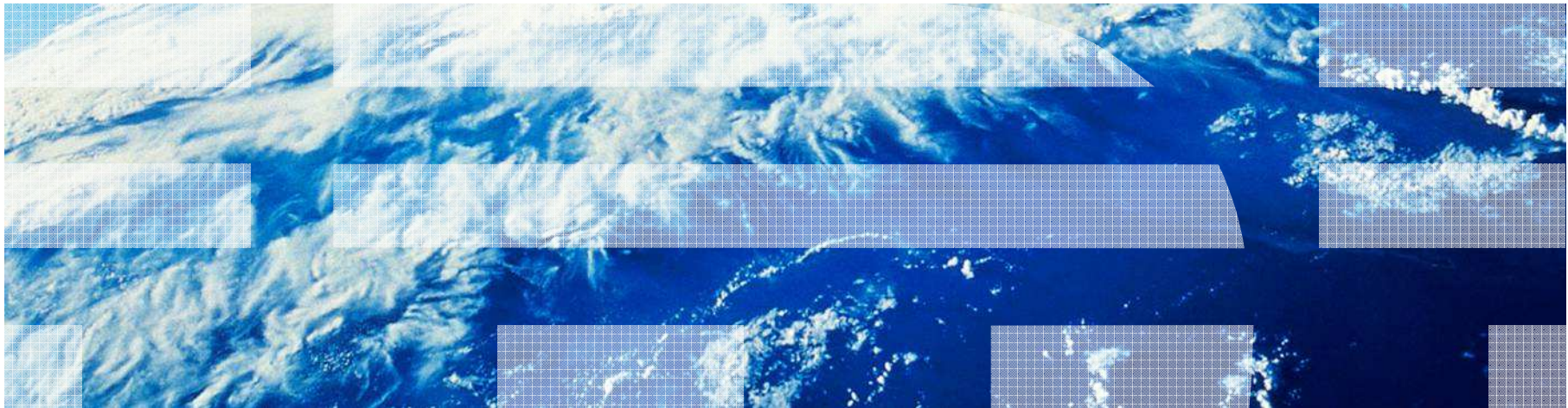**IBM**

ILOG Optimization and Analytical Decision Support Solutions for Finance and Banking

Sofiane Oussedik
soussedik@fr.ibm.com

Agenda

- Context of today's seminar

  - What's ILOG Optimization?

  - How does it work?

  - Recent Optimization developments

- What can it achieve in Finance ? – use cases

  - Portfolio Optimization

  - Trade Matching and Timing

  - Cash Management

  - Loan Configuration and Lending

  - Trade Settlement - Netting

- Q&A

What Can Optimization Do?

Optimization helps businesses make complex <u>decisions</u> and <u>trade-offs</u> about <u>limited resources</u>
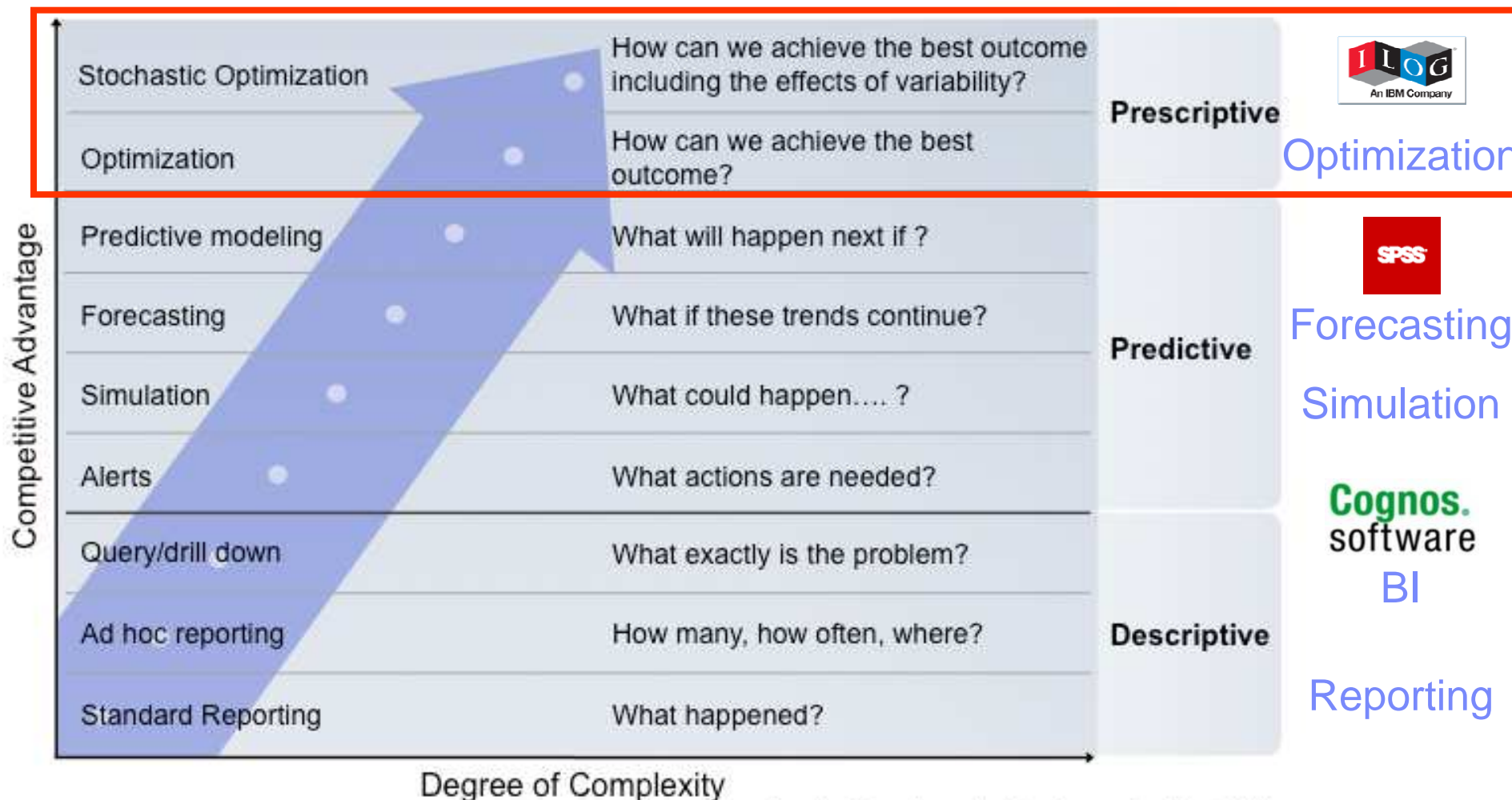
- **Discover previously unknown options or approaches**
  Automatically evaluate millions of choices

- **Automate and streamline decisions**
  Compliance with business policies and regulations
  Free up planners and operations managers so that they can leverage their expertise across a wider set of challenges
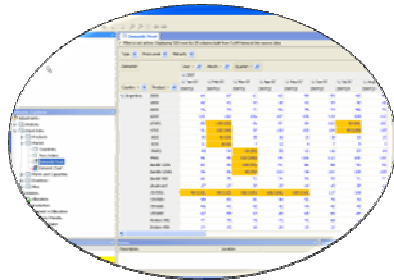
- **Explore more scenarios and alternatives**
  Understand trade-offs and sensitivities to various changes
  Gain insights into input data
  View results in new ways

