A Brief History of Networking at Unisys

Prologue

Before beginning this history, I need to thank all those who provided not only input to this paper, but took the time to review drafts and provide comment. These individuals include both past and present Unisys employees, without whom this paper would not exist. The list is long, and you all know who you are, so I hope you can take satisfaction in knowing that this paper would not exist without your support. In a very real sense, this is your history as much as it is Unisys'.

Scope

This history was compiled through a process of interviewing a small number of past and present employees of Unisys, whom the author selected based on their reputations as experts in this field, and also as having lived through much of this history. These people all contributed in some significant manner to much that is related in the following paragraphs, and knew many of the people who did the rest. I also am less concerned with the actual calendar dates of significant events, and more concerned with time frames. While this method does not result in a complete history, in the sense of capturing everything of note and relating them to calendar dates, it does I believe capture the highlights of our history in the field of communications and networking beginning with the end of the Second World War. I hope the readers will view it in that spirit, and take some pride in the significant contributions made by their company and coworkers, despite the fact that Unisys does not have the reputation as a "networking company".

Both Burroughs and Sperry (the companies that merged in 1986 to form Unisys) actively participated in the advancement of networking technologies as will be developed in the following paragraphs. One of the interesting aspects of our history in this field was how similarly in many respects the evolution of networking occurred at both companies. It proves that we were driven by the same external pressures, and in many cases solved the problem in very similar ways, despite the differences in our systems and customer requirements. I have made an attempt to relate the significant industry events to what was occurring at Unisys to aid in the understanding of this evolution.

The Beginnings

Over the five decades that Unisys has been involved in the computer industry, it has participated in the development of networking technologies while working under contract for the Department of Defense (DOD) and other government agencies and in the course of developing its commercial product offerings. During this time Unisys has made several significant technical contributions furthering the development of networking in the industry at large. In addition, as a large, multinational company Unisys has long used networking to connect its locations worldwide and has developed extensive experience in designing, implementing and operating large multinational networks.

The history of networking at Unisys begins in the late '40s with work done by Engineering Research Associates (ERA), one of the predecessor companies that eventually formed Unisys. Established right after World War II, ERA was primarily known for making cryptographic devices for the U.S. government. In fact, it was sponsored in large part by the Department of Defense to ensure that the United States did not lose the expertise developed during the war. In an attempt to expand its product offerings and markets, ERA developed a number of electronic devices. One of these devices used closed loop wireless technologies to connect to in-flight aircraft. Its purpose was to automatically focus the aircraft's antenna, maintaining communications independent of aircraft location relative to the ship. This early technology proved to be very successful for ERA and Remington Rand Univac (after Remington Rand purchased ERA and Univac) well into the '60s.

However, one of the first true computer networks was the Semi-Automatic Ground Environment (SAGE) air defense system developed by a number of companies under the direction of the Lincoln Laboratories at Massachusetts Institute of Technology (MIT) in the late '50s and early '60s. This network had many Direction Centers [large computer centers], long range radar digitizers, airfields, and command centers all interconnected by early modem [as well as voice] connections. Burroughs provided the first long range radar digitizing systems [code-named Haviland], the Back-Up Interceptor Control (BUIC) systems, the Airborne Long Range Input (ALRI) systems, and other parts of the SAGE network.

The '60s

An early network achievement in the computer industry was the development of a number of computerized message switches. At first these switches merely replaced "torn tape" teletype message centers. Later evolution included early versions of access control, adaptive routing methods, complex message distribution capabilities including multilevel security, automatic recovery from many error conditions, and the use of digital modem "trunks" rather than teletype connections. Burroughs developed and produced many message switching systems during the '60s and the '70s, including Automatic Message Processing Systems (AMPS), Automatic Digital Relay Center (ADRC), Canadian Military Switches (SAMSON), and Transportable Automatic Digital Switching Systems (TADSS). These systems were precursors of the AUTODIN network mentioned later.

The next real data communications utilization ramp-up in the computer industry came in the early '60s with the development of the first terminal-to-mainframe, star networks. In this form of networking, terminals attached to computers using "Plain Old Telephone Service" (POTS) lines and special devices called modems [which converted the analog telephony signals to and from computer digital signals]. The resulting network formed a star, with the computer in the center and the terminals radiating around it. Remember, these were the days of mainframe-centric application paradigms and networks. Both Burroughs and Sperry not only participated in the support of this new form of human-to-computer interface, but provided several significant innovations along the way. Both companies developed complete lines of terminal products, including paper-based [teletype-like] and Cathode Ray Tubes (CRT) "green screen" terminals, supporting both interactive and batch data traffic.

The Burroughs computer history is firmly rooted in providing systems to the financial industry, and its commercial history of networking begins with support for banks. In the early to mid '60s, the Burroughs computer line consisted of the B200 and B5000 series, and these were supported by a line of banking terminals [the B606] as well as Teletypewriters, both used primarily to service client accounts. These terminals were hardwired to a controller which connected to another controller at the B200 or B5000 via dial-up telephone circuits (POTS). The B606 terminals were polled, while the teletypes were asynchronous.

