Tetrahedral Unstructured Grids
for Drag Prediction on DLR-F4 Configuration

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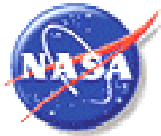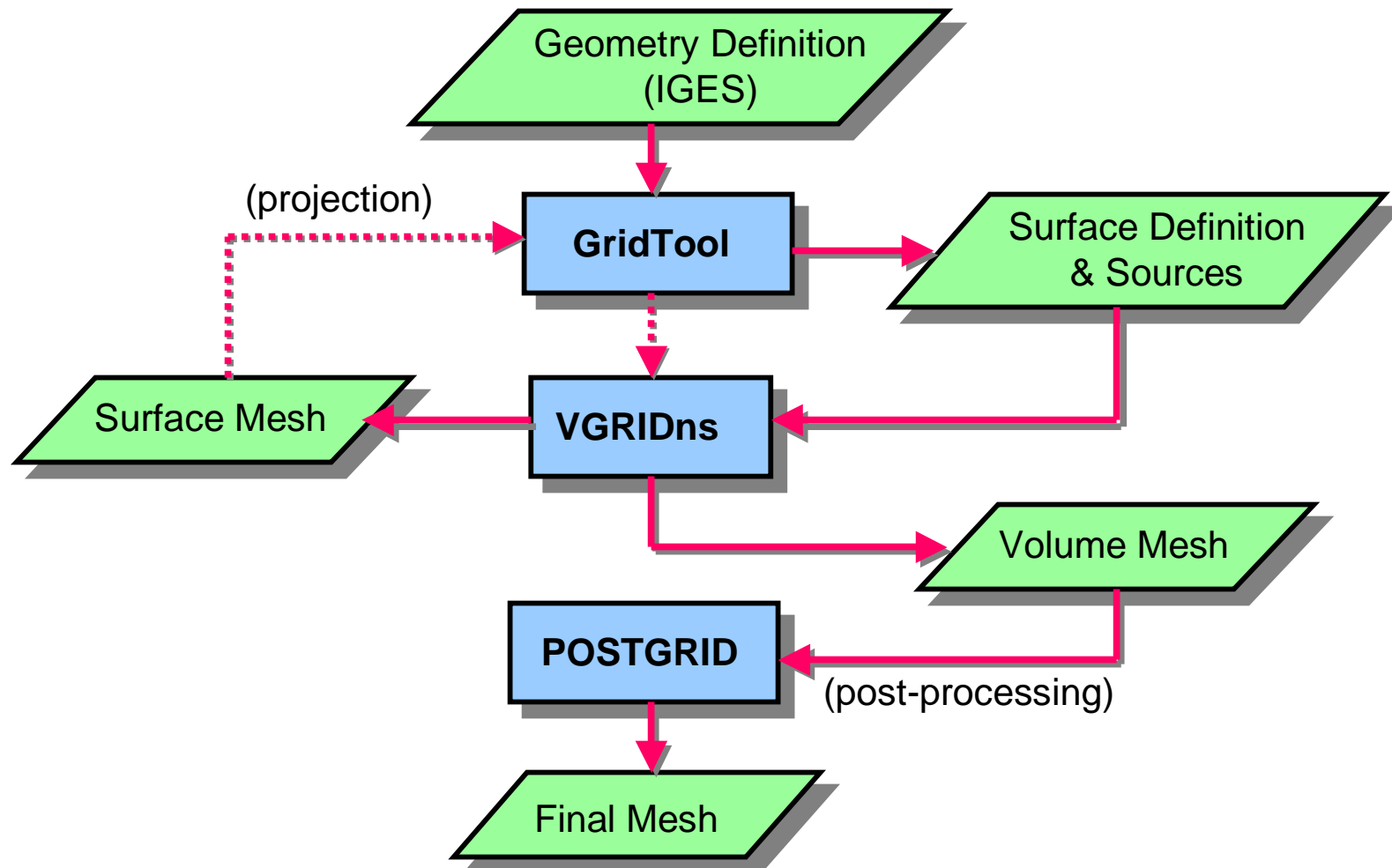
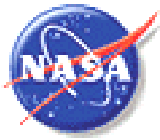# Grid Generation System VGRIDns

