

# The Economic Impact of Commercial Space Transportation on the U.S. Economy



**Associate Administrator for  
Commercial Space Transportation  
Federal Aviation Administration  
U.S. Department of Transportation**

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## CURRENCY CROSSRATES

Country	Jan 00	Jan 01	Jan 02	Jan 03	Jan 04
Canada	1.3127	69.974	24.495	26.624	28.268
ECU	1.2095	2.1023	1.8724	8.1044	7.7448
France	82665	1.2046	82214	86432	45734
Germany	1.4936	4.2026	4.8781	84127	3.8013
Italy	1.9364	2.4156	2.1848	1.701	
Japan	204.7	161.2	146.3	137.6	128.8



## Executive Summary

*The Economic Impact of Commercial Space Transportation on the U.S. Economy* is the Federal Aviation Administration Associate Administrator for Commercial Space Transportation's (FAA/AST) first study of the U.S. commercial launch industry's effect on the nation's economy. This report is a quantitative analysis of the extent to which commercial space transportation is responsible directly and indirectly for supporting a variety of space and non-space-related industries, thereby contributing to production and generating jobs in the United States.

Monies are generated in the U.S. economy from the manufacture and purchase of commercial launch vehicles as well as from the commercial space activities "enabled" by the launch industry. This report examines the U.S. commercial launch vehicle industry and the enabled commercial space activities together, as both are needed to assess fully the impact of commercial space transportation on the U.S. economy. The industries analyzed include launch vehicle manufacturing; satellite and ground equipment manufacturing; satellite services; remote sensing; and distribution industries. The impacts quantified in this report are based on data for the year 1999.

The economic impacts measured for the commercial space transportation industry and the industries it enables include economic activity (revenues), earnings of employees, and jobs. This report assesses the *full economic impact* of the commercial launch industry and the industries it enables; it does not simply present the revenues and employment statistics for the commercial launch industry and enabled industries. The figures herein reflect the economic activity, employee earnings, and number of jobs generated not only within these industries but also within the industries they support directly and indirectly.

U.S. economic activity linked to the commercial space industry in 1999 totaled over \$61.3 billion. Commercial space transportation was directly and indirectly responsible for \$16.4 billion in employee earnings in the United States. Over 497,000 people were employed in the United States as a direct or indirect result of commercial space transportation and enabled industries. Commercial space transportation and the industries it enabled affected the economic activity, employee earnings, and number of jobs in all major U.S. industry sectors.

# Introduction

*The Economic Impact of Commercial Space Transportation on the U.S. Economy* is the Federal Aviation Administration Associate Administrator for Commercial Space Transportation's (FAA/AST) first study of the U.S. commercial launch industry's effect on the nation's economy.<sup>1</sup> This report is a quantitative analysis of the extent to which commercial space transportation is responsible directly and indirectly for supporting a variety of space and non-space-related industries, thereby contributing to production and generating jobs in the United States. Commercial space transportation and the industries it impacts bear not only on the national economy but also on regional and local economies across the country.

Since the passage of the *Commercial Space Launch Act* and the ban of commercial payloads from flying aboard the Space Shuttle after the *Challenger* disaster in the mid-1980s, the U.S. commercial launch industry has emerged as a viable alternative for access to space for both commercial and government payloads. Today, commercial vehicles remain the only mode of transportation to space available in the United States for non-government payloads.

<sup>1</sup> This study classifies commercial launches as one or more of the following:

- Internationally competed launch events (i.e., launch opportunities considered available in principle to competitors in the international launch services market)
- Any launches licensed by the Associate Administrator for Commercial Space Transportation of the Federal Aviation Administration (FAA/AST) under U.S. Title 49, Section 701, Subsection 9 (previously known as the *Commercial Space Launch Act*)

This definition can include the launch of government payloads on commercial vehicles.

U.S. launch vehicle manufacturers and service providers offer boosters of many sizes to accommodate a variety of lift-capacity needs and continue to introduce new vehicles to the market.

Monies are generated in the U.S. economy from the manufacture and purchase of commercial launch vehicles as well as from the commercial space activities the launch industry enables. Indeed, the commercial launch industry has promoted the development of businesses that build satellites, sell satellite communications services and satellite imagery, and manufacture ground equipment necessary to operate satellites and use satellite services. Responsible for billions of dollars of U.S. production each year, these industries are examined here in tandem with the commercial launch industry to assess the full impact of commercial space transportation on the U.S. economy. This report refers to the commercial space industries that depend on commercial space transportation as "enabled" industries.

## Industries Included in Analysis

A complete list of the industries included in the calculation of economic impacts is shown below. The list comprises the commercial launch industry as well as the industries that commercial space transportation enables.

- **Launch vehicle manufacturing** includes the manufacture of launch vehicles and the provision of launch services.
- **Satellite and ground equipment manufacturing** are combined in this report due to limitations of the model used in this study. Satellite manufacturing

includes the construction and sale of satellites. Ground equipment manufacturing includes satellite-related hardware (e.g., gateways and satellite control stations), mobile uplink equipment, Very Small Aperture Terminals (VSATs), and consumer electronics used with satellite services (e.g., Direct Broadcast Satellite dishes, phone booths, and handheld phones).

- **Satellite services** include both end-user services and transponder leasing. End-user services include telephony, VSAT services, mobile data services, and direct-to-home television (DTH). Transponder leasing services are offered by companies that operate satellites and lease or sell satellite transponder capacity on a full-time or occasional use basis.
- **Remote sensing** includes the provision of raw data and satellite imagery services. It does not account for the sales by firms that digitally process imagery and combine it with additional information to create maps, databases, or other value-added products.
- **Distribution industries** represent wholesale, retail trade, and transportation industries that facilitate inter-industry transactions. Distribution industries must be considered in any comprehensive economic impact analysis because of the transit costs (e.g., trucking, air transportation) incurred as goods and services flow between industries. These distribution impacts were calculated along with the above industry groups.

## Source Data

The revenue information in this report is derived from the results of the Satellite Industry Association's (SIA) annual *Satellite Industry Indicators Survey*. SIA has conducted an annual survey of over 700 companies within the global space industry for the last four years. The survey output is the total revenue of the commercial space industry, including the launch, satellite manufacturing, satellite services, and ground equipment sectors, broken into U.S. and world revenue numbers.

This report considers only U.S. revenues and impacts of "commercial" launches as defined in Footnote 1. The data does not account for impacts on the economy of industries and activities enabled by launches from the Space Shuttle and non-commercial expendable launch vehicles, such as revenues from the manufacture of Global Positioning System (GPS) satellites and sales of handheld GPS navigation devices.

The impacts quantified in this report use data for the year 1999. Appendix A lists the commercial launches that took place from the United States that year.

