

Scalable Terrain Rendering Data Management Infrastructure

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Overview

- **Goal** [Ideal Terrain Rendering System]
- **Problem** [Performance]
- **Solutions** [GPUs, Level-of-detail, Out-of-core operation, Data streaming]
- **The Big Picture** [A Diagram]
- **What is missing?** [My Thesis]

Goal – Ideal Terrain Rendering System

- **Interactive**
 - [real-time rendering driven by user input]
- **Accurate**
 - [complex geometry and high-resolution images]
- **Scalable**
 - [rendering performance independent of hardware capabilities and data set size]

Problem – Performance

- In general, interactive 3D rendering is computationally intensive.
- Terrain rendering introduces additional performance issues.

Problem – Performance (cont)

- Accurate 3D rendering requires using detail and complex geometry as well as high-resolution images.
- Increased computational cost
- Increased data storage requirements

Problem – Performance (cont)

- The interactive rendering of complex geometry using **consumer-level PC hardware** is currently feasible by exploiting **GPU** hardware and by employing **Level of Detail** rendering techniques.

Problem – Performance (cont)

- GPUs allow improved rendering performance by the used of specialized hardware.
- Level-of-detail allow improved rendering by regulating the amount of detail used during the rendering.

Problem – Performance (cont)

- Increase in main memory and disk storage capacity in **consumer-level PC** partially alleviates the data storage needs required for accurate terrain visualization.

Problem – Performance (cont)

- Out-of-core operation allow working with data sets that surpass main memory capacity.
- Data streaming techniques allow working with data sets that surpass disk storage capacity.

Solutions - GPUs

- Specialized programmable hardware optimized for 3D rendering operations.
- Maximizing GPU utilization requires continuously **streaming** data into the GPU memory.

Solutions – GPUs (cont)

Limitations:

- Not all PCs have GPUs
- Not all GPUs are created equal

Solutions – Level of Detail

- Regulate geometric complexity and image resolution to used only the level of detail required for a particular situation (visual orientation, distance to the terrain, geometry complexity)

Solutions – Level of Detail (cont)

- Requires maintaining a data structure in memory to manage multiple terrain representations at different level of detail, and performing a selection criteria to select which representation to use.

Solutions – Level of Detail (cont)

- Different LOD techniques employ different data structures (generally trees) and employ different selection criteria as well as different simplification algorithms to produce the different terrain representations

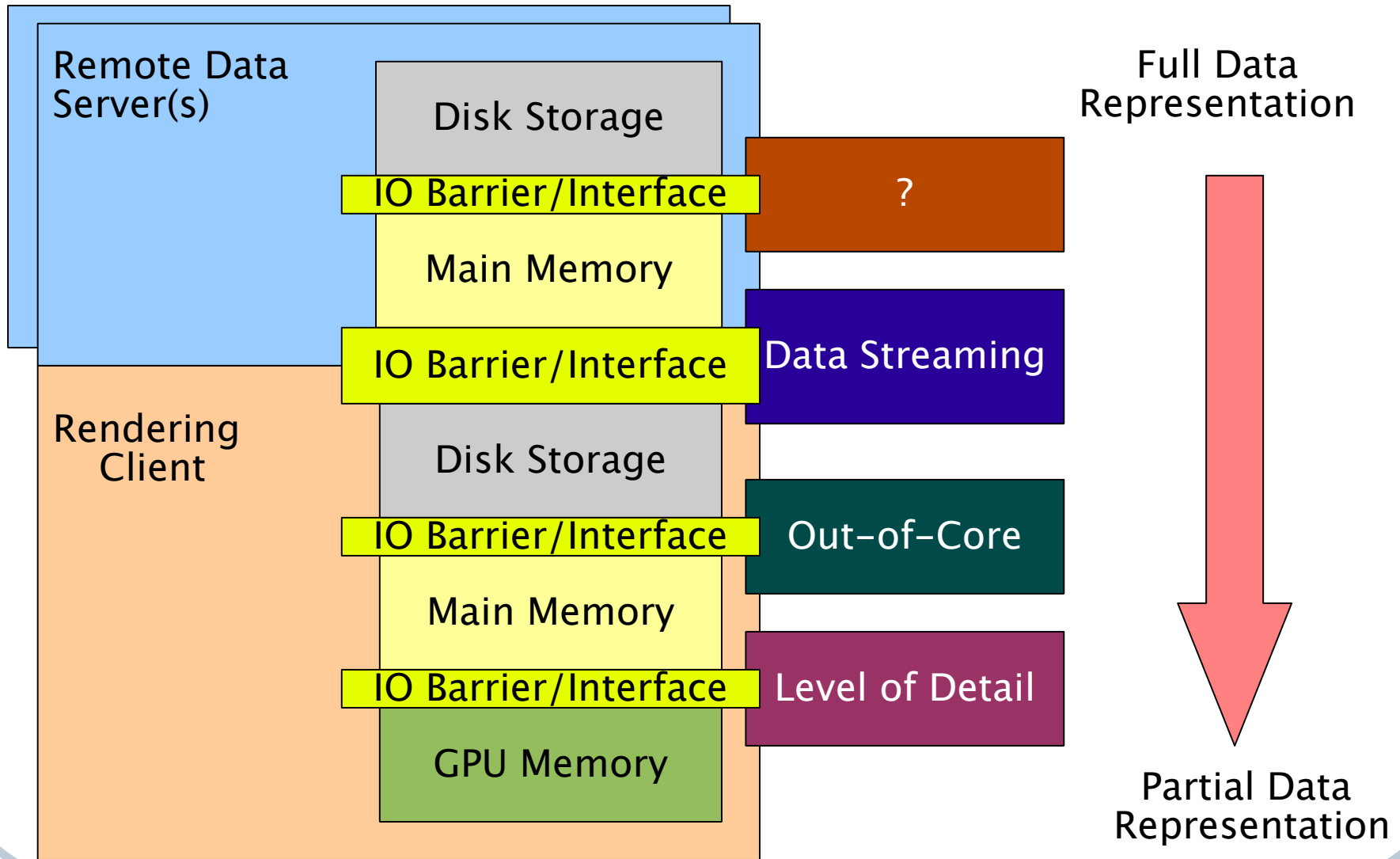
Solutions – Level of Detail (cont)

- LOD techniques may perform terrain simplification off-line (discrete), at run-time (continuous) , or a combination of both.

Solutions – Out-of-core Operations

- Data management scheme to support working with data larger than the available main memory.
- Requires maintaining a data structure to map terrain data segments to the actual data on disk.

The Big Picture



What is missing? (cont)

Conceptual framework of the problem:

- Data characteristics
- Layer characteristic
- IO Barrier characteristics
- Data selection characteristics ?

What is missing? (cont)

- What about embedded devices (smart phones and PDAs)?
- What about Web applications?
- Can we generalized for them too?

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Questions?

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