

INTRODUCTION .....	XVII
RADIO FREQUENCY TECHNOLOGIES AND APPLICATIONS.....	XVII
STUDY BACKGROUND .....	XVII
STUDY GOALS AND OBJECTIVES.....	XVIII
INTENDED AUDIENCE.....	XIX
SCOPE AND FORMAT .....	XIX
METHODOLOGY AND INFORMATION SOURCES.....	XX
ANALYST CREDENTIALS.....	XX
RELATED BCC RESEARCH .....	XX
BCC ONLINE SERVICES.....	XXII
EXECUTIVE SUMMARY .....	XXIII
<i>SUMMARY TABLE TOTAL U.S. MARKET FOR EMERGING RF TECHNOLOGIES BY</i>	
<i>TYPE, THROUGH 2008 (\$ BILLIONS).....</i>	<i>XXIII</i>
<i>SUMMARY FIGURE TOTAL U.S. MARKET FOR EMERGING RF TECHNOLOGIES</i>	
<i>BY TYPE, 2000-2008 (\$ BILLIONS).....</i>	<i>XXIV</i>
OVERVIEW OF RF MARKET .....	1
GENERAL DESCRIPTION OF RF.....	1
PROPERTIES OF RF.....	1
Frequency and Wavelength.....	1
Dispersion and Directivity .....	2
Wave Propagation.....	2
RF Bands.....	2
<i>TABLE 1 RF BANDS.....</i>	<i>3</i>
Very Low Frequency (VLF) Band.....	3
Low Frequency (LF) Band .....	3
Medium Frequency (MF) and High Frequency (HF)	
Bands .....	3
Very High Frequency (VHF) Band.....	4
Ultra-High Frequency (UHF) Band .....	4
Super-High Frequency (SHF) Band.....	4
Extremely High Frequency (EHF) Band .....	5
RF TECHNOLOGIES .....	5
Established Technologies .....	5
<i>TABLE 2 ESTABLISHED RF TECHNOLOGIES AND APPLICATIONS.....</i>	<i>6</i>
Emerging Technologies .....	6
Digital Radio .....	7
Technology .....	7
Satellite DR.....	7
Terrestrial DR.....	7
Products .....	8
Broadcast Equipment (Satellite).....	8
Broadcast Equipment (Terrestrial).....	9
Receivers and Antennas.....	9

High Definition TV .....	10
Technology .....	10
Standards .....	10
<i>FIGURE 1 DIGITAL TV SYSTEMS</i> .....	11
Products .....	12
HDTV Program Production and Transmission Equipment.....	12
HDTV Program Production and Transmission Equipment (Continued).....	13
HDTV Set-Top Boxes.....	14
HDTV Displays .....	14
HDTV Displays (Continued).....	15
HDTV Displays (Continued).....	16
Advanced Cellular Technologies .....	17
1G and 2G Wireless .....	18
<i>TABLE 3 COMPARISON OF MAJOR CELLULAR TECHNOLOGIES USED IN THE UNITED STATES</i> .....	19
2.5G and 2.75G Wireless .....	20
<i>FIGURE 2 MIGRATION PATHS FROM 2G TO 3G WIRELESS</i> .....	20
CDMA .....	21
TDMA .....	21
3G Wireless.....	21
Wireless Networking .....	22
<i>TABLE 4 WIRELESS NETWORKING TECHNOLOGIES</i> .....	22
Personal Area Networks.....	23
Wireless Area Networks.....	23
Spread Spectrum .....	24
Radio Frequency Identification (RFID) .....	25
Technology .....	25
Induction Transponders.....	25
Electronic Field Disturbance Transponders.....	26
Radio Transponders .....	26
RFID Industry Standards .....	27
RFID ICs.....	27
Products .....	27
RFID Transponders.....	28
<i>TABLE 5 COMMON U.S. TRANSPONDER FREQUENCIES</i> .....	28
Memory .....	29
Physical Form.....	29
