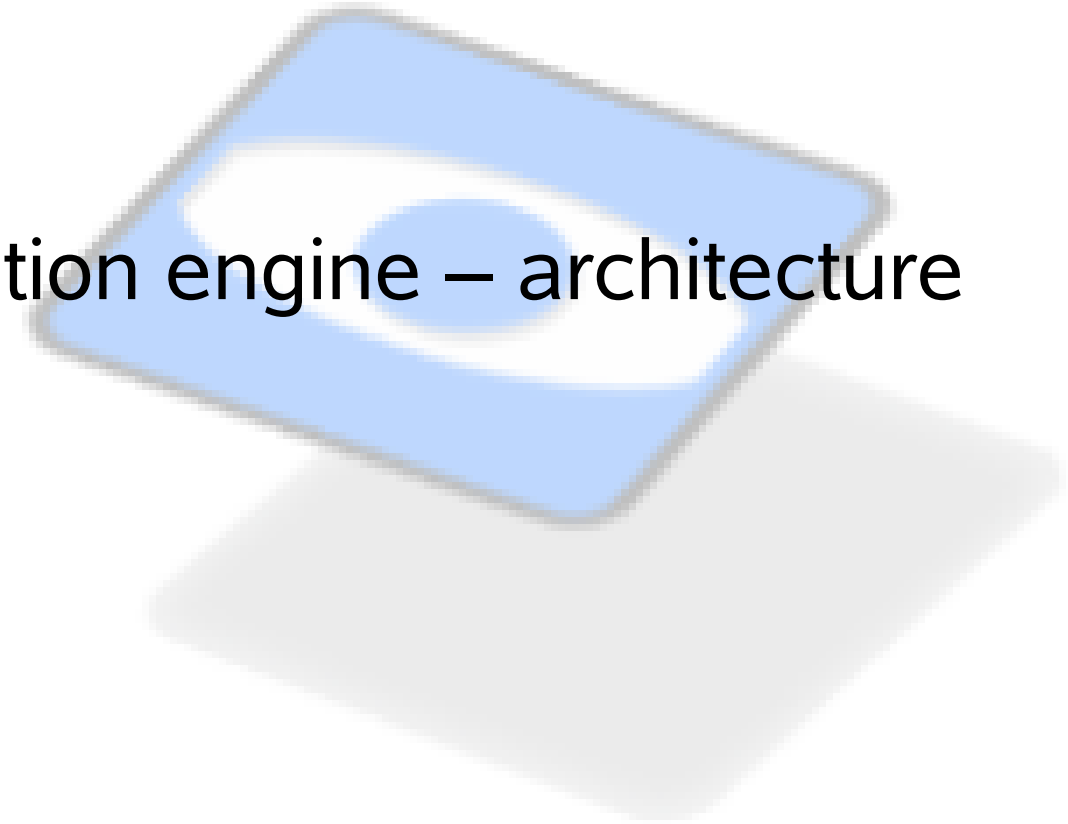
Volume visualization engine – architecture



Michal Hučko

Outline

- Key features
- Main layout
- Data manager
- Scene manager
- Renderer
- Main manager
- Miscellaneous

Key features

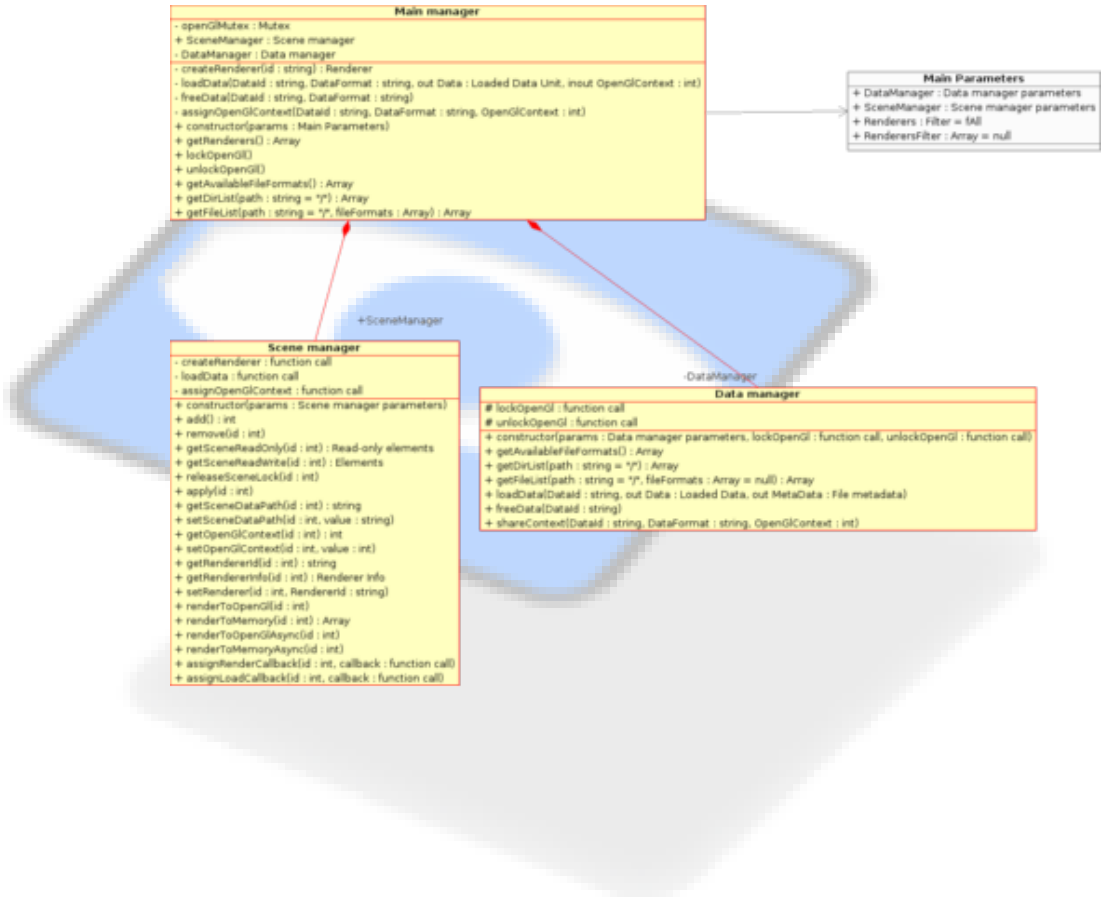
- Thread safety
- Safe OpenGl usage
- Expandability
  - visualization algorithms
  - external/internal data formats
- Data sharing

Outline

- Key features
- Main layout
- Data manager
- Scene manager
- Renderer
- Main manager
- Miscellaneous

Main layout

- Main manager
  - Scene manager
  - Data manager (private)
  - (Parameters)

