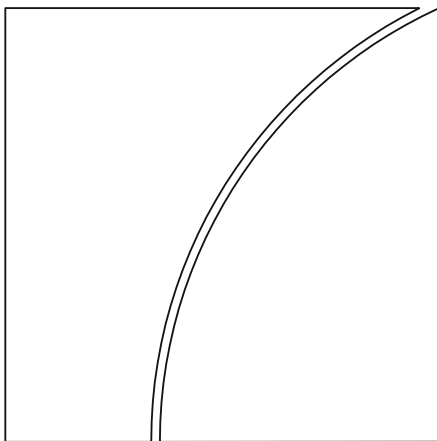


Committee on Payments and Market Infrastructures

Technical report



Operational and technical considerations for extending and aligning payment system operating hours for cross-border payments: An analytical framework

February 2023



BANK FOR INTERNATIONAL SETTLEMENTS

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Executive summary

This technical report by the Bank for International Settlements' Committee on Payments and Market Infrastructures (CPMI) provides an analytical framework to assist central banks and operators planning to extend real-time gross settlement (RTGS) system operating hours.

RTGS systems provide the foundation on which other payment systems and cross-border payment arrangements rely. Limited RTGS system operating hours can lead to delays in cross-border payments settlement. An extension and alignment of RTGS system operating hours across jurisdictions could help to speed up cross-border payments, especially between jurisdictions with significant time zone differences. It could also improve liquidity management, reduce settlement risk and enhance the performance of cross-border payment arrangements. To this end, extended RTGS system operating hours could facilitate faster, cheaper, more accessible and more transparent cross-border payments in line with the G20 targets. Beyond these direct benefits, extending operating hours can play a pivotal role as an enabler of – or even a prerequisite to – other building blocks. In particular, extending RTGS operating hours can support the payment-versus-payment (PvP) settlement of foreign exchange (FX) transactions. The adoption of a harmonised version of ISO 20022 message formats would promote increased interoperability, which, when combined with greater overlap of RTGS hours, could increase the end-to-end speed of certain cross-border payments. These interdependencies reflect the foundational importance of key payment systems for both domestic payments and cross-border payments.

The options for extending and aligning RTGS system operating hours for cross-border payments could range from an incremental increase in operating hours on current operating days (defined as end state 1), to an increase including current non-operating days (end state 2) and finally to an extension to full 24-hour and seven-day-a-week operations (end state 3). To understand how operating hour extensions in specific jurisdictions could expand overlaps with RTGS system operating hours at a global level, central banks and operators can consider the concept of a "global settlement window" (CPMI (2022)).

This report presents a systematic three-step approach building on the CPMI report "Extending and aligning payment system operating hours for cross-border payments". It includes a series of guiding questions to help a central bank and/or RTGS system operator planning to align/extend current RTGS system operating hours to develop a strategy in consultation with industry stakeholders.

In a first step, a central bank and/or operator should determine the most appropriate nature of the RTGS system operating hours extension, such as earlier opening, later closing or operation on additional days. An evaluation of the most effective extension vis-à-vis relevant cross-border payment corridors and/or the global settlement window could inform this decision. Secondly, a central bank and/or operator should identify technical and operational issues that come with the envisaged operating hours extension. Technical issues include RTGS system infrastructure changes and adaptations to processes such as RTGS system maintenance windows. Operational issues include staffing adaptations, changes to risk and liquidity management procedures and changes to the cost recovery and pricing policies. Based on these considerations a central bank and/or operator can develop an implementation plan, with shorter- and longer-term milestones.

Payment system interoperability and extension is one of the priority themes to help to achieve the G20 targets for cross-border payments (FSB (2022)). Extending and aligning RTGS system operating hours will be an important contribution in that regard. Central banks and/or operators considering potential extensions to their RTGS system operating hours are encouraged to use this report and previous work of the CPMI (CPMI (2022)) as a guiding framework. In doing so, central banks and/or operators may also wish to consider the guidance developed in other G20 cross-border payment programme building blocks. Going forward, the CPMI will continue to assist member jurisdictions and other central banks to exchange information and experiences on how to assess and implement options to extend RTGS system operating hours.

1. Introduction

The purpose of this CPMI technical report is to provide a systematic approach for central banks¹ considering how to deliver the benefits of extended RTGS system operating hours. It suggests a series of guiding questions to help determine the most appropriate extension, evaluate specific technical and operational issues and determine an implementation plan. The report does not attempt to provide an exhaustive list of questions or specific answers to such questions, as operational and technical aspects may differ significantly across jurisdictions. This systematic approach allows for flexibility in adapting to such differences but, in any case, each central bank might take its own approach to pursuing an extension of the RTGS system operating hours.

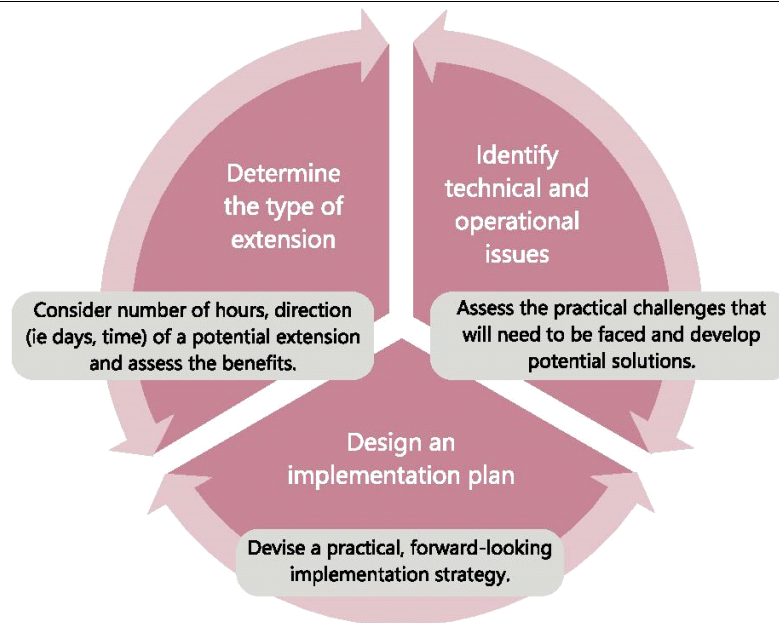
In 2022, the CPMI introduced three options (ie end states) for extending RTGS system operating hours to enhance for cross-border payments. The potential end states range from incremental increases in operating hours on current operating days (end state 1), to the inclusion of current non-operating days (end state 2) and finally to an extension to full 24-hour and seven-day-a-week (end state 3). This report considers, primarily, the extension on current operating days (ie end state 1) as this option might involve minimum changes and, therefore, may be the most achievable in the short term.² However, mitigating the frictions affecting cross-border payments as well as other payments developments in general (eg growing demand for fast payments) could point towards larger extensions of RTGS system operating hours. Therefore, some central banks may wish to consider extensions to end state 2 and/or 3 in the short term while others may do so either in the medium term or potentially as part of a longer-term strategic plan for RTGS system operating hours. As such, this report also considers how certain technical and operational aspects would apply (or change) in those end states.

When planning an extension of RTGS system operating hours, central banks would benefit from a systematic assessment in three broad areas, as illustrated in Graph 1. This evaluation is conceived as an iterative process in which a central bank conducts analysis, in consultation with industry stakeholders, gains information and draws lessons that it can continuously incorporate to update and enhance its extension strategy. In particular, new information and lessons learned in one step may cause a central bank to revisit its analysis in another step. Such a process could help central banks to determine their respective desired end states, thus providing them with an analytical tool to compare scenarios and to identify the one that best balances benefits and costs.

