

# *MobiDesk: Mobile Virtual Desktop Computing*

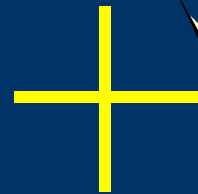
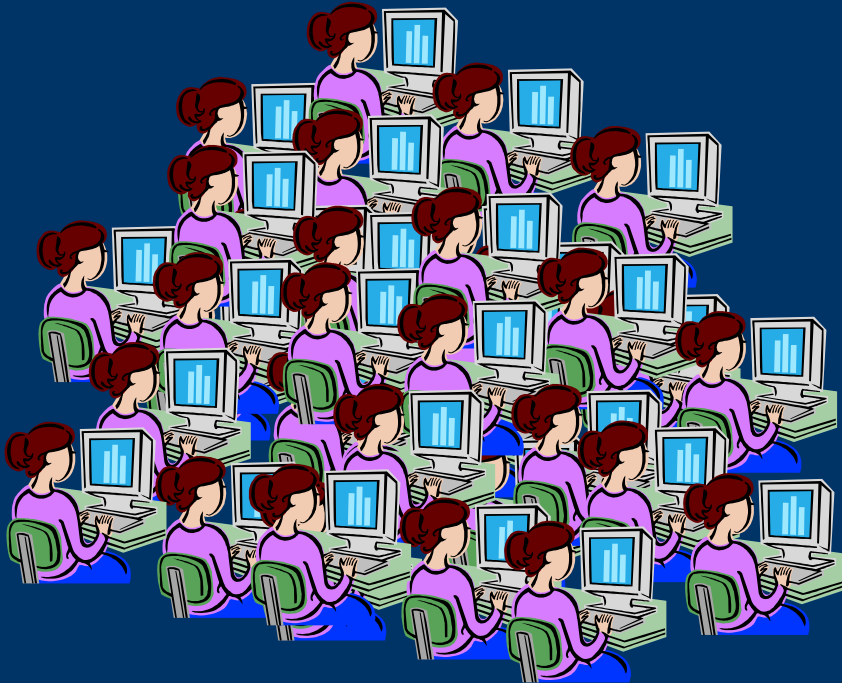
Ricardo A. Baratto, Shaya Potter, Gong Su, Jason Nieh  
Network Computing Laboratory  
Columbia University

September 28, 2004

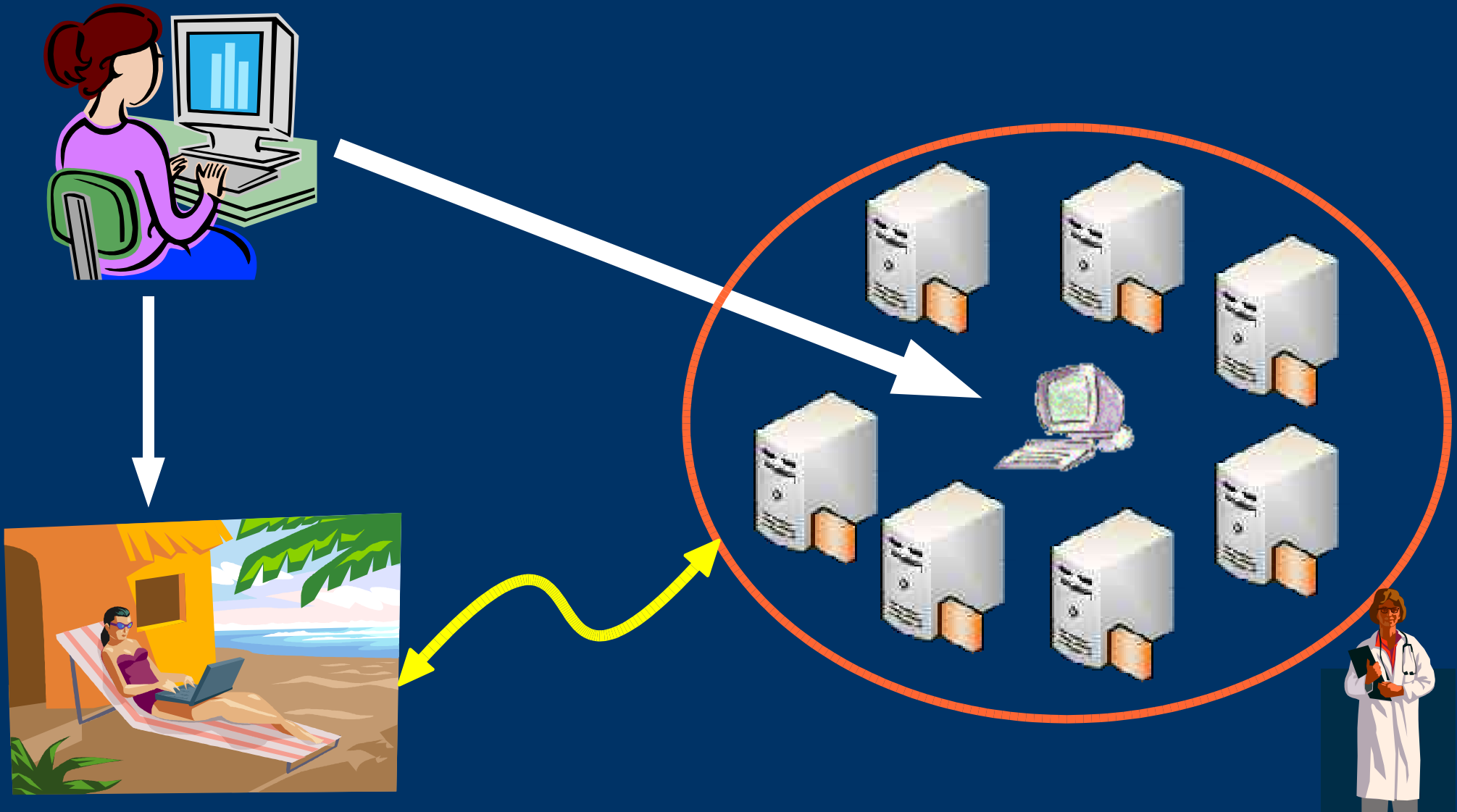
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# *Problem: Growing PC management complexity*



