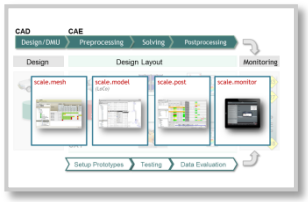
LoCo

Neue und geplante Entwicklungen im SDM-System LoCo

March 2015

SCALE

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
- Custumizability

New Developments / Outlook

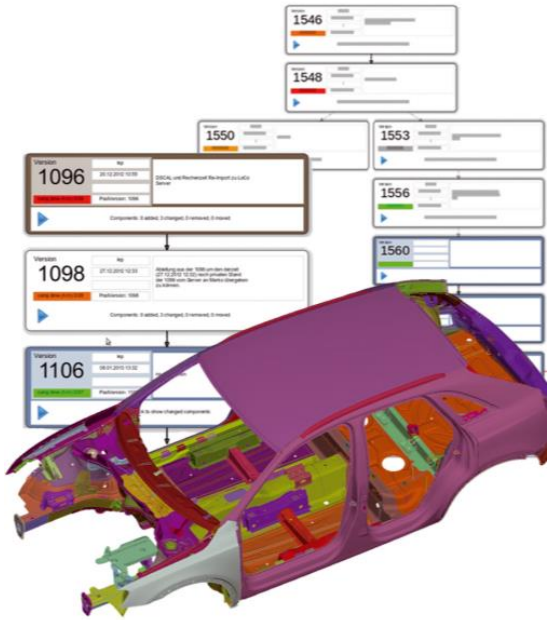
- Data deduplication
- Data compression for collections of simulation output data
- Check infrastructure
- Complete offline usage
- Optimization of domain decomposition
- Connection to CAD and PDM-Systems
- Multi run setups
- Multistage model assemblies
- Redesign of the User interface

SCALE

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

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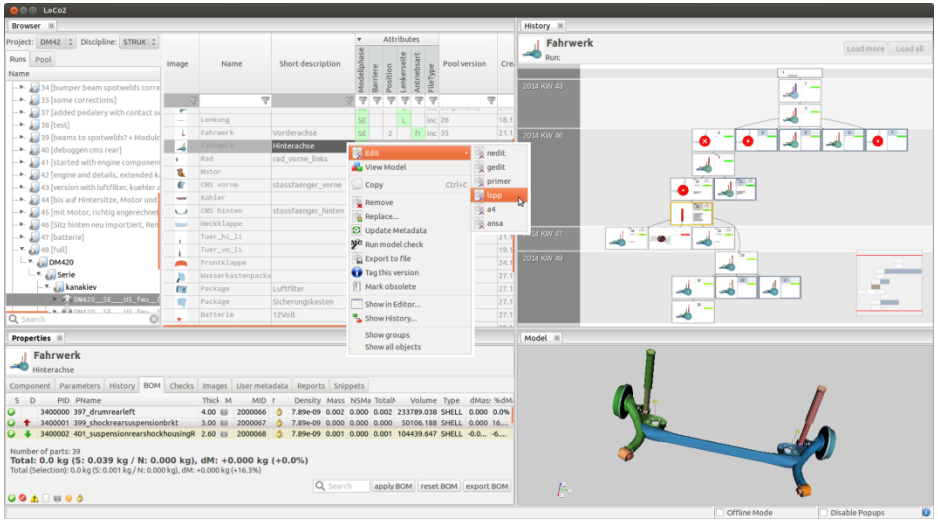

- **Characteristics**
  - Solution for simulation data and process management
  - Workbench for Simulation Engineers
  - Unique RichClient/Offline concept with sync-technology (internal and external)
- **Workflows / Features**
  - Integration of many specific CAE processes
  - Solver: PAM-Crash, LS-DYNA, Nastran, Abaqus
  - Quality check of models
  - Strong authentication, encryption
  - Distributed, collaborative working environment
  - Sophisticatd variant management
  - Documentation, development history
  - Optimization, DOE, robustness studies
  - ...

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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

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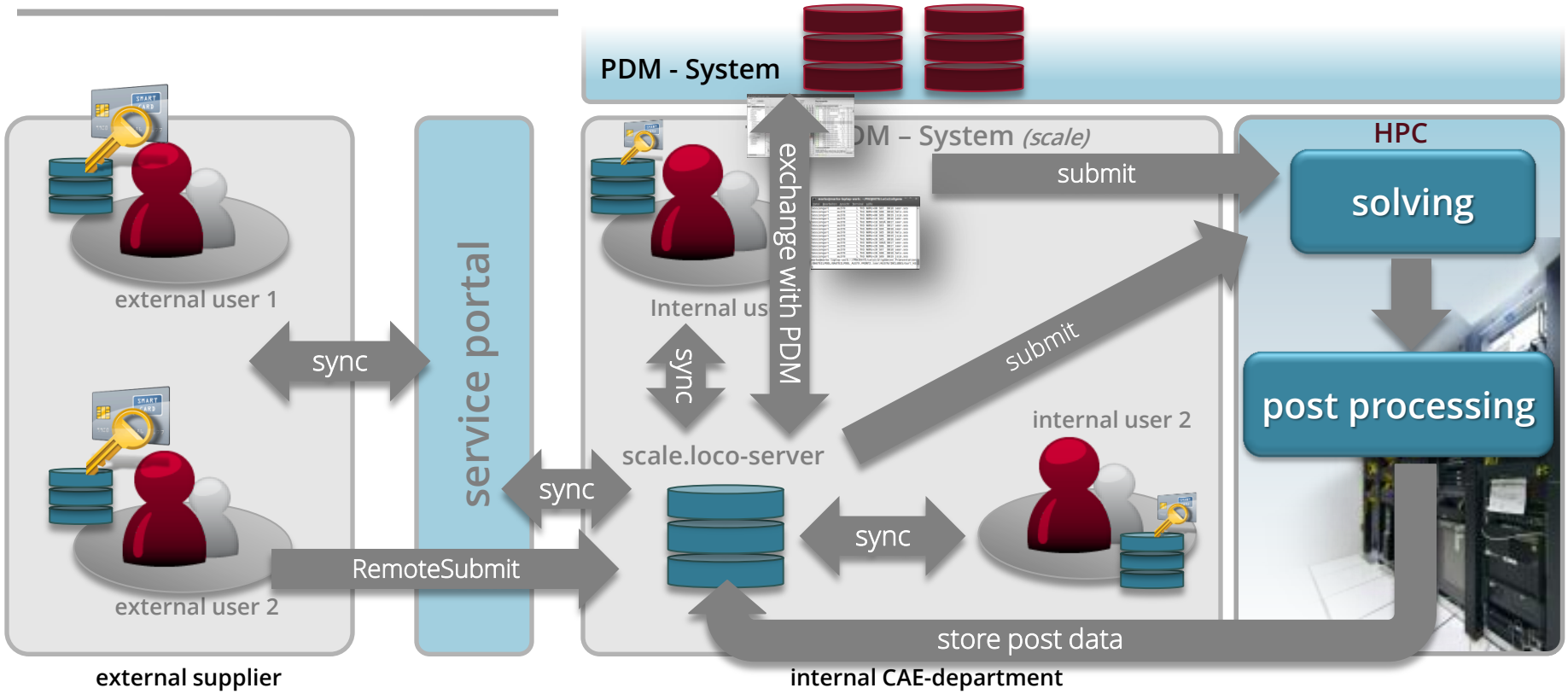
LoCo: *Workflow, Teamwork and Synchronization*



