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Project Funded by the Air Force Office of Scientific Research (AFOSR) (2024-2027):

Toward an Integrated Theory of Space-Cyber Power

Prof. Scott Shackelford

Principal Investigator

Prof. Eytan Tepper

Co-Principal Investigator and Project Manager

Report

Colloquium on Space-Cyber Power, January 29-30, 2026

The [Colloquium on Space-Cyber Power](#) featured papers and discussions on a range of topics including: **Theories of Power**, **The Space-Cyber Nexus as a Warfighting Domain**, **The Role of the Commercial Space Industry in Space-Cyber Power**, and **Strategy and Security in the 21st Century**.

Featured **authors and experts** included: **James D. Kiras**, Dean and Professor of Military Strategy and Security Studies, School of Advanced Air and Space Studies (SAASS), Air University; **Gregory D. Miller**, Dean of Space Education at US Space Force and Johns Hopkins University; **Kun-Chin Lin**, Professor of Military and Security Studies, US Space Force STARCOM Delta 13, and SAIS-Johns Hopkins; **Roger D. Launius**, former NASA Chief Historian and Director, Smithsonian's Air and Space Museum; **Herbert Lin**, Senior Research Scholar, Hoover Institution/Stanford University; and **Charles Stotler**, Director, University of Mississippi Center for Air and Space Law.

A complete list of papers, speakers, and discussants is attached as Annex I.

The Colloquium will lead to the publication of an edited volume by **Cambridge University Press**.

1 Background

Indiana University's [Space Governance Lab](#) launched a 3-year project funded by the Air Force Office of Scientific Research (AFOSR): [Toward an Integrated Theory of Space-Cyber Power](#), aiming to lay the foundations for the missing theory of space-cyber power: what power means in the 21st century, in an era of combined space-cyber theaters and operations, and how the U.S. can accumulate, project, and leverage space-cyber power for its defense and economic growth and to maintain and increase its influence a world defined by multipolar geostrategic competition.

A [Call for Papers](#) issued at the occasion of the [workshop launching the project](#) held in Washington D.C. on March 7, 2025 invited scholars and experts, across government, academia, and the private sector, including active and retired defense personnel, to submit paper proposals on space-cyber power. The project leads invited a select group of authors and papers to be presented and discussed during the [Colloquium on Space-Cyber Power](#) held on January 29-30, 2026.

2 Summary of the Event

The colloquium in numbers: 2 days, 25 papers, 38 authors & co-authors, 28 discussants, 8 panels, 9 moderators, and 68 attendees.

The colloquium brought together subject-matter experts from academia, industry, and current and former members of government agencies and the defense establishment, including NASA, the Department of Veterans Affairs, the National Artificial Intelligence Institute, and current and former warfighters in the USAF, USSF, and USN. With the majority of participants from the United States, there were international participants from academic institutions and organizations in Switzerland, Hungary, France, Poland, Estonia, Israel, and the United Kingdom.

During the colloquium, papers were presented by discussants that provided feedback to the authors, after which the authors would discuss the feedback, before the floor would be opened to commentary from colloquium participants.

The first day of the colloquium advanced a shared understanding that the space and cyber warfighting domains have converged, forming a single operational and strategic nexus that modern security planning must treat as an integrated domain. Participants emphasized that space-enabled services, including communications, navigation, sensing, cyber infrastructure, now underpin national security, economic activity, and military capability. A major outcome was widespread agreement that space-cyber power should be understood less in terms of platform dominance and more as the ability to assure continuity, resilience, and rapid recovery of distributed, hybrid space architectures on the one hand, and harnessing the nexus for integrated offensive operations on the other. This marked a shift from traditional spacepower theory toward an infrastructure-focused perspective grounded in interdependence, commercial integration, and below-threshold strategic competition.

Through multiple papers, contributors highlighted the need to recast classical strategic models for the space-cyber nexus. For example, Clausewitzian concepts such as centers of gravity, friction, and the nature vs. character of war were reinterpreted and recast to capture networks, data dependencies, cognitive pathways, and attribution challenges. Presenters showed how new orders of battle must reflect both physical and logical terrain, integrating satellite constellations, ground stations, software layers, and human decision-making. This theoretical modernization was paired with strong recommendations for professional military education reform, including wargaming, scenario-based learning, and training systems designed to teach uncertainty management, rapid adaptation, and hybrid domain awareness.

