

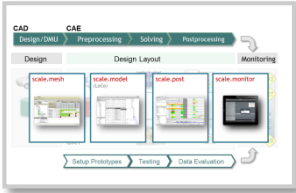
LoCo

Neue und geplante Entwicklungen im SDM-System LoCo

March 2015

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LoCo: *Agenda*



Introduction / Motivation

- Classification
- Key Features
- Unique selling points



Overview of LoCo

- Decentralization of development with LoCo
- Pools and Version management
- Assembly of simulations from modularized input decks
- Customizability



New Developments / Outlook

- Data deduplication
- Data compression for collections of simulation output data
- Check infrastructure
- Complete offline usage
- Optimization of domain decomposition
- Connection to CAD and PDM-Systems
- Multi run setups
- Multistage model assemblies
- Redesign of the User interface

LoCo: *Product of SCALE for Data and Process Management*

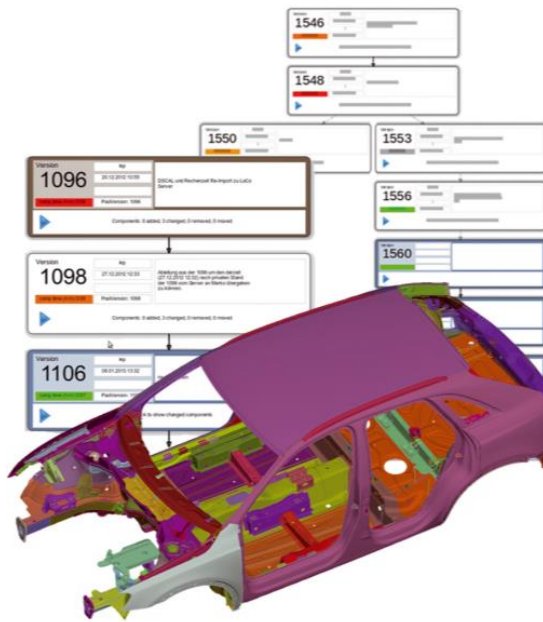
CAD/Meshing

PreProcessing

Solving

Postprocessing

LoCo *(since 2006)*



■ Target Group

- Simulation engineers
- Manager of simulation projects

■ Motivation

- Synergy
Sharing of common parts
- Transparency
Integrated documentation
- Consistency
Synchronization with all project members
- Time Savings
Automation of processes
- Homogeneity
Unification of simulation data and enforcement of standards

LoCo: Product of SCALE for Data and Process Management

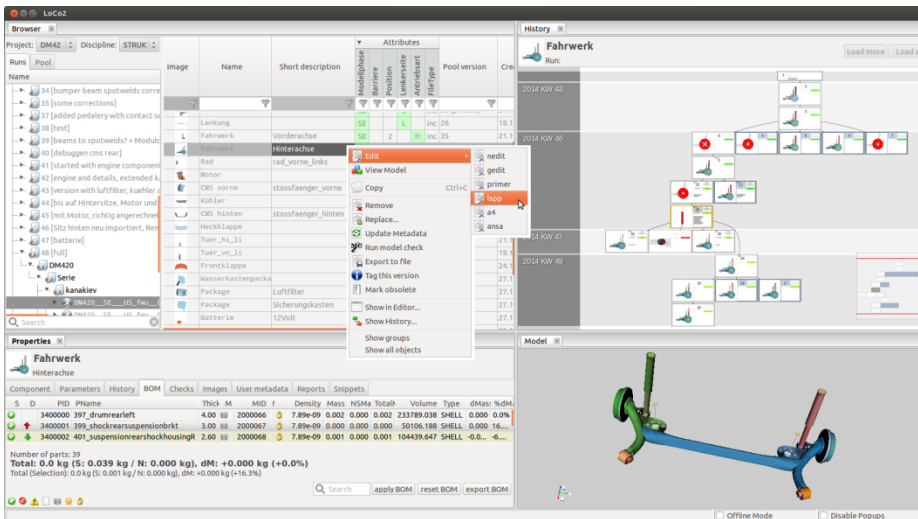
CAD/Meshing

PreProcessing

Solving

Postprocessing

LoCo (since 2006)



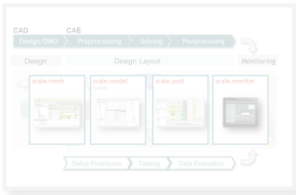
■ Characteristics

- Solution for simulation data and process management
- Workbench for Simulation Engineers
- Unique RichClient/Offline concept with sync-technology (internal and external)

■ Workflows / Features

- Integration of many specific CAE processes
- Solver: PAM-Crash, LS-DYNA, Nastran, Abaqus
- Quality check of models
- Strong authentication, encryption
- Distributed, collaborative working environment
- Sophisticated variant management
- Documentation, development history
- Optimization, DOE, robustness studies
- ...

LoCo: *Agenda*



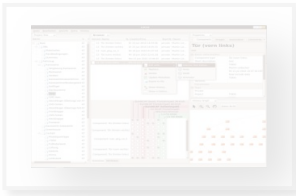
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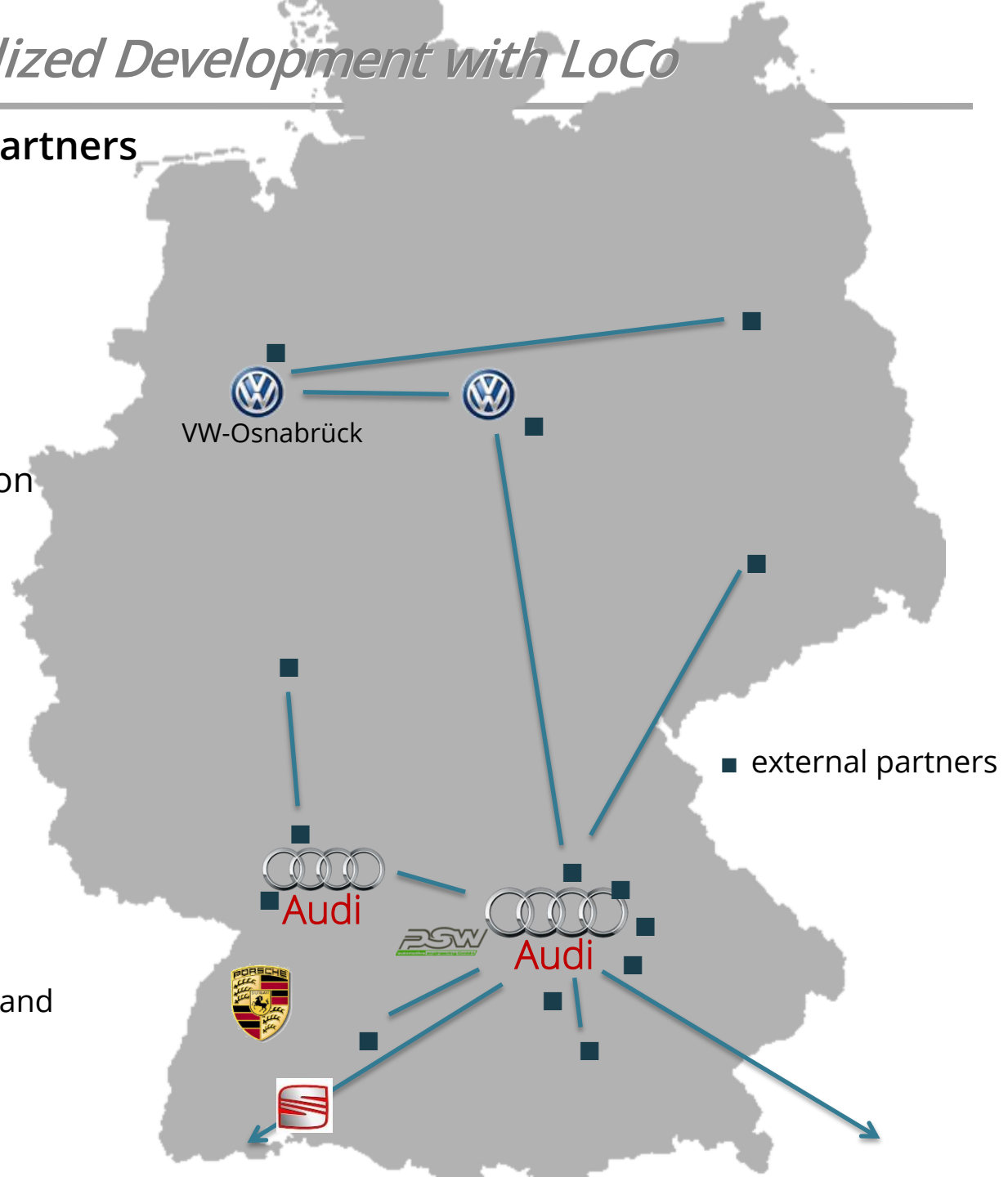
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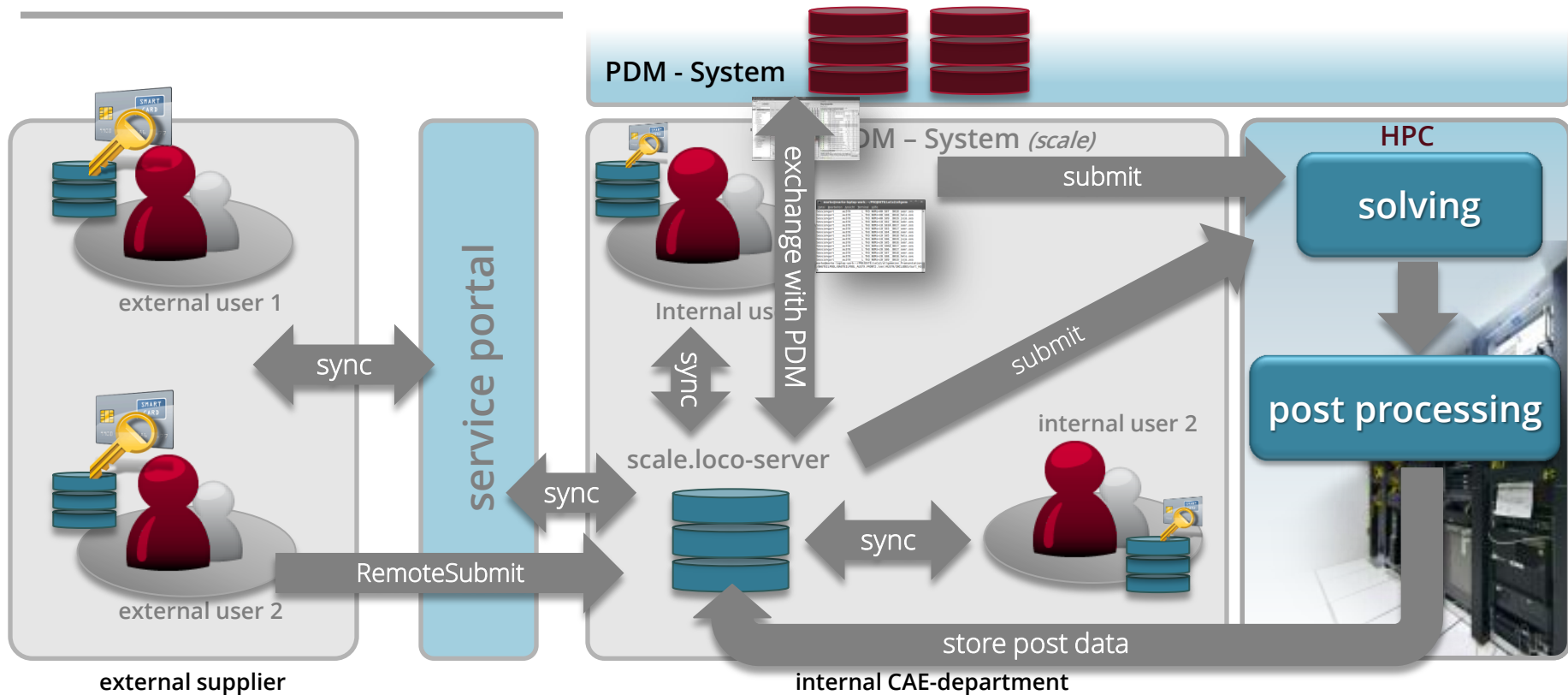
Example: *Decentralized Development with LoCo*