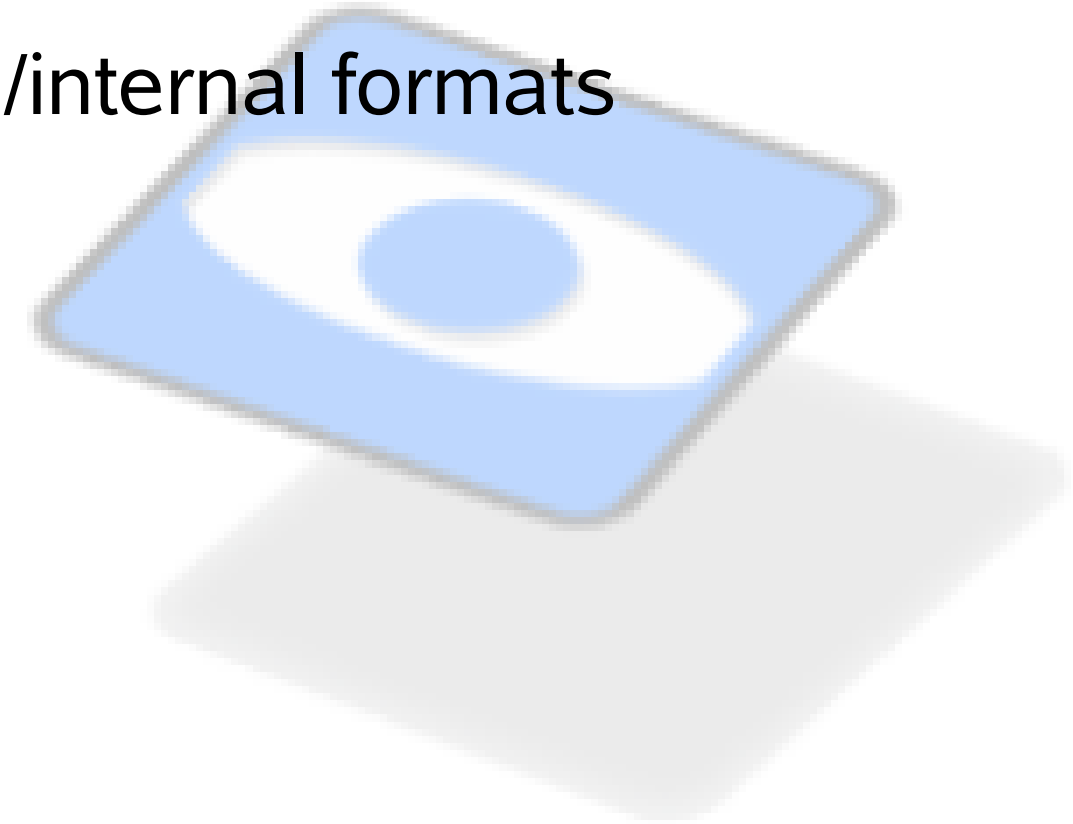


Outline

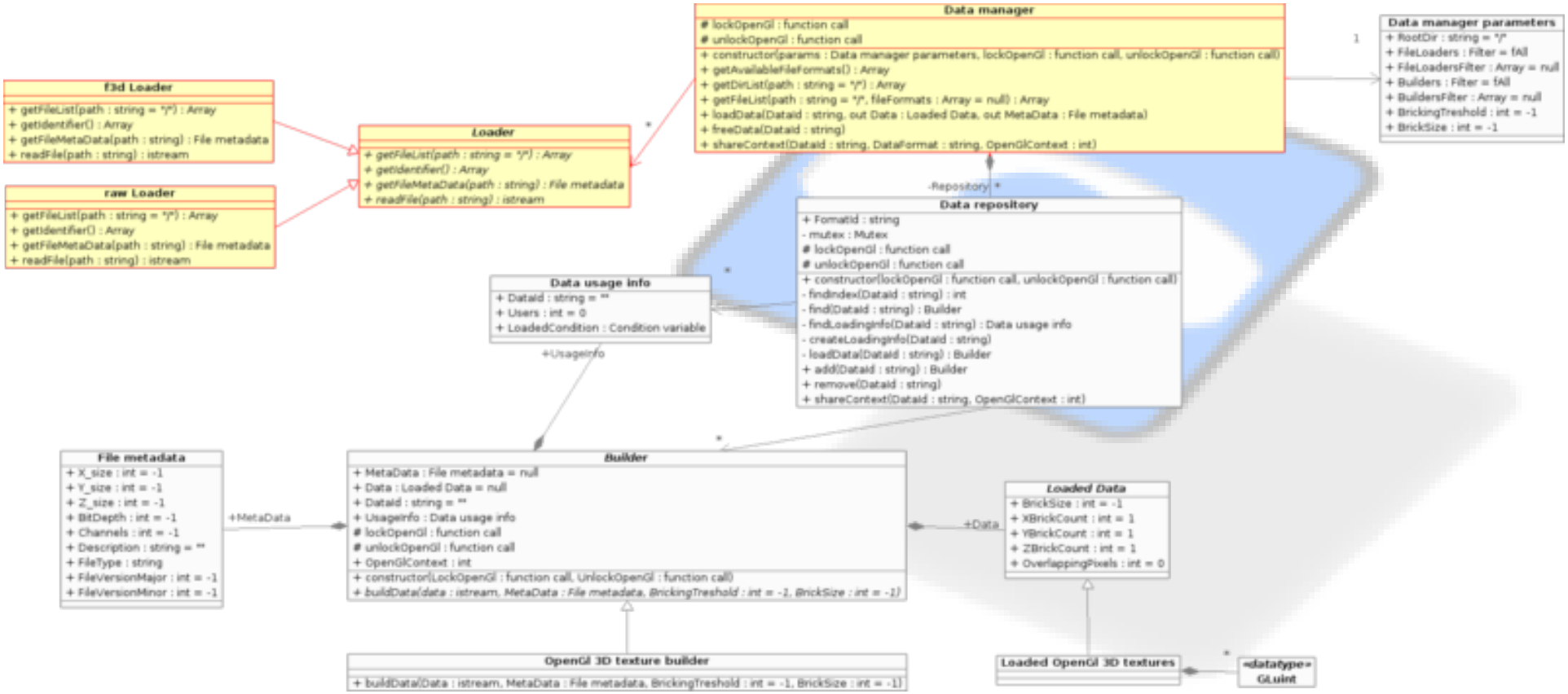
- Key features
- Main layout
- Data manager
- Scene manager
- Renderer
- Main manager
- Miscellaneous

Data manager

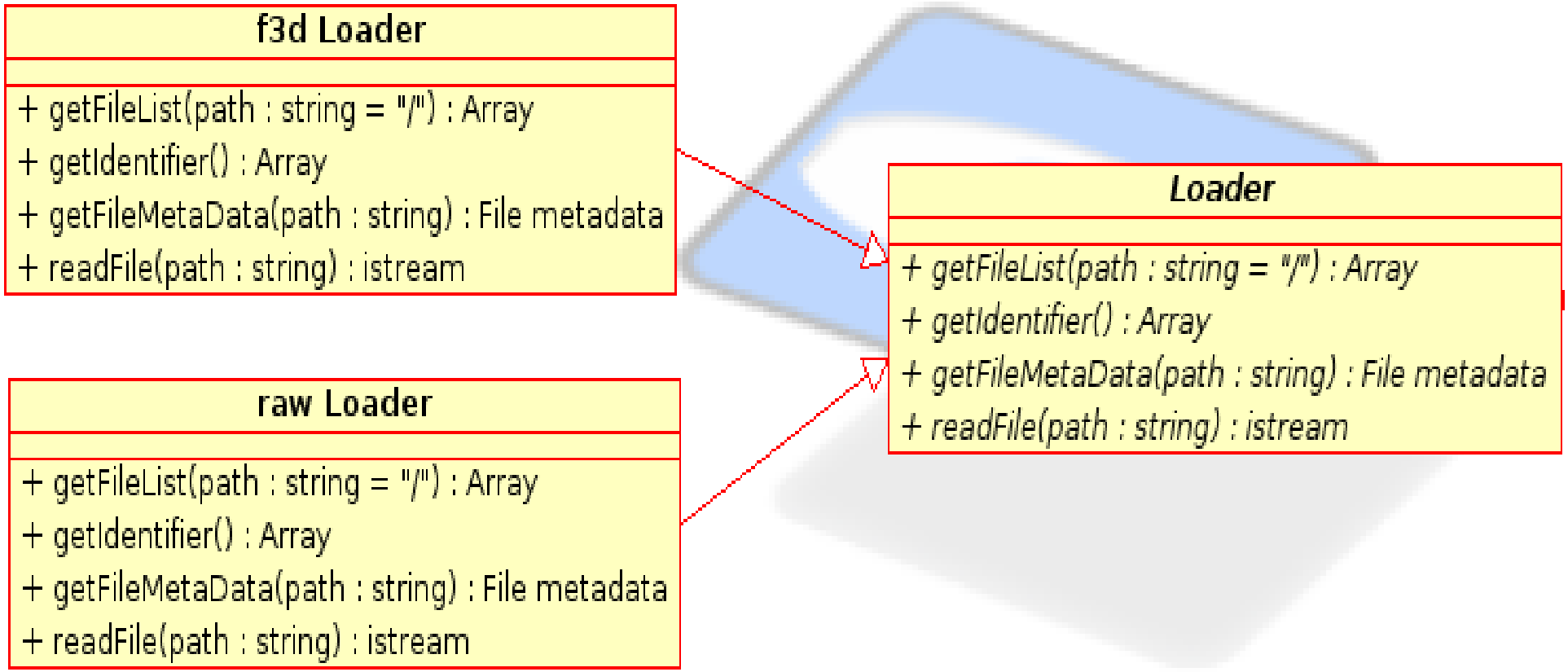
- Directory browsing
- Data loading
  - various external/internal formats
  - data sharing
- Data freeing



- Loaders for each external file format

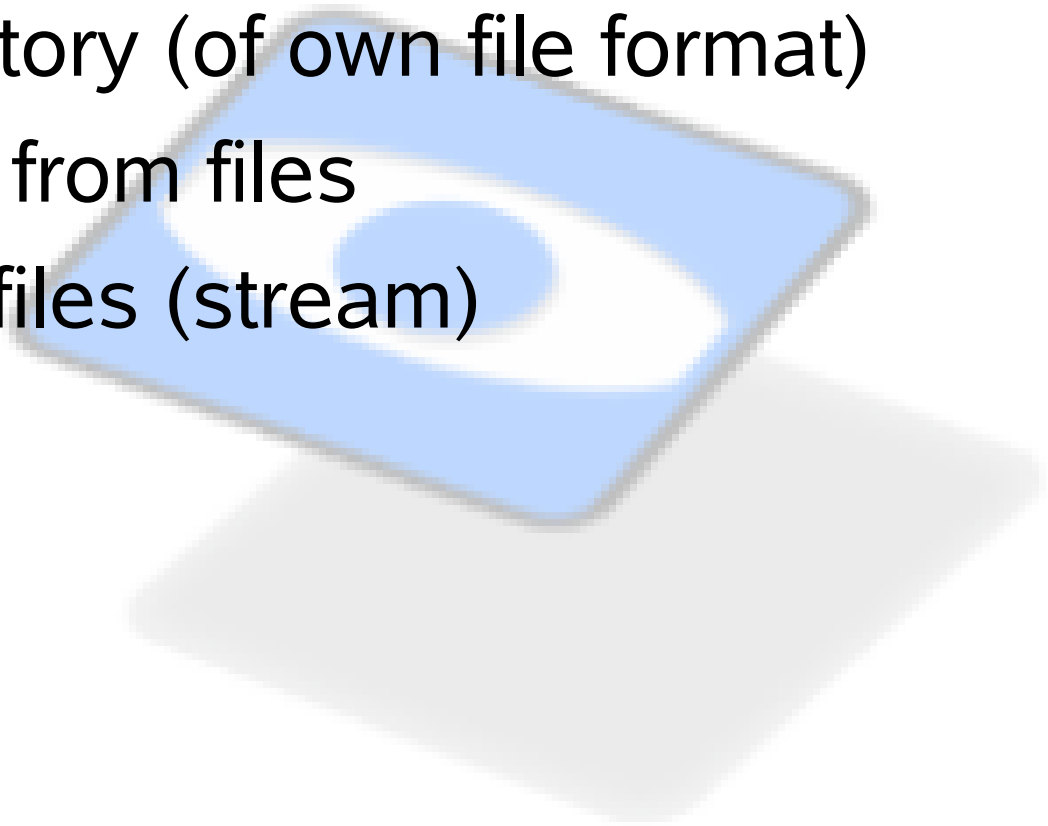


- Loaders


f3d Loader
+ getFileList(path : string = "/") : Array
+ getIdentifier() : Array
+ getFileMetaData(path : string) : File metadata
+ readFile(path : string) : istream
raw Loader
+ getFileList(path : string = "/") : Array
+ getIdentifier() : Array
+ getFileMetaData(path : string) : File metadata
+ readFile(path : string) : istream
Loader
+ getFileList(path : string = "/") : Array
+ getIdentifier() : Array
+ getFileMetaData(path : string) : File metadata
+ readFile(path : string) : istream

