

ADIOS Schema

Introduction

The ADIOS schema is our solution to the mismatch in semantics between scientists, visualization tools and existing data formats for HPC data. This schema is a data model for the purpose of shared visual understanding of a dataset. It is embedded in [ADIOS XML](#) requiring minimal input from users. From a few XML tags, ADIOS generates and inserts extra ADIOS attributes to describe variables and meshes from a dataset into the BP (ADIOS file format) file.

XML

Variables

To indicate that values of a variable are spatially represented on a particular mesh, users should add a mesh XML attribute to the variable tag.

```
<var name="cosine" mesh="mesh3" gwrite="cos" type="float" dimensions="iter,num_points"/>
```

Meshes

The main mesh tag requires **name** and **type** attributes. The **time-varying** attribute is optional and will be equal to "no" by default. Values of the mesh tag children can be set to scalars or variable names in most cases. However points and coordinates tags for example require variable names as values.

Uniform Mesh

```
<mesh name="mesh1" type="uniform" time-varying="no">
```

For the uniform mesh users should provide rows and columns (dimensions) with either two points (origin/minimum and maximum points) or an origin and a spacing to use between points. Therefore available XML children of the uniform mesh tag are:

- Dimensions – optional. Default will be the dimensions of the variables assigned to this mesh
- Origin – optional. Default will be {0, [0,0], [0,0,0] ...} depending on the mesh dimensions
- Maximum – optional. Default will be the number of points minus the origins
- Spacing – optional. Default will be one

Examples:

```
<mesh name="mesh3" type="uniform" time-varying="no">  
  <dimensions value="D1,50" />  
  <origin value="-2,02" />  
  <spacing value="S1,6" />  
</mesh>  
<mesh name="mesh4" type="uniform" time-varying="no">  
  <dimensions value="40,D2" />
```

```
<origin value="O1,-1" />
<maximum value="M1,600" />
</mesh>
```

These XML children are all optional; i.e. the default for this mesh will be a segmented line, a square or a bounding box that starts from the origin O, increases by one and ends at the number of points minus one for 1D, 2D and 3D space.

Structured Mesh

```
<mesh name="mesh1" type="structured" time-varying="no">
```

For the structured grid, users should provide the coordinates of all points in addition to the mesh dimensionality.

Available XML children of the structured mesh tag are:

- Dimensions – required
- Points (points-single-var/points-multi-var) – required
- nspace – optional

Examples:

```
<mesh name="mesh1" type="structured" time-varying="no">
  <dimensions value="D1,D2"/>
  <points-multi-var value="X1,Y1" />
</mesh>
<mesh name="mesh2" type="structured" time-varying="no">
  <dimensions value="30,D2"/>
  <nspace value="D0" />
  <points-single-var value="Z" />
</mesh>
```

The *dimensions* represent the rows, columns and planes (connectivity); the *points* specify the coordinates for each node while *nspace* indicates the number of coordinates per node. Points can point to one or multiple variables {C} or {X,Y,Z}. When using points-multi-var, nspace can be derived from the number of variables. When using points-single-var and providing one single 1D array, nspace is required to correctly section extracts the coordinates of points. However if the single variable used for points is multi-dimensional, the reader will be able to deduct nspace for rendering.

Rectilinear Mesh

```
<mesh name="mesh1" type="rectilinear" time-varying="no">
```

The rectilinear mesh is a special case of the structured mesh: the dimensions indicate the connectivity and only the coordinates of axis nodes need to be known. The number of coordinates per node (nspace) is equal to the number of axis provided. Available XML children of the rectilinear mesh tags are:

- Dimensions – optional
- Coordinates of axis (coordinates-single-var/coordinates-multi-var) – required

Examples:

```
<mesh name="mesh1" type="rectilinear" time-varying="no">
  <dimensions value="D0,D1,D2" />
  <coordinates-single-var value="XYZ" />
</mesh>
<mesh name="mesh2" type="rectilinear" time-varying="no">
  <dimensions value="30,D2"/>
  <coordinates-multi-var value="X1,Y1" />
</mesh>
```

Unstructured Mesh

```
<mesh name="mesh1" type="unstructured" time-varying="no">
```

In the case of the unstructured mesh, all the coordinates and the connectivity are required. Available XML children of the rectilinear mesh tags are:

- nspace – optional
- number-of-points – optional
- Coordinates (coordinates-single-var/coordinates-multi-var) – required
- Cells (uniform/mixed) tag (count, type and data) – required

Examples:

```
<mesh name="mesh4" type="unstructured" time-varying="no">
  <points-single-var value="P1" />
  <number-of-points value="25" />
  <mixed-cells count="100,NC2" data="V1,V2" type="4,hex" />
</mesh>
<mesh name="mesh4" type="unstructured" time-varying="no">
  <points-single-var value="P1" />
  <nspace value="N" />
  <mixed-cells count="100,NC2" data="V1,V2" type="4,hex" />
</mesh>
<mesh name="mesh1" type="unstructured" time-varying="no">
  <points-multi-var value="X1,Y1" />
  <uniform-cells count="num_cells" data="C1" type="myct" />
</mesh>
<mesh name="mesh1" type="unstructured" time-varying="no">
  <points-multi-var value="X2,Y2" />
  <uniform-cells count="150" data="C2" type="quad" />
</mesh>
```

