The config PFID (CF PFID) command is used for configuring PCIe Function IDs online or offline. Optionally, you also can specify the FORCE parameter.

If the PFID is allocated as shown in Figure 4-1 on page 70, z/OS requires the use of the FORCE option for configuring the PFID offline, even if zHyperLink is disabled.

Attention: FORCE is a powerful option. Never specify FORCE unless you understand all of its consequences for your system.

D IOS,ZHYPERLINK
The display IOS (D IOS) command with the ZHYPERLINK parameter shows if zHyperLink is ENABLED or DISABLED. When zHyperLink is ENABLED, it describes what I/O operation is available to use zHyperLink (READ|WRITE). In specific cases in which hardware requirements were not met, it might display NOT SUPPORTED BY THE PROCESSOR instead.

D M=DEV(devno)
The Display Matrix (D M) command with DEV parameter is commonly used to display the number of online channel paths to devices (including special devices) or a single channel path to a single device. It now provides the following information about zHyperLink:

- Interface IDs
  This ID is useful for determining whether CHPIDs share a host adapter (the first three digits represent the adapter).
  The interface ID line is displayed if the device was online at some point or self-description processing was performed for some other reason (for example, offline device discovery or IOSODS); that is, an SSCB exists for the device.
  If a D M=DEV(devno) command is issued and the particular path was never online to any device in the LCU but other paths were online, the interface ID is displayed as “…”. If a D M=DEV(devno, chpid) command was issued in this scenario, the interface ID line is not displayed.

- WWNN
  The WWNN is displayed if the WWNN was read when a path first came online to the LCU.
  The current device must be online at some point or self-description processing must be performed (that is, an SSCB exists for the device).

- zHyperlinks available
  This line is not displayed if no zHyperlinks are available, regardless of whether the device is enabled to use zHyperlink.
  A link is considered available (usable) if the PFID is online, the port is operational, and z/OS allocated the PFID. Links where the PFID is offline, the port is not operational, or z/OS failed to allocate the link are not included.

- Functions enabled
  If the device is enabled for zHyperlink reads and writes, ZHYPERLINK is displayed. If the device is enabled for zHyperlink reads only, ZHYPERLINK(R) is displayed. If the device is enabled for zHyperlink writes only, ZHYPERLINK(W) is displayed.

An example of how the D M=DEV command displays zHyperLink in an enabled state and the new information is shown in Figure 4-3 on page 73.
The `D M=DEV(devno),ZHYPERLINK` display command supports the option to display zHyperLink capabilities and shows the reason why a device is not enabled for zHyperLink. A new message was introduced to the output of the command: IEE587I.

Whether zHyperLink is entirely disabled for READ and WRITE, or partially disabled for READ or WRITE, it displays why it is disabled with the following statements:

- **Processor reasons**
  
  - PROCESSOR DOES NOT SUPPORT ZHYPERLINK

- **z/OS reasons** (`IECIOSxx`, `SETIOS`):
  
  - HYPERLINK IS DISABLED FOR THE SYSTEM
  - HYPERLINK (READS | WRITES) ARE DISABLED FOR THE SYSTEM
  - HYPERWRITE IS DISABLED FOR THE SYSTEM (Writes only)

- **Control unit reasons**:
  
  - CONTROL UNIT DOES NOT SUPPORT ZHYPERLINK
  - CONTROL UNIT DOES NOT SUPPORT ZHYPERLINK (READS | WRITES)
  - CONTROL UNIT WWNN COULD NOT BE RETRIEVED
  - CONTROL UNIT DOES NOT SUPPORT HYPERWRITE (Writes only)

- **zHyperLinks reasons**
  
  - THERE ARE NO ZHYPERLINKS AVAILABLE

- **Secondary device reasons** (when the primary is displayed, writes only):
  
  - THERE ARE NO ZHYPERLINKS AVAILABLE FOR SECONDARY devno
  - CONTROL UNIT WWNN COULD NOT BE RETRIEVED FOR SECONDARY devno
  - CONTROL UNIT DOES NOT SUPPORT ZHYPERLINK WRITES FOR SECONDARY devno
  - CONTROL UNIT DOES NOT SUPPORT HYPERWRITE FOR SECONDARY devno
**D M=CU(cuno)**

Issue the **D M=CU** command to see more information about zHyperLink from Control Unit.

As with the **D M=DEV** command, the Control Unit display includes fields that were recently added to its command response. For more information about Interface IDs, WWNN, and Functions enabled fields, see “**D M=DEV(devno)**” on page 72.

An example of a Control Unit display with the fields added to command response is shown in Figure 4-4.

```
CONTROL UNIT 0230
CHP 48 4A 59 5B
ENTRY LINK ADDRESS 0117 0111 0218 0212
DEST LINK ADDRESS 0101 0120 0205 0222
CHP PHYSICALLY ONLINE Y Y Y Y
. . .
ZHPF - CU INTERFACE Y Y Y Y
INTERFACE ID 0033 0230 0331 0330
MAXIMUM MANAGED CHPID(S) ALLOWED = 0
DESTINATION CU LOGICAL ADDRESS = 30
CU ND = 002107.981.IBM.75.00000000FCC41.0230
CU NED = 002107.981.IBM.75.00000000FCC41.3000
TOKEN NED = 002107.900.IBM.75.00000000FCC41.3000
WWNN = 5005076306FFD699
FUNCTIONS ENABLED = ZHPF, ZHYPERLINK(R)
DEFINED DEVICES
09200-0926F
DEFINED PAV ALIASES
19270-1927F
ZHYPERLINKS
  PFID PCHID Port LinkId S/W St Port St
  000000101 0140 01 0080 Alloc Oper
  000000201 0140 02 0180 Alloc Oper
  000000301 01A8 01 0280 Alloc Oper
  000000401 01A8 02 0380 Alloc Oper
```

Figure 4-4  Sample **D M=CU(cuno)** output

Only online PFIDs are shown, regardless of whether the link is usable. Offline (standby) PFIDs are not included. Processor-side information includes PFID, PCHID, and port data. Control unit side information includes CU link ID (which is similar to interface ID).

The following software and port states are available:

- **Software states:**
  - **Alloc**: The PFID is allocated and usable.
  - **Error**: The PFID is in permanent error or port is not operational.
  - **RcvPend**: Recovery is pending for the PFID.