- Developed at the NASA LaRC

- Generates triangular surface and tetrahedral volume grids

- Based on marching techniques:

  ○ advancing-front method (AFM) for "Euler" grids   (Löhner,   1988)
  ○ advancing-layers method (ALM) for "viscous" grids   (Pirzadeh, 1993)

- Salient features:

  ○ smooth grids by means of sources and solving elliptic PDE
  ○ thin-layer "viscous" grids
  ○ anisotropic grid stretching

  ○ restart capability
  ○ local remeshing } grid post-processing and adaptive refinement

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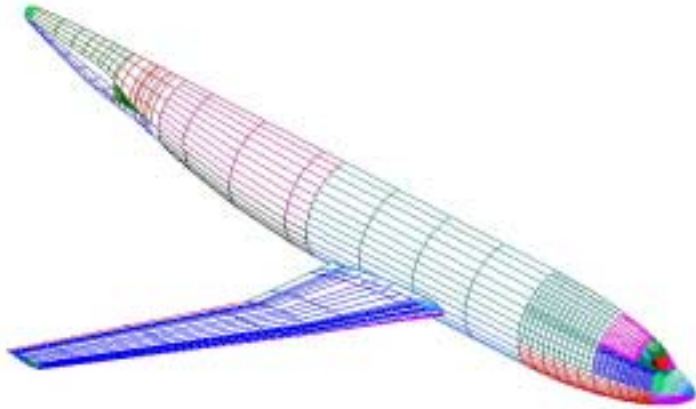
VGRIDns System

Geometry Definition
(IGES)

(projection)

GridTool → Surface Definition & Sources

Surface Mesh ← **VGRIDns** ←

VGRIDns → Volume Mesh

POSTGRID ← (post-processing)
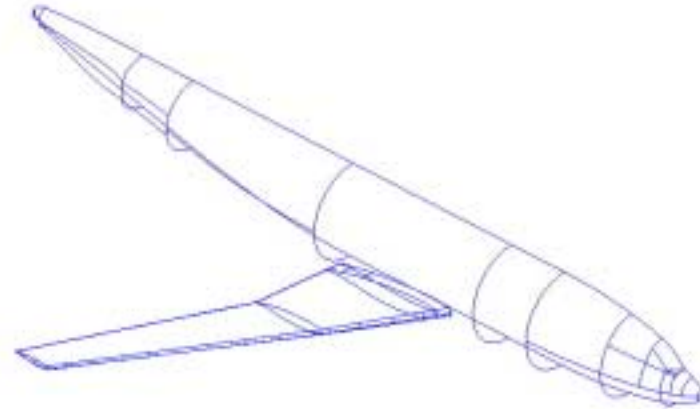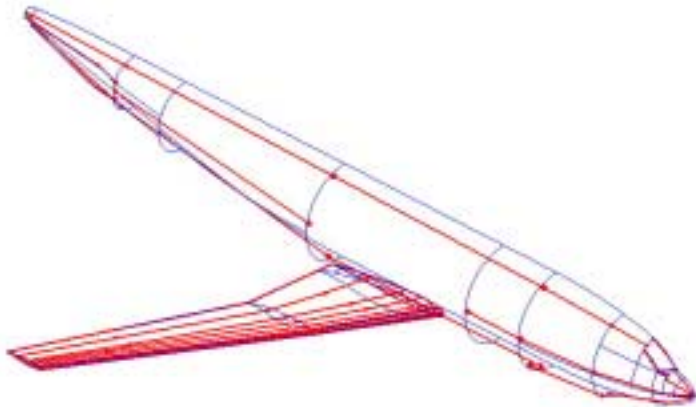
Final Mesh