In this iterative process, as a first step, a central bank should determine the nature of the desired extension of RTGS system operating hours. This involves identifying the point at which significant benefits materialise from an extension (eg an earlier open and/or later close). The relevant benefits can accrue for both domestic and cross-border payments. For cross-border payments, improvements to, for example, payments speed can depend on (i) how changes in operating hours improve the overlap for a jurisdiction's RTGS system vis-à-vis other jurisdictions' systems; (ii) demand for payments at different times of the day; and (iii) demand for payments between country corridors. For domestic payments, the advantages may depend on the extent to which specific payment, clearing and settlement systems and different users could benefit from additional RTGS system operating hours.

¹ Various parties, including RTGS system participants, will face technical and operational issues associated with an extension in RTGS operating hours. The current report focuses on these issues from the perspective of the central bank as the RTGS operator. In some jurisdictions (eg Canada), an entity other than the central bank operates the RTGS system. In the light of these variants, the discussion in this report should be viewed as addressing considerations for central banks and/or RTGS system operators, although for simplicity of presentation, the report will use the term central bank throughout.

² Industry feedback on the action 2 consultative report indicated support for end state 1 in the short-term, even as some respondents expressed support for end state 3 as a longer-term target.



Source: CPMI.

As a second step, a central bank should identify and assess specific technical and operational issues that apply to the desired RTGS system operating hours. Such issues include changes to (i) RTGS system infrastructure (ie hardware, software and related applications); (ii) system maintenance processes; (iii) measures to mitigate operational risk and support system recovery in the event of an operational disruption; (iv) start-of-day (SoD) and end-of-day (EoD) processes; (v) liquidity management measures; (vi) staffing; and (vii) cost recovery and pricing. An extension of RTGS system operating hours on current operating days (end state 1) may involve relatively modest adjustments in these areas depending on the length of the extension, although it would still be important for a central bank to perform a systematic assessment of these issues. An extension to new operating days (end state 2) or especially 24/7 operations (end state 3) may require more significant adjustments, but could also provide an opportunity for process improvements or broader system upgrades.

Finally, a central bank pursuing an operating hours extension should ensure that solutions to the identified challenges are part of a comprehensive implementation plan that incorporates robust feedback and engagement from key stakeholders, considers the effect on the payment ecosystem as a whole, supports potential future extensions and takes into account potential changes in other jurisdictions.

The report is organised as follows. Section 2 presents some considerations for central banks when determining the extension of RTGS system operating hours, focusing on the potential benefits. Section 3 presents a series of technical and operational issues that central banks should consider and address when undertaking an extension towards end state 1, and it also identifies additional considerations related to end states 2 and 3. Section 4 concludes with some possible steps for a central bank concerning the development of an implementation plan.

2. Determining the extension of RTGS system operating hours

This section is intended to help central banks to determine the most appropriate extension to RTGS system operating hours. The aim is to decide on the extension to be pursued in the light of the potential benefits, including the benefits for domestic and cross-border payments. This decision involves identifying the number of hours in the extension, the direction (earlier opening, later close, or a combination) of the extension, and the days on which RTGS system operating hours could be extended to achieve the desired benefits. As part of this assessment, a central bank may find it helpful to define multiple possible extensions that could be used as focal points in order to consider their implications, challenges and costs (such as those described in Section 3) in the next step and carry out a comparative analysis. This would enable central banks to assess which extension achieves the best balance between benefits and costs.

As a central bank conducts this analysis, it should keep in mind that this is likely to be an iterative process, involving an analysis of the adjustments needed to adapt to an extended operating hours scenario (see Section 3), as well as substantial industry consultation in order to better identify the current and future needs of all relevant parties. As further discussed in Section 4, it will be important for a central bank to identify such interdependencies and coordinate with the industry to fully realise the benefits of an extension. To conclude this section, Box 1 identifies some of the key questions that will assist central banks as they work to determine the extension of operating hours to pursue in view of the potential benefits for cross-border and domestic payments.

2.1 Benefits for cross-border payments

Extending RTGS system operating hours could reduce current delays in cross-border payments, which could help to increase speed and transparency and to reduce costs. Delays may result partly from the lack of overlap in RTGS system operating hours across jurisdictions (CPMI (2022)). In particular, delays could arise because of the need to wait for one or several RTGS systems to open.

A central bank can identify different ways of extending RTGS system operating hours as focal points that could potentially decrease speed-related frictions with respect to different groups of jurisdictions. In particular, the potential benefits of extending operating hours in a jurisdiction by each additional hour will depend on, among other things:

- *Global operating hours* – Overlap with the operating hours of other key payment systems globally, including the current alignment with the global settlement window,³ and which hours would support a better alignment with other key payment systems.
- *Demand for payments by corridor* – The current and potential future volumes/values of payments to/from each country corridor, and the overlap in hours with the jurisdictions where demand is greatest.
- *Demand for payments throughout the day* – The potential volumes/values of cross-border payments during different time intervals of the day. This may differ between payment types (retail payments, wholesale payments, settlement of ancillary systems) and across corridors.

A central bank planning to extend RTGS system operating hours would need to assess the direct benefits related to an extension with the relevant tools and analysis. This type of analysis could be helpful in clarifying some of the potential benefits of different types of extension – specifically, to help decide how much, in what direction and on what days to extend operating hours. For example, depending on the current alignment between the operating hours of a given jurisdiction with other jurisdictions, an extension in a certain direction (eg an earlier opening) may have a more significant effect on overlap (and ultimately

³ The CPMI report “*Extending and aligning payment system operating hours for cross-border payments – final report*” defines the ‘global settlement window’ as the time frame during which the highest number of RTGS systems across jurisdictions are concurrently open. As described in the report, at present, the best characterisation of what constitutes the global settlement window is the interval from 06:00 to 11:00 GMT on working days. (CPMI (2022)).

speed) than an equivalent extension in the other direction (eg a later close). In addition, the extent of cross-border payment flows can affect the aggregate benefits that result from increased overlap in operating hours. With respect to identifying the scope of future demands, consultation with stakeholders will be particularly important.

In conducting this analysis, it will also be important for a central bank to take into account actions related to operating hours in other jurisdictions, as actions elsewhere can affect a central bank's assessment of its own operating hours. For example, if actions in other jurisdictions served to expand the global settlement window, those actions could alter a central bank's assessment of its operating hours vis-à-vis this expanded window.

2.2 Benefits for domestic payments

A central bank may also evaluate extensions in the context of benefits that can accrue domestically, although a full accounting of such benefits is intrinsically specific to each jurisdiction and beyond the scope of this report.

An extension of RTGS system operating hours can improve the availability and performance of ancillary payment, clearing and settlement systems in the domestic economy by providing additional settlement windows earlier and/or later in the day in the case of end state 1, on additional days in the case of end state 2, or at any time round the clock in the case of end state 3 (CPMI (2022)). For example, an extension of RTGS system operating hours may enable another domestic financial market infrastructure (FMI) and its participants to more safely and efficiently clear and settle certain securities transactions (eg in the repo market), given a wider time window to complete cash settlement of margin payments. Extended RTGS system operating hours could also accommodate additional settlement cycles for retail payment systems, such as automated clearing houses, fast payment systems (FPS) and card payment systems, and encourage the development of enhanced product offerings or improved processes to accommodate the new operating hours (eg condensed and more efficient end-of-day processes).⁴ Additionally, depending on the arrangement, extensions of RTGS system operating hours could support improved liquidity management and the operational resiliency of ancillary payment systems while positioning the parties involved for increased interoperability. Existing requests for longer RTGS system operating hours may identify certain domestic use cases, and industry consultation may identify additional ones.

