15-413 Software Engineering - Carnegie Mellon University - School of Computer Science

PAID

Platform for Active Information Dissemination

Problem Statement

August 18, 1998

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1. The Problem

1.1. As-is Situation

Within Daimler-Benz aftersales information is created and distributed by different departments. The major information sources today are service, parts, and vehicle information. Depending on the type of information the company utilizes a variety of different distribution channels. Table 1. shows the main aftersales information types, the respective end user applications and distribution channels.

Information Type	Application	Distribution Channel
Service Information	WIS	CDROM, Paper, Microfiche
Diagnosis Information	STAR DIADNOSIS	CDROM, Paper, Microfiche
Parts Information	EPC	CDROM, Paper, Microfiche
Vehicle Information	FDOK	CDROM, Online
Car Configuration Data	MBKS	CDROM
Work Units & Operation Texts	ASRA	CDROM
Damage Codes	VEGA	Online

Table 1. Main Aftersales Information Types, Applications, and Distribution Channels

These distribution channels are typically very reliable but also very slow and inefficient. For instance the distribution of service, parts, and vehicle information to the worldwide Mercedes-Benz sales organization is done via a monthly published set of 12 CDROM. This information is already partially outdated when it gets to the dealer.

1.2. The Problem

Today and in the near future Daimler-Benz is extending its business in terms of new product lines (A-Class, M-Class, etc.) and new models of already existing product lines (S-Class, etc.). The amount of aftersales information is increasing due to the introduction of these new products. With the introduction of new aftersales information systems additional information distribution channels are created, which finally lead to a *proliferation* of distribution channels. All this makes the information management process (creation, publishing, distribution, installation) from a technology and management point of view more complex and expensive. Looking at today's information distribution channels we can see that they are too slow and inflexible to meet these demanding business requirements. The following picture illustrates the current situation:

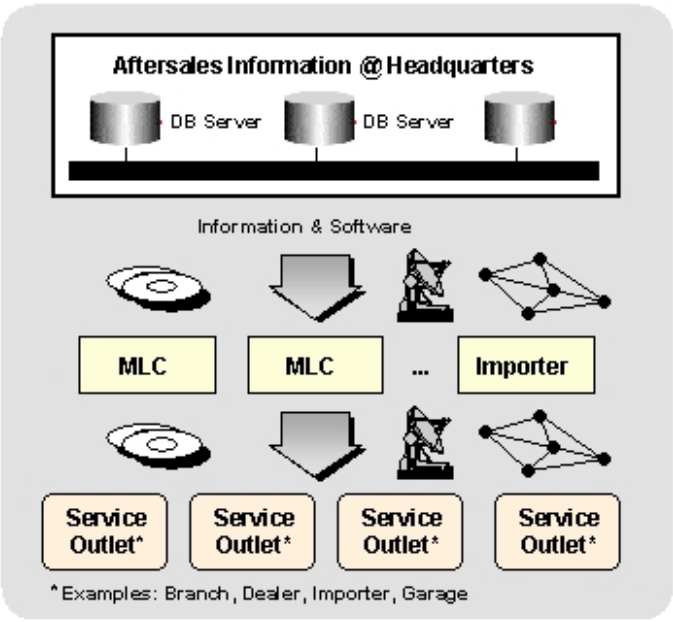
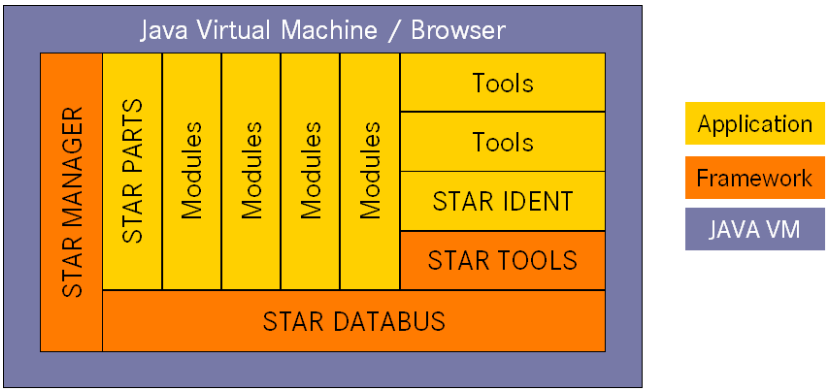


Figure 1: The current distribution process for Daimler-Benz aftersales informations

1.3. The Future IT Platform

STAR NETWORK, as the next generation network based IT platform for Mercedes-Benz Service, needs to provide a common information distribution facility for all applications that run within the framework. Even though STAR NETWORK is conceived as a network based platform giving access to distributed databases, these databases need to be replicated from a few central databases. Without a common information distribution facility, information management within STAR NETWORK and other network based applications continues to be a major concern.



Picture 1. The STAR NETWORK Framework

The STAR NETWORK framework is based on a service based architecture. The architecture subdivides an application in two parts: an application service running on the server implementing the business logic resp. data access and a client part running on the client implementing the gui and parts of the business logic. Within the client the framework offers a public databus used by the client parts for local communication. There are two classes of client parts: modules and tools. Modules are typical applications. Tools are common services used by several modules. STAR Parts is the application formerly known as EPC (Electronic Parts Catalog). STAR IDENT replaces the legacy system FDOK.

2. Objectives

2.1. Business Vision

Mercedes-Benz is extending its business in terms of new products and market share. In conjunction with the extension of the business the amount of aftersales information grows. In order to meet these business requirements Mercedes-Benz needs to improve its service applications / systems. The timely distribution of aftersales information is a success factor for the Mercedes-Benz Sales and the PAID architecture can be seen as an enabling technology.

