

# Soft Real-Time Acquisition in Windows XP

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## Purpose

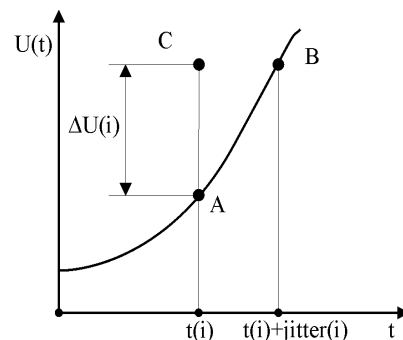
- ALLADIN project – measurement & analysis system in stroke rehabilitation
- 8 6-axis force/torque sensors
- Sample rate at sensor is 8 kHz



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## Real time systems

- Event or time triggered
- Hard real-time – robot control
  - Control delay, period, jitter, transient error
- Soft real-time – data acquisition
- Jitter introduces error



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## Software platform

- Software running on Windows XP
- Human movements bandwidth up to 10 (30) Hz => sample rate 100 Hz
- Jitter below 1 ms
- During acquisition is PC lightly loaded
  - Video playback
  - Network communication
  - Reading/writing to/from hard disk



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## Tested approaches

- 2 tested approaches, both in a driver
- High priority working thread
- Local advanced programmable interrupt controller (LAPIC) timer interrupt
- Testing on loaded and unloaded system
- Performance was assessed based on
  - Sampling time histograms
  - Maximum jitter



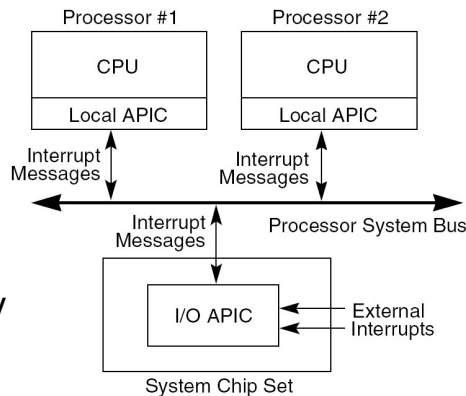
## High priority thread

- Has highest possible priority
- Can't be interrupted by other threads
  - Dual processor PC required
- Can be interrupted by interrupts
  - Interrupt service routines
  - Deferred procedure calls



## LAPIC

- It's part of the CPU
- Receives interrupts from external HW via IO/APIC
- Sends interrupts to the processor core according to priority
- Contains a timer



## LAPIC timer

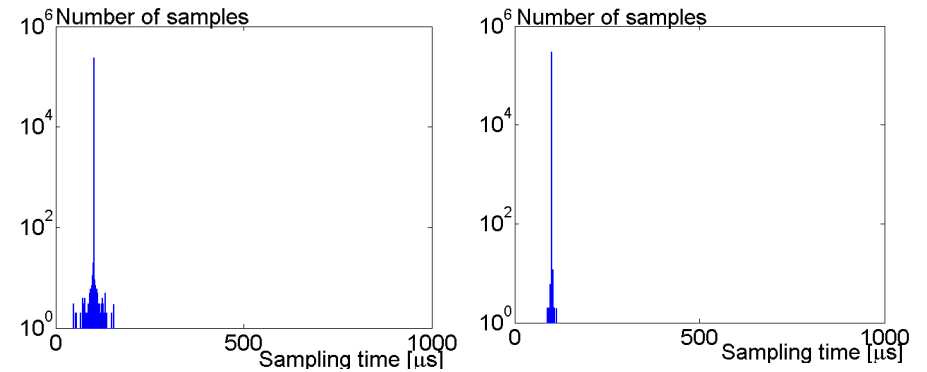
- One shot or periodic interrupts
- Frequency of the system bus (100 MHz)
- Selectable interrupt number/priority
- Can be masked with CLI instruction
- Is disabled on uniprocessor systems
  - Dual processor PC is needed



# Performance assessment

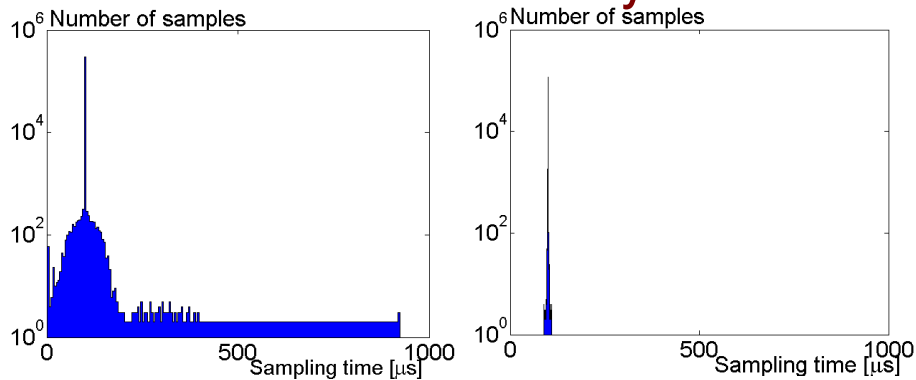
- Loaded and unloaded system
- At 5 and 10 kHz
- 2 different PCs (500 MHz, 2.8 GHz)
- Loaded system
  - Compressed video, 3D OpenGL graphics
  - File copied over network to local disk
  - Remaining time used by 2 user mode threads

# Results - unloaded system



- Both thread and LAPIC show good performance
- Almost no samples with jitter bigger than 10  $\mu$ s

# Results – loaded system



- Thread – jitter typically below 100  $\mu$ s
- LAPIC – jitter typically below 10  $\mu$ s

# Results – maximum jitter

		unloaded	loaded
		10 kHz	10 kHz
System 1	Thread	53.6	823.6
	LAPIC	11.2	11.3
System 2	Thread	27.0	227.2
	LAPIC	46.6	40.6

- Thread jitter is worst on loaded system
- LAPIC jitter is less dependent on loading

## Conclusions

- LAPIC gives lower jitter
  - Is less sensitive to the system load
  - Jitter could be minimized by use of a time buffer
  - Dual processor PC required
    - Hyperthreading is sufficient
  - Bad drivers (CLI instruction) can cause unlimited delay
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Thank you for your attention

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