IBM

IBM Netfinity Server Quality

Producing high-quality server products to support business-critical applications

Executive Summary

The IBM Netfinity family of servers and their associated subsystems offer quality that is among the best in the industry. This high level of quality begins with the IBM Netfinity Integrated Product Development (IPD) teams. The teams include design, development, systems testing, manufacturing and service planning and extend through our Business Partners to warranty, support and service. Early involvement of design, procurement, manufacturing, testing and support teams establishes the nature and extent of tests each new product must undergo before IBM is convinced that the product is measurably better than its predecessor and, therefore, may bear the IBM logo.

Adherence to stringent processes leads to compliance with the requirements of applicable agency approvals and certifications. These processes are followed during the life cycle of all IBM Netfinity products. They foster the repeatable delivery of the highest-quality products, providing the systems required to support customers' growing, business-critical applications.

Over the years, IBM has earned its reputation as a leader in:

- Designing powerful and scalable systems for business-critical, data-intensive environments

- Creating solutions that help ensure application availability

- Building technical support infrastructures that include skills, tools and procedures for service and support worldwide

This paper discusses the IBM Netfinity quality processes. It explains why IBM Netfinity products are durable and reliable, how they can protect your investments and how they help you attain the best performance from your enterprise networking systems. Product quality is an ongoing commitment subject to continuous review. This paper is meant to give you an overview of current processes. Of course IBM reserves the right to change and enhance such processes without notice. Our customers would expect nothing less.

Development Processes

IBM Netfinity products are developed using the comprehensive IPD process, which is followed during the development cycle.

Products are planned by IBM to meet your needs based on essential input gathered from IBM's industry partners and suppliers such as Intel, Microsoft, Seagate and Adaptec; from industry advisory boards; and from IBM's customer advisory councils. Furthermore, the IPD oversees development across products in the Netfinity family so that individual products will function consistently and reliably in a total solution.

IBM resources, such as our world-renowned research labs, rigorous competitive analysis and technology planning process, also play a major role in product planning.

All of this input results in Netfinity Product Roadmaps, which define the direction development must take to produce high-quality products repetitively. The process is concerned not only with the development of a product, but also with test and qualification of any externally acquired subsystem. The process is checkpoint-driven and monitored by concurrent quality assurance functions and processes.

Certification and Agency Approval

IBM's testing for agency approval is among the most thorough and stringent in the industry, so that Netfinity products meet various specifications established by industry groups for voluntary compliance, by individual country authorities and by the additional criteria established by IBM itself to ensure high levels of customer safety and electromagnetic compatibility (EMC).

These may include tests for product certification agencies such as UL, CSA, TUV Rheinland and emerging markets (where applicable). Our EMC department conducts electromagnetic emission and immunity tests in our internationally qualified EMC laboratories, which allows IBM to establish and/or maintain national authorizations, including product labeling, for such countries as the U.S. (FCC), Canada (CSA), Mexico (NOM), Japan (VCCI), Australia (C-TIC), New Zealand, Korea and Taiwan (BCIQ), as well as central European countries and Russia. All products shipped to the European Economic Area are provided with the CE mark and declaration, signifying conformity with both the safety and EMC EU directives.

System Validation

There are two ways to approach system testing. One is the "all-in-one" approach that uses a few stress tests to validate system design. Using such a tool means that a system is tested and fixes are applied until the system passes the tests. Once it does, the system is considered ready for customers. Such an approach does not ensure a robust system, because it is based on a particular test case, and small deviations from the test case will cause the system to fail.

Such an approach also means that problems are fixed only where they are found, in an isolated fashion; possible ramifications of a problem and their effects on the system as a whole are not considered. This means that the all-in-one approach cannot perform a true system test, one that will enhance the reliability, functionality and availability of the system in a real-world environment. That is why IBM does not use this test method, but uses the one described next.

The system testing that IBM uses for Netfinity server systems is based on a methodical approach and customer-driven focus. The tests are layered, each building on the preceding one. Each layer of tests has a specific purpose and validates the functions and interface for that layer. This method creates a strong foundation on which robust solutions can be built because the system, not just some component parts, is thoroughly tested in the customer environment. The methodical, layered approach requires more resources than all-in-one tests but, combined with the customer-driven focus, is what IBM demands for its products, resulting in the best total solutions.

Netfinity Server System Validation

There are two parts to system validation. First, the building blocks of technology and software are tested to specification. Second, the customer-focused system test provides customer-based compatibility test and solutions validation.

Building-block test

Each building block of the system is tested individually to specification. This starts with simulation, hardware analysis and testing and engineering software testing, which provides a sound foundation for the more complex system test that is performed next. Each major part of the building-block test is discussed below.

