



ASIC

Australian Securities & Investments Commission

REPORT 509

Review of the ASX equity market outage on 19 September 2016

December 2016

About this report

This report outlines the findings of our review of the ASX outage that affected the operation of the Australian equity market on 19 September 2016. It presents our observations on how ASX and various stakeholders responded to the outage, and highlights a number of recommendations designed to support the resilience and robustness of the Australian equity market.

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Executive summary

- 1 Well-functioning financial market infrastructure is critical to the integrity and reputation of the Australian equity market and the trust and confidence investors have in it. When operating optimally, it contributes to lower cost of capital for Australian businesses. As the primary equity market in Australia, ASX has a critical role to play.
- 2 Technology is central to the fair and effective operation of ASX's market infrastructure and market infrastructure generally. As systems have become increasingly automated, complex and interconnected, the robustness and resilience of market technology and associated processes is paramount. Historically, the uptimes of ASX systems have been consistently in line with global best standards (with annual uptimes routinely at 100%) and have generally served the Australian market well.
- 3 On 19 September 2016, ASX experienced a hardware failure in its equities trading system, ASX Trade. The initial technology failure triggered a number of events that delayed the opening of the ASX market and caused it to close early ('ASX equity market outage'). It also affected the operation of the Chi-X market and caused considerable uncertainty among market users, stifling trading volumes on the day.
- 4 We have reviewed the ASX equity market outage, drawing on:
 - (a) the [ASX trade outage report \(PDF 386 KB\)](#), detailed follow-up discussions and extensive documentation provided by ASX;
 - (b) discussions with Chi-X, market participants, fund managers and data vendors;
 - (c) our analysis of relevant trading activity; and
 - (d) perspectives from regulators in other major jurisdictions, with particular focus on their approach to incident management and equity market structure.

Findings from our review of the ASX equity market outage

- 5 This report provides a whole-of-market perspective of the ASX equity market outage, including an account of why—when the ASX market was unavailable—more liquidity did not shift to Chi-X as might be expected in a competitive market environment. It presents our findings on:
 - (a) ASX and market participants' operational and technological management of the ASX equity market outage; and
 - (b) the effect on market users and the wider Australian equity market— noting other markets that reference the equity markets were also affected.

- 6 Our review found that ASX broadly adhered to its procedures for incident management and its communications protocol. However, we have identified some areas where ASX could enhance its incident management processes, crisis preparedness and arrangements to support technology resilience. We have also identified some areas where market users could contribute to these improvements.
- 7 In a multi-market environment, we expect ASX's incident management to consider the broader equity market, including the implications of ASX's decisions on stakeholders and their dependencies on ASX's systems and processes. For example, Chi-X and market participants depend on ASX to send individual security statuses that determine which securities are available for trading. It is also important that market participants' systems function effectively when one market is unavailable.

Recommendations to enhance equity market resilience

- 8 We have made recommendations designed to improve the resilience and robustness of the wider market and to promote confidence that any future incidents will be managed as effectively as possible.
- 9 These recommendations also reflect our expectation that market licensees and market participants meet their statutory obligations at all times, including during significant market events. For market licensees, this includes their obligations under the *Corporations Act 2001* (Corporations Act) to:
- (a) operate a market that, to the extent reasonably practicable, is fair, orderly and transparent; and
 - (b) have sufficient resources (financial, technological and human) to operate the market.
- 10 Our recommendations are summarised in Table 1 and Table 2 and are more fully outlined in the body of the report.
- 11 ASX has already identified ways to enhance its incident management arrangements and technology resilience: see the Appendix. Some of these may address a number of our recommendations for incident management and technology issues, which were identified as a result of the outage. Other issues, particularly relating to ASX's role in matters of wider market structure (e.g. the listing function and closing prices), may require additional work from ASX together with ASIC and industry. ASX has agreed to provide a progress report to ASIC on the recommendations in this report and the reviews already underway by 31 March 2017.

Next steps

- 12 In 2017, we intend to:
- (a) undertake a wider (non-incident driven) review of ASX’s operational and technological risk management arrangements. We may consider requiring an independent evaluation of ASX’s arrangements as part of this review; and
 - (b) consult on whether to make market integrity rules on the technological and operational performance of market operators.
- 13 Our reviews of ASX’s performance have typically been event-driven, focusing on the historically rare incidents where ASX’s performance has fallen below market expectations (e.g. the ASX Trade outage in October 2011, see [Report 289](#) *Market assessment report: ASX Group* (REP 289)). A wider review will reflect the growing pace, complexity and dynamism of the Australian market, as well as the important role of market infrastructure in its integrity and reputation.

Table 1: Summary of our recommendations for ASX following the ASX equity market outage

Dependencies on ASX	<p>ASX to:</p> <ul style="list-style-type: none"> • consider and formally map stakeholder dependencies on ASX; and • make changes to mitigate the effect of ASX system failures on these stakeholders. <p>This includes dependencies on the listing function, trading session states, prices for reference products (e.g. derivatives) and closing prices. ASX to report to ASIC on its findings: see paragraphs 141–180.</p>
Availability of a subset of securities for trading	<p>ASX to review and report to ASIC on:</p> <ul style="list-style-type: none"> • the circumstances appropriate for all or a subset of securities to be available for trading or to be closed; and • whether the open rotation process is still necessary. <p>See paragraphs 80–84.</p>
Business continuity and IT disaster recovery	<p>ASX to strengthen its business continuity management (BCM) and IT disaster recovery (ITDR) arrangements, and integrate proactive and frequent testing into its business-as-usual operations. This should include system-specific recovery procedures and a central repository of key documentation: see paragraphs 113–120.</p>
Technology status monitoring regime	<p>ASX to implement more comprehensive and robust technology status monitoring, including review of its automated data integrity checking processes, and its monitoring tools and alerts of all applications, hardware, operating systems and network infrastructure: see paragraphs 125–134.</p>
Enterprise architecture	<p>ASX to enhance its key enterprise architecture artifacts to more fully describe ‘current’ and ‘target’ states for business processes, applications, data and information flows, and technology infrastructure: see paragraphs 135–137.</p>

Communication strategy	<p>ASX to review and then report to ASIC on:</p> <ul style="list-style-type: none"> • its consideration of a central platform that communicates a ‘single source of truth’ during incident management; • whether its communications protocol considers and details the dependencies other market operators have on ASX infrastructure; and • whether it is able to inform others of the status and condition of its infrastructure in a timely manner. <p>See paragraphs 97–112.</p>
ASX’s operational risk arrangements	<p>ASX to review and then report to ASIC on its current operational risk arrangements relevant to the outage, including the ‘four eyes’, pre-open period and cancellation policies: see paragraphs 58–91.</p>

Table 2: Summary of our recommendations for market participants following the ASX equity market outage

Participant arrangements for outages	<p>Market participants to review their arrangements for dealing with market outages and to inform their clients of the arrangements, including:</p> <ul style="list-style-type: none"> • best execution policies and procedures; • algorithms and smart order routers; • arrangements for undertaking and reporting crossings (including that transactions do not occur in securities that have been suspended and that the national best bid and offer (NBBO) calculation only includes accessible orders); and • ensuring there is awareness of who has been appointed as their contact for ASX and that there are clear channels for communicating updates internally. <p>See paragraphs 160–173.</p>
Participant involvement in market business continuity plan (BCP) testing	<p>Market participants to review their own system preparedness for managing market outages. We consider it important for market participants to be involved in ASX (and other market operators’) business continuity testing: see paragraphs 116–118.</p>

A Observations

Key points

In this section we look at the key activities and decisions taken by ASX in managing the incident on 19 September 2016 and the impact on, and responses of, other key stakeholders in the Australian equity market, including Chi-X, market participants, crossing systems, investors and issuers.

We also look at the market conditions leading up to, on and following the day of the ASX equity market outage.

Implications of the outage for the Australian equity market

- 14 Our observations of market disruptions are that those affected tend to focus heavily on the immediate avenues for maximising their own position. While this approach is understandable and perhaps inevitable, it may limit their ability to evaluate the wider market consequences and the full effect of their action (or inaction). Ultimately, it may result in a sub-optimal outcome for the market at large.
- 15 The ASX equity market outage had broad implications for the Australian market, for example:
- (a) ASX and Chi-X opened late, ASX closed early and there were limitations on market participants undertaking off-market crossings;
 - (b) ASX cancelled 1,221 trades and 3,062 transactions (since January 2016 the average number of trades per day on ASX Trade has been 1,051,017); and
 - (c) liquidity was significantly dampened and spreads were wide.
- 16 This resulted in considerable confusion among market users about the incident and the products that were available to trade: see Table 3 for a timeline of activities and decisions.

Table 3: Timeline of key activities and decisions on 19 September

Time	Activities and decisions
6.57 am	Disk failure on ASX Trade triggers a cascade of technical and operational issues
7.03 am	ASX receives disk failure alert and subsequent SMS alert to Application Support team
7.25 am	ASX commences incident management and escalation procedures. ASX contacts vendor
7.30 am	Market participants notice connection issues, commence troubleshooting and contact ASX
9.00 am	ASX notifies ASIC of failure (first of many communications)

Time	Activities and decisions
9.09 am	ASX notifies Chi-X of failure (first of many communications)
9.45 am	ASX market placed into 'enquire' session state
10.54 am	ASX advises that 'pre-open' will commence at 11.10 am and 'open' from 11.30 am
11.06 am	ASX's continuous disclosure data feed starts disseminating updated individual security statuses
11.10 am	Equity Groups 1, 2 and 3 transition to 'pre-open'. Equity Group 4 incorrectly transitions to 'open'
11.11 am	Equity Group 4 is placed into 'enquire'. Group 5, Stock Indices and Interest Rates remain in 'enquire'
11.22 am	ASX announces that all trades in Group 4 at 11.10 am are under investigation
11.30 am	Trading commences in Equity Groups 1, 2 and 3 on ASX and all securities on Chi-X
11.40 am	Delayed generation of trade confirmation broadcasts for Partitions 2 and 3 is resolved
11.49 am	ASX announces that all trades in Group 4 at 11.10 am are cancelled
12.00 pm	Trading commences in Equity Group 5 on ASX
12.30 pm	Trading commences in Stock Indices (non-tradeable) and Interest Rate Securities markets on ASX
1.20 pm	Trading commences in Equity Group 4 on ASX
2.05 pm	ASX market is placed into 'enquire' session state following the failure of processes in Partition 2
3.31 pm	ASX announces that the market will not reopen for the day and there will be no closing auctions
4.13 pm	Chi-X market closes at the normal time
5.03 pm	ASX announces the closing price methodology
8.00 pm	ASX distributes closing prices for the equity cash market to market participants
T+1	Before market open, ASX advises affected participants of the cancellation of 3,062 transactions in Partition 2 between 1.42 pm and 2.05 pm. A market notice is distributed at 12.47 pm

Responses to the ASX equity market outage

ASX Group

ASX Trade (equity market plus options and warrants)

- 17 ASX's equity trading system, ASX Trade, is a complex network of systems with many interdependencies.