Box 1

Key questions for central banks to consider on the benefits of extending RTGS system operating hours

- To what extent have industry stakeholders indicated that an extension of RTGS system operating hours could provide benefits for cross-border and/or domestic payments?
- What benefits have been achieved from prior extensions of operating hours? To what extent might similar benefits be achieved through a further extension of operating hours?
- To what extent would an earlier open, later close and/or extension into new operating days create overlaps with key RTGS systems in other jurisdictions, key cross-border payment corridors, and/or the global settlement window?
- To what extent might an earlier open, later close and/or extension into new operating days benefit ancillary payment, clearing and settlement systems, and other industry participants domestically?
- Based on an analysis of the potential benefits for cross-border and domestic payments, what are the top options for extending operating hours that could serve as focal points for comparing costs and benefits?

Source: CPMI.

⁴ Extended operating hours can specifically provide increased flexibility for ancillary systems in jurisdictions that span multiple time zones.

3. Key technical and operational issues

This section presents a series of technical and operational issues that central banks may need to consider and address when undertaking an extension of RTGS system operating hours. For a particular issue, the relevant subsection first describes the potential effect of an extension of operating hours on current operating days (end state 1). The subsequent discussion for each issue then considers how an extension to new operating days (end state 2) or 24/7 operations (end state 3) would alter the effect and require additional attention from the central bank.

As noted in Section 1, the following discussion is not intended to provide specific approaches to be used when addressing each issue; specific measures will depend on the situation in individual jurisdictions. Instead, this section is intended to provide a systematic approach for identifying and assessing the technical and operational issues that may arise with an extension of RTGS system operating hours. The boxes in this section lists pertinent questions regarding such issues.

Although this section is focused mainly on the challenges from the point of view of the central bank as the RTGS operator, participants, ancillary systems and other stakeholders may also face operational and technical issues from an extension of operating hours. Indeed, both central banks and stakeholders will need to make the necessary adjustments and incur costs to adapt to an extended operating hours scenario.

3.1 RTGS system infrastructure changes

In assessing plans for extending RTGS system operating hours, a key step is determining the infrastructure changes required to achieve the desired end state. The relevant infrastructure includes the hardware and software that comprise the core RTGS system. It can also include related applications and support systems that interface with the RTGS system, such as the messaging platform used by participants, the integration platform, and other downstream applications (eg reporting systems). The necessary changes could range from adjustments to system parameters (eg defining new settlement windows and/or cutoff times) to changes in, and potentially the replacement of, system software and hardware. Developing a comprehensive catalogue of the relevant components, for both the core RTGS system and related applications, will help to determine the nature and extent of required system changes and determine a plan for infrastructure changes. Such a plan will inform the overall timeline for an extension of operating hours and will serve as a valuable input in assessing cost.

3.1.1 Considerations for infrastructure changes under end state 1

In situations where the extension of operating hours under end state 1 is modest, the necessary infrastructure changes may be minor, such as adjusting a system parameter to allow for an extended settlement window. However, some extensions may have bigger implications and effects across various applications and/or support systems and processes. For example, an increase in operating hours to round-the-clock operations on current business days (ie 24/5 operations) could require changes to system start-up, shutdown and maintenance processes. Significant infrastructure adaptations could be required to support these process changes.

A central bank should also consider that infrastructure changes to support end state 1 may go beyond the accommodation of extended hours and may need to cater to new developments, such as increased payment volumes or a concentration of payment flows at certain times of the day. In these cases, expanding processing capacity, processing throughput, memory and storage capabilities would require further infrastructure changes.

Finally, infrastructure changes may also be needed to address other challenges and/or may be leveraged to improve the RTGS system. For example, infrastructure changes could be used to introduce more automation to speed up processes and to reduce the risk of error and/or unauthorised actions

brought about by manual tasks. A central bank could consider also the scalability and flexibility of its infrastructure, such that current infrastructure changes are made in support of other strategic initiatives and with an eye to the future.

3.1.2 Additional considerations related to end states 2 and 3

Whereas the potential infrastructure changes raised by end state 1 may not be substantial, end states 2 and 3 are more likely to require significant changes. End state 3 (24/7 operations) in particular may require fundamental changes to RTGS system infrastructure, as it requires the infrastructure to be capable of supporting (near) continuous settlement. Thus, a 24/7 environment may require the replacement of legacy infrastructure that relies on dedicated downtime to serve as maintenance windows (see also Section 3.2). At the same time, infrastructure changes to support 24/7 operations may provide an opportunity to refresh the overall RTGS system, replacing legacy infrastructure with state-of-the-art technology in the process.

For a central bank considering an extension under end state 1, it may be prudent to consider what would be required to reach end state 2 or 3 at a future date. This forward-thinking approach anticipates future infrastructure needs and helps avoid unnecessary or duplicative investments and effort as the RTGS system moves through the various end states.

Box 2

Key questions for central banks to consider on RTGS system infrastructure changes

- What components of the system infrastructure will be affected by the desired extension of operating hours? For example: software, hardware, and related applications and support systems.
- What is the extent of change required to implement the extension, over both the short and the long term?
- What is the overall infrastructure strategy, and how does the operating hours extension fit into that strategy?
- What initiatives are currently under way that either complement or conflict with the changes required to implement the extension?
- What infrastructure changes might require coordination with RTGS/industry participants?
- With respect to infrastructure changes, are there any lessons to be learned from prior extensions that could be applied to the desired extension of operating hours?

Source: CPMI.

3.2 Changes to system maintenance

As a central bank implements an extension of RTGS system operating hours, system maintenance requirements and potential changes to related processes are important considerations. System maintenance is a key activity for any payment system, helping to ensure and enhance a system's resiliency and performance. Such maintenance can involve the deployment of preventative measures to address potential issues or vulnerabilities. It can also involve upgrades to system components or capabilities to improve system performance. Testing can be an important aspect of system maintenance, evaluating both the viability of the planned changes and the system's overall performance. Participants also have their own maintenance requirements, involving deployment of updates and upgrades, as well as testing of changes.

The extent of changes to system maintenance processes resulting from extended RTGS system operating hours will depend on how maintenance is currently performed. System maintenance for many payment systems has traditionally relied on dedicated maintenance windows. These windows are typically scheduled time slots during which an entire payment infrastructure (or certain components) is unavailable, allowing various necessary IT-related tasks to be completed. In practice, technical maintenance windows can vary substantially, for example, in terms of their length, frequency, scheduled timing and degree of optionality.

Infrastructure changes to support extending RTGS system operating hours can have implications for system maintenance (and vice versa). In particular, maintenance-related issues deriving from longer operating hours may differ according to the underlying system architecture. For example, it may be more difficult to implement system changes on legacy infrastructures while operations are running because transaction activity cannot be switched to parallel systems. In contrast, distributed system architecture can allow for online adjustments of targeted system components without compromising the functioning of the system as a whole. The implications of infrastructure changes for system maintenance processes can be an important consideration, particularly to the extent that a jurisdiction envisions eventually moving to end state 2 or 3.