The cell types are: {"point" or "pt", "line", "tri" or "triangle", "quad" or "quadrilateral", "hex" or "hexahedron", "pri" or "prism", "tet" or "tetrahedron", "pyr" or "pyramid"}. Users may also choose to simply use a number from 1 to 8 to select one or more of these cell types. The schema allows for the type to point to another ADIOS variable. However for correct interpretation, the reader will expect strings or numbers equal to the previously specified cell types. nspace and number-of-points are

interchangeable and only required when providing a single 1D array of points in order to correctly assign coordinates to nodes.

BP file

From the XML description of the visual representation of the data, ADIOS adds extra attributes in the BP files to be interpreted by visualization tools. The attributes that place variables on meshes are of the following format:

```
string /varname/adios_schema attr = "meshname"
```

The attributes describing the different meshes vary with the mesh types.

Uniform mesh:

In the following example, mesh1 is described using the dimensions (number of points for 1D array) along with an origin point and the spacing between points. In the case of mesh2, an origin and a maximum point are used instead.

Examples:

```
<mesh name="mesh1" type="uniform" time-varying="no">
  <dimensions value="D0" />
  <origin value="O1" />
  <spacing value="S1" />
</mesh>
```

```
string /adios_schema/mesh1/type attr = "uniform" // mesh type
string /adios_schema/mesh1/time attr = "no" // time-varying
string /adios_schema/mesh1/dim0 attr = "D0" // first dimension
double /adios_schema/mesh1/ndims attr = 1 // number of dimensions provided
string /adios_schema/mesh1/org0 attr = "O1" // first origin
double /adios_schema/mesh1/orgs attr = 1 // number of origins provided
string /adios_schema/mesh1/spa0 attr = "S1" // first spacing
double /adios_schema/mesh1/spas attr = 1 // number of spacing provided
```

```
<mesh name="mesh4" type="uniform" time-varying="no">
  <dimensions value="D1,50" />
  <origin value="O1,-1" />
  <maximum value="M1,600" />
</mesh>
```

```
string /adios_schema/mesh2/type attr = "uniform" // mesh type
string /adios_schema/mesh2/time attr = "no" // time-varying
string /adios_schema/mesh2/dim0 attr = "D1" // first dimension
double /adios_schema/mesh2/dim1 attr = 50 // second dimension
double /adios_schema/mesh2/ndims attr = 2 // number of dimensions provided
double /adios_schema/mesh2/org0 attr = -2 // first origin coordinate
string /adios_schema/mesh2/org1 attr = "O2" // second origin coordinate
```

```

double /adios_schema/mesh2/orgs      attr = 2           // number of origins provided
string /adios_schema/mesh2/max0      attr = "M1"       // first maximum
double /adios_schema/mesh2/max1      attr = 600        // second maximum
double /adios_schema/mesh2/maxa      attr = 2           // number of maxima provided

```

Structured mesh:

The following examples describe structured meshes using the points-multi-var and points-single-var tags. There are no restrictions on the dimensionality of the single variable provided to describe the points. The reader will use dimensions and nspace values along with the points' variable dimensions to accurately construct the mesh.

Examples:

```

<mesh name="mesh1" type="structured" time-varying="no">
  <dimensions value="30,D2"/>
  <nspace value="D0" />
  <points-multi-var value="X2,Y2" />
</mesh>
string /adios_schema/mesh1/type      attr = "structured" // mesh type
string /adios_schema/mesh1/time      attr = "no"         // time-varying
string /adios_schema/mesh1/dim0      attr = "30"         // first dimension
string /adios_schema/mesh1/dim1      attr = "D2"         // second dimension
double /adios_schema/mesh1/ndims     attr = 2            // number of dimensions provided
double /adios_schema/mesh1/nsp       attr = D0            // nspace (coordinates/points)
string /adios_schema/mesh1/pts0      attr = "X2"         // first points variable
string /adios_schema/mesh1/pts1      attr = "Y2"         // second points variable
double /adios_schema/mesh1/nvars     attr = 2            // number of variables provided

```

```

<mesh name="mesh4" type="structured" time-varying="no">
  <dimensions value="D1,50" />
  <nspace value="2" />
  <points-single-var value="Z2" />
</mesh>
string /adios_schema/mesh4/type      attr = "structured" // mesh type
string /adios_schema/mesh4/time      attr = "no"         // time-varying
string /adios_schema/mesh4/dim0      attr = "D1"         // first dimension
string /adios_schema/mesh4/dim1      attr = "50"         // second dimension
double /adios_schema/mesh4/ndims     attr = 2            // number of dimensions provided
double /adios_schema/mesh4/nsp       attr = 2            // nspace
string /adios_schema/mesh4/nvars     attr = "Z2"         // single points variable

```

Rectilinear mesh:

In most cases for the rectilinear mesh, users will use the coordinates-multi-var tag to describe the different axis for the mesh. However there are no restrictions on using the coordinates-single-var. The

reader will use the number of dimensions provided to interpret the coordinates's variables and correctly construct the axis.