- 18 On 19 September 2016 at 6.57 am, ASX experienced a hardware failure on the main database server used to operate ASX Trade. This triggered an automated failover to the backup database server. While the failover was completed at 7.09 am, ASX observed issues with the functioning of software components and applications.
- 19 The ASX market commenced the ‘pre-open’ trading session at 7.00 am, just like any typical trading day, although a number of participants were unable to connect to ASX Trade. Participants who were already connected were able to submit orders.
- 20 At 9.45 am, it became apparent that the technology issues could not be resolved by the usual market opening time of 10.00 am. ASX placed the entire market into the ‘enquire’ session state to further examine the nature and severity of the failure: see Table 4 and paragraphs 72–79 for a summary of key ASX trading sessions.
- 21 At 10.54 am, ASX advised market participants’ trading operations contacts that the technology issues were resolved and the market would transition from the enquire session to pre-open at 11.10 am. This information was also disseminated through the ASX Trade platform. This same communication was emailed to the technology contacts of market participants and independent software vendors at 11.00 am. This would provide at least 20 minutes for market participants to manage their orders in preparation for the opening auction and commencement of continuous trading from 11.30 am.
- 22 ASX opens its market sequentially by groups of securities. These groups are classified as Equity Groups 1–5 in alphabetical order. Following an ASX operational error at 11.10 am, Equity Group 4 securities were erroneously transitioned to the ‘open’ session state instead of pre-open. ASX identified the error and subsequently returned this group of securities to the enquire session state at 11.11 am, while subsequent groups (i.e. Equity Group 5, Stock Indices and Interest Rate) remained in enquire and had their pre-open times delayed.
- 23 ASX Trade is segmented into five partitions to support load-balancing across the trading platform. Each partition is broadly based on industry segments (e.g. ‘financials’). Issues arose with the generation of trade confirmation broadcasts for trades executed in Partitions 2 and 3. The dissemination of these trade confirmations by ASX was delayed until 11.40 am, when the technology issue was resolved.
- 24 From 11.06 am, the ASX data feed on individual security statuses commenced disseminating complete information. Before this, ASX could not process individual security statuses because it experienced login issues with the Market Place Assistant (MPA) application, this affected both the Chi-X market (see paragraphs 32–34) and market participants and crossing systems: see paragraph 162.

Note: MPA is an application used by the ASX Trading Operations team to manage session states on the trading platform. This includes management at a market and individual security level. The system errors prevented ASX staff from logging into this application.

- 25 Before 11.06 am, ASX received six trading halt requests from listed companies but was unable to process these requests until the MPA application was recovered. These announcements were released between 11.08 am and 11.25 am. ASX received price-sensitive announcements from an additional 17 listed companies between 9.43 am and 11.06 am. These were released between 11.16 am and 11.31 am.
- 26 At 1.42 pm, there were further technology issues affecting ASX Trade—this time causing a failure in processes in Partition 2 securities and impeding post-trade transparency and the registration of trades in the ASX clearing system.
- 27 As the severity of the issue escalated, ASX decided to place the whole market into an enquire session state again at 2.05 pm. ASX subsequently announced the market would not re-open for the day at 3.31 pm.
- 28 Similar to the cash equity market, the market opening time for equity options and warrants was also delayed to 11.30 am and closed early at 2.05 pm: see paragraph 52.
- 29 ASX resumed normal operations on the next market day without incident.

ASX 24 (futures market)

- 30 ASX 24 operated as usual and without incident on the day of the ASX equity market outage. As a 24-hour trading venue, market users are familiar with trading in futures contracts while the underlying reference securities are not trading. However, volumes in the ASX SPI 200TM Index Futures contract were less than half that of a normal trading day: see paragraph 53.

CHESS (clearing and settlement facility)

- 31 The clearing and settlement (CS) system for ASX listed equities, the Clearing House Electronic Subregister System (CHESS), operated as normal on the day. The technology issues with ASX Trade meant that the 3,062 cancelled transactions were not sent to or received by CHESS: see paragraphs 85–91. Some participants, who use ASX OUCH for trading, experienced reconciliation issues with CHESS as a result of the ASX equity market outage: see paragraph 91. The ASX equity market outage also led to a delay in the calculation of closing prices: see paragraphs 92–96.

Note: ASX OUCH is one of the trading interfaces used to transmit orders and other data to and from ASX Trade.

Chi-X

- 32 Between 9.09 am and 9.15 am, ASX alerted Chi-X to the technology issues affecting ASX Trade. At 9.35 am, ASX notified Chi-X that it was

experiencing issues with the application that it uses to process individual security statuses: see paragraphs 24 and 25.

33 Chi-X made the decision to delay its market open because it is reliant on ASX for information on individual security statuses to determine which securities are available for trading.

34 After ASX resolved the issues affecting the MPA application, the ASX data feed on individual security statuses and system confirmations functioned normally. This gave Chi-X the confidence to open its market at 11.30 am, which was synchronised with ASX's planned market open. While ASX only opened Equity Groups 1 (at 11.30 am), 2 (at 11.32 am) and 3 (at 11.34 am) for trading (see paragraph 21–23), all securities were open for trading on the Chi-X market from this time.

35 When ASX placed its market into the enquire session state again at 2.05 pm, Chi-X continued to receive the data feed on individual security statuses. Chi-X decided to continue operating its market until the standard closing time of 4.12 pm without any incident.

Market participants

36 At around 7.30 am, market participants started observing rejections of overnight crossings and connectivity issues between their systems and ASX Trade. From our discussions with market participants, we understand that most participants carried out internal troubleshooting when they noticed the errors.

37 A number of market participants indicated that they were only made aware there was an issue with ASX Trade after they contacted ASX.

38 In the context of the uncertainty surrounding the day, we understand from market participants that they generally lacked confidence in the market system and data on 19 September. Many of them advised their clients not to trade unless necessary, while market makers and other liquidity providers were also cautious.

39 Some market participants that were not members of Chi-X did not have the ability to trade on any venue other than ASX. Others that were members of both ASX and Chi-X chose not to adjust their algorithms and smart order routers to access the Chi-X market: see Section D.

Crossing systems operated by market participants

40 On the morning of 19 September 2016, crossing systems accepted orders but matching did not occur when both ASX and Chi-X markets were not open. When ASX erroneously opened Equity Group 4 securities for trading at 11.10 am, two trades in crossing systems were executed. These trades were subsequently cancelled.

- 41 Crossing systems that report trades to Chi-X were able to conduct crossings from 11.30 am until the normal market closing time. Some crossing system operators were unable to operate their system after the ASX market was placed into the enquire session state at 2.05 pm because they only had arrangements to report to ASX or, in the case of some crossing systems, the systems have been programmed with a reliance on ASX (e.g. all securities partitions have to be open or they are dependent on ASX data): see paragraphs 160–163.
- 42 A small number of crossing systems did not operate at all because the ASX equity market outage triggered failures in the crossing system or the operator chose not to operate as a precautionary measure. Most operators informed their clients of the limited operation of their crossing systems.

Investors

- 43 We understand that most institutional investors held back their trades on the day due to a lack of confidence in the market and limited liquidity. A causal relationship between these two can reasonably be inferred. Given the uncertainty surrounding the events of the day, institutional investors were particularly concerned about the risk of trades being cancelled (and the consequential problem of managing cancelled trades), and the effect of the fragmented trading session states and available securities on their ability to execute volume-weighted average price and basket trades.
- 44 Many retail investors only access the ASX's order book data. As a result, there were significant portions of the day where retail investors did not have any order book data to inform their trading decisions. We understand that the general uncertainty in the market also contributed to very limited retail trading on the day.

Issuers

- 45 The market announcements platform is the communication mechanism that ASX issuers are required to use to notify ASX and the market of company announcements. On the morning of 19 September, the operation of the market announcements platform was not directly affected by the ASX equity market outage. However, as a result of the outage, ASX was not able to process individual trading halts and suspensions. This resulted in ASX delaying the release of company announcements for a number of issuers: see paragraphs 24–25.

ASIC

- 46 Our real-time market monitoring function was unaffected and continued to operate as normal for the whole day. The analysis in this report draws on information generated by ASIC's surveillance systems.

Market conditions

- 47 On Friday, 16 September, the last trading day before the ASX equity market outage, the S&P/ASX 200 index opened at 5,247 points and closed at 5,297 points. There was also relatively flat trading in the US and European markets on Friday night; and the ASX SPI 200TM Index Futures contract opened at a relatively small five-point premium to the previous day's close. There was no significant market-impacting news over the weekend.

