

May 2003



**Tivoli** software  
IBM TotalStorage™

**IBM storage solutions:**  
Delivering the value of  
an open environment

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**Executive summary**

Yesterday, storage networking was a new idea for solving storage growth, complexity and cost challenges. The rapid innovation by vendors that often comes with new ideas resulted in partial solution offerings that didn't interoperate. IT managers struggled to realize the potential of shared storage and the return on their storage networking investments. That was yesterday.

Today, storage networking solutions are maturing. The business challenges of reducing cost and complexity, managing growth and migration, and delivering highly available applications are being met by an expanding group of vendor offerings that are not only open but integrate across standardized interfaces. One of the driving forces behind this standardization is the Storage Networking Industry Association (SNIA) and the publication of its Shared Storage Model (see Figure 1).

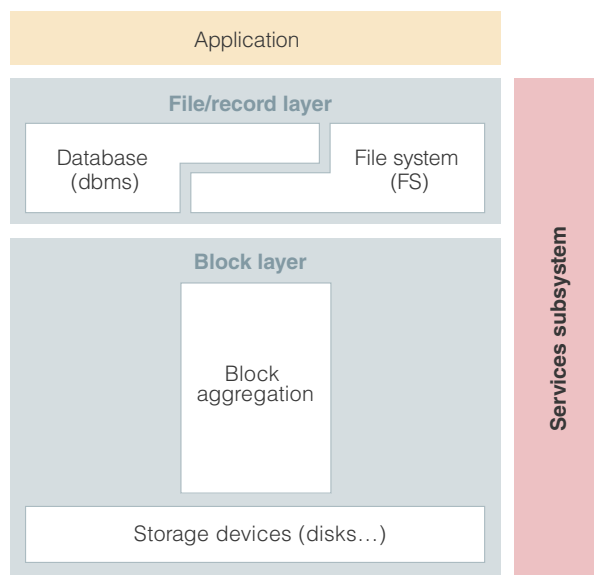


Figure 1. Highest-level view of the SNIA Shared Storage Model.

“Much like the OSI (Open Systems Interconnection) 7-layer model in conventional networking, the SNIA Shared Storage Model may be used to describe common storage architectures graphically, while exposing what services are provided, where interoperability is required, and the pros and cons of each potential architecture.”<sup>1</sup>



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## Highlights

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The Shared Storage Model is intended to provide a common vocabulary for vendors to talk about their architectures and to offer a standard that customers can use when comparing different proposals. This white paper uncovers the significant value that IT managers can derive from shared storage implementations by describing the various layers of the Shared Storage Model. The model is also used as a basis for understanding IBM storage solutions, part of an on demand operating environment.<sup>2</sup>

### The value of a common shared storage model

Emerging technologies are often the result of efforts by vendors to solve challenges that their customers face. In the case of shared storage, vendors are responding to IT managers who are faced with a daunting environment:

- *Businesses that require highly available applications*
- *Rapid growth in the amount of data used by those applications*
- *Constant change driven by the coming and going of applications and technology*
- *Highly complex storage environments requiring a great deal of administrator activity and attention*
- *Reduced or flat budgets resulting from global economic conditions*

*The SNIA Shared Storage Model provides a standard that IT managers can use when comparing and contrasting offerings from competing vendors.*

One additional challenge faced by IT managers is deciding when to begin implementing new technologies. The early shared storage offerings were characterized by closed designs and incomplete solutions. Recognizing this fact, the industry formed the SNIA in 1997 to help ensure that storage networks become efficient, complete and trusted solutions across the IT community. Today, every major storage vendor is a member of the SNIA.<sup>3</sup>



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## Highlights

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The Shared Storage Model, published by SNIA in 2001, describes a set of practical storage network architectures, the services that they can support, the functional responsibilities of the different architectural components and functional boundaries where interoperability must occur. IT managers can derive two very significant benefits from the Shared Storage Model:

- *It defines a common vocabulary that vendors can use when explaining their offerings, making it easier for IT managers to request specific information.*
- *It provides a standard that IT managers can use when comparing and contrasting offerings from competing vendors.*

“Overall, the hope is that this common ‘vocabulary’ will help to align the storage industry for the mutual benefit of all of its participants and customers.”<sup>4</sup>

### The SNIA Shared Storage Model

Frequently, conversations between IT managers and vendors use inconsistent terminology to describe what they want – or what they have. “Things are made worse by there being a great many network storage components, with relatively small differences between them. This causes designs that are actually the same to be described in different ways; and different designs to be described sometimes using identical forms of words. This is clearly undesirable, and results in many problems: it’s often not obvious what is being proposed or described; trade-offs between alternatives are harder to identify than they could – or should – be; and it’s harder for everybody to make high-quality decisions.”<sup>5</sup>

SNIA has attempted to simplify these conversations by describing its Shared Storage Model using modular components – each with well-defined functions and interfaces.

