

# **GENI**

Global Environment for Network Innovations

## **Solicitation 2 for GENI Development & Prototyping Proposals**

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## 1 General Information for this Solicitation

### 1.1 Important: This is a solicitation for engineering, not research

This solicitation is *not* requesting research proposals – rather, it is requesting engineering Development and Prototyping (D&P) proposals to inform GENI’s planning and design. As such, this solicitation is requesting proposals for engineering subcontracts, not for research grants. If you have interesting new ideas for research, such as ideas for novel network architectures you should contact NSF CISE directly.

### 1.2 Stimulating Competition

The GPO intends to **encourage competition**, and will if possible fund **multiple competing efforts** for every major part of GENI; including core areas such as resource discovery, control framework implementations, security, wireless & optical networks, etc. The GENI design is still immature. Proposals with different approaches to GENI’s conceptual designs will be considered.

### 1.3 Letter of Intent

Not required.

### 1.4 Proposal Submission and Deadline

**Submission:** Proposals must be submitted via [www.geni.net](http://www.geni.net).

**Deadline:** 5 p.m., February 20, 2009 (Eastern Standard Time).

**Confirmation:** Proposer should contact Point of Contact (POC) identified in section 1.7.1 if no email confirmation is received within 3 days after submission.

### 1.5 Soliciting Organization

The GENI Project Office (GPO) has been formed by a Cooperative Agreement between the National Science Foundation (NSF) and BBN Technologies, and has assumed responsibility for project management in GENI’s planning phase. Under this agreement, the GPO is issuing the Solicitation for GENI Development & Prototyping Proposals.

### 1.6 Revision Notes

At present there are no revisions to this solicitation. It is the proposer’s responsibility to check [www.geni.net](http://www.geni.net) for updates to this solicitation.

## 1.7 Contact Information

### 1.7.1 Point of Contact (POC)

All administrative correspondence and questions concerning this solicitation must be directed, in writing, to the GENI Proposal Point of Contact (POC), through email to:

**proposalpoc@geni.net**

### 1.7.2 GENI Project Officers

- Chip Elliott, GENI Project Director, telephone: (617) 873-2615
- Henry Yeh, GENI Project Manager, telephone: (617) 873-4821

### 1.7.3 GENI Subcontract Representative

Linda Cribbis  
BBN Technologies  
10 Moulton Street  
Cambridge, MA 02138

Voice: 617-873-8030  
Fax: 617-873-3797

## 1.8 Subcontract Information

This solicitation is *not* requesting research proposals – rather, it is requesting engineering Development and Prototyping (D&P) proposals to inform GENI’s planning and design. As such, this solicitation is requesting proposals for engineering subcontracts, not for research grants. If you have interesting new ideas for research, such as ideas for novel network architectures, you should contact NSF CISE directly.

**Anticipated Type of Subcontract:** Firm Fixed Price Contracts (FFP), Cost Reimbursement Contracts (CR), Cost Plus Fixed Fee Contracts (CPFF), and Cost Sharing Contracts (CS).

While the Proposer shall submit proposals in accordance with one of the anticipated award types, the GPO reserves the right, at the sole discretion of the GENI Contracting Officer, to make a final determination of the appropriate award instrument.

**Anticipated Funding Amount:** Refer to the table below and the additional information described in the later sections. All awards are subject to the availability of funds. The GPO oversees the process for identifying, prioritizing and supporting development and prototyping activities as described in this solicitation. Fee is allowed with a maximum cap not exceeding 5%.

**Estimated Number of Subcontracts:** The GPO anticipates awards will be in the ranges shown in the table below. All awards are subject to the availability of funds, and these figures are only preliminary estimates.

FIGURES BELOW FOR DISCUSSION ONLY

Size Classes	Suggested Duration	Suggested Value	Estimated # Subcontracts
Small: Analyses and idea papers, or travel funds to participate in working groups	12 to 36 months	\$10 to \$30 K per year	15
Large (A): Security requirements and architecture development	36 months	\$50 - 100 K per year	5
Large (B): Prototypes (software-only or software/hardware) and Early Experiments	36 months	\$50 - 200 K per year	12
Integration: Augmented Integration Support	36 months	\$50 - 150 K per year	5

## 1.9 Eligibility

Any organization meeting the criteria listed in this section, and with an approved United States Government accounting method in place, may submit a proposal. In particular, teams already receiving GPO funding, as well as those not already so funded, are eligible.

### 1.9.1 Organizations Allowed

Proposals may be submitted by the following types of organizations:

Organization Type	Description
Unaffiliated individuals	Scientists, engineers or educators not employed by, or affiliated with, an organization.
Academic institutions	Universities and two- and four-year colleges, including community colleges, acting on behalf of their faculty members.
Non-profit, non-academic organizations	Independent museums, observatories, private research labs, government research labs, professional societies, and similar organizations associated with educational or research activities.
For-profit organizations	Commercial organizations with strong capabilities in scientific or engineering research.

The GPO strongly encourages participation from teams composed of academic and industrial participants, and strongly urges foreign organizations to be part of a team led by U.S. Academic Institutions.

### 1.9.2 Limits on Proposals

Each proposal must identify a single Principal Investigator (PI) who is responsible for the project. However, any number of co-PIs may also be identified.

An individual who serves as PI or co-PI for an existing GENI effort (e.g. funded by Solicitation 1) may also serve as PI or co-PI for proposal(s) submitted under this Solicitation 2. The rules below apply for everyone regardless of whether they already have GPO funding.

An individual may appear as Principal Investigator or co-PI on **no more than one Large (A) or (B) GENI Development & Prototyping** proposal submitted to this solicitation. However, an individual who is PI on one proposal may also participate in other proposals in another role, i.e. key personnel, etc. In addition, an individual may appear as PI or co-PI on an **Integration** proposal as well as a Large (A) or (B) proposal, i.e., submit two proposals.

