**Supplementary information**

# An integrated space-to-ground quantum communication network over 4,600 kilometres

# Supplementary Information for Space-ground integrated quantum communication network over 4600 km

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We provide further results for the reliability test for the Jinan QKD network (Fig. S1), the backbone network in 2018 (Fig. S2) and 2019 (Fig. S3), in days (Fig. S4), in hours (Fig. S5), and in minutes (Fig. S6).
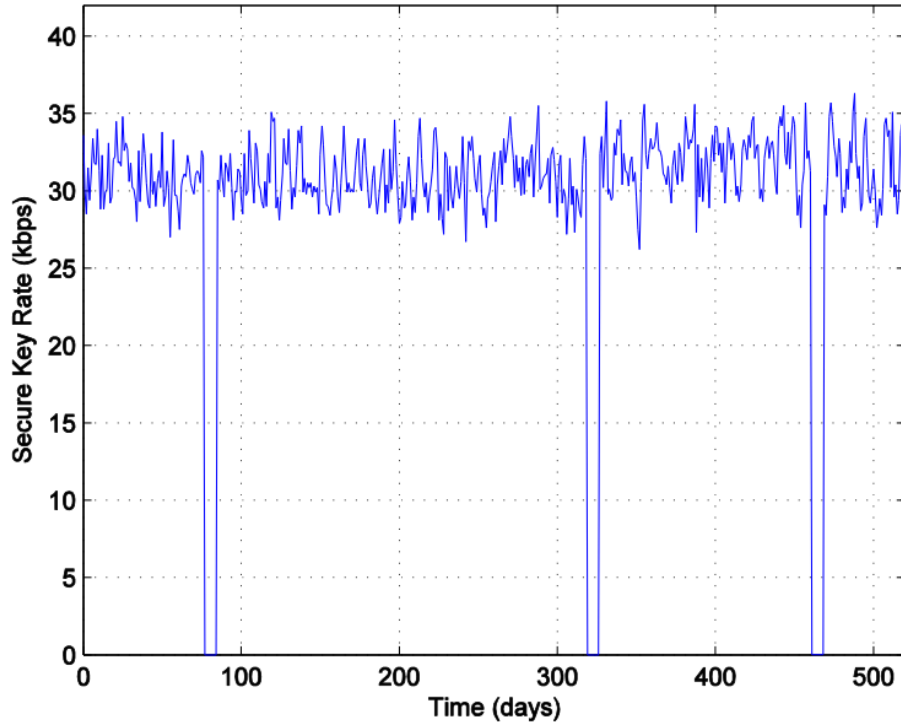
Figure S1: **Reliability test of the Jinan QKD network.** It shows the key rate between two of the three trusted relays, from November 11th, 2013 to April 15th 2015. The key rate is stable for almost all the 516 days except for three periods of national holidays from January 31st to February 7th, 2014, from September 30th to October 7th, 2014, and from February 7th to February 26th, 2015. For safety reasons, the system is shut down during these three periods and therefore the key rate dropped to 0. The fluctuation of the key rate is mainly because of the influence from the environment and node failures. However, as the network is coherently managed, connections between two nodes are optimised in real time. Therefore, the system is reliable and it can still successfully operate even if a few nodes fail to work.
