# Management and Optimization of a Military Car Pool

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# Grüß Gott ...

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Team

Kontakt

Forschungsschwerpunkte

Forschungsprojekte

CORMTESSA

Competence Center for Operations Research
Management of Intelligent Engineered
Secure Systems & Algorithms





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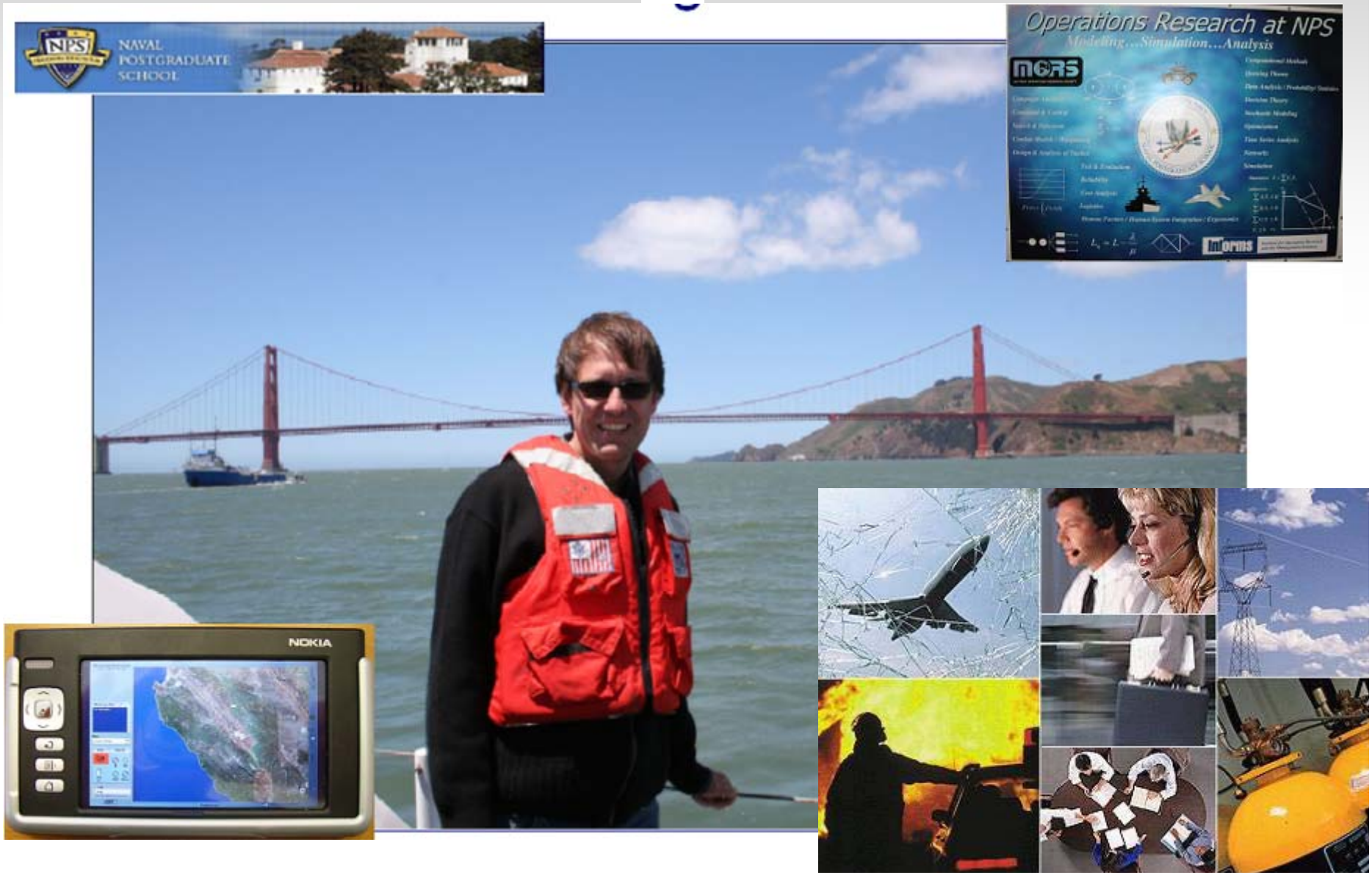
# Decision Support System