PAID as a standardized architecture for the distribution of aftersales information will allow

- Distribution of all kinds of information (content & software) to the sales organization world-wide through the same facility / technology,
- Low entry and administration cost, scaleable (cost proportional to added applications / systems) and
- Easy development of new applications / systems concerning the distribution of data

PAID is in line with other IT integration efforts, in particular STAR NETWORK©. To leverage the potential of STAR NETWORK© as the next generation Internet-based IT platform for Mercedes-Benz Service, a service like PAID is mandatory. For a business application like STAR NETWORK© to run in various locations world-wide, with the required performance (e.g. response time) and stability (24 hours every day), an information / software distribution facility based on a PAID-like architecture is needed. The combination of online access and the intelligent distribution of most used information to the world-wide sales organization offers the best tradeoff between up-to-date content and reliable and fast access.

The scenarios in section three illustrate the distribution processes of three important aftersales

information sources: service information, parts information and vehicle information.

- *Service information* encompasses among others the following document types: Service Instructions, Maintenance procedures, Fault trees, Service Bulletins, Data sheets and Wiring Diagrams.
- *Parts information* encompasses all the MB spare parts with their assigned parts numbers. Parts Information is one part of the Mercedes-Benz Aftersales Database (MAD). In order to find the appropriate documents to service a certain car another information source needs to be accessed:
- *Vehicle information* is stored in the vehicle documentation database FDOK. It holds the complete documentation of all cars produced since 1986.

Even though the scenarios focus on the information sources mentioned above, other information sources should be handled in the same way. In general the information distribution takes place on the DB Intranet (Daimler-Benz corporate network) and its extension to the worldwide dealers and service outlets, the DB Extranet. This network is heterogeneous in terms of bandwidth and quality. Other storage technologies like DVD and communication technologies such as satellite-based broadcasting should be considered as additional distribution vehicles.

Daimler-Benz wants to:

- Minimize the proliferation of different distribution channels for aftersales information.
- Facilitate the distribution of aftersales information and applications to business units located at all enterprise levels (e.g. headquarters, wholesale, dealers).
- Establish a powerful and secure standard for information distribution on the Daimler-Benz Intranet and its extension to the dealerships, the Daimler-Benz Extranet.
- Customize and adapt the distribution of aftersales information according to the specific business requirements of the accessing applications and the respective users.

This shall be achieved by the development of the PAID architecture. The main focus of the project is on the architectural vision, implemented as a prototype. The prototypical implementation of PAID is intended as a proof-of-concept and will be the basis for further development of the STAR NETWORK framework. The prototype itself will therefore focus on two of the applications running under STAR NETWORK, namely STAR PARTS and STAR IDENT.

2.2. Expected Achievements

The publication of the PAID architecture should initiate and lead to a common architecture for information distribution within Daimler-Benz. In a first step the architecture should enable or support effective distribution of up-to-date information to the world-wide sales / service units. A common architecture should reduce the cost of implementation of new information systems in the future.

From a *Daimler-Benz point of view*, PAID offers the opportunity of increased consistency of information in the sales organization leading to better service and fewer customer complaints. At the same time PAID wants to minimize the distribution cost.

From a *dealer point of view*, PAID provides instant access to the right aftersales information without the limitations of today's mainly CDROM based distribution.

2.3. Design Goals

The PAID system will consist of a set of services distributed over the enterprise system platforms. The software architecture of PAID is based on the following design goals:

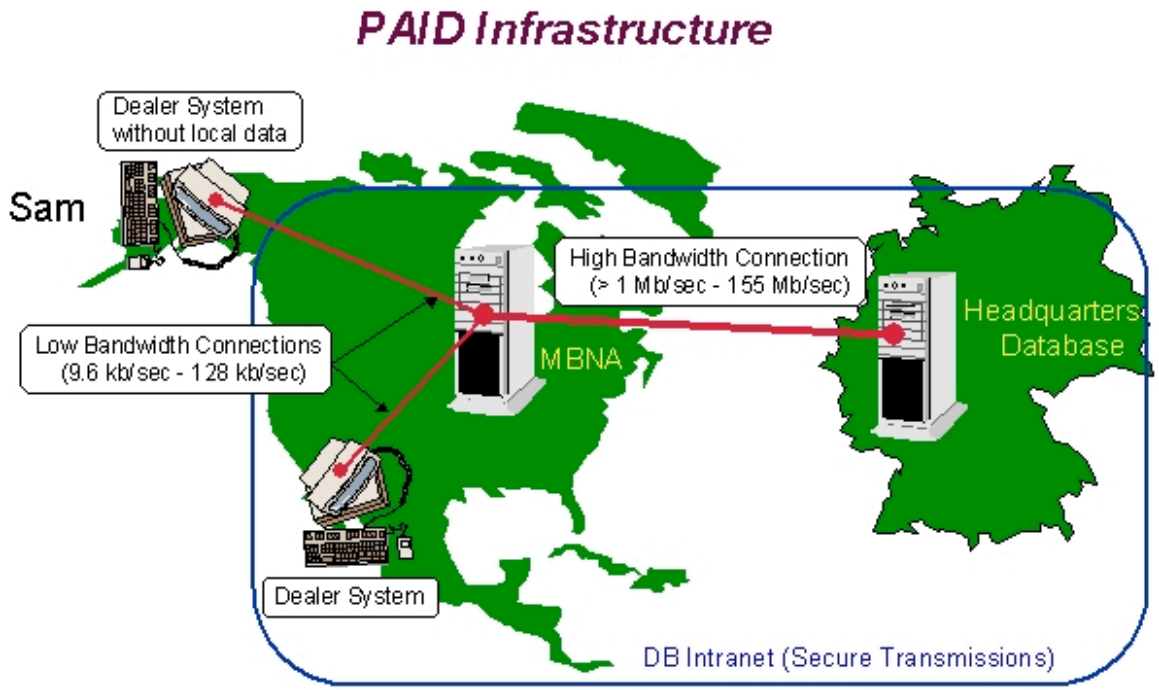
- **Extensibility:** New applications can be added later. These applications subscribe to the services offered by PAID.
- **Scalability:** PAID needs to be scaleable in terms of number of clients, subscribing applications, protocols, and bandwidth.
- **Location Transparency:** PAID provides location transparent access to data.
- **Actuality:** A dealer always accesses up-to-date information.