# *Solution: MobiDesk*



# *Issue: Interoperability*

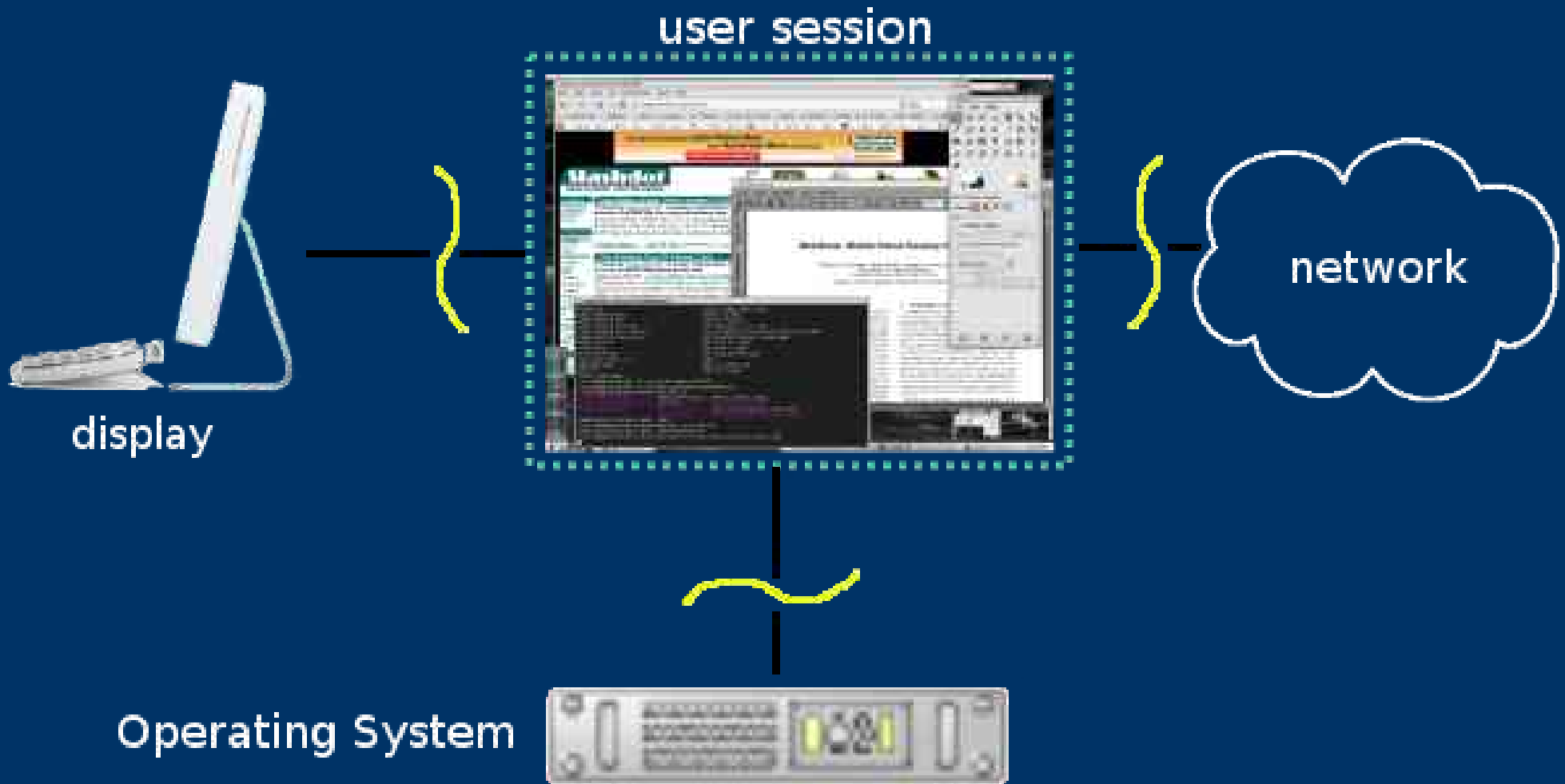
*Installed Base + Investment in place*



Unmodified applications, operating system  
kernels and network infrastructure



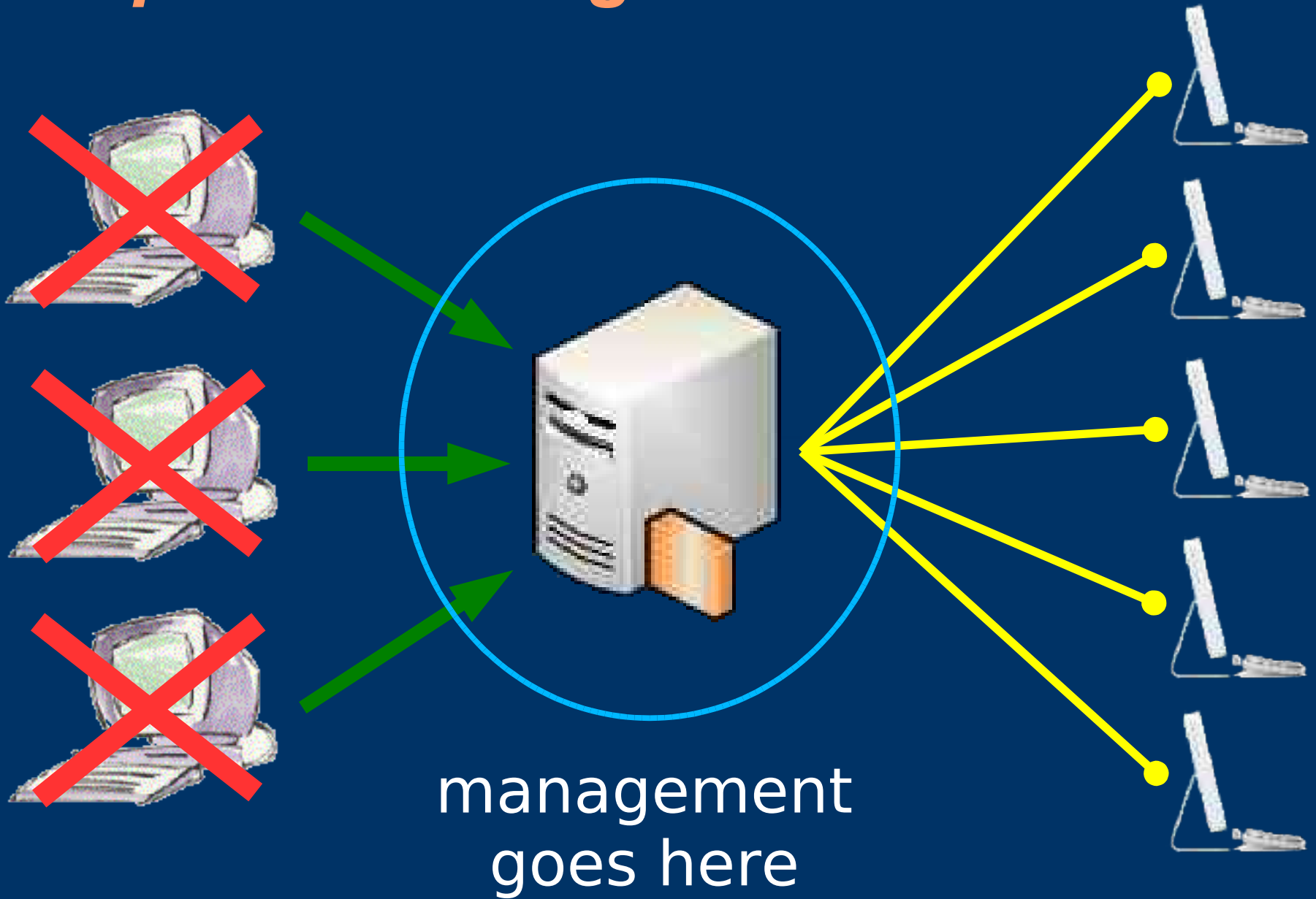
# Virtualize Everything



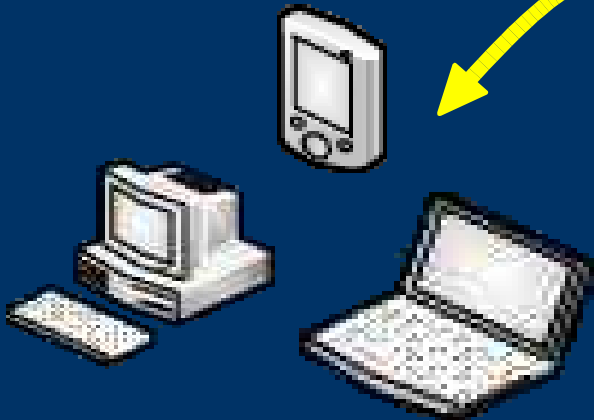
# *Benefits*



# *Simplified management*

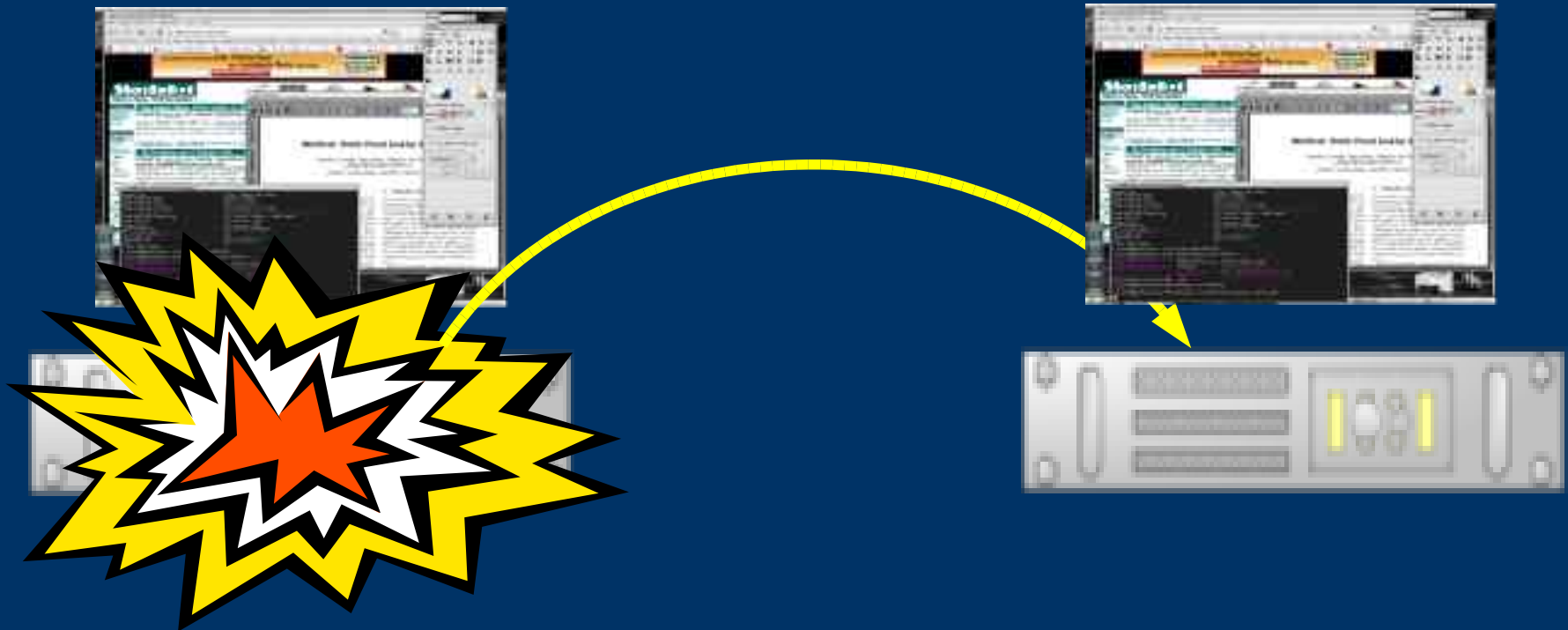