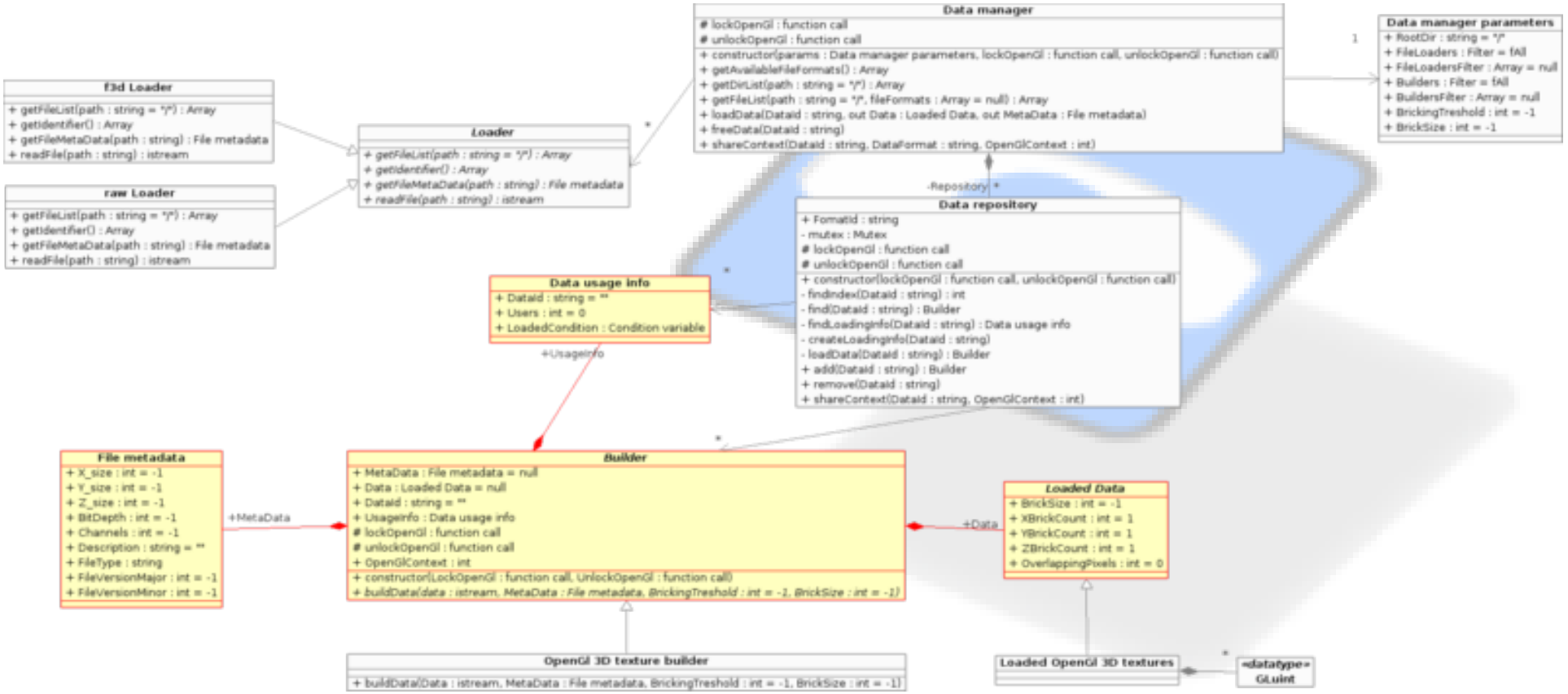
Data manager

- Loaders
  - common interface
  - lists files in directory (of own file format)
  - loads meta-data from files
  - loads data from files (stream)

