An Efficient FFT For OFDM Based Cognitive Radio On A Reconfigurable Architecture

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Background:

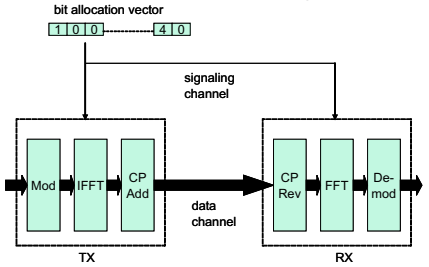
- Cognitive Radio is a promising technology to utilize non-used parts of the spectrum that are actually assigned to licensed users.
- An adaptive OFDM based Cognitive Radio system has the capacity to nullify individual carriers to avoid interference to licensed users
- There could be a considerably large number of zero-valued inputs/outputs for the IFFT/FFT in the OFDM transceiver to avoid licensed users.

Motivation:

Due to the wasted operations on zero values, the standard radix-2 FFT is no longer efficient. Based on this observation, we propose to use a computationally efficient FFT as an option for the OFDM based Cognitive Radio. The algorithm is implemented on a home grown low-power reconfigurable architecture. The result shows that the algorithm offers faster computation and significant energy saving when the number of zeros exceed half.

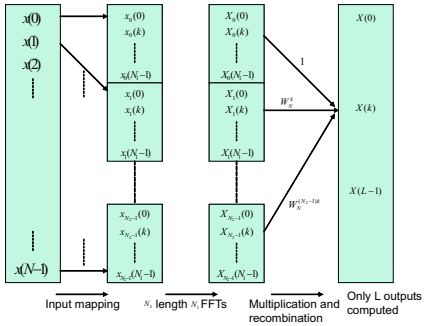
OFDM Based Cognitive Radio

- OFDM based Cognitive Radio system can achieve the optimal channel capacity in the segmented spectrum by adaptive bit loading. A bit allocation vector indicates how many bits are loaded onto each subcarrier, which corresponds to the different modulation type.
- A general structure of an OFDM based Cognitive Radio system:



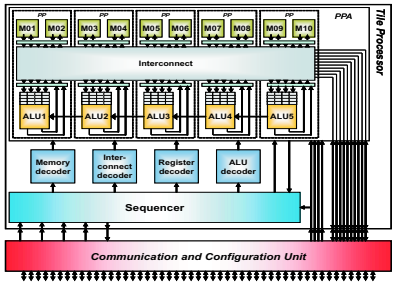
A Sparse FFT

- It takes advantage of zero input/outputs when zeros exceed the half
- It is based on transform decomposition



Montium Architecture

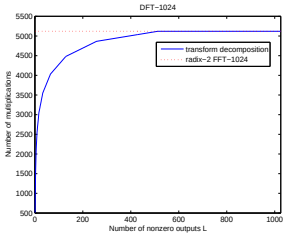
- It is the key element in our proposed Multiprocessor System-on-Chip platform for Cognitive Radio.
- It is a low-power reconfigurable architecture targeting DSP algorithms and it combines flexibility and energy efficiency.



Implementation on the Montium

- According to the number of zeros in the bit allocation vector, the general purpose processor chooses between sparse FFT and radix-2, and sends the configuration to the Montium.
- The computation in the Montium involves two steps: the normal radix-2 FFT and multiplication and recombination with twiddle factors.

Result



Conclusion

- We present a computationally efficient FFT as an option for OFDM based Cognitive Radio in case a large number of subcarriers are nullified. A reconfigurable platform is used to support this option. The algorithm is implemented in our home grown Montium architecture. The simulation result shows the algorithm achieves 30% speedup and energy saving compared with the radix-2 FFT when 32 out of 1024 are nonzero.

Future Work

- The implementation on the Montium will be integrated onto the entire platform.
- The whole OFDM system with the reconfigurable FFT will be implemented on the platform.

Acknowledgement

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