---

**Note:** IEE587I PROCESSOR DOES NOT SUPPORT ZHYPERLINK is received because the processor does not support the zHyperLink function or MACHMIG TX was specified in LOADxx to disable the transactional execution facility. zHyperLink is supported on z14 and later processors. The transactional execution facility must be enabled to use zHyperLink.
– AllocEr: An error occurred while attempting to allocate the PFID.
– IntvReq: Intervention is required to make the PFID usable.

Port states:
– Only high-level states are shown. Issue D PCIE,PFID=pfid for more information about non-operational conditions.
– None: The state of the port is unknown.
– Oper: The port is operational.
– NotOper: The port is not operational.
– Degraded: The port is operational, but running in degraded state (port state qualifier is 02 or 03).

D SMS,DSNAME(datasetname|ALL),ZHL
The Display SMS (D SMS) command was updated to include the option to display zHyperLink attributes to a specific data set. You can use this command to display whether SMS or non-SMS-managed data sets are zHyperLink eligible. Example 4-1 shows a sample output from the D SMS command.

Example 4-1   Sample D SMS,DSNAME command

IGW285I D SMS,DSNAME
zHyperLink------- Data Set Name-----------------------------
OVERRIDE STORCLAS
Rd  Wr  Rd  Wr  datasetname
ro  wo  sr  wr

The command output includes the following fields:
– ro: The current setting for zHyperLink Read. Yes|No|Def
– wo: The current setting for zHyperLink Write. Yes|No|Def
– Datasetname: The name of the data set.
– sr: The current storage class specification for zHyperLink Read. Yes|No|-  
– wr: The current storage class specification for zHyperLink Write. Yes|No|-  

For sr and wr, - indicates that no storclas is associated with the data set; blanks indicate that the storclas was not determined.

4.1.2 Modify commands

Modify commands allow you to alter system parameters to enable or disable specific functions or alter system values that are defined at IPL time. This section introduces some modify commands to control zHyperLink behavior in your systems.

VARY SMS,DSNAME(datasetname)
The Vary SMS command now includes the DSNAME option to enable zHyperLink eligibility changes to specific data sets. Both SMS and non-SMS data sets are eligible to the vary SMS command.

The following command options are available:
– DSNAMe(datasetname)
  The data set name. For VSAM, this name must be a component name and not a sphere name. Only VSAM data sets are supported for zHyperLink. A message IGW287I is issued if the data set is not cataloged or if the data set is not a VSAM-type component.
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ZHLREAD=YES|NO|DEFAULT
Specifies whether the data set can use zHyperLink for read requests:
- YES
  This data set can use zHyperLink for read requests. It overrides the Storage Class setting for zHyperLink read eligibility.
- NO
  This data set cannot use zHyperLink for read requests. It overrides the Storage Class setting for zHyperLink read eligibility.
- DEFAULT
  This data set uses the Storage Class setting for zHyperLink read eligibility. zHyperLink read eligibility is governed by the Storage Class. If no storage class is associated with the data set, it cannot use zHyperLink for reads. If the data set is non-SMS, zHyperLink is not used to read this data set.

ZHLWRITE=YES|NO|DEFAULT
Specifies whether the data set can use zHyperLink for write requests:
- YES
  This data set can use zHyperLink for write requests. It overrides the Storage Class setting for zHyperLink write eligibility.
- NO
  This data set cannot use zHyperLink for write requests. It overrides the Storage Class setting for zHyperLink write eligibility.
- DEFAULT
  This data set uses the Storage Class setting for zHyperLink write eligibility. zHyperLink write eligibility is governed by the Storage Class. If no storage class is associated with the data set, it cannot use zHyperLink for writes. If the data set is non-SMS, zHyperLink is not used to write this data set.

DELETE
Specifies that the attributes should be set to default. This parameter is mutually exclusive with ZHLREAD and ZHLWRITE. For SMS-managed data sets, zHyperLink eligibility is based on the Storage Class attributes. For non-SMS data sets, zHyperLink is not used to read or write to this data set.

Example 4-2 shows the VARY SMS command and output to enable a data set to use zHyperLink for READ operations.

Example 4-2  Sample VARY SMS command

VARY SMS,DSNAME(APPL01.VSAM.KSDS.DATA),ZHLREAD=YES
------ command output ------
SETIOS ZHYPERLINK

SETIOS ZHYPERLINK
The SETIOS command that is described in this section specifies the operation mode of zHyperLink in the system.

As in the IEC10Sxx specification, four different values are available for the OPER parameter in the SETIOS ZHYPERLINK command:

SETIOS ZHYPERLINK,OPER={ALL|READ|WRITE|NONE}
The defined value in the ZHYPERLINK statement specifies whether the zHyperLink facility is enabled on operations:

- ALL I/O operations
- READ I/O operations
- WRITE I/O operations
- DISABLED for all I/O operations

The following values are currently suitable for an OPER statement if you must activate zHyperLink:

- ALL
- READ

Whether zHyperLink is used for an I/O request depends on if this request meets the eligibility requirements. Because only read operations are currently supported by zHyperLink, OPER=ALL and OPER=WRITE do not activate this facility for write I/Os; instead, it keeps active for READs only, depending on the defined value.

If SETIOS ZHYPERLINK,OPER=WRITE is issued, it does not activate the zHyperLink function. In this case, zHyperLink remains disabled.

The SETIOS ZHYPERLINK,OPER=ALL commands activates zHyperLink for READ I/Os as expected. However, write I/O requests still are not supported by zHyperLink. In this case, write I/Os continue to be asynchronous by way of zHPF protocol, while read requests are eligible for synchronous I/O through zHyperLink.

The following examples show how to activate read I/Os for zHyperLink, and what is expected as a result of the use of the command:

SETIOS ZHYPERLINK,OPER=READ

Message IOS090I is displayed in response to the use of the SETIOS ZHYPERLINK command:
IOS090I SETIOS. ZHYPERLINK UPDATE(S) COMPLETE

### 4.2 System automation

The use of system automation tools to monitor and report any relevant messages on z/OS systems was widely adopted by customers around the world. These tools allow operators to focus on activities that cannot be automated and require manual intervention. The operations team can even use system automation tools to assist them in performing specific tasks, or creating alerts that are based on defined system messages.

zHyperLink introduced or updated a set of messages that can be tracked to monitor zHyperLink enabled and disabled states, and link degraded states that can affect your system performance.

