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Enhancing Access to the Radio Spectrum

Impacting the Wireless-Enabled Economy through NSF-sponsored Research

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Direct Value of the Radio Spectrum

- FCC auctions for slices of bandwidth have raised $78 billion in net bids since 1994
  - Only a small fraction of the radio spectrum has been auctioned – about 4%
- 2009 domestic wireless revenue was $151.2 billion, larger than the gross domestic product of Kuwait
  - 1992 – 2007 growth rate of U.S. wireless industry exceeded 16% per year, compared to 3% for the general economy
  - The domestic wireless sector presently exceeds the agriculture industry in economic size, and is predicted to exceed the auto industry within five years

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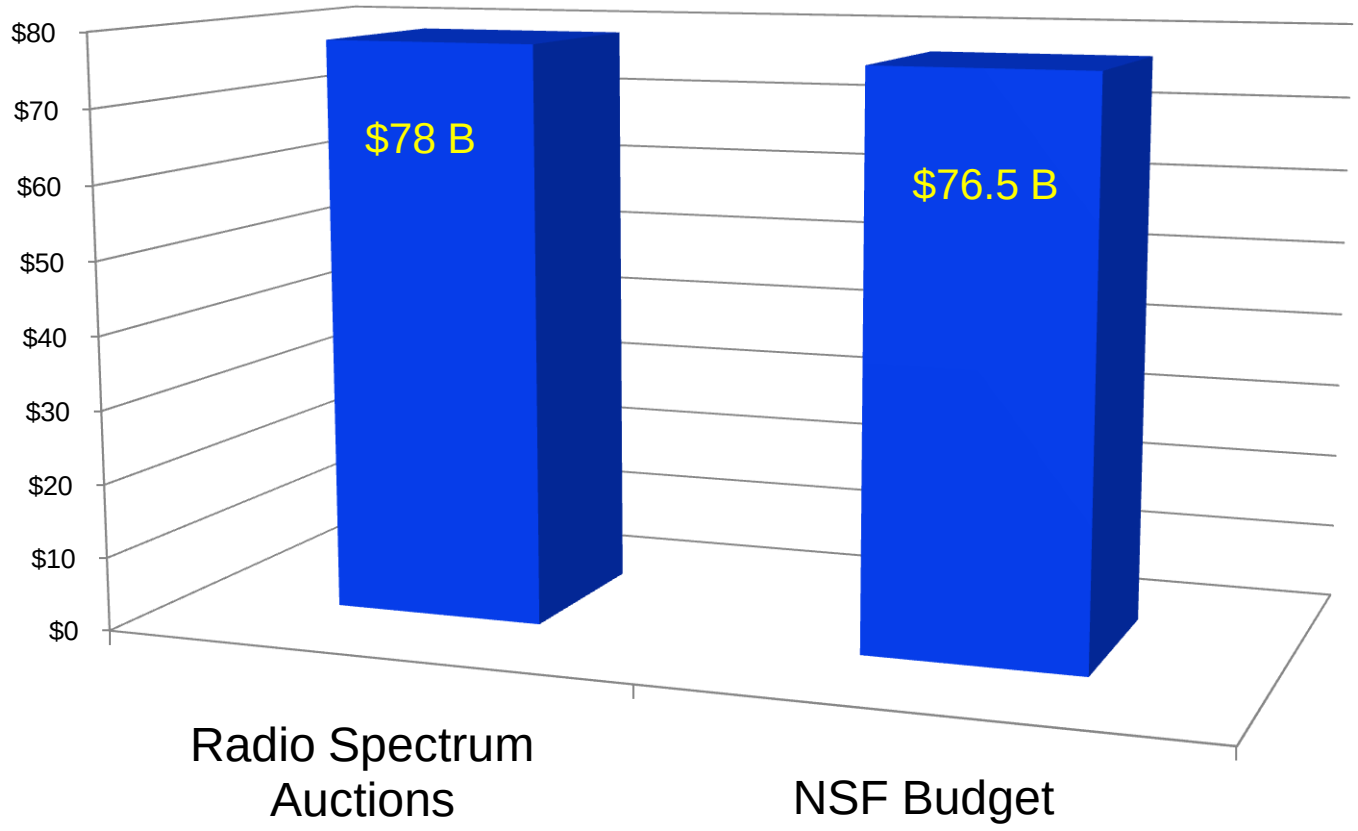

1994 - 2009

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Indirect Value of the Radio Spectrum

- **Economic impact of goods and services enabled by the radio spectrum is estimated to be 5 – 10% of the U.S. economy, or approximately $700 billion – $1.4 trillion annually**
  - **Wi-Fi, GPS, Cell phones, AM/FM/TV broadcast, satellite radio & TV, RFID, Bluetooth, FRS, microwave ovens, dispatch, security, etc...**

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NSF-sponsored Research Benefiting the Radio Spectrum

- NSF funds a wide variety of engineering, scientific, and economics research directly related to wireless technology and policy
  - Wireless networks, RF hardware, propagation, auction and market theory, antennas, security & encryption, policy and standards, etc.
- Approximate direct investment is $64 million per year
  - $700 million over past 11 years
- The results of past research have been incorporated in a large number of highly successful applications:
  - 802.11 and 802.16 (Wi-Fi and WiMAX), 911 cell phone location technology, explosives and biohazard detection, ground-penetrating radar, digital TV, adaptive antennas, SDR/CR...

