Report in respect of

Service Disruption on 9 April 2012

1. Introduction

On 9 April 2012, a power outage occurred in the Shatin Switching Centre, one of three switching centres deployed by SmarTone Mobile Communications Limited ("SmarTone"), causing a service disruption in some parts of the SmarTone cellular network. SmarTone submitted a preliminary report on 12 April 2012. This report provides an update on the preliminary report together with a detailed account of measures which have been taken and will further be taken in order to avoid similar incidents.

2. Service Disruption on 9 April 2012

2.1 Events Leading to the Occurrence of the Outage

On 9 April 2012 at around 8:00 am, the building in Shatin in which one of our three switching centres is located, suffered a power failure disrupting the power supply to the building. Our switching centre's standby battery system immediately substituted the failed mains power source and there was no disruption to service. Our backup generator then commenced operation 15 seconds later, successfully taking over from the standby battery system.

At approximately 10:35am the backup generator malfunctioned, stopping and restarting 3 times within 1 minute, causing the generator starter to burn out and the generator to stop operating. This introduced huge surges of electric

current that triggered all the eleven groups of circuit breakers to disconnect the cellular switching system from the standby battery system. The resulting power outage disrupted cellular service in several areas in Hong Kong and selected MTR stations in Kowloon, affecting approximately 25% of SmarTone's total cell sites in the territory. SmarTone's other two switching centres remained in normal operation throughout the period, providing normal service to the other 75% of SmarTone cell sites.

Emergency restoration and recovery procedures commenced immediately and service was restored progressively from 12:15pm onwards. Voice and mobile internet services were largely back to normal at 1:00pm. From 2:30pm onwards, all SMS services had returned to normal. Some servers controlling certain services affecting a relatively small number of customers required further manual intervention to reset and restore in subsequent hours on the same day.

2.2 Incident History

Time	Event
Around 8:00am 9 Apr	● A power failure occurred in the building in which one of our three switching centres is located. ● The standby battery immediately substituted for failed power. ● 15 seconds later, the backup generator commenced operation and successfully took over from the standby battery system. ● There was no disruption to service.
9:40am 9 Apr	● Confirmed by the Building Management Office, the power failure was caused by the short-circuit of a main AC bus bar to the earth. ● Building Management Office expected that the building's power supply system would take many hours to restore.
10:35am 9 Apr	● The backup generator malfunctioned, stopping and restarting 3 times within 1 minute, causing the generator starter to burn out and a complete cessation of operation of the backup generator. ● The three abnormal restarts also introduced 3 huge electric current surges within 1 minute, triggering all related main circuit breakers to disconnect the cellular switching system from the standby battery system. ● This resulting power outage disrupted cellular service in 25% of SmarTone cell sites affecting several areas in Hong Kong and selected MTR stations in Kowloon. SmarTone's other two switching centres remained in normal operation throughout the period, providing normal service to the other 75% of SmarTone cell sites. ● The emergency restoration and recovery procedures started immediately.
10:35 – 11:30am 9 Apr	● All tripped circuit breakers were inspected and manually reset in batches.
11:30am 9 Apr	● The standby battery system connections to the cellular switching system were restored. ● Switching equipment and servers recovered in stages.
12:15pm 9 Apr	● Voice and mobile internet services were gradually restored.
1:00pm 9 Apr	● Voice and mobile internet services were largely back to normal. ● After replacing the starter component, the backup generator was fully restored and successfully took over from the standby battery system.
2:30pm 9 Apr	● Short message service (SMS) resumed as normal. Some servers controlling certain services affecting a relatively small number of customers required further manual intervention to reset and restore in subsequent hours on the same day.
4:30am 10 Apr	● Building power supply was resumed.

