REAL TIME OPERATING SYSTEM

TOPICS OF DISCUSSION.

- WHAT IS RTOS.
- COMPARISON BETWEEN RTOS AND GENERAL OPERATING SYSTEMS.
- TYPES OF RTOS.
- CHARACTERISTICS OF RTOS.
- FUNCTIONS OF RTOS.
- APPLICATIONS OF RTOS.
- EXAMPLE OF SOME RTOS
- CONCLUSION.

What is Real Time ?

- “ Real time in operating systems:

  The ability of the operating system to provide a required level of service in a bounded response time.”

  - POSIX Standard 1003.1

WHAT IS RTOS.

- It responds to inputs immediately(Real-Time).
- Here the task is completed within a specified time delay.
- In real life situations like controlling traffic signal or a nuclear reactor or an aircraft,
- The operating system has to respond quickly.

What a RTOS is not

- Real time computing is equivalent to fast computing.
- Real time systems operate in a static environment
- Real time programming involves assembly coding, priority interrupt programming, writing device drivers.

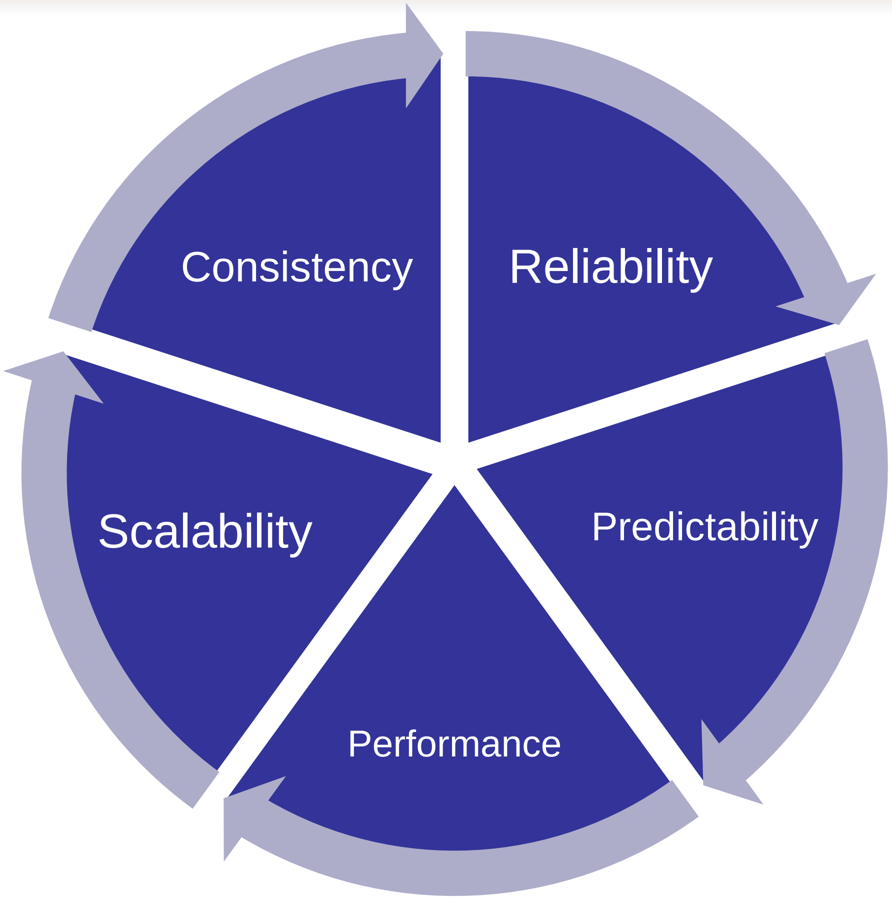
Soft RTOS…

- In a soft real-time system, it is considered undesirable, but not catastrophic, if deadlines are occasionally missed.
- Also known as “best effort” systems
- Most modern operating systems can serve as the base for a soft real time systems.
- Examples:
  - multimedia transmission and reception,
  - networking, telecom (cellular) networks,
  - web sites and services
  - computer games.

Hard RTOS…

- A hard real-time system has time-critical deadlines that must be met; otherwise a catastrophic system failure can occur.
- Absolutely, positively, first time every time
- Requires formal verification/guarantees of being to always meet its hard deadlines (except for fatal errors).
- Examples:
  - air traffic control
  - vehicle subsystems control
  - Nuclear power plant control

CHARACTERISTICS OF RTOS.



