



JAPAN EXCHANGE GROUP

JPX WORKING PAPER

Study on Applicability of Distributed Ledger Technology in Trade Matching Processes

Daiwa Securities Group Project Team

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This report presents the results of a joint study conducted by Daiwa Securities Group and 17 financial institutions concerning the applicability of blockchain technology, or Distributed Ledger Technology (DLT), in the trade matching of post-trade processing between institutional investors and brokers/dealers in the Japanese securities market.

The trade matching in Japan is driven by the systems provided by various service providers, which have led to increasing Straight Through Processing (STP). However, in order to achieve further improvement of STP in the securities industry, which comprised of institutional investors (buy-side), brokers/dealers (sell-side), trust banks, and service providers, the participating financial institutions concluded that all involved parties must work to unify standards for various codes and calculation methodologies.

The key issues identified in unifying standards are the lack of interoperability among service providers' systems and the non-shareability of databases (DB). The solution to these issues could be solved if a unified system is provided by a particular central institution. However, depending on the scope of business of that central institution, an undeniable limiting possibility might arise when dealing with multi-assets and global situations. The notion is that DLT might represent a new solution to these issues not predicated on centralized management by a central institution. It is possible that we could achieve the unification of standards without changing the make-up of industry participants by developing a smart contract reflecting standard industry specifications determined by a committee, place them on DLT, and have the products from the various service providers apply to such specifications.

Achieving this unification of standards and the vision for applying DLT will require both theoretical and practical work by the industry as a whole. The process of forming a consensus on industry standards will also require disclosure of information and a forum for fair debate. In the formation of such forum, the role of central institution is highly expected because of their neutral point of view. Moving ahead with the initiative of applying DLT to trade matching would lead to further improvement of STP of the financial system as a whole, which would contribute to the benefit of the investors.

1. Introduction

(1) Project Background and Objectives

The establishment of a project for applying blockchain technology in trade matching (the “project”) was decided by the Daiwa Securities Group Project Team (the authors, hereinafter “project team”) that leveraged the framework of “Collaborative Industry Technology Evaluation of DLT” of Japan Exchange Group, made a project proposal to numerous financial institutions, and obtained indications of participation from the majority of them.¹

The objectives of the project are to achieve additional efficiencies and optimizations in trade matching process by utilizing the rapidly-advancing DLT and to increase the international competitiveness of the services provided by each financial institution and Japanese financial market itself.

The process of trade matching in Japan’s securities markets has been systemized and automated in the form of expanding the target scope of the settlement system of the Japan Securities Depository Center (JASDEC PSMS), launched for use with domestic equities in 2001. The contract notification and allocation, which is the starting point of the trade matching process was excluded at the time, citing the difficulty of methodological unification. Nevertheless, with the revised regulations that appeared in 2003, contract notifications at average prices had started, with each company accumulating its knowledge in this area. In the U.S., these services were already being provided to process the usage of networked systems from contract notification through matching of settlement instructions, with unified methodologies, unified systemization, and automation all in place.

During the approximately three-month period from the end of September, 2017, to the end of December, 2017, we held a total of seven meetings, four of which were study groups, wherein an attempt was sought to unify methodologies in the trade matching—focusing mainly on domestic equities. Accordingly, we gathered ideas and carried out reviews designed to make processing flows more efficient and to expand the

¹ Daiwa Securities Group Headquarters Press Release “Blockchaining for Securities Post Trading Work/Regarding the Beginning of Consideration for Application of Blockchaining Technology – Establishment of a Project Considering the Method Standardization over the Domestic Securities Industry” (2017/9/14)

http://www.daiwa-grp.jp/data/attach/2267_86_20170914a.pdf

scope of automation, making use of DLT's characteristics. We also used a prototype application developed by Daiwa Institute of Research, the Daiwa Securities Group's think-tank, to confirm feasibility and identify areas for future enhancements.

This working paper summarizes the topics reviewed for the project and considerations by the project team based on those review topics. As such, it is intended to invite broad feedback from market participants and other relevant contributors. The opinions expressed in this paper belong to the authors and/or those cited, and are not the official views of Daiwa Securities Group or the organizations to which the participants belong. We hope this paper can help leverage DLT in the infrastructure of the financial markets.

The paper is organized as follows. Section 2 introduces the three themes proposed at the working meetings (current situation and challenges in trade matching, the possible optimized process, and applicability of DLT) and attempts to see how the project team converged.

In Section 3, "Considerations" in "Structure and Framework for DLT Applicability," we delve deeper in the nature of configuration and structure of DLT systems and propose hypotheses from the project team, in order to achieve the possible optimized process as discussed in Section 2. In "Future Initiatives," we then touch on initiatives necessary to move forward in order to refine and realize the hypotheses and present our conclusions.

(2) Acknowledgments

In writing this report, we received valuable opinions and pointers from many people working outside our company—notably those from financial institutions who participated in the project. We also received wide-ranging support, in particular the provision of advice and meeting places, from the people in charge at JPX Group. We would like to express our deep appreciation to them here. The authors bear responsibility for any errors.

Companies Participating in the Project (excluding Daiwa Securities Group)

HSBC Securities Company Tokyo Branch	Nomura Securities Co., Ltd.
SMBC Nikko Securities Co., Ltd.	BNP Paribas Securities Co., Ltd.

Okasan Securities Co., Ltd.	Marusan Securities Co., Ltd.
Japan Securities Depository Center	Mizuho Bank, Ltd.
Tokai Tokyo Financial Holdings Co., Ltd.	Mizuho Securities Co., Ltd.
Tokyo Tanshi Co., Ltd.	Sumitomo Mitsui Trust Bank Limited
Naito Securities Co., Ltd.	Mitsubishi UFJ Morgan Stanley Securities Co., Ltd.
Nippon Securities Finance Co., Ltd.	Merrill Lynch Japan Securities Co., Ltd.
The Master Trust Bank of Japan, Ltd.	