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)*

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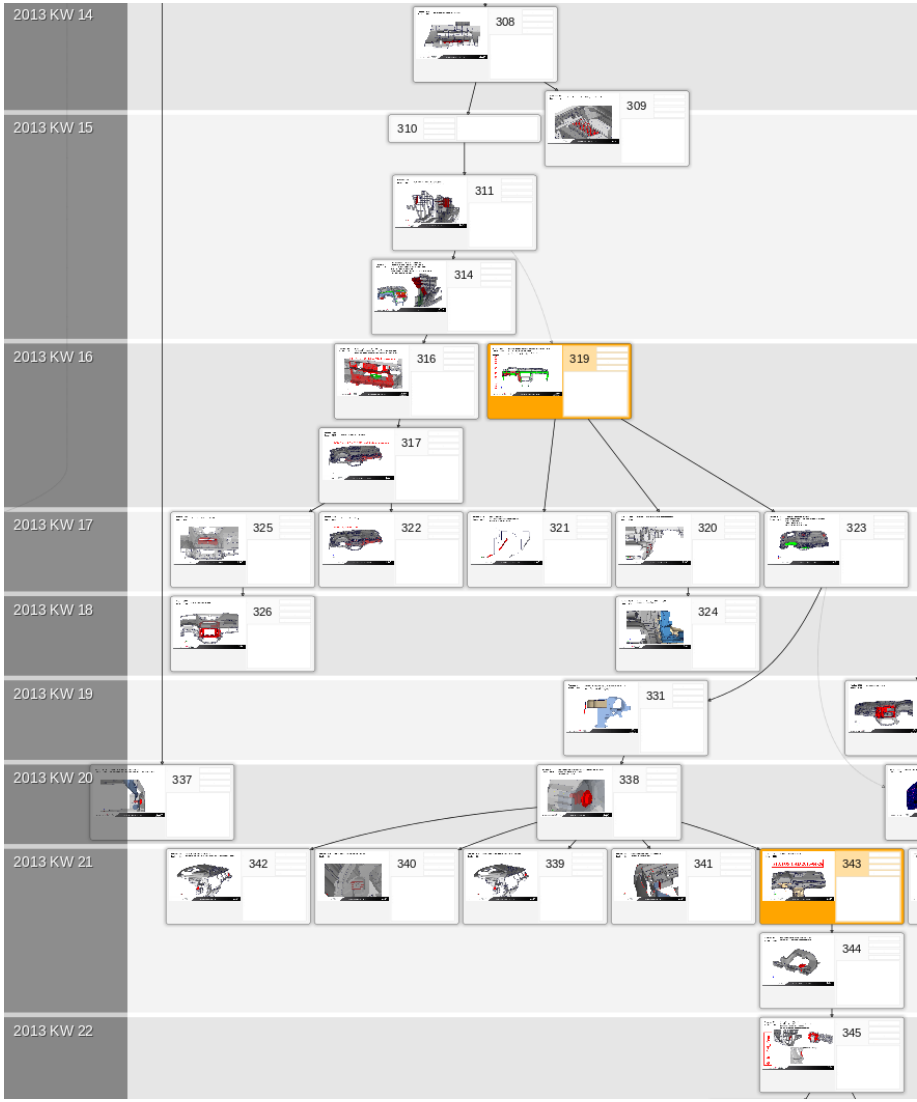
LoCo: *Version management*

- **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



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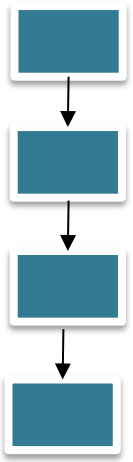
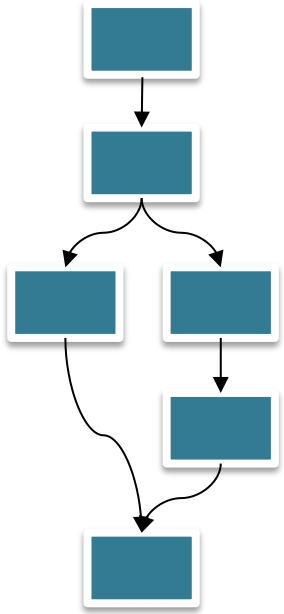
LoCo: *Version management* (http://de.wikipedia.org/wiki/Versionsverwaltung#Konzepte)

- **„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



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LoCo: *Basic principles of modular model assembly*

component pool

component parameters

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

Assembly of multiple load cases and derivates

Coupé

Convertible

Setup of optimizations and DOEs

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

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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

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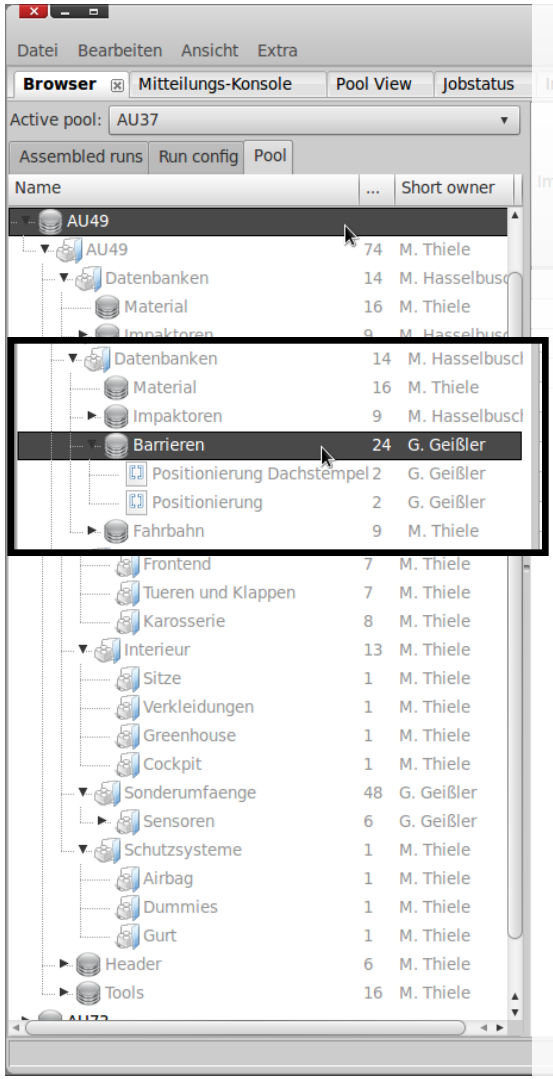
LoCo: *Component Management / Modeling Aspects*



- **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

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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

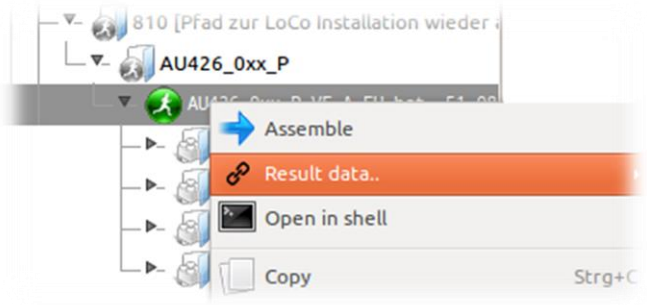
Monitoring job progress on the HPC-cluster

