General Information (Origin of Request)		
☐ User Requirements (URD)		
☒ Other User Functional or Technical Documentation (SYS)		
Request raised by: CSD Steering Group (CSG)	**Institute:** CSG	**Date raised:** 02/08/2018
Request title: Transaction ages up to 15 days should be differentiated by the settlement optimisation process		**Request ref. no:** T2S-0682-SYS
Request type: Common	**Classification:** Maintenance	**Urgency:** Normal
1. Legal/business importance parameter: Medium	**2. Market implementation efforts parameter:** Medium	
3. Operational/Technical risk parameter: Medium	**4. Financial impact parameter:** High	
Requestor Category: CSD	**Status:** Withdrawn	

Reason for change and expected benefits/business motivation:

The T2S CSDR Task Force was established by the T2S Steering level, in order to identify changes to the T2S platform resulting from the CSD Regulation (CSDR), with the objective to facilitate T2S CSDs' timely compliance to CSDR.

One of the core objectives of the CSDR is to promote settlement efficiency through a Settlement Discipline Regime that includes the payment of cash penalties and a mandatory buy-in process for failed transactions.

Failed transactions will be subject to daily cash penalties from the moment when settlement at the Intended Settlement Date (ISD) is no longer possible, while the buy-in process is triggered a certain number of days after ISD. This number of days is referred to as *extension period* within the CSDR and Regulatory Technical Standards (RTS) on Settlement Discipline and is defined differently according to the type of financial instruments subject to the fail:

Extension period:

  a. 4 business days for shares that have a liquid market (cf. Art 7(3)(1) of CSDR)
  b. 7 business days for all financial instruments other than shares that have a liquid market (cf. Art 36 of RTS on settlement discipline)
  c. 15 business days where the transaction relates to a financial instrument traded on an SME growth market, unless the SME growth market decides to apply a shorter period (cf. Art 7(3)(2) of CSDR)

The buy-in process relies on the appointment of a dedicated buy-in agent and results in either the delivery of the bought-in financial instruments or in the payment of a cash compensation to the party suffering from a fail. This implies economic and /or operational costs for CSD participants and their clients which are best avoided to the extent possible.

The T2S settlement optimisation process employs several criteria in order to pursue the overall objective of maximising settlement efficiency (volume and value of settlement). To do so, it favours first the settlement of transactions with a higher level of priority and then the oldest intended settlement date (ISD), as per the URD (T2S.08.060).

T2S uses the concept of 'age' of a transaction to apply the criterion of the ISD in the optimisation process. The age of a transaction is defined by the number of days between its ISD and the current business date. For efficiency reasons, it was decided, in the original T2S design, to limit the age metric at three days to avoid a breakdown in too many "buckets" for the transaction age criterion in the Night-Time Settlement optimisation process.

This approach makes it possible for settlement transactions with an age greater than or equal to 3 business days to be settled in an unexpected order as regards their age, i.e. the younger transaction is settling before the older one. However, the actual occurrences of an unexpected order of settlement are very limited. In order for this situation to materialise, the following conditions must be gathered:

- T2S is performing Night-Time Settlement (NTS) whereby such optimisation algorithm is performed at the start of each sequence;
- 2 pending transactions with age greater or equal to 3 (ISD>=3) have the same priority; and compete for the same resources, i.e. delivery from the same T2S ISIN and securities account, or same cash resources.

Accordingly, there is a minimal but potential risk that under the future CSDR settlement discipline framework, a buy-in process gets triggered, as available resources are used to settle the younger transaction (3 days old), while an older transaction (4 days old or more) remains unsettled at the end of the extension period. A consultation launched by the CSDR TF in March 2017 evidenced that this risk would be very seldom to materialise, as one potential case of buy-in due to unexpected settlement order[1] was identified among 17 million transactions.

Some CSDR TF members nevertheless consider that a change of the T2S design to increase the age considered in the settlement optimisation process could facilitate the management and potentially reduce the number of buy-ins under CSDR.

With regards to the expected benefits of the change, it must be highlighted that the possibility of an unexpected order of settlement would not be fully eliminated, due to parallel processing of transactions performed by T2S during Real-Time Settlement (RTS). This change request should also not be considered as a mandatory regulatory change, as a strict order of settlement is not mandated by CSDR.

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Description of requested change:

T2S currently considers ranking the age of a transaction according to the following breakdown:

- Age 0 = ISD;
- Age 1 = ISD+1;
- Age 2 = ISD+2;
- Age 3 = ISD+3 and more.