2. Outline of Study Results

(1) Current Status of, and Challenges in, Trade Matching

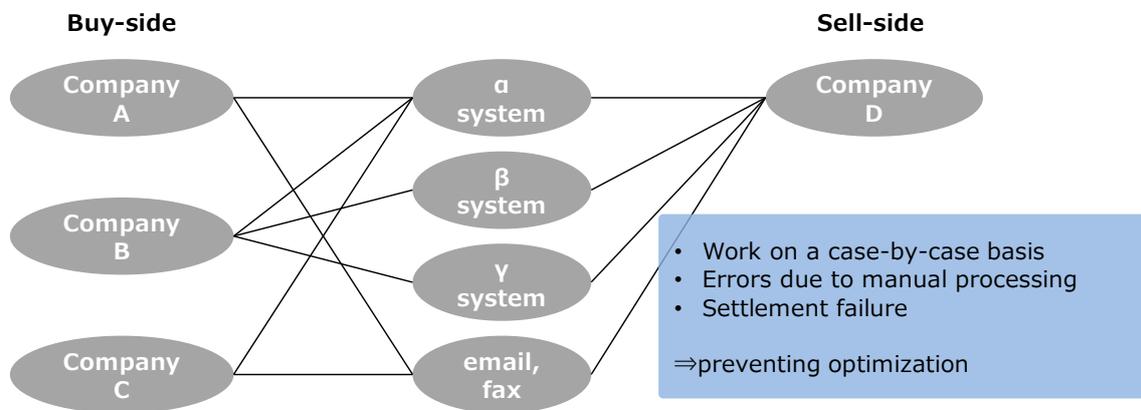
a. Current state of systems and issues

In the process of trade matching on the sell-side, first there is an order of Buy/Sell trade from the buy-side, the client. The sell-side then executes the order on the exchange and notifies the results of the trade to the buy-side (NOE: notice of execution). Next, the buy-side performs allocation to multiple funds, shares the allocation information with the sell-side, then, after trading closes, both sides validate the contract results (i.e., undertake trade matching). This series of steps from contract notification to trade matching was previously carried out manually, using email or fax, but now a number of systems have been developed by service providers and are widely spread.

However, the use of such systems is predicated on both sides using the same system, meaning that the sell-side has installed various systems based on the desires of the respective buy-side. Even after the system is installed, there are cases of information and data continuing to be sent and received by email or fax. It is common, in other words, to deal with specific companies individually. On the sell-side, there are many cases where matters are handled using EUC (end-user computing) or by manual means.

Concerns on measures taken by individual companies handling were voiced in terms of the possibility of inducing human error by making processing more complicated and the operational risks of EUC developed on the spot. In addition, with index-funds becoming more common, the number of trades offered is shooting up, leading to cases where fees for using the service providers' systems exceeds the execution commissions to be receivable, leading some to question the sustainability of trade matching.

Diagram 1. Current state and challenges in trade matching



Source: Daiwa Securities Group Project Team

b. Current state and challenges in rules and standards

Along with the individual treatment mentioned earlier, one factor behind the growing complexity of trade matching is the lack of standardization in various rules. For example, between the buy-side and the sell-side, there are no unified standards for price calculation methodologies, allocation notifications, pre-confirmations, various codes, and dealing with errors, with general agreement that these factors prevent the overall optimization (Diagram 2).

Diagram 2. Differences in rules and standards

Category	Current status and challenges
Unit price calculation	There are two types of calculation methods; "individual unit price" and "average unit price". "Individual unit price" is the traditional method in Japanese market. Due to the complexity of calculating commissions, mismatches can easily occur. "Average unit price" is a global calculation method that has now become mainstream. However, some companies prefer to continue using "individual unit price".
Calculating commissions	In the area of rules for calculating commissions, there are multiple conflicting rules about things like rounding, cap & floor, small deviances (i.e., those of one or several yen), and consumption taxes.
Allocation notifications	Buy side specifies the means of transmission. Alternatives include email and multiple systems from external vendors.
Pre-confirmation	In the case of Excel or CSV, in some cases the buy-side specifies the format and the sell-side deals with the request with EUC. The interfaces and functional specifications differ from one service provider to another.
Codes	There exist local codes and multiple types of global codes, requiring the sell-side to do contract matching with the code demanded by the buy-side.
Dealing with errors	Contingency plans for discrepancies differ from company to company.

Source: Daiwa Securities Group Project Team

With regard to rules for calculating unit prices, there is the non-average unit price method (individual unit price method) and the average unit price method. The traditional individual unit price method has the disadvantage of dealing with large amounts of data and the fact that mismatches can easily occur in the complex commission calculation (e.g., one-lot calculation, cap and floor, handling of rounding errors). In recent years, while many buy-siders have migrated to the average unit price method, which is the global method, there is no clear unified industry standard, leaving some on the buy-side still using the older individual unit price method. As a result, the sell-side is dealing with both the individual unit price method and the average unit price method.

In terms of rules for calculating commissions, there are multiple conflicting rules such as rounding, cap & floor, small deviances (i.e., those of one or several yen), and consumption taxes. When it comes to the tolerance of differences in commissions, for example, many buy-siders consider a difference of a few yen to be within the tolerable range, but some processes continue to require precision at the single-yen level. To avoid one-yen disparities, the sell-side thus adapts its implementation to the buy-side system specification (with the way numbers are truncated to obtain the actual amounts

depending on the company), and human intervention is required when mismatches of one yen occur. It was pointed out that there should be a chance to think about roles for tolerating discrepancies, if one wants to raise overall industry productivity.

With regard to allocation notifications and pre-confirmations—reports prepared at the stage of trade matching—there exists no standardized rules such as HOFURI PSMS. Indeed, there is a profusion of methods. As means of transmission, sometimes transmission services offered by multiple external service providers are used, while in other cases Excel spreadsheets and CSV files are transmitted via email, FTP (file transfer protocol), or fax. Even when transmission services offered by external service providers are used, multiple services exist—each company under a completely different situation in terms of functions and interface specifications.

It has been pointed out that since multiple code values have been assigned to the same issues and the same execution market, standardization of specifications should be considered.

For dealing with defaults or discrepancies, the reality is that there is no determined procedure for handling such errors or cancellations. Since contingency plans for dealing with the unavailability of transmission services provided by external service providers differ for each buy-side player, some argue that it would be desirable to come up with a standard plan for sending CSV files by email in a unified format.

(2) The Possible Optimized Process

a. Unification and maintenance/management of standards

One comment we received had to do with an optimized trade matching system, such as the one discussed in this project, and would involve industry-standard rules for the domestic market that would start with the stage of contract notifications, with rules for unit rate calculation being agreed on and used by all involved.

Nevertheless, some commented that standard specifications should be changed flexibly in response to changes in the external environment and advances in technology. For example, the Markets in Financial Instruments Directive, known as MiFID, which sets regulations for financial products, services, and markets in the E.U., will undergo a significant revision called MiFID II in 2018, where it is likely that people concerned, even in Japan, could be impacted by the changes in the system, which, as things stand,

would have to be dealt with individually on the buy-side and sell-side. A framework for determining changes in standard rules based on consultations by those concerned, if one existed, could avoid fragmentation in the case of future changes. What follows are some examples of formulating standards and formulating rules for maintaining and managing them.

■ Examples of formulating standards:

- Employing uniformity in unit price calculations to the average unit price method;
- Employing uniformity in calculation rules for fractional digits and rounding;
- Introducing rules for dealing with small discrepancies;
- Unifying data transmission formats and modes of transmission, e.g., FIX;
- Employing uniformity in various types of codes, e.g., market codes, and their nomenclature;
- Having a consensus that the data on the shared ledger is always correct;
- Standardizing ways of dealing with cancellations, errors, and responses to discrepancies.