## Approach

This impact study utilizes conventional and accepted methods to quantify the economic value of financial transactions that are associated directly or indirectly with commercial space transportation. The flow of funds is traced through the economy in order to identify which industry types benefit and by how much. Economic impacts measured herein include economic activity (revenues),



earnings of employees, and jobs. In this report, the impacts are shown for the national economy, with the understanding that the national economy is an aggregation of the regional economies throughout the United States.

It is important to recognize that this report assesses the *full economic impact* of the commercial launch industry and the industries it enables; it does not simply present the revenues and employment statistics for the commercial launch industry and enabled industries. The figures herein reflect the economic activity, employee earnings, and number of jobs generated not only within these industries but also within the industries they support directly and indirectly.

Commercial space transportation and enabled industries are responsible for both economic *impacts*—measurable financial transactions that occur throughout the production of a good or service—and *benefits*—immeasurable effects that result from the availability of goods and services—to the U.S. economy. This study examines only impacts. Benefits enabled by commercial space transportation, such as increased efficiency and decreased transaction time for large firms dependent on satellite communications, are not included herein, as these benefits are nearly impossible to quantify objectively. Appendix B, however, offers a qualitative discussion of some such benefits.

This study follows FAA-recommended procedures for economic impact analysis. Included in FAA-recommended procedure is the use of the Regional Input-Output Modeling System (RIMS II) developed by the Department of Commerce Bureau of Economic Analysis.

## RIMS II

RIMS II is an economic input-output model developed by the Department of Commerce Bureau of Economic Analysis to map the flow of goods and services within the U.S. economy and to illustrate the interconnection of producers and consumers. The model is used to measure individual industries' contributions to the economy. Appendix C explains the way in which RIMS II was used to generate the data for this study. Appendix D elaborates the translation of the aforementioned industries into applicable categories for use with RIMS II.

# Measuring Economic Impacts

Economic impact is measured in three ways: economic activity (revenues), earnings, and jobs. Economic activity, earnings, and jobs measure the same economic impact in different ways: some in dollars and others in numbers of jobs. Because they measure the same impact, they cannot be added together.

- **Economic activity** is the value of goods and services produced in an economy. In this study, economic activity includes the goods and services produced by commercial space transportation and enabled industries plus the goods and services produced by all other industry groups affected by the above industries.
- **Earnings** refers to the sum of all the wages and salaries (including employee benefits) paid to employees in an economy. In this study, earnings include wages and salaries paid to all persons employed by commercial space transportation and enabled industries, plus those employed by all other industry groups affected by the above industries.


- **Jobs** refers to the number of workers employed to produce goods and services in an economy. In this study, jobs includes all workers employed by commercial space transportation and enabled industries, plus those employed by all other industry groups affected by the above industries.

The total economic impact of commercial space transportation and its enabled industries in 1999 is summarized in Table 1.

Commercial space transportation was responsible for \$61.3 billion in economic activity in 1999, including \$30.8 billion generated by the manufacture of satellites and ground equipment. Satellite services generated \$25.8 billion in economic activity. As financial transactions rippled through the economy, distribution industries such as truck and air transportation added to the economic activity. Distribution industries were responsible for economic activity of over \$873 million because of commercial space transportation and other enabled industries.

Industry	Economic Activity (\$000)	Earnings (\$000)	Employment (Jobs)
Launch vehicle manufacturing	\$ 3,515,978	\$ 1,071,722	28,617
Satellite & ground equipment manufacturing	30,869,469	8,858,293	270,448
Satellite services	25,818,414	6,150,105	186,954
Remote sensing	235,879	85,292	2,820
Distribution industries	873,971	265,780	8,506
<b>Total Impact</b>	<b>\$ 61,313,711</b>	<b>\$ 16,431,192</b>	<b>497,346</b>

*Table 1: Total Impacts on the U.S. Economy Generated by Commercial Space Transportation and Enabled Industries, 1999*



The amount of the total economic impact for all of these activities was more than four times NASA's 1999 budget of \$13.6 billion.

As a result of economic activity in the commercial space transportation and enabled industries, employees in all industry groups earned a total of \$16.4 billion in salaries and wages. Commercial space transportation and enabled industries engendered over 497,000 total jobs throughout the economy.

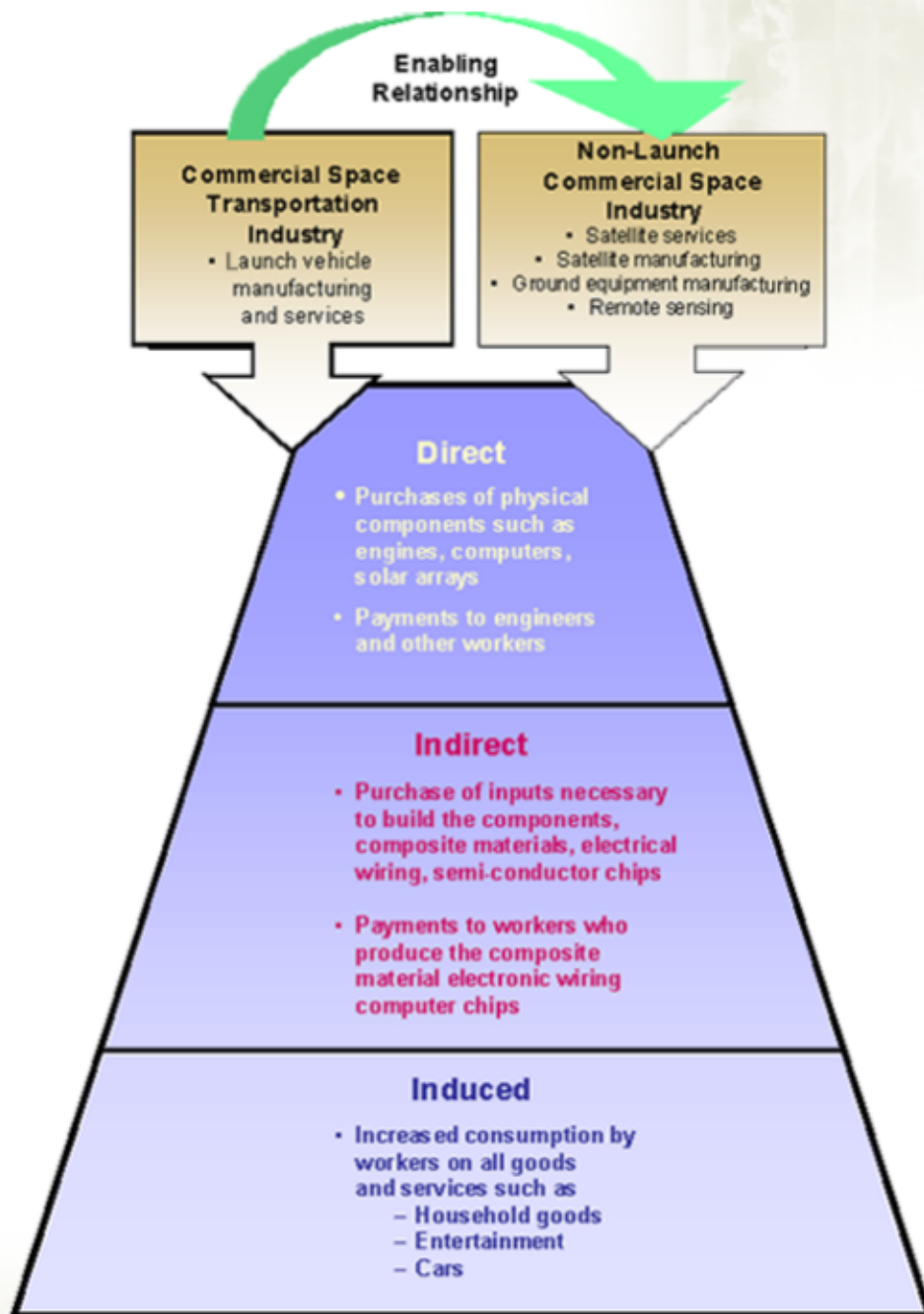
The economic impacts calculated in this study comprise those financial transactions that can be traced to commercial space transportation and enabled industries and which are of value to the nation's economy and its citizens. The impacts are real and quantifiable; hypothetical or subjective impacts are not considered. Each measure of economic impact (economic activity, earnings, jobs) has three components.<sup>2</sup>

