Will Globalstar meet the same fate as Iridium?

Kittilerk Puttalsri, Aphiwan Malaithong, Bradley Schroepfer

puttalsr@colorado.edu, malaitho@colorado.edu,

bmschro@earthlink.net

1) Introduction

Today, people throughout the world communicate more than ever before. Land and wireless networks grow each day, connecting millions of people both while at home and while traveling. Although technology continues to develop, there still remains a need for telephone service throughout the world, especially in developing countries and in rural areas. One solution to this global problem is satellite communications. Our team's goal is to determine whether Globalstar can survive as a Mobile Satellite Service (MSS) provider where Iridium failed. To limit the scope of this paper, detailed regulatory issues will not be covered. Only technical, economic and financial issues will be discussed and investigated as important keys to the success or failure of both systems. We will first analyze and compare the technological features of both systems to show they are viable technological concepts. We then will analyze and compare economic and finanacial information. By comparing Globalstar to Iridium we will be able to illustrate if Globalstar can succeed as a successful MSS provider. The comparative analysis in our paper will answer this question.

2) MSS Industry Overview

MSS was originally designed to operate where cellular and conventional terrestrial systems were nonexistent especially in rural areas. MSS systems can offer benefits such as broader coverage areas, easier to communicate because the signal will not be not blocked by hills, mountains or tall buildings a large degree of insensitivity to distance and the ability to span terrain of any type. Utilizing satellites to establish a global mobile personal communication system (GMPCS) is technically feasible and sometimes more cost-effective than using terrestrial cellular communication. Although the cost of the satellite constellation and its high per-minute charge, as well as the limitation of usage in buildings and cars, leave mobile satellite services as the prevalent cellular extension. MSS can still fulfill the need for a reliable and economical communication system that continues to grow, especially for use by international business travelers, developing countries and people in specific industries such as oil and mining and residents of rural communities.

2.1 Low Earth Orbit MSS

The main advantages of a Low Earth Orbit (LEO) satellite when compared to the Geostationary Orbit (GEO) satellite are modest demands on antenna, better receiver and transmitter performance (and thus smaller weight and unit cost), and very low propagation delay. Due to the

fact that one LEO satellite has a very limited footprint on the earth's surface, many satellites would be required to achieve global coverage. Furthermore, building a LEO constellation to cover only one part of the world alone is virtually impossoble because the LEO satellites are in motion around the earth handing off signals to each other. LEO satellites are therefore mostly used to provide Mobile Satellite Services that enable global connectivity to mobile terminals almost anywhere in the world. Two prominent LEO players in the MSS industry so far are Iridium and Globalstar. The next section of this paper will focus on technical issues of these two LEO players.

3) Technical Issues

In this section, the paper will first briefly give systems overview of Iridium and Globalstar, and then make the comparative analysis on technical factors of these two systems.

3.1 Who is Iridium?

Iridium LLC, funded primarily by Motorola Inc, provided a LEO-based personal communications network designed to permit any type of telephone, voice, paging, fax, or data (2,400 bps) transmission [1]. The launch of Iridium satellites began in 1996 with commercial service anticipated in November 1998.

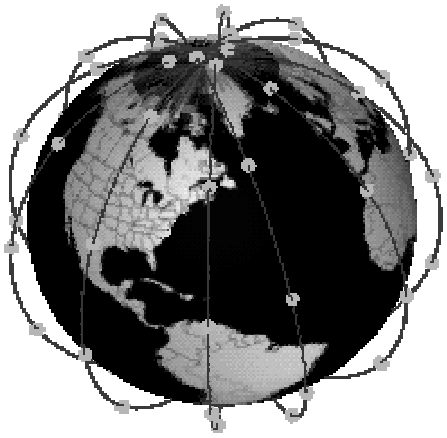

Figure 1: Iridium constellation [2]

3.2 Iridium Technical Factors

The Iridium system used a constellation of 66 LEO satellites to provide global coverage. The satellites were placed in six polar orbital planes with 11 satellites in each plane [3]. The altitude of the Iridium constellation was 778 km above the earth. The satellites possessed on-board switching and processing, as well as Inter-Satellite Links (ISLs) capabilities to provide complete connectivity with 4 adjacent Iridium satellites [4]. We will discuss about ISLs in more details in the Technical Comparative Section.

