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# The **E**quation **S**olver Interface Effort (SC'98 Update)

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<http://z.ca.sandia.gov/esi>

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# Outline

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- Intro and objectives of the ESI effort
- Object models and abstraction layers
- Current status
- Plans



# ESI is a Multi-Lab Effort

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DOE initiative, building on previous efforts.

- SNL: Ben Allan, Robert Clay, Lee Taylor, Alan Williams
- LLNL: Colin Aro, Andy Cleary, Rob Falgout, Juliana Hsu
- LANL: Mike DeLong, Robert Ferrell, Wayne Joubert
- ANL: Barry Smith, Lois Curfmann-McInnes
- ORNL: Noel Nachtigal, Jack Dongarra
- LBL: John Wu
- UC Chico: Kyran Mish
- U.Indiana: Randy Bramley
- technical forum: [if-forum@z.ca.sandia.gov](mailto:if-forum@z.ca.sandia.gov)

(<http://z.ca.sandia.gov/esi>)



# ESI Overview

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- Interface design, specification, and prototyping
  - » *scalable sparse linear* solution services and operators
  - » physics/discretization abstractions
  - » targeting ASCI-scale applications / scalable methods
  - » languages to include C, C++, F90 (JAVA)
- Developing an integrated system of object-oriented interface specifications which supports shared, scalable, solver components.
- Focus is on obtaining a long-term solution suitable for ASCI-scale applications.
- Participation in technical discussion is encouraged.



# What problem are we trying to solve?

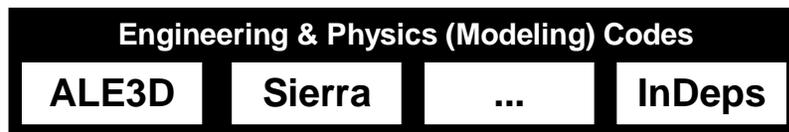
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- For developers... “component”-level interoperability of scalable solver modules.
  - » define & develop linear components (e.g., linear operator, preconditioner, matrix, vector, ...)
  - » improve development efficiency through cross-lab component exchange
- For apps folks... discretization abstractions, e.g. FEI, consolidate view and availability of solver services.
  - » provide broader selection of solver libraries/methods
  - » provide added information to solvers in some case (e.g., element matrices and topological info exposed)
- ESI design group is currently focusing on linear component specification.

