By-pass FIFO Queue Mechanism for Liquidity Risk Management in Electronic Payments of System

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The issues concerning liquidity risk management through implementation the by-pass FIFO mechanism. Transactions that cannot immediately be settled by RTGS because of lack of funds are placed in queue, awaiting funds. Transactions are executed from the queue according to priority classes. The queue management rule for queued payments will be "by-pass FIFO" (also known as FAFO) within priority class. This means that if the first queued payment of the highest priority class cannot be settled, the system will attempt to settle the next transaction in that class, and if that cannot be settled the next and so on within that priority class. No payment shall be effected as long as there are payments of a higher class in the queue. Payments with a higher priority are always treated first.

Keywords: *queued payments, liquidity risk management, by-pass FIFO mechanism, real-time settlement, gridlock resolution methods.*

Introduction
The theory of queue is the main instrument used for the study of the congestion phenomena, which occur when the number of the applications exceeds the servicing capacity. The term *queue* originates from the Latin word *coda* and it means the disposing under the form of a row of certain applications that are waiting. The theory of waiting is a branch of the operational researches, which has as an objective the mathematical approach of the queues or of the queue wires. The queue wires and the queue theory found their applicability in different fields such as telecommunications, traffic control, anticipation of computer performances, medical services, aerial traffic, sale of airplane tickets. Together with the implementation of the new digital technologies in the banking fields, this theory is currently applied for payments efficaciousness.

In practice, the theory of waiting is especially used in order to point out the malfunctions existing within an operating system and in order to show the directions for the efficaciousness of its operation by indicating the values which certain system variables have to reach, in order to come to a satisfactory level of the performances.

Liquidity Risk Management in the Electronic Payment System

From the point of view of the risk, the main characteristic of the payment system based on gross payment, RTGS, consists of the fact that this offers the possibility of eliminating the systemic risk, fact that is very important for the central bank, with a view to provide and maintain financial stability. This elimination is the result of the substantial intraday decrease of the inter-banking expositions, by the implementation of the liquidity facilities under the form of queues.

The payment instructions are processed in serial order of their arrival. In case of insufficient funds in the settlement account, the payment instruction is placed in a queue, centralized managed by the system. The payments are arranged in the queue depending on the attached priority class and, within the class, depending on the moment of their submission.

The by-pass FIFO queue management principle by observing the priority classes (the system makes payments in the chronological order „first available – first out"; if this is not possible, the following next payment is executed for which there is sufficient cash, procedure that is applied within each priority class; no payments in a priority class shall be made as long as there still are payments in the queue of a class superior to it). In the ReGIS system, the payment instructions may have priorities in a range from 0 (the lowest

level) and 99 (the highest level). The priorities from 51 to 99 are pre-defined in the system for specific aims, and they may not be allotted by the participants. The participants, except the organizations that provide compensation and settlement services (for example. BVB) may allot processing priorities between 0 and 50, for the instructions processed by them. The payment instructions initiated to RNB by the participants shall have allotted the priority 57.

A very important aspect in the analysis of the modality and solutions chosen for the implementation of the queues represents the possibility offered by the system to cancel the instructions that are in the queue.

During the operation day, the central bank as system administrator may cancel any payment instruction in the queue, on demand of the initiating participant, with a prior notification of the initiating participant. Exceptions are the payment instructions initiated by the organizations that provide compensation and settlement services (for example Bucharest Stock Exchange), the payment instructions of which may not be canceled by RNB from the intraday queue on demand of the initiating participant.

At the final limit moment of the operation day, the payment instructions that are in the queue are automatically canceled by means of a sub-routine which is automatically generated by the system.

Another very important aspect regarding the implementation modality of the queues consists of the fact that the electronic payment system has a proper algorithm for detecting and solving the „gridlock" type situations (intraday settlement blocking). In case the settlement of the payment instructions of two or more participants, which are in the queue, is blocked due to lack of funds in the settlement accounts of the respective participants, the ReGIS system provides the automatic release of a unblocking mechanism that aims at the concomitant settlement (by stimulating a bilateral or multilateral compensation) of as many instructions as possible of the respective participants.

The unblocking mechanism may also be released manually by the central bank in its capacity of system administrator. To this aim, RNB monitors the settlement accounts and the payment instructions statement of each participant, which are in the queue.

The release of the unblocking mechanism shall be postponed if a payment instruction was previously introduced in the system for the settlement of the net positions resulted from the compensation systems, as well as during the period when ReGIS system tries the settlement thereof. In case the unblocking mechanism is already operating when the payment instruction for the settlement of the net positions resulted from the compensation systems is introduced, the unblocking shall be finalized before processing the respective payment instruction.

