Reaching out for the enterprise with MulteFire

A conversation with Samy Mahmoud,
Professor Emeritus, Faculty of Engineering and Design,
Carleton University, Ottawa

By Monica Paolini, Senza Fili

Sponsored by MulteFire Alliance

Reaching out for the enterprise with MulteFire

A conversation with Samy Mahmoud, Professor Emeritus, Faculty of Engineering and Design, Carleton University, Ottawa

MulteFire makes it possible for enterprises, venue owners and public entities to deploy LTE-based private networks in the unlicensed 5 GHz band, where today Wi-Fi is by far the dominant technology.

In this conversation with Samy Mahmoud, Professor Emeritus of engineering at Carleton University in Ottawa, we talked about how different verticals can benefit from MulteFire, and how MulteFire will coexist with Wi-Fi and, in the US, with CBRS.

Monica Paolini: Samy, how does your work on MulteFire fit with the work you have done so far in your lab in wireless telecommunications?

Samy Mahmoud: In my research lab at Carleton University in Ottawa, in Canada, I have been conducting research, along with my graduate students, in the field of wireless communications and speech processing over the past 35 years. We have worked on 2G systems, 3G systems, 4G, LTE, and nowadays, of course, we work on 5G systems and future 6G systems.

In addition to my research work, I've been a consultant to a number of public organizations in Europe, Asia, North America, and the Middle East in the telecom regulatory field and on spectrum management. I have also been working as a consultant to the industry, including wireless carriers, and to enterprises in a number of verticals which seek to upgrade their IT systems and private telecom access.

One of the problems that attracted our interest in the research lab a few years ago was how to bring the advantages offered by the LTE standard – including high data rates, low latency and enhanced security – in small-cell configurations, in indoor and outdoor communications, and in frequency bands above 6 GHz.

It was then natural for us to consider whether the LTE air interface could replace or augment the Wi-Fi access used in the unlicensed 5 GHz band. Wi-Fi is widely used, and it's the primary occupant of the 5 GHz band.

Could LTE share the 5 GHz band with Wi-Fi on the basis of no-interference or when the spectrum is available? In other words, how could sharing using a multi-priority scheme be implemented in the 5 GHz or in the 3.5 GHz band?

Subsequently, advances were made in the technology of real-time implementation of spectrum access systems, or SASs. It became feasible to implement such sharing with features such as listen before talk, and then to develop algorithms for handover in small-cell network configurations.

Such thinking was a precursor to the introduction of LAA. Now we know it as MulteFire. We didn't anticipate MulteFire at that time. Now it's becoming a reality.

The formation of the MulteFire Alliance gave momentum to the addition of LTE in the 5 GHz band, especially in the outdoor environment and in areas not congested by Wi-Fi usage.

A number of our enterprise clients are considering MulteFire and are asking about its availability and performance. They also ask about LTE in the 3.5 GHz band. Here there are complications which make the deployment of a private LTE network a bit different from a network in the shared 5 GHz band.

Monica: Before we talk about the 3.5 GHz band, let's talk about applications. What does the enterprise want to do with MulteFire?

Samy: Let's look at the features and advantages of LAA and MulteFire. Most organizations want to own and control their private networks because it is deployed in a

small geographic area, typically just a few kilometers or a few miles in length and width. It's typically a specialized geographic area.

Industries that operate in such areas like to have broadband connections above 400 Mbps, which Wi-Fi does not offer. They like to use video and voice over LTE, which is facilitated by a low-latency time in the range of 50 to 100 ms. This is crucial for voice over IP. They like to have low-power small cells to preserve the battery life of IoT devices. They like the ease of installation, plug and play, and minimal engineering effort in setting up the network.

But most of all, they like to be able to support mobility so they can activate autonomous vehicles and other machinery using scheduled actions. Latency time is crucial in these cases. They like LTE technology for what it offers in this sense.

Security mechanisms, such as data encryption and authentication of devices and networks, are crucial in a private network. They enable the enterprise to implement automation in their processes, gain efficiency, enhance their production, and so on. Whatever vertical sector enterprises are in, these are typically the motivating factors.

Monica: Do latency and security differ in the 3.5 GHz band versus the 5 GHz band?