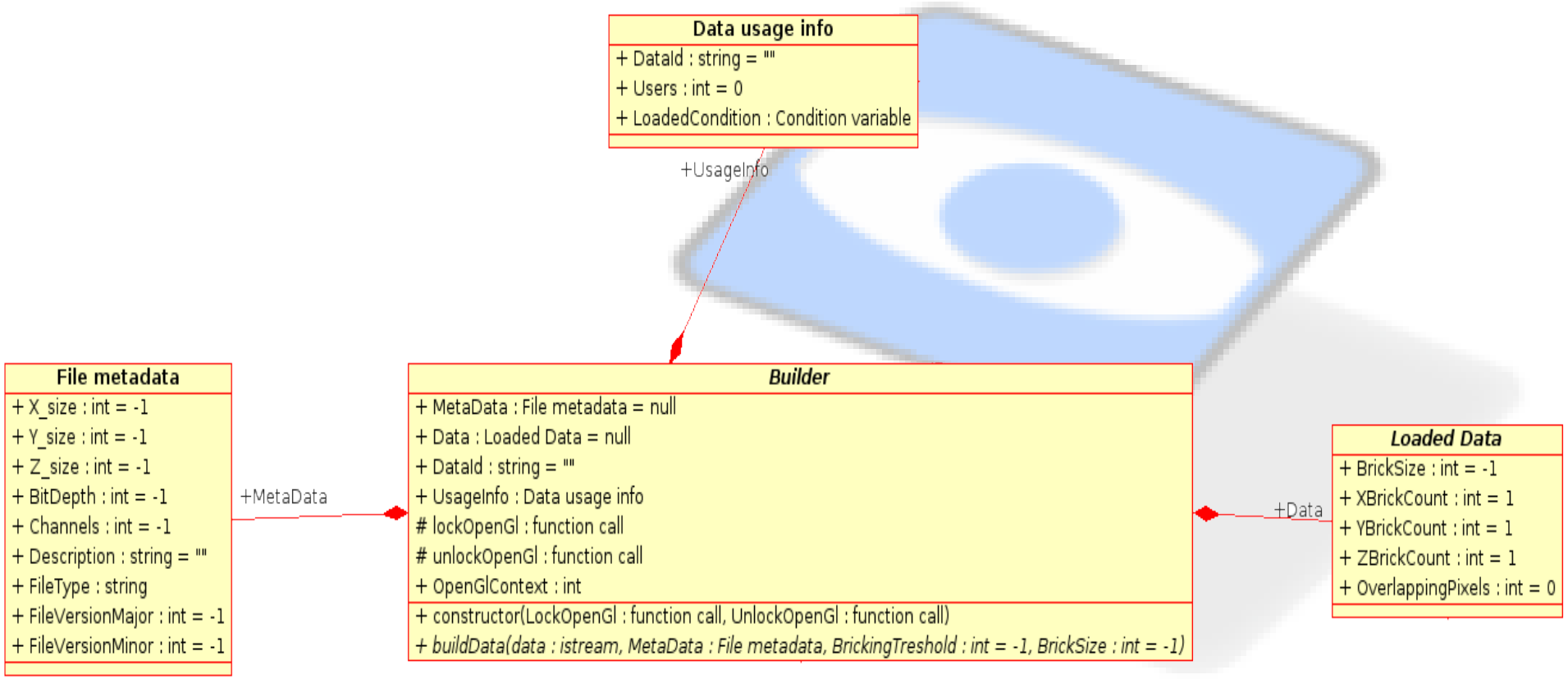


Data manager

- Builder and storage of internal data

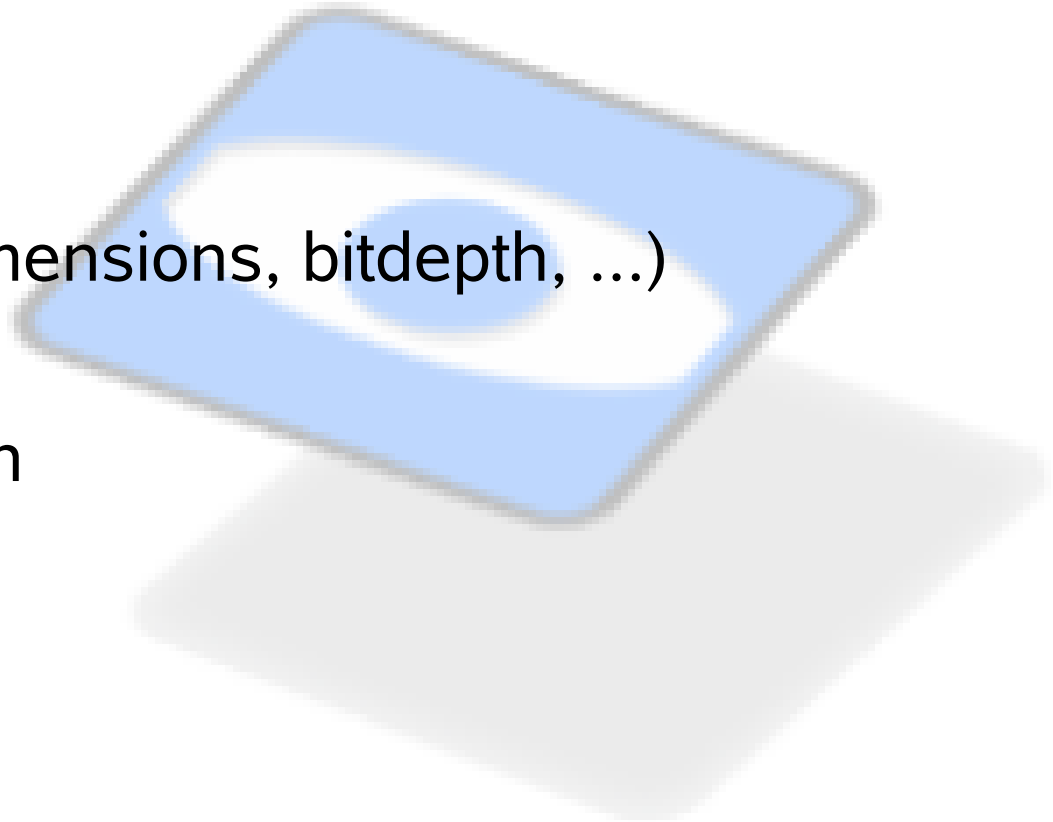


- Builder

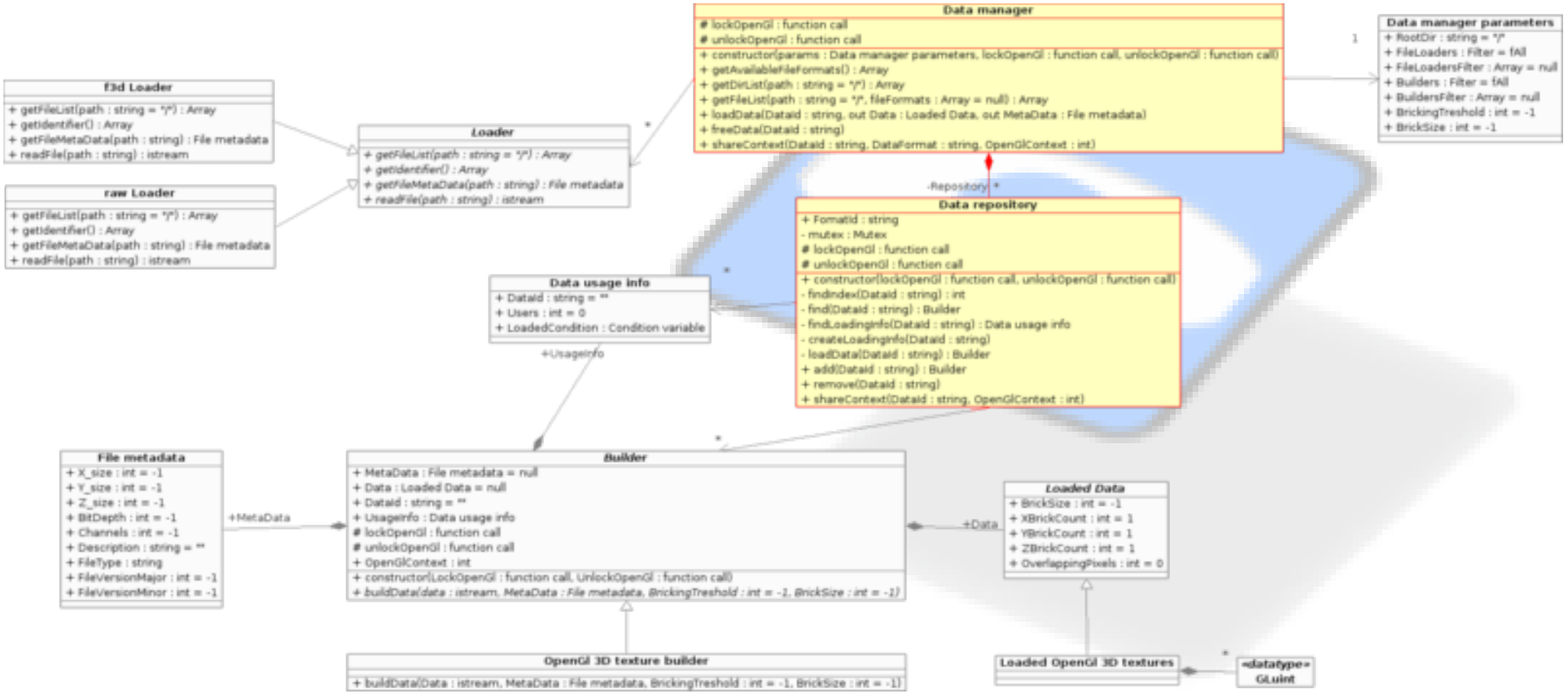

Data usage info
+ DataId : string = ""
+ Users : int = 0
+ LoadedCondition : Condition variable
+UsageInfo
File metadata
+ X_size : int = -1
+ Y_size : int = -1
+ Z_size : int = -1
+ BitDepth : int = -1
+ Channels : int = -1
+ Description : string = ""
+ FileType : string
+ FileVersionMajor : int = -1
+ FileVersionMinor : int = -1
+MetaData
Builder
+ MetaData : File metadata = null
+ Data : Loaded Data = null
+ DataId : string = ""
+ UsageInfo : Data usage info
# lockOpenGl : function call
# unlockOpenGl : function call
+ OpenGlContext : int
+ constructor(LockOpenGl : function call, UnlockOpenGl : function call)
+ buildData(data : istream, MetaData : File metadata, BrickingTreshold : int = -1, BrickSize : int = -1)
+Data
Loaded Data
+ BrickSize : int = -1
+ XBrickCount : int = 1
+ YBrickCount : int = 1
+ ZBrickCount : int = 1
+ OverlappingPixels : int = 0

Data manager

- Builder
  - builds data (internal format) from data stream (abstract)
  - stores
    - file metadata (dimensions, bitdepth, ...)
    - own data
    - usage information

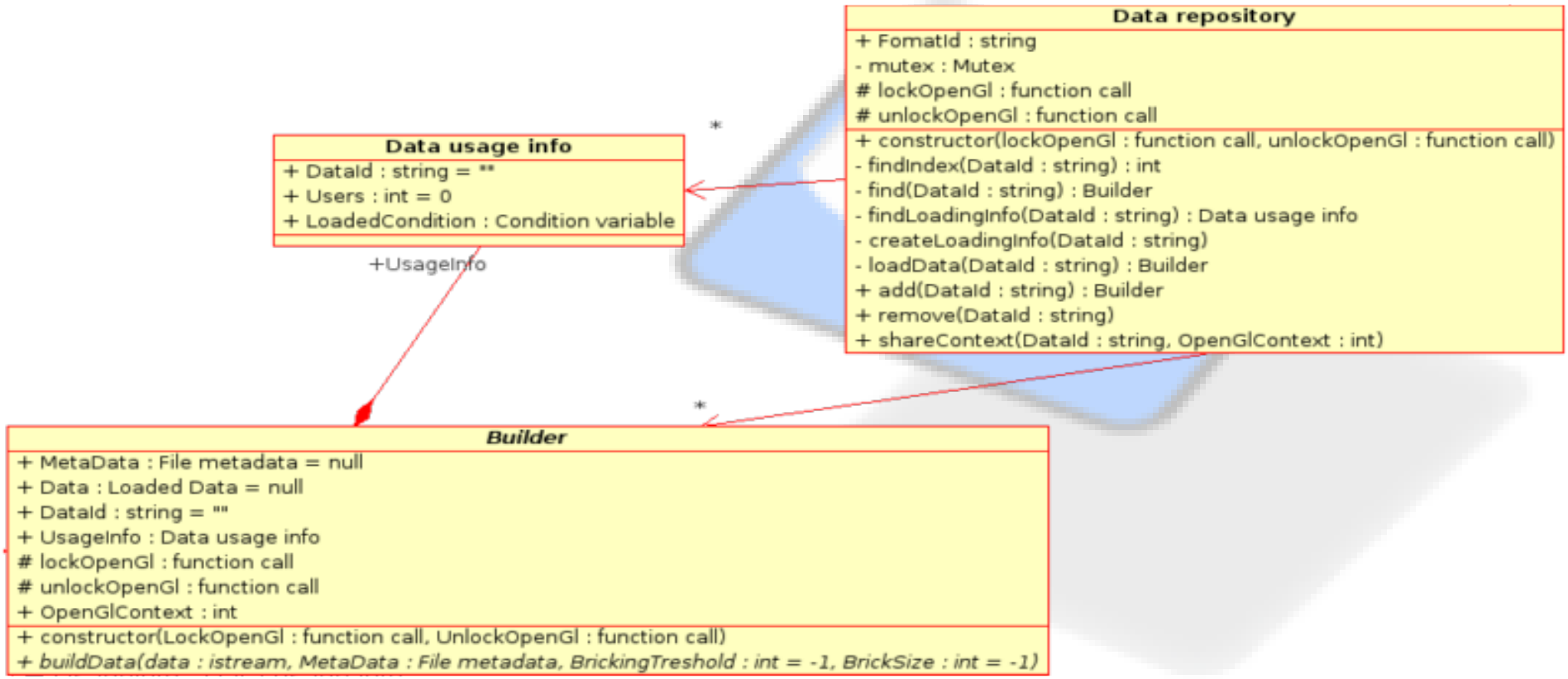


- Data storage for each internal file format



Data manager

- Data repository

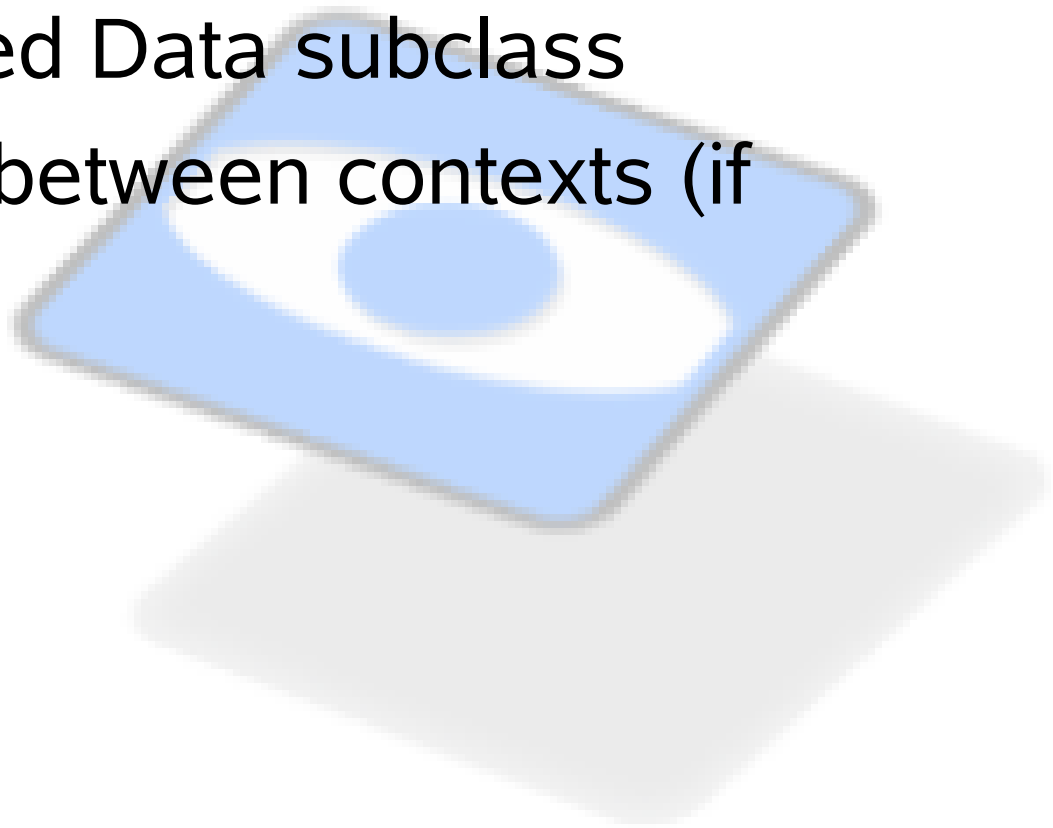


Data manager

- Data repository
  - stores all loaded data (Builder)
  - stores info about currently loaded data (Data usage info)
  - concurrent loading of the same data
    - first thread creates 'Data usage info' element
    - first thread starts loading process (unlocking mutex)
    - second thread finds 'loading' info and sleeps
    - first thread finishes and wakes all waiters
    - second thread finds loaded data

