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Title: **Considerations on MBMS Resource Allocation**
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1. Introduction

Since at least multi-cell MCH MBSFN point to multipoint (ptm) delivery of MBMS is agreed as a valid scenario for LTE MBMS, RAN2 is now in a position to progress further the structure of MCCH and MTCH when delivered via the MCH. 3GPP TS 36.300 [1] states that MCH resource mapping can at least be organised on a semi-static basis, with possible dynamic extensions for further study. But this concept requires further evolution and clarification. Clearly, the short-term dynamic signalling applied to the DL/UL-SCH L1/L2 control channel is inapplicable, but it is equally obvious that as MBMS services are added to, or deleted from, a multi-cell MCH transmission, the associated MTCH structures and resource allocations need to be reconfigured, albeit slowly. At the same time, it should clearly be possible to adapt the resources allocated to a particular MBMS service or MTCH. Finally, the outline requirements of [2][3] suggesting a 1s 'channel change time' should be achievable by MCH resource allocation mechanisms.

This contribution discusses means of configuring semi-static MCH, MTCH and MCCH structures in support of these objectives, while still preserving a flexible approach to wide-area and local MBSFN construction. Further principles on MCH and MCCH construction are proposed to guide RAN2's work in this area.

2. MCH Mapping

RAN WG1#47-bis adopted the working assumption that MBSFN-associated subframes be separated from non-MBSFN related subframes on a time division multiplexed (TDM) basis. This adoption of TDM as the basis for MBSFN MCH resource allocation enhances UE power consumption for MCH reception (especially in LTE_IDLE mode) but also permits eNB's to participate in several – possibly local but at least wide-area – multi-cell MCH MBSFN's (i.e. SFA's) by allocating common sets of subframes at each participating eNB.

An example of downlink TDM multiplexing of MBSFN and non-MBSFN subframes appears in Figure 1, with – in this case – the periodicity of the MBSFN allocation pattern equal to 10ms (i.e. a radio frame). Other periodicities are clearly feasible.

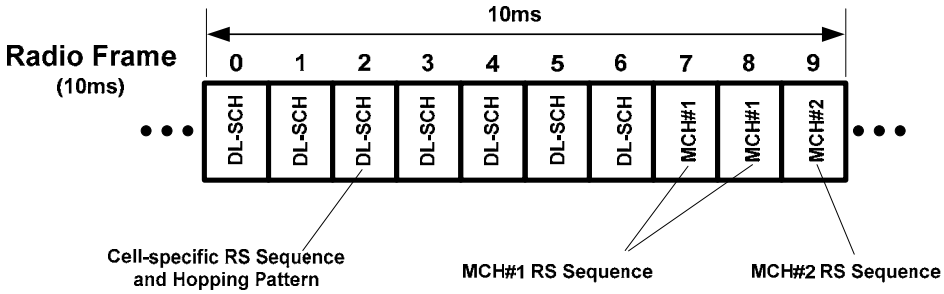

Figure 1 – Subframe type and RS sequence and hopping pattern allocation.

In the figure, a particular MBSFN MCH instance (MCH#1, MCH#2 etc.) in a cell is mapped with a one-to-one correspondence to an individual SFA. MBMS services are mapped – via appropriate MTCH – onto the SFA and corresponding MCH of interest.

Partitioning the downlink physical resource into multiple MBSFN MCH's in this way permits the independent construction of more than one SFA in a cell (e.g. divided into local or wide-area SFA's) while at the same time minimising UE power consumption by requiring UE's to receive only SFA-specific MBSFN MCH-allocated subframes containing the MBMS services of interest to the UE. Further, if required, a single UE can of course participate in more than one SFA.

3. MBSFN MCH Resource Allocation

The allocation of a specific sequence of subframes – plus any additional SFA-specific parameters such as an SFA or 'pseudo-cell' identifier to permit identification of reference symbol (RS) sequences etc. – to an MCH (and its corresponding SFA) must, however, be identified to UE's accessing MBMS services. This suggests the creation of a definition – labelled MCH Subframe Allocation Pattern (MSAP) here – which identifies the set of subframes in a cell allocated to a specific MBSFN MCH, and hence SFA. Note that such an MSAP could be enabled for a finite period in support of dynamic SFA concepts, but would at least include the case where the MBSFN MCH resource allocation is semi-statically configured. This might enable, for example, a phased introduction of MBMS-related features into LTE – i.e. initially static SFA's, followed by dynamic SFA's.