# *Ubiquitous access*





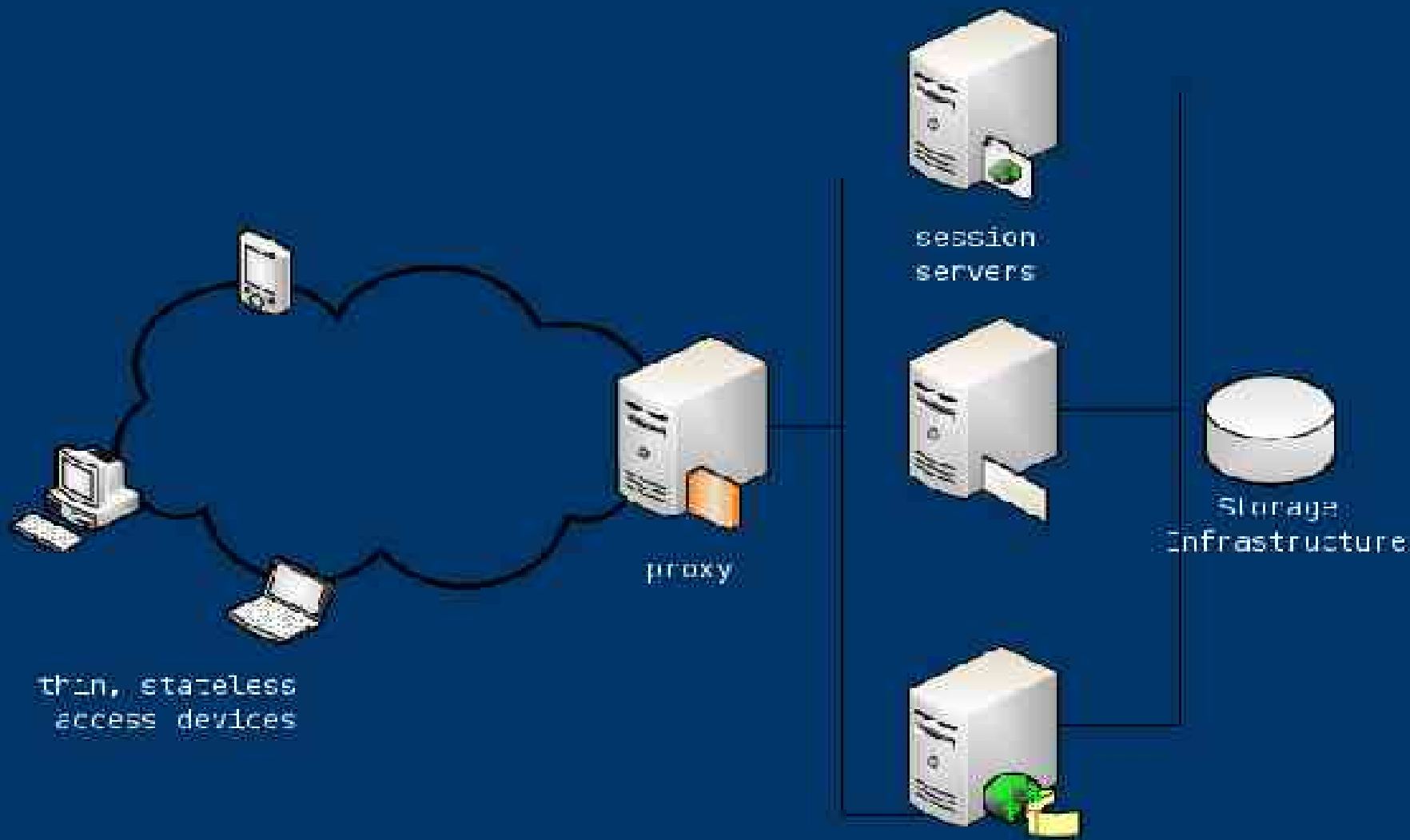
# *High-availability*



# *Outline*

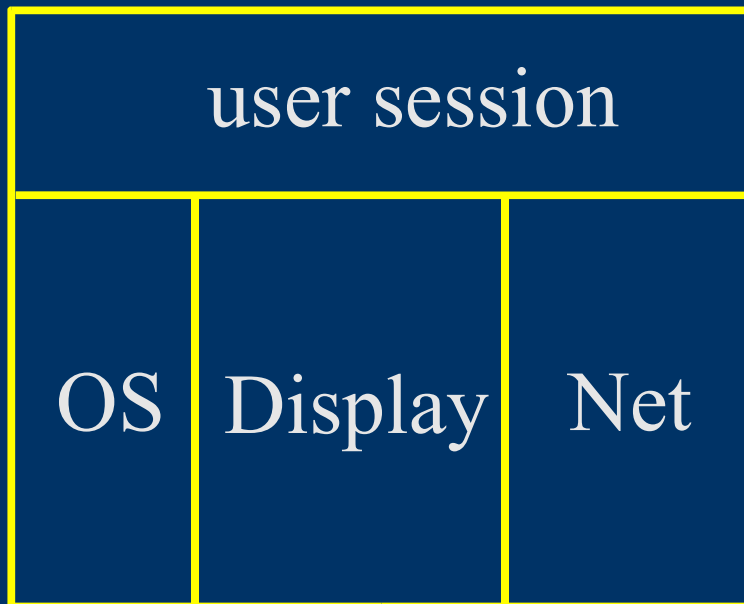
- MobiDesk Architecture
  - Virtualization
    - Display
    - Operating System
    - Network
  - Related Work
  - Experimental Results
  - Conclusions
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# MobiDesk Architecture