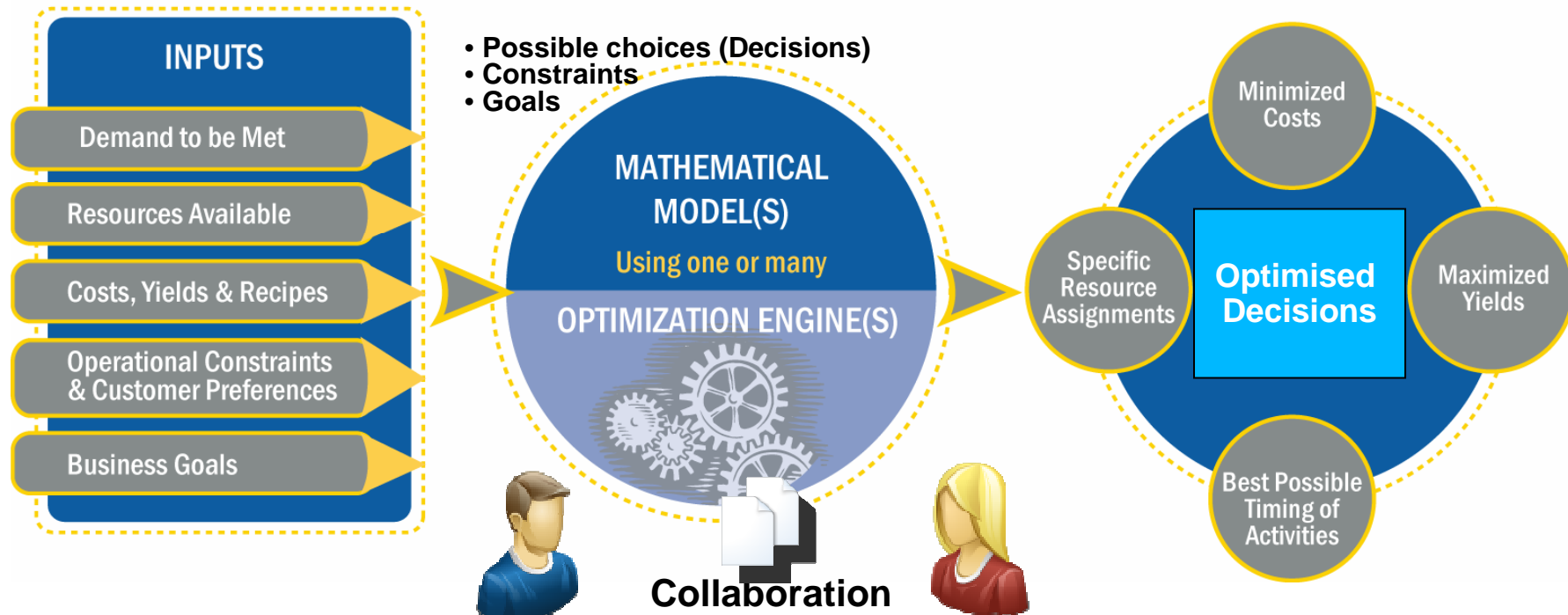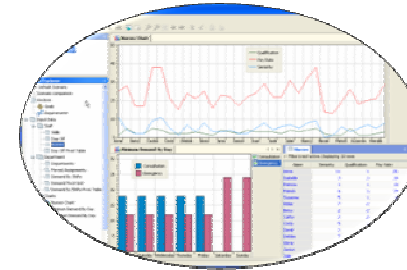# Where does Optimization sit in the Business Analytics Spectrum?

Business Analytics Landscape

Stochastic Optimization	How can we achieve the best outcome including the effects of variability?	**Prescriptive**
Optimization	How can we achieve the best outcome?	
Predictive modeling	What will happen next if ?	
Forecasting	What if these trends continue?	**Predictive**
Simulation	What could happen.... ?	
Alerts	What actions are needed?	
Query/drill down	What exactly is the problem?	
Ad hoc reporting	How many, how often, where?	**Descriptive**
Standard Reporting	What happened?	

Competitive Advantage

Degree of Complexity

ILOG — An IBM Company

Optimization

SPSS

Forecasting

Simulation

Cognos. software

BI

Reporting

Based on: Competing on Analytics, Davenport and Harris, 2007

How Does Optimization Work?

What-If Analysis

INPUTS

- Demand to be Met
- Resources Available
- Costs, Yields & Recipes
- Operational Constraints & Customer Preferences
- Business Goals

- Possible choices (Decisions)
- Constraints
- Goals

MATHEMATICAL MODEL(S)
Using one or many

OPTIMIZATION ENGINE(S)

Collaboration

Minimized Costs

Specific Resource Assignments

Optimised Decisions

Maximized Yields

Best Possible Timing of Activities

Portfolio Management Example
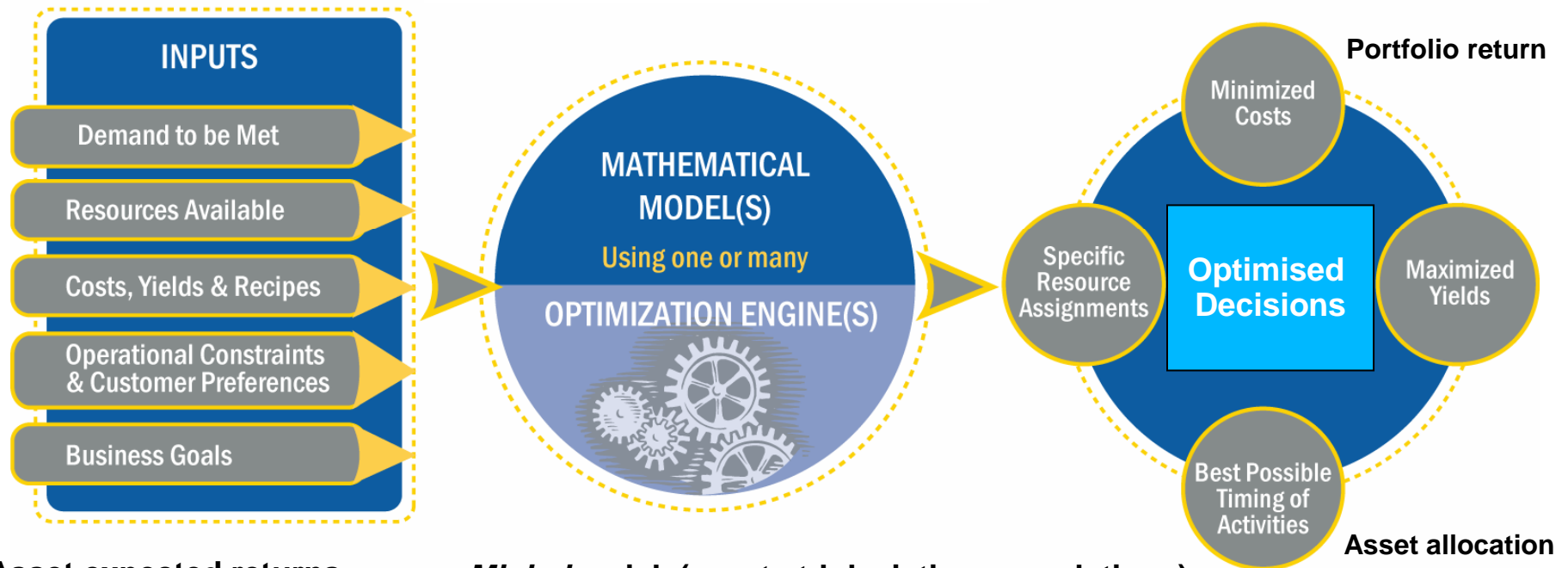
- **Asset expected returns**
- **Asset std deviation of returns**
- **Asset return correlations**

Minimize risk (asset std deviation, correlations) or CVaR

Subject to

Sum (asset expected returns) ≥ target

…

Build a custom model

Simple Portfolio Optimization model

range float FloatRange = 0.0..Wealth;

float alpha = …;

float Covariance = …;

float Return = …;

dvar float Allocation[Investments] in FloatRange; // Investment Level

dexpr float TotalReturn = sum(i in Investments) Return[i]*Allocation[i];

dexpr float TotalVariance = sum(i,j in Investments) Covariance[i][j]*Allocation[i]*Allocation[j];

dexpr float Objective = alpha * TotalReturn – (1 - alpha) (Rho/2)* TotalVariance;