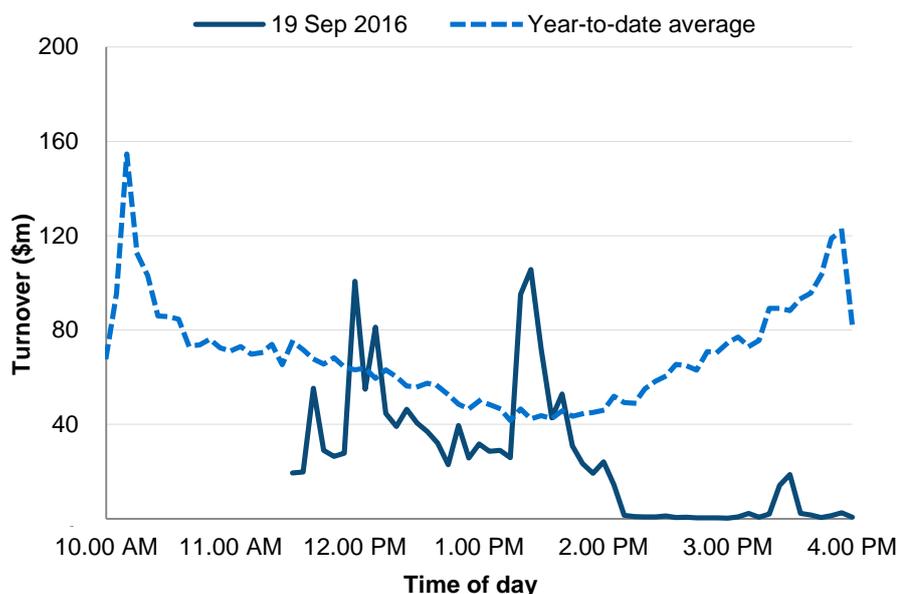
Note: The December SPI contract (APZ6) closed at 5,275 at 4.30 pm on Friday, 16 September and opened at 5,280 at 9.50 am on Monday, 19 September.

- 48 It is fortunate that market conditions were relatively flat leading up to 19 September because it limited the need for institutional and retail investors to trade on the day. If there had been market-impacting news, or if it was reporting season or the quarterly expiry period, there would have been greater pressure to trade.

Note: An example of a technical failure that did occur during an important trading period was the ASX Trade outage on 27 October 2011 between 10.05 am and 2.00 pm—an options expiry day. While the October exchange-traded option expiry completed according to schedule, some market participants experienced execution stress in trying to close out client positions because of the limited trading time that remained in the day.

- 49 As it was, trading on the Chi-X market was only 26% of its normal turnover and trading on the ASX market was 23% of its normal turnover. Turnover on the following day (i.e. 20 September) was higher than average by 10% on ASX and 19% on Chi-X.

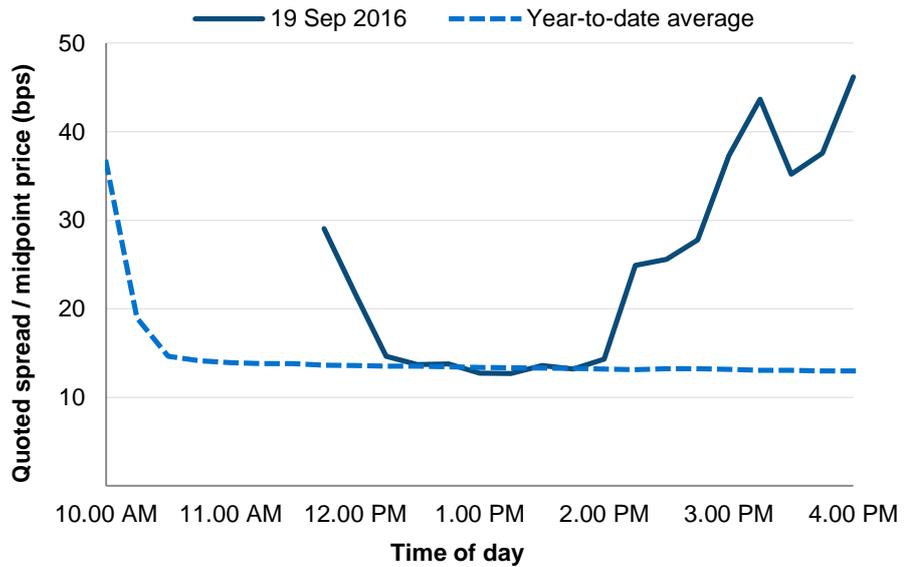
- 50 Figure 1 shows the intraday profile of market turnover compared with the year-to-date average across five-minute intervals—highlighting the extent to which trading activity in the cash equity market was substantially lower on the day of the outage. Turnover was higher than average immediately after the incremental opening of Group 5 at 12.00 pm and Group 4 at 1.20 pm. After ASX was placed into the enquire session at 2.05 pm, turnover was less than \$1 million across most of the intervals, contrasting with an average of \$78 million across these intervals in the year to date. Trading activity increased momentarily at around 3.30 pm, when ASX announced that the market would not re-open for the day.

Figure 1: Relative daily turnover on the Australian equity market

Source: ASIC.

- 51 Dark trading activity was also low on the day of the equity market outage, with block trades and price improvement trades accounting for 18% and 22% of their normal turnover, respectively. Trading on broker crossing systems was 37% of their normal turnover.
- 52 Trading volumes for equity options and warrants were 22% and 23% of the historical average, respectively.
- 53 The futures market remained open throughout the entire ASX equity market outage. Notional turnover in the ASX SPI 200TM Index Futures during the day session was \$2.2 billion, which was 44% of the \$5.0 billion historical average. There was substantial intraday variation in trading activity. Before the equity market opening at 11.30 am, futures volume was 40% of the historical average. Trading activity was 76% of the historical average when both ASX and Chi-X equity markets were open. After the ASX equity market was placed into the enquire session at 2.05 pm and Chi-X continued trading ASX SPI 200TM Index Futures volumes were 30% of the historical average.
- 54 During periods when the ASX equity market was available on 19 September, the average quoted bid–ask spread (turnover-weighted per security across the S&P/ASX 200) across the lit markets was only slightly higher than on an ordinary trading day in 2016, at 13.6 basis points (bps) compared to 13.4 bps: see Figure 2. Spreads tend to be wide until all securities are available for trading at the end of the incremental rotation of opening auctions.
- 55 After the ASX market was placed into the enquire session and liquidity was only displayed on Chi-X, spreads progressively increased from 14.3 bps to 46.2 bps by 4.00 pm, meaning that it became substantially more expensive to trade than usual during that period.

Figure 2: Intraday quoted spreads in S&P/ASX 200 securities

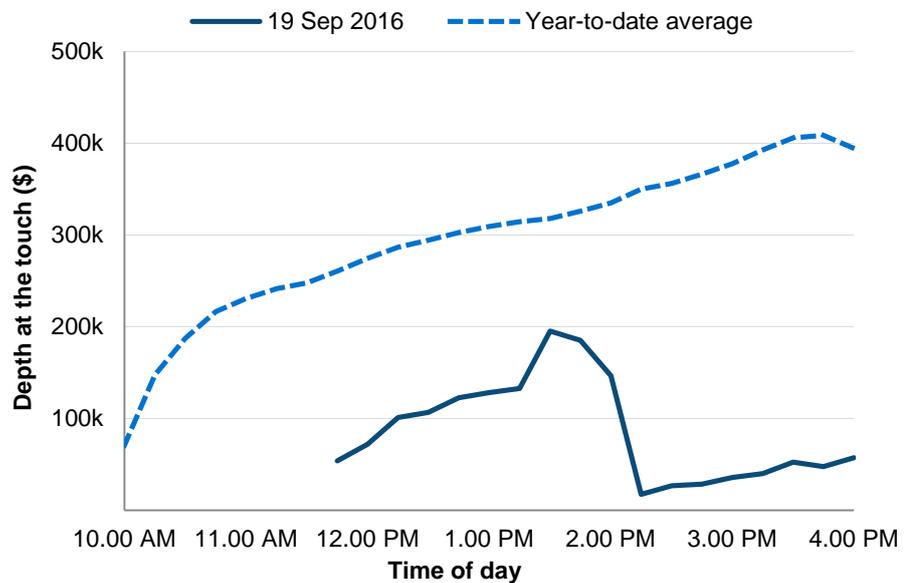


Source: ASIC.

56 Figure 3 shows the intraday evolution of consolidated order book depths for S&P/ASX 200 securities compared to the year-to-date average. Depths are the sum of the values of bids and offers at the touch in 15-minute intervals, averaged by security. Depths tend to accumulate as the trading day progresses. On 19 September, depths averaged \$124,000 when the ASX market was available, compared with \$302,000 for the same time during an ordinary trading day in 2016.

57 Depths increased substantially after all groups become available for trading on ASX at 1.20 pm. After ASX was placed into the enquire session at 2.05 pm and only orders on Chi-X were accessible, quoted depths averaged \$38,000 for the rest of the trading day, representing only 10% of the \$381,000 of depth usually available during this time.

Figure 3: Intraday quoted depth of orders in S&P/ASX 200 securities



Source: ASIC.

B ASX's incident management arrangements

Key points

In this section we review ASX's operational management of the outage. We also make a number of recommendations to improve ASX's incident management arrangements, including review of:

- its 'four eyes' principle, the operation of the pre-open session state and trade cancellation policies;
- communications with market participants and Chi-X; and
- certain aspects of its business continuity and ITDR arrangements.

We also recommend that market participants review their arrangements for dealing with market outages.

These recommendations are designed to ensure that any future incidents are managed as effectively as possible.

ASX's operational management of the ASX equity market outage

- 58 ASX has a documented incident management plan that governs how it responds to incidents. The plan was last reviewed in early 2016 when staff training was provided using a scenario-based exercise. These procedures were broadly followed on 19 September 2016.
- 59 A summary of ASX's actions on the day of the equity market outage are outlined in Section A. ASX has also taken a number of immediate remedial actions following the outage: see the Appendix.
- 60 ASX's focus is now on longer-term, forward-looking actions, including review of operational risk management controls, BCP, testing arrangements and further work with its technology service providers and hardware vendors. We have identified a number of ASX operational processes and procedures that should be reviewed in more detail. ASX has already undertaken a number of initiatives designed to deal with these issues.

Governance and decision making

- 61 The governance and decision-making arrangements in ASX's incident management plan were broadly followed on the day. An incident management team was established, made up of key senior representatives from the business, operations, technology, trading services, compliance and risk management teams. These representatives included the Deputy Chief Executive Officer, Chief Information Officer, Chief Risk Officer, Chief Compliance Officer, and the Group Executive responsible for Operations.

