# Computerized Linking of
# Capital Markets - A Viable Approach

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## Abstract

Interlinking capital markets has always been an interesting issue since it not only provides more investment opportunities but also results in reduction of the risk of market volatility due to increase in the size of market. However, global and local barriers like different currencies, legal issues, settlement risks and costs prevent such interlinkage to take place efficiently. In this paper, we propose a model for interlinking capital markets of different countries taking advantage of automatic guideline information provided from the settlement hub to the trading engines. The context data is used in order to take into account and accommodate the above differences and address challenges efficiently. We show that SAMIP (Settlement-Aware Market Interlinking Protocol) can be easily developed, deployed and integrated with current CSD (Central Securities Depository) and trading engines with minimal effort and can drastically reduce the cost and risk of international settlement which consequently can increase the practical volume of international investment. Computer-aided simulations show that SAMIP is viable, practical and does not require costs as much as international CSDs.

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# 1. Introduction
## 1.1 Business & Technical Challenges

Interlinking capital markets has always been an interesting issue but it has experienced serious challenges in terms of business-layer considerations and technical Limitations. For instance, heterogeneity of markets with regard to regulations, currency, legal and tax issues prevent effective performance of such an interlinking.

Coming to technical arena, i.e. information technology, one faces challenges with design and deployment of very large, international information system featuring high performance and low error probability. Reducing operation cost while increasing compatibility and reliability can be concluded as major goals of the system. Thus, cross border transactions in a linkage may involve some other challenges such as: matching of international trades regarding the differences in participants' currencies which can make an order unsatisfied due to volatility in currency exchange rates, Monitoring foreigners' book-entry of orders and order routing, reconciliation of positions between foreign investor and issuer and vice versa, controlling the participant's position to encounter any over drafts, safekeeping of registry, management of corporate action events for abroad investors and etc.

## 2. Efforts in Markets Interlinking

The inauguration date of efforts in this field cannot be explicitly determined. However, traditional cross border listing in form of cross membership, partial and double listing and establishment of international clearing and settlement institutions (ICSDs) show markets trial to make cross-border settlement identical to domestic settlement in terms of cost, risk and technical processing. Europe seems to be pioneer in this field. European Commission set vision for an integrated European stock market in 1985. In 1997 Amir N. Licht analyzed the trend toward stock market integration of member states of the European Union.

The Giovannini Group as one of forerunners addressed basic pillar of cross border trading, clearing and settlement due to the request of European commission. The barriers to have a cross border CSD solution identified in their research were called Giovanni barriers. The barriers are:

1. Diversity of IT platforms/interfaces;
2. Restrictions on the location of clearing or settlement;
3. National differences in rules governing corporate actions;
4. Differences in the availability/timing of intra-day settlement finality;

5. Impediments to remote access;

6. National differences in settlement periods;

7. National differences in operating hours/settlement deadlines;

8. National differences in securities issuance practice;

9. Restrictions on the location of securities;

10. Restrictions on the activity of primary dealers and market-makers;

11. Withholding tax procedures disadvantaging foreign intermediaries;

12. Tax collection functionality integrated into settlement system;

13. National differences in the legal treatment of securities;

14. National differences in the legal treatment of bilateral netting;

15. Uneven application of conflict of law rules;

European Central Securities Depository Association (ECSDA) prepared a report on cross-border settlement in 2002 contained a model for cross-border clearing and settlement based on DvP (Delivery Versus Payment) and allows to settle gross or net.

In 2004 The European Commission adopted an action plan on an action plan to create a genuine single market in securities in the European Union and to make cross-border clearing and settlement effective, safe and efficient at Europe level. The European Commission published a report on future of clearing and settlement in Europe Union which outlined the actions it intends to undertake in order to improve Clearing and Settlement arrangements and discussed about the barriers identified by the Giovannini reports.

Hamburg Institute of International Economics published a discussion paper on efficient securities clearing and settlement system in 2004. This paper concludes that in order to minimize the impacts of different national laws, taxation systems, as well as culture and language barriers, EU Commission and national governments have to harmonize laws and create a level playing field to foster competition among financial services providers.

