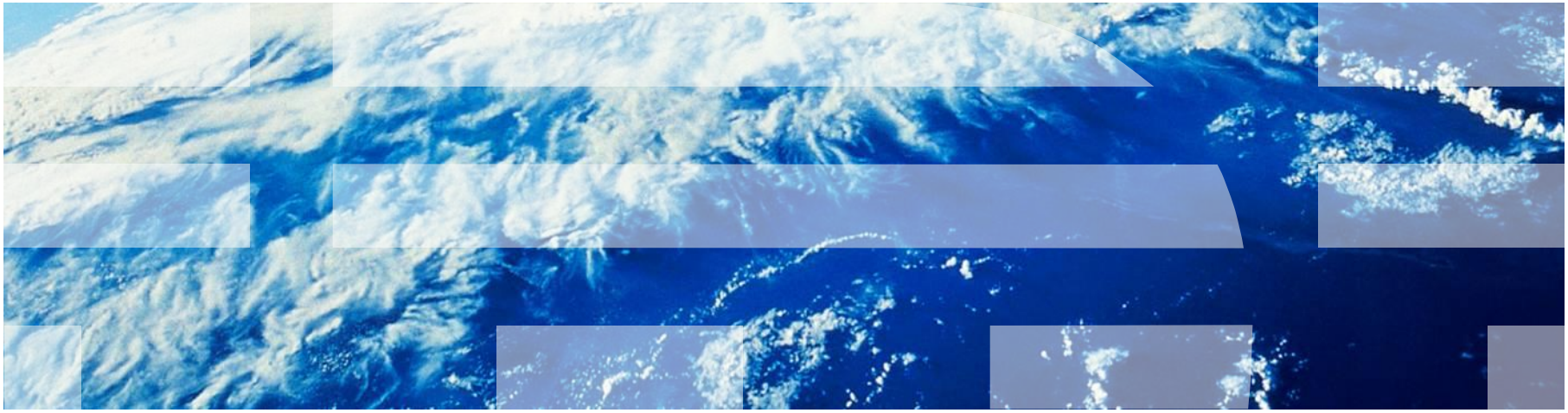
Clearing and Settlement Case Study



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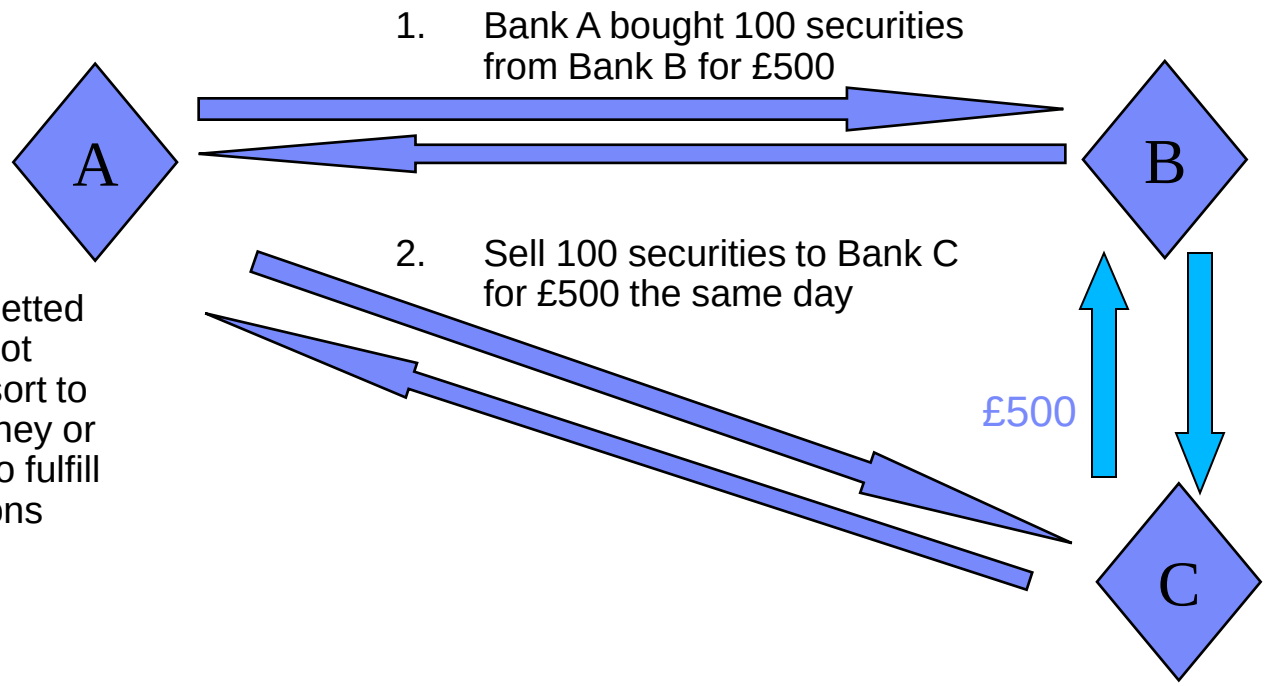
Three DvP morals

