The Eurosystem's exploratory work on new technologies for wholesale central bank money settlement

Annex I

Eurosystem-developed interoperability-based solutions

1 Introduction

The aim of the Eurosystem's exploratory work on new technologies for wholesale central bank money settlement was, among other things, to gain insight into how different solutions might facilitate interaction between TARGET Services and distributed ledger technology (DLT) platforms. To that end, three Eurosystem-developed interoperability-based solutions were tested: the Trigger Solution, provided by the Deutsche Bundesbank; the Full DLT Interoperability solution, provided by the Banque de France; and the TARGET Instant Payments Settlement (TIPS) Hash-Link solution, provided by the Banca d'Italia. The solutions are explained in further detail below. At a high level, (i) the Trigger Solution consisted of a DLT infrastructure that acted as technical bridge between TARGET Services (specifically the T2 real-time gross settlement (RTGS) system) and market DLT platforms, (ii) the Full DLT Interoperability solution was a proprietary DLT platform referred to as DL3S that enabled the settlement of wholesale financial transactions in central bank money (CeBM) in a DLT-based account held on a Eurosystem-provided DLT platform, and (iii) the TIPS Hash-Link solution enabled settlement of wholesale financial transactions in CeBM in accounts on a TIPS-like platform set up for the Eurosystem.

A bespoke operational and legal framework was put in place for the limited duration of the exploratory work (i.e. a total of six months). This temporary construct contained specific eligibility criteria for participation in the exploratory work, as well as procedures for the settlement of payments in T2 (for example, reliance on escrow accounts).
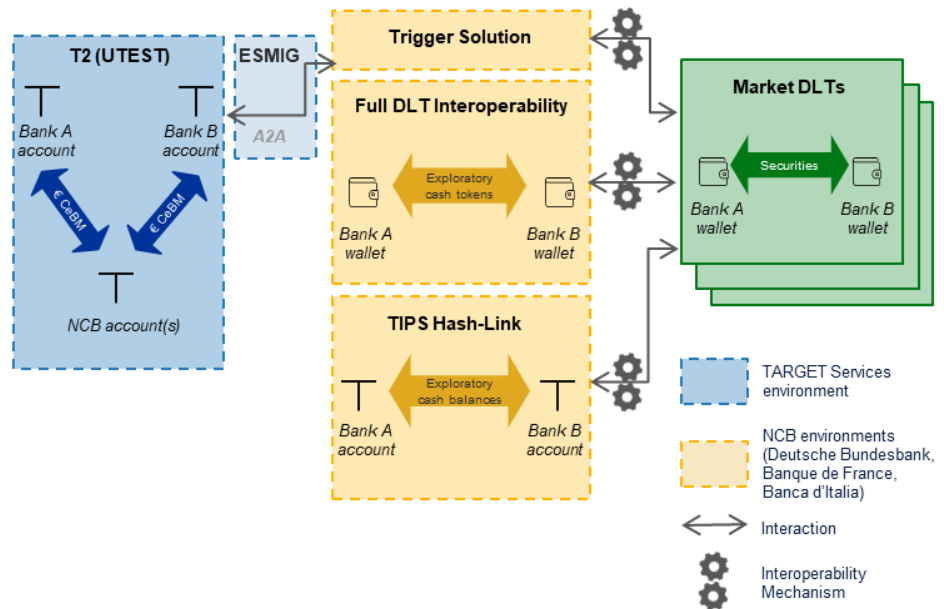
Figure 1

