

Memory Management

In Linux and GemStone

Martin McClure



GEMTALK
SYSTEMS

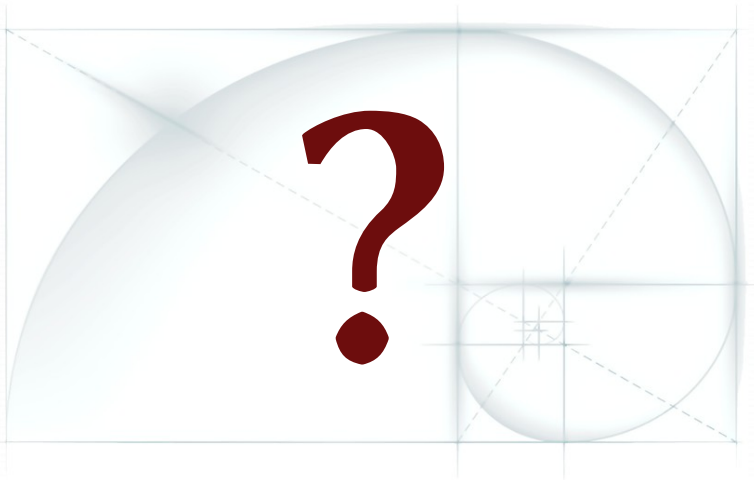
A light blue background featuring a large, faint Fibonacci spiral. The spiral is composed of a series of squares of increasing size, with a dashed line tracing the curve of the spiral. The text 'GEMSTONE S64' is centered over the spiral. The word 'GEMSTONE' is in black, 'S' is in orange, and '64' is in pink. A horizontal row of dots, transitioning from light pink to dark pink, is positioned below 'GEMSTONE' and above the 'S'.