A critical theme was the growing role of commercial actors and the commercial sector as a whole, as their systems now influence conflict outcomes and shape escalation dynamics. Discussions examined how private satellite operators, cybersecurity firms, and dual-use technologies affect sovereignty, liability, and norms of behavior. Participants noted that existing legal frameworks, such as the Outer Space Treaty and traditional international neutrality law, were not designed for an era in which private entities may enable or even constitute operational effects in conflict. This drove calls for improved state oversight, clearer attribution standards, and stronger mechanisms for coordinating public-private responses to space-cyber threats.

Suggested improvements for the broader research agenda centered on clarifying definitional boundaries, strengthening interdisciplinary foundations, and accounting for diverse political and technological contexts. Participants encouraged expanded analysis of escalation, kinetic-cyber interactions, and scenarios where resilience measures themselves may shape adversary perceptions. There was also strong support for deeper integration of ethical reasoning, international legal evolution,

and empirical data—such as incident databases and historical treaty analysis—to validate emerging theories.

The second day of the colloquium emphasized how deeply space and cyberspace have converged into a single strategic warfighting domain and arena for superpower competition, and projection national power, prompting calls for updated military doctrines, governance models, and legal frameworks. Discussions highlighted the destabilizing effects of attribution difficulties, dual-use technologies, and accelerated decision cycles in the space–cyber nexus, which collectively challenge traditional deterrence and crisis-management models. Speakers stressed that states and private actors must anticipate rapid escalation dynamics, especially as commercial constellations, AI-enabled sensors, and proliferated low-Earth-orbit systems increasingly shape national security considerations.

A major theme, as in the day prior, was the growing influence of commercial space companies, whose systems now underpin critical national functions and military operations. Participants argued that existing legal and policy structures, especially those grounded in Cold War-era assumptions, are insufficient for modern commercial–state entanglement. Several papers examined gaps in oversight, licensing, and contractual regimes, noting that regulatory chokepoints, slow approval timelines, and unclear liability rules hinder cooperation and create vulnerabilities. The colloquium underscored the need for updated definitions distinguishing terrestrial cyber activity from space-directed cyber operations, along with frameworks ensuring that commercial actors operate within predictable legal and strategic boundaries. Suggestions included adopting models analogous to the Montreux Document for private military contractors and exploring new forms of corporate governance that embed national-security awareness within major space firms.

Strategic stability and deterrence were recurring concerns. Presenters argued that deterrence in the space–cyber nexus must integrate reputational signaling, resilience measures, denial capabilities, and credible pathways for punishment. Because many hostile actions in space and cyberspace fall below the threshold of armed conflict, traditional escalatory ladders and response timelines are ill-suited to the domain’s speed and ambiguity. Improving situational awareness, clarifying red lines, and strengthening international norms were identified as essential steps toward preventing miscalculation. Participants also highlighted the prospective role of “entanglement” through shared infrastructure as a stabilizing factor—making hostile actions costly not only for adversaries but for all spacefaring actors, including the attacker.

Finally, several contributions pointed to the need for more robust interdisciplinary research, integrating strategic studies, international relations, international law, political economy, and technical analysis. Scholars urged clearer articulation of how sovereignty, authority, and responsibility should be conceptualized in an era when private entities can influence conflict outcomes. Others proposed expanding study of escalation pathways, kinetic–cyber interactions, and the risks posed by AI-enabled autonomy in orbital systems. The day concluded with consensus that developing an actionable theory of space–cyber power will require sustained collaboration between government, industry, and academia, supported by more rigorous empirical research and policy innovation.

Collectively, the Colloquium on Space-Cyber Power set the stage for a more rigorous, actionable theory of space-cyber power that links conceptual advances to operational and governance realities with a view to update U.S. strategy and military doctrine to account for the rise of the space-cyber nexus as a warfighting domain and primary battlefield for superpowers in the 21st century.

