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ARCNETworks

Two Decades of Networking

Text by Martha Stott

Inside ARCNETworks

Today Datapoint Corp. calls itself "The First Networking Company," but in 1975, when Datapoint was inventing networking, it wouldn't have dreamed of calling itself that. Networking, at the time, had an image problem: the word evoked images of behemoth systems that were complicated and hard to manage. The term "LAN" (local area network) was not yet in use, and some people even doubted that large numbers of computers ever would need to talk to each other, anyway.

" 'Network' was the last thing in the world we wanted our customers to associate with ARC," says John Murphy, who was the chief architect for ARCNET, the first local area networking system that could be seamlessly integrated into an operating system "It was only as Xerox began spending millions convincing the world that something called Ethernet was the wave of the future, that Datapoint decided maybe 'networks' had come of age."

Datapoint itself had quickly come of age as a high-tech innovator soon after its founding in 1968 in San Antonio, Texas. Today the company claims bragging rights to several firsts, including the first glass teletypes, the first desktop microcomputer, and the first client-server system implementation. Had Datapoint promoted itself as "The First Networking Company" in 1978, when the first ARC systems were installed for clients, the history of ARCNET might not be the behind-the-scenes success story that it is today. For ARCNET developers, the irony is that ARCNET was another technological front-runner from Datapoint, but the technology eventually lost the office market to Ethernet and today is a mostly transparent solution employed by OEMs serving customers with diverse networking needs. Seldom does the OEM give credit to its name.

Yet ARCNET's robust design, with its HUB concept, star topography, and token passing protocol, has stood up well over two decades. While ARCNET may not have the household name recognition of Ethernet, it still has an enviable reputation for reliability.

John Murphy (Murf), ARCNET's chief architect, continues to be amazed about the diverse applications for the technology he developed

"It is so reliable you could run it across barbed wire," says Michael Black, vice president of U.S. sales and marketing at Datapoint. "It is guaranteed to run at 2.5 Mbps with no error."

Gordon Peterson, senior systems programmer at Datapoint during the project, remembers training classes where ARCNET was run over coat hanger wire. That dependability explains why ARCNET chips still are being manufactured that run at the original 2.5 Mbps speed.

ARCNET also is considered a workhorse: its token-pass approach becomes more efficient under increasing load. Peterson credits ARCNET's performance to these design features:

- *ARCNET meters the load through the network so that it's not likely to flood any machine with requests faster than it can process*
- *ARCNET's flow control handles a temporary overload of requests to a saturated server, allowing it a chance to recover*

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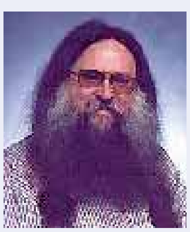
- *The file server can shed a load under these temporary conditions without impacting a user's wait for a reply, and*
- *Even with no traffic, the system is always being exercised by the passing of tokens; consequently, any problems with the system may be noted before heavy data loads are experienced.*

"Compare that with Ethernet, which collapses in a quivering and pathetic heap on the floor when running in overloaded conditions—which is quite often in the real world," says Peterson.

Timing is as key to technology as location is to real estate, and those who developed ARCNET agree that the system suffered from being ahead of its time. It was so far ahead of its time, in fact, that in 1975, major chip manufacturers scoffed at its future.

"Once the design was complete, virtually every silicon foundry in business was offered manufacturing rights," says Murphy. "The typical response was something like: 'Why would anyone want to have computers connected together?' "

But ARCNET had been developed precisely because Datapoint's customers had expressed a need to connect computers. Peterson likens the unveiling of ARCNET on Dec. 1, 1977, to pushing a boulder over a cliff. "I knew that we were changing forever the way that business data processing would be done," he says.



Gordon Peterson wrote ARC's innovative network operating system—an indispensable part of ARCNET's success.

The idea is born

In 1975, Datapoint was carving a niche selling Datashare, a system that could run a dozen or so terminals on a computer with 64K of memory and roughly the computing power of the earliest IBM PC. The company's customers wanted to support more terminals, but the Datashare computer could be stretched only so far, no matter how great the operating system and application language.

Harry Pyle, a senior developer in Datapoint's Research and Development department, recalls having lunch in a little hole-in-the-wall Italian restaurant on Datapoint Drive with colleague Ron Dombrowski when Dombrowski declared that what was needed was a dual-ported disk controller to enable two Datashare systems to access the same data files, effectively doubling the number of terminals that could be supported.

"My bulb brightened," recalls Pyle.

Datapoint already had an asynchronous multidropped network which ran at about 6,000 to 7,000 bits per second, called the Combus. This network was based on a modified Datapoint asynchronous communications adapter, and was used internally in R&D and Software Development for sharing printers and for transferring files from one machine to another. But the Combus only could be used serially for one job at a time, creating potentially long waits to receive or send communications. A commercial product would need to be faster with the ability to be interleaved, so that multiple printer servers could print simultaneously.

Pyle formed a team and began working to develop a "shared disk controller." Gradually, the idea of a shared disk controller gave way to the notion of just letting one computer handle all the disks, and providing fast communications between computers. To achieve high performance, a buffered design was employed that let the processor prepare a sector in a buffer for transfer and then write it to a specified location on disk, or likewise to read a sector from disk into a controller buffer and then go retrieve bytes from that buffer at the program's leisure.

So the multi-buffered, processor-and-timing-independent design of the ARCNET interface evolved from the design approach already used in Datapoint's disk controllers. The finished product would become, in effect, the first Local Area Network (LAN). Vic Poor, vice president of research and development at Datapoint, dubbed it the "Attached Resource Computer (ARC)."

"Datapoint was selling ARC systems well before anyone else was selling anything comparable, and of course, long before we started hearing about Local Area Networks," notes Murphy. "Terms like 'file server' weren't around yet."

