Case Study
FORE Systems (A case)
Version 4 - January 2007

This case was written solely by Mark Juliano and does not represent the opinions of any employee, past or present, of FORE Systems, Marconi Communications or Ericsson. Some facts of the case have been changed or added for educational purposes. The case is intended for the solely educational.

I. Company Background

FORE Systems was incorporated in April 1990 by three professors and one PhD student from Carnegie Mellon University (CMU) in the Computer Science department. At CMU, all four were working together doing research based on federal/military grants in the area of high-speed networking. At CMU, they researched, designed and built several high-speed switches which at that time “broke the speed barrier” running in excess of 2 Gbits/sec. These switches were in full use at CMU when FORE Systems was formed. The technology deployed in these high-speed networking switches was of proprietary design. By 1992, all four had left CMU and were working full time at FORE.

[Interesting Tidbit: The name FORE Systems derives from the first letters of the first names of the four founders. It also meant to be ahead – “to the fore!” At the Forefront of ATM Networking was FORE’s first tagline.]

II. The Networking Industry

In the late 1980’s and early 1990’s a new technology was being developed among large international corporations (AT&T, Bell Companies, International PTT’s, etc.) in conjunction with the CCITT (international standards body for telecommunications). This technology, called ATM (asynchronous transfer mode) was a component of a larger body of technology called B-ISDN (broadband integrated switched digital network). The goal of B-ISDN and ATM, as it was defined, was to become the foundation of a new generation of networking technologies, which would pave the way for the networks of the future. Among the advantages of ATM technology was:

- Integrated voice, data and video
- Ultra high-speed (from 1.5 Mbits/sec ➔ 192+ Gbits/sec)
- Scalable speeds
- Ease of network management
- Ability to handle a variety of networking protocols (i.e. ethernet, token ring, FDDI, frame relay, routing protocols, etc.)
- Seamless end-to-end network connectivity
- International standards-based

These were indeed far-reaching goals, and ATM became the key underpinning technology of B-ISDN. It should be noted, that the predecessor of B-ISDN, called ISDN, had been experiencing great difficulty in its deployment. While it was taking hold in some countries which had relatively low-speed networks, in the United States it was seen as a failure. Put simply, ISDN was too slow, too late, and too expensive.

**LANs and LAN Internetworking**

At the same time as the development of ATM and B-ISDN, the revolution of Local Area Networks (LANs) was well underway. Developed in the early to mid 1980’s, by the early 1990’s, LANs were proliferating throughout the U.S. and overseas. Ethernet (10 Mbps technology) and Token Ring (at 16 Mbps technology developed by IBM) were fighting it out for the top spot, with Ethernet emerging as the clear leader by 1990. As LANs developed, the issue turned to LAN internetworking – namely connecting individual LANs using devices such as bridges, routers and gateways. These internetworks could be deployed in a single building, corporate campus, metropolitan area, or across the nation or the world. However, due to the speed limitation of Ethernet (10 Mbits/sec), new technologies loomed on the horizon such as FDDI (100 Mbits/sec) and a potentially new technology called fast Ethernet (100 Mbits/sec). At the time of FORE Systems founding, only FDDI was a working, deployable technology. Fast Ethernet was still in the laboratories and there was question as to whether it could ever achieve the 100 Mbits/sec speed while preserving the Ethernet framing and overall protocol structure. In addition, other non-Ethernet protocol high-speed technologies had been proposed (such as 100VGanyLAN by Hewlett Packard)

Within internetworking, the name of the game was again speed and performance, as well as the devices ability to route specific protocols. Specifically a major issue was how many packets (frames) per second a bridge, router or gateway could correctly handle. As the LANs became more congested, so too did the internetwork. Companies such as Wellfleet, Cisco, Proteon, and Digital Equipment (DEC) hastened to add faster and faster processors (CPUs) to their devices to keep pace with growing network demand. Furthermore, these devices primarily relied on a technology called Frame Relay for their connection to the wide area (long distance) network (WAN). Frame Relay technology was limited to 1.544 Mbits/sec in the U.S. and 2 Mbits/sec internationally creating a serious WAN bottleneck for large, high-speed, long distance internetworks.

