EE/ CprE/ SE 491 - sddec23-17

Simulated Design of Quantum Networks

Week 10 Report

April 16 - April 30

Client: Dr. Durga Paudyal

Faculty Advisor: Dr. Durga Paudyal

Team Members:

Benjamin Amick - Network security engineer

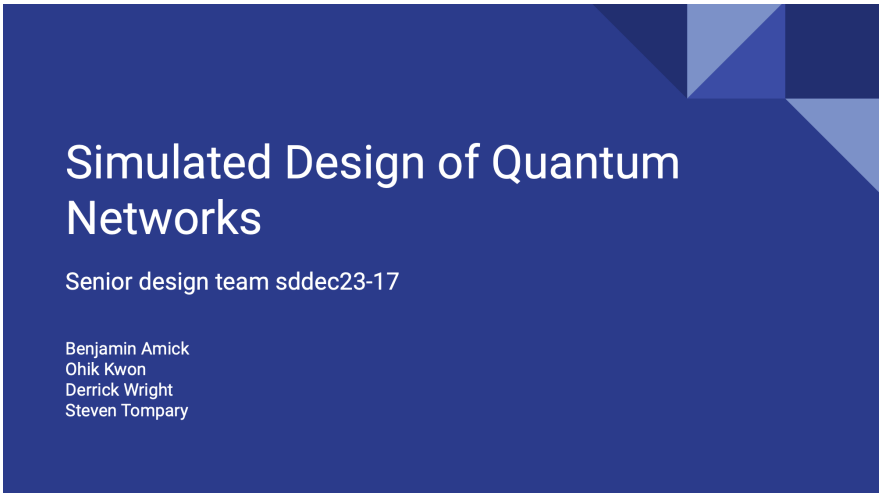
Derrick Wright - System integration engineer

Ohik Kwon- System component designer

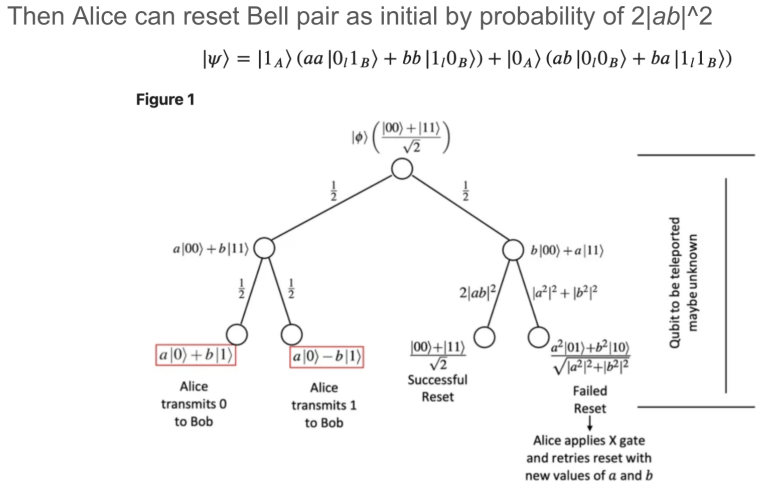
Steven Tompary- Network engineer

Past Week Accomplishments

- During these two weeks, we worked on researching our network design and also worked on class assignments. Especially for our final meeting before the end of this semester, we presented in front of our advisor, Dr. Durga, his colleague, Dr. Smith, and his graduate student Gavin, for getting feedback for improving our presentation. For researching, Ohik researched one bit quantum teleportation skim which might be great for communication efficiency.



[Front page of our final presentation slide.]



[one bit quantum teleportation.]

- **Ben** - Keep evolving pseudocode and prepare a testing presentation.
    - Worked to keep evolving simple pseudo code for our classical network which will distribute jobs to each node.

