

An Approach Towards Interoperability of CSM Models in the Virtual Structural Sizing and Testing of Lightweight Composite Structures

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CAE Interoperability
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Knowledge for Tomorrow

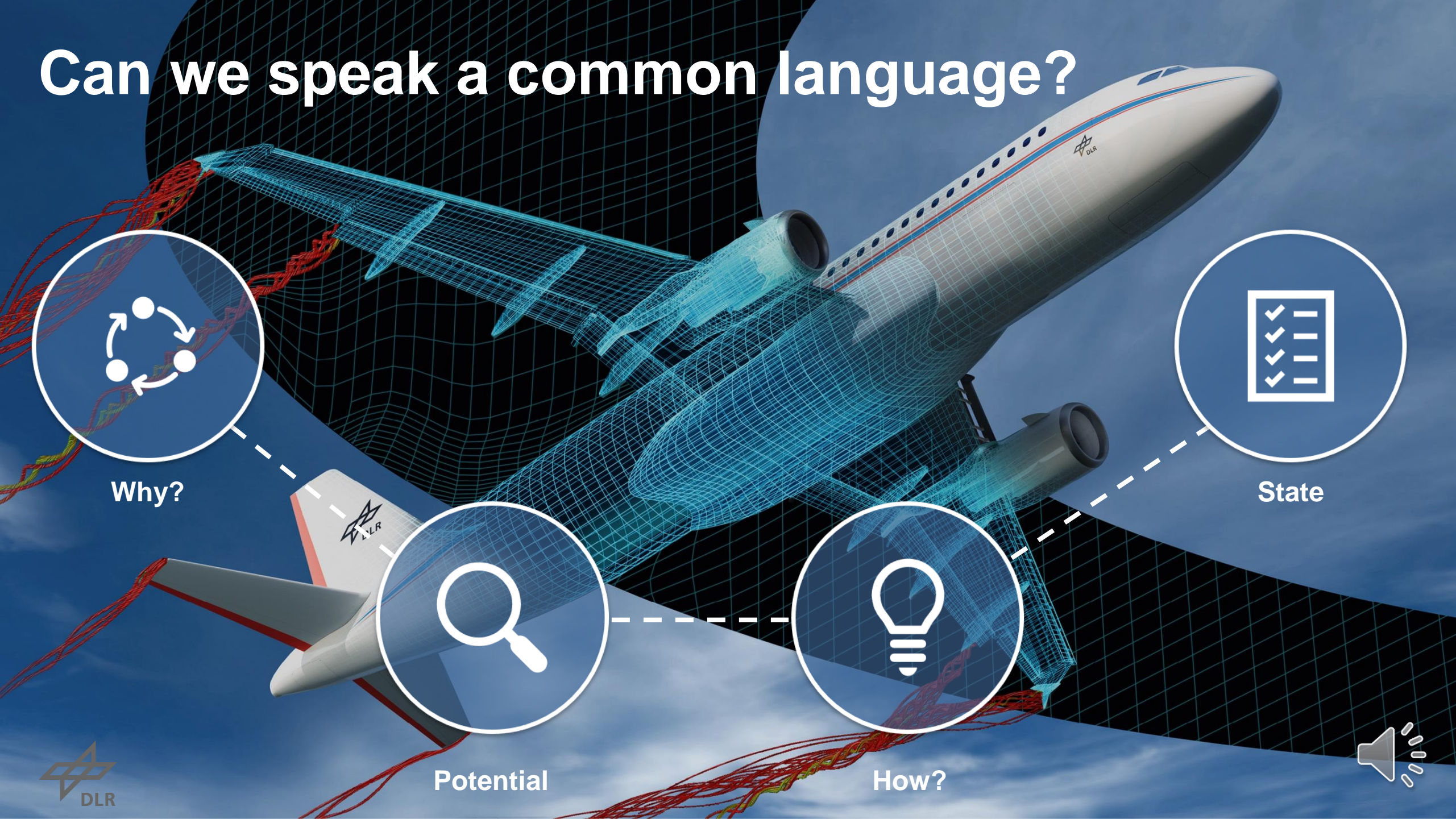




Can we speak a common language?



Can we speak a common language?



Why?



