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Name of Announcer *	SINGTEL
Company Registration No.	199201624D
Announcement submitted on behalf of	SINGTEL
Announcement is submitted with respect to *	SINGTEL
Announcement is submitted by *	Chan Su Shan (Ms)
Designation *	Company Secretary
Date & Time of Broadcast	16-Dec-2013 18:08:45
Announcement No.	00082

>> Announcement Details
 The details of the announcement start here ...

Announcement Title *	SingTel Board releases Board Committee of Inquiry Report on the Bukit Panjang fire
Description	1. News release: SingTel releases Board Committee of Inquiry Report on the Bukit Panjang fire 2. Presentation slides: SingTel Board Committee of Inquiry findings and recommendations on the fire at Bukit Panjang Exchange 3. Report of the SingTel Board Committee of Inquiry on the fire at the Bukit Panjang Exchange
Attachments	<ul style="list-style-type: none">  NR-20131216-BCOI-newsrelease.pdf  NR-20131216-BCOI-PressConfSlides.pdf  NR-20131216-Report.pdf Total size = 1162K (2048K size limit recommended)

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News Release

SingTel Board releases Board Committee of Inquiry Report on the Bukit Panjang fire

- **BCOI outlines actions to enhance fire safety practices and awareness and improve network resiliency**
- **SingTel accepts findings and commits to implement recommendations**

Singapore 16 December 2013 – The SingTel Board has accepted and endorsed the findings and recommendations of the independent Board Committee of Inquiry (BCOI) on the fire at the Bukit Panjang exchange on 9 October 2013.

The BCOI's findings and recommendations covered three main areas: fire prevention in exchanges, network reliability and resiliency, as well as public relations and communications. The BCOI was assisted by independent technical consultant, Bell Labs, and communications consultant, Bell Pottinger.

Following a full investigation, the BCOI concluded that the most probable cause of the fire was hot works carried out during maintenance activities in the cable chamber. An unauthorised blowtorch was used to heat and shrink a lead-based sealant to seal a cable duct. The employee carrying out the hot works did not have the company issued blowtorch equipment with him and had borrowed the unauthorised blowtorch from a contractor. The flame of the unauthorised blowtorch was almost twice as hot as that of a company issued SingTel blowtorch. The use of the unauthorised blowtorch most likely caused localised overheating, resulting in a slowburning fire in the cable chamber.

“While the fire was due mainly to human error, the inquiry uncovered shortcomings in fire safety practices that require immediate rectification,” said Chairman of the BCOI, Mr Bobby Chin, “The technical expert has, however, affirmed that the network has a high degree of resiliency. SingTel should continue to build on this.”



SingTel is committed to strengthening its network to enhance Singapore's status as a leading financial and business hub. "We recognise the impact of the incident on businesses and customers. The BCOI has given us a critical review of our operations, which will steer and motivate us to raise our standards. We will work with the industry to define a national engagement framework for greater collaboration to ensure that Singapore's telecoms infrastructure remains resilient even during major network incidents," said Mr Simon Israel, Chairman of SingTel.

SingTel management has accepted the BCOI's findings and is committed to implementing the recommendations. "We take full responsibility for the incident. We recognise the inconvenience it caused our customers and the public, and we are sorry for this. The BCOI review offers a valuable opportunity to take a step back and comprehensively assess our network design and operations. We want to assure customers that it is our top priority to prevent a recurrence and we have started work on the enhancements," said Ms Chua Sock Koong, Group CEO of SingTel.

BCOI Key Findings and Recommendations

1. Fire Prevention in Exchanges

The BCOI found that the use of lead-based sealants, and the associated use of open flames, posed fire risks. The BCOI recommended replacing lead-based sealants with alternative materials that do not require heating (eg, Multi Cable Transit systems¹), thereby removing the need for hot works in cable chambers. SingTel is already in the process of converting all duct seal installations to MCT Systems. Completion of this exercise is estimated to be at the end of 2014. Other recommendations included enhancing fire detection, fire watch practices and automatic fire suppression measures to augment existing smoke detectors and fire extinguishers.

¹ Multi Cable Transit system : A modular cable sealing system that provides protection from fire, smoke, water and blast pressures at the point where cables enter an exchange through the cable chamber.

The BCOI noted that in the interim, SingTel has switched to an alternative method for hot works, which uses a hot air blower without open flame, and enforced a longer fire watch. The BCOI found that SingTel had an existing set of safety protocols in relation to hot works and recommended a review of training for employees to ensure compliance with such protocols.

Other recommendations include:

Fire Prevention Recommendations

- Centrally monitor critical building alarms, including smoke detectors (and other fire-related warning systems), even if other contractors or organisations already provide such monitoring services.
- Take measures to limit the amount of polythelene (or PE) material² for indoor use. For new fibre optic cables being placed in exchanges, splice PE sheath cables to fire-retardant PVC sheath cables as soon as practicable upon entry of the cables into the cable chambers / exchanges. For existing fibre optic cables already placed in exchanges, provide fire-retardant capability and consider replacing existing PE sheath cables with PVC sheath cables.
- Strengthen fire-stop practices to prevent fire spreading between floors and rooms of the exchanges and consider the use of fire-retardant materials (including intumescent foam or putty), even though the fire did not spread to any other rooms or floors in this incident.
- Enforce a more effective process to control and record physical access to cable chambers.

Safety Practices Recommendations

- Ensure employees are aware of and comply with safety protocols. In particular, enforce onsite supervision of high-risk activities and clarify roles and responsibilities. Ensure formal training is conducted regularly for persons responsible for hot works.
- Enforce regular equipment checks and ensure that only SingTel standard-issue equipment is used for carrying out works.

²Polythelene material is used to protect fibre cables in ducts and cable tunnels due to its water/gas/oil resistant properties.

- Enhance existing fire watch practices. It is noted that SingTel has already instituted a 24-hour fire watch after completion of hot works and supplemented fire watches with the use of handheld thermal imaging cameras.
- Review and tighten protocols relating to disabling and re-activating of smoke detectors during and after hot works.

2. Network Reliability and Resiliency

Bell Labs has advised the BCOI that SingTel has a robust core network architecture which has a high degree of resilience against incidents such as the fire. As a result, the impact of the fire was localised to the area served by the Bukit Panjang exchange. Bell Labs also found that SingTel took fast and effective measures in its incident management and applied innovative processes, which allowed multiple splicing teams to simultaneously carry out repair work in a limited space.

The BCOI identified a number of areas of improvement in network design and stakeholder engagement. It recommended a stronger engagement with industry players in the existing three-tier industry structure for fibre services, and to establish a national framework that will foster a coordinated response from all telecom stakeholders on an agile, proactive basis in the event of a major network incident.

The BCOI also recommended that SingTel initiate regular exchanges with other global operators to share key learning points and best practices in network resilience and reliability.

Other recommendations include:

Recovery Recommendations

- Develop a plan to minimise the impact to customers during the transition from temporary solutions to permanent restoration measures.

Network Design and Architecture Recommendations

Develop and adopt automated systems and procedures to verify and maintain physical path diversity. This will improve infrastructure resiliency by avoiding any overlapping sections where the main path and back-up path(s) could be severed by one fibre cut (known as “folded rings”). For the same reason, the main and back-up path(s) for mission-critical traffic should use separate entranceways to cabinets.

- Set up dialogue or collaboration amongst SingTel, regulators and key customer groups to improve understanding of resiliency requirements and strengthen service resiliency by offering equipment, path and/or exchange diversity for key services. Encourage government agencies and enterprise customers to take-up protected services available.
- Further improve wireless resiliency by ensuring path diversity for mobile base stations. To consider exchange diversity coupled with path diversity to improve indoor wireless coverage resiliency.

Stakeholder recommendations

- Where the relevant facility is not owned by SingTel, there should be detailed and documented procedures between SingTel and the facility manager to ensure that there is a clear demarcation of roles and responsibilities.
- Enhance international collaboration by initiating formal and regular technical exchanges of knowledge with comparable operators in the region, or globally. This would enable the sharing of key learning points, best practices and other information related to exchange outages, service restoration and network reliability best practices. Alternatively, initiate a benchmarking review across a range of comparable operators.

3. Communications and Public Relations

Bell Pottinger advised the BCOI that SingTel was prompt and transparent in its release of information about the incident and found no areas requiring immediate improvement. SingTel used multiple channels, including social media, to communicate effectively with customers.



To further enhance communications crisis response, the BCOI's key recommendations were for SingTel to formalise crisis communications protocols which are currently based on ad hoc prior experience, extending crisis simulation drills to include key spokespeople and corporate communications staff, as well as adopt a more structured process for media and internal updates.

Other recommendations include:

Customer and Media Engagement Recommendations

- Institute standard procedures to issue information updates on a regular basis, even if there is no change of status.
- Introduce a media spokesperson at an earlier stage. Separate the roles of crisis command and media spokesperson.
- Tighten the processes around message creation and approval to ensure speed and coordination of response across multiple channels.
- Enhance online visibility by creating an "updates" section on SingTel's website.

Messaging

- Ensure that the full context of future incidents are well-explained, thereby improving clarity of information, reducing the risk of distractions and better managing customer expectation on restoration timelines.

Other Recommended Communications Initiatives

- Consider initiating a media familiarisation campaign to build on technical transparency and ensure a core understanding of the network.
- Involve fresh viewpoints in crisis preparation and response by inviting input from cross-functional teams within SingTel and external experts to update processes and procedures.

The full BCOI report is available on www.singtel.com

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About the BCOI

The BCOI was established to provide an objective and expert review of the Bukit Panjang fire, and to make recommendations to further enhance SingTel's network resilience. The BCOI used leading global experts to draw on international best practices in developing its findings.

The Terms Of Reference of the BCOI were to:

- i. Investigate the facts and circumstances leading to the fire
- ii. Review the effectiveness of the company's incident management and response, and recommend improvements
- iii. Benchmark current network design and contingency processes against international best practices and standards
- iv. Recommend appropriate improvements to prevent future occurrences and to strengthen network resilience

The BCOI is chaired by Mr Bobby Chin Yoke Choong, a non-executive and independent director of SingTel and Chairman of its Risk Committee. Mr Chin was previously the Managing Partner of KPMG Singapore. He is supported by two other non-executive and independent directors, Mrs Fang Ai Lian and Mr Low Check Kian. Mrs Fang is the Chairman of SingTel's Audit Committee. Mrs Fang was previously Managing Partner and then Chairman of Ernst & Young. Mr Low is a Member of SingTel's Corporate Governance and Nominations Committee. Mr Low was one of the founding partners of NewSmith Capital Partners LLP.

