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Real-Time Operating Systems

II.

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Kernel

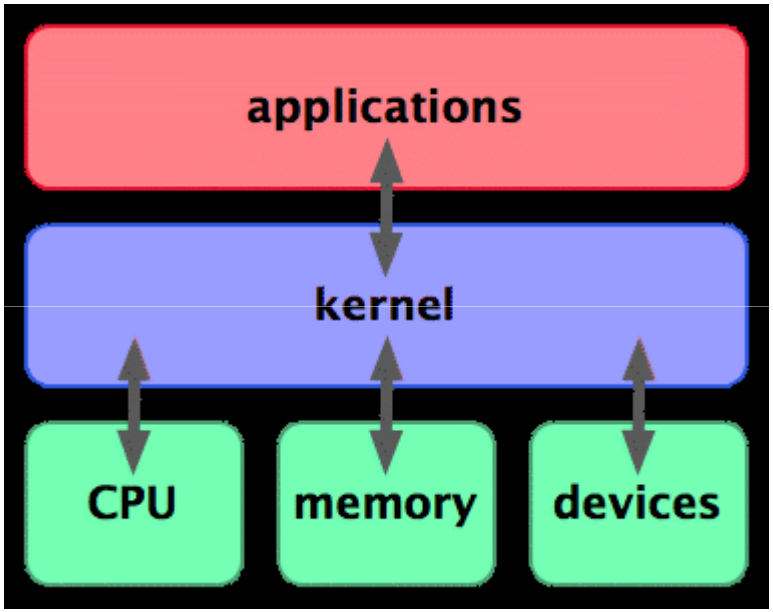
Kernel (core) is the main component of RTOS. It ensures following two main activities:

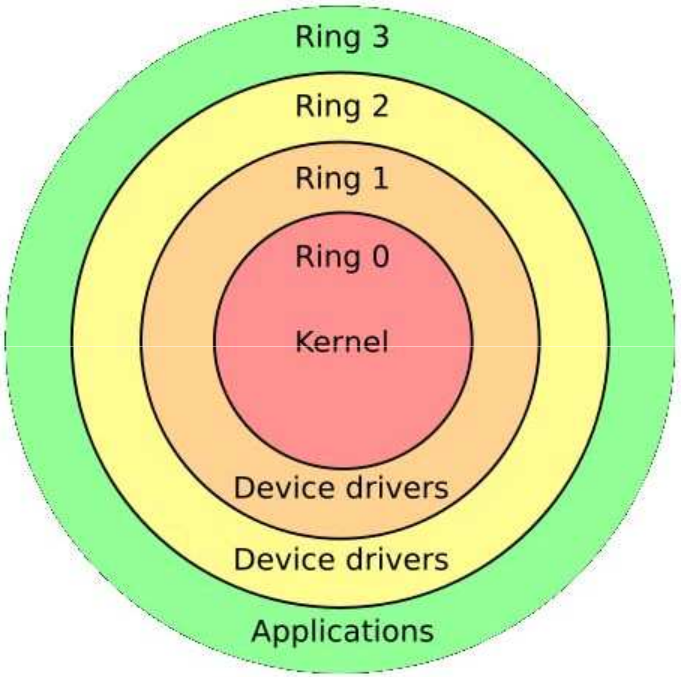
- to manage the computer's resources,
- to allow other programs to run and use these resources.

Other Kernel's functions

- to provide abstract layer for user-defined applications
- to provide unified method for accessing shared resources:
  - CPU
  - Memory
  - I/O
- to provide inter-process communication (IPC)