- **System simulation**. While a system design is in the concept phase, several types of simulation are performed to validate the concept and design. All critical timing, signal quality and logic are simulated with a combination of industry-leading and unique IBM tools. Some of the IBM tools have their heritage in IBM large systems and have been adapted for the Intel processor-based environment. Simulation can expose design weaknesses before hardware is produced. Boundary conditions are explored and tested, allowing many more configurations to be simulated than with hardware tests alone.

- **Subsystem test**. Each subsystem is tested extensively before system integration. Each element of the design specification is verified and each critical signal is measured to ensure adequate margins. This is done to produce a design with sufficient margins to handle small deviations from the norm.

  Measurements for compliance with key industry specifications are performed. For example, the PCI bus timing and protocol are measured for subsystem compliance with the PCI specification. Signal timing and quality are verified, and problems are corrected. This is critical in an open systems environment, where multiple vendor products can be combined to form the ultimate solution. In addition to system hardware measurements, each subsystem is stress-tested by running the operating system with specially designed tools written by IBM Netfinity engineers.

- **Functional verification test**. The functional verification test confirms that the functions specified in firmware and utilities work correctly. Automated test cases and tools are used throughout these tests, which significantly increases test reliability and efficiency. The key areas of these tests are BIOS, setup utilities, system management processor and remote service test, and diagnostic and maintenance effectiveness. Because diagnostic and maintenance effectiveness is so important in testing, it is discussed in some detail here.

  During system design, an error detection/fault isolation (ED/FI) model is created to confirm that the system meets the error detection and isolation goals. During system validation, faults are injected into the system and the system is tested with a system management processor and diagnostics to validate the ED/FI model. These test for fault detection during system operation and diagnostic testing. System logs are also tested to verify that the correct defects are reported.

  After validation of the ED/FI model, selected field service personnel are brought to the development lab, where blind faults are injected into the system and the service personnel are asked to find and isolate the faults with their field tools (diagnostics, hardware maintenance manual and others). Key parameters, such as method of isolation, method of detection and isolation effectiveness are measured. This structured, quantitative method results in much-improved diagnostic and maintenance effectiveness, both of which are essential for business-critical servers.

Customer-focused system test

One of the most important elements of IBM's test procedures is a focus on customer requirements. Once the system foundation has been established and verified, system stress testing with this strong customer focus begins. Classical tests are performed for compliance with worldwide government and IBM standards, and the robustness of the system design. System functional stress tests verify that the server will operate under extremely heavy loads and test not only the hardware, but also the device drivers and operating system. Compatibility, certification, cluster and solutions, and refresh and options tests are performed for compatibility with devices, software and operating systems. Each of these areas is described in more detail below.

- **Classical tests**. Some classical tests are included to meet worldwide government and IBM Corporate regulations. Others are required to increase system design margin. Tests include:

  - EMC, for minimal electromagnetic emission, to meet government requirements.

  - Guardband, which varies voltage and temperature parameters beyond the specification, to identify and correct weaknesses in the designs so that an adequate design margin is built in.

  - Thermal analysis and modeling, for adequate cooling for system components.

  - Packaging verification, so that the system, both packaged and unpackaged, can survive shipment and rough handling. Drop-tests and vibration tests are performed.

- Usability and human factors, for ease of installation, handling and service, and out-of-box experience meet IBM standards.

- Product safety analysis, so that IBM Netfinity servers meet electrical and mechanical safety standards.

- Environmental system stress (ESS), for component reliability through the use of extreme temperatures for accelerated product life testing. ESS also includes operational vibration and shock tests.

- Early life performance (ELP), for the reliability of the system by simulating its extended life on a large number of systems prior to shipment to customers and taking corrective actions for any problems discovered. ELP also includes non-operational vibration and shock tests.

- **System stress test**. Building on the foundation of robust subsystems, the entire system is integrated and stressed with a methodical, layered approach. The first layer is a targeted subsystem test. For example, the RAID/Disk subsystem is tested with IBM designed stress tools running Windows NT with the ship-level device drivers. This approximates operations in a customer environment but increases the stress level beyond what most customers would typically experience.

  Each functional subsystem is then stressed. System metrics are collected and exercises are tuned to reach the targeted stress level. By targeting specific subsystems, we can design particular stress points and bottlenecks so that the subsystems can handle the heavy workload of your IBM Netfinity server.

  This is in marked contrast with an "all-in-the-bucket" test approach used by some vendors, which runs whatever programs are available, with as many sessions as appear to make a system busy. With this approach, testers may not really know what is being stressed or tested, which yields a less robust product. For example, if the intent is to exercise a disk subsystem, it might make sense to run as many sessions as possible to make the subsystem "thrash." IBM Netfinity system testing, however, uses a more efficient and stressful test, which runs multiple threads in a single session. The overhead associated with each session on the operating system prevents maximum stress on the disk subsystem. With proprietary exercisers that can be tuned, we can create a more stressful test. This kind of methodical, metrics-driven approach is used with each of the subsystems.