*Much like the OSI 7-layer model in conventional networking, SNIA has assigned layers to its Shared Storage Model to assist in understanding where specific functions are delivered.*



**The file/record layer and the block layer**

The file/record layer and the block layer are where all data access paths reside—from the application to the physical storage. (see Figure 2).

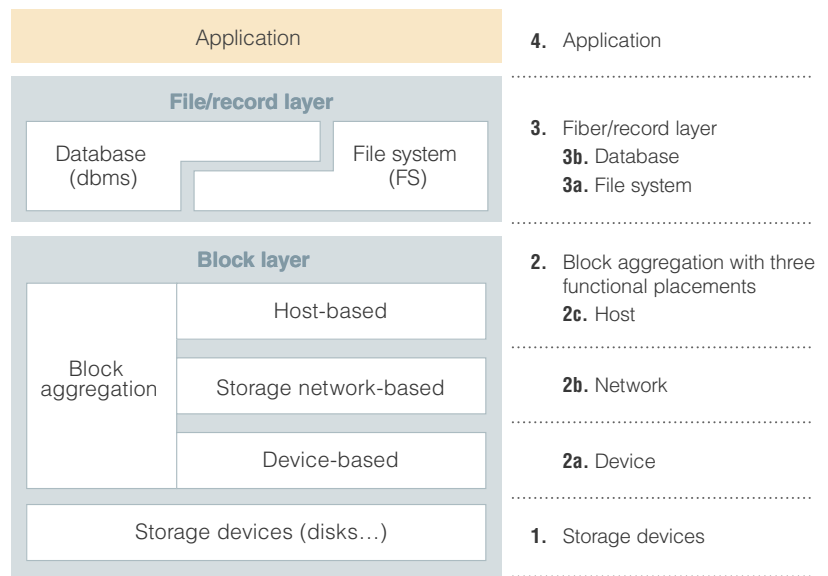


Figure 2. SNIA has assigned layers to its Shared Storage Model to assist in understanding where specific functions are delivered.

**The file/record layer**—This layer is responsible for packing items such as files and databases into larger entities such as block-level volumes and storage devices.

The functions provided by the file/record layer can be implemented solely in the host (these are the traditional host-based file systems and databases) or in both the host and a network server. In the latter case, the host is always a client to a server system that can be a:

- *File server with locally attached block storage devices*
- *Network-attached storage (NAS) head that relies on external block storage devices connected through a storage network*
- *Storage device such as a disk array or “smart disk”*



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## Highlights

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*As a key part of the block layer, block aggregation is used to deliver a powerful set of techniques used to serve many purposes – space management, striping and redundancy.*

**The block layer**—This layer is responsible for providing low-level storage to higher levels. “Ultimately, data is stored on ‘native’ storage devices such as disk drives, solid-state disks, and tape drives. These devices can be used directly, or the storage they provide can be aggregated into one or more block vectors to increase or decrease their size, or provide redundancy.”<sup>6</sup>

Block aggregation is used to deliver a powerful set of techniques that, when used individually or in combination, serve many purposes. They include:

- *Space management through combining or slicing-and-dicing native storage into new, aggregated block storage*
- *Striping through spreading the aggregated block storage across several native storage devices*
- *Redundancy through point-in-time copy and both local and remote mirroring*

“The block aggregation functions can be performed at several of the storage components described in this model. Indeed, it is common to find more than one being used:

- *Host-side, such as in logical volume managers, device drivers and host bus adapters (HBAs)*
- *In components of the storage network itself, such as specialized ‘SN (storage network) appliances.’ In addition, some HBAs are better thought of as part of the storage network.*
- *And, very commonly, in the storage devices themselves: disk array controllers (e.g., RAID) are classic examples of this. Modern disk drive controllers provide some level of this functionality too, such as logical-to-physical block mapping for supporting sparing.”<sup>7</sup>*

