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Applications of Organic Computing - An Industrial View

Rudolf Kober
Siemens AG, CT IC 6
Intelligent Autonomous Systems
rudolf.kober@siemens.com

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Vision for System Architecture > 2010

AIFB

- Organic Computer Systems
  - will possess lifelike properties.
  - will consist of autonomic and cooperating sub systems and will work, as much as possible, in a self-organised way.
  - will adapt to human needs,
  - will provide customized service in a user-friendly way
  - will be trustworthy.

- Self-organisation **allows for adaptive and context dependent behaviour:**
  - self-configuring
  - self-optimizing
  - self-healing
  - self-protecting
  - self-explaining
  - …

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Applications of Organic Computing - An Industrial View

Strategic Visioning at Siemens: „Pictures of the Future“

Application Areas of Organic Computing

1. Service
2. Information&Communications
3. Automation&Control
4. Transportation
5. Power

Conclusion

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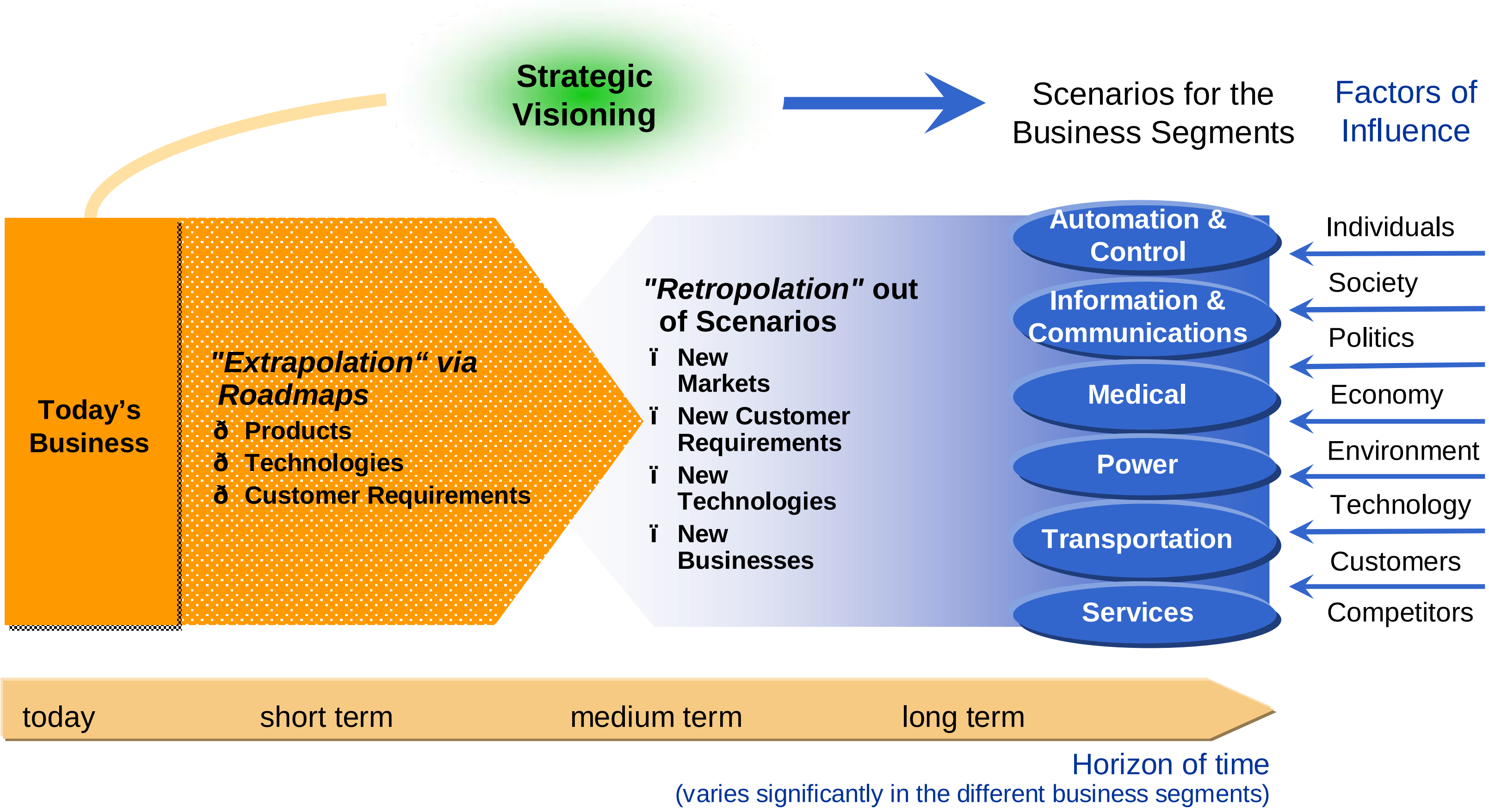
Strategic Planning of Technologies & Innovations



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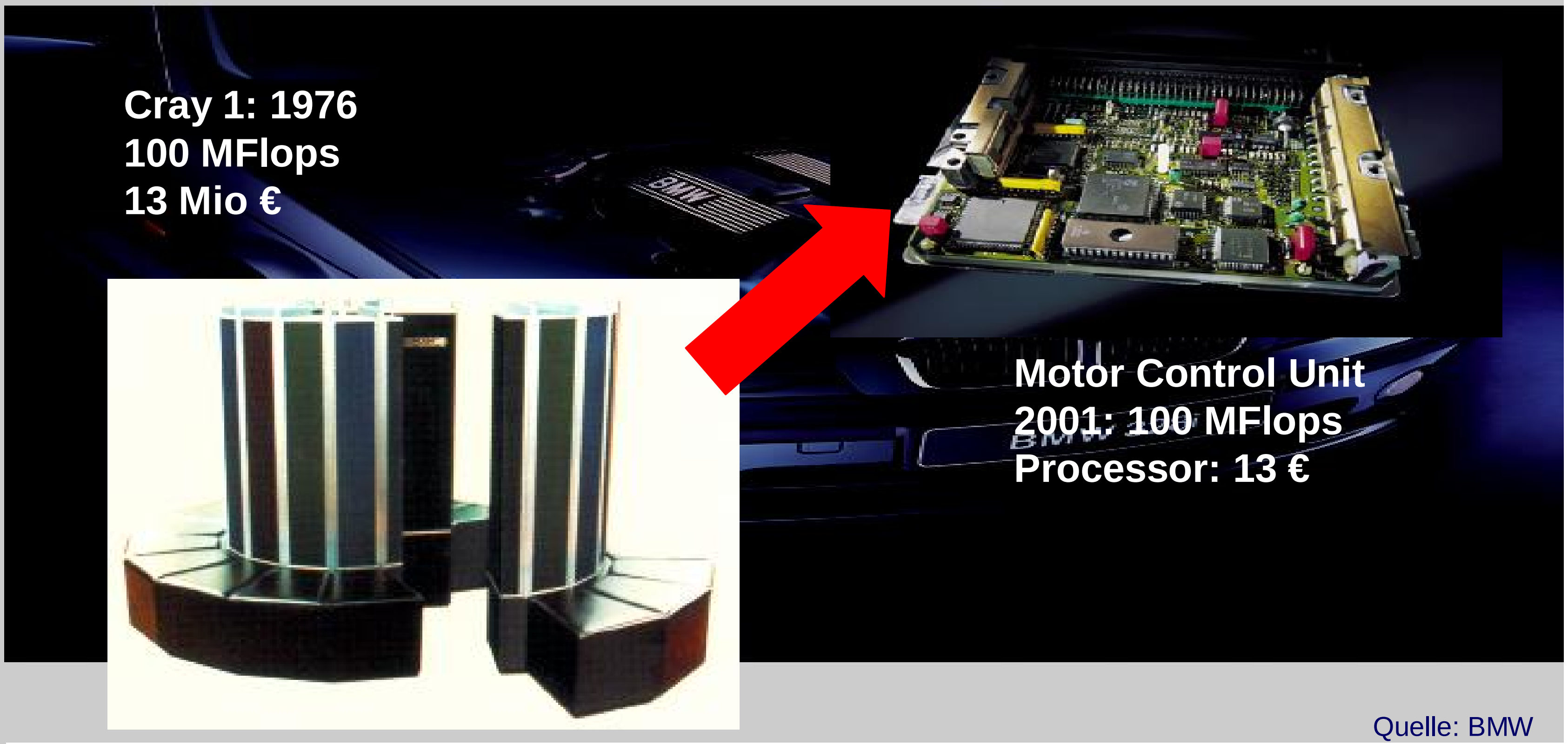
Driving Force: Microelectronics. The Computing Power Increases and the Price Decreases



Quelle: BMW

Driving Force: Software Technologies

The Importance of Software

- An increasing part of system functionality will be realized in software
- Up to 80% of the R&D-expenditures for the development of I&C-systems will be spent on software

Status

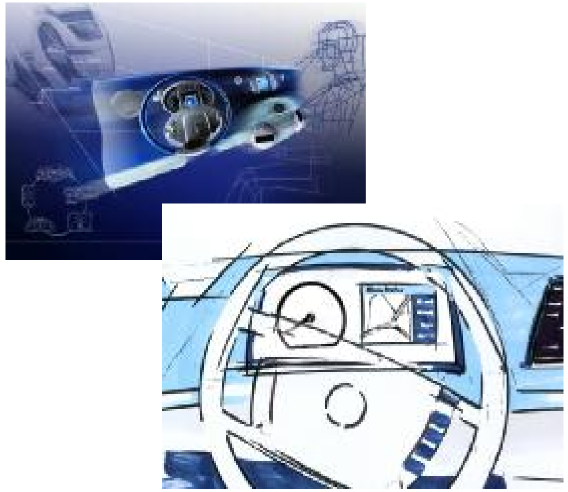
- Optimized software development processes
- Architectures for application frameworks and the reuse of software components
- Component based software development
- To some extent Aspect Oriented Programming
- Verification of software components

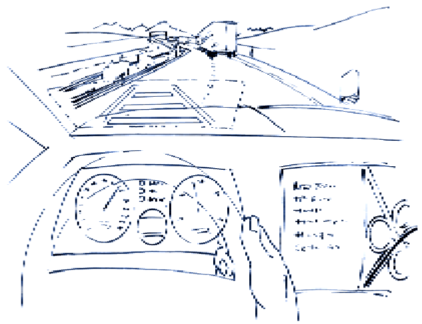
A Consequence: The Functionality of Systems Will Be Determined by Software. Example: Car

Cars 2010 – Networked in the Future

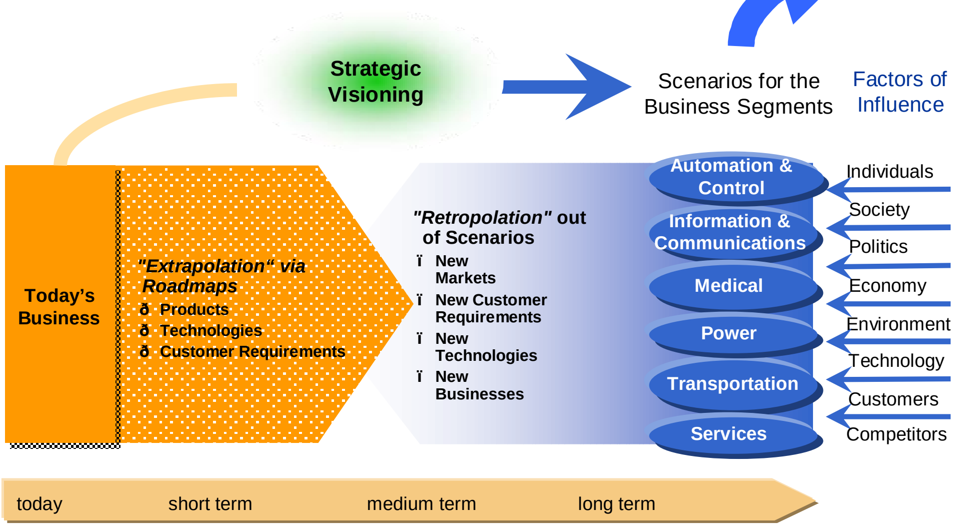
Today cars have up to more than 80 disconnected electronical systems and components. According to a forecast all of them could be networked in 2010 . Their functionality will be determined only by software.