Stylised overview of the infrastructures used during the exploratory work

a) Set-up for the trials (real transactions)
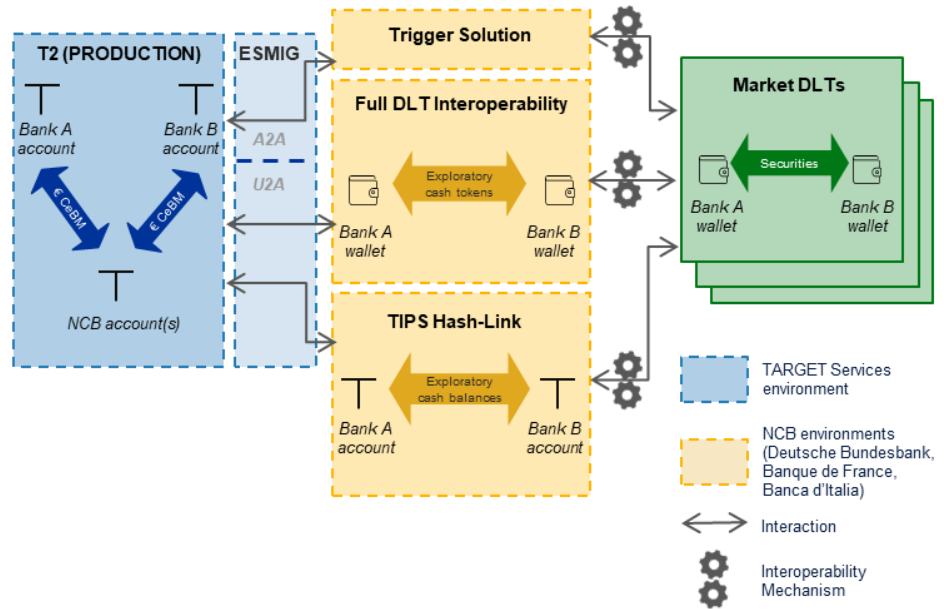
b) Set-up for the experiments (mock transactions)

Notes: For the experiments (i.e. mock transactions), exploratory cash liquidity was created directly in Full DLT Interoperability and TIPS Hash-Link, without interaction with the T2 UTEST environment. A2A stands for application-to-application, U2A for user to application, NCB for national central bank, ESMIG for European Single Market Infrastructure Gateway and DLT for distributed ledger technology.

The Deutsche Bundesbank's Trigger Solution triggered payments in T2, the Banca d'Italia's TIPS Hash-Link service relied on instant payments technology and the Banque de France's Full DLT Interoperability used a DLT-based cash token on DL3S.The Eurosystem, operating on the basis of a common legal and access framework and a level playing field among all stakeholders, made it possible for eligible market stakeholders to test new technologies for wholesale CeBM settlement in all three of these services.

2   Temporary set-up for settlement in the trials

The tests consisted of experiments (DLT-based mock transactions with settlement of the cash leg in test environments) and trials (DLT-based transactions with settlement of the cash leg in real CeBM in the T2 production environment).

Settlement in the trials relied on a temporary construct. The solution provider central banks offered specific connectivity to the different environments concerned (the Trigger Solution, the Full DLT Interoperability solution and the TIPS Hash-Link solution). For the TIPS Hash-Link and Full DLT Interoperability solutions, an ad hoc escrow mechanism (see the box below) was set up in T2 for locking CeBM funds during the trial process (with liquidity locked intraday only, for example for a number of hours). Nonetheless, realistic technical processes were trialled with all the solutions. The settlement finality of the asset leg depended on the rules applicable to the eligible market DLT operator.

Box 1
Escrow mechanism used in the trials

Each local NCB set up escrow accounts as a temporary construct to support their own eligible market participants in conducting trials with the TIPS Hash-Link and the Full DLT Interoperability solutions.

- Participants funded the NCB escrow account at the beginning of the trial intraday process (funding was made with full transfer of ownership to the NCB).

- Exploratory liquidity was minted at the start of the trial day on a 1:1 basis relative to the total amount held on NCB escrow accounts in T2.

- Defunding occurred at the end of the trial day on a net basis, or intraday on a gross basis in exceptional cases, resulting in final CeBM settlement of the (net) balances during trials in TARGET Services.

- Zeroing of the balance of the escrow account occurred at the end of the trial day (15:30).

