A Primer on Canada's Large Value Transfer System

Abstract

This paper provides a comprehensive overview of Canada's Large Value Transfer System (LVTS). The LVTS is a real-time electronic system for handling large-value payments and is an integral component of the country's financial system. Each day, approximately Can$140 billion in payments is sent through the LVTS, including payments used to settle other important clearing and settlement systems in Canada. The paper explains how the design of the LVTS, including its risk-control framework, collateral arrangements, and loss-allocation procedures in the event of participant default, exceeds the risk-containment requirements of the international Core Principles for Systemically Important Payments Systems. At the same time, the LVTS offers a more cost-efficient means of sending payments relative to standard Real-time Gross Settlement arrangements. This is facilitated by the availability of several liquidity-saving features, each of which is described. The paper also discusses the linkage between the LVTS and the daily implementation of Canadian monetary policy. Details of LVTS ownership and participation are also outlined.

A Primer on Canada's Large Value Transfer System

by

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BANK OF CANADA

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1.0 Introduction and Brief Overview of the LVTS

This paper describes the Large Value Transfer System (LVTS), Canada's real time electronic system for processing large-value payments.[1] This system is used by participating financial institutions to discharge payment obligations on behalf of their own business and that of their clients. The LVTS, which began operations on 4 February 1999, is an integral component of the Canadian financial system since it is used to settle approximately $140 billion in payments each day. Certain of these payments are time-sensitive, because the LVTS is used to settle final funds positions in other important clearing and settlement systems in Canada, such as that for securities and also the Canadian dollar leg of foreign exchange transactions. The LVTS also serves as the primary environment for the daily implementation of Canadian monetary policy.[2]

Payments are processed by the LVTS with finality in real time, while settlement of the system occurs on a multilateral net basis at the end of the payments cycle; i.e., end-of-day.[3] Immediate intraday finality is achieved because settlement of the LVTS is guaranteed under all circumstances. This is facilitated by use of collateral to secure participants' intraday net debit (negative) positions and also by a residual guarantee provided by the Bank of Canada. At any time during the payments cycle, there is sufficient collateral apportioned to the LVTS by participants to cover the largest possible net debit position of any participant. In the event of a participant default, this collateral will be used to secure the defaulter's LVTS settlement obligation, thus allowing the system to settle. If multiple participants default on their end-of-day LVTS settlement obligation, and collateral apportioned to the system is insufficient to cover the total value of the defaulting participants' settlement obligations, the Bank of Canada will realize on available collateral and become an unsecured creditor of the defaulting institutions for the residual amount. Certainty of settlement reduces risk for participants in the system, most importantly systemic risk, which is defined here as the risk that the failure of one participant to meet its LVTS settlement obligation could lead to the failure of another participant to meet its obligation.

The LVTS contains two payment streams—Tranche 1 (T1) and Tranche 2 (T2)—and each of these streams has its own collateral requirements and loss-sharing arrangements in the event of participant default. Participants may use either stream to send payments through the system. Real time risk-controls are applied to submitted payments in each tranche. In T1, participants may not incur a multilateral T1 net debit position that exceeds their Tranche 1 Net Debit Cap (T1NDC) when sending payments through the system. Participants determine the value of their T1NDC by apportioning eligible collateral equal

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[1] The LVTS is a 'credit-push' system, meaning that payment messages are initiated by the payor and move from the payor's bank to the beneficiary's bank. Despite the term 'large-value,' there is no minimum limit on the individual value of payments sent through the LVTS. For a more general overview of the LVTS, please see Dingle (1998) and Roach (2003).

[2] See Howard (2005) for a discussion of how monetary policy is implemented in the LVTS environment.

[3] Payment finality is achieved when a payment sent from one participant to another cannot be revoked or unwound under any circumstances, as in the case of participant insolvency.

to the full amount of this limit. Thus, T1 is referred to as a 'defaulter-pays' payment stream.

In T2, bilateral and multilateral net debit caps are employed. Participants grant bilateral credit limits (BCLs) to each other, where the grantee of a BCL cannot incur a bilateral T2 net debit position vis-à-vis the grantor that exceeds the value of this limit when sending payments. A participant's Tranche 2 Net Debit Cap (T2NDC) is calculated as the sum of all BCLs granted to it, multiplied by a system-wide percentage (SWP), which is currently equal to 0.24.[4] It follows that a participant cannot incur a multilateral T2 net debit position that exceeds the value of its T2NDC. In T2, a 'survivors-pay' collateral pool is used to facilitate settlement of the LVTS in the event of a participant default.[5] Participants must apportion collateral equal to the largest BCL that they extend to any other participant, multiplied by the SWP. This results in there always being sufficient T2 collateral value apportioned to the LVTS to cover the largest possible T2 net debit position of any participant. The T2 payment stream clearly economizes on collateral use relative to the T1 stream, and thus is the dominant payment stream for daily LVTS activity.[6]

In addition to the utilization of a survivors-pay collateral pool in T2, the LVTS employs other types of collateral cost-saving features. For example, payments unable to pass the real time risk controls will, if characterized as Jumbo payments,[7] enter a central queue, where multilateral offsetting of queued payments is attempted at frequent intervals throughout the payments cycle. This essentially lowers participants' funding requirements for the release of these payments from the queue and increases the speed at which they are processed by the LVTS. Throughput guidelines are also in place to encourage the smooth flow of payments between participants during the day, thus lowering the potential for liquidity problems in the system. These and additional collateral cost-saving features are discussed in Section 7. The design of the LVTS embodies the primary public policy objectives of safety and efficiency. The availability of these collateral cost-saving features provides participants with a cost-effective means of sending payments. At the same time, the LVTS meets or exceeds international standards for the containment of systemic risk, as described above.

The Bank of Canada maintains many roles with respect to the LVTS. Under the Payment Clearing and Settlement Act (PCSA 1996), the Bank is charged with formal oversight

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[4] The system-wide percentage is established by the General Manager of the CPA in consultation with the LVTS Management Committee. The value of the percentage was 0.30 when the LVTS began operations in February 1999 and was gradually reduced to its current value of 0.24, which took effect on 16 March 2000. For more details, please see LVTS Rule No. 2 available on the CPA website at < www.cdnpay.ca >.

[5] In the event of a participant default, the losses of surviving participants are determined based on the BCL they have granted to the defaulter. That is, a participant's loss-allocation is proportional to the BCL it has provided to the defaulter relative to the sum of all BCLs provided to the defaulter. See Section 6.4 for more details.

[6] On a typical day, approximately 85-90 per cent of LVTS value is sent through the T2 payment stream.

[7] The term 'Jumbo' applies to payments with values surpassing a minimum threshold that is determined by participants themselves. See Section 7.2.1 for more information.

responsibility of the LVTS with a view to controlling systemic risk.[8] In this capacity, the Bank oversees that the LVTS remains in compliance with international Core Principles for Systemically Important Payment Systems (SIPS).[9] The Bank is also the settlement institution for the LVTS, providing settlement accounts to participants and executing settlement of the system by transferring claims on itself between these accounts based on participants' end-of-day positions. The Bank also provides collateralized overnight advances to participants should they need these funds to cover their LVTS settlement obligation. In addition, the Bank performs several functions concerning collateral in the LVTS. Finally, the Bank is a participant in the system, sending payments on its own behalf and on behalf of its clients, which include the Government of Canada.

2.0 Development and Purpose of the LVTS
2.1 The LVTS: Motivation for Development
Prior to the implementation of the LVTS, large-value payments in Canada were processed through the Interbank International Payment System (IIPS).[10] Payments sent through the IIPS were ultimately settled in the Automated Clearing Settlement System (ACSS) by way of a paper debit.[11] By the time the LVTS was developed in February 1999, large-value payments comprised approximately 90 per cent of all daily payment value settled by the ACSS on average.[12]

The ACSS, which still settles most domestic retail and paper items, as well as smaller-value electronic payments, is an uncollateralized deferred net settlement (DNS) system.[13] Settlement of payments in this system takes place one business day following clearing, meaning that participants implicitly grant each other unsecured overnight credit. Moreover, participants have no way to manage the size of this credit provision or to which institutions this credit is being extended. In the pre-LVTS environment, the time gap between the clearing and settlement of large-value payments, coupled with the increasing value and volume of these payments, meant that participants were exposed to

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[8] In addition to granting formal oversight responsibility to the Bank of Canada, the PCSA contains provisions that, when combined with federal insolvency legislation, provide virtual certainty with regard to the legal enforceability of netting in the LVTS. The PCSA also contains provisions that make the LVTS's settlement rules immune to legal stays or other legal challenges, even in the event of participant failure. The PCSA increases the certainty that the legal arrangements governing the operations of the LVTS will produce the expected outcome in periods of financial stress. Visit the Bank of Canada website for more information, at < www.bankofcanada.ca >.

[9] See BIS (2001) for more information on the Core Principles for SIPS.

[10] Despite its name, most payments sent through the IIPS were between Canadian institutions. The IIPS was developed in 1976 and operated according to rules set out by the Canadian Bankers Association. IIPS payments were exchanged between financial institutions using the SWIFT network. The IIPS was discontinued on 4 February 1999 when the LVTS began operations.

[11] See Chamberland (1998) for a description of how large-value payments were cleared and settled in the IIPS/ACSS environment.

[12] Large-value payments in the ACSS are defined as those >$50,000. Migration of payments from the ACSS to the LVTS continues to take place.

[13] The ACSS is described as a 'debit-pull' system, where debit-collection orders authorized by the payor move from the payee to the payor and result in a charge (debit) to the account of the payor (BIS 2003). The ACSS has not been designated by the Bank of Canada as having the potential to pose systemic risk. See Northcott (2002).

heightened and unmanageable liquidity and credit risk, thus increasing the potential for systemic risk. In the event of a participant default, ACSS rules stipulate that a partial unwind of payments would take place which, in the pre-LVTS environment, could have led to serious disruptions throughout the financial system, including the realization of systemic risk.

At the same time, a payment system that was unable to offer immediate intraday finality for payments exchanged between participants was perceived as being ill-equipped to handle the increased speed of transaction activity in the new global economy. Canadian authorities argued that the creation of a new large-value payment system that could accommodate this increased transaction speed was necessary to maintain the country's international competitiveness.

The LVTS was developed jointly by public and private sector institutions in Canada.[14] The design of the system thus posed an interesting challenge, because although the new system would virtually eliminate potential systemic risk, proposed collateral arrangements meant that the LVTS would be relatively more costly for financial institutions than existing arrangements. The end result of this collaborative effort was a large-value payment system employing risk-proofing measures meeting or exceeding the requirements of international Core Principles for SIPS, while offering participants a variety of collateral cost-saving features that could be used in their daily payment operations.[15]

2.2 The LVTS: Canada's RTGS-Equivalent Payment System
Canada's LVTS is unique among large-value payment systems in G-10 countries. Prior to the 1980s, many countries' large-value payments were also cleared and settled through traditional DNS systems. As described above, such arrangements led to large credit and liquidity risk exposures between counterparties and to potentially increased systemic risk. The creation of a system with better risk proofing for the settlement of large-value payments seemed crucial in meeting central banks' objectives of maintaining confidence and stability in the financial system.

