Committee on Payments and Market Infrastructures

Final report

Extending and aligning payment system operating hours for cross-border payments

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Executive summary

In October 2020, the G20 endorsed a roadmap to enhance cross-border payments, developed by the Financial Stability Board (FSB) in coordination with the Bank for International Settlements' Committee on Payments and Market Infrastructures (CPMI) and other relevant international organisations and standard-setting bodies. The G20 cross-border payments programme aims to address long-standing challenges in the cross-border payments market, including high costs, low speed, limited access and insufficient transparency. This programme comprises the necessary elements of a globally coordinated response in the form of a set of 19 building blocks (BBs), based on a CPMI report to the G20 (CPMI (2020a,b)).

This report, produced by the CPMI Cross-border Payments Expansion Workstream and developed as part of BB 12 on extending and aligning operating hours of key payment systems to allow overlapping, **focuses on the operating hours of real-time gross settlement (RTGS) systems as key payment systems to enhance cross-border payments.**

An extension of RTGS operating hours across jurisdictions could speed up cross-border payments, improve liquidity management, reduce settlement risk and enhance the performance of ancillary payment systems that may be used for cross-border payments.[1] RTGS systems typically facilitate settlement in central bank money and, as a result, provide the foundation on which other payment systems and arrangements involved in cross-border payments rely. However, limited RTGS operating hours across jurisdictions can lead to a delay in cross-border settlement, especially between countries with significant time zone differences. Enhancing the speed of cross-border payments is an important ambition of the G20 cross-border payments programme, and targets have been developed by the FSB in this regard.[2]

Extending the operating hours of RTGS systems cannot, by itself, address slow speed or other challenges affecting cross-border payments, particularly given the diverse characteristics and needs of end users. **The realisation of the enhancements to cross-border payments relies on progress across the BBs in the G20 cross-border payments programme. The extension and greater alignment of the operating hours of RTGS systems will contribute to addressing the slow speed and other challenges affecting cross-border payments, as well as enabling the impact of other building blocks.** In addition, while a focus on RTGS systems is appropriate given their key role in supporting cross-border payments, some systems, in particular fast payment systems (FPS), have operating hours and speeds that could potentially alleviate certain frictions in cross-border payments. In some jurisdictions, the use of FPS for cross-border payments, particularly through interlinking such systems across jurisdictions,[3] may be a fruitful avenue to explore in parallel to consideration of extending RTGS operating hours.

This report presents three potential scenarios for extending RTGS system operating hours ("end states") and associated operational, risk and policy considerations. The three scenarios outlined here range from an incremental increase in operating hours on current operating days (eg standard working days), to an increase to include current non-operating days (eg weekends and holidays) and finally an extension to full 24-hour and seven-day-a-week (24/7) operations.

In November 2021, the CPMI released a consultative report inviting comments on these end states and the benefits and challenges related to them, as well as potential solutions to address potential issues (CPMI (2021)). This final report, which completes action 2 of BB 12, incorporates the inputs from a wide range of industry participants in the public consultation (see Annex 2 for a summary of the comments received in the consultation). The report also incorporates input from several central banks that have

1 Increasing operating hours of key payment systems to allow for overlapping may yield other benefits such as increased opportunities for payment-versus-payment (PvP) settlement of foreign exchange (FX) transactions including same-day PvP, the establishment of liquidity bridges and the ability to perform additional settlement cycles for ancillary payment systems involved in cross-border payments. These benefits can support reduced transaction costs for cross-border payments and tie in with other BBs in the G20 cross-border payments programme (FSB (2020b)).

2 By the end of 2027, 75% of cross-border payments are to be credited/provide availability of funds for the recipient within one hour of payment initiation and the remainder should be credited within one business day of payment initiation (FSB (2021a)).

3 BB 13 of the G20 cross-border payments programme is focused on interlinking of payment systems for cross-border payments.

extended RTGS system operating hours. **The CPMI used this feedback to validate the analysis in the report and provide additional perspectives on the benefits, risks, challenges and policy considerations of extending RTGS operating hours, including potential ways to address risks and challenges.** The CPMI appreciates the input received on the approach, analysis and questions included in the November 2021 consultative report.

The analysis presented in the report is based on a **survey of 82 jurisdictions conducted by the CPMI,** which identified 62 RTGS systems and provided information about their current operating hours, and has been informed by **input received from the consultation and discussions with several central banks that have expanded their RTGS operating hours to 24/7 or near 24/7**. The key findings are the following:

- **Operating hours vary significantly across RTGS systems in different jurisdictions, and there are sizeable gaps** in their daily operating hours that at least partially explain delays in the processing of cross-border payments. When the operating hours of RTGS systems in different jurisdictions do not overlap, the processing of cross-border payments suffers delays, increasing liquidity costs and settlement risk.
- **On a daily basis, gaps in operating hours exist across nearly all jurisdictions, affecting both CPMI and non-CPMI jurisdictions, whether they are advanced economies (AEs) or emerging market and developing economies (EMDEs)**, although gaps tend to be larger for non-CPMI jurisdictions and EMDEs. Gaps are particularly pronounced across regions, exceeding 20 hours per day for some jurisdiction pairs and sometimes approaching (or even reaching) the entire day. Daily gaps are less sizeable, but still noticeable, for jurisdictions within the same region due to smaller time zone differences.
- **Gaps in operating hours are even greater when considering weekly availability**, as only a limited number of RTGS systems are available on weekends.[4] At present, average operating hours on a weekly basis are nearly 25% less than if current average weekday operating hours were to apply throughout the entire week. If the effect of public holidays were to be added, these gaps would be even bigger because few RTGS systems are open on public holidays.

To improve the status quo and help facilitate further overlap, central banks could consider the three potential end states as they assess their current operating hours and plan for the future. These end state scenarios are not intended to be prescriptive, but provide high-level approaches outlining the outcomes an individual central bank could consider.

The report also proposes **the "global settlement window" – a new concept reflecting the time period during which the largest number of RTGS systems are simultaneously operating – as a key consideration for central banks assessing potential end states for RTGS operating hours. At present, the global settlement window is best characterised as the time period from 06:00 to 11:00 Greenwich Mean Time (GMT) on working days.** This is broadly the five-hour period when, on average, the highest number of CPMI and non-CPMI RTGS systems are concurrently operating across all jurisdictions covered in this report.

The global settlement window is not intended to be a target in and of itself, but rather a key consideration in each jurisdiction's decision-making process. **When evaluating an extension of RTGS operating hours, in addition to domestic considerations, individual jurisdictions may consider the resulting aggregate outcome in terms of the overall global overlap as reflected in the global settlement window**. While each end state represents a potential extension of an individual jurisdiction's RTGS operating hours, **a key objective for an extension of RTGS operating hours to support enhanced cross-border payments could be to consider an end state that meaningfully improves the status quo by adding to the current global settlement window in terms of the number of hours and days for that window and the number of jurisdictions with operating hours in that window.**

[4] In addition, the weekend days vary between jurisdictions. In some Middle Eastern and African countries, weekends are observed on Thursday and Friday, or Friday and Saturday, while in most other parts of the world they are observed on Saturday and Sunday.

Depending on each jurisdiction's present circumstances, needs and challenges, each end state will likely require differing levels of effort and paths of implementation. Individual jurisdictions have discretion over which precise operating hours they choose to extend, the overall extent of changes and the pace of changes, while being mindful of the impact of their actions both in support of the global settlement window and on domestic considerations. End states could be achieved incrementally over time or through a "big bang" approach in which an end state is reached in a single step. Timelines should be flexible to account for different circumstances across jurisdictions. The appropriate time frame to reach an end state will depend on individual factors such as near-term demand, industry readiness, infrastructure choices, and cost and risk management considerations, among others.

Transitioning into a new reality of extended RTGS operating hours implies a number of considerations and changes, which include operational adjustments by both payment system operators and participants, as well as the adaptation of certain market practices and conventions. As regards the former, an extension of RTGS operating hours is likely to require technical changes to existing systems, platforms and infrastructures that will need to be carefully planned and deployed. Staffing needs could also increase in order to cover extended operating hours, and many of the associated costs may persist over time. Other issues with operational implications may also arise. In particular, market conventions and practices may need to be reviewed in order to accommodate the new operating hours.

The extension of operating hours will generally not introduce new risks but will extend the times during which certain risks can materialise. As such, parties involved in RTGS systems may need to review and/or enhance existing operational procedures, risk monitoring tools and mitigation measures to accommodate longer operating hours. In particular, operators and payment system participants need to ensure that the extended hours do not jeopardise current levels of operational resilience and risk management, including against cyber attacks and payment fraud. Furthermore, participants need to ensure that they have sufficient liquidity to support their activities at all times, which will partially depend on the availability of current sources of liquidity during the extended hours. Central bank liquidity facilities, potentially including intraday lending or liquidity bridges, may be necessary to support liquidity management by participants.

The extent of these adjustments will be contingent on the end state that is pursued and necessarily involve costs which must be evaluated and managed by the parties that would incur them. Central banks, payment system participants and other industry stakeholders would need to assess the nature and magnitude of such operational costs when assessing the different end states and the potential impact on end users. In doing so, **it is important for these operational changes and associated costs to be viewed in a strategic light by all affected parties since the resulting benefits could be far-reaching and long-standing, notwithstanding the immediate cost burden.**

Extending RTGS operating hours could have wide-ranging implications for both operators and industry stakeholders, as emphasised in responses to the consultation. In addition, **jurisdiction-specific conditions will affect the analysis on the benefits and costs of extending RTGS operating hours**. As such, assessments of the possible end states, as well as any decision on the path and timeline for reaching an end state will depend on the situation in each jurisdiction. **Consultation between the central bank, industry stakeholders and other relevant parties will be crucial** in determining a jurisdiction's path forward. At the same time, the decisions of each individual jurisdiction will have effects on cross-border payments that go beyond that jurisdiction, pointing to a need to consider interdependencies in actions related to operating hours across jurisdictions.

Finally, an extension of RTGS operating hours also raises certain policy considerations relevant for central banks and/or other authorities, such as issues related to monetary policy, financial stability and resolution policy for troubled institutions. The relevance and impact of these issues will depend on the degree of the change and, to some extent, on the actual usage of the extended operating hours as it materialises over time. In view of this, changes may be required on the side of central banks and/or other authorities.

1. Introduction

In 2019, the G20 finance ministers and central bank governors tasked the Financial Stability Board (FSB), together with the Bank for International Settlements' Committee on Payments and Market Infrastructures (CPMI) and other international standard-setting bodies, to develop a roadmap to address challenges with cross-border payments: high costs, low speed, limited access and limited transparency. Through a three-stage process, 19 building blocks (BBs) were identified to tackle these challenges and ultimately enhance cross-border payments. The CPMI has formed the Cross-border Payments Expansion Workstream to work on BB 12 on extending and aligning operating hours of key payment systems to allow overlapping of hours across them.

Limited operating hours of key payment infrastructures that facilitate cross-border payments constrain the times when transactions can be initiated, cleared and settled, ultimately causing them to be delayed, thereby increasing liquidity costs and settlement risk. This effect is often exacerbated in an international setting due to a lack of overlap in operating hours across jurisdictions, particularly those located in different time zones. Extending the operating hours of key payment systems in individual jurisdictions and thus aligning operating hours across jurisdictions can increase overlap. This could speed up cross-border payments, improve liquidity management, reduce settlement risk and enhance the performance of ancillary payment systems that may be used for cross-border payments.

Conversely, extending the operating hours of key payment systems cannot, by itself, address the slow speed or other challenges affecting cross-border payments, particularly given the diverse characteristics and needs of end users. In addition, no specific extension of operating hours can serve as a one-size-fits-all solution across jurisdictions in the light of the differences in jurisdiction-specific conditions. Extending operating hours involves costs and other adjustments for both the payment system operator and participants. Central banks and other stakeholders across jurisdictions may differ in their assessment of the costs and benefits of extending operating hours, as well as the path and timeline that they might envision for such an extension. The G20 cross-border payments programme reflects these considerations, first, by identifying multiple BBs that, together with changes in operating hours, can contribute to improvements in cross-border payments, and second, by not prescribing a particular path for operating hours (or other BBs) to yield such improvements.

Although extending operating hours is no panacea for the challenges affecting cross-border payments, it is nevertheless a central element of the global effort to improve such payments. Beyond the direct benefits related to the speed of certain cross-border payments, extending operating hours can play a pivotal role as an enabler of – or even a prerequisite to – other BBs. Similarly, other BBs can support the ability of operating hour extensions to improve cross-border payments. In particular, extending real-time gross settlement (RTGS) operating hours can support the payment-versus-payment (PvP) settlement of foreign exchange (FX) transactions (BB 9). The adoption of a harmonised version of ISO 20022 message formats (BB 14) would enable greater automation, which, when combined with greater overlap of RTGS hours, could increase the end-to-end speed of certain cross-border payments. The interdependencies between BB 12 and other BBs reflect the foundational importance of key payment systems for both domestic payments and cross-border payments (see Annex 1 for a discussion of the interdependencies between BB 12 and other BBs).

This report presents the findings of a survey of 82 jurisdictions that identified the gaps and overlaps in the operating hours of 62 RTGS systems around the world. It further presents potential end states for extending the operating hours of key payment systems, and associated operational, risk and policy considerations. The report benefits from the comments received from a wide range of industry participants on the November 2021 consultative report (see summary in Annex 2) and also incorporates input from several central banks that have extended RTGS system operating hours. The report is structured as follows. After this introduction, Section 2 presents the scope of the analysis and discusses the relevance of RTGS operating hours for cross-border payments, including the potential benefits of their extension. Section 3 summarises the results of a global stocktake conducted by the CPMI in the first quarter of 2021 to survey the operating hours of key payment systems and identify current gaps in overlap, with the concept of a global settlement window introduced as a key concept related to overlap in operating hours. Section 4 describes a set of potential end states that individual jurisdictions could consider for extending key payment systems' operating hours, and how such extensions could support a global settlement window. Section 5 discusses the operational, risk and policy considerations related to these end states, underscoring the extent of changes both operators and participants may need to undergo when implementing extensions of operating hours. The report concludes by providing some key takeaways and next steps for advancing the work of BB 12.

2. Scope of the analysis

2.1 Key payment systems for cross-border payments

This report focuses its analysis on RTGS systems that settle in central bank money[5] (hereafter, RTGS systems) as key payment systems for cross-border payments. As is the case for domestic payments, RTGS systems are a core foundational component of current arrangements for cross-border payments because final settlement in central bank money only occurs within the operating hours of a jurisdiction's RTGS system.[6]

Beyond RTGS systems, other payment systems and critical services are also relevant for cross-border payments, particularly for retail payments and remittances. However, although extensions could be made to the operating hours of some of these payment systems and critical services, without an extension of the operating hours of the underlying RTGS infrastructure, final settlement in central bank money during certain times may be unavailable. As such, changes to RTGS operating hours can serve to enable improvements in other parts of the cross-border payments ecosystem.[7]

While a focus on RTGS systems is appropriate given their key role in supporting cross-border payments, some systems, in particular fast payment systems (FPS),[8] exhibit operating hours and speeds that have the potential to alleviate certain frictions in the payer's jurisdiction, the payee's jurisdiction, or both, even without an extension of RTGS operating hours (see Section 2.2). At the same time, extensions of RTGS operating hours can support liquidity management and may be necessary to affect settlement in some FPS, which is why RTGS systems are at the core of this report's analysis.[9] Moreover, RTGS systems and FPS are typically intended to address different use cases (wholesale and retail payments, respectively). Thus, FPS and RTGS systems may help improve cross-border payments in different ways and may complement each other to improve cross-border payments.

5 RTGS systems are funds transfer systems that allow the real-time gross settlement of money and/or securities. RTGS is the continuous process of settling payments on an individual order basis, without netting debits with credits. Central bank money means a liability of a central bank that can be used for settlement purposes. Final settlement constitutes the irrevocable and unconditional transfer of funds.

6 There might be some exceptions to this, as in certain jurisdictions (eg Australia, the euro area and the United States) fast payment systems have been developed (or are being developed) that allow for central bank money settlement for fast payments, potentially settling those payments in real time, even when the main RTGS system is closed. In these cases, and depending on the configuration of the FPS in individual jurisdictions and the type of cross-border payment to be processed, the use of an FPS could be considered for processing cross-border retail payments, including final settlement in central bank money outside RTGS operating hours.

7 BB 12 can thus have an impact on each payment sector (wholesale, retail, remittances) identified in the FSB's targets for cross-border payments (FSB (2021a)).

8 As described in CPMI (2016), fast payments are characterised by both the speed of the payment for end users (ie real-time or near real-time receipt of final funds by the payee) and the availability of systems over time to conduct such payments (ie 24/7 or as close to 24/7 as possible). Previous work by the CPMI has documented the deployment of FPS in jurisdictions around the world (CPMI-World Bank (2020)).

9 In some jurisdictions, extensions to RTGS operating hours may support the implementation of FPS. In Australia, for example, the Reserve Bank of Australia developed the Fast Settlement Service to support 24/7 RTGS for the New Payments Platform.

2.2 FPS and cross-border payments

The deployment of FPS in a growing number of jurisdictions and the novel features that they display may make the use of such systems for cross-border payments a fruitful avenue for some jurisdictions to explore in parallel to consideration of extending RTGS operating hours. Potentially, FPS could be used to enhance the speed of a cross-border payment in the following ways:

- an FPS could allow an end user to fund a cross-border payment that is ultimately conducted through another service, such as a money transfer service. This way, the FPS would mainly facilitate the domestic leg of a cross-border payment rather than the international one;
- an FPS could be used for one or more interbank legs of a cross-border payment based on correspondent banking arrangements;[10] or
- two or more FPS could be interlinked across jurisdictions.[11]

For instance, the New Payments Platform (NPP) in Australia – a domestic FPS – is being positioned to process incoming cross-border payments using the second approach. It is already being used under the first approach by some service providers facilitating outgoing cross-border payments. Singapore has pursued the third approach by interlinking the PayNow FPS with PromptPay in Thailand and is also looking to interlink with FPS in various other jurisdictions, including Malaysia and India, to enable real-time payments between end users in those jurisdictions.

