Top Level Newsletter: Connected Vehicle

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Vol 37: This issue includes an article on B5G/6G mobile communications and networks. The final article, which is unrelated, relates to Electric Vehicles.

(1) B56/6G Communications Challenges
(2) Reconfigurable-Intelligent-Surface-Assisted B5G/6G Wireless Communications
(3) The Electric Vehicle is Not Enough to Decarbonise Road Transport.

General Notes
This series of newsletters is intended to provide the IEEE member with a top level briefing of the many different subjects relevant to the research, development and innovation of the connected vehicle.

The objective is to provide a platform for fast learning and quick overview so that the reader may be guided to the next levels of detail and gain insight into correlations between the entries to enable growth of the technology. Intended audiences are those that desire a quick introduction to the subject and who may wish to take it further and deepen their knowledge. This includes those in industry, academia or government and the public at large. Descriptions will include a range of flavors from technical detail to broad industry and administrative issues. A (soft) limit of 300 to 600 words is usually set for each entry, but not rigorously exercised.

As descriptions are not exhaustive, hyperlinks are occasionally provided to give the reader a first means of delving into the next level of detail. The reader is encouraged to develop a first level understanding of the topic in view. The emphasis is on brief, clear and contained text. There will be no diagrams in order to keep the publication concise and podcast-friendly. Related topics in the case of Connected Vehicle technology, such as 5G cellular and the Internet of Things will be included. The terms Connected Vehicle and Automated Driving will be used inter-changeably. Articles from other published sources than IEEE that add to the information value will occasionally be included.

This newsletter forms part of the regional Advanced Technology Initiative (ATI) of which connected vehicles form a constituent part. Technical articles solely from IEEE journals/magazines are referred to by their Digital Object Identifier (DOI) or corresponding https link. The link for each article is provided. Those readers who wish to delve further to the complete paper and have access to IEEE Explore (www.ieeexplore.ieee.org) may download complete articles of interest. Those who subscribe to the relevant IEEE society and receive the journal may already have physical or electronic copies. In case of difficulty please contact the editor at kaydas@mac.com. The objective is to provide *top level guidance* on the subject of interest. As this is a collection of summaries of already published articles and serves to further widen audiences for the benefit of each publication, no copyright issues are foreseen.

Readers are encouraged to develop their own onward sources of information, discover and draw inferences, join the dots, and further develop the technology. Entries in the newsletter are normally either editorials or summaries or abstracts of articles. Where a deepening of knowledge is desired, reading the full article is recommended.

1. Mobile Communications and Networks (Wanshi Chen et al)

Published in: IEEE Communications Magazine (Volume 61 Issue 1, January 2023, pp 14-15)

Abstract/Editorial: The evolution of mobile communication is taking 5G forward to achieve its target metrics, and at the same time, providing a sense of what would be possible with 6G. The evolution is enabled by both the advancements of

the existing technology areas and the emergence of newer areas. This issue of the Mobile Communications and Networks Series presents seven different articles to the readers covering both emerging and existing areas. For example, the issue covers emerging topics like reconfigurable intelligent surface and edge intelligence. Similarly, advancements of a few existing topics are also covered, like near field communication for large-scale antenna array, network performance, security aspects of HTTP/2 in 5G service-based architecture, and open radio access network (O-RAN)-enabled heterogenous networks for enhanced video service. The intention is to meet the needs of wider interest groups with the outcome of concurrent research on mobile communication taking place all over the world.

Despite the increasing interest in the application of reconfigurable intelligent surface (RIS) in wireless networks, many daunting challenges still need to be addressed before its potential commercial reality. The first article, the only one of seven articles reviewed, “Reconfigurable-Intelligent-Surface-Assisted B5G/6G Wireless Communications: Challenges, Solution, and Future Opportunities,” is an attempt towards this direction. In particular, the article covers three challenging issues of RIS-aided operation for millimeter-wave multiple-input multiple-output (MIMO) communications: channel state information (CSI) acquisition, imperfect cascaded CSI for beamforming, and co-channel interference coordination. For each issue, after problem formulation, a scheme is proposed to tackle the respective challenge, whose performance and effectiveness are also verified via careful simulations. The article is concluded by presenting some further research issues and opportunities. (271 words)

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2. Reconfigurable-Intelligent-Surface-Assisted B5G/6G Wireless Communications: Challenges, Solution, and Future Opportunities (Zhen Chen et al)

Published in: IEEE Communications Magazine (Volume 61 Issue 1 January 2023, pp 16)

Beyond fifth generation (BSG) and sixth generation (6G) communication provide huge improvements in terms of data rates, reliability, high throughput, and low latency requirements. However, due to the wide deployment of millimeter-wave (mmWave) and massive multiple-input multiple-output (MIMO) technologies, the required hardware complexity and large power consumption become major implementation challenges. In general, large antenna arrays are accompanied by many radio frequency (RF) chains followed by multiple analog-to-digital converters (ADCs). Therefore, as the power consumption of ADCs grows exponentially with the number of quantization bits, reducing the power consumption has attracted considerable attention.

The authors discuss RIS-assisted channel estimation issues involved in B5G/6G communications including channel state information acquisition, imperfect cascade CSI for beamforming design, and co-channel interference coordination, and develop a few possible solutions or visionary technologies to promote the development of B5G/6G.

