Open Source Framework RCE: Integration, Automation, Collaboration

4th Symposium on Collaboration in Aircraft Design

27.11.2014, Onera, Toulouse

Doreen Seider

Outline

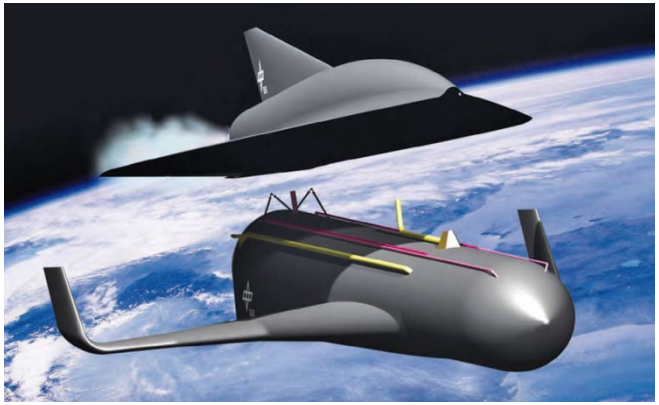
Implementing Multidisciplinary Design Processes in RCE

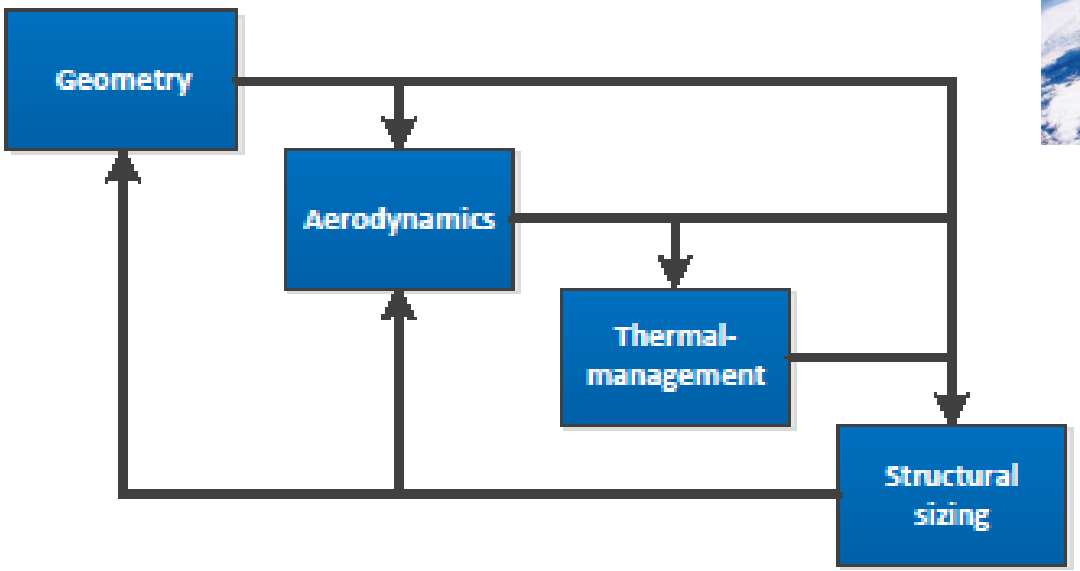
Collaboration in RCE

Outlook

MDO: Thermal Management of SpaceLiner

Process Chain

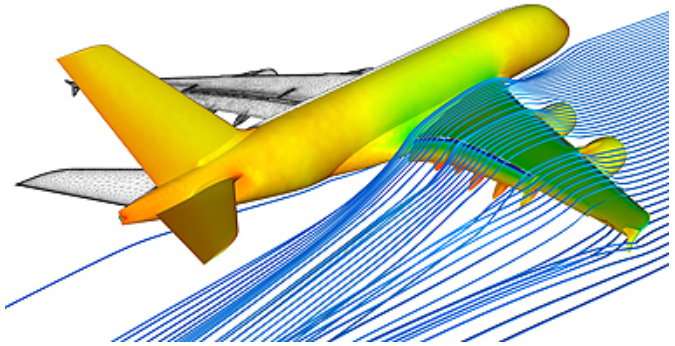


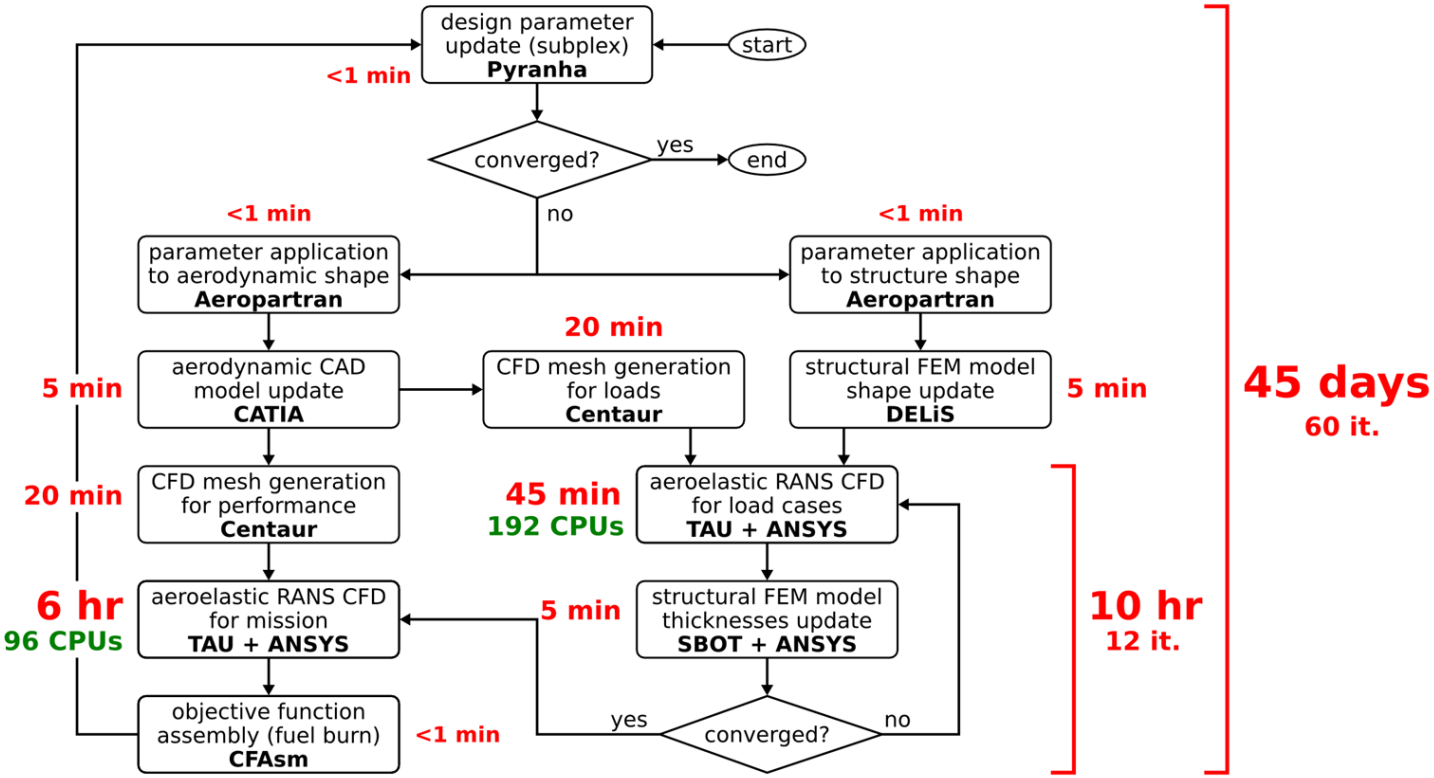


Source: A. Tröltzsch

MDO: High-Fidelity Aircraft Design

Process Chain

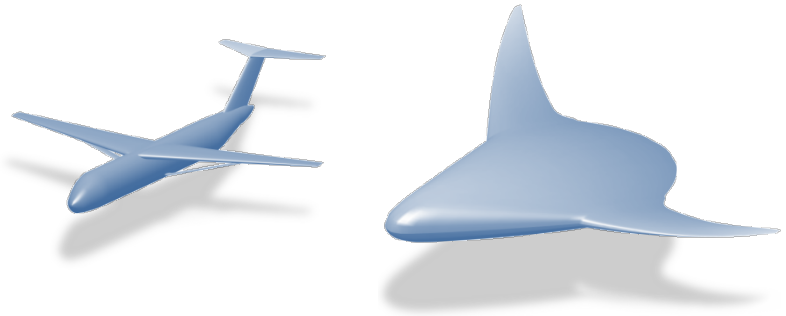




Source: C. Ilic

MDA: Preliminary Aircraft Design

Dependencies in N2 Chart

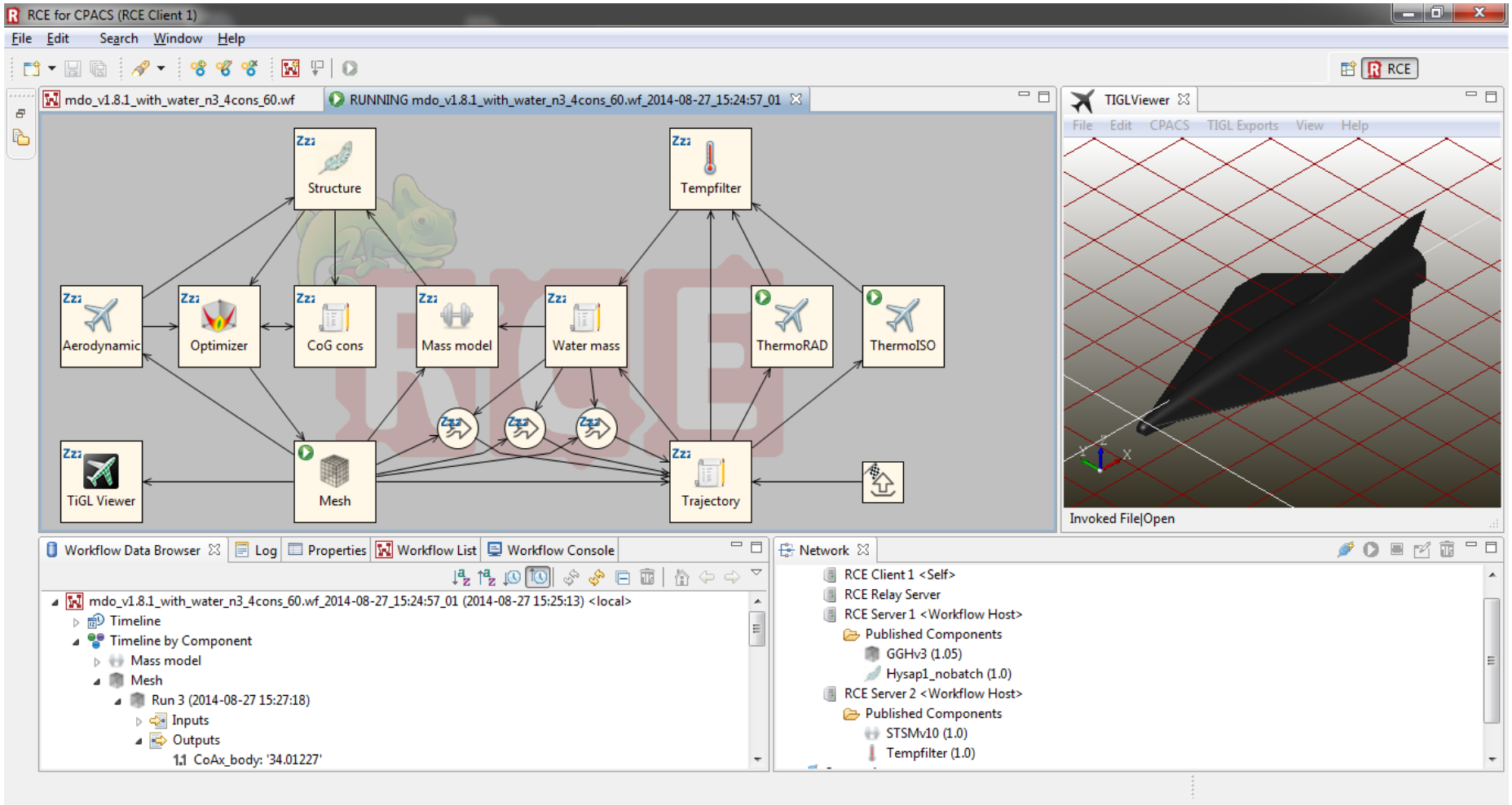


TLAR			TLAR								
	FuCD		Geometrie Rumpf, Payload-masse				Sekundärmassen Rumpf, Payloadmasse	Payload-masse		Sekundärmassen Rumpf, Payloadmasse	
		TWDat	Triebwerks-Masse					Schub-kennfeld		Triebwerk-masse	
			VAMPzero	Geometrie	Struktur, Geometrie	Geometrie	Geometrie, mass-Breakdown, Struktur	Mass-Breakdown	Klappen	Mass-Breakdown	
				Liftingline & Handbook-Aero			Aero Lasten	Aero Kennfeld			
					PESTsewi		Sekundärmassen Flügel			Sekundärmassen Flügel	
