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Satellite Communications Industry

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Abstract

Satellite Communications Industry

by

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This paper documents a baseline assessment of the Satellite Communications Industry which is defined as companies that:

1. Build communications satellites.
2. Build communications satellite earth terminals.
3. Provide satellite communications services.

The assessment uses the standard analysis tools of Structure, Conduct, and Performance to evaluate the current health of the industry, and includes a discussion of the outlook for the industry, the industry's strategy for survival, and government policy recommendations.

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Satellite Communications Industry
An Assessment

"For 30 years the United States has enjoyed a positive global balance of trade as well as the undisputed title of heavy-weight technology and reliability champion in the international business of commercial, military, and government communications satellite manufacturing."[1] The question is; Are the 30 years of United States communications satellite manufacturing dominance threatened?

Before answering this question I should explain two things:

- Why the Department of Defense(DOD) should care about the health of the U.S. Satellite Communications Industry and
- What constitutes a Threat to a Defense Industry?

Why the Department of Defense(DOD) should care about the health of the U.S. Satellite Communications Industry

Communications are essential in any military operation. Rapid, reliable, and secure communications represent a dramatic force multiplier, and recent conflicts in Grenada, Panama, and the Persian Gulf have highlighted our successes, and failures, in this critical area. Due to the nature of modern warfare, mobility of forces is the key to success, and world wide mobile communications are best provided via satellite. Without belaboring the point, for military operations, satellite communications will become more and more critical to national defense in the future.

Given the criticality of satellite communications, it follows that in order to maintain our current position of military technological leadership in this area, we must have a healthy Satellite Communications Industry. A healthy industry provides DOD with quality production and services with reasonable cost, technological sophistication, and the ability to surge needed products and services. DOD gains immeasurably when the private sector is a large competitive commercial marketplace which drives innovation. For example, DOD Research and Development (R&D) funding in the early days of the computer revolution may have been a driving force behind technology advancement however, the recent technological advances experienced in the micro-processor industry have occurred because of the large competitive commercial marketplace for micro-processors. As a result, DOD has been able to incorporate advanced micro-processors into new weapons without continued large investments in basic research. Market forces are just starting in the Satellite Communications Industry, and there is potential for great commercial activity which would ensure a healthy industry. This is especially important during the currently planned military drawdown, because increases in defense spending for satellite communications are unlikely.

What constitutes a Threat to a Defense Industry?

A U.S. Defense Industry can be threatened in two ways. The first is when there is no commercial market for it's product (such as tanks) and DOD does not buy in sufficient quantities to maintain production capability. The second (and the one that might apply to the U.S. Satellite Communications Industry) is when a commercial market exists, but foreign manufacturers gain a competitive advantage which could drive U.S. Industry out of the commercial market. This would cause a loss of efficient production capability, and might lead to a complete loss of production capability. The significance of the loss of domestic commercial production capability must be viewed with DOD's goal of "achieving the best "value" for the lowest cost in mind. Value in this case is defined according to three criteria, peacetime production efficiency, technological competitiveness, and surge and mobilization flexibility"[2]. Foreign suppliers can efficiently produce technically competitive products. However, foreign source dependence may reduce the U.S. Military's technological lead and control, and surge and mobilization capabilities are obviously degraded.

Are the 30 years of United States communications satellite manufacturing dominance threatened?

The short answer is that the early signs of a loss of dominance are starting to appear and if current trends continue the U.S. will eventually lose it's dominant position. In order to reach this conclusion it was necessary to conduct a baseline assessment of the industry. The purpose of this report is to document the baseline assessment using the standard analysis tools of Structure, Conduct, and Performance, followed by a discussion of the outlook for the industry, the industry's strategy for survival, and finally government policy recommendations which if implemented would help maintain the industry's position of dominance into the 21st century.

Definition of the Satellite Communications Industry

Although most people have an intuitive sense of what satellite communications are, a clear definition of the industry is in order. The Satellite Communications Industry consists of companies that:

1. Build communication satellites.

2. Build communication satellite earth terminals(i.e. antennas and radios).

3. Provide satellite communications services (i.e. companies that own and operate satellites). Satellite communications services consist of international telephone services, cable TV transmission services, mobile radio services, private satellite networks, and international maritime telephone services.

Due to the nature of this industry Standard Industry Codes (SICs) do not correlate to the industry directly. Satellite services fall within SICs 4812,4813,4822 and production of satellites and earth terminals fall within SIC 36631.38. Further the types, and numbers, of companies building satellites are entirely different from those building earth terminals. I will try to illuminate these differences whenever it is relevant to a clearer understanding of the industry.

Historical Overview of an Industry in Transition

The commercial Satellite Communications Industry can trace it's roots back to 1962, when President Kennedy proposed the creation of a global commercial satellite system. From then until 1984 virtually all international satellite communications was conducted through the International Telecommunications Satellite Organization (INTELSAT), or the International Maritime Satellite Organization (INMARSAT). These organizations are characterized by international consortiums, government bureaucracies, or government regulated monopolies. They provide universal access to satellite communications for all member nations (INTELSAT has approximately 119 members). The Communications Satellite Corp. (COMSAT) was formed by Congress as a private company to act as the U.S. participant in the global system, and today it is the largest owner and user of the INTELSAT and INMARSAT satellite communications networks.

In 1984, President Reagan determined that international communications satellite systems separate from INTELSAT/INMARSAT would be allowed, if they were not attached to the Public

Switched Telephone Network (PSN), and foreign authorities agreed to allow them (on a country by country basis). This decision effectively opened up international satellite communications for commercial development, and the Pan American Satellite system (PANAMSAT), the first international commercial communications satellite system separate from INTELSAT/INMARSAT, was established shortly thereafter. This first separate system has been a commercial success, and other separate systems are currently in various stages of development. In April, 1992 the federal government decided to allow separate satellite systems to connect to the PSN thus taking another step toward deregulation and increased competition in the industry.

In addition to the regulatory changes taking place there are numerous technological changes taking place. Micro electronics are enabling dramatic reductions in size, weight, and cost of both satellites and earth terminals; thus opening up numerous new applications for satellite communications. These include cellular telephone to satellite communications, airplane to satellite communications, and direct broadcast audio (i.e. commercial radio via satellite) and video (i.e. commercial broadcast TV via satellite).

The U.S. became the dominant force in the world in Satellite Communications because of large capital investments by DOD and the National Aeronautics and Space Administration (NASA) which were a direct result of the "Cold War" and the "Space Race". This gigantic effort started in October of 1957 following the launching of Sputnik 1, and continued until the recent collapse of the Soviet Union. The spin off from this effort put U.S. companies years ahead technically and gave them a tremendous competitive advantage in the commercial market place. The question is, in an environment where DOD and NASA are not investing in Satellite Communications at an ever increasing rate can U.S. satellite companies successfully adapt and maintain their position of dominance.

In summary, the Satellite Communications Industry is transitioning from expensive technology to less expensive technology, from limited commercial applications to unlimited commercial applications, from a highly regulated industry to a less regulated more competitive industry, and from an industry where technical advances are driven by DOD and NASA to an industry where technical advances are driven by the commercial market place.

Structure

Number of Sellers-Satellites

There are three major companies that build commercial communications satellites in the U.S., they are General Motors'(GM) subsidiary GM Hughes Electronics, Space

Systems/Loral, a subsidiary of New York's Loral Corp, and GE Aerospace which has recently been sold to Martin Marietta. In addition to these three companies, there are companies, such as Lockheed Missiles and Space Group, and Rockwell, that currently only build satellites for DOD. As shown in appendix A, U.S. firms have contracts to build approximately 60% of the commercial satellites on order world-wide as of November 1992. The top three U.S. firms have contracts for 98% of these, which means this segment of the industry is highly concentrated.

There are 11 foreign companies that build satellites however, as shown in appendix A, virtually all satellites built by these companies are sold to their own government. In fact, U.S. companies are the only ones that have successfully marketed satellites outside their own national region to any large degree (i.e. the U.S. has sold satellites to Japan, and the European community, but not vice versa).

The U.S. companies are subsidiaries of larger diversified electronics firms. As a typical example of size, GE Aerospace has 37,000 employees, had 1992 revenues of $5.2 billion, net profit of $420 million, and does a diversified business in radar, sonar, Navy Battle Management computers, weather satellites, NASA spacecraft, and Star Wars research, in addition to commercial communications satellites.