3.2.1 Considerations for system maintenance under end state 1

Extending operating hours for an RTGS system on current operating days (end state 1) would shorten the windows available for system maintenance on current operating days. Although such an extension may still preserve time for system maintenance during off hours on current operating days, the windows could become compressed in the case of a substantial extension (eg an extension approaching 24/5). Weekends and public holidays, however, would still be available for system maintenance under end state 1.

Thus, such an extension may not necessitate significant changes to be able to ensure adequate system maintenance but may require both the central bank and participants to consider shifting certain processes within or across days. A central bank may choose to compress or even remove some existing maintenance windows. A central bank could also choose to reschedule certain processes to weekends. In this case, or if maintenance is shifted to extremely late at night or early in the morning, staffing considerations may become relevant (see Section 3.6).

3.2.2 Additional considerations related to end states 2 and 3

End states 2 and 3 can affect system maintenance by further compressing the windows for system maintenance that rely on system downtime. Broadening the scope of the extension of RTGS system operating hours into current non-operational days such as weekends or public holidays (end state 2) may affect the availability of those days for maintenance windows. To the extent that a central bank relies on weekends or public holidays for extended periods during which maintenance activities can be performed, consideration would need to be given to whether and how that practice would need to change.

Full 24/7 operations (end state 3) further heighten the challenges of system maintenance by removing any and all downtime that was traditionally used for maintenance windows. As such, a central bank may need to consider substantial changes to system infrastructure to support maintenance activities while the system remains open. These changes can include adjusting the number of instances for the system (so that maintenance can be conducted on one version of the system while other versions are still operating) or shifting from a centralised to a distributed architecture (so that maintenance can be conducted while the system is in operation). As noted in Section 3.1, such infrastructure changes can provide an opportunity to upgrade the RTGS system while also supporting necessary system maintenance.

Key questions for central banks to consider related to system maintenance

- What system maintenance is currently performed, and when does that maintenance currently take place? To what extent do RTGS participants depend on the RTGS system's maintenance and testing schedule?
- What are the options for changing the length or timing of current system maintenance and testing processes to accommodate the desired extension, given any dependencies with RTGS participants?
- What changes to staffing would be required to support system maintenance at new times or on new days?
- How will planned or potential changes to system infrastructure (eg system architecture) facilitate necessary system maintenance?
- With respect to system maintenance changes, are there any lessons to be learned from prior extensions that could be applied to the desired extension of operating hours?

Source: CPMI.

3.3 Effect on operational risk management and recovery measures

RTGS systems face various operational risks that reflect their vulnerability to different disruptive events, including natural disasters, cyber attacks and fraud. Identification, assessment and mitigation of these risks ultimately determine the system's resilience. An extension of operating hours does not introduce new operational risks in this regard. However, an extension of RTGS system operating hours increases the time window during which operational issues can arise, even as expectations around operational risk mitigation and resiliency continue to apply in those windows (CPMI (2022)). At the same time, extended operating hours can shorten the interval during which unaddressed or unanticipated operational events (eg cyber attacks) could materialise and accumulate. If an operational event occurs during extended operating hours, recovery measures may need to be deployed at times during which such events had not previously taken place.

3.3.1 Considerations for operational risk management and recovery measures under end state 1

Any plan to extend RTGS system operating hours should ensure that the extended hours do not jeopardise current levels of operational risk management and resilience. Under end state 1, achieving this outcome may not involve significant changes beyond extending current operational risk mitigation measures to the new operating hours on current operating days. This points to the need to assess existing operational risk controls, including the associated technology, staffing and processes, to determine whether those controls might be applied during new operating hours and what changes might be necessary to do so. For moderate increases of operating hours under end state 1, the necessary changes might be minimal. More sizeable increases of RTGS system operating hours on current operating days (eg 24/5) may require more significant adjustments to current controls (eg more support and monitoring staff), which could suggest a broader reassessment of operational risk controls.

An extension of RTGS system operating hours under end state 1 could also warrant an assessment of the effectiveness of pre-existing business continuity arrangements aimed at ensuring the timely recovery of the services in the event of a major disruption. In particular, under an extension of operating hours, a postponement of the RTGS system closing time could potentially place the maximum recovery time of critical services too close to or past the change in the calendar date, thus raising a number of practical issues, such as value dating or participants' management of end-of-day balance sheet or cash positions. Consequently, the feasibility of current backup capabilities may need to be reviewed and re-engineered where necessary.

3.3.2 Additional considerations for end states 2 and 3

While existing operational risk controls could be applied in end states 2 and 3, these end states may introduce demands on the system that require more fundamental changes to operational risk mitigation measures. Round-the-clock operations in particular may require substantial changes to staffing arrangements (see Section 3.6). In addition, change management and other system maintenance processes may need to be considered and reworked to avoid persistent vulnerabilities (see Section 3.2). The risk of cyber attacks at any time may require special attention, particularly if bad actors believe that the new operating hours are especially vulnerable times at which to attempt such attacks. Finally, incident management and recovery capabilities will need to be available at all times.

Although new operating days or 24/7 operations may heighten operational risk in certain ways, the need to deploy new infrastructure to support those end states (see Section 3.1) may provide an opportunity to overhaul the system's operational risk profile. In particular, legacy infrastructure can be replaced with state-of-the-art technology that is designed to be more resilient and less vulnerable to operational issues. Similarly, new infrastructure may support process changes, such as increased automation, that reduce the need for manual review and/or intervention in certain monitoring and support activities. The potential for new infrastructure to support such improvements in operational risk management is an important consideration under end states 2 and 3.

Box 4

Key questions for central banks to consider on operational risk management and recovery measures

- What are the existing operational risk controls and business continuity arrangements (eg measures to address disruptive events such as natural disasters, cyber attacks and fraud), including the associated technology, staffing and processes?
- What are the risks and limitations/constraints of the current risk management and resiliency tools with respect to the ability to accommodate extended hours? How might system maintenance and change management processes need to adjust to ensure that vulnerabilities do not increase during extended hours?
- What staffing models could meet requirements for manual monitoring, stand-by and support during extended hours?
- To what extent could infrastructure changes provide an opportunity to overhaul the operational risk profile of the system and enhance resiliency and risk management (eg by enabling greater automation of certain monitoring and support activities)?
- With respect to operational risk management and resiliency changes, are there any lessons to be learned from prior extensions that could be applied to the desired extension of operating hours?

Source: CPMI.

3.4 Effect on end-of-day or start-of-day processes

The opening and closing of an RTGS system typically comprise a series of tasks that could be affected by an earlier opening or a later closing, respectively.

Before the business day starts, a central bank may need to perform tasks such as system updates and reconciliations, activation of credit and liquidity management processes, and revalidation of payments that were queued during off-hours. In general, start-of-day (SoD) processes such as these could be self-contained within the environment of the RTGS system and might not demand the active involvement of

most participants.⁵ Therefore, an extension pointing towards an earlier RTGS system opening may not require significant changes to SoD processes or substantial coordination with other parties.

On the other hand, end-of-day (EoD) processes, such as production of statements and statistics, calculation of reserves, overnight liquidity provision and verification of account balances, often have significant dependencies on other activities and/or players. For example, the production of statements by the RTGS system may be a prerequisite for participants to proceed with their book reconciliation and accounting processes. Liquidity management may be particularly relevant for participants at the EoD as they look to meet their obligations before the close of the RTGS system, requiring the central bank to consider how EoD liquidity needs are met. In addition, the provision of overnight liquidity by the central bank may require central securities depositories to be available to pledge collateral. These dependencies suggest that an extension postponing the RTGS system's closing time may require more changes and coordination with participants than an earlier opening.

