MeDaMAk

A measurement data management system based on the openMDM framework

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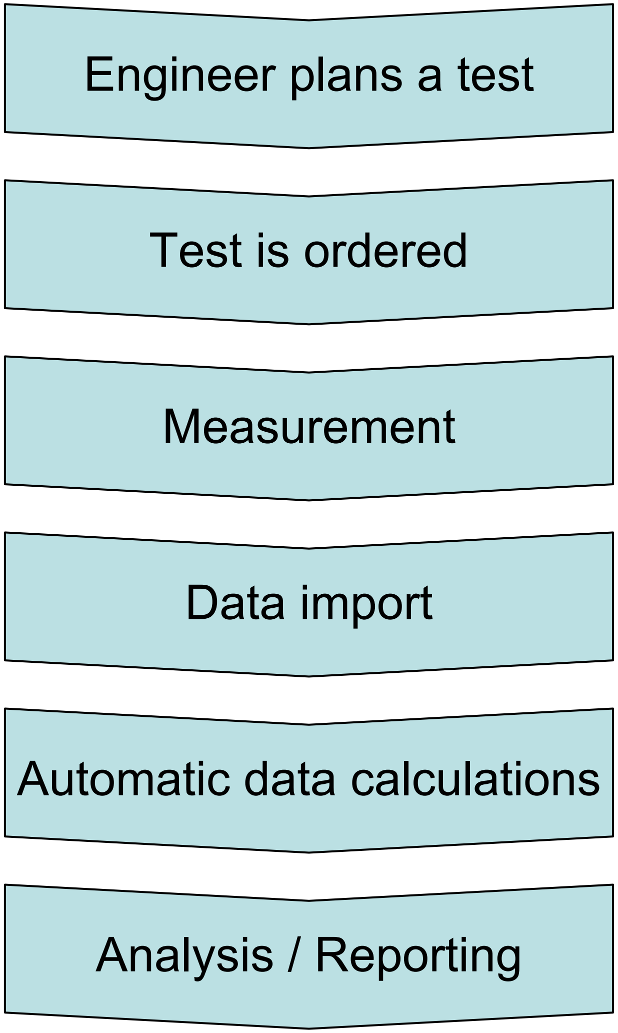
Topics

- Requirements
- System overview
- Database model
  - The MDM base model
  - System specific modelling
- System components
  - MeDaMAk client
  - Data import
  - Data post processing
  - Data export
  - Data viewing/analysis/reporting with external tools
- Data access layer
- Integration of company services
- Benefits of using the MDM framework

Use cases

- Acoustic measurements have to be performed
- Measurement data is produced by different measurement devices using various data formats
- The data shall be persisted in a standard format
- Automatic data post processing is required
- Analysis and reporting in the tool of choice of the individual engineer
- Long term data storage and interpretation are independent of originating measurement software

The standard measurement process



Engineer plans a test

Test is ordered

Measurement

Data import

Automatic data calculations

Analysis / Reporting

•Test order data is persisted in database

•Order data goes „offline“

•Additional actions

•Offline/Online measurement

•Measurement devices perform calculations

•Quality check

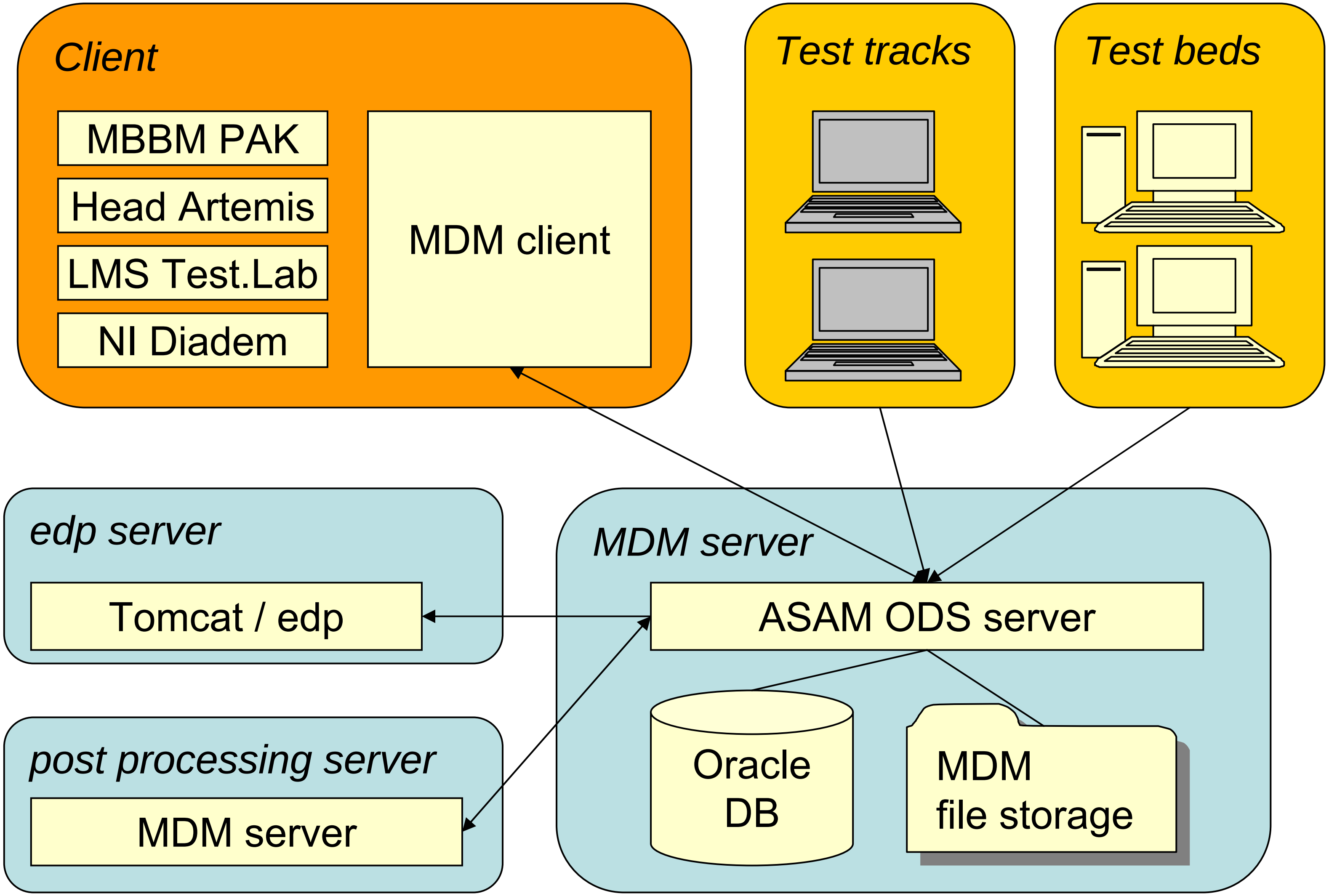
•Appended to order data

•Quality check

•Appended to order data

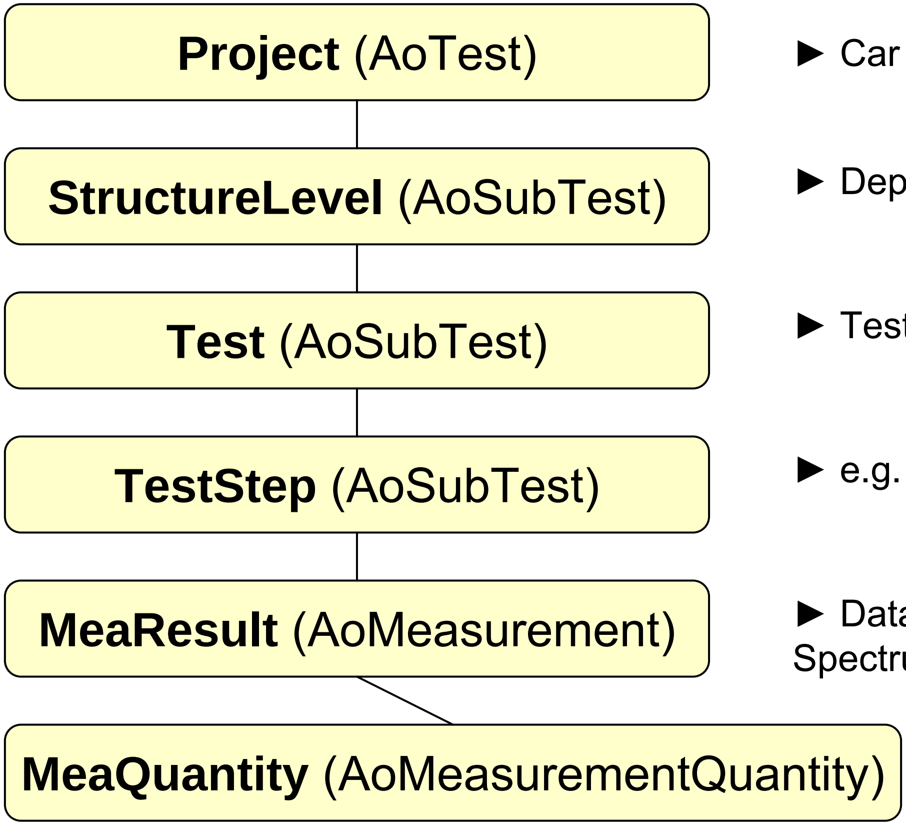
•Use of various tools

System overview



Database model – MDM model

The MDM idea:
A standardized and fixed application model for all use cases.



