FINAL DECISION OF
THE COMMUNICATIONS AUTHORITY

DISRUPTIONS OF THE TELECOMMUNICATIONS SERVICES OF HONG KONG BROADBAND NETWORK LIMITED

Telecommunications Licensee Investigated:	Hong Kong Broadband Network Limited ("HKBN")
Issue:	Disruptions of the fixed broadband services of HKBN on 8 June 2019
Relevant Instruments:	General Condition ("GC") 5.1 of HKBN's Unified Carrier Licence ("UCL") (Licence No. 045)
Decision:	No breach of GC 5.1 of HKBN's UCL (Licence No. 045)
Sanction:	N/A
Case Reference:	LM T 82/19 in OFCA/R/R/134/2 C

BACKGROUND

At about 7:42 a.m. in the morning of 8 June 2019, the Office of the Communications Authority ("OFCA") learnt from news report that there was disruption of HKBN's fixed broadband and Internet Protocol ("IP") telephony services. Having conducted some preliminary tests, OFCA contacted HKBN at about 8:17 a.m. and received its confirmation that a network outage had occurred causing disruption of fixed broadband and IP telephony services during the period from about 2:21 a.m. to 6:51 a.m. in the early morning (the "first incident"). About six and a half hours later (i.e. at about 1:11 p.m.) on the same day of 8 June 2019, HKBN reported to OFCA that there was another disruption of its fixed broadband and IP telephony services (the "second incident"). OFCA activated the Emergency Response System[1] in both

[1] Emergency Response System is the communication arrangement for maintaining contacts among OFCA and all the major public telecommunications network service operators when there is a risk of possible network congestion or network outage which may affect the general public.

incidents and kept in close contact with HKBN to monitor the situation throughout the incidents.

THE SERVICE DISRUPTIONS

The First Incident

2. According to HKBN, the first incident occurred at about 2:21 a.m. on 8 June 2019. Its network operating centre ("NOC") engineers observed that there were failure alarms from each of the main control boards of two core routers at its two engineering centres (hereinafter referred to as "Router A" and "Router B" and collectively referred to as "Routers"). The two Routers, operating in an active-active arrangement, acted as the main gateway routers for routing data traffic to and from end users within HKBN's network for the provision of its fixed broadband and IP telephony services. Owing to the malfunction of the Routers, some customers' access to the fixed broadband and IP telephony services of HKBN was affected. At about 3:05 a.m., the NOC engineers reported the problem to HKBN's senior management and requested its vendor to provide immediate support for on-site trouble-shooting and investigation. Upon confirmation of the problem, its NOC engineers attempted to restore the affected services by performing hardware reset of the two Routers, but without success. Having conducted further trouble-shooting and analysis, its vendor suggested modifying the configuration of the two Routers at about 5:50 a.m. by temporarily disabling the traffic monitoring function so as to free up memory space. Upon completion of the above-mentioned procedures at about 6:51 a.m., the two Routers were stabilised and all the affected services began to resume normal. The network outage lasted for about four and a half hours. About [✂] customers of HKBN using fixed broadband services (representing about 15.9% of its customer base) and [✂] customers of HKBN using IP telephony services (representing about 0.9% of its customer base) were affected.

The Second Incident

3. At about 1:11 p.m. on the same day of 8 June 2019, HKBN's NOC engineers observed that there were error logs generated by Router B while Router A was in normal operation. Similar to the first incident, HKBN's fixed broadband and IP telephony services were disrupted. At about 1:50 p.m., its

NOC engineers carried out procedures to power off Router B, and its fixed broadband and IP telephony services began to resume normal afterward.