- **Direct impacts** are the expenditures on inputs and labor involved in the provision of any final good or service relating to the industries analyzed herein.
- **Indirect impacts** involve the purchases (e.g., silicon, copper wire) made by and labor supplied by the industries that provide inputs to the launch and enabled industries. This impact quantifies the inter-industry trading and production necessary to provide the final goods and services.
- **Induced impacts** are the successive rounds of increased household spending that result from the direct and indirect impacts (e.g., a launch vehicle engineer's increased spending on household goods and services).

The full economic impact of the commercial launch industry and the industries it enables cannot be assessed without adding together all three of these components of impact. The figures herein thus reflect the economic activity, employee earnings, and number of jobs generated not only within these industries but also within the industries they support directly and indirectly.

These components of economic activity can be viewed as having a cascading effect on the nation's economy, as shown in Figure 1. The output of the commercial space transportation and enabled industries yields direct impacts, which in turn result in indirect and finally induced impacts. Thus, commercial space transportation results in payments to workers including personnel working for launch service providers, steelworkers that provide materials for launch vehicles and satellites, and food service employees that feed all of these workers. Workers then re-spend these payments in local economies.

<sup>2</sup> The direct, indirect, and induced components are broken out only for economic activity in this report. RIMS II does not make these distinctions for earnings and jobs.



*Figure 1: Diffusion of Economic Activity throughout the U.S. Economy*



## Economic Activity

The cascading effect illustrated on the previous page can be quantified for economic activity as illustrated in Table 2. The direct, indirect, and induced impacts on economic activity stemming from each industry group are presented.

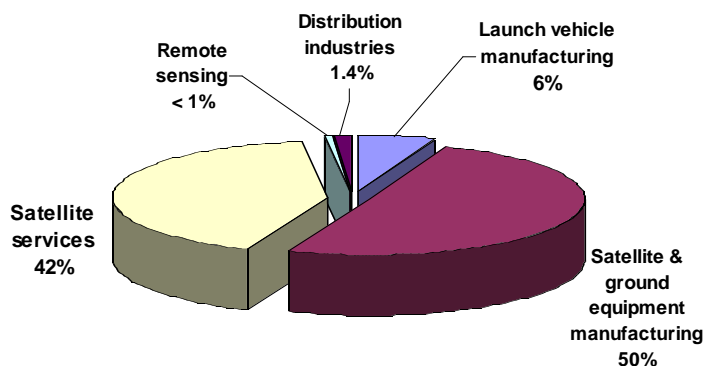
Adding together the direct, indirect, and induced impacts yields the total impact on the U.S. economy.

INDUSTRY	DIRECT	INDIRECT	INDUCED	TOTAL IMPACTS
Launch vehicle	\$ 489,027	\$ 1,580,890	\$ 1,446,061	\$ 3,515,978
Satellite & ground equipment manufacturing	4,537,356	14,385,166	11,946,947	30,869,469
Satellite services	4,483,698	13,042,696	8,292,020	25,818,414
Remote sensing	27,475	93,366	115,038	235,879
Distribution industries	106,873	408,615	358,483	873,971
<b>Impact Totals</b>	<b>\$ 9,644,429</b>	<b>\$ 29,510,733</b>	<b>\$ 22,158,549</b>	<b>\$ 61,313,711</b>

*Table 2: Economic Activity Impacts of Commercial Space Transportation and Enabled Industries, 1999 (\$000)*

Figure 2 shows the relative proportion that each of the five industry groups analyzed contributed to total economic activity in 1999. The largest single industry sector enabled by commercial space transportation was satellite services, which led to 42 percent of the total economic activity. The combination of satellite and ground equipment manufacturing was responsible for 50 percent of total economic activity.<sup>3</sup>

While the enabled industries generate 94 percent of the total economic activity, launch vehicle manufacturing generates just 6 percent. This figure suggests that the launch vehicle manufacturing industry primarily functions in the economy as an enabler of other industries.



*Figure 2: Total Economic Activity Resulting from Commercial Space Transportation and Enabled Industries, 1999.*

<sup>3</sup> In this study, satellite manufacturing and ground equipment manufacturing were grouped together for use with the RIMS II model. Although these industries have different Standard Industry Classification (SIC) codes, they share a RIMS II Input-Output (I-O) code because of similar manufacturing processes, as shown in Appendix D.

## Commercial Space Transportation's Impact on Major U.S. Industries

The impacts included in this report are those involved in the provision or use of commercial space transportation and enabled industries, plus the impacts associated with supplier industries and household spending. Although these industry types are seemingly unrelated to commercial space transportation, they are included because they provide goods and services, directly or indirectly, to the commercial space industry or they benefit from the re-spending of money.

Table 3 illustrates the economic impacts the commercial space transportation industry and enabled industries had on major U.S. industry groups in 1999. The values represent total economic activity.

The *electronic and other electric equipment* industry group benefited the most from the activity of the commercial space transportation industry, generating \$13.7 billion of output as a result of the demand for commercial space transportation and enabled industries' goods and services. In addition, about 20 percent of the total impact, or \$12.5 billion of output, was generated by the *communications* industries. *Business services*, which includes financial and consulting services, and *real estate*, which includes property for production facilities and office space, also benefited significantly from economic activity of commercial space transportation and enabled industries. The *chemicals and allied products* industries contributed \$1.3 billion to the total economic activity and the construction industry generated \$1.2 billion during 1999 as a result of commercial space transportation activity. *Wholesale and retail trade* together added \$4.4 billion to the total U.S. output.