						WingMass Surrogate				Primärmasse Flügel + Strebe	
							DELiS			Primärstruktur-massen	
		Triebwerks-skalierung	Treibstoff-Verbrauch					**FSMS**			Treibstoff-Verbrauch
									Paradise		
			Mass-Breakdown							**CMU**	

Source: D. Böhnke, E. Moerland

RCE is a Integration Framework for MD Design Processes

Graphical User Interface

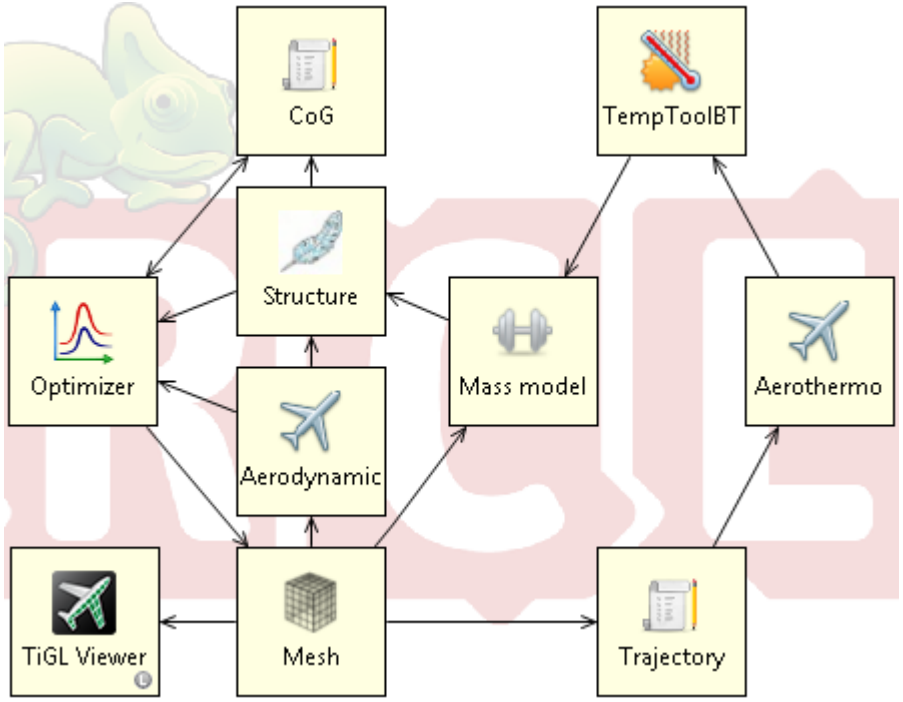


RCE is a Workflow-driven Integration Framework

From Design Processes to RCE Workflows

- Multidisciplinary design processes means multiple disciplines and multiple tools
- Tools needs to be executed multiple by considering their dependencies between each other

- To model a design process in RCE the tools involved need to be integrated into RCE first

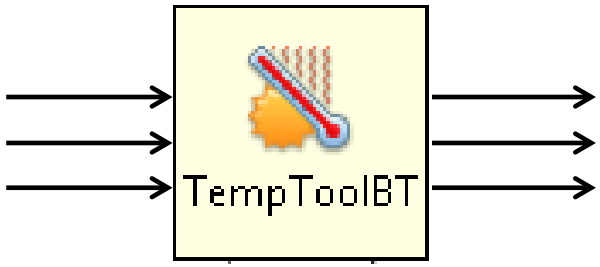


Tool Integration in RCE

Integration Concept

- Prerequisites a tool must fullfil
  - Runs without any user interaction
  - Is executable from command line

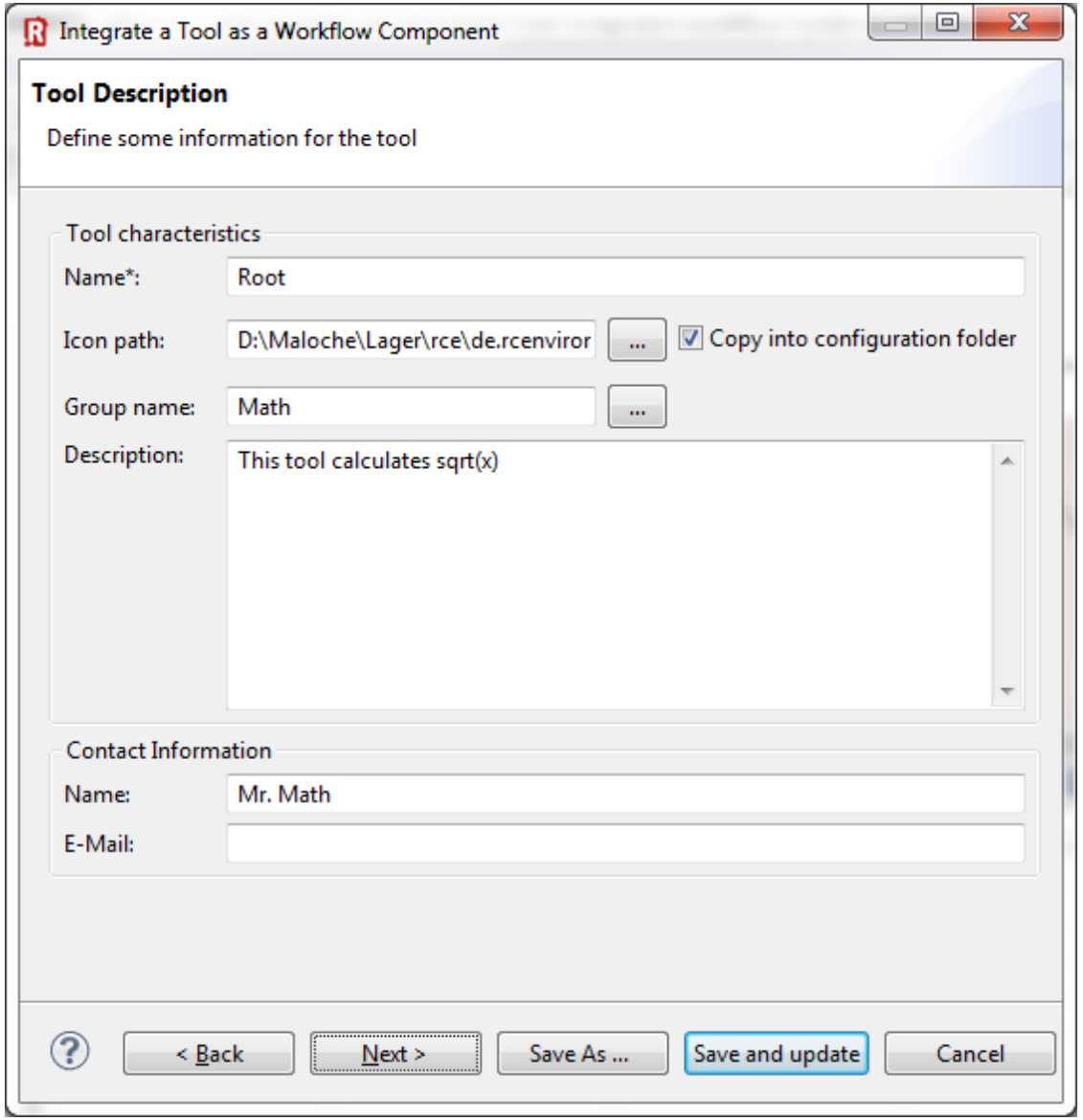
- Tools are black boxes for RCE with inputs and outputs (texts, floating point numbers, files, directories…)



Tool Integration in RCE

How the User does it?