SingTel Board Committee of Inquiry

**Announcement of Key Findings and Recommendations on the
fire at the Bukit Panjang Exchange**



16 December 2013

Agenda

01 // BCOI: Terms of Reference

02 // Cause of Fire

03 // Focus of Investigation

04 // Areas of Improvement

05 // Key Strengths

06 // Conclusion

BCOI: TERMS OF REFERENCE

- Investigate the facts and circumstances leading to the fire
- Review the company's incident management and response
- Benchmark current network design and contingency processes against international best practices and standards
- Recommend appropriate improvements to prevent future occurrences and to strengthen network resilience

BCOI



Mr Bobby Chin Yoke Choong,
Non-Executive and Independent director of SingTel,
Chairman, Risk Committee
Member, Audit Committee



Mrs Fang Ai Lian
Non-Executive and Independent director of SingTel,
Chairman, Audit Committee
Member, Executive Resource and Compensation Committee



Mr Low Check Kian
Non-Executive and Independent director of SingTel
Member, Corporate Governance and Nominations Committee
Member, Finance and Investment Committee

Independent Consultants

Bell Labs

**Bell
Pottinger**

Advisors

Allen & Gledhill

Mr. Richard Burns
Technical Advisor to BCOI



CAUSE OF FIRE

According to the fire investigation experts, the most probable cause of the fire:

- Maintenance work in cable chamber involving heating and shrinking lead-based seals using a blowtorch
- Fire detection system deactivated for hot works
- Unauthorised blowtorch flame was almost twice as hot as a SingTel standard issue blowtorch equipment
- Localised overheating resulted in a slow-burning fire



Unauthorised blowtorch
Heat generated: 800 deg C



Standard issue blowtorch equipment
Heat generated: 450 deg C

FOCUS OF INVESTIGATION

Fire Prevention

Network Reliability and Resiliency

Communications



Cable Chamber Operations



Incident Management



Recovery



Network



Stakeholder Engagement



Communications and Public Relations Management

KEY AREAS OF IMPROVEMENT

Fire Prevention

Subject

- Hot Works
- Smoke Detectors / Alarm Systems
- Fire Suppression Systems and Firestop Practices
- Safety Practices

Recommendations

- Replace lead-based sealant and cease hot works in cable chambers
- Monitor alarms centrally at SingTel
- Install fire suppression systems in cable chambers and strengthen fire-stop practices between floors and walls within the exchange with use of fire-retardant materials
- Develop centralised set of safety protocols
- Step up training to improve awareness among staff

KEY AREAS OF IMPROVEMENT

Network Reliability and Resiliency

Subject

- Incident Management
- Network design and architecture
- Global best practices

Recommendations

- Establish framework to foster coordinated response from other telecom stakeholders for future incidents
- Improve network design, path diversity and strengthen wireless network resiliency
- Initiate regular exchange between operators in the region and globally, and benchmark against best practices

KEY AREAS OF IMPROVEMENT

Communications and Public Relations Management

Subject

- Procedures and Processes
- Customer and media engagement
- Messaging

Recommendations

- Formalise communications crisis response processes
- Institute standard procedures to issue updates with greater regularity
- Ensure context given in crisis situations

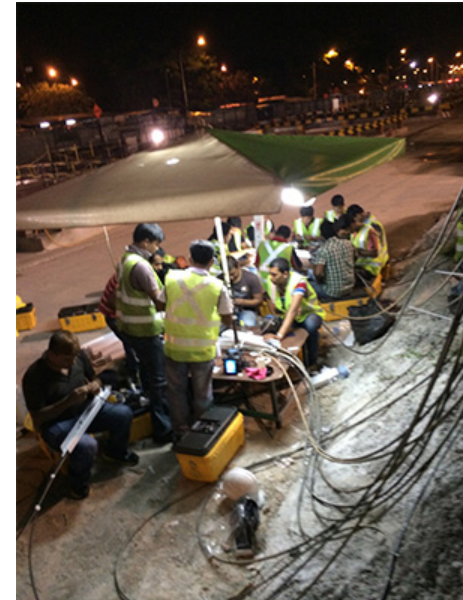
KEY STRENGTHS

Network Reliability and Recovery (Bell Labs)

- World-class core network with high degree of resiliency - Impact of fire contained and localised
- Robust processes for business continuity; incident management was fast and effective
- Well-executed recovery using innovative processes
- Good collaboration with OpenNet on restoration works

Communications and Public Relations Management (Bell Pottinger)

- Transparent and prompt in release of information to the public with consistent messages
- Multiple channels of communication, including social media, to keep public/customers informed



Multiple splicing teams at work

CONCLUSION

SingTel Board accepts all findings and recommendations of the BCOI

Management is committed to implementing the recommendations

The full BCOI report is available on www.singtel.com



9 DECEMBER 2013

SINGAPORE TELECOMMUNICATIONS LIMITED
REPORT OF THE BOARD COMMITTEE OF INQUIRY
FIRE AT THE BUKIT PANJANG EXCHANGE
ON 9 OCTOBER 2013

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GLOSSARY

PART A: GENERAL TERMS AND ABBREVIATIONS

(PART B (page iv) contains a definition or explanation of technical terms and abbreviations)

<u>SN</u>	<u>Term</u>	<u>Definition</u>
1.	“BCOI”	Board Committee of Inquiry
2.	“Bell Labs”	The research and development arm of Alcatel-Lucent Inc, and technical consultant to the BCOI
3.	“Bell Pottinger”	Bell Pottinger Pte Ltd, communications and public relations management consultant to the BCOI
4.	“Board”	SingTel’s board of directors
5.	“BPE”	The Bukit Panjang Exchange located at 40 Woodlands Road, Singapore 677919
6.	“CityNet”	CityNet Infrastructure Management Pte Ltd, trustee manager of NetLink Trust. CityNet carries on NetLink Trust’s business and hold the assets on trust for the benefit of the unitholders of NetLink Trust. ¹
7.	“DTZ”	DTZ Debenham Tie Leung (SEA) Pte Ltd, managing agent of the BPE
8.	“Fire Investigation Experts”	Dr Tan Yoke Lin of Octis Technology Pte Ltd and Mr Tan Jin Thong of JT Megan & Partners
9.	“IDA”	Infocomm Development Authority
10.	“Master Messaging Document”	A centrally approved document created by SingTel, from which all other communications were derived, to ensure that external messaging coming from SingTel is consistent across all channels.
11.	“MDA”	Media Development Authority

¹ <http://www.citynetlink.com.sg/index.php/overview>.

<u>SN</u>	<u>Term</u>	<u>Definition</u>
12.	“NetLink Trust”	In September 2008, OpenNet (see item 14 below) was selected to become the network company for the Next Gen NBN. As part of the IDA’s effective open access requirements, SingTel undertook to the IDA to transfer certain infrastructure assets (ducts, manholes and central offices) to a separate wholly-owned entity. NetLink Trust was established as a business trust under the Business Trusts Act, Chapter 31A of Singapore to comply with this undertaking. ² NetLink Trust was the owner of the BPE at the time of the fire.
13.	“Next Gen NBN”	The Next Generation Nationwide Broadband Network, the wired network of the Next Generation National Infocomm Infrastructure. This is an initiative by the IDA which seeks to transform Singapore into an intelligent nation and a global city, powered by infocommunications. ³ The Next Gen NBN is designed to be ultra-high bandwidth, resilient and scalable state-of-the-art optical fibre network that is capable of delivering speeds of 1Gbps and above to homes, offices and premises around Singapore. ⁴
14.	“OpenNet”	OpenNet Pte Ltd, a joint venture company formed by Axia NetMedia, SingTel, Singapore Press Holdings and Singapore Power Telecommunications. ⁵ OpenNet is the network company for the Next Gen NBN.
15.	“SCDF”	Singapore Civil Defence Force
16.	“SingTel”	Singapore Telecommunications Limited
17.	“Technical Advisor”	Mr Richard Burns, technical advisor to the BCOI
18.	“Terms of Reference”	The terms of reference of the BCOI set out at paragraph 4.2.1 below.

² <http://www.citynetlink.com.sg/index.php/overview>.

³ <http://www.ida.gov.sg/Infocomm-Landscape/Infrastructure/Wired/What-is-Next-Gen-NBN>.

⁴ <http://www.opennet.com.sg/press/opennet-completes-restoration-work/>.

⁵ <http://www.opennet.com.sg/press/opennet-completes-restoration-work/>; <http://www.opennet.com.sg/about-us/who-we-are/>.

PART B: TECHNICAL TERMS AND ABBREVIATIONS

<u>SN</u>	<u>Term</u>	<u>Definition</u>
1.	“access” network	The part of the telecommunications network beyond the core network (see item 4 below) and closest to the residential and business customer, typically from the exchange to the end-user.
2.	“active infrastructure”	Components of a telecommunications infrastructure that generates or transmits signals, including switches and transmission equipment.
3.	“Carrier Ethernet”	This protocol has the ability to provide automatic protection switching between 2 points, if diverse paths are available, resulting in no interruption of service in case of an outage.
4.	“core” network	The central part of the telecommunications network, furthest away from the subscriber and where most/all of the processing is typically performed, typically the network connecting the exchanges.
5.	“diversity”	The interconnection of 2 service nodes or points in the network over separate, equivalent paths. This ensures that the 2 points remain connected in case of an interruption in 1 of the paths.
6.	“DSL”	Digital Subscriber Line A family of technologies that provide Internet access by transmitting digital data over the wires of a local telephone network.
7.	“dual uplink”	2 links from a node to separate core elements in the network, providing for continuity of service in case 1 of the links is severed.
8.	“duct seal”	A system that seals external pipes to the cable chamber and prevents underground water and gas from entering the cable chamber.
9.	“firestop pillow”	A passive fire stopping barrier used between different floors and walls and cable entry openings.

<u>SN</u>	<u>Term</u>	<u>Definition</u>
10.	“folded ring”	A fibre ring with 2 or more overlapping segments. The overlapping segments result in a lack of protection as a fibre cut would sever both segments simultaneously.
11.	“FTTH”	Fibre To The Home A broadband architecture that provides fibre from a central point directly to individual buildings such as residences, apartment buildings and businesses to provide high-speed Internet access.
12.	“fully meshed”	A network architecture where every node has a direct link connecting it to all other nodes in the network.
13.	“GPON”	Gigabit Passive Optical Network A telecommunications network that uses point-to-multipoint fibre to the premises in which unpowered optical splitters are used to enable a single optical fibre to serve multiple premises.
14.	“INOC”	Integrated Network Operations Centre at Central Exchange, 15 Hill Street, Singapore 179352.
15.	“intumescent foam”	A foam that expands when exposed to heat, used as barrier between floors, walls, and cable entries to prevent fire and smoke from passing.
16.	“IPTV”	Internet Protocol Television Television services delivered via the Internet.
17.	“MSAN”	Multi-service Access Node A device typically installed in a telephone exchange (although sometimes in a roadside serving area interface cabinet) which connects customers' telephone lines to the core network, to provide telephone, Integrated Services Digital Network (ISDN), and broadband such as DSL all from a single platform.

<u>SN</u>	<u>Term</u>	<u>Definition</u>
18.	“MCT” System	Multi Cable Transit system A modular cable sealing system that provides protection from fire, smoke, water and blast pressures at the point where cables enter an exchange through the cable chamber.
19.	“NOC”	Network Operations Centre 1 or more locations from which network monitoring and control, or network management, is exercised over a computer, telecommunication or satellite network.
20.	“passive infrastructure”	The components of a telecommunications infrastructure, such as fibres not yet in use, that does not generate or transmit signals, and is necessary only to carry traffic.
21.	“PE”	Polyethylene The most common form of plastic. Used for cable sheathing, typically in outdoor environments.
22.	“pooling”	When a network function is shared among several elements of the same type, providing resiliency in the case of a failure, outage or overload condition.
23.	“protection”; “protected” services	A back-up strategy for elements or links in the network to allow for continuity of service in case of a failure or outage. It typically depends on a redundant design of the network so that a subset of the elements can continue service even if some fail.
24.	“PVC”	Polyvinyl chloride A common form of plastic. Typically used for cable sheathing in indoor environments.
25.	“Qualifying Persons”	An operator who is either a facilities-based operator, a service based operator, or a broadcasting licensee.
26.	“self-healing rings”	A network design in the form of a redundant ring configuration that automatically reconfigures in the event of a fibre outage.

<u>SN</u>	<u>Term</u>	<u>Definition</u>
27.	“small cell”	Low-powered wireless nodes that are operator managed in licensed and unlicensed spectrum to enable greater cell capacity and coverage.
28.	“SMS”	Short message service
29.	“SON”	Self Organising Network An automation technology designed to make the planning, configuration, management, optimization and healing of mobile radio access networks simpler and faster. SON functionality and behaviour has been defined and specified in generally accepted mobile industry recommendations produced by organizations such as 3GPP (3rd Generation Partnership Project) and the NGMN (Next Generation Mobile Networks).
30.	“splice”	To join 2 pieces of fibre at the ends.

Singapore Telecommunications Limited
Report of the Board Committee of Inquiry
Fire at the Bukit Panjang Exchange on 9 October 2013

1. INTRODUCTION

- 1.1** The defined terms and abbreviations used are set out in the Glossary.
- 1.2** On 9 October 2013, a fire broke out in the cable chamber of the BPE. The fire damaged 139 fibre optic cables, leading to outages in fixed line services to over 60,000 customers within the area serviced by the BPE. A small number of mobile customers experienced service interruption. Most mobile customers in the vicinity of the BPE continued to have voice and SMS service while a limited number of them experienced slower data speeds.
- 1.3** Given the severity of the damage and its impact on services, and recognising the importance of resilient network infrastructure to Singapore's status as a leading financial and business hub, SingTel established the BCOI on 16 October 2013 to provide an objective and expert review of the incident.⁶
- 1.4** The BPE is 1 of 22 exchanges in Singapore housing SingTel's telecommunications equipment and cables. Although the damage was severe, it bears mentioning that SingTel provides extensive services to an estimated 1.65 million fixed line customers and 3.9 million mobile customers; and the service outages experienced as a result of the fire are, as will be seen in this Report, geographically localised to the area served by the BPE.