*Table 3: Annual Economic Activity Generated by Commercial Space Transportation and Enabled Industries for Major U.S. Industry Sectors, 1999*

Industry Groups	Annual Economic Activity (\$000)
Farm products and agricultural, forestry, and fishing services	615,608
Forestry and fishing products	21,416
Coal mining	90,554
Oil and gas extraction	322,265
Metal mining and nonmetallic minerals, except fuels	53,752
Construction	1,163,905
Food and kindred products and tobacco products	1,337,520
Textile and mill products	177,531
Apparel and other textile products	199,867
Paper and allied products	514,066
Printing and publishing	843,833
Chemicals and allied products and petroleum and coal products	1,310,756
Rubber and miscellaneous plastic products and leather and leather products	550,772
Lumber and wood products and furniture and fixtures	256,863
Stone, clay, and glass products	129,877
Primary metal industries	790,439
Fabricated metal products	918,449
Industrial machinery and equipment	634,197
Electronic and other electric equipment	13,693,837
Motor vehicles and equipment	387,122
Other transportation equipment	1,491,876
Instruments and related products	232,589
Miscellaneous manufacturing industries	112,361
Transportation	1,434,547
Communications	12,494,470
Electric, gas, and sanitary services	1,110,644
Wholesale trade	2,558,607
Retail trade	1,893,617
Depository and nondepository institutions and security and commodity brokers	1,594,747
Insurance	818,194
Real estate	3,639,350
Hotels and other lodging places, amusement and recreation services, and motion pictures	1,789,076
Personal services	338,655
Business services	3,278,101
Eating and drinking places	870,792
Health services	2,057,098
Miscellaneous services	1,586,357
<b>TOTAL</b>	<b>61,313,711</b>

## Earnings

Commercial space transportation and enabled industries were responsible, directly or indirectly, for helping Americans in all industries take home \$16.4 billion in earnings.

Satellite and ground equipment manufacturers together generated a \$8.9 billion impact on earnings. Satellite services' impact on earnings was \$6.2 billion, while distribution industries yielded a total impact of \$265.8 million. Launch vehicle manufacturing alone was responsible for \$1.1 billion in earnings by employees of all industry sectors that it directly or indirectly affected.

Table 4 indicates how earnings in each major U.S. industry sector were impacted as a result of commercial space transportation and enabled industries in 1999. The *electronic and other electric equipment* sector had the highest earnings, totaling over \$4 billion. The *communications* sector paid its workers \$2 billion, and the *business services* sector wrote \$1.5 billion in paychecks.

*Table 4: Distribution of Earnings throughout Major U.S. Industry Sectors, 1999*

Industry Groups	Annual Earnings (\$000)
Farm products and agricultural, forestry, and fishing services	162,623
Forestry and fishing products	2,211
Coal mining	23,851
Oil and gas extraction	45,567
Metal mining and nonmetallic minerals, except fuels	12,874
Construction	444,249
Food and kindred products and tobacco products	158,619
Textile and mill products	34,613
Apparel and other textile products	48,057
Paper and allied products	91,692
Printing and publishing	256,560
Chemicals and allied products and petroleum and coal products	191,396
Rubber and miscellaneous plastic products and leather and leather products	122,142
Lumber and wood products and furniture and fixtures	58,655
Stone, clay, and glass products	33,188
Primary metal industries	146,474
Fabricated metal products	271,216
Industrial machinery and equipment	163,590
Electronic and other electric equipment	4,004,718
Motor vehicles and equipment	55,445
Other transportation equipment	490,337
Instruments and related products	66,405
Miscellaneous manufacturing industries	28,969
Transportation	511,964
Communications	2,099,856
Electric, gas, and sanitary services	151,719
Wholesale trade	886,309
Retail trade	714,763
Depository and nondepository institutions and security and commodity brokers	475,439
Insurance	300,922
Real estate	167,045
Hotels and other lodging places, amusement and recreation services, and motion pictures	668,957
Personal services	141,071
Business services	1,539,765
Eating and drinking places	276,281
Health services	1,027,463
Miscellaneous services	556,188
<b>TOTAL</b>	<b>16,431,192</b>

## Jobs

The commercial space transportation industry and enabled industries created directly and indirectly a need for 497,346 jobs across major U.S. industry sectors in 1999. Many industries that are not generally associated with commercial space transportation benefited, such as *construction, printing and publishing, and real estate.*

Table 5 shows how these jobs were distributed among the major industry sectors of the U.S. economy. The industry that was most affected by commercial space transportation and related industries was *electronic and other electric equipment*, this is not surprising given the technologically advanced nature of these industries. In 1999, *business services* employed 48,586 people as a result of commercial space transportation and enabled industries. The *communications* sector was able to employ 42,898 people.

*Table 5: Distribution of Jobs throughout Major U.S. Industry Sectors, 1999*

Industry Groups	Total Jobs
Farm products and agricultural, forestry, and fishing services	11,072
Forestry and fishing products	126
Coal mining	388
Oil and gas extraction	774
Metal mining and nonmetallic minerals, except fuels	284
Construction	14,625
Food and kindred products and tobacco products	5,063
Textile and mill products	1,320
Apparel and other textile products	2,392
Paper and allied products	2,166
Printing and publishing	7,353
Chemicals and allied products and petroleum and coal products	2,765
Rubber and miscellaneous plastic products and leather and leather products	3,886
Lumber and wood products and furniture and fixtures	2,306
Stone, clay, and glass products	911
Primary metal industries	3,103
Fabricated metal products	8,128
Industrial machinery and equipment	3,622
Electronic and other electric equipment	95,528
Motor vehicles and equipment	1,075
Other transportation equipment	7,809
Instruments and related products	1,279
Miscellaneous manufacturing industries	1,114
Transportation	16,209
Communications	42,898
Electric, gas, and sanitary services	2,194
Wholesale trade	22,829
Retail trade	42,453
Depository and nondepository institutions and security and commodity brokers	11,347
Insurance	7,920
Real estate	10,117
Hotels and other lodging places, amusement and recreation services, and motion pictures	24,452
Personal services	9,259
Business services	48,586
Eating and drinking places	24,150
Health services	29,960
Miscellaneous services	27,882
<b>TOTAL</b>	<b>497,346</b>



## Considerations for the Future

This report has attempted to quantify the economic impacts on the U.S. economy of an industry still in its infancy. Indeed, the developing nature of the commercial space industry was reinforced in the very input-output model used in this study. At the time this analysis was performed, the RIMS II model could not evaluate specific space-related industries in isolation, as they tended to be grouped with non-space industries. As a result, the analysis presented herein may not capture—or depict in the most ideal manner—all of the impacts generated by commercial space transportation and enabled industries.

