IBM Research

IBM Research – the next wave of solutions

June 2004

@business on demand software

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Business Optimization Group, IBM Zurich Research Laboratory

The IBM Research Division - worldwide presence with eight locations and more than 3000 Researchers

IBM Research – Worldwide Locations

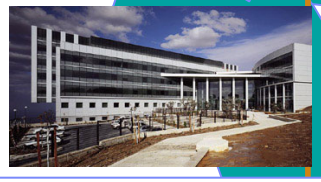
Almanden
Established: 1986
Employees: 500

Watson
Established: 1961
Employees: 1750

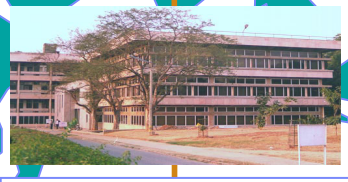
Zurich
Established: 1955
Employees: 300

Beijing
Established: 1995
Employees: 90

Austin
Established: 1995
Employees: 40



Haifa
Established: 1972
Employees: 500



Dehli
Established: 1998
Employees: 60

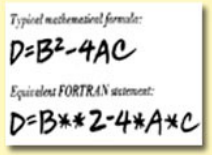
Tokyo
Established: 1982
Employees: 200

History of Innovation

1944: Mark 1

1948: SSEC

1956: RAMAC



1957: FORTRAN

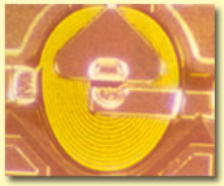
1966: One-Device Memory Cell

1967: Fractals

1970: Relational Database

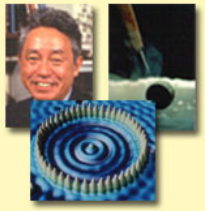
1971: Speech Recognition

1973: Winchester Disk



1979: Thin Film Recording Heads

1980: RISC

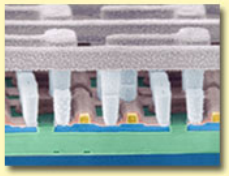


Nobel Prizes

1994: SiGe

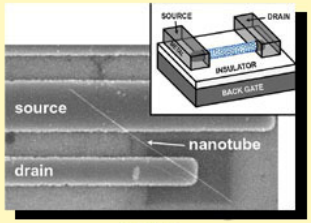
1993: RS/6000 SP
1996,97: Deep Blue

1997: Copper Interconnect Wiring

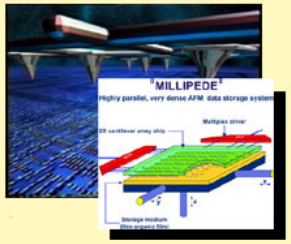


1998: Silicon-on-Insulator

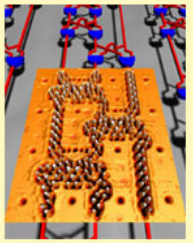
1998: Microdrive



2001: Nanotube Transistor



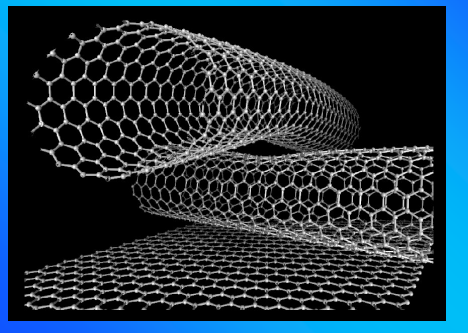
2002: Millipede



2002: Molecule Cascade Logic Circuit

IBM invests almost $5 billion a year in research and development, organized across 6 strategic thrusts

Exploratory Science

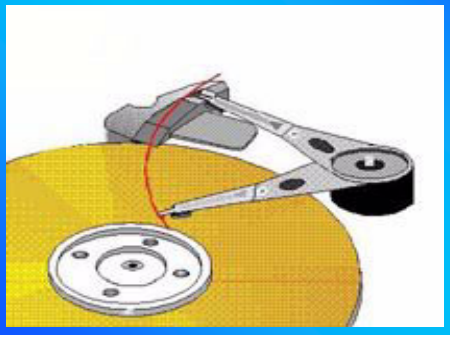


Servers & Embedded Systems

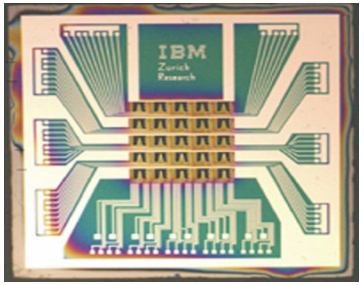
Personal Systems

Services & Software

Storage Systems & Devices

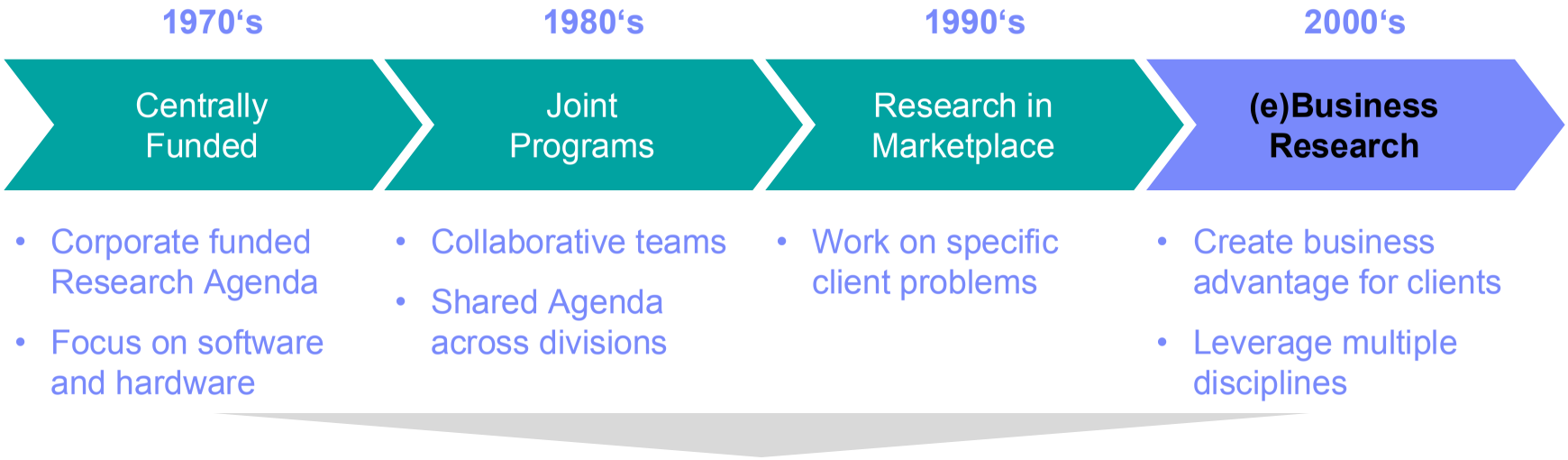


Technology



Over the last decades IBM Research has continuously evolved from a pure internal research to a client-focused organization

