

# Understanding **LTE-Unlicensed**



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## Editor's Note

By Sue Marek

Editor-in-Chief /// *FierceWireless*

At the Mobile World Congress trade show in Barcelona earlier this year, a hot topic of discussion was how and when wireless operators should deploy LTE over unlicensed spectrum. The idea of deploying LTE in unlicensed airwaves holds great promise for operators because it allows them to increase capacity without having to spend billions on licensed spectrum.

Operators like Verizon have tested the technology and the company said it plans to deploy LTE Unlicensed technology in the 5 GHz and 3.5 GHz bands starting in 2016. Likewise, T-Mobile announced this year that it too will deploy what it calls Licensed Assistance Access (a form of LTE-U) in the 5 GHz band in 2016.

Despite the bullish attitude of operators like Verizon and T-Mobile, there are still many concerns about whether Wi-Fi and other devices that use unlicensed spectrum can coexist with LTE-Unlicensed and LAA protocols. Wi-Fi is a pretty big user of unlicensed spectrum and Wi-Fi providers worry that LTE won't employ the Listen-before-Talk (LBT) protocol that Wi-Fi uses to avoid interference.

Proponents of LTE-U, meanwhile, insist that the

technology has a spectrum-sensing capability that can identify open frequencies not occupied by other unlicensed users. They also say that LTE-U has "adaptive duty cycle" that allows it to take turns with other users.

T-Mobile told *FierceWireless* contributor Colin Gibbs that the company is looking at protocols like LBT and Dynamic Channel Selection, which are used by LAA, to help ensure LTE co-exists with Wi-Fi, but said it's a bit early to have a discussion about specific technical capabilities of the protocols.

Qualcomm, which is a big proponent of LTE-U, has conducted many tests to on its LTE-Unlicensed product and recently said that it ran even more tests to show that LTE-U not only plays nice with Wi-Fi, but it also protects Wi-Fi to a greater degree than Wi-Fi protects itself. In a filing with the FCC, Qualcomm said that all three versions of LTE Unlicensed, including LAA and its own branded MuLTEfire product, will successfully share spectrum with Wi-Fi.

Nevertheless, the debate continues. In this ebook from *FierceWireless*, we explore the pros and cons of deploying LTE-Unlicensed. ■



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# LTE-U Attracts Controversy and Industry Support

*LTE-U is winning operator interest but concerns of Wi-Fi interference still linger.*

By Jason Bovberg

Demand for spectrum will only increase as more and more wireless devices proliferate around the world, requiring greater and greater bandwidth. Experts say that the wireless networks of the future will require 1000 times today's capacity. One way wireless operators meet these burgeoning capacity demands is by using unlicensed LTE spectrum, otherwise known as LTE-U, or the 3GPP-standardized version of LTE-U, License-Assisted Access (LAA).

Vendors are currently testing LTE-U technology as a way to improve coverage and overall network performance by using a combination of licensed and unlicensed spectrum—in essence, adding unlicensed spectrum as a supplement to licensed-spectrum LTE. Still in its testing phase, LTE-U is nevertheless poised to make a splash in mobile communications.

## What will deployment look like?

Experts agree that the deployment of LTE-U is a

foregone conclusion: The technology has attained a good amount of industry support, from Qualcomm and Ericsson on the vendor side to Verizon and T-Mobile on the operator side. Prospects are strong but analysts are divided about how large a rollout there will be of LTE-U.

“Almost all of the major small-cell vendors have promised to add this capability to their products within the next 12 months,” said Ed Gubbins, senior analyst, wireless infrastructure, Current Analysis. “They don't typically pursue commercializing technologies with that kind of near-term commitment and near-unanimity without getting genuine interest from operators.”

Nadine Manjaro, lead analyst, Maravedis-WBA, sees the rollout of LTE-U as a limited affair. “Deployments will be limited to provide indoor coverage, due to the smaller coverage radius of the 5GHz band.” Such installations will focus on small-cell deployments.



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Ahmed Ali, Research Analyst, ABI Research, agrees that deployment will initially focus on indoor locations using small cells. “The main targets are enterprise and public venues that have high data traffic. These locations are already covered by Wi-Fi. To deploy LTE-U small cells in such locations, operators need venue owners’ permission and collaboration. If venues believe LTE-U might cause a possible disruption to their Wi-Fi networks and their customers’ experience, they won’t support it. So, I believe winning over those players is crucial to drive large scale LTE-U adoption.”

