Market Outages

FINAL REPORT

The Board of the
International Organization of Securities Commissions

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Executive Summary

Market outages occur when a technical problem or an operational issue causes the disruption of trading outright or the orderly trading of a trading venue, leading to the suspension of trading. Market outages can be highly disruptive, particularly if they occur on a listing trading venue, potentially impacting price discovery, market resilience and the integrity of financial markets more broadly. Whilst market outages are rare, their impact on trading venues and other market participants can be significant. Hence, market outages require an appropriate response by trading venues and their regulators.

In June 2022, the Board of the International Organization of Securities Commissions (IOSCO) issued a mandate for the Committee on Regulation of Secondary Markets (Committee 2) to identify key findings from recent outages and to determine whether further IOSCO regulatory considerations or guidance could be developed to enhance market resilience and to help ensure, to the extent possible, that orderly trading in a market can be maintained throughout an outage. The focus of the market outages mandate was on equities listing trading venues, but some of the good practices identified in the Final Report may also be relevant to other types of trading venues, including non-listing trading venues and derivatives trading venues.

In 2022, Committee 2 developed a survey to gather information regarding recent market outages from its members. The scope of this survey covered market outages in member jurisdictions on equities listing trading venues between 2018 and 2022.

This Final Report is based on the information relating to recent market outages collected as part of this survey and it:

- examines key findings from recent market outages on listing trading venues in IOSCO jurisdictions; and
- builds on past IOSCO work on operational resilience and business continuity planning to identify good practices for listing trading venues that may enhance market-wide resilience in the event of a market outage.

To improve market-wide resilience in the event of outages, this Final Report proposes that listing trading venues consider adopting the following good practices:

- Establish and publish an **outage plan**. The outage plan may include, for example, the trading venue's communication plan, reopening strategy, the arrangements for operating a closing auction and the methodology for providing the market with alternative closing prices (if required);
- Implement a **communication plan**, which provides, through an appropriate communication channel, initial notice (as soon as practicable) of the outage to market participants and the general public and, thereafter, regular updates to all market participants on the status of the outage and the recovery pathway;

- Communicate information relevant to the **reopening of trading** in a timely and simultaneous manner to all market participants, providing clarity on the status of orders and ensuring an adequate period of notice before the resumption of trading. The outage plan may outline the processes and steps involved in the reopening strategy and, where relevant, the pre-opening phase. Such arrangements may interact with existing operational resilience measures, such as trading venues' business continuity and disaster recovery plans;
- Ensure the processes and procedures that trading venues will follow to operate a **closing auction** and/or to **establish alternative closing prices** are published in the outage plan and communicated to all market participants during an outage. Where a closing auction cannot be run at the scheduled time, trading venues may consider various options, including postponing the auction. Trading venues may consider including in the outage plan a cut-off time by which trading venues would inform market participants whether a closing auction will be run. Market participants may likely need an adequate period of notice before the revised commencement of the closing auction. If it is not possible to operate a closing auction, trading venues may consider the use of a pre-defined methodology (as set out in their outage plan) to establish alternative closing prices for the day; and
- Conduct and share with the relevant regulators a lessons-learnt exercise of the market outage and adopt a **post-outage plan**, with clearly defined timelines and allocation of responsibilities for remediation, designed to reduce the likelihood of future incidents and to improve the ability of the trading venue to effectively respond to outages. The lessons learnt exercise could include both a root cause analysis, with remediation actions for those root causes, and the evaluation of the handling of the outage.

Consistent with IOSCO's taxonomy, the good practices identified in this Final Report do not constitute IOSCO standards or recommendations. Nevertheless, IOSCO considers that they are an appropriate way of dealing with the issues identified in the report and, hence, encourages trading venues to consider adopting them.

These good practices provide sufficient flexibility so that they can be considered for adoption across different types of trading venues, asset classes and market structures. Whilst they were primarily developed for equities listing trading venues, IOSCO is of the view that some of these good practices may have relevance more broadly, for example, in the context of non-listing trading venues and derivatives markets.

IOSCO considers that these good practices are generally applicable to market outages caused by different types of root causes. However, given the range of potential scenarios under which a market outage may occur, IOSCO acknowledges that the good practices must be capable of being tailored to specific circumstances. As such, IOSCO recognises that subject to domestic legal and regulatory requirements, it is within individual trading venues' discretion whether and, if so, how to adopt these good practices.

Chapter 1 - Introduction

1.1. Background

A market outage[1] occurs when the provision of essential services offered by a trading venue – such as order processing, trade execution or the publication of confirmed trades – is disrupted as a result of technical problems or operational issues, leading to a temporary suspension of trading. Often the market outage is caused by a technical problem, but there may be other causes as well. Market outages can be disruptive on any trading venue. However, when they occur on a listing trading venue[2], they can be more problematic. This is because listing trading venues are usually the most liquid market for the securities they list, and they are often used by a larger and more diverse set of market participants. In addition, a market outage occurring on a listing trading venue that is the sole trading venue available in a jurisdiction can be particularly disruptive.

When a market outage occurs in a jurisdiction that has multiple trading venues, trading could potentially shift to alternative trading venues[3]. However, the extent to which this may occur is dependent on a number of factors, which are discussed below, especially if the outage happens on a listing trading venue.

Market outages that occur during, or otherwise impact, the opening or closing auctions of a listing trading venue bring additional risk. Without an opening auction to establish an initial price, it is difficult for trading in a security to commence. Closing auctions are widely used for benchmarking purposes, index calculation and pricing derivatives and funds, such as exchange traded funds. Thus, if an outage affects the closing auction, and closing prices cannot be produced, some securities may not be valued correctly, and the pricing of derivatives may also be disrupted. It could also have an impact on clearing and settlement processes.

Market outages occurred on listing trading venues in many of the surveyed IOSCO jurisdictions in recent years. These incidents disrupted the orderly, efficient, and transparent functioning of the impacted market for the duration of the outage. Such

[1] In this Final Report, the term "market outage" is used to refer to the disruption of trading outright or the orderly trading of a trading venue caused by a technical problem or an operational issue, which leads to the suspension of trading.

[2] In this Final Report, the term "listing trading venues" is used to refer to trading venues that facilitate secondary trading for the securities that they list. Listing trading venues are normally the most liquid markets in those securities and are often the sole operators of opening and closing auctions for those securities. They may also be referred to as primary exchanges or regulated markets.

[3] In this Final Report, the term "alternative trading venue" is used to refer to a trading venue where securities listed on another trading venue in a jurisdiction can be traded, including if or when trading is disrupted on the listing trading venue.

market outages were accompanied by different approaches taken by the trading venues regarding the coordination and communication of recovery pathways for the impacted market participants.

The resilience of trading venues is vital to the smooth operation of global capital markets. Operational resilience remains one of the key priorities for regulatory authorities globally, and regulators around the world have been implementing legislative and regulatory changes to strengthen operational resilience in the financial services sector. In addition, some IOSCO jurisdictions have established regulatory requirements in relation to market outages. These set out the arrangements that trading venues and, in some cases also market participants, are expected to put in place to ensure the resilience and integrity of financial markets during market outages.

1.2. Project mandate

In June 2022, the IOSCO Board approved a mandate for Committee 2 to identify lessons learnt from recent market outages and whether other regulatory considerations or guidance could be developed that would be helpful for improving market-wide resilience and to help ensure, to the extent possible, that orderly trading in the market can be maintained throughout an outage. The project mandate noted that previous IOSCO reports have addressed market outages, but mainly from the perspective of managing risks to critical systems and business continuity planning.

This Final Report considers market outages from a market-wide resilience perspective. It builds on previous IOSCO reports, discussed below, which analysed the risks and circumstances that may lead to a market outage from an operational resilience perspective.

1.3. Survey

The survey covered the period between 2018 and 2022 and included questions relating to: (i) recent market outages on listing trading venues, (ii) the rules and practices applicable to market outages in different jurisdictions, (iii) organisational requirements applying to trading venues and (iv) arrangements applying to market participants in an event of an outage.

Annex A to this report contains a list of the 24 IOSCO regulatory authorities that completed this survey.

1.4. Previous IOSCO work

IOSCO has previously considered issues related to market outages and recommended

mitigating actions[4]. For example, in July 2022, IOSCO published a report entitled *Operational resilience of trading venues and market intermediaries during the COVID-19 pandemic & lessons for future disruptions*[5]. This work focused on operational resilience during the COVID-19 pandemic and identified instances of trading venue closures that were not related to technological issues or business continuity planning failures.

The 2015 IOSCO Report on *Mechanisms for Trading Venues to Effectively Manage Electronic Trading Risks and Plans for Business Continuity*[6] provided an overview of the steps trading venues might take to manage electronic trading risks to mitigate disruptions, including market outages.

Finally, the *Thematic Review on Business Continuity Plans with respect to Trading Venues and Intermediaries*, published in 2021[7], highlighted that in some jurisdictions, trading venues are required to perform stress tests to verify the performance of their systems. Further, these trading venues are required to identify the scenarios under which their trading system or component parts can continue to perform during systems failures and outages.

1.5. Feedback on the Consultation Report

In December 2023, IOSCO consulted on the key findings and five proposed good practices primarily aimed at equities listing trading venues. The feedback period closed on 1 March 2024, with a total of 16 responses received from a range of stakeholders falling into these broad categories:

- Industry associations (5);
- Regulatory authorities (1);
- Trading venues (9); and
- Service providers (1)

The IOSCO Board is grateful for the responses received. The feedback has been carefully considered and, where appropriate, incorporated in the Final Report. In addition, Annex C summarises the feedback received on the consultation questions and sets out IOSCO's response.

[4] At the February 2021 IOSCO Board meeting, operational resilience was identified as a Board priority.

