

Source: Motorola
Title: Dedicated E-MBMS Deployment in Large Cells
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1. Introduction

It is well known that a network operating in single frequency (SFN) mode enables the delivery of wide-area broadcast services at high spectral efficiencies. Previous simulations have concentrated on scenarios generated for evaluation of unicast transmission where cell radii greater than 1000m are not considered [1]. While relevant for mixed cells, frequency layers dedicated to E-MBMS need not be constrained by the needs of unicast transmission. Therefore large cells, with radii greater than 1000m, can be considered with the objective of minimising the infrastructure required to support broadcast services. However sparse deployments of eNB's can obviously result in degradation of link and coverage performance not only due to increased path loss, but due to the well-known issue of inter-symbol interference induced by insufficient cyclic prefix length to accommodate the increased SFN-composite channel delay spread.

In this contribution we briefly investigate the impact of increased cell size on the maximum supportable spectral efficiency of a dedicated E-MBMS network in SFN mode. Specifically, we assess the impact of L1 parameters, cell radius, antenna height, maximum eNB transmit power and carrier frequency on the maximum achievable spectral efficiency. The contribution is intended to clarify any requirements for a dedicated E-MBMS mode aimed at large cell deployments.

2. Simulation Parameters

The system level parameters used in this contribution were based on Case3 [2] and are summarised in Table 2. A three ring hexagonal grid layout with the eNB's operating in SFN mode was simulated. UE drop locations were confined to cell sites within the second ring, and performance was evaluated over the 1st and 2nd rings (i.e. not only in the centre cell).

For the simulated performance results offered here, inter-symbol interference (ISI) and inter-subcarrier interference (ICI) were taken into account. A dual-antenna UE receiver was simulated, at 3km/h. The performance criterion used here is coverage (%) vs. spectral efficiency (bps/Hz). A user is defined as in outage if the simulated FER is greater than 1%.

3. E-MBMS Large Cell Performance – Dedicated Mode

The performance of the 6-symbol (long CP) reference L1 parameter set with a cyclic prefix duration of 16.67us and 5MHz bandwidth [2] is shown in Figure 1 both for 1km and 5km cell radii. It can be observed that, for 1km cell radius, when the eNB PA is constrained to 43dBm power output and the eNB antenna height is 15m, the achievable spectral efficiency for coverage levels above 95% is in the range 0.3-0.8 bps/Hz. Unsurprisingly, given the eNB radiated power level and antenna height, the coverage for all investigated spectral efficiencies is unacceptably low for the 5km radius cell.

Coverage can obviously be enhanced by increasing eNB transmit power and antenna height, as shown in Figure 1, where the performance for 56dBm radiated power levels and a 50m eNB antenna height is illustrated. However, this requires significantly different site engineering practices from those employed for mixed mode operation, including elevated antenna height and – perhaps most significantly – large increases in BS radiated power levels, potentially leading to coexistence issues that would require further study.

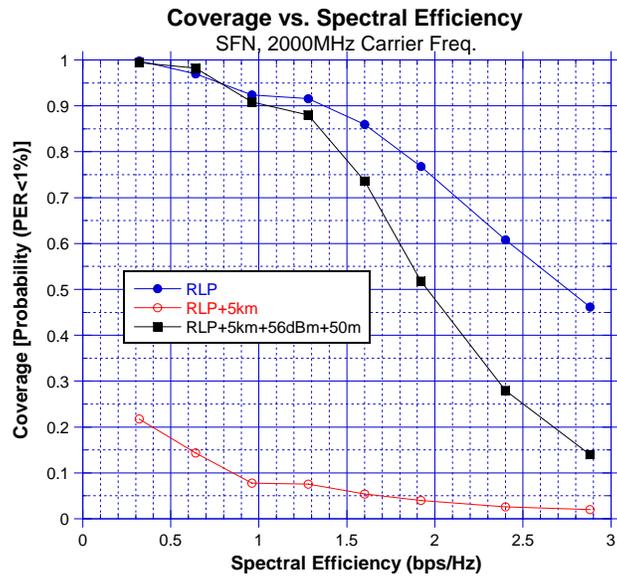


Figure 1 Coverage versus spectral efficiency for both 1km and 5km cell radius, 43dBm and 56dBm transmit power, 15m and 50m antenna height.

4. E-MBMS Large Cell Performance - L1 Parameter Optimisation

Solely in the case of large cell dedicated mode E-MBMS, aside from eNB transmit power and antenna height, frequency band and L1 parameters can be important considerations for deployment.

Table 1 shows the modified L1 parameter sets investigated in this section. The sets were originally proposed in [3] and are denoted MLP1 to MLP5 with cyclic prefix durations ranging from 13.8us to 91.67us. This set of parameters is used for illustration purposes only.

| L1 Parameter Sets | Units | MLP1 | MLP2 | MLP3 | MLP4 | MLP5 |
|-------------------------|--------------|--------|--------|--------|-------|-------|
| Sampling Frequency | MHz | 7.68 | 7.68 | 7.68 | 7.68 | 7.68 |
| FFT Length | | 1024 | 1024 | 1024 | 2048 | 4096 |
| Sub-carrier separation | kHz | 7.5 | 7.5 | 7.5 | 3.75 | 1.875 |
| #Cyclic Prefix Length | samples | 256 | 176 | 106 | 352 | 704 |
| Cyclic Prefix Duration | us | 33.33 | 22.92 | 13.8 | 45.83 | 91.67 |
| # OFDM Symbols Per Slot | symbols | 15 | 16 | 17 | 8 | 4 |
| Symbol Duration | us | 166.67 | 156.25 | 147.14 | 312.5 | 625 |
| # Used Sub-carriers | sub-carriers | 600 | 600 | 600 | 1200 | 2400 |

Table 1 – Reference (RLP) and modified L1 parameter (MLP) sets.