Project (AoTest)

StructureLevel (AoSubTest)

Test (AoSubTest)

TestStep (AoSubTest)

MeaResult (AoMeasurement)

MeaQuantity (AoMeasurementQuantity)

► Car development project, e.g. „AU123“

► Department, e.g. „Pass-By-Noise“

► Test Goal, e.g. „compare exhausts“

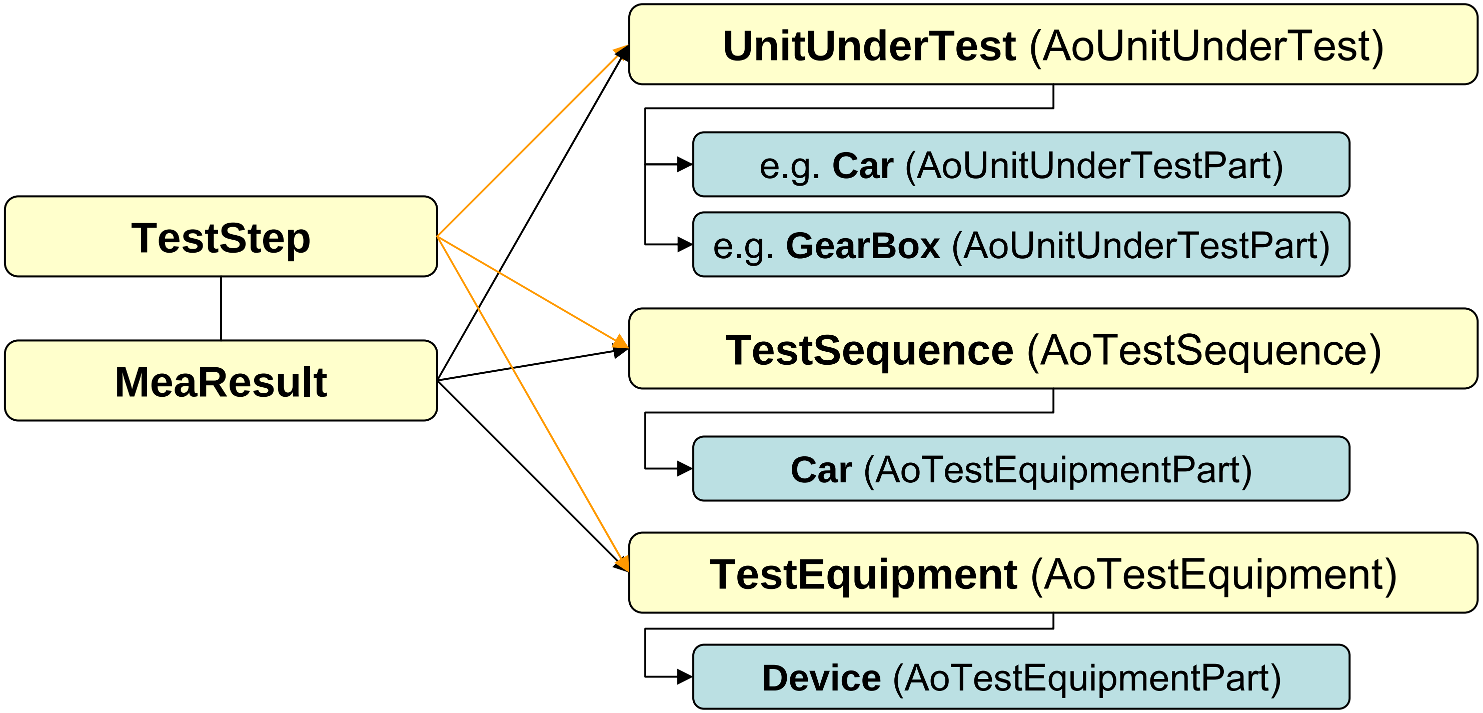
► e.g. „First gear, full throttle“

► Data type, e.g. „Throughput“, „Order Spectrum“,…

► The channel name
e.g. „MIC.front left“

Database model – MeDaMAk

- Containers are provided for descriptive data
- Changes of the model are permitted only for adding/removing/altering application elements and attributes of descriptive data
- Model changes can be made with a graphical user interface
- Separate storage of order and measurement descriptions

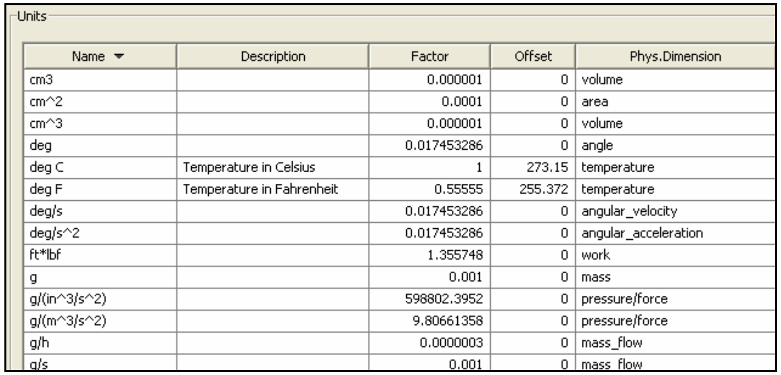


UnitUnderTest (AoUnitUnderTest)
e.g. **Car** (AoUnitUnderTestPart)
e.g. **GearBox** (AoUnitUnderTestPart)
TestStep
MeaResult
TestSequence (AoTestSequence)
Car (AoTestEquipmentPart)
TestEquipment (AoTestEquipment)
Device (AoTestEquipmentPart)

Database model – MeDaMAk

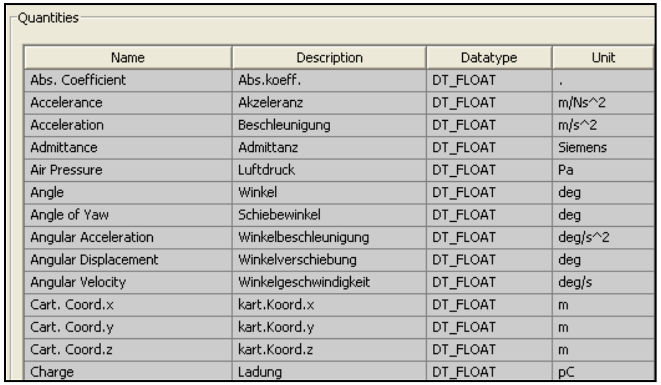
Metadata for measurement data

- physical dimensions
- unit catalogue
- quantity catalogue defines
  - comparable channels
  - storage-unit of channels
  - default-datatype of channel data



Units

Name	Description	Factor	Offset	Phys.Dimension
cm3		0.000001	0	volume
cm^2		0.0001	0	area
cm^3		0.000001	0	volume
deg		0.017453286	0	angle
deg C	Temperature in Celsius	1	273.15	temperature
deg F	Temperature in Fahrenheit	0.55555	255.372	temperature
deg/s		0.017453286	0	angular_velocity
deg/s^2		0.017453286	0	angular_acceleration
ft*lbf		1.355748	0	work
g		0.001	0	mass
g/(in^3/s^2)		598802.3952	0	pressure/force
g/(m^3/s^2)		9.80661358	0	pressure/force
g/h		0.0000003	0	mass_flow
g/s		0.001	0	mass_flow