Number of Sellers-Satellite Communications Services

There are currently six major commercial firms that operate commercial communications satellite systems in the U.S., they are Hughes Communications Inc (HCI), Alascom Inc, GTE Spacenet, GE American Communications Inc (GE Americom), AT&T, and Communications Satellite Corp. (COMSAT General). Based on currently planned launches, this number will grow to thirteen within the next few years.

Types of Buyers-Satellites

Buyers of satellites include various departments of the U.S. government (i.e DOD, NASA, etc), foreign governments, and commercial satellite services companies in the U.S. and abroad. Exact figures on sales to DOD are unknown however, based on the telecommunications industry as a whole at least 50%, and perhaps as high as 75%, of the total sales of the three largest satellite producers are to DOD. This includes satellite and non-satellite sales. As an example, 54% ($6.2 billion) of GM Hughes Electronics total sales in 1991 was to DOD. The unclassified DOD communications satellite business for fiscal years 1990 to 1992 is shown in table 1, which indicates a steady increase in procurement of satellites, earth terminals, and Research and Development (R&D). This trend will probably level out, however, because of the increased need for accurate intelligence in future military operations it will probably not go down. In terms of satellite sales (not counting classified satellite R&D and procurement) about 20% of the industry output is sold to DOD, and 75% of DOD expenditures are for R&D. The number of U.S. companies that own, or are in the process of buying, commercial satellites is increasing from 6 to 13 as plans for new mobile satellite services and direct-to-home satellite broadcasts are implemented.

Types of Buyers - Satellite Communications Services

There is a wide and growing number of buyers of satellite communications services. They include telephone companies (local and long distance), trucking companies (2,000 trucks were equipped with satellite transceivers in the U.S. in 1991), shipping companies and private vessel owners (there are approximately 14,000 earth terminals installed on vessels), private businesses such as United Parcel Service, and DOD (INMARSAT earth terminals have been installed on over 100 U.S. Navy ships and usage has increased to from 24,974 voice minutes in 1989, to approximately 730,878 voice minutes in 1992).

Unclassified DOD Communications

Satellite Business[3]

(In Millions)

	90	91	92
Satellites-procurement	$48.2	$257.4	$375.8
R&D	471.0	809.4	1,125.0
Earth Terminals-Procurement	88.5	239.1	221.4
R&D	350.8	148.4	383.4
Total Procurement	136.7	496.5	597.2
Total R&D	821.8	957.8	1508.4
Total	958.5	1,454.3	2,105.6

TABLE 1

Barriers to Entry-Satellites

Building satellites requires a high degree of technical expertise and specialized facilities such as climate controlled assembly rooms. As a result, most companies that enter the commercial market do so only after they have had satellite development contracts with NASA, or DOD. However, there are companies that currently only build satellites for the government, such as Rockwell (which built the GPS satellite system) and Lockheed Missiles and Space Group, that have the capability of entering the commercial market as prime contractors, or in teaming arrangements.

Barriers to Entry - Satellite Communications Services

The primary barrier to entry is the capital cost of building new satellite networks. For example, Motorola is in the process of acquiring a license from the Federal Communications Commission (FCC) for a new system called IRIDIUM, which would include about 77 satellites. The estimated cost of this system is over $3.0 billion, and finding that much venture capital is not expected to be easy. Another example of the high cost of entry is GM Hughes Electronics investment of $500 million to launch a 150-channel satellite TV network in 1993.

Another barrier to entry is the regulatory environment. A company must get government approval to operate and both the U.S. and foreign governments have been reluctant to approve systems separate from the international systems (See government regulation-satellite communications services for further details).

Acquiring launch services can also be a barrier to entry especially for companies that do not produce launch vehicles because of the expense and long lead times involved in the scheduling process.

Conduct

Pricing Policies-Satellites

Historically, most satellite sales have been to government organizations, and the INTELSAT treaty guarantees open procurement on government owned systems to all suppliers. However, the number of suppliers was relatively small so prices were basically set by the manufacturers. This situation has changed. Market forces are becoming more and more important in setting prices for two reasons. First, the number of manufacturers, especially overseas is increasing and second, the number of domestic and international buyers is increasing. This has resulted in a reasonably free world market with market based prices.

DOD acquisition policies have had a major impact on the industry because of the historically large percentage of sales to DOD. For example, Hughes builds all it's satellites, commercial and military, to the same Military Specification (MIL SPEC) requirements, and according to at least one industry analyst "this approach has enabled Hughes to cut costs by establishing stable and long-term relationships with suppliers and component manufacturers; these reductions have more than offset increased costs associated with the company's gold-plated approach to all procurement."[4] It is not clear how long a gold-plated approach to building commercial satellites will work in a truly international competitive commercial market place.

In addition, DOD has provided, through classified and unclassified programs, capital facilities which made U.S. firms more competitive. The competitive advantage provided by working on government programs will gradually diminish as more and more sales are generated by the commercial sector, especially if DOD and NASA programs are reduced.

Pricing Policies-Satellite Communications Services

Pricing policies for satellite communications services are increasingly being set by the market. There is competition between satellite service providers and there is competition between satellite service and other media; for example, fiber optic telephone links are in direct competition with satellite telephone links. As a result, services must be competitively priced in order to gain, or keep, market share. In fact, fiber optic cables are already replacing satellite links for fixed telephone communications due to reduced costs and increased bandwidth. The last bastion of regulated pricing is in the international market place where rates are still controlled by international treaty and foreign governments.

Management and Labor practices-Satellites

These are fairly large high-tech companies which have done business with DOD for a long time, and to a large degree they have acquired the "bad habits" the association entails. They are not used to marketing in the commercial market place, and they are not used to investing heavily without a defense contract in place. They are used to down cycles in defense and they have demonstrated the ability to downsize. Of all the major defense contractors those producing commercial satellites (i.e. GE Aerospace/Martin Marietta, GM Hughes Electronics, and Loral) have demonstrated the ability to evolve into non-defense business effectively, at least while DOD and NASA was providing significant funding for their defense business. Revised management approaches will be required for these companies to be successful in the future because of the impact of reduced defense spending.

There are various labor unions with memberships in the plants in this industry. However, labor unions do not appear to pose a problem for the industry.

Government Regulation-Satellite Communications Services

Government regulation plays a major role in the industry. In order to operate a company has to obtain an FCC license and an agreement with at least one foreign government in the case of international communications. In the past, both the U.S. and foreign governments have been reluctant to approve systems separate from the international systems like INTELSAT, because of the changes in pricing policies competition could cause. It was felt that competition could cause INTELSAT to abandon its global cost averaging pricing policy, which could have a detrimental effect on developing countries which have limited or no alternatives to INTELSAT. These issues are slowly being resolved, and an orderly transition to a less regulated industry is underway along the same path that deregulation of the telephone industry is following.

A separate but related area of regulation is frequency spectrum allocation. Obviously the FCC must control the RF spectrum in order to prevent interference between systems. However, according to several commercial firms, the spectrum currently available to the commercial sector is not large enough, and the process to allocate and reallocate available spectrum is inefficient. These issues are receiving Congressional attention in both houses. The Congress intends to transfer about 200 megahertz (MHZ) of spectrum from the federal government to non-federal users. The problem is how and/or who to allocate the spectrum to. The Senate bill proposes to auction the spectrum through a competitive bidding process, while the House of Representatives bill does not propose any changes to the current

FCC lottery system. The fact that issues of this nature have to be solved in Congress is an indication of how ineffective our current regulatory environment is.

Basic satellite communications technology is not classified and can be sold on the commercial market. However, a great deal of the technology developed for DOD is classified and must be controlled. As a result, this technology is not available for sale, and the companies involved can not make additional revenue beyond that provided by DOD. Without getting into the details on what should or shouldn't be classified, or how well the government limits foreign sales it is clear that this type of policy is necessary in the interest of national security. The important point is that the skills acquired, and the products produced, do not translate one for one into the commercial sector, and if DOD does not continue to invest in the classified high-technology areas of satellite communications the people and skills required to produce this technology will transition to some other type of work in the commercial sector.

