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25 FEB 1987

MEMORANDUM FOR: Glen Fukushima
Director for Japanese Affairs
United States Trade Representative

FROM: [redacted] 25X1
Chief, Technology and Industrial Competitiveness Division

SUBJECT: Contribution to Article 305 Study on Supercomputers [redacted] 25X1

1. As requested, we are providing a contribution to the 305 study on supercomputers. The attachment provides a brief history of the Japanese supercomputer industry and summaries of the three Japanese supercomputer suppliers. [redacted] 25X1

[redacted] 25X1

Attachment:
Contribution to Article 305 Study on Supercomputers [redacted] 25X1
GI M 87-20036, February 1987, [redacted] 25X1

[redacted] 25X1

[redacted] 25X1

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SUBJECT: Contribution to Article 305 Study on Supercomputers [redacted]

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Contribution to Article 305 Study on Supercomputers

4. Japanese Supercomputer Industry

4.1 Brief History

4.1a Government Role: Questionable Short Term Impact

The current generation of supercomputers offered by Fujitsu, Hitachi and NEC was developed without direct support from the Japanese government. Most of the circuit and systems design and production technologies in Hitachi's and Fujitsu's supercomputers, and to a lesser extent NEC's, are based on Japanese general-purpose mainframe technology developed in the late 1970's. Much of the development of this mainframe technology, however, was funded by Japanese government computer programs, including: the MITI-sponsored 3.75 general purpose computer project, the Pattern Information Processing System (PIPS), the software production technology development program, as well as NTT-sponsored programs such as the Denden Kosha Information Processing Project (DIPS). Although these projects greatly contributed to the overall current state of Japanese computer technology, none were directly targeted towards the development of a supercomputer. [redacted] 25X1

This memorandum was prepared by [redacted] Technology Analysis Branch, Office of Global Issues. 25X1

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Future supercomputer developments, however, will benefit from direct government support through several programs that are currently under way, including the High Speed Scientific and Fifth Generation Computer Projects. Although many of the stated goals of the programs are ambitious and may not be realized, these programs could result in important spin-offs as Japanese firms attempt to foster innovation in supercomputer development. 25X1

High Speed Scientific Computer Project.

The High Speed Scientific Computer Project is an eight year program initiated in 1982 to develop circuit technologies and system architectures useful in supercomputer design and production. According to the program guidelines, the project is designed to give the Japanese clear-cut domination in the high-speed, scientific computer area. The funding for this project is estimated to be about US $150 million, with matching funds coming from the six participating Japanese firms, Fujitsu, Hitachi, NEC, Toshiba, Mitsubishi, and Oki. The first six years of the program are aimed at development of Josephson junction and gallium arsenide (GaAs) circuit technologies. Concurrently, the project calls for the development of hardware and software designs that are to be configured into a high speed system during the final two years. The goals of the project include;

- o Uniprocessors capable of 100 million floating point operations per second (MFLOPS) and a multiprocessor capable of 10,000 MFLOPS.

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- o High-speed logic and memory devices, including; a 3,000 gate array chip with 10 picosecond delays (a picosecond is a trillionth of a second), implemented in Josephson junction transistors or low temperature gallium arsenide; a 3,000 gate array chip with 30 picosecond delay and a 16K memory device with a 10 nanosecond access time (a nanosecond is a billionth of a second), both implemented in room temperature gallium arsenide.

- o Software design and system architecture capable of supporting 100 individual processing elements for maximum parallel operation. 25X1

The project has not met with great success. With less than three years to project completion, expectations appear to have been drastically scaled back, and Japanese officials concede that they have yet to settle on the basic architecture for the prototype. Much of the problems are related to controlling parallel operation efficiently. Several Japanese engineers say that even if a prototype is developed, they doubt that it could result in a commercially usable machine in the near future. Additionally, research on Josephson junction technology and GaAs devices has not moved as fast as was originally expected. Designers say that they would now plan to use conventional silicon chips for all but a few of the new machine's components. 25X1

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Fifth-Generation Computer Project