The B200/B5000 series evolved through the B6000 and B7000 series to the A Series computer family of today. The B6000 and B7000 systems had an off-loading communications front-end [called a Data Communications Processor(DCP)] which provided terminal handler off-loading including the high-overhead polling operations. An early form of the Network Definition Language (NDL) was developed as part of this network program. NDL allows the network to be defined using a high level language format.

The B606 terminals evolved through the TC 500 and TC 700 during the late '60s. These terminals were Poll Select based, and were an intelligent workstation (programmable accounting machine) which could also be used on the desktop by adding a keyboard. These were the first Poll Select terminals which were controlled from the host computer rather than being hardwired to a controller. Also in the late '60s screen-based terminals began to emerge based on the TC500. These terminals included both thin panel and CRT types of displays and represented a significant improvement over the paper display terminals (e.g., TTY) that existed up to that time.

In the mid '70s time sharing support was introduced into the Burroughs computer line, and terminals began to add functionality [keyboard and screen controls] in support of more general purpose applications to the existing accounting-based functions.

At Sperry, support for networking evolved through a series of intelligent controllers which initially provided network connectivity to mainframe and mid size computers, and today support networking for the entire line of Unisys 2200, UNIX, and NT servers at client sites. These controllers begin with the Communications Terminal Synchronous (CTS) and Word Terminal Synchronous (WTS) in the early '60s. These devices attached a single dial-up POTS line to a single computer channel. As the demand for remotely connected terminal devices grew, this method of attachment proved too costly, primarily from a computer channel utilization point of view. In the latter half of the '60s the Communications Terminal Multiplexing Controller (CTMC) and General Communications Subsystem (GCS) were introduced. The CTMC and GCS, coupled with an architectural change to the mainframe computer that extended the Input/Output (I/O) addressing architecture (this was called Externally Specified Index (ESI) mode which allowed up to 32 pairs of I/O access words [buffer descriptors] per channel), allowed up to 32 dial-up or leased telephone lines to be attached to a single computer channel, greatly improving the cost per line ratios.

The early '70s saw the introduction of the Communications/Symbiont Processor (C/SP) by Sperry, which was an off-loading front-end processor for the 1100 Series computer family. This processor was originally a commercial system [from the 9000 family] whose instruction set was modified and then was programmed to move high overhead terminal handling from the 1100 system for both interactive and batch devices. At about the same time period, the 3760 Communications Controller was developed by an engineering team working in the St. Paul's Plant 5 mezzanine. This was a re-packaging of the 1616 computer along with the incorporation of an I/O functionality to emulate either a master or a slave unit on the IBM eight bit daisy chain interface. This development work took place somewhat in parallel with designs for RS-232 and Mil-Std-188 serial interfaces for the 1616 and AN/UYK-15 computers. After half a dozen 3760 units were built by Plant 5 and Plant 1 prototype engineering shops, before the design was transferred to Salt Lake City where their engineers did a few tweaks as they began work on the McDonnell Douglas-Autonetics (McAuto) communication contract. The 3760 was initially developed to support the attachment of Univac terminals to IBM 360/70 systems by emulating the IBM 270x Transmission Control Unit. The 3760 was later used as a Remote Concentrator for Uni-scope terminals with Sperry systems, and later provided communications for the Series 90 computer systems. Finally, with the introduction of the Distributed Communications Architecture in the second half of the '70s, the 3760 was used as the initial front end for the 1100 Series, and in fact the first Distributed Communications Processor (DCP/40) emulated the 3760 instruction set (more on the DCP later in this document).

Sperry also developed a line of screen-based, buffered, synchronous, polled terminals beginning with the U300 in the early '60s which was developed for the airlines industry under contract to United Airlines [the U300 single station sold for about $15K at that time]. The U300 was an interesting synchronous CRT device that transmitted data from wherever the cursor happened to be on the screen back to the beginning of the entry. This forced the receiving system to reverse the order in which characters were received before working on the data. The U300 was followed by the U100 and U200 in the latter half of the '60s. These newer terminals implemented the first versions of the Uni-scope protocol, and also corrected the character ordering problem of the U300.

The Uni-scope protocol, developed by Sperry to support these terminals, is a two-layer protocol including both link and data/screen handling support, and was recognized at the time as being very advanced, evolving over time to support features such as field characteristics and color. By the mid '70s, the Uni-scope family of terminals had evolved into a set of intelligent, programmable devices. This family included both a line of CRT terminals [the UTS/20, /30, and /40] and a complementary set of controllers [the U4000 series], which used an interpretive version of COBOL to develop client applications. In combination with mainframe-based programs, these applications were in many respects early forms of client/server computing [the terminals typically implementing what are being called "thin clients" these days].