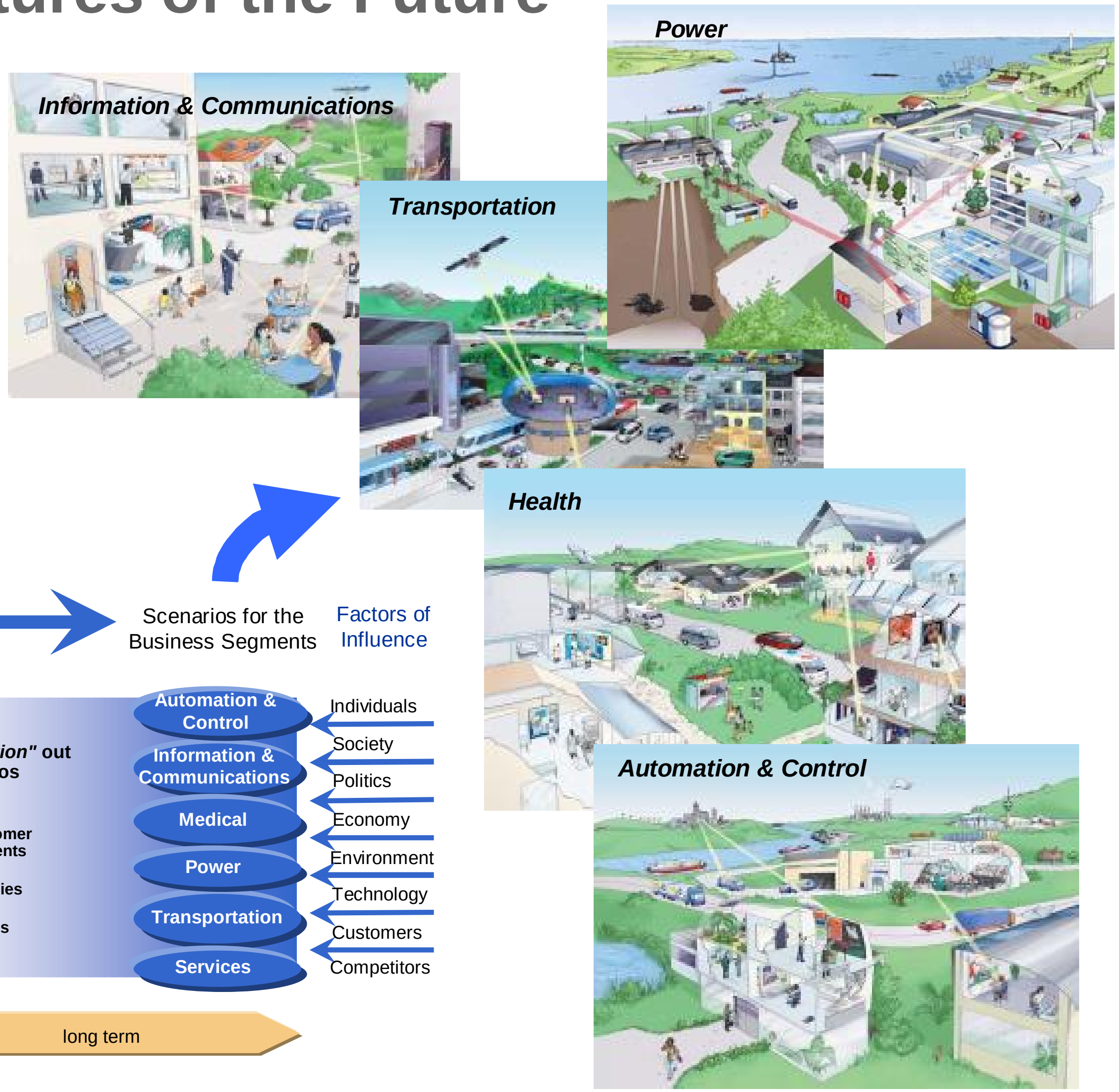
Quelle: Automobil Produktion 15.02.2004





Scenarios: “Pictures of the Future”





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Cleaning Service

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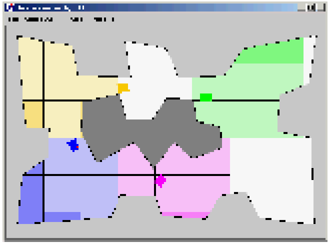
Example for Self-organization in Distributed Systems: Cooperating Cleaning Robots

- **Cleaning of large rooms, by using multiple robots (airports, train stations, hospitals, ...)**

- **Tasks:**
  - The area must be partitioned among the robots

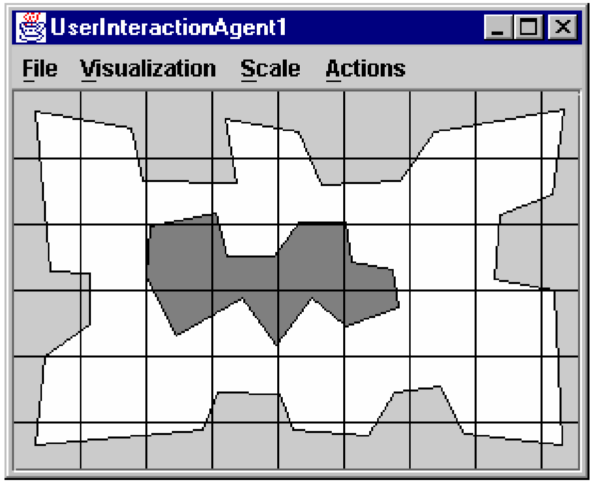


  - Paths for complete coverage must be planned
  - Collisions must be avoided

- Assumption:
  - The robots can communicate, but only locally (the communication range is limited)

Task Partitioning (1)

- **The area to be cleaned is divided into cells of similar size**



- **Robots allocate and clean cells**
  - Robots reserve and allocate cells in advance
  - Allocation strategy looks for compact areas

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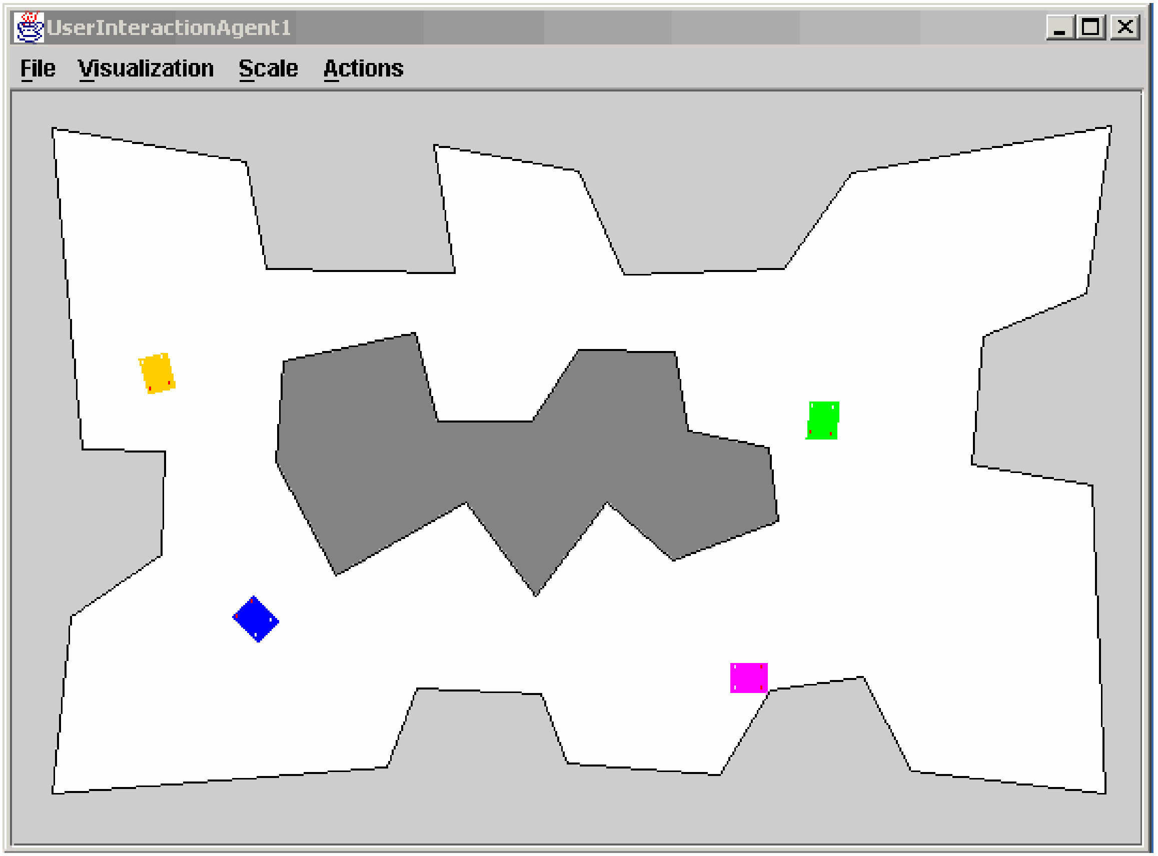
Task Partitining - Demonstration (1)



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Task Partitioning (2)

- **The robots have limited communication radii. Therefore they have only a „local“ view.**
- **When the communications radii of two robots intersect the robots communicate which cells have already been cleaned and which ones still need to be tackled (white area).**
- **The strategy is designed to avoid redundant work.**

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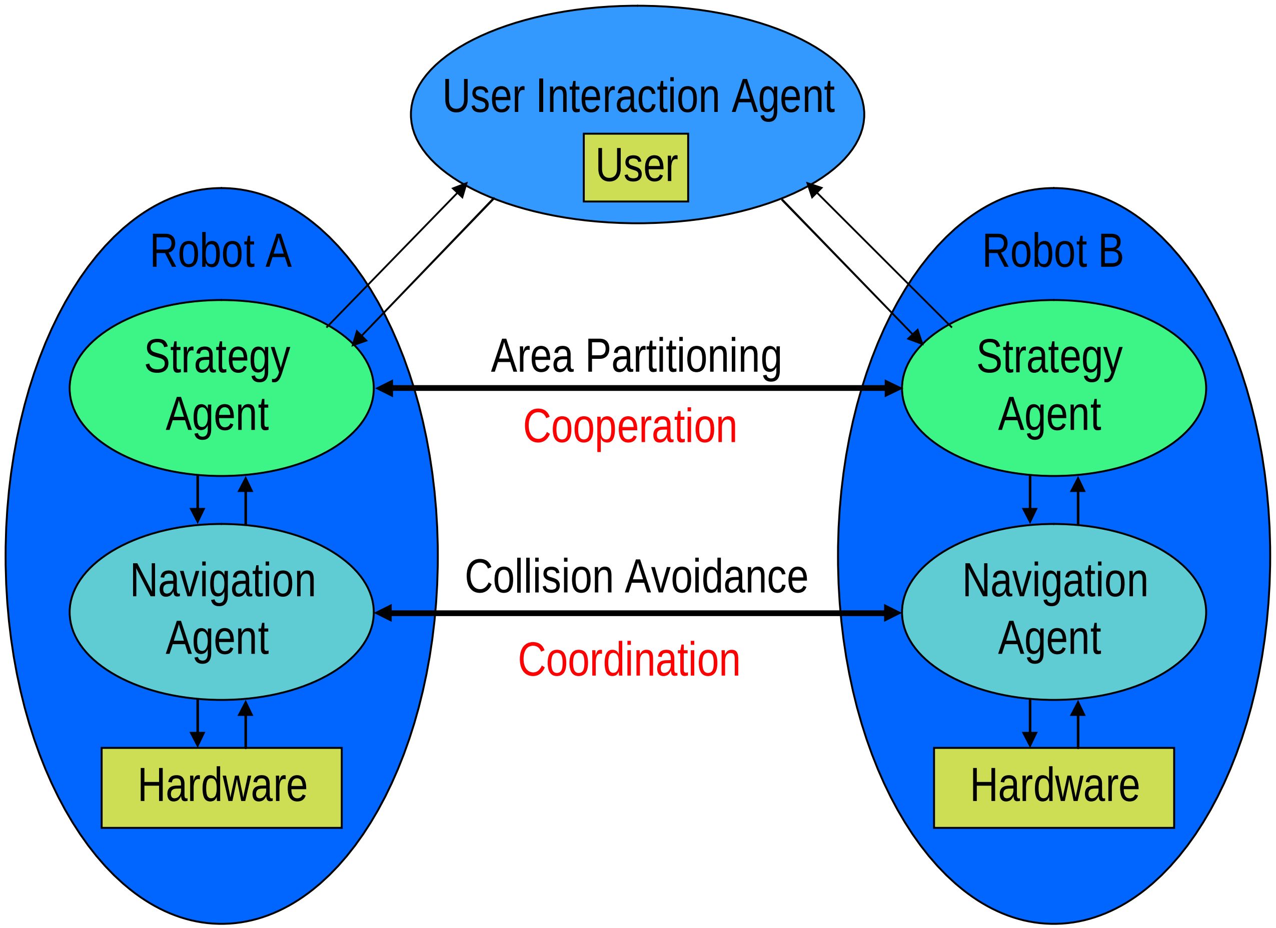
Cooperating Robots: Software Architecture



