UnixWare®
Based on SVR5

An SCO White Paper

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1. Introduction

The key to competitive enterprises today is information - information content, distribution and access. To facilitate easier creation, rapid distribution and ubiquitous access of business critical data, a new wave of computing has emerged - Network Computing. The most important elements in this model are the **network infrastructure** that allows users to connect, **reliable servers** to store and process information and **business critical applications** that allow you to exchange information or transact business. The desktop or the client is merely a tool to facilitate task completion. *The server acts as the hub for all information and processing.*

It is a dynamic environment. The clients are heterogeneous, sometimes remote and increasingly, mobile. Data models grow exponentially as IT systems become the basis for all business processing. And interoperability with legacy systems and the ability to run client/server or host based applications is as important as being able to deploy new Java enabled, browser based applications. While trying to accommodate these needs, Corporate IT is also seeking business critical systems that **offer lower total cost-of-ownership** . The answer is to build server-centric solutions using industry standard technology that are powerful, yet relatively easy to install and operate. The **strategy** is to bring the economies of scale and easy-to-use paradigm of Intel architecture based servers to enterprise computing.

This paper presents a look at the next generation UnixWare (SVR5) operating system, originally code-named Gemini, that enables such a strategy. Resulting from the Gemini project, this operating environment will provide customers with the most advanced UNIX server system on Intel. It is designed to support diversity in clients, to scale from small office server configurations to large scale enterprise servers and to provide high levels of reliability, availability and serviceability. Its out of the box Internet capabilities along with its strong ISV and IHV support provide the necessary server characteristics required for a successful network computing implementation. This paper does not provide information regarding packaging, licensing or pricing of the various features of a specific product offering. Details of this nature will be available at the time of general market availability of UnixWare (SVR5), scheduled for late 1997.

2. SCO's Vision

SCO's strategy to deliver network computing solutions is called The Internet Way of Computing™ It builds upon the next generation of open systems standards that includes the Internet, the World Wide Web, Java™, Network Computers and the rapid convergence in emerging technologies for computing, data communications and telecommunications. SCO believes that this confluence of technologies and standards is providing the foundation for the new wave of dramatic changes towards network computing. It also introduces the potential for a whole new generation of clients.

The ideal operating environment must therefore provide the ability to support the variety of exciting new clients while maintaining the ability to support existing ones. SCO systems have continually provided an evolutionary path when it comes to moving forward. This has been accomplished by allowing customers to integrate a new computing model with their existing ones, and by ensuring application compatibility as they migrate to take advantage of new systems. This is easily demonstrated by their ability to deal with diverse clients, from the most simple ASCII terminals to Windows desktops, point-of-service terminals to fully functional UNIX Workstations and specialized telecom devices to wireless, handheld PDAs.

SCO sees this move as an evolution of the client/server architecture which places far greater emphasis and importance on the reliability, robustness and interoperability of the server and its networking capabilities. This shift towards a server and network-centric application model is a natural extension of SCO's long-standing focus on business critical computing.

2. 1 Business Critical Computing and SCO

The UNIX system provides a large base of business applications, and has led the way in providing new and innovative technologies that have helped meet business computing needs. The UNIX system's established strengths in high-end performance, reliability, scalability, integrated networking as well as support of diverse clients take center-stage in this new computing model. Meanwhile, Intel processor based systems, known for their industry leading price/performance are increasingly capable of providing the scalability, raw performance and sheer throughput required of enterprise servers.

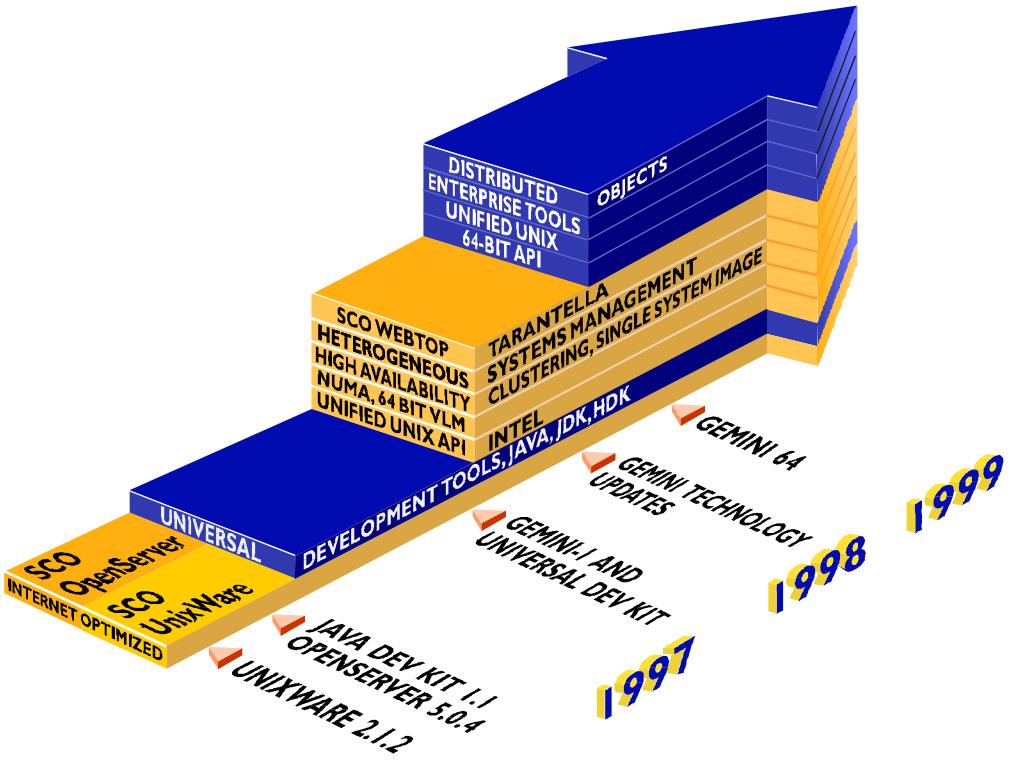
SCO has established its leadership in providing UNIX system software on commodity hardware platforms for enterprises of all sizes. SCO dominates the market for UNIX server systems, shipping more UNIX server units than any other vendor. According to the IDC report on Server Operating System Environments 1995-2000, SCO is the major player in the Intel UNIX marketplace with roughly 70% of shipments. The report goes on to say: "SCO has been the only truly successful Intel UNIX provider to date." SCO's operating systems, therefore, combine the strengths of the UNIX system with the economies of scale of Intel processor based servers to deliver a high quality, high performance and reliable network computing platform at cost-effective prices. By providing the most advanced UNIX implementation for Intel architecture based servers SCO is well-positioned to maintain its lead as the server of choice in this new, constantly evolving environment.

