3GPP TSG RAN Meeting #72
Busan, Korea, June 13 - 16, 2016

Document for: Discussion
Agenda Item: 10.1.1

RP-160999

Motivation of new work item proposal on LTE bandwidth flexibility enhancements

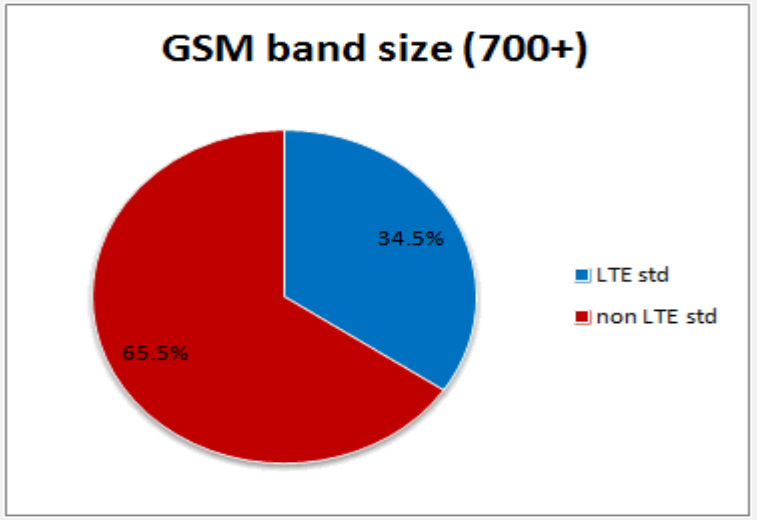
Huawei, HiSilicon

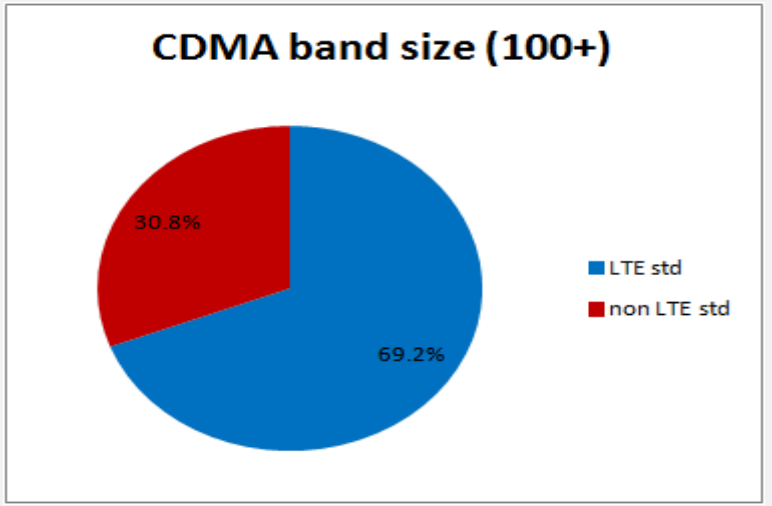
Motivation

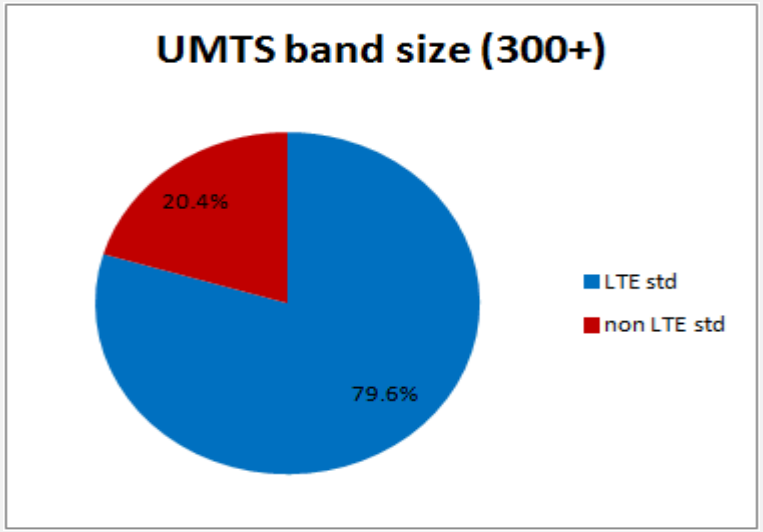
- Parts of the spectrum identified for IMT-advanced are not efficiently utilized by LTE in licensed bands because in certain countries **the channelization plan results in spectrum blocks allocated to an operator that do not exactly correspond to the specified nominal LTE bandwidth sizes supported since Rel-8**. Such cases may also arise when spectrum is displaced/re-farmed from GSM or UMTS to LTE within one operator's licensed spectrum. RAN4 studied LTE bandwidth flexibility enhancements within [1] with the corresponding conclusion captured in 36.740, which shows that there are many non-standard frequency blocks in certain countries.
- **Spectrum allocations across the world show a large variety of non-standard spectrum block sizes** (e.g. 1.8, 2.0, 2.2, 4.4, 4.6, 6, 6.2, 7.8, 7.0, 8.0, 11, 14, 18, 19 MHz):
  - Difficult for 3GPP to address this problem by defining a few new standardized nominal LTE bandwidth sizes