However, some FPS have not yet gained a critical mass of volume and participants in the jurisdictions in which they have been deployed. In addition, many have been designed with the aim of covering certain types of transaction in a domestic context, and not with the specific aim of being used for cross-border payments. As a result, the business rules and message formats might not be suited in all cases for easy integration into the existing cross-border network. For example, there might be caps on the maximum amount that can be transferred, or shortcomings in the information fields that might not allow the inclusion of detailed information on sender and beneficiary that might be required for cross-border payments. Furthermore, in many jurisdictions there may be substantial technical, regulatory and policy hurdles to interlinking FPS. Finally, as the usage of FPS for domestic and potentially cross-border payments grows, these systems may generate a need for additional liquidity – or prefunding for systems operating on a deferred settlement model – that might not be accessible if the RTGS system is not open.

As a result, there seems to be potential for FPS to improve cross-border payments, but depending on the FPS configuration, there might also be limitations to their broad use for all kinds of cross-border transactions. The potential use of FPS in the area of cross-border payments will continue to be investigated under BB 13, and BB 12 will continue to work with BB 13 on the interdependencies between extending operating hours and interlinking payment systems. Considerations could include how the extension of operating hours for RTGS systems as key payment systems in the existing cross-border payment network could facilitate interlinking between two or more FPS, or how RTGS systems and FPS could work in tandem to generate improvements in cross-border payments.

2.3 RTGS operating hours and cross-border payments

For the purposes of this report, an RTGS system's **operating hours are defined as the hours of the day and days of the year when its participants can perform final settlement of funds in the system**. Operating hours determine when participants in a payment system can settle transactions, but equally importantly, establish when a participant cannot do so. Indeed, faced with such a constraint, participants typically must either wait for the RTGS system to reopen or must proceed with the payment by deferring

[10] SWIFT has recently launched a new service – "SWIFT gpi instant". This service connects payments from members of the SWIFT gpi network with domestic FPS, thus improving the speed with which cross-border payments can be processed. See www.swift.com/news-events/press-releases/swift-enables-payments-to-be-executed-in-seconds.

[11] Issues associated with interlinking of payment systems and the implications for cross-border payments are being considered in the separate workstream on pursuing interlinking of payment systems for cross-border payments (BB 13) (CPMI (2020a,b)).

settlement (or some other activity) until a later time when the system has reopened, causing delays and taking on risks and costs in the process.[12]

While these implications of operating hours apply to domestic payments, in the case of cross-border payments, not only are the operating hours of a particular domestic payment system relevant, but so too are the relationship and potential overlap of that system's operating hours with the operating hours of payment systems in other jurisdictions. To the extent that certain events must occur in succession across the two legs of a cross-border payment, overlap and alignment in operating hours is a precondition to prevent delays that could arise, for instance, when the funds associated with a payment must be settled for an intermediary payment service provider (PSP) before moving to another PSP in the chain. Moreover, if risk considerations suggest that certain activities should occur concurrently, such as PvP settlement[13] for FX transactions, then an overlap in operating hours can support such concurrent activities.

The remainder of this subsection illustrates how the speed of a cross-border payment can be affected by the operating hours of the local payment systems through a stylised example leveraging correspondent banking and the use of RTGS systems (Box 1). The example highlights some benefits that can be drawn from extending the operating hours by delaying the closure of the main RTGS systems, both unilaterally and together, where the outcome is further overlap and alignment between the systems' hours. A similar effect can be achieved by opening an RTGS system earlier on a given operating day, rather than extending the operating day through a later closing time.[14]

As the example illustrates, extensions to RTGS operating hours could provide direct benefits to participants in the wholesale cross-border payments market, such as banks with direct connections to RTGS systems and corporates that frequently make time-critical, high-value payments. Even beyond improving the speed of wholesale cross-border payments, extensions to RTGS operating hours could allow corporates to settle payments for foreign goods and services over a longer time period, optimise liquidity management across global subsidiaries/operations and reduce FX exposure via improved capabilities in the FX market (eg greater opportunities for PvP transactions).[15]

On the other hand, end users in the retail payment and remittance segments may see fewer direct benefits from extensions to RTGS operating hours given that they are somewhat removed from connections to RTGS systems and have little need to make large-value payments. Nevertheless, such end users may benefit indirectly from extensions to RTGS operating hours to the extent that PSPs in the retail payments ecosystem benefit from such extensions. For example, extensions of RTGS operating hours could support improved liquidity management and additional settlement cycles for ancillary retail payment services such as automated clearing houses, FPS and card payment systems. Other PSPs, such as money transfer operators, may benefit from improved liquidity management and FX capabilities that may result from extensions to RTGS operating hours. Ultimately, PSPs for retail cross-border payments may pass on risk management and efficiency benefits from such extensions to end users in the form of expanded services and reduced fees.[16]

[12] For example, if the settlement infrastructure being used for a payment is not open, the payee's bank may credit the payee before settlement with the payer's bank has occurred. In such a situation, the payee's bank would be exposed to credit and liquidity risk with respect to the payer's bank.

[13] PvP is a settlement mechanism that ensures that the final transfer of a payment in one currency occurs if and only if the final transfer of a payment in another currency or currencies takes place.

[14] The treatment of payments for value date purposes and the implications for end-of-day processes could also vary depending on whether an extension of operating hours involves a system opening earlier or closing later on a given calendar day. These issues are additionally discussed in Section 5.

[15] Extensions of RTGS operating hours may eventually need to be accompanied by similar extensions of operating hours and services in other components of the payments ecosystem, such as banks, FX and money markets, in order to achieve the full benefits of RTGS hours extensions.

[16] At the same time, as discussed further in Section 5, banks and other PSPs may incur costs to utilise extended RTGS operating hours, which may also affect costs for end users.

Box 1

An illustrative case study of a cross-border payment from the euro area to Indonesia

While various arrangements can be used to conduct a cross-border payment, the correspondent banking model represents a material part of cross-border payments today. Given this model's reliance on RTGS systems, cross-border payments conducted through correspondent banking may particularly benefit from an extension in RTGS operating hours. In what follows, a simplified and hypothetical case study of a payment from the euro area to Indonesia is used to illustrate the implications of operating hours for the payment system participants and ultimately the end users. This case study is included for illustrative purposes only and does not consider the costs or overall benefits of an extension of the operating hours of the RTGS systems mentioned.

At present, in the euro area, TARGET2 is open from 06:00 to 17:00 GMT (11 hours per day) on weekdays, while Indonesia's Bank Indonesia – Real Time Gross Settlement (BI-RTGS) is open from 23:30 to 12:00 GMT the next day (12 hours 30 minutes per day) on weekdays. Currently, these two systems overlap between 06:00 and 12:00 GMT (six hours per day).

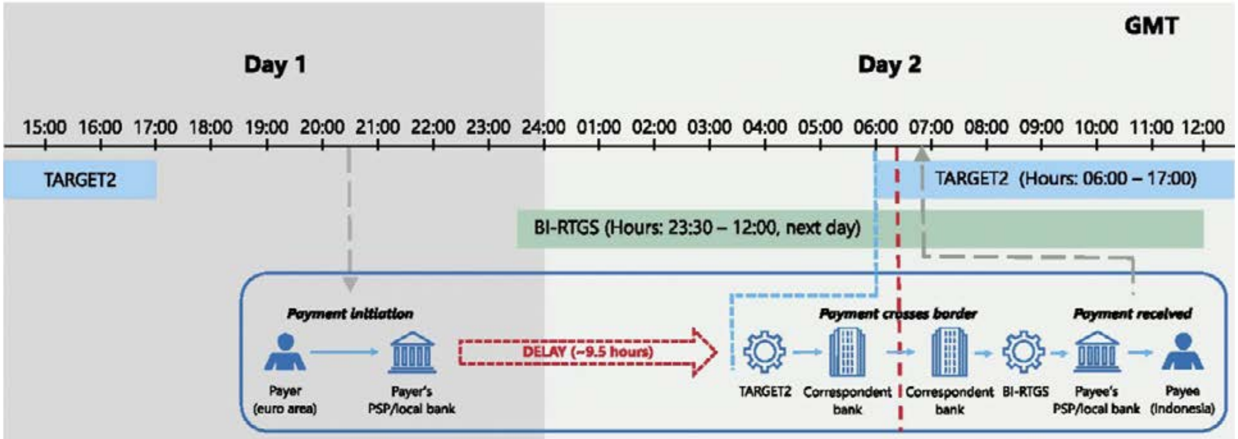
Outside the operating hours that overlap, a payment from a sender in the euro area to a receiver in Indonesia can experience a delay on the sender's side of the payment (from 17:00 to 06:00 GMT D+1), on the receiver's side (from 12:00 to 23:30 GMT), or on both sides (from 17:00 to 23:30 GMT, when both systems are closed).

A payment from the euro area to Indonesia under current operating hours for TARGET2 and BI-RTGS

For example, under the current operating hours (see Graph 1.1), if a payment were initiated in the euro area at 20:30 GMT when TARGET2 is closed, the payment could potentially be delayed until the reopening of TARGET2 at 06:00 GMT. Once TARGET2 reopens, the payment would be sent through the correspondent banking network and would settle in BI-RTGS operating hours. The resulting delay could thus be at least nine and a half hours, resulting from limited operating hours on the sender's side.

Current operating hours for TARGET2 and BI-RTGS

Graph 1.1

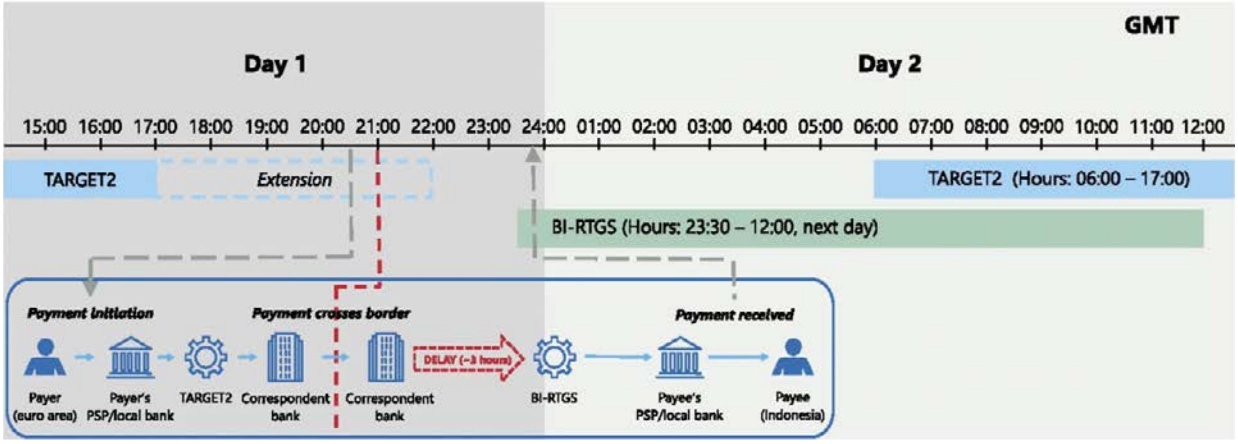


Source: CPMI.

A payment from the euro area to Indonesia under a hypothetical extension of the closing time for TARGET2 given current operating hours for BI-RTGS

If the closing time of TARGET2 were hypothetically extended from 17:00 to 22:00 GMT (Graph 1.2), a payment from the euro area to Indonesia initiated at 20:30 GMT could be settled through TARGET2 when initiated. At that point, the payment would be sent through the correspondent banking network across borders but could be delayed on the Indonesian leg of the payment, as the payment could not be settled until BI-RTGS reopens at 23:30 GMT, yielding a potential delay of at least three hours due to the limited hours on the receiver's side. Thus, an extension of hours in just one jurisdiction could increase speed by reducing delays on that side of the payment, although delays on the other side of the payment could still persist. In this example, an extension of TARGET2 operating hours through an earlier opening time could also reduce delays on the sender's side and would involve an increased overlap with BI-RTGS operating hours.

Hypothetical extension of the operating hours for TARGET2 — Graph 1.2

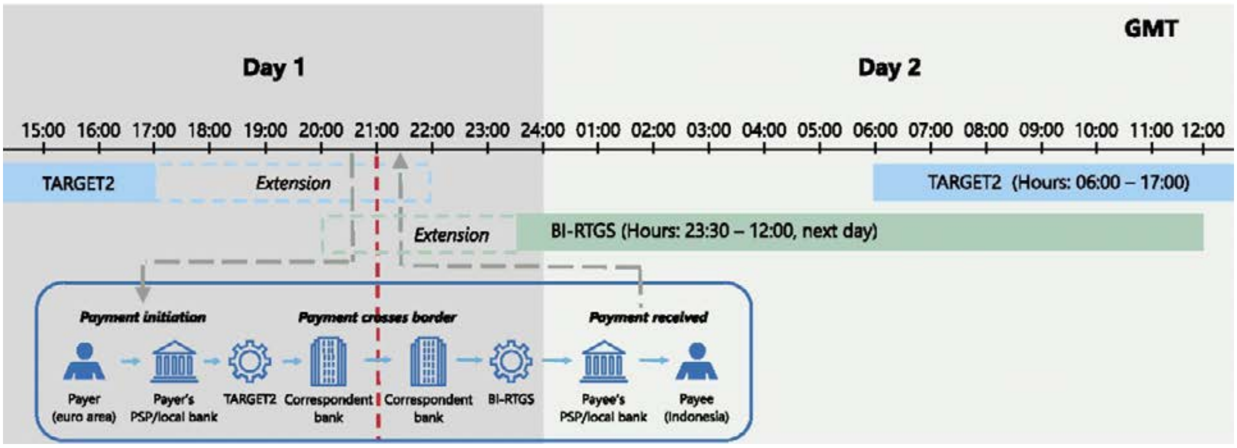


Source: CPMI.

A payment from the euro area to Indonesia under a hypothetical extension of the closing time for TARGET2 and a hypothetical extension of the opening time for BI-RTGS

Finally, if the closing time of TARGET2 were extended to 22:00 GMT, and the opening time of BI-RTGS were hypothetically extended to 20:00 GMT (Graph 1.3), the operating hours of TARGET2 and BI-RTGS would also overlap from 20:00 to 22:00 GMT. Given that overlap, a payment initiated in the euro area at 20:30 GMT could potentially be settled through TARGET2 and transferred through the correspondent banking network for settlement in BI-RTGS with minimal delays.①

Hypothetical extension of the operating hours for TARGET2 and BI-RTGS — Graph 1.3



Source: CPMI.

① In this example, an extension of BI-RTGS operating hours to allow an earlier opening time without an extension of TARGET2 closing time, would not affect the delays on the payer's side that result from limited TARGET2 operating hours.

2.4 Jurisdictions and RTGS systems covered in the analysis

The survey, which forms the basis of the empirical analysis in this report, was conducted in the first quarter of 2021 and covered 82 jurisdictions, including all 27 CPMI jurisdictions and 55 non-CPMI jurisdictions. Given the scope described in Section 2.1, RTGS systems were identified as those that meet the following criteria: (1) the system is a large-value payment system (LVPS), often referred to as wholesale payment system; (2) the system's settlement method is RTGS or RTGS-hybrid, where an RTGS-hybrid system combines an RTGS mechanism with a mechanism for offsetting or netting payments; and (3) the central bank operates and/or acts as manager/settlement agent for the system. The stocktake yielded responses from 62 RTGS systems, which are listed in Annex 4. Of these 62 systems, 21 are located in CPMI jurisdictions and 41 are located in non-CPMI jurisdictions across three regions, which broadly align with different time zones: Americas (AM); Europe, Middle East and Africa (EMEA); and Asia-Pacific (APAC). In addition, the jurisdictions can also be categorised in terms of AEs or EMDEs (see Annex 3).

3. Stocktake findings on RTGS operating hours

3.1 Current RTGS operating hours

On a daily basis, RTGS systems covered in the stocktake are currently open for almost 11 hours per day on average (Annex 3, Table A1), although there is substantial variation across jurisdictions in daily operating hours on working days (ie non-holiday workdays or "standard business days").[17] At present, 40 jurisdictions have below average operating hours on working days, with 21 featuring eight operating hours or fewer per day. Nearly all of these are non-CPMI jurisdictions and EMDEs. At the other end of the spectrum, of the 22 jurisdictions with above average operating hours, eight feature more than 16 hours per day. Of these, four jurisdictions (India, Mexico, South Africa and Switzerland)[18] have operating hours of 24 hours or nearly 24 hours per day on working days.

On a weekly basis, there are relatively few jurisdictions with weekend operating hours for their RTGS systems with only eight having any weekend hours[19] and only five operating seven days per week (Annex 3, Table A3).[20] Of these, three systems have weekend hours aligned with operating hours of 20 or more hours per day on working days, indicating that having weekend hours is closely related to having extensive daily hours overall.[21] The infrequency of weekend operating hours implies that, at present, average operating hours on a weekly basis are nearly 25% less than would result if current average weekday operating hours were to apply throughout the entire week (Annex 3, Table A2).[22]

3.2 Current gaps in RTGS operating hours

Gaps in operating hours between jurisdictions can be analysed on a daily or weekly basis. In each case, **the gap in operating hours between two jurisdictions can be defined as the time lapse when both**

17 Working days generally correspond to Monday to Friday, except for certain jurisdictions, such as those in the Middle East, where they correspond to Sunday to Thursday.

18 All of these are CPMI jurisdictions, of which three are EMDEs.

19 Weekends involve non-working days, according to the convention that applies for working days in a particular jurisdiction. In certain jurisdictions, such as those in the Middle East, the weekend comprises Friday and Saturday. In other jurisdictions, the weekend comprises Saturday and Sunday, except for eg Nepal, where it only comprises Saturday.

20 On an annual basis, total annual operating hours would depend on the extent of both weekend and holiday operating hours. As is the case for weekends, a large majority of RTGS systems in the survey do not operate on public/bank holidays. Indeed, only six systems, largely corresponding to those that also operate throughout the weekend, reported operating on holidays.

21 In particular, India, Mexico and South Africa all have weekend hours of (nearly) 24 hours per day, reflecting these systems' round-the-clock operations.

22 Current weekly hours average 57.9 hours, corresponding to 8.3 hours per day. If the current daily average of 10.9 hours on working days were to apply throughout the week, weekly hours would average 76.3 hours.

jurisdictions' RTGS systems are not operating simultaneously. Such gaps can arise either because both payment systems are closed at certain times or one payment system is open while the other is not.[23] Evaluation of gaps in operating hours can be considered bilaterally between jurisdictions (eg between specific country corridors where there may be a high value/volume of cross-border payments), regionally (eg where there may be close trade ties) or globally. While this report considers gaps in the overall operating hours of RTGS systems, some of them may have earlier cut-off times for international payments than for domestic payments. As a result of these requirements, gaps in the ability to settle cross-border payments may be greater than those presented in this report.