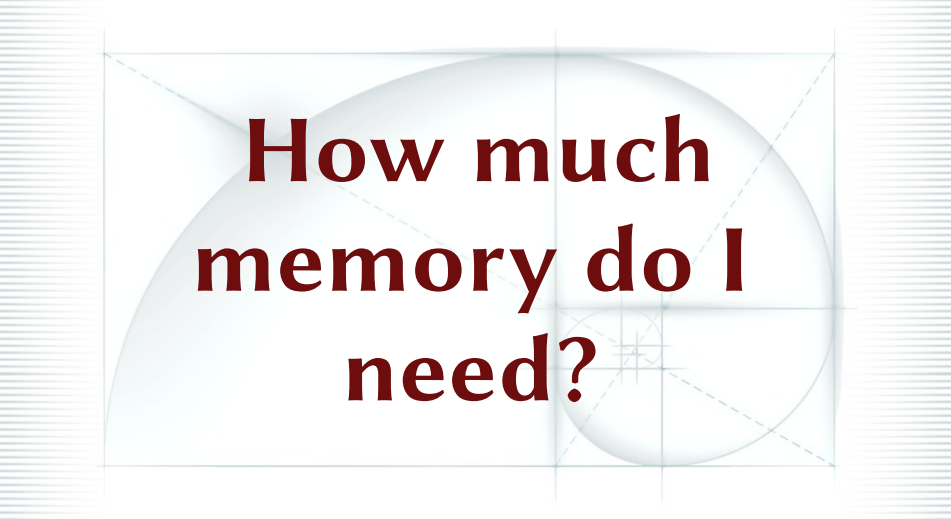
GEMSTONETM S64



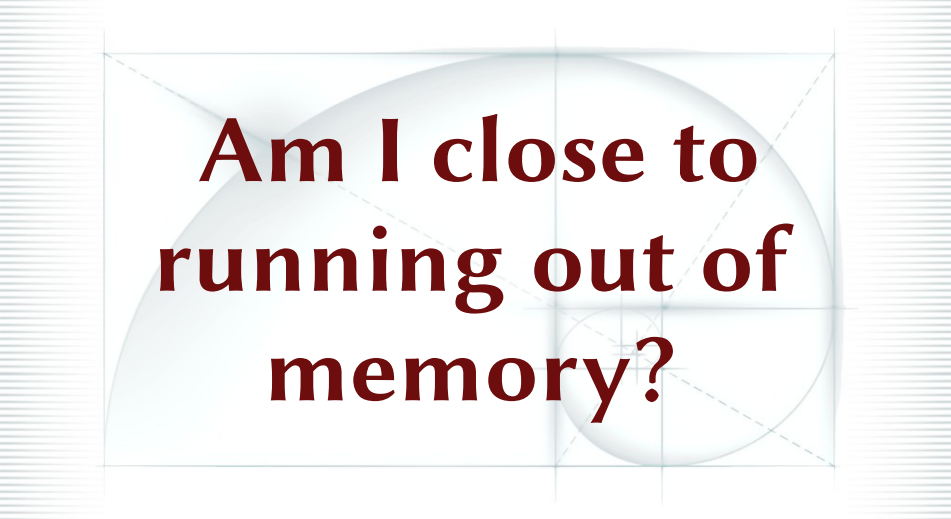
GEMSTONE[™] S 64

Linux





**How much
memory do I
need?**



**Am I close to
running out of
memory?**



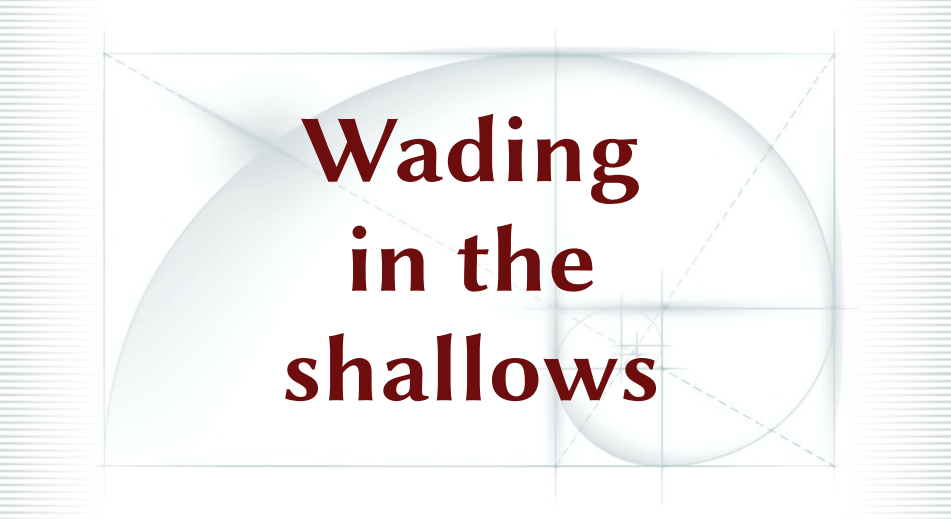
**Why did I run
out of memory?**

A geometric diagram featuring a light blue circle centered within a square frame. The square is defined by thin blue lines. Dashed blue lines extend from the corners of the square to the center, forming an 'X' shape. The text "Need for Information" is centered over the circle in a dark red, serif font.

Need for Information



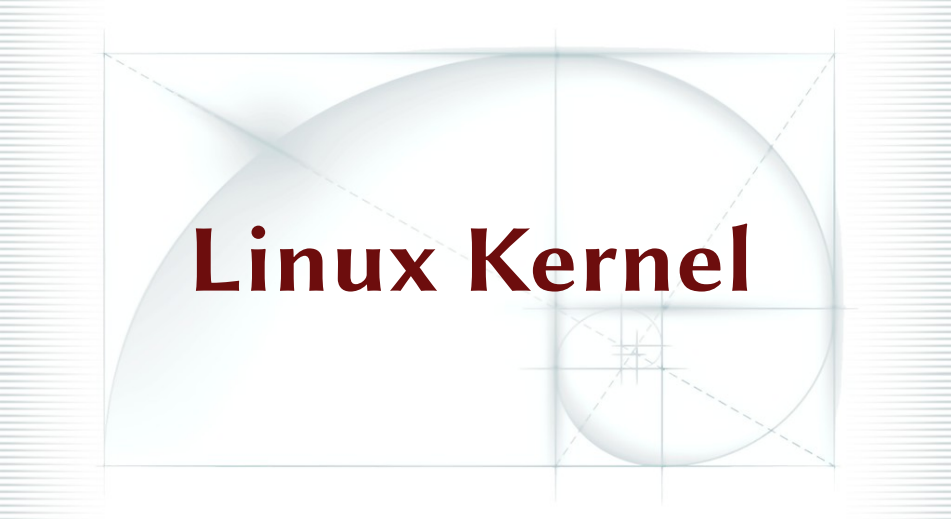
**...but the
Internet says...**



Wading in the shallows



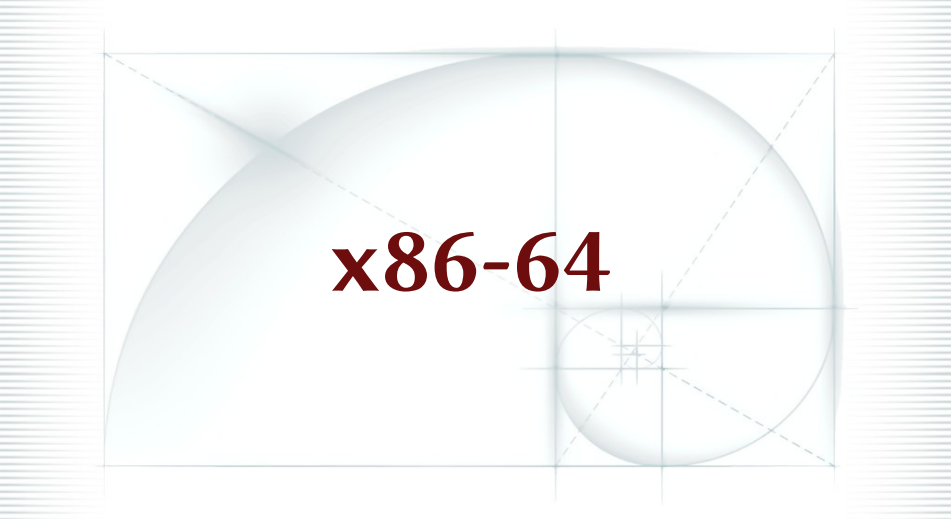
GemStone Memory Management

A light blue background featuring a large, faint Fibonacci spiral. The spiral is composed of a series of overlapping squares, with a dashed line tracing its path. The text "Linux Kernel" is centered over the spiral.

Linux Kernel

The background of the slide features a light blue, semi-transparent geometric design. It consists of a large rectangle containing a series of quarter-circles that form a spiral, known as a Fibonacci spiral or golden spiral. This spiral is constructed from squares whose side lengths are Fibonacci numbers. Dashed lines represent the diagonals of the rectangles and the curve of the spiral. The word "Hardware" is centered over this design in a dark red, serif font.

Hardware

A faint, light blue background featuring a Fibonacci spiral (golden spiral) that starts from the bottom right and expands counter-clockwise towards the top left. The spiral is composed of quarter-circles of increasing radii, each inscribed within a square. Dashed lines represent the diagonals of the squares, and solid lines represent the boundaries of the squares and the spiral itself. The overall aesthetic is technical and mathematical.

