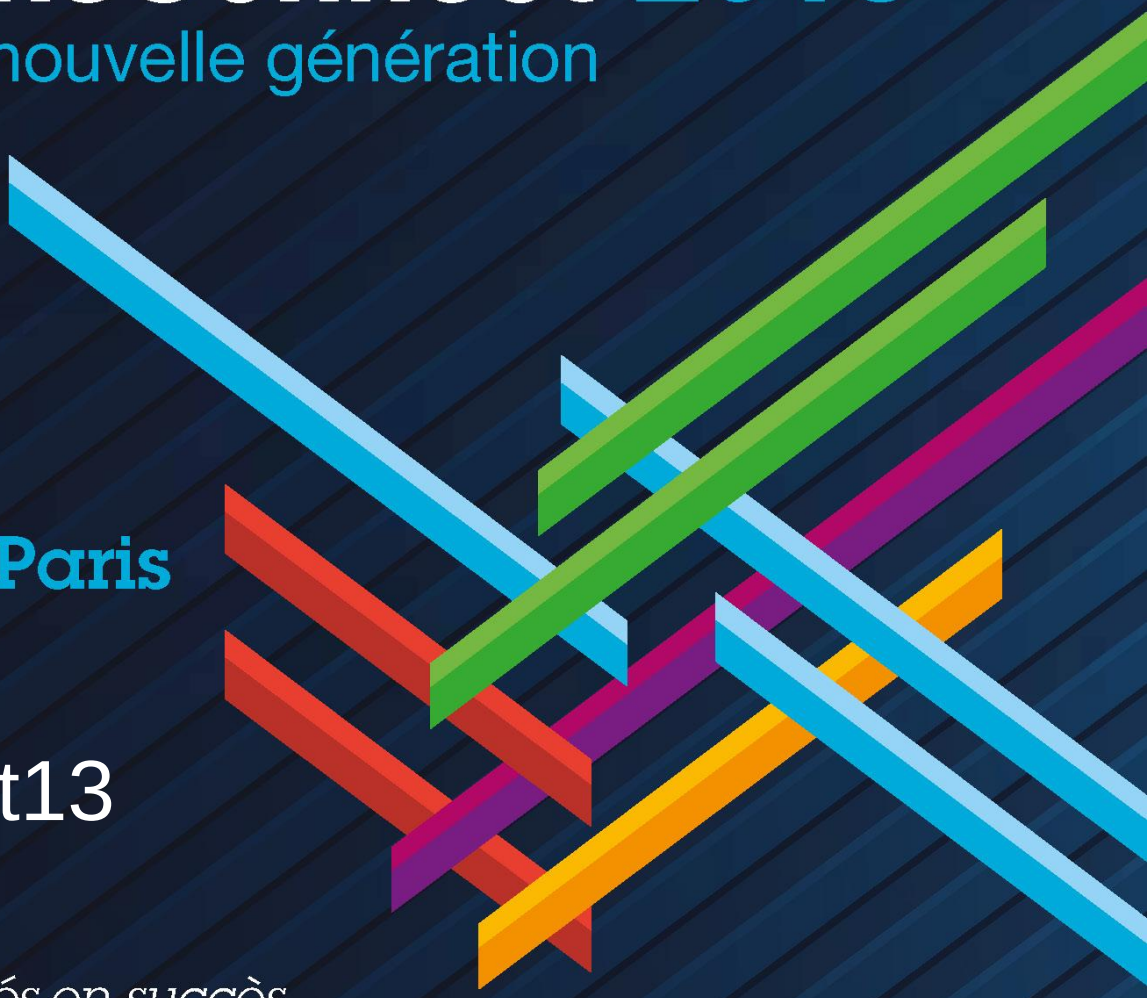
IBM SolutionsConnect 2013

L'IBM TechSoftware nouvelle génération



28, 29 et 30 août

IBM Client Center Paris

#solconnect13

Transformez vos opportunités en succès

IBM

Session IND05P2

L'innovation IBM au service du secteur E&U (*Energy & Utilities*)

Christian MOTTET – IBM E&U Industry Architect
Christian CHATEAUVIEUX – Software Architect
Alex FLEISCHER - ILOG Technical Sales Consultant

Agenda

- IBM's perception of the E&U Industry trends and directions
  - Problems/challenges/issues
  - Industry's answers/movements seen in the field
- Future trends and solutions
  - Overview of a few IBM Research energy projects
- Real-world implementations using readily available IBM expertise, IBM software and hardware technology
  - Incl. an introduction to ILOG Optmization solutions for E&U

Sessions describing IBM solutions used in the previously described projects

ISO01: Optimisation ILOG - Démonstration avancée des étapes de développement d'applications personalisées

Aug 28, 2:00pm - 2:45pm, salle Picpus

IM01P2: Le Big Data pour enrichir, complémenter et travailler en synergie avec vos Warehouse

Aug 28, 3:00pm - 3:45pm, salle Longchamp

SAN06: L'analyse prédictive avec IBM SPSS

Aug 29, 4:00pm - 4:45pm, Auditorium Blaise Pascal

TIV09: Solution d'EAM qui répond aux besoins de mobilité, planification et contraintes réglementaires