- The Bank for International Settlement has defined three morals of delivery versus payment
  - **Model I**, with real-time gross settlement for all transactions : each trade settles individually.
    - Bank A receives securities and Bank B has receives funds immediately.
    - Reduces uncertainty and risk
  - **Model II** calls for real-time delivery of the securities and the net settlement of the related payment obligations at the end of the settlement cycle
  - **Model III** involves net settlement of both securities and payments at the end of the settlement cycle
    - Reduces a large number of individual transactions to a smaller number to be settled
    - Reduces failed operations
    - Seen as lengthy and delays release of funds and securities

What Indeval achieved thanks to ILOG Optimization is the combination of both Model I and III advantages: Near real time Model III settlement

Multilateral Netting



Bank A is netted and does not need to resort to borrow money or securities to fulfill its obligations

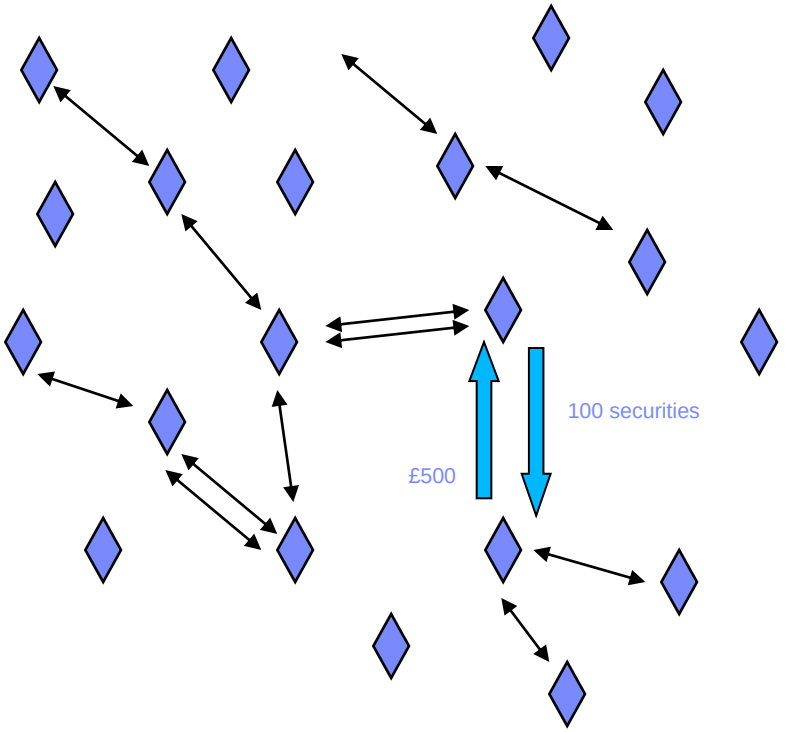
* Model 1: if a Bank A does not have funds or securities => Borrow to pay the securities to Bank B, and once it has received the securities, deliver them to Bank C in exchange for money. This transaction is costly and not efficient.

Multilateral Netting

– Hundreds of thousands to millions of transactions

– « Combinatorial » number of possible solutions (choices).

– Difficult to tackle with heuristic approaches



Steps to Indeval's Application of Optimization for Trade Settlement

- Attempt complete securities settlement
  - Problem for complete securities settlement is not tractable
  - "The usage of heuristics in SSS would yield poor solutions"
- Change The Game!
  - In Payment Systems, **partial settlement of a payment** is prohibited.
  - In Securities Settlement Systems, **partial delivery is becoming a more common practice** around the world.
  - Mexican market participants **accepted partial settlement**, so the problem now becomes a much easier optimization problem
- Two phase approach
  - Solve a linear program to maximize the value of what can be settled
    - Creates fractional share movements
  - Solve a second linear program to settle the securities without fractionality
    - With a very small trust fund to provide a buffer for the cash accounts
    - Guarantees integral share movements