  Next, the system under test is connected to a large number of clients to simulate the customer networking environment, with major supported operating systems and network topologies. Heavy network traffic is generated while the resources of the server system are constrained. Again, the key system metrics are measured, and the exercisers are tuned to achieve targeted test levels.

- **Compatibility test**. The ServerProven program is the options compatibility process for IBM Netfinity servers. ServerProven has three parts:

  - Alliances with leading software vendors

  - A compatibility testing program for third-party hardware and leading network operating systems vendors

- A software compatibility program, called ServerProven Solutions, aimed at independent software vendors (ISVs) who develop application software for small-to-medium-size businesses

The ServerProven matrix for the compatibility test is created for each product, based on customer demand, market demand and technology direction. Each device is tested extensively with the major supported operating systems to verify that the system as a whole performs as designed. A typical test for a system includes hundreds of such combinations. The ServerProven matrix is then published on the IBM Netfinity Web page, so that customers can choose from the list with confidence that the system has been tested by IBM. Detailed information such as device driver levels and slot information is included on the Web page. The customer drives our compatibility test matrix, not the testers. This customer focus enables IBM Netfinity servers to test the "right" devices and applications.

- **Certification**. IBM Netfinity systems are certified by supported network operating systems and applications vendors. These include Windows NT, Novell NetWare, OS/2 Warp Server and OpenServer/Unixware. Certification tests are performed at either the operating system partner's site or IBM. We work closely with our partners to execute a test suite defined by them. For example, the Netfinity server group operates a programming center in Kirkland, Washington, where Windows NT certifications are performed. IBM is one of only a few companies that have been certified by Microsoft to perform the certification test and submit the data to Microsoft for formal certification. The IBM Kirkland NT Programming Center has a close relationship with Microsoft, for problem resolution and new products testing. The Center tests beta-level software from Microsoft on existing and future IBM Netfinity servers. This confirms integration and compatibility of IBM Netfinity servers with Microsoft products.

  IBM also has 81 Open System Centers and Availability Centers that provide integration and testing sites for multi-vendor client/server systems. Using these centers, the Kirkland Programming Center and other development centers, IBM is building new technologies to enhance and better service customers' server environments.

- **Cluster and solutions**. IBM Netfinity places great importance on PC server cluster technology. Each solution is thoroughly tested to confirm that both the hardware configurations and software necessary to implement the solution are functional. Multiple failure modes are tested so that failovers are transparent to the client. While a failover occurs, stressful exercisers are executed from clients and on servers to verify that the cluster can handle the load. Specific solutions such as DB2, Domino, LAN Server, Oracle Parallel Server and others are among those tested.

Refresh and options

New products, solutions and technology come to market at a constant and rapid rate. Options and devices supported at the release of a system can become outdated within a few months. The IBM Netfinity team has a compatibility refresh program that runs monthly tests of new devices on existing systems. The ServerProven team tracks technology and trends through their close relationships with ISVs and key industry members. The marketing team provides customer requirements and market demand. Together the teams provide the key devices to be tested during the refresh cycle. Over 100 device

combinations are tested each month. The test results are added to the IBM Netfinity Web site.

Key options such as disk drives and communications adapters are tested with current and future IBM Netfinity systems before shipment. Functional, stress, compatibility, classical and reliability tests are performed before the release of options. An example of options testing is provided under "Hard-Disk Drive Procurement Process" later in this paper.

Test tools

Test tools are vital to the overall test process. The Netfinity team has developed an extensive test tools development program that incorporates knowledge from the IBM design team and many years of test experience. Off-the-shelf tools are not targeted specifically at system validation, so we do not use them. The IBM tools allow Netfinity test engineers to tailor test cases to methodically stress key areas of a system at each layer. The tests create scenarios similar to those seen in customer applications, and in the scenarios we increase the stress level above that of most typical customer environments.

ServerProven

The ServerProven group maintains a technical relationship with key third-party vendors for technical support during development and validation of systems and options. Unlike some other test approaches, the IBM Netfinity system and compatibility test depends on carefully researched market and industry requirements, not on guesses about which devices and technology our customers want.

The close relationship with third-party vendors enables quicker problem resolution and early testing of options and systems. The availability of a list of specific, tested IBM Netfinity configurations and devices on the Web allows customers to reference the list when choosing solutions to implement and be confident that IBM supports all the solutions presented.

Electromagnetic Compatibility

All Netfinity servers must pass a series of electromagnetic compatibility (EMC) tests in order to be shipped worldwide. The first group of tests are designed to verify that the servers comply with legal and government requirements. See "Certification and Agency Approval" on page 2 of this paper.

The second group of tests are designed to ensure that Netfinity systems have the highest possible quality, enhancing customer satisfaction. Netfinity systems are tested in dozens of configurations, every month, on three continents.