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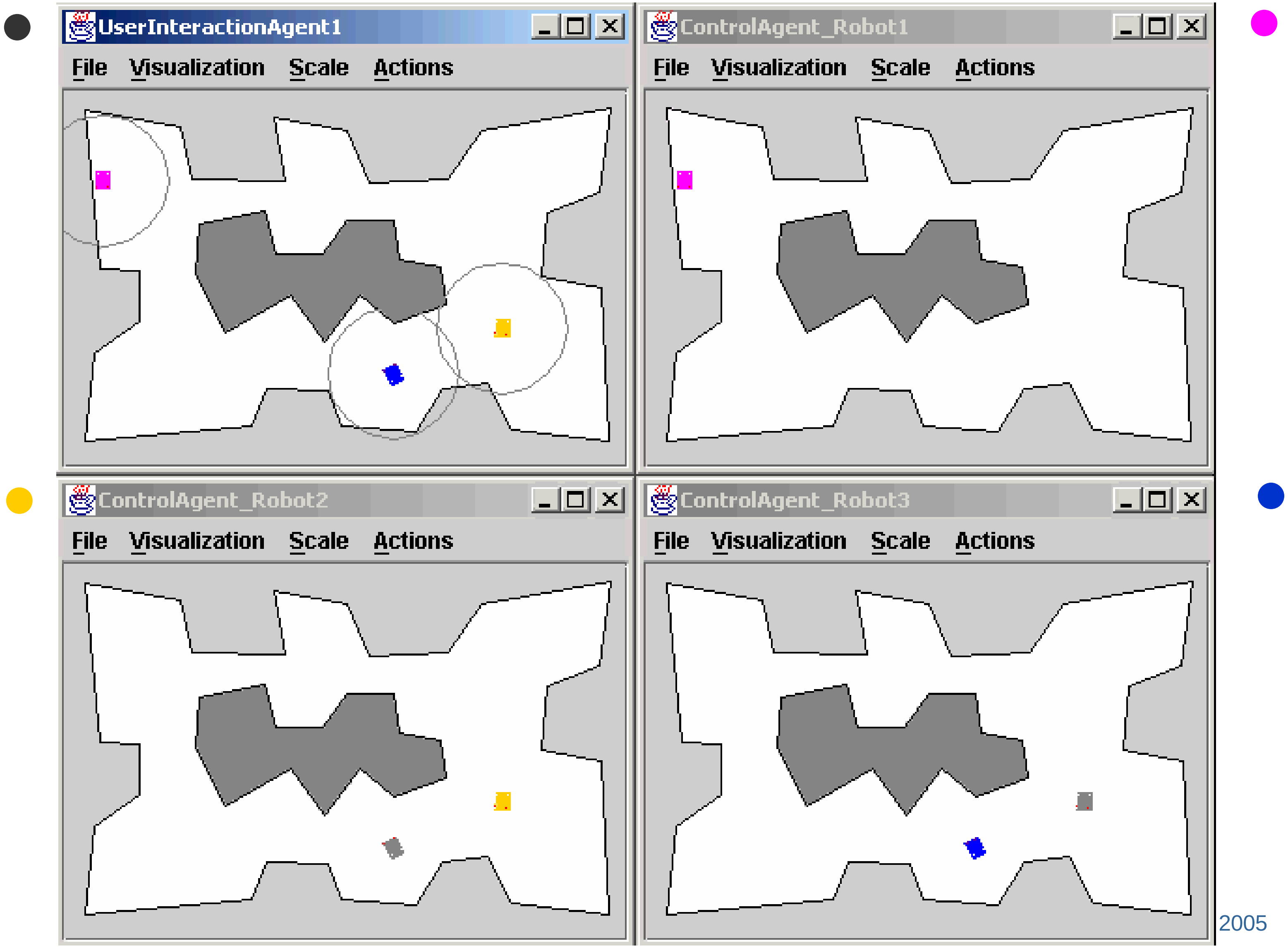
Task Partitioning - Demonstration (2)



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Experimental system

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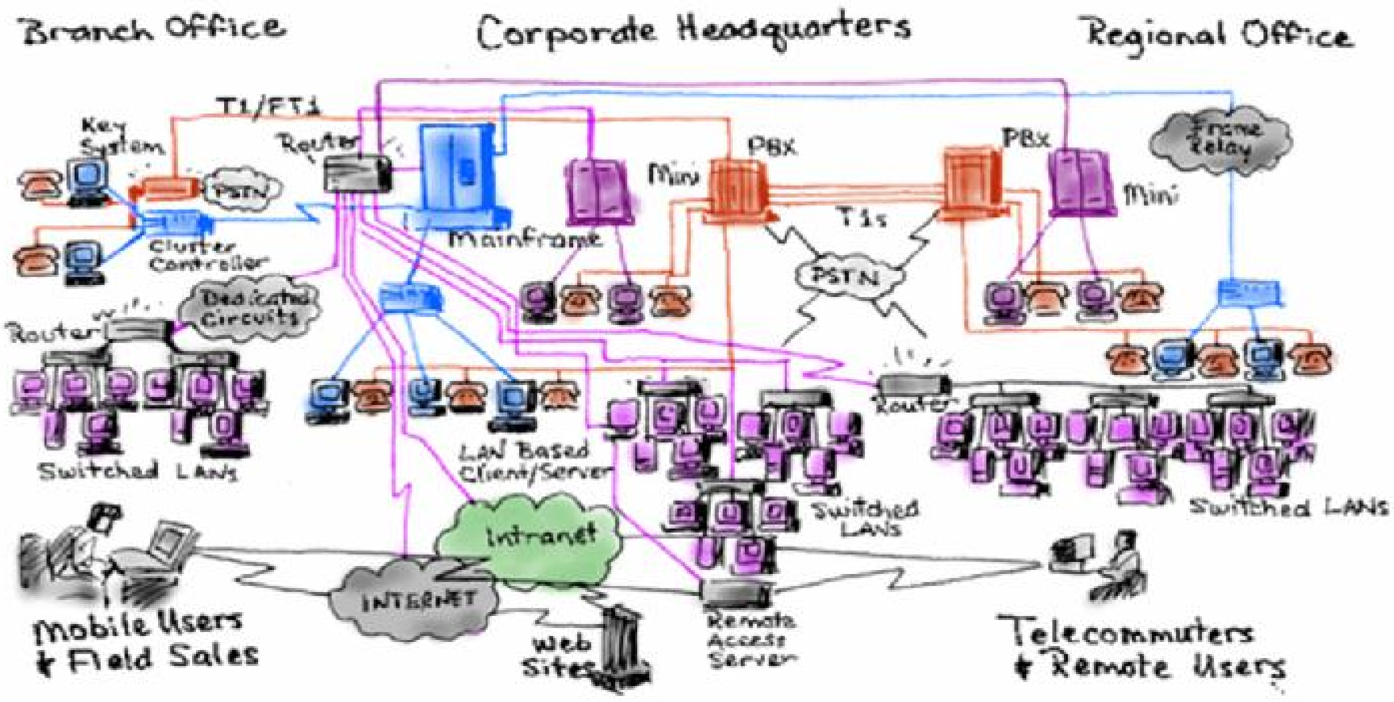
The situation today:
complex, inflexible and expensive IT infrastructures



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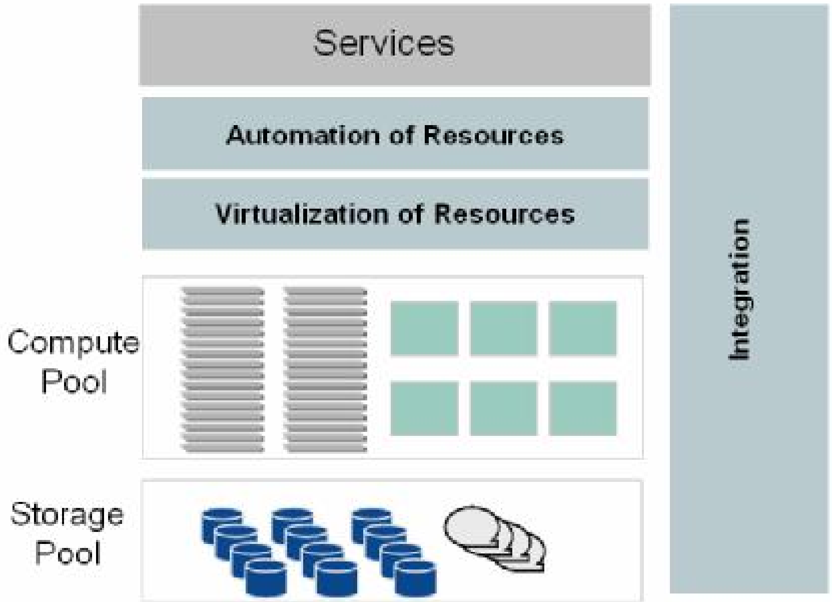
The ideal IT: the Dynamic Data Center (DDC)



The dynamic data center

- service-centric
- IT-systems are pooled and shared for best usage (virtualization)
- IT resources are automatically allocated to services (automation)
- all building blocks are seamlessly integrated

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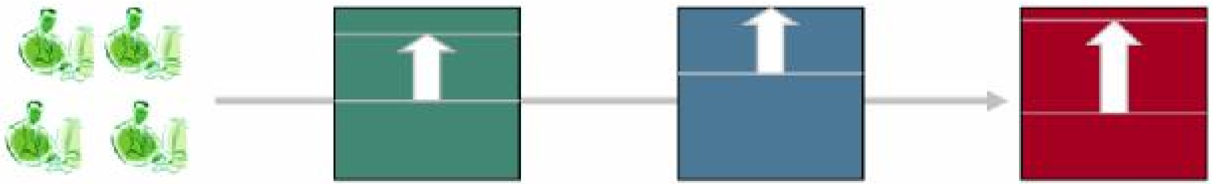
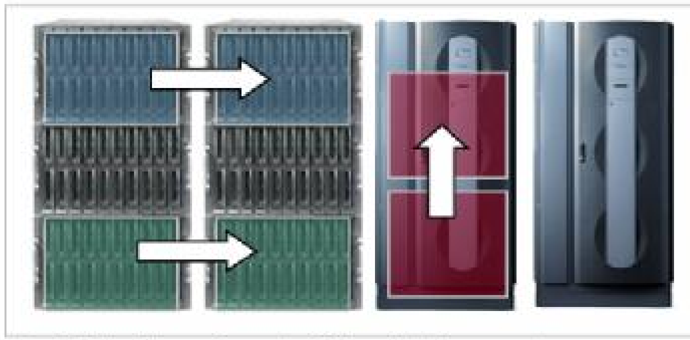
How to build a dynamic data center with TRIOLE™ ? An example (1/4)

- a special offer of a web-order company increases the workload of the web-, SAP order-processing- and data-base-services



- additional resources are allocated dynamically to these services



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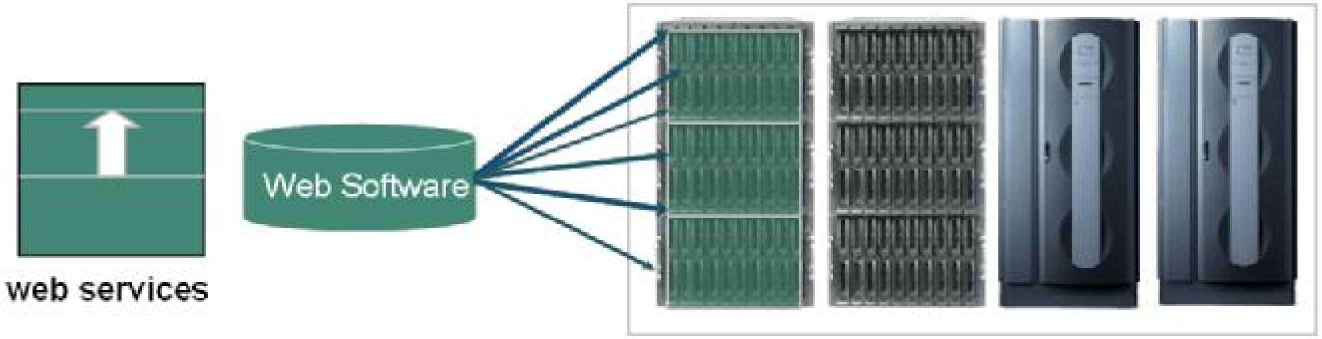
How to build a dynamic data center with TRIOLE™ ? An example (2/4)

- With the help of the Adaptive Services Control Center (ASCC) and RemoteDeploy additional PRIMERGY blade servers are loaded with web server software
- this is totally automated, depending on the workload
- server with applications of lower priorities get re-deployed



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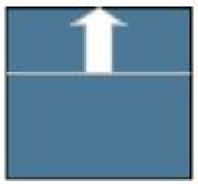
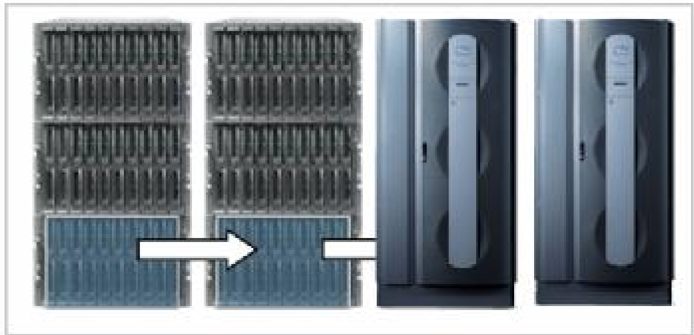
How to build a dynamic data center with TRIOLE™ ? An example (3/4)

- With FlexFrame from Fujitsu Siemens Computers every SAP services can run on every server
- needed SAP services are started on demand on a server
- the software is located on a central storage unit and is remotely booted via the network
- a SAP service becomes available on an additional server within a few minutes