- 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



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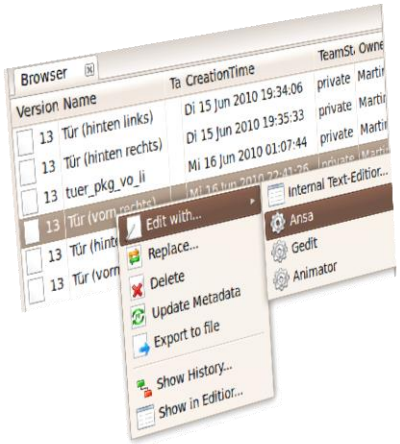
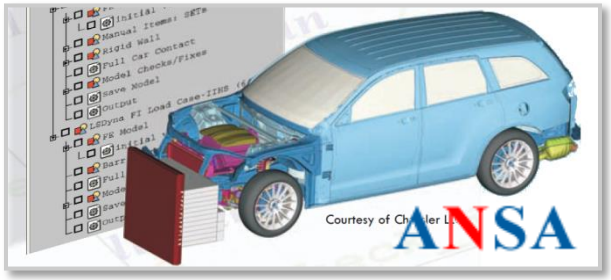
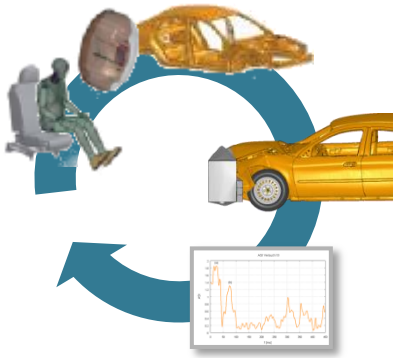
LoCo: *Integration of 3rd party Software (open system)*

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

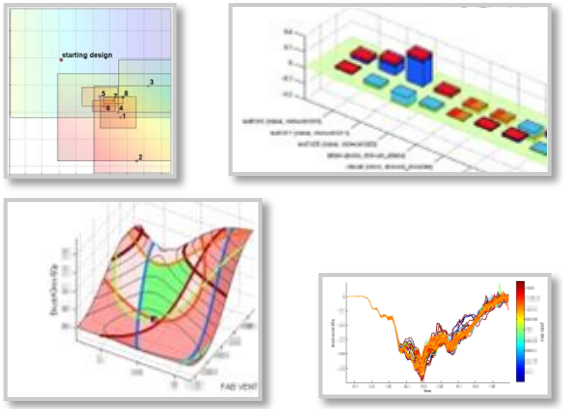




Integration of DOE Studies / Optimization



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



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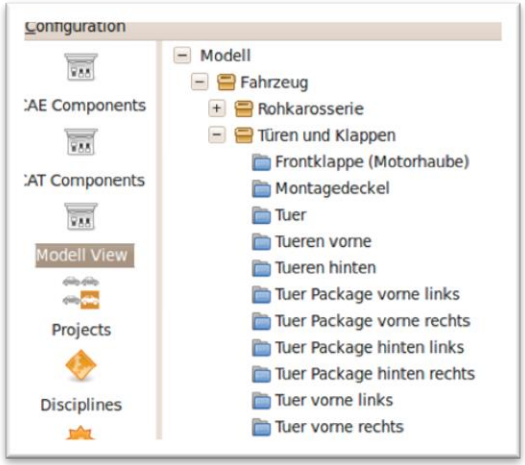
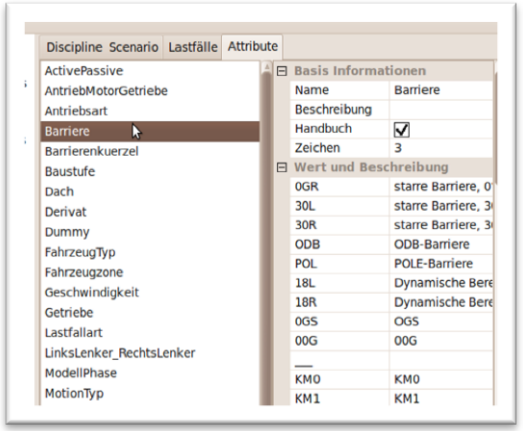
LoCo: *Customization*

- **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





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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)
  - Cockipt
  - Seats
  - NVH
  - Pedestraint Safety
  - Durability
  - ...

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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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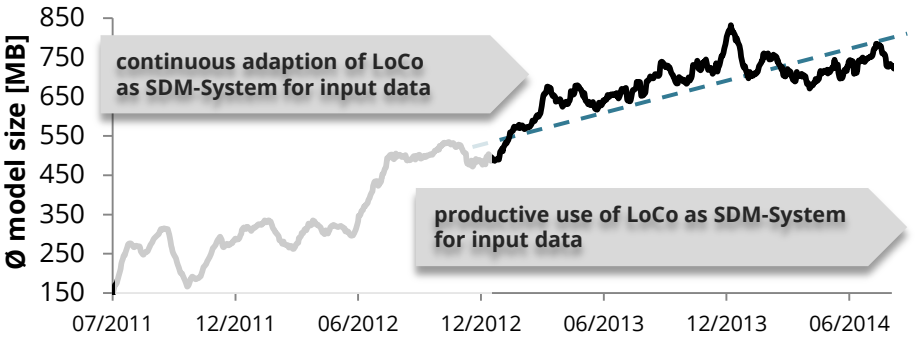
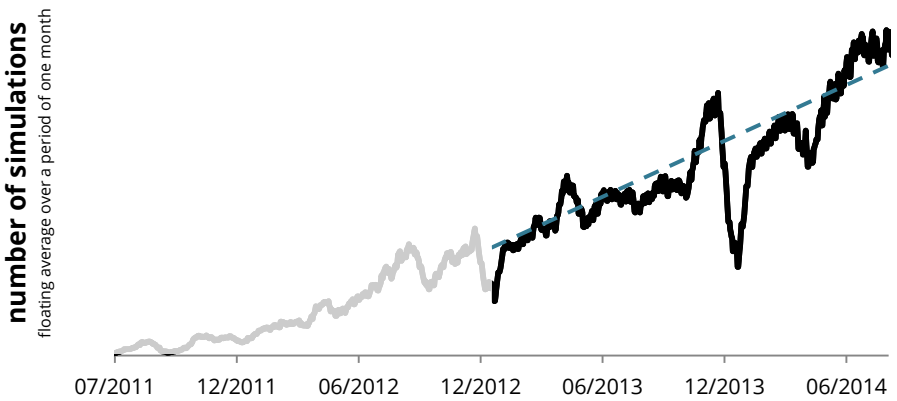
LoCo New Developments: *data deduplication*