To cope with the complexity of these objectives and goals, a software prototype must be developed in the PAID project starting on August 27, 1998. The software prototype will be evaluated by the customer on ???, 1998 to provide feedback to the developers. This might result in a refinement of the software architecture and the class library. A revised prototype must be delivered in February, 1999.

3. Scenarios and Additional Requirements

3.1. The scenario-infrastructure

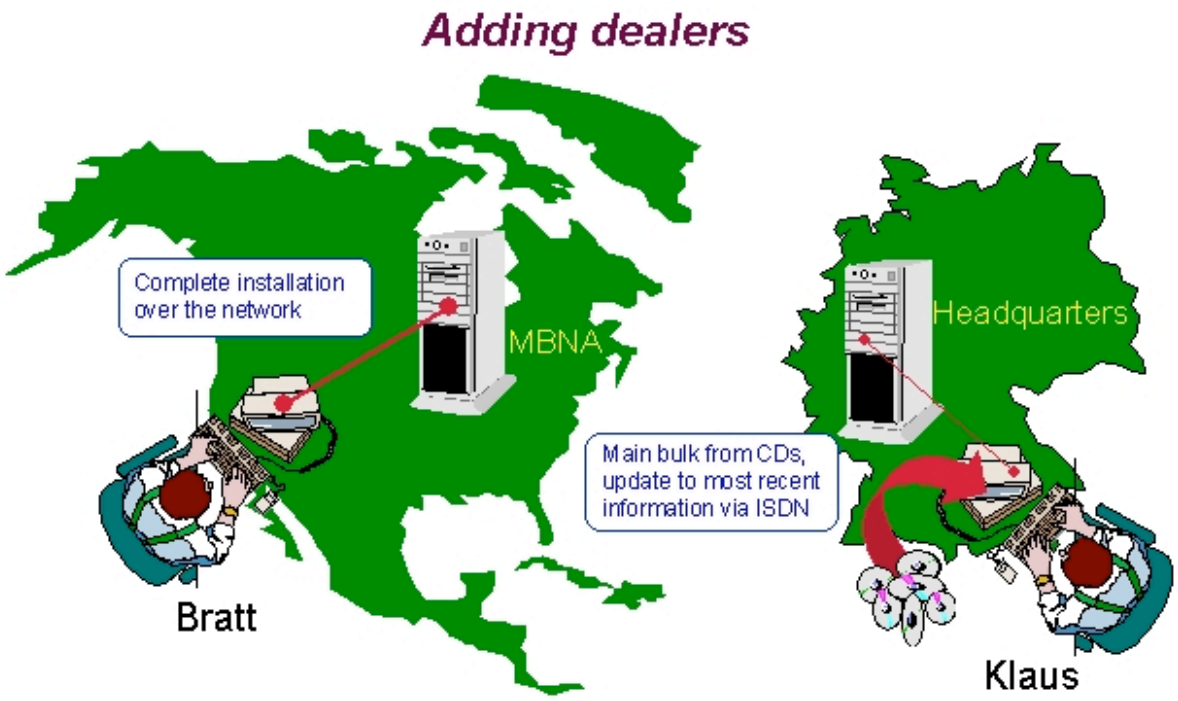
All scenarios within this document are based upon the following fictitious configuration of the Daimler-Benz Intra- respective Extranet. To simplify the description, the network is reduced to the central database of Daimler-Benz at Stuttgart (DBHQ), a local database Mercedes-Benz North America (MBNA), and three different dealers: two of them in the USA and the other one in Germany.



The network driven by PAID consists of two types of computers:

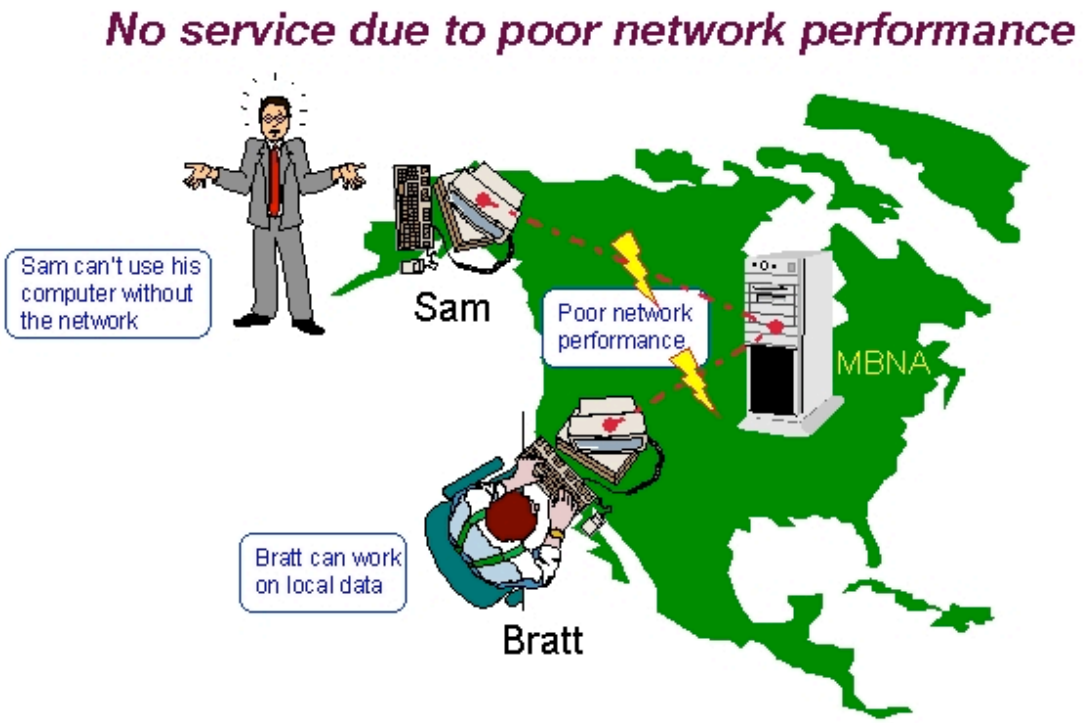
1. *Servers*. They represent the backbone of the Daimler-Benz Intranet and are connected via high-bandwidth network connections. To make the scenarios easier to understand, we concentrate on two servers: the headquarters database of Daimler-Benz in Stuttgart (Germany) and the database of Daimler-Benz North America in the United States.
2. *Dealer systems*. The clients of Daimler-Benz use these systems to provide aftersales support to their customers. Dealer systems normally have only low-bandwidth connections (e.g. ISDN) to the next server.