The primary solution adopted by virtually all G-10 countries was the implementation of Real Time Gross Settlement (RTGS) systems. Each payment processed by these systems involves an immediate transfer of funds across participants' accounts held with the settlement institution (usually the central bank). That is, each payment is settled on a gross (individual) basis in real time. Under this arrangement, exposure to credit and liquidity risk is avoided, and systemic risk is eliminated. Moreover, immediate intraday finality is achieved, and beneficiaries of payments do not have to worry that funds could be revoked or unwound at some future time. Participation in an RTGS system is more costly relative to a traditional DNS system, however, since participants must maintain

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[14] Involved parties included the Canadian Payments Association, the Bank of Canada, the Office of the Superintendent of Financial Institutions, and the Department of Finance.
[15] Private banks were also concerned that the LVTS access criteria were too broad and that the necessary technical and legal costs would be substantial. See Roach (2003) for a discussion of how these concerns were addressed.

sufficient funds in their settlement account to send each payment through the system. Where participants' liquidity needs may be greater than the supply of funds in their settlement account, they can typically borrow additional funds from the central bank through intraday credit, which is generally provided on a fully collateralized basis.[16]

In the LVTS, payments are also processed with finality on a gross basis in real time, while settlement of the system occurs on a multilateral net basis at the end of the payments cycle. The LVTS's real time risk controls, coupled with both its collateral arrangements and a Bank of Canada residual guarantee, serve to ensure that the LVTS will settle under all circumstances. As a result, beneficiaries of payments in the LVTS are also able to use these funds immediately upon receipt, knowing that they will not be revoked or unwound in the future. In this respect, the LVTS is an RTGS-equivalent payment system. At the same time, a survivors-pay collateral pool in the T2 payment stream reduces collateral requirements and related costs with respect to the provision of intraday credit compared with traditional RTGS arrangements. Thus, the LVTS represents a more efficient design (from a cost-minimization perspective) than traditional RTGS systems.[17]

2.3 Description of Payment Activity in the LVTS

Payments in the LVTS consist of both interbank and third-party funds transfers, including transactions between LVTS participants and the Bank of Canada.[18] The average value of these individual payments is relatively large (in excess of Can$7 million), while the median value is only about Can$50,000. Certain payments are also time-sensitive. In addition to the standard exchange of funds between LVTS participants and their clients to meet various payment obligations, other more specific types of payments flowing through the system include:

- o Foreign exchange payments, which may be conducted under both traditional correspondent banking arrangements, and also payments related to the settlement of the Canadian-dollar leg of FX transactions undertaken in the Continuous Linked Settlement (CLS) system;[19]

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[16] One exception is the Fedwire system in the United States, where the majority of account overdrafts at Reserve Banks are uncollateralized. Instead, the Federal Reserve controls credit risk by imposing a combination of quantitative limits, fees, and regulatory access criteria on Reserve Banks' provision of intraday credit to Fedwire participants (Martin 2005).

[17] The term 'traditional' is used here in recognition of the recent emergence, in some countries, of new RTGS arrangements that provide liquidity-saving features, such as payment offsetting. McAndrews and Trundle (2001) discuss these developments and provide some country examples.

[18] To qualify for third-party status, at least one party involved in the transaction (typically an end customer) must not be a SWIFT member. SWIFT stands for the Society for Worldwide Interbank Financial Telecommunications. LVTS participants' clients consist of both SWIFT members (correspondent banks) and non-SWIFT members (e.g., non-financial entities), and therefore client payments may be represented by either interbank or third-party payments.

[19] The CLS Bank virtually eliminates the settlement risk associated with foreign exchange transactions by providing a payment-versus-payment settlement arrangement. The CLS Bank began operations in September 2002. For details on the CLS Bank, see Miller and Northcott (2002).

- o Payments related to final funds settlement of CDSX, which is the clearing and settlement system for virtually all Canadian-dollar-denominated securities;[20]
- o Payments related to the final settlement of the ACSS, which is the clearing and settlement system for most retail payment items, including paper items (cheques) with a value of less than Can$25 million;[21]
- o Large-value Government of Canada transactions (federal receipts and disbursements) and transactions relating to the settlement of the daily Receiver General (RG) term deposit auction;[22] and
- o The Bank of Canada's own large-value payments and those of its other clients. Besides the Government of Canada, the Bank's clients consist of other central banks and certain international organizations including the International Monetary Fund, the Bank for International Settlements, the Asian Development Bank, the International Bank for Reconstruction and Development, and the European Bank for Reconstruction and Development.

3.0 Ownership and Participation

3.1 Ownership of the LVTS

The LVTS is owned and operated by the Canadian Payments Association (CPA), a not-for-profit organization created by an Act of Parliament in 1980. The CPA consists of 118 members, including banks, centrals, trust and loan companies, and other financial institutions. The CPA's Chair and Deputy Chair are both appointed from the Bank of Canada. The Association's formal mandate, as amended through the Canadian Payments Act in 2001, is (i) to establish and operate national systems for the clearing and settlement of payments and other arrangements for the making or exchange of payments, (ii) to facilitate the interaction of the CPA's systems with others involved in the exchange, clearing, and settlement of payments, and (iii) to facilitate the development of new payment methods and technologies.

The CPA aims to uphold the key public policy objectives with respect to the LVTS and other clearing and settlement systems in Canada. Specifically, the organization works with stakeholders and advisory groups to promote the safety and efficiency of the Canadian payment system through the development and implementation of specific rules and procedures governing the exchange of payment items, which are to be followed by system participants. The CPA is also responsible for ensuring participants' compliance with these rules and procedures.[23]

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[20] CDSX, which began operations in March 2003, is owned and operated by the Canadian Depository for Securities Limited (CDS). Systems used to settle debt and equity transactions in Canada prior to the development of CDSX also used the LVTS (and the ACSS before February 1999) for the settlement of final funds positions. Information on CDSX and on the securities settlement arrangements that it replaced can be found in McVanel (2003).

[21] As of 3 February 2003, paper items with a value greater than Can$25 million can no longer be settled through the ACSS, and are now sent through the LVTS.

[22] Transactions pertaining to the settlement of the RG term deposit auction are related to the Bank's role as banker for the Government of Canada and also to its monetary policy. See Howard (2005) for more information.

[23] The LVTS Rules can be found on the CPA website, available at < www.cdnpay.ca >. Further, the legal foundation for the LVTS is provided in the CPA's LVTS By-law No. 7, "Respecting the Large Value

3.2 Current LVTS Participants

There are currently 15 participants in the LVTS, including the Bank of Canada. The other 14 participants are:

> Alberta Treasury Branches
> Bank of America National Association
> Bank of Montreal
> The Bank of Nova Scotia
> BNP Paribas (Canada)
> La Caisse Centrale Desjardins du Québec
> Canadian Imperial Bank of Commerce
> Credit Union Central of Canada
> HSBC Bank Canada
> Laurentian Bank of Canada
> National Bank of Canada
> Royal Bank of Canada
> The Toronto-Dominion Bank
> State Street Bank and Trust Company

The LVTS began operations on 4 February 1999 with 16 direct participants including the Bank of Canada. In mid-1999 ABN AMRO Bank Canada relinquished its participation status in the LVTS, while the Canada Trust Company successfully merged its operations with the Toronto-Dominion Bank in mid-2001. LVTS operations of this merged entity are conducted under the Toronto-Dominion Bank participant title. The State Street Bank and Trust Company became an LVTS participant in October 2004.

3.3 Criteria for Participation

To become a participant in the LVTS, a financial institution must meet certain eligibility requirements established by the CPA.[24] For instance, potential participants must be members of the CPA and use the SWIFT telecommunications network. They must also establish a settlement account with the Bank of Canada and enter into agreements relating to taking loans from the central bank and to pledging the appropriate collateral. Further, LVTS participants must demonstrate their technical capability in carrying out payment operations in the LVTS, and must exhibit adequate backup capability for their LVTS operations. An initial membership fee is also required. Upon becoming an LVTS participant, an institution is required to pay annual LVTS participation fees. Further information on LVTS participation criteria and details on the calculation of annual participation fees can be found in Appendix I.

Transfer System", which was approved by the Governor General in Council on 2 April 1998, and in the Payments Clearing and Settlement Act (PCSA 1996).

[24] LVTS access criteria do not include restrictions relating to size or transaction volume of individual potential entrants.

4.0 The Tranche 1 and Tranche 2 Payment Streams

The LVTS consists of two payment streams: T1 and T2. Participants can use either tranche when sending payments and each payment stream is characterized by its own real-time risk controls. To send payments through the LVTS, participants require access to intraday liquidity (funds). As will be discussed below, two main sources of intraday funds are available to participants in each stream. Participants may use funds received earlier from incoming payments, or they may draw on an intraday line of credit.[25] Participants' ability to draw on intraday credit is constrained by net debit caps in both payment streams, and these net debit caps represent one of the primary elements of the LVTS's real time risk controls.

4.1 Tranche 1

Payments sent by a participant via the T1 payment stream may be funded using T1 payments already received or by drawing upon a T1 intraday line of credit. The maximum amount of T1 intraday credit available to each participant is known as its T1 Net Debit Cap (T1NDC). Thus, a participant's T1NDC represents the maximum multilateral T1 net debit position that it can incur during the payments cycle. Participants determine the value of their T1NDC and must fully secure this limit with eligible collateral. Participants are free to draw on their T1 intraday line of credit any time they send a payment through the system.

To prevent a participant from incurring a multilateral T1 net debit position that is in excess of its T1NDC, the LVTS applies a real-time risk-control test to each T1 payment submitted to the system. For example, if hypothetical Bank i wishes to send a T1 payment to another participant, the following condition must be met for the payment to be processed:

$$\text{Submitted T1 Payment Value} \leq T1NDC_i + \sum_{j=1}^{N, j \neq i} (T1PayVal_{ji} - T1PayVal_{ij})$$

where
$T1NDC_i$ = bank i's T1 Net Debit Cap
$T1PayVal_{ji}$ = total value of T1 payments sent from Bank j to Bank i
$T1PayVal_{ij}$ = total value of T1 payments sent by Bank i to Bank j
N = number of participants in the system

The second term on the right-hand side of this inequality is Bank i's multilateral T1 net position up to that time in the current payments cycle. It is calculated by adding up the total value of all T1 payments received by Bank i minus the total value of all T1 payments sent by Bank i. If this value is negative, it means that Bank i is already drawing

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[25] Funds received from incoming payments may include those advanced to a participant by another participant as part of an arrangement in the interbank overnight lending market. See Section 6 for more information.

on T1 intraday credit. In this case, the payment will be processed only if the participant still has enough funds remaining under its T1NDC to send the payment.

A T1 payment that successfully passes the real-time risk-control test will be immediately accepted and processed by the LVTS, and the sending and receiving participants' multilateral T1 net positions will be adjusted accordingly.[26] The sending participant will also be notified that the payment was successfully processed through receipt of a SWIFT confirmation message. If a participant is receiving the payment on behalf of a client, it is able to credit its client's account with these funds immediately without any risk of the payment being unwound or revoked in future.[27]

If a T1 payment fails the real-time risk-control test, then one of two things will happen under the LVTS's current central queuing arrangement:[28]

1) The payment will become queued, if it has been designated as a Jumbo payment; or,
2) The payment will be rejected by the system, if it is a Normal payment, at which point the participant may then resubmit the payment at a later time. The sending participant will be notified that the payment has been rejected through receipt of a SWIFT rejection message.

Please refer to Section 7 for more information on the current central queuing arrangement, including a definition of Jumbo and Normal payments.

4.2 Tranche 2
As in T1, T2 payments sent by a participant may be funded using T2 payments already received or by drawing upon a T2 intraday line of credit. The provision of intraday credit in T2 is subject to both bilateral and multilateral net debit caps. A participant is able to draw on its multilateral T2 intraday line of credit up to the value of its T2 Net Debit Cap (T2NDC).

A participant's T2NDC is determined by the other system participants. Specifically, participants grant Bilateral Credit Limits (BCLs) to each other at the beginning of each cycle. A BCL granted from Bank A to Bank B represents the maximum bilateral net debit position that Bank B can incur vis-à-vis Bank A at any time during the LVTS cycle. Bilateral credit limits between pairs of participants need not be reciprocal (although, in

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[26] Meaning that the sender's position will be debited and the receiver's position will be credited by the value of the payment.

[27] As a general rule, the amount of an LVTS payment received is to be made available to the payee (i.e., client beneficiary) by the receiving LVTS participant before the end of the same LVTS payments cycle. Some exceptions apply to this rule. See LVTS Rule No. 10, available at < www.cdnpay.ca > for more information.