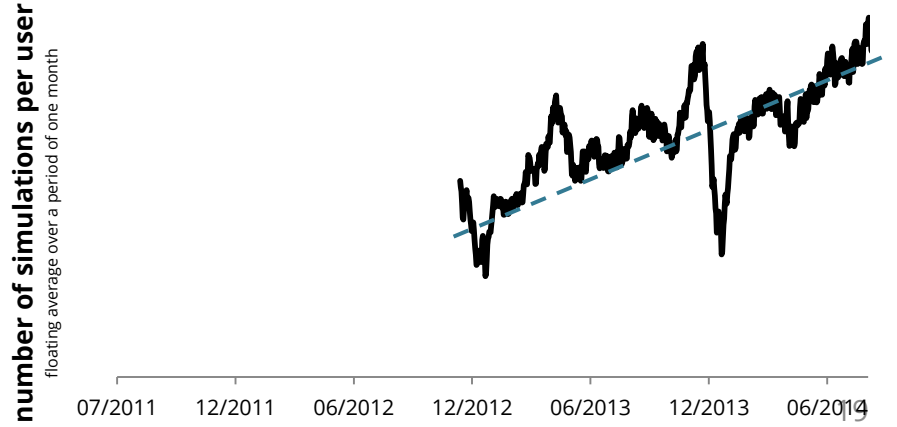
- **Increasing average model sizes**
  - average model size is still increasing
  - input data today partly exceed 1GB



- **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



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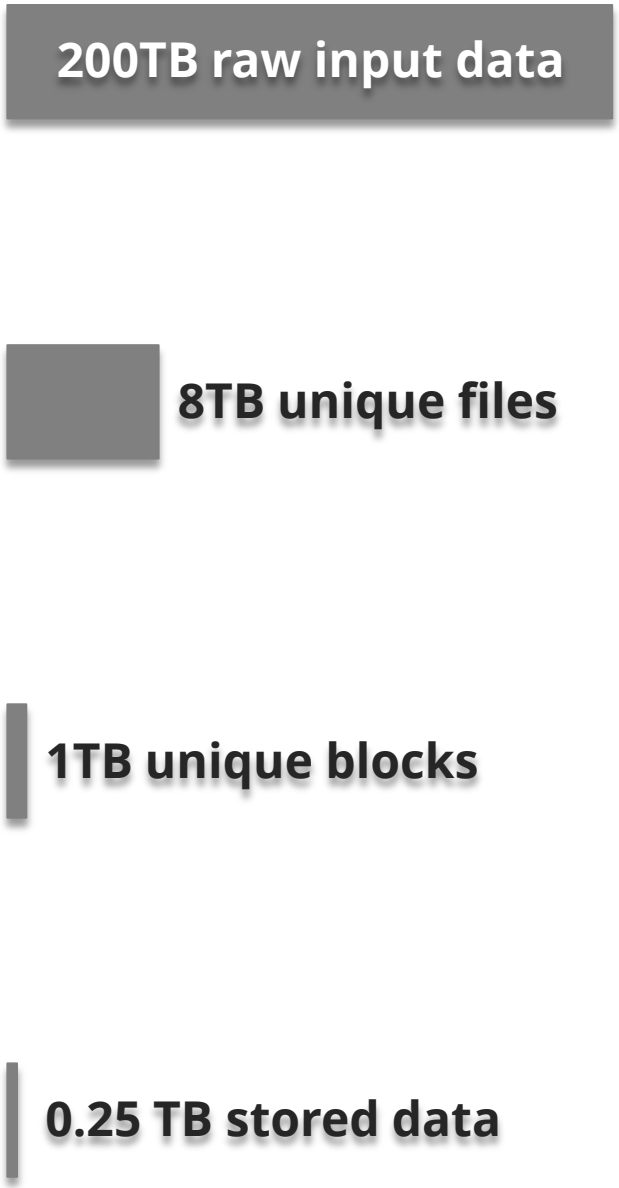
LoCo New Developments: *data deduplication*

- **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**

- **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]

- **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**



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[1] VAVID - BMBF Big Data research program, http://www.pt-it.pt-dlr.de/de/3138.php

LoCo New Developments: *data deduplication*

- initial file

LoCo_speichert_nur_das_was_nötig_ist.

Block A: LoCo_spe

Block B: ichert_n

Block C: ur_das_w

Block D: as_nötig

Block E: _ist.

include consists of blocks: A B C D E

5 + 37 = 42 characters

- changed file

LoCo_speichert_nur_das_was_geändert_ist.

Block F: as_geänd

Block G: ert

Include consists of blocks: A B C E F G

6 + 11 = 17 characters

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LoCo New Developments: *compression for output data*

Test Data

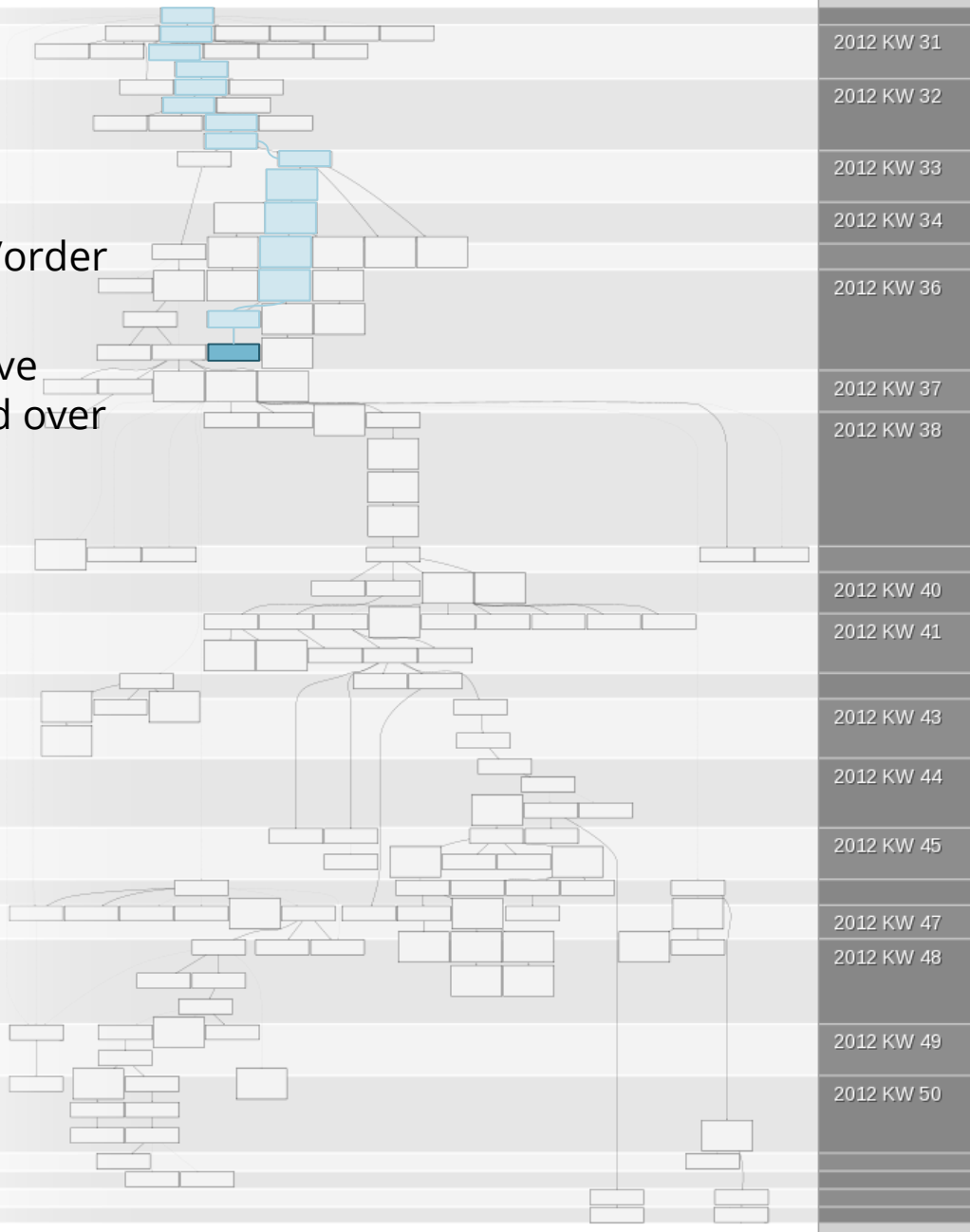
- one load case *(front wall)*
- 155 Results
- compressed with respect to history/order of creation
- Results are extracted from productive environment and have been created over a period of approximately 6 month