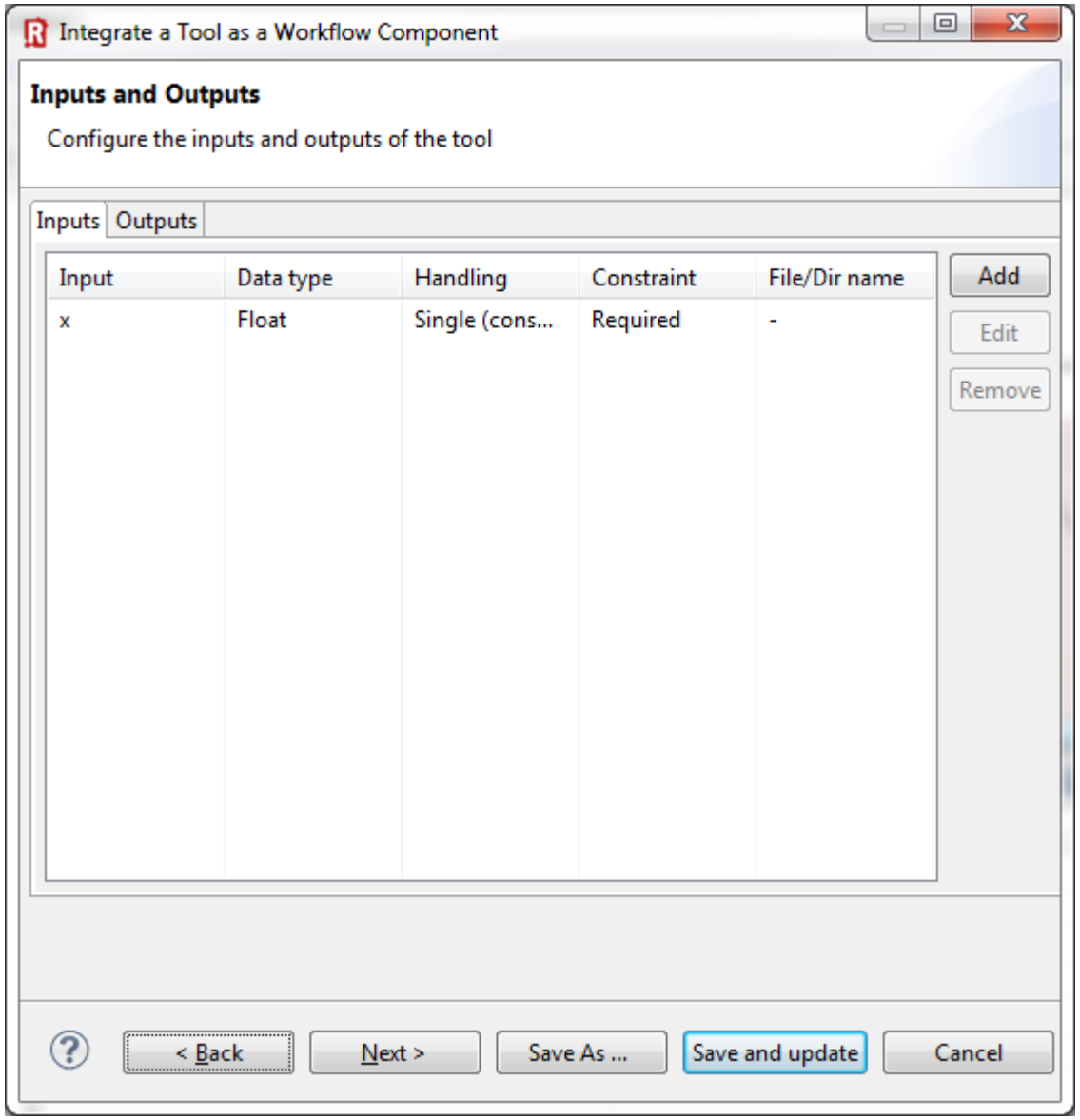
- Graphical dialog guides through the integration process
- Tool is immediately integrated in RCE



Tool Integration in RCE

How the User does it?

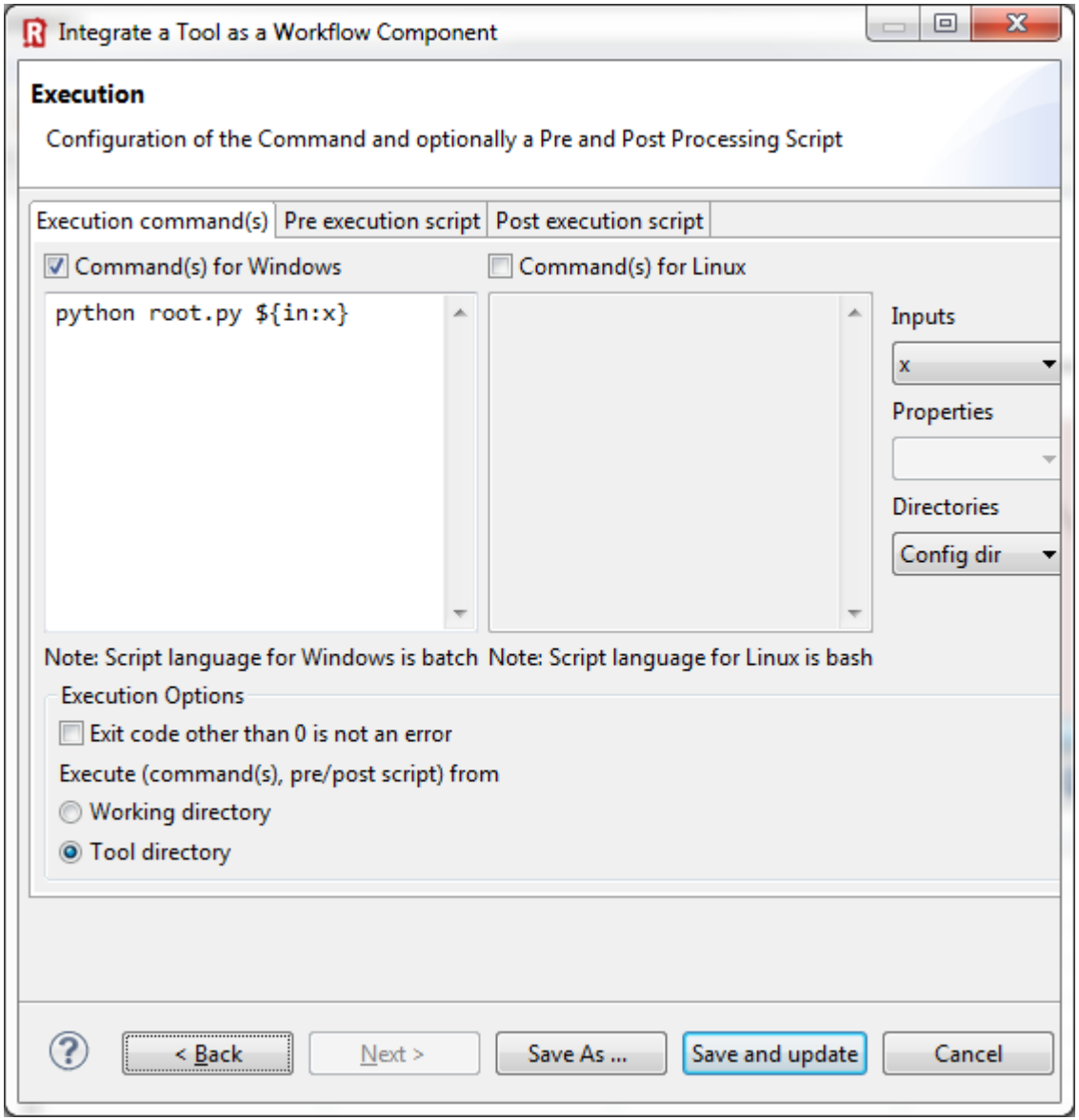
- Graphical dialog guides through the integration process
- Tool is immediately integrated in RCE



Tool Integration in RCE

How the User does it?

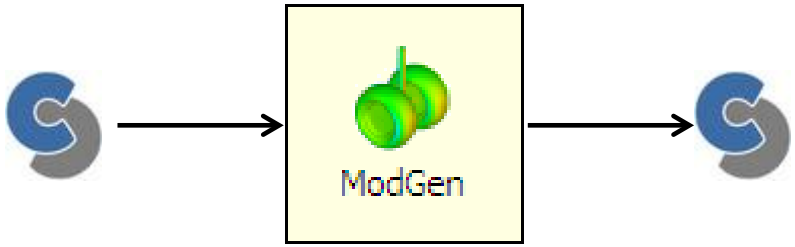
- Graphical dialog guides through the integration process
- Tool is immediately integrated in RCE