In 1981, the Japanese initiated a new program, the Fifth Generation

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Computer Project, to define new levels of performance for computer systems in the 1990s. It is an eight year program; calling for funding of about US $500 million by the participating Japanese computer makers (including all of the firms in the High Speed Scientific Project) and the Japanese government. The program is not explicitly intended to promote the development of Japanese supercomputers. It could, nonetheless, have implications for Japan's capabilities in the supercomputer field. [redacted] 25X1

An integral part of the high performance needed to implement these fifth generation systems will be the use of parallel processing techniques. Much of the hardware and software technology developed in this project could be used in the design of future generation supercomputers. Fifth generation systems (and supercomputer systems) will be increasingly dependent on parallel processing to realize high performance. However, mechanisms that control massively parallel systems have been difficult to design and build. [redacted] 25X6
[redacted] There will likely be no 25X6
short-term benefits of this program for the Japanese supercomputer manufacturers, although future systems may borrow on the technology that is currently under development. [redacted] 25X1

4.1b Fujitsu and Hitachi Entry in Late 1983

Fujitsu's entry in the supercomputer market were the VP-100 and VP-200 with claimed peak performance ratings of 250 and 500 MFLOPS respectively. (Table 1 outlines the full supercomputer product lines

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of the three Japanese firms.) These machines were first delivered in December 1983. A low-end model, the VP-50 (160 MFLOPS) and a high-end machine, the VP-400 (1,140 MFLOPS) were ready for delivery in late 1985, and mid 1986 respectively. [redacted] 25X1

Hitachi entered the supercomputer market at about the same time as Fujitsu, with the introduction of two supercomputers, the S-810/10 and S-810/20, with a claimed peak performance rate of 315 MFLOPS and 630 MFLOPS respectively. In late 1985, the company introduced a low-end version, the S-810/5. The firm is also planning a high-end processor, similar to the Fujitsu VP-400, that will have a maximum performance rate over 1,000 MFLOPS. [redacted] 25X1

[redacted] 25X6

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In achieving their levels of performance, Japanese supercomputer designers demonstrated some insights into critical factors affecting supercomputer performance. [redacted] they 25X6 avoided potential bottlenecks by providing high-capacity memory expansion units, improved channels from main memory to the processors, and increased memory storage outside and inside the processors. The Japanese also benefited from basic software research performed in the United States, but not yet applied by US manufacturers. For example, Fujitsu's automatic vectoring FORTRAN compiler received critical acclaim, not just for its vectorizing capabilities, but also for its well designed interactive user interface. [redacted] 25X1

The VP and S-810 machines also show that Japanese supercomputer designers made some mistakes because of their relative inexperience in supercomputer development. The designers gave too much capability to their vector processors, which handle large arrays of data, compared with their scalar processors which manipulate single units of data.

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As a result, important elements of the Japanese machines sat idle during many applications, while other portions ran too slowly. Although the Japanese decision to base their supercomputers on their general-purpose mainframe computer technology lessened development costs and risks, it also resulted in diminished performance. [redacted] 25X1

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The supercomputers from Hitachi and Fujitsu had an important difference from the original supercomputers offered by their US counterparts at Cray Research and Control Data. These Japanese systems were designed to run IBM-compatible operating systems. They could also use standard IBM-compatible peripherals. This was not surprising since Fujitsu and Hitachi benefited greatly from having IBM-compatible mainframe lines. Besides selling to the traditional target market for supercomputers---the scientific community--Hitachi and Fujitsu believed that they could make inroads into more traditionally oriented commercial computing environments. These were believed to represent about 20 percent of IBM compatible mainframe operations. [redacted] 25X1

[redacted] 25X6

[redacted] the Japanese enjoyed reasonable success in the sale of their supercomputers. At the end of 1985, Fujitsu had installed 17 machines---three were at Fujitsu plants, one was at Amdahl in Sunnyvale, with another 18 systems on order. Fujitsu's low-end machine, the VP-50 proved to be its most popular model and is likely to comprise almost half of its future orders. Twenty-two of the 25X6