2. EXECUTIVE SUMMARY

- 2.1** The BCOI comprises Mr Bobby Chin Yoke Choong (Chairman), Ms Fang Ai Lian and Mr Low Check Kian, all non-executive and independent SingTel board members. The BCOI reports to the Board.
- 2.2** The BCOI is assisted by independent consultants, Bell Labs (technical consultant) and Bell Pottinger (communications and public relations management consultant), and by its advisors, Mr Richard Burns (technical advisor) and Allen & Gledhill (legal advisor).
- 2.3** Prior to the appointment of the BCOI, SingTel's management had appointed the Fire Investigation Experts, Dr Tan Yoke Lin of Octis Technology Pte Ltd and Mr Tan Jin Thong of JT Megan & Partners, as independent experts, to ascertain the cause of the fire. According to the Fire Investigation Experts, the fire was most probably caused by hot works carried out in the cable chamber of the BPE on 9 October 2013.
- 2.4** In the process of cable diversion works, a SingTel worker had used a blowtorch to heat a lead sleeve seal. SingTel has in place standard-issue blowtorches which are given to all workers carrying out hot works. However, on the day of the incident, the said worker did not have the SingTel standard-issue blowtorch equipment with him. Instead, he borrowed a non-SingTel blowtorch from a contractor assisting in the cable diversion works. The said

⁶ Media release – “*SingTel Board establishes a Committee of Inquiry into Bukit Panjang fire*” dated 16 October 2013.

worker had, on at least one previous occasion, used a blowtorch other than a SingTel standard-issue blowtorch to carry out hot works without incident.

- 2.5** Unknown to the worker, the blowtorch which he had borrowed from the contractor had a flame of almost twice the temperature of a SingTel standard-issue blowtorch. The Fire Investigation Experts' finding is that the use of this unauthorised blowtorch most probably resulted in localised overheating, which started a slow burning fire at the lead sleeve seal. The workers in the cable chamber left shortly after the hot works had been completed. As the fire alarm system in the cable chamber had been deactivated for the hot works, the fire continued to burn unnoticed for some time, resulting in damage to 139 fibre optic cables.
- 2.6** The BCOI has examined the facts and circumstances leading to the fire with a view towards making appropriate recommendations to prevent future occurrences. The BCOI has also reviewed the effectiveness of SingTel's incident management and response, and benchmarked SingTel's current network design and contingency processes against international best practices and standards, with a view to recommending improvements.
- 2.7** The fire could have been prevented if the worker had carried out the hot works using the SingTel standard-issue blowtorch and/or if there had been compliance with existing safety protocols and practices. Going forward, the BCOI recommends the cessation of open flame, and hot works altogether, through the use of alternative equipment and materials in cable chambers.
- 2.8** With the assistance of the independent consultants, the BCOI has noted other shortcomings and areas requiring improvement, and a summary of the BCOI's recommendations is separately set out in Section 3 below. Some of the key recommendations include:
- 2.8.1** SingTel should review, tighten and improve its safety procedures and protocols, as well as materials and equipment used, in the management and operation of cable chambers in exchanges housing SingTel's telecommunications equipment and cables. SingTel should also enhance supervision, training and education of its staff to instil greater awareness and vigilance as regards safety issues.
- 2.8.2** SingTel should initiate formal and regular technical exchanges of knowledge with comparable operators in the region or globally, to share key learning points, best practices and other information related to service outages, service restoration and network reliability best practices. Alternatively, SingTel could initiate a benchmarking review across a range of comparable operators.
- 2.8.3** As a major player in the telecommunications industry in Singapore, SingTel should take the lead in industry collaboration; specifically, enhance engagement with other telecoms stakeholders in Singapore (including the government) and establish a framework that would foster a coordinated response from all telecoms stakeholders on an agile, proactive basis when there is a major network incident. This should include regular sharing of information amongst telecoms stakeholders through dialogues or otherwise, and an agreement or arrangement between stakeholders to augment existing emergency response capabilities.

2.9 Notwithstanding the above, in terms of **network reliability and resiliency**, Bell Labs observed significant strengths in SingTel's people, processes and network infrastructure. In particular, Bell Labs highlighted 4 areas of strength that had a direct, positive impact on reducing the impact of the fire:

2.9.1 SingTel has a world-class core network which enables a high degree of resilience in the face of unforeseen incidents such as the fire at the BPE. SingTel's core network architecture in support of both wireline and wireless services is robust. SingTel's wireless network is particularly robust with backup fibre connections for key sites and efficient sharing of traffic across the network. As a result, the impact of the fire was geographically localised.

2.9.2 SingTel has robust processes for business continuity. SingTel's incident management during this fire was fast and effective.

2.9.3 SingTel's recovery activities enabled SingTel to repair 28,000 fibres in 2 days. This was the result of innovative processes to allow multiple splicing teams to work simultaneously in a limited space.

2.9.4 As key subcontractor to OpenNet, SingTel worked closely with OpenNet and restored connections with all customers with the right process and appropriate priority.

2.10 In terms of **communications and public relations**, Bell Pottinger's view is that SingTel's incident management and communications response was robust and coordinated:

2.10.1 Internally, staff directly involved in incident management displayed clear understanding of the incident response procedures and their roles. Processes and procedures for alerting relevant staff were well-established and effectively executed. Externally, the need to keep the customers and public frequently updated was well understood. Social media was used extremely effectively as a tool to communicate quickly with customers. SingTel had good understanding of the importance of visibility in offering reassurance and demonstrating control over the crisis situation, as well as the transparency in its communications with the media. Further, SingTel's communication with the regulators, the IDA and the MDA, was thorough and exceeded regulatory obligations.

2.10.2 SingTel responded effectively to the pressure on its call centres and achieved noticeable success in its use of (amongst other things) SMS updates tailored to subscribers of individual services, call centre interactive voice recordings, customer care officer scripts, and radio messages. The multiple channels used demonstrated commitment to keeping customers as well-informed as possible.

2.10.3 SingTel's message content was consistent across all media and customer communications. SingTel was also transparent and honest in releasing information, acknowledging the fire and offering reassurance that it was in control of the situation. Clear and detailed facts and figures were provided on the areas and extent of the network outages. SingTel messages were responsive to

customer demands for information on how long their services would be disrupted, and indications were given as to when services were expected to be restored. Where necessary, SingTel was honest and transparent in correcting outdated and inaccurate information. Very good message traction was achieved.

2.11 SingTel management has informed the BCOI that it accepts all the findings and recommendations of the BCOI, and that management is committed to an implementation timetable for all recommendations. Specifically, SingTel management will report to the Board on the implementation details of such recommendations within 3 months of the date of this Report.

2.12 The BCOI's work commenced on 16 October 2013 and concluded on 9 December 2013.

3. SUMMARY OF FINDINGS AND RECOMMENDATIONS

3.1 This Section 3 sets out a summary of the BCOI's findings and recommendations:

S/N	Subject	Recommendations
<u>FIRE PREVENTION</u>		
Present mode of operation of cable chambers in exchanges		
A.	Hot Works [8.2.1(i)]	<p>Cease the use of hot works in cable chambers and switch all lead-sealed duct seal installations to products that do not require heating (e.g. MCT Systems, or intumescent foam and putty seals). [8.2.2(i)]</p> <p>SingTel is already in the process of converting all duct seal installations to MCT Systems. [8.1.3] [8.2.2(ii)]</p> <p>Pending such conversion, SingTel has switched to using temperature-controlled lead melting systems (that do not use open flame) for hot works at the duct seal installations, instead of blowtorches. [8.1.4]</p>
B.	MCT Systems [8.2.1(ii)]	<p>Discontinue the use of lead sealants in duct seal installations. Instead, seal cable ducts using products that do not use lead and do not require heating (e.g. MCT Systems, or intumescent foam and putty seals). [8.2.2(iii)]</p> <p>SingTel is in the process of converting all lead-sealed duct seal installations to MCT Systems. [8.1.3] [8.2.2(ii)]</p> <p>Pending such conversion, SingTel has switched to using temperature-controlled lead melting systems (that do not use open flame) for hot works at the duct seal installations, instead of blowtorches. [8.1.4]</p>

S/N	Subject	Recommendations
C.	Smoke Detectors / Alarm Systems [8.2.1(iii)]	Monitor critical building alarms, including smoke detectors (and other fire-related warning systems) centrally at the INOC, even if other contractors or organisations also provide monitoring services. [8.2.2(iv)]
D.	Fire Suppression Systems [8.2.1(iv)]	Install automatic fire suppression systems in cable chambers (e.g. sprinkler or gas-based, subject to engineering study), to augment the existing smoke detectors and hand-operated fire extinguishers. [8.2.2(v)]
E.	Fibre Optic Cables [8.2.1(v)]	For new fibre optic cables being placed in exchanges, splice PE sheath cables to fire-retardant PVC sheath cables as soon as practicable upon entry of the cables into the cable chambers / exchanges. [8.2.2(vi)] For existing fibre optic cables already placed in exchanges, provide fire-retardant capability. Consider replacing existing PE sheath cables with PVC sheath cables.
F.	Firestop Practices [8.2.1(vi)]	Strengthen firestop practices between floors and walls within exchanges. For example, consider the use of fire-retardant and intumescent putty / caulking compounds instead of firestop pillows. [8.2.2(vii)]
G.	Access to Cable Chambers [8.2.1(vii)]	Enforce a more effective process to control and record physical access to cable chambers. [8.2.2(viii)]
Safety practices		
H.	Safety Practices [8.3.2]	<ul style="list-style-type: none"> • Ensure workers performing hot works are aware of and comply with safety protocols. In particular, enforce onsite supervision of high-risk activities. • Enforce regular equipment checks. Ensure that only SingTel standard-issue equipment is used for carrying out works, in particular, high-risk activities. • Enhance existing fire watch practices. It is noted that SingTel has already instituted a 24-hour fire watch after completion of hot works and supplemented fire watches with the use of handheld thermal imaging cameras. • Review and tighten protocols relating to disabling and re-activation of smoke detectors during and after hot works. • Ensure that regular, formal training is given to workers and persons responsible for [8.3.3]

S/N	Subject	Recommendations
		ensuring the safety and standards of works. Strive to inculcate an appreciation and culture of awareness and vigilance as regards safety. Clarify the roles of various personnel responsible for works.
NETWORK RELIABILITY AND RESILIENCY		
Incident management		
I.	Processes and Procedures in the New 3-tier Industry Structure [9.3.3]	Take the lead in industry collaboration; specifically, enhance engagement with other telecoms stakeholders in Singapore and establish a framework that would foster a coordinated response from all stakeholders on an agile, proactive basis when there is a major network incident. [9.3.4] [9.6.4(ii)]
Recovery		
J.	Restoration Plan Coordination [9.4.3]	Review and plan how to minimise impact to customers during restoration activities. It is understood that the next phase of SingTel's recovery activities would be to work with other internal stakeholders, such as the Enterprise division, to jointly plan how to minimise the impact to customers during the restoration activities. [9.4.4]
Network design and architecture		
K.	Fibre Path Diversity [9.5.3(i)] [9.5.3(ii)]	Develop and adopt procedures and tools to automatically verify and maintain physical path diversity. [9.5.4(i)] Improve infrastructure resiliency by: [9.5.4(ii)] <ul style="list-style-type: none"> • Avoiding using folded rings; and • Re-routing all mission-critical traffic to cabinets with dual entranceways or create a second entranceway.
L.	Diversity Options for Key Services for Enterprise Customers [9.5.3(iii)]	Encourage government agencies and key enterprise customers to purchase protected services. Set up dialogue or collaboration amongst SingTel, regulators and representatives of key customer groups to obtain a better mutual understanding of resiliency requirements. [9.5.4(iii)(d)] [9.6.4(iii)] Improve services resiliency by offering equipment, path and/or exchange diversity for key services. [9.5.4(iii)]

