



System i  
Systems management  
Availability roadmap

*Version 5 Release 4*







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**Note**

Before using this information and the product it supports, read the information in "Notices," on page 23.

**Fourth Edition (February 2006)**

This edition applies to version 5, release 4, modification 0 of IBM i5/OS (product number 5722-SS1) and to all subsequent releases and modifications until otherwise indicated in new editions. This version does not run on all reduced instruction set computer (RISC) models nor does it run on CISC models.

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## Availability roadmap

In today's fast-paced Internet environment, it is crucial that your data and applications be available to you when you need them. If your customers cannot access your Web site because your system is down, they might go to your competitors instead.

*Availability* is the measure of how often your data and applications are ready for you to access when you need them. Different companies have different availability needs. Different systems or different applications within the same company might have different availability needs. The purpose of this topic is to guide you through the world of System i™ availability and help you decide which availability tools are right for your business. It is important to note that availability requires detailed planning. These availability tools are only useful if you have implemented them before an outage occurs.

Before you can really start to plan for availability on your system, you should become familiar with the basic availability concepts, understand the costs and risk associated with outages, and determine your company's needs for availability. After you have a basic understanding of availability concepts and know what level of availability you need, you can start to plan for that level of availability on a single system or on multiple systems within a cluster environment.

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### What's new for V5R4

This topic highlights changes made to this topic collection for V5R4.



#### Enhancements to Availability roadmap information

For this release, several updates have been made to the information. These updates include the following subject matter:

- Descriptions of new disk protection features, such as auxiliary write cache input/output adapter (IOA) and RAID 6.
- New information about data resilience technologies.
- New information about saving from a second copy of data.
- Enhancements to current information about backup window reduction, system-managed access-path protection (SMAPP), and journaling.

#### How to see what's new or changed

To help you see where technical changes have been made, this information uses:

- The  image to mark where new or changed information begins.
- The  image to mark where new or changed information ends.

To find other information about what's new or changed this release, see the Memo to users.

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## Availability concepts

- | Before you plan for the availability of your system, it is important for you to understand some of the concepts associated with availability.
- | Businesses and their IT operations that support them must determine which solutions and technologies address their business needs. In the case of business continuity requirements, the task is equally daunting. Detailed business continuity requirements must be developed and documented, the solution types must be identified, and the solution choices must be evaluated. This is a challenging task due in part to the complexity of the problem.
- | *Business continuity* is the capability of a business to withstand outages, which are times when the system is unavailable, and to operate important services normally and without interruption in accordance with predefined service-level agreements. To achieve a given level of business continuity, a collection of services, software, hardware, and procedures must be selected, described in a documented plan, implemented, and practiced regularly. The business continuity solution must address the data, the operational environment, the applications, the application hosting environment, and the user interface. All must be available to deliver a good, complete business continuity solution. Your business continuity plan includes disaster recovery and high availability (HA).
- | Disaster recovery provides a plan in the event of a complete outage at the production site of your business, such as during a natural disaster. Disaster recovery provides a set of resources, plans, services, and procedures used to recover important applications and to resume normal operations from a remote site. This disaster recovery plan includes a stated disaster recovery goal (for example, resume operations within eight hours) and addresses acceptable levels of degradation.
- | Another major aspect of business continuity goals for many customers is *high availability*, which is the ability to withstand all outages (planned, unplanned, and disasters) and to provide continuous processing for all important applications. The ultimate goal is for the outage time to be less than .001% of the total service time. The differences between high availability and disaster recovery typically include more demanding recovery time objectives (seconds to minutes) and more demanding recovery point objectives (zero user disruption).
- | Availability is measured in terms of *outages*, which are periods of time when the system is not available to users. During a planned outage (also called a scheduled outage), you deliberately make your system unavailable to users. You might use a scheduled outage to run batch work, back up your system, or apply fixes.
- | Your *backup window* is the amount of time that your system can be unavailable to users while you perform your backup operations. Your backup window is a scheduled outage that typically occurs in the night or on a weekend when your system has less traffic.



| An *unplanned outage* (also called an unscheduled outage) is typically caused by a failure. You can recover from some unplanned outages (such as disk failure, system failure, power failure, program failure, or human error) if you have an adequate backup strategy. However, an unplanned outage that causes a complete system loss, such as a tornado or fire, requires you to have a detailed disaster recovery plan in place in order to recover.

| High availability solutions provide fully automated failover to a backup system to ensure continuous operation for users and applications. These HA solutions must provide an immediate recovery point and ensure that the time of recovery is faster than a non-HA solution.

| Unlike with disaster recovery, where entire systems experience an outage, high availability solutions can be customized to individual critical resources within a system; for example, a specific application instance. High availability solutions are based on cluster technology. You can use clusters to avoid the impacts of both planned and unplanned outages. Even though you still have an outage, the business function is not impacted by the outage. A *cluster* is a collection of interconnected complete systems used as a single, unified resource. The cluster provides a coordinated, distributed process across the systems to deliver the solution. This results in higher levels of availability, some horizontal growth, and simpler administration across the enterprise. For a complete solution, you must address the operational environment, the application hosting environment, application resilience, and the user interfaces in addition to providing the data resilience mechanisms. Clusters focus on all aspects of the complete solution. The integrated cluster resource services enable you to define a cluster of systems and the set of resources that should be protected against outages. Cluster resource services detect outage conditions and coordinate automatic movement of critical resources to a backup system.

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## Estimating the value of availability

You need to build a business case for improving availability when you are asked to justify the cost of additional hardware to support availability.