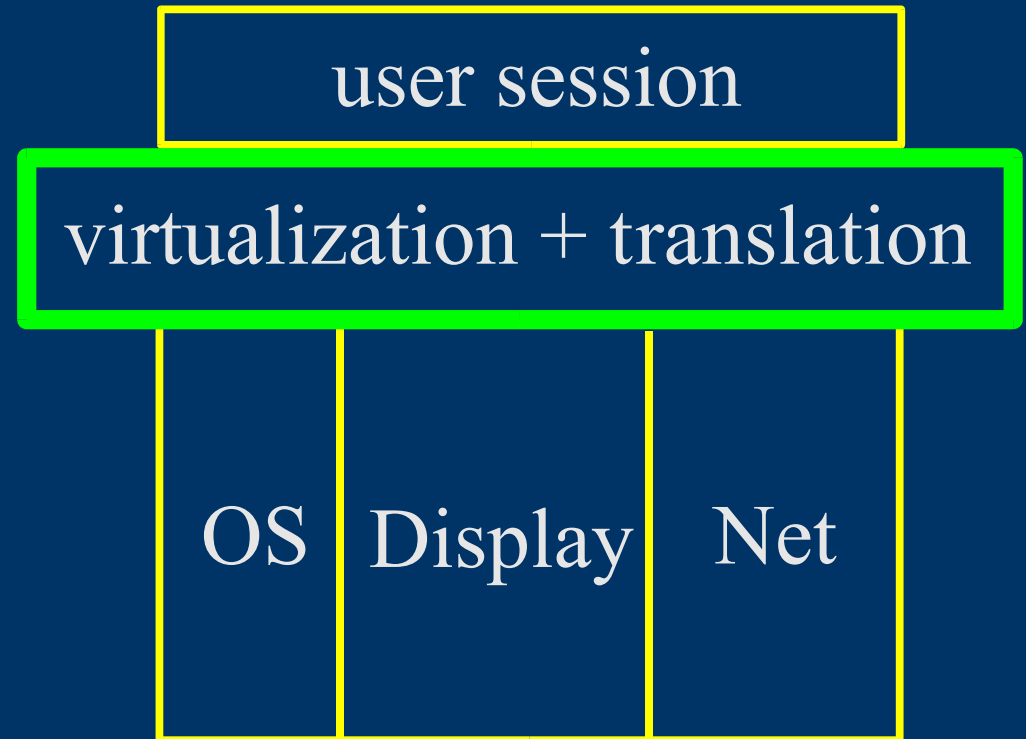


# Virtualization

PC



MobiDesk

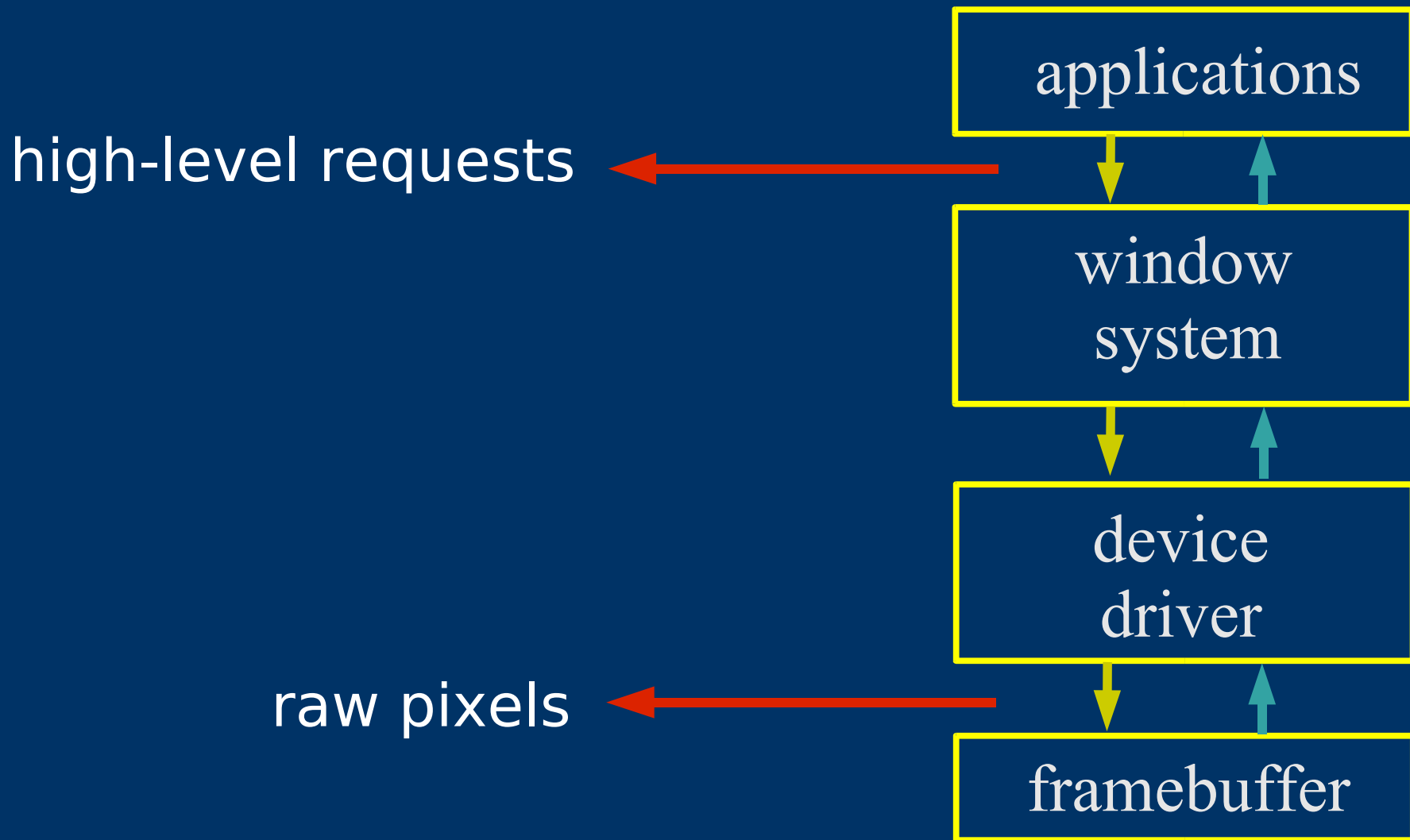


session environment decoupled from underlying physical infrastructure

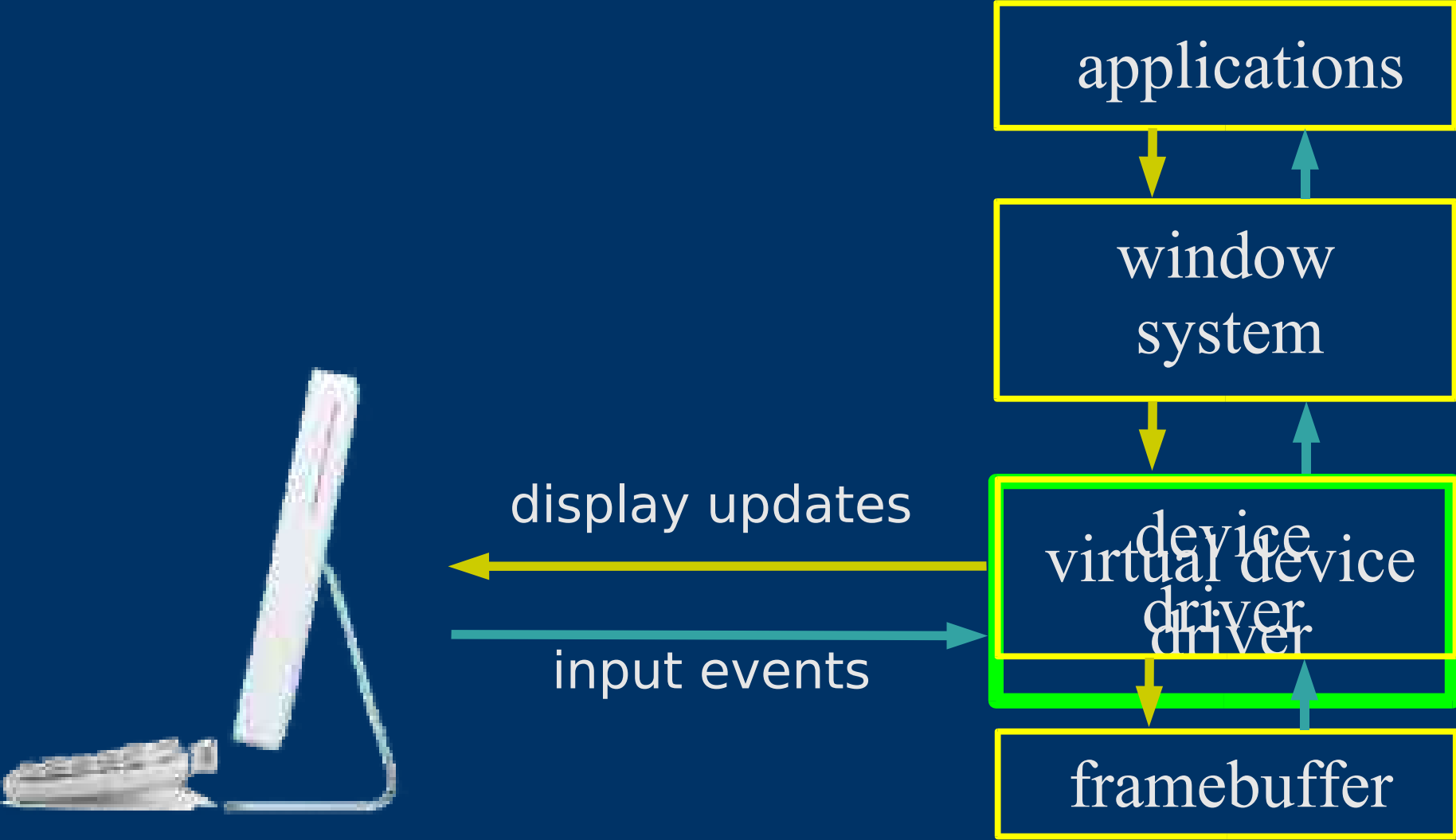
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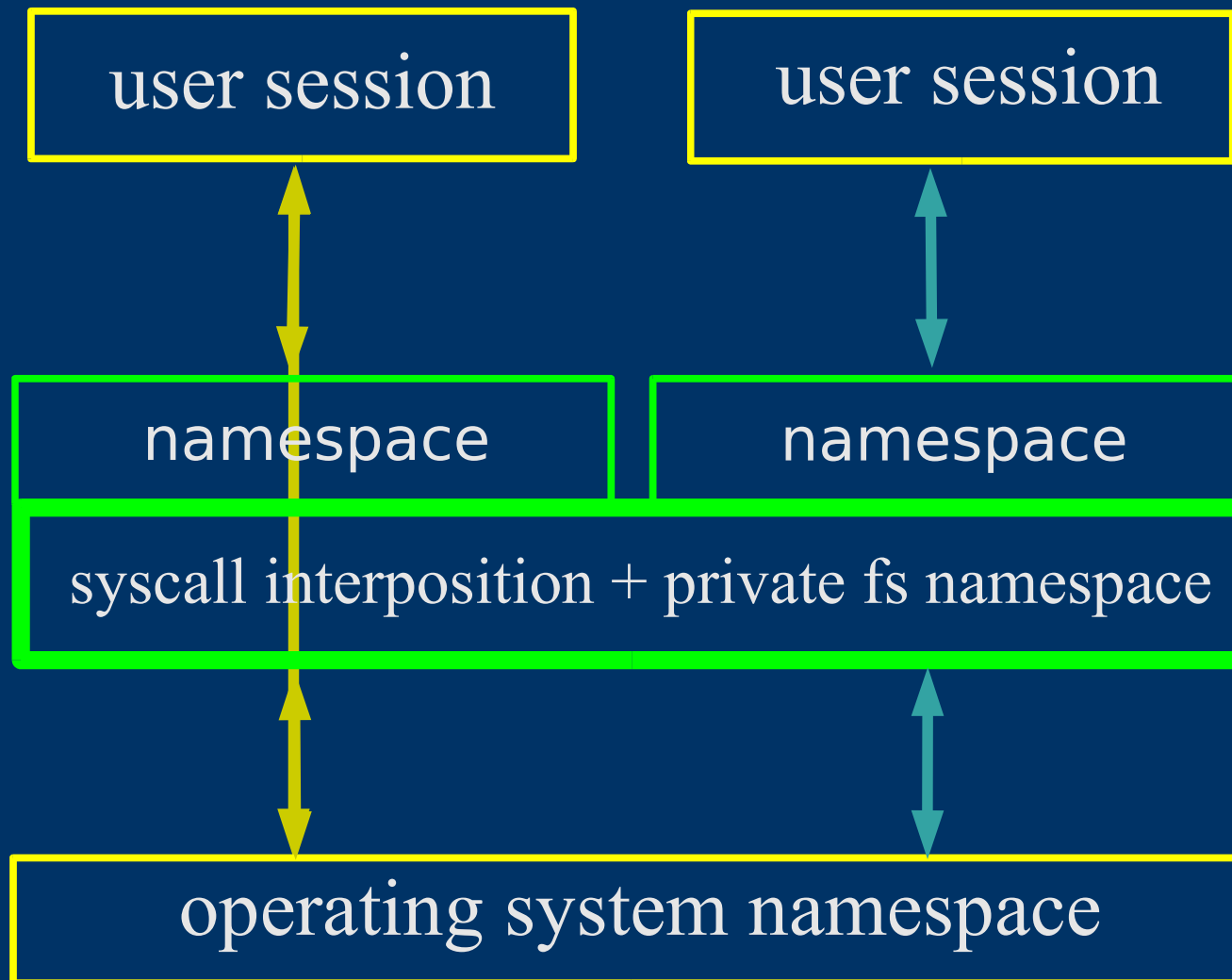
# Display Virtualization