3.2. Scenario 1: Adding a dealer



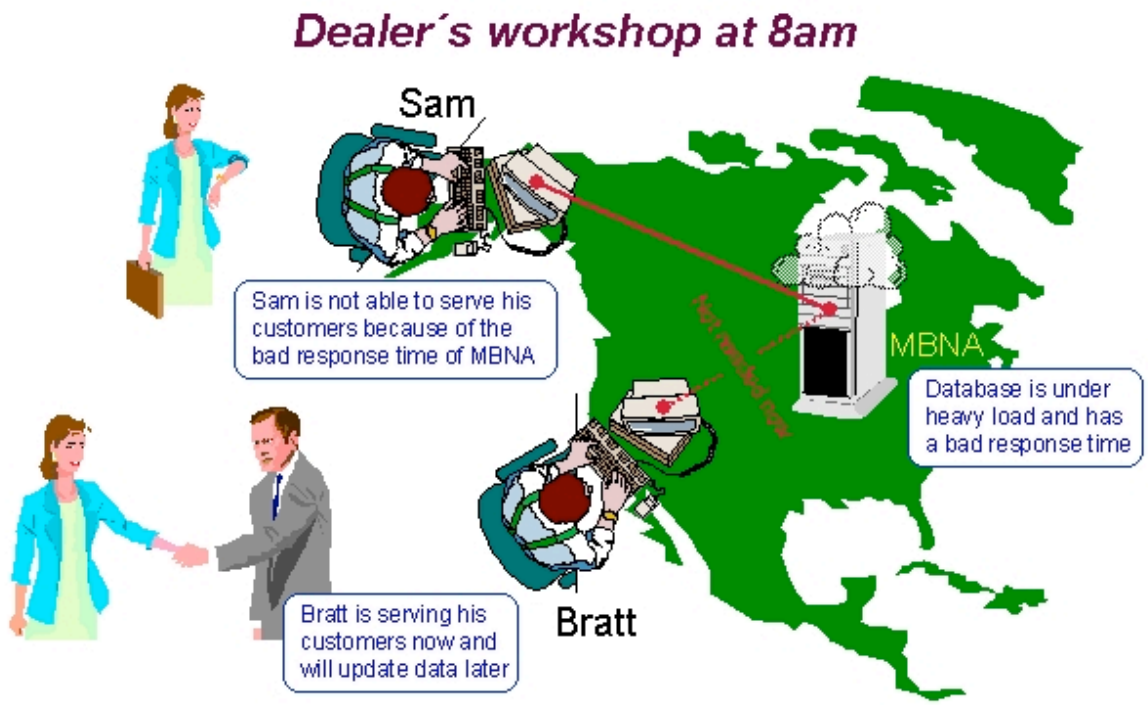
- Two dealers (Bratt and Klaus) are planning to integrate their computers into the DB Extranet. Bratt (residing in Beverly Hills) has a high performance network connection to MBNA. Klaus (Munich) has to pay for his 64KBit ISDN connection. Both dealers want a local copy of some important information according to their business requirements.
- Because of his good network capabilities, Bratt decides to install the software and data for STAR PARTS (EPC) and STAR IDENT (FDOK). He retrieves the information from the remote MBNA server. After this process has finished, he owns a copy of an up-to-date subset of the complete DB aftersales database.
- Because Klaus has to pay for the ISDN, he decides to install the bulk of the software and data from CD he received from Daimler 2 weeks ago. After the installation the system automatically contacts the closest server (the central server of DB in Stuttgart) and retrieves all updates necessary to bring the local data up-to-date.