[5] IOSCO Final Report (FR06/22): Operational resilience of trading venues and market intermediaries during the COVID-19 pandemic & lessons for future disruptions (July 2022)

[6] IOSCO Final Report (FR31/2015) Mechanisms for Trading Venues to Effectively Manage Electronic Trading Risks and Plans for Business Continuity (December 2015)

[7] IOSCO Final Report (FR03/21): Thematic Review on Business Continuity Plans with respect to Trading Venues and Intermediaries (May 2021)

Chapter 2 – Legislative and Regulatory Framework

2.1. Overview of legislative and regulatory requirements

All surveyed jurisdictions reported to have frameworks, including regulations, rules and guidance, which relate to business continuity, disaster recovery, operational resilience, notification requirements, and operational systems and controls. These requirements usually apply to all trading venues (including listing trading venues) and across multiple financial instruments (including equities).

Generally, operational resilience refers to the ability of firms and other market participants to prevent, respond to, recover and learn from operational disruptions. Operational resilience remains one of the key priorities for regulators around the world, as well as international organisations and global standard setting bodies, including IOSCO. As such, most jurisdictions have published regulatory requirements, including rules, principles and/or guidance applying to listing trading venues in relation to business continuity and operational resilience.

For example, in 2019 the Securities Commission of Malaysia (SC) published its Guiding Principles of Business Continuity to ensure the continuation of critical services and to mitigate any possible wider systemic risk in the event of disruption. In 2022, the Australian Securities and Investments Commission (ASIC) issued new market integrity rules intended to promote technological and operational resilience of market operators and participants. In the United Kingdom (UK), new regulatory rules and guidance came into force in 2022, which aim to ensure that the important business services offered by listing trading venues (and certain other financial services firms) operate with sufficient resilience to enable them to be delivered despite operational disruptions.[8] Going forward, third parties designated as critical third parties will become subject to joint oversight by the relevant UK regulatory authorities in order to strengthen the resilience of services and to mitigate potential systemic risk.[9] In the European Union (EU), the Digital Operational Resilience Act (DORA) entered into force in 2023, with the aim to achieve a high common level of digital operational resilience by creating a harmonised regulatory framework to strengthen the information and communication technology security of financial entities, including trading venues.[10]

[8] UK FCA Policy Statement on Building Operational Resilience (PS21/3)

[9] Financial Services and Markets Act 2023

[10] DORA entered into force on 16 January 2023 and will apply from 17 January 2025.

Some regulatory authorities have also implemented regulatory guidance specifically in relation to market outages. Collectively, these set out regulatory expectations for trading venues (and, in some cases, for market participants) in the event of a market outage. This guidance covers, for example, how trading venues should communicate with market participants if an outage occurs, and the steps they could take to reopen trading. For example, in 2021 ASIC published its expectations for industry in responding to market outages, with the aim of supporting the resilience and robustness of the Australian equity market.[11] In 2023, the European Securities and Markets Authority (ESMA) published its Opinion on market outages.[12] This Opinion provides guidance on the requirements that EU national competent authorities should require trading venues to have in place to deal with market outages events. In 2023, the UK's Financial Conduct Authority (FCA) established an industry-led committee to develop good practices for trading venues and other market participants to improve market-wide resilience during outages.[13] The committee is expected to report to the FCA in the course of 2024. In 2023, the Securities and Exchange Board of India (SEBI) issued standard operating procedures which outline regulatory requirements in relation to extending trading hours in the event of outages.[14]

2.2. Industry protocols

In 2022, the trade association for European exchanges – the Federation of European Securities Exchanges (FESE) – published industry-wide standard protocols with the aim of harmonising communication and outage procedures. As part of this industry-led initiative, FESE established 10 Principles for an Industry-wide Standard Protocol in Equity Markets (FESE Principles).[15] The FESE Principles cover playbooks, market notices, market status, reopening, closing prices and post-outage analysis. FESE has also published outages protocols for fixed income and exchange-traded derivatives markets.

The FESE Principles have been adopted by 35 European exchanges. Whilst widely accepted, the FESE Principles have not been endorsed by national regulators. Since the publication of these Principles, FESE members have been developing and publishing

[11] REP 708 ASIC's expectations for industry in responding to a market outage

[12] ESMA Final Report on market outages

[13] FCA Policy Statement 23/4: Improving Equity Secondary Markets (Chapter 4 – Our response to feedback on improving market-wide resilience during outages). In due course, the FCA will consider whether to confirm this guidance. If confirmed, the FCA will take this industry guidance into account when exercising its regulatory functions.

[14] SEBI Standard Operating Procedure for handling of Stock Exchange Outage and extension of trading hours thereof

[15] FESE, Trading Venue Outages: A framework for industry-wide standard protocols in equity markets (January 2022)

individual playbooks on outage protocols. The FESE website includes a centralised database for all available playbooks.[16]

Table 1 summarises the existing legislative and regulatory frameworks that apply to market outages in surveyed IOSCO jurisdictions.

Table 1: Overview of the legislative and regulatory framework governing market outages in the surveyed IOSCO jurisdictions

Legislative framework *Not specifically focused on listing venues – applies to all trading venues and across multiple instruments*				
Business continuity / disaster recovery	Systems resilience / adequate capacity	Monitoring for system disruptions	Obligation to notify regulator	Recovery time objectives
Regulatory requirements				
Specific to market outages				*On business continuity and operational resilience*
ASIC expectations for industry in responding to market outages (REP 708) • Sets out expectations for market operators, market participants and large institutional investors.	**ESMA Opinion on market outages** • Sets out the steps trading venues should take to reopen trading in an orderly manner. • The guidance covers outage plans, communication during an outage, reopening of trading, closing auctions and reference price.	**FCA Policy Statement on Improving Equity Secondary Markets (PS23/4)** • Confirms the establishment of an industry-led committee with the aim of developing good practices for trading venues and other market participants during an outage.	**SEBI Standard Operating Procedure for handling of Stock Exchange Outage and extension of trading hours thereof** • Sets out expectations for reporting requirements, trading on unaffected segments / exchanges, resumption of trading and extension of trading hours.	ASIC – Market integrity rules for technological and operational resilience FCA – Operational resilience requirements applying to UK Recognised Investment Exchanges MAS – Guidelines on Business Continuity Management SC – Guiding principles on business continuity SEBI – Guidelines for BCP/DR of Market Infrastructure Institutions
Industry protocols				
Regulator-endorsed industry guidance			*Federation of European Securities Exchanges (FESE) framework for industry-wide standard protocols for trading venue outages in equity markets*	
No specific industry guidance appears to have been endorsed by regulators.			• 10 Principles adopted by 35 European exchanges • Covers, for example, playbooks, market notices, market status, reopening, closing prices, post-mortem analysis.	
Trading venue playbooks				
Produced by trading venues and governs how incidents will be managed. Often part of the broader BCP/DRP procedures and not specific to market outages. May not be publicly available.				

[16] FESE, Exchange playbooks on outage protocols

Chapter 3 – Key Findings from Recent Market Outages

The IOSCO survey sought information relating to market outages on listing trading venues that occurred between 2018 and 2022.[17] Whilst the survey focused on the causes, impact and responses to recent market outages, it also asked questions about the organisational requirements and arrangements of trading venues and market participants. To complete the survey, IOSCO members sought input from trading venues within their jurisdiction, or alternatively, provided responses based on recently gathered information and perspectives from these trading venues.

3.1. Market structure

The majority of the jurisdictions surveyed have between two and seven listing trading venues.[18]

Less than half of jurisdictions have alternative trading venues operating within their borders. In some cases, alternative trading venues may be available in foreign jurisdictions, meaning in jurisdictions other than where the listing trading venue is located. In some jurisdictions, where there is more than one listing trading venue, alternative trading venues may not be available for each of the listing trading venues or for each security listed.

3.2. Incidents of recent market outages on listing trading venues

Respondents to the survey reported 42 market outages on listing trading venues between 2018 and 2022. The highest number of outages was reported in 2018, with 16 outages. Since then, the yearly number of outages decreased. In 2022, only three outages were reported. The jurisdiction with the greatest number of outages reported six events, and the jurisdiction with the second highest number of outages reported five events, including four on the same trading venue. Around a third of jurisdictions surveyed did not experience a market outage on their listing trading venue(s) between 2018 and 2022.

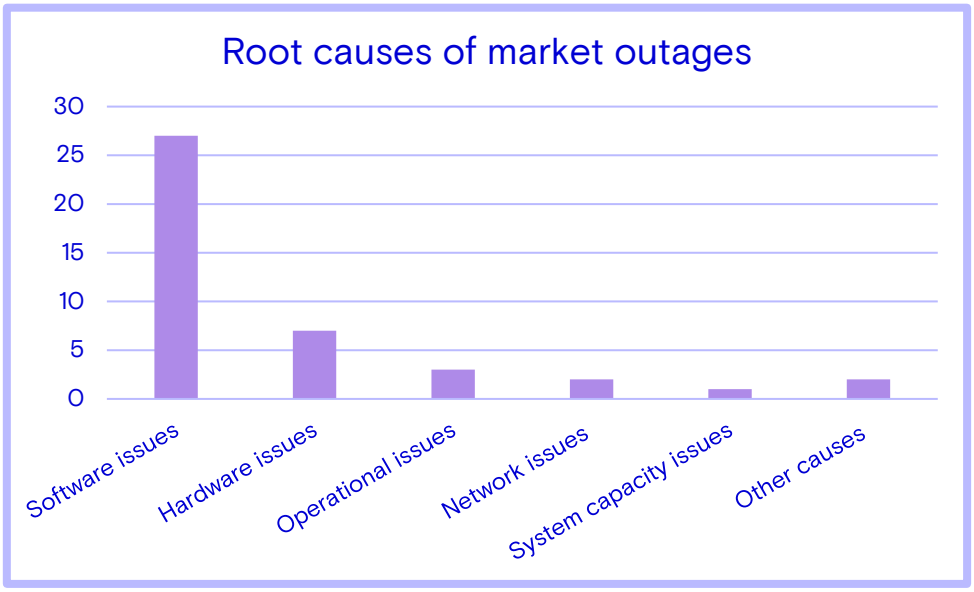
[17] The findings in Chapter 3 are based on the survey responses from 24 regulatory authorities.