At the same time that the CRT terminals were being developed, Sperry developed a range of Data Communications Terminal (DCT) devices including the DCT 500 and DCT 1000 which were paper-oriented asynchronous terminals, the DCT 2000 which was a punched card/printer remote batch device, and the DCT 3000 which was a RISC processor-based programmable batch terminal which concurrently supported several connected interactive terminals. Also during the '60s, software was developed to allow the 9000 family of systems and the 1004 card processor system to function as remote batch devices to midsize and mainframe systems [including the 1100 series, the 490 series and the 418]. Called the "Nine Thousand Remote" (NTR) and "Remote 1" (REM-1) systems respectively, these products proved commercially successful for Univac and later Sperry, and were widely emulated in terminal products from other vendors

The '60s also included the development of many types of modems, controllers, and multiplexers which made the task of connecting terminals to computers both more cost-effective and efficient. One must remember that this was a time period when a 2400 baud line for data communications was considered very fast, and the cost of connecting many of these lines to the computer very often exceeded the cost of the computer on an annualized basis.

One should also remember that many data compression techniques were developed during this time period to deal with the relatively slow speeds of available dial-up telephone lines. Service of less than 100 baud was available and 2400 baud half-duplex was common. Incidentally, the NTR and REM-1 protocols mentioned above, included compression algorithms designed to optimize the transmission of batch data formats over slow [by today's standards] POTS connections [2400, 4800, and later 9600 bits per second].

In addition, the focus of most link level protocols developed during this time and for many years following, dealt with the relative instability of the transmission media. In the early '60s it was not unusual for the telephone operator to monitor phone calls and to manually disconnect them when no voice conversation occurred for some time period. For data transmissions, voice was never transmitted so this was a fairly common occurrence. Even when a human didn't cause a problem, the telephone company's guarantee of quality was that "no more than one out of every ten bits could be lost". Since even with six-bit characters [that's about every other character], there is little wonder that link protocols were heavy on recovery schemes, covering both loss of connection and loss of data.

In the Sperry Defense Group there was considerable networking development activity as well. In about 1961, Sperry developed the 1206 [AN/USQ-20] computer for the Navy. This computer was used to support ship-to-ship and ship-to-aircraft communications. Furthermore, the 1206 I/O had an intercomputer mode which allowed direct computer-to-computer communications via memory buffering of predefined data packets. This computer was the forerunner of the Univac 490 system, a real time commercial system, and the AN/UYK family of processors still being used by the Navy today.

In 1967, Burroughs released the "Two wire Direct Interface" (TDI), which at the time was a unique form of connecting terminals to systems. TDI initially supported up to 10 taps over a single 9.6Kb two-wire cable at distances up to 1000 feet (the taps connected a host controller and 9 terminals). The number of supported taps was improved significantly over time. When viewed in retrospect, this was a very early form of a bus-based Local Area Network (LAN), and in fact, several of the engineers involved with TDI went on to serve on the IEEE 802 LAN standards committees.

The AUTODIN Network

During the early '60s The U.S. government awarded a contract for the development of a digital network which would interconnect all United States military bases, all United States embassies, and certain other government agencies world wide.

Called the Automatic Digital Network (AUTODIN), this network went operational during the first half of the 1960s. It was the first really large worldwide network, and continues to be the backbone network for serious message traffic throughout the DOD and other government agencies, where data is classified, must be secure, and very controlled in terms of access.

Unisys involvement began in 1963-64. Sperry provided terminals and computers for the network. Initially this hardware comprised over two-hundred-fifty 1004s, twenty 418s, twenty 9400s, eighteen 90/60s, and ten 1100s. In the late '70s Sperry supplied the White House computer system and its connection to the AUTODIN network from the basement of the White House.

One of the purposes of the AUTODIN network is support for the military in the field. Sperry installed many of the in-country networks during wartime, including those used during the Vietnam War. The first installation was at the Phu Lam communications center outside Saigon. This installation used 1004 card processors (discussed previously) connected via satellite. It was the first use of a transmission technology called "continuous mode" which was designed to overcome the delays associated with satellite transmissions. Because of their distance above the earth's surface, fixed orbit satellites introduce at least a half-second delay to any single transmission. In continuous mode the first block is transmitted, and the second block is sent while waiting for the acknowledgment (ACK) sequence for the first, and so on. This allowed transmission rates of over 200 cards per minute over 2400 baud transmission facilities over the satellite, where prior to continuous mode the rate was 120 cards per minute. This transmission methodology was quite innovative for its time.

Unisys involvement in the AUTODIN network continues to this date by providing computer systems to the military and several government agencies.

The '70s

In 1970 the Burroughs Data Communications Processor was first delivered with the B6000 systems. The DCP was a special purpose front end processor for data communications which exchanged messages with the B6000's operating system environment through a pair of shared memory queues. The use of shared memory queues was unique for its time and is still not a widely available capability. Another major innovation was the Network Definition Language (NDL), a third generation \ language for configuring the network, and more importantly, for programming link level protocols and device-specific characteristics. NDL was largely a response to the lack of standard protocols and the need to support several protocols concurrently. NDL was rated as best-in-class by several trade magazines, and was a significant factor in attracting numerous customers, especially financial institutions, to Burroughs systems.

