Agenda

- **Welcome and CISE Context**

  Margaret Martonosi
  Assistant Director, CISE

- **NGSDI Program--VMware Perspective**

  David Tennenhouse
  Chief Research Officer, VMWare

- **NGSDI Research Overview**

  Gurdip Singh
  Division Director, CNS

- **NGSDI Proposals, Review, & Project Management**

  Matt Mutka
  Program Director, CNS

  NSF-VMWare Team

- **Questions**

NGSDI: NSF – VMware Partnership

- **NGSDI: Continuing our NSF-VMware Partnership**
  - 2016: Software Defined Infrastructure as a Foundation for Clean-Slate Computing Security (SDI-CSCS)
  - 2018: Edge Computing Data Infrastructure (ECDI)
- **VMware's long-term commitment to Sustainability**
  - VMware's virtualization and resource management resulted in customer server consolidation, reducing power consumption by 120 million MWh and saving 67 million Metric Tons of CO_2 in 2015 alone
- **NGSDI Results: Dedicated to the Public**

NGSDI: Background

- LBNL US Data Center Energy Report found energy consumption in data centers grew 90% annually (2000-2005)
- Since 2005, growth rate has plateaued at 4%, due to server virtualization and hardware improvements
- First generation of innovation
  - increased density of workloads per computing unit via virtualization
  - redesign of computing systems power management
  - redesign of data center electrical and mechanical architectures

NGSDI: Program Goals

- Foster transformative research in fundamental and systemic approaches to bring dramatic increases in environmental sustainability of the Digital Infrastructure leading to practical methodologies and tools

  - The Digital Infrastructure is broadly defined as the totality of software, hardware, and the methods for managing them for efficient computation

- Progress to carbon-neutrality or carbon freedom requires efficiency in entire computation chain

NGSDI: New Considerations

- Metrics and benchmarks for systemic computational efficiency
- Software bloat and inefficiency
- Distributed resource allocation
- Capacity planning and provisioning
- Compute-storage-networking tradeoffs and placement
- Hardware-software co-optimization
- Service level agreement (SLA) trade space
- Renewable energy source optimization
- Hardware lifetime optimization
- Renewable-energy driven workload shifting

NGSDI: Central Question

- What fundamental and systematic approaches in *measurement*, *design*, *development* and *management* of the Digital Infrastructure resources and workloads will enable significant progress toward maximizing sustainability of the Digital Infrastructure *with minimal impact on traditional concerns* such as programmer *productivity* and Digital Infrastructure *performance* and *scalability*?

NGSDI: Research Objectives

- Consider fundamental nature of the problem
- Multiple aspects of sustainability
- Multitude of competing goals of Digital Infrastructure Management
  - Economics, performance, efficiency, sustainability

NGSDI: Example Research Vectors

- Metrics
  - E.g. Metrics and Instrumentation, Benchmarks, Service-Level Objectives (SLO)
- Workload Design and Development
  - E.g. DevOps Divide, Full Stack Visibility and Optimization, Migration of Applications to the Cloud
- Workload and Digital Infrastructure Managment
  - E.g. IT/OT Divide, Automation, Full Digital Infrastructure Optimization, Power-sensitive execution, Renewable power sources

NGSDI: Possible Techniques

- Passive and active measurements at systems, local and wide are levels
- Metrics aggregation services, statistical analysis and inference
- Modeling and learning techniques to assist automated control, complex resource management and optimization
- Process and system isolation (virtual machines, containers, functions-as-a-service) to enable control at a wide range of parameters and scale to include sustainability objectives
- Technologies for agile development and convergence of development and production environments

NGSDI: Expectations

- Disruptive innovative approaches
- Focus on software-layer sustainability
  - Narrow focus on non-software components and disciplines are **out of scope** (e.g., strictly hardware architectures, water, power, cooling)

NGSDI: Develop Prototypes

Purpose of prototypes

- Explore implementation aspects of designs
- Empirical demonstration of effectiveness of approaches

Prototypes should leverage existing software, tools, frameworks, testbeds if possible

NGSDI: Broader Impact Results

- Strive to achieve broader industry impacts with any foundational results.

- Interest in dissemination results including open source software, production and publication of datasets, activities leading to real-world experimentation, measurements, and deployments.

- When appropriate, proposers should be clear how to navigate broader policy, economic and social considerations.