Each system is configured in a maximum and typical customer configuration to exercise all system components. Each component is exercised and tested at a typical data rate to analyze the system's potential to generate radio frequency interference to nearby communication receivers. Successful completion of the test does not mean that a Netfinity server will never have emissions; it does mean, however, that any emissions will be within the limit set by government requirements.

The final measurement measures a Netfinity system's contribution, if any, to unwanted emission on power lines. If any such emission problems are found, IBM brings the system

into compliance by using the flexibility designed into the mechanical package, planar board or power supply.

Additional Netfinity EMC tests are part of the IBM EMC customer and environment satisfaction test. These tests are a key component in IBM's quality goal to reduce and eliminate field problems. These tests are based on a rich history of personal computer, midrange and host customer satisfaction issues.

Radiated susceptibility. Netfinity servers are subjected to electric field sources so that the system will not lose data or shut down when interfered with by emissions from other products or components. This test simulates exposure to AM and FM broadcasts, air traffic control, radar, television broadcast signals, monitors, television sets and even other computers.

IBM has led the industry in this test. It has been a part of IBM internal standard tests but did not become an industry-standard, worldwide requirement until 1996.

Power-line transients, disturbances, surges. These tests simulate interference, over-voltage and under-voltage situations by as much as 30% to verify that no data is lost and that the system does not have to reset itself.

Electrostatic discharge. This confirms that a Netfinity server can operate in accordance with its specifications when the system is exposed to electrostatic discharge. This test simulates high current spikes similar to those caused by walking across a carpet and creating an arc or spark. IBM does this 10,000 times per test, compared with 100 times per test for the industry.

Manufacturing Quality Processes

The manufacturing quality processes are based on early manufacturing involvement in the development cycle. Lessons learned from previous products and customer feedback are documented so that any problems in the design and test processes can be addressed.

Input is gathered from the manufacturing team (manufacturing engineer, test engineer, new products administration and quality assurance). Data collected is logged in a defect-tracking system so that the engineers have easy access to the data. Reviews of the design are performed to confirm that the product can be manufactured and configured correctly and that IBM's manufacturing facilities are compliant with ISO 9001 requirements.

The worldwide manufacturing engineer provides a rating of the product four times during the development cycle to verify that logged problems are solved. The rating is a relative measure based on the performance of previous products. Problems raised are logged in the defect-tracking system and corrected by the responsible team.

Manufacturing Line Qualification

- The purpose of manufacturing line qualification is to verify volume-production readiness. Both new and refreshed systems are tested to verify that tooling, process layout and controls, work instructions and training meet IBM standards. Component parts must perform at committed quality levels. If problems occur, there must be plans in place for their immediate correction. Time to manufacture must be within the limits defined by the manufacturing team. If it is not, the team must determine the root cause of the problem and take corrective actions to ensure that the process operates at an acceptable level.

Volume Production

At the start of volume production, we monitor the stability of our manufacturing process through our first-pass yield (FPY) and out-of-box (OOB) measurements. The FPY number indicates how many systems we expect to fail during manufacture. FPY targets are based on the incoming quality levels to which our suppliers have committed themselves. If the number of failures exceeds that determined to be acceptable, the manufacturing team must determine the root cause of the problem and take corrective actions to return the failure rate to a minimal level. All FPY results are reviewed weekly with the manufacturing and engineering teams, and corrective actions are tracked.

The OOB measurements are the results of an audit at the end of the manufacturing line. Ten percent of all products manufactured daily are inspected as they leave the line. Selected at random, they are inspected for visual or "cosmetic" defects as well as for functional and manufacturing defects. Defects are recorded with action plans from the manufacturing and engineering teams as required. Failed products are analyzed for root cause determination.

The IBM Quality Notification System (QNS) communicates product issues to all manufacturing, marketing and engineering personnel who require product status. The technical root cause of problems, corrective actions required, inventory levels and field actions are noted in the QNS document. QNS indicates all products affected by the problem and whether manufacture and shipment of the products should continue.

Extended Customer Simulation Process

The purpose of the Extended Customer Simulation Process is to find fundamental problems before they reach the customer by simulating the customer environment. We load the software and hardware most commonly used by our customers to assess ease of installation and configuration.

A test is performed on a sample of products coming out of manufacturing. Products are checked to verify that they are complete. The most commonly used options are added, and the operating system is installed. A functional verification test is run on a fully configured product. All defects are logged in the defect-tracking system so that the appropriate actions can be taken before the process continues.

First-Off Test

The first-off test is performed to validate the manufacturing process. A number of systems are tested as they are completed, to verify that the manufacturing control system is operational with all part information loaded, that all test procedures are established and working correctly, that routing is established and that all written procedures are in place and correct. Once units have passed the first-off test, the manufacturing line is ready to start volume production.

Procurement Processes

When subsystems cannot be obtained internally, we procure them from only the best suppliers, who must meet the criteria of IBM's formal, rigorous certification process. Early in the life cycle of each Netfinity product, procurement interacts with the IPD team to identify the latest technology, price and part trends. The emphasis of this relationship is proactive and defines IBM's long-term commitment to quality: prevent defects before manufacturing begins.