Summary .....	29
Tags.....	30
<i>TABLE 6 SUMMARY OF RF TAG FEATURES</i> .....	30
Readers .....	31
Global Positioning System (GPS).....	32

GPS Receiver Features.....	33
<i>TABLE 7 COMMON TYPES OF GPS RECEIVERS.....</i>	<i>34</i>
RF Plasma Sources and Applications .....	34
General Principles.....	35
<i>FIGURE 3 TYPICAL (CAPACITIVE) RF PLASMA SYSTEM.....</i>	<i>36</i>
Types of RF Plasma .....	37
Capacitive RF.....	37
RF Induction .....	37
Microwave RF .....	38
Patent Analysis.....	38
RF Technology Area.....	39
<i>FIGURE 4 U.S. PATENTS ON EMERGING RF TECHNOLOGIES BY TECHNOLOGY</i> <i>AREA, 2003.....</i>	<i>39</i>
Pace of Innovation.....	40
<i>FIGURE 5 NEW U.S. PATENTS ISSUED FOR EMERGING RF TECHNOLOGIES,</i> <i>1998-2002 (NUMBER OF PATENTS).....</i>	<i>40</i>
<i>FIGURE 5 (CONTINUED).....</i>	<i>41</i>
Patent Characteristics .....	41
Basic vs. Fabrication and Application	
Technology .....	42
<i>FIGURE 6 SAMPLING OF RECENT RF PATENTS BY TYPE OF TECHNOLOGY</i> <i>(NUMBER OF PATENTS).....</i>	<i>42</i>
Digital Radio .....	43
HDTV.....	43
Advanced Cellular and Wireless	
Networks.....	43
RFID .....	44
<i>FIGURE 7 NEW PATENTS FOR RFID APPLICATIONS BY SECTOR.....</i>	<i>44</i>
<i>FIGURE 7 (CONTINUED).....</i>	<i>45</i>
GPS .....	45
RF Plasma .....	46
Patent Assignees .....	46
Type of Assignee .....	46
<i>FIGURE 8 SAMPLING OF RECENT RF PATENTS BY TYPE OF ASSIGNEE</i> <i>(NUMBER OF PATENTS).....</i>	<i>47</i>
Nationality of Assignee .....	48
<i>FIGURE 9 SAMPLING OF RECENT RF PATENTS BY ASSIGNEE'S NATIONALITY</i> <i>(NUMBER OF PATENTS).....</i>	<i>48</i>
MAJOR RF APPLICATIONS .....	49
RADIO AND TV BROADCASTING .....	49
Datacasting.....	50
Interactive and On-demand Programming .....	50
TELECOMMUNICATIONS .....	51
Enterprise Applications.....	51
Consumer Applications .....	51
DATA NETWORKS.....	51
<i>TABLE 8 RF DATA NETWORKING APPLICATIONS.....</i>	<i>52</i>

Hands-Free Telecommunications .....	52
Human Interface Devices and Desktop Peripherals .....	52
Local Area Networks .....	53
Hotspots.....	53
Enterprise Networks.....	53
Home Networks.....	53
WLAN Phones .....	54
Industrial Automation and Process Control.....	54
Wide Area Networks.....	55
SECURITY/IDENTIFICATION .....	55
<i>TABLE 9 RF SECURITY/IDENTIFICATION APPLICATIONS .....</i>	<i>56</i>
Personnel Access Control/Monitoring.....	56
Vehicle Entry and Control .....	57
Retail Anti-Theft.....	57
Asset Tagging .....	58
Hospital Patient/Staff/Equipment Management .....	58
Ticketing .....	59
Livestock/Animal Identification.....	59
Cargo Container Security.....	60
Automatic Vehicle Identification .....	60
Parking and Gated Community Access .....	61
Fleet Tracking/Vehicle Location.....	61
Rail Car Identification and Tracking.....	62
