

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau

(43) International Publication Date
02 November 2023 (02.11.2023)



(10) International Publication Number
WO 2023/211500 A3

(51) International Patent Classification:

G06N 5/01 (2023.01) G06N 10/80 (2022.01)
G06N 10/20 (2022.01) G06N 10/40 (2022.01)

(21) International Application Number:

PCT/US2022/051412

(22) International Filing Date:

30 November 2022 (30.11.2022)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

63/284,722 01 December 2021 (01.12.2021) US
63/378,325 04 October 2022 (04.10.2022) US
17/974,991 27 October 2022 (27.10.2022) US

(71) Applicant: **QUANTINUUM LLC** [US/US]; 303 S. Technology Court, Broomfield, North Carolina 80021 (US).

(72) Inventors: **CHERTKOV, Eli**; 303 S. Technology Court, Broomfield, North Carolina 80021 (US). **DECROSS,**

Matthew; 303 S. Technology Court, Broomfield, North Carolina 80021 (US). **FEIG, Michael**; 303 S. Technology Court, Broomfield, North Carolina 80021 (US). **KOHAGEN, Megan**; 303 S. Technology Court, Broomfield, North Carolina 80021 (US).

(74) Agent: **ZIEGLER, Christopher** et al.; Alston & Bird LLP, Bank of America Plaza, 101 South Tryon Street, Suite 4000, Charlotte, North Carolina 28280-4000 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ,

(54) Title: APPARATUSES, COMPUTER-IMPLEMENTED METHODS, AND COMPUTER PROGRAM PRODUCTS FOR QUBIT REUSE IN A QUANTUM COMPUTING ENVIRONMENT

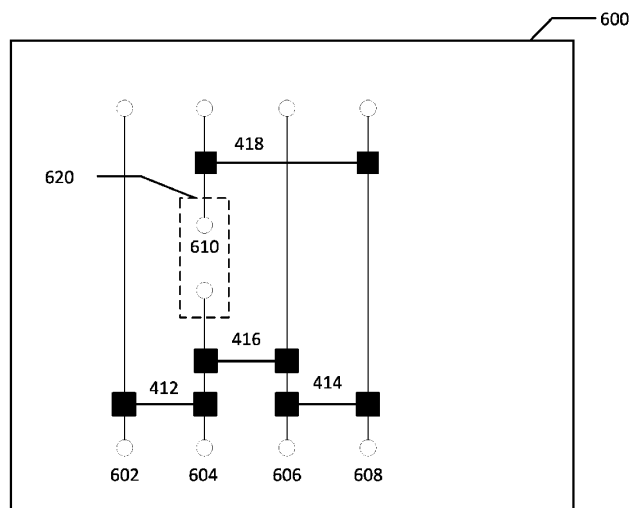


FIG. 6

(57) Abstract: Embodiments of the present disclosure provide for qubit reuse within a quantum computing environment for a quantum program in a quantum computing environment. In this regard, embodiments generate an optimized quantum program based on an initial quantum program. In some embodiments, the optimized quantum program may utilize fewer computing resources, such as qubits, than the initial quantum program. In some embodiments, the optimized quantum program may be compiled and executed in the quantum computing environment.

[Continued on next page]



WO 2023/211500 A3

TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA,
ZM, ZW.

- (84) Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- *as to the identity of the inventor (Rule 4.17(i))*
- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(88) Date of publication of the international search report:

25 January 2024 (25.01.2024)