The most relevant Directorate/Division is CISE/CNS.

Overview:

Cybersecurity and privacy (CS&P) threats increasingly impact our daily lives, our national infrastructures and our industry. Recent newsworthy attacks targeted nationally important infrastructure, our government, our nuclear facilities, our researchers, and research facilities. The landscape of what needs to be protected and from what threat evolves: new technologies are released and the threat actors improve their own capabilities through experience and close collaboration. Meanwhile, defenders work often in isolation, using private data and facilities, and producing defenses that are quickly outpaced by new threats. To transform CS&P research into a highly integrated, community-wide effort, CS&P researchers need *a common, rich, representative research infrastructure, which meets the needs across all members of the community, and facilitates reproducible science*.

We propose Mid-scale RI-1 (M1:IP): **SPHERE** - *Security and Privacy Heterogeneous Environment for Reproducible Experimentation.* SPHERE will offer access to an unprecedented variety of hardware, all relevant to CS&P research, connected by user-configurable network substrate, and protected by a set of security policies uniquely aligned with CS&P research needs. SPHERE will offer six user portals, closely aligned with needs of different user groups, facilitating wide adoption. SPHERE will provide built-in support for reproducibility, via easy experiment packaging, sharing and reuse. SPHERE will build a process, a standard and incentives for community-wide efforts to develop representative experimentation environments for CS&P research, and to continuously contribute high-quality research artifacts.

Intellectual Merit:

The SPHERE research infrastructure will offer a novel mix of experimentation capabilities, uniquely tailored to the needs of CS&P researchers and educators. SPHERE's novel offering of diverse, rich hardware infrastructure, configurable network substrate and safe network policies will support novel CS&P research in emerging areas, such as IoT, cyber-physical systems, programmable networks, edge computing, Internet measurement and human-centric CS&P. SPHERE's novel user portals will democratize access to CS&P research, and will facilitate practical CS&P education of broad student populations. SPHERE's novel support for representative experimentation and reproducibility, tight collaboration with researchers and close alliances with artifact evaluation committees, will enable vertical progress in the science of CS&P. The SPHERE research infrastructure will *transform* CS&P research, from piecemeal and opportunistic to highly integrated, by unifying the community's experimentation efforts on a common, rich, highly usable infrastructure. Integrated research efforts will increase the pace of innovation and improve the success and sophistication of CS&P research products. Thus, SPHERE will significantly advance scientific discovery and the Nation's research capabilities in CS&P.

Broader Impacts:

The broader impacts of SPHERE include a faster pace of innovation in cybersecurity and privacy fields, more mature solutions on the market meeting stakeholder needs, as well as higher impact of these solutions broadly across the U.S. scientific and economic communities. By enabling reproducible experimentation on shared hardware that is easily and remotely accessible by all U.S. researchers, SPHERE will democratize security and privacy research, and will especially benefit underserved researchers and students, enabling them to compete on an equal standing with those from top-tier institutions. SPHERE's support for reproducibility will lead to many high-quality CS&P artifacts, fueling future research publications. SPHERE will further enrich and broaden participation in CS&P education and strengthen the U.S. workforce by offering a common platform and a rich set of education materials. Students will develop marketable, practical skills, thus making them highly competitive in today's global labor market. The SPHERE project will further fund 20 interns per year, recruited solely from underserved student communities, to participate in SPHERE's implementation.