S/N	Subject	Recommendations
M.	Service Acceptance Test and Auditing for Enterprises [9.5.3(iv)]	See above at S/N (K). Develop and adopt procedures and tools to automatically verify and maintain physical path diversity. [9.5.4(i)]
N.	Wireless Resiliency [9.5.3(v)]	Improve wireless resiliency: [9.5.4(iv)] <ul style="list-style-type: none"> • Ensure path diversity for 2G/3G/4G services; • Consider exchange diversity coupled with path diversity; and • Improve indoor coverage.
Stakeholders		
O.	Relationship between SingTel and OpenNet pursuant to the 3-tier Industry Structure [9.6.3(i)]	See above at S/N (I). Take the lead in industry collaboration; specifically, enhance engagement with other telecoms stakeholders in Singapore and establish a framework that would foster a coordinated response from all stakeholders on an agile, proactive basis when there is a major network incident. [9.3.4] [9.6.4(ii)]
P.	Working agreement between SingTel and Property Owner [9.6.3(ii)]	Where the structure is not owned by SingTel, there should be detailed and documented interface procedures between the property owner and SingTel to ensure that there is a clear demarcation of roles and responsibilities. [9.6.4(i)]
Q.	Collaboration and information sharing with comparable operators in comparable countries on Global Best Practices [9.6.3(iii)]	Initiate formal and regular technical exchanges of knowledge with comparable operators in the region, or globally, to share key learning points, best practices and other information related to exchange outages, service restoration and network reliability best practices, or, alternatively, initiate a benchmarking review across a range of comparable operators. [9.6.4(iv)]
R.	Industry Collaboration for Business Continuity and Disaster Recovery [9.6.3(iv)]	See above at S/N (I). Take the lead in industry collaboration; specifically, enhance engagement with other telecoms stakeholders in Singapore and establish a framework that would foster a coordinated response from all stakeholders on an agile, proactive basis when there is a major network incident. [9.3.4] [9.6.4(ii)]
S.	Enterprise Adoption of Resilient Services [9.6.3(v)]	See above at S/N (L). Encourage government agencies and key enterprise customers to purchase protected services. Set up dialogue or collaboration amongst SingTel, regulators and representatives of key customer groups to obtain a better mutual understanding of resiliency requirements. [9.5.4(iii)(d)] [9.6.4(iii)]

COMMUNICATIONS AND PUBLIC RELATIONS MANAGEMENT				
Procedures and processes				
T.	Crisis Response Communications	[10.3.1(ii)(a)]	Extend crisis simulation drills to include crisis communications training for key spokespeople and Corporate Communications staff.	[10.3.1(iii)(a)]
U.	Template Media Statement	[10.3.1(ii)(b)]	Formalise communications crisis response processes into a communications crisis management manual containing (amongst other things) pre-prepared press statement drafts.	[10.3.1(iii)(b)]
V.	Communication to Staff	[10.3.2(ii)(a)]	Extend internal incident management information processes to provide prompt updates to all staff.	[10.3.2(iii)(a)]
W.	Queries from External Parties	[10.3.2(ii)(b)]	Send all staff a comprehensive reminder about the existing code of conduct for communicating with external parties.	[10.3.2(iii)(b)]
Customer and media engagement				
X.	Media Statements	[10.4.1(ii)(a)]	Formalise communications crisis response processes into a communications crisis management manual containing (amongst other things) pre-prepared press statement drafts.	[10.4.1(iii)(a)]
Y.	Responsiveness and Regularity in Communications	[10.4.1(ii)(b)]	Institute standard procedures to issue information updates with greater regularity even if no change of status. Manage expectations by providing an estimation of when the next update can be expected.	[10.4.1(iii)(b)]
Z.	Media Spokesperson	[10.4.1(ii)(c)]	Enhance management accountability and visibility by introducing a media spokesperson at an earlier stage.	[10.4.1(iii)(c)]
AA.	Separate Spokespersons	[10.4.1(ii)(d)]	Separate the roles of crisis command and media spokesperson.	[10.4.1(iii)(d)]
BB.	Social Media	[10.4.1(ii)(e)]	Tighten the processes around the Master Messaging Document to streamline drafting and approval of all messages, and ensure speed and coordination of response.	[10.4.1(iii)(e)]
CC.	Online Updates	[10.4.1(ii)(f)]	Enhance online visibility by (i) creating an “updates” section on SingTel’s website; and (ii) posting updates on Facebook as new threads instead of comments within existing threads.	[10.4.1(iii)(f)]
Messaging				

DD.	Projected Restoration Timelines	[10.5.2(ii)(a)]	Be less definitive on restoration projections to better manage customer expectations.	[10.5.2(iii)(a)]
EE.	Key Message	[10.5.2(ii)(b)]	Institute measures to ensure that the full context of future crisis situations are well-explained, thereby improving clarity of information and reducing the risk of distractions.	[10.5.2(iii)(b)]
Other recommended initiatives				
FF.	Media Familiarisation Campaign	-	Consider initiating a media familiarisation campaign to build on technical transparency and ensure a core understanding of the network in the event of future incidents.	[10.6.1(i)]
GG.	Standard Explanatory Precedents	-	Consider developing a bank of documentation that simply explains the way the network functions, and answers questions that might arise in the event of different types of crisis incidents, to help non-specialists understand the context in the event of a crisis incident.	[10.6.1(ii)]
HH.	Fresh Viewpoints	-	Involve fresh viewpoints in crisis preparation and response by inviting input from cross-functional teams within SingTel and external experts to update processes and procedures.	[10.6.1(iii)]
FURTHER RECOMMENDATIONS				
II.	New Developments / Technology	-	Conduct regular and timely reviews, at least annually, with a view to implementing and upgrading facilities, equipment and/or methods based on industry best practices and/or new developments/technology.	[11.1.1]
JJ.	Safety and Training	-	Review the scope of its existing management committee(s), and/or consider establishing new management committees comprising members of appropriate seniority, with a view to reviewing and regularly updating policies, processes and procedures in relation to safety and human resource (including training).	[11.1.2]

4. THE INQUIRY

4.1 The BCOI

4.1.1 The BCOI comprises Mr Bobby Chin Yoke Choong (Chairman), Ms Fang Ai Lian and Mr Low Check Kian, all non-executive and independent SingTel board members. The BCOI reports to the Board.

4.2 Terms of Reference

4.2.1 The BCOI's Terms of Reference are to:

- (i) Investigate the facts and circumstances leading to the fire;
- (ii) Review the effectiveness of SingTel's incident management and response, and recommend improvements;
- (iii) Benchmark current network design and contingency processes against international best practices and standards; and
- (iv) Recommend appropriate improvements to prevent future occurrences and to strengthen network resilience.

4.2.2 The common theme underlying the Terms of Reference is **improvement**. The BCOI wishes to emphasize that the overarching objective of the inquiry has been to recognise and build on strengths where they have been demonstrated, and to make recommendations for improvement where this is in line with SingTel's position as a world class telecommunications and network service provider. This inquiry is not a fault-finding exercise nor is it intended to focus on the actions of any particular individuals.

4.3 The appointment of independent consultants

4.3.1 Bell Labs was appointed as technical consultant to the BCOI.

4.3.2 As technical consultant, Bell Labs was tasked to review SingTel's network reliability and resiliency and contingency processes. Bell Labs compared the information and evidence it gathered against a well-established set of industry global Best Practices created and regularly refreshed by practitioners from US operators, as well as based on a comparative review of sources from the US, Europe and Asia-Pacific. Bell Labs also (i) conducted more than 10 interviews with other operators and external experts in the US, Europe and Asia-Pacific to discuss comparable benchmarks and common practice, (ii) where possible, visited comparable cable chambers, (iii) reviewed other outages to identify lessons learnt in those situations, and (iv) drew from its own experience of reviewing outages and assisting operators in the US, Europe and Asia to restore their services.

4.3.3 Bell Pottinger was appointed as communications and public relations management consultant to the BCOI.

4.3.4 As communications consultant, Bell Pottinger focused on reviewing the effectiveness of SingTel's incident management and communications response to the fire. Bell Pottinger drew information from all communications activities by SingTel from 9 to 19 October 2013 (inclusive), including print, broadcast and online media reports. In addition, Bell Pottinger conducted interviews with SingTel staff, and conducted interviews and surveys with consumer customers, enterprise customers and members of the media who were directly involved in reporting the incident. Bell Pottinger analysed SingTel's communications response according to crisis communications best practice, drawn from Bell Pottinger's 25 years of crisis communications experience.

4.3.5 Each of Bell Labs and Bell Pottinger was independently engaged and mandated by the BCOI. Each of them was directly instructed by the BCOI. The BCOI was satisfied that the independence of Bell Labs and Bell Pottinger would not be compromised by any previous or professional engagements.

4.4 Advisors to the BCOI

4.4.1 Mr Richard Burns advised the BCOI on technical issues arising from the inquiry.

4.4.2 Allen & Gledhill advised the BCOI on legal issues arising from the inquiry.

5. THE NEXT GEN NBN INDUSTRY STRUCTURE

5.1 Some of the key findings relate to issues arising from the unique "3-tier industry structure" under the Next Gen NBN initiative. This Section 5 outlines the structure as an aid to understanding such key findings.

5.2 Next Gen NBN is part of a government initiative to provide ultra-high broadband speeds to all physical addresses in Singapore. As part of this initiative, IDA designed a Next Gen NBN industry structure as follows:

5.2.1 Base Layer – NetLink Trust is a business trust that owns passive assets necessary to support the Next Gen NBN roll-out by OpenNet, including ducts/manhole network and exchanges transferred from SingTel. CityNet is the trustee-manager for NetLink Trust and manages the access to NetLink Trust's ducts, manholes and exchanges.

5.2.2 Layer One – OpenNet is responsible for the design, build and operation of the passive infrastructure.

5.2.3 Layer Two – NucleusConnect will provide wholesale active network services over the active infrastructure.

5.2.4 Layer Three – The Retail Service Providers ("**RSPs**") will offer services over the Next Gen NBN to end-users, including business and consumers.

- 5.3** Layer One to Layer Three is generally referred to the 3-tier industry structure for the purposes of Next Gen NBN. Other industry players, apart from the above-mentioned entities, also operate within these layers.
- 5.4** Under this 3-tier industry structure, SingTel was appointed as the key subcontractor to OpenNet. As OpenNet's key subcontractor, SingTel designs, builds and maintains OpenNet's passive infrastructure. OpenNet is then responsible for providing wholesale dark fibre services to Qualifying Persons, which include operating companies that are also RSPs (such as M1, StarHub, MyRepublic and SingTel etc).
- 5.5** In this regard, as key subcontractor, SingTel communicates only with OpenNet, and only OpenNet will communicate with the Qualifying Persons. SingTel does not have information as to which Qualifying Person or RSPs (e.g. M1 or StarHub) might be using OpenNet-owned fibre cables.

6. THE INCIDENT

6.1 Background to the works in the BPE cable chamber on 9 October 2013

- 6.1.1** On 9 October 2013, between about 1212h to 1305h, hot works were carried out in the cable chamber of the BPE as part of cable diversion works. The hot works involved heating a lead sleeve seal around the cable with a blowtorch.

6.2 The fire

- 6.2.1** At about 1400h, a fire was discovered in the cable chamber.
- 6.2.2** CityNet and DTZ employees attempted to fight the fire with fire extinguishers but were unable to enter the cable chamber due to thick smoke. The SCDF was notified and arrived at the BPE at about 1420h. In the meantime, evacuation of the BPE was coordinated by a CityNet employee.
- 6.2.3** The SCDF took about 20 minutes to locate and extinguish the fire. The fire was extinguished by about 1440h.
- 6.2.4** The SCDF allowed SingTel access to the cable chamber at the BPE only at about 1700h.

6.3 The cause of the fire

- 6.3.1** According to the Fire Investigation Experts, the fire was most probably caused by the hot works carried out in the cable chamber on 9 October 2013.
- 6.3.2** Other possible causes of fire were ruled out by the Fire Investigation Experts. The evidence indicates that the cause could not have been:
- (i) A lighted cigarette;
 - (ii) Incendiary (i.e. a deliberately set fire);

- (iii) Electrical origin; or
- (iv) Flammable gas explosion.

