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CHAPTER I:

## INFORMATION TECHNOLOGY PRODUCING INDUSTRIES—HOPEFUL SIGNS IN 2003

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After two years of retrenchment, IT-producing industries (Box 1.1.<sup>1</sup>) now show signs of resuming the dynamic role they played during 1996–2000. Based on evidence through the third quarter of 2003, we estimate that, during 2003, IT-producing industries, which account for about 8 percent of U.S. GDP, contributed 0.8 percentage points of the estimated 2.9 percent rate of real U.S. economic growth. (Table 1.1.)

Published data on recent spending for IT goods and services, and our estimates of IT production for 2002 and 2003 indicate: (1) while computer and semiconductor manufacturers have begun to rebound from major output losses suffered in 2001–2002, communications equipment makers show continued weakness; (2) IT service industries, which grew faster than IT manufacturing industries during 1996–2000, continued to grow during the economic slowdown of 2001–2002 though at a reduced rate, and contributed to the mildness of the recession; and (3), in 2003, IT producing industries became once again an important ingredient in an overall U.S. economic expansion.<sup>2</sup>

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<sup>1</sup> The industries listed in Text Box 1, above, are classified under the 1997 North American Industry Classification System (NAICS). Production data do not yet exist based on the 2002 version of the NAICS.

<sup>2</sup> Estimates of IT industry output (GDP by industry) for 2002 and 2003 are based on quarterly National Income and Product Accounts data and monthly production indicators through the first nine months of 2003. The Bureau of Economic Analysis (BEA) publishes quarterly data on types of spending by businesses, consumers, and governments (Federal, state, and local) on IT equipment, software, and communication services. The Census Bureau publishes monthly shipments, new orders and changes in inventories for computers, semiconductors, and communications equipment. Annual industry data for 2003 will become available in 2005. Likewise, industry data from the Census Bureau's economic (business) census for 2002 will become available in 2004. (See the *Digital Economy 2003 Technical Appendices* (<http://www.esa.doc.gov/reports.cfm>) for the method used to estimate IT producing industry output in 2002 and 2003.)

**Table 1.1. IT Producing Industries' Contribution to Real Economic Growth****Actual and Estimated**

	1997	1998	1999	2000	2001	2002*	2003*
	(Percent)						
(1) Changes in Real Gross Domestic Product <sup>3</sup>	4.5	5.0	4.2	4.7	0.1**	2.3	2.9
	(Percentage Points)						
(2) IT Contribution	1.5	1.6	1.5	1.1	0.1	0.1	0.8
(3) All Other Industries	3.0	3.4	2.7	3.6	0.0	2.2	2.1

Notes: \*Estimates based on Census and BEA data.

\*\* The table attributes the entire 0.1 percent change in GDP in 2001 to IT industries because numbers have been rounded to the nearest tenth. In 2001, if we round to the nearest hundredth, the IT share of GDP change is 72 percent. Estimates for other years are not affected. See the Digital Economy 2003 Technical Appendices for additional information.

**Box 1.1. Information Technology Producing Industries****Hardware Industries**

Computers and equipment  
 Wholesale trade of computers and equipment\*  
 Retail trade of computers and equipment\*  
 Calculating and office machines  
 Magnetic and optical recording media  
 Electron tubes  
 Printed circuit boards  
 Semiconductors  
 Passive electronic components  
 Industrial instruments for measurement  
 Instruments for measuring electricity  
 Laboratory analytical instruments

**Communications Equipment Industries**

Household audio and video equipment  
 Telephone and telegraph equipment  
 Radio and TV communications equipment

**Software/Services Industries**

Computer programming  
 Prepackaged software  
 Wholesale trade of software\*  
 Retail trade of software\*  
 Computer-integrated system design  
 Computer processing, data preparation  
 Information retrieval services  
 Computer services management  
 Computer rental and leasing  
 Computer maintenance and repair  
 Computer related services, nec

**Communications Services Industries**

Telephone and telegraph communications  
 Cable and other TV services

\*Wholesale and retail from computer manufacturer sales from branch offices. See the *Digital Economy 2003 Technical Appendices* (<http://www.esa.doc.gov/reports.cfm>).

<sup>3</sup> Gross domestic product is estimated by gross domestic income; see "Gross Domestic Product by Industry for 1999–2001," *Survey of Current Business* (November 22, 2002), p. 23, Box.