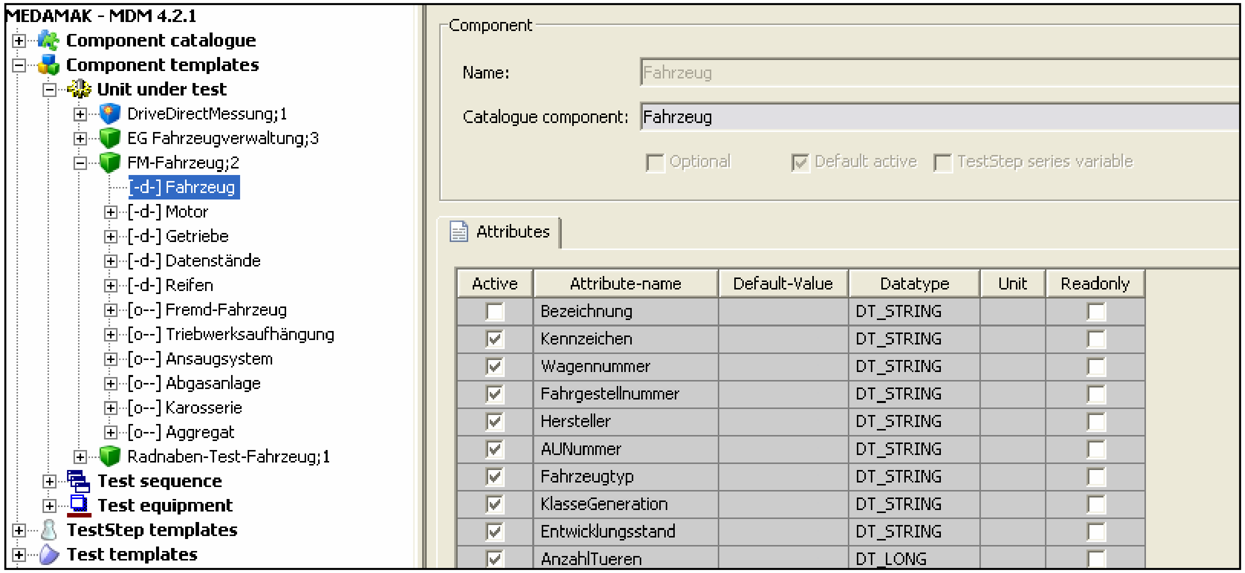
Quantities

Name	Description	Datatype	Unit
Abs. Coefficient	Abs.koeff.	DT_FLOAT	.
Accelerance	Akzeleranz	DT_FLOAT	m/Ns^2
Acceleration	Beschleunigung	DT_FLOAT	m/s^2
Admittance	Admittanz	DT_FLOAT	Siemens
Air Pressure	Luftdruck	DT_FLOAT	Pa
Angle	Winkel	DT_FLOAT	deg
Angle of Yaw	Schiebewinkel	DT_FLOAT	deg
Angular Acceleration	Winkelbeschleunigung	DT_FLOAT	deg/s^2
Angular Displacement	Winkelverschiebung	DT_FLOAT	deg
Angular Velocity	Winkelgeschwindigkeit	DT_FLOAT	deg/s
Cart. Coord.x	kart.Koord.x	DT_FLOAT	m
Cart. Coord.y	kart.Koord.y	DT_FLOAT	m
Cart. Coord.z	kart.Koord.z	DT_FLOAT	m
Charge	Ladung	DT_FLOAT	pC

Database model – MeDaMAk

Metadata for measurement descriptions

- Definition of different use cases
- Administration by the operating department
- Templates for
  - Component structures
  - TestSteps
  - Tests



MEDAMAK - MDM 4.2.1

- **Component catalogue**
- **Component templates**
  - **Unit under test**
    - DriveDirectMessung;1
    - EG Fahrzeugverwaltung;3
    - FM-Fahrzeug;2
      - [-d-] Fahrzeug
      - [-d-] Motor
      - [-d-] Getriebe
      - [-d-] Datenstände
      - [-d-] Reifen
      - [o--] Fremd-Fahrzeug
      - [o--] Triebwerksaufhängung
      - [o--] Ansaugsystem
      - [o--] Abgasanlage
      - [o--] Karosserie
      - [o--] Aggregat
    - Radnaben-Test-Fahrzeug;1
  - **Test sequence**
  - **Test equipment**
- **TestStep templates**
- **Test templates**

Component

Name: Fahrzeug

Catalogue component: Fahrzeug

☐ Optional ☑ Default active ☐ TestStep series variable

Attributes

Active	Attribute-name	Default-Value	Datatype	Unit	Readonly
☐	Bezeichnung		DT_STRING		☐
☑	Kennzeichen		DT_STRING		☐
☑	Wagennummer		DT_STRING		☐
☑	Fahrgestellnummer		DT_STRING		☐
☑	Hersteller		DT_STRING		☐
☑	AUNummer		DT_STRING		☐
☑	Fahrzeugtyp		DT_STRING		☐
☑	KlasseGeneration		DT_STRING		☐
☑	Entwicklungsstand		DT_STRING		☐
☑	AnzahlTueren		DT_LONG		☐

MeDaMAk client

User interface mainly for data lookup

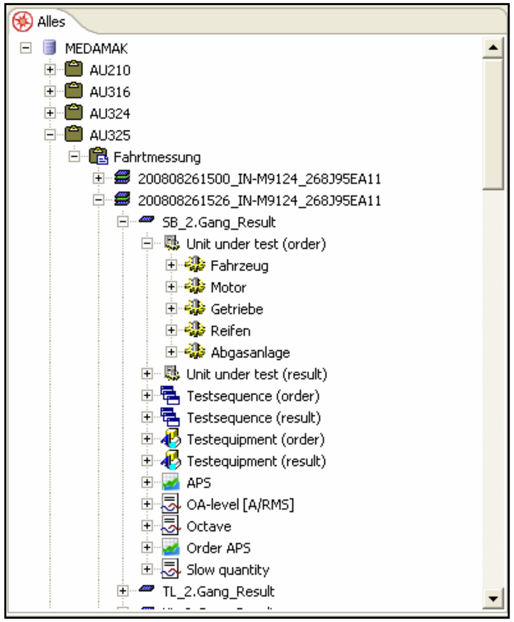
- Browsing and viewing measurement descriptions
- Collecting the data to compare into „shoppingbaskets“
- Serving data to external tools