Another government policy change allowing INMARSAT terminals on U.S. Navy ships in 1989 has affected the industry. In fact the Navy's current plan is to transfer administrative traffic from military systems to commercial systems in order to reduce the current overloads on Navy satellite systems. This change in policy has effectively redirected Navy funding from the development of military satellite systems to the development of commercial satellite systems, because to the extent that commercial systems can meet the needs of the Navy additional military systems will not be developed.

Research and Development (R&D) Expenditures-Satellites

DOD expenditures for satellite R&D have grown steadily over the last 3 years. This trend will probably flatten over the next few years as DOD budgets are reduced. However, because of the critical nature of mobile communications, funding in this area will probably not be reduced as much as many other areas. The companies involved in building satellites are acutely aware of the importance of R&D, and are taking steps to ensure they are capable of conducting meaningful R&D. For example, Hughes is consolidating its missile plant with the four it acquired from General Dynamics in order to have enough platforms to spread R&D expenses, and Martin Marietta got access to GE's corporate R&D center as part of the acquisition of GE Aerospace.

A recent (5 FEB 93) NASA/National Science Foundation (NSF) Conference on "**Satellite Communications In Europe, Russia, and Japan**" documented a disturbing trend in Satellite Communications R&D. Some of the preliminary results of the studies presented at the conference are contained in Appendix's B, C, D, and E. Appendix B documents the fact that Japan has seven Satellite Communication Development projects ongoing compared to three for the U.S.. Appendix C documents the fact that from 1976 to 1994 Japan launched 12 Communications R&D satellites compared to none for the U.S.. Appendix D documents a Comparative Analysis of Key Satellite Technologies which shows Japan surpassing the U.S. in 17 out of 18 key satellite technologies by the year 2003. Appendix E documents those Satellite Communications Technology areas where the U.S. leads (4), is tied (6), or lags (9) the rest of the world. These are preliminary results however, if the trends documented are accurate, and continue, there is no doubt that our competitive advantage will be gone by the year 2003.

Capital Investment-Satellites

Capital investment by the companies that build satellites has been relatively flat over the last few years. These companies are not reducing capital investment rapidly, like the rest of the defense industry, primarily because of the relatively optimistic outlook for their segment of the defense budget, and the optimistic outlook for commercial satellite communications.

Capital Investment-Satellite Communications Services

Capital investment by the companies that provide Satellite Communications Services is increasing. GM Hughes Electronics through it's service company HCI has invested $500 million to launch a 150-channel satellite TV network in 1993. Motorola is in the process of investing $3.0 billion in it's IRIDIUM satellite system, and COMSAT is investing in new technologies in order to bring the quality of it's satellite transmissions closer to that of fiber-optic cable.

Mergers and acquisitions-Satellites

All three of the major companies involved in building satellites have undergone major consolidations in the last few years. These mergers are indicative of the broad restructuring of the defense industry. For example, Martin Marietta acquired GE Aerospace for $3.0 billion in November, 1992. This move will enable Martin Marietta to combine its Titan rocket boosters with GE's communication satellites, which should give the company an edge in future marketing efforts.

Performance

Trends in Sales/Shipments-Satellites/Earth Terminals/Satellite Services

Revenues from the sale of complete satellite systems (including satellites and earth terminals) and the sale of satellite services are increasing as shown in the following table.

Revenues	90	91	92
Satellites	$1.86B	$2.1B	$2.7B
Satellite Services	$800M	$1.2B	$1.35B

Shipments of satellites will increase from 9 in 1990, to 13 in 1994. U.S. companies are under contract to deliver 57 satellites between 1992 and 1997 (24 for domestic companies, 11 for INTELSAT/INMARSAT, and 22 for foreign customers). These numbers are for large geo-stationary satellites. If the license for the IRIDIUM system, which consists of about 77 small, light, low earth orbit satellites is approved, Motorola could start launching numerous satellites (i.e. 6 per launch) in 1994. The potential market for small, light, low earth orbit satellites is estimated at about 180 satellites (worth well over $4.0 billion) based on license applications and constellation proposals currently before the FCC. Sales of earth terminals are also expected to grow. For example, INMARSAT terminal use is expected to grow from approximately 19,000 in 1992 to 235,000 in 1995.

Trade Restrictions, quotas, subsidies and calls for protection

The satellite communications industry is a good example of why the U.S. generally favors free trade. Because of the U.S. position of dominance in this industry, foreign companies have used their influence on foreign governments to restrict trade with U.S. firms. In order to successfully compete, U.S. firms generally have teamed with foreign companies in order to get licenses to operate. On at least one occasion The United States Trade Representative has intervened on behalf of U.S. companies to ensure fair trade practices in Japan. This effort resulted in a U.S.-Japan Satellite agreement that ensures all Government of Japan procurement of non-R&D satellites is open to non-Japanese companies.

Trends in Productivity - Satellites

U.S. productivity will increase as satellite sales increase over the next few years. However, U.S. productivity may not increase as quickly as productivity in Japan because of a relatively low number R&D projects underway in the U.S. compared to Japan (See Appendix B & C). As a result of large reductions in defense business all three companies (GM Hughes Electronics, GE Aerospace/Martin Marietta, and Loral) are in the process of consolidating and downsizing. For example, Hughes will shed at least 7,000 workers in 1993. This type of downsizing will increase productivity in the short run, on paper at least.

Trends in Productivity - Satellite Communications Services

Companies providing satellite services are attempting to increase productivity through reorganizations and downsizing. For example, COMSAT will shed 300 of its 1,600 workers as part of management's effort to streamline the company. As more domestic companies enter this market increased competition will force companies to streamline their operations in order to stay competitive.

Cost of Products - Satellites

Although satellites are not mass produced like automobiles, the cost of manufacturing is being reduced because the cost of components is going down, and the volume of sales is increasing. This trend should continue over the next 5 years. As shown in appendix A, commercial communications satellites cost between $25 million and $175 million.

Cost of Products - Satellite Communications Services

The cost of Satellite Communications Services is going down steadily, and this trend should continue over the next 5 years as more systems become available. For example, the INMARSAT rate for ship-shore telephone calls charged to the U.S. Navy prior to 1 January 1991 was $10.00/minute. Since that time the rate has decreased to it's current rate of $6.25/minute. This rate should continue to decline as usage increases and additional INMARSAT satellites are launched over the next few years.

Quality of products-Satellites/Earth Terminals

U.S. companies are acknowledged world-wide as high quality producers of communications satellites and earth terminals. Unfortunately, the quality gap between U.S. and foreign satellites is narrowing, and it is anticipated that foreign satellites will be on a par with those produced in the U.S. within about 5 years.

Exports-Satellites/Earth Terminals

The U.S. is a net exporter of communications satellites as shown in the following table.

	90	91
Satellite-Exports	$643M	$600M
Satellite-Imports	$20K	$20K

This trade surplus is due to the industries lead in advanced technology, which is a result of past R&D investments by DOD and NASA. In addition, the U.S. market for commercial systems was deregulated early which has provided U.S. manufacturers more experience in the commercial market than their foreign competition. However, the early warning signs of future problems are already starting to appear, as manufacturers from the Asia-Pacific region (which has 15 communications satellites in orbit) have made substantial inroads in the lower technology Television Receive Only (TVRO) terminal market. In fact, the U.S. experienced a $19.0 million trade deficit for TVROs in 1991, and when final figures are published the deficit for 1992 will be even greater.

Profitability-Satellites

The three major companies (GM Hughes Electronics, GE Aerospace/Martin Marietta, and Loral) that produce satellites are reasonably profitable, especially when compared to other defense companies. The following table shows some key financial indicators[5].

	Hughes	Martin Marietta	Loral
Financial Strength	A	A	B++
Safety	Average	Above Average	Above Average
P/E Ratio	12.4	9.1	10.0
Beta	.80	.90	.80
Dividend Yield	2.8%	2.4%	2.2%

Profitability-Satellite Communications Services

Headlines such as "Investors Propel Comsat Shares to a 21-Year High", and "Orbital Sciences..Profits Up" attest to the fact that the companies in this sector are making solid profits in general. COMSAT is the company most directly aligned with satellite communications profitability, and the rapid growth of it's mobile communications business is one of the major reasons for it's recent growth in earnings. Mobile communications, which now account for about 25% of company revenue, are growing at approximately 25% a year. International telephone calls routed through COMSAT's satellites grew 16% in 1992[6]. This trend should continue because maritime and airplane uses of mobile communications are not subject to competition from fiber-optic cable services.