In 2005 Karlo Kauko accomplished a paper on this issue. He offered linkage between CSDs and following DvP standard as a solution for interlink between markets.[7] In 2005 Noritaka Akamatsu issued a paper about Bond Market Cross Border Settlement. He addressed basic issues such as channels of cross border settlement, Multi-currency settlement arrangements. and finally defined a strategy to encourage competition among national CSDs to become a regional International Central Securities Depository ICSD.

In 2006 Federation of European Securities exchange in corporation with European Central Securities Depository Association declared the European code of conduct for clearing and settlement. In 2008, Clearstream founded together with the CSDs of Austria, Denmark, Greece, Norway, Spain and Switzerland the joint venture Link Up Markets to improve efficiency and reduce costs of post-trade processing of cross-border securities transactions in Europe. [8] In this joint venture each CSD would have direct access to the services of the other CSDs by connecting to the infrastructure of Link up Markets.

In 2009 European central bank declared the framework of the Target 2 Securities (T2S) Guideline including: insuring that CSDs do not pose risk to each other, preventing free-riding behavior in T2S and so on.[9]

## 3. SAMIP Philosophy and Requirements

Context Awareness [10], is an interesting idea coming to large scale integrated system. It does not violate the abstraction of modeling nor the demutualization of market players. The philosophy behind SAMIP is to reduce the risk of settlement by providing some intelligent agents from the CSD-Interlink to the trading engines in both buyer and seller sides. These agents are in form of some highly abstracted routines in a specialized computer language which It is called it FTDL; the Financial Transaction Description Language. They equip trading agents with some valuable information about the conditions of a successful settlement by which high risk trades are avoided to be confirmed. SAMIP does not require the participating countries to change their IT infrastructure The Capital market IT infrastructure and only makes very small augmentations. Besides, SAMIP provides a clear and straightforward T+0 international settlement hub which is compatible with all clearing/settlement system. The idea behind this system is to break clearing process into two layers: 1- between participating CSDs and 2- between the local CSDs and brokers. Obviously, there must be a clearing process between brokers and customers which varies from a system to the other.

SAMIP is mainly a means for markets interlink which its implementation effort is more dedicated to its CSD-Inter-linkage that not only provides a common basis for international settlement but the FTDL agents to the trading engines as well. In other words, SAMIP does not require the trading engines to become unified or even interlinked because it poses dramatic overheads which provide less benefit. It should be an open option for the brokerage houses whether to become a member of a foreign exchange or to facilitate a proxy brokerage partner in which a partner broker acts as local

trustee of the foreign counterpart. In each case SAMIP should work seamlessly.

## 4. SAMIP: A Big Picture

Figure1 shows a big picture of SAMIP. The major role players in a minimalistic SAMIP scenario are:

1. Local CSDs: Local CSDs role play as a clearing proxy for international clearing;

2. Local Trading/Matching Engines: Trading engines should be subject to a small modification to be able to run the FTDL modules and match through them.