[28] Participants are able to keep track of their net bilateral and multilateral positions in real time through their internal LVTS participant workstation (computer terminal), and are likely to be aware when submitting a payment whether the transaction is going to fail the risk-control test.

practice, they do tend to be reciprocal), and participants have a choice of granting a BCL of zero to another participant. The Bank of Canada also grants a BCL to each participant that equals 5 per cent of the total sum of all BCLs granted to that participant by others in the system.[29] The value of hypothetical Bank i's T2NDC is a function of the sum of all BCLs granted to Bank i (including the BCL granted by the Bank of Canada), and the system-wide percentage (SWP), introduced in Section 1.

In particular, Bank i's T2NDC is calculated as follows:

$$T2NDC_i = \sum_{j=1}^{N, j \neq i} BCL_{ji} \bullet SWP$$

   where

$T2NDC_i$ = Bank i's T2 Net Debit Cap

BCL_{ji} = BCL granted from Bank j to Bank i

SWP = system-wide percentage

N = number of participants in the system

The T2NDC represents the maximum multilateral T2 net debit position that Bank i can incur vis-à-vis all other participants during the payments cycle. In T2, two real-time risk-control tests are in place to make sure that a participant, when sending a T2 payment, is never in violation of either its T2NDC or the BCL granted to it by the receiver of the payment. Specifically, each T2 payment submitted to the system is required to successfully pass 1) a bilateral risk-control test and 2) a multilateral risk-control test.

Suppose now that Bank i submits a T2 payment to the LVTS to be received by Bank x. The payment will be processed by the LVTS only if it passes <u>both</u> risk-control tests, meaning that the following conditions must be met:

1) <u>Bilateral Risk-Control Test</u>

   Submitted T2 Payment Value $\leq BCL_{xi} + (T2PayVal_{xi} - T2PayVal_{ix})$
      where

BCL_{xi} = BCL granted from Bank x to Bank i

$T2PayVal_{xi}$ = total value of T2 payments sent from Bank x to Bank i

$T2PayVal_{ix}$ = total value of T2 payments sent from Bank i to Bank x

2) <u>Multilateral Risk-Control Test</u>

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[29] As Roach (2003) explains, "In this manner the Bank of Canada is not seen as making a statement on the creditworthiness of any of the participants." The value of 5 per cent has been in place since the LVTS began operations in February 1999 and was established based on a best estimate of daily Government of Canada payments being sent to the Bank of Canada from LVTS participants. It deserves mention that the Bank of Canada maintains the ability to increase the BCL it has granted to an LVTS participant as a contingency measure under exceptional circumstances. However, this measure has never been taken.

$$\text{Submitted T2 Payment Value} \le T2NDC_i + \sum_{j=1}^{N, j \neq i} (T2PayVal_{ji} - TotT2PayVal_{ij})$$

where

$T2NDC_i$ = T2 multilateral credit limit of Bank i

$T2PayVal_{ji}$ = total value of T2 payments sent to Bank i from Bank j

$T2PayVal_{ij}$ = total value of T2 payments sent by Bank i to Bank j

N = number of participants in the system

The second term on the right-hand side of each of these inequalities represents Bank i's T2 bilateral and multilateral net positions in the current payments cycle up to the point of payment submission, respectively. If either of these is negative, then Bank i is drawing on the BCL granted to it by Bank x and/or on its multilateral T2 intraday line of credit.

A T2 payment that successfully passes both of these risk-control tests will be accepted and processed by the system immediately, and both the sender's and receiver's T2 bilateral and multilateral positions will be adjusted accordingly by the value of the payment. The sender will also be notified that the payment was successfully processed through a SWIFT confirmation message. If a participant is receiving the payment on behalf of a client, it is able to credit its client's account immediately with these funds without any risk of the payment being subsequently unwound or revoked.[30]

As in T1, if a submitted T2 payment fails either the bilateral or multilateral risk-control test mentioned above, then it will become queued or will be rejected by the LVTS, depending on whether it is a Jumbo or Normal payment, respectively. Section 7 discusses the LVTS central queue and also defines Jumbo and Normal payments.

5.0 The Role of Collateral and Collateral Requirements in the LVTS
5.1 The Role of Collateral in the LVTS

Participants' ability to incur an intraday net debit position (i.e., to draw on intraday credit) in each payment stream is subject to collateral requirements. In the event that an LVTS participant defaults on its settlement obligation, collateral is used to secure necessary liquidity from the Bank of Canada to settle its final net debit position, thus permitting settlement of the system. Section 6 explains LVTS settlement under normal and default conditions in greater detail.

Each of the LVTS's payment streams has its own collateral requirements. In T1, participants must fully collateralize their T1NDC. In T2, a survivors-pay collateral pool is utilized where each participant must apportion T2 collateral equal to the largest BCL that it chooses to grant to any other participant, multiplied by the SWP. The value of a participant's T2 collateral requirement is referred to as its Maximum Additional

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[30] As mentioned earlier, as a general rule, the amount of an LVTS payment received by a participant is to be made available to the payee (i.e., client beneficiary) before the end of the same LVTS payments cycle. Some exceptions apply to this rule. See LVTS Rule No. 10, available at < www.cdnpay.ca >, for more information.

Settlement Obligation, or Max ASO. A participant's Max ASO represents the maximum financial loss that it may incur as a result of one or more participants defaulting in the LVTS.

Collateral is also used by participants during LVTS settlement to secure overnight liquidity advances from the Bank of Canada to settle final net debit positions in the system. Participants may use collateral apportioned to T1 and T2 during the current payments cycle to secure this overnight advance from the Bank.

5.2 The Bank of Canada's Role with Respect to LVTS Collateral

Participants' collateral securities earmarked for LVTS activity are pledged to the Bank of Canada using an electronic book-entry process within CDSX.[31] During the payments cycle, collateral pledged to the Bank of Canada may be designated as apportioned to the LVTS, i.e., assigned to cover participants' T1 and T2 collateral obligations, or held as 'excess' collateral, which is defined as the value of LVTS collateral pledged by a participant that is greater than what is apportioned (see Box 1). The Bank of Canada maintains a contingent security claim on collateral apportioned by participants to the LVTS during the payments cycle, but not to collateral held as excess.

> **Box 1: Pledging and Apportioning Collateral to the LVTS**
> LVTS participants *pledge* eligible LVTS collateral securities to the Bank of Canada through CDSX to support daily LVTS payments activity. Using the collateral they have pledged, participants confirm their collateral value *apportioned* to both T1 and T2 at the beginning of and throughout the daily payments cycle in order to secure both their T1NDC and Max ASO, respectively. Collateral securities *pledged* but not *apportioned* to the LVTS are referred to as *excess* collateral.

At a participant's discretion, excess collateral can be transferred out of its LVTS collateral holdings at any time through CDSX. Upon completion of LVTS settlement, the Bank of Canada relinquishes its contingent security claim on participants' LVTS collateral apportionment, and this too can be transferred out of participants' pledged collateral holdings through CDSX at their discretion.

The Bank of Canada is responsible for valuing participants' pledged LVTS collateral using its Collateral Valuation and Tracking System (CVTS). Collateral is valued subject to appropriate haircuts each morning prior to the payments cycle beginning and also when additional securities are pledged by a participant during the payments cycle.[32] Abnormal financial market circumstances may also lead to an intraday revaluation of collateral.

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[31] Virtually all physical securities are held at CDS. For securities not eligible for CDS, these are physically pledged to and held at the Bank of Canada.

[32] Appendix II contains a description of the different stages involved in the daily LVTS payments cycle, as well as a complete discussion of participants' beginning-of-day LVTS commencement procedure.

Recent research suggests that certain LVTS participants typically pledge a large amount of excess collateral to the Bank of Canada.[33] Participants may prefer to maintain this buffer of collateral to meet unforeseen payment obligations in a timely manner, without having to acquire and pledge additional collateral securities on short notice during the day and possibly at a high opportunity cost. Further, it has been observed that LVTS participants typically leave collateral pledged to the Bank of Canada overnight.

5.3 Changes to Collateral Requirements during the LVTS Payments Cycle

Participants can make changes at any time during the payments cycle to their T1NDC and/or bilateral lines of credit, which will result in the following changes to their LVTS collateral requirements:[34]

- A participant may increase its T1NDC at any time during the payments cycle by apportioning additional collateral on a dollar-for-dollar basis to T1;
- A participant may reduce its T1NDC at any time during the payments cycle, but may not reduce its T1NDC past the absolute value of its multilateral T1 net debit position at the time of the reduction. Collateral no longer needed to cover a participant's T1 apportionment becomes part of its excess holdings;
- A participant may increase a BCL that it has granted to another participant during the payments cycle. If an increase in a BCL results in a change in the grantor's Max ASO (i.e., the value of its largest BCL is increased), then the grantor must have sufficient excess collateral available or pledge additional T2 collateral to the system to secure the new value of its Max ASO;
- A participant may also decrease any of the BCLs that it has granted during the payments cycle. But if a participant's Max ASO declines following this BCL reduction, its T2 collateral requirement will not be changed, nor will the T2 survivors-pay loss-allocation formula be changed.[35] Thus, collateral will not be released to the participant's excess holdings. This means that the amount of a participant's T2 collateral apportioned to the LVTS at any time will always be equal to its largest Max ASO calculated during the payments cycle, even if that Max ASO is reduced before the end of the cycle.

As mentioned in Section 5.2, circumstances may arise when the Bank of Canada must revalue collateral pledged by LVTS participants during the payments cycle. If such a revaluation results in a decrease in the value of collateral pledged by a participant, to the extent that this new value is lower than the discounted value of its apportionment, the participant must pledge additional collateral in order to make up the difference within a time frame established by the Bank. If a participant is unable to fulfill this requirement, its T1NDC will be reduced by the amount of the deficiency.

5.4 Eligible collateral

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[33] See McPhail and Vakos (2003).

[34] See the LVTS Rules available at www.cdnpay.ca for more information.

[35] This applies not only to a participant's MaxASO, but also to the ASO for each participant for which a BCL is granted. See section 6.4 for the calculation of participants' ASO.

To enable LVTS settlement, the Bank of Canada can grant a discretionary advance of settlement funds to an LVTS participant in accordance with its Standing Liquidity Facility (SLF) to allow that participant to settle its multilateral net debit position at the end of the payments cycle. SLF loans are provided on an overnight, fully collateralized basis. Further, in the event of a participant default, the Bank of Canada is required to extend to the defaulter via a secured non-discretionary advance the funds necessary to settle its final net debit position. Collateral apportioned to the LVTS by the defaulter, and possibly that of remaining participants, is used to secure this loan.[36]

Given these arrangements, the Bank must be reasonably certain that the collateral can be liquidated in a timely manner without financial loss. Therefore, it restricts the types of collateral that LVTS participants may pledge. Eligible collateral ranges from debt securities issued by the federal and provincial governments, to high-quality corporate and municipal debt instruments. Additional pledging restrictions apply to certain types of instruments, as described below.

To control market risk, the Bank of Canada applies haircuts when valuing pledged securities. The current framework used by the Bank to determine appropriate haircuts is a "bucketed" approach that focuses on broad classes of issuers and asset characteristics.[37] This framework is relatively simple to implement and is aligned with market trading practices and, in general, with the practices of other central banks. More importantly, it allows the Bank to avoid making judgments regarding the liquidity or credit quality of securities issued by any particular borrower. Haircuts are typically larger the lower the class of issuers' credit rating and the longer the term to maturity of the asset. Specifically, haircuts applied to a particular class of asset reflect the following factors: the estimated amount of time necessary to liquidate holdings of the asset (immediacy); the chance that liquidation could affect the asset's market price (depth); and overall confidence in the accuracy of the asset's market price.

Table 1 lists securities eligible as collateral under the Bank's Standing Liquidity Facility (SLF) and associated haircuts for each instrument.