“LTE-U deployments will be limited until it is proven that there will be no interference with Wi-Fi,” Manjaro agreed.

One big factor influencing the pace of LTE-U rollouts is the pace of finalizing technology standards. “Some vendors have promised to have products supporting LTE in unlicensed spectrum this year,” Gubbins said. “But those early products aren’t likely to be deployed in some countries, because some regulators require that the technology include a Listen Before Talk (LBT) feature that guards against LTE interfering too much with Wi-Fi.”

That LBT feature isn’t expected to be finalized in industry standards for LTE-U until first-quarter 2016. “Where regulators don’t have that requirement (the U.S., China, Korea, India), you could see early adopters deploy the technology,” Gubbins said. “Where they do have that requirement (Japan, parts of Europe), deployment is likely to come later.”

It’s difficult to say how widely LTE-U will be deployed. In one respect, it’s a subset of how widely small cells will be deployed. Small-cell deployments have been climbing recently, but they have generally disappointed earlier expectations of speed and volume.



**“LTE-U deployments will be limited until it is proven that there will be no interference with Wi-Fi.”**

NADINE MANJARO, LEAD ANALYST, MARAVEDIS-WBA

Bottom line? So far, operators who have shown interest in LTE-U/LAA are only testing and haven’t declared future plans to adopt the technology. Verizon and T-Mobile US are the only operators committing to commercial deployments, even using pre-standard equipment, if available. “Unless the FCC rules against LTE-U deployments,” Ali said, “I believe that Verizon and T-Mobile will continue with their rollout plans, but they will probably be limited, small-scale networks. I don’t expect many operators to commit to commercial deployments before the 3rd Generation Partnership Project (3GPP) standard for advanced mobile communications is fully defined and mobile device support becomes available.”

### **Will LTE-U lead to significant cost savings?**

Some in the industry predict that operators can feasibly save money by moving into unlicensed territory, but



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how much? And would this happen in the short or long term?

“LTE-U can drive savings in two ways,” said Ali. “Saving on licensed spectrum by allowing operators to expand their capacity using free unlicensed spectrum, and saving on carrier Wi-Fi network integration. However, operators’ reliance on unlicensed spectrum is limited and won’t affect future plans to acquire and utilize licensed spectrum, so I don’t see major savings in this aspect.” As for the advantage over building a Wi-Fi network, the operator would still need to build an LTE-U small cell network, which in terms of equipment cost is more expensive than Wi-Fi.



**“Almost all of the major small-cell vendors have promised to add this capability [LTE-U] to their products within the next 12 months.”**

*ED GUBBINS, SENIOR ANALYST, WIRELESS INFRASTRUCTURE, CURRENT ANALYSIS*

Gubbins doesn’t see the debate as one of money, either. “For operators, the primary benefits of LTE-U/LAA are about adding capacity in the face of finite spectrum resources and using a common, unified management for LTE that’s simpler to operate and maintain than converged LTE/Wi-Fi networks. Thus, the benefits aren’t usually framed in terms of direct cost savings.”

In other words, don’t expect operators to be saying, “I don’t need to participate in this expensive spectrum-license auction because I’ve got LAA.” However, in the long term, Gubbins expects the unified management aspect to start yielding some cost benefits over a more bifurcated LTE/Wi-Fi platform. Also, if the expected performance benefits—increased capacity, smoother management, improved visibility into network performance—provide a better experience for users, it could grant economic benefits to operators in terms of increased service revenue and decreased churn.

“As far as saving money,” said Manjaro, “operators will still need to purchase spectrum and equipment for the baseline macro network build-out. They will only use unlicensed in urban or denser areas to fill coverage gaps and increase capacity. In some ways, it will be used similarly to how Wi-Fi is used today. Since there will be limited deployments, it will take some time for the price to be reduced based on volume, so initial infrastructure costs will be high.”

## Wait and see

Ali has yet to find a convincing business model that offers incentive for enterprise and end-user customers to use LTE-U in the presence of free Wi-Fi services. Qualcomm and equipment vendors argue that LTE-U is more efficient compared with Wi-Fi (“which sounds like they’re attempting to replace Wi-Fi!” he said), but if it doesn’t result in a considerable reduction in mobile data prices, it can’t compete with free and already well established Wi-Fi services. ■



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# Revolutionary Technology Demands Revolutionary Testing

By Vivek Vadakkuppattu, VP of Marketing



## Background

Given the comprehensive coverage of LTE-U basics and its challenges throughout the rest of this e-book, we will focus on the impact of this technology from a testing standpoint. Our Wi-Fi roots and performance testing expertise allows us to provide unique insights on this.