There is no limit specified on how many “small” proposals may be submitted by a single PI, and it is also permissible for a PI to submit a “large” proposal along with one or more “small” proposals.

There is no limit on the number of proposals that an organization may submit.

Note that the GPO reserves the right to return without review any proposals that do not adhere to the spirit of these rules.

### 1.10 Intellectual Property

Every proposal must explicitly state its acceptance of one of the two (2) GENI intellectual property rights licenses – the GENI Public License or the GENI Project License. The two licenses are posted at [http://www.geni.net/office/office\\_ip.html](http://www.geni.net/office/office_ip.html).

**IMPORTANT – Proposals that do not clearly state their agreement to one of the two Intellectual Property licenses, unmodified, will not be considered. Please attach a support letter from your contracting officer stating his or her support of the Intellectual Property Rights License selection.**

## 2 Background Information

The Global Environment for Network Innovations (GENI) promises a major paradigm shift in the way research in network science and engineering research is conducted. This section provides a reference to the online repository for all GENI material, background information on GENI's motivation and overview, and the GPO's plans for evolving GENI over time.

### 2.1 Current GENI Information

Please consult [www.geni.net](http://www.geni.net) for reference and background materials such as System Overview, Spiral 1 Overview, etc, and the most current information. It is the repository of all project documents relating to GENI.

Note that some documents in the repository are of historical interest only. In particular, current designs are being created by GENI Working Groups and can be found in the relevant working group areas within [www.geni.net/wg/wg.html](http://www.geni.net/wg/wg.html), e.g., in a working group's email archives, meeting minutes, wikis, and draft documents as they are created. As discussed below, GENI prototyping efforts are proceeding in parallel with design efforts.

### 2.2 GENI Overview

The Global Environment for Network Innovations (GENI) is a novel suite of infrastructure now being designed to support experimental research in network science and engineering.

This new research challenges us to understand networks broadly and at multiple layers of abstraction from the physical substrates through the architecture and protocols to networks of people, organizations, and societies. The intellectual space surrounding this challenge is highly interdisciplinary, ranging from new research in network and distributed system design to the theoretical underpinnings of network science, network policy and economics, societal values, and the dynamic interactions of the physical and social spheres with communications networks. Such research holds great promise for new knowledge about the structure, behavior, and dynamics of our most complex systems – networks of networks – with potentially huge social and economic impact.

As a concurrent activity, community planning for the suite of infrastructure that will support Network Science and Engineering (NetSE) experiments has been underway for several years. This suite is termed the Global Environment for Network Innovations (GENI). Although its specific requirements will evolve in response to the evolving NetSE research agenda, the initial design is now clear enough to support early planning and prototyping. The core concepts for the suite of GENI infrastructure are as follows:

- **Programmability** – researchers may download software into GENI-compatible nodes to control how those nodes behave;
- **Virtualization and Other Forms of Resource Sharing** – whenever feasible, nodes implement virtual machines, which allow multiple researchers to simultaneously share

- the infrastructure; and each experiment runs within its own isolated slice, created end-to-end across the experiment's GENI resources;
- **Federation** – different parts of the GENI suite are owned and/or operated by different organizations, and the NSF portion of the GENI suite forms only a part of the overall 'ecosystem'; and
  - **Slice-based Experimentation** – GENI experiments will be an interconnected set of reserved resources on platforms in diverse locations. Researchers will remotely discover, reserve, configure, program, debug, operate, manage, and teardown distributed systems established across parts of the GENI suite.

As envisioned in these community plans, the GENI suite will support a wide range of experimental protocols, and data dissemination techniques running over facilities such as fiber optics with next-generation optical switches, novel high-speed routers, city-wide experimental urban radio networks, high-end computational clusters, and sensor grids. The GENI suite is envisioned to be shared among a large number of individual, simultaneous experiments with extensive instrumentation that makes it easy to collect, analyze, and share real measurements.

### 2.3 GENI Planning, Design, and Prototyping Cycles

The GENI infrastructure suite currently exists as an evolving conceptual design together with a collection of early, integrated prototypes that help drive the design. The suite will be planned and prototyped over several years, during which time networking technology will continuously evolve. Its design must be flexible enough to incorporate new technologies as they develop, but reliable enough to simultaneously support ongoing research. The design must also be flexible enough to operate as new organizations join the GENI effort, allowing resources that are owned and managed by different organizations to be used effectively for individual research projects that themselves may have many users and developers.

Please see [www.geni.net](http://www.geni.net) for an overview of the GPO's planned spiral development and federation approaches. The URL for the Spiral 1 Overview document is <http://www.geni.net/docs/GENIS1Ovrw092908.pdf>.

Prototypes and integration efforts proposed for this solicitation must explicitly address how they will accommodate spiral development and federation during the funded performance period, including any technical or administrative procedural advantages that differentiate the proposed effort from others. Prototypes and integration efforts funded under this solicitation should drive the GENI design process forward, provide early inputs to the GENI working groups, and reduce technical, operational, and programmatic risks for the GENI system overall.

Because this solicitation funds prototype and integration work in parallel with design work, proposers will need to be actively involved in GENI working groups, and to build in opportunities to incorporate new results from those groups and from other prototype efforts as they develop. The GPO expects multiple competing prototypes to be running early demonstrations no later than 12 months after prototyping begins.

At this point, some degree of interoperability may be possible. It is also possible that some organizations may be ready to federate with GENI for prototyping efforts. Running prototypes will begin to strongly influence GENI's evolving designs after this first year of prototyping,

which should allow relatively rapid convergence on the next design iteration, after which we expect prototypes to demonstrate more complete end-to-end interoperability.