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Grid Generation Process with VGRIDns on DLR-F4

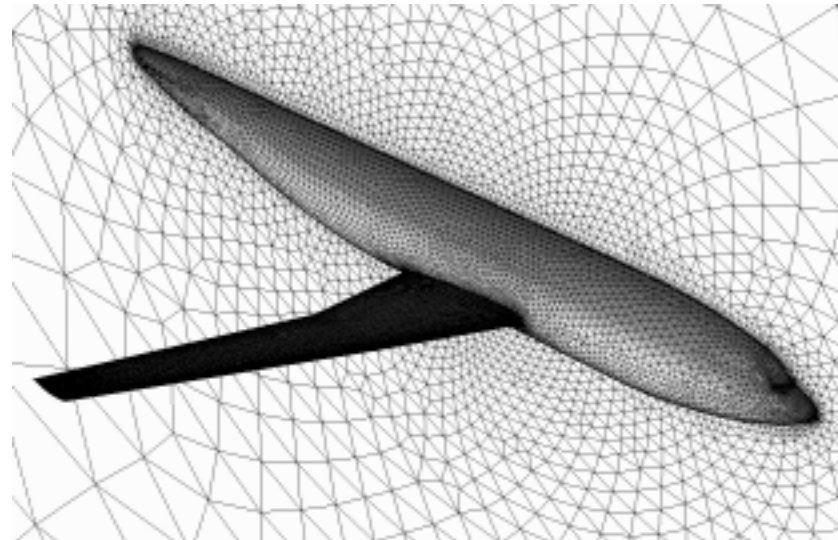a) surface definition (IGES)

b) VGRIDns surface patches

c) background grid sources

d) surface mesh

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DLR-F4 Unstructured "Coarse" Grid for Cell-Based Solvers

Grid statistics:

- Boundary points   23,290
- Surface triangles   46,576
- Triangles on the no-slip surfaces   30,037
- Total grid points: 470,427
- Points in the viscous layers   389,753
- Tetrahedral cells: 2,743,386
- Tetrahedrons in the viscous layers   2,208,260
- Total viscous layers: 35
- Complete viscous layers: 24
- Grid points across the T.E. thickness   5

Grid spacings:

- Chordwise grid spacing at L.E.   ~0.450 mm
- Chordwise grid spacing at T.E.   ~0.800
- Maximum spanwise spacing at L.E.   ~6.000
- Maximum spanwise spacing at T.E.   ~3.500
- Grid spacing on the fuselage   ~10.000
- Grid spacing at the outer boundary   ~3000.000
- Initial "viscous" spacing off the wall (δ_1)   0.003
- Rate of geometric stretching (viscous layers) ~1.2 (first 4 layers have spacing of δ_1)
- Outer boundary box   50 chord lengths in each direction

DLR-F4 Unstructured "Fine" Grid for Node-Based Solvers
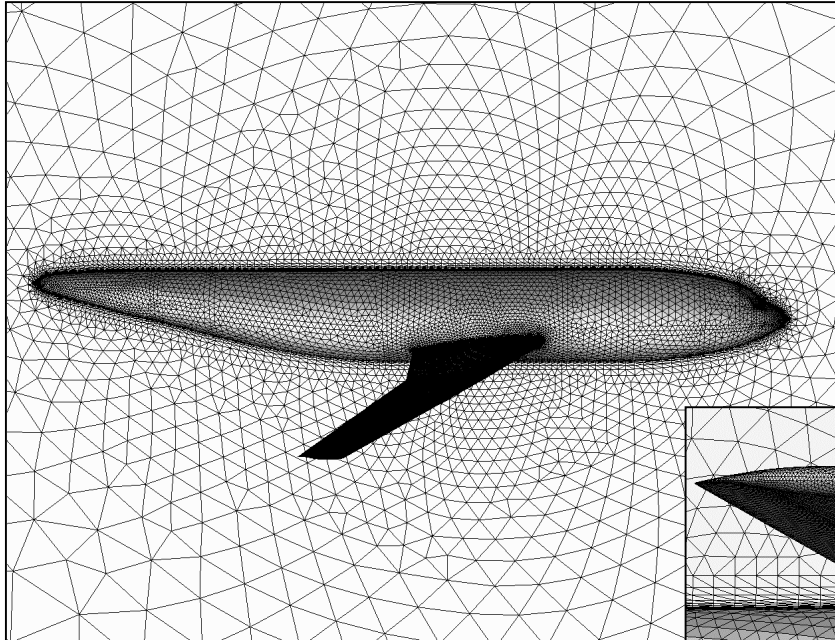
Grid statistics:

- Boundary points   48,339
- Surface triangles   96,674
- Triangles on the no-slip surfaces   72,902
- Total grid points: 1,647,810
- Points in the viscous layers   1,129,427
- Tetrahedral cells: 9,686,802
- Tetrahedrons in the viscous layers   6,495,828
- Total viscous layers: 35
- Complete viscous layers: 24
- Grid points across the T.E. thickness   5

Grid spacings:

- Chordwise grid spacing at L.E.   ~0.250 mm
- Chordwise grid spacing at T.E.   ~0.500
- Maximum spanwise spacing at L.E.   ~2.500
- Maximum spanwise spacing at T.E.   ~3.500
- Grid spacing on the fuselage   ~10.000
- Grid spacing at the outer boundary   ~3000.000
- Initial "viscous" spacing off the wall (δ_1)   0.001 (Y^+ ~1)
- Rate of geometric stretching (viscous layers) ~1.2 (first 4 layers have spacing of δ_1)
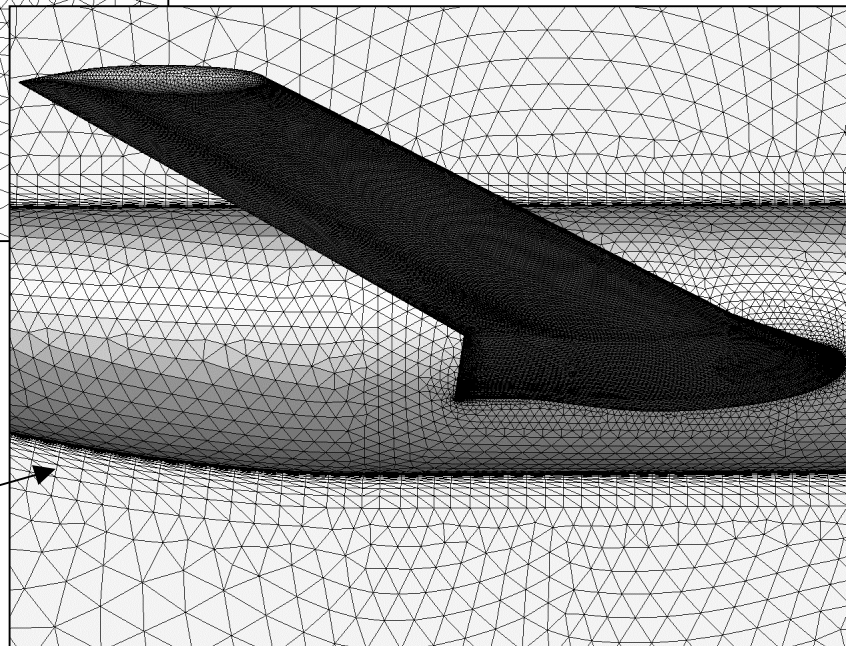- Outer boundary box   50 chord lengths in each direction

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DLR-F4 Unstructured "Fine" Grid