On 1 November 2001, the Bank of Canada announced its decision to expand the types of collateral that it would accept to support LVTS intraday activity and its end-of-day lending to LVTS participants. Expanded collateral includes Government of Canada stripped coupons and residuals; bankers' acceptances and promissory notes (bearer deposit notes); commercial and short-term municipal paper; and corporate and municipal bonds. The decision to expand the list of eligible collateral was preceded by close consultations between the Bank of Canada and the financial community. It was agreed

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[36] The Bank of Canada provides two types of loans to LVTS participants as described above: discretionary and non-discretionary loans. For a discussion of the Bank of Canada's lender-of-last-resort policies, see Daniel, Engert, and Maclean (2005). See Section 6 for more details on LVTS settlement procedures under normal conditions and in the event of participant default.

[37] The buckets are partitioned to include Government of Canada securities, Government of Canada guarantees, provincial bonds, provincial guaranteed bonds, and private sector debt obligations both in the money market and in bond markets, of which the latter are further segregated by credit rating.

that an expanded collateral list would bring many benefits to both the Canadian payments system and its clients, including lower costs of acquiring collateral and increased operational efficiency within the LVTS environment without increasing risk to the Bank of Canada in any significant way.[38]

Table 1: Eligible LVTS Collateral and Associated Haircuts[39]

Instrument	Haircut according to term to maturity (%)				
	Up to 1 year	1-3 years	3-5 years	5-10 years	> 10 years
Securities issued by the Government of Canada, including stripped coupons and residuals	1.0	1.0	1.5	2.0	2.5
Securities guaranteed by the Government of Canada (including Canada Mortgage Bonds and NHA MBS)	1.5	2.0	2.5	3.0	3.5
Securities issued by a provincial government	2.0	3.0	3.5	4.0	4.5
Securities guaranteed by a province	3.0	4.0	4.5	5.0	5.5
Bankers' acceptances, promissory notes, commercial paper and short-term municipal paper (rated A-1 (high) by S&P or R-1 (mid) or better by DBRS)	7.5				
Bankers' acceptances, promissory notes, commercial paper and short-term municipal paper (rated A-1 (mid) by S&P or R-1 (low) by DBRS or P1 by Moody's)	12.0				
Corporate and municipal bonds (AAA rated)	4.0	4.0	5.0	5.5	6.0
Corporate and municipal bonds (AA rated)	7.5	7.5	8.5	9.0	10.0
Corporate and municipal bonds (A rated)	12.0	12.0	13.0	13.5	15.0

The following conditions will be applied to use of eligible collateral noted in Table 1[40]:

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[38] For a complete description of the consultation process and the potential benefits of an expanded collateral list, see Hossfeld (2000).

[39] Taken from the Bank of Canada website, available at < www.bankofcanada.ca >.

[40] Taken from the Bank of Canada website, available at < www.bankofcanada.ca >.

o Only Canadian-dollar-denominated securities are eligible to be pledged as collateral;

o Securities used as collateral must be pledged to the Bank of Canada in a book-entry format using CDSX, or be physically delivered to the Bank in certificated form;

o No more than 20 per cent of the value of the collateral pledged by an institution should be the obligation of a single <u>private sector</u> issuer or related party. This condition does not apply for borrowings of less than $50 million;

o An institution may not pledge collateral issued by it or an issuer affiliated with it;

o The Bank of Canada must be notified 24 hours in advance (with a deadline of 15:00 hours E.T.) by the borrowing institution the first time it intends to pledge any private sector security for use as collateral the next day. At the time of notice the institution must also provide the relevant credit ratings of the security;

o The security must not have an embedded option or carry a right of conversion into equity securities;

o A minimum principal amount of $1 million of an individual security is required.

6.0 End of Cycle Procedure in the LVTS
6.1 Introduction and Overview

Settlement of the LVTS occurs on a multilateral net basis at the end of the payments cycle. The LVTS employs multilateral netting by novation; once a payment obligation is accepted by the system, the sender's bilateral settlement obligation with the receiver is extinguished and is replaced by a multilateral settlement obligation vis-à-vis all other participants in the system.

General payment exchange in the LVTS ends at 18:00 hours E.T. each day and participants' net positions resulting from daily payment exchange are confirmed at this time. A participant's net position is obtained by adding together its T1 and T2 multilateral positions. Some participants will hold net credit (positive) positions, others will hold net debit (negative) positions, and some participants' positions may be zero, following general payment exchange.

If a participant has a net debit position at 18:00 hours E.T. and this position is not brought to zero through overnight interbank lending prior to LVTS settlement, the participant must apply to the Bank of Canada to obtain a fully secured overnight liquidity advance through the Bank's Standing Liquidity Facility (SLF). The interest rate charged for overnight SLF advances is the Bank Rate, which is the upper-bound of the Bank's 50-basis-point target band for the overnight interest rate.[41] Those participants with positive net positions at the time of LVTS settlement must leave these funds with the Bank overnight, and are paid a rate of interest by the Bank equal to the lower-bound of the 50-basis point band. Overnight advances granted to participants by the Bank on day T are required to be repaid, with interest, to the Bank by 18:00 hours E.T. on day T+1. The

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[41] For more information on the Bank's 50-basis-point band, visit the Bank of Canada website at < www.bankofcanada.ca > and see Howard (2005).

Bank releases balances to those participants incurring a positive net position on day T through the LVTS at the beginning of general payment exchange on day T+1.

6.2 The Pre-Settlement Period

The Bank of Canada's borrowing and lending rates for overnight liquidity are intended to provide an incentive for participants to flatten (bring to near zero) their net positions prior to the time of settlement. Participants can accomplish this by entering into overnight lending agreements with each other (i.e., interbank lending). It is expected that the rate of interest negotiated in these agreements will be equal to or near the Bank's overnight target rate (which is equal to the midpoint of the 50-basis-point band). Participants are afforded the opportunity to enter into these types of overnight bilateral lending agreements during the pre-settlement period, which is scheduled to take place between 18:00 and 18:30 hours E.T.[42] Only transactions relating to overnight interbank lending are permitted during this time, and a sender of a payment (a participant with a net credit position) must not send a payment to another participant (in a net debit position) unless a formal agreement has been struck between the two parties.[43] Further, there is virtually no queuing during the pre-settlement period (see Section 7.2.3). Payments during pre-settlement can be sent using either payment stream – T1 or T2. Moreover, participants with excess balances are free to lend to more than one participant in a net debit position, and vice versa.

It should be noted that the Bank of Canada, in its cash-setting role to neutralize the impact of government activity in the system, and also in its implementation of monetary policy, leaves a predetermined level of excess balances in the LVTS each day.[44] Nevertheless, there are still occasions when some participants require an overnight advance from the Bank of Canada despite this excess level of balances in the system.[45]

6.3 LVTS Settlement

Settlement of the LVTS involves a transfer of settlement funds across participants' accounts at the Bank of Canada in accordance with their final net positions. Participants with positive final net positions will have their accounts credited, and those with negative final net positions will have their accounts debited, by the amount of their respective positions. LVTS participants do not retain funds in their settlement account at the Bank of Canada on a continuous basis. As a result, settlement begins with each participant that

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[42] Participants are not prohibited from entering into such overnight lending agreements prior to pre-settlement.

[43] Maintaining proof that such an agreement was struck is the responsibility of the sending participant. Proof can be in the form of a recorded telephone message evidencing such a prior agreement. To help ensure that only those payments intended to flatten participants' LVTS positions are sent during pre-settlement, only SWIFT MT205 (interbank) messages are allowed during this time. Any SWIFT MT103 (third-party) messages will be immediately rejected by the system upon submission.

[44] See Howard (2005) for more information

[45] For example, a participant's ability to lend funds overnight to another participant may be constrained by internal risk-management practices. Transactions costs are also expected to be a factor. A participant that ends the day with a very small net debit position may choose to take an overnight advance from the Bank of Canada and absorb potential costs related to the interest rate differential rather than search for another participant with these funds. Operational or infrastructure arrangements may also make it difficult to arrange an overnight loan on short notice.

incurred a negative final net position applying for a fully secured overnight (SLF) advance from the Bank equal to the value of its position. If sufficient collateral is pledged by these participants to secure these advances, the Bank will provide overnight liquidity and credit the settlement accounts of these participants with the value of their respective advance. The Bank will then debit these same funds from these participants' settlement accounts and use them to credit the settlement accounts of participants with a positive final net position by the amount of their respective positions. It should be noted that LVTS settlement <u>does not</u> entail any further transfers of funds through the system. It is conducted wholly on the books of the Bank of Canada.

Repayment of an overnight advance from the Bank of Canada is due before 18:00 hours E.T. on the following business day via an LVTS payment from the borrower to the Bank. Once repayment is completed, the Bank of Canada will release collateral used to secure the advance back to the participant. Box 2 discusses some implications of this arrangement.

Box 2: **Repayment of an LVTS Advance from the Bank of Canada**
If a participant obtains an overnight SLF advance from the Bank of Canada, this advance must be repaid by the participant, with interest equal to the Bank Rate, on the next business day via an LVTS payment. Once this payment is received by the Bank, collateral used to secure the loan will be released back to the participant. To make this repayment to the Bank on the next business day, however, collateral must be apportioned to the LVTS by the participant for that payments cycle. This means that a participant may need to temporarily apportion additional collateral to release the collateral used to secure the overnight advance from the day before.

6.4 LVTS Settlement Under Default Conditions

A participant is declared to be in default in the LVTS if it fails, for any reason whatsoever, to secure a discretionary (SLF) advance from the Bank of Canada to enable it to settle its final LVTS net debit position. In this case, the Bank will act by seizing necessary collateral value apportioned by the defaulting participant and crediting its settlement account with a non-discretionary advance of funds equal to the lesser of either:

1. The participant's final net debit position; or
2. The total value of collateral apportioned to the system on that day by the defaulter, which is equal to its Max ASO plus its T1NDC.

In the first case, the Bank will then enact LVTS settlement as described in Section 6.3, and will subsequently realize on collateral apportioned by the defaulter at a later time to recover the value of the advance.[46]

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[46] The repayment of any advances made by the Bank of Canada to the defaulting participant, and the Bank's rights with respect to the defaulting participant's collateral, are governed by the agreements between the defaulting participant and the Bank of Canada. See the LVTS Rules, available at < www.cdnpay.ca > for more details.

In the second case, where the final net debit position of the defaulting participant is greater than the total value of the collateral apportioned to the system by that participant, remaining participants that granted a BCL to the defaulter will have to make up the difference by meeting their ASO. Since the T2 loss-allocation formula is based on the value of BCLs granted to the defaulter by surviving participants, participants have an incentive to monitor the creditworthiness of other participants on an ongoing basis and to adjust the BCLs that they grant accordingly.

Specifically, surviving participant x's ASO in the event that participant i defaults is calculated according to the following formula.

$$ASO_x = S_i \bullet \left[\frac{BCL_{xi}}{\sum_{j=1}^{N, j \neq i} BCL_{ji}} \right]$$

where

ASO_x = participant x's additional settlement obligation

S_i = defaulting participant i's shortfall, calculated as the difference between i's final net debit position and its apportioned collateral

BCL_{xi} = the largest BCL that participant x has granted to defaulting participant i during the current payments cycle

BCL_{ji} = the largest BCL that participant j has granted to participant i during the current payments cycle

N = number of participants in the system.

In this case, the Bank of Canada will proceed by first crediting each surviving participant's settlement account with an advance equal to the value of their ASO, and subsequently debiting these same funds and transferring them to the settlement account of the defaulting participant. Once this step is complete, LVTS settlement is effected as described in Section 6.3. The Bank will then realize on necessary collateral apportioned by the defaulter and by surviving participants to recover the value of these advances.[47]

In the exceptionally remote event of multiple participant defaults, and where collateral seized by the Bank of Canada to meet the ASOs of surviving participants (in addition to the collateral apportioned by the defaulters) is still not sufficient to cover the value of the final net debit positions of the defaulting participants, the Bank will provide a guarantee of settlement; i.e., it will realize on available collateral and become an unsecured creditor of the defaulting institutions for the residual amount. LVTS settlement will continue to be

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[47] A defaulting participant is obligated to reimburse each surviving participant for the amount of the ASO incurred as a result of the default. This amount constitutes a debt of the defaulting participant that remains irrespective of whether its status as a participant is suspended or revoked.

carried out as outlined in the paragraph immediately above, with the Bank of Canada advancing defaulting participants the residual funds needed to effect settlement.