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



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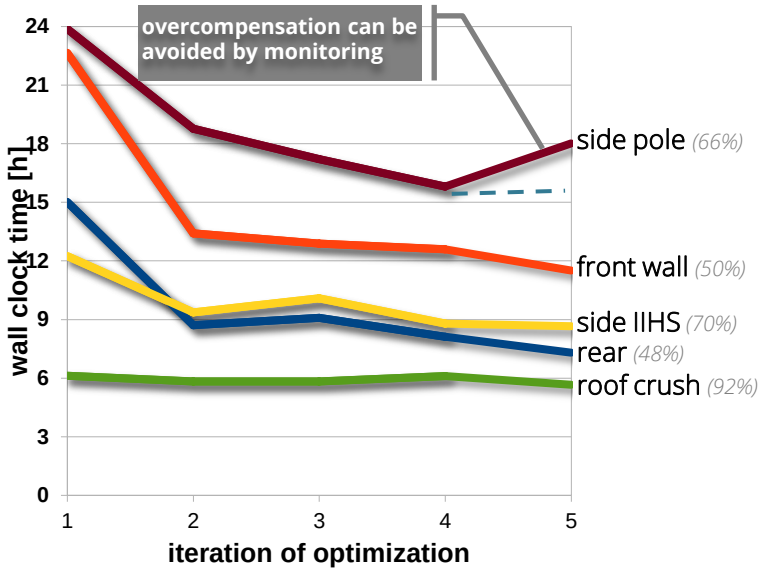
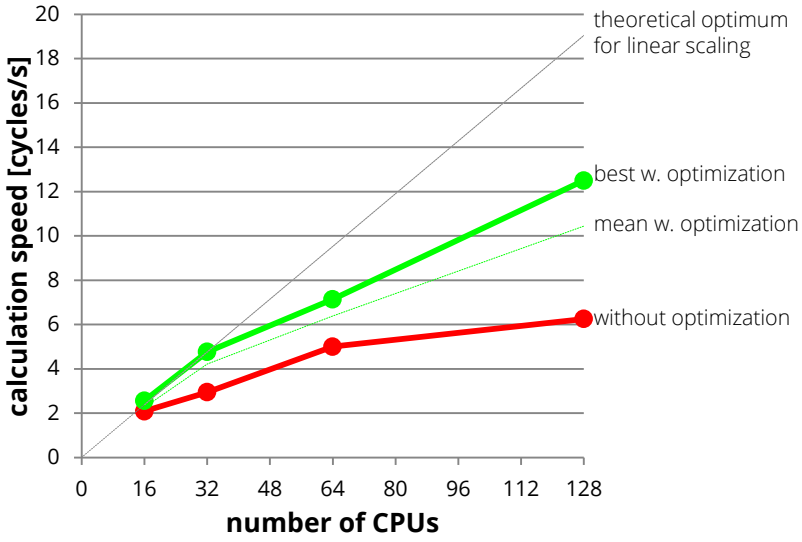
Optimization of Domain Decomposition

- **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
  - 48CPUs 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





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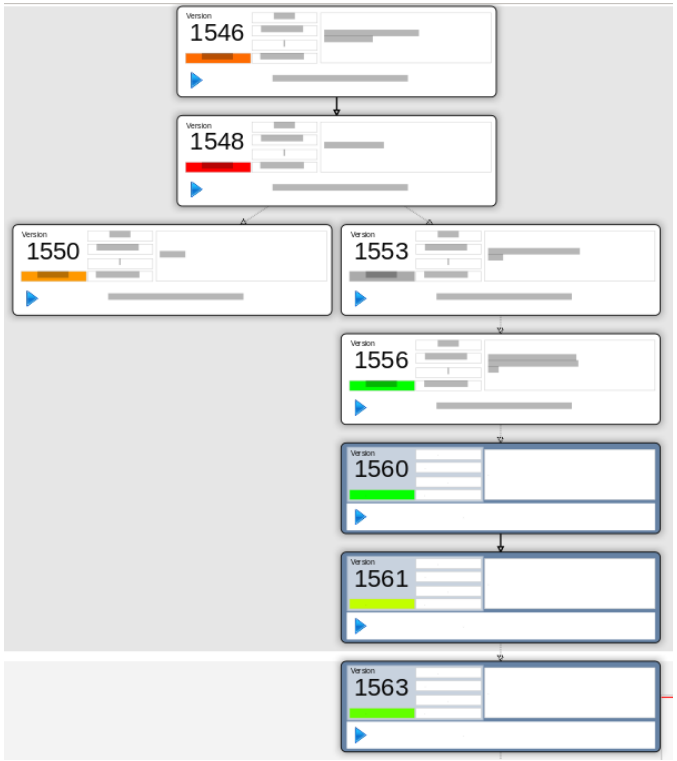
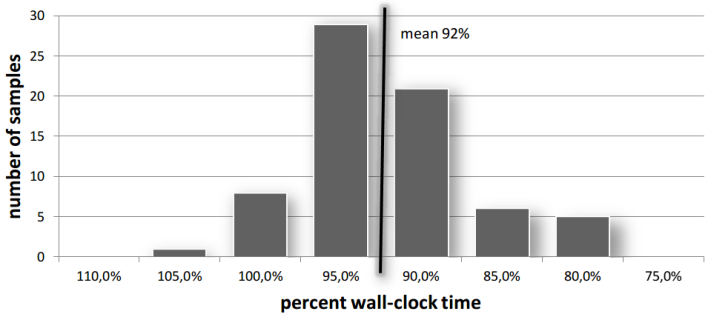
Optimization of Domain Decomposition