For IBM to use subsystems from only the best suppliers, they are continually graded for on-time delivery, defect-free products and flexibility to changes in volume and schedule. We evaluate their manufacturing processes as well as their impact on our internal processes.

Before a supplier's products are shipped to IBM, they go through ongoing inspection for quality verification. Only if the products pass that inspection are they shipped. Additionally, many suppliers are required to provide representation at IBM sites where their parts are used. This presence gives suppliers a sense of responsibility, of manufacturing process "ownership"; they are involved in finding and eliminating any defects, and their activity helps reduce cycle time.

Hard-Disk Drive Procurement Process

A key benefit of IBM's procurement process is that it consolidates worldwide demand for components, thus enabling us to make volume purchases at the lowest possible prices. Another benefit is that, with a single procurement organization, a single set of requirements is presented to our suppliers. These requirements are the standards to which we hold each supplier, as well as the components they provide.

These requirements are applied to hard-disk drives (HDDs) as they are to other components. Because their reliability and availability are vital to business-critical applications, they must be designed and tested to the highest standards to fulfill customer requirements.

In IBM Netfinity servers, we ship HDDs designed and manufactured by IBM. We also ship drives from other suppliers, but only after they have gone through the most rigorous tests, required by IBM, for the highest quality possible.

HDD Qualification Process

The selection of HDDs begins with a request for information from the leading HDD manufacturers. Based on the responses, the number of suppliers is narrowed down to two or three. At this time, hardware evaluation takes the HDDs through a series of "acceptance" tests. Successful completion of these tests is a prerequisite for further consideration.

Once a supplier has been selected, a design review is held with key engineers from IBM and the supplier. We verify that the device meets IBM's strict criteria and uses sound design and manufacturing techniques. IBM qualification of HDDs includes unit qualification, subsystem integration, subsystem compatibility and classical testing.

Unit qualification. Unit qualification verifies that the head-disk assembly meets the supplier's and IBM specifications and that there are no inherent problems in the drive. The assembly is exposed to an IBM developed, long-term test in a stress environment with multiple on/off cycles. HDDs are also tested to verify that they meet IBM's strict environmental requirements.

A second long-term reliability test subjects a large sample of HDDs to uninterrupted operation under nominal and stress environments. Problems are reported to the supplier for resolution. Special attention is paid to any errors affecting data integrity.

Subsystem integration. Subsystem integration confirms that the HDD functions correctly in a system environment. Subsystem integration includes but is not limited to the following tests: SCSI standards compliance, mechanical compatibility, power analysis, matrix, hot-swap function and operating system compatibility, including RAID function.

System compatibility testing. Whereas unit and integration testing focuses on the HDD and its associated subsystem, compatibility testing targets more of the customer environment such as operating systems, applications and interoperability with other IBM hardware.

The test process includes the use of proprietary software that verifies data integrity at the application level. This means that this test uses the same code paths than an application might use, including device drivers, BIOS, operating systems and file systems. Use of these "real" code paths confirms that the HDD will function correctly in customers' applications. This proprietary software is used in each of the following phases of test:

- Compatibility with systems

- Multitasking operating systems

- Data integrity

- Compatibility with network operating systems

- A LAN places unique demands on an HDD, especially when the drive is installed in a server. In order that IBM drives will perform correctly in these environments, each new system is certified as compatible with Novell NetWare, Windows NT and OS/2 LAN Server.

Classical tests. Classical testing includes the following tests:

- Acoustics: Verifies that the HDD meets the sound level requirements of the systems.

- EMC: Verifies that the HDD does not emit radio frequency energy, which would affect nearby communication receivers, and that HDD operation is not affected by these frequencies.

- Environmental (stress): Drives are subjected to ranges of temperature, humidity and voltage margins and subsequently put into operation.

- Power cycling: Multiple on/off cycles are performed to test the robustness of the mechanics of the drive as well as the electronics.

- Fragility: Drives are subjected to operational vibration and non-operational shock and subsequently tested to verify that no damage occurred within the specification of the drive.[1]

Manufacturing. The qualification of an HDD is not complete until a manufacturing test is performed. Before allowing the drive to be included in a Netfinity system, IBM performs a manufacturing test to verify that the supplier is capable of manufacturing the HDDs in high volumes to the specifications and functions required during qualification.

Large quantities of drives are functionally tested in a stressed environment with emphasis on data integrity and reliability. Long-term operation is simulated to predict how the drives will perform in the field. In order for the supplier to ship additional drives, the strict pass/fail criteria have to be met. Any failures found are analyzed by IBM and the supplier, and any fixes and modifications are again verified.