3.4.1 Considerations for end-of-day and start-of-day processes under end state 1

When considering an extension in end state 1, a central bank would need to evaluate how SoD and EoD tasks must be changed and aligned both internally and with participants. For a limited extension to the RTGS system opening time (eg opening earlier by a couple of hours), a central bank may have limited challenges in moving existing processes to the new hours, given the limited effect on RTGS system staff and participants. For a more substantial extension of the opening time, a central bank may need to consider ways to automate some processes to reduce the effect on staff. In the case of an extension to the closing time of the RTGS system, a central bank will likely need to coordinate closely with participants and other key stakeholders to ensure that EoD processes remain in sync, given the dependencies between the RTGS system and external parties.

To the extent that an earlier open, later close, or both extensions' types would create a limited window between the RTGS system's open and close (eg near 24/5 operations), the central bank would also need to consider making potentially significant RTGS system and process changes to allow SoD and EoD processes to complete in a compressed time frame. Such processes could include managing requests made by RTGS system participants to extend the cutoff time for the current business day in emergency circumstances or altering criteria (eg value thresholds) for honouring extension requests.

3.4.2 Additional considerations related to end states 2 and 3

A decision to extend RTGS system operating hours into new operating days (end state 2) may not require significant changes to SoD processes beyond the need to have experienced staff available to perform relevant tasks. However, running EoD processes could raise more issues, given the dependencies described above. The provision of information to third parties may not pose an issue as such parties could process the statements, statistics etc on their next business day (to the extent they choose not to operate on weekends and/or holidays). However, activities that depend on the support of participants or other parties (eg central securities depositories) would require a commitment from them to be available or imply the need to develop alternative mechanisms, if possible.

In the case of a move to near or full 24/7 (end state 3), the ability to complete existing SoD and EoD processes in a minimal time frame or even in parallel may require redesigning them (eg by adopting greater automation). In addition, it would be important to understand how the change in value date would occur in 24/7 operations and its effect on EoD processes for the RTGS system and its participants.

⁵ An exception is if certain participants need to provide additional liquidity or send static data updates or data feeds because it was not possible for them to do so the day before.

Key questions for central banks to consider on end-of-day or start-of-day processes

- What are the key SoD and EoD processes that could be affected by the desired extension of operating hours and how significant would these effects be?
- Do any of the SoD and/or EoD processes depend on or significantly affect third parties (eg participants, ancillary systems or other areas of the central bank)? What potential solutions could mitigate such effects from/on third parties?
- Does the scale of potential effects on SoD and EoD processes differ significantly depending on whether the extension under consideration is an earlier opening, later closing and/or extension into new operating days?
- What are the options for adjusting SoD and EoD processes to accommodate new operating hours, including changes to staffing and technology (eg greater automation)?
- With respect to SoD and EoD processes, are there any lessons to be learned from prior extensions that could be applied to the desired extension of operating hours?

Source: CPMI.

3.5 Effect on liquidity management measures

An extension of RTGS system operating hours may require changes to a central bank's liquidity management measures and operations to ensure that, during extended hours, RTGS participants have sufficient liquidity to support the smooth functioning of the payment system. When considering the need for liquidity measures during extended hours, a central bank should consider the availability of existing sources of liquidity, staffing and monitoring capabilities, as well as potential changes to lending arrangements.

3.5.1 Considerations for liquidity management measures in end state 1

For limited extensions in end state 1 (eg a few hours), a central bank may be able to extend its existing liquidity measures without significant challenges, as existing staff, systems, and funding methods may not be put under stress. However, more significant extensions into the early morning or overnight hours could create issues for RTGS participants that would need to be addressed. Such an extension could create a gap between certain RTGS system operating hours and the business hours of money markets, fixed income markets and other capital markets used by participants for funding. Given that RTGS participants may be unable to rely on such liquidity sources during overnight hours, a central bank would need to consider whether existing central bank tools and/or new lending arrangements could meet the liquidity needs of participants. To the extent that collateral management and securities settlement systems are offline during extended RTGS system operating hours, participants may not be able to pledge new collateral to central bank liquidity facilities. As such, the central bank and RTGS participants may need to develop plans to ensure that collateral can be positioned in advance and that related funding is available after hours.⁶

For any level of extension, the central bank and RTGS system participants would need to extend liquidity monitoring and credit controls to ensure that credit and liquidity risk do not increase. Maintaining these tools for minor extensions might require limited changes, although longer extensions would likely require additional staff and/or greater process automation.

⁶ For instance, system participants could be required to determine their minimum overnight liquidity needs before the close of collateral and securities settlement systems.

3.5.2 Additional considerations for end states 2 and 3

The options for a central bank to provide liquidity management measures in end states 2 and 3 are similar to those in end state 1; however, the challenges when implementing such measures would increase. In end states 2 and 3, it is increasingly likely that RTGS participants would have difficulty accessing liquidity from financial markets, although such markets may extend their operating hours over time to align with the domestic RTGS system. Indeed, a potential benefit of RTGS system operating hours on new days (end state 2) or round the clock (end state 3) would be to support the extension of hours for these markets. As a possible interim solution, participants in an RTGS system could implement lending arrangements with each other during off hours.

In the absence of market funding sources, RTGS participants are likely to rely on liquidity from the central bank in end states 2 and 3. As in end state 1, a central bank could extend its weekday liquidity measures, including monitoring and credit controls, to cover weekends and holidays. However, the central bank would need to invest more in staff and/or automation to perform these functions in end states 2 and 3 than it would in end state 1. Further, there may be a greater need to coordinate lending arrangements with participants to allow for the potential unavailability of securities settlement systems.

Finally, an extension to 24/7 operations may require a central bank to redefine value date conventions and the concepts of intraday and overnight lending, given the lack of system downtime. Such changes would need to incorporate industry feedback in order to reduce any adverse effects and ensure that these changes are feasible within the existing legal framework.

Box 6

Key questions for central banks to consider on liquidity management

- What are the existing measures for managing participants' liquidity needs and risks?
- What changes to current sources of liquidity, staffing and monitoring capabilities as well as lending conventions might be needed to address liquidity needs during new operating hours? What planning and testing with stakeholders would be needed to make such changes?
- To what extent will external providers of liquidity and supporting systems be available during extended hours? If certain providers/systems are unavailable, what alternative arrangements could fill the gap to support liquidity management during extended hours?
- With respect to liquidity management measures, are there any lessons to be learned from prior extensions that could be applied to the desired extension of operating hours?

Source: CPMI.

3.6 Effect on staffing models and requirements

While an RTGS system involves substantial IT elements, staff also play an important role in system operation. Their responsibilities include the administration of upgrades and other system maintenance, risk management and monitoring of the system's performance, responding to operational events, and providing help desk and other support functions.

Staffing arrangements are likely to be affected by any extension of RTGS system operating hours. The extent of the necessary adjustments may depend on the end state pursued and on the services and functions made available to participants as part of an extension of operating hours, as well as the reliance on staff for key support functions that could be affected when achieving such an extension.

3.6.1 Considerations for staffing requirements under end state 1

Subject to IT and infrastructure changes in the RTGS system for extended operating hours would probably also involve changes in the operational staff policies (eg introducing new shifts or extending the current

ones). Such changes could be significant if the extension on current operating days is also significant. Local labour laws and regulations in each jurisdiction will determine the extent to which existing and/or new shifts of staff would cover specific periods of extended operating hours.