Prof. Scott Shackelford
Principal Investigator (PI)

Dr. Eytan Tepper
Co-PI & project manager

Dr. Rob Templeman

Other Significant Contributor

James B. Romano, Senior Research Assistant

Madelyn Gamble, Research Assistant

Zachary Kistler, Research Assistant

Agenda

January 29, 2026 - Day 1

Day 1 - January 29th, 2026

Introduction

Opening Remarks: *The Need for A Theory of Space-Cyber Power and Its Concepts*

9:00-9:15 | **Scott J. Shackelford** - Provost Professor, Associate Vice President & Vice Chancellor for Research
Indiana University-Bloomington

Session 1: Theories of Power

Moderator: Eytan Tepper

Theories of Air, Sea, and Land Power and its Application to Space Cyber Power

9:15-9:25 | **Eytan Tepper** - Research Professor, Space Governance & Security and Director
Space Governance Lab, Indiana University-Bloomington

Beyond Terrestrial Realms: Translating Clausewitzian Order of Battle Concepts for Integrated Space-Cyber Power

9:25-9:55 | **Mahesa B. Suprobo** - 533d Training Squadron Detachment 2
United States Space Force

Discussant - Magdalena T. Bogacz

From Theory to Practice: Defining Space Cyber Power

9:55-10:25 | **Clemence Poirier** - Senior Cyberdefense Researcher
Center for Security Studies at ETH Zurich

Discussant - William R. Thompson

10:25-10:40 **Break**

Session 2: The Space-Cyber Nexus as a Warfighting Domain

Theme 1: *The Space-Cyber Nexus as a Warfighting Domain*

| *Moderator: Magdalena T. Bogacz*

Satellites, Sovereignty, and Security: The Rise of Space as Critical Infrastructure in Great Power Competition

10:40-11:10 | **Elie Alhajjar** - Senior Policy Researcher
RAND

Discussants - Scott Shackelford & James Romano

Critical Infrastructure as Power: Toward a Strategic Theory of the Space-Cyber Nexus

11:10-11:40 | **Deborah Housen-Couriel** - Adjunct Professor
Hebrew University

Gil Baram - Senior Lecturer (US Associate Professor)
Bar Ilan University

Discussant - Jonathan K. Sawmiller

Space Critical Infrastructure: Governance, Legal Challenges, and a Model for the Space Economy and Space Power

11:40-12:10 | **Nick Reese** - Adjunct Professor
New York University

Annslee Perego, Esq - Research Fellow
CENSA

Discussant - Afonso Seixas-Nunes

12:10-12:45 **Lunch**

Theme 2: *Space Cybersecurity and its Discontents*

| *Moderator: Nick Reese*

A Primer on Space Cybersecurity

12:45-1:15 | **Herbert Lin** - Senior Research Scholar, Center for International Security and Cooperation Research
Fellow, Hoover Institution
Stanford University

Keely Podosin - Graduate Student

Discussant - Clemence Poirier

The Risky Great Power Competition in Space

1:15-1:45 | **Rob Frieden** - Academy and Emeritus Professor of Telecommunications and Law
Penn State University

Discussant - Nick Reese

Theme 3: *Power Sources & Supply-Chain Security in Space*

| *Moderator: Richard J. Chasdi*

The Power of Secure Power for Deep-Space Exploration

1:45-2:15 | **David A. Koch** - Research Engineer
Pacific Northwest National Laboratory

Kathleen A. Doty - Advisor
Pacific Northwest National Laboratory

Discussants - Antonio Carlo & Andrés Edl

Unveiling the Shadows: Examining the Background of Space Supply Chains

2:15-2:45 | **Antonio Carlo** - Coordinator
Space Generation Advisory Council

Andrés Edl - Space Defence and Security Advisor
Institute of Space Law and Policy

Rayen Abid

Discussants - Cassidy Zehner & David A. Koch

2:45-3:15 **Break**

Session 3: Law, Ethics, and the Future of the Final Frontier

Moderators: Scott J. Shackelford & Afonso Seixas-Nunes

Law and Ethics in the Final Frontier

3:15-3:30 | **Scott J. Shackelford** - Provost Professor, Associate Vice President & Vice Chancellor for Research
Indiana University-Bloomington

Just War is Space: Does the Character of Space Warfare Demand a Revisionist Account of Just War Theory?

3:30-4:00 | **Magdalena T. Bogacz** - Assistant Professor of Military and Security Studies
Johns Hopkins University & the United States Space Force

Discussant - Matthew Zellner

A Struggle for the Core: What the Diplomatic Battle over the Creation of the Outer Space Treaty of 1967 Reveal About the Cyber-Space Nexus

4:00-4:30 | **Thomas Breece Lowe** - Graduated Senior
Yale University

Discussant - William R. Thompson

The 1967 Outer Space Treaty and the Problem of Corporate Appropriation: Quo Vadis?

4:30-5:00 | **Afonso Seixas-Nunes** - Associate Professor of Law
University of Saint Louis School of Law

Discussant - Deborah Housen-Couriel

Cybersecurity in Space: The Attribution Advantage?

