The Bank of England's Real-Time Gross Settlement infrastructure

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The Bank of England operates the United Kingdom's Real-Time Gross Settlement (RTGS) infrastructure for the settlement of electronic sterling transfers. This infrastructure plays a vital role in the safe functioning of the UK financial system and in fulfilling the Bank's core purposes — maintaining monetary and financial stability. This article explains the role of the RTGS infrastructure, how it operates, and how it reduces risk in the UK financial system. It also outlines how the design of the infrastructure will develop in the coming years.

Introduction

Electronic payments are essential to the functioning of modern economies. In the United Kingdom, over 98% of sterling payments, by value, are made electronically, with less than 2% made by notes, coins or cheques. The majority of electronic payments are retail: for example they are used by companies to pay salaries, individuals to pay bills and governments to pay benefits. But electronic payments are also used for high-value wholesale market transactions, for example by banks to lend to each other.

Securities transactions, such as purchases and loans of bonds, equities and money market instruments, are also vital to the functioning of modern economies. These transactions are also made electronically and enable governments to finance their budget deficits, companies to raise funds in capital markets, and banks to lend and borrow against collateral in the money markets. They also allow households to invest savings via pension funds and companies to invest their retained profits.

Safe, efficient and reliable settlement of payments and securities transactions is vital. As Alan Greenspan, former Chairman of the Federal Reserve Board, remarked:

'We'd always thought that if you wanted to cripple the US economy, you'd take out the payment systems. Banks would be forced to fall back on inefficient physical transfers of money. Businesses would resort to barter and IOUs; the level of economic activity across the country would drop like a rock.'[2]

The Bank of England operates the United Kingdom's Real-Time Gross Settlement (RTGS) infrastructure, which lies at the heart of the settlement of sterling payments and securities transactions. On an average day, it settles some £575 billion, equivalent to UK annual GDP every three days. This article explains the role the RTGS infrastructure plays, how it operates, and the ways that it will develop over the coming years.

The RTGS infrastructure acts as an accounting system, allowing banks and building societies to hold sterling balances, called reserves, at the Bank. These balances are held overnight for balance sheet management purposes and form part of the monetary policy transmission mechanism. In addition, these balances can be used during the day to settle the interbank obligations arising from payments and securities transactions made by banks and their customers.

The RTGS infrastructure is a critical component of the United Kingdom's two principal funds transfer systems: CHAPS, the same-day electronic funds transfer service for high-value sterling payments; and CREST, the securities settlement system. The RTGS infrastructure also settles the net interbank obligations arising from several of the major retail sterling payment schemes.[3] One principal design feature of the infrastructure is its ability to make certain types of transfers continuously throughout the day.

The RTGS infrastructure plays a vital role in the safe functioning of the UK financial system and in fulfilling both of the Bank's core purposes — maintaining monetary and financial stability. It therefore needs to be extremely operationally reliable.

(1) The authors would like to thank Joanna McLafferty for her help in producing this article.
(2) See Greenspan (2007).
(3) The CPSS-IOSCO principles define a payment scheme as a set of instruments, procedures and rules for the transfer of funds between or among participants. See Committee on Payment and Settlement Systems and Technical Committee of the International Organization of Securities Commissions (2012).

The first section of this article provides a high-level explanation of interbank settlement. It explains how transfers of funds give rise to interbank obligations, the role central banks play in settling these obligations, and the two principal settlement models available. The second section sets out the history of the development of the United Kingdom's RTGS infrastructure and how it supports both of the Bank's core purposes. The third section gives a more detailed account of the infrastructure: its different uses, the provision of intraday liquidity, and how its very high service levels are achieved. Since its inception, the United Kingdom's RTGS infrastructure has evolved continually to keep pace with the changing payments environment. This continues today, and the fourth section of the article highlights forthcoming developments that will further improve the infrastructure's efficiency and resilience.

Why central banks operate RTGS infrastructures

The role of the settlement agent

A 'settlement agent' facilitates the transfer of funds between the customers of different banks. Since not all bank accounts are held at the same commercial bank, transfers between accounts create interbank obligations. To settle these obligations, an asset must be transferred between banks. The role of a settlement agent is to provide accounts to banks for this purpose.

