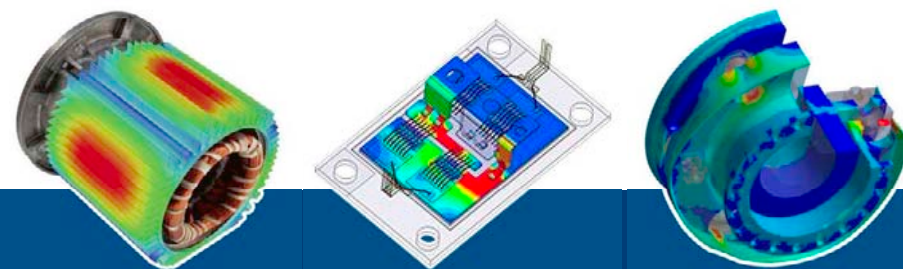


CADFEM®

ANSYS

Competence Center FEM

Simulation ist mehr als Software®



Simultaneous Calculation with ANSYS

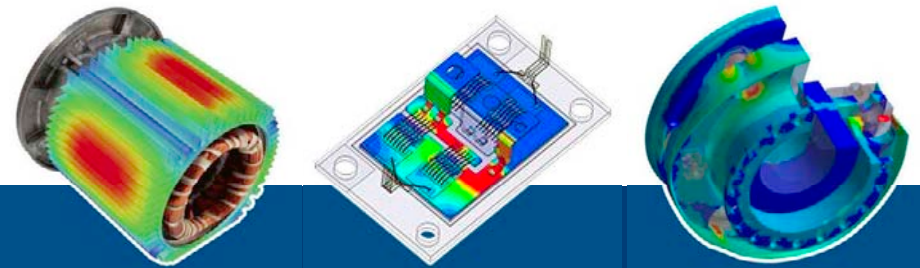
Ian Godfrey, Fujitsu, Nico Nagl, Lars Krüger, CADFEM GmbH
WOST 2014, Weimar, Nov. 7th

FUJITSU

Content

- General Usage
- Workbench Design Point Handling
- Cluster Strategy: “Fujitsu –RDO-Cluster”
- Example and Performance

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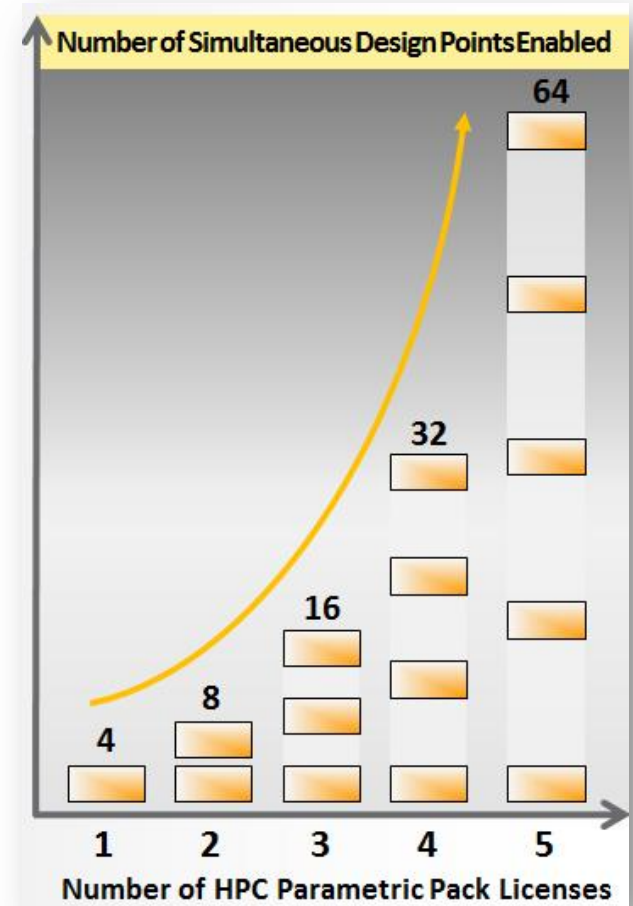
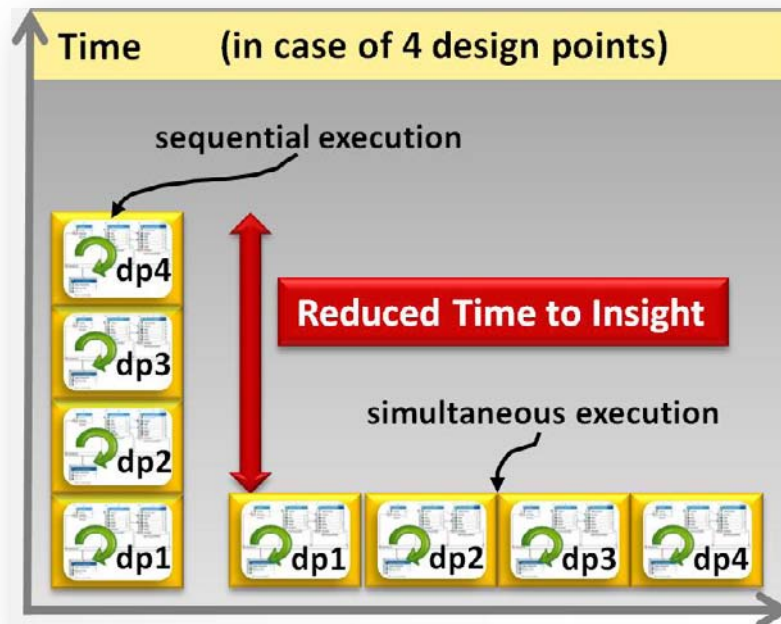
General Usage & Licensing

Which Parameters can be chosen?

- Geometry parameters (CAD, DesignModeler, ...)
 - Engineering data parameters (Young's modulus, density, ...)
 - Mesh parameters (element size, ...)
 - Boundary condition parameters (pressure load magnitude, ...)
 - APDL, Excel, ...
- All parameters which are listed in the Parameter Manager

ANSYS HPC Parametric Pack – Multiplying Base Licenses

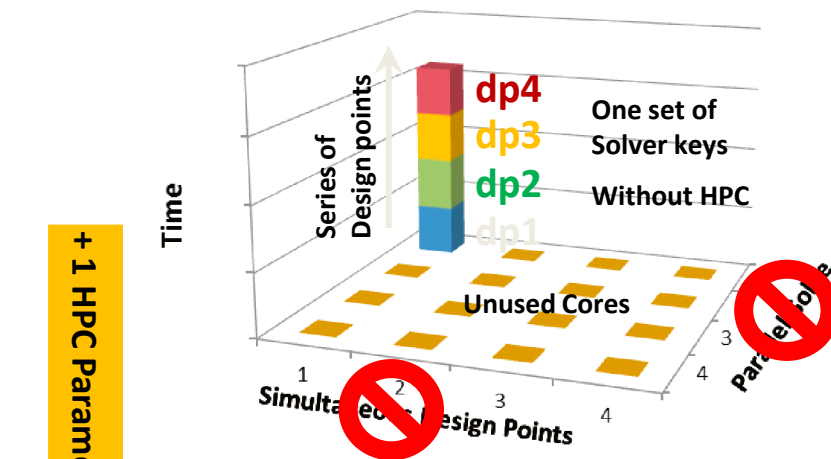
- One base license can be multiplied by **ANSYS HPC Parametric Packs**



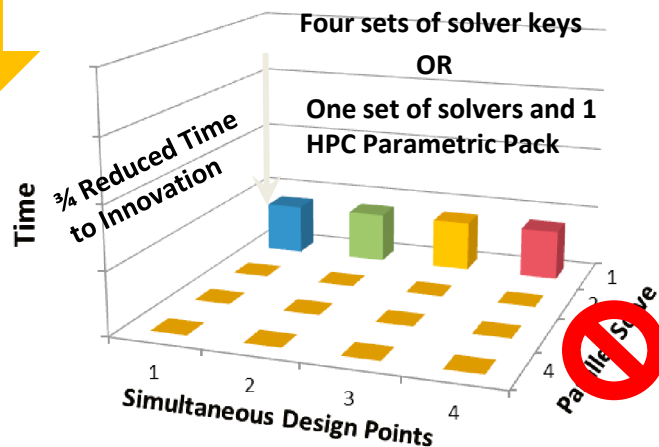
ANSYS HPC Parametric Pack – Supported Base Licenses

- The following table lists ANSYS products that are amplified by the **ANSYS HPC Parametric Pack** license.

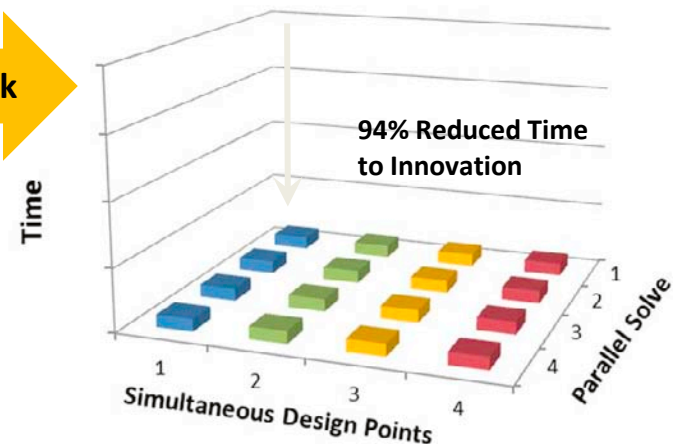
ANSYS CFD, ANSYS CFD Solver ANSYS CFD PrepPost ANSYS CFD-Post ANSYS CFX, ANSYS CFX Solver ANSYS Fluent, ANSYS Fluent Solver ANSYS Fluent PEM Fuel Cell Module, ANSYS Fluent SOFC Fuel Cell Module
ANSYS Professional (at R15.0) ANSYS Structural, ANSYS Structural Solver (at R15.0) ANSYS Mechanical ANSYS Mechanical Solver (at R15.0) ANSYS Mechanical EMAG ANSYS Mechanical CFD-Flo ANSYS Multiphysics ANSYS Multiphysics Solver (at R15.0)
ANSYS Fatigue Module
ANSYS HPC ANSYS HPC Pack ANSYS HPC Workgroup, ANSYS HPC Enterprise
ANSYS Meshing ANSYS Extended Meshing (incl. TGrid, ANSYS ICEM CFD functionality) ANSYS TurboGrid
ANSYS Polyflow, ANSYS Polyflow Solver ANSYS Polyflow BlowMolding, ANSYS Polyflow Extrusion



- Multiplying licenses enables you to drastically reduce time to innovation
→ Simultaneous Processing



+ 1 HPC Pack



Local

Remote

Setup 1: All Processes Local

Geometry Update
 Meshing Process
 Boundary Conditions Mapping
 Solution Process
 Result Extraction
 Result Processing

Setup 2: Local Pre/Post and Remote Solve Process

Geometry Update
 Meshing Process
 Boundary Conditions Mapping

Result Extraction
 Result Processing

Solution Process

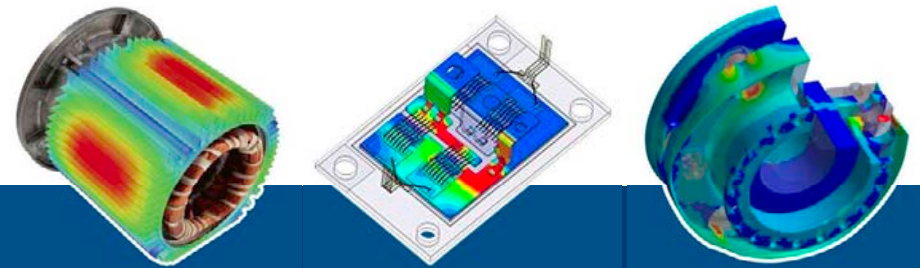
Setup 3: Main Processes Remote

Geometry Update

Result Processing

Meshing Process
 Boundary Conditions Mapping
 Solution Process
 Result Extraction

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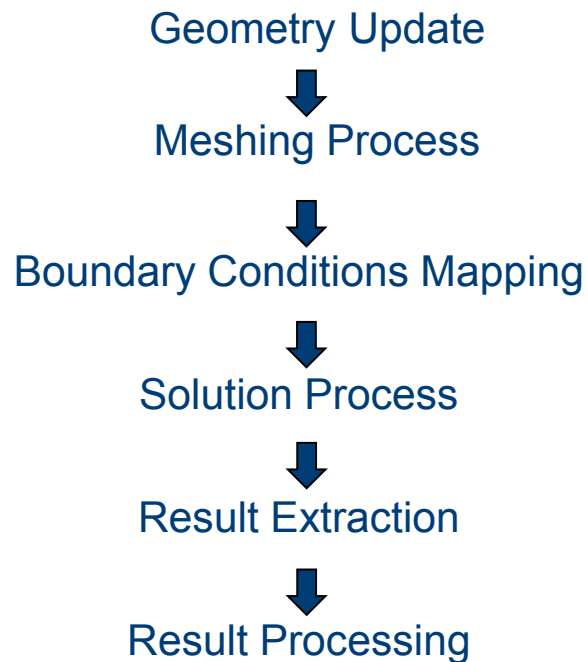


Workbench DP Handling

Setup 1: All Processes Local

Local (e. g. workstation)

Remote (e. g. calculation node)



Setup 1: All Processes Local

- All design points are calculated sequentially which means step by step (NO simultaneous processes)

The image displays two screenshots from the ANSYS Workbench interface, illustrating the configuration for 'Setup 1: All Processes Local'.

Left Screenshot: Properties of Schematic A6: Solution

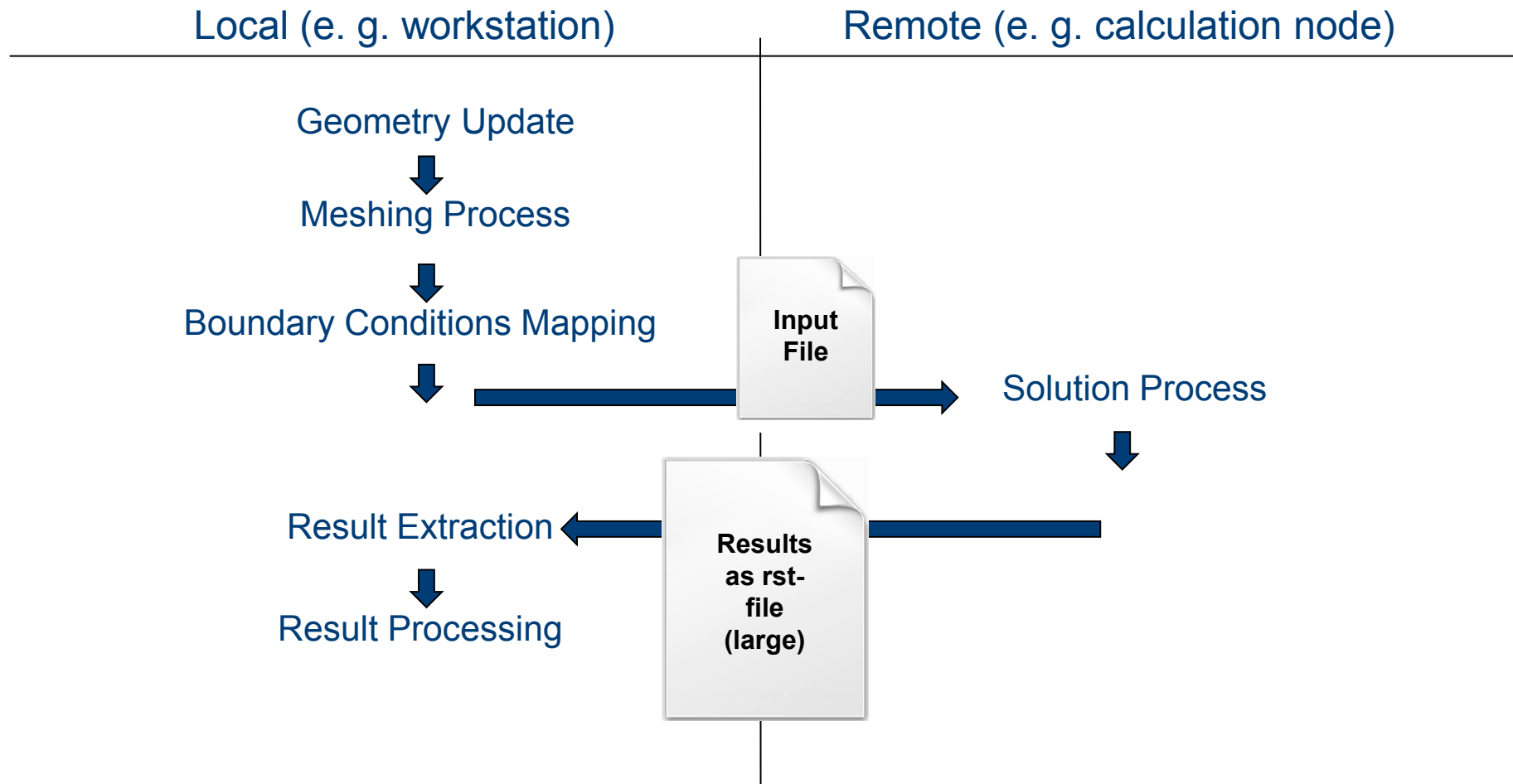
A	B
Property	Value
General	
Component ID	Solution
Directory Name	SYS
Notes	
Used Licenses	
Last Update Used Licenses	ANSYS Mechanical
System Information	
Physics	Structural
Analysis	Static Structural
Solver	Mechanical APDL
Solution Process	
Update Option	Use application default
Solve Process Setting	Eigener Computer
Solve Manager	
Queue	

Right Screenshot: Properties of Schematic: Parameter Set

A	B
Property	Value
Design Point Update Process	
Update Option	Run in Foreground
Design Point Update Order	Update from Current
License Checkout	On-demand

- Solution Process:**
 - Update Option: Use application default → Local
- Design Point Update Process:**
 - Update Option: Run in Foreground → Local

Setup 2: Local Pre/Post and Remote Solve Process



Setup 2: Local Pre/Post and Remote Solve Process

- All design points are calculated sequentially or simultaneously
- Licensing:
 - On Demand
 - **Base licenses** is used → sequential process of design points
 - **NO ANSYS HPC Parametric Pack** available
 - Reserved
 - **Base licenses** useable
 - If multiple base licenses available → simultaneous process possible
 - **ANSYS HPC Parametric Pack** useable → simultaneous process possible
 - **NO** usage of “ANSWAIT”-variable allowed

Setup 2: Local Pre/Post and Remote Solve Process

- Licensing: On Demand → Sequential process of design points

The image displays four screenshots from the ANSYS Workbench interface, illustrating the configuration for Setup 2: Local Pre/Post and Remote Solve Process.

Project Schematic (Left): Shows the project hierarchy. The 'Solution' component is highlighted in blue. A red arrow points from the 'Parameters' component to the 'Parameter Set' component.

Properties of Schematic A6: Solution (Middle-Left): A table showing properties for the Solution component. The 'Update Option' is set to 'Submit to Remote Solve Manager', 'Solve Process Setting' is 'muc-hpc-hn 8 cores', 'Solve Manager' is 'muc-hpc-hn', and 'Queue' is 'ansys145'. These four rows are highlighted with a red box.

Project Schematic (Right): Shows the project hierarchy. The 'Parameters' component is highlighted in blue. A red arrow points from the 'Parameters' component to the 'Parameter Set' component.

Properties of Schematic: Parameter Set (Right): A table showing properties for the Parameter Set component. The 'Update Option' is set to 'Run in Foreground', 'Design Point Update Order' is 'Update from Current', and 'License Checkout' is 'On-demand'. These three rows are highlighted with a red box.

- Solution Process:**
 - Update Option: Submit to Remote Solve Manager → Compute Server
- Design Point Update Process:**
 - Update Option: Run in Foreground → Local

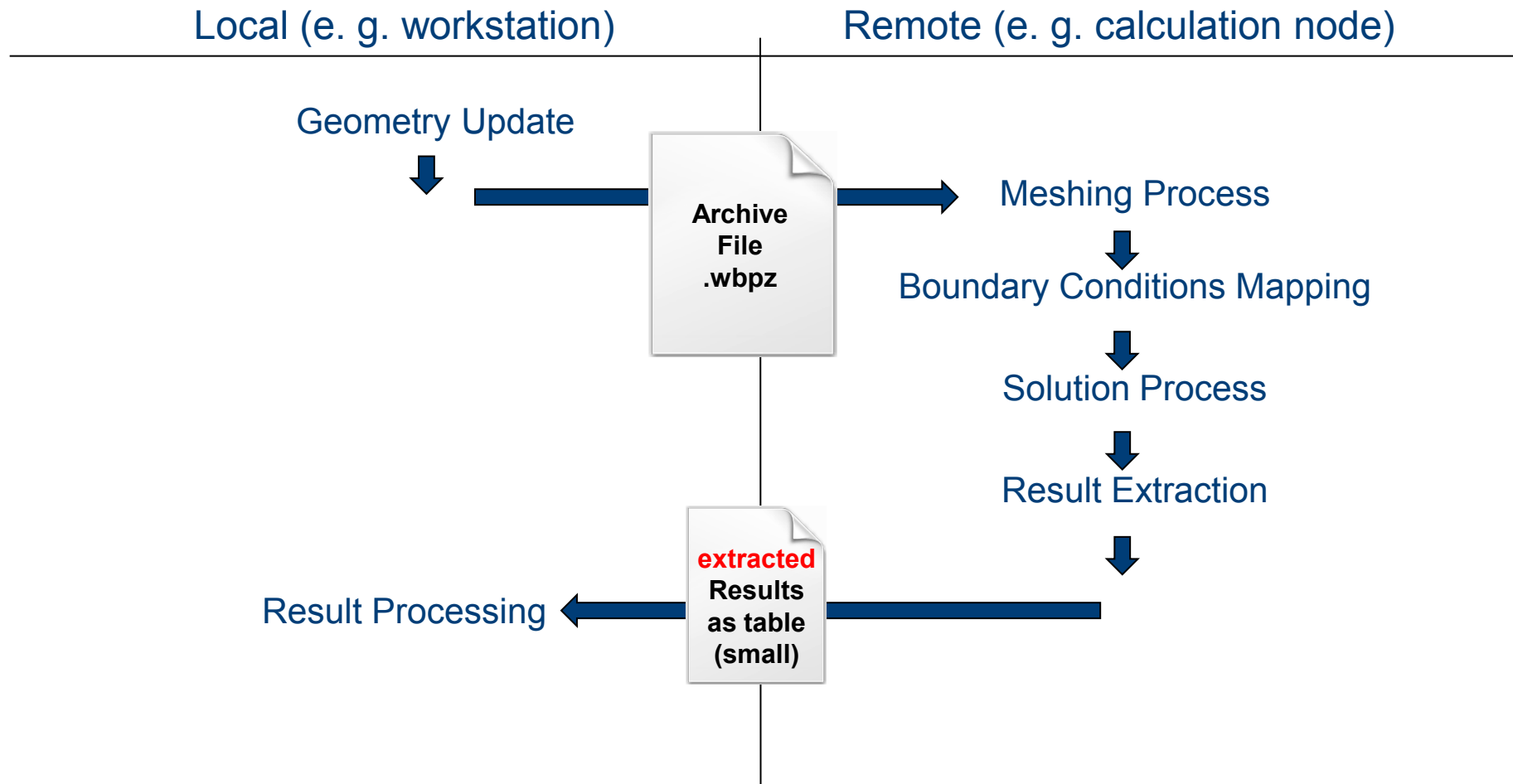
Setup 2: Local Pre/Post and Remote Solve Process

- Licensing: Reserved Licenses → Simultaneous process of design points possible (ANSYS HPC Parametric Pack usage)

The image displays two screenshots of the ANSYS Workbench interface. The left screenshot shows the 'Project Schematic' and 'Properties of Schematic A6: Solution' windows. The 'Properties of Schematic A6: Solution' window has a red box highlighting the 'Update Option' (Set to 'Submit to Remote Solve Manager'), 'Solve Process Setting' (Set to 'muc-hpc-hn 8 cores'), 'Solve Manager' (Set to 'muc-hpc-hn'), and 'Queue' (Set to 'ansys145'). The right screenshot shows the 'Project Schematic' and 'Properties of Schematic: Parameter Set' windows. The 'Properties of Schematic: Parameter Set' window has a red box highlighting the 'Design Point Update Process' section, which includes 'Update Option' (Set to 'Run in Foreground'), 'Design Point Update Order' (Set to 'Update from Current'), 'License Checkout' (Set to 'Reserved'), and 'Reserved License Set' (Set to 'Select Licenses').