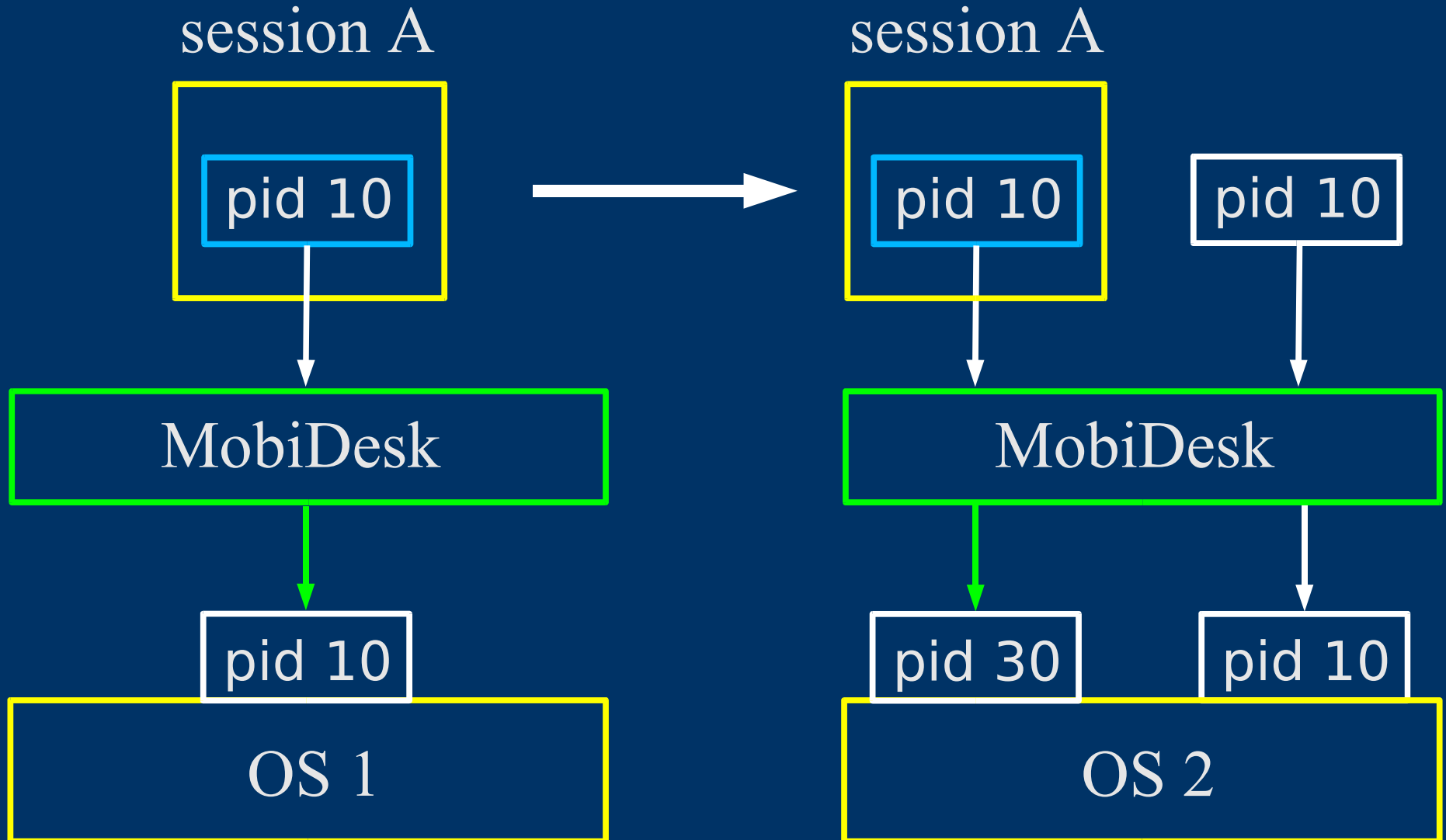
# Display Virtualization



# Operating System Virtualization

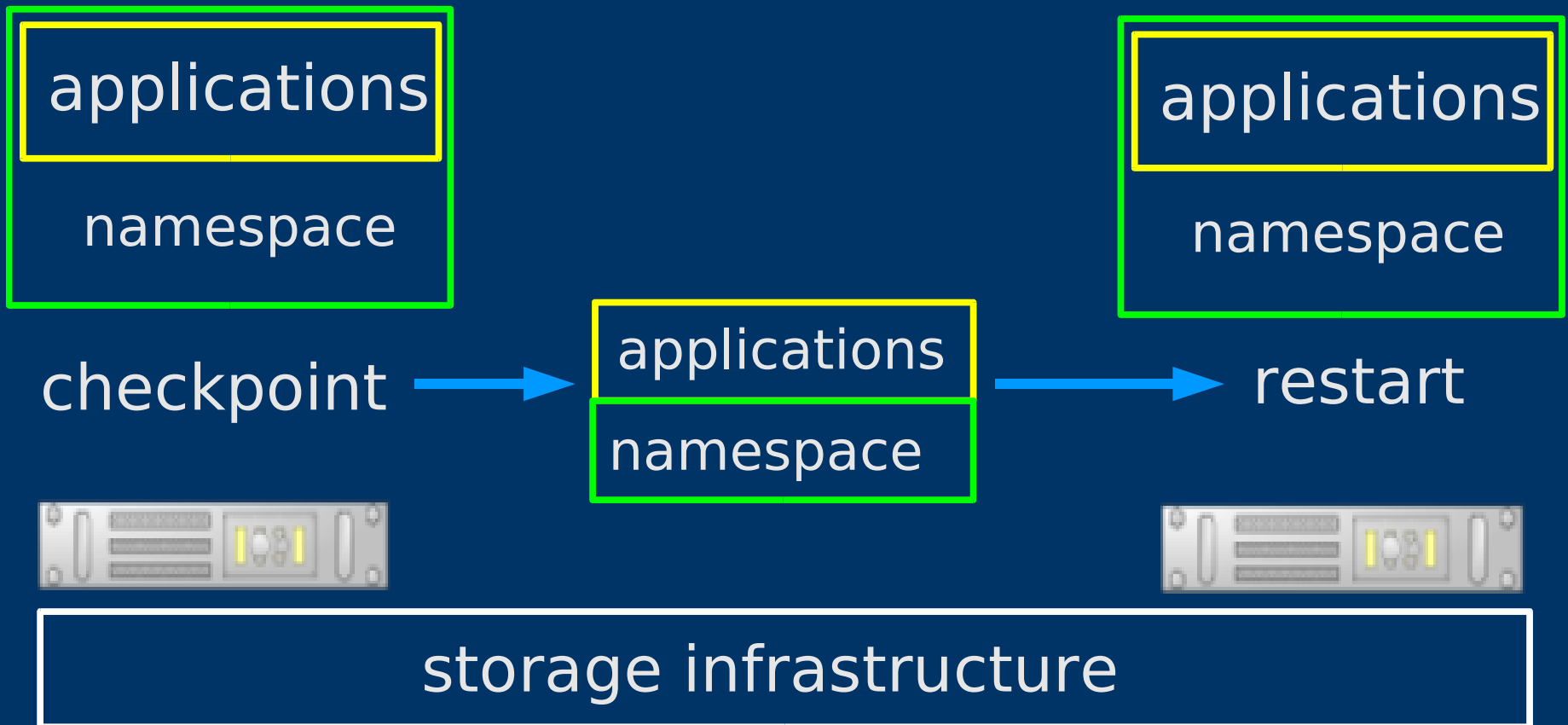


# Virtualization Example





# Session Migration

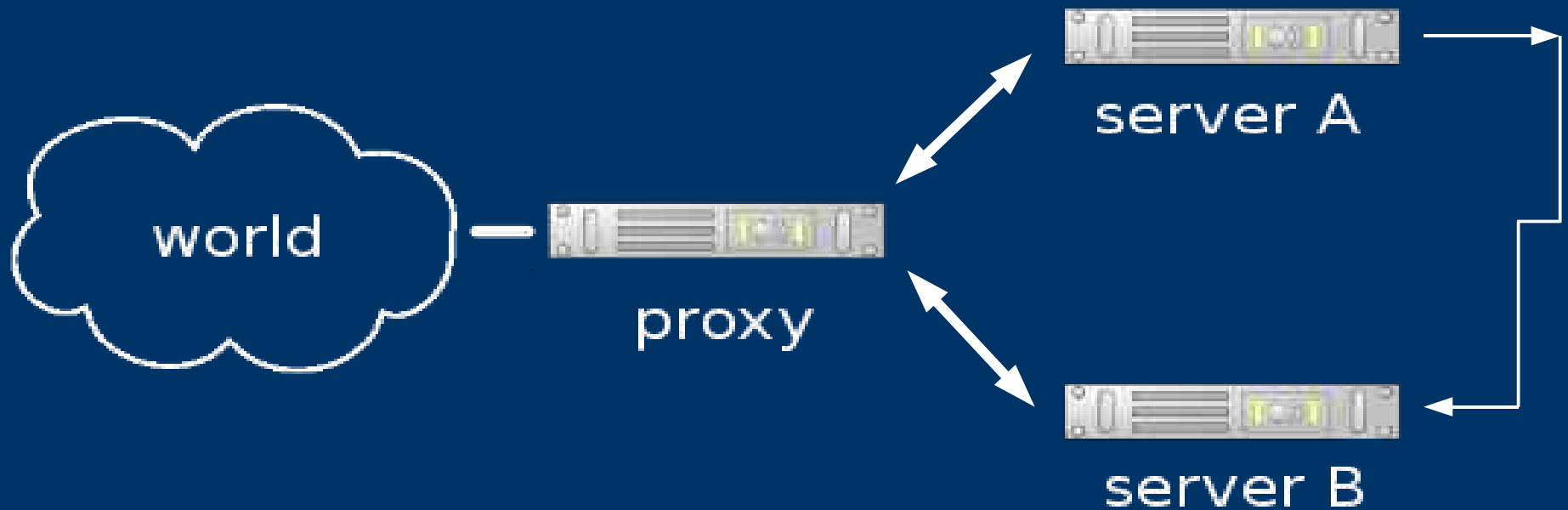


# *Session Migration (cont)*

- Application state saved in kernel independent format
