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An Assessment of the U.S. Telecommunications Industry Dependence on Foreign Sources as it Impacts the U.S. Telecommunications Infrastructure

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PREFACE

This report was submitted as a prime deliverable for a study conducted for the National Communications System (NCS), Office of the Manager, Technology and Standards Office, Washington, DC, under Reimbursable Order DNRO 26081. The study is an update to previous work done by the Joint Industry-Government Telecommunications Industry Mobilization (TIM) Group, a subcommittee of the National Security Telecommunications Advisory Committee (NSTAC). The TIM Group made an initial assessment, in 1987, of the telecommunications industry's dependence on foreign sources in light of the potential requirement for mobilization.

The objectives of this study were to update the 1987 assessment, and to develop an assessment mechanism that can be used to perform future assessments of foreign source dependence. This report contains data compiled from interviews of representatives of industry, the Government, and research of available literature. Certain commercial products and company names are mentioned in this report to specify and describe some of the necessary information. Such identification does not imply exclusive recommendation or endorsement of the companies or the products by NTIA or NCS. The views, opinions, and/or findings contained in this report are those of the authors and should not be construed as an official NTIA or NCS position unless designated by other official documentation.

This report is issued in two volumes. Volume I contains a summary of findings during this study. Volume II contains more detailed background information.

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ACRONYMS

ASIC	Application Specific Integrated Circuit
BXA	Bureau of Export Administration
COP	Committee of Principals
DOC	Department of Commerce
DQ	Dataquest, Inc.
DRAM	Dynamic Random Access Memory
DSP	Digital Signal Processor
EOP	Executive Office of the President
E/M	Electromechanical
EPA	Environmental Protection Agency
GDP	Gross Domestic Product
GNP	Gross National Product
IDA	Institute for Defense Analyses
Int	Interconnect
ITA	International Trade Administration
ITC	Initial Tax Credit
ITS	Institute for Telecommunication Sciences
Mech	Mechanical
NAFTA	North American Free Trade Act
NCS	National Communications System
NSTAC	National Security Telecommunications Advisory Committee
NTPA	NCS Telecommunications Plan of Action
NTIA	National Telecommunications and Information Administration
NS/EP	National Security and Emergency Preparedness
PCB	Printed Circuit Board
RBOC	Regional Bell Operating Company
SMT	Surface Mount Technology
TIM	Joint Industry-Government Telecommunications Industry Mobilization Group
U.S.	United States
USDA	United States Department of Agriculture

AN ASSESSMENT OF THE U.S. TELECOMMUNICATIONS INDUSTRY DEPENDENCE ON FOREIGN SOURCES AS IT IMPACTS THE U.S. TELECOMMUNICATIONS INFRASTRUCTURE

Volume 1: An Executive Summary

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The National Communications System (NCS) is responsible for defining operational infrastructures and processes that could be detrimental to the provision of telecommunications equipment and services necessary to the National Security and Emergency Preparedness (NS/EP) needs of the Nation. To this end, the President's National Security Telecommunications Advisory Committee (NSTAC) studied the industry's dependence on various infrastructures within the United States to (1) identify possible impediments to effective telecommunications industry mobilization, and to (2) assist in the development of corrective actions to overcome any identified impediments. This study was published in 1989. The information presented in this report is a result of follow-on investigations that attempt to determine those components and materials used in the telecommunications equipment manufacturing process that are obtained from foreign sources. This report lists those components that are primarily procured from foreign sources. For example, plastic-coated relays, printed circuit mounted transformers, and some types of semiconductors are a few of the components that represent vulnerabilities in the telecommunications switch (Class 5) manufacturing process. A result of this study is an analysis of the trends that are evident between the 1989 study results and the results of this report. This report shows an increase in the components that are obtained almost exclusively from sources outside the U.S. and Canada. A contributing factor to the trend toward more foreign sourcing of components is the general trend toward a more global economy. In the final analysis, one must determine the components, and their sources, that could be the most detrimental to the mobilization of the Nation's telecommunications resources if these sources were no longer available. A determination of the sources that are most likely to be cut off is also important. An analysis of the circumstances that could result in the cut off of foreign sources is not a part of this study.