x86-64

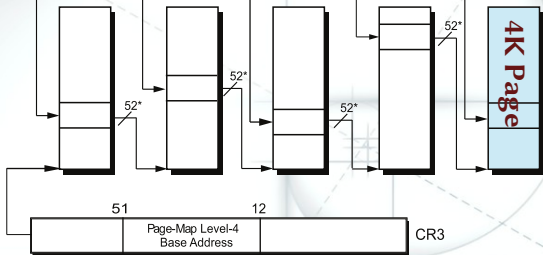
Page Tables

Virtual Address

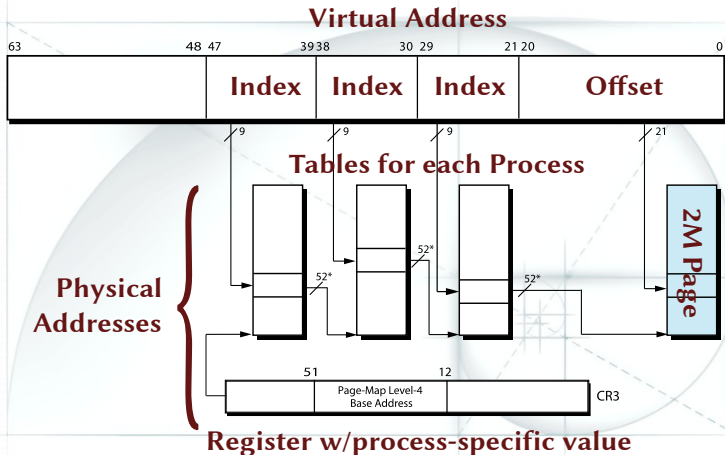


Tables for each Process

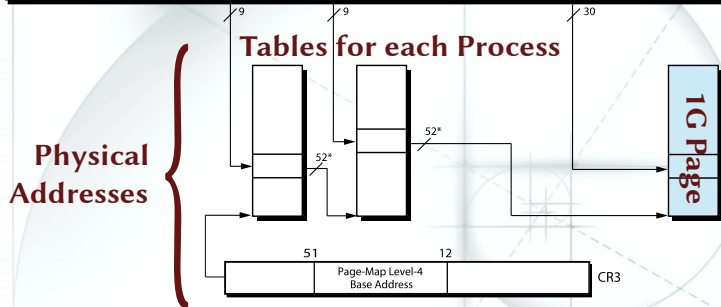
**Physical
Addresses**



Register w/process-specific value

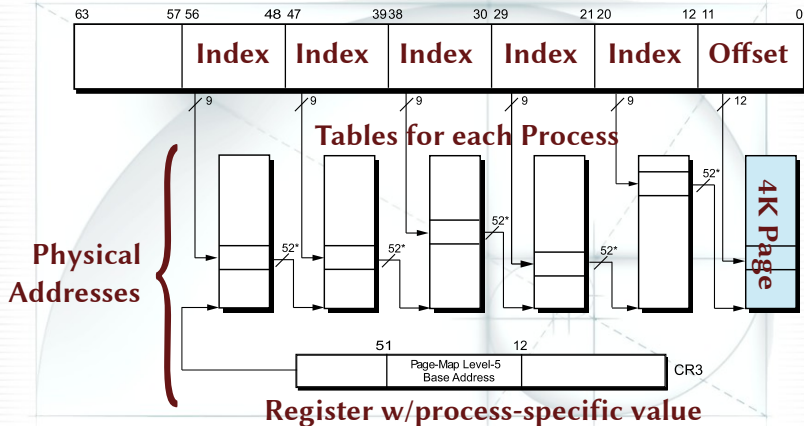


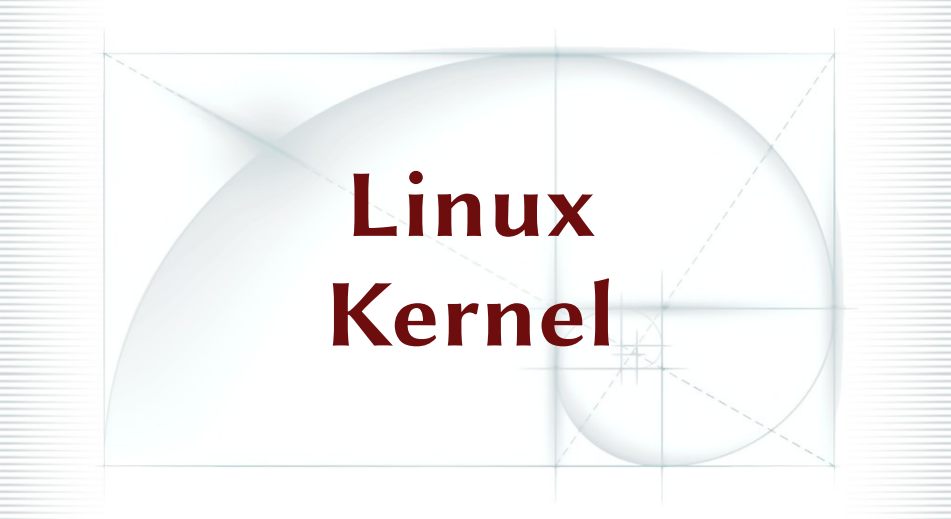
Virtual Address



Register w/process-specific value

Virtual Address

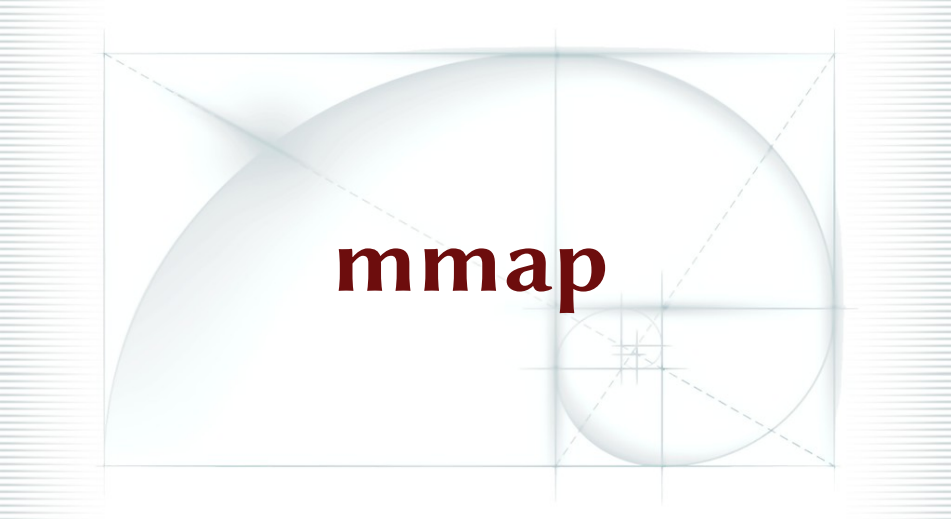


A light blue background featuring a faint, large-scale Fibonacci spiral. The spiral is composed of a series of squares of increasing size, with a dashed line tracing the curve of the spiral. The spiral starts from the bottom right and moves towards the top left. The text "Linux Kernel" is centered over the spiral.