The support and use of NDL spread to other Burroughs platforms, especially to the medium systems lines (B2000, B3000, B4000), and to small systems (CMS, B1700). It became the basis for a set of systems in the B700, B800, and B900 lines that served as small but highly flexible data communications processors for a variety of systems and in a variety of configurations. This technology was applied both to providing communications capabilities built into small business systems and to producing stand-alone, high-capacity front-end data communications processors. This provided the base for Burroughs-supplied technology underlying a major system implemented during the '70s for worldwide electronic funds transfer among major financial institutions.

The concepts behind the Burroughs DCP and NDL developments also led, in the same time period, to the implementation of the notion of Message Control System (MCS) on all major Burroughs systems. This provided for powerful and flexible message-handling capabilities on behalf of application programs, but without requiring application program coding. These functions were provided either by additional environmental software on the mainframes or by software on front-end processors. The functionality provided in this manner included such things as transaction-based routing, transaction auditing and recovery, and message translation and filtering.

The 1970s found the computer industry involved in the development of network architectures. Such architectures would permit multiple computers to communicate as peers, rather than be limited to supporting the connection of central computers to directly attached terminals, which was the dominant form of data communications up to this time. These architectures recognized the spread of intelligence throughout the network in mid- to small-sized computers and even intelligent terminals. The possibilities of distributed computing were beginning to glimmer, and protocols that supported communications between intelligent entities as peers, rather than the prevailing host-to-dumb terminal protocols of the day, were required.

This architecture work was rooted in the notion of "layering" mechanisms that handled various aspects of communication, and took advantage of the development of more efficient protocols for the transmission of data, especially at the link layer. The new link layer protocols were bit-oriented [which made them independent of specific character values in the data], and so able to transparently carry any sequence of bits efficiently. Examples of such protocols include the international standard HDLC and its variants, such as IBM's SDLC, and Unisys' BDLC and UDLC. These protocols, in combination with new network layer protocols [such as X.25] allowed data to be handled in individually-addressed packets, rather than as a continuous bit stream traveling on a dedicated circuit. This set of innovations led to so-called packet networks, where multiple intelligent network nodes could share a single circuit, and "route" packets through the network based on addressing. No longer did networks need to rely strictly on end-to-end polling schemes with their high overheads.

Packet networks in turn led to network architectures, and several competing architectures evolved during the '70s, both from the standards bodies [e.g., OSI & TCP/IP] and individual vendors. Unisys developed two architectures---the Burroughs Network Architecture (BNA) from Burroughs and the Distributed Communications Architecture (DCA) from Sperry. Both BNA and DCA differentiated themselves from the typical mainframe-centric, hierarchical network architectures of the day [e.g. IBM's SNA], that focused on providing terminal connectivity (which Unisys systems had been doing in a highly flexible way for a decade) by being distributed, peer architectures.

Burroughs' BNA was developed in the late '70s, based on several early Burroughs-designed custom networks [primarily the Society for Worldwide Inter-bank Financial Telecommunication (SWIFT) network], and evolved through the mid '80s to form the architectural basis for the CP2000 communications processor. The CP2000 was designed specifically to support BNA capabilities and standardized protocols, and to provide both routing and terminal connectivity for BNA networks. It was the first Burroughs communications processor based on an industry-standard microprocessor. It included a replacement for NDL, the Custom Protocol Generator, to handle the many remaining cases of special purpose or non-standard devices. A variant of the CP2000, the Integrated Communications Processor (ICP) was used as a mainframe plug-in module for local attachments and for small line configurations in place of the CP2000. BNA also incorporated numerous advances in commercial networking capabilities.

The lower layers of BNA were based on both standardized and proprietary protocols [initially including X.25, HDLC/BDLC, and RS232] extended over time to support Ethernet/IEEE802.3 LANs, satellite links, FDDI, and other technologies.

The network layer of BNA was based on a sophisticated adaptive routing mechanism [BIAS_ — the Burroughs Integrated Adaptive-routing System], which grew to support multilevel hierarchical addressing, clustered network topologies, and very large networks. This routing scheme automatically discovered available routes, reconfigured around failed links, and selected minimum-delay routings. It supported the use of parallel paths through the networks and of multiple link connections between neighboring systems. It allowed for the automatic detection and use of best-available segment sizes over any particular [end-to-end] communication path. During the late '80s, the router's data packet format was modified to be compatible with the OSI Network Layer packet format, allowing BNA frames to be routed by OSI routers. In the late 1980s [after the creation of Unisys] the BIAS_ mechanism was incorporated into both the networking structures of the Distributed Communications Architecture (DCA) from Sperry [see below], and the packet network products from TimePlex [at the time part of Unisys].