There is no pre-ordained outcome for these design and prototyping activities: the resultant GENI infrastructure suite could be the existing Internet, existing testbeds, federations of testbeds, something brand new (from small to large), federation of all of the above, and perhaps a federation with related international efforts.

## 2.4 GENI Control Framework “Clusters”

The GPO strongly recommends, but does not require, that your proposal integrates into one or more existing control framework clusters, listed below. If you do pick one or more in your proposal, please state clearly how you plan to integrate with the cluster(s).

A primary goal for GENI Spiral 1 is to develop and operate multiple competing approaches to the GENI control framework. Towards that end, most GENI projects have been grouped into one of five control framework clusters. Each cluster will implement key control framework functions and will be capable of supporting experiments. In general, each cluster consists of one prototype clearinghouse plus some number of prototype aggregates that it will control.

A single interoperable control framework will not be available in Spiral 1. In fact, we expect that control frameworks will implement the required functions in different ways. This will provide an opportunity to make design decisions on this important topic informed by implementation and operational experience. Over time, member projects may switch clusters, for example, if another cluster will provide easier integration. Clusters may share technology and merge if they desire.

Spiral 1 control framework clusters have different emphases. Some are more established and concentrate on integrating new approaches, technologies, and projects into their framework. Some are investigating characteristics of control frameworks for newer substrates in depth. Some are investigating alternative architectures in particular environments.

The five clusters currently being organized for Spiral 1 are:

- A. “TIED” control framework from USC/ISI, a cluster emphasizing issues around federation, trust, and security.
- B. “GENI Control Prototype” framework, a cluster based on the PlanetLab implementation at Princeton, emphasizing development of control framework reference implementations and integrating a range of component technologies and tools.
- C. “ProtoGENI” control framework, a cluster based on the Emulab implementation at the University of Utah, emphasizing network control and measurement.
- D. “ORCA” control framework from Duke University and RENCI, a cluster emphasizing development of resources allocation strategies and integration of sensor networks.
- E. “ORBIT” control framework from Rutgers University, emphasizing wireless networks.

### 3 Goals of this Solicitation

The GPO has the responsibility for project management to successfully complete all planning, design, and development activities for GENI. The GPO is using a “spiral development” methodology in which a series of integrated prototype systems drive forward GENI design and development. Working closely with the computing research community and NetSE council, the Development & Prototyping solicitation provides funding for engineering development and prototyping activities.

The GPO intends to **encourage competition**, and will if possible fund **multiple competing efforts** for every major part of GENI; including core areas such as security architectures, workflow tools, measurement systems, etc. The GENI design is still immature. Proposals with well thought-out alternatives to GENI’s conceptual designs will be considered.

#### 3.1 Development and Prototyping Subcontracts

This solicitation requests proposals for GENI Development and Prototyping (D&P) subcontracts, both in terms of further clarification of GENI’s architecture and requirements, and in terms of practical, demonstrable “proof of concept” prototypes that will provide early understanding of GENI’s design and operation. The specific areas being solicited are as follows; however any good idea not covered below will also be considered.

##### 3.1.1 Security Requirements and Architecture Development

GENI’s security requirements and architecture have not yet been formulated with sufficient scope and clarity to enable creation of robust system and subsystem engineering plans.

Note that the GENI suite is currently early in its design stage; thus, proposals should emphasize basic analysis, requirements definition, and architectural work rather than the details of specific security mechanisms.

**D&P goals include:** security analyses of GENI reference architecture and/or the five defined control framework “clusters”; security requirements definition; architecture definitions, including work tasks such as security analysis, design, and interactions with prototyping teams, resulting in documents that specify a proposed security architecture for GENI (to be issued in a series of drafts with revisions based on community feedback). The GPO encourages security proposals to include proof-of-concept integration with Spiral 1 and Spiral 2 prototypes, particularly in areas related to operational security, to demonstrate feasible implementation of security architecture concepts in the GENI environment.

##### 3.1.2 Experiment Workflow

Researchers will need easy-to-use, comprehensive tools to create, debug, and monitor experiments using the GENI infrastructure suite. Good “experiment workflow” tools and systems will be critical to GENI’s success.

**D&P goals include:** prototype implementations of experiment workflow tools and systems, including intuitive, easy-to-employ user interfaces, frameworks, specific tools, etc., that make it easy for researchers to define experiments, identify and schedule available resources, mechanisms for creating ‘virtual topologies’ on demand, tools for programming and debugging components and end-to-end slices, visualize system status, etc..

**Rapid Integration into GENI.** These tools and systems should be integrated with one or more of the existing GENI projects as rapidly as possible; please identify those explicitly in your proposal. Plan carefully for integration; we suggest, but do not require, that you attach letters of support from teams with which you will integrate.

### 3.1.3 Instrumentation and Measurement

Researchers will need good mechanisms for instrumenting their GENI experiments, and archiving, analyzing, and sharing the resultant measurements. Measurements of interest range from CPU and memory utilization, through network packet counts and ambient RF spectrum measurements, to recording arbitrary streams of data such as logging information, state machine transitions, etc. These measurements will be taken across widely distributed systems; at present, it is unclear whether the resultant measurements will be stored in a distributed fashion or centralized. Since GENI’s measurement framework is still in its early design stage, both basic design and specific prototype implementations will be needed; all must be easy to integrate into a broader, end-to-end GENI measurement system as it becomes defined. It is also worthwhile to reiterate that the instrumentation and measurement schemes should not be limited to IP-based networks.

**D&P goals include:** GENI ‘instrumentation and measurement’ implementations, including overall frameworks, specific tools, databases and repositories, means by which data can be archived and shared, analysis tools, etc. The GPO also encourages proposals that address privacy and security concerns related to sharing instrumentation and measurement data, and those that involve end-user communities such as campuses and researchers.