Kernel

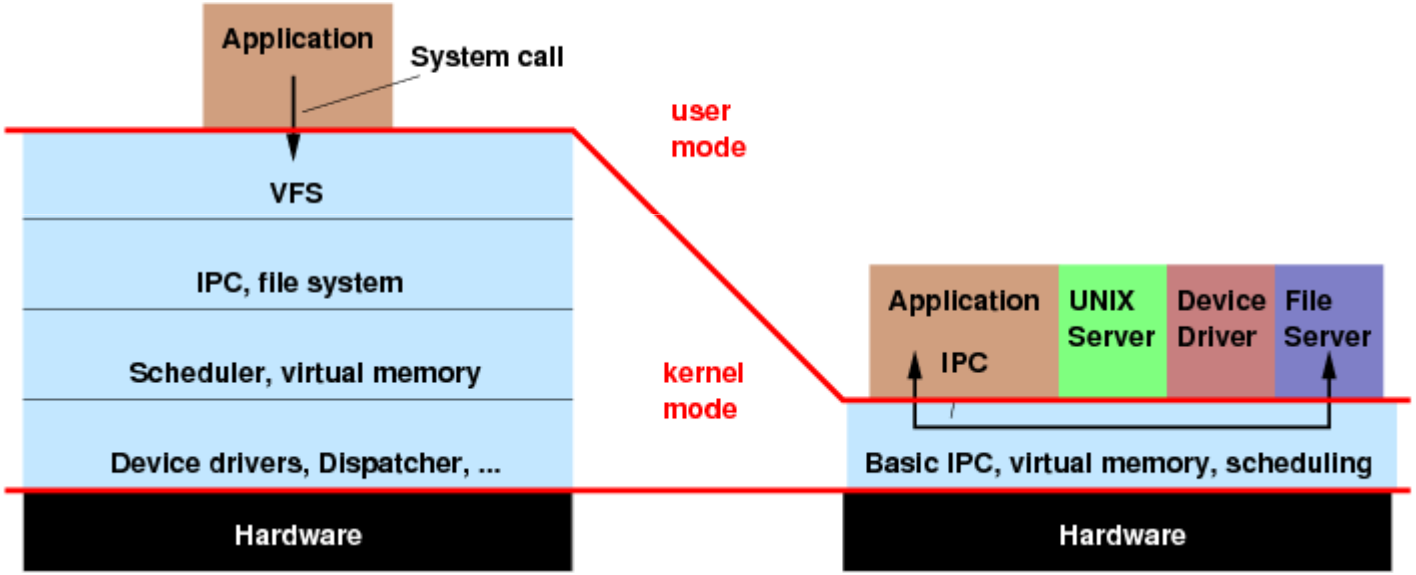




source: en.wikipedia.org

Kernel

Microkernel vs. Monolithic kernel



source: en.wikipedia.org

RTOS - overview

POSIX (IEEE 1003.1)	standard based on UNIX OS
Win32	not standardized but a lot of users

QNX

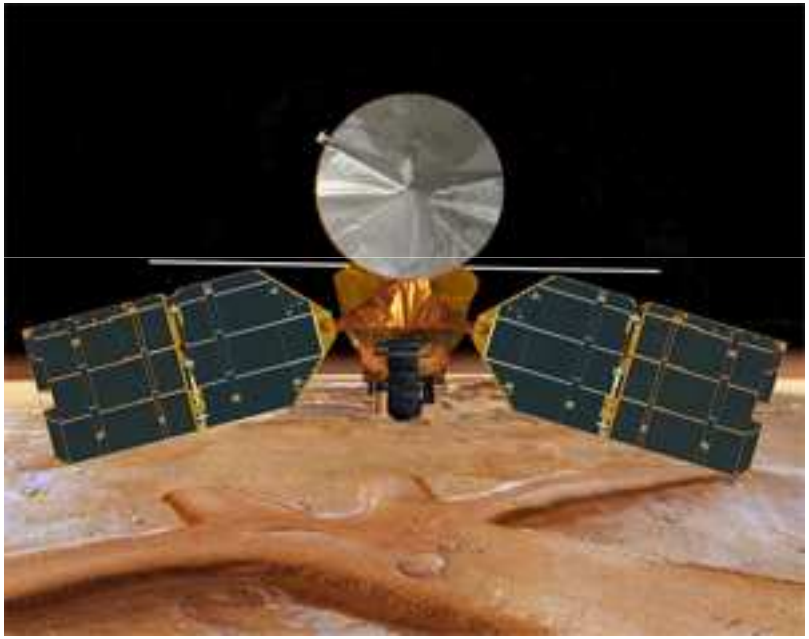
- Commercial RTOS based on POSIX standard.
- Microkernel architecture.
- Portable on x86, MIPS, PowerPC, SH-4, ARM, xScale.
- QNX kernel includes CPU scheduler, IPC, interrupt and timer services.
- Neutrino version supports symetric multiprocessing (SMP) and bound multiprocessing (thread might be detached to certain CPU).
- Core schedulers uses Adaptive Partition Scheduling (APS) algorithm.
- Source code is available for non-commercial usage
- More: www.qnx.com

LynxOS

- Unix-like real-time operating system.
- Based on POSIX standard, compatible with Linux.
- Microkernel architecture (dynamically scalable).
- Portable on 80386, ARM, PowerPC.
- Extremely low time responses on external interrupts.
- Protected memory (architecture 80386) and virtual addressing.
- Commonly used in embedded systems, aerospace, process control, telecommunication.
- More: www.lynuxworks.com/rtos

VxWorks

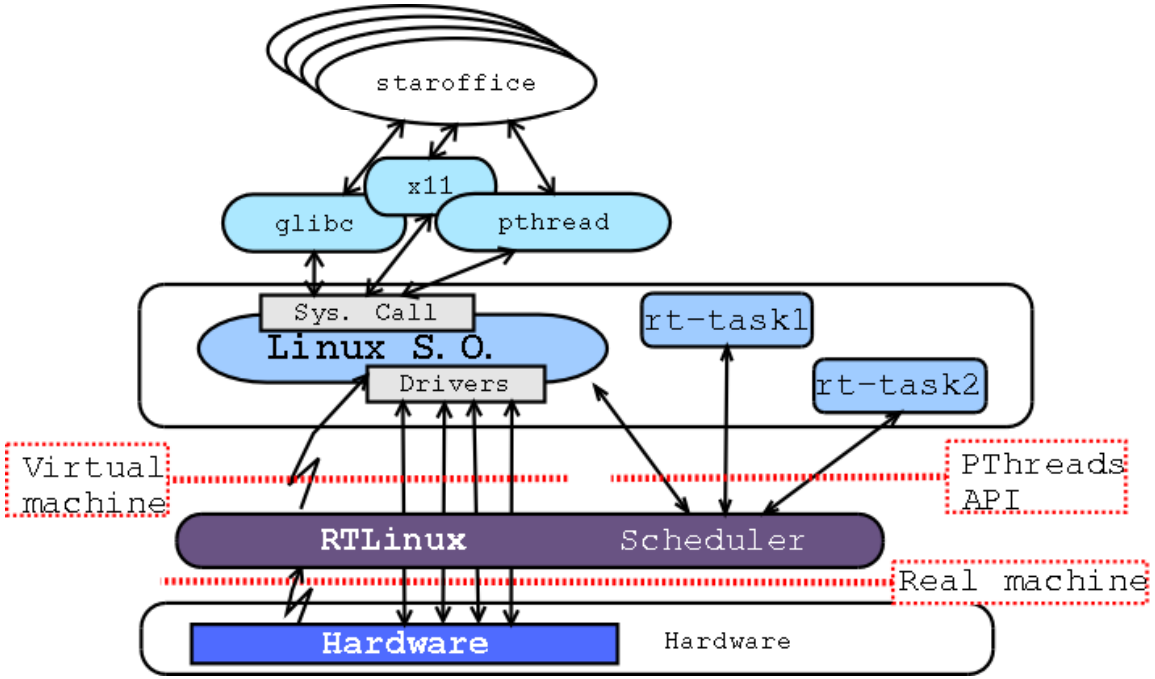
- Unix-like real-time operating system.
- Based on POSIX standard.
- Multitasking kernel architecture with preemptive task scheduler.
- Portable on x86, MIPS, ARM, PowerPC, SH-4 and xScale.
- Used in „Mars Reconnaissance Orbiter“.
- More: www.windriver.com