Aug 30, 10:45am - 11:30am, salle Longchamp

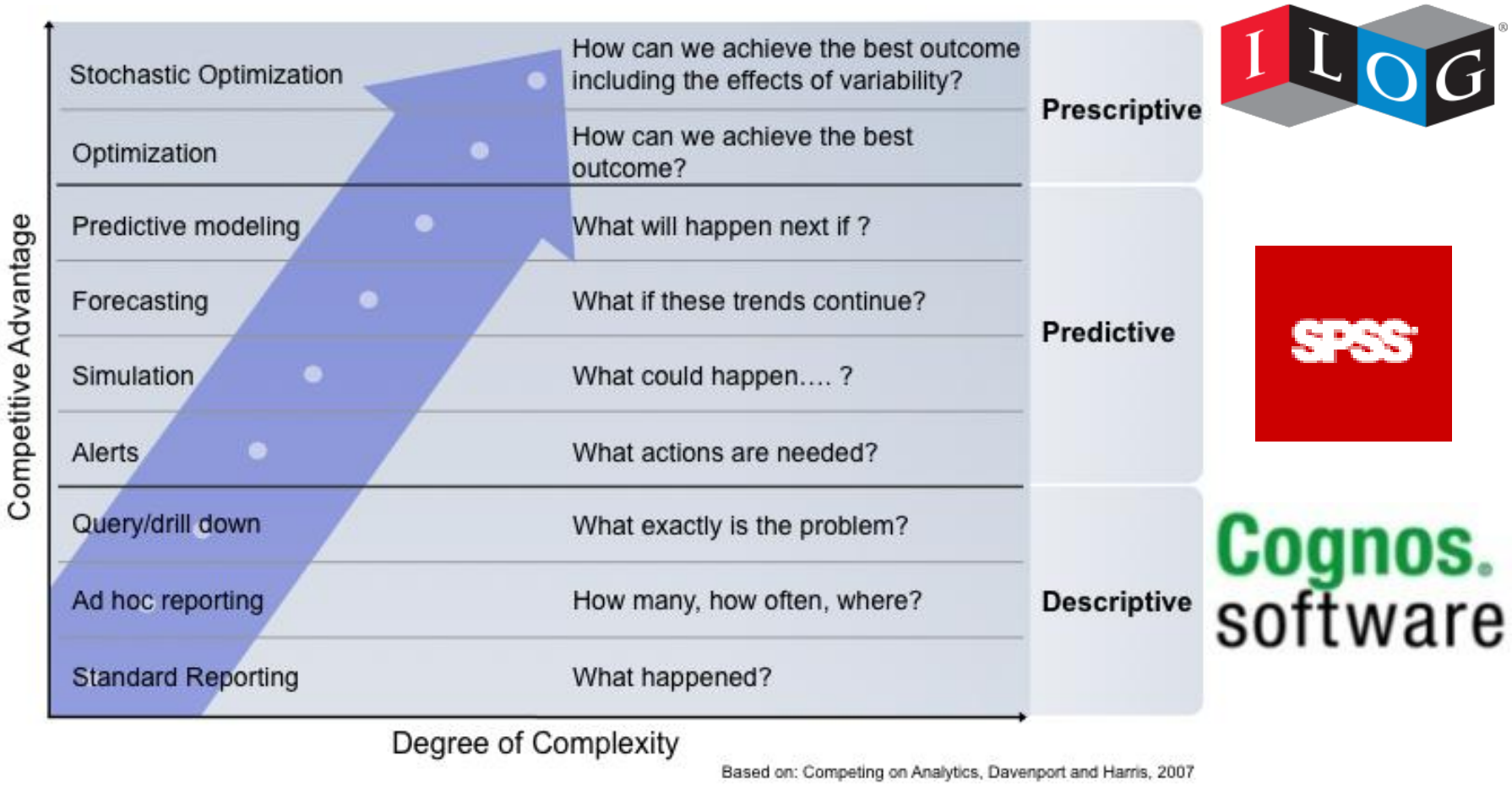
The Value of IBM ILOG Optimization Solutions

Smarter Commerce for a Smarter Planet

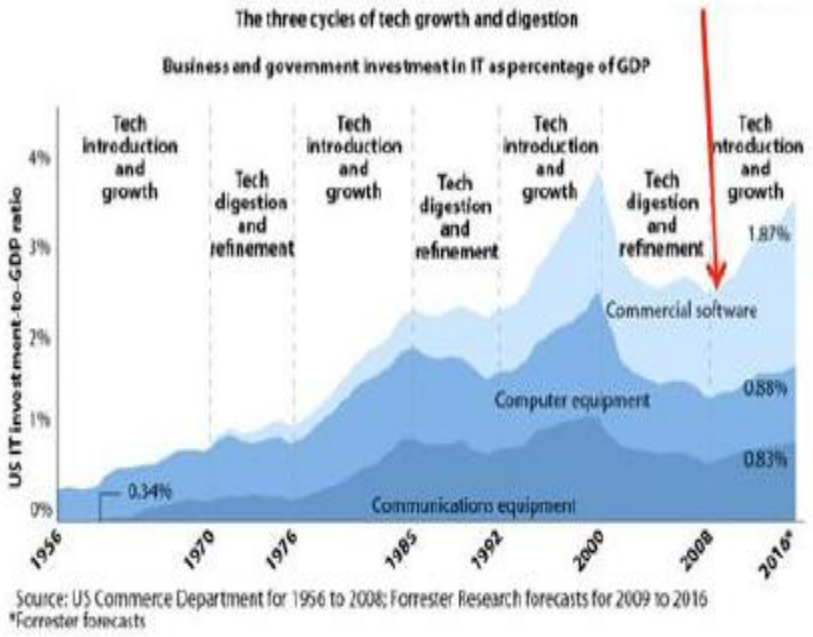
- Better
  - Get better performance for lower cost
  - Find non-obvious solutions for complex decisions
  - Produce quantifiable benefits to the bottom line
- Faster
  - Automate decision processes consisting of many alternatives
- Greener
  - Discover interactions among environmental impacts and business drivers
  - Realize opportunities to more efficiently operate a business in a better way