■ Examples of formulating rules for maintaining and managing them:

- Criteria for participating in consultative bodies;
- Mechanisms for adopting to changes in the external environment (e.g., changes in market rules and regulations);
- Mechanisms for considering the introduction of new technologies when they emerge.

b. Further progress in the move to STP

Formulating standard rules and regulations will contribute to the integration of upstream and downstream portions of the trade matching process, expand the scope of applicability, and even promote further STP (Straight-Through Processing). For example, it is eminently conceivable that if we could use the original data, processing it

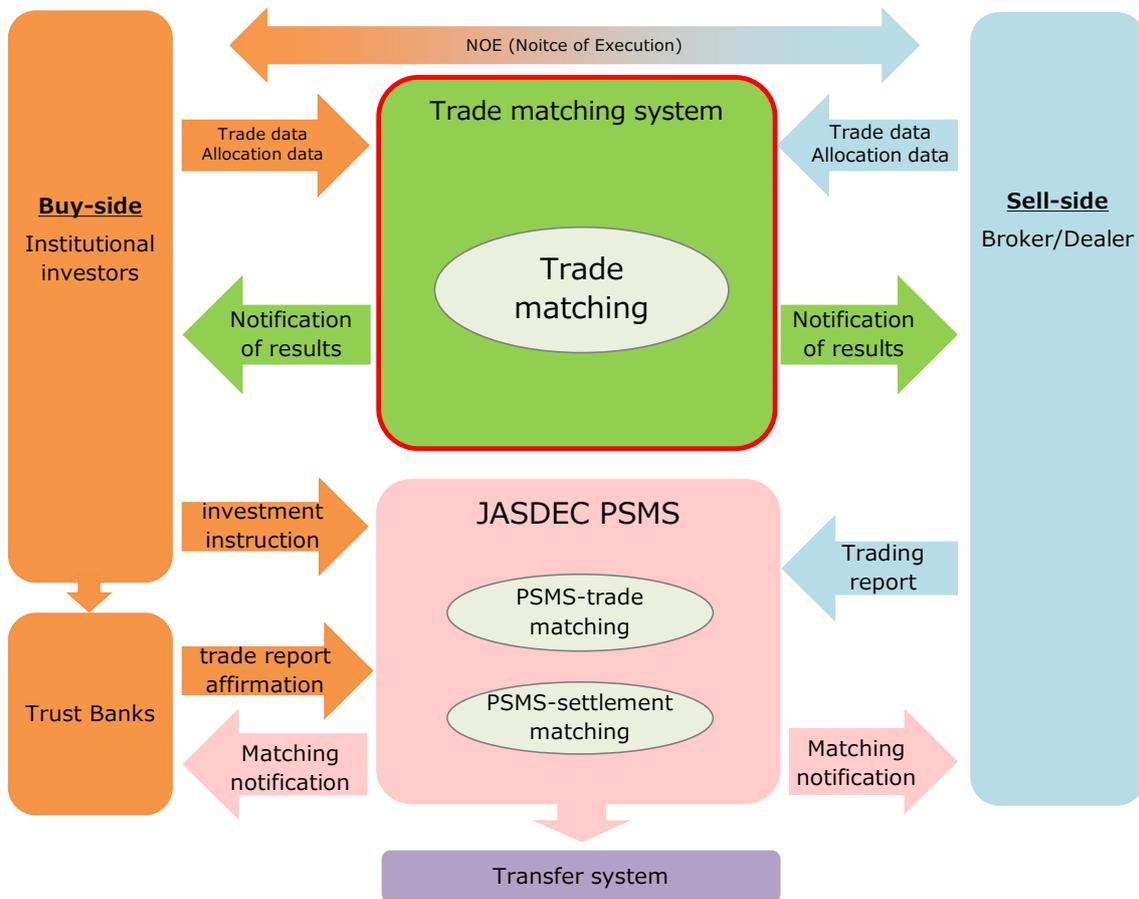
at each stage, all the way through to the settlement stage, we could eliminate or reduce the number of times data needed to be transmitted over each of the steps of trade matching.

Diagram 3 gives an overall picture of the current trade matching process. The sell-side issues a contract notification to the buy-side about how much of the placed order was executed, including the commission. In response, the buy-side then enters the allocation information about the ultimate allocation to accounts and sends it back to the sell-side. The sell-side divides the commission based on the allocation information received from the buy-side and transmits the results of the calculation to the buy-side. If both sides' data is aligned and same, then it is considered a match.

Subsequently, both the buy-side and the sell-side transmit the contract data using the JASDEC PSMS trade matching capability scheme. A match there is considered an official confirmation in electronic mean. Following that, once the trust bank approves the matching results, settlement direction data is generated automatically.

The JASDEC PSMS settlement matching feature includes matching up to SSI (standing settlement instruction). A match at this point automatically generates a DVP settlement instruction, and subsequently settled systematically.

Diagram 3. Current flow of trade matching process



Source: Daiwa Securities Group Project Team

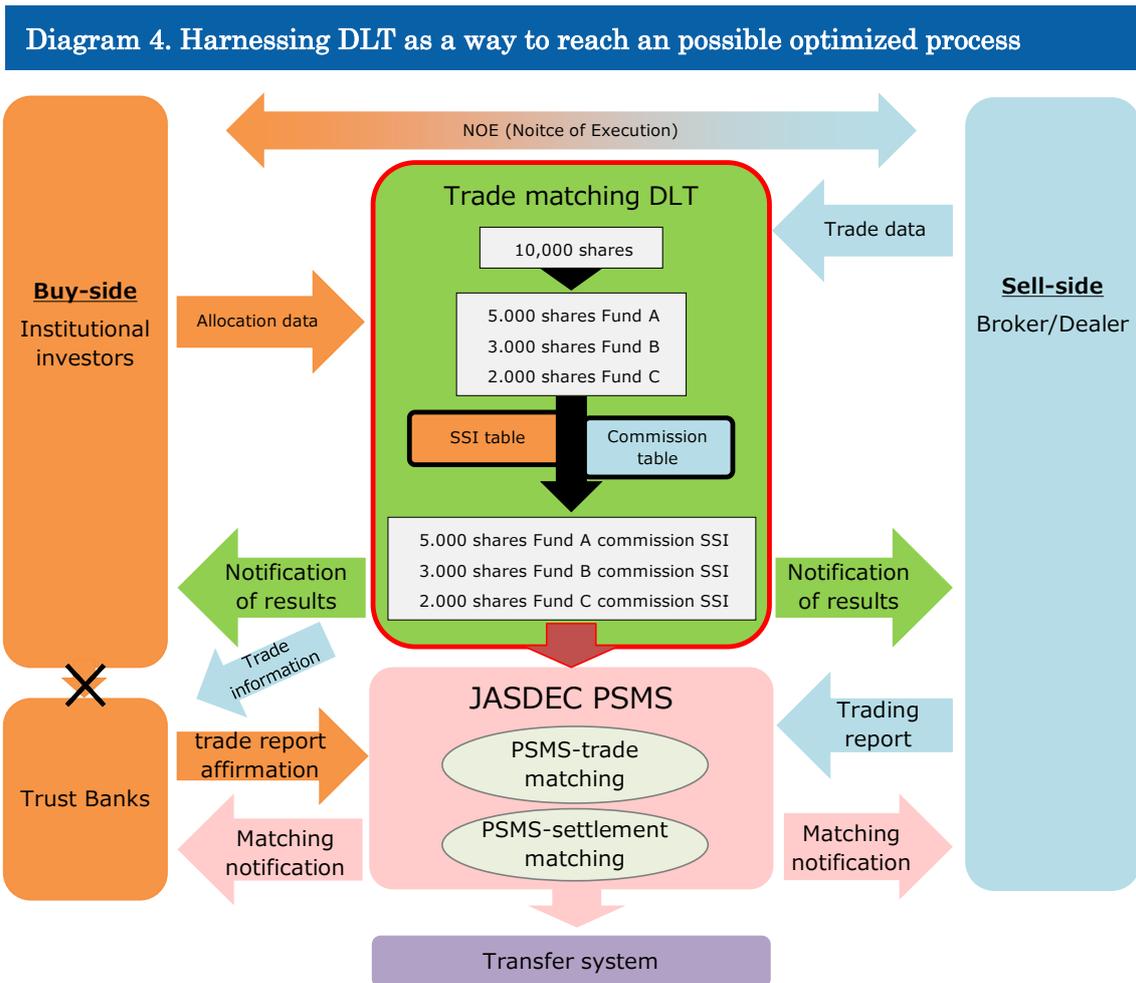
Diagram 4 depicts how DLT might be used to achieve the goals of the idealized world postulated herein.