6.3.3 The blowtorch used to carry out the hot works was not a SingTel standard-issue blowtorch. SingTel has in place standard-issue blowtorches which are given to all workers carrying out hot works. However, on the day of the incident, the said worker did not have the SingTel standard-issue blowtorch equipment with him. Instead, he borrowed a non-SingTel blowtorch from a contractor assisting in the cable diversion works. The Fire Investigation Experts noted that the temperature of the flame applied to the lead sleeve seal using the non-SingTel blowtorch was almost twice as high as that of the SingTel standard-issue blowtorch. The Fire Investigation Experts found that localised overheating of the lead sleeve seal by the blowtorch used on 9 October 2013 most probably caused the seal to catch fire.

6.4 Physical damage

- 6.4.1** The fire damaged a total of 139 fibre optic cables out of a total of 342 fibre optic cables housed in the BPE cable chamber.⁷
- 6.4.2** The mechanical and electrical services in the BPE were not affected, and the structural integrity of the BPE was not compromised.

7. SERVICES AFFECTED

7.1 Overview

- 7.1.1** SingTel provides extensive services to an estimated 1.65 million fixed line customers and 3.9 million mobile customers.
- 7.1.2** There are 22 exchanges in Singapore housing SingTel's telecommunications equipment and cables. 9 of the 22 exchanges which house SingTel's telecommunications equipment and cables also house OpenNet's passive infrastructure. The BPE is 1 of these 9 exchanges.
- 7.1.3** The services supported by the telecommunications infrastructure in the BPE include approximately:
 - (i) 15% of residential homes and 9.5% of business buildings using SingTel services nationwide; and
 - (ii) 9% of OpenNet fibre cables nationwide, which carry SingTel services as well as services provided by other operating companies under the Next Gen NBN framework.

⁷ SingTel fibre optic cables (corresponding to about 6,000 fibres): (i) 43 out of 106 fibre optic cables housing SingTel local fibres (i.e. fibres connecting the BPE to the end users); and (ii) 10 out of 58 fibre optic cables housing SingTel trunk fibres (i.e. fibres connecting BPE to other exchanges). OpenNet fibre optic cables (corresponding to about 22,000 fibres): 86 out of 178 fibre optic cables housing OpenNet local fibres.

7.1.4 The service outages experienced as a result of the fire at the BPE were geographically localised to the area served by the BPE.

7.2 SingTel services affected

7.2.1 Consumer services affected

- (i) Fixed line services affected over 60,000 customers, i.e. approximately:
 - (a) 15% of “mio Voice” services nationwide;
 - (b) 0.5% of direct exchange line services nationwide;
 - (c) 8.6% of broadband services nationwide; and
 - (d) 11% of “mio TV” services nationwide.
- (ii) Mobile infrastructure affected: fibre connections to approximately 186 mobile base stations.

7.2.2 Enterprise services affected

- (i) Fixed line services affected were approximately:
 - (a) 22% of Layer 3 multi-protocol label switching circuits nationwide;
 - (b) 0.2% of local leased circuits nationwide; and
 - (c) 4.6% of international leased circuits nationwide.

7.3 Other service providers affected

7.3.1 SingTel does not have visibility of the full extent to which the services provided by other service providers were affected.

7.4 Prioritisation and timelines for service restoration

7.4.1 SingTel, acting as the key subcontractor for OpenNet’s passive infrastructure, and taking responsibility for its own fibre optic cables, was the party solely responsible for repair of all the damaged fibre optic cables in the BPE.

7.4.2 2 methods were used concurrently to restore services:

- (i) Patching / diversion: this involved re-routing network signals to run through fibre optic cables other than the damaged ones.
- (ii) Splicing: this involved cutting out the damaged portions of the fibre optic cables, and re-joining with new fibre optic cable connections.

7.4.3 Prioritisation of restoration and repair activities was as follows:

- (i) SingTel cables: SingTel's Group Enterprise department identified critical circuits to be given restoration priority. Generally, priority was given to enterprise customers. Priority circuits were restored using spare fibres which were not affected by the fire. At the same time, splicing works were carried out at the cable chamber and the nearest manhole to re-connect the damaged optic fibre cables. No specific priorities were assigned as far as splicing works was concerned as it would not have been time efficient to identify specific cables for priority splicing.
- (ii) OpenNet cables: As there were duplicate cables with spare capacity available connecting the BPE to the first cabinet from the BPE (known as the primary cabinet), SingTel took steps to re-route the traffic (previously carried by the damaged cables) through the duplicate cables. This was done as soon as a transfer schedule was received from OpenNet.⁸ In the absence of the transfer schedule from OpenNet, SingTel was not able to re-route any traffic as SingTel, as key subcontractor to OpenNet, did not know which and whose services had been disrupted by the fire. At the same time, splicing works were carried out at the cable chamber and the nearest manhole to re-connect the damaged optic fibre cables. No specific priorities were assigned as far as splicing works was concerned as it would not have been time efficient to identify specific cables for priority splicing.
- (iii) Directions were given to the restoration and repair teams to give equal priority to the restoration of services of all service providers relying on the damaged fibre optic cables.

7.4.4 By about 1630h on 9 October 2013, about 2.5 hours from the discovery of the fire, SingTel's spare inventory of fibres and fibre optic cables were transported to the BPE. These were on standby to effect restoration by splicing as soon as SCDF allowed re-entry into the cable chamber. SCDF allowed re-entry into the cable chamber at about 1700h.

7.4.5 All fibre cables (whether SingTel or OpenNet) were repaired by about 0715h on 11 October 2013, about 38.25 hours from the time of re-entry into the cable chamber.

8. FIRE PREVENTION

8.1 Interim changes

8.1.1 MCT Systems do not require hot works for addition and removal of cables.

8.1.2 8 of SingTel's 22 exchanges use MCT Systems only, while the remaining 14 exchanges have either a combination of MCT Systems and lead-sealed duct seal installations or lead-sealed duct seal installations only. At the BPE, approximately

⁸ The transfer schedule from OpenNet will provide SingTel with the appropriate instructions as to which service path needs to be re-routed due to the network disruption.

44% of the ducts are sealed by MCT Systems while the remaining 56% use lead-sealed duct seal installations.

- 8.1.3 Pending the findings of the BCOI, SingTel has already taken steps to convert all existing lead-sealed duct seal installations to MCT Systems. Completion of this exercise is estimated to be at the end of 2014.
- 8.1.4 In the interim, SingTel has switched to using temperature-controlled lead melting systems (that do not use open flame) for hot works at the duct seal installations, instead of blowtorches.

8.2 Present mode of operation of cable chambers in exchanges

8.2.1 Findings:

- (i) The use of hot works in cable chambers is outdated, unnecessary and hazardous.
- (ii) The use of lead sealants in duct seal installations, and the associated use of open flames in hot works to remove lead sealants, are unnecessary fire risks. The use of lead sealants is outdated and is also a health hazard.
- (iii) Smoke detectors were not monitored by SingTel, but by a third party monitoring agent.
- (iv) There is no automatic fire suppression system in cable chambers. SingTel has in place automatic fire suppression systems on all floors of the BPE where there are electrical and heat-generating (active) equipment. The cable chamber contains non-heat generating (passive) equipment, and was therefore only equipped with smoke detectors and hand-operated fire extinguishers.
- (v) The use of PE sheath fibre optic cables inside the exchanges (including in the cable chamber) is a fire risk. Although PE sheath cables are suitable for use in ducts and cable tunnels due to their water / gas / oil resistant properties, PE is highly flammable and should not be used indoors, including in the cable chamber.
- (vi) There are inadequate firestop practices between different floors and rooms of the exchanges.
- (vii) Access to cable chambers is not specifically controlled and/or monitored.

8.2.2 Recommendations:

- (i) Cease the use of hot works in cable chambers and switch all lead-sealed duct seal installations to products that do not require heating (e.g. MCT Systems, or intumescent foam and putty seals).

- (ii) The BCOI notes that SingTel is already in the process of converting all duct seal installations to MCT Systems.
- (iii) Discontinue the use of lead sealants in duct seal installations. Instead, seal cable ducts using products that do not use lead and do not require heating (e.g. MCT Systems, or intumescent foam and putty seals). As noted above, SingTel is already in the process of converting all lead-sealed duct seal installations to MCT Systems.
- (iv) Ensure that critical building alarms, including smoke detectors (and other fire-related warning systems), are monitored centrally at the INOC, even if other contractors or organisations also provide monitoring services.
- (v) Install automatic fire suppression systems in the cable chambers (e.g. sprinkler or gas-based, subject to engineering study), to augment the existing smoke detectors and hand-operated fire extinguishers.
- (vi) To deal with PE sheath cables:
 - (a) For new fibre optic cables being placed in exchanges, splice PE sheath cables to fire-retardant PVC sheath cables as soon as practicable upon entry of the cables into the cable chambers / exchanges.
 - (b) For existing fibre optic cables already placed in exchanges, provide fire-retardant capability. Consider replacing existing PE sheath cables with PVC sheath cables.
- (vii) Strengthen firestop practices between floors and walls within exchanges. For example, consider the use of fire-retardant and intumescent putty / caulking compounds instead of firestop pillows, which can typically resist flames for longer than firestop pillows. Such compounds also expand when heated to create complete fire and smoke seals.
- (viii) Enforce a more effective process to control and record physical access to cable chambers, e.g. require the use of a coded key pass to enter the cable chamber.

8.3 Safety practices

8.3.1 Although SingTel has already taken steps to convert all existing duct seal installations to MCT Systems and, in the interim, temperature-controlled lead melting systems are now used instead of open flame blowtorches, the findings and recommendations in this section are nevertheless set out because (i) they may be applicable to hot works other than hot works using open flame; and (ii) the wider principles and thinking behind the findings and recommendations as regards hot works may also be useful learning points in relation to other forms of high-risk activities.

8.3.2 Finding: The BCOI noted that the worker responsible for the hot works on 9 October 2013 had attended a number of recent training courses in safety and fire prevention. These included: (i) a Ministry of Manpower accredited Safety Orientation Course for Workers in the Oil/Petrochemical Industry in January 2012; (ii) a SCDF course in First Aid & Fire Safety in November 2012; and (iii) an in-house General Safety Talk in February 2013. Such training was ineffective in instilling sufficient safety awareness and vigilance in the worker responsible for the hot works.

8.3.3 Recommendations:

- (i) Ensure workers performing hot works are aware of and comply with safety protocols. In particular, enforce onsite supervision of workers, particularly those carrying out high-risk activities. Site supervisors should be trained in relevant safety protocols and carry out supervision duties diligently and competently.
- (ii) Enforce regular equipment checks. Ensure that only SingTel standard-issue equipment is used for carrying out works, in particular, high-risk activities such as hot works.
- (iii) Enhance existing fire watch practices, including as follows:
 - (a) Ensure that site supervisors comply with safety protocols that require the site supervisor (and not only the worker) to conduct a fire watch upon completion of the hot works;
 - (b) Extend the duration of fire watches to 1 hour or more, based on the proximity of such relevant works to flammable materials (the BCOI notes that SingTel has presently instituted a 24-hour fire watch after completion of hot works); and
 - (c) The BCOI notes that SingTel has already supplemented fire watches with the use of handheld thermal imaging cameras, to visualise the surface temperature distribution of the hot works area accurately, and thereby enhance reliability of the fire watches.
- (iv) Review and tighten protocols relating to disabling and re-activation of smoke detectors during and after hot works.
- (v) Ensure that regular, formal training is given to workers and persons responsible for ensuring the safety and standards of works. Such training should cover both technical and safety skills and knowledge, and strive to inculcate an appreciation and culture of awareness and vigilance as regards safety. Regular assessments or spot checks should also be conducted to ensure that the relevant staff's skills and practices are consistently kept to a high level. Also, clarify the roles of various personnel responsible for works, and ensure that staff in supervisory roles

understand the need for safety checks and balances, particularly when carrying out high-risk activities such as hot works.

- (vi) Enhance education of staff to include awareness of written safety protocols and explain requirements in simple, clear, and unambiguous terms. Management should ensure that staff (including supervisors and workers) are thoroughly briefed on updates and new best practices, and provided with appropriate documentation to supplement their understanding. Consider a harmonisation exercise (including with CityNet) to develop a single consolidated and centralised set of safety protocols, which are drafted in language suitable for workers to understand (e.g. in plain and simple language).