- Turn information and insights into action
  - IBM ILOG Optimization Solutions leverage the investments you are making in enterprise information technology and business automation

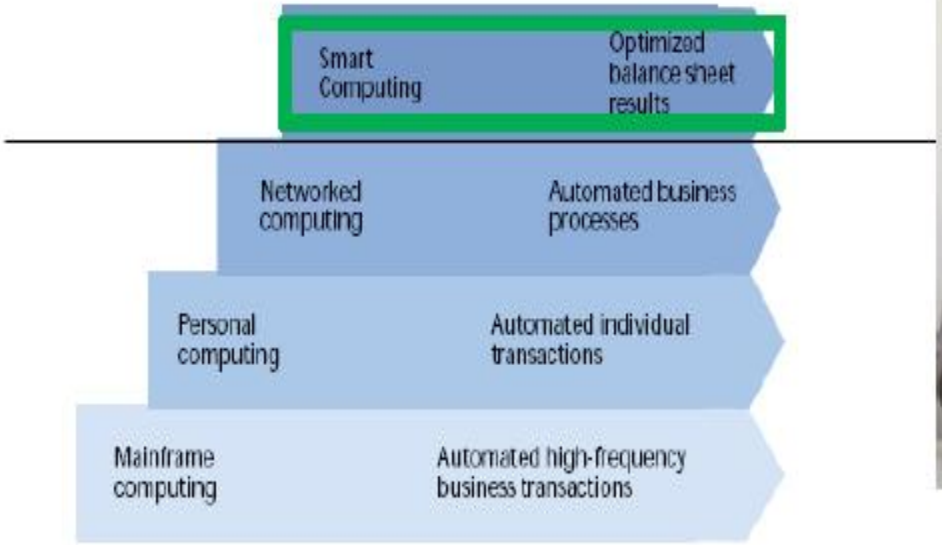
Smarter Analytics : Business Analytics and Optimization

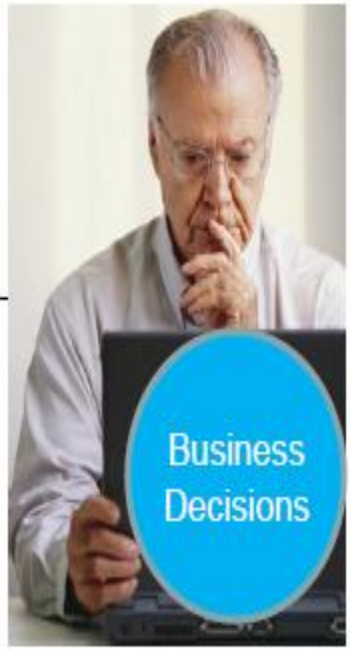


Based on: Competing on Analytics, Davenport and Harris, 2007



Andrew Bartels of Forrester Research says: there have been only three major IT technologies since 1960 (mainframes, PCs, networking), but that **the fourth wave has started**. It is "smart computing" or "optimization".





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Source: Forrester Research, Inc.

The Science of Better Decisions

How to best allocate aircrafts and crews?

What to build, where and when?

Inventory cost vs. customer satisfaction

Optimization helps businesses:

- create the best possible plans
- explore alternatives and understand trade-off
- respond to changes in business operations

Risk vs. potential reward

Cost vs.carbon emission

ILOG Optimization Results

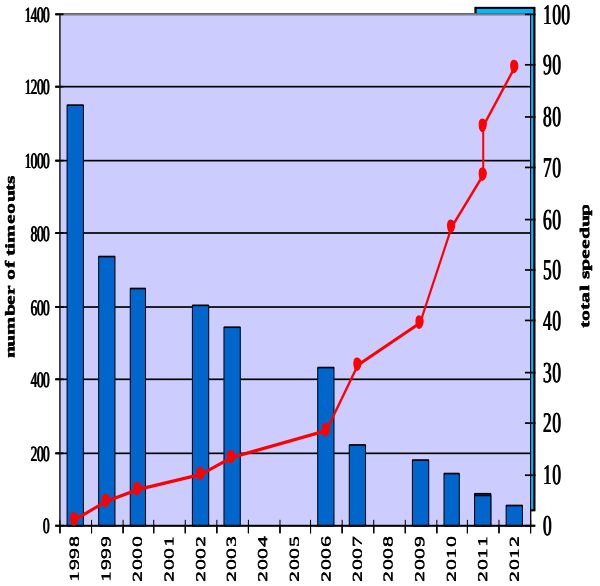
(Reported For Franz Edelman Award Competition, Institute for Operations Research and Management Science)

COMPANY	BUSINESS PROCESS	ROI
South African National Defense Force	Defense Force Design	22% cost savings
SNCF	Train Capacity Allocation	3-5% profit increase
Grantham, Mayo, van Otterloo	Portfolio Optimization	$4 mil / yr
Bosques Arauco	Timber Production	$5 mil / yr
AT&T	Telecom Network Recovery	35% reduction in spare capacity
Samsung Electronics	Semiconductor Manufacturing	60% reduction in cycle times
National Broadcasting Company (NBC)	Advertising Scheduling	$200 mil over 4 years
Continental Airlines	Airline Crew Recovery	$40 mil in one year
Menlo Worldwide Forwarding	Cargo Network Routing	21% cost savings
UPS	Air Network Design	$87 mil over 2 years
Motorola	Procurement Management	$100 mil-$150 mil / yr
Netherlands Railways	Commuter Rail Scheduling	€40 mil/year
Indeval	Securities Settlement	$150 mil/year

