The current state-of-the-art FFT libraries are not scalable on large heterogeneous machines with many nodes or even on one node with multiple high-performance GPUs (e.g., several NVIDIA V100 GPUs). Furthermore, these libraries require large FFTs in order to deliver acceptable performance on one GPU. Efforts to simply enhance classical and existing FFT packages with optimization tools and techniques—like autotuning and code generation—have so far not been able to provide the efficient, high-performance FFT library capable of harnessing the power of supercomputers with heterogeneous GPU-accelerated nodes. In particular, ECP applications that require FFT-based solvers might suffer from the lack of fast and scalable 3-D FFT routines for distributed heterogeneous parallel systems, which is the very type of system that will be used in upcoming exascale machines.

Thus, the main objective of the FFT-ECP project is to:

- Collect existing FFT capabilities recently made available from ECP application teams (LAMMPS/fftpi and HACC/SWFfft);
- Assess gaps and make available as a sustainable math library;
- Explore opportunities to build 3-D FFT libraries on vendor 1-D and 2-D kernels, especially leveraging on-node concurrency from 2-D and batched 1-D formulations;
- Focus on capabilities for Exascale platforms;
- Emphasize leverage of vendor capabilities and addressing vendor deficiencies over creation of new and independent software stack.

The FFT-ECP project intends to provide a sustainable 2-D and 3-D FFT library for distributed-heterogeneous parallel systems as the one projected for the upcoming exascale computing systems. FFT-ECP will leverage established but ad hoc software tools that have traditionally been part of application codes, but not extracted as independent, supported libraries. These 3-D FFTs rely on third-party 1-D FFTs, either from FFTW or from vendor libraries.