  - The alternative to utilize carrier aggregation within a non-standard block sizes would still not fully utilize the spectrum except in special cases, and would require the addition of many new band combinations
- **Enhancements to LTE should be specified such that the entire licensed spectrum block can be used by the network** with the possibility to schedule different UEs in different parts of the spectrum block, while limiting (or avoiding) any impact on the UE RF, and supporting legacy UEs in a backward compatible way.
- **The advantages of enhancing the LTE bandwidth flexibility are:**
  - **To enable the utilization of operator spectrum asset as much as possible**
  - **To increase the throughput on the available spectrum resources**

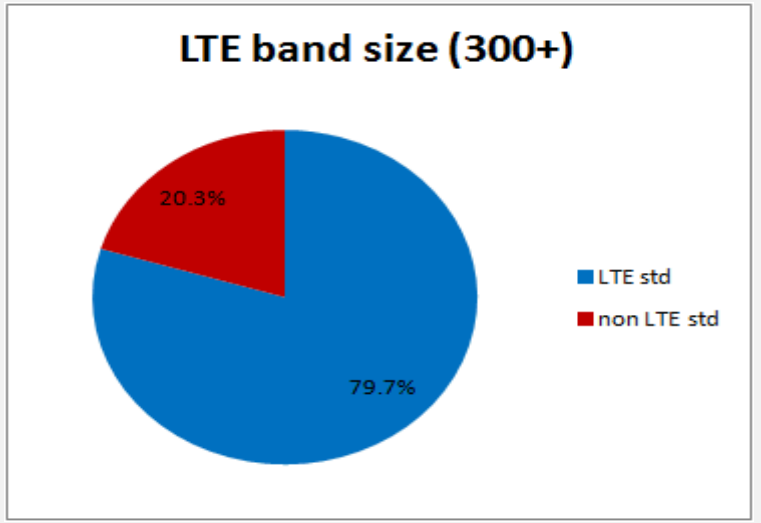
[1] RP-160681 New Study item proposal: LTE bandwidth flexibility enhancements Huawei, China Unicom, China Telecom, HiSilicon

Available Spectrum with Non-standard Bandwidth





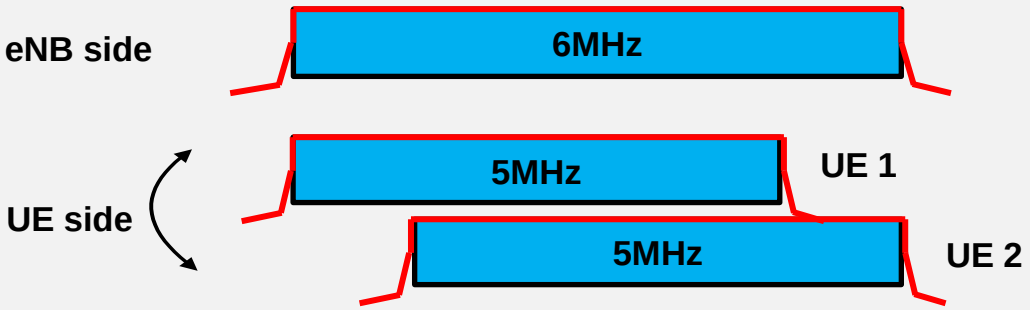




The numbers in brackets are a count of spectrum holdings

Examples of use cases and performance gain

Example of use case: The available spectrum block size is not one of the legacy LTE bandwidths.



