LTE Broadcast Multicast

Rolando Bettancourt, Carnegie Mellon University

The IEEE 5G Initiative Roadmap effort is a collaboration to assist in bringing clarity and direction to a highly convoluted mix of leading-edge technologies. In this regard, LTE Broadcast can be considered both as a technology and as an application.

1. Industry Trends

Point-to-point (PtP) unicast data delivery allows full flexibility for user-specific content, and it is quite effective as long as the number of users is not too large. When the number of users increase and the content they receive is the same, point-to-multipoint (PtM) delivery becomes a much more efficient alternative. Today, mobile broadband (MBB) users are increasingly demanding spontaneous access to high-quality multimedia content —either at home or *on-the-go*— with a more convergent experience across fixed, mobile and broadcast Radio/TV networks. With LTE Broadcast, mobile network operators (MNOs) can deliver to users the same content using the same radio resources [1][2].

First defined as MBMS (Multimedia Broadcast Multicast Service) with 3G services, and later eMBMS (enhanced) with 4G, LTE Broadcast defines two transmission modes: (1) the *single frequency network* (SFN) eMBMS mode and (2) the *single cell* (SC) eMBMS mode. With the SFN mode, multiple transmitters send the same physical signal over the same frequency channel. In contrast, SC-eMBMS allows MNOs to configure each eNodeB (eNB) for a different type of broadcast service operation.

Although mobile broadcasting is not a new concept, finding the right business model has remained quite elusive —having examples of unsuccessful attempts in DVB-H and MediaFLO. For example, it is still unclear how much users will be willing to pay for mobile TV, or if an advertised-financed model can eventually work. As live-video alone does not seem to be enough to create a 100% compelling business case, LTE Broadcast proponents are set to open new business models, so wider use cases are now taking shape. One avenue is to expand LTE Broadcast use cases to the Internet of Things (IoT), with the potential for multicast messaging and content delivery to large groups of cars, sensors, and/or embedded devices. In this regard, there are some straightforward applications such as automatic updates and software/firmware upgrades. Other applications may require greater technical effort, such as the dissemination of broadcast messages in Cellular Vehicular Communications (C-V2X) [3][4] —i.e. messages transmitted by a vehicle in broadcast mode such as basic safety messages (BSM) and cooperative awareness messages (CAM), e.g. emergency breaking. Another avenue to expand the use of LTE Broadcast includes public safety communications, weather warnings, transport information and breaking news. In general, any application where a platform can take advantage of PtM communications is expected to be within the scope.

2. Key Drivers and Business Model Perspectives

The mobile industry is not really growing in terms of new customers, and the existing customers are not showing a higher willingness to pay for new and improved services. Thus, as revenues are not growing, mobile network operators (MNOs) are putting their efforts in squeezing more capacity and value out of their existing spectrum and infrastructure assets.

- LTE broadcast can deliver the same content to multiple users with the potential capability to simultaneously support an unlimited number of users. LTE multicast is a much more efficient way to deliver video as unicast transmission will never be cost-effective for very popular linear broadcast video content.
- LTE Broadcast can provide gains not only by addressing many users at a time. When only a few users share the same content the capacity usage gains can be still quite significant. Dynamically moving users from unicast mode to LTE broadcast and vice versa can be an effective form of network traffic optimization.
- The network investments that are needed for LTE Broadcast are modest, at best: software licenses/upgrades, and two extra core network elements (eMBMS-SC, eMBMS-GW). For example, Telstra Australia claims that costs of deployment can be justified if LTE Broadcast carries only 1% of their network traffic by 2021.
- New 5G verticals could take full advantage with regards to PtM communications, in addition to other techniques aimed at network optimization and operating costs reduction such as Software Defined Networking (SDN) and Network Function Virtualization, which are becoming an important trend.

3. Technology Requirements and Link to 5G

3GPP Release 14 has recently added features to enable mobile networks to deliver broadcast services in a much more efficient way[1]. These new features and modifications have been long time requirements to achieve parity with existing broadcast TV standards (most notably, ATSC 3.0 and DVB-T2).

- Availability of larger OFDM guard intervals to make sure that the PHY layer can support low-density network deployments without excessive SFN self-interference. This overcomes the previous limitations of LTE Broadcast deployments which were focused on delivering media content to contained locations, such as stadiums and concert halls. Having a larger cyclic prefix (CP) of 200us allows for 15 km inter-site distances (ISD), which is a much more appropriate site density for large-scale deployments that may even provide coverage to entire countries [5].
- Extension of the broadcast mode subframe limit from 60% to 100%, which allows greater broadcast-unicast resource allocation flexibility. Moreover, this also enables for broadcast-dedicated frequency channels, including supplemental downlink (SDL) unpaired spectrum.
- Further advances in as eMBMS-operation-on-Demand (MooD) and session continuity for a much more dynamic and seamless operation. With MooD, certain content that is initially delivered over unicast can be turned into an MBMS service when the traffic surpasses a certain threshold and vice versa, becoming a traffic optimization tool.

4. Major Challenges

[1] 3GPP TS 36.211, TS 36.212, TS 36.213 and TS 26.346

Perhaps the greatest challenge is to create ample adoption of the technology by ensuring that LTE Broadcast becomes available in the large majority of top-tier and mid-tier devices (e.g. Apple still does not support LTE Broadcast in its iPhone). At the very least, it is critical that MNOs and device manufacturers do not disable the LTE Broadcast functionality [1].

In addition, regulators should promote convergence and better use of scarce spectrum by creating collaboration incentives between broadcasters, who hold a large amount of UHF spectrum, and MNOs, who hold a large amount of network infrastructure, to work together. By properly defining use cases, requirements and KPIs, and by developing more efficient and transparent session control and bearer management techniques, future network deployment will be able to provide truly hybrid multicast-unicast services with the right application and service layer intelligence.

Finally, a major challenge will still be how to monetize new service models, which is also a challenge for many of the new 5G vertical industries that will emerge in the near future.

[1] LTE Broadcast Alliance [Website: http://lte-broadcast-alliance.com/].

[2] 5G-PPP 5G-Xcast Project [Website: http://5g-xcast.eu/about/].

[3] Qualcomm, "Leading the world to 5G: Cellular Vehicle-to-Everything (C-V2X) Technologies".

[4] 5G Americas, "V2X Cellular Solutions", October 2016 [Website: http://www.5gamericas.org].

[5] R. Bettancourt and J. M. Peha, "On the trade-off between spectrum efficiency and transmission cost in traditional and SFN-based broadcast television," 2015 IEEE International Symposium on Dynamic Spectrum Access Networks (DySPAN), Stockholm, 2015.

Rolando Bettancourt received his B.Sc. and M.Sc. degrees in Electronics Engineering from Universidad Tecnica Federico Santa Maria, Chile, in 2004 and 2006 respectively. Between 2005 and 2006 he worked in iterative demapping and decoding for bit-interleaved coded modulation (BICM) receivers, in collaboration with the Institut National de la Recherche Scientifique (INRS), Montreal, Canada. After spending 5 years in industry, in 2012 he joined the Department of Engineering and Public Policy at Carnegie Mellon University USA for his Ph.D. degree as a Fulbright scholar. His research interests span across multiple aspects of the future of wireless communications and networks such as fundamentals of digital communications, technical standards, radio resource management and spectrum policy.