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Integrated Aircraft Design

Network

<http://ewade2013.AircraftDesign.org>

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FluMeS

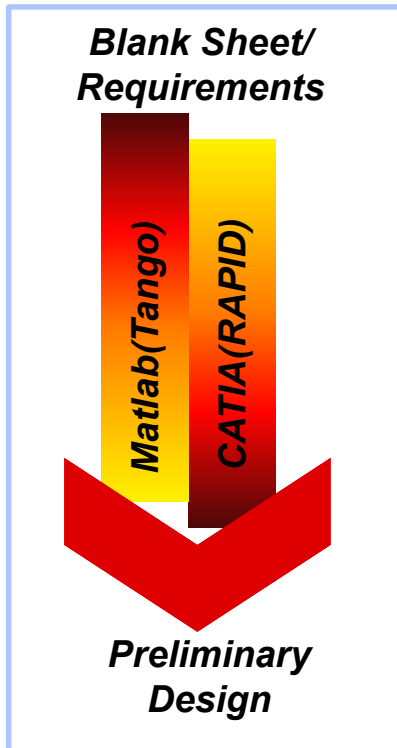
Fluid and Mechatronic Systems



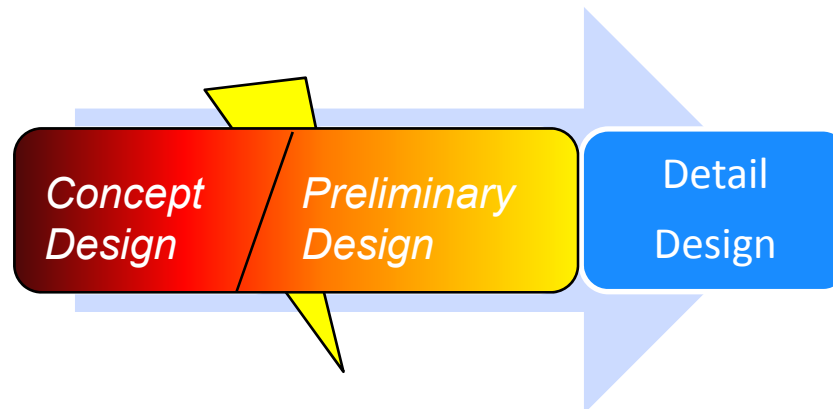
Agenda

- Aim
- Multidisciplinary Framework
- Aircraft Geometry Data Description
- Data Management
- XML Integration
 - RAPID XML
 - Tango XML
- Framework approach
- Implementation/Applications
- Conclusion
- Future Work

Aim



- XML based multidisciplinary tool integration in a conceptual aircraft design framework.
- ~~“One-tool”~~ or a “One-database” approach
- Design Automation for fast realization of the concept
- To support **Conceptual to Preliminary Aircraft Design**



Introduction

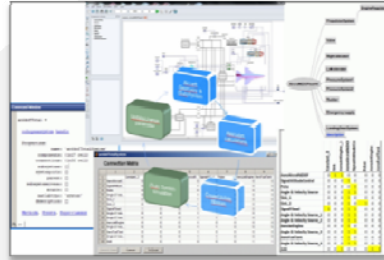
-Multidisciplinary Aircraft Conceptual Design Framework

- **Tango** - Data handling and tool integration, a/c sizing, mission calculation, aerodyn. calculations (e.g. Tornado), a/c systems definition
- **RAPID** - Sizing, Geometry definition, Structure definition, Geometry for Aerodynamic and Structural analysis
- **Hopsan** - Performance, Stability and Control, Fault Analysis
- **Dymola** - Systems architecture, power analysis, Verification

Hopsan

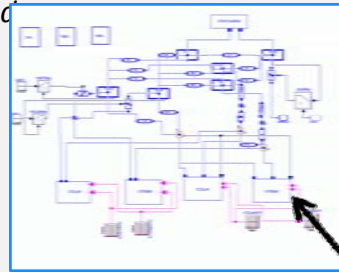
Total System Simulation (mission)

- **On-board power Systems / Subsystem simulation:** Hydraulic (Flight Control System) Fuel System, Electric System, etc.
- **Outcomes:** Performance, Stability and Control, Fault Analysis