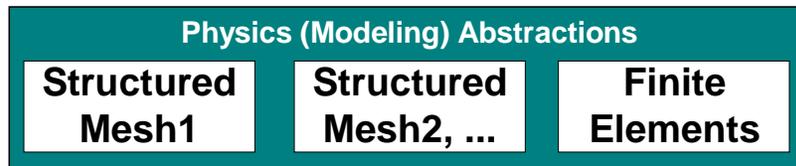


# Abstraction Layers

**E**  
**S**  
**I**



Application codes



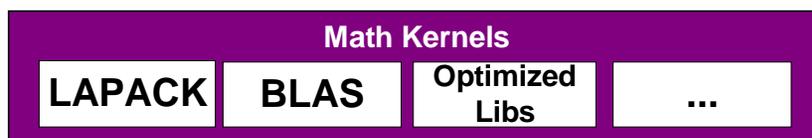
Discretizations



Solver services



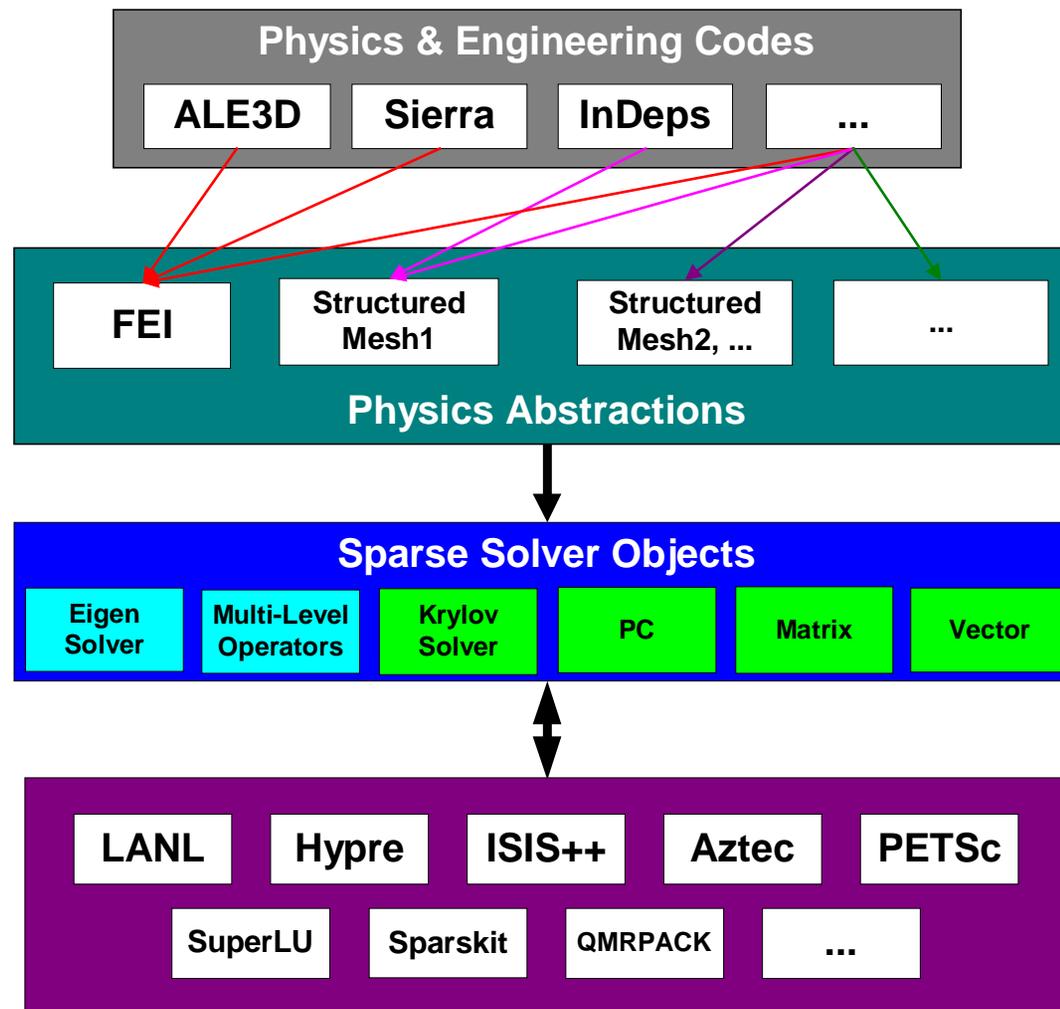
Solver libs