3. CXR (A Currency Exchange Market): This market is used to identify an agreed upon exchange rate instantly.

4. SCH (the SAMIP Clearing House): SCH is responsible for international clearing between CSDs.

5. ICF (International Clearing Fund): This fund should be supported by central banks of participating countries to exchange money in realtime according to the FTDL messages issued by TH.
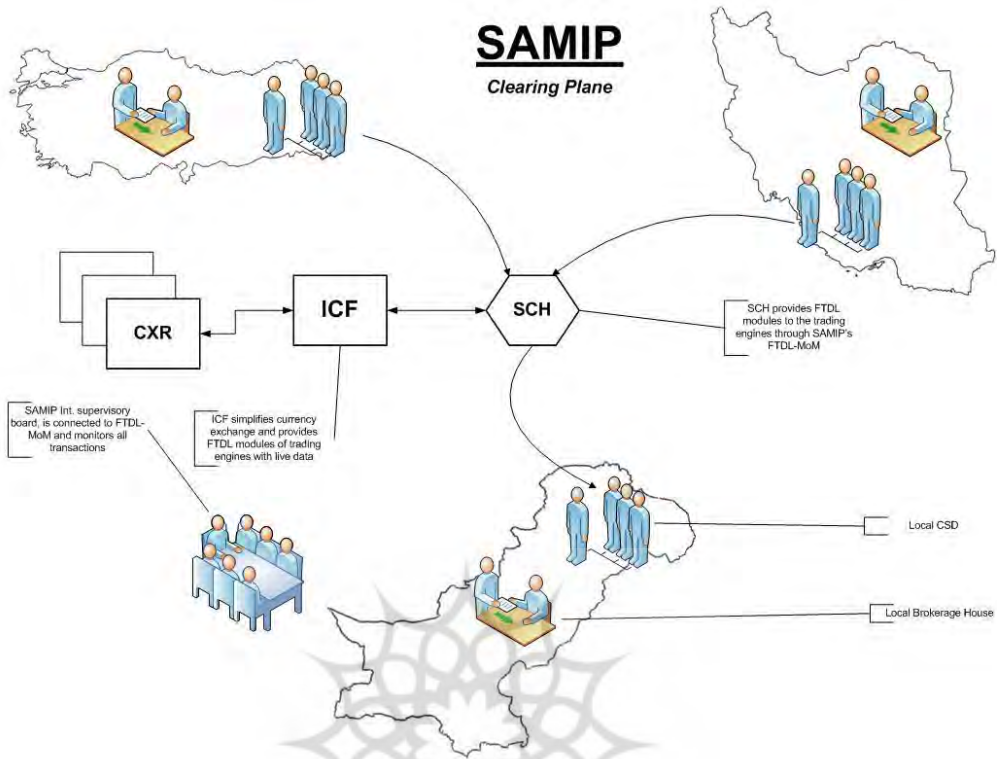
Figure 1: A big picture of SAMIP

Although any financial transaction could be easily described in FTDL (Even the local clearing & settlement), SAMIP just requires the S-Agents to be developed using FTDL. From a system-level perspective, more employment of FTDL in Capturing, confirmation, settlement and clearing of domestic and international trades results in better system-level outcomes concerning cost, effectiveness and reliability, and overall simplicity. It simply reduces the cost of development of such software module taking advantage of advances in hardware technologies which would result in better processing powers and better coverage of the performance issues behind interpreted scripting languages.

## 5. FTDL: Financial Transaction Description Language

It is a widely profited experience to make business objects and routines abstract from their implementation details in order to achieve scalability and flexibility in computerized business systems. A revolutionary advance for this issue has been the XML (eXtended Markup Language) which itself has

influenced its specialized successors like FPML [11]; (the Financial Products Markup Language; and MDDL [12]); the Market Data Definition Language.

FPML is mainly intended to describe a product characteristics and properties like any other XML-based data. However, in order to supply the trading engines with data and constraints about the candidate trade matches and to have sophisticated and deeply flexible scripted routines, FPML is not capable enough. Therefore, we need to propose a highly abstracted and flexible scripting language capable of describing any financial event as well as data.

FTDL is our response to such a challenge. It uses FPML for describing the properties of objects and facilitates a formal single-pass interpreted language capable of multi paradigm programming. The programmer can easily derive new object classes from FPML objects (in XML) and add new properties (again in XML) and methods to the new objects while taking advantage of modular or object-oriented programming paradigm.

For the sake of simplicity, a SAMIP routine always processes a vector of FPML objects retuning another vector of such objects. Hence, simple true-false results should be regarded as an always settled transaction. Obviously, any other local & global parameter in SAMIP wills an array of such objects. The programmer does not have to declare any parameter and any parameter will be initialized on its first use automatically. The language takes advantage of a lazy binding, seamless type conversion and automatic garbage collector.

Coming to integrated libraries, FTDL should be equipped with libraries providing at least the following facilities:

• Seamless data retrieval interfaces from web services, RSS, BBS, etc. to enable the programmer to use broadcasted data from other sources (here FOREX) and convert them to FTDL vector seamlessly.

• Security modules to encrypt decrypt and share keys in Financial Cryptography as well as providing code signing features.

• Measurement modules in order to enable the programmer to predict the performance of the modules and take it into account in its calculations. This property will be immediately addressed in specification of SAMIP.

• Concurrency management to avoid violation of shared parameters and communication channels just like ensuring the uniqueness of a buyer in the currency market.