- **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%**



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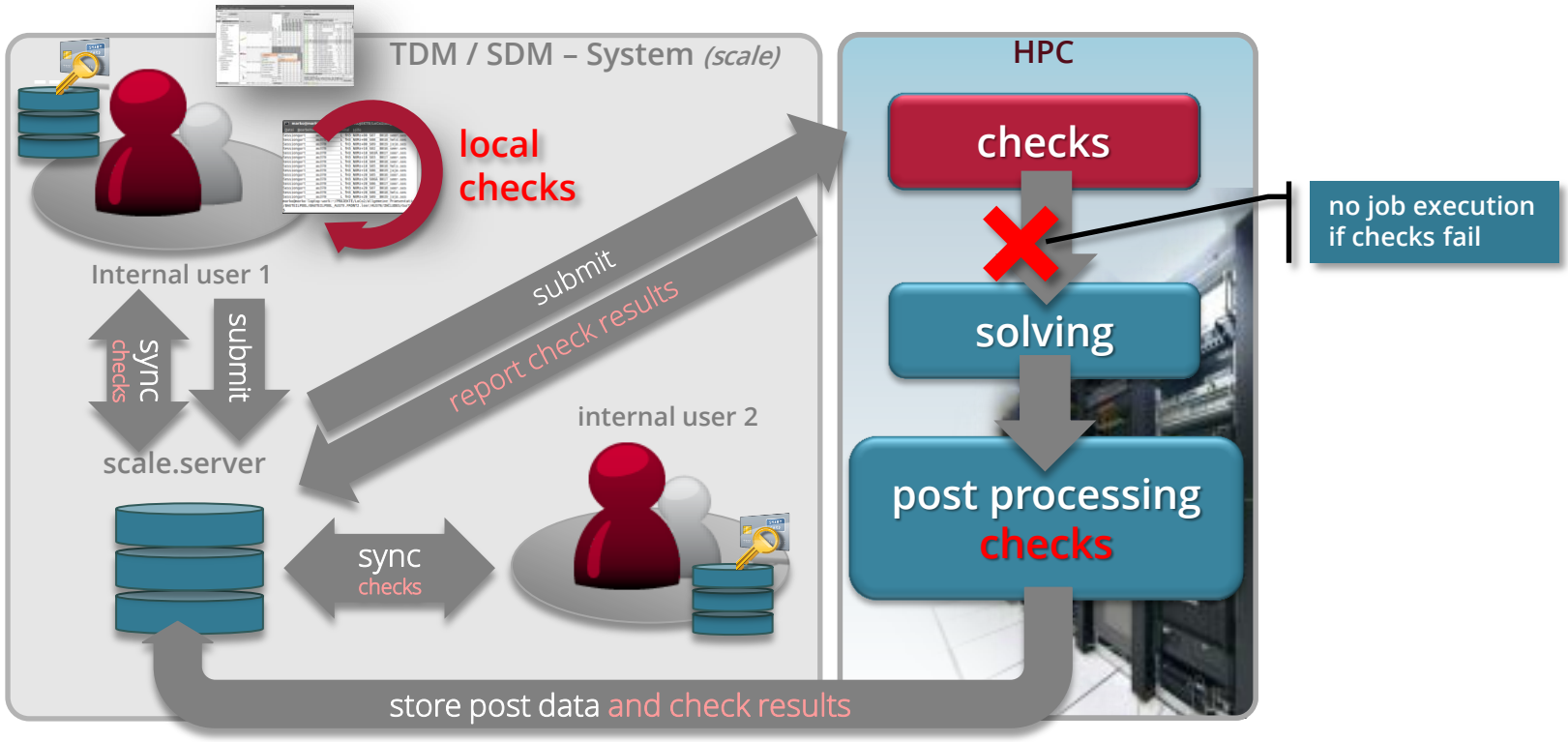
LoCo New Developments: *check infrastructure*



check early
immediate actions

check often
prevent errors
save ressources

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

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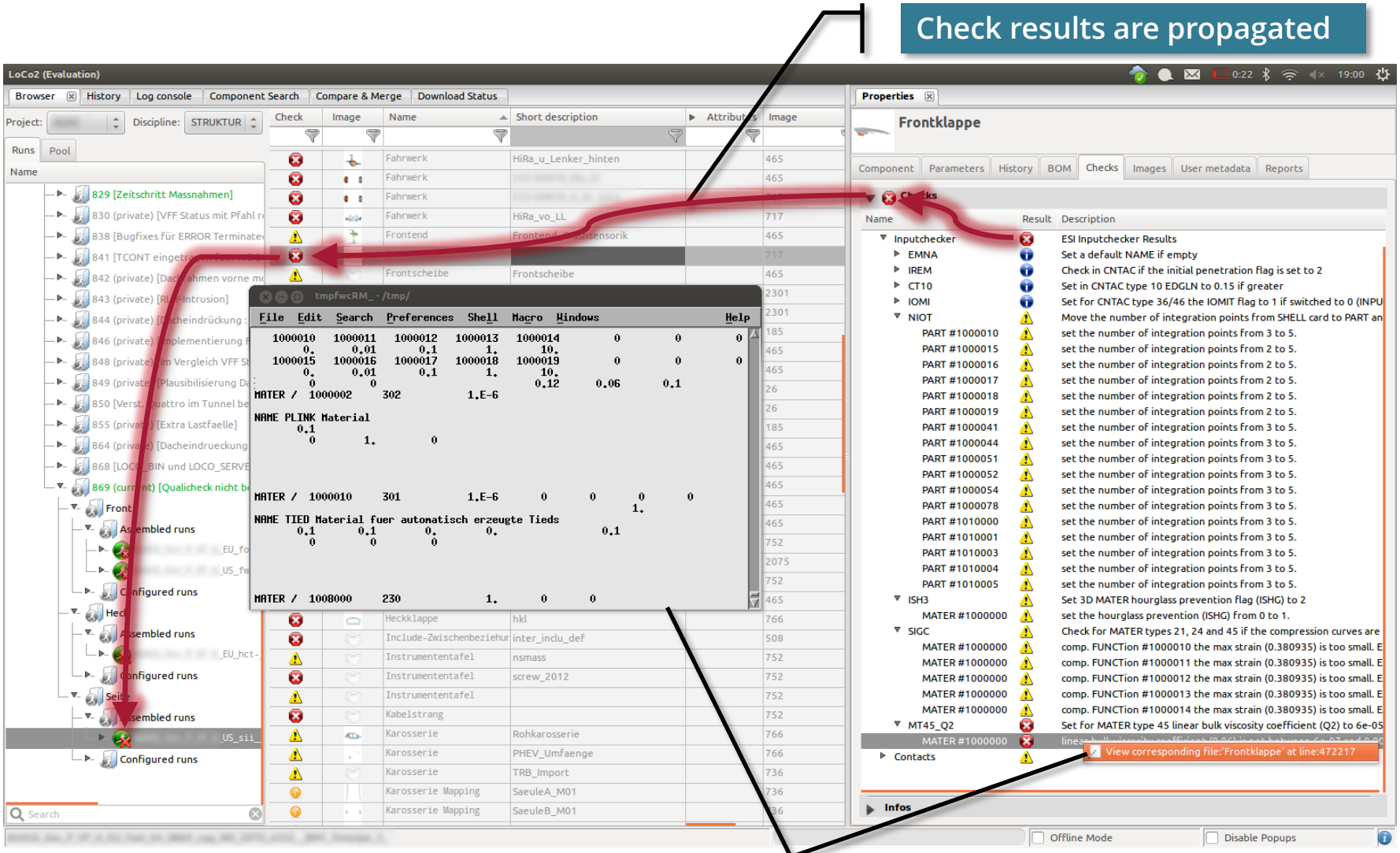
LoCo New Developments: *check infrastructure*



