



## **Proposed learning objectives for the Eurosystem exploratory work and Key Performance Indicators for the assessment of the findings.**

### **1. Introduction and scope**

The Eurosystem has developed a framework to conduct exploratory work with new technologies for central bank money settlement of wholesale financial transactions in 2024. The Eurosystem exploratory work is focused on three interoperability-type solutions (Trigger / TIPS Hash Link / Full-DLT Interoperability). The Eurosystem will conduct, jointly with the market, trials (settlement of transactions with real central bank money (CeBM)) and experiments (settlement of mock transactions) focused on Delivery-versus-Payment (DVP), automated single CeBM wholesale payments, and Payment-versus-Payment (PVP) use cases.

As part of the learning strategy of the Eurosystem exploratory work, as the Eurosystem aims to:

- a) compare the three Interoperability-type solutions from a business, operational and technical perspective, and understanding their respective merits as potential solutions for providing CeBM settlement with new technologies.
- b) Understand concretely what added value new technologies such as DLT could bring to wholesale settlement and capital markets.

This note presents the learning strategy proposed by the Eurosystem. The strategy conducts – when applicable:

- (i) a comparable field assessment across the three interoperability-type solutions

Additionally, if capacity constraints allow and a sound base of information for analysis is available, the learning strategy identifies several areas of interest to improve the Eurosystem knowledge on:

- (ii) the three interoperability solutions, without yielding directly comparable results on the three solutions or
- (iii) on topics that have been identified as potentially relevant for future Eurosystem decisions on the field of new technologies for wholesale settlement.

Tackling the questions in category (ii) may also contribute to understand which further development of the three interoperability-type solutions could be pursued in the future, if the Eurosystem would decide to do so. Questions of group (iii) may require a limited Eurosystem involvement in the analysis and may be conducted more easily via market questionnaires.

- Section two of the note provides a high level overview of the learning objectives identified: the Eurosystem has clustered questions into high-level themes on which the comparison of the solutions could be based on and/or in which the Eurosystem could seek further knowledge. The overall rationale of the proposed learning strategy is also presented.

- Section three details the themes and the specific questions to be included in the comparative assessment between the three interoperability-type solutions (category i).
- Section four details the themes and the specific questions requiring the Eurosystem involvement in the analysis for knowledge gain and improving the Eurosystem experience with the interoperability solutions (category ii).
- Section five details the themes and the specific questions that cover general aspects related to the usage of new technologies for wholesale settlement (category iii). These questions represent market-based knowledge gains with limited Eurosystem involvement required for the data collection.

## 2. Proposed learning objectives and rationale of the learning strategy

The Eurosystem has identified several dimensions, also called "themes", in which the current Eurosystem understanding of the interoperability solutions (and in general of new technologies) could be improved and on which the comparative assessment of the solutions could be based on. Several themes can be investigated directly via the trials and experiments that will be conducted ("practical themes"), while other themes will progress mainly via in depth desktop research and questionnaires with eligible market participants, eligible market DLT operators, and the NCBs including the Solution Provider Central Banks-SPCBs ("research themes").

In many cases, different approaches are combined to maximise the learning output:

- the Eurosystem will lead its own experiments to address specific questions (for example stress testing or performance testing):
  - In some cases, specific market participants and/or market DLT operators deemed relevant for the analysis may be invited to participate and contribute to these experiments.
- Eligible market participants and eligible market DLT operators will conduct their own trials and experiments and will be asked to share the results of their explorations with the Eurosystem. Before the start of their exploratory work (as part of wave 1 or wave 2), they will receive harmonised reporting templates including the Key Performance Indicators (KPIs) defined by the Eurosystem to collect both qualitative and quantitative data for the different themes. Depending on the business cases and the investigations performed during the exploratory work, eligible market participants and eligible market DLT operators will report the results for all KPIs that are relevant to the activities they will conduct.
- In parallel to trials and experiments, the Eurosystem will continue its desktop research and will issue questionnaires to eligible market participants, eligible market DLT operators and the NCBs (including SPCBs) to address the themes covered mostly via theoretical analysis. The questions covered in these questionnaires will have a more general scope, rather than being focused on the business cases investigated during the exploratory work.

While the themes should be understood as agnostic with respect to the different use cases part of the exploratory work (i.e. the same analysis may be repeated for all use cases), the more advanced discussion in the Eurosystem and in the NTW-Contact Group for the DvP use case with respect to the PvP and automated single CeBM wholesale payment use cases is reflected in the note. The description and the approach proposed for the assessment of the themes use as example the DvP use case. Nevertheless, the Eurosystem aims at covering in its analysis and assessment all use cases that will be investigated in the exploratory work. Further use case-specific questions and KPIs may be defined and assessed within the dedicated themes (i.e. PvP specific theme etc.)

For what concerns external dependencies, the Eurosystem highlights that for several questions identified the extend of the possible analysis will depend on the eligible market participants and eligible market DLT

platforms that will take part in the exploratory work. **In particular, the possibility to have the same market DLT connected to all three interoperability solutions, the variety of the business cases explored by the market and the technical features of the market DLT platforms will have an impact on the capability to perform a fully fledged comparison between the three interoperability solutions and on the ability to conduct a comprehensive analysis for some of the themes.** The Eurosystem will continue to reassess and further refine the themes identified once the list of participants will be available, to maximise the learning output and the comparability of the results.

It is also remarked that, while the Eurosystem aims at broadening its knowledge in numerous themes during the exploratory work (including cost determinants and possible interaction with TARGET Services – see section 2.2), the analysis conducted should not be understood as a feasibility assessment prior to implementation of the interoperability solutions, as any decision for potential implementation, if the Eurosystem would wish and decide to do so, has not been taken and it would need to be thoroughly assessed involving the relevant Eurosystem bodies and TARGET Services governances.

Finally, **the learning objectives listed in this note should not be considered as a conclusive list, but rather as an evolving documentation**, as further development in the preparation of the exploratory work, the final list of the market participants taking part in the exploratory work, the market feedback from the NTW-Contact Group and preliminary findings may contribute to new learning objectives and specific questions to be defined.

## **2.1 Themes to be investigated via trials and experiments (“practical themes”)**

This section lists the themes that can be assessed mostly or fully via practical work. Some of the questions included will be covered directly via the trials and experiments conducted by eligible market participants and eligible market DLT operators, while other questions will require the execution of *Eurosystem-led experiments* in coordination with the SPCBs. Six themes are identified as practical themes:

- **Settlement performance and efficiency** of the three solutions, including the possibility to implement atomic and instant settlement (or the extent thereof) as observed during trials and experiments. Specific experiments established by the Eurosystem will aim to measure the throughput and ease of scalability of DLT connections.
- **Reliability and safety:** the overall reliability, resiliency and the identification of possible risks and bottlenecks for the different solutions would be assessed based on the results of trials and experiments and parallel analysis. In addition, the Eurosystem would aim to set up Eurosystem-led experiments to investigate how the solutions cope with, and recover from, abnormal scenarios.
- **Integration with new environments (interoperability solutions connecting to market DLTs):** feedback from eligible market participants and eligible market DLT operators conducting trials and experiments would directly inform how easily the solutions would connect with different market DLTs, potentially relying on different DLT protocols and technologies, hence indicating how technologically neutral these solutions could be, and what types of operative frictions they could introduce. Subject to market interest, the possibility of interconnectivity between different market asset DLTs (with the interoperability solutions performing the CeBM leg of the transaction) would be explored via trials and experiments.
- **Information management and reconciliation:** feedback from eligible market participants and eligible market DLT operators conducting trials and experiments, as well as feedback from the SPCBs, would also assess which features could be deployed in the future in the interoperability solutions to enhance ease of reconciliation while preserving privacy, data integrity and transparency. This theme would also include identifying minimum requirements for the set of information needed from the central bank perspective to operate the solution while supporting the market business cases and automations, to be balanced with market stakeholders’ request for privacy.

- **Automation features:** trials and experiments would explore the level of support to automation and programmability provided by the different solutions when the automation is initiated on the market DLTs and/or when directly in the interoperability solutions. This would include exploring, with eligible market participants and eligible market DLT operators, the possibility to provide CeBM settlement for complex programmed payments, liquidity saving mechanisms when applicable, and other applications of automation.
- **Energy consumption** (if measurable) of the different solutions.

## 2.2 Themes to be investigated mostly<sup>1</sup> via desktop research (“research themes”)

This section lists the themes that can be mostly assessed via desktop research. The analysis of the following three themes (“research themes”) will be conducted by the Eurosystem and may be complemented with market stakeholders’ feedback.

- **RTGS, Liquidity management and 24/7:** specific analysis by the Eurosystem would aim to explore how liquidity saving mechanisms may be implemented in the interoperability solutions, as well as investigate the technical and operative implications of providing availability of the solutions on a 24/7 basis.
- **Connection with existing environments (interoperability solutions potentially connecting to TARGET Services):** the Eurosystem would continue its analysis on how the interoperability solutions could potentially be connected to/integrated with the TARGET Services, if the Eurosystem wished to do so, while advancing to better understand how the solutions design could look like in the steady state. This stage will focus primarily on the gathering of information on the pre-requisites for such connection/integration, while the ultimate feasibility would require in the future a thorough analysis by the TARGET Services governances. Analysis may be complemented with the feedback from eligible market DLT operators on their experience of connecting DLTs and traditional systems.
- **First qualitative information on factors determining the costs and time to market of the different solutions in the steady state** (also called “analysis of cost determinants”): while taking benefit from the information gathered in other themes (Integration with new environment in particular) market feedback and Eurosystem analysis could provide indicative high-level estimates as to the impact on the costs and time of connecting interoperability solutions to different type of DLT platforms and the TARGET Services. Difference in cost and time for market players to connect to the solutions of the SPCBs could also be considered. This analysis will be qualitative in nature and aim at identifying key determinants on costs and time to market: a fully-fledged cost analysis is not part of the learning objectives of the exploratory work.