SAP order processing services



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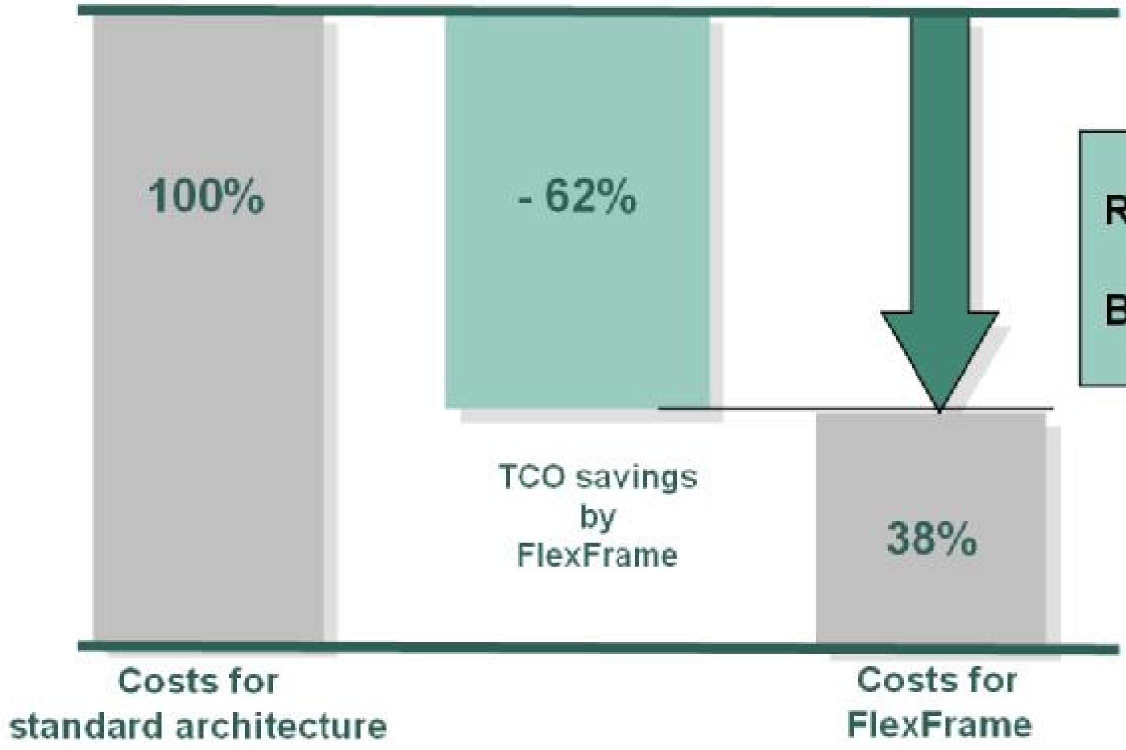
FlexFrame: Average results of the TCO/ROI evaluation by BearingPoint based on customer interviews



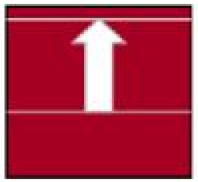
ROI:	168%
Break Even:	1,6 years

Calculation is based on a 3 year time period

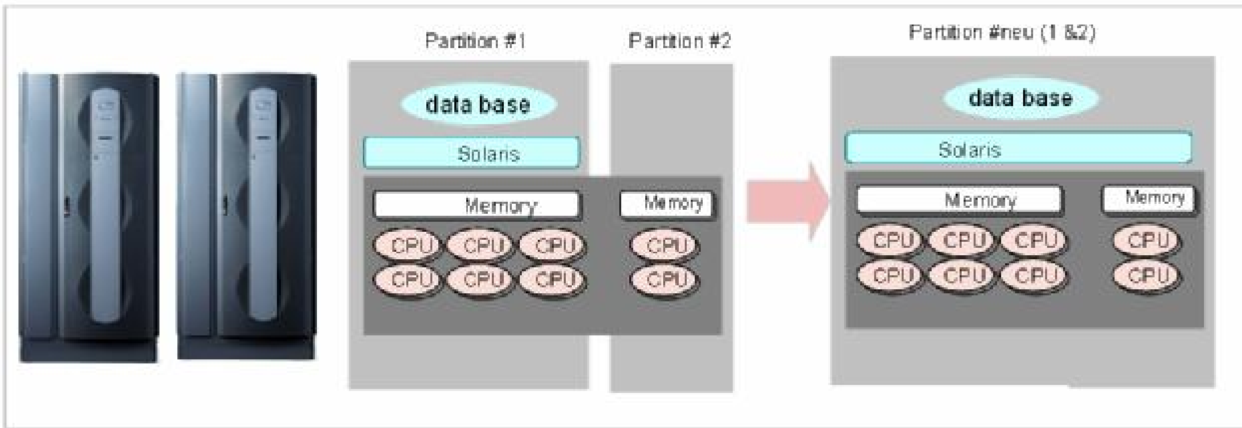
How to build a dynamic data center with TRIOLE™ ? An example (4/4)

The PRIMEPOWER server architecture allows a dynamic shift of resources without interrupting the server operation

This allows to combine dynamic resource allocation with mainframe class robustness for high service level agreements



data base services



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Advantages of a Dynamic Data Center

- Higher utilization of resources through a flexible allocation of services to available systems
  - reduction of costly buffers for peak loads
- Automatic reaction to failures or peak loads enhance the quality of service
  - ad-hoc availability of all necessary specialists to manage a crisis situation is often not given
- Reduction of administration efforts frees resources for new IT projects
  - more time for introducing innovations to strengthen the competitiveness of the organization
  - allows a faster adaptation of IT to changing business processes

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TRIOLE's way ahead: increasing the business value of IT

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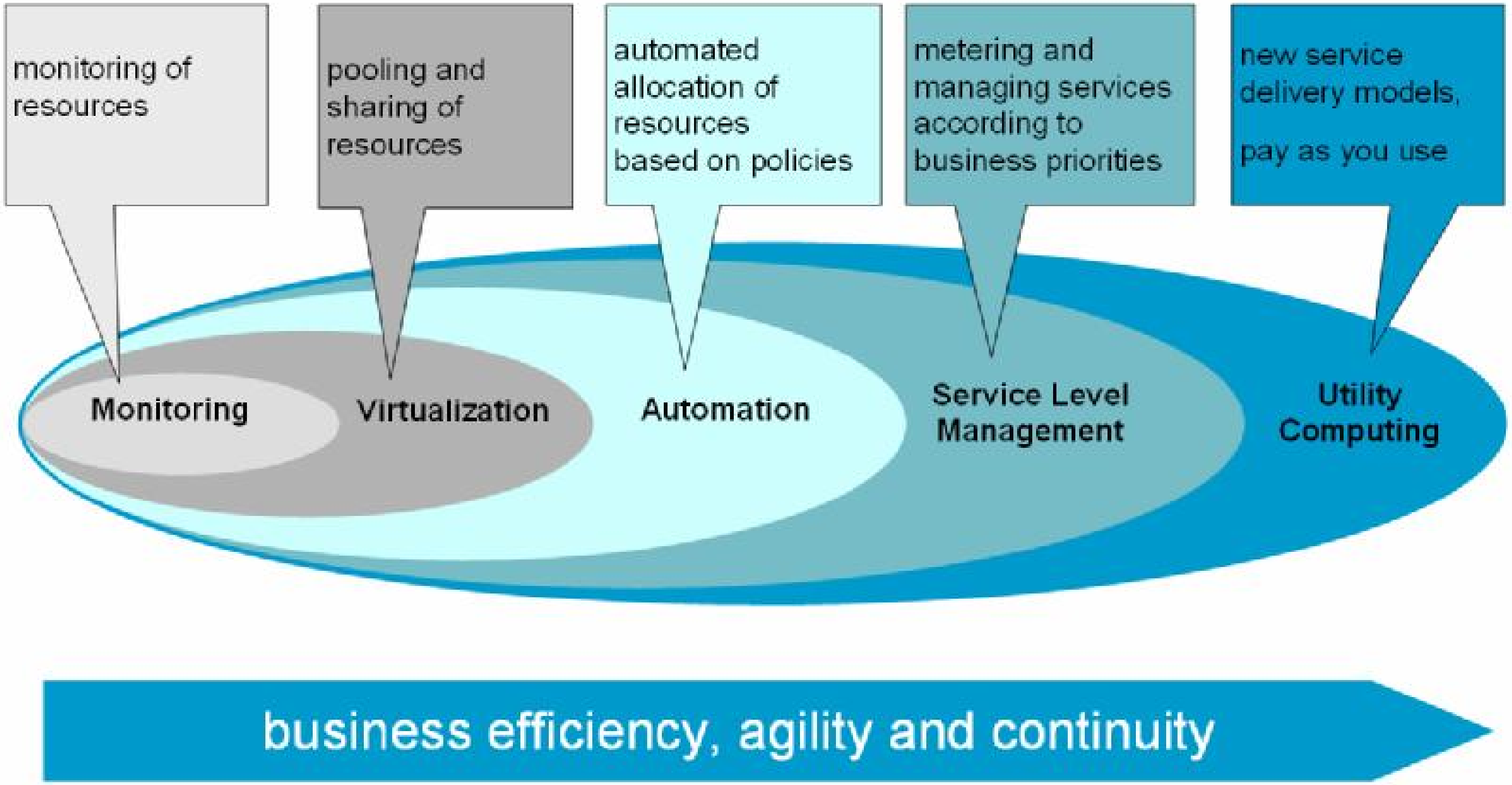

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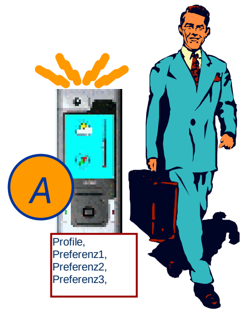
at work



at home

Organic Computing for Smart Environments

in the bar

on the move

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Intelligent Assistance: Development Steps

Glow Tags (Philips)

Glow tags

- **trigger personal memories**
- **are tiny computers listening to information flows in the home**
- **glow whenever they notice a connection betweeen a current event and the facts they store**

Intelligent Sportswear (Philips)

- High-performance sportswear can incorporate embedded technologies that combine
  - audio features with
  - body-monitoring
- Integrated biometric sensors
  - pulse
  - blood pressure
  - body temperature
  - respiration
- Data are analysed and displayed to guide sportspeople during training

Intelligent Assistance: Development Steps

Services and Applications
(mobile Office, e-Home, Community Support, ...)

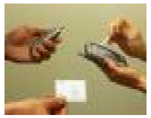
Ubiquitous Computing
(Sensors, Actors, Devices, Communication, Integration)

Context Awareness
(Context Processing, Personalization, Synchronisation)

Smart Environments
(Intelligent Behaviour, Adaptiv, Proactive, Situational)

Smart WebServices
Proactive Assistants in Mobile Devices

Jukebots
Adaptive Personalization and Collaboration

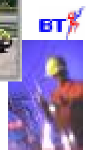


BlueLooxCar/Invent/FioSpace
Smart Environment in Cars

DataSync
Standardized Content Synchronization

Smart Avatars
Animated Personal Assistants

map (BMWA)
Adaptive Workflow Assistance



LEAP (EU)
Services for Mobile Teams and Communities

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Adaptive User Environments
Mobile Office -> Car Integration

Objective

- Mobile Office in the car
- Intelligent wireless integration of mobile devices and car equipment, intelligent data transfer

Approach

- Bluetooth, Java, PocketLoox / in-car entertainment unit, own SyncML implementation in Java (HTTP, XML)
- Applications: address and appointment synchronisation; map transmission to mobile device; office documents synchronisation

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juke bots Personal Music Assistant: Influence the atmosphere in your favorite location

- You can have an influence on the atmosphere in your favourite location.
  For example a café.
- Hear what you want:
  Watch your phone making an autonomous vote for you according to your music-taste

- Personal Music Assistant adapts to user's preferences
- Enables distributed voting process
- Based on agent-technology
- Votes via GPRS or SMS

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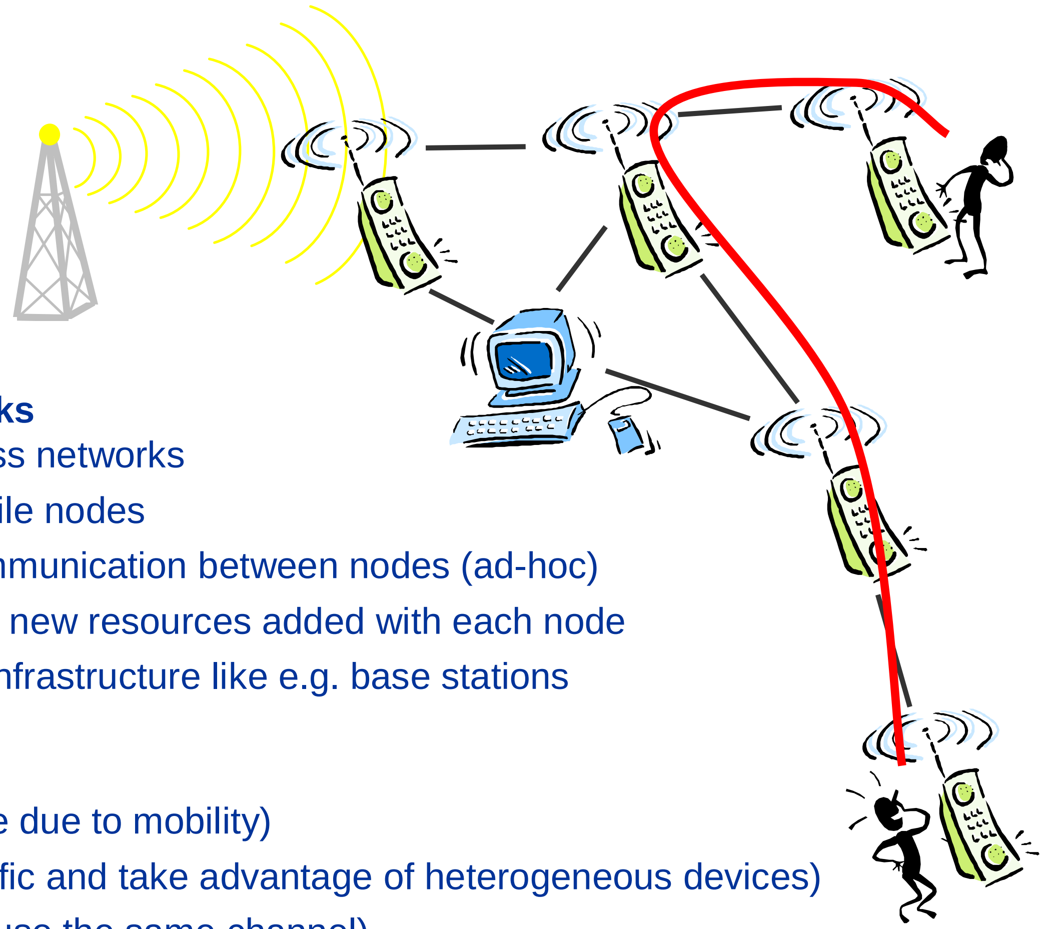
Self-Organizing Networks