5:00-5:30 | **Francesca Giannoni-Crystal**, Attorney at law, Founder
Crystal & Giannoni-Crystal, LLC

Charles Stotler - Professor of Practice of Law Director, Center for Air and Space Law
University of Mississippi

Discussant - Richard J. Chasdi

5:30-5:40 **Conclusion:** Day 1

January 30, 2026 - Day 2

Day 2 - January 30th, 2026

Introduction

Day 2: Opening Remarks

9:00-9:10 | **Eytan Tepper** - Research Professor, Space Governance & Security and Director
Space Governance Lab, Indiana University-Bloomington

Session 3: Law, Ethics, and the Future of the Final Frontier - Continued

Moderators: Sam Visner

Make It So: A Human-Centered Approach to Space Cybersecurity

9:10-9:40 | **Vivek Krishnamurthy** - Associate Professor
University of Colorado Law School

Discussant - Grzegorz Blicharz

Applicability of International Space and Cybersecurity Law: the State Responsibility for AI-Enabled Satellite Surveillance in the Space-Cyber Nexus

9:40-10:10 | **Max Fang** - Lead Researcher for Data and Cyber Programs
Ostrom Workshop

James Romano - Senior Research Assistant, Ostrom Workshop Space Governance Lab
Indiana University

Discussant - Vivek Krishnamurthy

10:10-10:25 **Break**

Session 4: The Role of the Commercial Space Industry in Space-Cyber Power

Moderator: Christos A Makridis

Privatizing Space Power: Revisiting Article VI and the Corporate Challenge to International Space Governance

10:25-11:15 | **Matthew Zellner** - Judge Advocate, Operations and International Law, Space Law Division
United States Air Force

Capt. Samantha Potter - Assistant Staff Judge Advocate
United States Air Force

Discussants - Francesca Giannoni-Crystal & Charles Stotler

Lessons From the Ancient Romans: Public-Private Governance of Sea and Air Frontiers

11:15-11:45 | **Grzegorz Blicharz** - Associate Professor
Jagiellonian University in Kraków

Discussants - Roger D. Launius

Competitiveness in the space innovation ecosystem

11:45-12:15 | **Sameeksha Desai** - Associate Professor
Indiana University

Discussants - Christos A. Makridis

12:15-12:50 **Lunch**

The Hidden Constraints on America's Space Economy: Fixing the Frictions in U.S. Commercial Space Partnerships

12:50-1:20 | **Christos A Makridis** - Associate Professor
Arizona State University

Jillian Wellard
Arizona State University

Discussant - Elie Alhajjar

Session 5: The Space-Cyber Nexus: Strategy and Security in the 21st Century: Remarks

Moderators: Eytan Tepper & Matthew Zellner

Glory, Gold, and God: Terrestrial Lessons Informing Security Issues on the Space Frontier

1:20-1:50 | **Roger D. Launius** - Retired
NASA/Smithsonian's Air and Space Museum

Discussant - Kun-Chin Lin

Integrated Deterrence in the Nexus of Space and Cyber

1:50-2:20 | **Gregory Daniel Miller** - Dean of Space Education
US Space Force and Johns Hopkins University

Discussant - Eytan Tepper

2:20-2:30 **Break**

Eliminating Artificial Silos in the Age of Convergence: Revising Joint Doctrine for Space and Cyberspace Operations to Enable Space-Cyber Power Projection

2:30-3:00 | **Jonathan K. Sawmiller** - Deputy Staff Judge Advocate
U.S. Space Command

Discussant - Mahesa B. Suprobo

Acquiring Dominance/Hegemony/Leadership in the Global Commons in the Twenty-first Century

3:00-3:30 | **William R. Thompson** - Distinguished and Rogers Professor Emeritus, Political Science
Indiana University

Discussant - Rob Frieden

The Space-Cyber Nexus in 21st Century Grand Strategy: Organizing Polycentric Regionalism

3:30-4:00 | **Kun-Chin Lin** - Professor of Military and Security Studies
US Space Force STARCOM Delta 13, and SAIS-Johns Hopkins

David Chen - China Aerospace Studies Institute, Air University (USAF)

Tim Reilly - Scott Polar Research Institute, University of Cambridge

Discussant - Sam Visner

4:00-4:15 **Conclusion:** Toward an Integrated Theory of Space-Cyber Power