

40. Research and Application Test of Communication Schemes for Differential Protection of Distribution Network Based on 5G

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0 Introduction

5G uRLLC provides latency as low as tens of milliseconds, which could be applied in control and protection systems, such as differential protection. However, to ensure the optimal operational performance, it is necessary to collect more application data through field test under variable 5G environment.

Typical Communication schemes of 5G Differential Protection

Mode	A	B
Packet Frequency	1200/second	150/second
Size of Packet	150 bytes	250 bytes
Protocol	UDP	TCP
Packet Redundancy	Yes	No

1 Main Conditions of Test

Test Conditions: A 5G SA(Standalone) test network is built in the laboratory, and 5G CPE on both sides are under the same indoor base station. Data exchange between internal and external networks is realized through DMZ(Demilitarized Zone).

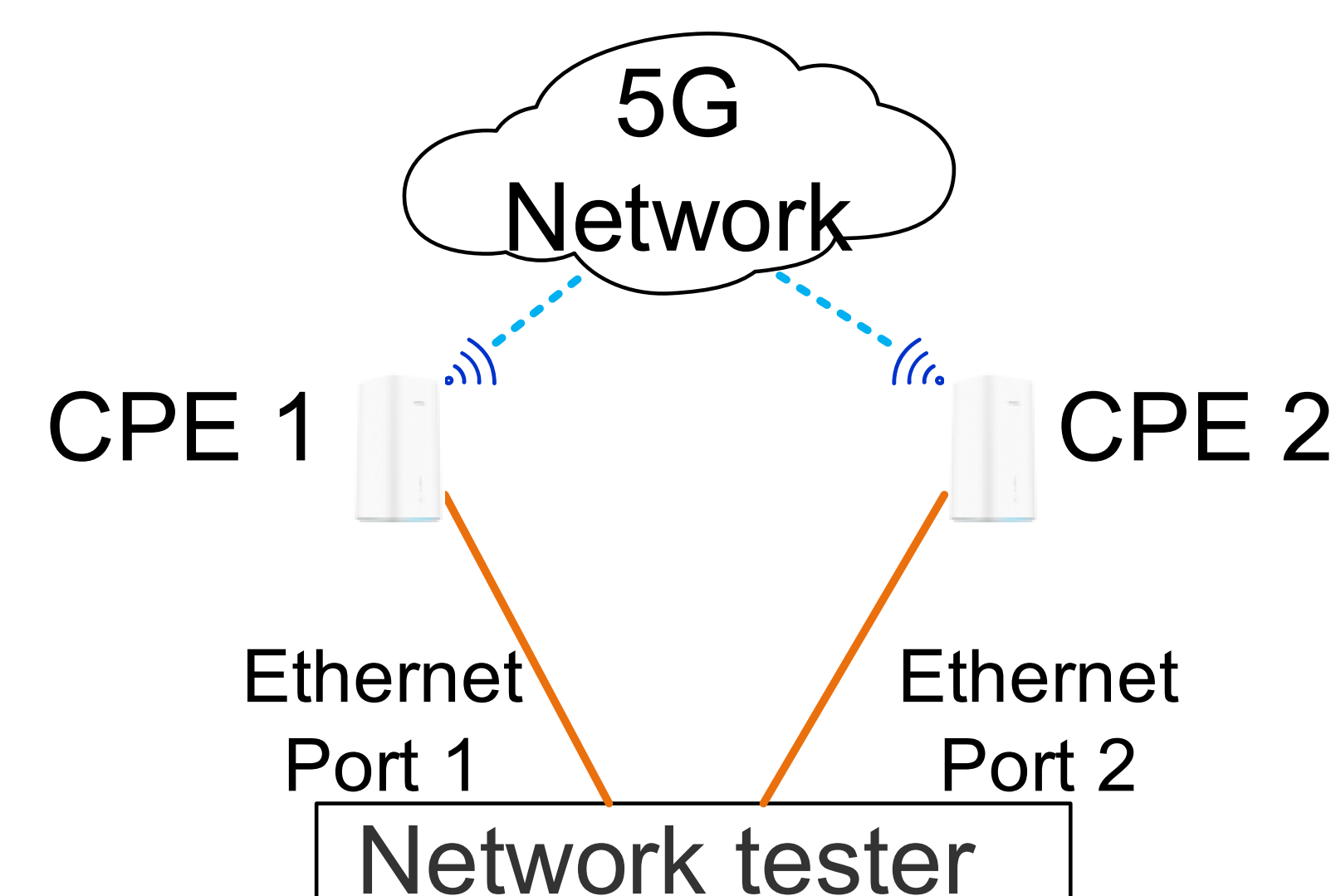
5G Network: In terms of access network, two kinds of 5G base stations are tested. One is the public indoor base station(5G Public Network). Another is to put the indoor base station in a shielding box (5G Private Network), simulating hard slicing with 100% resource isolation.

Typical 5G CPE tested

Type	Components	Baseband	Application
A	Chipset	Balong 5000	Commercial
B	Module	Snapdragon X55	Industrial
C	Module	Balong 5000	Industrial

2 Wiring and Content of Tests

More than 200,000 packets are tested every time. Therefore, test time for Mode A is 5 minutes, and for Mode B is 25 minutes.



3 Test Results

a. Latency of Mode A and B

Test Case	Route	AvgLatency	MaxLatency
CPE A/ Private Network/ Mode A	1	6.47ms	92.42ms
	2	6.81ms	41.56ms
CPE A/ Private Network/ Mode B	1	6.02ms	15.09ms
	2	6.64ms	16.96ms

(Route 1: CPE1→2, Route 2: CPE2→1)

The maximum latency can be significantly reduced by packing the sampling points once every eight points(Mode B).Excessively frequent packet delivery will increase the network burden.

b. Latency of Private and Public Networks

Test Case	Route	AvgLatency	MaxLatency
CPE A/ Public Network/ Mode A	1	150.04ms	306.72ms
	2	14.12ms	120.49ms
CPE A/ Public Network with QoS/ Mode A	1	190.41ms	272.14ms
	2	179.71ms	310.29ms
CPE A/ Private Network/ Mode A	1	6.47ms	92.42ms
	2	6.81ms	41.56ms

The interference from other services greatly increases the maximum Latency, while QoS of packet has little effect to improve it. Therefore, the average latency and stability of private network are the best.

c. Latency of different 5G CPE

Test Case	Route	Avg Latency
CPE A/ Private Network/ Mode A	1	6.47ms
	2	6.81ms
CPE B/ Private Network/ Mode A	1	12.60ms
	2	14.13ms
CPE C/ Private Network/ Mode A	1	10.91ms
	2	7.90ms