4. At about 3:20 p.m., HKBN's vendor identified that the above two incidents were caused by abnormal Border Gateway Protocol announcement messages with an attribute length longer than [✂] units[2] ("abnormal announcement messages") sent from an interconnected telecommunications network operator exchanging data traffic with HKBN in the upstream direction through the Internet (the "Upstream Carrier"). At about 3:41 p.m., its NOC engineers disconnected the Upstream Carrier from Router B and the problem no longer persisted. At about 4:37 p.m., its NOC engineers applied filtering function to the two Routers to discard the abnormal announcement messages[3] and Router B was brought back into normal operation at about 4:45 p.m. after the filtering function was enabled. The network outage in respect of the second incident lasted for about 39 minutes. About [✂] customers of HKBN using fixed broadband services (representing about 23.9% of its customer base) and [✂] customers of HKBN using IP telephony services (representing about 1.6% of its customer base) were affected.

OFCA'S INVESTIGATION

5. According to the criteria set out in the "Guidelines for Cable-based External Fixed Telecommunications Network Services Operators and Internet Service Providers for Reporting Network and Service Outage" issued by OFCA ("the Guidelines")[4], the two incidents were regarded as Internet service outage and HKBN is required to report to OFCA since the criterion of an outage of core network (as caused by failure of the Routers) affecting more than 10 000 users for more than 30 minutes was met. As a large number of HKBN's customers of fixed broadband services were adversely affected, OFCA considers it necessary to conduct an investigation into the two incidents to –

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[2] Border Gateway Protocol ("BGP") is a routing protocol that is used to exchange routing and reachability information between gateway routers. According to HKBN, the typical attribute length of announcement messages would be less than 100 units or 400 bytes.

[3] According to HKBN, the Routers were configured to discard those announcement messages with attribute length exceeding the maximum allowable length of [✂] units.

[4] A copy of the "Guidelines for Cable-based External Fixed Telecommunications Network Services Operators and Internet Service Providers for Reporting Network and Service Outage" is available at – https://www.coms-auth.hk/filemanager/statement/en/upload/286/gn_201403e.pdf.

(a) examine whether HKBN has breached GC 5.1 of its UCL (Licence No. 045), which stipulates that –

"5.1 The licensee shall, subject to Schedule 1 to this licence and any special conditions of this licence relating to the provision of the service, at all times during the validity period of this licence operate, maintain and provide a good, efficient and continuous service in a manner satisfactory to the Authority…"; and

(b) review the remedial actions taken by HKBN in handling the incidents (including the efficiency of service restoration, the communications with OFCA and customers, etc.) to examine whether there is any room requiring improvements by HKBN.

6. For the two incidents, HKBN submitted, as per OFCA's request, a preliminary report[5] on 12 June 2019 and a full report[6] on 3 July 2019. In the course of OFCA's investigation, HKBN also provided supplementary information in response to OFCA's enquiries about the two incidents.

7. OFCA received two consumer enquiries about the two incidents with one on the arrangement for termination of service contract with HKBN due to service disruptions and the other on release of information about the two incidents to members of the public. HKBN received a total of 3 333 complaints which were all settled with its customers. OFCA completed its investigation and submitted its findings to the Communications Authority ("CA") on 17 December 2019. Having considered the findings and assessment of OFCA, the CA issued its Provisional Decision to HKBN on even date and invited HKBN to make representations on the CA's Provisional Decision within 14 days. HKBN submitted its representations on the CA's Provisional Decision on 2 January 2020, indicating that it had no comment thereon.

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[5] The public version of the preliminary report regarding the incidents of HKBN may be downloaded from OFCA's website at https://www.ofca.gov.hk/filemanager/ofca/en/content_723/hkbn_report_20190612.pdf.

[6] The public version of the full report regarding the incidents of HKBN may be downloaded from OFCA's website at https://www.ofca.gov.hk/filemanager/ofca/en/content_723/hkbn_report_20190703.pdf.

MAJOR ISSUES AND OFCA'S ASSESSMENT

The Cause of the Incidents and the Adequacy of HKBN's Preventive Measures

HKBN's Representations on the First Incident

8. According to HKBN, the first incident was caused by the abnormal announcement messages that were continuously received from the Upstream Carrier, causing abnormally high memory usage and subsequent memory overflow of the two Routers. HKBN explained that when there was memory overflow in the Routers, the master main control board would switch to the slave main control board in an attempt to recover from the problem of memory overflow. However, during the recovery process, the Routers became unstable and were not able to function properly for a few minutes. As the abnormal announcement messages were received by the Routers continuously, all of the main control boards were reset and switched over repeatedly.