Mobile wireless ad-hoc networks

- are self-organizing wireless networks
- consist of distributed mobile nodes
- dynamically establish communication between nodes (ad-hoc)
- can be setup flexibly, with new resources added with each node
- do not require additional infrastructure like e.g. base stations

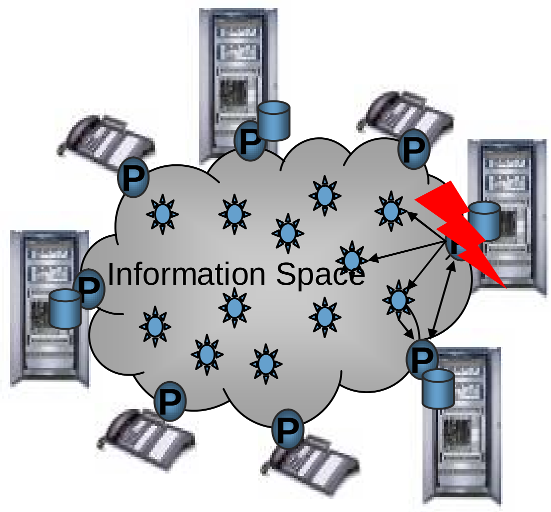
Self-organization of

- network topology (variable due to mobility)
- hierarchies (to reduce traffic and take advantage of heterogeneous devices)
- medium access (devices use the same channel)
- routing (variable due to mobility)

Virtualization in networks through Peer-to-Peer mechanisms / Resource Management Framework

An ever **increasing number of heterogeneous network elements** and functionality leads to an explosion in complexity and **maintenance** costs

- **"More through less":** Maximize resource exploitation by mechanisms to make all resources in a network visible / available and efficiently manage them
- **"Network Automation":** dynamic self organization, virtually no configuration, simplified administration, maintenance, installation
- **"Robustness":** network, service and data robustness by reliable, self-scaling environment



Application:
Self organizing robustness in communication systems

- Maintain a running system in case of network or node failures
- Efficient distributed keep-alive, load-balancing and data replication mechanisms

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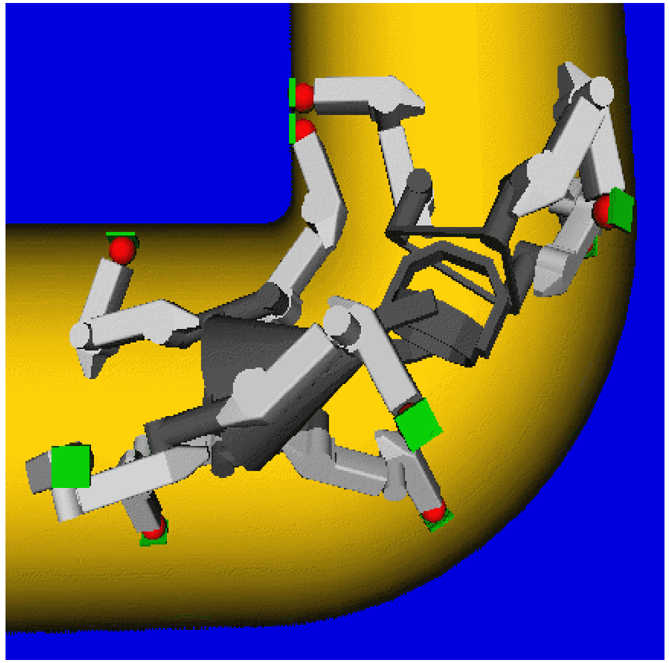
Autonomous Systems: Pipe climbing robot

Test robot

- Biologically inspired locomotion
- Biologically inspired hierarchical control architecture
  (planning, reactive behaviour, reflexes)

Application: inspection/maintenance



- Inspection and maintenance of complex pipe systems

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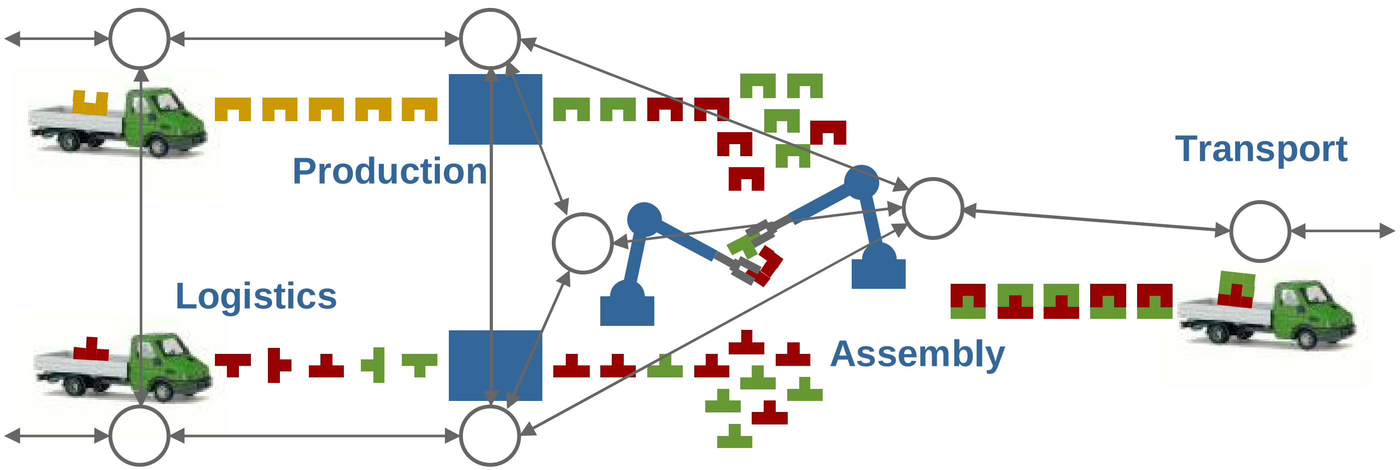
Selforganization in Production und Logistics

Central Control
- complex global models
- sub-optimal operation
- inflexibel and failure-prone

Decentral Control
- simple local models
- nearly optimal operation
- self-organization



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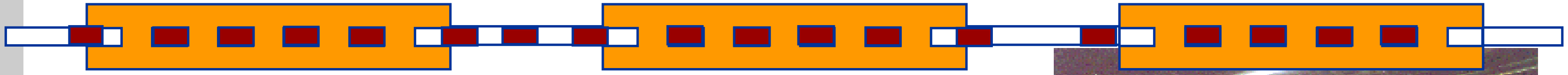
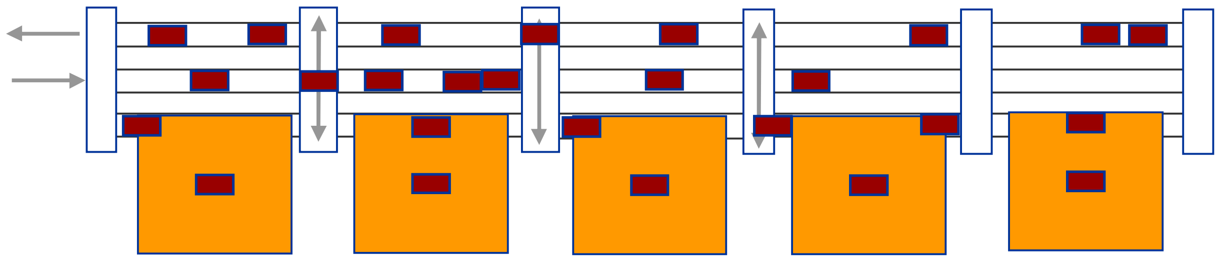
Example for Self-organization in Distributed Systems: Agent-Concepts in Production Systems



- *Disadvantages of transfer lines*
  - dedicated machines
  - rigid material flow

- *Introduce more hardware flexibility*

Flexible transportation system



Flexible machine

Source:DaimlerChrysler

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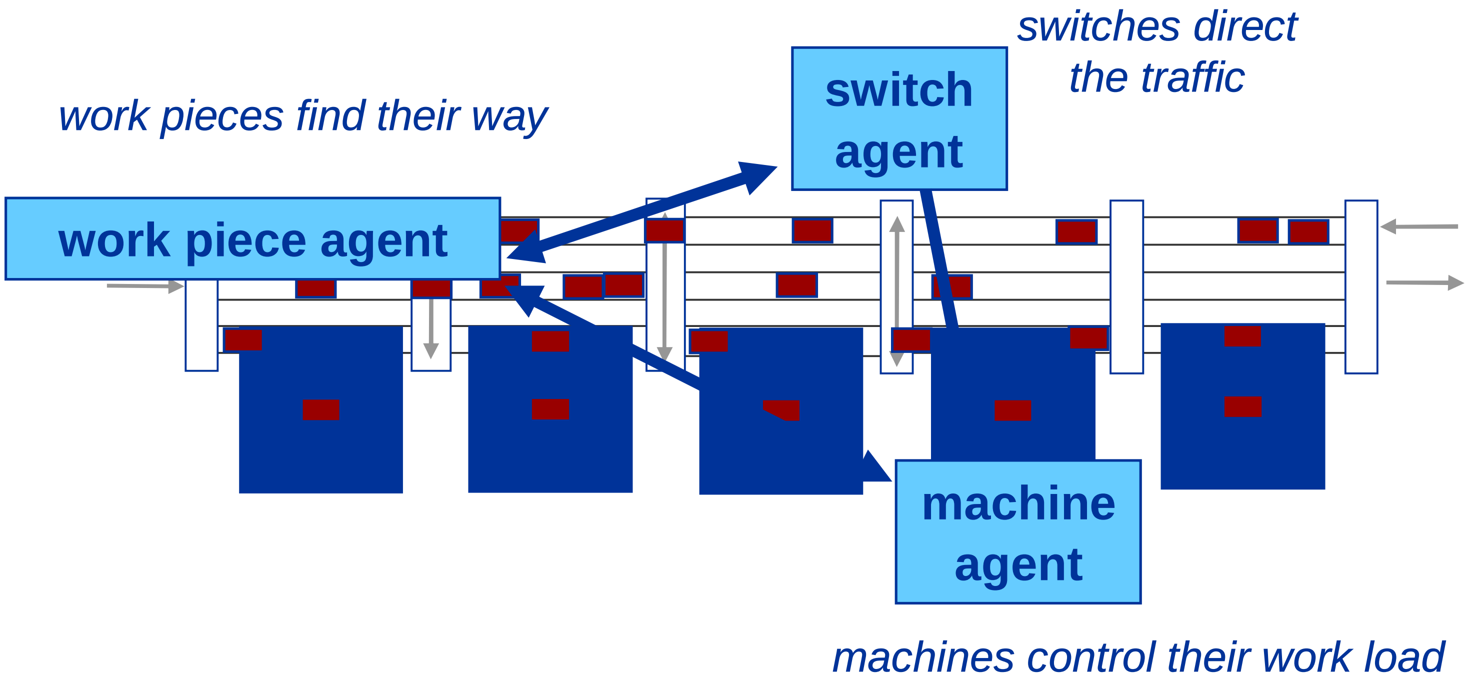
Example for Self-organization in Distributed Systems: Agent-based Control System



- **Control forces:**
  - **auction based market mechanism**
  - **work pieces push themselves**
  - **machines limit work-in-process**

Source:DaimlerChrysler

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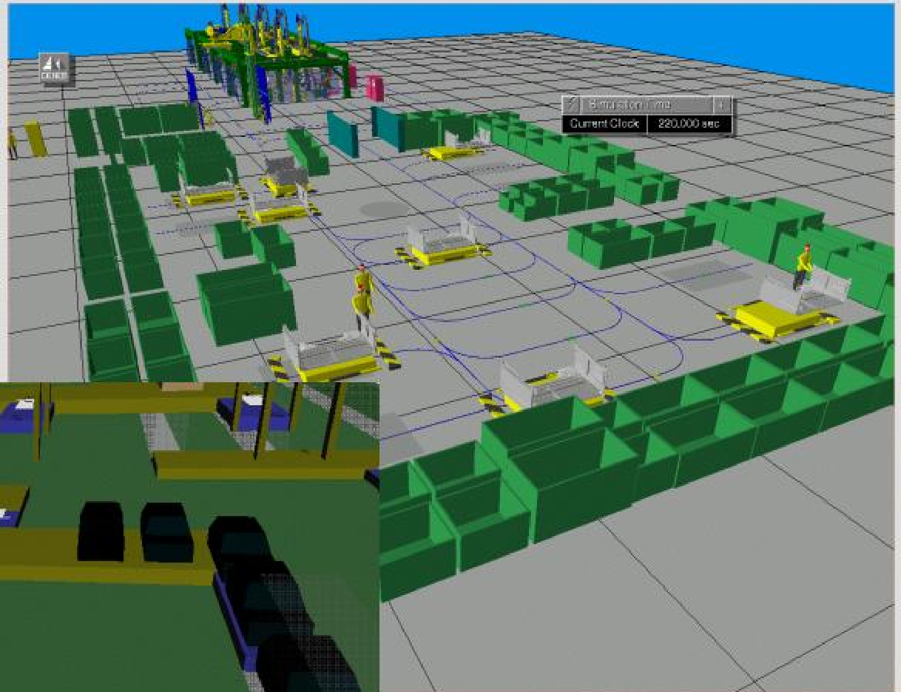
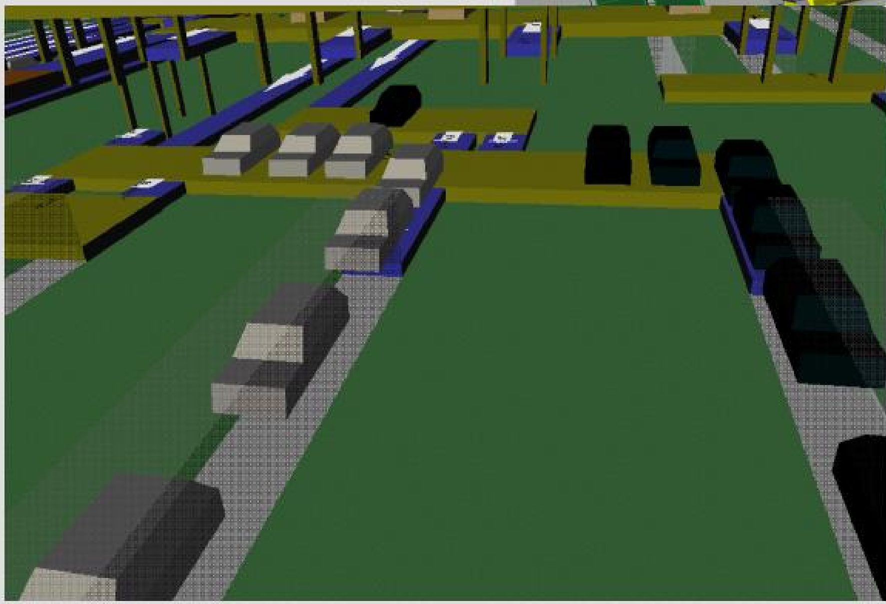
DaimlerChrysler

