I/O-efficient Buffer Tree Implementation

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Lars Arge. ``The Buffer Tree: A Technique for Designing Batched External Data Structures." Algorithmica, 37(1):1-24, 2003.

Guide

- Summary Buffer Tree
- Software Platform & Design
  - Software Design and Tree Representation
  - Tree Representation in External Memory
  - Implementation Details
- Evaluation
- Notes

Buffer Tree Data Structure

- Modified (a, b)-tree
  - Node fan-out is between m/4 and m
  - O(N) Leaves store each at most B elements
- Nodes are each associated with an operation buffer
- Tree operations are inserted into the operation buffer and processed in batches
- Operations are evaluated at the leaf level

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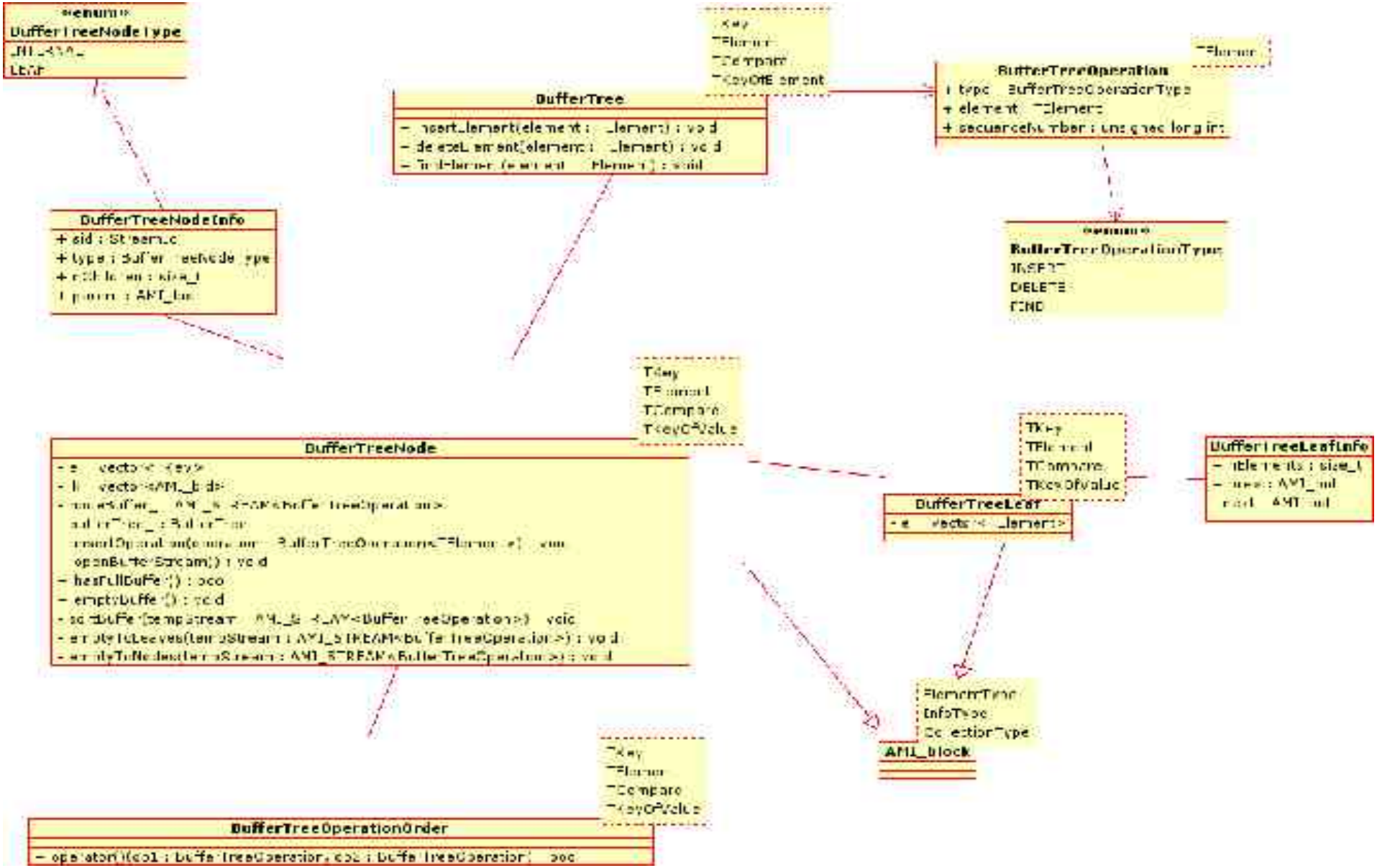
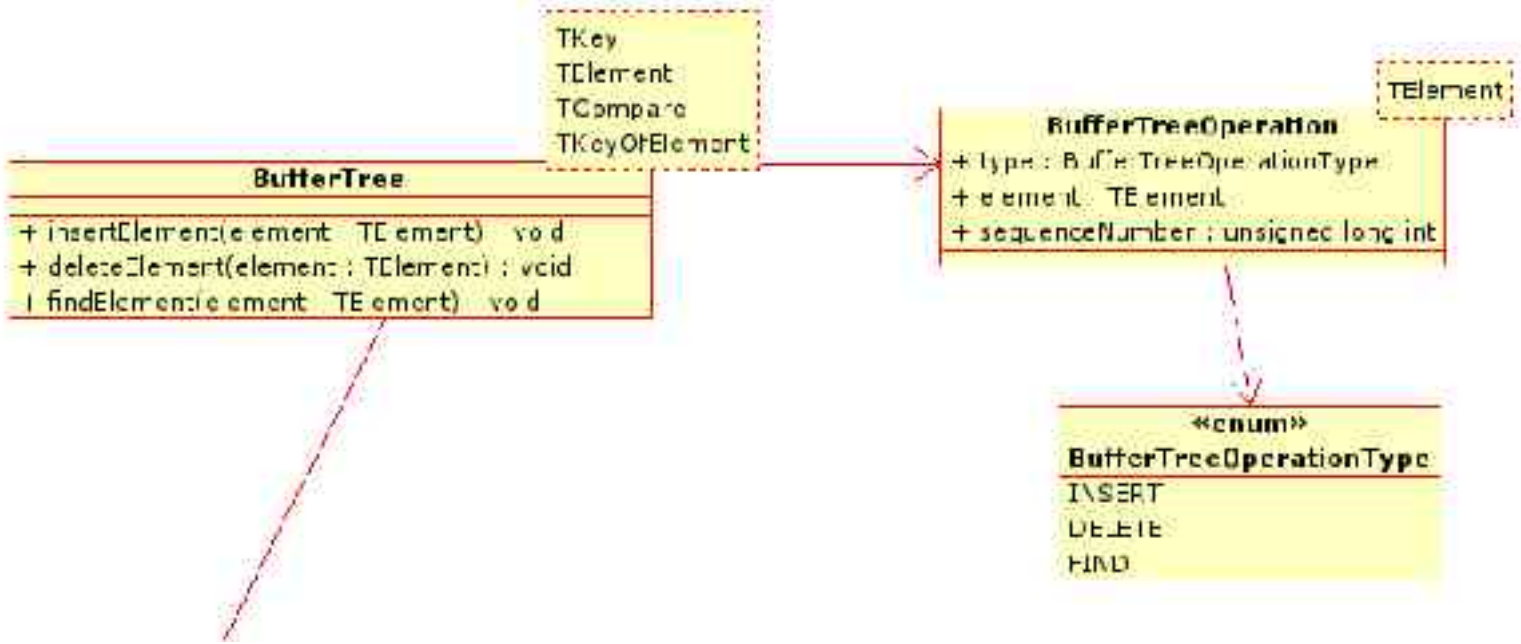
Platform

- C++ using TPIE library and STL
- Shared library (no stand-alone program)
- Type independent
- All TPIE supported hardware and software platforms