9. Even though HKBN had put in place relevant resilience and protection measures for its network (such as master/slave main control boards in each Router, more memory to handle announcement messages with an attribute length up to [✂] units etc.), the problem due to the abnormal announcement messages persisted and caused repeated reset of all main control boards of the two Routers, which subsequently led to disruptions of the fixed broadband and IP telephony services. As the root cause of the first incident could not be identified during the material time, HKBN modified the configuration of the two Routers by temporarily disabling the traffic monitoring function as an interim measure to address the problem of abnormally high memory usage. Upon completion of the re-configuration, operation of the two Routers became stable and all the affected services began to resume normal.

10. HKBN submitted that the root cause of the first incident was beyond its control since it was caused by the abnormal announcement messages that were continuously received from the Upstream Carrier. According to HKBN, both the software and hardware of the Routers were supplied by a reputable telecommunications equipment vendor (the "Vendor"). The resiliency and protection mechanisms of the Routers had been considered and incorporated into the design of the network architecture. HKBN emphasised that the first incident was caused by a problem which was unknown even to the

Vendor before the material time, and as such it was beyond the capability of the Vendor to contemplate and prevent the occurrence of the incident. According to HKBN, there was no evidence suggesting that it had ever received similar abnormal announcement messages from the Upstream Carrier prior to the first incident. HKBN also had no information as to whether it was the only network operator which received those abnormal announcement messages during the material time.

11. In order to avoid recurrence of similar incidents, HKBN submitted that following the first incident, it had –

(a) liaised with the Vendor to review the performance of the Routers and investigate into the root cause of the incident; and

(b) made arrangement to closely monitor the status of the Routers.

HKBN's Representations on the Second Incident

12. According to HKBN, the second incident was also caused by the abnormal announcement messages that were continuously received from the same Upstream Carrier. However, unlike the first incident, only Router B was found unstable during the material time.

13. HKBN submitted that similar to the first incident, the second incident occurred when the Vendor was investigating into the root cause of the first incident and was beyond the control of HKBN. Indeed, as soon as the root cause of the second incident was identified, HKBN disconnected the problematic connection with the Upstream Carrier and applied filtering function to both Routers to discard the abnormal announcement messages received from the Upstream Carrier.

14. Further, in order to avoid recurrence of similar incidents, HKBN submitted that following the second incident, it had –

(a) upgraded the software of the Routers to the latest version on 16 June and 8 September 2019 respectively. According to HKBN, the memory management function of the new software had been enhanced by the Vendor to avoid recurrence of memory overflow. Comprehensive acceptance tests had also been conducted on the

new software to ensure that the Routers could work properly when abnormal announcement messages were received in the future;

(b) thoroughly reviewed and audited all relevant systems supported by the Vendor to ensure that they were functioning properly;

(c) worked with the Vendor to improve the recovery procedures with a view to shortening the restoration time of affected services;

(d) reviewed and refined the procedures of internal and external communications in the event of network/service outages in the future;

(e) considered engaging an independent professional consultant to review and audit its network architecture and configuration; and

(f) made arrangement to closely monitor the operation and performance of the Routers.

OFCA's Assessment

15. OFCA notes that the software and hardware of the two Routers were procured from a reputable telecommunications equipment vendor and the incidents were caused by the abnormal announcement messages that were not received before. OFCA also notes that HKBN had taken measures to ensure stable operation of the Routers through proper and regular maintenance and adopted a network design with resilience at site level (with dual data centres) and equipment level (with master/slave main control boards). During the material time of the first incident, the two Routers were operating in an active-active arrangement and also acting as backup to each other. Extra memory allocation was made to handle announcement messages with an attribute length up to [✂] units even though the said length was typically not exceeding 100 units.