Data manager

- Actual builders
  - overriding abstract buildData method
  - producing Loaded Data subclass
  - shares textures between contexts (if requested)



Outline

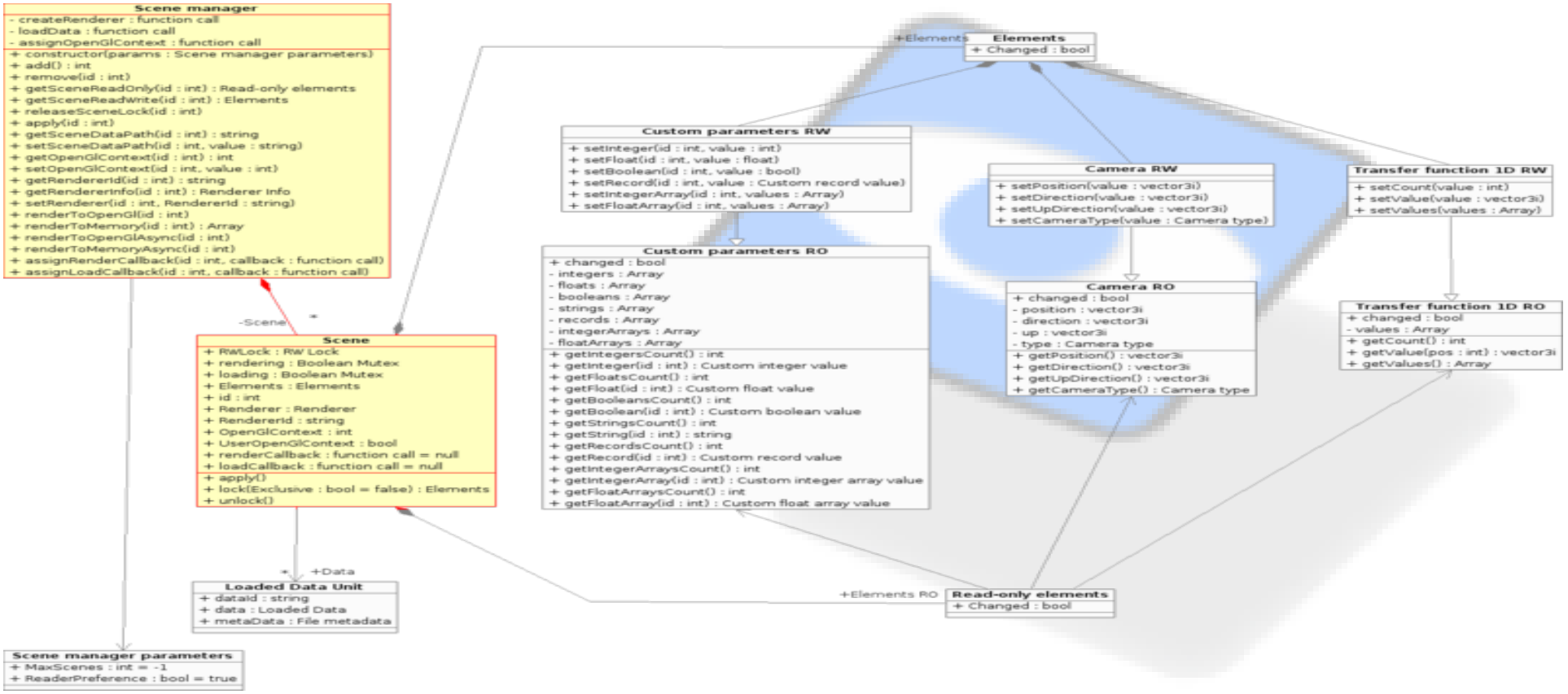
- Key features
- Main layout
- Data manager
- Scene manager
- Renderer
- Main manager
- Miscellaneous

Scene manager

- Scene management
  - adding, storing, freeing
  - assigning renderes, callbacks
  - providing scene parameters
- Rendering controls
  - target – OpenGl context, main memory
  - synchronous, asynchronous call