1,647,810 nodes

9,686,802 cells
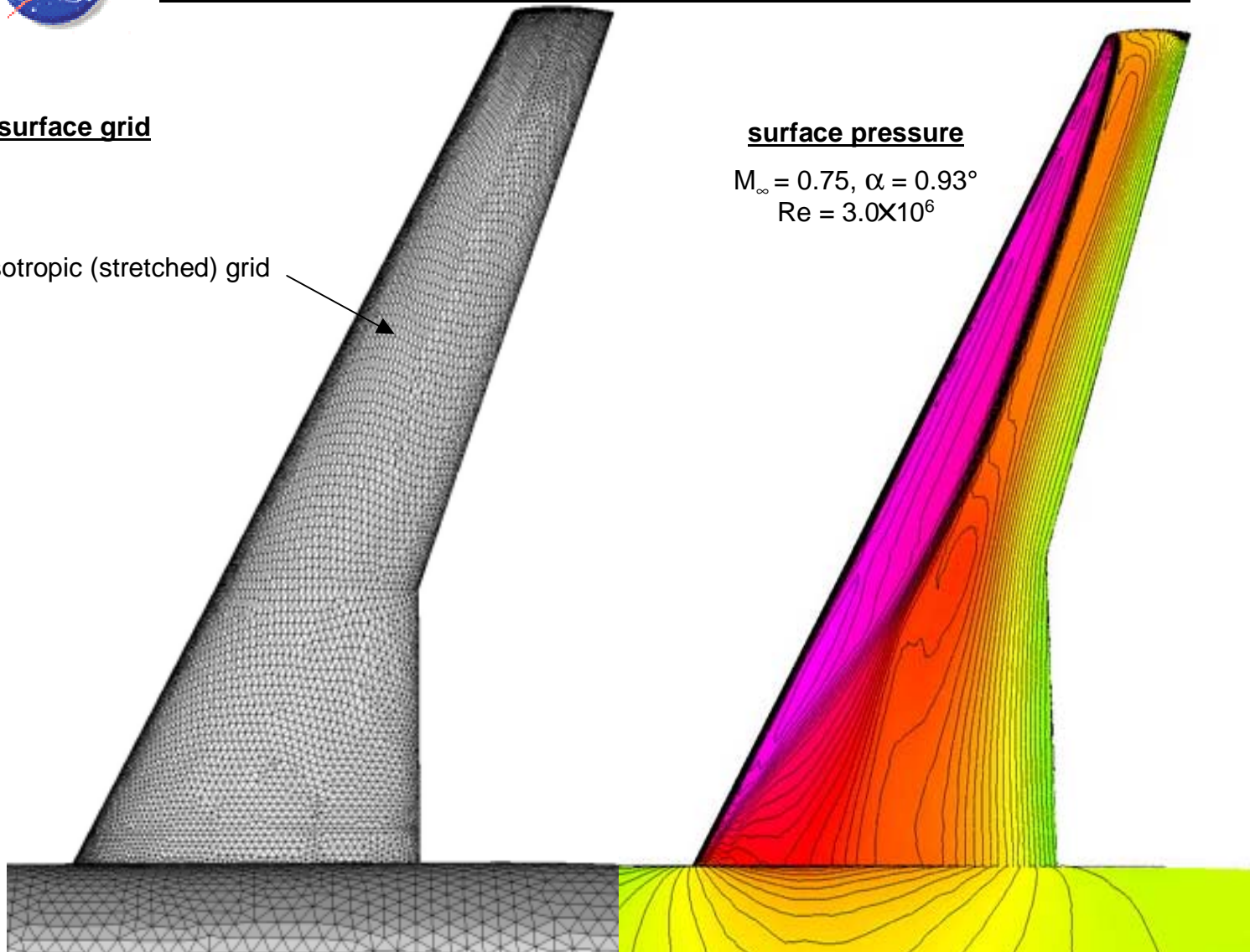
thin "boundary-layer" grid

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DLR-F4 Unstructured "Wall-Function" Grid & Solution

surface grid

surface pressure

$M_\infty = 0.75$, $\alpha = 0.93°$
$Re = 3.0\text{X}10^6$

Anisotropic (stretched) grid

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