3. The Gemini Project and Roadmap

SCO has developed a comprehensive road map and product strategy for UNIX System users and developers to easily leverage the advancements that SCO is making for small, medium and enterprise-class environments. Gemini is the code-name of the SCO project that will deliver next generation UNIX Systems from SCO. This development activity and the delivery of products

from this project will bring significant new technologies and deliver compelling benefits to both the UNIX systems market and to customers.

SCO has structured the releases of the resulting operating systems (OS), OS extensions, development tools and migration tools to ease the migration from existing systems. The first of these deliveries, Gemini I will come in late 1997 and will result in a new SCO offering, called UnixWare, based on SVR5. A significant step that consolidates the best technologies from the SCO OpenServer and SCO UnixWare product lines, the new UnixWare release also includes several enhancements to meet the demands for today's new network computing model. Along with the base platform SCO will also release a Universal Development Kit (UDK), designed to run on new and existing SCO OpenServer Release 5, SCO UnixWare 2.1 and UnixWare based on SVR5 systems. This includes development tools for network computing applications such as Java Development Kit and a Java Just-in-Time(JIT) compiler. Starting in 1998, SCO will continue to enhance this platform through a series of additional (optional) system services required by specific target segments. These will also include a set of migration tools for existing SCO OpenServer Release 5 customers. The roadmap graphic included below identifies some of the other optional services and their expected timelines.



This platform is also designed to provide the easiest path to the 64-bit, next-generation UNIX System being developed by SCO for the Intel Merced (IA-64) processor. UnixWare based on SVR5 will deliver 64-bit features such as large files and filesystems, large physical memory, and 64-bit ready API's. The Gemini road map will ensure that the benefits of performance and scalability that 64-bit computing promises are delivered at the same time as Intel's Merced processor. SCO recognizes the investment that our customers have in today's 32 bit applications as well as the need to provide a simple and easy migration at the time of their choice. For further details on SCO's plans for 64-bit computing please refer to another SCO whitepaper titled "Gemini and the Path to 64 bits".

To enable SCO OpenServer customers to move to the new operating environment in a planned fashion when it makes sense from a business operations and investment perspective, SCO will work on providing enhancements to that operating system. The enhancements will address two key areas. One, hardware support. Two, new technologies that are strategic to the network computing model and will make the adoption and migration of UnixWare based on SVR5 easier.

4. UnixWare Based on SVR5 - A Look Inside

The new UnixWare system delivers a multi-functional, scalable UNIX operating environment with tightly integrated enterprise networking services ideal for business critical computing. Designed to include a superset of functionality contained in SCO OpenServer and SCO UnixWare systems, it adds several new technologies and enhancements to take advantage of latest system hardware and peripherals. It has built-in support for SCO OpenServer and SCO UnixWare applications by providing full application binary compatibility. With the inclusion of certain key 64-bit features, it is designed to provide an easy path to the next-generation 64-bit UNIX systems for the upcoming 64-bit Intel Merced processor based systems.

For customers familiar with existing SCO operating systems, at a high level, UnixWare based on SVR5 can be described simply as a combination of:

- **SCO UnixWare 2.1 Core Operating System and Services**
- **SCO UnixWare 2.1 System Libraries**
- **SCO UnixWare 2.1 System Commands**
- **SCO OpenServer Release 5 System Networking Protocol Stacks**
- **SCO OpenServer Release 5 System Installation Framework and Tools**
- **SCO OpenServer Release 5 System Administration Framework and Tools**
- **Significant new functionality:**
  - ➢ **Advanced Internet Capabilities and Java**
  - ➢ **Enterprise Power and Reliability**
  - ➢ **Comprehensive Network Interoperability and Directory Services**
  - ➢ **High-Availability and Clustering**
  - ➢ **Mail and Messaging**
  - ➢ **Remote Administration and Systems Management**
  - ➢ **Support for New Storage, Graphics and Network Technologies**

A detailed discussion of the features in the operating system product is outside the intent and scope of this whitepaper. However, the following sections highlight some of the new and exciting features that will provide customers with clear benefits in the areas of reliability, scalability, manageability and ease-of-use.

4. 1 Advanced Internet Functionality

The new UnixWare system provides full Internet server capabilities built into the operating system. With the incorporation of the industry's leading brand of Internet server technology, Netscape FastTrack Server, UnixWare based on SVR5 has a complete set of features for web serving. With the Netscape Navigator Gold 3.0 browser and authoring tool, customers can both access information on the World Wide Web or within their intranet, as well as rapidly create web pages enabling them to publish their own information from their UnixWare SVR5-based Web servers.

The server provides several facilities to setup a secure, scalable and easy to manage Internet server platform. These include encrypted and authenticated transactions via the Secure Sockets Layer (SSL) 3.0 protocol, protected access by implementing access control of confidential files or directories and point-and-click web server management.

4.1.1 Java

One of the key new technologies that enables network computing and diverse client support is Java. The new UnixWare system includes the Java Virtual Machine. The Java Development Kit (JDK), supplied as part of the development kit *(see UDK*), enables the development of Java applications and applets to run on current and future SCO platforms. This includes Java, the full-featured programming language for creating network-centric applications, JavaScript, a scripting language based on Java useful for creating programs quickly, and CGI (Common Gateway Interface).