Evolution of IBM Research's Role



Technology Transfer	EBO – Emerging Business Opportunities
FOAK's – First of a kind Projects	ODIS – On Demand Innovation Services

Bringing Innovation to the Market

Tell us about your pain points and . . .

… IBM scientists will work with IBM consultants to analyze your business challenges and provide solutions that address these challenges

On Demand Innovation Services (ODIS)

- Consulting. Deeper.
- Become the future of the services and research industry.
- Bring fresh, innovative solutions to complex business problems.
- Give IBM the competitive advantage.

On demand Innovation Services (ODIS)

Part of IBM's Company Vision …

"An enterprise whose business processes -- integrated end-to-end across the company and with key partners, suppliers and customers -- can respond with speed to any customer demand, market opportunity or external threat." - Sam Palmisano, CEO, October 13, 2002

Requires Business Capabilities that are…

- ✓ **Responsive in real-time**
- ✓ **Variable cost structures**
- ✓ **Focused on what's core and differentiating**
- ✓ **Resilient around the world, around the clock**

On demand **Innovation** Services (ODIS)

What Is Innovation?

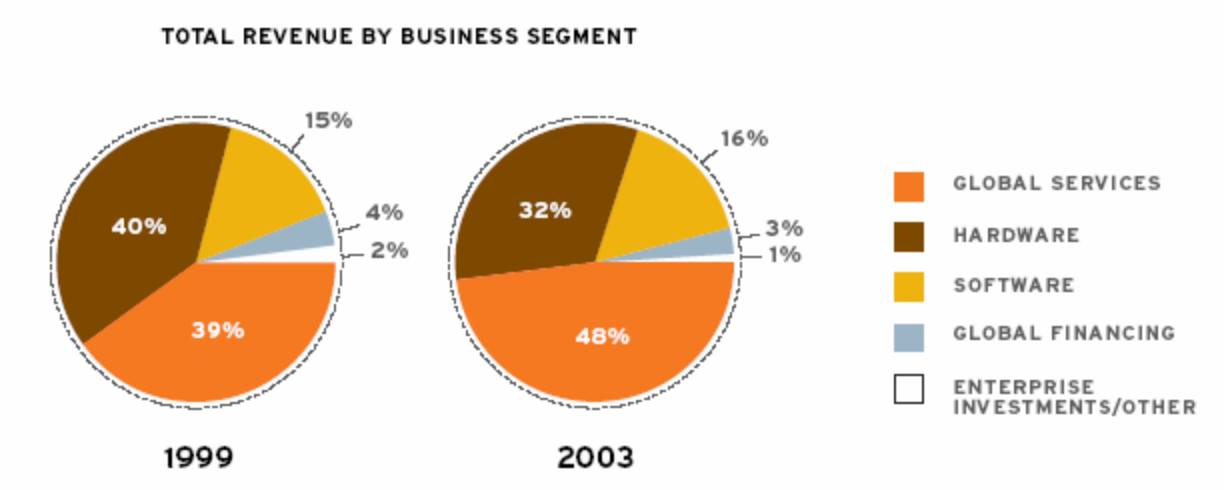
Innovation occurs at the intersection of invention and insight.

It's about the application of invention – the fusion of new developments and new approaches to solve problems.

--Sam Palmisano, Council on Competitiveness, October 2003

On Demand Innovation Services (ODIS)

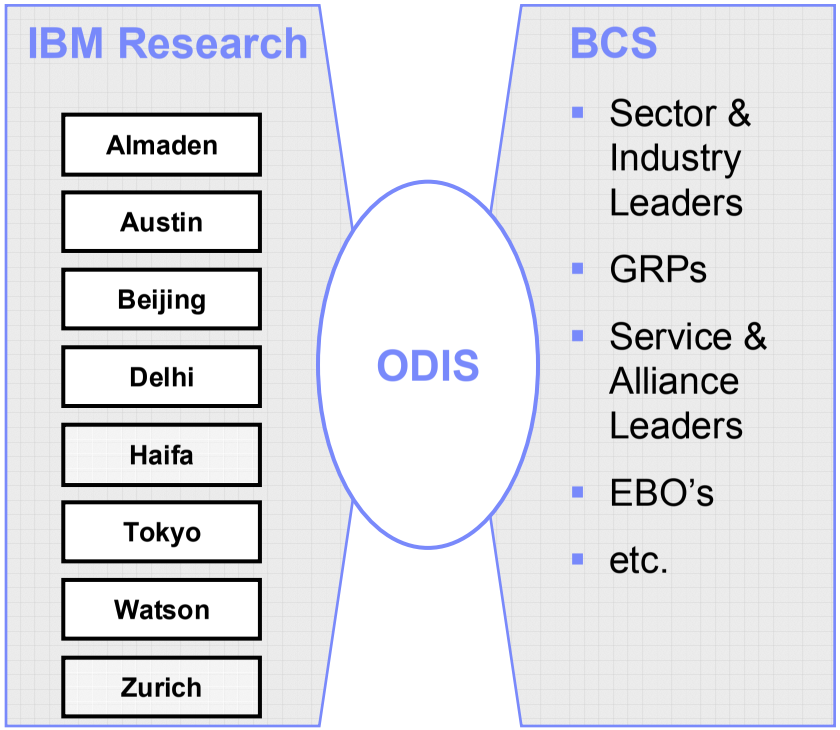
… we will provide leading-edge technology, services, expertise and intellectual capital, and will integrate these capabilities for each client to provide them with competitive advantage.