• Seamless multi-threading to enable the programmer to keep some equivalences to be always held.

- Interfacing Modules to provide services to third parties using an Enterprise Service Bus and vice versa. For example, a money transaction integrated with the banking protocols like RTGS and ACH should be described and performed as a single atomic instruction.

## 6. FTDL-based SAMIP Specification
### 6.1. From Book Entry to Trade Confirmation

A broker might be granted to trade in one market but not in another. Therefore, SAMIP proposes a method for an international portfolio to be made by a single brokerage house by using a proxy broker in the destination market which will clear on behalf of the desired brokerage house.

A broker from country A places its order in country B's trading engine using the 'Trade Hub Interface' which is itself a message oriented middleware. A major strength point is that the order is made in country A's currency and the later clearing will be done in this currency.

### 6.2. ICF and Currency Exchange Risk Management System

Currency exchange risk should be considered as an important factor in any change-embedded transaction in international trades. As the currency of different countries is different from each other, the participants in SAMIP protocol have to be hedged against the risk of reduction or elimination of cross border investments because of a change in the exchange rate of two currencies in settlement or ownership period. We propose ICF (International Currency Fund of SAMIP) in order to provide hedging mechanism in realtime. As mentioned before the European T2S program for interlinking the markets follows T+0 period of settlement and this is also inevitable in SAMIP due to the function of ICF. ICF will play its clearing role as the cross border transaction has been matched already. The purchase price will be deducted from the buyer's domestic CSD account on behalf of seller's domestic CSD account and simultaneously the domestic central banks will change the purchase price to domestic prices for both parties to avoid exchange rate risks. After that the position management and multilateral netting can be done on CSDs layer in ICF in a period of T+0 and the domestic CSD will charge the buyer (broker, custodian, investor) for purchase price in buyer side and domestic CSD of seller can pay the price of transaction to him on its own rule and period of settlement. As soon as clearing is accomplished the delivery of securities on both sides will be done. The buyer would have to pay the interest of money to domestic CSD in settlement duration. Financial resources for ICF can be provided by Central Banks, Participant CSDs or participant stock exchanges. They can

be motivated to mobilize such resources due to fund profits of commissions paid by participants and the interests on deposited fund resources in a withdraw able investment account. Finally it should be noted that financial resources in ICF should be deposited in one or two exchangeable base currencies which will pave the way for central banks to change domestic and destination market (primary) currencies to each other.

## 7. ICFv2: International Clearing Fund Revisited
### 7.1. What is/What for ICF

ICF (the International Clearing Fund) plays the role of cash clearing between participants in the SAMIP model. Currency exchange risk should be considered as an important factor in any change-embedded transaction in international trades. Participants in SAMIP protocol have to be hedged against the risk of reduction or elimination of cross border investments because of a change in the exchange rate of two currencies in settlement or ownership period. A big picture of clearing and settlement in SAMIP is shown in Figure 2.

In order to establish effective linkage between the participating markets in terms of CSD activities and in accordance to Giovanni's report[2] which indicates clearing and settlement is considered as challenge even in European link up market where participants enjoy the same currency, the need for effective and low cost ICF mechanisms.
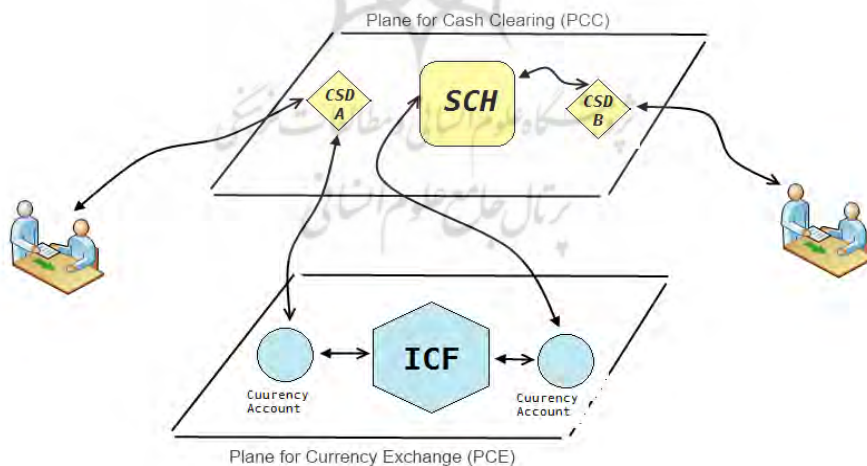


