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Architectural analysis of universal concatenated quantum codes TOMAS JOCHYM-O'CONNOR, Caltech, Institute for Quantum Computing, University of Waterloo, CHRISTOPHER CHAMBERLAND, Institute for Quantum Computing, University of Waterloo, RAYMOND LAFLAMME, Institute for Quantum Computing, University of Waterloo, Perimeter Institute — Concatenated quantum error correction provides a means towards fault-tolerant quantum computation. Moreover, a set of universal gates can be implemented through the concatenation of different error correcting codes, eliminating the need for magic state distillation. This work addresses the architectural costs of such an implementation and compares it to the leading candidate in the field, the surface code. We use a hybrid decoding scheme with a form of message passing between pairs of complementary codes and hard decoding between higher concatenation levels. While providing a favourable asymptotic threshold when compared to other concatenated schemes in the gate error model, we show that the concatenated code construction with the studied decoding algorithm will have high overhead costs when compared to the surface code construction assisted by distillation. We attribute this difference in overhead costs as a result of the difference in fault-tolerance threshold rates between the codes.

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