In its upper layers, BNA supported fully resilient end-to-end logical connections, with automatic retry, survival of network outages, automatic segmentation and reassembly, and guaranteed in-order delivery of user data. These capabilities were accessible via an easy-to-use application programming interface (API), that allowed application programs to utilize network connections just like any other files, without having to be aware of network configurations, addresses, or the type of remote system with which they might be communicating. Programs could dynamically request and obtain single or multiple network connections, with no pre-configuration required. Systems and applications were identified at the API by flexible, human-readable names that were dynamically, automatically, and transparently mapped to the relevant network addresses. The router and upper layer mechanisms combined to support powerful congestion-avoidance algorithms and priority-based delivery of multiple priority levels of both user data and control messages, allowing interactive (terminal) traffic, for example, to be given fast responses even in a network carrying a heavy load of lower-priority traffic [such as file transfers]. BNA also included several powerful management capabilities, including program agents [allowing user-written programs to monitor and control the networking subsystem on a host system] and centralized mechanisms such as the Network Administrative Utility [for network configuration] and the Network Control Facility [for centralized or hierarchical network control].

The Sperry Distributed Communications Architecture, (DCA) was one of the most significant networking developments for Unisys. DCA differentiated itself from the typical mainframe centric, hierarchical network architectures of the day (e.g., IBM's SNA) by being a distributed, peer structure. DCA was structured to match the seven-layer OSI architecture, and was designed such that its functionality could be distributed throughout the network, being implemented within the network wherever it made sense to do so. DCA has undergone several major updates over the years. Initially, these were mostly focused at remaining current with the definition of OSI, but also included significant features and functions needed by Unisys clients. As mentioned above, the

Burroughs BIAS_ mechanism was incorporated into the DCA IP layer as part of the implementation of the Dynamic Network Service (DNS), which provides features and functions beyond standards-defined IP layers, even to this date.

DCA also produced a significant network processor in the Distributed Communications Processor (DCP)—yes, both Sperry and Burroughs had a DCP. This message queuing architecture-based network processor was developed to support the distributed nature of DCA, and provides a wide range of network specific functions, including multi-protocol routing, protocol conversion, load balancing, security, and terminal handling. Because DCA was designed and implemented to be a distributed function architecture [that is, networking functions are implemented within the network as close to their point(s) of need as possible], the DCP can function as a terminal concentrator, multi-protocol router, protocol converting gateway server, firewall, security server, etc., either singularly or in combination.

The family of DCP processors has evolved from the introduction of the DCP/40 in the late '70s, to include the resilient, dual partitioned, fault tolerant DCP 600 processors supporting hundreds of network connections and tens of thousands of active end users. Over the years, the channels that provide the physical attachments for the DCP [called Line Modules] have evolved into highly intelligent devices, implementing at least the lower two layers of the architecture, able to communicate directly with each other, and capable of being removed and replaced without disturbing the remaining network.

The family of software products that reside on both the DCPs and the 1100, 2200 and today's IX systems have also evolved over time to provide a full set of networking functions, many listed in earlier paragraphs. These include coequal support for several network architectures and protocol suites including DCA, OSI, and TCP/IP. The DCP software supports a complete gateway to SNA, including PU Type 4/5, to and from both DCA and TCP/IP. In fact the industry press once stated that Unisys did SNA better than IBM in reference to the DCP-based SNA/net product.

The DCP/15s [a small version of the DCP family] was used extensively by the Military in Desert Storm, and received several very positive comments from the military concerning their durability and reliability. These DCPs were used by the Air Force out on the flight line to access maintenance and supply records in the U.S. On one occasion, the DCPs' Telnet capabilities where used in communications with a U.S. TV repair shop just to get a General's TV fixed. This was before the Internet and e-mail became so pervasive. In another Desert Storm incident, a DCP/15 fell off the back of a military vehicle, and operated correctly when powered-up.

In about 1977 Sperry led research into the development of a circuit-switched network based on Northern Telecom switches, using a Sperry 1100 as the network management platform. This network used time division multiplexing over circuits up to T3 speeds for a nationwide communication network for the U.S. government. This network also included work on early fiber optic based circuits having many SONET-like characteristics.

Also in 1977 there was considerable work on a "backpack" version of the DCP for the Marine Corps. This device used early micro-circuitry techniques to repackage the DCP into a "40 lb. pack" [note that the typical DCP of that time filled two five-foot high cabinets] which could be carried into combat and used to establish a data communications network in the field. The system was auto-configuring to support network setup anywhere in the world under field conditions.

The late '70s also saw Sperry working on the development of an "office" system that really was one of the first working examples of client-server, workgroup computing. Originally called SperryLink, this system was based on a deskstation which supported the user interface and localized features, and a server which provided additional document storage as well as multi-client features such as e-mail and meeting scheduling [file server and enterprise-wide features]. The deskstation was developed by programming a word processor and other office automation functions in an intelligent terminal [the UTS 40 [see above] was the original desktop used in the released product], several years before the PC was introduced. The server functions were developed originally on a small business system called the BC/7, and later moved to the 1100 mainframe in order to support larger numbers of clients concurrently. After the merger, this product was renamed OFISLink, and it continues to provide services to a number of clients to this day.