The following sections examine: the growth and recomposition of output of IT industries; recent indicators of increasing demand for IT goods and services (i.e., investment patterns and manufacturers' shipments, new orders and inventories); IT industries' contributions to output growth; and IT industries' contribution to U.S. research and development spending.

## **IT Producing Industries Weather the Recession and Recover Slowly**

On average, between 1996 and 2000, IT producing industries, which represented between 8 and 9 percent of the economy,<sup>4</sup> supplied 1.4 percentage points of the Nation's 4.6 percent annual average real GDP growth.<sup>5</sup> In 2001, IT-producing industries grew a scant 0.9 percent, though in a recession year that was still enough to account for practically all of the Nation's 0.3 percent economic growth. Overall, continued strength in IT producing industries, particularly communications services, helped to keep the recession comparatively mild.

In 2002, the U.S. economy gathered momentum, growing at over 2 percent. Unlike the 1996–2000 period, however, developments in IT producing industries were not a driving force. Losses in these industries, which had begun in 2001, accelerated in 2002; in the sector as a whole, revenues declined almost as rapidly in these two years as they had increased in the prior four. The poor showing was due largely to the slow recovery of business spending for capital equipment. Unlike the investment-led expansion of 1996–2000, growth in 2002 was driven mainly by increases in personal consumption, changes in private inventories, and government spending. Almost none of the real growth of the U.S. economy in 2002 reflected output growth from the IT-producing industries.

Happily, the investment picture has begun to change. Recent evidence indicates that businesses are once again investing in IT capital equipment. However, the pattern of recovery in 2003 contrasts with experience in 1996–2000. In the goods producing sector, renewed strength is concentrated in computers and semiconductors; while shipments of communications equipment have continued to decline. (These trends are detailed below in the section on IT manufacturers' shipments, new orders, and inventories and in Table 1.3.)

The services and software component of the IT-producing sector—which continued to grow during the economic slowdown of 2001 and the slowly developing recovery of 2002—continued to grow as well in 2003. But because IT service industries weathered the recession and its aftermath without sharply declining output, they are unlikely to rebound to the double-digit growth rates achieved during 1997–2000 as the current recovery gains strength. (A possible exception is the communications services industry, which appeared to grow at about the same rate in 2003 as it did during 1997–2000.)

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<sup>4</sup> See Table A-1.2. *Digital Economy 2003 Technical Appendices* (<http://www.esa.doc.gov/reports.cfm>).

<sup>5</sup> Gross Domestic Income (GDI) is used in this calculation in place of GDP since we use GDP by industry as a measure of the industries' outputs. The sum of all industries' GDP by industry is equal to GDI. GDI and GDP should theoretically be the same, but are not because of some statistical discrepancies.

As a consequence of continued, if slower growth in IT service industries, and the period of negative growth in IT goods industries, the composition of IT-producing industry output has become significantly more concentrated in services. In 1996, IT software and computer services and communications services represented about 59 percent of the total output (nominal dollars) of IT-producing industries. We estimate that in 2003, the output share of software and IT services industries increased to 71 percent.

The shift toward services in the composition of IT output suggests that future growth in the IT sector may be more modest and less volatile than in the past. We estimate that, between 2001 and 2003, the output of the IT Software and Computer services sector, on average, increased by 1.3 percent per year. The IT Communications services sector increased, on average, 4.8 percent per year. In contrast, output growth in the IT Hardware and IT Communications equipment sectors fluctuated between double-digit declines and single-digit increases.

Our estimates of IT-producing industries' 2003 output are based on available first-, second-, and third-quarter data on demand for IT goods and services, and industry production indicators through the first nine months of the year. This section of the chapter and the one that follows look at available demand data and production indicators. A third section uses these data and indices to estimate the performance of IT producing industries for the year as a whole.

### **Demand for IT Goods and Services Through the Third Quarter of 2003**

Business spending for equipment and software represents the largest source of demand for the hardware and communication equipment portion of the IT-producing sector. In the third quarter of 2003, businesses were buying IT equipment and software (information processing (IP) in Table 1.2) at a \$446 billion annual rate (seasonally adjusted), with IT spending accounting for half of all business investment in new equipment. In the second quarter, business investment in IT equipment and software contributed about 21 percent of the overall 3.3 percent real GDP growth and in the third quarter contributed 10 percent of the 8.2 percent GDP growth. In contrast, during 2002 as a whole, business spending for IT equipment and software contributed only 4 percent of the total 2.4 percent increase in GDP.

