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| Considerations on Cellular Traffic Offloading Use case in 802.11ah |
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Abstract

This submission considers a few technical requirements for the use case of cellular traffic offloading for 802.11ah.

In order to have successful cellular traffic offloading, it is vital that the technology used for the offloading has at least comparable performance to the cellular system being offloaded both from the user as well as the operator perspectives. Therefore, it is essential to consider what kind of spectral efficiency, user throughput, and system load the current and future cellular networks can and will support, and based on that, consider the performance requirements for 802.11ah. The aim of this contribution is to discuss the offloading requirements for future 802.11ah technology and ensure that the solution is viable from both technical and economical point of view.

# Introduction

In recent meetings different uses cases for 802.11ah have been discussed. Based on the different submissions the compromise use case definition was proposed in [1]. The main uses cases were: Sensors and meters, Backhaul Sensor and meter data and Extended WiFi range for Cellular offloading. In this submission we consider spectral efficiency, user throughput and system load that the current and future cellular networks can and will support. Based on those figures, we derive the set of requirements for 802.11ah. Finally, we compare these requirements with current requirements noted in [1].

# Discussion:

## Cellular Traffic Offloading

When considering cellular traffic offloading we observe that there are basically two main scenarios to perform such function.

*The first scenario* is to relieve operator’s cellular network load especially when it comes to services from which the operator has difficulty to charge extra on top of a monthly fee or it cannot provide significant added value. The first service type is typical internet bulk data; WEB surfing, file downloading, video streaming, etc. that the operator would prefer to eliminate from the cellular network during congestion. In addition, a typical example of the second type of service is voice traffic which is not typically offloaded due to the fact that cellular network’s coverage and mobility support provide a clear benefit for the user, and the operator may charge differently for such service. On the other hand, there are a lot of VoIP based solutions for home and office environments that are utilising WLAN instead of the cellular network, and thus a clear cut between services that are always offloaded and services that are never offloaded is not fully possible.

*The second scenario* is related to the user preference to directly use the Wi-Fi network for certain services instead of the cellular network connection. In such a case, the user may avoid or reduce the cost of data transfer or get clearly better service by connecting to the local Wi-Fi hotspot (e.g. prefer the Wi-Fi AP at home) than connecting to the wide area cellular network.

To establish successful offloading under both scenarios, the performance of the two systems should be at least comparable, both from the perspective of the user as well as the network operator. In the first case, the capacity of the system being used for traffic offloading should provide a clear relief to the operator’s traffic congestion. If the system being used for offloading cannot provide a clear benefit, the operator may be reluctant to invest in such functionality. Even if the system used for offloading were significantly cost efficient, or if its spectrum were free to use, there would be little (if at all) incentive for the operator to support such offloading functionality in case the amount of total system load being able to be moved to the new system were marginal.

From this point of view, the case of the current offloading solution of the existing cellular networks and the Wi-Fi networks is different than the case of future 802.11ah; 802.11g/n is a mature technology with high AP availability and offloading started only after a large number of APs were already deployed. In the case of 802.11ah the offloading would require motivation to roll out a new set of APs and request vendors to provide 802.11ah functionality in mobile devices as part of their Wi-Fi provisioning. Therefore, an alternative strategy for operators to improve their cellular network capacity would be to invest on cellular network capacity or 5GHz Wi-Fi hotspots rather than introducing capabilities to offload traffic to 802.11ah networks.

Additionally, the user should receive similar or at least comparable QoS i.e. in terms of throughput and latency or otherwise the user would be harmed by the offloading functionality. By requiring substantially similar QoS, the latency and throughput requirements are very strict, even when considering the second scenario. Thus, the user, before making any choice, would need to be assured that selecting its preferred technology would not compromise QoS that she/he would receive.

Finally, we note that LTE Rel8 is currently being rolled out to the live networks in many countries. Thus, when 802.11ah technology will be introduced , the LTE Rel8 or even LTE-A will be the cellular technology to which the 802.11ah will be benchmarked. Therefore, in the next section we summarize the LTE performance according to 3GPP.

## LTE Performance:

During the LTE standardization efforts the 3GPP conducted several evaluation rounds for evaluating system performance of the LTE and LTE – Advance for ITU-R submissions. In these evaluations different companies provided simulation results and 3GPP obtained the final results by calculating average of the results provided by different companies.