Linux Kernel

A geometric diagram featuring a light blue circle centered within a square frame. The square is defined by thin blue lines. Dashed diagonal lines cross the square from corner to corner. A horizontal line and a vertical line intersect at the center of the circle, dividing it into four quadrants. The text "Allocating Memory" is centered over the circle in a dark red, bold, serif font.

Allocating Memory

A faint background image featuring a golden rectangle with a large quarter-circle arc on the left and a smaller spiral on the right, illustrating the golden ratio. Dashed diagonal lines cross the rectangle.

mmap

The background features a light blue sphere with a subtle gradient, centered within a square frame. A grid of thin, light blue lines is overlaid on the sphere. Dashed diagonal lines cross the sphere from corner to corner. The text 'Anonymous' and 'File-backed' is centered over the sphere, separated by a horizontal line.

Anonymous

File-backed



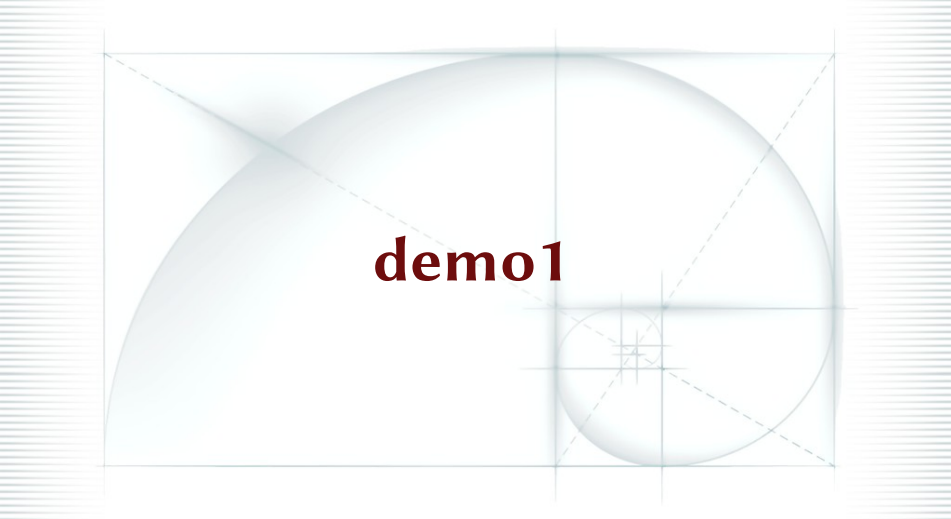
Private Shared

**Anonymous
Private**

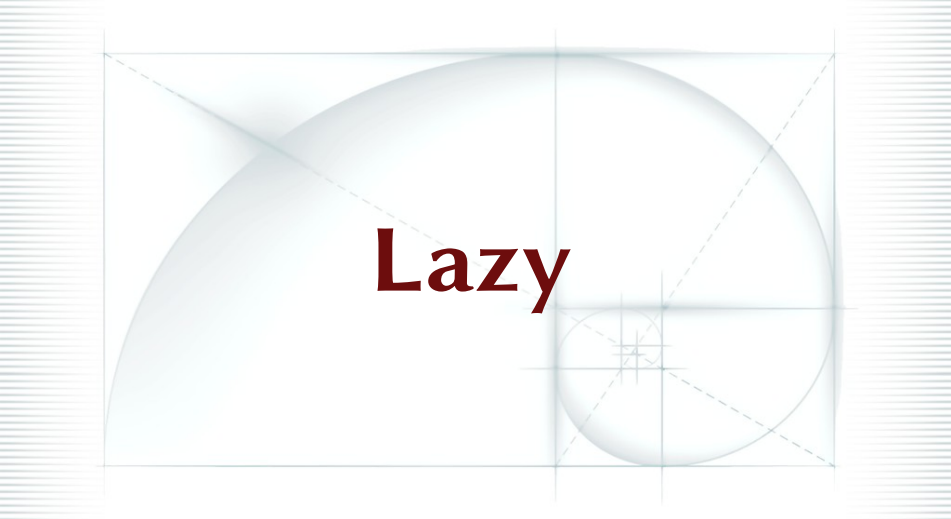
**Anonymous
Shared**

**File-backed
Private**

**File-backed
Shared**

A geometric diagram illustrating the Fibonacci spiral. It features a large rectangle divided into a grid of squares. A spiral is drawn by connecting quarter-circles within these squares, starting from the bottom right and moving counter-clockwise. Dashed lines represent the diagonals of the squares and the rectangle. The word "demo1" is written in a bold, dark red font in the center of the image.