As a remedy, the reconfigurable intelligent surface (RIS) concept and its various counterparts have emerged as a powerful and cost-effective solution to tackle these challenges. In simple tangible terms, a RIS consists of a large number of abundant reconfigurable reflective elements, which can be divided into active and passive RIS cases. The active RIS can adjust the phase shifts and amplify the received signal attenuated, but cost is expensive. In light of this, we focus on passive RIS in this article. By adjusting the phase shifters (PSs) of passive RIS reflective elements, the incident signals can be dynamically adjusted to support diverse user requirements without deploying additional mobile stations (MSs) or in-cell relay stations. As a result, it has ultra-low power consumption and low-cost hardware compared to that of the amplify-and-forward (AF) relay-

assisted systems relying on active transmission devices or base stations (BSs). From the design and implementation perspective, a passive RIS has attractive characteristics such as having a low profile and being flexible and lightweight; as a result, it can be deployed in existing cellular wireless networks without requiring any change to existing infrastructure, user terminals, as well as operating standards. These significant advantages make RIS a promising research direction for BSG/6G. However, current cellular communications designed and operated based on previous postulates may not be suitable for future RIS-assisted BSG/6G communication services, since optimal control of the RIS is the acquisition of the channel state information (CSI) required for beamforming, and co-channel interference will be inevitable for explosive growth in data storage capabilities and rapid BSG/6G communication. Thus, it is difficult to directly apply previous technologies to RIS-assisted communication scenarios. (413 words)

DOI: https://doi.org/10.1109/MCOM.002.2200047

3. The Electric Vehicle is Not Enough to Decarbonise Road Transport. (Heather Maclean et al)

Published in: IEEE Spectrum Magazine (Volume 59 Issue 11, November 2022, pp 28-33)

The total cost of purchasing and driving one–the cost of ownership–has fallen nearly to parity with a typical gasoline-fueled car. Scientists and engineers have extended the range of electric vehicles (EVs) by cramming ever more energy into their batteries, and vehicle charging networks have expanded in many countries. In the United States, for example, there are more than 49,000 public charging stations, and it is now possible to drive an EV from New York to California using public charging networks.

With all this, consumers and policymakers alike are hopeful that society will soon greatly reduce its carbon emissions by replacing today's cars with electric vehicles. Indeed, adopting electric vehicles will go a long way in helping to improve environmental outcomes. But EVs come with important weaknesses, and so people shouldn't count on them alone to do the job, even for the transportation sector.

Why not? EVs lack tailpipe emissions, sure, but producing, operating, and disposing of these vehicles creates green-house-gas emissions and other environmental burdens. Driving an EV pushes these problems upstream, to the factory where the vehicle is made and beyond, as well as to the power plant where the electricity is generated. The entire life cycle of the vehicle must be considered, from cradle to grave. When you do that, the promise of electric vehicles doesn't shine quite as brightly. Here we'll show you in greater detail why that is.

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Conclusion: EVS present both a challenge and an opportunity. The challenge could be hard to manage if EVs are deployed too rapidly–but rapid deployment is exactly what is needed to meet climate targets. These hurdles can be overcome, but they cannot be ignored: In the end, the climate crisis will require us to electrify road transport. But this step alone cannot solve our environmental woes. We need to pursue other strategies.

We should try as much as possible, for example, to avoid motorized travel by cutting the frequency and length of car trips through better urban planning. Promoting mixed-use neighborhoods–areas that put work and residence in proximity–would allow more bicycling and walking.

Between 2007 and 2011, the city of Seville built an extensive cycling network, increasing the number of daily bike trips from about 13,000 to more than 70,000–or 6 percent of all trips. In Copenhagen, cycling accounts for 16 percent of all trips. Cities around the world are experimenting with a wide range of other supporting initiatives, such as Barcelona's superblocks, regions smaller than a neighborhood that are designed to be hospitable to walking and cycling. Congestion charges have been levied in Stockholm and London to limit car traffic. Paris has gone further, with a forthcoming private-vehicle ban. Taken together, changes in urban form can reduce transport energy demand by 25 percent, according to a recent installment of the Sixth Assessment Report from the Intergovernmental Panel on Climate Change.

We should also shift from using cars, which often have just one person inside, to less energy-intensive modes of travel, such as public transit. Ridership on buses and trains can be increased by improving connectivity, frequency, and reliability. Regional rail could supplant much intercity driving. At high occupancy, buses and trains can typically keep their emissions to below 50 grams of carbon dioxide per person per kilometer, even when powered by fossil fuels. In electrified modes, these emissions can drop to a fifth as much.

Between 2009 and 2019, Singapore's investment in mass rapid transit helped reduce the share of private vehicle transport from 45 percent to 36 percent. From 1990 to 2015, Paris slashed vehicle travel by 45 percent through sustained investment in both public transit and in infrastructure to encourage walking and other human-powered transportation.

Implementing these complementary strategies could ease the transition to EVs considerably. We shouldn't forget that addressing the climate crisis requires more than just technology fixes. It also demands individual and collective action. EVs will be a huge help, but we shouldn't expect them to do the job alone. (815 words)

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