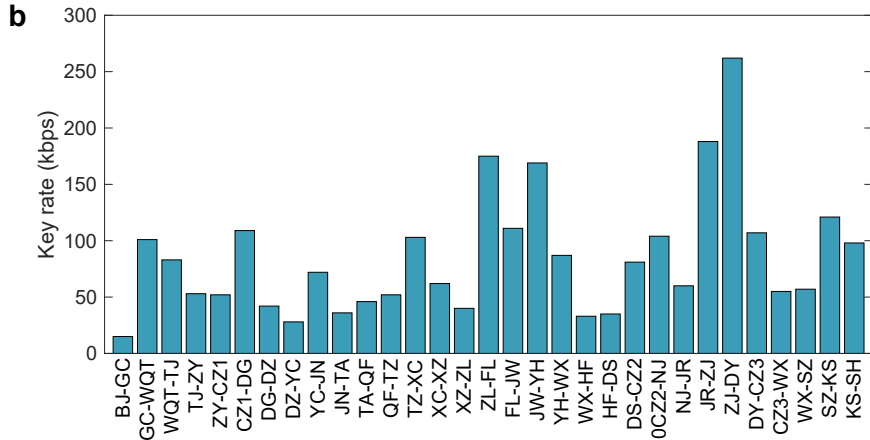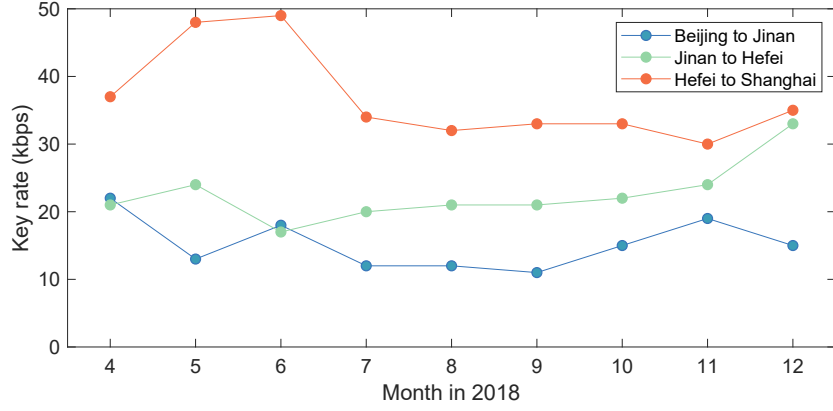
Figure S2: **Reliability test of the backbone network in months from Apr. to Dec. 2018. a,** The plotted data points of the averaged key rates between two cities represent the minimal key rates of all the intermediate backbone connections involved. **b,** The presented data is the averaged key rate over the months in 2018 between two adjacent backbone nodes.
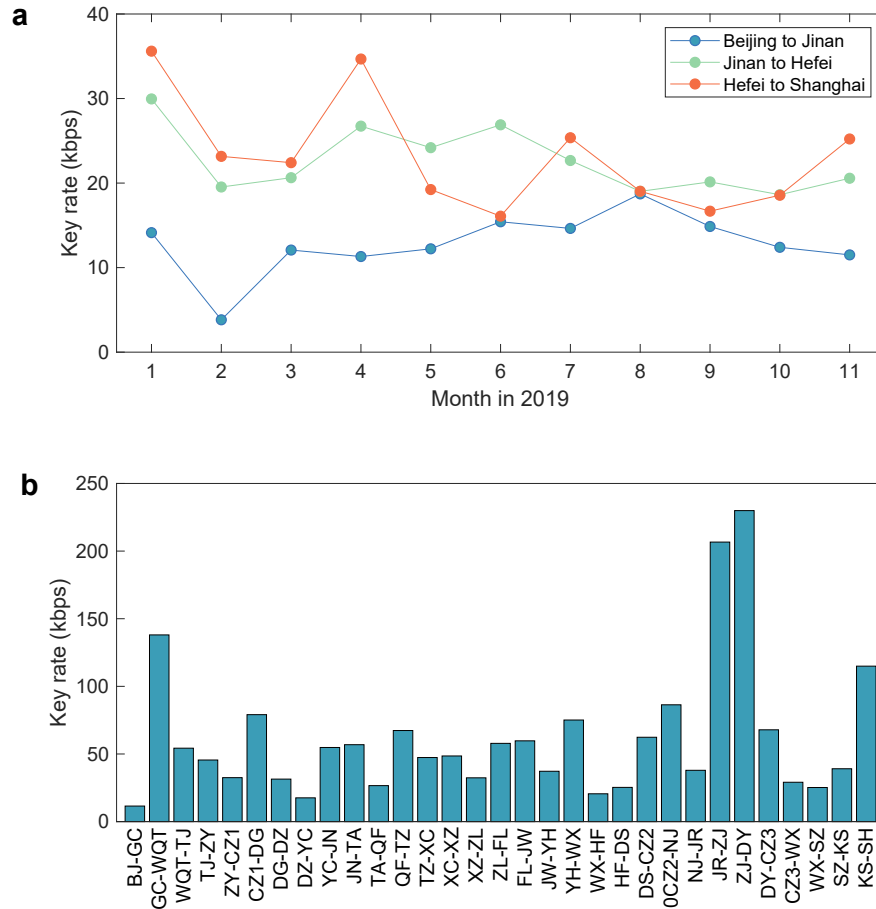
Figure S3: **Reliability test of the backbone network in months from Jan. to Nov. 2019. a,** The plotted data points of the averaged key rates between two cities represent the minimal key rates of all the intermediate backbone connections involved. **b,** The presented data is the average key rate over the months in 2019 between two adjacent backbone nodes.