- Use high-level application description



# Network Virtualization – Overall View

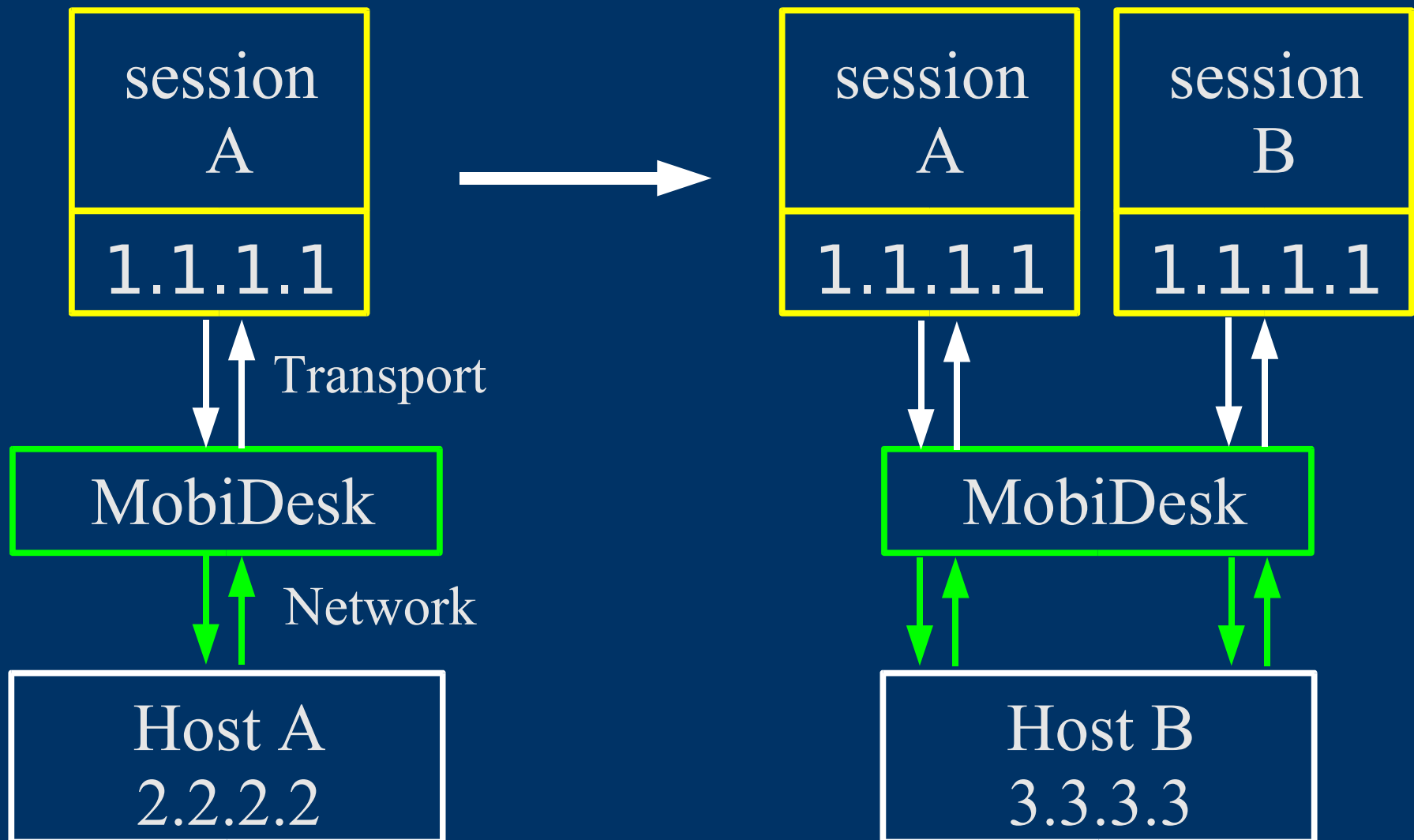


→ No changes to outside world

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# Session Network Virtualization



# *Related Work*

- Thin-client computing
- Virtual machines
- Network mobility
- On-demand services