Commission table and calculation logic are agreed upon in advance between the buy-side and the sell-side, and they are set as smart contracts on DLT. Logic embodied in smart contracts carries out automatic calculations. Because neither the buy-side nor the sell-side nor both, need to do any calculations, the occurrences of mismatches should be reduced. Furthermore, the mismatches could not happen if the matching is no longer required..

By holding the SSIs for ultimate allocation accounts in DLT, after confirmation matching, it becomes possible for the trust bank to access the contract data on DLT as per the SSI, making the information handoff between the buy-side and the trust bank more efficient. In addition, even when a single fund has done traded with multiple

sell-sides, it becomes possible for the trust bank to aggregate and refer to information for all trades on a fund-by-fund basis.

If the DLT contract data is deemed correct, then linking with JASDEC PSMS would make it possible to eliminate the process of transmitting operational instruction data between the buy-side and JASDEC PSMS itself.



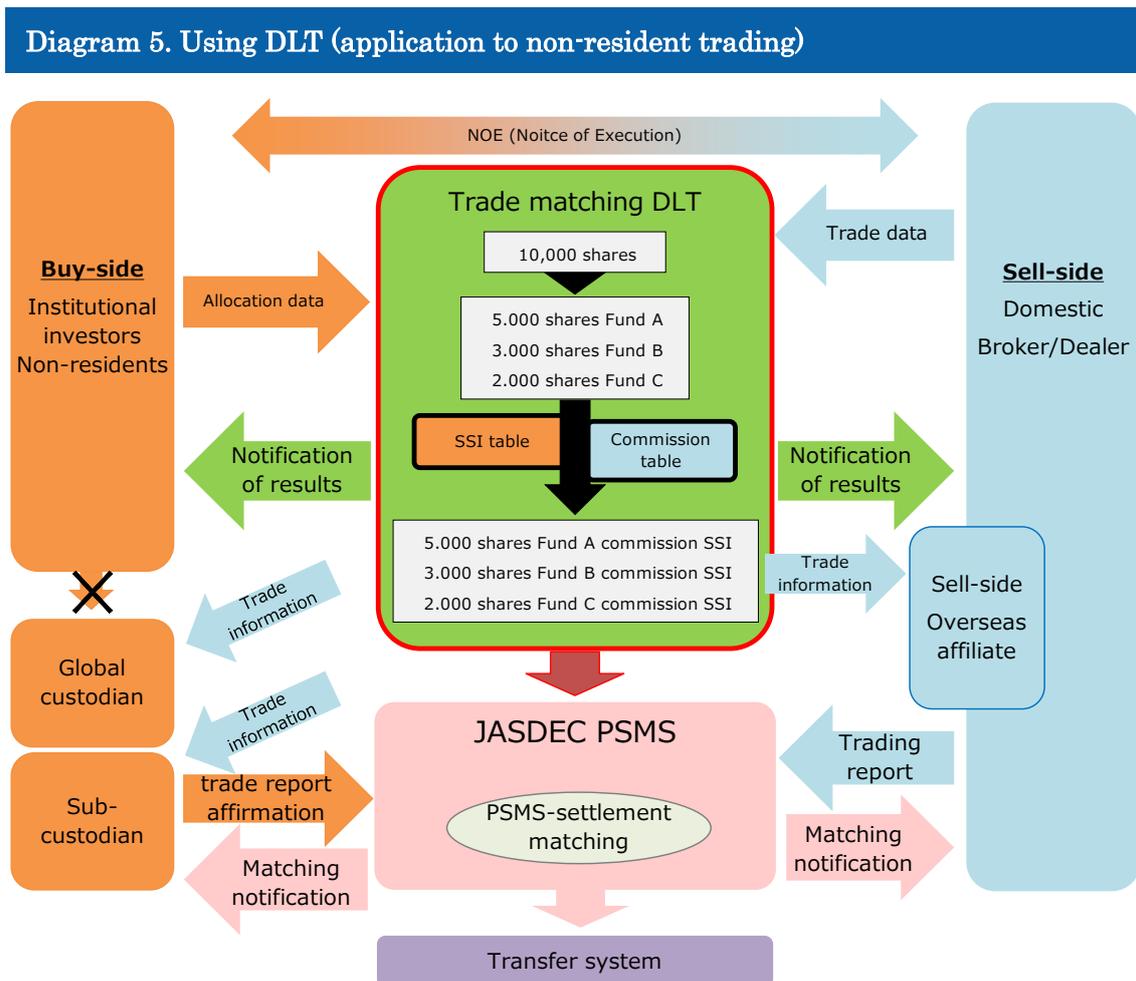
Source: Daiwa Securities Group Project Team

This scheme could also well contribute to making the process of trade matching for non-resident trading more efficient. Diagram 5 shows the application of DLT to non-resident trading.

Funds domiciled overseas carry out purchases and sales involving the buy-side (overseas) and the foreign subsidiary of the sell-side, meaning that in addition to the

possible optimized process above (Diagram 4), it will be necessary to allow the foreign subsidiary of the sell-side to access the DLT and share contract data.

Funds domiciled overseas have global custodians and subcustodians, with the subcustodians performing the final settlement process. Allowing both the ability to access the DLT would mitigate the risk of failures between the global custodian and subcustodian.