■ Suppliers and Service Partners

- Direct integration in CAE development process
- Uniform working environment
- Automatic synchronization of relevant data
- Good performance even for poor network bandwidth
- Complying with high security requirements
 - encrypted storage
 - encrypted transfer
 - two factor authentication and encryption



LoCo: *Workflow, Teamwork and Synchronization*



Sync

decentralized

- Central data storage, synchronization with local workstations (*cloud like infrastructure*)
- Encrypted transfer, encrypted storage (*two factor authentication and encryption*)
- Offline handling of components (*RichClient*)

Offline / Online

performance

- Users/Teams are independent of servers and infrastructure
- Users work with local data
- Good performance while application of preprocessing tools

Integration

- Integration with existing PDM Infrastructure as TDM-System (*Team Data Management*)

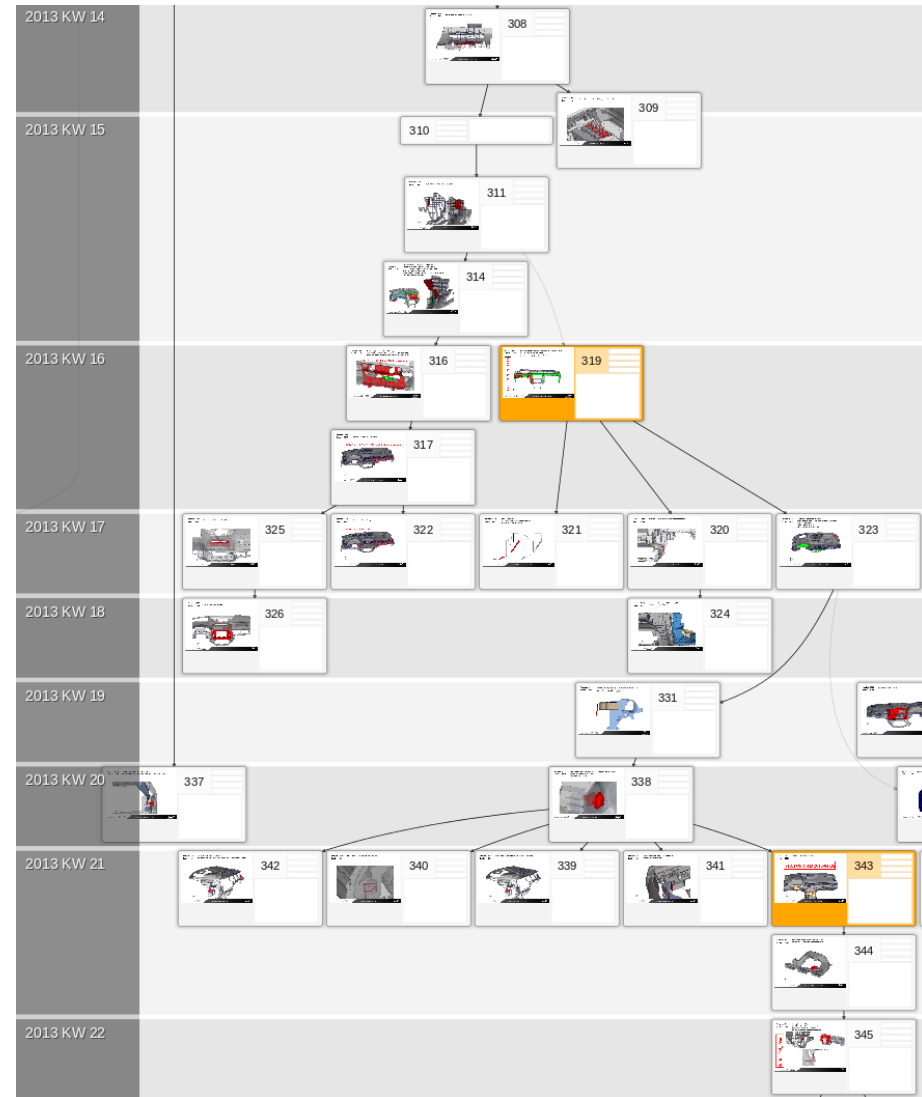
LoCo: *Version management*

■ Every object is versioned in LoCo

- Simulation Runs
- Includes
- Scripts
- Parameters
- Folders
- Projects
- ...

■ Motivation

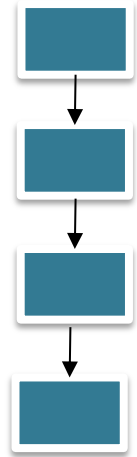
- Multiple users can work simultaneously on the same files
- Each action is documented
- Every operation in LoCo can be tracked back to its origin
- Powerful features to merge change of multiple different users
- Extension of audit trail over time and users



LoCo: *Version management* (<http://de.wikipedia.org/wiki/Versionsverwaltung#Konzepte>)

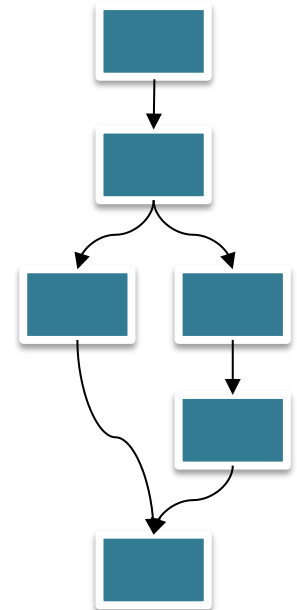
■ „Lock Modify Write“ (*classical PDM Systems*)

- Objects are locked if one person is working with them
- After the work is done users need to check in the changed items
- Problematic in situations where team members need to work independently
- No simultaneous working with the same objects
- Always consistent data (*no merging of data required*)