4.1.2 WebTop

This system has built into it a web-enabled, browser based desktop. This means that a user can access the Web, look at information within the Intranet as well as run existing character or graphical applications or new Java applications from the same user desktop or workspace. This also means that the system can be easily set up to have a user see the exact same desktop environment no matter where on the network the user logs in. For those environments that have standardized on the Common Desktop Environment(CDE), a CDE Desktop is also available. This gives you the choice of deploying a traditional Xwindows desktop or setting up an Internet Computing Environment which is network-centric and platform independent.

4.1.3 Enhanced Graphics and Audio Support

For customers that want to take advantage of the latest video graphics and audio hardware to create a high powered desktop server for graphical applications, UnixWare based on SVR5 makes it easy to install and configure the latest graphics adapters and digital audio interface cards. High-impact graphics devices are mostly auto-configured via advanced device detection and testing. In other cases such as audio hardware, SCOadmin has graphical managers to install and configure the required system software and drivers. The system is capable of supporting multi-monitor configurations and allows for multiple console devices especially useful in technical, design or financial applications.

4.1.4 The Latest Xwindows System

The graphics system is based on the X11 Release 6 Xwindows system, the industry's most current version of the Xwindows standard. In addition to performance and maintenance improvements over the previous release this version adds new functionality, for example support for DOUBLE-BUFFER, RECORD, SHAPE, SYNC, XC-MISC, XInputExtension) and XKEYBOARD. For those environments that have X applications and need to support NetWare ® protocols, this release supports X over IPX/SPX connections. The new Xwindows system continues to support older X applications by providing binary compatibility for UnixWare and SCO OpenServer™ Release 5.0-based X clients.

4. 2 Enterprise Power and Reliability

Network computing places a lot more emphasis on the robustness of the server. Key to the success of such a computing paradigm is the **R**eliability, **A**vailability and **S**calability of the server platform. The new UnixWare system contains several enhancements as well as introduces some leading edge technologies that improve the overall system's performance and reliability.

4.2.1 Designed for Scalability and High Performance

To accommodate a more centralized computing and data storage environment, UnixWare based on SVR5 extends the class of system supported with the incorporation of a number of scalability enhancements that will meet the requirements of the most demanding applications and workloads.

Each of the kernel data structures that keep track of users, groups, processes and devices now use expanded type sizes which means a greater number of system-wide UIDs, GIDs, PIDs,

devices and inodes. This results in a system that is much more scalable in terms of the users it can support and resources it can provide. The maximum process size supported is increased to 3.75GB.

Memory allocation for various kernel resources is more dynamic than in previous releases which means that the system automatically responds to variations in workloads and allows more flexibility in performance tuning. Kernel modules can be loaded and unloaded dynamically, which allows optimal use of available hardware and system resources. It also enables a small kernel footprint for specialized applications. The pre-emptive kernel is fully multi-threaded with fine-grained locking mechanisms which leads to increased scalability and better real-time performance. Light-weight processes (LWPs) allow parallel execution of multiple threads for the same process. The process scheduler allows real-time, timesharing and fixed-priority workloads simultaneously enabling the system to be used for a variety of applications. For example near real-time process scheduling is particularly important in manufacturing process control, while time-sharing is the typical requirement of a business application such as a database.

4.2.2 Large Scale Memory and Disks

System memory (RAM) configurations up to 4GB in size are supported for general purpose workloads. Extending this even further, specific applications running on SMP systems equipped with Pentium® Pro and Pentium II microprocessors, will be able to take advantage of up to 64GB of special purpose using the distributed shared memory (DSHM) APIs. This will allow a single server to support a far greater number of concurrent users and data models than is currently possible. For example, a database application can use these APIs to allocate large segments (> 3GB) of shared memory greatly improving high-end performance.

The I/O subsystem in UnixWare SVR5 is also designed to meet the scalability needs of large SMP machines and clustered systems. Multi-Path IO (MPIO) for example, fulfills I/O requests in a round robin fashion on each available active I/O path to a disk, providing maximum disk loading while reducing traffic on individual SCSI buses. This also allows multiple systems in a cluster to read and write to all connected disks, thus minimizing any single system or controller bottlenecks.

The maximum file size is now increased to 1TB as is the maximum file system size. The filesystems have been coded using the 64-bit LFS specification providing an easy transition to full 64-bit filesystems. The system will also be able to support a far greater number of independent disk storage devices. By extending the device addressing model, the system now provides a potential 2^32 unique addresses for controllers, buses, logical units.

The system kernel is ccNUMA capable. UnixWare based on SVR5 contains enhancements in the memory management subsystem, the I/O subsystem and in the process scheduler to take advantage of ccNUMA hardware implementations. System providers of ccNUMA based machines can work with SCO to build platform specific modules (PSMs) and drivers to support their implementations. These enhancements also provide scalability, performance and availability benefits to systems that use greater than 4-way SMP ™ configurations based on other architectures.

4.2.3 Improved Reliability and Availability

The core of this operating system leverages several years of field proven reliability and quality system software deployed in mission critical and business critical environments. Further improvements have been made to allow customers to take advantage of new hardware technologies without affecting the core system. For example, the Storage Device Interface(SDI) subsystem has been modified to provide support for layered storage device drivers. It is no longer necessary for such drivers to manipulate private kernel interfaces such as the device switch in order to intercept I/O requests. SDI now provides a set of concise, versioned interfaces to support such drivers.

Key to improving availability and protection in case of system failures, UnixWare based on SVR5 includes a logging filesystem, vxfs, which logs file transactions before committing them to disk. This helps fast recovery by reducing time spent checking and repairing filesystems in case of an unexpected system failure. Support for UPS systems along with UPS monitoring APIs allow for continued operation in the event of power failure.