Forschung & Technologie

Ausblick



Verteilte Karossensteuerung



Flexibler Rohbau

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Delivery Logistics at a Computer Manufacturer

Logistics process

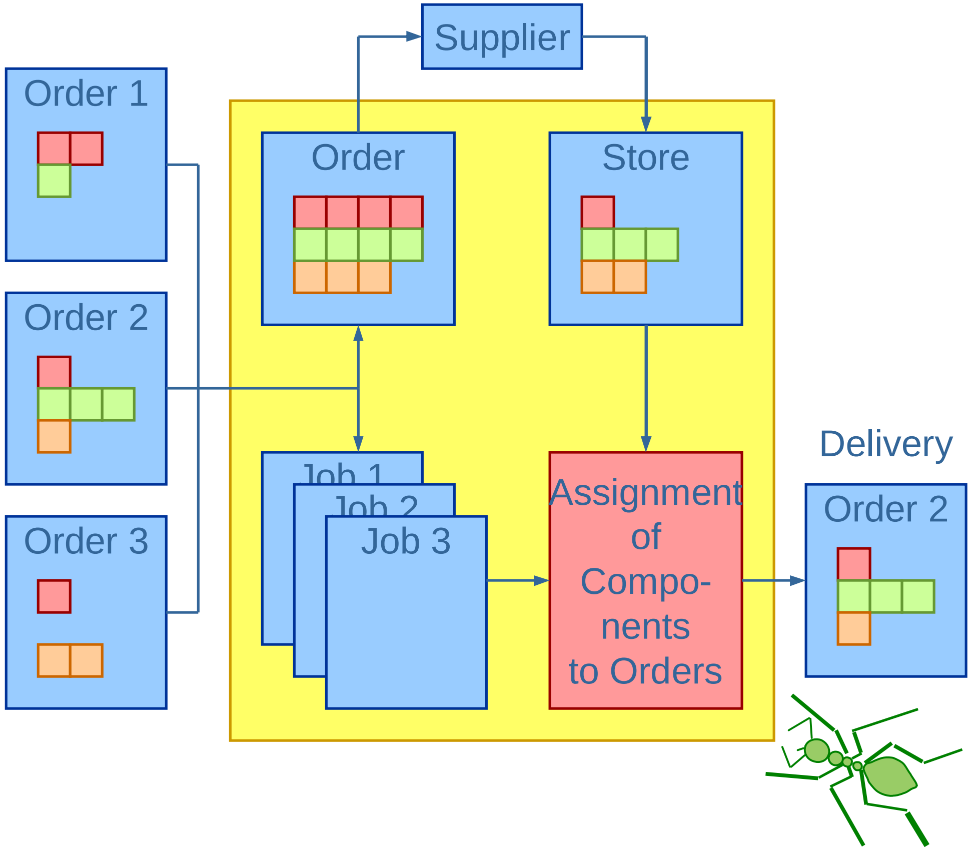
1. Customer places order
2. Generate component orders
3. Deliver to virtual store
4. Deliver to customer

Irregularities

- **Shortages** at component suppliers
- **Transport delays**
- **Transport damages**

State before Optimization

SAP-System assigns components to orders at the time of ordering



Result of Distributed Optimierung

Optimal **dynamic assignment** of components to orders

Reduction of Delayed Orders by 44%

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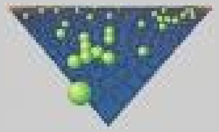

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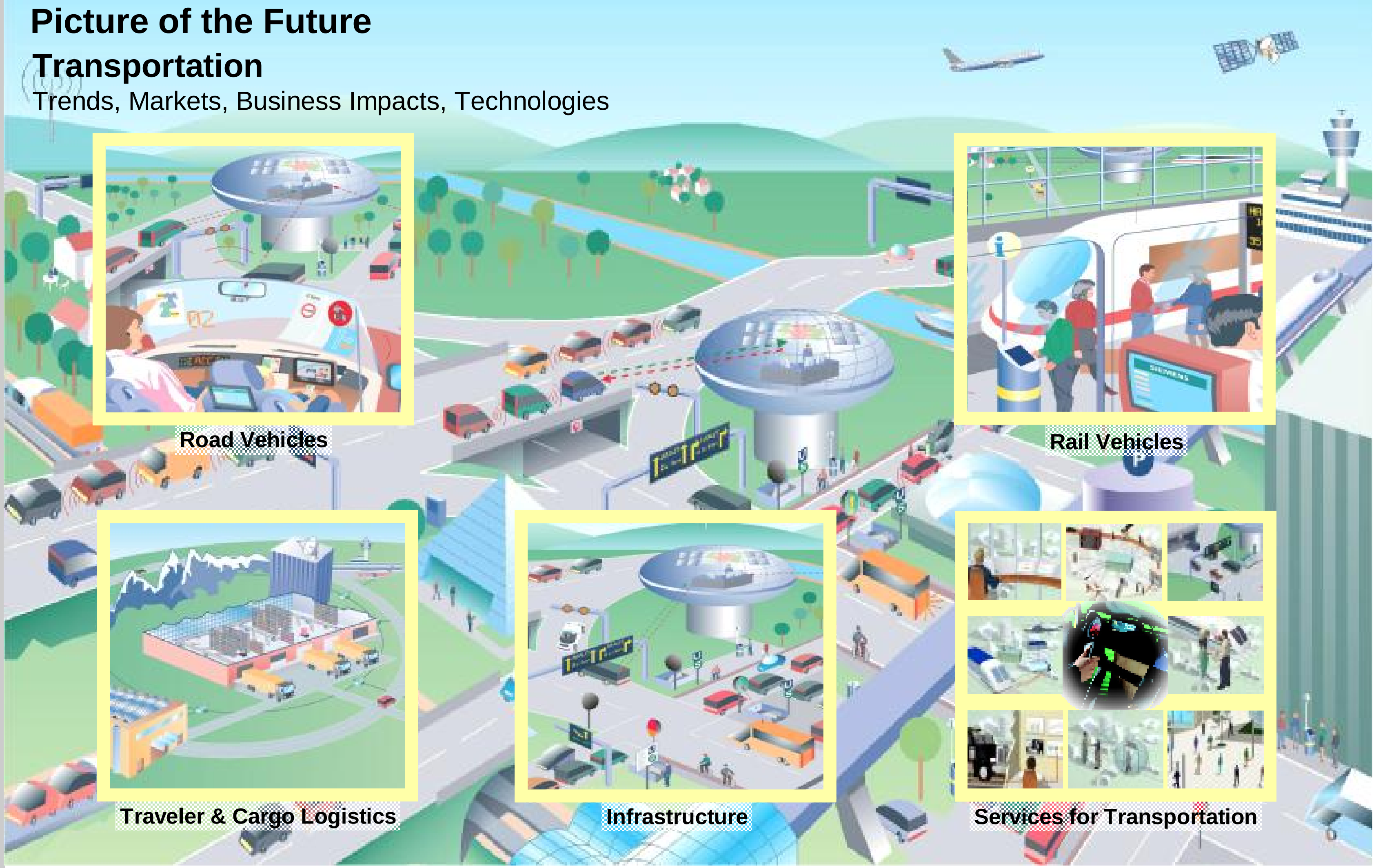
Pictures of the Future: Transportation



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Cooperative Traffic Systems

„Official" Definition (EC – eSafety):

- *Road operators, infrastructure, vehicles, their drivers and other road users will co-operate to deliver the most efficient, safe, secure and comfortable jouneys.*
- *The vehicle-vehicle and vehicle-infrastructure co-operative systems will contribute to these objectives beyond the improvements achievable with stand-alone systems*

Source: P.Mathias, Siemens ITS

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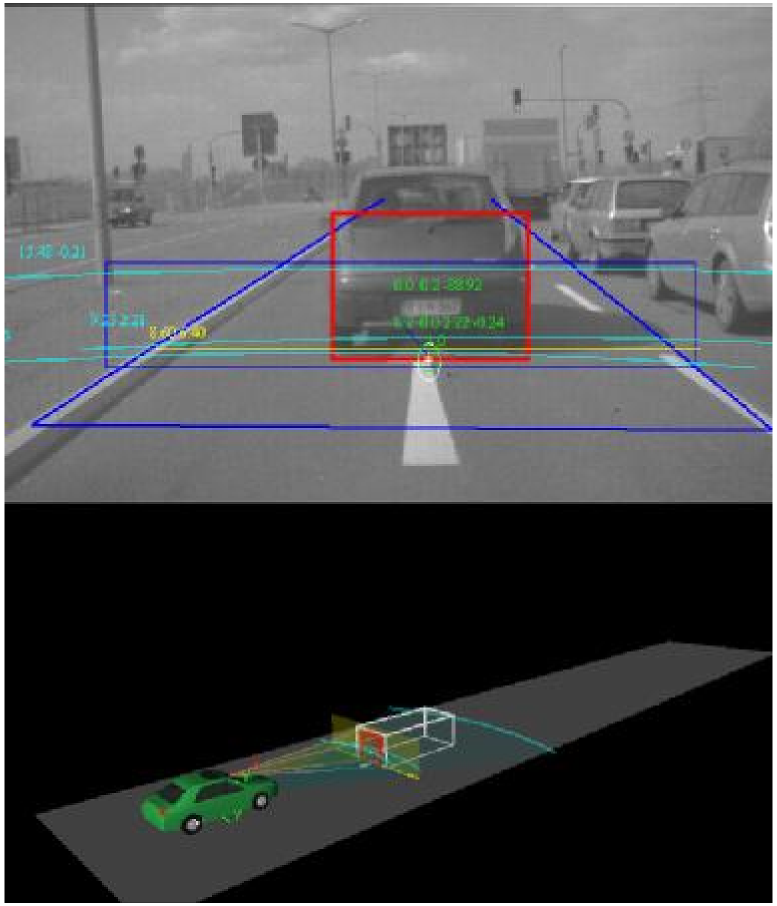
Cooperative Driving:
Driver Assistance Systems

- **Example: Traffic Jam Assistant**
  - Automatic Driving in a Traffic Jam (0-50km/h)
  - Vehicle Direction Control (Track and Distance)
- **Multisensor System**
  - Radar n
  - Lidar n
  - Camera (Mono) n
- **Test Vehicle from Siemens-VDO**
  - BMW 525i Touring
  - BMBF-Project INVENT



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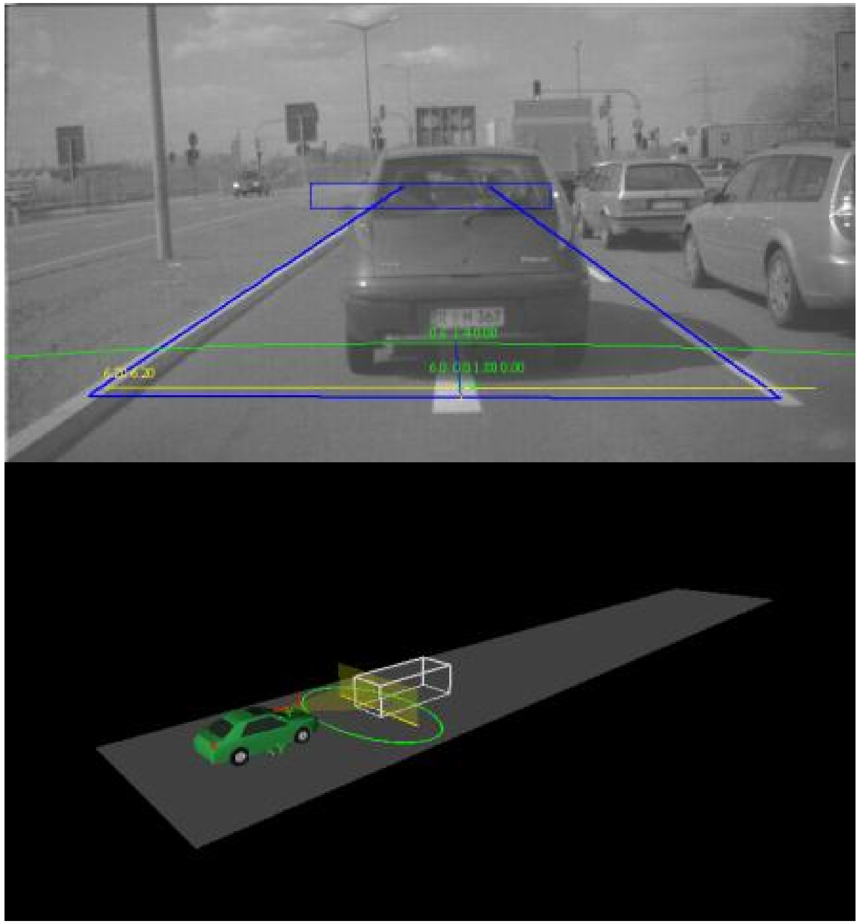
Test-Drive Video



