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RFI Mitigation for the ngVLA : Options + Cost-Benefit Analysis

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The increasing prevalence of radio communications in everyday life (cell 5G, satellite internet/media, car radar, aircraft/satellite communication, etc) and their increased use of the available radio spectrum is forcing radio astronomy to learn how to effectively co-exist with these transmissions. In this paper, we discuss strategies for incorporating adaptive RFI mitigation solutions into the real-time operation and data acquisition system of an interferometer such as the Next Generation VLA and present a cost benefit analysis of such a system.

Mitigation options include post-processing flagging, real-time RFI identification on visibilities or antenna-based data streams, real time RFI signal modeling and subtraction, and the generation and management of an RFI database that may be used for smart scheduling and automated tuning of algorithms. Machine learning solutions are likely to be required for this real-time adaptive and automated end-to-end RFI mitigation approach.

To perform a cost-benefit analysis of such a system in the presence of a variety of RFI sources (Cell 5G - high/low, People, Aircraft and Satellite communication protocols, LEO satellite for data transmissions and Ultra-WideBand transmissions), each type of RFI is characterized by its time and frequency occupancy and the fraction of the array that is expected to be affected. A cost-benefit analysis is then done by matching RFI characteristics with mitigation solutions and algorithms most suited to each type of RFI, and comparing the expected efficacy (in terms of fraction of data recovered or the amount of extra observing time required to compensate for data lost to RFI) with the operational cost of applying these real-time algorithms.

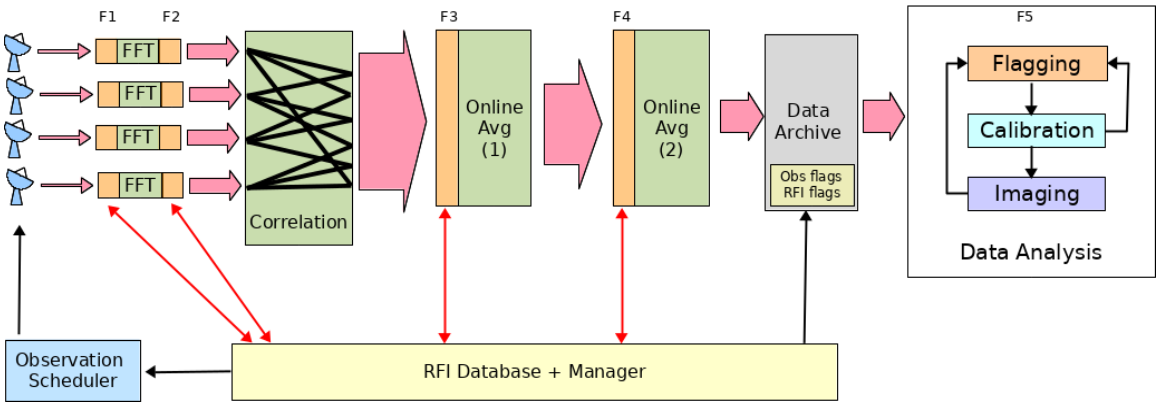

Figure 1. A schematic diagram of a data acquisition and processing system with RFI mitigation strategies embedded at multiple stages in the signal chain (orange boxes labeled as F1 through F5). F1 and F2 represent pre-correlation voltage streams and their short-term Fourier transforms. F3 indicates micro-sec timescales suitable for flagging and recovering data in between intermittent communication signals. F4 indicates milli-sec timescales more amenable to modeling and subtraction algorithms. F5 indicates solutions applied at archival and post-processing data resolutions. The RFI database/manager is a centralized entity that decides what options to invoke based on a-priori and real-time RFI characteristics and observation modes.

References

[1] U.Rau, R.Selina, A.Erickson, "RFI Mitigation for the ngVLA : A Cost-Benefit Analysis", ngVLA Memo #71, December 2019

[2] A.Erickson, "ngVLA Radio Frequency Interference Forecast:, ngVLA Memo #48, July 2018