CPACS-specific Tool Integration in RCE

Integration Concept

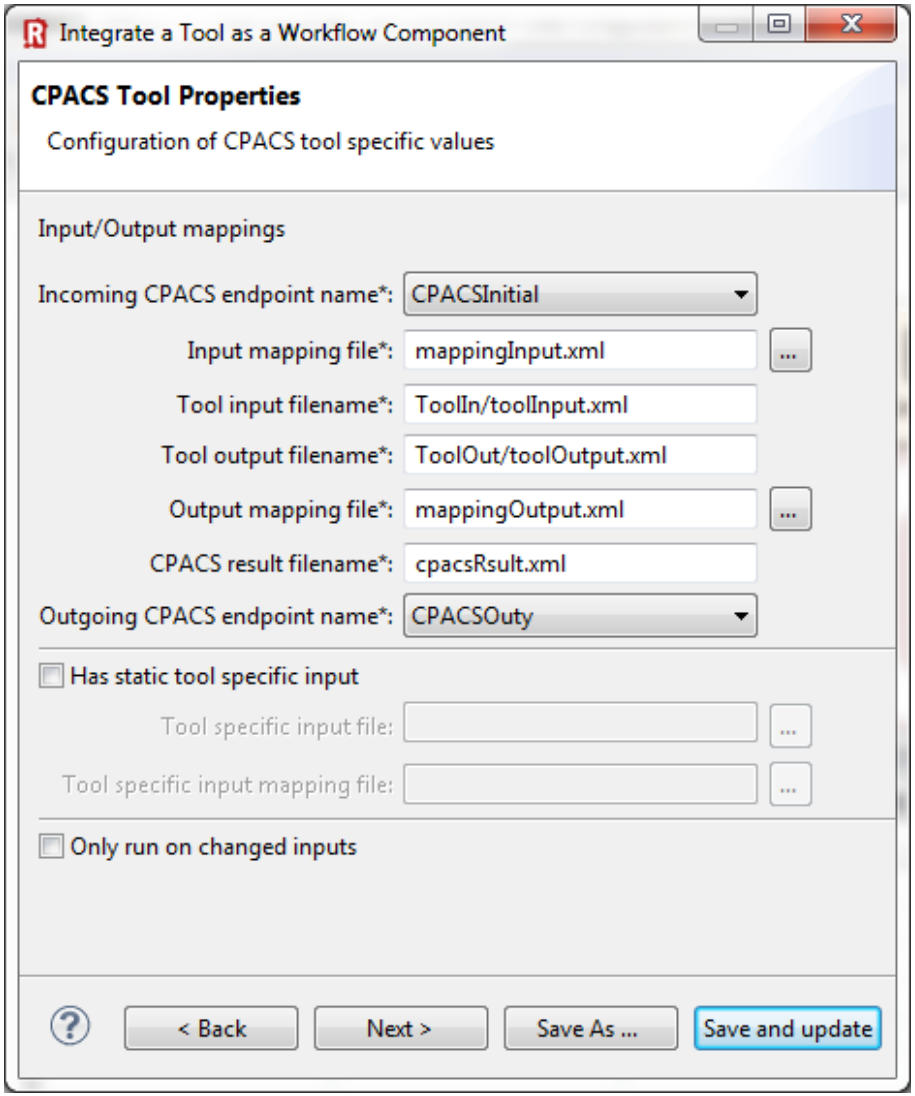
- Reading from CPACS before tool execution
- Writing back into CPACS after tool execution
- Use provided mapping file



CPACS-specific Tool Integration

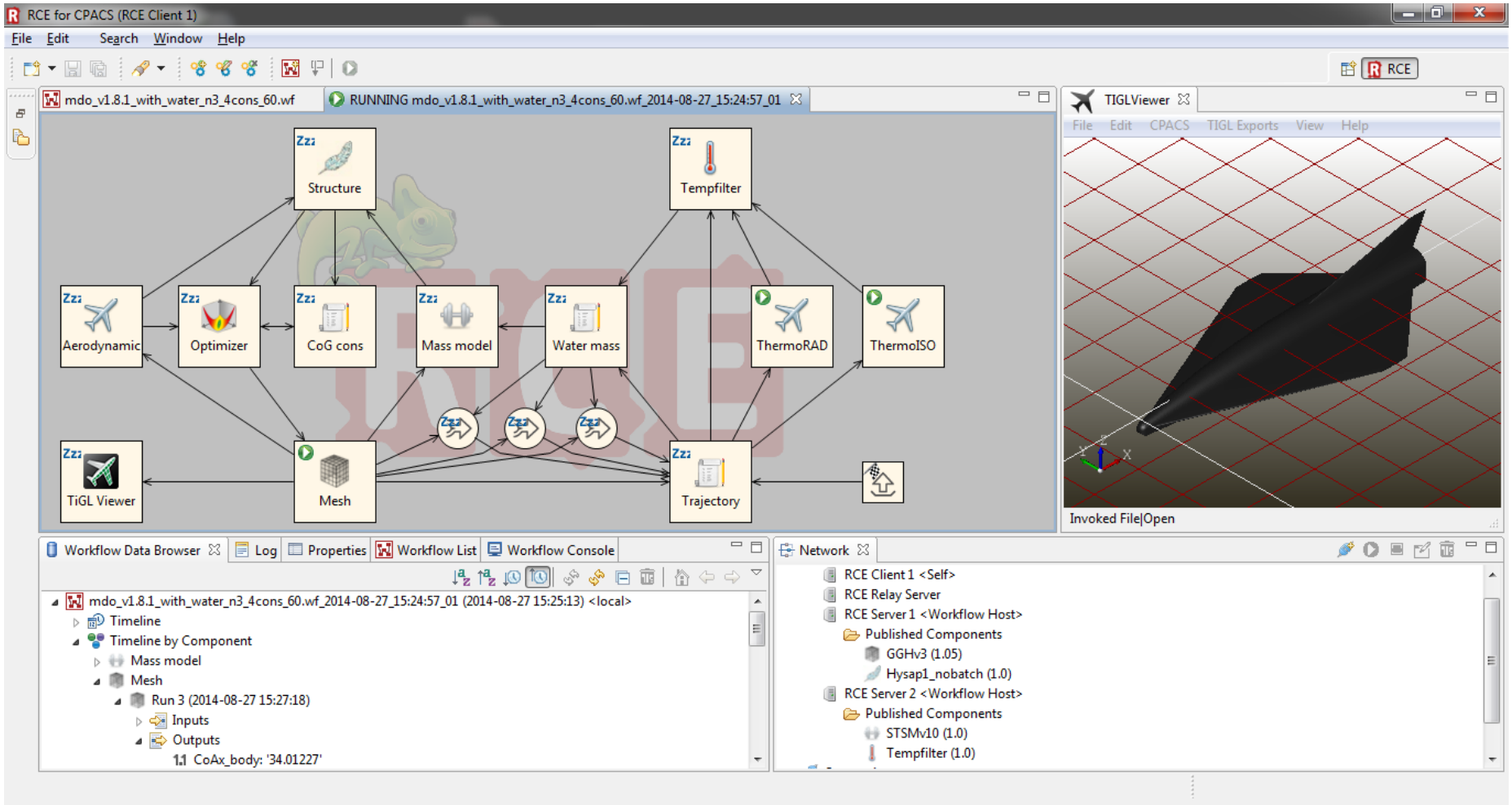
How the User does it?

- Extended integration dialog
- Defining mapping files, tool input files, CPACS result files, etc.



Workflow Execution

From the Graphical User Interface



Monitoring Workflow Execution

Console Output of Tools

Workflow Console

summary stdout stderr [ALL]

Optimizer search in messages Reset Search

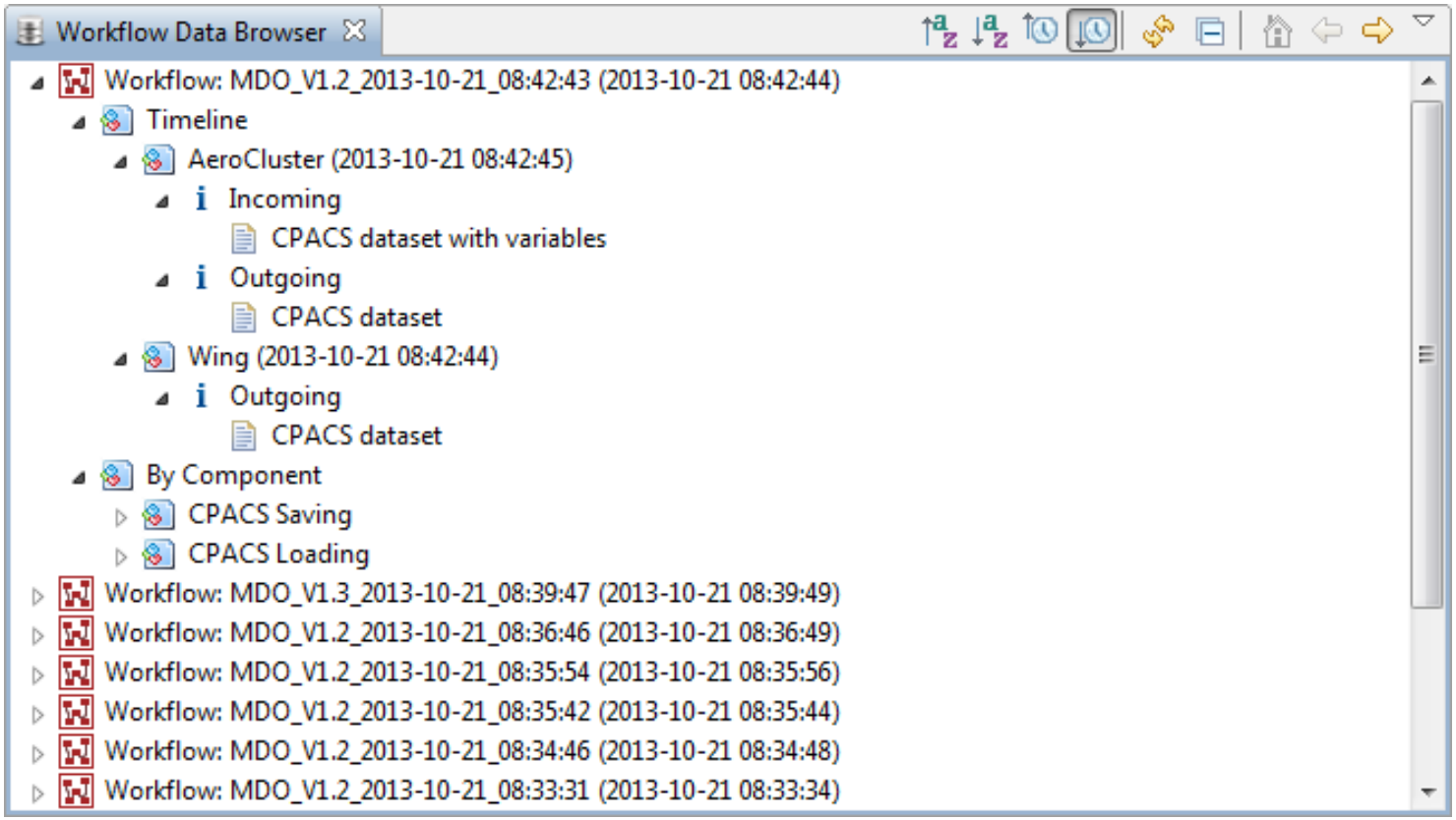
Message

```
<<<<< Function evaluation summary (interface1): 16 total (16 new, 0 dupl...
<<<<< Best parameters          =
                     4.0937500000e-001 TR
<<<<< Best objective function  =
                     -9.7430000000e-001
<<<<< Best data captured at function evaluation 12

<<<<< Iterator coliny_cobyla completed.
<<<<< Single Method Strategy completed.
DAKOTA execution time in seconds:
  Total CPU        =      3.851 [parent =      3.851, child =          0]
  Total wall clock =    3.85122
Optimization successfull!!
```

