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SATELLITE MOBILITY WORLD

Highlighting Disruptive, New, Mobility-Focused Satellite Ventures and Technologies

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Volume V, No. III March 2020

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Gilat's New ESA: Flying High and Connected

Development and commercialization of flat-panel, cost-efficient, electronically steered antenna (ESA) is an arduous and lengthy process. Today, many companies are pursuing that goal, yet none have achieved it. Gilat is different. In an exclusive live demonstration for *Satellite Mobility World*, we have seen their antenna in action.

On February 12th, over a Webex link between Tel Aviv, and a commercial jet flying at thirty-seven thousand feet over eastern Canada, Gilat showcased their antenna's capabilities.

As the Telesat LEO rose above the horizon, we experienced a live switch over from GEO and the LEO. What we saw was impressive both in terms of image resolution and latency. To see it for yourself, we urge you to view the video of the demo, which is embedded in this interview. Don't miss it.

To find out more about the antenna, its development, and the challenges overcome to produce an ESA, we interviewed Roni Stoleru, VP of Antenna Products and Strategy.

SMW: The complexity of tracking satellite antennas is a non-trivial matter, how does Gilat see the evolution or perhaps revolution of this market?

Roni Stoleru: In today's GEO and NGSO satellite constellations, antenna technologies must support multi-beam, and frequency reuse approaches, as well as simultaneous connectivity to more than a single satellite for seamless handovers.

For multi-satellite constellations such as LEO, beam to beam handover could be as often as every 3 to 5 minutes. In the case of mechanically steered antennas, this would mandate two separate units (since a single antenna can't simultaneously connect two different satellites at two different orbital locations), which implies additional cost as well as weight, footprint and volume occupancy. In the past and still in most cases today, the great majority of tracking terminals are based on mechanically steered antennas.

A fully electronically steered antenna (ESA) is the optimal solution to meet the challenge of multi-frequency reuse and beam switching requirements.

As an added benefit, ESAs open up new markets. Looking at inflight connectivity (IFC) as an example, the ultra-low-profile dimension of an electronically steered antenna opens new verticals such as broadband connectivity to business aviation and general aviation aircraft. Up till now, L-band high gain antennas (HGA) or tail mount antennas (TMA) had to be used on these aircraft.

SMW: Electronically Steered Antenna (ESA) terminals are often touted as the ultimate solution in terminal technology? What are the major advantages?

Roni Stoleru: There are many. Here are a few.

- **Enhanced reliability:** There are no moving parts. Antennas don't track the satellites mechanically. ESAs do beam steering by software reconfiguration, automatically adjusting in near real-time both azimuth and elevation directions.

- **Automatic antenna pointing:** With ESAs, all you need to do is to place the antenna on a rooftop or any fixed or mobility platform, provide power and connectivity to the modem, and the antenna will automatically point to the right satellite and track it. Automation of the installation process eliminates the need for a highly-skilled technician, reducing the total cost of ownership (TCO).

- **Support multiple beams that share the same aperture:** As antenna gain is a function of the effective aperture size, each of the separate beams would enjoy the maximal gain while operating simultaneously. Each of the beams can be steered to different orbital locations, thereby supporting "make before break" switching between satellites.

- **ESAs support flexible and customizable array shaping and scaling:** To conform to restrictive mounting spaces and other than flat surfaces, they can incorporate conformal designs, thereby maximizing gain and performance.

- **Signal amplification is done inside the array itself:** This design improves antenna efficiency and minimizes losses between antenna and transceiver. Such is the case in phased array antennas implemented using designed Radio Frequency Integrated Circuits (RFICs).

- **It has no moving parts:** Lack of moving parts makes the antenna easy to manufacture and assemble, greatly reducing production costs.

GILAT'S ESA DEMONSTRATED ONBOARD HONEYWELL'S COMMERCIAL TEST AIRCRAFT OVER TELESAT'S KA-BAND CAPACITY

SMW: Can you shed light on the challenges entailed in bringing such an antenna to market? Why does it take so long?

Roni Stoleru: First of all, developing ESAs is a highly complicated process. Gilat started the development of this technology many years ago. It takes a lot of time and experience to implement designs for various platforms, applications, and frequency bands.

Secondly, it is not only the RFIC core that powers the antenna that requires significant work. Development should include the design of special radiating elements, transmit and receive arrays architecture, feeding network layers, transmit and receive sub-modules, as well as power and control components to have a fully functioning system.

Finally, a mechanical structure, addressing heat dissipation and weight factors, must also be taken into account. Gilat is one of the few antenna companies that can do all of this in-house.

After overcoming these challenges, we have recently released our 3rd generation RFIC chipset and have demonstrated our Ka-band ESA in various ground and flight test environments.

An example is the ESA terminal that we are developing together with Airbus as part of the CleanSky2 project. In this program, Gilat has designed and manufactured the Ka-band terminal system, including the RFIC, the entire transmit and receive antenna modules, as well as the waveform and modem in use.