Key words: telecommunications; telecommunications switch; Class 5 switch, telecommunications manufacturing; foreign source; foreign source dependence

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EXECUTIVE SUMMARY

The telecommunication industry plays a critical role in ensuring the Nation's ability to maintain continuity of Government and essential private sector functions when faced with national security or emergency preparedness (NS/EP) challenges. The National Communications System (NCS) is the Federal Government's primary agent for planning and coordinating the Nation's NS/EP telecommunication activities.

The Institute for Telecommunication Sciences (ITS), in support of NCS, is studying the extent and nature of U.S. dependence on foreign sources for telecommunications systems and components that could affect U.S. telecommunications in a NS/EP scenario. (The work involves both the identification of current system and component dependencies, and the development of mechanisms for assessing ongoing and long-term dependence.)

Although it may be impossible to predict the precise national security scenario or emergency that the United States may face, it may be beneficial from a strategic and planning perspective, if the general economic and production problems likely to be encountered can be anticipated with some degree of certainty. Effective peacetime planning, focused on the problems likely to arise during a national emergency and on methods to address these problems, can increase the effectiveness of subsequent preparatory and response actions. Various levels and types of response measures will apply, depending upon the nature of the crisis or emergency and the stage of its development (FEMA, 1989).

The response time necessary to increase significant production of defense end-items has militated against reliance on production capabilities in a crisis or conflict. Even if major investments were made in industrial base enhancement measures, the industrial base could not respond immediately to mobilization requirements. Some time would be needed to refine plans and focus them on the crisis, develop new production requirements, adjust existing procurement plans, identify and qualify new sources of supply, let new contracts, and increase the flow of parts and components to end-item manufacture and assembly (FEMA, 1989).

It is difficult to assess, on an empirical basis, the extent of dependence on foreign sources in the telecommunications infrastructure, despite the wealth of evidence showing the problem exists. Data collection based on varying methodologies limits our ability to identify dependency trends in critical industrial sectors. In addition, the trends identified change rapidly as the technology evolves.

It is apparent, after discussion with U.S. companies, that to fully understand the foreign dependence and foreign sourcing issues, one must recognize the integral and complex U.S. policies and issues related to economics, politics, technology, import and export laws, taxes, and labor. Because these policies and issues are integral to the business practices of the companies interviewed, some comments related to the study have been cited herein. Figure ES–1 depicts some of the issues that affect foreign dependence.