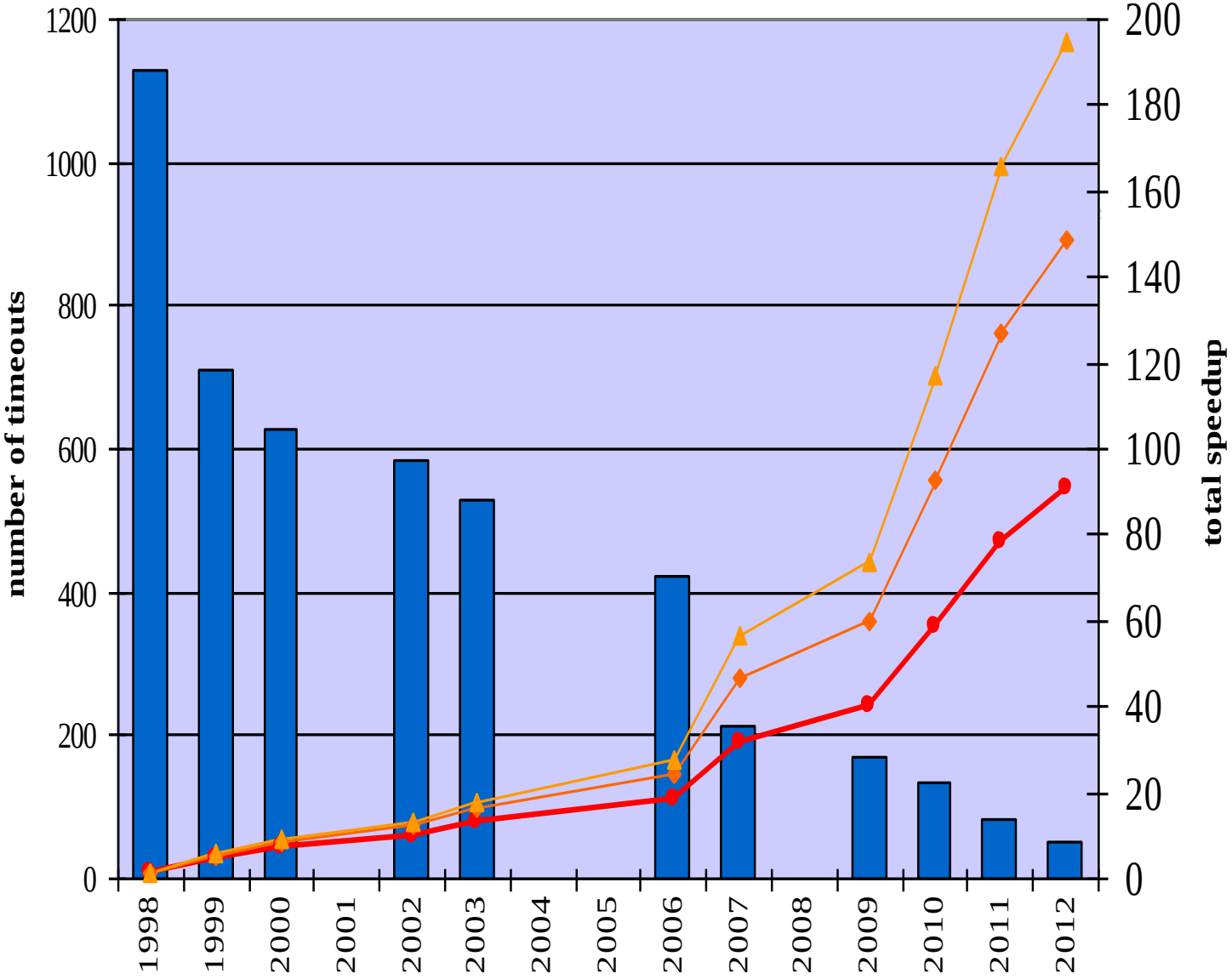
Progress in Linear and Integer Programming (CPLEX engine)

- 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



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



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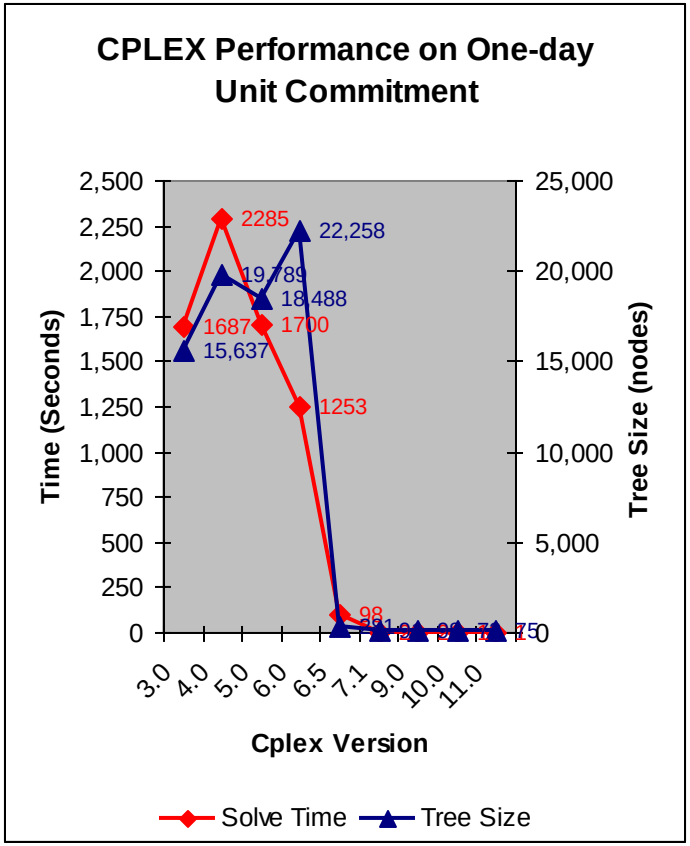
Timelimit: 10,000 sec