16. OFCA notes that the root cause of the incidents was due to the abnormal announcement messages that were continuously received from the Upstream Carrier which resulted in a reset of all main control boards of the Routers concerned. Such a problem was not known to either HKBN or the Vendor before the incidents.

17. According to information provided by HKBN, the Vendor had provided in May 2019 a new release of the software of the Routers which was essentially the same as the one mentioned in paragraph 14(a) above. Nonetheless, the new software was not installed prior to the incidents on 8 June 2019. In response to OFCA's inquiries, HKBN explained that it was its usual practice to take about three months to examine the various features and functions of a new version of software released by the Vendor before it was put to service. According to HKBN, it did not receive any alert/warning from the Vendor on potential/immediate risks due to software or hardware problem of the Routers prior to the incidents.

18. OFCA accepts HKBN's view that a prudent approach should be adopted in rolling out a new version of software for production Routers. As the new software would be used for the provision of telecommunications services for a large number of customers, it is not unreasonable for HKBN to take a certain period of time to conduct thorough testing on the new version of software before it is put to service. As to why the filtering function had not been enabled to discard the abnormal announcement messages prior to the incidents, OFCA notes from an extract of the manual of the Routers provided by HKBN that the discarding function is set to disabled mode by default. This is also the default setting found in some core routers supplied by other reputable telecommunications equipment manufacturers.

19. In conclusion, having examined the facts and circumstances of the two incidents and the improvement measures taken by HKBN (including the handling of software upgrade and configuration on the Routers), OFCA on balance accepts that the service disruptions, though undesirable, were due to circumstances reasonably beyond HKBN's control. OFCA notes that HKBN has taken reasonable remedial measures and undertaken to conduct a review and an independent audit on its network with a view to avoiding recurrence of similar incidents.

Time and Actions Taken by HKBN to Restore Services

HKBN's Representations on the First Incident

20. HKBN submitted that after detecting the service disruption and conducting some preliminary tests at about 2:21 a.m. and 2:50 a.m. respectively

on 8 June 2019, its NOC engineers immediately reported the problem to its senior management and requested the Vendor to provide support for on-site trouble-shooting and investigation. At about 3:46 a.m., HKBN's NOC engineers performed hardware reset of the two Routers with a view to restoring the services, but without success. At about 5:50 a.m., at the suggestion of the Vendor, its NOC engineers carried out procedures to temporarily disable the traffic monitoring function of the two Routers so as to free up memory space. Upon completion of the above-mentioned procedures, the two Routers became stable and all the affected services began to resume normal from about 6:51 a.m. on 8 June 2019.

HKBN's Representations on the Second Incident

21. HKBN submitted that at about 1:11 p.m. on the same day of 8 June 2019, HKBN's NOC engineers observed that there were error logs generated by Router B while Router A was in normal operation. At about 1:50 p.m., its NOC engineers carried out procedures to power off Router B. The fixed broadband and IP telephony services began to resume normal afterwards. After detailed trouble-shooting, its NOC engineers found that abnormal announcement messages from the Upstream Carrier should be the cause of the problem. HKBN disconnected the Upstream Carrier from Router B at about 3:41 p.m. and no more error logs were generated by that Router. At about 4:37 p.m., HKBN's NOC engineers applied the filtering function to the Routers to discard the abnormal announcement messages and carried out the relevant procedures at about 4:45 p.m. to bring Router B back into normal operation.

OFCA's Assessment

22. OFCA notes that the first incident occurred between about 2:21 a.m. and 6:51 a.m. on 8 June 2019. Notwithstanding the occurrence of the incident in the early morning, both HKBN and the Vendor had immediately dispatched experienced staff to provide support for on-site trouble-shooting of the network problem within a short period of time. Having failed to restore the services after a hardware reset, HKBN adopted the Vendor's suggestion to apply an interim measure to disable the traffic monitoring function so as to free up memory space of the two Routers. The affected services began to resume normal after implementation of the interim measure. Although HKBN and the Vendor had taken about four and a half hours to trouble shoot the problem, it had applied an effective interim measure to address the problem and restore the

services. OFCA considers that the time taken by HKBN to restore the affected services is not unreasonable in the circumstances given that the cause of the problem was unfamiliar and unexpected to HKBN and the Vendor. Having said that, HKBN should review its contingency procedures with a view to shortening the time for service restoration in the future.