**The services subsystem**

The services subsystem houses all the important services that lie outside of the critical data access paths. Although SNIA work to date has not provided a definitive list of services that are needed, it has offered the following example (see Figure 3) as a “flavor for the kinds of things that are handled by this services subsystem.”<sup>8</sup>

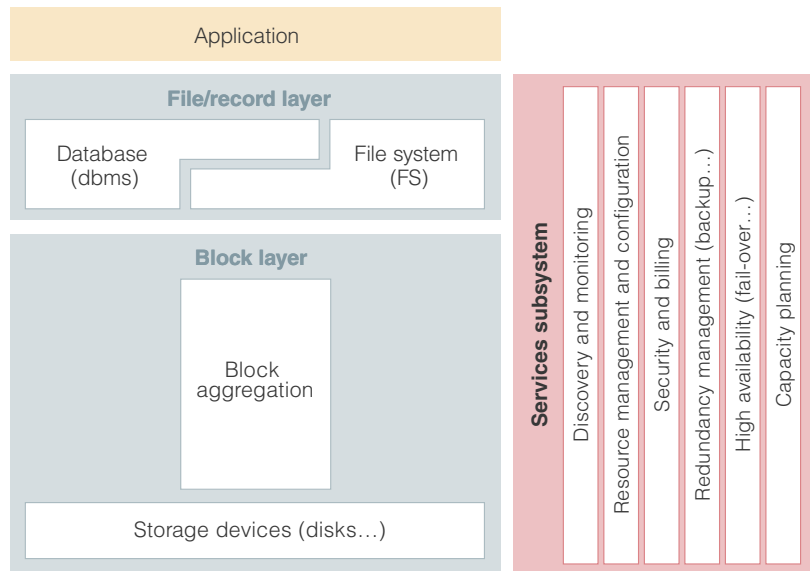


Figure 3. Example management services provided by the services subsystem.

Another key observation by SNIA is that “many of the services are ‘management’ tasks, and need to be tied into the larger system-wide service management tool processes and tools.”<sup>9</sup>

**Open interfaces**

The Shared Storage Model is described in modular components – the file/record layer and the block layer with their four modules (database, file system, block aggregation and storage devices), the services subsystem that interfaces with those modules and the applications that are the “clients.”



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## Highlights

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Vendors who deliver architectures with the ability to compose larger systems from modules or components offer many benefits to IT managers:

- *“Systems can be built using interchangeable components from different vendors. This makes competitive development by multiple suppliers possible, driving quality up and prices down for customers.*
- *Modules can be upgraded or enhanced independently (e.g., one module at a time rather than a complete system replacement), as long as the interface rules are adhered to. This can protect investments, reduce obsolescence, and support smooth improvements in functionality over time.*
- *System scale can be increased by adding or enhancing components, allowing smooth incremental growth. In turn, this minimizes disruptions to the system’s users, lowers the initial system cost, and lets customers take advantage of cost reductions in components over time.”<sup>10</sup>*

Achieving all this, however, requires that the components have well-defined functions and interfaces. “Interfaces may be proprietary or open. Proprietary interfaces deliver some of the same advantages as open interfaces, but the vendor choice is likely to be more limited and new developers may not have ready access to the technical specifications required for interoperability.”<sup>11</sup>

*The full benefits of storage systems will only be realized through the use of common, open interfaces.*

SNIA takes the strong position that the full benefits of modular systems will only be realized through the use of common, open interfaces. To this end, SNIA has focused a good deal of work on its Storage Management Initiative (SMI) resulting in a formal specification (SMIS) for a SAN management interface. The SMIS is the result of a collaborative effort involving many of the leading storage vendors including BMC Software, Brocade, Computer Associates, Dell, EMC Corporation, Emulex Corporation, Gadzoox Networks, Hewlett-Packard, Hitachi Data Systems, IBM Corporation, JNI Corporation, Prisa Networks, QLogic, Storage Technology Corporation, Sun Microsystems and VERITAS Software.

**Highlights**

The SMIS is the industry’s first standard storage (SAN) management specification using Common Information Model (CIM) technology (see Figure 4). SMIS-compliant products, when plugged into a SAN, will be capable of automatically announcing their presence and capabilities. SAN management tools in the services subsystem can then identify, classify, monitor and control both physical and logical resources across the SAN.