Source: Daiwa Securities Group Project Team

c. Points to consider in attempting to reach the possible optimized process

Attempting to reach the possible optimized process, it is necessary to devise ways to reduce barriers to deployment and not just the formation of standard rules and regulations to achieve overall optimization. The following points requiring consideration were raised at this juncture:

- accuracy,
- anonymity and confidentiality at a level not inferior compared to the present,
- integrity (data not being falsified or corrupted),
- availability (system does not go down, or goes down only rarely),
- operation speed with no noticeable delay (under one millisecond response time),
- lower cost compared to the present,
- hours of operation taking into account access from different timezone,
- English support,
- applicable for multi-assets,
- nexus with current infrastructure.

Attempting to accomplish these things, it will be necessary to emphasize general-purpose solutions, formulate specifications that may be used globally over the long term, operate and systematize the procedure democratically in a trusted way by fair, neutral third-party institutions.

(3) Applicability of DLT

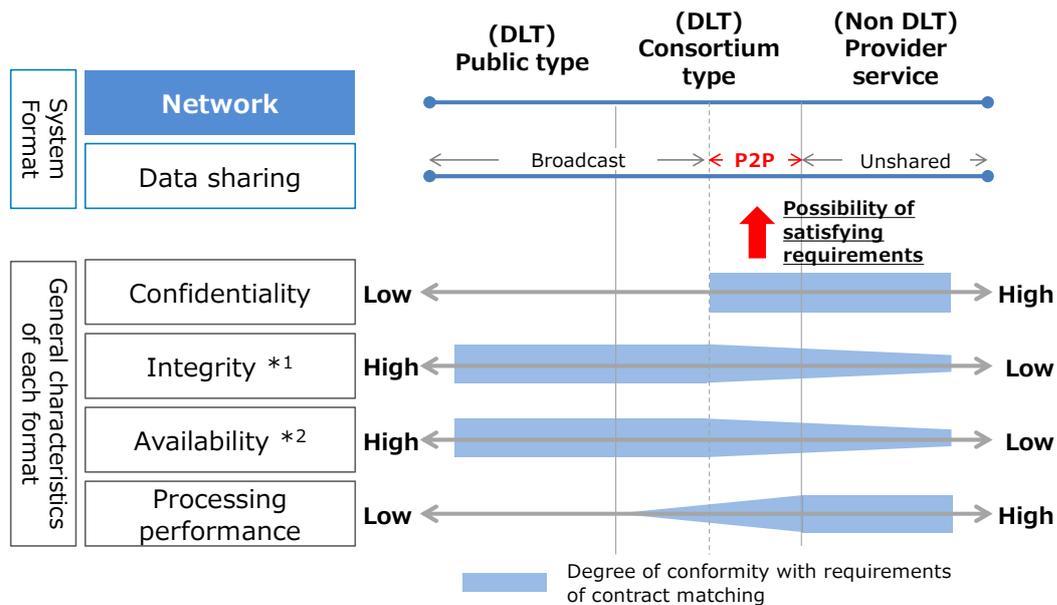
The review done through (2)b confirmed that the application of DLT is a promising proposition, in a functional sense, for the process of trade matching, requiring as it does the exchange and sharing of information among companies, and its features of extensibility and simultaneous sharing. We then considered whether or not DLT could satisfy non-functional requirements and/or what approach might be more appropriate.

There are many approaches to DLT, which can be categorized into the network approach (public-type or consortium-type) and data-sharing approach (broadcast-type or P2P-type²). This categorization determines the level of the major non-functional requirements such as confidentiality, integrity, availability, and performance, but these features are in a trade-off relationship with each other depending on the approach (Diagram 6). As you move toward the left in the diagram, confidentiality decreases, and performance worsens, but integrity and availability improve. The reverse is true as you

² Here, broadcast means a format in which all the DLT nodes hold the same data. P2P refers to a format in which only DLT nodes that are involved in data handling hold data.

move toward the right in the diagram. Based on this, we then discussed the sense of levels of requirements for the trade matching process from the perspective of which approaches are more desirable or which approaches are acceptable.

Diagram 6. Requirements for system formats, characteristics, and trade matching



*1 Integrity: Data is not falsified or corrupted

*2 Availability: Can be used at any time (system does not go down)

Source: Daiwa Securities Group Project Team

With regard to confidentiality, major concerns were raised about the broadcast approach, even assuming encryption techniques would be employed. There is massive resistance at present to storing data handled by financial institutions in external corporate environments unrelated to the transaction. While there is a possibility of this approach being accepted in the future based on applied studies of additional encryption technologies, at present P2P is necessary as a data-sharing approach. Note that since the primary type of public DLT is the broadcast approach, if P2P is selected then the network approach automatically requires the consortium type.

Integrity and availability are areas in which improvements can be expected from the public type and the consortium type compared to the use of service provider services.

Most of us thought that with regard to performance—of course for processes with deadlines, the faster the better—where it is a given that the required performance is

lower than it should be for matching and purchases and sales. Hence, while the public type might be a tough sell, the consortium type is very likely to satisfy the requirements.

Given the above, where there are many issues to review in the future, including whom to hold accountable when things go wrong, there was general agreement on the consortium-type, while it was agreed that the P2P approach seems to meet the non-functional requirements demanded by trade matching.

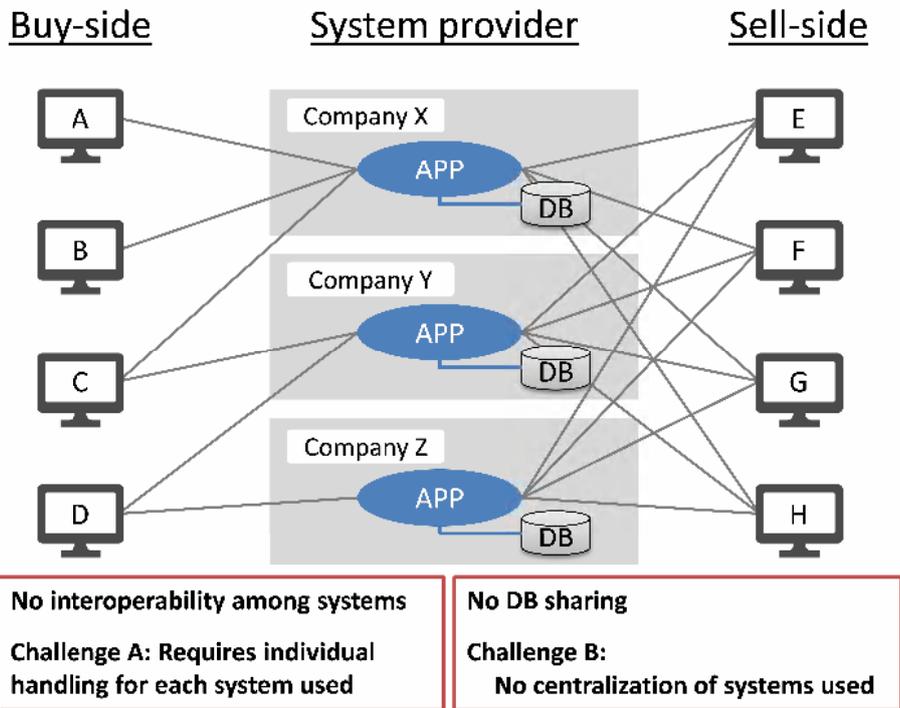
3. Consideration

(1) Organization and Setup for Moving Toward the Possible Optimized Process, Applicability of DLT