Outlook

The outlook for the U.S. satellite communications industry is optimistic. The industry's current technological advantage should ensure international dominance for at least 5 years according to Department of Commerce sources. The world-wide market for communications satellites, and satellite communications services should experience steady increases through the 1990's. The new light satellite low earth orbit technology could result in an enormous market with the potential for as many as 180 new satellites. These new commercial markets should provide those companies currently working solely on DOD contracts a reasonable chance of successfully converting to commercial efforts, and ensure a healthy industry. However, even this industry is not immune to outside threats.

Is Japan a current threat to the U.S. Satellite Communications Industry?

Foreign threats to the health of the U.S. Satellite Communications Industry could come from three directions; Europe, Russia, and Japan. This paper only addresses the possible threat from Japan, due to the historical fact that Japanese industry has proven itself more capable of devastating U.S. industrial capabilities (i.e. color TVs and VCRs) than Europe or Russia. To constitute a current threat to the U.S. Satellite Communications Industry Japan would have to satisfy two conditions:

- Be able to produce satellite communications technology which is as good as, or better than, that which can be produced in the U.S., and

- Implement business strategies based on unfair trade practices such as dumping, predatory pricing, and closed Japanese markets.

With regard to the first condition, evidence indicates that Japan will continue to invest heavily in space technology. In fact, the next satellite in it's Engineering Test Satellite (ETS) series is scheduled for launch in 1993. This satellite will test technologies for advanced satellite communications, including fixed and mobile satellite communications, and laser communications. It is clear that "Japan is proceeding along a carefully planned path to become a world-class spacefaring nation.... and.... several of Japan's largest high-technology companies have organized consortia to conduct complementary research and development into innovative space technology"[7].

Currently Japan's policy is to cooperate with other space powers however, there is little doubt that the Japanese will eventually attempt to enter the marketplace on their own. In fact, U.S. companies are contributing to this process through cooperative efforts with Japanese companies in the manufacture of satellites the U.S. has sold to Japan.

The inevitable conclusion one must draw is that Japan intends to be able to manufacture communication satellites that are as good as, or better than, those made in the U.S..

With regard to the second condition, it appears that Japan is not allowing, or encouraging, unfair trade practices in the satellite communications industry at present. The 15 June 1990 U.S.-Japan Satellite agreement requires that all Government of Japan procurements of non-research and development satellites are open to non-Japanese companies. This agreement also covers procurement by Nippon Telegraph and Telephone (NTT) Corporation (Japan's largest telecom company), and Nippon Hoso Kyokai (NHK) Corporation (Japan's national broadcaster). Based on the results of two satellite procurements concluded since this agreement, it appears Japan is complying with the terms of the agreement, however, based on the experiences of a prominent U.S. Trade Representative "they may be buying American technology to keep up, and their core attitudes toward international trade have not changed." Obviously the question is; what will they do after they catch up with the U.S. capability? and what can, and should, the U.S. do to keep them from catching up and devastating the U.S. Satellite Communications Industry?

In summary, **Japan is not currently a threat to the U.S. Satellite Communications Industry** for two reasons, first it does not have the manufacturing capability to build satellites as well as the U.S., and second it is not practicing unfair trade with the U.S. in this area. However, if current trends continue, Japan could become a threat within 5 years.

Satellite Communications Industry Strategy for Survival

Although the future of the commercial Satellite Communications Industry is optimistic the overall health of the companies that produce satellites is not as clear. This is because GM Hughes Electronics, GE Aerospace/Martin Marietta, and Loral are all defense contractors and DOD's shrinking budget will force them to make numerous strategic adjustments in order to survive and prosper. One possible strategy for survival would be to diversify into non-DOD business. However, according to Norm Augustine of Martin Marietta "In down cycles, and I've lived through three, the traditional solution is to diversify into things far away from defense, that has always failed".....“He recommends, instead, gradually moving into commercial markets that take advantage of a defense contractor's core competencies."[8].

The satellite manufacturers have all adopted the same basic strategy for survival. They have all acquired through acquisition larger stakes in their key defense businesses, and they are in the process of consolidating these acquisitions. This process has resulted, or will result, in significant downsizing over the next few years. In addition, all three companies are in the process of evolving into non-defense business. Each company's specific strategy follows:

- GM Hughes Electronics is consolidating it's missile plant with the four it acquired from General Dynamics, and will shed 7,000 employees in 1993. In an attempt to expand into non-defense business it has invested $500 million to launch a 150-channel TV network in 1993. In 1965, 100% of GM Hughes Electronics satellite sales were to the government, today 50% of sales are commercial and they have expanded into providing commercial satellite services.

- Martin Marietta is in the process of acquiring GE Aerospace which will enable it to combine it's titan rocket boosters with GE's communications satellites which should give the merged companies an edge in future marketing efforts. Martin Marietta is also in process of downsizing and has shed 14,000 employees since 1987. In the last 3 years Martin Marietta has won contracts for more than $7.0 billion in non-defense business, and it's goal is to generate 50% of it's revenue from non-defense business by 1997.

- Loral has spent $1.8 billion to buy 6 high-tech military businesses including Ford Aerospace and LTV's missile division and more acquisitions appear likely. It's strategy is to have a diverse program base and focus on upgrading existing defense systems versus new development.

The strategy's for survival in this industry look appropriate based on current projections for DOD expenditures, and the outlook for commercial satellite sales. These companies should survive the current defense drawdown. Unfortunately, the employees of these companies can take little comfort from this fact because the price for survival will be severe personnel cuts.

Government Policy Recommendations

Given the optimistic outlook for the Satellite Communications Industry, and the satellite manufacturer's strategy for survival, urgent government action to support this critical industry is not required. However, this paper has documented four early warning signs that indicate trouble in the future if current trends continue, they are:

1. The U.S. is losing it's technical leadership position.

2. Foreign manufacturers have penetrated the low-tech end of the equipment market.

3. DOD's R&D investment rate is not increasing as it did in the past.

4. The FCCs current spectrum allocation procedures are ineffective.

In order to maintain the United States current position of dominance in this industry in the future the government must:

- Continue to encourage the deregulation and commercialization of international satellite communications.

- Develop flexible and efficient frequency spectrum allocation procedures.

- Invest heavily in both commercial, DOD, and NASA related R&D, and encourage private companies to transition promising technology into efficient production prior to sharing it with potential foreign competitors.

- Maintain careful vigilance and ensure our trading partners do not practice unfair trade.

It is clear that U.S. military communications superiority is based on the U.S. Satellite Communications Industry. Successfully implementing these policies will create an environment in which innovative, aggresive, and well managed U.S. Satellite Communications companies can prosper.

End Notes

1. Scot Chase, "The U.S. Satellite Manufacturers," VIA SATELLITE, (September, 1991), p.40

2. "Deterrence in Decay: The Future of the U.S. Defense Industrial Base", Center for Strategic & International Studies Washington, D.C.

3. Space Business Indicators June 1992, (U.S. Department of Commerce, June, 1992), p.38-39

4. Scot Chase, "The U.S. Satellite Manufacturers", VIA SATELLITE, (September, 1991), p.46

5. Value Line, (January, 1993)

6. Washington Post Article of 20 Feb 1993

7. "Rising Sun Heads for Moon As Japan Plies High Ground", Signal, (April,1992), p.23

8. Nancy J. Perry, "What's Next for the Defense Industry", Fortune, (February 22, 1993), p.98

APPENDIX A.