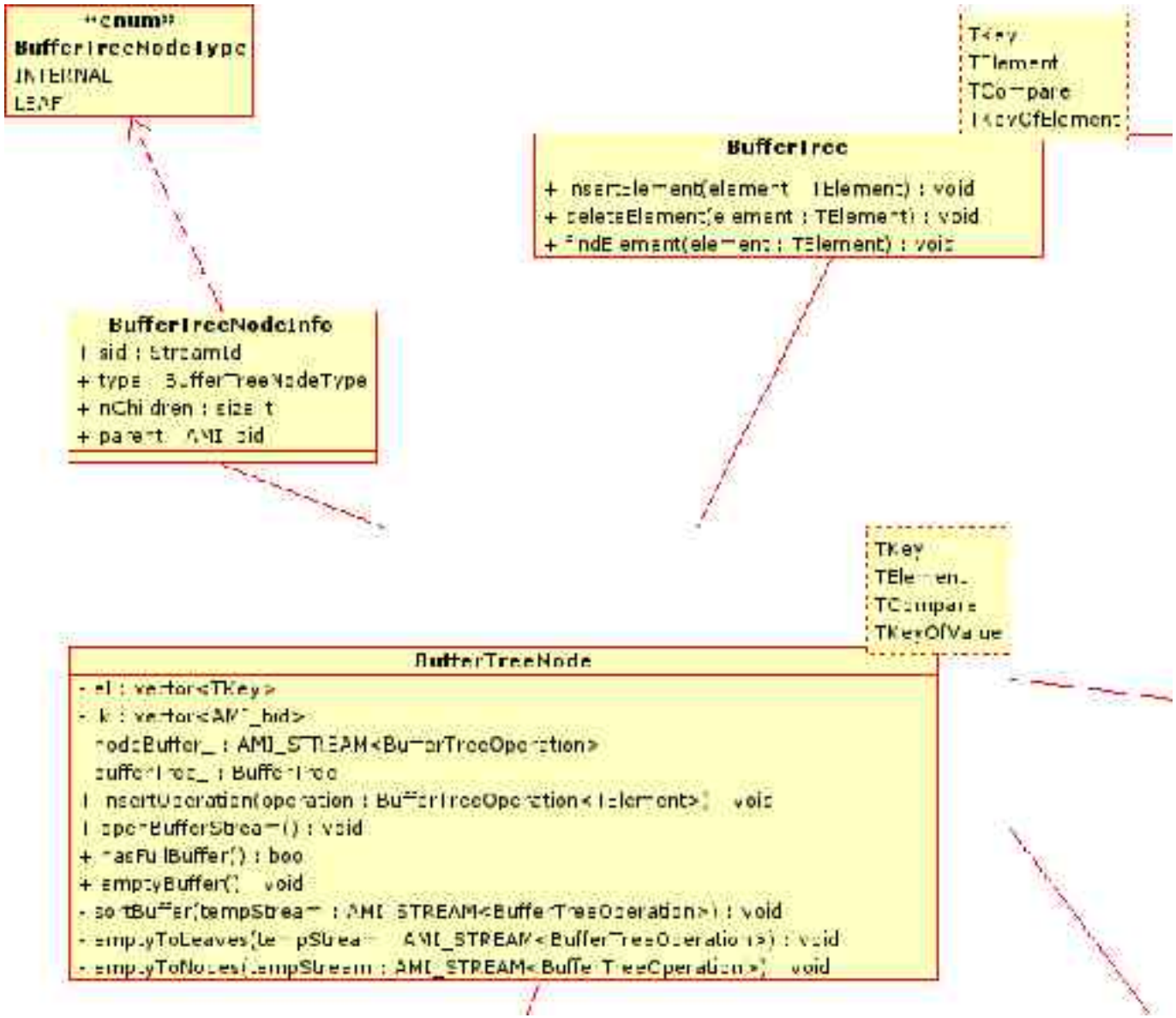
Software Design



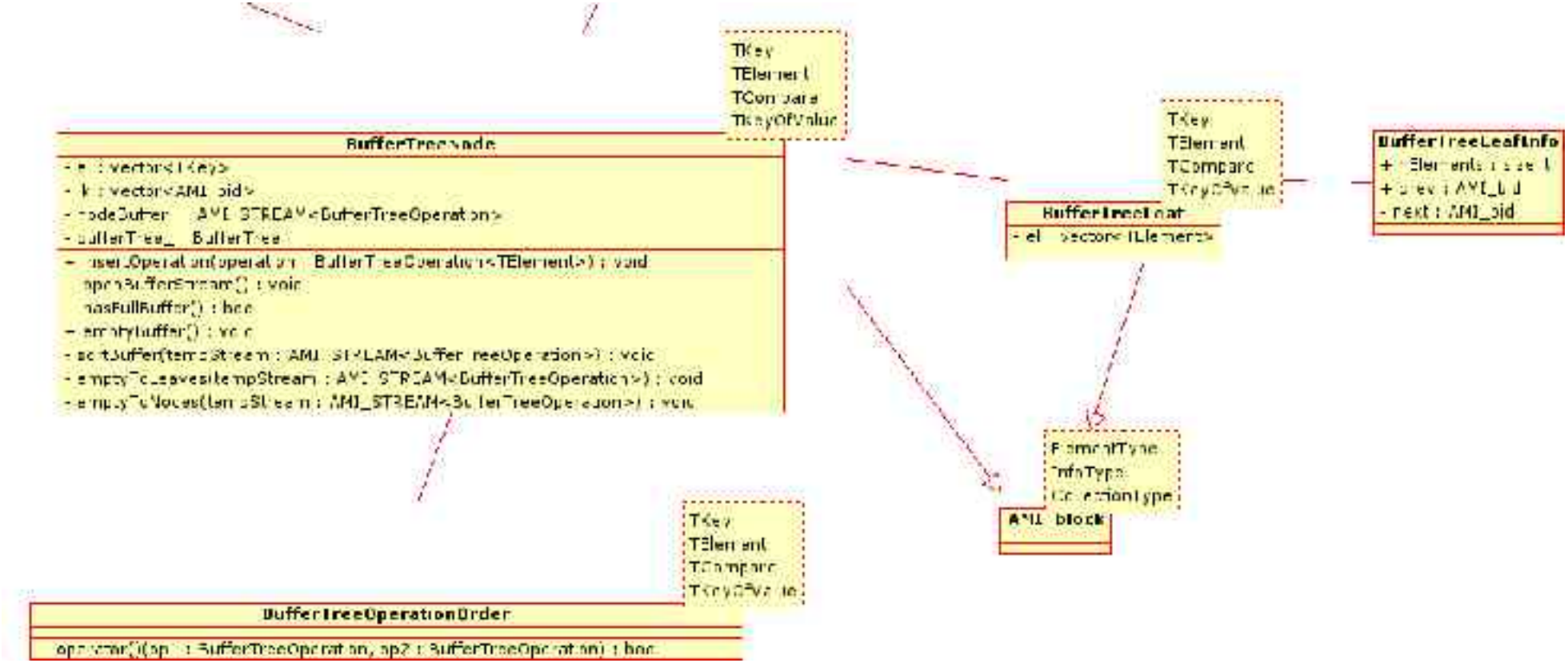
Software Design (BufferTree)



Software Design (BufferTreeNode)



Software Design (BufferTreeLeaf)



External Memory Representation

- Nodes and leaves are stored in collections
- Buffers are Streams
- Nodes link to nodes or leaves and buffers

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Implementation Details (sortBuffer)

- Read M operations from the buffer in memory
- Sort this list by defined order in-memory
- Merge list with rest of buffer into temporary stream
- Truncate operation buffer

Implementation Details (emptyToNodes)

- Scan temporary stream and merge with operation buffers of children nodes according to splitter keys
- Remove current node from memory
- Recursively empty buffer on child nodes where operation buffer $>$ M

Implementation Details (emptyToLeaves)

- Scan temporary stream and merge with element lists from all leaves
- Distribute resulting list to exiting leaves
- Add one leaf at a time and rebalance

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Evaluation Results

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Evaluation Plans

- Variation of available main memory
- Variation of leaf block size
- Impact of Tuning
- Caching?

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Notes

Difficulties:

- Determination of Parameters
- Real-world program vs. theoretical program
- Program complexity due to templates

Ende

EOF

1. Lars Arge. ``The Buffer Tree: A Technique for Designing Batched External Data Structures.'' Algorithmica, 37(1):1-24, 2003.
2. TPIE Manual
3. Personal lecture notes: CSCI6104 Summer 2004 taught by Dr. Norbert Zeh