3   Trigger Solution provided by the Deutsche Bundesbank

The Trigger Solution (developed by the Deutsche Bundesbank) facilitates wholesale settlement by linking an external platform with T2 through a "trigger" mechanism (a payment instruction smart contract) that makes it possible to coordinate asset or fund transfers by providing a blocking functionality through an interim account in T2.

The Trigger Solution offers two different interoperability mechanism modes from which participants can choose, depending on the business case and their individual needs and set-up.

The direct mode is focused on providing automated cash settlement in CeBM in cases where responsibility for process/settlement coordination lies primarily with the market DLT operators/participants.

With the hashed timelock contract (HTLC) mode, the Trigger Solution supports highly automated and atomic settlement on an all-or-none basis, provided that the market participants and/or the market DLT operator ensure that the status of the security leg remains consistent with the status of the cash leg.

The Trigger Solution is designed to be ledger-agnostic, allowing for integration with various platforms while fully leveraging existing RTGS infrastructures for settlement.

Figure 2
Simplified delivery versus payment transaction using the Trigger Solution
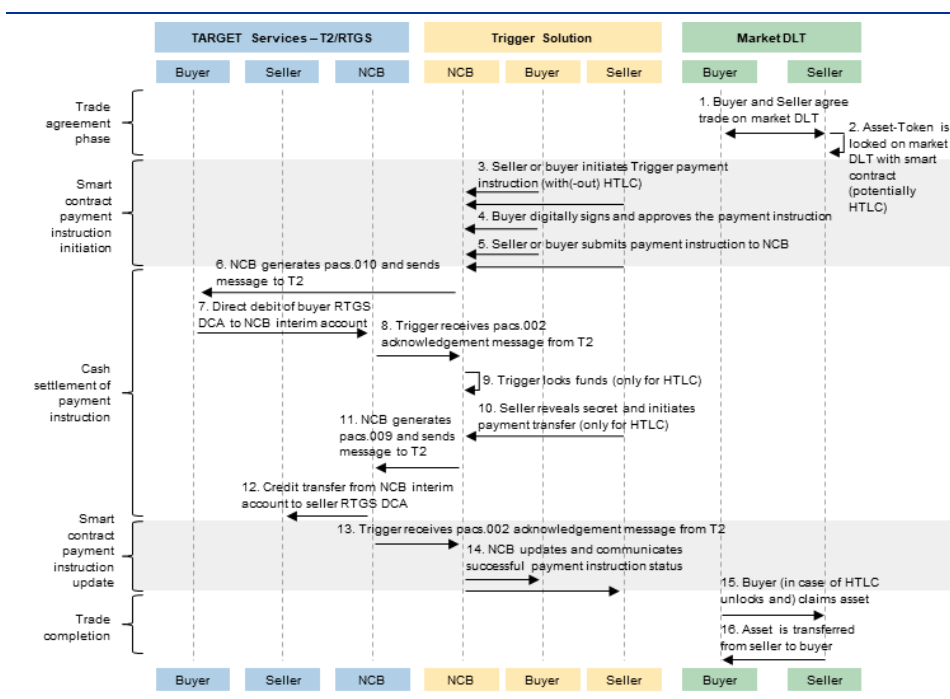
Notes: A simplified set-up for a delivery versus payment (DvP) trial is depicted. It is assumed that (i) no other market third parties are involved in the transaction, and (ii) both buyer and seller are eligible participants in TARGET Services, in the Trigger Solution and in the market distributed ledger technology (DLT) platform. T2 is the Eurosystem real-time gross settlement (RTGS) system. NCB stands for national central bank, HTLC for hashed timelock contract and DCA for dedicated cash account.

4 Full DLT Interoperability provided by the Banque de France

The Full DLT Interoperability solution relies on the DL3S platform developed by the Banque de France that makes it technically feasible to issue and settle wholesale CeBM directly on a DLT platform through cash tokens issued on DL3S.