To estimate the value of your information services, follow these steps:

- | **1. Develop a list of the major services and solutions that your system provides.** Your system exists so that users and solutions can accomplish tasks that are critical to the operation of your business. The systems provide solutions to a business function. If the system is unavailable, the business function cannot be completed or is significantly degraded to the point of causing the business lost revenue or increased expenses.
- | **2. Assess how much it costs you when these services are unavailable.** Each application or service has a direct effect on business functions. You need to determine how these business functions would be affected and what would be the overall cost to your business if these services were unavailable.
- | **3. Look at direct costs versus indirect costs.** Direct costs are losses that can be traced directly to a system being unavailable. Indirect costs are those that are incurred by another department or function as a result of an outage.
- | **4. Consider tangible costs versus intangible costs.** Tangible costs can be measured in currency. However, there are other costs that are not measured with money, such as market share, lost opportunity, and good will.
- | **5. Analyze fixed costs versus variable costs.** Fixed costs are those that result from a failure and are the same, regardless of the length of the outage. Variable costs are those that vary, based on the length of the outage.

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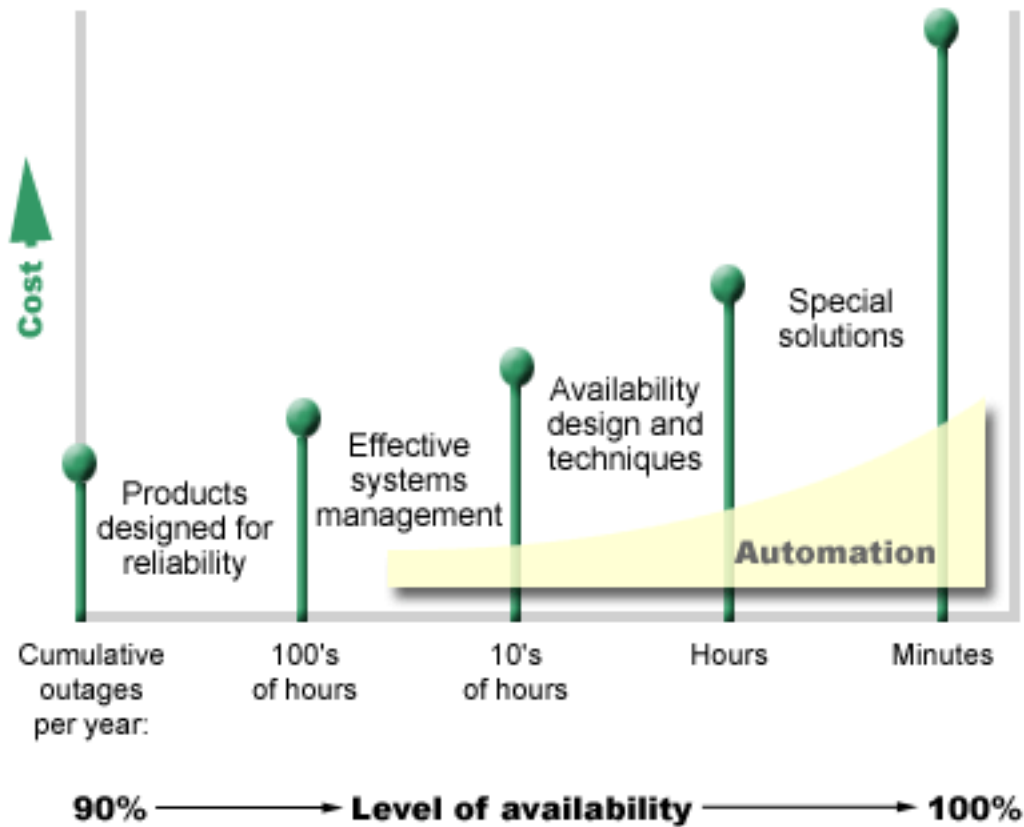
## Deciding what level of availability you need

After understanding availability at a basic level, it is important to assess your individual availability needs. Higher availability is more costly than a lower level availability. You must balance your needs and services with the overall cost of implementing and maintaining these availability solutions.

You want to be sure that you have analyzed your business needs thoroughly in order to decide what level of availability you can afford to maintain. To decide what level of availability you need, consider the following questions:

### Do you have any applications that require 100% availability?

In most cases, you can achieve a high level of availability by implementing sound processes and systems management practices. The closer you need to be to continuous availability, the more of an investment you must make. Before you make that kind of investment, you should be sure that you require that level of availability. The following figure shows how different techniques can improve availability, but can increase the price you must pay for it.



- | If your requirements for levels of availability increase, you can consider multiple system availability solutions, such as clusters.

### How much downtime is acceptable to you?

It is helpful to know the amount of downtime that each level of availability represents. The following table shows the amount of downtime expected for different levels of availability.

Level of availability	Downtime per year
90%	36.5 days
95%	18.25 days
99%	3.65 days
99.9%	8.76 hours

Level of availability	Downtime per year
99.99%	50 minutes
99.999%	5 minutes

Along with knowing how much downtime is acceptable to you, you need to consider how that downtime might occur. For example, you might think that 99% availability is acceptable if the downtime is a series of shorter outages that are distributed over the course of a year, but you might think differently about 99% availability if the downtime is actually a single outage that lasts three days.

- You also need to consider when a downtime is acceptable and when it is not. For example, your average annual downtime goal per year might be nine hours. If that downtime were to occur during critical business hours, it might have an adverse effect on the bottom line revenue for your company.

### What level of access do your customers need to your business?

- It used to be that customers and business partners accessed your business from 9 a.m. to 5 p.m., so it was realistic to expect that your system only had to be available during those hours. However, the Internet and a diverse global marketplace have changed that expectation; customers and business associates might expect to have access to your company's data at any time of the day or night. Your working hours might be hours or even days different from your global business partner or customer. You must determine what your customer expectations are, and what is realistic with regard to those expectations, as you determine what level of availability you will maintain.

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## Preventing unplanned outages


One way to approach availability is to try to prevent unplanned outages. You can use these different methods to ensure that your system experiences as little unplanned downtime as possible.

**Note:** If you have a single system and you cannot achieve the level of availability you need using these strategies, you can consider clusters.