# *Thin-client computing*

For example:

- Citrix Metaframe
- Virtual Network Computing (VNC)
- SunRay

Problem:

- Sessions tied to server
- Remote display not designed for WANs
  - Network latency becomes an issue



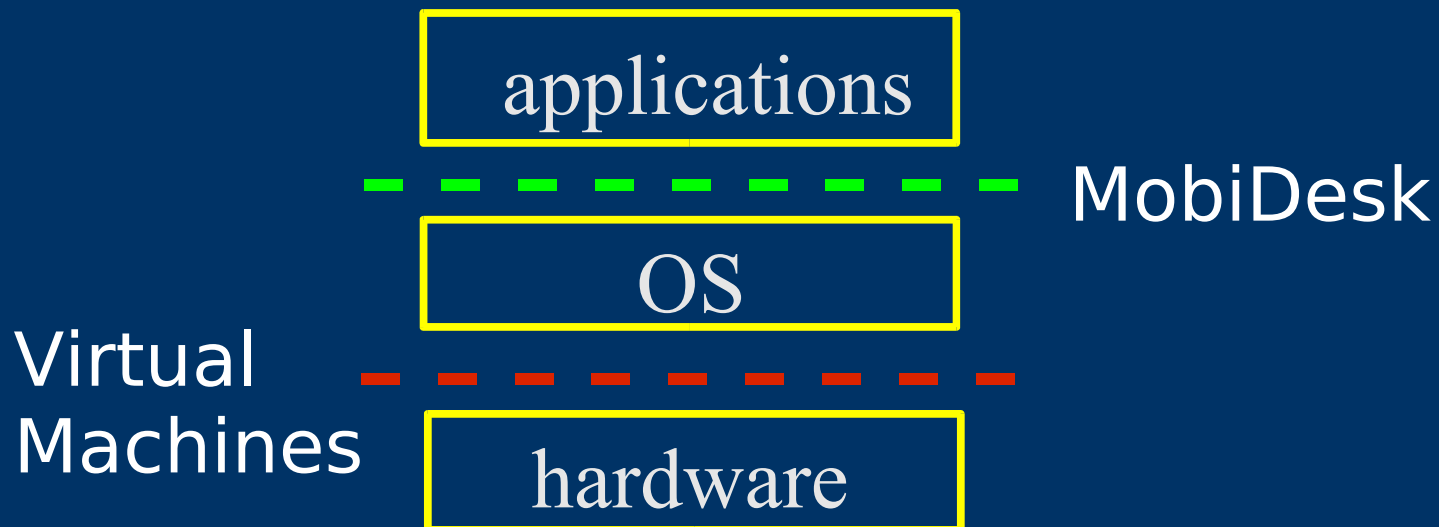
# Virtual Machines

For example:

- VMware ESX Server

Problem:

- Applications tied to OS, even if OS needs to be brought down



# *Network Mobility*

For example:

- MobileIP
- Rocks
- M-TCP

Issues:

- Simplicity
  - Transparency
  - Low-overhead
  - Reusable session addresses
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# *On-demand Web Services*

- Akamai
- IBM's Oceano
- Webmail

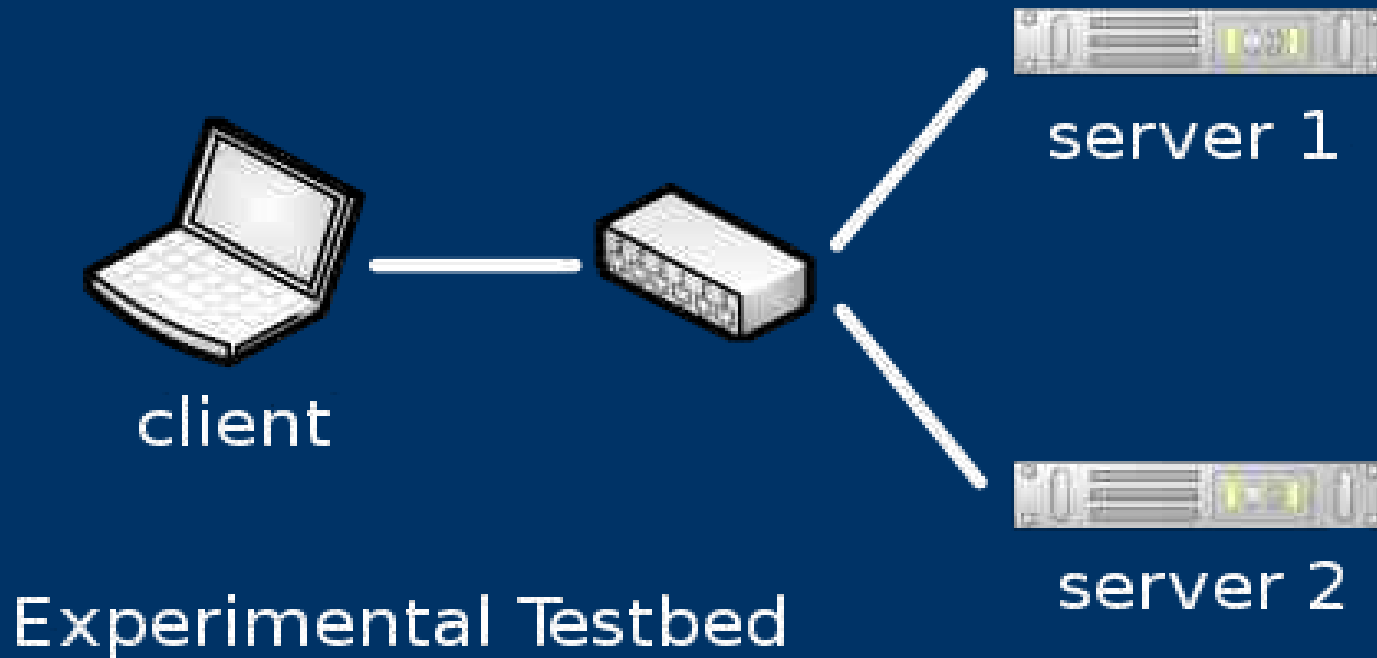
## Problem:

- Application specific solutions which depend on the statelessness of web services



# Experimental Results

- Prototype
  - Linux 2.4 kernel module and X device driver



# *Remote Display Performance*

User-perceived performance on popular applications

- Web browsing
- Video playback

across different network environments

- LAN
- WAN

and compared to existing commercial systems

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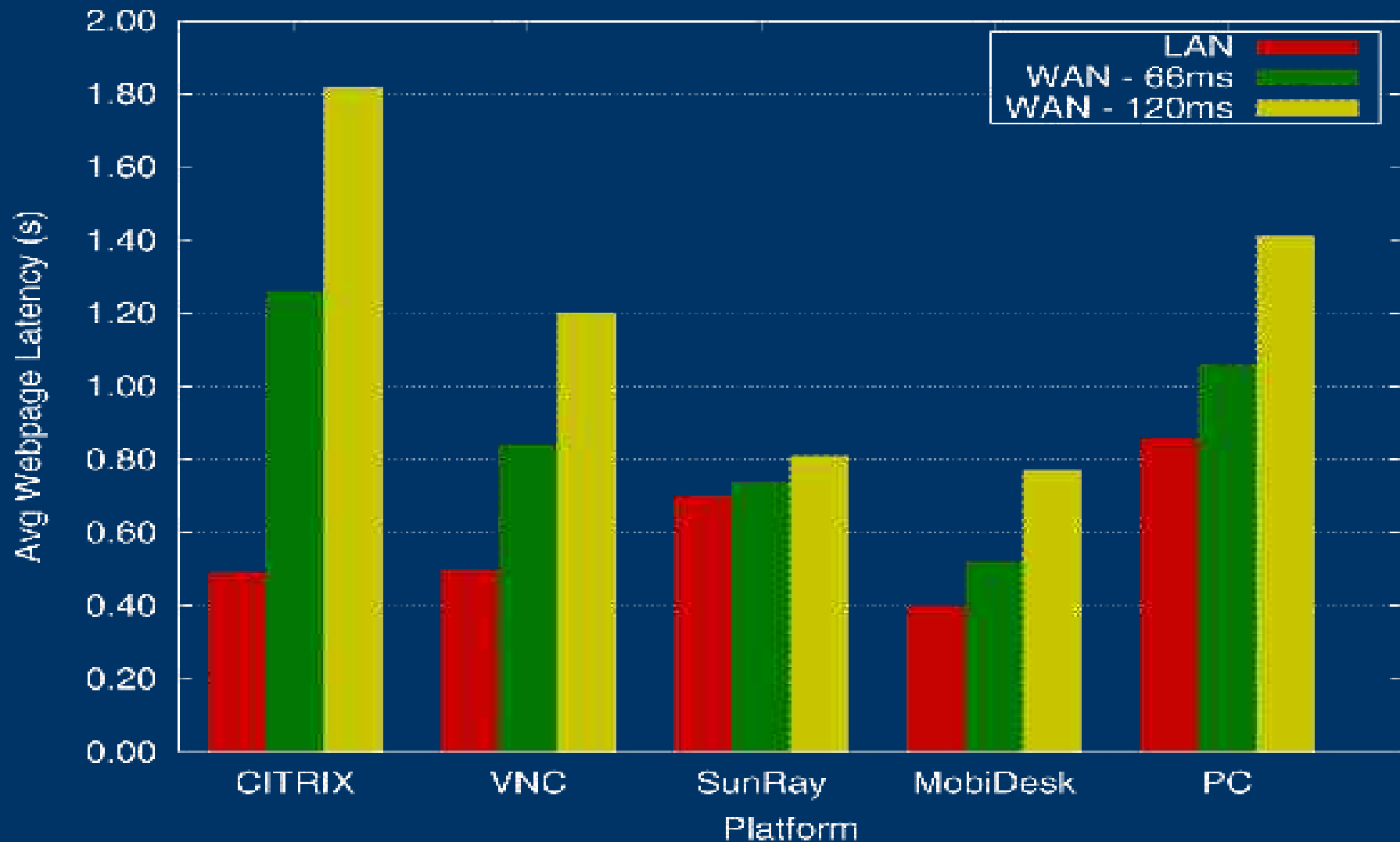
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# *Web Browsing Performance*