- Before 1999, unit commitment used specialized algorithms
  - Lagrangian Relaxation, Dynamic Programming
  - Hard to engineer, inflexible, uneven performance
- IBM ILOG CPLEX demonstrated that general MIP could solve unit commitment problems
  - Easier to adapt, flexible, good performance



"The improvement of times…gives promise that this approach can be useful for solving UCPs in the future… These results show that realistic unit commitment problems can be solved to optimality by off-the-shelf software"

Source: *The Next Generation of Electric Power Unit Commitment Models*. Benjamin F. Hobbs, Michael H. Rothkopf, Richard P. O'Neill, Hung-po Chao. Springer, 2001. ISBN 0792373340. p. 6-7.

Benefits

- 2004 – “PJM Interconnection has implemented new problem-solving software that will save its customers an estimated $56 million annually”
- By 2008, US FERC estimated PJM’s annual savings at $200 million

- US FERC estimates that world-wide adoption of MIP for unit commitment could save $10 to $200 billion/year
- Additional benefits:
  - Solve larger problems == longer time horizons and larger markets
  - Solve more complex problems == new market features

What Can Optimization Do?

- Optimization helps businesses make complex decisions and trade-offs about limited resources
  - 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

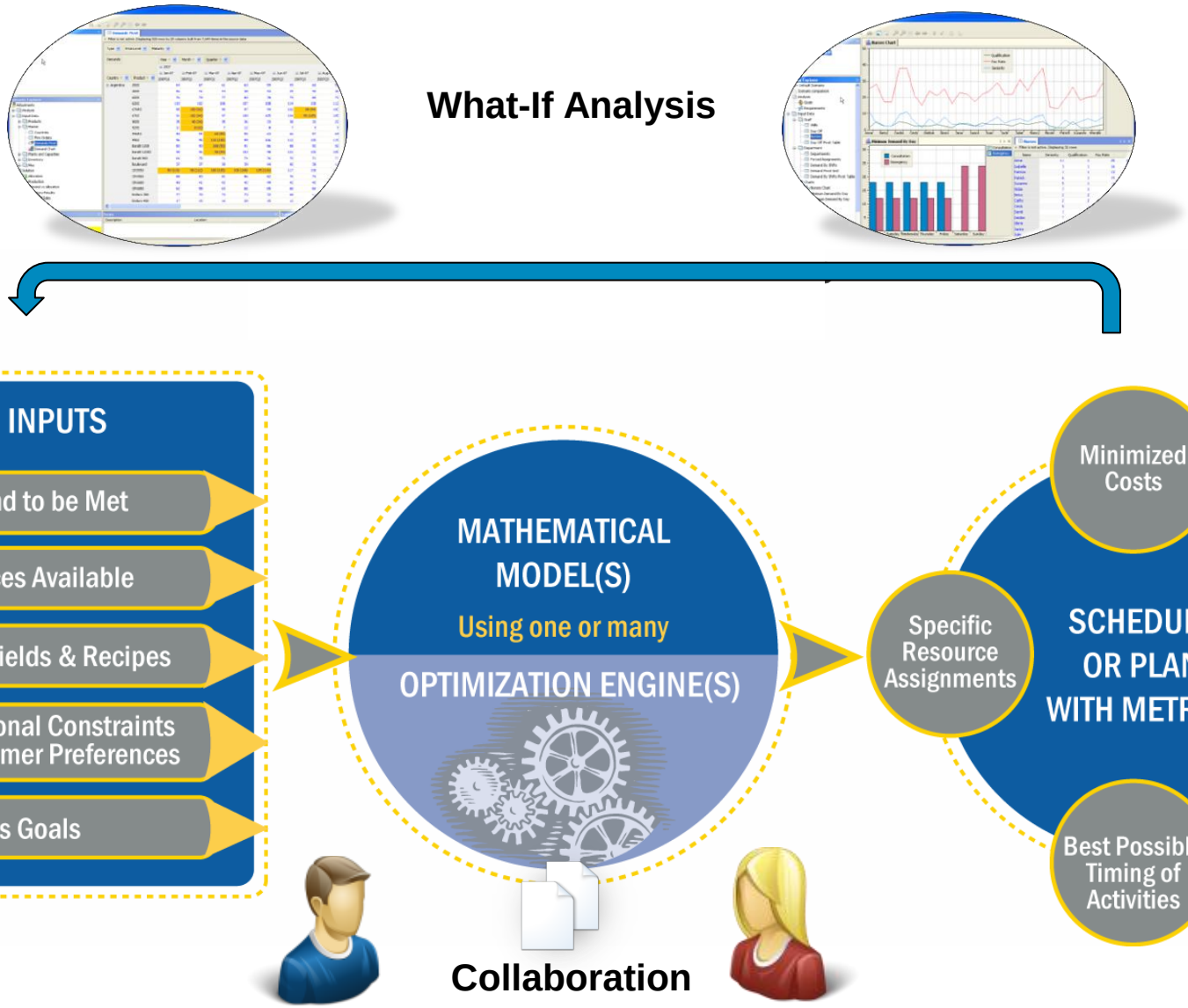
Optimization is used to solve Resource Allocation Problems

