R4-166952
Approval

# WF on 256QAM support in UL

Vodafone, Telecom Italia, Orange, Deutsche Telekom, Telefonica, [...]

# Background

- 256QAM in DL was specified in Release 13, and discussions took place on the difficulty for UEs to implement this feature in all bands
- Discussions indicated that high bands were more difficult and that low bands easier, and that a per band feature would mean faster Time To Market (TTM). The interest was in all bands but priority in high bands
- Operators indicated preference on per UE feature (all bands are supported from day 1) in order to avoid manufacturer fragmentation, and accepted any potential drawbacks like increased cost, later feature in roadmap
- At the end, it was resolved  that the DL256QAM was a per UE feature
- 256QAM in DL is coming to devices in 2017 timeframe and supported in all bands,
- As part of Release 14, 256QAM in UL is being specified, and 3GPP has to define how signalling should be specified, per UE or per band

# Discussion

Aspects brought up in the complexity analysis of 256QAM in UL and why agreement has not been possible so far

- **EVM, power back off and PA efficiency:** it has been indicated that some PAs have difficulties to operate in 256QAM mode, however none of these PAs were optimized and designed to operate at 256QAM
- **LO phase noise:** This aspect is not new, and is well understood. 256QAM in UL is likely to be used at high frequencies, so the challenge to do it at higher bands will be overcome (e.g. at 5GHz), and therefore other bands (<5GHz) will not suffer from this in comparative terms with not supporting 256QAM in UL
- **IQ image:** One source of IQ image is the IQ modulator. Qualcomm indicates that mitigations exist for 256QAM, but this will mean more development and from scratch design is needed. Another source is imperfections in the LO itself
- **Multimode-multiband PA (MMPA):** design of devices follow the use of MMPAs and therefore a single PA would be supporting several bands. It is expected that if a PA is 256QAM capable, and rest of affected RF components enable it, 256QAM would be possible in at least all bands that PA supports. In consequence a definition on a per-band basis would lead to an unnecessary fragmentation
- **Penalty to lower order modulation support:** although it has been mentioned that supporting 256QAM would affect performance of 64QAM and other lower order modulations, PA vendors have indicated that is not the case

# Proposals

- Per UE and per band approaches have each different pros and cons
- From our discussions with vendors and also based on the discussion section in previous slide, it is observed that it is not well justified a per-band approach
- From our point of view, in the same way 256QAM in DL and 64QAM in UL, 256QAM in UL should follow the same per UE approach, and there is no fundamental difference in why 256QAM in UL is different
- **Proposal 1: 256QAM in UL is defined as per UE**
- However, it may be attractive and feasible to find a point of compromise considering that 256QAM is mostly expected to be applicable in the beginning in higher frequency bands and the use of multimode-multiband PAs
- **Proposal 2: 256QAM in UL is defined in group of bands. Group 1: bands f>1.7GHz, Group 2: bands f<1.7GHz. If 256QAM is supported in the device, the device will signal which group/s of bands UE supports 256QAM in UL**
- Another option would be to select a set of bands as a middle ground point between all bands and an undefined (and possibly growing) group of bands like in Proposal 2. We propose 1, 2, 3, 7, 38, 39, 40, 41, 42, [46], 66 after discussion with interested operators during RAN4#80 meeting
- **Proposal 3: select a limited set of bands as part of minimum supported bands if UE supports 256QAM in UL: 1, 2, 3, 7, 38, 39, 40, 41, 42, [46], 66. For bands not listed, per-band signalling is used**

# Agreement

- It is proposed to follow proposal 3 in previous slide