Figure 2: Clearing and Settlement in SAMIP

### 7.2. Review of ICFv1

As seen in previous version of ICF (the previous section), this component was playing clearing role as the cross border transactions has been matched. The purchase price will be deducted from the buyers' domestic CSD account on behalf of buyers' domestic CSD account and simultaneously the domestic central banks will change the purchase price to domestic prices for both parties to avoid exchange rate risks. After that, the position management and multilateral netting can be done on CSDs layer in ICF in a period of T+0 and the domestic CSD will charge the buyer (broker, custodian, and investor) for purchase price in buyer side and domestic CSD of seller can pay the price of transaction to him on its own rule and period of settlement. As soon as clearing accomplished, the delivery of securities on both sides will be done. Obviously the buyer has to pay the interest of money to domestic CSD in settlement duration. Financial resources for ICF can be provided by Central Banks, participant CSDs or participant stock exchanges. They can be motivated to mobilize such resources due to fund profits of commissions paid by participants and the interests on deposited fund resources in a withdraw able investment account. Finally, it should be noted that financial resources in ICF should be deposited in one or two exchangeable base currencies which will pave the way for central banks to change domestic and destination market (primary) currencies to each other.

### 7.2.1. Challenges to ICFv1

International clearing involves some challenges in terms of volume of money have to be transferred from buyer to seller and also the limitation of each participant to maintain the money needed to guarantee clearing and settlement in T + 0. Therefore, each member or participant should contribute to the clearing fund depending on the status and amount of its transactions and the given status of clearing as well as total margin requirement. Currency exchange rate volatility is an important factor must be hedged in any links between countries with different currencies. Besides, each link participant has to guarantee clearing and settlement procedures in ICF. Money provider can be motivated through the interests on money in the period of settlement in charge of debtor CSD on generally agreed to mutual agreed upon rate determined at the time of joining the link. The other challenge can be considered is ICF overheads including money transfer fees, management fees and etc. This cost can be minimized due to mechanism of netting in ICFv2 described in 7.3.

As most of link participant countries may not have the support of local central banks to manage the convertibility of their local currency to proxy currencies in ICFv2 Central Banks are substituted by Currency Exchanges.

These exchanges are either delegates or nominees (agencies) of ICF. ICF itself owns a big currency exchange unites. ICF plays the role of cash clearing as well as managing different settlement periods. As mentioned before the European T2S program for interlinking the markets follows T +0 period of settlement. SAMIP joins this period of settlement as well avoid settlement risks in CSD's layer. And to ensure the international market integrity as well as protecting participant's different period of settlement.

Linking solution for netting of international transactions is mandated as an integral part of international clearing and settlement. Because gross clearing seems to increase the cost of international investment and makes link useless, therefore, the gap between settlement-periods of different link participants should be filled during the transaction taking into account the status of confirmed, matched and canceled order. On the other hand, any money exchange embedded link in large scale makes the existence of exchanging body essential. This leads to need to cooperate with central banks as an essential part and also limitation of SAMIP which should be taken care of in ICFv2.

### 7.3. ICFv2 Design Principles

The design of ICFv2 should be done having the challenges of the first version addresses while maintaining acceptable complexity and hitting the principle of modularity. For this purpose we divide the tasks of ICF into two major categories:

1. Currency-level clearing
2. CSD-Level clearing

The first issue will address the challenges with different currencies and their limited exchange opportunity while the second one will solve the problems caused by different cash settlement periods.

For the sake of modularity, we divide the tasks into two cooperating but yet separated planes named PCE (standing for Plane for Currency Exchange) and PCC (standing for Plane for Cash Clearing) as depicted in Figure 2.