**Rapid Integration into GENI.** These tools and systems should be integrated with one or more of the existing GENI projects as rapidly as possible; please identify those explicitly in your proposal. Plan carefully for integration; we suggest, but do not require, that you attach letters of support from teams with which you will integrate.

### 3.1.4 Early Experiments

Very early experiments with GENI prototype systems are desirable, as they will provide initial feedback on the utility of the systems being developed and help guide design going forward. The GPO is particularly interested in two types of early experiments: those that attempt to employ “end to end” functionality across two or more substrates, and those that provide experimental services that could potentially attract large numbers of “opt-in users” (e.g. via distributed games, virtual worlds, etc.) Other good ideas for experiments are also welcome.

**D&P goals include:** Rapid deployment and trials of early experiments within the emerging “end to end” GENI system, with substantial, ongoing feedback to the GENI community on the experience, what needs to be improved, etc.

**Rapid Integration into GENI.** These tools and systems should be integrated with one or more of the existing GENI projects as rapidly as possible; please identify those explicitly in your proposal. Plan carefully for integration; we suggest, but do not require, that you attach letters of support from teams with which you will integrate.

### 3.1.5 Federation of Clearinghouses

Federation is fundamental to the GPO's plans for creating a GENI "ecosystem" that is larger than NSF-funded portions of an interoperable infrastructure suite. The GPO is particularly interested in early federations with international partners and industry, though also open to other federations (e.g., of clusters with each other).

**D&P goals include:** Augmentation of existing clearinghouse functionality to federate with other clearinghouses. The GPO wishes to add this functionality to one or more of the five existing clearinghouses, and believes that this work is most easily performed by those research teams implementing the five control framework clearinghouses, but is open to receiving proposals from other teams that have good ideas on how this function can be rapidly demonstrated via one or more of the existing clusters.

### 3.1.6 Augmentation of System Integration Efforts

The GPO is interested in supporting the additional labor that will be required for a cluster as additional research teams add new projects to that cluster in response to this solicitation, i.e., for effort not already funded by Solicitation 1. Examples include adding experiment workflow tools and systems, measurement and instrumentation, early trial experiments, and so forth. The requisite additional labor may include training of new participants, documentation, additional software development, integration and shake-down, etc. The GPO believes that this work is most easily performed by those research teams implementing the five control framework clearinghouses but is open to receiving proposals from other teams with good ideas on how this should be accomplished. Augmentation of other integration efforts may also be considered if such augmentations add significant value to GENI prototyping.

**D&P goals include:** Integration of new functionality (not already funded under the previous Solicitation 1) into existing clusters.

## 3.2 Specific Areas for this Solicitation

This section illustrates the kinds of proposals that may be submitted. The list below is not exhaustive as we recognize that there could be many other good ideas. Every proposal must reduce risks as discussed above for architecture and requirements, slicing, and operational costs.

We emphasize that proposers do not need to confine themselves to the exact examples given in this solicitation. We actively solicit other good ideas that are compatible with, expand, and enhance the GENI infrastructure as currently envisioned, or that reframe its design.

GENI's current conceptual design is documented in the evolving GENI System Overview document, identified on the [geni.net](http://geni.net) solicitation page. Please do not hesitate to contact the GENI Project Office if you wish to discuss ideas prior to writing a proposal.

Proposal Type	Examples of Specific Areas
<p>Small: Course development, analysis and idea papers, or travel funds to participate in GENI working groups</p>	<ul style="list-style-type: none"> <li>• Develop educational materials and teach courses that employ the GENI infrastructure to teach concepts in networking, distributed systems, etc.</li> <li>• Participate in a GENI working group</li> <li>• Analyze current GENI conceptual designs, provide feedback, and suggest alternate approaches</li> <li>• Suggest major new ideas for the GENI conceptual design, within GENI's general context of programmability, federation, and virtualization</li> <li>• Help define GENI's Measurement &amp; Instrumentation approach</li> <li>• Help define GENI's 'user opt-in' issues &amp; techniques</li> <li>• Help define GENI's security requirements</li> <li>• Develop use-cases for how additional resources can be added to operating slices and identify how this might impact experiments</li> <li>• Develop small experiments for educational and training purposes</li> </ul>
<p>Large (A): Security requirements and architecture development</p>	<ul style="list-style-type: none"> <li>• Security analyses of GENI reference architecture and/or the five defined control framework "clusters"; security requirements definition; architecture definitions, including work tasks such as security analysis, design, and interactions with prototyping teams, resulting in documents that specify a proposed security architecture for GENI (to be issued in a series of drafts with revisions based on community feedback).</li> <li>• Mechanisms that provide useful, basic functionality for a security architecture, provided that are explicitly included within a larger security architecture effort</li> </ul>
<p>Large (B): Prototypes (software-only or software/hardware) and Early Experiments</p>	<ul style="list-style-type: none"> <li>• GENI 'experiment workflow' implementations, including user interfaces, frameworks, specific tools, etc., that make it easy for researchers to define experiments, identify and schedule available resources, mechanisms for creating 'virtual topologies' on demand, tools for programming and debugging components and end-to-end slices, visualize system status, etc.</li> <li>• GENI 'instrumentation and measurement' implementations, including overall frameworks, specific tools, databases and repositories, means by which data can be archived and shared, analysis tools, etc. Please enumerate equipment to be integrated.</li> <li>• Early experiments that employ the GENI prototype suite, particularly those that attempt "end to end" functionality across two or more aggregates, and those that provide experimental services that could potentially attract large numbers of "opt in" users. Other good ideas are also welcome.</li> <li>• Additional GENI 'aggregates' may also be proposed, provided that (a) they substantially augment GENI's research utility, and (b) they quickly become integrated into one or more of the five control framework clusters. As one specific example, the GPO is interested in prototypes that incorporate data centers / cloud computing into the evolving GENI infrastructure suite; other good ideas are also encouraged. Please enumerate equipment to be integrated.</li> </ul>