- Latency: average time for a web page to be displayed by the client



# Web Browsing Latency



# *Video Playback Performance*

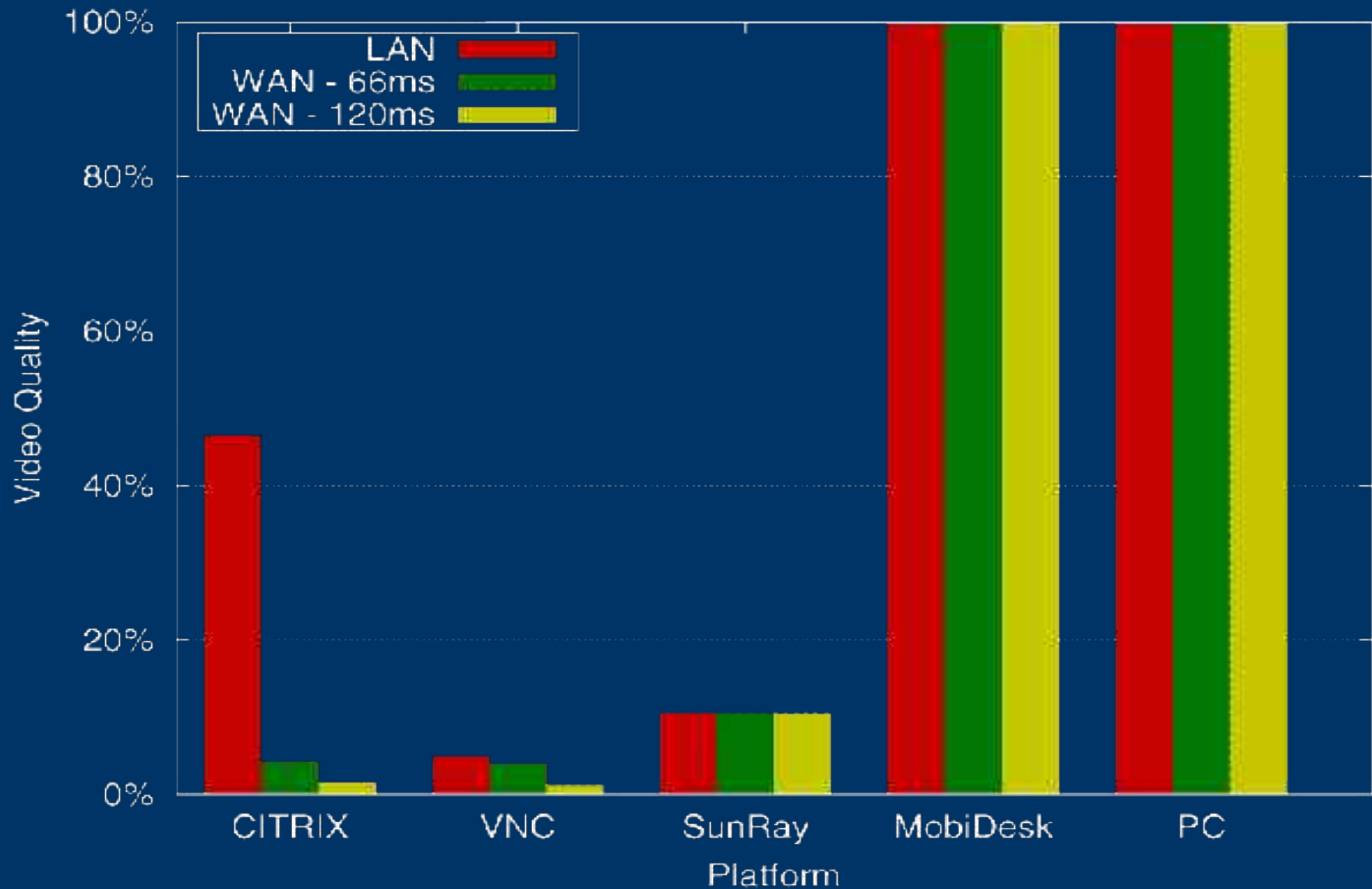
- Video quality: playback time and frames displayed at the client

Example: 50% video quality

- Twice as long to play the video, or
- Half of the frames were not displayed



# Video Quality



# Session Migration

The screenshot displays a Windows XP desktop environment with several open applications:

- Internet Explorer:** Opened to the Network Computing Lab website. The page title is "Network Computing Lab" and the URL is "http://www.cis.columbia.edu". The page content includes a "MISSION" section, a "RESEARCH PROJECTS" section with links to "Mobile Work: A Hybrid Desktop and Mobile Device Environment", "EMC: Transport Management in Large Data Centers", "MVC: Mobile Virtual Desktop Computing for Mobile Networks", "CSC: Columbia State Spacecraft", "SWAF: Software-Defined Networks", "SMT: Security for Mobile Networks", and "FRT: Flexible File Transfer". There is also a "CURRENT MEMBERS" section listing names like "Jinsheng Chen", "Yuan Chen", "Shuang Chen", "Srinivas Chittoor", "Danyu Guo", "Alex Hartono", "Gang He", "Gang He", "Chris He", "Alex Li", and "Ming Li".
- PDF Viewer:** Opened to a document titled "MobileDesk: Mobile Virtual Desktop Computing". The document includes an abstract and an introduction section.
- Terminal Window:** Opened to a command prompt showing a list of files and directories. The output is as follows:

```
total 16  
drwxr-xr-x 1 root root 4096 Jan 10 2008 .  
drwxr-xr-x 1 root root 4096 Jan 10 2008 ..  
-rwxr-xr-x 1 root root 12288 Jan 10 2008 .bashrc  
-rwxr-xr-x 1 root root 12288 Jan 10 2008 .bash_profile  
-rwxr-xr-x 1 root root 12288 Jan 10 2008 .cshrc  
-rwxr-xr-x 1 root root 12288 Jan 10 2008 .cshrc.login  
-rwxr-xr-x 1 root root 12288 Jan 10 2008 .kshrc  
-rwxr-xr-x 1 root root 12288 Jan 10 2008 .kshrc.login  
-rwxr-xr-x 1 root root 12288 Jan 10 2008 .profile  
-rwxr-xr-x 1 root root 12288 Jan 10 2008 .zshrc  
-rwxr-xr-x 1 root root 12288 Jan 10 2008 .zshrc.login
```
- Microsoft Word:** Opened to a blank document titled "Microsoft Word - [Untitled].doc".

The taskbar at the bottom shows the Start button, several icons, and the system tray with the date and time (1/10/2008 10:00 AM).



# *Session Migration Cost*

Subsecond checkpoint and restart times:

→ 0.85s checkpoint

→ 0.94s restart

→ 35MB image (8MB compressed)

→ Across Linux kernel versions: 2.4.5 to 2.4.18



# Conclusions

- Hosting infrastructure simplifies management
  - Virtualized session environment provides ubiquitous access, session independence from underlying infrastructure, and user isolation
  - Works with unmodified applications, operating system kernels, and network infrastructure, while being low overhead and providing efficient remote access
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*More information...*

<http://www.ncl.cs.columbia.edu>