Reversing declines in 2001–2002, business spending for IT equipment and software rose through the third quarter of 2003 by a quarterly average of 2.3 percent. (Table 1.2.) Spending in the second quarter was up 3.7 percent over the previous quarter and 4.5 percent in the third quarter. In the third quarter of 2003, spending on computers and equipment rose 7.3 percent following an 8.0 percent increase in the second quarter. Business spending for software rose over 2 percent in the second and 4 percent in the third quarter. In addition, following a 14 percent decline in 2001 and a 5 percent decline in 2002, spending for other IT equipment rose over 3 percent for each of the three quarters of 2003.

**Table 1.2. Private Fixed Investment**

**2001 and 2002 Annual Growth Rates  
and 2003-I, 2003-II, and 2003-III Quarterly Growth Rates\* (percent)**

	2001	2002	2003-1*	2003-II*	2003-III*
Private Fixed Investment	-2.7	-3.5	0.4	1.5	4.1
Nonresidential structures and equipment	-5.1	-7.0	-1.2	1.4	3.4
Nonresidential structures	3.3	-17.0	0.3	0.9	0.5
Nonresidential equipment and software	-7.8	-3.3	-1.7	1.5	4.2
Information processing (IP)					
equipment and software	-9.5	-1.1	1.4	3.7	4.5
Computers and peripheral equipment	-20.5	0.0	1.2	8.0	7.3
Software	0.6	1.3	0.2	2.1	4.0
Other IP equipment and software	-14.0	-4.7	3.0	3.4	3.5
Industrial equipment	-3.6	-4.3	-1.1	-0.1	1.5
Transportation equipment	-12.6	-10.2	-10.4	-2.6	4.2
Other equipment	-1.4	-0.4	-1.6	-1.1	6.3
Residential	4.4	6.1	4.3	1.7	5.7

Note: \*Current quarter over previous quarter, billions of current dollars, seasonally adjusted at annual rates.

Source: BEA, Table 5.4, Private Fixed Investment by Type.

While business investment is the major source of IT demand, the market for IT goods and services is broad and varied. Non-investment sources of demand for IT goods and services include businesses' purchase of IT goods and services (e.g., computer and communications services), personal consumption, and government spending:

- In 2002, in addition to investing in IT equipment and software, businesses spent approximately \$270 billion on communications services, up from \$258 billion in 2001.<sup>6</sup> For accounting purposes, these expenditures are considered current expenses (i.e., costs of production) rather than investment spending. Nonetheless, business spending on communications services constitutes the second most important market for IT-producing industries (after business investment).
- Personal consumption provides a second and growing (non-investment) market for IT goods and services. In the second quarter of 2003, personal consumption of IT goods and services almost certainly continued to rise.<sup>7</sup> In the second quarter of 2003, personal consumption in

<sup>6</sup> We have not provided estimates of business spending for communications through the first half of 2003 since we have no current data available to make these estimates. This spending is, however, incorporated into our overall estimate of IT producing industry output for 2003. Business spending estimates for 2001 and 2002 are provided here to give the magnitude and direction of this type of spending in the previous two years. See the *Digital Economy 2003 Technical Appendices* (<http://www.esa.doc.gov/reports.cfm>).

<sup>7</sup> Table 2.2, Personal Consumption Expenditures by Major Type of Product and Table 2.6, Personal Consumption Expenditures by Type of Product, Bureau of Economic Analysis, <http://www.bea.gov>, interactive tables.

the category of durable goods that includes computers, computer peripherals and software (furniture and household equipment) rose by 7.4 percent. In the third quarter, consumption in this category of durables rose another 2.7 percent. In 2001, the latest year for which data are available, personal consumption of computers, computer peripherals and software was \$32.9 billion representing about 11 percent of furniture and household equipment purchases.

