Testimony of Charles P. Baylis, Ph.D.
Senate Committee on Commerce, Science, and Transportation Hearing
"America Offline? How Spectrum Auction Delays Give China the Edge and Cost Us Jobs"
February 19, 2025

Good morning. My name is Dr. Charlie Baylis, and I serve as a Professor of Electrical and Computer Engineering at Baylor University and Director of SMART Hub, a Department of Defense Spectrum Innovation Center. "SMART" stands for "Spectrum Management with Adaptive and Reconfigurable Technology", and SMART Hub consists of 25 U.S. citizen researchers across 15 universities and 13 states. Our unified mission is to make spectrum usage adaptive and reconfigurable, from policy through circuits. We have been established through Congressional appropriation support, and commissioned through the Army Research Laboratory. We are not a typical collection of academicians. We do not desire merely to publish papers on technology that will stagnate in a laboratory, but to quickly put superior technologies into the hands of our warfighters and into the hands of consumers. We want to put America First in spectrum: arguably the most important dimension of battle and a very valuable natural resource.

As a center, we are creating adaptive and reconfigurable technologies that will provide a "win-win" for military dominance and economic growth. By adapting, we aim to provide flexible, opportunistic spectrum capabilities to military systems and 5G and 6G commercial wireless systems, maximizing performance in whatever band they operate. Two weeks ago, we demonstrated our initial technologies to the Pentagon, Congress, and the Defense Industry in Arlington, VA. As an example of some of our innovations, we have developed sense-react-and-avoid, sense-predict-and-avoid, and metacognitive techniques to choose the best available spectrum for operation in real time, and are looking to AI to speed spectrum selection. We are building a Dynamic Spectrum Management System (DSMS) that will include live interference reports to inform the real-time coordination of spectrum. We are working on reconfigurable plasma circuits and antennas, capable of handling high transmission power levels, that allow us to maximize radar range in under a millisecond after changing frequencies to avoid wireless communications. We are pioneering a novel measurement module that, when placed inside a transmitter chain, will allow us to assess what we are transmitting to avoid interference and improve our system performance "on the fly." These techniques will allow both incumbent government systems and commercial wireless systems to have the functionality to work around each other.

Technology innovation will convert congestion into opportunity.   Many attempts to organize spectrum have been limited to regulation and re-regulation, rather than innovative technology to revolutionize spectrum use. Adaptive and reconfigurable technology provides a better alternative. It will allow us to both "provide for the common defense" and "promote the general welfare."

As the developer of adaptive and reconfigurable technology, the United States will gain an enormous international advantage both economically and tactically. U.S. industries will develop these systems and sell their technology worldwide. Commercial wireless systems will realize heretofore uncomprehensible bandwidths. And our military systems will be the strongest, most agile in the world, dominating in the most important dimension of battle: the spectrum.

How do we get to this situation from where we are today? This is a question that I, as Director of a Congressionally funded Spectrum Innovation Center, have spent a lot of time considering and mapping to direct our research, innovation, and workforce development. If spectrum coexistence is like driving a car down a highway with other vehicles, we must develop adaptive and cognitive techniques to maneuver devices through a congested spectrum. In less congested environments, device-to-device interaction can be used to coexist, just as cars can pass each other autonomously in uncrowded highways. In more congested environments, like a traffic light, a DSMS will be useful for coordinating.

How do we grow into this paradigm? You cannot expect a kindergartener to drive a car, and you cannot expect rigid wireless technologies to coexist adaptively. In both cases, maturation and development is needed. We are mapping a technology development trajectory using Bloom's Taxonomy. Widely used by educators in cognitive development, Bloom's Taxonomy shows the progression from "knowledge," which is the simple memorization of facts, to "evaluation," the mature cognitive and adaptive approach to life. In elementary, middle, and high-school, educators carefully plot the course of these students in subjects such as reading, writing, mathematics, science, and physical education to develop the cognitive and physical skills the children will need to eventually get behind the wheel of a car and adaptively drive down a road. In a similar manner, we are moving quickly toward "evaluation" – cognitive and adaptive use of the spectrum.

In the race for spectrum superiority, America needs to win. The opportunity is now, and we must seize it or be left behind. There are 25 patriot scholars in SMART Hub, with their U.S. citizen students, that are determined and working hard to see this happen. With God's enablement and provision, we look forward to continuing to partner with Congress, our President, and our nation to ensure American superiority. Thank you for the opportunity to testify, and I look forward to answering questions that you have.

SMART Hub: www.spectrumsmart.org

- Commissioned as a DoD Spectrum Innovation Center headquartered at Baylor University.
- Initial Congressional Appropriation funding through the DEVCOM Army Research Laboratory.
- Leadership:
  - Charles Baylis, Director
  - Tom Brooks, Director of Business Development
  - Austin Egbert, Director of Strategic Initiatives
  - Casey Latham, Industry Liaison
  - Doug Sicker, Associate Director
  - Andy Clegg, Senior Research Scientist
  - Robert Marks, Senior Advisor

SMART Hub Functions:
- Research
- Workforce Development
- Testing and Certification

Focus Area	Researchers	Focus Area	Researchers
Policy	Doug Sicker, Baylor (Lead) Andrew Clegg, Baylor	Radar Systems	Yang Li, Baylor (Lead) Batu Chalise, NYIT
Security & Resiliency	Doug Sicker, Baylor (Lead)	Spectrum Coexistence	Michael Buehrer, Virginia Tech (Lead) Dimitriy Garmatyuk, Miami (Ohio) Yimin Zhang, Temple
Economics	Stuart Benjamin, Duke (Lead) Bill Lehr, Consultant	Reconfigurable Circuits	Abbas Semnani, Toledo (Lead) Nima Ghalichechian, Georgia Tech Hjalti Sigmarsson, Oklahoma Dimitrios Peroulis, Purdue
Passive Systems	Andrew Clegg, Baylor (Lead) Steve Reising, Colorado State	Algorithms	Robert Marks, Baylor (Lead) Charles Baylis, Baylor Liang Dong, Baylor
Workforce Development	Rashaunda Henderson, Texas-Dallas Tim Tuinstra, Consultant		
Communication Systems	Zhu Han, Houston (Lead) Jeff Reed, Virginia Tech Nishith Tripathi, Virginia Tech Alireza Vahid, Rochester Institute of Tech. Erik Perrins, Kansas	Propagation	David Jackson, Houston (Lead) Daniel Onofrei, Houston

SMARTHub