## Testing LTE-U

Predeployment testing is always important, but never more so than with new technologies—especially those as revolutionary as LTE-U, where technical coexistence presents significant

challenges, yet is vital its commercial success. Realizing the full potential of LTE-U will require a thorough and greatly augmented test approach.

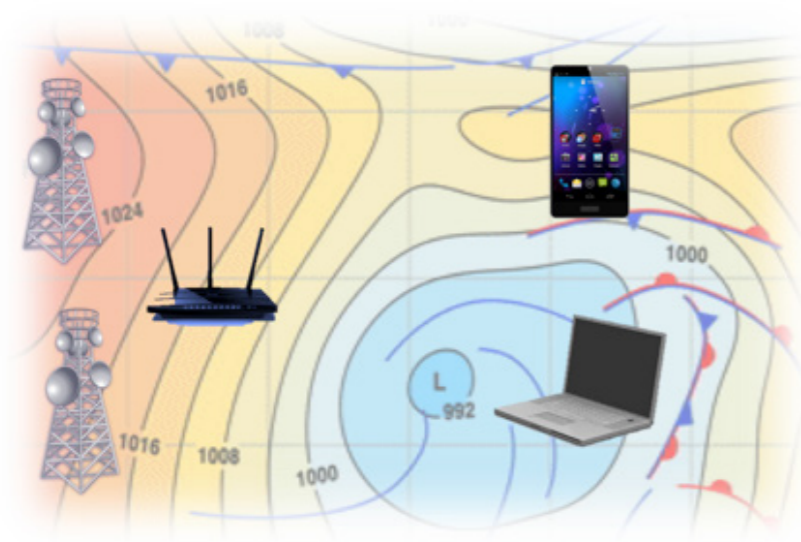
In the very early days of LTE, we saw the LTE vs. WiMax, co-existence vs. competition debate. While cellular and Wi-Fi didn't necessarily start this way, they had been two nearly distinct worlds for a long time. The first sign of convergence was with Wi-Fi offload, where traditional cellular players began look at Wi-Fi as a means to supplement and enhance the overall user experience. The newest evolutionary milestone in this convergence is LTE-U.

Standalone LTE-U performance aside, one of the key areas to test, is the coexistence of LTE-U with Wi-Fi and the overall system performance. Testing technical coexistence in an environment with LTE and Wi-Fi, has to focus not just on mechanisms such as Listen-Before-Talk (LBT) and its variants, but also on overall system performance. Recent studies by the LTE-U forum show that testing overall system performance requires accounting for multiple influencers: the LTE signal, neighboring Wi-Fi access points (AP), Wi-Fi clients and LTE device(s) in a controllable RF environment. Most

of the test solutions in today's world are built for single-link, single-technology applications. While we see this changing due to the additional testing requirements necessitated by LTE-A HetNet, it's important that test solutions also evolve to support the testing requirements of LTE-U.

LTE-U testing demands a controllable, multi-link, multi-technology environment that can thoroughly but easily assess performance. To explore and exercise the fundamental mechanisms in LTE-U, the testing process must make it possible for users to easily create a multiplicity of test cases and scenarios. This includes measuring relevant and practical metrics that provide insights into actual performance. Importantly, all of these testing requirements must be scalable from a time, complexity, cost standpoint.

The logical solution is to develop practical, comprehensive, scalable emulation solutions that address the technical and logistical challenges associated with LTE-U testing. You can no longer rely on single-link, single-technology experiential field testing for LTE-U conformance or performance. Revolutionary technology demands revolutionary testing. ■



## Can LTE and Wi-Fi Coexist in the Same Spectrum Band?

*Although LTE-U is designed to play nice in unlicensed spectrum and avoid interference with Wi-Fi, some in the industry are skeptical.*

By Jason Bovberg

The primary challenge for operators and vendors engaging in the debate about LTE-U will be to prove that LTE-U/LAA can coexist with Wi-Fi in the unlicensed spectrum band. Wi-Fi senses channel activity before starting a transmission and then backs off if the channel is occupied. This technology is called Listen Before Talk (LBT)—a technology that LTE-U doesn't implement. LAA, the 3GPP-standardized version of LTE-U, will presumably solve this challenge and ensure the fair use of spectrum by including LBT. However, LTE-U, as developed by Qualcomm and the LTE-U Forum, does not support LBT.

