




The Compute : Communicate Ratio



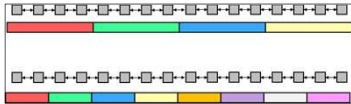
Oregon State University
Mike Bailey
mjb@cs.oregonstate.edu



This work is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](https://creativecommons.org/licenses/by-nc-nd/4.0/)




Oregon State University
Computer Graphics




compute_communicate_ratio.pptx


mjb - June 13, 2022

1D Compute-to-Communicate Ratio





Intracore computing




Intercore communication

Compute : Communicate ratio = N : 2

where N is the number of compute cells per core

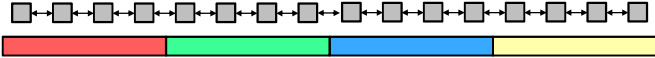
In the above drawing, Compute : Communicate is 4 : 2



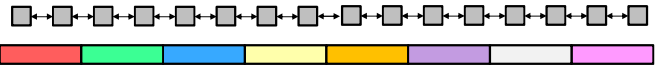
Oregon State University
Computer Graphics

mjb - June 13, 2022

How do more Cores Interact with the Compute-to-Communicate Ratio?



In this case, with 4 cores, Compute : Communicate = 4 : 2




In this case, with 8 cores, Compute : Communicate = 2 : 2

Think if it as a *Goldilocks and the Three Bears* sort of thing. :-)

Too little *Compute : Communicate* and you are spending all your time sharing data values across threads and doing too little computing

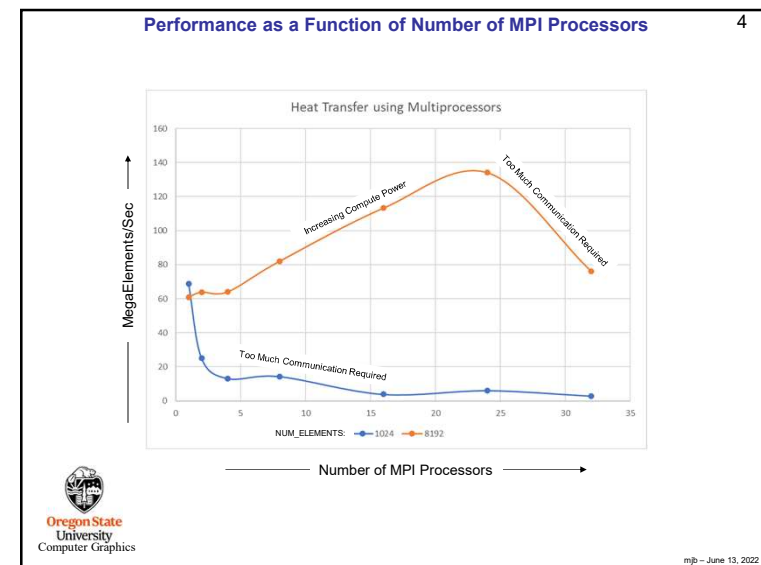
Too much *Compute : Communicate* and you are not spreading out your problem among enough threads to get good parallelism.