Consistency

Reliability

Predictability

Performance

Scalability

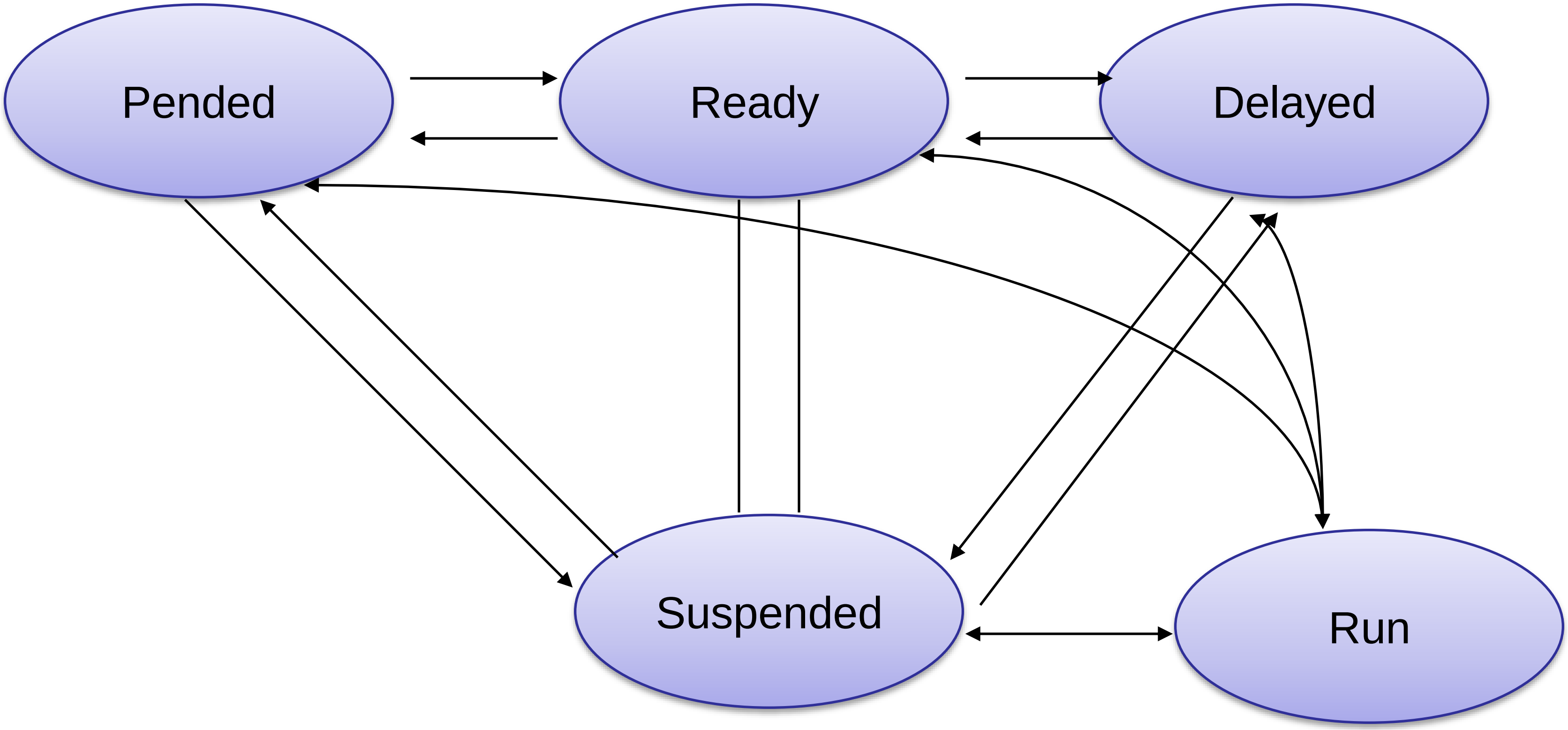
FUNCTIONS OF RTOS

- Task management
- Scheduling.
- Resource Allocation.
- Interrupt Handling.

Task management

- In Real Time Applications the Process is called as Task which takes execution time and occupies memory.
- Task management is the process of managing tasks through its life cycle.

Task States



Task/Process States

- Each task/Process can belong to one and only one state
- The Scheduler only operates on the processes in the Ready state
- There is a single process in the Run/current state at any time.
- Transitions to and from the Ready queue are affected as a part of the execution of the RTOS resource/object services or as a result of timing events

Typical Task Operations

- creating and deleting tasks,
- controlling task scheduling, and
- obtaining task information.

Scheduling in RTOS

- More information about the tasks are known
  - No of tasks
  - Resource Requirements
  - Release Time
  - Execution time
  - Deadlines
- Being a more deterministic system better scheduling algorithms can be devised.