9. NETWORK RELIABILITY AND RESILIENCY

9.1 Objective and methodology

- 9.1.1 Bell Labs was appointed by the BCOI to review SingTel's network reliability and resiliency and contingency processes.
- 9.1.2 Bell Labs worked closely with SingTel's network team to gather relevant information and evidence on the impact caused by the fire and the response thereto.
- 9.1.3 Bell Labs compared such information against a well-established set of industry global Best Practices created and regularly refreshed by practitioners from US operators, as well as based on a comparative review of sources from the US, Europe and Asia-Pacific. Bell Labs also (i) conducted more than 10 interviews with other operators and external experts in the US, Europe and Asia-Pacific to discuss comparable benchmarks and common practice, (ii) where possible, visited comparable cable chambers, (iii) reviewed other outages to identify lessons learnt in those situations, and (iv) drew from its own experience of reviewing outages and assisting operators in the US, Europe and Asia to restore their services.

9.2 Areas of study

- 9.2.1 Based on the location and timeline of the events surrounding the fire, the 5 areas of investigation in relation to network reliability and resiliency were as follows:
 - (i) Present mode of operation in the cable chamber;
 - (ii) Incident management;
 - (iii) Recovery;
 - (iv) Network; and
 - (v) Stakeholders.

9.2.2 The key findings and recommendations as regards the present mode of operation in the cable chamber have been addressed in paragraph 8.2 above. The remainder of this section will set out key findings and recommendations in the 4 remaining areas of investigation.

9.3 Incident Management

9.3.1 Scope:

- (i) Incident management includes the first steps taken as a reaction to the damage caused by the fire and ends when all services have been restored. The end goal of incident management is to restore service to the end customer.
- (ii) Incident management activities are divided into 2 categories:
 - (a) Fibre repair; and
 - (b) Service restoration.
- (iii) SingTel carried out incident management activities in its capacity both as the owner of the damaged cables and as key subcontractor to OpenNet.

9.3.2 Strengths:

- (i) Bell Labs observed that many of SingTel's processes are in-line with Best Practices. There is evidence of robust processes within SingTel to deal with major incidents.
- (ii) In this incident, SingTel recognised the seriousness of the fire quickly. It mobilised significant and appropriate resources to repair the damaged cables, and put in place emergency procedures that worked well. In fact, Bell Labs noted that SingTel devised an innovative process which allowed multiple teams to simultaneously splice fibres in a limited space to repair the damaged cables within 2 days of the fire. Bell Labs is not aware of other examples where this volume of splices (such as the 28,000 fibre splices carried out by SingTel) has been completed in such a short period of time.
- (iii) Bell Labs further noted that there was also a good level of collaboration between SingTel and OpenNet from the onset of the fibre repair activities in the immediate aftermath of the fire. This was possible as SingTel, as the key subcontractor, was singularly responsible for repairing both SingTel-owned and OpenNet-owned fibre cables.

9.3.3 Area for improvement:

The processes and procedures in place between the industry players in the 3-tier industry structure may have been adequate in steady state operations. Such

processes and procedures were inadequate in dealing with major incidents such as the BPE fire, as elaborated below:

- (i) SingTel had repaired all the OpenNet-owned cables within 2 days of the fire. However, as key subcontractor, SingTel was not able to conduct end-to-end testing with Qualifying Persons.
- (ii) There was no direct communication between SingTel's INOC (in its capacity as key subcontractor) and the NOCs of other Qualifying Persons to verify that services had been restored.

9.3.4 Recommendation:

As a major player in the telecommunications industry in Singapore, SingTel should take the lead in industry collaboration; specifically, enhance engagement with other telecoms stakeholders in Singapore (including the government) and establish a framework that fosters a coordinated response from all telecoms stakeholders on an agile, proactive basis when there is a major network incident. This should include a regular sharing of information on incidents and outages through dialogues or otherwise, and an agreement or arrangement between telecoms stakeholders to augment existing emergency response capabilities. Telecoms stakeholders should also consider engagement with the relevant regulators for a review of the current Fire Code and Electric Code.

9.4 Recovery

9.4.1 Scope:

- (i) Recovery includes returning operations to normal following an incident. The focus of recovery is to re-establish a communications infrastructure that meets all the design criteria of quality, reliability, and security. The recovery phrase includes ensuring that any non-standard equipment and procedures and/or any temporary solutions that may have been used to restore service to the end-customer quickly following an incident are brought back up to normal and acceptable levels as quickly as possible.
- (ii) SingTel commenced works to return the affected assets (including the damaged cables) to their original state at the BPE shortly after the fire. The recovery phase has not been completed as at the time of writing, and is expected to be completed in April 2014 in accordance with SingTel's fibre and cable-splicing plan to restore the affected BPE to its original design.

9.4.2 Strengths:

- (i) **See paragraph 9.3.2(ii) above.** SingTel devised an innovative process which allowed multiple teams to simultaneously splice fibres in a limited space to repair the damaged cables within 2 days of the fire.

- (ii) Bell Labs considered relevant Best Practices for recovery activities, and observed that SingTel's recovery activities to-date are in line with Best Practices.

9.4.3 **Area for improvement:**

The fibre and cable-splicing plan sighted by Bell Labs needs to be integrated with the activities of other SingTel internal stakeholders, such as the Enterprise division, to develop a comprehensive plan that maximises customer experience and minimises disruption during restoration.

9.4.4 **Recommendations:**

SingTel should review and plan how to minimise impact to customers during restoration activities. The next phase of SingTel's recovery activities is to work with other internal stakeholders, such as the Enterprise division, to jointly plan how to minimise the impact to customers during the restoration activities.

9.5 **Network design and architecture**

9.5.1 **Scope:**

This includes the network architecture, design, resilience, the fibre layout diversity for both wireline and wireless networks, and equipment pooling features for wireless services. A resilient network architecture and design must be able to withstand catastrophic network incidents by restoring protected services instantly and minimising the impact on non-protected services.

9.5.2 **Strengths:**

- (i) Bell Labs observed that SingTel's network architecture and design is established to allow for rapid restoration of protected services, and to ensure minimal impact on overall network operations.
- (ii) In this regard, Bell Labs observed that SingTel has a world-class core network which is highly resilient with no evident single point of failure. Key features include:
 - (a) A fully meshed fibre architecture, where 1 SingTel exchange is directly connected to a number of other SingTel exchanges and indirectly connected to all other SingTel exchanges, thus ensuring that a failure in a single exchange will not impact the core network;
 - (b) Full redundancy of equipment in all exchanges, which ensures that in the event 1 piece of equipment fails, services will be carried by alternative equipment; and
 - (c) Key assets are linked to at least 2 core routers, which ensures that in the event 1 router fails, services will be carried by alternative routers.

- (iii) In particular, Bell Labs observed that the wireless core network is well-designed to survive major network incidents, as there is full redundancy of wireless core equipment linked to diverse exchanges along diverse fibre paths.
- (iv) About half of SingTel's access rings are self-healing rings. Bell Labs noted that SingTel also has a proactive network planning process to improve the reliability and service availability of the access network. SingTel presently has plans to:
 - (a) Introduce dual-uplink for all new voice services – This means that the voice service is connected to 2 routers, which ensures that, in the event 1 router fails, service is still carried by the alternative second router; and
 - (b) Expand the use of Carrier Ethernet for wireless services – All exchanges and most cabinets in SingTel's network are physically connected by fibre cables in a loop. Each loop can contain an exchange and several cabinets in the case of a "*primary ring*", or several cabinets in the case of a "*secondary ring*". In the absence of a Carrier Ethernet solution, services are carried by the cables in a single direction along the loop (i.e. either clockwise or anti-clockwise). In the event there is a fibre cut along a service path, the services will be disrupted. The Carrier Ethernet solution is a protocol – like an automated switch – that will automatically reverse the service traffic in the opposite direction along the uncut fibres within a very short time. Such loops with a Carrier Ethernet solution are considered as "*self-healing*" fibre rings and hence resilient.
- (v) SingTel's wireless network also has additional resiliency arising from the following:
 - (a) SON functionality – During this fire, the SON functionality, deployed sometime in April 2013, allowed SingTel to restore 3G/4G services to some customers. In ordinary circumstances, the SON functionality allows adjacent / surroundings base stations with overlapping areas of coverage to automatically decide which base station would provide the necessary coverage to a customer within the area of overlap and to adjust their coverage accordingly. The SON functionality also decides, for instance, the load sharing between 2G/3G for the voice network or 2G/3G/4G for the data network in 1 base station. When the fire terminated the connectivity to some base stations, the SON functionality either: (I) allowed base stations that were not affected by the fire to adjust their coverage automatically to provide wireless services to some of the customers within the areas of overlap; or (II) allowed the 2G network (on the same base stations that provided the 3G/4G network which was disrupted due to damage to the fibres) to pick up the load on the 2G network. SingTel is reported to be the first

operator in Asia to deploy the SON functionality, and should continue to introduce new SON features as they become available; and

- (b) Pooling of equipment resources – Equipment pooling allowed SingTel to spread traffic across the network and provide back-up for high-demand services, thus providing redundancy. Bell Labs noted that SingTel is ahead of many operators in this regard, and should continue its plan to extend pooling when available.

9.5.3 **Areas for improvement:**

- (i) SingTel's internal audit of the fibre layout database showed that a limited number of fibre paths had been wrongly assumed to be diverse. However, the audit could not confirm whether the errors were due to record-keeping or actual non-diverse physical routes.
- (ii) Parts of SingTel's access network infrastructure lack physical path diversity⁹, thus giving rise to the risk of a single point of failure in each instance. These are as follows:
 - (a) Due to civil works, a few resilient, self-healing fibre rings that transport multiple sensitive services were temporarily folded (such that 2 or more segments of the fibre ring overlapped) and entered the exchange via a single entranceway. This gives rise to the risk of a single point of failure; and
 - (b) Some cabinets have a single entranceway.¹⁰ Some of these may carry critical services, and some may terminate both primary and secondary rings which serve a large number of customers. A fibre cable cut at such a single entranceway to the cabinet would cause significant service impact.
- (iii) Although diversity options are available or can be made available to improve service resiliency, diversity has not been fully implemented or utilised by customers in respect of the following key services:
 - (a) Not fully implemented:
 - (l) Equipment diversity: SingTel provides a voice service that connects the customer to the MSAN nodes, which are connected to routers. Only new nodes and existing large nodes are connected to a second router (i.e. dual uplink). Existing small nodes are connected to only 1 router (i.e. single uplink), even though they comprise two-thirds of all current

⁹ Physical path diversity includes the diversity of fibre cables (i.e. using different cables, which may or may not be travelling along the same geographical route), patch panels, fibre distribution frames, cabinet entranceways, power, manholes and chamber entrances.

¹⁰ There are, however, a large number of cabinets (approximately 30%) which have dual entranceways for the fibre cables.

nodes and serve, in total, a significant number of customers. The loss of connection via this single uplink will result in the risk of a single point of failure.

- (II) Path diversity: DSL access and GPON access is carried by a single cable between an exchange and a cabinet along 1 geographical path.
 - (III) Exchange diversity without path diversity: While SingTel offers enterprise services with an option of exchange diversity at an additional cost, exchange diversity does not guarantee path diversity. In some cases, the cables connecting the customer to the 2 separate exchanges may partially travel over the same geographical path, thus giving rise to the risk of a single point of failure.
- (b) Not fully utilised – SingTel also offers enterprise services with exchange and path diversity for an additional cost. However, the percentage of customers using such services is low.
- (iv) There is no established process to test and verify path diversity and/or exchange diversity when these are offered as part of SingTel's services prior to a customer accepting such services.
- (v) Connectivity to base stations was disrupted where automated service restoration was not available on the fibre paths that served these base stations:
- (a) 2G connectivity is carried over self-healing rings that connect the cabinets to the exchange. However, in this fire, some 2G base stations lost coverage as some of the self-healing rings were folded.
 - (b) At present, all 3G/4G base stations are connected to the exchanges (through cabinets) on a single fibre path, and not self-healing rings.¹¹ This exposed 3G/4G base stations to the risk of a single point of failure.
 - (c) Although SingTel's failure protection plan shows that 3G coverage generally has overlapping 2G coverage from outdoor base stations in the event of failure, some customers lost service as they were covered by indoor base stations that did not benefit from overlapping coverage from outdoor base stations.