3.3. Scenario 2: No service due to poor network performance



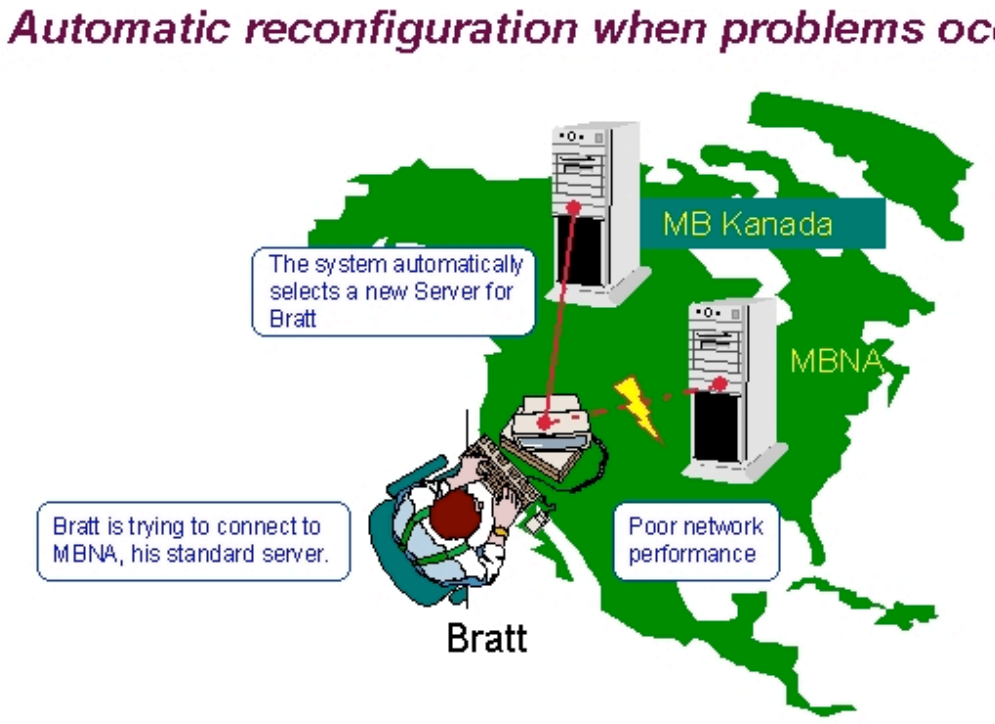
- A customer needs a new clutch. Sam tries to access the aftersales database at MBNA. Using the STAR NETWORK© standard configuration without local data he experiences a network problem: The transmission rate from MBNA to his computer is very poor, so Sam cannot get the part number and he does not remember it either. So he can not guarantee that he orders the right clutch.
- Bratt has the same network problems as Sam, but he has access to the price for the clutch on his machine. He can serve the customer because he does not need to access the aftersales database at MBNA.

3.4. Scenario 3: Dealer´s workshop at 8am



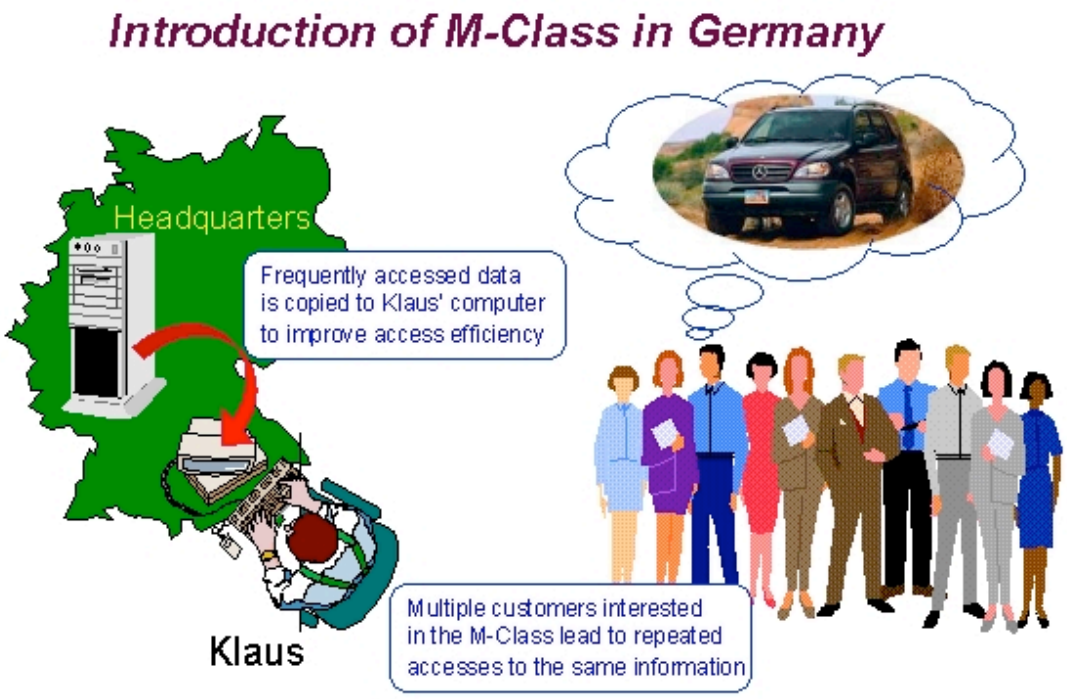
- It´s 8 o´clock in the morning. A long line of customers are impatient to get served at Sam´s workshop. The aftersales database at MBNA is under heavy load.
  - *The response time is so slow that Sam has to ask his customers to be patient. The customers get angry.*
- Bratt is opening his dealership at the same time. He also has a long line of customers impatiently waiting to get service.
  - *When he starts up the PAID enabled STAR NETWORK© system, he is asked whether he wants to update his local database. He doesn´t want to add any load on the network while his customers are waiting, so he decides not to do the update but serve his customers right away. Later in the morning, when his business has calmed down, he is asked again, and now he decides to update his database.*

