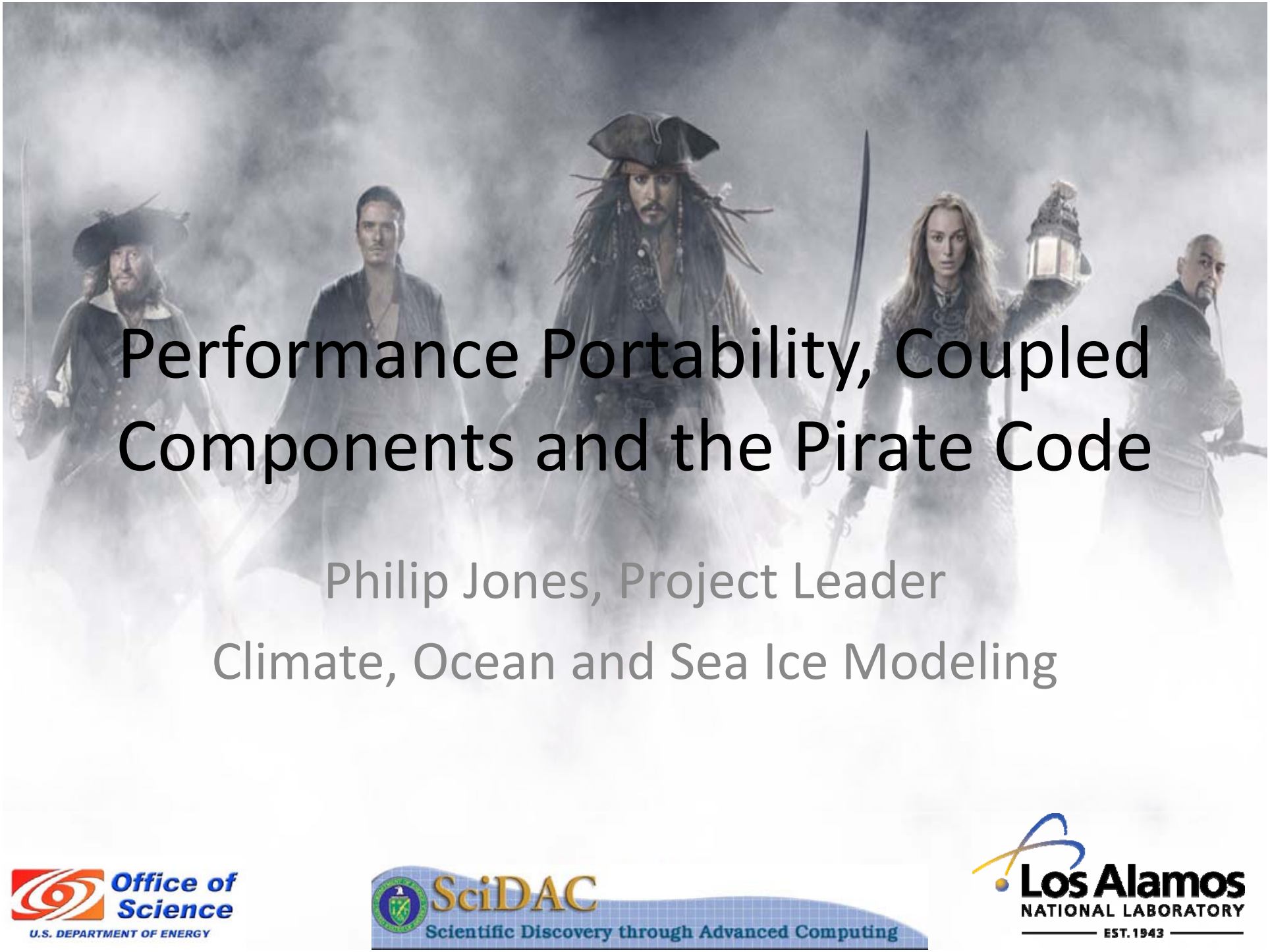

Performance Portability, Coupled Components and the Pirate Code

Philip Jones, Project Leader

Climate, Ocean and Sea Ice Modeling

Office of Science
U.S. DEPARTMENT OF ENERGY

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The Code of the brethren, set down by the pirates Morgan and Bartholomew

- Real
  - Bartholomew Roberts in 1720
  - John Phillips, captain of the *Revenge*, 1724
  - Articles of Edward Low and George Lowther, 1722

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- "The code is more what you'd call guidelines that actual rules" – Capt. Barbossa

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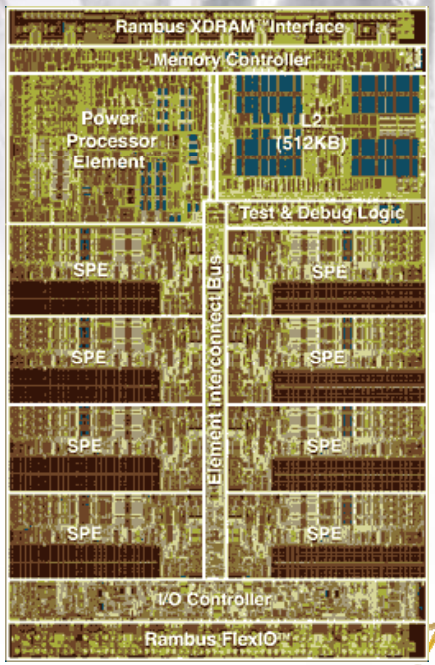
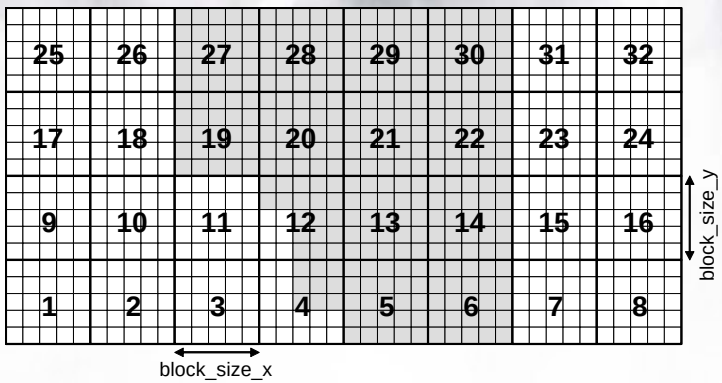
- "The code is more what you'd call guidelines that actual rules" – Capt. Barbossa
- Lessons learned from the Barbary Coast