Furthermore, not all resource requirements are uniform across the entire operating day for all aspects of the service. For example, less specialised staffing resources may be sufficient at certain times of the operating day, whereas specialised technology or liquidity/credit management professionals may be specially needed at critical times during the operational day.

3.6.2 Additional considerations for end states 2 and 3

In addition to the introduction of supplementary staff to cover overnight shifts or new operational days, technology support for critical technological processes and functions, such as system maintenance, upgrades and payments processing, may need to be enhanced or re-engineered. Similarly, arrangements for other monitoring and support functions may need to be adjusted. At the same time, significant system enhancements to accommodate 24/7 operations could enable greater process automation, which might reduce certain staffing needs. Particularly in the light of the substantial changes in operating hours that could occur under end state 2 or 3, consideration could also be given to whether staffing requirements would vary based on services offered during the new operating hours.

Box 7

Key questions for central banks to consider on staffing models and requirements

- What is the current staffing model for operating the RTGS system on a day-to-day basis, including the personnel and functions (eg operations, technology, client service, risk management etc) that are needed at different times of day?
- To what extent could the existing staffing model be adapted to cover additional operating hours? Are there alternative staffing models that might be effective for the desired operating hours?
- Are there ways to mitigate staffing needs through system design choices, such as greater automation or adjustments to system maintenance windows?
- With respect to staffing changes, are there any lessons to be learned from prior extensions that could be applied to the desired extension of operating hours?

Source: CPMI.

3.7 Effect on cost recovery and pricing

Addressing the operational and technical issues discussed in this report will necessarily generate costs. Recovery of these costs could be an important issue for a central bank and stakeholders. In particular, some central banks have a statutory and/or policy obligation to fully recover the costs of the RTGS system.⁷ Pricing of the service is a key mechanism through which costs are recovered. As such, there may be a need to assess current prices and pricing practices to determine whether adjustments may be required in the light of the one-off and ongoing costs of an extension of operating hours, as well as the likely demand over different time horizons.⁸ Moreover, the challenges of developing an effective pricing strategy to recover costs may constrain the ability to fund new investments and, thus, the extent of technical and operational changes that can be implemented in support of extended operating hours (or for other purposes).

⁷ The time horizon over which costs must be recovered and the way in which cost recovery requirements are applied across business lines for a central bank are relevant elements of the cost recovery framework.

⁸ Consideration could also be given to the potential effect of pricing changes on different participant segments or types of payment activity.

At the same time, improvements to an RTGS system, including extensions to operating hours, can increase volumes over time, thereby supporting cost recovery. In addition, an extension of RTGS system operating hours can generate other benefits, such as reduced liquidity costs for participants. In aggregate, these benefits may help offset the investment and operational costs of extending operating hours.⁹

Pricing and cost recovery are not strictly technical or operational issues. However, pricing is a key business/policy area that requires decisions by a central bank. In addition, it intersects with many of the technical and operational issues discussed in this section.

3.7.1 Considerations for cost recovery and pricing under end state 1

Depending on the magnitude of the extension under end state 1, the necessary RTGS system changes could vary with different implications for cost recovery and pricing. Minor extensions (eg a one-hour earlier opening) could involve relatively minor technical and organisational changes to an RTGS system and its operation. On the other hand, a significant increase in RTGS system operating hours (eg 24/5) could require more extensive changes and may generate substantial costs for the central bank. In this case, or if a central bank makes other investments in system upgrades to accompany that extension, there may be a more pressing need to evaluate the pricing policy. At the same time, investments to support extended operating hours (or other system upgrades) would provide an opportunity to employ state-of-the-art technologies that could provide cost savings, particularly in the longer term. More broadly, when the extension is part of a plan to gradually increase RTGS system operating hours towards other end states, cost recovery considerations could be embedded into a pricing strategy that accounts for a longer-term perspective.

3.7.2 Additional considerations for end states 2 and 3

As discussed in this section, end states 2 and 3 are likely to require more significant changes to an RTGS system. In particular, supporting new operating days or especially 24/7 operations may require substantial upgrades to an RTGS system, necessitating a sizeable investment. In addition, ongoing operational costs may be higher because of, for example, the need for additional staffing. However, as noted in Section 3.1, the changes needed to support end states 2 or 3 may also provide an opportunity to refresh the overall RTGS system, with potential efficiency gains and cost savings being achieved by replacing legacy infrastructure with state-of-the-art technology.

In the light of the generally higher costs of end states 2 and 3, the need to evaluate cost recovery and pricing will likely become more prominent in those end states. Indeed, a primary concern with these end states among some stakeholders – particularly, smaller participants with limited activity or larger ones with little cross-border presence – is that prices may increase substantially to recover costs. On the other hand, significant price increases may not be needed if RTGS system enhancements related to an extension of operating hours generate efficiency gains and/or promote additional payment volumes over time. In any case, an effective pricing strategy could be crucial for a major initiative, such as extending operating hours to new operating days or to 24/7.

⁹ In the light of these benefits, there may be public good aspects of extending RTGS system operating hours that a central bank could take into account when evaluating cost recovery, depending on its statutory and/or policy obligations related to cost recovery.

Key questions for central banks to consider on cost recovery and pricing

- What cost recovery requirements apply to the system? In the light of those requirements, what is the current pricing policy/strategy for the system?
- What are the estimated costs that will be incurred under the desired extension to operating hours? How are such costs divided between one-off investment costs and ongoing operational costs? What would be the difference with other extension scenarios?
- What demand is expected for the system over different time horizons? How could this best feed into the pricing strategy?
- What changes to pricing might be considered, and how might those changes affect revenue and cost recovery for the system in light of the costs that will be incurred? How might pricing incentivise payment behaviour during new operating hours?
- With respect to cost recovery and pricing strategies, are there any lessons to be learned/observations from prior extensions that could assist with the desired extension of operating hours?

Source: CPMI.

4. Development of an implementation strategy

Once the desired extension has been determined and the relevant technical and operational issues have been identified and assessed, including those affecting the RTGS participants and other stakeholders, the next step is to determine the implementation strategy. Such a strategy may incorporate a forward-looking approach that accounts for long-term considerations. In particular, a central bank could develop a broader strategy around improvements to the RTGS system, of which the extension of operating hours is one element. A central bank may also wish to consider extensions that have occurred or are planned in other jurisdictions. Where possible, a central bank may work to coordinate its extension of operating hours with similar extensions elsewhere, as noted in Section 2.

In developing an implementation strategy, the key is early engagement and close coordination with the RTGS system's participants, as well as other stakeholders that may be crucial for successful implementation and realisation of benefits. A central bank may need to consider not only the effects on the RTGS system, but adopt a holistic approach and assess the effect of the extension on the whole payments ecosystem as part of a broader strategy for improving domestic and cross-border payments. Additionally, it may be useful to explore different options in terms of the scope of the extension. Finally, establishing the timeline and implementation path for an extension of RTGS system operating hours is important for all stakeholders.

4.1 Implementation considerations

The heterogeneity of RTGS participants and payment types is something for a central bank to consider when designing an implementation strategy and deciding on the scope of the extension. For instance, some smaller institutions may not have a business case for extended hour payments, while some larger institutions may not have a cross-border presence or other business needs that would require an extension. In the light of such heterogeneity, a central bank that is extending RTGS system operating hours have instituted a voluntary or tiered participation model during new operating hours. The possibility of limiting the extension to certain payment types or to payments below a certain threshold amount may also be something to consider. This approach may still bring about significant benefits, while reducing the

effect of the extension by limiting participants' need to manage broad payment activity during extended hours.

