NOKIA

Nokia Networks

Nokia's 5G NPRM Comments Summary

Prakash Moorut
Spectrum Lead, North America

Executive Summary of Nokia's Comments to 5G mmWave NPRM- Licensing

- Criteria considered important guidelines, not bright line rules, allowing deviation where appropriate.
- Grant flexible use rights in 28 GHz and 39 GHz bands and auction "dormant" licenses. Oppose "overlay" auction proposal.
- Same service rules for 37 GHz as for 39 GHz. 37GHz: Oppose hybrid approach. Support combining 37 & 39GHz for 3GHz total.
- 66-71GHz should be licensed based on WRC-15 outcome. 64-66GHz unlicensed.
- At least 400MHz blocks. A single 850MHz block or (400 + 450MHz) in 28GHz; four blocks of 400MHz in 37GHz; two blocks of 500MHz + one block of 400MHz in 39GHz. If 37 & 39GHz are combined, six 500MHz blocks. Five 1GHz blocks in 66-71GHz.
- Retain larger areas in 28 GHz (BTAs) and 39 GHz (EAs) and adopt similar large areas (EAs) in 37 GHz & 66-71GHz.
- Satellite operations should not harm 5G services. Should not adopt use of a Spectrum Access System. Instead, use market based mechanism for coexistence/coordination.
- Substantial service or usage based requirement instead of a POP coverage performance metric. Oppose "use it or share it".
- Support 10 years license terms with renewal expectancies.
- Support secondary market transactions and also pre-auction swaps for large contiguous spectrum blocks.
- FCC should also reconsider other bands >24GHz like 24.25-29.5 GHz, 71-76/81-86GHz.
- FCC should also consider bands below 24GHz, including below 6GHz like 3.7-4.2GHz & 3.1-3.55GHz. Combined with 3.5GHz (3.55-3.7GHz), this will open 1.1GHz of contiguous spectrum below 6GHz. Another band of interest is the 1300-1390 MHz band.
- Keep backhaul needs in mind.

Executive Summary of Nokia's Comments to 5G mmWave NPRM- Technical

- 28/37/39GHz/66-71GHz: Proposes to align BS transmit power with fixed point-to-point and point-to-multipoint systems (85dBm EIRP).
- Supports + 43 dBm EIRP for mobile devices.
- Tentatively proposes to add a category of devices (e.g., CPEs) which would have higher power limits [e.g., 53dBm] than mobile devices but lower power limits than base stations, recognizing need for RF exposure studies.
- Out of Band Emission of -13dBm/100kHz for first one MHz and -13dBm/1MHz at 1MHz offset or larger. Should not use bandwidth dependence resolution bandwidth in first 1MHz (use -13dBm/100kHz).
- FCC should not establish field strength or power flux density limits at geographic service area borders at this time for bands without incumbent licensees. Coordination for bands with incumbents.
- Consideration of IEEE C95.1-2005, as updated by IEEE C95.1a-2010, as the applicable RF exposure standard for the proposed bands and continue to study RF exposure issues related to mmW in the context of the Commission's other open proceeding (ET Docket Nos. 13-84, 03-137) examining its RF exposure rules and policies. Guidance on how to demonstrate compliance with the Commission's exposure limits evaluation is to be issued by the FCC Laboratory.
- Nokia supports TDD in these bands. May also support FCC's proposal to be flexible and let market decide while noticing the advantages of TDD at these frequencies.

NOKIA

Caveats

- Simulation results and observations on following slides are based on some specific deployment scenarios and can change if other scenarios are assumed. Please see Nokia's comments to NPRM and other set of slides for details.
- Main goal of these initial results is to provide data to the FCC to ask for higher BS and UE Tx power and block sizes of at least 400MHz. They can be refined for specific deployments.

NOKIA

Impact of bandwidth (100% Indoor UEs (half with low penetration loss, half with high penetration loss))

Channel Bandwidth	200MHz	400MHz	800MHz
Throughput (Mbps)	123	246	495

Table 1: Downlink Mean UE throughput performance: 100% Indoor UEs (half with low penetration loss, half with high penetration loss), BS: 62dBm/100MHz EIRP.