IBM Annual Report 2003, Chairman's Letter

ODIS acts as a „gearbox“ in combining Research and BCS capabilities in an holistic way to bring substantial value to our clients

ODIS Set-Up



Mission of ODIS EMEA

- Create value add for customers through Innovation
- Provide leading edge subject matter expert know-how
- Help to transform businesses and to design new business models and processes based upon advanced technologies/ algorithms
- Assist customers to plan and manage their innovation process and run innovation councils

IBM Research EMEA with two labs focusing on advanced technologies and services and the ISL where customers and research meet

IBM Haifa Labs (HRL)

- Software and Services
- Software & Verification Technology
- Storage & Systems
- Lotus Products

Research Lab Zurich (ZRL)

- Science and Technology
- Computer Science
- Communication Systems

Industry Solution Lab Zurich (ISL)

- State-of-the-art briefing facility
- Professional event support
- Organization of tailored briefings; world-wide expertise
- Demonstrations of emerging technologies

ODIS assets and capabilities are organized within Micropractices which continuously evolve according to market needs

→ Advanced Call Center Solutions
- Natural language voice recognition, voice mining and other technologies enabling more effective customer service

→ Advanced Networking Services
- Innovative models, software and expertise to help design and optimize enterprise networks & networked applications

→ Automotive Industry
- Apply advanced conversational systems & telematics, diagnostics and embedded systems

→ Business Optimization & Analysis
- Optimization, planning, modeling, and analysis to transform businesses to on demand

→ e-business Systems & Architecture
- Design and deployment of applications, middleware, and web content

→ Collaboration
- Assess current collaboration environment and design future collaborative states; new innovative tools & best practices

→ Grid & Autonomic Solution
- Innovative models, software & expertise to evaluate, design and optimize grid and autonomic capability in client distributed computing environment

→ Information Mining and Management
- Gain business insight from all kinds of data: text, voice, video, etc. enabling on demand decision making

→ Mobile Enablement
- Automate and enhance business processes with mobile technologies

→ Product Lifecycle Management
- ROI modeling for portfolio management; Improve product development processes through better tools, methodologies and collaboration

→ Security & Privacy
- Assess, design and implement enhanced security processes and tools

→ Supply Chain & Operations Solutions
- Optimization, planning, modeling, and analysis of supply chain and transportation processes

→ Life Sciences Industry

Boston Coach – Fleet Optimization

BETTER SERVICE WITH BETTER SCHEDULES

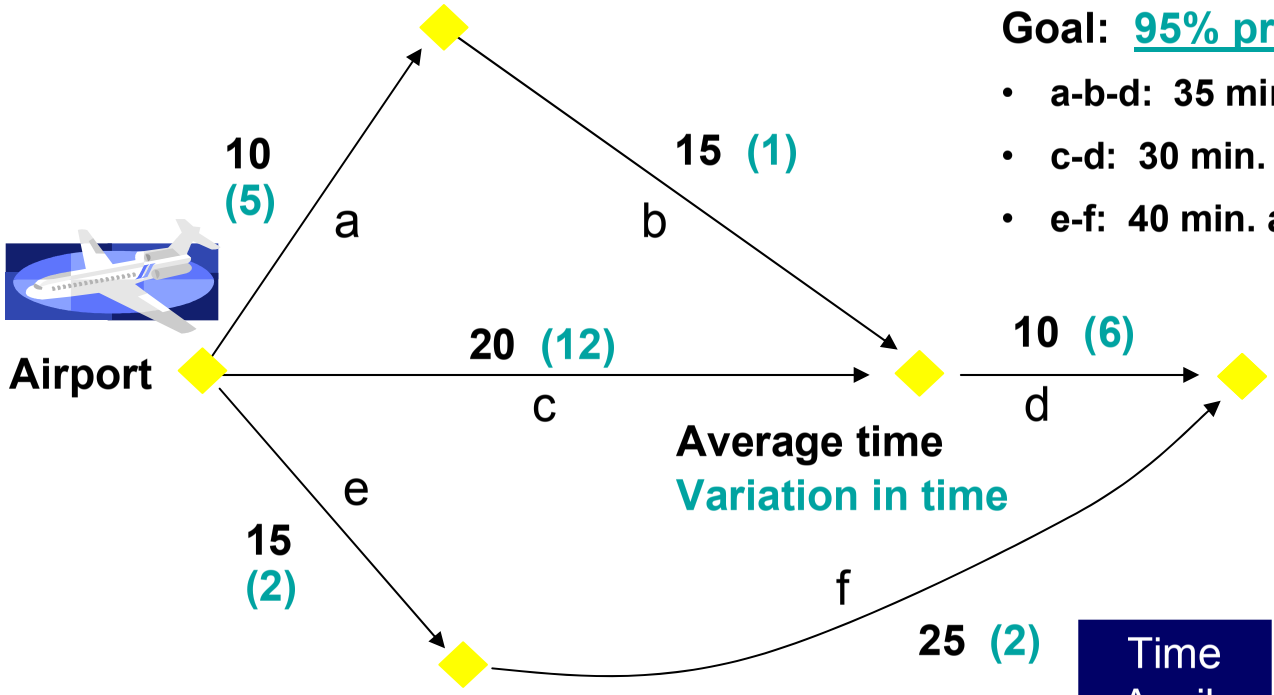
- BostonCoach leads in the van, limousine and sedan service industry for on-time pickup, but leadership used to come at a cost.

  Before the system created by IBM's On Demand Innovation Services, dispatchers would often turn down last-minute reservations — or send two cars to meet a single customer — rather than risk brand-damaging disappointment.

  Now, fleet controllers can accept more business and use cars more efficiently, with a system that optimizes schedules for three different time scales: daily, every 15 minutes and even several times per minute.