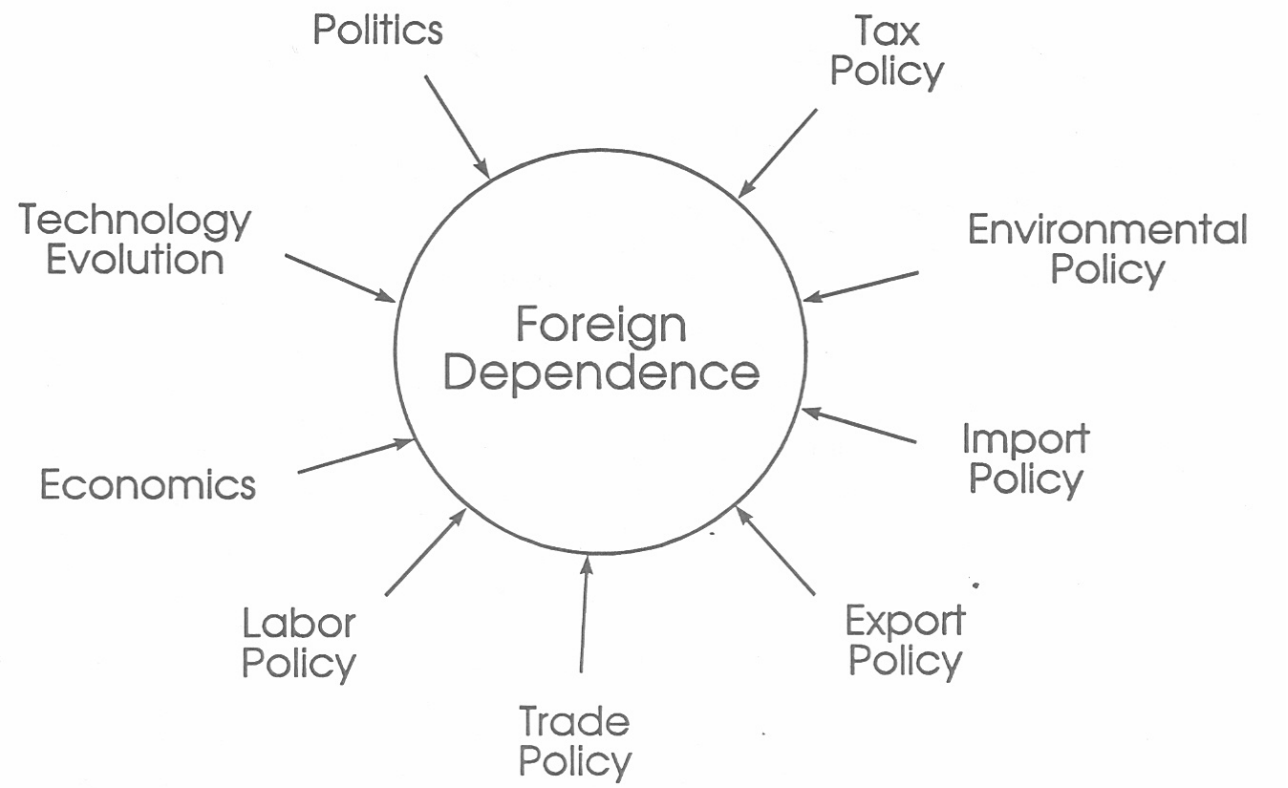

Figure ES-1. Factors affecting foreign dependence vulnerability.

Background

The extent of the telecommunication industry's dependence on foreign sources for raw materials, components, subassemblies, and equipment is a key area of concern in evaluating the industry's ability to maintain service and production capabilities and in accommodating increased service and equipment demands under mobilization conditions. The Joint Industry-Government Telecommunications Industry Mobilization (TIM) Group was established by the President's National Security Telecommunications Advisory Committee (NSTAC) and the National Communications System (NCS) Committee of Principals (COP) (1) to identify possible impediments to effective telecommunications industry mobilization, and (2) to assist in the development of corrective actions to overcome any identified impediments.

In a 1987 Government report (NCS, 1987), the Joint TIM Group sought information from Federal Government and private research organizations that previously studied the issue of foreign procurement or foreign dependence. On the basis of the survey results and other information obtained from the literature, briefings, and consultation with experts in the Federal Government and the private sector, the Joint TIM Group developed the following findings, conclusions, and recommendations (NCS, 1989):

- The Government, in conjunction with NSTAC, should establish a mechanism to periodically assess U.S. industry dependence on foreign sources in light of identified Government mobilization needs.

- The NCS and NSTAC should jointly keep the Executive Office of the President (EOP) apprised of any specific foreign dependency issues relating to telecommunications, and identify, if necessary, possible measures for reducing or mitigating these foreign dependencies.

The U.S. industry's foreign dependence presents a changing picture in terms of specific equipment, components, and materials for which dependency exists as well as the degree of dependence for each. Today's list of foreign dependence items is different from yesterday's, and tomorrow's will differ from today's.

Study Methodology

This ITS study was undertaken in response to the Joint TIM Group's recommendations that the Government (1) investigate more fully foreign dependence on specific telecommunications equipment critical to the telecommunications infrastructure, and (2) develop a mechanism to periodically assess foreign source dependence. ITS proposed a three-phase approach to identifying such dependencies:

Phase I: Systems-Level Analysis. Analyze each major telecommunications system or group of systems to determine the amount of production within the U.S., the imported quantities, the exported quantities, and the U.S. consumption.

Phase II: Component-Level Analysis. Identify specific components of those Phase I systems that were obtained primarily from foreign sources.

Phase III: Identification and Prioritization of Vulnerabilities. Investigate the vulnerabilities of the U.S. telecommunications infrastructure due to dependence on the identified systems and components.