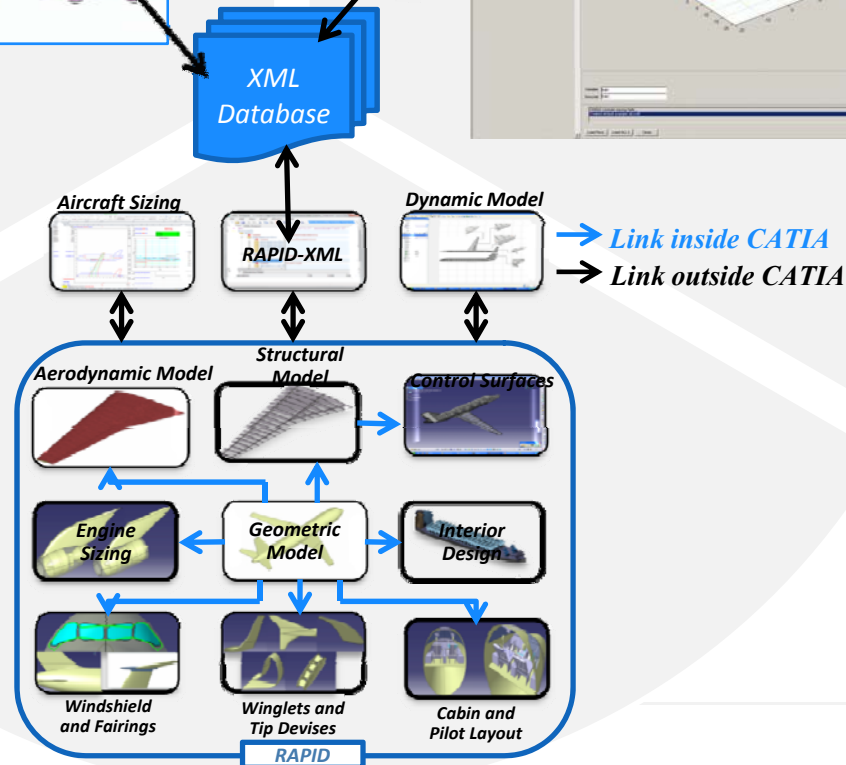
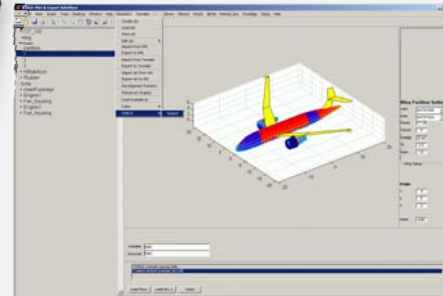
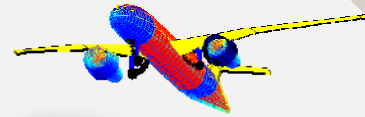
Dymola / Modelica usage of ModelicaXML

- **System Simulation:** ECS (Cooling, pressurization and Ventilation Systems) Thermal Management System
- **Outcomes:** Systems architecture / control modes, power analysis Verification



Tango (Matlab)

- aircraft designer & configurator
- aircraft sizing & design benchmark
- system integration
- knowledge based system design generation (simulation model export)



Input Tables

Tango

- A conceptual a/c design tool

Parametric a/c configurator including

- frameworks main GUI, data handling and tool integration
- Main topics:
 - a/c sizing
- a/c layout builder, including:
 - engine models
 - landing gear, control surfaces, control modes, etc...
- mission calculation
- aerodyn. calculations (e.g. Tornado)
- a/c systems definiton

addata Aircraft Geometry Setup

Wing Geometry Setting

Wing	Partion	Span	Taper...	Sweep	Rootch...	Chord2	Dihedral	Twist	Airfoil1	Airfoil2	Mirrored
1 main	1	10	0.5000	0.5000	5	2.5000	0.3000	-0.2000	N23018.DAT	N23018.DAT	<input checked="" type="checkbox"/>
	2	10	0.5000	0.7000	2.5000	1.2500	0.3000	0	N23018.DAT	N23018.DAT	<input checked="" type="checkbox"/>
	3	1	1	0	1.2500	1.2500	0	0	N23019.DAT	N23019.DAT	<input checked="" type="checkbox"/>
2 Stabilizer	1	5	0.8000	0.6000	3	1.8000	0	0	N23018.DAT	N23018.DAT	<input checked="" type="checkbox"/>
3 Flusider	1	5	0.4000	0.7000	5.5000	2.2000	0	0	N23018.DAT	N23018.DAT	<input type="checkbox"/>