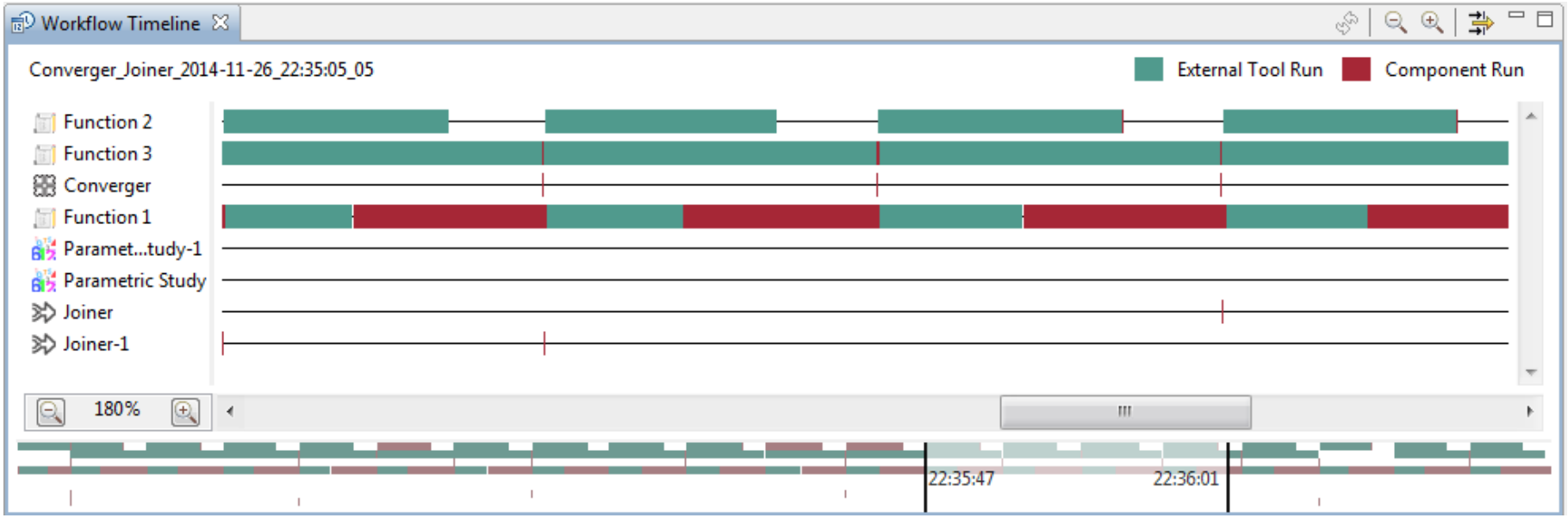
Monitoring Workflow Execution

Result Files and Data Sent



Monitoring Workflow Execution

Timeline on Workflow Run



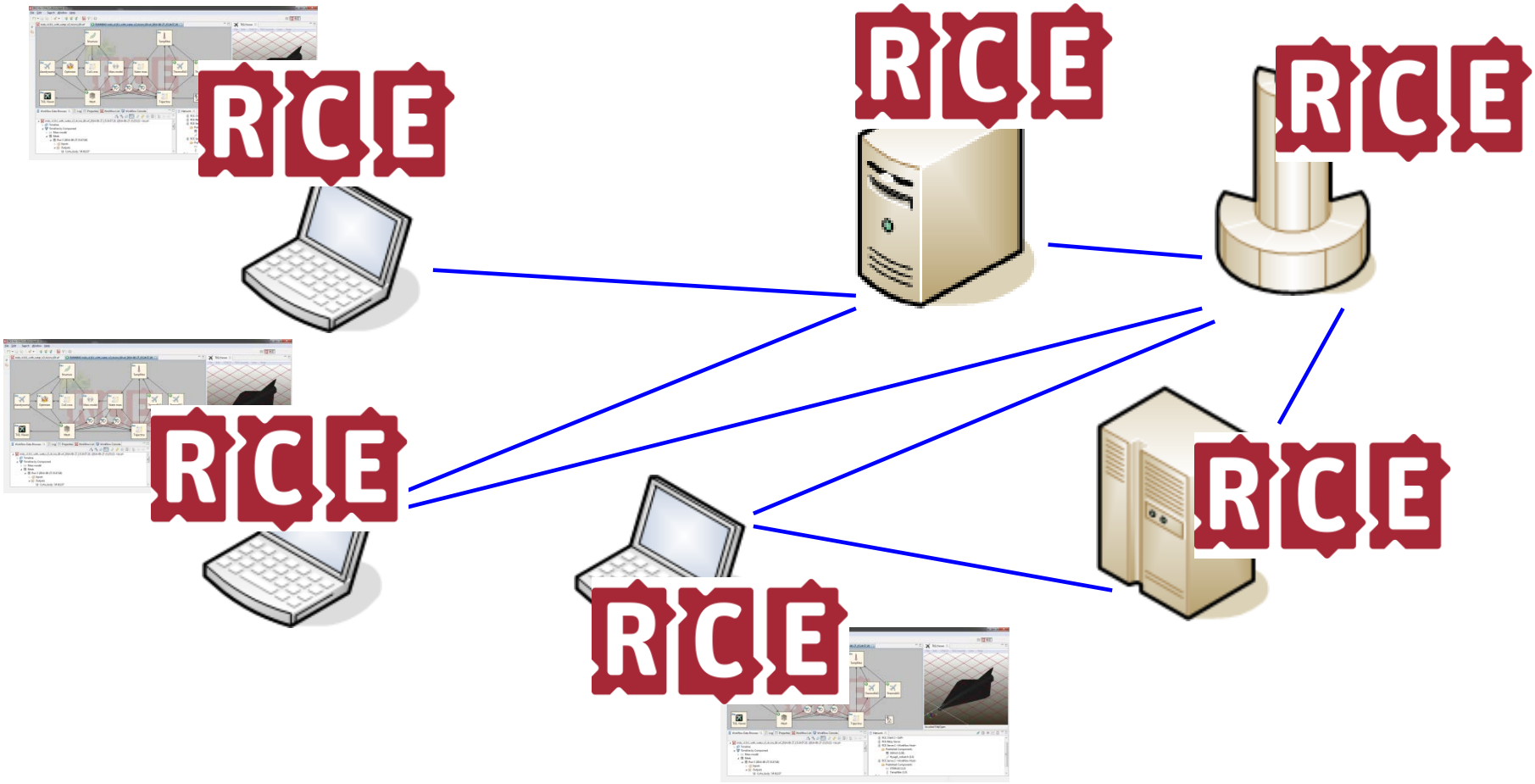
Multidisciplinary Desing Processes and Collaboration

- MDO means multiple disciplines, multiple tools, and multiple people
- People are often located on different sites
- Tools often run on different machines

- How does RCE support collaboration?

RCE is a Distributed Integration Framework

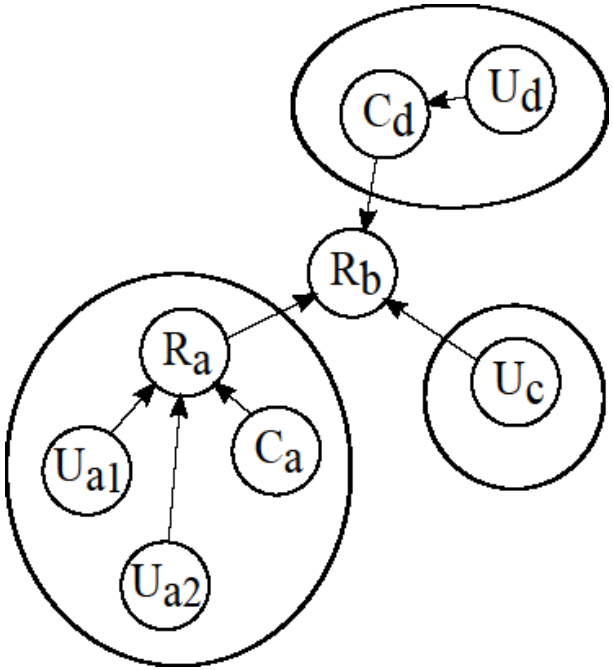
RCE Instances Build a Network



RCE is a Distributed Integration Framework

RCE Instances Build a Dynamic Network

- Network structure is fully flexible and dynamic
- RCE instances can have different roles: relay, compute, user frontend node, …