Maximize Objective;

subject to {

// sum of allocations equals amount to be invested

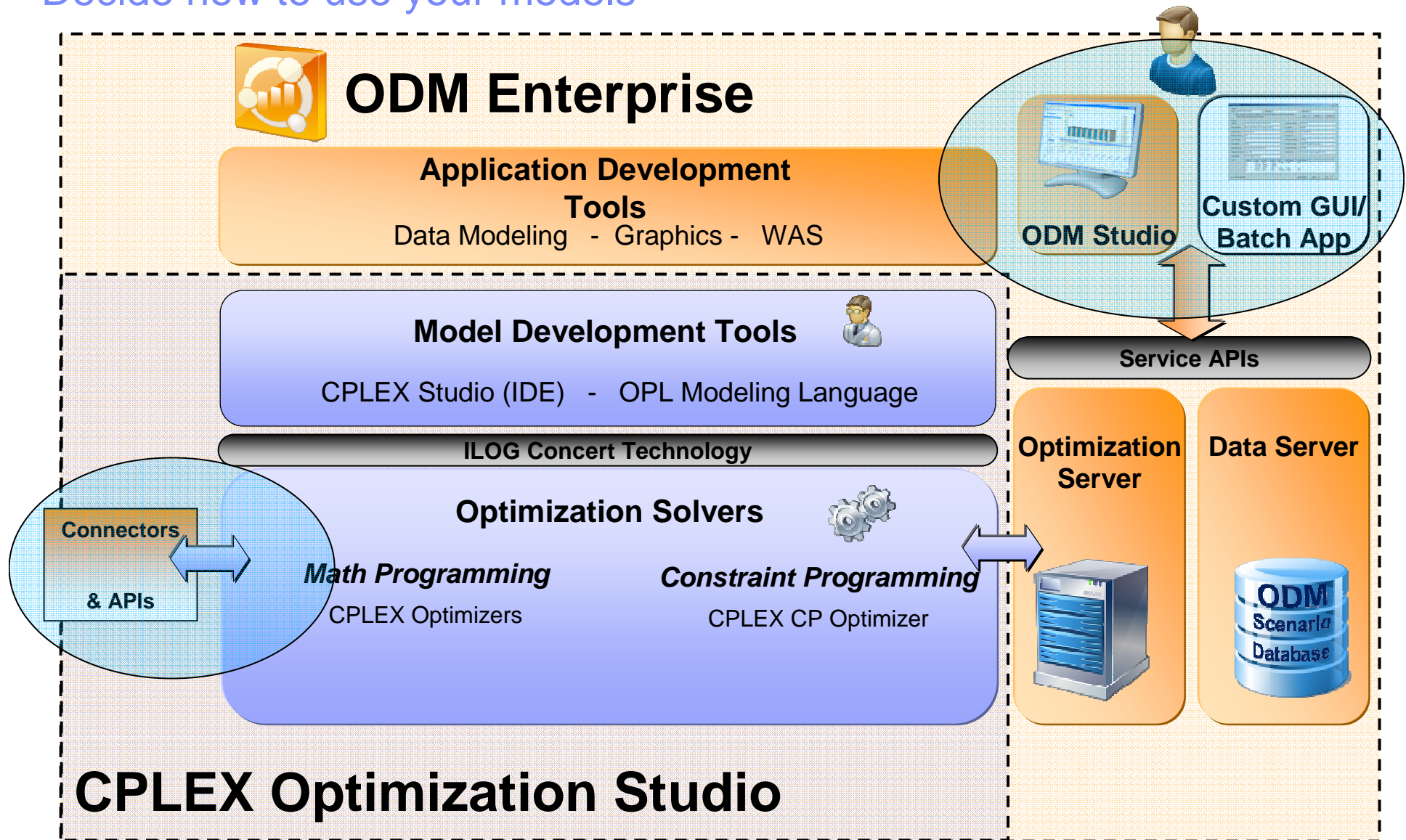allocate: sum (i in Investments) (Allocation[i])) == Wealth;

}

Data

Variables

Objectives

Constraints

Decide how to use your models

ODM Enterprise

Application Development Tools
Data Modeling   -   Graphics -   WAS

Model Development Tools
CPLEX Studio (IDE)   -   OPL Modeling Language

ILOG Concert Technology

Optimization Solvers
Math Programming
CPLEX Optimizers

Constraint Programming
CPLEX CP Optimizer

Connectors & APIs

ODM Studio

Custom GUI/ Batch App

Service APIs

Optimization Server

Data Server

ODM Scenario Database

CPLEX Optimization Studio

Progress in Linear and Integer Programming (CPLEX engine)

- Since the early 90s
  - Linear Programming
    - Algorithmic: More than 2000 times faster
    - Hardware: Factor 1000
    - **Net: Algorithm * Machine ~ 2 000 000x**
  - Integer Programming
    - Tremendous improvements
    - Still, experimentation can be necessary
      Algorithmic controls
      User knowledge
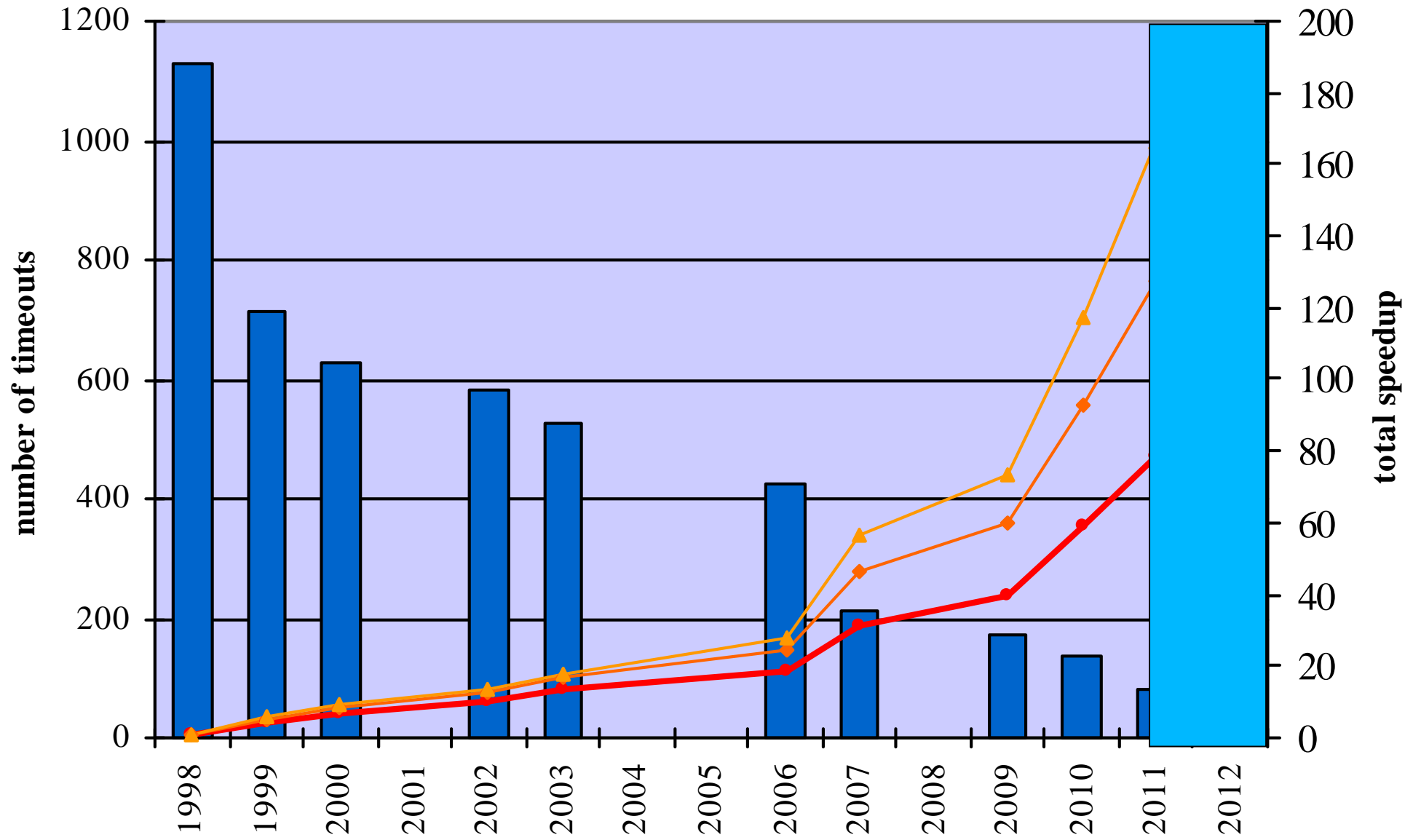   (Re-)Formulation