- Through the third quarter of 2003, personal consumption of communications services, almost certainly continued to rise. In the second quarter of 2003, consumption in the non-energy category of personal spending on household operation (i.e., the category of personal spending that includes telephone service) increased by 0.3 percent. In the third quarter, it rose another 0.7 percent. In 2001, consumer spending for communications was \$136.5 billion, about 54 percent of the non-energy portion of spending for household operation.
- Through the third quarter of 2003, growth in government spending for equipment, which includes IT equipment and software has remained positive.<sup>8</sup> Federal spending (defense and non-defense) for IT equipment and software during the period was about \$14.8 billion; state and local government spending was about \$8.3 billion.<sup>9</sup>

### **IT Manufacturers' Shipments, New Orders, and Inventories Show Positive Trends Through August**

Production indicators for the first nine months of 2003 support the view that IT-producing industries are gaining strength. (Table 1.3.) Though manufacturers' shipments and new orders for communications equipment remained depressed, reports on shipments for the computer and semiconductor industries were generally positive. Shipments of computers, for the first nine months of 2003, were 14 percent higher than in the same period in 2002. Shipments of semiconductors were 22 percent higher. In contrast, over the same period, shipments of communication equipment dropped 9 percent. New orders for computers and communication equipment were up—by 7 percent and 8 percent, respectively.

Through September, manufacturers' inventories of computers and communication equipment continued to decline (by 11 percent and 23 percent, respectively). Inventories of computers appear to have reached a balance indicating that new production will be necessary to meet demand. However, inventories for communications equipment continue to decline, and it is unclear clear how long manufacturers will continue to rely on existing stocks.

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<sup>8</sup> Table 3.7, Government Consumption Expenditures and Gross Investment By Type, Bureau of Economic Analysis, <http://www.bea.gov>, interactive tables.

<sup>9</sup> We made no estimates of government purchases of communications equipment, computer services, and communications services.

**Table 1.3. Shipments, New Orders, and Total Inventories for Computers, Communications Equipment and Semiconductors, 2003****(Percent)\***

	Month to Month 2003			January-September, (2003/2002)
	August-September	July-August	June-July	
<b>Computer and related products</b>				
Shipments	-1.3	5.6	25.1	13.9
New Orders	-3.2	8.3	9.2	7.0
Total Inventories	1.3	2.9	-6.7	-10.8
<b>Communications equipment (non-defense)</b>				
Shipments	-1.2	-0.8	-1.8	-8.9
New Orders	5.2	1.7	13.4	8.1
Total Inventories	0.0	-2.3	-1.9	-22.9
<b>Semiconductors</b>				
Shipments	-8.2	19.9	-12.8	22.3
New Orders	n.a.	n.a.	n.a.	n.a.
Total Inventories	n.a.	n.a.	n.a.	n.a.

Note: \*Based on current dollars, seasonally adjusted.

Source: Bureau of the Census, Manufacturer's Shipments, Orders, and Inventories (M3)

## IT Producing Industry Performance in 2003

Based on assumptions and methods described in the *Digital Economy 2003 Technical Appendices* (<http://www.esa.doc.gov/reports.cfm>), we estimate that, after a decline of 5.6 percent in 2001 and 0.3 percent growth in 2002, output<sup>10</sup> in IT producing industries increased by 4.8 percent in 2003, *in nominal dollars*.<sup>11</sup> (Table 1.4) Our overall estimate for the year assumes a continuation of the recent turnaround in IT-producing manufacturing industries and continued slow but steady growth in IT-producing service industries.

We estimate that, in 2003, IT hardware industries (computers, semiconductors, electronic components, and electronic measuring instruments) increased their output by 9.8 percent. In addition, after steep declines in 2001 and 2002, output of communications equipment declined by 5.6 percent, a slowdown in the decline in the previous years.

<sup>10</sup> GDP by industry equals an industry's total output less the cost of goods and services used to produce it. Basically, GDP by industry is used here as a measure of the industry's performance because it can be compared directly to the growth of the economy, as measured by its Gross Domestic Income (GDI). GDI is the income side measurement of the economy while Gross Domestic Product (GDP) is expenditures. In theory, GDI should equal GDP. In practice, they do not because of some accounting differences.

<sup>11</sup> Estimates of GDP by industry and GDP by industry growth for each IT producing industry that make up the aggregate industries—Hardware, Software and computer services, Communications equipment, and Communications services—are provided in Tables A-1.2 and A-1.3, *Digital Economy 2003 Technical Appendices* (<http://www.esa.doc.gov/reports.cfm>).