“Instead,” said Ahmed Ali, Research Analyst, ABI Research, “it uses an algorithm called Carrier Sensing Adaptive Transmission (CSAT), which is a form of time sharing (of the channel). From Qualcomm and other LTE-U proponents' point of view, this is ‘fair,’ but I still believe that there will be a negative impact on Wi-Fi. First, CSAT doesn't sense the channel

before transmitting, so it can still interrupt Wi-Fi transmission; and second, transmission period and resource allocation are completely controlled by LTE-U in this case.”

The promise of LTE-U is shadowed by this coexistence controversy. Although LTE-U is designed to play nice in the unlicensed spectrum and to avoid interference with other existing standards such as Wi-Fi, some in the industry remain skeptical.

### Complementary technology?

Monica Paolini, analyst, Senza-Fila, is the author of the comprehensive report “LTE unlicensed and Wi-Fi: moving beyond coexistence.” She believes LTE-U adds just as much of a burden on the spectrum band as another Wi-Fi access point (AP). In terms of congestion, whether you have Wi-Fi or LTE-U doesn't matter. “Spectrum is what it is,” she said, “and we have to share it.” From this perspective, LTE-U does


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compete with Wi-Fi but in the same way that other Wi-Fi competes with LTE.

“Suppose you have five channels and five users,” Paolini said. “Each user gets a channel. If you have five channels and ten users, each channel has two users, on average. Inherently, in this case, LTE and Wi-Fi compete for that spectrum. But that’s no different from Wi-Fi competing with other Wi-Fi users. So within a channel you might have two LTE-U users, or one Wi-Fi and one LTE user, or two Wi-Fi users, and if you have good coexistence rules you can split the available resources in a fair way.”

What about the operator perspective? “Suppose you’re an operator, and you need more capacity in an airport,” said Paolini. “Do you use LTE-U or Wi-Fi? You can use both, but if you have so much money to cover the airport, some of that money will go to Wi-Fi and some to LTE-U, or it might go only to one or the other, but if they do, the same coexistence rules apply. So in that sense, they compete with each other from an operator point of view.”

## Skepticism remains

It’s worth mentioning that mobile operators have been using “unlicensed” spectrum for Wi-Fi for a long time. “Most traffic that goes over mobile phones is over Wi-Fi—not cellular,” said Paolini. “So, mobile operators are accustomed to using spectrum they don’t own. They don’t have to pay for anything in that scenario. It’s unlicensed Wi-Fi infrastructure—a win-win situation.”

With LTE-U/LAA, however, to use unlicensed spectrum, the operator has to invest in the infrastructure. “It’s fundamentally different from using Wi-Fi to support additional access from a phone,” said Paolini. “The operator has to spend money on the network to support the unlicensed band. This is really where operators have been skeptical.”



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MONICA PAOLINI, ANALYST, SENZA-FILA

Operators can own, manage, and control licensed spectrum as they see fit. Whatever money they spend there, they know that the infrastructure is only for them. When operators invest in unlicensed spectrum, whether Wi-Fi or LTE-U, they’re investing in infrastructure but they can’t control that infrastructure the same way. They must fit in with others who are using that band. The more parties that want to use that spectrum, the lower the performance. So notions such as return on investment (ROI) are more difficult to gauge.


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“Today, an operator might find one channel that they can devote to their own use,” said Paolini, “but they don’t know—6 months a year from now, 5 years from now—who else is going to be sharing that spectrum.”

## Technical challenges

Although the debate is ongoing about whether LTE will “crowd out” Wi-Fi users, Jeff Thompson, CEO of Towerstream, believes the majority of technical challenges have been resolved. “We believe using licensed spectrum on the upstream would make LTE a good neighbor,” he said. “Ultimately, LTE-U will give a better user experience than Wi-Fi alone or LTE Licensed alone. We also think there is a great opportunity for carriers to use the 3.5 GHz band for LTE-U.”