Each 689-kg satellite had 48 spot beams or footprints on the earth. Each satellite's footprint diameter was approximately 4,700 km [5]. The 66-satellite constellation projected 2,150 active footprints on the earth surface so the system could carry 172,000 users simultaneously via the satellite network [6].

The Iridium system deployed a TDMA/FDMA scheme (Time Division Multiple Access/Frequency Division Multiple Access) to interface with its mobile users as well as the terrestrial public switched telephone network (PSTN) and global cellular networks. Iridium's system functioned as an independent telephony network that interconnected with the existing public telephone networks via earth-station gateways [1].

3.3 Who is Globalstar?

In October, 1999, Globalstar, a company funded primarily by Qualcomm Inc. and Loral Space & Communications began to provide a global mobile satellite personal communication service, as well as fixed telecommunication services such as voice, data (9.6 kbps), fax, paging and positioning. [7].

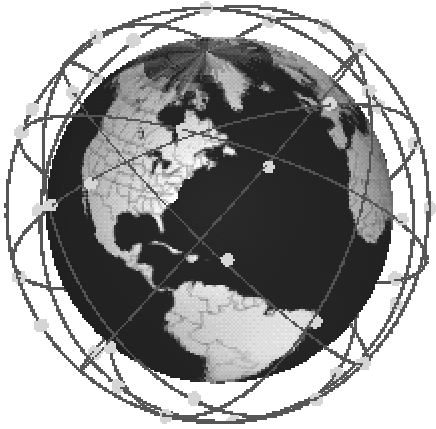

Figure 2: Globalstar constellation [2]

3.4 Globalstar technical factors

Globalstar constellations orbit at 1414 km above the earth, slightly higher than Iridium satellites. With an orbit inclination of 52°, Globalstar features 48 operational satellites (8 satellites per plane in six orbital planes). Similar to Iridium, Globalstar relies on ground-based gateways to link the Globalstar PCS (Personal Communication System) system to terrestrial AMPS (Advanced Mobile Phone System) and GSM (Global System for Mobile Communication) cellular networks. The Globalstar satellite differs from the Iridium satellite because it does not support on-board switching, but simply acts as a simple signal repeater (bent-pipe) with all call set-up and processing accomplished on the ground [8].

The Globalstar satellite weights 450 kg with a designed full operational life cycle of no less than 7.5 years. Each Globalstar satellite has a 16 spot-beam cell to form coverage regions on the earth for links between wireless users and the satellite. A satellite's coverage cell is around 4,800 km in diameter [3].

Ground-based gateways combine Globalstar's satellite network with the ground public mobile network or directly with the PSTN network. The gateway station is the terminal point of network transmission and network signaling. It can access the existing public network with standard T1/E1 relay and support various signaling protocols. Globalstar plans to build 38 gateways worldwide by the end of 2001 (currently 26 gateways are in position) [1].

In addition to using the CDMA/FDMA (Code Division Multiple Access/Frequency Division Multiple Access) channel-capacity-improvement algorithms provided by Qualcomm,

Globalstar uses the rake receivers from CDMA designs to provide path diversity, which is a proprietary means of combining multiple signals from different satellites into a single coherent signal.

Table 1: Iridium and Globalstar Technical Factors Summary and Comparison [5]

Major Technical Parameters	Iridium System	Globalstar System
Total Number of Satellites	66 + 6 spares	48 + 4 spares
Number of Orbital Planes	6	8
Orbit Altitude (km)	780	1414
Orbital Shape	Near Polar 86.4° Circular	Inclined 52° Circular
Coverage	Globe	70°N - 70°S
Feed Link Frequency (GHz) (Gateways - Satellites)	Uplink 29.1 - 29.3 Downlink 19.4 – 19.6	Uplink 6.87595 - 7.0529 Downlink 5.091 - 5.250
User Link Frequency (MHz) (Users - Satellites)	Uplink 1610 - 1626.5 Downlink 1610 - 1626.5	Uplink 6875.95 - 7052.9 Downlink 2483.5 - 2500
Beams per Satellite	48	16
Voice Circuits per Satellite	2000 – 3000	1100 -3840
Data Rate (kbps)	1.2 - 9.6 (Voice and Data)	4.8 for Voice 2.4 for Data
Satellite Lifetime (years)	5	7.5
Transponder	Onboard processing	Bent pipe
Multiple Access Scheme	TDMA/FDMA	CDMA/FDMA
Modulation	QPSK	QPSK
Satellite Cross-Link	Yes	None
System Function	Extension of Ground Cellular System	Global Cellular Communication

3.5 Comparative Analysis in Technical Issues between Iridium and Globalstar

The following section will discuss about the major technical differences and the advantages and disadvantages of these two systems.