Pairwise total gaps in daily RTGS operating hours on working days (GMT) for CPMI jurisdictions① Graph 1

		APAC								EMEA								AM				
		AU	JP	KR	CN	HK	SG	ID	IN	RU	TR	SA	ZA	CH	EA	SE	GB	BR	AR	US	CA	MX
APAC	AU	10	13	16	11	14	14	13	10	11	19	19	10	10	19	19	19	22	22	12	15	10
	JP		12	16	14	14	14	12	12	12	18	18	12	12	18	18	18	22	23	13	17	12
	KR			16	16	16	17	16	16	16	21	22	16	16	22	22	22	24	24	17	20	16
	CN				3	15	16	14	4	7	18	20	3	4	16	16	15	15	14	5	9	3
	HK					14	15	14	14	14	19	20	14	14	20	20	20	23	24	15	18	14
	SG						14	14	14	14	19	19	14	14	19	19	19	23	24	14	18	14
	ID							12	12	12	18	18	12	12	18	18	18	22	23	13	17	12
	IN								1	4	15	17	1	1	13	13	12	13	13	3	6	1
EMEA	RU									4	15	17	4	5	13	13	12	16	16	6	10	4
	TR										15	17	15	15	16	16	16	19	21	15	15	15
	SA											17	17	17	17	17	17	20	22	17	17	17
	ZA												0	1	13	13	12	12	12	2	6	0
	CH													1	13	13	13	13	13	3	6	1
	EA														13	13	13	17	18	13	13	13
	SE															13	13	17	18	13	13	13
	GB																12	16	17	12	12	12
AM	BR																	12	14	12	12	12
	AR																		12	12	12	12
	US																			2	6	2
	CA																				6	6
	MX																					0

0 6 12 18 24 Pairwise gap between the two systems considered (in hours)

0 6 12 18 24 Daily non-operating hours for a given system (in hours)

AM = Americas; APAC = Asia-Pacific; AR = Argentina; AU = Australia; BR = Brazil; CA = Canada; CH = Switzerland; CN = China; EA = euro area; EMEA = Europe, Middle East and Africa; GB = United Kingdom; HK = Hong Kong SAR; ID = Indonesia; IN = India; JP = Japan; KR = Korea; MX = Mexico; RU = Russia; SA = Saudi Arabia; SE = Sweden; SG = Singapore; TR = Turkey; US = United States; ZA = South Africa.

Source: CPMI survey.

① The stocktake was conducted in the first quarter 2021.

On a daily basis, **the vast majority of jurisdiction pairs have relatively large daily gaps in operating hours, often exceeding half of the day** (Graph 1).[24] These sizeable gaps exist within regions, primarily due to the limited operating hours of individual payment systems in each region. Gaps are

[23] Gaps in operating hours will also depend on the application of daylight savings time in individual jurisdictions. Jurisdictions differ in whether, when and how they implement time changes over the course of a year. Such time changes can affect gaps in operating hours on daily, weekly and annual bases.

[24] Some graphs in this section are only depicted for CPMI jurisdictions (Annex 3 provides analysis for the full set of jurisdictions). The analysis here focuses on the total gap in operating hours between two jurisdictions (ie the total number of hours from both systems being closed simultaneously and from one system being open while the other is closed). Graph 2 is symmetric because the gap in operating hours for jurisdiction A with respect to jurisdiction B is the same as the gap in operating hours for jurisdiction B with respect to jurisdiction A. In addition, the diagonal elements in Graph 2 represent the number of hours during a working day when a particular jurisdiction's RTGS system is closed.

particularly pronounced across regions due to the frequent lack of alignment in current operating hours across jurisdictions in different regions, especially where time zone differences are large. Indeed, gaps for certain jurisdiction pairs in different regions sometimes exceed 20 hours per working day, with some approaching (or even reaching) the entire day.

Pairwise total gaps in weekly RTGS-system operating hours (GMT) for CPMI jurisdictions (rounded) ① Graph 2

		APAC								EMEA								AM				
		AU	JP	KR	CN	HK	SG	ID	IN	RU	SA	TR	ZA	EA	SE	CH	GB	AR	BR	CA	US	MX
APAC	AU	96	111	126	104	118	118	111	96	103	148	141	96	143	143	96	143	158	157	126	108	96
	JP		106	126	119	118	118	106	106	106	144	136	106	138	138	106	138	163	156	131	113	106
	KR			126	126	128	131	126	126	126	158	153	126	156	156	126	156	168	168	148	131	126
	CN				64	124	127	119	67	90	150	141	64	134	134	71	130	126	132	102	85	64
	HK					118	121	118	118	118	150	143	118	146	146	118	146	168	163	138	121	118
	SG						118	118	118	118	148	141	118	143	143	118	143	168	161	136	118	118
	ID							106	106	106	144	136	106	138	138	106	138	163	156	131	113	106
	IN								4	68	131	123	4	113	113	36	108	111	111	78	61	4
EMEA	RU									68	138	123	68	113	113	71	108	129	126	97	79	68
	SA										131	138	131	138	138	138	138	158	152	138	138	131
	TR											123	123	126	126	123	126	151	143	123	123	123
	ZA												0	113	113	33	108	108	108	76	58	0
	EA													113	113	113	113	138	131	113	113	113
	SE														113	113	113	138	131	113	113	113
	CH															33	111	111	111	78	61	33
	GB																108	133	126	108	108	108
AM	AR																	108	116	108	108	108
	BR																		108	108	108	108
	CA																			76	76	76
	US																				58	58
	MX																					0

0 40 84 120 168 Pairwise gap between the two systems considered (in hours)

0 40 84 120 168 Weekly non-operating hours for a given system (in hours)

AM = Americas; APAC = Asia-Pacific; AR = Argentina; AU = Australia; BR = Brazil; CA = Canada; CH = Switzerland; CN = China; EA = euro area; EMEA = Europe, Middle East and Africa; GB = United Kingdom; HK = Hong Kong SAR; ID = Indonesia; IN = India; JP = Japan; KR = Korea; MX = Mexico; RU = Russia; SA = Saudi Arabia; SE = Sweden; SG = Singapore; TR = Turkey; US = United States; ZA = South Africa.

Source: CPMI survey.

① The stocktake was conducted in the first quarter 2021.

On a weekly basis, the overall relative patterns in gaps are similar to those for working days (Graph 2). In particular, **the same jurisdictions that exhibit relatively large daily gaps also tend to exhibit relatively large weekly gaps.** However, even those jurisdictions with relatively extensive weekly operating hours can face weekly gaps of up to 48 hours because of the absence of weekend operations in other jurisdictions, which is disproportionate to their daily gaps on working days.[25] While the alignment in operating hours to regional business hours tends to mitigate daily gaps within regions during working days relative to daily gaps across regions, **the general lack of weekend operating hours generates incremental increases in weekly gaps**, whether or not two jurisdictions fall within the same region. As in the case of daily gaps, the average size of weekly gaps increases when non-CPMI jurisdictions are taken into account, given that their RTGS systems generally have less extensive operating hours (Annex 3, Table A6).

[25] For example, Mexico and South Africa both exhibit weekly gaps that are disproportionate to their daily gaps on working days because of the absence of weekend operations in other jurisdictions.

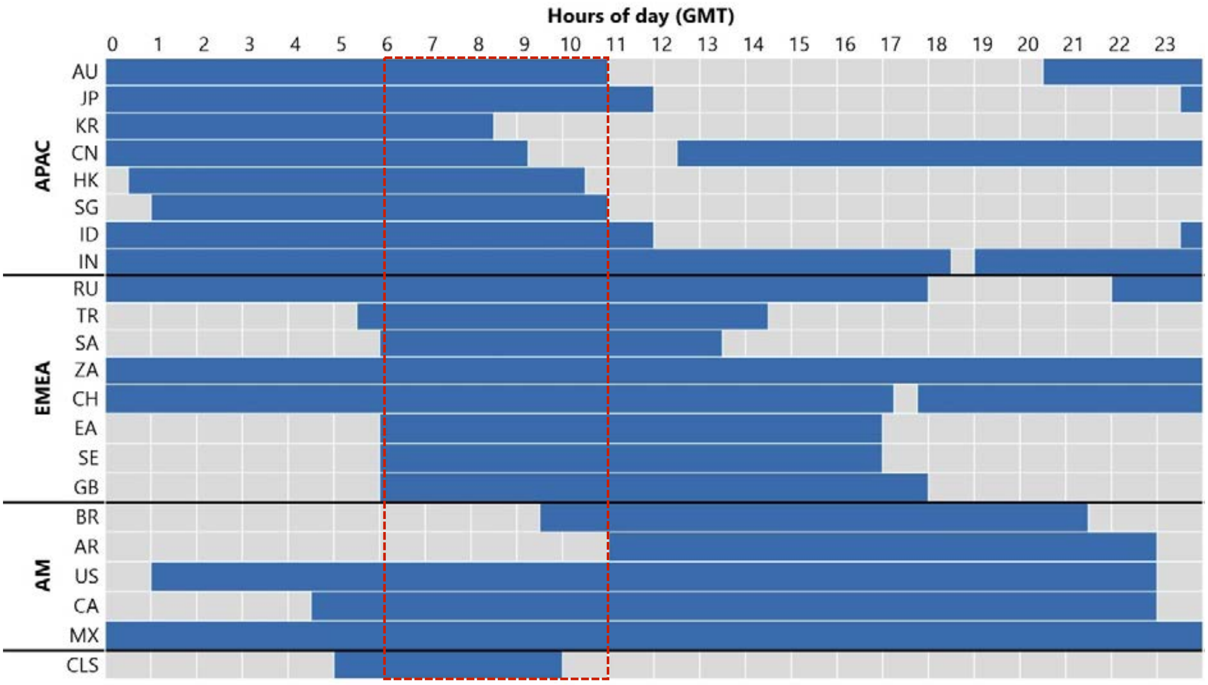
[26] The current overlap in hours including non-CPMI jurisdictions on working days is presented in Annex 3, Graph A2. Graph A3 shows the weekend operating hours in all surveyed jurisdictions.

3.3 Current overlaps in RTGS operating hours and defining the global settlement window

The importance of improving cross-border payments worldwide calls for an aggregate perspective for overlap in RTGS operating hours. The introduction of a new concept, namely the "global settlement window", is useful in this regard.

For the purposes of this report, **the global settlement window is the time frame during which the highest number of RTGS systems across jurisdictions are concurrently open**, allowing cross-border transactions to settle across those jurisdictions without delays being incurred, ceteris paribus. While the concept of a settlement window can be applied on a regional basis (ie a "regional settlement window" based on the operating hours of jurisdictions in the same region) or even a pairwise basis (ie a bilateral "corridor settlement window" based on operating hours for two specific jurisdictions), a focus on the settlement window on a global basis (ie the global settlement window) provides a useful concept for considering the aggregate implications of an extension to individual RTGS operating hours, as discussed further in Section 4.

RTGS system operating hours on working days (GMT) for CPMI jurisdictions per region① Graph 3



AM = Americas; APAC = Asia-Pacific; AR = Argentina; AU = Australia; BR = Brazil; CA = Canada; CH = Switzerland; CLS = CLS Bank; CN = China; EA = euro area; EMEA = Europe, Middle East and Africa; GB = United Kingdom; HK = Hong Kong SAR; ID = Indonesia; IN = India; JP = Japan; KR = Korea; MX = Mexico; RU = Russia; SA = Saudi Arabia; SE = Sweden; SG = Singapore; TR = Turkey; US = United States; ZA = South Africa.
Note: The time period of the global settlement window is marked red.

Source: CPMI survey.

① The stocktake was conducted in the first quarter 2021.

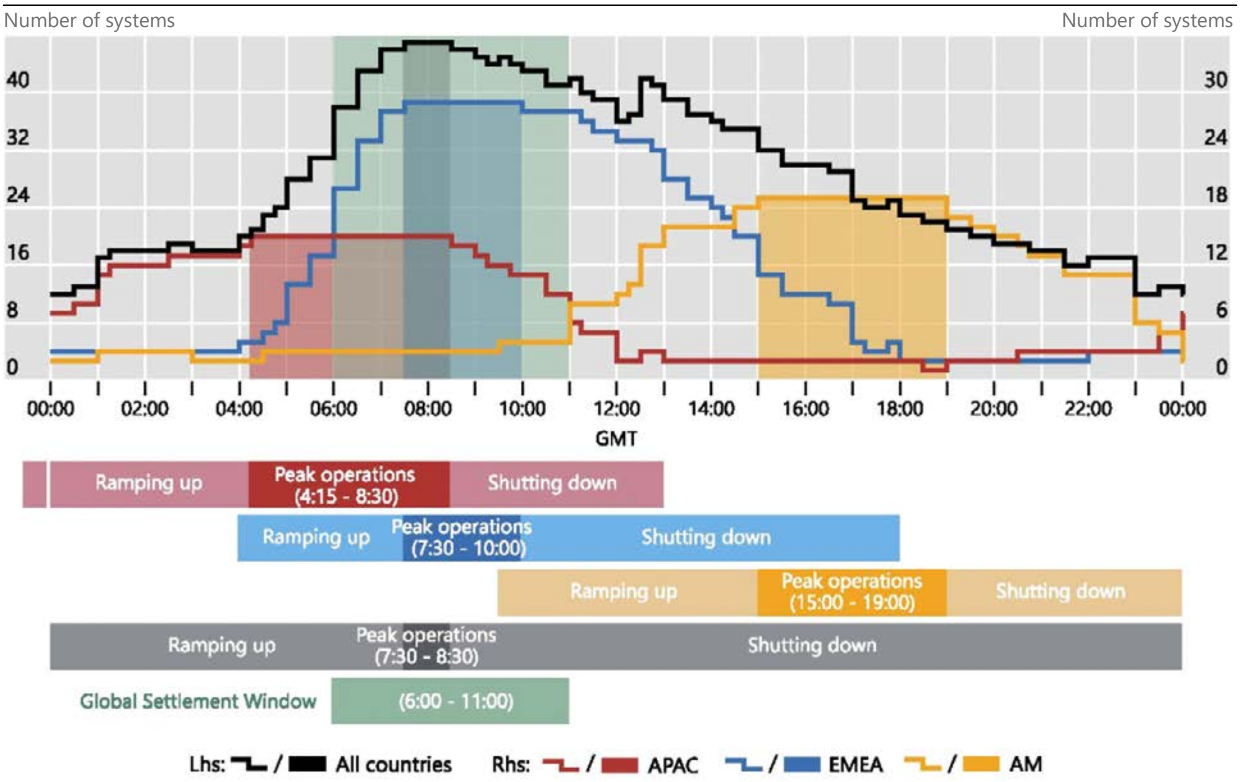
Focusing on working days for CPMI jurisdictions, distinct patterns in overlap of RTGS operating hours are evident across regions, reflecting the daytime business hours in each region (Graph 3).[26] In

[26] The current overlap in hours including non-CPMI jurisdictions on working days is presented in Annex 3, Graph A2. Graph A3 shows the weekend operating hours in all surveyed jurisdictions.

particular, given the time zones, **APAC jurisdictions have operating hours that fall earlier in the day (in GMT), while EMEA jurisdictions have operating hours that are more heavily concentrated in the middle of the day, and AM jurisdictions have operating hours slightly more concentrated in the second half of the day.** In each region, certain jurisdictions have extensive operating hours throughout the day. However, gaps in operating hours related to those jurisdictions exist to the extent that other jurisdictions do not have similarly extensive operating hours.

Considering all CPMI and non-CPMI jurisdictions, **the best characterisation of what currently constitutes the global settlement window is the interval from 06:00 to 11:00 GMT on working days.**[27] This is broadly the five-hour period when, on average, the highest number of CPMI and non-CPMI systems are concurrently operating across all jurisdictions covered in this report (Graph 4). This window also largely coincides with the core hours for PvP settlement through CLS Bank (ie 05:00 to 10:00 GMT), which relies on the overlapping hours of RTGS systems across jurisdictions to eliminate settlement risk for wholesale FX transactions of eligible currencies.[28]

Number of RTGS systems operating simultaneously on a standard working day① Graph 4



AM = Americas; APAC = Asia-Pacific; EMEA = Europe, Middle East and Africa.

[1] All 62 RTGS systems surveyed are included.

Source: CPMI survey.

In addition to its conceptual usefulness, the global settlement window is important for other reasons. First, it can support arrangements, such as liquidity bridges and PvP settlement for FX

[27] For the purposes of this report, the global settlement window has been determined by: (i) considering various time intervals (eg one hour, two hours); (ii) determining the peak time period for each interval that has, on average, the largest number of RTGS systems open for (a) CPMI jurisdictions, (b) non-CPMI jurisdictions and (c) all CPMI and non-CPMI jurisdictions; and (iii) selecting the largest interval and associated hours that involves the smallest difference in the peak time period across the three groupings of jurisdictions. This analysis identifies the five-hour period from 06:00 to 11:00 as the global settlement window with approximately 43 RTGS systems, on average, operating during that window. Alternative definitions could be used for the global settlement window.

[28] RTGS operating hours of several APAC jurisdictions were extended to facilitate the launch of CLS in 2002.

transactions, that reduce risks associated with cross-border payments and can therefore support reduced transaction costs. Second, it reflects the time period during which speed-related frictions are minimised across a wide range of jurisdictions. In the light of these implications of the global settlement window, the next section discusses the importance of this concept as a consideration for individual jurisdictions assessing potential changes in their RTGS operating hours.

4. Potential end states for RTGS operating hours in support of cross-border payments

This section presents potential future end states for the operating hours of individual RTGS systems. These end states are intended to provide different high-level scenarios that an individual central bank and industry stakeholders could consider, either as final outcomes or as stepping stones in a gradual process to reach a final target operating environment. Depending on a jurisdiction's current operating hours, each end state is likely to require differing levels of effort to implement, bringing with it several implications which are further discussed in Section 5. These end states, when viewed through the lens of the global settlement window, provide analytical tools to help central banks and industry stakeholders decide which extension of hours would be appropriate for them with respect to cross-border payments.

Overview of possible extension end states — Table 1

End state 1: extended hours on current operating days	Extend operating hours on days with current operations (usually "standard working days").
End state 2: expanded hours into current non-operating days	Expand operating hours into days without current operations (eg weekends and public holidays, as applicable).[29]
End state 3: 24/7 operations	Extend operating hours to 24/7 (or near 24/7).