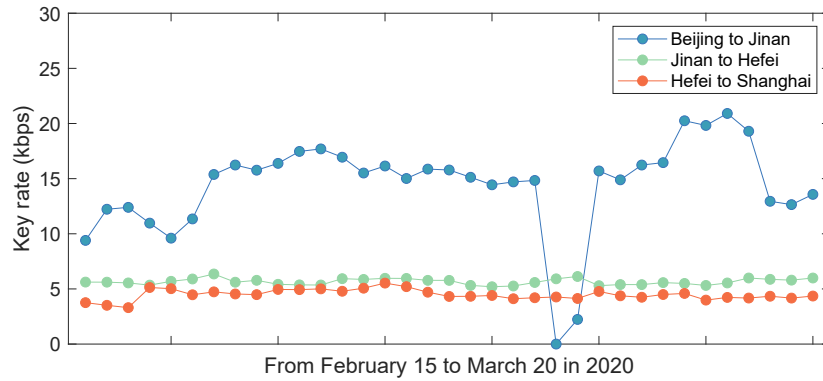
Figure S4: **Reliability test of the backbone network in days from February 15 to March 20 in 2020.** The plotted data points of key rates between two cities represent the averaged key rate over days. Because of the road construction, one of the fiber links was destroyed on March 8th, but the network was recovered on March 9th.
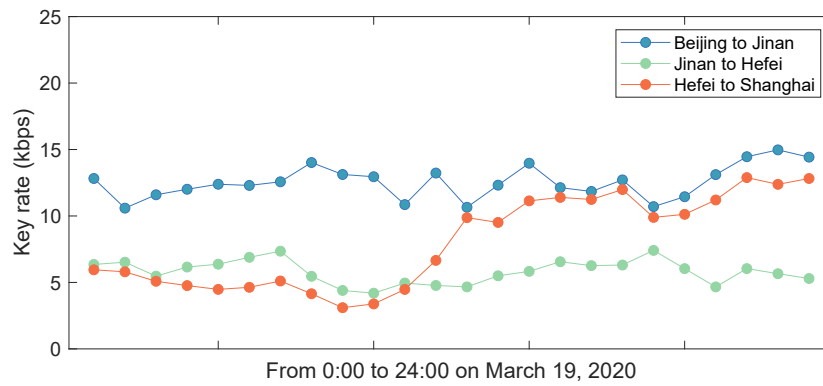


Figure S5: **Reliability test of the backbone network in hours from 0:00 to 24:00 on March 19, 2020.** The plotted data points of key rates between two cities represent the averaged key rate over hours.
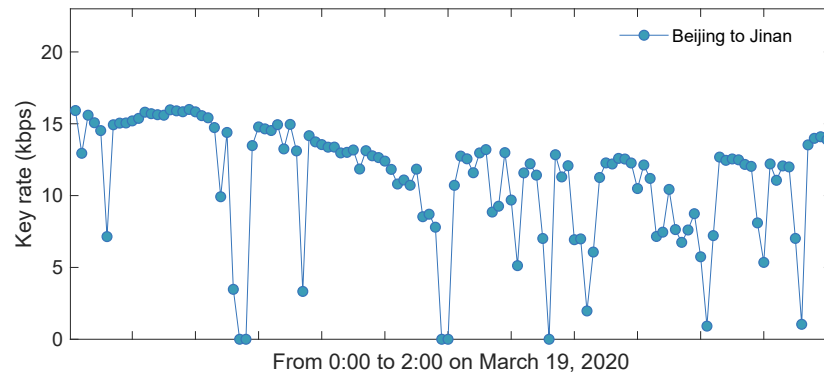
Figure S6: **Reliability test of the backbone network from Beijing to Jinan in minutes from 0:00 to 2:00 on March 19, 2020.** The plotted data points of key rates between two cities represent the averaged key rate over minutes. One can see roughly the fraction of down time is less than 1/10. The cause of down time in the system is mainly due to the polarization fluctuations and polarization feedback control.