Committee on Payment and Settlement Systems

New developments in large-value payment systems

May 2005

BANK FOR INTERNATIONAL SETTLEMENTS

Copies of publications are available from:

Bank for International Settlements
Press & Communications
CH-4002 Basel, Switzerland

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ISBN 92-9131-683-0 (print)

ISBN 92-9197-683-0 (online)

Foreword

Large-value payment systems (LVPS) play a key role in the financial infrastructure, by discharging payment obligations between banks. The 1990s experienced a major transformation in the design of these systems: from deferred net settlement (DNS) systems, which settled only at the end of the day, to real-time gross settlement (RTGS) systems, which settle on a continuous basis. This revolution was largely due to the possibilities offered by information and communication technology and to the measures taken by central banks to reduce systemic risks in these systems. The Committee on Payment and Settlement Systems (CPSS) of the central banks of the Group of Ten countries reflected these changes by publishing in 1997 the report *Real-time gross settlement systems*.

The purpose of this report is to present the state-of-the-art in LVPS, taking stock of the developments which have taken place since the 1997 report. It is written so as to be free-standing and not require reference to previous reports. The central message of the report is that interbank payments today settle faster, with a lower amount of liquidity (mainly central bank money), and at a lower cost. Indeed, whereas the key achievements in the 1990s were speed and safety of payments, the focus since the turn of the century has been to reduce liquidity costs and to provide users with more flexible intraday liquidity management.

In parallel, new systems have emerged to meet an expanding demand for cross-border payments. The primary example is CLS (Continuous Linked Settlement), which was established to reduce credit risk in the settlement of foreign exchange transactions. Another example is the emergence of new infrastructures in countries where a foreign currency plays an important role. Standardised arrangements have been established that enable financial institutions to settle foreign currency transactions through a correspondent bank while using the same system design as the local RTGS system.

While certain trade-offs exist between achieving lower risks and achieving lower costs, recent developments in LVPS design allow more flexibility in addressing various risk and cost trade-offs than previously available in traditional architectures. Central banks on their side have continued to seek a balance between more stringent risk controls and the need for systems to be cost-efficient.

The analysis in this report shows that the complexity of trade-offs between risks and costs implies a wide range of possibilities for the design of an LVPS. There is therefore no single solution fitting all markets and all participants' preferences. Hence, the report does not prescribe the adoption of any specific feature or design element introduced in a given LVPS in the CPSS countries. It is the responsibility of the owner of each LVPS to come up with the design that best fits the users' needs and achieve an optimal balance of risks and costs, while still meeting the relevant policy objectives.

The Committee set up a working group to analyse the new developments in LVPS and their implications for risks and costs. The CPSS is very grateful to the members of the working group, its chairman, Daniel Heller of the Swiss National Bank, and the CPSS secretariat at the BIS for their excellent work in preparing this report.

Tommaso Padoa-Schioppa, Chairman
Committee on Payment and Settlement Systems

Contents

Introduction and summary

The aim of this report is to take stock of the major developments in large-value payment systems (LVPS) that have occurred in the CPSS countries since the publication of the report on real-time gross settlement systems in 1997 (RTGS report).[1] It is not the intention of this report to recommend any specific feature or design element introduced in these LVPS. The optimal design of an LVPS depends, among other factors, on the structure of a country's monetary and financial system as well as on the volume, value and time-criticality of payments requiring settlement.

The main conclusion of the report is that recent innovations in LVPS allow more flexibility in addressing various risk and cost trade-offs than previously available in traditional architectures. Changes in LVPS design now make it possible for the banks which are the systems' main users to obtain:

- earlier finality;
- with a lower amount of liquidity, including central bank money;
- at a lower liquidity cost.

A payment is deemed final when it is unconditional and irrevocable. Thus, the earlier finality is achieved, the lower is the risk of unexpected credit exposures arising in the settlement process. The transfer of central bank money is what determines finality in the vast majority of LVPS. When finality is achieved with a lower usage of central bank money, banks can make the same amount of payments with fewer settlement balances. Thus, the liquidity cost of making payments is often lower. It becomes even lower when banks can fund their settlement accounts by obtaining sufficient amounts of intraday credit under flexible conditions.

In designing an LVPS, a certain trade-off exists between achieving early finality (and thus lowering risks) and economising on central bank money (and thus lowering costs). In general, trade-offs may exist in LVPS designs between reducing aggregate risks and lowering costs. These trade-offs can be affected by technological, financial and regulatory innovations. In particular, the design of message processing (eg queuing, queue management, matching, offsetting) provides additional options and opportunities that may more effectively address the particular needs and policy goals of a country. As a result, countries may be better positioned to obtain a risk-cost mix that is more appropriate for their monetary and financial needs.

The trade-off between risks and costs can be illustrated by comparing the two classic LVPS architectures, real-time gross settlement (RTGS) systems and deferred net settlement (DNS) systems:

- DNS systems were the predominant form of LVPS in the 1980s. In a DNS system, payment orders are accumulated throughout the day. Settlement of the net amount takes place typically once, at the end of the day. By reducing the number and overall value of payments between financial institutions, netting reduces the usage of central bank money. However, a well established drawback of (unprotected) DNS systems is the higher risks involved. Finality of settlement is only achieved at the end of the day and thus there is no certainty that the payments will be settled until that point in time. If one participant fails to meet its payment obligation when due, all processed payment orders could be unwound with the consequent risk of other participants defaulting in turn (systemic risk).
- RTGS systems developed in almost every country in the course of the 1990s. In contrast to DNS systems, RTGS systems settle each payment individually (ie on a gross basis). Provided the payer has sufficient balances (or credit availability), each payment order is settled as soon as it enters the system (ie on a real-time basis). When the payer's funds are insufficient, the order is typically queued. RTGS systems provide the advantage that payments become final in the course of the day, so that intraday exposures do not build up. The adoption of such safer systems was strongly supported, and often initiated, by central banks. A common downside of settlement in RTGS mode is that the associated needs in terms of settlement balances are higher than in a DNS environment. The number of RTGS

[1] *Real-time gross settlement systems*, BIS, March 1997, which analyses the features and the spread of RTGS systems.

systems increased dramatically in the 1990s. This trend was driven by a growing awareness of the need for sound risk management in large-value funds transfer systems.

The increase of LVPS design options that reduce liquidity costs and settlement exposures has been possible thanks to a variety of factors. On the supply side, the main driver has been technological progress in the area of information and communication technology. Features that were previously too expensive to be implemented have become affordable over time. On the demand side, users ask for features which reduce their central bank money needs, as well as for sophisticated payment and liquidity flow controls and real-time information on the payment process. Central banks have generally sought a balance between their goals for more stringent risk controls and the need for systems to remain efficient.

More specifically, the achievement of "earlier finality, with fewer settlement balances (usually central bank money), at a lower cost" can be explained by a number of developments:

- Earlier finality: LVPS are increasingly moving towards the provision of intraday finality. The number of DNS systems that settle large-value payments has clearly decreased over the past few years. In parallel, RTGS systems have become the most common type of LVPS. One of the reasons for this development may be an increasing demand for time-critical payments through the creation of the foreign exchange settlement system Continuous Linked Settlement (CLS) as well as through the increasing number of linkages between LVPS and ancillary systems (eg securities settlement systems or retail payment systems). More linkages imply short time frames to make time-critical payments from one system to another, hence the need to achieve finality within that time frame.
- Lower amount of liquidity, including central bank money: Another trend identified in this report is that many RTGS systems have incorporated design features of DNS systems in order to economise on the use of central bank money. A first innovation in this regard has been the introduction of so called "hybrid systems". These systems perform frequent netting or offsetting of payments in the course of the operating day. A typical approach is to hold payments in a central queue and to net or offset them at frequent intervals against queued payments from other participants. To the extent that resulting net debit positions are fully covered, the payments can be settled immediately. While hybrid systems reduce central bank money needs in comparison to RTGS systems by netting or offsetting, they reduce settlement risk in comparison to DNS systems by providing final settlement of the net positions immediately after each round of netting. Hybrid systems may, however, require more liquidity than DNS systems and may involve more settlement delay for some payments than RTGS systems. A second innovation has been the combination of recurrent netting or offsetting with a real-time settlement functionality. These systems typically first attempt to settle a payment order on a gross basis. If immediate settlement is not possible due to insufficient settlement balances, the system checks whether simultaneous settlement of one or more bilaterally or multilaterally offsetting payments is possible. Of course, a number of different optimisation routines can be used to match, offset or net queued payments. The applied algorithms vary greatly in terms of complexity. Usually, relatively simple bilateral algorithms tend to be applied in real time, while more complex multilateral algorithms are employed intermittently at short intervals.
- Lower liquidity cost: Drawing an analogy with driving a vehicle, cost savings may result from lower consumption of petrol or from a lower price of petrol. In LVPS, both of these factors have materialised. While the introduction of netting and offsetting features tends to reduce the amount of central bank money needed to settle the payments, the collateral policy of the central banks influences the costs of this liquidity. Since most central banks extend credit only against collateral, the type of collateral that the LVPS participants can use is an important factor in determining the opportunity costs of holding collateral. In general, most central banks have substantially broadened the range of collateral they accept in their provision of intraday liquidity. The Eurosystem, for instance, accepts euro-denominated collateral across borders within the euro area. Furthermore, a few central banks now also accept collateral denominated in foreign currency.

In addition to these developments, most LVPS now provide their users with a broader range of real-time information and more flexibility to manage liquidity. Originally, settlement accounts were often prefunded at the beginning of the day with no possibility to fund or defund up until shortly before the end of the processing day. Increasingly, users are able to add or withdraw settlement balances at any time during the operating day. In addition, most systems with a queue offer a variety of interactive control features that enable their users to fine-tune the settlement process. Such controls include the possibility to change the location of a payment in the queue, to prioritise the release of a payment or to set bilateral and multilateral limits to control the outflow of funds.

In parallel, new LVPS have emerged to meet an expanding demand for cross-border payments. The primary example is CLS, which started operations in 2002. CLS is a private sector system that specialises in the settlement of foreign exchange transactions on a payment-versus-payment basis. Settlement takes place in commercial bank money, on the books of CLS Bank. Currently, all of the 15 most actively traded currencies can be settled in CLS. The development of CLS was strongly encouraged by G10 central banks since it eliminates foreign exchange settlement risk in the trades it settles. Another example that can be highlighted in this realm is the emergence of new large-value payment infrastructures in countries where a foreign currency plays an important role. For instance, standardised arrangements have been established that enable financial institutions in Hong Kong and Switzerland to settle foreign currency transactions through a correspondent bank while using basically the same system design as the local RTGS system.

The report finds that the complexity of trade-offs between risks and costs implies a wide range of possibilities for the design of an LVPS. There is therefore no single solution likely to fit all markets or participants' preferences. As stated in the CPSS report *Core Principles for Systemically Important Payment Systems* of January 2001 (Core Principles report), an LVPS has to be appropriate to the needs of its users. It is the task of the owner to take these needs into account when deciding on the features of the system within the policy standards set by the relevant authorities. As before, risks and costs will have to be balanced to come up with the design that best fits the users' needs, while still meeting the relevant policy objectives.

The report is structured as follows. Chapters 2 to 4 provide an analytical framework that describes in a generic way: how an LVPS works (Chapter 2), what external factors affect LVPS design (Chapter 3) and what risks and costs are involved in these systems (Chapter 4). Chapter 5 focuses on the implications in terms of risk and cost of some of the developments described. Chapter 6 evaluates possible future developments in the LVPS area. The fact-finding for this report is based on information on the main developments in 24 LVPS that are currently operational in the CPSS member countries (see Table 1). The features of these systems are summarised in Annexes 1 and 2.

Table 1

List of LVPS discussed in the report

Country	System name	Acronym	Year of imple-mentation	Annual number of transactions (2003; in thousands)	Annual value of transactions (2003; in billions of USD)
Belgium	Electronic Large Value Interbank Payment System	ELLIPS[1]	1996	1,760	15,306
Canada	Large Value Transfer System	LVTS	1999	4,139	22,517
France	Transferts Banque de France	TBF[1]	1997	3,864	108,746
France	Paris Net Settlement	PNS	1999	7,332	20,294
Germany	RTGS^{plus}	RTGS^{plus} [1,2]	2001	32,792	145,115
Hong Kong	HK Dollar Clearing House Automated Transfer System	HKD CHATS	1996	3,508	11,207
Hong Kong	US Dollar Clearing House Automated Transfer System	USD CHATS	2000	999	1,236
Hong Kong	Euro Clearing House Automated Transfer System	Euro CHATS	2003	5[3]	135[3]
Italy	BI-REL	BI-REL[1]	1997	9,423	27,953
Japan	BOJ-NET Funds Transfer System	BOJ-NET	1988	4,925	161,914
Netherlands	TOP	TOP[1]	1997	4,717	24,119
Singapore	Monetary Authority of Singapore (MAS) Electronic Payment System	MEPS	1998	2,132	5,658
Sweden	K-RIX	K-RIX	1990	1,302	13,900
Sweden	E-RIX	E-RIX[1]	1999	93	2,141
Switzerland	Swiss Interbank Clearing	SIC	1987	192,700	33,202
United Kingdom	CHAPS Sterling	CHAPS Sterling	1984	27,215	84,267
United Kingdom	CHAPS Euro	CHAPS Euro[1]	1999	4,292	35,227
United States	Fedwire Funds Service	Fedwire	1918	123,300	436,706
United States	Clearing House Interbank Payment System	CHIPS[4]	1970	64,500	326,561
European Union	Trans-European Automated Real-time Gross Settlement Express Transfer System	TARGET	1999	66,608	474,993
European Union	EURO1	EURO1	1999	38,852	50,501
European Union	ECB Payment Mechanism	EPM[1]	1999	41	5
International	Continuous Linked Settlement	CLS[5]	2002	20,583	221,299
Germany/Switzerland	Swiss Euro Clearing Bank/euroSIC	SECB/ euroSIC[6]	1999	2,023	630

[1] Component of TARGET. TARGET consists of 15 national RTGS systems and the EPM system of the European Central Bank (ECB). When TARGET 2 is launched in 2007, it will provide a single sharable payments platform. [2] RTGS^{plus} evolved from the consolidation of the two former large-value payment systems of the Bundesbank, the RTGS Euro Link System (ELS) and the hybrid system Euro Access Frankfurt (EAF2). [3] From 28 August to 31 December 2003. [4] In January 2001, the design of CHIPS was changed from end of day, multilateral net settlement to real-time settlement. [5] The data for CLS are based on the aggregation of both sides of a foreign exchange transaction. [6] SECB/euroSIC can be classified as a payment system or a "quasi system"/correspondent bank.

1. Elements of large-value payment system design

This report focuses on large-value payment systems, ie systems that are designed primarily to process large-value or urgent payments.[2] There is no unique or exact definition of a large-value payment. In general, payments processed through an LVPS may feature one or more of the following characteristics:

- They are of large amounts;
- They are exchanged among financial market participants (so-called wholesale payments);
- They are usually urgent and require timely settlement (time-criticality);
- They are related to important financial market activities such as money market or foreign exchange transactions as well as many commercial transactions.

Some LVPS also process a large number of low-value or retail payments. While the processing of large-value payments is not a sufficient condition for a system to be considered a systemically important payment system (SIPS)[3], systems handling primarily large-value payments would usually be considered systemically important. Hence, it is not surprising that most LVPS meet high standards in terms of risk mitigation and that they are assessed against the Core Principles by overseers.

The aim of this section is to describe the design features and organisational aspects relevant to LVPS. Taking into account the environment in which an LVPS operates, its owner has a wide range of alternative features among which to choose in order to meet (ideally) the needs of the participants as well as the requirements of the overseer. The possible options include various aspects of the payment as a whole, starting with the submission of payment orders and ending with the irrevocable and unconditional (ie final) transfer of the settlement asset to the receiving participant.

1.1 Payment process

The payment process in an LVPS can be described in terms of the life cycle of a payment. As depicted in Figure 1, the payment process contains several steps. The report considers the submission process by participants; examines the fundamental conditions for settlement; describes a variety of alternative algorithms for the release of queued payments; analyses the conditions under which payments become irrevocable and unconditional (ie final); and considers the way in which the settlement asset is transferred between the sending and the receiving participant. As a matter of presentation, these steps are depicted in sequential order in Figure 1. It should, however, be kept in mind that some elements of the payment process can occur simultaneously. For instance, in most systems finality occurs at the same time as the transfer of the settlement asset. The Core Principles report contains a similar figure describing the changing status of a payment within a payment system.[4]

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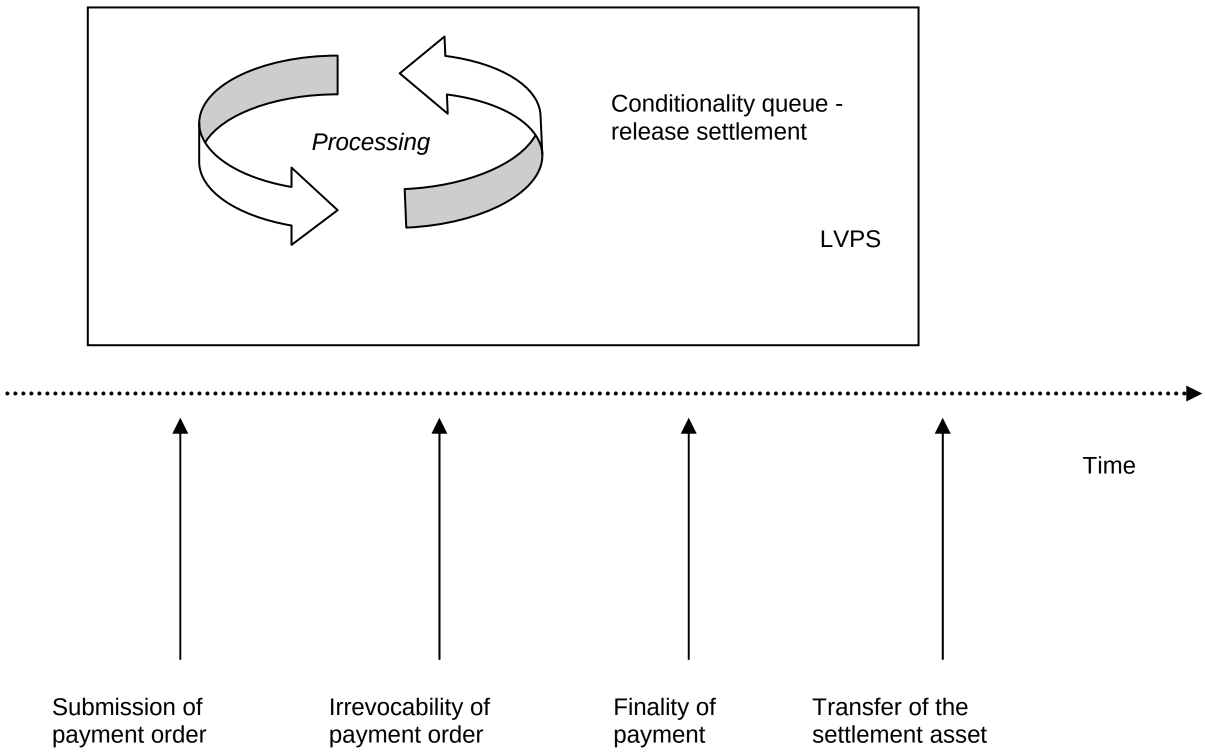
2 Large-value payment systems are also called large-value funds transfer systems (see *A glossary of terms used in payment and settlement systems*, BIS, March 2003).

3 A systemically important payment system is a payment system where, if the system were insufficiently protected against risk, disruption within it could trigger or transmit further disruptions amongst participants or systemic disruptions in the financial area more widely.

4 See *Core Principles for Systemically Important Payment Systems*, BIS, January 2001, p 32.

Figure 1

The life cycle of a payment



1.1.1 Submission

The first stage of the payment process is the submission of payment orders (or instructions) to the LVPS. A wide range of options can be offered by the LVPS for payment submissions and these may differ according to the type of payment submitted (time-critical versus not time-critical individual payment orders, balances of ancillary systems or cash legs of securities transactions). Whatever their type, and independently of whether they are transferred individually or in batches, submission to and processing of payment orders in contemporary LVPS are typically automated.

Individual payment orders can be credit transfers or debit transfers. In practice, however, almost all LVPS transactions are credit transfers, where both payment messages and funds move from the paying bank to the receiving bank. In fact, many payments processed in LVPS stem from monetary policy operations and money market or foreign exchange transactions. LVPS participants can usually store payment orders in internal queues before they are submitted to the system. The sequence of submission is therefore determined by the sending participant, which takes into account a number of factors such as delay and liquidity costs,[5] risk management considerations, queue management or the queue release algorithm of the LVPS.

An important factor influencing the submission process is the interaction with other financial market infrastructures, including retail payment systems, securities settlement systems (SSSs) and, most recently, CLS, which settles foreign exchange transactions. Ancillary systems settling balances in the LVPS may use several models for the submission of the related payment orders. In one model, all orders (debits and credits) are simultaneously submitted to the LVPS for settlement. In another model, first all debit positions are simultaneously submitted. Then, only after settlement of all the related payment orders has occurred, the credit positions are released. In SSSs, transactions are increasingly

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[5] The different risks and costs in LVPS are discussed in Chapter 3.

settled according to DVP model 1, ie the cash and the securities leg are settled simultaneously on a gross basis.[6]

Once payment orders are submitted, acceptance by the system for settlement generally includes a range of validation procedures. The level and type of validation performed by the LVPS depends on its specific design but typically includes, for example, verification that key data elements are included in the payment message. These validation procedures may also include security measures additional to those realised by the network provider to ensure the identification of the issuer as well as the integrity and non-repudiation of the payment orders. In the event that a payment message is not accepted by the system, it is usually returned to the sending participant and is not considered eligible for settlement.

1.1.2 Conditionality

Another key feature of the design of an LVPS is the set of conditions that has to be met in order for a payment to settle. In the most straightforward case, after the payment has been validated, the only condition for settlement is whether sufficient funds are available in the settlement account of the paying participant (or whether a sufficiently large overdraft facility is in place). If the payment is larger than the funds available, the payment may be rejected by the system. However, there are other possibilities for an LVPS to handle a payment that does not meet the conditions for immediate settlement. In most of the systems studied in this report, if the payment cannot be settled immediately, it is placed temporarily in a system (centrally located) queue. The queued payment will then be released from the queue at a later stage when all relevant conditions are satisfied (see also Chapter 1.1.3 on queuing arrangements). Alternatively, in systems without a queue, other options besides rejection are also possible. For example, in Fedwire, in the rare case that a payment cannot be settled under the sender's overdraft limit, the payment may still be settled and the sending institution then be subject to a programme of ex post counselling.

Additional conditions for settlement may be created by limits. These may be set either by a participant or by the system. While limits typically restrict credit exposures, a recent feature in some systems providing continuous intraday finality is the introduction of position or sender limits in order to control the outflow of settlement funds. Such limits were first implemented in hybrid systems like the German EAF2. A bilateral sender limit set by participant A to participant B is the maximum net amount participant A is willing to pay to participant B (see Box 1).

Box 1

Bilateral limits in the PNS system

In the French PNS (Paris Net Settlement) system settlement takes place continuously in central bank money on a payment-by-payment basis across dedicated accounts at the Bank of France. At any time the balance of each account remains positive, ie a participant cannot be a debtor in the system.

An important feature in PNS for the management of liquidity risk is the possibility for participants to set bilateral limits. Limits can be set voluntarily by each participant for each counterparty. A bilateral limit is the maximum net amount a participant is willing to pay to another participant. A payment order is placed in the queue as soon as the limit is reached or exceeded. If there is no instruction from the participant, the bilateral limits set on the last operating day are renewed.

Participants can change their bilateral limits during the operating day. If a bilateral limit is changed during the day, it will immediately affect the queued payments. The payments that are already settled with finality remain unaffected. Participants can monitor their limits vis-à-vis any other participant in real time. They can control the limits they have set on other participants and monitor limits other participants have set on them.

6 In a DVP model 2 the securities are transferred on a gross basis while the cash leg is settled on a net basis. In a DVP model 3 both securities and cash leg are simultaneously transferred on a net basis. For a detailed discussion of the settlement models in securities settlement systems, see *Delivery versus payment in securities settlement systems*, BIS, September 1992.

An LVPS may also offer the possibility for participants to set multilateral limits, which represent the maximum net outflow of funds a participant is willing to allow to all other or a group of participants in the system. Multilateral sender limits might also be used for the reservation of liquidity for the execution of time-critical payments. In RTGS^{plus}, for instance, it is possible to define a total limit in addition to bilateral and multilateral sender limits. This limit restricts the use of liquidity available for limit payments as a whole and reserves liquidity for express payments.

As described in Box 2, the settlement of payments also depends on priorities being assigned to the individual payment. The level of priority is either automatically assigned by the system according to the type of payment (for instance, settlement of ancillary systems or payments related to cash withdrawals) or can be chosen by the sender. In its simplest form, the system offers only two levels of priority, which are automatically assigned: a "high priority" and a "low priority".

Box 2

Express and limit payments in RTGS^{plus}

In the German real-time gross settlement system, RTGS^{plus}, the participants can choose between two types of payments - express payments and limit payments.

For express payments, the participant uses its entire RTGS^{plus} liquidity. The express mode is therefore particularly suitable for high-priority/time-critical payments. Typical examples include settlement payments (eg EURO1 via TARGET), transfers to private sector cash transporters and CLS pay-ins.

Alternatively, the participant may systematically control the outflow of settlement funds by defining limits within the system and submitting orders as limit payments. Such payments are only executed if the settlement balance on the RTGS^{plus} account of the submitting RTGS^{plus} participant is sufficient and the maximum amount of liquidity the participant is willing to use for limit payments has not been exceeded. Typical examples include money market or foreign exchange payments as well as domestic customers' payments.

For both types of payments, execution times can be preset. The participant can tag time-critical payments ("till" payments) with a due time. It is also possible to set up "from" payments. In this case, the participant defines the earliest processing time of the payment. In both cases, the participant continues to be responsible for the punctual execution of the payment. The interactive information and control system (ICS) enables the participant to monitor those payments simply and continuously by providing selective access to these transactions as well as a special warning feature.

Other conditions for settlement may apply depending on the types of transactions that are processed in the system. For instance, the settlement of a funds transfer can also be conditional on the settlement of another transfer, either a security in a DVP (delivery-versus-payment) mechanism or another currency in a PVP (payment-versus-payment) mechanism such as in CLS, where both counterparties must fulfil the set of conditions (see Box 3). If the LVPS is interfaced with an SSS which offers DVP model 1, transfers for both securities and funds settle on a trade-by-trade basis, with simultaneous finality. In this case, one method of processing is for the SSS to first earmark the securities to be transferred, then "block" them and issue a payment message for the settlement of funds in the LVPS. When the settlement of funds has taken place in the LVPS, a confirmation message is sent to the SSS, which transfers ownership of the earmarked securities.

Finally, there exist other methods to limit the outflow of funds. In some systems, it is possible to make "reservations" of funds for certain types of payments, for example for the settlement of time-critical or urgent payments. Alternatively, sub-accounts can be created for the settlement of certain types of payments.

In the French TBF (Transferts Banque de France) system each settlement account belongs to a so-called "group of accounts". When a payment is posted to the settlement account of the sending bank, the possibility to debit the settlement account is assessed against the "net sum" of balances available in the group of accounts to which that settlement account belongs and not against the sole balance of the account to be debited. This mechanism allows, among other things, a bank and its subsidiaries to "pool" their available liquidity.

Some systems use splitting of large payments into two or more smaller tranches, in order to speed up the settlement process. The potential legal complexities notwithstanding, splitting of payments can be achieved using two main conventions: by defining a maximum transaction size according to which larger transactions are split or by using the available liquidity in full to create a part of the current transaction that could be settled. If, for example, a participant has submitted a payment but does not have sufficient funds on its account, splitting according to available liquidity can process part of the original payment. Splitting of payments exists in CLS and in the Swiss Interbank Clearing System (SIC). In CLS payment instructions are automatically split by the system based on thresholds set for each currency while in SIC the participants themselves are obligated to split payments that exceed a certain amount.