IBM Annual Report 2003

Example -- Driving to an Important Appointment



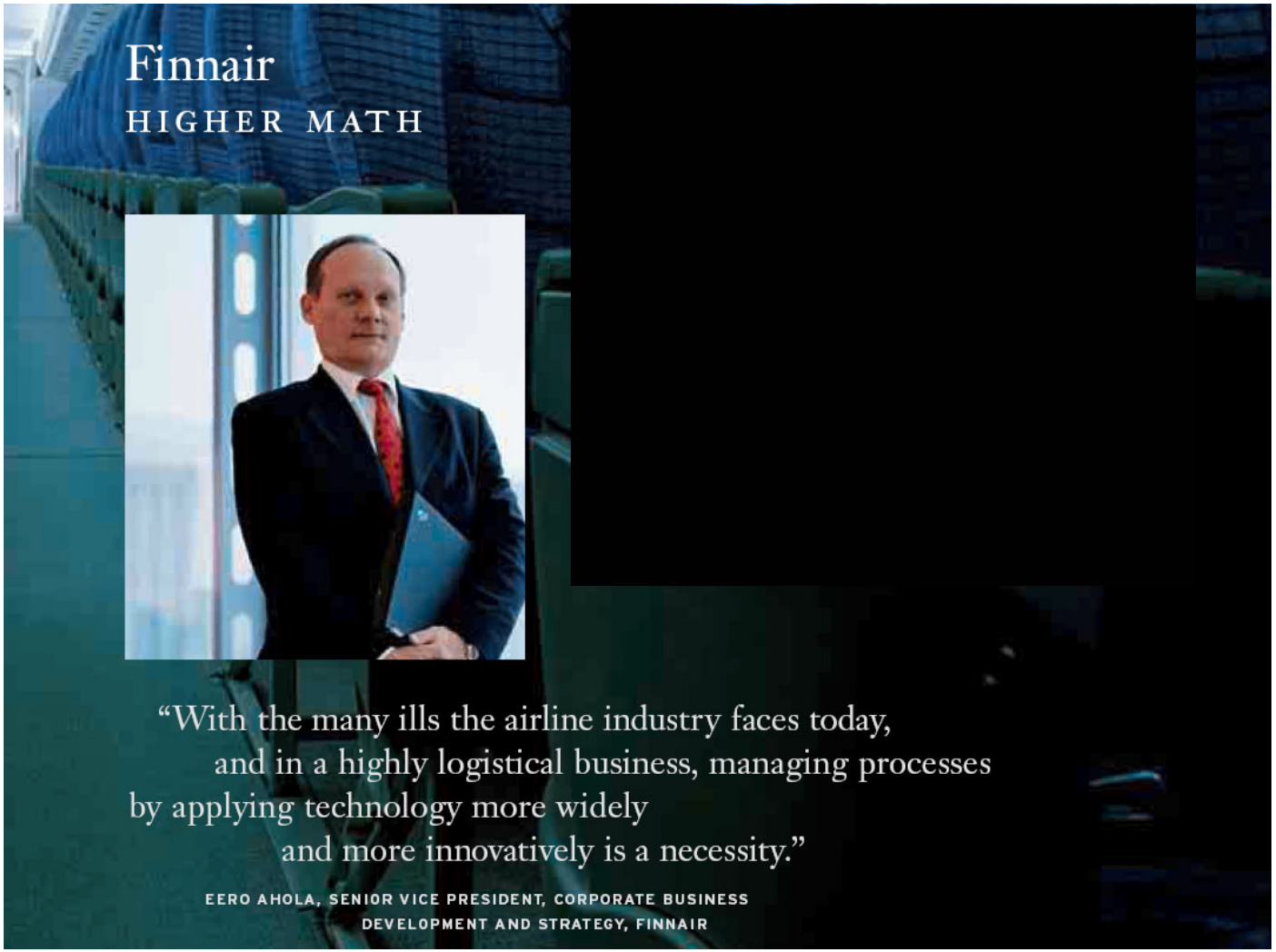
Goal: 95% probability of arriving on time

- **a-b-d: 35 min. average**
- **c-d: 30 min. average (map program result)**
- **e-f: 40 min. average**

Stochastic methods capture all the scenarios and all the uncertainty in a single analysis

Time Avail.	Route a-b-d ?	Route c-d ?	Route e-f ?
55	99%	97%	99.9%
50	97%	93%	99%
45	90%	87%	96%

Finnair – Customer Relationship Analytics



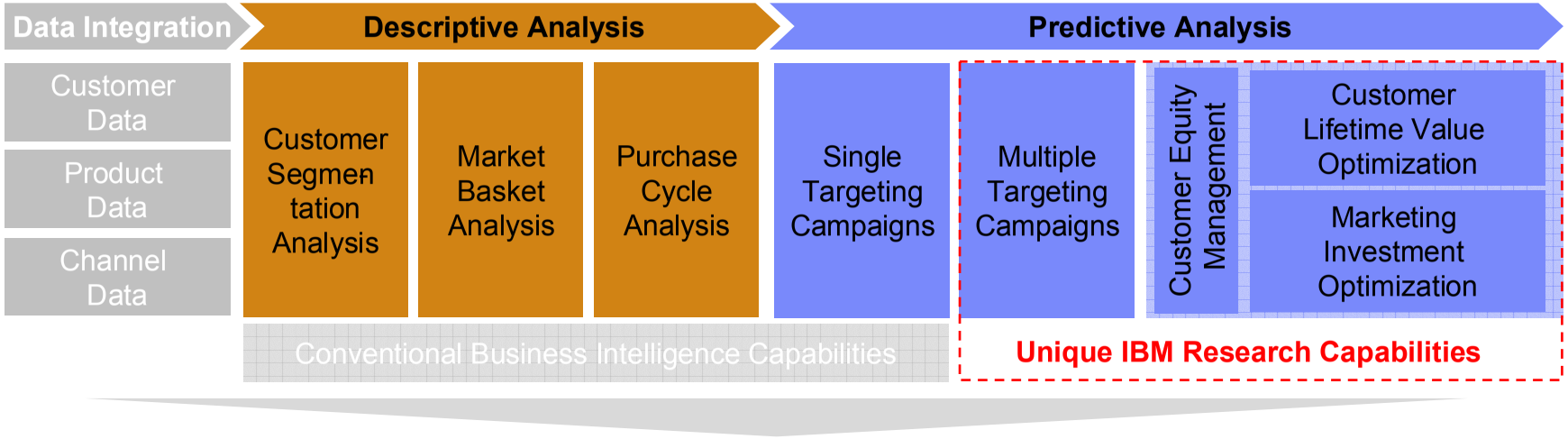
Increased Revenues and Customer Satisfaction

- Processing frequent-flier data has a potential impact of reducing marketing costs by 20 percent while improving marketing response rates by as much as 10 percent. And that means big money — in increased revenues and in savings.
- Still only a prototype, IBM's Customer Equity Management solution already has an 80 percent accuracy rate for predicting the eventual value a customer represents.
- By forecasting a frequent flier's future travel decisions, it's also helped improve the airline's customer satisfaction rate by 10 percent. And all from pulling numbers out of Finnair.