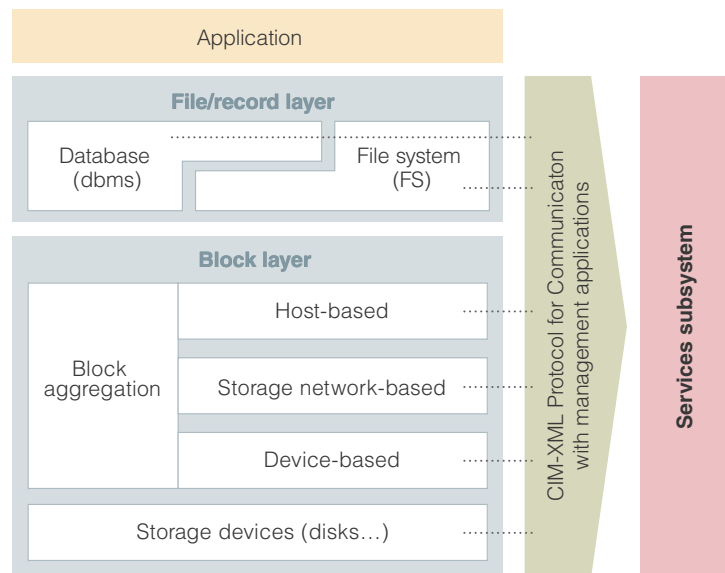


Figure 4. The SNIA SMIS defines an open CIM-XML SAN management interface.

**IBM storage solutions**

Understanding that IT managers face significant challenges in reducing cost and complexity, managing growth and migration, and delivering highly available applications – and with the SNIA Shared Storage Model as a reference – IBM is delivering solutions. Part of an on demand operating environment, these solutions are modular in design, each component with well-defined functions and open interfaces, making it possible for IT managers to construct, upgrade or enhance their storage system one component at a time.

*IBM storage solutions are modular in design, with well-defined functions and open interfaces, making it possible for IT managers to construct, upgrade or enhance their on demand operating environment one module at a time.*



**Comprehensive**

Shared storage solutions center on a storage network. IBM SAN infrastructure components—the plumbing of a Fibre Channel storage network—include entry- and workgroup-level switches, enterprise-class directors, routers and gateways.

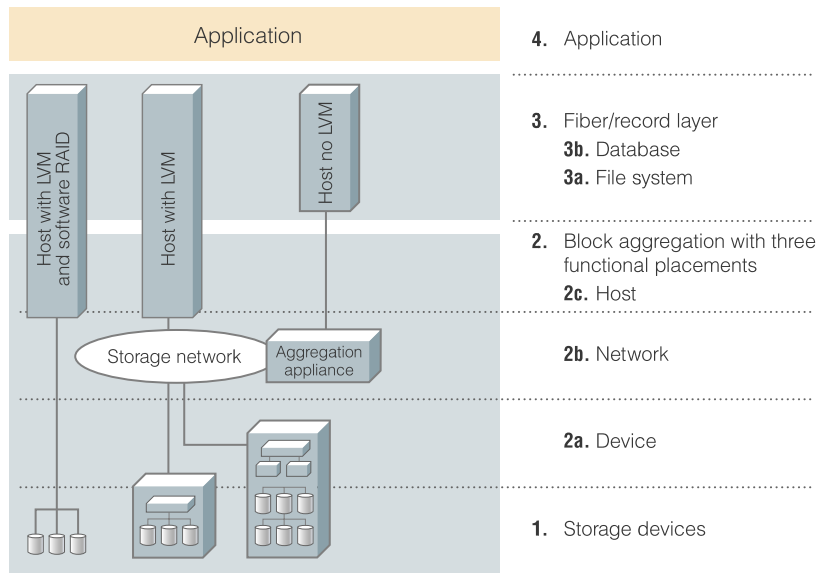


Figure 5. IBM direct- and SAN-attached disk solutions.

As the primary storage for application data, IBM storage devices, including the IBM TotalStorage™ Enterprise Storage Server™ and the IBM Fibre Array Storage Technology (FAStT) Storage Server, are available in direct- and SAN-attached configurations (see Figure 5). In addition, IBM simplifies volume management with the introduction, planned in mid-2003, of network block aggregation in the IBM TotalStorage SAN Volume Controller.

