FUTURE OF TELECOMMUNICATIONS

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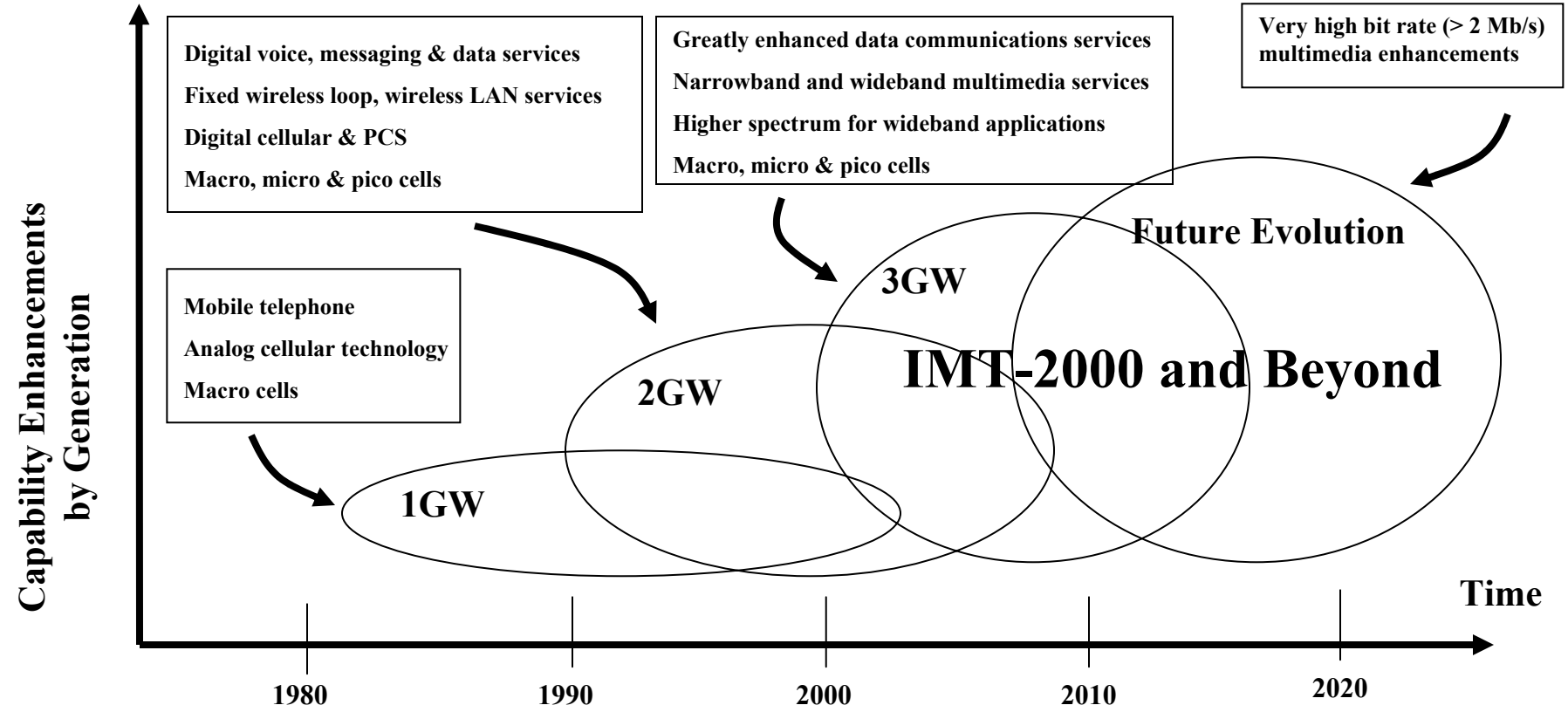
TOPICS FOR CUTTING EDGE DISCUSSION

FORCES IMPACTING THE FUTURE
IMT-2000 AND BEYOND (IMT-ADVANCED)
IEEE STANDARDS DEVELOPMENT
UNDERLAYS AND INTERFERENCE
SOFTWARE AND COGNITIVE RADIOS
RADIONAVIGATION SATELITES
BSS / FSS SHARING
> 50 GHz
RF IDENTIFICATION TAGS
POWER LINE TELECOMMUNICATIONS
SPECTRUM MANAGEMENT STUDIES
BROADCAST STUDIES
FUTURE TECHNOLOGY
S-CURVES

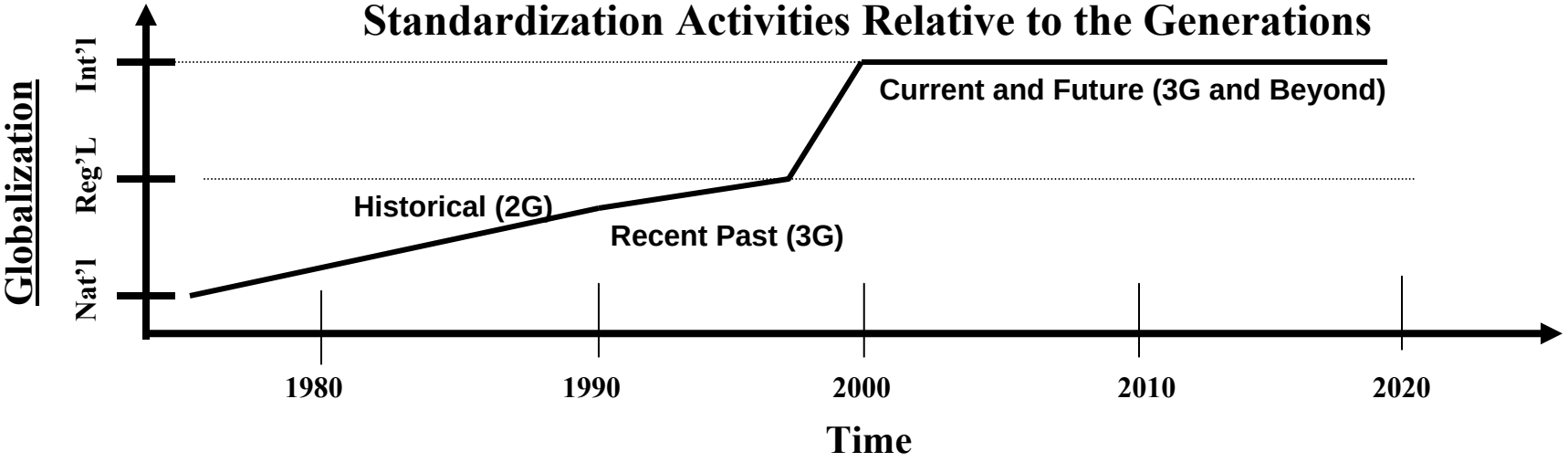
FORCES IMPACTING THE TELECOMMUNICATION FUTURE

- INTERNET
- GLOBALIZATION (UNIVERSAL NETWORK ACCESS) AND LIBERALIZATION
- NATIONAL PRIORITIES (REGULATIONS)
- PRIVATIZATION AND INVESTMENT OPPORTUNITIES
- COMPETITION AND ECONOMICS
- TECHNOLOGY AND MARKET INNOVATION
- PUBLIC AND SOCIAL INTEREST
- CONSUMERS' INTERESTS AND MOBILITY
- WORLD TRADE ORGANIZATION AND INTERNATIONAL TELECOMMUNICATION UNION AGREEMENTS (OPEN MARKETS)
- FOREIGN OWNERSHIP / ACCESS (INVESTMENT)
- EARTH ENVIRONMENT