## Preparing for disk failures

Because your data is spread across your disks, it is important that you consider how to protect your data if one of those disks fails. Disk protection help ensure the availability of data stored on the disks.

Disk storage is the storage that is either internal to your system or is attached to it. This disk space, together with your system's main memory, is regarded by your system as one large storage area. When you save a file, you do not assign it to a storage location; instead, the system places the file in the location that ensures the best performance. It might spread the data in the file across multiple disk units. When you add more records to the file, the system assigns additional space on one or more disk units. This way of addressing storage is known as *single-level storage*.

- In addition to internal disk storage, you can also use IBM® System Storage DS™ products to attach a large volume of external disk units. These storage products provide enhanced disk protection, the ability to copy data quickly and efficiently to other storage servers, and the capability of assigning multiple paths to the same data to eliminate connection failures. For additional information about IBM System Storage DS products and to determine whether this solution is right for you, see Enterprise disk storage .

## Device parity protection

- Device parity protection allows your system to continue to operate when a disk fails or is damaged. When you use device parity protection, the disk input/output adapter (IOA) calculates and saves a parity value for each bit of data. The IOA computes the parity value from the data at the same location on each

| of the other disk units in the device parity set. When a disk failure occurs, the data can be reconstructed  
| by using the parity value and the values of the bits in the same locations on the other disks. Your system  
| continues to run while the data is being reconstructed.

| The i5/OS<sup>®</sup> operating system supports two types of device parity protection:

#### | **RAID 5**

| With RAID 5, the system can continue to operate if one disk fails in a parity set. If more than one disk  
| fails, data will be lost and you must restore the data for the entire system (or only the affected disk pool)  
| from the backup media. Logically, the capacity of one disk unit is dedicated to storing parity data in a  
| parity set consisting of 3 to 18 disk units.

#### | **RAID 6**

| With RAID 6, the system can continue to operate if one or two disks fail in a parity set. If more than two  
| disk units fail, you must restore the data for the entire system (or only the affected disk pool) from the  
| backup media. Logically, the capacity of two disk units is dedicated to storing parity data in a parity set  
| consisting of 4 to 18 disk units.

#### | **Write cache and auxiliary write cache IOA**

| When the system sends a write operation, the data is first written to the write cache on the disk IOA and  
| then later written to the disk. If the IOA experiences a failure, the data in the cache might be lost and  
| cause an extended outage to recover the system.

| The auxiliary write cache is an additional IOA that has a one-to-one relationship with a disk IOA. The  
| auxiliary write cache protects against extended outages due to the failure of a disk IOA or its cache by  
| providing a copy of the write cache which can be recovered following the repair of the disk IOA. This  
| avoids a potential system reload and gets the system back on line as soon as the disk IOA is replaced and  
| the recovery procedure completes. However, the auxiliary write cache is not a failover device and cannot  
| keep the system operational if the disk IOA (or its cache) fails.

### **Mirrored protection**

Disk mirroring is recommended to provide the best system availability and the maximum protection  
against disk-related component failures. Data is protected because the system keeps two copies of the  
data on two separate disk units. When a disk-related component fails, the system can continue to operate  
without interruption by using the mirrored copy of the data until the failed component is repaired.

| Different levels of mirrored protection are possible, depending on what hardware is duplicated. The level  
| of mirrored protection determines whether the system keeps running when different levels of hardware  
| fail. To understand these different levels of protection, see [Determining the level of mirrored protection](#)  
| that you want.

| You can duplicate the following disk-related hardware:

- Disk unit
- Disk controllers
- I/O bus unit
- I/O adapter
- I/O processors
- A bus
- Expansion towers
- High-speed link (HSL) ring

## Independent disk pools

With independent disk pools (also called independent auxiliary storage pools), you can prevent certain unplanned outages because the data on them is isolated from the rest of your system. If an independent disk pool fails, your system can continue to operate on data in other disk pools. Combined with different levels of disk protection, independent disk pools provide more control in isolating the effect of a disk-related failure as well as better prevention and recovery techniques.

## Geographic mirroring

*Geographic mirroring* is a function that keeps two identical copies of an independent disk pool at two sites to provide high availability and disaster recovery. The copy owned by the primary node is the production copy and the copy owned by a backup node at the other site is the mirror copy. User operations and applications access the independent disk pool on the primary node that owns the production copy. Geographic mirroring is a sub-function of cross-site mirroring (XSM), which is a part of i5/OS Option 41, High Available Switchable Resources.

## Multipath disk units

- | You can define up to eight connections from each logical unit number (LUN) created on the IBM TotalStorage® Enterprise Storage Server® (ESS) or IBM System Storage DS products to the input/output processors (IOPs) on the system. Assigning multiple paths to the same data allows the data to be accessed even though some failures might occur in other connections to the data. Each connection for a multipath disk unit functions independently. Several connections provide availability by allowing disk storage to be used even if a single path fails.

### Related information

Disk management

## Preparing for power loss

To ensure that your system is available when you need it, you need to make sure that it has an adequate supply of power and that it is protected in the event that power is lost.

## Power requirements

Part of the planning process for your system is to ensure that you have an adequate power supply. You need to understand your system's requirements and then enlist the aid of a qualified electrician to help install the appropriate wiring, power cords, plugs, and power panels. For details on how to ensure that your system has adequate power, see *Plan for power*.

## Redundant power supplies

- | Some systems are designed with a fully redundant power system. A redundant power supply is a feature that prevents an unplanned outage by providing power if one power supply fails.

Some systems support a dual power cable feature. This allows you to provide power to the system from two different external power sources. This can avoid an unplanned outage if one power source fails.