Video with Overlay

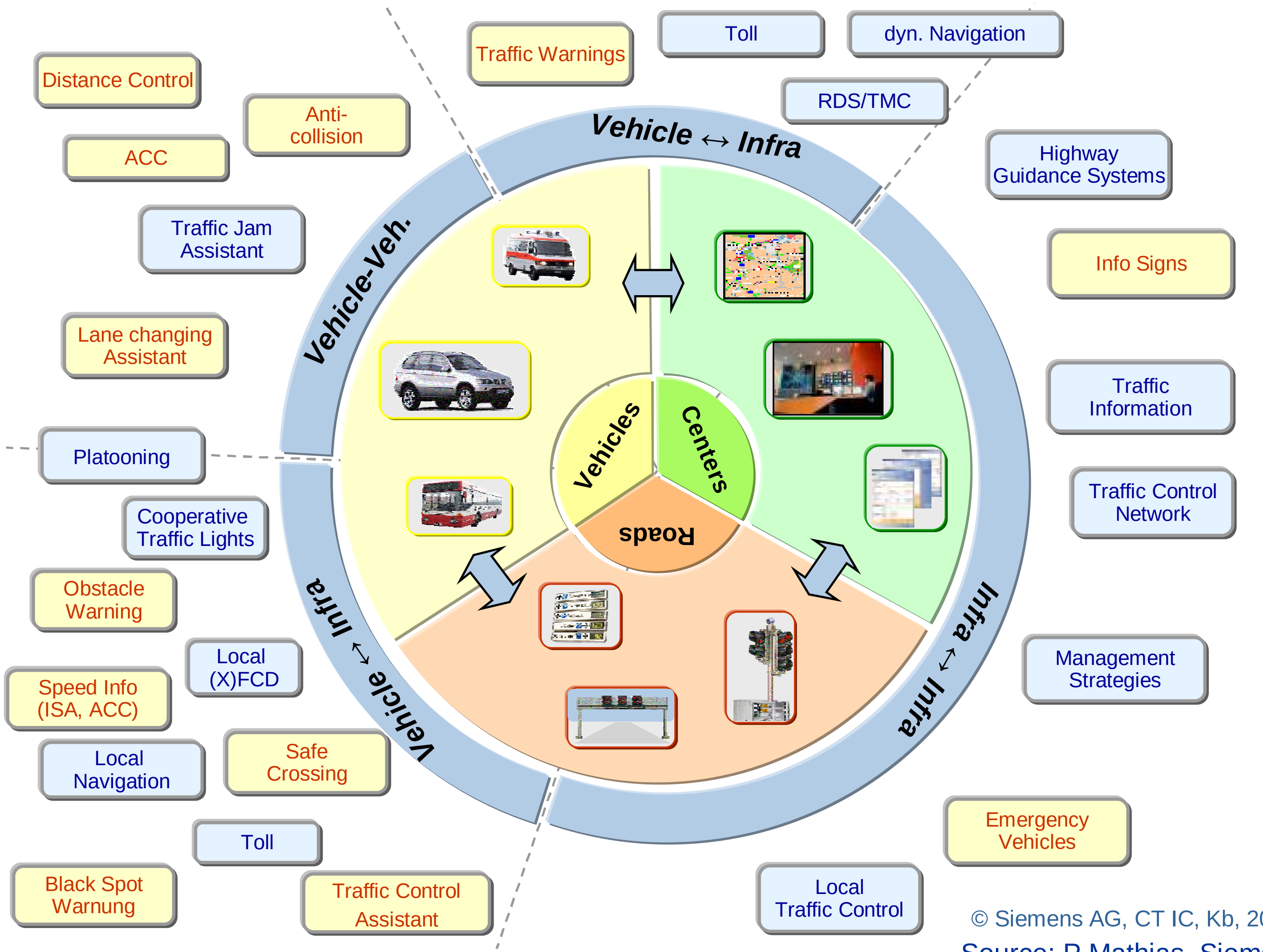
Visualization

Visualization and Overlay:

- Radar n
- Lidar n
- Camera (Mono) n

Information & Communications
Intelligent Autonomous Systems

Cooperative Traffic Systems



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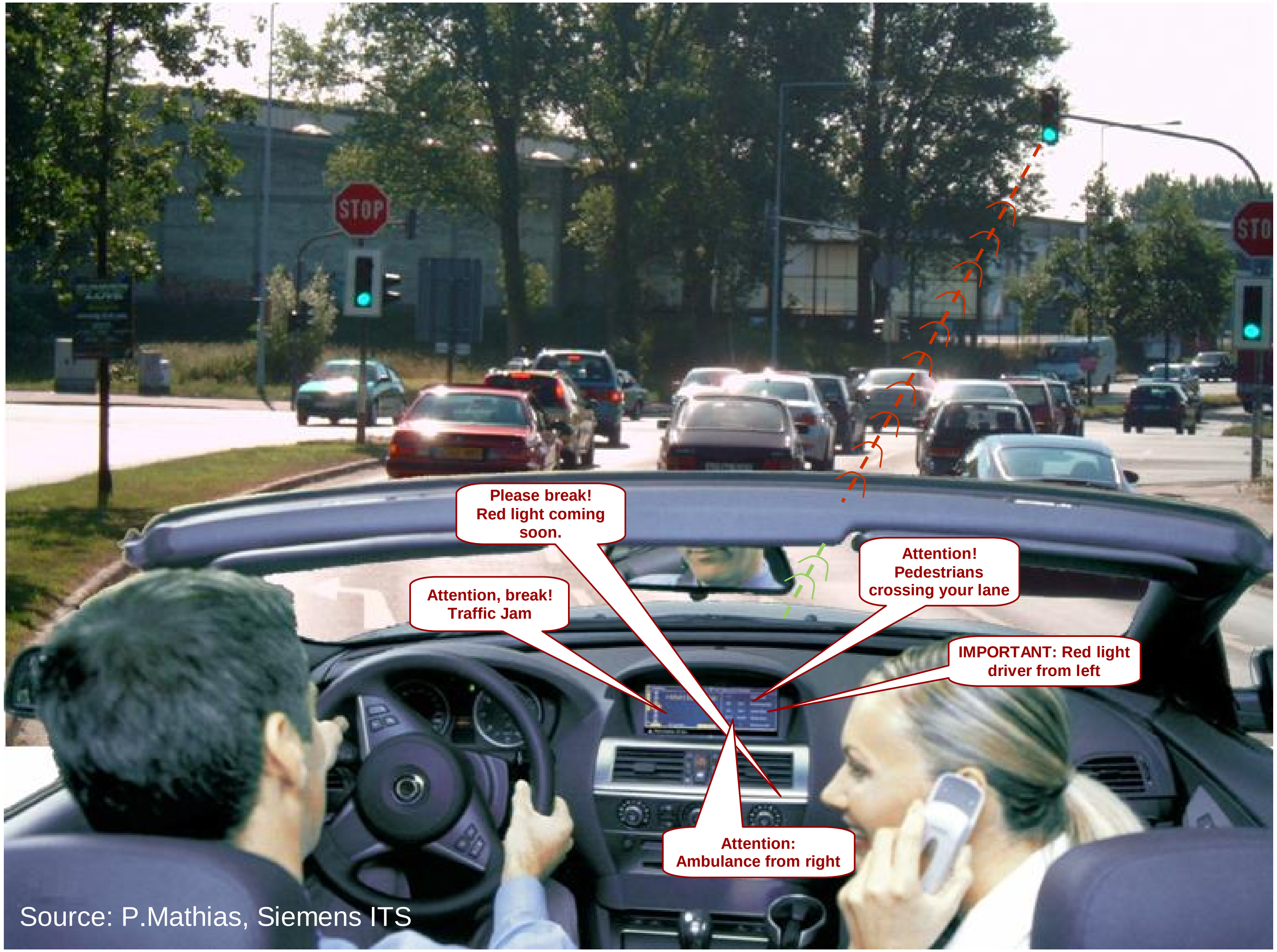
Source: P.Mathias, Siemens ITS

CORPORATE TECHNOLOGY

The Safe Crossing



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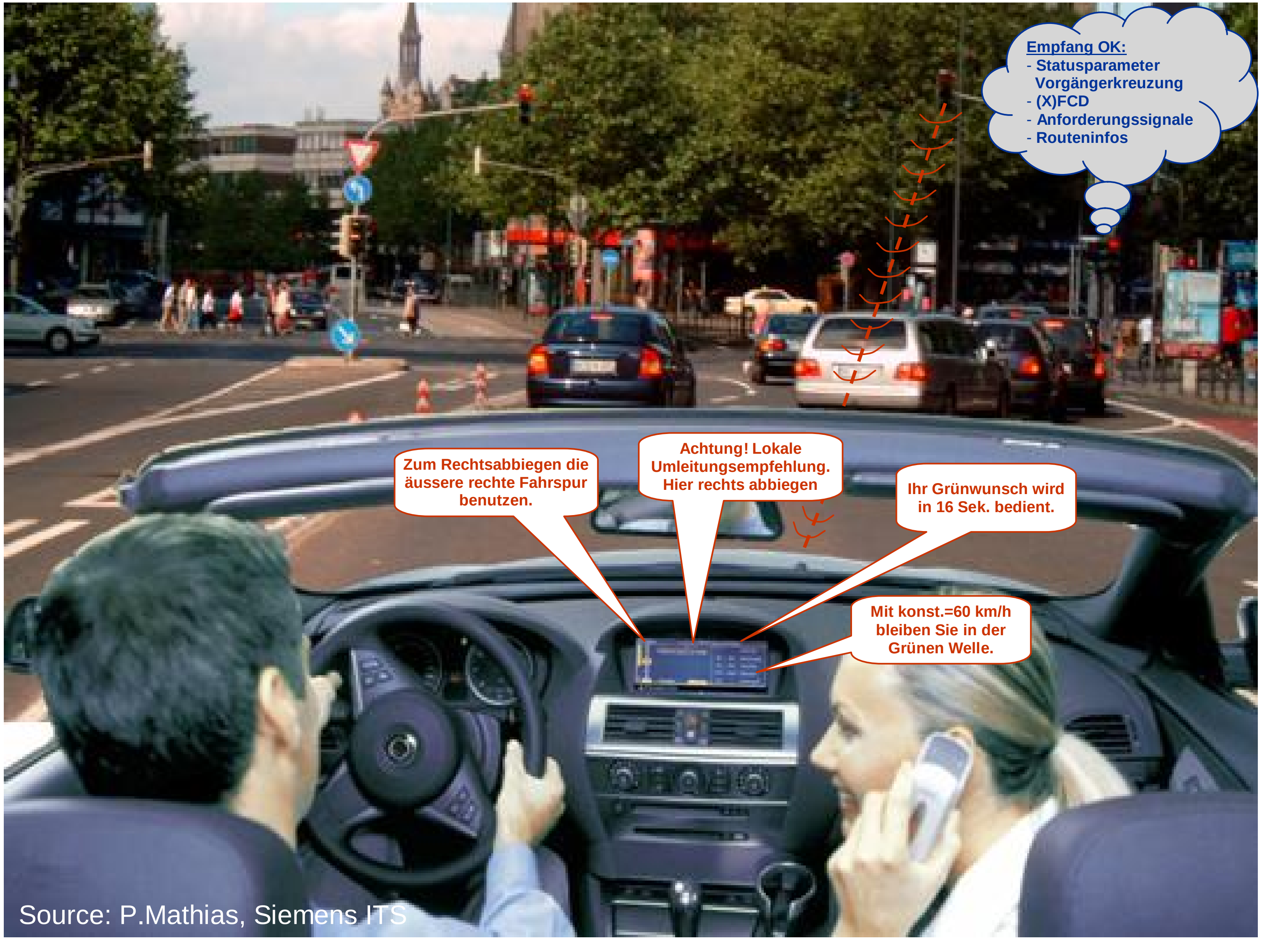
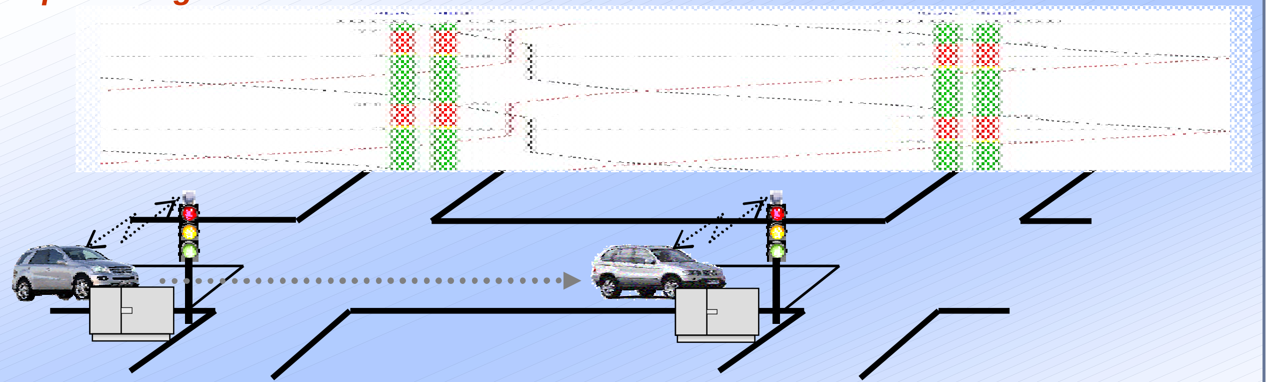
The Assistive Crossing