Integration: Augmented Integration Support	<ul style="list-style-type: none"><li>• Augmentation of existing clearinghouse functionality to federate with other clearinghouses. The GPO is particularly interested in early federations with international partners and industry, though also open to other federations. Please enumerate equipment to be integrated.</li><li>• Augmentation of system integration efforts. The GPO is particularly interested in supporting the additional labor that will be required for a cluster's clearinghouse implementer if additional research teams add projects to that cluster. Augmentation of other integration efforts may also be considered if such augmentations add significant value to GENI prototyping. Please enumerate equipment to be integrated.</li></ul>
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Again, we emphasize that proposers do not need to confine themselves to the exact examples given in this solicitation. We actively solicit other good ideas that are compatible with, expand, and enhance the GENI infrastructure as currently envisioned.

### 3.3 Important Note: Subcontracts are NOT Research Grants

This solicitation is *not* requesting research proposals – rather, it is requesting engineering Development and Prototyping (D&P) proposals to inform GENI’s planning and design. As such, this solicitation is requesting proposals for engineering subcontracts, not for research grants. If you have interesting new ideas for research, such as ideas for novel network architectures, this solicitation is not the right venue.

Successful proposals will receive *subcontracts*, rather than research awards, with the following implications:

- “Large” proposals must show realism for the management approach, and practical understanding of the effort, as well as technical merit.
- Specific deliverables and associated milestones must be clearly described.
- Emphasis on concrete, near-term results.
- Leveraging existing infrastructure (software, testbeds, etc.) is *good* because it reduces the risk of failure and may also reduce the cost.
- Clever ways to avoid new development work are *good* because they reduce the risk of failure and may also reduce the cost.
- Funded efforts will receive ongoing review by the GPO for GENI-relevant progress.
- Efforts with ongoing inability to make progress will be terminated.

The GPO currently intends to structure small and large subcontracts as follows: one year of funding, followed by two option years which will be exercised (funded) if the GPO determines that the subcontract is making useful progress. The GPO reserves the right to change this approach during negotiation of subcontracts.

## 4 “Small” Proposal Format

This section specifies how “small” proposals (subcontract value up to \$30,000 per year) must be prepared and submitted.

Proposals should be written in English, fonts size 11 point or larger, formatted for American letter paper size (8.5 x 11 inches) with reasonable margins. They must be submitted in Portable Document Format (PDF).

The technical part (sections I, II, and III) of the proposal must not exceed three (3) pages including figures, charts, graphs, maps, photographs, and other pictorial representations. This page limit does include the budget section or letters of support, which has no page limit.

The proposal **MUST** contain the following sections with the headings and contents as shown below. Non-conforming proposals may be rejected without review.

### 4.1 Section I. Header

Section / Heading	Required Contents
Section I. Title and Proposer List	Proposal title; name, organization, address and contact information for the Principal Investigator and contracting officer; Period of Performance; Total cost
I.1 Proposal Type	Small

### 4.2 Section II. Contributions of Key Personnel

Section / Heading	Required Contents
Section II. Contributions of PI & Key Personnel	Briefly describe relevant activities that demonstrate the proposer's potential for contributing to GENI development and prototyping.

### 4.3 Section III. Proposed Activities

Section / Heading	Required Contents
III.1 Scope of Work	State clearly what you are proposing to do and to deliver, along with your schedule of when you will make those deliveries.
III.2 GENI Relevance	Provide a clear rationale for these activities and how they tie into GENI's vision.
III.3. Deliverables	List the important deliverables and goals that the proposer plans to achieve and demonstrate. It is expected that performers will deliver the relevant work-product to GENI. Deliverables must also include quarterly reports and a final report. (See Section 7.2.)
III.4 Additional criteria	Provide a concrete, explicit description of how the proposed effort meets this solicitation's additional review criteria; see Section 6.1.

III.5 Outreach Plan	Provide a concrete, explicit description of your plan for involving under-represented institutions, geographic areas and communities.
III.6 Intellectual Property	<p>Clearly state acceptance of one of the following intellectual property rights for GENI participants, without modification:</p> <p>_____ GENI Public License</p> <p>_____ GENI Project License</p> <p>Each quarterly report and final report must also include copyright-free images and description of work performed (suitable for publication on web, in brochures, etc); proper credit will be given.</p>

#### 4.4 Section IV. Budget

The objective of this section is to establish that the proposed costs are reasonable and realistic for the technical and management approach offered. A secondary goal is to assess the proposer's practical understanding of the effort. There is no page limit for this section.

Section / Heading	Required Contents
IV.1 Type of Subcontract Requested	Specify the Subcontract instrument requested: Firm Fixed Price Contracts (FFP), Cost Reimbursement Contracts (CR) Cost Plus Fixed Fee Contracts (CPFF), or Cost Sharing Contracts (CS)
IV.2 Name and cost of Key Personnel	List names, titles, and cost of individual key personnel.
IV.3 Name and cost of other Personnel	List names, titles, and cost of total post doc, other professionals, graduate students, undergraduate students, administrative support, etc.
IV.4 Equipment	Provide brief description and dollar amount for each item.
IV.5 Travel	List domestic and foreign estimated travel (# of trips, purpose and cost). All successful proposers must participate in GENI Working Groups (by email lists) and attend 3 GENI Engineering Conferences per year. Please budget travel costs in this section; estimate travel costs by assuming that engineering conferences are 3 days long, and take place in hotels in major cities across the US.
IV.6 Participant support costs	Include any participant support costs.
IV.7 Other direct costs	Include itemization for materials & supplies, publication costs, subcontracts, consultant services, computer services, and other. If none, state "none".
IV.8 Indirect Costs	Itemize indirect costs applied. If none, state "none".
IV.9 Fee	State fee; if none, say "none".
IV.10 Total	Amount of total funds requested.
IV.11 In-kind Contributions	In-kind contributions are desirable but not required. If you provide such contributions, state clearly what is being contributed, and provide a reasonable estimate of the value.

