Incident Report on Service Disruption on 27 February 2018

1. Introduction

This report is submitted to OFCA by China Unicom (Hong Kong) Operations Limited ("China Unicom" or "we") on an incident occurred on 27 February 2018 relating to a service disruption in our MVNO network ("Incident"). We submitted a preliminary report on 2 March 2018 ("Preliminary Report") and this report aims to provide additional information on the Incident in order to assist OFCA's investigation.

China Unicom regrets the inconvenience caused to our customers and we are determined to ascertain the root cause of the Incident and make necessary improvements to prevent occurrence of similar incidents in future.

2. Incident Description

2.1 Events leading to the occurrence of the Incident

At around 10:50 on 27 February 2018, our Network Operations Centre ("NOC") observed that large number of customers had failed to complete the "Location Update" ("LU") process in our MNVO network ("Network"). The service disruption was found to be caused by a core dump problem resulting in malfunction of the 1-Card-Multi-Number system ("1CMN System"), which is responsible for managing the Signaling System No.7 (SS7) messages between MSC and HLR in the Network. As a result, our "1-Card-Multi-Number" service customers who failed to complete the LU process were unable to access our data services, SMS and voice services.

2.2 Event Log

Time and Date	Event Description
10:50 2018-02-27	Our NOC observed that large number of customers had failed to complete the LU process. The problem was immediately escalated to our Tier 2 network engineers and relevant vendors for investigation.
11:17 2018-02-27	Our support engineers detected the problem was caused by the 1CMN System and escalated to our 1CMN System vendor for investigation. Vendor remotely logged in the 1CMN System platform for

	troubleshooting. At the same time, the preliminary data obtained from the system indicated that the number of affected customers had been increasing and our NOC informed OFCA of the outage accordingly.
11:30 2018-02-27	Our vendor found that the drop in the successful rate of LU process is caused by a core dump problem in the 1CMN System, resulting in malfunction of the 1CMN System. They performed software reset action to the 1CMN System immediately under our permission.
13:00 2018-02-27	The vendor performed restoration actions to the 1CMN System but it could not take up traffic as normal. In parallel, our support engineers started to proceed with diverting the traffic to HLR directly, bypassing the 1CMN System, whereby leaving the 1CMN System idle for further remedial action.
14:20 2018-02-27	All MO call gradually resumed after the bypass action completed. Data service was 100% resumed provided that customers' handsets completed the LU process.
15:00 2018-02-27	Our vendor confirmed that the 1CMN System had been successfully restored. However, since the root cause of the core dump problem was yet to be identified, detailed testing was conducted to verify its proper functioning before re-diverting the traffic back to the 1CMN System.
16:15 2018-02-27	Our support engineers started re-diverting the traffic to the 1CMN System. The 1CMN System started to take up traffic in a controlled manner.
16:30 2018-02-27	All mobile services including data, SMS and voice resumed normal upon completion of LU of customers' handsets.

3. Remedial actions taken

After the Incident, our support engineers and vendor took urgent remedial actions to restore the 1CMN System but it could not take up traffic as normal.

Our support engineers worked in parallel to bypass the 1CMN System by diverting the traffic to HLR directly. The 1CMN System was left idle for further remedial action. The bypass action completed at 14:20 and all MO call service gradually resumed and data service 100% resumed. The 1CMN System was successfully restored by 15:00. However, since the root cause of the core dump problem was yet to be identified, detailed testing was conducted to verify its proper functioning before re-diverting the traffic back to the 1CMN System. At around 16:15, our support engineers started re-diverting the traffic to the 1CMN System and the 1CMN System started to take up traffic in a controlled manner. All mobile services including data, SMS and voice resumed normal at 16:30 upon completion of LU of customers' handsets.

4. Root cause analysis and problem resolution

Based on the investigation conducted jointly by us and vendor so far, the failure of LU process was caused by hardware fault and software bug which led to software operation error and failure of protection mechanism resulting in the malfunction of the 1CMN System.

5. Number of affected customers

We estimate that around 138,157 customers of our "1-Card-Multi-Number" service/ products who failed to complete the LU process, or 15.78% of our active customers, were affected.

6. Communication with the public

Soon after the coverage of affected customers was identified, we communicated with our customers, media and public on the Incident via the following channel:

6.1 Our website http://www.cuniq.com: Pop-up announcement was posted on our website at 12:11 on 27 February 2018. We also informed our customers that all services had resumed normal at 19:00 on the same day.

6.2 Facebook: Announcement was posted on our official Facebook at 13:41 on 27 February 2018. At 19:21 on the same day, we informed our customers that our services had resumed normal.

6.3 Contents of the announcements referred to in 6.1 and 6.2 above are set out in the table below:

Facebook Time	Website Time	Announcement
27 Feb 2018 13:41	27 Feb 2018 12:11	中國聯通(香港)運營有限公司，網絡服務出現故障，導致部份客戶的服務出現問題 (話音及短訊), 現在搶修中。服務正陸續回復正常。對用戶造成任何不便，深表歉意。
27 FEB 2018 19:21	27 Feb 2018 19:00	由於今日 11 時左右出現的網絡設備軟件故障，引致部分客戶的流動通訊服務受到影響。經全力搶修，受影響客户於 14 時 20 分起陸續恢復正常。我們對受本次故障影響的客户深表歉意，同時也感謝客户在服務受影響期間的包容與理解。 個別客戶如仍然未能使用服務，可以嘗試以下操作解決： 1、重新啟動手機；或 2、嘗試手動選擇網絡，點選其他運營商，再選擇 Unicom HK； 如仍未解決，請致電客服熱線 2122 1188，或瀏覽 www.cuniq.com 點選 Online Chat 解決。

6.4 Customer hotline: We had immediately increased manpower at our customers' service hotline center to answer inquiries from customers. Details of the time and contents of the information provided to our hotline staff are as follows:

Date & Time	Contents
27 February 2018, 12:00	我們有收到部份客戶反映, 語音服務出現問題, 現正核查中, 請問你現時位置是在那裡? 我記錄下來交給工程部, 請稍後再試

6.5 During and after the Incident, we received complaints from a total of 3,731 customers (including pre-paid and post-paid customers) at our retails outlets and customers' service hotline. 276 complaints received via social media.

7. Improvement measures

The root cause of the problem was due to new additional hardware fault and software bug which led to software operation error and failure of protection mechanism resulting in the malfunction of the 1CMN System. Actually, the redundancy and protection mechanism of 1CMN System had been considered during the design of the network architecture and capacity expansion, and effectively implemented thereafter. China Unicom has already made the best effort to avoid the possibility of the outage and the Incident was indeed uncontrollable.

China Unicom (Hong Kong) Operations Limited
19 March 2018