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Radio Spectrum Benefiting NSF-sponsored Research

- **NSF grantees and facilities rely on access to the radio spectrum for a large variety of scientific research**
  - Radio & radar astronomy
  - Remote sensing
  - Meteorology
  - Atmospheric science
  - Ionospheric research
  - Space weather modeling and prediction
  - Oceanographic research
  - Arctic/Antarctic science and logistics
  - Cyber-networking
  - Satellites
  - Many others
- **Major spectrum-reliant NSF centers:**
  - National Center for Atmospheric Research
  - National Radio Astronomy Observatory
  - National Astronomy and Ionosphere Center

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Enhancing Access to the Radio Spectrum (EARS): A potential NSF initiative

- NSF is uniquely poised to develop a coordinated, cross-cutting, and focused research initiative on topics that will improve the future of radio spectrum access and management
  - Historically, funding for spectrum-related research has been spread across multiple directorates, with no unified goals or objectives beyond those of the individual programs
- Enhancing spectrum efficiency will allow more applications to co-exist within a fixed amount of radio spectrum
  - With wireless becoming bigger than the automobile and agriculture industries, the potential economic impact is akin to finding ways to substantially increase average gas mileage or to significantly increase crop yield
- Enhancing spectrum efficiency is a major common objective across all sectors of the wireless telecom industry, including commercial, government, private, and scientific sectors

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EARS

- Basic question to be addressed: How can an ever-increasing number of diverse users share a valuable, finite resource?
- EARS objective: Bring considerable talents of NSF-funded researchers to bear on the challenges of spectrum efficiency and access

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Far-Reaching Impact

- Commercial & government telecommunications
- Public safety
- Defense
- Homeland security
- Personal, local, and wide-area networks
- Aviation
- Consumer electronics
- U.S. & world economy
- Science…
  - Remote sensing
  - Upper atmosphere/ionosphere
  - Space weather
  - Weather prediction
  - Global warming
  - Radio astronomy

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EARS Background & Status

- EARS concept has been under consideration since 2007
- First significant positive traction gained within the past few months
- Cross-directorate funding has been obtained to sponsor an invitational workshop bringing together the nation's leaders in spectrum-related science, engineering, and economics research
- The workshop will include observers from significant government and private-sector stakeholders
  - NTIA, FCC, DoD, OSTP, NIST, NASA, DHS, FAA, DOJ, others
  - IEEE, TIA, ANSI, CTIA, PCIA, other trade and standards bodies
- Prior to the workshop, an NSF-wide lecture was held to increase internal awareness of critical radio spectrum issues and NSF's role in developing solutions
  - Dr. Dave Staelin of MIT presented an overview of the importance of radio spectrum for scientific research
  - Dr. Paul Kolodzy, former chair of the FCC's Spectrum Policy Task Force, then established the broader impacts of NSF-sponsored spectrum research on the nation and the world

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EARS Workshop

- **Workshop goals:**
  - **Develop a vision for future spectrum access that accommodates anticipated uses and demand**
  - **Establish a prioritized and time-ordered list of research priorities that can help achieve that vision**
- **Status:**
  - **Steering committee invitations sent last week; committee will be set by Monday**
  - **NSF and workshop PIs have established a participant pool of leading researchers. Invitations will go out after steering committee input**
  - **Workshop scheduled for Aug 4th – 6th at NSF**

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The National Broadband Plan

- The American Recovery and Reinvestment Act mandated the FCC to develop a report containing a national broadband plan that will "seek to ensure that all people of the United States have access to broadband capability" [6001(k)]
  - 100 million Americans do not have broadband Internet access at home
- Radio spectrum plays a central role in the Plan, as wireless is among the quickest and most efficient methods to deploy broadband connectivity
- FCC's goal of providing at least 4 Mbps connectivity to the presently unconnected, and at least 100 Mbps connectivity to another 100 million Americans by 2020, is an ambitious plan that will require significant technology research and development to achieve.

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The National Broadband Plan

- The Plan includes recommendations to help accommodate new ways to deliver wireless services to all Americans
  - Spectrum allocation and utilization reform
  - Expanded economic incentives for efficient spectrum use
  - Make more spectrum available for broadband
  - Expand opportunities for innovative spectrum access models
- Through its sponsored research and its ongoing participation in regulatory bodies, NSF will play a significant role in these recommendations

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The National Broadband Plan

Expanding Opportunities for Innovative Spectrum Access Models

Recommendation 5.14

- **The FCC should initiate proceedings to enhance research and development that will advance the science of spectrum access. A robust research and development pipeline is essential to ensuring that spectrum access technologies continue to evolve and improve. As described in Chapter 7, the FCC should start a rule-making proceeding to establish more flexible experimental licensing rules. Additionally, the National Science Foundation, in consultation with the FCC and NTIA, should fund wireless research and development that will advance the science of spectrum access.** (emphasis added)

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Summary

- NSF is presently investing in spectrum-related research with a proven track record of creating economic value
- Exponentially growing demand for radio spectrum access calls for increasingly vigorous investments in research that facilitates improved spectrum efficiency and access
- NSF has been identified as the natural home to sponsor spectrum research
- The EARS concept is ideally suited to fill this role
- Given the value of the radio spectrum, positive results from the initiative would significantly advance American competitiveness across multiple arenas and provide significant positive impact to the nation's economy