Body Geometry Setting

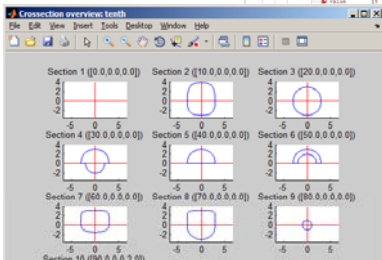
BodyName	Partion	Form	length	radius1	radius2	radius3	radiusZ
1 mainFuselage	1	NCPSE	8.4300	1	1	1	1.0750
	2	ELLIPSE	17.7300	1.9750	2.0950	1.9750	2.0950
	3	ELLIPSE	4.2700	1.9750	2.0950	1.9750	1.6700
	4	ELLIPSE	9.4200	1.9750	2.0950	1.9750	0.3352
2 Engine1	1	ELLIPSE	1	1	1	1.2000	1.2000

GUI

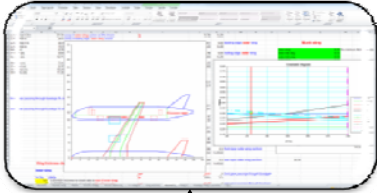
Documentation

XML File

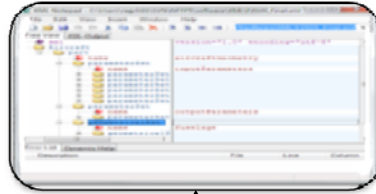
Fuselage Crosssections



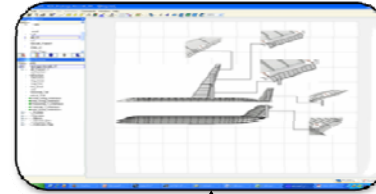
Aircraft Sizing



XML Database



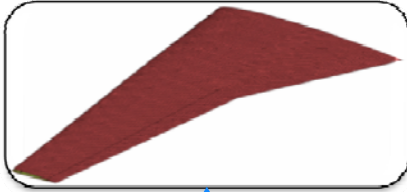
Dynamic Model



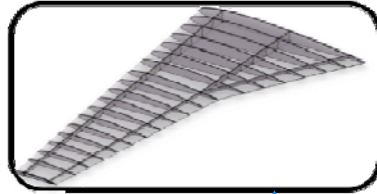
→ *Link inside CATIA*

→ *Link outside CATIA*

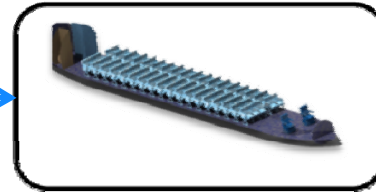
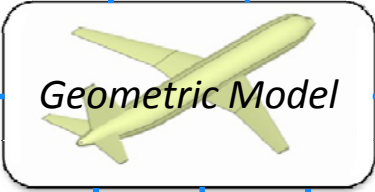
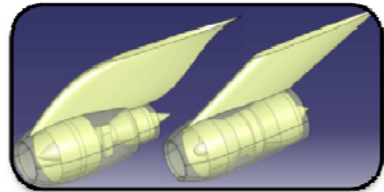
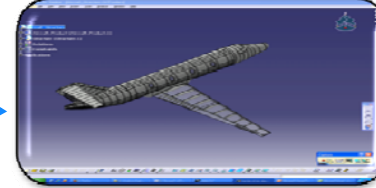
Aerodynamic Model



Structural Model

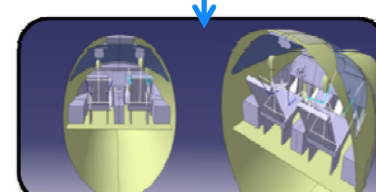
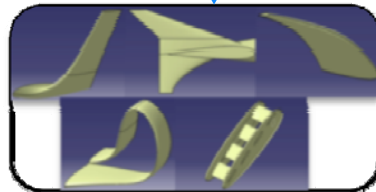
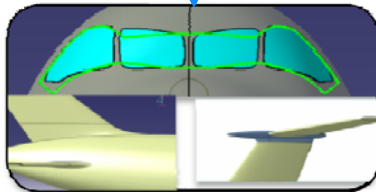