RCE instance

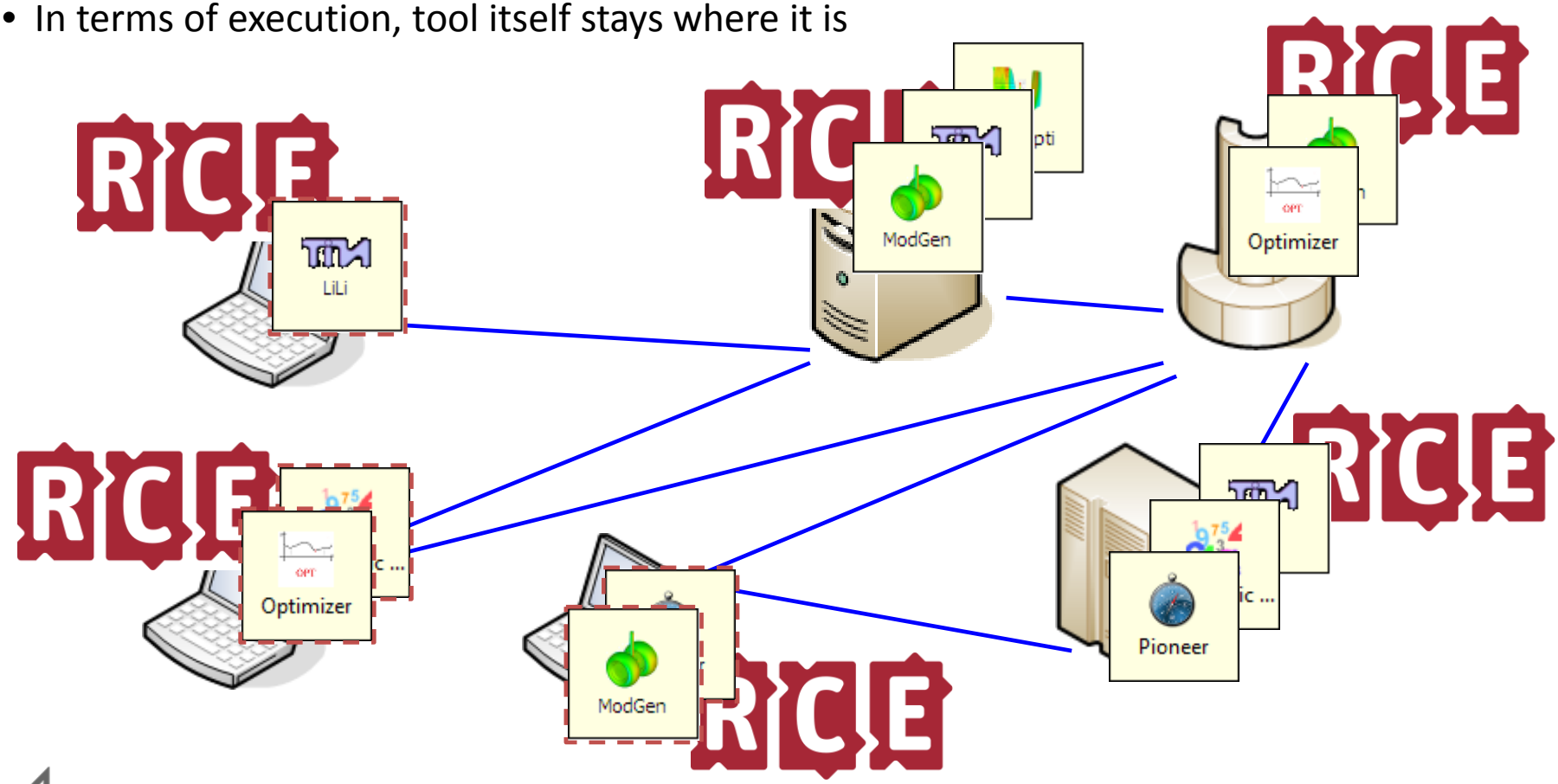
Direction of initialization

C…Compute node
R…Relay node
U…User frontend node

Collaboration in RCE

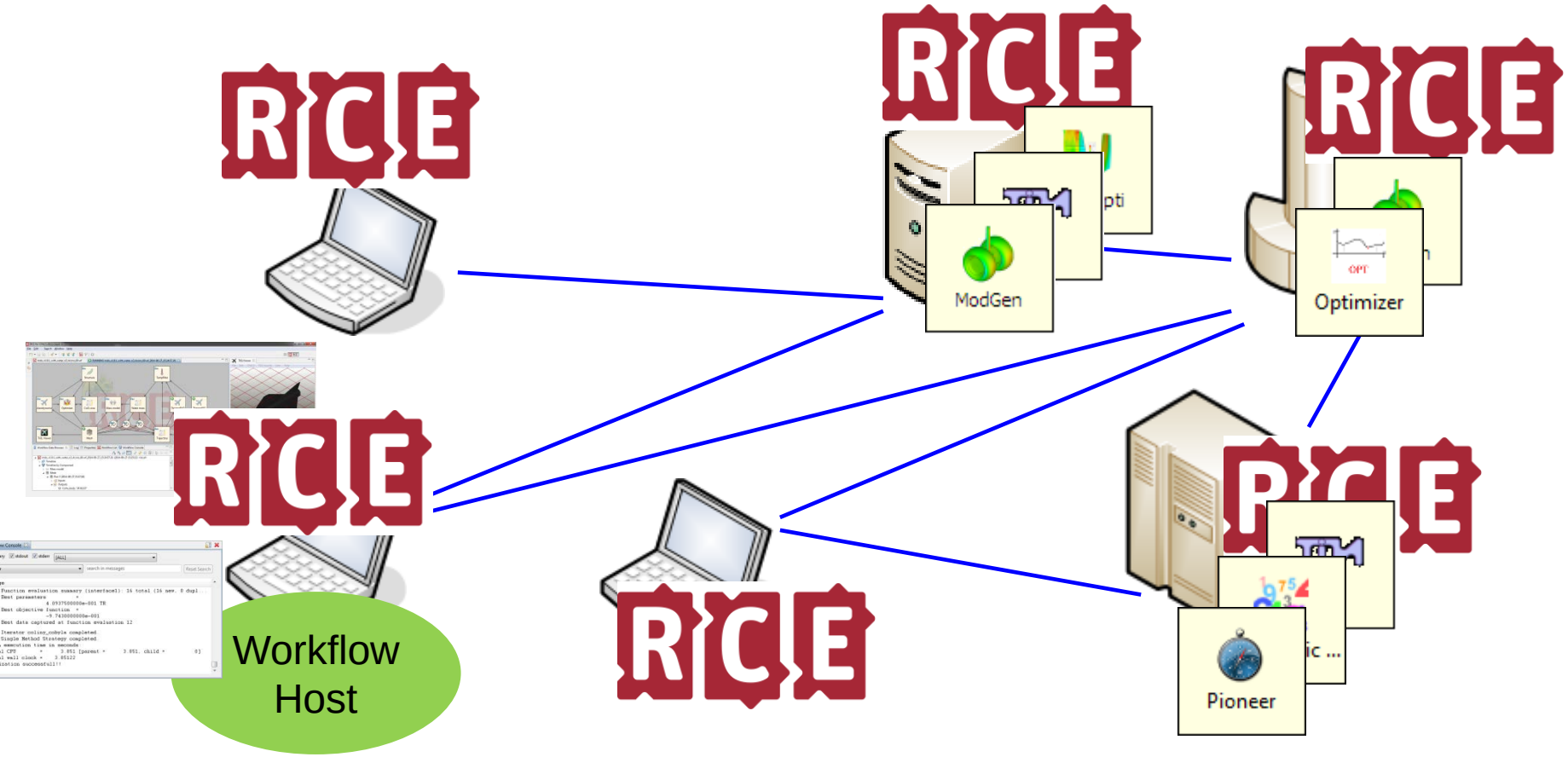
(Ad-hoc) Distribution of Tools

- Tools, which are integrated into RCE, can be provided to others in the network
- In terms of execution, tool itself stays where it is