- 62 The decision to delay market open was taken at 9.43 am by the Group Executive responsible for Operations and announced to the market at 9.45 am (i.e. 15 minutes before the scheduled commencement of the market opening routine). While we understand that the majority of the components of ASX Trade had been recovered by this time, there were still ongoing issues with some key ASX Trade processes and user connectivity. Further, the cause of the system failures had not yet been determined.
- 63 We recognise the fluid nature of the ASX equity market outage and the initial difficulty ASX had in identifying the cause of the outage. We also recognise that the goal for ASX and market users is, wherever possible, to avoid shutting the market (or delay opening it). This approach can lead ASX to defer the decision to delay opening until the latest possible moment.
- 64 It may be valuable for ASX to explore the development of a ‘set point’ procedure; that is, not to open the market if it cannot confirm by a set point before the scheduled commencement that the market will operate as normal. Feedback from participants and Chi-X supported this proposal, as well as a suggestion that the set point should be longer than 15 minutes. This would give market users more notice to make alternative trading arrangements and would allow Chi-X to consider options for its market.
- 65 Drawing from this incident, ASX is reviewing the incident management arrangements carried out on the day to determine what worked well and what requires improvement. As part of this review, we understand that ASX is assessing whether it could set out published timeframes for decision making so that market users have sufficient notice and certainty of recovery actions. We understand ASX is likely to consult the market on this specific issue in the second half of 2017.

Operational risk

- 66 Groups 4 and 5 did not automatically transition to pre-open at the scheduled time of 11.10 am. This was due to a configuration error. As a result, an ASX operations staff member attempted to manually move Group 4 to the correct session state. This was expected to transition the status to pre-open. However, Group 4 transitioned incorrectly to the open session state resulting in the execution of 1,221 trades. ASX cancelled the trades resulting from the error.
- 67 While ASX has operational controls in place that are designed to prevent this type of incident (e.g. the ‘four eyes’ principle), it did not prevent the operational error.

Note: The ‘four eyes’ principle applies where a person performing a key operational task is overseen by a separate person, either another staff member or a manager, to ensure the process is performed correctly. The ‘four eyes’ principle is generally used for manual tasks that do not have system-generated checks and controls.

- 68 As a result of the operational error, we understand that ASX is validating its trading operations processes and is reviewing potential enhancements to its risk controls more broadly. Potential changes include having an additional warning for ASX operations staff when session states have to be manually configured on the MPA application.
- 69 ASX's operational risk controls and frameworks are similar across all their trading and CS facilities, although there are obvious differences at the functional level. The Senior Manager, Operations Risk Management and the General Manager, Technology Security and Governance perform a parallel role in the technology team. These two roles work closely together to review changes to risk controls and processes, such as the 'four eyes' principle. Operational risk management is also overseen by the internal and external audit framework.
- 70 Because operational risk is managed across functions, any failure to appropriately manage operational risk within ASX's trading systems may have wider implications for CS facility systems or, in its role as a listings market, the relevant listings systems.
- 71 We will review ASX's internal controls for operational tasks as part of our 2017 assessment of ASX's compliance with its statutory obligations: see paragraphs 129–130 for information about ASX's framework for managing operational risk arising from system recovery processes.

Trading session states

- 72 Market trading session states determine what actions can and cannot be undertaken on a market at a given time. Table 4 provides a summary of the key actions that can occur for a sample of ASX trading session states.

Table 4: Summary of key ASX trading session states

Session	Actions
Pre-open	Participants <i>can</i> enter, amend and cancel their orders but <i>no matching</i> of orders occurs.
Open	Participants <i>can</i> enter, amend and cancel their orders and <i>matching</i> of orders does occur. The session commences with an auction.
Enquire	Platform is available for enquiries only. Participants <i>cannot</i> enter, amend or cancel their orders and <i>no matching</i> or auction occurs.
Adjust	Participants <i>can</i> amend or cancel their orders (provided their ranking in price–time priority is not improved). <i>No matching</i> of orders or auction occurs.

Note: The information in this table was drawn from [ASX Operating Rules Procedures Appendix 4013 Part 1\(a\) \(PDF 890 KB\)](#).

Enquire session state

- 73 ASX's long-standing practice when it experiences a technology or operational outage of the trading platform is to place the market into the 'enquire' session state. Market users such as market participants, data vendors and independent software vendors understand that the enquire session is used when ASX is investigating the cause of a technology or operational failure.
- 74 The enquire session state effectively locks ASX's order book and preserves the most recent snapshot. This assists technology staff to investigate technical problems in a stable environment, rather than one where the order book is dynamically changing.
- 75 From an initial technical perspective, this approach could be considered an appropriate risk control where there is significant uncertainty or concerns about the stability and functionality of the trading platform. However, in our view, there is merit in considering whether it was necessary to maintain the market in the enquire session state from 2.05 pm, and especially after 3.31 pm, when ASX announced its decision not to re-open the market for the day.
- 76 ASX has provided their account of the circumstances surrounding the generation of messages in Partition 2 securities at 2.05 pm. At 2.05 pm, the market was put into the enquire session state and ASX continued to assess the cause of the issue and the stability of the platform. During this investigation, a data inconsistency was identified. ASX reviewed whether recovery was feasible and formed the view that, in order to maintain stability, the enquire session needed to be retained. ASX decided it was likely that similar data inconsistencies were present in other partitions and further disruption could be caused if moved to an alternative session state. Consequently, shortly before 3.30 pm, ASX made the decision to maintain the enquire session for the remainder of the day and announced this to the market at 3.31 pm.
- 77 The session state protocol was originally formulated when ASX was a monopoly provider of cash equity market trading services in Australia. When Chi-X entered the market in 2011, ASX confirmed with Chi-X and ASIC how it uses session states. Because of the length of time since that confirmation, and given the competitive trading environment that now exists in Australia, we consider it appropriate to review the session state protocol with the current structure in mind: see paragraphs 151 and 156 for the implications of using the enquire session state in a multi-market environment.

Pre-open session state

- 78 Before the resumption of continuous trading, the enquire session is typically followed by a 'pre-open' session to allow for price discovery and for an auction process to take place. On the day of the outage, ASX administered a 20-minute pre-open session before the progressive opening of the market from 11.30 am.

79 To provide greater certainty about market re-opening arrangements after a technology or operational failure, there is merit in having a pre-defined minimum period for the pre-open session for future incidents. Consideration should be given to whether a period of 20 minutes for the pre-open session is sufficient and whether a minimum notice period is required before the commencement of the pre-open. The feedback we received suggests these are matters that should be clarified by ASX in their communications with stakeholders during a market incident. We understand that ASX is likely to consult on this issue in the second half of 2017.

Availability of a subset of securities for trading

80 The ASX market commences trading with a rotating series of opening auctions across five alphabetical groups of securities, as well as the various derivatives, listed funds, warrants, structured products, stock indices and interest rate products. If an outage delays the market open, ASX's standard practice has been to maintain this open rotation as part of the delayed commencement of trading to provide certainty that established processes are being followed.

81 Most other major markets open with a simultaneous commencement of trading across all securities. Many of the participants that we spoke with after the ASX equity market outage view the open rotation as a legacy feature of the market that has been made redundant with electronic trading. Some participants believe this adds to operational complexity and poor liquidity until the final group opens. It is worth noting that turnover is usually lower in the first few minutes before the availability of trading across all groups: see Figure 1.

82 An operational error caused Equity Group 4 securities to open early and led to the cancellation of the resulting trades: see paragraph 22. Many participants argued that after this operational error ASX should have ceased trading in all securities rather than continuing to open some equity groups from 11.30 am.

83 Many participants believed that the market should not have been opened unless there was absolute confidence in the operation of the whole market. This is a principle that is consistent with having a unified opening time across all securities.

84 Additionally, it is difficult to calculate market indices or to price certain securities (e.g. some exchange-traded funds, options, warrants and products over a basket of securities) when only a subset of the underlying securities is available for trading. Some crossing systems are programmed to require all securities to be open before they can start matching orders: see paragraphs 41.

Trade cancellations

85 ASX Operating Rule 3100 allows ASX to cancel or amend any transaction in the interest of maintaining a fair, orderly and transparent market. During

the ASX equity market outage, ASX cancelled the following trades and transactions:

- (a) 1,221 trades executed between 11.10 am and 11.11 am when an operational error caused Equity Group 4 securities to open at 11.10 am instead of 11.36 am. ASX notified the market of its decision to cancel these trades at 11.49 am; and
- (b) 3,062 transactions in Partition 2 securities between 1.42 pm until the market was placed into an enquire session state at 2.05 pm. ASX advised affected participants of these cancellations before the market opened on 20 September 2016 and later published a market notice advising of the cancellations at 12.47 pm.

86 The Equity Group 4 trades were cancelled because the premature placement of Equity Group 4 securities into the open session at 11.10 am (rather than into the pre-open session state) meant participants did not have an opportunity to manage their orders before trading commenced. This could also have affected access to the opening auction and any subsequent trades, hindering proper price discovery.

87 The Partition 2 transactions were cancelled because of the malfunctioning of ASX Trade. That is, it did not fully process these transactions, generate and report trading information for them, or trigger their novation in CHES in the normal way.

88 ASX Clear Operating Rule 12.2.1(a) states that if a cash market transaction is the result of the matching of bids and offers on the market of an approved market operator, novation occurs immediately after the matching of those bids and offers. However, a cash market transaction must be received in CHES for this operating rule to be triggered. Because these transactions were not sent by the trading system to CHES, they were not novated under the ASX Clear Operating Rules.

89 ASX made a decision not to cancel trades where trade confirmations to some users (i.e. those that use OMNet) were delayed. Between 11.30 am and 11.40 am, the generation of trade confirmations for a few thousand trades in Partitions 2 and 3 was delayed due to a technology issue, but market participants still had visibility of their orders. The delayed trade confirmations were subsequently disseminated shortly after the problem was rectified.

Note 1: ASX advised that all participants were able to see details of their trades other than the clearing code provided in the CB15 broadcast. Further, a number of OMNet users were not receiving trade confirmations through the private CB15 and public CB16 broadcasts in respect of trades.

Note 2: OMNet is one of the trading interfaces used to transmit orders and other data to and from ASX Trade.