### 4.2.1 Error messages

Tracking error messages automatically is vital to ensure a timely response to any errors that can affect your availability or your application response time. This section identifies error messages that are related to zHyperLink so that you can take corrective actions.
Example 4-3 shows an IOS637E error message stating that the zHyperLink task terminated.

**Example 4-3  Sample IOS637E error message**

IOS637E THE ZHYPERLINK MANAGER TASK HAS TERMINATED.  
ZHYPERLINK AVAILABILITY MAY BE AFFECTED.

This error message is displayed if the zHyperLink management task that is running under the IOSAS address space is terminated. This task is responsible for starting zHyperLink and reacting to changes in their states.

If this error occurs, the available zHyperLinks still can handle requests, but the recovered PFID is not available for use if the PCIe Function Identifier (PFID) is changed or the link recovers from an error.

Another error message that was added to report zHyperLink errors is message ID IOS639E. This message is displayed when the zHyperLink PCIe function fails recovery, and a manual intervention is required. Example 4-4 shows a sample output message.

**Example 4-4  Sample IOS639E error message**

IOS639E INTERVENTION REQUIRED FOR PFID pfid, reasontext

You can attempt to configure the PFID offline and online again to reset and recover the PFID. If the error persists, contact the IBM support center.

### 4.2.2 Informational messages

In addition to error messages, you might find it useful to track some informational messages that are displayed when zHyperLink or PCIe connectivity status change.

Example 4-5 shows a sample system message stating a PCIe function change. This message is issued whenever a zHyperLink status changes. The following statuses are possible:

- **ONLINE**
  - The z/OS PCIE FUNCTION is configured online and is ready to be used.

- **OFFLINE**
  - The z/OS PCIE FUNCTION was unconfigured and entered the standby state. It is still in the system configuration and can be reconfigured online for use.

- **AVAILABLE FOR CONFIGURATION**
  - The z/OS PCIE FUNCTION is in the system configuration. It is in the standby state and might need to be configured online before it can be used.

- **NOT AVAILABLE FOR USE**
  - The z/OS PCIE FUNCTION is removed from the system configuration and is no longer available for use.

**Example 4-5  Sample IQP034I message**

IQP034I PCIE FUNCTION 00000102 ONLINE.  
PCIE DEVICE TYPE NAME = (8GB zHyperLink)

You might want to track your PCIe function changes, especially those changes that might result in disabling zHyperLink connections, such as OFFLINE and NOT AVAILABLE FOR USE.
Another system message that also can be monitored is IOS640I, which states a change in zHyperLink port state. Check for unexpected changes in port status, and define procedures for extra checks and actions to be performed. Example 4-6 shows a sample IOS640I message stating that the port state changed to an operational state. The following values are possible:

- **Operational**
  - The port is operational.
- **Not Operational**
  - The port is not operational.
- **None**
  - The state of the port is not known.
- **Undefined**
  - The state of the port is undefined. Contact the IBM Support Center if this state is displayed.

For more information about the IOS640I message, see *z/OS MVS System Messages, Vol 9 (IGF-IWM)*, SA38-0676.

**Example 4-6  Sample IOS640I message**

IOS640I PORT STATE HAS CHANGES FOR 00000102, PCHID=0140, PORT 1
PORT STATE: Operational

Additionally, the IOS090I message was updated to inform when zHyperLink IOS updates were completed. Example 4-7 shows the result from a SETIOS command to update zHyperLink operation.

**Example 4-7  Sample IOS090I message**

IOS090I SETIOS. ZHYPERLINK UPDATE(S) COMPLETE

You also can set your system automation to issue regular commands to check the zHyperLink status, and take the necessary actions from there. For more information about the system commands that display zHyperLink information, see 4.1, “System commands” on page 70.

### 4.3 System messages

System messages are often used to determine the system health. In many cases, further effects can be avoided by an error prevention technique or by a system operator when automation setups are performed for a specific message.

System messages access the status of the operating system, optional software products, and applications. IBM System Automation can be an important component to help monitor zHyperLink operation.

Tracking error messages with IBM System Automation is vital to ensure a timely response to any errors that might affect your availability or application response time. You can set it to issue regular commands and check zHyperLink status with command outputs.

**Note:** For more information about system commands that are available to display and manage zHyperLink, see 4.1, “System commands” on page 70.
The message prefix for PCIe system messages is IQP. This prefix includes all PCIe functions, and not only zHyperLink.

The scope and content of system messages can be updated as part of upgrades or maintenance implementation. Check IBM Knowledge Center when searching for the latest edition of messages.

### 4.3.1 Error messages

This section identifies error messages that are related to zHyperLink so that you can take corrective actions. We suggest monitoring these messages to ensure that appropriate actions are taken if a message occurs.

**IOS637E**

The IOS637E error message states that zHyperLink task terminated, as shown in Example 4-8.

*Example 4-8  Sample IOS637E message*

| IOS637E | THE ZHYPERLINK MANAGER TASK HAS Terminated. ZHYPERLINK AVAILABILITY MAY BE AFFECTED. |

This error message is displayed whenever the zHyperLink management task that is running under the IOSAS address space is terminated. This task is responsible for starting zHyperLink and reacting to changes in their states.

If this error occurs, the available zHyperLinks still can handle requests. If the PCIe Function Identifier (PFID) is changed or the link recovers from an error, the recovered PFID is not available for use.

Contact IBM Support if an error occurs. The system should be restarted to recover the function.

**IOS639E**

This message is displayed if zHyperLink PCIe function fails recovery. In this case, a manual intervention is required. Example 4-9 shows a sample output message.

*Example 4-9  Sample IOS639E message*

| IOS639E | INTERVENTION REQUIRED FOR PFID pfid, reasonText |

In this case, you can try to configure the PFID offline and online again to reset and recover the PFID. However, if the error persists, contact IBM Support.
4.3.2 Informational messages

In addition to error messages, informational messages are displayed when zHyperLink or PCIe connectivity status changes, or as a command output. These messages are described next.