[18] Some jurisdictions have only one listing trading venue, and one jurisdiction does not have any listing trading venues.

3.3. Causes of market outages

Table 2 below demonstrates the different root causes of market outages on listing trading venues reported in the surveyed IOSCO jurisdictions between 2018 and 2022. The main causes of market outages were software and hardware issues, with some jurisdictions reporting more than one root cause for the same event. For example, several incidents were caused by a combination of hardware and software issues.

Table 2: Root causes of market outages on listing trading venues reported in the surveyed IOSCO jurisdictions between 2018 and 2022



Software issues

The majority of market outages were caused by software issues. Examples of software issues include a failed software release rollout, an unexpected and invalid instruction submitted by an exchange member, and a delayed restart to the system following scheduled maintenance.

Hardware issues

Examples of hardware issues include a failure in a central storage appliance of the trading system, a memory module failure leading to the failure of an automated switch to a back-up device, and a faulty hardware causing a power outage. Whilst hardware issues were identified as the root cause in several instances, there are other examples where a combination of software and hardware issues were involved.

Operational issues

Examples of operational issues include an incident where a data center service vendor mistakenly allowed access to third parties, which resulted in the disconnection of servers and telecommunications equipment by those third parties. In one case, a securities pricing error was introduced late in the development cycle and it was not identified in testing.

System capacity issues

Whilst not frequent, system capacity issues were another root cause. In one case, a large increase in messages congested the trading system, leading to connectivity issues and the system being unable to process the increased number of messages in real-time.

Network issues

Network issues were identified as another root cause by some survey respondents. In one case, an outage occurred during preparations for the launch of a new trading venue.

Other causes

This category includes market outages caused by issues other than those identified above. These included, for example, market outages caused by a false fire alarm and a real fire incident.

3.4. Resumption of trading

The timing of outages was generally spread throughout the day, with a slight concentration in the morning. Outages were not more prevalent in the opening or closing of a trading session than any other time. Most trading venues resumed trading activities within the same trading session using the primary site. When this did not occur, the reasons identified included:

- backup facilities exhibiting similar issues;
- more time required for problem investigation and resolution; and
- concerns over market readiness for the resumption of trading.

In some instances, trading was resumed on the next business day. Regardless of the extent of the interruption, opening (or re-opening) call auctions were usually used to resume trading in accordance with trading venues' outage protocols and guidelines.

3.5. Parts of the trading process affected

Market outages affect different parts of the trading cycle, including order entry and matching, participant connectivity, pre- and post-trade transparency, and post-trade processes (e.g., clearing and settlement). In most cases, all parts of the trading process were affected. However, in some instances the impact of the outage was limited to the directly affected trading segments due to segregated platform modules.

3.6. Closing auctions / closing prices

Survey responses suggest that where trading was affected by a market outage, the production and update of associated indices, benchmarks, and reference prices in the relevant asset classes were also interrupted for the duration of the outage.

Where a closing auction could not be held because of an outage, several trading venues used the last traded price (established during continuous trading prior to the outage) as the closing price. Some jurisdictions noted that third-party index providers have published procedures for determining reference prices during market outages, often using the last traded price instead of closing auction data. There have also been instances of trading venues using the mid-point of the best bid/offer price immediately before the outage as the closing price.

In some jurisdictions with multiple trading venues, more complex procedures and methodologies have been developed to determine a closing price in the event of a market outage. For example, in the United States of America, which has consolidated tapes for listed equity markets data, some exchanges have additional contingency procedures, whereby an alternate exchange may be designated to determine the official closing price.

In certain cases, trading venues in the United States of America and Canada have developed protocols to establish an alternative closing price, which may include the use of volume-weighted average prices within a specified time window, the consolidated last-sale, or the closing price for a security on the last day in which it traded on the applicable exchange.

Several other jurisdictions indicated that they determine the closing price on a case-by-case basis, depending on their assessment of each incident.

3.7. Business continuity plans

Business continuity plans are crucial to help ensure the effective management of any disruption. All jurisdictions reported having requirements for trading venues to have a business continuity plan in place with defined policies and procedures. Many jurisdictions

also require trading venues to have a disaster recovery site in a separate geographical location in the event of an operational failure of the primary trading system.

Some jurisdictions reported that their listing trading venues conduct regular rehearsals with market participants on contingency scenarios (including market outages), and that these exercises have proven to be useful in preparing the market for trading disruptions and enhancing market resilience.

In some jurisdictions, industry-wide business continuity testing is required or encouraged and/or coordinated by national regulators. For example, in one jurisdiction, there is an industry-wide test to verify that trading venues and other market participants can effectively leverage recovery and back-up sites. In some jurisdictions, market participants are required by regulatory requirements or by trading venues to participate in these exercises. In another jurisdiction, the regulator has successfully encouraged voluntary participation across the market.

3.8. Communication with the regulator

It is common practice for market outages to be broadly communicated to market participants. Survey responses indicate that real-time market notices are frequently used for this purpose. In addition, trading venues typically have an obligation to notify their regulator of market outages. In all instances, the relevant regulator was notified immediately via email or telephone calls, in accordance with the listing trading venue's notification obligations. In some instances, where the outage had a cross-border impact, relevant foreign regulators were notified as well.

3.9. Post-outage response

Most jurisdictions conduct a post-mortem or lessons learnt analysis following market outages. Depending on the jurisdiction, these were conducted by trading venues, the regulator or independent third parties. The reports containing the underlying analysis and any identified remedial action or recommendations put forward by the national regulator were published in only a few jurisdictions.

3.10. Market outage policies and procedures

Trading venues have various monitoring tools and methodologies designed to detect system disruptions on an ongoing basis. These include dedicated teams, systems and tools for monitoring possible issues related to hardware, software, network connectivity and trading activities. Where an incident was identified, trading venues generally conducted an initial assessment of the incident to determine its scope and impact.

Trading venues typically have policies and procedures they must follow in the event of a market outage. These procedures may include incident response playbooks, procedure handbooks, business continuity and disaster recovery plans and incident management plans. The application of these policies and procedures depends on the nature and severity of the incident. Several trading venues have established a disaster recovery site in a separate geographical location to the primary site as part of their disaster recovery plans. This is designed to allow them to continue trading operations in the event of an operational failure affecting the primary trading facility or site.

In addition, trading venues disseminate information concerning market outages through their standard communication protocols, which may be required by regulation or by industry convention. The information typically disseminated includes the nature and impact of the incident, proposed mitigation actions and the anticipated duration of the incident before the resumption of trading.

In the event of a market outage, trading venues will generally try to restart trading as soon as it is practicable to do so. Survey respondents noted the importance of trading venues communicating promptly to market participants on the status of their orders, and how they propose to resume operations in an orderly and controlled manner. The timing of the resumption of trading (e.g., intraday or next day) depends on when the cause of the trading suspension is resolved and how confident the trading venue is to safely reopen the market. For market pre-opening phases, trading venues generally follow specific procedures to ensure a fair and orderly market re-opening, which, among other things, considers mitigating risks associated with members' access to, and management of, open orders.

Most jurisdictions with multiple trading venues support efforts to facilitate the continuity of trading in the event of one trading venue experiencing a market outage. This is sometimes achieved by developing industry protocols that foster the routing of orders to operational trading venues while minimising the issues arising from market fragmentation.[19]

3.11. Impact on market participants

Listing trading venues generally account for the largest market share in terms of number and volume of executed transactions and are often used by a larger and more diverse set of market participants. Generally, listing trading venues lead the price discovery process, which means that the absence of a price formed on the listing venue negatively affects liquidity in other markets as there is greater uncertainty about the fair price of affected instruments. This may have adverse consequences for market participants, such as wider bid-offer spreads or smaller trade execution volumes.

[19] See for example ASIC's expectations for industry in responding to a market outage (Chapter entitled Expectations of large institutional investors).

Survey responses suggest that the impact of an outage on market participants depends on the specific circumstances of each case and the root cause of the event. Notwithstanding this, a market outage may have a range of potential consequences for market participants. These include:

- Uncertainty around whether orders had been filled, partially or fully, on the trading venue affected by the outage, sometimes preventing market participants' ability to use an alternative trading venue;
- Lack of liquidity, concerns about price formation and reliability of market data, and the consequent difficulty to fulfil best execution obligations;
- Difficulties in commencing the trading in an instrument in the absence of an opening auction to establish an initial price;
- Lack of a closing auction, which deprives market participants of a reference price which plays an important role in pricing benchmark trades and valuing funds;
- Adverse consequences for equity derivatives trading and benchmarking activities due to the inability to obtain reliable pricing for the underlying securities;
- Higher volatility upon the resumption of trading;
- The impact on clearing due to processing delays and potential margin calls caused by higher volatility; and
- Reputational issues for the impacted trading venue and the financial market more broadly.

3.12. Migration of order flow

To maintain market resilience and integrity, facilitating the continuity of trading is a key issue for jurisdictions with alternative trading venues. Strategies, such as the creation of links between trading venues or market participant connectivity to multiple trading venues, may help ensure trading can continue in the event of an outage, thus allowing for continuous trading and accurate pricing of securities throughout the trading day. On the other hand, switching from one trading venue to another may require enhanced technical capabilities, which could result in increased costs for market participants. This may create a disincentive to connect to multiple trading venues for some market participants.