Source: P.Mathias, Siemens ITS

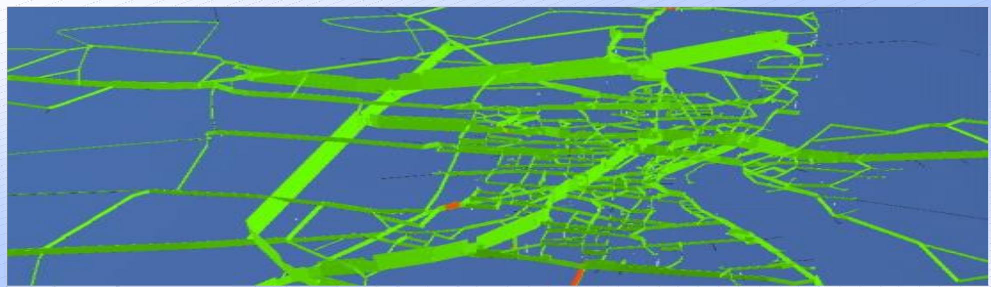
Cooperative Traffic Control

Cooperative green wave



- Vehicles carry control information from one crossing to the other
- Dynamic green waves emerge by self organization

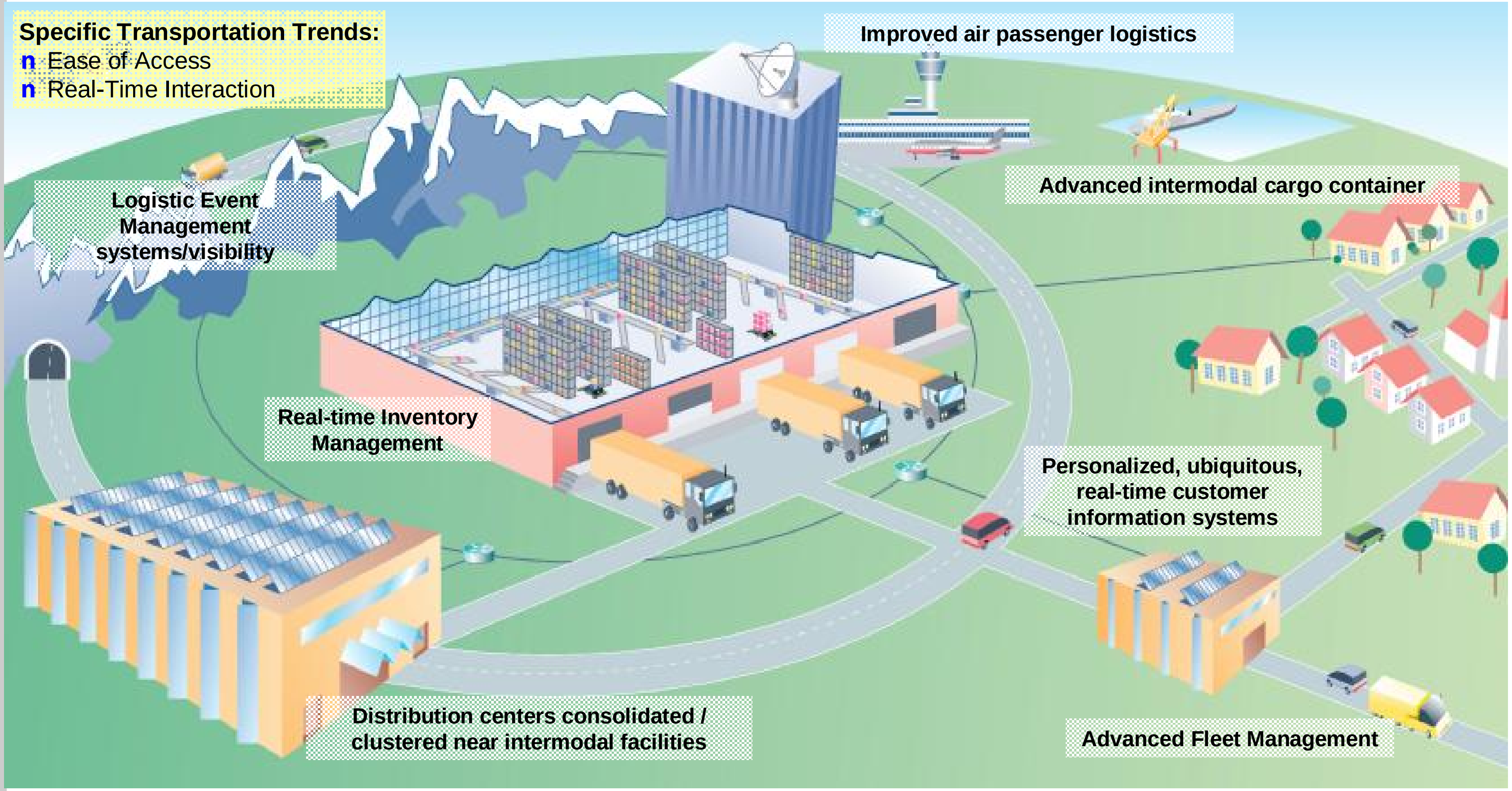
Self organizing traffic net



- Decentral control mechanisms emerge to global control by self organization wrt. load and coordination

Source: P.Mathias, Siemens ITS

Traveler & Cargo Logistics
Quality of Logistics Is a Key Factor



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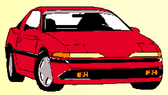
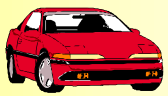
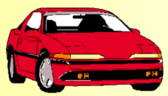
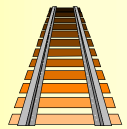
Transportation Trends
Chances for OC-Technologies

	Improving **Safety & Security**	Enhancement of **Environmental Protection**	Increasing **Connection in Mobility**	Reduction of **Life-Cycle-Costs**	Enhancement of **Cost Reduc-tion in Rail Operation**
Mostly affected Key Segment:	**Road Vehicles** 	**Road Vehicles** 	**Road Vehicles** 	**Rail Vehicles** 	**Infrastructure** 
Core Business Impacts:	■ **Integrated, IT-related systems**	■ **Efficient and low emission propulsion**	■ **Infotainment with ITS platform functionality**	■ **Continuous, remote vehicle monitoring and diagnostics**	■ **Automated, demand-oriented rail operation**

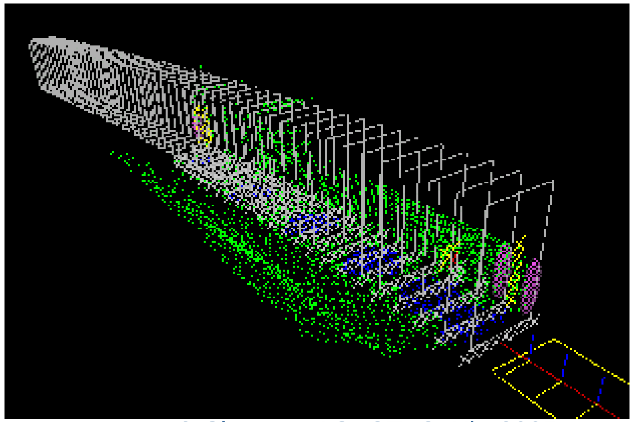
Information & Communications
Intelligent Autonomous Systems

Autonomous Freight Vehicle: CargoMover®

Goal
- Efficient rail transportation system for freight services
- Autonomous and driver-less operation

Approach
- Combination of Robotic Technologies and innovative sensor systems (laser, radar, vision)
- Modeling of track and three dimensional head space profile
- Sensor data fusion and obstacle detection using probabilistic methods
- Communication with control centers via GSM-R

Benefit
- New opportunities for rail-based logistics
- Economical and ecological solution
- Example for automation of metros, subways



Video

Information & Communications
Intelligent Autonomous Systems

Video

CORPORATE TECHNOLOGY

Applications of Organic Computing - An Industrial View

Strategic Visioning at Siemens: „Pictures of the Future“

Application Areas of Organic Computing

1. Service
2. Information&Communications
3. Automation&Control
4. Transportation
5. **Power**

Conclusion

Information & Communications
Intelligent Autonomous Systems

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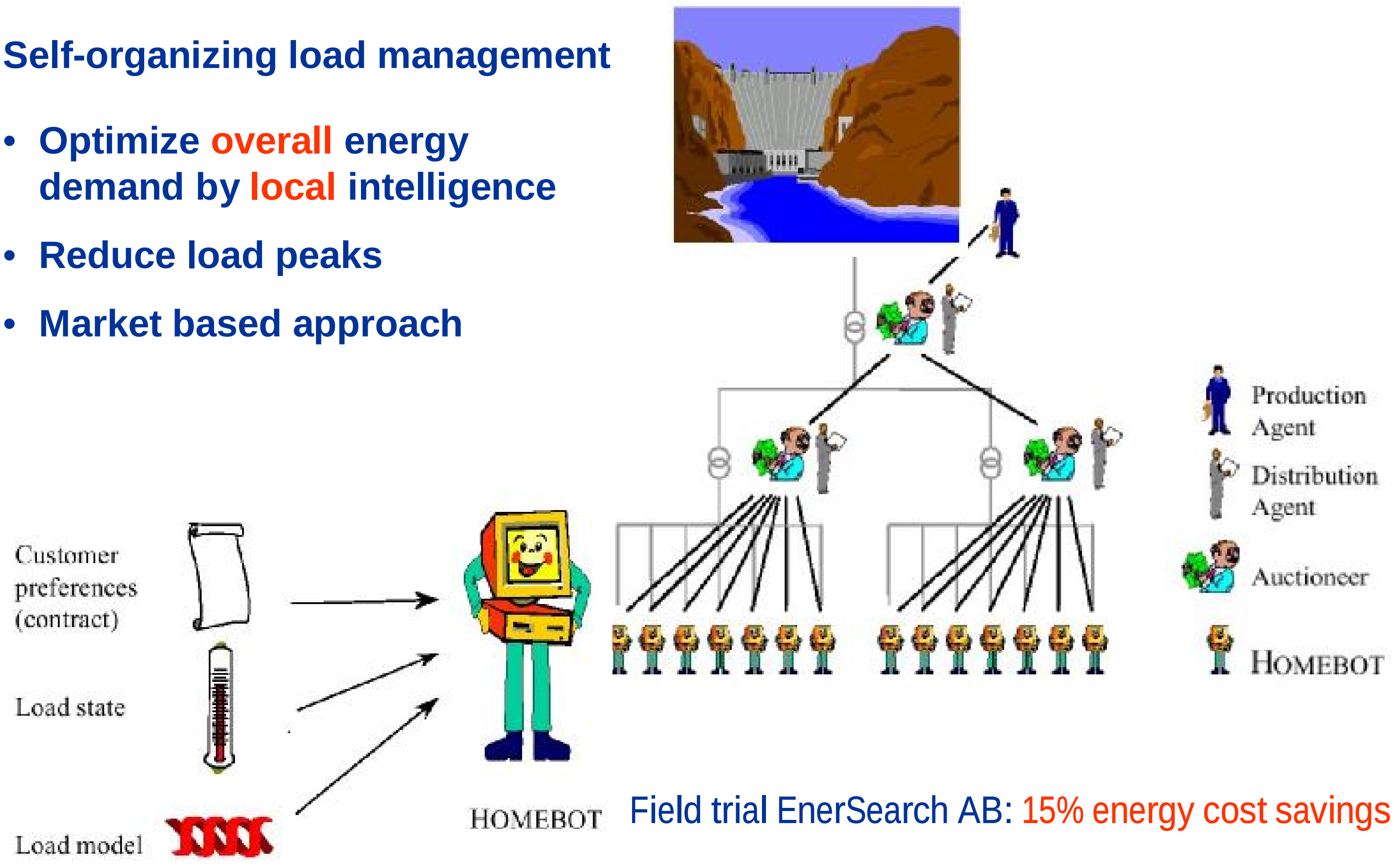
„Organic“ Energy Management

Self-organizing load management

- Optimize overall energy demand by local intelligence
- Reduce load peaks
- Market based approach



Field trial EnerSearch AB: 15% energy cost savings

CORPORATE TECHNOLOGY

Applications of Organic Computing - An Industrial View

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Conclusion

Information &
Communications
Intelligent
Autonomous
Systems

Conclusion

Wide spectrum of promising application areas for Organic Computing:

- **Service**
- **Information&Communications**
- **Automation&Control**
- **Transportation&Logistics**
- **Power**
- **Health**

Challenges:

- **Advance theory of OC principles**
- **Develop application oriented technologies, engineering frameworks and toolkits**
- **Look for early application spin-offs**
- **Improve interoperability: define standards**