Mining Anti-Collision Systems.....	62
Weighing Trucks .....	62
Traffic Management .....	63
Other Identification/Security Applications .....	63
E-PAYMENTS.....	63
RFID Payment Applications .....	64
Cellular Payment Applications .....	65
Wireless Networking Payment Applications.....	65
MATERIALS HANDLING/LOGISTICS .....	66
<i>TABLE 10 RF MATERIALS HANDLING/LOGISTICS APPLICATIONS .....</i>	<i>66</i>
Production Tracking .....	66
Silicon Fabs .....	66
Motor Vehicles .....	67
Other Manufacturing Applications .....	67
Automated Airline Baggage Systems .....	68
Warehouse Automation.....	68
Item Identification and Tracking .....	69
RF Picking.....	69
Shipment Tracking.....	70
SURFACE TREATMENT .....	71
Plasma Cleaning.....	71
Etching .....	71

Electronics.....	72
Medical Products.....	72
Other Industries .....	72
Surface Activation .....	72
Coating.....	73
MILITARY APPLICATIONS.....	74
TABLE 11 MILITARY APPLICATIONS OF EMERGING RF TECHNOLOGIES.....	74
High Definition Military Imagery.....	74
Military Logistics Tracking and Security.....	75
Smart Munitions Telemetry Equipment .....	75
Casualty Tracking Systems .....	75
Advanced Sensors.....	75
Tactical Communications.....	75
Enhanced Global Positioning System.....	76
Tactical Command and Control Systems .....	76
RESEARCH.....	76
Fusion Research.....	76
Advanced Rocket Propulsion Systems .....	77
RF END-USER SEGMENTS.....	77
AGRICULTURE.....	77
MINING.....	77
MANUFACTURING .....	77
HEALTH CARE .....	78
TRANSPORT & LOGISTICS.....	78
COMMUNICATIONS .....	79
RETAIL/ PERSONAL SERVICES .....	79
GOVERNMENT/MILITARY.....	79
CONSUMERS .....	80
U.S. MARKET FOR EMERGING RF TECHNOLOGIES.....	81
OVERALL U.S. MARKET .....	81
TABLE 12 TOTAL U.S. MARKET FOR EMERGING RF TECHNOLOGIES BY TYPE, THROUGH 2008 (\$ BILLIONS).....	81
DETAILED MARKET ESTIMATES AND PROJECTIONS, 2000-2008.....	82
TECHNOLOGY MARKETS .....	82
Digital Radio .....	82
FIGURE 10 U.S. DIGITAL RADIO SALES, 2000-2008 (\$ MILLIONS).....	82
FIGURE 10 (CONTINUED).....	83
Historical Sales .....	83
TABLE 13 INVESTMENTS IN SATELLITE RADIO BROADCAST AND TRANSMISSION FACILITIES, 2000-2002 (\$ MILLIONS).....	83
Market Drivers.....	84
Digital Conversion .....	84
Growing Consumer Interest in Digital Radio.....	84
Future Sales.....	85
TABLE 14 PROJECTED DIGITAL RADIO EQUIPMENT SALES, THROUGH 2008.....	85

HDTV .....	86
FIGURE 11 U.S. HDTV SALES, 2000-2008 (\$ BILLIONS).....	86
FIGURE 11 (CONTINUED).....	87
Historical Sales .....	87
FIGURE 12 PERCENT OF U.S. SALES OF DIGITAL TVs WITH INTEGRATED DIGITAL TUNER, 2002.....	88
Market Drivers.....	88
Growing Consumer Interest in HDTV .....	89
FIGURE 13 U.S. UNIT SALES OF HDTV DISPLAYS, 2000-2008 (MILLIONS).....	90
Declining Prices.....	90
