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USING A SATELLITE SWARM FOR BUILDING A SPACE-BASED RADIO TELESCOPE FOR LOW FREQUENCIES

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In radio astronomy, as in astronomy in general, a wide range of frequencies is observed as each spectral band offers a unique window to study astrophysical phenomena. In the recent years, new observatories have been designed and built at the extreme limits of the radio spectrum. For the low frequencies several Earth-based radio telescopes are constructed at this moment. In the Netherlands, the Low Frequency Array (LOFAR) is being constructed at this moment and will be operational later this year. LOFAR observes the sky between 30 and 240 MHz. Observing at even lower frequencies is very interesting, but, due to the influence of the Earth's ionosphere this is not possible from Earth. Thus, the only option to observe low frequencies is a telescope in space.

In the past several studies have been conducted on a low-frequency space-based radio telescope. In the recent ESA project Distributed Aperture Array for Radio Astronomy in Space (DARIS), such a mission was studied in detail. The study focused on a moderate-size three-dimensional satellite constellation operating as a coherent large-aperture synthesis array. The DARIS project is presented in a separate conference contribution.

In the DARIS project the focus was on technology available at this moment, with an outlook and technological development plan/roadmap to be exploited for the future. Using current-day technologies, a space-based low-frequency array would be bulky and, thus, costly. A logical next step would be to investigate possibilities to miniaturize the electronics and use very small satellites, perhaps even nano satellites with masses between 1-10 kg to build the radio telescope. The approach is to use a swarm of satellites to establish a virtual telescope to perform the astronomical task. This is investigated in the NWO/STW-funded OLFAR (Orbiting Low Frequency Array) project. The OLFAR radio telescope will be composed of an antenna array based on satellites deployed at a location where the Earth's interference is limited, and where the satellites can be maintained in a three-dimensional configuration with a maximum diameter of 100 km. A Moon orbit could be suitable option.

Each individual satellite will consist of deployable antennas. The sky signals will be amplified using an integrated ultra-low power direct sampling receiver and digitizer. Using digital fil-

tering, any subband within the LNA passband can be selected. The data will be distributed over the available nodes in space. On-board signal processing will filter the data, invoke RFI mitigation algorithms (if necessary), and finally, correlate the data in a phased array mode. If more satellites are available, they will automatically join the array. The final correlated or beam-formed data will be sent to Earth as part of the telemetry data using a radio link. As the satellites will be far away from Earth, communication to and from Earth will require diversity communication schemes, using all the individual satellites together.

In this paper, the design parameters for the satellites and the swarm will be discussed and status of the OLFAR project will be reported. Details will be given about the system and the signals that are expected.