Enabling workgroup and enterprise file sharing, network-attached storage (NAS) helps deliver simplicity and scalability. IBM offers a range of integrated NAS servers as well as a NAS head appliance, the IBM TotalStorage NAS Gateway 300, which can be part of a larger SAN or block-aggregated solution (see Figure 6).

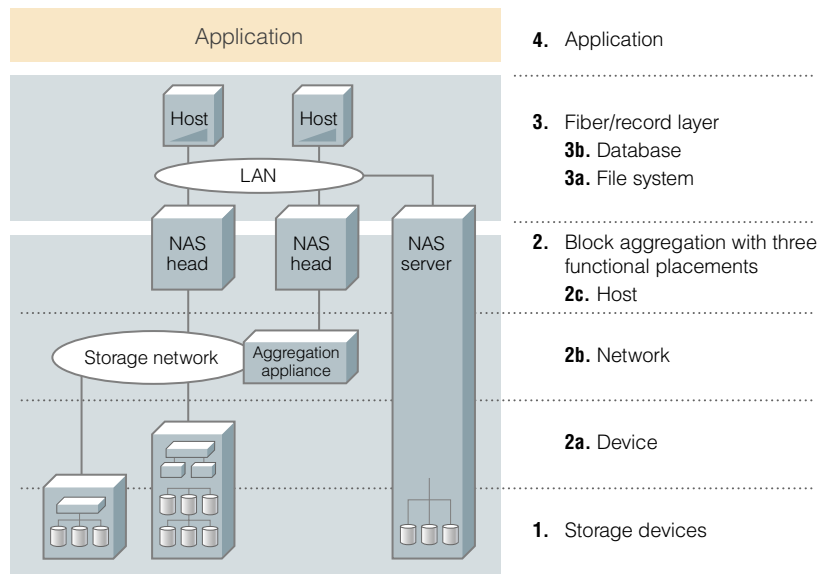


Figure 6. IBM NAS solution.

IBM removable media is an excellent choice for application backup and archival of vital business records. IBM offers high-performance native devices, highly scalable automated libraries and the high-function IBM TotalStorage Virtual Tape Server (VTS) (see Figure 7).

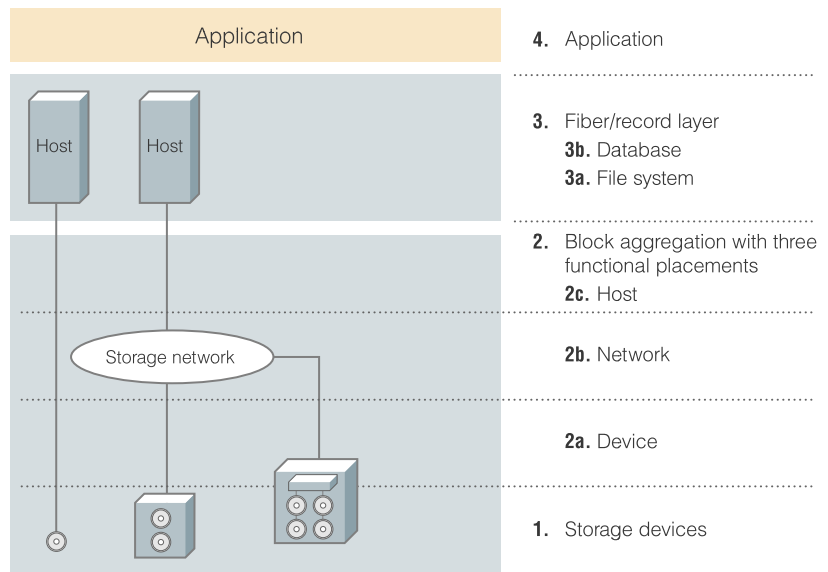


Figure 7. IBM tape and automation solutions.



With the introduction of the IBM TotalStorage SAN File System – a file system metadata server planned for availability in late 2003 (see Figure 8) – IBM is working to give IT managers the ability to realize the heterogeneous data-sharing capabilities of NAS with the performance and function of SAN-attached storage that is demanded by business applications. When IT managers combine these capabilities with the IBM TotalStorage SAN Volume Controller, they will be able to simplify the management of their storage environments greatly by moving legacy host-based file system and volume-management functions into the storage network.