The ARC was designed to compete with DEC and other mini-computer companies. The ALOHA project at the University of Hawaii had been in the literature for several years, and details of the development of Ethernet at Xerox's Palo Alto Research Center (PARC) were starting to leak out. ARCNET's distributed star-hub design would prove to be technologically superior to Ethernet's bus design, a fact underscored by Ethernet's evolution more than 10 years later from a bus to a star design.

"We did it right," says Pyle. "We were thinking about people tripping over cables and driving nails through them, and we wanted a robust and diagnosable system. When the Ethernet article came out [in the Journal of the Association for Computing Machinery], we were all thinking about what a nightmare it was going to be for them."

First efforts

Initial attempts centered on designing a "shared disk controller"—a method for Datapoint's customers' machines to communicate with each other. As might be expected, the design thus shared some of the characteristics of disk controllers.

"The disk controllers we were using at the time had four buffers, each one able to hold one disk sector," says Murphy. "That seemed like a nice number; we could double buffer data in both directions with four, and we had the parts in the lab. The disks we were using moved data to and from the disk surface at 2.5 Mbps, so that seemed like a nice target speed."

The team wanted to achieve something more comparable to disk transfer speeds than to "communications" speeds, with a communications stream that was packet-oriented rather than byte-oriented, Peterson recalls.

"Initially, ARCNET's design was going to be based on fixed 256-byte packets, but I managed to convince Murf [John Murphy] that we really wanted to try to implement variable-length packets, since so many of the packets were going to be way less than full. He did manage to figure out a way to do that, of course," says Peterson.

A higher speed was considered and rejected on the grounds of keeping the design simple and using asynchronous signaling.

"I wanted to sample the data at a minimum of eight samples per bit, and 20 MHz was pretty much the upper limit on common TTL parts," Murphy says. "So 2.5 Mbps both sounded fast enough, and was as fast as seemed feasible without a lot more complexity. …Remember the Ethernet that was under development at the same time ran at just 2.94 Mbps, even with its synchronous signaling. It was only because it took so long to become a real product that Ethernet was able to take advantage of developing technology and boost the speed to 10 Mbps."

Murphy recalls setting a goal to reach 2,000-feet on cable length: "Vic Poor told me that IBM could run terminals over 2,000 feet of RG 62, and that I wasn't much of an engineer if I couldn't do the same. 'Yes sir, 2,000 feet it is!' Once we had that working, and had prototyped the first two port active hub, we spent some time looking for bit jitter on a scope. We couldn't detect any jitter caused by one hop through a hub, so we guessed that 10 times that much would be tolerable, and set a limit of 10 hubs in any path. (Since there was only a single two-port hub in the whole world, we had no way to experimentally verify that decision!) Given the limits of 2,000 feet per run and 10 hubs, I calculated all the timeout parameters and embedded them in the microcode."

Dipulse signaling (similar to T1) reduced the inter-symbol interference on the cable but left a full cycle of dead time between each pulse.

The original hardware was known for a while as BAIL (Bit Assembly Intercom Link), then PAIL (Pass Around Intercom Link), and finally FRIL (Fast Resource Interconnection Link). Peterson recalls why the FRIL terminology didn't survive: "It was felt that FRIL made it sound somehow frivolous," Peterson says, "so it was changed to RIM (Resource Interface Module)."

Flow control was built in to remove a significant burden from the software and make transfers more efficient. Even today, built-in flow control is a feature of ARCNET that is lacking in competing technologies such as Ethernet.

The RIMs were designed to be external, because, Murphy notes, "At that time everything was an external box, everything from disk controllers to modems to terminal controllers. Datapoint computers of the time were small, stylish desktop units – with all of the rest of the hardware hiding either in or behind the desk, or under a computer room floor."

"The beauty of a separate box was that we could upgrade customers without a fork-lift," says Pyle. "And the modular approach made it easier on the product guys, who didn't want to design and sell a whole new computer. Our machines at the time did not have standardized internal slots, but a standard external IO bus (8-bit parallel, 8 microseconds per byte, power supplying 'water hoses', we called them)."

"Remember, in those days our machines had multi-microsecond instruction times and the IO bus transferred data at one byte every 8 microseconds," says Pyle.

Later, during 1981, the RIM was converted to a LSI (large scale integration) chip. George Beason managed the project, which he named "The Newport Program." Silicon Systems Inc. was chosen for the design work. SSI had trouble delivering the product, so the manufacturing was switched—with a handshake—to Standard Microsystems Corp. (SMC). When the legal agreement was signed, SMC requested the right to sell the chip to others.

Packet size

ARCNET's initial packet size was 253. Later, it was increased to 508.

"Our disks had 256 byte sectors, our disk controllers had four 256 byte buffers, and we were thinking 'shared disk controller,'" Murphy says. "The parts on our shelf made 256 bytes easy to start with. The need for a header to specify source, destination and size reduced the payload to 253 bytes.

"John Moschner came up with a very clever way to double the size of the page when he was working on the LSI version. Backwards compatibility was already an important issue, and John's technique provided a compatible way to send not only a complete, 256-byte sector in one packet, but left tons of room for future headers.

"For those that were still thinking 'shared disk controller,' 508 bytes was more than enough; for those who were thinking about Digital Research's CP/M operating system, with its 512 byte sectors, there was simply no backwards compatible way."

Technical issues influenced the packet size, Moschner notes. The ARCNET protocol includes a reconfiguration time-out that causes the RIM, when it has not received a token in a certain amount of time, to assume that it is not in the polling sequence and send out a burst which initiates the reconfiguration process.

"The recon time-out was set to be larger than the maximum possible number of RIMs multiplied by the time it would take each of those RIMs to transmit the largest allowable packet and pass on the token," Moschner says. "If the maximum packet size were increased, it would be possible for the time-out to occur not because anything was wrong, but simply because so many RIMs were transmitting so much data."

If a network got into trouble sending multiple maximum length packets, unsent messages would start accumulating at individual RIMs, which would then increase the likelihood of a long token loop time.