- 90 If a trade is not registered in CHESS, it is not novated. ASIC and the Reserve Bank of Australia are discussing these circumstances with ASX. To prevent potential confusion in the event of future incidents, ASIC believes there is merit in ASX providing greater clarity to market users on how novation works.
- 91 A number of market participants expressed disappointment with the time taken by ASX to inform them of the Partition 2 trade cancellations. Some participants had reconciliation issues, while others incurred additional costs in taking on exposures to their clients' trades, which ASX subsequently cancelled. While market conditions on the day were benign (meaning the cost implications were relatively low) it is concerning because it created operational risk for market participants, particularly smaller participants that do not usually take on client risk in this manner.

Closing prices

- 92 ASX's methodology for determining closing prices on the day of the outage followed established procedures. The closing prices for securities were determined as the last valid on-market traded price on ASX, or the previous business day's closing price, in the case where a security did not trade on ASX on the day. The closing prices for equity derivatives, used by ASX Clear for margining purposes, were determined as the more recent of the last traded price or the midpoint of the bid and offer on ASX.

Note: Closing prices for those securities in Partition 2 were based on trades up until 1.42 pm, when issues with this partition reoccurred.

- 93 ASX informed participants at 3.31 pm that there would be no Closing Single Price Auction (CSPA), and that it would subsequently advise on the process for determining closing prices. At 5.03 pm, ASX notified the market of the closing price methodology for securities and equity derivatives. This methodology meant that some security prices could have been 'stale' (i.e. they would not reflect the more recent prices traded on Chi-X or may be from the market close of the previous Friday).
- 94 An electronic file containing the last traded price (on 19 September) and/or the previous closing price (from 16 September) for all equity, interest rate, structured and listed fund products was distributed at 8.00 pm. A file with the settlement prices used by ASX for end-of-day processing for all exchange-traded options (ETOs) was distributed at 11.05 pm.
- 95 Market users indicated that they would have appreciated more certainty and clarity in communications before 5.00 pm about how the closing price would be determined. One vendor's system needs to receive the closing prices from the ASX CSPA soon after the scheduled CSPA time each day in order to broadcast it to clients. This vendor was unable to do so on the day of the outage due to the delay.

- 96 Following this incident, ASX has indicated it is reviewing its existing methodology for determining closing prices. If ASX proposes to change its existing methodology, it will consult on the issue in the first quarter of 2017. See paragraph 174 for more on the uses of closing prices.

Keeping the market informed

Communications with market participants

- 97 ASX has a published communications policy: see [ASX—Market unavailability—Communications process \(PDF 29 KB\)](#). The policy indicates that the objective of ASX communication in the event of a disruption to its trading systems is to facilitate an efficient recovery of the technology connections of participants and to ensure a fair, orderly and transparent resumption of ASX market availability. The channels of communication include:
- (a) emails to registered Customer Technical Support (CTS) contacts (i.e. trading representatives of market participants and technology contacts of market participants and independent software vendors);
 - (b) telephone inquiries received through the Market Access service desk;
 - (c) ASX’s Voiceline facility (which was decommissioned as scheduled in October 2016); and
 - (d) website updates through the ASX Trade System Status page.
- 98 The communication policy states the ASX website is the primary source of information to all market users in the event of a disruption. ASX’s policy is not to disclose information by telephone that is not already available on the ASX website.
- 99 ASX broadly adhered to this process. Once the decision was taken at 9.43 am to delay the market open, ASX sent regular 15-minute email updates to registered Market Access contacts. ASX also periodically disseminated market status updates through the ASX Trade market messaging facility.
- 100 Feedback from some market users indicated that the email updates routinely repeated information that had previously been disseminated and therefore added little value. In incidents of this nature, and particularly where ASX or another market infrastructure provider is continuing efforts to fully identify the cause, there can be a tension between market participants’ desire for full, detailed and frank information and ASX’s ability to provide that information as often as it is sought.
- 101 Some market users considered that the ASX updates did not give the confidence and certainty they were seeking, creating further uncertainty.

Other market users felt they were not fully informed because they were not registered recipients of Market Access emails—however, they generally agreed that this was more a question of effective communications within each participant’s own firm.

- 102 There was also feedback about the level of information asymmetry, with some market users getting additional information and insights from contacts at ASX or from discussions with ASX Technical Account Managers.
- 103 With the emphasis on email communication during the day of the outage, the ASX website system status page was not fully utilised and was only periodically updated. This created the risk that the wider market, including investors, may not have been kept sufficiently informed and had to rely on media channels or their brokers.
- 104 ASX also issued a public report in the days following the incident, and held a customer forum in the week after the incident to gather customer reactions and market feedback.
- 105 The outage raises questions as to whether the communications policy is still adequate and whether emails and service desk inquiries are the most appropriate channels given recent developments in communications. ASX is undertaking a review of its communications policy as part of its ongoing work.

Communications with Chi-X

- 106 In accordance with the communications protocol between ASX and Chi-X, ASX’s records show that it alerted Chi-X to the possible delay in the market open at 9.09 am. ASX subsequently informed Chi-X at approximately 9.35 am of an issue with its MPA application—which affected the data feed that broadcasts individual security statuses. At 9.44 am, ASX notified Chi-X of its decision to put the market into the enquire session state and to delay the market open until further notice.
- 107 Chi-X is reliant on the data feed from ASX on the status of individual securities to determine which are available for trading and which are suspended. As a result of the absence of this data feed from ASX, Chi-X had no choice but to delay opening its market. Chi-X’s decision to delay opening was also influenced by its assessment of uncertainty about the accuracy of the extreme trade range reference price that it receives from ASX: see paragraphs 141–159 for more detail on Chi-X’s dependencies on ASX.
- 108 ASX provided regular feedback to Chi-X on the status of the outage through a dedicated point of contact (a senior manager in the ASX Trading Operations team). At 10.16 am, ASX declined a request for an open conference call with Chi-X, instead managing incoming and outgoing communications with Chi-X through the dedicated ASX contact.

- 109 We received feedback that the process for communicating the availability of critical ASX infrastructure to Chi-X (e.g. CHESS), and the status of key information that Chi-X relies on (e.g. individual security statuses and extreme trade range reference prices) could be improved. Chi-X suggested that a three-way communications channel could be opened between ASX, Chi-X and ASIC in any such future event.
- 110 At 2.50 pm, Chi-X asked ASX to consider changing the trading session from 'enquire' to 'adjust' to allow market participants to purge or amend their orders so they could be transferred to Chi-X. ASX decided this would not be possible because the problems experienced in the afternoon were caused by a data issue and it was important that the data was kept in a stable state. The ASX market remained in the enquire session state for the remainder of the day. The individual security trading statuses data continued to be broadcast until the standard market close time of 4.10 pm, allowing the Chi-X market to keep operating.

ASX review of its communications protocol

- 111 ASX is reviewing the effectiveness of the communication channels it has historically used for incident management to assess whether improvements can be made to enable stakeholders to respond and take appropriate actions during market outages. ASX suggests that any potential change to the communications policy should be included as part of BCP testing.
- 112 Our discussions with industry suggest there is support for:
- (a) less frequent but more meaningful communications, including the use of a 'single source of truth' such as a central web page (which is updated periodically whenever the incident status changes) or an open teleconference bridge line;
 - (b) ASX communications to provide clarity on critical system statuses, including those systems that other market operators depend on, and ASX's intended actions; and
 - (c) market participants determining for themselves who the designated contact is within their firm.

Building muscle memory

Business continuity and IT disaster recovery testing

- 113 BCM and ITDR programs are important elements in building resilient markets during contingency events. Frequent rehearsals of meaningful test scenarios help incident management and response teams build institutional 'muscle memory', so that they can respond promptly and accurately when similar scenarios occur.

- 114 ASX has a BCM and ITDR program in place with a BCP test cycle of 12 months, or more frequently if driven by material system changes.
- 115 Because of the importance and complexity of ASX's systems, its testing should incorporate scenarios that may give rise to complex ITDR procedures and should contemplate the wider Australian market structure. Non-functional aspects, such as intraday recovery procedures and communications protocols, are equally important in designing an effective BCP.
- 116 ASX does not mandate market participants' involvement in its BCP and ITDR tests, in part because some market participants have expressed concerns about the operational cost of doing so. If market users are not familiar with the recovery procedures and protocols, there are limitations to the effectiveness of BCM and ITDR in building whole-of-market resilience.
- 117 As a critical market infrastructure provider, we expect ASX's arrangements to be validated and refined through more frequent testing. ASX should engage with market participants and Chi-X to enhance its testing and consider periodic street-wide tests.
- 118 At the same time, we encourage market participants to review their own system preparedness for managing market outages. We expect market participants to be involved in ASX (and other market operators') business continuity testing. This is an important part of participants' own risk management as well as their commitment to the integrity of the Australian market.

Central information repository

- 119 The lack of a clear, logical structure of BCM and ITDR documentation can obstruct the effective implementation of business continuity and ITDR arrangements. For this reason, we expect ASX (and all important market infrastructure providers) to have in place rigorous internal tools and systems that enable important documents to be readily located.
- 120 It is common for critical infrastructure providers and sizeable companies to use software tools that integrate the governance, documentation and implementation of incident management, BCM and ITDR procedures. Tools include a central platform for users to retrieve the latest plans, and procedures detailing when it is needed.