The main technical differences between Globalstar and Iridium are (1) Globalstar's network is not independent of terrestrial infrastructures; and (2) Globalstar has no Inter-satellite Links (ISLs) capability. ISLs are satellite-to-satellite high bandwidth microwave or laser links, which allow a satellite to route traffic to another satellite. By using ISLs, Iridium is able to wholly bypass the terrestrial fiber and copper networks. An originating user can beam the message up to an overhead satellite (using satellite mode handset), the message is then relayed from satellite to satellite until it is above the terminating user, where it is then beamed down. Therefore, the main benefit of ISLs is that time delay in the conversation can be then significantly reduced because the signal needs not to be transmitted up and down many times (hopping) from ground stations to ground stations using satellites as the bent pipes. On the other hand, the signal can be directly sent through the satellite constellation.

The reason why Globalstar does not have satellite cross-link capability is Globalstar's marketing strategy is to create value for service providers. All calls enter the provider's existing land-based network from the local gateway rather than bypassing the existing telephone network infrastructure. This helps Globalstar sell its concept to countries with highly restrictive telecommunication environments.

The downside of ISLs is a significant increase in system complexity, as the satellite must carry the onboard switch (or router) to handle the complexities of networking. Moreover, each satellite would need a set of adjustable cross-link antennas (typically 4 antennas per satellite) and associated receivers, transmitters and control hardware. Their positioning thrusters need more fuel than others did. Altogether, the Iridium satellites are larger, heavier, pricier, and more expensive to launch. These factors explain why Iridium has a significantly higher initial investment than Globalstar does(US $5 billions vs. US $3.8 billions).

Another key issue between these two systems is that Iridium deployed a TDMA/FDMA scheme while Globalstar deployed a CDMA technique. The big difference is CDMA/FDMA allows 4.4 trillion different codes, so different callers, even on different systems, can use the same spectrum at the same time. The time division in TDMA has to be done in one computer and these two different systems cannot use the same spectrum at the same time [9].

Ultimately, both Globalstar and Iridium's mobile satellite concepts have proven to be a viable technology by being capable of providing commercial voice, data, fax and paging communications services to their customers around the world.

4) Economic Issues

4.1 What happened to Iridium?

On November 1, 1998, Iridium's US $5 billion 66-satellite system started serving customers. In April of the following year, Iridium had signed only 10,294 voice customers and just over 2,000 pager users, out of the 200,000 projected customers for end-1998 [10]. By the end of March 1999, Iridium had substantially reduced its projected-signed customers to 27,000. In the first quarter of 1999, Iridium lost US $505 million and was unable to make payments on its US $800 million bank loan. At that point, Iridium had obtained two extensions on bank loans required that Iridium showed significant customer gains (27,000 by June 30) or risks default. Unfortunately, Iridium did not achieve the requirement. On August 1999, the Iridium LLC filed for Chapter 11 bankruptcy protection due to the lack of revenue and customers and to the overwhelming debt of US $4.4 billion [11]. Iridium had been in bankruptcy for a year and more than 30 parties had expressed interest in purchasing it with no success. The most recent failed bid came when Castle Harlan, a US investment group, walked away from its US $50 million bid in June 2000, claiming that further investigation of the company did not project recognition of even low levels of revenue [12]. Since then Motorola has gradually moved closer to going ahead with its decommissioning plan. Iridium's target market was to obtain 5 million subscribers by the end of 2002, but at the time it ceased operations, it had gathered only 55,000 subscribers [13].

4.2 Iridium's Business Failures

Iridium's market study and plan were important contributing factors to its failure. These factors include under-estimating the growth of cellular market, too narrow target markets, slow sales, the manufacturing shortfall, and shortage of fully trained sales representatives and service providers. These factors produced lower-than-expected subscribers and revenue, forcing Iridium to redirect its marketing strategy. Iridium shifted the target market from international business travelers to institutional users including government, military and industrial users such as shipping, oilrigs, or aviation, all of which need phones that work in even the most remote locations. Iridium then

began to cut the cost of handsets by two-thirds to under US$ 1,000, and cost of pagers to US$ 350, half its original cost. Retail airtime costs were slashed by 65 percent, and a flat rate was charged for international calls [14]. (These changes were implemented through arrangements with manufacturers and service providers, which might imply subsidies, payable down the line.) Although all the efforts had been done, it was not enough to increase the level of subscribers.