source: www.nasa.gov

RTLinux

- Based on Linux & POSIX.
- Adding layer virtual machine between HW and classical core.
- More: www.rtlinuxfree.com



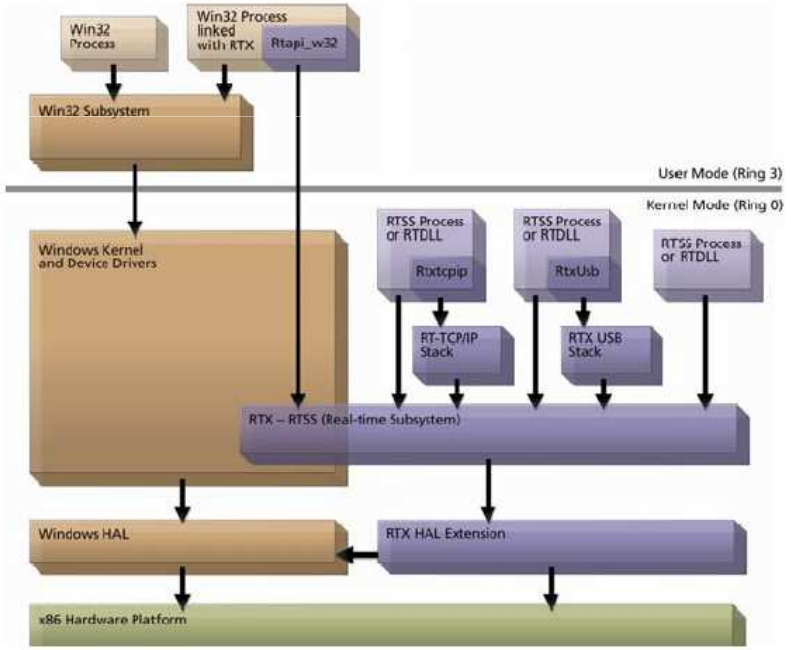
zdroj: rtportal.upv.es

Windows CE

- Based on Win32 standard.
- Core is a hybrid kernel (market hype; it’s a monolithic kernel).
- Portable on x86, MIPS, ARM, SuperH.
- Less then 1MB operating memory, no need of disk support.
- Also in version ‘closed’ in ROM.
- Deterministic respones on interrupts, including latency time.
- Supports 256 priorities. Priority inversion is solved by a priority inheritance algorithm.
- Platforms based on WinCE: AutoPC, Pocket PC 2000, Pocket PC 2002, Mobile 2003, Mobile 2003 SE, Mobile 5.0, Mobile 6.0 Smartphone 2002, Smartphone 2003.
- More: www.microsoft.com

Windows RTX

- Based on Win32 standard.
- Core is monolithic kernel based on NT technology.
- Portable on x86 architectures.
- Independent scheduler is running before all interrupts and all window's thread.
- No changes in a core, HAL or device drivers.
- HAL is expanded for real-time timers and STOP state detector.
- 128 priorities.
- ACPI support.
- SMP support.
- More: www.ardence.com



zdroj: www.ardence.com

Motivations for Win32 based RTOS

- Improving reliability
- Increasing computational power
- Decreasing price
- Development tools
- Developers
- Win32 API is a standard for all levels development
- Modern and attractive visualization
- Modern data store

Embedded systems

Control units

- Industrial Automation
- Medical Appliances
- Machine Control
- Building Control
- Decentralized system control

CPU with high reliability

- Small size
- Low power Consumption
- Low price
- High MTBF

Zdroj: Datapartner

RTX Architecture

- RTX adds a real-time subsystem, known as RTSS.
- RTSS is conceptually similar to other Windows subsystems (such as Win32, POSIX, WOW, and DOS) in that it supports its own execution environment and API.
- RTSS differs in one important area, though: Instead of using the Windows scheduler, RTSS performs its own real-time thread scheduling.
- Furthermore, in a uniprocessor environment, all RTSS thread scheduling occurs ahead of all Windows scheduling, including Windows-managed interrupts and Deferred Procedure Calls (DPCs).