- Solution Process:
 - Update Option: Submit to Remote Solve Manager → Compute Server
- Design Point Update Process:
 - Update Option: Run in Foreground → Local

Setup 3: Main Processes Remote = highest performance



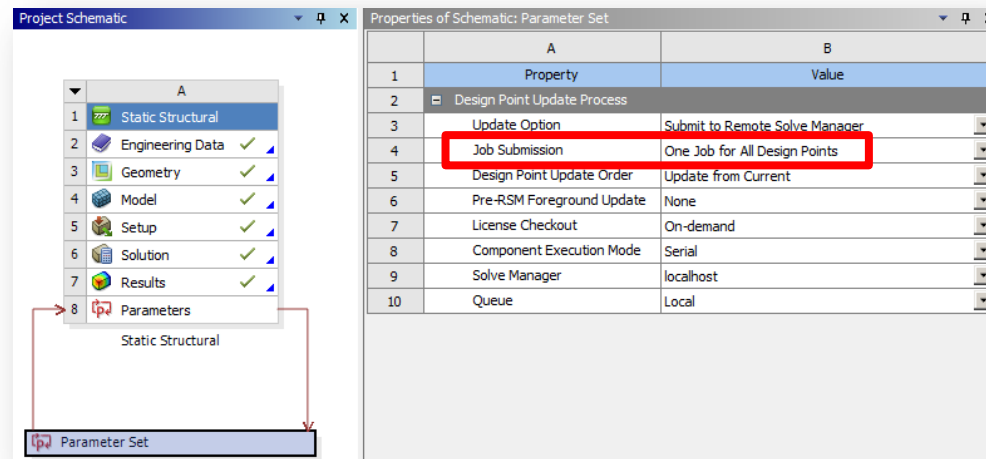
Setup 3: Main Processes Remote

- All design points are calculated sequentially or simultaneously

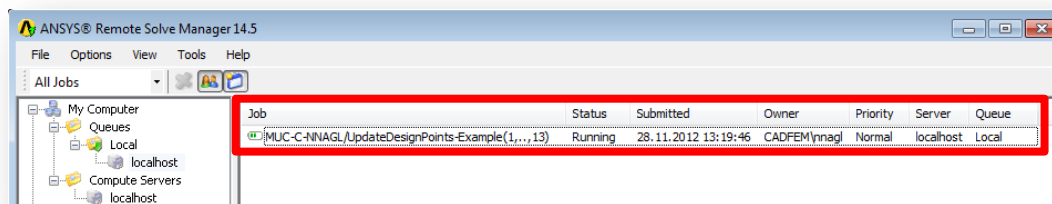
The image displays four screenshots of the ANSYS Workbench interface, illustrating the configuration for remote calculation. The first two screenshots show the 'Properties of Schematic A6: Solution' dialog, where the 'Update Option' is set to 'Use application default' and the 'Solve Process Setting' is set to 'Eigener Computer'. The last two screenshots show the 'Properties of Schematic: Parameter Set' dialog, where the 'Update Option' is set to 'Submit to Remote Solve Manager'.

- Solution Process:**
 - Update Option: Use application default → local run on Compute Server
- Design Point Update Process:**
 - Update Option: Submit to Remote Solve Manager → Compute Server
- Processing order defined by 3 types of settings (see following slides)

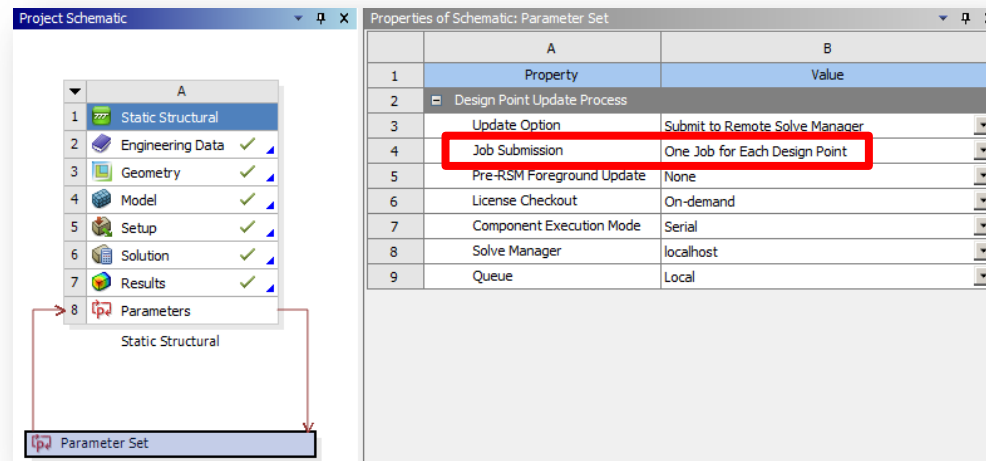
Setup 3.1: One Job for All Design Points



- Sequential process for all design points which means step by step, not simultaneously
- 1 Job is sent to RSM including dp1, dp2, ... dpn

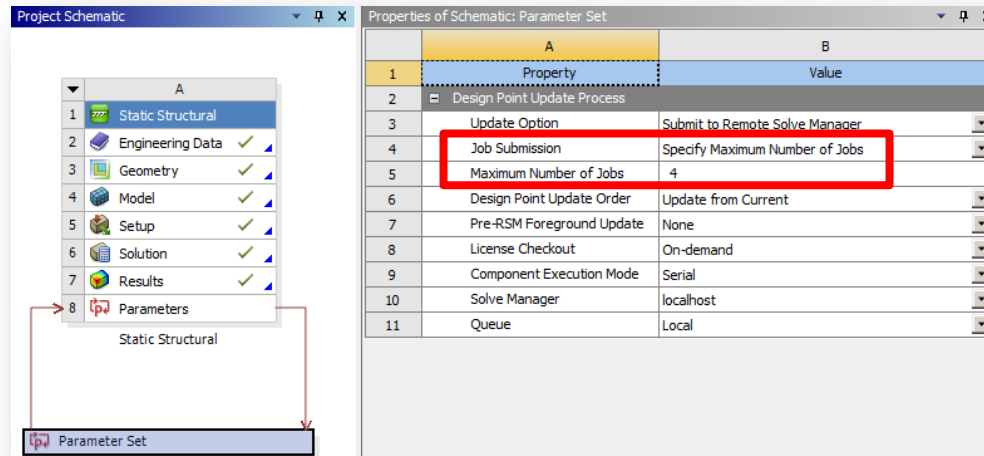


Setup 3.2: One Job Each Design Point



- Number of jobs is equal to design points
 - e. g. 32 design points → 32 jobs
 - Jobs can be processed sequentially or simultaneously, depending on licensing and **adjusted RSM settings**

Setup 3.3 : Specify Maximum Number of Jobs



- Maximum number of jobs is limited
 - Jobs can be processed sequentially or simultaneously, depending on licensing and **static RSM setting**
 - All Design Points in the Parameter Manager are equally distributed to the defined number of jobs

License Tracking for „Reserved Licenses“

- License tracking requires a solution started from solution cell in project manager (with Mechanical closed)
- There are two locations, where used licenses are displayed
 - In cells of the system in project manager
 - In the Parameter Set / Reserved License Set setting

The screenshot shows the 'Project Schematic' on the left and the 'Properties of Schematic A6: Solution' on the right. In the schematic, the 'Solution' cell is highlighted. In the properties table, the 'Last Update Used Licenses' row is highlighted with a red box, showing 'ANSYS Mechanical'.

	A	B
Property	Value	
General		
Component ID	Solution	
Directory Name	SYS	
Notes		
Notes		
Last Update Used Licenses	ANSYS Mechanical	
Physics	Structural	
Analysis	Static Structural	
Solver	Mechanical APDL	
Solution Process		
Update Option	Use application default	
Solve Process Setting	Eigen Computer	
Solve Manager		
Queue		

The screenshot shows the 'Project Schematic' on the left and the 'Properties of Schematic: Parameter Set' on the right. In the schematic, the 'Parameter Set' cell is highlighted. In the properties table, the 'Reserved License Set' row is highlighted with a red box, showing 'Select Licenses'.

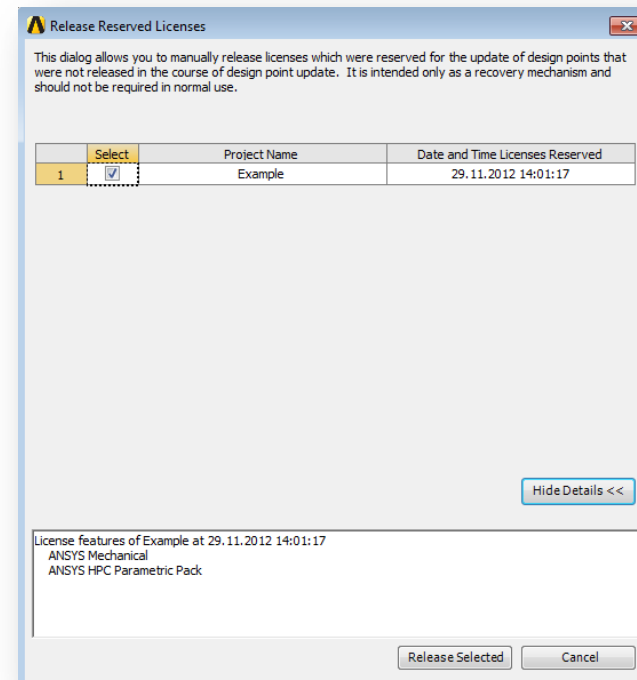
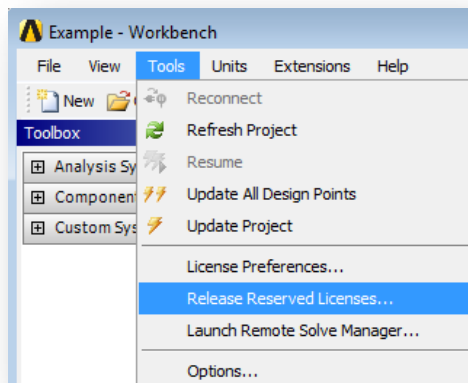
	A	B
Property	Value	
Design Point Update Process		
Update Option	Submit to Remote Solve Manager	
Job Submission	Specify Maximum Number of Jobs	
Maximum Number of Jobs	4	
Design Point Update Order	Update from Current	
Pre-RSM Foreground Update	None	
License Checkout	Reserved	
Reserved License Set	Select Licenses	
Component Execution Mode	Serial	
Solve Manager	localhost	
Queue	Local	

The screenshot shows the 'Select Licenses' dialog box. The 'Reserved Licenses' table is highlighted with a red box, showing 'ANSYS Mechanical' with 4 reserved licenses and 4 concurrent licenses.

License Name	Used	Cell IDs	Reserved	Concurrent Licenses
ANSYS Mechanical*	1	ANLAS	4	4

Release „Reserved Licenses“

- In case of processes terminated abnormally, reserved licenses remain reserved and will not be available.
- However, these licenses can be released manually.



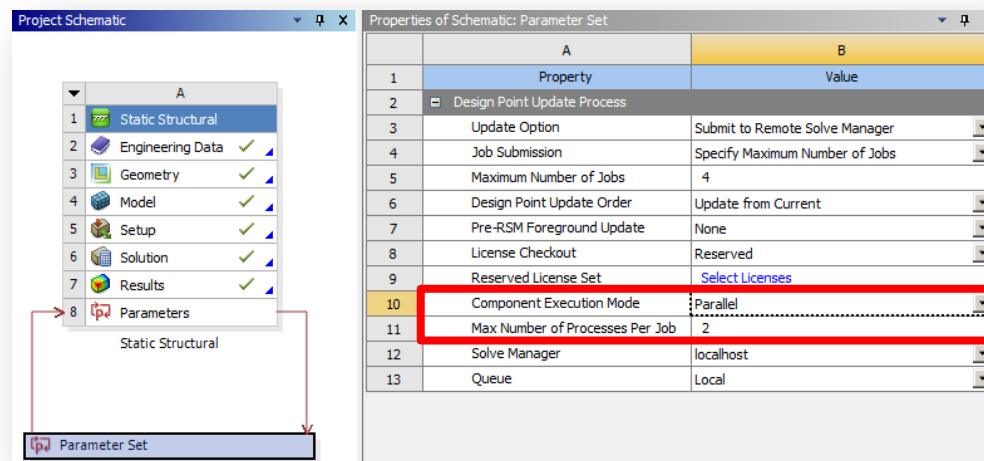
Restrictions in Multiplying Licenses

- One HPC Parametric Pack amplifies only one base license
- A mixture of amplified and non amplified base licenses is not possible
 - E. g.
 - 3 x **ANSYS Mechanical** + 1 x **ANSYS HPC Parametric Pack** available
 - For one parametric study, you may use EITHER
 - 1 x **ANSYS Mechanical** + 1 x **ANSYS HPC Parametric Pack** for 4 simultaneous jobs
 - OR
 - 3 x **ANSYS Mechanical** for 3 simultaneous jobs
 - **BUT NOT**
 - 1 x **ANSYS Mechanical** + 1 x **ANSYS HPC Parametric Pack** + 2 x **ANSYS Mechanical** for 6 simultaneous jobs



Parallel Execution Mode for Multicore Processing

- Switch default setting “Serial” (1 Core) to “Parallel” (Multicore)

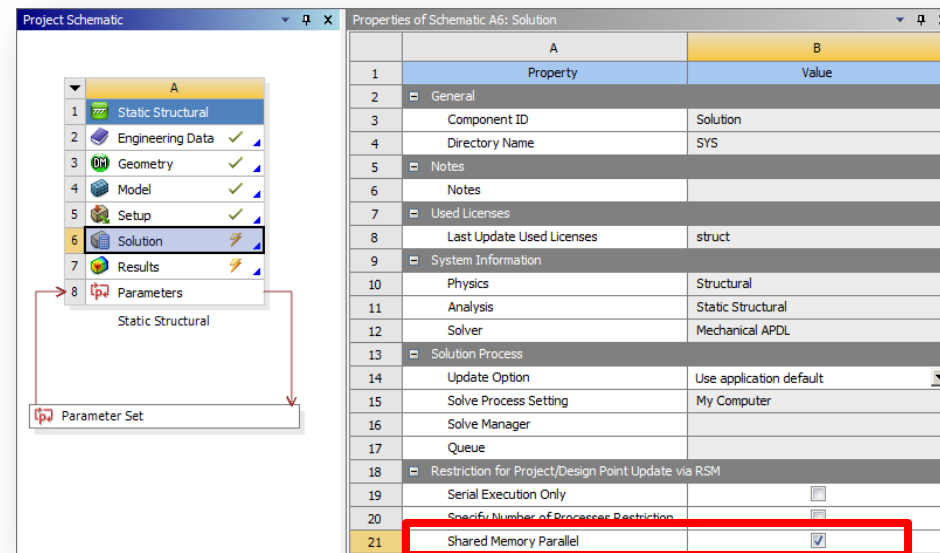


- Example:
 - 8 core machine
 - Setup for simultaneous processing enabled (Reserved Licenses + **ANSYS HPC Parametric Pack** + **ANSYS Mechanical**, RSM Limiter: 50 Jobs)
 - Specified Maximum Number of Jobs: 4
 - Maximum Number of Processes per Job: 2 (means 2 Cores per Job)
→ 8 cores in use while processing

Calculation Modes – SMP and DMP

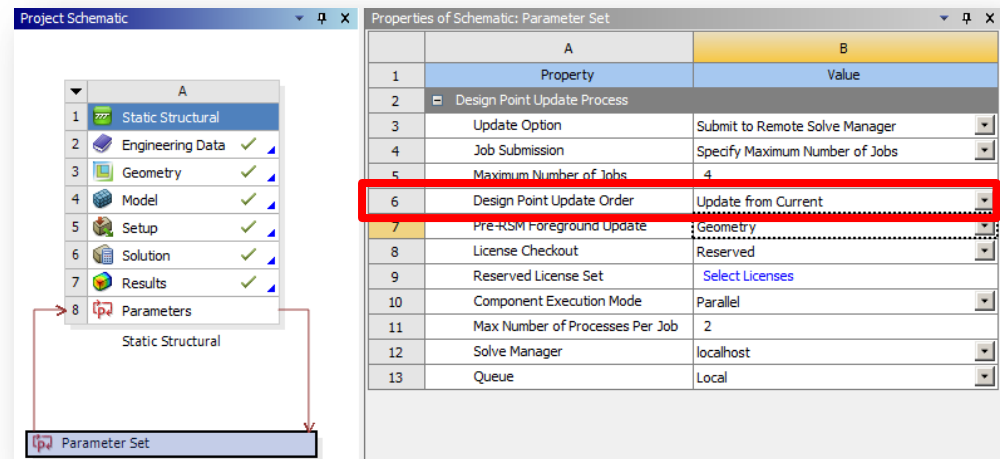
Setting in „Component Execution Mode“

- Serial: SMP single core calculation
→ Shared Memory ANSYS
- Parallel:
 - Default calculation mode: DMP multicore calculation with n cores
→ Distributed ANSYS
 - If DMP cannot be used for calculation, in most cases the mode changes automatically to SMP.
 - Manual change of calculation mode to SMP possible



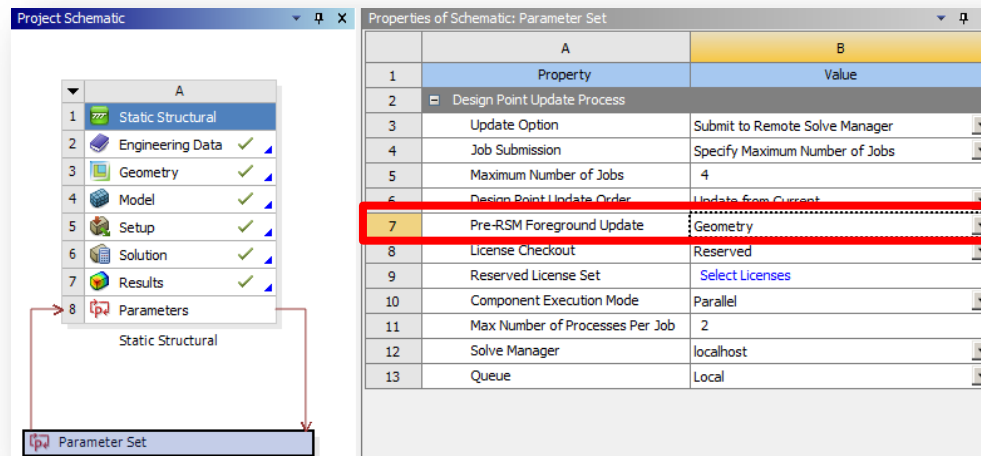
Design Point Update Order

- Update from Current: (recommended!)
 - Each design point is updated from the initial model (current design point in the design point manager)
- Update Design Points in Order:
 - Next design point refers to the previous design point which was updated
- Pro
 - If changes from DP to DP are small → time saving
- Con
 - If one DP update is failed → next DP will fail



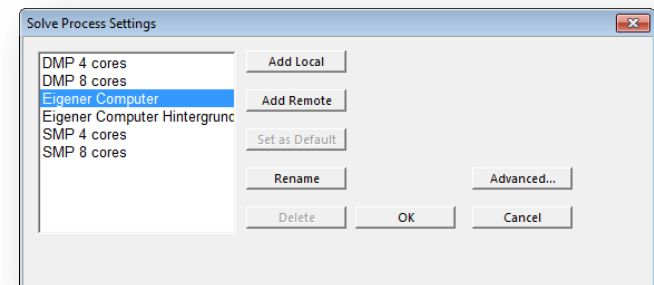
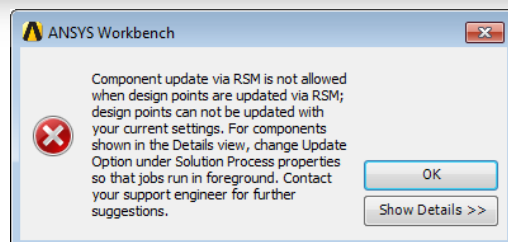
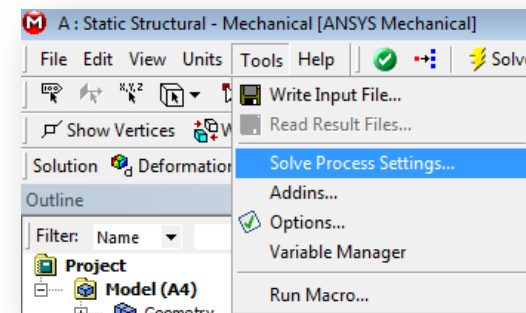
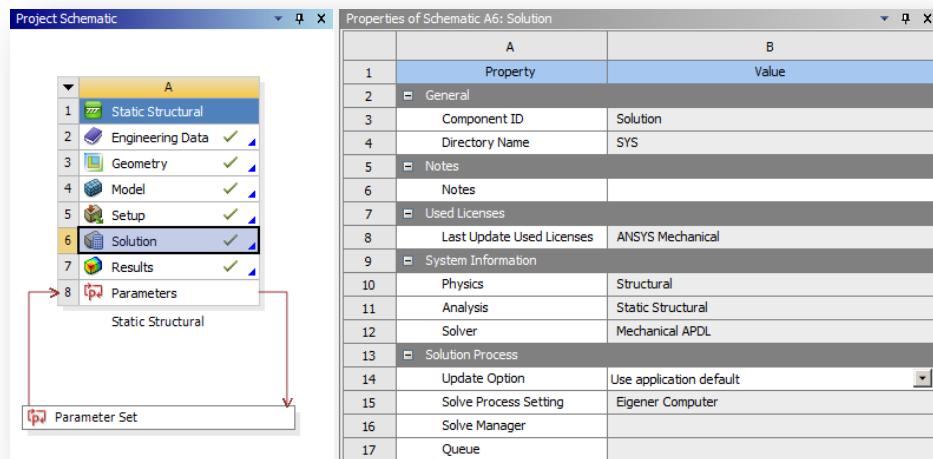
Geometry Update with Pre-RSM Foreground Update