Most jurisdictions do not impose specific obligations on market participants to connect to alternative trading venues in the event of a market outage on a listing trading venue, even where those trading venues form part of the market structure. However, where alternative trading venues are available, some market participants – at least the larger ones – are often already connected to those trading venues. This may occur in several ways, including:

- Alternative connectivity arrangements, such as direct membership of two or more trading venues;
- Direct market access or straight through processing via another market participant; or

- Using the intermediation of another market participant with trading access/membership of the alternative trading venue.

IOSCO members identified four scenarios regarding migration of order flow during a market outage:

- There were no alternative trading venues to which orders could migrate;
- Alternative trading venues were available, but there was only limited or no order flow migration;
- Material order flow migrated to alternative trading venues; or
- It was not possible to quantify how much trading migrated to alternative trading venues (for some jurisdictions operating within a cross-border environment, for example the EU), since trading that migrated to alternative trading venues was under the oversight of another regulatory authority.

Some of the jurisdictions surveyed have alternative trading venues. These are trading venues where securities listed on another trading venue can be traded, including if or when trading is disrupted on the listing trading venue.

In a few jurisdictions, regulators expect market participants to have arrangements in place to continue submitting orders to alternative trading venues during a market outage on the listing trading venue. There is also an alternative approach whereby market participants are not required to connect to alternative trading venues, but they are subject to a more general obligation to have in place policies and procedures setting out the steps to take in case of a market outage, including how to achieve the best execution of client orders. Continuity of trading during a market outage is also generally part of a market participant's operational resilience arrangements. In jurisdictions where a consolidated tape in equities is available, there appeared to be more significant migration to alternative trading venues. According to some survey respondents, this could be read as an indication that a consolidated tape might assist with the resiliency of markets by providing a trusted source of pricing which enables continuity of trading when there is an outage on a listing trading venue. In addition, material migration of order flow is generally supported when alternative trading venues are interconnected.

However, in the majority of jurisdictions that provided feedback, even where alternative trading venues were available, they contributed only to a limited extent in mitigating the effects of market outages. There may be a number of reasons for this, including:

- In the absence of a price formation on the listing trading venue, liquidity in the entire market – including on alternative trading venues – may be affected;
- Differences in, or limitations on, the capabilities of market participants to connect, or divert order flows, to alternative trading venues. This may in part be due to the capacity constraints and increased costs that smaller market participants may experience in connecting with such trading venues;

- Market participants lacking adequate information from the listing trading venue about the status of their orders;
- Uncertainty about the fair price of the affected instruments, and market participants being cautious about relying on "stale" prices;
- Differences in or limitations on order types on alternative trading venues;
- Coordination problems affecting the ability of alternative trading venues to gather liquidity. For example, trading on an alternative trading venue is not a viable alternative if only a fraction of market participants does the same; and
- Market participants not submitting client orders to alternative trading venues due to uncertainty around the application and interpretation of best execution policies and arrangements during market outages.

3.13. Third-party providers

Trading venues often rely on third-party service providers' data and software to carry out critical functions on their behalf, such as members' connectivity to trading venues, the operation of the matching engine and the determination of closing and settlement prices. If a system disruption affects any critical function operated by a third-party provider, this may result in a market outage.

The majority of survey respondents noted that they evaluate the risks related to operational processes and the provision of third-party services, as well as those related to the protection of data. One respondent conducted, together with an external independent technology consultant, a comprehensive review of the listing trading venue's IT infrastructure and systems to ensure it has strengthened its in-house technology capabilities and risk management framework. As a result, the trading venue improved its testing capabilities and alert monitoring.

Other respondents noted that following market outages in their jurisdictions, trading venues put in place mitigating actions to improve the monitoring of technical issues.

3.14. Cross-border / cross-trading venue implications

Survey responses indicate that market outages did not appear to have cross-border causes and that they had limited cross-border impact.

In one instance, the outage had some cross-border impact due to the underlying securities being traded in a different jurisdiction through the use of depositary receipts. Given the use of arbitrage strategies, in such instances an outage in one jurisdiction might affect price formation in both markets. In this instance, the relevant foreign exchange was notified about the trading interruption in the relevant instruments.

There may be cross-trading venue implications where trading venues share the same internal trading infrastructure. There were also instances, however, where an outage on a

trading venue impacted another trading venue using a different trading infrastructure. This may occur if a link exists between the two trading venues. For example, when the equity market experiences an outage, the related derivatives market could also be affected.

Survey responses suggest that listing trading venues publicly communicated market outages – via their website, status updates and market notices – to all market participants, regardless of their geographical location. There was also evidence that regulatory authorities from different jurisdictions were engaged when there was a link between the listing trading venue experiencing the outage and trading venues operating in another jurisdiction. This may occur, for example, where entities in the same exchange group operate in different jurisdictions.

Chapter 4 - Good Practices

Building on previous IOSCO work on operational resilience and business continuity[20], and the key findings identified from recent market outages, IOSCO has established five good practices for trading venues to consider adopting that may improve market-wide resilience during outages.

IOSCO has developed these good practices following an extensive survey covering outages on equities listing trading venues. Consequently, they are primarily applicable, and most relevant to, these markets. Nonetheless, the good practices are sufficiently flexible and some of them may also be considered for other asset classes. For example, IOSCO believes that the good practices on outage and communication plans could be considered more broadly, given that clear and meaningful communication remains essential across different types of trading systems and asset classes. However, IOSCO recognises that other recommendations, which are strictly related to the functioning, trading practices and organisation of equity markets, will have limited or no applicability to other types of trading venue. This might be the case, for example, for the good practices related to closing auctions.

IOSCO also recognises that, when developing good practices for consideration by trading venues located in different jurisdictions and with diverse market structures, a one-size-fits-all approach will generally not be appropriate. For this reason, the good practices are intended to be principles-based and high-level, to allow for sufficient flexibility for trading venues to consider. Subject to domestic legal and regulatory requirements, it is within individual trading venues' discretion whether, and if so, how to implement these good practices.

IOSCO also acknowledges that some jurisdictions have already developed regulatory frameworks aimed at enhancing the operational resilience of financial markets, which may already impose requirements on trading venues. The good practices set forth in this Final Report may share similarities and/or overlap with the regulatory requirements.

Finally, IOSCO recognises that market outages could occur as a result of different causes, some of which may not have been evidenced by the survey responses. Annex C to the Consultation Report (now reproduced in Annex B to this Final Report) identified three such additional causes, namely cyber-attacks, natural events and technical disruptions caused by reliance on a small number of third-party providers delivering key functions and services. Given these causes did not lead to market outages in the surveyed jurisdictions

[20] In FR31/2015, IOSCO identified a number of sound practices related to BCPs. As part of this, IOSCO asked trading venues to consider including in their BCP "clear and comprehensive communication protocols and procedures for both external and internal communications" and "testing the operation of the BCP on a periodic basis".

between 2018 and 2022, the Final Report does not capture any key findings relating to them.

IOSCO's view is that the good practices are generally suitable for general application and, hence they may also be relevant to outages resulting from root causes, other than those identified in the survey responses. However, IOSCO also acknowledges that there may be circumstances that might require a modified or alternative approach, as might be the case for outages caused by cyber-attacks. Additionally, some jurisdictions have specific regulatory requirements or guidelines relating to, for example cyber incidents, that would apply to such outages. In any event, IOSCO would support the use of judgement in applying the good practices.

4.1. Outage plans

Where trading venues have effective playbooks and outage plans in place, this provides market participants with certainty about the steps that trading venues will take in the event of an outage. This, in turn, could improve confidence and resilience in the market. IOSCO has identified the following good practices that trading venues could consider adopting:

- **Establishing an outage plan**, including the key steps and actions trading venues will take during an outage to ensure resumption of trading. The content of the plan may include, for example, communication protocols and procedures, the strategy for reopening, the arrangements for operating a closing auction and the methodology used for establishing alternative closing prices (where closing auctions do not take place), and the treatment of submitted orders.
- **Publishing the outage plan** on the trading venue's website to ensure it is available to all market participants and the public at large, noting that some information may not be appropriate for disclosure to the public or may only be relevant (and therefore made available) to a subset of market participants. Where it is not possible to publish an outage plan, a trading venue could consider other ways to make the outage plan available to market participants.
- **Outlining the governance arrangements** for the outage plan. This could include, for example, assigning roles and responsibilities, escalation procedures and training requirements.
- **Regular review and testing of the outage plan** to help ensure that it remains effective. This may include regular scenario planning and stress testing of potential outages and the trading venue's response, as well as regular testing of the communication protocols used in the event of an outage.

4.2. Communication plans

The survey results highlighted the importance of clear, informative, and frequent market communications by trading venues in the event of an outage. This is considered key to

help maintain, to the extent possible, orderly trading conditions and to allow market participants to take appropriate steps to manage related risks for their activity, for example by re-directing their order routing systems to alternative trading venues. In particular, trading venues may consider:

- **Formally setting out their communication plan** to be implemented in the event of an outage, including how and to whom information will be communicated, and the content of that communication.
- **Publishing an initial notice about the outage** as soon as practicable and using a communication channel – such as the trading venue's website – that is most likely to reach the intended audience, including market participants and the public at large. This initial notice may include, for example, information about the nature of the outage (e.g., details around the market participants, trading processes and financial instruments affected), a link to the trading venue's playbook and/or outage plan, the system status, the estimated time and method of re-opening, the orderbook status, and the expected key milestones and deadlines (e.g., the cut-off time for announcing whether a closing auction will be held). Given the initial notice may need to be provided as soon as practicable, it is unlikely that all relevant information will be available for dissemination in the initial notice. Where elements are not immediately known, these may follow in the update notices as soon as they become available.
- **Providing regular updates** to all market participants, using the same communication channel, at pre-defined time intervals or when new relevant information becomes available. The updates may include, for example, information about the status of submitted orders, the estimated time and method of re-opening and the cut-off times by which information will be communicated, and the methodology used for establishing alternative closing prices.
- **Maintaining specific communication channels** throughout the duration of the outage, where deemed appropriate. For example, this could include communication channels with affected market participants and interconnected market infrastructures – including other market operators within the same group – to mitigate the impact of the incident.