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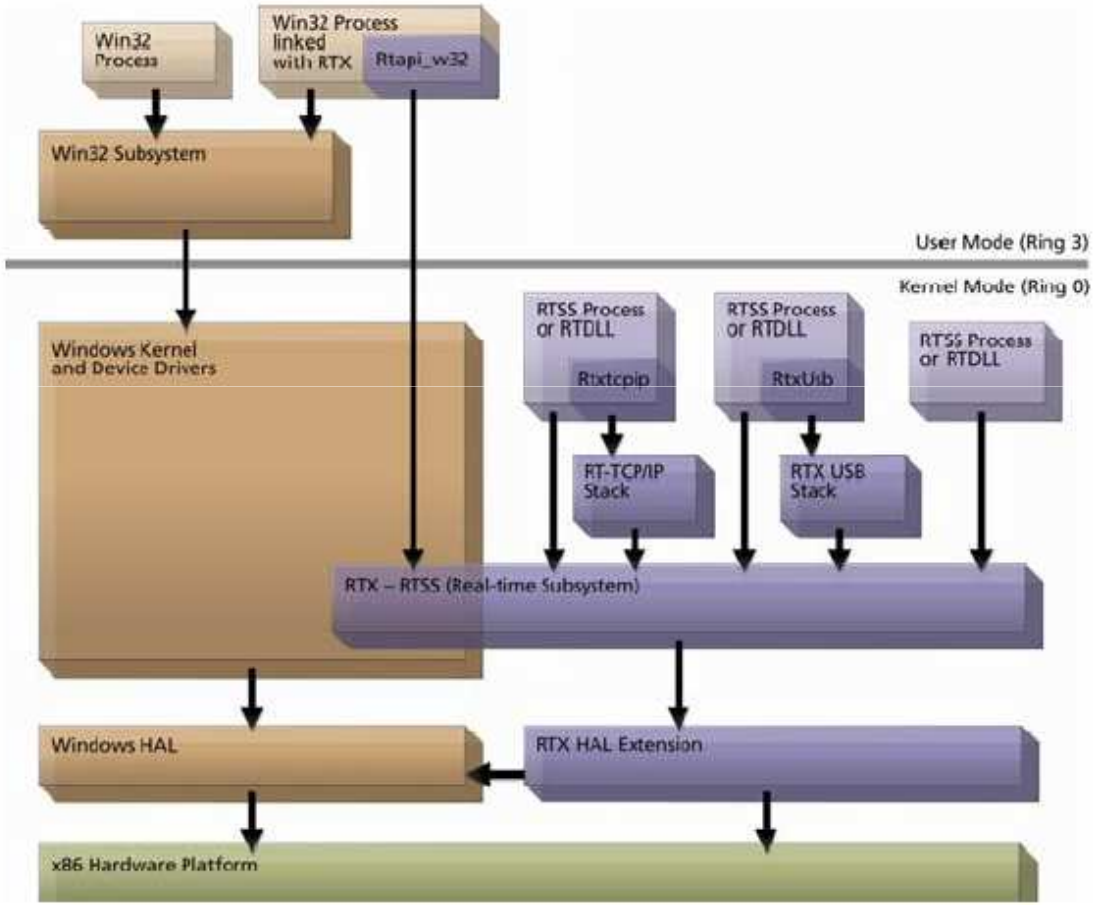
RTX Architecture



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RTX Feature

Latency times - CPU Pentium III 800 (Min/Max v µsec)

Operation	WinXP*	CE 3.0*	RTX 5.1*
SetEvent	1.04 / 5000+	1.49 / 7.20	0.29 / 2.71
ResetEvent	1.38 / 5000+	2.46 / 10.7	0.60 / 2.96
ReleaseMutex	1.49 / 5000+	3.51 / 10.5	0.70 / 3.26
ReleaseSemaphore	1.39 / 5000+	3.00 / 9.40	0.61/3.43
ChanagePriority	1.31 / 5000+	1.41 / 8.96	0.56 / 3.81
InterruptServiceTime	4.3 / 5000+	4.3 / 26	2.0 / 19