2.3 Remedial Actions Taken

- At 10:35am on 9 April, after observing the tripping of the eleven main circuit breakers that caused the disconnection of the cellular switching system from the standby battery system, our duty engineers started immediately to inspect all affected circuit breakers. Each of these main circuit breakers was in turn connected to a group of sub-circuit breakers connecting to individual switching equipment and servers.
- After confirming all the tripped main circuit breakers were in good condition, our duty engineers manually switched off all sub-circuit breakers to prepare for power restoration. Starting from 11:30am, all main circuit breakers, followed by all sub-circuit breakers, were reset in batches to restore standby battery connections to the cellular switching system. Switching equipment and servers were put back into service progressively from 11:30am. Voice and data services were restored progressively from 12:15pm onwards.
- During the restoration, some servers controlling certain services could not be returned to normal operation automatically. These required manual intervention to reset and restore them in subsequent hours on the same day.
- At 1:00pm on 9 April, the faulty generator starter was successfully replaced and the generator was put back into operation.
- At 2:21pm on 9 April, the building's faulty main AC bus bar was isolated from the AC main switch for repair. Mains electricity was temporarily resumed and the backup generator was switched off.
- At 4:30am on 10 April, the building's faulty main AC bus bar was repaired and provision of mains electricity resumed fully.

2.4 Root Cause Analysis

A thorough investigation of the root cause of the incident was conducted together with the building management office (BMO), the E&M facility contractor, and the DC Power vendor. Based on our findings from the review and the results of subsequent testing, we have identified the following:-

2.4.1 Building Power Failure

As advised by the building management office, one of the main AC bus bars of the building short circuited to the earth at 8:24am. This caused a power supply failure to the building where our switching centre is located.

It was further reported by the BMO that traces of moisture and a damaged insulation layer between the bus bar and the metal housing was observed. These factors led to a short circuit that in turn triggered the over-current protection, disconnecting the bus bar from the building's AC mains switch.

2.4.2 Backup Generator Failure

The backup generator stopped and restarted unexpectedly 3 times within 1 minute, causing the generator starter to burn out, preventing the generator from starting again. The burned out starter was replaced in the repair of the generator.

Two problems were identified during our root cause analysis:

Problem 1: The generator stopped suddenly after running for 2 hours

Problem 2: The generator automatically restarted 3 times after the initial unexpected stoppage when it should have just

stopped and any restart should have required manual intervention.

The root cause of Problem 1 has not been identified as yet, even after a comprehensive inspection of the generator including fuel supply systems as well as electrical and mechanical parts. This problem did not occur during regular drill tests, the latest of which took place on 22 Feb 2012, one and a half months before the incident, nor could it be reproduced in the 3 extensive load tests conducted after the incident on 14 April and 24 April 2012 respectively.

From our detailed investigation, Problem 2 was due to a malfunction in the generator control module. After the generator stopped suddenly, the control module should have required a manual restart instead of restarting automatically.

On 24 April, the control module has been replaced. We have tested and confirmed that in the event of an unexpected generator stoppage, the new control module will cut the fuel supply and place the generator into manual restart mode. At the same time, the system will rely on standby battery power before the generator kicks in.

While we cannot conclude the root cause of Problem 1, we will implement a new measure to effect a double protection eliminating the risk of unexpected restarts and electric current surges. A new control system will be implemented, consisting of a voltage sensor and an isolator. Should there be any abnormal fluctuation in the voltage output of the generator, e.g. under voltage or sudden surge, the generator output will be isolated immediately to prevent any electric current surges to hit the battery circuit breakers.

2.4.3 Tripping of Battery Circuit Breakers

The backup battery system consists of 11 battery groups with sufficient capacity to support up to 4 hours backup time. Each battery group is overload-protected with a battery circuit breaker.

The battery circuit breakers were tripped as a result of repeated restarts of the generator. The frequent current charging and discharging (3 times within 1 minute) generated a significant amount of heat, which tripped the circuit breakers for overload-protection. Once the circuit breakers were tripped, the batteries were disconnected from the switching equipment. During the incident, the circuit breakers functioned properly, as designed,

2.5 Analysis of Affected Customer Numbers

As mentioned in our Preliminary Report, the actual number of affected customers could not be confirmed. This is because complete network statistics on the number of active users in the affected parts of the network at the time of the incident are not available, as data pertaining to the time of incident could no longer be obtained from the failed network nodes.