### 7.4. ICFv2 Architecture
### 7.4.1. PCE: Plane for Currency Exchange

Handling of different currencies will be done in ICF by the plane called Plane for currency exchange (PCE). This plane bears the opportunity for ICF to make benefit of optimizing the time of netting during the day (in T + 0) by obtaining the optimum point of $F(p; q; x)$ while x = Net1; Net2; Net3, etc.
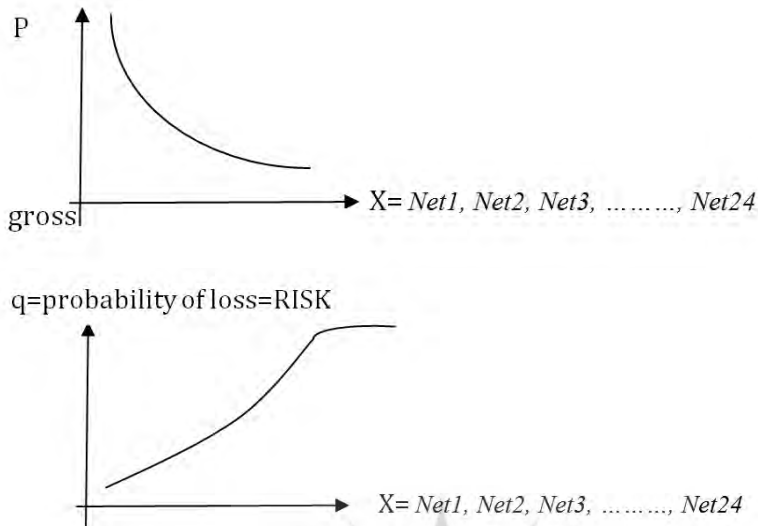
Figure 3: Appropriate probability behavior against netting period to profit from save or suffering loss due to fluctuations

Taking all the possible clearing hours of a trading day and P as Probability of performing real netting in action and say q to represent the probability of loss in different settlement periods, PCE will perform netting in a per hour manner which leads to gains from two sources. First one is the earnings fees of un-exchanged currencies but charged for applicant (buyer CSD) and second for saving of transfer fees for netting more than one transaction at the time. Figure 3 shows the expected behavior of the optimum function for the PCE.

### 7.4.2. PCC

In this plane, ICFv2 clears cash between participating CSDs. It is worth noting that ICF will only be interfaced with CSDs and no investor relation or information is directly stored. However, everything from Investor information to clearing account status will be kept in SCH.

Clearing cash between some CSDs with different settlement periods is a challenging issue since each CSD must clear on its own while the cash related to the international trade will be needed for local clearing with brokers and investors. ICFv2 maintains a plane for this purpose named 'Plane for Cash Clearing (PCC)'. In this plane, ICFv2 is faced with the problem of different times for trade confirmation, buyer and seller-leg

settlement periods. To handle it, ICFv2 maintains some funds to be lend to the requiring leg, hence charging it for fees as well as interests. Also it should accept the unneeded money for the seller legs with longer settlement periods than the buyers and pays its interest to the appropriate CSD and hence investor. Note that given a unified probability of currency exchange request, netting will result in need for much less funds and fees for the ICF which enhances its performance and efficiency.

Considering V = volume of Trade, T + S as seller's settlement period, T + B as buyer's settlement period, Cs as the currency of seller, Cb as the currency of buyer and T + 0 settlement period as criteria the possible scenarios can be depicted like figure 4.
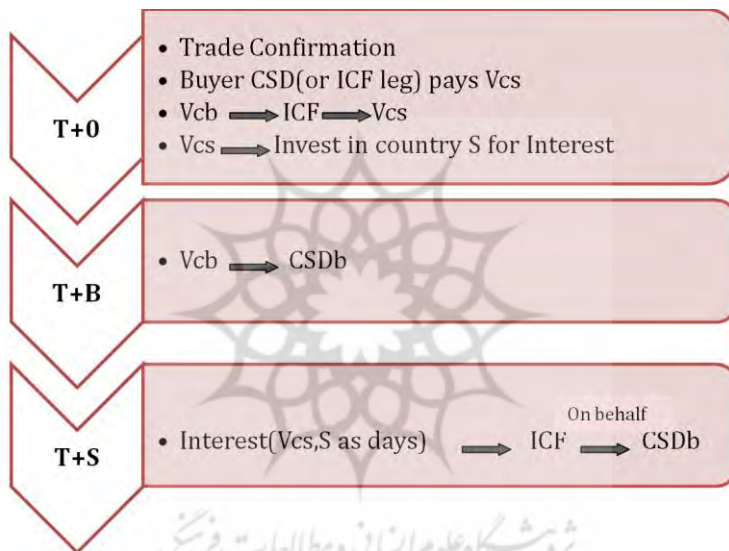