In the settlement system based on gross payment, ReGIS, risk management is provided by:

a) Supply of intraday liquidity based on bonds under the form of Government bonds

b) System monitoring by the competent authorities and taking the necessary measures.

In order to provide an efficient liquidity management, the ReGIS system offers to the participants a series of facilities meant to provide for them the framework and instruments necessary for a proper management of their own liquidities and of the financial risks that may occur, namely:

– intraday credit granted by the Romanian National Bank, which offers to the participants the possibility to obtain intraday liquidity for the fluidization of the settlements in the ReGIS system. This facility is granted through *repo* operations with eligible assets, according to the provisions of the *System Rules of ReGIS* and to the *Regulation No. 10/2005 regarding the facilities granted by the Romanian National Bank for the fluidization of the settlements in the ReGIS system*;

– the queue mechanism, which offers to the participants the possibility to allot to the payment instructions initiated in the ReGIS system processing priorities according to their own necessities, to re-prioritize them depending on the liquidity available in their

settlement accounts or to cancel the payments in the queue because of lack of availabilities in the settlement account;

– funds reservation facilities, in order to provide the settlement of the payment instructions initiated by compensation or settlement systems of the operations with financial instruments, funds that are blocked until the participants have the possibility of building up, anytime during an operation day, of a general cash reserve, for the management of their own resources and of the cash operations;

– the mechanism of settlement of the blockings through which the unblocking of the payment instructions settlement of two or more participants is provided, which are in the queue due to the lack of funds in the settlement accounts of the respective participants;

– the real time monitoring facilities of the settlement accounts. In order to obtain the information necessary for the efficient management of their own resources, the systems allows the participants to monitor their own activities, offering them real time information facilities regarding the statement of the settlement account and the evolution of the intraday liquidity cash, both by accessing the system and by specially drawn up reports.

As far as the risks management in the settlement system based on gross payment is concerned, SENT, it has to be pointed out the fact that the majority of the inter-banking payments are made through this system, which proved to be the most efficient.

As a result of this payment concentration on a certain system, the risk too, which is inherent to any system, has a higher value and may become system risk. The risk may occur due to the lack of liquidity of one of the participants which cannot receive their funds from their customers.

Risks management in the system with settlement based on gross payment is carried out through:

a) the existence of a system of risks covering;
b) system monitoring.

The system of risks covering is based on the building up of unilateral guarantees of the participants in favor of ACH in the system of Government bonds, SaFIR, and through the voluntary reservation of liquidities for the settlement of the net amounts resulted from the compensation made through ACH. The participants may sent for compensation, for each cycle, payment instructions of the credit transfer type or payment confirmations of debit direct transfer type, so that the total payment amount should not exceed the level of the bonds built up in the system.

While using this guaranteeing scheme, it is provided that the debtor multilateral net position of any participant is covered in any moment by the guaranteeing ceiling built up by the respective participant.

The final settlement of the net positions of the participants shall be made through ReGIS. In order to supply liquidity in ReGIS necessary for the final settlement of the net positions resulted from compensation and the decrease of the level of the necessary guarantees, there will be 3 daily compensation cycles.

The guaranteeing ceiling is calculated in *SENT*, based on the data communicated by ReGIS and SaFIR systems, as amount of the value of two types of guarantees:

a) under the form of funds blocked in *SENT* reserve of the ReGIS system;

b) under the form of financial instruments eligible in the SaFIR system.

The SaFIR and ReGIS systems communicate these values for each session, as an answer to *SENT's* request.

The guarantees are built up at the disposal of the Romanian National Bank in its capacity of settlement agent, by each participant, and they may be executed and used only for providing the settlement of its own debtor net position calculated in the compensation session in the *SENT* system, under the conditions when the amounts available in the settlement account of ReGIS are insufficient.

As far as the risks management in the third subsystem of the electronic payment system is concerned, it has to be pointed out the fact that the first mechanism of the management of the risks related to the operations with financial instruments is, from the point of view

of the importance, the settlement principle "supply against payment". The implementation of this principle is materialized, at the level of the system, through the interdependence between the funds transfer and the transfer of financial instruments.

Thus, the final transfer of the financial instruments takes place if and only if the final transfer of funds takes place. A means of risk decrease represents the very real time settlement pattern by eliminating the supplementary processing time, the risk of the occurrence of certain events of the nature to prevent the fluent carrying out of the settlement procedure being limited. At the same time, the settlement based on gross payment decreases considerably the uncertainties of a legal and operational nature, as well as the impact of a possible failure in settlement over the other participants, aspects related to a settlement system based on gross payment.