- Prepared for the testing section for our final presentation, and engineering standard

- **Ohik** - Researched about one bit quantum teleportation, and prepared a quantum computing explanation presentation
  - Keep reading quantum information books.
  - Researched about one bit quantum teleportation which might be useful if we need to design our network with high efficiency
  - Prepared for the explanation of the quantum computing section for our final presentation.

In general, teleportation of N qbits requires 2*ln*(N)

$$|\psi_0\rangle = |\psi\rangle|\beta_{00}\rangle \longrightarrow a|00\rangle + b|11\rangle \text{ or } b|00\rangle + a|11\rangle$$

What if Alice can reset to initial Bell State? => we only need 1 classical bit

How? Use ancillary qbit $\quad |\theta\rangle = c|0\rangle + d|1\rangle$

$$\begin{aligned}|\psi\rangle &= |\theta\rangle\,(a|1_A1_B\rangle + b|0_A0_B\rangle)\\ &= (c|0_l\rangle + d|1_l\rangle)\,(a|1_A1_B\rangle + b|0_A0_B\rangle)\\ &= ca|0_l1_A1_B\rangle + cb|0_l0_A0_B\rangle + da|1_l1_A1_B\rangle + db|1_l0_A0_B\rangle\end{aligned}$$

Apply CNOT. *l* is control, A is target

$$\begin{aligned}|\psi\rangle &= ca|0_l1_A1_B\rangle + cb|0_l0_A0_B\rangle + da|1_l0_A1_B\rangle + db|1_l1_A0_B\rangle\\ &= |1_A\rangle\,(ca|0_l1_B\rangle + db|1_l0_B\rangle) + |0_A\rangle\,(cb|0_l0_B\rangle + da|1_l1_B\rangle)\end{aligned}$$

[key difference between classical Quantum Teleportation and New QT protocol]

- **Steven** - Researched cluster computing and prepared design plan section
  Kept Research about classical cluster computing and routers. Since we're building a quantum network for quantum cluster computing, we still need classical channels and a router to run it.
  Worked on preparing the design plan section for our final presentation.

- **Derrick** - Leaning Qiskit and prepared project management section
  Kept working to search for example jobs for testing. This example job should take quantum information as input data and contain hybrid algorithms.
  Worked for project management section for our final presentation.

Resources

Slides we used during a meeting
https://drive.google.com/drive/folders/1ipsROV9yiffhSprLsNCV0rJlAuP1svb7?usp=share_link
https://docs.google.com/presentation/d/1FbqqJK6LLiZtOYegZfHzIID-3-F7_0wpYRpuU_k3Bw0/edit?usp=sharing

Books we are reading

- Quantum Computation and Quantum Information, Michael A. Nielson

Articles we found this week and reading

- Github Qiskit Community Tutorials
- https://journals.aps.org/prl/pdf/10.1103/PhysRevLett.86.5188
- Entanglement Swapping in Quantum Switches: Protocol Design and Stability Analysis
- https://www.nature.com/articles/s41598-022-06853-w

Pending Issues

- We need to make a plan for summer vacation and for the next semester.
- We need to wrap up our work and save useful resources.

Individual Contributions

Team Member	Contribution	Weekly Hours	Total Hours
Benjamin Amick	Work on pseudo code	5	41
Derrick Wright	Researched Qiskit	5	41
Ohik Kwon	Research quantum information	5	41
Steven Tompary	Work on cluster computing architecture	5	41

Plans for Coming Week

- Share individual research about quantum networks - everyone
- Work collaborate on our final presentation -everyone
- Keep studying about quantum information and computation. Make a plan for Quantum computing study during summer vacation -Ohik
- Keep evolving pseudo code of our quantum router and keep contact with our clients regarding performance of our router. Make a plan for cluster computing network study during summer vacation -Ben
- Keep communicating with Ben regarding quantum network cluster computing. Make a plan for network efficiency study during summer vacation - Steven
- Research regarding sample jobs for our testing which consider quantum input data. Make a plan for Qiskit study during summer vacation- Derrick