Control Surfaces



Engine Sizing

Interior Design



Windshield and Fairings

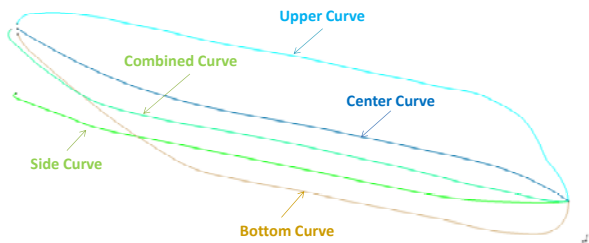
Winglets and Tip Devices

Cabin and Pilot Layout

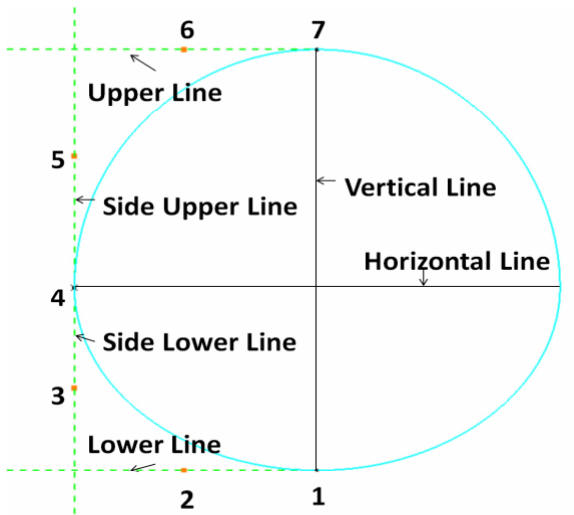
RAPID

Aircraft Geometry Data Description

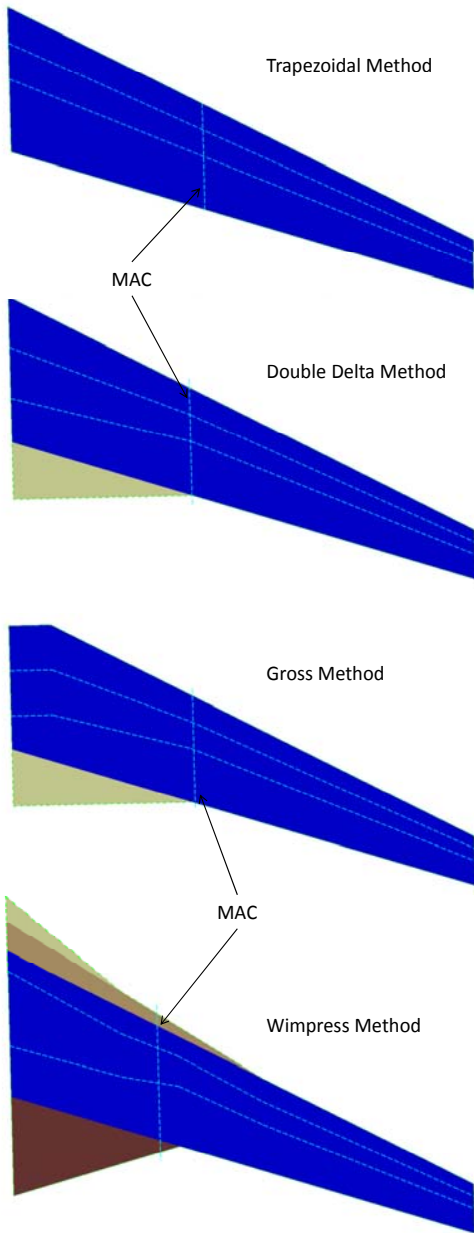
-Fuselage geometry description



- Four Splines to create the foundation for the Fuselage
- Two 3rd order Bezier curves