On the one hand, for many of the issues identified during our review, there exist no industry-standard specifications, which is the likely reason that various companies have deployed service provider systems implementing different specifications (Diagram 7). On the other hand, there is overall agreement on the direction for solving the issues among sell-side companies, making arriving at a consensus relatively straightforward. What thus becomes necessary in attempting to reach the proposed possible optimized process is the actual development of a system based on the intentions of a broader range of relevant participants, using the results of the review for this project as a foundation, and afterwards the building of an organization and a setup which can sustain it.

In this chapter, we considered as approaches for moving toward an ideal state of affairs not just DLT as a *fait accompli* but rather a variety of alternatives including the adoption of existing technologies. The outcome was that we arrived at the conclusion that the unique features of DLT could support achieving solutions that were not possible heretofore.

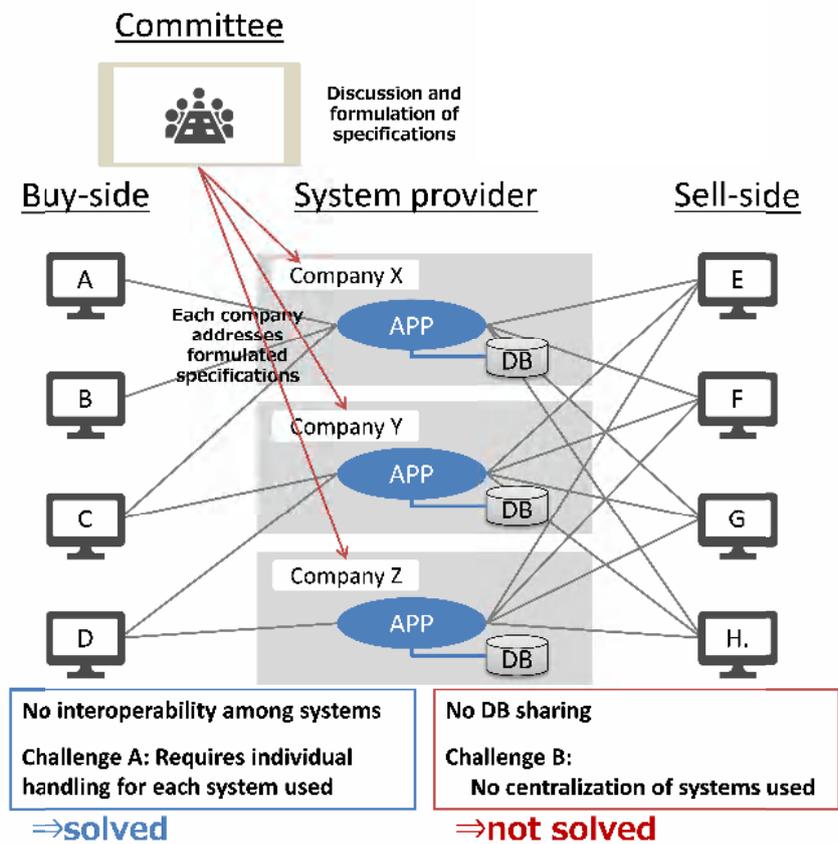
Diagram 7. Situation and Challenges with Current Systems



Source: Daiwa Securities Group Project Team

The first idea for extending this project in order to move toward the possible optimized process, called Proposal A, is to have a group of people (the “Committee”)—composed of industry participants—formulate a specification, and have the service providers implement it. Since implementing the specification would be up to each service provider, this would require evangelizing across the overall industry but, if successful, could render system-by-system support—one of the challenges we identified—unnecessary. However, DBs would continue to not be shared, so the effect would be limited (Diagram 8).

Diagram 8. Proposal A: Approach of having a committee formulate only specifications



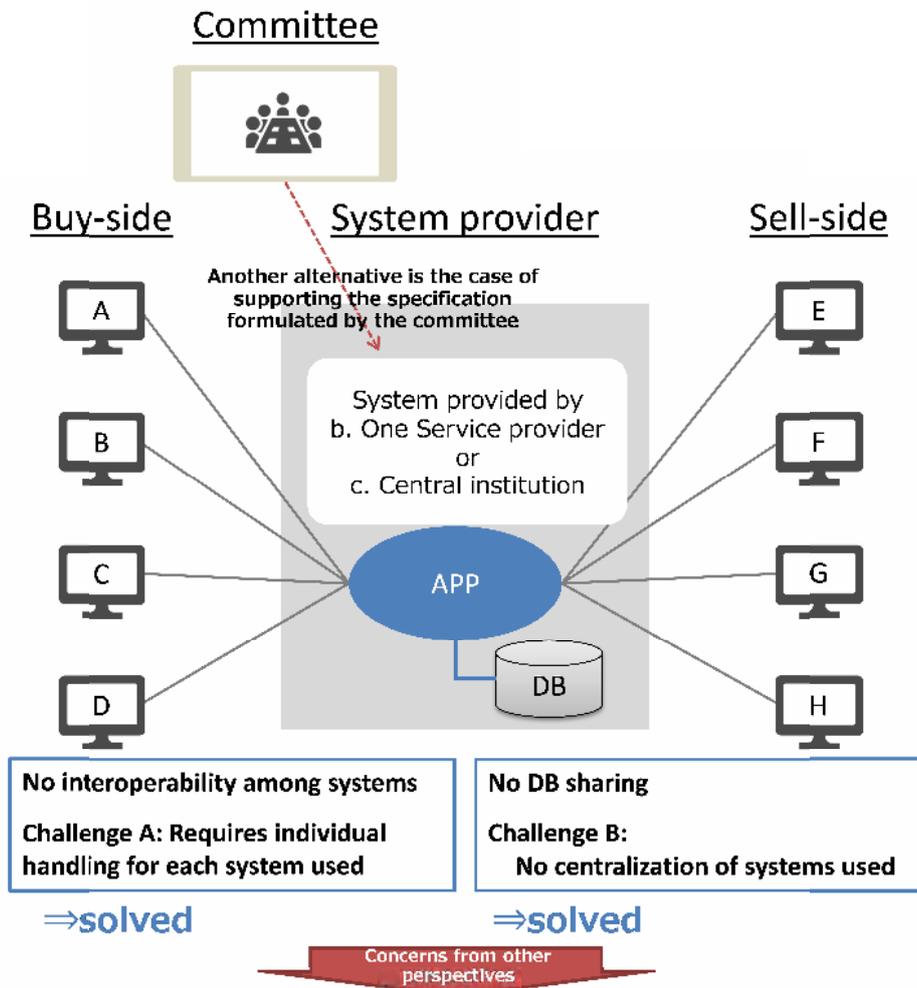
Source: Daiwa Securities Group Project Team

The next conceivable idea is to depend on one service provider (Proposal B). Moving to a single system provider would solve the problems of interoperability and DB sharing in one fell swoop. Another alternative is to do the same kind of evangelism (as in Proposal A) to get the service provider systems to support the specification designed by the committee. However, a situation in which a single service provider has a monopoly on providing the system gives rise to other concerns, such as poor service levels or rising fees, due to lack of competition between service providers.