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Fujitsu's 35 total orders were in Japan. The other 13 were overseas. Four of the overseas orders were booked by Amdahl, which is selling the Fujitsu supercomputers in the United States, but under the Amdahl company label. [redacted] 25X1

Hitachi has not done as well as Fujitsu. At the end of 1985, Hitachi had only shipped seven systems and had two additional systems on order. Three of the installations were within Hitachi. There were several reasons why Hitachi sales were significantly below that of Fujitsu. Performance tests indicated that the Hitachi machine was not as fast as its Fujitsu counterpart. Additionally, Hitachi was slow to introduce a low-end counterpart to the VP-50. Finally, and perhaps most importantly, Hitachi restricted its sales to the domestic market, while Fujitsu was selling its supercomputers on a world-wide basis.

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In the future, the Japanese supercomputer suppliers will face increasing competition [redacted]. When the Japanese supercomputers 25X6 were introduced, a major selling point was that they were IBM-compatible, while Cray and CDC supercomputers were not. The Japanese strategy received a setback at the low-end when IBM introduced a vector facility for its 3090 processors announced in early 1985. IBM used a different instruction set than Fujitsu and Hitachi for their vector processors. This will not be a major problem in Japan, but could severly limit the sales of the Japanese in offshore markets. The Japanese could have real problems in the low end of the supercomputer performance spectrum because of IBM's competitive

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hardware and superior marketing power. 25X1

4.1c NEC Enters the Market in 1985

NEC announced and delivered two new supercomputers almost two years after Fujitsu and Hitachi. In the middle of 1985, NEC had available two systems, the SX-1 with a claimed maximum performance of 570 MFLOPS, and the SX-2 that had a performance of 1,300 MFLOPS. At that time, the SX-2 was the highest claimed peak performance of any commercially available supercomputer. In early 1986, NEC shipped its first SX-1E, the low end of the SX series with a maximum performance of 285 MFLOPS. 25X1

The NEC machines were quite different, both architecturally and physically from the machines offered by Fujitsu and Hitachi. Specifically, the NEC machines represented some of the first attempts by any Japanese computer manufacturer to address some of the tough engineering problems facing next-generation supercomputer suppliers. Unlike Fujitsu and Hitachi, the NEC supercomputers were not an extension of the firm's mainframe line. The NEC supercomputers used water cooling---a first for any Japanese computer manufacturer--as well as an advanced multilayer ceramic chip package. The system had an extremely fast cycle time (6 nanoseconds), fastest available at the time from any Japanese or US manufacturer. Like the other Japanese manufacturers, the NEC supercomputers were heavily dependent on pipelined vector operations to achieve high performance, thus limiting its range of applications. Additionally, the SX supercomputer had one

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of the fastest scalar processors then available. In general, the hardware of NEC's SX series represented a giant step forward by the Japanese in supercomputer development. [redacted] 25X1

Although the SX systems were impressive on paper, there were many disadvantages to the machines. Most importantly, like the rest of the NEC data processing line, the SX systems were not IBM-compatible. This greatly limited the commercial acceptability of the systems. Also, the operating systems and support software that was supplied along with the system was considered weak, and diminished the capability of the system to perform at high rates. [redacted] 25X1

By the middle of 1986, NEC has only shipped seven machines, three internally to NEC. NEC, though not traditionally an aggressive force outside Japan, spent some effort trying to market the machine themselves in the United States. NEC only sold one machine in the US, to a university research consortium in Houston. [redacted] 25X6
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[redacted] the company announced last year that they would begin a joint venture with Honeywell to market NEC supercomputers in the US. NEC hopes to sell more than 50 supercomputers through the joint venture [redacted] over the next five years. [redacted] 25X1

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4.2 Principal Companies and Market Performance

