GSMA Intelligence

Using RIS to go around, rather than through, obstacles

INSIGHT SPOTLIGHT

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This report is the first part of a new series – called 5G Next – to better understand the next phase of the 5G era and to highlight promising technology innovations that are shaping networks. This report explores reconfigurable intelligent surface (RIS) solutions, which can help with the delivery of cost-efficient 5G deployment and make more economical use of higher spectrum bands in indoor and dense urban environments. The control of radio frequency (RF) signal reflections has now reached a level of development where operators can consider using an intermediate network element between base station antennas and user equipment. RIS innovation can help operators in terms of capex-efficient network densification, operational cost efficiencies (mostly electricity) and increased coverage. Of course, as with any cutting-edge innovation, there are also risks and challenges to consider.

Analysis

The purpose of RIS

By the second half of 2023, most 5G-related discussions had turned to not what 5G can do, but rather how it can be more efficient. Technology vendor R&D departments are pushing hard to improve system efficiency, even rethinking the basic architecture of traditional cellular connectivity.

Reflective surfaces, relays and mirroring are not particularly new concepts, but some vendors are actively trying to refresh the idea of guiding RF signals via new network elements. The timing couldn't be better: against the backdrop of massive 5G investment requirements, operators are actively looking for cost- and time-efficient solutions to densify their 5G networks. At the same time, mobile broadband is expanding into ever higher bands, from 6 GHz up through mmWave bands. Higher spectrum bands, however, raise a new set of questions around propagation. At such frequency levels, it can be easier to go around obstacles than to go through them. This is what RIS solutions can help with: guiding RF signals to where customers need them.

How does it work?

With a new reflection point in between the antenna and the user equipment, network coverage can be significantly improved. This intermediate network element is the RIS. Generally, this will be a pizza-box-sized piece of equipment sitting between the base station and the user device, with surfaces that have reflection, refraction and absorption properties (thanks to many small antennas) and reflective material elements that can be adapted to a specific radio channel environment. What is driving RIS is the technological achievements in programmable materials that can control electromagnetic waves, with key enablers including shrinking form factors of network elements, new materials and advanced network-management software.

There are two main types of RIS: passive and active. While passive RIS reflects a fixed outgoing beam, active RIS achieves beam steering and user tracking, effectively enhancing the coverage range of base stations and ensuring an optimal user experience, even when the user is on the move.

Impact on network economics

While RIS is a relatively new product, early trials and tests (such as the first active RIS trial) give an indication of advantages that operators can expect across four main categories:

- **Capex:** Less capex for network densification is needed, as fewer macro sites or small cells are needed.
- **Sustainability:** Energy efficiency is improved, as there is less need for higher-power solutions for penetrating thick objects, such as walls.
- **Deployment ease:** Time to market is reduced because installation and governmental authorisation are significantly quicker for smaller equipment than a new macro site.
- **User experience:** Better quality of service and customer satisfaction are achieved thanks to fewer gaps in the coverage map.

On the cost side, the introduction of a new network element and building new network management skills always come with their own cost; but maintaining traditional network architecture can cause long-lasting competitive disadvantages.

Although the cost of RIS is expected to be a fraction of a base station, RIS solutions are still expected to have a considerable additional deployment cost since a larger number of RIS elements will be required to cover a specific area. Deployments may also be complicated by the bidirectional near-line-of-sight requirements, need for an unobstructed deployment location and the size of an RIS, all of which can limit the appeal of the technology. However, if network operators would like to solve the issue of coverage holes in a quickly changing environment with high data demand, RIS could offer an alternative solution, complementing existing solutions.

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Implications

Mobile operators

- **Think distributed –** Distributed mobile networks are a collection of smaller independently run networks that can be collectively managed. This distributed design has the potential to deliver better quality, as well as make deployments easier, faster and cheaper, with a significantly smaller environmental footprint. Network analytics and management tools, materials and components are improving rapidly, so localising and distributing networks will become easier and cheaper every year. Distributed solutions are easier to personalise and update, and smaller coverage gaps can be handled with smaller network elements. There are currently three main types of distributed coverage-enhancement solutions: micro active antenna units (AAU), integrated access backhaul (IAB) and network control repeater (NCR). Operators considering any of these options should explore RIS.
- **Consider RIS as part of a broader deployment –** Introducing new network architecture without impacting customer experience can take time, especially if using new spectrum bands. The greatest efficiency gains can be achieved with mmWave in dense city squares, malls, offices, stadia, train stations, factories and warehouses. Passive RIS is cheaper and ideal when the user experience is static, while active RIS can do more but involves added complexity. Ultimately, any RIS solution should be considered as part of a larger mmWave deployment in order to drive commercial efficiencies.
- **Don't heat the concrete –** Propagation characteristics of higher spectrum bands are different from an energy-efficiency perspective. While lower bands can easily penetrate thick walls without significantly losing signal strength, the same wall can easily absorb the majority of higher-frequency signals, transforming them into heat. Most demand for connectivity is generated indoors and traditionally served from outdoors. Thus, the propagation characteristics of these higher-frequency bands encourage network architects to get around, rather than penetrate, thick-walled buildings. Before selecting the technology for their mmWave network, operators should consider energy efficiency and CO_2 emission characteristics and include sustainability as a factor in their decision-making.

Vendors

- **Pick early partners carefully –** Vendors need to select the right network operator partner for their first RIS deployment, as the success of early trials and deployments is essential for a vendor's commercial strategy. A properly communicated successful early RIS deployment is one of the most important commercial tools for a vendor that wants to sell RIS solutions. Before RIS reaches technology maturity and the adoption of it reaches critical mass, customers will not be just a monetisation exercise but also a strategic commercial decision. Selecting experienced, larger operators and those that already own the necessary spectrum and operate in the ideal RIS environment can be critical for successful, long-term commercialisation.
- **Build partnerships with infrastructure suppliers –** Introducing new technologies is never easy in the telecoms industry, especially when it can impact customer satisfaction and quality of service. Mobile operators want to make sure that any new technology is lab- and/or field-tested enough not to impact customer satisfaction. Potential costs/benefits and quality of service are both heavily dependent on the environment where RIS is being deployed. As such, building close relationships and long-term partnerships with building owners and local municipalities is essential for the success of RIS.
- **Explain why RIS instead of other coverage-extension solutions –** Creating an RIS market and convincing operators to include these new intermediate network elements between the antenna and the user equipment requires proof, knowledge and trust. To achieve this, vendors should dedicate significant resources on educating their potential customers on why RIS is different from other more mature coverage-extension solutions such as micro AAU, IAB or NCR. Vendors can even cooperate with each other to educate operators and expand the RIS market together.

Related reading

Vision 2030: mmWave Spectrum Needs

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