COMMERCIAL SATELLITES ON ORDER (97)*
(By Prime Contractor)

UNITED STATES (57 or 58.7%)

tellite:	Prime:	Customer:	Launch:	Launcher:	Value:
Adv Comm (DBS)	GE	Advanced Comm	/95		
AFRISTAR 1 (DAB)	ITI/DSI	Afrispace	/94	PRC	$40??
AP-SAT	Hughes	AsiaPacific Sat/HK	06/94	PRC	$140m
ARABSAT 1	Hughes	ARABSAT	/95		$100m
ARABSAT 2	Hughes	ARABSAT	--	(spare)	$100m
ASTRA 1C	Hughes	SES/Luxembourg	04/93	Ariane	$100m
ASTRA 1D	Hughes	SES/Luxembourg	06/95	Ariane	$100m
Brasilsat B1	Hughes	EMBRATEL	04/94	Ariane	$100M
Brasilsat B2	Hughes	EMBRATEL	10/94	Ariane	$100M
BS-3N	GE	NHK (Japan)	/93		$50m
Caribsat (DAB)	ITI/DSI	Afrispace	/95	PRC	$40??
Continental (DBS)	Loral	Continental	/95		
DirectSat1 (DBS)	GE	Direct Broadcast Sat	/95		
DirectSat2 (DBS)	GE	Direct Broadcast Sat	/95		
DirecTV 1 (DBS)	Hughes	HCI/USSB/Hubbard	12/93	Ariane	$150m
DirecTV 2 (DBS)	Hughes	HCI/USSB/Hubbard	/95	Ariane	$150m
Dominion (DBS)	GE	Dominion Video	/95		
EchoStar 1 (DBS)	GE	Echosphere	/95		
EchoStar 2 (DBS)	GE	Echosphere	/96		
EchoStar 3 (DBS)	GE	Echosphere	/96		
EchoStar 4 (DBS)	GE	Echosphere	/97		
EchoStar 5 (DBS)	GE	Echosphere	/97		
EchoStar 6 (DBS)	GE	Echosphere	/98		
EchoStar 7 (DBS)	GE	Echosphere	/98		
lipso 1 (6 LEO)	Fairchild/IAI	Ellipsat			
lipso 2 (18 LEO)	Fairchild/IAI	Ellipsat			
Galaxy 4	Hughes	Hughes Comm.	12/92	Ariane	$150m
Galaxy 8	Hughes	Hughes Comm.	04/93	Ariane	$150m
Galaxy (Ku)	Hughes	Hughes Comm.	12/92	Ariane	
GlobalStar(24RDSS)	Loral	Loral/Qualcom	/97		
IndoStar (DBS)	Intl Tech (ITI)	PT MediaCitra (Indonesia)			$88m
INMARSAT 3 F1	GE/Marconi	INMARSAT	/94		$88m
INMARSAT 3 F2	GE/Marconi	INMARSAT	/94		$88m
INMARSAT 3 F3	GE/Marconi	INMARSAT	/95		$88m
INMARSAT 3 F4	GE/Marconi	INMARSAT	/95		$88m
INTELSAT 7 F1	Loral	INTELSAT	10/93	Ariane	$100m
INTELSAT 7 F2	Loral	INTELSAT	02/94	GD	$100m
INTELSAT 7 F3	Loral	INTELSAT	08/94	GD	$100m
INTELSAT 7 F4	Loral	INTELSAT	06/96	Ariane	$100m
INTELSAT 7 F5	Loral	INTELSAT	/95		$100m
INTELSAT 7A F6	Loral	INTELSAT	/93	PRC	$100m
INTELSAT 7A F7	Loral	INTELSAT	/95		$100m
INTELSAT 7A F8	Loral	INTELSAT	/96		$100m
INTELSAT 8A	GE	INTELSAT	/95		$100m
INTELSAT 8B	GE	INTELSAT	/95		$100m
IRIDIUM (66 LEO)	Lockheed	Motorola	/94		
LDBS 1	Loral	Local-DBS	/95		
LDBS 2	Loral	Local-DBS	/96		
LDBS 3	Loral	Local-DBS	/97		
MEASAT	Hughes	Bina Riang (Malaysia)	/95	Ariane	$25m
xico (DBS)	GE	SCT (Mexico)	/95		

* **Includes commercial communications satellites already awarded to a prime contractor, but not launched as of November 23, 1992.**

Continued.....

UNITED STATES (Cont'd)

Satellite:	Prime:	Customer:	Launch:	Launcher:	Value:
MSAT 1	Hughes/Spar	Telesat Mobile	05/94	Ariane	$100m
MSAT 2	Hughes/Spar	AMSC	/95	GD	$100m
Mugunghwa 1	GE	Korea	04/95		$145m
Mugunghwa 2	GE	Korea	10/95		$145m
N-Star	Loral	NTT	06/95	Ariane	$175m
N-Star	Loral	NTT	10/95	Ariane	$175m
Odysssey	(12 LEO RDSS)	TRW	/96		
Orbcomm	(20-24 LEO)	Orbital Sciences			
OPTUS B2	Hughes	AUSSAT	12/92	PRC	$100m
Pacifcom 1	TRW	TRW	/95		$70m
PanAmSat1 (POR)	Hughes	PanAmSat	04/94	Ariane	$100m
PanAmSat2 (AOR)	Hughes	PanAmSat	12/94	Ariane	$100m
PanAmSat3 (IOR)	Hughes	PanAmSat	03/96	Ariane	$100m
SAJAC 1	Hughes	Satellite Japan	06/94		$150m
SAJAC 2	Hughes	Satellite Japan	--	(spare)	$150m
SatcomH1	GE	GE Americom	/95		$50m
SOLIDARIDAD 1	Hughes	SCT (Mexico)	11/93	Ariane	$100m
SOLIDARIDAD 2	Hughes	SCT (Mexico)	/94		$100m
Superbird A1	Loral	Space Com Gp (Jap)	11/92	Ariane	$175m
Superbird C	Loral	Space Com Gp (Jap)	/94		$100m
Telstar 401	GE	AT&T	10/93	GD	($80m)
Telstar 402	GE	AT&T	/94	GD	($80m)
Telstar	GE	AT&T	--	(spare)	($80m)
Tempo (DBS)	Loral	Tempo DBS	/95		
THAICOM1	Hughes	Thailand	12/94	Ariane	$50m**
THAICOM2	Hughes	Thailand	/94	Ariane	$50m**

FRANCE (10 or 9.2%)

Satellite:	Prime:	Customer:	Launch:	Launcher:	Value:
EUROPESAT 1 (DBS)	Matra	EUTELSAT	/94		
EUTELSAT 2/F5	Aerospatiale	EUTELSAT	/92	Ariane	
EUTELSAT 2/F6	Aerospatiale	EUTELSAT	/93	Ariane	
HISPASAT 1B	Matra	Spain	03/93	Ariane	
LOCSTAR	Matra	LOCSTAR	/92	Ariane	
TURKSAT 1	Aerospatiale	Turkey	/93	Ariane	
TURKSAT 2	Aerospatiale	Turkey	/93	Ariane	
Telecom 2C	Matra	France Telecom	/92	Ariane	
Zohreh 1	Alcatel	Iran	/95		$175m
Zohreh 2	Alcatel	Iran	/95		$175m

ITALY (5 or 5.1%)

Satellite:	Prime:	Customer:	Launch:	Launcher:	Value:
ITALSAT2	Selena Sp.	ASI/Telespazio		/93	Ariane
Artemis/PSDESat2	Selena Spazio		ESA	/94	Ariane
SARIT-1	Selena Spazio		RAI/ASI	/93	
SARIT-2	Selena Spazio		RAI/ASI		
SAX	Selena Spazio		Italy	/94	GD

· Estimated

Continued.......