FIGURE 14 AVERAGE HDTV SELLING PRICE TRENDS, 2002-2008 (\$).....	91
Changing Market for Set-Top Boxes .....	92
Broadcaster Conversion to Digital Broadcasting.....	92
Projected Market.....	93
TABLE 15 PROJECTED U.S. HDTV DISPLAY MARKET, THROUGH 2008.....	93
TABLE 16 PROJECTED U.S. SALES OF SET-TOP BOXES, THROUGH 2008.....	93
TABLE 17 PROJECTED U.S. MARKET FOR HDTV BROADCASTING EQUIPMENT, THROUGH 2008.....	94
Advanced (2.5G/3G) Cellular Technologies .....	94
FIGURE 15 U.S. MARKET FOR 2.5G/3G MOBILE INFRASTRUCTURE AND HANDSETS, 2001-2008 (\$ MILLIONS).....	95
Historical Sales .....	95
FIGURE 16 U.S. 2.5G/3G CELLULAR MARKET SUBSEGMENTS, 2002 (%).....	96
Market Drivers.....	96
Number of 2.5G/3.G Cellular Subscribers .....	96
FIGURE 17 PROJECTED GROWTH IN U.S. 2.5G/3G CELLULAR SUBSCRIBER BASE, 2000-2008 (MILLIONS).....	97
Replacement Handset Sales.....	98
Average Handset Costs .....	98
Projected Demand.....	98
FIGURE 18 U.S. 2.5G/3G CELLULAR MARKET SUB-SEGMENTS, 2008 (%).....	99
TABLE 18 2.5G/3G PROJECTED SALES, THROUGH 2008 (\$ MILLIONS).....	100
Wireless Networking .....	100
FIGURE 19 U.S. WIRELESS NETWORKING DEVICE AND EQUIPMENT SALES, 2002-2008 (\$ MILLIONS).....	101
Historical Sales .....	102
FIGURE 20 U.S. WIRELESS NETWORKING DEVICES MARKET SUB-SEGMENTS, 2002 (%).....	102
Market Drivers.....	102
Personal Area Networking .....	103
Hands-Free Headsets for Mobile Telephones .....	103
FIGURE 21 U.S. SALES OF BLUETOOTH MOBILE PHONE HANDSETS, 2000-2008 (THOUSAND UNITS).....	104
Computers .....	104
Computer Accessories and Peripherals .....	105
TABLE 19 SALES OF BLUETOOTH COMPUTER ACCESSORIES AND PERIPHERALS, THROUGH 2008 (THOUSAND UNITS).....	106

	Personal Digital Assistants (PDAs) .....	106
<i>FIGURE 22 U.S. PERSONAL DIGITAL ASSISTANT SALES, 2000-2008 (THOUSAND UNITS)</i> .....		107
<i>FIGURE 23 BLUETOOTH PDAS VERSUS ALL PDAS SOLD IN THE U.S., THROUGH 2008 (THOUSAND UNITS)</i> .....		108
	Automobiles.....	108
	Wireless Local Area Networking .....	109
<i>FIGURE 24 U.S. WLAN EQUIPMENT SALES MARKET SHARES, 2002 (%)</i> .....		110
	SOHO Market .....	110
<i>FIGURE 25 NUMBER OF U.S. HOUSEHOLDS WITH BROADBAND INTERNET ACCESS, 2000-2008 (MILLIONS)</i> .....		111
	Enterprise Market .....	112
	Public WLANs (Hotspots) .....	112
<i>FIGURE 26 NUMBER OF U.S. PUBLIC WLAN HOTSPOTS, 2000-2008</i> .....		113
	Wireless Wide Area Networking .....	113
	Projected Sales .....	114
<i>FIGURE 27 U.S. WIRELESS NETWORKING DEVICES MARKET SUBSEGMENTS, 2008 (%)</i> .....		115
	Personal Area Networking .....	116
<i>TABLE 20 WIRELESS PERSONAL AREA NETWORKING PROJECTED SALES, THROUGH 2008 (\$ MILLIONS)</i> .....		116
<i>TABLE 21 PROJECTED SALES OF BLUETOOTH COMPUTER ACCESSORIES AND PERIPHERALS, 2002-2008 (THOUSAND UNITS)</i> .....		117