Another challenge is that in certain markets, you need to design for the specific environmental and electromagnetic requirements. For example, military-grade antenna terminals must meet mil-spec requirements as well as DO-160G aero antenna requirements. Moreover, our subsidiary, Wavestream, has significant experience in bringing line-fit qualified products supporting both Airbus and Boeing specific standards.

We also need to address the terminal cost. It's key and sometimes an enabler to many new markets and applications.

For example, the design of a low-cost ESA for consumer broadband is quite different from a maritime antenna or a high-performance multi-functional aero antenna. With enhanced manufacturing techniques and an increase in delivery volumes, we could drive production and equipment costs down - making the NGSO powered ESA offering, more attractive.

Power consumption is also a critical parameter in many of the ESA applications. In some remote applications, power is limited and in others, extreme climatic conditions necessitate cooling technology (e.g. with an aero antenna under the radome on a hot day).

Last, I would mention the issues of quality and production. To deliver many antennas to our customers, Gilat has its own antenna production facility where our antennas are being built, tested, calibrated, and delivered to our customers.

Gilat is continuously investing and improving its production lines. Today our facilities both in the USA and in Bulgaria hold the AS9100D certification.

SMW: How do NGSO constellations affect the need and development of ESA?

Roni Stoleru: Unlike with GEO satellites, where tracking antennas are only mandatory for mobility platforms, NGSOs mandate the use of tracking antennas for both mobility as well as fixed applications.

The big promise of the new NGSO constellations is the abundance of capacity that hopefully will drive down bandwidth operational costs, as well as introduce high-quality low-latency communication services.

Looking just at the fixed application, a bundled offering of a low-cost terminal, together with the cheaper bandwidth cost, could revolutionize the ESA technology penetration to many of the traditional parabolic (dish) antenna served markets.

For mobility, having an efficient, low profile ESA that can operate on multiple satellites and constellations, is critical (e.g. 4K video streaming running over high capacity HTS/VHTS GEO satellite and low-latency voice applications running on LEO satellites).

SMW: Last December and then again in February, Gilat demonstrated a first-ever successful operation of its ESA terminal flying on Honeywell's commercial test aircraft over Ka-band capacity on Telesat's high throughput satellite and then over Telesat's LEO-1 satellite. Can you elaborate further?

Roni Stoleru: This demonstration was the first-ever was the first-ever on a commercial aircraft over Ka-band, operating with GEO as well as LEO satellites.

Our primary motivation was to demonstrate the maturity of our Ka-band ESA technology in both ground and aero environments, paving the way for Gilat's upcoming aero ESA, which would be fuselage mountable.

As part of this initiative, we passed a set of safety-of-flight qualification tests successfully delivered the equipment to Honeywell to complete the first Ka-band ESA antenna installation onboard their Boeing 757 testbed aircraft.

During the December 2019 flight demonstration, we performed a comprehensive set of tests such as stable operation under extreme airplane maneuvers, in-and-out of satellite beam scenarios and as it happened, stable operation under heavy turbulence conditions. The system performed well over our expectations, demonstrating gate-to-gate operation.

While cruising at 37K feet, we tested multiple applications concurrently, such as video conferences as well as 4K video streaming from YouTube and including 18 users running various applications simultaneously.

Then, in February 2020, we continued with our testing, over an NGSO. Gilat's high throughput and small form factor ESA operated continuously over GEO then instantaneously switched connectivity to LEO and back to GEO again. The ESA terminal demonstrated high performance, with broadband throughput of up to 58 Mbit/sec on both FWD and RTN, round trip delay as low as 18msec and robust operation at low elevation angles of down to 20 degrees.

SMW: As we move forward, what are the prime applications for ESA, and when do you expect such antenna terminals to be on the market? Where does Gilat fit in with ESA terminals?

Roni Stoleru: We are most pleased with the keen interest that this progress is generating in the IFC market for both a short-term and long-term product. The successful demonstrations were a significant step towards a commercial ESA aero antenna product.

As a result of the successful demonstration, we have already teamed up with one of the leading integrators to introduce a single LRU terminal, which will include the antenna, the adapter, skirt, and radome in a tightly packaged solution.

We plan to showcase this solution at the Satellite 2020 exhibition in Washington D.C. in March, and we welcome interested parties to visit our booth: 1017 and take a look and hear about this exciting offering.

We are already hard at work on our next generation RFIC technology, which will introduce enhanced capabilities to our next generation terminal offering, expected availability in the 2022 timeframe. This antenna architecture will address the unique features of the NGSO constellations, and we plan to have the terminal in time for their start of service.

As we see significant market demand, our goal is to introduce a commercial terminal within 2020. As our technology is now proven, the next step is to package it to the specific vertical market requirements.

About Roni Stoleru:

About Roni Roni Stoleru, VP Antenna Products & Strategy at Gilat is responsible for antenna product roadmap definition and presales support.

Stoleru holds a BSc in Electrical Engineering & Electronics from Ben Gurion University and an MBA in Technologies Management & Information Systems from Tel-Aviv University in Israel.