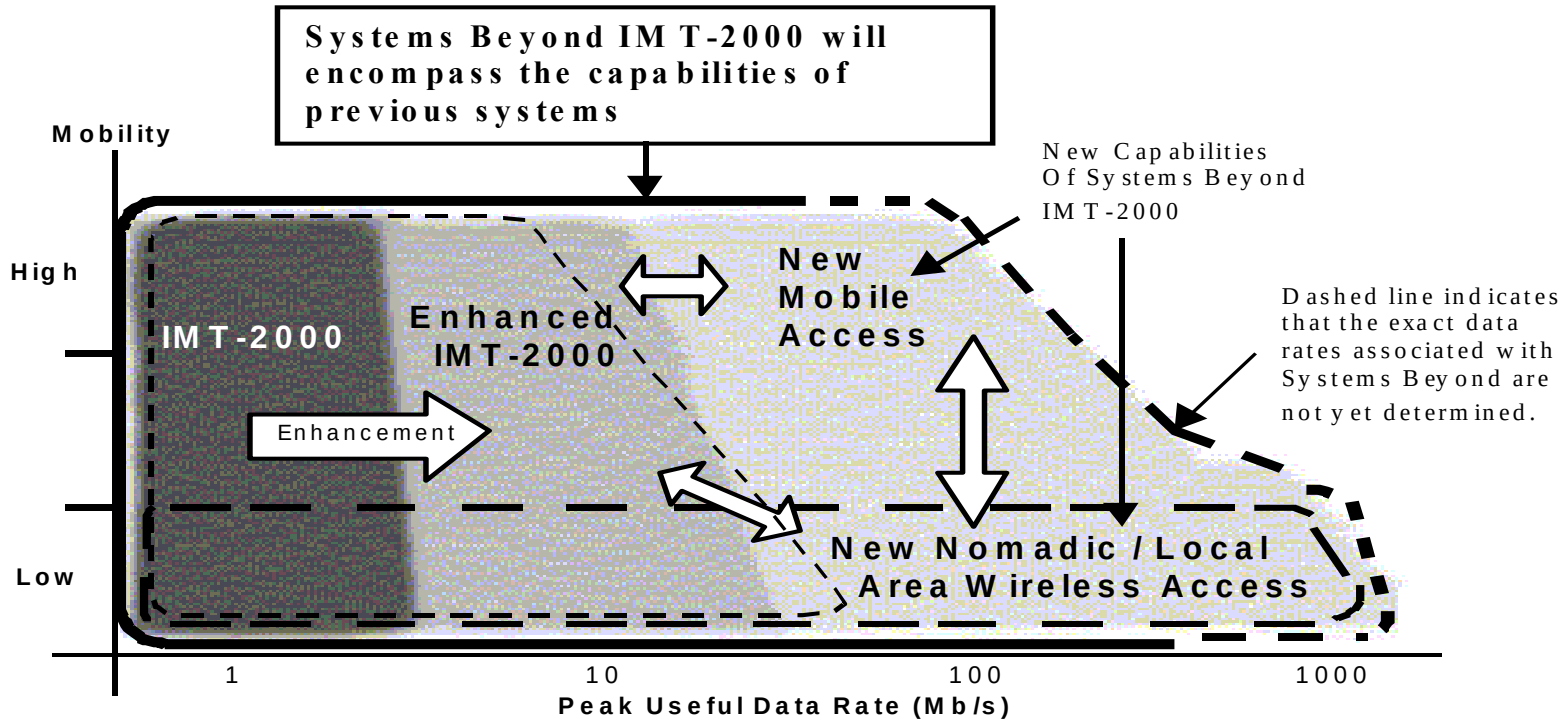
Generations of Terrestrial Commercial Wireless Systems



Standardization Activities Relative to the Generations



CAPABILITES OF IMT-2000



KEY: ⇔ denotes interconnection between systems via networks or the like, which allows flexible use in any environments without making users aware of constituent systems.

Nomadic / Local Area Access Systems

Digital Broadcast Systems

Dark gray color indicates existing capabilities, medium gray color indicates enhancements to IMT-2000, and the lighter gray color indicates new capabilities of Systems Beyond IMT-2000.

The degree of mobility as used in this figure is described as follows: Low mobility covers pedestrian speed, and high mobility covers high speed on highways or fast trains (60 km/h to ~250 km/h, or more).

ITU-R WORKING PARTY 8F

- **WP8F IS THE GLOBAL FOCAL POINT FOR THE CONTINUING VISION OF NEXT GENERATION WIRELESS SERVICES AND SYSTEMS, ACTING AS A FORUM FOR USER REQUIREMENTS AND AS A CATALYST FOR TRANSLATING THOSE REQUIREMENTS INTO TECHNICAL REALITY**

- **WP8F HAS THE CHALLENGING TASK OF SUPPORTING THE NEAR TERM NEEDS OF THE IMT-2000 MARKETPLACE WHILE EXPLORING WHERE WE MIGHT GO IN THE WIRELESS WORLD OF THE FUTURE (IMT-ADVANCED)**

MOBILE SERVICE STUDIES ITU-R WORKING PARTY 8F (IMT-ADVANCED)

- **FUTURE WIRELESS SYSTEMS WITH DATA RATES > 2 Mbit/s**
- **SERVICE APPLICATIONS, OBJECTIVES AND USER NEEDS**
- **ENHANCED INTERNET PROTOCOL**
- **TECHNICAL AND OPERATIONAL ISSUES, AND CHARACTERISTICS**
- **HARMONIZE SPECTRUM**
- **MIGRATION STRATEGY TO NEXT GENERATION**
- **GLOBAL CIRCULATION AND MUTUAL RECOGNITION AGREEMENTS BETWEEN COUNTRIES**

THIRD GENERATION SHARING ISSUES SPECTRUM (IMT-2000 AND BEYOND)

1710 - 1755 MHz - FIXED & MOBILE

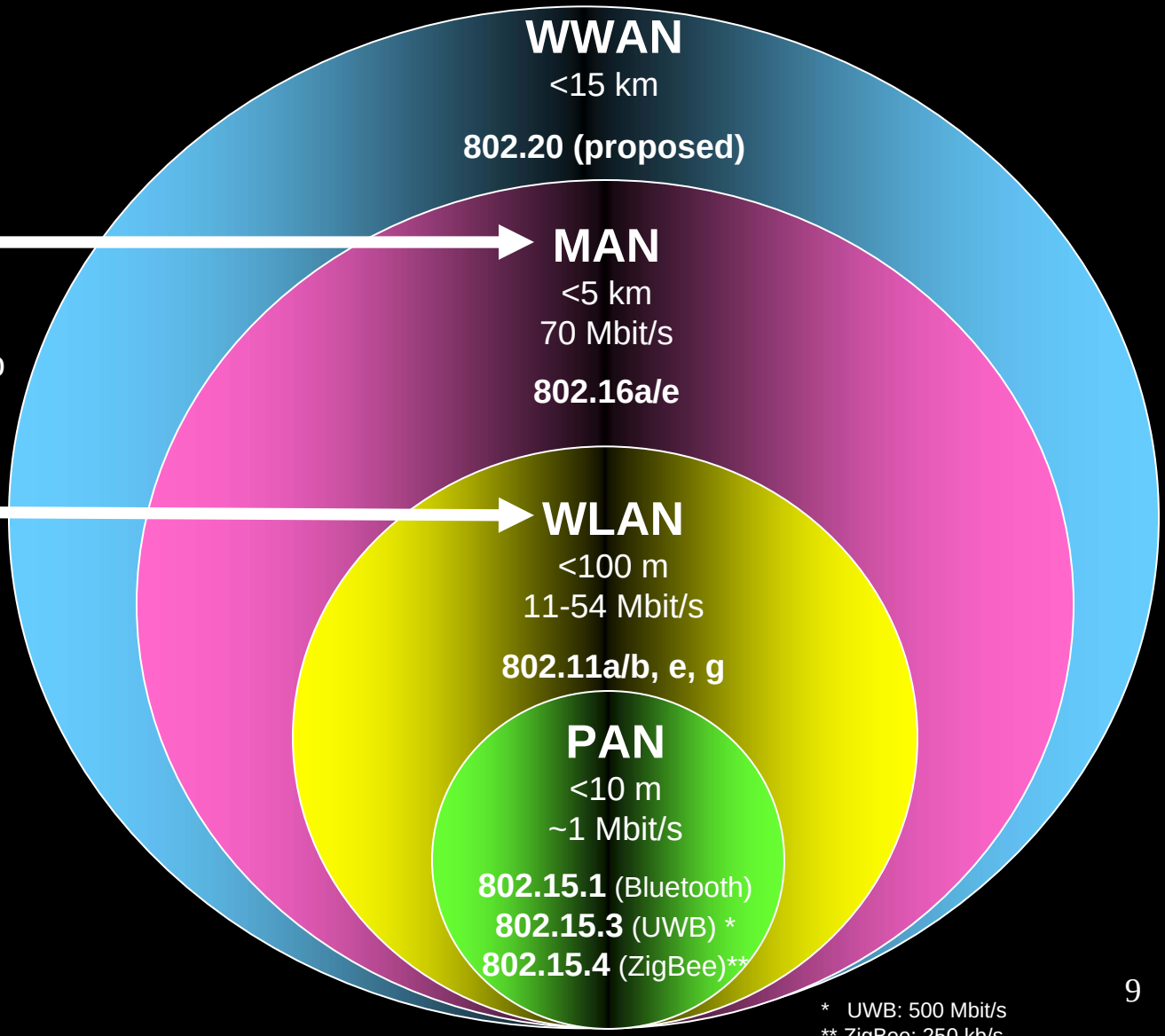
1755 - 1850 MHz - DEFENSE USES

2110 - 2150 MHz - FIXED & MOBILE

2160 - 2165 MHz - FIXED & MOBILE

*2500 - 2690 MHz - MMDS, ITFS, BSS (SOUND)

IEEE STANDARDS VIEW OF WIRELESS NETWORK TECHNOLOGIES - NOMINALLY NONDIRECTIONAL APPLICATIONS



WiMAX
New standard for Fixed broadband Wireless. Trying to do for MAN what Wi-Fi did for LAN.