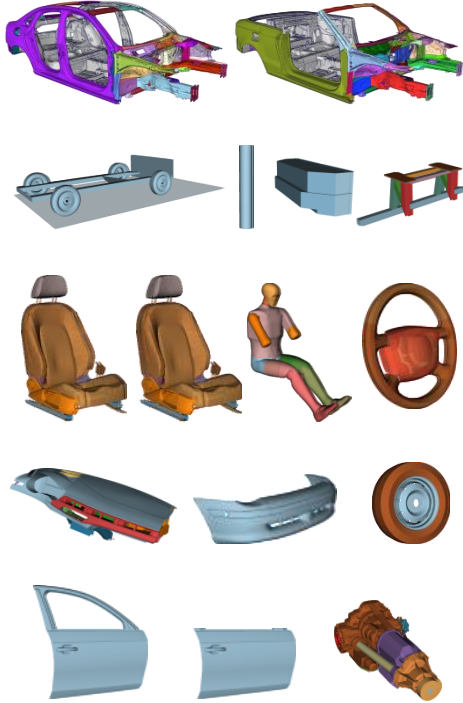
■ „Copy Modify Merge“ (*LoCo, git, svn, ...*)

- Objects can be used instantly (*on changes a copy will be created*)
- No „check in“ – „check out“ necessary
- Users can act independently from other users and servers
- Simultaneous work on the same objects is possible
- It's possibly required to merge branches



LoCo: *Basic principles of modular model assembly*

component pool



component parameters

airbag TTF	1.0mm
vent area	...
sheet thickness	... mm
calc time	1.4mm
friction	

➤ Assembly of multiple load cases and derivatives

Coupé



Convertible



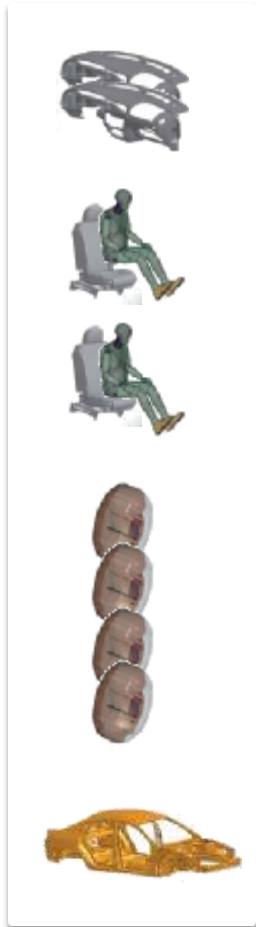
➤ Setup of optimizations and DOEs

- Parameters and optimization goals are defined
- Assembly of vast amounts of simulations



LoCo: *Attribute based allocation of content*

Pool



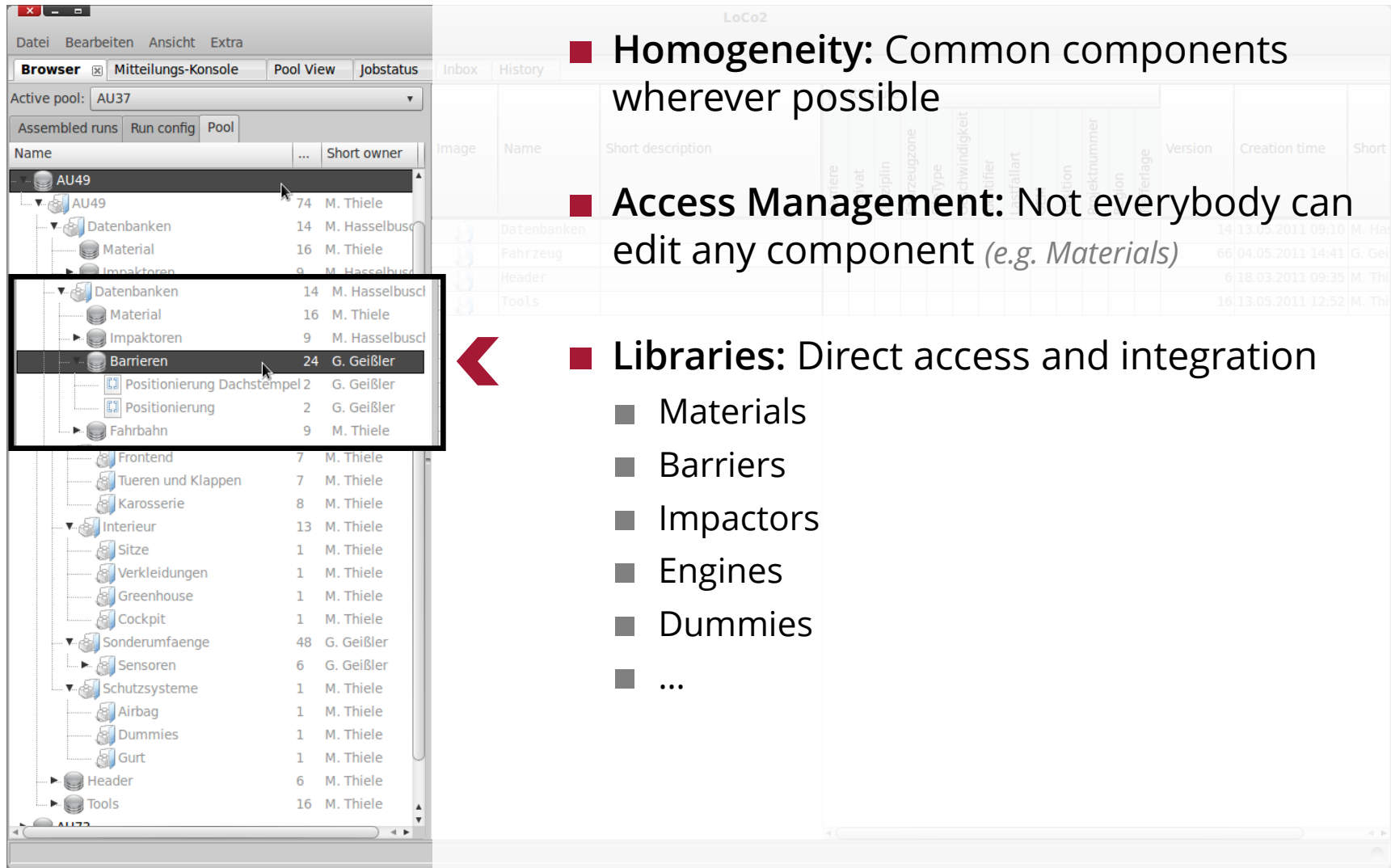
Region	Zone	Side	Dummy
Europe			



Attribute based assignment

- Definitions assigned to components
 - Region: EU, US
 - Components are used only for US or EU
 - without attribute:
 - Components are used always
- Same approach for parameters
- Changes get automatically applied to all relevant simulations
- Easy creation of new setups
- Users need to get used to it

LoCo: *Component Management / Modeling Aspects*



■ **Homogeneity:** Common components wherever possible

■ **Access Management:** Not everybody can edit any component (*e.g. Materials*)

■ **Libraries:** Direct access and integration

- Materials
- Barriers
- Impactors
- Engines
- Dummies
- ...

■ Uniform model structure for all departments

LoCo: *Submitting and monitoring of jobs*

■ Job Submit

Instant start of jobs on the HPC-cluster

- Decks are assembled directly in the datacenter at the HPC-cluster
- A minimum of data have to be transferred
- Jobs start instantly

■ Job Control

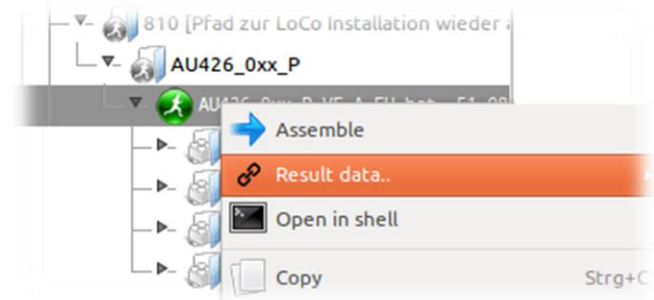
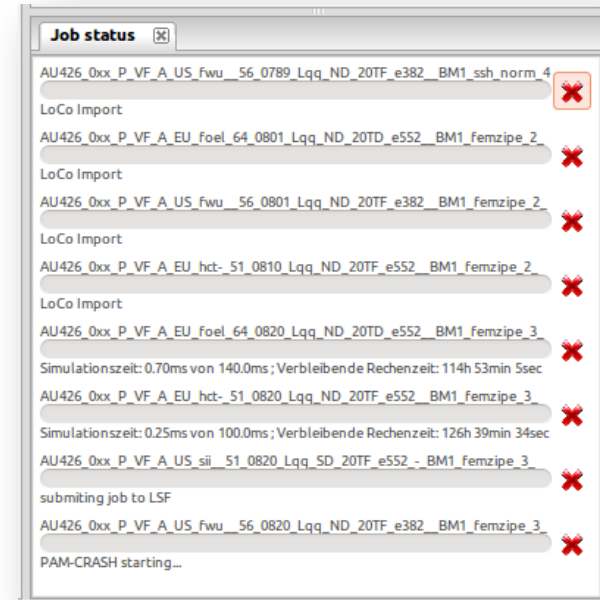
Monitoring job progress on the HPC-cluster