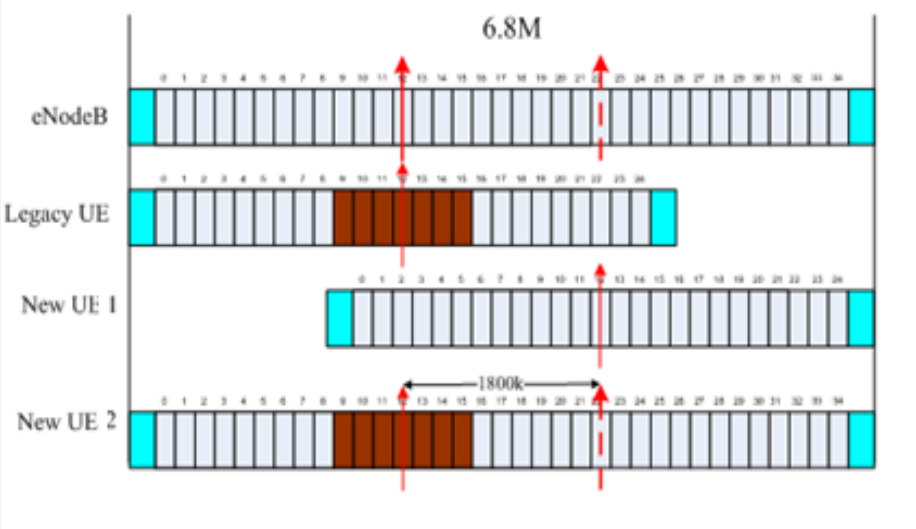
Performance Gain: Example for a 6MHz block

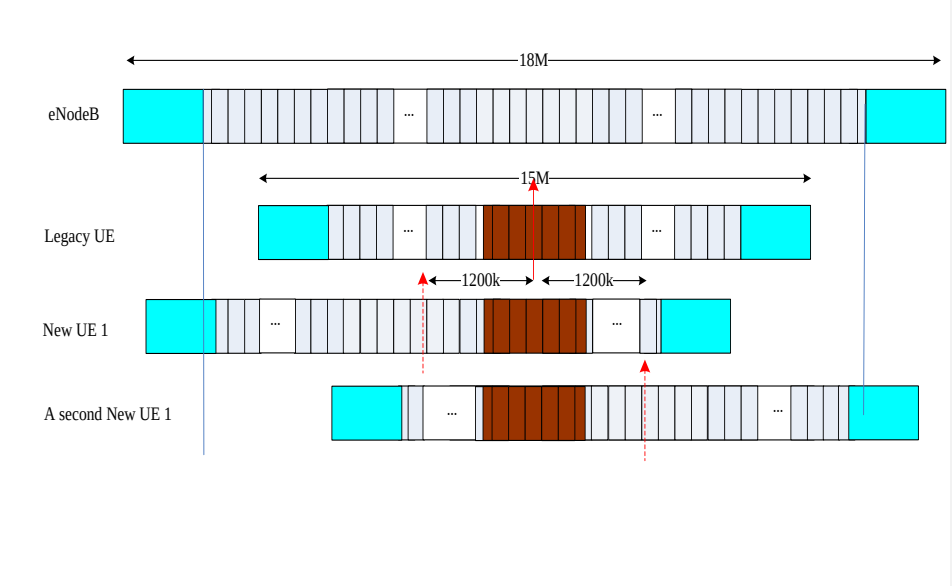
Available bandwidth (MHz)	LTE Baseline 1	LTE with bandwidth flexibility	Network gain (example)
6	1x5 MHz carrier Usable: 4.5 MHz	5.4 MHz (+20%)	20% (5.4 vs. 4.5 MHz)

