Internet Measurement Research (IMR): Methodologies, Tools, and Infrastructure

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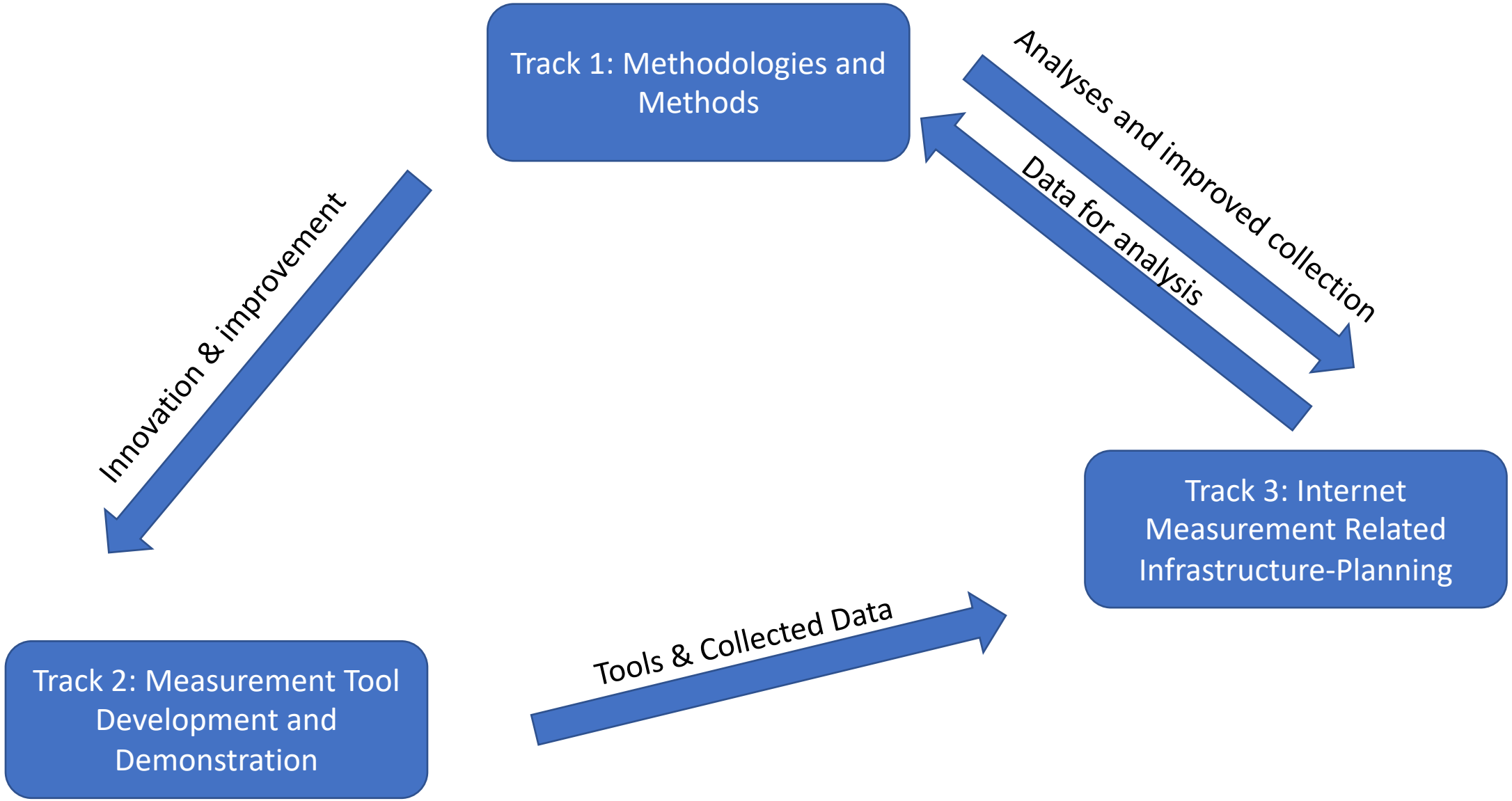
Overview of the IMR Program

Synopsis

- New, focused program to support Internet measurement
- Currently, Internet measurement work is done in an ad hoc and piecemeal manner
- There is work on wired core networks, but going forward, a comprehensive approach both for wired and wireless Internet together would give us a better understanding
- While providers provide some data on performance, they are coarse grain and provider specific
  - Independent ways to assess Internet performance are very important
- Currently, little ability to understand longitudinal behavior
- The goal of the IMR program is to encourage, coordinate, and connect research in Internet measurement in a comprehensive manner
- Tracks
  - **Track 1: Methodologies and Methods:** support the creation of new methods for collecting, anonymizing, modeling, and analyzing Internet measurement data.
  - **Track 2: Measurement Tool Development and Demonstration:** support the creation and deployment of new tools to collect Internet measurement data
  - **Track 3: Internet Measurement Related Infrastructure-Planning:** support the creation of infrastructure for hosting measurement tools and data