Figure 4: Possible scenarios for settlement - CSD Level

### 7.5. Parameters and Joining Configurations

As the reader might noticed, ICFv2 features some parameterized configurations on the joining exchanges determining:

1. How they will clear bi-lateral cash in either currency exchange level or trade level. In other words, a participating country might prefer to net cash flow for multiple trading hours with a certain exchange whose currency does not have hazardous fluctuations against its own featuring significant save in exchange fees or it might shift the issue towards gross settlement in case of a more fluctuating one.

2. The political, economic and managerial limitations to the maximum amount of money to be exchanged for example in a trading day.

3. The issues, considerations and limitations for customer-level supervisory which might cancel the trade if not accounted. For example, Tehran Stock Exchange does not allow certain investors from opposing countries or might accept them with some predefined conditions. All the above considerations should be clearly mentioned, documented and then converted to FTDL scripts which will be provided to the trading engines as settlement-awareness. The provided information integrated within the FTDL routines, will decrease settlement risks drastically.
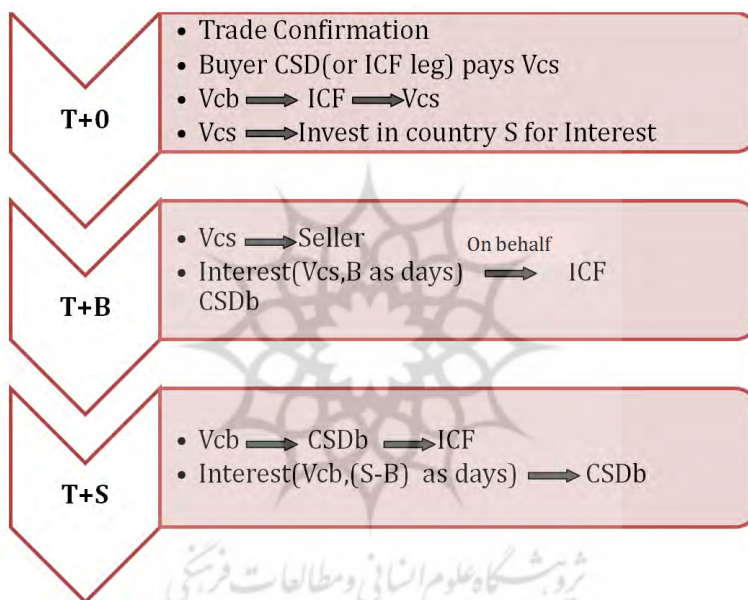
**T+0**
- Trade Confirmation
- Buyer CSD(or ICF leg) pays Vcs
- Vcb $\longrightarrow$ ICF $\longrightarrow$ Vcs
- Vcs $\longrightarrow$ Invest in country S for Interest

**T+B**
- Vcs $\longrightarrow$ Seller    On behalf
- Interest(Vcs,B as days) $\longrightarrow$ ICF CSDb

**T+S**
- Vcb $\longrightarrow$ CSDb $\longrightarrow$ ICF
- Interest(Vcb,(S-B) as days) $\longrightarrow$ CSDb

Figure 5: An alternative scenarios for settlement

### 7.6. Tax and Commissions

Taxes will be charged for seller according to the seller's domestic market tax rates through the FTDL channel. It can be deductible at time of matching. FTDL has the capability of charging more or less tax rates for foreign investors and even charging taxes for international buyers or executing tax discounts or any tax pattern due to the participant's rules. All commissions will follow the primary commissions of each market and there will be no need to change them. But if any market desires to change commission rates for foreign investors, it can be implemented in FTDL channel as well. FTDL will enable the participants to prescribe a verity of commission rule due to any local and international dominant rule.