At the system level, ITS and NCS used import/export data published by the Bureau of the Census, U.S. Department of Commerce, to select the general category of Telephone Switching and Switchboard Equipment for this study. This category includes an overwhelming number of systems. After evaluating the available data and data sources, we limited the scope of the study to the area of telephone switching equipment (specifically, Class 5 central office telephone switches), developing a working approach using the Class 5 switch which then could be applied to other areas as appropriate. The Class 5 central office telephone switch was selected because of its widespread use, its significant importance within the telecommunications infrastructure, the limited number of U.S. manufacturers of this switch, and the perceived ease of collection of component- and system-level data. In addition, a fully configured Class 5 central office switch system uses nearly all of

the components that are used to manufacture smaller telecommunications systems, and thus provides a very good representation of the profile of the components used.

At the component level of the analysis, the goal was to identify components of the Class 5 switch that are wholly or primarily obtained from foreign sources. Information on Class 5 switch components and their sources was obtained from the switch manufacturers via questionnaire and on-site visits. ITS teamed with Dataquest Incorporated (a telecommunications market research firm) to develop the method for collecting component-level data. This method consisted of sending out a questionnaire soliciting preliminary information from each manufacturer of Class 5 switches, and then following up with an on-site visit.

This report identifies items obtained predominately from foreign sources by at least one manufacturer, and prioritizes these items by vulnerability. The identification of components, subassemblies, and consumables used to manufacture the Class 5 switch indicates only potential problems with foreign sourcing, should a condition arise that cuts off the supply of one or more of the predominately foreign-sourced items.

Mechanism to Assess Foreign Dependence

During Phase I of the study, ITS concluded that data required to perform the foreign dependency analysis was not available from statistical sources. A 1989 report written by the Office of Technology Assessment supports this observation (Kaminow, 1992). Telecommunications manufacturing is complex and rapidly changing. By the time information is gathered and processed it is most likely out of date. Statistics lose meaning and become convoluted when one considers the assumptions used in their development. Respondents to questionnaires often make assumptions as to the scope of a question when answering it, or may decline to answer the inquiry, thereby deselecting their input and skewing the results. Therefore, ITS decided that the questionnaire used in this study would be a preliminary step in the assessment process.

The Institute concluded that a research-oriented approach via face-to-face interviews with company personnel would be the most accurate, timely, and cost-effective mechanism. Such personal interaction proved to be successful.

During face-to-face interviews, the scope and purpose for the study were explained to the respondent. Personal inquiry helped overcome the company's reluctance to release information that, in some cases, is considered to be proprietary. Justification for the need of the information and the building of credibility with company representatives were key to the effort's success.

Questions during the visit were of a nature that (1) generated fruitful discussion of the problem, (2) were not too specific, and (3) encouraged continued involvement from the company. As a result, the interviews produced independent, useful, updated, and intelligible information. This approach was flexible and could be modified and redirected as necessary to achieve the objectives of the study.

Factors That Affect the Assessment Mechanism

Gathering proprietary data from manufacturers is a delicate process. Credibility must be established with the source, when marketing the need of the Government. The only justification the researcher has is based on benefits to the Nation. The following are factors that affect an assessment of this type.

Technical expertise. The interviewer must have a technical background in the telecommunications field. Technical knowledge enables the interviewer to collect the correct information by asking the correct questions and conversing, in depth, about the technical aspects of the manufacturer's product.

Establishment of rapport. A research-oriented approach proved to be necessary in obtaining reliable, useful, and timely information. The use of questionnaires or surveys was not fruitful in obtaining this information, primarily because the companies consider this information sensitive. The approach used during this study included making contact by telephone with personnel who were directly concerned with U.S. Government procurement. This contact provided researchers with a referral to the appropriate person within the organization who could provide the necessary information. The next step was to send the contact person a written explanation of the study goals and a list of questions that the ITS staff would like to ask. An on-site visit was then made to build a rapport with that person and their staff. In a face-to-face meeting with the manufacturer's representatives, up-to-date and accurate information was imparted, and an understanding was gained of the "real" foreign dependency issues faced by the manufacturer.