Clearly, some breakthroughs were needed in the area of 1) LANs, 2) LAN internetworking, and 3) WANs to keep pace with the ever-growing demand on networks. At this time, ATM emerged as a prime contender for all three applications, and was even
talked about as the panacea for what plagued the networks of the early 1990’s. During 1992 the first revenue forecasts were developed by consulting firms such as Yankee Group, Gartner Group, IDC, etc. These forecasts predicted that ATM would be a $4-10 Billion industry within 5 years.

III. FORE Systems Story Continued

Seeing the need for a solution to the networking problems of the day, the founders of FORE Systems turned to ATM technology. Within two years from their founding, they were able to design, develop and manufacture an ATM switch with 2.5 Gbits/sec of capacity and 16, high-speed 155 Mbits/sec input/output interfaces (ports).

At the same time they realized that while their ATM switch was ready, there was a dilemma. Few if any devices in the world had an ATM interface to connect to their switch. To that end, FORE developed a series of interfaces (NICs) for high-speed workstations (computers) with initial support for Sun Microsystems and Silicon Graphics workstations. FORE knew that to remain competitive, it would be required to design NIC cards for the remaining workstation vendors’ products (Hewlett Packard, IBM, DEC) and eventually for PCs and Apple MACs. In addition, the company would need to provide continual development and support for all operating system versions of these platforms.

Several manufacturers of LAN hubs, bridges and routers had announced their plans to develop ATM interfaces for their equipment (Cisco, Retix, Cabletron, Wellfleet, Synoptics) although by the end of 1992, none of these vendors were shipping ATM interfaces.

Therefore, by definition, FORE was shipping the first true ATM LAN, with up to 16 computer workstations (containing ATM NICs) connected to a single ATM switch, and with the capability of connecting multiple switches together to form a “pure” ATM internetwork. Still, FORE equipment could only “talk to” other FORE equipment since no other ATM switches, NICs or router interfaces were available.

By the end of 1992, FORE Systems had achieved the following milestones:

- Shipped the first commercially available ATM switch
- Shipped the first commercially available ATM NICs for workstations
- Derived approximately $4 million in revenue for 1992 (virtually 100% of all ATM revenues). Sales prior to 1992 were less than $200,000.
- Secured contracts from several U.S. military agencies for ATM R&D and product purchases (totaling approximately $2 million)
- Sold to approximately 10 customers (primarily government agencies and universities doing research)
Other FORE Systems facts by the end of 1992
- Staff of ~20 people including engineering (12), sales (3), marketing (1), manufacturing (2) and administration (2). Also had one (1) contractor/consultant working in London with sales/marketing background.
- 3 of 4 founders were non-US citizens from UK, Turkey and Switzerland. All are 33 or 34 years of age.
- All engineers have PhD or Masters educations
- Head of Sales from NSC and Ultra (high speed computer networking companies) with strong background in sales to government customers. Little international experience. Two previous startups. About 45 years old.
- Head of Marketing from ROLM, NET, and TTC. Strong WAN background. Strong sales to Fortune 500. Some international experience. Two previous startups. 34 years old.
- CFO experience with one previous startup. 34 years old.
- All funding at this point came from government contracts and customers until Dec. 1992.
- Company had achieved profitability
- Sales to international customers accounted for approximately 16% and 46% of FORE’s total revenues for the years 1991, 1992.
- FORE’s current customers included Naval Research Labs, Sandia National Labs, US Dept. of Defense, Columbia University, University of Stuttgart, and AT&T Bell Labs.