## Uninterruptible power supplies

Even when you have an adequate power supply, there are still times when you might lose power, such as during a storm. To prevent unplanned outages that result from losing power, you might need to invest in hardware specifically designed to keep your system going when power is lost. One such piece of hardware is an *uninterruptible power supply*. You can use an uninterruptible power supply to provide auxiliary power to your processor, disks, system console, and any other devices. Uninterruptible power supplies provide the following advantages:

- Let you continue operations during brief power outages (brown outs).
- Protect the system from voltage peaks (white outs).
- Provide a normal end of operations in case of an extended power outage, which can reduce your recovery time when you restart your system. For information about how to write a program that helps you control your system's shutdown in these conditions, see Controlling system shutdown using a power-handling program.

For information about which uninterruptible power supplies are compatible with your system, see Uninterruptible power supply.

## Generator power

To prevent a long outage because of an extended power failure, you might consider purchasing a generator. A generator goes a step further than an uninterruptible power supply in that it enables you to continue normal operations during longer power failures.

### Related information



Plan for power

Controlling system shutdown using a power-handling program



Uninterruptible power supply

## Using effective systems management practices

One of the simplest ways to prevent unplanned outages is to ensure that you are doing everything you can to keep your system running smoothly. This includes performing basic preventive maintenance and systems management tasks that help your system perform at its peak.

Many of these systems management tasks can be automated, which helps you prevent failures that might occur because of human error or an oversight.

One way you can help ensure the availability of your system is to monitor its performance and react promptly to any problems that you encounter. You can use the collection services and monitors functions in Management Central to actively monitor and track the performance of your system. You can be notified of any problems that jeopardize the availability of your system in time to react and prevent an unplanned outage.

Fixes are also an important systems management component that can help you keep your system available. When problems are discovered in i5/OS or other IBM software, IBM issues a fix (also known as a PTF, or program temporary fix) to solve the problem. You need to be aware of fixes and install them on your system to ensure that your system is operating at its optimal level. You should create a fix management strategy and make checking for and applying fixes part of the routine maintenance for your system. For more information about how to obtain and apply fixes, refer to Using software fixes. For help in determining a strategy for preventive maintenance based on your i5/OS environment and applications, see Guide to fixes.

In addition, you should also develop a strategy of when and how new applications are added to your systems. Before adding a new application or updating an existing application, ensure that any software, hardware, or other dependencies are understood and in place. It is also important to plan and test these new or changed applications before introducing them into a production environment to help avoid potential outages or other unexpected impacts.



### Related information

Performance




Maintain and manage i5/OS and related software

## Preparing the space for your system

One way to prevent unplanned outages is to ensure that the space where you put your system promotes availability. Many physical and environmental factors contribute to how your system performs.

The first thing you need to do is to familiarize yourself with your system. Different system models have different requirements with regard to the conditions they are in, so you should be aware of what your system needs. For more information about the physical characteristics of each model, see [Server specifications](#) . For information about the physical characteristics of the hardware that you can attach to your system, see [Hardware specification sheets](#) .

After you are familiar with the physical characteristics of your system, be sure to consider the following information about the space where the system resides:

- **Location.** The physical location of your system can have an impact on how available it is. For example, if the room is not secure, your system might be vulnerable to vandalism or even someone accidentally dislodging the power cord. For more details on what precautions you need to take with regard to your system's location, see [Physical site planning and preparation](#) .
- **Cables.** Cables are often overlooked, but without them your system will be unusable. You need to ensure that your cables are in good condition and are being used correctly. For more information about how to ensure that your cables do the job that you want them to do, see [Plan for cables](#) .
- **Environment.** The environment you provide for your system is also crucial to the availability. The environment includes such things as temperature, humidity, and other factors that can inhibit the performance of your system. For more detailed information about the environment you need to provide for your system, see [Physical site planning and preparation](#) .

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## Shortening unplanned outages

Unplanned outages do occur, and a key to availability is to ensure that you can recover from the outages as quickly as possible.

The purpose of all recovery strategies is to get back to where you were before the outage occurred.

If you have a single system and you cannot achieve the level of availability you need using these strategies, you can consider clusters.

## Reducing the time to restart your system

Unfortunately, systems periodically experience an unplanned outage. Use the availability tools described here to restart your system as quickly as possible after an unplanned outage.

| Before your system turns off, it performs certain activities to ensure that your data is protected and that  
| jobs are ended in a controlled manner. When you experience an unplanned outage, your system cannot  
| perform these activities. Each of these tools should be used together to quicken the startup times for your  
| system.

For more details on what happens when your system ends abnormally, see [Starting and stopping the system](#)

Use the [Reducing iSeries™ IPL Time experience report](#) to learn how to control the time that it takes to start your system.

## System-managed access-path protection (SMAPP)

An *access path* is the route that an application takes through a database file to get to the records it needs. A file can have multiple access paths, if different programs need to see the records in different sequences. When your system ends abnormally, such as during an unplanned outage, the system must rebuild the access paths the next time it starts, which might take a long time. When you use system-managed access-path protection, the system protects the access paths so that they do not need to be rebuilt when your system starts after an unplanned outage. This saves you time when you restart your system, which enables you to get back to your normal business processes as quickly as possible.

### Journaling access paths

Like SMAPP, journaling access paths can help you to ensure that critical files and access paths are available as soon as possible after you restart your system. However, when you use SMAPP, the system decides which access paths to protect. Therefore, if the system does not protect an access path that you consider critical, you might be delayed in getting your business running again. When you journal the access paths, you decide which paths to journal.

- | SMAPP and journaling access paths can be used separately. However, if you use these tools together, you
- | can maximize their effectiveness for reducing startup time by ensuring that all access paths that are
- | critical to your business operations are protected.
  
- | Protecting your access paths is also important if you plan to use any disk-based copy services, such as
- | cross-site mirroring or the remote mirror and copy features that are supported on the IBM System Storage
- | DS products, to avoid rebuilding access paths when you failover to a backup system.

### Independent disk pools

When a system is started or restarted, you can start each independent disk pools individually. By starting each independent disk pool separately, the system can be made available more quickly. You can prioritize the workload so that the critical data becomes available first. You can then vary on independent disk pools in a specific order based on this priority.

