FTCN Replay: Metasurface Technology: A Game-Changer for Electronic Warfare

In a recent episode of the "From the Crows' Nest" podcast, host and AOC's Director of Advocacy and Outreach Ken Miller spoke with Dr. Rafael Licursi, author of "Metasurface-Driven Electronic Warfare," about how metasurface technology is revolutionizing electronic warfare capabilities. The discussion explored how this innovative approach allows for greater adaptability and agility in responding to electromagnetic threats in real-time.

Understanding Metasurfaces

Licursi explained that metasurfaces represent a paradigm shift in how we approach electromagnetic properties. Unlike traditional materials where engineers must work with fixed natural properties, metasurfaces offer unprecedented control.

"To understand what would be a metasurface-driven anything, it would be nice to have a clear view about what a metasurface is," explained Licursi. "For example, metal … reflects waves with specific properties and, if we think about that, we can see that we need to accept what nature provides to us."

The key breakthrough with metasurfaces is the ability to control specific properties of a material to fit a required objective: "Now I can use something that I call metasurface and will provide the exact reflection properties that I want. In this way, instead of shaping the final object accordingly, I can define a specific shape that fits my project, my drone, my spacecraft, my aircraft, and then choose the properties of the metasurface that will lead to a final result."

Reconfigurability at the Physical Layer

One of the most significant advantages of metasurface technology is bringing reconfigurability to the hardware level. Licursi described how this represents a major advancement:

“In the last decades, software brought these assets … and now reconfigurability is reaching the hardware, reconfigurability is reaching the physical layer.”

This capability has profound implications for electronic warfare. As Licursi noted, “Instead of creating new systems, designing new systems to counter adversaries, now we can reconfigure existing ones in the speed of light, let’s say being much more effective to counter those adversarial systems.”

Beyond Platforms: Controlling the Environment

Perhaps most revolutionary is the ability to make not just platforms but environments reconfigurable. Licursi highlighted how this approach is already being incorporated into next-generation communications:

“The 6G will use metasurface in the physics level to guide waves, let’s say, within cities. In the 6G, we are going to have metasurface installed over the walls of buildings,” he said. This control extends beyond civilian applications into the military domain, where degrading adversary signals becomes possible through environmental manipulation.

Specialized Systems for Modern Challenges

The conversation touched on how metasurface technology aligns with broader trends in defense technology. Licursi noted, “The trend nowadays is to have distributed, scalable, specialized systems.”

This represents a significant shift from previous approaches:

“After the Cold War, when things became more stable and we believed that we would not have large scale conflicts anymore, there were less reasons to put money on defense … and then we could afford the idea of creating generic platforms that could handle many missions.”

Today’s complex threat environment demands a different approach: “The only solution nowadays is to create specialized counters against specific threats.”

The Future: AI and Metasurfaces Working Together

Looking ahead, Licursi described how artificial intelligence and metasurfaces complement each other in two key ways:

“AI and metasurface, they can work together at different levels. For example, I can incorporate metasurface in a system that’s driven by AI, and the AI will control the metasurface so as to provide specific behaviors that will really bother, that will disturb the functioning of adversarial systems.”

Additionally, “AI is contributing in this area as well. There are some approaches where we can ask an AI model to design the unit cell, making things faster.”

Licursi used an octopus analogy to describe future defense systems: “The tentacles, they are composed by metasurface and kinetic elements, let’s say. And this is controlled by the brain, which nowadays is AI … The strongest force will be the one that can create the cleverest ways of building the octopus as a whole.”

METASURFACE-DRIVEN EW AT AOC EUROPE

Dr. Rafael Licursi will be teaching a workshop on the principles of metasurface-driven electronic warfare on May 5, immediately before AOC Europe 2025 in Rome, Italy. The workshop will connect the dots between metasurfaces and EW. It

will cover not only the so-called metasurface-based stealth technology, but also applications in electronic support, electronic attack, and electronic protection. The workshop will also discuss emerging use cases for distributed EW in drone swarms.