The generation of such an MBSFN MCH Subframe Allocation Pattern can, of course, be performed in a number of ways. One simple example is to associated with a specific MBSFN MCH the set of subframes whose subframe number *SubFN* – derived, say, from the system frame number (SFN) or some other suitable frame index – meets the condition:

$$SubFN_{\bmod K_{MCH_p}} = M_{MCH_p} \tag{1.1}$$

That is, every K_{MCH_p} -th subframe, with an offset of M_{MCH_p} subframes, is allocated to the p -th MBSFN MCH in the cell.

Clearly, alternative MBSFN MCH Subframe Allocation Patterns could be readily specified. For example, 'clusters' (in time) of consecutive subframes could be allocated to a specific MBSFN MCH, or MSAPs could be defined which are congruent with the DL-SCH H-ARQ round-trip time and hence remove from unicast use a single 'H-ARQ process' on a particular unicast/MBMS mixed carrier, and so on.

Note also that, as agreed in RAN1, subframes allocated, for example, to BCH and/or SCH use could be omitted *a priori* in a static fashion from the MSAP. The precise method of indicating the MBSFN MCH Subframe Allocation Patterns to UE's would require further study.

4. MCCH Association with an MCH

As stated above, separating MBSFN MCH's on a subframe TDM basis permits multiple SFA's to be conveniently supported in a cell. UE's could then monitor a single MBSFN MCH, or multiple MBSFN MCH's depending on the MBMS service(s) being accessed. The number of MBSFN MCH's being monitored by the UE could, of course, change with time as MBMS sessions commence and terminate.

Defining a *single* MCCH as the means of transporting schedule and related control information on *all* MCH's (equivalently, SFA's) in the cell would beneficially require UE's to monitor only a single MCCH in order to access MBMS services on possibly multiple MCH's available within a cell. Nevertheless, delivering this single MCCH would require at least one MCH to be promoted as the 'master' MCCH-bearing MCH for all MCH's in the cell. All UE's – whether subscribed to the services delivered on the resulting master MCH or not – would need to access the master MCH. Further, the data rate-bearing requirement for the MCCH on the master MCH would scale as the number of MCH's varied.

As an alternative, each MCH could transport its own MCH-specific MCCH. UE's accessing a single MCH would then only have to monitor a single MCCH delivered on that MCH, but would then lack information on potentially new MBMS services of interest being made available on other MCH's in the same cell. One approach to resolve this would be to deliver MCCH information for *all* MCH's in the cell on *every* MCH-specific MCCH, but clearly this could be inefficient. Another approach would be to simply design – for the purpose of UE power consumption reduction – per-MCH MCCH transmissions to be disjoint, and then require UE's to observe the MCCH transmission on all MCH's on a cell, and then subsequently to only access those MCH's bearing MBMS services of interest to the UE. The resulting regularity and simplicity of the MCCH definition and association with the MCH suggests this could be a preferable way forward.

5. Conclusions

It is proposed that RAN2 support further evolution of MCCH and MCH structures by capturing in TS 36.300 the following working assumptions:

a) an MBMS-mixed carrier frequency may support more than one MCH, where the physical resource allocation to a specific MCH is made by specifying a pattern of subframes, not necessarily adjacent in time, to that MCH. [*The term MCH Subframe Allocation Pattern (MSAP) could be used here*.]

b) in a cell there is a one-to-one mapping between an MCH and an SFA.

c) resource allocation within an MCH is performed using the MCCH, and there is a one-to-one association between an MCH and its associated MCCH.

6. References

[1] TS 36.300 V0.3.1 (2006-11), Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2 (Release 8)

[2] S1-061441, SA1, "LS on Service Requirement for MBMS LTE", TSG-SA WG1#34, Paris, France, Oct. 23-27, 2006

[3] RP-060826, RAN, “Reply LS to SA1 (Cc. SA4) on Service Requirement for MBMS LTE”, TSG-RAN#34, Budapest, Hungary, Nov. 28 – Dec. 1, 2006

[4] R1-070051, Motorola, “Performance of MBMS Transmission Configurations”, RAN WG1#47-bis, Sorrento, Italy, Jan. 15-19 2007