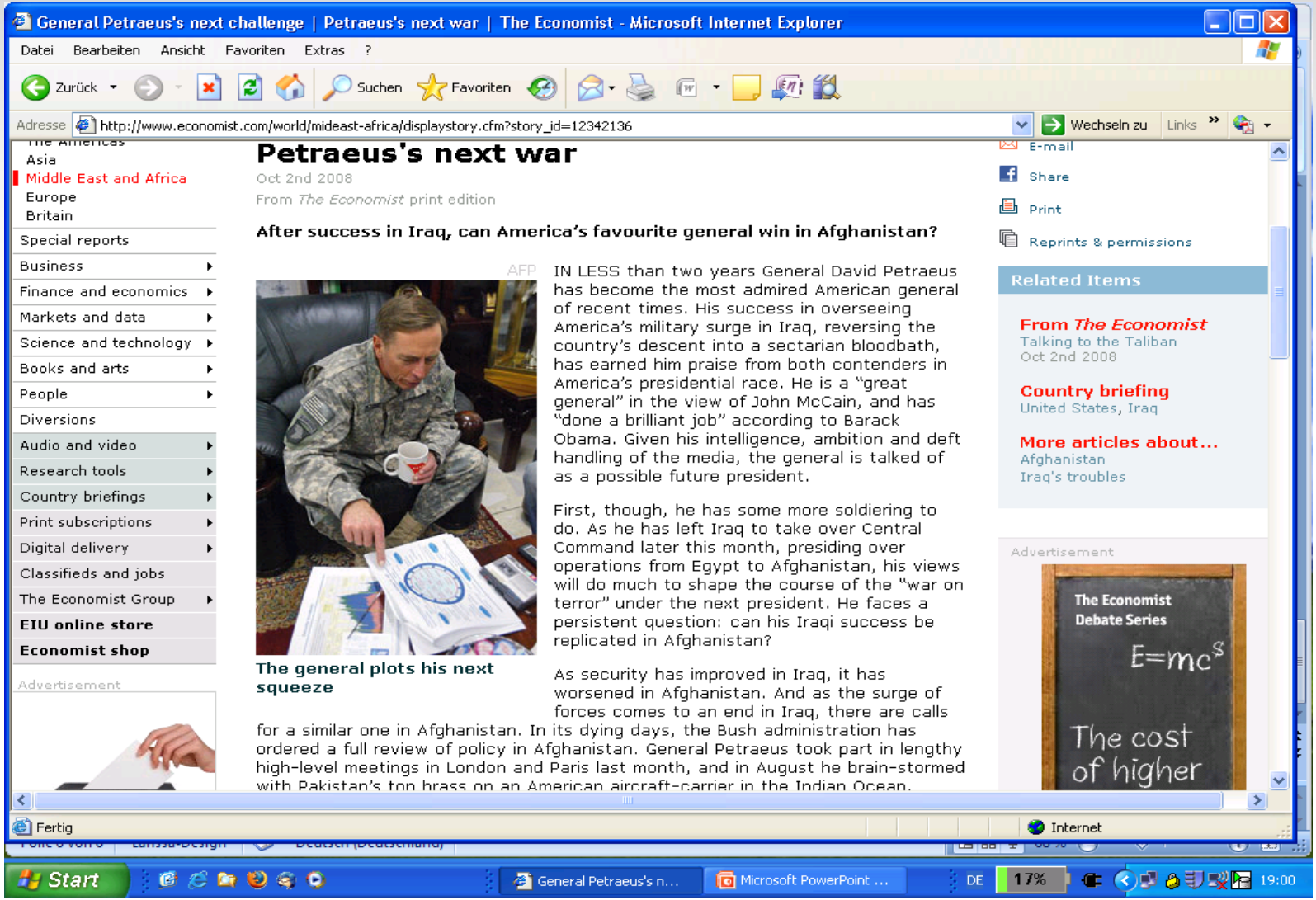
# Outline

- Introduction - Motivation
- Optimization on Process Level
- Optimization on Decision Level
- Embedded Service-Oriented Approach
- Conclusion

# Introduction - Motivation

# Introduction

- Initiator:
  - branch of a large (military) authority
- Task:
  - examine an existing software that's used to manage and optimize the car pool of that branch
  - identify process inefficiencies
  - detect synergies
  - optional/if needed: develop a (better) software to manage and optimize the car pool of that branch
  - service orientated holistic approach

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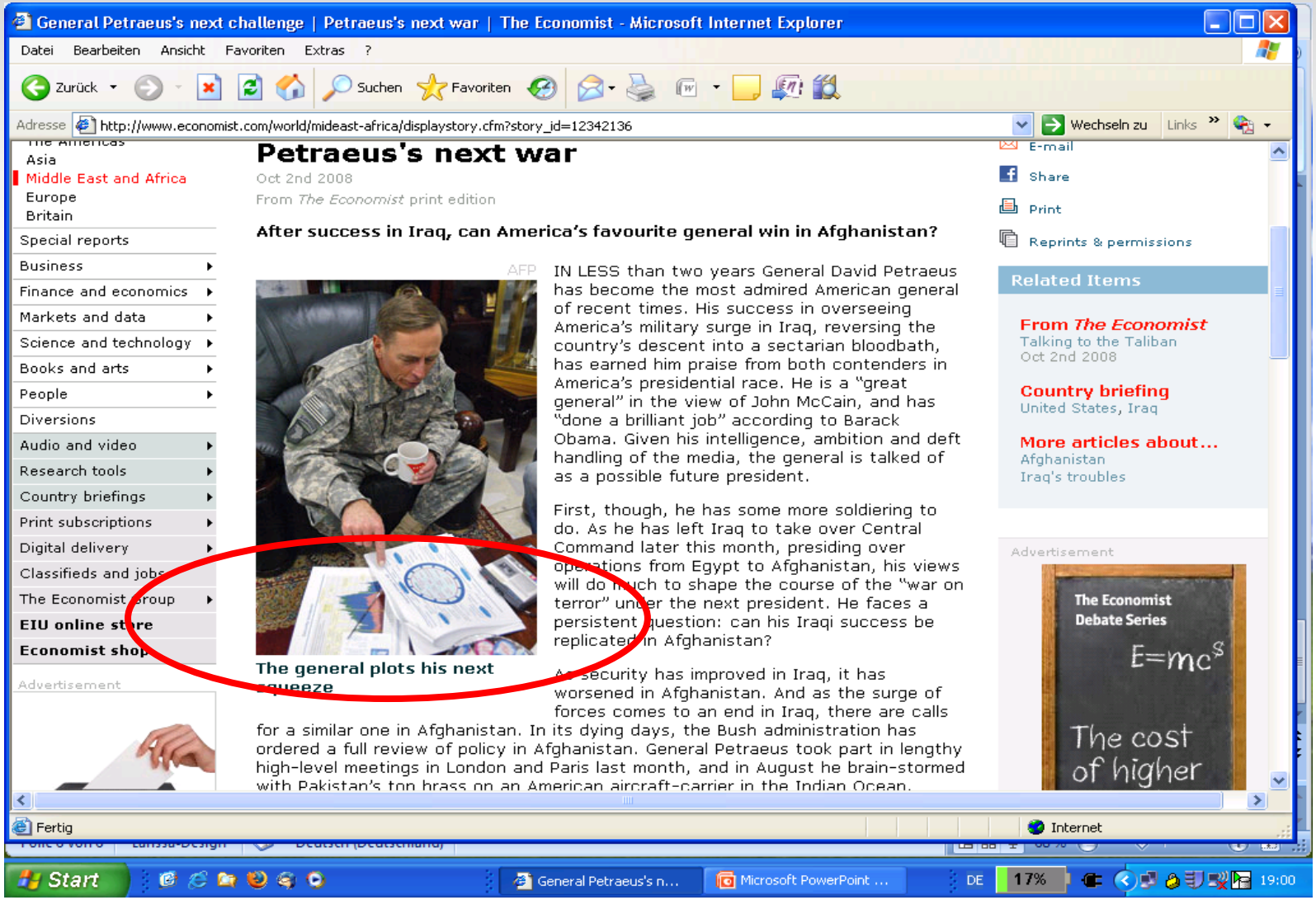


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# car pool details

- about 150 cars of different types and classes in the base pool
- about 1000 different driving jobs per month
- base pool populated with long-term-rent (usually two years each)
- peak demand met with short-term-rent (usually half a day up to one year)
- all rents with a range allowance (extra payment for overcharge,

  refund for not exploiting the allowance)

# status quo

- some opinions on the existing software from military experts:
  - *„Results are neither consistent nor targeted.“*
  - *„Instead of making savings possible, the software suggested excess expenditure of 50%.“*

- software problems:
  - software is not fit to the specifics of the users daily needs
  - quality of data is poor
  - used algorithms are not accessible (black box)

# status quo

- process problems:
  - long cycle times of requests to get a car
  - several media breaks
  - redundant actions and data