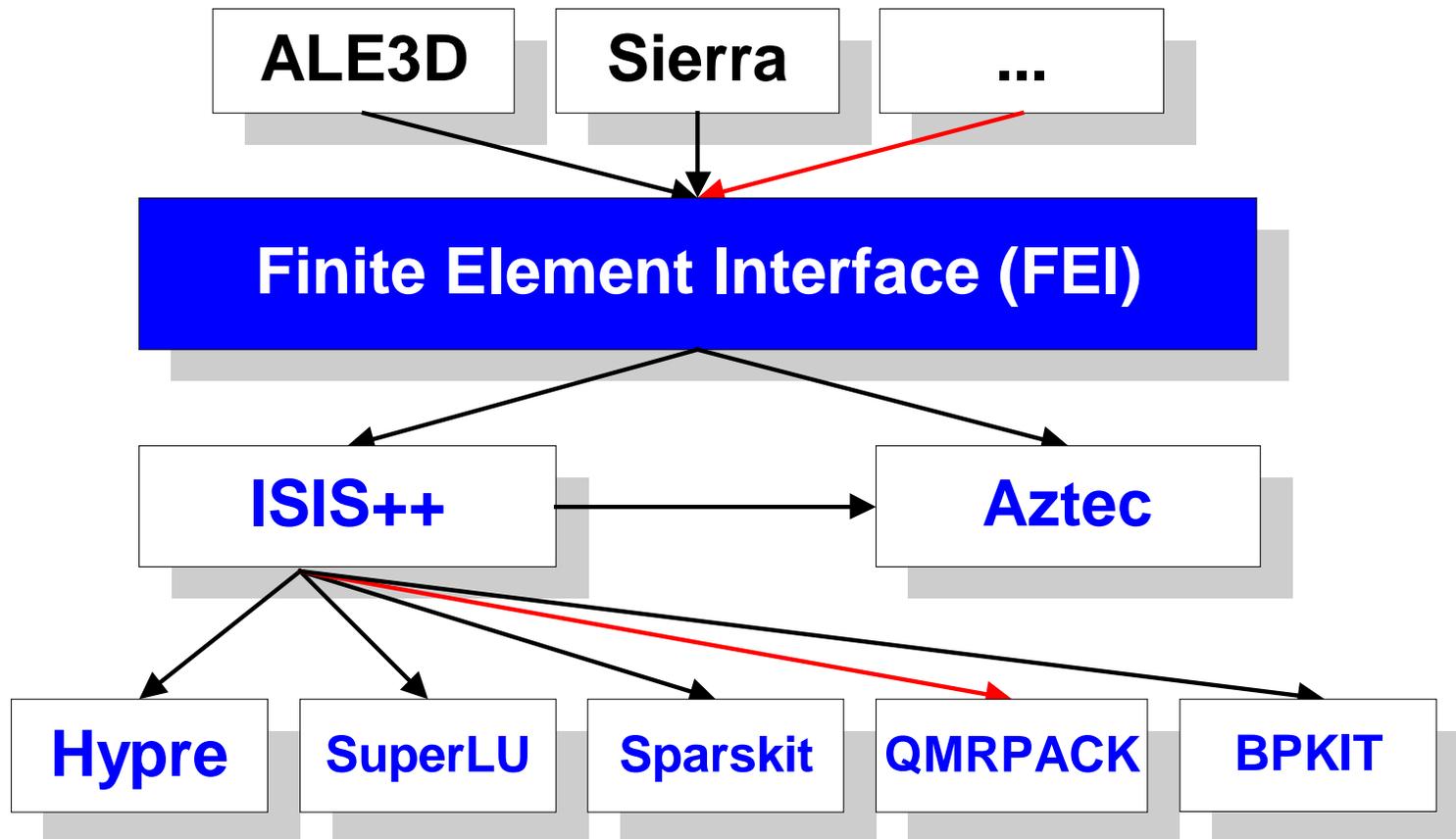
Math kernels



# Access to Solver Libraries

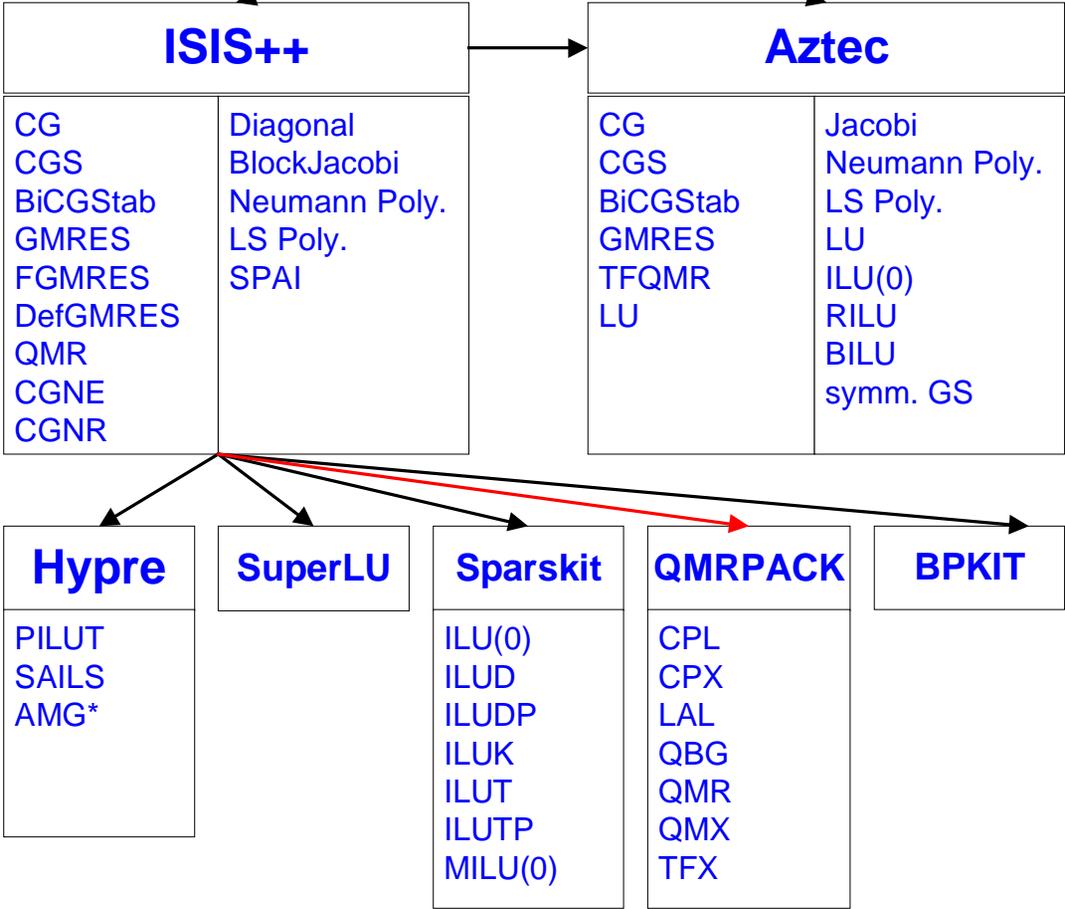