23. As for the second incident, OFCA notes that it occurred when the root cause of the first incident was not yet identified. OFCA also notes that upon detection of the problem during the second incident, HKBN had promptly powered off the affected Router and the affected services began to resume normal. Having disconnected the problematic connection of the Upstream Carrier and applied filtering function to discard the abnormal announcement messages, the affected Router was brought back into normal operation. OFCA considers that HKBN and the Vendor gained experience from the first incident so that it took a much shorter time of about 39 minutes to resume the disrupted services.

24. Overall speaking, OFCA considers that the time and actions taken by HKBN to restore the affected services in both incidents were marginally acceptable.

HKBN's Communications with OFCA over the Service Disruptions

HKBN's Representations on the First Incident

25. According to HKBN, the first incident of service disruption occurred at about 2:21 a.m. and the affected services were restored at about 6:51 a.m. on 8 June 2019. It affected a total of about [✂] customers using fixed broadband services (representing about 15.9% of its customer base) and lasted for about four and a half hours. Pursuant to the Guidelines, HKBN should report the first incident to OFCA by 8:30 a.m. According to OFCA's record, the first contact made between HKBN and OFCA regarding the first incident was at about 8:17 a.m. when OFCA called HKBN's NOC to inquire about the incident following reading the news report on HKBN's service disruption.

HKBN's Representations on the Second Incident

26. According to HKBN, the second incident of service disruption occurred at about 1:11 p.m., about six and a half hours after recovery from the first incident. It affected a total of about [✂] customers using fixed broadband services (representing about 23.9% of its customer base) and lasted for about 39 minutes. Pursuant to the Guidelines, HKBN should report the second incident to OFCA within one hour from the occurrence of the outage, i.e. by 2:11 p.m. According to OFCA's record, HKBN informed OFCA of the second incident at about 2:09 p.m. when OFCA took the initiative to call it to follow up the first incident.

OFCA's Assessment

27. OFCA notes that although HKBN had notified OFCA of the occurrence of the two incidents within the timeframe stipulated in the Guidelines, it was done so in response to OFCA's enquiry and HKBN did not take the initiative to report service disruptions to OFCA in a proactive and timely manner. In the first incident, OFCA was aware of the service disruption from the news report before HKBN reported the incident to OFCA in response to OFCA's enquiry at about 8:17 a.m. in that morning. As to the second incident, HKBN informed OFCA of the service disruption only when OFCA called it to follow up the first incident at about 2:09 p.m. OFCA is doubtful whether HKBN would have complied with the time limit stipulated in the Guidelines in reporting the two incidents to OFCA had OFCA not taken the initiative to communicate with HKBN and check about the incidents.

28. In the two incidents, it is considered that HKBN should proactively report the two incidents to OFCA so that OFCA could be aware of the incidents at an earlier stage to facilitate assessment on the seriousness of the incidents and the impacts on the customers as well as to make the necessary preparation for enquiries from the public.

29. Overall speaking, OFCA considers that the manner in which HKBN handled its communications with OFCA on the incidents was not satisfactory. There is room for HKBN to improve the timeliness and pro-activeness in reporting service disruptions to OFCA.

HKBN's Communications with Customers

HKBN's Representations in Both Incidents

30. HKBN submitted that it had informed customers of the service disruptions through release of announcements on its official website and customer service page on Facebook. It had also notified the staff of its customer service hotline centre, provided them with the relevant information about the incidents, and deployed additional manpower to the customer service centre to answer enquiries. Details of the relevant communications in both incidents are as follows –

(a) announcement about the first incident was posted on HKBN's customer service page on Facebook at about 8:08 a.m. on 8 June 2019;

(b) additional manpower was deployed to HKBN's customer service hotline at about 9:00 a.m. on 8 June 2019;

(c) announcement was posted on the HKBN's official website at www.hkbn.net at about 5:34 p.m. on 8 June 2019; and

(d) announcement was posted on the HKBN's corporate services landing page on its official website at about 6:12 p.m. on 8 June 2019.