	Wireless Local Area Networking .....	118
<i>TABLE 22 U.S. WLAN PROJECTED SALES, THROUGH 2008 (\$ MILLIONS)</i> .....		118
	Wireless Wide Area Networking .....	118
	Public WLANs .....	119
	RFID .....	119
<i>FIGURE 28 U.S. RFID SALES, 2000-2008 (\$ MILLIONS)</i> .....		119
<i>FIGURE 29 PERCENT OF U.S. RFID SALES BY TYPE OF PRODUCT/SERVICE, 2002</i> .....		120
	Historical Sales .....	120
	Market Drivers.....	120
	Electronic Article Surveillance (EAS) .....	121
	Supply Chain Management .....	122
	Real-Time Location Systems.....	123
	Baggage Handling.....	124
	Point of Sale Payment Systems .....	125
<i>FIGURE 30 TREND IN NUMBER OF SPEEDPASSES, 1997-2002 (MILLIONS OF TAGHOLDERS)</i> .....		126
	Projected Sales .....	127
<i>TABLE 23 RFID PROJECTED SALES, THROUGH 2008 (\$ MILLIONS)</i> .....		127
	“Traditional” Markets.....	127
	RF-EAS .....	128
	Supply Chain Management .....	128
	RTLS .....	129
	Airline Baggage Tracking.....	129
	Point of Sale.....	129
	Global Positioning Systems.....	130

<i>FIGURE 31 U.S. GPS SALES, 2000-2008 (\$ BILLIONS)</i> .....	130
Historical Sales .....	131
Market Drivers.....	131
<i>FIGURE 32 U.S. GPS MARKET SUBSEGMENT MARKET SHARES, 2002 (%)</i> .....	131
<i>FIGURE 32 (CONTINUED)</i> .....	132
Vehicle Location and Tracking Systems .....	132
Vehicle Onboard Navigation Systems .....	132
Telematics Systems .....	133
Automatic Vehicle Location (AVL) Systems .....	133
<i>TABLE 24 NUMBER OF AVL-EQUIPPED VEHICLES IN U.S. FLEETS, THROUGH 2002</i> .....	134
Consumer GPS .....	134
Consumer GPS (Continued).....	135
Aviation.....	136
<i>FIGURE 33 U.S. GENERAL AVIATION PILOTS WITH INSTRUMENT RATINGS, 1992-2001 (THOUSANDS)</i> .....	136
<i>FIGURE 33 (CONTINUED)</i> .....	137
Machine Control.....	138
Other Applications .....	138
Projected Sales .....	139
<i>TABLE 25 GPS PROJECTED SALES, THROUGH 2008 (\$ MILLIONS)</i> .....	139
<i>FIGURE 34 U.S. GPS MARKET SUBSEGMENT MARKET SHARES, 2008 (%)</i> .....	140
Vehicle Navigation Systems.....	141
Consumer GPS Products .....	141
<i>TABLE 26 PROJECTED CONSUMER GPS SYSTEM SALES, THROUGH 2008 (\$ MILLIONS)</i> .....	142
Machine Controls .....	142
Aviation.....	142
Other GPS Applications .....	142
Plasma Surface Modification Equipment .....	142
<i>FIGURE 35 U.S. PLASMA SURFACE MODIFICATION EQUIPMENT SALES, 2000- 2008 (\$ BILLIONS)</i> .....	143
Historical Sales .....	143
Market Drivers.....	143
<i>FIGURE 36 TRENDS IN U.S SEMICONDUCTOR SHIPMENTS, 2000-2008 (\$ BILLIONS)</i> .....	144
Projected Sales .....	145
<i>TABLE 27 PLASMA EQUIPMENT MARKET DRIVERS AND PROJECTED SALES, THROUGH 2008 (\$ BILLIONS)</i> .....	145
RF Components .....	145
<i>FIGURE 37 U.S. MARKET FOR RFICs, 2000-2008 (\$ BILLIONS)</i> .....	146
FREQUENCY BANDS.....	147