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<sup>1</sup> In these themes, the bulk of questions will be investigated through research and not through practical trials and experiments. Some specific aspects or research questions may benefit from the results of trials and experiments.

## 2.3 Overview of the full list of questions

The questions identified by the Eurosystem have been clustered in high-level themes according to the topic/subject that they cover (as described in section 2.1 and 2.2). At the same time, based on the expected usage of the information that will be collected, questions have been separated into three categories (as described in section 1). For some questions, there are potential findings that could fit into more than one category. The classification in categories should not be considered as final, as new information and preliminary findings might lead to further adjustments.

Themes and questions	comparative assessment (category (i))	improve knowledge (category ii)	improve knowledge (category iii)
<b>Theme 1: Settlement performance and efficiency</b>			
1.1. Latency	X	X	
1.2 Throughput	X		
1.3 Ease of scalability (of DLT connections) – how many DLTs can be connected without affecting performance	X		
1.4 Support DvP instant settlement	X		
1.5 Support DvP atomic settlement	X		
1.6 Support DvP instant and atomic settlement	X		
1.7 Comparison of DLT consensus algorithm to enhance efficiency in settlement for the interoperability solutions in the presence of multiple Eurosystem nodes		X	
1.8 Improvement / loss of integration in settlement compared to using traditional platform or compared to using single platform on both legs		X	
1.9 Settlement finality in potential steady state: identify correct timestamps for finality in steady state scenario		X	
<b>Theme 2 RTGS, Liquidity management and 24/7</b>			
2.1 Feasibility of implementation of liquidity saving mechanism	X	X	
2.2 Efficiency of liquidity management for new liquidity pots and transfers of CeBM liquidity across pots		X	
2.3 Support DvP settlement on a 24/7 basis	X		
2.4 Implication of 24/7 availability for liquidity management	X		
<b>Theme 3: Reliability and safety</b>			

3.1 Robustness	X		
3.2 Resiliency	X		
3.3 Applicability of contingency procedures	X		
3.4 Identification of system bottlenecks		X	
3.5 Dependency from specific 3 <sup>rd</sup> party service providers	X		
3.6 Risk management (operational, liquidity, cyber)	X		
3.7 Minimum requirement for accepting interconnection with external DLT (resilience, cyber, legal jurisdiction?)		X	
<b>Theme 4: Connection with existing environment (for example TARGET Services)</b>			
4.1 Gap assessment for potential TARGET Services connection/integration (basic pre-requisites)	X		
4.2 Ability to support ISO20022	X		
<b>Theme 5: Integration with new environment (market DLT)</b>			
5.1 How to ensure connectivity with market DLT, both technical features and operational aspects (example: error handling, timeout limits etc)	X		
5.2 Technological neutrality (do the technological choices for the SPCB environment or Interoperability mechanism constrain participants to adopt some technological standards?)	X		
5.3 Technical mitigation measures to ensure interconnectivity between assets DLTs and avoid the creation of silos (Fragmentation) both from technical and operational perspective		X	
5.4 Comparison of operative frictions in daily business operations / needs with respect to traditional infrastructures	X		
<b>Theme 6: Analysis of cost determinants</b>			
6.1 Different operational burden of the solutions	X		
6.2 Cost difference in ensuring narrower or broader interconnectivity to external DLT platforms (in terms of number and different protocols used)	X		
6.3 Cost for market participants to connect and operate in new solutions	X		
<b>Theme 7: Information management and reconciliation</b>			

7.1 Supporting transparency on the market DLT side / asset leg: techniques to implement transparency of information on DLT for reconciliation while maintaining users privacy			X
7.2 Transparency and information management on the SPCB solutions	X	X	
7.3 Ease of reconciliation between interoperability solutions and market DLT	X	X	
7.4 Confidentiality techniques available	X	X	X
7.5 Preservation of data integrity	X	X	X
7.6 Comparison of consensus algorithm for data management		X	X
<b>Theme 8: Automation features</b>			
8.1 Supporting programmability and automation (smart contracts) on the market DLT side – in particular securities lifecycle management – e.g. programmed coupon payments, corporate actions	X		
8.2 Supporting programmability and automation on the cash leg	X	X	X
8.3 Comparison with traditional infrastructures (what we can currently do)		X	
<b>Theme 9: ESG</b>			
9.1 Environmental impact / energy consumption	?		
<b>Theme 10: PVP</b>	tbc	tbc	tbc
<b>Theme 11: Automated single CeBM wholesale payments use case</b>	tbc	tbc	tbc

**3. Detailed questions for the comparative assessment of the solutions (category i)**

This section lists the questions that the Eurosystem identified in scope to perform the comparative assessment of the three interoperability-type solutions part of the exploratory work. They questions are listed following the high-level theme they belong to.

For what concerns external dependencies, the Eurosystem highlights that for some of the themes (in particular for “Settlement performance and efficiency” , “Integration with new environment”, “Information management” , “Automation features”), having the same one or group of eligible market DLTs connected to all three interoperability solutions and having the same or similar business cases being explored in all three solutions would enhance the comparability of the findings and would allow to increase the scope of the comparative assessment. In case this would not be possible, the Eurosystem will identify eligible market DLTs with similar features or in some cases perform the comparative analysis considering only the interoperability solution (i.e. excluding factors affected by the eligible market DLT being connected).

In parallel to the comparative assessment of the detailed KPIs identified (reported below), the Eurosystem will also pursue the more general objective of identifying the differences between the three solutions in the design/nature and in the approach to provide interoperability.

*NB: all references to market DLT and market participants in the table below refer to eligible market DLTs and eligible market participants conducting trials and experiments, after their eligibility is confirmed.*

**3.1 Settlement performance and efficiency**

This theme will focus on the identification of bottlenecks and to what extent they could be mitigated.

Theme	1. Settlement performance and efficiency
Question	1.1 Latency
Key terminology to be defined	<p>Latency: the delay before the settlement begins following an instruction for its execution. We identify the following steps for the transaction:</p> <ol style="list-style-type: none"> <li>1. A valid DvP order is received from the market DLT</li> <li>2. Processing of the transaction on the cash leg</li> <li>3. The transaction is confirmed to the market DLT</li> </ol> <p>Latency is the delay between 1 and 3. Latency is measured in milliseconds (ms)</p>
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p>We want to measure how long does it take for the cash leg transaction to be executed after the order has been received from the market DLT Experiments on latency will test which processing times the solutions are capable of. We would measure each timestamp for the whole chain of transaction processing.</p> <p>Two objectives identified:</p> <ol style="list-style-type: none"> <li>a) For the measurement/comparison of solutions and final reporting, the analysis will focus on the cash side only. For all three solutions there is a two-step process for measuring latency, as the time needed for the market confirmation to be received is not taken into account. First, the latency measurement is stopped when the confirmation of the cash reservation is sent to the asset DLT, then the latency measurement is restarted when the asset DLT confirms that the cash movement can be executed. In case a same group of market DLT will be connected to all three interoperability solutions, the Eurosystem will evaluate whether extending the scope of the comparison to the full DvP transaction</li> </ol>



Data collected	<p>Quantitative findings</p> <p>Duration of the settlement process in the interoperability solutions (cash leg)</p> <p>Market participants to provide timestamp of the settlement of the asset leg in the market DLT (to potentially analyse the full DvP process duration)</p>
What are the practical implications / steps / process needed for the testing via Trigger Solution	<p>We identify the following steps for the transaction:</p> <ol style="list-style-type: none"> <li>1. Buyer and Seller agree on the exchange Eligible Assets against EUR in an external Eligible DLT Platform. (Asset Trade Agreement)</li> <li>2. According to the Interoperability Mechanism, a Payment Instruction will be created through a smart contract in the Trigger Solution (Create Payment Instruction) <ol style="list-style-type: none"> <li>a. The payment instruction is approved by an authorized third party/payer bank</li> <li>b. The payment instruction is submitted for settlement in the Trigger solution</li> </ol> </li> <li>3. Bundesbank converts the Payment Instruction in the Trigger Solution into ISO20022 messages and submits them via ESMIG to T2/RTGS (Validate Payment)</li> <li>4. Bundesbank as solution provider sends a direct debit via the Network Service Provider (NSP) to T2 in order to debit the payer bank's RTGS DCA and credit an interim account of Bundesbank (Process Debit Payment) <ol style="list-style-type: none"> <li>a. In case of HTLC, the status is updated (payment locked) by the Trigger Solution</li> <li>b. The final credit transfer is initiated by the Trigger Solution by providing the secret to the hash included in the payment instruction</li> </ol> </li> <li>5. Bundesbank as solution provider sends a credit transfer via the Network Service Provider to T2 in order to debit the interim account of Bundesbank and credit the payee bank's RTGS DCA (Process Credit Payment)</li> <li>6. Information on the successful or failed settlement on the RTGS DCAs will be sent to the Trigger Solution. (Update Payment Instruction)</li> <li>7. The status of the Payment Instruction is transferred to the Eligible Market DLT Platform, where the assets are finally transferred (Transfer Asset)</li> </ol> <p>The Trigger Solution offers two approaches:</p> <ul style="list-style-type: none"> <li>- STP approach (without HTLC) – latency between 2b and 6</li> <li>- HTLC (submit until payment locked and payment unlocked and payment confirmed) – latency between 2b and 4a and 4b and 6</li> </ul> <p>If HTLC is used, the time needed by the market DLT to confirm the transaction is not included in the latency measurement.</p>
What are the practical implications / steps / process needed for the testing via TIPS Hash-Link	<p>We identify the following steps for the transaction:</p> <ol style="list-style-type: none"> <li>1. The API Gateway receives a call to initialise the transaction</li> <li>2. The API Gateway generates R and R', computing hash(R) and hash(R')</li> <li>3. The initialisation is confirmed to counterparties.</li> <li>4. The API Gateway receives a call to settle the cash leg</li> <li>5. The payment system processes the settlement of the cash leg</li> <li>6. The transaction is confirmed to the counterparties</li> </ol> <p>Latency is the delay between 1 and 3 + the delay between 4 and 6. Delay between steps 3 and 4 must be excluded from computation.</p>
What are the practical implications / steps / process needed for the testing via Full DLT interoperability	<p>The HTLC protocol foresees that the market DLT manages the DVP (matching, ...), and then calls via API the interoperability solution to reserve the cash. Then in a further step, the market DLT calls via API to move the cash.</p> <p>We identify the following steps for the transaction/DVP:</p> <ol style="list-style-type: none"> <li>1. Once the market DLT starts the settlement of a DVP, a call via API is received from the market DLT: Check of DVP information from the seller, including the secret received, and answer to the market DLT.</li> </ol>