#### Related information

Starting and stopping the system

System-managed access-path protection

Reducing iSeries IPL Time

Example: Make independent disk pool available at startup

## Recovering recent changes after an unplanned outage

After an unplanned outage, your goal is to get your system up and running again as quickly as possible. You want to get back to where you were before the outage occurred without having to manually reenter the transactions.

This might involve rebuilding some of your data. There are a few availability tools that you can use that help you get back to where you were before the outage more quickly.

### Journaling

Journal management prevents transactions from being lost if your system ends abnormally. When you journal an object, the system keeps a record of the changes you make to that object.



## Commitment control

Commitment control helps to provide data integrity on your system. With commitment control, you can define and process a group of changes to resources, such as database files or tables, as a single transaction. It ensures that either the entire group of individual changes occurs or that none of the changes occurs. For example, you lose power just as a series of updates are being made to your database. Without commitment control, you run the risk of having incomplete or corrupted data. With commitment control, the incomplete updates are backed out of your database when you restart your system.

You can use commitment control to design an application, so that the system can restart the application if a job, an activation group within a job, or the system ends abnormally. With commitment control, you can have assurance that when the application starts again, no partial updates are in the database because of incomplete transactions from a prior failure.

### Related information

Journal management

Commitment control

## Recovering lost data after an unplanned outage

You might lose data as a result of an unplanned outage, such as a disk failure. The most extreme example of data loss is losing your entire site, such as what might happen as a result of a natural disaster.

There are a few ways that you can prevent your data from being lost in these situations or at least limit the amount of data that is lost.

## Backup and recovery


It is imperative that you have a proven strategy for backing up your system. The time and money you spend on creating this strategy is more than recovered should you need to restore lost data or perform a recovery. After you have created a strategy, you must ensure that it works by testing it, which involves performing a backup and recovery, and then validating that your data was backed up and restored correctly. If you change anything on your system, you need to assess whether your backup and recovery strategy needs to be changed.

Every system and business environment is different, but you should try to do a full backup of your system at least once a week. If you have a very dynamic environment, you also should back up the changes to objects on your system since the last backup. If you have an unexpected outage and need to recover those objects, you can recover the latest version of them.

To help manage your backup and recovery strategy and your backup media, you can use Backup, Recovery, and Media Services (BRMS). BRMS is a program that helps you implement a disciplined approach to managing your backups, and provides you with an orderly way to recover lost or damaged data. Using BRMS, you can manage your most critical and complex backups, including online backups of Lotus® servers, simply and easily. You can also recover your system fully after a disaster or failure.

In addition to these backup and recovery features, BRMS enables you to track all of your backup media from creation to expiration. You no longer need to keep track of which backup items are on which volumes, and worry that you might accidentally write over active data. You can also track the movement of your media to and from offsite locations.

For detailed information about the tasks that BRMS can help you perform, see Backup, Recovery, and Media Services.

For help in planning and managing your backup and recovery strategy, see Business continuity and resiliency .

## Limiting the amount of data that is lost

You can group your disk drives into logical subsets called *disk pools* (also known as auxiliary storage pools or ASPs). The data in one disk pool is isolated from the data in the other disk pools. If a disk unit fails, you only need to recover the data in the disk pool that contains the failed unit.

*Independent disk pools* are disk pools that can be brought online or taken offline without any dependencies on the rest of the storage on a system. This is possible because all of the necessary system information associated with the independent disk pool is contained within the independent disk pool. Independent disk pools offer a number of availability and performance advantages in both single and multiple system environments.

*Logical partitions* provide the ability to divide one system into several independent systems. The use of logical partitions is another way that you can isolate data, applications, and other resources. You can use logical partitions to improve the performance of your system, such as by running batch and interactive processes on different partitions. You can also protect your data by installing a critical application on a partition apart from other applications. If another partition fails, that program is protected.

### Related information

- Planning a backup and recovery strategy
- Backing up your system
- Recovering your system
- Backup, Recovery, and Media Services (BRMS)
- Disk pools
- Disk management
- Independent disk pool examples
- Logical partitions

## | Reducing the time to vary on independent disk pools

| When unplanned outages occur, the data stored within independent disk pools is unavailable until they can be restarted. To ensure that the restart occurs quickly and efficiently, you can use the strategies described in this topic.

## | Synchronizing user profile name, UID, and GID

| In a clustered environment, a user profile is considered to be the same across systems if the profile names are the same. The name is the unique identifier in the cluster. However, a user profile also contains a user identification number (UID) and group identification number (GID). To reduce the amount of internal processing that occurs during a switchover, where the independent disk pool is made unavailable on one system and then made available on a different system, the UID and GID values should be synchronized across the recovery domain for the device CRG.

## | Using recommended structure for independent disk pools

| The system disk pool and basic user disk pools (SYSBAS) should contain primarily operating system objects, licensed program libraries, and few user libraries. This structure yields the best possible protection and performance. Application data is isolated from unrelated faults and can also be processed independently of other system activity. Vary on and switchover times are optimized with this structure.

| This recommended structure does not exclude other configurations. For example, you might start by migrating only a small portion of your data to a disk pool group and keeping the bulk of your data in SYSBAS. This is certainly supported. However, you should expect longer vary-on and switchover times with this configuration since additional processing is required to merge database cross-reference information into the disk pool group.

## | **Specifying a recovery time for the independent disk pool**

| To improve vary on performance after an abnormal vary off, consider specifying a private customized access path recovery time specifically for that independent disk pool via the Change Recovery for Access Paths (CHGRCYAP) command rather than relying upon the overall system-wide access path recovery time. This will limit the amount of time spent rebuilding access paths during the vary on.

### | **Related information**

- | Synchronizing user profile name, UID, and GID
- | Recommended structure for independent disk pools

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## **Shortening planned outages**

Planned outages are necessary and are expected; however, because they are planned does not mean they are nondisruptive. Planned outages are often related to system maintenance.

| Clusters can effectively eliminate planned outages by providing application and data availability on a second system or partition during the planned outage.