In view of the above, a central bank could consider the possibility of limiting the scope of the extension, possibly on a temporary basis, bearing also in mind that the overall benefits for end users may be larger when payment type availability and the participation of payment service providers (PSPs) in extended hours are more extensive, as end users would have more assurance that they would be able to send and/or receive payments during newly extended operating hours.

The path for implementing an extension of RTGS system operating hours, in terms of timeline and number of steps, is another key decision in an implementation plan. The time needed to achieve an extension depends on several factors, including the need to update the RTGS system's legacy technology and coordinate with industry stakeholders (see Section 4.2). Finding the right balance between the expected results and a sound implementation is key. While an ambitious timeline may allow the benefits of extended hours to be realised sooner, a central bank, RTGS participants and other parties will need enough time to be able to support the changes. Regardless of the timeline that is selected for an extension, clarity and transparency towards all stakeholders is crucial to allow appropriate planning for the needed changes and their execution.

The implementation path could involve a series of incremental extensions in operating hours or a single-step move to a new end state. The approach taken may depend on the degree to which operating hours are intended to increase in the near to medium term, in addition to any strategic plans where initial (limited) extensions are viewed as steps in a progression of extending RTGS system operating hours.

In some cases, a big bang approach may imply lower implementation costs for a central bank and participants, as it may be more efficient to move in one step to the final scenario rather than implementing intermediate extensions. Experience with 24/7 payment system operations may also help determine whether an incremental or a single-step extension is appropriate. For instance, certain jurisdictions with 24/7 FPS have gained experience with extended hours and may have also adapted certain systems (eg accounting systems) to extended operating hours. Such readiness may better support a single-step RTGS system operating hour extension, particularly during current operating days.

However, input from the public consultation on the CPMI report "Extending and aligning payment system operating hours for cross-border payments" suggests that an incremental approach may have advantages that are worth considering. Some respondents to the consultation¹⁰ took the view that a more incremental expansion in hours may be preferred, in particular when moving to 24/7, for the following reasons:

- A continued dialogue with the private sector can facilitate that an extension of the RTGS system operating hours would be followed by a similar extension of PSP operating hours in order to realise as much benefit as possible;
- A "learning by doing" process can help to build on key lessons drawn from a first limited extension to implement a smoother process in the next steps (eg extension to more business days, as envisioned in end state 2, and then to end state 3);
- Costs and benefits can be reassessed at each step of the process, in order to determine if a further extension is still needed after evaluating the outcome of the first steps.

¹⁰ In November 2021, the CPMI conducted a public consultation on the operating hours of real-time gross settlement (RTGS) systems, which are considered key to enhancing cross-border payments.

The summary of the inputs received in the consultation can be found in the Annex 2 of the report "Extending and aligning payment system operating hours for cross-border payments". For more information, see the full report at www.bis.org/cpmi/publ/d203.htm. Detailed comments by the consultation respondents are also available at www.bis.org/cpmi/publ/comments/d199/overview.htm.

4.2 Stakeholder coordination

Close coordination with RTGS system participants and ancillary systems, as noted above, is critical for determining the nature and scope of the extension, designing the implementation plan and thorough testing. A central bank should engage early and often with stakeholders, including RTGS participants (domestic and foreign), operators of ancillary payment, clearing and settlement systems and other relevant parties, to ensure a clear understanding of required system and process changes.

Stakeholder coordination and engagement would help ensure that the implementation approach (ie big bang or incremental deployment) and timeline can take into account the needs and heterogeneity of the different parties.

Additionally, a central bank should consider that the realisation of potential benefits does not depend solely on the RTGS system extending operating hours, but also on the changes that other parties are prepared or willing to implement. As a consequence, a central bank must engage with the industry in order to incentivise certain changes, such as an extension of operating hours in securities settlement systems to ease liquidity management, or in correspondent bank relationships to realise gains in cross-border payments. As regards the latter, it would also be helpful to know the extension plans of RTGS systems in other jurisdictions to maximise overlaps with the widest range of jurisdictions and regions, thus allowing the broadest range of payments to be settled without the delays arising from current RTGS system operating hours.

Box 9

Key questions for jurisdictions to consider on implementation strategy

- Who are the key stakeholders with an interest in an extension to RTGS operating hours? What is the plan to coordinate and engage with those stakeholders to ensure a smooth transition to new operating hours?
- How might the extension of operating hours affect different participant categories (eg small vs large)? Could participants be given a degree of choice in whether and how to use the extended hours?
- Would it be beneficial to support only certain payment types under the extended hours?
- Could the extension benefit from an incremental approach?
- What is the universe of ancillary payment, clearing and settlement systems that depend operationally on the RTGS system? How do the extended hours of the RTGS system affect the ancillary service's business and operational processes?
- With respect to implementation approaches, are there any lessons to be learned or observations from prior system changes or extensions that could assist with the desired extension of operating hours?

Source: CPMI.

5. Conclusions

The framework presented in this technical report builds on three potential end states for extending and aligning operating hours (CPMI (2022)). By providing a systematic approach to identifying the benefits of different extensions of RTGS system operating hours and to addressing the associated technical and operational issues, this report provides central banks with a tool to approach the extension of RTGS system operating hours and to develop their extension strategies.

This report focuses on approaches that apply to end state 1 as a potential first step from which central banks could build on extending their current RTGS system operating hours, given that it is the most achievable option in the short term. However, end states 2 and 3 could also be considered, since they may be relevant as part of a medium to long-term strategy. From an aggregate perspective, each central bank's roadmap to its most appropriate end state could be considered as one part of the collective path towards broadening the global settlement window and, in particular, supporting the G20 target of increased speed for cross-border payments.

A successful planning process would be one that enables a central bank to develop its strategy across the end states, maintaining flexibility as it continues to respond to the needs of its stakeholders and to its individual mandates. This process requires both short- and long-term operational and technical planning, as addressed in Section 3, as well as an understanding of how RTGS systems and processes will be affected. The needs and challenges of the broader payments industry should be considered when determining an extension of RTGS system operating hours. In addition to working with stakeholders in a given jurisdiction, central banks are encouraged to work collectively towards common goals, sharing lessons learned along the way.

The analysis and frameworks developed in this report and in previous work of the CPMI (CPMI (2022)) are intended to assist central banks in taking the necessary measures in order to advance the work on RTGS system operating hours and to help achieve the G20 targets for faster, cheaper, more transparent and more inclusive cross-border payments. Central banks are encouraged to consider potential extensions to RTGS system operating hours by using this analytical framework as a guiding tool and to coordinate with the relevant stakeholders domestically and across jurisdictions.

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Annex 1: Consolidated questions for central banks planning to extend operating hours

Benefits of extending RTGS system operating hours

- To what extent have industry stakeholders indicated that an extension of RTGS system operating hours could provide benefits for cross-border and/or domestic payments?
- What benefits have been achieved from prior extensions of operating hours? To what extent might similar benefits be achieved through a further extension of operating hours?
- To what extent would an earlier open, later close, and/or extension into new operating days create overlap with key RTGS systems in other jurisdictions, key cross-border payment corridors, and/or the “global settlement window”?
- To what extent might an earlier open, later close, and/or extension into new operating days benefit ancillary payment, clearing, and settlement systems and other industry participants domestically?
- Based on an analysis of the potential benefits for cross-border and domestic payments, what are the top options for extending operating hours that could serve as focal points for comparing costs and benefits?