Box 3

Risk controls in the CLS system

The CLS system provides settlement of foreign exchange transactions on a trade-by-trade basis. In order to insure this PVP mechanism, the accounts of the counterparties to a trade are debited and credited simultaneously on the books of CLS Bank, which acts as the settlement institution.[7] CLS Services acts as the settlement agent,[8] crediting or debiting participants' accounts at CLS Bank. All transactions to be settled on a given date must be submitted to CLS by both counterparties before the beginning of the settlement process. Before the transaction is included in the settlement queue, its two legs are matched in terms of date, currencies, amounts and identification codes. Before transactions are released for settlement, several conditions must be satisfied:

- Positive Adjusted Account Balance: After settlement of an eligible instruction, the account of each of the two counterparties with respect to the sum of all eligible currencies (expressed in terms of US dollars) must continue to have a positive account balance adjusted by the currency specific haircuts. Consequently, settlement cannot occur until both counterparties have funded their accounts.
- Short Position Limit (SPL): After settlement of an eligible instruction, neither of the two counterparties of the foreign exchange transaction is allowed to have a short position in excess of the applicable SPL. The SPL for each currency is the maximum debit balance a settlement member is allowed to incur in that specific currency. In each currency, the limit is the same for all members.
- Aggregate Short Position Limit (ASPL): After settlement of an eligible instruction, neither of the two counterparties is allowed to have an aggregate short position after adjustment by the currency specific haircuts in excess of their respective ASPL. The ASPL is the maximum total debit balance that a settlement member is allowed to incur in all currencies. A CLS participant's ASPL is set by CLS Bank based on its assessment of the risks (eg short-term credit rating, Tier I capital and operational risks, among others).

Upon determining that both counterparties of the transaction satisfy each of these conditions, CLS Bank settles the eligible transaction, removing the paired instructions from the queue, and simultaneously debiting and crediting both counterparties' accounts at CLS Bank with the specified currency amounts. If any test is not passed the transactions are not settled and the paired payment instructions remain queued. The settlement process then advances to the next queued transaction and the system again checks whether the three conditions described above are satisfied. After the system has attempted to settle the last instruction in the queue, it automatically jumps to the first one in the queue. CLS can also run "circles processing", which seeks to settle offsetting groups of payments that are in the queue. The tests specified are repeatedly applied to all settlement eligible instructions in the settlement processing queue until these have all been settled, but in no event later than the currency close deadline for the applicable eligible currency.

1.1.3 Queuing arrangements and release methods

In systems with a queue, if a payment does not satisfy the conditions for immediate settlement, it is placed in a system (centrally located) queue. Such LVPS typically store validated but not yet settled payments in the queue until the payment meets the conditions for settlement (see Figure 2). The order in which these unsettled payments are placed in the queue is usually based on the time of

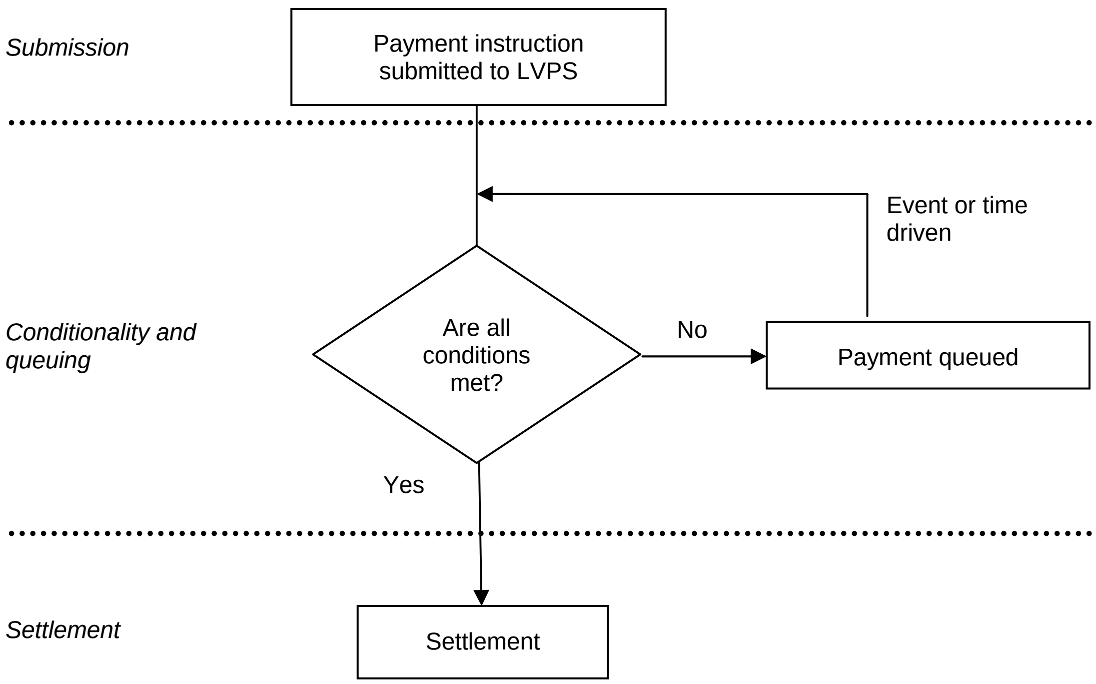
[7] The settlement institution is the institution across whose books transfers between participants take place in order to achieve settlement within a settlement system. (See also *A glossary of terms used in payment and settlement systems*, BIS, March 2003.)

[8] The settlement agent is the institution that manages the settlement process (eg the determination of settlement positions, monitoring of the exchange of payments, etc) for transfer systems or other arrangements that require settlement. (See also *A glossary of terms used in payment and settlement systems*, BIS, March 2003.)

submission/validation, so that the earlier a payment has been submitted to the LVPS, the higher its position in the queue.

Figure 2

The settlement process with a central queue



While the order in which unsettled payments are placed in the queue does not vary among LVPS, the ways in which they are released from the queue (tested for settlement) differ. In fact, several queue release methods can be found (see Table 2).

If queued payments are released on a first-in, first out (FIFO) basis, payment messages are held in the order in which they are dispatched by the sending bank; the payment at the top of the queue is released and settled when covering funds become available, and only then is the payment behind it in the queue considered for settlement.[9] This implies that a strict FIFO principle may cause large transactions at the head of the queue to block the settlement of subsequent transactions. In order to address this problem, different solutions have been developed. In some systems, the sending participant can reorder or revoke queued payments. An additional approach is to define different levels of priority for payments. In this case, the most common model is for the LVPS to operate on a FIFO basis within each priority level. This allows the settlement of time-critical payments (high priority) not to be dependent on the existence of non-urgent payments already in the queue. A higher degree of complexity is reached when several levels of priority coexist with priority dependent settlement algorithms. Another alternative to solve the problem of big payments blocking the queue is a bypass FIFO mechanism, where the system tries to process the transfer in the queue, but if it cannot be executed owing to lack of funds it then tries to settle the next transfer instead. A further alternative to FIFO is to run the scanning algorithm according to the "FAFO" principle (first available, first out): if the first payment in the queue cannot be settled according to the prevailing conditions, payments further down in the queue are tested for settlement.[10]

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[9] As discussed in Chapter 1.1.2, additional conditions can possibly apply.

[10] See *Real-time gross settlement systems*, BIS, March 1997, p 24.

Table 2

Queuing arrangements in selected LVPS

FIFO	Bypass FIFO	Different levels of priority	Reordering of payments
ELLIPS (Belgium)	ELLIPS (Belgium)	ELLIPS (Belgium)	RTGS^{plus} (Germany)
LVTS (Canada)	PNS (France)	TBF (France)	HKD CHATS (HK)
TBF (France)	RTGS^{plus} (Germany)	RTGS^{plus} (Germany)	USD CHATS (HK)
PNS (France)	BI-REL (Italy)	HKD CHATS (HK)	Euro CHATS (HK)
RTGS^{plus} (Germany)	K-RIX (Sweden)	USD CHATS (HK)	BI-REL (Italy)
HKD CHATS (HK)	E-RIX (Sweden)	Euro CHATS (HK)	TOP (Netherlands)
USD CHATS (HK)		BI-REL (Italy)	K-RIX (Sweden)
Euro CHATS (HK)		TOP (Netherlands)	E-RIX (Sweden)
BI-REL (Italy)		SIC (Switzerland)	SIC (Switzerland)
TOP (Netherlands)		SECB/euroSIC (Germany/Switzerland)	SECB/euroSIC (Germany/Switzerland)
K-RIX (Sweden)		CHAPS Euro (UK)	CHAPS Euro (UK)
E-RIX (Sweden)		CHAPS Sterling (UK)	CHAPS Sterling (UK)
SIC (Switzerland)		CHIPS (US)	CHIPS (US)
SECB/euroSIC (Germany/Switzerland)		EPM (ECB)	
EPM (ECB)			

In recent years, several LVPS have introduced more complex algorithms, which search the queues for a set of payments between participants that is largely offsetting (see Boxes 4 to 6). The payments in such a set are then settled by offsetting, which means either the gross execution of individual payments simultaneously within one legal and logical second or the settlement of net balances. These algorithms can work on a multilateral or bilateral basis. Inter alia, the objectives of offsetting are to increase the capacity of the system to settle payments, thereby reducing queues, speeding up the settlement process and reducing intraday liquidity needs.

Probably the simplest form of offsetting is when an algorithm tries to bilaterally offset the first queued payment of Bank A for Bank B with the first queued payment of Bank B for Bank A. More generally, a "full" bilateral offsetting mechanism considers all payments in the queues of the pair of participants and tries to settle them simultaneously. A "partial" bilateral offsetting algorithm takes only a subset of bilaterally queued payments into account. Bilateral offsetting is implemented in a number of systems (LVTS, PNS, RTGS^{plus}, BI-REL).

Another form of offsetting is a "full multilateral" offsetting of queued payments. This algorithm operates in a way similar to the traditional settlement of end of day positions in a DNS system. For each participant, a "virtual" net position is calculated by summing (the values of) all queued incoming payments to the actual position and deducting all queued outgoing payments. If the conditions applied by the system allow the settlement of all the "virtual" net debit positions, all queued payments are settled individually, but simultaneously on a gross or net basis. If (eg due to lack of funds or other conditions applied by the system) at least one position cannot be settled, the entire multilateral offsetting is cancelled.

Box 4

The optimisation mechanism in BI-REL

The new generation of BI-REL, which became operational in June 2003, provides an optimisation mechanism for domestic interbank payments between direct participants. This mechanism is not applied for cross-border payments or payments involving the Bank of Italy. The optimisation mechanism promotes the simultaneous bilateral settlement of queued payments on a gross basis, on condition of sufficient account balances. It is triggered automatically during the operating day.

The mechanism is triggered whenever a new payment is entered into the system or when the available liquidity on the settlement account changes. It is activated before gross settlement takes place even when the funds available on the settlement account would be sufficient to settle payments on a gross basis.

The optimisation mechanism operates on a "one-to-many" bilateral basis. This means that when Bank A enters a payment for Bank B the mechanism checks whether there are any queued payments of Bank B for Bank A and tries to mach them. Queued payments of Bank B are processed according to size and not according to priority or input time. The largest payments are settled first, then as many as possible of the remaining ones are processed. The optimised payments are always settled on a gross basis. No netting takes place and a notification message for each single payment is produced.

Settlement occurs when the debtor's available funds exceed the net balance. In the previous example, Bank A uses funds on its settlement account that are not reserved for urgent payments. If the optimisation mechanism is triggered by the entry of an urgent payment Bank A can also use the liquidity reserved for urgent payments. Bank B on the contrary can only use the liquidity that is not reserved, in order to prevent the optimisation from using its liquidity reserved for urgent payments to other participants.

Box 5

The settlement mechanism of CHIPS

Since January 2001, CHIPS has provided intraday finality for payment messages immediately upon their release from a centralised queue. Under this system, payment messages settle either individually (on a gross basis) or in groups (on a bilateral or multilateral net basis), against participants' positive positions in CHIPS.

CHIPS settlement is dependent upon two basic stages of prefunding. For initial prefunding, participants, either directly or through another bank, use Fedwire to send a predetermined amount to the CHIPS Prefunded Balance Account at the Federal Reserve Bank of New York. This payment is then marked on CHIPS' books as the participant's opening position, and the system will begin to process the participant's payment messages. The CHIPS algorithm seeks opportunities to settle individual messages or match groups of payment messages that, upon their release: (1) do not cause any participant's CHIPS position to become negative, and (2) do not cause any participant's position to exceed twice its initial prefunding requirement (the credit cap). The first condition ensures that there is sufficient funding to ensure that all payment messages are finally settled when they are released. The second condition constrains the amount of liquidity any one participant can absorb, improving the liquidity efficiency of the optimisation algorithm. The second condition is lifted at 17:00 ET, when CHIPS stops accepting new payment messages into the CHIPS queue for the business day. Payment messages remain queued until the algorithm can satisfy the relevant prefunding conditions.

Initial prefunding may not be sufficient to settle all queued payment messages prior to 17:00 ET. To settle and release the remaining payment messages, yet not allow participants to incur negative positions, a final end of day prefunding is required. CHIPS tallies the remaining queued payment messages on a multilateral net basis, without settling these payment messages. If the value of a participant's outgoing queued messages exceeds the value of its incoming queued messages, the participant has a "closing position requirement" and must send (directly or through another bank) a Fedwire funds transfer in this amount (adjusted for any positive position as of the 17:00 ET cut-off) to the CHIPS Prefunded Balance Account. Once all participants have transferred their closing position requirements into the CHIPS Prefunded Balance Account, CHIPS settles and releases the remaining payment messages and sends Fedwire payment orders to participants that were in a positive closing position. CHIPS rules provide that if a participant is unable to pay its final prefunding requirement, the system settles and releases as many payment messages as possible, employing the same algorithm used to settle payments throughout the day (without the credit cap). Payment messages that remain unsettled after this process "expire" and are deleted from the CHIPS queue.

In addition to the two stages of required prefunding, CHIPS participants are also permitted to provide supplemental prefunding throughout the operating day. Participants that provide supplemental funds may also be able to withdraw these funds in certain, limited circumstances. In conjunction with CHIPS' message priority system, supplemental prefunding allows participants to ensure the release of any queued message.

A more complex form of multilateral offsetting is the "partial multilateral" offsetting procedure, where some payments or participants are removed from the offsetting procedure to identify a subset of transactions that can be settled in accordance with the systems' conditions for settlement. "Partial multilateral" mechanisms can be found, for instance, in PNS and RTGS^{plus}. The offsetting can take place in a pre-specified order (for example, by FIFO, priority or size) or according to other rules. Systems can employ multiple types of offsetting.

Box 6

The settlement mechanism of RTGS^{plus}

RTGS^{plus} went live in November 2001. It combines the risk-reducing benefits of gross settlement of the former German RTGS system (ELS) with the advantages of liquidity-saving processing of the former hybrid system (EAF2). The gross settlement procedure consists mainly of three measures:

1. immediate real-time settlement, but under consideration of offsetting payment flow;
2. event-oriented optimisation of queued express payments;
3. ongoing resolution of queued express and limit payments by using offsetting algorithms.

In detail, the settlement process can be described as follows. If sufficient cover is available, express payments are settled immediately. If not, the system checks whether the submitted payment can be settled taking offsetting queued express payment(s) of the recipient into account. These offsetting payments have to be at the top of the recipient's queue. In principle, express payments are settled according to the FIFO principle. Limit payments are processed according to the FAFO principle. This means that they may be processed immediately (irrespective of any other queued limit payment) and can therefore violate the FIFO principle, provided the participant has sufficient cover in its RTGS^{plus} account and no limit is breached. In addition, RTGS^{plus} can have recourse to three settlement algorithms, via which a queue of limit payments is continuously resolved by including express payments that are not yet settled. The algorithms are based on bilateral and multilateral offsetting. Settlement in this case is no longer related to FIFO since the algorithms try to maximise the number of settled payments. Algorithms are chosen either on a regular basis or depending on the situation.

It is worth noting that offsetting algorithms are not new to LVPS that provide continuous finality. Previously, they were applied in case of gridlock, in DNS or in hybrid systems (eg EAF2). Recent progress in computing technology, however, has made it possible for offsetting algorithms to be used as a standard settlement feature in RTGS systems. They can be run at discrete intervals (either at designated times or upon decision of the system operator) or be event-driven (eg each time a participant's account is credited with an incoming payment or each time a payment has been added to the queue). Current technology makes it possible for bilateral and multilateral offsetting to be run continuously.

Another important element of queuing arrangements is the extent to which the central queue is transparent and, if so, how much information is released to the potential receivers of queued payments. Various approaches to providing incoming queue visibility can be distinguished. The queues can either be fully transparent, in which case the full release of customer specific information allows participants to identify incoming customer payments prior to their settlement. Alternatively, they can be only partly transparent, and the LVPS may only reveal to a participant the aggregate value of all payment messages, or of payment messages per participant, that are addressed to it. More details on information and control can be found in Chapter 1.3 of the report. The implications of queues in terms of risk are developed more fully in Chapter 4.

1.1.4 The points of irrevocability of a payment order and finality of a payment, and transfer of the settlement asset

The precise moment when a payment order becomes irrevocable differs across systems depending on the underlying legal regime and the rules of the LVPS concerned. In some systems, a payment order becomes irrevocable as soon as it is validated by the system (eg LVTS, TBF and PNS), ie queued payment orders cannot be revoked anymore. In other systems, payments remain revocable until settlement takes place (eg RTGS^{plus}, BI-REL, K-RIX, SIC, CHIPS and CHAPS), whereas in a few systems (eg ELLIPS) payment orders can only be revoked with the consent of the receiver.

Finality of payments is defined as the point in time at which a payment becomes irrevocable and unconditional. Hence, it can be argued that a reduction of the time lag between the submission of a payment and the point of finality may help to reduce uncertainties about a possible failure of the sending bank after the initiation, but prior to completion of the payment. It is therefore important, as stated in the Core Principles report, for a systemically important payment system to have a sound legal basis with regard to the finality of payments. Otherwise, participants could be acting with erroneous expectations, which may give rise to credit exposures of which they are not aware. When the release mechanisms rely on any form of netting, it is also essential for the legal system in the jurisdiction of the system and all of its participants to recognise netting or offsetting as a valid form of settlement of payments.

As a general rule, LVPS design has ensured that the settlement asset (that is, claims on the settlement institution) is transferred at the same time as finality is achieved. Notable exceptions are the Canadian LVTS and the European EURO1. Both systems provide examples of how the transfer of funds across accounts held with the settlement institution (the Bank of Canada and the ECB, respectively) may take place after the time of finality. Box 7 describes the design of LVTS, which is often characterised as an RTGS-equivalent netting system.

Box 7

Separation of finality of payments and settlement of the system in Canada's LVTS

The Canadian Large Value Transfer System (LVTS) employs multilateral netting by novation. Every payment that passes through the LVTS's real-time risk controls has immediate finality. This is true despite the fact that settlement of multilateral net positions across the books of the Bank of Canada does not occur until the end of the day. Thus, the LVTS can be considered to be an RTGS-equivalent system, but one which economises on liquidity compared to a traditional RTGS system. Even if one or more LVTS participants default before the time at which the system is due to settle, the unconditional and irrevocable status of payments that had previously passed through would not be at risk, because the system provides certainty of settlement.

The LVTS has two payment streams, Tranche 1 (T1) and Tranche 2 (T2). Each participant can choose to send a payment via either stream, assuming that the payment can pass the risk controls of the selected stream.

T1 payments sent must be funded, dollar for dollar, by T1 payments already received or by collateral that is pledged to the Bank of Canada by the sending institution. If a default were to occur, the Bank of Canada would be entitled to realise on the participant's collateral in exchange for supplying the liquidity necessary to bring the defaulter's position to zero. This stream is called "defaulter pays".

In the T2 stream, participants extend bilateral credit limits (BCLs) to each other. The BCL of one participant to another represents the maximum positive bilateral position that the first participant is willing to assume with respect to the second. A participant's T2 net debit cap equals the sum of the BCLs that it receives from other participants multiplied by a fraction (currently 24%) called the "system-wide percentage". The T2 net debit cap represents the maximum allowable multilateral net debit position of a participant. There is no cap on multilateral net credit positions.

In order for a payment to pass through the T2 risk controls, it must not violate the caps on bilateral positions, represented by the BCLs, or the cap on the overall multilateral net debit position.

To support its T2 activity, each participant must pledge to the Bank of Canada collateral equal to the largest BCL that it extends, multiplied by the system-wide percentage. This results in sufficient collateral being pledged to the Bank to cover the single largest multilateral net debit position. The Bank of Canada is obligated to provide the liquidity necessary to settle each participant's multilateral net T2 position. For each institution, this obligation is completely collateralised by the T2 collateral requirement described above. In the event of a single default, the Bank of Canada would realise on the collateral of the defaulter and on sufficient collateral from those surviving participants who had extended BCLs to the defaulter to cover the multilateral net debit position of the defaulter and would provide the liquidity necessary for the system to settle. Surviving participants would share in the losses in proportion to the size of the BCLs they extended to the defaulter. Thus, a participant that had extended no BCL to the defaulter would suffer no loss. This stream is called "survivors pay". In the event of a single participant failure, the Bank's exposure is completely collateralised.

In the extremely remote event of multiple defaults and if the collateral pledged by participants to the Bank was not sufficient to cover the net debit positions of the defaulters, the Bank would realise on the available collateral, according to the loss allocation rule described above, and become an unsecured creditor of the defaulting institution. Under the Payment Clearing and Settlement Act, the Bank of Canada provides an explicit guarantee of settlement for the LVTS. It is this certainty of settlement that permits the LVTS to provide intraday unconditional finality and irrevocability of payments that pass through its risk controls, despite the fact that settlement across the Bank's books does not occur until the end of the day.

1.2 Funding

This section discusses the sources of LVPS funding. It considers three separate sources of funding. First, there usually exists a centralised source of funding by the settlement institution, which can affect the aggregate level of funds in an LVPS. It also includes the minimum reserves held at the settlement institution if they can be used for payment purposes. Second, funds can be redistributed between the LVPS and another system through linkages between them, which affects the aggregate level of funds in the LVPS as well as in the other system. Finally, there exist decentralised sources of funding between LVPS participants that redistribute funds between them and do not affect the aggregate level of funds in the system. Borrowing funds on the money market, for instance, can be considered as a decentralised source of funding.

1.2.1 Centralised sources of funds in an LVPS

The settlement institution is in the unique position of being able to create a centralised source of settlement funds to the participants of the system. This source is called centralised because the settlement institution is the only counterparty that can influence the total amount of settlement assets that participants hold (apart from transfers of funds between systems as described in Chapter 1.2.2 below). If the settlement institution is a central bank, the funds are deposits in central bank money, which is generally considered a risk free settlement asset.

Central banks can influence settlement funds without extending credit through the outright sale or purchase of securities (so-called open market operations) and foreign exchange. In addition, any other payments sent to and from the settlement institution affect the total level of settlement balances held by payment system participants. For example, central banks typically provide payment services to the government, and payments sent on behalf of the government will raise the level of settlement balances available to the receiving participants (and vice versa).

Funds can also be created by the settlement institution through credit operations. Besides the funds provided for monetary policy reasons, the settlement institution often also provides funds for payment purposes with a maturity of less than a day (intraday credit or intraday liquidity). The amount of intraday credit in an LVPS is an important element in determining the settlement speed. For this reason, nearly all CPSS central banks were providing intraday liquidity through credit extensions by the late 1990s. Box 8 illustrates the effect of the introduction of intraday credit on the settlement process in the Swiss SIC system.

Most central banks are - by law or by self-imposed rules - required to extend credit only on a secured basis. These secured credit operations are typically structured in various ways.[11] In payment systems, two common forms of credit extension by the central bank are repurchase agreements (repos) and overdrafts on central bank accounts (pledge). Repos are securities transactions in which one party agrees to sell securities to another against the transfer of funds, with a simultaneous agreement to repurchase the same or equivalent securities at a specific price at a later date. With overdrafts, a participant's balance at the settlement institution is allowed to be negative. When an overdraft is fully collateralised, its economic impact is similar to that of a repo.

The settlement institution may also provide intraday credit on an unsecured basis. This is done, for instance, by the Federal Reserve, where qualified depository institutions are allowed to overdraw their accounts during the day up to a predefined limit or net debit cap. Fees are imposed on daily average overdrafts (less a deductible amount) in order to provide incentives to control intraday credit usage. In certain circumstances, a higher limit may be acquired through the pledging of collateral.

Settlement institutions may lend against a range of collateral. A common form of collateral is government debt instruments, but other instruments are also frequently accepted. Appropriate haircuts (or margins) are applied on the collateral in order to reduce the risk of financial loss in the event of the default of the counterparty.

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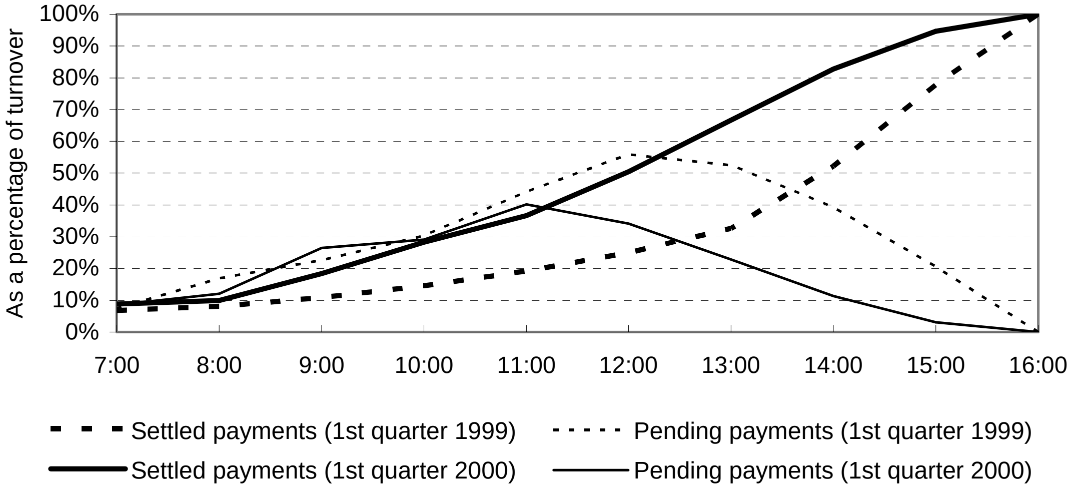
[11] See *Securities lending transactions: market development and implications*, CPSS/IOSCO, July 1999.

Box 8

Introduction of intraday credit in SIC

Earlier settlement of payments
due to provision of intraday credit



Until autumn 1999 the Swiss National Bank (SNB) neither provided intraday credit nor allowed overdrafts in the SIC. Due to the increase of time-critical payments and the forthcoming start of CLS the SNB introduced provision of intraday credit through repos in October 1999. The chart shows the effect this had upon the settlement process in SIC comparing the average daily settlement pattern in the first quarter of 1999 and that of 2000. The thin lines, which represent the number of queued payments, indicate a clear decrease in the length of the queue. While in 1999 the maximum length of the queue amounted to 55% of total turnover, this figure decreased after the introduction of intraday credit to 40% in 2000. The thick lines represent the settled payments. This line shifted accordingly to the left, as payments were settled faster than without the provision of intraday liquidity. The amount of settled payments at noon rose from less than one third to about half of the daily turnover.

In recent years, several central banks have widened the range of eligible collateral by accepting debt instruments denominated in foreign currency (United States, United Kingdom, Sweden and Switzerland). A similar initiative is the Scandinavian Cash Pool, which allows participants to pool liquidity using securities held as collateral at any of the Scandinavian central banks (see Box 9). Several reasons are quoted in favour of accepting securities in foreign currency as collateral, most notably a reduction of opportunity costs, enhanced flexibility in crises and the facilitation of foreign banks' access to capital, money and payment markets. By accepting foreign currency denominated collateral the central bank is bearing a market risk arising from exchange rate fluctuations.