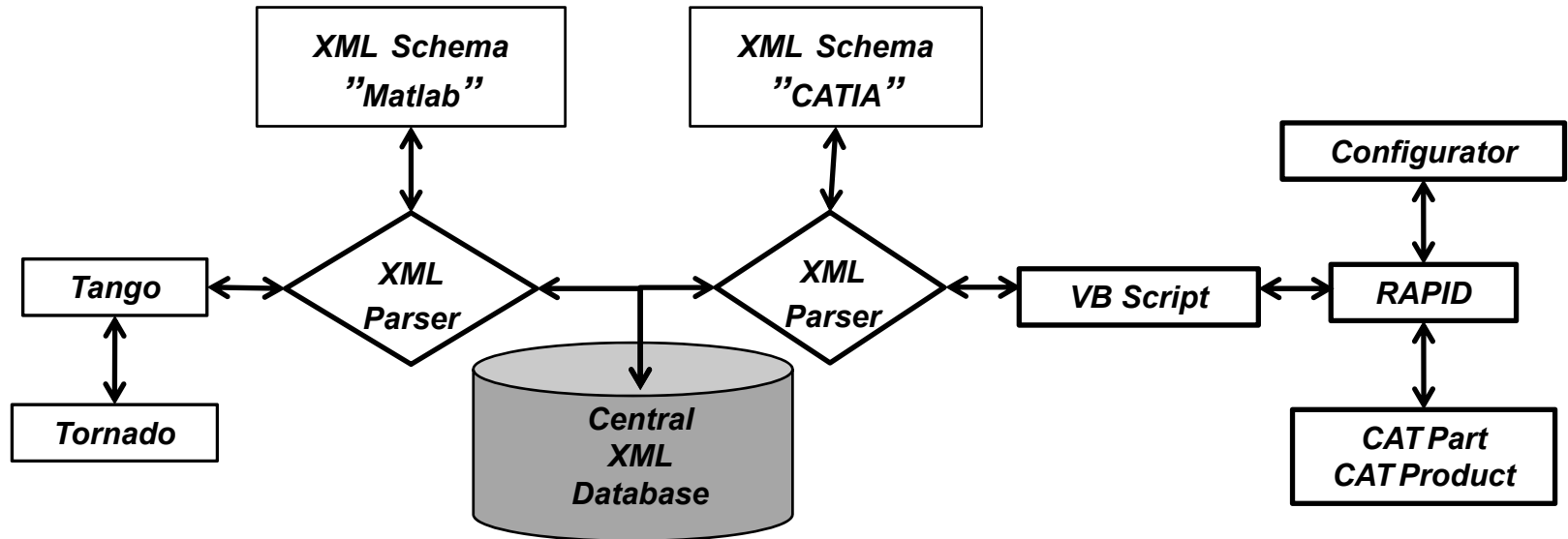


Aircraft Geometry Data Description - Wing Description



- Trapezoidal Method
- Double delta Method
- Gross Method
- Wimpress Method

Data Management



Directory
Z:\SVN\software\XML\
Open File
Ctrl
Save File
acRAPIDRoundTrip

Product	Sub Product	Part Name	Array	Arraylist
RAPID	geometry	reference\inputParameters\	part_parameterSet_parameter	referenceList
		fuselage\inputParameters\	part_parameterSet_parameter	fuselageList
		fuselage\fuselageGeometry\	part_geometricalSet_parameterSet_parameter	fuselageList
		wing\inputParameters\	part_geometricalSet_parameterSet_parameter	wingList
		wing\outputParameters\	part_geometricalSet_parameterSet_parameter	wingList
		wing\wingGeometry\	part_geometricalSet_parameterSet_parameter	wingList
		horizontalTail\inputParameters\	part_parameterSet_parameter	horizontalTailList
		horizontalTail\geometry\	part_geometricalSet_parameterSet_parameter	horizontalTailList
		verticalTail\inputParameters\	part_parameterSet_parameter	verticalTailList
		verticalTail\geometry\	part_geometricalSet_parameterSet_parameter	verticalTailList
		canard\inputParameters\	part_parameterSet_parameter	canardList
		canard\geometry\	part_geometricalSet_parameterSet_parameter	canardList
		propulsion\inputParameters\	part_parameterSet_parameter	propulsionList
		propulsion\engineGeometry\	part_geometricalSet_parameterSet_parameter	propulsionList
Product	Sub Product	Part Name	Array	Arraylist

XML Integration

- RAPID XML Export

- Configuration of Parameter and Geometric sets through Excel

Example: “fuselage\inputParameters\” & “fuselage\instantiatedGeometry\”

- Value Parsing
- Writing into XML using DOM Object
- Spline from CATIA to XML

Example: “fuselage\exchangeTest”

- Finally the XML DOM object is written to XML

XML Integration

- *RAPID XML Import*

- Parsing the XML using DOM object
- Recursive Function to get child nodes
- Constructing the Parameter Strings to be updated
- Spline from XML to CATIA
- Updating CATIA

