Virtual Memory
A Project for CS854

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Proposal

Our proposal has 3 parts:

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1. Literature Review

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1. Literature Review
2. Experimental Design

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2. Experimental Design
3. Implementation

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Proposal: Literature Review

We wish to investigate the following
operating systems:

Proposal: Literature Review

We wish to investigate the following
operating systems:

1. Linux

Proposal: Literature Review

We wish to investigate the following operating systems:

1. Linux
2. OpenBSD

Proposal: Literature Review

We wish to investigate the following operating systems:

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2. OpenBSD
3. OpenIndiana
   (Previously Solaris)

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Proposal: Literature Review

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For each OS, we wish to answer the following questions:

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- Are there data structures for physical pages, separate from the page tables?

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  - What happens when the kernel runs out of memory?

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For each OS, we wish to answer the following questions:

- How is physical memory managed?
- Are there data structures for physical pages, separate from the page tables?
- How are contiguous regions of memory managed?
- How is memory freed?
  - What happens when the kernel runs out of memory?
- Do they do anything special on Non-Uniform Memory Access (NUMA) architectures?

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Proposal: Experimental Design

Proposal: Experimental Design

- Make a *testable* hypothesis based on lit. review

Proposal: Experimental Design

- Make a *testable* hypothesis based on lit. review
- Design *simple* experiments to test this hypothesis

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Proposal: Implementation

- Implement a memory management system for KOS

We have made some progress:

- OpenBSD data structures

Progress: OpenBSD

- 386BSD
  ↓
  NetBSD
  ↓
  OpenBSD

Progress: OpenBSD

- 386BSD
  ↓
  NetBSD
  ↓
  OpenBSD
- VM based on NetBSD

Progress: OpenBSD

- 386BSD
  ↓
  NetBSD
  ↓
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  - Rewritten in 1998

Progress: OpenBSD

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  $\downarrow$
  NetBSD
  $\downarrow$
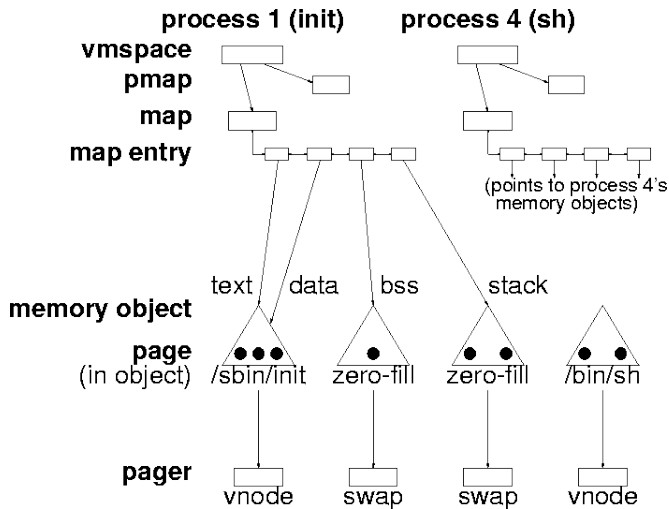 OpenBSD
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Progress: OpenIndiana

1. Open source fork of OpenSolaris after Oracle take over
2. Stewarded by the Illumos Foundation
3. VM uses the ast package by AT&T, written by Kiem-Phong Vo
4. Based on paper "Vmalloc: A General and Efficient Memory Allocator"

Progress: OpenIndiana

1. Legacy malloc function is old, has shortcomings
2. malloc not designed for modern environments
3. Vmalloc a memory allocation library that is flexible and allows a wide range of memory operations
   1. Regions to organize memory
   2. Obtain memory by application definable disciplines
   3. Customize memory management

Summary

1. Literature Review
   - Some progress on data structures!
2. Experimental Design
3. Implementation

References

- UVM dissertation:
  `http://vorpal.math.drexel.edu/course/opsys2/uvm-project/uvm.pdf`

- Vmalloc: A General and Efficient Memory Allocator:
  `http://onlinelibrary.wiley.com/doi/10.1002/%28SICI%291097-024X%28199603%2926:3%3C357::AID-SPE15%3E3.0.CO;2-%23/abstract`

Attribution

- OpenBSD data structure diagram from:
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