The input-output tables used for RIMS II are being updated and are scheduled for release in 2002. Both the standard industry classifications (SICs) and the inter-industry transactions that form the source data for RIMS II will be refined and should better represent certain facets of the space industry. An analysis performed using the new information would undoubtedly yield a more accurate picture of the commercial space transportation industry's impact on the U.S. economy.

An additional useful assessment of the scope of the launch industry's impact would be a region-by-region or state-by-state analysis of the industry's impacts. Such a study would identify the extent to which various regions in the United States benefit from commercial space activities.

In the coming years and decades, commercial space transportation will enable additional enterprises and industries. Examples of some such activities and businesses may include:

- State- or commercially-owned spaceports
- Satellite Internet content delivery
- Improved disaster relief and emergency communications
- Satellite-aided agriculture
- Sub-orbital fast-package delivery
- Space manufacturing
- Space tourism
- Exploitation of extraterrestrial resources
- Space solar power

The extent to which these activities could impact the U.S. economy is still unknown, but the prospects are enticing. Commercial space transportation will remain an essential element in making these activities possible.

## Appendix A: 1999 U.S. Commercial Launch Events

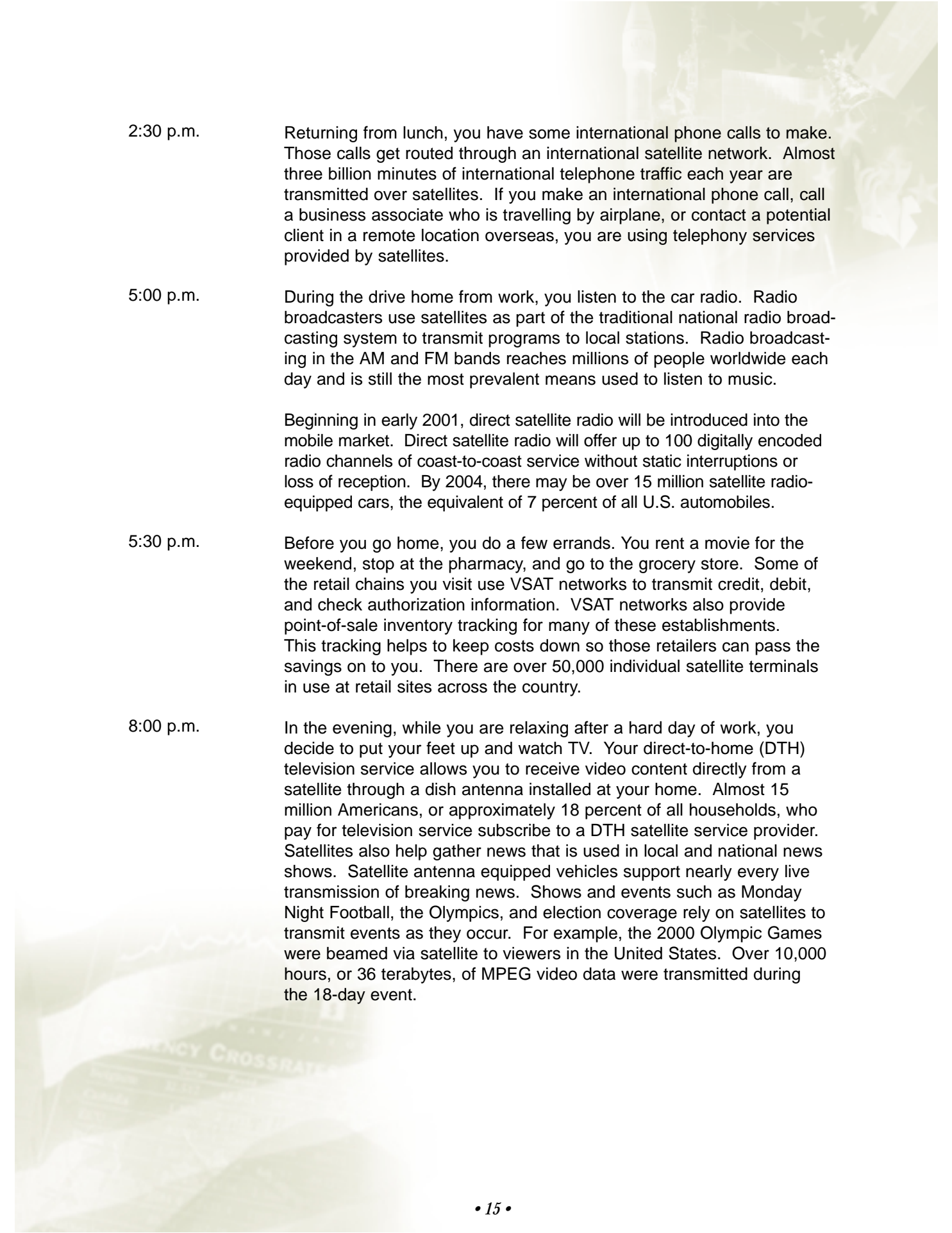
Date	Vehicle	Site	Payload	Operator	Manufacturer	Use	Comml Price	L	M
1/26/99	Athena 1	Spaceport Florida	Formosat-1	Natl. Space Prog. Office (NSPO)	TRW	Development	\$16-17 M	S	S
2/16/99	Atlas 2AS	CCAFS	* JCSAT 6	Japan Satellite Systems	Hughes	Communications	\$90-105 M	S	S
3/27/99	Zenit 3SL	Odyssey	* Demosat	Sea Launch	Hughes	Test	\$75-95 M	S	S
4/12/99	Atlas 2AS	CCAFS	* Eutelsat W3	Eutelsat	Aerospatiale	Communications	\$90-105 M	S	S
4/27/99	Athena 2	VAFB	* IKONOS 1	Space Imaging Inc.	Lockheed Martin Corp.	Remote Sensing	\$22-26 M	F	F
5/4/99	Delta 3	CCAFS	* Orion F3	Orion Network Systems	Hughes	Communications	\$75-90 M	F	F
5/17/99	Pegasus XL	VAFB	TERRIERS MUBLCOM	Boston University/NASA ARPA	AeroAstro Orbital Sciences Corp.	Scientific Communications	\$12-15 M	S	F
6/10/99	Delta 2 7420	CCAFS	* Globalstars 25,47,49,52	Globalstar, Inc.	Space Systems/Loral	Communications	\$45-55 M	S	S
7/10/99	Delta 2 7420	CCAFS	* Globalstars 30,32,35,51	Globalstar, Inc.	Space Systems/Loral	Communications	\$45-55 M	S	S
7/25/99	Delta 2 7420	CCAFS	* Globalstars 26,28,43,48	Globalstar, Inc.	Space Systems/Loral	Communications	\$45-55 M	S	S
8/17/99	Delta 2 7420	CCAFS	* Globalstars 24,27,53,54	Globalstar, Inc.	Space Systems/Loral	Communications	\$45-55 M	S	S
9/23/99	Atlas 2AS	CCAFS	* Echostar 5	Echostar	Space Systems/Loral	Communications	\$90-105 M	S	S
9/24/99	Athena 2	VAFB	* IKONOS 2	Space Imaging Inc.	Lockheed Martin Corp.	Remote Sensing	\$22-26 M	S	S
10/9/99	Zenit 3SL	Odyssey	* DirecTV 1R	DirecTV, Inc.	Hughes	Communications	\$75-95 M	S	S
11/22/99	Atlas 2A	CCAFS	GBS 10	DoD	Hughes	Communications	\$75-85 M	S	S
12/4/99	Pegasus XL/HAPS	Wallops	* Orbcomms 30-36	Orbcomm	Orbital Sciences Corp.	Communications	\$12-15 M	S	S
12/21/99	Taurus 1	VAFB	Kompsat ACRIMSAT * Celestis 3	Korea Aerospace Research Institute NASA Celestis, Inc.	TRW/KARI Orbital Sciences Corp. Celestis, Inc.	Remote Sensing Scientific Other	\$18-20 M	S	S