Besides the main mechanisms above-described there are also settlement ceilings for the participants, which have no settlement account in the ReGIS system, the queue management system for the settlement instructions and their unblocking procedure.

Risks management in the SaFIR system is carried out through a good management of the liquidity facilities too.

The central bank grants intraday liquidity facilities for the participants in the high value settlement system, according to the requirements provided by the standards of the European Central Bank.

The credit institutions participating in the SaFIR system have the possibility to procure from the Romanian National Bank the necessary intraday liquidity, in order to go on with the settlements in this system through *repo* operations carried on with assets eligible for transaction.

For an optimum management of the risk, the SaFIR system manages 7 queues. The queues managed by SaFIR system are the following: 1) queue for „Awaiting counterpart message" where the messages are placed for their matching; 2) the queue „Awaiting securities" includes the transactions for the securities available in the account of Government

bonds record of the seller participant are not sufficient for settlement; 3) the queue „Awaiting funds settlement" includes the transactions that await for the settlement of the funds in RON, from the part of the ReGIS system, and the settlement of the foreign currency funds from the part of the seller participant; 4) the queue „Awaiting subsequent initiation" that includes information related to the operations that imply the execution at a subsequent moment, respectively: the second step of the REPO transaction and/or the DvP type transactions related to the settlement of the results of the primary market of the Government bonds denominated in foreign currency; 5) the queue „Awaiting authorization" includes the operations of execution of the guarantees that await the authorization for the carrying out of the settlement; 6) the queue „Awaiting additional funds" includes the transactions the value of which exceeds the limit of the funds available for the participants which have no settlement account in ReGIS, respectively the participants for which the system manages the settlement ceiling; 7) the queue „Awaiting lien" where the messages are entered for the execution of the liens that are subject to the Title VI of the Law No. 99/1999 regarding certain measures for the acceleration of the privatization, messages sent by the participants which are the beneficiaries of the liens.

The system releases the unblocking procedure of the processing of the instructions that are in the queues "Awaiting securities" and "Awaiting additional funds" through the modification of the scanning method of the respective queues in FAFO (First Available First Out). Thus, the order of the transactions in the queue is modified within the same priority class.

The unblocking mechanism is initiated before the closing of the corresponding services: DvP, FoP (Delivery versus Payment and Free Operation Payment) or manually by the Romanian National Bank, in its capacity of system administrator.

Risk management in the SaFIR system is provided through the settlement ceiling managed by SaFIR for the participants that have

no settlement account in ReGIS, but also through the system monitoring by the competent authorities.

The settlement ceiling represents the amount within the limit of which the bank undertakes to settle in the ReGIS system, the equivalent value of the operations with Government bonds carried out through the SaFIR system by the participant with no settlement account in the ReGIS system. The values of the settlement ceiling maintained by the system are modified on the occasion of the payments events, correspondingly to the debtor or creditor position which the respective participant has at the settlement (based on net or gross payment) of the respective payment event. If the equivalent value of a sale transaction exceeds the foreseen value of the settlement ceiling, the respective transaction is placed in the queue "Awaiting additional funds". The system administrator provides through this procedure a proper risk management. In this sense, the system cancels the instructions initiated by the participant who has no settlement account in ReGIS if up to the Limit Moment (established by the participants or set by the system for DvP service), the respective instruction exceeds the foreseen value of the settlement ceiling.

The Effect of Queues Implementation over the Participants in the Electronic Payments System

Not all the payments settled through an important payment system, such as it is for example the ReGIS system, necessitate an immediate settlement. No all the payments are urgent payments, they may be settled during the day, but not necessarily in real-time. This means that the participants must not immediately obtain the liquidity in order to cover all the payments. Instead, they may wait for the settlement of the payments the beneficiaries of which they are, in order to be able to use this liquidity avoiding in this way the collateral costs for the intraday credit. The participants may use for this the management facilities of the liquidity offered by the ReGIS system.

We shall focus in this article on the management facilities of the liquidity offered by the

queues and by the mechanism for gridlock type blockings settlement. For the beginning, we consider as being set out the volume of liquidity necessary for the participants and we consider that there is a measuring method of the delays in the payment system. Then, we shall introduce a stimulating system for the payments in the three subsystems of the Electronic Payments System. These 3 subsystems have different methods of liquidity management, such as it was described above. We shall use a data panel of the payments in the Electronic System at the end of the year 2005, after the implementation of the SAFIR system.

The results prove us the fact that the implementation of the facilities of liquidity management by means of the queues decreases the necessity of liquidity of the participants in the electronic payments system and that each method implemented at the level of each of the three subsystems has its own advantages. This mathematical modeling proves us also the fact that there is no liquidity crisis for the participants in SEP. The liquidity risk is practically zero.