- Continuous feedback on job progress
- Stopping of jobs

■ Result Access

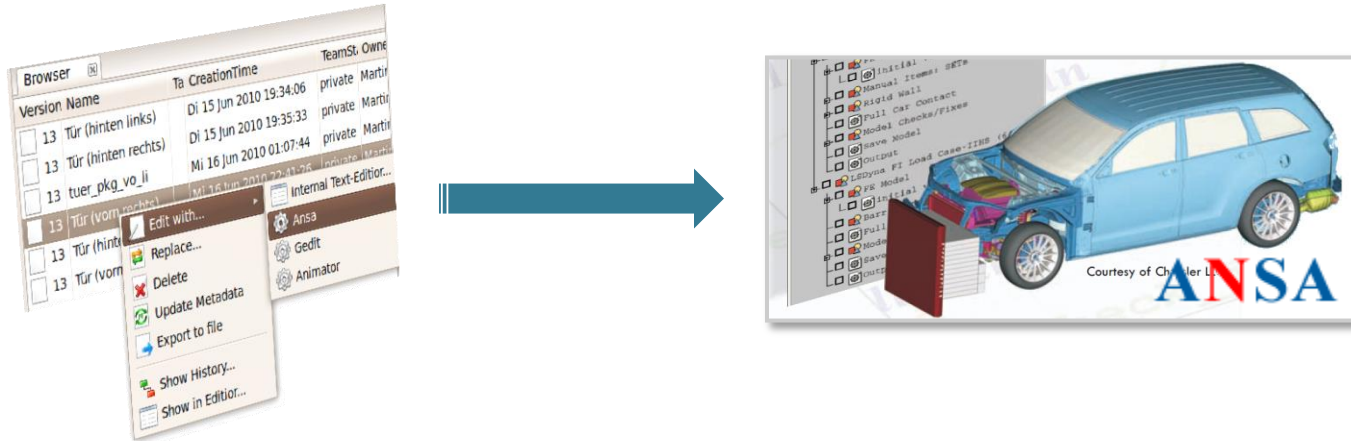
Retrieving and accessing result data

- Automatic download of result data
- Access to result data of other users
- Direct integration with postprocessors

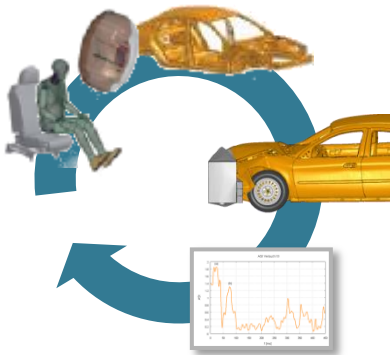


LoCo: *Integration of 3rd party Software (open system)*

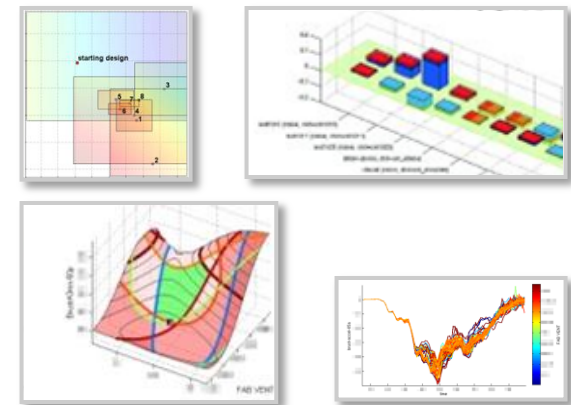
Direct application of external tools (*Ansa, Animator, nedit, vi, user scripts, etc...*)



Integration of DOE Studies / Optimization



- Models are parameterized within the data management system
- Simulation models are assembled automatically
- Access to optimization software such as LS-OPT



LoCo: *Customization*

■ Specific configurations for Department-/Discipline-/Project

- Project structure
- Attributes / Metadata
- Filters
- ...

■ GUI for service administrators

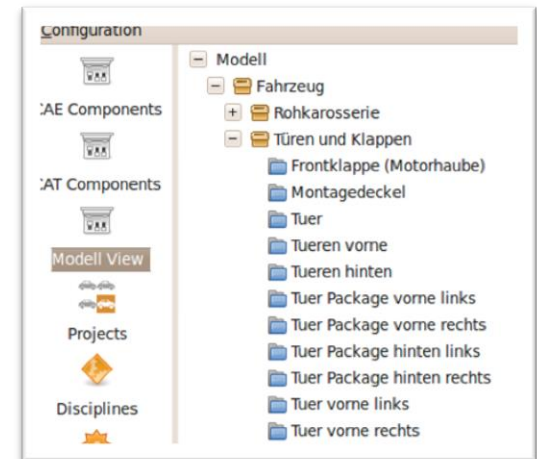
- Fast response times upon user requests
- Independence from developers

■ XML syntax for advanced configuration

- Covers full feature set of application
- Flexible and extendable

■ Scripts for individual processes

- Tightly integrated with full version control
- Rich Python API



The screenshot shows a table with columns 'Discipline', 'Scenario', 'Lastfälle', and 'Attribute'. The 'Barriere' row is selected. The 'Attribute' column is expanded to show a table of values.

Discipline	Scenario	Lastfälle	Attribute
ActivePassive			
AntriebMotorGetriebe			
Antriebsart			
Barriere			
Barrierenkuerzel			
Baustufe			
Dach			
Derivat			
Dummy			
FahrzeugTyp			
Fahrzeugzone			
Geschwindigkeit			
Getriebe			
Lastfallart			
LinksLenker_RechtsLenker			
ModellPhase			
MotionTyp			

Basis Informationen	
Name	Barriere
Beschreibung	
Handbuch	<input checked="" type="checkbox"/>
Zeichen	3

Wert und Beschreibung	
OGR	starre Barriere, 0
30L	starre Barriere, 3
30R	starre Barriere, 3
ODB	ODB-Barriere
POL	POL-Barriere
18L	Dynamische Bere
18R	Dynamische Bere
OGS	OGS
00G	00G
KM0	KM0
KM1	KM1

LoCo: *Solvers and disciplines*

■ Flexibility for easy and fast integration of processes

- New disciplines, processes, solvers
- Fast response times to user requests

■ Integrated scripting interface and version management

- Advanced process development
- Independent from code changes of the core software

■ Solver Independent, e.g.

- LS-DYNA
- PAM-Crash
- Abaqus
- Nastran
- ...

■ Simple adaption to new disciplines

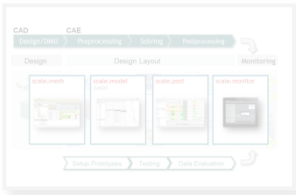
- Structural crash
- Occupant Safety (Front/Side)
- Cockpit
- Seats
- NVH
- Pedestrant Safety
- Durability
- ...

LoCo: *Example for operation*

- ~500 registered users (*~300 active users over a period of one month*)
- server is self hosted by client
 - slim server architecture, low server load, easy setup
 - service friendly operations
 - no high availability required due to software architecture (*offline capable clients, decentralized synchronization*)
 - allows for maintenance during regular working hours
 - complying with state of the art security standards
- ~500.000 simulations created during last 3 years
 - the entire history of how each simulation that has been created can be browsed down to the history of each include
 - any single simulation or include can be extracted at any time from the system
- just ~2.5TB of total storage occupied on server for all simulation input data
 - achieved by file level data deduplication
 - In the future compression levels can be increased by fact 8 (*block level data deduplication*)