**Table 1.4. IT-Producing Industries Gross Domestic Product (GDP) by Sector**

	<b>Actual and Estimated</b>							
	1996	1997	1998	1999	2000	2001	2002*	2003*
	<b>Billions of Current Dollars</b>							
<b>Total</b>	589.0	666.1	739.5	821.7	877.8	828.9	831.6	871.9
Hardware	201.1	231.6	242.2	252.2	244.1	189.6	189.3	208.0
Software and Services	166.3	193.6	238.0	278.3	316.6	320.3	323.7	328.8
Communications Equipment	39.0	52.7	53.2	60.6	67.3	54.9	46.6	43.5
Communications Services	182.6	188.2	206.1	230.6	249.8	264.3	272.1	291.6
	<b>Annual Change-Percent</b>							
<b>Total</b>	n.a.	13.1	11.0	11.1	6.8	-5.6	0.3	4.8
Hardware	n.a.	15.2	4.6	4.1	-3.2	-22.4	-0.2	9.8
Software and Services	n.a.	16.4	22.9	16.9	13.8	1.2	1.0	1.6
Communications Equipment	n.a.	35.1	0.8	14.0	10.9	-18.4	-15.1	-5.6
Communications Services	n.a.	3.1	9.5	11.9	8.3	5.8	3.0	7.2

Source: Estimates are derived from BEA and Census data for 1996 through 2001.

\*Estimates for 2002 are based on BEA data on GDP and the INFORUM LIFT model to estimate outputs. Estimates for 2003 are based on the Global Insights' economic forecast.

Output from the IT-producing services sectors continued to grow in 2003, though at a pace that was significantly slower than the double-digit growth of the latter 1990s. Our overall estimate reflects industry-level estimates of 1.6 percent growth in software and computer services and 7.2 percent growth in communications services.

*Adjusting output estimates for inflation* results in a similar picture of modest improvement. (Table 1.5.) Prices of computers fell by about 24 percent per year, from 1997 through 2000, then 16 percent through 2002. Semiconductor prices fell an average 15 percent per year during 1997–2000, followed by an average 9 percent reduction through 2002. For the purpose of estimating real output in 2003, we have assumed that computer and semiconductor prices declined throughout 2003 at the 2002 rate (16 percent and 9 percent, respectively). Reflecting these continuing price declines, in 2003, *real* growth in the IT hardware sector increased sharply.<sup>12</sup>

The average inflation-adjusted annual growth for IT producing industries between 1997 and 1999 was about 20 percent. In 2000, growth dropped to 13 percent. And in 2001 and 2002, despite the continued decline in prices in hardware, there was virtually no real growth in output. In 2003, however, reversing this trend, real growth in IT producing industries was about 6 percent.

<sup>12</sup> For BEA's use of hedonic price indexes, see "A Note on the Impact of Hedonics and Computers on Real GDP" by Steven Landefeld and Bruce Grimm, Survey of Current Business, December 2000, pgs. 17 to 22 and "Measuring the New Economy" by Steven Landefeld and Barbara Fraumeni, Survey of Current Business, March 2001, pgs. 23–40.

**Table 1.5. IT-Producing Industries Inflation Adjusted Output**

	<b>Actual and Estimated</b>							
	1996	1997	1998	1999	2000	2001	2002*	2003*
	<b>Billions of Chained (1996) Dollars</b>							
<b>Total</b>	589.0	706.4	849.0	1,012.0	1,138.4	1,149.1	1,167.3	1,241.5
Hardware	201.1	275.5	364.1	464.5	524.5	485.6	527.7	665.4
Software and Services	166.3	192.7	236.1	271.1	300.2	302.5	301.7	306.3
Communications Equipment	39.0	53.3	56.0	66.3	76.2	64.1	52.4	48.9
Communications Services	182.6	187.8	204.0	235.7	267.7	304.0	313.7	318.7
	<b>Annual Change-Percent</b>							
<b>Total</b>	n.a.	19.9	20.2	19.2	12.5	0.9	1.6	6.4
Hardware	n.a.	37.0	32.2	27.6	12.9	-7.4	8.7	26.0
Software and Services	n.a.	15.9	22.5	14.8	10.7	0.8	-0.3	1.5
Communications Equipment	n.a.	36.6	5.2	18.3	14.9	-15.9	-18.3	-6.7
Communications Services	n.a.	2.8	8.7	15.5	13.6	13.5	3.2	1.6

Source: Estimates are derived from BEA and Census data for 1996 through 2001.