Here there be monsters

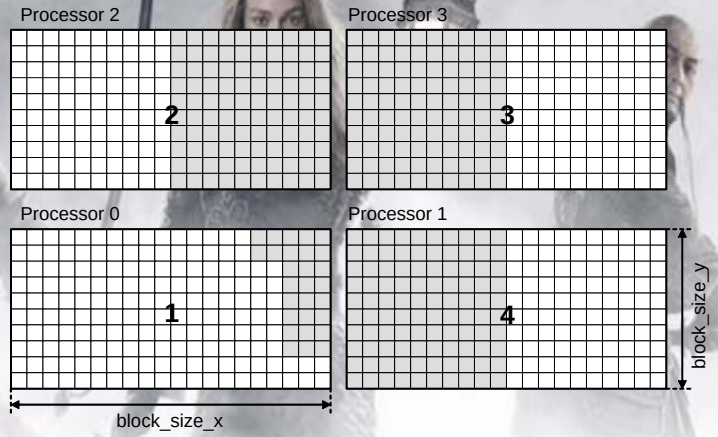
- Computer architectures
  - Single processor perf flat
  - Multi-core
  - Scaling to large proc counts
  - Accelerators (Roadrunner)
- Performance portability
  - Standards
  - Flexible decompositions
  - Encapsulation/abstraction
- Algorithm choice (50%)

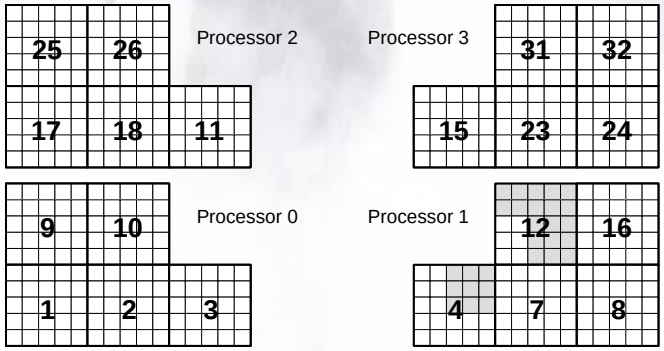


Decomposition for Performance Portability



Load balancing
Land point elim.
Cache blocking
Hybrid parallel
For multi-core





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Architecture

- Hierarchical

Top Level	Drivers, coupling layer, component interface
Mid Level	“Science”, operator abstractions
Low Level	Parallel utilities, performance monitoring, I/O primitives, architecture-specific

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- Abstractions

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Architecture

- Hierarchical
- Abstractions
- We're going to steal the ship? Commandeer. We're going to commandeer that ship. Nautical term.
  - Frameworks (PETSc, CCA, ESMF, MCT)

Top Level	Drivers, coupling layer, component interface
Mid Level	"Science", operator abstractions
Low Level	Parallel utilities, performance monitoring, I/O primitives, architecture-specific

Community Climate System Model

Atmosphere
CAM
(NCAR)

NSF/DOE
300+ Participants

Land
CLM
(NCAR,
Others)

7 States
10 Fluxes

Once
per
hour

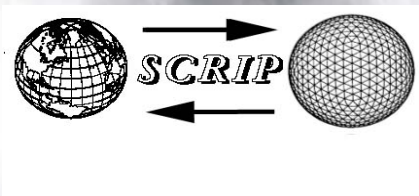
6 States
6 Fluxes

6 States
6 Fluxes

hour
per
Once

7 States
9 Fluxes

Flux Coupler
NCAR/ANL/LANL



4 States
3 Fluxes

day
per
Once

6 Fluxes

6 States
13 Fluxes

Once
per
hour

11 States
10 Fluxes

Ocean
POP
(LANL, NCAR)

Ice
CICE
(LANL,
others)

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  - Init, Run, Finalize
  - Import State, Export State, error/time
  - No side effects
  - At subroutine level too

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- Components
  - Init, Run, Finalize
  - Import State, Export State, error/time
  - No side effects
  - At subroutine level too
- Issues
  - Shared fields
  - Interpolation (dynamic): adaptive meshes, variable coastlines and topography, retreating ice
  - No longer surface: ice shelf and ocean vert. coords, b.c.

Community Development

- I think we've all arrived at a very special place. Spiritually, ecumenically, grammatically.

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- Shared repositories (svn)
- Interfaces and documentation
  - Trac (wiki based for community, bug/feature tracking, links to svn), internal doc (proTeX)
- Testing (unit and system)
- If you were waiting for an opportune moment, that was it.

Savvy?

Drink up, me hearties, yo ho…

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