Samy: The 3.5 GHz band does work differently from the 5 GHz band. In the 3.5 GHz band, there are current occupants who have to be protected and have priority of access. These are typically authorized users of applications such as geographic location services, navigation services, various Department of Transport applications, and so on.

In the 150 MHz within the 3.5 GHz band, these users and their applications have priority. They must be protected.

Only when the channels are not occupied by these services can other, lower-priority tiers come in and use the band. Second-tier users must obtain licenses, called priority access licenses, or PALs. These licenses cover roughly half the 3.5 GHz band.

Finally, there is a third tier for general access or, technically, unlicensed access. I said technically because there're still some regulations that would apply to them. Third-tier users still need to access the service through a specific server, called Spectrum Access Server, SAS, that is approved by the FCC and manages the users' access to the spectrum.

This is different from the 5 GHz band, where there are no incumbent licensed users, no licenses, and no spectrum management entity.

Enterprises may not need a license, but they need to register and obtain approved equipment. They need to access the system through the SAS, which typically would be run by an operator and would provide these services to multiple users.

There are more restrictions in the 3.5 GHz band. Potentially, there's more bandwidth available in many areas, but there will be fees to pay to some enterprises that would help in managing the access.

Monica: In terms of applications, would some applications be more suitable for the 3.5 GHz versus the 5 GHz band?

Samy: Yes, indeed. The 3.5 GHz offers potentially better performance and improved latency. Latency could go down from 100 ms to 50 ms. That will allow low-power devices to use the band. In some areas, more bandwidth could potentially be available.

We see the 3.5 GHz band as a potentially beneficial technology for many vertical applications. The benefits may justify the small fees for network management.

Monica: Let's look more closely at MulteFire. How do the requirements vary across different verticals?

Samy: The use of MulteFire varies across verticals.

For example, the energy and mining sector includes oil fields, mines, and power-generating stations, which tend to occupy a footprint of three or more square miles. Many enterprises in this sector would like to own and operate a secure private network that would give them the performance they require to manage their operations – for instance logistics, operating equipment, obtaining output from sensors to make decisions. That's one of the first big sectors moving ahead with private networks in the unlicensed band.

Other organizations that operate within exclusive geographic zones are in the transportation sector, and include airports and

seaports. A major airport I work with is considering the implementation of a MulteFire network. The airport now has Wi-Fi in its passenger areas and offices, mainly to facilitate data communications inside the airport, but it's not used for the aerospace applications.

The airport wants to move to an LTE network to automate many of its processes, to employ autonomous vehicles for transporting freight and luggage, and so on. To do so, it would need to move beyond Wi-Fi into an LTE-based, MulteFire private network.

Whether to do this in the 5 GHz or 3.5 GHz band remains an open question. Any technology that is available in the near future and allows migration to 5G systems is a candidate that this airport is considering.

Monica: Could this airport or other enterprises use both the 3.5 GHz and 5 GHz bands and keep different applications on different bands?

Samy: They could employ both bands simultaneously at some point in the future. There's nothing that prevents them from employing both networks in the two bands. It would lead to some complications in the interfaces, but they could utilize the advantages of both bands.

Monica: Are there other verticals, in addition to transportation, energy and mining that stand to benefit from MulteFire?

Samy: Yes, there are other verticals, such as the education vertical. For instance, university campuses are looking for a network to support facility and physical plant management, grounds and landscape management, surveillance and security applications, and communications for both students and instructors throughout the campus.

MulteFire is a natural candidate to support all these applications. Right now, universities, like everyone else, are using Wi-Fi, which has its own limitations. University campuses would like to go beyond Wi-Fi and expand the range of applications on campus, and to do so they need a private network with LTE capabilities.

Then there are large industrial compounds, where production facilities – perhaps private power stations, warehouses and logistics – create a fairly complex operations system. The combination of services such as automation, autonomous vehicles, event scheduling, voice over IP, and video surveillance will motivate – and in fact is already motivating – enterprises to move toward a private network based on the LTE standard.

Monica: Would the military consider the use of MulteFire for its applications?