One could also consider the approach where a central institution such as JSDC or JPX provides the system rather than a service provider (Proposal C). Like Proposal B, this would solve the two challenges with things as they stand, and since there would be no concerns of poor service levels or higher fees, it is more likely that this Proposal C could move us toward our possible optimized process. Having said that, as with

Proposal B, serious study would be required to have a central institution provide a service in a new area, and based on the products sold by that central institution, or its geographical scope of operations, there is an undeniable possibility of limitations arising in support of multi-assets and dealing with global situations. Proposal C is thus a highly promising alternative, but it would be more desirable if a different alternative could be presented that could be carried out by the Committee's own efforts (Diagram 9).

Diagram 9. Proposal B: Approach of depending on one service provider/Proposal C: Approach of a central institution providing the needed service



- ✓ Approach of depending on SP1 company has concerns regarding service being brittle due to monopoly power faced.
- ✓ Approach of providing through a central institution has concerns regarding the barriers to implementation being too high and taking too long (limits self-efforts set by committee).

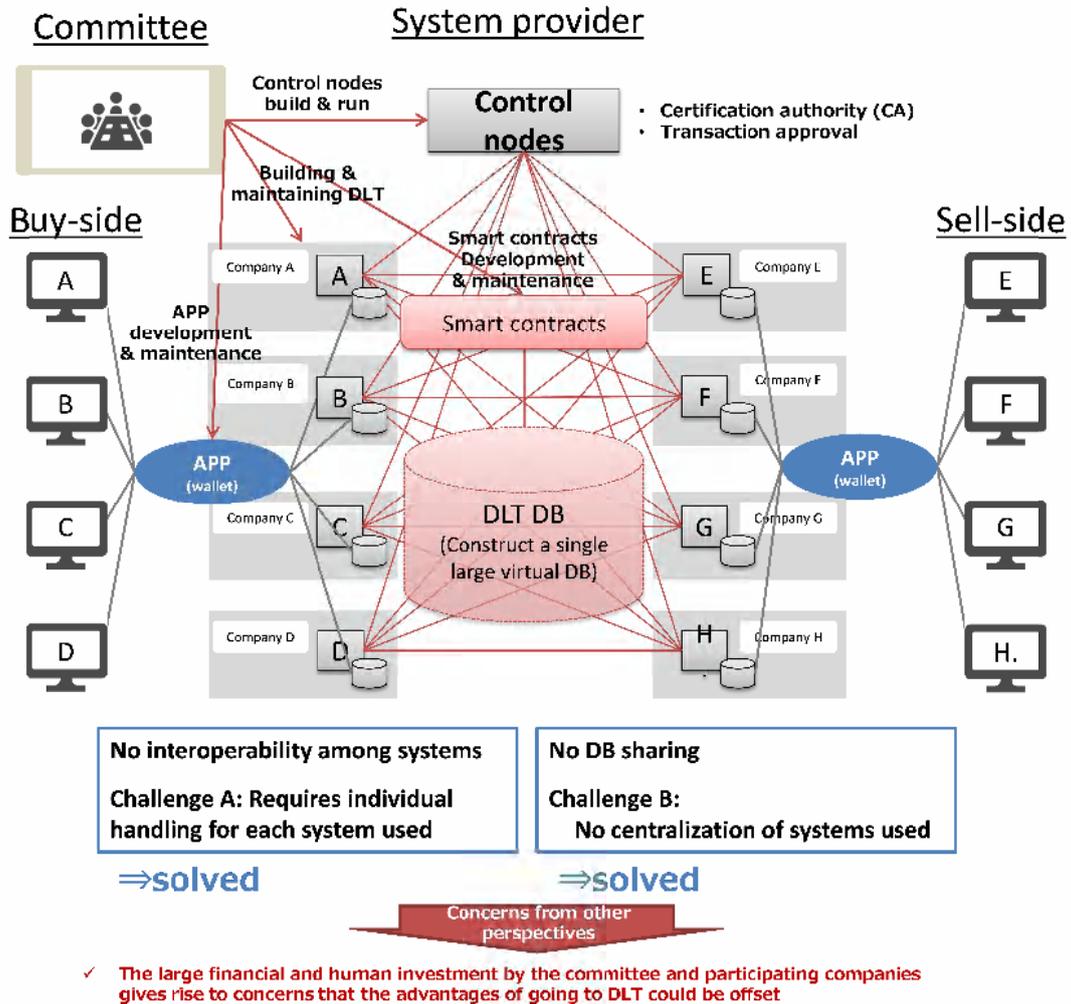
Source: Daiwa Securities Group Project Team

The next conceivable approach is for the committee itself to provide the system. In order for a committee composed of different organizations to provide a single system, normally one would create a joint venture, launching one consisting of industry players is almost the same as establishing a new central institution, which is structurally similar to Proposal C.

Given existing technologies and systems one would struggle to present any further alternatives, but adopting DLT allows us to present a new alternative.

What DLT makes possible is first the approach that the committee member companies could develop systems conforming to the specification defined by the committee, without creating a joint venture, and share DBs by means of DLT. Defining the specification would be the responsibility of the committee, and each company in the committee would build the system in accordance with that specification. The unique features of DLT mean that even if each company architects its own DB, they would be linked so as to form a single, huge virtual DB—the result being that the DB could be shared even as it is managed in distributed fashion. This approach, distinct to Proposal C, allows each participating member of the committee to solve their challenges through their own efforts, although the approach of developing a new system based on funds of people provided by each company places a large burden on them for implementing the initial architecture, operation, and maintenance, which might offset many advantages gained by moving to DLT (Diagram 10).