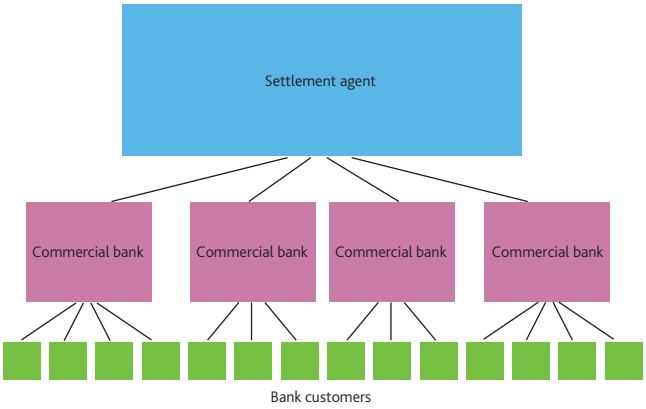
A simple example illustrates how these interbank obligations arise. Suppose a customer of a gas company wants to pay a bill using an electronic payment. If the customer and the gas company happen to have accounts with the same commercial bank, the payment can be made very simply: the bank just debits the customer's account and credits an equal amount to the company's account. No obligation between banks arises.

But if the customer and the gas company have accounts with different commercial banks, then an interbank obligation does arise. To achieve the transfer from the customer to the company, the customer's bank debits the customer's account, and the company's bank credits an equal amount to the company's account. At this stage the customer has in effect made a transfer to their bank, and the company's bank has made a transfer to the company. An obligation has been created: the customer's bank owes the company's bank the value of the payment. To eliminate this exposure, and complete the end-to-end transfer from the customer to the company, a transfer must be made from the customer's bank to the company's bank. This final transfer is known as 'settlement'.

The asset used for this interbank settlement is known as the settlement asset and its provider as the settlement agent.

Historically, the settlement asset was gold and, later, banknotes. Today, it is usually electronic money held in an account at a bank.(1) It follows that, to settle an interbank obligation between two commercial banks, both banks must themselves hold accounts at a single bank designated for this purpose. This latter bank is the settlement agent. The resulting structure of accounts, sometimes referred to as the 'payment pyramid', is illustrated, in a simplified format, in **Figure 1**.

Figure 1 The payment pyramid account structure



The settlement agent could be either a commercial or a central bank. If the settlement agent is a commercial bank, the settlement asset is 'commercial bank money'.(2) Commercial bank money is the balances held in accounts at commercial banks, which includes the money individuals have in their own bank accounts. Indeed, in modern economies, most money held by individuals and companies is commercial bank money.

But for systemically important payment schemes, there is a clear financial stability rationale for the settlement agent being a central bank. In this case, the settlement asset is 'central bank money', ie the balances held in accounts at a central bank. If a settlement agent defaults, account holders lose both the value of their deposits and the mechanism for settling interbank obligations. As a central bank is financially supported by its government, its default risk is generally considered to be the lowest of any agent in the economy and its liabilities close to risk-free. The risk of the settlement agent defaulting is therefore largely eliminated by settling in central bank money.

The choice of settlement model

Interbank settlement via the settlement agent usually follows one of two principal models: deferred net settlement (DNS) or real-time gross settlement (RTGS).

(1) For more detail on the history of interbank settlement arrangements, see Norman, Shaw and Speight (2011).
(2) For example, in the United Kingdom, credit and debit card payments are settled in commercial bank money.

Under the DNS model, payments are exchanged between participant banks during a 'clearing cycle', at the end of which the net obligations between participants are calculated and presented to the settlement agent for settlement. This process of clearing and settlement may be achieved several times a day, or the whole end-to-end process may take several days. By contrast, under the RTGS model, payment instructions are exchanged and settled individually on a gross basis throughout the business day.

Settlement will only occur if the bank being debited has sufficient money (often termed 'liquidity') available on its account with the settlement agent. Any settlement model will therefore generate a demand for liquidity. The 'liquidity efficiency' of a model refers to the value of payments that can be settled for a given amount of liquidity. The DNS model is more liquidity efficient than the RTGS model as only the net obligations incurred between banks during a clearing cycle are settled, and these will always be less than (or equal to) the gross values. The box on page 237 presents an example of payment flows and their liquidity needs under the two models.

Although the DNS model is more liquidity efficient than the RTGS model, it is likely to increase settlement risk to some extent. Under the DNS model, a payment between two banks generates a credit exposure for the recipient bank. This exposure is only extinguished at the end of the clearing cycle when settlement occurs. The exposure could crystallise into a loss for the recipient bank if the paying bank defaults during the cycle and before settlement has been completed. The default of a participant could have systemic consequences, particularly if the values passing through the payment scheme are large: a failure to settle by one participant could have repercussions on the ability of other participants to settle, potentially compounding the adverse effects of the first settlement failure. DNS payment schemes can adopt various controls to mitigate this credit risk. These include default funds, loss-sharing agreements, net debit caps, and prefunding requirements.