<i>FIGURE 38 RF TECHNOLOGIES MARKET SHARES BY FREQUENCY BAND, 2003 (%)</i> .....	148
<i>TABLE 28 EMERGING RF TECHNOLOGY SALES TRENDS BY FREQUENCY BAND, THROUGH 2008 (\$ BILLIONS)</i> .....	149
<i>FIGURE 39 RF TECHNOLOGY MARKET SHARES BY FREQUENCY BAND, 2008 (%)</i> .....	149



APPLICATIONS.....	150
FIGURE 40 EMERGING RF TECHNOLOGIES MARKET SHARES BY GENERAL APPLICATION, 2003 (%).....	150
TABLE 29 EMERGING RF APPLICATIONS SALES, THROUGH 2008 (\$ BILLIONS).....	151
FIGURE 41 EMERGING RF TECHNOLOGIES MARKET SHARE BY GENERAL APPLICATION, 2008 (%).....	151
END-USERS.....	152
FIGURE 42 RF TECHNOLOGY MARKET SHARES BY TYPE OF END-USER, 2003 (%).....	152
FIGURE 42 (CONTINUED).....	153
TABLE 30 EMERGING RF TECHNOLOGY END-USERS, THROUGH 2008 (\$ BILLIONS).....	153
FIGURE 43 EMERGING RF TECHNOLOGIES BY TYPE OF END-USER, 2008 (%).....	154
COMPETITION .....	155
DIGITAL RADIO RECEIVERS.....	155
FIGURE 44 OEM AUTOMOTIVE AUDIO (RECEIVER/ANTENNA) MARKET SHARES, 2002 (%).....	156
DELPHI CORP.....	156
VISTEON CORP. ....	157
OTHER MANUFACTURERS.....	157
HIGH DEFINITION TELEVISION.....	157
FIGURE 45 U.S. TV RECEIVER MARKET LEADERS, 2002 (%).....	158
ADVANCED (2.5G/3G) CELLULAR.....	159
FIGURE 46 W-CDMA INFRASTRUCTURE MARKET SHARES, 2002 (%).....	159
FIGURE 47 3G HANDSET MARKET SHARES, 2002 (%).....	160
WIRELESS NETWORKING .....	160
PERSONAL AREA NETWORKS .....	160
WIRELESS LOCAL AREA NETWORKS .....	161
Small Office/Home Office (SOHO) Sub-Segment .....	161
FIGURE 48 SMALL OFFICE/HOME OFFICE WLAN MARKET SHARES, 2002 (PERCENT OF TOTAL SALES BY VALUE).....	161
FIGURE 48 (CONTINUED).....	162
Linksys .....	162
Netgear.....	162
D-Link .....	162
Buffalo Technology.....	163
Enterprise Sub-Segment .....	163
FIGURE 49 ENTERPRISE WLAN MARKET SHARES, 2002 (PERCENT OF TOTAL SALES BY VALUE).....	163
FIGURE 49 (CONTINUED).....	164
Proxim Corp. ....	164
Symbol Technologies, Inc.....	164
RFID .....	164
FIGURE 50 RFID MARKET SHARES, 2002 (%).....	165
TEXAS INSTRUMENTS .....	165
TYCO INTERNATIONAL.....	166
CHECKPOINT SYSTEMS.....	166
ALIEN TECHNOLOGIES .....	166

MATRICS .....	166
SAVI TECHNOLOGY .....	167
GPS .....	167
<i>FIGURE 51 GPS MARKET SHARES, 2002 (PERCENT OF TOTAL SALES BY VALUE).....</i>	<i>168</i>
GARMIN .....	168
TRIMBLE NAVIGATION .....	168
ROCKWELL COLLINS .....	169
THALES NAVIGATION .....	169
OTHER COMPANIES .....	169
RF PLASMA APPLICATIONS.....	169
LONG-TERM OUTLOOK FOR THE U.S. MARKET .....	170
DEVELOPMENTS THAT WILL INFLUENCE THE LONG-TERM	
MARKET FOR EMERGING RF TECHNOLOGIES.....	170
ECONOMIC TRENDS .....	170
HEALTH/ENVIRONMENTAL ISSUES .....	171
LEGAL/COPYRIGHT ISSUES .....	171
The Debate .....	172
PRIVACY ISSUES .....	173
Effects.....	174
SECURITY ISSUES.....	175
TECHNOLOGY TRENDS.....	175
BANDWIDTH COMPETITION.....	176