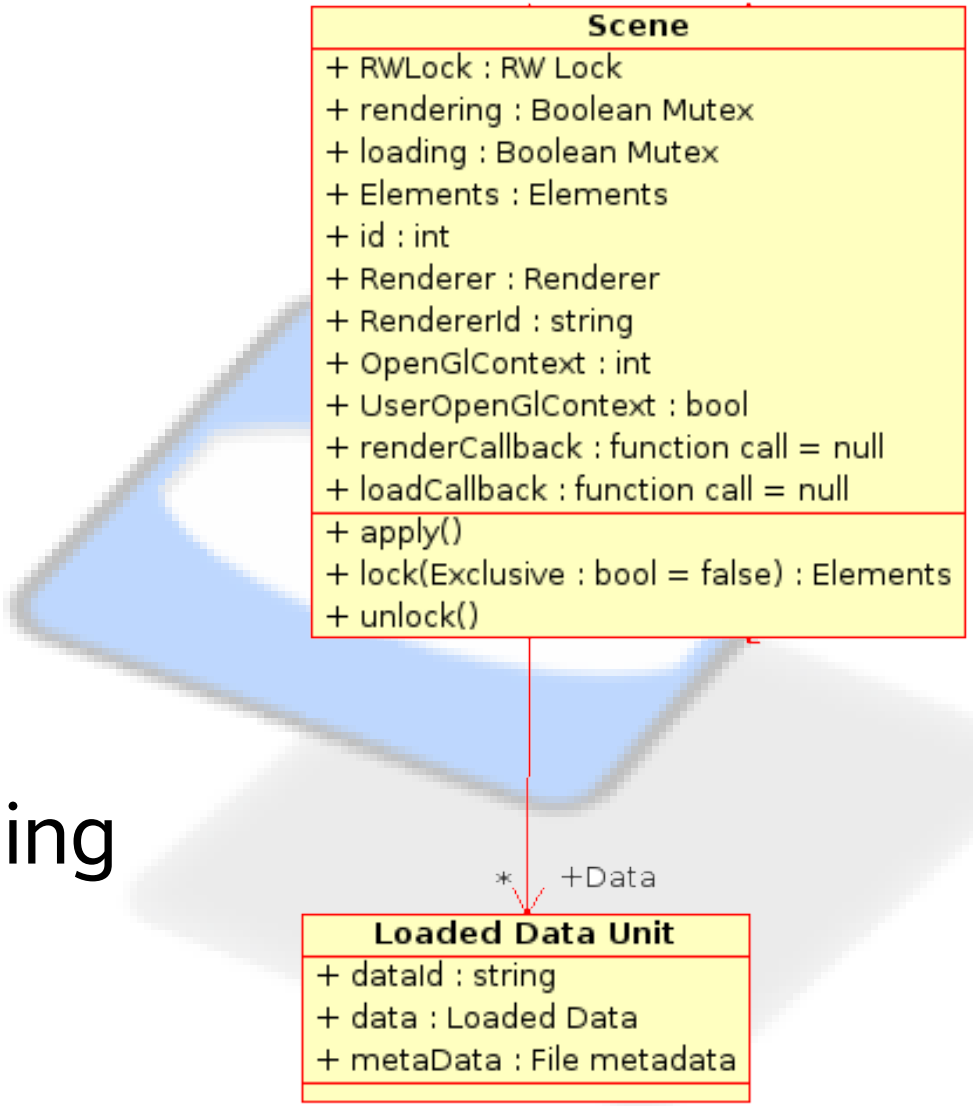
Scene manager

- Manages scenes



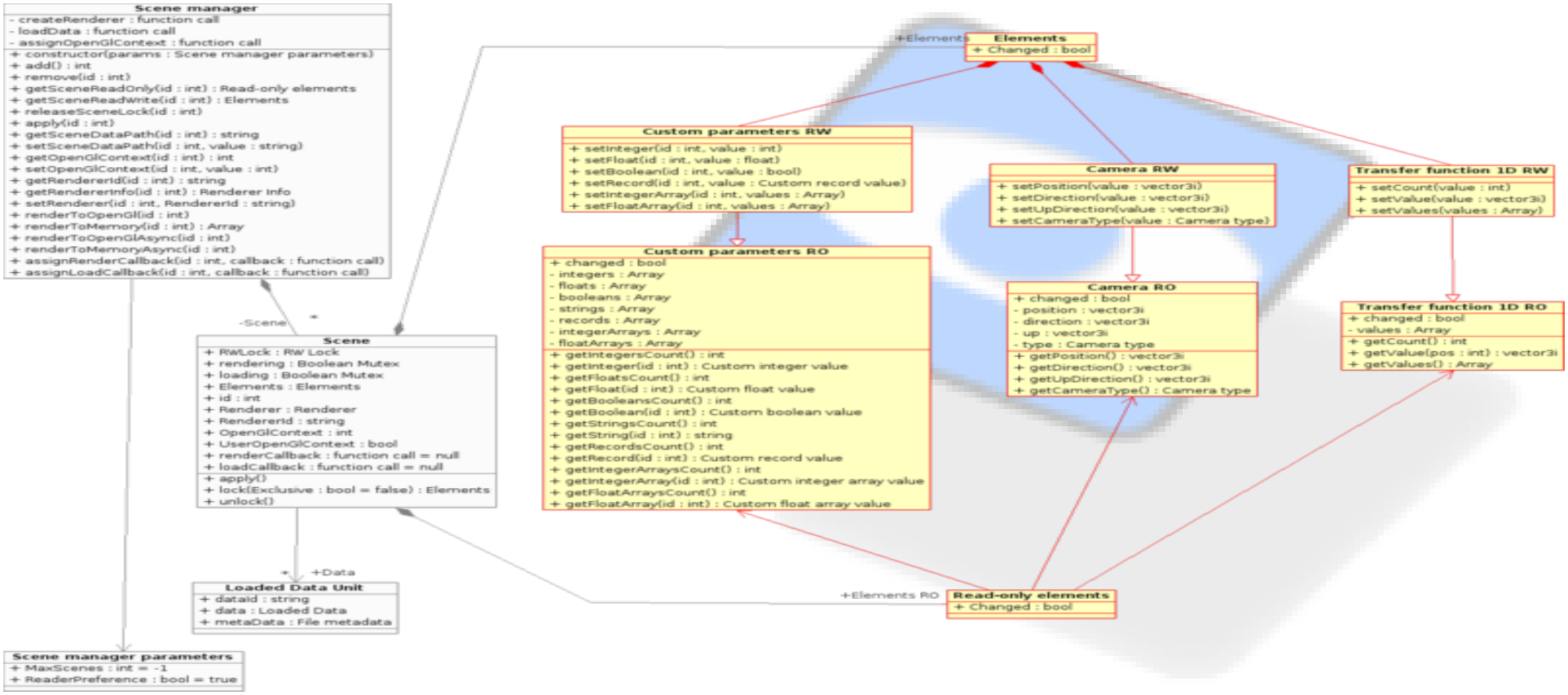
Scene manager

- Scene
  - data
  - parameters
  - renderer
  - RW-lock
  - callbacks
  - rendering & loading flags



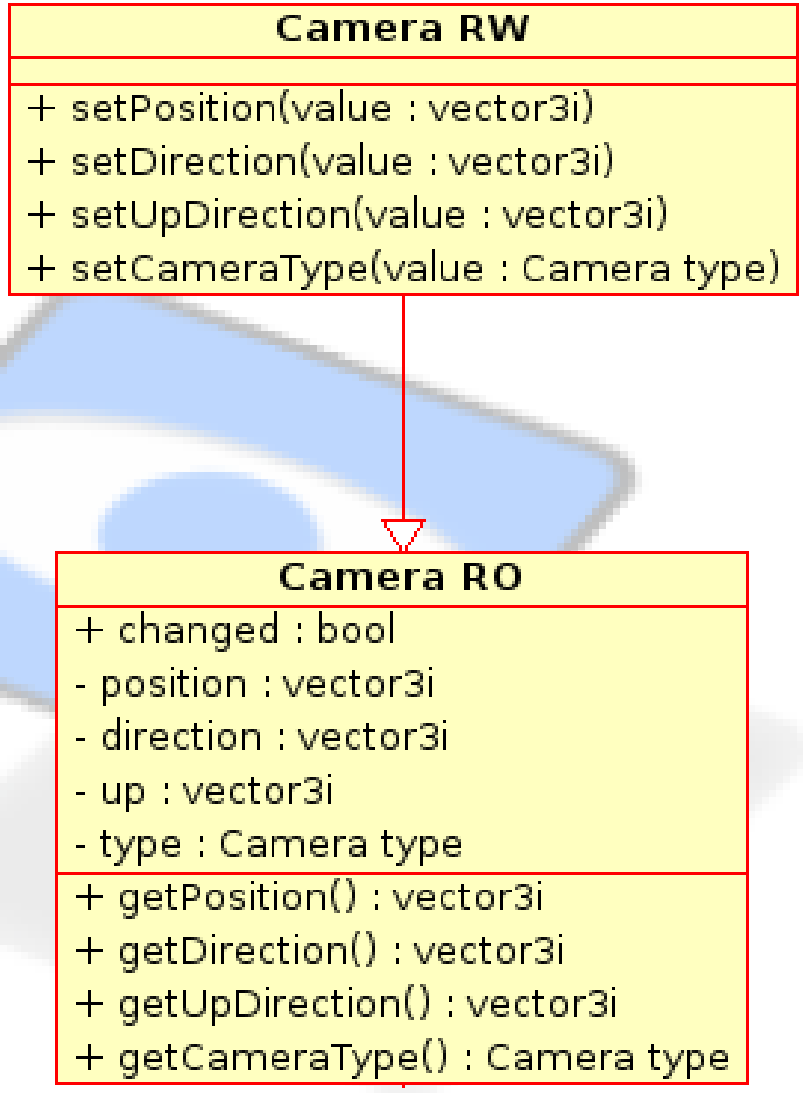
Scene manager

- Manages scene parameters



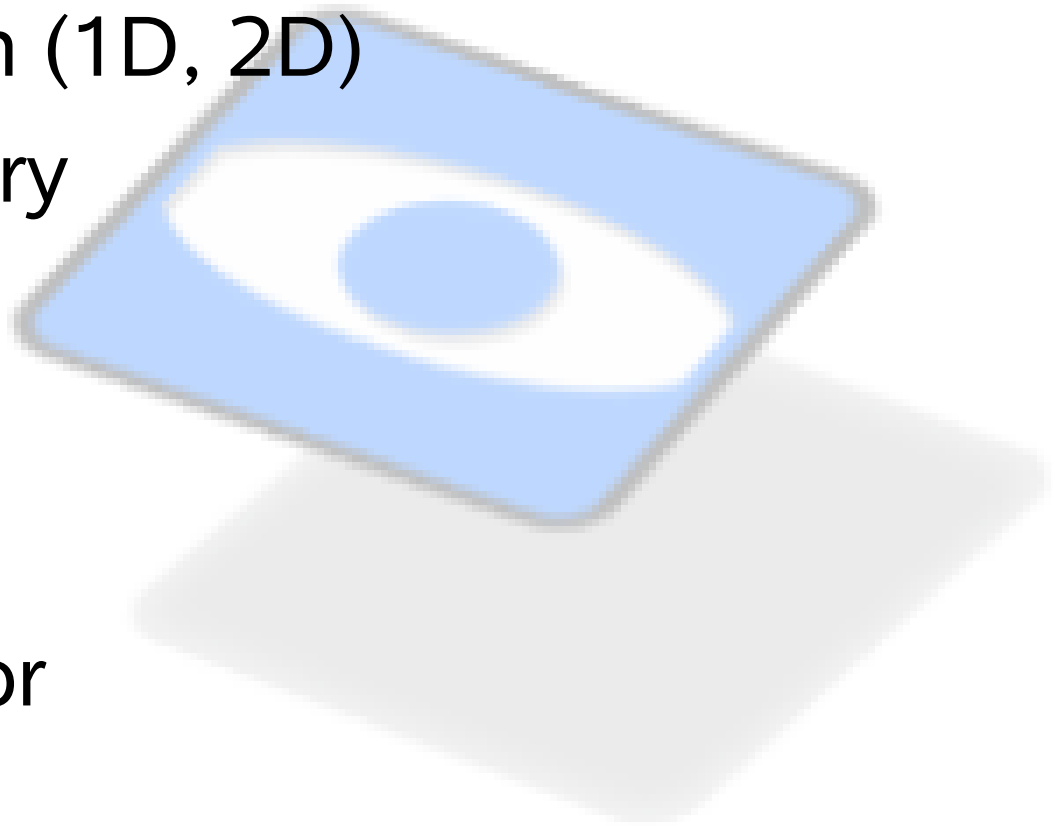
Scene manager

- Parameters
  - base 'read-only' class
  - 'read-write' subclass
  - changed flag

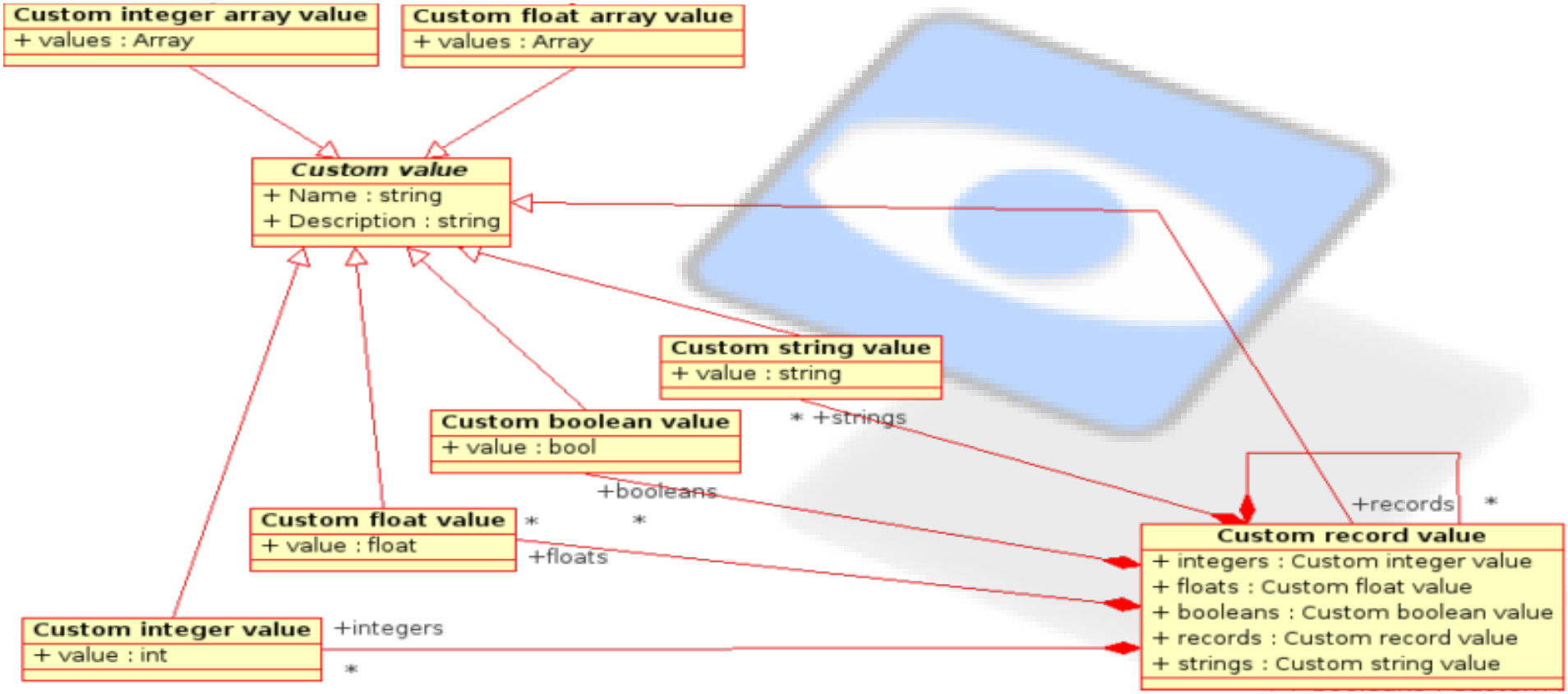


Scene manager

- Parameters
  - Camera
  - Transfer function (1D, 2D)
  - Clipping geometry
  - Lights
  - Gradient
  - Mask
  - Background color