It should be noted that it is extremely unlikely that the Bank of Canada will have to exercise its residual guarantee. For such an event to occur, multiple participants would have to default on the same day during the LVTS payments cycle. Furthermore, the final net debit positions of the defaulting participants would need to be sufficiently large that the collateral value apportioned by them to the LVTS, along with T2 collateral apportioned by non-defaulting participants, was less than the collective value of these net debit positions. Perhaps most importantly, given the LVTS's incentive-compatible risk-control structure, these defaults would have to be completely unanticipated to prevent non-defaulting participants from having earlier taken the opportunity to reduce or eliminate the BCLs granted to the defaulters to avoid financial loss.[48]

6.4.1 Non-Viability of LVTS Participants

If a participant is declared non-viable by a financial regulator during the LVTS cycle,[49] the CPA General Manager will immediately suspend the participant's LVTS payment activity and will notify all other participants. All payments to and from the non-viable participant that have not yet been accepted by the LVTS will become ineligible for processing by the LVTS. However, the non-viable participant's net position resulting from payments already processed must still be settled at the end of the cycle. If the non-viable participant has incurred a net debit position during the payments cycle, settlement of the LVTS will occur as described in Section 6.4 (i.e., participant default), and the Bank of Canada will provide a non-discretionary advance of settlement funds to the participant up to the value of its apportioned collateral, if necessary. It follows that if collateral apportioned by the participant is insufficient to cover its net debit position, remaining participants that have granted BCLs to the non-viable participant will be required to meet their ASOs. If, instead, this declaration of non-viability is made outside of the LVTS cycle, the participant will be suspended from participating in subsequent LVTS cycles.

7.0 Collateral Cost-Saving Measures

Maintaining intraday liquidity in the LVTS can be costly for participants, since an opportunity cost may exist on holdings of eligible collateral, given the low-risk nature of these assets. To accommodate participants in their objective to economize on collateral use while still maintaining the ability to send payments through the system, the LVTS has been designed with several cost-saving features. Selected features are described below.[50]

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[48] To avoid financial loss from a BCL granted to the defaulter, the BCL would need to be reduced prior to the CPA initiating the LVTS cycle for that business day.

[49] The term non-viable is used in the LVTS rules to describe the situation where a federal or provincial regulator or other supervisory body takes control of a participant's assets or makes a declaration that a participant is considered non-viable or that the participant will be unable to meet its liabilities as they come due.

[50] The decision in November 2001 to expand the list of eligible collateral that can be pledged to support LVTS activity is also considered an important collateral cost-saving feature. See Section 5.4.

7.1 The Tranche 2 Payment Stream

A survivors-pay collateral pool is used to secure T2 intraday credit in the system, thus substantially reducing participants' collateral requirements when accessing intraday credit relative to the T1 payment stream.

7.2 The LVTS Jumbo Queue[51]

7.2.1 Defining Jumbo Payments

The LVTS employs a 'Jumbo-only' queuing mechanism, meaning that only Jumbo payments failing the initial risk-control test will become queued. At the beginning of each LVTS cycle, participants set their Jumbo threshold to determine which of their payments will be designated as Jumbo. In setting its Jumbo threshold, each participant has three options: 1) set the threshold at the CPA-established limit of $100 million; 2) set it above $100 million; or 3) set it at zero, which means that all payments submitted by a participant and failing the initial risk-control test will be rejected by the system. The Jumbo-threshold value set by a participant is applied to both its T1 and T2 payments.

7.2.2 Queued Payment Storage and Release

The LVTS queue stores payments according to tranche type and also SWIFT priority class.[52] Payments are resubmitted from the queue on a First-In-First-Out (FIFO) basis within priority class upon the occurrence of one of the following three events.

1) Whenever a participant receives a T1 or T2 payment from another participant, its first queued payment of the applicable tranche type is resubmitted against the real time risk controls.

2) Whenever a participant apportions more collateral towards T1 (thus raising its T1NDC) or receives an increase in a BCL granted to it by another participant (which increases its T2NDC), its first queued payment of the applicable tranche type is resubmitted against the real time risk controls.

If a participant's first queued payment is able to pass the applicable risk-control test(s) as a result of (1) or (2), then its second queued payment is resubmitted, and so on. However, if a queued payment is resubmitted against the risk-control test(s) but still does not pass, then the process stops, and the failed payment plus all the queued payments behind it remain queued. In other words, there is no FIFO by-pass allowed in the LVTS queue.[53]

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[51] The LVTS is capable of running under four different central queuing arrangements, including the Jumbo-only option. Please see Appendix III for more details on the other three options.

[52] Participants may designate payments as SWIFT Priority 01 for urgent payments and SWIFT Priority 02 for normal payments. SWIFT priority affects the ordering and release of queued payments but does not affect entry into the system, since payments are applied against the risk-control test at their time of submission. LVTS participants do not appear to make use of SWIFT priority messaging.

[53] Anecdotal evidence suggests that, as a result of the no-FIFO-bypass rule, there are times when a very large queued payment stalls the resubmission process even though there are smaller payments behind it that would successfully pass the necessary risk-control test.

3)The LVTS Jumbo Algorithm

The LVTS's Jumbo algorithm attempts to search for and offset batches of queued payments every fifteen minutes during general payment exchange.[54] The first running of the algorithm is at 01:00 hours E.T. and the final running of the algorithm occurs at 18:00 hours E.T. at the beginning of the pre-settlement period. All queued payments passed by the algorithm are processed normally by the system, and participants' net bilateral and/or multilateral positions are adjusted accordingly in real time.

The operation of the Jumbo algorithm for each tranche is described below. See Appendix III for a specific example.

Operation of the Jumbo algorithm for Queued T1 payments

When applied to T1 payments in the queue, the algorithm first calculates the net multilateral position (based on T1 queued payments only) that would result for each participant if all T1 queued payments were netted together simultaneously.

The resulting position of each participant in a multilateral net debit position is then applied against the participant's respective T1 risk-control test. If the resulting net debit positions of participants successfully pass the respective risk-control test, then all T1 payments in the queue will be processed by the system. But if the resulting net debit position of one or more participants fails the risk-control test, then the last queued T1 payment sent by the participant that is in the largest net debit position (based on T1 queued payments) is eliminated from the overall collection of payments, and the procedure is retried again.

This process of elimination will continue until a batch of T1 queued payments emerges with no participant incurring a net debit position that fails its risk-control test, or until all T1 payments in the queue have been eliminated.

Operation of the Jumbo algorithm for Queued T2 payments

When applied to T2 payments in the queue, the Jumbo algorithm first groups all payments together on a bilateral basis (i.e., grouping together queued payments between each set of two participants) and subsequently calculates a T2 bilateral net position for each participant in each pairing based on these payments.[55]

For each participant in each pairing with a resulting bilateral net debit position, the algorithm then assesses whether this position can pass the participant's respective T2 bilateral risk-control test. If one or more of the participants' resulting bilateral net debit positions violates their bilateral risk-control test, then the last queued T2 payment sent by the participant in violation (and intended for the other participant in the pairing) is eliminated, and the process is retried.

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[54] The frequency of this algorithm was increased from every 20 minutes to every 15 minutes in December 2005.

[55] It follows that the value of the resulting net bilateral position will be the same in absolute terms between a set of two participants.

The elimination process is repeated for every pair of participants, where a participant's resulting bilateral net debit position is in violation of the bilateral risk-control test, until a batch of T2 queued payments emerges which all successfully pass the respective bilateral T2 risk-control tests, or until all T2 queued payments have been eliminated.

If either all or some of the T2 queued payments are able to pass participants' T2 bilateral risk-control tests, the Jumbo algorithm will proceed to net this batch of payments on a multilateral basis and will subsequently apply any resulting net debit positions against the respective participants' T2 multilateral risk-control test. If the resulting multilateral net debit positions of all participants successfully pass the respective risk-control tests, then the batch will be processed normally by the system, and participants' T2 bilateral and multilateral real time net positions will be adjusted accordingly.

However, if the resulting multilateral T2 net debit position of any participant fails its T2 risk-control test, no further elimination occurs; the Jumbo algorithm stops, and all T2 payments remain queued.

7.2.3 The Queue-Expiry Algorithm

Payments do not remain queued indefinitely in the LVTS. A queue-expiry algorithm runs at regular intervals throughout the LVTS cycle. Between 00:30 and 18:00 hours E.T., the queue-expiry algorithm runs every hour, beginning at 01:05 hours E.T., and expires all payments that have been in the queue for 65 minutes or more.[56]

The frequency of the queue-expiry algorithm increases to every minute during the pre-settlement period between 18:00 and 18:30 hours E.T. and expires all queued payments when it runs, regardless of each payment's duration in the queue. Participants are not supposed to send payments that will fail the applicable risk-control test during this time.

Further, no queued payments from the general payment-exchange period remain in the queue at the beginning of the pre-settlement period. In particular, the end-of-cycle schedule for both the LVTS Jumbo algorithm and the queue-expiry algorithm is as follows.

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[56] This means that the longest any payment can remain in the queue between 00:30 and 18:00 hours E.T. is 02:04:59 (2 hrs. 4 min. 59 sec.). For example, consider a payment that becomes queued at 01:00:01 hours E.T. When the algorithm runs at 02:05 hours E.T., the payment will have been in the queue for only 00:64:59, and therefore will not be expired. But if the payment is still queued during the next running of the queue-expiry algorithm at 03:05 hours E.T., it will be expired, since by then it will have been in the queue for 02:04:59.

Time (E.T.)	Algorithm Event Description
17:59 hours	The queue-expiry algorithm runs, expiring all payments in the queue regardless of their duration in the queue.
18:00 hours	The Jumbo algorithm will run as scheduled at 18:00 hours; however, nothing is expected to be processed by it since all queued payments were expired only one minute before.
18:01 hours	The queue-expiry algorithm begins running every minute, expiring all payments from the queue regardless of their duration in the queue.

7.2.4 Issue: Queue Usage and Transparency

The CPA discourages excessive use of the LVTS queue by participants, and reserves the right to impose queue usage fees if participants appear to be abusing use of the queue.[57] Anecdotal evidence suggests that participants are abiding by this rule, since less than ten payments are queued each day. The average value of a queued payment is typically very large (about Can$500 million).

LVTS participants can access real time information on incoming and outgoing queued payments by generating a Transaction Report through their internal LVTS workstation. A requesting participant's current queued payments appear in this report, labeled as "EC" and "ED" for expected credit and expected debit transactions, respectively. The report does not provide information on the intended client beneficiary of these queued funds, but LVTS participants may still be able to ascertain this information through, among other methods, ongoing intraday communication with other participants. It has been argued that queue transparency may lead participants to take on increased credit risk by crediting client accounts with queued funds prior to the payment being processed by the system (BIS 1997). Nonetheless, this does not appear to be a concern in the LVTS at this time.[58]

7.3 LVTS Throughput Guidelines

The CPA recommends that LVTS participants abide by the following daily throughput guidelines:[59] 25 per cent of daily transaction value and 40 per cent of daily transaction volume should be completed by 10:00 hours E.T., 60 per cent of both aggregate volume and value should be completed by 13:00 hours E.T., and 80 per cent of both aggregate volume and value should be completed by 16:30 hours E.T. In general, throughput guidelines are designed to promote payments

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[57] Since participants are able to manage their bilateral and multilateral LVTS positions in real time, they are encouraged to send only those payments that will pass the risk-control test(s). See LVTS Rule No. 7, available at < www.cdnpay.ca > for more information.