RAPID - Robust Aircraft Parametric Interactive Design

Read XML to RAPID

Create XML from RAPID

Directory Z:\SVN\software\XML\
Open File
Cancel
Save File
actRAPIDRoundTrip

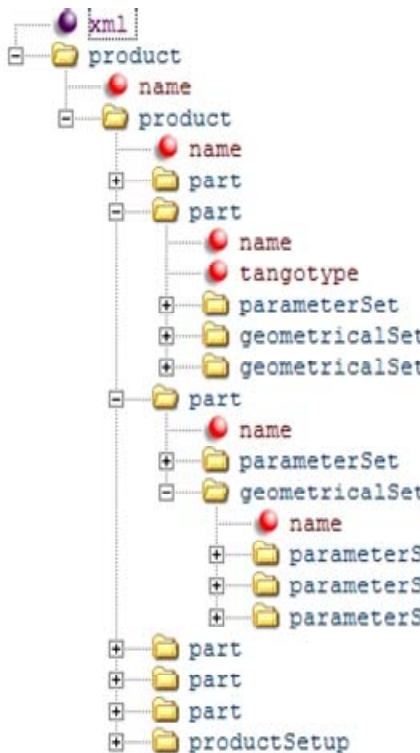
Product	Sub-Product	Part Name	Array	ArrayList
RAPID	geometry	reference(inputParameters)	part_parameterSet.parameter	referenceList
		fuselage(inputParameters)	part_parameterSet.parameter	fuselageList
		fuselage(fuselageGeometry)	part_geometricalSet.parameterSet.parameter	fuselageList
		wing(inputParameters)	part_geometricalSet.parameterSet.parameter	wingList
		wing(outputParameters)	part_geometricalSet.parameterSet.parameter	wingList
		wing(wingGeometry)	part_geometricalSet.parameterSet.parameter	wingList
		horizontalTail(inputParameters)	part_parameterSet.parameter	horizontalTailList
		horizontalTail(geometry)	part_geometricalSet.parameterSet.parameter	horizontalTailList
		verticalTail(inputParameters)	part_parameterSet.parameter	verticalTailList
		verticalTail(geometry)	part_geometricalSet.parameterSet.parameter	verticalTailList
		canard(inputParameters)	part_parameterSet.parameter	canardList
		canard(geometry)	part_geometricalSet.parameterSet.parameter	canardList
		propulsion(inputParameters)	part_parameterSet.parameter	propulsionList
		propulsion(engineGeometry)	part_geometricalSet.parameterSet.parameter	propulsionList

Product	Sub-Product	Part Name	Array	ArrayList
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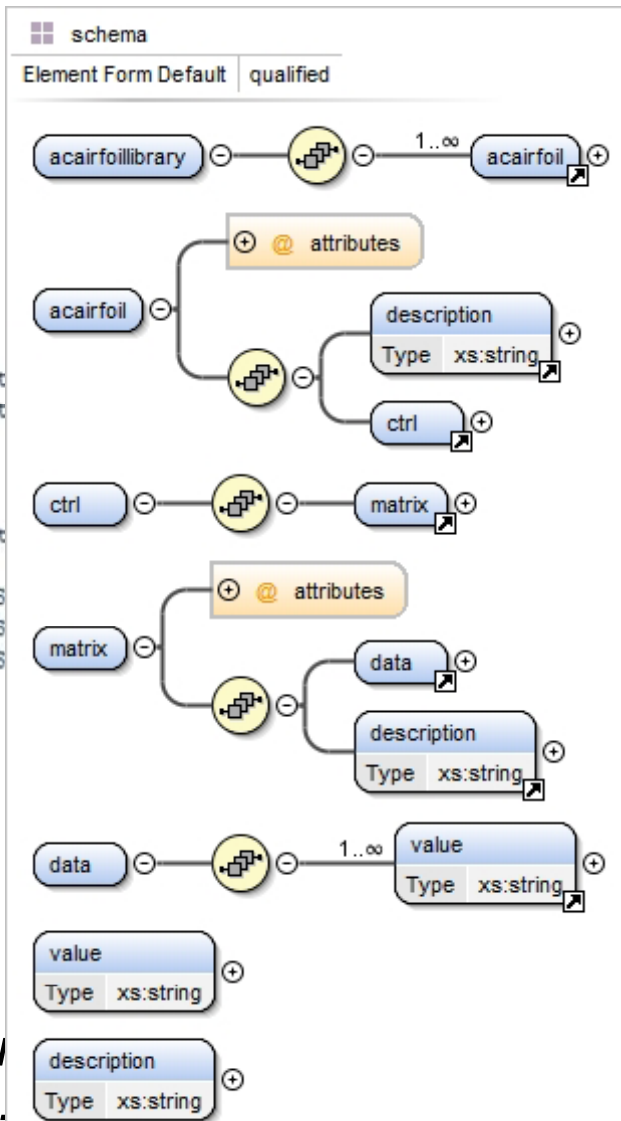
XML Integration