Recommendations on operational matters

Recommendations for ASX

We recommend that ASX, as part of its current internal review:

- 1 strengthen its BCM and ITDR arrangements to adequately reflect the criticality and complexity of its systems, and integrate a regime of

proactive and frequent testing into its business-as-usual operations. This should include testing to ensure:

- (a) that system-specific recovery procedures are documented in sufficient detail, and are validated and rehearsed during regular technology disaster recovery tests; and
 - (b) that there is a logical structure for all documentation on incident management, BCM and ITDR; and that there are adequate linkages between documents and frequency of document reviews. A central information repository or an equivalent information management tool should be considered to enable quick and easy access to critical procedures;
- 2 report to ASIC on the circumstances appropriate for all or a subset of securities to be available for trading or to be closed. In addition, ASX should report to ASIC about whether the opening rotation process is still appropriate for the Australian market;
 - 3 report to ASIC on its communication strategy, including:
 - (a) its consideration of a central platform that communicates a 'single source of truth' during incident management. This should contain sufficient information to allow market users to be fully informed of the market status and the planned recovery steps; and
 - (b) about whether its communications protocol considers and details the dependencies other market operators have on ASX infrastructure (e.g. CHES and the data feed for individual security trading statuses). ASX should ensure that it has adequate arrangements to inform ASIC and other market operators of the status and condition of its infrastructure in a timely manner; and
 - 4 report to ASIC on its review of the policies and procedures relevant to the outage, including:
 - (a) the 'four eyes' principle—by identifying:
 - (i) the key operational tasks undertaken across its listing, trading and CS facility functions that are subject to the policy; and
 - (ii) who performs the validation checks to ensure they are familiar with their responsibilities and sufficiently trained to carry out the operational task accurately;
 - (b) pre-open session—by considering the appropriate minimum pre-open period in the event of a trading disruption. ASX should ensure that such information is transparent and clearly communicated to market participants before re-opening the market; and
 - (c) cancellation policy—by considering whether it requires further clarity on the circumstances ASX may cancel trades, the timeframes for making and communicating the decision and the factors that influence the decision (e.g. if the trading session state is administered erroneously, if there is asymmetry in pre- or post-trade information, or if transactions are not fully processed and registered in CHES). We also expect ASX to clarify its novation procedures and ensure that its operating rules accurately reflect these procedures.

Recommendations for market participants

- 5 We recommend that market participants review their own system preparedness for managing market outages. This includes ensuring there is awareness of who has been appointed as their contact for ASX and that there are clear channels for communicating updates internally. We also expect market participants to be involved in ASX's (and other market operators') business continuity testing.

C Implications for technology resilience

Key points

Markets have become increasingly automated and complex, and market operators need to ensure their systems are robust and resilient.

In this section we identify a number of areas for improvement in ASX's technology resilience practices, including the need for:

- a more comprehensive and robust monitoring framework for applications, hardware, operating systems, network infrastructure and data management; and
- key enterprise architecture artifacts that adequately describe current and target states for systems and data flows.

We will continue to monitor these practices and engage with ASX as it continues to invest in technology during 2017 and beyond.

Importance of resilient technology

- 121 Technology is fundamental to the operation of efficient and effective financial market infrastructure. As systems become increasingly automated and complex, market infrastructure providers are continually challenged in maintaining the resilience of their technology infrastructure.
- 122 Despite having backup systems in place, the technology failure that triggered the events of 19 September 2016 made it challenging for ASX to troubleshoot and recover its functions properly.
- 123 While ASX has taken steps to address this specific equity market outage, the incident calls for ASX to review its approach to ensuring its technology infrastructure is sufficiently resilient to withstand technical faults. This is increasingly important in the near term as ASX carries out technology investments involving critical infrastructure platforms that support the equity market in Australia.
- 124 ASX carried out a security analysis and concluded that the equity market outage was not a cyber security incident.

Application and infrastructure monitoring

- 125 In a technology-driven environment, it is important for system owners to design and implement effective monitoring and alert tools to enable early detection and prompt diagnosis in the event of a failure.

- 126 On 19 September 2016, there were a number of event triggers that could have been detected earlier with more effective monitoring tools. For example, it was not immediately apparent to ASX that a number of application processes were in a hung state, creating an inconsistent configuration for ASX Trade.
- 127 The ASX Trade application errors only affected certain securities or traders using certain trading protocols, which ASX found difficult to detect. From the information provided to ASIC, it appears the error that caused orders for financial securities to match (but with only a subset of confirmations being issued) was only identified when participants reported inconsistencies in the information they were receiving from ASX.
- 128 A comprehensive monitoring regime should include capabilities to identify critical system applications and processes that are not functioning as designed. Drawing from this incident, ASX advised that it has implemented additional monitoring tools. We understand that ASX is also conducting an overall assessment of its monitoring tools and alerts to determine further enhancements to strengthen its monitoring capabilities.

Detailed system-specific recovery procedures

- 129 With the help of effective system monitoring tools, system owners can carry out a diagnosis and take appropriate steps to recover the system.
- 130 Recovery efforts may be impeded where there is a lack of detailed documentation and infrequent testing. For critical infrastructure services, such as ASX Trade, it is common practice to test and rehearse a broad set of failure scenarios and associated recovery procedures so that delays to restoring trading services can be minimised during a technology or operational disruption. ASX should review its procedures to identify areas for improvement.

System integrity checks

- 131 Before reinstating a system after an outage, it is critical for system owners to carry out integrity checks to confirm that recovery procedures have successfully created an acceptable starting position from which the market can resume trading. This is to prevent any flow-on effects that could exacerbate the severity of a technology or operational disruption.
- 132 While ASX carried out integrity checks at various levels on 19 September (i.e. applications, databases and infrastructure), it did not detect critical reference data values that were in an inconsistent state and that compromised the trading platform when reinstated. For example, there were inconsistencies between memory and database reference data that led to the Partition 2 failure at 1.42 pm.

- 133 Further, had ASX undertaken additional checks, it would have increased the likelihood of detecting downstream issues with trade confirmation broadcasts. For example, ASX tested practice securities in Partitions 1 and 4, before re-opening the market at 11.30 am. However, ASX did not test practice securities in Partitions 2 and 3, and the problem that caused certain trading in these securities to not generate trade confirmation broadcasts (known as CB15 and CB16) was undetected.
- 134 This indicates that more readiness testing should have been performed before the decision to open the market from 11.30 am, and that ASX can further improve this process. ASX indicated it has considered these matters in its review of the incident and will incorporate additional integrity checks. ASX will report to ASIC on this work.

Enterprise architecture

- 135 Enterprise architecture is commonly used by organisations with complex transformation strategies to conduct enterprise analysis, design, planning and implementation, using a holistic approach for the successful development and execution of strategy. It guides organisations through a structured approach in analysing business processes and information flows to determine technology changes necessary to execute their strategies.
- 136 Enterprise architecture provides a conceptual ‘blueprint’ that defines the structure and operation of an organisation. It is supported by a roadmap that shows how it plans to move effectively from its current state to the desired target state.
- 137 Because of the significant investment in business and technology transformations being undertaken by ASX, it is essential that ASX has a detailed blueprint defining the journey from current to target state that identifies the interdependencies between business processes, systems and, importantly, data architecture and information flows, to adequately support future operations. ASIC will work with ASX in reviewing its detailed enterprise architecture as part of our assessment in 2017.

Regulatory requirements on technological resources

- 138 Part 7.2 of the Corporations Act requires market operators to have sufficient technological resources. We have provided guidance in [Regulatory Guide 172](#) *Australian market licences: Australian operators* on our expectations for fulfilling this obligation. However, given the growing dependency on the technology and associated processes of market infrastructure providers, there

is merit in strengthening these obligations and providing further clarity about our expectations.

- 139 Over recent years, there has been greater regulatory focus on the resilience of critical market infrastructure. For example, in December 2015, IOSCO issued a report on managing trading risks and BCP: see IOSCO, [*Mechanisms for trading venues to effectively manage electronic trading risks and plans for business continuity \(PDF 450 KB\)*](#), FR31/2015.
- 140 We are considering whether specific market integrity rules should apply to Australian market operators for systems, controls, security and disaster recovery. We will engage with market operators and other stakeholders on this issue in the future.

Recommendations for technology resilience

Recommendations for ASX

We recommend that ASX:

- 6 implement a more comprehensive and robust monitoring regime. ASX should review its:
 - (a) automated monitoring tools and alerts of all applications, hardware, operating systems and network infrastructure for primary and secondary environments; and
 - (b) automated data integrity checking processes to ensure that reference values and states of critical data elements are in a consistent state for the purposes of recovery from a systems failure, and as a routine check to detect abnormal systems behaviours; and
- 7 enhance its key enterprise architecture artifacts to more fully describe 'current' and 'target' states for business processes, applications, data and information flows, and technology infrastructure. These should be informed by an appropriate level of consultation with participants, and developed with internal ASX business stakeholders to ensure the transition to future state business models and any implications are understood.

D Equity market structure considerations

Key points

There has been a multi-market structure for trading in Australian cash equities since Chi-X commenced operation in October 2011. One of the benefits of competing exchanges is the availability of an alternative trading venue when ASX is unavailable—enabling trading to continue and improving the overall resilience of the market.

However, on 19 September 2016 liquidity did not shift from ASX to Chi-X. In this section, we look at why liquidity and trading did not shift to Chi-X and consider several broader market structure issues, including:

- the dependencies stakeholders have on ASX;
- how market participants' systems, order routing decisions and data feeds inhibited the ability of many to use Chi-X on the day;
- the need for ASX to review how closing prices are determined in future; and
- the calculation of benchmark information.

Dependency on ASX as the primary market

- 141 The outage has shown that ASX's trading systems are still a single point of failure for Australia's equity markets.

Note: Liquidity did not shift from ASX to Chi-X on the day of the equity market outage. Trading on the Chi-X market was 26% of its normal turnover, and trading activity diminished after ASX was placed into the enquire session state at 2.05 pm: see Figure 1.

- 142 ASX performs a number of separate, critical functions that are relied on by other trading venues and market users. Some of these functions are currently technologically and/or operationally dependent on ASX Trade systems for all or part of their execution. Examples of these dependencies include:
- (a) the listing function that determines the availability of individual securities for trading;
 - (b) the trading session on ASX and the corresponding ability of market participants to amend and cancel their orders on ASX;
 - (c) extreme trade range reference prices that set the parameters for daily volatility controls on ASX and Chi-X (see also paragraphs 157–159); and
 - (d) off-market trades that must be reported to a licensed exchange market (ASX or Chi-X).