State



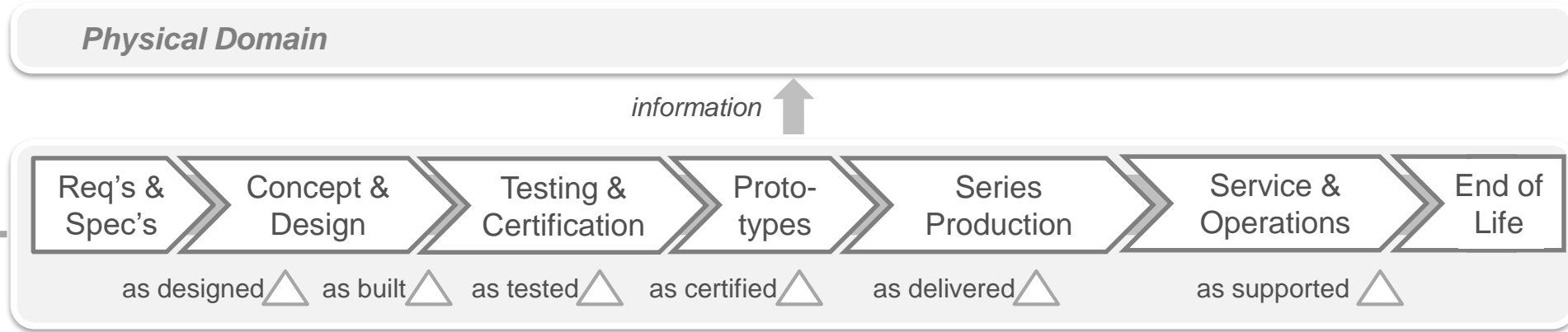
Potential



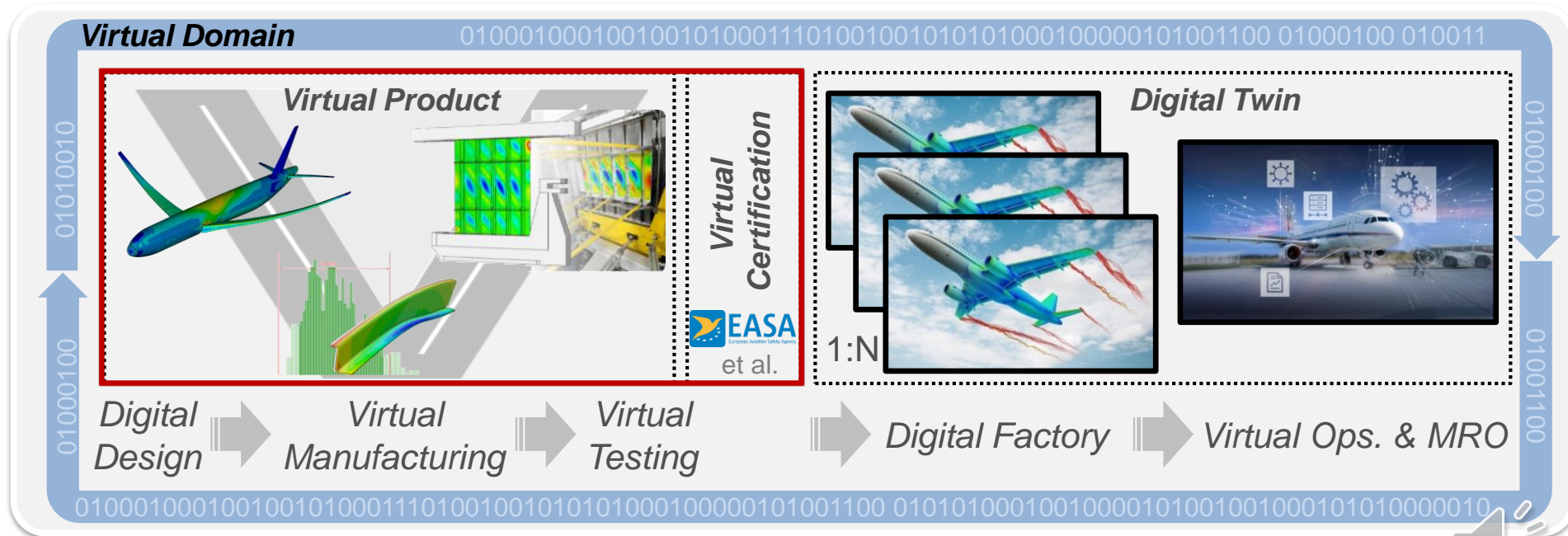
How?



Why?

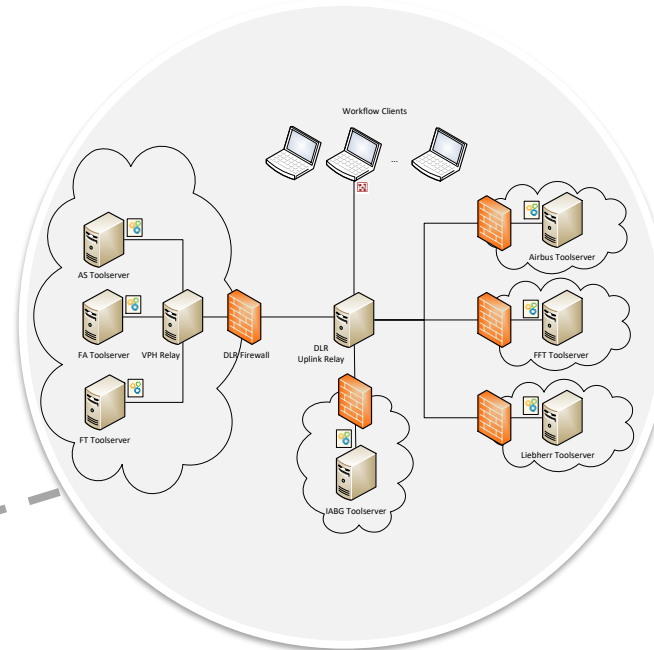
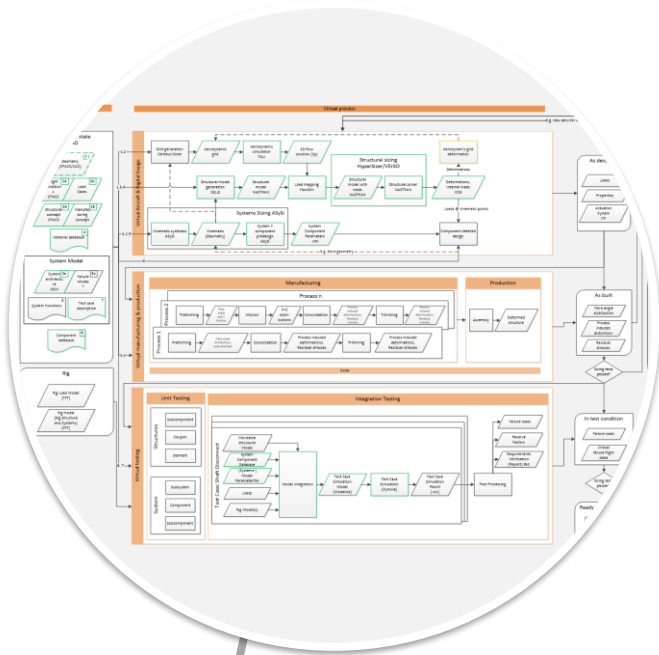


- Virtual product house (VPH) @ EcoMaT Bremen, Germany
- www.dlr.de/VPH
- Multidisciplinary
- Today: Focus on CSM

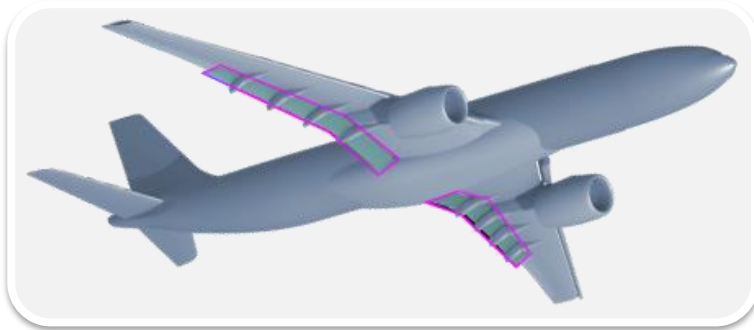


Why?