End state 1 involves the most incremental extension in operating hours for an RTGS system. This end state holds current operating days as fixed and envisions an extension achieved through increased operating hours on those days. Such an increase in operating hours could involve a later closing time for an RTGS system, an earlier opening time, or both.[30] If undertaken by multiple jurisdictions, this end state would help to close daily gaps in RTGS operating hours, primarily on standard working days given that the majority of jurisdictions' RTGS systems currently do not operate on weekends and public holidays. As such, this end state could help to alleviate frictions for cross-border payments on those days but would not address frictions that arise on other days. Pursuing an earlier opening time on current operating days could be the least challenging option for many RTGS systems and participants, as such an extension would not impact critical end-of-day activities/practices. For instance, such extensions to RTGS opening times could also be particularly beneficial for jurisdictions in the AM region by enabling overlap with the global settlement window and greater opportunities for PvP.

End state 2 involves an expansion of operations into additional days on which a jurisdiction's RTGS system is not currently operating. As documented in Section 3, limited operations on weekends for RTGS systems give rise to substantial gaps in RTGS operating hours over the course of a week. A lack of operations on holidays in many jurisdictions also gives rise to substantial gaps in operating hours over the course of a year, as well as gaps during certain weeks that involve holidays. If undertaken by multiple jurisdictions, this end state would help to close those gaps. For a jurisdiction that does not currently operate on weekends and holidays, an expansion could involve applying current operating hours on working days to weekends and holidays. An alternative expansion could involve limited weekend and

[29] As described in Section 3, RTGS systems in some jurisdictions already operate on some weekend days and holidays. In this end state, those that do so could consider expansion to additional weekend days or holidays.

[30] The value date for transactions performed during new operating hours could correspondingly be considered in the light of the specific extension undertaken and the objective of that extension (see Section 5).

holiday hours that are focused more directly on achieving a specific period of operations and overlap on those days.[31]

End state 3 involves the boundary scenario of a jurisdiction extending its operating hours to 24/7 (or near 24/7). This end state reflects the most extensive versions of end state 1 and end state 2 combined (ie extending operating hours to 24 hours per day on working days, as well as weekends and holidays). In practice, this end state could involve a brief period of time at the end of the operating day to support end of day activities and system maintenance. At present, only a small number of jurisdictions already have RTGS systems that operate 24/7 or near 24/7.

4.1 Potential trade-offs of the different end states

If broadly adopted, all three end states can contribute to improvements in cross-border payments as they can result in new overlaps in operating hours and remove potential frictions, particularly related to the speed of transactions. In principle, the benefits may be greater as operating hours are further extended, but the scale of changes under each end state gives rise to different cost and risk implications for both payment system operators and participants. In this vein, end state 1 could be the most straightforward to achieve in the short run because it may involve relatively moderate changes to the existing operations of a jurisdiction's RTGS system, while end state 2 may require more substantial changes to existing operations for a larger number of jurisdictions. End state 3 would clearly support the greatest overlap in operating hours and may be viewed as an aspirational target that is consistent with the broader trend towards 24/7 commerce and economic activity. However, that end state would also involve more significant costs and operational changes for operators and participants. It may also require a broad assessment of liquidity and risk management, operational processes, IT infrastructure and market-wide practices. The cost and risk implications may also vary across different types of participants, as small institutions, for example, may find it more difficult to absorb the costs of increasing their own hours relative to their business activity. Operational and risk considerations, as well as policy considerations, of extensions to RTGS operating hours are further explored in Section 5.

Against this background, a successful extension strategy for RTGS operating hours requires consideration of the costs and benefits of the possible end states. Such analysis should not only focus on the most immediate and local benefits, but also adopt a forward-looking approach that accounts for long-term and global benefits. In this sense, end states 1 and 2 may be viewed as steps in a progression of extending RTGS operating hours and not necessarily final outcomes. Therefore, while analysis of costs and benefits may identify one of the end states as the preferable option in the near term for an individual jurisdiction, the central bank and industry stakeholders in that jurisdiction could also consider longer-term goals, potentially resulting in a gradual implementation approach.

The benefits of the different end states for cross-border payments will also depend on how many jurisdictions move towards a particular end state. For example, the benefits of end state 1 may depend less on changes across jurisdictions, as an extension of RTGS operating hours by an individual jurisdiction could (marginally) increase overlap with a number of other jurisdictions – even absent a concurrent increase in operating hours for those other jurisdictions. In contrast, realising benefits of end states 2 or 3 may depend more on mutual action across jurisdictions because one jurisdiction's decision to expand into new operating days or to 24/7 operations may have a limited impact on overlap in relation to the costs incurred if other jurisdictions do not undertake similar expansions. The interdependence of outcomes across jurisdictions underscores the importance of considering a more aggregate perspective on overlap in operating hours, with the global settlement window providing such a perspective (see Section 4.2).

At the same time, however, jurisdiction-specific conditions will affect the evaluation of end states by payment system operators and participants in each jurisdiction and will influence which end state is viewed as viable in the near term versus the long run. In addition, certain jurisdictions may be more future-

[31] A further end state involves a combination of end states 1 and 2. In particular, a potential end state could involve an extension of operating hours on current working days and an expansion of operating hours to weekends and holidays. The report treats these end states as distinct to focus on the different actions needed to support them and their different implications.

oriented when considering expansions. Differences across jurisdictions may lead to a heterogeneous set of extension strategies, underscoring the importance of considering the interplay of extension across jurisdictions. This is to ensure that extensions of hours provide increasing overlap across jurisdictions' RTGS systems and yield collective benefits.

4.2 Assessing end states through the lens of the global settlement window

While each end state represents a potential extension of an individual jurisdiction's RTGS operating hours, a key consideration from the perspective of improving cross-border payments, would be to envision an end state that meaningfully adds to the current global settlement window. As indicated in Section 3.3, this is currently best characterised as 06:00 to 11:00 GMT on working days. In particular, end state 1 would contribute to an extension of the current global settlement window on working days; end state 2 would support the creation of a meaningful global settlement window on weekends and public holidays; and end state 3 would support a round-the-clock global settlement window. If each RTGS operator were to take these effects into account when evaluating potential end states, the global settlement window could be extended in terms of the number of hours and days, on the one hand, and the number of jurisdictions with operating hours in that window, on the other.

Extending the settlement window on a global basis to maximise the number of RTGS systems that are open concurrently across a broad range of jurisdictions and regions yields the most advantages with respect to cross-border payments. It maximises overlaps between a wide range of jurisdictions and regions, and thus enables the broadest range of payments to be settled without delays being incurred due to RTGS systems being closed. As a result, the speed and efficiency with which cross-border payments are processed could be increased as payments would not need to be queued while the respective systems are closed. The nature and extent of these changes will depend on a jurisdiction's current RTGS operating hours and the end state under consideration. For example, a jurisdiction may already have extensive operating hours on standard working days, such that end state 1 brings little or no gains in terms of expanding the global settlement window. Another jurisdiction may have more limited current operating hours that are not well aligned with the current global settlement window. Such a jurisdiction would need to make more substantial changes to its operating hours to align with the global settlement window and to support the expansion of that window. Both jurisdictions may consider expanding operations to weekends and holidays (end state 2) to support this objective.

The approach set out in these end states provides guidance to individual jurisdictions on the ways in which they could extend their RTGS operating hours in support of expanding the global settlement window to enhance cross-border payments, both in terms of the number of jurisdictions operating in that window and the size of the window itself**. The end states are not intended to be prescriptive, and individual jurisdictions have discretion over which precise operating hours they might choose to extend, the overall extent of changes and the pace of changes. Jurisdictions could consider the impact of their actions both in support of the global settlement window and on domestic considerations.** A central bank may have other motives to promote extended RTGS operating hours, such as improvements in the safety and efficiency of domestic payments. This report does not look to enumerate or evaluate these considerations; instead, it focuses on enhancing cross-border payments as a key consideration for such an extension. Importantly, however, an extension in operating hours that yields benefits for cross-border payments may also generate benefits domestically, and vice versa.

4.3 A complementary regional or corridor perspective

While individual jurisdictions may examine their RTGS operating hours relative to the global settlement window, it may also be useful for jurisdictions to consider end states that affect settlement windows on a corridor (ie pairwise) or regional basis, as suggested in Section 3. A corridor or regional perspective may identify extensions of operating hours that would be particularly impactful for an individual jurisdiction or a combination of jurisdictions. For example, expansions to end state 1 may better facilitate continuous payment flows between the AM and EMEA as opposed to those between AM and APAC. This is because the overlap between the former regions is already significant and expanding to end state 1 may further increase that overlap. In addition, consideration of regional or corridor payment flows may identify linkages that would particularly benefit from increased overlap. At the same time, **expansions based on a regional or corridor perspective may serve as vehicles for expanding the global settlement window**.

Similar to the concept of the global settlement window, the "regional settlement window" can be viewed as the time frame during which the largest number of RTGS systems within a region are open simultaneously and, thus, cross-border payments within that region can be processed without delay stemming from limits to RTGS operating hours. By expanding regional settlement windows, overlaps in operating hours between jurisdictions within the same region would be extended, which would also support more overlaps in operating hours globally, further enhancing the efficiency of cross-border payments and supporting marginal gains in ultimately achieving a global outcome (Box 2).

Box 2

An illustrative example of the impact of an expansion in operating hours in regional settlement windows in support of the global settlement window[①]

This example shows how a change in the operating hours of countries within a region can increase the extent of overlap in operating hours between these countries (intraregional overlap) thus extending the regional settlement window. This extension of the regional settlement window also increases the extent of overlap between countries across different regions (inter-regional overlap), thus supporting expansion of the global settlement window.

The two scenarios in this analysis are as follows:

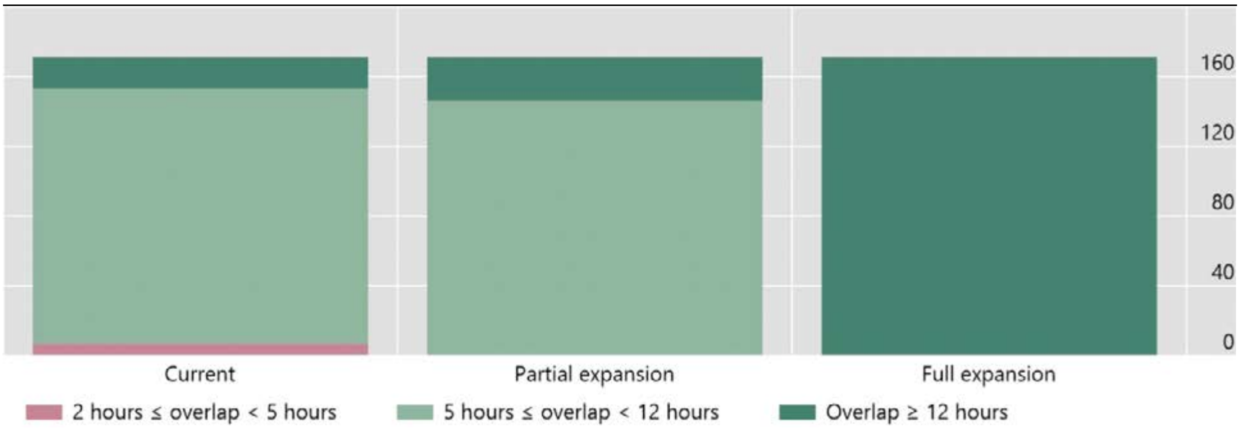
- "Partial expansion". The scenario assesses the impact on the global settlement window if countries within a region whose operating hours do not currently overlap completely with the global settlement window collectively extend their operating hours **by up to an hour**, either to increase their overlap with the global settlement window or to operate closer to the global settlement window.
- "Full expansion". The scenario assesses the impact on the global settlement window if countries within a region collectively extend their operating hours so that their regional settlement window **fully overlaps** with the global settlement window.

Looking at the impact of the above two scenarios for the Americas (AM) region, currently, most country pairs within this region already share an overlap of at least 5 hours (Graph 2.1). Conversely, the overlaps in operating hours between AM region countries and countries in the other regions – Europe, Middle East and Africa (EMEA) and Asia-Pacific (APAC) – are more modest. In particular, where there are large time zone differences, such as between the AM and APAC regions, over half of the inter-regional country pairs have an overlap of less than two hours (Graphs 2.2 and 2.3).

Under the **partial expansion scenario**, the scale of overlap both intra-regionally and inter-regionally is increased more marginally than under the full expansion scenario. On an intra-regional basis (Graph 2.1), the scale of overlap is increased such that all country pairs in AM have at least a five-hour overlap. On an inter-regional basis, a partial extension of operating hours has a greater impact on the scale of overlap between country pairs in the AM and EMEA regions (Graph 2.2) – increasing the number of country pairs with more than five hours of overlap by around one third. The scale of overlap between AM and APAC countries (Graph 2.3), on the other hand, is much more modest given the degree of time zone divergence.

Intra-regional overlap between AM RTGS systems[1]

Number of pairs | Graph 2.1



[1] The graph includes 171 unique pairs.

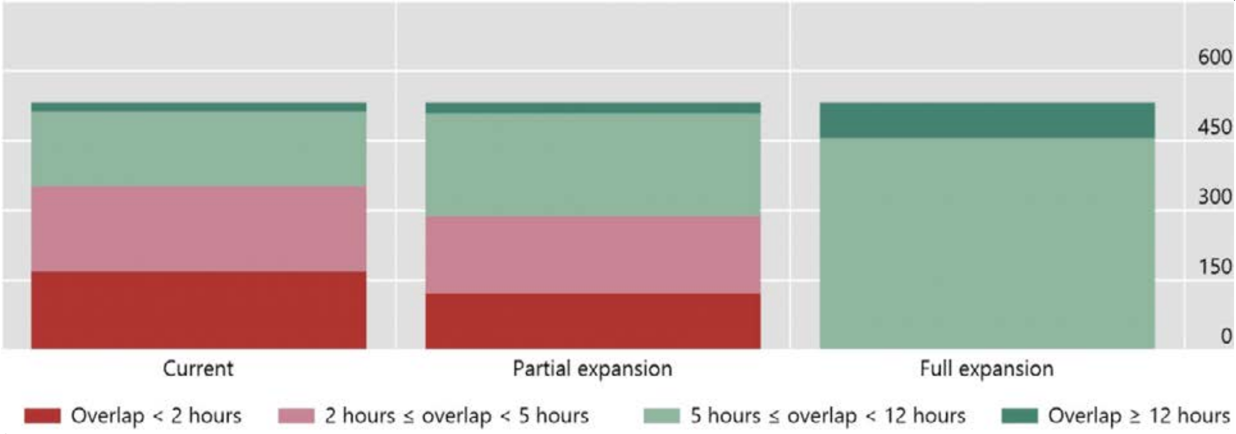
Source: CPMI survey.

Under the **full expansion scenario**, the extension of operating hours ensures all country pairs within AM have at least 12 hours of overlap on an intra-regional basis (Graph 2.1). At the inter-regional level, the overlaps in operating hours for country pairs between AM and EMEA (Graph 2.2), and between AM and APAC (Graph 2.3), are increased up to a minimum of five hours for all country pairs.

Inter-regional overlap between AM and EMEA RTGS systems

Number of pairs

Graph 2.2



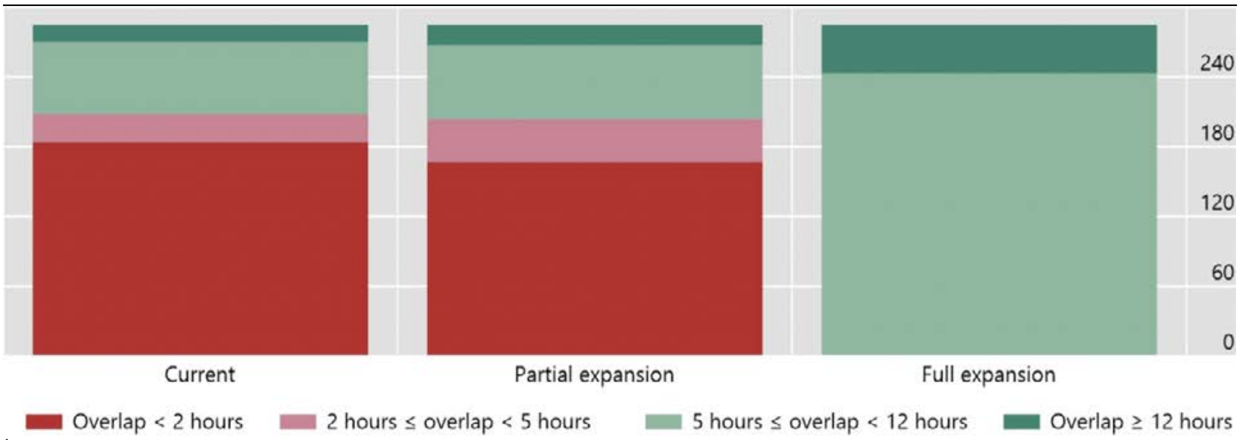
[1] The graph includes 532 unique pairs.

Source: CPMI survey.

Inter-regional overlap between AM and APAC RTGS systems

Number of pairs

Graph 2.3



[1] The graph includes 285 unique pairs.

Source: CPMI survey.

① The analysis is based on the 62 jurisdictions in the scope of this report.

Individual jurisdictions may also choose to increase overlaps in operating hours between specific country corridors. For example, individual jurisdictions may choose to prioritise an extension of RTGS operating hours for specific country corridors where there may be a high value/volume of cross-border transactions and currently limited overlap in RTGS operating hours. This in turn increases the scale of overlaps in RTGS operating hours between individual jurisdictions, potentially contributing to an expansion in their respective regional settlement windows and, ultimately, the global settlement window (Box 3).

Box 3

An illustrative example of the impact of an expansion in operating hours on bilateral corridors in support of the global settlement window

This example shows the impact of individual jurisdictions extending their operating hours between specific corridors. For example, Brazil's RTGS system currently operates from 09:30 to 21:30 GMT from Monday through Friday. As shown in Table 3.1, given time zone differences, the overlap in operating hours between Brazil's RTGS system and the other CPMI jurisdictions' RTGS systems varies between no overlap with South Korea to a 12-hour overlap with Canada, Mexico, South Africa and the United States.

Bringing forward the opening time of Brazil's RTGS system by one hour (to 08:30 rather than 09:30 GMT) would extend the degree of overlap it has with 18 CPMI jurisdictions' RTGS systems on a bilateral basis. It would increase the overlap, in particular, with jurisdictions with which it currently has relatively less overlap, namely eastern time zone RTGS systems in APAC. It would also extend the scale of overlap for Brazil's RTGS system with the global settlement window (06:00 to 11:00 GMT on working days) by one hour.