Supplier process reviews and ongoing monitoring. During the qualification phase, a team of skilled engineers performs process reviews and manufacturing readiness reviews at the suppliers' premises to confirm that their processes meet IBM's stringent requirements. Successful completion of manufacturing readiness reviews is a prerequisite for start of shipment. IBM also sets up an ongoing monitoring process to verify that the HDDs conform to the specifications and quality requirements.

IBM Netfinity Server Power Systems and Power Supplies

IBM Netfinity servers include an IBM designed power system architecture, and specified power supplies and power subsystem components. The primary function of the power system is to provide a safe and stable, isolated, low-voltage energy source for the electronics and electromechanical subsystems within the server product.

The power supply itself is designed from a specification provided by IBM's engineers to suppliers, and the resulting unit is rigorously qualified both as an individual component and in the server. In addition, the power supply manufacturing process is reviewed and

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[1] Although HDDs are designed to be robust, they should be handled carefully. A .25" drop on a hard surface can cause the heads to contact the media and inflict permanent damage to the drive. Correct ESD and packaging practices should always be used.

certified by an IBM Quality Engineer before production is approved and on an audit basis thereafter. Performance is monitored throughout the life of the system.

The IBM Difference

IBM's power products begin life as a set of requirements for a given system that eventually lead to a formal engineering specification. These specifications contain detailed and specific requirements that must be designed to and complied with in the final unit. Many are unique to IBM and far exceed those normally specified by the industry at large.

The IBM quality engineer, along with brand quality teams, continually tracks the performance of our products and provide corrective action when required. Continual improvement is expected.

Power Supply Development and Qualification Process

The qualification process has five phases; in the first, the fundamental requirements, both electrical and mechanical, for the power subsystem are defined. These requirements are sent to a select group of power supply companies that form part of the IBM core supplier base. These companies are the recognized experts in their particular fields. At the close of this phase, a contract is awarded to the supplier, or occasionally two suppliers, who have demonstrated that their design can meet the system requirements.

Before receiving hardware for qualification, a detailed design review and peer review are performed. The design review involves senior engineering representation from IBM's power engineering team and the design engineering team from the selected suppliers.

Testing is performed at both the power supply level and at the system level, following a test plan developed jointly by IBM and the suppliers. The plan defines the test conditions, equipment and methodology used, the data to be collected and the pass/fail criteria for each measurement.

Functional testing is performed on hardware that has been updated with all of the fixes identified during the previous level of the product. Qualification includes verification that the power supply complies with all aspects of the engineering specification at the unit level. In addition, at the system level, validation data is collected for EMC, system thermal, system acoustics and functional integration.

Component assessment involves the evaluation of stress margins to verify that each device is being used within the defined application for the electrical component and that no over-stress condition is being applied. Reliability verification determines subsystem compliance with the reliability performance defined in the engineering specification. Also at this time, the supplier is responsible for obtaining the unit level safety agency approvals defined in the engineering specification.

A manufacturing assessment review is performed to identify potential problems in the design that would affect the ability of suppliers to manufacture the product consistently and meet the quality requirements of the overall system. Areas reviewed include component placement, ease of subassembly preparation and electrical interconnections.

System verification testing is the last phase of the qualification process. An on-site audit by IBM of the suppliers' manufacturing line is held to verify that the final-level design of the power supply is being produced in accordance with supplier and IBM manufacturing instructions.

Incoming shipments are inspected to verify that transportation and packaging are sufficient to protect the part from damage. Shipments are also inspected to verify that the part is sufficiently robust to withstand the rigors of shipping and that it is meeting its quality performance requirements.

During each phase of the power supply development and qualification process, data is collected and analyzed. Actions are developed and implemented based on the performance analysis. In addition, these actions are summarized for use in future products as part of the continuous improvement planning process.

Authorized Assembler Program

The Authorized Assembler Program (AAP)[2] is a program that allows IBM certified Business Partners to custom-configure IBM systems at the Business Partner locations. In order to ensure that the quality of the configured systems is equivalent to that of factory-produced systems, all IBM Business Partners are certified to meet stringent IBM AAP process and test requirements. Customers receive thoroughly tested, IBM approved solutions.

In order to become an AAP certified Business Partner, the Business Partner sites must be ISO 9001 certified and must use documented IBM assembly and test processes. Each Business Partner's assemblers are given IBM training, and the Business Partner must be able to perform warranty service. Each AAP procedure has an engineering change (EC) number, in order to control any unauthorized changes within the process. All EC changes must be approved and must be given a new EC number. Use of the EC process management system ensures that the Business Partners' manufacturing lines are always operating according to the latest approved processes, as well as ensuring quality and consistency in our products.