Scheduling Algorithms in RTOS

- Clock Driven Scheduling
- Weighted Round Robin Scheduling
- Priority Scheduling

  (Greedy / List / Event Driven)

Scheduling Algorithms in RTOS (contd)

- Clock Driven
  - All parameters about jobs (release time/ execution time/deadline) known in advance.
  - Schedule can be computed offline or at some regular time instances.
  - Minimal runtime overhead.
  - Not suitable for many applications.

Scheduling Algorithms in RTOS (*contd*)

- Weighted Round Robin
  - Jobs scheduled in FIFO manner
  - Time quantum given to jobs is proportional to it’s weight
  - Example use : High speed switching network
    - QOS guarantee.
  - Not suitable for precedence constrained jobs.
    - Job A can run only after Job B. No point in giving time quantum to Job B before Job A.

Scheduling Algorithms in RTOS (*contd*)

- Priority Scheduling (Greedy/List/Event Driven)
  - Processor never left idle when there are ready tasks
  - Processor allocated to processes according to priorities
  - Priorities
    - static - at design time
    - Dynamic - at runtime

Priority Scheduling

- Earliest Deadline First (EDF)
  - Process with earliest deadline given highest priority
- Least Slack Time First (LSF)
  - slack = relative deadline – execution left
- Rate Monotonic Scheduling (RMS)
  - For periodic tasks
  - Tasks priority inversely proportional to it’s period

Resource Allocation in RTOS

- Resource Allocation
  - The issues with scheduling applicable here.
  - Resources can be allocated in
    - Weighted Round Robin
    - Priority Based
- Some resources are non preemptible
  - Example : semaphores
- Priority Inversion if priority scheduling is used

Other RTOS issues

- Interrupt Latency should be very small
  - Kernel has to respond to real time events
  - Interrupts should be disabled for minimum possible time
- For embedded applications Kernel Size should be small
  - Should fit in ROM
- Sophisticated features can be removed
  - No Virtual Memory
  - No Protection

INTERRUPTS HANDLING OF RTOS.

- An interrupt is a signal from a device attached to a computer or from a program with in a computer that causes the main program that is operating system to stop and figure out what to do next.

- Interrupts cause the processor to suspend the operations whatever it is doing instead execute the code that will respond to the event whatever caused the interrupt.

APPLICATIONS OF RTOS.

- Almost all the modern telecommunication systems make use of RTOS .
- Radar systems, network switching control systems, satellite monitoring systems, satellite launch-control and maneuvering mechanisms, global positioning systems all have their roots in RTOS.
- Now a days RTOS are increasingly finding use in strategic and military operations. These are used in guided missile launching units, track-and-trace spy satellites, etc.

Comparison of RTOS

	VXWorks	pSOS	eCos
Scheduler	Preemptive	Preemptive	Preemptive
Synchronization mechanism	No condition variable	Y	Y
POSIX support	Y	Y	Linux
Scalable	Y	Y	Y
Custom hw support	BSP	BSP	HAL, I/O package
Kernel size	-	16KB	-
Multiprocessor support	VxMP/ VxFusion (accessories)	PSOS+m kernel	Y/only basic support (SMP)

VxWorks

- Created by Wind River.
- Current Version: VxWorks 6.0 →
- VxWorks is the most established and most widely deployed device software operating system.
- Currently there are more than 300 million devices that are VxWorks enabled.
- The core attributes of VxWorks, include high performance, reliability, determinism, low latency and scalability.