Select Financial Data for 1993 (approximate)

<table>
<thead>
<tr>
<th></th>
<th>CY 1993</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIC Revenues</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>ATM Switch Revenues</td>
<td>$3,000,000</td>
</tr>
<tr>
<td>TOTAL Revenues</td>
<td>$4,000,000</td>
</tr>
<tr>
<td>COGS</td>
<td>$1,200,000</td>
</tr>
<tr>
<td>GROSS Profit</td>
<td>$2,800,000</td>
</tr>
<tr>
<td>Gross Margin</td>
<td>70%</td>
</tr>
<tr>
<td>R&amp;D Expense</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>Sales &amp; Marketing Expense</td>
<td>$ 800,000</td>
</tr>
<tr>
<td>General &amp; Administration Expense</td>
<td>$ 700,000</td>
</tr>
<tr>
<td>NET Profit</td>
<td>$ 300,000</td>
</tr>
<tr>
<td>NET Margin</td>
<td>7.5%</td>
</tr>
</tbody>
</table>
In addition, FORE just completed its first round of venture capital financing in December 1992. It raised $5 million with a market valuation of $15 million from Battery Ventures (Boston) and Patricoff & Co. (New York). All Silicon Valley venture capital firms had declined to invest and were not interested in funding FORE for several reasons:
- Pittsburgh based company (re not Silicon Valley, Boston, etc.)
- University founders and CEO had limited business experience
- Didn’t believe the ATM LAN market would succeed (versus ATM backbone and WAN markets)
- FORE lacked a strong marketing presence

Due to FORE’s size and market conditions, FORE did not plan to do an IPO in 1993. FORE assumed that in the best-case scenario it will be able to do an IPO sometime during late 1994.

A. FORE’s Markets and Customers
Due to the lack of devices which contained ATM interfaces, FORE had no choice but to initially sell small, pure, ATM LANs. These were initially sold to those organizations doing research and long-term planning for deployment of ATM (government agencies, universities, research labs, etc.). They were willing to pay the high price of $4,000 per NIC (versus $200 for Ethernet) and $4,500 per ATM switch port (versus $500 for hub/router port). In addition, FORE developed NICs for engineering workstations (which sold for $15,000 - $30,000 the price) and the price was considered reasonable given the high throughput.

In fact, some of FORE’s initial revenues actually came from other future ATM switch manufacturers who were planning to build high-end ATM equipment costing in the $1+ million range. They used FORE’s ATM switch primarily for testing. In short, FORE was really the only game in town and customers would pay the price to get their hands on what had only a year ago been thought of as a technology in the 3-5 year timeframe.

B. FORE’s ATM Switch
Dubbed the ForeRunner ASX-100, FORE’s switch had the following features:
- 16 ATM ports per switch (4 cards are supported by the switching fabric)
- 155 Mbits/sec interfaces (standard) 4 per card
- 100 Mbits/sec TAXI ATM interfaces (proprietary) 4 per card
- Modular (could be 4, 8, 12 or 16 ports)
- Plans for T3 (45 Mbits/sec) ATM WAN interface (2 or 4 per card)
- Plans for 155 Mbits/sec SONET WAN interface (2 or 4 per card)
- Could interconnect multiple switches together
- Fiber optic-only interfaces
- Future plans for copper interfaces
- List price of $50,000 - $80,000 depending upon configuration
- Cost of Goods sold (COGS) are approximately 25% of list price
- Competitors’ announced pricing was +/- 20% of FORE’s switch price

C. FORE’s ATM NICs
- Supported Sun (Sbus) and Silicon Graphics (GIO bus & VME bus)
- 100 Mbits/sec proprietary TAXI interfaces (using FDDI chips)
- Plans for 155 Mbits/sec standard ATM interfaces
- List price of $3,995
- COGS are approximately 40% of list price
- Competitors’ NIC pricing ranges from $3,000 to $4,500

IV. The ATM Market

Industry consultants and analysts (those who watch and predict industry trends) were predicting in early 1993 that ATM would first appear in the backbone internetwork (interconnecting LANs, not the LANs themselves), soon to be followed by the WAN. These conclusions were based on the assumption that the biggest need for bandwidth was in the center of the network where there was the most congestion. They predicted internetwork deployment before WAN deployment largely due to the degree of difficulty for large carrier, RBOC (Regional Bell Operating Companies – ex-AT&T), etc. to deploy, tariff and manage these networks.

Furthermore, they concluded that ATM would not be deployed in the LAN (or at the “desktop”). They saw that few computers could even produce anywhere near the 10 Mbits/sec that Ethernet already offered (with the exception of few, very high-speed servers). Furthermore, they concluded that unless ATM NICs could get below the $500 per NIC, they would never be cost effective for mass deployment.