## 5 “Large” Proposal Format

This section specifies how “large” proposals (subcontract value over \$30,000 per year) must be prepared and submitted.

Proposals should be written in English, fonts size 11 point or larger, formatted for American letter paper size (8.5 x 11 inches) with reasonable margins. They must be submitted in Portable Document Format (PDF).

The technical part (sections I, II, and III) of the proposal must not exceed ten (10) pages including figures, charts, graphs, maps, photographs, and other pictorial representations. This page limit does not include the budget section or letters of support, which has no page limit.

The proposal **MUST** contain the following sections with the headings and contents as shown below. Non-conforming proposals may be rejected without review.

### 5.1 Section I. Header

Section / Heading	Required Contents
Section I. Title and Proposer List	Proposal title; name, organization, address and contact information for the Principal Investigator and contracting officer; name, organization, and contact information for all subcontractors, if any; Period of Performance; total cost
I.1 Proposal Type	Large or Integration

### 5.2 Section II. Contributions of Key Personnel in Past 3 Years

Section / Heading	Required Contents
Section II. Contributions of PI & Key Personnel in Past 3 Years	For the Principal Investigator and other Key Personnel, provide a brief biographical sketch that discusses relevant work, e.g.: <ul style="list-style-type: none"> <li>• Experience with advanced networking infrastructure planning, construction, deployment and operations;</li> <li>• Effective project management, on-schedule and within budget; and</li> <li>• Effective management of software-intensive or rapid hardware prototyping projects.</li> </ul>

### 5.3 Section III. Proposed Activities

Section / Heading	Required Contents
III.1 Scope of Work	Define the scope of work that you are proposing; identify and discuss project goals and associated milestones. State clearly what you are proposing to deliver. Identify specific analysis, development

	and/or prototyping activities. Describe the methods/metrics that will be used to evaluate work-product. If there are subcontractor(s) on the team, clearly state who is responsible for what tasks and deliverables.
III.2 GENI Relevance	<p>Provide a clear rationale for these activities and how they tie into GENI's vision. Describe in detail how you will integrate your project into GENI. Describe how other participants and users will take advantage of your prototype or integration efforts e.g.; by sharing source code, integrations, early user trials from other institutions, etc.</p> <p>Indicate how the technology being developed evolves over the life of GENI, including technology roadmap, technology refresh path, and scalability as GENI usage grows.</p> <p>Describe how the technology being developed encourages broad-scale usage of the GENI infrastructure. Examples might include providing wide-area coverage, scalable access for users, and/or compelling applications or capabilities that will attract users. Note that users can include GENI researchers, or consumers of GENI applications.</p> <p>Explain how GENI technical risk is reduced by your proposal.</p>
III.3 Deliverables	List the important technical deliverables and goals that you plan to achieve and demonstrate. It is expected that performers will deliver the relevant work-product to GENI. Deliverables must also include quarterly reports and a final report. All deliverable documents will be published on geni.net with proper credit. (See Section 7.2.)
III.4 Technical Approach	Describe in detail the technical approach for one of the areas below. Describe how this approach will drive down technical risk in GENI construction / operation.
- GENI Prototype Infrastructure /Tools	Describe any lab / facilities that will be used by the project and that may resemble envisioned parts of the GENI infrastructure, including computing / storage clusters, communications capabilities, outdoor installations, regional or national footprint, etc.
- GENI Prototype Integration Trials	Describe the approaches including tools and methods to be developed on supporting integration trials for GENI prototyping.
III.5 Additional criteria	Provide a concrete, explicit description of how the proposed effort meets this solicitation's additional review criteria (sec. 6.1). These criteria are important and may form a fundamental part of the proposal strategy (e.g. may drive team formation).
III.6 Outreach Plan	Provide a concrete, explicit description of your plan for involving under-represented institutions, geographic areas and communities.
III.7. Project Schedule	Provide a Gantt chart identifying key milestones and major activities over the project period. Key milestones should be no more than 6 months apart, and their success should be clearly demonstrable. Identify and discuss the critical path for development over proposed duration. The schedule should show the sequencing of all <b>major</b> activities to be conducted in sufficient detail to justify the proposed budget.
III.8 Intellectual Property	Clearly state acceptance of one of the following intellectual property

	<p>rights for GENI participants:</p> <p>_____ GENI Public License</p> <p>_____ GENI Project License</p> <p>Each quarterly report and final report must also include copyright-free images and description of work performed (suitable for publication on the web at geni.net, in brochures, etc); proper credit will be given.</p>
<p>III.9 Management Plan, Organizational Structure, and Project Staffing</p>	<p>All proposals must describe the project organizational and management structure.</p> <p>Proposals should include a table that provides the following information for each individual participating in the project: name, position/title on the project, level of effort (monthly and annually), activities assigned, and responsibilities for achievement of key project goals and milestones.</p> <p>Provide a functional project budget in tabular form showing how resources will be allocated.</p> <p>Provide a plan for annual project critical self-assessment that includes measurable metrics and discuss how the results of the self-assessment will be used for project improvement.</p>
<p>III.10 Letters of Support</p>	<ol style="list-style-type: none"> <li>1. Integration partners' proposals for "Large" projects are requested to include at least one letter of support from the PI's of projects with which they will integrate.</li> <li>2. Campus CIO. All proposals for "Large" projects that involve participants on an academic campus are requested to include a letter of support from the campus Chief Information Officer (CIO) or equivalent. This is not strictly required but does serve as part of the evaluation criteria. (Letters of support from regional networks are also helpful.)</li> <li>3. Contracts Representative. All proposals for Large projects are requested to include a letter of support from the lead organization's contracts personnel, stating organizational support of the selected Intellectual Property License. This requirement will be waived for those organizations already under subcontract from the GPO that already have the relevant licenses in place.</li> </ol>