4.3. Reopening of trading

Ultimately, the objective of the outage plan is to set out the trading venue's strategy for reopening, once the issue causing the outage has been identified and resolved. Trading venues may also need to consider their wider operational resilience arrangements, such as their business continuity and disaster recovery plans, to determine their approach to the resumption of trading.

Reopening of trading may start as soon as it is safe to do so, provided trading venues can operate their markets in a fair and orderly manner. There are a number of factors that trading venues may need to consider before trading resumes. The main elements that may be considered as part of reopening include: (i) reopening strategy, (ii) assessment, (iii) communication; and, where relevant, (iv) pre-opening phase.

- **Reopening strategy:** Trading venues' reopening strategies may be set out in their outage plan. These may include, for example, their approach to any pre-opening phase and how orders will be managed prior to reopening. Trading venues may also consider the amount of time market participants may need to ensure that they are ready for reopening, taking into consideration relevant factors, such as the nature and severity of the outage, the type of trading system used, and the asset classes traded.
- **Assessment:** Trading venues may wish to establish certain criteria or thresholds which must be met before reopening can occur. For example, the criteria may include the number of participants connected, or the percentage of historical trading reflected in connected participants.

  Trading venues may also wish to consider whether there remains sufficient time during the trading day to allow for a certain, minimum period of time for full market trading to recommence. If, upon a positive assessment to reopen, there is insufficient time left to resume trading, trading venues may consider extending the trading hours or postponing the closing auction.
  Prior to resumption of trading, market participants would also likely need clarity on the status of their orders.
- **Communication:** Clear communication about reopening is important to market participants and the public at large. Market participants would likely need to receive an appropriate period of notice prior to the resumption of trading. Trading venues may consider how to communicate information about reopening in a timely manner, and to all market participants simultaneously. This may include, for example, the time of reopening and, where relevant, information about the pre-opening phases, closing auction and the extension of trading hours.
- **Pre-opening phase:** Prior to the reopening of trading, trading venues may consider whether market participants are able to access the market and the status of their orders. One way of doing this, depending on the trading system used, is to include a pre-opening phase before the resumption of trading. Where trading venues decide to include a pre-opening phase, information about this phase could be published via an appropriate communications channel that is accessible to all market participants.

4.4. Closing auctions / closing prices

The closing price established in the closing auction is crucial to the proper functioning of financial markets. It is an important benchmark that is used by market participants for a number of purposes, including fund accounting, index valuation, determining end of day net asset values, benchmark trading, and managing trading risk. For some, the closing price is of crucial importance because it is employed as a reference for contractual obligations, including determining the fair value for equity derivatives instruments, indices, and exchange traded funds.

In the event of a market outage occurring on a trading venue that establishes the closing price for a security, it is important to determine whether the trading venue's ability to

provide a closing price would be impacted and, if so, how the market would be provided with alternative closing prices. This would help maintain investor confidence and market transparency. Trading venues that establish closing prices may consider adopting the following good practices:

- **Outage plan:** Trading venues' pre-determined arrangements for the operation of the closing auction (including, for example, the postponement of the closing auction and the latest time it may be run), as well as the methodology used for the provision of alternative closing prices may be considered as part of the outage plan. It may be useful to have this information available to market participants and the public at large before an outage happens.
- **Communication:** Trading venues may consider arrangements in relation to the closing auction and the methodology used for establishing alternative closing prices, and how to clearly communicate such arrangements to all market participants during the outage. Consideration of how market participants could receive an appropriate period of notice before the commencement of the closing auction may also be useful.
- **Closing auction:** Closing auctions and the establishment of closing prices may need to be prioritised. Where a closing auction cannot be run at the scheduled time, trading venues may need to consider postponing the closing auction before cancelling it. Certainty about the latest time that trading venues may run a closing auction or establish a closing price is crucial for market participants. Therefore, setting out the cut-off time in the outage plan, and communicating this to all market participants and the public at large during the outage may be an important consideration.
- **Alternative closing prices:** If the operation of a closing auction is not possible, trading venues may need to consider how to ensure the market is provided with alternative closing prices. This may include a designated alternative trading venue determining the closing prices, where contingency procedures provide for this. Trading venues may also consider setting out a methodology for the establishment of alternative closing prices in the outage plan.

4.5. Post-outage plans

After an outage, conducting a lessons learnt exercise – or post-mortem analysis – can help trading venues identify the root cause of the outage, evaluate the effectiveness of their response to the incident, and identify any potential areas for improvement.

Applying lessons learnt from outages is important to drive continuous improvements and to build trust and confidence with market participants and regulators. In this context, the lessons learnt exercise may need to cover several distinct areas including the root cause analysis, with remediation of those root causes, an evaluation of the effectiveness of the handling of the outage, and identification of any areas for improvement. The lessons learnt exercise and any subsequent remediation plan could reduce the likelihood of future outages and improve the ability of trading venues to effectively respond to and recover from future outages.

The lessons learnt exercise may include a detailed analysis of what went well and what could be done differently in the event of future outages. This could cover, for example, the evaluation of the effectiveness of the outage plan, communication protocols, reopening strategy, and the operation of the closing auction. It could also consider the effectiveness and the speed of decision making and the market impact, as well as feedback from market participants. Following this exercise, trading venues may consider sharing the post-mortem analysis with the relevant regulators, and putting in place a remediation plan with clearly defined timelines and allocation of responsibilities.

Market participants may also be invited to provide feedback to the trading venue in order to improve the trading venue's response to outages going forward.

Chapter 5 – Conclusion

Market outages, particularly if they occur on a listing trading venue, can be highly disruptive, impacting price discovery and market resilience, and undermining the integrity of financial markets more generally. Previous IOSCO reports addressed disruptions, but mainly from the perspective of managing risks to critical systems and business continuity planning.

This Final Report identifies key findings from recent market outages and puts forward five good practices for trading venues to consider adopting to help to improve market-wide resilience during an outage. These good practices may assist regulators, trading venues and market participants in preparing for, and managing, future market outages and thereby help improve market-wide resilience.

Annexes

A. List of IOSCO members that completed the survey

Regulatory authority		Jurisdiction
The Dutch Authority for Financial Markets	AFM	Netherlands
Autorité des marchés financiers	AMF	France
Australian Securities and Investments Commission	ASIC	Australia
Bundesanstalt für Finanzdienstleistungsaufsicht	BaFiN	Germany
Capital Market Authority	CMA	Kuwait
Capital Market Authority	CMA	Saudi Arabia
Capital Markets Board	CMB	Türkiye
Comisión Nacional Bancaria y de Valores	CNBV	Mexico
Comisión Nacional del Mercado de Valores	CNMV	Spain
Commissione Nazionale per le Società e la Borsa	CONSOB	Italy
Comissão de Valores Mobiliários	CVM	Brazil
Dubai Financial Services Authority	DFSA	Dubai
Financial Conduct Authority	FCA	United Kingdom
Swiss Financial Market Supervisory Authority	FINMA	Switzerland
Financial Supervisory Authority	FSA	Romania
Finansinspektionen	FSA	Sweden
Financial Services Regulatory Authority	FSRA	Abu Dhabi
Financial Service Agency	FSA	Japan
Monetary Authority of Singapore	MAS	Singapore
Ontario Securities Commission	OSC	Canada

Securities Commission Malaysia	SC	Malaysia
Securities and Exchange Board of India	SEBI	India
Securities and Exchange Commission	SEC	United States of America
Securities and Futures Commission	SFC	Hong Kong

B. Market outage causes not reported in the survey

The survey identified several technical and operational causes, which led to market outages on equities listing trading venues in the surveyed jurisdictions between 2018 and 2022. The survey responses were used to identify key findings from recent market outages and to propose good practices that trading venues could consider adopting to improve market-wide resilience in the event of future outages.

Nevertheless, IOSCO recognises that there may be other causes that were not identified by the responses because these had not led to an outage in the surveyed jurisdictions over the relevant period. Three such causes – some of which have been identified in previous IOSCO reports[21] – include cyber-attacks, natural events, and technical disruptions caused by reliance on a small number of third-party providers delivering key functions and services. Whilst the Final Report does not capture any key findings relating to market outages resulting from these causes, IOSCO nevertheless recognises that the good practices identified may also be relevant to these.

(a) Cyber-attacks

The speed and scale of the propagation of cyber incidents, as well as the potential intent of threat actors, differentiate cyber risk from other sources of operational risk that potentially cause market outages.

Cyber risk has become an increasingly significant concern for the global financial system as technology continues to advance and reshape the way financial markets operate. Due to digital developments and the current geopolitical situation, cyber threats are evolving at an unprecedented pace, posing new challenges for market operators and their participants.

The surveyed jurisdictions did not report market outages related to cyber events. However, trading venues should endeavor to be aware of potential cyber-attacks given their critical role in maintaining market liquidity and price discovery. In fact, the integration of advanced technology in the trading, clearing and settlement processes of secondary markets – as well as the deep interconnectedness of market participants and cross-listed securities – can make them targets for cybercriminals. Disruptions from cyber incidents can have severe consequences on the orderly functioning of a market, potentially leading to market outages, liquidity shortages, and increased volatility.