4.2.1.a

Fujitsu

Fujitsu is Japan's leading computer company and second overall behind NEC in Japanese industrial electronics, with more than US $6.5 billion in revenues in fiscal 1985. (See table 2 for a financial comparison of the three Japanese computer firms.) The firm is first and foremost a computer firm; approximately 60 percent of Fujitsu revenues are derived from sales of computers and data processing systems. (See table 3 for a breakdown of the firms' data processing revenues.) For the rest of its revenues, 21 percent comes from semiconductor sales, 13 percent from communications equipments sales, and the remainder from sales of products including automobile electronics. It is much less diversified than the other giants of Japanese electronics. [redacted] 25X1

Compared with Hitachi annual revenues (US $20.9 billion in 1985) and NEC (US $ 9.9 billion in 1985), Fujitsu is a relatively small firm. Despite its size, Fujitsu has a leading-edge position in computers, and semiconductor technologies. In computers, the company offers a wide spectrum of products, ranging from supercomputers to mini- and micro-computers. Fujitsu currently holds 29 percent of the Japanese mainframe market, and more than 18 percent of the domestic microcomputer market. Fujitsu has also recently announced some of the most impressive Japanese mainframe systems offered to date [redacted] 25X6

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[redacted]. In peripherals, Fujitsu has announced impressive developments in erasable optomagnetic disks, and sputtered thin film magnetic disks. Through the Fifth Generation Project, the company is involved in the development of systems based in artificial intelligence and parallel processing techniques. [redacted] 25X6 25X1

In semiconductors, Fujitsu is a leading supplier of high density memory components, and is particularly strong in developments related to large computers--- high speed logic and gate arrays, and fast bipolar memories. Fujitsu is also a leader in the development of GaAs semiconductor devices. GaAs devices offer the potential to have higher-speed, lower-power performance than their silicon counterparts. Fujitsu, along with many other Japanese and US electronics firms, believes that GaAs components could play an increasingly important role in the production of future supercomputer and mainframe systems, as well as advanced telecommunications systems. [redacted] 25X1

In telecommunications, Fujitsu has one of the fastest optical transmission systems available on the market, and appears to hold the lead in the field of optoelectronic integrated circuits. A major area of Fujitsu interest has been ISDN technology for central office switching. Fujitsu has announced developments in the entire range of telecommunications systems components, including new switching and transmission techniques as well as terminal development. [redacted] 25X1

NEC

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NEC offers a wide range or important electronics products and is a major player in the computer, telecommunications and semiconductor markets. NEC products are well balanced across the spectrum of high performance electronics. NEC revenues from computers and industrial electronics is about 32 percent of total revenues; communications equipment account for about 28 percent, microelectronics for about 27 percent, home electronics and other products generate the remaining 13 percent of total revenues. NEC products include:

o A full range of computers. In microcomputers, it holds 70 percent of the domestic market for 16-bit machines. In supercomputers, it currently offers one of the highest performance systems available in the market.

o An extensive line of subscriber switching products--key telephone systems, private branch exchanges, and hybrid KTS/PBS systems.

o A complete selection of networking equipment including central office switches, packet switches, and a wide spectrum of transmission equipment. For its communications equipment, NEC relies on the quasi-privatized Nippon Telegraph and Telephone for about 25 percent of its total sales, sales to the US telecommunications market account for another 25 percent.

o A broad range of semiconductors and components--NEC is the largest semiconductor manufacturer in the world merchant market,

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surpassing the US-based Texas Instruments in 1985.

- o A wide variety of other equipment including consumer electronics, facsimile equipment, direct broadcast satellite receivers, cellular radio sets, and semiconductor manufacturing equipment. 25X1

In data processing, NEC has carved out a niche market in which IBM compatibility does not matter. Its ACOS operating systems reflect NEC historic ties with General Electric and Honeywell. Unlike Fujitsu and Hitachi, NEC has been able to concentrate on mainframe technology and performance instead of anticipating IBM product announcements. This has, however, resulted in NEC being the least active Japanese large systems supplier outside of its domestic market. Strategic alliances with France's Bull and Honeywell in the United States may help to increase NEC foreign participation in the near future. 25X1

Hitachi

Hitachi generated over US $20 billion in revenues in fiscal 1985. Although the foundation of the firm is based on the older technologies of steel, chemicals and electricity, its long term goal is to transform itself into a company increasingly based on electronics. Total revenues generated by the industrial products category ---which includes computers and semiconductors-- accounted for less than 20 percent of Hitachi revenues in 1981, had risen to 30 percent only four years later.