\*Estimates for 2002 are based on BEA data on GDP and the INFORUM LIFT model to estimate outputs. Estimates for 2003 are based on the Global Insights' economic forecast.

## IT Research and Development Expenditures Remain Strong

The rapid pace of technological change in IT producing industries, particularly IT hardware industries, drives a high rate of spending on investment in research and development (R&D) in these industries. The sector uses more R&D inputs than other areas of the economy and its R&D intensity (i.e., R&D spending divided by industry sales) is three times the national average. Recent growth patterns in R&D investment by the IT sector are influenced by the transition to digital technology in several large markets: television, photography, and motion picture reproduction (DVD).

IT companies accounted for a disproportionate share of company-funded R&D (31 percent), relative to the sector's small share of the economy. Moreover, R&D investment has funded innovations that contributed to the rapid decline in the price indexes for computers and semiconductors. R&D spending by the IT sector has contributed to economic growth—through R&D's role in technological change<sup>13</sup>—and created spillovers to local communities by creating high paid jobs for 300,000 scientists and engineers in all IT industries.

In contrast to the cyclical swings in IT industry production and employment, IT industry investment in R&D has shown greater stability. Strong growth in R&D spending by the IT

<sup>13</sup> A brief survey of the literature on technological change and growth is discussed in Subodh Kumar and R. Robert Russell. "Technological Change, Technological Catch-up, and Capital Deepening: Relative Contributions to Growth and Convergence." *American Economic Review*, June 2002.

**Table 1.6. R&D Expenditures, Company-funded****\$ billions**

Industry	1997	1998	1999	2000	2001
<b>Total U.S. R&amp;D (including federal)</b>	212.4	226.9	244.1	264.6	281.1
Company-funded R&D	133.6	145.0	160.2	180.4	181.6
<b>IT R&amp;D, total</b>	35.2	38.4	36.2	46.9	56.5
Computers and peripheral equipment	7.7	8.3	4.1	5.2	5.2
Communications equipment	2.8	8.4	5.8	11.1	15.2
Semiconductors, other components	14.0	9.1	10.6	12.8	14.2
Other electronics	0.5	0.6	0.8	0.3	0.3
Total, IT equipment	25.0	26.4	21.3	29.4	34.9
Software publishing	7.2	9.2	10.9	12.6	13.0
Computer systems design	3.0	2.9	4.0	4.9	8.7
Total, IT services	10.2	12.0	14.9	17.5	21.7
<b>IT Share of Company R&amp;D (percent)</b>	26.4	26.5	22.6	26.0	31.2

Source: National Science Foundation, Survey of Industrial R&amp;D

sector occurred in 2001 and R&D investment reached \$56.5 billion, according to the latest available data from the National Science Foundation.<sup>14</sup> (See Table 1.6.) Compared with company-funded R&D by all industries, which was flat in 2001, growth in R&D by the IT sector boosted the IT share of total R&D to 31 percent from an average share of 26 percent in previous years. Another year of growth in R&D investment by IT industries is likely to be reported in 2002, because the NSF estimates an increase in R&D spending by all industries.<sup>15</sup>

A variety of factors contributed to the growth in R&D expenditures in 2001 that occurred despite the decline in IT industry sales. R&D investment was required to develop products for new applications with rapid growth potential. Semiconductor industries increased investment in R&D to meet demand for a number of rapidly growing markets, such as a new generation of televisions with thin screen features (LCD and plasma displays and high-definition TV (HDTV) with much better resolution), digital cameras, camera-equipped cell phones, video game machines, and personal computers with editing features for video and digital photos. In the communications equipment industry, R&D growth was stimulated by rapidly growing markets, such as broadband (including computer modems), wireless networks, HDTV broadcasting, instant messaging, and enhanced mobile phone equipment to allow users to send and receive photos and video.

<sup>14</sup> Infobrief. "U.S. Industry Sustains R&D Expenditures During 2001 Despite Decline in Performers' Aggregate Sales." National Science Foundation, October 2003.

<sup>15</sup> Infobrief. "Slowing R&D Growth Expected in 2002." National Science Foundation, December 2002.