"It's important to keep in mind that one reason ARCNET is so robust is that the original design was very conservative, with the goal of sustaining operation under the most unlikely circumstances. If the design philosophy had been to fudge on things like recon timeouts, ARCNET wouldn't have had the reliability it is known for," Moschner says.

Potential alternatives—to increase the recon time-out proportionally or to create a new algorithm to decide how long a RIM should wait—were discarded.

"In the early 1980s, there was no perceived need for packet sizes longer than 253 bytes," Moschner says. "The primary ground rule for the RIM chip project was to simply re-implement the external RIM and to avoid reinventing the wheel. No one ever requested the extension to 508 bytes. The 508-byte option made it into the chip for one reason—it was so trivial to implement, it was hard to oppose it. There were no requests for the option and no plans to even use it."

Token-passing

Communicating within the network was based on a token-passing protocol, rather than a carrier sense arbitration method. The team considered using random timers to resolve contention for the media, but rejected the idea after building a couple of wire wrap breadboards and playing with them for a while. Datapoint's Combus system had been using a low speed carrier sense system, complete with random timeouts, for printer sharing and file transfer for some time, and the team didn't want to base a large system on such a scheme.

"We decided we didn't like the idea of using random timeouts. We wanted something more predictable, like polling, where a master node asks each node in turn if he has any traffic to send. But we didn't want a master node, a single point of failure. So I hit on the idea of distributing the polling task among the nodes, a self-polling system. Years later, this became known as token-passing," says Murphy.

It is interesting to note that little has changed between the original breadboard, the production of the SSI/MSI version, and the LSI chip version, Murphy notes. "In fact, an ARCNET chip produced today will communicate with a RIM produced 20 years ago. You cannot say that for Ethernet," says Murphy.

Microcode

Limited resources, the need to keep it small and working with the extreme simplicity of the hardware were key challenges in developing the ARCNET microcode. Nevertheless, the microcode project was completed in three months, and developers had working FRILs by late summer 1976.

"The strange business of the header having not a size, but a 'continuation pointer,' was dictated by the fact that the only way I had to detect the end of the buffer was to observe the carry signal out of the address register," says Murphy. "Similarly, the destination address is repeated in the header, not so much for redundancy, as because I simply didn't have enough time to process the byte and make all the necessary decisions before another byte came in on the wire – so I sent the same byte twice."

"Murphy's code was a miracle of bit-twiddling," says Pyle, noting that the code interfaced with a single pair of 512x4-bit ROMs. "Some basic protocol decisions were made to accommodate the limited code resources."

Deliverance

The outstanding feature of ARCNET was its star (or distributed star) topology connected to a hub.

"When it came time to think about node-to-node wiring, we started with the obvious thought that occurs to everyone: you run a wire through the ceiling and pull down a tap wherever you want a connection. The problem, though, is that we're dealing with high-frequency, high-bandwidth signals. Wires are funny critters at high frequencies: you have to consider characteristic impedances, terminations, reflections, all those radio type things. Luckily, I'd had some background in radio communication, so

I wasn't caught totally by surprise by this," says Murphy.

"Anyone who ever put up a Christmas tree should know better than to try and connect several computers with a bus," says John Moschner, who was a senior engineer at Datapoint during the project.

Murphy realized that active hubs could pose a burden to users of very tiny networks. To counteract this, he designed the passive hub – a simple resistive matching pad.

"The original idea was to use the passive hub in a network of up to four nodes, or to split a single cable into two or three within an office," says Murphy. "But no sooner had we built the first active hub than a programmer managed to combine a passive hub with the active hub in a way that crashed the system."

Rather than trying to educate the world about transmission lines and reflections, Murphy established one simple rule: active and passive hubs cannot be mixed.

"Once your network grows beyond four nodes, you take your passive hub and either throw it away or put it up on your bookshelf with the other mementos, something to look at in future years as a reminder of the old days when you first got into networking," Murphy says. "Of course, in reality, you can mix active and passive hubs: and if you feel that you completely understand the dangers, if you know exactly what that programmer in Datapoint R&D did in 1977, then you're welcome to mix them – but if you have to ask, don't! Keep it simple and reliable."

Open Network

At the time of ARCNET's development, Datapoint viewed itself as a computer systems company and not a network supplier; consequently, there were no serious attempts to create an open network. "Until SMC [Standard Microsystems Corp.] entered the picture, every attempt was made to keep the technology proprietary so that ARCNET would be a unique selling point for Datapoint computer systems," Moschner says. "This was before the time when the IBM PC demonstrated the power of open systems."

"Remember that we didn't start out to design a separate entity called ARCNET, we were building a high speed I/O bus to facilitate more powerful computer systems," notes Murphy. "Once we had committed the hardware to silicon, it made sense to try to lower our costs by increasing the volume of silicon being manufactured. A lot of effort was expended in trying to popularize the hardware. The software was pretty intimately connected with our operating system, and there was no real thought of making any of the protocols public until after the development of RMS, Datapoint's Resource Management System, an operating system designed from the ground up with networking in mind."

Marketing

With so much going for it, ARCNET initially competed quite well against other LANs, including Ethernet. In a benchmark study conducted in December 1986 of LANs under Novell's Netware by PC Magazine, Frank Derfler gave the "Editor's Choice" award to ARCNET. Still, ARCNET ultimately lost the office market. Those familiar with ARCNET say lack of marketing played a large role in its defeat.

"I think Xerox spent more money touting Ethernet as a technology of the future than Datapoint's entire advertising budget," says Murphy.

"First, Ethernet was supported by three companies whose names were known to everyone – Digital, Intel and Xerox -- three companies with enormous advertising budgets," says Moschner. "Second, Datapoint kept ARCNET proprietary for several years. Finally, about the time SMC started making ARCNET chips, Datapoint's name was making unfavorable headlines in the news. For anyone in charge of computers at a large company, it would have taken an enormous amount of courage to select ARCNET over Ethernet."

To a lesser extent, the changing nature of data transfer discouraged the popularization of ARCNET.