Within the European System of Central Banks, the Correspondent Central Bank Model (CCBM) enables participants in TARGET to use euro-denominated collateral located within the euro area for obtaining credit from the home central bank (see Box 9).

Box 9

Cross-border use of collateral

Both the Scandinavian Cash Pool (SCP) and the Correspondent Central Banking Model (CCBM) were developed in order to access collateral deposited in one country for raising settlement funds in another country.

The automated SCP system was established in 2003, mostly in order to cope with the risk that the liquidity providers for the Scandinavian currencies (Norwegian, Danish and Swedish krone) in CLS would need large amounts of liquidity to cover other participants' failure to deliver Scandinavian currencies to CLS. The facility can only be used to obtain intraday credit. The basic principle of the model is that the participants first use collateral located in one Scandinavian country to raise liquidity according to that country's normal procedures. The resulting liquidity may then be used as collateral for raising liquidity in a second Scandinavian country. In principle, therefore, a participant is able to maintain one central pool of collateral and use the SCP to raise liquidity in another country. Hence, liquidity is able to flow cross-border without the cross-border transfer of collateral.

The model implies that a domestic central bank can give credit based on cross-border collateral without questions about the quality of foreign assets. The foreign central bank assumes the credit risk, and the domestic central bank assumes the exchange rate risk. Each central bank is responsible for determining the appropriate haircuts and/or margins so that these risks are managed appropriately.

The CCBM was introduced at the beginning of Stage Three of Economic and Monetary Union in January 1999. It can be used by all credit institutions participating in TARGET. They can only obtain credit from the central bank of the country in which they are based - their home central bank (HCB). The CCBM permits the use of eligible collateral issued (ie registered and deposited) in one country for obtaining credit from the central bank in another country. In order to use this "foreign collateral" the counterparty has to transfer the collateral to an account that is maintained by the "foreign" central bank at the issuing SSS (ie the SSS in which the securities have been registered and deposited). The "foreign" central bank then holds the collateral on behalf of the HCB and thus acts as a correspondent central bank (CCB). Based on the information on delivery and eligibility of the securities provided by the CCB, the HCB values the securities (including haircuts, margin calls, etc) and grants credit to the counterparty. In this system, all risks are borne by the HCB, since the CCB is only managing the account to which the collateral has been posted on behalf of the HCB.

1.2.2 Liquidity bridges between systems as a source of LVPS funding

In order to facilitate the settlement process in different payment systems so-called liquidity bridges were introduced in the late 1990s. Especially hybrid systems have used this functionality to give the user the possibility to adjust its liquidity held in different payment systems. Due to the increasing importance of linkages between infrastructures, funding and defunding operations have also become increasingly common. In some countries, participants have the ability to transfer funds between the LVPS and another payment or settlement system. If funds are moved between systems the total amount of funds available in each system changes. Usually the LVPS that is used for monetary policy operations and through which the central bank provides intraday credit is also used to fund or prefund settlement accounts in other systems. One example of such transfers is CLS. During the settlement period, the participants fund their own CLS accounts with transfers from the national RTGS (or equivalent) systems. In fact, CLS holds these funds in accounts maintained at the central bank corresponding to each currency. At the end of the day, all accounts held with CLS are returned to zero, ie CLS then moves all of these balances back to participants in the RTGS or equivalent systems.

1.2.3 Decentralised sources of funding

Decentralised sources of funding stem from a system participant other than the settlement institution. Broadly speaking, decentralised sources of funding are all payments that a participant receives from other participants. These payments and receipts may be associated with many forms of underlying activity, such as those deriving from correspondent banking activities. They simply redistribute the funds among the participants and leave the sum of all funds in the system unchanged.

If near the end of the day the level of participants' funds differs significantly from their targeted balances, there is typically a mechanism that allows these deviations to be resolved. Generally, participants in need of extra funds will attempt to borrow settlement assets from those participants holding excess settlement balances, and vice versa. Common transactions to this end are money market transactions, repos and foreign exchange swaps with same day settlement. Practices differ across countries according to whether these transactions tend to be secured by collateral. These transactions tend to be high in value and have a maturity of one or a few days.

1.3 Infrastructure, communication and control

Payment systems are based on a core infrastructure - the payment system infrastructure in a narrow sense - and on a complementary infrastructure that is needed to support the system and its participants. The core infrastructure is directly used to perform the settlement function; it is the “system” itself in a technical sense and includes the hardware and software needed to run the system. In some LVPS, the system owner also acts as the core infrastructure provider - this is particularly true for systems owned by central banks. An alternative approach is for the system owner to outsource the provision of infrastructure (eg hardware) or wholly or partly outsource operational responsibilities to one or more third-party service providers, usually under the terms of a formal contract or a service level agreement. Outsourcing plays a crucial role in terms of how an LVPS is operated on a day-to-day basis.

The complementary infrastructure also plays an essential role in the functioning of a payment system, and makes communication with the external environment possible. The connection between the system and its participants relies on the one hand on the telecommunication lines provided by network operators and the message carrier, which defines the standards, encryption, authentication procedures, and routing of information and payment messages. Over the past decade, more LVPS systems in CPSS member countries began using SWIFT as their message carrier.[12] Not surprisingly, those systems also use SWIFT message formats. Some LVPS that do not use SWIFT as a message carrier have adopted SWIFT, or SWIFT compatible, message formats. Others continue to use proprietary message formats.

For an individual LVPS, the choice of a communication network is likely to be influenced by a number of factors, including market structure and compatibility with existing message standards. There is also a significant degree of path-dependency, as switching from one network provider to another is usually costly and operationally complex. These largely external influences imply that no single solution is suitable for all LVPS. However, increased cross-border banking brought about by financial globalisation and deepening linkages among market infrastructures has emphasised the importance of compatibility between alternative networks. In this respect, harmonisation of message formats may generally be desirable.

Reliability of both core and complementary infrastructure is crucially important because any operational problem with any of the key elements of a systemically important LVPS has the potential to disrupt the whole system and can have serious implications for financial stability. For instance, if all parties communicate through the same channels, this exposes the network provider, the payment system and its participants to risks due to concentration. These risks are mainly of an operational nature for the network provider; but for the payment system, a disruption to normal operations could create additional credit and liquidity risks. Overseers and operators of such systems, therefore, have increased their attention concerning security aspects, operational reliability and business continuity planning arrangements in accordance with Core Principle VII.[13]

Through the communication network, the banks forward their payment instructions to the payment system in order to achieve the exchange of funds. Moreover, the same channels can also be used for the provision of information on the clearing and settlement process to the participant. One flow of information is from payer to payee, where the former must provide sufficient information to allow the payment to reach its intended destination. This typically involves compiling a (standard-format) payment message that, when accepted by the LVPS, will be transmitted to the receiving bank. The same (or a subset of the) information contained in the payment message will be sent to the system operator or the settlement institution for processing. Another information flow goes from the system to

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12 SWIFT stands for the Society for Worldwide Interbank Financial Telecommunication: an industry-owned supplier of (payment) message carrier services.

13 Core Principle VII: The system should ensure a high degree of security and operational reliability and should have contingency arrangements for timely completion of daily processing. See *Core Principles for Systemically Important Payment Systems*, BIS, January 2001.

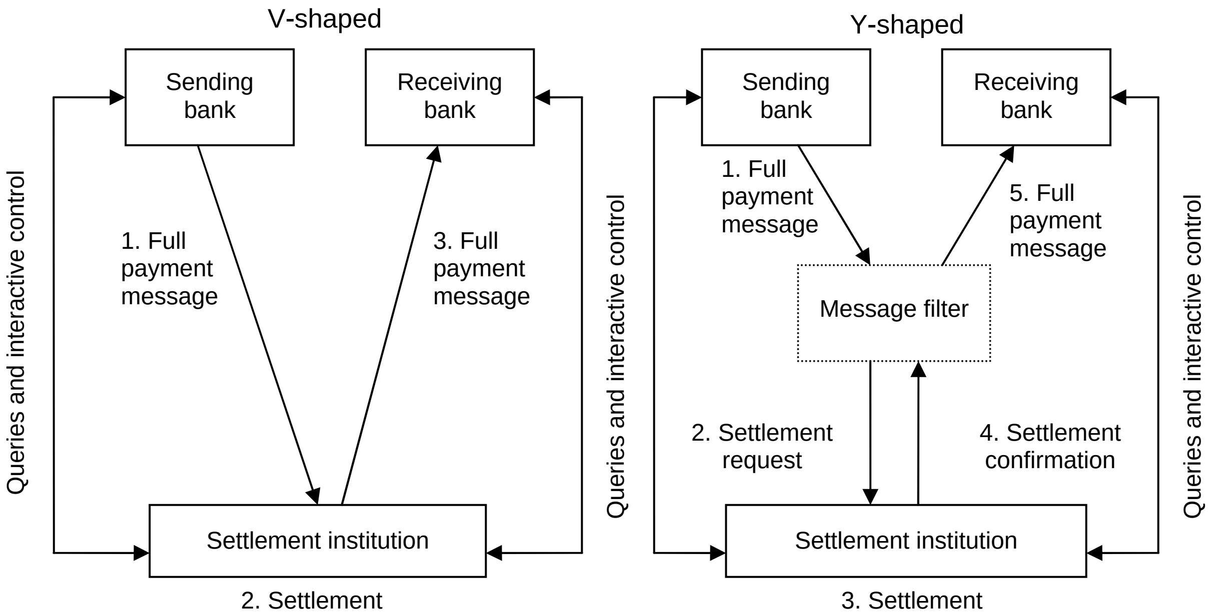
the participants and usually contains real-time information about the status of payments, participants' account balances and, in some cases, details of incoming queued payments. The online provision of information by the system operator has become more widespread. The information provided makes it easier for the participants to control the payment process interactively in real time. They may be able to change the position of payments in the queues or their priority, to revoke payments from the queue, or modify the sender limits.

A number of arrangements exist for routing payment messages to the system operator. The simplest way of routing is the so-called V-shaped message flow (see Figure 3). The payment message containing all the relevant information is sent from the sending bank directly to the core infrastructure, which is assumed here to be the same as the settlement institution (although this need not be the case). After settlement has taken place the entire payment order (potentially including a settlement confirmation) is forwarded to the receiving bank. In this structure, the full message with all the information about the payment (including the details of the beneficiary) is passed on to the settlement institution.

Many LVPS are currently relying on the communications networks and message formats provided by SWIFT. Especially for market infrastructures, SWIFT has designed the Y-shaped message flow. In this case, the sending bank addresses a payment message directly to the receiving bank, for instance, by an MT103 message. SWIFT intercepts this message, copies the entire content (or a subset) of the message, and sends this copy to the settlement institution. Once the SWIFT network receives a respective approval and settlement message from the settlement institution, it forwards the original payment message to the receiving institution. SWIFT also provides a number of query and reporting features which enable participants to obtain information to facilitate their liquidity management, to achieve reconciliation in case of system outages and to smooth their payment operation.

Figure 3

Message flow structure



1.4 Participation structure

1.4.1 Access criteria

One important role of the contractual framework governing the operation of an LVPS is to establish the conditions for participation/membership of the system.[14] These conditions, collectively known as *access criteria*, serve to define the population of potential members (or direct participants) of an LVPS. Access criteria may feature quantitative minimum requirements on, for example, the capital base, credit rating, or payment volumes of a potential member. It is also common for qualitative standards based on a financial institution's legal status (for example, country of incorporation) and/or regulatory position to be included. Moreover, technical, operational and geographical criteria may also be applied.

In common with other types of market infrastructure, LVPS impose access criteria as a means of controlling or mitigating risk. The basic objective is to ensure that individual members do not introduce an unacceptably large amount of financial, operational or legal risk to the system. More competition between financial institutions tends to lead to a higher overall level of efficiency in the market for large-value payment services for customers. A trade-off generally emerges between risk mitigation achieved by imposing restrictive access criteria and improved levels of efficiency potentially realised by allowing a wider range of financial institutions to become members of the LVPS.

Although system owners can define the access criteria according to their risk/cost preferences, they must take into account the requirements imposed by overseers, financial regulators or legal authorities.[15] Systemically important LVPS should comply with Core Principle IX,[16] which requires access criteria to be both objective (in terms of permitting fair access) and transparent. Beyond oversight and regulatory requirements, it is also necessary for the owner(s) of an LVPS to ensure that access criteria are fully consistent with all relevant competition laws. A failure to achieve compliance with the requirements of anti-trust authorities exposes the LVPS and its owner(s) to the reputational and, ultimately, financial risks associated with action undertaken by these authorities or through the courts. When the owner of an LVPS is not the same as the settlement institution, the policies of the latter concerning the provision of accounts and (intraday) credit facilities will also influence the access to the system. The reason for this is that the ability to open an account with the settlement institution constitutes a necessary condition for direct participation in an LVPS.

1.4.2 Direct and indirect participation

A common approach concerning access to LVPS is to allow an eligible financial institution to choose its preferred method of access. Two basic alternatives are available: join the LVPS as a full member and thereby participate directly; or participate indirectly by establishing an agency (or correspondent banking) relationship with a member of the system. If an LVPS has both direct participants and also a considerable number of indirect participants its participation structure is called "tiered". This kind of arrangement is analysed in more detail in the CPSS report *The role of central bank money in payment systems*.[17]

The definition of direct participation in an LVPS (and in market infrastructures more generally) is well established. In particular, it is recognised that the direct participants exhibit two essential characteristics: *first*, they are signatories to the set of internal contracts that govern the way in which the system is operated; and *second*, they usually hold an account with the settlement institution, across which payment obligations are settled.[18] It is typically the case, therefore, that the identity of the direct participants in an LVPS is fully transparent to all parties. In some countries, for instance the

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14 In this context the terms member and participant are used interchangeably.

15 The potential influence of oversight and supervisory arrangements on LVPS is considered in more detail in Chapter 2.2.2.

16 See *Core Principles for Systemically Important Payment Systems*, BIS, January 2001.

17 See *The role of central bank money in payment systems*, BIS, August 2003.

18 An exception is EURO1. The direct participants of EURO1 do not have accounts with the settlement institution, which is the ECB. Instead they settle their payment obligations vis-à-vis EURO1 by paying/receiving - using their accounts with their national central banks - to/from the EURO1 account at the ECB where the settlement takes place.

United States and Switzerland, a large proportion of banks have established direct access. However, in the majority of the LVPS currently operating in the CPSS member countries, the number of direct participants is lower (and in some cases significantly lower) than the number of potential members as established by the access criteria of these systems. This reflects the option to participate indirectly via a direct participant.

In principle, the range of potential indirect participants includes not only financial institutions, but also corporate entities and individuals. However, in the context of LVPS, it is standard practice to restrict the definition of indirect participants to financial institutions. A characteristic common to all indirect participants in LVPS is that they do not hold an account with the settlement institution which can be used to settle their payment obligations; rather, these obligations must eventually be settled by means of postings to the settlement account of a direct participant, under the terms of a bilateral agreement between the parties involved. In terms of their relationship with the settlement institution, the distinction between direct and indirect participants is clear. This is not the case, though, in respect of the extent to which the rights and responsibilities of the different types of participant are captured within the contractual framework of an LVPS and the legal regime under which the system operates.[19] Similarly, there is no universally accepted solution for determining whether indirect participants should be directly addressable within an LVPS. This would imply that they are recognised by the system, so that payments for them can be processed and settled without the sender needing to specify the identity of the direct participant on whose account the payment is settled. A number of alternative models of indirect participation have therefore evolved.

In order to facilitate the implementation of monetary policy, the central bank is a direct participant in an LVPS. Usually, central banks also provide large-value payment services to the government and may provide correspondent banking services for other central banks or institutions. Some financial institutions may prefer to use the central bank rather than a competitor for correspondent business. Nevertheless, constraints may exist concerning the participation possibilities. In some jurisdictions legal or regulatory provisions explicitly or implicitly require particular types of financial institutions to participate directly in a local LVPS. Existing arrangements in Hong Kong provide examples of this type of approach. Conversely, it is also possible that a financial institution may not be able to participate directly as a result of specific provisions contained in the access criteria of an LVPS; in such circumstances, indirect participation would be the only option available.

Within these constraints, financial institutions' decisions on whether to participate directly or indirectly in an LVPS are influenced by a range of factors. Most fundamentally, a financial institution will typically choose the method of participation that allows it to minimise both the costs and the risks associated with settling large-value payments, although factors related to the extent of involvement in central bank monetary policy operations and requirements arising from direct membership of other market infrastructures (eg SSSs) may also play an important role in influencing this decision. Furthermore, it may be the case that correspondent banking facilities constitute only one part of a wider "bundle" of banking services. An indirect participant that could, from a purely payments perspective, beneficially switch to direct participation may therefore be worse off overall through the deterioration of a valuable banking relationship (see "banking structure" in Chapter 2.3). The option of indirect participation has traditionally been well suited to smaller domestic banks and to financial institutions accessing LVPS located outside their country of incorporation, although the trend towards more integrated global financial markets has led to a significant increase in cross-border direct participation over recent years.

1.5 Governance arrangements

The way in which an LVPS is governed can have a significant impact on how it is operated and developed. A wide range of alternative governance arrangements is feasible, and there is no single model used by all types of LVPS; a significant number of factors combine to determine the actual ownership and decision-making structure for each system.

The complexity and variety of LVPS governance arrangements notwithstanding, it is possible to identify at least two fundamental ways in which alternative models may differ. First, and perhaps most

[19] Bilateral correspondent banking relationships between direct and indirect participants are considered to fall outside the contractual framework of the LVPS.

importantly, a distinction can be drawn between LVPS that are publicly owned (usually by central banks) and those that are owned by the private sector. This distinction is not always clear-cut, however, as there are a number of examples of systems that are jointly owned by both the central bank and the private sector. Second, the user (or member) involvement in decision-making is likely to play a role in determining the way in which the system is designed and subsequently developed.

The governance arrangements of an LVPS can also be characterised by the extent to which they are transparent and hold management accountable. In this field, there are widely recognised standards of best practice, for LVPS as for corporate bodies more generally. For example, Core Principle X recommends that a system's "governance arrangements should be effective, accountable and transparent".[20] Transparency and accountability in governance arrangements help those with an interest in the operation of an LVPS to monitor whether it is being run effectively.

1.5.1 Ownership models

Acting within any constraints imposed by the legal and regulatory framework (discussed in more detail in the next chapter), the system owners are able to determine the basic design of the LVPS; establish a framework for internal decision-making; draw up and amend the set of contracts governing its operation; and, where relevant, enter into arrangements with the settlement agent, [21] the settlement institution and any third-party service providers.

Most LVPS currently operating in the CPSS member countries are wholly owned by the local central bank. One rationale for public ownership has derived from these systems' crucial function in contributing to financial stability by minimising systemic risk, although it has long been recognised that other types of ownership can be consistent with the safe and efficient operation of an LVPS. A second factor explaining central bank ownership derives from the historical role of central banks in providing facilities allowing the transfer of funds between financial institutions. In line with this, all publicly owned LVPS currently operating in the CPSS member countries settle payment obligations across accounts held at the local central bank. Moreover, it is the norm for the central bank to act as the settlement agent and to manage the operation of these systems.

There are also some completely privately owned LVPS operating in the CPSS member countries, for example CHIPS, EURO1 and SIC.[22] A majority of these systems adopt a cooperative structure under which each member has an equal (or sometimes weighted) share in the ownership of the system. Cooperative ownership is typically associated with not-for-profit business models; this is the approach currently employed by all privately owned LVPS. It is also possible, however, to conceive of an alternative approach whereby an LVPS is owned by a group of general shareholders (which may include, but is not restricted to, users of the system) and operated with a view to maximising profits. Variants of this type of ownership structure are employed by some trading exchanges, clearing houses and SSSs, but there is no precedent in the CPSS member countries for such a model to be adopted for an LVPS.

A common variant of the cooperative ownership structure arises where the local central bank is a part owner of an LVPS, sharing ownership rights with the private sector (normally the members/direct participants of the system). Examples include CHAPS Sterling in the United Kingdom, ELLIPS in Belgium and PNS in France. Within this type of joint ownership model, there is considerable flexibility in respect of the degree of involvement of the central bank in the operation of the LVPS concerned. While it is standard practice for the central bank to perform the settlement institution role, this is not the case for the settlement agent function. Indeed, the latter role is in several cases undertaken by a (usually not-for-profit) company or organisation that is itself owned by the members of the LVPS. More

[20] Other best practice guidelines for infrastructures include Recommendation 13 of both the CPSS/IOSCO Recommendations for Securities Settlement Systems (see *Recommendations for Securities Settlement Systems*, BIS, November 2001) and the parallel Recommendations for Central Counterparties (see *Recommendations for Central Counterparties*, BIS, November 2004); and statements in the EC Communication on Clearing and Settlement in the EU (2004).

[21] The settlement agent is the institution that manages the settlement process (eg the determination of settlement positions, monitoring of the exchange of payments, etc) for transfer systems or other arrangements that require settlement. (See also *A glossary of terms used in payment and settlement systems*, BIS, March 2003.)

[22] The situation in SIC differs from that in CHIPS and EURO1. Based on a bilateral contract with the operator the Swiss National Bank has maintained substantial control and approval rights for changes to the system.

generally, it is feasible for a jointly owned LVPS to outsource the settlement agent role to any private sector entity.

1.5.2 Decision-making structure

Independently of its ownership model, decisions regarding the operation and strategic development of an LVPS are made by some form of internal management and "board" (or equivalent) structure. In the case of publicly owned LVPS, ultimate decision-making responsibility rests exclusively with the relevant central bank as system owner. But this does not necessarily mean that the users of public LVPS are unable to exert influence over the way in which these systems are designed and operated. Indeed, it is becoming increasingly common for central banks and/or industry groups to establish fora through which interested parties are able to exchange views on particular issues concerning one or more LVPS. Furthermore, the involvement of interested parties in a user consultation is increasingly used before the introduction of a new LVPS.

By contrast, under the cooperative ownership model, it is the views of the LVPS members/direct participants that influence decision-making most directly. In systems with a relatively small number of members (for example, CHAPS Sterling in the United Kingdom), it is feasible for all of them to be represented on the board, giving them all direct influence over the decision-making process. Where the number of members is large, however, an LVPS may restrict the size of the board to ensure that it remains of manageable size. It may additionally establish alternative procedures to allow the views of other interested parties to be reflected in the decision-making process. For example, procedures can be put in place to ensure that members without a representative on the board have the opportunity to input their views prior to final decisions being made. In a way, this is similar to user-group input in a publicly owned system. A further possibility is to appoint to the board directors responsible for representing the interests of the full population of system members,[23] as in Belgium where a member of the Belgian Bankers' Association is appointed to the Executive Board of ELLIPS. An LVPS may also have outside board members, appointed to represent the public's interest in a safe and efficient payment system, as in Canada where the board of the Canadian Payments Association - which owns and operates the LVTS - includes three outside directors appointed by the Minister of Finance.

2. External influences on large-value payment systems

This section examines how external influences, beyond the direct control of the system owner, affect the design, operation and use of individual LVPS. These influences include changes in the global environment, in particular technological progress or financial market integration; the legal and regulatory framework, including oversight arrangements on large-value payment systems; the participants' market structure and their practices; and the degree of competition in the market for large-value payments. These influences affect both the feasibility and desirability of particular design features and, coupled with historical factors, contribute to explaining the diversity of LVPS designs across markets and regions.

2.1 Changes in the global environment

For a long time, environmental factors have been influencing the global development of LVPS. Two prominent examples are technological progress and the on-going integration of financial markets.

2.1.1 Technological progress

In generic terms, technological progress takes place in two phases - innovation and maturation. Technological innovation involves the development of new technologies that may allow for superior

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[23] This approach represents an adaptation of the traditional role of independent directors in a corporate governance context (that is, protecting the interests of minority shareholders).

outcomes, albeit usually requiring substantial additional investment. Technological maturation occurs when pre-existing technologies are enhanced, or improved, with only a marginal investment.

Many of the recent developments in LVPS have been facilitated by technological progress in two areas. First, increasing computing power has made it possible to increase the complexity of the settlement algorithms and the speed at which they can be run, thereby enabling more frequent use of these algorithms. For instance, offsetting algorithms can now be applied on a continuous basis. Second, progress in communication technology has brought about a number of improvements. For example, modern communication technology allows participants to obtain a large set of online information on the settlement process. As a consequence, they are now in a better position to measure and manage the risks involved with participation in an LVPS. Technological progress has also facilitated the implementation of enhanced services and controls, which allows for better or easier management of risks.

2.1.2 Financial market integration

In recent years, cross-border financial flows have increased, partly due to the lowering of various legal and operational barriers. Many financial institutions have become more active in foreign markets, increasing the demand for cross-border payments in multiple currencies and contributing to the international integration of financial markets. Against this background, an increasing number of LVPS have extended their operating hours (due to, among other things, the creation of CLS), allowing for a long overlap of operating time across time zones. In some cases, a more integrated financial market has been the result of political processes, as in the European Union, where 12 of the member states have adopted the euro as their common currency.

The increasing integration of financial markets has coincided with - and partly contributed to - ongoing and accelerating consolidation of financial institutions within, and sometimes across, industrial countries. Improvements in communication technology, liberalisation and financial deregulation as well as pressure of shareholders for enhanced financial performance also help to explain the acceleration of the consolidation process.[24] Financial institutions have expanded in terms of both scale and scope, creating larger and more complex institutions. In addition, in some countries, the division between banking and other financial activities has blurred, increasing the institutional complexity even further.

Global financial market integration has had a significant impact on LVPS development, on at least two levels. First, the traditional model whereby an LVPS focuses on providing for settling payments between domestic financial institutions has evolved as the importance of cross-border activity has increased. Indeed, some LVPS operate across national borders (TARGET), whereas CLS involves settlement of multiple currencies.

A related development is the emergence - in Hong Kong and Germany/Switzerland - of new arrangements for the settlement of local payments in foreign currency. These arrangements neither fit perfectly in the traditional category of “correspondent banking” nor in that of “payment systems”.[25] The main common characteristic of these arrangements or systems is that they do not settle in central bank money but across accounts held with a commercial bank and that they are based on clearly defined and transparent rules for payment activities. Compared to traditional correspondent banking, these new solutions are standardised and settle payments in real time with continuous finality (see Box 10).

Second, financial integration has served to increase the extent of financial institutions’ cross-border banking activities. Increasingly, larger banks are conducting their operations on a global scale, either through a branch network or by establishing local subsidiaries, a trend which has influenced both the

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[24] See *Report on consolidation in the financial sector*, BIS, January 2001.

[25] The term “quasi-system” has often been used in relation to these arrangements. There is no universally accepted definition of a quasi-system. The report on central bank money states the following: “At a high level, a quasi-system might be defined as: ‘A commercial institution responsible for clearing and settling payments on behalf of customers which represent, by value, a substantial percentage of payments in a particular currency, a significant proportion of which are internalized by being settled across the books of the institution rather than through an organized payment system.’ But such a definition is deceptively - perhaps even misleadingly - simple.” See *The role of central bank money in payment systems*, BIS, August 2003.

participation structure of LVPS and the requirements of users in respect of these systems. In particular, the range of members of a typical LVPS has broadened significantly to cover foreign-owned as well as domestic banks.[26]

Box 10

New dimensions in correspondent banking

In Hong Kong, the US dollar and euro clearing systems USD CHATS (Clearing House Automated Transfer System) and Euro CHATS were introduced in 2000 and 2003 respectively, in order to enhance the safety and efficiency of settling these foreign currencies in the local time zone. These systems are almost exact replicas of the Hong Kong dollar RTGS system (HKD CHATS). The key functions of both systems are to enable PVP settlement of foreign exchange transactions between HKD, USD and euros and DVP securities settlement in the respective currencies through a linkage with the Central Moneymarkets Unit (CMU). Both systems settle in commercial bank money. The Hong Kong Monetary Authority (HKMA) has appointed the Hongkong and Shanghai Banking Corporation (HSBC) as the settlement institution for USD CHATS and Standard Chartered Bank (Hong Kong) Limited as the settlement institution for Euro CHATS. Both institutions provide intraday liquidity to the direct participating banks by means of repos as well as overdraft facilities. The operator of both systems is HKICL,[27] the same as that of HKD CHATS.