The '80s and the LAN decade

Perhaps the decade of the '80s is best known for the development of Local Area Network technologies, and the deployment of LAN-based networks. LAN technologies are important to the industry because they [along with the Personal Computer (PC)] enabled the implementation of the collaborative processing, client/server paradigm. The peer network architectures developed during the '70s provided the high level networking protocols that established the basis for client/server computing, but LAN technologies supplied the high bandwidth interconnect that made it happen. Further, LANs proved that by controlling factors such as distance, packet size the number of supported nodes, and assuming all attached nodes are intelligent, much higher bandwidth could be achieved over common available cabling systems than previously held—in fact, by at least one order of magnitude.

The technical research and development undertaken by Unisys over the years on networking technologies, has resulted in several significant contributions to the industry at large. Unisys was, and continues to be a contributor the IEEE 802 LAN standards, the ATM Forum, and other standards bodies. In fact, for several years in the late '70s and during the '80s, Unisys held the Chairmanship of American National Standards Institute (ANSI) Standards Committee X.3, which oversees most ANSI standards for data processing and information technology. Unisys also chaired International Organization for Standardization (ISO) Technical Committee (TC) 97 working groups X3 and SC 6, which included ISO's work on data communications, LANs, network layer protocols, etc. In addition, for several years Unisys served as secretary of IEEE 802.

Both Sperry and Burroughs did significant early work on fiber optic-based, high bandwidth, token passing ring networks. In the late '70s, Unisys had under development a counter-rotating ring technology at the Paoli Research Labs. This work led to several patents on self-healing counter-rotating dual-ring technology. This work was eventually moved to Danbury, Connecticut and formed the basis of the Ring10 and Ring100 projects.

Also in the late '70s, work was underway at the Unisys Blue Bell, PA, facility on a fiber optic-based interconnect technology. It was later incorporated into a program in Roseville, MN, intended to support the clustering of many mainframe class systems where it was call "LUMIN." This fiber optic, token passing, counter-rotating, dual ring technology operating at 100Mbps was submitted to the American National Standards Institute (ANSI) in the early '80s as a high speed LAN standard, and became in short order the Fiber Distributed Data Interface (FDDI) standard widely used in the industry today. Unisys also chaired the ANSI FDDI committee for many years.

In 1980, the Sperry Defense Group in Salt Lake City implemented a three-station FDDI ring as part of a military contract proposal. In this implementation a Motorola 68000-based controller was developed which supported sustained rates of 80 Mbps and demonstrated the resiliency of the counter-rotating rings. While Sperry did not win the contract, it was believed to be the first working FDDI LAN.

Also in the area of LAN innovation, considerable work has been done over the years on the development of support for voice over Ethernet. A prototype demonstration system was put in place in Salt Lake City which supported up to 100 concurrent telephone conversations. Unisys holds four patents for this technology.

One of the most common algorithms used in computer graphics is the Lempel Ziv Welch (LZW) compression scheme. This loss-less method of data compression is found in several image file formats such as GIF and TIFF, is part of PostScript Level 2, and is also part of the V.42 bis modem compression standard.

In 1977, Abraham Lempel and Jakob Ziv published a paper on a universal algorithm for data compression. This was called the LZ77 compression algorithm. In 1978, Lempel and Ziv introduced an improved, dictionary based compression scheme called LZ78. In 1981, while working for Sperry Corporation, Lempel and Ziv, along with Cohen and Eastman, filed for a patent claiming the LZ78 compression algorithm. They were granted patent number 4,464,650 in 1984. Also in 1984, while working for Sperry Corporation, Terry Welch modified the LZ78 algorithm to increase efficiency for implementation of high performance disk controllers resulting in the LZW algorithm for which Sperry was granted patent No. 4,558,302 in 1985, which transferred to Unisys upon completion of the merger in 1986.

In 1987 CompuServe created the Graphic Information Format (GIF) file format for use in the storage and on-line retrieval of bitmapped graphics data. The GIF specification used the LZW algorithm to compress the data stored in each GIF file. In 1988, Aldus Corporation released revision 5.0 of the TIFF file format, which added a new feature allowing TIFF to store Red Green Blue (RGB) bitmapped data using either a raw format or a compressed format which used the LZW compression algorithm. In 1990, Unisys began granting licenses for the use of the LZW algorithm, including Adobe for PostScript, Aldus for TIFF, CompuServe for GIF, America Online and Prodigy, and hundreds of other companies.