	<ol style="list-style-type: none"> <li>2. Once the securities are locked, a second call via API is received from the market DLT, in order to reserve the cash, and an answer is sent back to confirm or not the reservation. The payment is processed within DL3S with the secret and a call via API is sent to the market DLT in order to confirm the payment</li> <li>3. The securities are delivered on the market DLT side</li> </ol> <p>The latency for a DVP includes all the steps. Nevertheless, for DL3S, latency should be measured for step 1, then stop the clock, and restart the clock for step 2.</p>
Market feedback received from NTW-CG	Keep in mind that both on the assets and cash side the solutions are not at production-grade level yet, latency important but other measures more relevant in a forward-looking approach, i.e. scalability, reliability of the systems

Theme	1. Settlement performance and efficiency
Question	1.2 Throughput
Key terminology to be defined	<p>Throughput: the number of settlements executed in a given timeframe</p> <p>We identify the following steps for the transaction:</p> <ol style="list-style-type: none"> <li>1. A valid DvP order is received from the market DLT</li> <li>2. Processing of the transaction on the cash leg</li> <li>3. The transaction is confirmed to the market DLT.</li> </ol> <p>Throughput is the number of steps 2-3 completed in a given timeframe.</p>
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p>In experiments, we want to measure how many settlements each of the 3 solutions is able to perform in a given timeframe.</p> <p>We expect to collect results in form of quantitative findings</p> <p>Throughput is measured in transactions per second and the analysis is conducted over a few hours per day, over several days, to ensure consistency and stability of the results</p>
Data collected	<p>Quantitative findings</p> <p>Market participants to provide timestamp of the settlement of the asset leg in the market DLT and list of instructions submitted</p>

Theme	1. Settlement performance and efficiency
Question	1.3 Ease of scalability (of DLT connections) – how many DLTs can be connected without affecting performance
Key terminology to be defined	<p>Scalability: the ability of the settlement solution to function properly when the variables affecting its behaviour/ability to connect further DLTs without a significant decrease in performance or the need for major architectural changes. It measures how well a payment system can grow and adapt to accommodate greater demands and workloads while maintaining efficiency, speed, and reliability. For the comparison, we focus on whether the number of DLTs connected affects the settlement performance</p> <p>Possible variables: number of DvPs per second and number of different market DLTs requiring DvPs per second</p>
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p>in <i>Eurosystem-led experiments</i>, we want to measure if there are particular variables the variations of which affect significantly latency and throughput (i.e. if performance decline after a certain volume of transactions in a given timeframe). Focus of scalability is on settlement only:</p> <ul style="list-style-type: none"> <li>• Impact of having N DLTs connected to each solution</li> <li>• Impact of adding X new DLTs to each solution</li> <li>• Impact of having N+X DLTs connected to each solution</li> </ul>

	<p>Approaches:</p> <p>a) each new DLT adds a fixed number of transactions per second  b) number of DvP transactions per second is fixed but the number of DLT changes</p> <p>The preliminary assessment of throughput and latency will allow to define, in preparation of the scalability experiment:</p> <ul style="list-style-type: none"> <li>- What is the normal flow (Number of DLT x Number of transactions per DLT)</li> <li>- Which increase can be needed, either via new DLT and/or via increase of transactions per existing DLT</li> </ul> <p>There is a dependency on the type of market DLT participating in exploratory work and a need to coordinate with market DLTs for conducting this experiment  There is a need to check if the market DLTs have different processing mechanisms and response times that could affect the results. It is unlikely to have a high N as not all market DLTs would necessarily connect to all the solutions. Pragmatically, we could ask all market DLTs connected to each solution to take part in one experiment per solution where each submits an increasing number of transactions per second until throughput and latency degrade too much.</p> <p>Additional possible question: for specific business cases where multiple asset DLTs are involved for a single order (for example interlinked CeBM-Commercial Bank Money, Delivery vs Payment vs Payment, etc.), would there be an impact on the number of transactions (i.e. multiplications of transactions to achieve one single order across multiple DLTs)</p>
Data collected	<p>Quantitative findings  Market participants to provide timestamps of the settlement of the asset leg in the market DLT and a list of instructions submitted</p>
Market feedback received from NTW-CG:	<p>Platform scalability is deemed as the most important feature by the NTW-CG in the settlement performance theme</p>

<b>Theme</b>	<b>1. Settlement performance and efficiency</b>
<b>Question</b>	<b>1.4 Support DvP instant settlement</b>
<b>Key terminology to be defined</b>	Instant: DvP instant settlement is a specific mechanism that ensures the simultaneous and immediate exchange of assets and funds in a financial transaction.
<b>Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome</b>	<p>We use the TIPS / SCT Inst definition (10 seconds): base scenario involves checking only cash leg (stopping the clock when waiting for the asset leg confirmations)</p> <p>If there will be some assets DLT technically capable and willing to provide instant settlement, we will test if full DvP can occur in an instant settlement fashion</p> <p>The evaluation will give a score to the three solutions: do they support instant settlement?  Yes fully / Yes, partially / No</p>
<b>Data collected</b>	<p>Quantitative findings  Market participants to provide timestamp of the settlement of the asset leg</p> <p>Qualitative findings  Do they support instant settlement? Yes fully / Yes, partially / No</p>
<b>Market feedback received from NTW-CG:</b>	<p>Is instant settlement a key features of future infrastructures, is there a business case for instant settlement? Is atomicity enough on DLT?  Diverging views, while atomicity is deemed important, it may have significant impact on cost of capital. Instant settlement brings benefit on liquidity management and new product offering, therefore it is also important</p>

Theme	1. Settlement performance and efficiency
Question	1.5 Support DvP atomic settlement
Key terminology to be defined	Atomicity: a characteristic of a transactions which is guaranteed to either completely occur or have no effects. In our base scenario (DvP), delivery and payment are the transactions
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p>(Linked to question 3.1 Robustness) We want to identify if, in certain conditions, only delivery or only payment would occur, breaking the atomicity condition (breaking the all or nothing condition)</p> <p>We expect all three solutions to provide the same level of atomic DvP settlement. However, specific experiments to try to break atomicity (technical failures) will be conducted by the Eurosystem Also to be confirmed via qualitative assessment of the trials: keep track of reported failures from the market participants (and checking business reasons if it does occur)</p> <p>The expected result of the assessment will classify whether the solutions support atomics settlement: Yes ,fully / Yes, partially / No</p> <p>It will also be identified what are the possible mitigation actions to eliminate the risk that atomicity is broken</p>
Data collected	<p>Qualitative findings Report on settlement failures by market participants / market DLT via templates Results from <i>Eurosystem-led experiments</i> to break atomicity</p>

Theme	1. Settlement performance and efficiency
Question	1.6 Support DvP instant and atomic settlement
What are the practical implications	<p>By conducting the analysis of question (1.4 and 1.5), it will also be assessed whether there is any obstacle to provide atomicity and instant settlement together.</p> <p>Yes, fully / Yes, partially / No</p> <p>Identifying any possible obstacle (on the Eurosystem cash leg or the leg on the external market DLT) that makes the steps ensuring atomicity not compatible with the timeframe of instant settlement (10 seconds as reference)</p>
Data collected	<p>Quantitative findings Market participants to provide timestamp of the settlement of the asset leg Qualitative findings Do they support instant and atomic settlement? Yes fully / Yes, partially (when not) / No</p>

### 3.2 RTGS/Liquidity management and 24/7

Theme	2. RTGS, Liquidity management and 24/7
Question	2.1 Feasibility of implementation of liquidity saving mechanism
Key terminology to be defined	<p>Liquidity saving mechanisms (LSM) are processes which exist among others in TARGET Services to facilitate and optimise the use of liquidity (cash or securities) and consequently of settlement.</p> <p>These might include:</p> <ul style="list-style-type: none"> <li>(auto)collateralisation : possibility to pledge securities (on flows or on stocks) to free cash to settle pending transactions</li> </ul>

	<ul style="list-style-type: none"> <li>• Partial settlement</li> <li>• shaping</li> <li>• auto-borrowing</li> <li>• liquidity reservation : possibility to allocate dedicated liquidity to a specific usage</li> <li>• prioritisation : instructions are given a priority level for settlement</li> <li>• netting : possibility to aggregate transactions to proceed with a net settlement</li> <li>• floor/ceiling thresholds</li> </ul>
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p>Identify to what extent or how the proposed solutions might allow for LSM to be implemented:</p> <ul style="list-style-type: none"> <li>○ Trigger : fully, partially, not ; which ones if not or partially</li> <li>○ TIPS Hash link : fully, partially, not ; which ones if not or partially</li> <li>○ Full DLT Interop : fully, partially, not ; which ones if not or partially</li> </ul> <p>For the comparison, to be assessed via experiments if actual LSM are in place, otherwise analyse technical feasibility of further LSM being implemented in the future. Any finding would be preliminary and would require confirmation by the Eurosystem governance bodies in case LSMs were to be pursued.</p> <p>Likely implementable / Partially implementable / Not implementable</p>
Data collected	<p>Qualitative findings</p> <p>Market participants to report on conducted experiments – when LSM are available</p> <p>Technical assessment with SPCB on implementation – when LSM not available</p>
Market feedback received from NTW-CG:	<p>Which LSM do market participants expect to see available in in the trigger TIPS Hash Link / full DLT interoperability solutions?</p> <p>Should LSMs be prioritised, which would come 1st and 2nd?</p> <p>In steady state, the Eurosystem should seek to implement the same LSM as in T2S to avoid a reduction of functionalities.</p> <p>Autocollateralisation, partial settlement, netting, floor/ceiling to be prioritised for exploratory work.</p> <p>Moreover, solutions should be integrated with current TARGET Services' liquidity management to avoid creating new liquidity pots not connected to current accounts in TARGET (MCA and DCAs)</p>