In 1999, Swiss financial institutions established a cross-border solution in order to facilitate their cash management in euros. This solution involves a fully licensed bank in Germany, Swiss Euro Clearing Bank (SECB). To process euro transactions SECB uses the euroSIC platform in Switzerland, which is often referred to as the euro payment system of Switzerland. Some consider SECB/euroSIC to be a payment system and others see it as a “quasi-system” or as correspondent banking. In terms of design, euroSIC is a replication of the Swiss franc RTGS system Swiss Interbank Clearing (SIC), so that it provides to a great extent the same functionalities. SIC and euroSIC are technically operated by Swiss Interbank Clearing AG.[28] SECB is the settlement institution and shares the role of settlement agent with the operator SIC AG. SECB is also the liquidity provider in euroSIC. It extends intraday and overnight credit to the participants of euroSIC against collateral. SECB provides a link to the euro area as it is a direct participant in RTGS^{plus}, through which access to TARGET is established.

2.2 Legal framework

LVPS users must be able to have confidence in the legal enforceability of the settlement process. Therefore, the legal regime (or regimes) under which a system operates, and the internal contracts that govern the system, are crucially important. In particular, any inconsistency between the rules of an LVPS and the underlying legal environment has the potential to expose the users, operators and owners of the system to legal risk and thereby undermine the overall effectiveness of the LVPS.

Overseers have a close interest in the establishment of a suitable legal environment as well as contractual arrangements to mitigate legal risk in LVPS (reflected in Core Principle I). More generally, the oversight function aims to ensure that risks are adequately managed in a particular payment system. In addition, some or all of the individual parties involved in the use and sometimes the operation of an LVPS are typically subject to requirements imposed by prudential supervisors. These requirements are likely to impact indirectly on the functioning of the LVPS.

2.2.1 Legal regime

A wide range of general points of law is relevant to the design and effective operation of payment systems. Clearly, laws establishing the role and powers of the local central bank, particularly in respect of its ability to provide settlement accounts and liquidity to LVPS participants and its oversight competencies, are relevant. Contract law and insolvency law are likely to be particularly important, and

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26 The issue of consolidation is also addressed in Chapter 2.3.

27 HKICL (Hong Kong Interbank Clearing Limited) is a private company jointly owned by the HKMA and the Hong Kong Association of Banks.

28 Swiss Interbank Clearing AG is owned by Swiss banks and Postfinance.

may influence the desirability of particular LVPS design features. Furthermore, anti-trust regulations may represent a significant factor influencing LVPS access criteria (see Chapter 1.4 above). Aspects of other legal regimes may also play a role, especially in cases where an LVPS operates across national borders and/or the parties involved in its use and operation are incorporated in different jurisdictions.

Crucially, the enforceability of specific provisions contained in the systems' internal contracts derives from the legal regime under which the agreements have been concluded. The rule of law has primacy in terms of guaranteeing the outcome of the process of settling payments in an LVPS. A well designed RTGS cannot entirely eliminate settlement risk in circumstances where the underlying legal framework allows for the reversal of payments deemed by the rules of the system to have been completed. Similarly, the benefits of a netting (by novation) process are undermined where the legal regime does not explicitly recognise the replacement of multiple gross obligations with a single net position.

It is possible, however, for the requirements of an LVPS (and other elements of market infrastructure, such as SSSs) to prompt the relevant authorities to make amendments to the legal environment. Many legal regimes now feature legislation specific to payment and settlement systems. The EU Settlement Finality Directive,[29] for example, establishes legally enforceable rules regarding the status of payment orders processed by designated systems (see Box 11). In some jurisdictions, such as Canada, similar legal arrangements have been implemented in order to reinforce the legal certainty of netting processes in LVPS. In other jurisdictions, changes have strengthened the robustness of collateral transactions.

Box 11

The EU Settlement Finality Directive

In a number of countries, insolvency law includes a so-called "Zero Hour Rule", which may invalidate transactions conducted by a commercial entity on the day bankruptcy proceedings have been opened, as from midnight of that day. This means that payment orders or payments may conceivably be unwound, irrespective of the way they have been settled. In view of (especially large-value) payment systems' central role in maintaining financial stability and supporting the smooth functioning of the real economy, and in order to protect payment system participants from settlement-related credit risks, some countries have introduced specific finality legislation.

For example, in the European Union, the Settlement Finality Directive (98/26/EC) ensures that "transfer orders cannot be revoked after a moment defined by the rules of the system". Moreover, "transfer orders and netting shall be legally enforceable and, even in the event of insolvency proceeding against a participant, shall be binding on third parties, provided that such transfer orders were entered into a system before the moment of opening of such insolvency proceedings" and even exceptionally once they have started, provided "the settlement agent, the central counterparty or the clearing house can prove they were not aware, nor should have been aware, of the opening of such proceedings". Therefore, the internal rules of payment and securities settlement systems that have been designated under the Directive are recognised and respected by the general domestic insolvency laws.

The introduction of the CLS system represents another example of a situation where the requirements of a market infrastructure have precipitated changes to national legislation; some jurisdictions strengthened the legal basis for (intraday) payment or settlement finality before their currency was included in the CLS system

2.2.2 Oversight and supervision

Although the scope and activities of central bank oversight vary from country to country, CPSS central banks oversee most LVPS in their respective countries. Usually, a majority of the users - typically banks - of an LVPS are additionally subject to some form of supervision by prudential supervisors. It is

29 Directive 98/26/EC of the European Parliament and of the Council of 19 May 1998 on settlement finality in payment and securities settlement systems.

also possible for the parties involved in the operation of an LVPS to fall within the scope of general or specific supervisory arrangements.

2.2.2.1 Central bank oversight

The rationale for central bank oversight of LVPS derives from the fundamental objectives common to all central banks - maintaining monetary and financial stability. In particular, central banks have an interest in the interaction of financial market participants, because of concerns over systemic risk. It is an important factor contributing to the achievement of these objectives that infrastructural arrangements for settling payment obligations are both safe and efficient. In practical terms, oversight typically involves central banks monitoring the functioning of individual LVPS, assessing them against relevant standards and, where appropriate, inducing desirable changes to their design or operations.

In order to facilitate effective and even-handed oversight of payment systems, the CPSS central banks have developed and published qualitative standards with which the operators of systemically important payment systems (a category that includes most LVPS) are expected to comply.[30] The 10 Core Principles are primarily addressed to payment system operators, but they also include four oversight responsibilities for central banks, which should ensure that the Core Principles are being applied. Continued compliance with the Core Principles exerts an important direct influence on the design and operation of a system. Influence can also be exerted through other channels by overseeing third-party service providers to LVPS such as SWIFT.

The substantial development of cross-border and multi-currency infrastructures has underscored the need to review the framework for cooperative oversight. The first such framework for cooperative oversight was defined in the Lamfalussy Principles on cooperative oversight in 1990.[31] The CPSS central banks have recognised that both the oversight function itself and the systems they oversee have evolved considerably since then. A new CPSS report, *The oversight of payment and settlement systems* (2005), discusses these issues in detail.[32]

2.2.2.2 Supervisory arrangements

The majority of the direct participants in LVPS are individually subject to supervisory requirements imposed by prudential supervisors. In addition, private settlement institutions (and other types of infrastructure providers) are often subject to supervision from the supervisory authority. The supervisory environment therefore significantly influences the way in which an LVPS is designed, operated and used.

A significant aspect of banking supervision for LVPS concerns some prudential supervisors' rules requiring financial institutions to maintain a minimum holding of liquid assets. In particular, these rules tend to influence the overall costs of posting collateral. Since many LVPS control the credit exposures arising from the settlement process by requiring direct participants to partially, or fully, collateralise their (intraday) open positions, the opportunity cost of posting collateral is an important influence on financial institutions' behaviour when using LVPS. This opportunity cost may be influenced by the extent to which assets held to comply with prudential liquidity requirements can also be used (simultaneously) as intraday collateral in the payment system.[33] Through this channel, the supervisory requirements can affect the relative costs and benefits of particular system design features. This effect is, however, difficult to quantify, given the fact that banks are, even in the absence of prudential liquidity requirements, likely to hold liquid assets to comply with their own risk management policies.

Supervisory requirements may also influence the settlement institution or the settlement agent when these roles are fulfilled by one or more private financial institutions. In particular, a commercial bank

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[30] See *Core Principles for Systemically Important Payment Systems*, BIS, January 2001.

[31] See *Report of the Committee on Interbank Netting Schemes of the central banks of the Group of Ten countries*, BIS, November 1990.

[32] A number of LVPS studied in the report are owned and operated by central banks. As a standard practice, such central banks establish an internal structure that separates the operational and oversight functions. Moreover, oversight is often rule-based; these rules can therefore be seen as an external influence on the LVPS.

[33] Regulatory arrangements that allow collateral to be used to meet prudential requirements and to be used simultaneously to support LVPS transactions are sometimes described as allowing assets to perform "double duty".

that acts as settlement institution for an LVPS may be supervised within a broader supervisory framework or under specifically designed arrangements. The former approach is most suited to situations where the entity concerned, usually a large bank, also undertakes a range of activities unrelated to its role in the LVPS. This is the case for both of the “off-shore” systems in Hong Kong settling in foreign currency. Specific supervisory arrangements are common in instances where the settlement institution is a single-purpose bank. CLS Bank falls into this category - it is chartered by the Federal Reserve as an Edge Act Corporation.

2.3 Banking structure and market practices

An LVPS provides settlement services to banks and other financial institutions operating in a particular market (normally an individual country or currency area). The suitability of different system designs can therefore be influenced by the structure of the market, particularly the organisation of the banking sector and other financial institutions. Moreover, established market practices may impact upon the relative costs and benefits of particular LVPS design features.

2.3.1 Structure of the banking sector

As discussed in Chapter 1.4, individual banks generally have the option of participating in an LVPS directly or indirectly (by establishing a correspondent relationship with a direct participant). A range of factors is likely to influence this decision, but there is evidence that LVPS participation often reflects the structure of the banking sector in the relevant market. For example, the numbers of direct participants in the UK and Canadian LVPS (CHAPS Sterling and LVTS, respectively) are relatively low, which reflects the highly concentrated nature of these countries’ banking sectors. By contrast, the number of direct participants in Fedwire is relatively high, reflecting the relatively lower concentration in the US banking system. But this tendency is not universal; in spite of the very concentrated banking structure in the Netherlands, in Belgium and in Switzerland, almost all domestic banks participate in the local LVPS (TOP, ELLIPS and SIC). Nevertheless, by influencing the type and range of likely participants in an LVPS, the structure of the banking sector can be an important factor in the choice of specific design features.

The trend towards consolidation in the banking sector, both internationally and in domestic markets, exerts influence on LVPS in at least two distinct ways. First, increased concentration of payment flows may have important credit, liquidity and operational risk implications. For example, the credit exposures that arise within an LVPS that does not achieve intraday finality are likely to become concentrated on a smaller number of banks. In addition, operational problems experienced by a single large bank could have significant repercussions for other participants in the system. Second, a concentration of payment flows in commercial institutions has emerged. The volumes and values settling across their books are, in some countries, quite substantial. Such traffic has often been accompanied by increased formalisation of the correspondent relations.

2.3.2 Market practices

The interaction between banks operating in a particular market is governed by a number of factors, including formal contractual arrangements and regulatory requirements. In addition, informal market practices, which typically emerge over time, can be significant. These behavioural conventions cover a range of issues, some of which may have an impact on the relative desirability of particular aspects of LVPS design. For example, although recognised to be a distant prospect, the development of an intraday money market would likely have a significant impact on the way in which LVPS are used, and consequently on their design and operation.

From the payment systems perspective, the timing of the submission of payments is a market practice of major importance. It is not uncommon for stable behavioural conventions to arise in terms of the time at which participants submit certain types of payments for settlement. Such a convention can arise endogenously among the direct participants, or may take the form of an accepted (but non-binding) recommendation: for example the throughput guidelines employed in LVPS currently operating in the United Kingdom, Canada, France (PNS), and Hong Kong.[34]

2.4 Competitive environment

Besides being influenced by their users, LVPS are affected by the competitive environment in which they operate. The presence of alternative settlement arrangements is likely to impact the choice of services and the design of different LVPS. Domestically, there is often a single LVPS providing payment services to the domestic interbank market, with a few exceptions such as CHIPS and Fedwire or EURO1 and TARGET. The absence of multiple LVPS in a single market can be attributed to economies of scale (high fixed and low variable costs) and network externalities (the benefits of direct participation increase with the number of other direct participants). These effects, combined with high start-up costs for both users and providers, at least historically, and possibly other implicit costs, such as those associated with oversight and regulatory compliance, have served to limit the number of competing LVPS.

Even though LVPS are often monopolies in their respective markets, their market power is inherently limited. In addition to the possibility of direct competition from other LVPS or even from retail systems,[35] LVPS may face competition from correspondent banking. Unless otherwise legally specified, a payment may be settled either through correspondent banking arrangements or through an LVPS. Correspondent relationships may play an even greater role when the use of an LVPS is impeded by restricted access. However, substitutability between the payment services provided by different types of institutions is imperfect. The payment services provided by correspondent banks and LVPS have different characteristics. Furthermore, there is a need for an interbank settlement system at the top of the payment chain. To a certain degree, this means that the core LVPS and other mechanisms for settling large-value payments may face a combination of competitive and complementary properties from bilateral correspondent arrangements. As to a commercial bank acting as ultimate settlement institution, while this remains possible, it is not likely to be deemed acceptable by its customers. Most importantly, however, most LVPS settle in central bank money, a (largely) non-replaceable public good.

The existence of other payment systems or other settlement service providers is likely to impact the use and functioning of an individual LVPS and influences its strategic choice of services, design or organisation. In general, participants should benefit from choice in how to settle their payments, as they can more closely match the desired characteristics, including costs, of their heterogeneous payments by choosing which system they will submit a payment to or - in systems with differentiated payment streams - by choosing a payment stream.

3. Risks and costs in LVPS

Central banks endeavour to promote and support the smooth functioning of financial markets. Maintaining financial stability necessitates well-designed payment systems that enable the safe and efficient settlement of large-value payments. Most LVPS are judged to be systemically important payment systems; consequently, they should achieve a high degree of safety. The design of a SIPS should not amplify or propagate financial shocks and should, ideally, mitigate the impact of such shocks and contain their spread. The system cannot eliminate all risks, however, as managing risks is an important function of the participants in a SIPS. As codified in Core Principles II and III, the rules and procedures of the SIPS should enable participants to understand the risks associated with

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34 A throughput guideline states that a certain percentage (or more) of the daily volume or value has to be settled by a certain point in time.

35 Retail payment systems are increasingly likely to offer an alternative to the use of LVPS for non-urgent payments, as their settlement frequency rises from once a day to multiple daily settlements (approximately every half an hour in the Netherlands or 10 times a day in Sweden).

participating in it. In addition, the system operator and the participants should have tools to effectively monitor, manage and control such risks.

While safety is essential in LVPS, the design and operation of an LVPS is constrained by costs. In the extreme case, if a system was so costly or burdensome that no one used it, the system would have no effect on risks no matter how extensive its risk controls. The resource costs of a system and the resulting charges, both explicit and implicit, faced by participants are an important factor in system design. Hence, any system design will invariably involve marginal trade-offs between risks and costs. Annex 3 discusses these trade-offs at a general level using the concept of an “efficient frontier”.

This chapter provides a description of both payment system risks and costs. While other CPSS reports have discussed the various risks that exist in payment systems, this report focuses on settlement risk, because that is the risk that is most directly influenced by the design of the system.

3.1 Settlement risk in LVPS

Payment systems are used to extinguish obligations that one party in the economy has towards another. The risks between two parties originate when the parties agree to a trade or other business transaction creating one or more obligations between the parties. The risk between the parties is eliminated when all obligations are settled with *finality*, ie all necessary transfers are *irrevocable and unconditional*.[36] In general, settlement risk is the risk that settlement in a transfer system will not take place as expected. Hence, settlement risk refers to the exposure between participants; other exposures, for example between the settlement institution and the participants, or between participants and their customers, may continue or even be created. More specifically, *settlement risk* can also be defined as the risk that settlement of individual transactions or some group of transactions, up to and including all transactions submitted to the system, does not occur as expected due to one, or more, participant’s failure to meet their obligations within the system.

As identified in other CPSS reports, settlement risk can involve credit and liquidity risk. *Credit risk* is the risk that a counterparty will not settle an obligation for full value, either when due or at any time thereafter. Such risk includes not only the possibility of the direct loss, but also the potential replacement costs for the transaction. *Liquidity risk* is the risk that a counterparty will not settle the full value of an obligation when due, but, in contrast to credit risk, does settle at a later time or date. The delay affects the expected liquidity position of the counterparty; it may be forced to cover the shortfall on short notice from other sources.[37] Like settlement risk, credit and liquidity risks can be examined at multiple levels ranging from the individual payment, to a group of payments, up to the entire system. Final settlement of a transaction (ie when all necessary transfers are unconditional and irrevocable) eliminates both the credit and liquidity risks between the participants, and obviously the settlement risk associated with that transaction, while final settlement of all transactions (or an explicit central bank (or assured) guarantee that all transactions will settle) eliminates these risks for the system.

Credit and liquidity exposures may also exist in the payment system between the settlement institution and the participants. For example, if the settlement institution extends credit to participants, it may face some credit or liquidity exposures. As the credit and liquidity exposures between the settlement institution and the participants can be largely controlled through the choice of settlement institution and the extent of its activities, the settlement institution’s identity and the scope of its activities are crucial design characteristics. This chapter, however, focuses on settlement risk, and it is implicitly assumed that the settlement institution and operator have been chosen to minimise participants’ risk vis-à-vis these entities.

A primary concern of central banks is that a payment system could act as a conduit for transmitting financial shocks. Central banks oversee systemically important payment systems, which include most

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36 For the steps in the payment process, refer to Chapter 1 and Figure 1.

37 Liquidity risk arising from a failure to complete settlement due to a problem, such as a communication breakdown or human error, that is unrelated to the financial condition of a participant or the system is usually separately denoted as o*perational risk*. Reducing operational risk to acceptable levels is a design issue that is addressed in Core Principle VII, but it and other risks, such as *legal risks* (discussed previously), are not specifically distinguished in this section.

LVPS, to ensure that *systemic risk*[38] is adequately controlled, because of concerns that disruptions, if allowed to spread by the system, could threaten the stability of the financial system. In the payment system, this leads to the concern that the settlement failure of a payment or group of payments could lead to settlement failure for other payments, participants or even, in the worst case, the entire system.

Looking at the settlement cycle, each payment, each group of payments and the system in aggregate are expected to settle by the end of the day at the latest. Typically, the earlier each individual payment or each group of payments is settled (or a guarantee of settlement exists), the earlier settlement risk is eliminated *within a specific LVPS*. Other exposures may, however, be created, for example between the settlement institution and participants, or between participants and their customers, or between participants themselves. Despite this caveat, clearly the length of time until final settlement is completed is one important characteristic of settlement risk. Simply put, everything else being equal, the longer the duration of the credit and liquidity exposures the greater the likelihood that something could go wrong and thus the greater the risk. The length of the settlement interval, including the possibility of delays due to participants' behaviour, is the subject of Chapter 3.1.1.

The phrase "within a specific LVPS" is an important qualifier in the previous paragraph, because the original transaction may have multiple legs. In particular, there are many transactions with two counterbalancing legs, such as either securities or foreign exchange transactions. Consequently, if one leg is settled while the other leg remains unsettled, settlement risk for the transaction remains and in fact is now concentrated on one party. Any lag[39] between the settlements of the two legs of such a transaction creates *principal risk* - the credit risk in an exchange-for-value transaction that one party will lose the full value (the principal) due to differences in the time at which the legs of the transaction become final - and is likely to contribute to systemic risk. Central banks have consequently strongly supported the development of mechanisms both for DVP settlement of securities transactions and for PVP settlement of foreign exchange transactions.

While the speed with which settlement occurs is important, probably the most important consideration for analysing settlement risk is the conditions which must be met in order for settlement to be finalised either for individual payments, for groups of payments, or for the entire system. Such conditions, after all, control whether and when the settlement risk is ultimately eliminated. Importantly, such conditions also impact what happens if the system fails to settle.

The conditions for settlement can be separated into different groups. Again, there is the division into single payments, groups of payments, and system levels. Some conditions can be met by a single participant for a single payment. For example, in an RTGS system the sender can ensure there are adequate funds in its account to settle a transaction before it submits the transaction and thus "guarantee" settlement. Other conditions are contingent on the actions of multiple participants. For example, successful settlement of the system and individual payments in an unprotected DNS system depends on every participant meeting their net funding requirement. These two examples also illustrate another division of settlement conditions. Some conditions only depend on the current state of the system or the current actions of participants, while others depend on future states or actions. Chapter 3.1.2 examines alternative conditions for settlement in LVPS.

3.1.1 Settlement delay

One way of characterising risk in LVPS is according to whether it is independent of the behaviour of the participants or not. If a risk is independent of the behaviour of participants, then it reflects some fundamental uncertainty vis-à-vis the environment in which the payment system operates. On the other hand, if the probability of loss to a participant is affected by its behaviour, then the outcome results to some extent from the actions of the participant itself (and its interaction with other

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[38] The risk that the failure of one participant in a transfer system, or in financial markets generally, to meet its required obligations will cause other participants or financial institutions to be unable to meet their obligations (including settlement obligations in a transfer system) when due. "Such a failure may cause significant liquidity or credit problems and, as a result, might threaten the stability of financial markets." See *A glossary of terms used in payment and settlement systems*, BIS, March 2003.

[39] Such lags are called a *payment lag* or *settlement lag* in the context of securities and foreign exchange settlement respectively.

participants). Although the effects of these behaviours may be difficult to predict and quantify, they are important in terms of their effect on overall risk and efficiency in payment systems.

Most, or at least many, LVPS payments do not have to be sent at a specific point during the day, even though, compared to five years ago, more payments are now time-critical. However, the efficient operation of RTGS systems requires participants to submit payments throughout the day. By doing so, the incoming payments received by other participants can be used to fund their outgoing payments, and funding can be recirculated. Thus, the value of payments exchanged is many times in excess of the underlying sources of funding.

Some delays to settlement are associated with uncertainty as to the timing (or, in extreme circumstances, the submission) of expected payments by counterparties. In most LVPS that are designed as RTGS systems, participants require central bank settlement assets in order to fund outgoing payments. These assets may have been acquired by payments already received (in excess of those sent) or by drawing on central bank credit in order to create central bank settlement balances. Normally, given the expectation that incoming payments will be received later in the day, participants may be willing to draw down lines of credit (or enter into intraday repos) with the central bank, or borrow settlement assets from other participants with excess funds, to make outgoing payments. These actions quicken the settlement of a participant's outstanding obligations, and improve the overall resolution of outstanding obligations in aggregate. However, any event that causes participants to believe that incoming payments will be delayed or will not arrive that day *may* trigger a negative reaction, as participants act to protect their own ability to make future payments. Participants might slow the release of outgoing payments. Thus, a shock that substantially revises down the expectation of incoming funds (well beyond the typical variability in payment receipts) may trigger payment system gridlock. In addition, if obtaining credit is costly, participants have an incentive to delay payment submission to minimise their costs. Such a behavioural response could in aggregate lead to slower resolution of all payments during normal operations, and may further attenuate the system's response to a shock.

Delays to settlement are potentially more problematic, leading to credit concerns in situations in which there is a high proportion of offsetting payments and creditor rights in bankruptcy are weak. When a payment system has a high level of offsetting payments, each party involved may prefer that its counterparties send payments first, thereby resolving any credit or liquidity risk associated with the expected incoming payments. As each party may have this preference, they may all delay their payments until late in the day. Similarly, if creditor rights are weak in bankruptcy, participants may hold a stronger preference to first receive payments from counterparties. In either case, the delay may intensify the system's settlement risk.

The potential for participants' individual behaviour to lead to substantively delayed settlement may be more pertinent in systems that achieve intraday finality but do not allow offsetting or netting of payments. As an illustration, consider a case in which the underlying financial obligations the participants are attempting to discharge through the payment system are largely offsetting, but the system does not allow any netting or offsetting of obligations. If, and this is a crucial caveat, the parties cannot coordinate effectively on their own, then one party or the other must be first to discharge its obligation, which may advantage its counterparty. The parties may be made better off by making each other's payment dependent on the counterparty's payment; ie by netting or offsetting payments.

In sum, settlement risk is typically partly a function of duration and, therefore, settlement delay is one source of settlement risk. The possibility for participants' strategic behaviour to cause problems at the system level raises issues for the system's efficiency and potentially even the concern of systemic risk for payment system participants, operators and overseers. System design and policies can encourage earlier or smoother submission of payment instructions. For example, throughput requirements provided by the system operator to settle certain percentages of the day's payment value by certain times of the day can mitigate participants' incentive to hold payments in internal queues by making the timing of submission of payments by counterparties more predictable. Offsetting algorithms are another means of reducing settlement delay. In addition, sender limits, time-dependent transaction fees or fees for credit can be used to provide incentives to synchronise payment flows. Alternatively, participants may also learn to coordinate their payments over time, creating non-binding behavioural conventions or implicit contracts.

3.1.2 *Settlement conditions*

System designs may incorporate a variety of conditions that must be met in order for settlement to occur. These conditions may apply to individual payments, to groups of payments, or to the system as a whole. Conditions may possibly contribute to settlement risk by making settlement harder to achieve. Alternatively, they can also influence or determine what happens in the event of settlement failure at one or more such levels. These conditions may differ widely among systems.

Some conditions depend on participants' behaviour, such as the decision on when a payment is submitted to the system as was discussed in the previous chapter. For another example, consider the situation in an unprotected net settlement system in which one participant fails to settle. In this system, payments are conditional, ie there is some probability that payments involving the defaulter may be reversed and net positions could be recalculated, resulting in increased liquidity requirements of other participants, or, in extreme conditions, secondary failures to fund the recalculated final positions. In this case, settlement is conditioned on the future funding of all net settlement positions. As this condition is not subject to verification when payments are submitted, and is only satisfied at a future point, there is a risk that it will not be met. In an unprotected DNS system, if net funding is not successfully completed, payments can be unwound with the concomitant credit, liquidity and even systemic risks.

The risk that the net funding will not be met, of course, also exists for participants in protected net settlement systems. But loss sharing agreements or posting of collateral in such a system mitigates settlement risk. And in a net settlement system that provides an explicit guarantee of settlement, all transactions and the system are certain to settle. Nevertheless, there continues to be a risk of financial loss in the event of a participant default because any associated losses would be apportioned to surviving participants and their collateral could be sold.

The financial losses attributable to a participant's failure to fund its net settlement payment are also much easier to quantify and manage in protected net settlement systems than would be the case in an unprotected net settlement system. Participants or the system itself may take steps to limit their exposures to each other, for example by imposing bilateral or multilateral limits. Such limits control potential financial losses but could lead to some settlement delay if they were set at low levels.

While an increasing number of systems provide various queue functionalities, participants are likely to be able to replicate most of this functionality through the use of internal queues. The centralised functionality may provide a coordination device, and in particular, if participants use the centralised functionality rather than relying on internal queues, the queue functionality may harmonise participants' queue release rules. The system may also provide for bilateral and multilateral offsetting of payments in the central queue, which may be difficult to achieve through individual coordination.

Systems which introduce various queue functionalities face the potential of increased settlement risk due to the dependence on new conditions that must be fulfilled relative to systems with no or simple queues. Alternatively, centralised queue functionality may potentially decrease settlement risk due to weakened incentives to hold payments in internal queues, which delay the submission of payments. The actual impact on settlement risk must be judged for each system and may vary widely, due to the factors discussed in previous sections. Enhanced payment information and control functions have put participants in a better position to measure and manage their risks. Queue functionality and queue release methods are designed to reduce participants' liquidity usage and consequently their costs, which is the subject of the next section.