4.3 Iridium and Globalstar's Economic Factors

4.3.1 Initial Investment

Iridium and Globalstar's plan to design, build, market and deliver mobile satellite communications to the world was quite expensive. The Iridium project carried an initial price of US $4.5 billion supported mostly through one major investor, Motorola. Iridium's initial investment was not much higher than Globalstar's. According to the first quarter report ending March 31, 2000, Globalstar required an investment of US $3.8 billion [15]. That number continues to rise today. Deep-pocketed investors continue to pump money into Globalstar, realizing that if Globalstar fails, the money pot will dry up in the satellite industry. Primary investors include Qualcomm Inc. (San Diego, CA), Loral Space & Communications Ltd., TE.SA.M (France), Elsacom SpA (Italy) and Vodaphone AirTouch Plc (UK).

4.3.2 Target Markets

Iridium believed that most of its subscriber base would come from the business sector, especially international business travelers who would pay a premium to stay in touch anywhere in the world using voice, e-mail, fax, data, or paging services. When it became apparent that this customer base was too narrow, Iridium tried to target other markets, but it was too late.

Globalstar operates in the global telecommunications segment targeting customers who live, work or travel outside the boundaries of traditional communication networks. Globalstar's network was designed to offer a cost-effective communications network for areas under-served or not served at all. Realizing that traveling business executives alone cannot sustain a system, Globalstar has also focused on people who live in rural areas and developing countries, as well as people who work in industries out of these remote locations such as utilities, oil and gas, mining, forestry, construction, maritime and military. Globalstar estimates the potential customer base for satellite phones around the world to be 40 million [16].

4.3.3 Distribution and Marketing Strategy

Iridium's distribution strategy focused on one component, the wholesale market. Iridium used its gateway operator in each market as the exclusive distributor of its products and services. Iridium's marketing strategy was to position Iridium as the premier brand in global wireless services for its traveling businessperson market. A position it originally thought would be a formidable competitor to the cellular market.

Iridium's distribution and marketing strategies were narrower than the plan implemented by Globalstar. Globalstar's marketing strategy is to market its products and services from "high use" users to those customers who might only bill a few minutes a year. Globalstar estimated this market to be approximately 40 million users worldwide.

Globalstar's also has a more aggressive distribution plan taking advantage of the reseller channel, direct sales, cellular extension and wholesale. Outsourcing the sale of its products and services through the reseller channel puts the sales burden in the hands of businesses use to dealing with broad distribution in the consumer market. Resellers include American Wireless,

Verizon Wireless and Alcatel which have more than 1,000 points of sell in the US and strong presence overseas [17].

In addition to selling products and services through the reseller channel, Globalstar recently developed a direct marketing group to target large industrial and government accounts. Customers signing up through this channel include Qwest Communications, CNN, Italian government agencies and the Argentine Coast Guard.

Globalstar plans on taking advantage of the fast growing cellular market by marketing its product as an extension of that service. Customers that use a Globalstar phone will receive one bill from their cell provider and are charged the rate of US $1.49 per minute extra if the phone is used in satellite mode.

Globalstar also acts as a wholesaler for service providers outside the United States selling capacity on its space segment and collecting approximately US $0.47 per minute of usage [18].

4.3.4 Handset/Service Costs

Iridium's hand-held unit manufactured by Motorola and Kyocera Corporation switched between local cellular standards and the satellite system, providing voice, messaging, and paging services. Iridium's 12 gateway operator/investors sold Iridium services around the world. Satellite airtime cost US $3 per minute with a monthly service charge of US $25. Handsets sold for approximately US $3000 [19].

Currently, Globalstar has more than 143,000 handsets available from its three manufacturers, Qualcomm, Ericsson, and Telit. Although sales of handsets are slow, they have been steady. As of August 21, 2000, there were 67,000 Globalstar phones in use and 12,800 fixed phones on boats and remote buildings [20]. Subscribers to a one-year plan can purchase the phone for US $1,000, two-year plans drop the price to US $700, and subscribers who qualify as "high-use" users can purchase the phone as low as US $199. Globalstar plans on introducing 9.6 kbps data and fax service by the end of 2000 [21].

