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Timing and synchronisation of the DUNE far detector

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The Deep Underground Neutrino Experiment (DUNE) will be composed of two neutrino detectors positioned in an intense neutrino beam, originating at the Fermi National Accelerator Laboratory (FNAL). The near detector (ND) will be located at FNAL, and will characterise the neutrino beam. The far detector (FD) will be 1300 km from FNAL, and 1.5 km underground. The FD is segmented into four liquid argon time projection chamber (LArTPC) modules, each with a mass of 17kt. The DUNE timing system (DTS) will distribute a phase-aligned clock and synchronised timestamps to all FD electronics. Alongside clock and timestamps, the DTS will be able to distribute fast fixed-latency messages, allowing synchronised operations across the large DUNE FD, e.g. calibration laser firing. The system is expected to achieve sub-ns timestamp synchronisation within a FD module. High reliability through system redundancy in a hot-swap configuration is a fundamental feature of the system's architecture. The built-in redundancy will help minimise downtime, and allow cross-checking of synchronisation. An overview of the DTS hardware, firmware, software, and system level functionality is given, as well as summary of the DTS prototype operations at the ProtoDUNE detectors hosted at the European Organization for Nuclear Research (CERN).

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