Program Officer Presentation on Spectrum Innovation Initiative: National Radio Dynamic Zones (SII-NRDZ) Solicitation

John Chapin, Special Advisor for Spectrum
Logistics

SII home page
  • https://nsf.gov/mps/oma/spectrum_innovation_initiative.jsp

Live Q&A webinar
  • Registration required
  • Date, registration link, and link to recording – posted to SII home page

Written questions
  • Email to SII@nsf.gov
  • Responses posted to the solicitation page – possible 30 day delay

Caveats
  • NSF publications take precedence over this briefing
  • Forward-looking information may be changed without notice
**Spectrum Innovation Initiative: National Radio Dynamic Zones (SII-NRDZ)**

<table>
<thead>
<tr>
<th>Goal</th>
<th>Advance the use of dynamic spectrum sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>Extended field trials of radio dynamic zones</td>
</tr>
<tr>
<td>Vision</td>
<td>Radio dynamic zones enhancing spectrum access for multiple facilities and applications</td>
</tr>
<tr>
<td></td>
<td>A National Radio Dynamic Zone supporting a facility for at-scale research and experimentation on systems that use or manage spectrum in innovative ways</td>
</tr>
</tbody>
</table>
## Interdisciplinary collaboration sought in SII-NRDZ

### Research on Spectrum Sharing
- Spectrum sharing, monitoring, and enforcement
- Spectrum management
- Systems engineering, control, analysis, and prototyping
- Reliability and cybersecurity analysis and engineering

### Research on Applications and Sites
- Spectrum-dependent applications
- Scientific activities, or instruments
- Operations / constraints of specific facilities / systems
- Interference issues, mitigations
- Spectrum access opportunities

### Engineering and Field Trials
- Systems engineering, software engineering
- Hardware / software integration, validation
- Field testing of complex systems
- Operation and construction of complex facilities
- Spectrum regulations and processes

### Research on Adoption (Anticipated FY23)
- Interactions between technical / regulatory changes and social, behavioral, economic issues
- Spectrum user business models
- Auctions and federal agency incentives
Important Proposal Information

Solicitation text and deadline

- Link at: https://nsf.gov/mps/oma/spectrum_innovation_initiative.jsp

Anticipate 8-12 awards

- Approximately 6-10 grants for SII-NRDZ Studies, up to $2,000,000
- Approximately 2 cooperative agreements for Engineering and Execution Lead Phase 1, up to $500,000

Proposals may be submitted by

- Institutions of Higher Education
- Non-profit, non-academic organizations

Memorandum of Agreement with NTIA and FCC

- NSF may share information from proposals; may discuss the shared information; may request feedback

Total anticipated funding: $10,000,000
Context
Categories of NSF work in the radio spectrum

**Activities and investments that use the radio spectrum**
- Astronomy
- Advanced Wireless
- Geosciences
- Climate Change
- Biosphere Monitoring
- Wireless Devices/Circuits
- Economic Theory
- ...

**Activities and investments that ensure spectrum is available for use**

```
Spectrum Management
```

- The operational activity of planning and managing spectrum use

```
Spectrum Capabilities
```

- Devices and techniques enabling a system to operate in multiple bands or in constrained or shared spectrum

```
Spectrum Science
```

- The basic and applied understanding of resource management of the electromagnetic spectrum
NSF’s Spectrum Innovation Initiative

https://nsf.gov/mps/oma/spectrum_innovation_initiative.jsp

I. Spectrum Innovation Centers
II. National Radio Dynamic Zones
III. Spectrum Research Integrative Activities
IV. Education and Workforce Development
Terminology
Spectrum Sharing

Traditional spectrum management
- Static separation of systems in frequency, space, or time
- Fixed limits on transmission power and out of band emissions

Spectrum sharing
- Operation of independent systems close enough together that dynamic mechanisms are required to prevent harmful interference
Radio dynamic zone

An area or volume with automatic spectrum management mechanisms that control electromagnetic energy entering, escaping, or occupying the zone.
SII-NRDZ Program
## SII-NRDZ priorities – sites and applications

<table>
<thead>
<tr>
<th>Sites for field trials starting in 5 years or less</th>
<th>Application</th>
<th>Desired benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Research and experimentation facility</td>
<td>Enhance spectrum access and reduce delays</td>
<td></td>
</tr>
<tr>
<td>2. Radio telescope observatory</td>
<td>Mitigate interference, enhance broadband access</td>
<td></td>
</tr>
<tr>
<td>3. Satellite-based sensors</td>
<td>Mitigate interference from terrestrial communications</td>
<td></td>
</tr>
<tr>
<td>4. Radar</td>
<td>Improve efficiency when co- or adjacent-channel communications</td>
<td></td>
</tr>
<tr>
<td>Future national facility site</td>
<td>Research and experimentation facility</td>
<td>Same as #1</td>
</tr>
</tbody>
</table>

For future national facility sites, the research and experimentation facility site is the same as the first item listed: enhancing spectrum access and reducing delays.
## SII-NRDZ priorities – solicitation-specific broader impacts