*MIN/MAX

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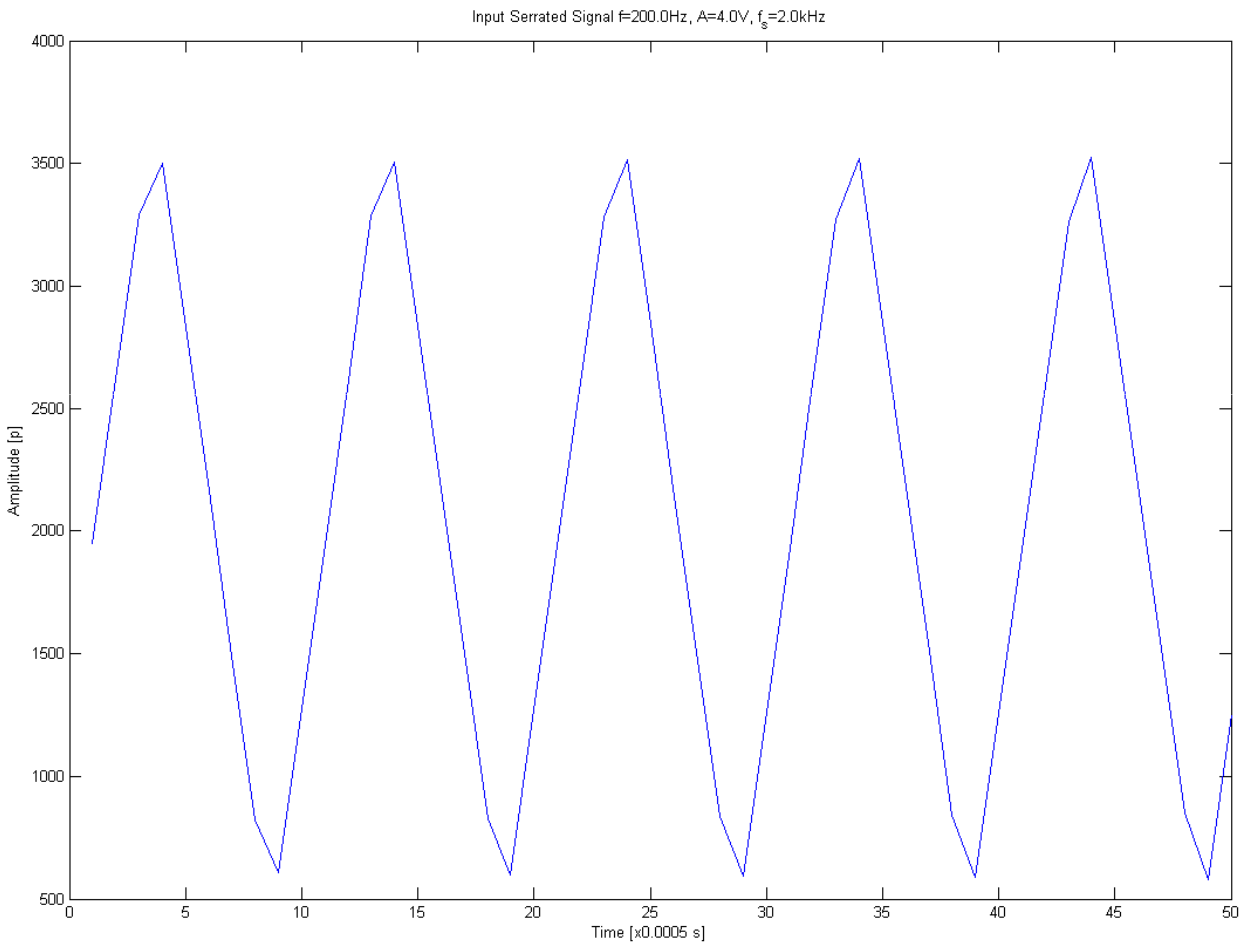
Testing parameters – absolute timing



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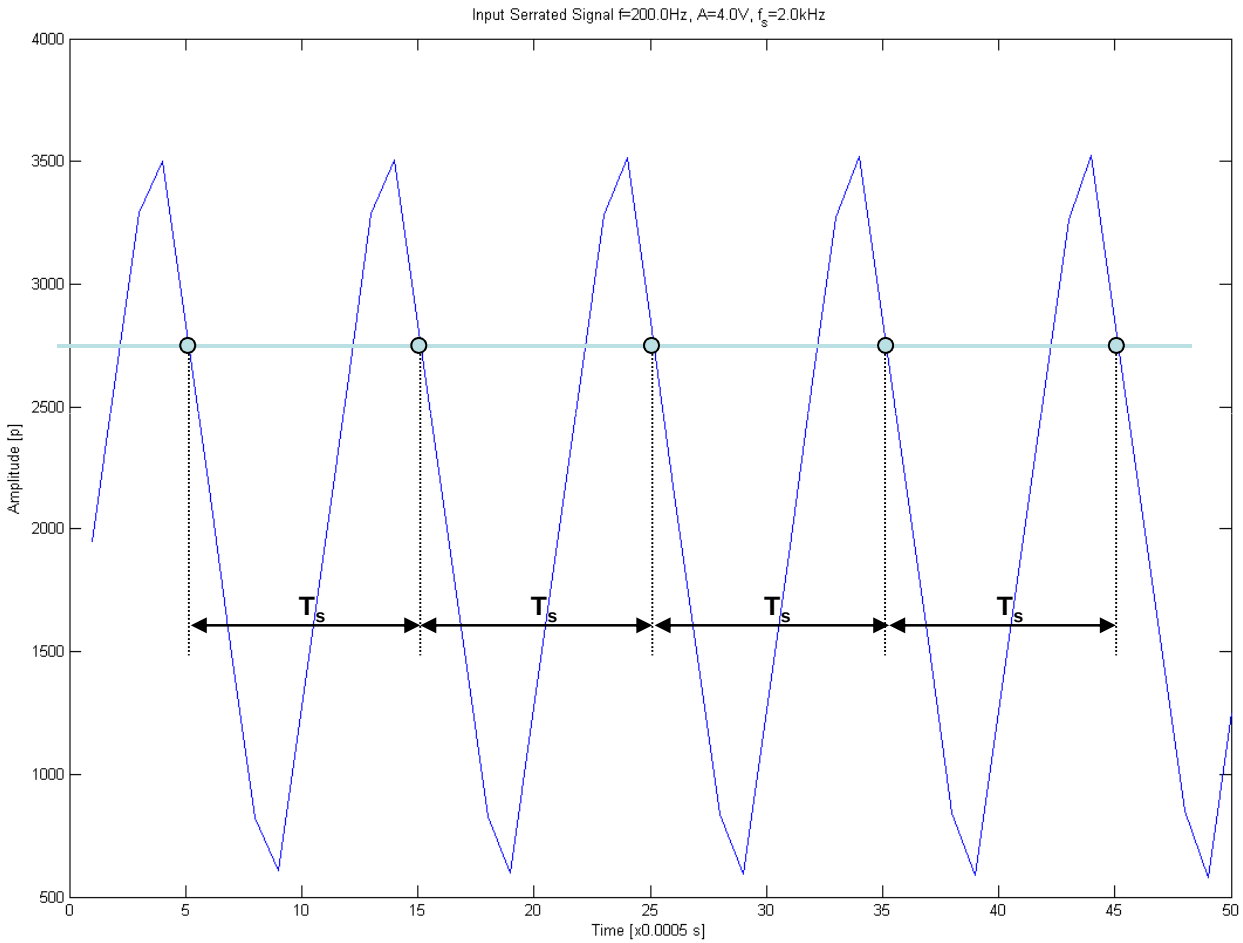