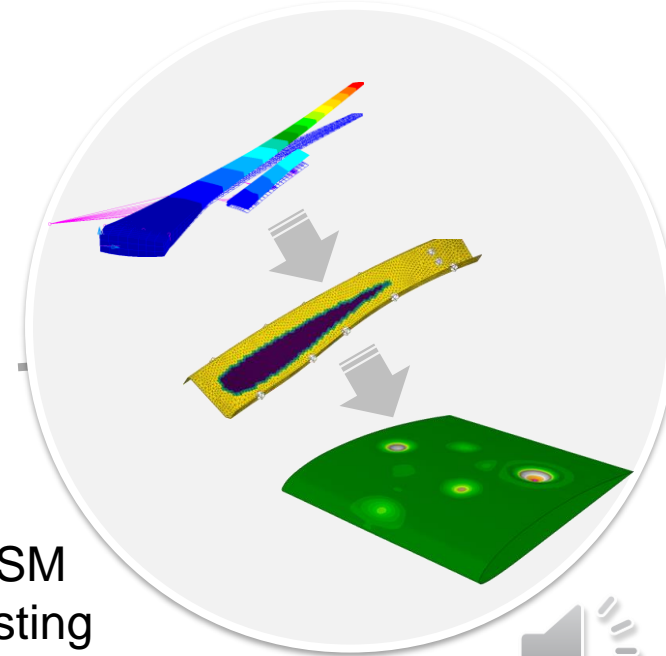
- V-process
- Aerodynamics, Software, Structures, Systems, Virtualization
- Industrial & research partners



- RCE workflow
- Common source architecture:
 - Black box tools & services
 - Interfaces important



Virtual product

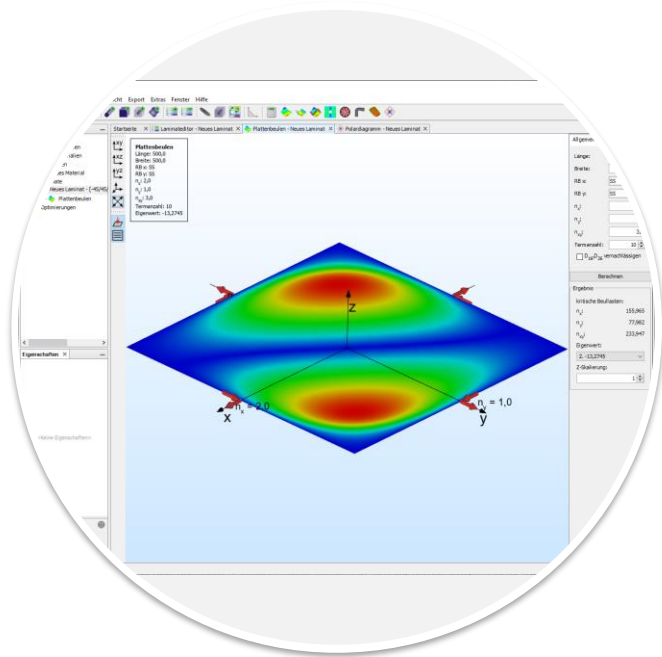


- Multitude of analytical & numerical methods for CSM sizing, manufacturing, testing