=> NOT intended to be used for sophisticated reporting and analysis

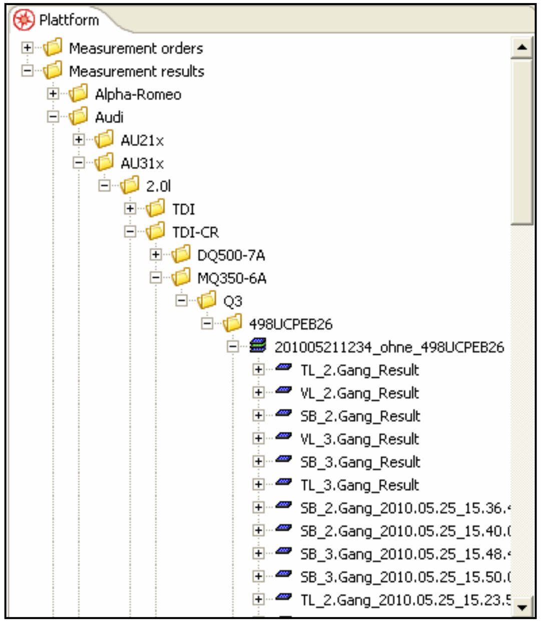
MeDaMAk client - Navigation

openMDM
Measured Data Management

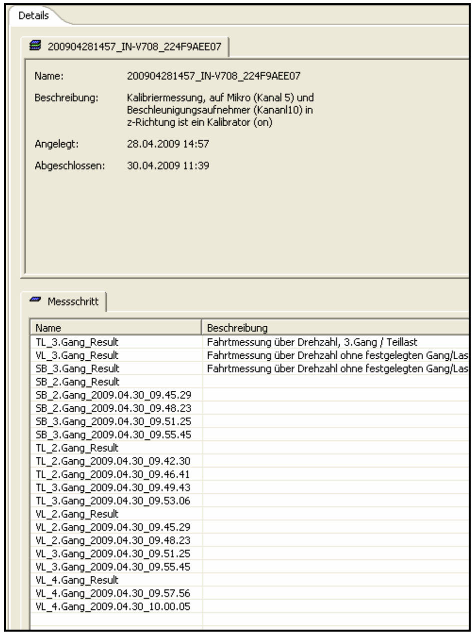
- Navigating the default MDM structure
  => Similar view as in an standard ODS client
- Navigating user-views
  => Every user group has its own interest
  => Replaces complex search masks
- Using a detail view



```
Alles
⊟ MEDAMAK
   ⊞ AU210
   ⊞ AU316
   ⊞ AU324
   ⊟ AU325
      ⊟ Fahrtmessung
         ⊞ 200808261500_IN-M9124_268J95EA11
         ⊟ 200808261526_IN-M9124_268J95EA11
            ⊟ SB_2.Gang_Result
               ⊟ Unit under test (order)
                  ⊞ Fahrzeug
                  ⊞ Motor
                  ⊞ Getriebe
                  ⊞ Reifen
                  ⊞ Abgasanlage
               ⊞ Unit under test (result)
               ⊞ Testsequence (order)
               ⊞ Testsequence (result)
               ⊞ Testequipment (order)
               ⊞ Testequipment (result)
               ⊞ APS
               ⊞ OA-level [A/RMS]
               ⊞ Octave
               ⊞ Order APS
               ⊞ Slow quantity
            ⊞ TL_2.Gang_Result
```



```
Plattform
⊞ Measurement orders
⊟ Measurement results
   ⊞ Alpha-Romeo
   ⊟ Audi
      ⊞ AU21x
      ⊟ AU31x
         ⊟ 2.0l
            ⊞ TDI
            ⊟ TDI-CR
               ⊞ DQ500-7A
               ⊟ MQ350-6A
                  ⊟ Q3
                     ⊟ 498UCPEB26
                        ⊟ 201005211234_ohne_498UCPEB26
                           ⊞ TL_2.Gang_Result
                           ⊞ VL_2.Gang_Result
                           ⊞ SB_2.Gang_Result
                           ⊞ VL_3.Gang_Result
                           ⊞ SB_3.Gang_Result
                           ⊞ TL_3.Gang_Result
                           ⊞ SB_2.Gang_2010.05.25_15.36.
                           ⊞ SB_2.Gang_2010.05.25_15.40.
                           ⊞ SB_3.Gang_2010.05.25_15.48.
                           ⊞ SB_3.Gang_2010.05.25_15.50.
                           ⊞ TL_2.Gang_2010.05.25_15.23.5
```



Details

200904281457_IN-V708_224F9AEE07

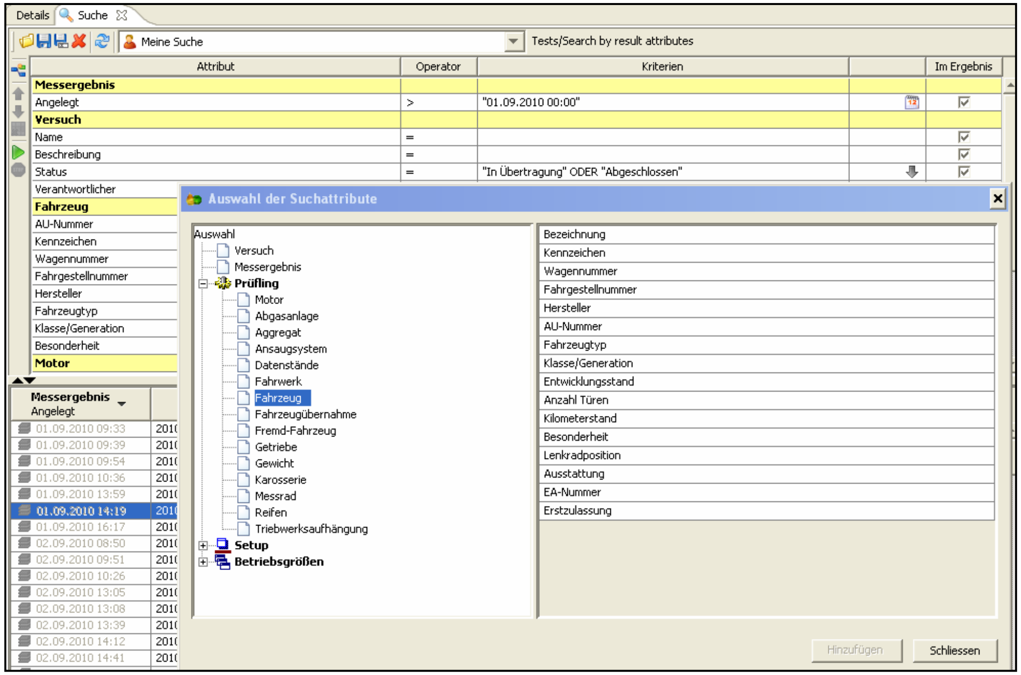
Name:	200904281457_IN-V708_224F9AEE07
Beschreibung:	Kalibriermessung, auf Mikro (Kanal 5) und Beschleunigungsaufnehmer (Kananl10) in z-Richtung ist ein Kalibrator (on)
Angelegt:	28.04.2009 14:57
Abgeschlossen:	30.04.2009 11:39

Messschritt

Name	Beschreibung
TL_3.Gang_Result	Fahrtmessung über Drehzahl, 3.Gang / Teillast
VL_3.Gang_Result	Fahrtmessung über Drehzahl ohne festgelegten Gang/Las
SB_3.Gang_Result	Fahrtmessung über Drehzahl ohne festgelegten Gang/Las
SB_2.Gang_Result	
SB_2.Gang_2009.04.30_09.45.29	
SB_2.Gang_2009.04.30_09.48.23	
SB_3.Gang_2009.04.30_09.51.25	
SB_3.Gang_2009.04.30_09.55.45	
TL_2.Gang_Result	
TL_2.Gang_2009.04.30_09.42.30	
TL_2.Gang_2009.04.30_09.46.41	
TL_3.Gang_2009.04.30_09.49.43	
TL_3.Gang_2009.04.30_09.53.06	
VL_2.Gang_Result	
VL_2.Gang_2009.04.30_09.45.29	
VL_2.Gang_2009.04.30_09.48.23	
VL_3.Gang_2009.04.30_09.51.25	
VL_3.Gang_2009.04.30_09.55.45	
VL_4.Gang_Result	
VL_4.Gang_2009.04.30_09.57.56	
VL_4.Gang_2009.04.30_10.00.05	

MeDaMAk client - Search

- Generic search



Attribut	Operator	Kriterien		Im Ergebnis
Messergebnis				
Angelegt	>	"01.09.2010 00:00"		☑
Versuch				
Name	=			☑
Beschreibung	=			☑
Status	=	"In Übertragung" ODER "Abgeschlossen"		☑
Verantwortlicher				
Fahrzeug				
AU-Nummer				
Kennzeichen				
Wagennummer				
Fahrgestellnummer				
Hersteller				
Fahrzeugtyp				
Klasse/Generation				
Besonderheit				
Motor				

Messergebnis Angelegt	
01.09.2010 09:33	201
01.09.2010 09:39	201
01.09.2010 09:54	201
01.09.2010 10:36	201
01.09.2010 13:59	201
01.09.2010 14:19	201
01.09.2010 16:17	201
02.09.2010 08:50	201
02.09.2010 09:51	201
02.09.2010 10:26	201
02.09.2010 13:05	201
02.09.2010 13:08	201
02.09.2010 13:39	201
02.09.2010 14:12	201
02.09.2010 14:41	201

Auswahl der Suchattribute

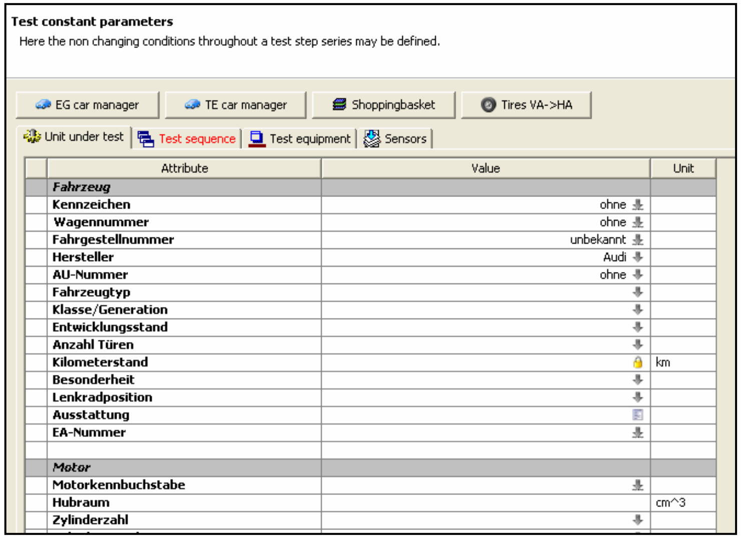
Auswahl
- Versuch
- Messergebnis
- **Prüfling**
  - Motor
  - Abgasanlage
  - Aggregat
  - Ansaugsystem
  - Datenstände
  - Fahrwerk
  - Fahrzeug
  - Fahrzeugübernahme
  - Fremd-Fahrzeug
  - Getriebe
  - Gewicht
  - Karosserie
  - Messrad
  - Reifen
  - Triebwerksaufhängung
- **Setup**
- **Betriebsgrößen**