#### 5.4 Section IV. Budget

Your cost proposal should have sufficient detail to allow a thorough understanding of the pricing methodology used and assumptions made. The GPO will conduct a cost analysis of each proposal and any unsupported costs may be deducted from the proposer's total budget.

Provide the basis of estimate for proposed hours, labor rates, indirect costs and other direct costs as appropriate. State any assumptions upon which the estimates of your costs were based.

Specifically state whether any Government furnished equipment, facilities, data or software is required. If any portion of the research is predicated upon the use of Government Owned Resources of any type, the proposer shall specifically identify the property or other resource required, the date the property or resource is required, the duration of the requirement, the source from which the resource is required, if known, and the impact on the research if the resource cannot be provided. If no Government Furnished Property is required for conduct of the proposed research, a statement to that effect will be included in the basis of estimate section of the cost proposal.

<b>Section / Heading</b>	<b>Required Contents</b>
IV.1 Type of Subcontract Requested	Specify the Subcontract instrument requested: Firm Fixed Price Contracts (FFP), Cost Reimbursement Contracts (CR), Cost Plus Fixed Fee Contracts (CPFF), or Cost Sharing Contracts (CS)
IV.2 Name and cost of Senior Personnel	Show individual labor category or person, with associated labor hours (or percentage of time for non-profit educational institutions) and unburdened direct labor rates;
IV.3 Name and cost of other Personnel	List of total post doctoral, other professionals, graduate students, undergraduate students, administrative support, etc. with labor category or person, associated labor hours (or percentage of time for non-profit educational institutions) and unburdened direct labor rates;
IV.4 Equipment	List item and dollar amount for each item exceeding \$2500.00.
IV.5 Travel	List domestic and foreign estimated travel (# of trips, purpose and cost). All successful proposers must participate in GENI Working Groups (by email lists) and attend 3 GENI Engineering Conferences per year. Please budget travel costs in this section; estimate travel costs by assuming that engineering conferences are 3 days long, and take place in hotels in major cities across the US. Number of trips, number of travelers and days per trip, departure and arrival destinations, etc. Per diem rates must not exceed those published in the Federal Travel Regulations (or costs must be consistent with university travel policies).
IV.6 Participant support costs	Include any participant support costs.
IV.7 Other direct costs	Include itemization for materials & supplies, publication costs, consultant services, computer services, and other. An explanation of any estimating factors, including their derivation and application, shall be provided, as well as a brief description of the Proposer's procurement method to be used. If none, state "none".
IV.8 Indirect Costs	Estimate indirect Costs, by category – Fringe Benefits, Overhead, General and Administrative Expense, Cost of Money, etc. (Must show base amount and rate). If none, state "none".
IV.9 Fee or Cost Sharing	State fee in dollars and as a percentage; if none, say "none". If proposing cost sharing, include both dollar amount and percentage and explain the basis for the estimate.
IV.10 Total	Amount of total funds requested.

IV.11 In-kind Contributions	In-kind contributions are desirable but not required. If you provide such contributions, state clearly what is being contributed, and provide a reasonable estimate with your rationale for the stated value.
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**ADMINISTRATIVE INFORMATION**  
(to be filled-in then attached with your proposal)

- 1. Signature of authorized individual \_\_\_\_\_  
Name of Individual \_\_\_\_\_  
Title of Individual \_\_\_\_\_  
Name of Organization \_\_\_\_\_
  
- 2. Organization Information  
First Line Address: \_\_\_\_\_  
Street Address: \_\_\_\_\_  
City/State/Zip Code: \_\_\_\_\_
  
- 3. Identifying Numbers  
Taxpayers Identification Number (TIN) \_\_\_\_\_  
Corporate and Government Entity Code (CAGE) \_\_\_\_\_  
North American Industrial Classification System (NAICS) \_\_\_\_\_  
DUNS Number \_\_\_\_\_
  
- 4. Administrative Contact Information  
Name of Offerors' Point of Contact: \_\_\_\_\_  
Title of Point of Contact: \_\_\_\_\_  
Telephone Number of Point of Contact \_\_\_\_\_  
Email address of Point of Contact \_\_\_\_\_
  
- 5. Proposed Costs  
a. Cost: \_\_\_\_\_  
b. Profit/Fee or (Cost Sharing) \_\_\_\_\_  
c. Total: \_\_\_\_\_
  
- 6. Provide the Following  
Place of Performance: \_\_\_\_\_  
Period of Performance: \_\_\_\_\_
  
- 7. Name of Administrative Contract Office: \_\_\_\_\_  
Street Address: \_\_\_\_\_  
City/State/Zip Code: \_\_\_\_\_  
Point of Contact: \_\_\_\_\_

- Telephone number: \_\_\_\_\_
8. Name of Audit Office: \_\_\_\_\_  
Street Address: \_\_\_\_\_  
City/State/Zip Code: \_\_\_\_\_  
Point of Contact \_\_\_\_\_  
Telephone Number: \_\_\_\_\_
9. Accounting System approved for federal cost-type contracting  
 Yes  No
10. Forward Pricing Rate Agreement or other such Approved Rate Information  
 Yes  No
11. Purchasing System approved for federal contracting  
 Yes  No
12. Billing System approved for federal contracting  
 Yes  No
13. Estimating system approved for federal contracting  
 Yes  No
14. Pricing based on established catalog or commercial pricing  
 Yes  No

## 6 Proposal Review

All proposals will be treated as confidential.