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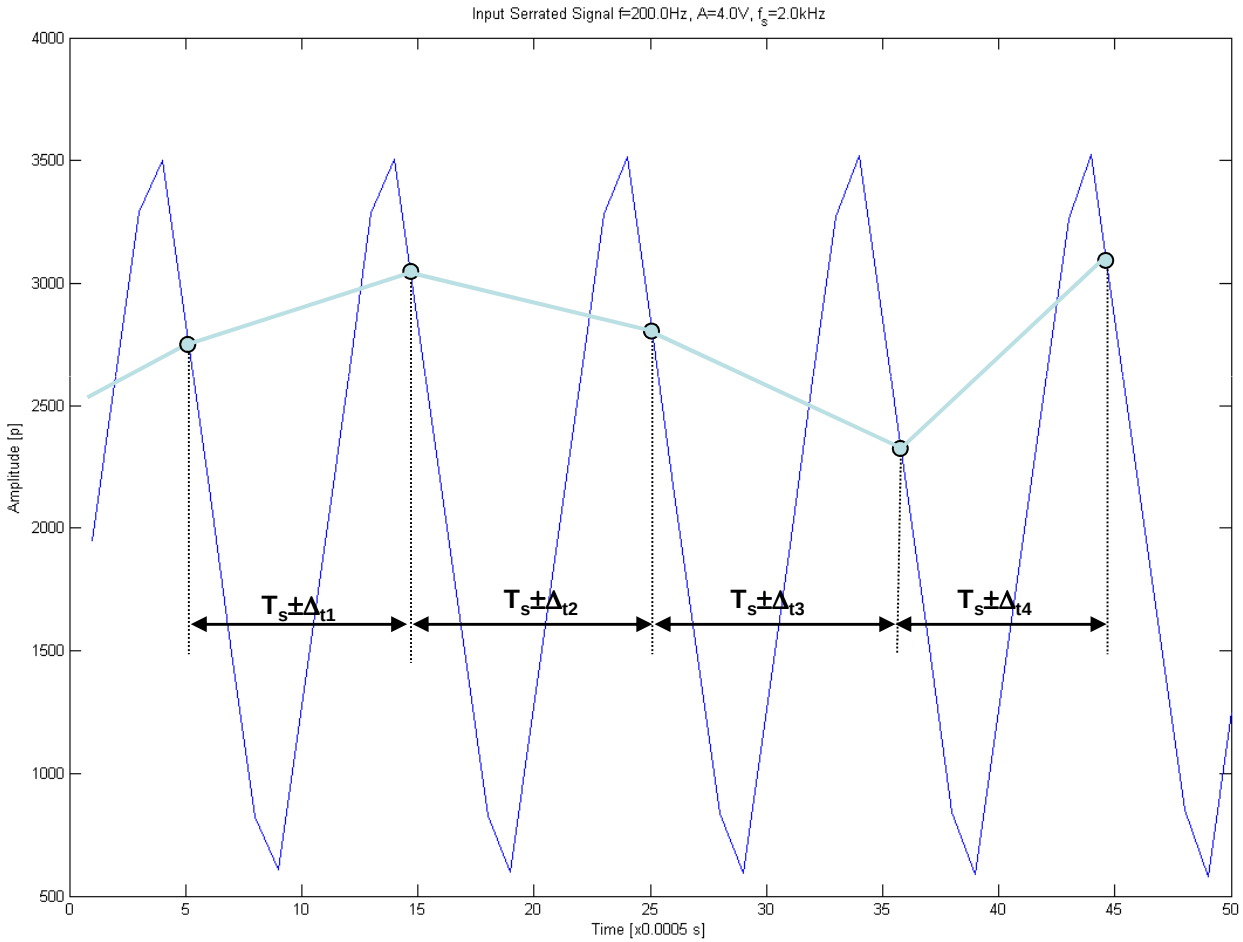