Nevertheless, we have estimated the number of affected customers based on network statistics between 4 April and 8 April, which should exhibit a similar pattern to that existing on the day and at the time of the incident. This period includes the Ching Ming holiday, the Easter holiday and the long weekend in between. We have reviewed our approach with our equipment vendor and confirmed that the method we used should provide a reasonable estimation.

2.5.1 Approach

- We estimated the number of active SmarTone customers affected using the following formula:

$$Number\ of\ SmarTone\ customers\ affected = A\ x\ \frac{B}{C}$$

where:
A = total no. of active customers in the network
B = traffic normally generated from the affected cell sites
C = total network traffic

- The active customers in the network are those with their devices powered on, i.e. users that are ready to make or receive calls.
- We assume that the amount of traffic generated is proportional to the number of active customers. Thus, the traffic ratio in the above formula (i.e. B/C) can be used to estimate the number of affected customers.

2.5.2 The Number of Active Customers

- The number of active customers between 4 April and 8 April remained relatively stable during 10:00 to 13:00 and ranged from 1,047,000 to 1,075,000 respectively.
- We have taken the higher figure of 1,075,000 as an estimation of the number of active customers on 9 April during the incident.

2.5.3 Ratio of Traffic from Affected Cell Sites

- The ratio of traffic generated from affected cell sites to the network total (i.e. B/C in the above formula) was 22.6% between 10:00 to 13:00 during the sample period.
- The actual loss of traffic should be less than this, because of the overlapping coverage of cell sites and some of the traffic would be handled by the unaffected cell sites nearby.
- We used 22.6% as an estimation of the percentage of affected customers during the incident.

2.5.4 The Number of Affected Customers

Based on our estimation, the total number of active customers at the time of the incident was 1,075,000 and 22.6% of these customers were affected. By extrapolation,

No. of affected customers = 1,075,000 x 22.6% = 243,000

3. Communication with OFCA on the Outage

As mentioned in our Preliminary Report, we agree that we were not adequately proactive in notifying OFCA about the network outage according to the guidelines, which requires us to inform OFCA within an hour of such an event. In mitigation, our staff were focusing on restarting the system and restoring service as soon as possible. We also agree that we should have kept OFCA better updated both in terms of frequency and details of the incident.

Since the submission of the Preliminary Report, the dialogue between our NOC and OFCA has been reviewed with OFCA. The details of the event log are as follows.

Time	Event	Summary of dialogue
~12:30pm, 12:45pm	Call received from OFCA informing our NOC that there were complaints of a service outage in Central and Western Districts with a follow up call at 12:45pm requesting a report	NOC confirmed with OFCA that there was an outage involving hundreds of cell sites and we were attempting to restore our services as soon as possible. OFCA requested to be kept informed of the status of the outage.
~1:36 pm	Call received from OFCA requesting an incident update.	NOC informed OFCA that the service was largely restored and only a small number of cell sites requiring manual recovery remained out of service. OFCA requested to be kept informed when the service could be totally resumed.
~2:53pm	Call received from OFCA requesting an incident update.	NOC informed OFCA that our cell sites and services were back to normal, with only around 10 cell sites yet to be restored.
~3:35pm, 3:40 pm	NOC sent an email to OFCA at 3:35pm providing a brief account of the outage, with a follow up call at 3:40pm	NOC's email reported to OFCA about the time and event causing the outage. OFCA also requested the number of customers affected. NOC advised that the number of affected customers was not available at that moment.

~ 4.20 pm, 4:27pm	OFCA called SmarTone at 4.20pm, but was unable to reach the person they had been communicating with. SmarTone returned the call at 4.27pm	SmarTone advised OFCA that all cell sites and services had been resumed. OFCA again requested the number of affected customers.
~5:14pm	SmarTone called OFCA	SmarTone repeated that it would be difficult to provide the number of affected customers. OFCA advised SmarTone that they had communicated with media at approximately 16:00 about the outage.