- Custom values

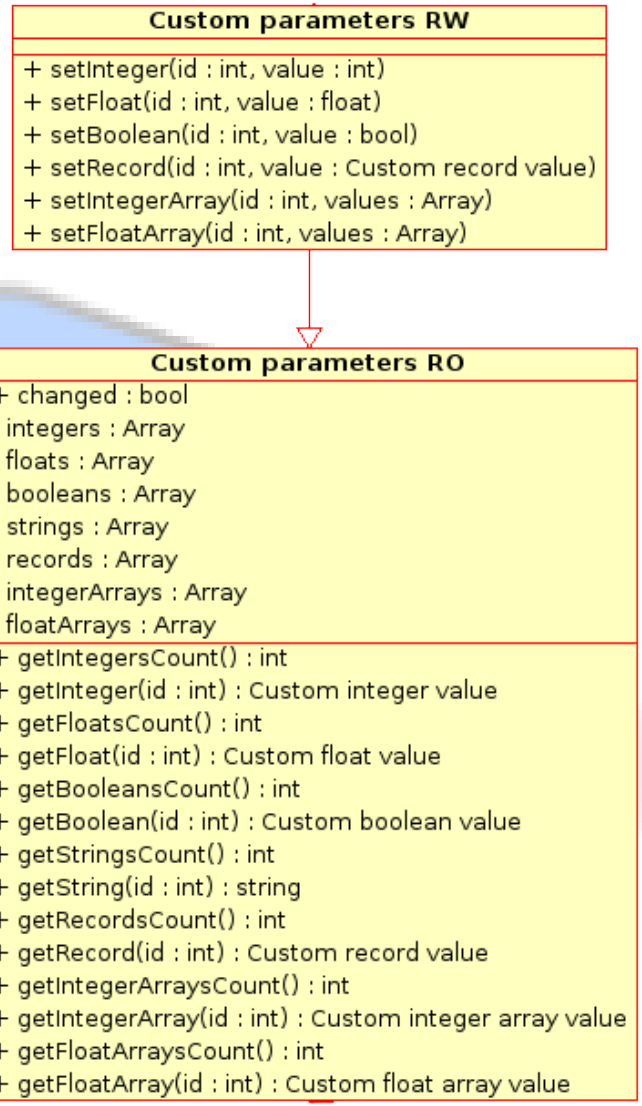


Scene manager

- Custom values
  - integer
  - float
  - boolean
  - string
  - record (of previous)
  - array of integers
  - array of floats

Scene manager

- Custom parameters
  - previously mentioned custom values
- Custom values
  - name
  - description

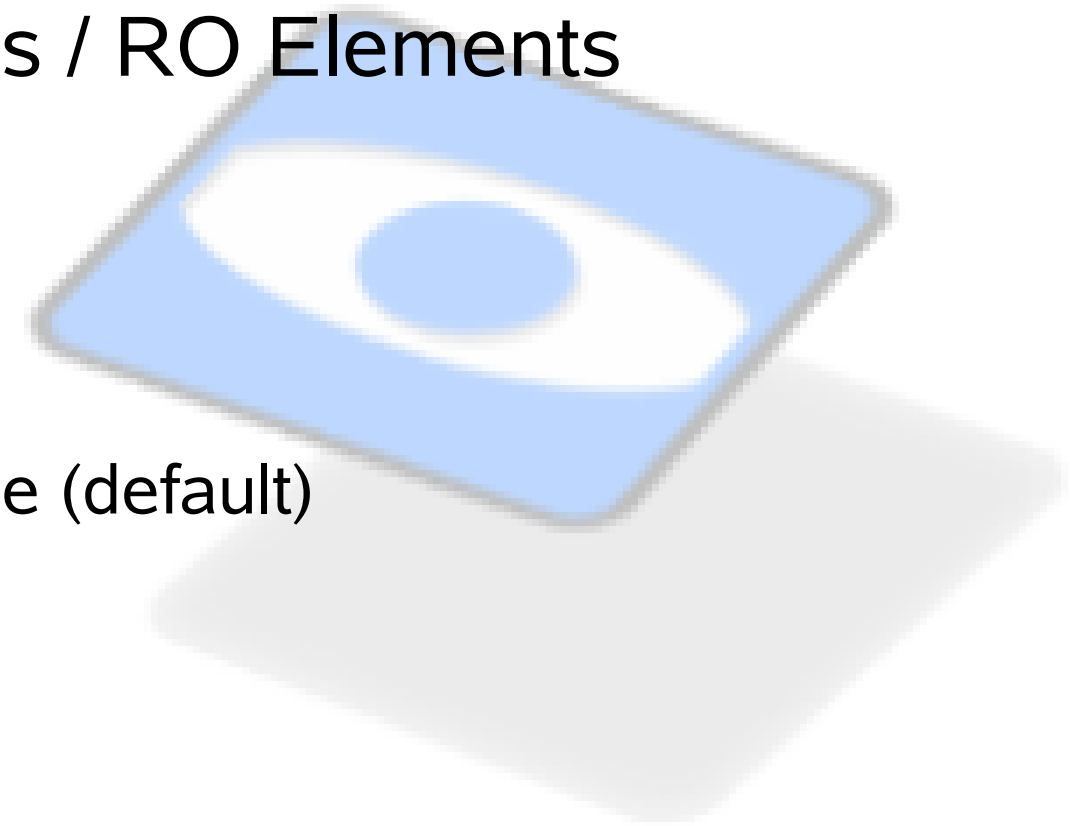


Scene manager

- two collections
  - read-only elements, elements
  - only references (marginal memory overhead)
  - both contains same RW parameters
  - RO elements refers to base RO parameter classes
  - RO elements forbids writing

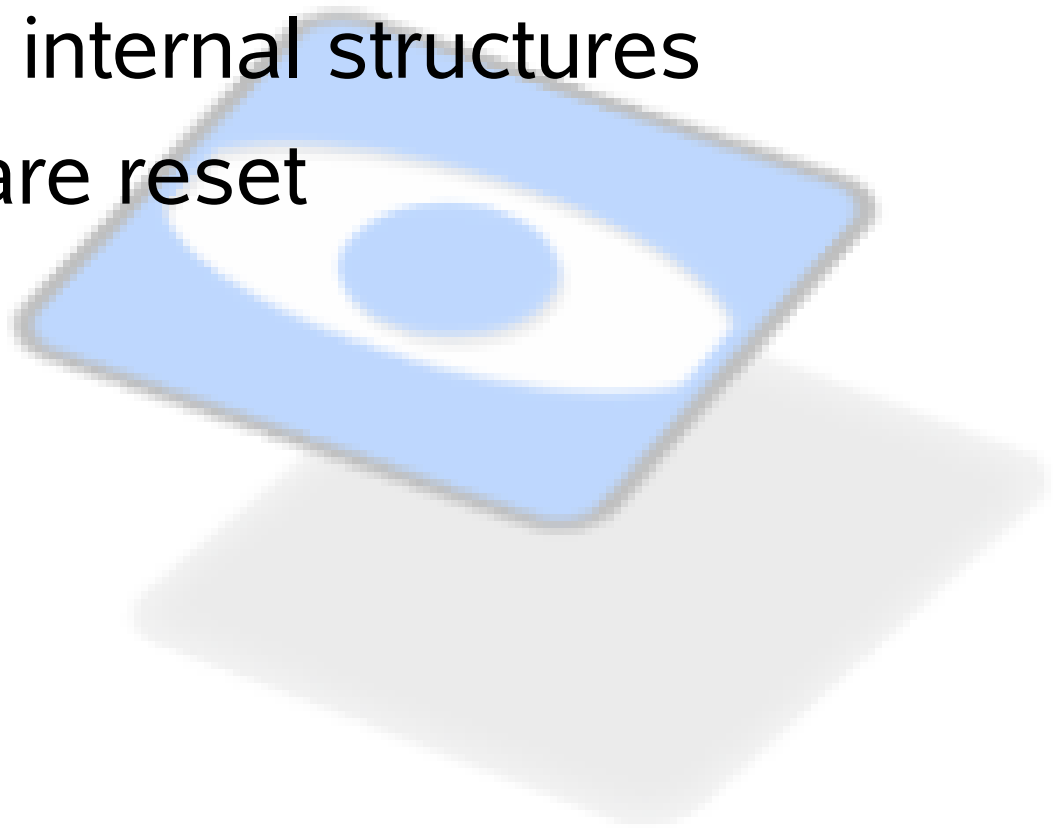
Scene manager

- Scene
  - two types of lock (RO / RW)
  - returns Elements / RO Elements
  - thread safety
    - single writer
    - multiple readers
    - reader preference (default)



Scene manager

- Apply method
  - informs renderer about changes
  - renderer adjusts internal structures
  - 'changed' flags are reset