Wi-Fi®

* UWB: 500 Mbit/s
** ZigBee: 250 kb/s

Source: International Telecommunications Union, "Birth of Broadband", September 2003

WiMAX

WiMAX IS BEING CONSIDERED BY ITU-R WP 8F AS A POSSIBLE IMT-2000 TECHNOLOGY (IP-OFDMA)

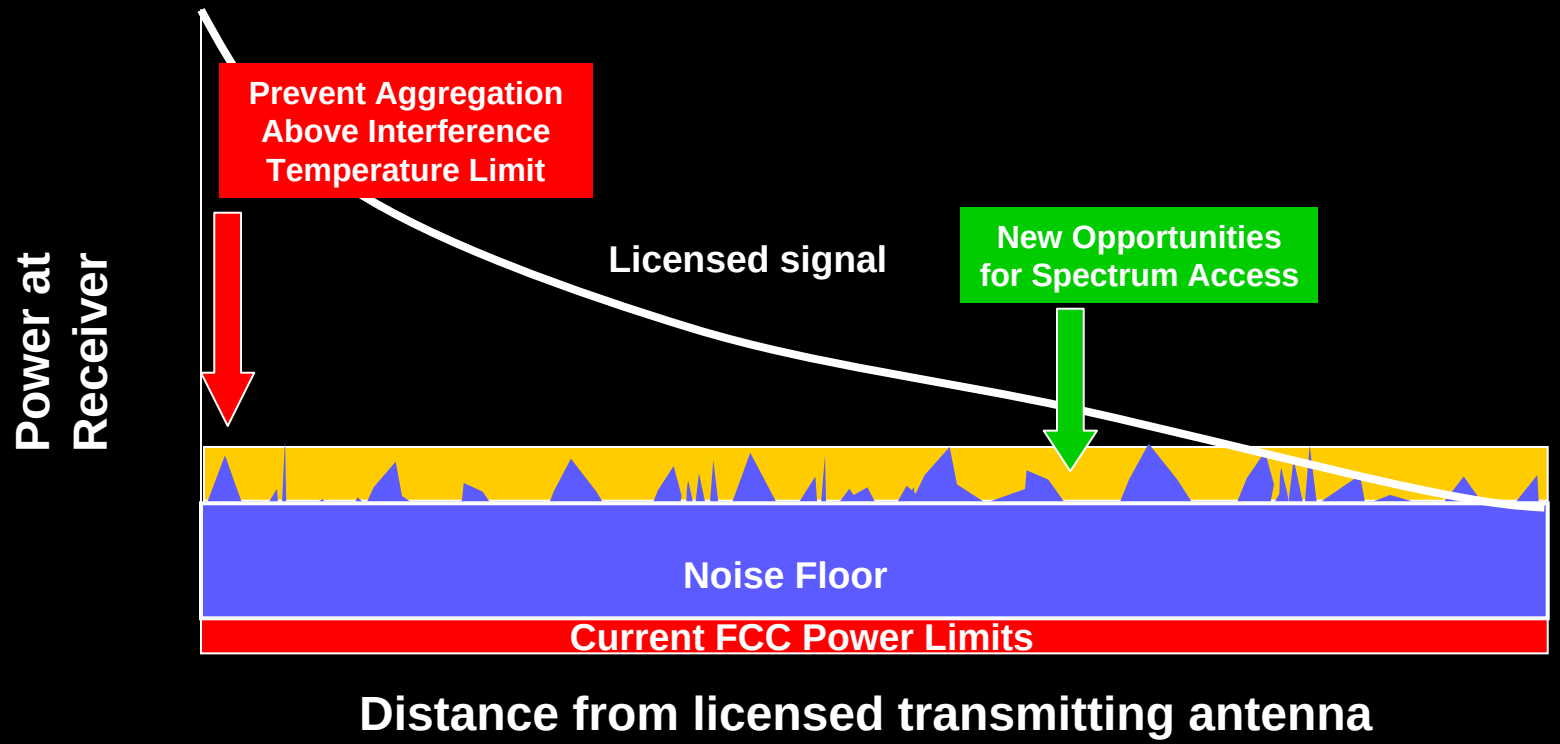
IEEE 802.16e MOBILITY STANDARD

2.5 GHz BAND IN U.S., RUSSIA, AND U.K.

CALLER ID VIA BLUETOOTH

$200 - $250 FOR A WATCH THAT SHOWS CALLER IDENTIFICATION (NAME OR NUMBER) FROM NEARBY CELLPHONES

UNDERLAYS AND INTERFERENCE AVOIDANCE



INTERFERENCE TEMPERATURE

WITH THIS CONCEPT, USING COGNITIVE RADIOS, OPERATION IS BEING CONSIDERED IN FIXED SERVICE, FIXED SATELLITE SERVICE, AND MOBILE SERVICE BANDS:

- **6525-6700 MHz**
- **12.75-13.15 GHz**
- **13.21-13.25 GHz**

SOFTWARE DEFINED RADIO

A RADIO THAT INCLUDES A TRANSMITTER IN WHICH THE OPERATING PARAMETERS OF FREQUENCY RANGE, MODULATION TYPE OR MAXIMUM OUTPUT POWER (EITHER RADIATED OR CONDUCTED) CAN BE ALTERED BY MAKING A CHANGE IN SOFTWARE WITHOUT MAKING ANY CHANGES TO HARDWARE COMPONENTS THAT AFFECT THE RADIO FREQUENCY EMISSIONS

COGNITIVE RADIO

A RADIO NETWORK THAT SENSES ITS ENVIRONMENT AND LOCATION, AND AUTOMATICALLY ADAPTS TO THAT ENVIRONMENT MAKING USE OF AVAILABLE SPECTRUM AND TECHNOLOGY INCLUDING FOR OVERLAYS AND UNDERLAYS

SDR / COGNITIVE RADIO ABILITIES AND PROCESSES

1. USE "EMPTY" SPECTRUM
2. FILL EMPTY TIME SLOTS
3. VARY SIGNAL LEVELS
4. APPLY CODING
5. DIGITALLY PROCESS
6. VARY ROUTING
7. USE ADAPTIVE ANTENNAS
8. ENABLE BOTH NEGOTIATED AND NON-VOLUNTARY SHARING

(USED TODAY IN WIRELESS LANs AND MOBILE SERVICE NETWORKS BOTH ON A MULTIBAND AND MULTIFUNCTION BASIS)

GLOBAL POSITIONING (RADIONAVIGATION SATELLITE SERVICE - - RNSS)

GPS - - U.S.