Track 1: Methodologies and Methods
Analyses and improved collection
Data for analysis
Innovation & improvement
Track 3: Internet Measurement Related Infrastructure-Planning
Tools & Collected Data
Track 2: Measurement Tool Development and Demonstration

Partners

- Directorate for Computer and Information Science and Engineering (CISE)
  - Computer and Network Systems (CNS)
  - Computing and Communication Foundations (CCF)
  - Office of Advanced Cyberinfrastructure (OAC)
  - Secure and Trustworthy Cyberspace Program (SaTC)
- Directorate for Mathematical and Physical Sciences (MPS)
  - Division of Mathematical Sciences (DMS)

Program Tracks

Track 1: Methodologies & Methods

- Support the creation of new methods for collecting, anonymizing, modeling, and analyzing Internet measurement data
- Subtracks:
  - 1A: **Statistical Methodologies:** supports the creation of new stochastic models and statistical methodologies for Internet measurement research
  - 1B: **Privacy-Preserving Methodologies:** supports innovative techniques or methodologies to ensure privacy protection during collection, sharing and analysis of Internet measurement data
  - 1C: **Other Methodologies:** Supports the creation of new Internet measurement methodologies, analyses, or post-processing not covered by the first two subtracks
- Total Budget: up to $600,000 up to 4 years

1A: Statistical Methodologies

- This subtrack is intended to develop new stochastic models and statistical methodologies for Internet measurement data from fixed, wireless, or core Internet.
- Such models and methodologies may include, but are not restricted to:
  - Statistical methodologies (including experiment design) to de-bias skewed Internet measurements (such as might be due to sparsity of collected data, lack of geographic representation, crowd sourced data);
  - Statistical sampling methods to obtain holistic measurements of the Internet in different dimensions for a better sense of the health of the Internet at various levels;
  - Models that allow for the normalization of collected data or extrapolation from collected data;
  - Internet data modeling at different frequencies including high-dimension high-frequency and mixed frequency data analysis;
  - Longitudinal studies of Internet measurements;
  - Statistical analysis, such as change-point and regression analysis of Internet multi-streaming data; and
  - Assessment of the validity of crowd-sourced datasets.

- Strongly encourage to have both measurement and statistics researchers

1B: Privacy-Preserving Methodologies

- This subtrack is intended to improve Internet measurement data collection and dissemination by addressing privacy concerns in the data lifecycle.
- Proposals in this subtrack may include, though are not limited to:
  - Collection methodologies that de-identify data at the outset;
  - Creation of methods to de-identify existing data;
  - Creation of anonymization methods which do not compromise data quality and utility;
  - Creation of methods to access and/or share collected data in a privacy-preserving manner; and
  - Privacy preserving analysis of Internet data.

- Strongly encourage to have both measurement and security researchers

1C: Other Methodologies

- This subtrack is intended to support the creation of new Internet measurement methodologies, analyses, or post-processing, not covered by the first two subtracks.
- Proposals to this subtrack may include, but are not limited to:
  - Reduction of the footprint or improving the efficiency of current data collection methods;
  - Integration of the measurement of core and access networks with the ability to characterize performance by segment;
  - AI or ML-based methodologies for Internet measurement;
  - Measurement methods for the IPv6 address space; and
  - Examination of the extent to which cross layer specifications or measurements can be rendered useful (e.g., propagation maps, signal-related measurements), and assessment of whether these are applicable to mobile Internet performance.

Track 2: Tool Development & Demonstration

- Development of deployable Internet measurement data collection tools that others can use (e.g., the research community and citizen scientists)
- May collect data at different levels, including but not limited to: core Internet, mobile Internet (that can be downloaded to a mobile phone), hand-held devices, laptops/desktops, or tools that could be deployed by ISPs
- Proposals should seek to demonstrate the application of the tool in a particular environment, and to make the tool publicly available, while at least one version of the tool is expected to be made available through an open-source license
- Should consider privacy and security aspects, including unintended harms of the proposed data collection mechanism
- Total Budget: up to $600,000 for 2 years
- Integration supplement of up to $100,000 may be requested at least 18 months into project based on notable progress