Under the RTGS model this settlement risk does not occur: all payments are settled individually and on a gross basis, so there is no scope for unintended credit exposures between banks to build up within the settlement process. Receiving banks can credit customer accounts or use incoming funds to pay other banks in the certain knowledge that settlement of each payment has already occurred.

An additional risk arises in securities settlement, as transfers of both cash *and* securities need to be settled. 'Principal risk' refers to the risk that one party to a trade defaults before fulfilling its obligation, leaving the buyer without securities or the seller without cash. This risk is addressed by settling under the delivery versus payment (DvP) principle, whereby the cash is transferred if and only if the securities are also transferred.

Intuitively, this logical link is best achieved when both cash and securities settle under the RTGS model. However, different securities settlement systems around the world apply different models of DvP. In some systems, for example, the associated cash transfers settle on a DNS basis.

The development of the United Kingdom's RTGS infrastructure

The move to real-time gross settlement

The Bank has provided accounts for the settlement of interbank obligations since the mid-19th century. Early accounting systems were paper-based, but developments in technology meant that by the mid-1980s, CHAPS payments settled electronically across the Bank's books. By the early 1990s, the interbank cash obligations arising from transactions in gilts and sterling money market instruments also settled electronically at the Bank, as did the main electronic and paper-based retail clearings. They all did so, however, on an end-of-day multilateral net settlement basis.

During the 1980s and 1990s, central banks around the world progressively moved to settling their high-value domestic payment schemes using the RTGS model. In 1980, of the major developed economies, only the United States had an RTGS infrastructure; by the end of the 1990s, such infrastructures had been established in all the G10 countries except one.(1) Advances in technology made real-time accounting operationally feasible. But the key policy driver of the change was the recognition by public authorities of the systemic risks inherent in settling high-value or wholesale payments under the DNS model.

In the United Kingdom, Robin Leigh-Pemberton, the then Governor of the Bank of England, used his 1989 Ernest Sykes Memorial Lecture(2) to open a debate on 'the future of the wholesale payment system in the United Kingdom'. In 1992, the Association for Payment Clearing Services announced(3) that an infrastructure would be developed for settling CHAPS payments under the RTGS model. The Bank's RTGS infrastructure was subsequently launched in 1996. In 2001, securities settlement in CREST moved to an RTGS-equivalent model of DvP.

The benefit of this move to the RTGS model was demonstrated in 2008 during the financial crisis. Risk appetites in the sterling money markets shrank, but the absence of credit risk in the settlement process contributed to the willingness of market participants to continue transacting with one another.

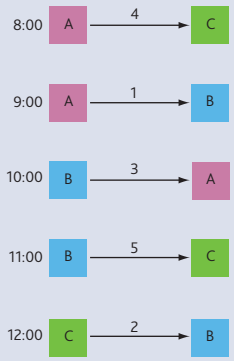
(1) For a comparison of the infrastructures for settling payments in different countries, see Committee on Payment and Settlement Systems (2005).
(2) The lecture was reprinted in Bank of England (1989).
(3) See Bank of England (1994).

Real-time gross settlement versus deferred net settlement

This box presents an example illustrating the differences between the deferred net settlement (DNS) and real-time gross settlement (RTGS) models and demonstrating the higher liquidity needs of the RTGS model.

Suppose three banks, A, B and C, make payments to each other at the indicated times (**Figure A**).

Figure A



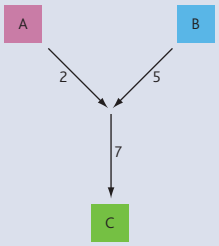
Under the DNS model, and assuming that all the payments are processed in the same clearing cycle, only the net obligations resulting from the payments would be settled at the end of that cycle. These end-of-cycle positions are calculated in the following table: payments sent by a bank are shown as a negative figure, while payments received are shown as a positive figure (**Figure B**).

Figure B

A	B	C
-4		+4
-1	+1	
+3	-3	
	-5	+5
	+2	-2
-2	-5	+7

Banks A and B have end-of-cycle net obligations of 2 and 5 respectively, while bank C has a net claim of 7. Settlement on a multilateral net basis would therefore consist of the following transfers across the accounts the banks hold at the settlement agent (**Figure C**).

Figure C



For settlement to occur, banks A and B need only have balances of 2 and 5 respectively on their accounts at the start of the day, while bank C needs no balance at all. The liquidity usage under the DNS model would therefore be 2 + 5 + 0 = 7.