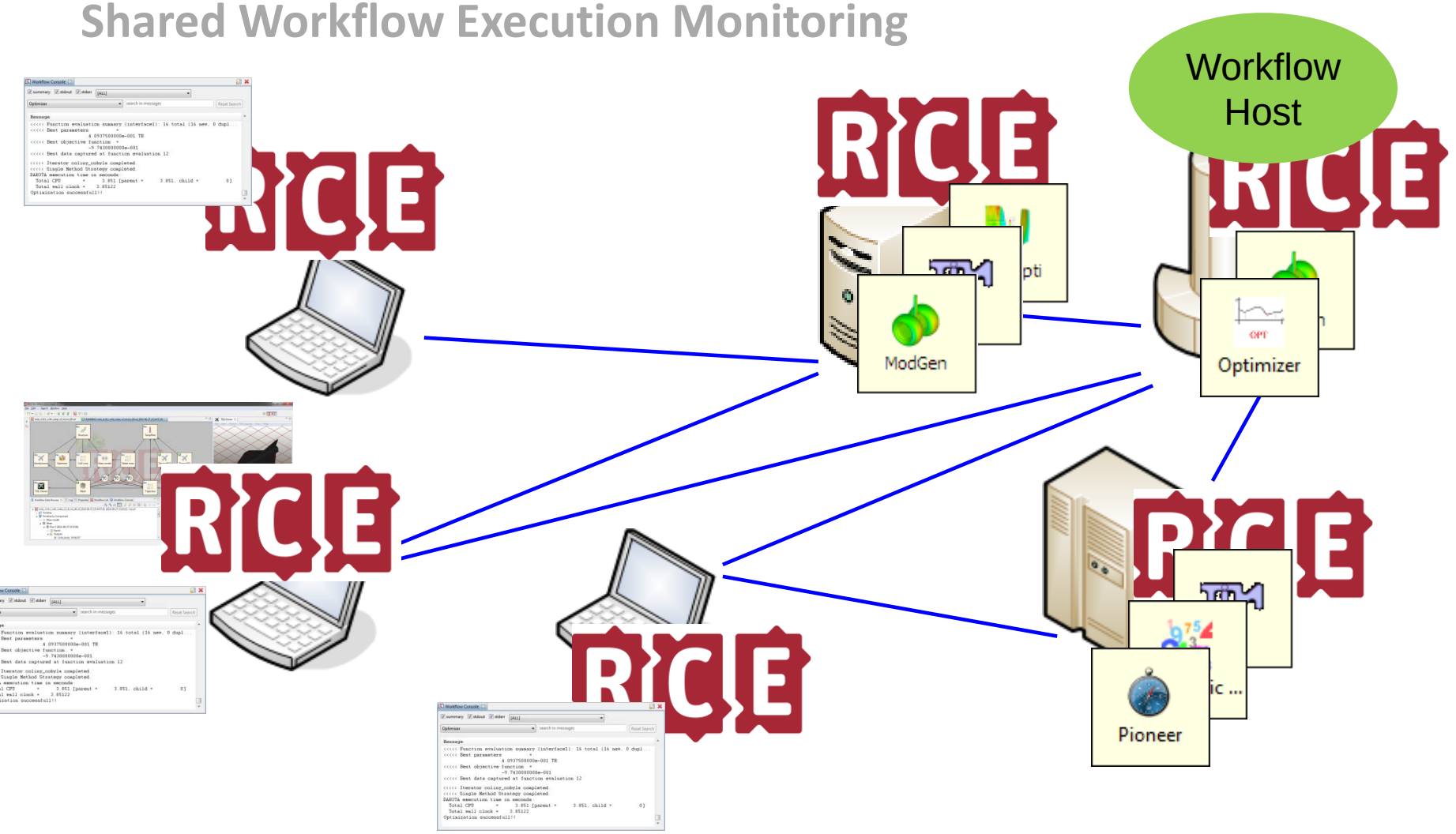
Collaboration in RCE

Shared Workflow Execution Monitoring



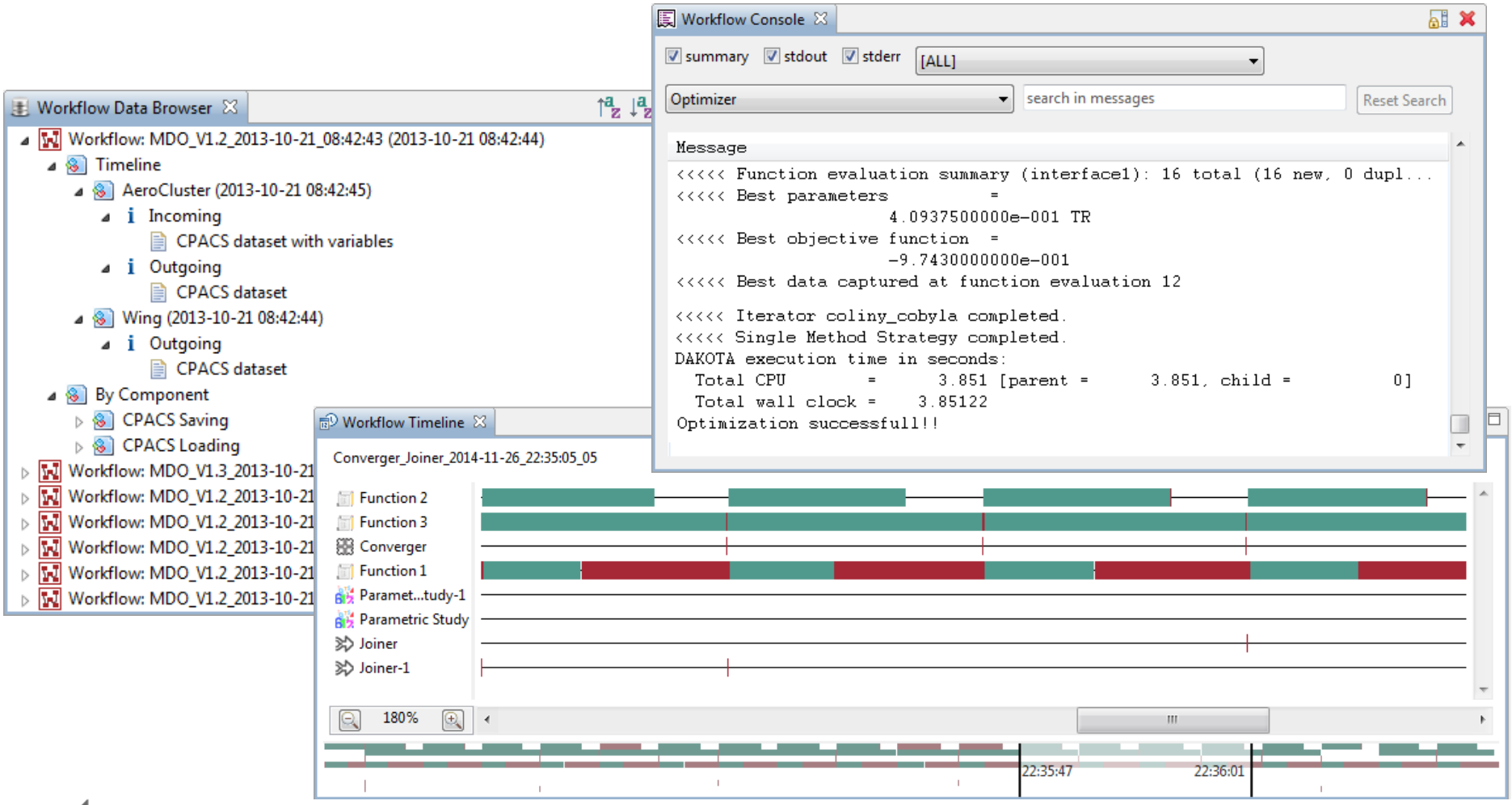
Collaboration in RCE

Shared Workflow Execution Monitoring



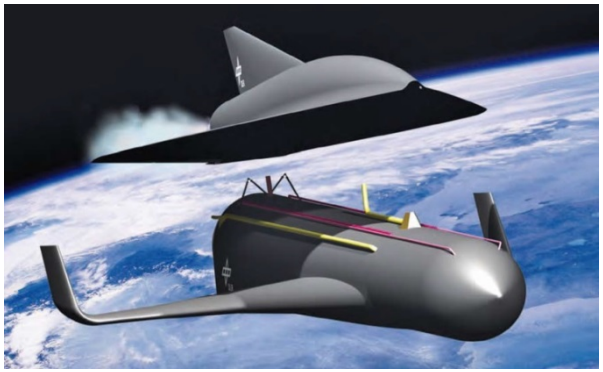
Collaboration in RCE

Shared Workflow Execution Monitoring

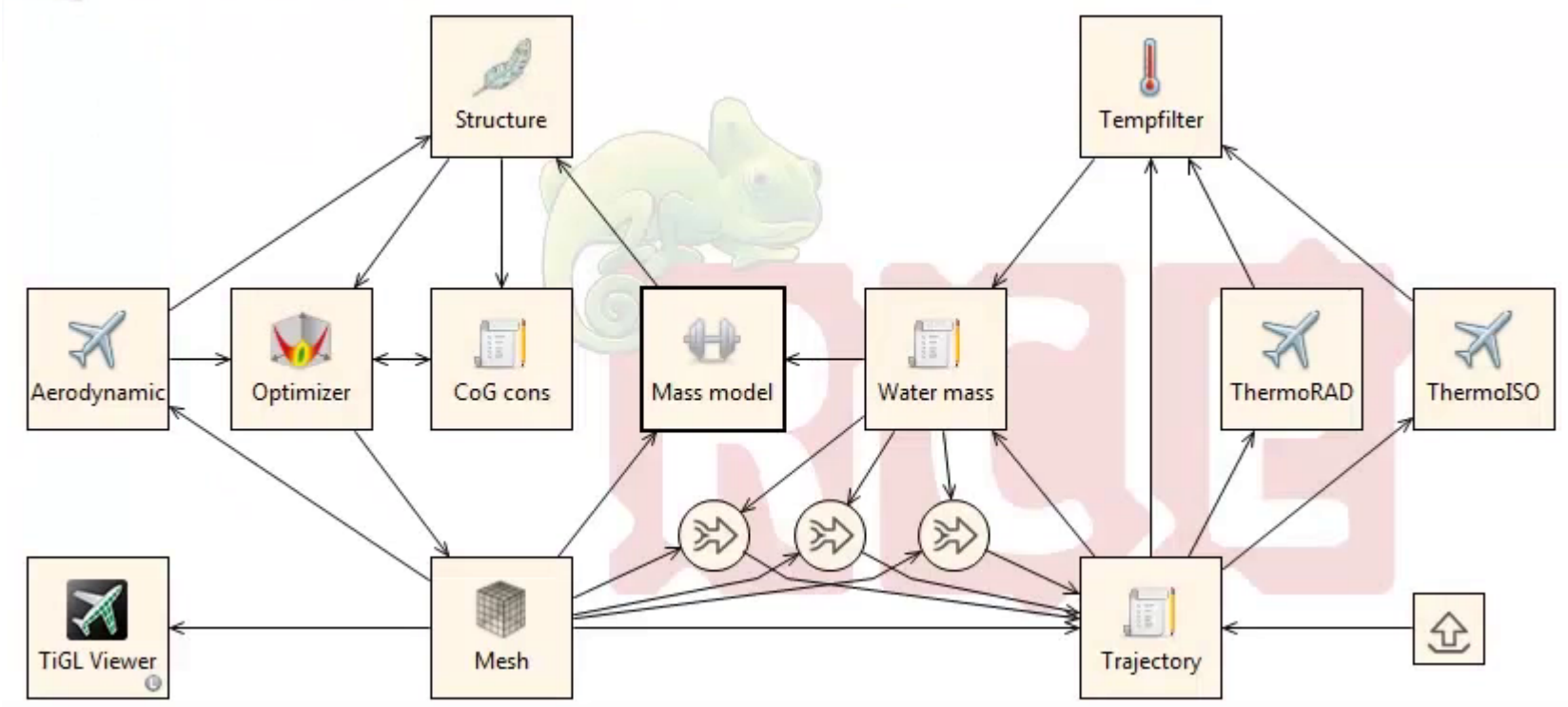


MDO: Thermal Management of SpaceLiner

RCE Workflow

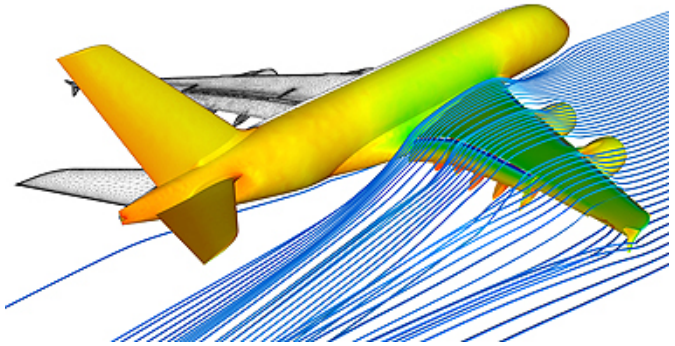


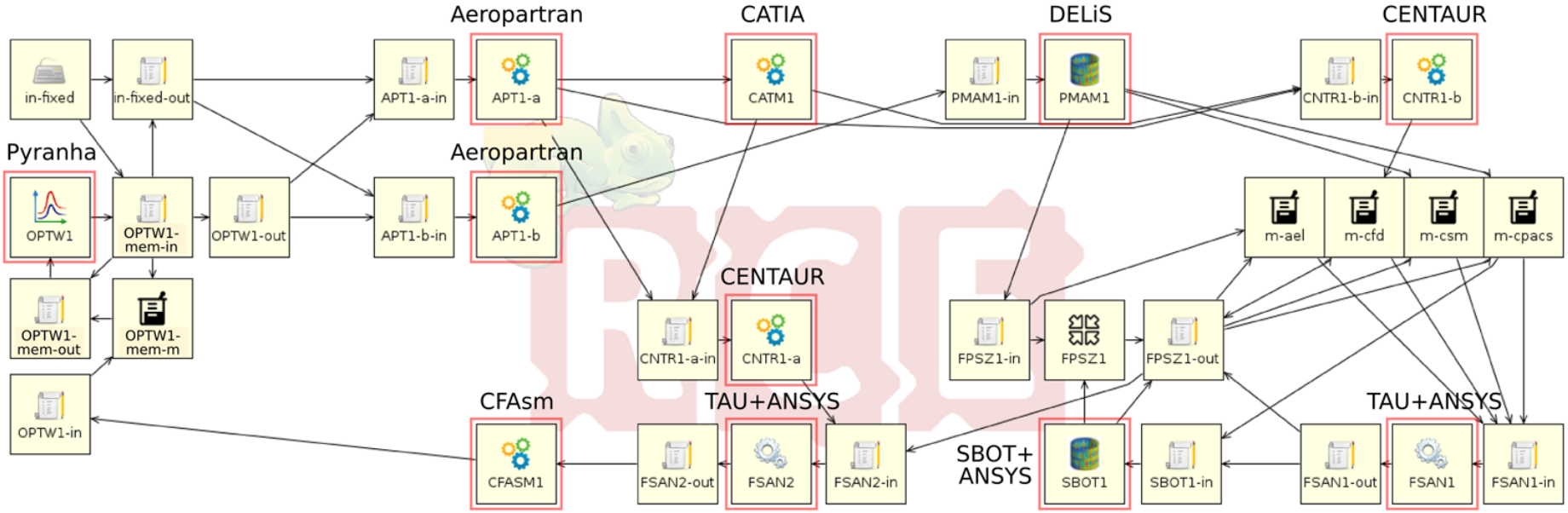
Source: A. Tröltzsch



MDO: High-Fidelity Aircraft Design

RCE Workflow

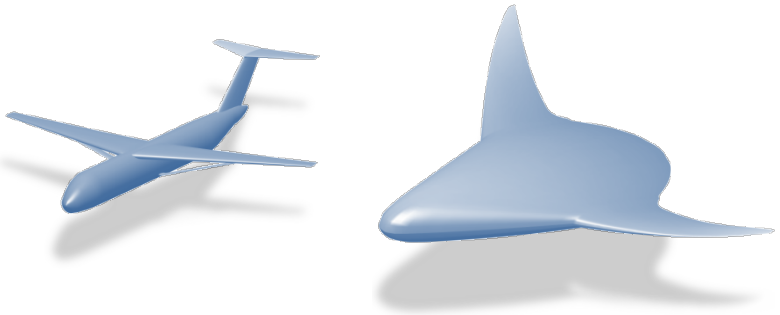


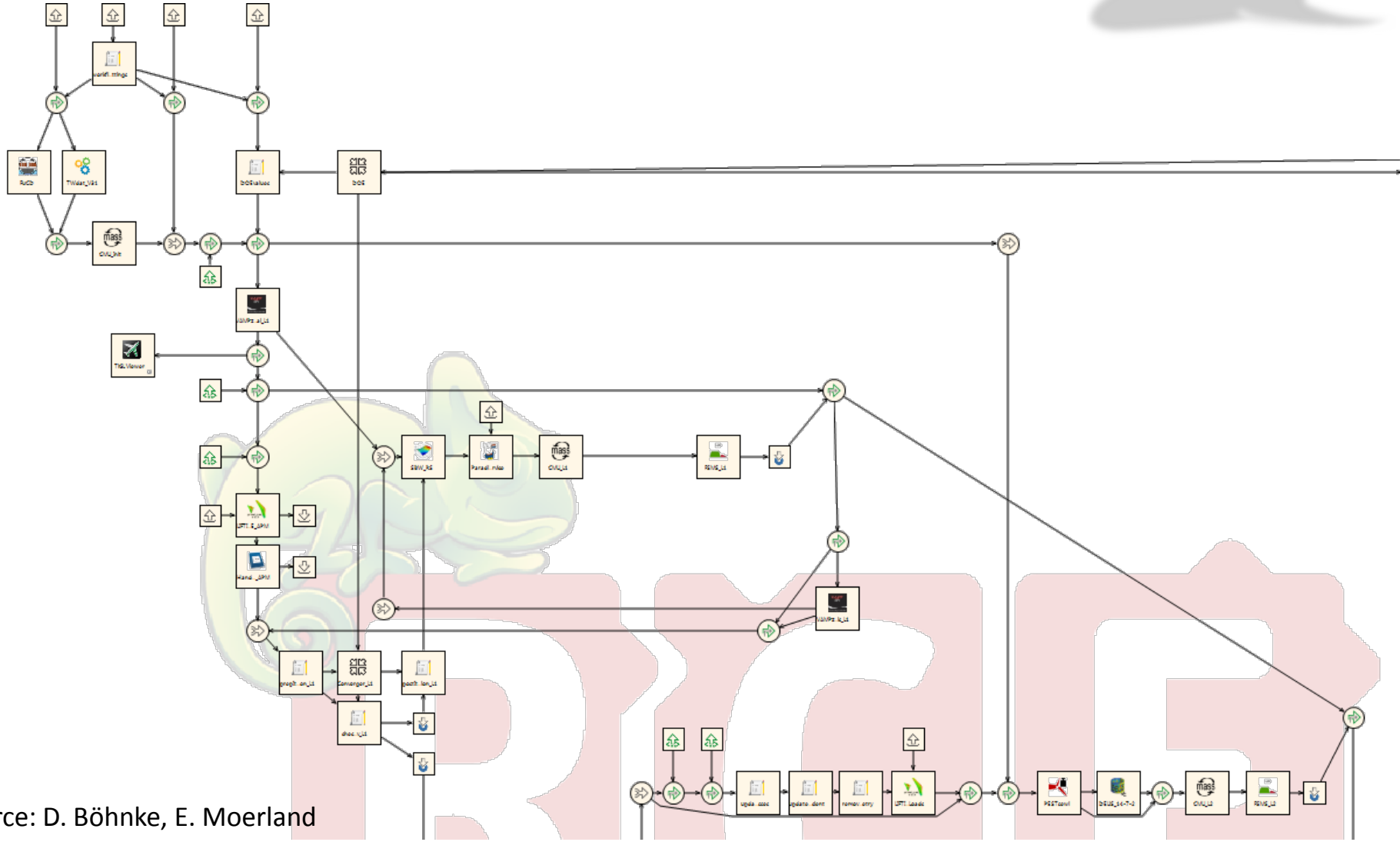