If Brazil's RTGS system opened three and a half hours earlier, it would significantly increase its overlap with other CPMI jurisdictions, including with those in the APAC region. For example, such a change would result in the number of hours that Brazil's RTGS system overlaps with Hong Kong's RTGS system, increasing from one hour currently (09:30 to 10:30 GMT) to four and a half hours (06:00 to 10:30 GMT). It would then also have a 100% overlap with the global settlement window.

Operating hours overlap①

Table 3.1

		Total operating time	Brazil RTGS					
			Overlap given current operating hours (09:30-21:30)		Overlap after extending the Brazil RTGS operating hours			
			In hours	Per cent of total operating time	Opening 1h earlier (08:30-21:30) towards global settlement window		Opening 3h 30mins earlier (06:00-21:30) towards global settlement window	
APAC	AU	14:30	02:30	17%	03:30	+40%	06:00	+140%
	JP	12:30	02:30	20%	03:30	+40%	06:00	+140%
	KR	08:30	00:00	0%	00:00	-	02:30	-
	CN	20:45	09:00	43%	09:45	+8%	12:15	+36%
	HK	10:00	01:00	10%	02:00	+100%	04:30	+350%
	SG	10:00	01:30	15%	02:30	+67%	05:00	+233%
	ID	12:30	02:30	20%	03:30	+40%	06:00	+140%
	IN	23:30	11:30	49%	12:30	+9%	15:00	+30%
EMEA	RU	20:00	08:30	43%	09:30	+12%	12:00	+41%
	SA	07:30	04:00	53%	05:00	+25%	07:30	+88%
	TR	09:00	05:00	56%	06:00	+20%	08:30	+70%
	ZA	24:00	12:00	50%	13:00	+8%	15:30	+29%
	EA	11:00	07:30	68%	08:30	+13%	11:00	+47%
	SE	11:00	07:30	68%	08:30	+13%	11:00	+47%
	CH	23:30	11:30	49%	12:30	+9%	15:00	+30%
	GB	12:00	08:30	71%	09:30	+12%	12:00	+41%
AM	AR	12:00	10:30	88%	10:30	-	10:30	-
	BR	12:00						
	CA	18:30	12:00	65%	13:00	+8%	15:30	+29%
	US	22:00	12:00	55%	13:00	+8%	15:30	+29%
	MX	24:00	12:00	50%	13:00	+8%	15:30	+29%
	CLS	05:00	00:30	10%	01:30	+200%	04:00	+700%
	Total	**306:45**	**141:30**	**44%**	**159:15**	**+13%**	**206:45**	**+46%**

AM = Americas; APAC = Asia-Pacific; AR = Argentina; AU = Australia; BR = Brazil; CA = Canada; CH = Switzerland; CLS = CLS Bank; CN = China; EA = euro area; EMEA = Europe, Middle East and Africa; GB = United Kingdom; HK = Hong Kong SAR; ID = Indonesia; IN = India; JP = Japan; KR = Korea; MX = Mexico; RU = Russia; SA = Saudi Arabia; SE = Sweden; SG = Singapore; TR = Turkey; US = United States; ZA = South Africa.

Source: CPMI survey.

① The stocktake was conducted in the first quarter 2021.

5. Operational, risk and policy considerations of the end states

While moving towards any of the potential end states identified in Section 4 could contribute to enhancing the speed and reducing some costs of cross-border payments (eg liquidity and FX costs), extending RTGS operating hours also raises a number of considerations and costs relevant for central banks and industry stakeholders.[32] These issues include operational adjustments by both payment system operators and participants, as well as changes to certain market practices and conventions, the impact of which will be borne across the entire payment ecosystem. RTGS operators will need to assess the costs and benefits of extending operating hours in their jurisdictions, including to the RTGS operator itself, participants and other industry stakeholders. Such an assessment will require extensive industry engagement and consultation, involving both domestic and cross-border considerations. At the same time, it is important for these operational changes and associated costs to be viewed by all affected parties in a strategic light since resulting benefits could be far-reaching and long-standing notwithstanding the immediate cost burden. Moreover, operational changes to extend RTGS operating hours can be part of a broader reform programme to enhance a jurisdiction's RTGS system in support of cross-border payments and for other purposes (eg to foster improvements in the domestic payments market).

While an extension of operating hours will not be expected to introduce new risks beyond those the CPMI and the International Organization of Securities Commissions (IOSCO) have previously identified for payment systems, it will extend the times during which certain risks can materialise.[33] Furthermore, while all risks and considerations need to be treated in parallel, the materiality of certain risks may vary across scenarios for extending operating hours (ie at which time of the day the operating hours are extended) and may also depend on the degree of utilisation of the extended operating hours (ie the actual level of activity during these hours). As such, parties involved in RTGS systems may need to review and/or enhance existing mitigation measures to accommodate longer operating hours while maintaining at least current levels of operational resilience and risk management, including against service disruptions, cyber attacks, and payment fraud. Changes and costs to expand existing resilience and risk mitigation measures could be substantial, particularly for extensions of operating hours into new operating days. For example, RTGS system operators and their participants may need to update or replace their technology platforms and software to maintain resilience and add shifts of skilled staff in IT and treasury departments, among other areas.

An extension of RTGS operating hours also raises certain policy considerations relevant for central banks and/or other authorities. These include issues related to monetary policy, financial stability and resolution policy for troubled institutions.

This section presents risks and policy considerations which result from extending RTGS operating hours and some potential mitigants, distinguishing between the parties for which they are relevant, where appropriate. The considerations may also differ depending on whether the focus is placed on the transition process to an end state or a longer-term outcome where an end state has been reached. The end state that an individual RTGS system pursues – whether one of those presented in Section 4, a combination of them, or an alternative – may be particularly important. Where relevant, this section draws these distinctions between the end states.

For example, a more ambitious extension in operating hours, as would be consistent with end state 3 (ie 24/7 operations), may specifically raise different or more significant issues than a more modest extension. The fact that some jurisdictions have already successfully moved into a 24/7 scenario demonstrates, however, that the issues associated with that end state are manageable in practice, at least in certain cases. Both central banks and industry stakeholders can leverage existing experiences and

32 The analysis in this section has been informed by input previously received from the industry, in the context of the CPMI conference "Pushing the frontiers of payments: towards a global payments area" (held in March 2021), including a questionnaire and responses to questions related to extended operating hours for the 62 RTGS systems included in this report.

33 The *Principles for financial market infrastructures* provide a description of risks in financial market infrastructures, including payment infrastructures (see, in particular, CPSS-IOSCO (2012), Section 2).

approaches to learn from each other as part of their decision-making process in extending RTGS operating hours.

A final set of considerations concerns the path and timeline to reach an end state. Consistent with the non-prescriptive approach taken in Section 4, this report does not envision a specific implementation path or timeline for a RTGS system to extend its operating hours.

5.1 Operational considerations: technical, staffing and other adjustments

Operational changes needed to support an extension to RTGS operating hours can apply to the system operator itself (often, the central bank), as well as participants, critical service providers and other industry stakeholders, including other payment infrastructures that rely on the RTGS system for settlement, PSPs that indirectly access it and end users that utilise it through PSPs. The diversity of parties that may need to make operational changes points to the importance of broad engagement when planning an extension of RTGS operating hours. The significance of operational changes will depend on the extent of current operating hours for the RTGS system and the chosen end state.

The operational changes associated with the different end states necessarily involve costs, which must be evaluated and managed by the parties that would incur them. Some of these costs, such as those associated with technical accommodation of a particular end state, may be particularly relevant in the transition to that end state. Others, such as staffing costs, may be ongoing costs that would be incurred permanently in any end state, although the degree of these costs will vary depending on the extent of the operating hours extension. Payment system operators, participants and other industry stakeholders would need to assess the nature and magnitude of such operational costs when assessing the different end states and the potential impact on end users.

The impact of operational changes may vary by type of payment system participant. Smaller participants may have fewer resources to devote to the changes needed to accommodate an extension of RTGS operating hours. In addition, the business model of these participants may be such that they are less engaged in cross-border payment activity, and as a result, would experience fewer benefits associated with improvements in cross-border payments due to extended hours. In the presence of significant differences between participants, payment system operators could consider allowing certain participants to tailor their use of the RTGS system during new hours.

5.1.1 Technical considerations

An extension of RTGS operating hours is likely to require changes to existing systems, platforms and infrastructures. These changes will broadly involve modifications, upgrades and potential replacement of software and hardware. Such changes will need to be carefully planned and deployed by the payment system operator so as to ensure that the infrastructure can successfully process payments during its operating hours.

On account of the above, some potential technical considerations for the payment system operator include assessing which activities that require settlement to be stopped can be taken offline such as end-of-day processing. Payment system operators may also consider how settlement can be kept running while some tasks such as maintenance take place, for example by operating two payment systems in parallel and then transferring between the two while each is being upgraded (see Section 5.1.2). Along the same lines, payment system operators may also have to secure adequate rollback capabilities between these separate environments to be able to unwind a failed change, in case of need.

Payment system participants and other parties may be further required to make changes to their internal systems to accommodate additional hours for the RTGS system. For the payment system operator, participants and other industry stakeholders, these changes are likely to have downstream impacts and may extend beyond those specific to the RTGS system itself to include changes to related systems. For example, the operator (especially a central bank) may need to adjust systems that monitor certain risks, such as credit exposures, in the event that credit is provided during new operating hours. Participants may similarly have to make changes to systems that support client services, treasury, fraud prevention, sanctions screening and other functions.

The necessary technical changes are likely to vary across the potential end states. An extension of operating hours on current operating days, as in end state 1, could require relatively minor technical changes. By contrast, a move to 24/7 operations under end state 3 may require a complete system renewal if the legacy platform is not able to accommodate round-the-clock operations. Such a system renewal would be likely to necessitate substantial upfront adjustments, but could also have longer-term implications if new technologies or capabilities are included as part of a renewed RTGS system.

5.1.2 Staffing considerations

Both the RTGS system operator, participants, and potentially, some other industry stakeholders would need to increase staffing levels in order to cover extended operating hours. While some initial adjustments may be required to ensure that, at all times, available staff have appropriate skillsets to manage extended operating hours, many staffing adjustments and associated costs would persist over time. Such changes are likely to extend beyond core operational functions to include additional staffing adjustments in related areas, such as technology and customer support, for both the payment system operator and participants, as well as other parties.

As with technical changes, the nature of staffing adjustments will vary across the end states. For a limited extension in operating hours (eg end state 1), it may be possible to address staffing needs with relatively small adjustments to existing resources. By contrast, an end state that involves a more substantial increase in operating hours (eg end states 2 and 3) would be likely to require more significant staffing changes, such as additional employees and shifts, especially qualified staff as a result of the potentially reduced maintenance window.[34] At the same time, a more ambitious end state and the associated renewal of technical systems may provide an opportunity to take advantage of new technologies in order to automate some tasks. Such changes could free up staff to then be reallocated to other, more specialised activities.

5.1.3 Industry practices and business conventions

An extension of RTGS operating hours can raise various other issues that, while not purely operational, have operational implications. In particular, certain market conventions and practices have developed over time around the operating hours of RTGS systems. In order to fully realise the benefits of an extension of RTGS operating hours, operators, system participants and other industry stakeholders would need to assess the required changes in industry rules and practices – both operational and business – to accommodate such an extension (see Box 4).

Payment system participants and other affected parties across the industry may specifically need to assess and adapt their end-of-day processes. These could include liquidity management activities, reconciling books and records, and refreshing and updating system applications, among other activities. Such processes are often designed to account for the closing and opening times of a jurisdiction's RTGS system. For example, parties that rely on an RTGS system that has a significant amount of end of day downtime may rely more heavily on manual processes to complete their end of day activities. As extensions of operating hours move closer to a 24/7 business day, there may be an increasing need to redesign end of day processes and adopt greater automation.

In an end state involving weekend operations (end state 2) or 24/7 operations (end state 3), it will also be important to consider certain date conventions. In particular, the "business day" definition for the RTGS system is a key consideration. For example, in end state 3, such a definition would involve establishing a "start of day" and "end of day" for a system that is operating continuously. A related date convention concerns the "value (or settlement) date" that applies to payments processed through the system.

34 Legal considerations (eg labour regulation) may be relevant for staffing changes.

Box 4

Implications for market conventions

This box explores some of the market conventions that need to be considered alongside a change to RTGS operating hours in order to fully realise the benefits of an extension of operating hours. Coordination between industry stakeholders and central banks will be required to assess the options available to amend definitions, rules and practices, and to understand the wider implications which these amendments could have on other asset classes and existing legal/business conventions.

Value date conventions

The definition of "business day" typically captures working days. In an end state involving weekend (ie end state 2) or 24/7 (ie end state 3) operations, the implications for the "business day" convention should be reviewed – including to establish a "start of day" and "end of day".

In addition, the definition and application of "settlement date" ("value date")① will also need to be reviewed. Currently, the settlement date is applied to the local business day of each currency within the transaction and is therefore especially relevant when RTGS hours of the two currencies involved in a transaction do not overlap. For example, a transaction in AUD-USD settling on the 1 December, the AUD element will settle on 1 December in Australia. Meanwhile, the USD element will settle on 1 December in the United States which, due to the time zone differences, will actually be the next business day (ie 2 December) in Australia.

These date conventions are the basis on which transactions are agreed and settled between parties, interest payments are calculated and cut-off times are managed (eg to determine if a repurchase agreement fails). As such, these conventions are central for legal/regulatory accounting, risk management, reference, monetary policy and other purposes. Changes to the definitions would need to be reflected in legal and regulatory frameworks, and their potential implications further considered.

Market "end-of-day" processes

Market participants currently perform several checks and processes at the "end of day". These end-of-day activities can include checks to ensure that all payments requiring processing have been made (and subsequent resolutions), end-of-day batch processing (eg to roll trading positions to the next business day and unwind intraday liquidity), interest payments and regulatory reporting.

Due to longer settlement hours, these checks and processes may need to be performed throughout the day, as well as later in the day. The changes that may be required necessitate further review – both to assess what changes might need to be made and potential impacts of those changes on other areas.

For example, nostro account balances are typically currently reconciled at the end of the settlement date via statements of activity provided to the account holder to confirm settlement finality. If an extension to RTGS operating hours results in end-of-day statements for reconciliation being provided later in the day, it will impact the ability of a market participant to manage settlement risk and potentially their ability to benefit from increased PvP opportunities (such as the management of capital allocated to settlement risk).

Capital and liquidity management/regulations

Extended RTGS operating hours could have different impacts on financial institutions' intraday capital and liquidity management, especially as technology develops to enable more efficient liquidity management and recycling of balances following the determination of final settlement. Regulators and financial institutions will need to fully consider the impact of the potential changes to capital and liquidity management and regulation when moving to extended operating hours. This should include a review of local capital and liquidity regulations to ensure they remain fit for purpose.

① The settlement date and time are agreed and contracted between the two counterparties to the transaction at the point the transaction is agreed. On this date and time, there will be an exchange of payments between counterparties in each of the currencies contracted for exchange.

Consideration of value dates is relevant for payment system participants vis-à-vis the RTGS system, their clients and central banks. Such date conventions are important for FX transactions, legal/regulatory practices, accounting, risk management (eg settlement risk), definition of reference rates, monetary policy (see also Section 5.3 below) and other purposes. The CPMI anticipates important work with industry stakeholders to consider common rules/definitions for the determination of "business day" and "value date", assess any impact changes to these conventions could have on regulatory reporting and identify any further adjustments to market conventions that could be required.

5.2 Risk considerations

As noted previously, an extension of RTGS operating hours would not necessarily introduce new risks beyond those that have previously been identified as relevant for payment systems, but would extend the window during which such risks can materialise. The key risks considered below are financial risks (ie credit and liquidity risk) and operational risk with attention also paid to fraud and cyber risk as subtypes of operational risk. When considering these risks, it is important to recognise that an extension of RTGS operating hours can decrease as well as increase certain risks. For example, reducing downtime between systems can allow for faster action to be taken in cases in which fraud is detected, eg requesting a quick return of the compromised funds.

Appropriate risk management is particularly important given the systemic importance of RTGS systems. Therefore, as during current operating hours, risks during extended RTGS operating hours in any end state will need to be appropriately managed. In particular, at least current levels of operational resilience would be important to maintain.

In general, risks arising during extended operating hours could be addressed through the application of established mitigation measures during those hours. However, there may be a lack of existing capabilities to deploy such measures out of hours (and particularly round the clock in end state 3), as well as a lack of experience in doing so. As a result, the adjustments needed to apply risk mitigation measures during new operating hours may warrant particular attention, and consideration should be given to where automation can support risk mitigation during extended operating hours.

5.2.1 Financial risks

Extended RTGS operating hours will require participants to ensure they have sufficient liquidity to support their activities during new operating hours and to understand the potential implications on their broader liquidity management approaches. Support for effective liquidity management may require an expansion of central bank credit facilities (see also Section 5.3). The availability – or unavailability – of other interconnected financial markets that payment system participants use to source liquidity (eg securities market, FX market and interbank money markets) will also affect participants' ability to effectively manage their liquidity during extended RTGS operating hours.[35] All these aspects can potentially have implications in terms of financial stability (see also Section 5.3).

Liquidity shortfalls could, nevertheless, be managed by applying a range of mitigation measures. For example, payment system participants could hold additional funding to support extended RTGS operating hours, and central banks could provide liquidity tools, such as account overdraft capabilities, repo facilities and liquidity bridges.[36] Alternatively, participants could adjust their existing liquidity management practices to ensure adequate access to liquidity. Such measures may increase liquidity costs for participants. RTGS systems could also contemplate the possibility of improving the availability and effectiveness of liquidity savings mechanisms, for example, by implementing alerts and tools for monitoring liquidity needs during new extended operating hours.

[35] Market participants may use securities markets and central bank borrowing to monetise non-cash assets (such as government bonds) via both sale and repurchase agreements. If such markets and/or facilities are not available during extended RTGS operating hours, market participants may need to adjust their liquidity management approaches such as holding relatively higher levels of central bank reserves.

[36] A dedicated workstream (BB 11) is exploring reciprocal liquidity arrangements across central banks (ie liquidity bridges).

5.2.2 Operational risk

On top of the necessary initial adaptations, payment system operators and participants may need to focus on a number of additional considerations related to operating over extended periods of time. In general, longer operating hours extend the time window during which operational issues can arise. Such operational issues could involve errors, fraud, money laundering/terrorist financing, business continuity planning arrangements and cyber attacks.

