Numerical Algorithm Focus Group

"Estimating and minimizing modeling cost"

SEAM Workshop, SEG 2005, Houston

Outline

- Role of numerical algorithm group
- Basic consideration for seismic modeling
- Cost estimates for actual example models

Algorithm Group

- Find best solution method to geological modeling problem
- Ensure simulation results are accurate
- Provide cost/time estimates for simulations
- Potentially provide/locate modeling capability

Algorithm Group

- Support for the design group
- QC of results
- Transparency

Algorithm Group – Why QC?

- Potentially several providers of simulation results
- Providers may not be able to give access to source code or otherwise prove the applicability of modeling capability

Algorithm Group – Why QC?

Reasons for several providers:

- Speed/Delivery time
- Accuracy
- Acceptance
- Use of proprietary techniques

Basic Cost Considerations

- Number of grid points in a model coupled with source frequency and velocity range determines the computational effort, and eventually the final cost

Basic Cost Considerations

- Only parts of the actual model are used to simulate a shot (we do not expect significant illumination of other parts of the model)
- Source peak frequency scales with power of 4 for computational effort
  cost ~ $(f_{peak})^4$

Basic Cost Considerations

- Lowest velocity determines maximum spatial discretization (cost ~ $(\Delta x)^3$ in 3D)
- Highest velocity determines temporal discretization (cost ~ proportional)
- Actual size (cost ~ proportional to volume)

Basic Cost Considerations

- Choices of modeling methods

- Standard FD O(2,4)
- Standard FD O(4,4)
- Pseudo spectral FD

- Other ???

Basic Cost Considerations

- Core processor
- Memory (Bus) Speed
- Network interconnect
- Parallel implementation

- All above leads to actual available compute speeds

Preliminary Cost Estimates

- Acoustic variable density model
- The simulation cost is based on shot modeling, i.e., the actual model is bigger than what is modeled per shot, assuming that the other parts of the model will not affect data significantly due to acquisition geometry

Suggested model

Core Model Size	Δx	Memory
30x30x15 km, O(2,4)	10 m	201 – 302 GB
30x30x15 km, O(4,4)	12.5 m	103 – 155 GB

Suggested model

Accuracy	P only formulation	P-V formulation
O(2,4)	16600TFlops	8100 TFlops
O(4,4)	19640 TFlops	16174 TFlops

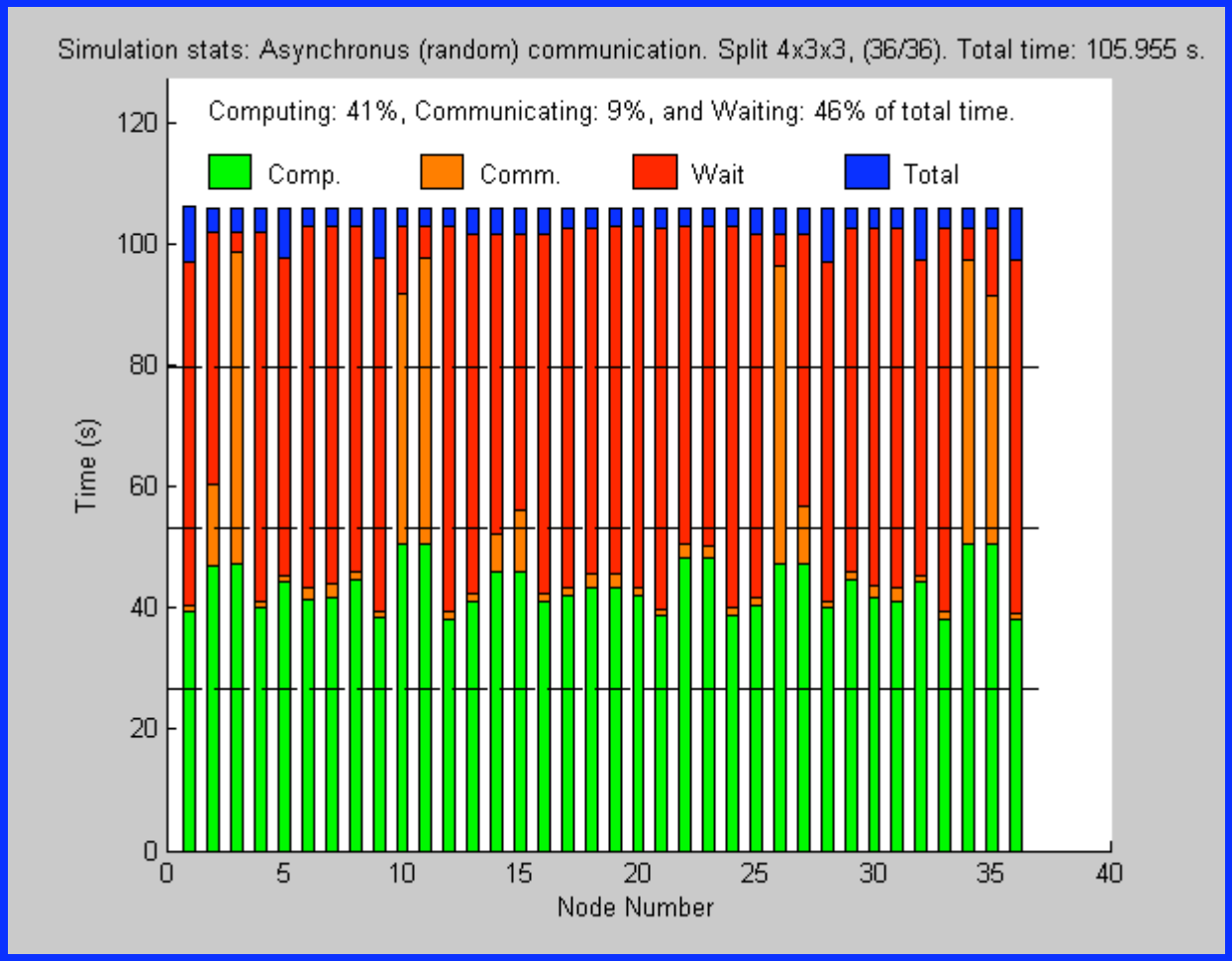
12 s data, 30 Hz peak

Suggested model

Current computer architecture have likely higher flop-rate with O(4,4) schemes than O(2,4)

Currently investigating the different schemes for computation cost

Preliminary results



P only
O(4,4)

2000x20
00x1000
points