31. According to HKBN, it had received a total of 3 333 complaints pertaining to the two incidents and they were all settled. OFCA had received two consumer enquiries about the two incidents.

OFCA's Assessment

32. After examining the actions taken by HKBN and the complaints/enquiries from the public, OFCA is of the view that HKBN failed to provide customers with timely information about the two incidents.

33. For the first incident, OFCA notes that HKBN made the first notification to its customers (by posting a message on its customer service page on Facebook) at about 8:08 a.m. on 8 June 2019, which was about one hour and

17 minutes after the service disruption was over. For the second incident, no specific notification was made by HKBN to its customers. After the two incidents were over, HKBN made two more notifications to its customers by posting messages on its official website and corporate services home page at about 5:34 p.m. and 6.12 p.m. respectively.

34. During the material time of both incidents, HKBN did not release any information to its customers about the occurrence of service disruption and progress of restoration. The affected customers therefore had no knowledge of what had happened with HKBN's affected services and when the services would resume normal in the course of the two incidents. OFCA considers that HKBN should timely notify its customers in the event of service disruptions, such as through mass media channels when communications channels were severely interrupted by the outage.

35. Overall speaking, OFCA considers that the arrangements made by HKBN in notifying its customers of the service disruptions were unsatisfactory in both incidents. HKBN should review and improve its internal procedures to ensure timely and effective dissemination of information to its customers in the event of service disruption in the future.

THE CA'S CONSIDERATION AND DECISION

36. Having examined all the facts and circumstances of both incidents, including the representations of HKBN and the assessment of OFCA, the CA considers that HKBN has –

(a) taken reasonable preventive measures to ensure the healthiness and stability of its fixed broadband network, and made provision of resilience/redundancy arrangement to deal with possible failure of the Routers. The service disruptions were caused by circumstances reasonably beyond the control of HKBN;

(b) taken effective actions to identify the cause of the problem and has restored the affected services within a marginally acceptable timeframe;

(c) reported the service disruptions to OFCA within the timeframe stipulated in the Guidelines but its initiative and timeliness in

communications with OFCA were not satisfactory and had room for improvements; and

(d) notified its customers of the service disruptions, but the manner in which HKBN handled the communications with the customers was unsatisfactory and would need improvements.

37. On the basis of the above, the CA considers that as far as the two incidents are concerned, HKBN has not breached GC 5.1 of its UCL (Licence No. 045), which requires it to operate, maintain and provide a good, efficient and continuous service in a manner satisfactory to the CA.

IMPROVEMENT MEASURES

38. Notwithstanding the finding of no breach by HKBN of GC 5.1 of its UCL, the CA advises HKBN that it should consider implementing the following suggested measures to avoid the recurrence of similar incidents, enhance its capability and efficiency in handling service disruptions and improve the manner in which it handles the communications with OFCA and its customers in the event of service disruptions in the future –

(a) conducting a holistic review on the design, management and maintenance of its fixed network for the provision of fixed broadband and IP telephony services, including the configuration of active/standby equipment, the scope to be checked/examined in routine maintenance and the software upgrade procedures to ensure that its fixed network is robust, reliable and stable in handling daily traffic;

(b) working with the Vendor to review the two incidents, identify the vulnerabilities of its network and optimise the contingency plan so as to enhance the network resiliency and minimise the outage time and impact on customers in the event of service disruptions;

(c) reminding its staff of the importance of timely communications with OFCA, and that under all circumstances they must make their best endeavours to proactively provide the most updated information to OFCA as soon as possible; and

(d) reviewing and improving its internal procedures to ensure timely and effective dissemination of network and service outage information to its customers through the appropriate channels in the event of service disruption.

39. HKBN is requested to report to OFCA the progress of implementing the above improvement measures until they are accomplished.

The Communications Authority
March 2020