**IOS090I**
The `IOS090I` message was updated in support of zHyperLink as a response to `SETIOS ZHYPERLINK, OPER={ALL|READ|WRITE|NONE}`. It provides information about when zHyperLink IOS change was completed. Example 4-10 shows the result from a `SETIOS` command to update zHyperLink operation.

*Example 4-10  Sample IOS090I message*

```
IOS090I SETIOS. ZHYPERLINK UPDATE(S) COMPLETE
```

**IOS640I**
The `IOS640I` message is issued when the state of a zHyperLink port changed for some reason. It identifies the physical port and its state, and the PFID that is associated with that port for this LPAR. This message is only displayed if the PFID is online to the current LPAR. Example 4-11 includes a sample message display.

*Example 4-11  Sample IOS640I message*

```
IOS640I PORT STATE HAS CHANGES FOR 00000102, PCHID=0140, PORT 1
PORT STATE: Operational
```

The following statuses are possible for `PORT STATE` on the `IOS640I` message:

- **Not Operational**
  The port is not operational. The following information might be displayed that indicates why the port is not operational:
  - **Link down**
    The port is not operational because the link is down.
  - **Control unit not responding**
    The link is up, but the control unit is not responding to the start sequence.
  - **Fenced by processor**
    The port was fenced by the processor because the number of errors that was detected exceeded the internal threshold.
  - **Fenced by control unit**
    The port was fenced by the control unit because the number of errors that was detected exceeded the internal threshold.
  - **Processor side in service mode**
    The port is not operational because the processor side of the link is in service mode (for example, a support person is testing or replacing the optics).
Getting Started with IBM zHyperLink for z/OS

– Control unit side in service mode
  The port is not operational because the control unit side of the link is in service mode (for example, a support person is testing or replacing the optics).

– Insufficient control unit resources
  The port is not operational because not enough resources are available to support the link. For example, not enough CPUs are available on the control unit to support the link.

▼ None
  The state of the port is not known.

▼ Undefined
  The state of the port is undefined. Contact IBM Support if this state is displayed.

▼ Operational
  If the port state is operational, the system allocates the PFID for zHyperLink requests.

**Note:** If the state is not operational, none, or undefined, the system deallocates the PFID (if it was previously allocated), and it becomes unavailable for zHyperLink requests.

**IEE587I**
The IEE587I message was introduced in support of zHyperLink as a response to the **D M=DEV(devno),ZHYPERLINK** command. In Example 4-12, we display the zHyperLink capability on the device. The display shows whether the device is enabled for zHyperLink READ operations, WRITE operations, or both READ and WRITE operations. If zHyperLink capability is disabled for the device or disabled for only READ or WRITE operations, the reasons why are displayed.

**Example 4-12  Sample IEE587I message**

<table>
<thead>
<tr>
<th>IEE587I</th>
<th>hh.mm.ss DISPLAY M 199</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEVICE</td>
<td>09200 STATUS=ONLINE</td>
</tr>
<tr>
<td>DEVICE IS</td>
<td>ENABLED FOR ZHYPERLINK</td>
</tr>
<tr>
<td>READ</td>
<td>OPERATIONS ARE ENABLED</td>
</tr>
<tr>
<td>WRITE</td>
<td>OPERATIONS ARE DISABLED FOR THE FOLLOWING REASON(S):</td>
</tr>
<tr>
<td>ZHYPERLINK</td>
<td>WRITES ARE DISABLED FOR THE SYSTEM</td>
</tr>
<tr>
<td>CONTROL</td>
<td>UNIT DOES NOT SUPPORT ZHYPERLINK WRITES</td>
</tr>
</tbody>
</table>

**IQP024I**
This message is issued in response to the **DISPLAY PCIE,PFID=<pfid>** system command. This command shows the status of one specific z/OS PCIE FUNCTION or device when it is in the configuration, and might be issued to monitor PCIe for zHyperLink. If the PCIE FUNCTION requested is not in the configuration file, system replies indicating that PFID displayed is not available.

The IQP024I command output includes the following structure:

<table>
<thead>
<tr>
<th>IQP024I</th>
<th>hh.mm.ss DISPLAY PCIE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PcieName</td>
<td>PcieAsid status</td>
</tr>
<tr>
<td>text</td>
<td></td>
</tr>
</tbody>
</table>
Example 4-13 shows a status of PCIE for PFID 101.

Example 4-13  Example of command DISPLAY PCIE,PFID=101

IQP024I 19.46.08 DISPLAY PCIE 317
PCIE     0012 ACTIVE
PFID     DEVICE TYPE NAME         STATUS  ASID  JOBNAME  CHID VFN  PN
00000101  8GB zHyperLink           ALLC    001A  IOSAS    0140 0002 1
CLIENT ASIDS: NONE
CU WWNN: 5005076306FFD699  CU Link Id: 0080
S/W State: Allocated
Port State: Operational
CU Node Descriptor: 002107.981.IBM.75.0000000FCC41

The highlighted ACTIVE statement is the STATUS of the PCIe address space. It can feature the following values:

- **NOT ACTIVE**
  - The z/OS PCIe address space was not started.

- **ACTIVE**
  - The z/OS PCIe address space is active.

- **ENDED**
  - The z/OS PCIe address space ended.

The following fields are in the text section and include the values that are displayed when the previous command is issued:

- **PFID**
  - PCIE Functional-ID

- **DEVICE NAME**
  - The printable name of the device type for the listed PFID. If the device was not named, the name is displayed as UNNAMED (aaaa bbbb), where aaaa is the vendor ID and bbbb is the device ID.

- **STATUS**
  - The STATUS is for the device. It can have one of the following values:
    - **ALLC**
      - The device is allocated or in use.
    - **ENBL**
      - The device is enabled but not fully started for use.
    - **CNFG**
      - The device is configured online.
    - **STNBY**
      - The device is in standby mode and ready to be configured online.
    - **DP**
      - The device is deallocate-pending and is waiting for a deallocate command from its owner to clean up its resources.
    - **PERR**
      - The device is in permanent error. It must be unconfigured to recover from this status.
ASID
The address space ID that currently owns the z/OS PCIe device that was identified by the PFID. The ASID is not displayed if the device is not currently owned.