Information volatility. Foreign dependency information associated with areas of high technology is quite volatile. It is difficult to determine the stability of a sourcing situation—in some cases the sourcing of particular components may be in a "transition state," i.e., a foreign-sourced component may now be available in the U.S., or a technology turnover may obsolete a component that is foreign sourced. An example is the replacement of plastic coated relays with solid state relays—a transition that is on the horizon.

Availability of accurate information. Statistical data, published in periodic reports by the Government [e.g., The Bureau of the Census, DoC International Trade Administration (ITA), DoC Bureau of Export Administration (BXA)], cannot be segregated to obtain specific information about the telecommunications industry. Currently, Government-published information is obtained using a global type of gathering mechanism (i.e., questionnaire or request), and reports only end-user products. The component makeup of each telecommunications product is not reported by anyone in the Government or industry. Privately held companies in the U.S. specialize in data analysis that is directed toward a specific use, e.g., gauging the size of a particular market either within the U.S. or a specific area of the world (e.g., the Pacific Rim, the European Community, South America). Numerous reports are available; however, none of them are of value in determining the source of components used to build the equipment integral to the U.S. NS/EP telecommunications networks.

Summary of Findings

This study is an analysis of U.S. dependency on foreign components, assemblies, subassemblies, and raw materials used to manufacture the Class 5 telecommunications switch. The analysis of data collected from the various companies in this study was compiled and is presented in summary here. The information is not identified with a particular company for reasons of confidentiality. In separating the data from its source, we can provide a more clear picture of foreign source dependencies and the reasons for the dependence.

Some preliminary results from the collected data revealed:

- In general, dependency, as a total dollar value of components, is not getting worse. However, several isolated components continue to present a foreign dependence vulnerability, as discussed in the following section.

- Some of the significant technology-related foreign source dependencies identified appear common to most systems that utilize substantial micro-electronic components, commodity memory semiconductors, plastic-coated relays, and ferrite cores.

- U.S. firms have the advantage in terms of technology and innovation. However, some commonly cited disadvantages are capital costs, and U.S. economic and international trade policies and practices (GAD, 1992). An analysis of these disadvantages is beyond the scope of this study.

Components obtained primarily from foreign sources were found to be the same for all manufacturers. There are cases in which a U.S. manufacturer is dependent on the components from foreign sources due to a lack of implementation of a particular technology in the U.S. However, only very isolated cases exist where there are no suppliers in the U.S. of components or subassemblies that are obtained, in volume, from a foreign source.

In the high-tech arena, U.S. companies provide product engineering and prototype development. However, in many cases, the U.S. company is not competitive for volume production of that product. In some cases, a foreign supplier becomes the source for high-volume supply of some components.

An analysis of the semiconductor market indicates that the penetration of U.S. companies into the Japanese market is slightly lower than the penetration of Japanese companies into the U.S. market. The problem is fully evident in emerging technologies such as high-end memory and microcontroller devices.

Foreign-Sourced Component Categories

This study identifies two categories of components of Class 5 switches predominantly (over 50 percent) supplied by foreign sources to at least one U.S. company: the components themselves, and the materials and technology used in the manufacturing process for the

Class 5 switch. These components and materials are listed below in descending order of percent of product obtained from foreign sources, then discussed briefly.

Category 1. Foreign Dependency on Class 5 Switch Equipment Components

- Printed circuit board (PCB) mounted transformers
- Plastic-coated relays
- PCB assemblies
- Ceramic packages used for ruggedized semiconductor components
- Bare PCBs (fiberglass substrate)
- Ferrite products
- Semiconductors (high-capacity memory chips and microcontrollers).

PCB-mounted transformers. The assembly of these components is very labor intensive; thus countries with significantly lower labor rates are able to produce the PCB mounted transformer, in volume quantities, at a lower cost.

Plastic-coated relays. The plastic block (encapsulated) packaged relay replaces the older version commonly called a "reed relay." At present, all U.S. manufacturers of the Class 5 switch state that they are purchasing nearly 100 percent of their relays from the Pacific Rim countries.