One of the most distinctive operational risks that could increase as a result of longer operating hours relates to information technology change management, such as adding new functionalities, applying software patches and testing the cyber resilience framework. Many RTGS systems rely on scheduled downtime to address these technical requests and to onboard new direct participants. Reduced or virtually non-existent closure times (as in the case of end state 3) place an additional burden on both payment system operators and participants in dealing with these fundamental issues.[37] As such, along the lines described in Section 5.1.1, interested parties may start by considering potential ways of redesigning how this process is executed, including the exploration of modern approaches to technology to provide greater practical flexibility and facilitate proper servicing of different financial markets by the RTGS system at peak times.

Extending operating hours further increases the time during which fraudulent payments can be initiated and/or cyber attacks can originate and propagate. This may, therefore, require an enhancement of existing monitoring tools and resilience measures including the migration towards novel automated screening solutions such as those based on artificial intelligence/machine learning (AI/ML) techniques. It may also entail the definition and deployment of an appropriate awareness and learning strategy which can help to achieve a solid understanding of the new threat landscape and delineate adequate countermeasures. As a result, direct investment in hardware/software is likely to be needed, as well as staffing adjustments to best manage such risk during extended hours.

5.3 Policy considerations for central banks and other authorities

Extended RTGS operating hours could raise certain issues of particular relevance for central banks and other authorities. As is the case for many other topics discussed in this section, these issues are likely to be most pronounced under a more substantial extension of operating hours, as contemplated in end states 2 or 3. The relevance and impact of these issues will depend to a large degree on the actual usage of the extended operating hours. In the early stages after extension, changes to operating hours of money markets and business hours of financial institutions may be limited. However, these issues might gain relevance in the longer term, as the payments industry and financial markets evolve and adapt to extended RTGS operating hours, as needed.

5.3.1 Monetary policy implementation

RTGS systems are a critical component of the ecosystem through which central banks implement monetary policy. Short-term market interest rates are held close to the central bank's policy interest rate through a variety of different central bank interventions. The primary vehicle through which these market interest rates are controlled is commercial banks' reserves (deposits at the central bank). Central banks typically exert control over the quantity of reserves and their remuneration. Transactions in reserves by both commercial banks and the central banks are settled in RTGS systems. These transactions may also involve the purchase and sale of securities and foreign currencies.

An extension of operating hours could lead to a change in the timings of these transactions: current off-hours could see extended activity. This in turn could require central banks to extend the hours in which their open market operations take place in order to maintain control of market interest rates. For some central banks, this may require revisions to their reserves forecasting models. To the extent that

[37] The same considerations could apply in the case of an RTGS system relying on weekends to perform maintenance tasks and opting to extend operations over that window as a result of pursuing end state 2.

central banks extend the hours in which they undertake their policy operations, this might also have an impact on operating hours of a jurisdiction's securities settlement systems, given that these systems settle the securities leg of open market transactions.

An extension of operating hours may also affect the administration of reserve requirements and remuneration. Typically, each central bank sets a cut-off time for quantifying and (in some cases) remunerating the reserves held by each institution in their deposit account overnight. Central banks could consider how these cut-off times in different jurisdictions interact, to manage any potential new risks to the effective implementation of monetary policy. Overall, the impact of extended hours and the importance of the aforementioned considerations could vary significantly across jurisdictions as central banks implement domestic monetary policy in different ways.

5.3.2 Intraday liquidity provision and overnight lending

As noted in Section 5.2, the extension of an RTGS system's operating hours could create liquidity needs for participants that operate during those extended hours. To address these potential liquidity needs, central banks might want to review their provision of credit facilities, including intraday credit and overnight lending.[38] A central bank may consider providing temporary intraday liquidity during extended hours to support the smooth functioning of business-as-usual activities in the payment system. In addition, extending overnight lending tools may be particularly important for addressing liquidity needs that might arise from stress experienced by a payment system participant or in the market more broadly during periods related to newly extended RTGS operating hours. A further consideration is that the provision of liquidity by the central bank may require the availability of collateral services in order to pledge collateral as guarantee for the provided liquidity.

The nature of intraday and overnight credit tools may not change significantly across end states as central banks may be able to leverage existing policies and tools in each end state. However, the costs to central banks and their participants of extending their credit and liquidity functions (ie staff and technology) to cover extended hours would be likely to increase from end state 1 to end state 3. A unique consideration for end state 3, however, is the need to evaluate the terms of overnight credit in an environment with little or no down time (eg how to delineate between intraday and overnight credit).

5.3.3 International market operations

With respect to international market operations, an extension of operating hours is likely to provide greater flexibility to execute FX or swap transactions with foreign central banks. An increase in the overlap of operating hours across jurisdictions would, thus, create a longer window across corridors for central banks to potentially execute these transactions. This could offer the potential to promote same-day FX settlement for the benefit of both risk reduction and speed. In addition, multiple expansions into weekends and holidays could open up new days for these activities. Such flexibility could promote enhanced liquidity arrangements between central banks, a goal of the work on exploring liquidity bridges across central banks (BB 11).

5.3.4 Financial stability

Another consideration in the extension of the operating hours of RTGS systems concerns the potential impact on financial stability. By design, RTGS systems limit systemic risk by settling time-critical wholesale transactions on a gross basis and in real time. Nevertheless, in a cross-border payment where multiple intermediaries may be involved, disruptions may happen along the chain that could result in a failed transaction and have spillover effects throughout the financial system.

The extension of overlaps in operating hours, and consequently, the increased speed of transactions, could minimise the exposure to this risk, and hence have positive effects on financial stability. Nevertheless, it could also result in a broader window in which shocks may propagate rapidly throughout

[38] An additional angle to bear in mind is how these increased liquidity needs may not only arise in relation to the domestic currency but also to foreign ones, in particular, in times of stress.

the financial system. Again, the more extensive the changes (in particular end state 3), the larger the potential impact. Furthermore, the likelihood of these shocks could increase if proper measures are not taken to address the challenges discussed above (eg appropriate liquidity management, see Section 5.2.1). Therefore, the effects on financial stability will largely depend on the extent to which (i) the risks discussed above are properly managed; and (ii) current monitoring tools and practices are also upgraded to cover extended operating hours.

5.3.5 Monitoring of troubled institutions and resolution policy

Extended operating hours of RTGS systems may facilitate depositors moving their funds to other financial institutions (both domestic and abroad) at times when it was previously not possible, potentially exacerbating the problems of an institution at risk. This is more likely to be the case for corporate clients but could also happen for retail depositors if the extension of the RTGS system operating hours led to similar extensions in other payments systems that settle their positions in the RTGS accounts.

In addition, the extension of operating hours could also affect the way resolution policies are envisaged and implemented. Since the resolution of a financial institution during operating hours may introduce disruptions, generally these procedures are carried out in practice over the weekend. As a consequence, an extension of operating hours such as those foreseen in end states 2 and 3 might affect resolution processes. Hence, central banks may need to consult with resolution authorities about any possible effects and alternative approaches, should a plan to extend RTGS operating hours be under consideration.

5.4 Implementation considerations

As noted previously, the end states presented in this report are not intended to be prescriptive, with the decision of which, if any, end state to pursue made by individual central banks in consultation with industry stakeholders. Such consultation is a vital element of any assessment of potential changes to RTGS operating hours in a jurisdiction. It can help identify the preferred end state, the path to reach that end state and the risks and challenges that may arise, as well as mitigants for these risks and challenges. In addition to determining which end state is preferable, central banks, payment system operators and industry stakeholders could consider additional factors associated with how and when an end state might be reached.

5.4.1 Potential implementation paths to future end states

The possible end states in this report could be achieved incrementally over time or through a "big bang" approach in which an end state is reached in a single step.[39] Consultation feedback suggests that the incremental approach might be preferred by industry participants in most jurisdictions, although the best approach for each jurisdiction will depend on its particular needs and challenges, and both approaches could support a collective long-term objective to expand the global settlement window. This subsection highlights different reasons why jurisdictions might prefer one implementation path over another to reach the desired end state.

Decisions regarding the potential implementation path should be considered carefully, with the needs of various stakeholders in mind (eg RTGS operators and participants, relevant authorities and end users). Jurisdictions might also consider the timing and implementation of other relevant initiatives, including interlinking frameworks, and regulatory, supervisory and oversight frameworks, which are also part of the G20 cross-border payments programme. The implementation of these initiatives may occur on a jurisdiction-specific basis but might need to be considered in tandem, to take account of the potential costs and benefits from overlapping or sequential implementation paths.

[39] As noted previously, a jurisdiction could also pursue an end state involving extended operating hours on current operating days (end state 1) and expanded operating days (end state 2). In doing so, a jurisdiction could consider whether and how to sequence the two elements of extended operating hours. In particular, a jurisdiction could consider achieving extended operating hours prior to expanded operating days, or vice versa. It could alternatively do the two expansions simultaneously.

One path that jurisdictions could pursue is to move to a particular end state by extending operating hours in incremental steps. This approach could bring near-term efficiency and risk reduction benefits to cross-border payments that could not be achieved through a longer-term big bang approach. For example, an incremental extension of operating hours could allow innovative cross-border payment services to develop more quickly than they would in a big bang extension scenario if the latter took longer to achieve. Incremental extensions could also allow stakeholders in specific jurisdictions (ie all interested parties in the payment ecosystem) to gain experience with progressively longer operating hours, which could help them to prepare for the operational, staffing and risk management needs of potentially more extensive operating hours in the long term.[40] An incremental approach could also allow for ongoing review of the costs and benefits to the extended hours at each step, taking into consideration the new evidence/information brought to light from recent extensions of operating hours.

Alternatively, some jurisdictions might prefer a big bang approach to reaching an end state in order to reduce their overall time and cost to reach that end state.[41] An incremental extension could increase overall costs relative to a big bang approach if the technology that supports an interim extension cannot be leveraged for further extensions. A big bang approach would allow payment system operators and participants to focus on building infrastructure and processes to support the target end state rather than multiple *interim* states over time. A variation of the big bang approach is a focus on building the technical capability to extend operating hours (eg up to 24/7). Extended operating hours could then be implemented incrementally once the technical capability is achieved.

5.4.2 Potential timelines for achieving the end states

Closely related to implementation paths are the timelines associated with achieving different end states. As with implementation paths, timelines should be flexible to account for different circumstances across jurisdictions. As a result, this report does not aim to identify a specific timeline for any end state. Instead, it presents various factors that jurisdictions might consider when choosing an implementation time frame.

A jurisdiction could view each proposed end state as an outcome to be achieved in the near term or in the long term. The appropriate time frame to reach an end state will depend on individual factors such as near-term demand, industry readiness, infrastructure choices, cost and risk management considerations, among others. A jurisdiction could also consider the extent to which potential implementation timelines would contribute to global efforts to enhance cross-border payments and support achieving associated global targets, such as those established for the G20 cross-border payments programme (FSB (2021a)).

6. Conclusion

The slow speed of cross-border payments is one of the four key challenges that the G20 cross-border payments programme aims to improve. As this report has described, speed frictions can be partly attributed to existing differences in RTGS systems' operating hours. The G20 cross-border payments programme considers the potential extension and alignment of operating hours across key payment systems to be an important element to address both speed and costs frictions in this market. By increasing the availability of payment systems across jurisdictions to process transactions, potential delays in their execution can be meaningfully reduced. The analysis in this report shows that, at present, the operating hours of RTGS systems vary significantly across jurisdictions, providing significant scope for extension of hours. Even within the same region, substantial gaps exist in the daily operating hours of these key payment infrastructures. These gaps become even greater when considering weekly availability, due to the typical lack of weekend operations, and are further exacerbated by lack of service availability on public holidays.

40 Incremental expansions could allow operators and participants to reduce their reliance on end-of-day and weekend downtime.

41 A big bang approach generally applies to significant expansions of operating hours, such as moving to weekend operations or to full 24/7 operations.

The extension and overlap (alignment) of RTGS operating hours across jurisdictions could certainly yield lasting benefits by improving the speed and reducing ancillary transaction costs of cross-border payments. At the same time, it is important to recognise that change does not come without adjustment costs, various risks and other issues that need to be addressed. Therefore, central banks and industry stakeholders could evaluate a potential change under a strategic light, consider its long-term impact and decide on the most appropriate way forward to strike the right balance between its expected payback and the potential consequences it may entail for the entire payments ecosystem, including end users.

Extending RTGS operating hours has broad implications. Its relevance is not limited to providers of RTGS services (mostly central banks), rather it also has implications for their participants and other industry stakeholders. All these parties will need to consider the profound impact such changes will bring, depending on the chosen strategy to increase the availability of key payment systems' operating hours. As such, this report presents three potential end states for central banks (as RTGS system operators) and other relevant payment system operators to consider as they assess their current operating hours and plan for the future. The associated operational, risk and policy considerations related to those end states are also relevant.

Looking forward, central banks and operators of other key cross-border payment systems can consider the applicability and desirability of each end state with differing degrees of ambition, preferably over a longer-term perspective. This report calls on central banks and the payments industry more broadly to reflect on the benefits and costs of extending RTGS operating hours while also taking into account the positive effects of overall coordination on the cross-border payments market and considering the global settlement window.

This report completes action 2 for BB 12, and attention now turns to development of technical and operational approaches to address key challenges associated with the extension of operating hours of key payment systems (as per the G20 roadmap for BB 12, further details can be found in Annex 5). More specifically, the CPMI will work to develop technical and operational approaches to support the respective end states for authorities and operators aiming to extend and align operating hours. On their end, central banks and payment system operators are encouraged to work with their participants and other stakeholders to consider the potential end states and their benefits, risks and challenges, to determine the best path forward for RTGS operating hours.

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[42] The Committee on Payment and Settlement Systems (CPSS) changed its name to Committee on Payments and Market Infrastructures (CPMI) in September 2014. References to reports published before that date use the Committee's old name.

Annex 1: Interdependencies between BB 12 and other BBs

Each BB in the G20 cross-border payments programme considers a specific area that could contribute to improvements in cross-border payments. However, the BBs are also interrelated in that the impact of one BB may depend on (or support) other BBs. Interdependencies between BBs is an area of active consideration for the workstreams tasked with advancing the BBs.

With respect to BB 12, extending the operating hours of key payment systems intersects with the benefits of other BBs. In some cases, extending operating hours can enable the advancement of other BB objectives:

– BB 9 (*"Facilitating increased adoption of payment-versus-payment (PvP) mechanisms")*: extending operating hours enables more overlapping between payment systems, thus providing more opportunities to settle cross-currency payments simultaneously via new or existing PvP mechanisms and arrangements;

– BB 11 (*"Exploring reciprocal liquidity arrangements across central banks")*: greater overlap of operating hours for payment systems operated by central banks can facilitate the development of new central bank liquidity bridges, supporting financial stability;

– BB 13 (*"Pursuing interlinking of payment systems for cross-border payments")*: greater overlap of operating hours across systems could allow interlinking arrangements to operate over prolonged time windows, which could facilitate timely settlement of a greater volume of transactions and mitigate operational risks stemming from the difficulty of managing incidents in a limited time frame. Even with the interlinking of FPS that operate 24/7, a greater overlap of RTGS operating hours can support liquidity management and may be necessary to affect settlement in some FPS; and

– BB 17 ("*Considering the feasibility of new multilateral platforms or arrangements for cross-border payments")*: as with interlinking, overlapping operating hours across multiple jurisdictions can pave the way for increasing the efficiency and time period for settlement in new or existing multilateral platforms.

These benefits may be proportionate to the extent RTGS system operating hours overlap, particularly for multicurrency systems or multilateral platforms which cover several time zones. The initiatives under these BBs may be considered to increase the demand/need for extended RTGS operating hours and, hence, they should be taken into account among the factors that influence jurisdictions' assessment of costs and benefits.

However, the benefits of extended and overlapped operating hours could be reduced without greater harmonisation in payment processing rules and standards at the payment system and beneficiary bank level. In this regard, BB 12's contribution to improved speed may be supported by enhancements provided by other data or compliance-related BBs, such as BB 3 (*"Defining common features of cross-border payment service levels"*), BB 5 (*"Applying AML/CFT rules consistently and comprehensively"*), BB 6 (*"Reviewing the interaction between data frameworks and cross-border payments"*) and BB 14 (*"Adopting harmonised ISO 20022 version for message formats"*).

Annex 2: Summary of the inputs received in the consultation

The CPMI received 27 responses to the public consultation. The responses were submitted by a range of parties in the payments ecosystem including banks, non-bank PSPs, operators of financial market infrastructures, industry trade associations and a central bank. The respondents also represented a range of jurisdictions around the world with many respondents having a global scope. Reflecting this heterogeneity in the respondents, the views and perspectives presented in the comments were similarly varied. Annex 2 provides an overview of the responses, while the full responses can be found on the CPMI's website.[43]

Benefits of extending RTGS operating hours

Most respondents to the consultation thought that extending and aligning RTGS operating hours would be a positive step towards improving cross-border payments, although they expressed a range of views on the potential benefits.

Some commenters strongly agreed that such extensions would materially contribute to achieving the cross-border payments targets endorsed by the G20, especially in terms of speed. Commenters also noted that extending RTGS operating hours could provide a range of additional benefits including reduced settlement risk, additional settlement cycles and off-hours funding for ancillary payment systems, improved liquidity management related to international business payments and expanded FX capabilities for market participants. On the other hand, a few commenters disagreed that extending RTGS operating hours would provide significant benefits, citing limited demand and significant costs as key challenges to such extensions. Some of these commenters argued that adjustment costs for participants could ultimately yield higher costs for end users.

Commenters also presented a number of qualifications and considerations around the benefits of extending RTGS operating hours. Many commenters emphasised that extending RTGS operating hours alone would not be sufficient to advance the G20 targets, pointing to other actions that could reinforce (or substitute for) such extensions. A number of commenters suggested that extending RTGS operating hours would most directly benefit wholesale payments, such as large-value interbank and corporate payments, with more indirect benefits, if any, for retail payments and remittances. Several commenters suggested that other approaches, such as interlinking FPS and central bank digital currencies (CBDCs), should be explored as potential ways to make more rapid and potentially lower-cost improvements to speed for end users. In addition, some respondents suggested that extending RTGS operating hours would make limited contributions to cross-border payment speed without addressing other areas like service levels (BB 3); AML/CFT rules (BB 5); data frameworks (BB 6); and ISO 20022 (BB 14).