3.2 Cost in LVPS

Payment system designers (owners, operators, settlement agents and/or settlement institutions) need to take into account the system's cost. This includes not just the costs passed on to participants and other users through charges, but also other resource costs, such as the indirect costs of liquidity. This section first discusses the costs borne by the system operator, which are usually passed on to the participants in the form of fees such as fixed fees for connection, admission or membership as well as transaction fees. The costs of obtaining the liquidity or funds for settling outgoing payments are subsequently described. From a participant's point of view, the costs of liquidity are an important parameter in a number of decisions such as the choice of system that is used or the sequencing of payments. More generally, costs are an important determinant of the system's efficiency because they may influence both the participation structure and the pattern of payment submission.

3.2.1 *Operational costs of LVPS*

The costs related to the operation of an LVPS include a number of elements ranging from investment and capital costs to operational and overhead costs.[40] Costs in an LVPS can typically be characterised by considerable fixed costs but low marginal costs; this is not surprising for a system that makes extensive use of telecommunication and computational facilities. For example, the recent creation of CLS involved considerable IT investment costs. In recent years, however, some private sector vendors have developed LVPS infrastructures that offer the standard functionalities of RTGS systems indicative of the maturation of the technology. This development can reduce the initial fixed investment costs associated with designing and implementing a new LVPS.

Operational costs also tend to be significant, particularly due to the high degree of operational reliability and redundancy that LVPS are usually required to have. These costs have probably escalated recently as standards for business continuity and operational resilience have been promulgated and strengthened in response to, among other things, the increased globalisation of the financial sector and the lessons learnt in the aftermath of the events of 11 September 2001. Partly due to increasing costs among other strategic considerations some system owners (including central banks) are outsourcing the operational function to third-party service providers.

3.2.2 *Cost of liquidity*

Liquidity costs for participants stem both from any fees or interest they may have to pay to obtain funds from the central bank or the market and from any requirement to post collateral in the system if there is an opportunity cost for the collateral. The cost of liquidity depends both on the elements of LVPS design and the external influences covered in Chapters 1 and 2.

The costs of liquidity for participants are difficult to measure and to compare across systems. They can vary according to the classes of assets that can be used to secure liquidity within the system and other features of the payment system environment. The costs of liquidity are, for instance, influenced by prudential liquidity requirements or by minimum reserve requirements. The direct (opportunity) costs of the overnight balances held in excess of the reserve requirements can be calculated as the difference between the remuneration by the settlement institution (often zero) and a (risk-adjusted) overnight rate.

Fees charged by the settlement institution for access to funds on an uncollateralised basis impose positive direct costs on the use of liquidity. Participants, in some instances, may also obtain liquidity from other participants on an uncollateralised basis and may therefore incur explicit interest costs. If participants are required to provide collateral in order to obtain credit that can be used to create liquidity, there is an indirect (opportunity) cost. This opportunity cost arises, for instance, since collateral used for cash credit purposes cannot be used for other purposes such as securities lending. Another source of opportunity costs can stem from the possibility that the type of collateral accepted by the settlement institution may cause the participants to hold assets they would not otherwise hold. Both direct fees and opportunity costs represent a form of non-linear pricing if either the fee or the opportunity cost varies with the amount of liquidity utilised.

Since the opportunity cost of collateral is generally assumed to be positive, there have recently been a number of initiatives to make more efficient use of participants' assets as collateral. The opportunity cost can be reduced, for example, by extending the range of collateral accepted or by allowing a flexible management of the collateral posted (eg easy substitution of collateral posted). Collateralised intraday liquidity is usually provided free of interest with the exception of the Federal Reserve, which provides intraday liquidity to depository institutions for a fee whether or not the institutions pledge collateral to secure the liquidity they obtain. However, participants have to incur the handling fees at the central securities depository and in some cases a transaction fee.

The amount of liquidity necessary (and hence its costs) is also highly dependent on how quickly the participants want or need to settle their outgoing payments. As a general rule, the faster payments need to be settled the larger are the liquidity needs of the participant. Participants may also trade off

[40] An illustration of a possible cost accounting methodology for the establishment and operation of an LVPS is provided in Annex 4.

the costs of liquidity associated with making immediate payments versus the cost of postponing the submission of customer payments. Reputational costs may arise owing to the possibility of losing dissatisfied customers, to relationship effects, or in fact to fines for postponing time-critical payments. Banks may choose to postpone payments if the incremental cost of doing so is lower than the cost of the liquidity required to make immediate payment. However, these costs (and especially reputational costs) are extremely difficult to quantify and therefore practice may show a slightly different picture. As mentioned earlier, the design of payment systems can influence all of these types of costs.

From a system perspective, the faster liquidity is "recycled" during the day (higher turnover), the lower the amount of liquidity (and hence its costs) necessary to settle the participants' payments quickly. A higher turnover of funds can be achieved, for example, by throughput guidelines, lower fees for payments submitted early, offsetting of payments, limits or informal market practices to coordinate submission of payments during a relatively short time period. Box 12 summarises a number of indicators that may be used to measure the amount of liquidity used in an LVPS.

Box 12

Measuring liquidity usage in an LVPS

One aspect of operational efficiency of a payment system is the liquidity needed to settle all payments and the delay payments incur before final settlement. Both are only partly determined by payment system design, which makes it difficult to assess properly the impact of design changes on system efficiency. Other factors of influence include local rules and regulations, market structure and participant behaviour.

For DNS systems, the *netting ratio*, or net value expressed as a percentage of gross value, traditionally gives an indication of the relative amount of liquidity needed to settle all payments over a certain amount of time. The figure ranges between 0 and 100, with gross settlement yielding a result of 100. However, as liquidity can be recycled and used for numerous payments throughout the day, the actual liquidity needs in RTGS systems appear to be much lower than the total value of all transactions. Relative liquidity needs in RTGS systems can be rendered by a *turnover ratio*, which expresses the total value of payments in relation to the total value of settlement balances. However, it does not reflect intraday fluctuations in liquidity needs and the use of intraday credit.

A *liquidity usage indicator* takes balances as well as intraday credit into account. This indicator is made of the sum of liquidity available to all banks at start of day plus the sum of individual maximum intraday credit positions, divided by the total value of all payments. The higher the ratio, ranging between 0 and 1, the higher the liquidity needs. A settlement delay indicator is the sum of the values of queued payments divided by the total cumulative values of outgoing payments, over each minute of the day. In simulations carried out with real or artificial payment data, liquidity needs appear to be significantly influenced by the introduction of time-critical payments and by the prioritisation of payments. The introduction of offsetting algorithms considerably reduces settlement delays, while also reducing liquidity needs.

4. Implications of new developments in LVPS

LVPS have developed rapidly over the past 15 to 20 years. Most notably, RTGS systems have been introduced in a large number of countries, often as a replacement for, but in some cases as a complement to, pre-existing DNS systems. The properties of RTGS systems were analysed by the CPSS in 1997.[41] Since that time, however, a range of further innovations in LVPS design have been forthcoming. In addition, the external environments within which these systems operate have also changed in a number of ways. These "new developments in LVPS", which have been described in the previous chapters of this report, are likely (and in many cases intended) to significantly influence the level of risk and/or cost associated with settling large-value payments; therefore obtaining an understanding of their implications is important for central banks and financial institutions alike.

[41] See *Real-time gross settlement systems*, BIS, March 1997.

Detailed analysis of all the observed developments in the field of LVPS design is beyond the scope of the current report. Rather, this section provides a few examples of the way in which the analytical framework described in the previous chapters may be applied in order to evaluate the consequences (and possible underlying causes) of changes in the design of an LVPS. To this end, four particularly significant developments in LVPS design are considered in the following subsections: innovative solutions for achieving continuous intraday finality; increased centralisation of payment control functions and provision of online information; new queue release algorithms; and the introduction of multiple settlement streams.

The analysis below is limited to an evaluation of the possible implications of each development for different sources of cost and risk in LVPS. It does not seek to assess the likely impact on *overall* levels of risk, cost and efficiency, which will in practice vary significantly from case to case.

4.1 Innovative solutions for achieving continuous intraday finality

The 1997 CPSS report on RTGS systems highlighted the way in which these systems serve to mitigate systemic risk in LVPS. This property derives largely from the fact that RTGS provides financial institutions with a means of settling payment obligations with *continuous intraday finality*. That is, a payment submitted to an RTGS system may be settled with finality immediately when all relevant conditions are satisfied.

Continuous intraday finality reduces the average duration of the exposure underlying individual payment obligations and serves to mitigate settlement risk by removing the possibility that payments deemed irrevocable by the system rules will be unwound (or reversed) in the event of a participant being declared insolvent. However, RTGS systems that provide continuous intraday finality are commonly associated with increased liquidity requirements relative to deferred finality DNS systems.

Traditionally, the introduction of an RTGS system has been viewed as the only feasible means of achieving continuous intraday finality. But recent developments in LVPS design have illustrated that this is not the case. Two systems currently operating in the CPSS member countries - CHIPS in the United States and LVTS in Canada - have implemented payment processes that do not employ the RTGS paradigm but nevertheless allow individual payments to become final on a continuous (or near-continuous) basis throughout the day. In addition to settling individual payments, CHIPS seeks to identify and settle sets of payments whose value is closely offsetting on a bilateral or multilateral basis during the day. Those payments that remain unsettled at the close of the system typically approximate the non-offsetting values. LVTS is a multilateral netting system that provides a guarantee of settlement and immediate intraday finality for all payments that pass the real-time risk controls of the system. See Box 5 for more details on the settlement process in CHIPS and Box 7 for details on LVTS.

The introduction of systems such as CHIPS and LVTS can be interpreted as a response to developments in the external environment of LVPS. More specifically, a combination of technological progress (which serves to broaden the set of feasible designs); oversight initiatives aimed at reducing systemic risk; increasing significance of time-critical payments; and competitive pressure to control the costs and risks of participating in LVPS have served to encourage the owners and designers of these systems to consider the development of innovative new solutions. In particular, the introduction of systems such as CHIPS and LVTS derives from an overarching objective to achieve risk (and service) levels equivalent or comparable to an RTGS system, but at reduced overall cost.

While such new solutions achieve risk-reduction benefits that in some respects are similar to those provided by a typical RTGS system, other types of settlement conditions not necessarily present under the RTGS paradigm are likely to remain. In CHIPS, for example, prior to 2003, the use of fixed intraday position limits introduced a possible source of settlement delays for individual payments beyond what might be expected in a typical RTGS system. In 2003, CHIPS introduced a supplemental funding facility that allows participants to add funds to the system during the day for the release of individual payments that are flagged with high priority; participants can use this facility to reduce the settlement delay for individual payments. In LVTS' Tranche 2, if bilateral credit limits were set at very low levels, some settlement delay could be introduced.

However, the risk-reducing effects of implementing intraday finality are not free of cost. In particular, new approaches to ensuring continuous intraday finality are often characterised as imposing intermediate levels of liquidity cost on LVPS participants - higher than in unprotected DNS systems but lower than in RTGS systems. Assuming that the (marginal) cost of liquidity is strictly positive, a standard trade-off between conditions for settlement and liquidity cost therefore emerges.[42] In addition, the development of innovative new payment processes that combine netting/offsetting processes with continuous intraday finality is also likely to involve the system operator incurring additional investment costs. Nonetheless, if a previously existing DNS system and an RTGS system were replaced by such a new system the overall costs might still be lower.

4.2 Increased customisation and centralisation of payment control functions

Chapter 1 described a range of LVPS design features that can assist financial institutions in the intraday management of their (large-value) payment flows - examples include bilateral and multilateral position limits; liquidity reservations; and timed payments. A common characteristic of these "*payment control functions*" is that they allow LVPS participants to attach additional conditions to the settlement of individual payments submitted to the system concerned. In the event that one or more of these conditions is not satisfied, it is standard practice for the payment to be placed in a central queuing facility until some event occurs (or action is taken) such that settlement can take place without violating any condition.

Financial institutions need to exercise a degree of control over their payment flows independently of the design of the LVPS concerned. In a deferred finality DNS system, for example, the ability to impose limits on the size of net positions is an effective means of placing an upper bound on the scale of credit and liquidity exposures that can arise between direct participants. However, payment control is generally recognised to carry more significance in the context of RTGS systems. In large part this reflects the importance of efficient participant-level liquidity management in these systems - position limits and other payment control functions most commonly act as tools designed to achieve this objective. The remainder of this section therefore focuses on the payment control functions in RTGS systems and on the effects of bilateral and multilateral position limits in particular.

Although it has become more common - largely in response to user demands - for the design of RTGS systems to incorporate extensive payment control functions, the use of, for example, position limits is not a new phenomenon[43]. In the event that a participant wishes to impose a specific condition on the settlement of a payment, one possible option is simply to delay submitting the payment to the system until that condition is satisfied. The availability of this decentralised method of controlling payment flows is clearly independent of the design of the payment system. However, it is now often the case that RTGS systems provide participants with the ability to impose a range of "standard" conditions *within* the system itself. That is, payment control functions have become increasingly customised and centralised over recent years. One important consequence of this trend is that, in principle at least, a larger proportion of payments are now queued centrally within LVPS (rather than in financial institutions' internal systems) than was the case in 1997.

The impact of increased customisation and centralisation of payment control functions depends on the behaviour of participants. In particular, in some LVPS, participants can independently determine bilateral and multilateral exposures which influence the settlement conditions. These limits then positively affect the pattern of settlement flows through the system. Such an outcome may, however, also depend on the specific environmental factors that are present in a particular system. For example, if the largest financial institutions already exercise significant decentralised control of their exposures by closely controlling their payment flows, the settlement pattern may be influenced less by the introduction of centralised control tools.

There might also be a trade-off between the additional investment costs associated with developing a more complex system which includes extensive payment control functions and the cost-reducing effect

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[42] As noted in Chapter 3.2, the assumption that the marginal cost of liquidity is positive may not be appropriate in all cases owing to the structure of regulatory arrangements in certain markets.

[43] During the design phase of RTGS^{plus} and TARGET2, for instance, the participants expressed a preference for having comprehensive liquidity management features.

of individual financial institutions being able to decommission (or at least scale back) their internal payment control systems.

4.3 New queuing arrangements and release methods

Over recent years, a number of *new* queuing arrangements and queue *release methods* have been incorporated into the designs of LVPS operating in the CPSS member countries. Notable examples include RTGS^{plus} in Germany, BI-REL in Italy, PNS in France and CHIPS in the United States. These methods or algorithms often operate in tandem with the types of centralised payment control functions described previously. An element of complementarity can therefore be observed between increases in the range of conditions that may be attached to the settlement of individual payments and the added complexity of algorithms designed efficiently to select payments for release from the LVPS central queue. Furthermore, it is apparent that continuing technological progress has been a crucial factor in increasing the technical and (perhaps more importantly) financial viability of sophisticated queue release algorithms.

Two basic types of new queue release algorithm may be identified. First, a number of RTGS systems have introduced mechanisms that allow queued payments to be offset bilaterally or multilaterally on a continuous basis (see Chapter 1 for a more detailed description of offsetting processes). The main motivation behind the introduction of this type of algorithm, which ensures that the gross settlement paradigm is preserved for all payments, has been to reduce the amount of liquidity required to settle a given value of payments with a given level of (financial) risk. That is, the primary objective has been a user-driven desire to achieve improved levels of efficiency in the process of settling large-value payments.

A prominent case is provided by RTGS^{plus}. All payments are processed on an individual transaction basis and are settled with immediate finality, provided that there is sufficient liquidity for processing the payments. Offsetting payment flows are also used as cover. Offsetting payments are only executed when the calculation of the reciprocal claims has been finished. Simultaneous gross settlement is achieved by the execution of all the payments within one legal and logical second. RTGS^{plus} never leaves net positions (debit or credit positions) and never processes batches like DNS systems. Another example is the offsetting mechanism introduced in the BI-REL.

The second type of algorithm - uniquely implemented by the CHIPS system - releases queued payments for settlement in either gross or net form, after a participant meets its daily initial prefunding requirement. With respect to netting, this approach to LVPS design, which evolved from a more traditional DNS model as well as developments in the German EAF2 system, substantially reduces the length of time during which payments that can be netted remain unsettled. As noted above, development of the new CHIPS algorithm formed part of a broader initiative, motivated by a combination of user requirements and oversight objectives, which aimed to reduce risk by ensuring that all payments released from the CHIPS central queue are settled with immediate intraday finality in an environment characterised by low liquidity requirements.

In economic terms, however, the two types of new queue release algorithm share similar objectives and properties. In particular, both seek to achieve intraday finality, and to speed the release of closely offsetting sets of payments. In this way, the costs and risks of these tools can be analysed as means of achieving the benefits of intraday finality. These innovations in intraday finality were discussed in Chapter 1.

4.4 Introduction of multiple settlement streams

A common assumption underlying the analysis in the RTGS report is that an LVPS provides a single method of settling large-value payments. However, it is becoming increasingly common for the design of LVPS to incorporate two or more "*settlement streams*" operating on a common technical platform. This represents a means by which LVPS allow participants greater control over the input of payments. The range of settlement methods available to financial institutions is therefore broader than in traditional, single-stream systems. Furthermore, participants in multi-stream LVPS typically have full discretion over which settlement stream to use to settle each individual payment.[44]

Notable examples of systems that have developed multi-stream designs include LVTS in Canada and the German RTGS^{plus} system.[45] In LVTS, participants are able to submit payments to two alternative settlement streams known as "tranches". The key feature of Tranche 1 is that all payments submitted to this stream must be funded in full, either by Tranche 1 receipts or by collateral pledged to the Bank of Canada by the sending participant. Payments submitted to Tranche 2, on the other hand, must pass a range of risk controls and are funded by receipts and by central bank credit backed by a collateral pool pledged to the Bank of Canada by all participants. Participants in RTGS^{plus} have the option to submit payments to either the "express stream" or the "limit stream". The two streams are distinguished by different queue release algorithms and a wider range of payment control functions (including total, bilateral and multilateral position limits) in the limit stream.

In both LVTS and RTGS^{plus}, the risk-cost profiles of the alternative settlement streams differ. In line with the analysis above, establishing the extent to which the overall level of risk or cost is greater in one settlement stream relative to another is not straightforward. However, it is clear that a move from system designs based on a single settlement stream to the multi-stream alternative allows LVPS participants to exercise some discretion over the overall amount of risk and cost they incur in the course of settling large-value payments.

Faced with the choice of two settlement streams, an LVPS participant is not required to use both streams. Indeed, one possibility is to submit every payment to one of the two streams - Stream 1, for example. This course of action ensures that the overall level of risk and cost incurred by the participant concerned is defined by the specific design features of Stream 1. At the opposite extreme, every payment could be submitted to Stream 2, and the risk-cost outcome would be determined accordingly. However, it is also possible for the participant to use both settlement streams and realise an intermediate overall level of risk and/or cost.

One important implication of this analysis is that the presence of multiple settlement streams creates an additional role for participant behaviour in determining overall levels of risk, cost and efficiency in an LVPS. While the design of a multi-stream LVPS establishes upper and lower bounds on the amount of risk and cost potentially incurred as a result of settling payments through the system concerned, it is the decisions of participants in respect of how payments are allocated across the set of available settlement streams that determines the actual risk-cost outcome. Moreover, allowing individual LVPS participants to choose (within constraints defined by the design of the system) the level of risk and cost they wish to incur should, in theory, lead to a more efficient outcome. An important caveat to this conclusion, however, is that the decisions of individual LVPS participants are unlikely to take full account of the impact of their choice on other participants; therefore it is not necessarily the case that multi-stream settlement establishes an improved outcome.

There are also strong similarities between multi-stream settlement and situations where two (or more) LVPS coexist in a particular market or currency area - in both cases, financial institutions have the option to choose between at least two alternative methods of settling payment obligations. This implies that participants in substitutable LVPS (for example, Fedwire and CHIPS) also have the ability to exert some influence over the level of risk and cost they incur as a result of their payment activities. It seems likely that the scale of this effect will not be as significant as in cases where a single LVPS offers multiple settlement streams, as the possibility to choose between two LVPS is limited to financial institutions that participate in both systems.

[44] In some cases, the rules of the system may require particular types of payment (for example those related to ancillary system settlement) to be submitted to a specific settlement stream.

[45] See Boxes 2 and 6 as well as Box 7 for a more complete description of the design of RTGS^{plus} and LVTS, respectively.

5. Possible future developments

Clearly it is not feasible to forecast exactly how existing LVPS will evolve or the form new systems will take. Nevertheless, the trends highlighted elsewhere in this report may be used as a guide in seeking to identify the possible future direction of LVPS development. In particular, technological progress and the developments in the structure of the global financial markets are likely to continue to act as key drivers for change in the way LVPS are designed, operated and used. The risk-reduction priorities of central banks - in their role of LVPS operators and overseers - and of regulators may also play a significant role.

5.1 Continuing technological advancement

As highlighted previously, technological progress has played an important role in facilitating the introduction of ever more sophisticated and complex LVPS designs, such that practical constraints on the technical or financial viability of particular design features have been reduced. More generally, the development of new solutions (technological innovation) and cost-reducing enhancements to existing technologies (technological maturation) jointly serve to widen the range of feasible LVPS designs.

Irrespective of the precise form of technological progress, it is possible to identify at least two more specific ways in which the set of feasible LVPS designs may be expanded. First, improvements in the processing power of the hardware components essential to the operation of modern LVPS are likely both to increase the volume capacity of these systems and to facilitate the use of increasingly sophisticated settlement algorithms. One possible consequence of the former effect may be to allow LVPS to attract the processing of a greater range of low-value payments than at present. This can already be observed, for instance, in SIC, whose capacity is large enough to process a significant fraction of retail payments on a gross basis.

Second, technological progress keeps expanding the range of feasible business continuity arrangements. In particular, current limitations on the distance across which transaction data can be synchronously mirrored between operational sites are likely to become less relevant as new data transfer technologies are introduced. A wider range of failure-resistant hardware (and software) solutions may also become available to LVPS designers. Implementation of increasingly robust contingency arrangements, with consequent reductions in the level of operational risk to which an LVPS is exposed, should therefore become feasible at lower cost.

In order fully to exploit the potential benefits of these and other possible areas of technological progress, the parties involved in the operation and use of LVPS will probably need to make financial investments. A characteristic of many new technologies is that their implementation is, at least initially, relatively expensive. Decisions over whether to introduce new LVPS designs are therefore taken on the basis of thorough cost/benefit analyses, within which short-term development costs are evaluated against potential long-term benefits in the form of reduced levels of risk and/or lower delay, liquidity or operational costs.

5.2 Changes in financial market structure

Technological progress serves to widen the set of feasible LVPS designs. It is, however, the preferences of LVPS users, together with the requirements of overseers, which ultimately determine the way in which individual systems are designed and used. In this respect, continuing developments in the structure of the domestic and international financial systems and the institutions that participate in them will be a key factor influencing the future direction of LVPS development.

Since the integration of international financial markets is likely to continue, so will the demand for cross-border and multi-currency settlement services. The same applies to the number of time-critical large-value payments which illustrates the continued importance of the availability of LVPS that allow financial institutions to discharge payment obligations with immediate finality.[46]

[46] That is, the presence of at least one RTGS or RTGS-equivalent system is necessary.

Although new systems, most notably CLS, have been designed and implemented with the intention of providing enhanced cross-border services, further developments may bring about market infrastructures which fully reflect the pattern of activity in modern, increasingly globalised financial markets. Initiatives aimed at developing new and strengthening existing infrastructural arrangements for the settlement of payment obligations across national borders are therefore likely to be a major future influence on the design, operations and use of LVPS.

Further development could occur if CLS broadens its range of services or if new systems for the settlement of cross-border transactions (not necessarily stemming from foreign exchange transactions) are introduced.

One of the most significant and already tangible changes in the payment landscape is the project for TARGET2 in the European Union (see Box 13). Unlike the current TARGET system, TARGET2 will provide a centralised payments platform offering a variety of offsetting algorithms. Due to TARGET2 most of the current LVPS in the European Union will eventually cease to exist, ie there will be a high degree of consolidation. TARGET2 will also lead, in conjunction with the ongoing consolidation of central securities depositories in Europe, to stronger integration and increased interlinkages between LVPS and SSSs. One potential consequence of increased linkages may be a further extension of LVPS opening hours, eg in order to accommodate the needs of SSSs in terms of night-time settlement. In recent years, some LVPS have already extended their operating hours, mostly in response to the introduction of CLS.

Future developments in the financial sector are likely to play an important role in determining how LVPS evolve. In the event that the consolidation process continues, the importance of large and complex financial institutions in the market for large-value payments is likely to grow further. Along with the potential impact on the way in which LVPS are designed and operated, this trend could also lead to increased competition from large correspondent banks trying to internalise part of the interbank payment business.

Box 13

The planned TARGET2 system

With the introduction of the euro and the single monetary policy in 1999, the TARGET system commenced live operations. It was based on the existing infrastructures. Since then, the environment in which TARGET operates has changed and continues to change. Technological developments as well as the fast-moving process of European integration have triggered requests from system users for further and more harmonised services. In addition, TARGET will need to cope with the enlargement of the European Union.

In October 2002, the Governing Council of the ECB defined the strategic direction for the next generation of TARGET (TARGET2). According to this decision, in TARGET2 it will no longer be necessary for each national central bank to maintain a national RTGS system of its own. All central banks will be able to share one technical platform, the Single Shared Platform (SSP), thus supporting the RTGS services that they offer to their banks. However, the settlement account relationship and the intraday credit provision will continue to belong to the business relationship between each central bank and its national banking community.

A public consultation on TARGET2 user requirements indicated that the benefits of full harmonisation and integration, such as efficiency and effectiveness, could only be achieved by means of an SSP. In the light of the aforementioned decision of the Governing Council and the responses from the public consultation, the Bank of Italy, the Bank of France and the Deutsche Bundesbank have declared their intention to cooperate on the development of the new payment system. In December 2004, the Governing Council accepted the offer made by the three central banks and approved the building of the SSP for TARGET2 operations. This enables all central banks of the European Union to outsource their RTGS services to a common platform.

TARGET2 will provide fully harmonised and standardised services from a business and technical point of view.

- TARGET2 will be a system for the settlement of individual euro payments in central bank money. There will be no de jure or de facto minimum limits set by the Eurosystem on any payments that users may wish to process in real time in central bank money. The increased time-criticality of payments will be taken into account by enabling the submission of timed transactions, such as those needed in the context of CLS.
- TARGET2 will offer liquidity management services with a broad range of optional tools (reservation, prioritisation, defining of sender limits, active queue management). One important innovation in this context is that TARGET2 will offer consolidated account information and allow for intraday liquidity pooling on a cross-border basis.

Box 13 (cont)

The planned TARGET2 system

- TARGET2 will include mechanisms that incorporate mutually offsetting payment flows.
- An Information and Control Module (ICM) will enable participants to control and manage actively their liquidity and payment flows. Moreover, the ICM will allow participants to access all information related to their accounts and payments sent and received.
- TARGET2 will provide full settlement services for all kinds of ancillary systems (ASs), especially for the settlement of securities transactions. The number of ASs currently in operation in Europe is relatively high (around 100). TARGET2 will offer one interface for ASs, supporting six generic models and DVP facilities. The interface performs a number of functions that ASs can choose to combine according to their preferred mode of operation.
- TARGET2 offers a set of harmonised interfaces with users (credit institutions, market infrastructures and central banks). In terms of communication (tools and standards, both in terms of format of messages and network connections), the major purpose is to allow all market participants to benefit from maximum economies of scale in this framework. Therefore, SWIFT messages and communication infrastructure will be used.
- The proposed concept to ensure resilience and business continuity is based on a multi-region/multi-site architecture. For payment processing and accounting there will be two regions, with two remote sites in each region. This will be combined with the principle of region rotation, in order to ensure the presence of skilled staff in both regions.

The system is being developed in 2005. Testing will also start in 2005, with participant tests expected to begin around the middle of 2006. The launch of the new TARGET system is planned for January 2007.