"ARCNET is great for handling lots of small packets, inquiries into a database and the like. But a lot of today's systems spend a lot of time doing bulk data transfer, loading enormous programs, moving enormous graphic images, and so on," says Murphy.

"In their early days, Novell published benchmarks of every sort of networking known to man, and the fastest thing they found was ARCNET," says Murphy. "It's an interesting commentary on the importance of software that the very slowest system they tested was also ARCNET! For a long time, Novell was very high on ARCNET and promoted it heavily."

ARCNETplus, a 20Mbps system that would interoperate with conventional ARCNET nodes, was introduced in the early 1990s, but never took off. Murphy conducted an informal, verbal poll that showed Datapoint's customers were evenly split between those for whom interoperability was of the utmost importance, and those for whom it didn't matter at all. Meanwhile, the complexities of handling interoperability in the hardware adversely affected ARCNETplus's development schedule and production costs. It was introduced late and as a proprietary Datapoint technology, dooming its acceptance.

"On the other hand, Thomas Conrad's 100 Mbps TCNS (Thomas Conrad Network System), which was fully software-compatible with ARCNET, didn't exactly set the world on fire either, so it may be that the perception of Ethernet as 'the only way to go,' was just too tough to beat, no matter what the approach," says Murphy.

What they'd change

In hindsight, the creation of ARCNET stands up well to the test of time.

"The only really nasty failure mode was caused by a dead receiver, sometimes caused by a bad power supply," says Murphy. "If the box went deaf, it would think it was the only box on the network, and keep polling and waiting for a second box to be powered up. Its constant transmissions had a definitely detrimental effect on the general stability of the rest of the network. If I were to do it again, I'd add some hardware/firmware to detect the fact that I couldn't hear anything, including my own transmitter, and shut myself down."

Difficulty in diagnosing network behavior was the biggest nightmare, Pyle agrees, but difficult tradeoffs had to be made because of limited hardware. "The good news was that seemed to enable cheap chip integration earlier than for Ethernet," he says.

"Looking back from the early 1980s, it was hard to fault the original design," says Moschner. "The only problem I remember is that we often wished there were provisions in the design to make it easier to diagnose network failures. When considering what might have been done at that time, you also have to keep in mind that the cost of the circuitry was considerable in those days.

"Looking back from today, you realize how technology has changed in 20 years. The first chip, if I remember correctly, was made with 5-micron design rules. Temperature was a problem because the large die consumed a lot of power. Had it included much more circuitry, not only would the cost have been prohibitive, but the entire project might have failed.

"Today Intel is producing Pentiums with 0.25 micron design rules. That means that the 1981 design, if shrunk in proportion to current technology, would consume about 1/400th of the silicon that the original chip consumed. With such a radical change in circuitry costs, the most logical approach to a re-design would be to start over from scratch."If starting from scratch, Murphy is certain of one change he would make: "I'd ask for a royalty of a few cents on every node installed…." ■

Scratching the surface

The first samples of the ARCNET IC were delivered after the development team had been working on the project for a year. John Moschner recalls the excitement at finally seeing some concrete results:

"We had built a breadboard to plug the chip into, and the breadboard was connected with coax to a production version of the RIM, giving us a small, two-RIM network for evaluation purposes.

"We did not expect a perfect chip – that rarely happened in those days, but neither did we expect the disaster that awaited us. Shortly after the first die was packaged, the vendor called us with the bad news. There was a short in the layout and the clock signal was grounded! All of the important circuitry was run off of the central clock, so that meant that little could be achieved by testing the chip, and it would be another six weeks or so before new samples could be produced.

"We asked the vendor to send us some samples anyway, so we could at least look at them. We had just acquired Datapoint's first probe device. It included a microscope for looking at the surface of the chip, and some microscopic needles attached to holders, which let you probe internal paths on the chip and measure voltages. We put one of the shorted chips under the microscope and began poking around with the needles. It was a chance to get some practice for those of us, like myself, who had never used a probe station.

"After a few days of poking we had accidentally made several scratches on the surface of the chip, when it occurred to us, if we could scratch the surface accidentally, maybe we could learn how to scratch it on purpose. After a week or so, and after destroying several more of the samples, we successfully scratched away the clock short on one of the chips. Operation of the chip at that point was still marginal, but it ran well enough for us to see that the design was highly functional, and our experience working with scratched chips helped immeasurably in preparing us for when the next samples arrived." ■

The ARCNET timeline

1968: Datapoint Corp. founded in San Antonio, Texas

1969: Harry Pyle, Vic Poor, and Jonathan Schmidt begin working on research and development concepts at Datapoint

1973: Harry Pyle designs and builds a low speed LAN used in Jonathan Schmidt's R&D group for printer and file sharing

1974: Gordon Peterson joins to maintain and enhance Datapoint's DOS to support new features, including several new types of disk drives

1975: Peterson produces the Partition Supervisor at Datapoint, a software system making it possible to run multiple copies of the operating system (within the same CPU) against a single disk subsystem

1975: Datapoint customers want a system that can support more than a dozen terminals.

Harry Pyle initiates work on a "Shared Resource Computer"

1976: John Murphy joins Datapoint to design and develop ARCNET hardware. He hires his colleague, Ed Bertness

Vic Poor, senior vice president of research and development, elevates the project to top priority

Peterson develops initial Datapoint DOS ARC protocols

1977: Lewis Donzis writes ARCSTAT program—which remains almost unchanged today

Peterson's file server begins to be tested

First out-of-house installation completed at Chase Manhattan Bank in New York City

ARC system announced on Dec. 1 at press conference in New York

1980: Newport program initiated to port the RIM to an LSI chip

1982: ARCNET chips are made available outside Datapoint for first time

1985: Novell incorporates ARCNET as an available product offering, selling over 300,000 units in the first year

1987: The ARCNET Trade Association (ATA) is chartered
By the end of the year, more than one million ARCNET chips have been produced and sold

1988: Production of ARCNET chips jumps to 800,000 per year

1991: The ATA is certified as an ANSI standards development body

1992: ANSI/ATA 878.1 becomes a standard

1998: Over 7 million ARCNET chips have been produced to date

THE NEWPORT PROGRAM

By George Beason, September 4, 1998

WHY NEWPORT?

