N-Qubits Pauli Channel

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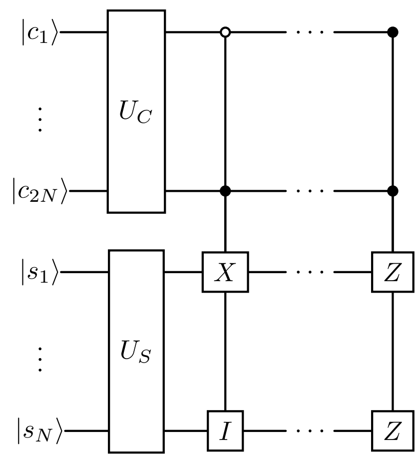
A more complicated quantum channel using the Pauli matrices is considered N qubits. Every qubit can have decoherence: state flip (σ_x), phase-state flip (σ_y)) and a phase flip (σ_z). From this, the Kraus operators have the form $\sigma_i^{\otimes N}$, with $i = 0, x, y, z$, where $\sigma_0 = \mathcal{I}$. The Kraus operators are the Pauli basis for N qubits, so, for N qubits we have $4^N - 1$ operators.

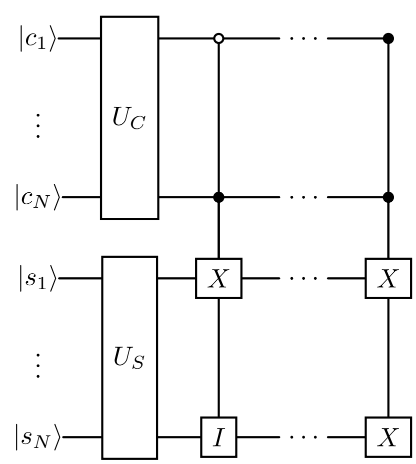
To generate the circuit of this channel we need $4^N - 1$ states, so, we need N qubits for the system and $2N$ auxiliary qubits to control the Kraus operators,



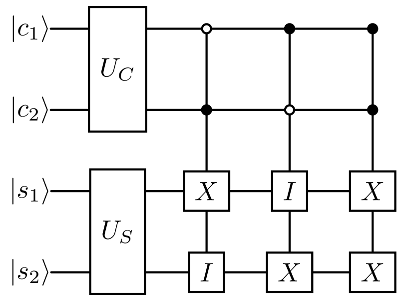
The problem with this circuit is that, even if we consider two qubits, the number of controlled gates is sixteen. In native gates of IBM_torino, the number of gates is 172357, with six qubits. No option to optimize.

A better option is to consider only a state flip, a generalized N qubits bit flip channel. This channel simulates the effect of the environment over N qubits, with the probability of flipping the states.

Since we have 2^N Kraus operator in this generalized bit flip, we only need N control qubits for the environments,



For two qubits, the circuit is



This circuit, with random values for the initial system and the probabilities of the channel, has around 1300 native gates.