GLONASS - - RUSSIA

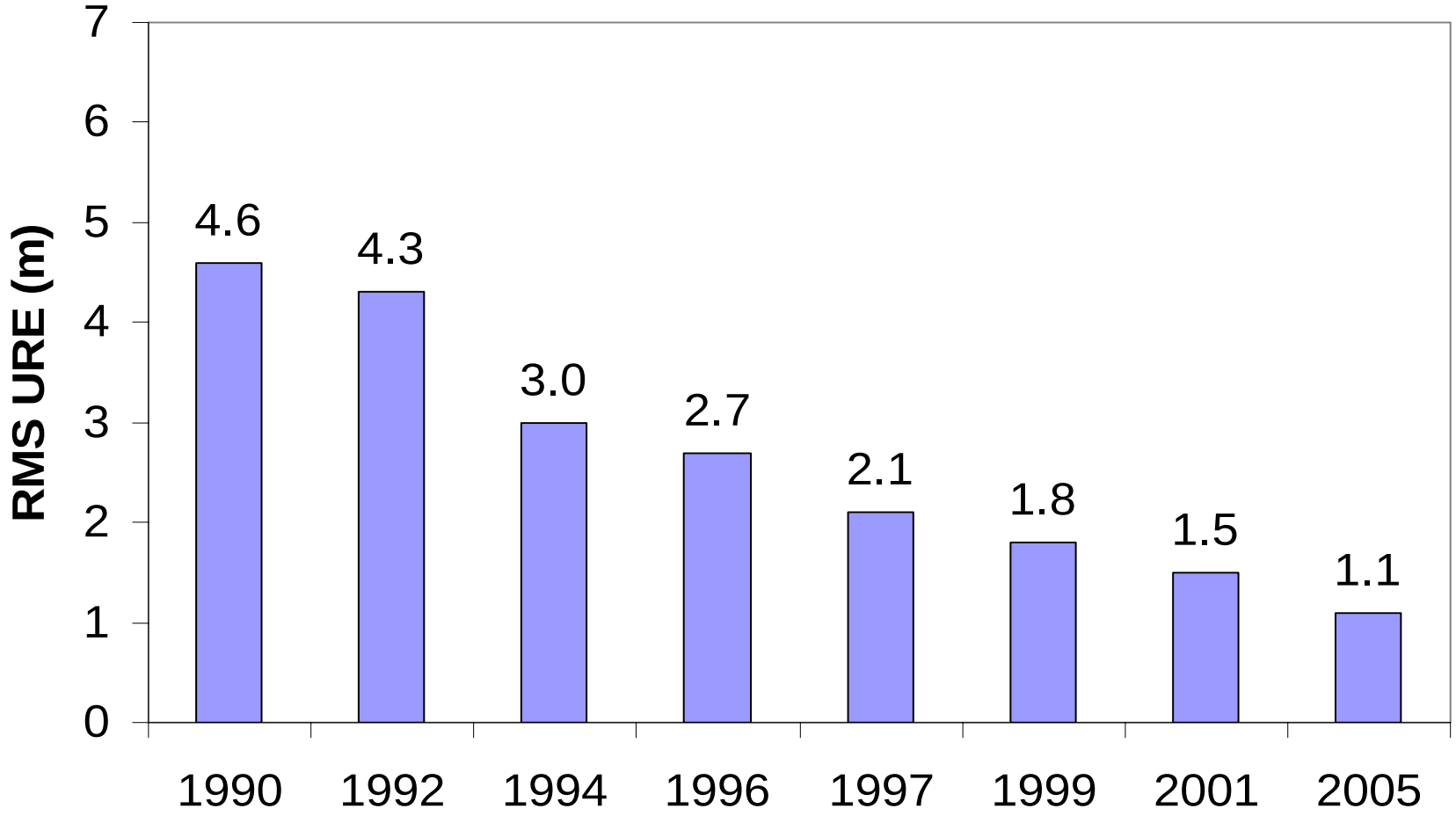
GALILEO - - EUROPE (2011-2012)

GAGAN - - INDIA

COMPASS (BEIDOU) - CHINA

QZSS - JAPAN

GPS IMPROVEMENTS
- - DECREASING ROOT MEAN SQUARE USER RANGE ERROR (URE) - -



BSS / FSS SHARING

- BSS RR APPENDIX 30 PLANNED SATELLITES, SHARING WITH NGSO FSS OPERATIONS, IS FEASIBLE
- TERRESTRIAL MVDDS CAN OPERATE AT 12 GHz (Ku) BAND ON NON-HARMFUL INTERFERENCE BASIS
- GLOBAL TECHNICAL AND SERVICE RULES IN PLACE FOR AGGREGATION IN A CLOSED ENVIRONMENT
- INTERFERENCE TESTING MANDATORY

MILLIMETER WAVES (ABOVE 50 GHz)

- **51.4 - 52.6 GHz AND 58.2 - 59 GHz ALLOCATED TO FIXED AND MOBILE SERVICES TO INTERCONNECT MOBILE SERVICE BASE STATIONS AND OTHER SYSTEMS**
- **57 - 64 GHz UNLICENSED ALLOCATION (HIGH O_2 ABSORPTION) TO PROVIDE 7 GHz OF VERY HIGH SPEED AND/OR HIGH BANDWIDTH COMMUNICATION OVER SHORT DISTANCES, AND TO NETWORK BACKBONE CONNECTIONS IN CONGESTED AREAS**
- **64 - 66 GHz ALLOCATED TO FIXED AND MOBILE SERVICES, EXCEPT AMS TO INTERCONNECT MOBILE SERVICE BASE STATIONS AND OTHER SYSTEMS**
- **65 - 71 GHz ALLOCATED TO INTERSATELLITE SERVICE FOR SATELLITE NETWORK INTERCONNECTIONS PROMOTING VIDEO TELEPHONY, MEDICAL AND TECHNICAL TELE-IMAGING, HIGH SPEED DATA NETWORKS, AND BANDWIDTH-ON-DEMAND FOR CONSUMERS**

RF IDENTIFICATION (RFID) TAGS

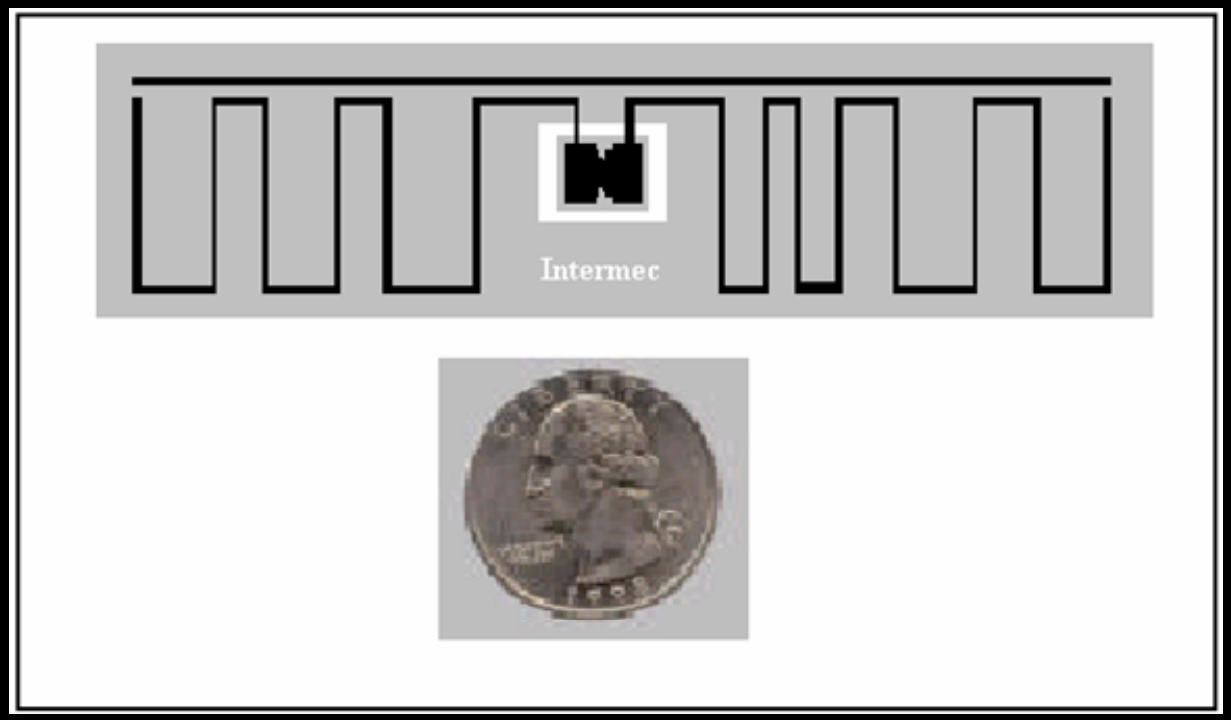
READ AT ~ 3 OR 4 METER DISTANCE

- - PRIVACY IS A PARTICULAR ISSUE - -

RAPID TRANSPORTATION
RAIL CARS
TOLLBOOTH PASSES
PARKING GATES
PALLETS
PERSONNEL ENTRY
LIBRARY MANAGEMENT
FINANCIAL PROTECTION
"BEST CUSTOMER" CARDS
FARE CARDS (BUSES & TRAINS)

PRODUCT INVENTORY
PRODUCT DISTRIBUTION
AIRLINE LUGGAGE / SECURITY
SCHOOL ATTENDANCE
MEDICATION TRACKING
FOOD TRACEABILITY
ENVIRONMENTAL, ANIMAL, POULTRY, FISH, WILDLIFE MANAGEMENT

Source: TIA, "The Economic and Social Benefits of Broadband Deployment", October 2003