Tuning the application – Using simulation

- Goals
  - Find a suitable balance between the liquidity in the system and the time taken to settle transactions
  - Determine a set of values for the parameters that would allow the SSS to work effectively.
- Consider 3 performance measures
  - The average settlement time
  - The amount of money required to settle transactions,
  - A global performance index that is the product of the first two measurements.
- Conduct multiple simulations with historical data to tune the methodology
  - 30K$ needed as a buffer to sell $250 Billion every day
- Trade-off between reducing the settlement times and using more funds in the system as expected. Furthermore, the best results were achieved in the model three environment with an objective function optimizing the quantity of securities.

Trade-offs and simulation

- Trade off between hard requirements, tractability, and pure optimality
  - For example
    - Prioritization of trades
    - Trades not in DvP cycle
    - 100% elimination of cash on credit to settle

- Can “simulate” Indeval methodology on one day’s worth of trades
  - Divide into 5 minute batches
  - Optimize for each batch
  - Unsettled trades carry over to next batch
  - At end of “day”, have settled all trades
- Important to develop parameterized models and use simulation to discover optimal approach!

Indeval (Mexican Central Securities Depository)

What if you could raise an entire country's economy through more efficient securities transactions?

A private securities depository organization in Mexico implements a customized solution to reconcile and complete trading operations faster and more efficiently.

The need

Indeval was looking for a solution to **process security transactions in real time, rather than on a daily basis**, to provide the best service to the Mexican Stock Exchange and be more cost effective for trading partners.

Solution Components

- IBM ILOG CPLEX Optimization Studio
- IBM System p5 running AIX

What Makes It Smarter

By integrating a more robust platform, Indeval is completely transforming the way it serves the stock exchange trading brokers and the way the Mexican Financial Community used to operate, taking the trading activity in the country to a new level. Trading operations are now being reconciled and completed faster and more efficiently, increasing the number of operations the organization can perform each day and lowering the liquidity requirements of traders. With immediate data on market fluctuations and movements, investors are armed with the right intelligence to make informed decisions and react the moment changes occur instead of a day later. Thanks to the new system, Mexican economic performance has improved, reducing its "Country Risk" factor qualification among worldwide financial analysts.

Business Results

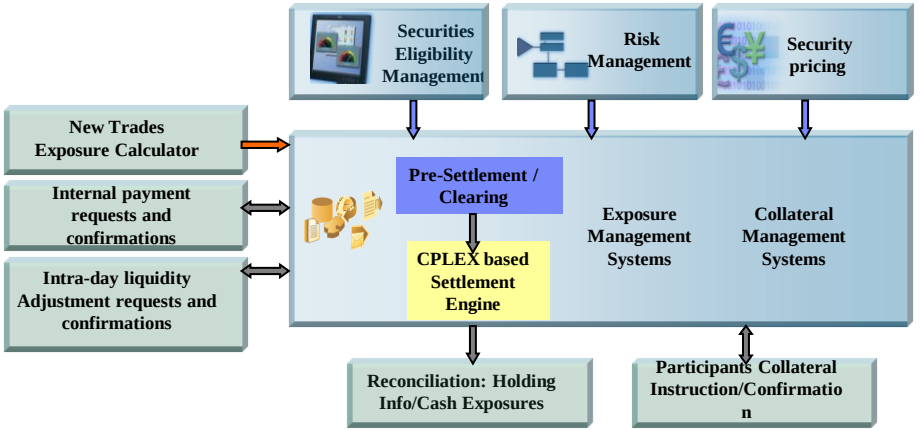
- **Real time reconciliation and completion of trading operations** for more than **USD$250 B in average, every day**
- **Reduced liquidity** requirements for trading partners **by 52 percent**
- **Increased the volume** of operations **by 26 percent**
- **Reduced the costs of each trading transaction** for electronic trading facilities, the Stock Exchange and trading brokers
- **Enhanced Mexico's risk status among analysts**

"By building a unique technology solution for our securities services, we now better serve the Mexican Financial Community and trading partners. We are very proud that this solution has played a key role in helping elevate the economy of Mexico."
Jaime Villaseñor
Chief Risk Officer, INDEVAL

Value Enhancement for CSD and ICSD: **IBM® ILOG CPLEX**

Optimization Solution

- Cutting edge custom settlement solution based on ILOG CPLEX Optimization engine
- Robust, safe and reliable settlement engine*
- Allows moving to a system where cash and securities positions for trades are netted optimally at the end of a settlement cycle.
- Operational transparency.



