Control and Readout Software in Superconducting Quantum Computing

Author: Cheng Guo
Speaker: Jin Lin
1) Layering of quantum computer
2) The structure of Device Control layer
3) Managing the readout signal from digitizers
4) Managing the waveform for AWGs
Introduction
Quantum computers can solve the problem that classical computers cannot accomplish at acceptable cost by harnessing the principles of quantum mechanics. Quantum computers use qubits, which can exist in multiple states simultaneously, to perform operations that classical computers cannot.

Layering and Modularization
Considering the high layering of instruments involved in a superconducting quantum computing system, it is necessary to develop a software platform for quantum computing. Layering and modularization enhance the system to be effective for overcoming software development difficulties. In this paper, we describe the layering architecture shown in Figure 1. The components of the software stack are separated into 6 layers: the lowest layer is the hardware layer, the next two are the control layer and the interface layer, and the upper three are the service layer, the application layer, and the user interface layer.

Readout and Control Server
In order to provide a consistent interface, we abstracted the readout device, which is a fixed number of waveforms, and we use the index number to address the waveforms. The click on the CMS waveform-processing engine can generate axes, graphs, histograms, and provide additional functionalities. Integration, differentiation, and so on, can be done on these histograms. Each waveform-processing engine has several input channels, which are connected to the CMS readout device. Each channel can be utilized to calibrate the waveform-processing engine. The waveform-processing engine can generate multiple waveforms, which can be used to generate multiple waveforms. The readout server is used to acquire and analyze data. The readout server can be configured to provide the data to the CALS daemon, which can then send the data to the control server.

Randomized Benchmarking
The randomized benchmarking approach can be used to characterize the gate fidelity of the quantum computer. As below figure show, in the following tests, the waveform engine produces random sequences of gate operations from the CALS group. And then applying the unique recovery Clifford group. The data for the sequence are calculated and the error rate is obtained. The readout device and control server are securely connected.

Conclusion
Superconducting quantum computing requires a large number of qubits. The high price of commercial qubits makes it difficult to use at a large scale. In addition, commercial qubits cannot meet the requirements of customization and rapid operation change. It is generally used by researchers. In recent years, some research companies have joined the development of new control devices for superconducting quantum computing. New metrics such as the quantum svd are important. In particular, the layering stack of superconducting quantum computing and device control and readout and control server for device control. We explored the application in quantum and comprehensive benchmarking in the end. In the future, the software needs to be further expanded in terms of functions and layers. For functions, function-based readout and control is an important direction. For layers, from device control to gate operation is an irreplaceable change.