COURTESY OF INTERMEC TECHNOLOGIES

SOURCE: WASHINGTON POST

RFID TAG CONTAINING A MICROCHIP SURROUNDED BY COPPER STRANDS THAT ACT AS AN ANTENNA

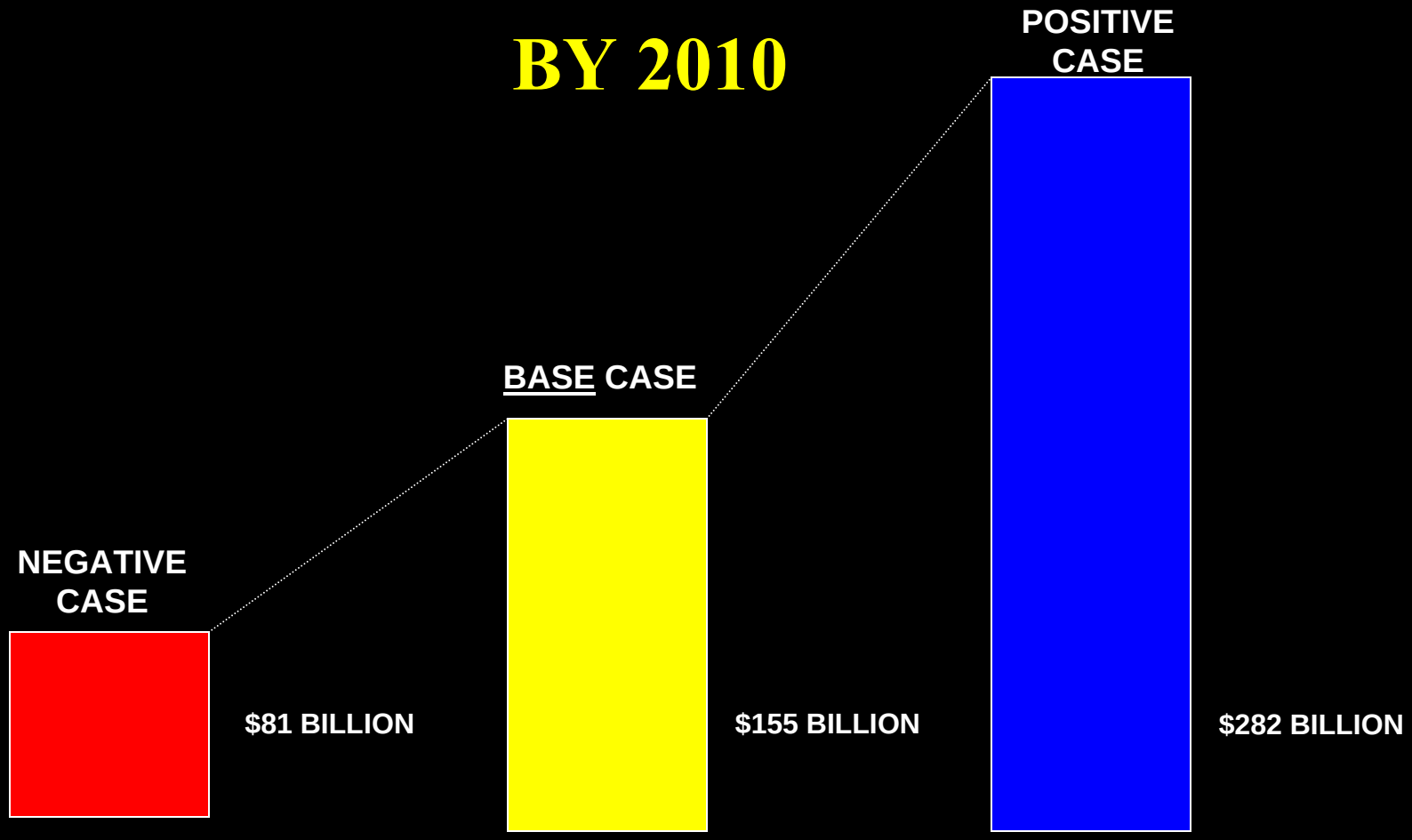
CURRENT RFID TAG TYPES BY FORM, DIMENSIONS, AND MAIN APPLICATION

TECHNOLOGY – UWB?

FORM	DIMENSIONS	MAIN APPLICATION
DISK	SEVERAL mm TO TENS OF mm	•CLOTHING MANAGEMENT •TAGS FOR EMBEDDING IN DEVICES
TUBE	SEVERAL mm TO TENS OF mm	•ANIMAL / AQUATIC MANAGEMENT •PALLET MANAGEMENT
LABEL	SEVERAL mm TO TENS OF mm	•TAGS FOR POINT-OF-SERVICE PAYMENT •DOCUMENT MANAGEMENT •FREIGHT MANAGEMENT
CARD	85 x 54 x SEVERAL mm	•PUBLIC TRANSPORTATION PASSES •TELEPHONE CARDS •ID CARDS FOR ENTRY / EXIT
BOX	50 x 50 x 10 mm ~	•VEHICLE MANAGEMENT •CONTAINER MANAGEMENT

SOURCE: NEW BREEZE, ITU ASSOCIATION OF JAPAN 2004

FORECAST OF RFID ECONOMIC IMPACT BY 2010



SOURCE: NEW BREEZE, ITU ASSOCIATION OF JAPAN 2004

POWER LINE TELECOMMUNICATIONS (PLT OR BPL)

- ADVANCED DIGITAL PROCESSING AND MODULATION
- MULTIPLE CARRIERS
- SERVICE OUT TO ≈ TWO KILOMETERS
- 2 to 80 MHz BANDWIDTHS - - UP TO 80 MHz RF
- TELECOMMUNICATIONS ACCESS TO NEIGHBORHOODS, BUILDINGS, OR HOMES WHERE POWER INFRASTRUCTURE EXISTS

PLT / BPL BENEFITS

- COMPETITION TO DSL, CABLE, AND SATELLITE
- ACCESS TO WHEREVER THERE ARE POWER MAINS
- REDUNDANCY AT LOW COST
- BETTER MANAGEMENT OF ELECTRIC GRIDS
- SMART HOME APPLICANCES
- REMOTE NOTIFICATION (SECURITY, TRAFFIC, REMOTE METER READING, INTERNET CONNECTIVITY)

TYPICAL PLT / BPL RULES

- UNLICENSED
- NO HARMFUL INTERFERENCE TO BE CAUSED
- MUST ACCEPT INTERFERENCE
- LIMITED RF EMISSION (SEE FOLLOWING TABLE)
- 12 AERONAUTICAL BANDS RESTRICTED (TABLE)
- REQUIRED CONSULTATION WITH PUBLIC SAFETY AND AERONAUTICAL SITES
- EXCLUSION ZONES
  - 2182 kHz WITHIN 1 km OF A MARITIME STATION
  - 73-74.6 MHz WITHIN 29 km OVERHEAD AND 11 km UNDERGROUND OF RADIOASTRONOMY SITES
- ADAPTIVE IX MITIGATION TECHNIQUES
  - EXCLUDE OR NOTCH ANY SPECIFIC FREQUENCY
  - REMOTELY TURN OFF ANY BPL DEVICE

EMISSION LIMITS APPLICABLE TO PLT / BPL (BASED ON CISPR QUASI-PEAK-DETECTION) FROM 2 MHz TO 80 MHz

FREQUENCY (MHz)	FIELD STRENGTH (μV/m)	MEASUREMENT DISTANCE (m)
2-30	30	30
30-80	100	3

PLT / BPL EXCLUDED AERONAUTICAL FREQUENCIES

2850 – 3025 kHz	3400 – 3500 kHz	4650 – 4700 kHz
5450 – 5680 kHz	6525 – 6685 kHz	8815 – 8965 kHz
10005 – 10100 kHz	11275 – 11400 kHz	13260 – 13360 kHz
17900 – 17970 kHz	21924 – 22000 kHz	74.8 – 75.2 MHz

SPECTRUM MANAGEMENT (ITU-R SG 1) STUDIES

- HOW ARE INTERACTIVE MULTIMEDIA APPLICATIONS OF TERRESTRIAL FIXED, MOBILE, AND BROADCASTING SERVICES CONVERGING TECHNICALLY?
- HOW DOES TECHNICAL CONVERGENCE IMPACT ON THE NATIONAL AND INTERNATIONAL RADIO REGULATORY ENVIRONMENT?
- IF TECHNICAL CONVERGENCE IMPACTS THE SERVICE DEFINITIONS OF THE RADIO REGULATIONS, HOW SHOULD THE DEFINITIONS (FIXED, MOBILE, AND BROADCASTING) BE REVISED?
- SHOULD STUDIES BE CONSOLIDATED INTO TWO CATEGORIES, TERRESTRIAL ON ONE HAND, AND SATELLITE ON THE OTHER HAND?