Examples:

```

<mesh name="mesh1" type="rectilinear" time-varying="no">
  <dimensions value="D0,D1,D2" />
  <coordinates-single-var value="XYZ" />
</mesh>
string  /adios_schema/mesh1/type      attr = "rectilinear" // mesh type
string  /adios_schema/mesh1/time      attr = "no"          // time-varying
string  /adios_schema/mesh1/dim0      attr = "D0"          // first dimension
string  /adios_schema/mesh1/dim1      attr = "D1"          // second dimension
string  /adios_schema/mesh1/dim2      attr = "D2"          // third dimension
double  /adios_schema/mesh1/dims      attr = 3              // number of axis provided
string  /adios_schema/mesh1/nvars     attr = "XYZ"         // single points coordinates

<mesh name="mesh2" type="rectilinear" time-varying="no">
  <dimensions value="30,D2"/>
  <coordinates-multi-var value="X1,Y1" />
</mesh>
string  /adios_schema/mesh2/type      attr = "rectilinear" // mesh type
string  /adios_schema/mesh2/time      attr = "no"          // time-varying
double  /adios_schema/mesh2/dim0      attr = 30            // first dimension
string  /adios_schema/mesh2/dim1      attr = "D2"          // second dimension
double  /adios_schema/mesh2/dims      attr = 2              // number of dimension provided
string  /adios_schema/mesh2/pts0      attr = "X1"          // first points variable
string  /adios_schema/mesh2/pts1      attr = "Y1"          // second points variable
double  /adios_schema/mesh2/nvars     attr = 2              // number of variables provided

```

Unstructured mesh:

In the case of the unstructured mesh the reader expects complete connectivity and topology information for each node and generates attributes about both points and cells. There are no assumptions made about the data; the user must explicitly describe the type, count and connection list for the points. The schema allows for mixed-cells meshes. When using the mixed-cells tag, the parsing expects the given number of counts, types and data to match. For example if there are two types of cells such as triangle and quadrilateral cells, the schema requires two cell counts and pointers to two variables for cell data.

Examples:

```

<mesh name="mesh1" type="unstructured" time-varying="no">
  <nspace value="N" />
  <points-multi-var value="X,Y" />
  <uniform-cells count="num_cells" data="C1" type="myct" />
</mesh>

string  /adios_schema/mesh1/type      attr = "unstructured" // mesh type
string  /adios_schema/mesh1/time      attr = "no"           // time-varying

```

```

string /adios_schema/mesh1/nsp attr = "N" // nspace
string /adios_schema/mesh1/pts0 attr = "X" // first points variable
string /adios_schema/mesh1/pts1 attr = "Y" // second points variable
double /adios_schema/mesh1/nvars attr = 2 // number of variables provided
double /adios_schema/mesh1/ncsets attr = 1 // number of cell sets
string /adios_schema/mesh1/ncell attr = "num_cells" // number of cells
string /adios_schema/mesh1/cdata attr = "C1" // cell data
string /adios_schema/mesh1/ctype attr = "myct" // cell type

```

```

<mesh name="mesh2" type="unstructured" time-varying="no">
  <nspace value="N" />
  <points-single-var value="XY" />
  <mixed-cells count="100,num_cells" data="C1,C2" type="4,hex" />
</mesh>

```

```

string /adios_schema/mesh2/type attr = "unstructured" // mesh type
string /adios_schema/mesh2/time attr = "no" // time-varying
string /adios_schema/mesh2/nsp attr = "N" // nspace
string /adios_schema/mesh2/nvars attr = "XY" // # of variables provided or varname
double /adios_schema/mesh2/ncsets attr = 2 // number of cell sets
double /adios_schema/mesh2/ccount0 attr = 100 // first number of cells
string /adios_schema/mesh2/cdata0 attr = "C1" // first cell data
double /adios_schema/mesh2/ctype 0 attr = 4 // first cell type
string /adios_schema/mesh2/ccount1 attr = num // second number of cells
string /adios_schema/mesh2/cdata1 attr = "C2 " // second cell data
string /adios_schema/mesh2/cdata1 attr = "hex " // second cell type

```

```

<mesh name="mesh3" type="unstructured" time-varying="no">
  <points-single-var value="XYZ" />
  <number-of-points value="N3" />
  <uniform-cells count="NC" data="C0" type="quad" />
</mesh>

```

```

string /adios_schema/mesh3/type attr = "unstructured" // mesh type
string /adios_schema/mesh3/time attr = "no" // time-varying
string /adios_schema/mesh3/npoints attr = "N3" // nspace
string /adios_schema/mesh3/nvars attr = "XYZ" // # of points variables or varname
double /adios_schema/mesh3/ncsets attr = 1 // number of cell sets
string /adios_schema/mesh3/ccount attr = "NC" // cell count
string /adios_schema/mesh3/cdata attr = "C0" // cell data
string /adios_schema/mesh3/ctype attr = "triangle" // cell type

```