Banque de France developed an HTLC for the Full DLT Interoperability solution. HTLC is a mechanism for the conditional transfer of certain assets, the condition for that transfer being enforced by the underlying protocol. Timelock ensures that a transaction is time-bounded: the recipient only has a certain amount of time in which to perform the payment before the asset is returned to the sender. Hashlock prevents the counterparties to a transfer from claiming the intended assets without fulfilling the conditions stated in the transaction agreement. The combination of hashlock and timelock ensures secure asset transfer and can be used for delivery versus payment (DvP) between different chains/protocols.

Figure 3

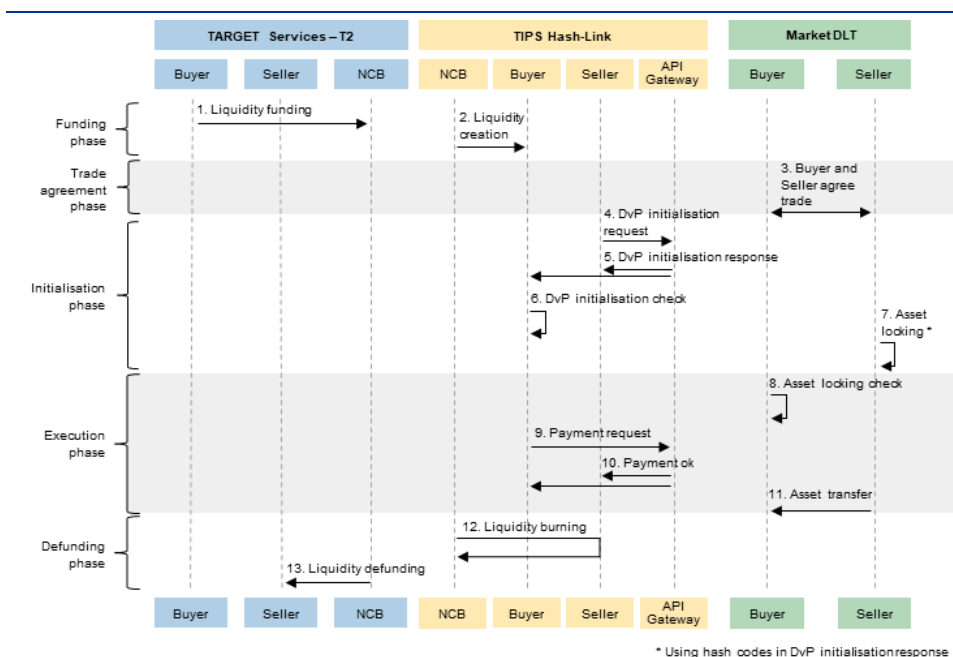Simplified delivery versus payment transaction using Full DLT Interoperability
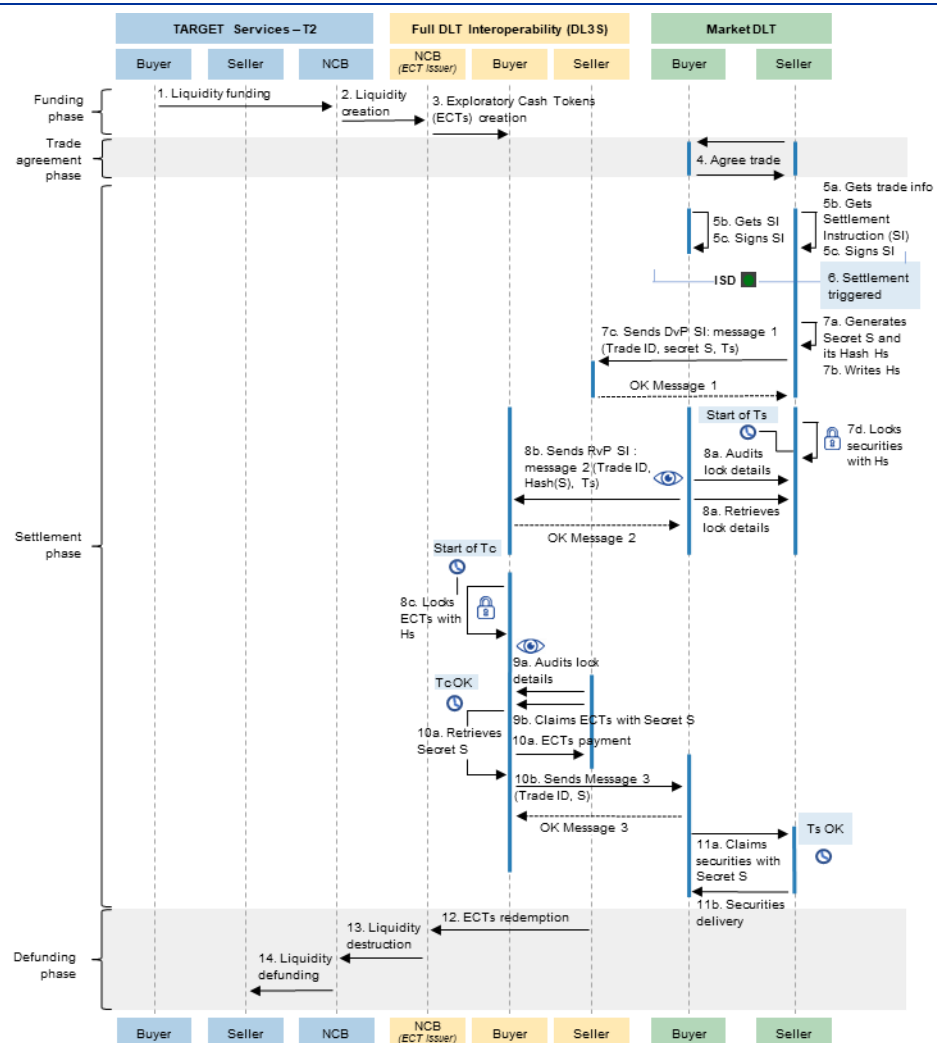
Notes: A simplified set-up for a delivery versus payment (DvP) trial is depicted. It is assumed that: (i) no other market third parties are involved in the transaction; (ii) both buyer and seller are eligible participants in TARGET Services, in the Full DLT Interoperability solution and in the market distributed ledger technology (DLT) platform; (iii) the buyer and seller have the same national central bank (NCB), that NCB being able to issue exploratory cash tokens (ECTs) in the Distributed Ledger for Securities Settlement System (DL3S); and (iv) the buyer and seller are technically able (and permitted) to handle their own custody of the ECTs in DL3S and of the assets in the market DLT. T2 is the Eurosystem real-time gross settlement (RTGS) system. ISD stands for intended settlement date, SI for settlement instruction, Hs for Hash(S), S for Secret, Ts for time lock - securities, RvP for receipt versus payment and Tc for time lock - cash tokens.