[58] This credit-risk issue may also be avoided in the LVTS since a client beneficiary of funds can always request a Payment Confirmation Reference Number (PCRN) from its bank. All payments processed by the LVTS are assigned a PCRN indicating that the payment has successfully passed all LVTS risk-control tests and is thus considered final and irrevocable. Upon obtaining the PCRN, the beneficiary does not have to worry about the funds being revoked at a later time, as might occur if an LVTS participant were to credit a customer's account conditional on receipt of a future LVTS payment.

[59] Although these throughput guidelines are not mandatory at this time, the CPA reserves the right to make them mandatory if participants do not appear to be abiding by them.

coordination between participant banks in the system, thereby offsetting the incentive for participants to wait to receive payments before sending payments, and reducing participants' need to draw on intraday credit. Internal research conducted by the Bank of Canada during 2003 indicates that aggregate payment flows in the LVTS are generally in accordance with these recommendations.

7.4 Type "T1R" Payments: A Cost-Saving Measure for the Settlement of CDSX

In Section 4.2, it was noted that the Bank of Canada automatically grants a T2 BCL to each LVTS participant that is equal to five per cent of the total sum of BCLs granted to the participant by others in the system. LVTS participants often bump up against this BCL constraint rather quickly when sending payments to the Bank because of its low value, and also because the Bank does not send T2 payments through the system.[60] Thus, LVTS participants must largely rely on the T1 payment stream when sending payments to the central bank.

This is often the case for payments intended for CDSX settlement. The Bank of Canada acts as banker for CDSX. LVTS payments intended for CDSX settlement are usually sent to and from the Bank between 16:00 and 17:00 hours E.T. each day in accordance with final funds positions in that system. Because of the typical size of these payments, a participant may need to apportion additional collateral to T1 for its CDSX settlement payment to successfully pass the T1 risk controls.

LVTS participants therefore have the option of making a type "T1R" payment for the sole purpose of settling final funds positions in CDSX. A T1R payment is a T1 payment sent by a participant to the Bank of Canada with CDS listed as the beneficiary in the payment message, and is supported by reserved collateral (i.e., eligible LVTS collateral securities that have been purchased and pledged by the participant during the current CDSX cycle). This option was implemented to help LVTS participants economize on collateral usage during settlement of final funds positions in CDSX. Moreover, safeguards are in place to ensure that participants do not use reserved collateral to secure any other LVTS payments besides those intended to settle CDSX funds positions, and T1R payments never become queued.

7.5 CDSX-LVTS Funds Transfer

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 LVTS payments cycle prior to CDSX settlement.[61] As an example of how this transfer works, consider an LVTS participant that is a net seller of securities in CDSX on a particular day. This participant knows that it will receive a payment from the Bank of Canada on behalf of CDS during CDSX settlement but prefers to access these funds earlier in the day to fund its other, possibly time-sensitive, LVTS payments. This participant may request a CDSX-LVTS funds transfer where, upon receiving

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[60] An exception to this may occur on the infrequent occasions when the Bank must send back a misdirected payment.

[61] Virtually all LVTS participants maintain a CDSX account at the Bank of Canada. For more information, see McVanel (2003).

confirmation from both CDS and the participant that is initializing the transfer, the Bank of Canada will advance the participant an LVTS payment equal to the value of its CDSX receivable position and will subsequently realize on the amount owing to it at time of CDSX settlement.[62] This provision is available at no cost to participants.

8.0 LVTS Contingency Arrangements for Time-Sensitive Payments

As mentioned, the LVTS maintains key linkages with the broader financial system. Many payments sent through the LVTS are time sensitive, such as those related to final funds settlement of other important clearing and settlement systems operating in Canada. These payments are sent between the Bank of Canada and private sector participants. In the event that technical difficulties prohibit one or more LVTS participants from sending a time-sensitive payment to the Bank, the following contingency arrangements may be invoked.[63]

8.1 Technical Difficulties Involving Connection to the LVTS Central Site (SWIFT Network is Available)

Technical difficulties may arise that involve the following: 1) an interruption of communications between the LVTS central site and one or more participants, where an affected participant is unable to send LVTS payments to the Bank of Canada because of a proprietary failure; or 2) problems with the ability of the LVTS central site to receive, transmit, send, approve, or otherwise process a payment or administration message. Affected participants generally have two options available to meet their time-sensitive payment obligations when due. First, they can have participant that is not encountering any difficulty send the LVTS payment to the Bank on their behalf (this is not an option in the second case). If an affected participant is unable to find another participant to send its payment then, at the discretion of the Bank of Canada, it may send a SWIFT MT202 payment message to the Bank, instructing the Bank to make the payment entry directly on its settlement account; i.e., debit the participant's LVTS settlement account and credit the participant's account of the system for which the payment is intended to settle.

To debit the participant's LVTS account, the Bank must first typically grant an intraday advance to the participant equal to the value of the payment. This advance is interest free and must be fully secured by eligible collateral. Repayment of the advance is due by 18:00 hours E.T. on the same day and should be sent to the Bank via an LVTS payment. For all advances from the Bank, participants are also required to complete a standard application that outlines specific collateral securities to cover the obligation. If the affected participant is unable to electronically pledge these collateral instruments to the Bank of Canada because of technical difficulty, then the Bank may agree to act on behalf of the participant, based on facsimile instructions.

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[62] This transfer-of-funds option is not used frequently.

[63] These contingency guidelines are not binding and may be adjusted, at the discretion of the Bank of Canada, to account for circumstances unique to each case. These measures should not be mistaken for the Bank's SLF or Emergency Liquidity Assistance (ELA) procedures.

If the participant is still experiencing technical difficulty at the end of general payments exchange and is unable to repay the intraday advance when it becomes due, then this advance will be converted into a fully secured overnight advance from the Bank of Canada. This overnight advance will be subject to the same terms and conditions as a Bank of Canada SLF advance, and must be repaid with interest equal to the Bank rate by 18:00 hours E.T. on day T+1.

The risk of a moral hazard problem emerging as a result of this provision of intraday credit by the Bank of Canada is controlled, since one of the technical-competency requirements for LVTS participation requires each participant to establish procedures to ensure that its payment-processing capability is available at least 98 per cent of the time in any given 30-day period. The CPA is involved in the ongoing monitoring of participants' LVTS activity to maintain this rule, and will address any violation accordingly.

8.2 Technical Difficulties Involving the SWIFT Network (LVTS Central Site is Available)

Technical difficulties may also arise where the operation and availability of the SWIFT network is affected. As of November 2005, participants experiencing SWIFT problems but which are still connected to the LVTS central site can send time-sensitive payments across the LVTS Direct Network. Participants normally use the Direct Network for sending LVTS commands and queries; however, rule changes and application enhancements now permit contingent use of the Direct Network for payment messaging if the SWIFT network is unavailable. Previously, participants would send a tested facsimile in place of the SWIFT MT202 payment message to the Bank of Canada, at which point the Bank would directly debit the LVTS settlement account of the affected participant to make the time-sensitive payment (as described in Section 8.1). Payments executed over the Direct Network receive the same treatment as other LVTS payment messages; i.e., they are subject to risk-control tests, assigned a PCRN, and are considered final and irrevocable upon passing the risk controls. The Direct Network is to be used only for time-sensitive payments and only after the affected participant(s) have made an attempt to re-establish connection with SWIFT.

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APPENDIX I: LVTS Membership Criteria and Participation Fees
I.1 Membership Criteria
Participation in the LVTS is granted based on the following requirements:[64]

o CPA Membership
   All LVTS participants must be members of the Canadian Payments Association
   (CPA). Since 1997, the following changes have been introduced to CPA membership
   criteria:

   ▪ As of June 1999, changes to the Bank Act allow authorized foreign banks to
     operate in Canada as direct branches rather than solely as a separate subsidiary.
     Currently, two foreign banks (Bank of America and State Street Bank and Trust
     Company) are LVTS participants, operating through their Canadian branches.[65]
   ▪ As of November 2001, the Canadian Payments Act contains an expanded list of
     CPA-eligible organizations, including life insurance companies, securities
     dealers,[66] and money market mutual funds.[67] At this time, none of these
     institutions has applied for CPA membership or participates in the LVTS.

o Arrangements with the Bank of Canada
   Because settlement in the LVTS involves the transfer of balances across participants'
   settlement accounts at the Bank of Canada, participants must hold such accounts at
   the Bank and must enter into formal agreements with the Bank regarding the
   provision of key central bank services relating to LVTS operation (e.g., Standing
   Loan Facility and collateral management services).[68]

o SWIFT Participation
   LVTS participants must arrange the necessary system interface, which consists of a
   SWIFT Computer Based Terminal (CBT) and an LVTS Workstation (IBM
   compatible PC). Participants must be members of both SWIFT and the Canadian
   National User Group of SWIFT. Potential entrants must provide evidence that they
   are in full compliance with all SWIFT requirements.

o Technical Competency Requirements
   Owing to the importance of the LVTS within the Canadian financial system,
   participants must demonstrate that they are capable of transacting within the LVTS
   and that they have adequate business-continuity arrangements in place.

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[64] For more details on LVTS membership criteria, see the LVTS Rules, available at <www.cdnpay.ca>.
[65] Foreign institutions that participate directly in the LVTS through a Canadian branch are required to
provide enhanced legal documentation to the Bank of Canada, including legal opinions from the home
jurisdiction on conflict-of-laws issues and the enforceability of netting and security interests under the laws
of the home jurisdiction.
[66] Securities dealers that are members of the Investment Dealers Association or the Bourse de Montréal.
[67] To gain CPA membership, these institutions must meet certain requirements regarding the investment of
their holdings and must have access to an immediate and reliable source of liquidity.
[68] The Bank of Canada website provides extensive details regarding the provision of these central bank
services and associated agreements. For more information, please visit www.bankofcanada.ca.

In particular, they must
- successfully complete necessary training and testing requirements established by the CPA (e.g., testing of the participant's ability to properly use its LVTS workstation).
- demonstrate that their technical infrastructure meets minimum CPA standards.
- provide a description of their backup capability for LVTS operations.

o Payment of Admission Fee
   Participants are required to pay an initial LVTS admission fee intended to cover administrative costs. This is currently set equal to Can$60,000. Prior to August 2003, new LVTS entrants were also required to provide payment in addition to the LVTS admission fee, which was intended to cover a reasonable share of the unamortized portion of the LVTS development cost. These development costs were fully recovered by the CPA in August 2003.[69]

Financial and non-financial institutions that are not participants in the LVTS may access the system through a system participant, which sends or receives payments on their behalf. Non-participating deposit-taking institutions can thus access the LVTS through a correspondent banking relationship with an LVTS participant.

I.2 Annual Participation Fees
LVTS participants are required to pay two incremental fees to conduct payments activity in the system. First, each participant must pay an annual LVTS fee imposed by the CPA, which is intended to cover annual operating costs of the system. This fee is based on each participant's estimated share of total LVTS volume.[70] Second, each participant is required to pay a usage fee to SWIFT based on the number of SWIFT payment messages sent during a billing period.

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[69] Roach (2003) states that over 99 per cent of the development cost of the LVTS was paid for by the private sector in Canada.
[70] Estimates of current annual participant activity are based on each participant's LVTS payment volume in the previous year. Minimum dues for CPA members are set at $10,000. Each participant must pay the CPA at least this amount annually, regardless of how minimal its LVTS transaction volume is estimated to be.