Channel Bandwidth	200MHz	400MHz	800MHz
Throughput (Mbps)	96	173	312

Table 2: Uplink Mean and 5th percentile UE throughput performance: 100% Indoor UEs (half with low penetration loss, half with high penetration loss), UE: 43 dBm EIRP.

NOKIA

Impact of bandwidth (100% Outdoor UEs (zero penetration loss))

Channel Bandwidth	200MHz	400MHz	800MHz
Throughput (Mbps)	214	430	855

Table 3: Downlink Mean UE throughput performance: 100% Outdoor UEs (zero penetration loss), BS: 62dBm/100MHz EIRP.

Channel Bandwidth	200MHz	400MHz	800MHz
Throughput (Mbps)	187	367	725

Table 4: Uplink Mean UE throughput performance: 100% Outdoor UEs (zero penetration loss), UE: 43 dBm EIRP.

NOKIA

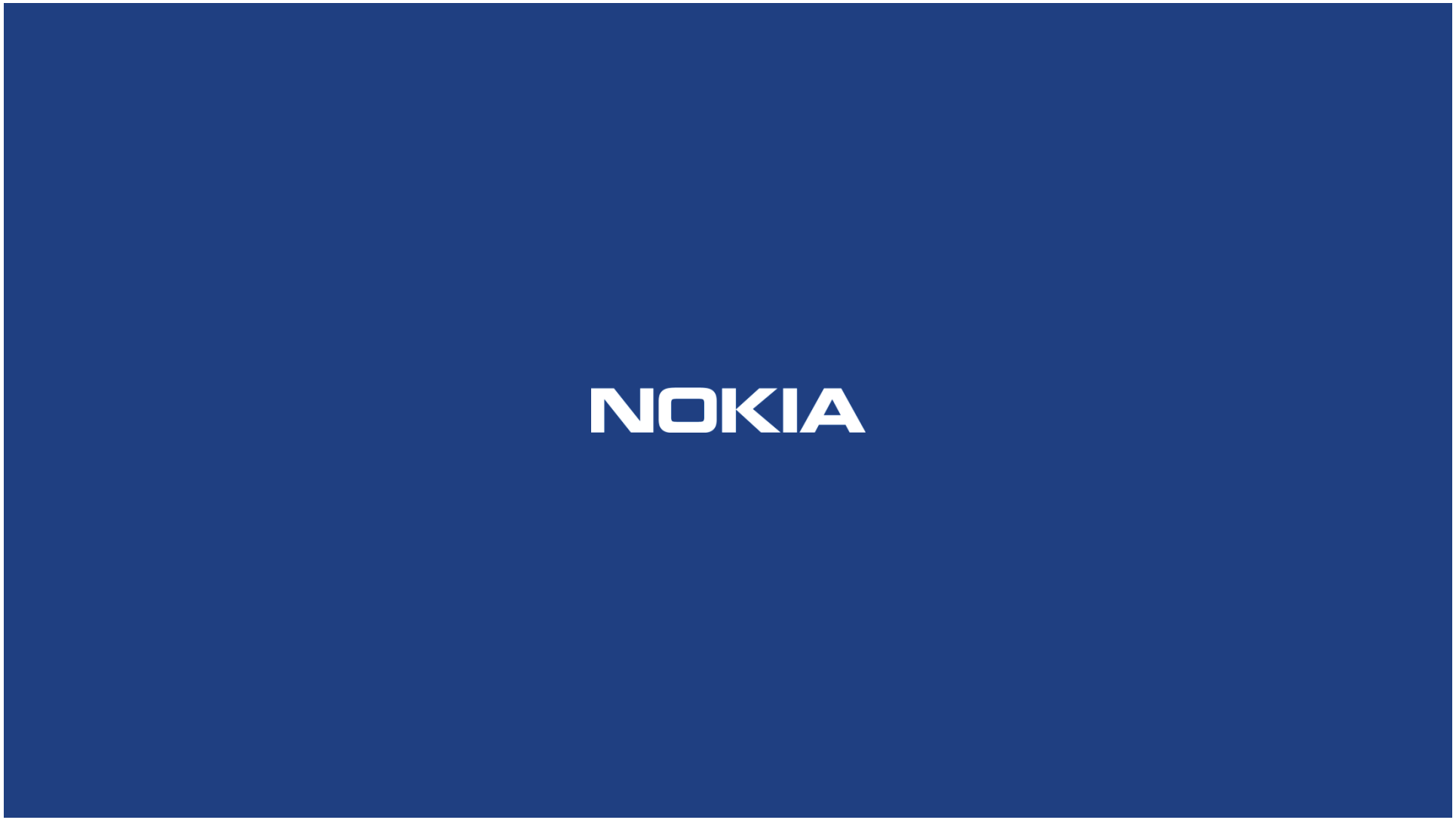
Impact of BS Tx power (400MHz)