# Solver libraries accessible through the FEI

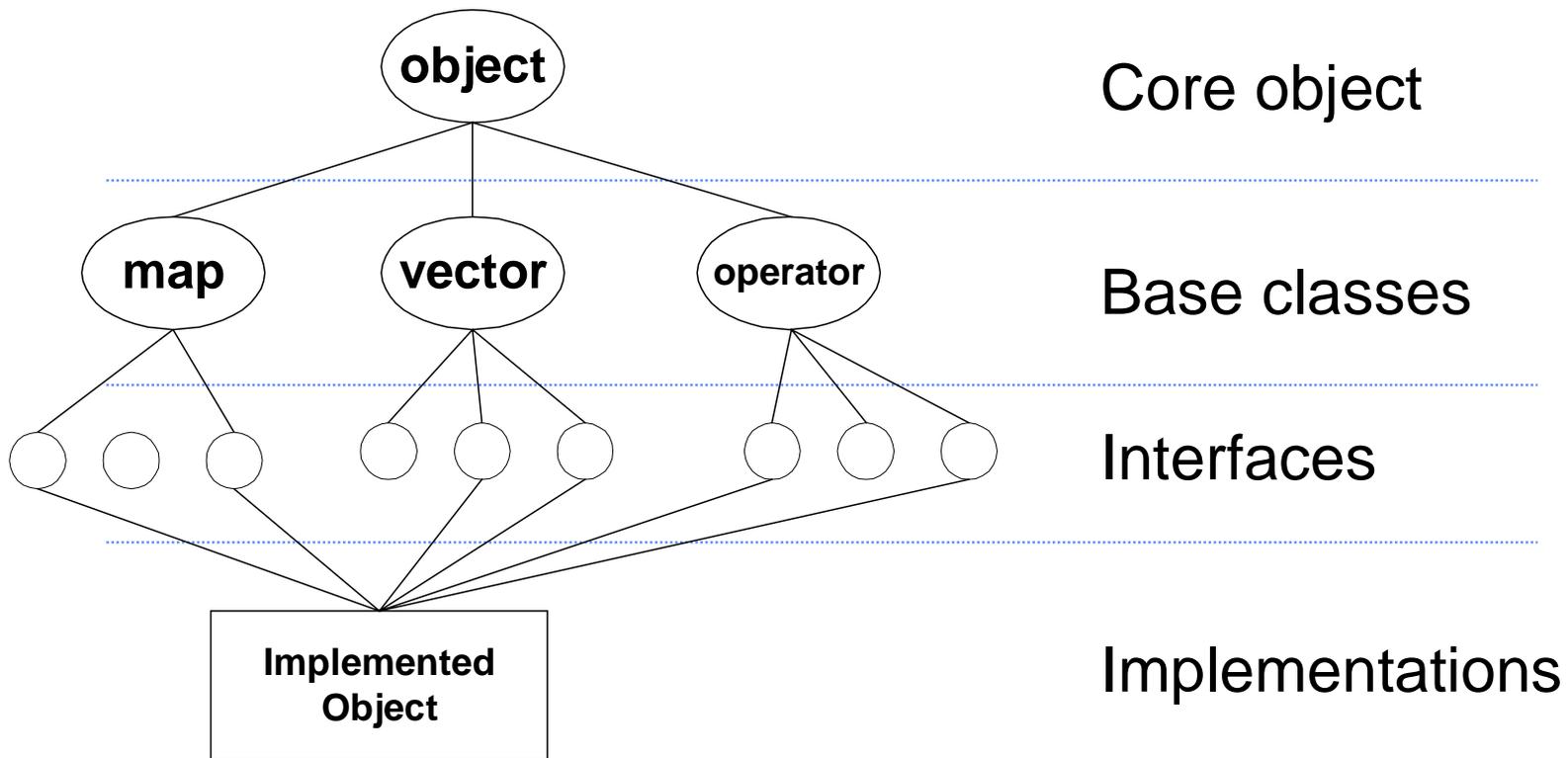


ALE3D Sierra ...