\*Denotes a commercial payload, defined as a spacecraft which serves a commercial function or is operated by a commercial entity.  
L/M refers to the outcome of the launch and mission: S = success, P = partial success, F = failure.

## Appendix B: Space is an Integral Part of Daily Living

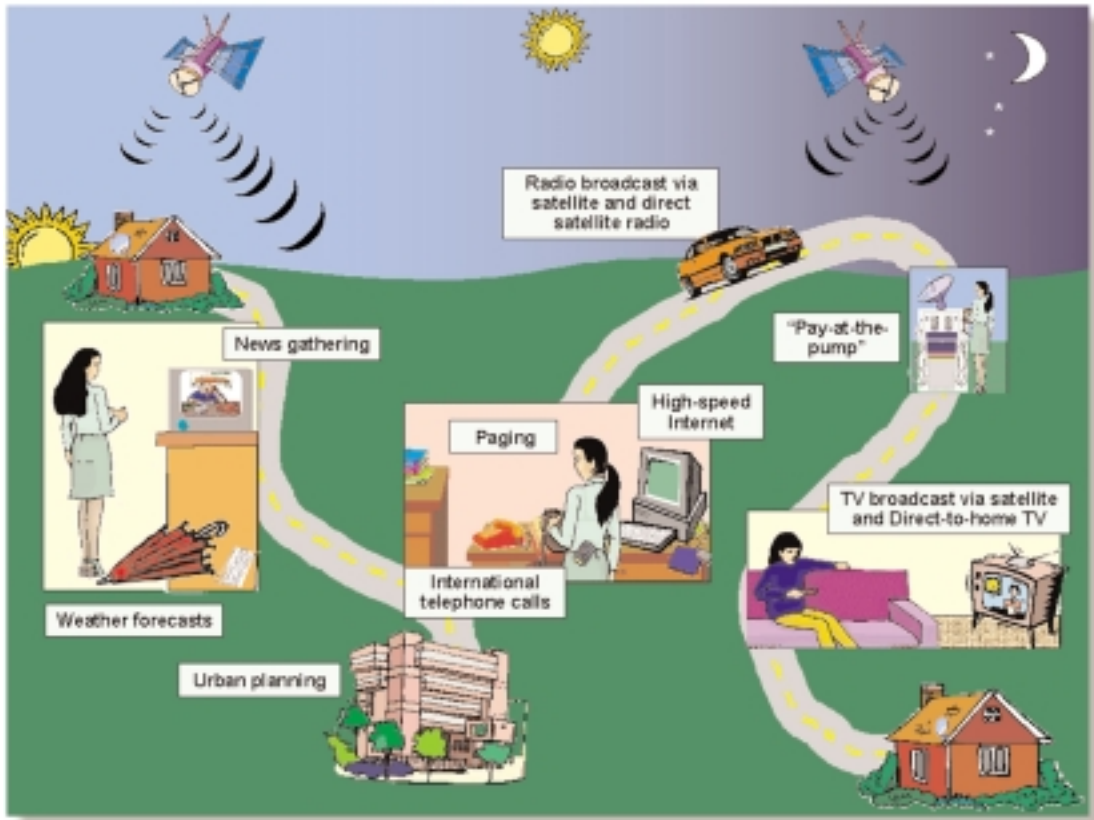
In addition to the economic impacts that commercial space transportation and enabled industries have on the U.S. economy, these industries offer a wide range of value-added benefits to the people in the United States and around the world. Economic impacts, as discussed throughout the report, quantify the financial transactions that occur throughout the course of production of a good or service. Benefits, on the other hand, are financial transactions that occur after a good or service is produced. The following hypothetical chronology illustrates the benefits that industries enabled by commercial space transportation contribute to daily activities:

- 7:30 a.m. After waking up, you turn on your TV to the local news. You may be one of the 150 million Americans who watches local news to receive the latest weather information. Satellite data are used to forecast weather by nearly 1,000 local television stations. Satellites are also used to relay most television content from national programmers to local broadcast and cable head ends across the country. Everyday the average broadcast affiliate shows 19 hours of national television content that is broadcast over satellite to local studios.
- 8:00 a.m. As you drive to work, the radio traffic reporter alerts drivers to congested highways and suggests alternate routes. Urban planners used satellite imagery and enhanced surveying techniques to plan construction of the office park where you work. The commute to your office is probably several minutes shorter than it would have been without the use of satellite maps.
- 8:30 a.m. You arrive at the office and log on to your computer. When you check your email and do research on the Internet, you are one of the 1.4 million people in the United States connected to the Internet by satellite. Over 60 Internet Service Providers (ISPs) use satellites to connect to the Internet backbone. The number of ISPs using satellite links is increasing as the number of online information requests outpaces the growth of bandwidth capacity.
- 10:00 a.m. You drive to a meeting across town and stop to get gas on the way. As you use a credit card at the gas pump, approval verification takes place using satellite technology. About half of all gas stations use Very Small Aperture Terminals (VSATs) for instantaneous point-of-sale transactions.
- 2:00 p.m. As you drive back to the office, you receive a page on your beeper from a client located on the other side of the country. You are one of nearly 46 million Americans using satellites to provide national pager coverage.