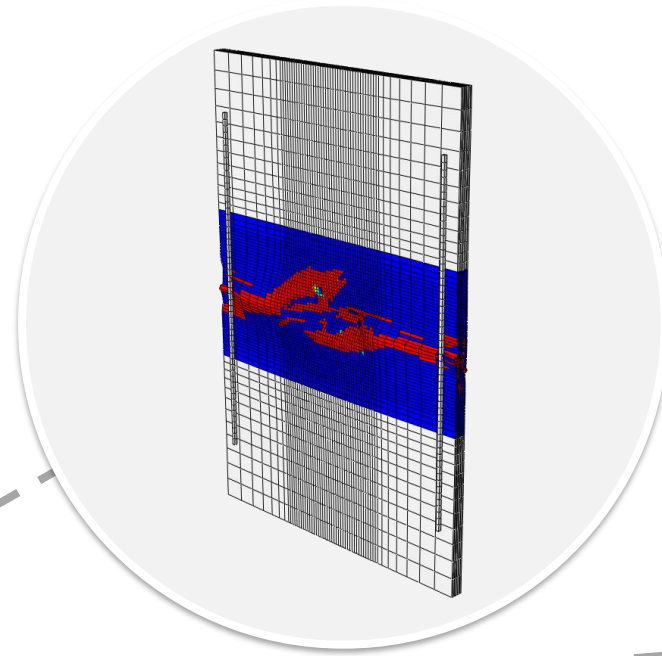


Potential

- Examples

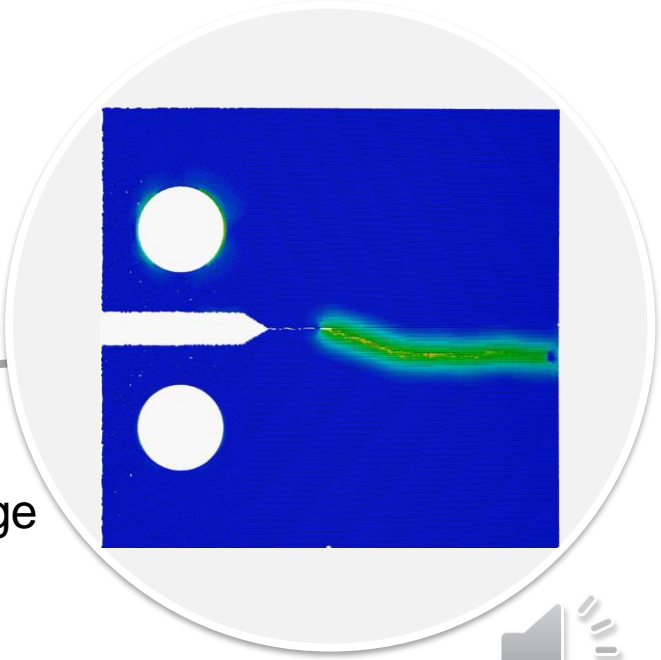


- Composite plate buckling
- CLT + Ritz-approach



- Residual strength
- CAI
- FEM + CZM

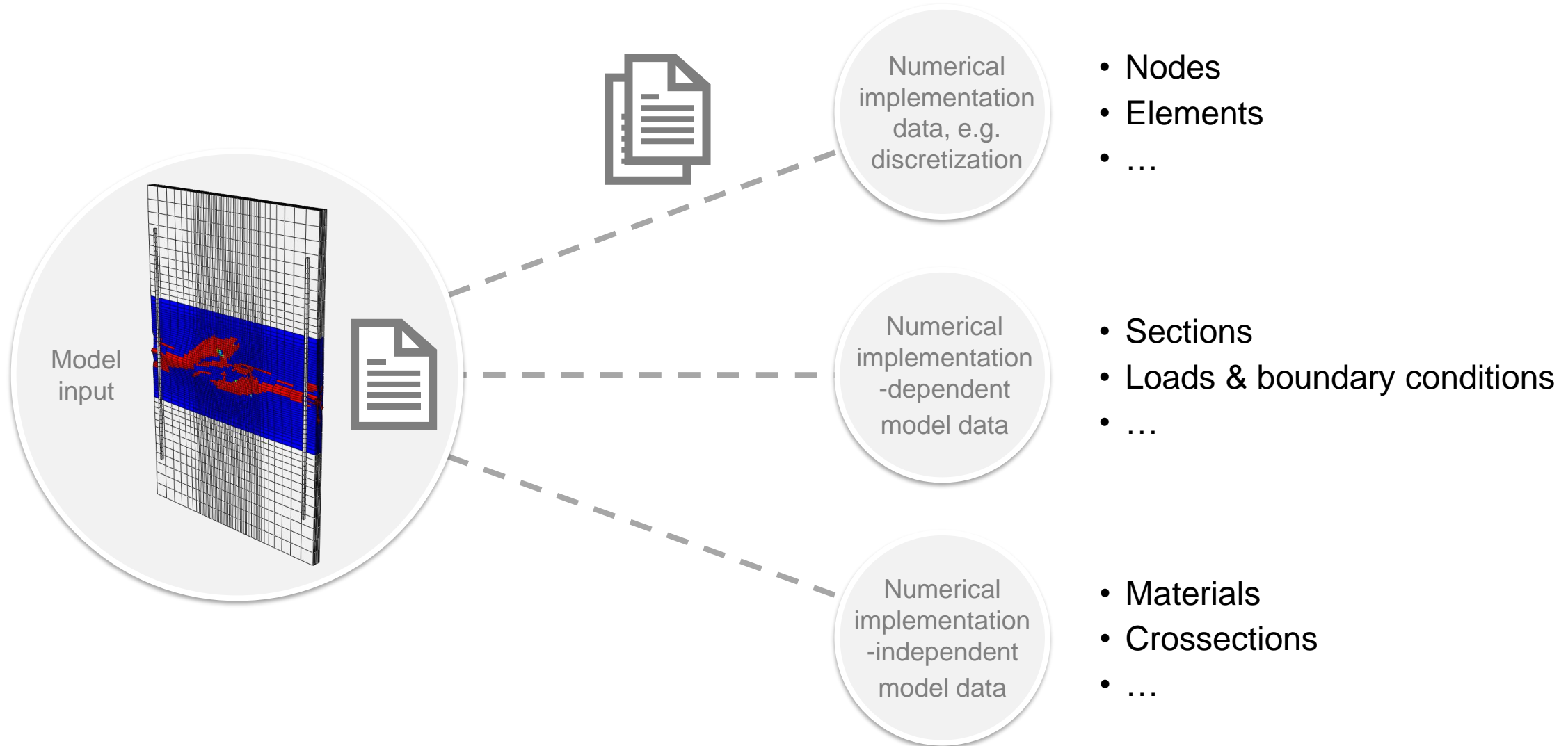
- Commonality: descriptions



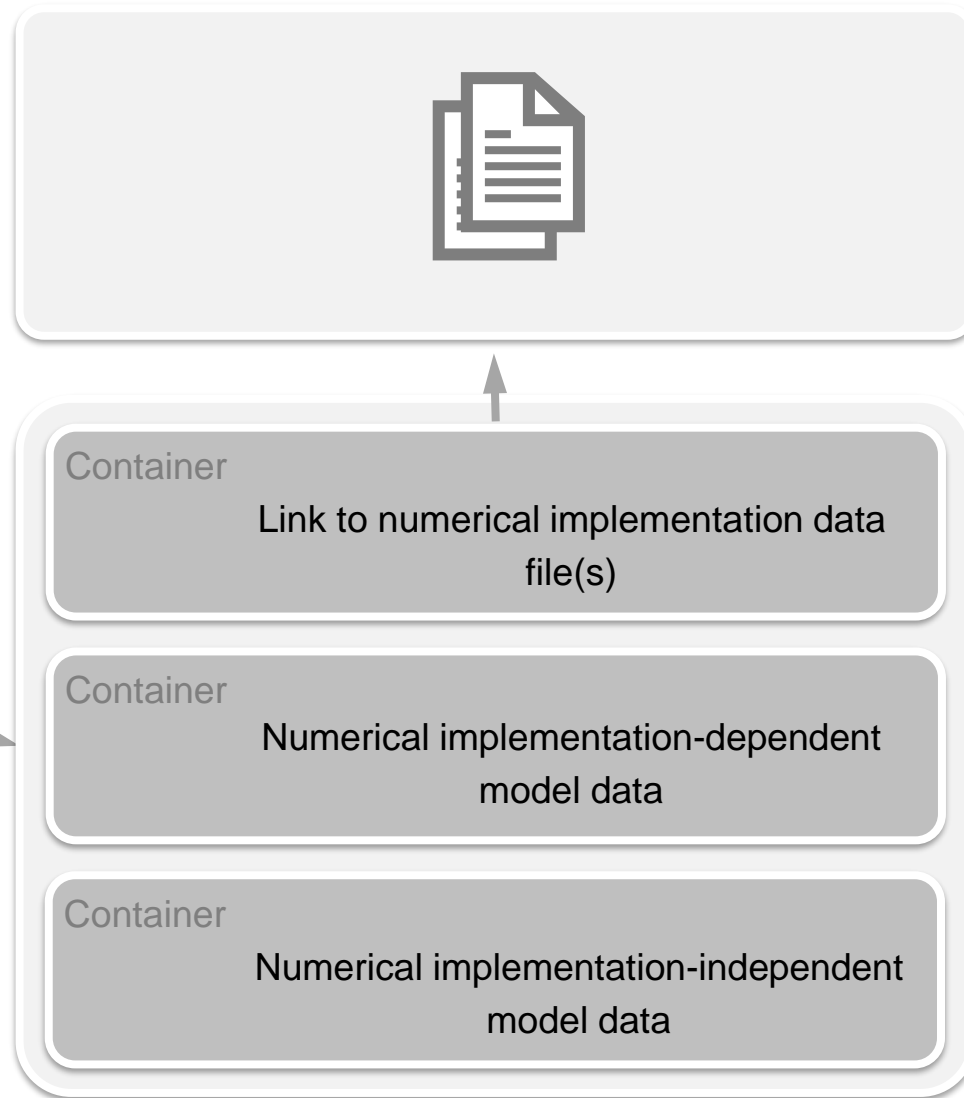
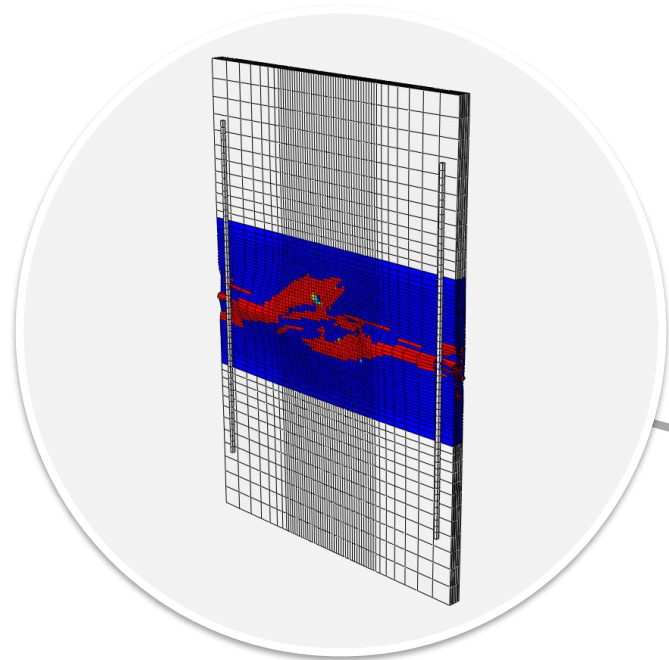
- Stochastic resin damage analysis
- [Peridynamics](#)