PCB assemblies. The foreign sourcing of PCB assemblies is a result of the use of contractors (or manufacturing plants) outside the U.S. to perform the assembly and test of the PCB subassemblies that become components of the Class 5 switch.

Ceramic packages. This type of package is used for ruggedized semiconductor devices used in high-reliability applications. There is recent concern by U.S. manufacturers that the U.S. military is dependent on foreign sources of ceramic packages (Leopold, 1992).

Bare PCB substrate. A slightly less than 100-percent dependence on foreign sources was noted for PCB substrates (fiberglass material). U.S. manufacturers are capable of producing this material in quantity. No explanation was discovered for the reason why the U.S. companies cannot compete.

Ferrites. Ferrite cores (used for transformers, ferrite beads, and noise blocking devices).

Semiconductors. Foreign source dependence for semiconductors varies with the type of device. In mid 1992, when this study was completed, volume shipments of Application Specific Integrated Circuits (ASICs) and memory devices with up to 1 Mbit capacity were readily available from U.S. manufacturers at competitive prices. Memory devices with larger than 1 Mbit storage capacity were primarily sourced from outside the U.S. However, U.S. manufacturers are able to produce devices with capacities of 4 Mbits and larger in prototype quantities. U.S. manufacturers are dependent on foreign sources for microcontrollers used in volume by the automobile industry (e.g., for antilock brake control systems, and air bag actuators).

Category 2. Foreign Sourcing of Materials and Technology Used in the Manufacturing Process for the Class 5 Switch

- Consumables (petrochemical-based items such as solvents, solder paste, adhesives)
- Raw silicon (silicon ingots or wafers)
- Manufacturing process equipment (primarily for the microelectronic manufacturing process)
- Photolithography equipment and technology
- Metals (such as copper, aluminum, gold, silver, and zinc).

Some of the equipment used in the assembly process of the Class 5 switch is also foreign dependent. Such equipment includes conveyors, robotics, test equipment, surface mount technology (SMT) PCB process equipment, certain machine tools, and photolithography equipment (required to manufacture microelectronic chips).

The manufacturing process is dependent on certain consumable materials (i.e., solvents, adhesives, paper products, plastics, specially formulated compounds, and raw materials). The specific items found to be dependent on foreign sources include solder paste, raw silicon ingots, adhesives, gold/silver/copper-coated connectors and contacts, copper wire, aluminum, gallium arsenide, and filter glass.

A global source analysis, derived from data collected during this study, is shown in Figure ES-2. The actual proportion for each segment of the graph will very for each company. The foreign source dependence discovered in this study is concentrated in the Pacific Rim area.