# Finite Element Interface (FEI)



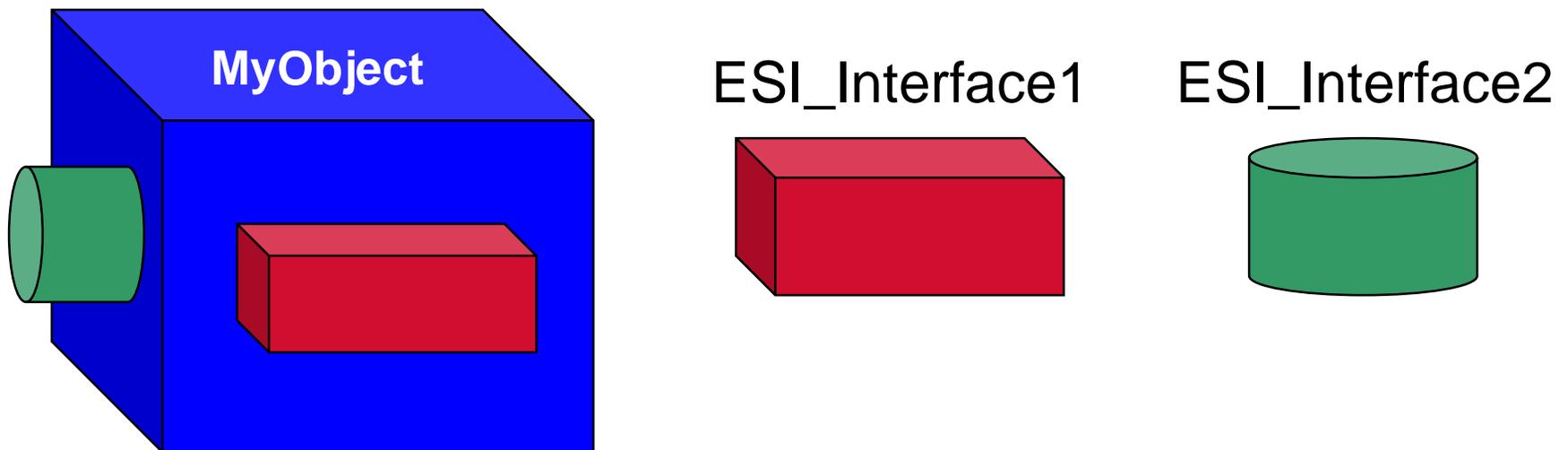
# Multiple Inheritance Model



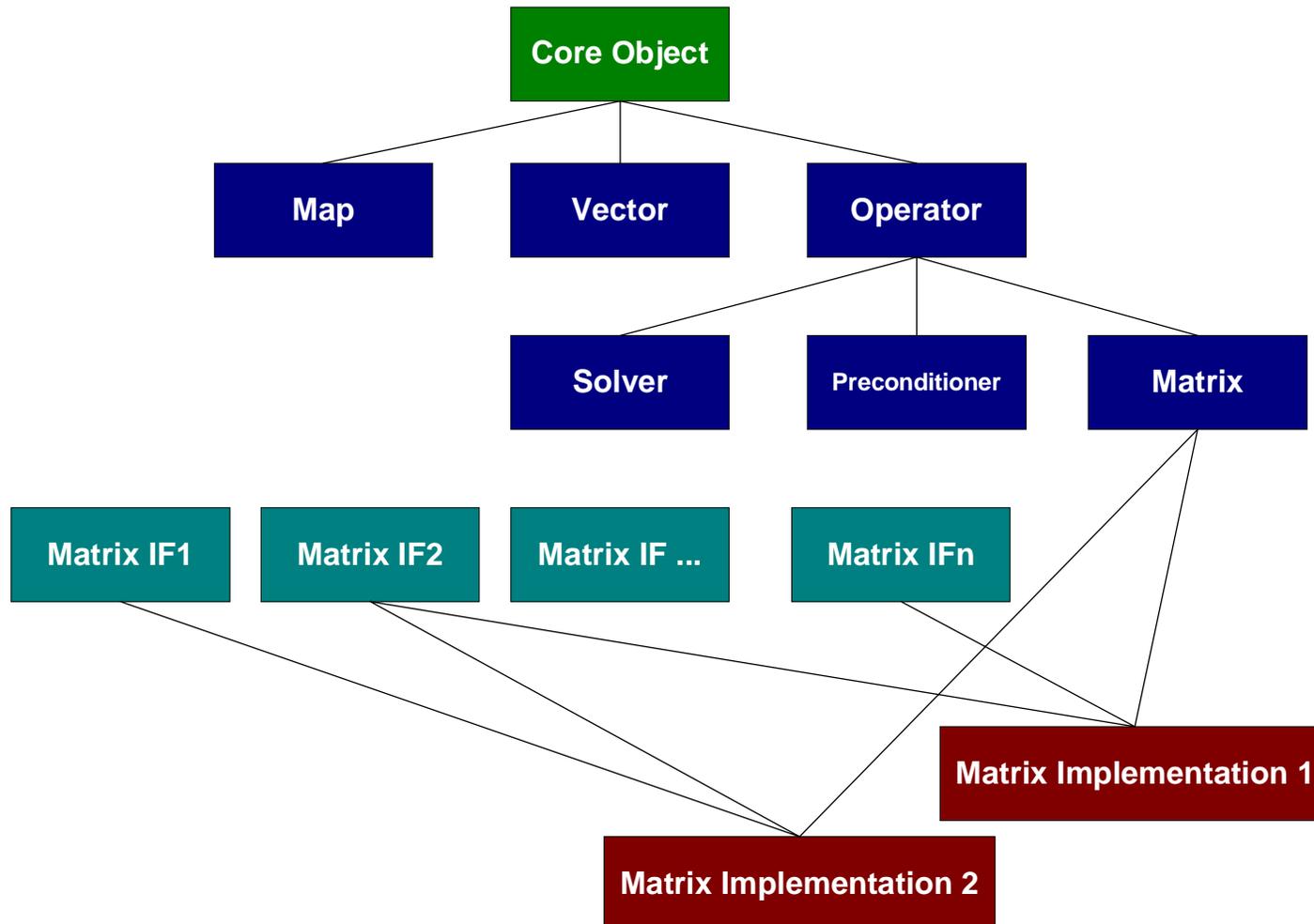
# Multiple Inheritance -- think of building-blocks