Potential



Potential



Heavy data

Light data



Potential

- Discretization formats

- Platform independent
- View
- Access
- Visualization
- Verification
- Customization

Requirements

- FEM:
 - Exodus
 - MOAB
 - Silo
 - VMAP**
 - XDMF**
- Particles:
 - H5Part
- CFD:
 - CGNS

Alternatives

XML Metadata:

```
<?xml version="1.0" encoding="utf-8" standalone="no"?>
<Xdmf xmlns:xi="http://www.w3.org/2001/XMLSchema" Version="3.0">
  <Domain>
    <Grid Name="Grid">
      <Geometry Origin="" Type="XYZ">
        <DataItem DataType="Float" Dimensions="100 3" Format="HDF" Precision="8">mesh.h5:Data0</DataItem>
      </Geometry>
    </Grid>
  </Domain>
</Xdmf>
```

HDFView 3.0 Data Table:

Data0 at / [mes...			
Table			
0-based			
	0	1	2
0	0.0	0.0	0.0
1	10.0	0.0	0.0
2	33.0	0.0	0.0
3	33.0	30.0	0.0

ParaView 5.6.0.00 Screenshot:

Left window: 3D visualization of a mesh on a wing-like geometry.

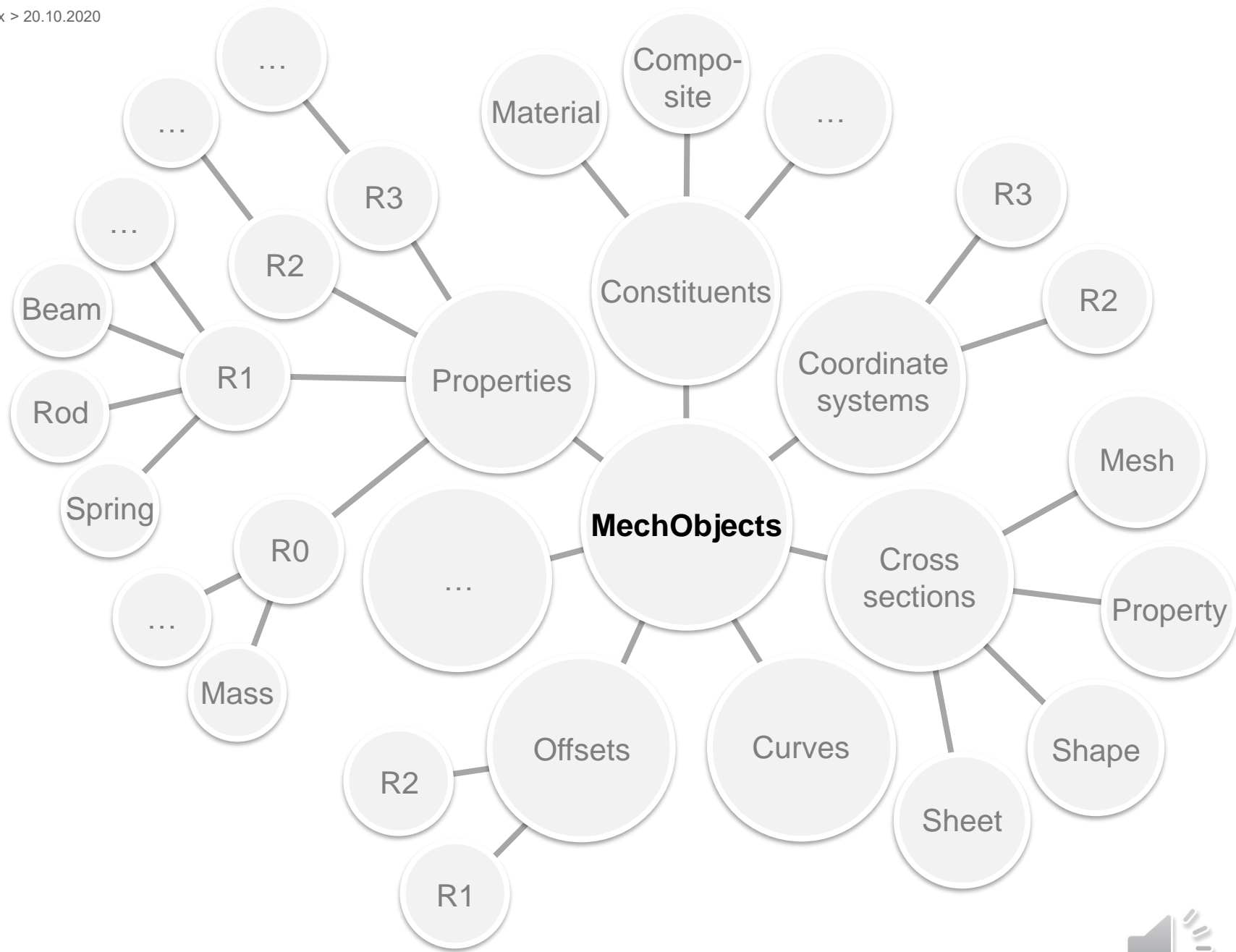
Right window: 2D visualization of a mesh grid on a similar geometry. Title: DB: mesh.xmlf Time:0. Axes: X, Y, Z.