Theme	2. RTGS, Liquidity management and 24/7
Question	2.3 Support DvP settlement on a 24/7 basis
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p>Assessment (mostly on paper) on the technical and operation feasibility of the solutions to support 24/7 settlement</p> <ul style="list-style-type: none"> <li>• Availability of the platform (on paper, no market appetite identified via the CG for experiments)</li> <li>• Ability to manage and execute settlement 24/7 (on paper, no market appetite identified via the CG for experiments)</li> <li>• Availability of technical support</li> <li>• Error handling</li> <li>• Funding/de-funding</li> </ul> <p>Final assessment will identify whether the solutions support 24/7 settlement: Yes fully / Yes partially / No</p> <p>If partially or no, what are the obstacles and how can they be solved</p>
Data collected	Theoretical assessment with SPCB
Market feedback received from NTW-CG	No real business case/market appetite at the moment for 24/7, many highlight significant impact on treasury management

Theme	2. RTGS, Liquidity management and 24/7
Question	2.4 Implications of 24/7 availability for liquidity management
Key terminology to be defined	Connected to 2.3, here focus is on liquidity
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p>Mostly covered by theoretical analysis</p> <ul style="list-style-type: none"> <li>• Availability of the platform (on paper)</li> <li>• Ability to manage and execute liquidity transfers 24/7 (on paper)</li> <li>• Availability of technical support</li> <li>• Error handling</li> <li>• LSM availability in 24/7 liquidity management (collateralisation notably)</li> <li>• Funding/ de-funding</li> </ul> <p>• Potentially tested in experiments: ISO 20022 message at 3pm for funding /defunding / minting / burning liquidity</p> <p>Final assessment will identify whether there are particular implications created by the platforms on liquidity management, when moving on a 24/7 scenario</p>
Data collected	Theoretical assessment with SPCB Potential <i>Eurosystem-led experiments</i>
Market feedback received from NTW-CG	No real business case/market appetite at the moment for 24/7, many highlight significant impact on treasury management

### 3.3 Reliability and safety

Theme	3. Reliability/safety
Question	3.1 Robustness – to conduct in synergy with 1.5
Key terminology to be defined	Robustness: robustness is the ability of a computer system to cope with errors during execution and cope with erroneous input
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p>Experiments on robustness will test whether the solutions are capable of not executing the transaction if something goes wrong on the cash side / asset side.</p> <p>We want to understand / demonstrate that the overall safety of the transaction is guaranteed. Focus is on ex-ante measures, rather than ex-post mitigations (that is covered on question 3.3).</p> <p>In practice we will test in the case where the cash leg is not paid if the asset is not delivered and vice versa. If a smart contract is executed well, the transaction should take place atomically, else it should be rejected. <i>Eurosystem-led experiments</i> involves injecting on purpose erroneous transactions and checking that they will not be processed.</p> <p>We expect to collect results in form of quantitative / qualitative findings: quantitative, since we observe if it either works or does not work, so yes or no: either the transaction is valid and reaches the settlement (check if both legs are settled) or the transaction is erroneous and does not reach the settlement</p>
Data collected	<i>Eurosystem-led experiments</i> to “break atomicity” Market participants to report on failed transactions via templates
Market feedback received from NTW-CG	Robustness is considered a key feature from the market: suggestion to define both 'happy' and 'unhappy' path scenarios that will be tested side-by-side for each solution focus on Business Continuity Plans to be put in place would be welcome (both asset and cash side)

Theme	3. Reliability/safety
Question	3.2 Resiliency
Key terminology to be defined	<p>Resiliency: What happens in case of a technical failure in one component of the infrastructure. (For example: if one node / one server goes down etc)</p> <p>We define two types of resilience:</p> <ul style="list-style-type: none"> <li>• redundancy requirements: which fraction of the infrastructure can go down while the system as a whole keeps running</li> <li>• byzantine or crash fault tolerance: whether the solution can cope only with node failures or also with byzantine behaviour</li> </ul>
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p>Eurosystem led-experiments on resiliency will test whether the solutions are capable of redundancy requirements: which fraction of the infrastructure can go down while the system as a whole keeps running &amp; bizantine or crash fault tolerance: whether the solution can cope only with node/settlement core failures or also with byzantine behaviour</p> <p>In practice we will test and measure: in experiments, we can measure what % of nodes/settlement cores can go down before the transactions cannot be processed anymore, to measure redundancy requirements.</p> <p>We expect to collect results in form of quantitative / qualitative findings, for the redundancy requirements we have quantitative findings. For the bizantine or crash fault tolerance it will be a paper analysis.</p> <p>Our paper analysis will focus on understanding what happens if a node is compromised.</p>
Data collected	<p><i>Eurosystem-led experiments</i></p> <p>Quantitative / qualitative findings, for the redundancy requirements quantitative findings. For the bizantine or crash fault tolerance it will be a paper analysis.</p>

Theme	3. Reliability/safety
Question	3.3 Applicability of contingency procedures
Key terminology to be defined	Contingency procedures: preparing plans and procedures to effectively respond to and manage incidents which may occur with the normal running of the transactions.
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p>Learning outcome: In case of incident, contingency procedures should be ready, also in case the cash side is unavailable or the interoperability mechanism fails.</p> <p>A paper analysis is needed to identify which failure happen and what a procedure to solve it could be.</p> <p>Also define how to react if atomicity is broken, which measures to implement?</p> <p>The assessment will identify the presence of any failure and potential solutions to address it</p>
Data collected	Technical/theoretical assessment with SPCB

Theme	3. Reliability/safety
Question	3.5 Dependency from specific 3 <sup>rd</sup> party service providers
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p>Consider from a holistic point of view, any type of 3<sup>rd</sup> parties such as communication providers or, for example, Hyperledger fabric</p> <p>What are the necessary service providers needed to provide the interoperability solutions service (service needed to run NCB side and interoperability mechanism for the settlement service). Who develops or verifies the smart contract? / Is there any transaction coordinator?</p> <p>Paper analysis to focus as much as possible on how the steady state could look like if any of the solutions were implemented.</p> <p>Experience gained depends also on which market participants want to contribute to the experiments/trials.</p>
Data collected	<p>Qualitative analysis with SPCBs</p> <p>Might be complemented by market feedback on how they connect to the interoperability solutions</p>
Market feedback received from NTW-CG:	<p>The CG provided feedback on its preferences between a direct connection to the solution provider's' solutions or intermediation.</p> <p>Different views: direct connection preferred (by technically oriented entities) for liquidity management purposes and to increase the base of possible users reachable. Connectivity could be still intermediated for many users, especially smaller entities that already relies on instructing parties</p> <p>Market participants may not require a direct interaction with the technical solution that intermediates between the asset DLT and the cash leg solution to deliver DvP, therefore entities may create direct connection with T2/TIPS rather than the interop mechanism</p>

Theme	3. Reliability/safety
Question	3.6 Risk management (operational, liquidity, cyber)
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p>Paper analysis in alignment with question 3.5</p> <p>Focus on the connectivity risk:</p> <ul style="list-style-type: none"> <li>• Risk implications of participants connecting to the Trigger Solution / TIPS Hash-Link / DL3S directly to initiate settlement vs the market DLT operator doing so?</li> <li>• What are the risk implications for the Eurosystem of interacting directly with end-users in the settlement process?</li> </ul> <p>This analysis could compare the risk profiles of the different interoperability mechanisms used.</p> <p>Other examples of risk that could be assessed:</p> <ul style="list-style-type: none"> <li>• What are the risks associated with the 3<sup>rd</sup> party dependency identified?</li> </ul> <p>What are the risks associated with the envisioned operational day to day activities for the steady state?</p>
Data collected	<p>Qualitative analysis with the SPCB</p> <p>Market participant and market DLT operators may provide feedback on how they are connected to the interoperability solutions</p>



### 3.4 Connection with existing environments (for example TARGET Services)

Theme	4. Connection with existing environment
Question	4.1 Gap assessment for potential TARGET Services connection/integration (basic pre-requisites)
Key terminology to be defined	Integration: general capability of different Systems/Services to interact.
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p>Research and analysis: we want to understand and to identify what it would take to efficiently connect if not integrate the three new solutions in the existing TARGET Services, if the Eurosystem would decide to do so in the future. This analysis would have to be verified by the TARGET governance bodies if pursued.</p> <p>Information gathering exercise only as trials and experiments will not allow observing the solutions as they should be under a real production setup, as several features of current TARGET Services are not available to the new solutions during trials and experiments.</p> <p>Preliminary theoretical research could identify whether the solutions could potentially be integrated into TARGET Services, whether key hurdles to do so are identified: Yes, fully / Yes, Partially / No, which one not, why</p>
Data collected	Qualitative paper analysis with the SPCB
Market feedback received from NTW-CG	<p>ISO 20022 is very important to ensure that the same instructions can be used for existing systems as well as the new solutions</p> <p>Priority is to analyse the feasibility of potentially connecting the new solutions to the current TARGET Services for liquidity management, to avoid creating separate liquidity pots.</p>