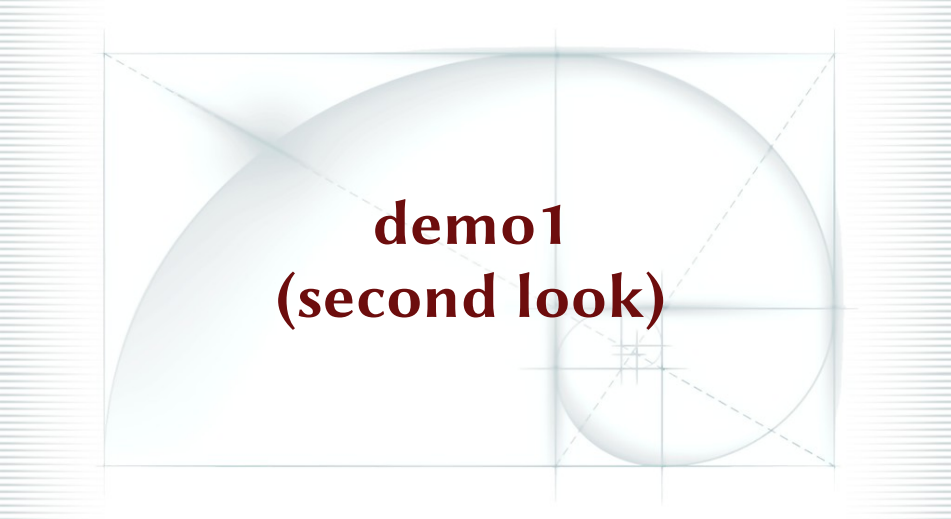
demo1



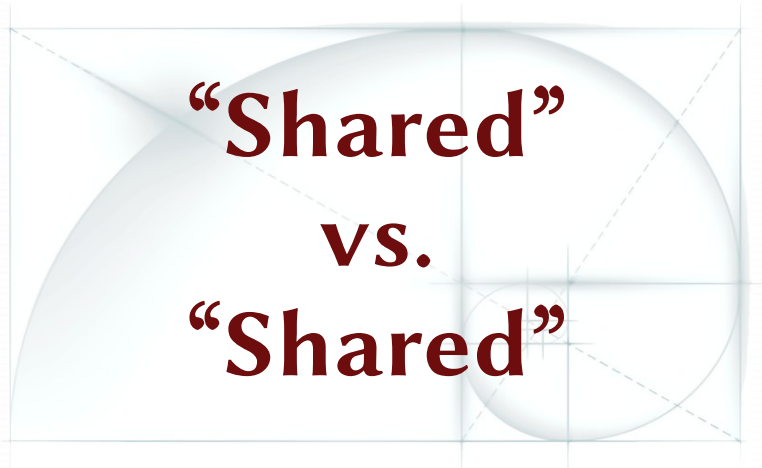
Lazy

A light blue background featuring a faint, large-scale Fibonacci spiral. The spiral is composed of a series of quarter-circles of increasing radii, centered at the origin of a coordinate system. The text "Zero Page" is centered over the spiral.

**Zero
Page**

The background of the slide is a light blue grid. A large circle is centered horizontally, with its left half filled with a darker blue gradient. A smaller circle is positioned to the right of the large circle's center. Dashed lines represent the diagonals of the grid. The text "demo1 (second look)" is centered in a dark red, serif font.

demo1
(second look)



“Shared”

vs.

“Shared”



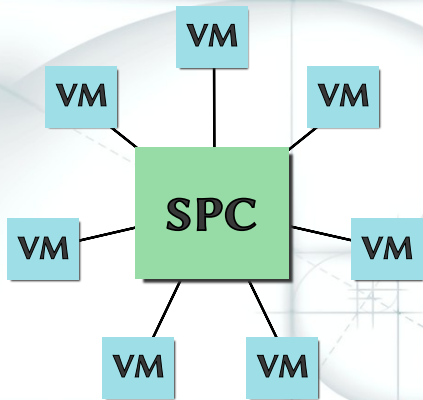
**Copy
on
Write**

The background of the slide features a light blue geometric design. It includes a large rectangle with a dashed diagonal line from the top-left to the bottom-right. A large quarter-circle arc is drawn from the bottom-left corner towards the center. In the bottom-right corner, there is a smaller square containing a spiral that follows the Fibonacci sequence, with several smaller concentric circles and lines intersecting at its center. The word "Pharo" is centered over this design.

Pharo

The background of the image features a light blue, semi-transparent geometric design. It consists of a large rectangle containing a series of quarter-circles that form a spiral, known as a Fibonacci spiral. Dashed lines represent the diagonals of the rectangle and the arcs of the spiral. The text 'GemStone' is centered over this design.

GemStone



A light blue background featuring a large, faint Fibonacci spiral. The spiral is composed of several concentric quarter-circles of increasing radii, starting from a small point in the lower right and expanding towards the top left. Dashed lines represent the radii of these circles. The entire spiral is contained within a rectangular frame defined by thin blue lines.

Hugepages



Reserved Hugelpages

The background features a light blue sphere with a subtle gradient, positioned behind a grid of thin, light blue lines. Dashed lines form a cube-like structure around the sphere, with some lines intersecting at points marked by small asterisks. The overall aesthetic is technical and architectural.

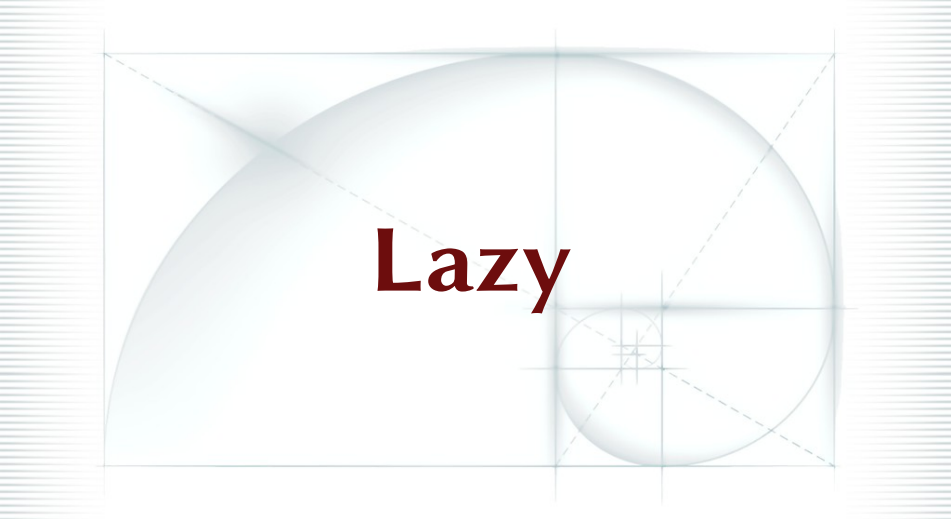
Transparent Hugepages

A geometric diagram featuring a light blue circle centered within a square frame. The square is defined by thin blue lines. Dashed diagonal lines cross the square from corner to corner. A horizontal line and a vertical line intersect at the center of the circle, dividing it into four quadrants. The text "Allocating Memory" is centered over the circle in a dark red, bold, serif font.