¹¹ The exchange and the cabinets could be physically connected by fibre cables in a loop. However, in the absence of an automated switching mechanism such as the Carrier Ethernet, such loops are not "self-healing" rings and the service would still only be carried on a fixed single path to the exchange.

9.5.4 **Recommendations:**

- (i) Verify physical path diversity
 - (a) SingTel should develop and adopt procedures and tools to automatically verify and maintain physical path diversity of the network. These should be used to validate and authenticate physical path diversity prior to launching a service for a customer purchasing protected services with or without exchange diversity.
 - (b) In this regard, SingTel is planning to implement regular audits on the characteristics of the physical layers of the network. SingTel is also developing a more comprehensive set of processes or automated tools to check for physical path diversity. SingTel should introduce these processes and tools as soon as possible.
 - (ii) Improve access network infrastructure resiliency
 - (a) SingTel should avoid using folded rings as much as possible:
 - (I) Where possible, SingTel should consider re-routing mission-critical traffic, i.e. traffic which failure would result in a serious disruption of the customer's operations;
 - (II) Where traffic is not re-routed, it must be closely monitored;
 - (III) No additional traffic should be allowed to use the temporarily folded rings; and
 - (IV) SingTel should minimise the length of time for which any fibre rings are temporarily folded.
 - (b) Cabinets with critical services and cabinets terminating both primary and secondary rings should have dual entranceways for path diversity. This is achieved by either re-routing all mission-critical traffic to cabinets with dual entranceways where possible, or creating a second entranceway for these cabinets. In the spirit of continuous improvement, SingTel should consider changes to its existing policies, and engaging relevant stakeholders to review building requirements for cabinet entranceways.
 - (c) It is noted that in a sophisticated setting like Singapore, the standard is to have as much as 70% of the access network with physically diverse and self-healing design.
 - (iii) Improve services resiliency: The objective here is to enhance key services to end-users by taking advantage of the capabilities available in the network.
-

- (a) MSAN – Since all new MSAN nodes and existing large nodes have dual uplinks, SingTel should cap growth on existing nodes which are connected only to 1 router. Existing nodes serving more than 200 voice customers should also be connected to a second router, given that any outage of more than 200 voice customers is considered a critical outage under SingTel's processes. This ensures continuity if 1 router fails.
 - (b) GPON – SingTel should offer key enterprise customers GPON access with path diversity i.e. 2 fibres running along diverse geographical paths between the exchange and the cabinet. This ensures continuity if 1 fibre is cut.
 - (c) DSL – Given that SingTel is planning to phase out DSL service and migrate these customers to GPON, and GPON is currently available, SingTel should encourage DSL customers to transition to GPON service. The DSL to GPON migration should be closely monitored. Large enterprise customers may consider migrating to other protected services.
 - (d) SingTel should work with government agencies and its large enterprise customers to encourage them to purchase protected services with a level of resiliency that corresponds with importance of the traffic carried. On a higher level, SingTel can also set up a collaboration or dialogue amongst SingTel, the regulators and representatives of key customer groups to obtain a better mutual understanding of resiliency requirements.
- (iv) Improve wireless resiliency
- (a) SingTel should ensure path diversity for its 2G/3G/4G wireless services:
 - (I) SingTel should avoid using folded rings for its 2G services;
 - (II) As for SingTel's 3G/4G services, it is noted that SingTel has plans and is currently testing its Carrier Ethernet solution to connect 100% of its 3G/4G base stations to the exchange. A fibre ring with Carrier Ethernet solution would be a self-healing ring, and thus enable automatic restoration of 3G/4G services; and
 - (III) However, given the finding that some physical fibre paths had been wrongly assumed to be diverse, SingTel should verify that the cabinets connecting 3G/4G base stations to the exchange do in fact have diverse physical fibre paths.

- (b) As in the case of wireline services, SingTel should consider exchange diversity¹² coupled with path diversity for its wireless network.
- (c) SingTel can improve indoor coverage by:
 - (I) Providing redundancy for fibre connections of high traffic zones (**see paragraph 9.5.4(iv)(a) above**); and
 - (II) Using the latest small cell architecture for additional reliability, indoor coverage and even capacity, which is already in trial-use by SingTel.

9.6 Stakeholders

9.6.1 **Scope:**

This includes a review of the interactions among the different groups of SingTel stakeholders. Such stakeholders include government, customers and a range of suppliers from property management companies, IT service and equipment vendors. This also includes a review of the interactions among SingTel and other operators in Singapore.

9.6.2 **Strength:**

See paragraph 9.3.2(iii) above. Bell Labs noted that there was a good level of collaboration between SingTel and OpenNet from the commencement of the fibre repair activities in the immediate aftermath of the fire. This was possible as SingTel, as the key subcontractor for OpenNet, was singularly responsible for repairing both SingTel-owned and OpenNet-owned fibre cables.

9.6.3 **Areas for improvement:**

- (i) The relationship between SingTel (in its capacity as key subcontractor) and OpenNet introduced pursuant to the 3-tier industry structure lacks end-to-end accountability which was observed during the fire:
 - (a) **See paragraph 9.3.3(i) above.** SingTel had repaired all the OpenNet-owned cables within 2 days of the fire. However, as key subcontractor, SingTel was not able to conduct end-to-end testing with Qualifying Persons.
 - (b) SingTel contacted key representatives of customer and industry group separately. Such separate points of contact with affected customers reduced the efficiency and speed of communication.

¹² Exchange diversity means that the services are connected to 2 exchanges, such that continuity of service is ensured even if 1 exchange fails.

- (c) Some Qualifying Persons opened new tickets days after the fire had occurred, and in some case, reopened old tickets after they had been thought to be resolved and closed.
- (ii) There is a general working agreement between SingTel and CityNet, which outlines the operational relationship between the 2 companies as they pertain to the management of the exchange office buildings (owned by NetLink Trust and managed by CityNet) during regular operations and in the event of an outage. However, the divestiture of SingTel's exchange properties to NetLink Trust has created gaps. SingTel no longer has full visibility of some systems at the entire exchange property and there are different security access and alarm policies for the cable chamber than there are for the other floors in the exchange.
- (iii) There is insufficient collaboration and information sharing with comparable operators and comparable countries to ensure continuous learning of leading edge technology and practices used by model operators globally. As set out in paragraph 8.2 above, there are several outdated practices adopted by SingTel in the cable chamber.
- (iv) Singapore does not have an official, formal and regular meeting amongst telecoms stakeholders (including the government) for Business Continuity and Disaster Recovery. There appeared to be low levels of collaboration amongst operators during the fire when compared to US operators.
- (v) Resilience appeared to be a matter of low priority for Enterprise customers. Although SingTel has a range of enterprise products offering resilience, few Enterprise customers have purchased fully resilient service options that offered diversity.

9.6.4 **Recommendations:**

- (i) Where the structure is not owned by SingTel, there should be detailed and documented interface procedures between the property owner and SingTel to ensure that there is a clear demarcation of roles and responsibilities.
- (ii) **See paragraph 9.3.4 above.** As a major player in the telecommunications industry in Singapore, SingTel should take the lead in industry collaboration; specifically, enhance engagement with other telecoms stakeholders in Singapore (including the government) and establish a framework that would foster a coordinated response from all telecoms stakeholders on an agile, proactive basis when there is a major network incident. This should include a regular sharing of information amongst telecoms stakeholders through dialogues or otherwise, and an agreement or arrangement between stakeholders to augment existing emergency response capabilities. Telecoms stakeholders should also consider a

review of the current Fire Code and Electric Code to address the nature of telecommunications infrastructure.

- (iii) **See paragraph 9.5.4(iii)(d) above.** SingTel should work with government agencies and its large enterprise customers to encourage them to purchase protected services with a level of resiliency that corresponds with importance of the traffic carried. On a higher level, SingTel can also set up a collaboration or dialogue amongst SingTel, the regulators and representatives of key customer groups to obtain a better mutual understanding of resiliency requirements.
- (iv) SingTel should initiate formal and regular technical exchanges of knowledge with comparable operators in the region, or globally to share key learning points, best practices and other information related to exchange outages, service restoration and network reliability best practices. Alternatively, SingTel could initiate a benchmarking review across a range of comparable operators. In this regard, SingTel has already established a collaboration agreement with another operator in the areas of IPTV and FTTH.

9.7 Concluding observation

- 9.7.1 It is clear that there are areas for improvement. In particular, there are several outdated practices in relation to the cable chamber which should be quickly mitigated. However, on the overall, Bell Labs identified world-class strengths in SingTel's network and operations and observed that many of SingTel's processes are in line with Best Practices. On balance, SingTel's network would be considered resilient and SingTel's contingency processes in the event of an incident are relatively robust.

10. COMMUNICATIONS AND PUBLIC RELATIONS MANAGEMENT

10.1 Objective and methodology

- 10.1.1 Bell Pottinger's analysis focused on:

- (i) Reviewing the effectiveness of SingTel's incident management and communications response to the fire on 9 October 2013; and
- (ii) Recommending areas for improvement.

- 10.1.2 Bell Pottinger drew information from all communications activities by SingTel from 9 to 19 October 2013 (inclusive), including print, broadcast and online media reports. An analysis of posts, comments and tweets on Facebook, Twitter, YouTube and online forums and blogs was also conducted. In addition, Bell Pottinger conducted interviews with SingTel staff (including senior management, communications specialists, frontline customer service and network staff), and conducted interviews and surveys with consumer customers, enterprise

customers and members of the media who were directly involved in reporting the incident.

- 10.1.3 After collecting the information, Bell Pottinger analysed SingTel's communications response to the fire on 9 October 2013 according to crisis communications best practice. Bell Pottinger's best practices framework was drawn from its 25 years of crisis communications experience.

10.2 Areas of study

- 10.2.1 The areas of study involved evaluating the adequacy and effectiveness of:

- (i) Processes and procedures;
- (ii) Media and customer engagement; and
- (iii) Messaging,

in response to both the fire and the issues raised by it.

- 10.2.2 Overall, Bell Pottinger found that SingTel's incident management and communications response was robust and coordinated:

- (i) SingTel appeared to have done well as regards existing procedures for external communication (customer, media and regulators); customer communications and engagement; and message consistency and traction. No further action was recommended as far as these areas were concerned.
- (ii) Suggestions for improvement were, however, made in the areas of general crisis preparation and procedures for internal information flow; execution of media communication and engagement; and message content.

- 10.2.3 Bell Pottinger's key findings and recommendations in relation to the areas of study are set out in detail below.

10.3 Procedures and processes

10.3.1 Crisis Preparation

- (i) **Strengths:** Bell Pottinger found that the staff directly involved in incident management displayed a clear understanding of the incident response procedures and their roles. Organisational response was executed according to planned procedures. An incident response command centre (the "**War Room**") and communications bridge (the "**Bridge**"), were convened quickly and proved effective at (i) ensuring internal information flow between staff directly involved in the incident management; and (ii) speeding up decision making by flattening the layers of decision making.

- (ii) **Areas for improvement:**
 - (a) Although the persons directly involved in incident management were, in substance, aware of their roles, Bell Pottinger found that the procedures for communications response to a crisis situation were only put in place informally. The staff's knowledge of communications crisis procedures was based on *ad hoc* prior experience, rather than organised drills or formal protocols.
 - (b) Although template media statements were available for disruption to services, there was no template media statement for an incident of this nature. This meant that the first media statement had to be created from scratch. Even though this was prepared quickly for a document created from scratch, this still took longer than would have been the case if a suitable template media statement had been available.
- (iii) **Recommendations:**
 - (a) Extend crisis simulation drills (which presently focus only on service and network restoration) to include crisis communications training for key spokespeople and Corporate Communications staff.
 - (b) Formalise communications crisis response processes into a communications crisis management manual. It is recommended that this manual contain key contact information, reminders of how different scenarios should be tackled and pre-prepared press statement drafts.