UNITED KINGDOM (2 or 2.06%)

Satellite:	Prime:	Customer:	Launch:	Launcher:	Value:
Orion 1	BAe	Orion	/94	GD	
Orion 2	BAe	Orion	/95	GD	

JAPAN (2 or 2.06%)

Satellite:	Prime:	Customer:	Launch:	Launcher:	Value:
ETS-V/KIW5	Mitsubishi	NASDA		H1	
ETS-VI	Toshiba	NASDA	/93	HII	

CANADA (1 or 1%)

Satellite:	Prime:	Customer:	Launch:	Launcher:	Value:
SovCan Star	Spar	Canada/USSR			

INDIA (1)

Satellite:	Prime:	Customer:	Launch:	Launcher:	Value:
INSAT 2B	ISRO	India	04/93	Ariane	
GRAMSAT	ISRO	India	/96		$78m

ISRAEL (2)

Satellite:	Prime:	Customer:	Launch:	Launcher:	Value:
`MOS 1	Israel Aircraft	Gen Sat Corp	/94	Ariane	
.IOS 1	Israel Aircraft	Gen Sat Corp	/95	Ariane	

CHINA (1)

Satellite:	Prime:	Customer:	Launch:	Launcher:	Value:
Dong Fang Hong 3	PRC	PRC	/93	PRC	

rrepared by: Patricia Cooper, Office of Telecommunications
U.S. Department of Commerce
As of November 23, 1992

COMMUNICATIONS SATELLITE LAUNCHES
18 Launches in 1991:

Satellite:	Prime:	Customer:	Launch:	Launcher:	Value:
EUTELSAT 2/F2	Aerospatiale	EUTELSAT	01/91	Ariane	
ITALSAT1	Selena Spazio/Telespazio		01/91	Ariane	
DFS Kopernikus	GESAT/Siemens/MBB DBP		01/91	Ariane	
ASTRA 1B	Hughes	SES/Luxembourg	03/91	Ariane	
INMARSAT 2-F1	BAe	INMARSAT	03/91	MDSSC	
INMARSAT 2-F2	BAe	INMARSAT	04/91	MDSSC	
BS-3H (DBS)	GE	Japan	(Lost 04/91)	GD	
Anik E2	Spar	Telesat Canada	04/91	Ariane	$90m
Spacenet4/ASC2*	GE	Contel ASC	04/91	MDSSC	
SatcomC5/Aurora	GE	Alascom	05/91	MDSSC	
Orbcomm X	OSC	OSC	07/91	Ariane	
INTELSAT 6 F5**	Hughes	INTELSAT	08/91	Ariane	$157m
EUTELSAT 2/F3	Aerospatiale	EUTELSAT	08/91	GD	
BS-3B (DBS)	NEC/GE	Telecom Sat Corp	08/91	H1	
INTELSAT 6 F2	Hughes	INTELSAT	10/91	Ariane	
Anik E-1	Spar	Telesat Canada	10/91	Ariane	
Telecom 2A	Matra	France Telecom	12/91	Ariane	
INMARSAT 2/F3	BAe	INMARSAT	12/91	Ariane	

* As of 6/91, 3 of the 6 Ku-band transponders were below power

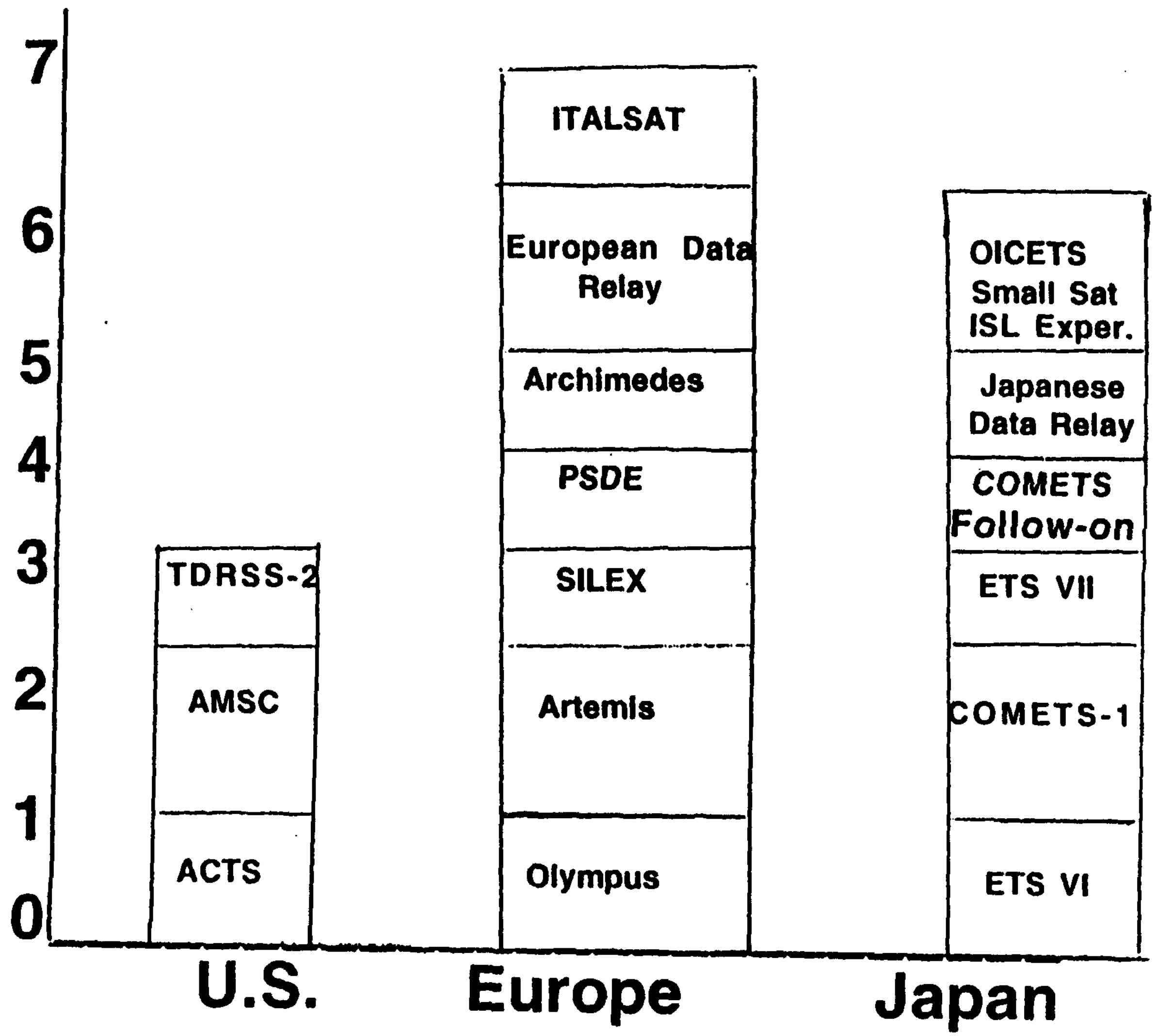
COMMUNICATIONS SATELLITE LAUNCHES
1992

Satellite:	Prime:	Customer:	Launch:	Launcher:	Value:
Superbird B	Loral	Space Comm Group	02/92	Ariane	$175m
ARABSAT 1C	Aerospatiale	ARABSAT	02/92	Ariane	$100m
Galaxy 5	Hughes	Hughes Comm.	03/92	GD	$100m
Telecom 2B	Matra	France Telecom	04/92	Ariane	
INMARSAT 2/F4	BAe	INMARSAT	04/92	Ariane	
INTELSAT K	GE	INTELSAT	06/92	GD	$102m
Palapa B4	Hughes	Perumtel	05/92	MDSSC	$50m
EUTELSAT 2/F4	Aerospatiale	EUTELSAT	07/92	Ariane	
INSAT 2A	ISRO	India	07/92	Ariane	
SatcomC4	GE	GE Americom	08/92	MDSSC	$50m
OPTUS B1	Hughes	AUSSAT	08/92	PRC	$100m
Galaxy 1R*	Hughes	Hughes Comm.	08/92	GD	$100m
SatcomC3	GE	GE Americom	09/92	Ariane	$50m
HISPASAT 1A	Matra	Spain	09/92	Ariane	
DFSKopernikus	GESAT/Siemens/MBB DBP Telekom		10/92	MDSSC	
Galaxy 7	Hughes	Hughes Comm.	10/92	Ariane	$150m