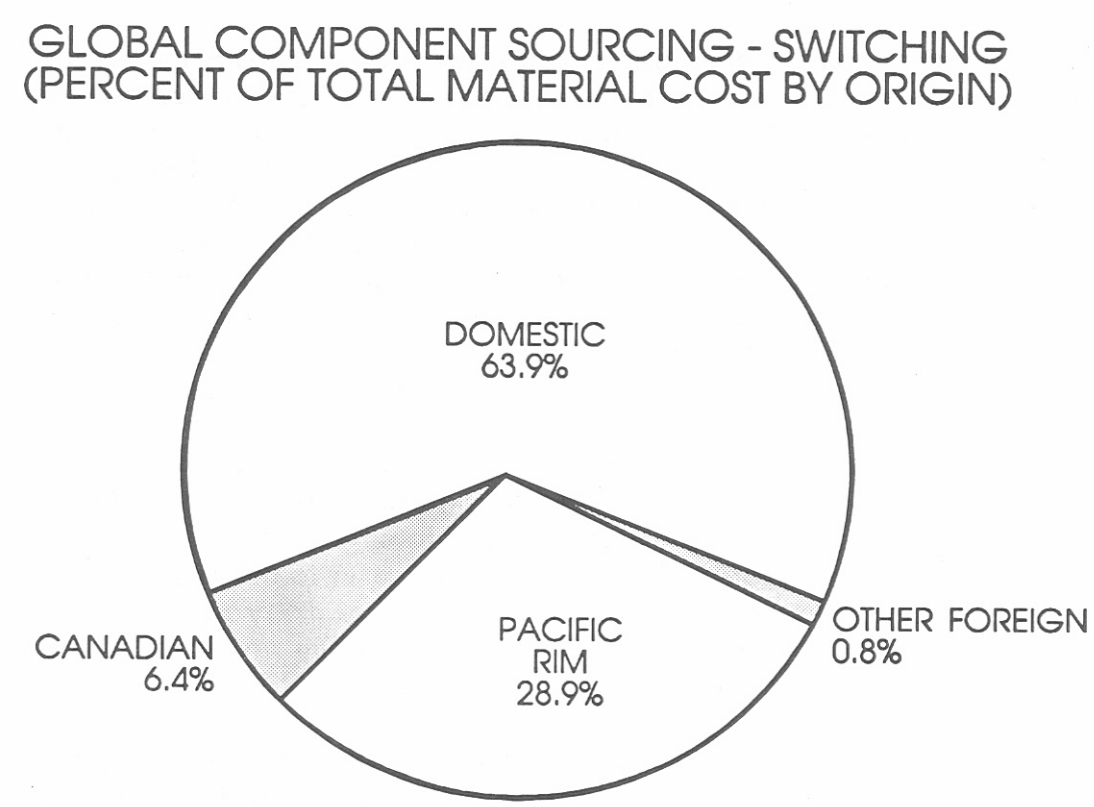

Figure ES-2. A global source analysis for Class 5 switch equipment.

Factors Cited That Affect Foreign Dependence

Foreign source dependencies in the areas discussed in this study are generally a result of a U.S. company's inability to compete with foreign companies. A conspectus of the reasons why U.S. companies are not able to compete follows.

Technology Outflow. This is commonly referred to as "technology giveaway." A number of examples can be cited illustrating the acquisition of technology by organizations outside the U.S., which has resulted in a loss of technology and, subsequently, a loss in the U.S. lead in system-level technology development. A study completed by the Institute for Defense Analyses (IDA) in 1990 (Heginbotham et al., 1990) summarizes the situation very well. The IDA report states that "dependence on foreign sources should be viewed less in terms of risk of potential foreign denial or disruption, and more in terms of risk of U.S. ability to remain in the lead in system development."

Environmental Concerns. Many of the countries that are competing successfully (offering components at lower cost) do not have the same restrictions for toxic waste disposal, disposal of solvents and other chemicals, safety of employees, etc. that inflate the overhead of doing business in the U.S. The additional overhead must be reflected in the cost of production.

Tax Laws. Most companies operating in countries outside the U.S. are subject to more favorable tax depreciation limitations than companies in the U.S. For example, a U.S. manufacturer must depreciate a capitalized asset (in this case a factory production line) in no less than 7 years, and there is no Initial Tax Credit (ITC). A foreign counterpart (competitor) can depreciate the full capitalized asset value, in some cases, the first year (similar to a 100-percent ITC), or over whatever period provides the greatest tax benefit. The current telecommunications equipment technology turnover (a combination of product technology enhancement and factory automation enhancement) is about 18 months, requiring recapitalization of the production line every 18 months. As a result, the U.S. manufacturer is not able to take full advantage of the depreciation tax benefit.

A similar situation exists for the user of telecommunications equipment (e.g., a Class 5 switch). A major feature turnover (similar to a technology turnover) or upgrade is necessary on a 4- to 6-year cycle. The user is obliged to upgrade to keep up with the latest technology to remain competitive. Tax law allows the user to depreciate the equipment over no less than 15 years. Recapitalization is required at every major upgrade (major expenditure), or every 4 to 6 years. The end user is in a similar predicament to that of the factory; the full advantage of tax depreciation cannot be realized.