Listing and associated functions

- 143 As the listing authority for securities listed on its market, ASX is responsible for setting, monitoring and enforcing its listing standards. The listing function is separate from ASX's trading function, and there is a significant reliance by other market operators and market participants on ASX's performance of this function.
- 144 ASX receives and processes company announcements under the continuous disclosure regime and, where they are deemed to be price sensitive, can institute a trading halt (typically for 10 minutes) to allow sufficient time for market users to consider the announcement ('company monitoring').
- 145 ASX can also impose a trading suspension for other reasons, including for an issuer's non-compliance with the ASX Listing Rules. While these processes are functionally independent of ASX Trade, the administration of individual security statuses (e.g. trading halts) and dissemination of information is dependent on components of ASX Trade functioning correctly.
- 146 There were problems with the MPA component of ASX Trade on the morning of the ASX equity market outage (see paragraph 24), which resulted in ASX not processing trading halt requests and the corresponding company announcements. The MPA application was recovered at 10.28 am, but only started updating and broadcasting complete individual security statuses at 11.06 am. Issuers (and investors) have a reasonable expectation that all company announcements are published by ASX in a timely and complete manner.
- 147 There were 23 securities that should have been halted or otherwise had time allocated for investors to digest the price-sensitive news before 11.06 am. ASX subsequently advised ASIC that the dissemination of individual security statuses was not prioritised over recovering the core components of ASX Trade.
- 148 Without accurate and complete information on individual security statuses, Chi-X could not offer trading services in the relevant securities. Crossing systems and other off-market transactions are impaired without this information because transactions are not permitted to occur when a security is suspended: see paragraphs 160–163.
- 149 As the listing authority, ASX should continue to ensure it has appropriate processes and contingency measures to carry out its listing and associated functions. These arrangements should allow ASX to process and disseminate individual security statuses and company announcements in a timely manner, irrespective of the trading status of the ASX market. We do not consider that placing the ASX market into the enquire session state is a suitable substitute for properly determining, broadcasting and implementing individual security trading suspensions. ASX has confirmed that it understands the importance of this function and that it shares our expectations on the role of session states and suspensions.

- 150 Some stakeholders have suggested to us that the company monitoring function should be separated from ASX as is the case in some overseas jurisdictions that have competing exchange markets. For example:
- (a) in Canada, the Investment Industry Regulatory Organization of Canada (IIROC) is a central authority that carries out company monitoring for the whole market (there are nine market operators). When the Toronto Stock Exchange (the primary listing market) is unavailable, IIROC continues to perform this function for other market operators; and
 - (b) in the United Kingdom, the Financial Conduct Authority is responsible for the listing function for the market—which includes reviewing and approving prospectuses, administering and enforcing listing standards, and company monitoring.

Trading session states

- 151 ASX trading sessions determine whether orders can match and if market participants can enter, amend and cancel their orders: see paragraph 72. It is important to distinguish the functional use of the enquire session state in order to assist technical diagnosis and recovery from the market-wide implications of constraining market participants from cancelling their orders.
- 152 ASX's decision to place its market in the enquire session state (which effectively locked resting orders in ASX's order book and prevented market participants from amending or cancelling their orders), may have hindered the migration of order flow to the Chi-X market. Some market participants advised that their internal risk management frameworks limit their traders' capacity to duplicate orders if there is a possibility of over-filling orders, even if trading on one market is suspended. Many market participants also expressed concerns about the complexity of accurately reconciling their orders if they had replicated their ASX orders on Chi-X.
- 153 A small number of market participants suggested that, because of the uncertainty and low levels of liquidity in the market, all trading (i.e. on ASX, Chi-X and crossings) should have ceased when ASX was in the enquire session state. However, this approach would penalise those market participants that have invested in the systems and processes to use alternative venues, as well as penalising the alternative venues.
- 154 Where a locked static order book is not critical for technical diagnosis and recovery, we encourage ASX to consider using a more flexible trading session (e.g. the 'adjust' session state) in future incidents.
- 155 Many major overseas exchanges offer a 'cancel on disconnect' functionality that automatically cancels nominated orders in the event of a disconnection between a participant and the exchange. This functionality provides market participants with the flexibility to manage their orders (and their clients' orders) if needed.

Chi-X offers this function on its market in Australia. We understand that ASX may also offer similar functionality. However, the market participants we spoke with appeared to be unaware of this functionality and its availability to them when the ASX market is in the enquire session state.

Note: London Stock Exchange, NASDAQ, New York Stock Exchange, Stock Exchange of Hong Kong and Toronto Stock Exchange all offer a 'cancel on disconnect' functionality.

156 ASX has advised that it is reviewing its management of session states and the interaction with its 'cancel on disconnect' functionality. ASX will report to ASIC on the outcomes of its review.

Extreme trade range reference price

157 Chapter 2 of the ASIC Market Integrity Rules (Competition in Exchange Markets) 2011 (ASIC Market Integrity Rules (Competition)) requires market operators to have execution risk controls (e.g. rejection of orders within an extreme trade range) to prevent a disorderly market resulting from extreme price movements. As the primary market, ASX sets the daily reference price for the calculation of the extreme trade range for each security. The reference price is typically set as the opening auction price and updated by any intraday auctions.

158 On a typical day, Chi-X opens the securities on its market simultaneously before ASX completes its determination of the reference price each day. Chi-X determines an interim reference price for each security—which is typically the price of the first transaction on its market. However, once ASX generates a reference price, Chi-X is required to use it to calculate the extreme trade range.

159 On 19 September 2016, there was uncertainty about the determination of the extreme trade range reference prices when the ASX market did not open on time. In circumstances where a reference price has not been sent to ASX, Chi-X should use its own determined reference price.

Reporting venue for off-market trades

160 Under Part 7.2.1 of the ASIC Market Integrity Rules (Competition), market participants must not execute any transactions when there is a trading suspension in a security on all licensed markets. This includes trading suspensions for continuous disclosure purposes. This does not preclude market participants from trading off market and through crossing systems when there is a technology or operational failure on only one market.

161 All off-market crossings need to be reported to a licensed market operator (i.e. ASX or Chi-X). ASX does not accept trade reports when the market is in the enquire session state. On 19 September 2016, market participants that use ASX as their reporting venue were not able to execute crossings for much of the day, whereas those that report to Chi-X were able to cross while the Chi-X market was open.

- 162 From our discussions with market participants, many were unaware of whether their systems were receiving and accurately processing individual security statuses. This information is imperative for market participants (and crossing systems) to determine whether they are permitted to execute a crossing under the market integrity rules. Some market participants indicated that they rely on the market operator they report crossings to, to reject them if they are not permitted (e.g. if in suspension) rather than processing the individual security statuses themselves.
- 163 We strongly discourage market participants from relying on this approach because it is inconsistent with their obligations under the market integrity rules and may introduce operational and compliance risk if the market operator's systems fail to reject such crossings.

Market participant systems and processes

- 164 On 19 September 2016, there were several factors that caused market participants to lose confidence in the market, affecting turnover and market quality, including:
- (a) concerns about the status of trades executed on ASX Trade, the integrity of market information, and the risk implications from resolving cancelled trades;
 - (b) concerns with losing queue position on the ASX order book if market participants cancelled orders on ASX;
 - (c) concerns about price impact, including compliance implications, if large volumes shifted between execution venues;
 - (d) that trading was more expensive as spreads increased significantly to 45 bps by market close (see Figure 2);
 - (e) that displayed depths were too thin to trade in size without potentially contributing to excessive price impacts (see Figure 3); and
- Note: Some institutional investors were uncomfortable submitting any orders of size and some participants were concerned about violating fair, orderly and transparent markets if their trading volumes resulted in large price impacts.
- (f) limited trading volumes on Chi-X in the afternoon, accompanied by muted levels of price discovery.
- 165 Some market participants' trading algorithms and smart order routers rely on the operation of the primary market and will not function unless that market is open. Some rely solely on ASX data feeds, while others are configured to route to ASX before Chi-X and require a 'cancel' or 'no fill' message before the order is routed to another venue.
- Note: This is particularly true for smart order routers that are designed for markets with relatively low levels of fragmentation.

- 166 Some market participants have optimised their systems to operate in a multi-market environment. However, most were reluctant or did not have the confidence to adjust their algorithm and smart order router settings intraday to trade on Chi-X while ASX was unavailable.
- 167 Some smaller participants and those with a predominantly retail investor client base do not make Chi-X data available to their clients. This resulted in a lack of current pre-trade transparency for these clients after ASX was placed into the enquire session state in the afternoon. On a normal trading day, many of the marketable orders sent to Chi-X that interact with its displayed liquidity originate from retail investor clients. When these clients were unable to see prices in the market, they ceased trading altogether and trading activity on Chi-X declined.
- 168 Several market participants have indicated that they are reviewing their best execution policies in light of the ASX equity market outage. Many have also indicated potential adjustments to handle trading disruptions, and are reviewing their smart order routing logic and data policies to improve their ability to use other markets when the primary market is unavailable. We encourage all market participants to consider the observations and recommendations in this report when they next review their best execution policies.
- 169 Separately, some market participants' trading algorithms were affected by the amended length of session states. These algorithms are configured in fixed time intervals throughout a normal trading day, rather than interpreting trading session states from a data feed. It is critical that trading algorithms are able to interpret key market information to support a fair and efficient market.

Reference prices

National best bid and offer

- 170 Market operators and participants continually calculate the NBBO prices for individual securities throughout each trading day. The NBBO is determined as the best available pre-trade transparent bid and offer across both the ASX and Chi-X markets. Market participants use the NBBO to inform their order routing decisions, and it serves as a benchmark for fulfilling their best execution obligations to their clients. Market operators and participants also use the NBBO where they seek to rely on the 'trade with price improvement' exception from pre-trade transparency to execute crossings or for dark orders: Part 4.2.3 of the ASIC Market Integrity Rules (Competition).
- 171 Many market participants expressed uncertainty about the calculation of the NBBO on 19 September 2016 while ASX was in the enquire session state. Data feeds provided by data vendors typically do not identify the prevailing NBBO,

and continued to include ASX orders after this time. From our discussions with market participants, some used ASX stale orders in the NBBO calculation. This could have resulted in the appearance of locked or crossed markets—which did not accurately reflect available trading opportunities—and the incorrect calculation of the midpoint price for dark trades. Indeed, some crossings reported to Chi-X were rejected for mispricing.

172 We expect the NBBO to only reflect orders that are posted on a pre-trade transparent market that is open for continuous trading. It should not include orders in a market that has been suspended or placed into the enquire session state. As such, the NBBO should have been determined solely with Chi-X data while the ASX market was in the enquire session state after 2.05 pm.

173 We understand from Chi-X that dark orders executed on its market after 2.05 pm correctly referenced only the best available bid and offer prices on Chi-X for the purposes of compliance with Rule 4.2.3 of the ASIC Market Integrity Rules (Competition) (i.e. on trades with price improvement).