Samy: We've recently received an inquiry from one army training base in Europe that is looking at upgrading its internal communications system from an old technology to a new, standards-based one that will permit tactical training using moving vehicles, armored vehicles, and wearable sensing and computing devices for the soldiers in training. Communications, in this case, involve video, voice, signaling, and movement of autonomous vehicles. It is a combination of services similar to what we have seen in the verticals we just talked about and that requires the presence of a private network. This is not a combat network, but a private network that would facilitate the training exercises inside the base.

Monica: In this case, there is no issue with interference, because the network will be deployed in an area controlled by the military.

Samy: Exactly. Right now, they use Wi-Fi for their clerical and office operations. That's also under their control since the military base is in a secluded area. Therefore, they will have plenty of bandwidth to use in the 5 GHz band and as a second- or third-tier user in the 3.5 GHz band.

Monica: Agriculture is another vertical where there is a need for outdoor networks in a well-controlled environment. Is it a good fit for MulteFire?

Samy: Small farms are looking into MulteFire. This is really a crucial, growing market segment. By a small farm I mean farms that have 250 acres on average, not the large, extensive farms that are 2,000 acres or more. Farms with up to 250 acres represent about 90% of farms in the USA and in Canada. Typically, they are family-owned farms, which have relied for the most part on manual farming techniques.

It's becoming increasingly difficult for them to be productive if they ignore the advances in technology, and especially, the so-called smart farming or intelligent farming in which sensors are deployed to measure everything from soil content to moisture and to the condition of the seeds and plants. The sensor output that is

gathered determines the optimum amount and timing of fertilizers, herbicides, and pesticides to be applied. The effort here is to maximize the crop yield to the extent possible.

Manufacturers of farming equipment are producing small combines for small farms. This will make it possible for small farms to adopt smart-farming technologies that have been employed by large farms in a cost-effective way.

This is all coming together and causing small-farm owners to inquire about a network that connects their equipment and their sensors. They're looking for a local solution to enable IoT applications, many of which require data collection from sensors to be fed into the farming equipment that's becoming increasingly available. This is a large market segment which could benefit from a private network.

These small farms are located in areas where the Wi-Fi signal is not in heavy use. In most cases, a small farm is open air and has very few inhabitants – typically the farm family itself and some helpers. Plenty of bandwidth is thus available in the 5 GHz band, and the MulteFire technology offers a low-cost option for farmers to adopt smart-farming technologies.

Monica: In the healthcare vertical there is also a great need for wireless connectivity to support a wide range of applications. Is there a role there for MulteFire?

Samy: The healthcare sector can also benefit from MulteFire. One example is the use of low-power wearable equipment for monitoring vital signs, especially for patients with heart conditions. There, MulteFire devices enable a high degree of mobility, and benefit from the availability of an LTE network with low latency.

We have also received an inquiry from a large residential community for retirees and senior citizens. The community has about 1,200 homes and other facilities, which include a shopping center, and community, entertainment and recreation centers.

Since the safety of residents is of paramount importance, the community is planning to use autonomous vehicles as the main transporting mode for people and goods inside its compound. The community is inquiring about the deployment of a network suited for this. LTE-based MulteFire is an ideal candidate to meet the needs of applications such as autonomous vehicles.

Monica: Across verticals, MulteFire is attractive because, when the enterprise has control over the venue, it also has control over its MulteFire network. And this gives the enterprise performance, reliability and security levels comparable to those in a licensed band. That's a great advantage.

Samy: Exactly. The availability of voice and video is essential, you will always need real-time communications. Hence, you need low latency.

Second, the mobility factor is becoming increasingly attractive for various reasons – including the ability for small and large vehicles to move autonomously. And MulteFire inherits LTE's support for mobility. In addition, you have security and authentication.

When you look at these verticals and try to identify a horizontal plane of applications that cuts across all these verticals, the most common applications are surveillance and security, as they monitor a physical facility using video cameras and voice communications.

Facility and physical plant management can use a network to facilitate movement of personnel and machinery and to monitor conditions of the infrastructure.

Across these applications, we see a common thread that includes wearable devices, fixed IoT sensors, actuators, and devices to monitor and control machinery and equipment, with each vertical having its own specific and additional applications.