Many of the companies that make LTE chips have a financial incentive to not devalue Wi-Fi, so it’s in many companies’ best interest to make coexistence work. “Our own tests and research have shown that LTE can be a better neighbor than a new Wi-Fi device introduced in the same location,” said Thompson. “With Towerstream’s systems in major urban markets,

we know what channel we are using on our Wi-Fi systems and will have a large advantage to deploy carrier LTE over the 5 GHz band.”



**“Ultimately, LTE-U will give a better user experience than Wi-Fi alone or LTE Licensed alone. We also think there is a great opportunity for carriers to use the 3.5 GHz band for LTE-U.”**

*JEFF THOMPSON, CEO OF TOWERSTREAM*

“The real challenge,” Mike Schabel, VP of small cells, Alcatel-Lucent, said, “is this: If you’re going to use that unlicensed spectrum, how do you do it in a way that’s fair, standardized in a way that everybody can go use it, and doesn’t really change the nature or behavior of the other technologies that are already there? It requires a tremendous amount of collaboration and careful study to get that done properly.” ■



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## Being a Good Neighbor: Mobile Industry Points the Way to LTE-Unlicensed

*Two approaches and small cells drive LTE-U deployments*

radisys



By Renuka Bhalerao

Mobile operators are feeling the strain of our digital lifestyles. Today, the average person carries 2.9 connected devices and that number is growing. Mobile operators' networks bear the brunt of the associated exploding traffic so maximizing spectrum remains a critical strategy for mobile operators for keeping up with the data deluge.

First things, first. Spectrum is expensive. Mobile operators are already implementing LTE-Advanced techniques to add capacity to their networks, without having to purchase new spectrum. However, in addition to leveraging licensed spectrum, operators can also access unlicensed spectrum in the 5GHz band to add even more bandwidth. Currently, 5GHz is used for 802.11n and 802.11ac Wi-Fi connectivity, so being a good neighbor with the Wi-Fi community is very important to avoid congestion and interference.

### Two approaches

To date, LTE has been exclusively deployed on licensed spectrum owned by operators around the world. While licensed spectrum remains a requirement for LTE deployments, operators are beginning to supplement their 'pipes' with unlicensed spectrum to achieve higher performance. This new method called LTE-

Unlicensed (LTE-U) is taking root with multiple trials to prove the technology already underway.

In North America, silicon vendors and mobile operators are taking a 'pre-standardized' approach to LTE-U, delivering proof-of-concepts to get a head-start on LTE-U deployments. This approach is being driven by the LTE-U Forum. In Europe and Asia where spectrum has more stringent regulations, the 3GPP is seeking a 'standardized' approach to LTE-U or LTE-LAA (License Assisted Access) as it's termed. Members have created a work item for LTE-LAA and are collaborating to incorporate it into Release 13, planned for release in March 2016. LTE-LAA will incorporate a better process for avoiding interference with the introduction of 'Listen Before Talk.'

### The role of small cells in an LTE-U world

As LTE-U is an extension of LTE-Advanced, small cells remain central to its deployment. Small cells play a crucial role in global LTE-Advanced deployments, driving carrier aggregation and key interference management techniques.

At Radisys, our TOTALeNodeB™ LTE small cell software, part of our CellEngine™ portfolio, provides our customers with a natural transition

from delivering carrier aggregation in an LTE-Advanced environment to aggregating unlicensed spectrum for LTE-U as well.

TOTALeNodeB's versatility enables both the standardized and pre-standardized approaches to meet our global customers' needs. We are working closely with our silicon partners to deliver a pre-standardized variant of LTE-U. As these silicon vendors adjust their chip offerings, TOTALeNodeB's flexibility allows us to quickly embrace new features. Providing a pre-standardized version of LTE-U with our small cell software allows us to begin proof-of-concepts and support our North American customers now, rather than when the specification is completed. At the same time, we are watching carefully the standards efforts by the 3GPP and collaborating with the ecosystem to support our European customers that prefer to take a standards-based approach to LTE-U.

