Intelligent surfaces signal better coverage

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Reconfigurable intelligent surfaces (RISs) on buildings could significantly improve communication network coverage. The RIS system could eliminate blind spots by redirecting signals that would otherwise be blocked by buildings. Credit: KAUST, Mustafa Kishk & Maha M. Kamal

A mathematical model shows specialized reflective panels could be deployed on a large scale to enhance communication networks in urban areas.

Specialized reflective panels located on top of buildings and deployed widely across a city could significantly improve network coverage, shows a KAUST modeling study.

Next-generation cellular networks (5G and beyond) will provide communication coverage to wider rural areas, while improving data exchange rates to meet rapidly rising demand. In urban areas in particular, obstacles in the form of buildings and other structures can impede wireless communication links, reducing mobile device signals and slowing data exchange.

Research has shown that reconfigurable intelligent surfaces (RISs) hold great promise as a technology for eliminating communication "blind spots" caused by blockages. RISs are specially designed surfaces comprising multiple reflective elements that can modify and redirect incoming signals, allowing for better control and performance over an entire communication network. RISs can be opaque or transparent, and they are well established in terms of their energy efficiency and effectiveness at manipulating signals. An RIS system can use both localization and beam tracking technologies to pinpoint a user's location and to follow their device—even if they are moving in a car at high speed.

A communication scenario in an urban area before the deployment of RISs that shows how one user does not have a line of sight with the base station. Credit: KAUST; Mustafa Kishk & Maha M. Kamal

"The RIS system and the way it reflects signals has been thoroughly studied in the literature, leading to various useful mathematical models," explains postdoc Mustafa Kishk, who conducted the study with his advisor Mohamed-Slim Alouini. "We used one of these well-established models for RIS behavior in our system setup. Then, using a mathematical tool called stochastic geometry, we created a large-scale system that distributes RISs at random on the faces of buildings. We then analyzed the probable coverage gains under different scenarios."

The results demonstrate that RISs can dramatically improve coverage in areas with blind spots. At a density of 300 blockages per square kilometer, the researchers found that only six RISs would be needed per kilometer to significantly enhance coverage. However, if the blockage density rises to 700 per kilometer, the system becomes inherently far more complex, and an estimated 490 RISs per kilometer would be needed.

"An interesting question still to be answered is whether there is an optimum number of RISs that can be deployed in any one area before they begin to interfere with one another," says Kishk.

"Our model can be used to anticipate the performance of any given large-scale network," adds Alouini. "We believe it will provide accurate, rapid assessments of potential real-world RIS applications. We could see RISs deployed in 6G networks, possibly in a decade."

More information: Exploiting Randomly-located Blockages for Large-Scale Deployment of Intelligent Surfaces. arXiv:2001.10766 [cs.IT] arxiv.org/abs/2001.10766

Mustafa A. Kishk et al, Exploiting Randomly-located Blockages for Large-Scale Deployment of Intelligent Surfaces, *IEEE Journal on Selected Areas in Communications* (2020). DOI: 10.1109/JSAC.2020.3018808

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