JOBNAME
The job name of the owning address space.

CHID
The physical or virtual channel identifier.

VFN
The virtual PCIe function number.

PN
The physical port number for the PCIe device. If blank, the port is not applicable or more than one port is associated with the PCIe device.

IQP034I
The IQP034I message displays the new status of a PCIE FUNCTION that was changed. The IQP034I message features the following structure:

IQP034I PCIE FUNCTION pfid dev_status.
PCIE DEVICE TYPE NAME = (DevTypeName).

Example 4-14 shows a sample IQP034I message:

Example 4-14 Sample IQP034I message

IQP034I PCIE FUNCTION 00000102 ONLINE.
PCIE DEVICE TYPE NAME = (8GB zHyperLink).

The z/OS PCIE FUNCTION can have the following statuses displayed by IQP034I:

- **ONLINE**
  The z/OS PCIE FUNCTION is configured online and is ready to be used.

- **OFFLINE**
  The z/OS PCIE FUNCTION was unconfigured and entered the standby state. It is still in the system configuration and can be reconfigured online for use.

- **AVAILABLE FOR CONFIGURATION**
  The z/OS PCIE FUNCTION is in the system configuration. It is in the standby state and might need to be configured online before it can be used.

- **NOT AVAILABLE FOR USE**
  The z/OS PCIE FUNCTION is removed from the system configuration and is no longer available for use.

As critical resources for zHyperLink, you might want to track your PCIe functions, which can result in disabling zHyperLink connections.

Although we displayed some of the available messages for zHyperLink monitoring, you might want to check for other messages to build your own automation setup. For more information about PCIE-related messages, see z/OS MVS System Messages, Vol 9 (IGF-IWM), SA38-0676.
4.4 Hardware Management Console

This section documents Hardware Management Console (HMC) functions that are available to monitor and operate zHyperLink. The following procedure gets zHyperLink functions on the HMC:

1. To log on to the HMC. Use your browser and point to the HMC URL: https://<HMC_IP>.
   The HMC supports Multi-factor Authentication, and has five different roles for user IDs. The tasks that are described in this section are available for all of those IDs.
   For more information about logon options and user ID roles, see the Hardware Management Console Operations Guide.

2. After logging on to the HMC, select Systems Management and then, the CPC.


4. When you are logged on to the SE, select Systems Management.

5. Select the CPC and then, the Channel ID of the zHyperLink channel to be managed. The following options at the CPC level are not applicable for monitoring:
   - The Change Management task group. The Manage PCIe System Services task does not include zHyperLink.
   - The Change Management task group. The Update PCIe Adapter Internal Code task is a disruptive task to be used for Engineering Changes (ECs) only.

After selecting the Channel ID, options that are described next are available for managing zHyperLink. All tasks are available in the Channel Operations group. Some of the tasks are also available in the CHPID Operations task group.

Note: The PCIe zHyperLink is defined at the CPC level, not at the Logical Channel Subsystem (LCSS) level or the LPAR level. zHyperLink Channels are not Channel Path IDs (CPHIDs); therefore, you cannot toggle it online/offline by using the Configure Channel Path ON/OFF task. It is also not available on the System Input/Output Configuration Analyzer task.

Viewing Port Parameters window

To view the port parameters, complete the following steps:


2. Select View Port Parameters and then, select the port (1 or 2).

The window displays the WWNN and Link IDs for both ends of the connection. It also includes other information, such as the Link Speed and Transmitter/Receiver power rates for all eight lanes.
Running Port Diagnostics window
To run port diagnostics, complete the following steps:

2. Select Run port Diagnostics.

Use this window to test the hardware ports on the selected zHyperLink channels.

Attention: A diagnosis test cannot be stopped after it starts.
Configuring On/Off window
Use this window to configure one or more Channel IDs online or offline on one or more partitions.

Figure 4-6 shows an example of the Configure On/Off window.

Note: z/OS system commands should be used for configuring Channel IDs online/offline on active systems, if possible.
4.5 Troubleshooting

This section documents several examples of how to identify and solve issues that are related to zHyperLink, such as zHyperLink not being allocated or being disabled for devices. For more information about performance issues, see 3.7, “Measuring after deployment” on page 63.

4.5.1 zHyperLink port in CNFG status

To display the port status and troubleshoot, complete the following steps:

1. Issue the D PCIE system command to display the port status. In this example, a zHyperLink adapter port is in status CNFG, as shown in Figure 4-7.

```
IQP022I 15.47.04 DISPLAY PCIE 135
PCIE 0012 ACTIVE
PFID DEVICE TYPE NAME STATUS ASID JOBNAME CHID VFN PN
00001001 8GB zHyperLink CNFG 0140 0002 1
00001081 8GB zHyperLink ALLC 001A IOSAS 0140 0002 2
```

*Figure 4-7 zHyperLink adapter port in CNFG status*

2. Issue the D M=CU(cuno) system command, which in this example displays a Software Status of Error and Port Status of NotOper, as shown in Figure 4-8.

```
ZHYPERLINKS
PFID PCHID Port LinkId S/W St Port St
00001001 0140 01 0080 Error NotOper
00001081 0140 02 0180 Alloc Oper
```

*Figure 4-8 zHyperLink Error NotOper status*

In this case, the cable between zHyperLink adapters in the z14 CPC and zHyperLink adapters on the DS8880 was not connected.