<table>
<thead>
<tr>
<th></th>
<th>Near term</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Enhance spectrum access for facilities or applications</td>
</tr>
<tr>
<td></td>
<td>• Achieve one or more of the benefits listed in the previous slide</td>
</tr>
<tr>
<td>Mid term</td>
<td>Enable wider use of spectrum sharing</td>
</tr>
<tr>
<td></td>
<td>• Overcome technical and nontechnical barriers to approval and acceptance</td>
</tr>
<tr>
<td></td>
<td>• Address workforce needs</td>
</tr>
<tr>
<td></td>
<td>• Inform spectrum regulation</td>
</tr>
<tr>
<td></td>
<td>• Create reusable components and tools</td>
</tr>
<tr>
<td>Long term</td>
<td>Establish a research facility that accelerates innovation</td>
</tr>
<tr>
<td>Overall</td>
<td>Build trust in spectrum sharing</td>
</tr>
</tbody>
</table>

**Solicitation-specific merit review criteria**

1. How effectively does the proposed project support one or more of the broader impact goals identified for the SII-NRDZ program?
A challenge

Professional engineering and management is required

E.g., to enhance spectrum access for active facilities or applications
  • integrate new mechanisms into complex facility operations
  • operate successfully for 6–12 month field trial
Engineering and Execution Lead (SII-NRDZ-EEL)

Near term
• System/software engineering of a robust solution based on SII-NRDZ research prototypes
• Scientific, operational, and spectrum regulatory lead for field trials

Mid term
• Engages with skeptical spectrum stakeholders
• Fosters a community of researchers, practitioners, and industrial partners
• Engineers and supports a reusable toolkit of components for spectrum sharing solutions

Long term
• Evolves into builder and operator of the envisioned national facility
Evolution of SII-NRDZ program structure

Research, Analysis, and Prototyping Stage

- NSF
- Planned FY22 awards
- Research studies on solutions, applications, sites
- SII-NRDZ-EEL Phase 1
- Anticipated FY23 supplements
- Research studies on adoption issues

Engineering and Field Trials Stage

- NSF
- Anticipated FY24 award
- SII-NRDZ-EEL Phase 2
- Research study participants
- Anticipated subawards, consultant or internship opportunities
## Anticipated program timeline for SII-NRDZ

<table>
<thead>
<tr>
<th>Qtr ending</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sep</td>
<td>Dec</td>
<td>Mar</td>
<td>Jun</td>
<td>Sep</td>
</tr>
<tr>
<td>FY22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Radio Dynamic Zone studies
- EEL phase 1
- Adoption study supplements
- Selection of first field trial
- EEL phase 2 proposals due
- EEL phase 2
- Selection of remaining field trials
- EEL phase 2b proposal due
- EEL phase 2b
- Community Open Meeting (virtual)
- Community Open Meeting (in person)

Note: The timeline continues beyond the 2026 period with similar events continuing.
2. How effective is the proposed plan for interaction with and responding to information provided by other SII-NRDZ program participants and stakeholders?
Solicitation Overview
Proposal opportunities in SII-NRDZ solicitation

SII-NRDZ Studies

- 3 areas
  - Area 1 – Prototyping and Risk Analysis
  - Area 2 – Application and Site Analysis
  - Area 3 – Field Tests
- A proposal may cover multiple areas
- Multiple proposals are permitted from a PI or Co-PI *
  
  * only one proposal may cover Area 1

SII-NRDZ Engineering and Execution Lead Phase 1
Prototyping and Risk Analysis

- Prototype needed for field trials
- Risk analysis needed to build trust and facilitate regulatory approval

Research on a range of spectrum sharing topics is in scope, for example:

- Prediction of potential interference
- On-line computation of constraints that dynamically prevent interference
- Rapid detection and identification of interference sources
- Methods to limit the likelihood, severity, duration, or impact of interference
- Hardware components for retrofit to enhance spectrum sharing
- Collection or obfuscation of spectrum monitoring data
- Bounding the performance of AI/ML subsystems
- Approaches to simplify the regulatory complexities of spectrum sharing
Prototyping of end-to-end solutions

Integrate all components required for a radio dynamic zone

• Technical components including
  • Architecture, standards, software applications, hardware devices, tools, system designs, and control algorithms
  • Monitoring and characterizing radio frequency interference, and for detecting and identifying rogue emitters

• Non technical components including
  • Human and organizational processes for radio dynamic zone operations and for spectrum management activities
  • Applications of approved regulatory structures or proposals for regulatory changes
  • Model contracts and business processes for interactions among spectrum users
  • Integration into external spectrum management and other control systems

Prototypes may use simplified implementations or models of some components
General applicability and assessment

Generally applicable solution

- Applies to multiple spectrum sharing scenarios
- May require specializing components

Assess in 2 of the field trial priority scenarios

- Analysis
- Modeling and simulation
  - Challenge: aggregate interference
- Emulation
  - Radios exchanging RF via a wired channel emulator