IBM Annual Report 2003

Customer Relationship Analytics:
Increasing customer lifetime value und optimizing Marketing ROI

- Data gathered through CRM systems is often not leveraged to turn data into actionable knowledge
- Decision support for targeting valuable customers and increasing customer equity is often lacking

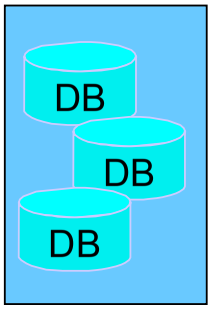


- Effective quantitative decision framework to long-term and profitable customer relationship
- Focused management/ acquisition of valuable customers resulting in increase of revenue and profit
- Increased revenues through multi-targeting campaigns and cross-selling
- Increased customer loyalty/ satisfaction
- Maximized ROI on marketing budgets

Customer Equity and Lifetime Management (CELM)

- Perform segmentation of the customer base and estimate the value profile of each customer/segment (lifetime value and risk)
- Determine which sets of marketing actions (promotions/campaigns/offers/etc) should target which customers/segments over given variable time horizons
- Use advanced statistical and optimization algorithms to determine when and how much should the Marketing organization spend on each customer/segment in order to maximize the overall Return/Risk ratio.

Underlying Process / Technology



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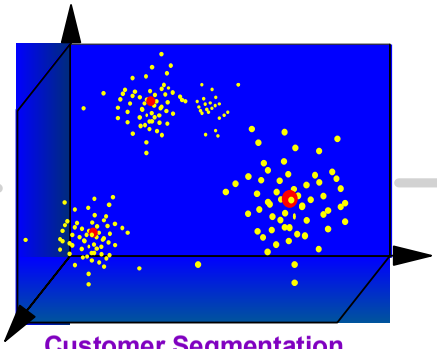
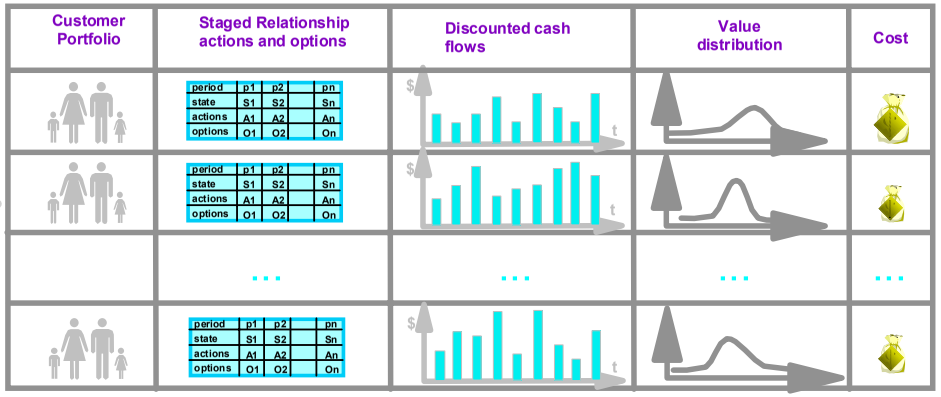


Customer Segmentation

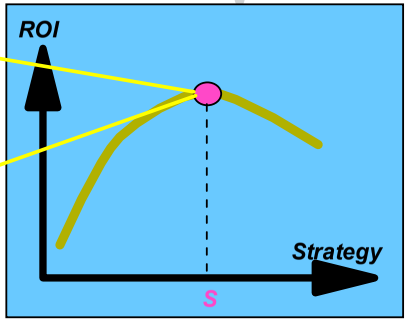


Estimation of customer lifetime value and risk.

Distribution of Optimal Multi-period Budget Investment

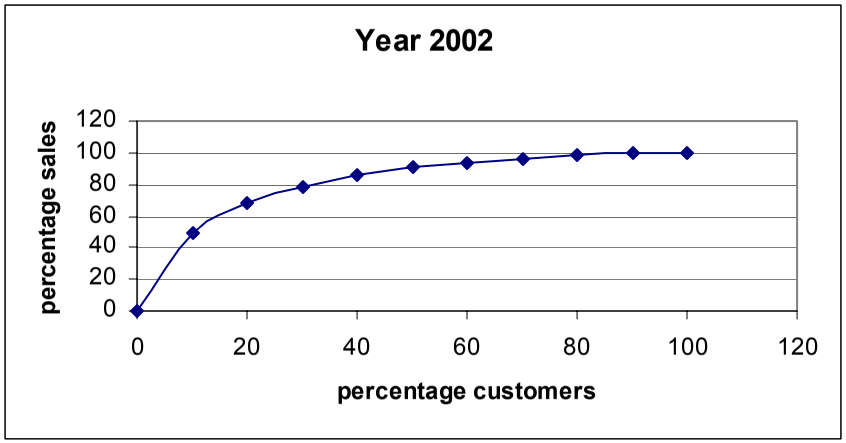
Customers Portfolio	Period 1	Period 2	...	Period p	Lifetime
Customer 1	5%	5%	...	7%	20%
Customer 2	2%	3%	...	6%	15%
...	...	...	...	...	...
Customer N	9%	6%	...	8%	25%
Total	25%	20%	...	15%	100%

Determine when and how much to invest in each customer in order to maximize portfolio ROI over given a time horizon.