Diagram 10. Proposal D: Approach of participating companies sharing DB (DLT)

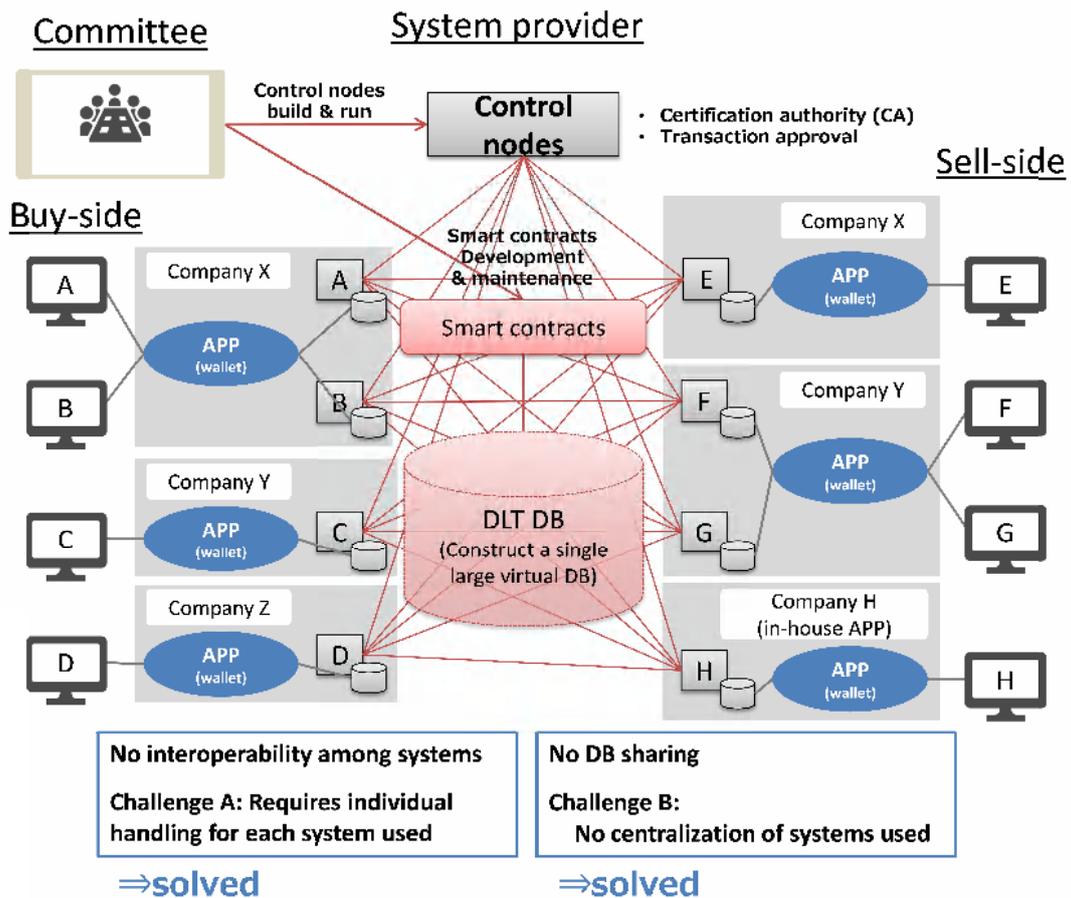


Source: Daiwa Securities Group Project Team

To ease the burden on the participating companies, the most realistic approach is to collaborate with service providers, as is done presently. We may thus take advantage of the DLT features that permit separating the implementation of the specification from building and managing it, and to add to the list of alternatives the notion of having the committee take care of things through implementing the specification. In that case, the service providers would take care of building and managing the applications and databases, while the service provider collaboration approach (below, “Proposal E”) would be used. It is thus even possible to achieve the unification of standards without changing the make-up of industry participants by developing a master contract reflecting standard industry specifications under the aegis of a committee, place them

on DLT, and have the products from the various service providers support it. We envision being supplied with systems by the service providers that will continue to compete in areas where they can differentiate themselves with frequent updates, e.g., appearance, usability, and support of various connection types. Yet, they would always adhere to the standard specification promises to promote service enhancements, thanks to attaining appropriate competition among service providers. In addition, having selected services provided by providers for DLT nodes that conform to the specifications in crowd form, it should be easier for the buy and sell-sides that found it difficult technically to set up their own DTL nodes to now be able to participate. Therefore, we consider Proposal E to be achievable and sustainable (Diagram 11).

Diagram 11. Proposal E: Service providers collaborative approach (DLT)



Source: Daiwa Securities Group Project Team

Diagram 12 summarizes the discussion up to this point. Assuming current technology and structures, Proposal C would appear to be optimal from the standpoint of putting in place standard rules and regulations, but with the advent of DLT, Proposal E, which presumes no central control by a central institution, must be included as a promising alternative.

Diagram 12. Comparison of approaches to reach the possible optimized process

		Distributed management (Non DLT)		Centralized management (Non DLT)		Distributed management (DLT)	
		Status quo Each individual SP company Approach	Proposal A Approach of having committee formulate only specification	Proposal B Approach of depending on one SP	Proposal C Approach of a central institution providing	Proposal D Approach of participating companies sharing DB (DLT)	Proposal E Approach of service providers collaborating (DLT)
Ap- proach	Formulate specification	SP (each company)	Committee	SP and/or Committee	Central institution and/or Committee	Committee	Committee
	Implement specification	SP (each company)	SP (each company)	SP (one company)	Central institution	Committee	Committee
	Build /manage app and DB					Participating companies	SP (each company)
Effect	DB shareability	no	no	yes	yes	yes	yes
	Cost of using external system	large	large	small to large (monopoly could push fees up)	small	none	small
	Internal cost	large	small	small	small	medium to large (cost of running committee)	small
Overall Assessment		Requires support from each user due to lack of interoperability between SPs DB sharing is also not possible	Individual company support may not be required, but limited benefits due to DB unsharability	Solves challenges of both interoperability and DB sharing, but could cause separate problem of monopoly	Solves challenges of both interoperability and DB sharing, but feasibility is poor	Solves challenges of both interoperability and DB sharing, but requires too much work by committee	Enabled DB sharing based on committee specification without changing makeup of industry players

Annotations: "Enables DB sharing via centralized management" (between Non DLT and DLT); "DLT enables separating implement specification and building app" (between Centralized and DLT); "Going to DLT enables DB sharing even with distributed control" (between Centralized and DLT).

Notes: "SP" means service provider(s)
Source: Daiwa Securities Group Project Team

(2) Preparing for Upcoming Initiatives

The project clearly established the new potential alternative of harnessing DLT as a way to solve problems in the field of trade matching. In taking advantage of DLT, in addition to the progress of technology itself, forming a consensus among companies in the industry, system providers, and central institutions is crucial, as is the schema for reaching such a consensus. We observed that there were several conceivable patterns for achieving success.

When setting out to achieve the overall optimization of trade matching, what is required is both theory and practice on the part of the buy-side, sell-side, trust banks, and service providers who make up the industry, while gaining deeper knowledge of

DLT, which is still in the process of development. The process of forming a consensus on industry standards also requires disclosure of information and a forum for fair debate. Expectations will be high for the role of third parties acting as central institutions in the formation of such a forum. Moving ahead with the initiative of applying DLT to trade matching would lead to further improvement of STP of the financial system as a whole, which would contribute to the benefit of the investors.