Alternatively, suppose that the payments settle under the RTGS model. Assuming each bank has a sufficient balance on its account, each payment would settle individually at the time it is made. If banks A, B and C start the day with balances of 5, 7 and 0 respectively, then hourly snapshots of the balances on their accounts at the settlement agent, just after each payment has settled, would be as follows (**Figure D**).

Figure D

	A	B	C
Start of day	5	7	0
8:01	1	7	4
9:01	0	8	4
10:01	3	5	4
11:01	3	0	9
12:01	3	2	7

If any one of the banks begins the day with a lower starting balance than this, then at least one of the payments would not be able to settle, as there would be an insufficient balance on the payer's account at the time the payment was to be made. The liquidity usage under the RTGS model is therefore 5 + 7 + 0 = 12.

Supporting the Bank's core purposes

The Bank of England's two core purposes are to ensure monetary and financial stability. The United Kingdom's RTGS infrastructure plays a key role in helping the Bank to meet both these aims.

The RTGS infrastructure supports the Bank's monetary stability core purpose in three ways. First, the reserves held in the infrastructure are a key component of the Sterling Monetary Framework (SMF). This framework implements the Monetary Policy Committee's decisions by aiming to maintain overnight interbank money market rates in line with Bank Rate.(1) The interbank money market is a market in central bank reserves

(1) For an explanation of the SMF and how monetary policy is implemented, see Bank of England (2012).

and so needs a mechanism to transfer reserves between banks. Second, monetary policy influences the real economy through the interest rates faced by households and companies when they lend and borrow. When these transactions are between customers of different banks they create interbank obligations and hence a need for a settlement agent. So while these transactions are typically made in commercial bank money, they usually settle in central bank money across the RTGS infrastructure. And third, the Bank's monetary policy operations settle across the infrastructure. These operations include asset purchases using newly created central bank money ('quantitative easing') and the more traditional open market operations that lend reserves to banks.

The RTGS infrastructure also supports financial stability in three ways. First, it facilitates the safe transfer of funds between parties: settling in central bank money mitigates the risk of the settlement agent defaulting, and settling under the RTGS model prevents credit exposures between banks building up in the settlement process. Second, as one of the most liquid and risk-free assets in the economy, the reserves that banks hold in accounts in the RTGS infrastructure provide a buffer against unexpected liquidity shocks. And third, many of the Bank's financial stability operations settle across the RTGS infrastructure. These operations include lending funds against high-quality securities that have become temporarily less liquid due to stressed market conditions (referred to as liquidity insurance) and providing emergency liquidity assistance to individual financial institutions.

The operation of the United Kingdom's RTGS infrastructure

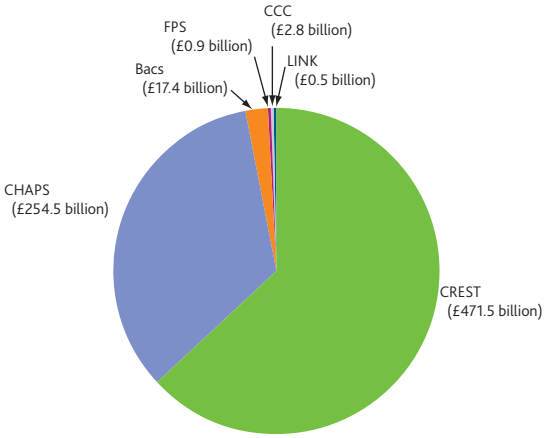
Users of the infrastructure

The Bank acts as the settlement agent for the CREST securities settlement system, the CHAPS high-value payment scheme, and four retail payment schemes: Bacs, the Faster Payments Service (FPS), Cheque and Credit Clearing (CCC) and LINK. The sterling interbank obligations arising from these systems and schemes are settled using transfers of central bank money between accounts that commercial banks hold in the RTGS infrastructure.

Much of the operation of the infrastructure is automated, allowing hundreds of thousands of transfers to occur daily, with minimal manual intervention by the operators. The account-holding banks communicate with the infrastructure via the international financial telecommunication network operated by SWIFT.

Although CHAPS and the four retail payment schemes all settle across the RTGS infrastructure, only CHAPS payments settle under the RTGS model; the retail payment schemes settle using the DNS model. The RTGS model is most appropriate for CHAPS because of its systemic importance to UK financial stability and the large values passing through it compared with the other payment schemes (**Chart 1**). The retail payment schemes, which process a much higher volume but lower value of payments (**Charts 1** and **2**), use the DNS model. Although credit exposures between banks can still build up in the settlement process of the retail schemes, they implement controls to mitigate the risks these cause.

