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# Unichos: A Full System Simulator for Thin Client Platform

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# Issues



# Motivation

- **Hardware Variety**

- varieties of hardware designs in thin client as a kind of high-end embedded systems

- **OS Requirement**

- thin client relies heavily on the support of the network and graphics devices
- Related research: omitting the behavior of the OS introduces errors as high as 100% for the SPECint 2000 benchmarks
- profiling and binary instrumentation cannot catch all the behaviors of applications and operating system

# Contributions

- **A Retargetable Full System Simulator**
  - combining the characteristics of retargetable instruction template and extensible device model which make it suitable for more architectures of thin client platforms
- **Complete Support for Simulation**
  - models the complete target hardware system faithfully to run an unmodified Linux 2.4 on network computer.
  - runtime simulation status switching between the functional simulation and performance simulation

# Outline

- Motivation
- Issues
- Contribution
- **Related Work**
- Unichos Simulator
- Evaluation
- Conclusions

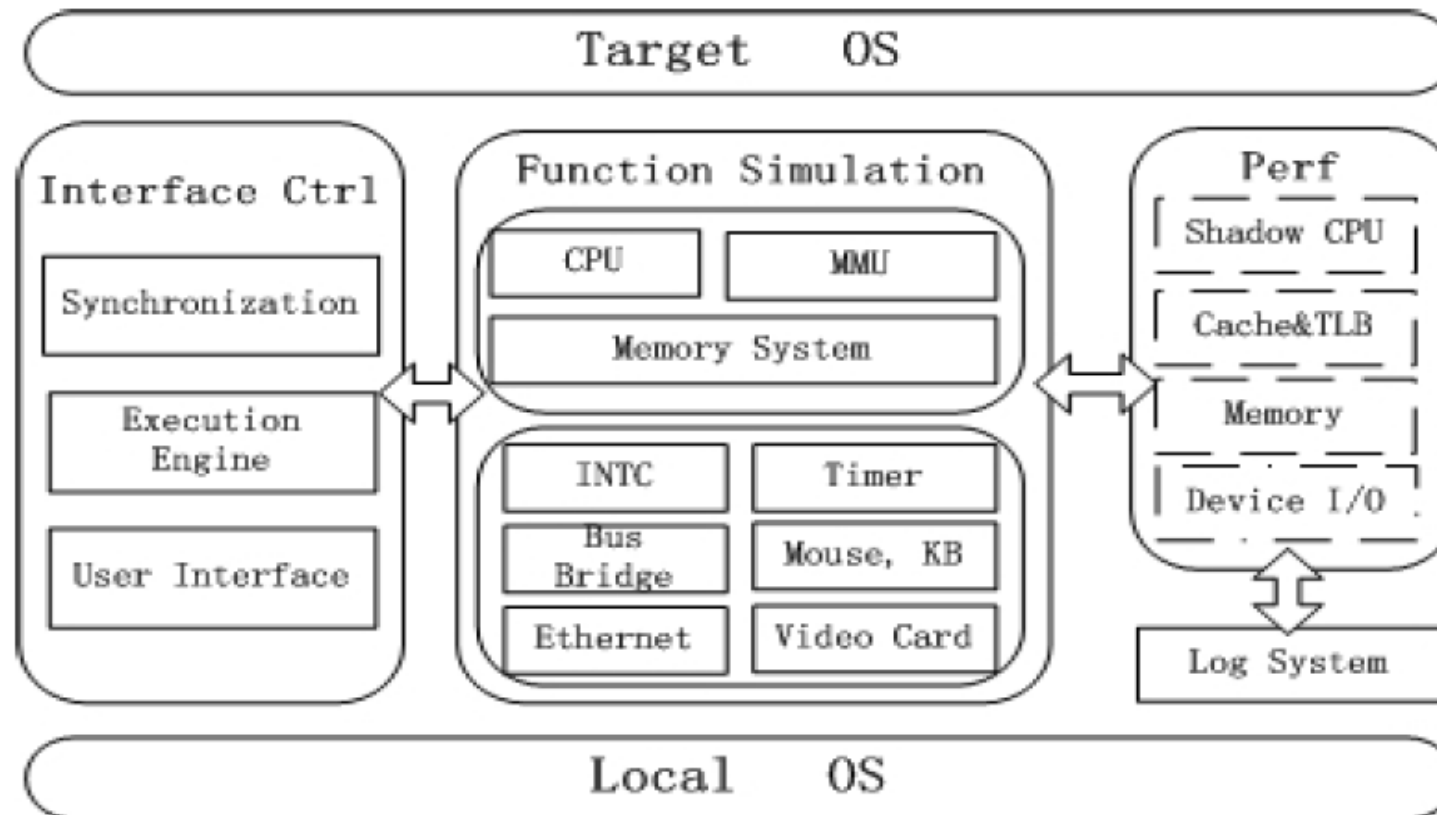
# Related Works

- **Application Simulator**
  - SimpleScalar
    - ss-os: A full system simulator for ARM
- **Full System Simulator**
  - Bochs: x86 Function Simulator
  - SimOS
  - M5
  - Simics ...

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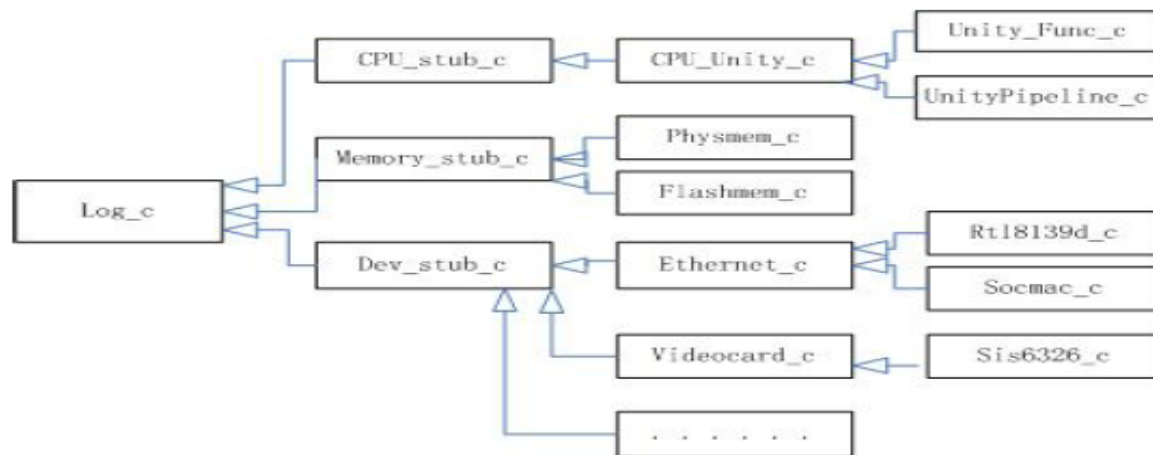
# Unichos Simulator Architecture