BROADCAST (ITU-R SG 6) STUDIES

STUDY GROUP 6 STUDIES TERRESTRIAL [AND SATELLITE] BROADCASTING FROM END-TO-END, INCLUDING VISION, SOUND, MULTIMEDIA AND DATA SERVICES INTENDED FOR THE GENERAL PUBLIC. USE IS MADE OF POINT-TO-EVERYWHERE INFORMATION DELIVERY. WHEN RETURN CHANNELS ARE REQUIRED FOR ACCESS CONTROL, E.G., INTERACTIVITY, AN ASYMMETRICAL INFRASTRUCTURE IS USED.

DIGITAL FM BROADCAST

- 88 - 108 MHz BAND
- EXISTING FM RADIO STATIONS USE EITHER +/- 75 kHz DEVIATION AT 200 kHz CHANNEL SEPARATION, OR +/- 50 kHz DEVIATION AT 100 kHz CHANNEL SEPARATION
- IN-BAND ON CHANNEL (IBOC) DIGITAL UNDERLAY IMPLEMENTATION
- IBOC DIGITAL SIGNAL INSERTED ~ 25 dB BELOW THE ANALOG FM SIGNAL
- STANDARDS BEING DISCUSSED INTERNATIONALLY WITH THE HOPE OF FINDING A COMMON GLOBAL STANDARD

DIGITAL SOUND BROADCASTING BELOW 30 MHz

THE WORLD BROADCASTING UNION AND THE INTERNATIONAL TELECOMMUNIUCATION UNION HAVE BEEN COOPERATING IN SUPPORT OF STUDIES LEADING TO THE ADOPTION OF WORLDWIDE BROADCASTING STANDARDS, PARTICULARLY:

- SINGLE COMMON DIGITAL SOUND BROADCAST SYSTEM IN LF, MF, AND HF
- DIGITAL CODING AND MODULATION COMPATIBLE WITH EXISTING STATION PLANNING
- IDENTIFYING ADVANTAGES OVER ANALOG
- FINDING NEW SERVICES
- NOTING COMPLEXITY OF DUAL STANDARD (ANALOG AND DIGITAL) BROADCAST RECEIVERS

DIGITAL TELEVISION

- **HIGH DEFINITION DEFINED AS EQUIVALENT TO A 35 mm CINEMA PICTURE**
- **TWO COMMON GLOBAL STANDARD (ANALOG) TELEVISION BROADCAST CHANNEL BANDWIDTHS, 6 MHz AND 8 MHz**
- **THERE IS A COMMON DIGITAL TELEVISION DISPLAY FORMAT BUT DIFFERENT RF MODULATION SCHEMES (COFDM AND 8VSB)**
- **TRANSITION FROM ANALOG TO DIGITAL**
- **VERY POLITICAL (RRC-06) BUT WITH A HAPPY ENDING**

INTERACTIVE TELEVISION

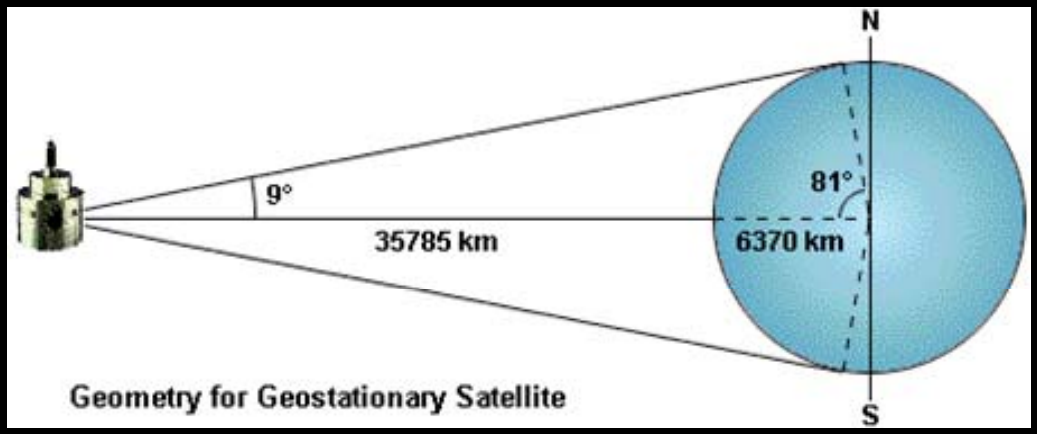
STUDIES ARE UNDERWAY OF *INTERACTIVE TELEVISION SERVICES* SO AS TO FACILITATE APPROPRIATE LICENSING:

- **VIDEO PIPELINE (MPEG VIDEO)?**
- **HIGH SPEED INTERNET PROTOCOL?**
- **CUSTOMER PREMISES EQUIPMENT?**
- **ANTI-COMPETITIVE BEHAVIOR?**

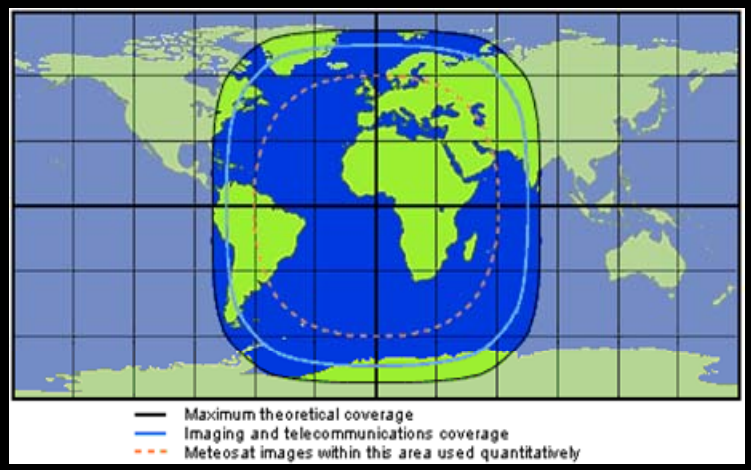
BSS-TERRESTRIAL SHARING

- TERRESTRIAL TELEVISION SYSTEM SHARING WITH GEOSTATIONARY SATELLITE, BROADCAST SATELLITE SERVICE (BSS), IS FEASIBLE
- UNIQUE TECHNICAL APPROACH
- INTERFERENCE TESTING
- POLITICALLY SENSITIVE