I named the project NEWPORT because it helped me remember where the chip design was happening. Silicon Systems Inc. (SSI) was in Tustin, CA. I had several assignments taking me to various semiconductor companies. When I visited SSI, I stayed in Newport Beach, CA …next door to Tustin. In later years there was some rewriting of the history book to say that the name came from the fact that the chip was the NEW PORT of the LAN world. I wasn’t that smart … just wanted to know where my project was located.

Dub Warren, Vice President of Engineering, hired me at Datapoint in June 1978. He wanted someone with experience in design programs exploiting LSI (large-scale integrated circuits), and I had been managing programs using MOS LSI since 1967 at NCR and later at DEC.

The top priority assignment he gave me was to "make a RIM chip". He showed me the "larger than a breadbox" external RIM which contained its own power supply. I didn’t know why it was so important to connect Datapoint’s little computers together, but the job sounded like something I could do, and it got me out of the snow in Massachusetts!

The most important contribution I made to the program was to hire John Moschner from NCR. He already knew John Murphy. They were both students at Notre Dame. In my mind John Moschner is MR. RIM CHIP. He was the Project Engineer. He wrote the chip specifications with the advice, review and counseling of John Murphy and Gary Asbell and probably others. Gary had already converted the "box" design to a PC board inside the Datapoint 6600. It was this board that served as the basis for the chip design and testing. John was the day-to-day manager of the project. He was the primary interface with the chip design engineer at SSI and later with the engineering staff at SMC.

After looking around at the emerging Gate Array technology, I decided that it wasn’t mature enough to bet the RIM chip on it. I visited a few silicon design houses that I knew from my days at NCR and DEC. I elected to recommend Silicon Systems Inc. of Tustin, CA., after Bill Bramlett and I reviewed their facility and design process. The choice was made on two points. First, I had some experience with SSI. At DEC, Ned Forrester used them to design two video chips for the VT 100. He and Len Halio were very impressed with their expertise. Secondly, I was very satisfied with the state of their design automation that was just beginning to be used for total chip design in the industry. Hand layout, using pasties of standard cells, had been the state of the art. So I came back to Dub Warren with a quote for the job. SSI was to be Datapoint’s proprietary chip vendor. Dub said go for it! He had sufficient TI experience to make judgements about the cost of chip design.

One of the requirements we specified to SSI was the necessity to have more than one silicon foundry capable of producing the chip. (SSI didn’t have their foundry running.) The compromises they made to accommodate the different manufacturing processes almost wrecked the program. Even though we did get the few chips John Moschner was testing, SSI could not get the design to yield at either foundry. We were paying for wafer runs and sometimes getting only one working chip per wafer!!! The chip had been designed to 6-micron rules and shrunk to 5-microns which was the industry standard at the time unless you could get access to Intel's 4-micron HMOS. Their process and foundry were not available unless one would commit to buying a million chips a year.

I had met Paul Richman of SMC a couple of times. I had moved a chip (floppy disk controller) to him when I became dissatisfied with Western Digital. Now I really needed help and when I called Paul he committed all of SMC’s resources to "fixing" the chip. I negotiated a quit-claim with SSI and moved design, artwork and all to SMC. The rest was easy. SMC did make the chip yield, fixing the short John discussed and beefing up the ground plane. Paul asked SMC personnel to work through the Thanksgiving holiday to package enough chips to keep Datapoint’s 8600 line supplied. Our agreement was still a handshake. Paul Richman’s word was better than a contract. The chip was customer specific (CSIC) for Datapoint. However, when Paul and I sat down to finalize a legal agreement, SMC asked for the right to sell the chip to others. Datapoint management agreed … and we had a deal ! Later they produced boards for the PC bus. Then John Tweedy met someone from Novell looking for a "network bus". He sold them on ARCNET, and the game was on! Later on, I was directed by Datapoint management to develop a second source. I went to people I knew at NCR; Jim Van Tassel, VP Microelectronics Division, in Dayton and Mike Morrisey, Plant Manager at Fort Collins. Bill Carr managed this interface. NCR became second only to SMC in volumes shipped until they withdrew from the market. Bob Jones was instrumental in their success.

At the time we were putting together and completing the NEWPORT PROGRAM, it seemed like just another conversion of a discrete design to LSI. In retrospect, it was much more. I would never have dreamed that I would be working on the same project 20 years later!

■

The Newport Program chip

A Wild Ride With ARCNET

Len Shustek and three partners founded Nestar in late 1978 to build and sell networked systems of PCs using proprietary network hardware and software that Shustek designed. In 1982, Nestar created a diagnostic device using ARCNET technology that became known as the Sniffer.

"The Sniffer ™, whose lineage traces directly back to our involvement in ARCNET, has been very good to me," Shustek says.

Here's his story:

"In late 1981, we decided to move to hardware and software that had a chance of being standardized. We also wanted to avoid the common-bus topology that our network shared with Ethernet and whose disadvantages we were intimately familiar with. We chose ARCNET and were one of the first users of the SMC chipset in 1982. We built network interface cards for the PCs, our own 68000-based servers and even our own hubs.

"In the lab, we also made a diagnostic device out of a specially-modified network interface card that allowed the RIM chip to read all packets regardless of the destination address. Initially called TART (a play on "promiscuous receiver"), it was soon called the Sniffer. We made a dozen or so for our own use and even sold some to customers who saw us use it and realized that it made debugging network software and applications so much easier. "In 1985, we started working with TI on the IBM-defined Token Ring, but by 1986, the company was sold to DSC in Texas and I wanted out. Harry Saal and I (the only two of the original four Nestar founders still there) left with the rights to the Sniffer—in exchange for all our shares in Nestar—and created Network General as a startup to make the Sniffer ™ (now our registered trademark) into a commercial product. For the first release, I redesigned the product from the ground up for Token Ring, and six months later I added an Ethernet version. We were an instant and surprise (to me!) success story. We went public in 1989 with 29 employees, and by 1995 had about 600 employees and were selling about $150 million of Sniffer-derived products a year. In 1997, we merged with McAfee Associates in a transaction valued at $1.3 billion, which formed Network Associates.