[21] FR21/2015 provides an overview of the steps trading venues can take to manage electronic trading risks to mitigate possible disruptions. See also FR03/2021 and FR06/2022.

Most recently, incidents such as distributed denial-of-service attacks and ransom demands caused by malware-related data breaches have impacted both trading venues and financial services companies.

Some key impacts of a prolonged market outage caused by a cyber-attack may include:

- A loss of confidence in the financial system due to the inaccessibility of the trading venue or confidential market data breaches;
- Systemic risks leading to a "contagion" effect generated by the interconnectedness of financial markets and trading venues; and
- Market integrity breaches due to unauthorised access to order book data and other inside information leakages.

Market outages caused by cyber-attacks may pose unique challenges for trading venues, which are different from those resulting from other market outage causes. While there has been significant progress in increasing global awareness and action to address cyber risks, cyber incidents continue to occur with greater frequency and sophistication. To address these issues, the IOSCO Board established the Cyber Task Force in October 2017. The Cyber Task Force published a report in 2019[22] to raise awareness about existing international guidance on cyber resilience[23], and to encourage the adoption of good practices among the IOSCO regulatory community.

(b) Natural events

Natural events may lead directly or indirectly to market outages[24]. These events can directly generate a market outage if, for instance, they impact the premises (either the primary or secondary sites) of a trading venue. Natural events may also affect the physical functioning of trading venues, for instance by affecting communication networks. Therefore, they can be linked to the operational resilience of the market. For example, one respondent to the survey indicated that a fire, although of a limited nature, caused a market outage on a listing trading venue.

Natural events can also be an indirect cause of a market outage if they have a significant impact on the broader economy, leading to an increase in volatility or extraordinary price

[22] FR09/2019: Cyber Task Force Final Report (June 2019)

[23] In 2016, IOSCO and the Committee on Payments and Market Infrastructures published guidance for financial market infrastructures to enhance their cyber resilience. Please see CPMI/IOSCO Guidance on cyber resilience for financial market infrastructures (June 2016) and CPMI/IOSCO Implementation monitoring of PFMI: Level 3 assessment on financial market infrastructures' cyber resilience (November 2022).

[24] Natural events may include such things as hurricanes, typhoons, floods, wildfires, droughts, earthquakes, volcanic eruptions, pandemics, and similar events but do not include instance of civil disruption, politically motivated actions or warfare.

movements, or low transactions volumes that do not allow efficient price formation. In such instances, trading venues (or the relevant regulator) may decide to suspend or halt trading.

In addition, a pandemic may have global impact for significant periods of time. While a pandemic may not cause physical damage to property and assets like a natural disaster, it can threaten the health of key personnel and demand a special level of consideration.[25]

Furthermore, indirect effects could arise on trading venues located in different jurisdictions to the trading venue directly affected by the natural event. This is particularly true if they rely heavily on liquidity and investor activity located in the trading venue experiencing the outage.

Natural events can potentially have both short-term and long-term effects on market outages. The short-term effects depend on the severity, duration, and frequency of the event, as well as the resilience and recovery capacity of the affected market. The long-term effects may instead depend on the adaptation and mitigation strategies adopted by the market, as well as the policy responses implemented by the authorities. Understanding the causes and consequences of these events can help regulators and trading venues to deal with them more effectively.

(c) Material third parties

In an increasingly digital world, some trading venues are becoming more dependent on a small number of third-party providers that deliver their key functions or services. For example, technology services, such as cloud computing, are often delivered by third parties. Well managed outsourcing and other arrangements with third parties can bring benefits to trading venues, for example through efficiency gains, reduced costs, and improved operational resilience. However, the increasing reliance on a small number of third-party providers may also pose resilience and concentration risk if these third parties were to fail or experience disruption.

This may cause risks to individual trading venues and to the wider financial system. These risks stem from a combination of: (i) dependency on third parties for services whose failure or disruption could have a material impact on the continued operation of trading venues; (ii) concentration in the provision of these services; and (iii) the potential impact of the failure or disruption of these services on the resilience of trading venues, as well as the stability and market integrity of the financial system more generally. Therefore, factors such as the ability to recover or substitute a third party's services following disruption may influence the potential impact that their failure or disruption could have.

[25] For further guidance on the operational resilience of trading venues and market participants during the COVID-19 pandemic, refer to IOSCO final report FR06/22: Operational resilience of trading venues and market intermediaries during the COVID-19 pandemic & lessons for future disruptions (July 2022).

Disruption to any material services that third parties provide to trading venues could therefore lead to a single-point-of-failure that may simultaneously impact multiple trading venues and their members, market-wide resilience and, in extreme cases, financial stability. Trading venues are ultimately accountable for their operational resilience, regardless of whether they rely on third parties to support the delivery of their important business services.

C. Feedback Statement

Q1. Do you agree with the key findings and/or do you think there are additional aspects of recent market outages that have not been captured?

Detailed summary of the feedback

Respondents generally agreed with IOSCO's key findings, stressing the significance of operational resilience within public markets and the need for robust outage and communication plans in minimising market impact.

The need for effective communication during market outages was echoed by a respondent who cited examples of inadequate notifications during certain market outage incidents on trading venues, highlighting the adverse impact on market participants arising from delayed or insufficient communication.

The utility of the consolidated tape in improving market-wide resilience

There were differing views as to whether a consolidated tape may support market resilience in the event of an outage. A few respondents noted that where trading venues follow prices formed on the listing trading venue, they might not be able to continue trading without this primary source. Some other respondents said that in fragmented market structures latency and connectivity issues may diminish the benefits of a consolidated tape. However, other respondents argued that without a consolidated tape, trading venues may disseminate stale or erroneous market data, which is disruptive to the ability to trade on alternative trading venues. One respondent noted that absent a consolidated tape, trading venues should set out ex-ante a robust waterfall price cascade for the establishment of a closing reference price.

Equities listing trading venues leading price discovery

A respondent expressed disagreement with the language used in the Consultation Report, which stated that listing trading venues are *perceived* to lead the price discovery process. Instead, the respondent asserted that these trading venues *do* lead the price formation process. As evidence for this, the respondent noted that this view is supported by academic literature, as well as the decrease in trading activity during outages on listing trading venues.

Migration of trading to alternative trading venues

Most respondents observed that market participants are not prepared to trade on alternative trading venues as they typically do not, as a matter of course, maintain connections to multiple markets. According to these respondents, significant effort and expense would be required, on the part of trading venues and market participants, to establish the requisite interconnections and associated capacity and infrastructure. Moreover, these respondents noted that

interactions with alternative trading venues could create risks and potentially sub-optimal trading outcomes for market participants.

One respondent implicitly confirmed the above statement by observing that if a listing trading venue experiences a market outage, it is unlikely that other trading venues, who generally peg or follow the prices formed on the primary venue, would be able to continue trading without this primary source.

This view was echoed by another respondent, noting that market resilience depends on the strength and resilience of the systems and procedures of the listing trading venues and that the number of trading venues in a particular jurisdiction does not necessarily determine the market's resilience.

The counter argument to this – as put forward by some respondents – is that encouraging migration of trading from listing trading venues to alternative trading venues during an outage could significantly reduce the disruption caused. In some jurisdictions, alternative trading venues may be available during an outage, but various constraints may lead them to be under-utilised. The respondent therefore argued that trading venues and market participants should have a role to play in addressing these constraints by supporting the continuous trading of fungible products and ongoing price formation.

IOSCO's response

We acknowledge the differing views regarding the utility of the consolidated tape in mitigating the effects of market outages and the feasibility of its implementation in certain jurisdictions.

IOSCO agrees that listing trading venues play a central role in price discovery and, hence, we have amended the Final Report to more prominently reflect this point.

We recognise that market structure differs amongst jurisdictions. Not all jurisdictions have alternative trading venues and, even where they do, migration of trading may not be significant, or even feasible for various reasons. However, IOSCO considers that it is important to understand the extent and impact of trading migration during a market outage. Therefore, we dedicated Chapter 3(I) of the report to assess and enable us to improve our understanding on this topic. IOSCO acknowledges that different jurisdictions have different approaches on this topic and that there are numerous factors, which may impact the viability and desirability of trading migration during an outage.

Q2. Do you agree with the good practices that IOSCO recommends for trading venues? If not, please explain why and provide further information.

Detailed summary of the feedback

In general, there was broad support for the five good practices outlined in the Consultation Report. In several cases, this support was unqualified and many supported IOSCO's work in seeking to harmonise listing trading venues' responses to market outages across different jurisdictions.

However, several respondents suggested that certain aspects of the good practices could be reconsidered so that they provide sufficient flexibility to reflect the circumstances of individual trading venues and jurisdictions more accurately.

Some respondents highlighted that several jurisdictions already have in place legal and regulatory requirements aimed at increasing operational and cyber resilience in financial markets, or covering market outages specifically. Some respondents noted that there may be areas of overlap between the IOSCO good practices and domestic frameworks governing market outages. These respondents encouraged us to ensure that existing frameworks are not disrupted or conflicted as a result of the creation of these new good practices. An example cited included the US Regulation Systems Compliance and Integrity rules, which sets out the regulatory obligations regarding, for example, the dissemination of information to market participants relating to market outages. Another respondent pointed to DORA in the EU, which will harmonise planning and related testing of business continuity plans.

<u>Outage plans</u>

Whilst none of the respondents objected to trading venues establishing outage plans, one of them believed that IOSCO's proposed good practices were overly prescriptive, pointing specifically to the statement that outage plans could outline the strategy for reopening and the treatment of submitted orders. Along the same lines, another respondent warned that outage plans should not be drafted too granularly.