* Destroyed during launch

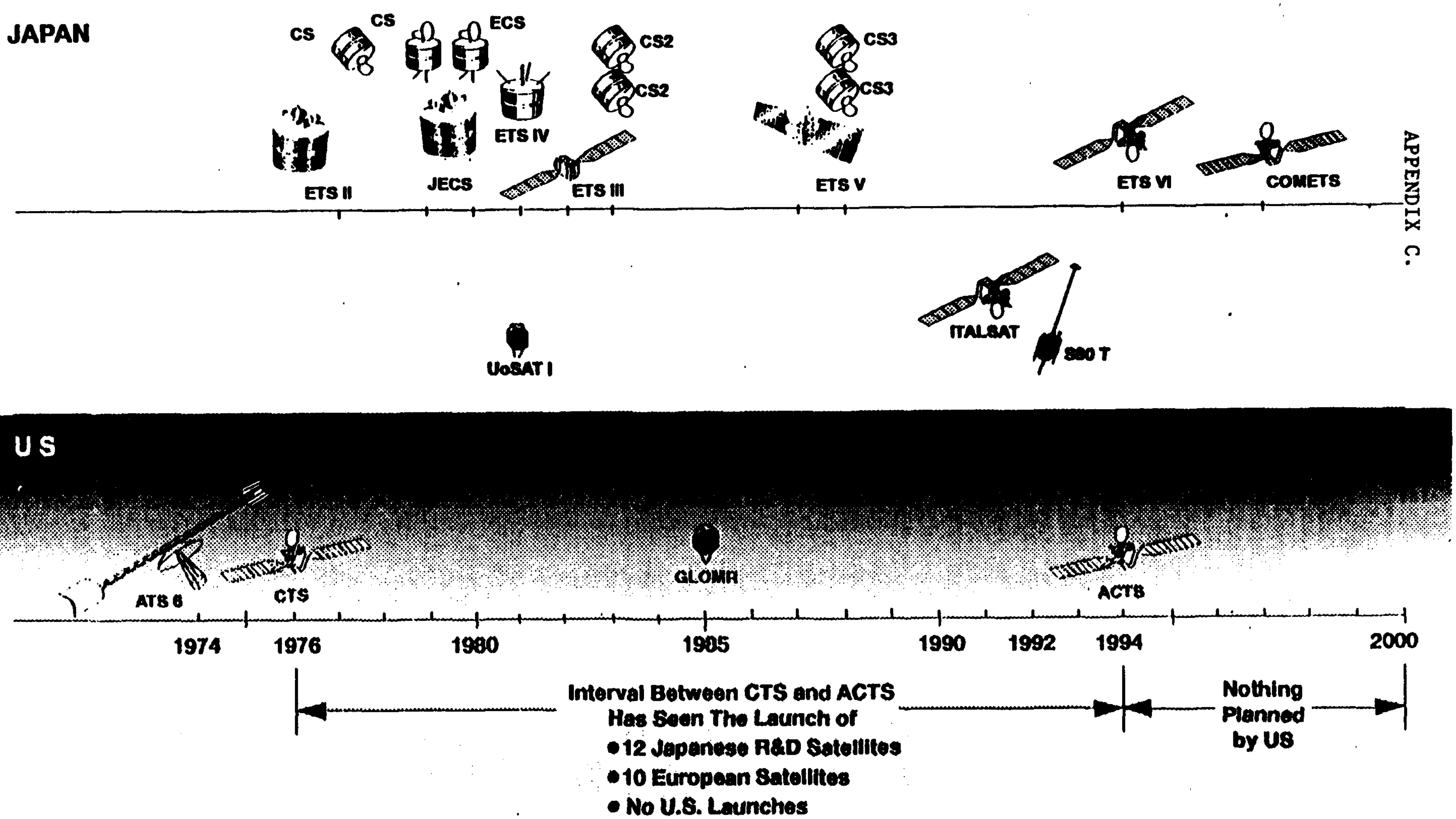
epared by: Patricia Cooper/ITA/TD/S&E/Telecom/x4466/November 23, 1992

A COMPARATIVE VIEW: NUMBER OFSATCOM DEVELOPMENT PROJECTS US-JAPAN-EUROPE



APPENDIX C.