Theme	4. Connection with existing environment
Question	4.2 Ability for new solutions to support the ISO 20022 versions of TARGET Services
Key terminology to be defined	<p>Support: new solutions to be compatible with or be capable to adopt to TARGET Services ISO message policies and versioning</p> <p>Yes fully / Yes with limitations / No</p>
Objectives: What do we want to achieve as learning outcome	Our paper analysis will focus on understanding if the three solutions are capable to adopt the TARGET Services standards in the future.
Data collected	Qualitative paper analysis with the SPCB
Market feedback received from NTW-CG	<p>ISO 20022 is very important to ensure that the same instructions can be used for existing systems, focusing on TARGET Services as a benchmark, as well as the new solutions, to ensure interoperability over time, especially if an asset is issued on a network with long maturity (e.g. 20 years or more)</p> <p>Since some DLT/blockchain networks may use different messaging types and formats, mapping to ISO20022 or translating into ISO20022 seem more likely than 'native' alignment with ISO 20022.</p> <p>It is also worth considering to what extent DLT applications may be able to leapfrog some of the issues encountered in the existing architecture.</p>

### 3.5 Integration with new environments (market DLTs)

Theme	5. Integration with new environment
Question	5.1 How to ensure connectivity with market DLT, both technical features and operational aspects (example: error handling, timeout limits etc)
Key terminology to be defined	Point 5.1 and 5.2 to be assessed together: technological neutrality as a key factor to achieve integration Key terminology: <ul style="list-style-type: none"> <li>• Connectivity: with one market DLT at time</li> <li>• Interconnectivity: (connectivity between many market DLTs) is instead discussed in question 5.4</li> </ul>
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	Qualitative assessment: feedback from SPCB and market participants  On a level playing field (i.e. with 1 market DLT) <ul style="list-style-type: none"> <li>○ Onboarding procedure and time / ease of onboarding Market DLTs</li> <li>○ Operational readiness</li> </ul> Error handling Timeout management  Feedback received should be weighted by maturity and complexity of asset DLT that tries to connect. The range of asset DLT type covered in the analysis may not be complete
Data collected	Qualitative data Market participants and market DLT operators to report on how easy / complex is to establish connectivity to the interoperability solutions, including some data on the technical features of the asset DLT used

Theme	5. Integration with new environment
Question	5.2 Technological neutrality (do the technological choices for the SPCB environment or Interoperability mechanism constrain participants to adopt some technological standards?)
Key terminology to be defined	Technological neutrality: ability for market participants to “plug and play” any given solution provided by the three central bank solution providers.
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<ul style="list-style-type: none"> <li>• Ease and efficiency of communication across environments</li> </ul> We want to evaluate whether some of the 3 solutions introduce technology constraints for the participants, apart from the logic required to interact with the 3 solutions (smart contracts). It may be needed to verify that asset DLT platforms have comparable features, as some could be objectively more complex to connect to.  Qualitative assessment: smooth onboarding and communication between market DLT and the SPCB environments (assessed by solution providing central banks as well as market DLTs via surveys).
Data collected	Qualitative data Market participants and market DLT operators to report on how easy / complex it is to establish connectivity to the interoperability solutions, including some data on the technical features of the asset DLT used
Market feedback	Technological neutrality is considered very important given the current early stage of adoption of DLT.  Since any type of infrastructure or solution, irrespective of the use of DLT or not, will rely on a specific technology stack, the concept of neutrality should be meant as ensuring compatibility with different types of DLTs.

Theme	5. Integration with new environment
Question	5.4 Comparison of operative frictions in daily business operations / needs
Key terminology to be defined	Operative frictions: difference in the effort required to perform daily business operations on the cash side <b>with respect to traditional infrastructures</b>
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p><b>Feedback from SPCB and market survey:</b></p> <ul style="list-style-type: none"> <li>• <b>Compared with current processes (Target Services)</b>, do solutions facilitate <ul style="list-style-type: none"> <li>○ Operations</li> <li>○ Reconciliation</li> <li>○ Settlement</li> <li>○ Accounting</li> </ul> </li> <li>• Management of the above across the 3 solutions</li> <li>• In case of asset DLT multiplication, what would be the additional operational burden to mitigate fragmentation?</li> </ul>
Data collected	<p>Qualitative data Report from SPCB Market survey to assess frictions identified by market participants / market DLT operators in the conduction of their trials and experiments. If possible, evaluation on how using the interoperability solutions differs from having done the same in TARGET Services</p>

### 3.6 Analysis of cost determinants

It is noted that given the limited volumes of transactions and data that could be collected as part of the exploratory work, the analysis of costs will focus on providing an initial indication of the main cost determinants / cost factors.

Theme	6. Analysis of cost determinants
Question	6.1 Different operational burden of the solutions
Key terminology to be defined	<p>Operational burden: the operational burden of the different solutions as could look like in the long run. (keeping in mind that some operational burden are specific to the framework of the exploratory work and should be ignored, such as the escrow mechanism)</p>
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p>The goal is to compare via an on-paper analysis, the theoretical cost of operating the different solutions <b>as foreseen in the long run</b>. A possible way to do so could be: (1) identify a list of different dimensions (e.g. configuration, monitoring, daily activities during the business day, trouble shouting, deployment activities, tools, periodical update and release, contingency procedure, auditing...), (2) specify for each of them who is supposed to bear the activity (3) how often the activities are supposed to happen, (4) if the activity is manual and/or automated (and/or automatable), (5) if it relies on already existing functionalities, processes, tools, best-practices or something new to be implemented, (6) new members and new skills, on the new technologies, needed on the operators side. The measure, even if only theoretical and qualitative, should compare the different solutions considering a set of possible use cases and or (contingency) scenarios.</p> <p><b>Feedback from SPCB and market participants</b></p>
Data collected	<p>Qualitative and possibly quantitative data Feedback from SPCB Market survey to collect market participants experience and perceived operational burden in the execution of trials and experiment</p>

Market feedback received from NTW-CG	Market highlights the need for the solutions to align with current TARGET Services ISO policies implemented (e.g. ISO20022 messages for A2AQueries and Liquidity Transfers, U2A Access to GUI). Need for smooth liquidity management and avoiding creating separate liquidity pots is also highlighted.
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Theme	6. Analysis of cost determinants
Question	6.2 Cost difference in ensuring narrower or broader interconnectivity to external DLT platforms (in terms of number and different protocols used)
Key terminology to be defined	In this context, the connectivity cost is the cost the solution provider (the Eurosystem in general) would bear in terms of development activities, customer support and time needed to connect a given market DLT platform to the solution. <b>Focus on Eurosystem costs, not market side costs here (addressed in 6.3)</b> Connected to question 5.1, 5.2 on technological neutrality, based on such findings on how technologically neutral the solutions are, here the focus is on the associated costs to ensure technical neutrality.
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	The goal is to measure the connectivity cost (and how it changes) of connecting via the three solutions (1) a higher number of market DLT platforms, (2) different DLT protocols (in terms of (i) underlying technology – i.e. blockchain or distributed ledger like Corda, (ii) programming language (iii) consensus mechanism, (iv) interoperability mechanism, such as HTLC). Focus on the costs associated to technical aspects (not for example legal costs) To sanitize the measure we should be able to identify una tantum costs (the cost of which, in the future, could be split over multiple participants) and the recurring ones.
Data collected	Qualitative and quantitative data from SPCB

Theme	6. Analysis of cost determinants
Question	6.3 Cost for market stakeholders to connect and operate in new solutions
Key terminology to be defined	Market stakeholders: in this topic we should distinguish between the cost up to the market DLT operators and the cost up to the market participants (i.e. the counterparties of the DvP transactions) This question related to 5.1,5.2 and 6.2, the less there is technological neutrality, the higher the potential cost that market DLT operators will incur
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<b>Market survey</b> the goal is comparing via an <i>on-paper analysis</i> , the theoretical cost up to the market stakeholders of connecting and operating the different solutions, <b>as they could look like in the long run if implemented</b> . Considering a set of possible use cases and or (contingency) scenarios, the Eurosystem defines that this measure would consider only (1) cost of the activities/configurations in the interoperability solutions side and local NCB side. Instead, (2) the cost of the activities/configuration on the market DLT platforms are not covered. (In case of considering also the cost of (2), in order to have a level playing field, the analysis must consider the same/similar market DLT platform.) Limitations of the setup of exploratory work may inflate the findings, hence there is the need to distil only the costs (and if qualitatively) that might be relevant for the potential steady state scenario
Data collected	Qualitative and quantitative data Market survey to report to the cost incurred to connect to the interoperability solutions, including some information on the technical features of the DLT platforms and how they affected the costs

### 3.7 Information management and reconciliation

Theme	7. Information management
Question	7.2 Transparency and information management on the SPCB solutions
Key terminology to be defined	<p>This question is related to the reconciliation between interoperability solutions and their participants' internal systems for the cash movement / cash movement confirmation (layer 3 of reconciliation<sup>2</sup>). It also includes reconciliation with other NCBs that might participate in the interoperability solutions</p> <ul style="list-style-type: none"> <li>• Reconciliation is a key benefit of DLT, does it hold for when we have interoperability solutions performing the cash leg of DvP on a distinct platform from the delivery of the asset?</li> <li>• Do the three solutions provide similar benefits in terms of reconciliation?</li> </ul>
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<ul style="list-style-type: none"> <li>• Availability of necessary data to perform reconciliation: what data does the payment instruction needs to include? (feedback received from CG)</li> <li>• Assessing reconciliation: <ul style="list-style-type: none"> <li>○ Survey to participants: interoperability solutions provide different tools for reconciliation, participants perform the reconciliation in their internal system and provide feedback on any issue, what to change and improve in the future</li> <li>○ Survey to other NCBs: is it possible to perform reconciliation effectively?</li> </ul> </li> </ul>
Data collected	<p>Qualitative data</p> <p>Market participants to report on the ease on reconciliation with their internal system, provide feedback on potential improvements</p> <p>Market participants to include identifiers in the instructions sent to the interoperability solutions, to allow reconciliation activities</p> <p>Feedback from NCBs – when participating in the exploratory work</p>
Market feedback received by NTW-CG	<ul style="list-style-type: none"> <li>• Participants' point of view on necessary data / information to be shared by SPCBs in the steady state (list provided by CG includes : EUR Cash balances ; EUR locked for settlement on a per-transaction basis ; transaction IDs (of the asset chain) ; Intra-day balance delta (-ve or +ve) ; Interest accrued (if any) and O/N rate ; BIC / T2 Account details ; Legal entity)</li> <li>• Interest from the market to receive information from the interop platforms for reconciliation? Or would they rely only on the market DLT?</li> </ul> <p>Different view on intermediation expressed:, it may sometimes be easier for market participants to rely on market DLTs rather than to reconcile themselves two legs at the same time (asset and cash). However, market participants active in numerous market DLT may prefer to reconcile directly with the cash leg platform of the SPCB.</p> <p>If integrated in TARGET Services, reconciliation should be directly with TARGET Services for users.</p>

