

Full Report of Service Disruption on 4 January 2017

1. Introduction

On 4 January 2017, a UPS power outage happened at an IT data center, in which a RADIUS server was down, causing service disruption of China Mobile Hong Kong Company Limited (“CMHK”) network partially. This full report provides detailed description of events that led to the occurrence of service disruption, remedial actions taken and improvement measures to be taken.

2. Service Disruption on 4 January 2017

2.1 Events Leading to the Occurrence of the Outage

On 4 January 2017 at around 11:30am, one of two UPS at an IT data center was failed, which caused power interruption to some equipment connected thereto. This affected some IT application servers including a RADIUS server which was used for user accounting purpose. This caused mobile data service interruption to some users in 2G/3G/4G network and VoLTE voice call failures. Minor value-added services including WAP data service and MMS were also interrupted, as the WAP gateway and RADIUS server were deployed in the same hardware.

CMHK IT data center is located separately from Mobile Switching centers which were not affected in this incident. There was no outage of CMHK mobile radio and core network equipment in any of the Mobile Switching centers in this incident.

During the time when RADIUS server had problem between 11:30am and 12:15pm, high load occurred in some core network nodes (PCRF, HLR, MSC) due to high volume of network attach and call re-attempts. This resulted in network congestion affecting mobile data and voice

services. After trouble shooting, CMHK engineers started to bypass RADIUS server at 12:15pm, from which network service was restored progressively. The network data and voice traffic was gradually back to normal level at 1:45pm.

At 12:35pm, power supply to affected equipment was resumed with city power.

2.2 Event History Log

Time	Event Description
Around 11:30am	<ul style="list-style-type: none"> ● Network alarm alerts were received ● Engineers started trouble shooting and conducted voice & data call testing. ● Found newly setup mobile data service and VoLTE call failed.
11:35am	<ul style="list-style-type: none"> ● On-site engineer reported one UPS at IT data center was down, and 2 MCCB were tripped including the AC Main MCCB of UPS (200A) and one output MCCB (63A). ● Conducted network investigation, and decided to bypass RADIUS server query during mobile data service setup.
12:15pm	<ul style="list-style-type: none"> ● Started configuration of PGW nodes to bypass RADIUS server query. ● Mobile data and voice service was started to resume gradually. ● UPS vendor support arrived at data center, and started trouble-shooting of the power failure.
12:35pm	<ul style="list-style-type: none"> ● Vendor engineer bypassed the UPS to city power, and power supply to affected equipment was resumed. ● Engineers started to resume website applications, which were not affecting the mobile network services.
12:40pm	<ul style="list-style-type: none"> ● Confirmed mobile data and VoLTE call OK. ● Informed OFCA that the network service

	started resume gradually.
Around 1:45pm	● The network data and voice traffic was mostly back to normal level.

2.3 Remedial Actions taken

At 12:15pm, engineers started configuration of PGW nodes as RADIUS unacknowledged mode, in order to bypass RADIUS server. In this mode, PGW can ignore any Accounting-Response messages sent from RADIUS server during data session setup. This enabled PGW nodes to set up new data session, disregard of the query response from RADIUS server for user accounting purpose. The network service was then restored progressively. The network data and voice traffic was mostly back to normal level at 1:45pm.

Regarding the UPS outage, vendor engineer arrived on site at 12:15pm. Vendor engineer bypassed the UPS to city power, and power supply to affected equipment was resumed at 12:35pm. Engineers started to resume website applications, which were not affecting the mobile network services. IT applications including CMHK Corporate website were resumed after 10:30pm. Vendor replaced the faulty components of the failed UPS, and resume UPS power supply after midnight.

2.4 Root cause analysis

One of two UPS at an IT data center failed. Some equipment only connected with the failed UPS were shut down due to power supply interruption. One of the affected equipment was RADIUS server, which was used for user accounting purpose of mobile data application service. In normal operation, PGW would query RADIUS server for user accounting information before setting up a data service for a customer. As PGW received no response from the failed RADIUS server, it resulted in new mobile data service setup failure.

During RADIUS server problem between 11:30am and 12:15pm, high load occurred in some core network nodes (PCRF, HLR, MSC) due to high volume of network attach and call re-attempts. This resulted in network congestion, affecting network data and voice services.

Additional software resources were allocated to the congested nodes in order to relieve the traffic congestion.

To ensure the stability of Electrical facilities and UPS power in IT data center, CMHK has entered into regular maintenance contracts, in which monthly and quarterly Preventive Maintenance (PM) are included respectively. The last PM for electrical facilities and UPS were conducted in 30-Dec-2016 and 22-Nov-2016 respectively, and no problem was found in these PM.

UPS support vendor had provided an incident report of the outage. In this incident, the UPS input 200A MCCB and the output 63A MCCB for DB-4 were tripped. The other UPS output 63A MCCBs for DB-1, DB-2 and DB-3 were not tripped. During the investigation, the insulation test of the output power cables was passed. No burn mark and smell were found inside the UPS, distribution boards (DBs) and the cables. One IT server connected to DB-4 could not be switched on again by providing temporary power. The equipment connected to DB-1, DB-2, DB-3 and DB-4, except the faulty IT server, could be switched on and work normally with city and UPS power. The faulty IT server had been disconnected from DB-4 of UPS. UPS vendor concluded that the fault on the IT server in DB-4 caused a large UPS output current which made:

- a) the tripping of UPS output 63A MCCB for DB-4;
- b) the shutdown of UPS inverter power and also the failure of one power module;
- c) the failure of static bypass module to transfer UPS to static bypass output from the inverter output;
- d) the tripping of UPS input 200A MCCB, which is also the bypass input of the UPS.

Vendor replaced the faulty power module and static bypass module to start up the UPS system again after midnight. UPS power for the affected equipment were then resumed.

2.5 Number of affected customers

The outage affected mobile data service and voice calls for some customers. Based on network statistics, the total number of active customers in CMHK 2G/3G/4G network has been decreased by a maximum of 189,172 during the incident period, as compared with same period in previous Wednesday (28-Dec-2016). These affected customers could not log on CMHK network and use any network service.

3. Communication with the Public

CMHK had communicated with customers, local media, and the general public about the service disruption via the following channels on the day of the incident.

1. Retail, Corporate Sales and Hotline staff
2. Facebook
3. Media

3.1 Retail, Corporate Sales and Hotline staff

To align the communication messages, CMHK had notified Retail, Corporate Sales and Hotline staff with a consistent verbiage for response to customers' enquiry during and after the incident.

We had also immediately adjusted manpower in Customer Services Hotline center to answer the influx of customers' enquires.

3.2 Facebook

Messages and announcements were posted in CMHK official Facebook during and after the incident, informing customers of the network service disruption and service recovery status.

3.3 Media

CMHK had kept following up with the media and immediately responded to their queries during and after the incident.

4. Improvement Measures

- The dual power feeds of RADIUS server had already been re-connected separately to two UPS sources at the night of 4-Jan-2017.
- Site resiliency for RADIUS servers will be implemented in Mobile Switching centers by June 2017, to replace the old one in IT data center.
- We have also planned to relocate the IT data center to our new Mobile Switching center before the end of 2017 for better building facility security.

China Mobile Hong Kong Co. Ltd.

Date: 24-Jan-2017