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Hitachi is the most broadly diversified Japanese supercomputer supplier, revenues are generated from five major product areas:

- o 30 percent--industrial electronics including semiconductors, computers and telecommunications equipment.
- o 22 percent--consumer products.
- o 18 percent--wire and cable, metals, chemicals.
- o 16 percent--industrial plants and machinery.
- o 14 percent--power systems and equipment. [redacted] 25X1

Hitachi strategy in industrial electronics is simple; the company has isolated semiconductor technology as a key to its future success in a wide range of electronic goods. By focusing money and engineering talent on the semiconductor business, Hitachi has moved into the number two spot in the world semiconductor industry, behind NEC. Because about 70 percent of Hitachi semiconductor revenues comes from the sales of semiconductor memories, the firms financial performance is closely linked to the rise and fall of that segment of the industry. Hitachi is attempting to diversify into other segments of the industry, with principle targets being microprocessors and microcontrollers. [redacted] 25X1

Historically, telecommunications equipment has ranked a distant third in Hitachi's corporate strategy, behind semiconductors and computers. However, telecommunications will likely play an increasingly important

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role in Hitachi's future. Recently, Hitachi has introduced several new digital PBX systems designed to move it into some new vertical markets such as hospital and general business applications. Hitachi is also the sole supplier for cellular radios to AT&T. [redacted] 25X1

In Japan, Hitachi is a full-line supplier of computer systems, from personal computers to supercomputers. The most important task it now faces is successfully moving that product line into export markets. Traditionally, Hitachi has used original equipment manufacturer agreements to sell its computers abroad. Virtually all of the Hitachi computer products sold in North America carry another company's name, or are built into another companies product. In the North American market, Hitachi continues to rely on National Advanced Systems to market its mainframe products. This agreement is tenuous, and Hitachi may be looking for alternate distributors and seeking ways to bolster its US computer sales and service network. [redacted] 25X1

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Table 1
Japanese Supercomputer Product Lines

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	Maximum Performance (MFLOPS)	Livermore Loops (Harmonic Average, MFLOPS)	Memory Capacity (MBytes)	Announced	FCS*
Fujitsu					
VP-400	1440	na	256	04/85	1H/86
VP-200	500	19.8**	256	07/82	4Q/83
VP-100	250	18.7	128	07/82	12/83
VP-50	160	na	128	04/85	11/85
Hitachi					
S-810/20	630	14.7	256	08/82	4Q/84
S-810/10	315	na	128	08/82	4Q/83
S-810/5	160	na	128	09/85	1Q/86
NEC					
SX-2	1300	na	256	04/83	06/85
SX-1	570	37.7	256	04/83	1986
SX-1E	285	na	128	10/85	03/86

* First Customer Shipment
** Harmonic average for Cray X-MP-1 is 13.7 MFLOPS

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Table 2
Comparison of Leading Japanese Computer Firms Financial Status 25X1

	Fujitsu	Hitachi	NEC
1985 Total Revenue	6,563	20,919	9,899
1985 DP Revenues	4,309	2,885	3,761
1985 Total R&D	524	1,223	249
1985 Net Income	235	768	249
DP Export In percent (est)	19	20	14
PP&E as a percentage of Revenues over last 3 years	15.4	8.8	14.0

All number in $US millions unless otherwise noted

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Table 3

Data Processing Revenue Breakdowns 25X1

	Fujitsu	Hitachi	NEC
Mainframes	38*	29	32
Minicomputers	10	0	0
Microcomputers	4	2	9
Datacommunications	9	0	12
Peripherals	25	49	28
Software	6	7	10
Maintenance	9	10	9
Other	0	3	0

* percent total data processing revenues for Japan fiscal 1985

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