Leveraging small cells for LTE-U provides a localized approach to carrier aggregation that helps mobile operators stay good neighbors with the Wi-Fi community, while being able to further maximize their spectrum to increase capacity and coverage and ease network strain. Radisys' TOTALeNodeB small cell software is good to know in the neighborhood. ■

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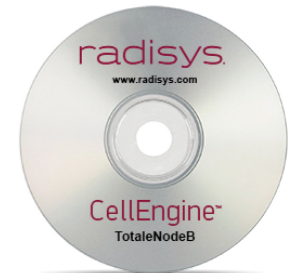
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## T-Mobile and LTE-U: An Early Entrant Goes All-In

*T-Mobile plans to be one of the first carriers in the world to leverage LTE-U sometime next year. The technology could give T-Mobile a chance to gain ground on its bigger competitors, but the move isn't without risk.*

By Colin Gibbs

T-Mobile is positioned to be one of the first mobile carriers in the world to leverage LTE-U when it launches service using unlicensed spectrum next year. The company has confirmed that it expects to begin trials of LTE-U in the second half of this year, and then deploy LTE commercially in the unlicensed 5 GHz band in 2016. The rollout will initially focus on in-building solutions for enterprises and perhaps consumers before expanding to outdoor uses.

While AT&T and some other mobile network operators have taken a more measured approach to LTE-U, T-Mobile clearly believes the technology can help it add capacity and boost network speeds with relatively little investment. The carrier will integrate unlicensed airwaves with its existing LTE spectrum via carrier aggregation, providing an initial connection to the network through licensed spectrum and then using LTE-U to increase network capacity on the downlink. In the short term, at least, aggressively rolling out

LTE-U could help T-Mobile quickly expand its LTE footprint, which is relatively small compared to rivals AT&T and Verizon.

“The deployment of LTE in unlicensed spectrum is intended to complement licensed spectrum deployments,” Zacks Equity Research wrote on its company blog earlier this year in a report on T-Mobile’s plans. “Thus, by using carrier aggregation between LTE in licensed and unlicensed spectrum, operators can considerably augment connectivity and deliver data speeds at rates more than two times quicker than LTE.”

### The LAA flavor of LTE-U

T-Mobile’s trials will use LTE-U enabled small cells from Alcatel-Lucent and Ericsson that have been equipped with small cell system-on-chip (SoC) solutions from Qualcomm Technologies. The service will leverage Licensed Assisted Access, a version of unlicensed LTE that will be addressed in Release 13


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from the 3GPP, which is expected to finalize standards for the technology early next year. The new LAA specifications may not be identical to the LTE-U spec, and may be completed within just weeks of T-Mobile's launch.

One major question is whether the LAA spec will include a feature such as Listen Before Talk, which would prevent it from overtaking Wi-Fi and other technologies that use unlicensed spectrum. LBT is mandated in some markets worldwide, but not in the U.S. T-Mobile insists that Wi-Fi remains a top priority, which is logical considering the fact that the carrier has been a leader in Wi-Fi calling. But while it supports "efforts that enhance fair sharing of spectrum between mobile and Wi-Fi devices," T-Mobile declined to say whether its deployment of LTE in unlicensed spectrum would include LBT.

"(T-Mobile is) looking at protocols like Listen Before Talk (LBT) and Dynamic Channel selection, which are used by LAA to help ensure LTE co-exists with Wi-Fi," the carrier said in an e-mailed response to questions from *FierceWireless*. "It's a bit early to have a discussion about specific technical capabilities of the protocols but overall, (CTO) Neville (Ray) and team see in LAA a new and emerging LTE technology that shows a lot of promise."

## What LTE-U might mean for T-Mo

And while a rollout of unlicensed LTE could be provide a big boost for the company's mobile data business, it may have an even larger impact on its

prospects of merging with another major company. Comcast, Dish Network and Sprint have all been reportedly eyeing the company in recent months, and in each case an LTE-U based service could make the carrier a more attractive partner: In addition to giving the two TV providers an entry into mobile without having to build out their own networks, it enables them to boost viewership outside of the home.

As an early entrant to this new space, though, T-Mobile faces some daunting challenges. Any interference problems with Wi-Fi, Bluetooth or other technologies that use unlicensed spectrum will surely result in a backlash not just from consumers but from companies whose business models are built on Wi-Fi. Any interference problems will only be exacerbated by the rise of the Internet of Things, which is already producing a wide variety of newly connected devices. T-Mobile may also have to find a way to create incentives for users to access unlicensed spectrum rather than traditional airwaves to maximize data offload. And building out a nationwide network of small cells that is free of technical wrinkles won't be pain-free.

Unlicensed LTE technologies are still being developed, and standards are still being completed. So even the end of 2016 might be too early to gauge just how successful these new technologies and services might be. But carriers around the world will be watching T-Mobile and other early entrants as they bring their unlicensed data services to launch. In fact, they surely are already. ■



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