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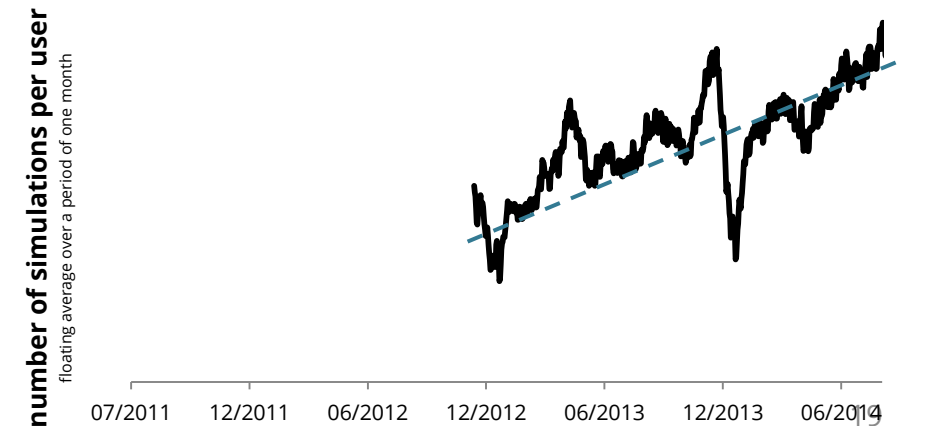
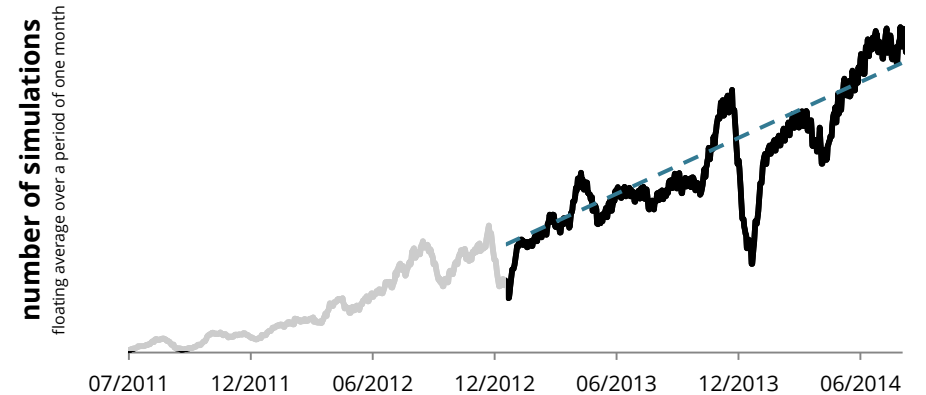
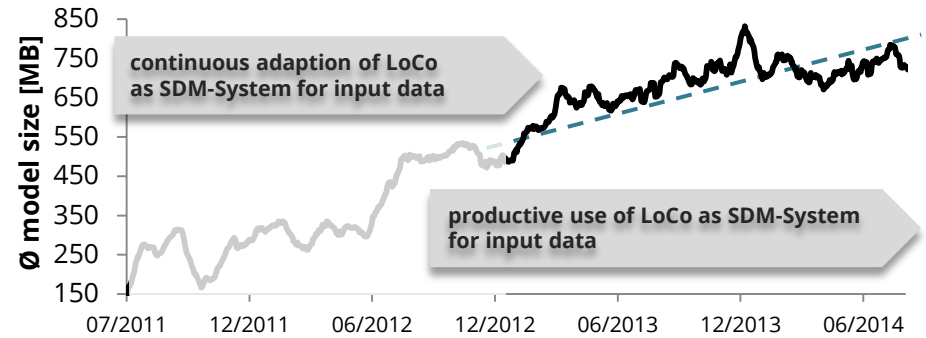


New Developments / Outlook

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LoCo New Developments: *data deduplication*

- Increasing average model sizes
 - average model size is still increasing
 - input data today partly exceed 1GB
- Increasing number of simulations
 - more load cases
 - more vehicle models
 - more simulation disciplines
 - more ...
- Increasing throughput of simulations per user
 - Individual users are doing more simulations



LoCo New Developments: *data deduplication*

■ File level Data Deduplication

- each Simulation consists of multiple Files
- changes for a simulation usually only affect a few files
- only changed files are stored and transferred
- savings approximately factor 20-25
- **standard in LoCo**

200TB raw input data

■ Block level Data Deduplication

- changes on simulation input usually affect only a few lines
- file is separated into blocks
- only changed blocks are stored and transferred
- savings approximately factor 8
- **in development for LoCo** (VAVID)¹

8TB unique files

■ Standard compression algorithms

- simulation input files are usually ASCII
- standard compression algorithms (e.g. zip, bzip, lzma) work best on ASCII data
- savings approximately factor 3
- **standard in LoCo**

1TB unique blocks

0.25 TB stored data

LoCo New Developments: *data deduplication*

■ initial file

L o C o _ s p e i c h e r t _ n u r _ d a s _ w a s _ n ö t i g _ i s t .

Block A: L o C o _ s p e

include consists of blocks:

A B C D E

Block B: i c h e r t _ n

5 + 37 = 42 characters

Block C: u r _ d a s _ w

Block D: a s _ n ö t i g

Block E: i s t .

■ changed file

L o C o _ s p e i c h e r t _ n u r _ d a s _ w a s _ g e ä n d e r t _ i s t .

Block F: a s _ g e ä n d

Include consists of blocks:

A B C E F G

Block G: e r t

6 + 11 = 17 characters

LoCo New Developments: *compression for output data*

■ Test Data

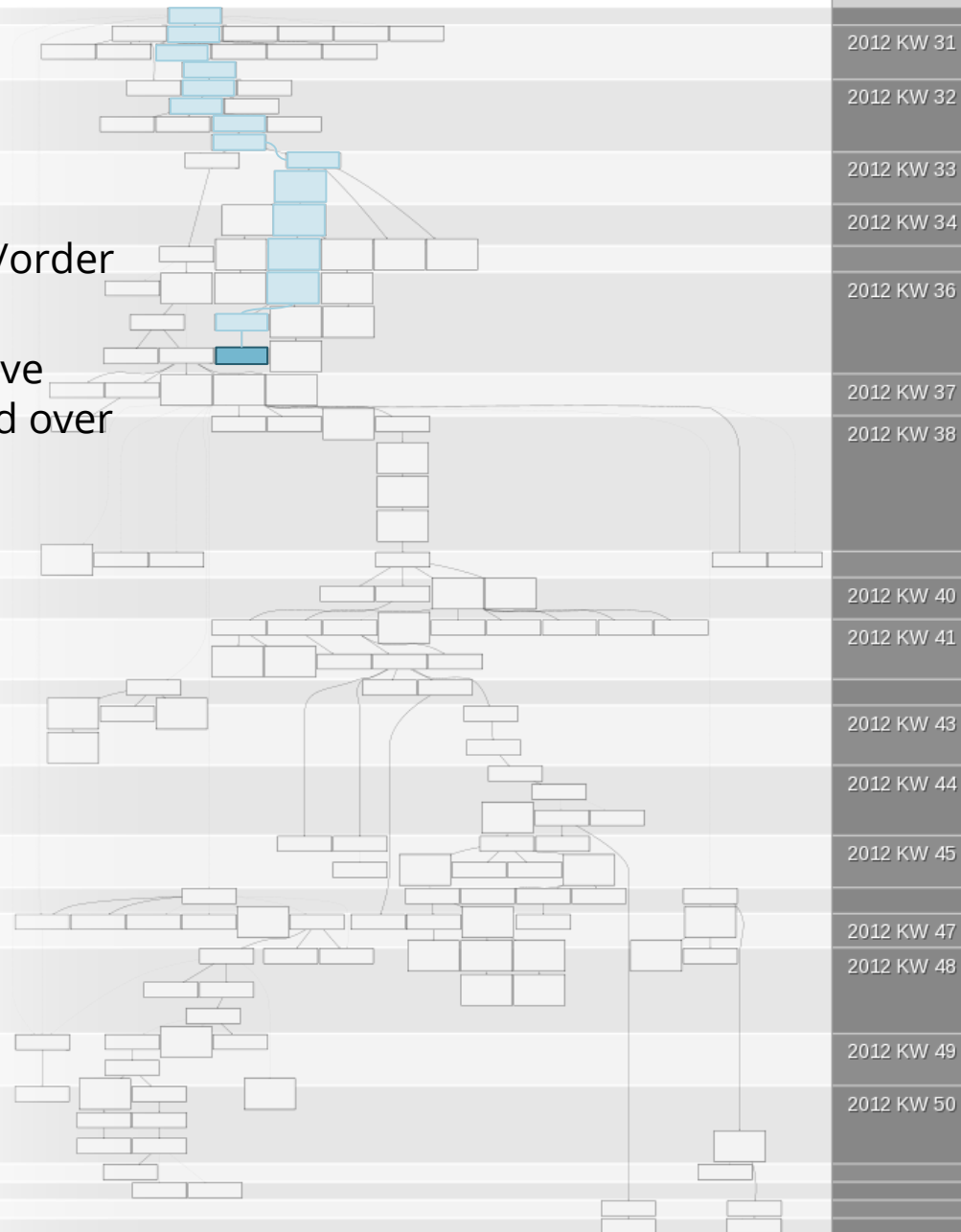
- one load case (*front wall*)
- 155 Results
- compressed with respect to history/order of creation
- Results are extracted from productive environment and have been created over a period of approximately 6 month

■ Results

FEMZIP-P		13,95 GB	
FEMZIP-E	FDB	0,85 GB	15%
	EFZ	5,00 GB	85%
	Total	5,85 GB	
FEMZIP-E + gzip		4,74 GB	

Factor P/E **2,94***

* higher compression rates of up to factor 4 could be achieved when compressing all files at once