In order to fully respect the ranking on the age of transactions having the same priority in the settlement optimisation process, T2S would have to consider an unlimited age number, since matched settlement instructions are recycled until they are settled or cancelled. However, this could have a dramatic impact in terms of efficiency / performance of the T2S platform.

Hence, it is advised to limit the age metric in order to align with the relevant business scenario, i.e. CSDR buy-in process.

Main option:

T2S shall use the following breakdown for ranking the age of a transaction within the settlement optimisation process:

- Age 0 = ISD;
- Age 1 = ISD+1;
- Age 2 = ISD+2;
- Age 3 = ISD+3;
- Age 4 = ISD+4;
- […]
- Age 15 = ISD+15 and more.

With this option, the number of breakdowns is extended to 16 compared to 4 currently (64 "buckets" vs 16 taking into account the four available Priorities in T2S).

Alternative option(s):

In order to further optimise / limit the age metric for efficiency purposes, alternative options with limited business impact could be investigated. One option identified would be that T2S uses the following breakdown when ranking the age of a transaction within the settlement optimisation process:

- Age 0 = ISD;
- Age 1 = ISD+1;
- Age 2 = ISD+2;
- Age 3 = ISD+3;
- Age 4 = ISD+4;
- […]
- Age 7 = ISD+7;
- **Age 8 = ISD+8 to ISD+14;**
- Age 9 = ISD+15 and more;

With this option, the number of breakdowns is extended to 10 compared to 4 currently (40 "buckets" vs 16 taking into account the four available Priorities in T2S). This could only impact the order of settlement for transactions of 8 days of age or older, while still differentiating between ISD+14 and ISD+15 which could be useful in last resort to avoid buy-in for SME growth market transactions.

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[1] The scope of the consultation covered unexpected settlement order that could also arise due to the parallel processing of settlement transactions during Real-Time Settlement (RTS).

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Submitted annexes / related documents:

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Proposed wording for the Change request:

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High level description of Impact:

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Outcome/Decisions:

* CRG members on the 4 September 2018: CRG agreed to launch the preliminary assessment of CR-682.

* On 15 January 2019: This Change Request was withdrawn by its initoator in light of the results of its preliminary assessment.

Preliminary assessment:
- **Findings:**

I-   Current use of age and priority with maximum age = 4

In compliance with the URD the T2S settlement optimization process:

- *shall favour the settlement of transactions with a higher level of priority.*

- *When several transactions with the same level of priority compete for settlement, T2S settlement optimisation process shall favour the settlement of transactions with the oldest intended settlement date (ISD)*

- *When several pending transactions with the same level of priority and the same intended settlement date compete for settlement, T2S settlement optimisation process shall favour the settlement of transactions in a way that maximises the volume and value of settlement (in an optimum balance).*

The two first requirements regarding priority and age are handled in the current implementation:

- (i) by calculating a weight to each transaction as follows:

$$Weight(p, a) = \frac{1}{10^{2(4p-a-1)}}$$

Where:
- o   p represents the priority (reserved=1, Top=2, High=3, Normal=4)
- o   a represents the age
- o   the "4" in (4p-a-1) represents the value (Max of ages +1). This value is therefore 4 in the current implementation

- (ii) with this weight by allocating the transaction in a static bucket as follows:

Priority	Reserved	Top	High	Normal
Age	1	2	3	4
0	0,000001	1E-14	1E-22	1E-30
1	0,0001	1E-12	1E-20	1E-28
2	0,01	1E-10	1E-18	1E-26
3	1	0,00000001	1E-16	1E-24

The third requirement related to the optimum balance is handled with the implementation of a Balance Ratio Indicator (BRI) to reach by the Optimisation process and defined as follows:

$$BRI_\lambda = \frac{1}{\sum\limits_{p,a} Weight(p,a)} \sum\limits_{p,a} Weight(p,a) \times BRI_\lambda(p,a)$$

With:

- $\lambda = 0.5$,
- p the priority,
- a the age,
- BRI the Balanced Ratio Indicator between the Value ratio and the Volume ratio defined as:

$$BRI_\lambda(p,a) = \lambda R_{Vol}(p,a) + (1-\lambda)R_{Val}(p,a)$$

As a result the weight (p,a) of the transactions intervenes in a complex mathematical calculation that is used in order to optimize the settlement.