A. Market Forecasts
- The worldwide market for ATM was projected to be at least $4 billion within by 1997. The market was forecasted by one industry analyst as follows:
  - 1993 $40 million (15% international)
  - 1994 $160 million (25% international)
  - 1995 $500 million (30% international)
  - 1996 $1.5 billion (40% international)
  - 1997 $4.0 billion (50% international)

With the following breakdown in network applications:
- LAN workgroup/desktop 20%
- LAN Backbone 50%
- WAN Backbone 30%

B. Customer Segments
A number of different customer segments were also identified based upon past trends and sales of other networking technologies. The following numbers were predicted when ATM reached maturity.

<table>
<thead>
<tr>
<th>Segment</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finance &amp; Banking</td>
<td>30%</td>
</tr>
<tr>
<td>Medical</td>
<td>10%</td>
</tr>
<tr>
<td>Manufacturing &amp; Engineering</td>
<td>30%</td>
</tr>
<tr>
<td>Government &amp; University</td>
<td>10%</td>
</tr>
<tr>
<td>Other</td>
<td>20%</td>
</tr>
</tbody>
</table>

C. Worldwide Adoption
ATM was predicted, due to its flexibility in applications as well as being an international standard, to be adopted worldwide. While no county-by-country forecasts were available, analysts predicted that ATM would follow the traditional model:

- **Phase 1** U.S.
- **Phase 2** Leading European countries (England, Scandinavian countries, Germany) and Japan
- **Phase 3** Other European and Asian countries

In addition, since ATM technology was largely defined by international standards, ATM was currently viewed by most countries outside the U.S. as being a WAN technology. Several long-term trials were already underway in Europe and Japan to study ATM in the WAN environment.

D. ATM to the Desktop
In 1992, high-end computer workstations comprised approximately 15% of the total desktop computer market. The desktop market was dominated by Microsoft Window-Intel Processor (WINTEL) platforms. These PC’s processors were currently capable of driving data at a maximum of 10 Mbits/sec. It was not believed that these computers would be capable of driving an ATM connection for 3-5 years.

Workstations (Sun, IBM, HP, Silicon Graphics, DEC, etc.) were generally used in engineering applications (CAD CAM, modeling), graphics-intensive applications (film production, medical imaging) and data intensive industries (finance, banking). These workstations were capable of currently driving 20-40 Mbits/sec data rates, with large high-speed servers capping out at 60-80 Mbits/sec. In 1992, these computers used multiple 10 Mbit/sec Ethernet connections to support their speeds.

Several workstation manufacturers had plans to develop their own ATM cards for their high-speed platforms, with Sun being the most notable as they controlled over 40% of the market. Their NIC would be based upon the Adaptive/National Semiconductor chipset (see below)
V. The Competition

As would be expected, any technology which is projected to have a market size of $10 billion in 5 years and could be the panacea for LAN and WAN networking was going to attract a good deal of attention, investment and competition. Fortunately for FORE, the venture capital markets were relatively dry in the 1990-1991 timeframe, and no other start-ups were funded to do ATM technology and products. That left the big boys…

NET/Adaptive
Network Equipment Technologies (NET), a silicon valley company, had been the darling of the networking industry in 1987 and 1988 when in introduced the then highest-speed WAN networking technology, T1 (1.544 Mbits/sec). T1 was then deployed as a voice/data integration technology and a way for Fortune 500 companies to build their own private networks thereby bypassing the public network and obtaining great cost savings. NET had gone public in 1987 and by 1990 had achieved revenues of ~$190 million. At that time, NET formed a wholly owned subsidiary called NET/Adaptive which was to develop next generation products using SONET and ATM technology. By the end of 1992, Adaptive was shipping their SONET multiplexer and their ATM switch was in beta trial. The Adaptive ATM switch was originally designed for WAN applications (as that was NET’s business). Later, it was concluded by the management team that LAN Internetworking was their primary market, and the switch was re-designed for that market. The final product was a 1.6 Gbits/sec ATM switch with ATM interfaces and T3/SONET WAN interfaces planned.