5   TIPS Hash-Link provided by the Banca d'Italia

The TIPS Hash-Link solution uses a ledger-agnostic application programming interface (API) interoperability model that employs cryptographic hash functions to create a secure link between an external DLT platform and a payment system that supports ISO 20022 messages. The TIPS Hash-Link solution provides full atomicity for the transactions, including where the parties are in dispute, without the need for (manual) contingency procedures.

With this solution, hash values are generated and shared between the external DLT platform and TIPS-like platform (one value for execution of the transaction and one for cancellation) to be used in the case of disputes. Completion of a transaction on the external DLT platform is contingent on irrevocable settlement of the corresponding payment in the TIPS-like platform.

Figure 4

Simplified delivery versus payment transaction using TIPS Hash-Link

Notes: A simplified set-up for a delivery versus payment (DvP) trial is depicted. It is assumed that: (i) no other market third parties are involved in the transaction; (ii) both buyer and seller are eligible participants in TARGET Services, in TIPS Hash-Link and in the market distributed ledger technology (DLT) platform; (iii) the buyer and seller have the same national central bank (NCB), that NCB being able to issue exploratory liquidity in TIPS Hash-Link; and (iv) no dispute arises between buyer and seller. T2 is the Eurosystem real-time gross settlement (RTGS) system, API stands for application programming interface.