3.5. Scenario 4: Automatic configuration change



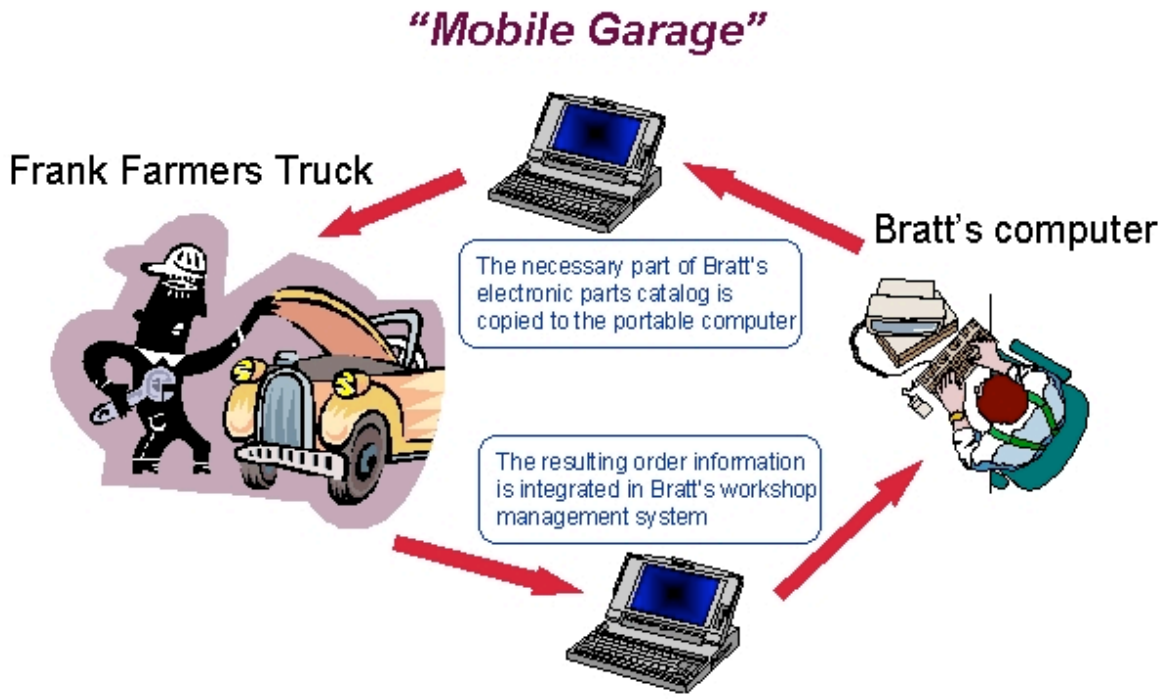
- Bratt normally connects to MBNA when he has to access data that is not stored locally. Today the connection to MBNA is really bad.
- The PAID enabled STAR NETWORK© system monitors the network performance and changes its own configuration automatically. Instead from MBNA, the data is retrieved from MB Kanada. This reconfiguration is temporary only.

3.6. Scenario 5: Introduction of M-Class in Germany



- Klaus, who doesn´t yet have the data for the new M-Class in his local database, has to access the data remotely.
- Serving customers he has to access the same data again and again, and experiences that the response is faster and faster because more parts of the data are cached locally.
- After some days of repeated accesses, the PAID enabled STAR NETWORK system asks him whether he wants to copy the data for the new M-class into his local database.
- Klaus says yes, and is happy to learn that this also guarantees that all necessary updates in the future are done automatically.