4.5.2 zHyperLink port in STNB status

To display the port status and troubleshoot, complete the following steps:

1. Issue the D PCIE system command to display status. In this example, a zHyperLink adapter port is in status STNBY, as shown in Figure 4-9.

```
IQP022I 15.47.04 DISPLAY PCIE 135
PCIE 0012 ACTIVE
PFID DEVICE TYPE NAME STATUS ASID JOBNAME CHID VFN PN
00001001 8GB zHyperLink STNBY 0140 0002 1
00001081 8GB zHyperLink ALLC 001A IOSAS 0140 0002 2
```

*Figure 4-9 zHyperLink adapter port in STNBY status*
2. Issue the `D PCIE,PFID=1001` system command and review message IQP024I. In this example, S/W State is Not Available, while the Port State is Operational, as shown in Figure 4-10.

```
IQP024I 11.24.04 DISPLAY PCIE 024
PCIE 0010 ACTIVE
PFID DEVICE TYPE NAME STATUS ASID JOBNAME CHID VFN PN
00010001 8GB zHyperLink STNBY 01C0 0001 1
CLIENT ASIDS: NONE
CU WWNN: 5005076307FFD2AD CU Link Id: 0380
S/W State: Not Available
Port State: Operational
CU Node Descriptor: 002107.981.IBM.75.0000000YZ981
```

*Figure 4-10  zHyperLink S/W State Not Available*

3. Issue the `CF PFID(1001),ON` system command to configure the Function ID online.

4. Issue the `D PCIE` system command again to verify that the zHyperLink status is now ALLC.

### 4.5.3 zHyperLink is disabled

To display the device status and troubleshoot, complete the following steps:

1. Issue the `D M=DEV(devno)` system command to display device status. In this example, zHyperLink is not enabled for the device, as shown in Figure 4-11.

```
IEE174I 16.16.17 DISPLAY M 149
DEVICE 09443  STATUS=ONLINE
CHP 48 4A 59 5B
ENTRY LINK ADDRESS 0117 0111 0218 0212
DEST LINK ADDRESS 0101 0120 0205 0222
PATH ONLINE Y Y Y Y
CHP PHYSICALLY ONLINE Y Y Y Y
PATH OPERATIONAL Y Y Y Y
MANAGED N N N N
CU NUMBER 0234 0234 0234 0234
INTERFACE ID 0033 0230 0331 0330
MAXIMUM MANAGED CHPID(S) ALLOWED: 0
DESTINATION CU LOGICAL ADDRESS = 34
SCP CU ND = 002107.981.IBM.75.0000000FCC41.0230
SCP TOKEN NED = 002107.900.IBM.75.0000000FCC41.3400
SCP DEVICE NED = 002107.900.IBM.75.0000000FCC41.3443
WWNN = 5005076306FFD699
HYPERPAV ALIASES CONFIGURED = 16
ZHYPERLINKS AVAILABLE = 2
FUNCTIONS ENABLED = MIDAW, ZHPF
```

*Figure 4-11  zHyperLink not enabled for device*

The FUNCTIONS ENABLED should include ZHPF and ZHYPERLINK(R); however, ZHYPERLINK(R) is missing in the example.
2. Issue the `D M=DEV(devno),ZHYPERLINK` system command to obtain more details. The result is shown in Figure 4-12.

```
IEE5871 16.20.19 DISPLAY M 173
DEVICE 09443  STATUS=ONLINE
DEVICE IS DISABLED FOR ZHYPERLINK FOR THE FOLLOWING REASON(S):
  ZHYPERLINK IS DISABLED FOR THE SYSTEM
WRITE OPERATIONS ARE DISABLED FOR THE FOLLOWING REASON(S):
  CONTROL UNIT DOES NOT SUPPORT ZHYPERLINK WRITES
```

Figure 4-12  zHyperLink disabled for system

zHyperLink is disabled for the system.

3. Enable zHyperLink by issuing the `SETIOS ZHYPERLINK,OPER=READ` system command.

4. Verify the device again by using the `D M=DEV(devno)` system command. zHyperLink is now enabled.

### 4.5.4 zHyperLink is degraded

To display the control unit status and troubleshoot, complete the following steps:

1. Issue the `D M=CU(cuno)` system command to display control unit status. In this example, zHyperLink is degraded, as shown in Figure 4-13.

```
IEE1741 16.42.27 DISPLAY M 180
CONTROL UNIT 0234
CHP  48 4A 59 5B
ENTRY LINK ADDRESS  0117 0111 0218 0212
DEST LINK ADDRESS  0101 0120 0205 0222
CHP PHYSICALLY ONLINE Y Y Y Y
PATH VALIDATED Y Y Y Y
MANAGED N N N N
ZHPF - CHPID Y Y Y Y
ZHPF - CU INTERFACE Y Y Y Y
INTERFACE ID 0033 0230 0331 0330
MAXIMUM MANAGED CHPID(S) ALLOWED = 0
DESTINATION CU LOGICAL ADDRESS = 34
CU ND   = 002107.981.IBM.75.0000000FOCC41.0230
CU NED  = 002107.981.IBM.75.0000000FOCC41.3400
TOKEN NED = 002107.900.IBM.75.0000000FOCC41.3400
WWNN    = 5005076306FFD699
FUNCTIONS ENABLED = ZHPF, ZHYPERLINK(R)
DEFINED DEVICES
09400-0946F
DEFINED PAV ALIASES
19470-1947F
ZHYPERLINKS
  PFID PCHID Port LinkId S/W St  Port St
  00000101 0140 01 0080 Alloc Degraded
  00000201 0140 02 0180 Alloc Oper
```

Figure 4-13  zHyperLink degraded
Degraded connections can be caused by cable issues, such as a cable connector that is not clean.

2. Configure zHyperLink offline and request the IBM service representative to clean the connectors.

3. Configure zHyperLink back online and verify again.

How to verify cabling is described next.

4.5.5 zHyperLink cabling issue

If any of the following conditions are met, the cable might not be connected, needs its connectors cleaned, or be replaced:

- If the Receiver or Transmitter dBm value is far beyond the valid range for all lanes (for example at -40), the cable is most likely disconnected.
- If the Receiver or Transmitter dBm value is -INF, the lane is broken and the cable must be replaced.
- If the Remote Link speed is GEN1 or GEN2, the link speed is degraded. The Remote Link Speed should be GEN3.
- One or more Receiver lane dBm values are outside the range of -9.5 dBm to +2.4 dBM.
- One or more Transmitter lane dBm values are outside the range of -7.6 dBm to +2.4 dBM.

To correct these conditions, complete the following steps:

1. Configure zHyperLink offline and request the CE to clean the connectors or replace the cable.
2. Configure zHyperLink back online and verify again.

For more information about the HMC Advanced Facilities window, see 3.1.7, “Verifying zHyperLink cables” on page 49.