The results are summarized in Table 1.The number of samples is presenting how many different companies provided results in this simulation environment.The details of those results can be found in [2]. The average and cell edge performance results in a coverage urban environment are presented, where urban macro-cell channel models with inter-side distance of 500 meters are utilized. The system has 10MHz of bandwidth for UL and DL in FDD mode and 20 MHz of bandwidth in the case of TDD as defined in [3] with Rel8 capabilities. These results also assume downlink control overhead spanning over 3 DL symbols out of 14 symbols in 1 millisecond TTI (Transmission Time Interval).

Table 1: Summary of LTE performance evaluation results in Base coverage urban environment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Scheme and antenna configuration** | **Number of samples** | **Cell average [b/s/Hz/cell]** | **Cell edge [b/s/Hz]** |
| **FDD/DL** | MU-MIMO 4 x 2 (C)[[1]](#footnote-1) | 7 | 2.4 | 0.066 |
| **TDD/DL** | MU-MIMO 4 x 2 (C) | 7 | 2.4 | 0.066 |
| **FDD/UL** | Rel-8 SIMO 1 x 4(C) | 12 | 1.5 | 0.062 |
| **TDD/UL** | Rel-8 SIMO 1x4 (C) | 9 | 1.5 | 0.062 |

It should be noted that since the above table shows the results in a coverage urban scenario, the performance results will be significantly improved in other environments e.g. in indoor or micro cellular or when other improvements of future LTE releases (LTE-A) are considered. For example in an indoor scenario the cell average and cell edge results for FDD DL would be 4.1b/s/Hz/cell and 0.19b/s/Hz respectively.

However, as the use case for an extended Wi-Fi range for cellular offloading in sub-1GHz frequency bands would operate potentially in similar conditions, these results provide sufficient evidence on the worst-case offloading performance.

## Requirement for 802.11ah

Considering the requirements defined in [1] for the offloading use case (page 25), we note that the data rate (Aggregate BSS PHY rate) of 20Mbps is quite comparable with cellular network performance, discussed in the previous section, when 20MHz bandwidth in TDD mode is considered. However, table in [1] does not take into account whether these results should be obtained only in an isolated STA and AP case with high SNR or average aggregated BSS throughput in a multi-AP deployment, where a sufficiently large geographical area is covered with a significant number of randomly located STA that are willing to transfer data. Additionally, aggregate BSS PHY rate does not take into account overhead introduced by used multiple access scheme, which is included in Table 1 above.

When considering the use case and properties of sub-1GHz operating frequency, it sounds natural that the requirement is not only valid in a single link environment but, rather the requirement defines the average system capability in a multi-AP environment taking account the used multiple access scheme. One could imagine for instance that an operator could deploy 802.11ah in the same locations as a cellular BTS to avoid site and transport costs and in this way also cover a comparable geographical area with 802.11ah as well as with the cellular system. Therefore, a baseline evaluation environment could be to consider 500 meters inter site distance between APs to evaluate average bit/s/Hz/m2 of different schemes and how the targeted system performance could be achieved.

## Conclusions:

As a summary:

* In the cellular offloading use case the 802.11ah system performance should be close to the cellular performance in order to enable the *first offloading scenario* (offloading non urgent/background data to relieve cellular network congestion)
* In order to enable *second scenario* the user needs to be assured that selecting its preferred technology would not compromise the QoS that she/he would receive.
* If the performance is not sufficient or if the 802.11ah offloading provides only marginal gains and no real additional value for the end user, the offloading might not be successful and operators and end users may prefer the existing solutions e.g. 802.11n and 802.11ac at 5GHz or utilization of cellular network.

## Straw poll:

* In future work of 802.11ah for cellular traffic offloading use case, one evaluation criterion for different offloading schemes should be the average aggregate BSS throughput in a multi-AP deployment taking into account overhead introduced by used multiple access scheme where a set of randomly located APs and STAs is transferring data – Exact evaluation environment is TBD.

# References

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1. [3GPP TR 36.912](http://www.3gpp.org/ftp/Specs/archive/36_series/36.912/36912-a00.zip) V10.0.0, Feasibility study for Further Advancements for E-UTRA (LTE-Advanced) 3rd Generation Partnership Project; Technical Specification Group Radio Access Network;
2. REPORT ITU-R M.2135 Guidelines for evaluation of radio interface technologies for IMT-Advanced
3. [3GPP TS36.331](http://www.3gpp.org/ftp/Specs/archive/36_series/36.331/36331-8e0.zip) V8.14.0 Evolved Universal Terrestrial Radio Access (E-UTRA) Radio Resource Control (RRC); Protocol specification (Release 8)
1. Multi-User MIMO is a mandatory feature of LTE Re8 but is defined under feature group indicators that may have not been fully implemented and tested by all Release 8 devices [4]. [↑](#footnote-ref-1)