IBM Limited Warranty Program

IBM's limited warranty for the IBM Netfinity product line is a leading-edge, three-year, on-site program. It includes hardware problem determination performed remotely, using the latest technology and tools. If a problem cannot be corrected remotely, IBM will perform service at the customer site. Labor and IBM parts are covered for the duration of the warranty period, including parts identified during predictive failure analysis, and IBM will install ECs. Additionally, IBM Netfinity customers are entitled to access to the IBM HelpCenter 24 hours a day, 7 days a week, 365 days a year (response times may vary depending on the number and nature of calls received) for remote phone support. Options by IBM (OBI) products assume the warranty.

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[2] The AAP is not available in all countries.

The Netfinity server limited warranty is three years for parts and labor, on-site, 9 hours a day, 5 days a week.[3] If a customer determines that the server is critical to business, it is possible to have enhanced coverage and quicker response time. IBM Global Services offers a warranty upgrade to protect a customer's business by covering a server with extended coverage of 24 hours a day, 7 days a week and with same-day response.

Netfinity Server Support

IBM is uniquely qualified to deliver service and support that allow businesses to concentrate on doing business. IBM continues to build its Personal Systems Group (PSG) HelpCenter organization and bring many new support services to its customers. *Fortune* magazine on 23 June 1997 described IBM's PSG HelpCenter as a veritable "...army of personnel trained to help companies manage and maintain their system. That assistance has never been more important than now...." The statistic is impressive: 116,000 worldwide IBM service and support personnel in 163 countries. Working directly with customers and dealers, the IBM PSG HelpCenter's 2,500 specialists assist with many calls per month at 9 international call centers.

Since 1996 IBM has enhanced its support infrastructure as it expands its global reach and innovative use of technology. The PSG has major international HelpCenters in Australia, Brazil, Canada, Ireland, Japan, Scotland and the United States. Advanced technological links and one centralized database allow IBM technicians to share information and solutions worldwide, helping to eliminate potential problems and providing faster, more accurate responses to customer enquiries. This global support strategy makes it possible for the PSG HelpCenter to deliver the high-quality service and support IBM's customers expect.

Our worldwide Level 2 support team provides the highest level of system skills to meet customer server needs. Specialists support a variety of hardware and software. Hardware support includes not only PCs and servers, but also network adapters, routers, bridges, hubs, ATM switches and modems. Software support includes Windows NT, NetWare, OS/2 and UNIX.

The Level 2 team works in a unique environment that combines all of the above skills into a virtual team around the world to offer a total-systems approach to solving problems. The team provides problem determination, problem source identification, and problem re-creation in well-equipped labs.

The team has direct access to product engineering to assist in solving a problem, if required. Also, through technical agreements and relationships with other vendors, we can offer support on selected other manufacturer products.

90-Day IBM Start Up Support

Included with the purchase of any IBM Netfinity or PC Server system is a comprehensive support program designed to speed installation of both hardware and system software, and to assist in resolving other technical challenges associated with the installation of new systems. To maximize the value of customers' investments and resolve complex issues, IBM expands its network operating system coverage for Start Up Support. During the first critical 90 days after installation, customers receive support in the following areas:

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[3] Warranty coverage and conditions of warranty coverage vary from country to country, so be sure to check with your Netfinity representative to determine what is available in your area.

- IBM Netfinity and PC Server system installation, setup and configuration

- Network operating systems, including Novel NetWare and IntraNetWare, OS/2 Warp Server, Microsoft Windows NT Server, SCO OpenServer and UnixWare, Citrix WinFrame Enterprise, and NCD WinCenter Pro

- Selected network interface cards, such as IBM, 3Com, Madge Networks and Standard Microsystems Corporation

90-Day IBM Start Up Support is operational for all of North America 24 hours a day, 7 days a week, and is also available for IBM Netfinity and PC Server system customers and dealers around the world.

Enhanced Support Services

The Enhanced Support Services (ESS) program offers some IBM customers extended HelpCenter telephone support and toll-free access to our bulletin boards and automated fax system. These advanced services are grouped to handle hardware, software and network support needs quickly and efficiently.

ESS provides customers with:

- Streamlined access to the PSG HelpCenter

- Priority queuing on HelpCenter phone lines so that customers reach product specialists quickly

- Direct access to experienced product specialists

- Toll-free, dial-up access to the PSG Bulletin Board

- Access to more than 6,000 documents on IBM's automated fax system

Customers are nominated by marketing to receive ESS. ESS customers receive an authorization code and PIN for their exclusive use. ESS membership is valid for six months and can be renewed at IBM's option by the PSG marketing specialist.

ESS telephone support is available from 9 a.m. to 9 p.m. eastern standard time, Monday through Friday. Emergency network and server support is available after 9 p.m. and on weekends. The automated fax system and Bulletin Board Services are available 24 hours a day, 365 days a year.[4]

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[4] ESS may not be available in all geographies.

Remote Connect ... "Call Home" Remote Support

IBM has announced a major enhancement to its service and support for Netfinity servers. Using the latest technology advances delivered by the Netfinity 7000 product line, IBM offers a "Call Home" remote support capability in an Intel processor-based server.[5] If a server experiences a problem, it will dial IBM to set in motion the right level of support to keep a system up and running.