# Unichos Simulator Features

- Features

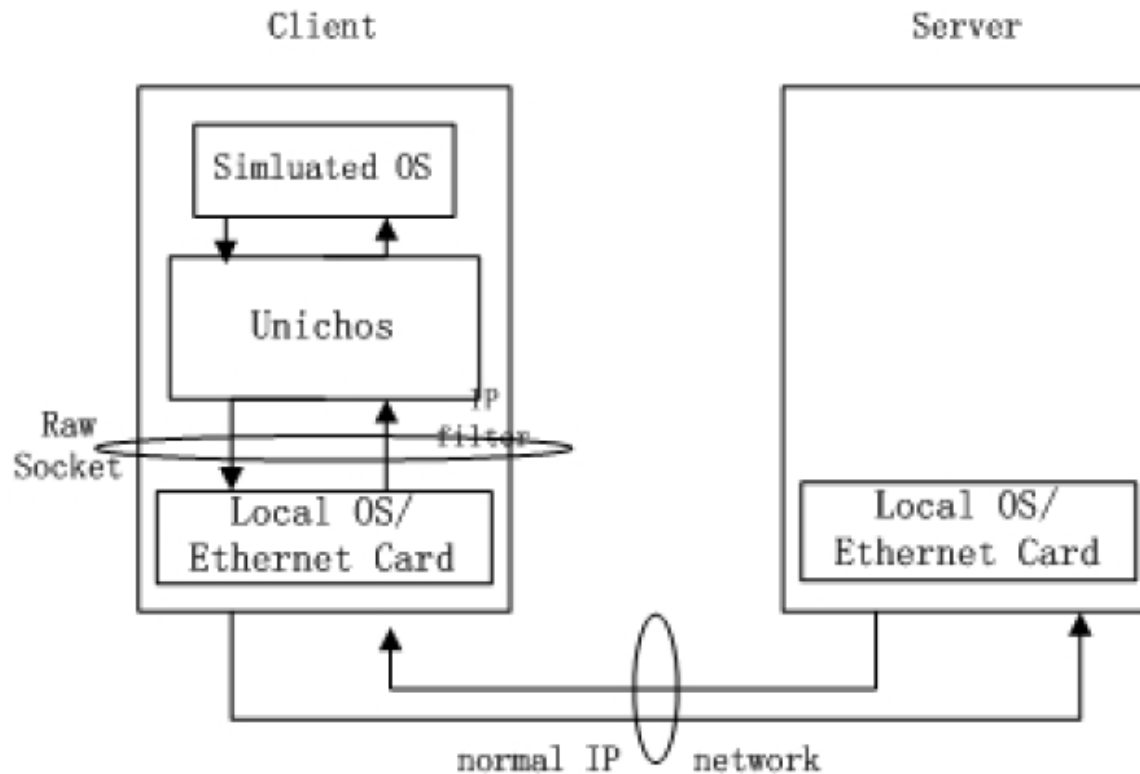
- combining the characteristics of retargetable instruction template and extensible device model
- models target hardware system in object-oriented structure for modularity



# Unichos Simulator Features

- **Features**
  - Separate the performance support from the functional simulation. Provide detailed micro-processor model, multi-level Cache and TLB memory system model and important I/O device model (such as DMA during network transferring)
  - Supports runtime simulation status switching between the functional simulation and performance simulation
  - Supports runtime configuration to allow user to specify the detailed parameters according to different simulation requirements.

# Network in Unichos Simulator



# Tools in Unichos Simulator

- UniTLB: A System Level Trace-driven Simulator
  - Design reference by sim-cache of SimpleScalar toolkit
  - Deal with multi-process condition in trace file. With the information of PID, TLB operations and etc, it could analysis the TLB miss in multi-process environment and the impacts which OS brings

# Unichos Simulator

- **Disadvantages**

- No bus contention simulation
- No memory controller simulation
- Still need great improvements in performance simulation

- **Has been used in:**

- Application TLB behavior characterization
- Dynamic superpage management evaluation
- Kernel hardware design optimization (such as Cache)

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# Evaluation

<b>Benchmark</b>	<b>MIPS</b>	<b>Benchmark</b>	<b>MIPS</b>
164.gzip	1.488	255.vortex	1.254
175.vpr	1.725	256.bzip2	1.698
176.gcc	1.333	300.twolf	1.581
181.mcf	1.354	Kaffe-fft	1.503
186.crafty	1.301	Kaffe-heapsort	1.438
197.parser	1.447	mplayer-ffmpeg	1.609
252.eon	1.709	mplayer-mpeg12	1.679
253.perlbmk	1.132	rdesktop	1.483
254.gap	1.557	Konqueror	1.454

Simulation Speed under Detailed Performance Simulation

# Case Study

- Characterizing d-TLB behavior of typical applications on thin client
  - evaluate d-TLB miss rate and its contribution to the performance penalty
  - analysis the impacts that the characterization of multi-process brings
- Separated sequential data
  - provides full support on trace-generation and performance simulation of network and streaming applications and OS.

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# Conclusions

- **Unichos Full System Simulator**
  - combines the characteristics of retargetable instruction template and extensible device model
  - a general architecture design in object-oriented structure, and provides full support for key functions such as graphics and network
  - used in system verification, software development and performance evaluation

# Conclusions

## ● Future Work

- Improve performance simulation support
  - bus contention
  - memory controller
  - etc
- Automatic Flow from SimpleScalar to Unichos

Thank You!

Questions?