XtreemOS

Enabling Linux for the Grid

Object Sharing Service

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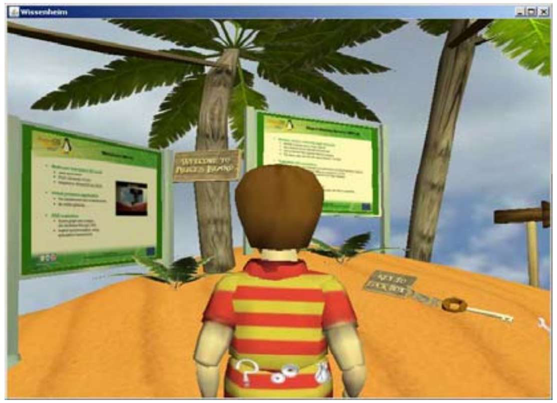
Information Society Technologies

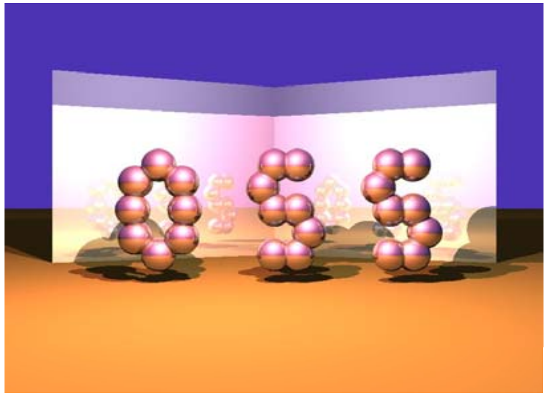
Objectives

- Simplify data exchange & consistency management
- By supporting (shared) memory-mapped files
- Allowing transparent remote data access
- Automatic consistency management
- Complement traditional message passing:
  - Eliminate hand-written code to maintain consistency of cached data
  - Avoid passing large object structures repeatedly by value
  - Avoid deep-copy of parameters

Target Applications



- **Distributed interactive applications:**
  - **Multi-user applications**
  - **E.g. virtual worlds (Wissenheim, WP4.2)**
    - Test Scene graph and avatars are accessed through OSS
    - Implicit synchronization using speculative transactions



- **Number crunching:**
  - **Cluster of clusters (JuxMem)?**
  - **Not our major goal but OSS is open source …**

Replica & Consistency Management

- **Naming / access control through XtreemFS**
  - **One file contains one or many objects**
  - **New objects can be allocated dynamically**

- **Replication Management:**
  - **Shared objects are automatically replicated**
  - **For performance near clients accessing objects**
  - **For reliability reasons also farer away**

- **Consistency Management:**
  - **Supporting different consistency models**
    - Further models can use basic operations: *push*, *pull*, *sync*, …
  - **Transactional consistency of major interest (~transactional memory)**

Transactional Consistency

- Speculative transactions defined by the programmer.
  - BOT, EOT, Abort

- Write accesses to shared objects are bundled into transactions:
  - Reduce synchronization frequency
  - Smaller number of messages
  - Avoid lock management

- Write sets are validated & propagated at commit time.

- In case of a conflict transactions may be aborted:
  - Changes are reset using shadow pages
  - But for modified shared objects only

Scalability

- Different consistency domains.
- Local commits / read-only transactions.
- Pipelined transactions:
  - Start next transaction before a commit is validated
  - Pros: Hides latency of commit
  - Cons: May result in a cascading abort
- P2P techniques (synergies with WP3.2):
  - Hierarchical network structure (super peers)
  - Distributed hash table for data search
  - P2P server network + clients
- Weak consistent objects

Reliability

- **Overlay network structures.**
- **Transaction history buffers for recovery from missed TAs**
  - **Avoiding a reliable overlay multicast**
- **Replication of shared objects**
- **Grid Checkpointing for severe errors.**
- **XtreemFS for persistence.**

Heterogeneity

- Types and data structures need to be defined using a IDL
- Language-dependent mappings by a custom pre-compiler
- Conversion mechanisms
  - Pointer-swizzling to adapt pointers to local machine architectures
  - Data conversion using IDL stubs
- Memory access detection by MMU or compiler support
- Alternative: integration of OSS into a JVM (e.g. Kaffe).

False Sharing Control

- **Solution: one logical memory page per object**
  - **But several objects stored on a page frame**
  - **Allows access detection at the object level**

- **Pros:**
  - **Eliminates false sharing**
  - **Without wasting physical memory**

- **Cons:**
  - **Pollutes TLB (not too critical in a grid)**
  - **Consumes more logical address space (→ 64-Bit)**

- **Object access groups:**
  - **For adaptive access control management**
  - **One page fault per object access group**

Conclusions

- **Simplify development of distributed/parallel applications.**
- **Automatic replica & consistency management.**
- **Allowing transparent remote data accesses.**
- **Complement traditional message passing.**
- **Speculative transactions for convenience and efficiency.**