

Formal Specification of MPI 2.0: Case Study in Specifying a Practical Concurrent Programming API

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Abstract

We describe the first formal specification of a non-trivial subset of MPI, the dominant communication API in high performance computing. Engineering a formal specification for a non-trivial concurrency API requires the right combination of rigor, executability, and traceability, while also serving as a smooth elaboration of a pre-existing informal specification. It also requires the modularization of reusable specification components to keep the length of the specification in check. Long-lived APIs such as MPI are not usually ‘textbook minimalistic’ because they support a diverse array of applications, a diverse community of users, and have efficient implementations over decades of computing hardware. We choose the TLA+ notation to write our specifications, and describe how we organized the specification of 150 of the 300 MPI 2.0 functions. We detail a handful of these functions in this paper, and assess our specification with respect to the aforesaid requirements. We close with a description of possible approaches that may help render the act of writing, understanding, and validating specifications much more productive.