Defense Advanced Research Projects Agency Spectrum Collaboration Challenge at APL: Introduction

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ABSTRACT

With the emergence of fifth-generation (5G)-cellular and Internet of Things technologies, alongside legacy wireless systems, the radio frequency (RF) spectrum is becoming heavily congested, creating availability and throughput challenges for wireless service providers as well as our military forces. In addition to the congestion, our forces face threats from advanced jamming and cyberattack. This competition for use and control of the RF spectrum is one of the critical challenges facing the nation. Exemplifying its focus on making critical contributions to critical challenges, the Johns Hopkins University Applied Physics Laboratory (APL) is pleased to present this issue of the Johns Hopkins APL Technical Digest. *The issue describes the Colosseum—the first-of-its-kind wireless communication test bed that APL developed for the Defense Advanced Research Projects Agency (DARPA) Spectrum Collaboration Challenge (SC2). This test bed enables research into artificial intelligence and machine learning for networked systems—systems that autonomously negotiate use of the RF spectrum in real time based on instantaneous user demand, available spectrum, and environmental conditions. Through this effort, APL has provided a new capability enabling research beyond constrained RF allocations, ultimately contributing to improved resilience of networked systems on the battlefield.*

This issue of the *Johns Hopkins APL Technical Digest* introduces the development of architecture and key components within the wireless communication research test bed known as the Colosseum. APL developed the Colosseum for the 3-year (2016–2019) Defense Advanced Research Projects Agency (DARPA) Spectrum Collaboration Challenge (SC2). Understanding the need for repeatable and consistent training environments for artificial intelligence and machine learning (AI/ML), APL leveraged its expertise in testing and evaluation to develop an architecture that is scalable to next-generation networked systems with fine-grain control, enabling evaluation of emergent (unpredicted) AI responses simultaneously across 128 radios. APL also recognized the need for test-driven development and continuous integration into future networked systems and, thus, incorporated real-world phenomenon in the test bed via the world's largest wireless channel emulator. Altogether, the Colosseum provides researchers a trusted, repeatable,

and consistent platform for designing and testing AI/ML solutions on networked systems.

Over the past 3 years, APL has applied insights and lessons learned from the Colosseum to further internal research and address emerging challenges in contested electromagnetic environments. The spectrum research on SC2 is contributing to advancements in test and evaluation of networked communication systems and deployment of new test range architectures. Virtual environments underpin SC2 and enable rapid porting of prototype capabilities to fielded solutions.

None of these achievements could have been accomplished without the dedicated staff members who committed to the hard work and travel required to field these capabilities rapidly and effectively. We thank our staff for their collaborative spirit and their contributions, and hope you find this collection of articles as fascinating as we do.

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