- In case of simultaneous settings, an upfront update of **all** Geometries is done automatically, no matter which Pre-RSM option is set
- In the other cases, the user can choose



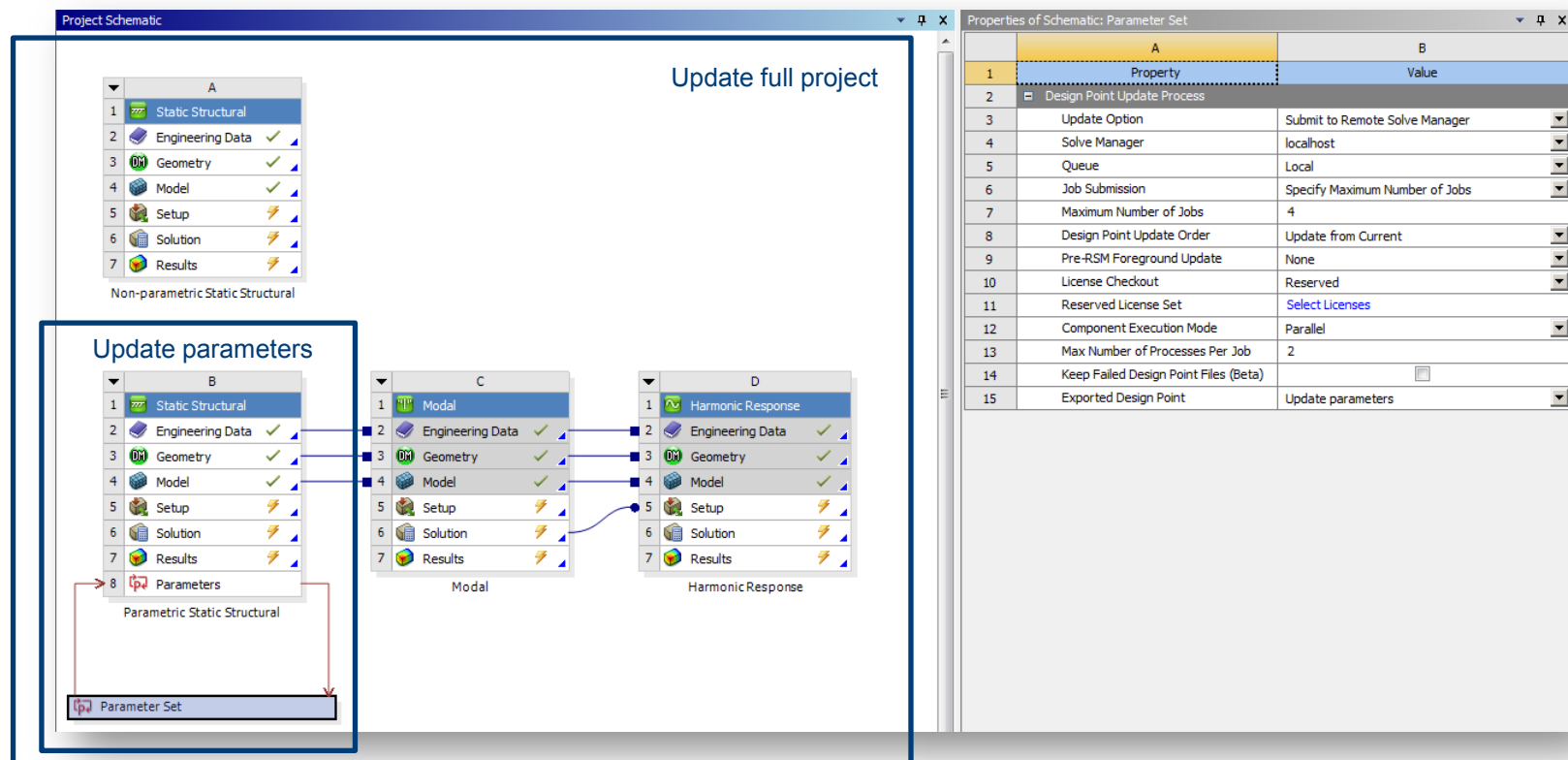
Application Default Setting in Update Option

- The update option in the solution cell has to be set to „Eigener Computer“. Otherwise a warning arises. The default solve setting need to be defined in the Solve Process Setting in the Mechanical Editor.



Update Parameters vs. Update full Project

- Update Parameters: Only unsolved analysis systems with parameters will be updated
- Update full Project: All unsolved analysis systems will be updated



Example

- Simultaneous Processing with ANSYS HPC Parametric Pack
 - 32 core remote compute server machine
 - 1 x **ANSYS HPC Parametric Pack**
 - 1 x **ANSYS HPC Pack**
 - 1 x **ANSYS Mechanical**
 - 100 design points
 - Geometry parameters + load parameters

The screenshots illustrate the recommended setup for simultaneous processing in ANSYS Workbench. The first two images show the 'Properties of Schematic A6: Solution' and 'Properties of Schematic: Parameter Set' for a Static Structural analysis. The last two images show the same properties for a Parameter Set analysis.

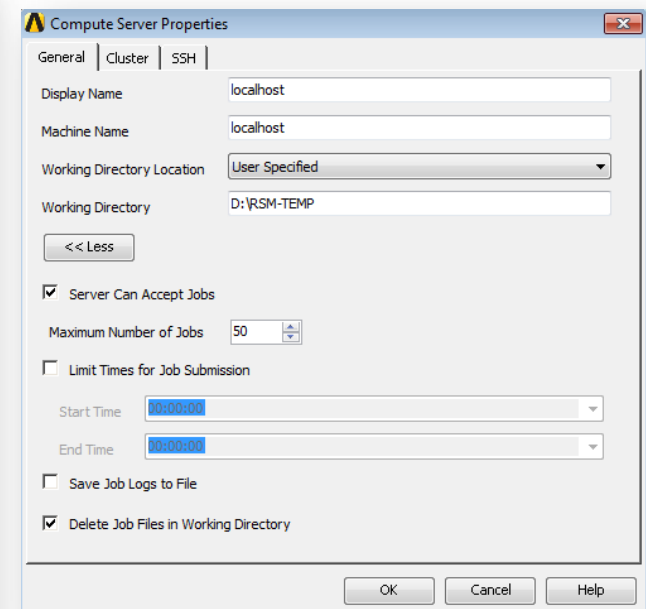
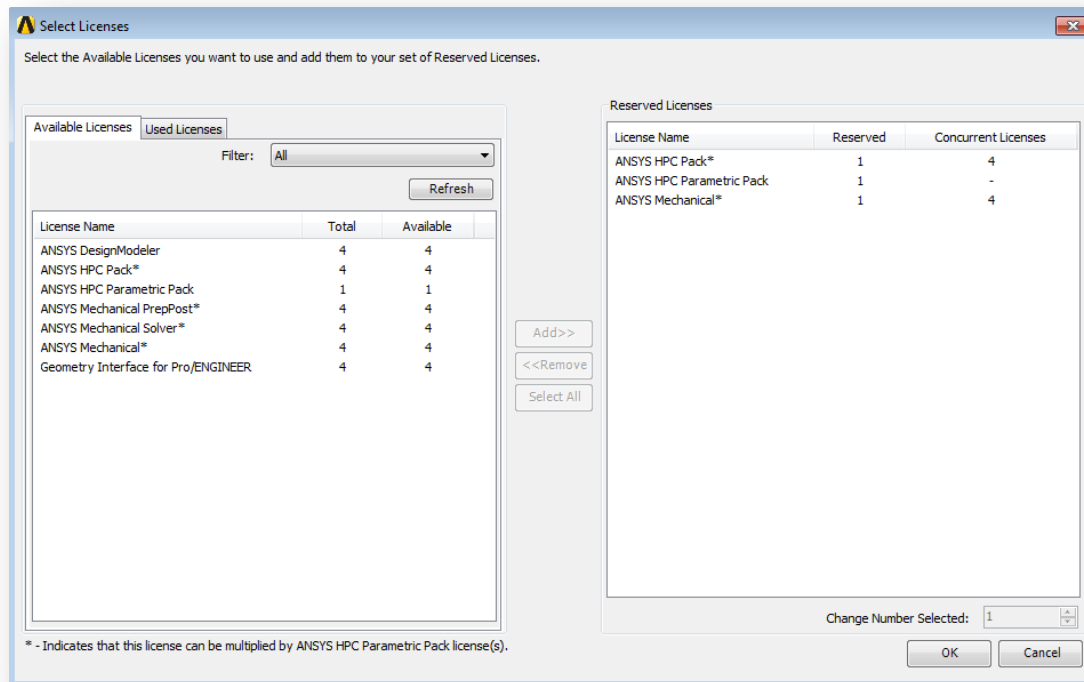
Properties of Schematic A6: Solution	
A	B
Property	Value
1	
2	General
3	Component ID: Solution
4	Directory Name: SYS
5	Notes
6	Notes
7	Used Licenses
8	Last Update Used Licenses: ANSYS Mechanical
9	System Information
10	Physics: Structural
11	Analysis: Static Structural
12	Solver: Mechanical APDL
13	Solution Process
14	Update Option: Use application default
15	Solve Process Setting: Eigener Computer
16	Solve Manager

Properties of Schematic: Parameter Set	
A	B
Property	Value
1	
2	Design Point Update Process
3	Update Option: Submit to Remote Solve Manager
4	Job Submission: Specify Maximum Number of Jobs
5	Maximum Number of Jobs: 4
6	Design Point Update Order: Update from Current
7	Pre-RSM Foreground Update: Geometry
8	License Checkout: Reserved
9	Reserved License Set: Select Licenses
10	Component Execution Mode: Parallel
11	Max Number of Processes Per Job: 8
12	Solve Manager: localhost
13	Queue: Local

Recommended Setup

Example

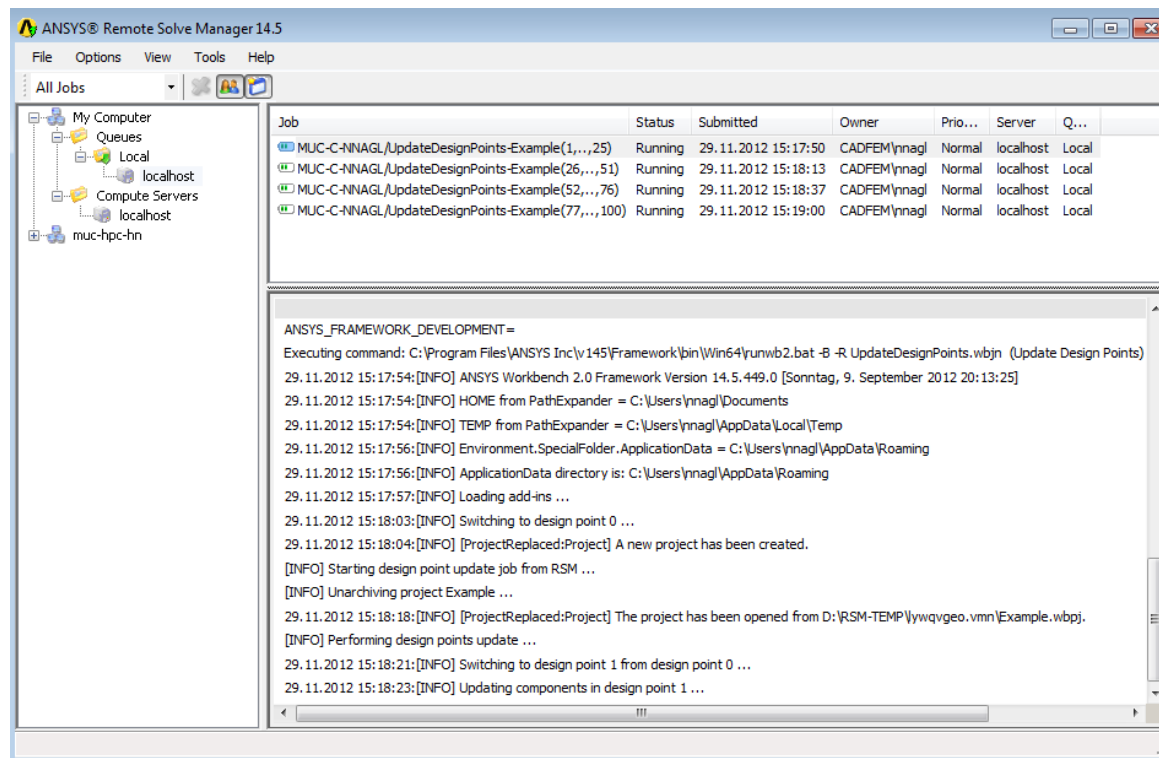
- Simultaneous Processing with ANSYS HPC Parametric Pack



Recommended Setup

Example

- Simultaneous Processing with ANSYS HPC Parametric Pack



Recommended Setup

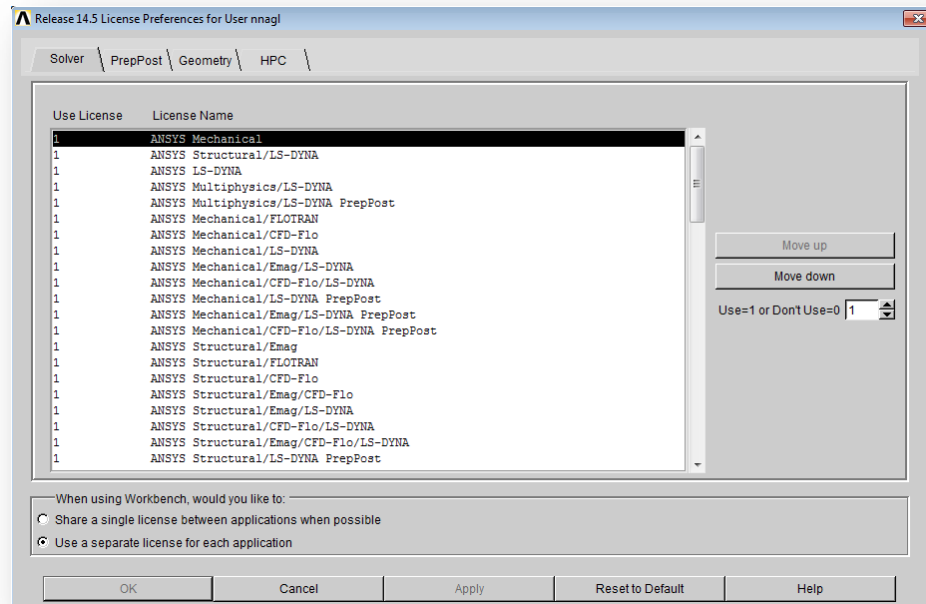
Example - Summary

- Simultaneous Processing with ANSYS HPC Parametric Pack
 - Simultaneous processing enabled by
 - “Reserved Licenses”
 - Specified Maximum Number of Jobs: 4
 - **ANSYS HPC Parametric Pack**
 - All geometries are updated locally upfront
 - 4 jobs in process (each job includes 25 design points), 0 jobs in RSM-Queue
 - 8 cores per job → 32 cores in process; enabled by ANSYS HPC Pack
 - Specified Maximum Number of Jobs < RSM Limiter

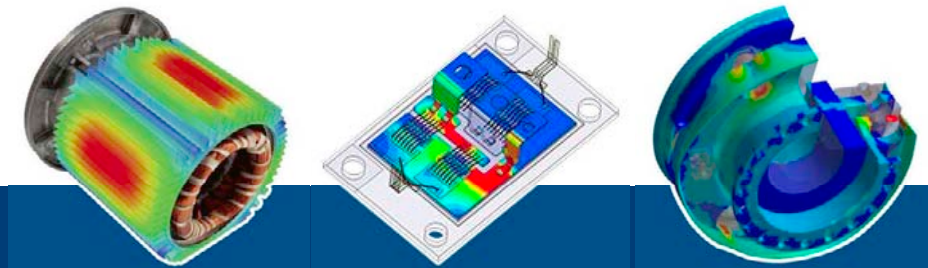


Settings

- “ANSWAIT” variable must not be set
- Set user specific variable:
 - ANSYS_FRAMEWORK_ENABLE_REDUCE_RSM_FILE_TRANSFER=1
 - Reduces transfer from compute server to local client to scalar results in parameter manager only
 - BUT: From client TO compute server, the full project incl. all included data is transferred
→ Recommendation: clear all simulation results from the current design in the Mechanical Editor
- For selecting licenses in „reserved licenses“, they need to be activated in “Licenses Preferences” (e. g. Mechanical = 1)



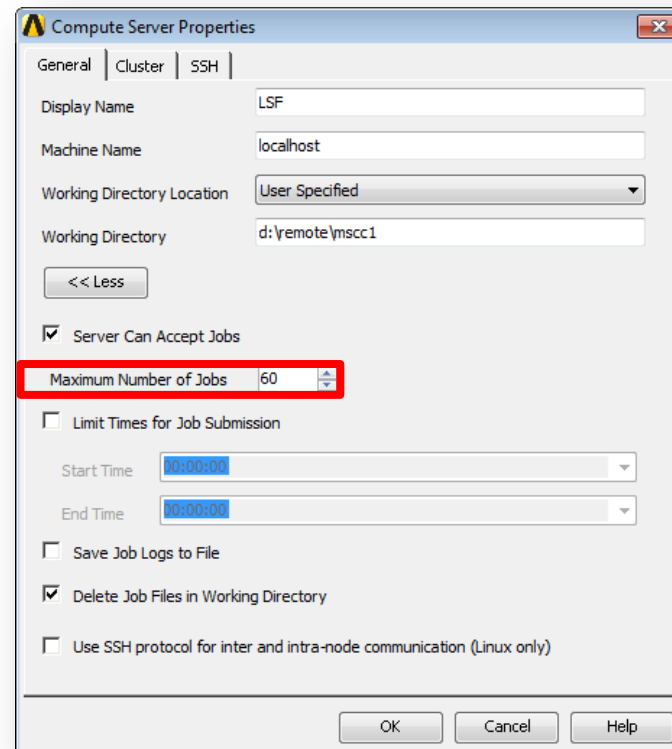
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Job Limitation

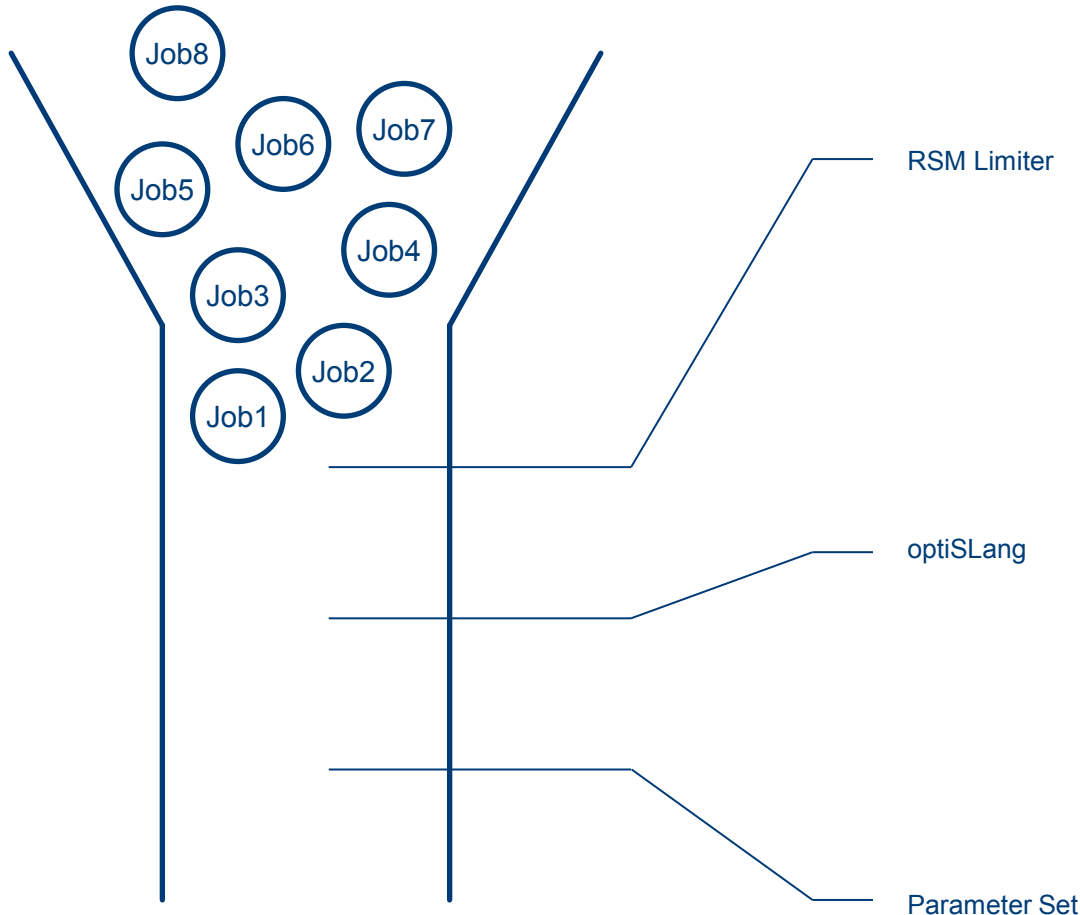
RSM Limiter – Limiting Maximum Number of Jobs

- RSM Settings for Compute Server
 - RSM limits Maximum Number of Jobs → RSM Limiter