The "Hot Toy" Problem. Commercial products have become increasingly more "high-tech," and frequently use the same type of electronic devices (e.g., microprocessors, memory chips, digital signal processors (DSPs), and displays) that are used in the latest technology telecommunications equipment. Manufacturers of these products compete for the supply (and inventory) of these devices throughout the year. Usually distributors and manufacturers of these devices can factor in the inventory to supply all of the demand requirements. However, at certain times of the year the demand for these devices is increased to meet the seasonal requirements—for example, during the late summer decisions are made as to which toys and other commercial products will be "hot items" during the holiday shopping period (December-January). Inventories during this period become very low, or in some cases, may be depleted. If a sudden demand, due to a disaster or hostile activity, for more telecommunications equipment or spare parts coincides with the "hot toy" manufacturing period, the telecommunication production requirement may not be met. Certain manufacturers have stated that their manufacturing process has been affected by a "glitch" of this type in the supply system.

The Erosion of Technology. The U.S. is not as competitive in volume production of components that rely upon emerging technologies, resulting in foreign dependence for high-end components. These areas include large-capacity dynamic random access memories (DRAMs), reduced instruction set computing (RISC) technology, narrow-line-width photolithography, and flat panel displays (Heginbotham et al, 1990). For the most part, U.S. companies developed these technologies, and foreign companies have applied the technologies, and have subsequently developed the process for high-volume production.

The decision by the DoD to rely more on commercial components and technologies has caused some concern because many of the commercial components (i.e., off-the-shelf) are procured from foreign sources (Van Atta and White, 1992). The DoD has put into place

the procedures and personnel to support the DoD in times of NS/EP mobilization situations.

Other Related Facts

Some of the foreign-sourced items, discussed previously, (e.g., some types of consumables, raw materials, and precious metals) can be critical to the manufacturing process of other items within the telecommunications infrastructure. For example, components such as copper wire, aluminum cable sheath, telephone poles, dies used to color parts within the cable, and the polyethylene used for the cable sheath, all require foreign-sourced raw materials.

The manufacturing process of many of the components listed above are dependent on raw materials that are petrochemical based. For example, petrochemicals are used to formulate the creosote used to treat telephone poles (to retard decay of the wood). An item as simple as a telephone pole can be a "show stopper." A recent example illustrates this point: the Regional Bell Operating Companies (RBOCs) providing service in the geographic area affected by Hurricane Hugo (along the East Coast in 1990) experienced shortages of telephone poles and the associated hardware. The hurricane traversed through three RBOCs as it passed up the coast. The first RBOC affected placed replenishment orders for telephone poles, depleting the supply. Subsequent orders to suppliers required production of more poles, resulting in a depletion of the creosote used to treat the poles. As the chain of events progressed, the result was a shortage of petrochemicals used in the manufacture of creosote. This story illustrates the complexity of the supply chain and the difficulty in identifying possible foreign source problems.

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See attached sheet

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An Assessment of the U.S. Telecommunications Industry Dependence on Foreign Sources as it Impacts the U.S. Telecommunications Infrastructure

Volume I: An Executive Summary -- Volume II: Background Information

ABSTRACT

The National Communications System (NCS) is responsible for defining operational infrastructures and processes that could be detrimental to the provision of telecommunications equipment and services that are necessary to the National Security and Emergency Preparedness (NS/EP) needs of the Nation. To this end, the President's national Security Telecommunications Advisory Committee (NSTAC) studied the industry's dependence on various infrastructures within the United States to: (1) identify possible impediments to effective telecommunications industry mobilization, and to (2) assist in the development of corrective actions to overcome any identified impediments. This study was published in 1989. The information presented in this report is a result of follow-on investigations that attempt to determine those components and materials used in the telecommunications equipment manufacturing process that are obtained from foreign sources. This report lists those components that are primarily procured from foreign sources. for example, plastic-coated relays, printed circuit mounted transformers, and some types of semiconductors are a few of the components that represent vulnerabilities in the telecommunications switch (Class 5) manufacturing process. A result of this study is an analysis of the trends that are evident between the 1989 study results and the results of this report. This report shows an increase in the components that are obtained almost exclusively from sources outside the U.S. and Canada. A contributing factor to the trend toward more foreign sourcing of components is the general trend toward a more global economy. In the final analysis, one must determine the components, and their sources, that could be the most detrimental to the mobilization of the Nation's telecommunications resources if these sources were no longer available. A determination of the sources that are most likely to be cut off is also important. An analysis of the circumstances that could result in the cut off of foreign sources is not part of this study.

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