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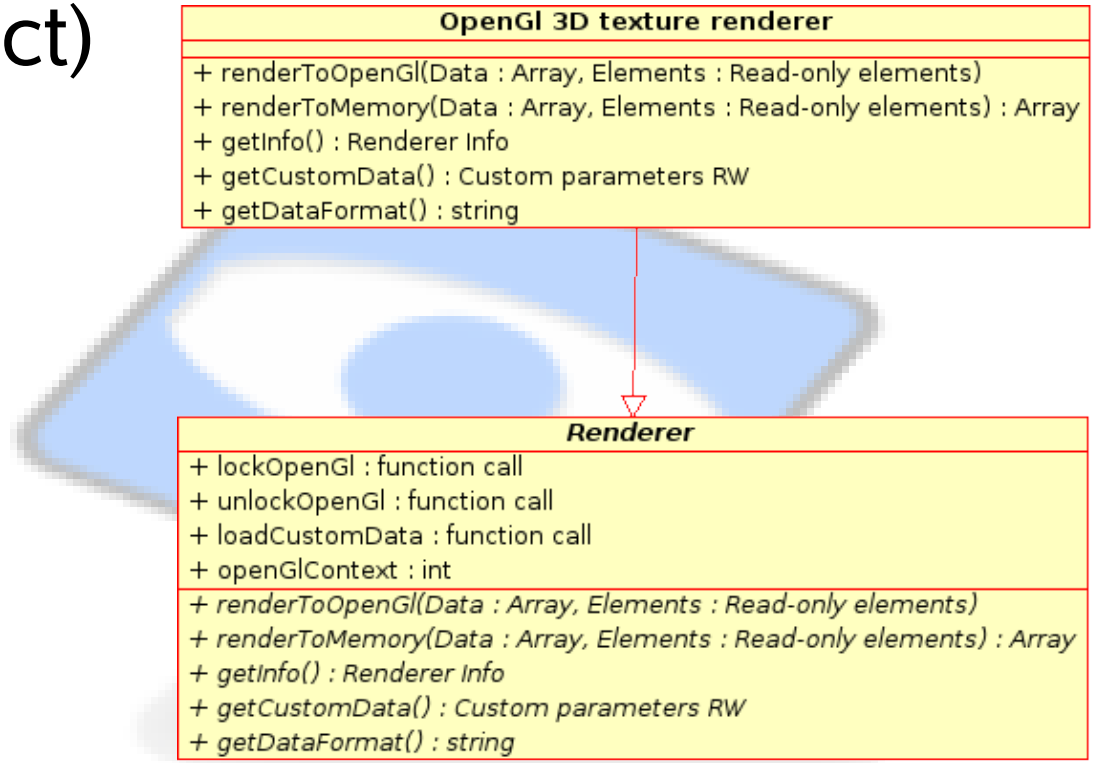
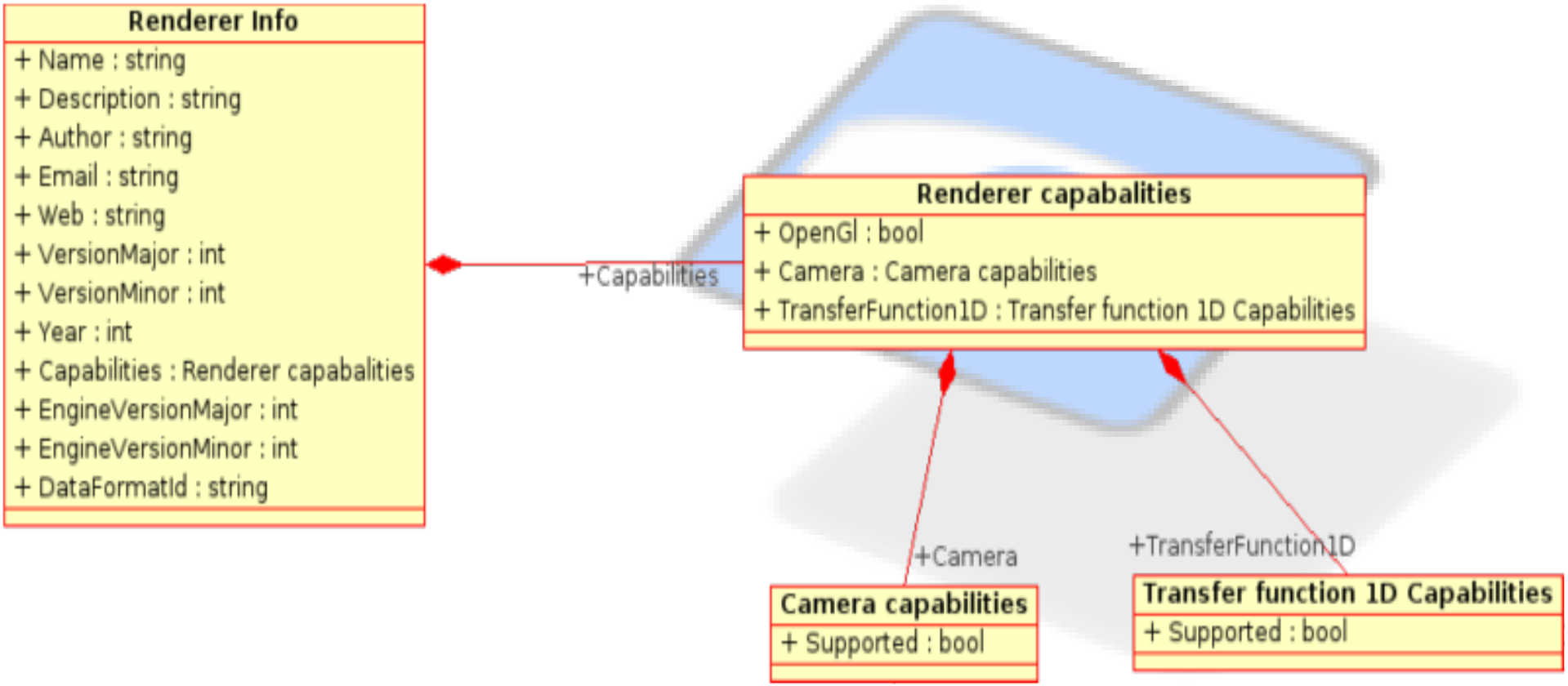
Renderer

- Renderer
  - interface (abstract)
- Subclasses
  - implements rendering
  - provides info
  - creates custom data
  - specifies data format



- Renderer info



Renderer

- Renderer info
  - name, desc., author, version, data format, ...
  - capabilities
    - → supports rendering to OpenGl context
    - → for each scene parameter
      - supported flag
      - supported features (if parameter is supported)
- Scene parameters always present
- Renderer ignores unsupported parts

Outline

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Main manager

- Data manager's routines
  - directory/file browsing
  - available file formats
- List of available renderers
- OpenGl mutex
  - to protect OpenGL when used in GUI

Main manager

- Parameters
  - common, scene, data, ...
  - provided to constructor
  - for server engine – from config file

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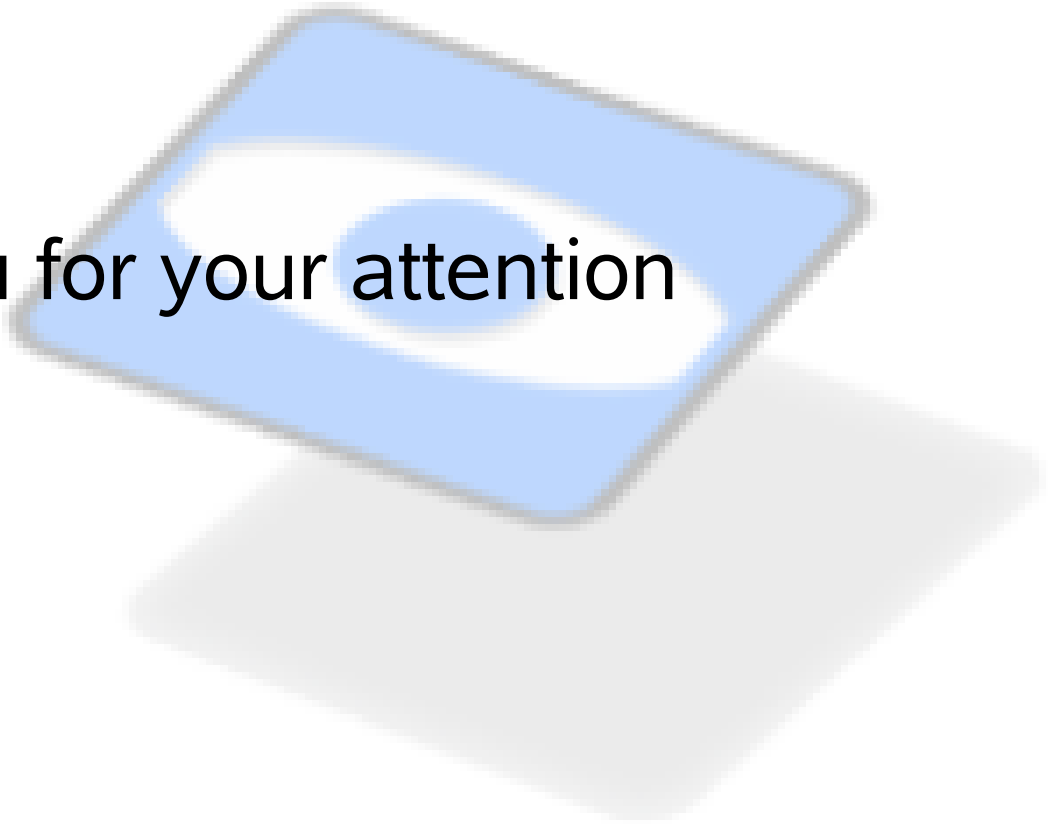
Miscellaneous

- OpenGL problem
  - global namespace
  - not thread-safe
  - only available solution – big mutex
  - problem with multiple clients
  - separate process (engine) for each client on UNIX systems (fork)
  - OpenGl mutex for threads in one process
  - OpenGl 3 => elegant solution? (classes)

Thank you for your attention



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