Available bandwidth (MHz)	LTE Baseline 2	LTE with bandwidth flexibility	Non-CA UE gain (5 MHz filter)
6	3+3 MHz carrier Usable: 5.4 MHz	5.4 MHz (0%)	66.7% (4.5 vs. 2.7 MHz)

Solution for maximizing the bandwidth utilization

- Solution of flexible bandwidth (examples for a 6 MHz or 18 MHz spectrum block size)
  - **Legacy UE**: access 5 MHz of a legacy carrier with a fixed center frequency
  - **New UE 1** : 5 MHz bandwidth with a single RF chain (no hardware impact compared to a legacy UE)
  - **New UE 2** : Full bandwidth but potentially with CA-like solution, and peak data rate can be achieved
  - OFDM mapping and resource allocation to ensure baseband orthogonality with legacy UEs
  - Solutions to receive common control channels should be investigated if the new carrier is configured as a PCell





Objectives of the Work

- The solution should support backward compatible operation of UEs over a legacy carrier occupying part of a non-standard spectrum block.
- In this use case, the objective of this work item is to specify a solution such that UEs (except legacy UEs) can be scheduled for downlink and uplink in the non-legacy parts of the block, under the following constraints:
  1. The eNB operates in the entire N MHz block ($5 \leq N \leq 20$) with a guard band larger than or equal to 10% of the N MHz block.
  2. All legacy UEs operate in the same legacy carrier with a fixed central frequency within the N MHz block and operate as SCell.
  3. A non-legacy UE operates within a configured sub-block of the N MHz block:
     - the sub-block size is one of 3/5/10/15/20 MHz;
     - the sub-block contains the central 6 PRBs of the legacy carrier;
  4. A non-legacy UE and a legacy UE can be scheduled in adjacent PRBs with orthogonal subcarriers.
- The work item will also
  - Specify necessary enhancements for transmission of data and control [RAN1, RAN2]
  - Specify necessary enhancements for RRM measurements for non-legacy UE [RAN1, RAN4]
  - Specify necessary enhancements to the LTE RAN protocols [RAN1, RAN2, RAN4]
  - Specify eNB and UE core and performance requirements [RAN4]
- The solution should allow a non-legacy UE to be scheduled in PRBs of the legacy carrier.
- The solution may allow that CRS are not transmitted in PRBs outside the legacy carrier.
- The solution should reuse LTE design as much as possible.

Note 2: backward compatibility for BS RF is ensured for a block of at least 5 MHz (cf page 7)

RF impact and cell search for legacy UE

- A detailed overview of the impact to the BS and UE RF was provided in RP-141912.
- RAN4 studied LTE bandwidth flexibility enhancements within [1] with the corresponding findings captured in TR 36.740 [2]. In summary:
  - BS RF impact analysis
    - There are different implementations for BS to achieve new channel BW with limited impact on hardware implementation.
    - >= 10% CBW is used as guard band for BS flexible bandwidth.
    - New CBW >5MHz is considered for flexible bandwidth
    - Most of RF requirements can be re-used without change if legacy physical channel are re-used. A few BS RF requirements may need further study if the DL and UL physical channels are not in accordance with the existing (legacy) physical channels.
  - UE RF impact analysis
    - The UE operates in legacy channel bandwidths and no new channel bandwidth will be introduced.
    - No change is needed if the legacy physical channels are re-used. for new UE A few UE RF requirements may need further discussion for LTE BW flexibility enhancement feature if the DL and UL physical channels are not in accordance with the existing (legacy) physical channels.
  - Cell search for legacy UE
    - For legacy UE, the flexible bandwidth is only deployed under a CA deployment as SCell and the PCell using the legacy frame structure and legacy signals;

[1] RP-160681, New Study item proposal: LTE bandwidth flexibility enhancements, Huawei, China Unicom, China Telecom, HiSilicon
[2] R4-164510 , TR 36.740 V0.2.0

Proposed RAN Workplan

- 4 WG meetings for RAN1/2/4 core work
  - From RAN72 (June 2016) to RAN75 (March 2017)

- Performance part until RAN75