RF Exposure Procedures

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Note: The views expressed in this presentation are those of the authors and may not necessarily represent the views of the Federal Communications Commission.

Overview

- 5G NR FR1 Measurement Procedures
- mmWave and Time-Averaged SAR Measurement
- Sum-Peak Location Separation Ratio (SPLSR)

5G NR FR1 Measurement (1)

- We have seen several inquiries regarding 5G NR FR1 Test Reduction
- Most have requested utilizing LTE Tests to cover equivalent bands/configurations in 5G NR FR1
- Others have requested full LTE test and only spot-check equivalent 5G NR FR1 test

5G NR FR1 Measurement (2)

- Examples of equivalent bands:

5G NR FR1		LTE	
Band	Tx Freq (MHz)	Band	
n2	1850 - 1910	B2	1850 - 1910
n5	824 - 849	B5	824 - 849
n7	2500 - 2570	B7	2500 - 2570
n12	699 - 716	B12	699 - 716

5G NR FR1 Measurement (3)

- Existing LTE measurement procedures allow for extended bands to cover smaller bands, fully contained within them
  - Example: B25 (1850 – 1915 MHz) tests are allowed to be used to cover B2 (1850 – 1910 MHz) test
- Guidance:
  After considering the various factors, the existing guidance should be used for the time being. Fully test LTE and 5G NR FR1.
  - This is preliminary and subject to change

mmWave and Time-Averaged SAR Measurement(1)

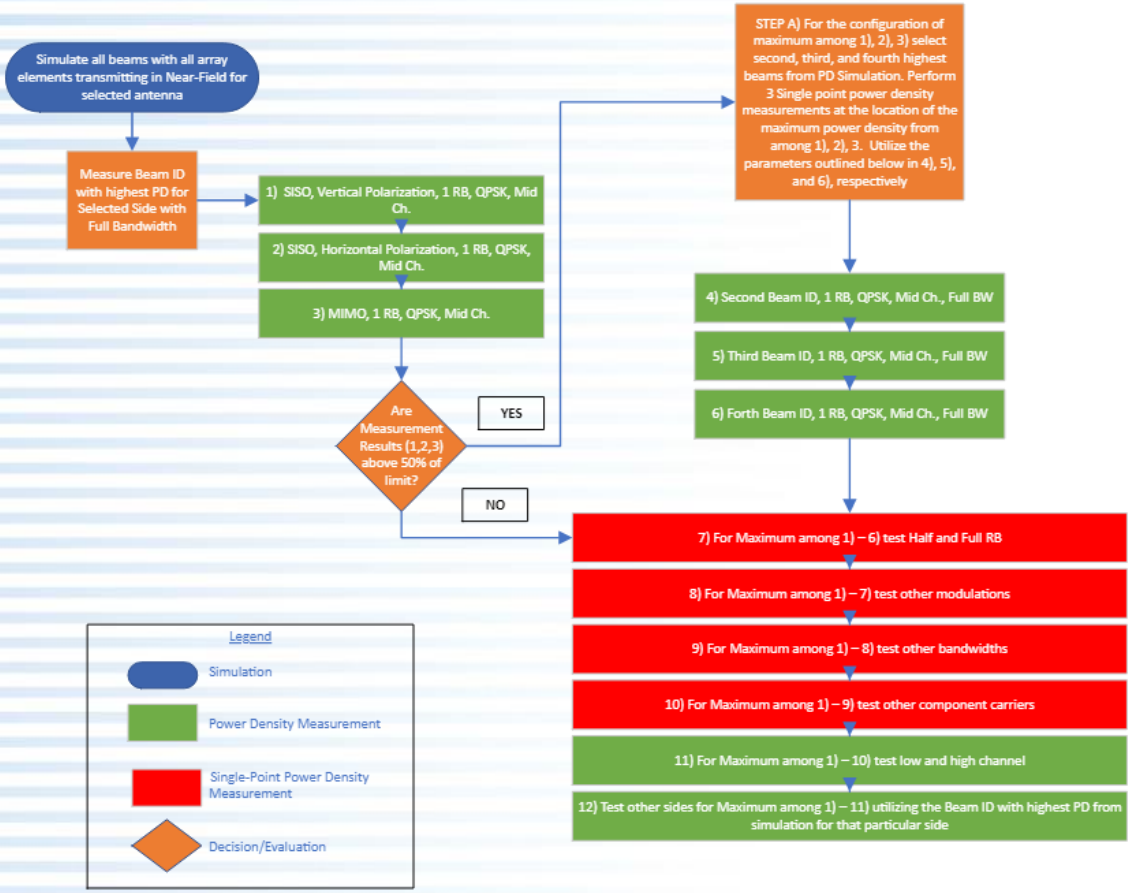
- Provided a blueprint for mmWave measurement in RF Exposure Procedures presentation from April 2019 TCB Workshop
  - Flowchart entitled “Millimeter Wave Testing Workflow”
- Uses roughly same process as LTE testing in terms of the different parameters (i.e. modulations, resource blocks, channels, etc.)
- It has worked well and many devices have been certified using it

mmWave and Time-Averaged SAR Measurement(2)

