Validation of OpenMPI transferred data using Merkle Trees

Secure Coding 2024/2025

Bc. Pavel Kratochvíl





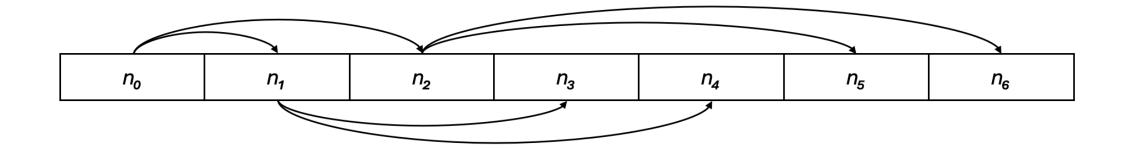
- Ensuring data integrity in High-Performance Computing (HPC) domain
- Message Passing Interface (MPI)
- Common transmission protocols TCP/IP, Infiniband, ROCE
- Error detection in transmission protocols
- MPI mechanisms to prevent common faults
- Hardware error detection and correction mechanisms

Scenarios leading to errors in transmission



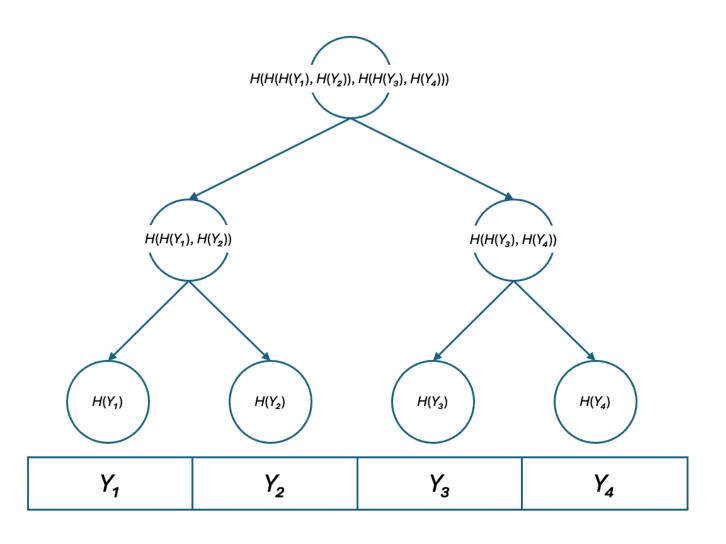
- Memory corruption
- Race conditions
- Buffer overflows
- Implementation bugs
- Hardware malfunctions



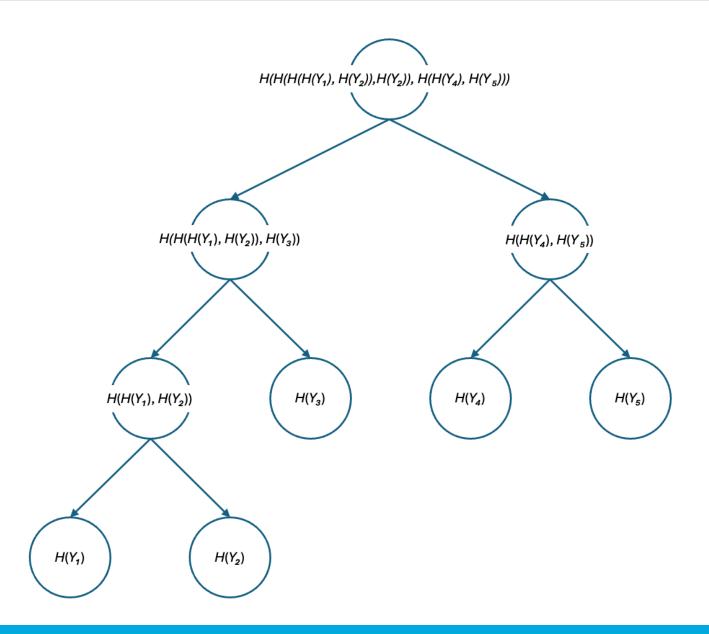


Merkle tree construction



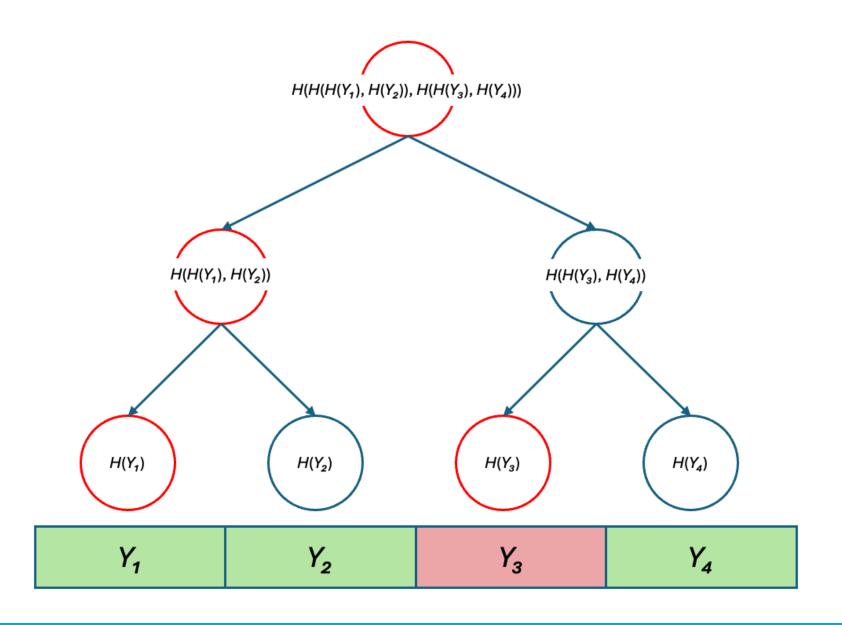






Data validation validation post transmission





Data validation validation post transmission



- Faulty segment detection O(1)
- Faulty segment localization O(logn)
- XXH3 () hashing function
- Data validation and correction communication protocol
- Usage of OpenMP for parallelization
- Implementation of several MPI Point-to-Point and Collective functions