Optimization of Domain Decomposition

Investigations

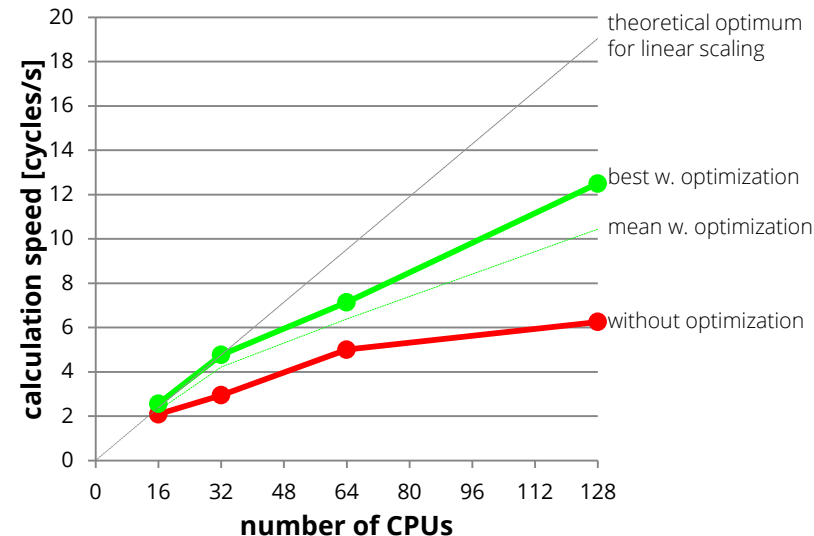
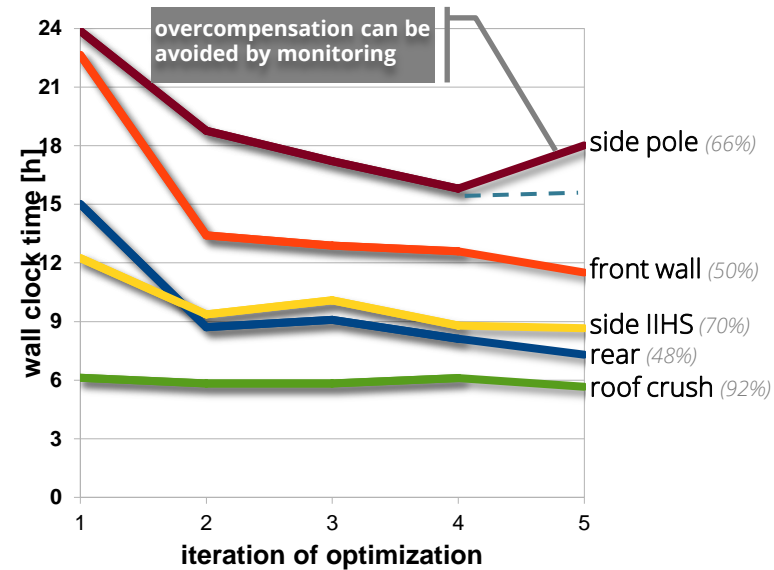
- performance gain depends on load case and number of CPUs
- Investigations have been performed using the same model without applying changes

Performance gain depending on load case

- 5 typical load cases have been investigated
- 48 CPUs have been used for each simulation
- 10 simulations have been performed per iteration
- 5 iterations have been performed for each load case
- no changes to models between iterations

Performance gain depending on number of used CPUs

- 1 load case (front wall)
- 16, 32, 64 and 128 numbers of CPUs
- 5 iterations per setup
- no changes to model between iterations
- 10 runs for final iteration on each setup



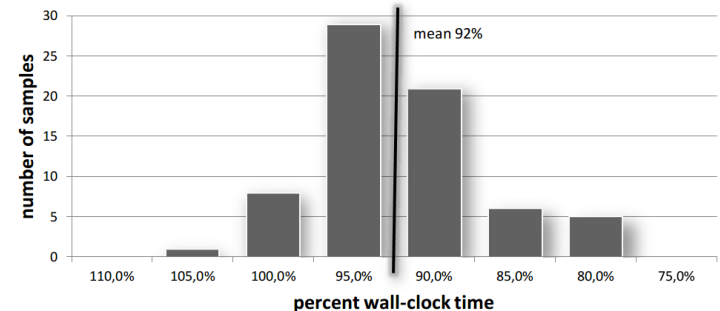
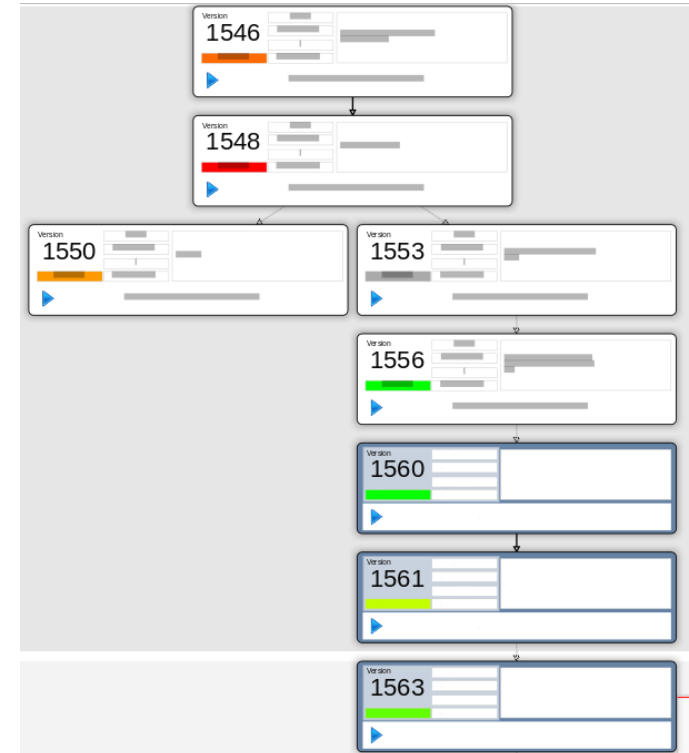
Optimization of Domain Decomposition

■ Implementation in productive environment

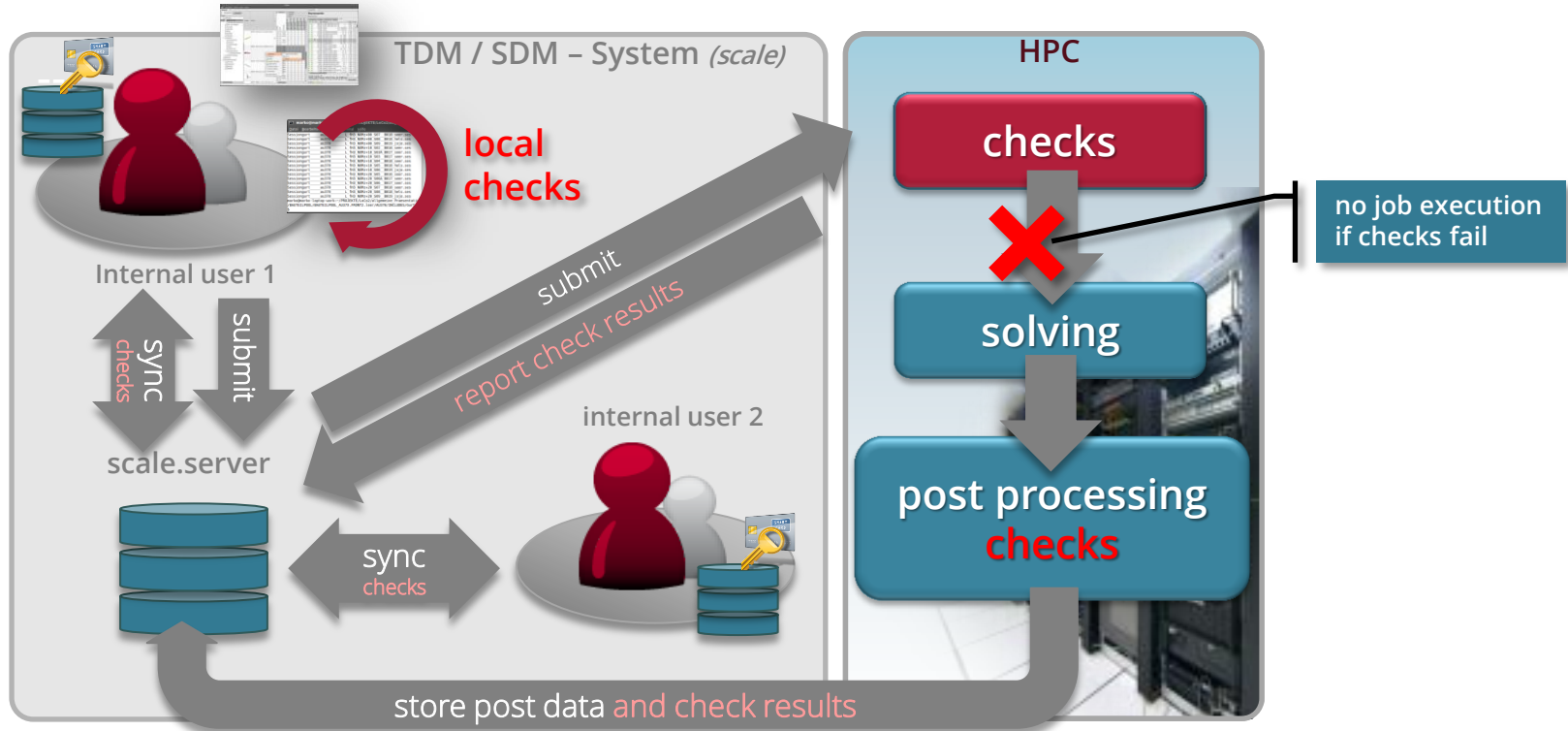
- LoCo has been used as SDM-System to gather the profiling information of ongoing simulations and provide this information to new simulations in order to optimize domain decomposition
- each simulation in LoCo may use the profiling information of one of its predecessors
- overcompensation is avoided by monitoring the performance over multiple runs
- all simulations started with LoCo use this approach by default, **no user interaction is required**
- the difference between artificial tests and the productive environment is that in the productive environment there are always ongoing changes between calculations

■ Results in productive environment

- 74 samples of original simulations of Q2/2014 have been recalculated without optimization
- all simulations have been performed on 32CPUs
- the overall performance gain has been **8%**



LoCo New Developments: *check infrastructure*



check early
immediate actions

- Checks are carried out as early as possible in the process
- Checks are integrated by using existing tools and scripts
- Checks are enforced at various occasions during the process

check often
prevent errors
save resources

- Each time a file changes
- Before solving
- As part of the postprocessing
- Checks can stop the process
- Check results are synchronized among all users

LoCo New Developments: *check infrastructure*

Check results are propagated

The screenshot displays the LoCo2 (Evaluation) software interface. The main window shows a project tree on the left, a table of components in the center, and a 'Checks' panel on the right. A red arrow points from a check result in the 'Checks' panel to a component in the table, and another red arrow points from a component in the table to a file in a 'tmp' directory. A blue callout box at the bottom right says 'Files can be opened at the line where the error occurred'.