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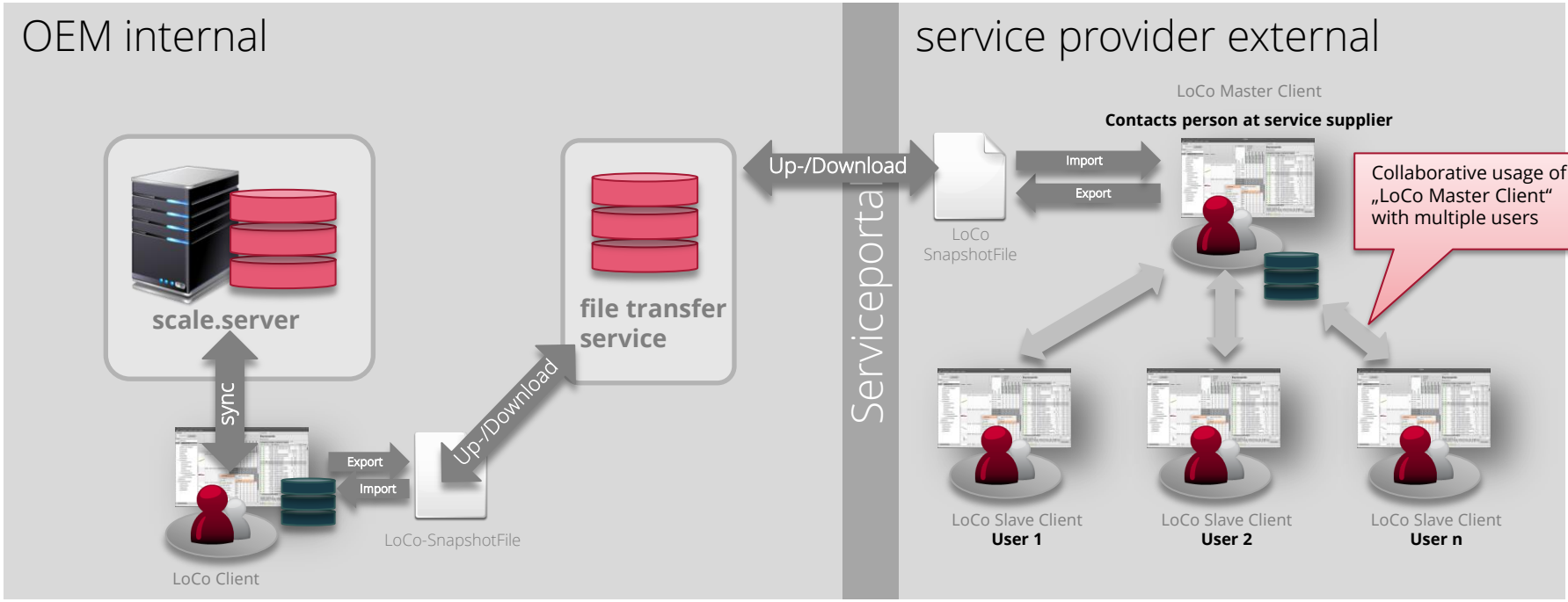
LoCo New Developments: *complete offline usage*



- 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

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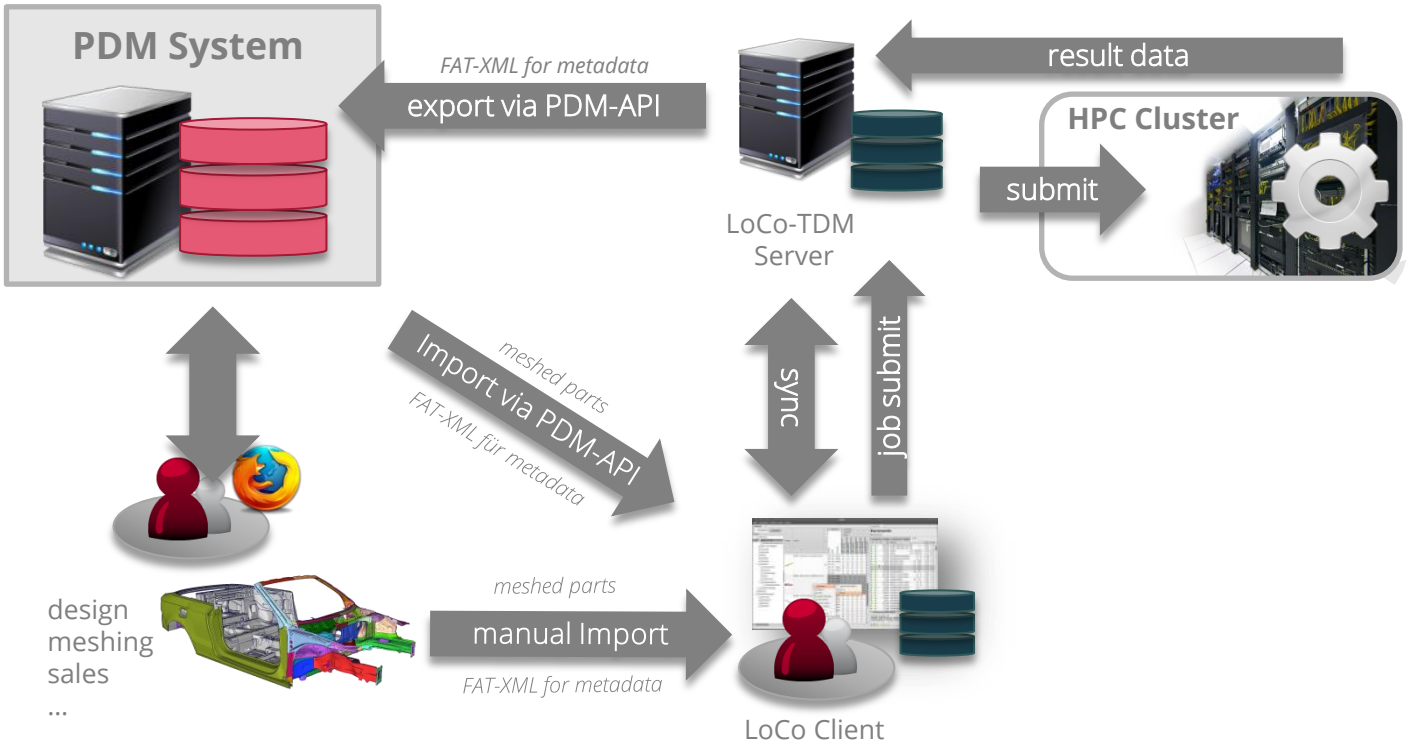
LoCo New Developments: *closing the gap to CAD and PDM*