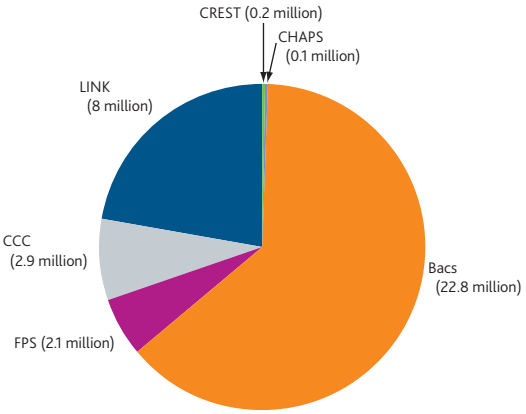
Chart 1 Average daily gross values transferred through UK payment systems in 2011[a][b]



Sources: Bank of England, Euroclear UK and Ireland Ltd, LINK and UK Payments Administration Ltd.

(a) CREST figures refer to the value of cash movements within CREST (and will therefore include the value of transactions settled between CREST participants who use the same settlement bank). CREST figures refer to sterling transactions.
(b) CCC figures refer to sterling cheques and paper bank giro credits exchanged in Great Britain.

Chart 2 Average daily gross volumes transferred through UK payment systems in 2011[a]



Sources: Bank of England, Euroclear UK and Ireland Ltd, LINK and UK Payments Administration Ltd.

(a) See footnotes to **Chart 1**.

CHAPS is primarily used for high-value wholesale sterling payments, such as interbank loans, but also for some lower-value but time-critical payments such as those for house purchases. Consequently, the average value of a CHAPS payment is large, some £1.9 million in 2011. The banks that participate directly in the CHAPS scheme, by holding settlement accounts in the RTGS infrastructure at the Bank, are called CHAPS settlement banks. There are currently

18 CHAPS settlement banks, while several hundred other banking institutions access the scheme indirectly via one of these. When a CHAPS settlement bank wants to make a CHAPS payment, it sends a message to the RTGS infrastructure via the SWIFT network. Assuming there is a sufficient balance on the paying bank's settlement account at the Bank, the infrastructure then automatically transfers the money from this account to the recipient bank's settlement account, before notifying the recipient bank that the payment has settled.

The four retail payment schemes settle different types of payments. The Bacs scheme processes bulk electronic direct debits and direct credits, such as salaries, pensions and utility bill payments. It operates on a three-day clearing cycle. FPS, launched in 2008, processes many payments initiated by internet and telephone banking, and is also used for standing orders. FPS transfers occur almost immediately after initiation, with the net interbank obligations settling three times a day across the RTGS infrastructure. The LINK scheme settles the interbank obligations that arise when cash is withdrawn from an ATM by another bank's customer. Interbank obligations arising from the use of sterling cheques and paper-based credits also settle across the RTGS infrastructure.

The Bank and Euroclear UK and Ireland Limited (the operator of the CREST securities settlement system) together deliver a particular model of real-time gross DvP settlement in sterling central bank money for transactions in UK securities. The cash transfers arising from securities transactions between CREST participants are settled across the CREST settlement accounts that the fourteen CREST settlement banks hold at the Bank. This relies on technical and legal links between the Bank's RTGS infrastructure and the CREST infrastructure.

The international Continuous Linked Settlement (CLS) system settles foreign exchange transactions on a so-called 'payment versus payment' (PvP) basis. As with securities settlement, foreign exchange settlement has to address the issue of principal risk (explained on page 236), often referred to in this context as 'Herstatt risk'. This risk is removed by settling transactions PvP, whereby the two currency transfers of a foreign exchange transaction settle simultaneously. Sterling transfers to and from CLS are made using the CHAPS payment scheme and settle across accounts held at the Bank.

Purchases and sales of wholesale quantities of Bank of England notes between the UK banking sector and the Bank are effected via the Bank's Note Circulation Scheme.(1) These high-value daily transactions are settled by start-of-day and end-of-day payments between the Bank and the settlement account that the transacting bank holds at the Bank.

The Bank recovers the costs of operating the RTGS infrastructure from its users. The Bank neither subsidises the infrastructure nor seeks to generate a profit from it. Settlement banks are charged per-item fees for CHAPS and CREST settlement, as well as annual account management fees and annual fees for settling their DNS payment scheme obligations.

The Bank acts as overseer for some of the payment schemes that settle across the RTGS infrastructure. The 2009 Banking Act made the Bank responsible for ensuring that systemically important schemes take sufficient measures to mitigate risks. Payment scheme oversight and the operation of the RTGS infrastructure are carried out by separate areas of the Bank.