Using the many technologies in IBM's newest Netfinity server, Netfinity Manager software and the system management processor, our new support capability allows us to remotely deliver hardware problem determination, launch on-site resources if needed and invoke any level of support, including product engineering, within minutes. Included in this offering is a comprehensive problem-management system that provides tracking, management, escalation and transfer of problem ownership to the appropriate skills required to resolve an issue.

MoST Connect ... A Direct Communication Link to the Experts

Using the latest technology advances in IBM Netfinity and PC Server systems and Netfinity Manager software, IBM increases its on-site support by enhancing the Mobile Solution Terminal (MoST)*,* carried by our field service representatives*.* The latest enhancement*,* MoST Connect, provides a direct communication link between the IBM field service specialist at a customer's location and remote experts at the IBM HelpCenter support centers. Continuing to improve on-site support, IBM delivers remote console capability with both voice and data communications through an IBM Netfinity or PC Server's serial port.

Update Connector ... Web Access to the Latest BIOS and Driver Code

Update Connector is the quickest and most convenient way to access the latest BIOS and driver code*.* Connecting and executing through the Web, Update Connector searches a system's configuration, determines the current levels of BIOS and driver codes and notifies the customer of the latest available levels. At the customer's discretion, Update Connector can send the latest versions for the system and prepare them for installation at the customer's convenience. This service is included at no additional cost on ServerGuide 4.0 and future releases.

Personalized Electronic Support on the Web

IBM offers personalized support on the Web, dramatically improving data accessibility and reducing the time spent on Web navigation by presenting users with targeted information. Customers can easily access online support, including personalized IBM Web sites customized by machine type, computing environment and individual interests such as business applications. This capability expands IBM's industry-leading range of electronic support options, enhancing our ability to provide information when, where and how customers want to receive it.

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[5] Remote support is available for only certain Netfinity server models, only in the United States.

This personalized site offers customers the ability to tell us about their operating environment. We determine which solutions are applicable. Whether a customer wants a list of our frequently asked questions (FAQs), technical tips or information on downloading a new driver, it can be found on a personalized Web site in no time.

In addition, customers receive proactive e-mail, alerting them to timesaving hints and tips and product-specific updates such as new BIOS and driver codes.

The IBM Web site for electronic support is www.pc.ibm.com/support.

Options by IBM

OBI products are developed and released using the same kind of stringent processes as those for Netfinity products. Procurement Engineering verifies the sample testing and supplier qualification using the same disciplines, guidelines and mechanisms. Suppliers are routinely evaluated, and an approved supplier list is maintained. Through stringent controls of incoming components, and thorough supplier selection and qualification, a firm foundation for overall product quality is maintained.

OBI product development undergoes the same cycles of test and verification as do Netfinity products. Product assurance teams confirm each OBI product's compliance with the applicable agency approvals and certifications. The latest environmental and safety aspects and effects are considered and implemented in all OBI development.

Before the start of volume production, an OBI product undergoes customer setup tests that simulate the actual manner in which customers will unpack, install and use the product. These tests verify not only the intrinsic quality of the components, but the overall integration and functionality of the OBI product, including ease of installation.

Concern and focus on OBI quality does not end with the start of production and shipment to customers. Continuous monitoring and improvements to products are conducted through a closed-loop relationship with the HelpCenter, Business Partners, service organizations, direct customer feedback and survey results. These inputs drive improvements not only in the existing products, but also serve to improve the design of the next generation of OBI products.

Conclusion

IBM has a long-term commitment to Netfinity customers, offering them servers and associated products of the highest quality. In order to do this, IBM requires that each product adheres to rigorous, ongoing processes from design and development through the entire product life cycle.

These processes include many types and levels of testing, to confirm the availability and reliability of enterprise networking products for business-critical applications. Testing is also performed to protect customers' investments in existing products and technology, both hardware and software, and to verify that all products will be configurable to function correctly and easily with new products.

IBM's commitment is also evident in the Netfinity limited warranty and in the range and availability of service and support programs worldwide, with 2,500 specialists in 9 call centers expertly trained and ready to help customers through the IBM HelpCenter.

IBM knows that it is vital for customers to have their networks operating 24 hours a day, 7 days a week, 365 days a year. Our IBM Netfinity family of products, now and in the future, help make that requirement a reality.

Additional Information

For more information on IBM Netfinity directions, products and services, refer to the following white papers, available from our Web site at **www.pc.ibm.com/netfinity**.

IBM Netfinity Technology Directions
IBM Netfinity Servers and Intel Architecture
IBM Netfinity 8-Way SMP Directions
IBM Netfinity Cluster Directions
IBM Netfinity Fibre Channel Directions
IBM Netfinity Ultra2 SCSI Directions
System Management for Servers
At Your Service...Differentiation beyond technology

IBM.