Several respondents stressed the importance of trading venues considering the safety and security of the financial system before publishing their outage plans. Some of them stated that there is a risk that information gleaned from outage plans could help nefarious actors to undertake cyber-attacks against trading venues and lead to further outages. However, other respondents saw a public good in publishing such information.

Among those respondents who cautioned against making outage plans publicly available, one strongly advised against encompassing detailed and specific governance arrangements including assigning roles and responsibilities, escalation procedures and training requirements. In the opinion of this respondent, sensitive internal information like the identities of individuals could be used for malicious behaviour and should only be shared with regulators.

Finally, some respondents expressed the view that the regular review and testing of outage plans should not be mandated outside of existing procedures to test critical systems. It was noted that regulatory requirements would generally include system testing for new system releases and would cover all aspects of the system testing from pre-trade controls to cyber-attacks or recovery system effectiveness.

Communication plans

While none of the respondents expressly objected to trading venues formally setting out their communication plans, some thought the suggestion that such plans should include the manner, the recipients, and the contents of each communication was overly prescriptive. This was because the actions a trading venue may take in the event of an outage, as well as the information that will be communicated to market participants, will vary depending on specific circumstances. Another respondent observed that it is the responsibility of members of a trading venue to communicate outages to their clients.

Regarding the publication of the initial notice of disruption and the provision of regular updates on the status of the outage, respondents generally agreed that clear, meaningful and frequent communication was important. However, feedback varied from those who felt that, in the event of an outage, the priority for a trading venue should be to inform its market participants quickly and to keep them informed on a regular basis, to those that urged caution. Within this latter group, one respondent thought the initial notice should be published 'as soon as practicable' rather than 'as soon as possible', as there may be security and/or privacy concerns with public notification of the incident. Several other respondents were of the view that updates on the status of outages should only be provided when there is new and relevant information to be shared rather than at regular, pre-defined intervals. In these respondents' view, during a market outage, a trading venue's priority is to resolve the disruption.

Finally, on maintaining specific channels to communicate with members in the event of an outage, respondents suggested various options that trading venues could consider. One respondent proposed that trading venues support an open incident line during an outage. Another respondent noted that in certain jurisdictions industry supported forums exist to enable market participants to share intelligence to assist with incident response management, including the formation of standard reconnection protocols. One respondent was of the view that the main market status page, rather than the emergency news board, should be used to alert market participants to disruptions. Finally, one respondent suggested that in addition to the direct communication protocols implemented by a trading venue, there is a need for the development of a central venue-status communications platform.

Reopening of trading

There were differing views as to whether a trading venue's reopening strategy should be set out in their outage plans. While some respondents felt that the proposed good practice was overly prescriptive – as market operators may determine that a different strategy is more

appropriate for a particular situation or instrument – others thought that a trading venue's playbook should set out scenarios explaining the circumstances under which trading venues would resume their trading operations as well as clear procedures for re-opening, including a statement on how orders will be managed prior to market resumption.

Regarding the assessment criteria used by trading venues to determine whether reopening could occur, one respondent said it did not support imposing hard-coded thresholds in the outage playbook and expressed the view that trading venues should have discretion when determining to re-open a market. In this respondent's view, imposing prescriptive criteria may also impair a trading venue's ability to respond to the market outage and could have the unintended effect of preventing or delaying re-opening.

Other respondents did not object to the suggestion that trading venues should establish criteria or thresholds for reopening, however they were opposed to making these public, as they considered these to be sensitive information that could be exploited by malicious parties.

One respondent expressed concerns towards the suggestion that trading venues might consider an extension of trading hours or a postponement of the closing auction when the outcome of their assessment was that there wasn't enough time left to resume trading. In this respondent's view, it is essential that the market closes within a reasonable time or on time via a pre-established closing price procedure, as this is necessary to avoid issues with benchmarking and post-trade processing activities. This is now particularly significant in light of the global shift towards shortening the settlement cycle to T+1.

Several respondents highlighted the importance of clear and timely communication on the status of orders. One respondent noted that IOSCO made minimal comments to this regard and emphasised that information on the status of orders is crucial for market participants to assess their risk position before resuming trading and, where relevant, to enable them to continue to trading on alternative trading venues. A few respondents went as far as to recommend specific timeframes within which such communication should take place.

With specific regard to the pre-opening phase, most respondents agreed the timing of a market reopening after an outage should be effectively evaluated and risk assessed in advance. Several respondents noted the dangers involved in reopening a market prematurely or if participants were not ready. Regarding the treatment of outstanding orders during the pre-opening phase, there were differing views as to whether trading venues should mandate an order purge as a first step.

One respondent believed that for trading to migrate to existing alternatives, it is particularly important for trading venues to make available to members functionalities that enable the cancelling of orders during an outage. A couple of respondents observed that, rather than forcing an order book purge, trading venues should make public, within a specified timeframe, the specific time stamps of the point at which orders were cleared/or rejected.

Closing auctions / closing prices

There were no objections to the suggested good practice that trading venues should have pre-determined arrangements for the operation of closing auctions. However, one respondent did not believe the methodology for establishing closing prices should be included in outage plans.

There was some disagreement amongst respondents as to whether trading venues should be able to extend trading hours or to postpone the closing auction to some unspecified time later in the day, because of an outage. As noted above, the feedback on the good practices relating to the reopening assessment saw some respondents viewing it essential that the market close within a reasonable time or on time via a pre-established price procedure.

With this regard, one respondent believed, absent a consolidated tape, trading venues should set out ex-ante arrangements for a robust waterfall price cascade for the establishment of a closing reference price. This would provide for a viable closing price and should, in most cases, negate the need to postpone the close or mandate an alternative closing price mechanism. On the other hand, one respondent noted the closing auction should be delayed or deferred to the next day if normal participation in the auction cannot occur.

With specific regard to the designation of alternative closing arrangements, one respondent noted that in the European Union, to arrange for a backup trading venue to conduct a closing auction on a listing trading venue would require undue effort and expense for market participants.

Another respondent was of the opposite view and suggested that designating an alternative venue to provide a back-up closing auction mechanism should be strongly considered. In this respondent's opinion, each jurisdiction should align on an alternative mechanism, favouring in particular those mechanisms that provide price formation and leveraging to the greatest extent possible existing market infrastructure to reduce complexity and increase operational resilience.

Post-outage plans

Similar to outage plans, several respondents recommended against publicly releasing post-outage/post-mortem reports, given the potentially sensitive nature of such reports and the possibility that bad actors may use such information for their own advantage. One of these respondents thought it more sensible to engage with industry via open follow-up calls to discuss and share insights on the events that transpired. That said, other respondents expressed opposing views.

Noting that, in Europe, ESMA only requires that trading venues provide a summary of findings publicly, one respondent suggested that trading venues should provide all stakeholders and market participants with a comprehensive post-mortem analysis and follow-up points after any major incident, including the root cause and the steps taken to rectify and prevent recurrence.

Echoing this feedback, another respondent strongly recommended that following an outage, trading venues should make post-mortems public to enable market participants to properly understand the trading venue's analysis regarding the root causes and remedial actions taken. In this respondent's view, this will also ensure that the firm can provide appropriate feedback to the trading venue in order to improve outcomes going forward.

IOSCO's response

The good practices set out in this Final Report are designed to be principle-based and high-level in nature, rather than granular and prescriptive in order to allow for sufficient flexibility in considering their application across different jurisdictions and trading venues. Subject to domestic legal and regulatory requirements, it is within an individual trading venue's discretion whether, and if so, how to implement these good practices. As a result, the Final Report has been amended to provide further clarity on this.

Some jurisdictions have already developed legal and regulatory frameworks aimed at enhancing the operational resilience of financial markets, which may already impose requirements on trading venues. IOSCO recognises that the good practices identified in this Final Report may share similarities or seem to overlap with existing regulatory requirements in certain jurisdictions. Therefore, the Final Report has been amended to outline the status of good practices and to confirm that, subject to domestic legal and regulatory requirements, the adoption of these good practices is within the discretion of individual trading venues.

While we believe it is important that trading venues have robust governance arrangements in place with clearly assigned role and responsibilities, we recognise that trading venues may not wish to make available to the public certain sensitive information, such as the personal information of specified individuals, which could be used by malicious actors for nefarious purposes. For this reason, we have amended the Final Report to clarify that, while we propose that trading venues consider having robust governance arrangements in place, these would not necessarily need to form part of the published outage plan, subject to domestic legal and regulatory requirements.

Q3. Are there any other good practices that could be considered?

Detailed summary of the feedback

Overall, respondents thought that the good practices were sufficiently comprehensive to address major issues that might arise from market outages. However, several respondents suggested other good practices that could be considered. For example, these included:

- Enhancing the robustness of outage procedures through closed-door sharing sessions amongst trading venues of experiences and insights on the best practices and post-outage responses. The respondent noted that global industry associations have a role to play in facilitating these information sharing sessions for trading venues.

- Collaboration between trading venues and regulatory authorities and fostering a culture of continuous improvement through transparent knowledge sharing amount trading venue operators and stakeholders.

- Market participants and other trading venues being encouraged to take steps to help support a resilient equity market. The respondent noted that market participants should be prepared for outages and consider them in their enterprise risk management and operational resilience strategies. This includes participating in industry-wide testing, when appropriate, as well as demonstrating sufficient access to existing alternative trading venues and relevant market data and ancillary systems.

- Industry-wide testing being encouraged, and periodic rehearsals being conducted across trading venues and market participants.

- Trading venues providing market participants with as much certainty as practicable about the status of their orders and executions. The respondent noted that timely order status communications and functionality that enables the cancellation of orders are important mechanisms to help support the migration of trading to existing alternative markets if the primary market cannot promptly resume trading.