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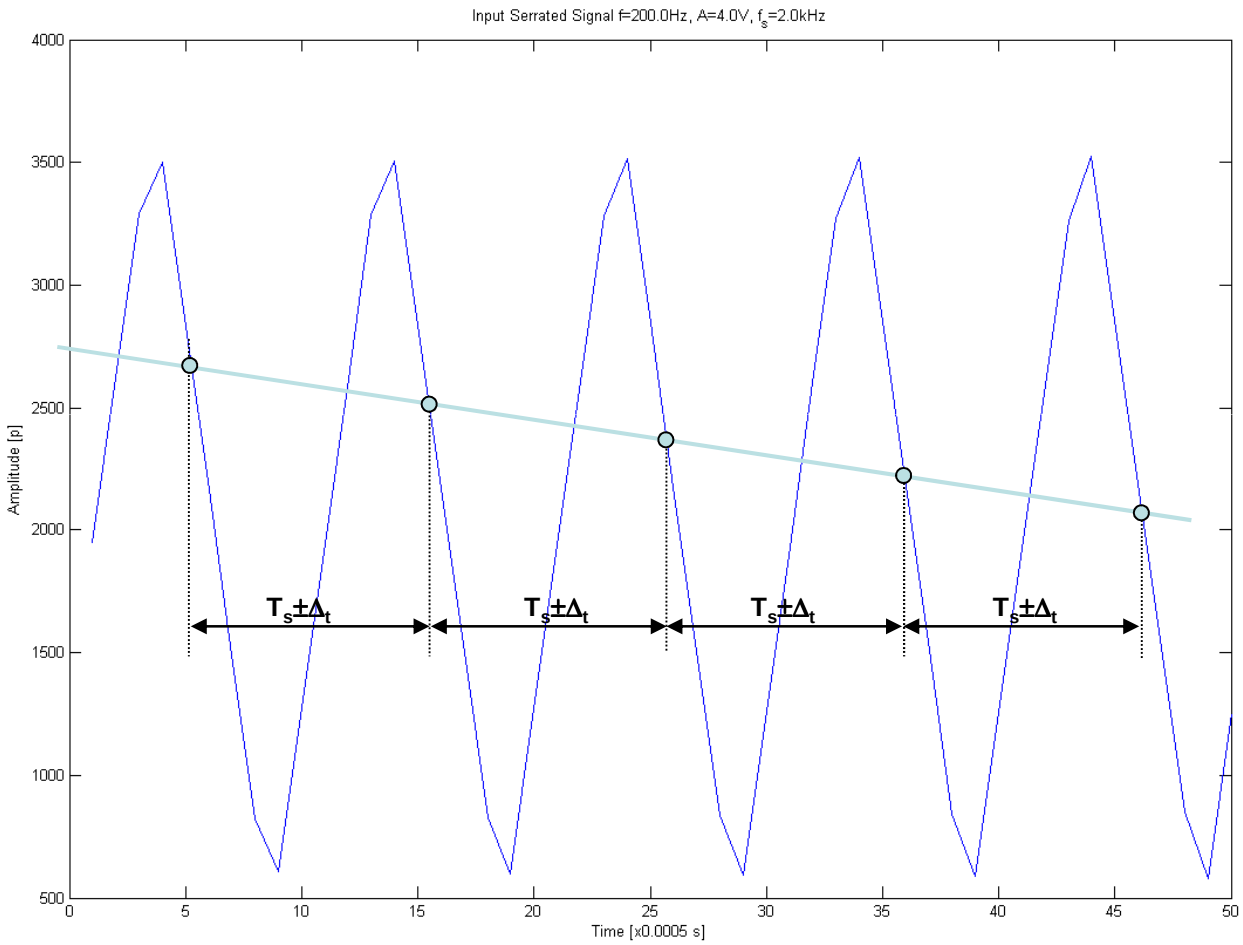