Bezeichnung
Kennzeichen
Wagennummer
Fahrgestellnummer
Hersteller
AU-Nummer
Fahrzeugtyp
Klasse/Generation
Entwicklungsstand
Anzahl Türen
Kilometerstand
Besonderheit
Lenkradposition
Ausstattung
EA-Nummer
Erstzulassung

- Search definitions
  - System defined
  - User defined

MeDaMAk client – Test planner

- Engineer may order tests directly from their desk
- The graphical user interface is implemented as a wizard to lighten the use for unexperienced users
- The description patterns are loaded from MDM templates
- Optional test descriptions may be added depending on the test goal
- The sensor composition of a test can be defined
- The graphical user interface may be extended
  - Dock on company services like part management systems
  - Interface for name generation to ensure clean database entries
  - Custom actions may be defined to be executed on test ordering



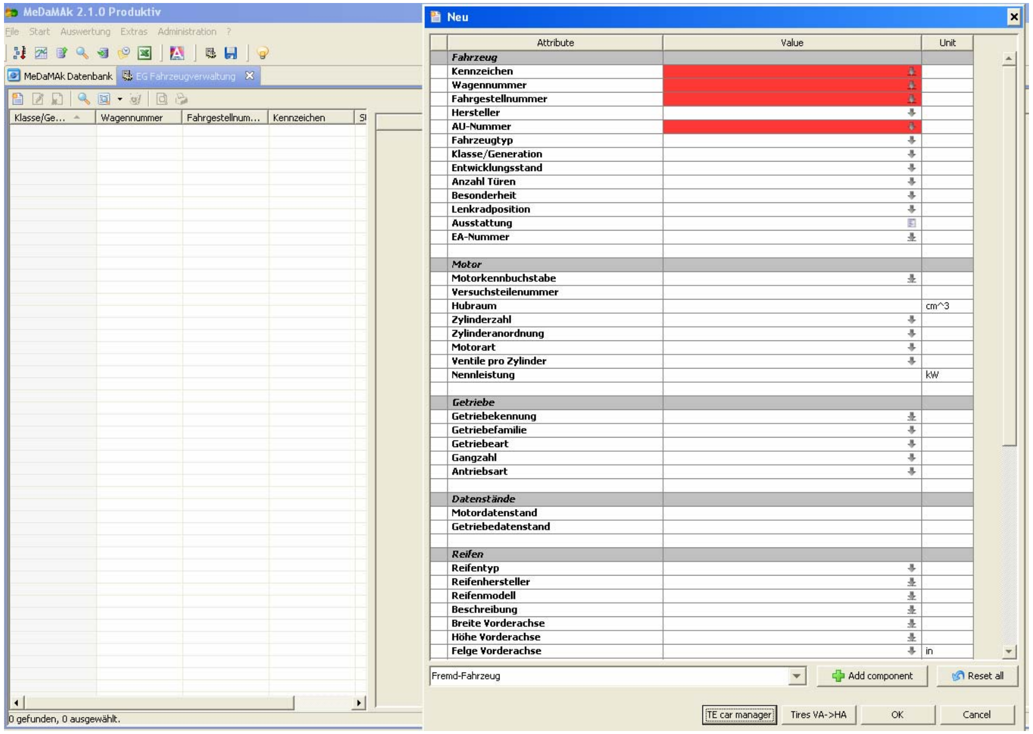
Test constant parameters

Here the non changing conditions throughout a test step series may be defined.

Attribute	Value	Unit
Fahrzeug		
Kennzeichen	ohne	
Wagennummer	ohne	
Fahrgestellnummer	unbekannt	
Hersteller	Audi	
AU-Nummer	ohne	
Fahrzeugtyp		
Klasse/Generation		
Entwicklungsstand		
Anzahl Türen		
Kilometerstand		km
Besonderheit		
Lenkradposition		
Ausstattung		
EA-Nummer		
Motor		
Motorkennbuchstabe		
Hubraum		cm^3
Zylinderzahl		

MeDaMAk client – Part manager

- Every TestStep has its own measurement description
  => state of the test object at the moment of the test
- For support of the test planners catalogues of test objects may be created
- In the test planning component the data is searched for and copied into the test description

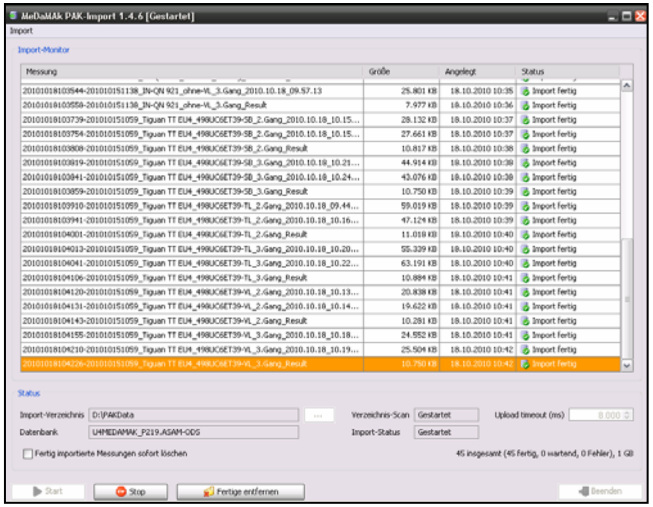


Attribute	Value	Unit
Fahrzeug		
Kennzeichen	🟥	
Wagennummer	🟥	
Fahrgestellnummer	🟥	
Hersteller		
AU-Nummer	🟥	
Fahrzeugtyp		
Klasse/Generation		
Entwicklungsstand		
Anzahl Türen		
Besonderheit		
Lenkradposition		
Ausstattung		
EA-Nummer		
Motor		
Motorkennbuchstabe		
Versuchsteilenummer		
Hubraum		cm^3
Zylinderzahl		
Zylinderanordnung		
Motorart		
Ventile pro Zylinder		
Nennleistung		kW
Getriebe		
Getriebekennung		
Getriebefamilie		
Getriebeart		
Gangzahl		
Antriebsart		
Datenstände		
Motordatenstand		
Getriebedatenstand		
Reifen		
Reifentyp		
Reifenhersteller		
Reifenmodell		
Beschreibung		
Breite Vorderachse		
Höhe Vorderachse		
Felge Vorderachse		in

Fremd-Fahrzeug

Data import

- **Automatic import (scheduler)**
  - Polls at a local directory
  - Imports data in background
  - Administrator gets notified only in case of an error