"It's ironic to me that Ethernet has now evolved towards the same kind of hub-based non-shared wiring configuration that ARCNET designers knew was better more than 15 years ago. Many people have said that with better marketing and standardization efforts, an ARCNET-like system might have become the dominant networking system instead of Ethernet.
Sic transit gloria mundi."

■

History of the ARCNET Trade Association

by George Thomas, Contemporary Controls
gthomas@ccontrol.com

We first learned about ARCNET in 1982. At that time, we were designing and manufacturing STD Bus boards and integrating them into custom systems for our customers. The STD Bus was a late 1970's bus board technology developed by PRO-LOG Corporation. We would either make or buy boards and put them into systems. Our biggest customer at the time was Dewer Information Systems Corporation (DISC). Their president had the idea of replacing Digital Equipment Corporation (DEC) minicomputers in a pre-press newspaper system with distributed microcomputers. Of course a network was needed and he asked us which one to choose. In those days there were not many choices but we did find chip sets from Western Digital and Standard Microsystems Corporation (SMC). We studied the specifications and chose the technology from SMC, which we felt showed the best promise—it was ARCNET.

There were no STD Bus ARCNET cards available, only an S-100 and PC Bus card from SMC, so we designed the first STD Bus ARCNET card in 1983 and added it to the other STD Bus cards in the system. Our customer developed all the software and in the fall of 1983 installed the first microprocessor-based pre-press newspaper system in Monterey, California. This system provided editorial, classified ad, display ad and typesetting functions on individual 8088-based microcomputers all linked together with ARCNET. For active hubs, the customer purchased ARCNET active hubs from Radio Shack.

We started to advertise our STD ARCNET card in 1984 and won some designs. One of our customers, Robertshaw Controls, who was buying our ARCNET cards, had made their own Multibus ARCNET card and offered to sell the design to us. They had written their system around the Intel iRMX real-time operating system. We bought the design in 1986, which gave us another computer bus for ARCNET. Internally we started development of a PC Bus ARCNET card, since the PC Bus was beginning to be used in industrial control applications which was our major market. We also started the design of a modular active hub that used a STD Bus backplane to interconnect the various modules. From our point of view, ARCNET was an industrial networking technology because of its token-passing protocol and resulting deterministic performance.

The idea for an ARCNET Trade Association (ATA) came from Ben Wolfe of the IPS Company. Ben was our marketing consultant at the time and he was asked to assess the strength of our STD Bus product line against alternative systems in the market. Ben's resulting report basically said that we should throw out all the STD Bus cards except the ARCNET card and concentrate on ARCNET. One of the recommended action steps at the end of his report was to create a trade association.

A trade association? We thought that was extremely ambitious. We were only a little company in one market-industrial automation. How could we pull off such a task? Ben was confident this could be done so with seed money from us he began making calls to our customer list by identifying any company remotely interested in ARCNET. After awhile he came back to say we need to expand to the office automation market and did I know anyone at Datapoint? I knew no one at Datapoint nor did I even think they would be interested. So Ben called Dr. Robert Potter, then president of Datapoint, about the idea of an ARCNET Trade Association. To both our surprises, Dr. Potter was not only interested but enthusiastic.

We arranged an organizational meeting in Chicago between those companies most interested in starting an association—Datapoint Corporation, Standard Microsystems Corporation (SMC), NCR Corporation, Gracon Services, Inc. and Contemporary Control Systems, Inc. (CCSI). NCR was the second licensee of Datapoint's ARCNET micro code while Gracon Services was a Novell reseller. These companies eventually became the founding sponsors. Although we tried, Novell never became an ATA member. This was ironic since it was Novell that was fueling all the demand for ARCNET.

Ben proposed that he become development director of the association while Andy Larsen would manage the association as executive director. Andy had a company C.A. Larsen & Associates which was involved in managing associations. At this organizational meeting, Billy Cox of Datapoint, Geoff Karlin of SMC, Mike Shapiro of NCR Corporation, Mike Grady of Gracon and George Thomas of CCSI attended along with Andy and Ben. Plans were made for the incorporation of the trade association and for the inaugural meeting in the fall.

Ben and I discussed the name of the organization. We wanted the word "factory" in the title to indicate our focus of the technology towards industrial applications. Our company had just published a book, ARCNET Factory LAN Primer, to promote ARCNET's use on the plant floor. However, Ben realized that we needed the strength of the office automation companies to reach critical mass so we proposed the name ARCNET Trade Association (ATA) to simplify things. It is interesting to note that now the majority of interest in the ATA is from the industrial segment.

The interim board of directors was quickly expanded and Ben assumed the role of Interim Board Coordinator. The ATA was incorporated in the State of Illinois as a not-for-profit organization in August 1987. The inaugural meeting was held October 12-13, 1987 at the Hyatt Regency O'Hare Hotel in Rosemont, Illinois. Dr. Potter, president of Datapoint, was the keynote speaker. Three divisions were established—user, system and supplier. Representatives from the three divisions were named to the board. A total of six papers were presented:

Why ARCNET Over Other LANs,
Performance Technology, San Antonio, TX

Interfacing DEC products with ARCNET,
Comendec, Ltd., Traffordshire, England

ARCNET Versatility—Nuclear Power to Nuclear Subs,
TIAC System, Inc., Port Moody, BC Canada

Monitoring ARCNET LAN Systems,
Network General, Sunnyvale, CA

ARCNET—Experiences Over the Year,
Standard Microsystems Corporation, Hauppauge, NY

ARCNET Application—Compaq's 1100 Node Office/Factory LAN, Compaq, Houston, TX

Awards were given out. Contemporary Control Systems, Inc. was recognized for their pioneering efforts in forming the ATA and each founding sponsor received a plaque. At the board meeting, Ben Wolfe was made board chairman and development director. Several committees were formed to address standards development and promotion of ARCNET. In the evening a reception was held. In total, about 70 people attended the inaugural meeting including nine members of the press. It was a very encouraging launch of the ATA and we received press in both office automation and industrial automation publications.