Liquidity provision

The central bank liquidity needed intraday for settlement in the RTGS infrastructure arises from three sources.

- First, reserves held overnight in the RTGS infrastructure can be used intraday.

- Second, once a CHAPS payment has settled, the CHAPS settlement bank receiving the payment can immediately reuse the funds credited to its settlement account to make outgoing payments. CREST settlement banks can reuse the incoming funds from securities transactions in a similar manner. The box on page 240 explains this concept in more detail.

- Third, the Bank provides collateralised intraday loans to both CHAPS and CREST settlement banks. CHAPS settlement banks can also convert euro balances into sterling liquidity using a link to the euro high-value payment system TARGET2. The provision of this 'intraday liquidity' to settlement banks means that the Bank's intraday balance sheet is currently around 15% larger than its end-of-day balance sheet.

The mechanisms for providing intraday loans for CHAPS and CREST settlement work in different ways. Intraday liquidity provision to a CHAPS settlement bank requires an active decision by the settlement bank to enter into each intraday loan with the Bank. Typically, CHAPS intraday liquidity is supplied at the start of the business day; these loans automatically unwind at the end of the day before commencing again at the start of the next business day.

The CREST system's intraday liquidity mechanism with the Bank, on the other hand, is automatic once a liquidity need is identified. If a CREST settlement bank would otherwise have insufficient funds to settle a CREST transaction, a secured intraday loan is automatically generated using as collateral either the purchased security (if eligible) or other securities

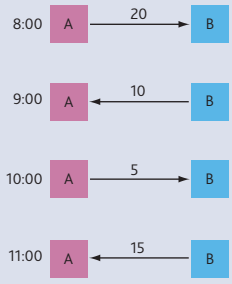
(1) See Allen and Dent (2010).

Liquidity recycling

This box illustrates how liquidity can be recycled, with the same unit of liquidity being used to make multiple payments.

Consider the sequence of payments between two banks shown in **Figure A**.

Figure A



Suppose banks A and B start the day with balances of 20 and 0 respectively. If the payments settle under the RTGS model, then hourly snapshots of the balances on their accounts at the settlement agent, just after each payment has settled, would be as follows (**Figure B**).

Figure B

	A	B
Start of day	20	0
8:01	0	20
9:01	10	10
10:01	5	15
11:01	20	0

The key point is that although bank B starts the day with no balance, it is able to make its payments using the liquidity it receives from bank A's payments. And despite only starting the day with a balance of 20, bank A is able to make payments of total value 25. In aggregate, a total payment value of 50 is settled, despite the system only containing liquidity of value 20. This illustrates how liquidity recycling can significantly reduce the liquidity needed for settlement in RTGS.

held by the settlement bank in CREST. This mechanism, known as an 'Auto Collateralising Repo' (ACR) is described in more detail in the 'Markets and operations' article in the 2012 Q2 *Quarterly Bulletin*.

The ACR mechanism is operated within the CREST system and activated without direct control by the Bank. But the mechanism automatically generates sterling central bank money, thereby creating an exposure for the Bank and increasing the size of the Bank's intraday balance sheet. Consequently, all CREST settlement flows, including ACR generation, are automatically monitored by both the Bank and Euroclear UK and Ireland Limited. In addition, the Bank has the capability to cap the amount of ACR liquidity generated, both by each individual bank and in aggregate.

The Bank carefully manages the liquidity that it provides in order to protect its balance sheet. The banks eligible to receive this liquidity must pass the Bank's prudence and risk standards before it will grant them an account in the RTGS infrastructure or allow them access to credit facilities. All intraday loans are collateralised by high-quality securities. If a bank to which the Bank has extended intraday credit defaulted during the day, the Bank could realise the value of these securities to cover the loss. The Bank also applies haircuts to collateral, whereby banks only receive a proportion of the current market value of the securities pledged. These haircuts protect the Bank against adverse movements in the value of the collateral: for all but the most extreme declines in the value of the securities, this will still exceed the value of the cash lent.(1)

Operational reliability

Given its critical role in the settlement of sterling payments and securities transactions, the RTGS infrastructure needs to maintain extremely high levels of operational reliability. Under a service level agreement, the Bank aims for 99.95% availability of the settlement services the RTGS infrastructure provides to CHAPS. Over the past four years, the infrastructure has been available for 99.997% of its usual operating hours. So on average it has been unavailable for settlement for just six minutes out of the 2,700 business hours each year. To ensure that the infrastructure can cope with spikes in payment activity, and can make up for processing time lost during operational outages, it must be able to process in just three hours in excess of the highest daily volume of CHAPS payments to date — a target it surpasses comfortably in regular tests.