- However, there are some shortcomings with the procedure
  - Uses combination of simulation and measurement increasing time to certify
  - Evaluating all parameters very time consuming
  - PD measurement scans take a very long time
- New Guidance:
  In order to decrease the total amount of time needed for mmWave testing, the following modified Millimeter Wave Testing Workflow may be applied

mmWave and Time-Averaged SAR Measurement(3)

- Modified Millimeter Wave Testing Workflow



mmWave and Time-Averaged SAR Measurement(4)

- New Guidance:

The modified procedure is as follows:

Note: Steps 1), 2)…..11), 12) refer to steps in the Millimeter Wave Testing Workflow outlined on slide 6 of the RF Exposure Procedures presentation at the April 2019 TCB Workshop. Steps I., II., III., IV., V., and A) refer to steps in this modified procedure.

I. Proceed with the simulation of all beams and determine the Beam ID with the highest power density for the selected side at full bandwidth.

II. Proceed with power density measurements for steps 1), 2), 3). If any of those results are > 50% of the limit proceed to step A) below. Otherwise, continue to step III. below.

III. For steps 7), 8), 9), 10), perform single-point power density measurements at the location of maximum power density from steps 1), 2), 3) {and A) if applicable}. (i.e. out of those steps, where is the maximum power density; perform the single-point power density measurements at that location). For each of those single-point power density measurements vary the respective dimensions corresponding to that step. For example for step 7), perform one single-point power density measurement for half RB, one single-point power density measurement for full RB. Then, using that information continue down the flow chart performing single-point power density measurements, varying the dimensions. For example for step 8), if full RB gave you the maximum single-point power density measurement in step 7), perform the single-point power measurements in step 8 using full RB, varying the dimension of modulation, covering the various modulations supported by the device. Repeat this methodology for steps 9) and 10)

IV. Using the information gained from steps I.- III. above, for the maximum configuration perform power density measurements for step 11).

V. For step 12), test the other sides using the maximum among steps II.- IV. of this modified procedure utilizing the beam ID with the highest power density from simulation for that particular side. Testing is completed.

A) For the configuration of maximum among steps 1), 2), 3) select the second, third, and fourth highest beams from the power density simulation. Perform power density measurements at the location of maximum power density at the location of maximum power density from steps 1), 2), 3). (i.e. out of those steps, where is the maximum power density; perform power density measurements at that location.) These power density measurements should utilize the parameters outlined in steps 4), 5), and 6), respectively. After those power density measurements have been completed proceed to step III. above.