- *Tango XML*

- Tango makes usage of the underlying Java DOM application classes in Matlab that serves for the XML data handling.
- Class-related XML parsing functionalities allows for greater flexibility and fast replacement or appending of new classes.
- The basic classes are product–geometry related arranged (e.g., wing and underlying wing partition class)
- Higher level classes are product-functional (system) related (e.g., fuel system, primary flight control system).



Data Structure
Left Side:



XML Schema

ie

```

UID
mirrored
name
nr
partitionNrs
xyplane
description
origin
acwingpartition
acwingpartition

```

```

version="1.0"...
file generated from
Creation date:...
Do not change/edit/!

```

```

735483.57143936341
aircraftRAPID
acdata

```

```

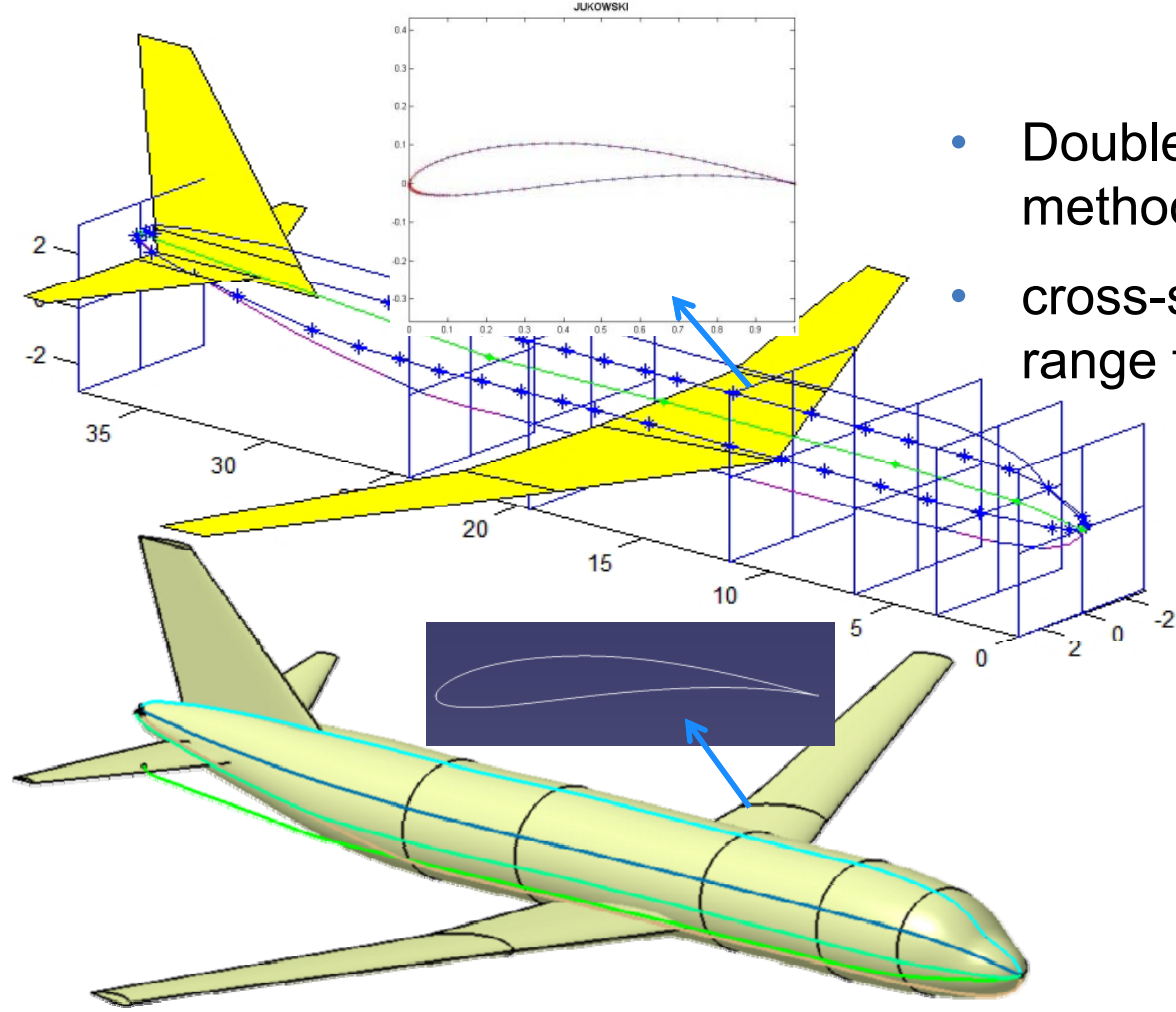
735483.57146016206

```

tools needs
Tango XML

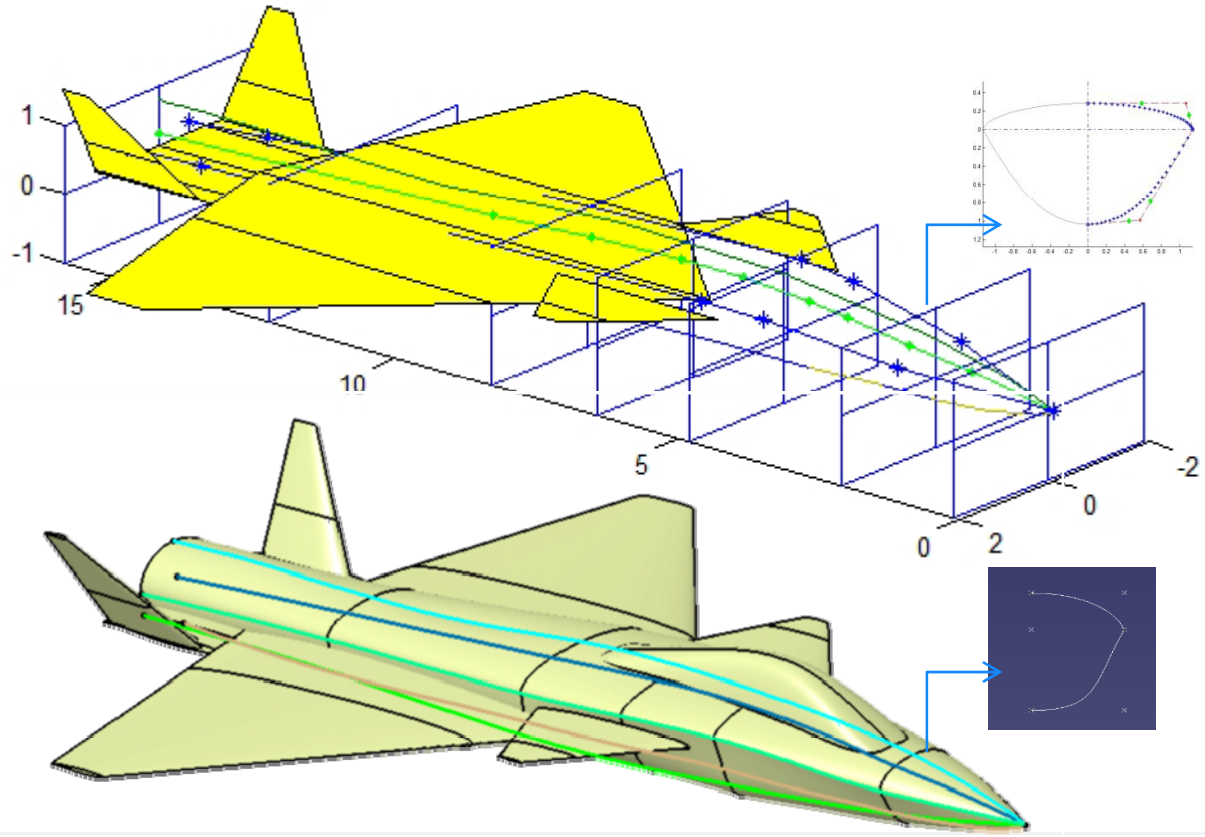
Application Example 1

- Double delta reference method
- cross-sections of the fuselage range from a circle to ellipse



Application Example 2

- Same data Structure as E.g.1
- Canard is added



Conclusions

- Multidisciplinary conceptual aircraft design analysis based on a central parametric XML database.
- This database -containing all project related data- is intended to grow simultaneously with the refined specification of the airplane
- The unified geometry makes meshing easier and serves for no aperture for high fidelity CFD

THANK YOU

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