→ RSM Limiter

Job Limitation – 3 Ways to Adjust



Compute Server Properties

General | Cluster | SSH

Display Name: LSF

Machine Name: localhost

Working Directory Location: User Specified

Working Directory: d:\remote\mscc1

<< Less

☒ Server Can Accept Jobs

Maximum Number of Jobs: 4

☐ Limit Times for Job Submission

Start Time: 00:00:00

End Time: 00:00:00

☐ Save Job Logs to File

☒ Delete Job Files in Working Directory

☐ Use SSH protocol for inter and intra-node communication (Linux only)

OK Cancel Help

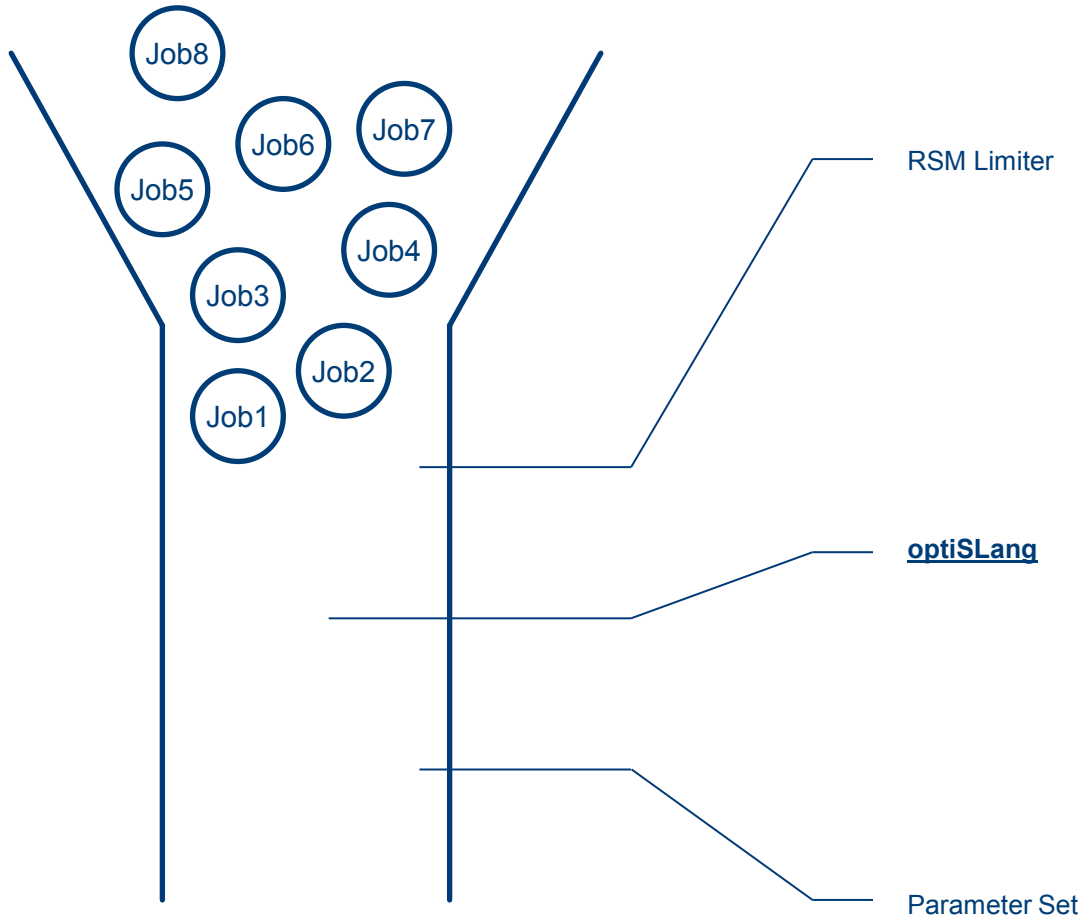
Properties of Schematic B2: DOE

	A	B
1	Property	Value
2	General	
3	Component ID	DOE (optiSLang)
4	Directory Name	Sensitivity
5	Save Design Points As Projects	☐
6	Clear Design Table during Update	☐
7	Notes	
8	Notes	
9	Update Options	
10	Specify Maximum Runtime per Job	☐
11	Use RSM Mode	☒
12	Preferred Number of Simultaneous Runs	4
13	Run Python Script for Update	☐

Properties of Schematic: Parameter Set

	A	B
1	Property	Value
2	Design Point Update Process	
3	Update Option	Submit to Remote Solve Manager
4	Solve Manager	muc-hpc-hn
5	Queue	ansys145
6	Job Submission	Specify Maximum Number of Jobs
7	Maximum Number of Jobs	4

Job Limitation – Adjustment for Setup 2



Compute Server Properties

General | Cluster | SSH

Display Name: LSF

Machine Name: localhost

Working Directory Location: User Specified

Working Directory: d:\remote\mscc1

<< Less

☒ Server Can Accept Jobs

Maximum Number of Jobs: 60

☐ Limit Times for Job Submission

Start Time: 00:00:00

End Time: 00:00:00

☐ Save Job Logs to File

☒ Delete Job Files in Working Directory

☐ Use SSH protocol for inter and intra-node communication (Linux only)

OK Cancel Help

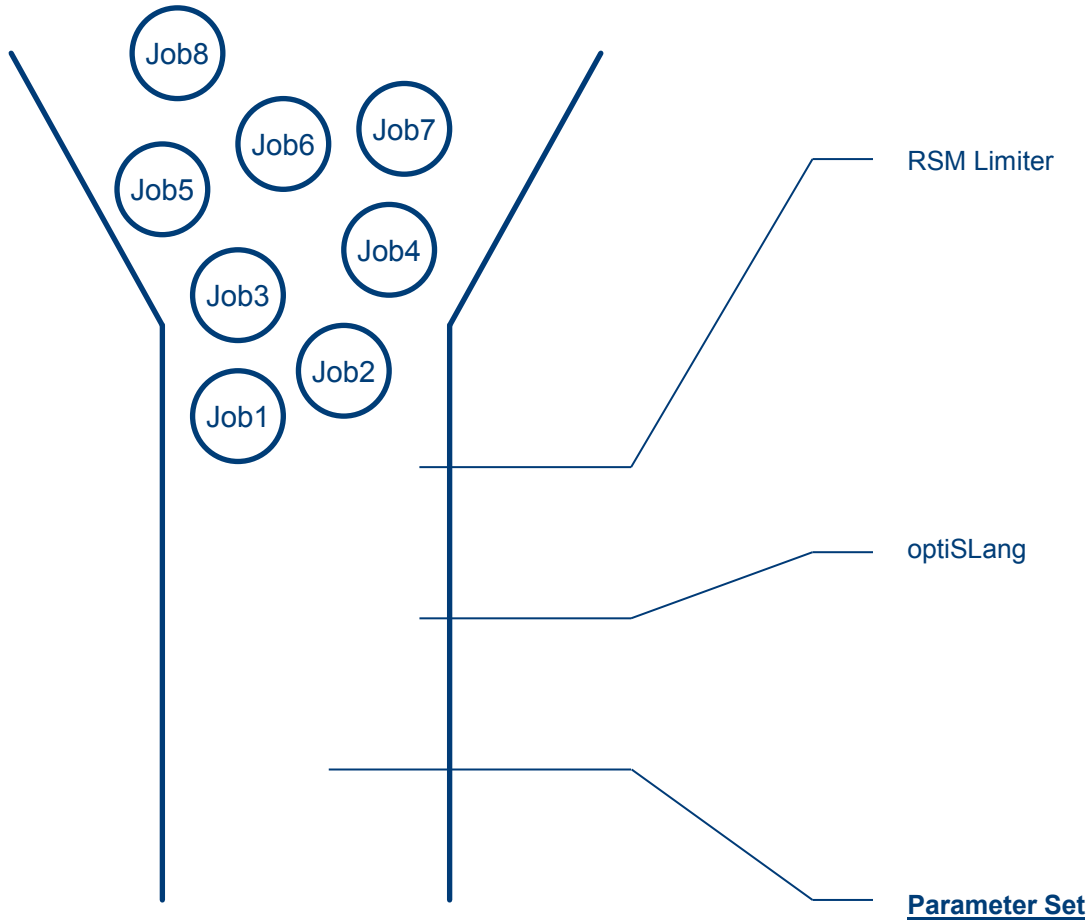
Properties of Schematic B2: DOE

	A	B
1	Property	Value
2	General	
3	Component ID	DOE (optiSLang)
4	Directory Name	Sensitivity
5	Save Design Points As Projects	☐
6	Clear Design Table during Update	☐
7	Notes	
8	Notes	
9	Update Options	
10	Specify Maximum Runtime per Job	☐
11	Use RSM Mode	☒
12	Preferred Number of Simultaneous Runs	4
13	Run Python Script for Update	☐

Properties of Schematic: Parameter Set

	A	B
1	Property	Value
2	Design Point Update Process	
3	Update Option	Run in Foreground
4	Design Point Update Order	Update from Current
5	License Checkout	Reserved
6	Reserved License Set	Select Licenses
7	Keep Failed Design Point Files (Beta)	☐
8	Exported Design Point	Update parameters

Job Limitation – Adjustment for Setup 3



Compute Server Properties

General | Cluster | SSH

Display Name: LSF

Machine Name: localhost

Working Directory Location: User Specified

Working Directory: d:\remote\mscc1

<< Less

☒ Server Can Accept Jobs

Maximum Number of Jobs: 60

☐ Limit Times for Job Submission

Start Time: 00:00:00

End Time: 00:00:00

☐ Save Job Logs to File

☒ Delete Job Files in Working Directory

☐ Use SSH protocol for inter and intra-node communication (Linux only)

OK Cancel Help

Properties of Schematic B2: DOE

	A	B
1	Property	Value
2	General	
3	Component ID	DOE (optiSLang)
4	Directory Name	Sensitivity
5	Save Design Points As Projects	☐
6	Clear Design Table during Update	☐
7	Notes	
8	Notes	
9	Update Options	
10	Specify Maximum Runtime per Job	☐
11	Use RSM Mode	☒
12	Preferred Number of Simultaneous Runs	64
13	Run Python Script for Update	☐

Properties of Schematic: Parameter Set

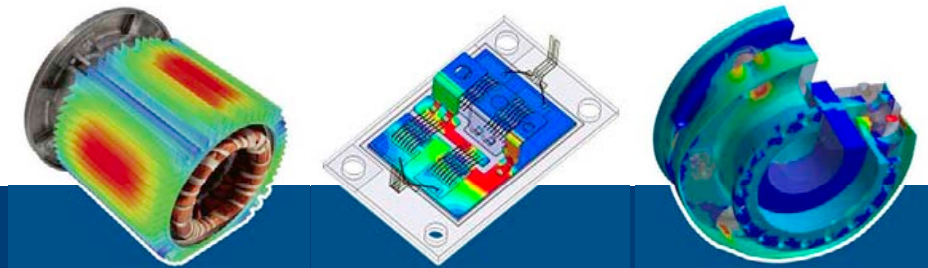
	A	B
1	Property	Value
2	Design Point Update Process	
3	Update Option	Submit to Remote Solve Manager
4	Solve Manager	muc-hpc-hn
5	Queue	ansys145
6	Job Submission	Specify Maximum Number of Jobs
7	Maximum Number of Jobs	4

CADFEM[®]

ANSYS[®]

Competence Center FEM

Simulation ist mehr als Software[®]



Cloud Computing

Fujitsu RDO cluster

The Fujitsu logo, featuring a red infinity symbol above the word "FUJITSU" in a red serif font.

Optimisation Cluster elements

Head node = 1x PRIMERGY RX350 S8



CPU : E5-2637 v2 @ 3.50GHz (4 core)
MEM: 8*16384 MB /DDR3 /1866 Mhz
1*NVIDIA Tesla K40m
Mellanox FDR 1 port
4 * SAS 900GB 10 k
2 disc in RAID1 for RedHat and HCS
2 disc in RAID0 for data

Compute nodes = 8x PRIMERGY CX250 S2



CPU: 2*E5-2697V2 (12 core, 2,7GHz)
MEM: 16*8GB /1866 Mhz (on cn1 and cn2 8*16GB)
Mellanox FDR 1 port
RAID controller 0/1
2 * SAS 900GB 10 k
2 disc in RAID0 for RedHat & data

System stack = Fujitsu HPC Cluster Suite (HCS)



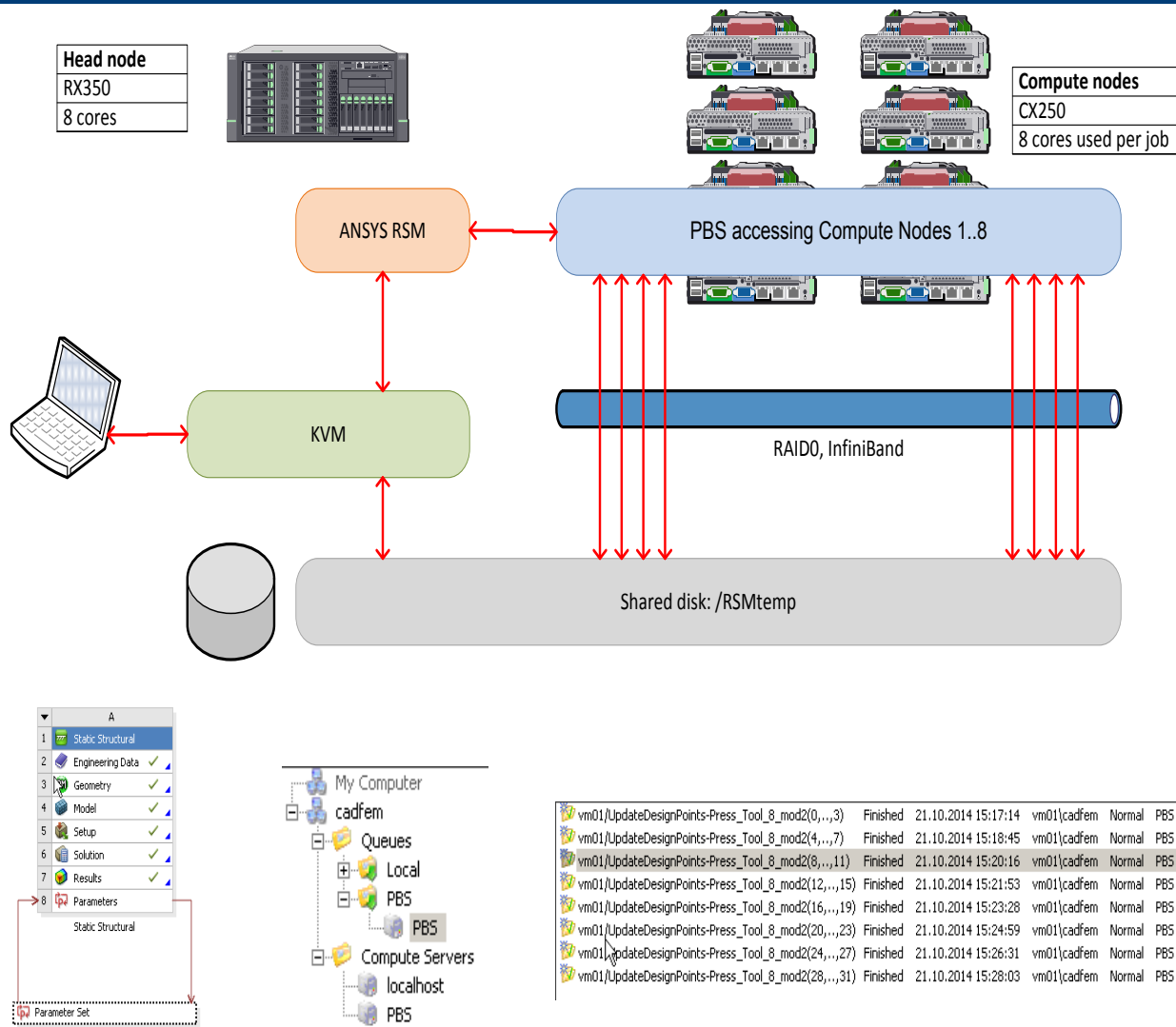
OS: RedHat Enterprise Linux 6.4
HCS version 2.2_04
Advanced Edition
PBSpro: 12.2.0.133411
ICR certified

Fast interconnect = InfiniBand



Mellanox FDR for MPI and I/O
GbE for management and control

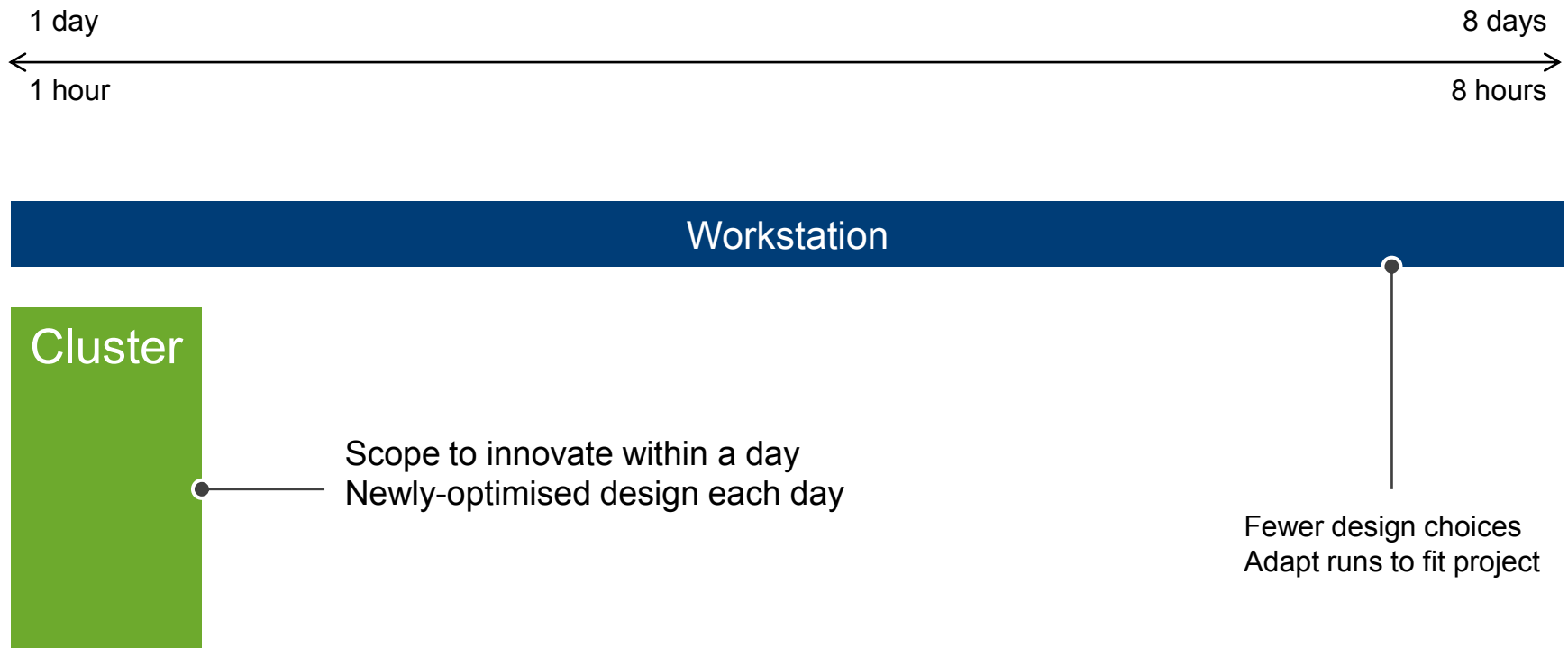
RDO Cluster Setup



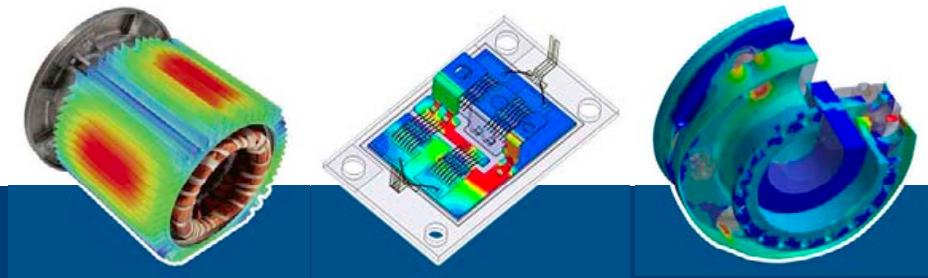
Pre-packaged as a ready-to-use appliance