- 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, ...)*



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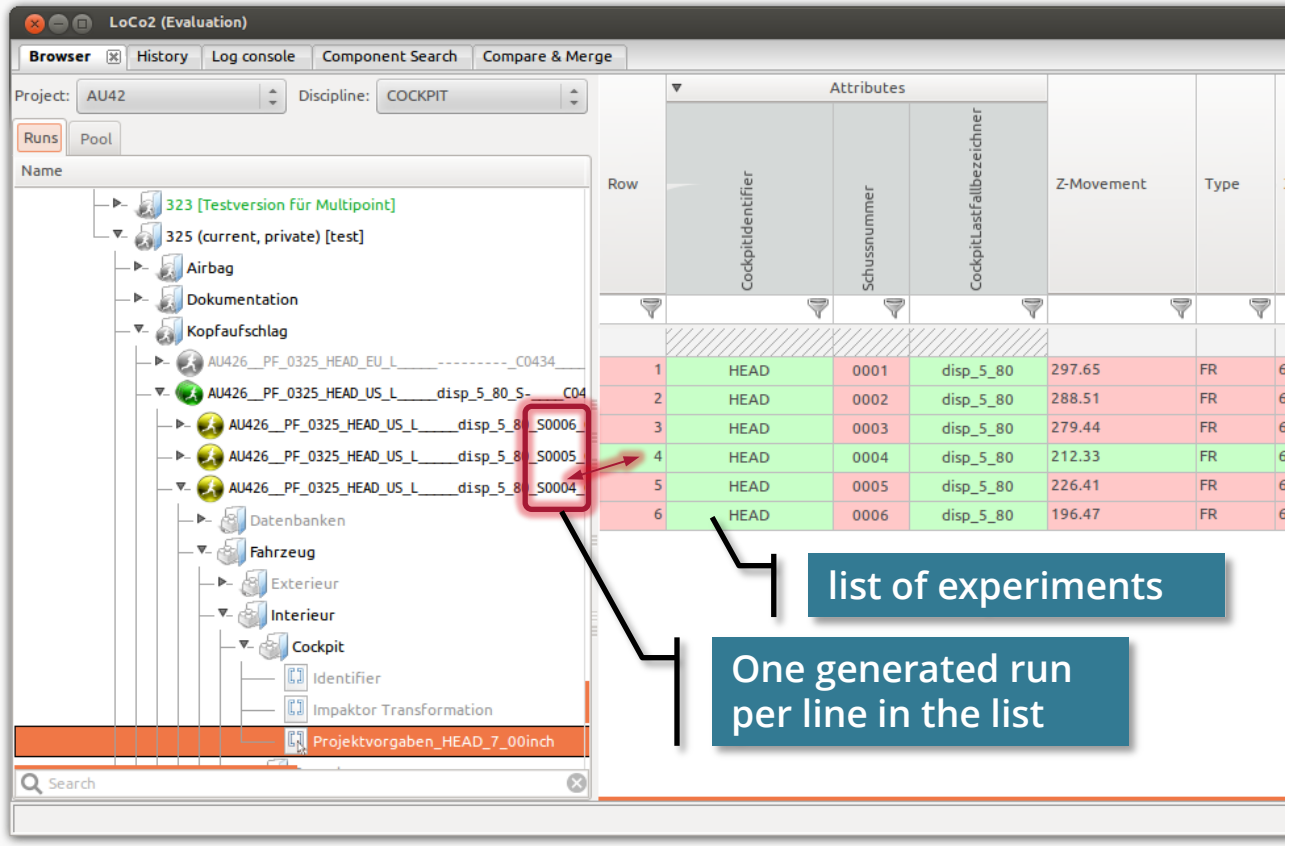
LoCo New Developments: *multi run setups*

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



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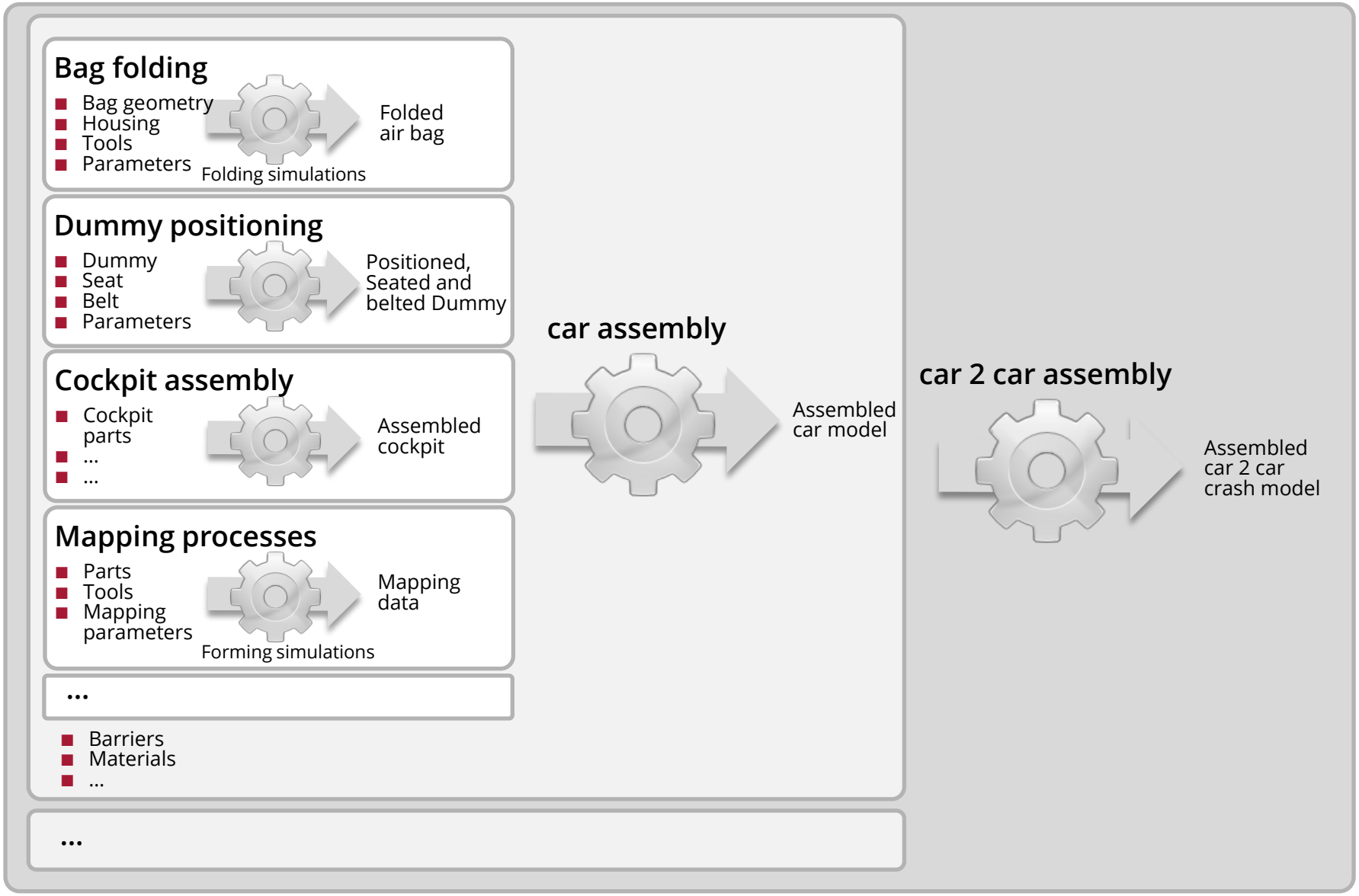
LoCo New Developments: *multi stage assemblies*



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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	Verbindungsel
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 Rücklaufleitung...	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 B8	VERBINDUNGS...	Schraube in Schweißmutter	1	11,74	N910733

Eigenschaften

BT 1 Beschreibung	BEFESTIGUNGSLEISTE
BT 1 Teilenummer	8K9807861
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