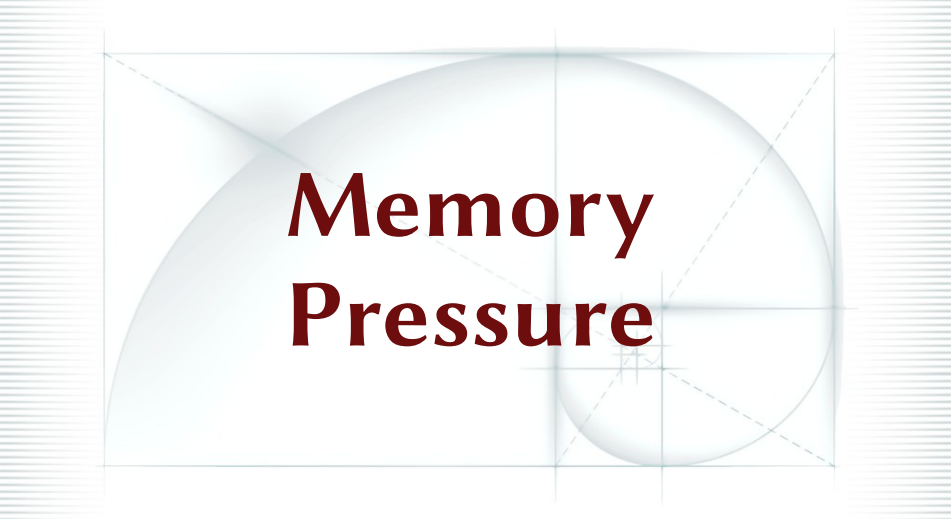
Allocating Memory

A light blue background featuring a faint, stylized Fibonacci spiral. The spiral is composed of several concentric quarter-circles of decreasing size, starting from the bottom right and spiraling outwards towards the top left. Dashed lines connect the centers of these circles, forming a smooth curve. The overall aesthetic is clean and technical, typical of a presentation slide.

Deallocating?



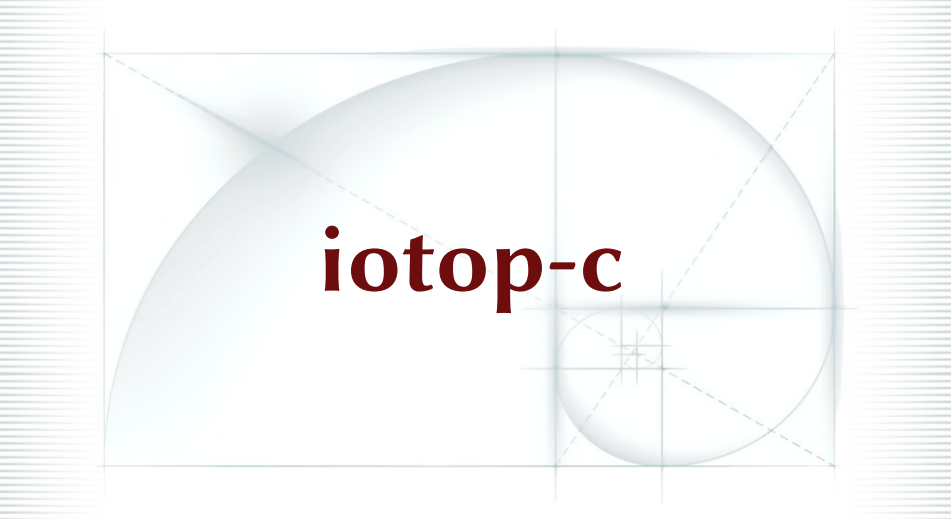
Lazy

The background features a light blue circle centered on a white grid. The grid consists of thin, light blue lines. A dashed diagonal line runs from the top-left corner to the bottom-right corner of the circle. Another dashed diagonal line runs from the top-right corner to the bottom-left corner. The text 'Memory Pressure' is centered over the circle in a dark red, serif font.

Memory Pressure



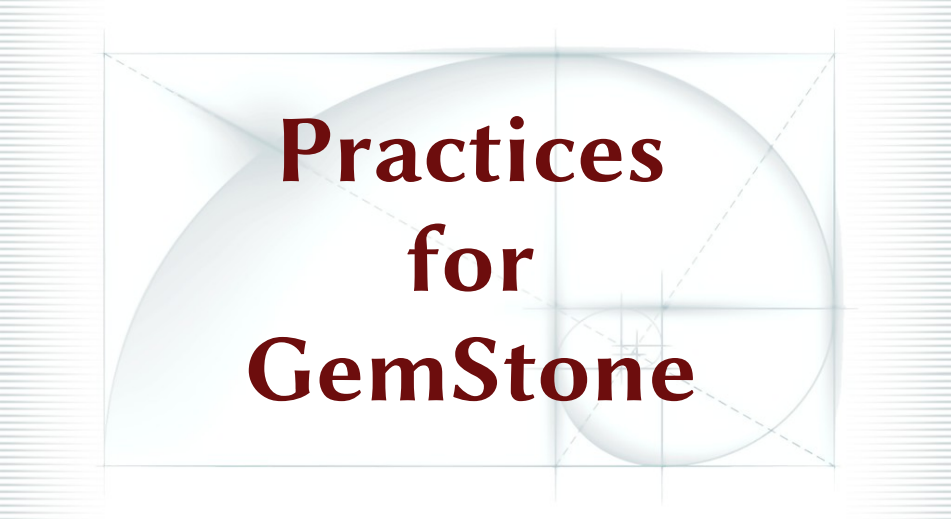
In Defense of Swap

A light blue background featuring a faint, large-scale Fibonacci spiral. The spiral is composed of a series of quarter-circles of decreasing radii, centered at the origin of a coordinate system. The entire composition is overlaid with a grid of thin, light blue lines, including horizontal, vertical, and diagonal dashed lines that intersect at various points, creating a technical or architectural drawing aesthetic.