In principle, a participant in a real-time funds transfer system must have liquidity for covering the amount of the payments which it has to settle in favor of the other participants. But the participant may also participate with a significantly lower quantity of liquidity if he waits to be settled during the day in his favor more payments which shall provide for him the necessary of liquidity.

We may dispose in the ReGIS system of the facilities offered by the queues and by a settlement at the end of the day, the minimum liquidity necessary for a participant may be defined as:

$$MiL = \min\left[0, \left(\sum_{t=0}^{T} P_t^i - \sum_{t=0}^{T} P_t^U\right)\right], where$$

P_t^i = payments that enter and $\quad P_t^U$ = payments that exit

The minimum limit, *MiL,* is 0, if the participant is only creditor and it corresponds thus to the necessity of liquidity of the participant in order to be able to honor its payment commitments.

In most of the case, a participant is in the position of debtor as against some of the participants in SEP and in creditor position as against others. The maximum limit, *MaL,* shows us which the volume of liquidity is necessary for the participant in order to be able to honor all its payment commitments, even if during this time he does not cash any payment:

$$MaL = \min\left[0, \sum_{t}^{\min} \sum_{i=0}^{t} (P_i^t - P_i^U) \forall t \in [0, T] \right]$$

The delay of payment in the inter-banking payment system may be a systemic risk generating factor, delay factor at the system level. The delay factor measures the medium time necessary for a payment to be settled in relation with the time of transmission of the payment instruction:

$$\rho = \frac{\sum_{i=1}^{T} Q_i}{\sum_{i=1}^{T} \sum_{i=1}^{t} P_i^U}$$

The numerator represents the sum of the payments values in the queues, and the denominator represents the total value of the payments regarded as exit variable, namely of the payments that debit the account of the participant.
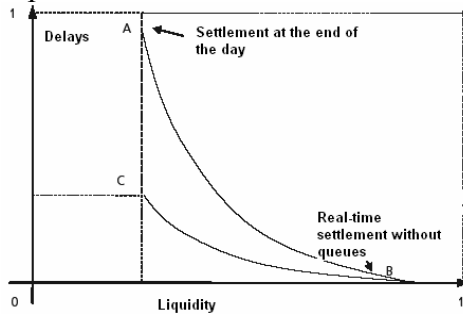
In the above figure, the point A represents the maximum value of the delays. In a payment system without any other facility of liquidity management than the final settlement at the end of the day, a participant that has only a minimum volume of liquidity (*MiL*) shall be in point A. In the same system a participant that has a sufficient volume of liquidity in order to be able to honor immediately his payment commitments (*MaL*) shall be in point B. In a system of real-time funds transfer, such as it is the ReGIS system, benefiting

from the facilities offered by the queues, point C represents the maximum value of the delays. The multitude of values which point C can take, regarded as maximum value of the delays of a real-time funds transfer system that benefits from the facilities offered by the implementation of the queue system is represented by the multitude of the points situated under the AB curve.

In a system where some payments are critical (high value and urgent payments) and where the payment processing is done sequentially, the values *MiL* and *MaL* are dynamically modified.
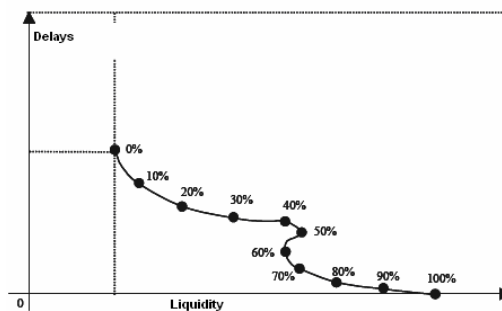
The percentage values in the above diagram show the variation of the liquidity depending on the delay occurred in the settlement of the critical payments (of high value and urgent). It is clear the fact that insofar as the delays decrease, the liquidity increases. This is explained by the fact that no participant obtains liquidity if this transaction generates a crisis of liquidity in the system. This is why the participant must obtain extra-liquidity in order to be able to honor its own critical payments. In this sense, the mechanism of the guaranteeing schemes was implemented into the Electronic Payments System.

Conclusions

The theory of waiting is a very useful instrument for the anticipation of the performances of the liquidity risk management system. In this way, the medium interest sizes (the medium number of payments for settlement in the queue and in the system, the medium time of waiting on the wire and in the system,) can offer us a clear image over the general performances of the system and of the directions of their improvement. By associating a waiting pattern to a calculation system, we can highlight the existing malfunctions, and the theory of waiting shall help us

to make efficient its operation by indicating the values which certain parameters of the system must reach in order to achieve to a satisfactory level of the performances.

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