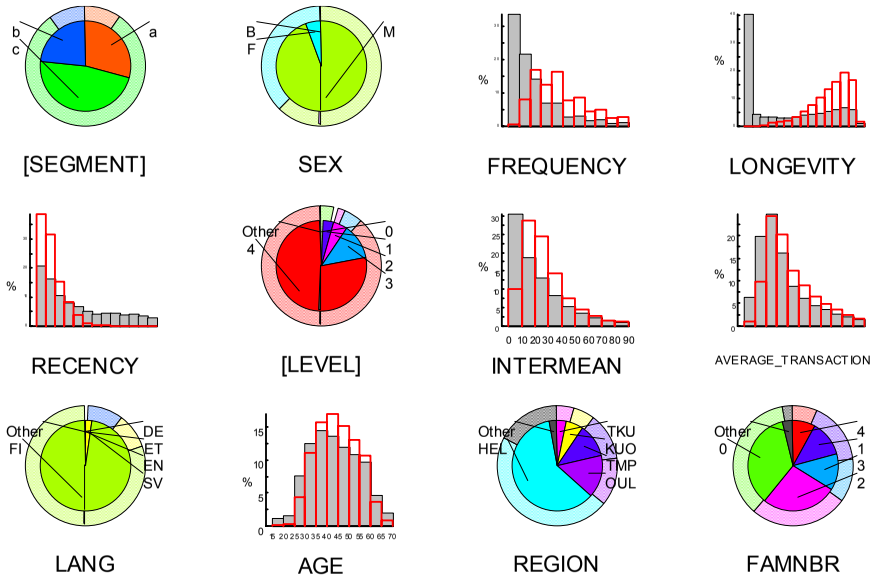
Find targetting strategy which maximizes portfolio ROI.

Value-based Segmentation Analysis



40% of the customers generate 85% of the total annual sales

What do the top 40% customers have in common?



Feature selection

Behavioral: Longevity, frequency, inter-transaction time, recency and average transaction size

Demographics: Age, family number, language, region, sex, seat, post indicator

CELM Definition of Customer Lifetime Value

- **Current value**:
  The sum of the profits generated by a customer over some given time window (e.g. 1 year/quarter).

$$CV_i = \frac{\sum_{t=1}^{T_i} revenu_{i,ti}}{frequence_{i,t_i}} \times \frac{\sum_{t=1}^{T_i} profit_{i,ti}}{\sum_{t=1}^{T_i} revenu_{i,ti}} \times frequence_{i,t_i}$$

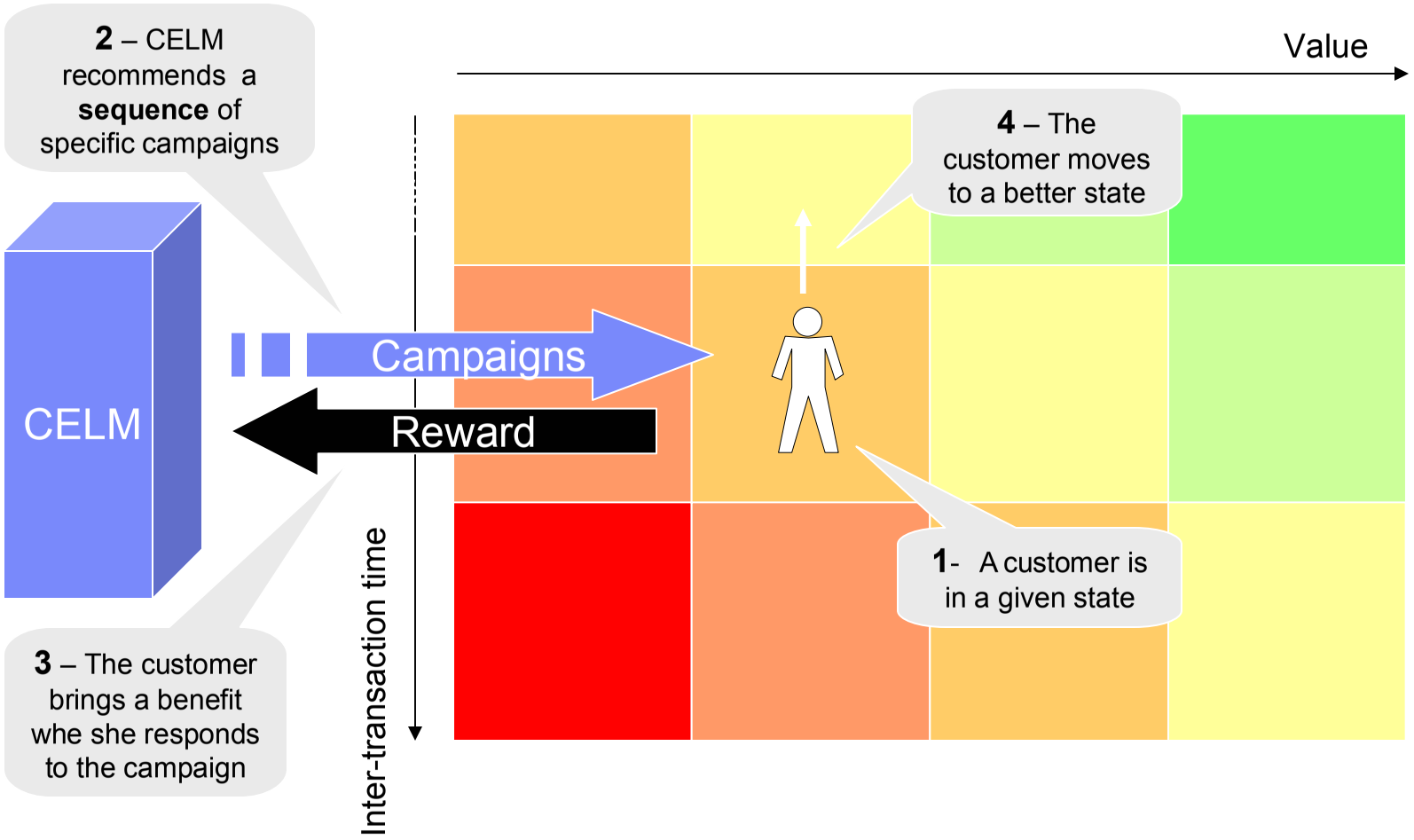
Average Trans. size | Average Margin | # Trans. per year

+

- **Future value**:
  The sum of the future discounted (d) profits (Revenues - Costs) generated by potential (p) future customer transactions (e.g. in next year/quarter).

