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PARALLEL MESH MULTIPLICATION AND GENERATION: TOWARDS PETASCALE SIMULATIONS

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Abstract. In this talk we review our current efforts in the development of enabling technologies for parallel large-scale simulations. We begin by revisiting the concept of what is large, given the current capabilities of today's high performance computers and high resolution visualisation devices. In the sequel we discuss a very efficient parallel procedure to produce high resolution models, the mesh multiplication (MM). MM recursively refines your mesh until a preset level is reached. Implementation issues, associated to mesh partition and unknown reordering are addressed. We then show a parallel implementation and performance analysis of a linear octree-based mesh generation scheme designed to create reasonable-quality, geometry-adapted unstructured hexahedral meshes automatically from triangulated surface models. We present algorithms for the construction, 2:1 balancing and meshing large linear octrees. Our scheme uses efficient computer graphics algorithms for surface detection, allowing us to represent complex geometries. We show that our implementation is able to execute the 2:1 balancing operations over 3.4 billion octants in less than 10 seconds per 1.6 million octants per CPU core. Next we examine the performance impact from tetrahedralization of non- conforming meshes generated by our parallel octree mesh generation scheme. We end our talk with a discussion of the applicability of these enabling technologies in challenging new applications in science and engineering.