Parallel RDO is transformative



Simulation ist mehr als Software®

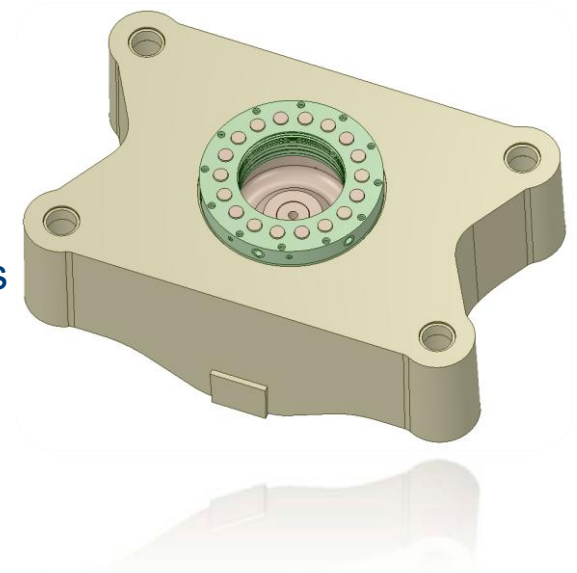


Test Example

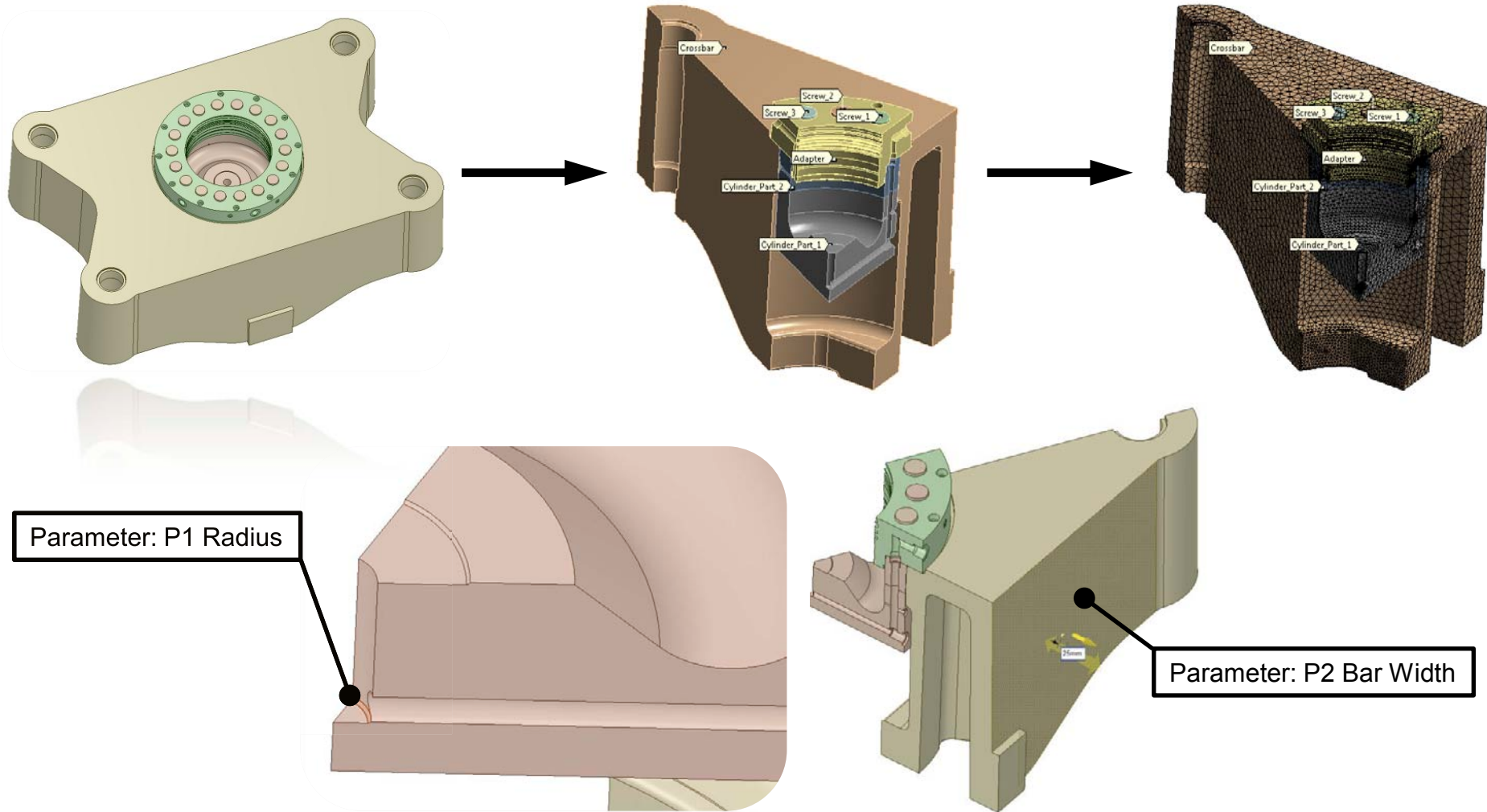
Fujitsu RDO cluster

Press Tool - Overview

- Description
 - This press tool is a part of a hydraulic press. It is guided by four poles and loaded with pressure.
 - Manual geometry and load case variation
- Objectives:
 - Find out the minimum radius in the cylinder
 - Understand influence of pressure load to stresses in adapter
 - Mass reduction considering Total deformation and stresses
- Parameters:
 - 2 variable parameters in the CAD geometry
 - 5 load parameters (2 pressure and 3 force parameters)

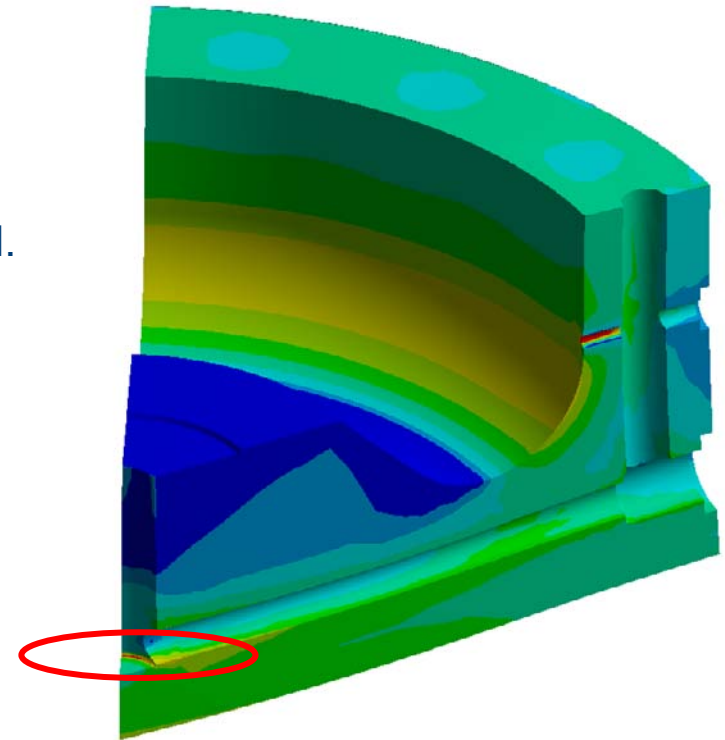
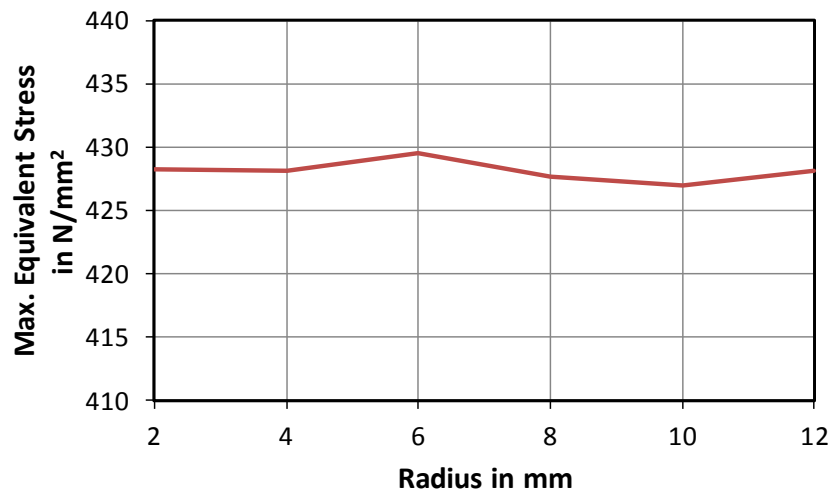


Model: Crossbar in Press Tool



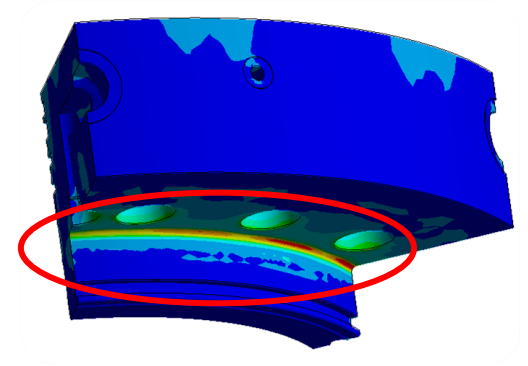
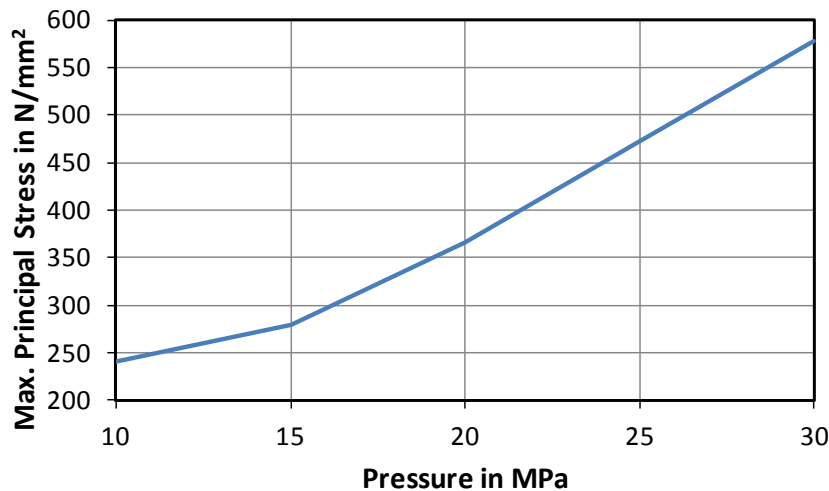
Results - Overview

- How to minimize the Radius (increased contact area) without exceeding max. stresses?
 - The variation of the radius has no influence on the maximum equivalent stress of the cylinder.
 - The geometry can be modeled with a radius of 4 mm in this area.
 - Critical stresses are dominated by the fluid channel.



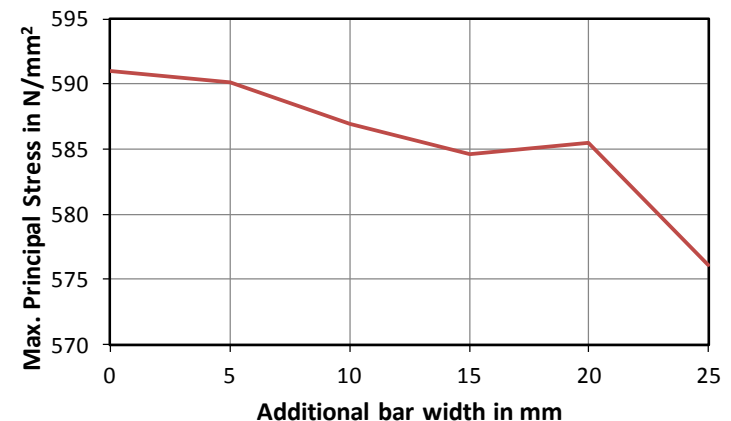
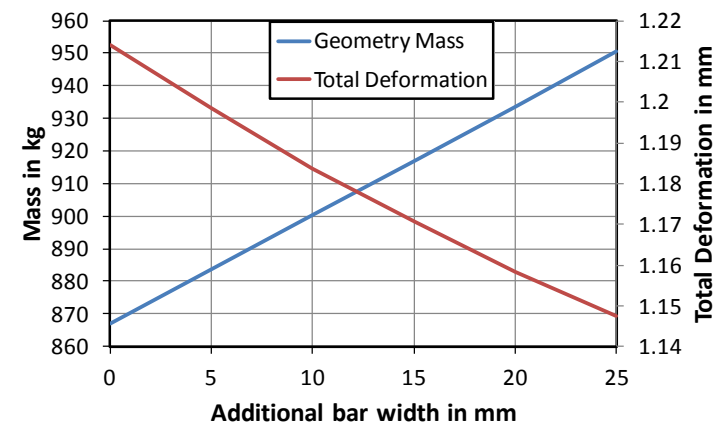
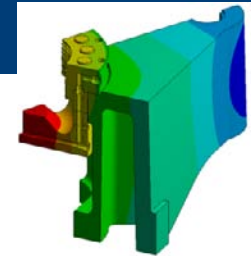
Results - Overview

- Understand influence of pressure load to stresses in adapter
 - Pressure load variation from 10 MPa to 30 MPa
 - Stresses in adapter:
 - Nonlinear behavior between the pressure load and maximum principal stresses



Results - Overview

- Bar width variation from 0 mm to 25 mm
 - The bar width has a linear influence on the total mass of the pressing tool.
 - Because of the increasing bar width, the total deformation decreases slightly nonlinear.
 - Due to a decreasing deformation, the max. principal stresses in the adapter decrease nonlinearly.
- Easier evaluation of multiple parameters by systematic multiobjective optimization to reduce
 - Mass
 - Total deformation
 - Max. principal stress of the adapter



Setup Strategies

a

„send to cluster“

b

„arrange resources“

c

„minimize
communication loss“

6	Job Submission	Specify Maximum Number of Jobs	One Job for Each Design Point
7	Maximum Number of Jobs	4	

all cores of all compute nodes
available

job scheduler to distribute DP's

restrict number of cores of all compute nodes

no DP's across compute nodes

☒ Server Can Accept Jobs

Maximum Number of Jobs

Workbench-Setting (User)

RSM-Setting (Admin)

Setup Strategies

run parallelization

submission/file transfers

a

„send to cluster“

-

- (too many per node)

b

„arrange ressources“

+

- (too many at the same time)

c

„minimize
communication loss“

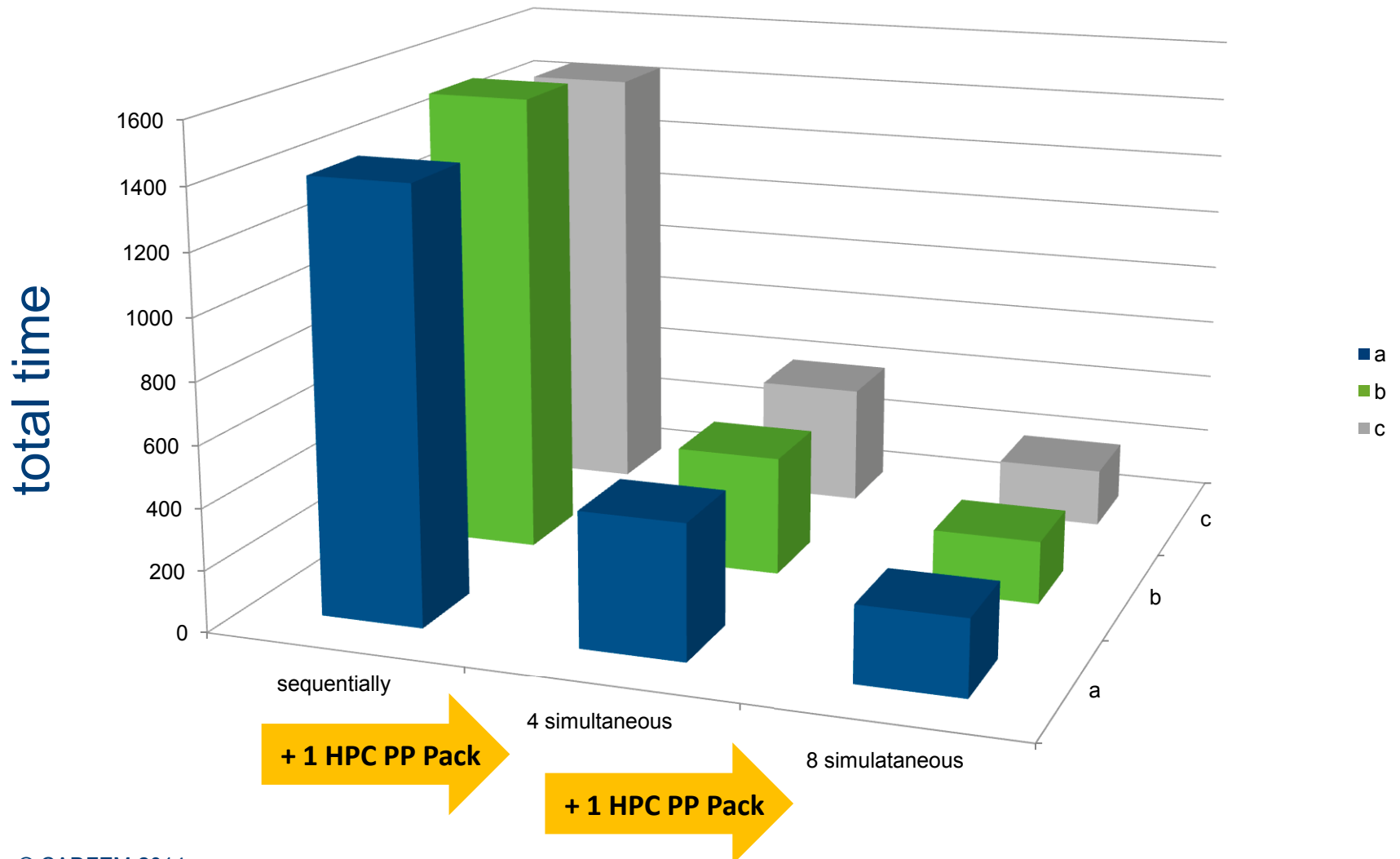
+

+ (immediate)

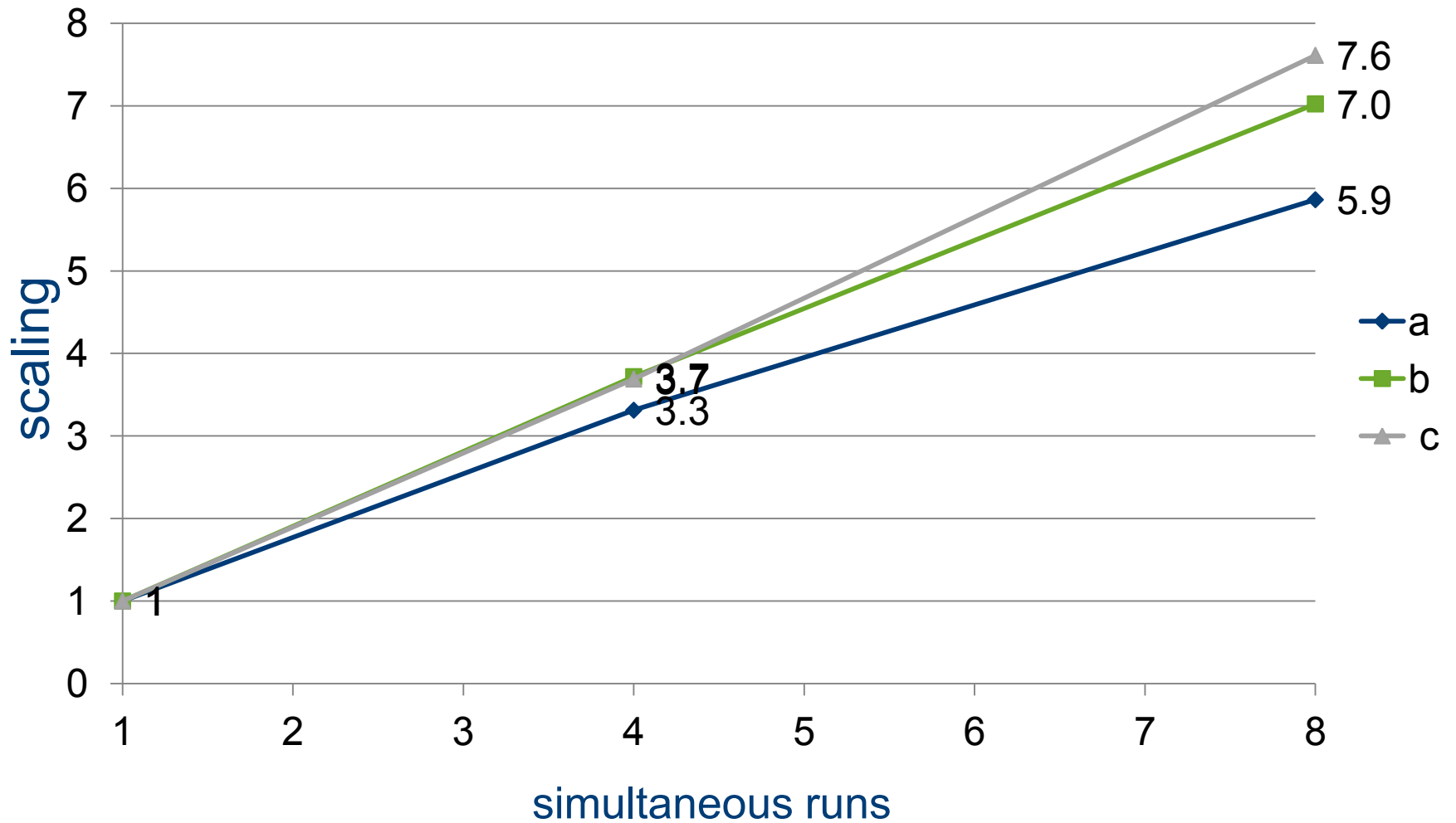
vm01/UpdateDesignPoints-Press_Tool_8_mod2(0,...,3)	Finished	21.10.2014 15:17:14
vm01/UpdateDesignPoints-Press_Tool_8_mod2(4,...,7)	Finished	21.10.2014 15:18:45
vm01/UpdateDesignPoints-Press_Tool_8_mod2(8,...,11)	Finished	21.10.2014 15:20:16
vm01/UpdateDesignPoints-Press_Tool_8_mod2(12,...,15)	Finished	21.10.2014 15:21:53
vm01/UpdateDesignPoints-Press_Tool_8_mod2(16,...,19)	Finished	21.10.2014 15:23:28
vm01/UpdateDesignPoints-Press_Tool_8_mod2(20,...,23)	Finished	21.10.2014 15:24:59
vm01/UpdateDesignPoints-Press_Tool_8_mod2(24,...,27)	Finished	21.10.2014 15:26:31
vm01/UpdateDesignPoints-Press_Tool_8_mod2(28,...,31)	Finished	21.10.2014 15:28:03

vm01/UpdateDesignPoints-exp8mal8calc(0)	Running (Running)	01.11.2014 10:46:29
vm01/UpdateDesignPoints-exp8mal8calc(1)	Running (Running)	01.11.2014 10:46:51
vm01/UpdateDesignPoints-exp8mal8calc(2)	Running (Running)	01.11.2014 10:47:14
vm01/UpdateDesignPoints-exp8mal8calc(3)	Running (Running)	01.11.2014 10:47:36
vm01/UpdateDesignPoints-exp8mal8calc(4)	Running (Running)	01.11.2014 10:47:58
vm01/UpdateDesignPoints-exp8mal8calc(5)	Running (Running)	01.11.2014 10:48:21
vm01/UpdateDesignPoints-exp8mal8calc(6)	Running (Running)	01.11.2014 10:48:43
vm01/UpdateDesignPoints-exp8mal8calc(7)	Running (Running)	01.11.2014 10:49:05
vm01/UpdateDesignPoints-exp8mal8calc(8)	Queued	01.11.2014 10:49:28
vm01/UpdateDesignPoints-exp8mal8calc(9)	Queued	01.11.2014 10:49:50

Performance

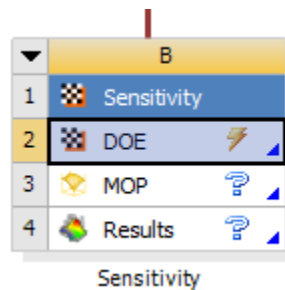


Speed Up

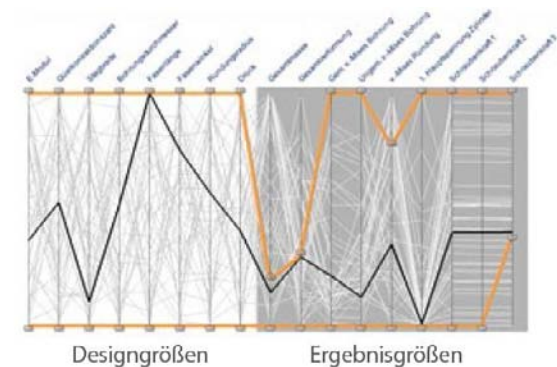
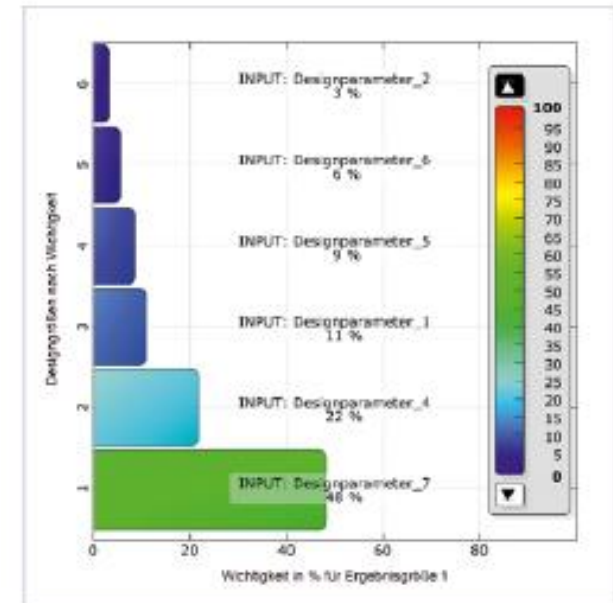


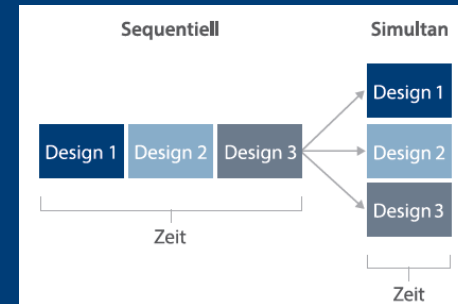
Sensitivity Study

- Going for RDO



	A	B
1	Property	Value
2	General	
3	Component ID	DOE (optiSLang)
4	Directory Name	Sensitivity
5	Save Design Points As Projects	☐
6	Clear Design Table during Update	☐
7	Notes	
8	Notes	
9	Update Options	
10	Specify Maximum Runtime per Job	☐
11	Use RSM Mode	☒
12	Preferred Number of Simultaneous Runs	64
13	Run Python Script for Update	☐





CADFEM/Fujitsu RDO Cluster Strategy

„simultaneous – not sequentially“

„ready to use hardware+software“

Try it!