Messung	Größe	Angelegt	Status
20101018103544-20101015113 8_IN-QN 921_ohne-VL_3.Gang_2010.10.18_09.57.13	25.801 KB	18.10.2010 10:35	Import fertig
20101018103558-201010151138_IN-QN 921_ohne-VL_3.Gang_Result	7.977 KB	18.10.2010 10:36	Import fertig
20101018103739-201010151059_Tiguan TT EU4_498UC6ET39-SB_2.Gang_2010.10.18_10.15...	28.132 KB	18.10.2010 10:37	Import fertig
20101018103754-201010151059_Tiguan TT EU4_498UC6ET39-SB_2.Gang_2010.10.18_10.15...	27.661 KB	18.10.2010 10:37	Import fertig
20101018103808-201010151059_Tiguan TT EU4_498UC6ET39-SB_2.Gang_Result	10.817 KB	18.10.2010 10:38	Import fertig
20101018103819-201010151059_Tiguan TT EU4_498UC6ET39-SB_3.Gang_2010.10.18_10.21...	44.914 KB	18.10.2010 10:38	Import fertig
20101018103841-201010151059_Tiguan TT EU4_498UC6ET39-SB_3.Gang_2010.10.18_10.24...	43.076 KB	18.10.2010 10:38	Import fertig
20101018103859-201010151059_Tiguan TT EU4_498UC6ET39-SB_3.Gang_Result	10.750 KB	18.10.2010 10:39	Import fertig
20101018103910-201010151059_Tiguan TT EU4_498UC6ET39-TL_2.Gang_2010.10.18_09.44...	59.019 KB	18.10.2010 10:39	Import fertig
20101018103941-201010151059_Tiguan TT EU4_498UC6ET39-TL_2.Gang_2010.10.18_10.16...	47.124 KB	18.10.2010 10:39	Import fertig
20101018104001-201010151059_Tiguan TT EU4_498UC6ET39-TL_2.Gang_Result	11.018 KB	18.10.2010 10:40	Import fertig
20101018104013-201010151059_Tiguan TT EU4_498UC6ET39-TL_3.Gang_2010.10.18_10.20...	55.339 KB	18.10.2010 10:40	Import fertig
20101018104041-201010151059_Tiguan TT EU4_498UC6ET39-TL_3.Gang_2010.10.18_10.22...	63.191 KB	18.10.2010 10:40	Import fertig
20101018104106-201010151059_Tiguan TT EU4_498UC6ET39-TL_3.Gang_Result	10.884 KB	18.10.2010 10:41	Import fertig
20101018104120-201010151059_Tiguan TT EU4_498UC6ET39-VL_2.Gang_2010.10.18_10.13...	20.838 KB	18.10.2010 10:41	Import fertig
20101018104131-201010151059_Tiguan TT EU4_498UC6ET39-VL_2.Gang_2010.10.18_10.14...	19.622 KB	18.10.2010 10:41	Import fertig
20101018104143-201010151059_Tiguan TT EU4_498UC6ET39-VL_2.Gang_Result	10.281 KB	18.10.2010 10:41	Import fertig
20101018104155-201010151059_Tiguan TT EU4_498UC6ET39-VL_3.Gang_2010.10.18_10.18...	24.552 KB	18.10.2010 10:41	Import fertig
20101018104210-201010151059_Tiguan TT EU4_498UC6ET39-VL_3.Gang_2010.10.18_10.19...	25.504 KB	18.10.2010 10:42	Import fertig
20101018104226-201010151059_Tiguan TT EU4_498UC6ET39-VL_3.Gang_Result	10.750 KB	18.10.2010 10:42	Import fertig

Import-Verzeichnis: D:\PAKData

Datenbank: U4MEDAMAK_P219.ASAM-ODS

Verzeichnis-Scan: Gestartet

Import-Status: Gestartet

Upload timeout (ms): 8.000

☐ Fertig importierte Messungen sofort löschen

45 insgesamt (45 fertig, 0 wartend, 0 Fehler), 1 GB

- **User driven data import**
  - Measurement data often has to be edited before import
  - MDM comes with a generic user interface
  - Only the data driver has to be implemented
  - Drivers for a few standard file formats already exist

Data post processing

Calculations have to be performed on measurement data.
Calculation results have to be persisted.

- **Calculations before data import**
  - The result data is treated like measurement data

- **Manually processed by an user**
  - Data is transferred from MDM to an external tool
  - Import calculation results
    - Import result files with an MDM importer
    - The external application writes the data itself to the MDM data storage (e.g. LMS Test.Lab)

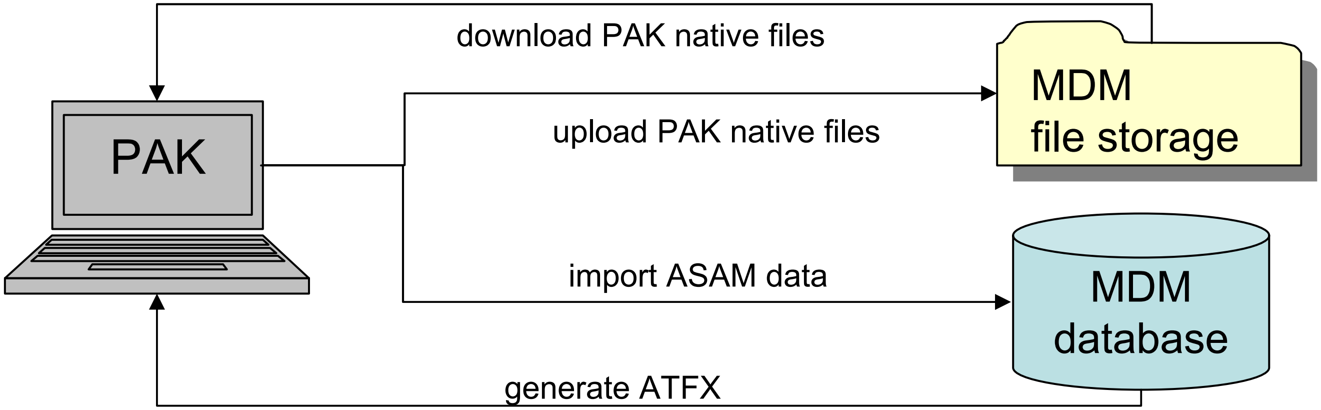
- **Automatic post processing**
  - The source data is marked at import time
  - A server process searches for marked data and processes the data over night
  - MDM has a build-in mechanismn for this process

Integration of external tools

- Engineers want to use the best fitting software tool for their field of activity
- MDM has the responsibility to ensure the exchangeability of stored measurement data
- The MDM client is no replacement for professional data analysis tools
- External tools are mostly rich client software
- The analysis tools provide interfaces
  => MDM serves the data to external software
- MeDaMAk has interfaces to the following tools
  - *MuellerBBM „PAK“*
  - *MuellerBBM „edp“*
  - *LMS „Test.Lab“*
  - *HeadAcoustics „Artemis“*
  - *National Instruments „Diadem“*

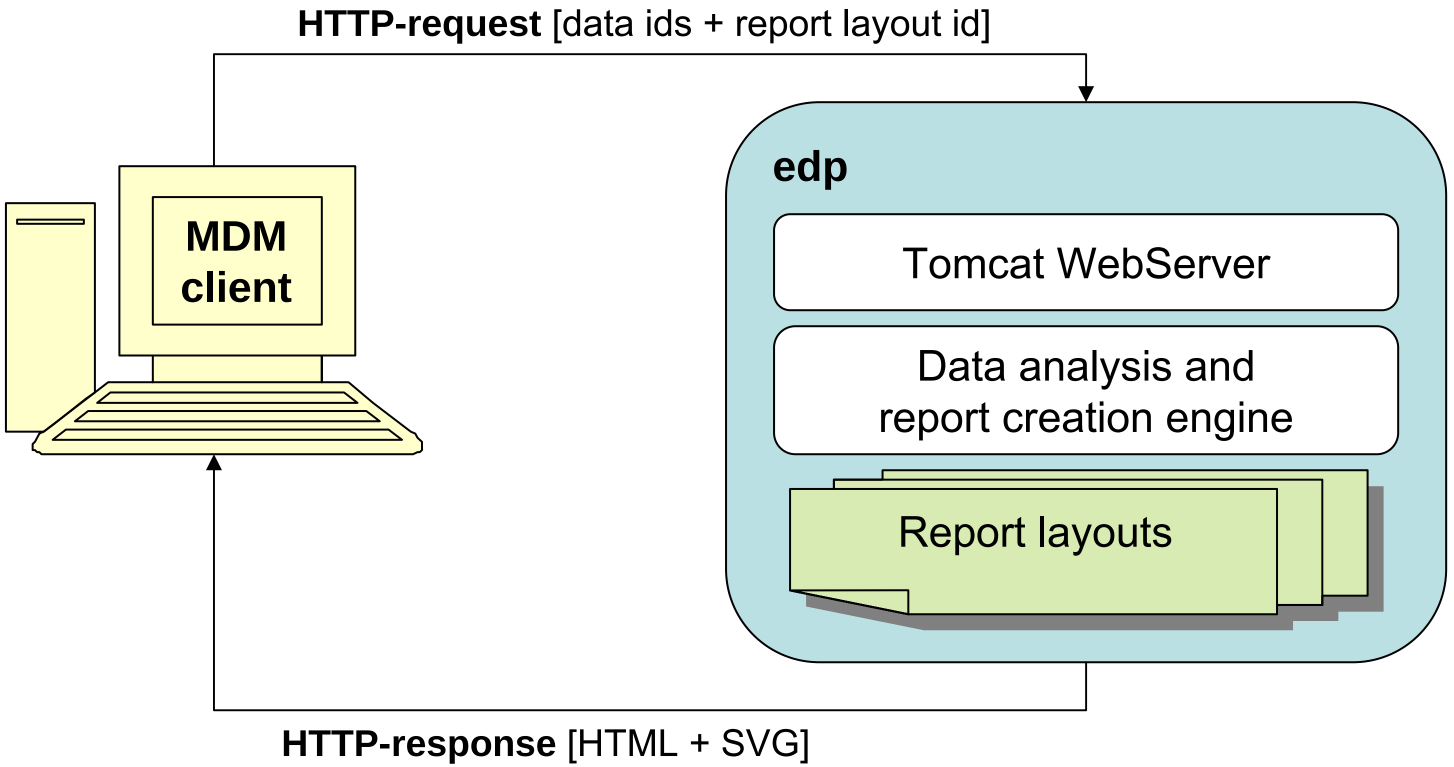
Integration of MuellerBBM „PAK“

- As much data as possible is imported into standard ODS dataformat
- Additional information is uploaded to the MDM data storage as blackbox files
- PAK provides two interfaces for reading data
  - **PAK native file format**
    => MDM downloads selected data from file storage
  - **ATFX file format**
    => MDM generates an ATFX-File containing the data in the shoppingbasket
    => non PAK measurement data can be analysed