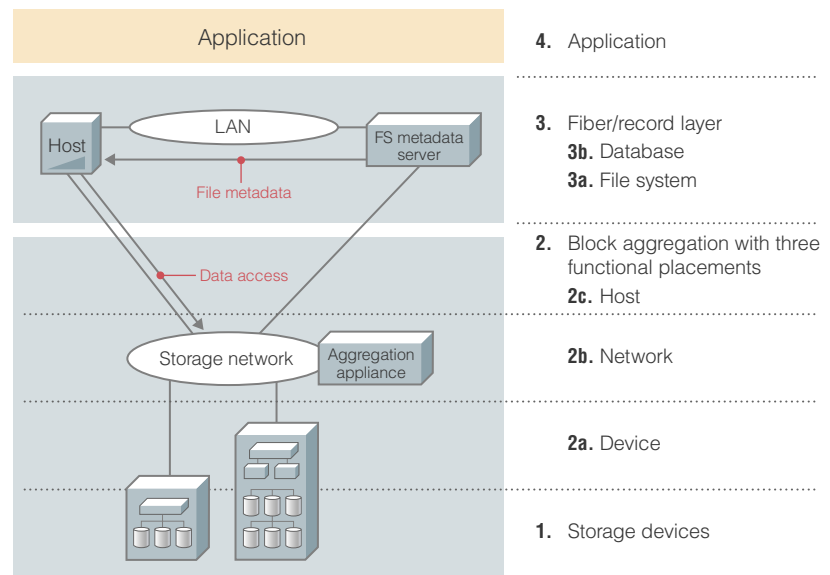


Figure 8. IBM TotalStorage SAN File System.

The management services for the IBM TotalStorage components are provided by IBM Tivoli® software components (see Figure 9). The Tivoli Storage Area Network Manager performs discovery, classification and monitoring of the storage network, its connected hosts and devices. From this interface, IT managers can also interact with IBM TotalStorage device managers through SMIS for device configuration.

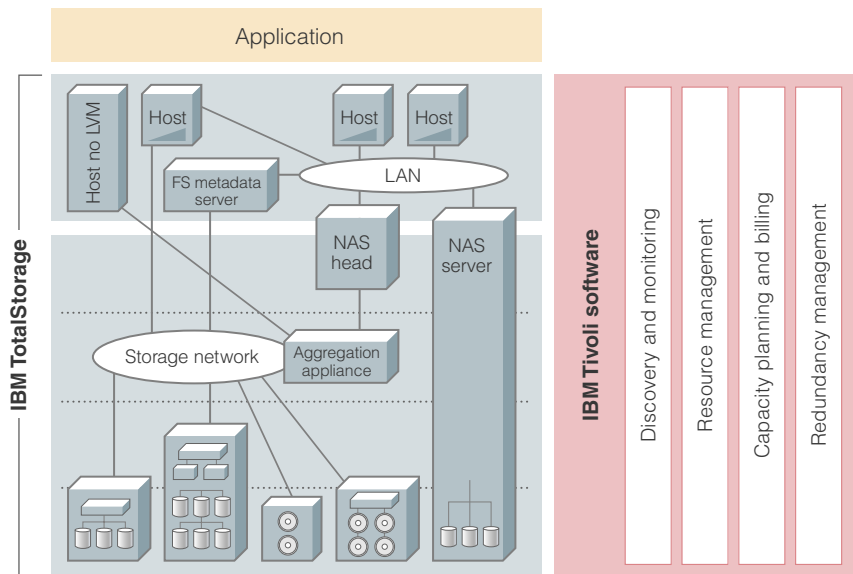


Figure 9. IBM Tivoli software management services.

Resource management gives IT managers the tools both to understand what is driving storage growth and to improve utilization efficiency. Tivoli Storage Resource Manager integrates both with file systems (including NAS and the IBM TotalStorage SAN File System) and with databases to produce detailed reporting and capacity planning analysis. Tivoli Storage Resource Manager also includes autonomic functions that can detect if a server's storage space is crossing a threshold and dynamically provision new storage to increase the space before business applications are affected. Further, using gathered information, IBM Tivoli Storage Resource Manager for Chargeback assists IT managers in associating the cost of storage with the individual users, departments, locations or other defined groups within the enterprise. For chargeback, both reporting and invoicing are supported.