4.2.4 Hot Plug, Hot Swap and Failover

The I/O subsystem in this release supports new hardware technologies designed to improve the high-availability and fault-tolerance of the system. Multi-path IO allows systems to be configured for alternate routes to disk storage in the event of a single point failure in the IO system. DDIv8, the device driver subsystem includes support for systems with Hot Plug PCI storage, allowing drivers to be written so that failed or failing parts can be replaced without having to reconfigure the kernel and without taking the system down. The system supports hardware RAID subsystems. A software RAID solution, the Online Data Manager, will be available as an add-on option. This provides facilities like disk mirroring, striping and spanning that protect against disk failures.

A more complete discussion on new hardware storage technologies supported in UnixWare based on SVR5 is included under *New Hardware Technologies.*

4.2.5 UnixWare Clustering

When deploying more network and server centric solutions, it is even more crucial that service interruptions due to network and server failures be minimized. To provide customers a high-availability solution, SCO has provided UnixWare clustering technology for system and application failover via an add-on product SCO ® Reliant®HA.

4. 3 Comprehensive Network Interoperability

To support the diverse set of clients and existing, legacy environments, UnixWare based on SVR5 contains a rich set of protocols and the latest networking technologies. Existing protocols have been enhanced to conform to the latest standards (RFCs), improve performance, increase the number of concurrent connections and provide higher network bandwidth and data transfer rates.

4.3.1 New Networking Protocols and Services

A new SCO **PPP** implementation provides Multilink (MP) support, STAC Compression Control Protocol (CCP) and support for up to 256 concurrent links. The NetBIOS protocol stack can now support more than 1024 connections as well as multiple interfaces. It also provides *resolver* support for NetBIOS names. IPX/SPX™ protocol stack is updated to include the **SPX II** protocol. A series of new networking utilities and the latest versions of networking services have been included. Some of these are the **Dynamic Host Configuration Protocol (DHCP), Address Allocation Services**, connection server call filtering and automatic detection of an incoming PPP connection. SCO DHCP implements the server aspects of the Dynamic Host Configuration Protocol as defined in RFC 1534, RFC 1542, RFC 2131, and RFC 2132. New versions of existing services include Gated 3.5.3, BIND 4.9.4, NTP 3.5 and FTPD WU 2.4.2.

In the areas of routing, a key piece of functionality for Internet and network computing, UnixWare BASED ON SVR5 adds support for new routing protocols. Some of these are **OSPFv2, RIPv2 and IGMPv2**. Also available is support for multi-casting and router discovery. All of this means that the TCP/IP implementation now complies with the definitions set forth in RFC 1122/1123, RFC 1583, RFC 1256 and RFC 1323. This version also includes BSD IPv6 APIs, provided for future application compatibility with **IPv6**, the next generation IP protocol.

4.3.2 Tuned for Performance

All network specific kernel tunables are now dynamic in nature. As network traffic and usage grows, the system will automatically increase these resource allocations without the need for kernel re-links and reboots. Any administrator-defined limits can also be changed dynamically using the Network Manager. New high-performance extensions as defined in RFC 1323 are added. PPP now allows multi-link aggregation, which can greatly improve remote connection throughput where multiple lines are available. It also supports much faster modem connections as well as ISDN links.

4.3.3 Built-in, Dynamic Network Security

For added remote access security, the system contains dynamic **IP packet filtering** which is supported over PPP for remote connectivity and MDI drivers for LANs. By configuring a packet filter on Internet gateway(s) to control the types of packets in and out of a site's networks, the security of the networks against unauthorized access is increased significantly. Dynamic firewall technology examines every packet passing through the network interface. When a packet meets the requirements of the packet filtering rules, it triggers dynamic firewall technology to write new, temporary rules on-the-fly. This ability to adapt to network traffic provides a distinct advantage over ordinary static packet filtering, a widely used technology which can leave networks vulnerable to attack by intruders. Account management commands conform to POSIX 1387.3.

4.3.4 Easy LAN and Remote Access Configuration

Almost every aspect of configuring the network subsystem is now easily accomplished using a set of graphical managers. The graphical managers are part of the SCOadmin framework. Setting up the network hardware and protocols is made easy via a Network Configuration Manager for configuring LAN and WAN hardware and protocol stacks, the Serial and Modem Configuration Managers for remote connections and the PPP Administration Manager for setting up PPP.

Configuring network services such as **NIS, NTP, DNS** name service, anonymous FTP, dial-in and dial-out configurations and routing is driven by point-and-click graphical SCOadmin Managers.
Allocating IP addresses for new nodes in a network can now be automated via an Address Allocation Server. Support for the Dynamic Host Configuration Protocol (DHCP) greatly reduces administrative overhead and allows you to easily accommodate remote and mobile users.

4.3.5 File and Print Services

NFS® and support for PCNFS clients is built-in, allowing file sharing with other server systems and PC clients running PCNFS. For Windows ®clients, customers will have additional options for file and print services on the new UnixWare system. Via add-on software such as SCO **VisionFS**™ or SCO **Advanced File and Print Server(AFPS),** a Windows client can access resources on the new UnixWare server transparently, using native access facilities available on the client i.e. no additional client side software is required. While SCO VisionFS is appropriate for workgroup environments, AFPS is more appropriate for large environments or those that require integration with NT servers.

The printing subsystem is based on the SCO UnixWare 2.1 product with the addition of SCO OpenServer Release 5.0 features including support for HP® Network Printers. Print jobs submitted remotely can now be controlled from UnixWare systems. To improve the level of print management capabilities, this print subsystem is inter-operable with other SVR4-based ones such as SUN and SGI.

Building on UnixWare 2.1's strong interoperability with NetWare environments, this system contains the latest version of **NetWare File, Print and Directory Services** . File and Print services have been upgraded to version 4.10a for both client and server functionality. Novell's directory service NDS v 5.04 is included in the system as the premier enterprise class directory

service for heterogeneous computing. A significant new addition is the ability to run NetWare Services over IP connections, which is accomplished by tunnelling IPX packets over IP.