Integration of MuellerBBM „edp“

- Web application „engineering data portal“
- Online data viewer and reporting tool
- Comes with own ODS browser
- The report is generated on the server side
  => Benefit: measurement data has not to be transferred to the client



HTTP-request [data ids + report layout id]

MDM client

edp

Tomcat WebServer

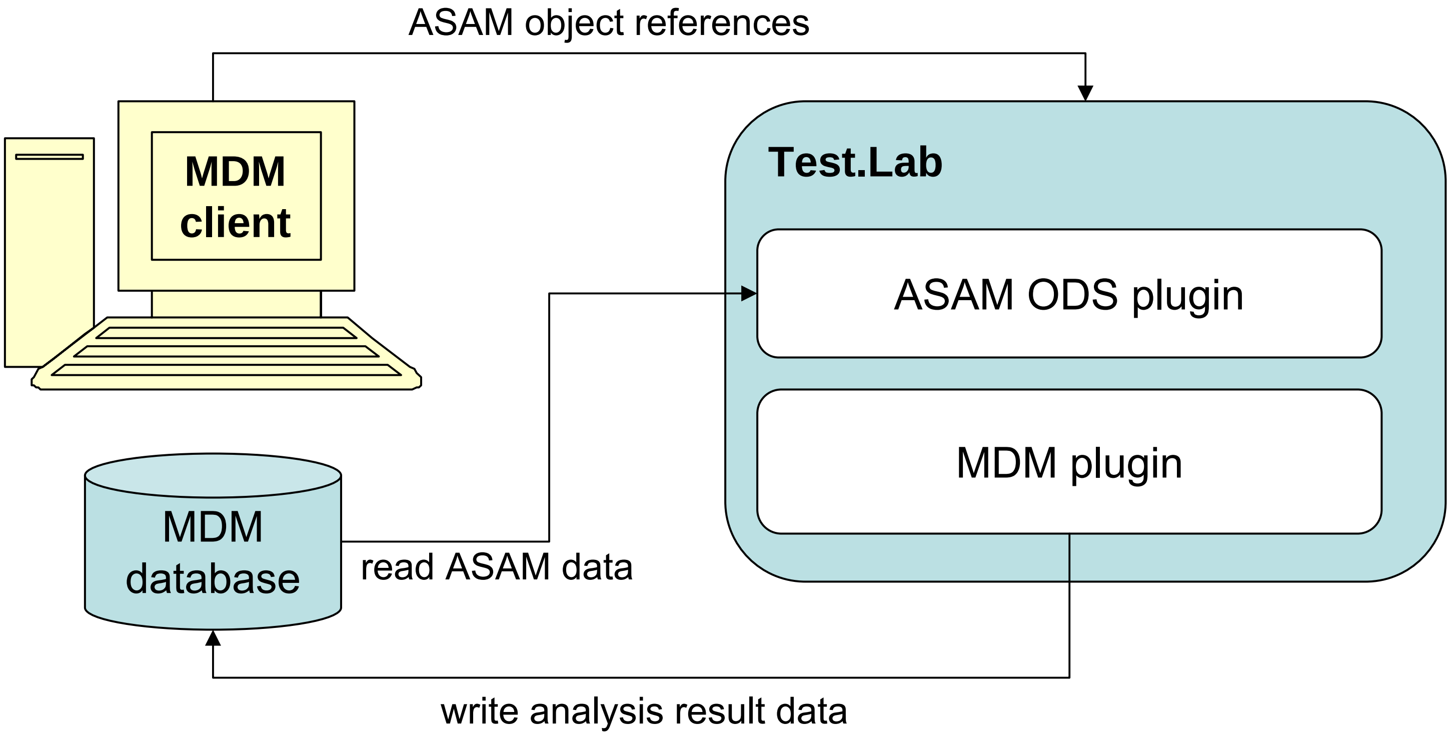
Data analysis and report creation engine

Report layouts

HTTP-response [HTML + SVG]

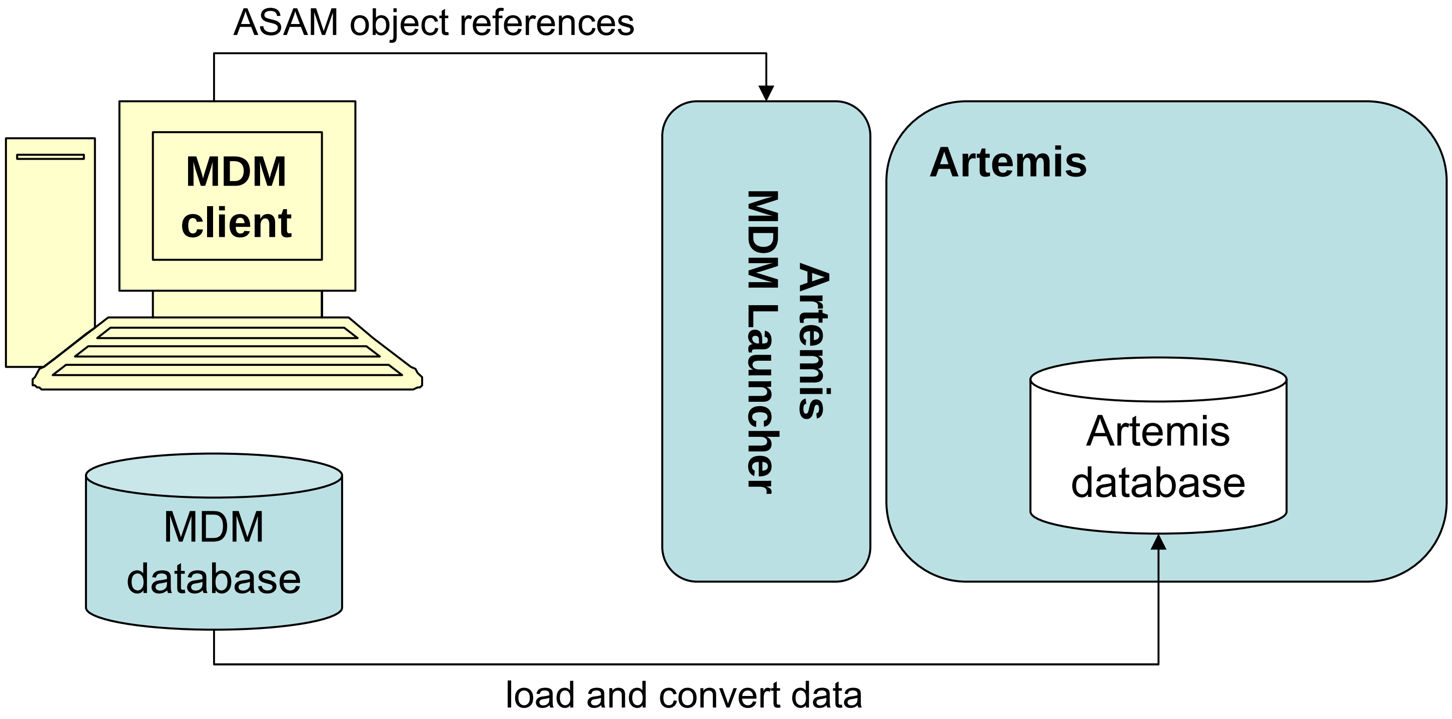
Integration of LMS „Test.Lab“

- Windows rich client
- Professional NVH analysis tool
- Comes with own ODS browser
- Provides interfaces for
  - Reading from ASAM-ODS persistence
  - Writing to ASAM-ODS persistence
  - May be configured which data to load