### 7.7. Corporate Actions

SAMIP supports corporate actions occur during the withholding of foreign securities. Accurate processing and recording of corporate action events can be managed in SAMIP. The rights and dividends can be delivered through ICF on behalf of hierarchy of SCH, local CSD, Investor as the originating CSD have identified foreign investors in it's registry through the data dissemination network. Stock Split and spin offs are done on behalf of SCH, local CSD, local Custodian, investor due to the owners hierarchy rules. The redemption of debt securities also can be managed through messages between CSDs via SCH.

### 7.8. Position Management

Position limits for each participant country will be defined due to each country's contribution to ICF resources. The position sizing (i.e. the amount of money being invested into a particular security by a foreign investor) will be managed through FTDL channel in time of position building. So both cash and securities position management has predefined mechanism in SAMIP protocol.

### 7.9. Defaults and Canceling

SAMIP data dissemination will bring about the capability of any order canceling management as the orders are administrated by SCH book-entry which involves direct registration system (DRS) through Trading Hubs. The cancellation may be made by investor itself or due to order dissatisfaction (limit, fill or kill, immediate or cancel etc.). The T+0 period of settlement in SCH occurs between CSDs which is an embedded mechanism to hedge the risk of any participant's defaults. If the investor or even broker defaults to pay the cash or to deliver the security, the domestic CSD can punish him/her according to the local punishment regulations or employ predefined local compensation mechanism, hence the investor or broker participants do not bear the default risk of international party.

### 7.10. Registry Management

Registry of international investment will be done in a hierarchical fashion. We make this choice not only to enable the local CSDs to apply local regulations on stock holding but to simplify implementation of such a system by making no significant augmentation in the current systems.

To achieve such flexibility, the target CSD which has firstly listed the traded company, registers the share for a non-trivial subset of (SCH, Buyer CSD, Investor). Obviously, more information kept more flexibility in terms of law enforcement and monitoring achieved. SCH does the same but registers the share on behalf of Buyer CSD, Investor. Finally, local (buyer) CSD registers for the investor as a SCH share.

Following this approach, both CSDs and the SCH itself can monitor the flow of cash to prevent money laundering and they can originate tasks for legal transfer of securities as well. Heterogeneity in legislation can be easily accommodated since each CSD just applies the local rules. Besides, an implicit replication of registry data in business layer is also made as an advantage point.

### 7.11. Data Dissemination Fundamentals

In order to build a practical interlinkage between capital markets, one needs to establish live, secure, reliable and easy ways to disseminate data from trading engines, local CSDs, SCH and other role players like supervisory board.

It is worth noting that factors like security and reliability of a data channel are in a direct accordance with type and importance of data and threats for it. Therefore, SAMIP proposes three channels for data dissemination as follows:

- TICH (Trade information channel): This channel simply broadcasts the prices, conditions and messages of trading engines among other participants.

- OTCH (Order Tracking Channel): This channel routes unicast messages between participating countries about the status of the placed orders. Obviously, data for this channel is provided by the FTDL module. OTCH-Routers should be provided by domestic trading systems to route each part of the message properly and in accordance to local infrastructure.

- SLMCH (Settlement, Legislation, and Monitoring Channel): As the name indicates, this channel should provide information used for managing and monitoring. SCH will be responsible for these messages to take place.

According to the nature of data for each channel, various technologies might be put into practice for data dissemination. The major candidate is FIX [13] (the Financial Information Exchange) but candidates include but

not limited to RSS, Web Service Messaging, use of a MoM (Message Oriented Middleware) can be applied.

## 8. Conclusion and Future Roadmap

SAMIP can be a good framework to provide efficient basis for international investment especially among countries that have not enjoyed common currency. Since SAMIP does not require the legislation methods, IT infrastructure and local regulations of the participating counties to change radically, it can be put to practice with less effort.

The next step will be to specify the model and its related technological issues (like FTDL) and business players (like ICF) in detail then to focus on modeling, design, simulation and final implementation. Of course a working group of at least two counties will be needed and the first simulation results are estimated to be obtained within a year followed by full implementation in a couple of years depending on funding, support and the will to achieve such a point.

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