Resources	Choices to make
Capital	Allocate
People	Acquire, schedule, assign
Equipment	Acquire, schedule, locate
Facilities	Locate, schedule
Vehicles	Acquire, route, schedule
Raw Material	Acquire, assign

- **Planning and scheduling activities**
  - Which are subject to complex operating constraints (e.g. limited resources, large volume of data, complex manufacturing or design processes)
  - With multiple business objectives to reduce time, cost, or increase KPI's such as productivity
- **While enabling**
  - Adjustment of changes in operating environment
  - What-if analysis

Keywords: Buy, sell, schedule, assign, staff, plan, create, locate

Optimization Supports Decision Making



About IBM and Optimization Solutions

ILOG built a huge Optimization ecosystem

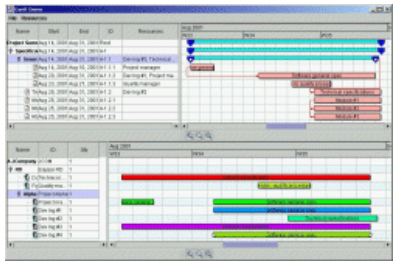
- **Leader in Optimization for 25 years**
- **Used by over 50% of the world's largest companies,**
- **About 300 projects implemented**
- **Embedded by 250+ largest software editors**
  - •SAP APO, ORACLE (SNO, JDE, e-Business Suite, Siebel), JDA (Manugistics, i2 Tech), Infor, AspenTech, Jeppesen, Manhattan, Demandtech, Quintiq, Ortec, McHugh, Sabre, Giro, PTV, Paragon, GeoConcept, etc
- **Used by 1000+ Universities,**
- **R&D owning & mastering 100% of the technology**
- **Core offering, made ILOG's success and reputation**

"ILOG Optimization solutions tackle the world's toughest problems allowing firms to gain a unique competitive advantage"

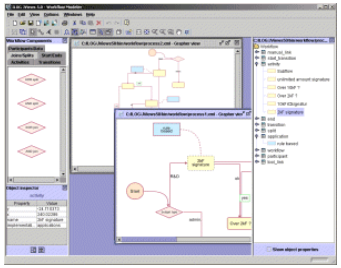
JViews Enterprise included with ODM Enterprise