To achieve these operational service levels, the RTGS infrastructure and risk controls need to be of the highest standard. The IT processor that holds the accounts and records the credits and debits to them runs on fault-tolerant computers. Additionally, a standby site duplicates the hardware and software at the Bank's principal site. The Bank's operators control the infrastructure from both sites every business day and changes to the database at one location are automatically copied to the database at the other in real time.

(1) For more information on the Bank's collateral management, see Breeden and Whisker (2010).

In some developed economies, central banks have decided to outsource the development and operation of their RTGS infrastructures to commercial infrastructure companies. In the United Kingdom, outsourcing of the operation of the RTGS infrastructure is not being considered.

The value of the infrastructure's reliability was seen in Autumn 2008. In the aftermath of Lehman Brothers' bankruptcy, as risk appetites diminished and the terms of interbank loans shrank, the daily value flowing through the infrastructure grew. Until mid-September 2008, the maximum daily value ever settled by CREST was £450 billion. In mid-January 2009, a new peak of £630 billion was hit, nearly twice the pre-crisis 2008 average. Any faltering of the RTGS infrastructure during this period could have greatly exacerbated the crisis, but its resilience ensured that this was avoided.

The future

A changing environment

The authorities' response to the financial crisis has changed the environment in which the RTGS infrastructure operates. In particular, the Financial Services Authority (FSA) has revised its liquidity regulations so as to reduce the risk that banks experience liquidity shortfalls.(1)

This change has had a particular impact on settlement banks' liquidity management. A settlement bank holds a buffer of liquid assets for two purposes: to maintain prudential balance sheet resilience and to meet intraday payment needs. These liquid assets may be reserves held at the Bank or high-quality securities that can be used to generate reserves either through outright sale or by pledging them as collateral in intraday loans from the Bank. Under the pre-crisis regulatory framework, the size of a bank's liquid asset buffer was calibrated to be sufficient to meet prudential resilience needs alone. But intraday, the buffer could also be used to fund payment activity. This practice is known as 'double duty'.

The problem with this approach was that the same assets were charged with meeting two separate shortfalls: prudential liquidity buffers exist to fund outflows at times of stress, so may not always be available to fund intraday payment activity. Under the new regulatory framework, liquid asset buffers are calibrated to be sufficient to meet both needs simultaneously, thereby removing double duty.

This change has made intraday liquidity more costly: previously, if a bank's intraday liquidity usage was less than the amount of liquid assets it was required to hold by the regulator, then intraday liquidity had no opportunity cost, as the bank could use for this purpose the liquid assets it already held. Furthermore, liquid asset buffers are now calibrated based on historical intraday liquidity usage. It follows that the more intraday liquidity a bank uses to make its payments, the larger its liquid asset buffer will need to be in future. This regulatory change could therefore incentivise banks to demonstrate economies in their liquidity usage.

Forthcoming developments to the United Kingdom's RTGS infrastructure

To meet this change to the payments landscape, and further strengthen the operational resilience of the United Kingdom's payments infrastructure, the RTGS infrastructure will develop in a number of ways over the coming years. Two principal forthcoming developments are the introduction of a Liquidity Saving Mechanism (LSM) in 2013, and the launch of the Market Infrastructure Resiliency Service (MIRS) in 2014.

The LSM functionality, a similar form of which is already used in a number of other countries' RTGS infrastructures, will reduce the liquidity needed for the settlement of CHAPS payments between banks. Its development is motivated by the changes to the FSA's liquidity regulations described above.

The LSM will contain a flow management system, housed within the RTGS infrastructure, called the 'central scheduler'. Settlement banks currently control their payment flows before their payments leave their own internal systems. After the LSM is introduced, banks will manage their payment flows using the central scheduler, which will have similar functionality to banks' existing systems.