II-   Impact on optimization process when maximum age is increased

The 2 options propose to increase the maximum age as follows:
-    Main option: 15 distinct days (from 0 to 15, more than 15)
-    Alternative option: 10 distinct days (from 0 to 7, from 8 to 14, more than 15)

These options would lead to have the following buckets:

Main option:
-    64 buckets with following static weights :

Priority	Reserved	Top	High	Normal
Age	1	2	3	4
0	1E-30	1E-62	1E-94	1E-126
1	1E-28	1E-60	1E-92	1E-124
2	1E-26	1E-58	1E-90	1E-122
3	1E-24	1E-56	1E-88	1E-120
4	1E-22	1E-54	1E-86	1E-118
5	1E-20	1E-52	1E-84	1E-116
6	1E-18	1E-50	1E-82	1E-114

7	1E-16	1E-48	1E-80	1E-112
8	1E-14	1E-46	1E-78	1E-110
9	1E-12	1E-44	1E-76	1E-108
10	1E-10	1E-42	1E-74	1E-106
11	0,00000001	1E-40	1E-72	1E-104
12	0,000001	1E-38	1E-70	1E-102
13	0,0001	1E-36	1E-68	1E-100
14	0,01	1E-34	1E-66	1E-98
15	1	1E-32	1E-64	1E-96

Alternative option:

- 40 buckets with following static weights :

Priority	Reserved	Top	High	Normal
Age	1	2	3	4
0	1E-18	1E-38	1E-58	1E-78
1	1E-16	1E-36	1E-56	1E-76
2	1E-14	1E-34	1E-54	1E-74
3	1E-12	1E-32	1E-52	1E-72
4	1E-10	1E-30	1E-50	1E-70
5	0,00000001	1E-28	1E-48	1E-68
6	0,000001	1E-26	1E-46	1E-66
7	0,0001	1E-24	1E-44	1E-64
8	0,01	1E-22	1E-42	1E-62
9	1	1E-20	1E-40	1E-60

As a result adding buckets will add weights having different orders of magnitude which could lead to a numerical instability risk.

Additionally, the more complex the multi-objectives function, the longer the treatment will last. In other words**, with the same duration, the solution provided risks to have smaller settlement efficiency**. It may also **not be possible to reach the same settlement efficiency as today even with a very longer duration**.

III-   4CB pre-requisite to handle increased maximum age

In order to cope with the increasing number of buckets, whichever the option chosen, the multi-objectives function needs to be rendered dynamic. It means that the multi-objectives function would identify the buckets effectively relevant for the ongoing optimisation and affect dynamically an appropriate weight. As there won't be transactions in every bucket each time, it should reduce drastically the number of relevant buckets.

IV-   4CB alternative to handle increased maximum age

4CB alternative

The CSDR seems to indicate a will to settle the transactions as soon as possible. Would it be feasible that the priority of a transaction is taken into account only at ISD and that afterwards only the ages of the transactions is considered?
It would drastically reduce the number of buckets. However, even in this case, rendering the multi-objective function dynamic is a pre-requisite.

New proposal:
- 19 buckets with following static weights :

Priority	Reserved	Top	High	Normal
Age	1	2	3	4
0	1E-30	1E-32	1E-34	1E-36
1	1E-28			
2	1E-26			
3	1E-24			
4	1E-22			
5	1E-20			
6	1E-18			
7	1E-16			
8	1E-14			
9	1E-12			
10	1E-10			
11	0,00000001			
12	0,000001			
13	0,0001			
14	0,01			
15	1			

V-   4CB additional questions and request for a POC

All options considered above (main option, alternative option, 4CB alternative) raise the following questions to the market:

- Could you please confirm the exact rules of age determination in particular for the alternative option?
- First could you please confirm we shall consider T2S business days and not calendar days?
- Then if the age is calculated based on T2S calendar shall we take into account the currency closing days when relevant?

Last this CR bares no dependencies with other CRs but it does however have the potential to impact the systems performance.

As such we propose – for all options considered above - to develop a POC (Proof of concept) to provide some performance analytics and ensure that no specific risks are posed by the proposed implementations

Only a prototype and volumetric tests on a relevant sample (at least 30 business dates) would allow evaluating concretely the impact of these changes and the possibility to implement any of both options.

- **Open issues/ questions to be clarified by the originator:**

- **Can you consider and answer with your choice to the 4CB alternative proposal above**
- **Can you also answer the following**
    o Could you please confirm the exact rules of age determination in particular for the alternative option?
    o Could you please confirm we shall consider T2S business days and not calendar days?

o Then if the age is calculated based on T2S calendar shall we take into account the currency closing days when relevant?