Multiapplication Intertile Synchronization on Ultra-High-Resolution Display Walls

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The Importance of Visualization

• Vision is the dominant sense for the acquisition of information from our everyday world.
• Nearly 1/3 of your brain is devoted to processing visual information.
• Visualization has 3 main roles in scientific / engineering computing:
  – As an instrument to view and understand complex phenomena (like a microscope)
  – To validate results (like a computational simulation)
  – To explain complex results to a lay audience (such as government / policy makers and the general public, and to inspire the next generation of scientists)
• 28 PCs with GPU
• 11x5 LCDs
• 105 Mpixel
The 20 Mpixel Lens

- 1 PC
- 3 GPUs
- 18 Screens
Scalable Adaptive Graphics Environment (SAGE)

- It consists of
  - FreeSpace Manager (FSM)
  - Node Display Manager (NDM)
  - Application Interface (SAIL)
  - Sync. Manager
  - UI

- Each NDM manages single logical screen (a tile) and is driven by a computer in a cluster.

- SAIL streams pixel to the display wall
Communication methods for a cluster-based display wall

• Synchronized Execution
  – all render nodes have the same copy of the application instance

• Primitive Distribution
  – a client distributes graphics primitives to render servers

• Pixel Distribution
  – a client renders and transmits only pixels to display servers
What is the problem?

• You are watching motion pictures on the tiled display run by a cluster of computers.
• You want to synchronize frame transition on each tile to be seamless.
• It's a human factor.
• It is trivial if there is only one animation on the tiled display.
• What if you want to display multiple animations each has its own frame rate at the same time.
Intertile Synchronization Requirements

1. Data Synchronization
   - All the image fragments must be in the same frame number

2. Graphics Swap Buffer Synchronization
   - NDM 0 and NDM 1
   - NDM 3 and NDM 4
   - Graphics Swap Buffer
SAGE Intertile Synchronization (old)

Application generated a frame

SAIL partitions it based on its position on the wall

syncManager

Synchronization Process

SyncManager

frame

NDMs
A Global Synchronization Manager (Two Phase Algorithm)

Data Synchronization

1. Wait for a msg from NDMs for certain period.
2. Determine which application screen is ready to be displayed.
3. Create a message based on step 2, and broadcast the message. A single message for all application on the wall.
4. Corresponding NDMs are ready to display their fragment, if the message contains a flag for the application

Graphics Swap Buffer Synchronization

1. wait for a msg from all NDMs
2. Broadcast a msg
3. NDMs execute graphics swap buffer

SyncManager
Refresh Rate (SRR)
A Global Synchronization Manager
(One Phase Algorithm)

Data Synchronization
1. Wait for sync. msgs from NDMs for certain period.
2. Determine which application screen is ready to be displayed.
3. Create a message based on step 2, and broadcast the message.
   A single message for all application on the wall.
   A Presentation Time is included in the message.
4. Corresponding NDMs are ready to display their fragment if the message contains a flag for the application.

Graphics Swap Buffer Synchronization using Network Time Protocol (NTP)
1. Each NDM waits until its own clock reaches the Presentation Time
2. A NDM executes graphics swap buffer
Sync Mismatch (Single Application)

- millisecond (y-axis)
- frame (x-axis)
- Graph lines:
  - old sage (cyan)
  - Two Phase (yellow)
  - One Phase (green)

NDM:
- Time points: 0, 1, 2, 3
- max graphics swap buffer difference

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Sync Mismatch and Frame Rate (Multiple Application)

Number of Applications: 1, 2, 4, 8

- Old Sage
- Two Phase
- One Phase

Millisecond:
- 2.0
- 3.0
- 3.0
- 4.0

Aggregate Frame Rate:
- 1.0
- 2.0
- 4.0
- 8.0
Conclusion

- Presented two algorithms to achieve intertile synchronization.
  - Two Phase Algorithm
  - One Phase Algorithm
- Both focus on reducing network messages.
- We can enforce graphics swap buffer sync. with global sync. manager in multiapplication enabled tiled-display environment.
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