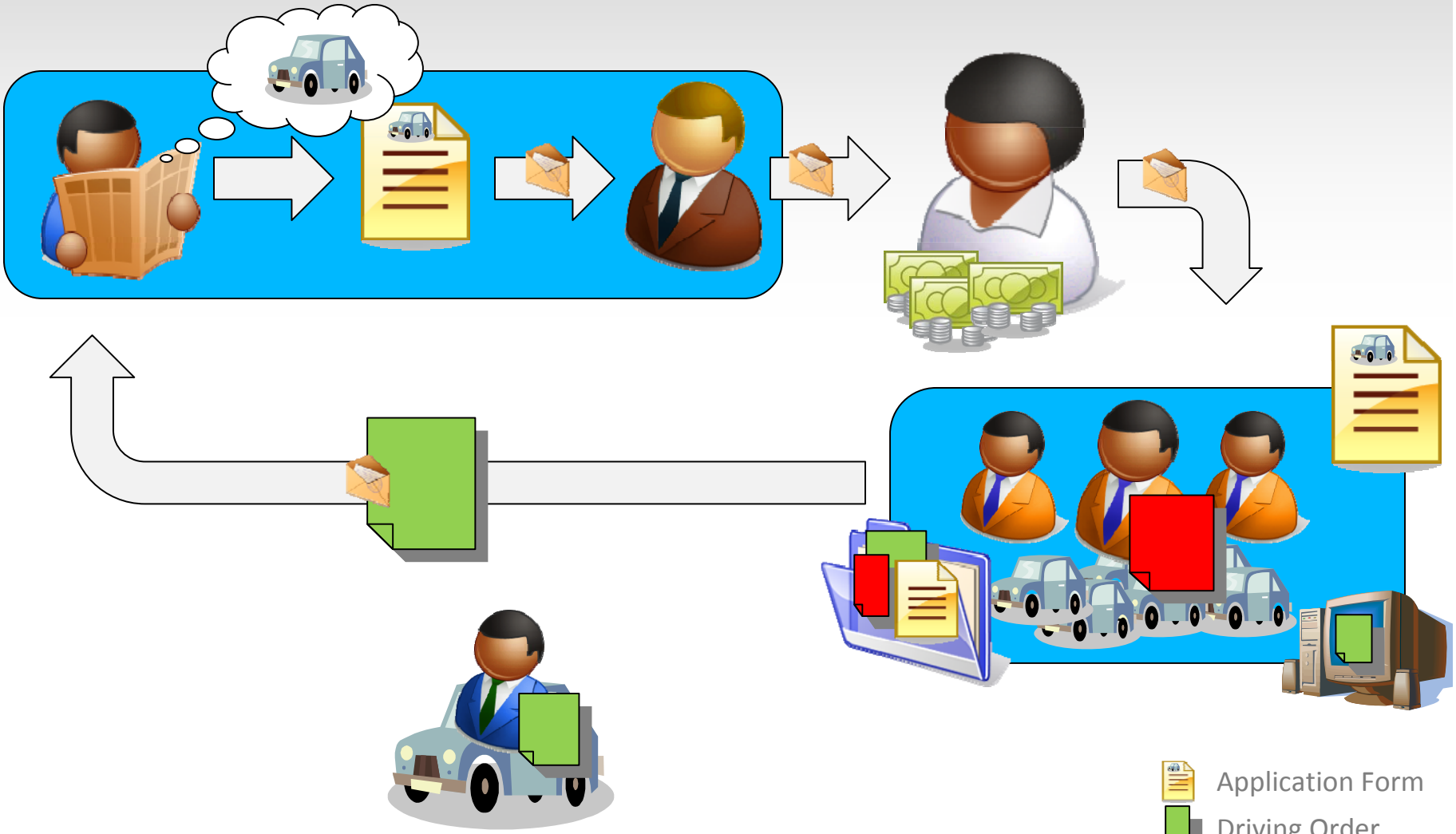
# optimization questions

- Where can the process be optimized?
- How can workload (driving jobs)  be predicted?
- Whats the optimal matching of cars to the driving jobs?
- Whats the optimal mix of short-term vs. long-term?
- What means “optimal” in this context?
  - Total cost?
  - Cost per time frame?
  - Service?
  - Quality?

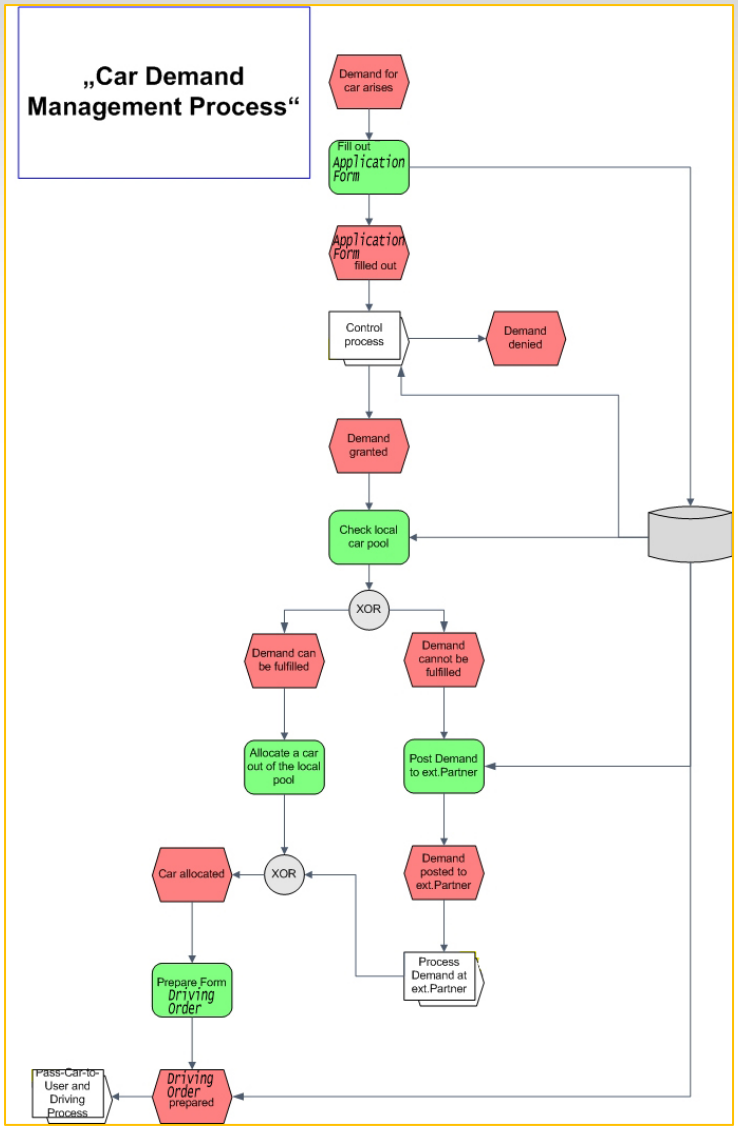
1st Approach:

# optimization on process level

# process so far



# process modeling

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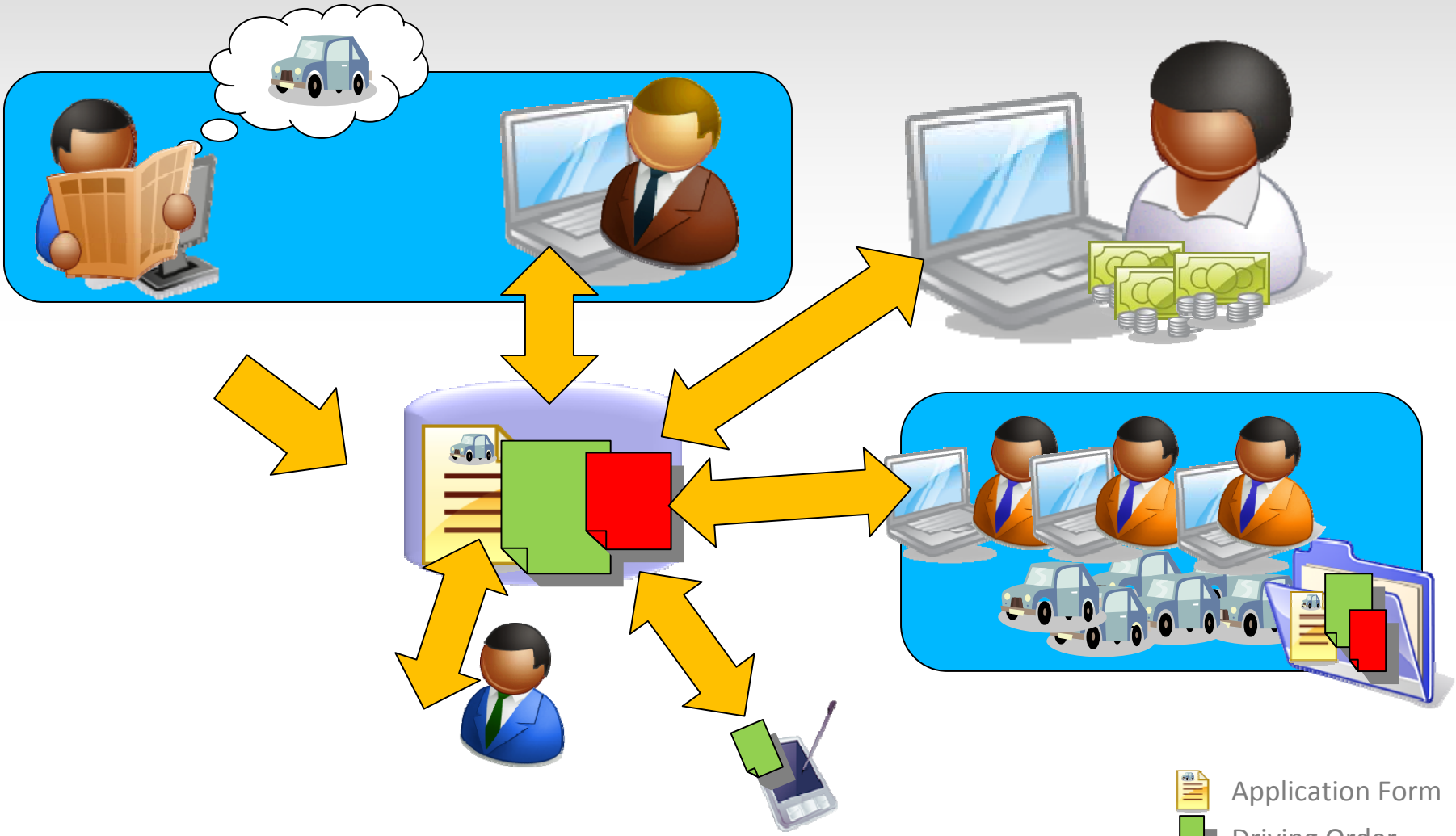
# optimized process



# optimized process

results of the optimized prosess:

- higher process quality
- shorter cycle times for requests
- less errors and mistakes
- no media breaks
- better data quality
- cost reduction

# 2nd Approach
# optimization on decision level

# cost of the car pool

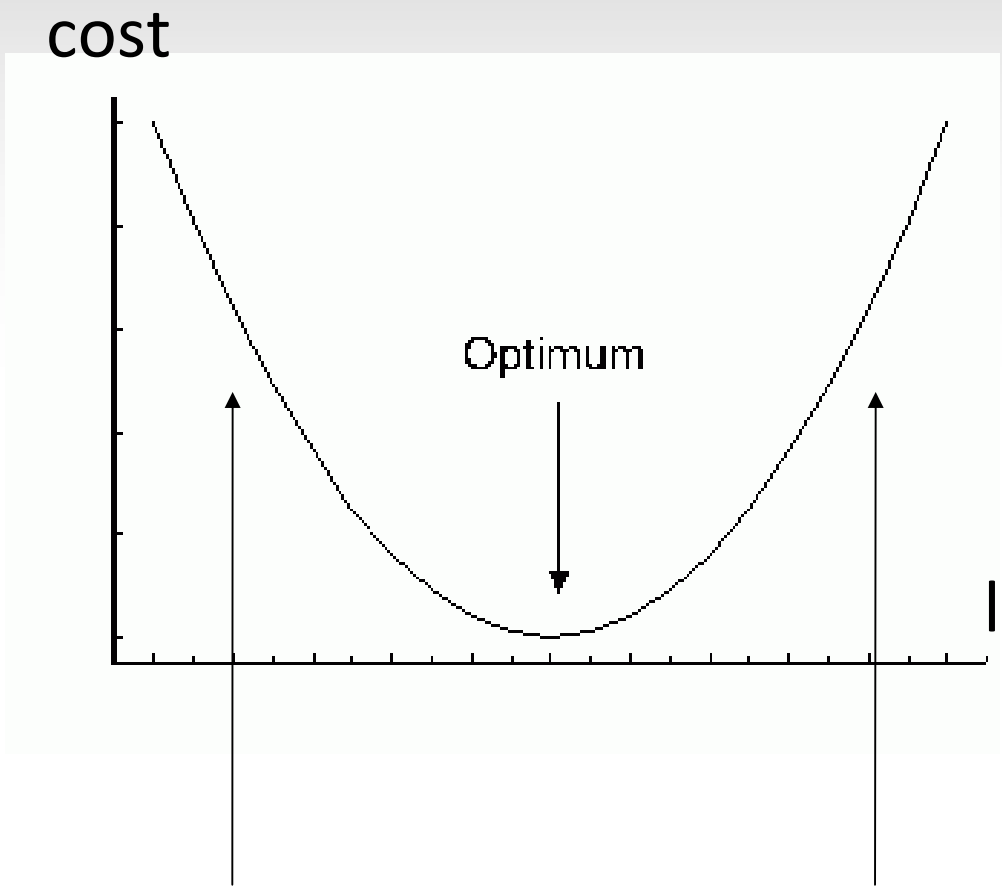
easy approach:

- car pool = long-term + short-term

→ therefore

- cost = fixed cost (long-term)
  + life cycle cost (short-term, fuel, repairs, ... )

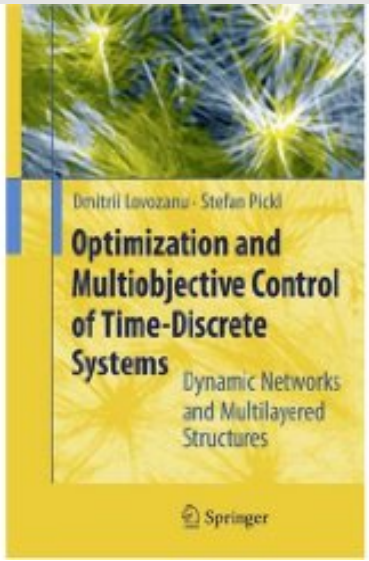
# Whats the optimal „OR“-mix?



# How to find the optimum?

naive approach:

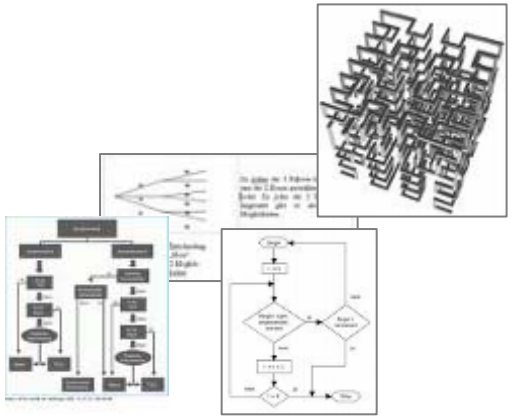
- predict the future workload (driving jobs)
- enumerate all options to deal with the future workload
- calculate the cheapest option



# Problem 1

"It's hard to make predictions –
especially about the future."

--Robert Storm Petersen



# Problem 2

There are  just too many options.

(really) small example:

five cars in the pool and ten driving jobs result in over 4.8 billion possible combinations to check

Formula:

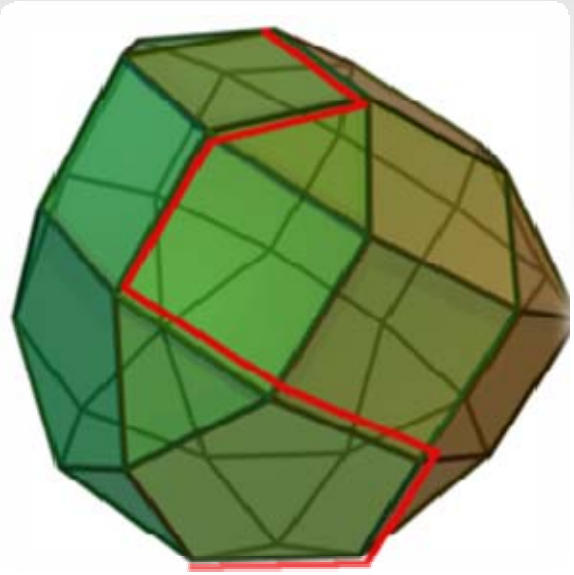
F: p

$$\sum_{k=0}^{n} \left[ \frac{1}{k!} \cdot \sum_{i=0}^{k} \left[ (-1)^i \cdot \binom{k}{i} \cdot (k-i)^n \right] \cdot (F+1)^k \right]$$

# Optimization

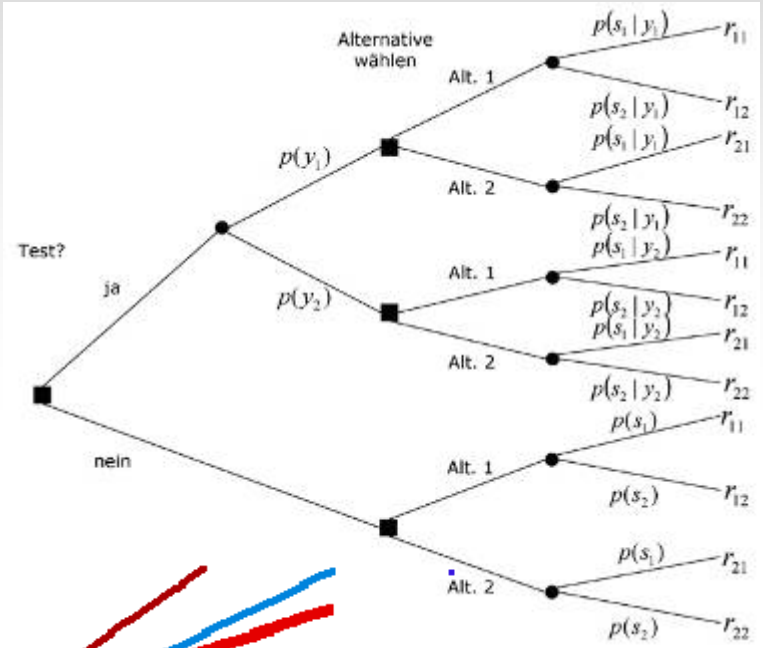
further research needs to develop

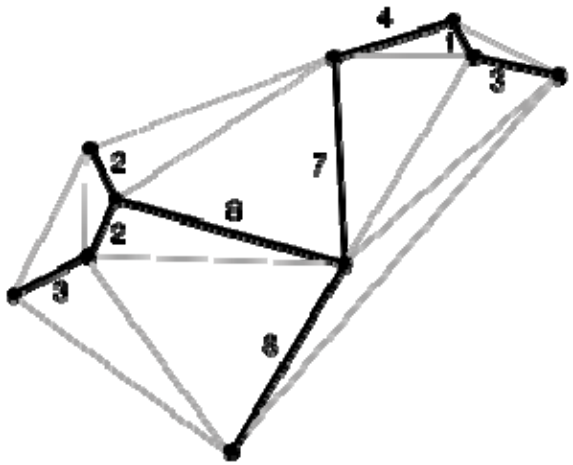
- a suitable mathematical model
  - assignment problem?
  - scheduling problem?
  - packing problem?
  - something else?
- a good and quick optimization approach
  - dynamic algorithm?
  - heuristics?
  - something else?