World Development of Communications Satellite Advances

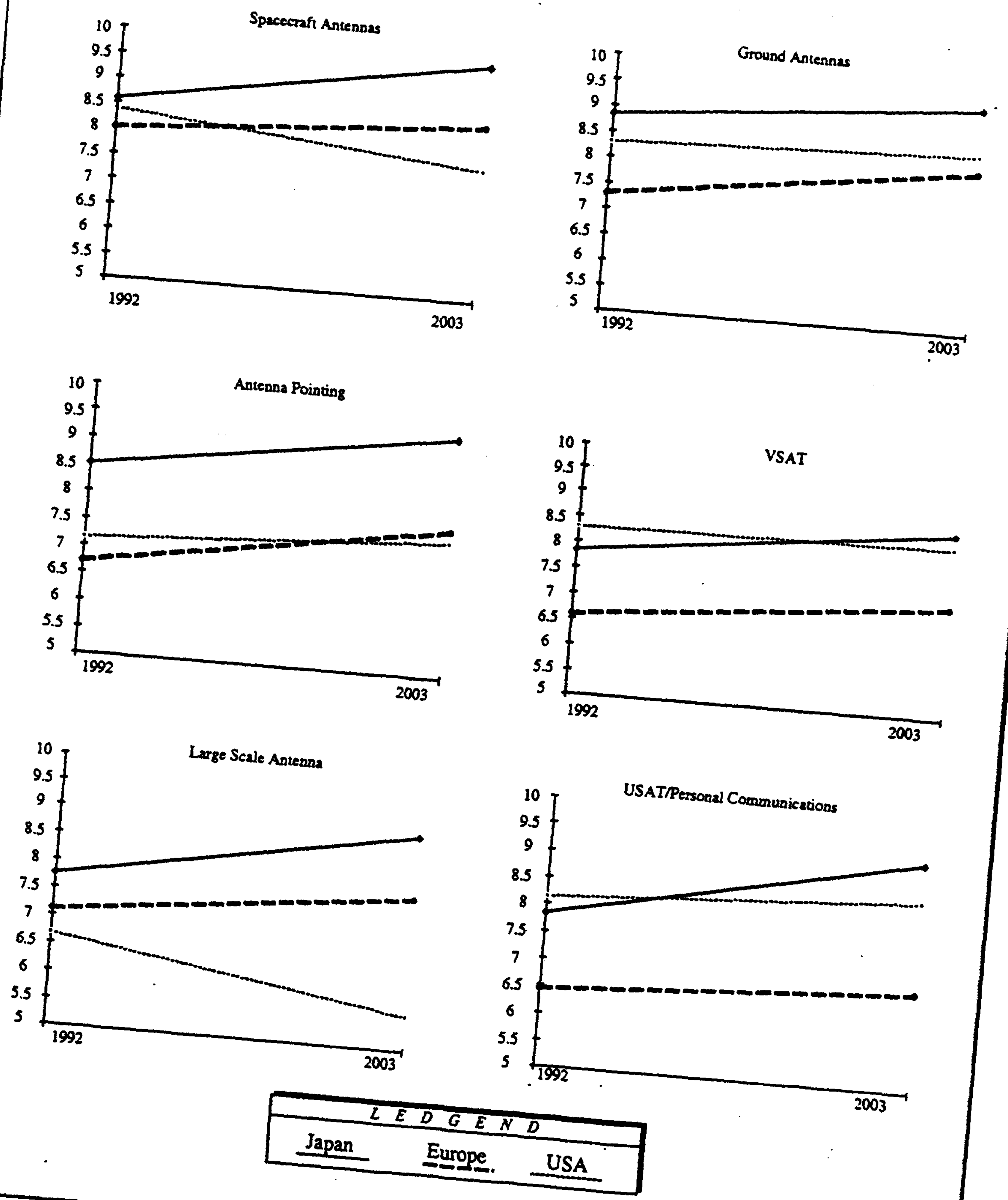


MITRE

VG25590

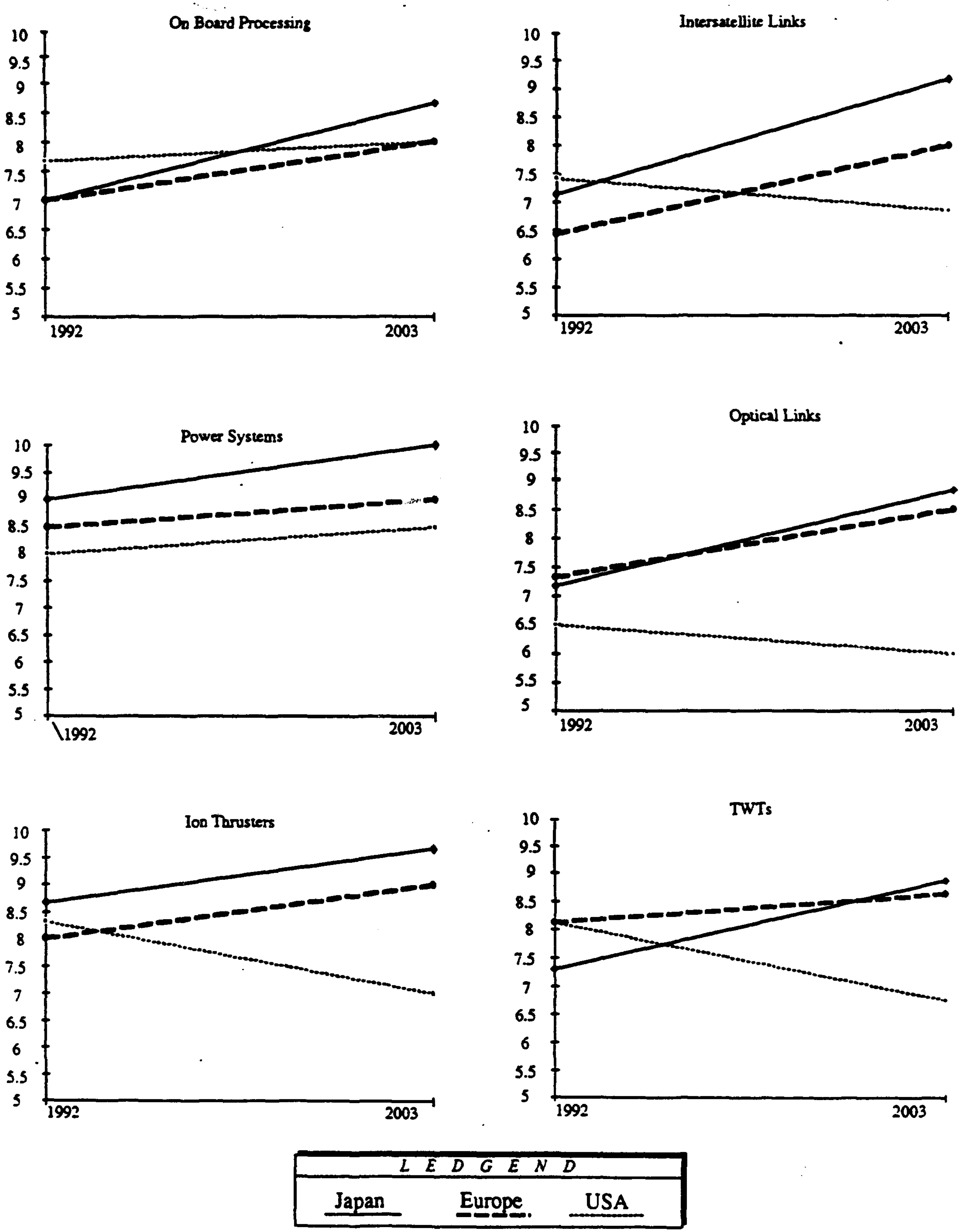
APPENDIX D.

Comparative Analysis of Key Satellite Technologies



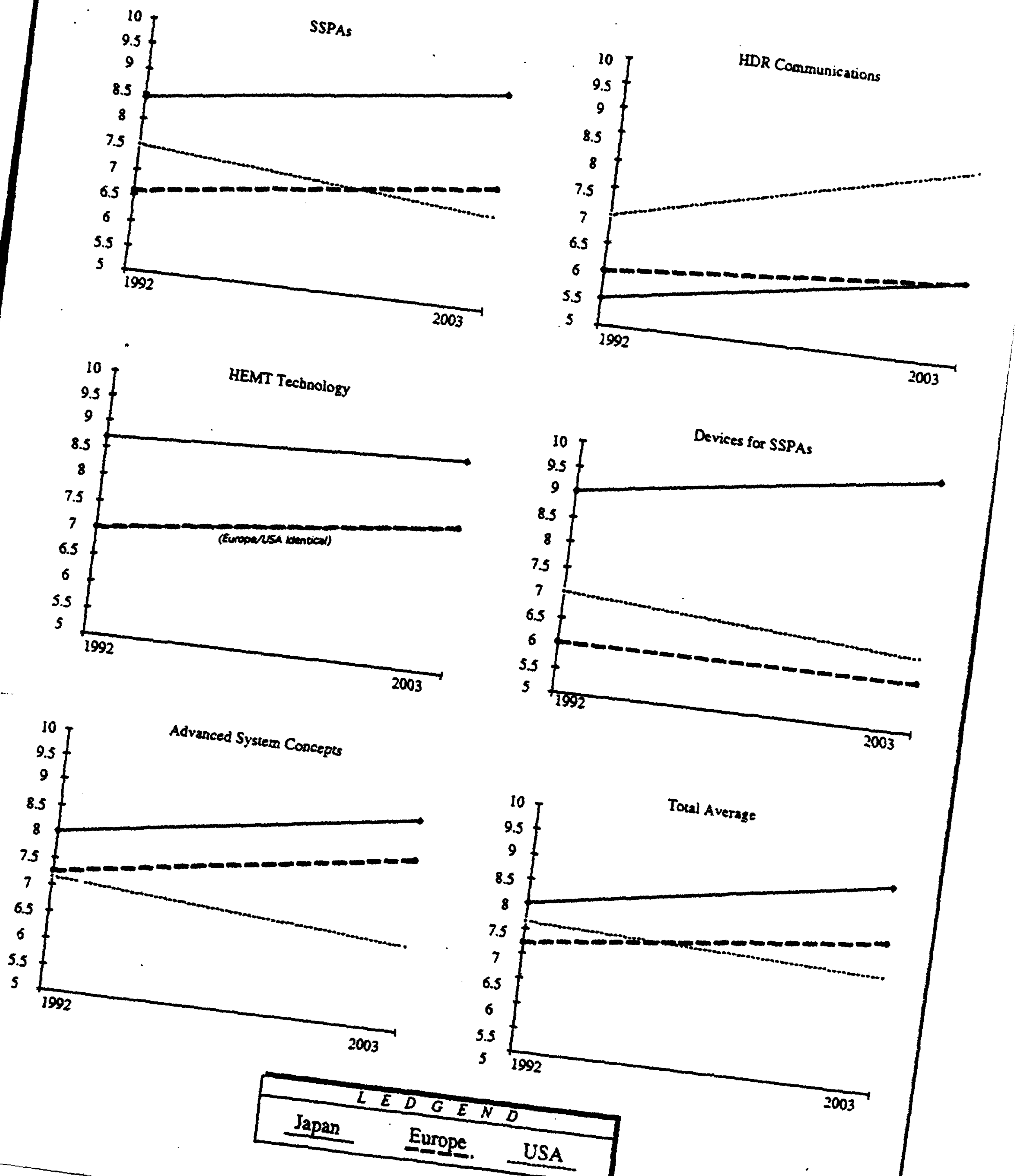
APPENDIX D.

Comparative Analysis of Key Satellite Technologies
(continued)



APPENDIX D.

Comparative Analysis of Key Satellite Technologies
(continued)



U.S. TECHNOLOGY LAG

- INTERSATELLITE LINKS
- FREE SPACE OPTICAL COM.
- BATTERIES (E.G LITHIUM ION)
- SOLAR ARRAY SYSTEMS (E.G. FLEXIBLE ROLL OUT)
- SOLID STATE POWER AMPLIFIERS (SSPA)
- POINTING AND POSITIONING SYSTEMS
- LARGE SCALE DEPLOYABLE ANTENNA SYSTEMS.
- ADVANCED SYSTEM DESIGN AND LONG RANGE PLAN. CONCEPTS
- NEW APPLICATION DEVEL.

U.S. SCORECARD IN SATCOM TECHNOLOGY

U.S. TECHNOLOGY LEAD

- HIGH DATA RATE SATCOM
- USAT'S AND PERSONAL COM. TRANSCEIVERS
- SMALL SATS-BIG & LITTLE LEOS.
- SPACE APPL. FOR HIGH TEMP. SUPERCONDUCTIVITY

U.S. TECHNOLOGY "TIE"

- TRAVELLING WAVE TUBES-L BAND TO MILLIMETER WAVE.
- ION THRUSTERS (E.G. XENON)
- ON-BOARD PROCESSING / SIGNAL REGENERATION
- SPACE ANTENNAS
- HEMT TECHNOLOGY
- AUTONOMOUS CONTROL SYSTEMS

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