Name	Image	Attributes	Image
Fahrwerk			
Fahrwerk			
Fahrwerk			
HiRa_u_Lenker_hinten			
HiRa_vo_LL			
Frontend Sensoren			
Frontscheibe			

Properties: Frontklappe

Component Parameters History BOM Checks Images User metadata Reports

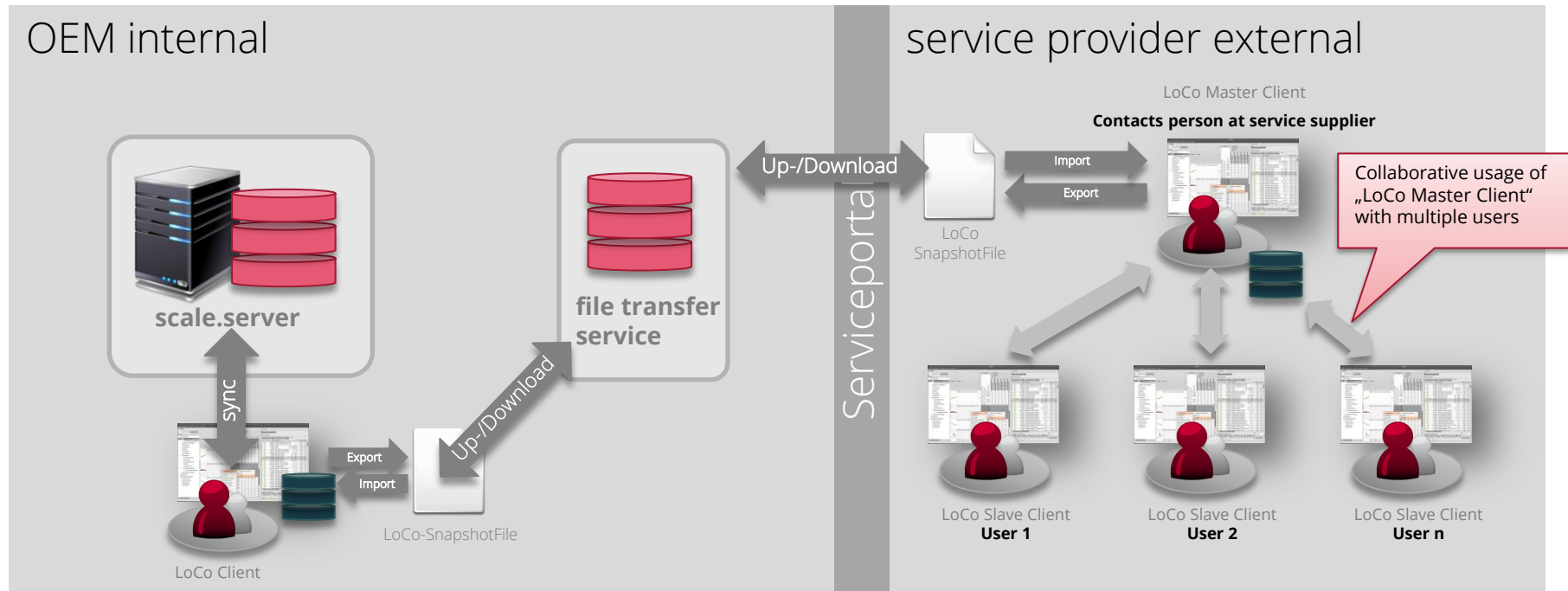
Checks

Name	Result	Description
Inputchecker		
EMNA		Set a default NAME if empty
IEM		Check in CNTAC if the initial penetration flag is set to 2
CT10		Set in CNTAC type 10 EDGLN to 0.15 if greater
IOMI		Set for CNTAC type 36/46 the IOMIT flag to 1 if switched to 0 (INPU
NIOT		Move the number of integration points from SHELL card to PART an
PART #1000010		set the number of integration points from 3 to 5.
PART #1000015		set the number of integration points from 2 to 5.
PART #1000016		set the number of integration points from 2 to 5.
PART #1000017		set the number of integration points from 2 to 5.
PART #1000018		set the number of integration points from 2 to 5.
PART #1000019		set the number of integration points from 2 to 5.
PART #1000041		set the number of integration points from 3 to 5.
PART #1000044		set the number of integration points from 3 to 5.
PART #1000051		set the number of integration points from 3 to 5.
PART #1000052		set the number of integration points from 3 to 5.
PART #1000054		set the number of integration points from 3 to 5.
PART #1000078		set the number of integration points from 3 to 5.
PART #1010000		set the number of integration points from 3 to 5.
PART #1010001		set the number of integration points from 3 to 5.
PART #1010003		set the number of integration points from 3 to 5.
PART #1010004		set the number of integration points from 3 to 5.
PART #1010005		set the number of integration points from 3 to 5.
ISH3		Set 3D MATER hourglass prevention flag (ISHG) from 0 to 2
MATER #1000000		set the hourglass prevention (ISHG) from 0 to 1.
SIGC		Check for MATER types 21, 24 and 45 if the compression curves are
MATER #1000000		comp. FUNCTION #1000010 the max strain (0.380935) is too small. E
MATER #1000000		comp. FUNCTION #1000011 the max strain (0.380935) is too small. E
MATER #1000000		comp. FUNCTION #1000012 the max strain (0.380935) is too small. E
MATER #1000000		comp. FUNCTION #1000013 the max strain (0.380935) is too small. E
MATER #1000000		comp. FUNCTION #1000014 the max strain (0.380935) is too small. E
MT45_Q2		Set for MATER type 45 linear bulk viscosity coefficient (Q2) to 6e-05
MATER #1000000		line:472217
Contacts		

View corresponding file: 'Frontklappe' at line:472217

Files can be opened at the line where the error occurred

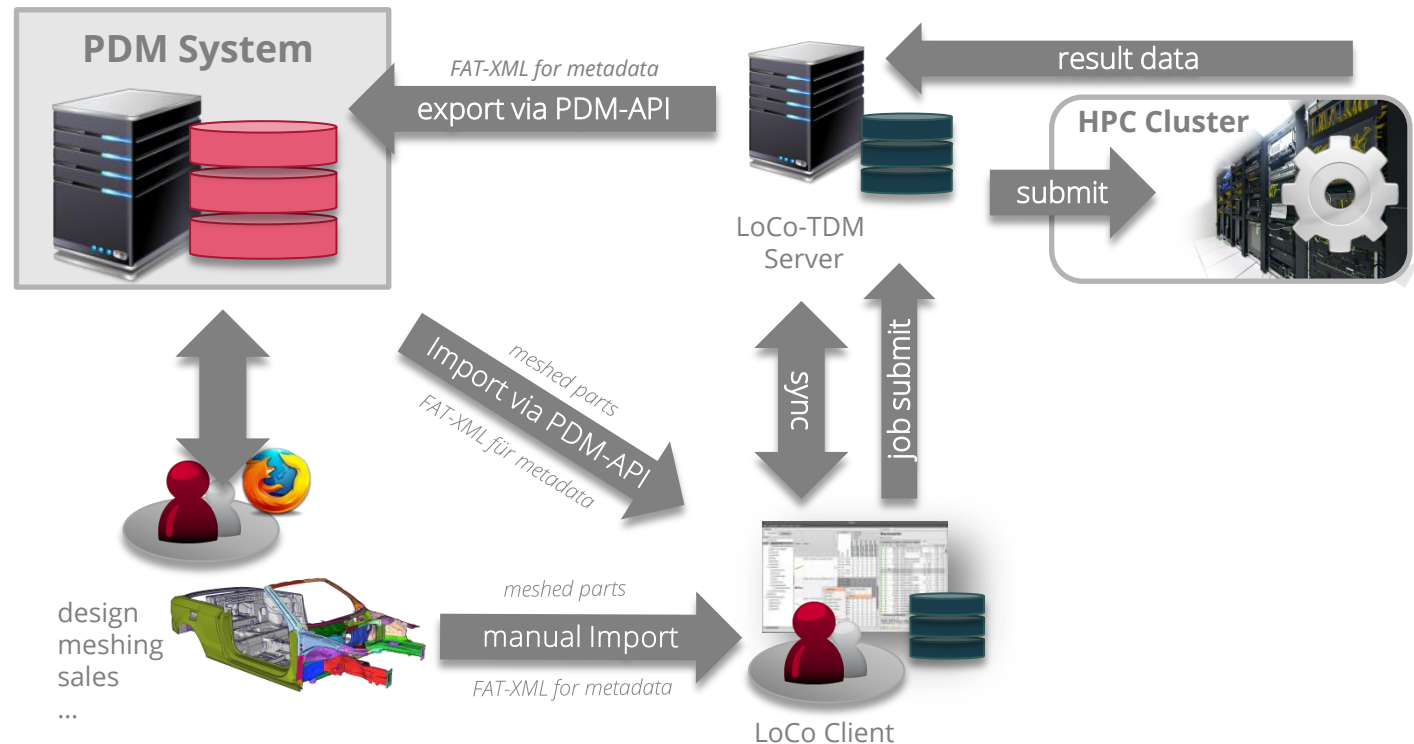
LoCo New Developments: *complete offline usage*