4.3.5 Alliances/Partnerships

While Iridium positioned itself as an exclusive provider serving international business travelers, Globalstar is attempting to form alliances and partnerships in other areas of the industry to better push its products into current markets and open up new markets. Partnerships have been established with cellular providers and Globalstar is also working on an In-Flight Telecom System (IFNS) to send signals between the plane and ground, providing services such as Internet access and live television [22]. Companies working with Globalstar include Aerospatiale Matra Airbus of France and Boeing Co. and Mitsubishi.

Table 2: Economic Factors Summary between Iridium and Globalstar

Factors	Iridium	Globalstar
Initial Investment	$5 billion	$4 billion
Target Markets	International Business Travelers	Business Travelers, Remote Area Business, Remote Area Residents, Developing Countries
Marketing Strategies	Wholesale, Cellular Extension	Reseller, Wholesale, Direct Sales, Cellular Extension
Alliances/Partnerships	Regional Gateway Providers	INFS, Cellular Service Providers
Handset Price	$3000	$199 - $1000
Per-Minute Charge	$3 - $7	$0.48 - $1.69
Monthly Fee	$25	$24.95 - $299.95

(5) Financial Issues

This section provides an overview of the revenue and subscriber levels that Iridium obtained in its final year of business, as well as what Globalstar estimates by the end of it's first year of operation in 2000. This information will be used to perform a break-even analysis, one of the most important metrics to measure Iridium and Globalstar's survival in MSS industry.

5.1 Iridium's Revenue/Subscribers

Iridium and its network of gateway service providers were only able to sign up 55,000 subscribers, amassing total revenue of US $30.8 million [23].

5.2 Globalstar's Revenue/Subscribers

Globalstar's revenue for the first three-quarters of 2000, was US $2,507,000, well shy of investor's original expectations of US $160 Million for the first year of operation. Disappointing revenue numbers are a reflection of Globalstar's subscriber rate. Globalstar estimates only 80,000 subscribers at year-end, 270,000 below original estimate [24]. Table 2 sums up the revenue and subscribers for year one.

Table 3: Globalstar Revenues for 2000 [13, 14, 20, 25, 26]
(Total subscribers at the end of quarter)

	1st Quarter (report)	2nd Quarter (report)	3rd Quarter (report)	4th Quarter (estimate)
Revenue	$609,000	$708,000	$1,190,000	$1,993,000
Subscribers	2,000	10,000	21,300	46,700
Billable Min.	550,000	1.14 Million	2.3 Million	3.9 Million

5.3 Break-even Analysis

5.3.1 Iridium Break-even Analysis

Iridium's US $5 billion system was too expensive to support with only 55,000 subscribers. Subscribers paid an average of US $560 per year totaling US $30.8 million in revenue. Revenue only covered 1.5% of Iridium's US $2 billion in annual expenses. At US $560 per customer, Iridium needed 3.6 million subscribers to cover its expenses, or charge each existing customer US $36,363.63 per year, clearly an unreasonable amount [6].

5.3.2 Globalstar Break-even Analysis

The break-even comparison shows Globalstar following a similar path to Iridium. Globalstar's US $4 billion system has an annual expense of approximately US $528 million [14]. Based on Globalstar's estimate of 80,000 subscribers at year's end, and US $4.5 million in revenue, the average subscriber pays only US $56.25 per year. At this rate, Globalstar needs 9.4 million customers to cover its expenses. Revenue covers less than 1% of annual expenses.

Table 4: Break-even Comparison

	Iridium	Globalstar
System Cost	$5 billion	$4 billion
Annual Expenses	$2 billion	$528 million
Annual Revenue	$30.8 million	$4.5 million
# Subscribers	55,000	80,000
Annual Revenue per Subscriber	$560	$56.25
# Required Subscribers	3.6 million	9.4 million