Unisys was also a leader in promoting GOSIP and compliant OSI implementations. Unisys was one of the first vendors with a NIST-certified interoperability lab, and the first vendor to certify the entire seven-layer OSI stack. Unisys processed all its system platforms through this lab, and led the industry in interoperability, as demonstrated by the number of registered interoperability pairings between Unisys and other vendors' products.

From the early days at ERA, Unisys has continued to be involved in wireless communications. Wireless technologies have long played an important role in naval communications and in missile guidance systems. In the '70s the existing hardware based sensor system in Navy aircraft was replaced with a new Sperry-developed system based on a single wire bus network. This network connected the thousands of monitors onboard the aircraft with its onboard computer(s), and communicated with an Ethernet-based network on board the ship via wireless technologies.

Wireless research has continued into the '90s with the development of spread spectrum technologies, for which Unisys holds several patents. In addition to deploying wireless spread spectrum systems for the military, Unisys developed and demonstrated so called "last mile" solutions based on their spread spectrum technologies at a number of conferences during the early '90s. In 1995, Unisys entered into a partnership with Granger Telecom and Loral Communications Systems [later Lockheed/Martin MS2] to develop a fixed wireless loop telephony system to be deployed in third world countries and wherever the terrain prohibits land-based systems. [Press announcement in early August, 1995]. This system is currently undergoing testing prior to deployment.

This solution addresses a very large and untapped market. In 1996, there were only around 500 million telephones in a world of over 5 billion people, with over 50 million more people waiting for service each year. Half the adults in the world have never made a phone call. Traditional landline service can be expensive to implement and take a long time to install, especially in sparsely populated, remote, or rugged areas. In the US, Telephone service providers state that the cost of wiring or re-wiring the connection to a residence with standard copper cable averages $2,000. This increases rapidly in parts of the country that are sparsely populated or mountainous. At the other extreme, cellular telephone service can be very expensive for the user.

This technology, which is a wireless local loop system using narrowband Code Division Multiple Access (CDMA) spread spectrum, can deliver both voice and data at up to 64 kilobytes per second, at up to 18.5 miles from the wired telephone network. The system is easier and less costly to maintain than a wired service, and because it is digital can be readily upgraded to handle advanced services, including ISDN.

Unisys and the Internet

These days, the Internet is the place to be in the world of networking, and companies are scrambling to gain a presence. Unisys was an Internet pioneer from the beginning. The Internet has its foundations in the Department of Defense ARPAnet, which had its beginnings in 1970. Unisys had a presence on the ARPAnet in 1970, and by 1971 had two ARPAnet facilities. Around 1980, the DOD initiated its "Internet working group," and by 1982 had declared TCP/IP as the standard, had begun the Internet project, and had split the MILNET from the ARPAnet/Internet. By 1983-84 Unisys was delivering commercial Internet products, and by 1990 had a commercial Internet presence ("...unisys.com"). Of course today Unisys views the Internet as a key strategic thrust, both internally with the Unisys Intranet, and externally through a series of commercial products. Unisys has developed a separate program around the Internet and the World Wide Web, and is providing enhanced support across its product lines.

Unisys as a network user

As a large multinational company, Unisys long ago recognized the importance of connecting its many locations together onto a corporate-wide network. The data communications network which today connects all of the Unisys sites together is called the Unisys Enterprise Network (UEN). The UEN spans the globe and has connections in every major country on every continent. It is supported on a 7-day-per-week, 24-hour-per-day basis as it covers every time zone and always has a prime-shift operating. At the same time that the production day moves from time zone to time zone, all Unisys sites are networked into the InfoHub Center in Eagan, Minnesota, where the company's centralized computer resources are housed. Data accessed from anywhere on the UEN can be transmitted across tens of thousands of miles of circuits, traversing oceans or bouncing off satellites, and arrive in tenths of a second. All 34,000 Unisys employees have access to shared information and collaborative working via the UEN.

The UEN is actually three separate networks in one. There is of course the data communications network we've been discussing. Also included is the telephony network that supports voice communication, and a video conferencing network that supports the interconnection of Unisys video conference centers around the world. Until recently, available network technologies would not support the very different techniques required to transmit both real time [voice and video] and non-real time data on a single network. Today, work is underway to combine these three separate networks onto a single network that can support all three forms of transmission [telephony, video, and data], using modern networking technologies such as Frame Relay and Asynchronous Transfer Mode (ATM). This modernization is expected to greatly reduce the cost and effort of operating and managing the UEN, while providing increased network throughput.

Also included in the UEN is a logically separate development data network which connects all the engineering locations within the company and supports the development activities of thousands of engineers on a daily basis. The development network is in itself a very large network. It simultaneously supports multiple networking architectures, including TCP/IP, SNA, BNA and DCA. To give some perspective as to the complexity and size of this network, in 1992, the development network included four major engineering "hubs" in Pennsylvania, Minnesota, Utah, and California, with connections to Japan, New Zealand, and England. The network included 215 network processors, 286 computer systems including Unisys 2200, A Series and UNIX systems, as well as systems from IBM, DEC and others. Over 12,000 terminals or PCs emulating terminals were supported.