Conclusions and issues for central banks

Technological advances, financial integration, regulatory oversight and user demands have led to a number of significant developments in large-value payment systems (LVPS) since the publication of the RTGS report in 1997. New LVPS have been introduced and some previously existing systems have made important enhancements. While some of these developments raise issues for central banks, recent developments in LVPS can be seen to be promoting a more efficient and less risky payment system environment.

Since 1997 several important developments can be identified. First, the vast majority of LVPS nowadays provide intraday finality of payments. At the time of publication of the RTGS report, many countries had adopted or were in the process of implementing RTGS systems. RTGS systems were viewed as the way to ensure intraday payment finality in LVPS and as the surest way to control systemic risk. More recently, new types of LVPS have been developed that achieve continuous intraday finality without being based on the RTGS paradigm.

Second, some RTGS systems have recently implemented complex queue release algorithms that incorporate offsetting queued payments into the settlement process. The effect of these algorithms is that finality is achieved earlier and that the intraday liquidity needs - typically central bank money - are lower. Using offsetting or netting is not new to LVPS. It has previously found widespread application in gridlock resolution mechanisms, in DNS as well as in hybrid systems. The innovation is that offsetting is now applied in real time while also providing gross settlement.

In addition to the introduction of offsetting other factors have recently influenced the costs of liquidity in payment systems. Currently all central banks of the CPSS countries provide intraday liquidity to qualifying institutions. A few of them have recently also broadened the range of securities they accept as collateral, in some cases to include cross-border collateral, as a means of reducing costs of obtaining liquidity for participants.

Taken together, these developments can be seen as a blurring of the key distinctions between RTGS systems and other LVPS. Some RTGS systems now offer features similar to netting (eg near-continuous offsetting in queues), and some new systems that do not employ the RTGS paradigm offer continuous intraday finality - one of the key benefits of RTGS systems. In many cases, however, these new or enhanced features, such as sophisticated queuing and offsetting algorithms or methods for placing sender limits on payments, make the technical infrastructure of an LVPS more complex and the analysis of risks and efficiency more demanding.

Central banks play a number of key roles in the LVPS considered in this report. In most LVPS settlement takes place in central bank money: hence, central banks provide settlement accounts and are a source of liquidity. They also typically oversee these systems with the objective of maintaining their safety and efficiency and thus contributing to the sound functioning of the financial system. Many LVPS discussed in this report are owned and operated by central banks. Some are owned by the private sector but, even then, central banks tend to provide essential services to these systems including, in some cases, the intraday provision of central bank liquidity or the provision of settlement accounts.

This report provides a framework that can help promote effective analysis of risk and efficiency in LVPS and illustrate the nature of some of the trade-offs involved. There is no unique LVPS design appropriate for all environments, but it is helpful for payment system participants, operators and overseers to have a clear understanding of these issues (as emphasised in the Core Principles). The basic definitions of key elements of payment system risk outlined in the Core Principles (eg legal, credit, liquidity, operational, systemic) are now well understood. This report adds to that analysis by examining how different payment system designs create various incentives for payment system participants to act in a way that affects the risk that they and other participants bear. Ultimately, this can affect particular elements of risk in the LVPS as a whole. This analysis is presented in the report's discussion of settlement conditions and settlement delay. However, further analytical work will be needed to understand more fully the incentives and resulting behaviours in increasingly complex and interlinked financial infrastructures.

Since the 1997 RTGS report, financial integration has continued to affect the payment system environment. For example, growth in cross border-flows and in foreign exchange trading has led (with the encouragement of central banks) to the development of CLS, a multi-currency foreign exchange settlement system. CLS Bank provides an indirect link to many LVPS by holding accounts with central banks whose currency is settled in CLS. In a number of countries, there are also now closer links between LVPS and SSSs. This greater interdependence between financial infrastructures typically promotes efficiency and reduces risk overall, but may exacerbate certain types of risk. For example, greater real-time links between LVPS and SSSs can cause operational problems in one system to propagate more quickly and have more significant effects on the other system. In addition, although CLS eliminates foreign exchange settlement risk on the trades it settles, it has also created new channels for operational events to impact LVPS. Central banks, for these and other reasons such as the events of 11 September 2001, are now focusing increasingly on operational risk and on ensuring that sound contingency arrangements are in place.

Future developments in the financial sector are likely to play an important role in determining how LVPS will evolve over time. If consolidation in the financial sector continues, the importance of large and complex financial institutions in the market for large-value payments is likely to continue to grow. Along with the potential impact on the way in which LVPS are designed and operated, this trend could also lead to the creation of an increased number of correspondent banks that specialise in transacting large-value payments across their books for other financial institutions (these are sometimes called quasi-systems). Such banks provide services that compete to some extent with those offered by LVPS. Moreover, the trend towards standardisation of services provided by such correspondent banks (just as all participants of an LVPS typically follow the same rules, are submitted to the same pricing structure and have access to the entire range of available services) could lead to an outcome under which the distinction between these arrangements and LVPS becomes increasingly blurred. At the same time, increased financial integration may lead, in the future, to the creation of new infrastructures specifically designed to settle large-value payments across borders and in multiple currencies and for multiple assets. These developments could raise further issues for central banks.

Cost and pricing are other important policy issues for central banks. If the costs of transactions in an LVPS are considered to be too high by participants, they might choose to use a less expensive but more risky payments alternative. One development affecting participants' costs has been the move on the part of a number of central banks to broaden the list of securities they accept as collateral, in some cases to include cross-border collateral, to reduce the costs of obtaining liquidity. Financial market consolidation - and the potential for an increase in the number of quasi-systems - is relevant with regard to cost, as this could lead to a reduction in the number of direct participants in an LVPS and a greater burden on remaining participants when pricing in the LVPS is determined on a cost-recovery basis. Central banks must also pay careful consideration to the costs and benefits of implementing increasingly complex features in the LVPS that they own.

For those central banks that own *and* operate LVPS, technological progress and its impact on LVPS design may influence the decision of system owners with respect to selecting operators of the system. In some countries, commercial entities are already performing this role. But, while the decision to outsource this settlement agent role may be considered more actively in the future, the role of central banks as the settlement institution of systemically important LVPS is likely to remain. This, along with the other factors referred to in this report, may affect how the market structure of payment services will evolve.

The forces that have caused LVPS to evolve since 1997 are likely to continue to elicit further innovations to these systems and raise new issues for central banks, although the direction of these effects is difficult to predict. This report has focused on new developments in LVPS in CPSS member countries. Simultaneously, payment systems in other countries continue to evolve. This report may also be useful to other countries for analysing the choices they face in the development or enhancement of their LVPS.

Annexes

Annex 1:
Introduction to the comparative tables

All large-value payment systems and arrangements (LVPS) have a common primary objective, namely to allow participants to settle payments promptly, safely and efficiently. The recent developments in LVPS reflect this, differing from case to case, given the variety of interested parties and the relative variations in changes in the environment. This annex describes the main new features that have been implemented in LVPS since the publication of the CPSS report *Real-time gross settlement systems* in March 1997 (RTGS report). Details of the current features of selected LVPS in the countries of the CPSS central banks (central banks of the G10 countries, the European Central Bank, the Hong Kong Monetary Authority and the Monetary Authority of Singapore) are provided in the comparative tables of Annex 2.

Starting point

The RTGS report was published in 1997 in order, inter alia, to familiarise market participants with a number of aspects of the developments in real-time gross settlement (RTGS) systems. Since then, a lot of new LVPS have been established: in Canada (LVTS), the European Union (TARGET,[47] EURO1), France (TBF, PNS), Hong Kong (HKD CHATS), Singapore (MEPS[48]), Sweden (E-RIX), and the United Kingdom (CHAPS Euro). In Italy, BI-REL became fully operational in 1998 and underwent major changes in 2003. Furthermore, CLS has begun operations and new types of correspondent banking arrangements/systems have been launched (USD CHATS and Euro CHATS in Hong Kong and SECB/euroSIC in Germany/Switzerland). In Germany, ELS (the former RTGS system) now serves, along with SWIFT, as an access channel to RTGS^{plus} based on a proprietary network only. Moreover, other LVPS, such as ECU clearing in the European Union, SNP in France, and EIL-ZV in Germany have closed down.

Governance

LVPS have different ownership structures. Currently, most of the systems are owned by central banks. There are also examples (in France - PNS, in Belgium - ELLIPS and in the United Kingdom - CHAPS Sterling and CHAPS Euro) that are jointly owned by the central banks and the private sector. These systems settle in central bank money and are often operated by central banks.[49] In addition, there are a number of privately owned LVPS (in Hong Kong - USD and Euro CHATS, in Switzerland - SIC, in the United States - CHIPS, and globally - CLS).

Payment process

The settlement of payments in real time with continuous intraday finality has been established in LVPS, studied in this report. However, this is not always achieved by means of an RTGS system; for example, LVTS in Canada is an RTGS-equivalent multilateral netting system (offering the same degree of safety as an RTGS system); and CLS offers real-time gross and PVP settlement. Furthermore, the high liquidity needs in RTGS systems and the risks involved in unprotected DNS

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[47] A new TARGET system (TARGET2) will replace TARGET in 2007.

[48] A new RTGS system (MEPS+) will replace MEPS in 2005.

[49] Details on central banks' interbank payment system policies are provided in the CPSS report *The role of central bank money in payment systems*, BIS, August 2003.

systems have resulted in the creation of LVPS, which offer real-time gross settlement by means of a mix of RTGS and DNS features. One new development, which evolved from the DNS design, is the frequent netting of payments, resulting in net positions to be settled throughout the day, which was made possible through the prefunding at the beginning of the settlement day (CHIPS in the United States). A further new development, which emerged from the RTGS design, is the possibility of offsetting payments (PNS in France, BI-REL in Italy, RTGS^{plus} in Germany), which achieves the gross execution of single payments simultaneously within one legal and logical second.

Queuing arrangements, based on the first in, first out (FIFO) principle, have become a conventional component in the design of the contemporary LVPS. Nevertheless, FIFO does not always apply due to variations, which have developed such as optimisation routines and payment control measures (like prioritisation, reordering and revocability of payment messages). However, these features are much more sophisticated than in the LVPS described in the RTGS report.

For example, settlement optimisation routines or algorithms, which are activated to minimise the payments waiting in the queues, now work automatically and continuously rather than as a gridlock solution. They are often combined with certain payment control functions, for example position limits set by the sender of a payment in order to control liquidity flow.

A new feature in central queuing facilities is the possibility of submitting a payment, which can be settled "till" or "from" a specific time during the same business day (TBF in France, RTGS^{plus} in Germany, HKD CHATS in Hong Kong). In some cases, it is now also possible to store payments in a queue for processing at a future value date (EPM in the European Union, SECB/euroSIC in Germany/Switzerland, HKD CHATS, USD CHATS, Euro CHATS in Hong Kong, BI-REL in Italy, TOP in the Netherlands, MEPS in Singapore, SIC in Switzerland and CLS).

Information and control

Online information on the payment process has become more widespread in LVPS. This includes queue visibility on incoming payments (on an individual or an aggregate basis) and outgoing payments, information concerning actual and projected account balances and the status of unsettled payments. Payment control parameters can nowadays be changed interactively as long as the payment is not final: limits (a total limit, bilateral and multilateral sender limits), the position of payments in the queues, the priority (express or limit payments), the setting of execution times ("from" and "till" payments) or the revocation of payments. Furthermore, in many cases, the information and control system can also be used for liquidity transfers to/from other market infrastructures or other accounts held with the settlement institution

Message carrier

In contrast to the situation described in the RTGS report, an increasing number of LVPS rely on the communication networks and messages provided by SWIFT in order to forward payment messages. At present, the majority of these LVPS are based on the so-called Y-shaped message flow structure while two use Y structures as well as V structures (BI-REL in Italy, CHAPS Euro in the United Kingdom). Seven LVPS continue to make use of proprietary networks.

Funding and credit

The range of potential sources of settlement funds - balances on the account with the settlement institution, incoming transfers from other participants, credit extensions provided by the settlement institution (intraday and overnight credit on a collateralised or uncollateralised basis) and borrowing on the money markets - has changed relatively little since 1997. However, nowadays funding is also possible via links to other systems (one recent example is CLS; other examples are TBF, PNS and the securities settlement system RGV in France). Furthermore, the rules governing eligible collateral have changed in some countries. Today foreign currency denominated collateral is accepted by four CPSS central banks. In addition, new possibilities have been created to make efficient cross-border and cross-currency use of collateral and funds.

Interrelationship with other systems

The direct or indirect interrelationships between LVPS across national borders and between those with different clearing and settlement systems have increased since 1997. These links range from the settlement of ancillary systems (cash leg of securities transactions, based on DVP models, net positions in retail payment systems) up to a real-time link (TARGET in the European Union) or, as a recent development, up to the pay-ins in the case of CLS.

Fee structure

There is no uniform approach to the charging of membership and admission fees. The majority of the LVPS collect admission fees and membership fees. With respect to payment transaction fees, the flat-rate fee model is still preferred. In some cases, the fee is based on volume, time and mode of delivery. LVPS participants often also have to pay communication fees to network providers such as SWIFT.

Annex 2

Comparative tables of selected large-value payment systems

Country	Belgium	Canada	France		Germany	Hong Kong			Italy
System[a]	**ELLIPS**	**LVTS**	**TBF**	**PNS**	**RTGS**[plus]	**HKD CHATS**	**USD CHATS**	**Euro CHATS**	**BI-REL**
1. Governance and structure									
Year of implementation	1996	1999	1997	1999	2001	1996	2000	2003	1997
Ownership[b]	B+CB[1]	PA[2]	CB	CB+B[3]	CB	CMA[4]	B[5]	B[6]	CB
Settlement agent/System operator	CB	PA[2]	CB	CB+B[3]	CB	CMA+PA[7]	CMA+PA[7]	CMA+PA[7]	CB
Settlement institution	CB	CB	CB	CB	CB	CMA	B	B	CB
Opening-closing time for same day transactions (local time)	07:00-18:00[8]	00:30-18:30[9]	07:00-18:00[8]	08:00-16:00	07:00-18:00[8]	09:00-17:30[10]	09:00-17:30	09:00-17:30	07:00-18:00[8]
Latest time for acceptance of same-day transactions (local time)	17:00 for customer payments; 18:00 for bank payments	18:30[11]	17:00 for customer payments; 18:00 for bank payments	16:00	17:00 for customer payments; 18:00 for bank payments	17:00 for customer payments; 17:30 for bank payments	17:00 for customer payments; 17:30 for bank payments	17:00 for customer payments; 17:30 for bank payments	17:00 for customer payments; 18:00 for bank payments
The LVPS operator maintains an account at the central bank	Nap	N	Nap	Nap	Nap	N	N	N	nap
Two-tiered system	Y	N	Y	Y	Y	N	Y	Y	Y
Number of direct participants (end 2003)[c]	17[12]	14	156[12]	21	93[12]	130	67	23	204[12, 13]

Comparative tables of selected large-value payment systems (cont)

Country	Belgium	Canada	France		Germany	Hong Kong			Italy
System[a]	**ELLIPS**	**LVTS**	**TBF**	**PNS**	**RTGS^{plus}**	**HKD CHATS**	**USD CHATS**	**Euro CHATS**	**BI-REL**
Number of indirect participants formally known by the system operator (end 2003)	72[14]	0	367[14]	491	8,412[14]	0	160[15]	22[15]	583[14]
Annual number of transactions (2003 in thousands)	1,760	4,139	3,864	7,332	32,792	3,508	999	5[16]	9,423
Annual value of transactions (2003 in billions of USD)[d]	15,306	22,517	108,746	20,294	145,115	11,207	1,236	135[16]	27,953
2. Payment process									
2.1 Finality of payments									
Type of settlement	Real-time gross	Real-time gross settlement equivalent multilateral netting system	Real-time gross	Real-time gross	Real-time gross	Real-time gross	Real-time gross	Real-time gross	Real-time gross
Time of final settlement	Real time	End of the day	Real time	Real time	Real time	Real time	Real time	Real time	Real time
Fund transfer out of the system during the day	The funds are kept in RECOUR[17]	At the time of final settlement	At the time of final settlement	At the time of final settlement	At the time of final settlement	At the time of final settlement	At the time of final settlement	At the time of final settlement	At the time of final settlement
2.2 Release method									
Standard rule for payment processing	FIFO	FIFO	FIFO	FIFO	FIFO	FIFO	FIFO	FIFO	FIFO
FIFO is always applied	N	Y	Y	N	N	Y	Y	Y	N

Comparative tables of selected large-value payment systems (cont)

Country	Belgium	Canada	France		Germany	Hong Kong			Italy
System[a]	**ELLIPS**	**LVTS**	**TBF**	**PNS**	**RTGS**[plus]	**HKD CHATS**	**USD CHATS**	**Euro CHATS**	**BI-REL**
Offsetting mechanism used as a standard settlement algorithm	N	Y[18]	Y	Y	Y	Y	N	N	Y
– type of settlement algorithm	Nap	Multilateral and bilateral optimisation	Multilateral optimisation	Bilateral optimisation	Multilateral and bilateral optimisation[19]	Multilateral optimisation	Nap	Nap	Bilateral optimisation[20]
– frequency of use	Nap	At regular intervals	Continuous	Continuous	Continuous	Once a day	Nap	Nap	Continuous
– automatic use of offsetting mechanism	Nap	Y	Y	Y	Y[21]	Y[22]	Nap	Nap	Y
Offsetting used to resolve system wide gridlock	Y	N	Y	Y	Nap[23]	N	N	N	Y[24]
– type of settlement algorithm	Multilateral optimisation	Nap	Multilateral optimisation[25]	Multilateral optimisation	Nap[23]	Nap	Nap	Nap	Multilateral optimisation
– automatic use of offsetting mechanism	Y[26]	Nap	Y	Y[27]	Nap[23]	Nap	Nap	Nap	By the system operator
2.3 Queuing arrangements									
Central queuing facility	Y	Y[18]	Y	Y	Y	Y	Y	Y	Y
Priorities of payments									
– predefined priority (number)	N	N	Y (2)	N	Y (2)	Y[28] (1)	Y[28] (1)	Y[28] (1)	Y

Comparative tables of selected large-value payment systems (cont)

Country	Belgium	Canada	France		Germany	Hong Kong			Italy
System[a]	ELLIPS	LVTS	TBF	PNS	RTGS[plus]	HKD CHATS	USD CHATS	Euro CHATS	BI-REL
– set by participants (number)	Y (9)	N	N	N	Y (2)	N	N	N	Y (2)
– possibility to change by participants	N	N	N	N	Y	N	N	N	Y
Intraday reordering of queued payments									
– by participants	N	N	N	N	Y	Y	Y	Y	Y
– by system operator	N	N	N	N	Y[29]	N	N	N	Y[29]
Revocation of queued payments									
– by participants	Y[30]	N	N	N	Y	Y	Y	Y	Y
– by system operator	Y[31]	N[32]	N	N	Y[29]	N	N	N	Y[29]
End-of-day procedure									
– rejection of unsettled payments	Y	Y	Y	Y	Y	Y	Y	Y	Y
– special procedure	Y	Y	N	Y	Y[33]	N	N	N	N
Payments can be stored for processing									
– at a specific time during the same business day (timed payments)	N	N	Y	N	Y	Y	N	N	N
– at a future value date	N	N	N	N	N	Y	Y	Y	Y[34]

Comparative tables of selected large-value payment systems (cont)

Country	Belgium	Canada	France		Germany	Hong Kong			Italy
System[a]	**ELLIPS**	**LVTS**	**TBF**	**PNS**	**RTGS^{plus}**	**HKD CHATS**	**USD CHATS**	**Euro CHATS**	**BI-REL**
2.4 Other controls or requirements									
Position limits	N	Y	N	Y	Y	N	N	N	Y
Incentives or requirements for early submission and settlement of payments	N	Y	N	Y	Y	Y	Y	Y	Y
Incentives or requirements for minimum initial/intraday balance on settlement accounts	N	N	N	Y	N	N	N	N	N
2.5 Queue visibility									
Individual amounts of incoming payments	Y[35]	Y	Y	Y	Y	Y[36]	Y[36]	Y[36]	Y
Aggregate amount of incoming payments	Y[35]	Y	Y	Y	Y	Y[36]	Y[36]	Y[36]	Y
Full payment message	Y[37]	N	Y	Y	Y	Y	Y	Y	N
Outgoing payments	Y	Y	Y	Y	Y	Y	Y	Y	Y
Account balance	Y	Y	Y	Y	Y	Y	Y	Y	Y
Payment status	Y	Y	Y	Y	Y	Y	Y	Y	Y
2.6 Communication									
Message carrier	SWIFT	SWIFT	SWIFT	SWIFT	SWIFT	Proprietary network	Proprietary network	Proprietary network	SWIFT

Comparative tables of selected large-value payment systems (cont)

Country	Belgium	Canada	France		Germany	Hong Kong			Italy
System[a]	**ELLIPS**	**LVTS**	**TBF**	**PNS**	**RTGS^{plus}**	**HKD CHATS**	**USD CHATS**	**Euro CHATS**	**BI-REL**
Message flow shape	V-shape	Y-shape	Y-shape	Y-shape	Y-shape	Y-shape	Y-shape	Y-shape	Y-shape and V-shape[38]
Additional network connection for backup purposes	Y	Y	N	N	Y	N	N	N	Y
3. Interlinkages									
3.1 Settlement of ancillary systems									
Cash leg of securities transactions	Y	Y[39]	Y	N	N[40]	Y	Y	Y	Y
– settlement mechanism[e]	DVP model 1 multiple settlement cycles a day	DVP model 2, once a day	DVP model 2, three times a day on an all-or-nothing basis	Nap	DVP model 1 and 2+3[41]	DVP model 1; DVP model 3, settled at end-of-day	DVP model 1; DVP model 3, settled at end-of-day	DVP model 1; DVP model 3, settled at end-of-day	DVP model 1; DVP model 3 (twice a day) for the SSS, overnight and daily cycles
Retail payment systems	Y	Y[39]	Y	N	N[42]	Y	Y	N	Y
– settlement mechanism	Once a day, net	Once a day, net	Once a day on an all-or-nothing basis	Nap	Gross	Once a day, net	Once a day, net	Nap	Cash multilateral balances/net, once a day
Other systems	N	N	LCH.Clearnet SA (CCP)	N	Eurex Clearing (CCP)	N	N	N	N
– settlement mechanism	Nap	Nap	Once a day[43]	Nap	Nap	Nap	Nap	Nap	Nap

Comparative tables of selected large-value payment systems (cont)

Country	Belgium	Canada	France		Germany	Hong Kong			Italy
System[a]	ELLIPS	LVTS	TBF	PNS	RTGSplus	HKD CHATS	USD CHATS	Euro CHATS	BI-REL
3.2 Real-time links to other systems									
CLS	N[44]	Y	N[44]	N	N[44]	Y	N	N	N[44]
Others	Euroclear is linked to RECOUR[45]	LVTS is linked to CDSX[46]	PNS and RGV[45]	TBF	N[45]	USD and Euro CHATS - for PVP transactions	HKD and Euro CHATS - for PVP transactions	USD and HKD CHATS - for PVP transactions	N[45]
4. Funding and credit									
Source of intraday credit[f]	CB	CB	CB	N	CB, IMM	CMA[4]	PSI	PSI	CB
Intraday transfer of funds from other systems	N	Y[46]	Y	Y[47]	N	N	Y	Y	N
Form of intraday credit provided by settlement institution	Repos, pledge	pledge, guarantee	Repos	Nap	Pledge	Repos	Uncollateralised credit, repos	Uncollateralised credit, repos	Pledge
Limits of credit provision	N	Y	N	Nap	N	N	Y	Y	N
Additional credit during the day	Y	Y	Y	Nap	Y	Nap	Y	Y	Y
Change maximum amount of credit (credit ceiling) on a daily basis	Y	Y	Y	Nap	Y	Nap	Y	Y	Y
Access to intraday credit									

Comparative tables of selected large-value payment systems (cont)

Country	**Belgium**	**Canada**	**France**		**Germany**	**Hong Kong**			**Italy**
System[a]	**ELLIPS**	**LVTS**	**TBF**	**PNS**	**RTGS**^{plus}	**HKD CHATS**	**USD CHATS**	**Euro CHATS**	**BI-REL**
– restrictions for domiciled foreign institutions	N	N	N	Nap	N	N	N	N	N
– restrictions for remote members	Y	Nap	Y	Nap	Y	Nap	N	N	Y
Types of the eligible collateral	Securities[48]	Securities	Securities, bank loans[48]	Nap	Securities, bank loans[48]	Securities	Securities	Securities	Securities[48]
Collateral denominated in foreign currency	N	N	N	Nap	N	N	Y	Y	N
Collateral located in foreign jurisdictions	Y - within the euro area[49]	N	Y - within the euro area[49]	Nap	Y[49] - within the euro area	N	N	N	Y - within the euro area[49]
Cost of intraday credit									
– interest	N	N	N	Nap	N	N	N	N	N
– haircut on collateral	Y	Y	Y	Nap	Y	Y	Y	Y	Y
Access to required minimum reserves for payment purposes	Y	Nap	Y	Nap	Y	Nap	Nap	Nap	Y
Access to prudential liquidity reserves for payment purposes	Nap	Nap	Nap	Nap	Nap	Nap	Nap	Nap	Nap
5. Fee structure									
Admission fee	Y	Y	Y	Y	N	Y	Y	Y	N
Membership fee	Y	Y	Y	Y	N	N	N	N	Y

Comparative tables of selected large-value payment systems (cont)

Country	Belgium	Canada	France		Germany	Hong Kong			Italy
System[a]	**ELLIPS**	**LVTS**	**TBF**	**PNS**	**RTGS^{plus}**	**HKD CHATS**	**USD CHATS**	**Euro CHATS**	**BI-REL**
Payment transaction fee									
– flat fee	Y	Y	Y	Y	N	Y	N	N	Y
– volume-based fee	N	N	N	N	Y	N	Y	Y	Y
– time-based fee	N	N	N	N	N	N	N	N	N
– mode of delivery	N	N	N	N	N	N	N	N	N
Communication fee	Y	Y	Y	Y	Y	N	N	N	Y

Key: Y - yes; N - no; Nap - not applicable.

General notes: [a] Data relate to end-September 2004 unless indicated otherwise. [b] B - bank(s); CB - central bank(s); CMA - central monetary authority; PA - payment association. [c] Direct participants are signatories to the set of internal contracts that govern the way in which the system is operated; they typically hold an account with the settlement institution, across which payment obligations are settled. In some systems, direct participants also exchange payment orders on behalf of indirect participants. [d] Converted at yearly average exchange rates. [e] For definitions see *Delivery versus payment in securities settlement systems,* BIS, 1992. [f] CB - central bank; PSI - private sector settlement institution; IMM - Interbank money market; N - no intraday credit facilities.