iotoo-c

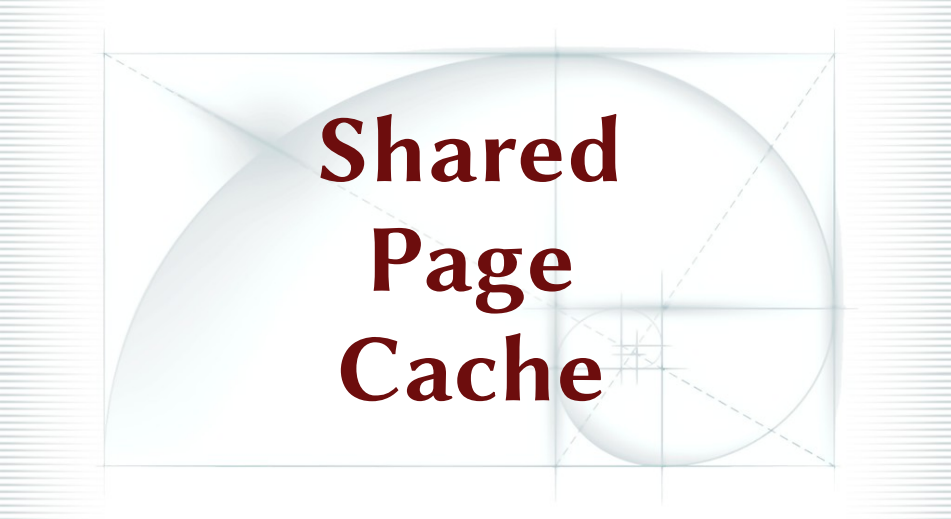
The background features a light blue circle centered on a white grid. The grid consists of solid vertical and horizontal lines, and dashed diagonal lines forming an 'X' shape. The circle is semi-transparent, allowing the grid lines to be seen through it.

The Dreaded oom-killer

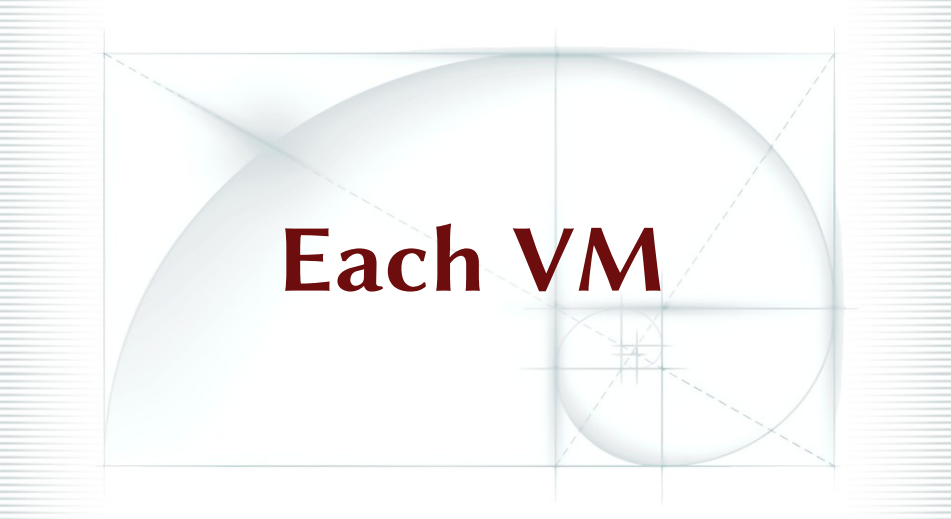


Practices for GemStone

SPC
vs.
VM Private

The background features a large, light blue sphere with a subtle gradient. A golden spiral is drawn on the right side of the sphere. A light blue grid is overlaid on the entire image, and dashed lines connect the corners of the grid to the center of the sphere.

Shared Page Cache

A light blue background featuring a large, faint Fibonacci spiral. The spiral is composed of a series of quarter-circles of decreasing radii, starting from a small square in the bottom right and spiraling outwards towards the top left. The entire spiral is contained within a rectangular frame defined by thin blue lines. Dashed lines also connect the corners of the frame to the center of the spiral.

Each VM



**Working
Set
Size?**

A light blue background featuring a faint, large-scale Fibonacci spiral. The spiral is composed of a series of overlapping circles of increasing radii, centered at the origin. Dashed lines represent the radial paths of the spiral. The word "Hugepages" is centered over the spiral in a dark red, serif font.