- Benefits
  - Larger, more accurate models
    - Example: Portfolio optimization under uncertainty
  - Optimizing over multiple processes
    - Taking into account more constraints and objectives
  - Real-time, execution level models

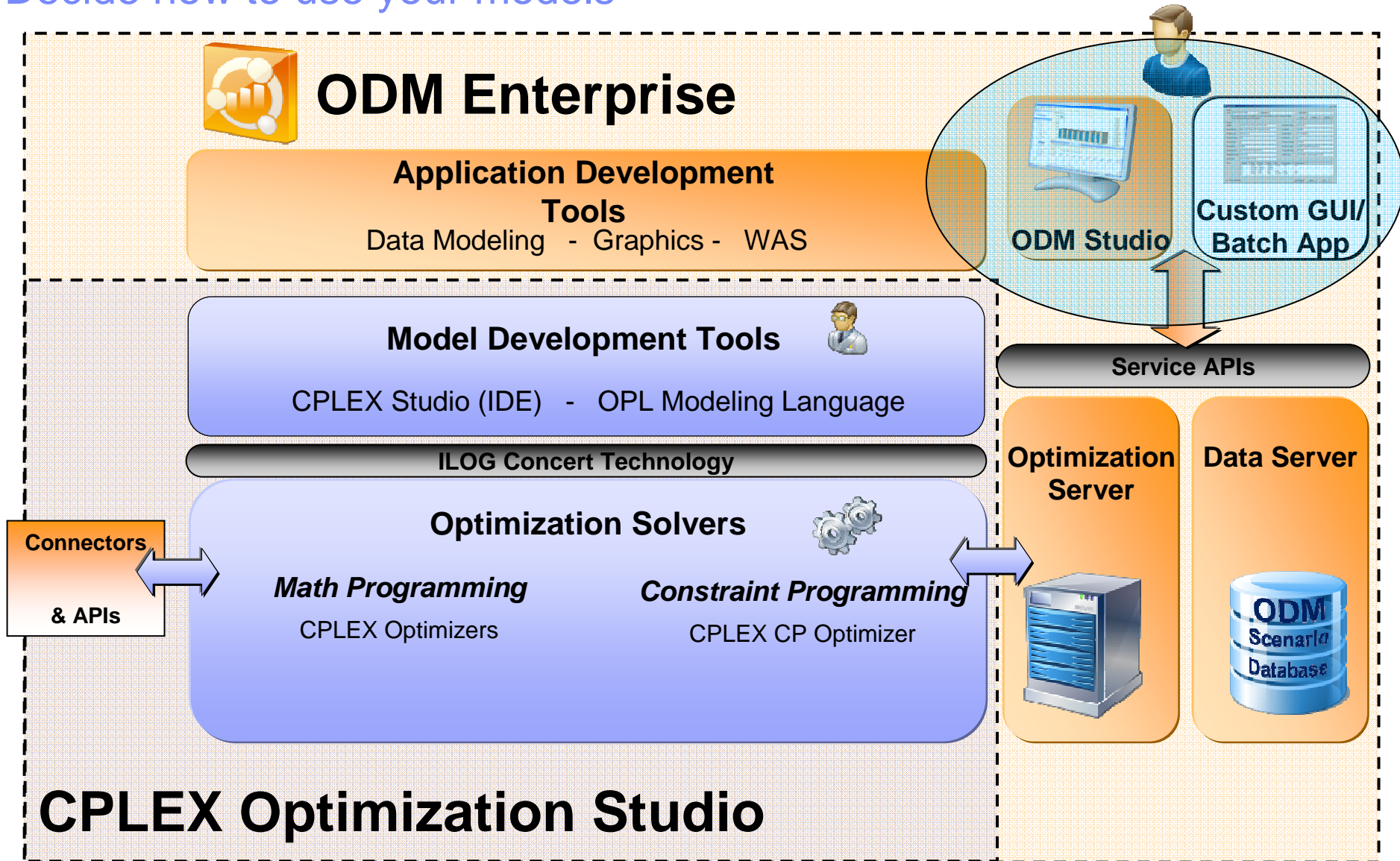- The only engine *software that supports z/OS®*
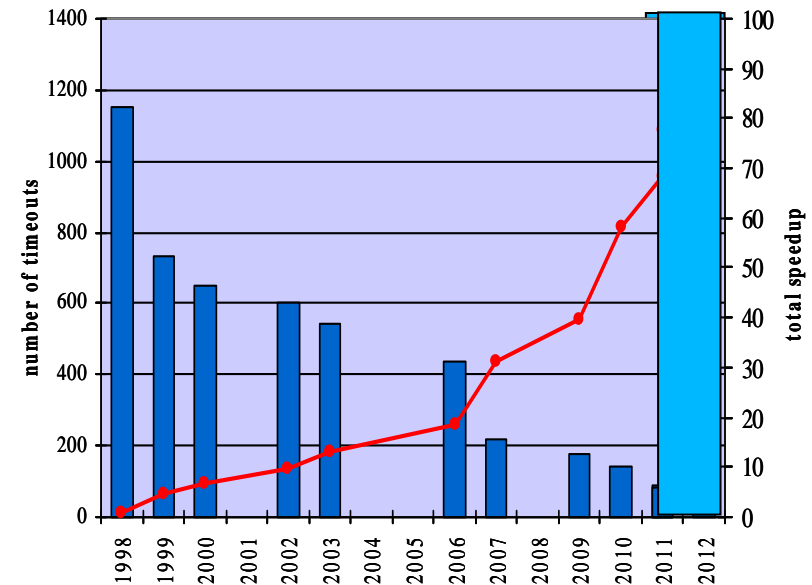
Integer Programming
Date: 31 Oct 2012
Testset: 3177 models (1753 in ≥ 10sec, 1515 in ≥ 100sec, 1354 in ≥ 1000sec)
Machine: Intel X5650 @ 2.67GHz, 24 GB RAM, 12 threads (deterministic since CPLEX 11.0)
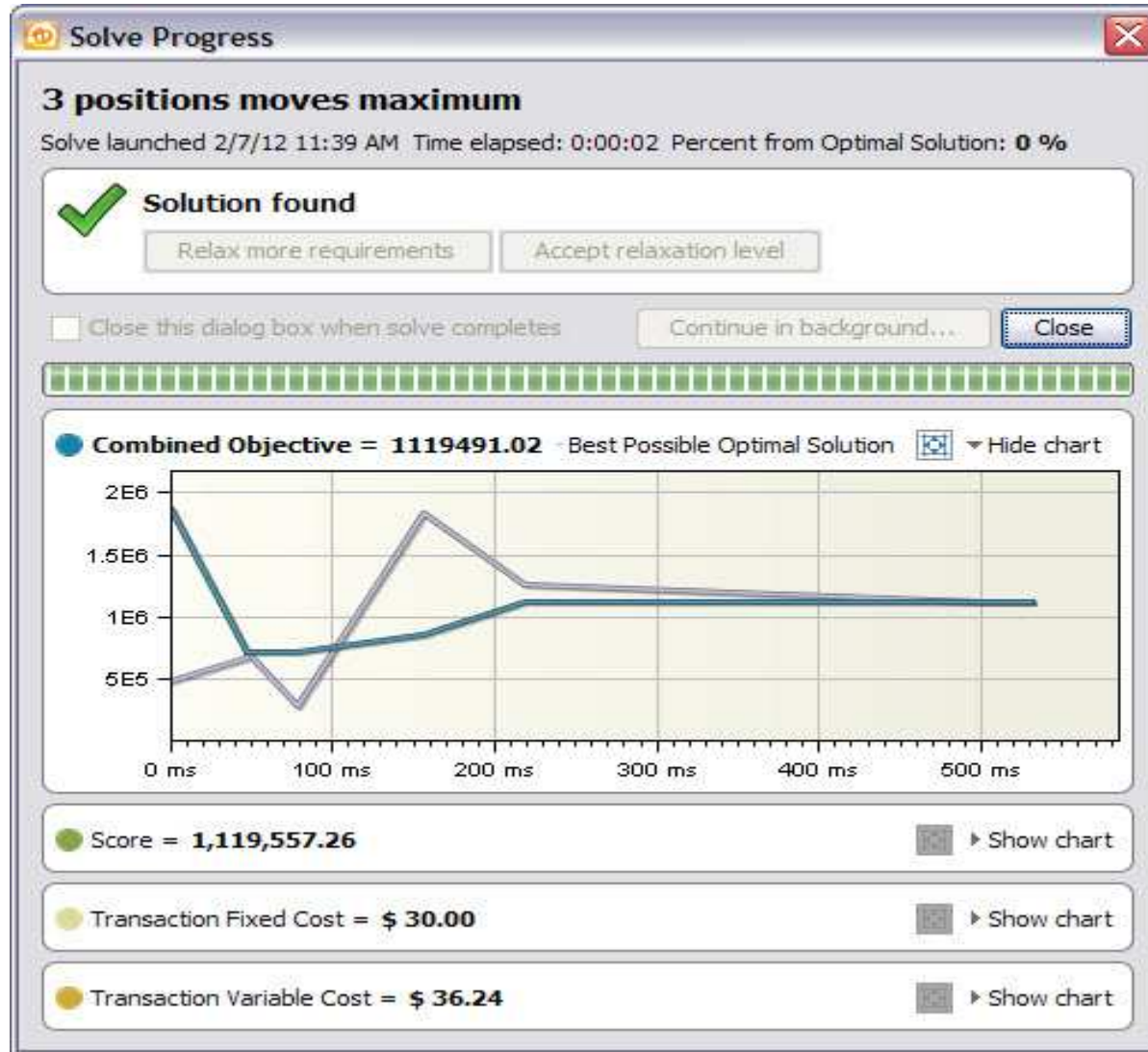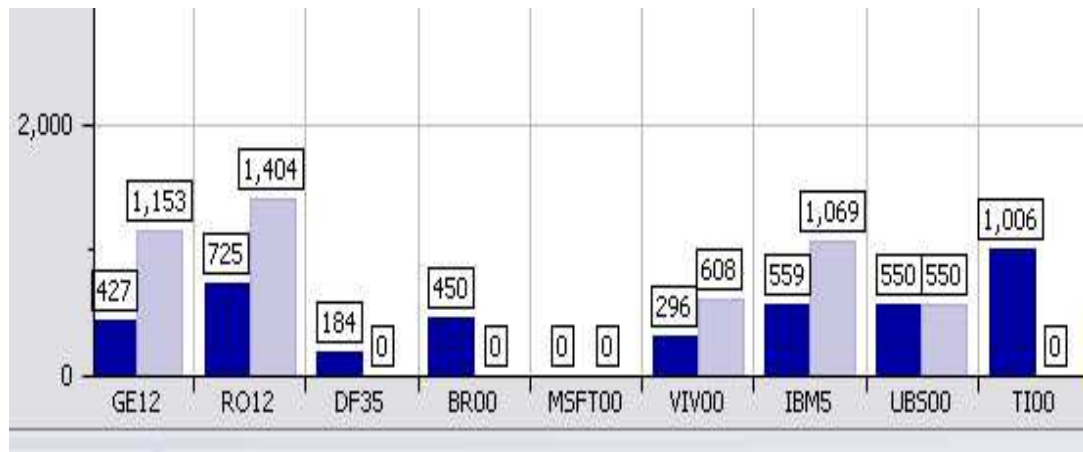Timelimit: 10,000 sec