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Inheriting multiple standard interfaces makes **MyObject** “plug-compatible” in multiple roles.

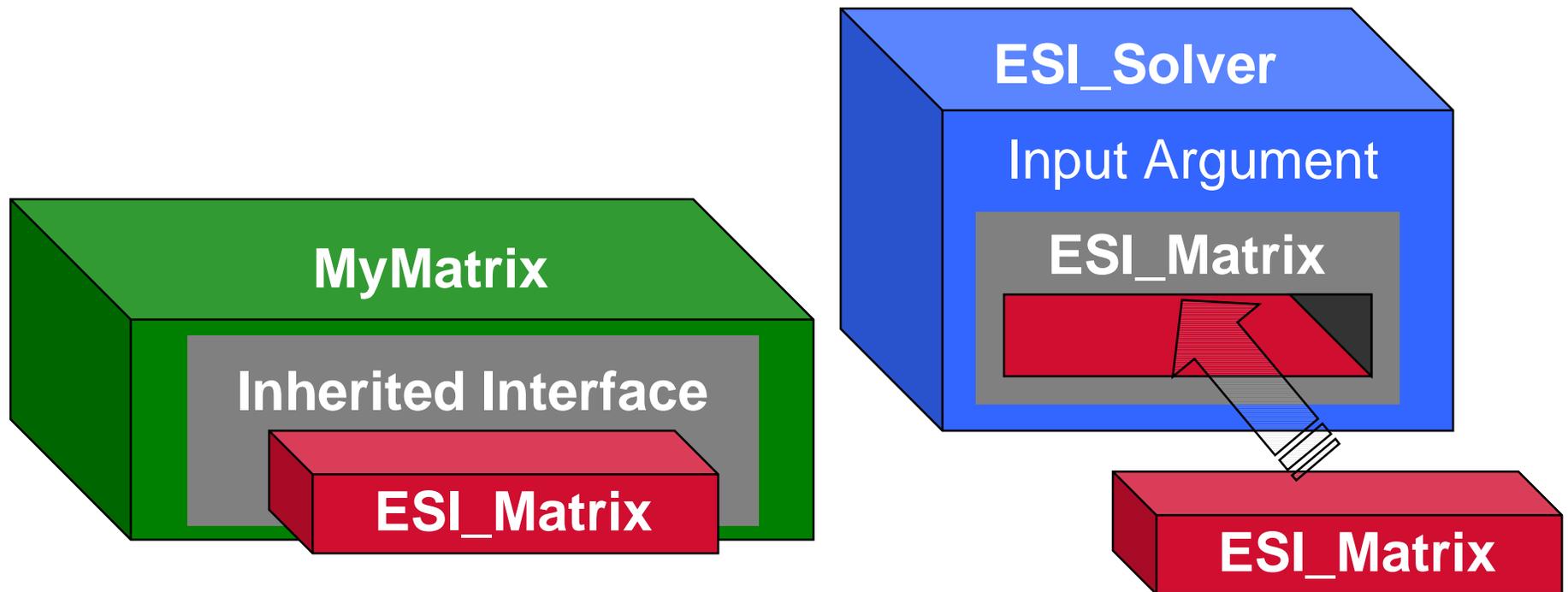


# Core Linear Object Hierarchy



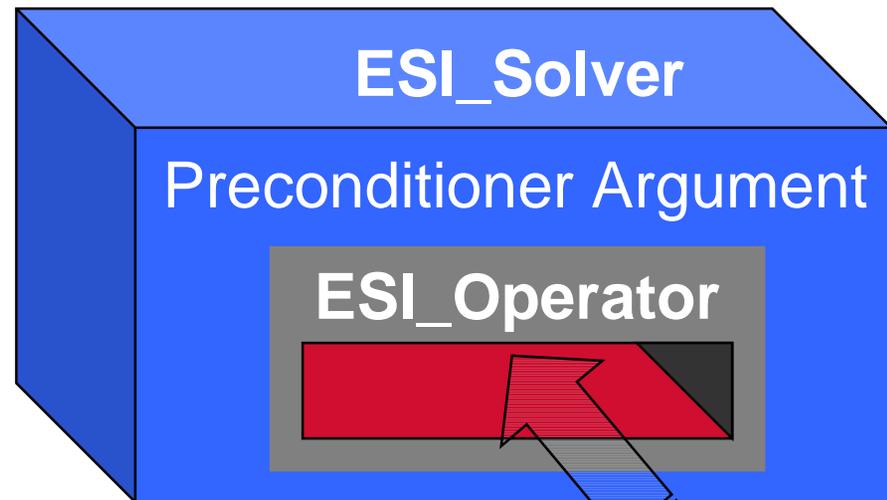
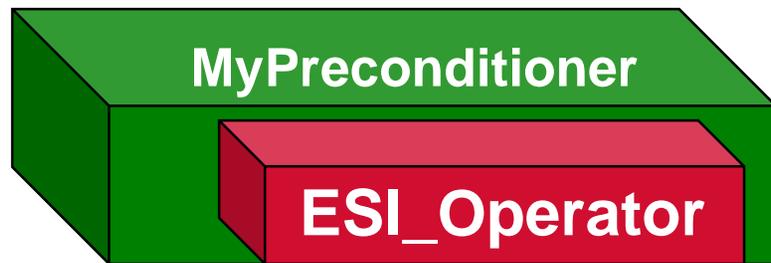
# Standard Interface Example

Any matrix which implements the ESI\_Matrix interface can be plugged into an ESI\_Solver.



# Preconditioning with an ESI\_Operator

Anything that supplies ESI\_Operator functionality can be plugged in and used as a preconditioner.



# ESI Status

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- Linear component interface specification progressing
  - » v0.0 spec posted 8/98
  - » v0.1 spec due end 11/98
- Design meeting held 9/14-15/98
  - » v0.0 spec review
  - » base class definition and functional/interface decomposition
  - » materials posted on web site
  - » converging on flat, multiple inheritance object model
- MPI communication layer (no wrappers)
- FEI v1.0 spec in final review



# ESI Plans

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- Evaluating multiple inheritance model (in progress)
  - » test problems on various machines
  - » core object model design analysis
  - » updating draft linear component spec for review/input
  - » code prototyping (in progress)
- Issue v1.0 linear component specification ~ '99
  - » develop initial implementations
  - » demo interoperability
- Extend linear component specification to include additional services:
  - » eigen solver services
  - » multi-level methods



# ESI Plans - cont.

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- Advance FEI specification and implementations
  - » eigen-solver services
  - » multi-level algorithm support
  - » connection to ESI linear component interface spec
- Next ESI design meeting ~late January '99



# ESI-CCA Interactions

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- Why does ESI effort concern itself w/ the CCA forum?
  - » component definition
  - » object interface negotiation
  - » seamless interface evolution
- ESI can be a sparse linear solver common component
- Overlap in contributors interest in interface and object evolution and standards
- BOF session today -- 5:30PM, room 108a