<sup>2</sup> Please see Annex 1 on the reconciliation layers identified by the Eurosystem

Theme	7. Information management
Question	7.3 Ease of reconciliation between interoperability solutions and market DLT
Key terminology to be defined	The assessment here is for the reconciliation between the interoperability solutions and the market DLT platform on the DvP transactions performed (layer 2 of reconciliation – see annex 1) <ul style="list-style-type: none"> <li>• Reconciliation is key benefit of DLT, does it hold for when we have interoperability solutions performing cash leg of DvP?</li> <li>• Does the three solutions provide same benefit for reconciliation?</li> </ul>
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<ul style="list-style-type: none"> <li>• Availability of necessary data to perform reconciliation: what data does the payment instruction needs to include?</li> </ul> <p>To allow participants to respond effectively to the reconciliation surveys, <b>market participants are asked to provide, as part of their payment instructions sent to the interoperability solutions, the necessary information they need to reconcile effectively on their side.</b> Technically speaking, the interoperability solutions already use an ID to identify the asset movement, but the number of info could be increased to facilitate reconciliation.</p> <ul style="list-style-type: none"> <li>• Assessing reconciliation: <ul style="list-style-type: none"> <li>○ Survey to asset market DLT: interoperability solutions provide dashboards/reports for reconciliation, asset DLT performs the reconciliation and provide feedback on any issue, what to change and improve etc</li> </ul> </li> </ul>
Data collected	Qualitative data Market participants and market DLT to report on the ease on reconciliation with the asset leg, provide feedback on potential improvements. Market participants to include identifiers in the instructions sent to the interoperability solutions, to allow reconciliation activities and reporting

Theme	7. Information management
Question	7.4 Confidentiality techniques available
Key terminology to be defined	After having identified a key list of information to be made available in the interoperability solutions to market participants to allow their business cases, assessing the techniques available/that could be implemented to be transparent while ensuring privacy of participants' data.
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	Surveys to collect info on: SPCB confidentiality techniques Confidentiality techniques used in the market DLT, while supporting user business cases  Potentially, <i>Eurosystem-led experiment</i> may test confidentiality techniques
Data collected	Qualitative data Market participants and market DLT to report on which confidentiality techniques they adopt in the market DLT SPCB feedback on techniques implemented or under consideration Results of potential <i>Eurosystem-led experiments</i> on confidentiality
Market feedback received from NTW-CG:	Suggestion to test obfuscation capabilities that can be possibly leveraged in confidentiality of positions as well as transactions

Theme	7. Information management
Question	7.5 Preservation of data integrity
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p>Collect info from SPCB on the current status / potential development for</p> <ul style="list-style-type: none"> <li>• Data recording / holding process</li> <li>• Data recording length of time</li> <li>• Data protection</li> <li>• Encryption methods</li> <li>• Back-up / contingency</li> </ul> <p>Specific <i>Eurosystem-led experiments</i> could be organised to try to break immutability of the chain in case of Trigger and Full DLT interoperability</p>
Data collected	<p>Qualitative findings</p> <p>SPCB to provide feedback on data integrity features</p> <p>Results of potential <i>Eurosystem-led experiments</i> on data integrity</p>
Market feedback from NTW-CG	Immutability of DLT chain is considered very important

### 3.8 Automation features

Theme	8. Automation features
Question	8.1 Supporting programmability and automation (smart contracts) on the market DLT side – in particular securities lifecycle management - e.g. programmed coupon payments, corporate actions
Key terminology to be defined	Programmability on the market side means that the underlying business case is based on DLT involving automated transactions using smart contract functionality.
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p>Do the cash side solutions put any constraints on the programmability/automation on the asset side?</p> <p>Can all use cases on the market DLT be processed through the interoperability solutions? Can the cash leg of all use cases be settled?</p> <p>Collect feedback from market based on the experience with trials and experiments conducted</p> <p>In addition specific <i>Eurosystem-led experiments</i> can be conducted for testing different scenarios: the base case, automation when throughput is high, and the scenario of dealing with complex smart contracts. Coordination with the market would be needed to conduct such experiments</p> <p>Having the same/similar programmability cases tested by the market in all three interoperability solutions will improve the comparability</p>
Data collected	<p>Qualitative findings</p> <p>Feedback from market participants and market DLT on automation use cases explored and whether automation was successfully deployed, which obstacles</p> <p>Same feedback also from SPCB side</p> <p>Quantitative findings</p> <p>Potential <i>Eurosystem-led experiment</i> to test complex case of automation, also when the throughput is high (test if performance degrade)</p>

Theme	8. Automation features
Question	8.2 Supporting programmability and automation on the cash leg
Key terminology to be defined	Programmability on the cash side means the ability of deploying automation tools (in whatever form, such as traditional software, smart contracts, API-Based tools) within the solution in order to allow more complex transaction, e.g. with multiple system being involved. Programmability does not necessarily require CeBM cash to be on a DLT
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	It would be possible to assess the capability of the solutions to support complex programmability and automation scenarios, also in presence of high volumes of transactions to be settled, when the programmability is on the cash leg No strict comparison is envisioned but feedback from market participants and market DLTs would be collected on whether SPCBs are able to accommodate market business cases when they need automation on the cash side SPCB environments, and the reason to do so (compared with deployment on the market DLT) and whether market participants find it easy or not to deploy it on the SPCB environment.  Survey with the market can help assessing what is needed based on the use cases. Are there any uses cases requiring programmability on the cash side?
Data collected	Qualitative findings Feedback from market participants and market DLT on automation use cases explored and whether automation was successfully deployed, which obstacles Same feedback also from SPCB Quantitative findings Potential <i>Eurosystem-led experiment</i> to test complex case of automation, also when the throughput is high (test if performance degrades)
Market feedback received from NTW-CG	Focus on general automation features, - e.g., transaction splitting, payment conditionality - rather than selecting specific processes. Focus on features that could be adopted for different types of transaction, such as DvP or PvP

### 3.9 Energy consumption

Theme	9. ESG
Question	9.1 Sustainability: environmental impact/energy consumption
Key terminology to be defined	Environmental impact: primarily, energy consumption of the solutions
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	We want to compare the environmental impact of the solutions. The main factors impacting the energy consumption of the solutions will be: <ul style="list-style-type: none"> <li>- Geographical dispersion of elaboration facilities</li> <li>- Carbon footprint of elaboration facilities</li> </ul> For exploratory work limit the energy measurement to the settlement process Check if energy consumption scales linearly or exponentially when you scale the solution, run comparison between legacy and DLT solutions  Eurosystem to further assess feasibility of measuring energy consumption for those interoperability solutions currently hosted on a cloud (can we identify consumption of the settlement process specifically?)
Data collected	To be confirmed if possible for interoperability solutions hosted on shared cloud to collect the necessary data Quantitative finding on energy consumption Qualitative findings on how the energy consumption scales



Market feedback received from NTW-CG	NTW-CG suggested to focus first on the Energy aspect of the ESG, although noting the limited data that could be available given the limited volumes during exploratory work. To draw a meaningful comparison, energy consumption of existing settlement systems would also be assessed and measured: energy consumption should not be a criterion applied to exclusively to DLT-based solutions. the comparison to existing/legacy infrastructure is important.
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#### 4. Detailed questions to be potentially pursued for knowledge gain on the three solutions (category ii)

This section lists the questions that the Eurosystem identified as potentially relevant for improving the Eurosystem knowledge on the three interoperability solutions and that require the Eurosystem involvement in the analysis. In principle, these questions are not meant to contribute directly to the comparative assessment of the three solutions, but to yield general knowledge gain. In some cases, tackling these questions may directly contribute to understand how to further develop the solutions in the future, if the Eurosystem would decide to do so.

For what concerns external dependencies, the variety of type of market DLT platforms and business cases brought forward by the market may influence the extensiveness and comprehensiveness of the analysis.