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- 2:30 p.m. Returning from lunch, you have some international phone calls to make. Those calls get routed through an international satellite network. Almost three billion minutes of international telephone traffic each year are transmitted over satellites. If you make an international phone call, call a business associate who is travelling by airplane, or contact a potential client in a remote location overseas, you are using telephony services provided by satellites.
- 5:00 p.m. During the drive home from work, you listen to the car radio. Radio broadcasters use satellites as part of the traditional national radio broadcasting system to transmit programs to local stations. Radio broadcasting in the AM and FM bands reaches millions of people worldwide each day and is still the most prevalent means used to listen to music.
- Beginning in early 2001, direct satellite radio will be introduced into the mobile market. Direct satellite radio will offer up to 100 digitally encoded radio channels of coast-to-coast service without static interruptions or loss of reception. By 2004, there may be over 15 million satellite radio-equipped cars, the equivalent of 7 percent of all U.S. automobiles.
- 5:30 p.m. Before you go home, you do a few errands. You rent a movie for the weekend, stop at the pharmacy, and go to the grocery store. Some of the retail chains you visit use VSAT networks to transmit credit, debit, and check authorization information. VSAT networks also provide point-of-sale inventory tracking for many of these establishments. This tracking helps to keep costs down so those retailers can pass the savings on to you. There are over 50,000 individual satellite terminals in use at retail sites across the country.
- 8:00 p.m. In the evening, while you are relaxing after a hard day of work, you decide to put your feet up and watch TV. Your direct-to-home (DTH) television service allows you to receive video content directly from a satellite through a dish antenna installed at your home. Almost 15 million Americans, or approximately 18 percent of all households, who pay for television service subscribe to a DTH satellite service provider. Satellites also help gather news that is used in local and national news shows. Satellite antenna equipped vehicles support nearly every live transmission of breaking news. Shows and events such as Monday Night Football, the Olympics, and election coverage rely on satellites to transmit events as they occur. For example, the 2000 Olympic Games were beamed via satellite to viewers in the United States. Over 10,000 hours, or 36 terabytes, of MPEG video data were transmitted during the 18-day event.



## Satellites in Daily Life



## Appendix C: Methodology

### RIMS II

The Regional Input-Output Modeling System (RIMS II) is an economic input-output model developed by the Department of Commerce Bureau of Economic Analysis to map the flow of goods and services within the U.S. economy and to illustrate the interconnection between producers and consumers. The model is used to measure individual industries' contributions to the economy. The RIMS II model is based on an industry-by-industry matrix with 38 industry aggregate rows and 490 detailed industry columns. The aggregate industry groups that make up the rows are conglomerations of the detailed industries listed in the columns. Industries that are most similar are grouped together. The row industries are inputs to the column industries' output. The model industries are categorized by the RIMS II input-output (I-O) codes, which are based on standard industry classification (SIC) codes. Each I-O code includes several SIC codes and these numerical codes are used to categorize all industries in the economy. RIMS II includes several sets of multipliers that are used to calculate the value of backward linkages, which are the inputs necessary to provide a good or service. This study takes into account only the economic activities that occur during production of a good or the offering of a service.

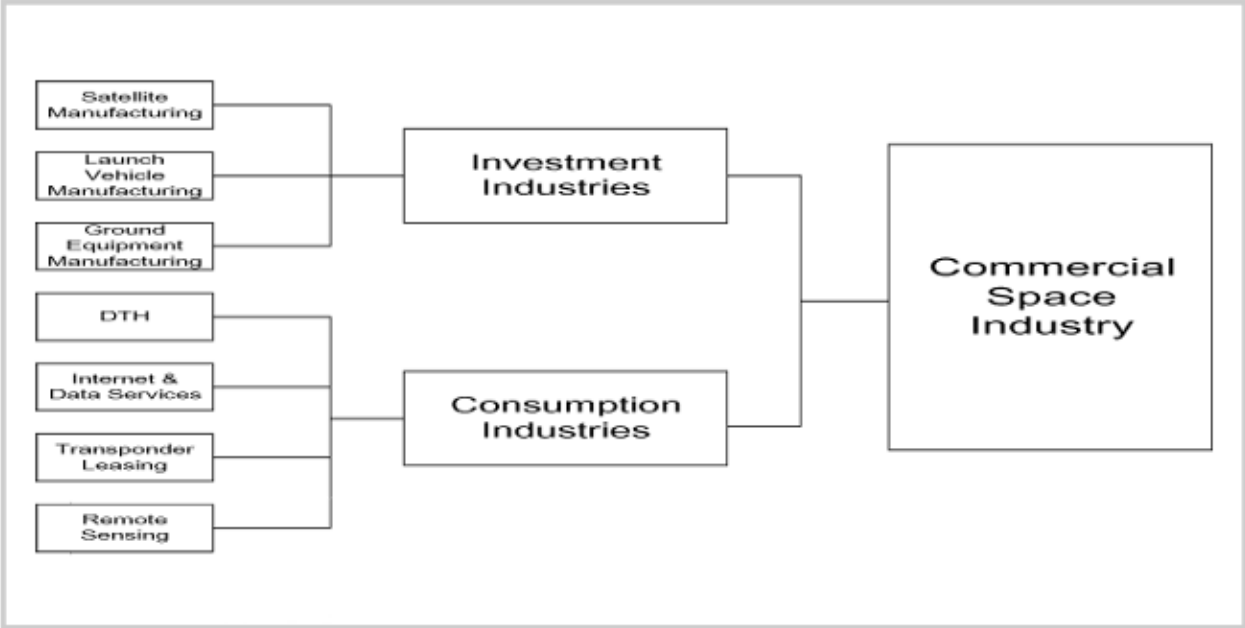
### Approach

In the RIMS II model, the economic equation for the total output of the economy is the sum of consumption, investments, government expenditures, and net exports (exports-imports).<sup>4</sup> Consumption includes business and personal expenditures that do not contribute to future economic activity. Investment, on the other hand, enables a firm to increase its productive capacity, and thus the productive capacity of the economy as a whole. Consumption and investment are weighted equally, and this study considers both in calculations of the economic impact of commercial space transportation. Because this is a study of the commercial space transportation industry, government expenditures on space transportation are not included in the economic impact. RIMS II accounts for net exports by subtracting the value of imports from the total value of inputs used in the production of final goods and services.

The final demand goods and services analyzed in this study are categorized as consumption and investments. Final demand is defined as the value of a good when it is delivered to its final user. Satellite manufacturing, launch vehicle manufacturing, and ground equipment manufacturing were considered investments while direct-to-home television, Internet and data services, transponder leasing, and remote sensing services were considered consumption.

<sup>4</sup>  $Y = C + I + G + (X - I)$ , where Y = Gross National Product, C = consumption, I = investment, G = government purchases of goods and services, X = exports, and I = imports.

