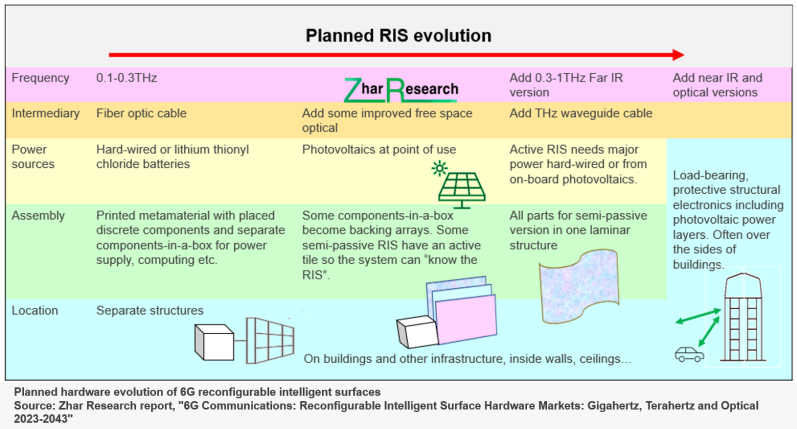
Different 6G Reconfigurable Intelligent Surfaces in Future Architecture

Reconfigurable Intelligent Surfaces RIS enhance and redirect wireless telecommunications with a necessary twenty-year view of this large emerging market given.



Planned hardware evolution of 6G reconfigurable intelligent surfaces
Source: Zhar Research report, "6G Communications: Reconfigurable Intelligent Surface Hardware Markets: Gigahertz, Terahertz and Optical 2023-2043"

LONDON, UNITED KINGDOM , April 4, 2023 /EINPresswire.com/ -- Reconfigurable Intelligent Surfaces RIS enhance and redirect wireless telecommunications. The necessary twenty-year view of this large emerging market is given in the Zhar Research report, "6G Communications: Reconfigurable Intelligent Surface Hardware Markets: Gigahertz, Terahertz and Optical 2023-2043".

It reveals not one but many RIS types and markets ahead. In 5G Communications, they are a curiosity. In 6G Communications they will be essential and needed in many forms deployed in concert, hidden in billboards, covering skyscrapers, as wallpaper indoors and even as transparent window covering if certain research succeeds. Eventually, as structural electronics, they may even make their own electricity in one multifunctional, load-bearing, protective composite.

The dilemma is this. 5G covers a miniscule area of the world and its initial user proposition failed to stop smartphone sales tumbling 12% last year. It will become profitable and more-widely useful. However, satellite communications, not 5G, is starting to cover the whole world albeit at a performance limited by mere GHz frequencies.

6G will provide dramatically better performance than either 5G or these satcoms provided it uses much higher frequencies with no weak links - lower frequencies - in the chain. That means a Phase One around 2030 at 0.1-0.3THz or so followed by a Phase Two around 2035 adding up to 1THz transmission, when that more-difficult technology is ready, to achieve the full promise. For example, developing it for sensing and location, the European RISE-6G program reported

progress this year.

That journey requires improving the transmission range currently achieved at these frequencies and also inserting RIS in the propagation path. Indeed, we also need to boost the newly-huge 6G UM-MIMO base station's performance by including RIS technology.

Initially, RIS in the propagation path will collimate (concentrate like a searchlight), polarise and redirect the beam according to electronic instruction. RIS that amplify and focus beams on moving targets will come later because of cost, power supply and management issues.

Only with RIS can we hope for market-moving 6G user propositions. They include holographic communication and movie downloads that are instant to human perception and Internet of Things as a large, genuinely-additional market for things-collaborating-with-things. Yes, it could also include the smartphone reinvented as a must-have new product.

Let us consider some of the initial progress towards these and other heroic 6G objectives because right now the intended THz beams do not go far enough even to reach a potential RIS to be sent on their way and we cannot cover the world with fiber-optics as intermediary with its clunky interfaces.

Northeastern University, in Nature Electronics (Priyangshu Sen et al, "Multi-kilometre and multi-gigabit-per-second sub-terahertz communications for wireless backhaul applications",) claims routes to THz communication over kilometers.

The fiber-optic intermediary for wireless 6G systems may be simplified by RIS and the same frequency. In the reverse approach, THz 6G systems may be simplified by THz cable intermediary. Both are being developed.

Traditional free-space optical transmission for 6G? Aircision now reports 1.2Tbps over a 1.7 km link. NTTDoCoMo demonstrated reflecting signals with a transparent metasurface film over a window but only at a fixed angle and the 5G frequency of 28GHz This year SK-Telecom did that up to 0.3THz 6G frequencies, calling it "RIS-glass". Reconfigurable versions will follow.

Zhar Research finds that nearly all of the 6G "super-relay" demand will be for reconfigurable versions that redirect signal carriers in real time. To achieve that, you must minimise the reflection mode and the most popular version emerging will be driven by a tiny amount of electricity, little more than a DC bias, by using the magic of metamaterials. Call that semi-passive RIS.

NTT DoCoMo, ZTE, Greenerwave and others are independently demonstrating versions, initially at sub-6G frequencies. ZTE showcases four different types of RIS prototypes, including PIN diode RIS, liquid-crystal RIS, transparent planar RIS and transparent flexible RIS with different pros and cons.

Later will come more-expensive, fully active RIS taking considerable amounts of power to amplify and focus beams onto moving targets and even – a dream – operate client devices lacking on-board power. Such IoT nodes, personal electronics and so on are called battery-free. “Battery-free” creates large markets detailed Zhar Research report, “Battery-free 6G Communications, IoT, Microgrids and Other Batteryless Technology Markets 2023-2043”.

Ericsson refers to the rosy future of “zero-energy” devices. These do not require any batteries or manual charging. There are two ways of achieving this. One is Simultaneous Wireless Information and Power Transfer SWIPT envisaged as a later stage of 6G using active RIS and already demonstrated with laboratory RIS by Sunkyunkwan University. Alternatively, a zero-energy device may employ on-board energy harvesting.

Initially, RIS metasurfaces will involve discrete electronic components on or behind metamaterial patterning and some separate boxes of electronics and operating at around 0.1-0.3THz. To meet the full performance promises and business cases, they must add capability up to one terahertz. Some hope for up to 10THz despite a nightmare of atmospheric absorption bands above 1THz. Zhar Research does not.
Pleasingly, this year, ETH Zurich in Nature (Mohammad Samizadeh Nikoo & Elison Matioli, Nature 614, 451-455 (2023).pages 451–455,). reports successful work on new THz electronic metadevices.

The Zhar Research report, "6G Communications: Reconfigurable Intelligent Surface Hardware Markets: Gigahertz, Terahertz and Optical 2023-2043" finds that, from zero in 2027, a 6G RIS hardware market of around $15 billion will be reached in 2043. The installed cost, software and services, taken together, will be a multiple of that. Questions remain however, such as, “How much does it cost in time and money to persuade the owner of a high-rise building to let you cover it with your electronic surfaces?” Are some of the more wild-eyed researchers right in envisaging that 6G RIS will eventually be able to charge your phone while you use it?

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