GEOSTATIONARY ORBIT



Geometry for Geostationary Satellite

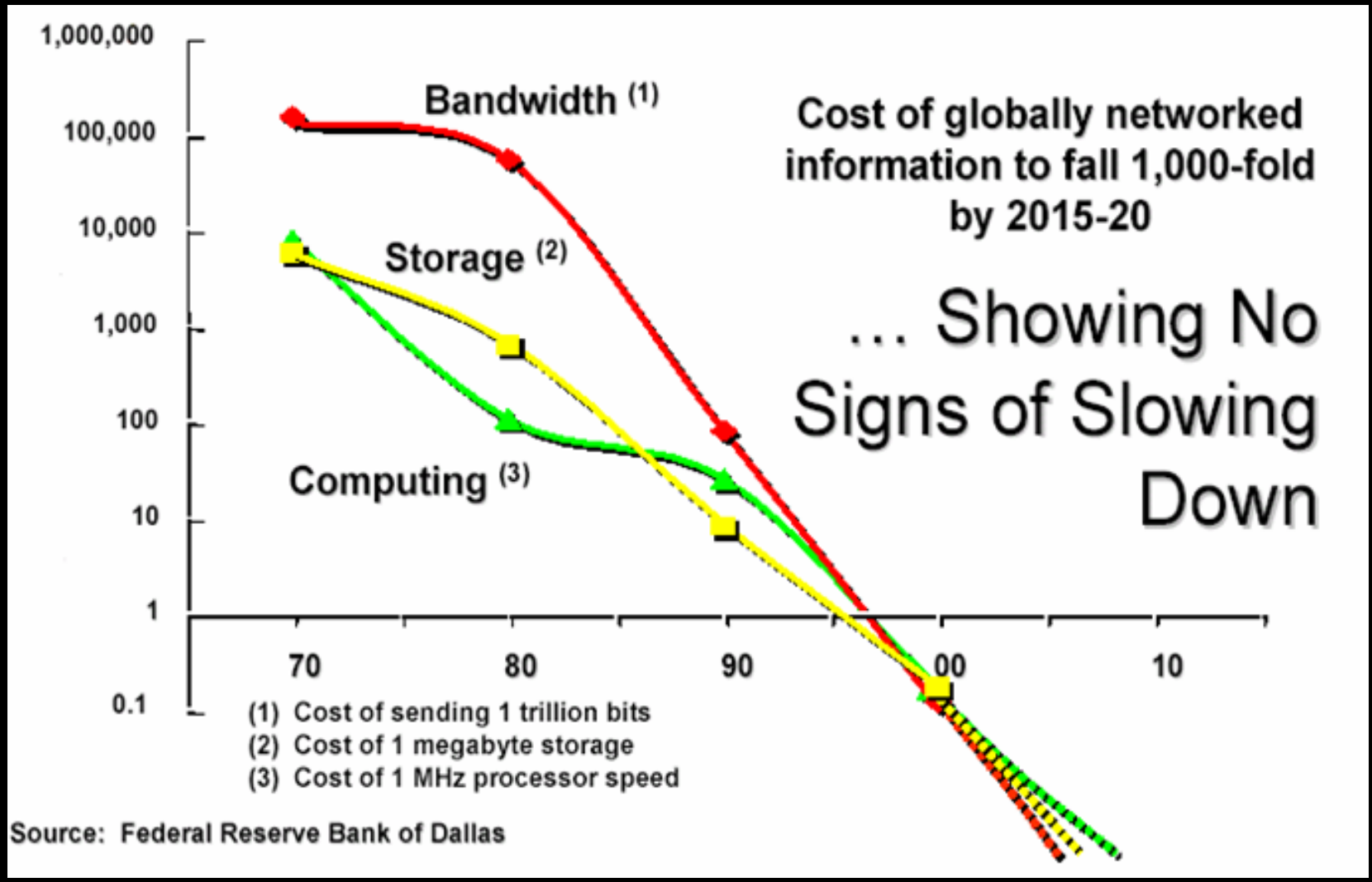


THREE-DIMENSIONAL TELEVISION

JAPAN HAS BEGUN WORK TO CREATE 3-DIMENSIONAL, HOLOGRAPHIC, VIRTUAL TELEVISION IMAGING FOR THE HOME MARKET BY YEAR 2020.

(MATSUSHITA ELECTRIC INDUSTRIAL AND SONY PUBLISHED AN INTERIM REPORT, JULY 2005)

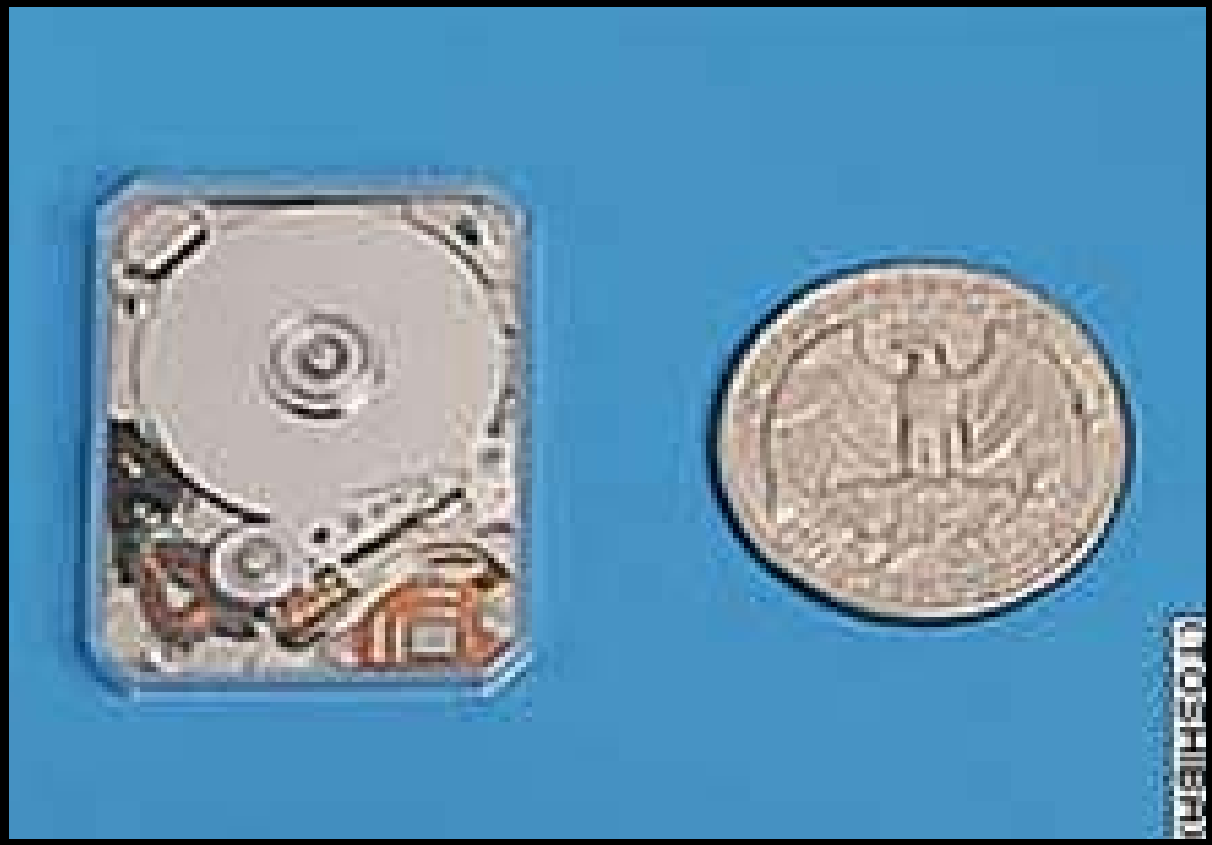
TECHNOLOGY CONTINUES TO EVOLVE



NEW COMPUTER TECHNOLOGY

6 GIGABYTES STORAGE IN A SMALL PACKAGE

64 GIGABYTES ARE AVAILABLE IN ABOUT THE SAME SIZE BUT COSTING ABOUT $5,000 (2007)



SOURCE: TOSHIBA

MOORE'S LAW

FAMOUS FORECAST BY INTEL FOUNDER GORDON MOORE: THE NUMBER OF TRANSISTORS ON A CHIP WOULD ROUGHLY DOUBLE EVERY TWO YEARS

INTEL HAS ACHIEVED A MILESTONE IN SHRINKING THE SIZE OF TRANSISTORS TO POWER ITS NEXT-GENERATION CHIPS TO 35 NANOMETERS

45 NANOMETER TRANSISTORS DELIVERED IN 2006

35 NANOMETER TRANSISTORS (30% SMALLER THAN TODAY'S STATE-OF-THE-ART CHIPS) ARE USED ON 70 MBIT MEMORY CHIPS

POSSIBLE WITH NEW MATERIALS, PROCESSES, AND CHIP STRUCTURES SUCH AS INSULATING METALLIC ELEMENTS INSTEAD OF SILICON (TO STEM CURRENT LEAKAGE)

SLEEP TRANSISTORS SHUT OFF ELECTRICAL CURRENT TO CHIP PARTS (NOT BEING USED) → DECREASING HEAT GENERATION AND HELPING BATTERY-POWERED DEVICES LAST LONGER