One promotional effort of the ATA was to demonstrate ARCNET connectivity at the Control Expo Show in Chicago in June 1988. This was a show Contemporary Control Systems always participated in. The idea was to connect as many booths together as possible in order to demonstrate the breadth of ARCNET. Datapoint offered their Point of Use Adapters (POUAs) and servers for the demonstration. But it still took much human effort to pull the cables, configure devices and promote the event. Ernie Miller of Datapoint and Stephen Briggs of Comendec were tireless in this regard. The event was staged with some success and an ATA meeting was held at the show. It was clear from the ATA meeting that the Control Expo show was strange to the office automation people attending the show demonstrating that there were not always common interests between the office automation and industrial automation members. It was then decided to promote both office automation and industrial automation shows during the year.

A key part of the promotional efforts was to continue to inform the press of ARCNET's viability. During 1988 Art Sidorsky of SMC presented the 1,000,000th ARCNET chip to Dr. Potter. That was indeed a milestone but what was more important was that ARCNET was shipping at a 700,000 per year rate. Most chips went into Novell systems. Novell supported virtually all available network technologies including ARCNET. Their own RXnet network was actually ARCNET. Still ARCNET was being compared to Ethernet at 10 Mbps and Token Ring at 16 Mbps. ARCNET was perceived as slow although benchmark studies showed differently. Ben Wolfe was occupied defending ARCNET against market share studies that were claiming that ARCNET was losing share.

Another point of ATA business was to achieve standardization of the ARCNET protocol. The obvious first place to go for standardization was the Institute of Electrical and Electronic Engineers (IEEE) 802 committee, which was formed in 1980 to standardize all the LAN technologies. Different subcommittees were established to address individual technologies. Bob Harris of Pure Data Corporation approached the 802 committee and did not receive an encouraging reception. Even if the committee accepted our technology for review, there surely would be changes requested to fit the framework of activities underway. This was not what the ARCNET community wanted. ARCNET systems had been installed and successfully working for over ten years. Stable silicon was in place with four licensees of the ARCNET micro code. The risk was that for the sake of a standard, backward compatibility would be lost to an installed base at that time of 2,000,000+ nodes. Another approach was needed.

Andy Larsen and George Beason of Datapoint Corporation suggested approaching the American National Standards Institute (ANSI) and becoming accredited as an ANSI standards development body like IEEE. Bob Harris was not encouraged and felt that approach would be difficult at best. Still Bob Harris approached ANSI and submitted the required documentation on September 26, 1990. A mail vote of the ANSI board to the application of the ATA becoming accredited failed by one vote. Attempts to have one of the descending votes changed from no to abstain failed so the ATA was left with the only remaining option, appeal to the ANSI board of directors.

Andy Larsen, George Beason and Robert Hollingsworth of Datapoint Corporation appeared before the ANSI board of directors on September 19, 1991 at their New York City office to appeal their case. They again received objections from IEEE as to why there should be another standards body for local area networks besides the IEEE. George argued the fact that with an installed base of close to 3,000,000 users, this group of users deserved a standard without the necessity of revising the standard for the benefit of another organization. The board voted in favor of the ATA and on that day, the ATA was accredited by ANSI.

The ATA decided to develop their standard using the canvass method, which is one of the ANSI approved methods for developing a standard. With this approach, the ATA standards committee proposes the standard and develops a canvass list of individuals willing to review and vote on the standard. ANSI adds their own names to the list and a ballot is sent to the canvass list. The ATA canvass list consisted of more than 35 professionals willing to review the standard. Still someone had to write the standard and it was Billy Cox of Pure Data Corporation and Michael Fischer of Child Systems who painstakingly translated the ARCNET micro code and physical layer characteristics into a standards document. Michael did most of the standard writing and Billy did the laboratory verification. Ironically, Billy and Michael used the definitions and framework of IEEE 802.4 Token Passing Bus as a basis for the proposed ARCNET standard. In less than a year, the proposed standard was sent to the canvass list for balloting. There were some objections to the proposed standard that had to be individually addressed to the objector. This was all accomplished and on October 16, 1992, ANSI/ATA 878.1-1992 Local Area Network: Token Bus (2.5-MBPS) became an ANSI standard. Both Billy Cox and Michael Fischer were recognized by the ATA for their accomplishment.

There have been other standards activities. The ATA endorsed Gene Hughes' NetBIOS over ARCNET implementation. ATA 878.2, based upon RFC 1201, addresses TCP/IP over ARCNET. ATA 878.3 explains how master/slave control protocols can be encapsulated within ARCNET frames. These were all activities that enhanced the functionality of ANSI/ATA 878.1.

The next order of business was to determine what was to been done with ARCNET's performance. Since ARCNET was always perceived to be four times slower than Ethernet, it seemed obvious that we needed a boost in speed. Datapoint proposed the concept of ARCNETplus, which would have two operating speeds-2.5 Mbps and 20 Mbps. At the low speed ARCNETplus would interoperate with conventional ARCNET nodes; but at high speed ARCNETplus could communicate to other ARCNETplus nodes. ARCNETplus could also support larger packets, which was another criticism of ARCNET.

The beauty of ARCNETplus was that it would interoperate with existing ARCNET over the same cable. The bad news was that it was technically difficult and costly to provide this feature. The ARCNETplus chip set and transceivers were to be made available to other ARCNET vendors but this never happened. Eventually ARCNETplus was kept by Datapoint as proprietary technology. Introduced late, it never achieved any market share.