Decide how to use your models

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Application Development Tools
Data Modeling - Graphics - WAS

ODM Studio

Custom GUI/ Batch App

Service APIs

Model Development Tools

CPLEX Studio (IDE) - OPL Modeling Language

ILOG Concert Technology

Optimization Server

Data Server

Optimization Solvers

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Constraint Programming

CPLEX CP Optimizer

Connectors

& APIs

ODM Scenario Database

CPLEX Optimization Studio

ILOG ODM Enterprise Solve – portfolio rebalancing

ILOG ODM Enterprise Results

ILOG ODM Enterprise Results

- Deploy scenarios - batch runs
- Use results to provide recommendations to clients

ILOG ODM Enterprise - scenarios of usage

Portfolio Anaylst - ODM Studio
Existing GUI

Portfolio Analyst
Tactical Tuning

Processing Service API

Data Service API

ODM Optimization Server

ODM Scenario Repository
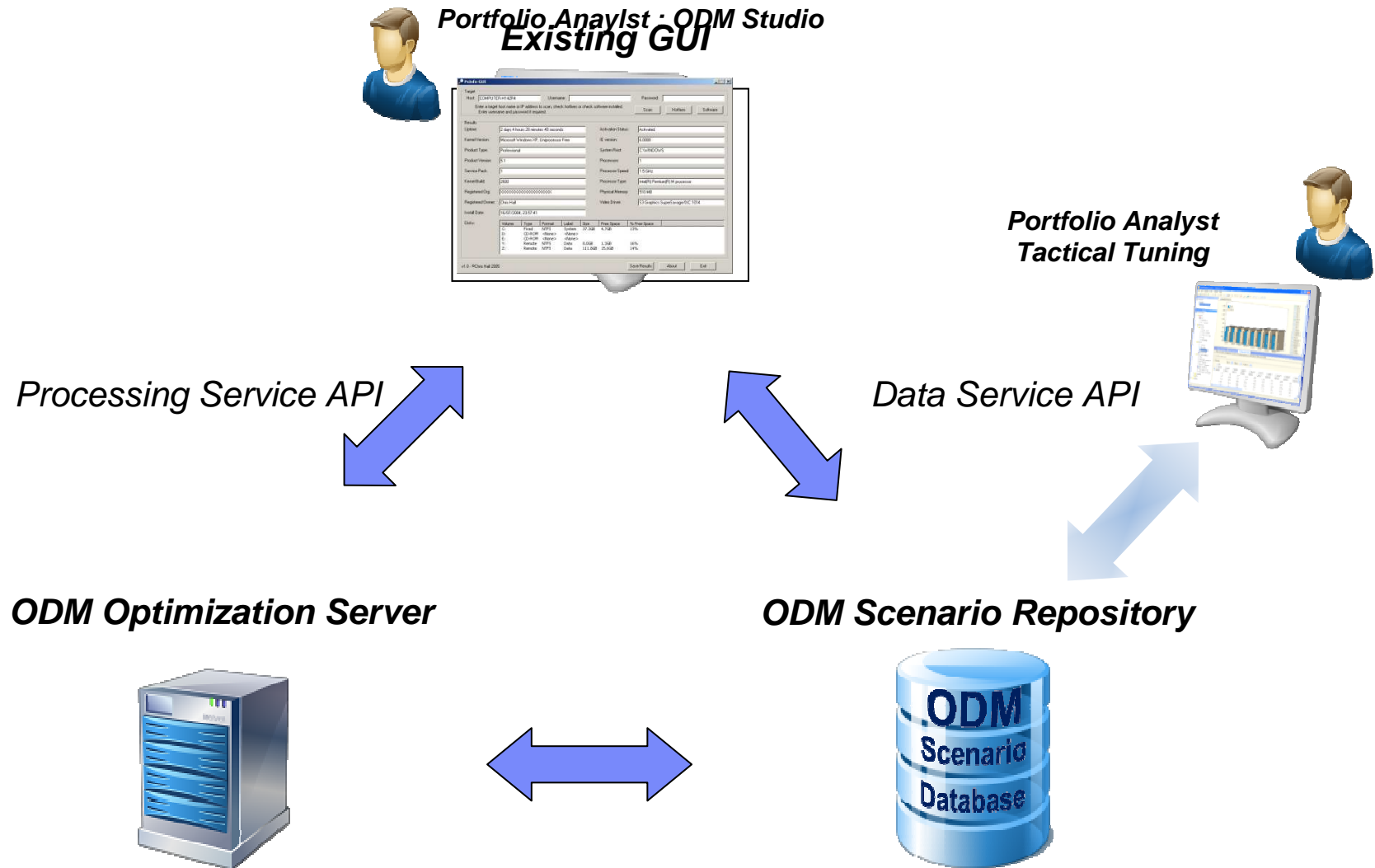
Optimization Applications in Finance