Country specific notes: [1] Non-profit corporation ELLIPS, which is owned by the direct participants, of which the National Bank of Belgium is one. [2] Canadian Payment Association. [3] Centrale des règlements interbancaires (CRI), held by the Bank of France and nine credit institutions. [4] Central Monetary Authority: Hong Kong Monetary Authority (HKMA). [5] Hongkong and Shanghai Banking Corporation (HSBC). [6] Standard Chartered Bank (Hong Kong) Limited. [7] The system operator is Hong Kong Interbank Clearing Limited (HKICL), which is a private company jointly owned by the HKMA and the Hong Kong Association of Banks. [8] Operating hours and time for acceptance of same-day transactions are synchronised within TARGET. [9] Local times are Eastern time. 00:30-06:00: LVTS is open for CLS-related payments only; 06:00-18:00: LVTS is open for general payment exchange. [10] 09:00-12:00 on Saturdays. [11] 18:00 for general payment exchange of both interbank and third-party funds transfers. The period between 18:00-18:30 (pre-settlement) is strictly reserved for interbank funds transfers intended to flatten end-of-day multilateral positions among LVTS participants. [12] For the EU countries, including national central banks or the ECB whether in their capacity as settlement agents, direct participants or otherwise. [13] At the end of 2003 the transition to new participation mode in a new version of BI-REL was in place ("duality" regime). Out of 203 formally direct participants, 85 were definite positions, 118 were in the "duality" regime. At the end of September 2004 there were only 120 direct participants in the system. [14] The following definition applies to payment systems which are TARGET components: "indirect participant" shall mean any institution without its own RTGS account which is nevertheless registered by a national RTGS system and which can be directly or indirectly (ie via a participant depending on the technical features of the system) addressed in TARGET via its own Bank Identifier Code (BIC); all transactions of an indirect participant are settled on the account of a participant (as defined in the 4th indent of Art 1.1 of the TARGET Guideline ie of a "direct participant") which has explicitly agreed to represent the indirect participant in the framework of the RTGS system. [15] The indirect participants of the USD CHATS and Euro CHATS in Hong Kong have formal contractual arrangements with the direct participants, but they have no formal contractual arrangements with the system operator/settlement institution. Indirect participants have no settlement account at the settlement institution. [16] From 28 August to 31 December 2003. [17] RECOUR is the current accounts application of the National Bank of Belgium. [18] For "jumbo" payments only (greater than CAD 100 million). [19] Algorithm 1: all-or-nothing optimisation; algorithm 2: partial optimisation; algorithm 3: multiple optimisation. [20] "One-to-many" bilateral basis. [21] In the case of specific needs additionally by the system operator. [22] For specific payments. [23] In RTGS^{plus} the offsetting mechanism is used as a standard mechanism. [24] Furthermore, FAFO (first available, first out) is applied twice a day in order to resolve gridlock. [25] There are two multilateral offsetting mechanisms in TBF: global optimisation (used continuously) and simulation of ancillary systems (for queued payments from ancillary systems). [26] By the system operator and automatically at 17:00 for customer payments and at 18:00 for interbank payments. [27] Automatically or by the system operator. [28] This refers to direct debit by the settlement institution, which has priority over other interbank payments. [29] On instruction from the sender. [30] With agreement of beneficiary bank and manual intervention of system operator. [31] On instruction from the sender

Comparative tables of selected large-value payment systems (cont)

and agreement with the beneficiary bank. [32] Although payments are not revoked at the discretion of the operator, a payment expiry algorithm is applied to queued payments at regular intervals during the general payment exchange period, and automatically revokes payments which have been in the queue for greater than 65 minutes at the time that it runs. [33] A standard procedure provided by SWIFT. [34] For some categories of payments. [35] Only for domestic payments. [36] During the last 30 minutes before system closes. [37] Only for national incoming payments and for national and international outgoing payments. [38] Y-shape for customer and interbank payments; V-shape for intrabank/interbank payments and payments sent to/received from the central bank. [39] Settlement occurs via the transfer of funds to and from the Bank of Canada using the LVTS. [40] The settlement of the securities transactions is made on the giro accounts of the Deutsche Bundesbank. [41] A mixture of DVP models 2 and 3 is used. [42] The settlement is made on the giro accounts of the Deutsche Bundesbank. [43] EURO1 pay-ins are keyed in by the operator of the system. When all payments are made to the account of EBA held at the ECB, “pay-outs” are made to participants. The settlement of Clearnet margin calls is similar to individual payments but they must be settled within a short time frame. [44] Although there is no “real-time link”, a real-time transfer is possible via EPM for all national TARGET components. To execute pay-ins and -outs from CLS Bank’s central bank accounts settlement members and CLS Bank utilise each central bank’s respective RTGS system to transfer funds. [45] A real-time transfer to/from EURO1 via EPM is possible for all national TARGET components. EURO1 settles at the end of the day. After the cut-off time, clearing banks with debit positions will pay their single obligations into the EBA settlement account through TARGET. After all amounts have been received upon the instruction from the EBA the ECB will pay the clearing banks with credit positions also through TARGET. [46] An institution participating in both the LVTS and CDSX may request a transfer of excess funds from its CDSX account to the LVTS (or vice versa) during the payment processing cycle. [47] There is no intraday credit mechanism in PNS, but intraday liquidity can be obtained in TBF and transferred immediately in PNS thanks to the real-time link. [48] Assets, included in the Eurosystem list of eligible assets. Since July 2003, eligible collateral for intraday credit has been the same as that accepted for monetary policy operation. Currently there are two lists of eligible assets referred to as: Tier-1 assets, fulfilling uniform euro area-wide eligibility criteria. These consist of marketable debt instruments issued by central banks and public sector, private sector, international and supranational institutions. Tier-2 assets are assets that are of particular importance to national financial markets and banking systems. Specific eligibility criteria are established by the national central banks, subject to the minimum eligibility criteria established by the ECB. The Tier-2 assets are: other marketable debt instruments, non-marketable debt instruments (such as bank loans) and equities traded on a regulated market. However, all assets are available to all Eurosystem counterparties, regardless of where the assets or the counterparties are situated. For more details see the ECB publication *The single monetary policy in Stage Three: General documentation on Eurosystem monetary policy instruments and procedures*, February 2004. The Governing Council has recently approved the gradual introduction of a “Single List” in the collateral framework of the Eurosystem to replace the current two-tier system of eligible collateral. As a first step it is intended to introduce a new category of previously ineligible assets (euro-denominated debt instruments issued by entities established in those G10 countries that are not part of the European Economic Area) as well as some changes in the eligibility criteria relating to some marketable debt instruments by May 2005. As a consequence, a limited number of currently eligible assets will lose their eligibility status and will be phased out over a period of 36 months. As a second step, the Governing Council has approved in principle the inclusion of bank loans as well as non-marketable retail mortgage-backed debt instruments from all euro area countries in the Single List. Finally, the Governing Council has also decided that equities shall not be included in the Single List any longer and thus will be phased out from eligibility. [49] No collateral can be settled outside the euro area, however inside the euro area the collateral can be delivered in any countries of the area and then be used on a cross-border basis.

Comparative tables of selected large-value payment systems (cont)

Country	Japan	Netherlands	Singapore	Sweden		Switzerland	United Kingdom	
System[a]	**BOJ-NET**	**TOP**	**MEPS+**	**K-RIX**	**E-RIX**	**SIC**	**CHAPS Sterling**	**CHAPS Euro**
1. Governance and structure								
Year of implementation	1988	1997	2005[1]	1990	1999	1987	1984[2]	1999
Ownership[b]	CB	CB	CMA[3]	CB	CB	B and Postfinance	B+CB[4]	B+CB[5]
Settlement agent/System operator	CB	CB	CMA	CB	CB	CB+PA[6]	CB	CB
Settlement institution	CB	CB	CMA	CB	CB	CB	CB	CB
Opening-closing time for same day transactions (local time)	09:00-19:00[7]	07:00-18:00[8]	09:00-18:30[9]	07:00-17:00	07:00-18:00[8]	17:00-16:15[10]	06:00-16:20	06:00-17:00[8]
Latest time for acceptance of same day transactions (local time)	14:00 for customer payments;[11] 19:00 for bank payments	17:00 for customer payments; 18:00 for bank payments	18:30[9]	17:00	17:00 for customer payments; 18:00 for bank payments	15:00 for customer payments; 16:00 for bank payments	16:00 for customer payments; 16:20 for bank payments	16:00 for customer payments; 17:00 for bank payments
The LVPS operator maintains an account at the central bank	Nap	Y	Nap	Nap	Nap	N	Nap	Nap
Two-tiered system	N	N	N	N	N	N	Y	Y
Number of direct participants (end 2003)[c]	371	107[12]	70[13]	13	13[12]	307[14]	13	19[12]
Number of indirect participants formally known by the system operator (end 2003)	0	49[15, 16]	0[17]	0	0[15]	0	Nap	116[15]
Annual number of transactions (2003 in thousands)	4,925	4,717	2,132[18]	1,302	93	192,700	27,215	4,292[19]

Comparative tables of selected large-value payment systems (cont)

Country	Japan	Netherlands	Singapore	Sweden		Switzerland	United Kingdom	
System[a]	**BOJ-NET**	**TOP**	**MEPS+**	**K-RIX**	**E-RIX**	**SIC**	**CHAPS Sterling**	**CHAPS Euro**
Annual value of transactions (2003 in billions of USD)[d]	161,914	24,119	5,658[18]	13,900	2,141	33,202	84,267	35,227
2. Payment process								
2.1 Finality of payments								
Type of settlement	Real-time gross[20]	Real-time gross	Real-time gross	Real-time gross	Real-time gross	Real-time gross	Real-time gross	Real-time gross
Time of final settlement	Real-time[21]	Real-time	Real-time	Real-time	Real-time	Real-time	Real-time	Real-time
Funds transfer out of the system during the day	At the time of final settlement	At the time of final settlement	At the end of the day	At the time of final settlement	At the time of final settlement	At the time of final settlement	At the time of final settlement	At the time of final settlement
2.2 Release method								
Standard rule for payment processing	FIFO	FIFO	FIFO	FIFO	FIFO	FIFO	Lowest value first[22]	Lowest value first[22]
FIFO is always applied	N[23]	Y	Y	N	N	Y	Nap	Nap
Offsetting mechanism used as a standard settlement algorithm	N	N	Y	N	N	N	N	N
– type of settlement algorithm	Nap	Nap	Bilateral offsetting	Nap	Nap	Nap	Nap	Nap
– frequency of use	Nap	Nap	Continuous	Nap	Nap	Nap	Nap	Nap
– automatic use of offsetting mechanism	Nap	Nap	Y[24]	Nap	Nap	Nap	Nap	Nap
Offsetting used to resolve system-wide gridlock	N	Y[25]	Y	N	N	Y	Y	Y
– type of settlement algorithm	Nap	Multilateral offsetting	FIFO bypass or multilateral offsetting	Nap	Nap	Bilateral offsetting	Multilateral offsetting	Multilateral offsetting

Comparative tables of selected large-value payment systems (cont)

Country	Japan	Netherlands	Singapore	Sweden		Switzerland	United Kingdom	
System[a]	**BOJ-NET**	**TOP**	**MEPS+**	**K-RIX**	**E-RIX**	**SIC**	**CHAPS Sterling**	**CHAPS Euro**
– automatic use of offsetting mechanism	Nap	Unsolvable system-wide gridlock	Y or by the system operator	Nap	Nap	Y[26]	N[27]	N[28]
2.3 Queuing arrangements								
Central queuing facility	N	Y	Y	Y	Y	Y	Y	Y
Priorities of payments								
– predefined priority (number)	Nap	Y (2)	Y (6)	N	N	Y (3)	Y	Y
– set by participants (number)	Nap	Y (3)	Y (3)	Y[29]	N	Y (5)	Y (99)	Y (99)
– possibility to change by participants	Nap	Y	Y	Y	Y	Y	Y	Y
Intraday reordering of queued payments								
– by participants	Nap	Y	Y	Y	Y	Y	Y	Y
– by system operator	Nap	Y	N	Y	Y	N	Y[30]	Y[30]
Revocation of queued payments								
– by participants	Nap	Y[31]	Y	Y	Y	Y	Y	Y
– by system operator	Nap	N	N	Y	Y	N	Y[30]	Y[30]
End-of-day procedure								
– rejection of unsettled payments	Nap	Y	Y	Y	Y	Y	Y	Y
– special procedure	Nap	N	N	N	N	N	N	N
Payments can be stored for processing								

Comparative tables of selected large-value payment systems (cont)

Country	**Japan**	**Netherlands**	**Singapore**	**Sweden**		**Switzerland**	**United Kingdom**	
System[a]	**BOJ-NET**	**TOP**	**MEPS+**	**K-RIX**	**E-RIX**	**SIC**	**CHAPS Sterling**	**CHAPS Euro**
– at a specific time during the same business day (timed payments)	Nap	Y, partly	Y	N	N	N	N	N
– at a future value date	Nap	Y	Y	N	N	Y	N	N
2.4 Other controls or requirements								
Position limits	N	N	Y	Y	Y	Y	N	N
Incentives or requirements for early submission and settlement of payments	Y	N	Y	Y	N	Y	Y	N
Incentives or requirements for minimum initial/intraday balance on settlement accounts	N	N	N	N	N	N	N	N
2.5 Queue visibility								
Individual amounts of incoming payments	Nap	Y	Y	N	N	Y	N	N
Aggregate amount of incoming payments	Nap	Y	Y	Y	N	Y	N	N
Full payment message	Nap	Y	Y	N	N	Y	N	N
Outgoing payments	Nap	Y	Y	Y	Y	Y	Y	Y
Account balance	Y[32]	Y	Y	Y	Y	Y	Y	Y
Payment status	Nap	Y	Y	Y	Y	Y	Y	Y

Comparative tables of selected large-value payment systems (cont)

Country	Japan	Netherlands	Singapore	Sweden		Switzerland	United Kingdom	
System[a]	**BOJ-NET**	**TOP**	**MEPS+**	**K-RIX**	**E-RIX**	**SIC**	**CHAPS Sterling**	**CHAPS Euro**
2.6 Communication								
Message carrier	Commercial telephone companies	SWIFT	SWIFT	SWIFT	SWIFT	Proprietary network[33]	SWIFT	SWIFT
Message flow shape	V-shape	V-shape	Y-shape	Y-shape	Y-shape	Y-shape	Y-shape	Y-shape for domestic payments, V-shape for cross-border TARGET payments
Additional network connection for backup purposes	N	N	N	Y	Y	Y	N	N
3. Interlinkages								
3.1 Settlement of ancillary systems								
Cash leg of securities transactions	Y	Y	Y	Y	Y	Y	N[34]	N[34]
– settlement mechanism[e]	DVP[35]	DVP models 1 and 3	DVP model 1	DVP[36]	DVP model 1	DVP model 1	Nap	Nap
Retail payment systems	Y	Y	Y	Y	Y	Y	Y	Y
– settlement mechanism	End-of-day, net	Every 30 minutes, net	Twice a day, multilateral net[37]	10 times a day, net	Real-time gross	At regular intervals, aggregate gross	Multilateral, net, once a day	Multilateral, net, once a day

Comparative tables of selected large-value payment systems (cont)

Country	Japan	Netherlands	Singapore	Sweden		Switzerland	United Kingdom	
System[a]	**BOJ-NET**	**TOP**	**MEPS+**	**K-RIX**	**E-RIX**	**SIC**	**CHAPS Sterling**	**CHAPS Euro**
Other systems	Derivatives; Foreign exchange transactions	Derivatives	Cash handling operations	Derivatives	Derivatives	Derivatives	Cash handling operations	
– settlement mechanism	End-of-day, net; End-of-day, net and real-time gross	Once a day, net	Real-time gross	Once a day, net	Real-time gross	DVP model 1	Real-time gross	Multilateral DNS
3.2 Real-time links to other systems								
CLS	Y	N[38]	Y	Y	N[38]	Y	Y	N[38]
Others	N	N[39]	The Central Depository (Pte) Limited	N	N[39]	N	CHAPS Euro, CREST	CHAPS Sterling, CREST[39]
4. Funding and credit								
Source of intraday credit[f]	CB, IMM[40]	CB	CB, IMM	CB, IMM	CB, IMM	CB	CB	CB
Intraday transfer of funds from other systems	N	N	N	N	Y	N	N	N
Form of intraday credit provided by settlement institution	Pledge	Pledge	Repos	Pledge	Pledge	Repos	Repos	Repos
Limits of credit provision	N	N	N	N	Y	N	N	Y
Additional credit during the day	Y	Y	Y	Y	N	Y	Y	Y
Change maximum amount of credit (credit ceiling) on a daily basis	Y	Y	Y	Y	N	Y	Y	Y

Comparative tables of selected large-value payment systems (cont)

Country	Japan	Netherlands	Singapore	Sweden		Switzerland	United Kingdom	
System[a]	**BOJ-NET**	**TOP**	**MEPS+**	**K-RIX**	**E-RIX**	**SIC**	**CHAPS Sterling**	**CHAPS Euro**
Access to intraday credit								
– restrictions for domiciled foreign institutions	N	N	N	N	N	N	N	N
– restrictions for remote members	Nap	Y	Nap	Y	Y	N	N	Y
Types of eligible collateral	Securities and loans	Securities[41]	Securities[42]	Securities and euros	Securities[41]	Securities	Securities[43]	Securities
Collateral denominated in foreign currency	N	N	N	Y	Y	Y	Y	Y
Collateral located in foreign jurisdictions	N	Y - within the euro area[44]	N	Y	Y - within the euro area[44]	Y	Y	Y
Cost of intraday credit								
– interest	N	N	N	N	N	N	N	N
– haircut on collateral	Y	Y	Y	Y	Y	Y	Y	Y
Access to required minimum reserves for payment purposes	Y	Y	Y	Nap	Nap	Y	Nap	Nap
Access to prudential liquidity reserves for payment purposes	Nap	Y	N	Nap	Nap	Y	Y	Y
5. Fee structure								
Admission fee	N	N	N	Y[45]	Y[45]	Y	Y	Y
Membership fee	N	Y	Y	Y[46]	Y	N	Y	Y
Payment transaction fee								
– flat fee	Y	N	Y	Y	N	N	Y	Y
– volume-based fee	N	Y	N	N	Y	Y	N	N

Comparative tables of selected large-value payment systems (cont)

Country	Japan	Netherlands	Singapore	Sweden		Switzerland	United Kingdom	
System[a]	**BOJ-NET**	**TOP**	**MEPS+**	**K-RIX**	**E-RIX**	**SIC**	**CHAPS Sterling**	**CHAPS Euro**
– time-based fee	N	N	Y	N	N	Y	N	N
– mode of delivery	N	Y	N	N	N	N	N	N
Communication fee	Y	Y	N	N	N	N	Y	Y

Key: Y - yes; N - no; Nap - not applicable.

General notes: [a] Data relate to end-September 2004 unless otherwise indicated. [b] B - bank(s); CB - central bank(s); CMA - central monetary authority; PA - payment association. [c] Direct participants are signatories to the set of internal contracts that govern the way in which the system is operated; and they typically hold an account with the settlement institution, across which payment obligations are settled. In some systems, direct participants also exchange payment orders on behalf of indirect participants. [d] Converted at yearly average exchange rates. [e] For definitions see *Delivery versus payment in securities settlement systems,* BIS, 1992. [f] CB - central bank; PSI - private sector settlement institution; IMM - Interbank money market; N - no intraday credit facilities.

Country specific notes: [1] MEPS will be replaced by MEPS+ in 2005. [2] CHAPS Sterling operated as a DNS system from 1984 to 1996. [3] Central Monetary Authority: Monetary Authority of Singapore. [4] The payment scheme (ie the rules and procedures of CHAPS Sterling) is owned by the CHAPS Clearing Company, which is itself owned by the CHAPS members. The payment processing infrastructure is owned by the Bank of England. [5] The payment scheme (ie the rules and procedures of CHAPS Euro) is owned by the CHAPS Clearing Company, which is itself owned by the CHAPS members. The payment processing infrastructure is owned by the Bank of England. [6] Swiss Interbank Clearing AG (SIC AG) operates the technical infrastructure and the Swiss National Bank monitors the settlement process. [7] The closing time is 19:00 for participants who make an application for an extension and 17:00 for other participants. [8] Operating hours and time for acceptance of same-day transactions are synchronised within TARGET. [9] 09:00-14:45 on Saturdays. [10] Settlement services are open from 17:00 on the previous business day to 16:15 on the value day. The system is open for input 24 hours a day. [11] With the consent of the receiver, instructions for customer payments may be entered for same day settlement until the closing time of the system. [12] For the EU countries, including national central banks or the ECB whether in their capacity as settlement institutions, direct participants or otherwise. [13] Includes CLS Bank. [14] The Swiss National Bank (SNB) enters payments on behalf of about 50 mainly foreign participants. These participants have accounts with the SNB and in SIC. They are also directly addressable in SIC, but they do not have the technical infrastructure to access the real-time information system. [15] The following definition applies to payment systems which are TARGET components: “indirect participant” shall mean any institution without its own RTGS account which is nevertheless registered by a national RTGS system and which can be directly or indirectly (ie via a participant depending on the technical features of the system) addressed in TARGET via its own Bank Identifier Code (BIC); all transactions of an indirect participant are settled on the account of a participant (as defined in the 4th indent of Art 1.1 of the TARGET Guideline, ie a “direct participant”) which has explicitly agreed to represent the indirect participant in the framework of the RTGS system. [16] The Netherlands Bank acts as correspondent bank for 49 (mostly international financial) institutions, which maintain accounts on the books of the central bank without direct access to the payment system. [17] Indirect participants are here defined as (a) having a formal contractual arrangement with the system operator/settlement institution and (b) having no settlement account at the settlement institution. [18] Data is related to MEPS. [19] Volume and value figures include domestic and outward cross-border payments. [20] BOJ-NET has an additional settlement mode called “simultaneous processing”, in which payment instructions are deferred until designated times (09:00, 13:00, 15:00, and 17:00) and then effected on a gross basis using batch processing. This settlement mode is mainly used to settle payments between the central bank and the participants, and accounts only for approximately 8% of the total value of payments handled in the system. [21] In the “simultaneous processing” mode, final settlement of all payment instructions subject to the particular cut-off time takes place when the processing for that group of payments is completed. [22] Within each priority class, payments are queued by value (lowest first). Only where two payments are identical in terms of priority and value is the FIFO rule applied. [23] See footnote 20 above. [24] Subject to payment limits imposed by the sending participant. [25] Technically, the system is able to provide multilateral net settlement in case of gridlock, upon demand from the system operator. The procedure, however, has never been used, as large gridlock situations did not materialised. [26] After 15 seconds of gridlock. [27] At discretion of system operator. [28] At discretion of system operator. [29] Possibility to prioritise CLS payments. [30] On instruction from the sender. [31] With the agreement of the counterparty. [32] The BOJ-NET does not have a central queuing function, but users can request account balance information. [33] Remote members which access through remote GATE use SWIFT for payment messages and internet for queue information messages. [34] The cash legs of securities transactions are settled on dedicated central bank settlement accounts (using a DVP model 1 arrangement). [35] DVP Model 1: BOJ-NET JGB Services (a government bonds settlement system) and Japan Securities Depository Centre (JASDEC)’s book-entry system for CP; Deferred gross settlement: Japan Bond Settlement Network (JB Net, an online network for corporate bonds settlement); DVP Model 2: JASDEC Clearing (a central counterparty for off-exchange traded stocks); DVP Model 3: Japan Securities Clearing Corporation (JSCC, a central counterparty for exchange-traded stocks). [36] Liquidity transfers to VPS (SSS) system four times a day. The settlement is made DVP in the ancillary system but in CB accounts held at VPS. [37] Once a day, multilateral net on Saturdays. [38] Although there is no “real-time link”, a real-time transfer is possible via EPM for all national TARGET components. To execute pay-ins and -outs from CLS Bank’s central bank accounts settlement members and CLS Bank utilise each central banks’ respective RTGS system to transfer funds. [39] A real-time transfer to/from EURO1 via EPM is possible for all national TARGET components. EURO1 settles at the end of the day. After the cut-off time, clearing banks with debit positions will pay their single obligations into the EBA settlement account through TARGET. After all amounts have been received, upon instruction from the EBA the ECB will pay the clearing banks with credit positions also through TARGET. [40] Use of the intraday money market is limited under the monetary policy of quantitative easing adopted in March 2001. [41] Assets, included in the Eurosystem list of eligible assets. Since July 2003, eligible collateral for intraday credit has been the same as that accepted for monetary policy operation. Currently there are two lists of eligible assets referred to as: Tier-1 assets, fulfilling uniform euro area-wide eligibility criteria. These consist of ECB debt certificates and marketable debt instruments issued by central banks and public sector, private sector, international and supranational institutions. Tier-2 assets are assets that are of particular importance to national financial markets and banking systems. Specific eligibility criteria are established by the national central banks, subject to the minimum eligibility criteria established by the ECB. The Tier-2 assets are: other marketable debt instruments, non-marketable debt instruments (such as bank loans) and equities traded on a regulated market. However, all assets are available to all Eurosystem counterparties, regardless of where the assets or the counterparties are situated. For more details see the ECB publication *The single monetary policy in Stage Three: General documentation on Eurosystem monetary policy instruments and procedures*, February 2004. The Governing Council has recently approved the gradual introduction of a "Single List" in the collateral framework of the Eurosystem to replace the current two-tier system of eligible collateral. As a first step it is intended to introduce a new category of previously ineligible assets (euro-denominated debt instruments issued by entities established in those G10 countries that are not part of the European Economic Area) as well as some changes in the eligibility criteria relating to some marketable debt instruments by May 2005. As a consequence, a limited number of currently eligible assets will lose their eligibility status and will be phased out over a period of 36 months. As a second step, the Governing Council has approved in principle the inclusion of bank loans as well as non-marketable retail mortgage-backed debt instruments from all euro area countries in the Single List. Finally, the Governing Council has also decided that equities shall not be included in the Single List any longer and thus will be phased out from eligibility. [42] Singapore government securities. [43] Government debt securities. [44] No collateral can be settled outside the euro area, however inside the euro area the collateral can be delivered in any countries of the area and then used on a cross-border basis. [45] Admission fee is paid once and counts for E-RIX and K-RIX. [46] Volume based.