You are welcome to contact
CADFEM or Fujitsu for a trial of
High Performance RDO



- Ian Godfrey
ian.godfrey@fr.fujitsu.com
Fujitsu Systems Europe, Toulouse

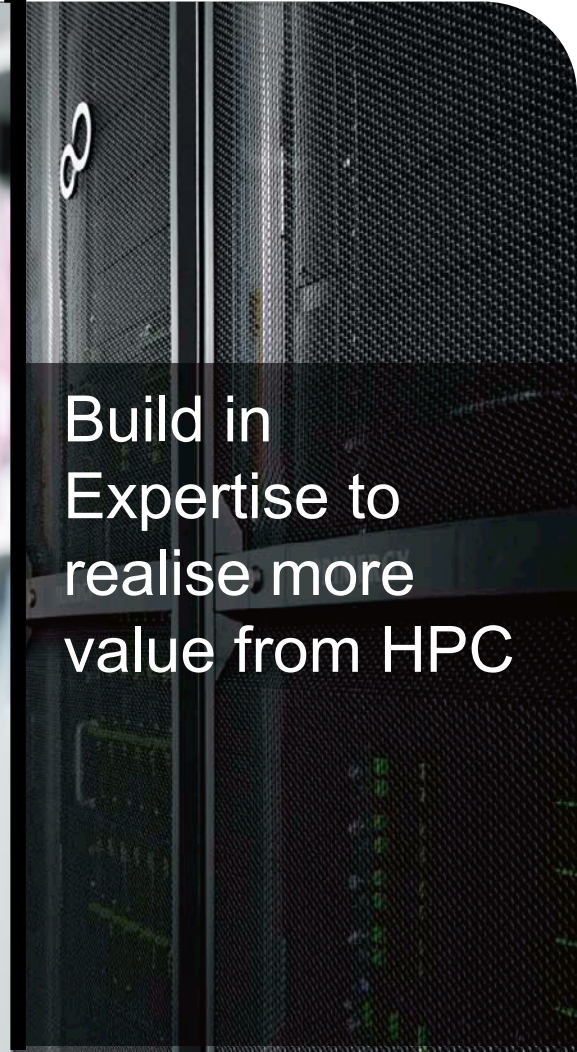
- Lars Krüger
lkrueger@cadfem.de

CADFEM Grafting

Fujitsu Application Solutions

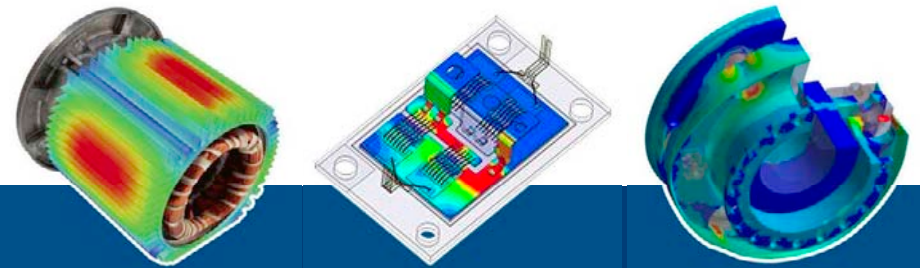


Simplify HPC to lower cost and risk, and increase access



Build in
Expertise to
realise more
value from HPC

Simulation ist mehr als Software®

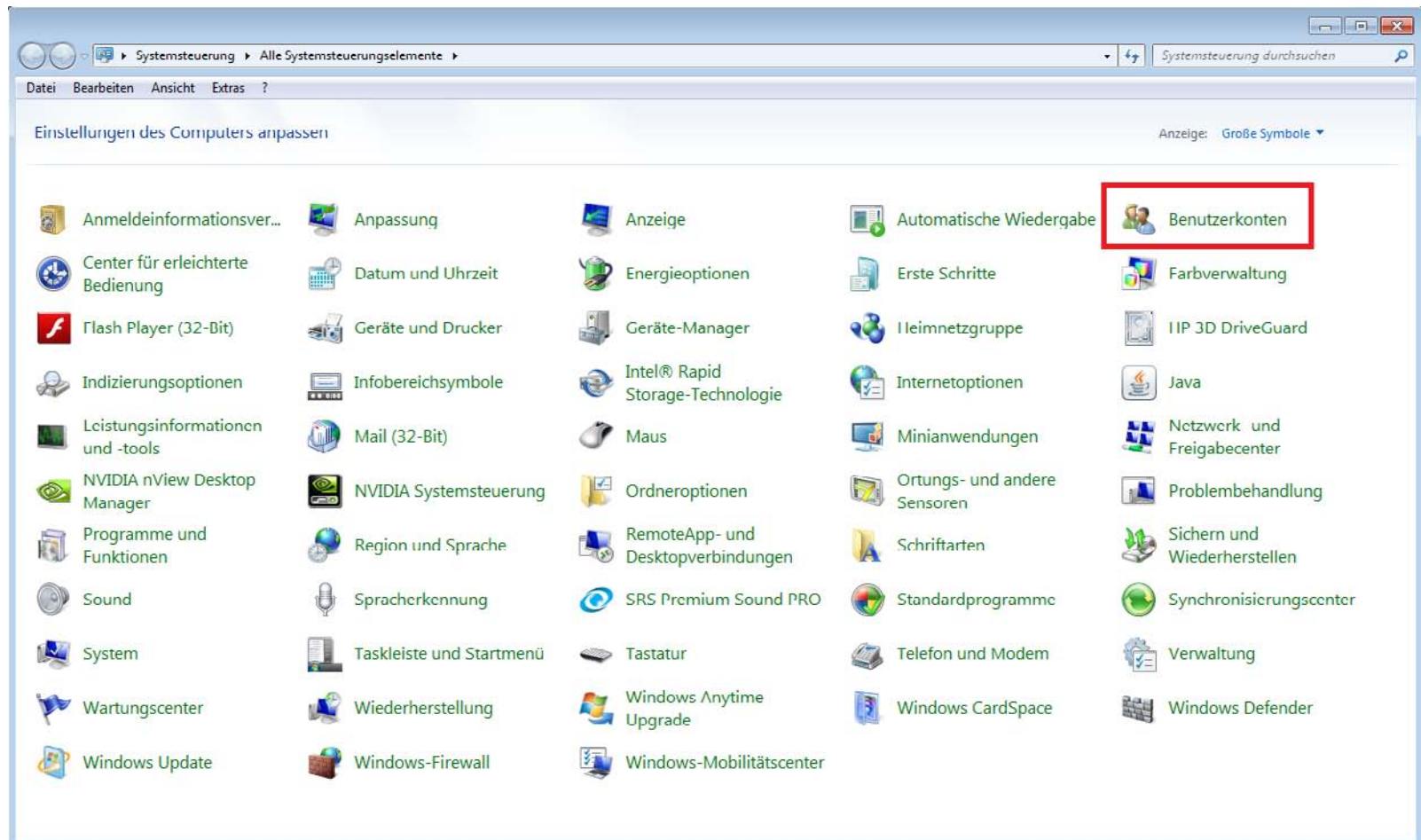


Minimizing Data Transfer

Minimizing Data Transfer to/from the RSM

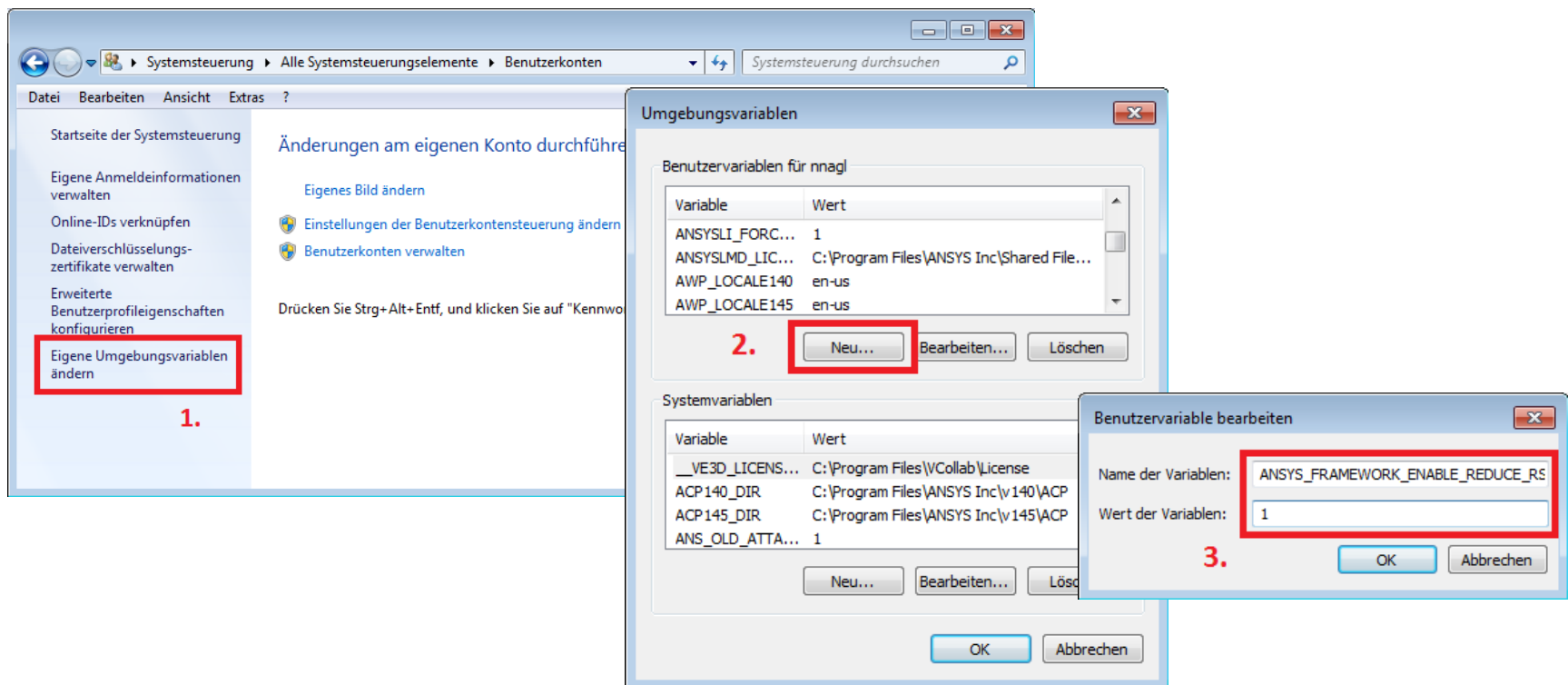
- When calculating simultaneous design points, all design points are created as archived projects at the local machine as an archive of the current project before submitting to the RSM. As the archives are submitted to the RSM, the file size ought to be as small as possible. Yet, the archived design points contain all data (e. g. rst-file) from the current design point. Therefore, the data files size transferred to/from the RSM needs to be minimized.
- There are two steps for best performance:
 1. Set a user variable
 - After setting the user variable, only the scalar values for the Parameter Manager are transferred back after calculation
 2. Manual Clearing of the Current Design Point in the Mechanical Editor
 - Before updating all designs, clear the current design point in the Mechanical Editor and save the project. The archived design point projects will not contain large file data (rst-file, ...). The transfer to/from the RSM is accelerated most with this option.

Set User Variable



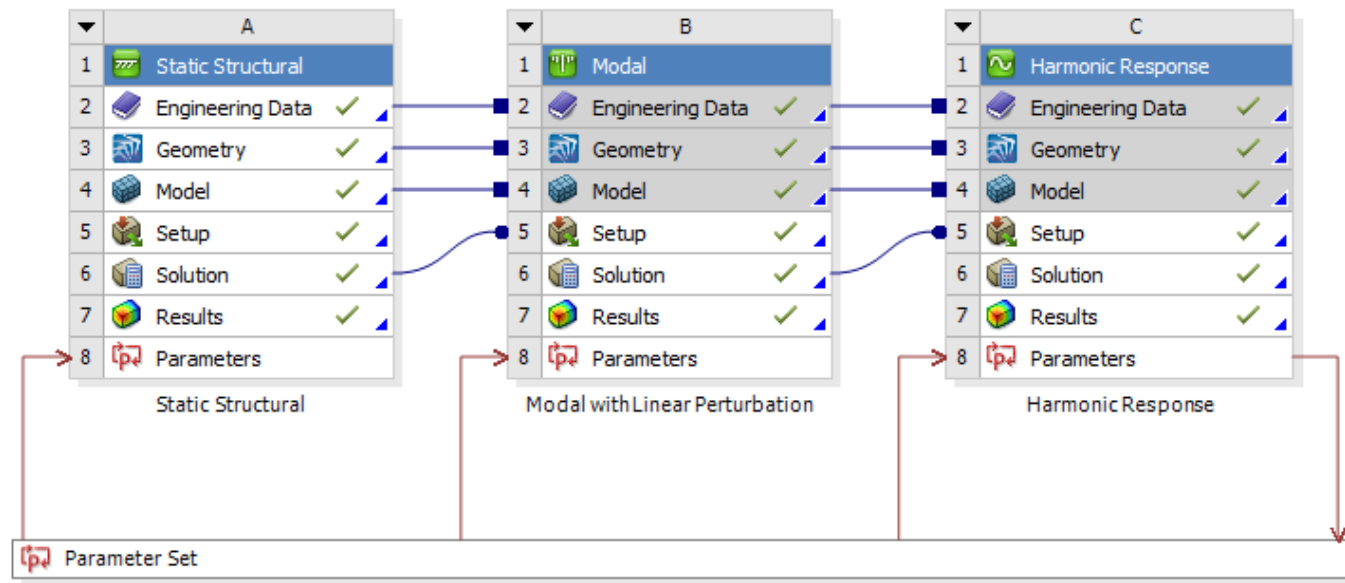
Set User Variable

- Name of Variable:
ANSYS_FRAMEWORK_ENABLE_REDUCE_RSM_FILE_TRANSFER
- Value of Variable: 1



Manual Clearing of Current Design Point

- Example: Harmonic Response Analysis



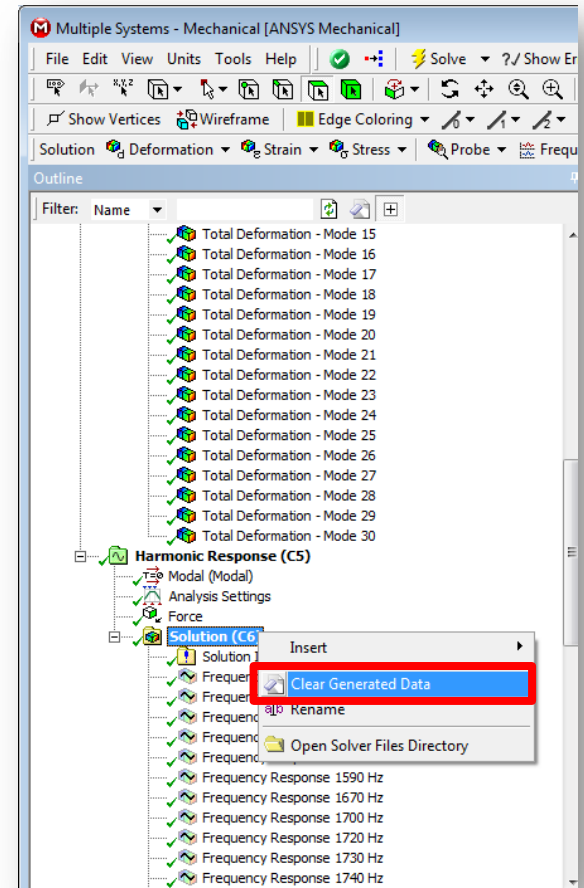
- File Size of each archived design point before clearing: ~ 2 GB

Name	Änderungsdatum	Typ	Größe
Reverse_Engineering_Harmonic_Analysis.wbpz	12.11.2013 11:33	ANSYS v145 .wbpz...	2,243,143 KB

Manual Clearing of Current Design Point

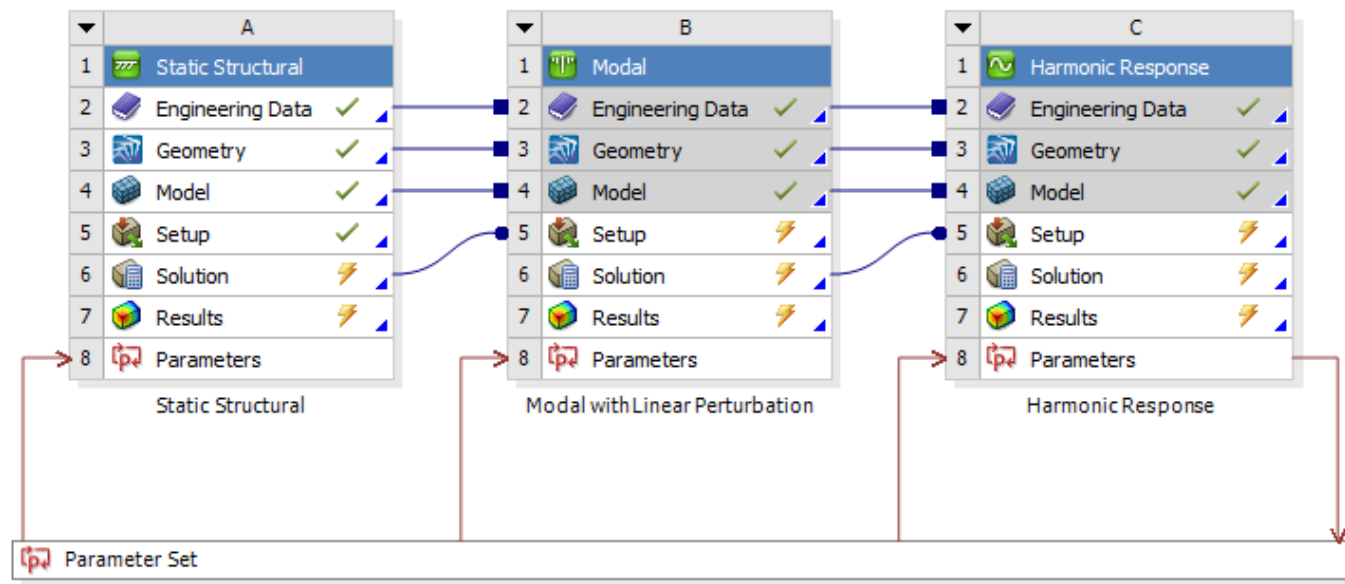
- Example: Harmonic Response Analysis

1. Open Mechanical Editor
2. Click RightMouseButton the Solution cell
3. Proceed „Clear Generated Data“
4. Repeat step 1 - 3 for all solution cells
5. Save Project



Manual Clearing of Current Design Point

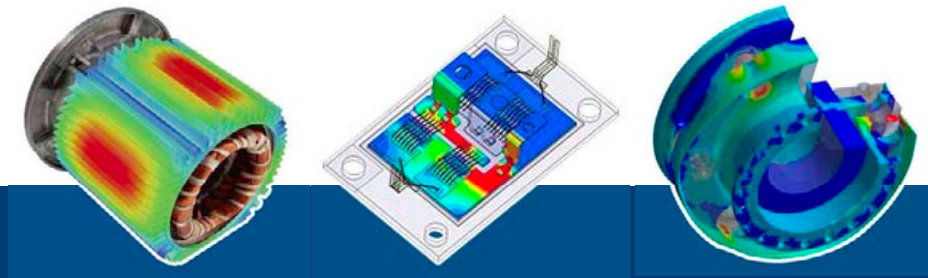
- Example: Harmonic Response Analysis



- File Size of each archived design point after clearing: ~ 4.5 MB

Name	Änderungsdatum	Typ	Größe
Reverse_Engineering_Harmonic_Analysis.wbpz	12.11.2013 12:00	ANSYS v145 .wbpz...	4,527 KB