Glossary

CBRS	Citizen Broadband Radio Service
FCC	Federal Communications Commission
LAA	License Assisted Access
PAL	Priority Access License
SAS	Spectrum Access System

About MulteFire Alliance

The MulteFire Alliance is an independent, diverse, and international member-driven consortium defining and promoting MulteFire – a cellular-based technology for operating in unlicensed and shared spectrum. The MulteFire Alliance purpose is to support the common interests of members, developers and users in the application of LTE and next generation mobile cellular technology – such as 5G New Radio – in configurations that use only unlicensed or shared radio spectrum. As an open organization, the MulteFire Alliance will collaborate with stakeholders that have an interest in shared unlicensed spectrum. Its goal is to develop technology that will be widely adopted in global standards.

About Carleton University

Founded 75 years ago, Carleton University has grown into a dynamic research and teaching institution with a tradition of anticipating and leading change. From a splendid campus just a short distance from downtown Ottawa, Canada's Capital City, the university provides excellent education and learning experience to its more than 24,000 full- and part-time students at the undergraduate and graduate levels. Its more than 900 academic staff are recognized internationally for their scholarship and cutting-edge research in more than 50 disciplines. Carleton's reputation is built on its strengths in the fields of journalism, public affairs, international affairs, architecture, engineering and high technology. Its students benefit from the interdisciplinary, active, hands-on approach to teaching and research practiced by its faculty members and from the numerous partnerships the university has with the federal government, other universities and private sector partners.

About Samy Mahmoud

Professor Samy Mahmoud served as President and Vice Chancellor of Carleton University during the period 2006-2008, and as Dean of the Faculty of Engineering and Design from 1986 to 2006. He obtained the Masters and Doctoral Degrees in Electrical Engineering from Carleton University in 1971 and 1975 respectively.

Professor Mahmoud won several international awards in recognition of his original research and for innovations that led to technology transfer to industry. He has published over 200 archival and conference papers in telecommunications, Electronics and Optoelectronics in recent years and supervised 40 doctoral and 85 Masters graduate students to completion over the past 35 years. He is the co-author of a major textbook on "Communication Systems Analysis and Design", published in 2004 by Pearson-Prentice-Hall. He served as a senior consultant to major international regulatory and industrial organizations in the telecommunications field.

About Senza Fili

Senza Fili provides advisory support on wireless technologies and services. At Senza Fili we have in-depth expertise in financial modeling, market forecasts and research, strategy, business plan support, and due diligence. Our client base is international and spans the entire value chain: clients include wireline, fixed wireless, and mobile operators, enterprises and other vertical players, vendors, system integrators, investors, regulators, and industry associations. We provide a bridge between technologies and services, helping our clients assess established and emerging technologies, use these technologies to support new or existing services, and build solid, profitable business models. Independent advice, a strong quantitative orientation, and an international perspective are the hallmarks of our work. For additional information, visit www.senzafili.com, or contact us at info@senzafili.com.

About Monica Paolini

Monica Paolini, PhD, founded Senza Fili in 2003. She is an expert in wireless technologies and has helped clients worldwide to understand technology and customer requirements, evaluate business plan opportunities, market their services and products, and estimate the market size and revenue opportunity of new and established wireless technologies. She frequently gives presentations at conferences, and she has written many reports and articles on wireless technologies and services. She has a PhD in cognitive science from the University of California, San Diego (US), an MBA from the University of Oxford (UK), and a BA/MA in philosophy from the University of Bologna (Italy).

© 2019 Senza Fili. All rights reserved. The views and statements expressed in this report are those of Senza Fili, and they should not be inferred to reflect the position of the sponsors or other parties involved in the report. The document can be distributed only in its integral form and acknowledging the source. No selection of this material may be copied, photocopied, or duplicated in any form or by any means, or redistributed without express written permission from Senza Fili. While the document is based on information that we consider accurate and reliable, Senza Fili makes no warranty, express or implied, as to the accuracy of the information in this document. Senza Fili assumes no liability for any damage or loss arising from reliance on this information. Trademarks mentioned in this document are the property of their respective owners. Cover page photo by manine99/Shutterstock.