Optimization Problems in the Financial Industries

Classic Applications

- Portfolio Optimization

- Trade Matching and Timing

- Asset-Liability Management

- Cash Management

Novel Applications

- Loan Configuration and Lending

- Derivatives Pricing

- Workforce scheduling/dispatch

- Ad scheduling

- Targeted Marketing

- Collateral management

- Trade Settlement - Netting

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Portfolio Optimization

- **Issue**: Portfolio holders and managers seek maximum return from assets while limiting risks of adverse outcomes. Classical formulation by Markowitz has become enriched by several factors. Competitive advantage and client preferences lead fund managers to tailor portfolios to specific regional, sectoral, and other diverse preferences. Novel assets have risk characteristics very different from standard stocks and bonds.

- **Scope**: Thousands of assets, hundreds of sectors, hundreds of regions. Rebalancing frequency (daily, weekly,…)

- **Decisions**: Amount of fund allocated to each asset

- **Objectives**: Minimize risk as measured by variance of portfolio return, VAR, CVAR, …

- **Requirements**:
  - Expected return at least achieves target
  - Total funds invested does not exceed amount available
  - Total funds invested per sector and/or region does not exceed limit
  - Limits on leverage

Retail Financial Services
Investment Banking

Portfolio Management

- Customer
  - The Asset Management Group of a major European retail bank
  - Manages financial assets for institutions, enterprises, and private clients

- Problem
  - Enhance quality of investment advice, improving customer service and creating a competitive differentiator
  - Redundant, incomplete, or inaccurate data impacts investment advice and trading

- Solution
  - IBM ILOG Business Rules Management System validates and consolidates incoming data from multiple feeds (mergers, acquisitions, stock data, etc.)
  - **IBM ILOG CPLEX** determines optimum portfolio based on investment guidelines, creating tax-efficient portfolios while meeting customers' investment goals and risk profile
  - **CPLEX** reduces "tracking error" between benchmarks and a tailored portfolio
  - Allows account managers to comply automatically with specific client requests and regulations

- Benefits
  - Consolidation of data reduced to seconds from days
  - Able to negotiate better rates with financial feeds through audit trail of rules (e.g. based on validation rules)
  - Ensures highest quality investment recommendations
  - Personalizes client offerings

Portfolio Optimization

- Customer
  - A financial services company
  - Provides portfolio management solutions to institutions and wealthy individuals
  - Widely recognized for pioneering research in tax-efficient investing

- Problem
  - Automate determination of best mix of tax-efficient investments in consistent and timely manner

- Solution
  - **IBM ILOG CPLEX** offers proven algorithms that lend the stability and reliability to enable the company to evaluate portfolios daily
  - Evaluation incorporates cash level; capital gains and losses; risk; investor needs; risk tolerance and time since last optimization
  - **IBM ILOG CPLEX Optimization Studio** simplifies the modeling process by quickly modeling a problem and converting it into code used by CPLEX

- Benefits
  - Compared with passive management, the company's portfolio optimizer increases after-tax returns by up to 1.5% per year
  - Accommodates a broader range of portfolios, from $500,000 to $500 million
  - Achieve twofold growth and enlarge its customer base
  - Respond faster to requests, delivering better service to customers

Portfolio Optimization

- Customer
  - Software and services company providing investment managers with research and production workflow solutions

- Problem
  - Deliver portfolio construction and rebalancing functionality for portfolio managers to minimize business risk, increase operational efficiency, and improve strategic investment decision-making

- Solution
  - Portfolio optimization using IBM ILOG CPLEX
  - State of the art solver with easy to use API
  - CPLEX flexibility allows injecting domain specific insight into the solve process
  - CPLEX at the cutting edge of optimization research

- Benefits
  - Up-sell opportunity with existing client base
  - Has generated interest and new business leads
  - One-stop shop for quant needs

Passing Stress tests – Financial Risk Management – Sept 2011

- A global financial services company, with assets of more than $1.4T, large bank holding company in the United States. serving clients in more than 150 countries with services including finance, insurance, banking, mortgages, equity and credit cards.

- Needed to meet Federal Reserve "stress test" standards to demonstrate its ability to remain stable throughout various economic fluctuations, and to gain approval to increase dividends.

- The IBM Team used IBM ILOG CPLEX to create a simulation for the stress tests, achieved through portfolio optimization. This involved:
    - balancing risk versus reward
    - finding the most appropriate asset allocation according to investment goals,
    - market history and forecast using a unique approach to quantify 'black swan events' such as the financial crisis of 2008, ensuring that risk was properly accounted for.
    - The model was then implemented as the primary solution for investment trading.

- The bank was able to meet the Federal Reserve's standards and pass the stress tests. The bank also expects
    - increased profit on investment portfolios,
    - increased market share
    - And, improved customer satisfaction.

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Trade Matching

- **Issue**: Portfolio managers engage in trading activity to invest new money and to rebalance asset allocations to achieve investment goals. Many firms manage multiple portfolios. Trade matching enables executing trades among multiple portfolios within a firm to avoid transactions costs of going to the markets

- **Scope**: Hundreds of funds, thousands of assets, hundreds of transactions per week

- **Decisions**: Amount of each security to buy or sell from/to each fund

- **Objectives**: Minimize net cost to move the assets

- **Requirements**:
  – Achieve target asset allocation in each fund
  – Minimize net transfers of assets among funds
  – Market transactions fill net supply or demand in each fund

Investment Banking

Trade Matching

- Customer
  - One of the world's largest investment managers
  - 13 global offices and clients in 40 countries

- Problem
  - Optimize portfolio management applications to help the firm create competitive advantage and provide substantial savings to clients

- Solution
  - **IBM ILOG Optimization** used in three core portfolio management applications
  - Trade Crossing: match thousands of assets in buy and sell orders, avoiding market trades and related transaction costs
  - Optimized In-kinding: transfer a large majority of portfolio assets directly ("in-kind") into targeted funds, saving clients hundreds of millions in transaction costs
  - Fund Rebalancing: create optimal holdings of fund assets through appropriate trades, allowing fund managers to perform accurate index tracking, while minimizing transaction costs