Remark: OFCA advised that they were unable to reach our NOC at 1:10pm, 2:00pm, and 2:40pm as the line was busy.

4. Communication with our Customers and the Public on the Outage

SmarTone has communicated with customers and the public about the service disruption through the following channels on the day of incident:

- Retail and Hotline staff
- Facebook
- Customers
- The media

4.1 Communication through our Retail and Hotline Staff

At 11:01am and 12:26pm on 9 April, two notifications were issued through internal email to inform our retail and hotline staff, for public dissemination, about the power outage at one of our switching centres causing service disruption, and that investigation and restoration was in progress. Retail and Hotline staff informed customers of the service disruption upon enquiries.

At 2:56 pm, an updated notification was issued to inform retail and hotline staff that service has been restored.

At 5:56 pm, a further notification was issued to inform retail and hotline staff of further details of the incident.

4.2 Communication through Facebook

A holding statement on the service disruption should have been posted as soon as the disruption occurred. However the personnel responsible for communicating with customers mistakenly decided to gather more detailed information on the cause of the incident and the progress of recovery before providing a more complete explanation to the public.

At 2:13 pm on 9 April, SmarTone posted the first message on Facebook in response to customer enquiries about our service disruption. The message informed our customers of the power outage at one of our switching centres causing a service disruption, and that most services, except SMS, were largely back to normal after our emergency recovery process.

At 7:46 pm and 7:51 pm, full Chinese and English statements were posted on Facebook to explain the details of the incident to the public.

4.3 Communication to Customers

An email was sent on the evening of 10 April to all customers with whom we have their email address, informing them the details of the incident.

4.4 Communication to the Media

Between 12:30 - 5:00 pm on 9 April, SmarTone received calls from the media. SmarTone acknowledged to media that there was a network outage and responded that the service interruption was due to a power failure at one of our switching centres.

At 5:36 pm on 9 April, SmarTone issued a press statement to media to explain the incident and apologize to affected customers.

At 5:00 pm on 10 April, SmarTone issued another press release with further information including our preliminary investigation results and evaluation.

Despite our official press statement issued on 9 April and the subsequent press release on 10 April, there were unsubstantiated media reports regarding the incident. We would like to make the following clarifications.

Media reports	**SmarTone's clarifications**
1. The service disruption was caused by a power or technical failure at a switching board or centre in Central and Western District, according to OFCA.	- The service interruption was caused by a power failure at a building in which one of our three switching centres is located.
2. The entire network broke down.	- The outage affected approximately 25% of SmarTone's cell sites in the territory, rather than the entire network. - SmarTone's other two switching centres remained in normal operation throughout the period, providing normal service to the other 75% of SmarTone cell sites.
3. The service disruption lasted six to eight hours.	- The service disruption lasted for 2.5 hours from 10:35am to 1:00pm. - Voice and mobile internet services were largely back to normal at 1:00pm. From 2:30pm onwards, all SMS services had returned to normal. Some servers controlling certain services affecting a relatively small number of customers required further manual intervention to reset and restore in subsequent hours on the same day.
4. The service interruption might have been caused by testing of the 4G network.	- The service disruption was definitely not related to any testing of the 4G network, but a power failure at the building in which one of our three switching centres is located.

5. Measures Implemented to Prevent Similar Incidents

5.1 Current Design of our Backup Power Supply System

- Each of our switching centres is equipped with two levels of backup power protection. The first level is the standby battery system which activates immediately upon any power disruption. The second level is the backup generator which takes over from the standby battery after 15 seconds. Such an arrangement worked as designed when the standby battery took over the failed mains power and the generator kicked in at 8:24am on the day of the incident.
- The standby battery system can run continuously for four hours. To ensure proper functionality and designed capacity, the battery system is inspected and tested every two months.
- As for the backup generator, it is designed for continuous operation as long as it receives adequate fuel. Like the standby battery system, it is thoroughly inspected and drill tested every two months.
- The concerned backup generator successfully passed recent full inspections and drill tests on 22 February 2012 and the standby battery passed tests on 5 April 2012.