Potential

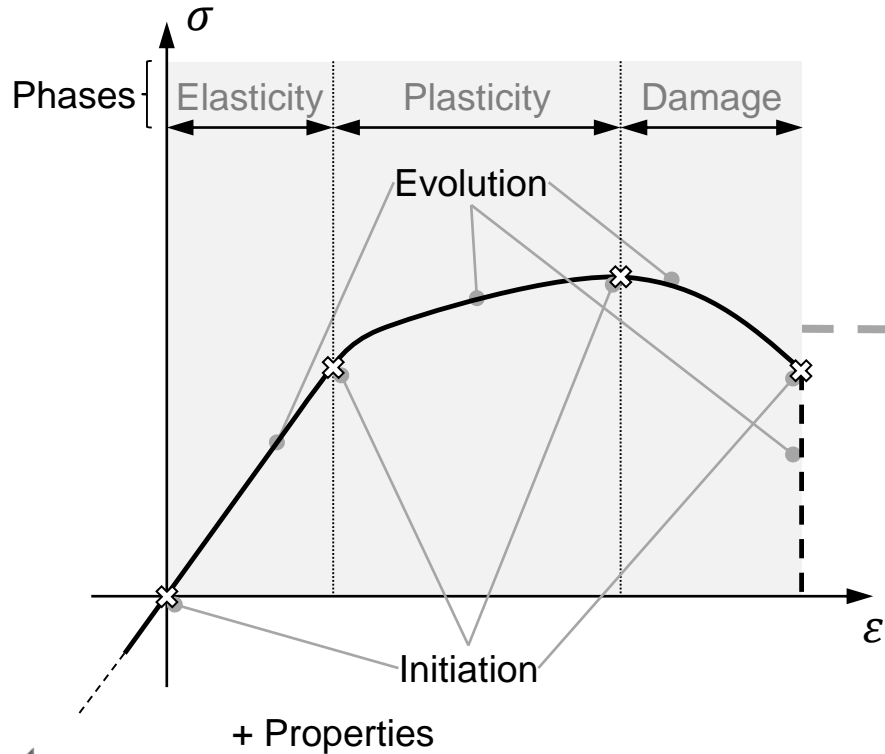
- Independent of numerical implementation
- Not independent of model assumptions
- Expandable ontology

- = Container syntax for communication with
 - Tools
 - Services
 - ...