- Benefits
  - Saved $500 million in transaction costs
  - Crossing and In-Kind Trading are a major source of competitive advantage for the company
  - High complexity of reconciling risk/return objectives, fund policies, and regulatory guidelines makes fund rebalancing process a differentiating factor in the investment industry

Trade Scheduling

- Customer
  - The company provides
  - Execution management and algorithmic trading systems for equities, currencies and derivatives

- Problem
  - Minimize average implementation shortfall across portfolio trade list
  - Implementation shortfall: difference between prevailing security price when list sent to trading and execution price

- Solution
  - IBM ILOG CPLEX generates schedule for completing trade list within specified time window

- Benefits
  - Clients – significantly reduced implementation shortfall and dramatically improved performance fluctuation
  - The company – differentiation from competitors, new business for flagship product, increased revenues from the trade scheduling product

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Managing Cash

- **Issue**: Cash is necessary for economic liquidity but handling cash entails numerous costs and earns no returns. Banks need to manage cash efficiently to reduce costs while providing essential services

- **Scope**: Billions of daily cash transactions, tens of thousands of disbursement points, hundreds to thousands of vaults, horizon one day to several weeks on a scale of hours to days

- **Decisions**: Amount of cash to hold at each disbursement point and vault, shipment amounts to/from each disbursement point, how much cash to invest or liquidate into or from other assets

- **Objectives**: Minimize carrying costs, minimize transportation costs

- **Requirements:**
  - Cash available at each dispersal point meets demand at that point in each time period
  - Cash withdrawn or deposited at each vault does not exceed limits in each time period
  - Amount of cash transported to/from each disbursement point does not exceed transport capacity

- **Benefits**
  - Reduce cash inventories by +30% (optimization + better forecasting + better management)
  - Reduce replenishment costs by +50%
  - Decrease cross-shipping fees about +50%

Retail Financial Services

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Loan configuration

- **First Union Home Equity** Bank Brings **Personalized Loans to the Web** Using ILOG Optimization Software New Loan Arranger Technology Instantly Matches Loans with Real Customers

- MBS Loan pooling for Ameriquest (Now Citybank)
    - Sell loan pools to Freddie Mac, Fannie Mae and private investors
    - Increase profitability
    - Minimize time to market of loan pools (2 weeks → less than 5 minutes)
    - The engine that increased profit by providing ability to build pools that closely match the investor desired characteristics, provided what if analysis ability, minimized the penalty on characteristics violations after due diligence

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Targeted Marketing

- **Issue**: Competing for customers' business requires structuring attractive packages for customers that satisfy your profitability and risk tolerance criteria

- **Scope**: Hundreds to thousands of offers per day, tens to hundreds of products and product features to offer

- **Decisions**: Which products and product features to offer which customer

- **Objectives**: Maximize customer acceptance

- **Requirements**:
  - Offer satisfies profitability criteria
  - Offer satisfies risk criteria

Retail Financial Services

- Customer
    - A Spanish Bank, one of the largest in Europe, has more than 90 million retail customers world-wide

- Business Problem
    - Enhance customer care and help drive sales and operational efficiency
    - Generate, filter, and optimize sales opportunities to maximize both customer satisfaction and bank return on investment (ROI)

- Solution
    - Everyday, IBM WebSphere ILOG JRules receives several million sales opportunities from an upstream marketing automation process, all qualified with a success probability. JRules filters all opportunities, to remove those that do not make sense and selecting those that provide added customer value without risking the customer relationship.

    - Using the filtered sales opportunities, IBM ILOG ODM Enterprise maximizes the use of the sales network while minimizing costs and enforcing constraints such as avoiding contacting the same customer via different channels.

- Benefits
    - Generate, filter and optimize sales opportunities
    - Handle multiple contact channels
    - Improve customer satisfaction
    - Maximize bank ROI for customer contacts
    - Allocate and execute the opportunities in the right channel

Optimization Problems in the Financial Industries

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Settlement and Clearing

- **Issue**: Quickly and reliably settle securities transactions

- **Scope**: Hundreds of trading institutions, thousands of assets, millions of transactions per day

- **Decisions**: Amount of each security and of cash exchange among from/to each trading institution

- **Objectives**: Minimize securities and cash transactions

- **Requirements**:
  - Net transfer of each security and of cash into each institution equals net demand
  - Net transfer of each security and of cash out of each institution equals net supply

Exchanges
Investment Banking

Key elements

- Optimization plays a key role in delivering
  - Smarter Decisions
  - Faster Decisions
  - Deeper Insights
  - Information into Action

- Optimization addresses hot button issues in Banking and Financial Markets
  - Better Risk Management
  - More Efficient Operations
  - Innovative Client Services

# 3 Ways to Use IBM Products and Services to Help Your Business Run More Efficiently

- Build an optimization application yourself
  - If you have the Optimization experts, IBM technology will make their development faster and more reliable

- Use a packaged solution for your business
  - IBM and its ISV partners have configurable applications for many kinds of business issues
  - Portfolio Optimization, Cash Management, Trade Scheduling, …

- Let IBM help you build it
  - Our Professional Services and Partners can provide the expertise to build custom applications that meet your business requirements

Q&A

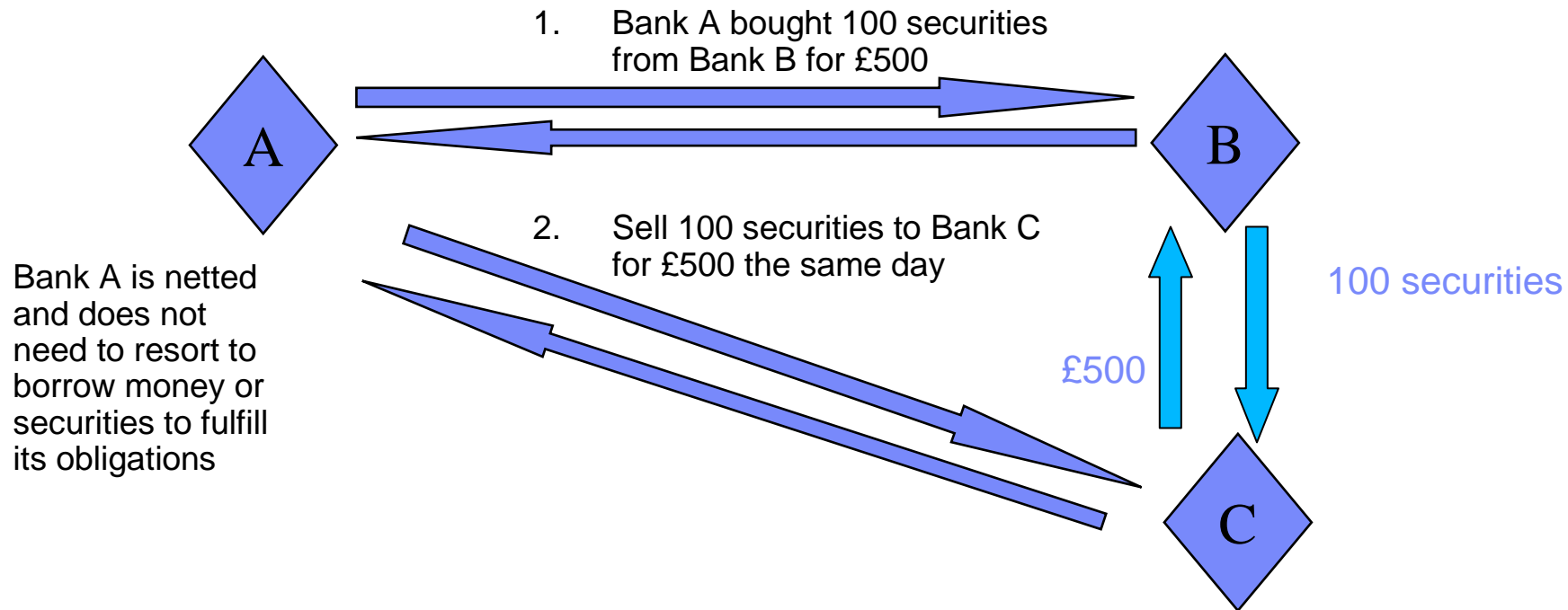# Clearing and Settlement Case Study
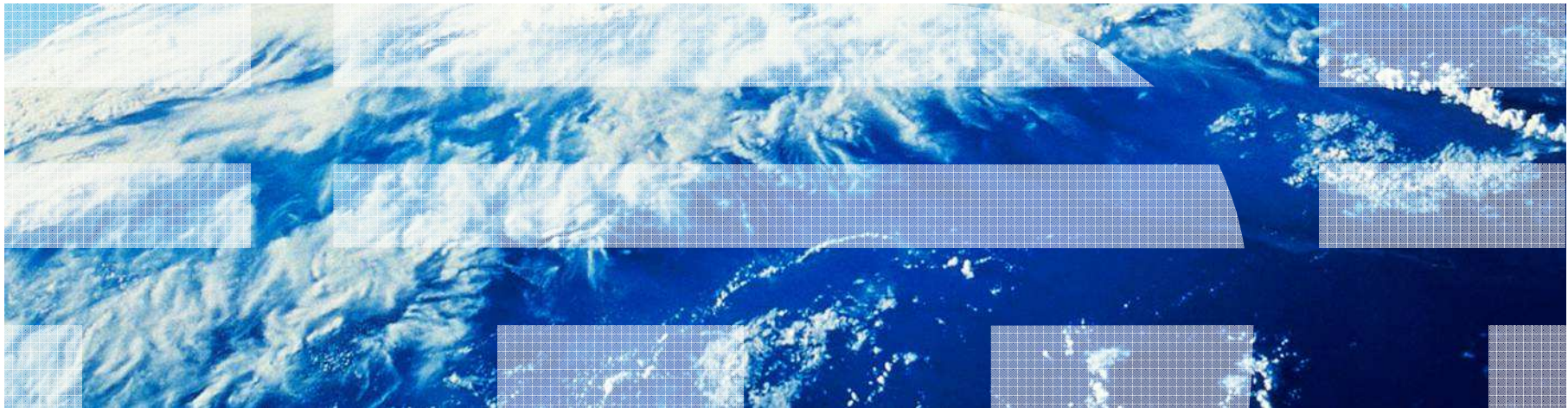
Sofiane Oussedik
soussedik@fr.ibm.com