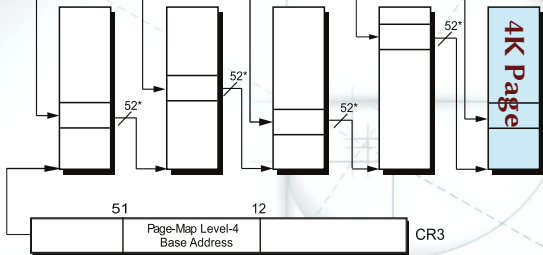
Hugepages

Virtual Address



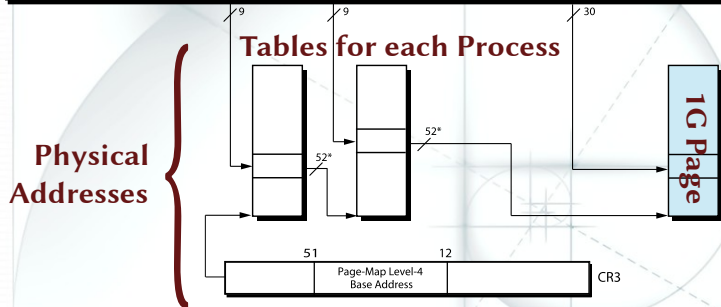
Tables for each Process

**Physical
Addresses**



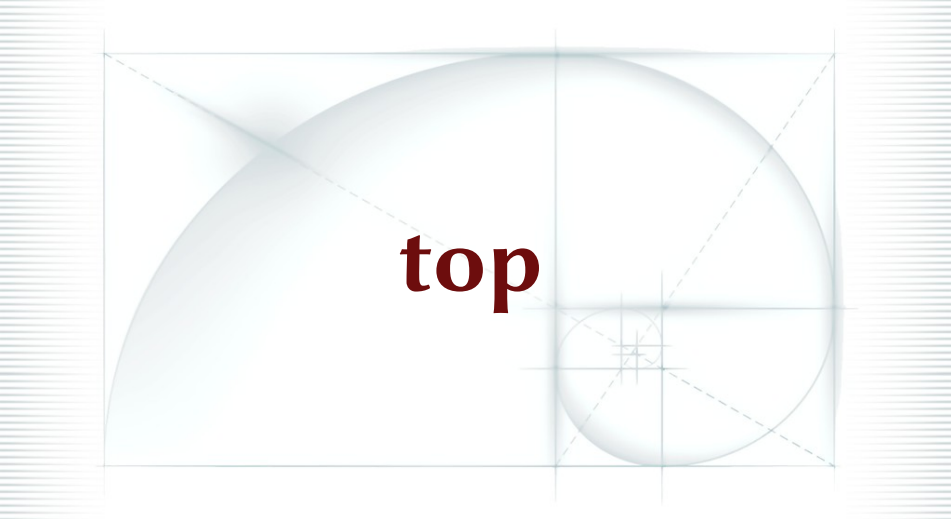
Register w/process-specific value

Virtual Address



The background of the slide features a light blue, semi-transparent geometric design. It consists of a large rectangle containing a spiral that starts from a small circle in the lower right and expands outwards, passing through a series of smaller squares. Dashed lines represent the diagonals of the rectangles at each stage of the spiral. The word "Tools" is centered over this design in a dark red, serif font.

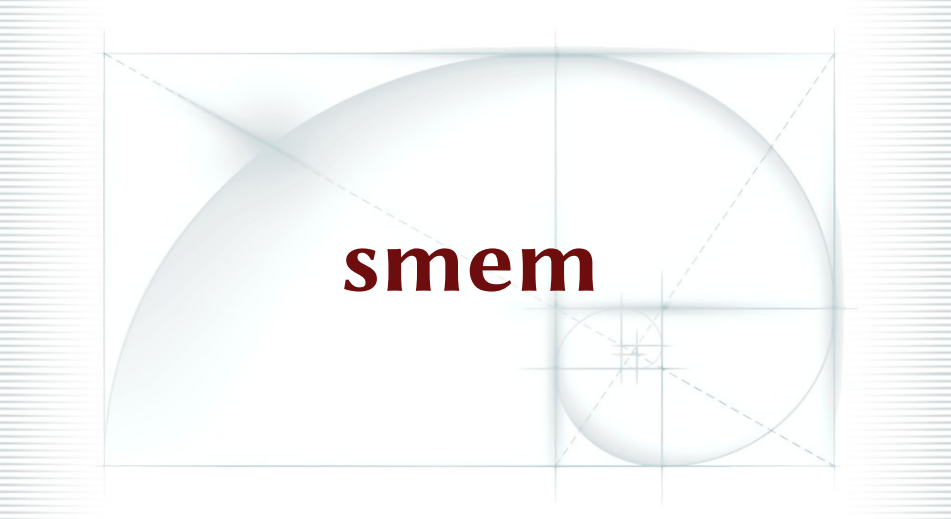
Tools

A diagram illustrating the Fibonacci spiral, also known as the golden spiral. It features a large rectangle divided into a grid of squares. A spiral line, composed of quarter-circle arcs, starts from the bottom-left corner and winds inward, passing through the centers of the squares. The spiral is constructed using a series of concentric circles and squares, with the word "top" written in a large, bold, dark red font across the center. The word "top" is positioned over the spiral, which is a common way to indicate the top view of a spiral object in technical drawing.

top

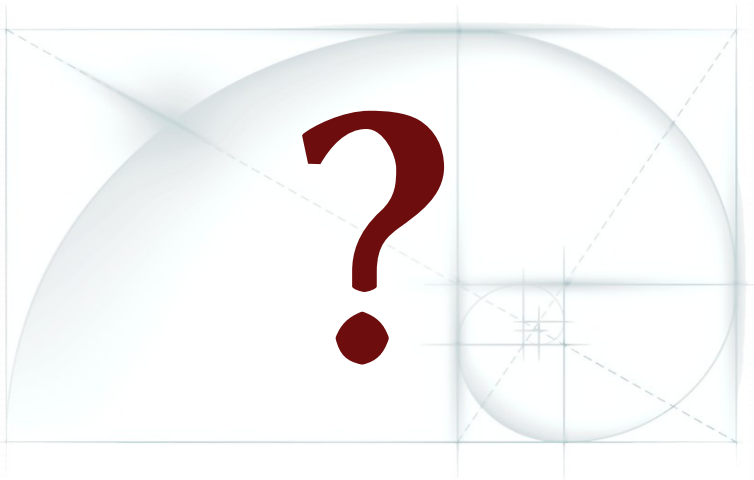
A light blue background featuring a faint, large-scale Fibonacci spiral. The spiral is composed of a series of overlapping squares, with a dashed line tracing the path of the spiral's growth. The text is centered over this background.

/proc/meminfo

The background of the slide features a light blue geometric design. It includes a large rectangle with a dashed diagonal line from the top-left to the bottom-right. A large quarter-circle arc is drawn from the bottom-left corner towards the center. On the right side, a smaller circle is inscribed within a square, with a spiral line (Fibonacci spiral) starting from its center and winding outwards. The word "smem" is centered in a dark red, bold, sans-serif font.

smem

**statmonitor
&
VSD**



Memory Management

In Linux and GemStone

Martin McClure



GEMTALK
SYSTEMS