TECH OFFER

Smart Wireless Repeater based on Meta-surface for Enhancing 5G Coverage in Urban Areas

KEY INFORMATION

TECHNOLOGY CATEGORY:
Infocomm - Smart Cities
Infocomm - Wireless Technology
Materials - Composites
Electronics - Printed Electronics

TECHNOLOGY READINESS LEVEL (TRL): TRL5
COUNTRY: SINGAPORE
ID NUMBER: TO175387

OVERVIEW

Reconfigurable meta-surfaces have emerged as a game-changing technology for next-generation wireless networks. Unlike traditional phased-array antennas, meta-surfaces manipulate electromagnetic waves through sub-wavelength elements to steer, focus, and reflect signals with very low power consumption. This technology aims to address the critical issue of unsatisfactory outdoor-to-indoor reception quality in 5G networks.

To tackle this challenge, a brand-new smart wireless repeater featuring power-active, high-selectivity, and low-cost characteristics has been developed. It is capable of redirecting and focusing outdoor 5G signals into buildings or basement car parks, thereby enhancing signal coverage, enabling high-quality outdoor-to-indoor 5G communications.

Global meta-surface hardware revenue was approximately US$1.2 billion in 2024 and is projected to exceed US$6 billion by

2033, with annual growth rates above 23.5%. However, commercial products remain limited. Current solutions are either passive, offering limited control over frequency and angle, or active but bulky and energy-hungry.

There is a clear need for high-selectivity, active reconfigurable meta-surfaces that can amplify and direct specific bands or angles for demanding users, alongside passive, low-cost meta-surfaces for power-constrained scenarios. By combining active gain with high selectivity and offering a complementary passive product line, this technology can deliver differentiated value and capture multiple segments of the growing meta-surface market.

The technology provider is seeking collaborators among telcos, building owners or facility managers, and communications equipment vendors.

TECHNOLOGY FEATURES & SPECIFICATIONS

Reconfigurable meta-surface can guide electromagnetic waves to designated indoor zones by shaping their wavefronts, which is suitable for complex and infrastructure-constrained scenarios. However, traditional Reconfigurable Intelligent Surfaces (RISs) typically suffer from two key limitations: (i) signal attenuation resulting from inherent losses introduced by active components and control circuit, and (ii) broadband low-selectivity frequency response, which leads to undesired interaction with adjacent frequencies, thereby degrading signal-to-noise ratio (SNR) and reducing channel capacity.

A novel meta-surface architecture has been proposed that integrates high-selectivity frequency/angle response with signal amplification, featuring:

- Signal-amplified beam steering – Integrated Power Amplifiers (PAs) enable the RIS to redirect weak 5G signals with enhanced amplitude, compensating for losses caused by propagation and control circuitry.
- High-selectivity frequency response – High-selectivity resonators restrict the RIS's frequency response to match only the target 5G band, suppressing out-of-band signals and noise, minimizing interference from adjacent channels, and improving channel capacity.
- Joint frequency–direction beam control – By combining frequency reconfigurability and phase coding, the RIS achieves synchronized control over both beam direction and frequency filtering.
- Low-power, regulation-compliant deployment – With milliwatt-level power consumption (or even zero power) and a compact, surface-mounted design, the RIS system can be flexibly installed in any building.

These capabilities fill a critical gap in current wireless infrastructure deployment strategies and unlock substantial engineering, societal, and commercial value. Major communication service providers, as well as households seeking to enhance communication quality, can become potential users.

POTENTIAL APPLICATIONS

Mobile network operators (MNOs), enterprises (e.g., smart factories, warehouses), automotive radar suppliers, satellite service providers, and IoT solution integrators are primary target markets. Secondary segments include defense/aerospace for stealth or conformal antennas, and healthcare for low-power connectivity.

Collaboration is planned with a competitive local exchange carrier, who expressed interest in testing RIS panels for indoor 5G coverage. A prototype will be provided by the technology provider, demonstrating >20 dB reflection gain and remote configurability.

Enhancing wireless signal coverage in basements is another key application scenario, particularly for enabling reliable mobile payment of parking and charging fees. In such cases, the demand for high-quality communication is especially urgent. Consequently, electric vehicle manufacturers also represent a potential user group.

MARKET TRENDS & OPPORTUNITIES

Market Size & Growth: Verified Market Reports values the global RIS hardware market at US$1.2 billion in 2024, expecting it to reach US$6.5 billion by 2033, with a CAGR of 23.5%. Reports by Market Research Intellect project a similar trajectory, estimating US$1.5 billion in 2024 and US$7.8 billion by 2031. The metamaterial antenna market is also growing, from US$1.2 billion in 2024 to US$3.5 billion by 2033.

5G and emerging 6G networks require energy-efficient beam steering to overcome millimeter-wave losses. Smart cities, autonomous vehicles, and Industry 4.0 applications demand adaptive surfaces for connectivity and sensing. Regulatory bodies such as ETSI are developing RIS standards. Self-assembly and nanoimprint manufacturing are maturing, promising large-area, low-cost production.

UNIQUE VALUE PROPOSITION

Impact on Industry Needs: Active RIS offer enhanced coverage, capacity, and reliability for MNOs and enterprises, reducing the number of base stations and lowering energy consumption. Passive versions extend connectivity to devices and locations without a power supply. Combined, they enable green communications and support new services (e.g., indoor navigation, integrated sensing & communication).

Production Costs & Adoption: Passive RIS costs are estimated at SGD 100–200 per square metre, while active RIS, including amplifiers, may cost SGD 800–1,000 per square metre. Adoption costs include integration into existing networks and software upgrades but avoid the need for expensive phased arrays or additional base stations. The return on investment comes from energy savings and improved service quality.

High-Selectivity Active RIS: Each unit cell combines a tunable resonator with a power amplifier and digital control, enabling continuous 0–360° phase control, frequency band filtering, and adjustable gain. An embedded AI controller optimizes patterns in real time for specific user beams and frequency channels.

Passive/Low-Cost Meta-Surface: Utilizes PCB fabrication or 3D printing technologies; panels require no external power. Large-area fabrication via self-assembly reduces cost while maintaining >90% reflection efficiency.