➔ Build custom views with Gantt, Charts, Diagrammer, Maps, Flowcharts, etc

Model

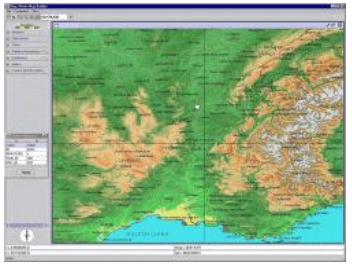


Schedule Editor



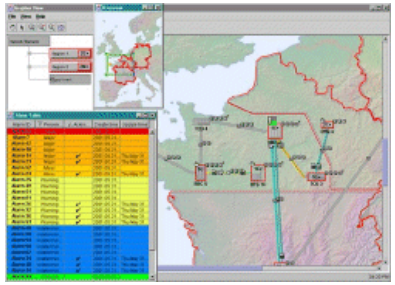
Flow Modeler

Drawing Editor

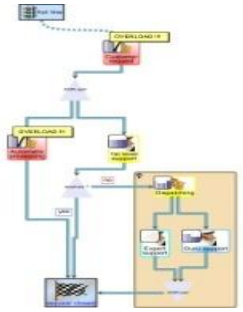


Map Editor

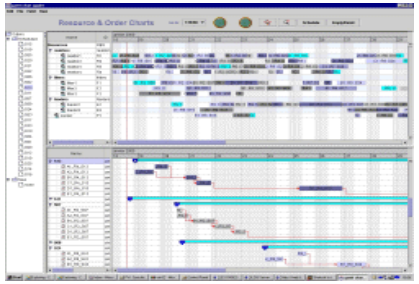
Monitor



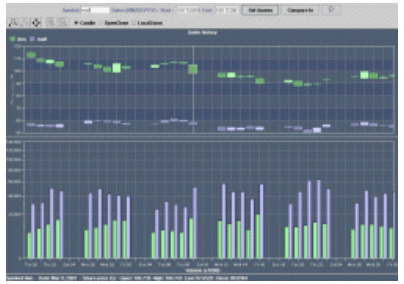
Network Monitoring



Workflow Monitoring

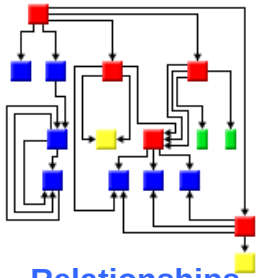


Supply Chain Monitoring

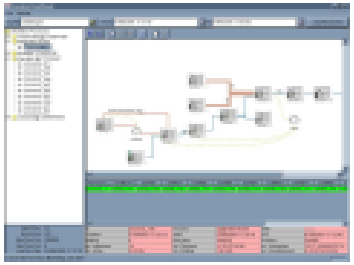


Real-Time Charts

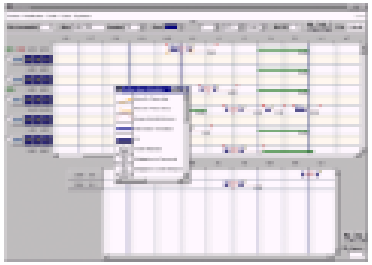
Analyse



Relationships, Smart Diagrams



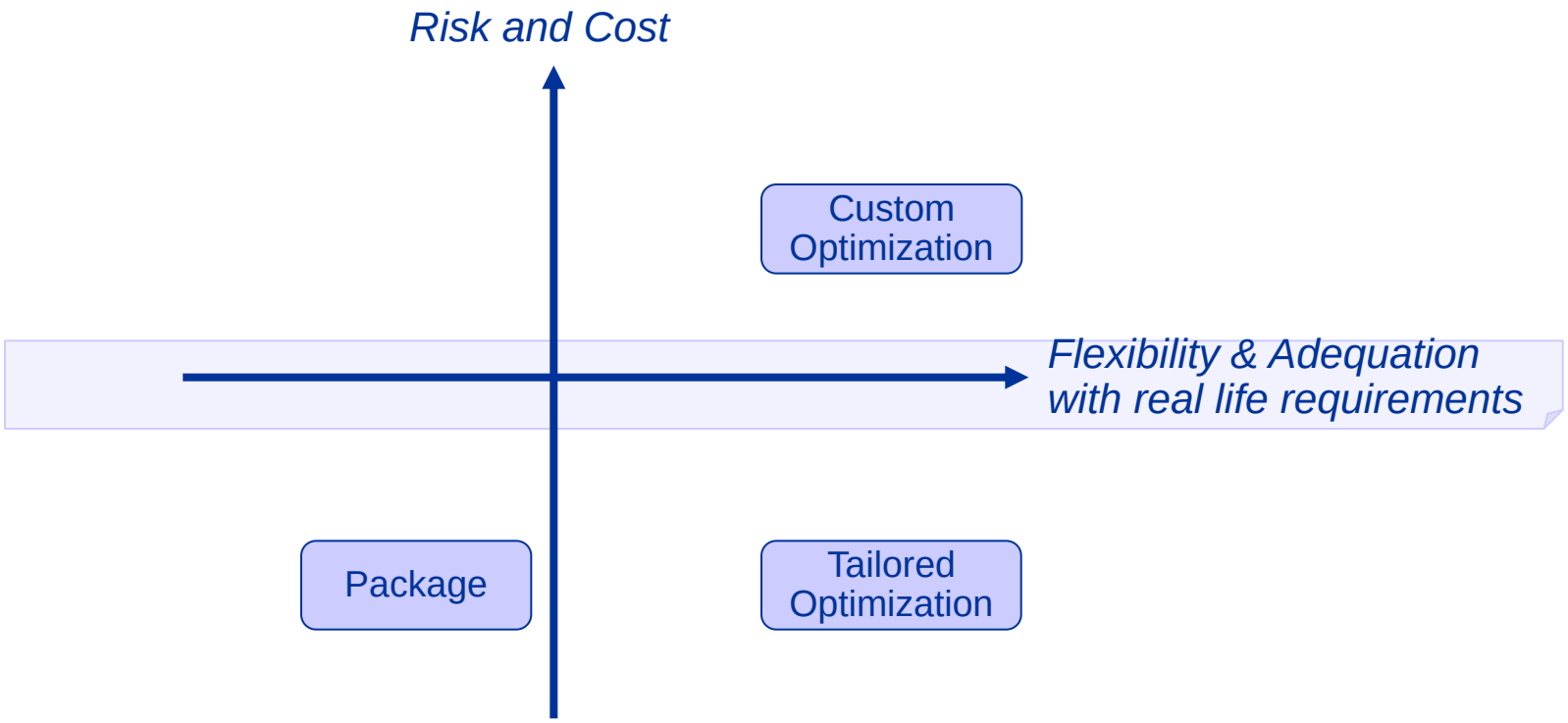
Management Cockpits



Optimization Analysis

Numeric Data Charts

IBM ILOG solution approach – Benefits of a tailored solution



Le trading énergie à l'intersection de l'énergie et de la finance : des sujets d'optimisation

Optimiser par silos ou optimiser globalement

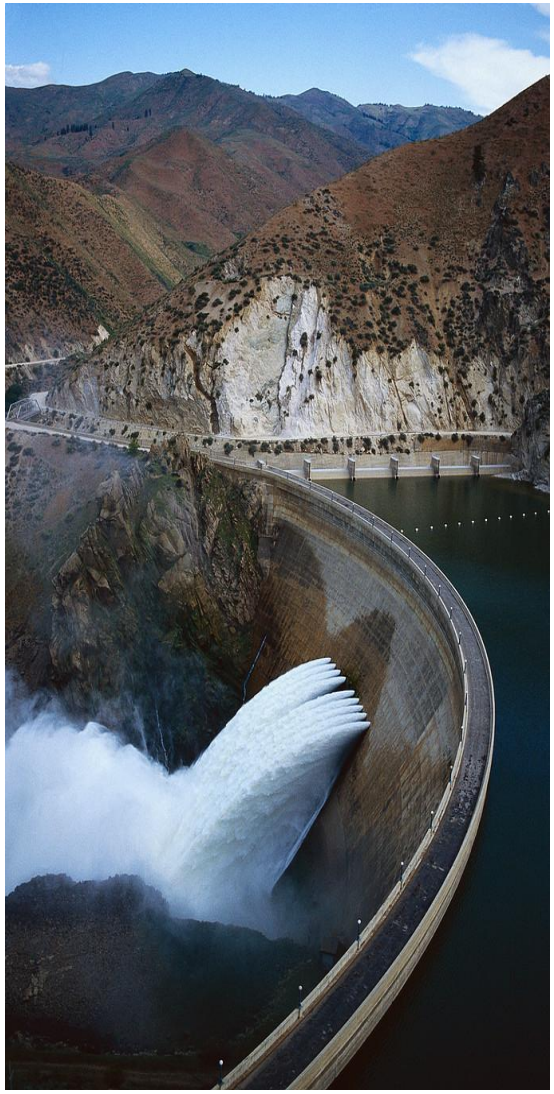
- Optimisation de portefeuilles gaziers
- Maintenance préventive et opérations
- Circulation et distribution du gaz
- Approvisionnement
- Unit commitment
- Smart grids