At the same time, realizing that few if any devices would have ATM interfaces, Adaptive developed an ATM “chip set” which they later licensed to National Semiconductor (one of the worlds 3 largest chip makers at the time). The intent was to make it easier for other vendors to develop ATM interfaces. Adaptive had initially partnered with Sun to develop an ATM NIC for Sun’s platform. Adaptive also hoped to be seen as the obvious choice for ATM switches by nature of developing the ATM chip sets.

The Adaptive switch had one major shortcoming, its size. Although an ATM LAN could be built using the Adaptive switch, it could never be deployed in the real-world LAN environment. Nicknamed by some industry followers as “the frig” it was the size of a small refrigerator (compared with FORE’s switch which stood only 10” high) and Adaptive’s switch required a good deal of power to run the device. Nonetheless, the Adaptive switch was 2nd to market.

More importantly, Adaptive had NET/Adaptive’s marketing and a good deal of funding. They quickly became known as the ATM market pioneer and leader, even though FORE had shipped earlier and shipped more equipment. Adaptive achieved their market presence by hiring a seasoned marketing staff, spending a good deal of money on ATM
marketing, being a founder of the ATM Forum (an international group of ATM vendors), and having a large, stable, high-end base of T1 customers from NET.

Adaptive’s position against FORE was that FORE was university-based technology with university professor management, and that the company lacked the financial resources to compete.

NET had sales in U.S., Europe and Asia, but was by far the strongest in the U.S.

**Cisco Systems**
Cisco (derived from San FranCISCO), the pioneer of internetworking routers, had developed into the leading internetworking company selling multiprotocol routers, LAN and WAN switches, and network management software. By 1993 Cisco’s revenues had topped the $700M sales level with over 90% year-to-year growth. Their interest in ATM was twofold. First, to eventually replace Frame Relay as the WAN technology for high-speed router interconnectivity, and second to produce “router-farms” or “router-clusters” which were collections of high-end routers interconnected by a high-speed ATM “bus” to produce super-routers. Cisco thought of ATM in many ways as just another protocol that would need to be internetworked with other LAN and WAN devices.

Since ATM was inherently capable of doing some router functions, Cisco remained somewhat cautious of the technology and was quick to educate their installed customer base and the industry at large to the limitations of ATM as a LAN or LAN internetworking technology. Having said this, Cisco was also quick to announce (by early 1993) an ATM switch, which was an OEM/private label product from NEC in Japan. The NEC switch was a virtual carbon copy of the FORE Switch’s hardware (on paper) though it was due to be shipped about a year after FORE’s initial product. What it lacked was the highly intelligent FORE Systems ForeThought software, which was able to route connections through the network. That software was what Cisco intended to develop.

Cisco’s strategy was clearly “wait and see” about ATM, which often translated to “just buy more Cisco routers Mr. Customer, and we’ll take care of you when (and if) ATM comes around. Besides, ATM is a new, unstable technology, and who best to turn to but Cisco to help you through this transition.”

This FUD (fear, uncertainly and doubt) marketing strategy was echoed by a number of other bridge, router, and hub manufacturers who they themselves were not yet ready to ship an ATM product. Cisco had strong sales throughout the world, and was extremely strong in Japan.

**Newbridge**
Newbridge was a large Canadian company (~$400M sales) formed in the mid-1980’s which competed directly with NET in the T1 market. Newbridge was highly successful at the low-end of this market, and had recently begun to infringe on NET’s stronghold at the
high-end of the market. They, like NET, saw ATM as the future of LAN, backbone and WAN technology.

Newbridge introduced their ATM switch in 1993, as a pure WAN switch. It was not seen as a direct competitor to FORE’s switch, although for those organizations conducting ATM research, they generally would purchase only one switch. Having said that, Newbridge’s strategy was broad and daring. The chose to take Cisco’s “ATM in the WAN strategy” head on and positioned ATM as the only true end-to-end networking technology. Their marketing literature clearly foretold the “death of routers” (death of Cisco?) claiming that ATM would eventually be the one ubiquitous networking technology. And while Newbridge did not form a separate subsidiary like NET/Adaptive, they pumped a massive amount of R&D into ATM technology and products.