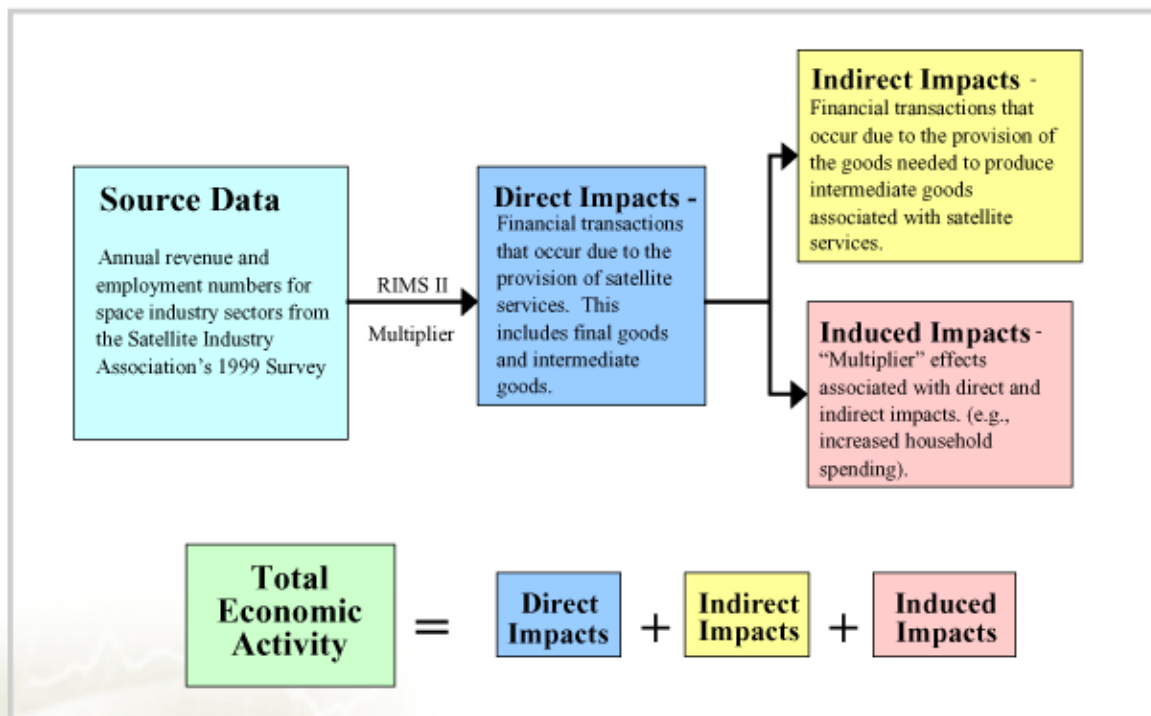
The impacts of the investment and consumption industries were added together to determine the total economic impact of commercial space transportation, as shown in Figure C1. The manufacturing and services industries are shown in separate boxes to emphasize the fact that these industries have different inputs and that they do not provide inputs to each other. Therefore, the economic impacts of the commercial space transportation and enabled industry segments can be added together without double counting. In order to capture the total impacts of these industry groups as a whole, RIMS II was used to calculate the impact of the consumption of satellite service industries enabled by investments as well as the impact of the investments themselves.



*Figure C1: Industry Components Analyzed*

The proper characterization of commercial space transportation and enabled industries into applicable I-O codes was necessary for use of RIMS II. Currently, there is not a single SIC or I-O code that accurately characterizes the relationship between launch vehicles and the industries they enable. Therefore, this analysis used I-O codes from both launch vehicle manufacturing and enabled industries to accurately characterize the impact of the commercial space transportation industry. Please see Appendix D for a discussion of the SIC and I-O codes chosen.

Source data from the Satellite Industry Association were used with the RIMS II model to derive the total economic impacts of the selected industries. The total impacts were expressed in terms of economic activity, employment, and earnings. Further calculations using RIMS II were used to derive the direct, indirect, and induced effects of economic activity. Figure C2 illustrates this methodology.



*Figure C2: Methodology Example*



## Appendix D: Selection of Industries for Analysis

RIMS II input-output (I-O) codes are based on standard industry classification (SIC) codes. The SIC codes selected were those that were most related to commercial space transportation and enabled industries. From the selected SIC codes, I-O codes were assigned to accurately characterize the impact of the commercial space transportation industry. Source data from the Satellite Industry Association were then sorted by I-O code. This table depicts the relationships between the industries selected for study and their appropriate SIC, I-O code, and Satellite Industry Association industry segment.

SIC code	Description	I-O Code	Description	SIA industry segment
3663	<i>Manufacture of radio &amp; TV broadcasting and communications equipment</i> . Includes antennas, transmitting and communications; cellular radio telephones; pagers; radio transmitting and communications antennas and ground receivers; satellites, communications; space satellite communications equipment; telemetering equipment; transmitting apparatus, radio & TV	56.0500	Communication equipment	Satellite manufacturing
3669	<i>Manufacturing communications and related equipment, not elsewhere classified</i> . Includes intercommunications equipment, electronic (assumed to include VSATs)	56.0500	Communication equipment	Ground equipment manufacturing (VSATs & other ground equipment)
3679	<i>Electronic components, not elsewhere classified</i> . Includes manufacture of antennas, receiving; antennas, satellite: home type (generally includes equipment for receiving signals, rather than transmitting)	57.0300	Other electronic components	Ground equipment manufacturing (manufacture of satellite dishes)
3761	<i>Guided missiles and space vehicles</i> . Includes R&D on guided missiles and space vehicles; space vehicles, complete	13.0100	Guided missiles and space vehicles	Launch vehicle manufacturing
4899	<i>Communications services, not elsewhere classified</i> . Includes radar station operation; satellite earth stations; satellite or missile tracking stations, operated on contract basis; tracking missiles by telemetry and photography on contract basis. (assumed data services including VSAT services, internet, and transponder leasing were included)	66.0100	Telephone/telegraph communications and other communications services, not elsewhere classified	VSAT, mobile data services, transponder leasing
4822	<i>Telegraph and other message communications</i> . Includes e-mail and fax transmission services.	66.0100	Telephone/telegraph communications and other communications services, not elsewhere classified	Satellite services
4812	<i>Radiotelephone communications services</i> . Includes cellular telephone services; paging services.	66.0100	Telephone/telegraph communications and other communications services, not elsewhere classified	Mobile satellite telephony
4841	<i>Cable and other pay TV services</i> . Includes DBS/DTH; SMATV; Multipoint distribution systems (MDS) services; subscription TV services.	66.0200	Cable and other pay TV services	DTH
8713	<i>Surveying services</i> . Includes establishments primarily engaged in providing professional land, water and aerial surveying services; engineering services: photogrammetric; photogrammetric engineering; surveying: land, water, aerial.	73.0302	Engineering, architectural and surveying services	Remote sensing

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