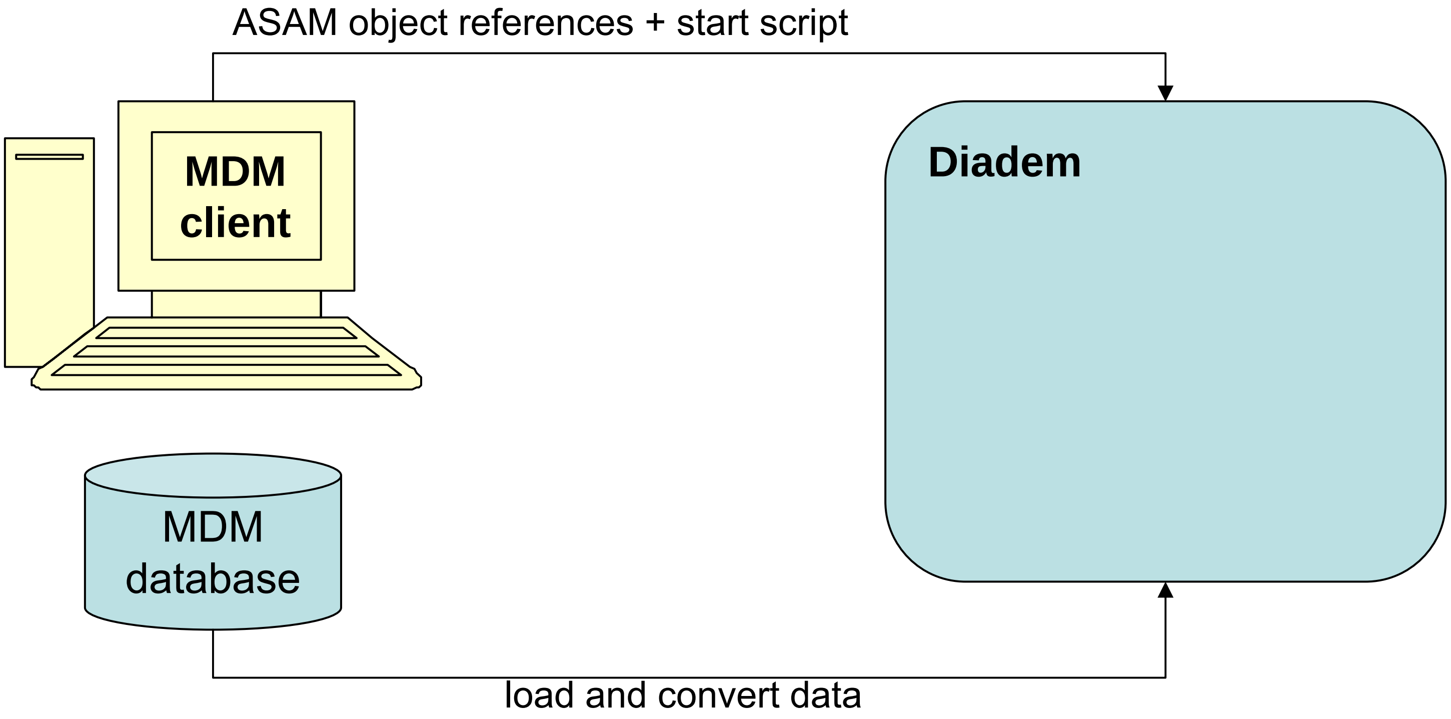
Integration of „Artemis“

- Windows rich client
- Professional NVH analysis tool
- Provides a tool for converting ASAM-ODS data to internal Artemis data format
- Comes with an user interface to load data from MDM shoppingbaskets



Integration of NI „Diadem“

- Windows rich client
- Comes with own ODS browser
- Provides a scripting language to handle ODS objects
- Provides an interface to start a script on startup



ASAM object references + start script

MDM client

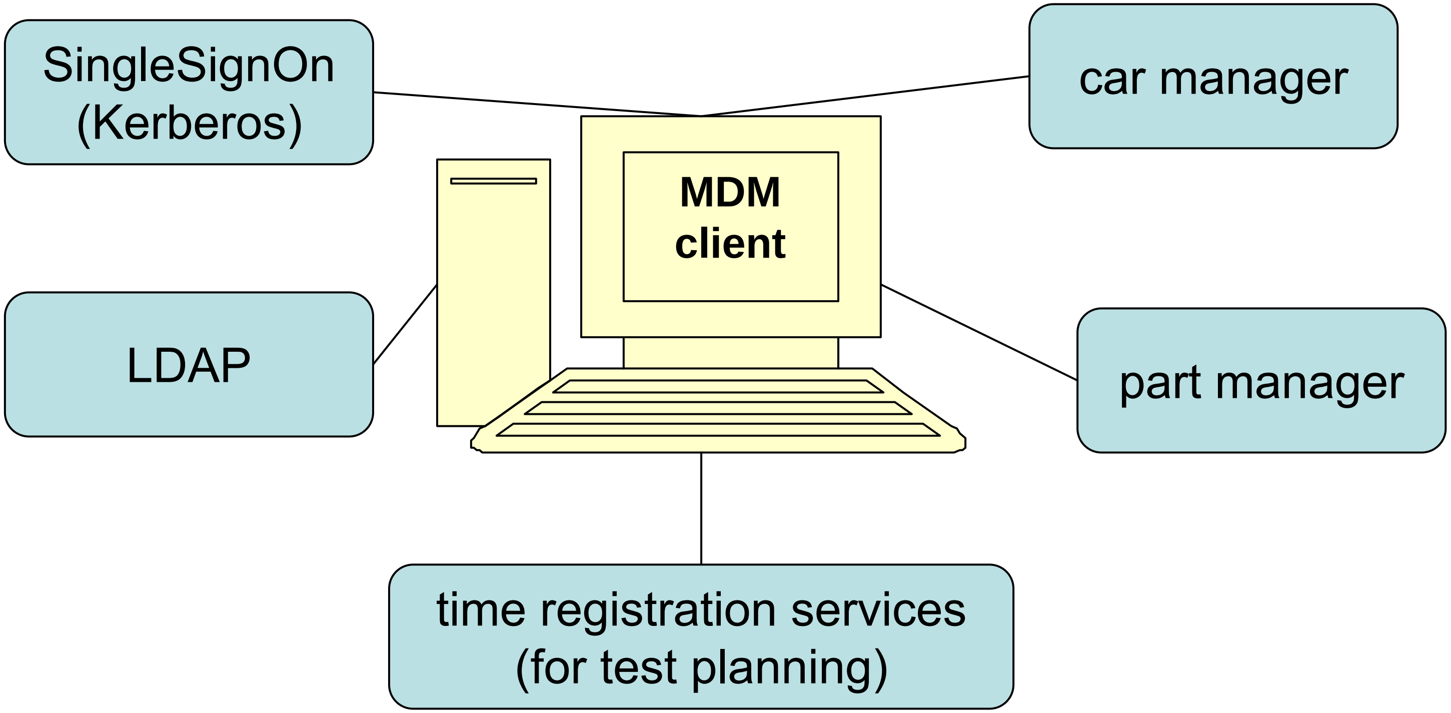
Diadem

MDM database

load and convert data

Integration of company services

- MDM **uses** company services



- MDM **provides** a central company service
  => Business objects for measurement data

Data access layer – MDM API

- Programming against the ODS OO-API is difficult and needs a huge knowledge about ASAM ODS
- MDM provides high level API defining business objects
- The MDM-API hides the generics and complexity of the ASAM model
- To avoid violation of MDM storage rules direct access to the ASAM objects model is prohibited
- Because the MDM-API knows the physical model, data access has good performance

Benefits of using the MDM framework

- No need for custom database design
- Datamodels may „grow“ without the need to extend the software
- By chosing MDM you get a system based on many years of experience implementing „ASAM ODS“ best practices
- Proved 100% ASAM ODS compatibility
  - Includes ASAM NVH specification
  - Includes ASAM workflow specification
  - In future: Includes ASAM geometry model specification
- MDM provides a high level data access API
  => no need for ASAM ODS specialists when developing new components
- Optionally you get a full grown server/client framework
- There already exist a lot of proven generic MDM-components
- Many professional analysis tools already provide an interface to read/write data from an MDM data storage

Thank you!