5.2 Improvements Made and to be Made to the Backup Power System

- On 10 April 2012, the BMO of the Shatin Switching Centre repaired the insulation of the bus bar portion which caused the earth fault. In addition, as a permanent solution, BMO has laid a plastic cover above all horizontal bus bar routes to protect against dripping water.
- SmarTone has inspected the power supply systems for all switching centres and confirmed that they are all in good condition. In order to improve the robustness of the backup power supply system, an E&M consultant will be appointed in coming months to conduct a more detailed

power system review. So far, we have interviewed 4 consultants and expect to make a decision by mid May. The target is to complete the power system review for the Shatin Switching Centre in June 2012 and all other switching centres by September 2012.

- The generator control module was replaced on 24 April 2012 followed by detailed functional tests. In a simulated generator stoppage event with the new control module, the generator did not auto restart. This mechanism has also been tested and confirmed functioning properly in all other switching centres.
- A new design in the rectifier system has been implemented on 24 April 2012 with different delay timer settings for each batch of rectifiers to further improve the circuit breaker's robustness when handling unexpected electric current surges. Whenever the AC mains or generator supply is connected, rectifiers will start operation batch by batch, reducing the simultaneous current going through the circuit breakers. This design will also be implemented in all other switching centres.
- As an additional protection, a new control system will be implemented, consisting of a voltage sensor and an isolator. Should there be any abnormal fluctuation in the voltage output of the generator, e.g. under voltage or sudden surge, the generator output will be isolated immediately to prevent any electric current surges to hit the battery circuit breakers. The same will be implemented in all other switching centres.

5.3 Review of Procedures for Communication with OFCA, our Customers, the Media and the Public

SmarTone has thoroughly reviewed the procedures for communication with OFCA for compliance with OFCA's Guidelines for Fixed and Mobile Operators for Reporting Network Outages. We have also reviewed the procedures for informing our customers, the media, and the public in the event of a major service disruption through various channels.

5.3.1 Communication with OFCA

We have revamped the procedures for communication with OFCA in the event of critical network outages. Our Head of Engineering, or his backup in case he is unavailable, will be the prime contact for the reporting and communicating with OFCA within 15 minutes of any critical network outages, with regular updates at least on an hourly basis.

5.3.2 Communication with our Customers, the Media and the Public

Media

Within 30 minutes of a critical network outage, we will inform the media of the incident, including TV, radio and electronic media through email and phone calls. Hourly updates on restoration progress will be provided until service returns to normal. A full press statement will be issued within 24 hours of the incident.

Corporate Website and Social Media

Within 30 minutes of a critical network outage, we will post a notice about the incident on our corporate website and on the Company's official Facebook page. Hourly updates on restoration progress will be provided until service returns to normal.

Hotline and Store

Within 30 minutes of a critical network outage, staff will be briefed on the incident and restoration progress so that they can respond to customer enquiries. In stores, notices on the incident will be placed in each storefront. This will be updated from time to time until service restoration. A final notice will be placed in all storefronts once service is restored.

Email

Within 24 hours of a critical network outage, an email will be sent to all customers for whom we have an email address detailing the cause of the incident.

SmarTone regrets the inconvenience caused to our customers. We have thoroughly investigated the events leading to the building's power outage and the malfunction of our backup power systems, in order to ascertain the root causes. We have already implemented additional protection for our backup power system, specifically to guard against generator malfunction. Further improvements are pending, and together with any additional measures that may arise from a forthcoming E&M consultant review, we are confident that any power disturbances will not impact our service in future.

SmarTone Mobile Communications Limited

Date: 27 April 2012