OLFAR – Orbiting Low Frequency Antennas for Radio Astronomy

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One of the last unexplored frequency ranges in radio astronomy is the frequency band below 30 MHz. New interesting astronomical science drivers for very low frequency radio astronomy have emerged, ranging from studies of the astronomical dark ages, the epoch of reionization, exoplanets, to ultra-high energy cosmic rays. However, astronomical observations with Earth-bound radio telescopes at very low frequencies are hampered by the ionospheric plasma, which scatters impinging celestial radio waves. Sometimes the ionosphere is even opaque for radio waves. Although the ionosphere is transparent at frequencies above roughly 10 MHz, Earth-bound radio astronomy is affected by the short-term phase fluctuations of the received celestial radio waves. An additional factor which limits the sensitivity of Earth-bound radio telescopes at frequencies in the band below 30 MHz, is the world-wide occurrence of very strong transmitter signals (RFI). A radio telescope in space would not be hampered by the Earth's ionosphere and RFI. Therefore several initiatives have been started recently to explore this unexplored frequency band.

OLFAR – the Orbiting Low Frequency Antennas for Radio Astronomy – will be a network of satellites that will create the low-frequency image of the universe by collecting information and processing it by means of interferometric imaging algorithms. In order to generate relevant astronomical data, the satellites will have to gather large amounts of data and then distribute it to all other swarm members. The high data rates, the number of nodes, and the large distances between nodes, make the communication layer problem very complex.

Inter-satellite communication

The inter-satellite communication must ensure that the imaging process is carried out without flaws. For the distributed correlation it is needed that each satellite shares its astronomical data, position and time, with all its peers. Clustering will be employed to reduce the length of the links and the data distribution efforts. Still, satellites will have to deal with data rates of Mbit/s over distances of tens of kilometers. Suitable modulation and multiple access techniques will be combined with an efficient antenna system to fulfill the demands.

Swarm-Earth communication

After collecting and processing the astronomical data, the swarm needs to send the results to a base station on Earth. Although the data rate will be only in the order of hundreds of kbits/s, the length of the swarm-Earth link will be considerably larger than in the previous scenario.