- Fast integration for new service suppliers
- Minimizing on site resources
 - Less traffic
 - Less user accounts
 - Less server load
- Use existing file transfer mechanisms
- Bridge technology to get started while planning a tight integration

LoCo New Developments: *closing the gap to CAD and PDM*

- FAT-XML for storing meta data
- Metadata is stored where it belongs
 - ASCII input data
 - Solver output data
- Each sub model holds only the metadata that belongs to it (*metadata can be recombined*)
- FAT-XML is solver independent (*LS-DYNA, PAMCRASH, NASTRAN, ...*)
- Supported by Pre- and Postprocessors (*ANSA, Animator, Hypermesh, ...*)



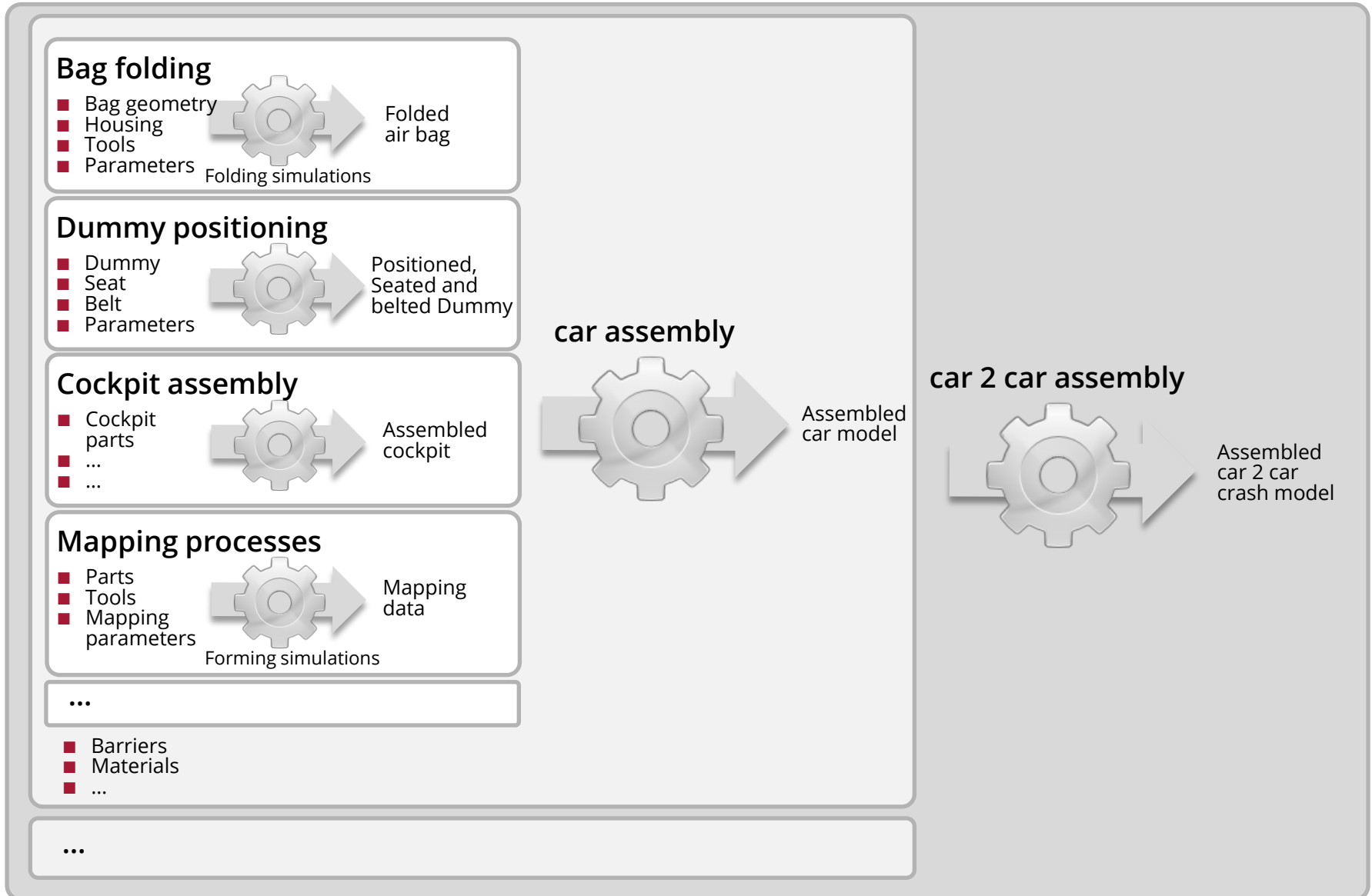
LoCo New Developments: *multi run setups*

- Automatic generation of multiple runs
- Permutation through a provided list of experiments
- Integration with LS-OPT
- Usecases
 - Cockpit
 - FGS
 - Sensorik
 - ...

The screenshot shows the LoCo2 (Evaluation) software interface. On the left, a project tree is visible under the 'Runs' tab, showing a hierarchy of components including '323 [Testversion für Multipoint]', '325 (current, private) [test]', 'Airbag', 'Dokumentation', 'Kopfaufschlag', and 'Cockpit'. On the right, a table displays the generated runs. The table has columns for 'Row', 'CockpitIdentifier', 'Schussnummer', 'CockpitLastfalbezeichner', 'Z-Movement', and 'Type'. A red box highlights the row for 'AU426_PF_0325_HEAD_US_L_disp_5_80_S0004', with an arrow pointing to a callout box that says 'One generated run per line in the list'. Another arrow points to the entire table area with a callout box that says 'list of experiments'.

Row	CockpitIdentifier	Schussnummer	CockpitLastfalbezeichner	Z-Movement	Type
1	HEAD	0001	disp_5_80	297.65	FR
2	HEAD	0002	disp_5_80	288.51	FR
3	HEAD	0003	disp_5_80	279.44	FR
4	HEAD	0004	disp_5_80	212.33	FR
5	HEAD	0005	disp_5_80	226.41	FR
6	HEAD	0006	disp_5_80	196.47	FR

LoCo New Developments: *multi stage assemblies*



LoCo New Developments: *redesign of user interface*

VTM Prototype

Produkt Ansicht Hilfe

A1 A3 A4 A5 A6 A7 A8 Q3 Q5 Q7 T

Schnellfilter Fachteam SE-Team

Ausgabe

BT 1 Beschreib...	BT 2 Beschreib...	Fügeverfahren	Anz. Verbindun...	Fügeäquivalent	Verbindungsk...
BEFESTIGUNG...	VERSTAERKUNG HECKABSCHLU...	Schraube in Spreizdübel od...	2	10,24	N90974701
FUEHRUNGSTEIL	EINSATZTEIL	Schraube in Spreizdübel od...	3	15,36	N90775001
ANTENNENVE...	SEITENWAND...	Schraube in Spreizdübel od...	2	10,24	N10656901
ANTENNENVE...	HECKKLAPPE	Schraube in Spreizdübel od...	1	5,12	N10656901
ZSB Rückaufleitung...	SGR Achtraeger	Schraube in Schweißmutter	1		N10405604
EINFUELLSTUT...	RADHAUS HI AUSSEN	Schraube in Schweißmutter	1	4,14	N90809003
EINFUELLSTUT...	RADHAUS HI AUSSEN	Schraube in Schweißmutter	1	4,14	N90809003
GURTHOEHEN...	SCHLIESSTEIL 2 SAEULE B INNEN	Schraube in Schweißmutter	1	4,14	WHT003478
VERSTAERKUNG SCHLOSS	DIEBSTAHLSC...	Schraube in Schweißmutter	1	4,14	N10653201
ADAPTER LUFTFILTER RR	VERBINDUNGS...	Schraube in Schweißmutter	1	11,74	N910733

Eigenschaften



BT 1 Beschreibung	BEFESTIGUNGSLEISTE
BT 1 Teilenummer	8K980786 1
BT 1 Material	Kunststoff
BT 1 Gewicht	116
BT 2 Beschreibung	VERSTAERKUNG HECKABSCHLUSST. OB
BT 2 Teilenummer	8K9813333
BT 2 Material	Stahl
BT 2 Gewicht	1110
Kategorie	C
Anzugsverfahren	

Vielen Dank!

SCALE 