## **Shortening backup windows**

A key consideration of any backup strategy is determining your backup window, which is the amount of time that your system can be unavailable to users while you perform your backup operations. By reducing the amount of time it takes to complete your backups, you can also reduce the amount of time your system is unavailable.

The challenge is to back everything up in the window of time that you have. To lessen the impact the backup window has on availability, you can reduce the amount of time a backup takes using one or more of the following techniques.

### **Improved tape technologies**

Faster and denser tape technologies can reduce the total backup time. See Storage solutions for more information.

### **Parallel saves**

Using multiple tape devices concurrently can reduce backup time by effectively multiplying the performance of a single device. See Saving to multiple devices to reduce your save window for more details on reducing your backup window.

### **Saving to nonremovable media**

Saving to nonremovable media is faster than removable media. For example, directly saving to a disk unit can reduce the backup window. Data can be migrated to removable media at a later time. See Virtual tape media for more information.

### **Performing online backups**

You can reduce your backup window by saving objects while they are still in use on the system or by conducting online backups.

## | **Save-while-active**

| The save-while-active function is an option available through Backup, Recovery, and Media Services (BRMS) and on several save commands. Save-while-active can significantly reduce your backup window or eliminate it altogether. It allows you to save data on your system while applications are still in use without the need to place your system in a restricted state. Save-while-active creates a checkpoint of the

- | data at the time the save operation is issued. It saves that version of the data while allowing other
- | operations to continue.

## Online backups

Another method of backing up objects while they are in use is known as an *online backup*. Online backups are similar to save-while-active backups, except that there are no checkpoints. This means that users can use the objects the whole time they are being backed up. BRMS supports the online backup of Lotus servers, such as Domino® and QuickPlace®. You can direct these online backups to a tape device, media library, save files, or a Tivoli® Storage Manager (TSM) server.

**Note:** It is important that you continue to back up system information in addition to any save-while-active or online backups you do. There is important system information that cannot be backed up using save-while-active or online backups.

### Related information

- Saving your system while it is active
- Backup, Recovery, and Media Services (BRMS)

## Backup from a second copy

You can reduce the backup window by conducting backups from a second copy of the data.

**Note:** If you are saving from a second copy, ensure that the contents of the copy are consistent. You may need to quiesce the application.

These techniques are as follows:

## Saving from a second system

Some technologies, such as replication, make available a second copy of the data that can be used to shift the save window from the primary copy to the secondary copy. This technique can eliminate the backup window on the primary system since the backup processing is done on a second system.

## | IBM System Storage DS FlashCopy® used with Copy Services for System i

- | IBM System Storage™ DS6000™ and DS8000™ provides enhanced storage capabilities. This technology uses
- | the FlashCopy function on an independent disk pool. A single DS6000 or DS8000 server creates a
- | point-in-time version of the independent disk pool where the host is not aware of the copy. The toolkit
- | enables bringing the copy on to the backup system to perform save operations or other processing.

### Related information

 IBM System Storage and TotalStorage

 Copy Services for IBM System i

## Backing up less data

You can reduce your backup window by backing up smaller amounts of data at different times. There are several ways that you can isolate the data on your system for this type of operation.

**Note:** You can use Backup, Recovery, and Media Services (BRMS) to perform all of these kinds of backups.

## Incremental backups

Incremental backups enable you to save changes to objects since the last time they were backed up. There are two types of incremental backups: cumulative and changes-only. A *cumulative backup* specifies a backup that includes all changed objects and new objects since the last full backup. This is useful for

objects that do not change often, or do not change greatly between the full backups. A *changes-only backup* includes all changed objects and new objects since the last incremental or full backup.

Incremental backups are especially useful for data that changes frequently. For example, you do a full backup every Saturday night. You have some libraries that are used extensively and you need to back them up more frequently than once a week. You can use incremental backups on the other nights of the week instead of doing a full backup to capture them. This can shorten your backup window while also ensuring that you have a backup of the latest version of those libraries.

## Security data and configuration data

You can also reduce planned outages by isolating certain kinds of data and then backing it up separately. Security data includes user profiles, authorization lists, and authority holders. Configuration data includes information about how your system is set up, such as line descriptions, device descriptions, and configuration lists. These types of data are saved as part of a full system backup, but you can also save them separately without having to shut your system down. For details on how to back up these types of data, see *Manually saving parts of your system*.

## Omitting certain items

You can also reduce your backup window by reducing the number of objects you save or preventing objects from being saved more than once. You can do this by choosing to omit certain objects from a backup. For example, you might want to save all user libraries except for temporary libraries. You can choose to omit all temporary libraries from your backup, which will shorten the length of backup processing. Many of the commands that you use to save your system give you the option to omit items from the backup. For details on these commands, see *Commands for saving parts of your system* and *Commands for saving specific object types*. You can also use Backup, Recovery, and Media Services (BRMS) to omit items from a backup.

## | Data archiving

| Any data that is not needed for normal production can be archived and taken offline. It is brought online  
| only when needed, perhaps for month-end or quarter-end processing. The daily backup window is  
| reduced since the archived data is not included.

### Related information

Manually saving parts of your system

Commands for saving parts of your system

Commands for saving specific object types

## Shortening software maintenance and upgrading windows

You can keep your system available by effectively planning and managing fixes and installing new releases.

## Managing fixes

To reduce the amount of time your system is unavailable, you should ensure that you have a fix management strategy in place. If you stay current on what fixes are available and install them on a routine basis, you will have fewer problems. Be sure that you apply fixes as frequently as you have decided is appropriate for your business needs.

Individual fixes can be delayed or immediate. Delayed fixes can be loaded and applied in two separate steps. They can be loaded while your system runs and then applied the next time you restart your system. Immediate fixes do not require you to restart your system for them to take effect, which eliminates the need for downtime. Immediate fixes might have additional activation steps that are

described in full in the cover letter that accompanies the fix.