APPENDIX II: The LVTS Daily Payments Cycle and Commencement

II.1 Brief Description of Daily Commencement and Other Daily LVTS Operations

Table 1 summarizes the schedule of participants' operations during the daily payments cycle. More details about the daily commencement process undertaken by each LVTS participant, as well as by the CPA and the Bank of Canada, are provided in Section II.2.[71]

II.2 Daily LVTS Commencement: Preparation for Payment Exchange

With the introduction of the CLS Bank, LVTS participants typically do not complete each of the stages involved in commencement at the same time of the day, and the time of each participant's completion of this process typically depends on whether or not it is a CLS participant. Therefore, separate deadlines for completion of the commencement process have been established for both CLS and non-CLS participants as described in Table 1. The procedures each participant must follow to successfully complete commencement are outlined in detail below.[72]

Steps Involved in Daily LVTS Commencement

o   <u>Sign-on, Pledge (if necessary), and Apportion Collateral to the LVTS</u>
    Participants must demonstrate both an ability to communicate in the system and a readiness to participate in the upcoming LVTS cycle. Each participant accomplishes this by responding to the "Hello" dialogue sent to it at the start of the day by the CPA. Participants will generate an LVTS Status Report to determine those participants that have responded.

    Each participant must also set its T1NDC and the BCLs that it is willing to grant to the other participants. Participants have a choice at this stage of either confirming their pre-established 'standing' limit for their T1NDC and the BCLs that they are granting, or choosing a different 'cycle' limit, which takes effect immediately for the duration of the LVTS cycle or until it is changed again throughout the day.

    Participants are free to change both their 'standing' and 'cycle' limit at any time during the LVTS cycle. However, whereas changes to 'cycle' limits take effect immediately, changes to 'standing' limits will take effect only at the beginning of the following LVTS cycle.[73] Cycle changes last only to the end of the payments cycle and then revert back to the standing limit for the following payments cycle.

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[71] In general, only one payments-processing cycle will occur each LVTS business day. Under emergency circumstances, more than one processing cycle may occur during the same calendar day in the LVTS, however, this procedure has never been exercised.

[72] For more information on LVTS commencement including exact deadlines, please see the LVTS Rules, available at www.cdnpay.ca.

[73] Participants are not required to establish 'standing' limits, and indeed, some do not have standing limits in place.

Table 1: Summary of Daily LVTS Cycles/Periods and Associated Procedures

Time Effective (E.T.)	Details of Period
00:00-00:30 hours	**Initialization Cycle State** • LVTS participants intent on processing CLS-related payment messages by 00:30 hours, must complete all of the steps relating to LVTS commencement by no later than this time, as outlined in Section II.2.
00:30–06:00 hours	**Open for Payment Processing Cycle State (OPP) – Period Reserved for CLS-Related Payments Only** • LVTS participants intent on processing CLS-related payment messages by 01:00 hours must complete all of the steps relating to LVTS commencement by no later than this time, as outlined in Section II.2. • This period is strictly reserved for processing of CLS-related payments.
06:00–18:00 hours	**OPP Cycle State - General Payment Exchange Period** • All LVTS participants, regardless of whether they participate in CLS, must complete all of the steps relating to LVTS commencement no later than 08:00 hours, as outlined in Section II.2. • All payment types are allowed during this time, including third-party (customer) payments and interbank payments.
18:00–18:30 hours	**Pre-Settlement Period** • LVTS participants may use this period strictly to flatten end-of-day multilateral positions through overnight lending arrangements with each other. Only interbank payments (i.e., SWIFT message MT205) will be accepted during this period. The LVTS will automatically reject any third-party transfers (i.e., SWIFT message MT103) sent during this time.
18:30 hours	**LVTS settlement** • Settlement of final LVTS multilateral positions is completed directly on the books of the Bank of Canada. No further LVTS payments are needed to complete LVTS settlement.

Note: Times may be subject to change at the discretion of the CPA General Manager (in consultation with the LVTS Emergency Committee and the Bank of Canada) during unusual circumstances.

Following completion of participants' T1 and T2 apportionment, the CPA will confirm each participant's T2 collateral obligation (Max ASO) based on the largest BCL it has granted to any other participant in the system, and will also confirm each participant's T2NDC based on the sum of the BCLs granted to it by all other active participants in the system for that particular payments cycle. For example, for LVTS participants that become active at 00:30 hours E.T. to participate in CLS, their confirmed T2NDC at commencement will be lower than at 08:00 hours E.T. when all other non-CLS participants begin their daily LVTS activity.

If they have not already done so, LVTS participants are also required to pledge eligible collateral securities to the Bank of Canada via CDSX and also to indicate the apportionment of this collateral among the T1 and T2 payment streams. When pledging collateral to the Bank of Canada, participants must also make an identical entry in CVTS so that the discounted value of this pledged collateral can be calculated.[74] The Bank of Canada is responsible for valuing each participant's collateral account by no later than 00:30 hours E.T., and usually completes this process by 00:15 hours E.T. The CPA then confirms that the total value of collateral pledged by each participant is sufficient to cover its collateral requirements based on its T1 and T2 apportionment.

If the value of a participant's pledged collateral is not sufficient to cover its collateral requirement based on its T1 and T2 apportionment, then that participant's T1NDC will be reduced until the value of its T1NDC plus its Max ASO is equal to the total value of its pledged collateral. If during this time a participant's T1NDC is reduced to zero but the value of its Max ASO is still greater than the value of its pledged collateral, then the BCLs granted by the participant must be reduced by a sufficient amount pro rata, such that its Max ASO is equal to the value of its collateral pledged.

Any remaining value of pledged collateral beyond that apportioned to cover a participant's T1 and T2 collateral obligation is considered to be 'excess' collateral, and a participant is free to either draw on this collateral at any time during the LVTS cycle in order to further increase its T1 or T2 apportionment, or remove this collateral from its account at the Bank of Canada and use it for other purposes.

o Testing SWIFT Communication
  Each participant that is active in the LVTS and has indicated both a readiness to transact and an ability to communicate in the system during the LVTS cycle must ensure that (at a minimum) its SWIFT connection is open for receiving incoming transactions. The CPA must also ensure that the LVTS's SWIFT connection is open for receiving and sending transactions.

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[74] Expected future changes in the LVTS infrastructure will alleviate this 'double entry' responsibility.

o <u>Verification of Other Active Participants' Status</u>
  Once a participant has completed the above steps, and prior to releasing any payments, it is required to generate an LVTS Status Report to verify which other participants are successfully active in the system.

  Participants may then begin to send payments through the system; however, they are able to send payments only to other active participants.

APPENDIX III: An Example of the LVTS Jumbo Algorithm and Description of Other Available LVTS Queuing Options

III.1 An Example of the LVTS Jumbo Algorithm
o An Example of the LVTS Jumbo Algorithm for T1 Queued Payments
Consider the case where the following T1 payments are queued at the time the algorithm runs, where ">>" indicates the direction of the payment.

Bank A >> Bank B $100
Bank B >> Bank A $80
Bank C >> Bank B $90
Bank D >> Bank C $20

The Jumbo algorithm begins by calculating the net T1 multilateral position for each participant (based on these queued payments) that would result if all of these payments were netted together simultaneously:

Bank A = -$20 (Sent $100, Received $80)
Bank B = +$110 (Sent $80, Received $190)
Bank C = -$70 (Sent $90, Received $20)
Bank D = -$20 (Sent $20, Received $0)

The resulting position for each bank that is in a net <u>debit</u> position is then applied against its T1 risk-control test, meaning that the following condition must be met:

$$\left|NetT1Position_i\right| \leq T1NDC_i + (TotT1PayVal_{N-1,i} - TotT1PayVal_{i,N-i}) ,$$

where $\left|NetT1Position_i\right|$ = the absolute value of Bank i's resulting multilateral net debit position based on T1 queued payments.

All other terms and subscripts are as defined in Section 4. Suppose that the right-hand side of the above inequality (we can refer to this value as a participant's 'T1 liquidity available') is equal to the following hypothetical value for each participant that is in a net debit position:

Bank A = $10
Bank C = $60
Bank D = $30

Consider Bank A's resulting T1 net debit position, which is $20, meaning that the value of Bank A's queued outgoing T1 payments is greater than the value of Bank A's queued incoming T1 payments by $20. Bank A's T1 multilateral liquidity available is $10, and therefore its resulting multilateral T1 net debit position will fail the risk-control test. A similar calculation is conducted for Bank C and Bank D. Bank C's resulting T1 net debit position is $70 while its T1 multilateral liquidity

available is $60. Hence, similar to the case for Bank A, Bank C's resulting net debit position also fails to meet the above condition. Bank D's resulting net debit position ($20) is less than its T1 multilateral liquidity available ($30), and does pass the T1 risk-control test.

Given that there are two banks (Bank A and Bank C) whose resulting T1 net positions are in violation of the risk-control test, one payment must be eliminated, and the process must be retried. Since Bank C's resulting T1 net debit position ($70) is greater than Bank A's resulting T1 net debit position ($20), the last sent payment by Bank C in the queue will be eliminated, and the process will continue. Once eliminated, the remaining transactions are as follows.

> Bank A >> Bank B $100
> Bank B >> Bank A $80
> Bank D >> Bank C $20

If netted together simultaneously, these queued payments yield the following T1 net multilateral positions.

> Bank A = -$20 (Sent $100, Received $80)
> Bank B = +$20 (Sent $80, Received $100)
> Bank C = +$20 (Sent $0, Received $20)
> Bank D = -$20 (Sent $20, Received $0)

Each participant's T1 multilateral liquidity available remains the same as before, and the T1 risk-control test is applied against each of the resulting net debit positions (Bank A's and Bank D's). Both Bank A's and Bank D's revised net debit positions are unchanged (equal to $20), since neither bank was a counterparty in the eliminated transaction. From above, we know that Bank A's net debit position is in violation of the T1 risk-control test, while Bank D's resulting net debit position passes the T1 risk-control test. Hence, this revised batch of payments is still unable to be processed, and further elimination of payments is necessary. In particular, the last sent payment of Bank A will be eliminated from the batch, and the process will be retried. The remaining batch of payments is as follows.

> Bank B >> Bank A $80
> Bank D >> Bank C $20

If netted together simultaneously, these queued payments yield the following multilateral T1 net positions.

> Bank A = +$80 (Sent $0, Received $80)
> Bank B = -$80 (Sent $80, Received $0)
> Bank C = +$20 (Sent $0, Received $20)
> Bank D = -$20 (Sent $20, Received $0)

Bank D's T1 multilateral liquidity available remains the same ($30), and we introduce T1 multilateral liquidity equal to $100 for Bank B. The T1 risk-control test is applied against each of these banks' resulting net debit positions. This time, both T1 net debit positions pass the respective T1 risk-control test, and both of these payments are processed by the system. Participants' real time multilateral T1 net positions are adjusted accordingly, and Banks A & D each receive notification of the successful processing of their payment. The two eliminated payments remain in the queue.

o   An Example of the LVTS's Jumbo Algorithm for T2 Queued Payments
Consider the case where the following T2 payments are in the LVTS queue at the time the algorithm runs, where ">>" indicates the direction of the payment

> Bank A >> Bank B $100
> Bank B >> Bank C $120
> Bank C >> Bank A $50
> Bank C >> Bank B $80
> Bank B >> Bank A $150

The Jumbo algorithm begins by netting all of these payments together bilaterally and then calculates the resulting bilateral net position for each participant vis-à-vis each other participant in the system (based on these queued payments). In this example, the resulting bilateral net positions are as follows.

> Bank A & Bank B: Bank A = +$50, Bank B = -$50
> Bank B & Bank C: Bank B = -$40, Bank C = +$40
> Bank A & Bank C: Bank A = +$50, Bank C = -$50

Once the resulting T2 bilateral net position for each bank in each pairing is determined, all bilateral net debit positions are applied against their respective T2 bilateral risk-control test, meaning that the following condition must be met (for any Bank i vis-à-vis Bank j).

$$\left| NetT2BilatPosition_{ij} \right| \leq BCL_{ji} + (TotT2PayVal_{ji} - TotT2PayVal_{ij})$$

where $\left| NetT2BilatPosition_{ij} \right|$ = the absolute value of Bank i's resulting net bilateral position vis-à-vis Bank j based on T2 queued payments.

