EITP30: Lab 3 - 2022

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For the third lab, our aim is to be able to carry out cell search on a set of measurements taken at the wireless lab at the EIT department. You will be receiving a set of measured in-phase and quadrature (IQ) samples received in real-time, from the university's frequency-range-1 (FR1) channel sounder. A different set of measurements will be given to each study team.

Pre-lab Section

1. Review the theory and 3GPP specifications sections from all the other labs related to Initial Access for 5G NR [1-5].
2. Read 3GPP 38.101-1 [5], Sections 5.2, 5.4.2 and 5.4.3 (pp. 26-28, 59-64, 64-67)

Lab Programming Section

3. Download the MATLAB code, on NR cell search and master information block (MIB) and system information block 1 (SIB1) recovery, from one of these options:
   a. Visit the webpage: https://www.mathworks.com/help/5g/ug/nr-cell-search-and-mib-and-sib1-recovery.html. Then, run the following command on MATLAB's terminal: **openExample('5g/NRCellSearchMIBAndSIB1RecoveryExample')**. Work with the opened file for the laboratory.
   b. (Not recommended) The course content for Lab 3.
4. Read about how cell search is performed in MATLAB on its webpage.
   a. Hint: If you have a doubt about how any function being used in the MATLAB script works, right-click on the function's name and click on 'open "functionName"'. You can also look it up on the MATLAB documentation.
5. Measure raw IQ data from the wireless lab. You will receive an amount of samples equivalent to 100 milliseconds.
6. Consider the following parameters for the design of your code sections:
   a. Carrier frequency, $f_c = 3789.990 MHz$
   b. Baseband sampling rate, $f_s = 122.88 MHz$
   c. Measurement duration $T_{end} = 100ms$
   d. NR operating band, $n78$
   e. Global synchronization channel number, $GSCN = 8048$
   f. NR absolute radio frequency channel number for synchronization signal block (SSB), $NRARFCN_{SSB} = 652704$
   g. Frequency for pointA, $f_{pointA} = 3780.810 MHz$
7. Create a function/script that transforms your IQ two-dimensional array of data into a complex one-dimensional array of data.
   a. Hint: Use the code provided in the material to output a file that you can work with in the MATLAB cell search script. If you prefer, extract a subset of data that you consider long enough to successfully carry out cell search in the next steps. You can always use all the samples available in your data file, but your processing time will be longer for the next steps.

8. Modify the MATLAB script given in the material, so that it finds the SS burst within the measured physical-layer grid. Make any necessary adjustments so that you successfully perform cell search up to physical cell identity (PCI) estimation.
    a. Hint: Use the script option that loads measurements from a file, since you are working with real data instead of ideal data.
9. Infer the following parameters from the design parameters and the measurement processing (Hint: Start by searching for missing information from the recommended sections of the 3GPP specifications):
    a. Subcarrier spacing (SCS)
    b. SSB frequency
    c. Frequency offset between carrier frequency and SSB frequency, given by the design parameters
    d. Frequency offset from the design SSB frequency
    e. Time offset to start of the first SS burst/SSB
    f. Physical cell identity (PCI)
    g. SSB periodicity
    h. Number of SSBs within an SS burst
    i. Selected SSB index
    j. (Optional) System frame number (SFN)
10. (Optional) Look at the following steps for the cell search procedure. Analyze their purpose and performance when using measurement data instead of the synthetic dataset provided by MATLAB.

References

[1] Dahlman, Erik, Stefan Parkvall, and Johan Skold. 4G: LTE/LTE-advanced for mobile broadband. Academic press, 2013.

[2] 5G NR: The next generation wireless access technology. Academic Press, 2020.

[3] 3GPP TS 38.211 version 17.1.0 Release 17. Physical channels and modulation. 2022. Available online:
https://www.etsi.org/deliver/etsi_ts/138200_138299/138211/17.01.00_60/ts_138211v170100p.pdf

[4] 3GPP TS 38.213 version 17.1.0 Release 17. Physical layer procedures for control. 2022. Available online:
https://www.etsi.org/deliver/etsi_ts/138200_138299/138213/17.01.00_60/ts_138213v170100p.pdf

[5] 3GPP TS 38.101-1 version 17.5.0 Release 17. Physical layer procedures for control. 2022. Available online:
https://www.etsi.org/deliver/etsi_ts/138100_138199/13810101/17.05.00_60/ts_13810101v170500p.pdf