4.5.6 Other reasons that zHyperLink is not used

zHyperLink is not used for a request for the following reasons:

- The I/O request does not meet the requirements.
- HPF is not enabled for the device.
  - IOS does not require zHPF to be enabled to use synch I/O; therefore, the channel driver does work, but media manager requires zHPF to be enabled.
- zHyperLink is not enabled in the user’s parameters; for example, Db2 ZPARM.
- The device is not in a usable state or is undergoing recovery:
  - Device offline
  - No paths available
  - Hot I/O
  - Device not ready
  - Validating paths after an MIH condition
- The device is reserved to another system or pending from this system.
- All zHyperLinks are busy with other requests.
- Not enough usable zHyperLinks are available to process the request; for example, more read requests than the number of available virtual functions.
zHyperLink Checklist

This appendix provides a checklist for zHyperLink implementation on z/OS.
### zHyperLink implementation checklist

In Table A-1 we provide a checklist that you can use as you install and enable zHyperLink in your systems. You can add any other steps your that might be relevant to your scenario.

**Table A-1  Sample implementation checklist**

<table>
<thead>
<tr>
<th>Task</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Verify hardware level requirements</td>
<td>1.3.1, “Hardware prerequisites” on page 4</td>
</tr>
<tr>
<td>□ Verify software level requirements</td>
<td>1.3.2, “Software requirements” on page 7</td>
</tr>
<tr>
<td>□ Identify eligible workloads</td>
<td>2.1, “Identifying eligible workloads” on page 14</td>
</tr>
<tr>
<td>□ Ensure host and DASD hardware are within zHyperLink range (150 m)</td>
<td>2.1.1, “zHyperLink in different site configurations” on page 15</td>
</tr>
<tr>
<td>□ Determine number of required zHyperLink adapters</td>
<td>2.2.1, “Number of connections” on page 20</td>
</tr>
<tr>
<td>□ Measure environment before enabling zHyperLink</td>
<td>2.2.2, “Sizing your system by using Resource Measurement Facility” on page 21</td>
</tr>
<tr>
<td>□ Order Feature Codes for z14 and DS8880</td>
<td>3.1.1, “Ordering features” on page 40</td>
</tr>
<tr>
<td>□ Update the Microcode Levels on the z14 and IBM DS8880</td>
<td>3.1.2, “Updating microcode” on page 40</td>
</tr>
<tr>
<td>□ Verify DS8880 Z Synergy License</td>
<td>3.1.3, “Enabling the DS8880 zHyperLink feature” on page 41</td>
</tr>
<tr>
<td>□ Install the Feature Codes for z14 and DS8880</td>
<td>3.1.4, “Installing features” on page 42</td>
</tr>
<tr>
<td>□ Connect the cables between z14 processor and the DS8880 subsystem</td>
<td>3.1.4, “Installing features” on page 42</td>
</tr>
<tr>
<td>□ Verify whether IBM Z C.U.I.R. support is enabled</td>
<td>3.1.5, “Activating zHyperLink on the DS8880” on page 42</td>
</tr>
<tr>
<td>□ Disable DS8880 I/O Priority Manager</td>
<td>3.1.5, “Activating zHyperLink on the DS8880” on page 42</td>
</tr>
<tr>
<td>□ Activate DS8880 zHyperLink for Read I/O</td>
<td>3.1.5, “Activating zHyperLink on the DS8880” on page 42</td>
</tr>
<tr>
<td>□ Update I/O Configuration</td>
<td>3.1.6, “Updating I/O configuration” on page 43</td>
</tr>
<tr>
<td>□ Verify zHyperLink cables</td>
<td>3.1.7, “Verifying zHyperLink cables” on page 49</td>
</tr>
<tr>
<td>□ Upgrade products to required version or release</td>
<td>3.2.1, “Product upgrades” on page 52</td>
</tr>
<tr>
<td>□ Run the SMP/E REPORT MISSINGFIX for FIXCAT, and install APARs or PTFs if required</td>
<td>3.2.2, “Product maintenance” on page 53</td>
</tr>
<tr>
<td>□ Verify that MACHMIG TX parameter is not specified in LOADxx member</td>
<td>3.3, “zHyperLink enablement” on page 54</td>
</tr>
<tr>
<td>□ Verify zHyperLink status on PCIe links</td>
<td>3.3, “zHyperLink enablement” on page 54</td>
</tr>
<tr>
<td>□ Verify enablement of zHPF</td>
<td>3.3, “zHyperLink enablement” on page 54</td>
</tr>
<tr>
<td>□ Enable zHyperLink on IOS</td>
<td>3.3, “zHyperLink enablement” on page 54</td>
</tr>
<tr>
<td>Task</td>
<td>Reference</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>□ Verify device status for zHyperLink</td>
<td>3.3, “zHyperLink enablement” on page 54</td>
</tr>
<tr>
<td>□ Configure System Automation</td>
<td>3.4.1, “System automation” on page 59</td>
</tr>
<tr>
<td>□ Activate VSAM for zHyperLink</td>
<td>3.5, “Activating zHyperLink for VSAM data sets” on page 60</td>
</tr>
<tr>
<td>□ Activate Db2 v12 for zHyperLink</td>
<td>3.6, “Activating zHyperLink for Db2” on page 62</td>
</tr>
<tr>
<td>□ Measure environment after enabling</td>
<td>3.7, “Measuring after deployment” on page 63</td>
</tr>
<tr>
<td>zHyperLink</td>
<td></td>
</tr>
</tbody>
</table>
Sample IOCDS

The IOCDS zHyperLink statements for two z14 features that are assigned to two Logical Partitions (LPARs) are provided in this appendix.