(6) Conclusion

After evaluating and comparing the technical, economic, and financial information presented, it is apparent to our capstone team that Globalstar **will** meet the same fate as Iridium. Globalstar originally thought that it could build a more cost-effective system than Iridium by lowering the number of satellites and not using Inter Satellite Links, however the cost of Globalstar's system is not much less than that of Iridium's system. Our comparison shows that even though Globalstar has a stronger group of investors, broader target markets, and more aggressive marketing schemes, it is failing to sign up enough subscribers to cover its operating expenses. If Globalstar cannot earn enough revenue to cover its operating expenses, its investors cannot expect return on their investment. This is the same situation Iridium found itself in and they finished in bankruptcy. Despite the poor financial numbers and our belief Globalstar will not survive, we believe investors will stick it out as long as possible, but in the end it will fail. The industry consequence is that the collapse of both Globalstar and Iridium will devastate the mobile satellite communications market, and the prospective financial investors in the industry may not be willing to risk such huge amounts of capital in the future.

References

[1] Uusitalo, M., “LEOS Systems,” http://www.tml.hut.fi/Studies/Tik-110.350/1998/Essays/leos.htm, February 2, 1998.
[2] Thurman, R. & Worfolk, P., “Commercial Constellation,” http://www.geom.umn.edu/~worfolk/SaVi/constellations.html, June 19, 1997
[3] Williamson, J., “New Horizon For Satellite Communications,” http://www.globalcomms.co.uk/technology/publicsat.htm, September 1998.
[4] Ahopelto, T., “Iridium Project,” http://www.tml.hut.fi/Studies/Tik-11.350/1998/Essays/iridium_project.html, March 15, 1998.
[5] Wood, L., “Big Leo Tables,” http://www.ee.surrey.ac.uk/Personal/L.Wood/constellations/tables/tables.html, August 17, 1999.
[6] Burton, L., Holl, B., Lopez, J. & Singletary, G., “An Analysis of Iridium,” in *Proceeding Capstone Paper*, December 12, 1999.
[7] “Globalstar links the whole world,” *China Communications*, June 1999.
[8] Megalli, M., “Low Earth Satellites and the New Universal Service,” http://fargo.itp.tsoa.nyu.edu/~megalli/leos.html, December 15, 1997.
[9] Flower, J., “Big Leo and the Dysprosium Project: The Bigfoot Mambo at the UnWired Ball,” *Wired*, vol. 2.06, November 1993.
[10] Clark, V., “No Immediate Solution for Troubled Iridium,” *Total Telecom*, April 26, 1999.
[11] “Motorola’s Iridium likely to burn,” *Chicago Sun-Times*, July 31,2000, Pg.53.
[12] Bowe, C., "$30m bid to keep Iridium’s satellites in orbit," *Financial Times*, August 29, 2000, Pg.15.
[13] Bulloch, C., “RIP for the voice-only big LEOs,” *Telecommunications magazine*, June 2000.
[14] "SEC Filings," *Edgar Online*, http://www.edgar-online.com/bin/edgardoc/glimpseFrame.asp?doc=A-1042685-0000950133-99-001138&glm=1, March 31, 1999.
[15] "Globalstar Telecommunications is getting $56 mil in new financing via share sale to five of its founders," *Space News*, October 9, 2000.
[16] Cholewka, K., "Globalstar Clears The Air," *Forbes*, June 21, 2000.
[17] Lajoie, S., "Bucking Stratospheric Failure," *Forbes*, August 21, 2000.
[18] “Iridium World Communications.” *Redherring*, http://www.redherring.com/mag/issue67/news-feature-du99-iridium.html, April 19,2000.
[19] White, M., "Satellite phone venture toils in shadow of others' failures," *Austin American Statesman*, August 11, 2000.
[20] Clonan, J., “Globalstar Third Quarter Results Show Modest Growth,” *Globalstar Press Release*, http://www.globalstar.com/EditWebNews/174.html, October 30, 2000.
[21] "Industry observers say the success of terrestrial mobile has left satellite communications providers with mere niches in which to make money," *Financial Times*, September 20, 2000.
[22] "French Unveil Inflight Cell Phone System," *Aviation Week & Space Technology*, September 18, 2000.
[23] "Globalstar tries to make satellite communications pay California firm vows it will vault same hurdles that tripped Iridium,” *The Plain Dealer*, August 13, 2000.
[24] Carroll, K., "Satellite players struggle against time," *Telephony*, June 19, 2000.

[25] "Globalstar USA lowers satellite phone prices." *Business Editors*, July 17, 2000.
[26] "Building a global communications network." *Patriot News*, August 11, 2000.