Source: C. Ilic

MDA: Preliminary Aircraft Design

RCE Workflow



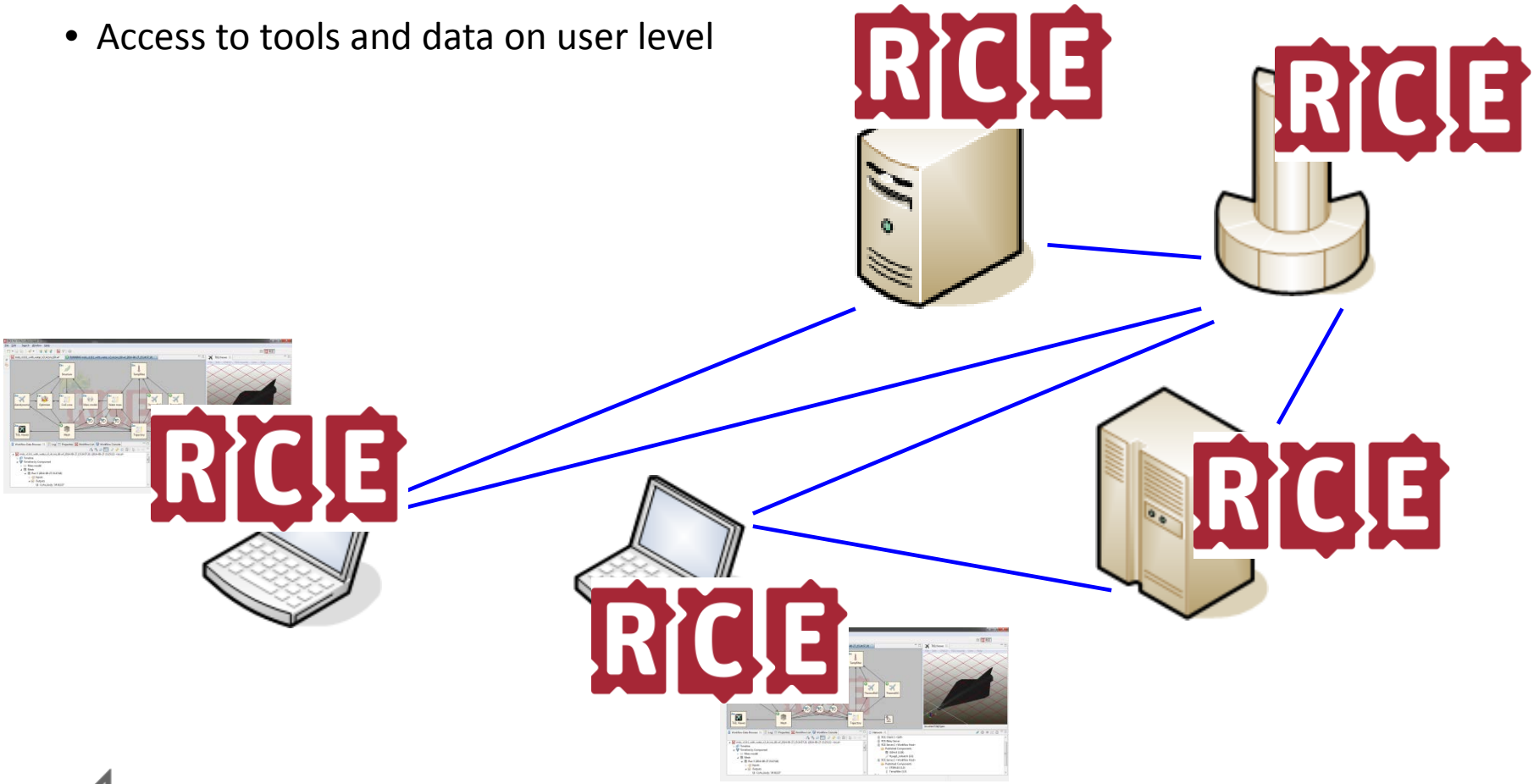


Source: D. Böhnke, E. Moerland

Outlook

Multi User Concept

- Shortterm to midterm
- Access to tools and data on user level



Conclusion

- RCE is a workflow-driven integration framework for MDO processes (among others)
- It is distributed and allows collaboration

- RCE is Open Source
- Contributions are welcome
- Not only in terms of code, but also in terms of feedback, ideas, concepts
- RCE is developed by developers and by users

http://rcenvironment.de
@rcenvironment
http://youtube.com/rcenvironment