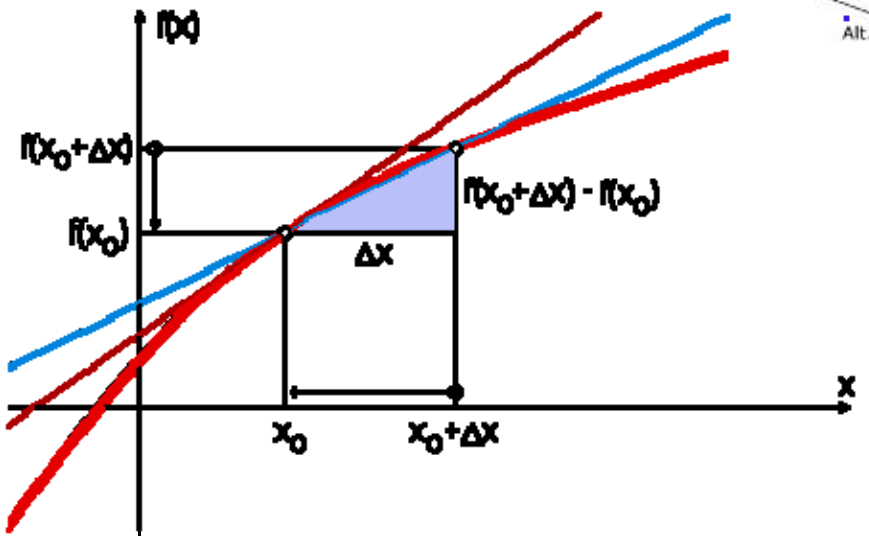


# optimization options

- linear programming
- integer programming
- combinatoric optimization
- heuristics



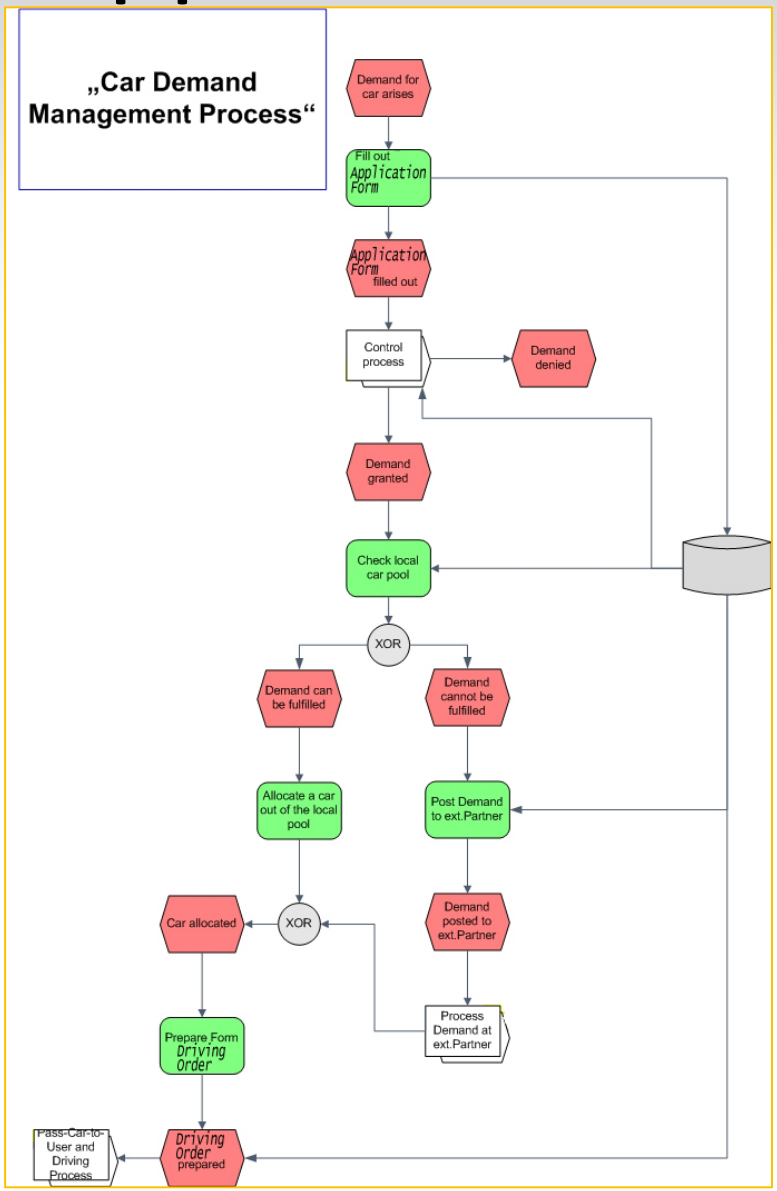



# Service-Oriented Approach

Starting point for

Considerations about SOA:

- *Business Process Level*
- → *identification of* ***Business Services***
- → *Transformation to* ***Web Services***



# Service-Oriented Approach

***Business Services*** that comprise to the "Car Demand Management Process"

- Application Form Handling
  - handles the application form and supports the user in requesting a car by collecting all relevant data including consistency checks etc.
- Controller Service
  - supports the controller in handling the request
- Handling of Local Car Pool Allocation
  - the "intelligent" component that is in charge of a cost efficient and balanced allocation of a car to the given request

# Service-Oriented Approach

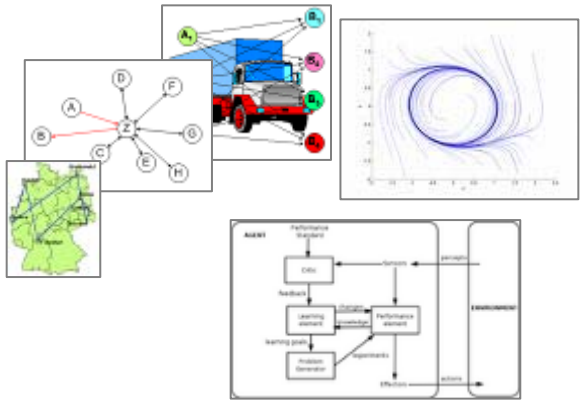
***Business Services*** that comprise to the "Car Demand Management Process"

- Allocation Service to External Partners
  - Involvement of external rental car partners if demand cannot be met
- Form Generation Service
  - WS generates the necessary driving order for the specific request
- Car Handling Service
  - initializes the mobile device with the needed data and manages the data handling of the checklist and trip data (at rental period start and finish)