10.3.2 Procedures for internal information flow

- (i) **Strengths:** SingTel's awareness of the network outages was triggered by (i) network outage alarms monitored at the INOC; (ii) the unusual surge of calls received by customer care helplines; and (iii) the increased amount of complaints on social media platforms. All this information was fed back to the INOC for verification, and an initial situation report was sent to all relevant staff via SMS and email within about 20 minutes. Bell Pottinger considered this to be very efficient action. Further, the setting up of the War Room and Bridge facilitated information flow from senior management to frontline staff. Overall, processes and procedures for alerting relevant staff about the incident were well-established and effectively executed.
- (ii) **Areas for improvement:**
 - (a) While internal information flow to staff directly involved in the incident management was praised, Bell Pottinger noted that staff not directly

involved in incident management were not notified about the incident or kept updated via internal channels until 17 October 2013.

- (b) During this time, such staff faced concerns about how to deal with queries from external parties.

(iii) **Recommendations:**

- (a) Extend internal incident management information processes to provide prompt updates to all staff.
- (b) In the event of a major incident, send all staff a comprehensive reminder about the existing code of conduct for communicating with external parties.

10.3.3 Procedures for external information flow

- (i) **Strengths in procedures for communication with customers:** Bell Pottinger commented that the teams responsible for communication touch points understood the need to keep the customers and public frequently updated.

- (a) Consumer customers: When customer care helplines reached full capacity, a pre-prepared interactive voice message was activated in the interim. This was later replaced with a message prepared in line with the Master Messaging Document. Frontline staff manning customer care helplines and retail shops made efforts to follow up with customers who were unable to reach a representative, and fed information on the extent of service disruption back to the War Room. This in turn increased the speed and accuracy of service restoration. SingTel also responded promptly to issues raised on social media channels. Customers were further encouraged to continue their engagement via private avenues such as email, enabling more customers to receive appropriate assistance.

- (b) Enterprise customers: Service delivery managers were additionally deployed as points of contact for enterprise customers.

- (ii) **Strengths in procedures for communication with the media:** On a procedural level, Bell Pottinger commented that Corporate Communications staff understood the need to stay in close touch with the media, give the media the right information through multiple channels, and act with speed and regularity. Communications with the media were streamlined to 1 spokesperson, to ensure consistency of messages given to the media. SingTel was also readily available to answer questions from the media.

- (iii) **Strengths in procedures for communication with regulators:** Bell Pottinger observed that SingTel had a Regulatory and Interconnect Team

responsible with dealing with the regulators, the IDA and the MDA. In addition, senior management such as the SingTel's Chief Country Officer, the Group Chief Technical Officer and the Group Chief Executive Officer maintained multi-layered engagement with the regulators in their respective capacities. Bell Pottinger found that SingTel's communication with the regulators was thorough and went above and beyond regulatory obligations.

- (iv) No specific recommendations for improvement were identified as far as procedures for external information flow were concerned.

10.4 Customer and media engagement

10.4.1 Media communication and engagement

- (i) **Strengths:** Bell Pottinger commended SingTel on its good understanding of the importance of visibility in offering reassurance and demonstrating control over the crisis situation, as well as the transparency in its communications with the media. Overall, the media was found to be happy with the level of interaction and detail provided by SingTel. Bell Pottinger considered that the format of the press conference on 10 October 2013 was effective, and noted that SingTel adapted its media strategy to respond quickly to potential media confusion about key issues of redundancy and diversity by (i) distributing a further clarificatory media statement; and (ii) holding one-to-one media briefings with key journalists.
- (ii) **Areas for improvement:**
 - (a) Even though the first media statement was quickly prepared from scratch, some media members still considered this to be too slow. Bell Pottinger also noted that there was then a 3 hour gap before the second media statement was released. This led to some initial suspicion that SingTel was not being upfront with information in the early hours following the fire.
 - (b) Bell Pottinger also considered that SingTel could have demonstrated greater responsiveness and regularity in its communications during the early hours following the fire.
 - (c) A media spokesperson did not make a public statement until 23 hours after the incident, whereas a statement by an identifiable individual or a visual holding statement, at an earlier time, could have sent a stronger message of management control.
 - (d) SingTel faced time pressure in briefing its media spokesperson in time for the press conference.
 - (e) Social media updates and customer care officer scripts tended to lag behind formal media statements.

(f) Visibility of online and social media updates could be improved.

(iii) **Recommendations:**

- (a) **See paragraph 10.3.1(iii)(b) above.** Formalise communications crisis response processes into a communications crisis management manual. It is recommended that this manual contain key contact information, reminders of how different scenarios should be tackled and pre-prepared press statement drafts.
- (b) Institute standard procedures to issue information updates with greater regularity even if there was no change of status, and manage expectations by providing an estimation of when the next update could be expected.
- (c) Enhance management accountability and visibility by introducing a media spokesperson at an earlier stage.
- (d) Separate the roles of crisis command and media spokesperson – the crisis command would be responsible for operational restoration, enabling the media spokesperson to focus attention on anticipating communications issues and preparing and delivering clear responses.
- (e) Tighten the processes around the Master Messaging Document to streamline the drafting and approval of all messages, and ensure speed and coordination of response.
- (f) Enhance visibility of online and social media updates, specifically, the creation of an “updates” section on SingTel’s website, and posting of updates on Facebook as new threads instead of comments within existing threads.

10.4.2 Customer communication and engagement

- (i) **Strengths in communications via Twitter:** Bell Pottinger’s analysis revealed that Twitter was used extremely effectively as a tool to communicate quickly with customers. SingTel’s active social media presence meant that Twitter could be used to effectively communicate with customers. SingTel also coordinated the message from its 2 Twitter accounts, and SingTel’s tweets were re-tweeted by key opinion leaders with a large following in Singapore.
- (ii) **Strengths in communications via Facebook:** SingTel’s active social media presence meant that Facebook could be used to effectively communicate with customers. Although SingTel received negative and strongly emotionally worded comments from the public via Facebook, Bell Pottinger supported SingTel’s strategy in choosing to close the discussion and not engage with negative comments after 14 October 2013.

- (iii) **Strengths in communications via other modes of customer communication and engagement:** Bell Pottinger observed that SingTel responded effectively to the pressure on its call centres and achieved noticeable success in its use of (amongst other things) SMS updates tailored to subscribers of individual services, call centre interactive voice recordings, customer care officer scripts, and radio messages. The multiple channels used demonstrated commitment to keeping customers as well-informed as possible.
- (iv) **Communications with enterprise customers:** Contact with enterprise customers was handled personally by service delivery managers and received mixed reviews.
- (v) **Please see areas for improvement at paragraphs 10.4.1(ii)(e) and 10.4.1(ii)(f) above and recommendations at paragraphs 10.4.1(iii)(e) and 10.4.1(iii)(f) above,** which also have impact on customer communication and engagement. No other specific recommendations for improvement were identified as far customer communication and engagement were concerned.

10.5 Messaging

10.5.1 Message consistency

- (i) **Strengths:** Although message tone varied depending on the channel employed to deliver the message and it was suggested that SingTel could have considered a more apologetic tone across all communications, message content was consistent across all media and customer communications. The strategy of creating a centrally agreed Master Messaging Document to be used as a basis for all communications was highly effective in ensuring consistency.
- (ii) No specific recommendations for improvement were identified as far as message consistency was concerned.

10.5.2 Message content

- (i) **Strengths:** Bell Pottinger found SingTel to be transparent and honest in releasing information. Its messages were concise and factual. SingTel acknowledged the fire and offered reassurance that SingTel was in control of the situation. Clear and detailed facts and figures were provided on the areas and extent of the network outages, albeit that these could have been better put in context to avoid creating the impression that the outage was a wide one. SingTel's messages were responsive to customer demands for information on how long their services would be disrupted, and indications were given as to when services were expected to be restored. Where necessary, SingTel was honest and transparent in correcting outdated and inaccurate information. The press conference on

10 October 2013 was highly detailed and the images provided were effective in communicating the situation in the cable chamber.

(ii) **Areas for improvement:**

- (a) It was found that projected restoration timelines proved optimistic, and customers were left disappointed when these were not met.
- (b) Difficulties were encountered when public and media concerns swayed towards a focus on network resilience and contingency, and the sale of OpenNet rather than the key message of service restoration. A public disagreement between SingTel and a competitor further distracted from this key message.

(iii) **Recommendations:**

- (a) Be less definitive on restoration projections, in order to better manage customer expectations.
- (b) Institute measures to ensure that the full context of any future crisis situation is well-explained, thereby improving clarity of information and reducing the risk of distractions.

10.5.3 Message traction

- (i) **Strengths:** Bell Pottinger found that SingTel achieved very good message traction, and observed that SingTel's statements and social media posts were reported by the mainstream press. Despite the distractions encountered (**see paragraph 10.5.2(ii)(b) above**), focus on service restoration gained good traction. This was particularly so following the key journalists' one-to-one interviews with the spokesperson. SingTel used this platform to further address the issues of contingency and back-up plans, as well as the gestures of appreciation that it would be offering affected customers. These messages also obtained good traction.
- (ii) No specific recommendations for improvement were identified as far as message traction was concerned.

10.6 Other recommended initiatives

10.6.1 To further enhance SingTel's capacity for communications response to incidents, Bell Pottinger proposed the following additional initiatives for consideration. It was suggested that SingTel:

- (i) Consider initiating a media familiarisation campaign to build on technical transparency and ensure a core understanding of the network in the event of future incidents;

- (ii) Consider developing a bank of documentation that simply explains the way the network functions, and answers questions that might arise in the event of different types of crisis incidents, to help non-specialists understand the context in the event of a crisis incident; and
- (iii) Involve fresh viewpoints in crisis preparation and response by inviting input from cross-functional teams within SingTel and external experts to update processes and procedures.

11. FURTHER RECOMMENDATIONS

11.1 Having considered all key findings and expert recommendations, the BCOI makes the following additional recommendations:

11.1.1 SingTel should conduct regular and timely reviews, at least annually, with a view to implementing and upgrading facilities, equipment and/or methods based on industry best practices and/or new developments/technology.

11.1.2 SingTel should review the scope of its existing management committee(s), and/or consider establishing new management committees comprising members of appropriate seniority, with a view to reviewing and regularly updating policies, processes and procedures in relation to:

- (i) Safety – implement new standards, review previous standards, and enforce compliance with all standards to develop a safety culture that takes into account industry best practices and/or new developments/technology; and
- (ii) Human resource – recruitment, retention and training (including initial and refresher training) of technicians and engineers to maintain a skilled and adequate pool of technical and engineering talent.

12. ACKNOWLEDGEMENTS

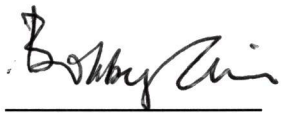
12.1 The BCOI, its consultants and its advisors wish to express their appreciation to SingTel's management for its full and timely cooperation in the inquiry. In particular, the BCOI is grateful for the honest and transparent manner in which the management has conducted itself in the inquiry, including providing the BCOI complete, timely and direct access to SingTel's documentation for review, and SingTel personnel for interviews and discussions. The BCOI carried out its inquiry free of management constraints or interference. With the management's strong commitment and dedication to the inquiry process, the BCOI has been able to complete an in-depth, independent inquiry quickly, and within 2 months of its appointment.

12.2 The BCOI also wishes to express its appreciation to the following for their timely and dedicated efforts, advice and assistance in the course of this inquiry:

12.2.1 Mr Chor Khee Yang, Secretary to the BCOI, as well as the BCOI Secretariat;

- 12.2.2 Bell Labs, technical consultant to the BCOI;
- 12.2.3 Bell Pottinger, communications and public relations management consultant to the BCOI;
- 12.2.4 Mr Richard Burns, technical advisor to the BCOI;
- 12.2.5 Dr Tan Yoke Lin and Mr Tan Jin Thong, Fire Investigation Experts; and
- 12.2.6 Allen & Gledhill, legal advisor to the BCOI.

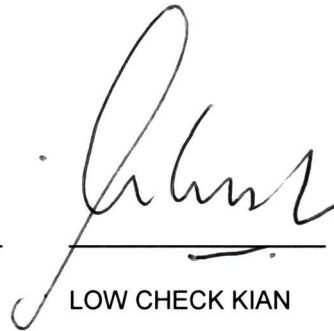
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