4.3.6 LDAP Directory Services

A notable new addition is support for the **Lightweight Directory Access Protocol (LDAP)** as a means for applications to access directory services. LDAP is a directory service protocol defined in RFC 1777 and runs over TCP/IP. Directory entries represent objects such as people, printers or documents and are arranged in a hierarchical tree-like structure that may have geographic and/or organizational boundaries. Applications can query an LDAP directory server using this protocol, however there are ways to have the LDAP server act as a gateway to other directory servers, such as NDS. One of the applications in the new UnixWare system that will use these capabilities is the mail and messaging system. With the Netscape ™ mail client, which is LDAP enabled, users can locate email addresses of people within the organization using the LDAP server.

4.3.7 Enterprise Network Management

The **SNMP** package included in the system provides both agent and management station capabilities. The new UnixWare server can be managed by an SNMP Enterprise Management system and can also serve to monitor other nodes within the network. By using the SCO SNMP implementation, a network administrator can gather information such as routing entries, interface status, and protocol statistics. If problems are encountered, the administrator can manipulate items such as the ARP cache and the routing table to add, delete, and modify entries.

The SNMP Agent Manager allows you to perform most SNMP configuration graphically. It supports the standard objects MIB-II (RFC 1213), IP Forwarding Table MIB (RFC 1354), Ethernet-like Interface Types MIB (RFC1398), IEEE 802.5 Token-Rings MIB (RFC 1231), FDDI MIB (RFC 1512), RIP Version 2 MIB Extension (RFC 1389) , OSPF MIB (RFC 1253) , BGP MIB (RFC 1269). It also supports all the objects under the SNMP Multiplexing (SMUX) group.

4. 4 Mail and Messaging

The mail and messaging subsystem included with UnixWare based on SVR5 represents a vast improvement over previous versions with significant enhancements in both Mail Transport Agent (MTA) and Mail User Agent (MUA) technologies.

4.4.1 Multi-homed Mail Server

Sendmail is the default MTA for the new UnixWare mail system. It handles the transport of messages to and from your system and supports local, networked (SMTP), and dial-out (UUCP) mail delivery. The server also supports multi-homing which means that it can function as a mail gateway to other servers on the network. Multi-homing enables you to set up multiple virtual domains on your system, so that (for example) you can host several companies or departments (and their associated email addresses) on a single mail server. All of this is easily configured using the Virtual Domain User Manager.

The SCOadmin Mail Manager is the primary tool used to configure and administer sendmail on your system or on others with remote administration capability. The system also allows automated processing of incoming mail via *mail processing filters*. A Vacation Manager, available to any user from the desktop, allows an automatic reply facility in case of extended absence, while a folder recovery tool, called mfck, helps recovery from a corrupted mail folder.

4.4.2 Scalable Message Store

A key new enhancement is the addition of a *scalable message store*. This message store, used by both sendmail and mail user agents, results in higher overall performance of the mail system and also enables a single server to support a far greater number of mail clients. Other

improvements include support for RFC1123 v8, support for extended SMTP as defined in RFC 1651, RFC 1653 and some support for RFC 1652.

4.4.3 Remote Mail Access and Multimedia Messages

Users will have a wide range of character, graphical and browser-based MUAs all with the ability to send and receive "rich" data via support for MIME attachments. Netscape mail, mail/mailx, PINE and Dtmail (from CDE) are supplied as the standard mail agents and readers.

The leading mail access protocols **IMAP4** and **POP3** are supported for client connectivity. This enables remote and mobile users to easily read mail from Windows laptops and remote desktops. A MAPI DLL allows Microsoft® **MAPI** compatible clients to connect to SCO servers in a true client/server model where mailfolders remain on the host. To further facilitate remote mail capabilities, the system also allows Microsoft MAPI compatible clients such as Microsoft's Outlook and Exchange to do address book lookups via LDAP to SCO's directory services.

4. 5 Easy to Use, Intuitive Systems Management

System administration facilities are based on the SCO OpenServer Release 5.0 SCOadmin model. SCOadmin, an object-oriented framework written in SCO Visual Tcl ™, can be rendered on a character-based display or as a graphical user interface on an Xwindows display. With this release, a Java™ rendering engine for SCO Visual Tcl has been added. This means that you can now run SCOadmin from any browser based client, further facilitating the "manage from anywhere" concept..

4.5.1 Graphical Managers

Several new subsystem managers are provided that enable point-and-click management of system resource and services. For example, using the new Filesystem Manager, an administrator can add a new filesystem, establish it as a shared resource and view its mount status via the GUI.

4.5.2 Remote Control

The ability to remotely administer a UNIX® system has been a key differentiator and with UnixWare based on SVR5, administrators can manage remote servers via dial-up or networked connections. A productivity enhancing feature is the addition of the concept of Host Groups. Host groups allow the replication of SCOadmin operations across the network. One can select a remote server on the network by name, use a pick list or search using various filters. To ensure secure control, administrators can enable or disable the remote management capability.

4.5.3 SCOadmin Setup Wizards

This release of the operating system introduces the concept of *setup wizards*. SCOadmin Setup Wizard, for example, makes it easy to define system owners who have authorization to run SCOadmin managers. The SCOadmin setup wizard will also simplify the setup of remote access and administration by allowing an administrator to specify which remote users can access the system. A new Intranet Manager provides a hierarchical view of local network nodes that may be managed.

4.5.4 Distributed Systems Management

A new **Intranet Manager** presents the user with a default list of local network nodes to be managed. An administrator can modify this list and utilize this capability to manually create hierarchical representations of their network topology. If a managed node becomes unreachable, an alert is sent to the administrator. Via a graphical, easy-to-use interface, one can view/set/get

SNMP MIB attributes and generate hardware or software asset-tracking reports for groups of nodes based on information stored in the host resources MIB (*see Enterprise Network Management under Comprehensive Network Interoperability).*

4.5.5 System Usage Tracking

Facilities for auditing and accounting system and resource usage are included. For example with *connect accounting* you can determine how long a user was logged in, obtain information about the usage of tty lines or the number of reboots on your system. *Process accounting* allows you to keep track of data on each process run on the system while disk accounting gathers data about the files each user has on disks. The system also allows you to set up *fee-based access* for special services such as file restores or remote printing via a program that maintains service accounts.