End states for RTGS operating hours and the global settlement window

In general, respondents thought that the three end states capture the key scenarios for central banks to consider, although views on the optimal end state varied. Preferences for a particular end state fell on a spectrum from most practical to most future-oriented, recognising the increasing level of effort required to reach 24/7 operations, and that end state 2 may be considered a step towards reaching 24/7 operations, among other views. Almost all of those that stated a preference favoured either end state 1 (extended hours on current operating days) or end state 3 (24/7 operations).

Those in favour of end state 1 highlighted the substantial costs of and limited demand for extending into the weekend and especially to 24/7. These commenters noted that extensions on current business days would be sufficient to realise significant benefits, particularly for wholesale payments, at manageable costs. In contrast, those in favour of end state 3 considered 24/7 RTGS operating hours to be reflective of the future payments landscape and the only way to realise significant benefits to cross-border payments. Some of these commenters argued that 24/7 RTGS operating hours should be the aspirational

[43] See https://www.bis.org/cpmi/publ/comments/d199/overview.htm

target, although they acknowledged that the path to reaching 24/7 operations would take time and may vary across jurisdictions.

Commenters generally supported the concept of the global settlement window as a useful tool to consider the aggregate implications of a coordinated expansion of RTGS hours. Some further refinements were suggested, including consideration of (i) the most used/demanded currencies and corridors; (ii) regional or bilateral settlement windows; and (iii) specific country operating/access requirements that impact the practical ability to settle cross-border payments. Some commenters viewed the global settlement window to be useful primarily when considering FX transactions or transactions in the major currencies.

Considerations related to extending RTGS operating hours

Many commenters expressed the view that there is no one-size-fits-all approach to extending RTGS operating hours across jurisdictions, with most commenters favouring a gradual approach to extend hours rather than a "big bang" approach, particularly when moving to 24/7 operations. Some commenters suggested that each individual jurisdiction undertake a full analysis of the business case for extending RTGS operating hours to decide on an end state (and the path to it) that best optimises the costs/benefits for that jurisdiction.

In general, commenters thought that operational and risk considerations become more challenging as operating hours extend into new operating days. As such, commenters considered end state 2 and, especially, end state 3 to be most challenging. However, commenters noted that the level of difficulty of each end state largely depends on the specificities of each jurisdiction.

Commenters emphasised a number of key considerations including (i) liquidity management needs of participants; (ii) resource needs and costs for the operator and participants; (iii) fraud and operational risks; (iv) the ability to carry out system maintenance or onboard new participants (tasks that are currently performed during down hours); and (v) downstream effects on other systems and markets. Many commenters also stressed the importance of business day definitions and value date conventions as key considerations when expanding RTGS operating hours. These commenters noted the importance of such conventions across jurisdictions in a cross-border payments context.

To mitigate the challenges of extending operating hours, commenters suggested that RTGS system operators focus on the transition approach, liquidity risk management and internal and external coordination. Regarding the former, commenters noted that a phased approach and clear time frame for extending RTGS operating hours would give participants time to adapt to new operating hours. A few commenters also suggested that participants would benefit from an option not to participate in some or all of the extended operating hours given that not all participants have the same capabilities, resources or needs. According to one commenter, such optional participation would need to be transparent, potentially in the form of a participant directory, to support informed payment and liquidity management by RTGS participants and their end customers. Regarding liquidity risk, commenters emphasised that participants should have sufficient access to liquidity during extended hours, which could include access to central bank liquidity facilities. Finally, commenters emphasised that a successful transition to extended RTGS operating hours would require significant coordination and collaboration on several levels. Many commenters emphasised the importance of engaging with a range of internal and external stakeholders as part of an assessment of future operating hours to take into account the diverse impacts of extending RTGS hours.

Annex 3: Tables and figures

Daily RTGS operating hours on working days

Extent of daily operating hours

Table A1

		All jurisdictions	Jurisdiction category		Economic category[1]		Region		
			CPMI	Non-CPMI	AE	EMDE	AM	EMEA	APAC
All hours	No of jurisdictions	62	21	41	14	48	19	28	15
	Average daily hours	10.9	15.2	8.7	12.9	10.3	11.6	10.0	11.7
Low hours (hours/day ≤ 8)	No of jurisdictions	21	1	20	1	20	6	12	3
	Average daily hours	7.3	7.5	7.3	8.0	7.3	7.6	7.2	7.6
Moderate hours (8 < hours/day ≤ 16)	No of jurisdictions	33	12	21	10	23	10	13	10
	Average daily hours	10.5	11.3	10.0	10.9	10.3	11.0	9.8	10.8
High hours (16 < hours/day ≤ 23)	No of jurisdictions	4	4	0	2	2	2	1	1
	Average daily hours	20.3	20.3	-	20.3	20.4	20.3	20.0	20.8
Very high hours (hours/day > 23)	No of jurisdictions	4	4	0	1	3	1	2	1
	Average daily hours	23.8	23.8	-	23.5	23.8	24.0	23.8	23.5

AE = Advanced economies; AM = Americas; APAC = Asia-Pacific; EMDE = Emerging market and developing economies; EMEA = Europe, Middle East and Africa.

[1] Classification based on International Monetary Fund (IMF) criteria.

Source: CPMI survey.

Weekly RTGS operating hours for non-holiday weeks

Extent of weekly operating hours — Table A2

		All jurisdictions	Jurisdiction category		Economic category[1]		Region		
			CPMI	Non-CPMI	AE	EMDE	AM	EMEA	APAC
All hours	No of jurisdictions	62	21	41	14	48	19	28	15
	Average weekly hours	57.9	83.6	44.8	66.0	55.5	62.2	52.9	61.7
Low hours (hours/week ≤ 56)	No of jurisdictions	44	7	37	8	36	11	24	9
	Average weekly hours	42.5	47.9	41.5	48.9	41.1	41.5	42.5	43.8
Moderate hours (56 < hours/week ≤ 112)	No of jurisdictions	14	10	4	5	9	7	2	5
	Average weekly hours	77.4	78.4	74.9	79.5	76.2	79.6	80.0	73.3
High hours (112 < hours/week ≤ 161)	No of jurisdictions	1	1	0	1	0	0	1	0
	Average weekly hours	135.5	135.5	-	135.5	-	-	135.5	-
Very high hours (hours/week > 161)	No of jurisdictions	3	3	0	0	3	1	1	1
	Average weekly hours	166.8	166.8	-	-	166.8	168.0	168.0	164.5

AE = Advanced economies; AM = Americas; APAC = Asia-Pacific; EMDE = Emerging market and developing economies; EMEA = Europe, Middle East and Africa.

[1] Classification based on IMF criteria.

Source: CPMI survey.

RTGS operating status on weekends and holidays[1]

Number of jurisdictions — Table A3

	All jurisdictions	Jurisdiction category		Economic category[2]		Region		
		CPMI	Non-CPMI	AE	EMDE	AM	EMEA	APAC
All systems	62	21	41	14	48	19	28	15
Systems operating on								
One weekend day	3	0	3	0	3	0	3	0
Two weekend days	5	4	1	1	4	2	2	1
Public/bank holidays	7	5	2	2	5	2	3	2
Public/bank holidays and two weekend days	5	4	1	1	4	2	2	1

AE = Advanced economies; AM = Americas; APAC = Asia-Pacific; EMDE = Emerging market and developing economies; EMEA = Europe, Middle East and Africa.

[1] Weekends are defined as Friday and Saturday for the Middle East; Saturday for Nepal; and Saturday and Sunday elsewhere. [2] Classification based on IMF criteria.

Source: CPMI survey.

Average total gaps in RTGS operating hours per day on working days by region

Average number of hours Table A4

		Region			All regions
		APAC	EMEA	AM	
CPMI jurisdictions					
Region	APAC	13.6	15.3	15.4	14.9
	EMEA		13.2	12.7	14.0
	AM			9.9	13.6
	All regions				14.0
All jurisdictions (CPMI and non-CPMI)					
Region	APAC	15.4	18.2	21.0	18.8
	EMEA		16.7	19.9	18.5
	AM			15.7	19.5
	All regions				17.8

AM = Americas; APAC = Asia-Pacific; EMEA = Europe, Middle East and Africa.

Source: CPMI survey.

Average total gaps in RTGS operating hours per week by region

Average number of hours Table A5

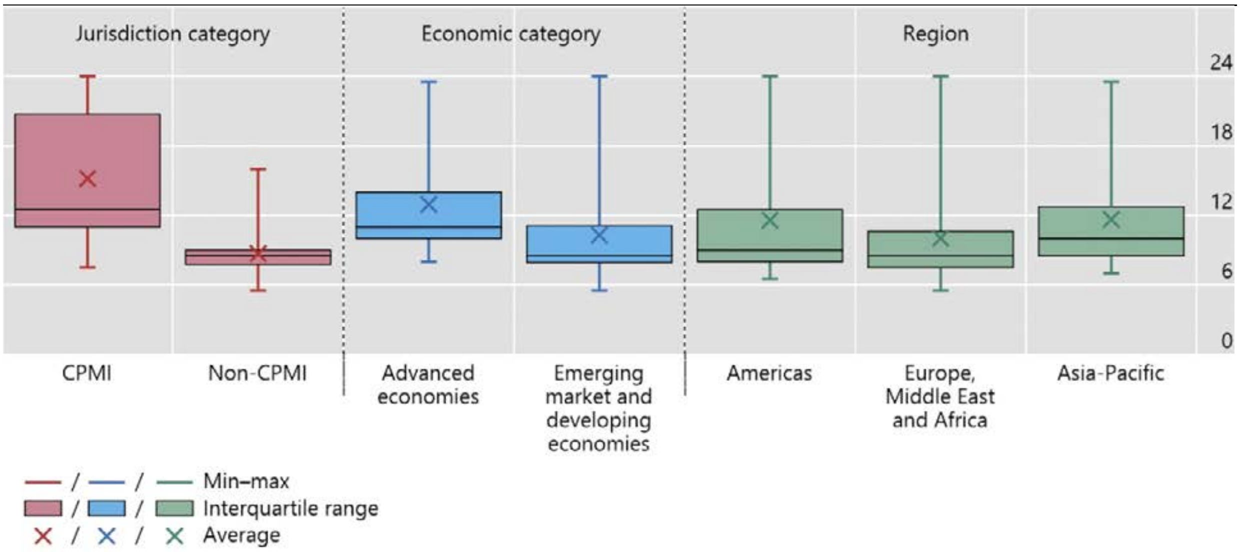
		Region			All regions
		APAC	EMEA	AM	
CPMI jurisdictions					
Region	APAC	115.9	124.2	125.0	122.7
	EMEA		114.9	110.4	118.1
	AM			97.3	115.4
	All regions				118.1
All jurisdictions (CPMI and non-CPMI)					
Region	APAC	125.4	139.6	153.4	142.6
	EMEA		133.4	147.7	141.3
	AM			126.0	145.6
	All regions				138.0

AM = Americas; APAC = Asia-Pacific; EMEA = Europe, Middle East and Africa.

Source: CPMI survey.

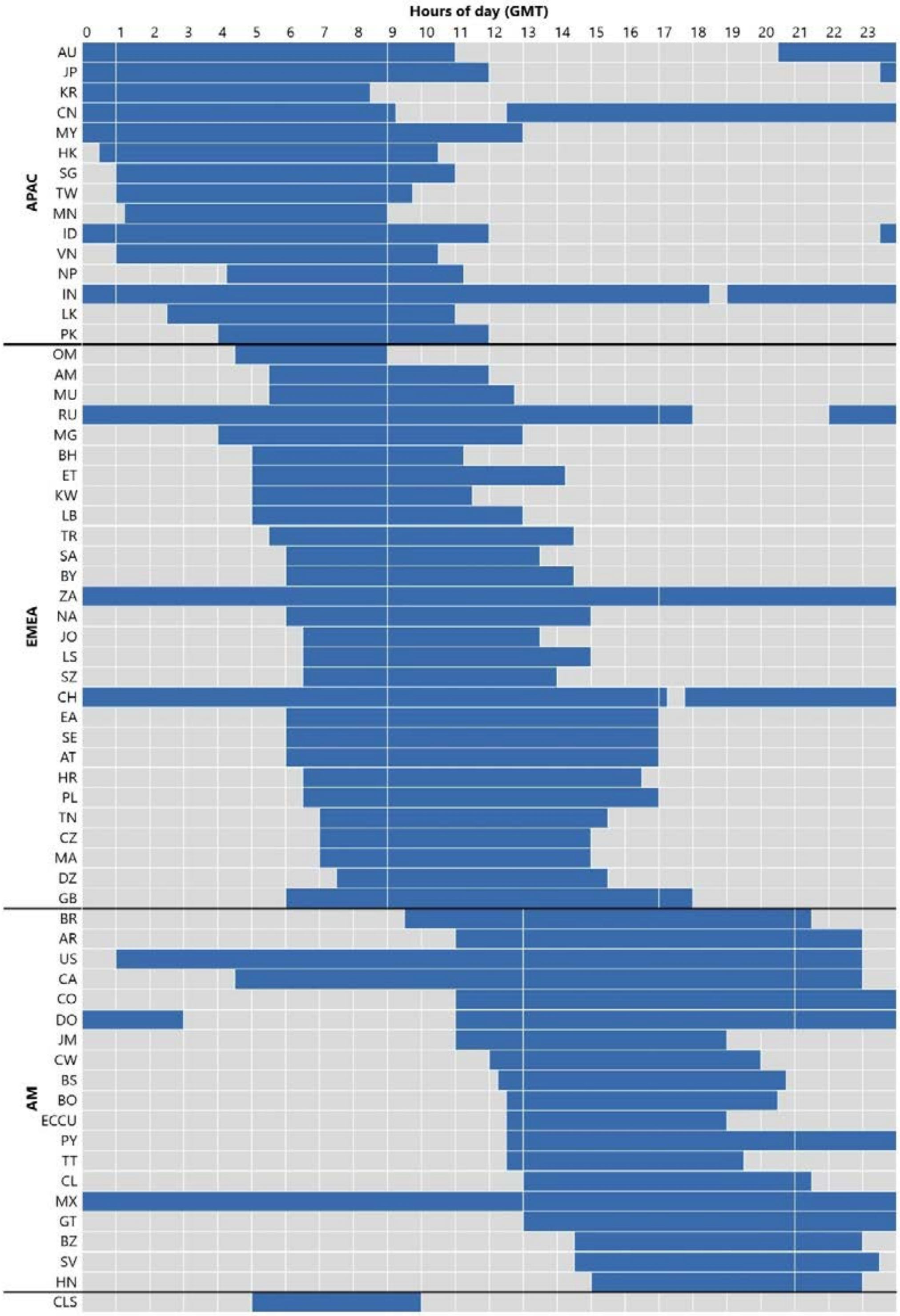
Distribution of daily RTGS operating hours on working days

Operating hours Graph A1



Source: CPMI survey.

RTGS operating hours on working days (GMT) for all jurisdictions per region① Graph A2

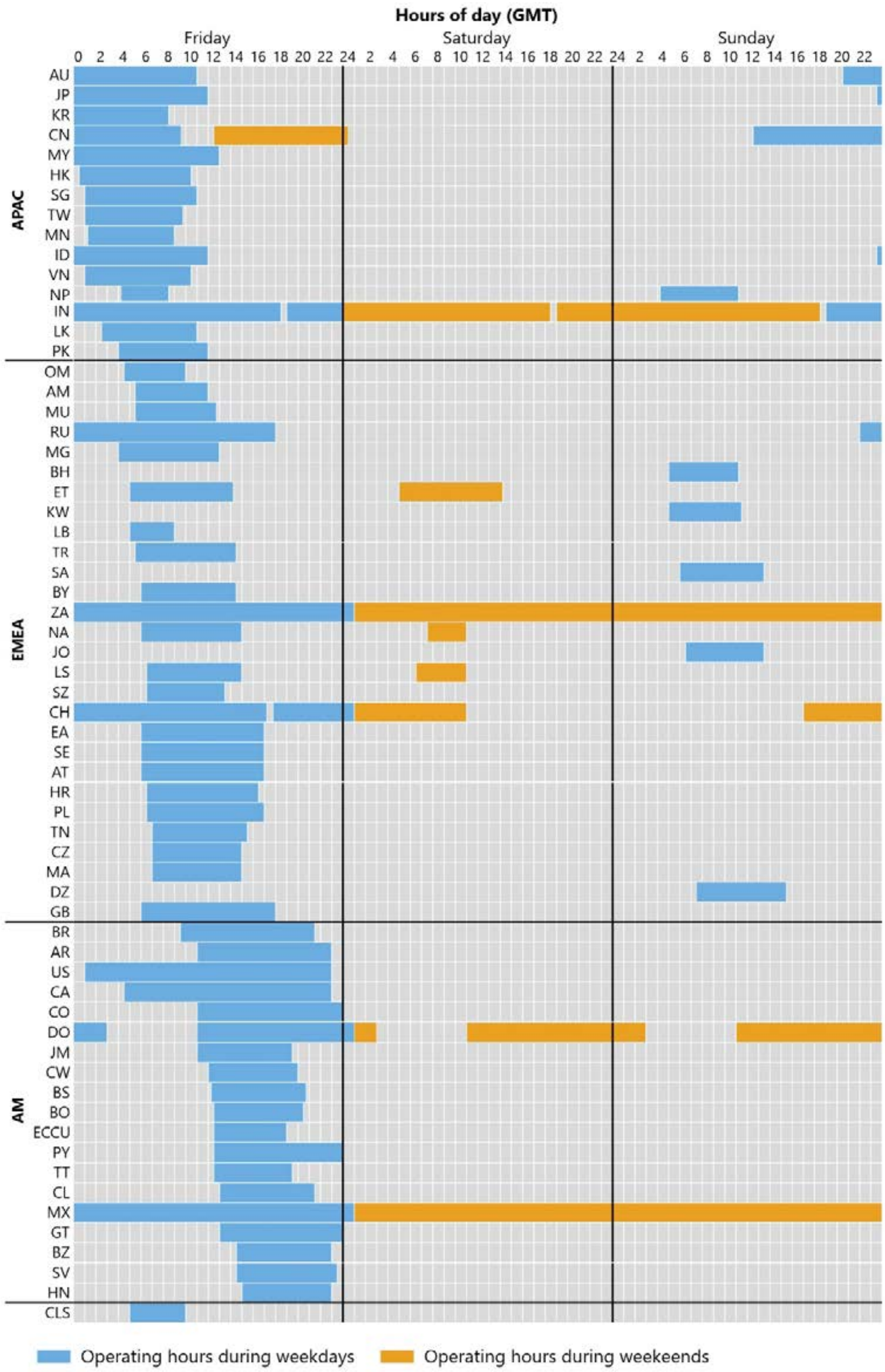


Jurisdictions ISO codes and acronyms are used. For the complete names, please refer to Annex 4, Table A6. CLS = CLS Bank.

