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Hardware for dynamic quantum computing experiments: Part I[1] BLAKE JOHNSON, COLM RYAN, DIEGO RISTE, BRIAN DONOVAN, THOMAS OHKI, Raytheon BBN Technologies — Static, pre-defined control sequences routinely achieve high-fidelity operation on superconducting quantum processors. Efforts toward dynamic experiments depending on real-time information have mostly proceeded through hardware duplication and triggers, requiring a combinatorial explosion in the number of channels. We provide a hardware efficient solution to dynamic control with a complete platform of specialized FPGA-based control and readout electronics; these components enable arbitrary control flow, low-latency feedback and/or feedforward, and scale far beyond single-qubit control and measurement. We will introduce the BBN Arbitrary Pulse Sequencer 2 (APS2) control system and the X6 QDSP readout platform. The BBN APS2 features: a sequencer built around implementing short quantum gates, a sequence cache to allow long sequences with branching structures, subroutines for code re-use, and a trigger distribution module to capture and distribute steering information. The X6 QDSP features a single-stage DSP pipeline that combines demodulation with arbitrary integration kernels, and multiple taps to inspect data flow for debugging and calibration. We will show system performance when putting it all together, including a latency budget for feedforward operations.

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Blake Johnson
Raytheon BBN Technologies

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