4.5.6 Improved System Analysis Tools

There is source-level instrumentation for runtime events, including DEBUG assertions, memory leaks, memory corruption, lock hierarchy checking and lock statistics **.** This enables a system administrator to get a lot more diagnostic information on what is happening in the kernel when troubleshooting software problems. The new *crash* command includes a batch mode for generating dump summaries, selective dumping, generic storage dumping and support for large physical memory. The *dump* command can dump memory selectively for kernel mapped pages, and to multiple devices if required. This is especially useful in large scale systems with large RAM configurations.

4. 6 Security

UnixWare based on SVR5 inherits the security program from the SCO UnixWare 2.1 system. It is designed to be C2 certifiable and includes B2 extensions to meet the most demanding government and enterprise system security requirements.

4.6.1 Pre-defined Security Levels

Setting up security is easy and one can choose from several available profiles. A security profile is a set of pre-configured values for parameters that control the security behavior of your system, such as how long passwords last, or what privileges are assigned to users. Administrators can select different profiles using the SCOadmin Security Profile Manager. Pre-configured levels include *High*, for systems containing confidential information and accessed by many users, *Improved* systems accessed by groups of users who can share information, *Traditional* which is compatible with other UNIX systems and *Low* which is recommended only for systems which are not publicly accessible and which have a small number of cooperating users. One can further choose to alter any of the values that make up a profile, individually.

4.6.2 Multi-level Access Control

SCO UnixWare provides a secure operating environment by means of these key features

- Identification and authentication
- Access Control Lists
- Least privilege/trusted facility administration
- Auditing

The Trusted Facility Management (TFM) tools provide the means to maintain a database of users and the commands they may execute with privilege. TFM eliminates the need to place fixed privileges on a command itself. This way the privilege can be assigned on a per user basis.

UnixWare based on SVR5 also provides facilities for secure and authenticated access over the network. These facilities are discussed under the *Comprehensive Network Interoperability* section.

4. 7 Localized for International Environments

The new UnixWare system is an internationalized operating system that supports many different language/cultural environments. It enables multi-byte representations of characters as well as single byte representations of non-ASCII characters. Left to right EUC, 8 bit and UTF8 encoded languages are supported. With the delivery of over 200 locales and 30 keyboards, it allows internationalized applications to enter, display and print characters in many different encodings. UnixWare is localized for Japanese, French, German, Spanish and English. Support for other languages can be easily added by 3rd parties.

4.7.1 Easily Integrate New Language Support

UnixWare based on SVR5 uses a locale based model for internationalization and supports both the MNLS and XPG4 APIs. The locale based model is one where all text seen by the user is kept in a file separate from the binary. The file is accessed based on the current language the user is running in, which is generally defined via the LANG environment variable. The OS is programmed in a manner referred to as 8-bit clean. This means that all countries and languages which can be specified using an 8-bit left to right character set can work with the new UnixWare system. In addition, those which can be specified using an EUC (Extended UNIX Characters) codeset will also work. The EUC work has been extended to also include support for the UTF8 encoding of Unicode. Support of state dependent locales such as Shift-JIS and Big5 is not currently included.

4. 8 New Hardware Technologies

One of the key advantages and benefits of a platform such as SCO's is the wide choice of industry standard and commercial off-the-shelf(COTS) hardware systems and peripherals. This allows you to pick the most cost-effective solution for your business while also taking advantage of new advancements in hardware technology. UnixWare based on SVR5 leverages the IHV support for SCO OpenServer Release 5 and SCO UnixWare 2.1 systems and adds support for several new and exciting hardware technologies.

4.8.1 Scalable Storage Subsystems

The new UnixWare system provides support for several new storage devices that provide increased I/O performance, support for large **I_2O** mass storage devices and the ability to connect large numbers of storage devices at high data rates. Some of these are Fibre Channel, I2O and SSA.

I2O is designed to facilitate intelligent I/O subsystems, with support for message-passing between multiple independent processors. By relieving the host of interrupt intensive I/O tasks required by the various layers of a driver architecture, the I2O intelligent I/O architecture greatly improves I/O performance. I2O- compatible systems will be able to more efficiently deliver the I/O throughput required by a wide range of high bandwidth applications, such as networked video, groupware, and client/server processing.

Serial Storage Architecture(SSA) is also supported. SSA, the industry standard interface designed for low-cost, high-performance serial data transfer enables high speed transfer of data between computers and storage devices such as disk drives, CD-ROMs and tape drives. It offers a total interface bandwidth of 80 MB/s. The technology can support really large configurations and is designed to support hundreds to thousands of disks on a single bus.

Tape data compression characteristics control allows system administrators and backup software to control data compression and decompression hardware features supported by various SCSI tape drives.

As mentioned before the Hot Plug PCI driver infrastructure is provided. Both plug & play PCI and ISA Network Interface and graphics cards are auto-detected. PC-Card support is inherited from SCO UnixWare and additional support will be available from 3 rd parties.

4.8.2 High-speed Networking and Communications

ISDN capabilities for voice and data networking. This SCO UnixWare release supports Basic Rate Interface (BRI) ISDN service, consisting of two 64K B-channels and one 16K D-channel. The SCO ISDN implementation is based on the CAPI standard and is supported within the MDI Streams architecture.

A wide range of 100Mbps fast networking standards are supported for high speed connections. These include 100BaseT, FDDI and 100VG. Non-intrusive network card restart and failover is part of the new high-availability infrastructure that facilitates runtime device maintenance, and supports hot-pluggable adapters. This can significantly reduce downtime and also allow planned upgrades to take advantage of new networking cards without bringing down the system.

With support for the 16650 UART chip, serial connections between systems either direct or using dial-up modems can now run at up to 115.2Kbps. Modem support has been greatly enhanced with built-in support and, in most cases, automatic detection of over a 1000 popular modems.