Collateral Management – ILOG CPLEX based Settlement Engine

Compelling reason to act

- Increasing demand in optimizing collateral allocation and in monitoring intra-day liquidity
- Volumes of processed transactions are increasingly growing
- Better use of available resources

Benefits

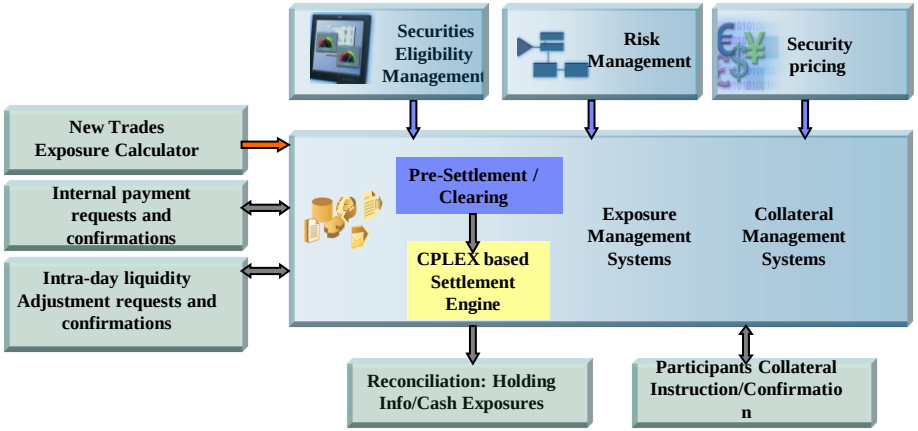
- Improves collateral management by making less collateral assets idle and less risky collateral used
- Reduces the time to settlement of trades and liquidity risk
- Maximize the value of pending trades
- Reduce intraday financing costs and daily liquidity requirements (Mexican Central bank saved 240 M USD in 18 months).
- Minimize risk and maximize the use of available assets in collateral management
- Flexibility to quickly adapt to new business conditions (adding new constraints as legislation or customer behavior changes).
- Ability to scale and integrate with other systems

* ILOG CPLEX have an outstanding record of successful delivery and customer satisfaction
* IBM's Architecture expertise for a High Availability settlement engine
* The usage of heuristics in Settlement would yield poor solutions

Value Enhancement for CSD and ICSD: **IBM® ILOG CPLEX**

Partnering with IBM

- Unique combination of strong technical expertise combined with business domain knowledge.
- Consulting and expertise on the business process change management for a successful system changeover strategy
- Extensive workshop sessions with experienced IBM consultants and partners
  - Find a suitable balance between the liquidity in the system and the time taken to settle transactions
  - Determine a set of values for the parameters that would allow the Securities Settlement System to work effectively
  - Conduct multiple simulations with historical data to tune the methodology
- IBM Best International practices – new system ran in parallel to existing system
- Joint IBM/Central bank steering committee meetings to follow the move to the optimized settlement system.
- Seamless connectivity and integration with internal and external system flows



Collateral Management – ILOG CPLEX based Settlement Engine

Uses IBM ILOG CPLEX to get the best fit taking into consideration: Value, Volume and time between clearing periods:

- Pending operations are analyzed as a whole in a two ways: amount of money to be cleared and transactions volume
- It determines the best deal where a higher volume of orders are cleared
- It accepts orders to be partially cleared

"There was really no question of selecting anything other than ILOG. There was no other algorithm that we could rely on and not have to worry about."

—Jaime Villaseñor, Chief Risk Officer, INDEVAL

Discovery Workshop

Validate if and how an optimization-based approach would impact your business

A two-day solution development exercise

- Led by team of IBM “business optimization” experts
- IBM provides a summary session and documentation of findings and recommendations
- Results aim at reducing risk for both parties, and identifying the main potential issues to be managed from the start

Answer the Key Questions

- What is the impact for our business of a vendor application product vs. a general optimization solution platform extended for us?
  - Revenue, cost, risk
- What are realistic user expectations?
  - Meeting the users’ need for accessibility and interactivity
- How do we develop a workable architecture and implementation plan?
- How will a system fit with other technologies & processes
- How do we determine total cost of ownership (TCO) associated with a new system
- What will be the value of an optimization-based solution?

Q&A