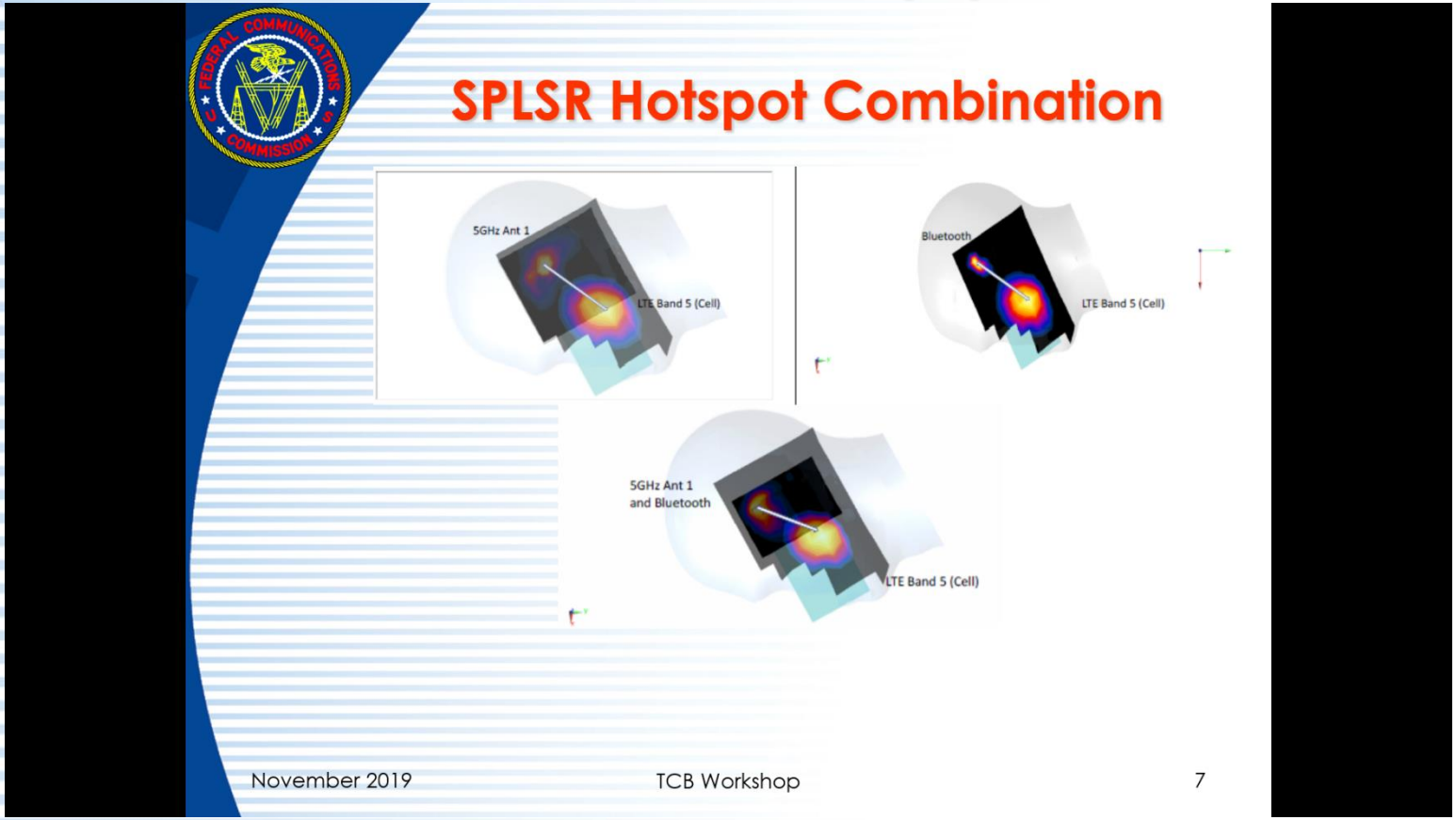
mmWave and Time-Averaged SAR Measurement(5)

- Even with the forementioned Modified Millimeter Wave Testing Workflow, PD Measurement can still take days
  - Main bottleneck is all the different parameters that must be evaluated
- Evaluating all the different parameters (Number of RBs, channels, modulations, etc.) may be overly conservative for devices that utilize Time-Averaging SAR methodologies/algorithms in conjunction with mmWave transmitters
- New Guidance:
  - For devices that utilize Time-Averaged SAR methodologies/algorithms in conjunction with mmWave transmitters, a CW signal may be used in place of evaluating all of the various parameters outlined in the Modified Millimeter Wave Testing Workflow
  - TAS methodology must be able to actively and dynamically be able to control mmWave output power
  - Requires a pre-testing KDB Inquiry and approval of the appropriate TAS methodology
  - Preliminary guidance subject to change

Sum-Peak Location Separation Ratio (1)

- SPLSR Hotspot combination procedure (Hybrid SPLSR) was introduced in RF Exposure Procedures presentation from November 2019 TCB workshop
- Allows for aggregate SAR distribution of a co-located antenna pair (obtained from a small enlarged zoom scan/volume scan) to be used in SPLSR calculation
- Allows certain combinations to use SPLSR that would otherwise require full device volume scan

Sum-Peak Location Separation Ratio (2)



Source: RF Exposure Procedures Nov 2019

Sum-Peak Location Separation Ratio (3)

- However, this Hybrid SPLSR still requires a small volume scan to be done
  - Labs prefer avoiding volume scans in order to save testing time
- New Guidance:
  Instead of doing a small volume scan over a co-located antenna pair, you may algebraically sum the SAR values of the co-located pair and use that value in SPLSR calculation
  - In the calculation you must use the minimum distance between the spatially separated antenna and the closest antenna of the co-located antenna pair to be conservative
- Sometimes, this calculation may result in a high value (i.e. it doesn't help) but sometimes it will allow you to avoid volume scans all together

Sum-Peak Location Separation Ratio (4)

- We have received several inquiries regarding SPLSR for frequencies over 6 GHz
  - Also, combinations between sub-6 GHz and above-6 GHz SAR tests
- New Guidance:
  SPLSR can now be used on SAR tests above 6 GHz. SPLSR can be used in combinations between sub-6 GHz and above-6 GHz SAR
  - Apply procedures as per FCC KDB Pub 447498 D01
- Total Exposure Ratio (TER) procedure must still be used for combinations of SAR and PD tests

Questions?

Thank You!