4. 9 Software Installation and Management

The system uses the standard UNIX system installation utility, **pkgadd**. Widely used in SVR4 based UNIX systems, pkgadd enables both interactive and non-interactive installation modes.
A graphical Application Installer is also available and allows installation of system software, patches and applications in an interactive mode. The system also allows you to spool packages for delayed on scheduled installation at a later date. Packages and sets can be installed from CD-ROM, cartridge tape, disk, or over a network. The system provides utilities to allow the installation of software designed for other UNIX systems that require the use of tools such as cpio, custom, and tar.

4.9.1 Remote Installation

Network installation is particularly useful if you have to install the same packages on many machines, or if your network includes multiple sites. Network installation removes the need to transport media from site to site. The entire UnixWare system can be installed over the network. This provides an efficient way to install system software, especially if the system you are installing on does not have a CD-ROM or cartridge tape drive.

4.9.2 Centralized “Install Server”

An install server allows you to “stage" software so that other systems in your network can use it to perform a network installation of SCO UnixWare or of specific packages. An install server is a SCO UnixWare server that is configured to provide software products and packages to other systems in the network. Once an install server is configured, subsequent software installation of additional machines can be performed over the network.

5. The Universal Development Kit

To enable developers to create powerful new applications that will take advantage of the new features in the UnixWare system, SCO is providing a development environment that contains a solid foundation of APIs, libraries, and the basic technical tools that enable a broad range of

applications and systems development. However, there is also within SCO, a traditional emphasis to enable customers and ISVs to evolve to new computing models and OS releases.

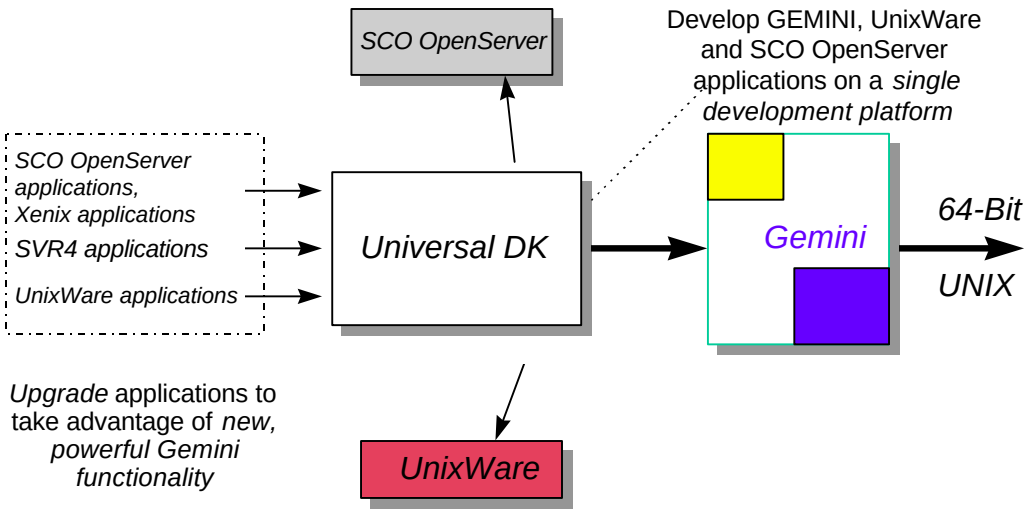
The software development environment for Gemini is called the UDK or Universal Development Kit. The UDK is one component in a suite of developer tools that support SCO operating systems. The UDK is comprised from technical tools from the SCO OpenServer and UnixWare Software Development Kits, with major enhancements and new features.

The universal nature of the Gemini UDK comes from it's ability to support development of applications (restricted to the subset of common APIs) that run on several SCO operating system products:

- SCO UnixWare Release 2.1.1 and later
- SCO OpenServer Release 5.0.0, 5.0.2, and 5.0.4
- SCO UnixWare based on SVR5 (aka Gemini)

The UDK itself will install and run on SCO UnixWare 2.1.2, SCO OpenServer 5.0.4, and the new UnixWare product.

Advanced development environment for SCO OpenServer, UnixWare and Gemini Developers



The UDK tools will be familiar to traditional UNIX software developers, but include significant new capabilities that are equal to the tasks of developing and managing applications in a range of customer environments from desktops to Internet to enterprise data centers.

The UDK will enable developers to bring applications forward from earlier UNIX systems, as well as make it easy to port applications and move business data processing solutions from mainframe or Windows systems to SCO.

UDK has been planned for modularity, with the ability to be extended in future to new generation computing environments such as 64-bits.

UnixWare based on SVR5 and the UDK enables a source and binary compatible environment for existing SCO UnixWare 2 and SCO OpenServer Release 5.0 binaries. Applications that depend upon particular SCO UnixWare 2 and SCO OpenServer Release 5.0 features may need additional porting changes.

The basic C Compilation System (compiler, libraries, linker/loader, debugger) and the Java technology (JDK) are shipped with the Gemini OS run-time at no extra charge. The complete UDK is available as a layered product.

Java technology is an object-oriented, distributed, platform and vendor-independent programming language and execution environment. The Java Development Kit (JDK) enables the development of Java applications and applets on current and future SCO platforms. The JDK includes the essential runtime engine of Java, that is, the equivalent of an OS's kernel and libraries:

- Java Virtual Machine (JVM)
- appletviewer browser
- basic API libraries - language support, I/O, AWT, networking, utilities, images, media, math, compression, security

The JDK also includes Java development tools:

- Javac compiler
- jdb command-line debugger
- javah header/stub generator for native methods
- javap bytecode disassembler
- javadoc documentation formatter
- jar JAR archive tool

The JDK also includes components to support distributed applications and database access:

- Java Beans (visual development model)
- JDBC (database access)
- Remote Method Invocation (RMI)

UnixWare based on SVR5 is "Java aware" treating Java class files as first-class executables.

Extensive UDK documentation available via hypertext is supplied, the documentation is also readable with standard browsers, SCOhelp. and the "man" command.