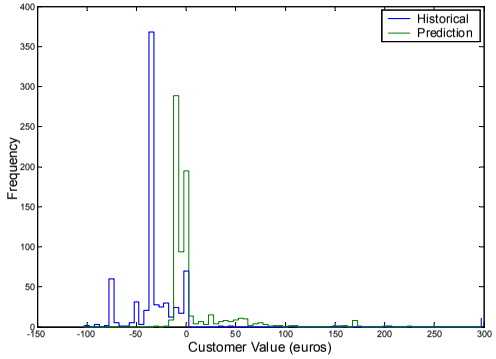
$$CLV_i = \sum_{t=0}^{T_i} \frac{(R_{i,t} - C_{i,t}).p_{t,i}}{(1+d)^t}$$

Optimal Control of Customer Dynamics

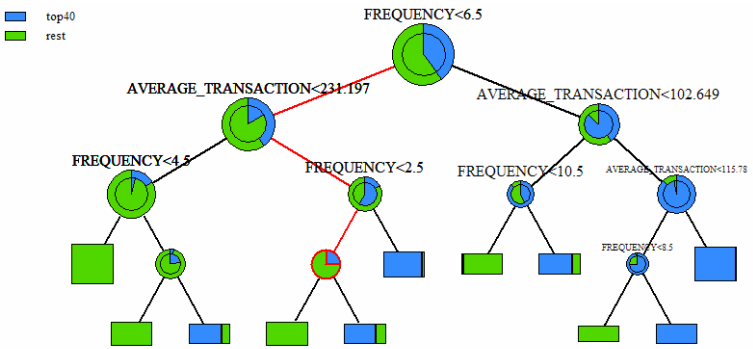


Optimization and Prediction

- Optimization to predict optimal lifetime value
  - What was the value of a customer in the past?
  - What the customer value is likely to be in the next months?
  - What is the distribution (uncertainty) of the value (risk)?

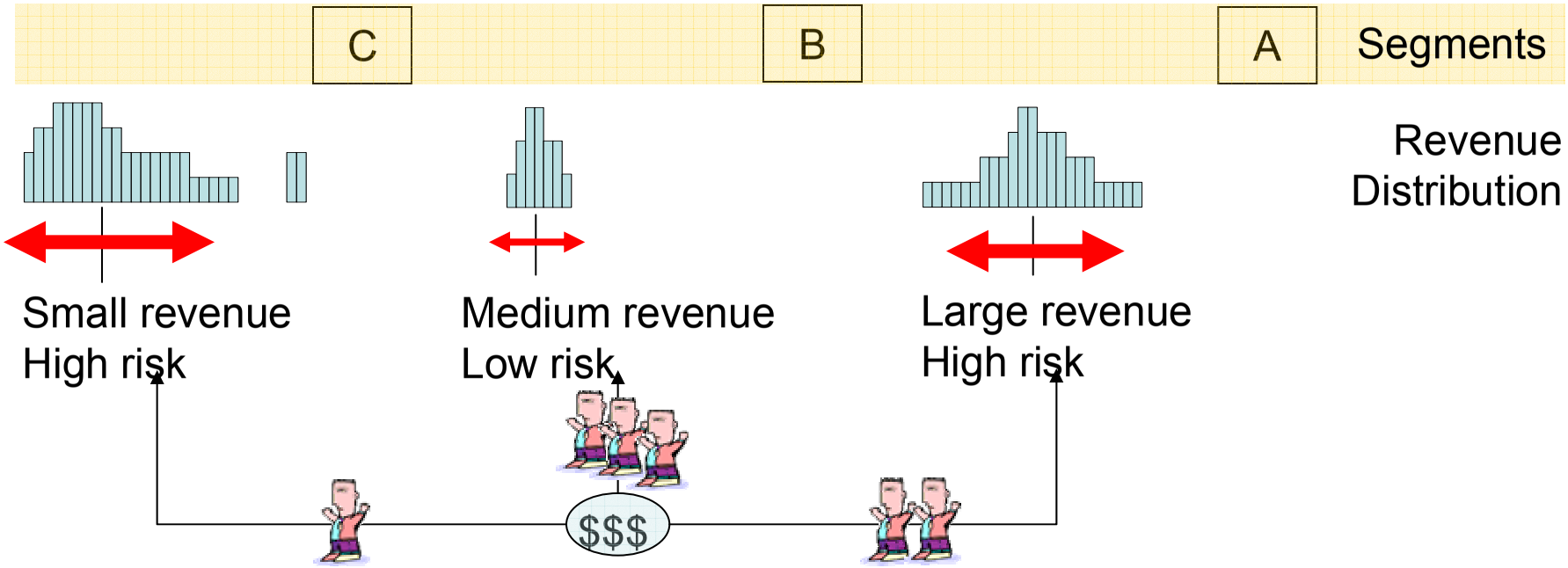


- Determine relevant business rules to move customers to higher value states
  - Using classification trees on the results from Markov Decision Process (MDP)
  - Predicts which customers will move to another state (for example, to detect the most probable customers to move up to better segment)

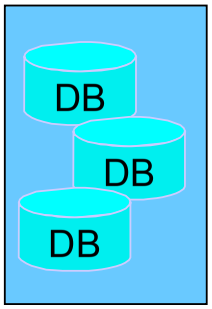


Portfolio Management

Given a limited budget and a policy, select the number of customers to target in each segment in order to minimize the cost and the risk while maximizing the reward.



Underlying Process / Technology



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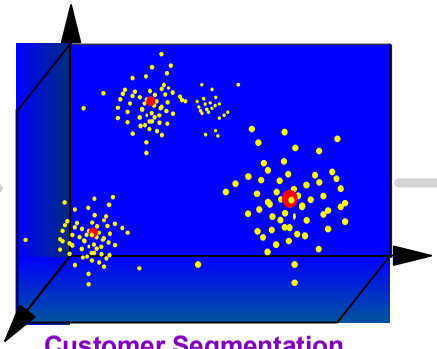

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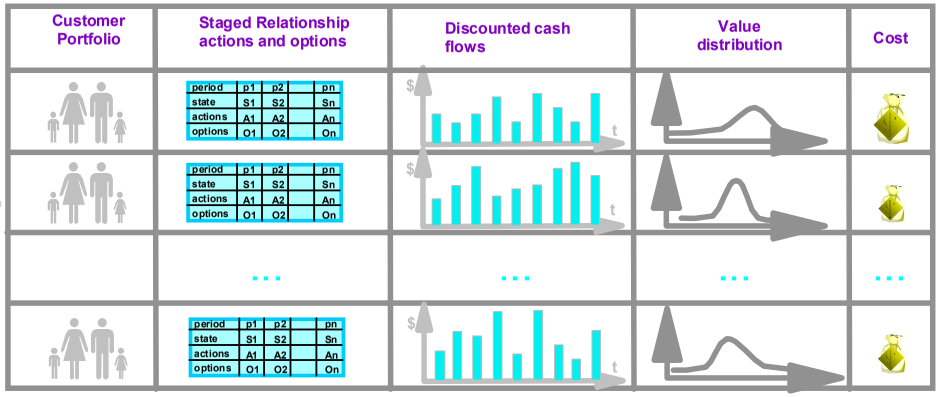

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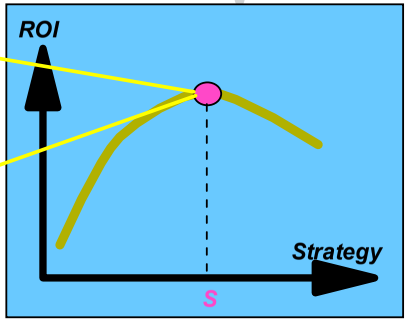


Find targetting strategy which maximizes portfolio ROI.