Track 3: Measurement-Related Infrastructure

- Planning Grant for potential ***future*** research infrastructure grant
  - Anticipated range of $5,000,000 to $10,000,000 for 5 years
- Intended to support comprehensive infrastructure development to host data and measurement tools to investigate Internet performance, connectivity, network topology, and service gap
- Should provide an interface for researchers to submit data for use by other researchers, curate the data, and ensure the data can be accessed in a way that is efficiently utilized in a privacy-preserving manner
- Expected to leverage and coordinate with existing Internet measurement repositories/infrastructure to avoid duplication of functionalities, and focus on addressing gaps, especially in wireless and fixed broadband access Internet
- Develop data exchange formats (such as a temporal markup language for data exchange) or tools (such as data retrieval APIs) to facilitate data sharing and usage
- The infrastructure is expected to work with developers of tools in Track 2 to ensure that the data collection can be integrated into the platform
- The development of the infrastructure should consider privacy, security aspects, including resilience to external attacks, access control, and the security of the data housed by the infrastructure.
- Total Budget: up to $100,000 for a year

Estimated Number and Size of Awards

- Track 1 (Methodologies and Methods)
  - Approximately 11 Awards
  - 3 to 4 years
  - $600,000
- Track 2 (Measurement Tool Development and Demonstration)
  - Approximately 11 Awards
  - 2 years
  - $600,000
  - $100,000 integration supplement may be requested after 18 months
- Track 3 (Internet Measurement-Related Infrastructure Planning)
  - Approximately 4 Awards
  - 1 year
  - $100,000
- Total Funding Amount: $14,000,000

Deadlines

- Track 1 (Methodologies and Methods)
  - February 15, 2022
  - February 15, 2023
- Track 2 (Measurement Tool Development and Demonstration)
  - March 8, 2022
  - March 8, 2023
- Track 3 (Internet Measurement-Related Infrastructure Planning)
  - March 22, 2022

Review Criteria

Intellectual Merit

- The Intellectual Merit criterion encompasses the potential to advance knowledge

- What is the potential for the proposed activity to advance knowledge and understanding within its own field or across different fields?
- To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
- Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
- How well qualified is the individual, team, or organization to conduct the proposed activities?
- Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

Broader Impacts

- The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes

- What is the potential for the proposed activity to benefit society or advance desired societal outcomes?
- To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
- Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
- How well qualified is the individual, team, or organization to conduct the proposed activities?
- Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

Solicitation Specific Review Criteria Track 1

- How does the proposed methodology fill a current gap? (1A, 1B, 1C)
- Significance in Internet Measurement: Does the project address a significant problem in the area of Internet measurement? Is the prior research supporting the proposed project rigorous? (1A, 1B, 1C)
- Statistical Innovation: Are the proposed statistical methods innovative? Does the project apply existing statistical methodologies to a new situation? If yes, how challenging are such applications? (1A)
- Integration: How well do the proposed statistical methods integrate with the intended Internet measurement problems? How well does the project develop new statistical methodologies that can apply to Internet Measurement? (1A)
- Privacy-preserving innovation: How well do the proposed privacy protection methods integrate with the intended Internet measurement privacy problems? How well does the project develop new privacy protection methodologies that can apply to Internet Measurement? (1B)
- Integration and Utility: How well will the proposed methods integrate with the intended Internet measurement problems? To what extent do the approaches proposed preserve data utility? (1A, 1B, 1C)
- Are security and privacy aspects being considered in the design, implementation and evaluation of the proposed methods, methodologies, approaches, and tools? (1A, 1C)

Solicitation Specific Review Criteria Track 2

- How broadly applicable is the tool expected to be?
- Will the tool provide a new method for collecting Internet Measurement data?
- If the tool is developed for end-users, how will the tool provide privacy for data collection?
- Will the tool be made publicly deployable and include plans for an open-source license? If so, how?
- Are security and privacy aspects being considered in the design, implementation and evaluation of the proposed methods, methodologies, approaches, and tools?

Solicitation Specific Review Criteria Track 3

- Is there a vision for an innovative infrastructure project that could lead to advancing Internet Measurement research, as described in this solicitation?
- Is there a compelling plan of activities presented to develop a realistic project management and execution plan for the eventual infrastructure and associated services, tools and resources?
- Does the proposed team have the expertise and leadership needed to lead a community effort and help shape the resource to meet community needs?

Additional Submission Information

Supplementary Documents

- A list of Project Personnel and Partner Institutions
- A List of Letters of Collaboration
- Letters of Collaboration
  - Documentation of collaborative arrangements of significance to the proposal
- Collaboration Plans
  - If a project with more than one PI does not include a Collaboration Plan of up to 2 pages, that proposal will be returned without review
- Data Management Plan (required)

Collaboration

- Collaborative proposals with separate submissions from multiple organizations are only allowed for Track 1 (MM) proposals

- For track 1, non-lead collaborating organizations may be submitted as collaborative proposals or as subawardees

- For Track 2 (MT) and Track 3 (RI-P): support for non-lead collaborating organizations should be requested as subawards by the lead organization submitting the proposal. For these tracks, separately submitted collaborative proposals are not allowed.

Questions