Sample I/O Configuration Data Set (IOCDS) statements for the zHyperLink configuration are described in 3.1.6, “Updating I/O configuration” on page 43.
Sample IOCDS

The IOCDS statements for two zHyperLink adapters for two LPARs are shown in Figure B-1. In this scenario, only the first port of each adapter is configured, and two other LPARs are specified on the Candidate List.

```
FUNCTION FID=1001, VF=1, PCHID=140, *
  PART=((LPZOSAPR), (LPZOSCDE, LPZOSDDE), TYPE=HYL, PORT=1
FUNCTION FID=1002, VF=2, PCHID=140, *
  PART=((LPZOSAPR), (LPZOSCDE, LPZOSDDE), TYPE=HYL, PORT=1
FUNCTION FID=1003, VF=3, PCHID=140, *
  PART=((LPZOSAPR), (LPZOSCDE, LPZOSDDE), TYPE=HYL, PORT=1
FUNCTION FID=1004, VF=4, PCHID=140, *
  PART=((LPZOSAPR), (LPZOSCDE, LPZOSDDE), TYPE=HYL, PORT=1
FUNCTION FID=1005, VF=1, PCHID=1A8, *
  PART=((LPZOSAPR), (LPZOSCDE, LPZOSDDE), TYPE=HYL, PORT=1
FUNCTION FID=1006, VF=2, PCHID=1A8, *
  PART=((LPZOSAPR), (LPZOSCDE, LPZOSDDE), TYPE=HYL, PORT=1
FUNCTION FID=1007, VF=3, PCHID=1A8, *
  PART=((LPZOSAPR), (LPZOSCDE, LPZOSDDE), TYPE=HYL, PORT=1
FUNCTION FID=1008, VF=4, PCHID=1A8, *
  PART=((LPZOSAPR), (LPZOSCDE, LPZOSDDE), TYPE=HYL, PORT=1
FUNCTION FID=1101, VF=1, PCHID=1A8, *
  PART=((LPZOSBPR), (LPZOSCDE, LPZOSDDE), TYPE=HYL, PORT=1
FUNCTION FID=1102, VF=2, PCHID=1A8, *
  PART=((LPZOSBPR), (LPZOSCDE, LPZOSDDE), TYPE=HYL, PORT=1
FUNCTION FID=1103, VF=3, PCHID=1A8, *
  PART=((LPZOSBPR), (LPZOSCDE, LPZOSDDE), TYPE=HYL, PORT=1
FUNCTION FID=1104, VF=4, PCHID=1A8, *
  PART=((LPZOSBPR), (LPZOSCDE, LPZOSDDE), TYPE=HYL, PORT=1
FUNCTION FID=1105, VF=5, PCHID=1A8, *
  PART=((LPZOSBPR), (LPZOSCDE, LPZOSDDE), TYPE=HYL, PORT=1
FUNCTION FID=1106, VF=6, PCHID=1A8, *
  PART=((LPZOSBPR), (LPZOSCDE, LPZOSDDE), TYPE=HYL, PORT=1
FUNCTION FID=1107, VF=7, PCHID=1A8, *
  PART=((LPZOSBPR), (LPZOSCDE, LPZOSDDE), TYPE=HYL, PORT=1
FUNCTION FID=1108, VF=8, PCHID=1A8, *
  PART=((LPZOSBPR), (LPZOSCDE, LPZOSDDE), TYPE=HYL, PORT=1
```

Figure B-1  Sample IOCDS
DCOLLECT

DCOLLECT Record Type ‘SC’ is modified to support zHyperLink and display the new SC attributes zHyperLink Read and zHyperLink Write.

The mapping of DCOLLECT data is provided in this appendix.
Two bits of CMM flags were assigned to display zHyperLink attributes. The first bit DSCHLERD being ON indicates that zHyperLink Read is eligible. The second bit DSCHLEWR being ON indicates that zHyperLink Write is eligible.

The mapping of DCOLLECT data is listed in Table C-1.

### Table C-1 Sample of DCOLLECT

<table>
<thead>
<tr>
<th>Offset</th>
<th>Type</th>
<th>Length</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>265(X'109')</td>
<td>UNSIGNED</td>
<td>1</td>
<td>DSCPAV</td>
<td>PAV requirements, 0 = None, 1 = Standard, 2 = Preferred, 3 = Required</td>
</tr>
<tr>
<td>266(X'10A')</td>
<td>UNSIGNED</td>
<td>1</td>
<td>DSCSTOSL</td>
<td>OAM SUBLEVEL VALUE</td>
</tr>
<tr>
<td>267(X'10B')</td>
<td>BITSTRING</td>
<td>1</td>
<td>DSCVFLG2</td>
<td>VSAM FLAG 2</td>
</tr>
<tr>
<td>268(X'108')</td>
<td>BITSTRING</td>
<td>1</td>
<td>DSCCMMFT</td>
<td>CMM Flags</td>
</tr>
<tr>
<td>[...]</td>
<td></td>
<td>[...]</td>
<td>DSCDCLS</td>
<td>Disconnect Sphere at CLOSE 1 = YES 0 = NO</td>
</tr>
<tr>
<td>.111 1111</td>
<td>*</td>
<td></td>
<td>RESERVED</td>
<td></td>
</tr>
<tr>
<td>1... ....</td>
<td>DSCCHLERD</td>
<td></td>
<td></td>
<td>Eligible for zHyperLink Reads 1 = YES 0 = NO</td>
</tr>
<tr>
<td>.1... ....</td>
<td>DSCCHLEWR</td>
<td></td>
<td></td>
<td>Eligible for zHyperLink Writes 1 = YES 0 = NO</td>
</tr>
</tbody>
</table>
Related publications

The publications that are listed in this section are considered particularly suitable for a more
detailed discussion of the topics that are covered in this paper.

IBM Redbooks

The following IBM Redbooks publications provide more information about the topic in this
document. Note that some publications that are referenced in this list might be available in
softcopy only:

- *System Management Interface Tool SMIT*, REDP-0105
- *IBM Z Connectivity Handbook*, SG24-5444
- *IBM z14 Technical Guide*, SG24-8451
- *IBM DS8880 and IBM Z Synergy*, REDP-5186

You can search for, view, download, or order these documents and other Redbooks,
Redpapers, Web Docs, draft, and additional materials, at the following website:

ibm.com/redbooks

Other publications

The following publications are also relevant as further information sources:

- *MVS System Commands Version 2 Release 3*, SA38-0666
- *MVS System Messages Volume 9 (IGF-IWM) Version 2 Release 3*, SA38-0676

Online resources

The following websites are also relevant as further information sources:

- IBM Techdocs zBNA:
- IBM Techdocs CP3KEXTR:
  http://www.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/PRS4229
- IBM Resource Link:
  https://www.ibm.com/server/resourcelink
- IBM Data Storage Feature Activation:
  https://www-03.ibm.com/storage/dsfa/home.wss
Help from IBM

IBM Support and downloads
ibm.com/support

IBM Global Services
ibm.com/services