Closing prices

174 Closing prices are widely used by stakeholders for a variety of purposes. For example:

- (a) ASX Clear uses closing prices to calculate its margin values for both securities and ETOs. The dependency on ASX Trade to supply closing price data becomes even more apparent on option expiry days, on days of high volatility or on days of high market activity, such as financial quarter end dates;
- (b) in the event of a participant default, stale prices could result in ASX facing potential losses if the calculated initial margin amounts do not adequately cover its market exposure;
- (c) fund managers use closing prices for fund valuation purposes; and
- (d) market participants could face unexpected variation margin calls where closing prices are based on stale prices.

175 Because the outage on 19 September 2016 resulted in ASX closing early, the CSPA for each security did not run. This meant that, for a large number of securities, the closing price was set as the last traded price (which for many was from Friday 16 September, three days earlier). The ASX equity market outage raises the question of how closing prices should be determined if the CSPA is disrupted in future.

176 Some stakeholders expressed the view that Chi-X's prices should have been considered when determining the official closing price, because these were genuine transactions. Some fund managers commented that ASX's stale prices affected the valuation of funds, while some stakeholders expressed

doubts about whether there was sufficient liquidity on Chi-X to provide a closing price that was representative of prevailing market conditions.

- 177 The ASX equity market outage has also raised broader questions about how closing prices should be determined on an ordinary day. Some funds and indices are currently mandated to use the last traded price on ASX as the valuation reference price. Others have more flexible mandates that can take account of Chi-X prices—data vendors are accommodating this—and there is already movement on this issue.
- 178 There has been feedback that there are some less-liquid securities that trade more frequently on Chi-X than ASX. It has been suggested that it would make sense for Chi-X prices to inform the closing price of these securities.
- 179 This is an issue with broad ramifications that warrants further dialogue with industry. Thought will need to be given to the different closing mechanisms and the risk of price manipulation.

Pricing of other products

- 180 Intraday pricing of derivative instruments, such as options and futures, is assisted by the underlying security being available for trading. When the underlying market is closed, a consistent reference price for the derivative instrument is unavailable, which may reduce trading activity (e.g. because market makers are less able to hedge their positions). See paragraph 53.

Recommendations on market structure

Recommendations for ASX

- 8 We recommend that ASX consider, formally map and report to ASIC on the dependencies that different stakeholders have on ASX's processes and decision making, and determine what changes need to be made to mitigate the effect of ASX system failures on these stakeholders. This includes dependencies on:
 - (a) the *listing function*—ASX should develop procedures to allow ASX to carry out its listing and associated functions (including the processing and dissemination of individual security statuses and company announcements) in a timely manner, irrespective of the trading status of the ASX market;
 - (b) *ASX trading session states*—ASX should review the appropriate trading session states that apply during a trading disruption, including where ASX Trade is unavailable for an extended period of time. ASX should give due regard to the needs of market users in a multi-market environment. ASX should also consider developing functionality to provide market participants with greater flexibility in managing their orders during such events;

- (c) *closing prices*—ASX should review its methodology for determining closing prices in the absence of a CSPA and be transparent about its approach; and
- (d) *security prices* that may be used to price other products (e.g. derivatives).

Recommendations for market participants

- 9 We recommend market participants review their arrangements for dealing with market outages and inform their clients of the arrangements, including:
 - (a) that *best execution* policies and procedures adequately address such incidents and are clear about how the participant will respond;
 - (b) that their *algorithms and smart order routers* are configured to adequately respond to such incidences in accordance with their clients' expectations about how their orders are managed. In particular, participants should consider the appropriateness of algorithms and smart order routers that rely on fixed-time intervals rather than the status of the market; and
 - (c) that their arrangements for undertaking *crossings* are adequate. This includes ensuring that transactions do not occur in securities that have been suspended from trading and that the NBBO calculation only includes pre-trade transparent orders from markets that are accessible at that time.

Appendix: ASX initiatives in response to the outage

181 ASX has provided the following information for inclusion in this report about its initiatives in response to the outage.

Table 5: ASX actions in response to the outage

Themes	Actions
Platform Enhancements	ASX has taken steps to improve the ASX Trade platform. These include replacing the hardware components that triggered the incident and, in conjunction with its vendor, reviewing a number of process and functional enhancements to the platform.
Monitoring Tools and Procedures	<p>ASX has implemented a number of additional monitoring tools and processes to enable early detection of issues, improve failover and recovery processes, and more quickly identify data inconsistencies.</p> <p>ASX has enhanced its start of day procedures to include additional validations and integrity checks on the readiness for market open. This includes improved procedures that underpin market readiness in a recovery scenario.</p> <p>ASX has enhanced its procedures regarding the amendment of market schedules to further mitigate the risk of a market management error occurring during the recovery process.</p>
BCP Testing	<p>ASX is reviewing its Business Continuity Planning (BCP) testing practices including frequency of its testing cycle and change management-related Industry Wide Testing. BCP test plans will be expanded to include additional tracking, assessing and reporting of Disaster Recovery (DR) scenarios, and specific components will be tested.</p> <p>As in 2016, ASX intends to conduct its future ASX Trade BCP testing in conjunction with other market operators.</p>
Market Management Actions	<p>ASX is reviewing its market management actions to provide greater decision-making certainty and to ensure actions are fit for purpose under the current market structure. The areas under review include:</p> <ul style="list-style-type: none"> • Cut-off times on deferral of market open • Use of alternative market session states e.g. Pre-Open, Adjust, Enquire • Cancel on disconnect functionality • Continued use of group openings • Generation of session states for individual securities • Processing of company announcements • Determination of closing prices. <p>Consultation will be undertaken to understand the potential impact of any changes on current market practices. ASX is working closely with ASIC on these matters throughout the review process.</p>

Themes	Actions
Communications	ASX has undertaken a review of the effectiveness of communications with the market during and post the incident. A number of improvements to the communication process are being considered in response to market feedback, such as the use of a single communication channel to improve the distribution and consistency of information. ASX will advise of the outcome as soon as possible.

Source: ASX.

Key terms

Term	Meaning in this document
ASIC	Australian Securities and Investments Commission
ASIC Market Integrity Rules (Competition)	ASIC Market Integrity Rules (Competition in Exchange Markets) 2011—rules made by ASIC under s798G of the Corporations Act
ASX	ASX Limited or the licensed market operated by ASX Limited
ASX 24	The exchange market formerly known as Sydney Futures Exchange (SFE), operated by ASX Limited
ASX Clear	ASX Clear Pty Limited (formerly known as Australian Clearing House Pty Limited)
ASX equity market outage	On 19 September 2016, ASX experienced a hardware failure in its equities trading system, ASX Trade. The initial technology failure triggered a number of events that delayed the opening of the ASX market and caused it to close early
ASX Listing Rules	Rules made by ASX that govern the admission of entities to the official list, quotation of securities, suspension of securities from quotation and removal of entities from the official list
ASX Trade	ASX's equities trading platform
Australian market licence	Australian market licence under s795B of the Corporations Act that authorises a person to operate a financial market
BCM	Business continuity management
BCP	Business continuity plan
block trade	Has the meaning given to it by Rule 4.2.1 of the ASIC Market Integrity Rules (Competition)
CHESS	Clearing House Electronic Subregister System
Chi-X	Chi-X Australia Pty Limited or the exchange market operated by Chi-X
closing price	The price determined by ASX, typically established by the CSPA, which is used for margining and fund valuation
Corporations Act	<i>Corporations Act 2001</i> , including regulations made for the purposes of that Act

Term	Meaning in this document
crossing	A transaction where the market participant is the same for both the buyer and seller. The market participant may be acting on behalf of the buying client and the selling client, or acting on behalf of a client on one side of the transaction and as principal on the other side of the transaction
crossing system	<p>An automated service provided by a market participant to its clients that matches or executes client orders with orders of:</p> <ul style="list-style-type: none"> the market participant (i.e. against the market participant's own account); other clients of the market participant; or any other person whose orders access the automated service <p>These orders are not matched on a pre-trade transparent order book of a licensed market</p>
CS facility	Clearing and settlement facility
CSPA	Closing Single Price Auction
ETO	Exchange-traded option
extreme trade range reference price	A price determined in accordance with Rule 2.2.2 of the ASIC Market Integrity Rules (Competition)
enterprise architecture	A plan that defines the structure and operation of an organisation, which guides how it will execute its strategies and achieve its future objectives
IIROC	Investment Industry Regulatory Organization of Canada
IOSCO	International Organization of Securities Commissions
ITDR	IT disaster recovery
individual security status	The trading status of an individual security (e.g. whether available for trading or suspended from trading)
listing standards	The listing rules of a licensed market operator (e.g. ASX) and the administration of the listing rules
market integrity rules	Rules made by ASIC, under s798G of the Corporations Act, for trading on domestic licensed markets
market licensee	A market operator licensed to operate a market in Australia under Pt 7.2 of the Corporations Act
market operator	An operator of a licensed market
market participant	As defined in s761A of the Corporations Act
market user	Market users include market participants, data vendors, underlying investors and independent software vendors

Term	Meaning in this document
MPA	ASX's Market Place Assistant application
NBBO	National best bid and offer
session state	The status of a trading platform (e.g. ASX Trade) that determines permissible functions and actions (e.g. open or enquire session state)
trade	A transaction that has been validated and accepted by ASX Clear and registered in CHES
transaction	A contract entered into or reported to ASX under which one party has an obligation to deliver a particular number of financial products and the other party has an obligation to pay for the delivery

Related information

Headnotes

ASX, ASX equity market outage, ASX Trade, BCM, BCP, business continuity management, business continuity plan, Chi-X, clearing and settlement, crossing, crossing system, CS facility, equity market outage, incident, incident management, IT disaster recovery, ITDR, market, market infrastructure, market operator, market participant, outage, technology, trade, transaction, 19 September

Regulatory guides

[Regulatory Guide 172](#) *Australian market licences: Australian operators*

Reports

[Report 289](#) *Market assessment report: ASX Group*

Media and other releases

[16-352MR](#) *ASIC statement on review of ASX technical failure on 19 September 2016*