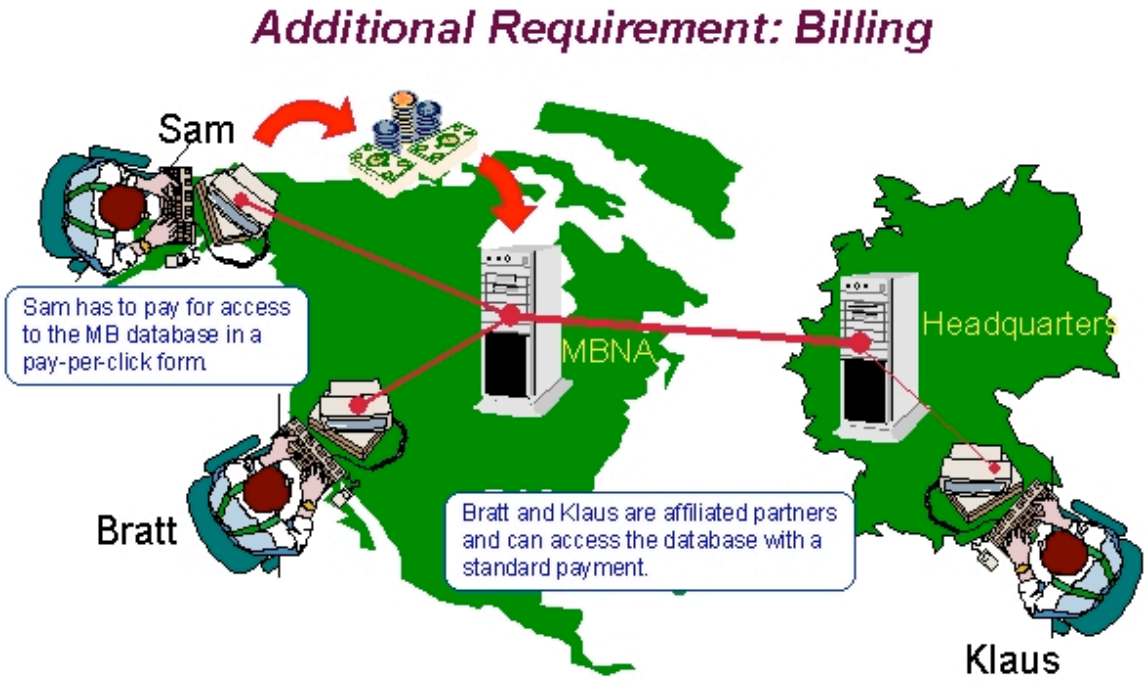
3.7. Scenario 6: Mobile Garage



- Bratt receives a phone call from Frank Farmer. Frank lives far outside of Beverly Hills and his DB-Truck doesn't work anymore. He needs the truck for his harvest and the weather forecast for the next week is bad, so he asks Bratt for a fast repair.
- Bratt activates his starts up his laptop and connects it to the computer in his office. He selects the parts catalog belonging to the truck series of MB and gets an extract of the MB database installed on his laptop. Due to the limited storage capacity of the assistant, Bratt is asked either to remove some other, yet not necessary information manually or to let this be done by the system automatically. He selects the "automatic" option.
- Bratt asks his mechanic Willy to go to Frank's Farm and check out the truck. Willy takes the laptop with him and after a short inspection of about 30 minutes Willy realizes that the clutch is broken.
- Willy searches for the appropriate part in the electronic parts catalog on the laptop and suggests Frank to install a new clutch. Frank inquires about the price a new clutch and approves of the necessary repairs.
- Back in Bratt's garage Willy connects the laptop with the computer in the garage and the ordering information for the clutch is integrated into the dealer management system.

3.8. Additional Requirement: Billing

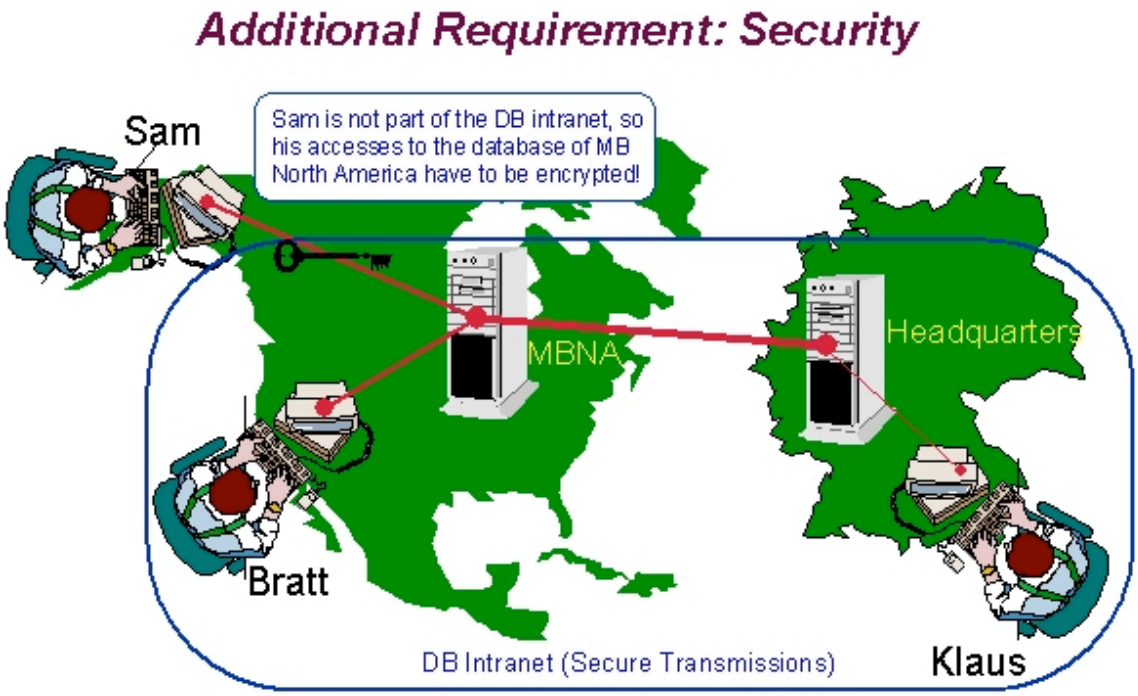
Problem: Not every dealer is an affiliated partner of Mercedes-Benz.



- Independent partners like Sam pay for access to the headquarter database.
- PAID provides accounting mechanisms that allow different forms of billing such as per-pay-click or flat rates.

3.9. Additional Requirement: Security

Problem: Not every dealer is connected directly to the Daimler-Benz Intra- or Extranet.



- A dealer connects to the Daimler-Benz network over the internet, an insecure channel.
- Transmissions to and from the dealer have to be encrypted.
- Different security mechanisms such as encryption and authentication have to be supported depending on the information he accesses.

4. Requirements and Constraints

4.1. Functional Requirements

The PAID system will consist of a set of applications and servers distributed over enterprise system platforms. The system realizes an adaptive, selective multicast of information. The PAID enhanced STAR NETWORK is

- **Adaptive** because the network is able to adapt itself to the behaviour of the users. A typical example for this functionality is given in scenario 5, where frequent accesses to the same data lead to a reconfiguration of the users local database.
- **Selective** because only the information a user is interested in is transmitted to his computer. No user receives data that he will not use. The same behaviour also applies to the server machines. MBNA for example does not receive information for vehicles which are sold only in Asia.
- **a Multicast-Network** because PAID does not simply broadcast new information but it instead sends it explicitly to those people who can use it.

The PAID system should also provide the following functionality:

- **Hierarchical Caching**
  - The informations within the PAID driven STAR NETWORK are cached hierachically. This means, that on the different servers of the DB Intranet different subsets of the headquarters database are cached.
- **Push/Pull-Mode Support**
  - The PAID driven STAR NETWORK supports both standard access modes:
    - New information from headquarters is *pushed* through the network to the dealers.
    - Any information that is not present at the dealer's local database is *pulled* from the next server that stores this information.
- **Secure Transmissions**
  - Data transmissions over the PAID driven network can be encrypted if necessary. The necessary encryption level can either be explicitly specified by the author of an information (e.g. DB headquarters) or it is based upon the profile of the user (e.g. affiliated dealer or not?) who is accessing it.
  - The system provides an authentication mechanism to identify every user.
- **Incremental Updates:**
  - Unlike in the currently used system (this is valid for the CD based delivery as well as for the standard STAR NETWORK), only new or modified data is transmitted. This feature reduces the amount of data which has to be submitted.
- **Disconnected Mode**
  - This allows *Mobile Computing* with laptops or other personal digital assistants. This does not mean, that any application can be installed on a mobile system
  - Disconnected mode makes the system insensible to unreliable network connections.
- **Transparency of Medium**
  - All types of media like networks, CD-ROM or satellite-based broadcast are handled in a transparent way by PAID. The end-user can select the medium he prefers.