All other terms and subscripts in the above equation are as defined in Section 4. Given the participant pairings listed above, Bank B's resulting bilateral net position is negative in both its relation with Bank A and Bank C. Further, Bank C's resulting bilateral net position vis-à-vis Bank A is also negative. The algorithm proceeds to apply the respective bilateral risk-control test to each of these bilateral net debit positions.

Suppose that the right-hand side of the above equation (we can refer to this value as a participant's 'T2 bilateral liquidity available') is equal to the following hypothetical value in each of the above cases.

> Bank B's bilateral liquidity available vis-à-vis Bank A = $60
> Bank B's bilateral liquidity available vis-à-vis Bank C = $30
> Bank C's bilateral liquidity available vis-à-vis Bank A = $85

Consider Bank B's resulting bilateral net debit position vis-à-vis Bank A, which is $50, meaning that the value of Bank B's queued T2 outgoing payments intended for Bank A is greater than the value of Bank B's queued T2 incoming payments from Bank A by $50. Bank B's T2 bilateral liquidity available in this particular pairing is $60, and therefore its resulting bilateral net debit position with respect to Bank A successfully passes the bilateral risk-control test. On the contrary, Bank B's resulting bilateral net debit position with respect to Bank C is $40, while its bilateral liquidity available in this pairing is $30. In this case, the above condition is not met, meaning that Bank B's resulting bilateral net debit position with respect to Bank C fails the bilateral risk-control test. Lastly, Bank C's resulting bilateral net debit position vis-à-vis Bank A ($50) is less in absolute terms relative to its bilateral liquidity available in this pairing ($85) and thus will also pass the bilateral risk-control test.

Since Bank B's resulting bilateral net debit position with respect to Bank C was unable to successfully pass the bilateral risk-control test, the last-sent payment in the queue from Bank B intended for Bank C is eliminated, and the process is retried. Once this elimination takes place, the remaining payments are as follows.

> Bank A >> Bank B $100
> Bank C >> Bank A $50
> Bank C >> Bank B $80
> Bank B >> Bank A $150

Once bilaterally netted, these T2 queued payments yield the following bilateral net positions.

> <u>Bank A & Bank B</u>: Bank A = +$50, Bank B = -$50
> <u>Bank B & Bank C</u>: Bank B = +$80, Bank C = -$80
> <u>Bank A & Bank C</u>: Bank A = +$50, Bank C = -$50

Each participant's available T2 bilateral liquidity remains the same as before, and we introduce T2 bilateral liquidity available for Bank C in its relationship with Bank B equal to $90. Once again, the corresponding bilateral risk-control test is applied against each of the revised bilateral net debit positions. Since a payment sent from Bank B to Bank C was eliminated, only the resulting bilateral net positions in this pairing are affected by the change. Specifically, it is now Bank C's resulting bilateral net position with respect to Bank B that is negative (-$80). But because this position

is less in absolute value than Bank C's bilateral liquidity available with respect to Bank B ($90), it successfully passes the bilateral risk-control test.

Since all bilateral net debit positions are now able to successfully pass the bilateral risk-control test, the Jumbo algorithm proceeds to net the revised batch of payments on a multilateral basis, and applies each of the resulting T2 multilateral net debit positions (based on these queued payments) against the corresponding T2 multilateral risk-control test.

In this example, the resulting T2 multilateral position for each participant is as follows.

> Bank A = +$100 (Sent $100, Received $200)
> Bank B = +$30 (Sent $150, Received $180)
> Bank C = -$130 (Sent $130, Received $0)

Applying the above T2 multilateral net debit positions against the T2 multilateral risk-control test, the following condition must be met.

$$\left|NetT2Position_i\right| \leq T2NDC_i + (TotT2PayVal_{N-1,i} - TotT2PayVal_{i,N-i})$$

> where $\left|NetT2Position_i\right|$ = the absolute value of Bank i's resulting net multilateral position based on T2 queued payments.

All other terms and subscripts are as defined in Section 4. Suppose that the right-hand side of the above inequality (we can refer to this value as a participant's 'available T2 multilateral liquidity') is equal to the following hypothetical value for Bank C, which is the only participant with a resulting multilateral net debit position.

> Bank C = $150

Since Bank C's resulting multilateral net debit position ($130) is less than Bank C's available T2 multilateral liquidity ($150), the risk-control test is successfully passed, and the revised batch of T2 payments is processed by the system. Participants' real time T2 bilateral and multilateral net positions are adjusted accordingly, and sending banks will receive notification that their T2 queued payments have been successfully processed through receipt of a SWIFT confirmation message. The eliminated payment of $120 from Bank B to Bank C remains in the queue.

Note: If instead it was the case that Bank C's resulting multilateral net debit position was greater in absolute value than Bank C's T2 available multilateral liquidity, the risk-control test would not have been passed, and the algorithm would stop immediately; all T2 payments would remain in the queue.

III.2 Other Available LVTS Queuing Options
The LVTS is capable of running under four different queuing arrangements.[75]
1) Jumbo-only
   Since the opening of the LVTS, only the Jumbo-only queuing option has been tested
   and used. This queuing arrangement is described in Section 7.2.

2) Jumbo/Normal
   Both Jumbo and Normal payments failing the risk-control test become queued under
   this arrangement. Payments are stored in the queue, with all Jumbo payments at the
   front and Normal payments behind. Payments are resubmitted to the system whenever
   a sender's available funds are increased in the applicable tranche (i.e., if they receive
   a payment, or their credit limit is increased). Jumbo payments are stored in the queue
   and are retried in descending order of value. There is a bypass option if the first
   Jumbo payment is unable to pass the risk-control test; i.e., the algorithm will skip the
   first payment and move to the second largest Jumbo payment, and so on. Normal
   payments are stored in the queue and are resubmitted in FIFO order. There is no
   bypass option for Normal payments, so blocking may occur if the first queued
   payment is unable to pass the risk-control test(s).

3) No Queuing
   Under this arrangement, no central queue exists, and any payments failing the risk-
   control test are immediately rejected by the system.

4) First In First Out (FIFO)
   Under this arrangement, both Normal and Jumbo payments failing the initial risk-
   control test become queued. Once again, payments in the queue are resubmitted to the
   system whenever a sender's available credit is increased in the applicable tranche
   (i.e., if they receive a payment, or their credit limit is increased). Payments are stored
   and are retried in FIFO order, regardless of whether they are Jumbo or Normal
   payments. If the first queued payment is unable to pass the risk-control test, then that
   payment is skipped and the second queued payment is retried, and so on (i.e., no
   blocking). This queuing arrangement is more generally known as "FIFO-bypass."

Only one queuing option can be used in the LVTS at a time. It is up to the General
Manager of the CPA, in consultation with the LVTS Management Committee, to decide
which queuing option shall be used in the system. If the General Manager and the LVTS
Management Committee decide to change the queuing arrangement, then the CPA must
notify each LVTS participant as soon as is practical upon the decision being made, and
no later than one full business day prior to the change taking effect.

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[75] The Jumbo algorithm is employed under all queuing arrangements mentioned in this section, except
under the no-queuing option.

APPENDIX IV: Glossary of Selected Terms and Acronyms[76]

Additional settlement obligation (ASO): Each participant's obligation to advance funds to ensure settlement in the event that another participant is in default.

Automated Clearing Settlement System (ACSS): Canada's DNS payments system operated by the Canadian Payments Association, primarily for retail payments.

Bank Rate: The minimum interest rate that the Bank of Canada is prepared to charge in respect of advances.

Bilateral credit limit: The aggregate value of Tranche 2 payment messages that one participant has indicated it is willing to accept from another participant in excess of the aggregate value of Tranche 2 payment messages sent to that other participant by the first participant.

Cap: A quantitative limit on the funds-transfer activity of individual participants in a system.

Clearing: The process of transmitting, reconciling and, in some cases, confirming payment orders or security-transfer instructions prior to settlement.

CDSX: Canada's securities clearing and settlement system provided by the Canadian Depository for Securities.

CLS: Continuous Linked Settlement foreign exchange system co-operatively supervised by participating central banks, led by the Federal Reserve Bank of New York.

Collateral: An asset or third-party commitment that is accepted by the collateral taker to secure an obligation of the collateral provider vis-à-vis the collateral taker.

Credit limit: Limit on the credit exposure a payment system participant incurs vis-à-vis another participant (bilateral credit limit) or vis-à-vis all other participants (multilateral credit limit) as a result of receiving payments that have not yet been settled.

Credit-Push System: A funds-transfer system in which payment messages are initiated by the payor and move from the payor's bank to the beneficiary's bank.

CVTS: The Bank of Canada's Collateral Valuation and Tracking System.

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[76] Definitions are based on those of the LVTS rules, where applicable, and on those of the Bank for International Settlements (BIS) (specifically BIS 2003) in most other cases. These definitions are meant solely to give the reader an understanding of the terms used in this paper and are not meant to represent legal definitions.

Debit-Pull System: A funds-transfer system in which debit collection orders authorized by the payor move from the payee to the payor and result in a charge (debit) to the account of the payor.

Defaulter-pays: A loss-sharing arrangement where each participant is required to collateralize any exposure it creates for other participants. As a result, losses from a party's default are borne by the creditors of the defaulting party.

Deferred net settlement system: A system that effects the settlement of obligations or transfers between or among counterparties on a net basis at some later time.

Final (finality): Irrevocable and unconditional.

Haircut: The difference between the market value of a security and its collateral value. Haircuts are often taken by a lender of funds to protect the lender (should the need arise to liquidate the collateral) from losses owing to declines in the market value of the security.

Jumbo payment: A payment that will be queued if it does not initially pass the risk-control tests under Jumbo-only queuing arrangements.

LVTS cycle: The period of time beginning with the initialization of the LVTS and ending with the next settlement at the Bank of Canada of all participants' multilateral net positions.

Maximum additional settlement obligation (Max ASO): The maximum amount that any participant could be required to pay in any single LVTS cycle by reason of its additional settlement obligations.

Multilateral net position: For each participant, at any time during the LVTS cycle, the value obtained by subtracting all payment messages sent to other participants that have passed all risk-control tests from the value of payment messages received by other participants that have passed all risk-control tests.

Normal payment: A payment that will be rejected by the LVTS if it does not initially pass the risk-control tests under Jumbo-only queuing arrangements.

Payment: The payer's transfer of a monetary claim on a party acceptable to the payee.

Payment queue: The storage mechanism by which payment messages that have been tried against, but have not passed, the applicable risk-control tests may be stored in the payments system until such time that the payment messages are either delivered to the receiving participants or returned to the sending participants.

Pledge: A grant to the Bank of Canada of a security interest in collateral as security for any advances of funds that the Bank of Canada may make; this includes a grant of a

security interest in which the Bank of Canada does not take physical possession of the collateral.

Real Time Gross Settlement: A system that can effect final settlement of individual payment obligations on a continuous (real time) basis during the processing day, by means of transfers of funds held in participants' accounts at the settlement agent (typically the central bank).

Settlement: An act that discharges obligations in respect of funds or securities transfers between two or more parties.

Survivors-pay: Loss-sharing arrangements which, in the event of a participant's inability to settle, require losses to be borne by the surviving participants according to some predetermined formula.

SWIFT: The Society for Worldwide Interbank Financial Telecommunications and the payment-messaging system used by LVTS.

System-wide percentage: The percentage (currently set at 24 per cent) used for calculating a participant's maximum ASO and Tranche 2 net debit cap.

Tranche 1 Net Debit Cap: For each participant, the maximum negative amount of its multilateral net Tranche 1 position that is allowed. The Tranche 1 net debit cap for the Bank of Canada is unlimited.

Tranche 2 Net Debit Cap: For each participant, the maximum negative amount of its multilateral net Tranche 2 position that is allowed.

Unwind: A procedure followed in certain clearing and settlement systems in which transfers of securities and funds are settled on a net basis at the end of the processing cycle, with all transfers provisional until all participants have discharged their settlement obligations. If a participant fails to settle, some or all of the provisional transfers involving that participant are deleted from the system, and the settlement obligations from the remaining transfers are recalculated.