The office automation market changed dramatically during the 1990s. Novell's dominance subsided to Microsoft. The Internet fundamentally changed the way business was being conducted. The office industry has accepted Ethernet as the defacto office network and even rejected basic changes to the protocol to improve performance. Instead the technology has been scaled to 100 Mbps and development is underway for 1000 Mbps scaled version. With lack of interest in ARCNET in the office market came lack of interest in the ATA from office automation companies.

ARCNET still exists quietly selling about 500,000 nodes a year into applications never dreamed before by their inventors. The ATA has curtailed its efforts by dropping its three divisions and has become a virtual organization using the Internet to communicate to its members and ARCNET users. The ATA, still guardian of the ANSI/ATA 878.1 standard, is supporting more and more embedded networking applications that require dependable and timely delivery of data packets. That was what ARCNET was designed for.
■

Inaugural Meeting October 12-13, 1987

ARCNET Trade Association hereby honors the following:

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Beason Associates

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Standard Microsystems Corporation

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ANSI Canvassee List—February 1992

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Jack Sinclair
Yamatech Connectivity Solutions

Gregory Stauffer
Ingersoll-Rand

Chuck Thurwachter
Square D Company

Ed Young
State of Washington
Dept. of Licensing, Bus. Lic. Serv.

KEY ARCNET PARTICIPANTS

What are they doing today?

GARY ASBELL
Worked on HDLC interface, hardware and detailed protocol. His microcontroller design was converted and used in the original RIM design. Currently an independent consultant in San Antonio.
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GEORGE BEASON
Manager of the LSI chip project—The Newport Program—at Datapoint. Currently, executive director of the ARCNET Trade Association.
arcnettx@gvtc.com

ED BERTNESS
John Murphy's colleague, hired to help design and develop ARCNET. Currently at Data Race, designing modems.
ebertness@datarace.com

BILLY COX
Conducted test verification for ANSI/ATA 878.1. Currently Director, System Engineering for Compaq Computer.
Billy.Cox@COMPAQ.com

LEWIS DONZIS
Author of the ARCSTAT program and a client-side program to insert print jobs into the print queue. Worked with Gordon Peterson and the R&D group while still in high school. Currently Director of Engineering for the IP Appliance Group of Northern Telecom in San Antonio.
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MICHAEL FISCHER
Principal author of the ANSI/ATA 878.1 standard and developer of ARCNET-plus. Joined Datapoint in 1984. Also worked with ATA enhancment committee. Currently Chief Technology Officer at CHOICE Microsystems in San Antonio.
mfischer@child.com

GENE HUGHES
Assisted with original design and implementation work and author of the ATA NetBIOS. Currently with IP Appliance Group of Northern Telecom.

JOHN MOSCHNER
Played an integral part in converting the original RIM (Resource Interface Module) to an LSI chip. Currently, retired in San Antonio. jlm@texas.net

JOHN MURPHY
Hired in 1976 as a senior engineer to design and develop ARCNET hardware. Designed circuits for the original RIM: an 8-inch by 11-inch breadbox with 100 SSI and MSI ICs. Currently, Senior Software Sorcerer at IP Appliance Group at Northern Telecom.
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GORDON PETERSON
Wrote ARC's innovative network operating system, an indispensable part of ARCNET's success. He proposed the LAN system software and the use of a dedicated server. Currently a computer consultant based in Dallas.
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http://www.computek.net/public/gep2/

VIC POOR
Senior vice president of Research and Development at Datapoint and Chief Technical Officer who is credited with inventing the name, Attached Resource Computer. Considered a guiding light, he elevated the project to top priority in 1976 and helped the team dodge company political potholes. Currently, retired and sailing the world.
vpoor@compuserve.com

HARRY PYLE
Primarily an OS software developer who liked to experiment with analog hardware because of his ham radio background, he was the driving force behind the development of ARCNET. He etched the first circuit boards in his bathtub at home. By 1975 he was testing media, arbitration methods and topology for higher speed mechanisms. Currently, Chief Engineer, Human Factors at Corbis Corp.
harrypy@seanet.com

JONATHAN SCHMIDT
Part of the R&D "creative idea" group for ARCNET who managed the original design and implementation work. Early on, he grasped the idea that "the network is the computer." Considered an ARCNET evangelist. Currently with IP Appliance Group at Northern Telecom in San Antonio.
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LEN SHUSTEK
Founded Nestar in 1978 and became one of the first users of the SMC ARCNET chipset when it became available outside of Datapoint in 1982. Developed the ARCNET "Sniffer." Currently a part-time "Fellow" at Network General/Associates.
len@shustek.com

ATA Membership Benefits

- Information free of charge
- Participation in marketing activities
- Influence specifications
- Credit on ARCNET events
- Credit on ARCNET publications
- Entries in ARCNET product database free of charge
- Web site link

Get involved today!

The ARCNET Trade Association encourages and welcomes new members. In addition to the membership benefits listed at left, the ATA sponsors outreach and educational projects such as the ARCNET Platinum Anthology CD.

This latest endeavor—coming in October—will be an interactive CD devoted to the ARCNET industry. In a single CD, developers and users will have the most comprehensive resource on ARCNET technology. The ATA is still accepting participants in this CD and would love to hear from you if you have an interesting application or technical expertise you would like to share with the world. If you are interested in participating, complete the information below and fax back. You will be sent a participation guide!

Membership information

The ARCNET Trade Association offers two classes of membership—Sponsoring and Member. The benefits are the same except in the appointment of directors. Director positions on the governing board are only available to sponsoring members. All members can vote for board members and vote on other association and members issues. Membership categories and annual fees:

Sponsoring Member—$1500 **Member**—$500.

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About the newsletter contributors

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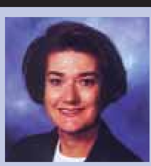
Freelance journalist Martha Stott is president of Say It Now, a custom gift service that publishes commemorative news stories for all occasions. For information, call toll-free, 1-888-863-0070.



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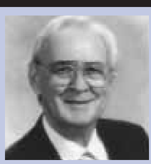

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