# LOFAR

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LOFAR is the first of a new generation of radio telescopes. Rather than using expensive dishes, it forms a distributed sensor network that combines the signals from many thousands of simple antennas. Its revolutionary design allows observations in a frequency range that has hardly been studied before.

This talk focuses on another novel feature of LOFAR: the approach to process the real-time data in *software*, where traditional telescopes use customized hardware. The use of software yields a much more flexible instrument, but the high processing and bandwidth requirements compel the use of a supercomputer. The signals from the LOFAR stations are centrally combined, filtered, and beam formed or correlated by a 2.5-rack IBM Blue Gene/P system.

To meet the real-time requirements, the application is highly optimized. By implementing performance-critical functions in assembly, we achieve up to 96% of the theoretical floating-point peak performance. To handle the large amounts of data, we use the Blue Gene in an atypical but highly efficient way, by running part of the application on I/O nodes. We also devised and implemented a low-overhead, high-bandwidth network protocol to communicate between compute nodes and I/O nodes. The achieved performance results imply that we need only one rack to process all foreseen observation modes, while increasing the observation bandwidth by more than 50% beyond the LOFAR specifications. Therefore, the telescope can observe proportionally more sources or frequencies simultaneously and becomes a much more efficient instrument.