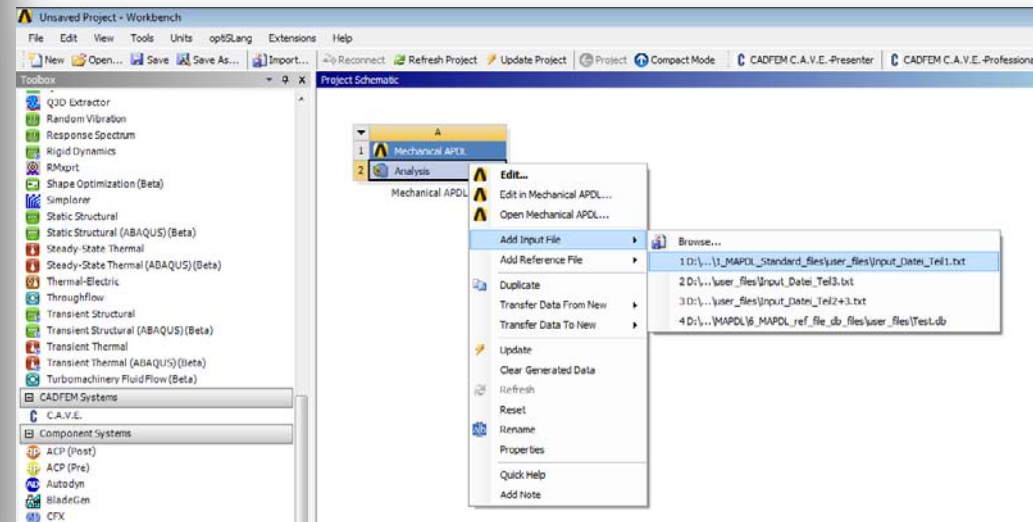
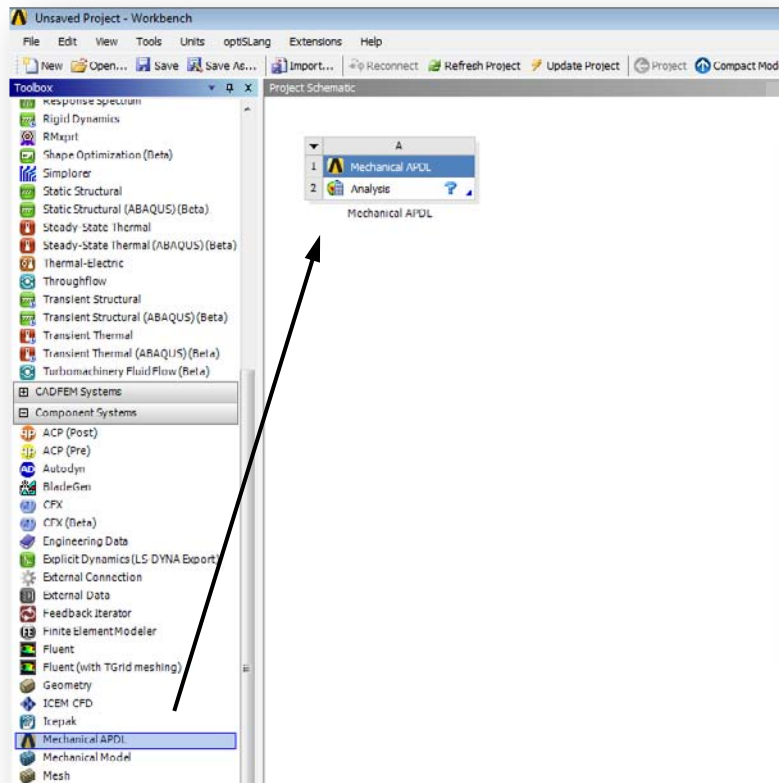
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Mechanical APDL and Simultaneous Calculation

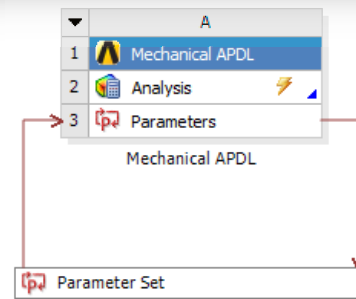
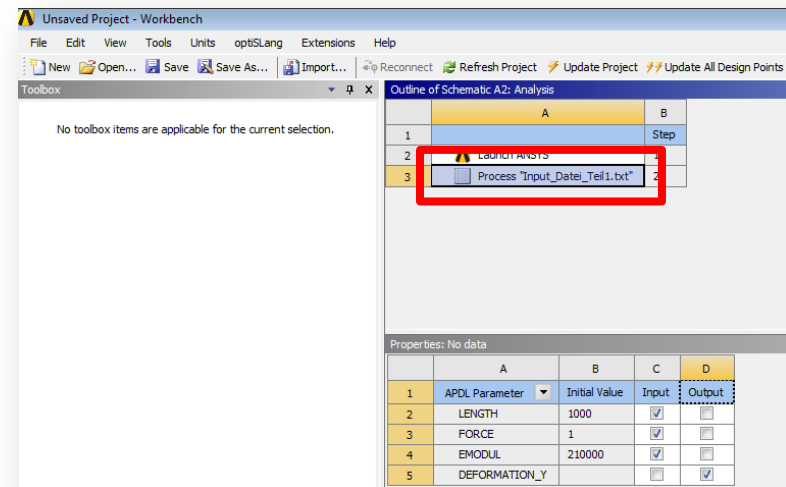
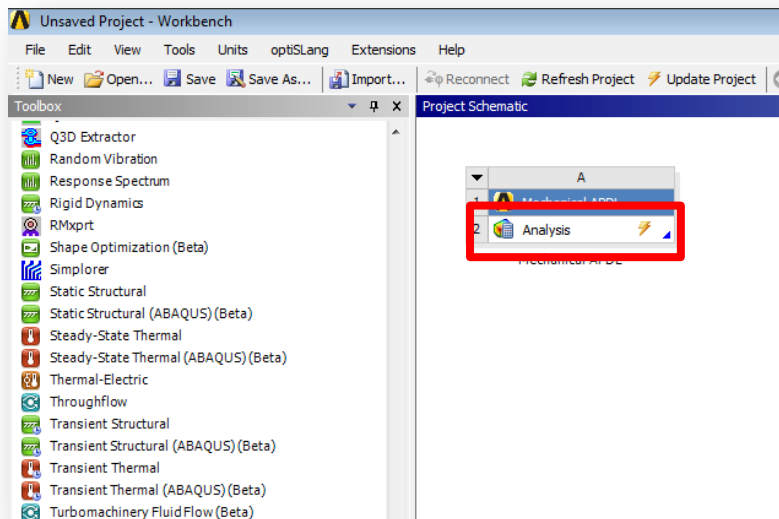
Analysis Selection + Adding Input File

1. Drag and drop “Mechanical APDL” analysis in the Project Manager
2. Add Input file to the Mechanical APDL analysis (RightMouseButton RMB)



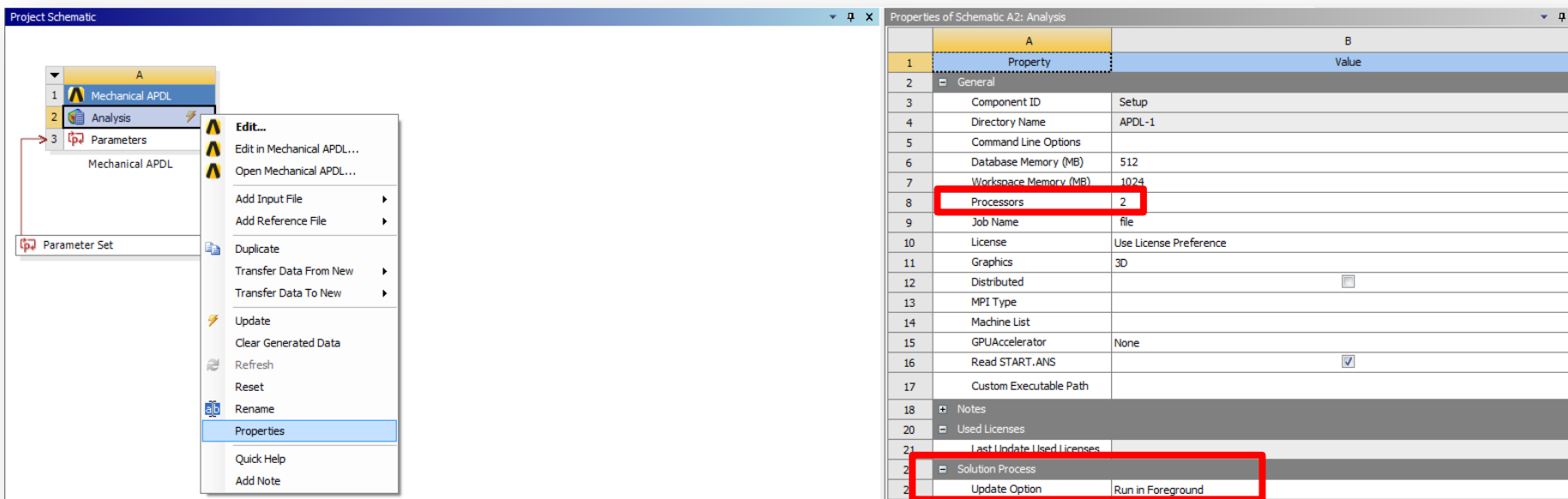
Input and Output Parameter Selection

3. Double click "Analysis" to enter the file overview
4. Click the added file to display the properties and select Input and Output parameters
→ Parameter Set is available



Update Option for Analysis

5. Click “Analysis” once or RMB “Properties” for analysis properties
6. Check, if the update option “Run in Foreground” is selected
→ necessary for simultaneous processing



The screenshot displays the ANSYS Workbench interface. On the left, the 'Project Schematic' window shows a tree structure with 'Mechanical APDL' (1), 'Analysis' (2), and 'Parameters' (3). A right-click context menu is open over the 'Analysis' component, with the 'Properties' option highlighted. On the right, the 'Properties of Schematic A2: Analysis' dialog box is open, showing the 'General' tab. The 'Processors' field is set to '2' and is highlighted with a red box. The 'Update Option' is set to 'Run in Foreground' and is also highlighted with a red box.

Properties of Schematic A2: Analysis	
A	B
Property	Value
General	
Component ID	Setup
Directory Name	APDL-1
Command Line Options	
Database Memory (MB)	512
Workspace Memory (MB)	1024
Processors	2
Job Name	file
License	Use License Preference
Graphics	3D
Distributed	☐
MPI Type	
Machine List	
GPUAccelerator	None
Read START.ANS	☒
Custom Executable Path	
Notes	
Used Licenses	
Last Update Used Licenses	
Solution Process	
Update Option	Run in Foreground

Simultaneous Design Point Processing Options

7. Click “Parameter Set” once to select the simultaneous design point setup
Notice: These settings overwrite the general settings (previous slide), e. g. “number of processors” or “distributed option”.

Properties of Schematic: Parameter Set

	A	B
1	Property	Value
2	[-] Design Point Update Process	
3	Update Option	Submit to Remote Solve Manager
4	Job Submission	Specify Maximum Number of Jobs
5	Maximum Number of Jobs	4
6	Design Point Update Order	Update from Current
7	Pre-RSM Foreground Update	None
8	License Checkout	Reserved
9	Reserved License Set	Select Licenses
10	Component Execution Mode	Parallel
11	Max Number of Processes Per Job	4
12	Keep Failed Design Point Files (Beta)	☐
13	Solve Manager	muc-hpc-hn
14	Queue	ansys145

8. Configure the simultaneous design point process as seen in the section “General Usage” of this document

Parameter Manager

9. Double click the “Parameter Set”

→ All selected parameters (Input and Output) are available in the Parameter Manager

10. Add design points to the “Table of Design Points”

11. Save Project

12. Click “Update All Design Points”

MAPDL - Workbench

File Edit View Tools Units optiSlang Extensions Help

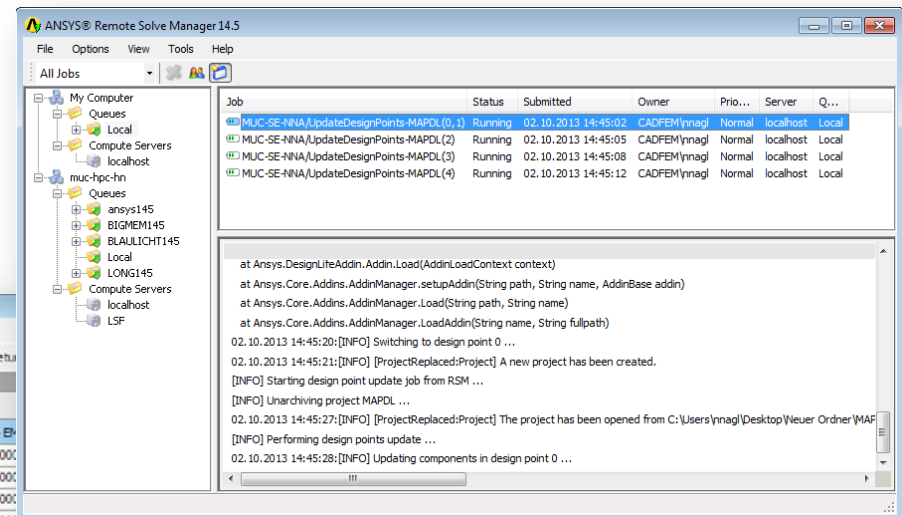
New Open... Save Save As... Import... Reconnect Refresh Project Update Project Resume Update All Design Points Return

Outline: No data

	A	B	C	D
	ID	Parameter Name	Value	Unit
2	Input Parameters			
3	Mechanical APDL (A1)			
4	P1	LENGTH	1000	
5	P2	FORCE	1	
6	P3	EMODUL	210000	
*	New input parameter	New name	New expression	
8	Output Parameters			
9	Mechanical APDL (A1)			
10	P4	DEFORMATION_Y	3.7541012	
*	New output parameter		New expression	
12	Charts			

Table of Design Points

	A	B	C	D
	Name	P1 - LENGTH	P2 - FORCE	P3 - EMODUL
1	Current	1000	1	210000
2	DP 1	1200	1	210000
3	DP 2	1000	2	210000
4	DP 3	1000	1	200000
5	DP 4	1200	2	190000
*				



ANSYS MAPDL HPC Parametric Pack Settings

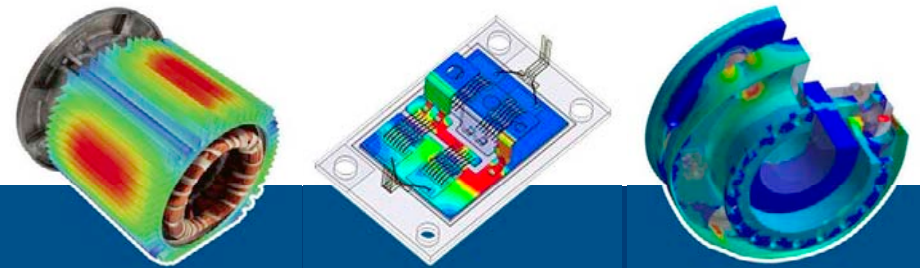
Example Setting for:

- Simultaneous calculation of 4 design points
- Parallel calculation with 8 cores for each design point
- Background solving

The screenshot displays the ANSYS MAPDL HPC Parametric Pack interface. On the left, the 'Project Schematic' shows a workflow with three steps: 1. Mechanical APDL, 2. Analysis, and 3. Parameters. A red arrow points from the 'Parameters' step to a 'Parameter Set' box below it. On the right, the 'Properties of Schematic: Parameter Set' dialog is open, showing a table of properties and values.

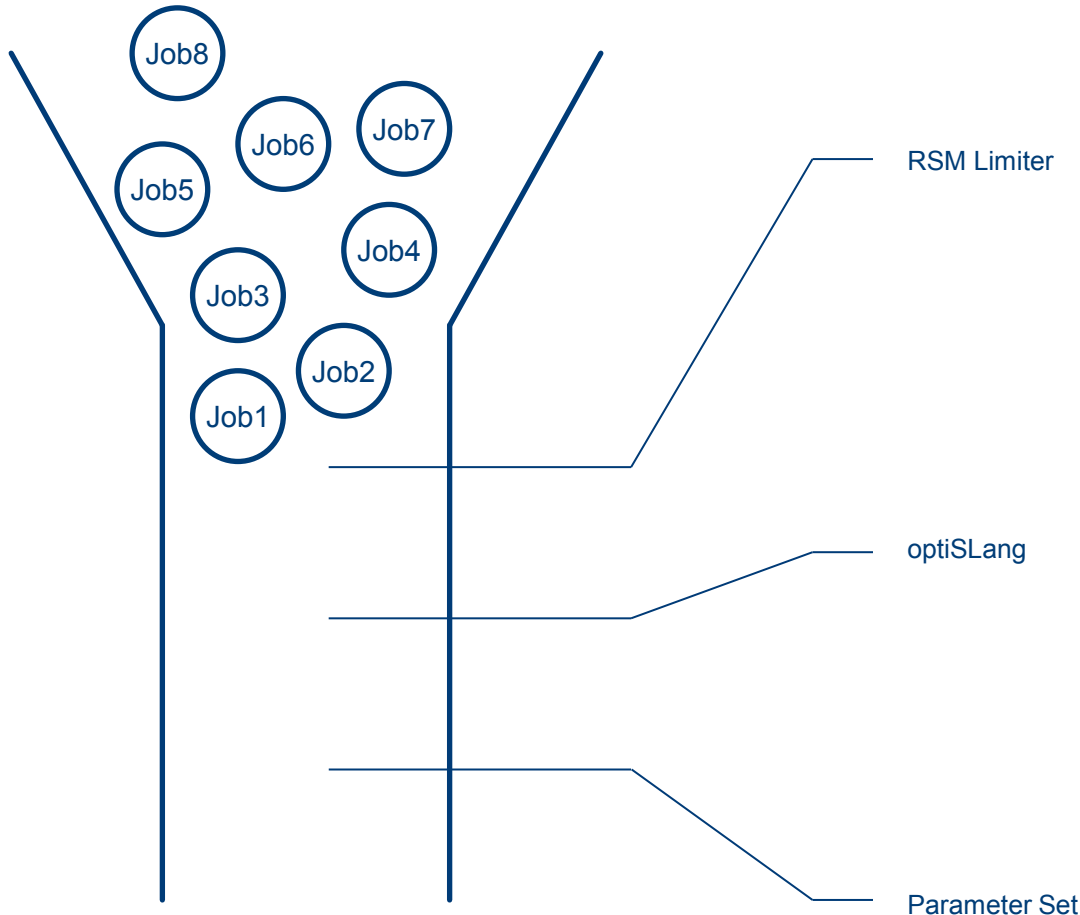
A		B	
Property		Value	
1	Design Point Update Process		
2	Update Option	Submit to Remote Solve Manager	
3	Job Submission	Specify Maximum Number of Jobs	
4	Maximum Number of Jobs	4	
5	Design Point Update Order	Update from Current	
6	Pre-RSM Foreground Update	Geometry	
7	License Checkout	Reserved	
8	Reserved License Set	Select Licenses	
9	Component Execution Mode	Parallel	
10	Max Number of Processes Per Job	8	
11	Keep Failed Design Point Files (Beta)	☐	
12	Solve Manager	localhost	
13	Queue	Local	

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optiSLang Settings for optimal Design Point Calculation

Job Limitation – 3 Ways to Adjust



Compute Server Properties

General | Cluster | SSH

Display Name: LSF

Machine Name: localhost

Working Directory Location: User Specified

Working Directory: d:\remote\mscc1

<< Less

☒ Server Can Accept Jobs

Maximum Number of Jobs: 4

☐ Limit Times for Job Submission

Start Time: 00:00:00

End Time: 00:00:00

☐ Save Job Logs to File

☒ Delete Job Files in Working Directory

☐ Use SSH protocol for inter and intra-node communication (Linux only)

OK Cancel Help

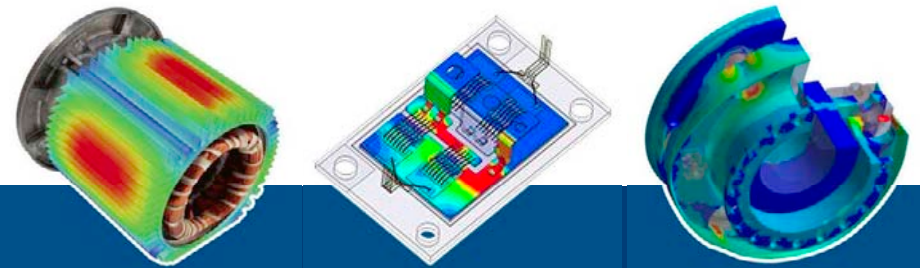
Properties of Schematic B2: DOE

	A	B
1	Property	Value
2	General	
3	Component ID	DOE (optiSLang)
4	Directory Name	Sensitivity
5	Save Design Points As Projects	☐
6	Clear Design Table during Update	☐
7	Notes	
8	Notes	
9	Update Options	
10	Specify Maximum Runtime per Job	☐
11	Use RSM Mode	☒
12	Preferred Number of Simultaneous Runs	4
13	Run Python Script for Update	☐

Properties of Schematic: Parameter Set

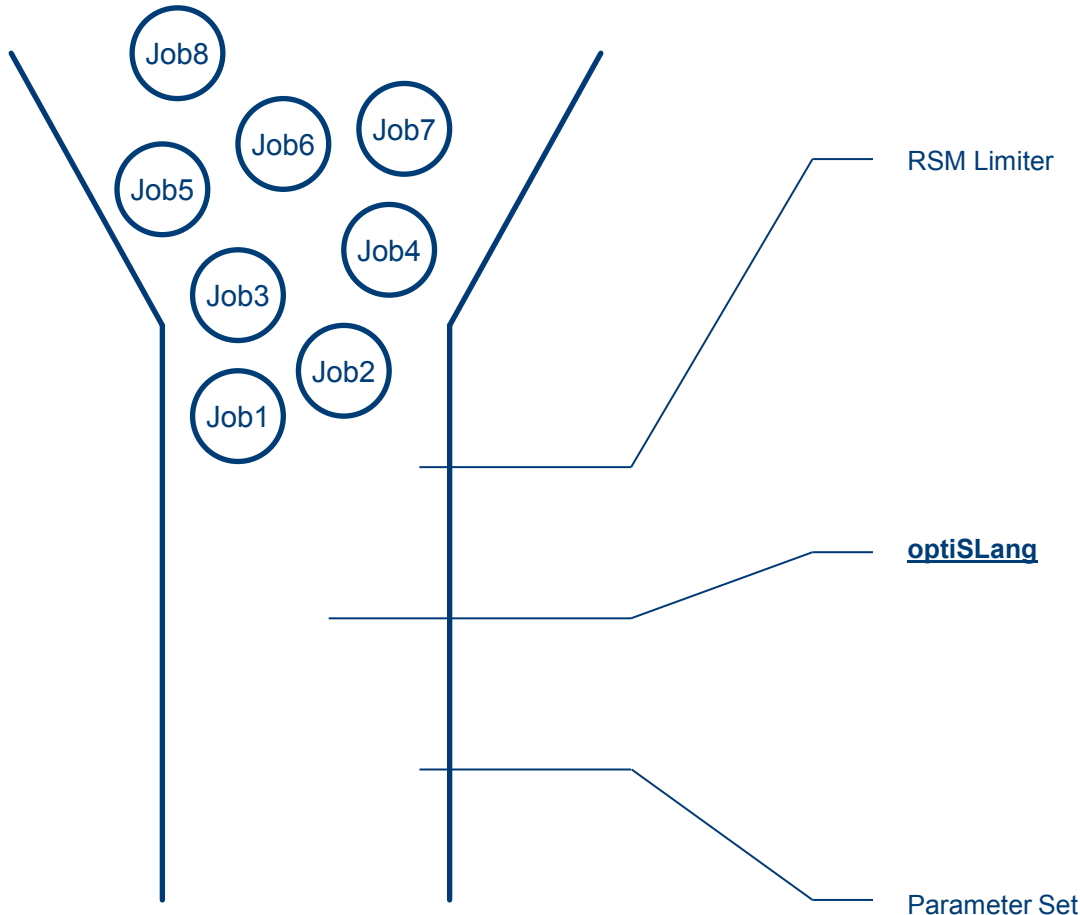
	A	B
1	Property	Value
2	Design Point Update Process	
3	Update Option	Submit to Remote Solve Manager
4	Solve Manager	muc-hpc-hn
5	Queue	ansys145
6	Job Submission	Specify Maximum Number of Jobs
7	Maximum Number of Jobs	4