MOORE'S LAW HOLDS

NEW COMPUTER CHIPS

MULTIPLE FUNCTIONS REPLACE SPEED AS MAIN FEATURE

NEW CHIPS SIMULTANEOUSLY RUN MULTIPLE TASKS SUCH AS BURNING CDS AND WORD PROCESSING

WORLD'S SEMICONDUCTOR MAKERS DESIGNING CHIPS WITH MORE THAN ONE PROCESSOR

"A SEA CHANGE IN COMPUTING" - - MOVING FROM FASTER CHIPS TO MULTIPLE FUNCTION CHIPS

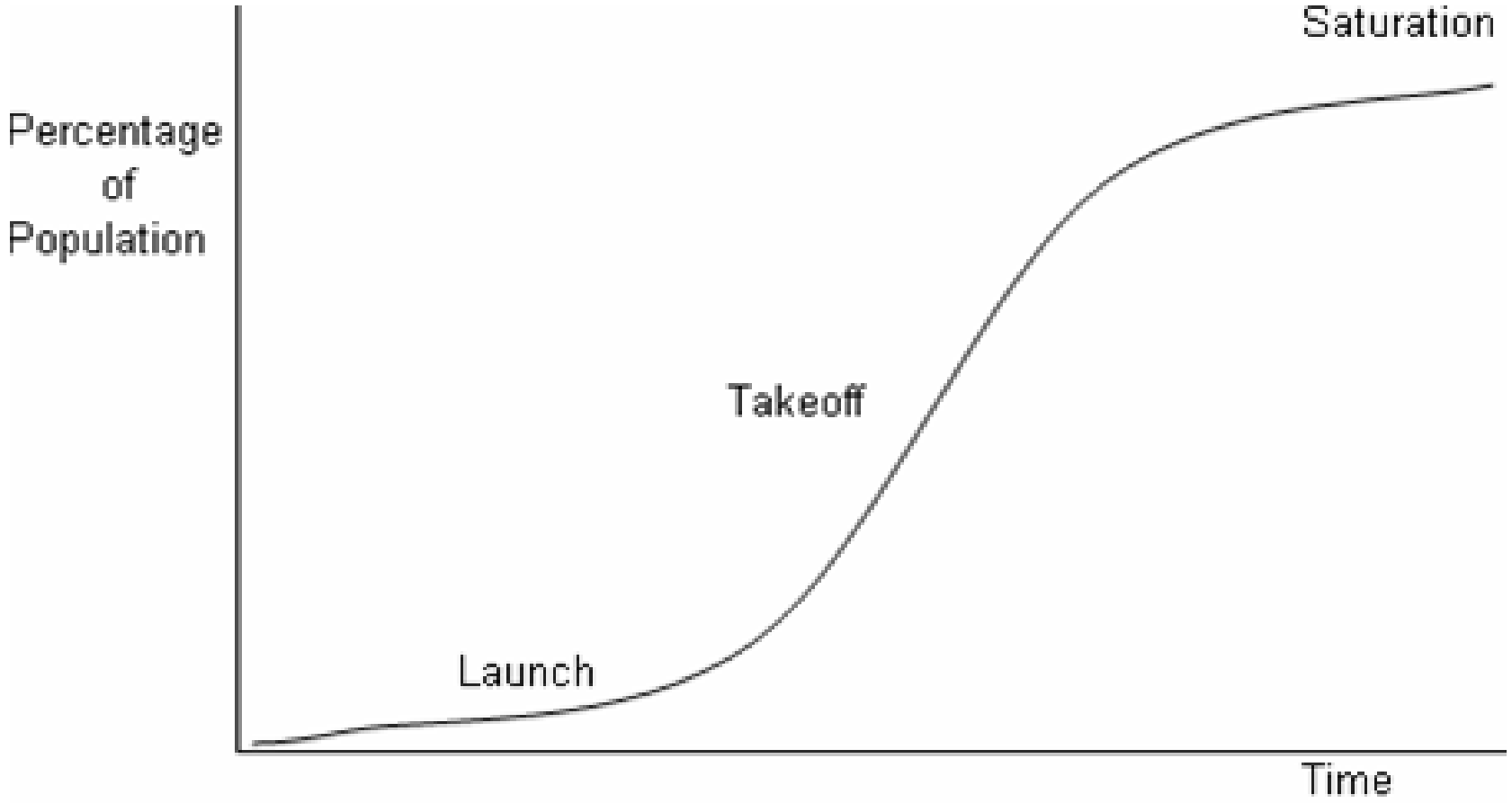
TRADITION HAS BEEN INCREASING CHIP "CLOCKSPEED" (NUMBER OF CALCULATIONS PER SECOND)

"CLOCKSPEED" TODAY IS 36 TIMES FASTER THAN IN 1995, BUT USERS WANT FEATURES SUCH AS A LONGER BATTERY LIFE, SURROUND SOUND, AND MULTIPLE FUNCTIONS

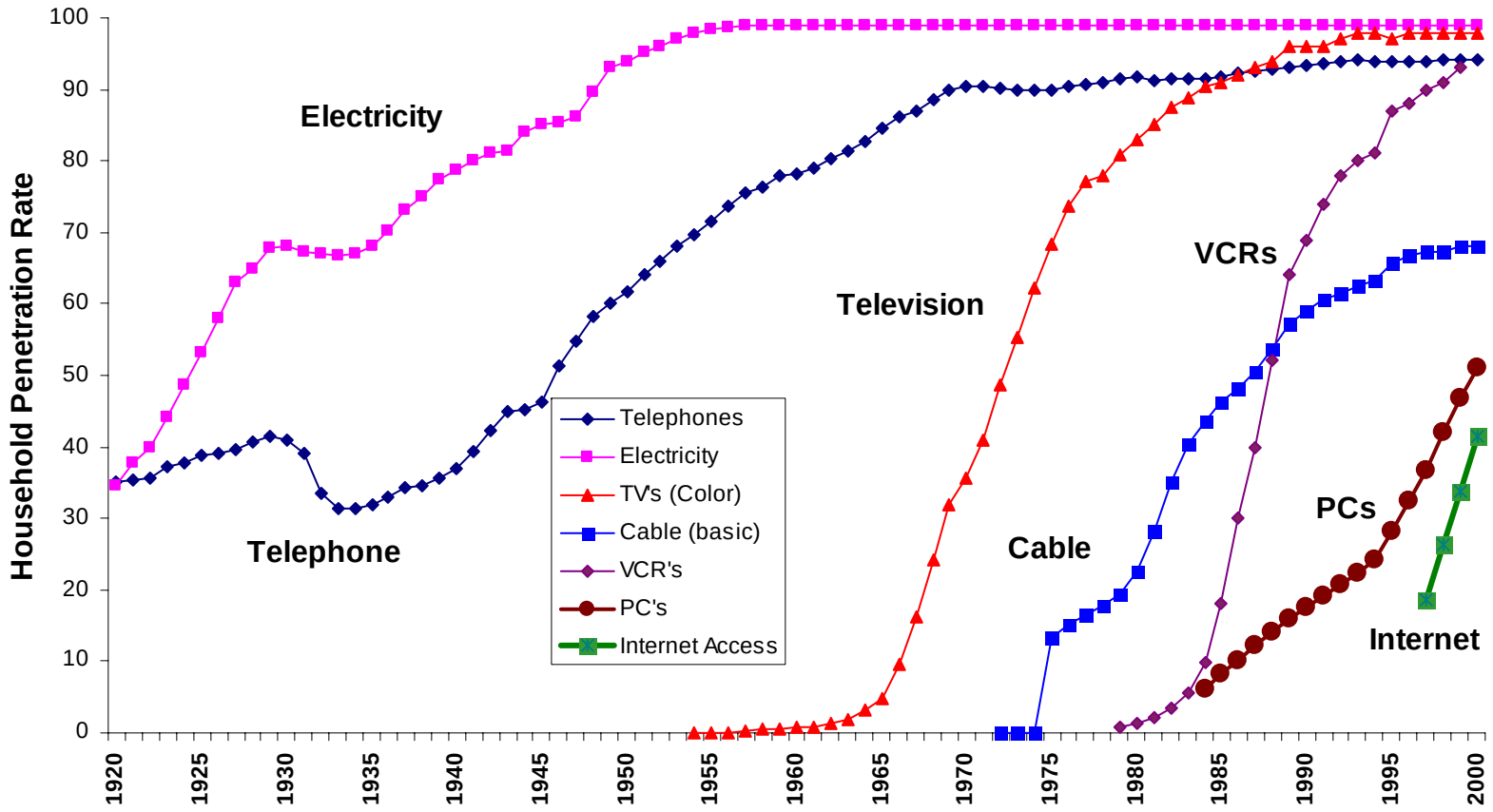
EACH NEW CHIP TODAY HAS ON THE ORDER OF 2 MILLION TRANSISTORS

SOURCE: WASHINGTON POST

GENERIC "S-CURVE"



"S-CURVES" FOR VARIOUS TECHNOLOGIES



Sources: Telephone and electricity industry data from 1920-1970 from Historical Statistics of the United States: Colonial Times to 1970, Part 2, p. 783. 1970-present and from Statistical Abstract of the United States, various years. Cable data from A.C. Nielsen Co. data as reported by the National Cable Television Association (NCTA). VCR, PC, and TV data from Consumer Electronics Association, E-Brain (http://www.ebrain.org/). Internet data from U.S. Department of Commerce (http://www.ntia.doc.gov/ntiahome/fttn00/chartscontents.html).