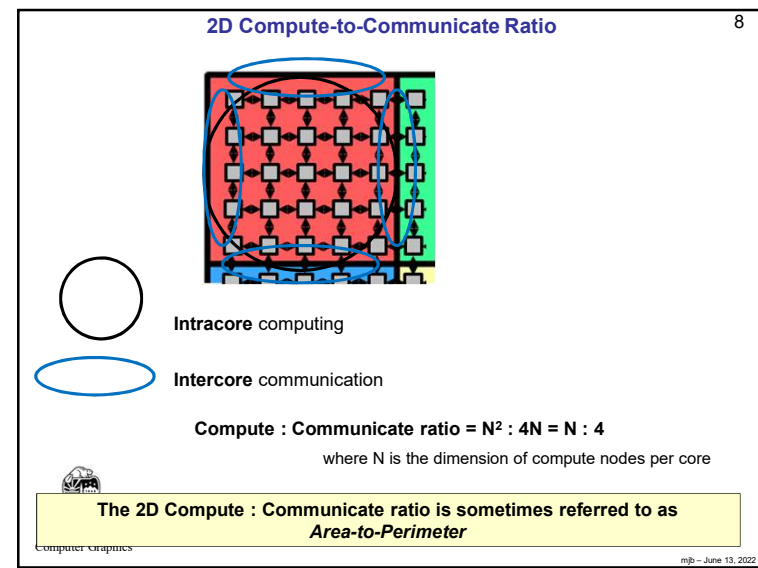
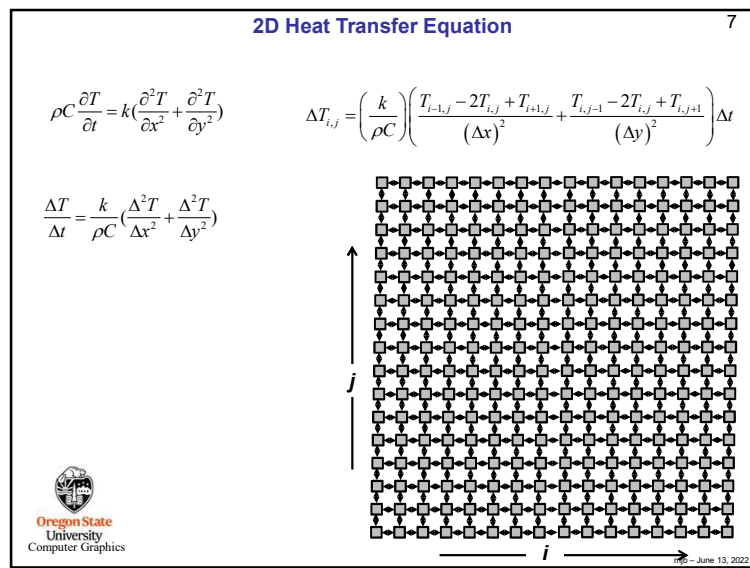
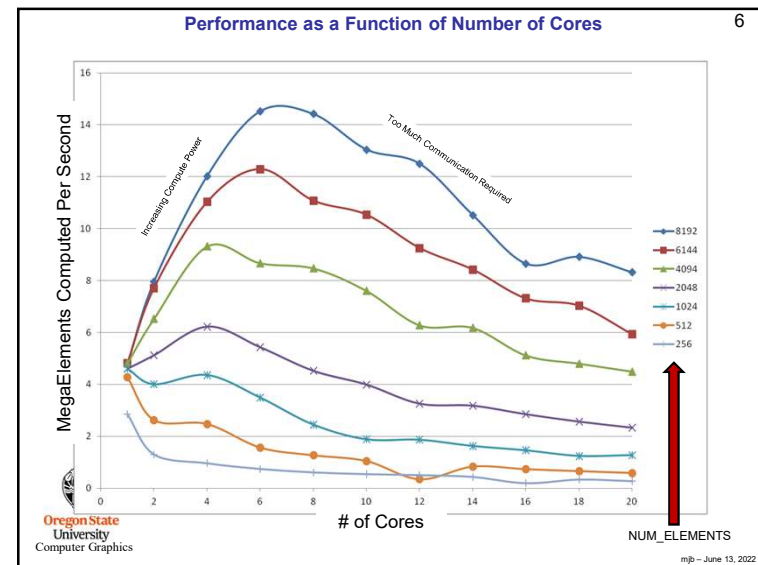
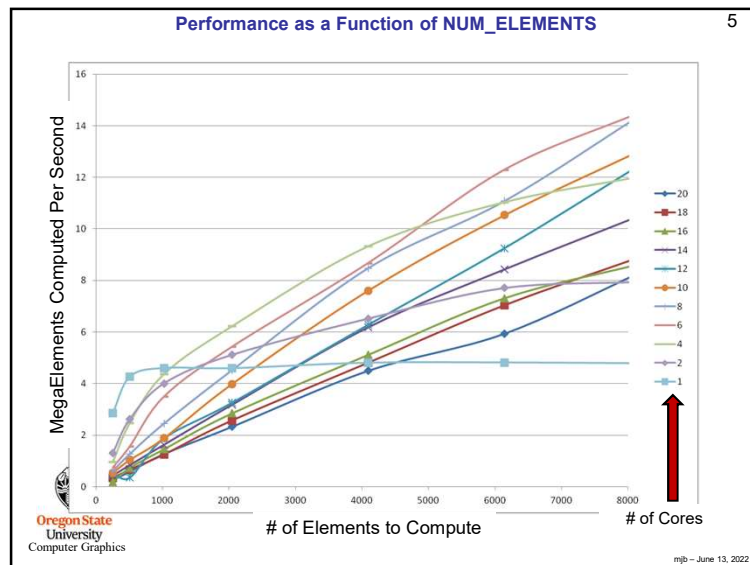
It's difficult to find the "sweet spot" without running experiments



Oregon State University
Computer Graphics

mjb - June 13, 2022





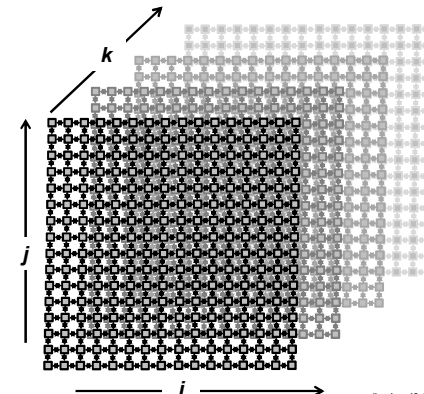
3D Heat Transfer Equation


$$\rho C \frac{\partial T}{\partial t} = k \left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial z^2} \right)$$

$$\Delta T_{i,j,k} = \left(\frac{k}{\rho C} \right) \left(\frac{T_{i-1,j,k} - 2T_{i,j,k} + T_{i+1,j,k}}{(\Delta x)^2} + \frac{T_{i,j-1,k} - 2T_{i,j,k} + T_{i,j+1,k}}{(\Delta y)^2} + \frac{T_{i,j,k-1} - 2T_{i,j,k} + T_{i,j,k+1}}{(\Delta z)^2} \right) \Delta t$$

$$\frac{\Delta T}{\Delta t} = \frac{k}{\rho C} \left(\frac{\Delta^2 T}{\Delta x^2} + \frac{\Delta^2 T}{\Delta y^2} + \frac{\Delta^2 T}{\Delta z^2} \right)$$

9





mjb - June 13, 2022



3D Compute-to-Communicate Ratio

Compute : Communicate ratio = $N^3 : 6N^2 = N : 6$

where N is the dimension of compute nodes per core

10

In 3D the Compute : Communicate ratio is sometimes referred to as
Volume-to-Surface

mjb - June 13, 2022