## Upgrading to a new release

You are required to turn off your system when you upgrade to a new version of i5/OS. To minimize the amount of time a software upgrade takes, it is important that you plan your installation carefully.

### Related information

Planning your fix management strategy

Installing fixes

Upgrading or replacing i5/OS and related software

## Shortening hardware maintenance and upgrade windows

By effectively planning hardware maintenance and upgrades, you can greatly reduce and even eliminate the impact of these activities to the availability of your system.

There are times when you need to perform routine maintenance on your hardware or increase the capacity of your hardware. These operations can be disruptive to your business.

If you are performing a system upgrade, be sure that you plan carefully before you begin. The more carefully you plan for your new system, the faster the upgrade will go.

### | Concurrent maintenance

| Many hardware components on the system can be replaced, added, or removed concurrently while the  
| system is operating. For example, the ability to hot plug is supported for Peripheral Component  
| Interconnect (PCI) card slots, disk slots, redundant fans, and power supplies. Concurrent maintenance  
| improves the availability of the system and allows you to perform certain upgrades, maintenance, or  
| repairs without impacting the users of the system.

## Capacity on Demand

With Capacity on Demand, you can activate additional processors and pay only for the new processing power as your needs grow. You can increase your processing capacity without disrupting any of your current operations.

Capacity on Demand is a feature that offers the capability to nondisruptively activate one or more central processors of your system. Capacity on Demand adds capacity in increments of one processor, up to the maximum number of standby processors built into your model. Capacity on Demand has significant value for installations where you want to upgrade without disruption.

### Related information

Concurrent maintenance

Upgrading your system

Capacity on Demand

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## Availability for multiple systems: Clusters


For multiple system environments, you can use clusters as a strategy to maintain a high or continuous availability for your systems and applications.

A *cluster* is a collection or group of multiple systems that work together as a single system. If your business needs high or continuous availability, you should consider a clustering solution.

The systems in a cluster work cooperatively to provide a single computing solution. You can have up to 128 systems in a cluster. This allows you to efficiently group your systems together to set up an environment that provides availability that approaches 100 percent for your critical applications and data. This helps ensure that your essential systems and applications are always available. Clusters also provide simplified systems management and increased scalability to easily add new components as your business grows.

You must weigh the cost of this solution against the cost of downtime on your system to decide whether to implement clusters in your business.


If you do choose to use clusters in your environment, you will have the added benefit of improving application availability. The level of application availability depends on how well the application integrates with cluster resource services. For more information about these applications, see Highly available programs.

To learn more about clusters, including how they work and how to implement clusters in your business, see Clusters. For more information about clusters in the context of other high availability solutions, see High Availability and Clusters .

## Highly available programs

Highly available applications provide users continued access to data and application functions despite a planned or unplanned outage. The i5/OS operating system provides an application resilience architecture that supports various degrees of highly available applications. Applications at the high end of the availability spectrum are enhanced with integrated functions and provide automation of the environment. These functions are controlled by cluster management utilities. For more information about these topics, see Cluster applications.

### Cluster middleware

- | Cluster middleware is a group of competitive third party products that provide cluster management and data replication functions and services. These products make full use of the Cluster Resource Services functions of i5/OS and adhere to the cluster architecture. For a list of the cluster middleware products and a description of the criteria these programs must meet, see High Availability and Clusters. .


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## Data resilience solutions for i5/OS clusters

This topic contains an overview of different data resilience technologies that can be used to with i5/OS clusters to enhance high availability in multiple system environments.

*Data resilience* is the ability for the data to remain accessible to the application even if the system that originally hosted the data fails. Choosing the correct set of data resilience technologies in the context of your overall business continuity strategy can be complex and difficult. It is important to understand the different data resilience solutions that can be used alone or with clusters to enhance availability in multiple system environments. You can either choose a single solution or use a combination of these technologies to meet your needs.

For more details on these solutions, see Data Resilience Solutions for IBM i5/OS High Availability

Clusters . The section called "Comparison characteristics" contains a detailed comparison of the attributes for each of these technologies.

## Replication

With replication, changes to an object are copied to a saved version with near real-time accuracy. Replication is one of the most widely used high availability solutions in multiple system environments. This solution is most often implemented through a business partner.

Consider replication when you have the following requirements:

- You need two or more copies of the data.
- You want concurrent access to the second copy of data.
- You need backup window reduction.
- You need to selectively replicate the objects within a library or directory.
- Your IT staff can monitor the state of the replication environment.
- You need geographic dispersion between copies, especially if they need distances greater than what can be achieved by hardware solutions.
- You already have deployed a solution using logical object replication.
- You need a solution that has no special hardware configuration requirements.
- Failover and switchover times should not exceed tens of minutes.
- Transaction level integrity is important for all the journaled objects.

## Switchable disk pools

Switchable disk pools are storage devices on the operating system that are independent of a particular system. This allows you to switch disk pools from one system to another without performing a full initial program load (IPL). The key benefits to switchable disk pools involve its simple design and maintenance. One copy of the data is always current with no other version to synchronize so that there is minimal administration.

Consider switchable disk pools when you have the following requirements:

- Only one copy of the data with hardware protection satisfies your requirement and you have considered or addressed avoiding unplanned outages because of disk subsystem failures.
- You need a simple, low cost and low maintenance solution.
- Disaster recovery is not needed.
- You only need coverage for planned outages and certain types of unplanned outages.
- The source and target system are at the same site.
- You want consistent failover and switchover times within minutes and that do not depend on transaction volumes.
- Transaction-level integrity is important for all objects.
- You need immediate availability of all object changes with no loss of in-flight data.
- Objects not within an independent disk pool either do not need to be replicated or are handled by using some other mechanism.
- You need the highest throughput environment.
- Your environment calls for multiple, independent databases that can be moved between the systems.