*NB: all references to market DLT and market participants in the table below refer to eligible market DLTs and eligible market participants conducting trials and experiments, after their eligibility is confirmed.*

##### 4.1 Settlement performance and efficiency

Theme	1. Settlement performance and efficiency
Question	1.1 Latency
Key terminology to be defined	<b>[for information]</b> latency of the whole DVP, including cash and asset leg settlement could be collected. If market asset DLTs connected to the three solutions are similar performance-wise (or the same asset DLT is connected to three solutions), this could be moved into category (i)
Data collected	Quantitative findings Duration of the full settlement process: market participants to provide timestamp of the settlement of the asset leg in the market DLT to calculate full DvP duration
Market feedback received from the NTW-CG	Keep in mind that both on the assets and cash side the solutions are not at production-grade level yet, latency is important but other measures are more relevant in a forward-looking approach, i.e. scalability, reliability of the systems

Theme	1. Settlement performance and efficiency
Question	1.7 Comparison of DLT consensus algorithm to enhance efficiency in settlement for the interoperability solutions in the presence of multiple Eurosystem nodes– (linked to 7.6)
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	For DL3S and Triggerchain: could it be assessed (theoretically and eventually practically) that for the Trigger and for DL3S the findings of settlement performance and efficiency would not change significantly if we move to a set up of shared nodes among the Eurosystem in such solutions, to provide assurances, even if only qualitatively, that the results obtained could hold for a Eurosystem DLT "in general", with potentially multiple Eurosystem validating nodes
Data collected	Quantitative findings (when applicable) and theoretical analysis How much could settlement performance increase / decrease depending on the consensus algorithm. Market DLT to provide feedback on solutions adopted to reach consensus on asset DLT

Theme	1. Settlement performance and efficiency
Question	1.8 Improvement / loss of integration in settlement compared to an integrated settlement model such as in T2S
Objectives: what would be exactly	preliminary information gathering

measured/tested to address this question. What do we want to achieve as learning outcome	Qualitative assessment to compare the interactions needed in order to perform transaction settlement (funding, transaction initiation, notifications etc.). We could also analyse the number of interactions between the different systems (TARGET Services, Cash system, market DLT) needed to complete a full DvP in comparison to an integrated model.  Additionally, there can be a general comparison of a DVP with the three solutions vs a DVP in T2S for specific KPIs. We compare the findings with T2S keeping in mind limitation of exploratory work
Data collected	Qualitative and quantitative findings Market participants and market DLT reporting on perceived difference in integration of settlement between using T2S or interoperability solution

Theme	1. Settlement performance and efficiency
Question	1.9 Settlement finality in potential steady state: identify possible timestamps for finality in steady state scenario
Key terminology to be defined	Steady state: It would be the “hypothetical” production environment of the deployment of the solutions.
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	Qualitative analysis to identify when the Eurosystem should consider final the settlement of transactions in the context of interoperability solutions It requires analysing a potential steady state setup while ignoring the limitations set in the context of the trials and experiments (analysis.g. escrow mechanism)
Data collected	Qualitative analysis Market could provide input based on experience of exploratory work

#### 4.2 RTGS/Liquidity management and 24/7

Theme	2. RTGS, Liquidity management and 24/7
Question	2.1 Feasibility of implementation of liquidity saving mechanism
Key terminology to be defined	Liquidity saving mechanisms (LSM) are processes which exist among others in T2/T2S to facilitate and optimise the use of liquidity (cash or securities) and consequently of settlement. These might include : <ul style="list-style-type: none"> <li>• (auto)collateralisation : possibility to pledge securities (on flows on on stocks) to free cash to settle pending transactions</li> <li>• Partial settlement</li> <li>• Shaping</li> <li>• Auto-borrowing</li> <li>• liquidity reservation : possibility to allocate dedicated liquidity to a specific usage</li> <li>• prioritization : instructions are given a priority level for settlement</li> <li>• netting : possibility to aggregate transactions to proceed with a net settlement</li> <li>• floor/ceiling thresholds</li> </ul>
Objectives: What do we want to achieve as learning outcome	If the solutions would have LSM available for the exploratory work, they could be tested in trials and experiments for knowledge gains.
Data collected	Qualitative and quantitative findings from the experiments conducted Market participants to report on their experience if LSMs are tested in experiments

Theme	2. RTGS, Liquidity management and 24/7
Question	2.2 Efficiency of liquidity management for new liquidity pots and transfers of CeBM liquidity across pots
Key terminology to be defined	What are new liquidity pots How do / would they interact with current TARGET Services
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	Collecting info for potential future developments regarding:  Automation / manual workload needed Operational procedure Omnibus accounts vs. segregated accounts (number of accounts required, account structure etc.) Optimisation of funding/de-funding procedures
Data collected	Technical / theoretical feedback from SPCB

### 4.3 Reliability and safety

Theme	3. Reliability/safety
Question	3.4 Identification of system bottlenecks
Key terminology to be defined	To be assessed together with 1.2 throughput and 1.3 ease of scalability
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	Objective is to identify bottlenecks via the trials and experiments executed by the market Analysis would cover after exploratory work which bottleneck have been identified.. No specific experiment is planned, rather an post-mortem analysis of uncovered issued during trials and experiments (but experiments of 1.2 and 1.3 can help identifying). Potential solutions to address the bottlenecks will be identified (or listed, if already implemented during exploratory work)
Data collected	Qualitative data Market participants and market DLT to report on bottlenecks and difficulties encountered while using Interoperability solutions during the execution of trials and experiments

Theme	3. Reliability/safety
Question	3.7 Minimum requirement for accepting interconnection with external DLT (resilience, cyber, legal jurisdiction?)
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	In alignment with the risks identified in 3.6 Paper analysis that could cover some of these topics listed below, to identify key factor to consider when accepting connectivity with external DLT, if decided by the Eurosystem in the future <ul style="list-style-type: none"> <li>• Settlement finality, what is a reasonable amount of time for settlement finality if probabilistic?</li> <li>• Governance requirements</li> <li>• Minimum cyber/safety requirements</li> </ul>
Data collected	Qualitative data Market participants / market DLT to report on security features adopted to ensure safe and efficient settlement

#### 4.4 Connection with existing environment (for example Target Services)

No question in this subsection – kept for numbering reasons

#### 4.5 Integration with new environments (market DLTs)

Theme	5. Integration with new environment
Question	5.4 Technical mitigation measures to ensure interconnectivity between assets DLTs and avoid the creation of silos (Fragmentation) both from technical and operational perspective
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p>Tackle fragmentation of assets in case many assets DLT will emerge in the future to avoid assets illiquidity and the need for market participants to be present in numerous assets DLTs</p> <p><b>Survey to market</b> to assess how they tackle the issue of interconnectivity / standardisation:</p> <ul style="list-style-type: none"> <li>• analyse how to create interlink between assets DLTs</li> <li>• analyse usage of industry standards</li> </ul> <p><b>Feedback from SPCB and possible <i>Eurosystem-led experiments</i> (if market initiatives not present already):</b></p> <ul style="list-style-type: none"> <li>• What types of links between market DLTs are established or could be established from a technical and operational perspective?</li> <li>• Identify technical way for market DLTs to interconnect for DvP transactions or asset transfers</li> </ul> <p>If there is market demand, the Eurosystem could support potential <b>market experiment on cross market DLT DvP</b></p> <p>Scalability of interoperability mechanisms used: how many times at once could an interoperability mechanism be used for all three solutions (i.e. how many locks could be put in place for executing a single order?)</p>
Data collected	<p>Qualitative data</p> <p>Market to report on the technical approaches used to ensure interconnectivity between market DLTs</p> <p>Results from experiments on interconnectivity, either from the market or <i>Eurosystem-led experiments</i></p>
Market feedback from NTW-CG	<p>Interconnectivity between DLT platforms is considered very important to prevent fragmentation</p> <p>In the CG, market players mentioned the possibility to organise a cross chain asset transfer to investigate the usage of common standards / protocols.</p> <p>Market fragmentation is seen as a risk, while some market participants do not see the risk of high asset fragmentation as they expect that network effects will emerge in the medium term.</p> <p>Still common standards are considered crucial</p>

#### 4.6 Analysis of cost determinants

No question in this subsection – kept for numbering reasons

#### 4.7 Information management and reconciliation

Theme	7. Information management
Question	7.2 Transparency and information management on the SPCB solutions
Key terminology to be defined	<p>This question is related to the reconciliation between interoperability solutions and their participants for the cash movement / cash movement confirmation (layer 3 of reconciliation<sup>3</sup>). It also includes reconciliation with other NCBs participating in the interoperability solutions</p> <ul style="list-style-type: none"> <li>• Reconciliation is a key benefit of DLT, does it hold for when we have interoperability solutions performing the cash leg of DvP on a distinct platform from the delivery of the asset?</li> <li>• Does the three solutions provide similar benefits in terms of reconciliation?</li> </ul>
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<ul style="list-style-type: none"> <li>• ad-hoc experiment may measure the efficiency of reconciliation processes:</li> <li>• Speed of data transfer</li> <li>• Speed of reconciliation</li> <li>• Error handling</li> <li>• Reporting of the reconciliation outcome in case of error</li> <li>• Speed of error handling</li> <li>• Technical support</li> <li>• Audit trail, confidentiality linked to the roles</li> </ul>
Data collected	Qualitative and quantitative findings from potential <a href="#">Eurosystem-led experiments</a>

Theme	7. Information management
Question	7.3 Ease of reconciliation between interoperability solutions and market DLT
Key terminology to be defined	<p>The assessment here is for the reconciliation between the interoperability solutions and the market DLT platform on the DvP transactions performed (layer 2 – see annex 1)</p> <ul style="list-style-type: none"> <li>• Reconciliation is a key benefit of DLT, does it hold for when we have interoperability solutions performing the cash leg of DvP on a distinct platform from the delivery of the asset?</li> </ul> <p>Does the three solutions provide similar benefits in terms of reconciliation?</p>
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<p>ad-hoc <a href="#">Eurosystem-led experiment</a> for reconciliation might be organised</p> <p>Experiments will measure the efficiency of the reconciliation:</p> <ul style="list-style-type: none"> <li>• Speed of data transfer</li> <li>• Speed of reconciliation</li> <li>• Error handling</li> <li>• Reporting of the reconciliation outcome in case of error</li> <li>• Speed of error handling</li> <li>• Technical support</li> </ul>
Data collected	Qualitative and quantitative findings from potential <a href="#">Eurosystem-led experiments</a>

<sup>3</sup> Please see Annex 1 on the reconciliation layers identified by the Eurosystem

Theme	7. Information management
Question	7.4 Confidentiality techniques available
Key terminology to be defined	After having identified a key list of information that could be made available to market participants in the interoperability solutions to support their business cases, testing on a technical level the possible techniques to be transparent while ensuring privacy of participants
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	Possible experiment: apply confidentiality measures based on users profiles / expectations Suggestion from Contact Group: test obfuscation capability that can be possibly leveraged in confidentiality of positions as well as transactions
Data collected	Qualitative data Market participants and market DLT to report on confidentiality techniques implemented Potential <i>Eurosystem-led experiments</i>
Market feedback from the NTW-CG	Suggestion to test obfuscation capabilities that can be possibly leveraged in confidentiality of positions as well as transactions