- Trading venues should consider the readiness of market participants before arranging for a market to re-open.

- Bolstering market resilience by focusing on preventing outages through resilient design, such as implementing highly available systems, avoiding single points of failure and ensuring location separation of facilities.

In addition, one respondent put forward proposals on how good practices for equities listing trading venues can facility clarity, certainty and efficiency in related over-the-counter (OTC) derivatives markets. For example:

- Trading venue operators providing time-stamped communications of the commencement and completion of an outage. The respondent noted this would help derivatives market

participants in their assessment of the impact of any market outage on equity derivatives.

- Trading venues providing information on impacted securities within an index. The respondent highlighted this would allow market participants to make a determination on materiality.

- Where a derivatives exchange offers listed contracts referencing securities impacted by outage at the primary listing venue, encouraging communication from the derivatives exchange to follow the same good practices as those recommended for the primary equities listing trading venues.

- Reopening preceded by timely communications to ensure there are sufficient market participants for appropriate price discovery. If the trading venue operator cannot ensure full participation in the normally scheduled closing auction, it could consider deferring the time of the closing auction.

- Communications using clear and simple language, addressing the practical impact of the outage, as well as communications being retained for audit trail purposes.

A potential gap in the good practices was highlighted by one respondent where infrastructure service providers and critical third parties operate in an unregulated environment. Given these vendors will not be covered by the good practices, risks may emerge if they do not have adequate operational resiliency arrangements, e.g. impacting industry's ability to migrate order flow and to ensure continuity of trading during a market outage.

IOSCO's response

IOSCO recognises the importance of trading venues having robust and resilient systems in place that minimise the likelihood of a disruption occurring. However, IOSCO is also of the view that it will not always be possible to prevent an outage from happening and that there will be situations where trading is disrupted. In these circumstances, the proposed good practices identified in this report will be relevant. IOSCO's focus is on helping to ensure that trading venue operators take all reasonable steps to prevent, manage and remediate outages as well as mitigating their effects.

IOSCO notes that operational resilience remains a key priority across member jurisdictions and that helping to ensure operational resilience is a critical factor in preventing and managing outages.

The IOSCO good practices identified in the report are expected to provide an effective and adequate framework for addressing issues arising from market outages. IOSCO recognises that these could be adaptable for use by trading venues.

The good practices identified in the IOSCO report are based on the evidence gathered through member surveys, which focused on the impact of outages on equities listing trading venues. IOSCO notes the additional good practices put forward by respondents and recognises that they may have some application in certain circumstances. We also welcome

proposals for increased collaboration between trading venues and industry-wide testing. IOSCO will continue to monitor developments regarding market resilience and may use the feedback received to inform our future work in this area. In the meantime, IOSCO encourages trading venues to consider all possible mechanisms for reducing the impact and mitigating the risk of market outages occurring.

Q4. Do you agree that these good practices could also be useful for addressing other causes of market outages, such as those set out in Annex C to the Consultation Report (now reproduced in Annex B to this Final Report)? If not, please explain why and/or provide further information on what additional good practices may be relevant to these.

Detailed summary of the feedback

Whilst some respondents believed that identifying the root cause more precisely may be helpful for formulating the appropriate solution, others believed that the cause of the outage should not matter for the purposes of the overall outage and communication plan. For example, one respondent noted that the cause may not be known for some time so the outage and communication plan should operate effectively regardless of the root cause, and therefore should not be a determining factor when defining and developing these plans. Another respondent noted that it is essential to manage any outage incident in a secure manner, regardless of its root cause.

Broadly, most respondents agreed that the proposed good practices would be useful for addressing other causes of market outages and that there was no need to introduce additional good practices for different root causes. The exception to this was market outages caused by cyber-attacks. There was a recognition amongst respondents that cyber incidents require a specific response and that the proposed good practices might not be relevant in these circumstances. In particular, the timing of communication and reopening may differ depending on the threat actors at play, and the expected recovery time may be longer. Respondents also highlighted that the resolution of cyber-attacks is complex and time-consuming and that requiring trading venue operators to provide regular updates while the resolution is ongoing may adversely impact the ability of trading venue operators to investigate and resolve the incident and allow threat actors to further identify or modify their attack.

One respondent noted that market outages caused by the examples provided in Annex C (those being cyber-attacks, natural events and material third parties) are the results of extrinsic factors, not within the control of trading venues. Extrinsic factors may be harder to identify and control and may increase the level of complexity of the situation, thus making it harder to prescribe good practices that may be applicable. Nonetheless the respondent agreed that the good practices would continue to remain generally relevant in those circumstances.

One respondent suggested outages related to terrorism or geopolitical conflicts – such as sabotage against communication and energy infrastructure – could be considered for inclusion in Annex C. Another respondent set out a scenario of a market outage being caused by the regulatory authority having, and exercising, the power to suspend trading on the exchange.

IOSCO's response

The survey used to establish key findings on recent market outages covered the period between 2018 and 2022. During the survey period there were no incidents of market outage

caused by natural events, cyber incidents or reliance on material third parties reported by the survey respondents. However, we note that incidents occurred shortly after and since the end of the survey period. IOSCO members are aware of the importance of ensuring that good practices remain up to date and accommodate the full variety of potential root causes of market outages. This was why we sought feedback from market participants on the root causes set out in Annex C.

In IOSCO's view the good practices are generally applicable to different types of root causes. However, we recognise that there may be circumstances that might require a modified approach. The good practices are therefore not intended to be prescriptive and instead allow sufficient flexibility for them to be tailored to specific scenarios. Additionally, we note that many jurisdictions already have domestic and legal requirements relating to, for example cyber incidents. In any event, we would support the use of judgement and discretion in considering whether to apply the good practices.

The good practices outlined in the report may be useful for trading venues to consider in mitigating risks associated with market outages. However, given the range of potential scenarios under which an outage may occur, they cannot be fully exhaustive. Responses to an outage will therefore need to be considered in light of the regulatory requirements of a jurisdiction and the specific circumstances of the outage itself.

Given this, in IOSCO's view there is no current need to introduce additional protocols for the root causes set out in Annex C.

General Comments on the market outages Consultation Report

Detailed summary of the feedback

One respondent noted that in the absence of a harmonised legal definition, each trading venue should develop its own clear criteria for what constitutes an outage. The respondent argued that, by establishing clear parameters, exchanges can better assess the impact of outages, implement appropriate risk management measures, and take steps to minimise disruptions to market participants and the broader economy.

One respondent noted the number of trading venues in a jurisdiction does not determine a market's resilience, although others noted that outages are inevitable. It is the effectiveness of the trading venue's systems that matters. If the regulatory regime does not require high resilience standards, there is a risk that standards will drop across competing trading venues leading to regulatory arbitrage.

Respondents proposed that a "fit-for-purpose" rather than a "one-size-fits-all" approach, based on the size, scale and complexity of the trading venue is the optimum model. As such, respondents felt that good practices should provide sufficient flexibility and avoid disrupting well established existing legal and regulatory regimes.

There were different viewpoints as to whether the good practices identified would be applicable to trading venues other than equities listing trading venues. Some respondents noted that their Business Continuity Management Policy are generally applicable to both equities and derivatives trading venues, with some variations to cater to the participant mix, contract specifications and market opening timings. The respondent noted this is because operational resiliency, technical safeguards and investor protection should apply identically across all execution venues. Another respondent expressed the view that there is a link between equities listing venues and the safety and efficiency of OTC derivatives markets. In this respondent's view, good practices relating to equities listing venues can facilitate clarity, certainty and efficiency in related OTC derivatives markets.

Other respondents felt that given the fundamental differences in the nature and practices between equities and derivatives trading venues, IOSCO should differentiate between these markets and develop separate good practices for derivatives trading venues. For example, the migration of order flows to alternative trading venues is not applicable, as in most cases there is no fungibility of exchange traded derivatives. In addition, derivative trading venues do not operate closing auctions. Another respondent noted that equities listing venues may have different trading protocols, settlement processes and other matching algorithms compared to derivatives trading venues. Therefore, the good practices might not be entirely applicable.

IOSCO's response

IOSCO recognises that there is no single, harmonised definition of what constitutes an outage. Every incident will have its own unique features and any definitions developed by regulatory requirements or individual venues will need to be sufficiently broad and flexible to accommodate the different scenarios which may occur. However, IOSCO recognises that, if applied sensibly, this could be a useful mechanism for individual venues to categorise and manage incidents in line with their outage plans, and that this is consistent with the need for trigger points to activate outage plans.

IOSCO agrees that the good practices provide for sufficient flexibility in consideration of their application across different scenarios and between different jurisdictions and trading venues. The good practices were therefore developed with this feature in mind, and we welcome respondents support for this approach. As such, the good practices allow trading venues the flexibility necessary to resolve incidents and tailor communications in the most effective manner under the circumstances in which the outage occurs.

IOSCO developed the good practices following an extensive survey of outages in equity markets. Consequently, the findings and good practices are primarily applicable to such markets. Nonetheless, the good practices are sufficiently flexible, and some of them may also be useful to other types of asset classes. For example, IOSCO believes that the good practices on outage and communication plans could be considered more broadly. However, IOSCO recognises other good practices will have limited or no applicability to other types of trading venues, such as those related to closing auctions.

We also note the submission relating to the linkages between the equity and derivatives markets. Given the scope of the evidentiary base developed, we have not validated any additional good practices proposed. However, while not endorsed by IOSCO, we have reproduced a summary version of these proposals within the Feedback Statement in Annex C of this report, to enable trading venues to refer to them and consider their applicability. OTC derivatives markets may find these good practices to be a useful resource.