4.2. Nonfunctional Requirements

The software architecture of PAID must also meet the following requirements:

- PAID is **extensible**: New applications and data sources can be added after PAID is launched. This requires an **open architecture** for PAID and all subsystems of it.
- The system is **customizable to the needs of the users:**
  - Every user can select automatic or manually initiated updates.
  - Every user can customize his local database according to his business requirements.
- PAID is **scalable** in terms of number of clients, number of applications, used protocols and bandwidth.
- **Internal management aspects** such as data location and replication are **transparent for the end-user** and only visible to people who are engaged in the management of the system.

4.3. Project Constraints

- The reference applications for the proof-of-concept prototype are applications from StarNetwork. These applications (*StarIdent* and *StarParts*) have been selected in collaboration with the customer.
- A web site will be established, that allows the client to participate in the project remotely from Stuttgart.
- All Applications must be written in 100% Java
- The PAID software must be published in Javadoc
- The software architecture and class library must be placed under configuration control
- All project documents must be published in HTML or PDF

5. System Design

Note: The preliminary subsystem decomposition will be mainly developed based upon the problem statement review at Stuttgart on August, 21st.

Here is a preliminary subsystem decomposition (in no special order):

- User Management
  - Handles all types of users (dealers, administrators, ...) within PAID. Has to define and handle access rights as well as user profiles which allow for example to create a partial copy of a user's database on his laptop.
- Network Monitoring
  - This subsystem monitors the network activity. It provides (statistical?) information about the network traffic that allows other subsystems like the Intelligency Subsystem to make decisions
- Intelligency Subsystem
  - Work together with the monitoring subsystem and realizes the "intelligent" part of PAID. This subsystem is responsible for expansions (and reductions) of local databases as well as for clever information distribution strategies ("low bandwidth: if informations can be re-ordered, transmit high priority data first").
- Transport Subsystem
  - Implements the necessary transport mechanisms: Routing, Compression, Push-Mode, Pull-Mode, Integrity checks, etc.
- Configuration and Data Management
  - Stores, displays and changes the configuration of the PAID network. A graphical user interface is needed for all tasks belonging to network management. Data Management includes all types of accesses to data.
- Security Subsystem
  - Works in cooperation with the transport subsystem (and perhaps other subsystems like the User Management) and provides all the functionality around authentication and encryption.
- Name Service
  - Every piece of information within PAID needs to be identified
- Graphical User Interface
  - Provides all the functionality necessary for an integrated, unique graphical user interface for

all subsystems that require one.

6. Development Environment

The development of the PAID is splitted into two projects at Carnegie Mellon University (CMU) and Technische Universität München (TUM).

- At CMU, Development makes use of the facilities offered in the clusters on CMU Campus as well as ***please add CMU specific information here!***
- At TUM, the computer laboratory in Room 3175 will be used for PAID. For additional work, students can also use the laboratory in Room 3219 and the computers of the Faculty for Computer Science at TUM.

The following development environments are provided:

Director. A tool that allows fast prototyping.

Together/J (CASE Tool). A CASE tool supporting the object-oriented model based development of systems written in Java. It provides modeling based on UML and OMT and supports round-trip reengineering between models and source code as well as generation of documentation.

Database Management System (DBMS) A not yet defined database management system to mirror the reference databases. The particular system will be selected during the development.

CodeWarrior Pro (Interactive Development Environment). A software development environment with a
powerful symbolic debugger for Java 1.1. CodeWarrior runs on the platforms Windows 95, Windows NT and
MacOS 8. It allows cross compilation.

Visibroker for Java (Object Request Broker). Middleware following the OMG CORBA standard. It provides remote method invocation across heterogenous platforms.

7. Target Environment

The development environment at CMU and TUM will be used for demonstrating the prototype. The target environment for the field-test demonstration of PAID will be selected during the development phase. By moving to a different environment, the PAID system shows its portability.

8. Client Acceptance

The client considers this problem statement to be a broad definition and does not expect that all the functionality mentioned in this document will be demonstrated either at the end of the semester at Carnegie Mellon University or at the end of the semester at Technische Universität München. However, the analysis and design should be extensible to include this functionality in a future version of the system.

During the requirements analysis phase of the project the client will negotiate with the software engineers an acceptable prototype for delivery. After the negotiation phase the specific requirements for the client acceptance tests (one at Carnegie Mellon University, the other at Technische Universität München) will be baselined. The client expects to sign off on the negotiated deliverables within 4-6 weeks of the client presentation.

For a demonstration of the system on client acceptance day, an appropriate scenario will be developed in cooperative work between the client and the project leader respective the software engineers.

9. Deliverables

The client expects a successful demonstration of the PAID prototype in a field trial at the end of February, 1999 in the Software Engineering Lab at Technische Universität München with participation of remote observers at Daimler Benz Headquarters, Stuttgart and other viewers around the world viewing the demonstration remotely in real time over the Internet. A similar presentation of the preliminary prototype is expected on December, 8 in the Software Engineering Lab at Carnegie Mellon University, Pittsburgh.

A set of documents on a CD-ROM describing the requirements analysis (RAD), the system design (SDD), object design (ODD), testing procedures (TM) and user manual of the PAID system should accompany the final demonstration in Munich.