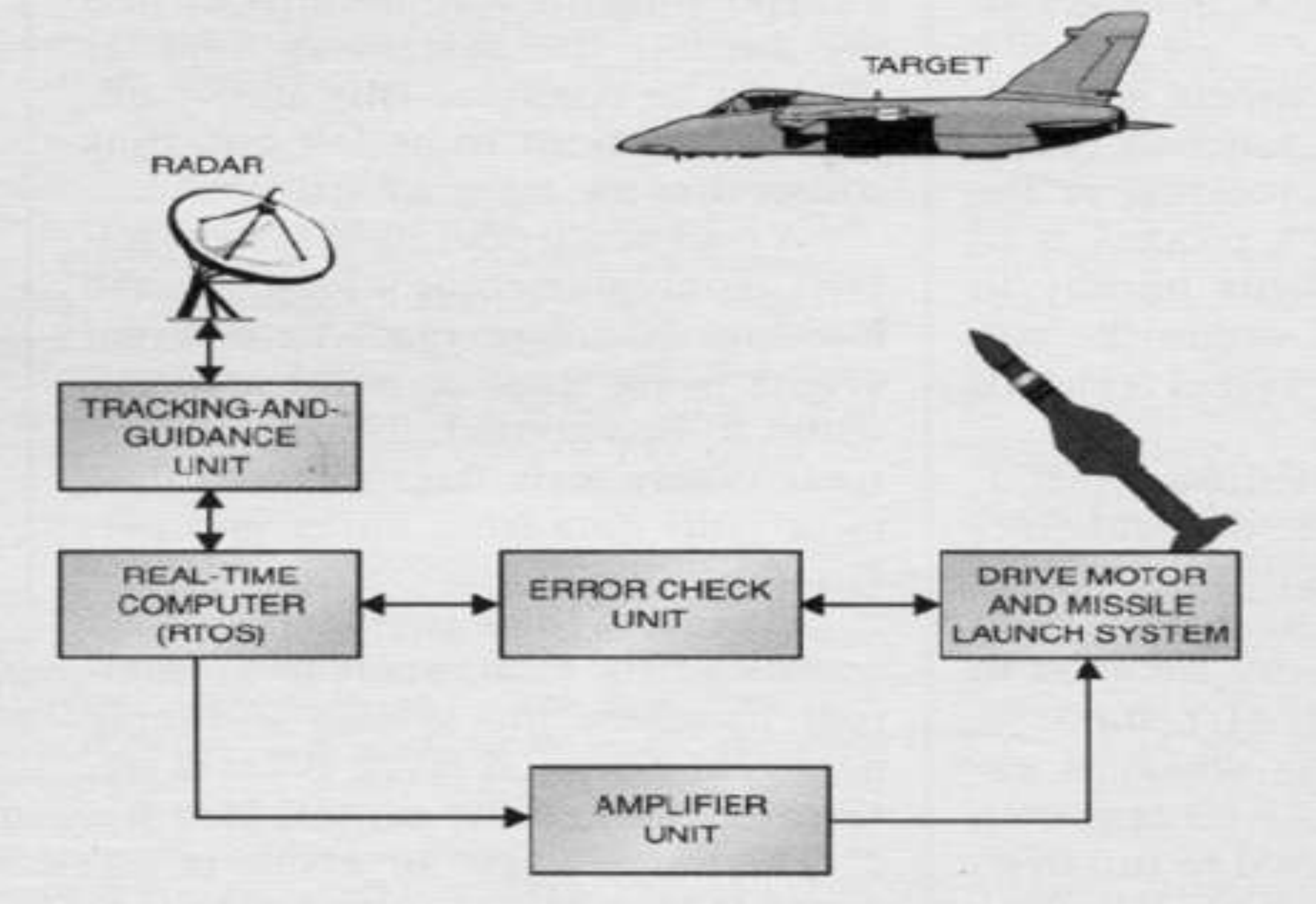
VxWorks (contd..)

- Enhanced error management
- Backward compatibility to previous versions features for exception handling and template support
- Extensive POSIX 1003.1, .1b, .1c compatibility
- Scheduling
  - – Uses preemptive priority with round robin scheduling to accommodate for both
    - Real time processes
    - Non-real time processes

VxWorks (contd..)

- Memory Protection
  - MMU based memory protection.

- Reduced Context Switch time
  - Saves only those register windows that are actually in use
  - When a task’s context is restored, only the relevant register window is restored
  - To increase response time, it saves the register windows in a register cache – useful for recurring tasks



TRACKING-AND-GUIDANCE UNIT

REAL-TIME COMPUTER (RTOS)

ERROR CHECK UNIT

DRIVE MOTOR AND MISSILE LAUNCH SYSTEM

AMPLIFIER UNIT

microkernel

- Several types of semaphores
  - binary,
  - counting
  - mutual exclusion with priority inheritance
- 256 priorities
- POSIX compliant

Microkernel features (cont.)

- High scalability
- Incremental linking and loading of components
- Fast, efficient interrupt and exception handling
- Optimized floating-point support
- Dynamic memory management
- System clock and timing facilities

A note on POSIX

- Portable Operating System Interface
- set of standards under ISO/ IEEE charter
- POSIX standard 1003.1b, (formerly called 1003.4) for RTOS
- makes it easier to move applications from one operating system to another.

CONCLUSION.

RTOS have been the heroes in most of the technological areas, right from fuel injection system to nuclear reactor control, satellite control, global positioning systems, and fully equipped high-tech warfare aircrafts. And the best is yet to come!