The IBM Tivoli Storage Manager provides comprehensive redundancy management through backup, archive and disaster-recovery planning functions. With its focused modules for databases, application servers, enterprise resource planning (ERP) and mail along with the ability to drive storage device replication services, Tivoli Storage Manager specializes in speed of recovery, giving IT managers the tools to protect and retain critical business data better.



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## Highlights

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*Open interfaces, combined with the modular components in the IBM storage solution, mean that IT managers have the flexibility to choose to implement their storage system using both IBM and non-IBM components.*

In addition to offering a comprehensive set of modular storage solutions, IBM is a leader in integrating storage management with the broader system-wide management tools and processes. This is accomplished through integration with other Tivoli software components such as:

- *Tivoli Configuration Manager for software distribution and inventory*
- *Tivoli Enterprise Console® event management system*
- *Tivoli NetView® network management software for consolidated management of both storage and traditional networks*
- *Tivoli Service Level Advisor and the Tivoli Enterprise Data Warehouse for service level management*

### **Flexible**

There are two absolutes required to give an IT manager flexibility in designing a shared storage system. First is a set of modular components with well-defined functions. Second is a set of common, open interfaces used by these components. Subtle modifications to these absolutes can dramatically undermine IT manager flexibility:

- *Top-to-bottom frameworks that present a single interface, even if it is “open,” limits an IT manager’s flexibility to choose best-of-breed modular components.*
- *Modular components that present proprietary interfaces limit an IT manager’s flexibility to choose best-of-breed management applications.*
- *The key to common, open interfaces is the word “common.” Many offerings claim “open” interfaces because the vendor that wrote the interface makes it available to anyone who wants to use it. Only when the interface is commonly used by all vendors – often the result of work by industry organizations like SNIA – will IT managers have the flexibility to choose.*



IBM adheres to the SNIA belief that the full benefits of storage systems will only be realized through the use of common, open interfaces. Open interfaces, such as the SNIA SMIS, combined with the modular hardware and software components in the IBM storage solution, mean that IT managers have the flexibility to choose to implement their on demand operating environment using both IBM and non-IBM components.

Supporting this approach, IBM works with other vendors to validate combined solutions under both the IBM TotalStorage Proven™ and Ready for Tivoli programs.<sup>12</sup> IBM also participates in industry interoperability demonstrations like those sponsored by SNIA.<sup>13</sup>

The result of this focus on modular design and common, open interfaces, supported by validation and demonstration, is a comprehensive set of storage solutions that offer IT managers compelling cost and functional characteristics today with flexibility of choice in the future.

For more information about e-business on demand and IBM storage, visit [ibm.com/ondemand](http://ibm.com/ondemand), [ibm.com/totalstorage](http://ibm.com/totalstorage) and [ibm.com/tivoli](http://ibm.com/tivoli)

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**Note:** Graphical representations of the SNIA Shared Storage Model and quotes from the SNIA *Shared Storage Model* white paper are used with permission from the Storage Networking Industry Association.

<sup>1</sup> SNIA *Shared Storage Model*, Storage Networking Industry Association, June, 2001.

<sup>2</sup> For a more-complete discussion of the value of an on demand operating environment, please see the IBM white paper *IBM Storage Solutions: Evolving to an on demand operating environment*.

<sup>3</sup> The SNIA member list can be found by going to [www.snia.org/about/member\\_list](http://www.snia.org/about/member_list).

<sup>4</sup> SNIA *Shared Storage Model*, Storage Networking Industry Association, June, 2001.

<sup>5</sup> Ibid.

<sup>6</sup> Ibid.

<sup>7</sup> Ibid.

<sup>8</sup> Ibid.

<sup>9</sup> Ibid.

<sup>10</sup> Ibid.

<sup>11</sup> Ibid.

<sup>12</sup> IBM TotalStorage Proven solutions can be found at [ibm.com/storage/proven/index.html](http://ibm.com/storage/proven/index.html)

IBM Ready for Tivoli solutions can be found at [ibm.com/software/tivoli/products/tivoliready](http://ibm.com/software/tivoli/products/tivoliready)

<sup>13</sup> Demonstration details can be found at [www.snia.org/news/press\\_releases/2002/2002\\_10\\_28/](http://www.snia.org/news/press_releases/2002/2002_10_28/)

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