During 1993, Newbridge announced its plans for 1) ATM WAN switch, 2) ATM LAN internetworking switch, 3) ATM LAN switch, 4) ATM bridge/router (a bridge/router with built-in ATM interfaces), and 5) a complete software suite to control all ATM networking devices.

Newbridge had its strongest sales in Europe, strong sales in the U.S. and was weak in the Asian markets.

**Synoptics**

Synoptics (a Silicon Valley company) was the leading manufacturer of LAN Hubs – devices which network PCs and workstations in a LAN environment. As a result of an advanced research project done with Washington University in St. Louis, they had jointly developed an ATM switch with similar specifications to the FORE ATM switch. At first, Synoptics had no plans to actually launch their ATM switch as a formal product, but after FORE’s initial success and the continual build-up of ATM as the “nirvana” technology, Synoptics indeed launched the product in the first half of 1993. Like FORE’s switch, it was 1) university-experienced researchers, 2) was LAN focussed, 3) was compact, and 4) had 16 ports. Unlike FORE’s switch, it was not modular in that only 155Mbits/sec ports could be housed in its chassis, and only 16 ports could be purchased (much like a LAN hub).

Synoptics had very strong sales in the U.S. and was relatively weaker in Europe and Asia due to presence of foreign competition.

**LightStream**

LightStream was a start-up company that was in the development stage of an enterprise-class ATM switch that was primarily focused on the ATM WAN market and the interconnection of routers and other data devices across the wide area network. LightStream was in the beta phase of product development with its ATM product due to hit the market at the end of 1993.
**Workstation Vendors**
A number of workstation vendors such as Sun, HP, IBM, DEC and Silicon Graphics had announced plans to provide an ATM NIC for their computer platforms. To date, only Sun’s NIC was shipping based upon the Adaptive-designed chip set.

**Other Competition and Potential Competition**
General DataComm (Connecticut - ~$200M) – A traditional WAN company (like NET & Newbridge) which launched an ATM WAN switch about 6 months after Newbridge
Cabletron Systems (New Hampshire--~$300M) – The #2 hub company after Synoptics. Needed ATM to attack Synoptics but had no internal source for technology
3Com (Silicon Valley--~$400M) – the clear market leader in Ethernet NIC products that had to protect their turf. Wants to get into the LAN internetworking market and compete with Cisco.
Retix (San Diego--~50M) – a medium size router company which was the first to ship an ATM interface
AT&T (New Jersey--~$60B) – has a BIG ATM switch in development for the long distance backbone network
NEC (Japan-$Billions) – OEM’d to Cisco and sold their own version in Asia.
Fujitsu (Japan-$Billions) – Launched Big ATM WAN switch in 1993
Xylan (startup in southern California) – developing an ethernet switch with ATM uplinks. Product due to ship at the end of 1994.
Alantec, Kalpana and others – pure ethernet switch vendors with no concrete plans to add ATM to their products
VI. Case Study Questions

One assumption:
The commercial Internet does not really exist yet (REALLY!). It was only being used for email and some FTPing.

- Perform a thorough analysis of the case including company, competitive, customers, industry and market analysis
- What are the various ways FORE can segment the market?
- Which segments should FORE focus on and why?
- Positioning
  - How should FORE position ATM as a technology?
  - How should FORE position the company in the ATM market in early 1993?
  - How should FORE position its products in the ATM market(s)? Are there any new products or features they need to develop to address these markets?
- Which competitors are to be feared and why?
- What type of sales channel should FORE use? (i.e. direct sales, distribution, systems integrators, value added resellers, OEM partners, etc.) What would you plan for FORE’s gross sales to be in 1993?
- How should FORE price its products? What is the pricing strategy? What are the absolute specific prices and prices relative to competition?
- What types of partnerships (and with whom) should FORE be developing? Why?
- What should FORE do internationally?
- What other data would you like to know (or collect) to help make your decisions?