Current status of GSL

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Outline

- Introduction
- How GGD is organized
- What is available
- What is missing at the moment

Terminology

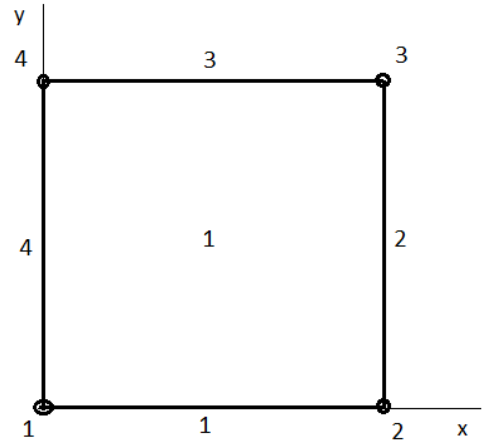
- GSL is GGD Standard Library – a Fortran-90 library intended for work with GGD data.
- GGD is a data structure for storing grids of arbitrary structure, together with physical quantities given on these grids.
- GGD is found in the Data Dictionary of each IMAS IDS.
- GSL can work with both structured and unstructured grids.
  - ‘Structured grids’ are grids with quadrangular (hexahedra) cells organized in rows and columns.
  - ‘Unstructured grids’ are all other grids (e.g., triangular-cell grids).
- The aim of the presentation is to review what is available in the library.
- The review is based on the documentation to version 1.4, 03 Apr 2018 (available at iter.org).

GGD basics

- Each IDS contains the data structures `grid_ggd` and `ggd`. `grid_ggd` holds grid description; `ggd`, quantities on this grid.
- The grid may vary with time (separate grid for each IDS time slice) or be constant (just make sure that the reader knows it!).
- The AOS (array of structures) `grid_ggd` describes the grid elements (nodes, edges, cells etc.), their geometry, and relations between them.
- Physical quantities are “attached” to grid subsets (for example, all grid points, all grid cells, SOL grid points, separatrix grid edges etc.).
- If you want to store, say, ion flux at separatrix edges, you put a list of the flux values to `ggd` and refer to the separatrix-edges subset (defined in `grid_gdd`).

How the grid structure is described

- To prepare a GGD grid, we need
  - To allocate all arrays of grid elements
  - To provide to node coordinates
  - To provide all relations between objects :
- Example: one cell in 2D-space




```
...objects_per_dimension(1)%object(1)%geometry(1) = 0.0  ! x-coord, node 1
...objects_per_dimension(1)%object(1)%geometry(2) = 0.0  ! y-coord, node 1
!...................   The coordinates of all other nodes
...objects_per_dimension(2)%object(2)%node(2)=2  ! Nodes of edge 2
...objects_per_dimension(2)%object(2)%node(2)=3  !
!...................   Nodes of all other edges
...objects_per_dimension(3)%object(1)%node(1)=1  ! Nodes of cell 1
...objects_per_dimension(3)%object(1)%node(2)=2  !
...objects_per_dimension(3)%object(1)%node(3)=3  !
...objects_per_dimension(3)%object(1)%node(4)=4  !
!...................   Nodes of all other cells
```

GSL content: edge plasma IDS

- Module `ids_helper` provides routines for initializing and writing several IDS's (`edge_profiles`, `edge_sources`, `edge_transport`, `transport_solver_numerics`).
- Module `ids_grid_common` defines symbolic notations for standard IDS constants (say, `coordtype_rho_tor=107`).

Generic (unstructured) grids in GSL

- Module `ids_grid_access` contains routines for accessing basic grid information (number of objects etc.).
- In addition, it contains function `ggdtimeslice`, reading a time slice from IDS `edge_profiles`.
- Modules `ids_grid_object` and `ids_grid_objectlist` provide service routines to deal with grid objects (say, to get a list of nodes constituting a cell).
- Module `ids_grid_subgrid` contains routines for organizing grid subsets.
- Module ids_grid_data contains subroutines `gridwritedatascalar`, `gridwritedatavector`, and `gridwritedatamatrix`, which set a scalar data field given in a scalar / vector/ matrix representation to a generic IDS data field; the input array is of dimension 1 for a scalar, …, 3 for a matrix.
  - It is not quite clear to me what is “a scalar data field given in a vector / matrix data representation”.

Generic grids in GSL, cont.

- Service routines:
  - Module `ids_grid` contains subroutines for grid sanity check.
  - Module `ids_assert` provides methods to deal with abnormal situations.

Structured grids in GSL

- Module `ids_grid_structured` provide tools for setting up a structured grid and working with them.
  - One simply gives meshes and types for all coordinates; the objects and relations between them are set up automatically.
  - Tools for getting properties of a grid and its objects
    - For example, measure (length, volume) of an object
  - Interface to modules `gridstructurereaddata` and `gridstructurewritedata`
- Module `gridstructurereaddata` contains subroutines which read data from a `ggd` data field and return a “usual” array (1D, 2D, 3D, …, 6D).
- Module `gridstructurewritedata` contains subroutines which put a “usual” array (1D - 6D) into a `ggd` data field.

Summary

Available service

	Generic grids	Structured grids
Grid setup	No	Yes
Conversion from non-GGD format	No	Yes
Info on grid	Yes	Yes
Info on grid objects	Yes (to a lesser extent)	Yes
Work with grid subsets	Yes	Yes
Reading and writing data	Partly	Yes

How to start

- Information on GGD: “GGD Guide” https://confluence.iter.org/download/attachments/178133297/GGDguide.pdf?version=1&modificationDate=1648825366807&api=v2
- The “GGD Guide” contains examples of the grid setup and how the GSL library can help with it (especially for structured grids). This is the best way to start.
- The Fortran text of the examples is a part of the libraty; it is available at https://git.iter.org/projects/IMEX/repos/ggd/browse/examples/f90
- Documentation of IMAS GGD Grid Service Library: Fortran 90 https://user.iter.org/?uid=VSF9KY&action=get_document is a reference document.

Conclusions

- The service provided for work with structured grids is much better than for unstructured ones (EIRENE).
- This presentation was intended to revise what is currently available.
- For detailed information on work with GSL see
  - GGD guide https://confluence.iter.org/download/attachments/178133297/GGDguide.pdf?version=1&modificationDate=1648825366807&api=v2
  - Fortran examples provided with GSL (they are described in GGD Guide) https://git.iter.org/projects/IMEX/repos/ggd/browse/examples/f90
  - Documentation of IMAS GGD Grid Service Library: Fortran 90 https://user.iter.org/?uid=VSF9KY&action=get_document

Thank you for attention!