Simulation ist mehr als Software®



optiSLang and Setup 2

Job Limitation – Adjustment for Setup 2



Compute Server Properties

General | Cluster | SSH

Display Name: LSF

Machine Name: localhost

Working Directory Location: User Specified

Working Directory: d:\remote\mscc1

<< Less

☒ Server Can Accept Jobs

Maximum Number of Jobs: 60

☐ Limit Times for Job Submission

Start Time: 00:00:00

End Time: 00:00:00

☐ Save Job Logs to File

☒ Delete Job Files in Working Directory

☐ Use SSH protocol for inter and intra-node communication (Linux only)

OK Cancel Help

Properties of Schematic B2: DOE

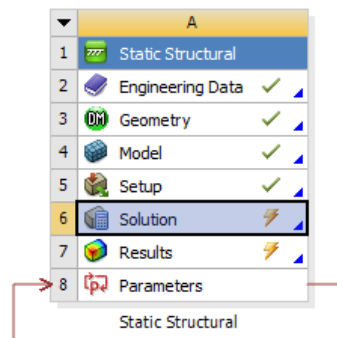
	A	B
1	Property	Value
2	General	
3	Component ID	DOE (optiSLang)
4	Directory Name	Sensitivity
5	Save Design Points As Projects	☐
6	Clear Design Table during Update	☐
7	Notes	
8	Notes	
9	Update Options	
10	Specify Maximum Runtime per Job	☐
11	Use RSM Mode	☒
12	Preferred Number of Simultaneous Runs	4
13	Run Python Script for Update	☐

Properties of Schematic: Parameter Set

	A	B
1	Property	Value
2	Design Point Update Process	
3	Update Option	Run in Foreground
4	Design Point Update Order	Update from Current
5	License Checkout	Reserved
6	Reserved License Set	Select Licenses
7	Keep Failed Design Point Files (Beta)	☐
8	Exported Design Point	Update parameters

Setup 2: Local Pre/Post and Remote Solve Process and optiSLang

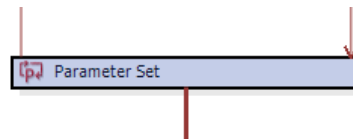
Solution



Properties of Schematic A5: Solution

	A	B
1	Property	Value
2	General	
3	Component ID	Solution
4	Directory Name	SYS
5	Notes	
6	Used Licenses	
7	Last Update Used Licenses	ANSYS Mechanical
8	System Information	
9	Physics	Structural
10	Analysis	Static Structural
11	Solver	Mechanical APDL
12	Solution Process	
13	Update Option	Submit to Remote Solve Manager
14	Solve Process Setting	muc-hpc-hn 8 cores
15	Solve Manager	muc-hpc-hn
16	Queue	ansys145
17	Restriction for Project/Design Point Update via RSM	
18	Serial Execution Only	☐
19	Specify Number of Processes Restriction	☐
20	Shared Memory Parallel	☐
21		

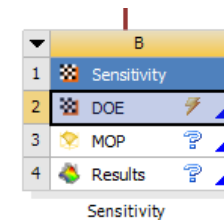
Parameter Set



Properties of Schematic: Parameter Set

	A	B
1	Property	Value
2	Design Point Update Process	
3	Update Option	Run in Foreground
4	Design Point Update Order	Update from Current
5	License Checkout	Reserved
6	Reserved License Set	Select Licenses
7	Keep Failed Design Point Files (Beta)	☐
8	Exported Design Point	Update parameters

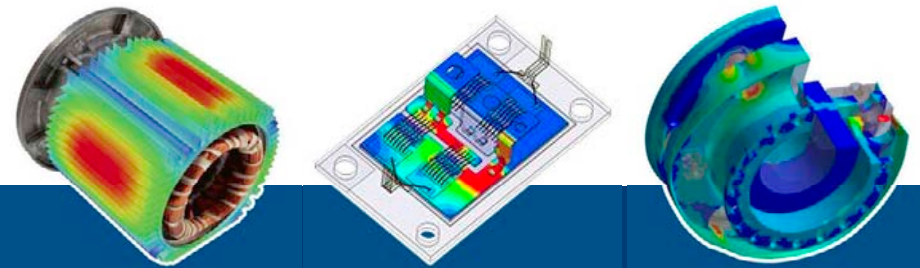
DOE



Properties of Schematic B2: DOE

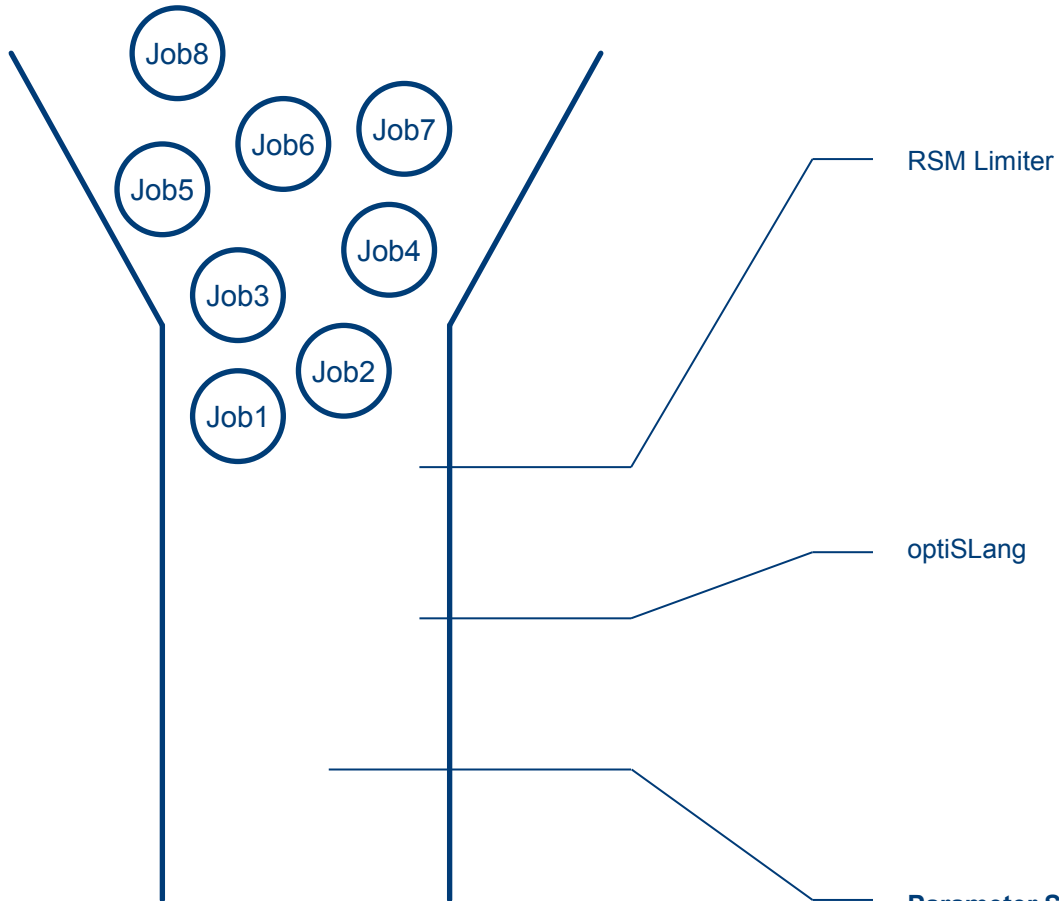
	A	B
1	Property	Value
2	General	
3	Component ID	DOE (optiSLang)
4	Directory Name	Sensitivity
5	Save Design Points As Projects	☐
6	Clear Design Table during Update	☐
7	Notes	
8	Update Options	
9	Specify Maximum Runtime per Job	☐
10	Use RSM Mode	☒
11	Preferred Number of Simultaneous Runs	4
12	Run Python Script for Update	☐
13		

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optiSLang and Setup 3

Job Limitation – Adjustment for Setup 3



Compute Server Properties

General | Cluster | SSH

Display Name: LSF

Machine Name: localhost

Working Directory Location: User Specified

Working Directory: d:\remote\mccc1

<< Less

☒ Server Can Accept Jobs

Maximum Number of Jobs: 60

☐ Limit Times for Job Submission

Start Time: 00:00:00

End Time: 00:00:00

☐ Save Job Logs to File

☒ Delete Job Files in Working Directory

☐ Use SSH protocol for inter and intra-node communication (Linux only)

OK Cancel Help

Properties of Schematic B2: DOE

	A	B
1	Property	Value
2	General	
3	Component ID	DOE (optiSLang)
4	Directory Name	Sensitivity
5	Save Design Points As Projects	☐
6	Clear Design Table during Update	☐
7	Notes	
8	Notes	
9	Update Options	
10	Specify Maximum Runtime per Job	☐
11	Use RSM Mode	☒
12	Preferred Number of Simultaneous Runs	64
13	Run Python Script for Update	☐

Properties of Schematic: Parameter Set

	A	B
1	Property	Value
2	Design Point Update Process	
3	Update Option	Submit to Remote Solve Manager
4	Solve Manager	muc-hpc-hn
5	Queue	ansys145
6	Job Submission	Specify Maximum Number of Jobs
7	Maximum Number of Jobs	4

RSM Setting in optiSLang for Setup 3

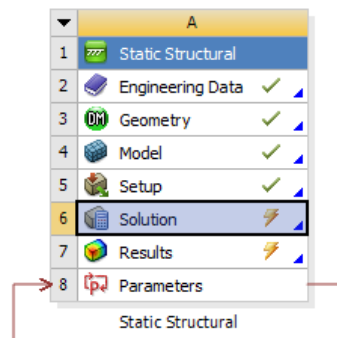
- Activate RSM Mode
- Specify „Number of Design Points in Parallel“: 64 (keep it always as a fixed number, even if there are less design points to calculate!)

The screenshot displays the ANSYS Workbench interface. On the left, the 'Project Schematic' window shows a hierarchical tree. Under 'A', 'Static Structural' is selected. A red arrow points from 'Parameters' in the 'Static Structural' branch to a 'Parameter Set' box. Another red arrow points from the 'Parameter Set' box to 'DOE' in the 'B' branch. The 'B' branch also includes 'Sensitivity', 'MOP', and 'Results'. On the right, the 'Properties of Schematic B2: DOE' window is open, showing a table of properties. The 'Update Options' section is expanded, and the 'Preferred Number of Design Points in Parallel' is set to 64. The 'Use RSM Mode' checkbox is checked.

	A	B
1	Property	Value
2	General	
3	Component ID	DOE (optiSLang)
4	Directory Name	Sensitivity
5	Save Design Point Directories	☐
6	Clear Design Table during Update	☐
7	Notes	
8	Notes	
9	Update Options	
10	Specify Maximum Runtime per Job	☐
11	Use RSM Mode	☒
12	Preferred Number of Design Points in Parallel	64
13	Run Python Script for Update	☐

Setup 3: „Specify Maximum Number of Jobs“ – 3rd Type and optiSLang

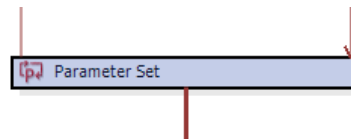
Solution



Properties of Schematic A6: Solution

	A	B
1	Property	Value
2	General	
3	Component ID	Solution
4	Directory Name	SYS
5	Notes	
6	Used Licenses	
8	Last Update Used Licenses	ANSYS Mechanical
9	System Information	
10	Physics	Structural
11	Analysis	Static Structural
12	Solver	Mechanical APDL
13	Solution Process	
14	Update Option	Use application default
15	Solve Process Setting	My Computer
16	Solve Manager	
17	Queue	
18	Restriction for Project/Design Point Update via RSM	
19	Serial Execution Only	☐
20	Specify Number of Processes Restriction	☐
21	Shared Memory Parallel	☐

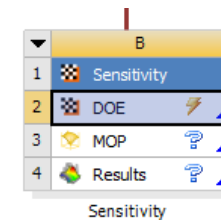
Parameter Set



Properties of Schematic: Parameter Set

	A	B
1	Property	Value
2	Design Point Update Process	
3	Update Option	Submit to Remote Solve Manager
4	Solve Manager	muc-hpc-hn
5	Queue	ansys145
6	Job Submission	Specify Maximum Number of Jobs
7	Maximum Number of Jobs	4
8	Design Point Update Order	Update from Current
9	Pre-RSM Foreground Update	None
10	License Checkout	Reserved
11	Reserved License Set	Select Licenses
12	Component Execution Mode	Parallel
13	Max Number of Processes Per Job	2
14	Keep Failed Design Point Files (Beta)	☐
15	Exported Design Point	Update parameters

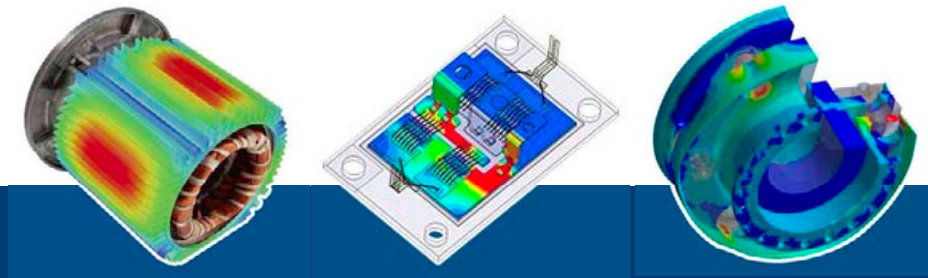
DOE



Properties of Schematic B2: DOE

	A	B
1	Property	Value
2	General	
3	Component ID	DOE (optiSLang)
4	Directory Name	Sensitivity
5	Save Design Points As Projects	☐
6	Clear Design Table during Update	☐
7	Notes	
8	Update Options	
10	Specify Maximum Runtime per Job	☐
11	Use RSM Mode	☒
12	Preferred Number of Simultaneous Runs	64
13	Run Python Script for Update	☐

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Good to Know

Setup 3 – Path Length

- In Windows the maximum length of a path/name is limited to **256 characters**. In case of exceeding this limit design points cannot be transferred back from the remote computer even if they are calculated correctly.

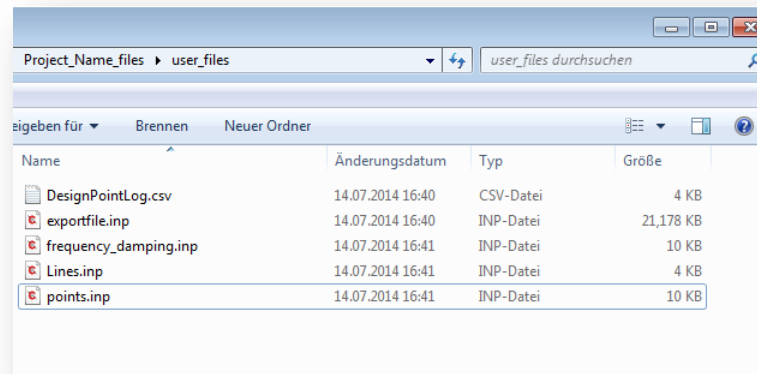
Keep the path and name as short as possible!

- Path Structure :
 - Verzeichnispfad\Dateiname_pending_tasks\UpdateDesignPoints-x\Dateiname_updated_dpx.wppz**
- Examples:
 - File name: optiSLang_XXXXXX_Test_mosl_3rdV
 - Path: D:\nnagl\optiSLang-Test\optiSLang_XXXXXX_Test_mosl_3rdV_pending_tasks\UpdateDesignPoints-2\optiSLang_XXXXXX_Test_mosl_3rdV_updated_dp5.wppz
→ 139 characters
 - File name: sensi2_xx_adv_30Apr2014_fuer_Sensitivitaetsanalyse_mit_Parameterraum_u3_75_v7mp_Gerechnet
 - Path: D:\nnagl\optiSLang-Test\sensi2_xx_adv_30Apr2014_fuer_Sensitivitaetsanalyse_mit_Parameterraum_u3_75_v7mp_Gerechnet_pending_tasks\UpdateDesignPoints-xxx\sensi2_xx_adv_30Apr2014_fuer_Sensitivitaetsanalyse_mit_Parameterraum_u3_75_v7mp_Gerechnet_updated_dpxxx.wppz
→ 259 characters

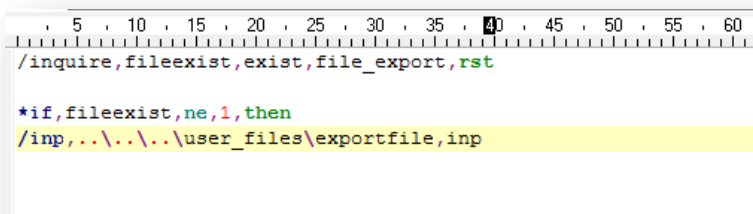


Setup 3 – Transfer of Additional Data to Remote Computer

- Put all necessary data (e. g. input files, material data, ...) in the user_files folder. This folder is copied to the remote computer.

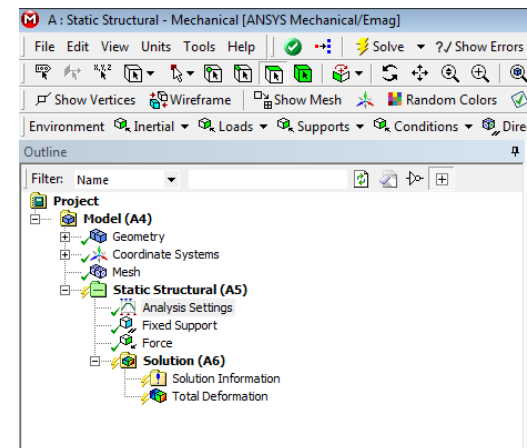
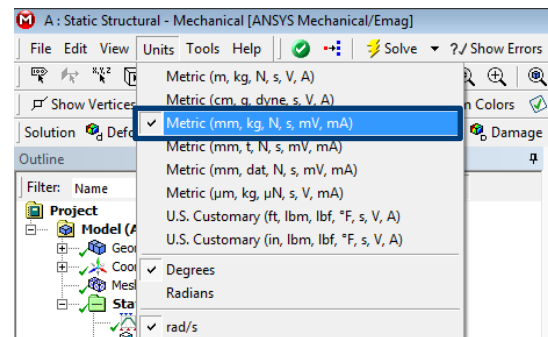
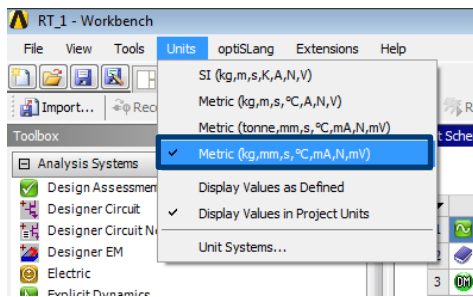


- Use relative paths instead of fixed ones



Unit Systems in Workbench – 3 Possibilities in Workbench

- Project page
- Mechanical Editor
- Analysis Settings



Use ONE unit systems for ALL analyses. If you assign the unit system in the analysis setting manually, do it for ALL analyses!

Nonlinear Solution	Yes
Solver Units	Active System
Solver Unit System	Active System
Visibility	Manual

Details of "Analysis Settings"	
Step Controls	
Solver Controls	
Restart Controls	
Nonlinear Controls	
Output Controls	
Analysis Data Management	
Solver Files Directory	D:\nag\HPC_Parametric_Test\HPC-PP-Variante2x_fil...
Future Analysis	None
Scratch Solver Files Directory	
Save MAPDL db	No
Delete Unneeded Files	Yes
Nonlinear Solution	Yes
Solver Units	Active System
Solver Unit System	nmm
Visibility	

Deutschland

**CADFEM GmbH
Zentrale Grafting**

Marktplatz 2
85567 Grafting b. München
T +49 (0) 8092 7005-0
info@cadfem.de

Geschäftsstelle Berlin

Breite Straße 2a
13187 Berlin
T +49 (0) 30 4759666-0

Geschäftsstelle Dortmund

Carlo-Schmid-Allee 3
44263 Dortmund
T +49 (0) 231 993255-46

Geschäftsstelle Hannover

Pelikanstraße 13
30177 Hannover
T +49 (0) 511 390603-0

Geschäftsstelle Chemnitz

Cervantesstraße 89
09127 Chemnitz
T +49 (0) 371 334262-0

Geschäftsstelle Frankfurt

Im Kohlruß 5-7
65835 Liederbach am Taunus
T +49 (0) 6196 76708-0

Geschäftsstelle Stuttgart

Leinfelder Straße 60
70771 Leinfelden-Echterdingen
T +49 (0) 711 990745-0

Österreich

**CADFEM (Austria) GmbH
Zentrale Wien**

Wagenseilgasse 14
1120 Wien
T +43 (0) 1 5877073
info@cadfem.at

Geschäftsstelle Innsbruck

Grabenweg 68 (SOHO 2.0)
6020 Innsbruck
T +43 (0) 512 319056

Schweiz

**CADFEM (Suisse) AG
Zentrale Aadorf**

Wittenwilerstrasse 25
8355 Aadorf
T +41 (0) 52 36801-01
info@cadfem.ch

Geschäftsstelle Gerlafingen

Privatstrasse 8
4563 Gerlafingen
T +41 (0) 32 67580-70

Bureau Lausanne

Avenue de la Poste 3
1020 Renens
T +41 (0) 21 61480-40