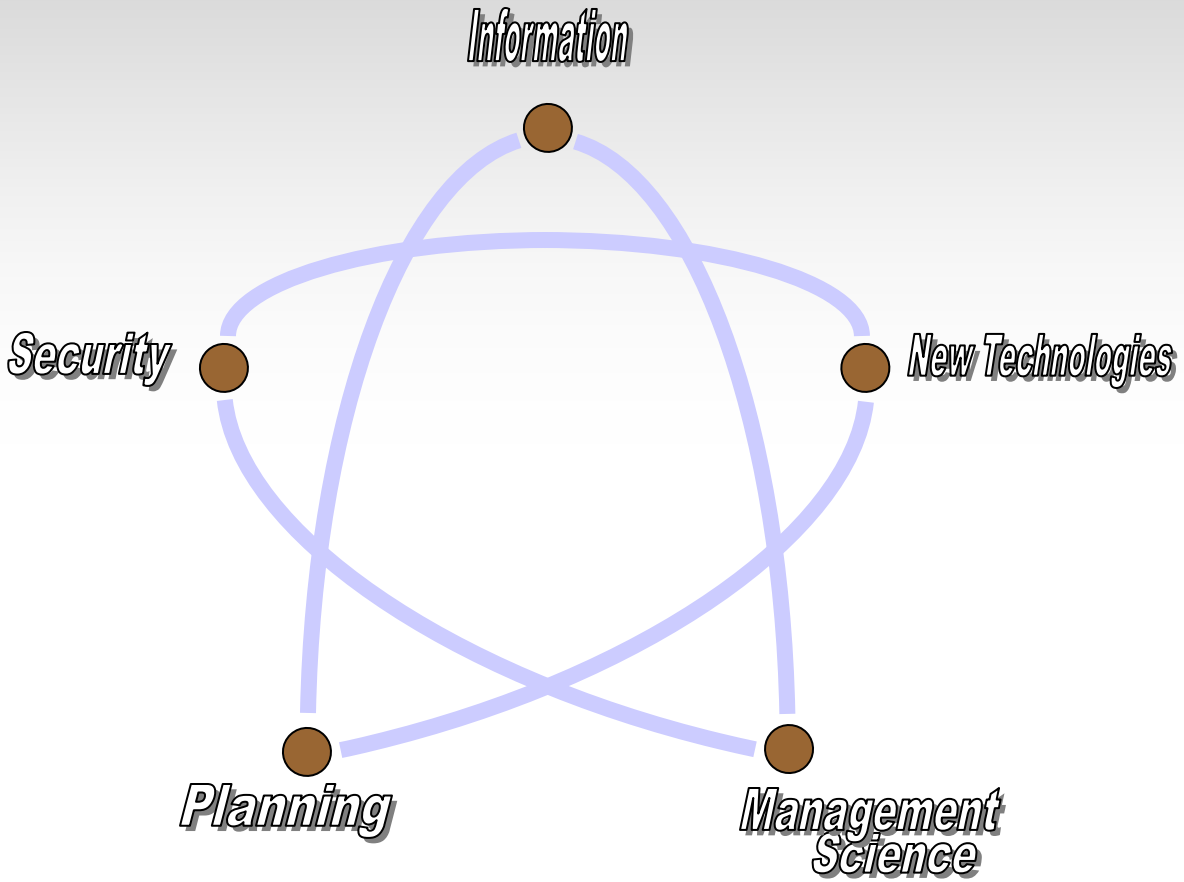
# Service-Oriented Approach

Matching of ***Business Services*** to ***Web Services*** (WS)

- *Application Form WS*
- *Control Process WS*
- *Local Car Pool Allocation WS*
- *External Partner Allocation WS*
- *Driving Order Generation WS*
- *Car Handling WS*



# Process Chain



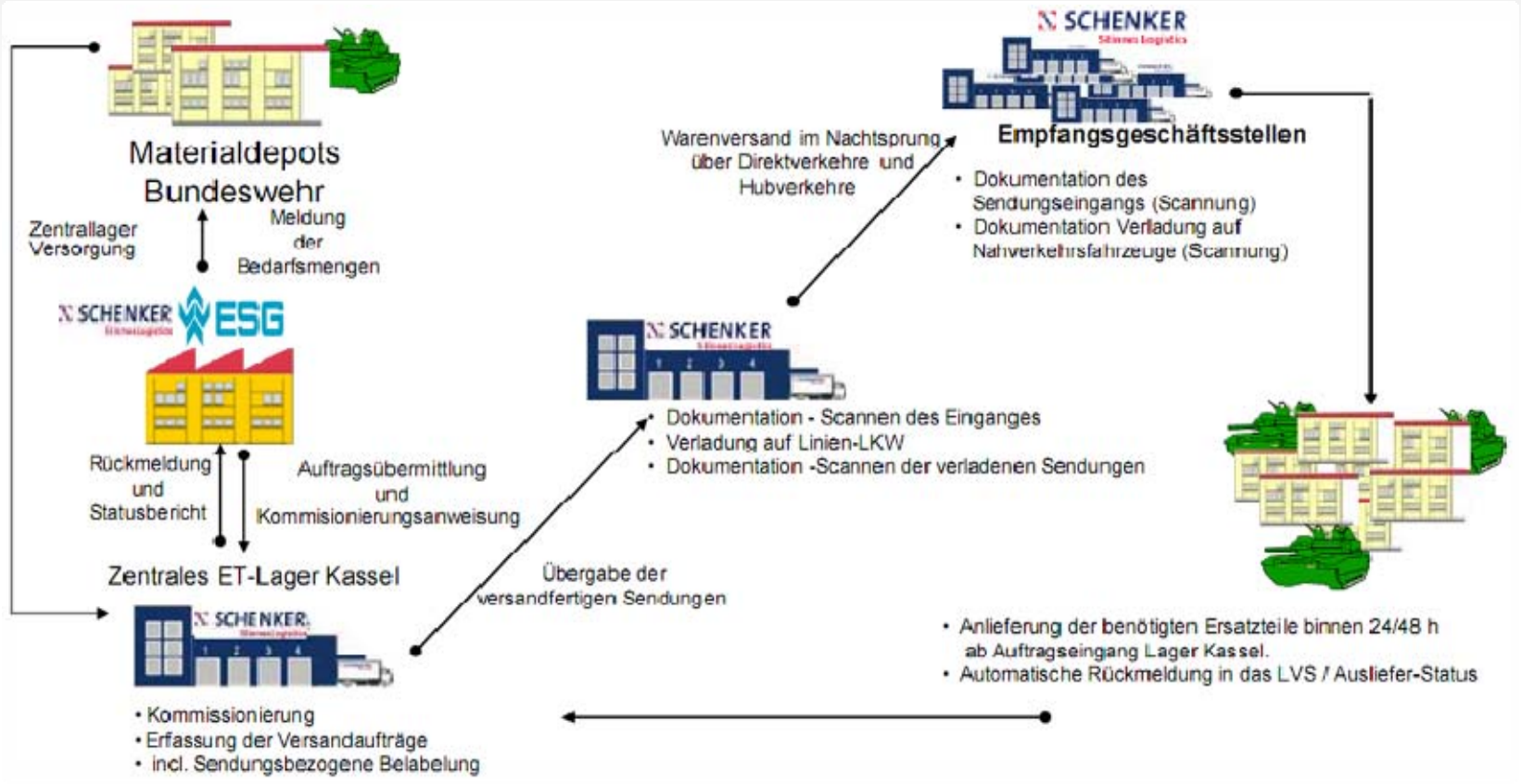
# Service-Oriented Approach

Advantages of SO-Approach:

*A service oriented software approach enables an **agile**, **efficient** and **user-friendly** realization of the described "Car Demand Management Process" and it supports the **flexible adaption** of single services to the demand of the involved organizational units as well as the **integration** of external business partners.*

*Extend: Training and Simulation Facilities*

# Embedded Holistic Solution

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# INVITATION … TO BAVARIA

Merci


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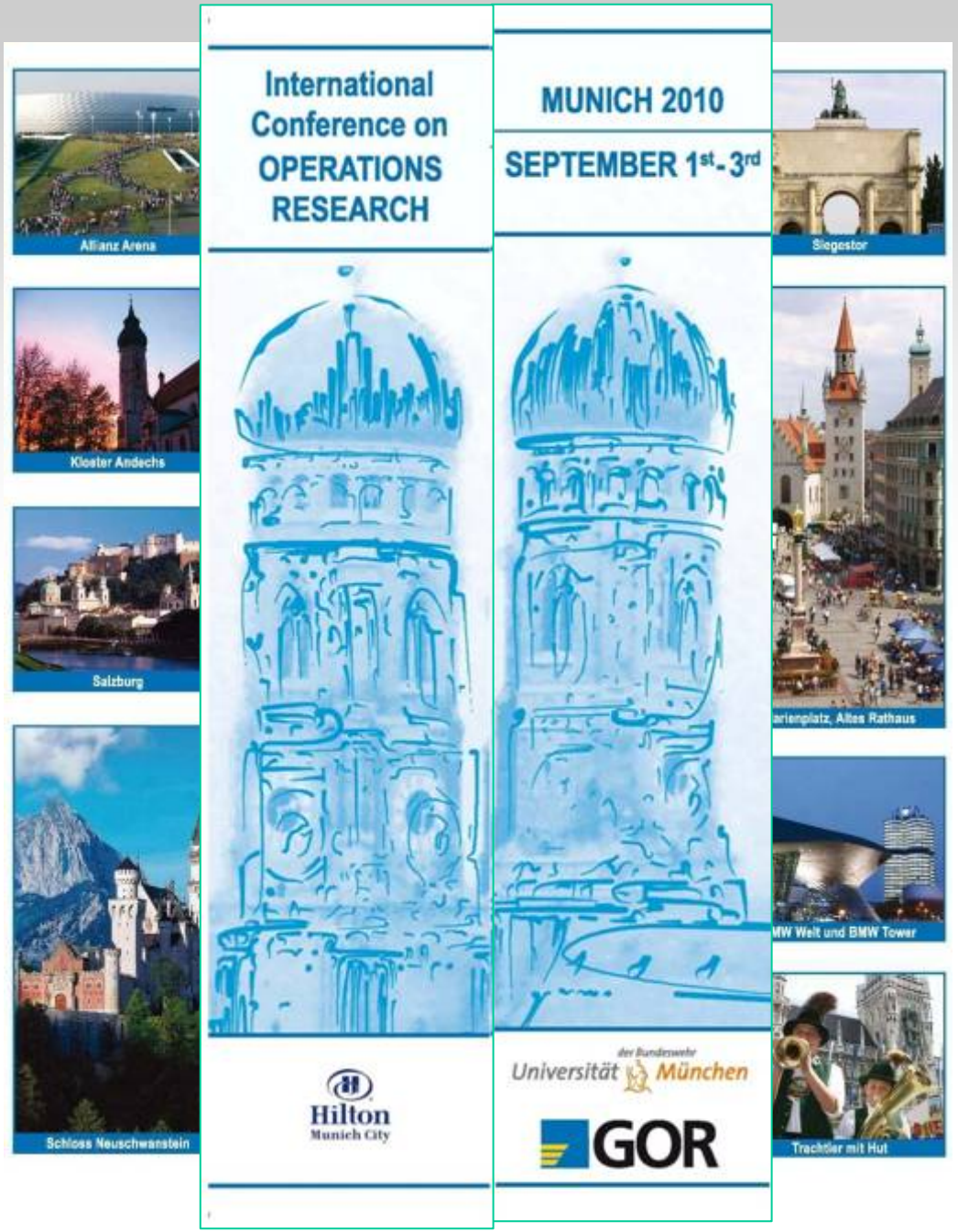


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## MASTERING COMPLEXITY

Complexity is a natural component of the globalization process. Financial markets, traffic systems, network topologies and, last but not least, energy resource management, all contain complex behaviour and economic interdependencies which necessitate a scientific solution. **Operations Research** is one of the key instruments to model, simulate and analyze such systems. In fact, gaining optimal solutions, suitable heuristics and efficient procedures are some of the challenges which will be discussed at the **international OR 2010.**

## WELCOME TO MUNICH

Often called "the Florence of the Alps", this metaphor symbolizes Munich's unique architecture and hospitality, similar to Italy's renowned flamboyant spirit and cultural contributions. The forthcoming conference "**Mastering Complexity**" takes a new look at this Italian influence in Bavaria, while reinforcing the special cultural relationship. Indeed, Italian researchers have now become embedded in the scientific program of **OR 2010.** Guests might notice the Italian flavour if they attend the social program with our guests from the Italian Operations Research Society.


Allianz Arena


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# *Mastering Complexity*

## SELECTED TOPICS

I.1 Forecasting, Data Mining and Machine Learning
I.2 Game Theory and Experimental Economics
I.3 Finance and Managerial Accounting
I.4 Revenue Management and Pricing
I.5 Quantitative Models for Performance and Dependability
I.6. Business Informatics, Decision Support Systems and Artificial Intelligence

II.1 Traffic, Transportation and Logistics
II.2 Discrete Optimization - Graphs & Networks - Stochastic Programming
II.3 Linear, Nonlinear and Vector Optimization
II.4 Production and Service Management
II.5 Supply Chain Management & Inventory
II.6 Scheduling and Project Management

III.1 Land/ Ressource and Environmental Management
III.2 Energy and Climate
III.3 Health Care
III.4 Multiple Criteria Decision Making - Metaheuristics
III.5 Simulation and System Dynamics - Modelling Languages
III.6 OR in Life and Human Sciences: Trends, History and Ethics


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