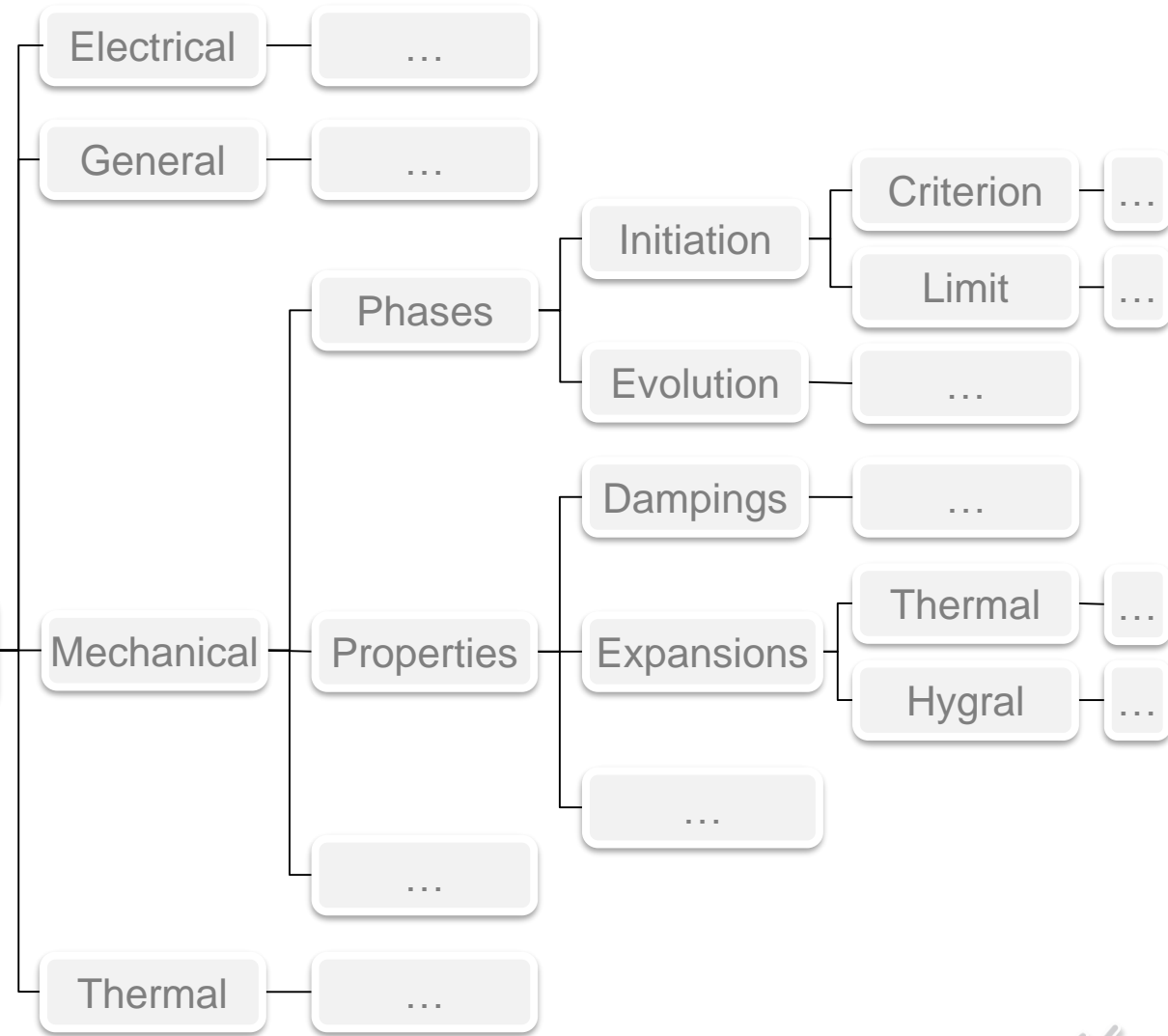


How?

- Expandable ontology example: Continuum material model definition
- Separation of property & model

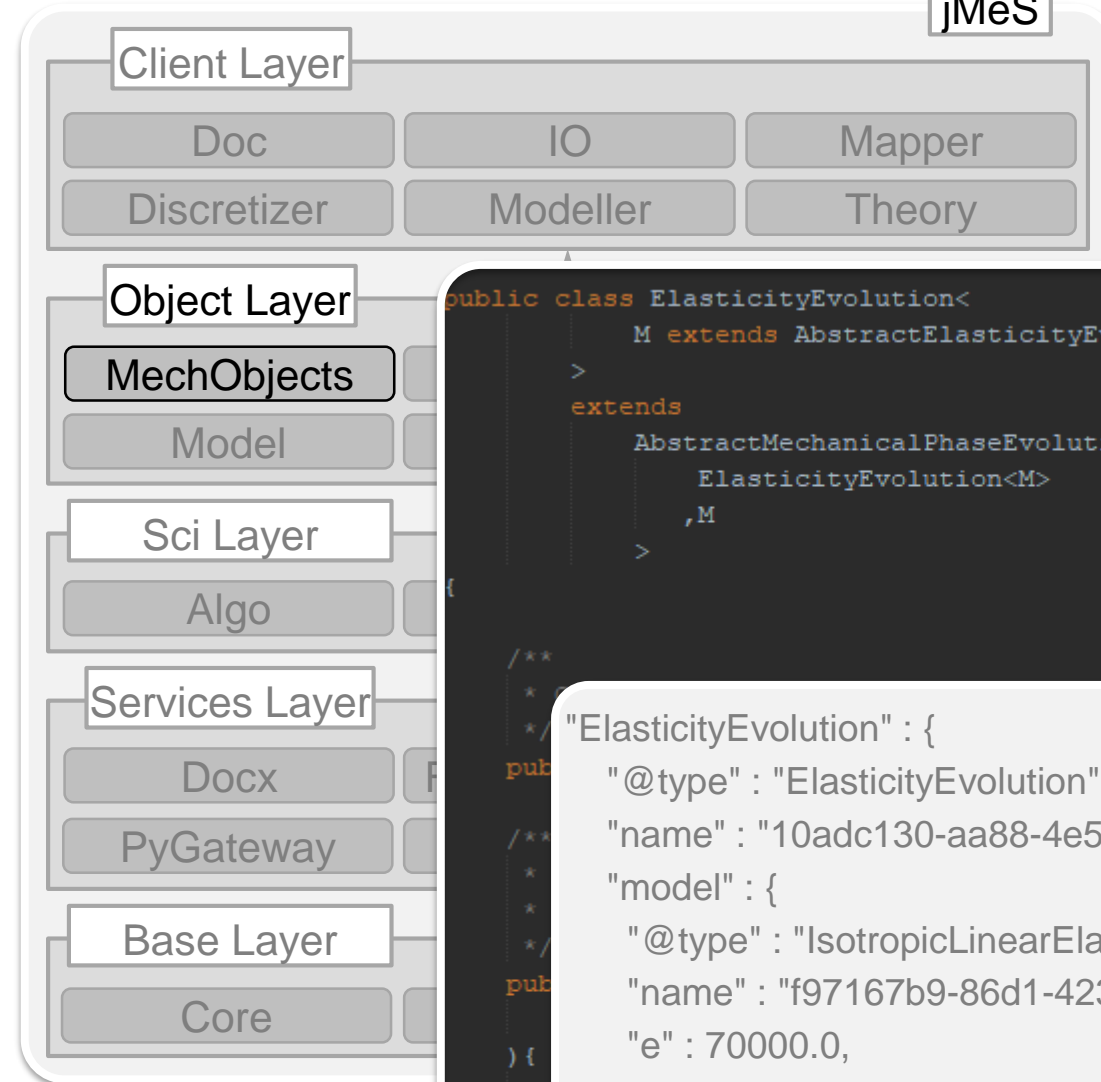


Material model



How?

- OOP implementation
 - Java
 - Py4J Python interface
- Ontology items = POJOs
- Σ POJOs \rightarrow Container data model
- Serialization container data model to
 - XML
 - JSON
- XML/JSON container data model
 - Object structure via deserialization
 - = Syntax for container