The UDK has a improved and industry leading C++ compiler that closely tracks the emerging ANSI/ISO language standard.

The UDK is based on the SCO UnixWare development environment. This provides the basic support for the native ELF SRV4 based ABI, iBCS2 and UNIX 95 compatibility and multibyte EUC support as standard. Advanced tools such as an enhanced graphical debugger and extensive optimization support are also carried over from SCO UnixWare. New features include long compiler support for 64 bit data types, DWARF2 support and the ASPEN extensions for 64-bit compatibility going forward.

6. Add-on, Optional Services

In addition to the rich set of features included in the new UnixWare operating system, SCO is will provide a series of add-on, optional software packages that serve to extend or enhance the capabilities of the system for specific solutions. While this paper does not provide details on pricing and packaging of these services, the following sections briefly describe these add-on services. More detailed information on each of these technologies is available in the form of datasheets, other SCO whitepapers and information at the SCO website, www.sco.com.

6. 1 *Tarantella*

One of the most exciting new technologies that will be available from SCO is Tarantella technology (herein after referred to as "Tarantella"). Tarantella is designed to allow any application to be run on any client from any server. This means that existing or new business critical applications running on NT servers, UNIX servers or mainframe-class systems can be accessed and run by any web-enabled client. This includes existing UNIX workstations and Windows PCs or the emerging Network Computers (NCs) and handheld Java clients. Without rewriting!

Tarantella also provides a centralized storage and management capability. Users' environments are stored on the Tarantella server which also keeps track of user sessions. This means that a user logging in from anywhere in the world will see the same user environment. It also means that if need be, mobile users can depend on Tarantella to keep their session alive even as they physically disconnect and reconnect their client systems. Tarantella keeps the application process alive.

From an administrative and systems management perspective, Tarantella greatly simplifies software deployment and distribution. Due to the centralized nature of application deployment and user environment, changes made once on the server are automatically propagated to all targeted users. A detailed whitepaper and additional information on this product is available at http://tarantella.sco.com.

6. 2 SCO ReliantHA

SCO ReliantHA is high-availability clustering solution for customers that require high levels of application, system and data availability. It is the first 2+ node enterprise-class clustering solution available for industry standard Intel server platforms using an industry standard UNIX operating system, the solution supports up to 4 nodes in a cluster. Features include fine-grained failover and automated recovery of entire systems, applications or an individual service intervention. The solution uses standard SCSI peripherals and Ethernet networks for interconnect.

6. 3 SCO VisionFS

File and print services for SCO UnixWare. Designed to provide transparent file and print services to Windows 3.x and Windows 95 PC clients, SCO VisionFS is a server based solution that requires no additional client side software. Ideal for TCP/IP LAN environments that need to easily integrate Windows PC clients with an SCO UnixWare server. It is a cost-effective and easy-to-deploy alternative to existing PC-NFS client solutions. SCO VisionFS is also available for other UNIX implementations.

6. 4 SCO ARCserve/Open

SCO® ARCserve®/Open is an easy-to-use, high performance, comprehensive system for centralized backup/restore as well as data management of servers and clients within an enterprise network. With an intuitive graphical interface, facilities for automated and unattended

backup and a high performance engine, SCO ARCserve/Open makes managing the backup and restore of a large server, or clients and servers within a heterogeneous network, simple.

6. 5 SCO Doctor

SCO Doctor™ is a systems management package that autonomously and pro-actively monitors and manages SCO servers to ensure optimum reliability and performance efficiency. Using advanced process monitoring, accurate diagnosis, automatic problem correction, and automatic tuning, alerts can be communicated to the administrator via the Doctor console, built-in pager support, e-mail notices, or SNMP traps. A powerful inference engine enables automatic management of UNIX systems by utilizing built-in rules and reasoning. An extensive suite of customizable views and reports clearly and concisely presents every facet of system performance and provides an invaluable resource for analysis of system performance and historical trends.

6. 6 SCO Online Data Manager (ODM)

SCO Online Data Manager is an enterprise-level storage management system for UnixWare. The three components of ODM: the ODM Advanced File System (VxFS), Volume Manager (VxVM version 2.3) and Volume Manager Visual Administrator (VxVA) work together to provide RAID 0, 1 and 5 capabilities i.e. disk mirroring, striping and spanning. The system enables dynamic disk defragmentation and filesystem resizing. VxVA allows the administrator to visually identify 'hot spots', or high activity areas on disks. These can then be moved closer together to reduce disk seek times or moved to others disks to increase performance. All these powerful features are delivered through an intuitive and powerful graphical user interface.

7. Summary

As businesses move towards a more centralized, network oriented computing model, one of the key ingredients for a successful implementation will be the server. Along with this change is the continued growth of Intel architecture servers in business critical computing. SCO, with its leadership in UNIX systems for the Intel platform has developed server technologies to help customers take full advantage of networked computing.

SCO's new UnixWare system, based on SVR5 will deliver on SCO's vision for information technology called the Internet Way of Computing. Building upon the next generation of open systems standards including the Internet, Worldwide Web, Java and Network Computers to enable a server centric application architecture based on open Internet standards and client neutrality. The new UnixWare system builds upon the well-known strengths of the UNIX system by providing significant enhancements in the areas of high availability, scalability, performance and network interoperability.

Along with this UnixWare system, SCO is delivering key new technologies such as Tarantella and UnixWare clustering to enable customers to evolve their existing clients and applications while also deploying new network centric solutions. Tarantella is an enabling technology that also provides significant benefits in the areas of enterprise wide application deployment and support for remote and mobile users. It allows Business Critical applications on UNIX servers and Mainframe-class systems to be deployed anywhere in the world to Network Computers (NC) and other Java clients. With no rewriting.

SCO UnixWare system, based on SVR5 is the SCO platform which will provide the easiest path to the 64-bit, next-generation UNIX System being developed by SCO for the Intel Merced processor. In addition it provides a scaleable, manageable and available solution to Business Critical Computing.

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