NGSDI: Solicitation and Review

- Solicitation Requirements

- Review Process
  - Solicitation-Specific Review Criteria

- Award Selection Process

- Management of the Projects

- Q & A

NGSDI: Key Numbers

[NSF](#) 20-594

- Proposals due: Nov. 4, 2020
- Approximately 2 project awards
  - Up to $3,000,000 per project
  - Over 3 years
- NSF funds from FY2021
- Awards Early 2021

NGSDI: Who Can Submit

- Institutes of Higher Education (IHEs) Universities and two- and four-year Colleges (including community colleges)

  - See special instructions for International Branch Campuses of IHEs

  - Sub-awardee requirements: same as submitting institutions

NGSDI: Proposal Requirements

- Personnel:
  - 1 proposal submission per person as PI, co-PI, or senior personnel in response to this solicitation.
    - Inclusion of each member needs to be justified with respect to the goals of the project
  - Some number of graduate students expected
  - Some number software engineers or programmers may be submitted as needed
- Proposal Sections
- 20-pages for the Project Description

NGSDI: Proposal Requirements

- 1-page Postdoc Mentoring Plan (if applicable)
- 2-page (max) Collaboration Plan (if applicable)
  - Appropriateness of team participants and expertise
  - Role of each team member
  - Management and Coordination mechanisms
  - Interdependencies among tasks
  - Reference of budget lines to support collaboration
- 2-page (max) Data Management Plan
  - See http://www.nsf.gov/cise/cise_dmp.jsp for guidance.
- 0 general letters of support

NGSDI: Intellectual Property

- NSF/VMware Partnership awardees will agree to dedicate to the public all intellectual property resulting from the research funded as part of this program, and further:

- The awardees will offer its software through an open source license under an Apache 2.0 license found at:
  - http://www.opensource.org/licenses/apache2.0.php or other similar open source license; in the event the software already contains code licensed under GNU's General Public License (GPL), then the open source shall be through GPL version 3 found at http://www.gnu.org/licenses/gpl.html;

- The awardees will submit for publication in openly available literature any results of this research; and

- The awardees will deposit all published manuscripts and juried conference papers in a public access-compliant repository in accordance with the guidelines set forth in NSF's Public Access Policy (see NSF Public Access Frequently Asked Questions at:
  - https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf18041)

no later than 12 months after initial publication.

NGSDI: Review Process

NSF: Panel with ad hoc reviews as appropriate:

- Intellectual Merit & Broader Impacts
- See NSF 20-1; Proposal and Award Policies and Procedures Guide (PAPPG) for more information
- Additional Review Criteria—see next slide
- VMware team members participate as observers

Joint NSF-VMware reverse site visits as needed

Joint NSF-VMware decisions on awards based on NSF Merit Review process

NGSDI: Solicitation-specific Review Criteria

In addition to Intellectual Merit and Broader Impact, the proposal will be evaluated on the degree to which:

- Project pursues a <u>systems perspective</u> and the creation, deployment, and evaluation of <u>demonstrations or prototypes</u> at the component and eventually the system levels;

- Project features a <u>lean, well-integrated team</u> of researchers with expertise area(s) necessary to conduct the proposed work;

- Convincingly frames meaningful system-level sustainability metrics and argues that successful results will have a meaningful impact in terms of those metrics;

- Projects demonstrate <u>concrete plans to impact the broader industry;</u>

- Researchers <u>leverage existing components and infrastructure</u> such as the NSFFutureCloud projects, Chameleon and CloudLab, and NSF-funded CloudBank; if proposing to build a new infrastructure, justification is needed for why the existing infrastructures do not suffice.

NGSDI: Funding Model

Projects will be jointly funded by NSF and VMware through separate NSF and VMware funding instruments.

- NSF awards will be made as grants.

- VMware awards will be made as VMware agreements (Contracts or Grants) through VMware or its Vanguard-managed University Research Fund.

- NSF and VMware will manage their respective awards/agreements in accordance with their own guidelines and regulations.

- Either organization may supplement a project without requiring the other party to provide any additional funds.

NGSDI: Program Management

- NSF and VMware will each designate a Program Director for each NSF/VMware Partnership award who will jointly oversee the execution of the project

- The VMware Program Director may become a member of the NSF/VMware Partnership Project Management Team.
- Annual on-site reviews may be conducted jointly by NSF and VMware.

- Institutions may request site visits to VMware or invite site visits from VMware.

- VMware may invite academic faculty and students to visit VMware and may visit research institutions upon request.

NGSDI: Proposal Summary

- Title: NGSDI: <title>
  - For Collabs: Collaborative Research:NGSDI: <title>
- Project Description: 20 pages
- Supplementary Documents
  - A list of Project Personnel and Partner Institutions
  - Collaboration Plan
  - Data Management Plan
  - Post-Doctoral Mentoring Plan (if applicable)
- Single Copy Documents
  - list of collaborators

NGSDI: Full Proposals

Deadline

5:00 pm submitter's time on Nov. 4, 2020

Questions?