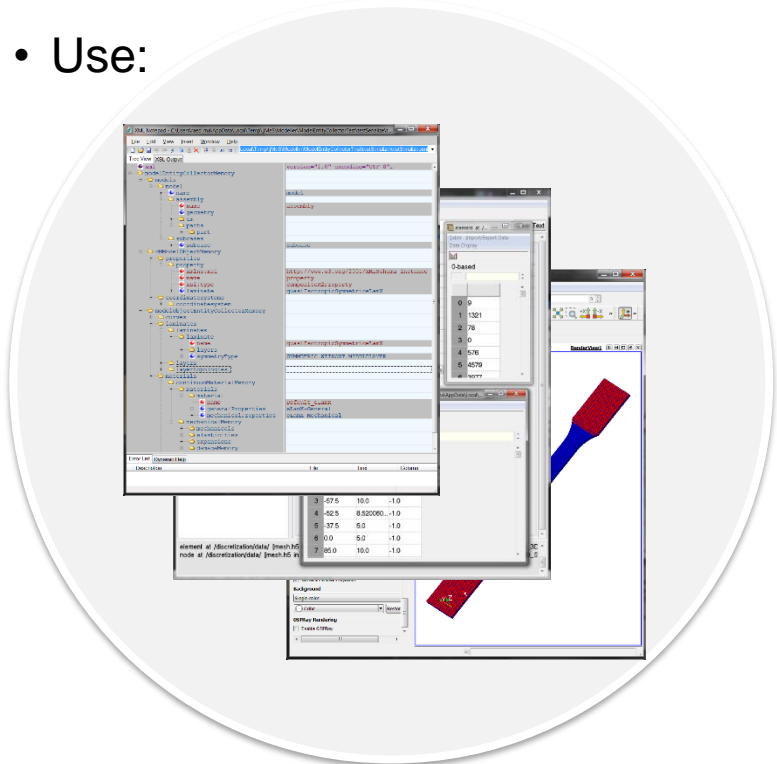


```

"ElasticityEvolution" : {
  "@type" : "ElasticityEvolution",
  "name" : "10adc130-aa88-4e54-8218-4fa8d371e0fc",
  "model" : {
    "@type" : "IsotropicLinearElasticityModel",
    "name" : "f97167b9-86d1-423f-81e8-718ffeb08b96",
    "e" : 70000.0,
    "nu" : 0.33
  }
}
  
```

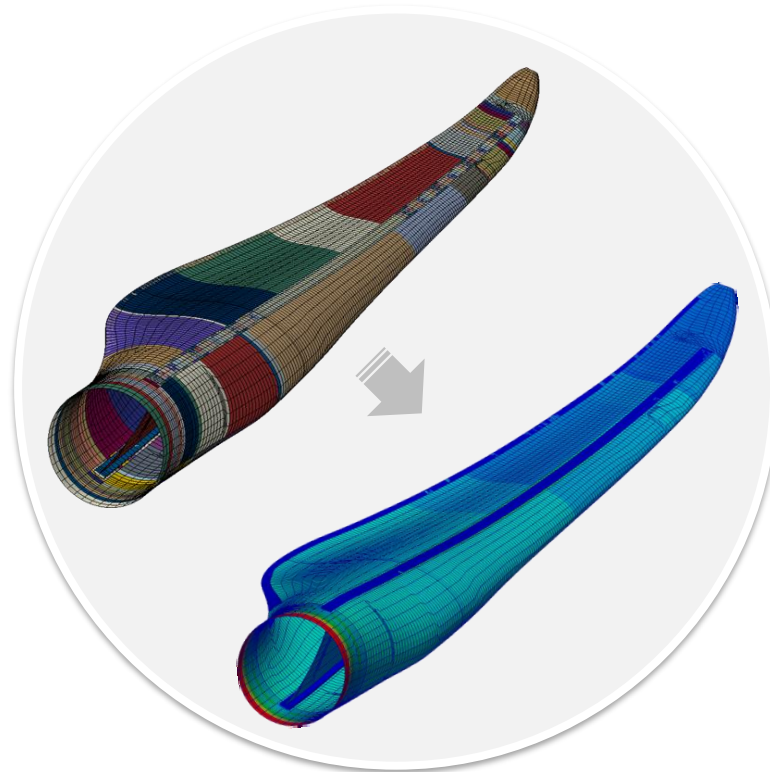
State

- Use:

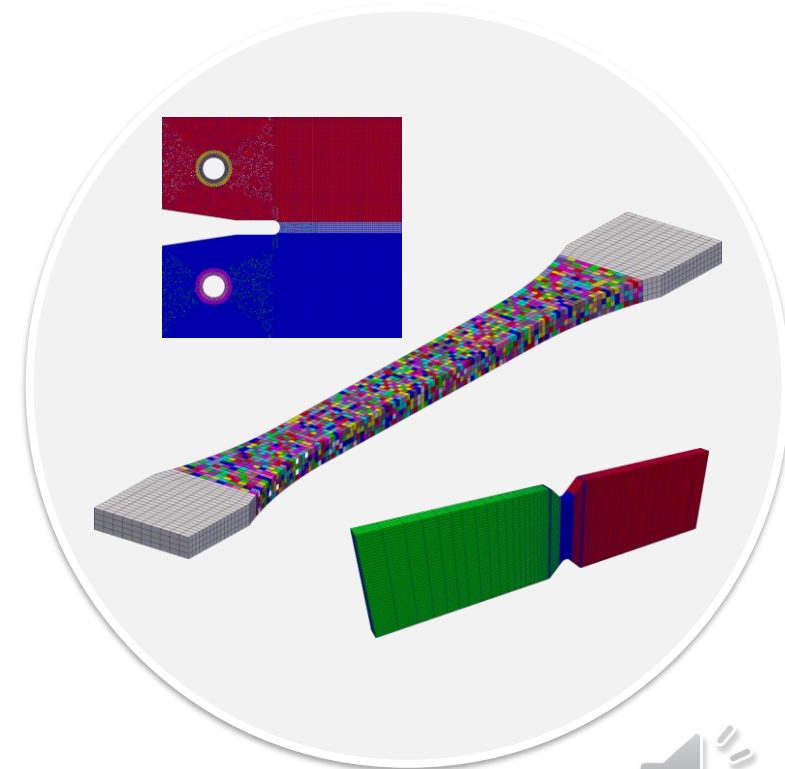


Model format
for tools & services,
MongoDB storage

Frontend tools,
e.g. format conversion



Parametric model
generation input



State

Result

- We can speak a common language
 - Format (Containers)
 - Syntax (Data models)
- Facilitates communication
- Common format = Prerequisite for efficient further developments

We would like to

- Benchmark our approach for the VMAP project application cases
- Collaborate

We remark

- Strong believe in separation of
 - “light data”
 - “heavy data”
- Discussion expansion of VMAP to support the XDMF standard for “free” visualization

We will

- Prepare for public domain release
- Implement VMAP as description for FE-data
- Plan integration into DLR FE solver framework





Thank you for your attention!

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