An Efficient Random Routing Transmission Mechanism with Raptor Coding and Adaptive Redundancy Control

Yanyan Xue* **, Jiali You* **, Jun Chen* **

*National Network New Media Engineering Research Center, Institute of Acoustics, Chinese Academy of Sciences, Beijing, China

** School of Electronic, Electrical and Communication Engineering, University of Chinese Academy of Sciences, Beijing, China

xueyy@dsp.ac.cn, youjl@dsp.ac.cn chenj@dsp.ac.cn

***Abstract*—Random-routing systems such as KRRD often suffer from long-tail latency and elevated packet-loss rates due to unpredictable routing paths. To address these challenges, we design an efficient random-routing transmission mechanism built upon rateless Raptor coding. By leveraging its strong end-to-end forward error-correction (FEC) capability, the proposed mechanism effectively mitigates performance degradation caused by long-tail effects (excessive session completion time). To further improve transmission efficiency, we introduce an adaptive redundancy regulation scheme driven by decoding-state feedback, referred to as ARRCT. The receiver dynamically reports redundancy requirements according to real-time decoding progress and the observed packet-loss rate, enabling the sender to inject additional coded packets on demand. This closed-loop adaptation strikes a balance between transmission reliability and bandwidth utilization. ns-3 simulation results show that, for packet-loss rates between 0.01% and 1.0%, ARRCT reduces session completion latency by approximately 10%–20% compared with baseline random-routing schemes. Under severe loss conditions, ARRCT maintains a high decoding probability and significantly enhances the robustness of random-routing covert communication systems.**

***Keyword*—Adaptive redundancy, Forward error correction, KRRD, Raptor code, Random routing.**

Yanyan Xue received the B.E. degree from Northeastern University, Shenyang, China. She is currently pursuing the graduate degree with the National Engineering Research Center for Network New Media, Institute of Acoustics, Chinese Academy of Sciences, Beijing, China. Her research interests include secure transmission and reliable transmission.

Jiali You is an professor of the National Network New Media Engineering Research Center, Institute of Acoustics (IOA), Chinese Academy of Sciences (CAS). Her research interests include distributed network and network intelligence.

Jun Chen is a Professor with the National Network New Media Engineering Research Center, Chinese Academy of Sciences, China. She received the Ph.D. degree in signal and information processing from the Institute of Acoustics, Chinese Academy of Sciences, in 2004. Her research interests include broadband communication and future networks.