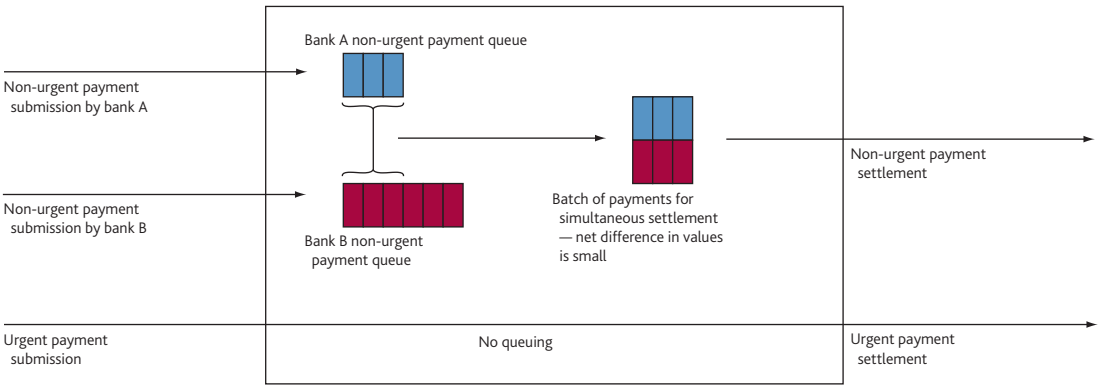
A key development is that the LSM will contain offsetting algorithms that will match batches of broadly offsetting payments from different banks to be settled simultaneously. The liquidity needed to settle a batch of payments will be the net difference between their values, a considerable change from the current system (**Figure 2**). Consistent with the philosophy of the RTGS model, offsetting payments will still settle gross from a legal standpoint. The mechanism will therefore combine the risk-reduction benefits of the RTGS model with the liquidity efficiency of the DNS model.

Many payments have a contractual deadline of the end of the business day. But some payments, such as transfers to CLS, need to be settled more urgently, for example by a certain time during the day. The LSM will process these urgent payments immediately. To enable it to do so, settlement banks will decide whether to submit each payment to an urgent or a non-urgent queue.

By design, the LSM will most of the time only be available to settle urgent payments, and it will do so in a similar manner to the existing RTGS model. But, every few minutes, the LSM will briefly suspend processing urgent payments and switch to a 'matching cycle'. During the matching cycles, which are each

(1) For more detail on the changes to the FSA's liquidity regulations, see Ball *et al* (2011).

Figure 2 Settlement in the LSM



expected to last around fifteen seconds, offsetting algorithms will be run to match and settle batches of non-urgent payments. Any non-urgent payments not settled by the end of a matching cycle will remain in the queue until the start of the subsequent cycle in a few minutes' time. This process will ensure that urgent payments settle much more quickly than non-urgent payments: typically in a matter of seconds rather than minutes.

The key design feature of the LSM is that while urgent payments will have access to all the liquidity that the paying bank has available for payment settlement, banks will be able to constrain the liquidity available for settling their non-urgent payments. This design ensures that urgent payments will have the best opportunity to settle without delay, while it is intended that non-urgent payments will generally queue awaiting incoming payments against which they can be offset, and so settle with lower liquidity usage. Banks will be able actively to control the liquidity available for settling their non-urgent payments throughout the business day.

The Bank has performed simulation studies(1) which suggest that the introduction of the LSM could reduce the total liquidity needed for CHAPS settlement by around 30%. Liquidity savings will be maximised if all banks submit payments into the central scheduler as soon as possible, as there will then be a greater likelihood that the offsetting algorithms can identify offsetting payments.

Another forthcoming development is MIRS, which will provide an additional contingency RTGS infrastructure that could be invoked should the infrastructures at the Bank's principal and standby sites ever fail simultaneously. MIRS will be developed and hosted by SWIFT and is expected to launch in 2014.

As well as offering an additional contingency option, MIRS will increase operational resilience in two key ways. First, it will be technically operated from outside the United Kingdom, so bringing greater geographic diversity to the sites hosting the infrastructure. And second, MIRS achieves technical diversity as it will be based on a different technology platform. This addresses a problem common in contingency arrangements that sites share software and hardware configurations and so could be susceptible to the same risks.

The generic design of MIRS by SWIFT means that it could be adopted by multiple central banks, thus lowering its cost to each user. To further reduce costs, the service provided will be simpler than that offered by the Bank's main RTGS infrastructure — it will be designed to maintain only essential functionality in the event of a low-probability but very high-impact event.

Conclusion

The RTGS infrastructure is essential to the functioning of the UK economy and supports both of the Bank's core purposes. It therefore needs to meet extremely high standards of service, availability and resilience. The infrastructure's record against these criteria is impressive, as evidenced in particular by its smooth functioning during the financial crisis.

But the environment in which the infrastructure operates is constantly changing: in particular new FSA regulations will raise the cost of accessing intraday liquidity.

To keep pace with this changing landscape, the RTGS infrastructure must itself evolve. Upcoming developments to the infrastructure will improve its efficiency and resilience to ensure it continues to meet the challenges it faces.

(1) See for example Denbee and McLafferty (2013).

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