Unisys Networking Services

Unisys has a long tradition of providing direct consultation and development support to its clients in all areas of computing. Going back at least to the 1970s, both Burroughs and Sperry provided consultation, network design support, and custom protocol design and implementation services as part of its marketing and engineering activities. These activities were provided either on a cost recovery basis ---charge the customer for the cost to develop the feature (i.e., CER)--- or as part of the cost of sale. It was not a business that generated revenue for the company beyond the sales of its computer products.

In 1989, Unisys examined its service business which was based on an annuity maintenance agreement with its clients. While it was earning a very respectable $2.6b annually, it was also declining at an annual rate of about 14%. Computers were rapidly becoming less complex and more stable, so maintenance had less value to the client. The company looked for ways to expand the service business and generate new revenues. One area that looked promising was networking---or more precisely, the planning, design, and implementation of large enterprise networks.

Starting with an existing facilities wiring business, this practice grew to become an integrator of products, to become the Network Enable business unit. The service is based on a few key rules:

1. Teaming of sales and technical experts [develop experts in each geographic area and sell their expertise at an hourly rate]. Today, Network Enable has service capabilities in over 300 cities world wide.
2. Partner with key product suppliers, based on best-in-class products so the client gets the best possible solution [Unisys is the second largest reseller for Cisco]
3. Find the experts and partners necessary to provide solutions

Unisys, with Enable is recognized as a leader in network integration. Over the past year they have been merging a very successful desktop service business with an integration and wiring business and the "One Call" help desk service.

As networks become increasingly complex, more distributed, and a key enterprise resource [and often a differentiation], the task of management becomes more important, more complex and more costly. Increasing numbers of clients are looking to outsource this work. Unisys has recently developed new a network management service as a natural outgrowth of the Unisys technical expertise, Unisys Enterprise Network capabilities, and the Network Enable service.

Announced to the world on July 15, 1997, the new network management service [called NetWORKS] is structured to provide a range of client support depending on each client's needs, with services ranging from a "monitor and report" activity to "full network management" including the isolation and correction of problems, liaison with the telecommunications service providers, etc. The focus is on "open" networks [TCP/IP, NT, UNIX, NetWare] and their network devices and servers. It is intended to be a global service, starting in US in '97, adding Europe in '98, and continuing the roll out worldwide. Unisys is putting field people in place today to help with the installation and day-to-day activities as well as training of sales people. Unisys has been doing some network management service for a few clients on a small scale in Europe and Australia and it is this base which will evolve into the full service over time.

As further proof of Unisys' commitment to this new service and its confidence in the abilities of the staff, the management of our own Unisys Enterprise Network is transferred to this new NetWORKS management service group.

Epilogue

That pretty much brings us to the present. What the future holds no one can say for sure. To quote Richard W. Hamming, a professor and senior lecturer at the Naval Postgraduate School based in Monterey, California, “It requires a brave person or a fool to attempt a detailed and accurate prediction for the next half century of computing". While I've never been known as the shy and retiring type, I'm not going to attempt to predict what the future of networking at Unisys might be.

However, there are some trends which are too obvious to ignore. Computers keep getting more powerful, smaller and less costly. Experts predict that this trend will continue as we find new technologies for the construction of computers. As we continue to make computers ever smaller and less costly, they will become ubiquitous, used to control the most common of everyday functions, available to everyone.

Networking technologies are technically capable of supporting multi-megabit, even gigabit transmission of all forms of data from anywhere to anywhere, and as soon as it becomes economically feasible will provide "limitless" bandwidth to everyone, everywhere. That will enable all those low cost computers we're going to build to be interconnected. Advances in mobile computing services and wireless technologies will allow us to be "connected" no matter where we happen to be. No longer will we be tethered to a desktop and wired network.

The Internet and World Wide Web have shown us how simple it can be to access data anywhere in the world. As a client we no longer need to be aware of the location of the data, the address of the system it's on, the format of the data, or the network structure that connects us. With a simple click of the mouse on a hyperlink we are provided with information---any information that is available on the Internet. This combination has made the fabric of the network and the many computers interconnected on the network incidental to information. They're there, but who cares. This trend will certainly continue as we move forward in time.

I read an article just the other day about ongoing research into the use of synthesized strands of DNA to build computers. With the addition of audio, video and voice recognition as well as a wireless interface will we wear the computer of the future and merely speak commands? Or perhaps the computer and its user will become as one, and we will only need to think the command and information will instantly be made available to us?

What does all this mean to the future of Unisys? I can't begin to guess. However, I am an optimist by nature, and I am positive that the skill and inventiveness of Unisys employees will create at least as many innovations over the next fifty years as were produced in the last.

Finally, I want to thank the people in GCS for giving me the opportunity and incentive to pursue this project. I hope you've enjoyed reading about our past at least half as much as I enjoyed uncovering it.

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