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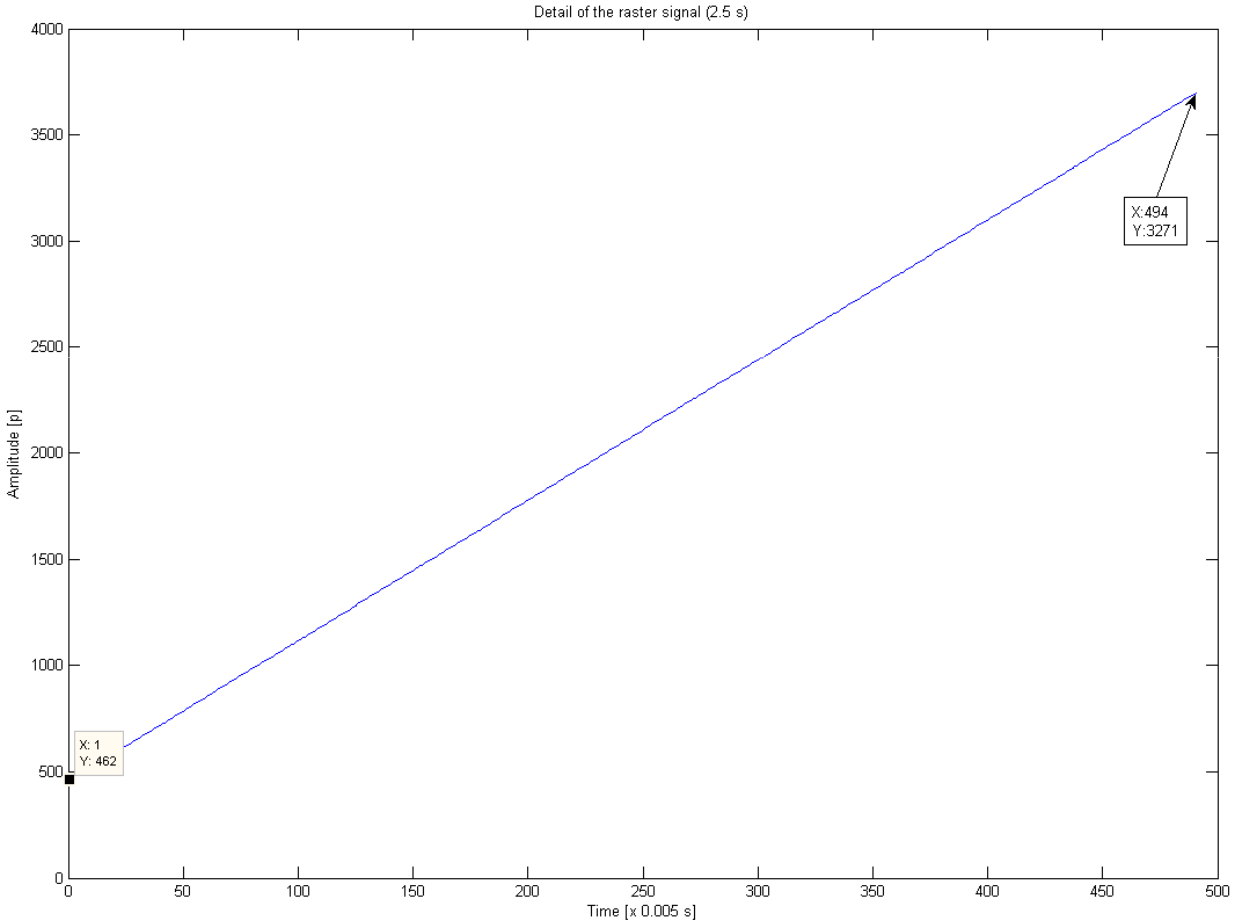
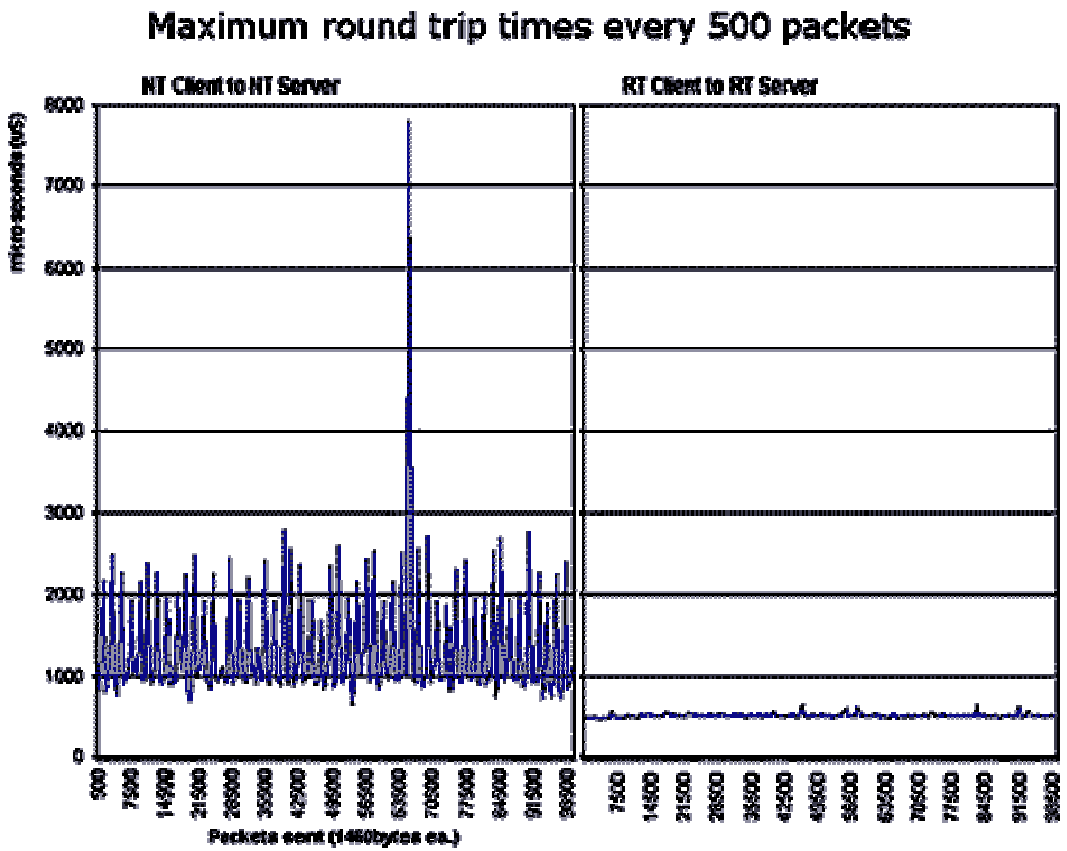


Testing parameters – TCP/IP Round Trip



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Testing parameters – Shared Memory