Theme	7. Information management
Question	7.5 Preservation of data integrity
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	Specific <i>Eurosystem-led experiments</i> could be organised to try to break immutability of chain in case of Trigger and Full DLT interoperability
Data collected	Qualitative and quantitative data Results of <i>Eurosystem-led experiments</i>
Market feedback From NTW-CG	Immutability of DLT is considered very important

Theme	7. Information management
Question	7.6 Comparison of consensus algorithm for data management
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	Feedback with SPCB: how the consensus mechanism would perform in DL3S and Trigger if NCBs want to join with one node (also linked to performance)  Potential <i>Eurosystem-led experiment</i> on reaching consensus with multiple NCB nodes involved

#### 4.8 Automation features

Theme	8. Automation features
Question	8.2 Supporting programmability and automation on the cash leg
Key terminology to be defined	Programmability on the cash side means the ability of deploying automation tools (in whatever form, such as traditional software, smart contracts, API-Based tools) within the solution in order to allow more complex transaction, e.g. with multiple system being involved. Programmability does not necessarily require cash to be on ledger (tokenized).
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	It would be possible to assess the capability of the solutions to support complex programmability and automation scenarios, also in presence of high volumes of transactions to be settled, when the programmability is on the cash leg
Data collected	Qualitative data Market participants to report on automation use cases experimented with trials and experiments and on whether they were able to adopt the automation needed on the cash leg
Market feedback from NTW-CG	Work on general automation features, - e.g., transaction splitting, payment conditionality - rather than selecting specific processes. Focus on features that could be adopted to different types of transaction, such as DvP or PvP

Theme	8. Automation features
Question	8.3 Comparison with traditional infrastructures (what we can currently do)
Key terminology to be defined	Identify: Use cases that can only be settled by the use of the new technological solutions. Use cases that are easier to be settled with current centralised approach, e.g. by developing new automation features.
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	Need to analyse the business cases explored by the market and see if we can compare these business cases to what we do today in TARGET Services, and if there is more automation that could not be replicated in the traditional environment.  Surveys with the market and theoretical assessment  Involvement with the market: try to do the same that the market is trying to do in DLT via traditional systems? Could be expanded from theory to practice if the market is interested
Data collected	Qualitative feedback Market participants and market DLT to report on automation deployed and on if they could consider it possible to reach the same result on traditional infrastructures (why / why not)
Market feedback from NTW-CG	Identify what needs to go on DLT and what can be automated already in traditional infrastructures E.g. coupon payments is a perfect example of this, since the payment goes one-way only (no DvP) and could be automated now already via existing rails.

#### 4.9 Energy consumption

No question in this subsection – kept for numbering reasons



## 5. Detailed questions to be potentially pursued for knowledge gain on the market approaches for implementation of new technologies for wholesale settlement (category iii)

This section collects more general questions where market feedback and experience on new technologies implementation to wholesale settlement could be sought. They are not directly related to the assessment of the three interoperability solutions, and the data collection will require market participants and market DLT operators to fill-in general questionnaires not strictly focused to the trials and experiments conducted. Data collected represents market-based information that could be acquired independently from the types of trials and experiments market participants will conduct in the exploratory phase and that could be used as valuable input for future Eurosystem decision making in the context of wholesale settlement with new technologies

*NB: all references to market DLT and market participants in the table below refer to eligible market DLTs and eligible market participants conducting trials and experiments, after their eligibility is confirmed.*

### 5.1 Settlement performance and efficiency

No question in this subsection – kept for numbering reasons

### 5.2 RTGS/Liquidity management and 24/7

No question in this subsection – kept for numbering reasons

### 5.3 Reliability and safety

No question in this subsection – kept for numbering reasons

### 5.4 Connection with existing environments (TARGET Services)

No question in this subsection – kept for numbering reasons

### 5.5 Integration with new environments (market DLTs)

No question in this subsection – kept for numbering reasons

### 5.6 Analysis of cost determinants

No question in this subsection – kept for numbering reasons

### 5.7 Information management and reconciliation

Theme	7. Information management
Question	7.1 Supporting transparency on the market DLT side / asset leg: techniques to implement transparency of information on DLT for reconciliation while maintaining users privacy
Key terminology to be defined	Here we focus on the reconciliation between the market DLTs and their participants for the asset movement (layer 4 <sup>4</sup> )

<sup>4</sup> Please see Annex 1 on the reconciliation layers identified by the Eurosystem

	<p>And on the reconciliation between market DLT platforms and market traditional platform (tokenised securities) (layer 5<sup>5</sup>)</p> <p><b>(survey to market):</b> what solutions/features Market DLT have for reconciliation? What can we learn from market approaches.</p> <p>Layer 4: potential benefit of DLT in facilitating information management by allowing access to information for all, use cases by market participants (golden source / golden copy that all can use – e.g. for coupon payment, the owner of the securities and its account information are known so that the payment can be automatically processed through smart contracts?) Layer 5: any experience in reconcile transaction between DLT platform and traditional platforms they own? Whenever tokenised assets are exchanged during the exploratory work, it will be interesting to know the way those exchanges are reflected on legacy systems.</p>
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	<ul style="list-style-type: none"> <li>• Market survey to collect info on how transparency and privacy can be implemented on DLT and how to reflect transaction between DLT and legacy systems</li> <li>• Record holding</li> <li>• Ability to Audit transactions</li> <li>• Speed of communication</li> <li>• Compliance with GDPR (and any other regulation pertaining to data / information) which countermeasures they (are willing to) adopt in order to protect the data.</li> <li>• Granularity of information pertaining to securities transactions made available, i.e. individual transactions or net end of day flow</li> </ul>
Data collected	Qualitative data market participants and market DLT to inform on the type of information management/transparency features adopted and on their experience in reconciliation between DLT and legacy systems

Theme	7. Information management
Question	7.4 Confidentiality techniques available
Key terminology to be defined	After having identified a key list of information that could be made available to market participants to support their business cases, investigate the techniques that could be implemented to be transparent while ensuring privacy of participants
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	Market Feedback on: Encryption requirements DLT operators confidentiality techniques to support market business cases
Data collected	Qualitative data Market participants and market DLT approaches to ensure confidentiality

Theme	7. Information management
Question	7.5 Preservation of data integrity
Objectives: what would be exactly measured/tested to address this question. What do we want to	Survey with the market (asset side) to collect info on: <ul style="list-style-type: none"> <li>• Data recording / holding process</li> <li>• Data recording length of time</li> <li>• Data protection</li> <li>• Encryption methods</li> <li>• Back-up / contingency</li> </ul>

achieve as learning outcome	The information collected may help improving the future design and development of the interoperability solutions
Data collected	Qualitative data Market feedback on approached to data management / data integrity
Market feedback received from NTW-CG	Immutability of DLT is considered very important

Theme	7. Information management
Question	7.6 Comparison of consensus algorithm for data management
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	Survey with market: feedback to evaluate the way transaction logs are stored and shared once transactions are finalised in market DLT
Data collected	Qualitative and quantitative data Market participant feedback on experience and solutions adopted for data management

## 5.8 Automation features

Theme	8. Automation features
Question	8.2 Supporting programmability and automation on the cash leg
Key terminology to be defined	Programmability on the cash side means the ability of deploying automation tools (in whatever form, such as traditional software, smart contracts, API-Based tools) within the solution in order to allow more complex transaction, e.g. with multiple system being involved. Programmability does not necessarily require cash to be on ledger (tokenized).
Objectives: what would be exactly measured/tested to address this question. What do we want to achieve as learning outcome	Survey with the market can help to assess what needed to support their business cases. Important assessment: are there any uses cases strictly requiring programmability on the cash side that could not be equivalently automated on the asset leg?
Data collected	Qualitative data Market feedback on which use cases / scenarios strictly require automation on the cash leg and how automation is implemented
Market feedback from NTW-CG	Work on general automation features, - e.g., transaction splitting, payment conditionality - rather than selecting specific processes. Focus on features that could be adopted to different types of transaction, such as DvP or PvP

## 5.9 Energy consumption

No question in this subsection – kept for numbering reasons

## **6. Placeholder for additional themes**

The themes and questions listed in this note use as main example DvP transactions to explain the objectives pursued by the Eurosystem, but they are generally meant to be agnostic with respect to the use cases covered in the exploratory work. The themes could be further amended or complemented to also cover the case of PVP and automated single CeBM wholesale payments use case on the findings.

### **6.1 PVP-specific questions**

### **6.2 Automate single wholesale payment in CeBM use case specific questions**

## **7. Annex 1 clarification on the reconciliation layers identified for Theme 7: information management and reconciliation**

There are different layers of reconciliations that could be considered for the analysis. For convenience, the Eurosystem has numbered them:

- 1) Reconciliation on the interactions between TARGET services and the interoperability solutions
- 2) Reconciliation between the interoperability solutions and the market DLT platform on the DvP transactions performed
- 3) Reconciliation between interoperability solutions and their participants internal systems for the cash movement (or confirmation of the cash movement in the case of Trigger). This layer also includes other NCBs
- 4) Reconciliation between the market DLT and their participants internal system for the asset movement
- 5) Reconciliation between market DLT platforms and market traditional platforms (tokenised securities)

The question relates to specific layers:

**1)** is not covered for the Full DLT interoperability and TIPS HL solutions given the temporary nature of the escrow process used during the exploratory work. For the Trigger, the reconciliation between TARGET and the Trigger Chain could already be captured in the other metrics (e.g. on settlement efficiency).

**2)** and **3)** are the focus of the Eurosystem analysis and of the comparison between the solutions

**4)** and **5)** might be covered by collecting information from market DLTs for knowledge gain on the market approaches, that could be helpful for potential future improvement of the interoperability solutions