Restructuring IWave

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IWave now

- provide a variable den AWE solver in up to 3D
- staggered grid FD scheme of order 2 in time and $2k$ in space
- support either reflecting or absorbing bnd cond
- output traces (seismograms) at specified sample rates and/or movie frames
- *mpi* parallelization via domain decomp and/or *openmp*

IWave in future for users

- provide other wave solvers, e.g., linear elastic wave equations
- implement various FDTD methods for research and practical uses

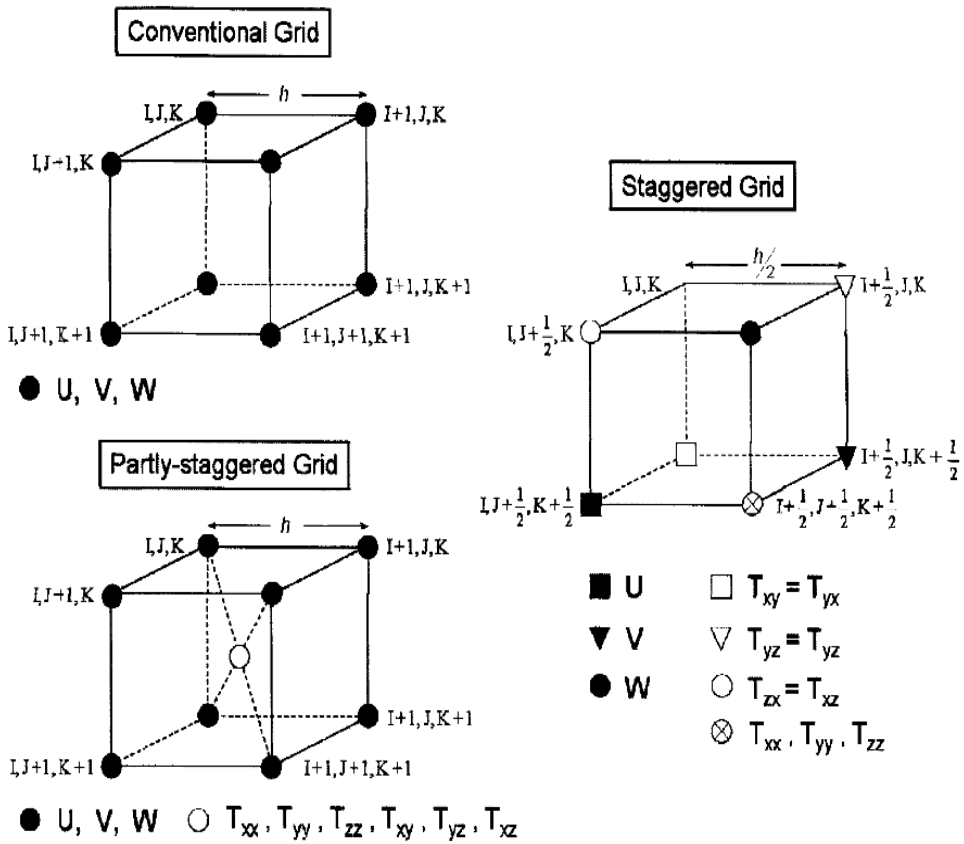


Figure: courtesy of Moczo et al. 2007

IWave in future for developers

make it easy to generate new wave solver

- leave memory allocation, process communication, I/O and so on to IWAVE
- let developers concentrate on
  - designing the efficient computing routines
  - trying their ideas very quickly

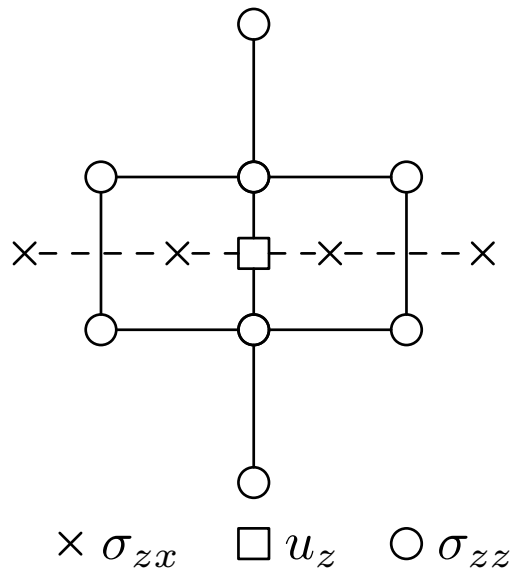
FD stencils

determine the preparation stage of a FD solver, but seems there are a lot of choices

e.g.,

$$\rho \frac{\partial u_z}{\partial t} = \frac{\partial \sigma_{\mathbf{zz}}}{\partial \mathbf{z}} + \frac{\partial \sigma_{\mathbf{zx}}}{\partial \mathbf{x}}$$

staggered grid stencil



using 4th order stencil, updating u_z at (i,j) requires

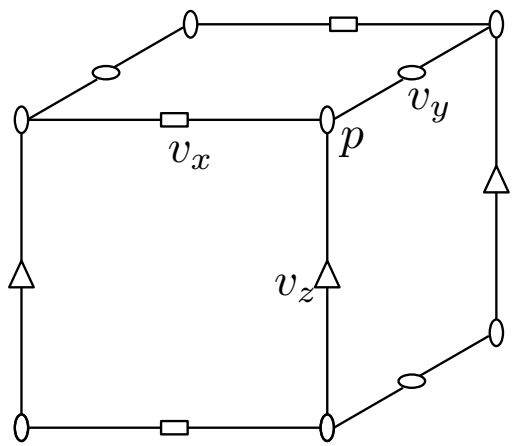
- σ_{zz}: $(i-1,j),(i,j),(i+1,j),(i+2,j)$
- σ_{zx}: $(i,j-2),(i,j-1),(i,j),(i,j+1)$

Patterns of FDTD wave solvers

- wave equations have terms of up to 1st order spatial derivative

- FD discretization **along each spatial axis** has up to 2 different types of grids,
  - primal grid: integer grid, index-0 grid $\Rightarrow$ 0
  - dual grid: half integer grid, index-0 grid $\Rightarrow$ 1/2

  e.g., pressure p on primal grids along 3 axes, v_x on dual grid along x-axis and primal grids along y-axis and z-axis



Define the FD stencils

- grid type table for each variable
- dependent relation involving field variables

e.g., 2D isotropic elastic wave staggered grid FDTD solver

	grid type		dependent relation				
	z-axis	x-axis	σ_{zz}	σ_{xx}	σ_{zx}	u_z	u_x
σ_{zz}	P	P	-	-	-	$\partial/\partial z$	$\partial/\partial x$
σ_{xx}	P	P	-	-	-	$\partial/\partial z$	$\partial/\partial x$
σ_{zx}	D	D	-	-	-	$\partial/\partial x$	$\partial/\partial z$
u_z	D	P	$\partial/\partial z$	-	$\partial/\partial x$	-	-
u_z	P	D	-	$\partial/\partial x$	$\partial/\partial z$	-	-

Automatic wave solver generation

according to the tables, IWave will automatically

- generate FD stencil
- then allocate necessary memory for field variables
- prepare I/O, parallelization required information
- finally, link user's computation routines

Create your WAVE

- fill the table

	grid type		dependent relation				
	z-axis	x-axis	σ_{zz}	σ_{xx}	σ_{zx}	u_z	u_x
σ_{zz}							
σ_{xx}							
σ_{zx}							
u_z							
u_z							

Submit

- click the **Submit** button $\Rightarrow$ **a parallel FDTD wave solver**
- enjoy your own wave solver

Thank You

Q&A