Comparative tables of selected large-value payment systems (cont)

Country	United States		European Union			International	Germany/Switzerland
System[a]	**Fedwire**	**CHIPS**	**TARGET**	**EURO1**	**EPM**	**CLS**	**SECB/euroSIC**[1]
1. Governance and structure							
Year of implementation	1918	1970[2]	1999	1999	1999	2002	1999
Ownership[b]	CB	B[3]	CB[4]	B[5]	CB[6]	B[7]	B and Postfinance
Settlement agent/System operator	CB	B[3]	CB[8]	B[9]	CB[6]	B[10]	B+PA[11]
Settlement institution[c]	CB	B[12]	CB	CB	CB	SPI[13]	B[14]
Opening-closing time for same day transactions (local time)	21:00 to 18:30[15]	21:00-17:00[15]	07:00-18:00[16]	07:30-16:00	07:00-18:00[16]	07:00 and 12:00[17]	20:15 (T-1)-18:30[18]
Latest time for acceptance of same-day transactions (local time)	17:00 for foreign payments; 18:00 for customer payments; 18:30 for settlement payments	17:00	17:00 for customer payments; 18:00 for bank payments	16:00	17:00 for customer payments; 18:00 for bank payments	06:30	16:15 for customers and “domestic” bank to bank payments; 17:15 for cover and cross border payments; 17:50 for Swiss Euro Clearing Bank payments
The LVPS operator maintains an account at the central bank	Nap	Y	Nap	Y	Nap	Y[19]	N
Two-tiered system	N	N	See national TARGET components	N	N	Y	N
Number of direct participants (end 2003)[d]	7,736[20]	51	1,043[21]	714[22]	5[21]	54	117

Comparative tables of selected large-value payment systems (cont)

Country	United States		European Union			International	Germany/Switzerland
System[a]	**Fedwire**	**CHIPS**	**TARGET**	**EURO1**	**EPM**	**CLS**	**SECB/euroSIC**
Number of indirect participants formally known by the system operator (end 2003)	0	0	9,440[23]	0[24]	0[23]	2	0
Annual number of transactions (2003 in thousands)	123,300	64,500	66,608	38,852	41	20,583[25]	2,023
Annual value of transactions (2003 in billions of USD)[e]	436,706	326,561	474,993	50,501	5	221,299[26]	630
2. Payment process							
2.1 Finality of payments							
Type of settlement	Real-time gross	Real-time gross and net	Real-time gross	Deferred net	Real-time gross	Gross, PVP[27]	Real-time gross
Time of final settlement	Real-time	Real-time	See national TARGET components	End of day[28]	Real-time	Real-time	Real time
Fund transfer out of the system during the day	At the time of final settlement	End-of-day[29]	”	N	At the time of final settlement	At the time of final settlement[30]	At the time of final settlement
2.2 Release method							
Standard rule for payments processing	FIFO	CHIPS settlement algorithm	“	FIFO	FIFO	The order of the matched instruction pairs is randomised	FIFO
FIFO is always applied	Y	Nap	”	N	N	Nap	Y

Comparative tables of selected large-value payment systems (cont)

Country	United States		European Union			International	Germany/Switzerland
System[a]	**Fedwire**	**CHIPS**	**TARGET**	**EURO1**	**EPM**	**CLS**	**SECB/euroSIC**
Offsetting mechanism used as a standard settlement algorithm	N	Y	”	Y	N	N	N
– Type of settlement algorithm	Nap	CHIPS optimisation algorithm	”	Nap	Nap	Nap	Nap
– Frequency of use	Nap	Continuous	”	Continuous	Nap	Nap	Nap
– Use of offsetting mechanism automatically	Nap	Y	”	Nap	Nap	Nap	Nap
Offsetting used to resolve system wide gridlock	N	N	”	Y (to respect the system's limits)	N	Y	Y
– Type of settlement algorithm	Nap	Nap	”	Nap	Nap	Circle processing	Bilateral offsetting
– Use of offsetting mechanism automatically	Nap	Nap	”	Nap	Nap	N	Y[31]
2.3 Queuing arrangements							
Central queuing facility	N	Y	See national TARGET components	Y	Y	Y	Y
Priorities of payments							
– predefined priority (number)	N	N	”	N	Y (99)	N	Y (1)
– set by participants (number)	Nap	Y (3)	”	N	Y (98)	N	Y (5)
– possibility to change by participants	Nap	Y	”	N	Y	N	Y

Comparative tables of selected large-value payment systems (cont)

Country	United States		European Union			International	Germany/Switzerland
System[a]	**Fedwire**	**CHIPS**	**TARGET**	**EURO1**	**EPM**	**CLS**	**SECB/euroSIC**
Intraday re-ordering of queued payments							
– by participants	Nap	Y	”	N	Y	N	Y
– by system operator	Nap	N	”	N	N	N	N
Revocation of queued payments							
– by participants	Nap	Y	”	N	Y	Y	Y
– by system operator	Y[32]	Y	”	N	Y	N	N
End-of-day procedure							
– rejection of unsettled payments	N	N	”	Y	Y	Y	Y
– special procedure	Y	Y[33]	”	N	N	N	N
Payments can be stored for processing							
– at a specific time during the same business day (timed payments)	Nap	N	”	N	N	N	N
– at a future value date	N	N	”	Y	Y	Y	Y
2.4 Other controls or requirements							
Position limits	N	Y	See national TARGET components	Nap	Y	Y	N
Incentives or requirements for early submission and settlement of payments	N[34]	Y	N	Y	N	Y	Y

Comparative tables of selected large-value payment systems (cont)

Country	United States		European Union			International	Germany/Switzerland
System[a]	**Fedwire**	**CHIPS**	**TARGET**	**EURO1**	**EPM**	**CLS**	**SECB/euroSIC**
Incentives or requirements for minimum initial/intraday balance on settlement accounts	N	Y	N	N	N	Y	N
2.5 Queue visibility							
Individual amounts of incoming payments	Nap	Y	See national TARGET components	Y	N	Y	Y
Aggregate amount of incoming payments	Nap	Y	”	N	N	Y	Y
Full payment message	Nap	N	”	Y	N	Y	Y
Outgoing payments	Nap	Y	”	Y	Y	Y	Y
Account balance	Y	Y	”	Y	Y	Y	Y
Payment status	Y	Y	”	Y	Y	Y	Y
2.6 Communication							
Message carrier	Proprietary network	Proprietary network	SWIFT for TARGET interlinking. See national TARGET components for domestic network	SWIFT	SWIFT	SWIFT	Proprietary network[35]

Comparative tables of selected large-value payment systems (cont)

Country	United States		European Union			International	Germany/Switzerland
System[a]	**Fedwire**	**CHIPS**	**TARGET**	**EURO1**	**EPM**	**CLS**	**SECB/euroSIC**
Message flow shape	V-shape	V-shape	V-shape for cross-border TARGET payments. See national TARGET components for intra-member state payments	Y-shape	V-shape	V-shape	V-shape
Additional network connection for backup purposes	Y	Y	See national TARGET components.	Y	Y	N[36]	N
3. Inter-linkages							
3.1 Settlement of ancillary systems							
Cash leg of securities transactions	Y	N	“		Nap	Nap	Y
– settlement mechanism[f]	DVP model 1	Nap	”		Nap	Nap	DVP model 1
Retail payment systems	Y	N	”	STEP 1 and STEP 2	N	N	N
– settlement mechanism	Nap	Nap	”	Once a day, gross settlement	Nap	Nap	Nap
Other systems	Cash services	N	”	N	N	Nap	N
– settlement mechanism	Several times a day	Nap	”	N	Nap	Nap	Nap

Comparative tables of selected large-value payment systems (cont)

Country	United States		European Union			International	Germany/Switzerland
System[a]	**Fedwire**	**CHIPS**	**TARGET**	**EURO1**	**EPM**	**CLS**	**SECB/euroSIC**
3.2 Real-time links to other systems							
CLS	Y, PVP	N	N[37]	N	Y	Nap	N
Others	CHIPS, Depository Trust Company	N	N[38]	TARGET	EBA/Euro1	Y[39]	N[40]
4. Funding and credit							
Source of intraday credit[g]	CB	N	CB	N	N	N	B[14]
Intraday transfer of funds from other systems	N	Y[41]	See national TARGET components	N	N	Y[42]	N
Form of intraday credit provided by settlement institution	Uncollateralised credit, pledge	Nap	Repos, pledge[43]	Nap	Nap	Nap	Pledge
Limits of credit provision	Y	Nap	See national TARGET components	Nap	Nap	Nap	N
Additional credit during the day	N	Nap	Y	Nap	N	Nap	N
Change maximum amount of credit (credit ceiling) on a daily basis	N[44]	Nap	Y	Nap	N	Nap	N
Access to intraday credit							
– restrictions for domiciled foreign institutions	Y	Nap	N	Nap	Nap	Nap	N
– restrictions for remote members	Nap	Nap	Y	Nap	Nap	Nap	N

Comparative tables of selected large-value payment systems (cont)

Country	United States		European Union			International	Germany/Switzerland
System[a]	**Fedwire**	**CHIPS**	**TARGET**	**EURO1**	**EPM**	**CLS**	**SECB/euroSIC**
Types of the eligible collateral	Securities and customer obligations[45]	Nap	See also national TARGET components[46]	Nap	Nap	Nap	Securities
Collateral denominated in foreign currency	Y[47]	Nap	N	Nap	Nap	Nap	N
Collateral located in foreign jurisdictions	Y	Nap	Y - within the euro area[48]	Nap	Nap	Nap	N
Cost of intraday credit							
– interest	Y	Nap	N	Nap	Nap	Nap	N
– haircut on collateral	Y	Nap	Y	Nap	Nap	Nap	Y
Access to required minimum reserves for payment purposes	Y	Nap	Y	Nap	Nap	Nap	N
Access to prudential liquidity reserves for payment purposes	Nap	Nap	Nap	Nap	Nap	Nap	Y
5. Fee structure							
Admission fee	N	Y	See national TARGET components for domestic fees, N for cross-border	Y	N	Y	Y
Membership fee	N	Y	”	Y	N	Y	Y
Payment transaction fee							
– flat fee	N	Y	”	N	N	Y	N
– volume-based fee	Y	N	”	Y	Y	N	Y
– time-based fee	N	N	N	N	N	N	Y
– mode of delivery	Y	N	”	N	N	N	Y
Communication fee	Y	Y	”	Y	N	Y	Y

Comparative tables of selected large-value payment systems (cont)

Key: Y - yes; N - no; Nap - not applicable.

General notes: [a] Data relate to end-September 2004 unless indicated otherwise. [b] B - bank(s); CB - central bank(s); PA - payment association. [c] SPI - special purpose institution. [d] Direct participants are signatories to the set of internal contracts that govern the way in which the system is operated; they typically hold an account with the settlement institution, across which payment obligations are settled. In some systems, direct participants also exchange payment orders on behalf of indirect participants. [e] Converted at yearly average exchange rates. [f] For definitions see *Delivery versus payment in securities settlement systems,* BIS, 1992. [g] CB - central bank; PSI - private sector settlement institution; IMM - interbank money market; N - no intraday credit facilities.

Country specific notes: [1] SECB/euroSIC can be classified as a payment system or a “quasi system”/correspondent bank. [2] In January 2001, CHIPCo converted CHIPS from an end-of-day, multilateral net settlement system to one that provides real-time final settlement. [3] The Clearing House Interbank Payments Company LLC (CHIPCo). [4] The Eurosystem, consisting of the European Central Bank (ECB) and the 12 national central banks that have adopted the euro. [5] Shareholders of the EBA Clearing Company. [6] The ECB. [7] CLS Group Holdings AG. [8] The ECB plus 15 participating NCBs. [9] EBA Clearing Company. [10] CLS Bank International; most of the processing is contracted out to CLS Services Ltd. [11] Swiss Interbank Clearing AG (SIC AG), which is located in Switzerland, operates the technical infrastructure and the SECB Swiss Euro Clearing Bank GmbH monitors the settlement process. [12] CHIPS settles payments with finality through participants’ positions on its books. [13] CLS Bank International. [14] The settlement institution, SECB Swiss Euro Clearing Bank GmbH, has a full banking licence under German law. The SECB has the responsibility to monitor and control euroSIC and to manage system liquidity. [15] The opening time is 21:00 on the previous business day for electronically originated funds transfers (local times are Eastern time). [16] Operating hours and time for acceptance of same day transactions are synchronised within TARGET. [17] Local times are Central European Time. [18] The opening time is 20:15 on the previous business day (T-1). The closing time is 18:30 of the value day. [19] CLS Bank maintains an account at each of the central banks whose currencies it settles. [20] Number of depository institutions that used the Fedwire Funds Transfer Service in 2003. Other Fedwire Funds Transfer participants not included here are: the US Treasury and any entity specifically authorised by federal statute to use the Reserve Banks as fiscal agents or depositories; entities designated by the Secretary of the Treasury; foreign central banks, foreign monetary authorities, foreign governments and certain international organisations. [21] For the EU countries, including national central banks or the ECB whether in their capacity as settlement agents, direct participants or otherwise. [22] The direct participants of EURO1 do not have accounts with the settlement institution, which is the ECB. Instead they settle their payment obligations vis-à-vis EURO1 by paying/receiving - using their accounts with their national central banks - to/from the account of EURO1 at the ECB where the settlement takes place. [23] The following definition applies to payment systems which are TARGET components: “indirect participant” shall mean any institution without its own RTGS account which is nevertheless registered by a national RTGS system and which can be directly or indirectly (ie via a participant depending on the technical features of the system) addressed in TARGET via its own Bank Identifier Code (BIC); all transactions of an indirect participant are settled on the account of a participant (as defined in the 4th indent of Art 1.1 of the TARGET Guideline, ie a “direct participant”) which has explicitly agreed to represent the indirect participant in the framework of the RTGS system. [24] There are directly addressable participants. [25] The data for CLS are based on the aggregation of both sides of a foreign exchange transaction. [26] Total gross value, including inside/outside swaps. [27] CLS settles matched pairs. [28] After cut-off, usually around 16:30. [29] For primary CHIPS positions. Participants are able to withdraw funds intraday from their supplemental position, subject to the certain limits. [30] CLS Bank makes payouts throughout the settlement period consistent with risk management controls. [31] After 15 seconds of gridlock. [32] Payment transactions over the Federal Reserve’s Fedwire Funds Service are governed by the Federal Reserve’s Regulation J, which incorporates the requirements of Article 4A of the UCC. Under subpart B of Regulation J, a Federal Reserve Bank may reject, or impose conditions that must be satisfied before it will accept, a payment order for any reason. Under subpart B of Regulation J and Operating Circular 6 each Fedwire participant is required to enter into a security procedures agreement with its Federal Reserve Bank. An institution sending payment orders to a Federal Reserve Bank is also required to have sufficient funds, either in the form of account balances held at the Federal Reserve or overdraft capacity. [33] Queued payments are tallied on a multilateral net basis. [34] There are no specific incentives or requirements for early submission and settlement of payments; however, to the extent a participant uses Federal Reserve intraday credit, there is some economic incentive to manage the use of this credit given that it is priced. [35] Remote members which gain access through remote GATE use SWIFT for payment messages and the internet for queue information messages. [36] Contingency arrangements have been made with SWIFT. [37] Although there is no “real-time link”, a real-time transfer is possible via EPM for all national TARGET components. To execute pay-ins and -outs from CLS Bank’s central bank accounts settlement members and CLS Bank utilise each central banks’ respective RTGS system to transfer funds. [38] No real-time “link” but via EPM a real-time transfer to/from EURO1 is possible for all national TARGET components. EURO1 settles at the end of the day. After the cut-off time, clearing banks with debit positions will pay their single obligations into the EBA settlement account through TARGET. After all amounts have been received, upon instruction from the EBA the ECB will pay the clearing banks with credit positions also through TARGET. [39] With national LVPS of countries whose currency is settled, through CB accounts. [40] The settlement institution (SECB) is a direct participant in RTGS[plus] and holds an account with the Deutsche Bundesbank. [41] Intraday credit can be obtained in Fedwire and transferred to CHIPS. [42] CLS participants can obtain intraday credit from their national central banks and transfer the fund to CLS. [43] Depends on national LVPS. [44] Caps do not typically change on a daily basis; however, institutions may apply for higher net debit caps at any time. Those institutions which have maximum caps must post collateral to benefit from the collateralised portion of their cap. The value of this collateral is checked daily and, as a result of fluctuations in the collateral value, the cap may change on a daily basis. [45] The categories of eligible collateral are: US Treasuries and Fully Guaranteed Agencies, Government Sponsored Enterprises, International Agencies, Brady Bonds, Foreign Governments, German Jumbo Pfandbriefe, Municipal Bonds, Corporate Bonds, Asset-Backed Securities, Commercial Mortgage-Backed Securities, Mortgage-Backed Securities, Collateralized Mortgage Obligations, Trust Preferred Securities, Mutual Funds, Government Sponsored Enterprise Stock, Bankers Acceptances, Certificates of Deposit, Commercial Paper, Commercial and Agricultural Loans, Agency Guaranteed Loans, Commercial Real Estate Loans, Construction Real Estate Loans, 104 Family Residential Mortgages, Home Equity, Consumer Loans, and Raw Land. Additional information is available at www.frbdiscountwindow.org. [46] Assets, included in the Eurosystem list of eligible assets. Since July 2003, eligible collateral for intraday credit has been the same as that accepted for monetary

Comparative tables of selected large-value payment systems (cont)

policy operation. Currently there are two lists of eligible assets referred to as: Tier-1 assets, fulfilling uniform euro area-wide eligibility criteria. These consist of ECB debt certificates and marketable debt instruments issued by central banks and public sector, private sector, international and supranational institutions. Tier-2 assets are assets that are of particular importance to national financial markets and banking systems. Specific eligibility criteria are established by the national central banks, subject to the minimum eligibility criteria established by the ECB. The Tier-2 assets are: other marketable debt instruments, non-marketable debt instruments (such as bank loans) and equities traded on a regulated market. However, all assets are available to all Eurosystem counterparties, regardless of where the assets or the counterparties were situated. For more details see the ECB publication *The single monetary policy in Stage Three: General documentation on Eurosystem monetary policy instruments and procedures*, February 2004. The Governing Council has recently approved the gradual introduction of a “Single List” in the collateral framework of the Eurosystem to replace the current two-tier system of eligible collateral. As a first step it is intended to introduce a new category of previously ineligible assets (euro-denominated debt instruments issued by entities established in those G10 countries that are not part of the European Economic Area) as well as some changes in the eligibility criteria relating to some marketable debt instruments by May 2005. As a consequence, a limited number of currently eligible assets will lose their eligibility status and will be phased out over a period of 36 months. As a second step, the Governing Council has approved in principle the inclusion of bank loans as well as non-marketable retail mortgage-backed debt instruments from all euro area countries in the Single List. Finally, the Governing Council has also decided that equities shall not be included in the Single List any longer and thus will be phased out from eligibility. [47] All foreign currency denominated collateral is currently held at Euroclear or Clearstream. Prior to establishing either pledging arrangement, a depository institution will need to provide the Federal Reserve Bank of New York (FRBNY) with a legally enforceable security interest in the pledged securities. This may require that a depository institution provide the FRBNY with a legal opinion from counsel satisfactory to the FRBNY. It will also require execution by all relevant parties of the necessary pledging agreements, the forms of which have already been negotiated by the FRBNY, Euroclear, and Clearstream [48] No collateral can be settled outside the euro area; however, inside the euro area the collateral can be delivered in any countries of the area and then be used on a cross-border basis.

Annex 3:
The LVPS efficient frontier

The process of settling large-value payments is neither free of risk nor costless. Against this background, it has long been recognised that a key factor influencing the way in which LVPS are designed and operated is the need to ensure that overall levels of both risk and cost within the payment system itself are suitably well controlled. By keeping total costs low, an LVPS allows financial institutions to settle payment obligations as cheaply as possible. However, it is usually the case that lower costs cannot be achieved without introducing additional risk exposures; therefore, LVPS designers typically face a trade-off between overall levels of risk and cost. Moreover, this trade-off is multi-dimensional in the sense that it is often possible for one source of risk/cost to be reduced at the expense of an increase in another source of risk/cost.

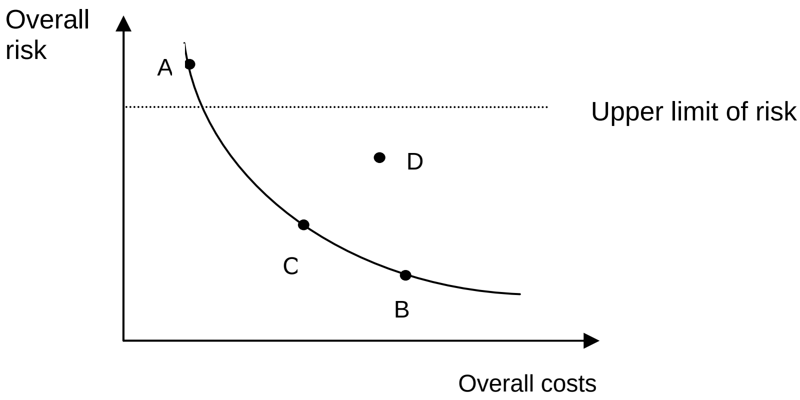
The presence of this type of complex, multi-dimensional trade-off is reflected in the multitude of ways in which LVPS designs can (and do) differ. The wide range of possibilities available shows that the risk-cost preferences of system owners are crucial to determining the way in which an LVPS is designed; there is no one solution that will suit all markets and all parties in a given market. In particular, it is likely that central banks will place greater emphasis on achieving lower overall levels of risk than the users of an LVPS, reflecting their focus on the system-wide impact of risk as opposed to the risks faced by individual participants.

The basic risk-cost trade-off

In order to achieve the best possible cost-risk combination outcome, an LVPS should be designed with a view to minimising total costs for a chosen overall level of risk (or vice versa). The set of system designs that satisfy this objective serve to define the *LVPS efficient frontier*, as illustrated by Figure A1.

Figure A1

The LVPS efficient frontier



In Figure A1, all points above the efficient frontier are feasible risk-cost combinations, but only those points actually on the frontier itself represent efficient outcomes. Points A, B and C are examples of such efficient solutions. While all points on the frontier may be “efficient”, not all of them might be acceptable from the overseer’s point of view. For example, Point A exceeds the maximum level of risk that the overseer is willing to accept in the LVPS. This upper limit of overall risk is depicted by the dashed horizontal line. Point D can be considered to be an inefficient system, since overall risk could be reduced at a given level of costs and vice versa.

Perhaps the most well recognised type of risk-cost trade-off relevant to LVPS design is that arising from the inverse relationship between the level of settlement risk in an LVPS and overall liquidity costs. In an unprotected DNS system, for example, liquidity requirements are minimised but there are also likely to be large-scale credit exposures between direct participants. These exposures reflect the high degree of settlement risk typically associated with such systems, a risk that arises as a result of the mutual dependency amongst each and every payment submitted during a particular settlement cycle. In contrast, an RTGS system with no central queue eliminates settlement risk payment by payment, but imposes correspondingly large liquidity requirements upon its members. Many of the LVPS described in this report lie at intermediate points along this risk-cost trade-off.

There are, however, a number of other areas in which a trade-off between risk and cost in an LVPS may emerge. For example, the resilience of an LVPS to operational disruption can be improved by implementing more extensive, but necessarily costly, business continuity arrangements; this mechanism introduces a trade-off between operational risk and development (and possibly also operational) costs. Similarly, there may be a relationship between settlement delay and the financial resources devoted to designing and operating an LVPS capable of achieving very high settlement speeds.

It is also possible for trade-offs to emerge between different sources of risks and different sources of costs in an LVPS. One notable example, discussed in Chapter 3.1, is that there are circumstances under which the behaviour of direct participants can create a trade-off between the conditions imposed as precursors to settlement and settlement delay. It is even possible for participants' behaviour to move a system to an inefficient outcome off the efficient frontier, even though a point on the frontier is technically feasible.

Furthermore, extensive simulation-based analysis (undertaken by a number of central banks using payment flow data from different LVPS) has shown the existence of an inverse relationship between the extent of delays to the settlement of individual payments and the amount of liquidity available in the system concerned. Under the standard assumption that there is a positive marginal cost of liquidity, this immediately implies the existence of a trade-off between liquidity costs and risks arising from settlement delay in an LVPS.

The consequence of these trade-offs between sources of risk and cost is to make the LVPS efficient frontier multi-dimensional; the frontier illustrated in Figure A1 therefore represents a simplification of the considerably more complex interrelationships that exist between the different sources of the costs and risks inherent to LVPS. Nevertheless, a two-dimensional representation of the efficient frontier provides a useful means of illustrating intuitively the way in which the designers of LVPS must recognise the fundamental risk-cost trade-off.

Shifts in the efficient frontier

The precise position and shape of the LVPS efficient frontier is influenced by a range of factors beyond the control of the LVPS designer. To a large extent, these factors coincide with those described in Chapter 2 of this report - legal arrangements, regulatory requirements, technological advancement and the structure of the banking sector all contribute to influencing the scale and incidence of particular sources of risk or cost in an LVPS, and therefore affect the efficient frontier. There are, however, certain external factors (notably central bank oversight and the competitive environment) that can affect where on the efficient frontier a system chooses to situate itself.

Shifts in the position or shape of the efficient frontier therefore reflect a change in one (or more) of these external factors. For example, a change to the legal environment such that the point of finality is more robustly defined would serve to reduce legal risk and therefore move the frontier vertically downwards. Amendments to institutional arrangements for the regulation of financial institutions' liquidity may influence the cost of liquidity (via the opportunity cost of collateral), precipitating a horizontal shift in the frontier. And perhaps most significantly, technological progress may broaden the range of technically feasible system designs such that the efficient frontier moves closer to the origin over time in Figure A1.

Annex 4:
A framework for cost accounting in LVPS

This annex sets out one possible framework for determining the costs of establishing and operating an LVPS. It is intended to be illustrative rather than prescriptive.

Considerations for the cost categories

LVPS costs can be classified into the following cost groups: investment (development) costs, operational costs, overhead costs and capital (financing) costs. In the following sections, the different cost groups are discussed in more detail.

Investment costs

Costs related to the initial development of an LVPS are classified as investment (development) costs. Any subsequent enhancements of the system components (hardware and software) are also classified as investment (development) costs. Investment costs can be sub-divided into (at least) the following cost items:

Staff costs: include the costs (salaries, allowances, contributions to social security and pension schemes) for staff members developing, carrying out initial testing and/or implementing new hardware, software and telecommunication devices for any system components. The costs for business analysts involved in projects are also included.

Hardware costs: include the costs for the purchase of system-related hardware components and their implementation/installation and initial testing by external staff.

Software costs: include the costs for the purchase of software from external software providers as well as the implementation/installation and initial testing of the software and staff training by the provider or other external staff.

Telecommunication costs: include the costs for the purchase of the interfaces between the payment system and external parties (direct participants and ancillary systems), and the interfaces between the LVPS system and the central bank's other internal systems (accounting system, collateral management, etc). Implementation/initial testing by external staff is also considered.

Other costs: include the costs directly related to specific technical areas (building and basic technical infrastructure). This can be the relative share of costs for the local IT centre, a backup centre or a disaster standby site.

Operational costs

Operational costs include all expenses related to the operation and maintenance of the LVPS (including regular testing activities). Operating the LVPS is understood as running the system in a technical sense and managing it by defining access conditions, pricing policy, etc. Based on this definition, operational costs can be sub-divided into the following cost items:

Operational staff costs: include the costs (salaries, allowances, contributions to social security and pension schemes) for staff members operating and monitoring the LVPS components, business analysts and policy experts preparing decisions concerning the management of the system, staff members providing support functions and managers.

IT staff costs: include the costs (salaries, allowances, contributions to social security and pension schemes) for staff members involved in the regular testing, operation and maintenance of the payment system components (hardware and software), independent of the organisational unit to which the staff members belong.

Hardware costs: include the costs for the leasing or the purchase of equipment necessary for the operation, maintenance and regular testing of the system components which have not been entered on the assets side.

Software costs: include the costs for software licences/leasing and, if applicable, the purchase of software, as well as maintenance fees charged by external software service providers or the maintenance costs of supporting internal software.

Telecommunication costs: include all costs related to communication (payment messages and other payment system-related information) between the LVPS and, on the one hand, external parties (direct participants and ancillary systems) and, on the other hand, the central bank's other internal systems (accounting system, collateral management, etc). Telecommunication costs can be further sub-divided into: costs for the maintenance of interfaces, costs for the leasing of telecommunication lines and related equipment and message costs.

Overhead costs

Overhead costs include expenses that occur in the organisational units providing services or support to those units in the payments and/or the IT departments that are in charge of developing and operating the LVPS. The calculation of the overhead costs includes two main issues: first, the identification of the overhead areas and second, the allocation of an appropriate share of the costs of these overhead areas to the payment system. For the calculation of total overhead costs, a distinction between *local overheads* and *global overheads* is made.

Local overhead costs: include all costs related to payment systems which cannot be directly allocated to LVPS activities. They include part of the costs for secretarial and managerial staff of the payment systems department. With regard to the latter, only the costs for managers above the level of the organisational unit directly responsible for the development and operation of the LVPS should be taken into account, if the costs for the managers of this organisational unit will be directly allocated to the LVPS (eg as part of operational costs). A part of the depreciation, maintenance and running costs for office equipment of the payment systems department is also included.

IT overheads include the costs for all IT activities which cannot be directly related to the output activities of the IT department. Examples are the internal IT support activities such as data security management, capacity management, depreciation of security software, secretarial staff, depreciation and maintenance of office equipment as well as managers above the level of the units directly responsible for the development and operation of the payment system and general operating expenditure allocated to the IT department and not directly allocable to the output activities of the department.

Global overhead costs: The administration, personnel and payroll division includes the organisational units in charge of general accounting, central secretarial functions, travel services, post and messenger services, photocopying services and switchboard. This division also includes training/staff development and similar organisational units.

Construction costs include building services and general security support functions costs related to the LVPS. All building-related costs such as rent, cleaning, insurance, electricity and mechanical installations are taken into account as general overheads and allocated in an appropriate share to the LVPS. Building investments in technical areas incorporated "in other investment costs" should be excluded.

Other global overheads: include costs related to the LVPS that are incurred by the publication and public relations division, audit division, organisational planning and controlling divisions, procurement division, legal division and archives division.

Capital costs

Capital costs for committed resources represent the return that could have been earned if the resources were invested elsewhere, either in another project or in financial markets. How to calculate such an opportunity cost for the capital is not straightforward. A reasonable approach is to develop a method that is at least comparable to standard practices in the economy generally.

Annex 5:
Members of the CPSS

This report was produced by the Committee on Payment and Settlement Systems, whose members are listed below.

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Annex 6:
Members of the working group

In producing this report, the Committee on Payment and Settlement Systems was greatly assisted by the working group it set up, whose members are listed below.

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Significant contributions were also made by Masayuki Mizuno (Bank of Japan), Chua Yeon Lee Nelson (Monetary Authority of Singapore) and Morten Bech (Federal Reserve Bank of New York).