Solicitation-specific merit review criteria

4. How generally applicable is the proposed solution?
5. What is the potential for the proposed solution or components to be used in SII-NRDZ field trials?
Risk Analysis of Prototype

Required: likelihood of excursion beyond interference limits

Additional creative/innovative techniques are encouraged

- Severity, duration, or impact of interference
- Likelihood of interference due to causes that are not just statistical variation
  - Security vulnerabilities
  - Software bugs, hardware faults, and malfunctions
  - Spurious emissions, out-of-band emissions, and intermodulation effects
- Simplification of risk analysis through synergies with hardware/software design

Medium-term broader impact goal
Enable spectrum sharing mechanisms to be more easily approved by regulatory authorities, through developing innovative analysis techniques for interference and security risks
Active NSF solicitations for research on spectrum sharing

Spectrum and Wireless Innovation enabled by Future Technologies (SWIFT)

- Individual components, tools, algorithms, subsystems, or analysis techniques
- Can be fundamental research
- Max research award $750,000
- Due 5/11/2022

SII-NRDZ Area 1

- End-to-end solutions and analysis
- Apply to identified facilities or applications
- Max research award $2,000,000

SII-NRDZ Studies Area 2

Application and site analysis

To study distinct sites or applications, submit multiple independent Area 2 proposals
SII-NRDZ Studies Area 2

Comprehensive investigation of all topics relevant for selection as a field trial or national facility site

- Ways to use dynamic zone spectrum sharing that are beneficial and deployable
- Roadmap of bands and dynamic zone features or capabilities
- Tradeoffs between dynamic zone performance and application benefits
- Design of experiments
- Interference monitoring and characterization
- Social/economic impacts and mitigations

Educational innovation is encouraged

Solicitation-specific merit review criteria

6. What is the potential for the selected application and site to be used for a SII-NRDZ field trial or for the future national facility?
SII-NRDZ Studies Area 3

Early field testing relevant to a potential future SII-NRDZ field trial
- Gather data to inform field trial design
- Assist in regulatory approval
- Reduce risk through characterizing prototype solution’s behavior

Envisioned use of funds (other uses are permissible)
- Add-on to an Area 1 or Area 2 project
- Area 1 + 3: gain early field experience with prototype
- Area 2 + 3: deploy existing spectrum sharing solution to gain experience with application & site

Solicitation-specific merit review criteria
7. How much benefit will the proposed field tests provide for the design, approval, or risk reduction of a potential SII-NRDZ field trial?
Some NSF-sponsored experimental resources

Large-scale emulator
  • https://www.northeastern.edu/colosseum/
  • colosseum@northeastern.edu

City-scale outdoor experimentation platforms
  • https://advancedwireless.org/platforms/
  • Salt Lake City  powder-contact@powderwireless.net
  • New York City:  cosmos-contact@cosmos-lab.org
  • Research Triangle  aerpaw-contact@ncsu.edu
  • Central Iowa  contact@arawireless.org
Program participation and planning by teams interested to serve as the SII-NRDZ-EEL in Phase 2

An organization can submit SII-NRDZ-STUDY and SII-NRDZ-EEL proposals

- PIs and co-PIs must be different
SII-NRDZ-EEL Phase 1 activities

Support collaborations as invited by SII-NRDZ study teams
NRDZ Community Open Meeting inputs, participation and reports
Long-lead technical and spectrum regulatory work for potential Phase 2 activities
Prepare a SII-NRDZ-EEL Phase 2 proposal
Phase 1 proposal must describe qualifications to do Phase 2 work

Solicitation-specific merit review criteria
9. How qualified is the proposed team to successfully perform a SII-NRDZ Engineering and Execution Lead Phase 2 project?
Program risk #1: spectrum access for field trials

Proposers are encouraged to include project activities to help mitigate this risk.

The solicitation includes a list of potentially useful activities:

- Creative proposals for activities not on the list are also encouraged.

Solicitation-specific merit review criteria

3. How effective is the plan for mitigating spectrum access risk?
Proposal titles must have the format “SII-NRDZ: Your Project Name”

Proposals are encouraged to use the terms and definitions from the solicitation

Proposals that include spectrum monitoring should describe privacy protections

Letters of Collaboration from centers funded under NSF solicitation 21-558 (SII-Center) must be non-exclusive

SII-NRDZ Study projects should not initiate interactions with federal regulators
  • Initially, NSF will be primary contact for regulators and will establish interaction opportunities
  • Thereafter, the EEL will take the lead role

Proposals should include an IP management plan that supports the broader impact goals of SII-NRDZ
  • Field trials, and the subsequent reusable toolkit published by the EEL, may incorporate IP from multiple SII-NRDZ awardees
Spectrum Innovation Initiative: National Radio Dynamic Zones (SII-NRDZ)

Goal: Advance the use of dynamic spectrum sharing

Method: Extended field trials of radio dynamic zones

Vision: Radio dynamic zones
enhancing spectrum access for multiple facilities and applications

A National Radio Dynamic Zone
supporting a facility for at-scale research and experimentation
on systems that use or manage spectrum in innovative ways
Thank you