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

1. Bank A bought 100 securities from Bank B for £500

A

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

2. Sell 100 securities to Bank C for £500 the same day

B

100 securities

£500

C

* 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

100 securities

£500
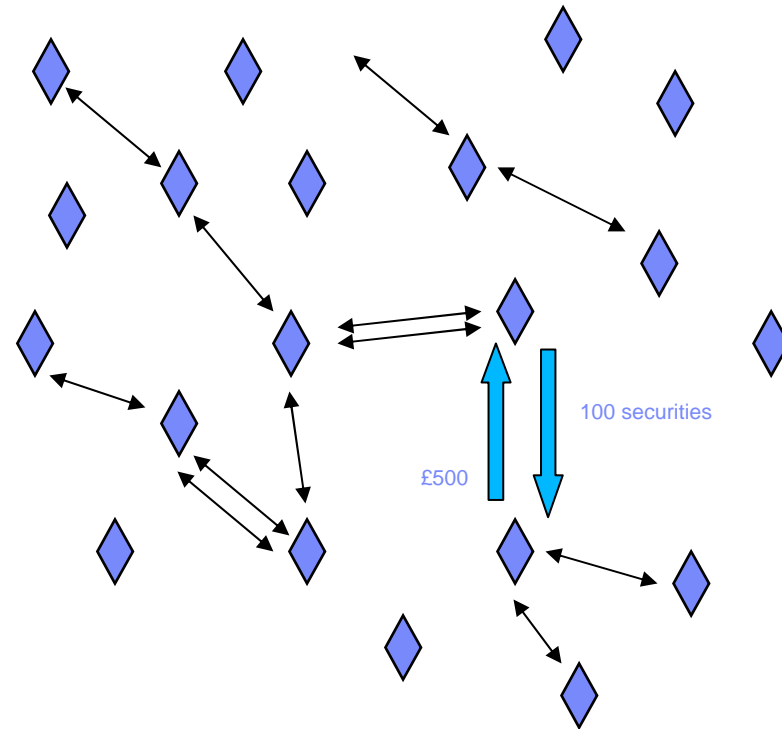
Indeval (Mexican Central Securities Depository)

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.

S.D. INDEVAL
Instituto para el Depósito de Valores

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.
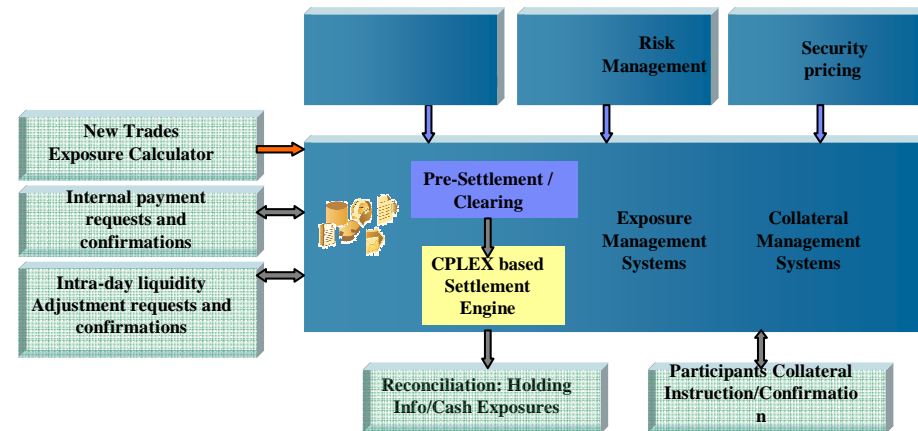
Collateral Management – ILOG CPLEX based Settlement Engine

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

* 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

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

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
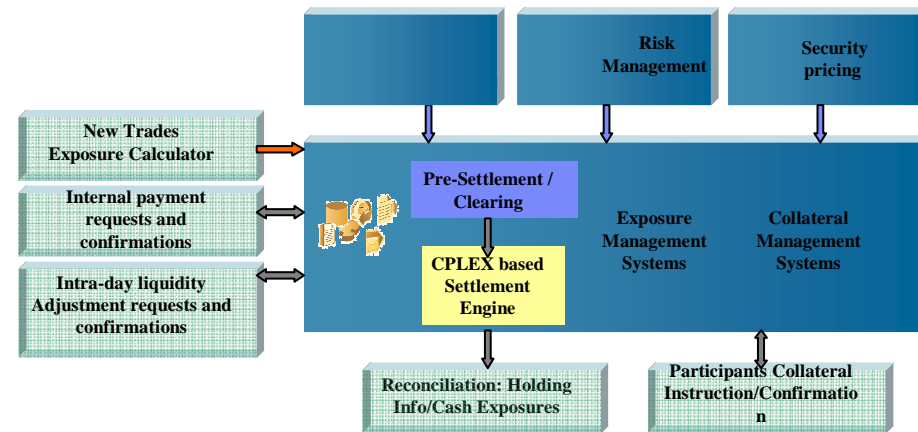
Collateral Management – ILOG CPLEX based Settlement Engine

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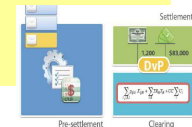
"There was really no question of selecting anything other than ILOG. There was no other algorithm that we could rely on and not have to worry about."

—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