Infrastructure changes

- What components of the system infrastructure will be affected by the desired extension of operating hours? For example: software, hardware, and related applications and support systems.
- What is the extent of change required to implement the extension, over both the short term and the long term?
- What is the overall infrastructure strategy, and how does the operating hours extension fit into that strategy?
- What initiatives are currently under way that either complement or conflict with the changes required to implement the extension?
- What infrastructure changes might require coordination with RTGS/industry participants?
- With respect to infrastructure changes, are there any lessons to be learned from prior extensions that could be applied to the desired extension of operating hours?

System maintenance

- What system maintenance is currently performed, and when does that maintenance currently take place? To what extent do RTGS participants depend on the RTGS system’s maintenance and testing schedule?
- What are the options for changing the length or timing of current system maintenance and testing processes to accommodate the desired extension, given any dependencies with RTGS participants?
- What changes to staffing would be required to support system maintenance at new times or on new days?
- How will planned or potential changes to system infrastructure (eg system architecture) facilitate necessary system maintenance?

- With respect to system maintenance changes, are there any lessons to be learned from prior extensions that could be applied to the desired extension of operating hours?

Operational risk management and recovery measures

- What are the existing operational risk controls and business continuity arrangements (eg measures to address disruptive events such as natural disasters, cyber attacks and fraud), including the associated technology, staffing and processes?
- What are the risks and limitations/constraints of the current risk management and resiliency tools with respect to the ability to accommodate extended hours? How might system maintenance and change management processes need to adjust to ensure that vulnerabilities do not increase during extended hours?
- What staffing models could meet requirements for manual monitoring, standby and support during extended hours?
- To what extent could infrastructure changes provide an opportunity to overhaul the operational risk profile of the system and enhance resiliency and risk management (eg by enabling greater automation of certain monitoring and support activities)?
- With respect to operational risk management and resiliency changes, are there any lessons to be learned from prior extensions that could be applied to the desired extension of operating hours?

End-of-day and start-of day-processes

- What are the key SoD and EoD processes that could be affected by the desired extension of operating hours and how significant would these effects be?
- Do any of the SoD and/or EoD processes depend on or significantly affect third parties (eg participants, ancillary systems or other areas of the central bank)? What potential solutions could mitigate such effects from/on third parties?
- Does the scale of potential effects on SoD and EoD processes differ significantly depending on whether the extension under consideration is an earlier opening, later closing, and/or extension into new operating days?
- What are the options for adjusting SoD and EoD processes to accommodate new operating hours, including changes to staffing and technology (eg greater automation)?
- With respect to SoD and EoD processes, are there any lessons to be learned from prior extensions that could be applied to the desired extension of operating hours?

Liquidity management measures

- What are the existing measures for managing participants' liquidity needs and risks?
- What changes to current sources of liquidity, staffing and monitoring capabilities as well as lending conventions might be needed to address liquidity needs during new operating hours? What planning and testing with stakeholders would be needed to make such changes?
- To what extent will external providers of liquidity and supporting systems be available during extended hours? If certain providers/systems are unavailable, what alternative arrangements could fill the gap to support liquidity management during extended hours?

- With respect to liquidity management measures, are there any lessons to be learned from prior extensions that could be applied to the desired extension of operating hours?

Staffing models and requirements

- What is the current staffing model for operating the RTGS system on a day-to-day basis, including the personnel and functions (eg operations, technology, helpdesk service, risk management etc) that are needed at different times of day?
- To what extent could the existing staffing model be adapted to cover additional operating hours? Are there alternative staffing models that might be effective for the desired operating hours?
- Are there ways to mitigate staffing needs through system design choices, such as greater automation or adjustments to system maintenance windows?
- With respect to staffing changes, are there any lessons to be learned from prior extensions that could be applied to the desired extension of operating hours?

Cost recovery and pricing

- What cost recovery requirements apply to the system? In light of those requirements, what is the current pricing policy/strategy for the system?
- What are the estimated costs that will be incurred under the desired extension to operating hours? How are such costs divided between one-off investment costs and ongoing operational costs? What would be the difference with other extension scenarios?
- What demand is forecasted for the system over different time horizons? How could this best feed into the pricing strategy?
- What changes to pricing might be considered, and how might those changes affect revenue and cost recovery for the system in light of the costs that will be incurred? How might pricing incentivise payment behaviour during new operating hours?
- With respect to cost recovery and pricing strategies, are there any lessons to be learned/observations from prior extensions that could assist with the desired extension of operating hours?

Implementation strategy

- Who are the key stakeholders with an interest in an extension to RTGS operating hours? What is the plan to coordinate and engage with those stakeholders to ensure a smooth transition to new operating hours?
- How might the extension of operating hours affect different participant categories (eg small vs large)? Could participants be given a degree of choice in whether and how to use the extended hours?
- Would it be beneficial to support only certain payment types under the extended hours?
- Could the extension benefit from an incremental implementation approach?
- What is the universe of ancillary payment, clearing and settlement systems that depend operationally on the RTGS system? How do the extended hours of the RTGS system affect the ancillary systems' business and operational processes?
- With respect to implementation approaches, are there any lessons to be learned/observations from prior system changes or extensions that could assist with the desired extension of operating hours?

Annex 2: Cross-border Payments Expansion Workstream

Chair of the Workstream	Carlos Conesa (Bank of Spain)
Members	
Reserve Bank of Australia	Grant Turner
National Bank of Belgium	Reinout Temmerman
Bank of Canada	Sajjad Jafri
Bank of France	Nicolas Peligry [until September 2022] Pierre Berger**
Hong Kong Monetary Authority	Jessica Szeto Angel Lam
Reserve Bank of India	Visvanathan Srinivasan [until July 2022] Kashiap Balakrishnan [since August 2022] Satish Singh**
Bank Indonesia	Butet Linda Nenden Endah Sari
Bank of Italy	Enrica Detto
Bank of Japan	Masami Inoue Seiya Hikuma [until April 2022] Amika Matsui [since April 2022]
Bank of Korea	Youngsun Yoo Jisoon Park Yunhwa Kim [until February 2022]
Central Bank of the Russian Federation [±]	Andrey Shamrayev [until February 2022]
Saudi Central Bank	Lamya Alhumaid
South African Reserve Bank	Annah Masoga Peter Makgetsi Pearl Malumane
Bank of Spain	Sergio Gorjón Rivas** Ana Fernández Bedoya** Justo Arenillas
Swiss National Bank	Basil Guggenheim Maurizio Denaro

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

Central Bank of the Republic of Türkiye	Bilal Taşkın Ömer Cem Aksoy
Bank of England	John Jackson Michaela Costello** Abigail Whiting** Anna Koch
Board of Governors of the Federal Reserve System	Mark Manuszak ^{11*} Aaron Compton** Priyanka Slattery [until June 2022] Larkin Turman [since June 2022]
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Observers

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* Lead of the drafting team.

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Annex 3: Acronyms and abbreviations

AM	Americas
APAC	Asia-Pacific
BB	building block
BIS	Bank for International Settlements
CPMI	Committee on Payments and Market Infrastructures
EoD	end-of-day
EMEA	Europe, Middle East and Africa
FMI	financial market infrastructure
FPS	fast payment system
FSB	Financial Stability Board
GMT	Greenwich Mean Time
G20	Group of Twenty
PSP	payment service provider
RTGS	real-time gross settlement
SoD	start-of-day