For “small” proposals, review will be conducted by the GENI Project Office.

“Large” proposals will be assigned to panels of appropriate reviewers, which may be drawn from nominations from the Network Science and Engineering (NetSE) Council, working groups, proposers, academic and industrial research community. All proposals will be carefully reviewed, typically by three to five persons who are experts in the particular fields represented by the proposal. These reviewers will be selected by GPO Project Officers charged with the oversight of the review process; care will be taken to ensure that reviewers have no conflicts with the proposer.

### 6.1 GENI Review Criteria

Review Criteria for this solicitation are as follows:

Criterion	Discussion
Relevance to GENI Development & Prototyping	How well do the proposed work and its outcome reduce GENI's overall risk during the planning and design phase?
Best Value	How much value does the proposed work provide for its cost? Potential areas of value includes high impact, enabling a broad range of research, near-term demo of integration & trials, etc
Type of IPR license	Which Intellectual Property Rights (IPR) license is proposed? The GENI Public License is preferred over the GENI Project License.
Cost and schedule realism	Are the costs and schedule reasonable? Reviewers will be asked to evaluate the proposed costs in relation to reasonableness, technical and management approaches.
Probability of success and high impact	Does the proposer demonstrate a practical understanding of the technical challenges? Is success likely? Will a successful effort have a high impact on enhancing GENI and/or reducing its risk?
Academic / industrial team	Combined academic / industrial teams, led by an academic organization, will be preferred over other types of teams.

In addition, the following criteria will be considered:

Criterion	Discussion
Active involvement of under-represented institutions, geographic areas, communities, etc.	Proposals with strong, clear plans for actively involving under-represented institutions, communities, and areas will be preferred over those that present vague plans or no plans at all.
Additional mechanisms, e.g., involvement of high schools, interns, etc.	Proposals that present strong, clear plans to further core NSF interests such as education, involvement of high schools, an active involvement of interns in the projects, etc., will be preferred over those that present vague plans or no plans at all.
Letters of Support	All letters of support as requested in this solicitation, potentially including letters from the relevant integration partners, academic campus Chief Information Officer (CIO) or equivalent, and contracts personnel.

## 6.2 Review and Selection Process

“Large” proposals will be reviewed by external reviewers as indicated in section 6. After scientific, technical and programmatic review and consideration of appropriate factors, the reviewers will advise the GPO whether the proposal should be declined or recommended for Subcontract. The GENI Project Director will make the final determination and will submit a proposal for NSF review.

A summary rating and accompanying narrative will be completed and submitted by each GPO-assigned reviewer. In all cases, reviews are treated as confidential documents. The proposer will receive a notification of the decision to award or decline funding.

In cases of programmatic approval, the proposals recommended for funding will then be forwarded to the GENI Contracting Officer for review of business, financial, and policy implications and the processing and issuance of an agreement. (See Section 7.1)

## 6.3 Public List of Subcontracts

The GPO will make every award public within 4 weeks after the contract has been issued, and will include at least the following information for each award: principal investigator and co-investigators, institution(s), proposal title, technical body of the proposal (not budget), monetary value of subcontract, date awarded and period of performance.

## **7 Award Administration**

### **7.1 Notification of the Subcontract**

Notification of the selection for Subcontract award will be made to the submitting organization by the GENI Contracting Officer. Organizations whose proposals are declined will be informed as promptly as possible by the GENI Contracting Officer.

Proposers are cautioned that only the GENI Contracting Officer or the Senior Manager of Subcontracts may make commitments, obligations or awards on behalf of the GPO or authorize the expenditure of funds. No commitment on the part of the GPO should be inferred from technical or budgetary discussions with a GENI Project Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a subcontract signed by the GENI Contracting Officer or Senior Manager of Subcontracts does so at their own risk.

### **7.2 Estimated Timeline**

The GPO currently expects to announce its selections by late spring 2009 and start subcontract negotiation in summer 2009. For budget purposes, you should use September 1, 2009 as the project start date.

### **7.3 Reporting Requirements**

For all Subcontracts, the Principal Investigator is expected to report current project status in person at every GENI Engineering Conference, and must submit quarterly and final project reports to the GENI Project Officer. Quarterly reports are due at the end of calendar quarters, i.e. March 31, June 30, September 30 and December 31. The final report is due within 30 days after expiration of a Subcontract.

Each quarterly report and final report must also include copyright-free images and description of work performed (suitable for publication on the web at [geni.net](http://geni.net), in brochures, etc); proper credit will be given. Other forms of publication material are also encouraged.

Failure to provide the required quarterly project reports may affect any future funding increments as well as any pending proposals for that PI. PIs should examine the formats of the required reports in advance to assure availability of required data.

The quarterly report will be submitted electronically via <http://geni.net>. For preparation and submission of quarterly and final project reports. Such reports provide information on activities and findings, project participants (individual and organizational) publications and other specific products and contributions. For the quarterly report, PIs will not be required to re-enter information previously provided. Submission of the report via <http://geni.net> constitutes certification by the PI that the contents of the report are accurate and complete. A report is not complete until the GENI Project Office has reviewed and accepted via electronic email notification. The GPO will notify the PI within 10 days of receiving the report submission confirmation with either “accept” or “additional information is requested”.

### **7.4 Other Information**

The [geni.net](http://geni.net) website provides the most comprehensive source of information about the GENI initiatives. Consultation of this website by potential proposers is strongly encouraged.