- For indoor UEs, the deployment under consideration was path loss limited due to the high penetration losses at 39GHz. For example, the mean UE throughput with 100% of Indoor UEs (half with low penetration loss, half with high penetration loss) increases from 246 Mbps to 377 Mbps with a 400 MHz channel bandwidth.
- For outdoor UEs, the deployment under consideration was heavily interference limited, as shown by the fact that increasing the transmit power led to no significant improvement in system performance (mean UE throughput of around 430 Mbps for a BS EIRP of 62 dBm/100 MHz EIRP versus 437 Mbps for a BS EIRP of 85 dBm, with 100% of Outdoor UEs and 400 MHz channel bandwidth for both cases).

NOKIA

Impact of UE Tx Power (400MHz)

- For indoor UEs, the deployment under consideration was path loss limited due to the high penetration losses at 39 GHz. For example, the mean UE throughput with 100% of Indoor UEs (half with low penetration loss, half with high penetration loss) increases from 173 Mbps to 237 Mbps with a 400 MHz channel bandwidth.
- For outdoor UEs, the deployment under consideration was heavily interference limited, as shown by the fact that increasing the transmit power led to no significant improvement in system performance (mean UE throughput of 367 Mbps for a UE EIRP of 43 dBm versus 373Mbps for a UE EIRP of 53 dBm, with 100% of Outdoor UEs and 400 MHz channel bandwidth in both cases).


NOKIA

57-64GHz

- Limits the average power of any emission in this band to 40 dBm EIRP and the peak power to 43 dBm EIRP for transmitters located either indoors or outdoors.
- In 2013, the Commission modified these rules to provide transmitters located outdoors with very high gain antennas (i.e., higher than 30 dBi) an average EIRP emission limit of 82 dBm and a peak EIRP limit of 85 dBm, in each case minus 2 dB for every dB that the antenna gain is below 51 dBi.
- Don't go lower than 40 dBm EIRP and the peak power to 43 dBm EIRP. With our antenna gain of 28dBi (3degree beamwidth), we could emit 82 – {2(51-28)}=+36dBm. If the antenna gain is 20dBi, then our allowable emission is 82 – {2(51-20)}= +20dBm which maybe too small.

Spectrum above 6GHz: WRC-15 outcome and FCC NPRM

WRC-15 Outcome: Agenda Item for 5G spectrum with a list of bands to be studied towards WRC-19:

- Bands with Mobile Allocation:
  - 24.25 - 27.5 GHz
  - 37 - 40.5 GHz
  - 42.5 - 43.5 GHz
  - 45.5 - 47 GHz
  - 47.2 - 50.2 GHz
  - 50.4 - 52.6 GHz
  - 66 - 76 GHz
  - 81 - 86 GHz
- Bands without an existing Mobile Allocation:
  - 31.8-33.4 GHz, 40.5-42.5 GHz and 47-47.2 GHz

FCC'S 2014 Notice of Inquiry:

•LMDS Band (27.5-28.35 GHz, 29.1-29.25 GHz, and 31-31.3 GHz)
•39 GHz Band (38.6-40 GHz)
•37/42 GHz Bands (37.0-38.6 GHz and 42.0-42.5 GHz)
•60 GHz Bands (57-64 GHz and 64-71 GHz)
•70/80 GHz Bands (71-76 GHz, 81-86 GHz)
•24 GHz Bands (24.25-24.45 GHz and 25.05-25.25 GHz)

FCC's 2015 NPRM:

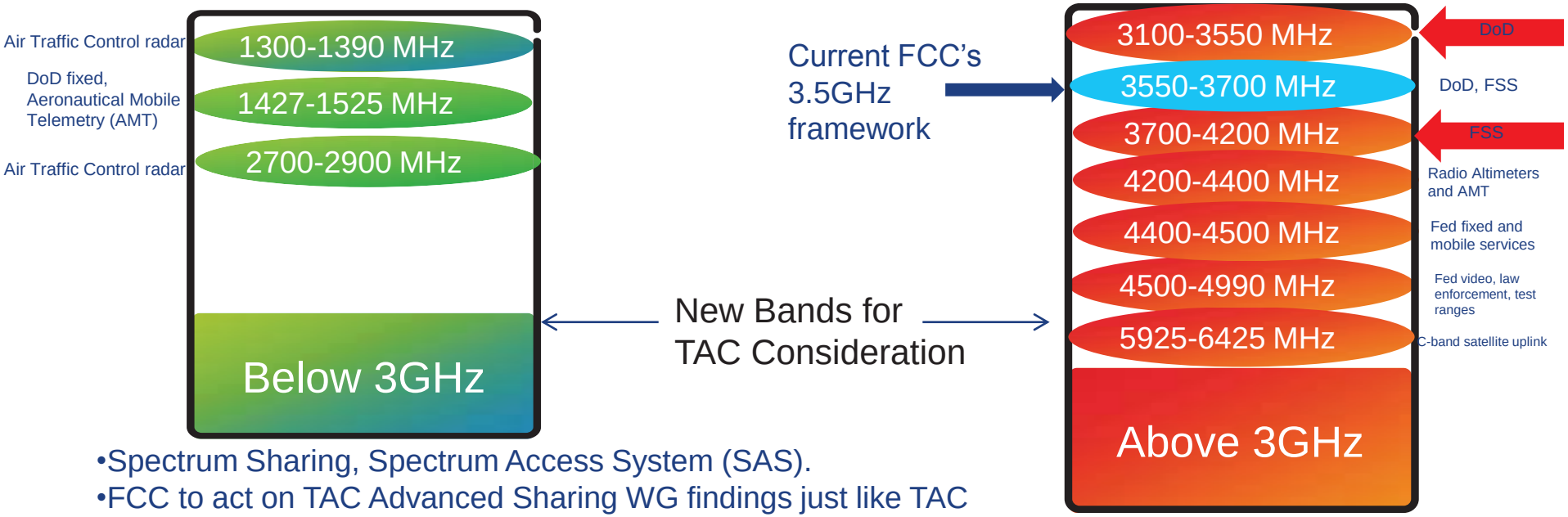
•27.5-28.35GHz,
•37.0-38.6 GHz,
•38.6-40 GHz,
•64-71 GHz

Lack of bands below ~24 GHz
FCC should study more bands, especially < 28GHz (including below 6GHz like 1.3GHz, 3.7-4.2GHz) and >71GHz
E.g., 24.25-29.5 GHz and 70/80 GHz Bands (71-76 GHz, 81-86 GHz)

NOKIA

Potential bands below 6GHz in USA

FCC Technological Advisory Council (TAC) Advanced Sharing WG



- Spectrum Sharing, Spectrum Access System (SAS).
- FCC to act on TAC Advanced Sharing WG findings just like TAC Spectrum Frontiers WG led to 5G mmW NPRM.

NOKIA