## Cross-site mirroring

*Cross-site mirroring*, combined with the geographic mirroring function, enables you to mirror data on disks at sites that can be separated by a significant geographic distance. Geographic mirroring provides the ability to replicate the changes made to the production copy of an independent disk pool to a mirror copy of that independent disk pool. As data is written to the production copy of an independent disk pool, the operating system mirrors that data to a second copy of the independent disk pool through another system. This process keeps multiple identical copies of the data.



Consider cross-site mirroring when you have the following requirements:

- You want a system-generated second copy of the data (in an independent disk pool).
- You need two copies of data, but do not need concurrent access to a second copy.
- A relatively low cost and low maintenance solution is required, but you also need disaster recovery.
- Geographic dispersion between copies is needed, but your distance requirement does not adversely impact your acceptable production performance goals.
- You want consistent failover and switchover times within minutes and that do not depend on the transaction volumes.
- Transaction-level integrity is important for all objects.
- You need immediate availability of all object changes with no loss of in-flight data.
- Objects not within an independent disk pool either do not need to be replicated or are handled by using some other mechanism.
- The second copy that is not available during resynchronization fits within your service level objectives.

## Copy Services for System i

You can replicate data at the storage unit level using Copy Services functions that are provided with the IBM System Storage DS products. An independent disk pool is the basic unit of storage for the remote mirror and copy features. The remote mirror and copy features generate a second copy of the independent disk pool on another Enterprise Storage Server (ESS), or DS6000 or DS8000 storage unit. This solution comes as part of the Copy Services for System i services offering. It provides a set of functions to combine the remote mirror and copy features, IASP, and i5/OS cluster services for coordinated switchover and failover processing through a cluster resource group.

This solution provides the benefit of the remote copy function and coordinated switching operations, which gives you good data resiliency capability if the replication is done synchronously. It enables you to attach the second copy to a backup system without an IPL. No load source recovery is involved in the operations. You also have the ability to combine this solution with other copy services functions, such as FlashCopy, for additional benefits such as save window reduction.

Consider Copy Services for System i when you have the following requirements:

- You want a storage-based solution for disaster recovery, especially if multiple platforms are involved.
- You do not need complete high availability (HA), but seek to cover disaster recovery and some planned outages for critical application data.
- You want consistent failover and switchover times within minutes and that do not depend on the transaction volumes.
- You want two copies of data, but do not need concurrent access to a second copy.
- Geographic dispersion between copies is needed, but your distance requirement does not adversely impact your acceptable production performance goals. Alternatively, consider Global Mirror, which is also known as asynchronous Peer-to-Peer Remote Copy (PPRC).
- Transaction-level integrity is important for all objects.
- You need availability of all object changes with no loss of in-flight data.

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## Related information for Availability roadmap

Listed here are the product manuals and IBM Redbooks™ (in PDF format), Web sites, and information center topics that relate to the Availability roadmap topic collection. You can view or print any of the PDFs.








## Manuals

- Backup and Recovery 
- Backup Recovery and Media Services for iSeries 

## IBM Redbooks

- AS/400® Remote Journal Function for High Availability and Data Replication 
- Choosing the right backup strategy for Domino 6 for iSeries 
- Clustering and IASPs for Higher Availability on the IBM eServer™ iSeries Server 
- Data Resilience Solutions for IBM i5/OS High Availability Clusters 
- Domino 6 for iSeries Best Practices Guide 
- Guide to fixes 
- High Availability on the AS/400 System: A System Manager's Guide 
- i5/OS V5R4 Virtual Tape: A Guide to Planning and Implementation 
- IBM eServer iSeries Independent ASPs: A Guide to Moving Applications to IASPs 
- IBM WebSphere® V5.1 Performance, Scalability, and High Availability WebSphere Handbook Series 
- Improve Whole System Backups with the New Save-While-Active Function 
- Independent ASP Performance Study on the IBM eServer iSeries Server 
- Integrating Backup Recovery and Media Services and IBM Tivoli Storage Manager on the IBM eServer iSeries Server 
- Introduction to Storage Area Networks 
- iSeries in Storage Area Networks: A Guide to Implementing FC Disk and Tape with iSeries 
- Microsoft® Windows® Server 2003 Integration with iSeries 
- Multipath for IBM eServer iSeries 
- Planning for IBM eServer i5 Data Protection with Auxiliary Write Cache Solutions 
- The LTO Ultrium Primer for IBM eServer iSeries Customers 
- The System Administrator's Companion to AS/400 Availability and Recovery 
- Seven Tiers of Disaster Recovery 
- Striving for Optimal Journal Performance on DB2® Universal Database for iSeries 

## Web sites

- Backup Recovery and Media Services 
- Business continuity and resiliency 
- High Availability and Clusters 
- IBM System Storage and TotalStorage 
- Implementing PeopleSoft EnterpriseOne ERP 8.0 Using an Independent Auxiliary Storage Pool 
- Performance Management 
- System i Capacity BackUp Editions 


## i5/OS Information Center topics

- Systems management: Backup and recovery
- Backup, Recovery, and Media Services (BRMS)
- Capacity on Demand
- Commitment control
- Clusters
- Disk management
- Journal management
- Logical partitions
- Storage solutions

## Experience reports

- Backing up the integrated file system
- Reducing iSeries IPL Time

## Other information


- Copy Services for IBM System i 
- IBM POWER5™ Processor-based Servers: A Highly Available Design for Business-Critical Applications 

## Saving PDF files

To save a PDF on your workstation for viewing or printing:

1. Right-click the PDF in your browser (right-click the link above).
2. Click the option that saves the PDF locally.
3. Navigate to the directory in which you want to save the PDF.
4. Click **Save**.

## Downloading Adobe Reader

You need Adobe Reader installed on your system to view or print these PDFs. You can download a free copy from the Adobe Web site ([www.adobe.com/products/acrobat/readstep.html](http://www.adobe.com/products/acrobat/readstep.html)) .



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