- Collateral optimization
- Risk heging, risk sharing
- Randomness
- Hedging
- Short term spatial arbitrage
- Long term risk justification : spot market vs long term contracts
- VAN (NPV) optimization

The Third Industrial Revolution is based upon 5 Pillars (Jeremy Rifkin)

1. Shifting to Renewable Energy
2. Converting Buildings into Power Plants
3. Hydrogen and Other Energy Storage Technology
4. Smart Grid Technology
5. Plug in, Electric, Hybrid, and Fuel Cell based Transportation

Optimization Problems in the Energy and Utility Industry



- Generation/Resource Planning
- Unit Commitment/ Economic Dispatch
- Hydro/Thermal Scheduling
- Optimal Power Flow/ Security Constrained Dispatch
- Network Planning
- Contract and Risk Management
- Power Market Simulation
- Nuclear Power Outage Scheduling

…

Optimizing the Grid: Unit Commitment at RED Eléctrica de España

Business Problem: Use exact mathematical methods to replace the approximate, heuristic methods Red Eléctrica de España, in charge of managing the Spanish national power grid, had been using for the last 20 years

The methodology applied until now … was an interactive methodology, which did not guarantee an optimum solution. There were many difficulties in the smaller systems and it was hard to find the most viable solution. Thanks to the new methodology, we have resolved this type of problem.

- Mr. Mustafa Pezic, REE Project Director

- The implementation of IBM ILOG OPL/CPLEX and ODM solution has provided great operational advantages to company's managers and engineers
  - "The new tool allows us to simplify all maintenance tasks and any changes made to the model, which in our particular case, are very frequent."
  - "From a user viewpoint, it has brought greater trust in the solution and a significant reduction in planning time required by users. In parallel with this, from a development and maintenance viewpoint, there has been a significant reduction in associated costs, as well as in the duration of the processes."

- REE reduced production costs by between €50,000 and €100,000 per day.
- REE has reduced its carbon emissions by approximately 100,000 tons of CO_2 annually.

Energy Management: E.ON Ruhrgas optimizes purchasing and storage of natural gas

E.ON Ruhrgas Business Problem – Strengthen its entire natural gas supply chain from the wellhead to the burner, as it expands beyond its home market to the rest of Europe. Minimizing costs by optimizing activities for purchase contracts and storage facilities became key to the company's business operations.

Using IBM® ILOG CPLEX, E.ON Ruhrgas developed an optimization solution that identifies the margins for the quantities of purchase contracts and performs sensitivity analysis to identify risks

- CPLEX solves very large, real-world optimization problems (problems ranging in size from 11,000-140,000 decision variables, 500-80,000 constraints and 50,000-1,300,000 data elements) while providing the speed required for interactive applications
- E.ON Ruhrgas applies the results in managing purchase contracts and storage facilities, determining pipeline capacities and negotiating purchase costs

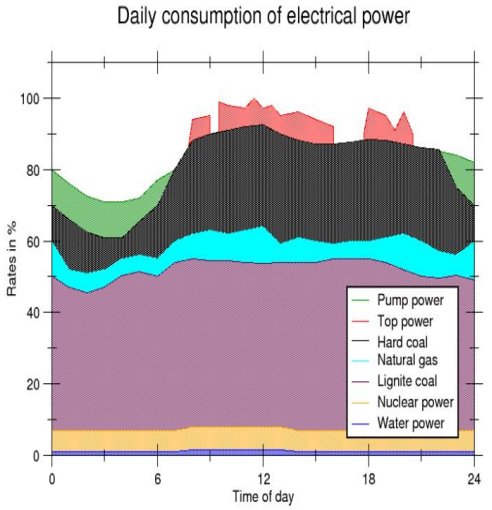
E.ON Ruhrgas' ILOG-based pricing and storage optimization system offer:

- Better planning and decision making
- Greater competitiveness, as it allows E.ON Ruhrgas to react quickly to market changes
- Ability to analyze a large number of scenarios in trying to find the best solution for optimizing activities

Energy Market Coupling: BELPEX EPEXSpot

(40% of the European power load) power exchange for Anonymous, cleared, short term trading in electricity)

Market coupling is both a mechanism for matching orders on power exchanges (PXs) and an implicit cross-border capacity allocation mechanism. Market coupling optimizes the economic efficiency of the coupled markets: all profitable deals resulting from the matching of bids and offers in the coupled markets of the PXs are executed; matching results are however subject to capacity constraints calculated by Transmission System Operators (TSOs) which may limit the flows between the coupled markets..



Market prices and schedules of the connected markets are simultaneously determined with the use of the available capacity defined by the TSOs. The transmission capacity is thereby implicitly auctioned and the implicit cost of the transmission capacity is settled by the price differences between the markets. In particular, if no transmission capacity constraint is active, then there is no price difference between the markets and the implicit cost of the transmission capacity is null.

More efficient energy market
Better economic efficiency, higher capacity utilization, lower volatility

Smart Grid: ILOG Optimization for Electrical Vehicles charging

- EV in Zurich
- EV in Denmark

Questions / Answers

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