It can be observed from Figure 2 that the choice of L1 parameter set does have an impact on the achievable spectral efficiency and that performance can be further enhanced by operating at lower frequency bands. In particular, the L1 parameters sets MLP4 and MLP5 with larger cyclic prefix durations provide the best coverage in both the 2000MHz and 900MHz scenarios investigated. Note that a complete optimisation of the dedicated mode E-MBMS numerology will require further study including any higher Doppler frequencies identified for E-MBMS deployment scenarios.

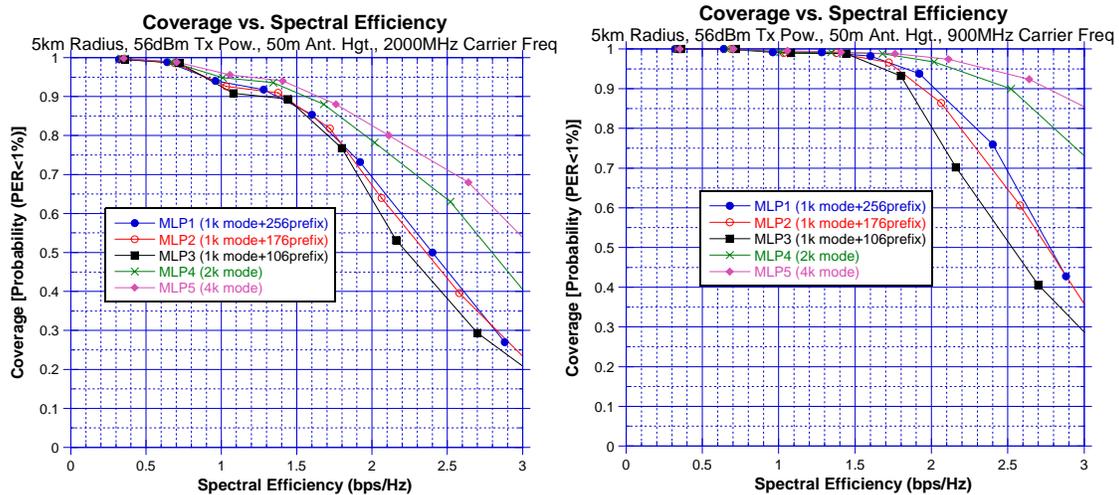


Figure 2 – Coverage versus spectral efficiency for 5km cell radius, 56dBm transmit power, 50m antenna height and both 2000MHz and 900MHz carrier frequency

5. Conclusion

In the prior contribution [2], and as expressed in the subsequently adopted working assumptions, no modification of the existing L1 parameters are necessary for conventional LTE cell dimensions, such as for Case 1, 3 scenarios.

In this contribution, we examined the impact on the achievable spectral efficiency of E-MBMS broadcast services in *large dedicated cells*. In particular the impact of eNB antenna height, eNB transmit power and deployment frequency band are investigated. We conclude that:

- a) if *large cell radii* (defined as radii much larger than the unicast scenarios considered to date) are considered to be valid, improvements in E-MBMS network performance can be achieved by further modifying the L1 numerology,
- b) in order to achieve the target spectral efficiency of 1bps/Hz, large cell dedicated E-MBMS deployments will require significantly different site engineering practices, radiated power levels and antenna heights significantly different from, or in excess, of the assumptions of [2]. This will create coexistence issues which, if such scenarios were to be adopted for assessment, would need to be addressed by WG4. Further discussion of the validity of these scenarios in WG2 would be useful, and operator input essential.

6. References

- [1] R1-061998 , “Observations on Alternative L1 Parameters for E-MBMS”, Motorola, Tallinn, Estonia, Aug.28-Sep.1, 2006
- [2] 3GPP TR 25.814, v.7.0.0, “Physical Layer Aspects for Evolved UTRA”, 3GPP TSG RAN, June 2006
- [3] R1-061847, “Supporting TV broadcast services in LTE (LTE-B)”, Nortel, Cannes, France, June 27-30 2006

7. Appendix – System Simulation Assumptions

| Parameter | Units | Value |
|--------------------------------|-------|---|
| Bandwidth | MHz | 5 (as opposed to 10 assumed in reference [1]) |
| Penetration Loss (PL) | dB | 20 |
| Cell Layout | | Hexagonal grid, 37 cell sites, 3 sectors per site |
| Path Loss | dB | UMTS 30.03 Section B 1.4.1.3 |
| Lognormal Std Dev. | dB | 8 |
| Inter-Site Shadow Corr. Coeff. | | 0.5 |
| Intra-Site Shadow Corr. Coeff. | | 1 |
| Channel Model | | Typical Urban (TU) |
| BS # Antennas | | 1 |
| BS Ant. Pattern | | LTE - R1-050669, Table 2 |
| BS Ant. Gain | dBi | 14 |
| BS Ant. 3dB Beamwidth | degs | 70 |
| BS Ant. Front-Back Ratio | dB | 20 |
| MS Speed | km/h | 3 |
| MS Noise Figure | dBi | 9 |
| MS # Antennas | | 2 |
| MS Ant Gain. | dBi | 0 |
| MS Ant. Corr. Coeff. | | 0 |

Table 2 – Baseline Simulation Parameters