Source: CPMI survey.

① The stocktake was conducted in the first quarter 2021.

RTGS operating hours on weekends (GMT) for all jurisdictions per region① | Graph A3



Jurisdictions ISO codes and acronyms are used. For the complete names, please refer to Annex 4, Table A6. CLS = CLS Bank.

Source: CPMI survey.

① The stocktake was conducted in the first quarter 2021. For Nepal, the weekend is only on Saturday, while for Algeria, Bahrain, Jordan, Kuwait and Saudi Arabia the weekend is from Friday to Saturday.

Annex 4: RTGS systems in scope of this report

RTGS systems in scope of this report① Table A6

Jurisdiction (ISO code)	Name of the RTGS system
Algeria (DZ)	Algeria Real Time Settlements System (ARTS)
Argentina (AR)	Mercado Electronico de Pagos (MEP)
Armenia (AM)	Electronic payment systems (EPS)
Australia (AU)	Reserve Bank Information and Transfer System (RITS)
Austria (AT)	ASTI
Bahrain (BH)	Real Time Gross Settlement System (RTGS)
Belarus (BY)	Belarus Interbank Settlement System (BISS)
Belize (BZ)	Automated Payment and Securities Settlement System (APSSS)
Bolivia (BO)	Sistema de Liquidación Integrada de Pagos (LIP)
Brazil (BR)	STR – Sistema de Transferência de Reservas
Canada (CA)	Lynx
Chile (CL)	Sistema de Liquidación Bruta en Tiempo Real (Sistema LBTR)
China (CN)	HVPS
Colombia (CO)	Sistema de Cuentas de Depósito LBTR – CUD
Croatia (HR)	Croatian Large Value Payment System – CLVPS
Curacao (CW)	National Automated Clearing & Settlement system (NACS3)
Czech Republic (CZ)	CERTIS
Dominican Republic (DO)	Real Time Gross Settlement System (RTGS)
Eastern Caribbean Currency Union (ECCU)	RTGS
El Salvador (SV)	Sistema de Liquidación en Tiempo Real (LBR)
Eswatini (SZ)	RTGS
Ethiopia (ET)	Ethiopian Automated Transfer System/RTGS system
Euro area (EA)	TARGET2
Guatemala (GT)	Real Time Gross Settlement System (RTGS)
Honduras (HN)	Sistema Banco Central de Honduras en Tiempo Real (BCH-TR)
Hong Kong SAR (HK)	HKD CHATS
India (IN)	Real Time Gross Settlement (RTGS)
Indonesia (ID)	Bank Indonesia Real-Time Gross Settlement System
Jamaica (JM)	JamClear® Realtime Gross Settlement System (RTGS)
Japan (JP)	BOJ-NET Funds Transfer System (BOJ-NET FTS)
Jordan (JO)	Real Time Gross Settlement System (RTGS-JO)
Kuwait (KW)	Kuwait's Automated Settlement System for Inter-participant Payments (KASSIP)
Lebanon (LB)	BDL RTGS
Lesotho (LS)	Real Time Gross Settlement system – RTGS(LSW)
Madagascar (MG)	RTGS
Malaysia (MY)	Real-time Electronic Transfer of Funds and Securities System (RENTAS)
Mauritius (MN)	Mauritius Automated Clearing and Settlement System MACSS
Mexico (MX)	Interbanking Electronic Payment System (SPEI)
Mongolia (MN)	Banksuljee RTGS system
Morocco (MA)	Système de Reglements Bruts du Maroc (SRBM)

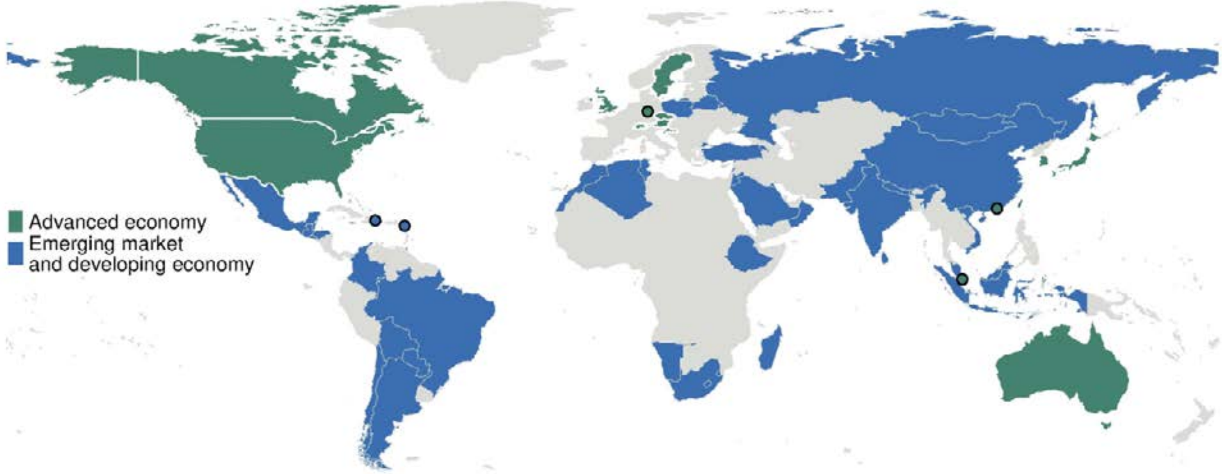
Jurisdiction (ISO code)	Name of the RTGS system
Namibia (NA)	Namibia Inter-bank Settlement System (NISS)
Nepal (NP)	Real Time Gross Settlement
Oman (OM)	Real Time Gross Settlement (RTGS) System
Pakistan (PK)	Pakistan Real-time Interbank Settlement Mechanism (PRISM) – RTGS
Paraguay (PY)	Real Time Gross Settlement – RTGS
Poland (PL)	SORBNET2
Russia (RU)	Bank of Russia Payment System (BoR PS)
Saudi Arabia (SA)	Saudi Arabian Riyal Interbank Express (RTGS System)
Singapore (SG)	New MAS Electronic Payment and Book-Entry System (MEPS+)
South Africa (ZA)	South African Multiple Option Settlement (SAMOS)
South Korea (KR)	Bank of Korea Financial Wire Network (Bok-Wire+)
Sri Lanka (LK)	LankaSettle System
Sweden (SE)	RIX-RTGS
Switzerland (CH)	Swiss Interbank Clearing (SIC)
Chinese Taipei (TW)	CBC Interbank Funds Transfer System (CIFS)
The Bahamas (BS)	Bahamas Interbank Settlement System/Real Time Gross Settlement System (BISS/RTGS)
Trinidad and Tobago (TT)	Settlement Assured for Financial Exchange in Trinidad and Tobago (Safe-tt)
Tunisia (TN)	Tunisia's large amounts transfer system (SGMT)
Turkey (TR)	EFT– Electronic Fund Transfer System
United Kingdom (GB)	CHAPS
United States (US)	Fedwire Funds Service
Vietnam (VN)	National Interbank Payment System – IBPS

Source: CPMI survey.

① The stocktake was conducted in the first quarter 2021.

RTGS systems by economic region①

Graph A4



The use of this map does not constitute, and should not be construed as constituting, an expression of a position by the BIS regarding the legal status of, or sovereignty of any territory or its authorities, to the delimitation of international frontiers and boundaries and/or to the name and designation of any territory, city or area.

The categorisation of jurisdictions into advanced economies (AE) and emerging market and developing economies (EMDE) is based on the World Economic Outlook (WEO) International Monetary Fund (IMF) classification.

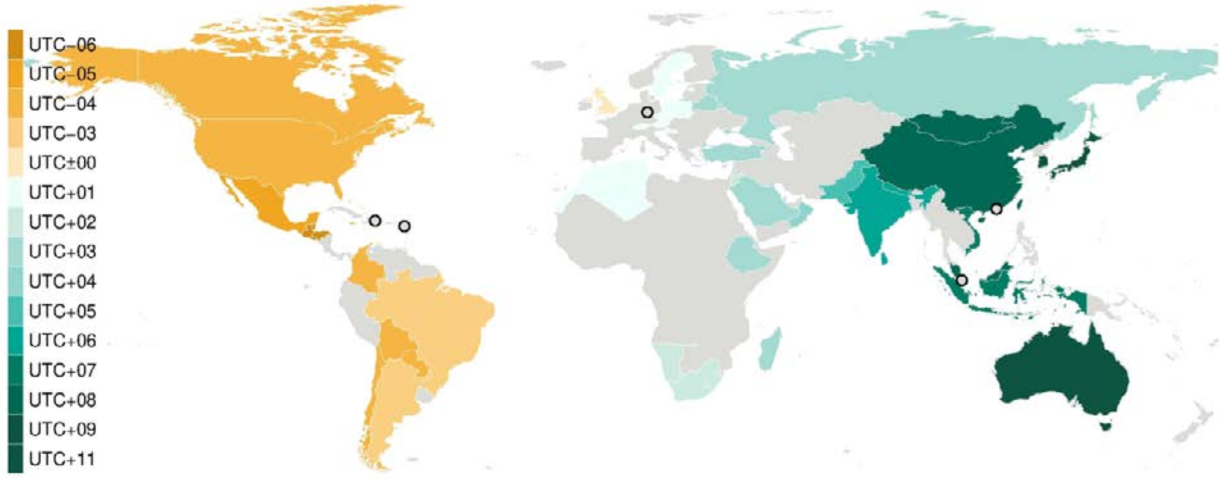
The circle in Europe represents TARGET2. The RTGS systems in the Dominican Republic, the Eastern Caribbean Currency Union (ECCU) countries, Hong Kong SAR and Singapore are also represented by circles.

Source: CPMI survey.

① The stocktake was conducted in the first quarter 2021.

Time zones of the RTGS systems①

Graph A5



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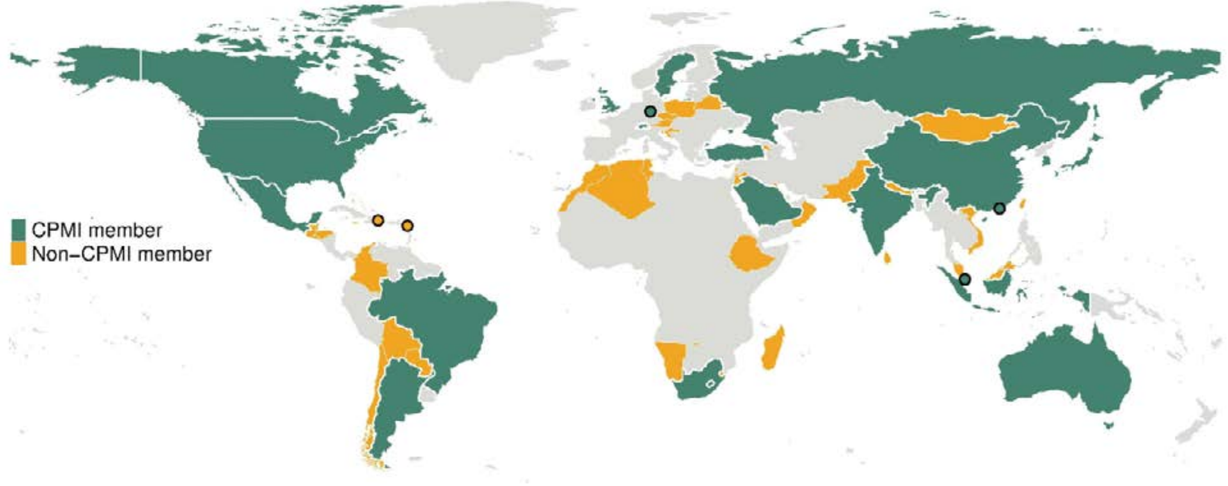
The circle in Europe represents TARGET2. The RTGS systems in the Dominican Republic, the Eastern Caribbean Currency Union (ECCU) countries, Hong Kong SAR and Singapore are also represented by circles.

Source: CPMI survey.

① The stocktake was conducted in the first quarter 2021.

RTGS by CPMI membership[1]

Graph A6



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The circle in Europe represents TARGET2. The RTGS systems in the Dominican Republic, the Eastern Caribbean Currency Union (ECCU) countries, Hong Kong SAR and Singapore are also represented by circles.

Source: CPMI survey.

[1] The stocktake was conducted in the first quarter 2021.

Annex 5: Actions and milestones for BB 12

The full actions and milestones for BB 12 ("*Extending and aligning operating hours of key payment systems to allow overlapping*") are outlined below, based on the G20 roadmap (FSB (2020b)). The dates for each milestone in the table indicate the start date and completion date for the steps described in the milestone. For all actions in 2021 and 2022, actions and dates are committed deliverables. The content of actions and dates of milestones beyond end-2022 are indicative (see FSB (2020b, 2021b)).

Actions and milestones

Action 1: Identification of payment systems relevant for (global) cross-border payments and stocktake of their operating hours.

CPMI to consolidate information on current operating hours and planned expansion efforts in order to identify potential remaining gaps in overlap/alignment of operating hours across jurisdictions and collect quantitative data to help identify which payment systems and currency corridors are most relevant.

November 2020–January 2021.

Action 2: Setting out potential future operating hour "end states" to support enhanced cross-border payments, analysis of risks and policy considerations, and potential solutions to address them.

CPMI to set out potential future "end states" of key payments systems operating hours and how these could enhance cross-border payments, and to identify any risks including operational, cyber and fraud; credit and liquidity; monetary policy considerations; financial structure and financial stability considerations; and resolution policy considerations for each "end state". To identify potential solutions to mitigate or address these key risks or policy considerations via a publication.

February 2021–March 2022.

Action 3: Development of technical and operational approaches on how to address key challenges.

CPMI to develop technical and operational approaches on entity-level and/or required industry-wide rule changes to support the respective "end states" for authorities and operators aiming to extend/align operating hours.

April 2022–September 2022.

Central banks and payment system operators wishing to align/extend operating hours to work with their direct participants and other domestic stakeholders to consider each of the potential "end states", along with the associated challenges, risks and potential solutions that have been identified, with the goal of seeking consensus on if, and how best, to move forward.

June 2022–May 2023.

Annex 6: Cross-border Payments Expansion Workstream

Chair of the Workstream	Carlos Conesa (Bank of Spain)
Members	
Reserve Bank of Australia	Grant Turner[1]
National Bank of Belgium	Reinout Temmerman
Bank of Canada	Annetta Ho[1] [until November 2021] Sajjad Jafri [from November 2021]
Bank of France	Nicolas Peligry Pierre Berger (Alternate)[2]
Hong Kong Monetary Authority	Jessica Szeto Angel Lam (Alternate)
Reserve Bank of India	Visvanathan Srinivasan Satish Singh (Alternate)
Bank Indonesia	Butet Linda Nenden Endah Sari (Alternate)
Bank of Italy	Enrica Detto
Bank of Japan	Masami Inoue[1] Hironori Ishizaki (Alternate) [until June 2021] Seiya Hikuma (Alternate) [since June 2021]
Bank of Korea	Youngsun Yoo [since June 2021] Jisoon Park [since October 2021] Yunhwa Kim (Alternate) [until February 2022]
Netherlands Bank	Ellen Naudts[1, 2] Judy van der Graaf (Alternate) [since September 2021]
Central Bank of the Russian Federation[±]	Andrey Shamrayev [until February 2022]
Saudi Central Bank	Lamya Alhumaid
South African Reserve Bank	Annah Masoga Peter Makgetsi (Alternate) Pearl Malumane (Alternate)
Bank of Spain	Esther Barruetabeña[2] [until September 2021] Sergio Gorjón Rivas[1, 2] [since September 2021] Ana Fernández Bedoya[1, 2] (Alternate) Justo Arenillas (Alternate)

[±] The access of the Central Bank of the Russian Federation to all BIS services, meetings and other BIS activities has been suspended.

Swiss National Bank	Basil Guggenheim[1] Maurizio Denaro (Alternate)
Central Bank of the Republic of Türkiye	Bilal Taşkın Ömer Cem Aksoy (Alternate)
Bank of England	John Jackson* Michaela Costello (Alternate)[2] Lisa Gupta (Alternate)[2] [until August 2021] Michael Pywell (Alternate)[1] [until September 2021] Abigail Whiting (Alternate)[2] Anna Koch (Alternate)[1]
Board of Governors of the Federal Reserve System	Mark Manuszak** Kathy Wilson (Alternate) [until June 2021] Aaron Compton (Alternate) [2] Priyanka Slattery (Alternate)[1]
Federal Reserve Bank of New York	John Rutigliano [until September 2021] Heidy Medina [since September 2021][2] Vanessa Lee (Alternate) [2] Emilie Walgenbach (Alternate)[1]

Observers

Basel Committee on Banking Supervision	Stefan Hohl
Financial Stability Board	Kieran Murphy Alexandre Stervinou (Alternate) [until September 2021] Kris Natoli (Alternate) [from February 2022]
International Monetary Fund	Anca Paduraru Tommaso Mancini Griffoli (Alternate)
World Bank Group	Gynedi Srinivas

Secretariat

CPMI Secretariat	Boniswa Khohliso (Secretary) [until December 2021] Raúl Morales (Secretary) [from December 2021] Thomas Lammer

* Lead of the drafting team for BB 10
** Lead of the drafting team for BB 12
[1] Core BB 10 drafting team member
[2] Core BB 12 drafting team member

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Regis Bouther (Bank of England) and Ilaria Mattei (Bank for International Settlements) provided data support to the Workstream.

Annex 7: Acronyms and abbreviations

AE	advanced economies
AM	Americas
APAC	Asia-Pacific
BB	building block
BIS	Bank for International Settlements
CPMI	Committee on Payments and Market Infrastructures
EMDE	emerging market and developing economies
EMEA	Europe, Middle East and Africa
FMI	financial market infrastructure
FPS	fast payment system
FSB	Financial Stability Board
FX	foreign exchange
GMT	Greenwich Mean Time
gpi	Global Payments Innovation
G20	Group of Twenty
IMF	International Monetary Fund
IOSCO	International Organization of Securities Commissions
LVPS	large-value payment system
PFMI	Principles for Financial Market Infrastructures
PSP	payment service provider
PvP	payment-versus-payment
RTGS	real-time gross settlement
SWIFT	Society for Worldwide Interbank Financial Telecommunication
WEO	World Economic Outlook