Enterprise Performance Analytics:
Making fact-based decisions under uncertainty

Challenges

- Immense pressure to optimize business processes and reduce cost
- Need to respond quickly under uncertainties/ risks
- Pressure to monitor performance and adapt quickly to changes

ODIS Solution

- Adaptive models and time series analysis as basis for trend detection
- Performance tracking through real-time analysis/prediction of key quality metrics
- Quantification of risks and their correlation, e.g. for project portfolio optimization
- Development of novel concepts and methodologies for business transformation (case-by-case)

Customer Benefits

- Optimal decision support based on quantitative analysis
- Improved monitoring process/ risk management
- Risks, dependencies & expected value of projects identified and quantified and ROI of overall project portfolio optimized

For a leading European financial services company we have applied our predictive analysis capabilities to optimize the ROI of their IT project portfolio

Challenge:

- Optimization on ROI of IT project portfolio
- Lacking measures to predictively assess and manage project risks and return

Solution:

Predictive analysis of project portfolio risks and scenarios to develop robust budgeting and adequate mitigation plans for project risks

- Integrate project data from existing business management systems of IBM Global Services with existing customer history data on IT-projects
- Use advanced predictive data mining and optimization algorithms for accurate project profiling, budgeting and monitoring

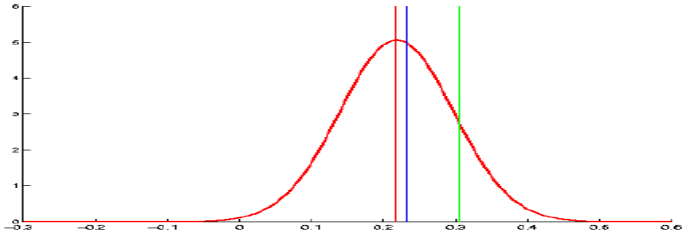
Benefits:

Optimized ROI on overall project portfolio

- Precise up-front cost, schedule, and resource estimates
- Ongoing, predictive detection of budget overruns and other project risks
- Rapid assessment of financial impact of changes in project scope

Application Example:

ΔGP comparison (predicted with modeling vs. actual, and traditionally estimated vs. actual) of a portfolio of 500 IT projects



- Deviation of predictive model (1%)
- Deviation of traditional model (10%)

Federal Office of Management and Budget

Challenge

Create a system that is consistent among all federal wildland fire fighting agencies, to produce more comprehensive budgets for fire management.

Solution

Working with government and university researchers, IBM researchers developed a model that considers various factors that affect fire growth and containment. Optimization techniques allow the system to identify the most effective initial attack organizations for a range of budget levels.

As the budgeting model and framework were developed, IBM consultants began working on the architecture and application that will be deployed in September 2004. A user-friendly, Web-based interface will facilitate input of key variables that describe the probability and behavior of wildfires. Over time, interactive maps will be added to the system making budget allocation faster and easier to understand.

Business benefits

✓Improved understanding of the costs and benefits of fire preparedness alternatives and a common, easy-to-use framework are expected to produce more comprehensive budgets as well as facilitate inter-agency collaboration to increase national effectiveness.

Billy Goat – used by IBM and external customers

Challenge:

To ensure high availability and efficiency for expansive networks for the defined business utilization for external and internal users.

- How can the protection of the IT-infrastructure be guaranteed from Worm attacks?
- What precautions can be taken to enable a business IT infrastructure on a high availability level?

Solution:

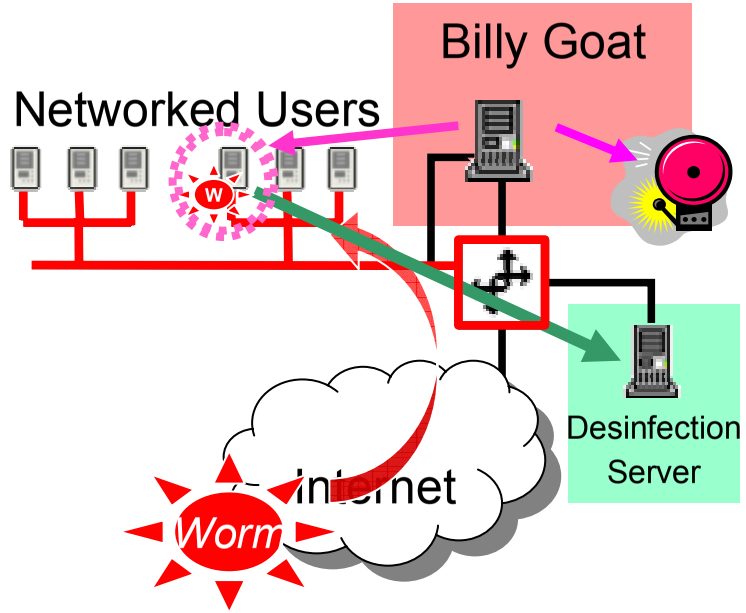
Integration of sensors in the network which are accurately determining attacks

- Rapid identification & containment of worm-infected machines
  - easy deployment
  - detection of known & new worms and viruses
  - detection of unusual traffic patterns
  - automated notification/logging

Benefits:

Increased customer availability of the IT infrastructure to support its business purpose

- More effective IT operation with less downtime & bandwidth loss
- Additional security control and reporting
- Less dis-infection costs necessary
- Low installation & operation cost



The IBM research solution-concept is integrated at all points in the supply chain and enables a complete, unbroken chain of trust verifiable in an independent way