

EECS 298 - RTOS survey

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RTOS survey

- eCos
 - RedHat (Open Source)
- VxWorks
 - Windriver (Commercial)
- QNX Neutrino
 - QNX Software (Commercial)

Architecture

- **eCos**
 - Kernel Based (Optional)
 - Scheduling and synchronization, interrupt and exception handling, counters, clocks, alarms, timers,
 - OS components can be customized
- **VxWorks**
 - Kernel Based
 - Individual scheduler, memory management, intertask, synchronization, messaging, timers, interrupt servicing, and device I/O, interface
 - OS components can be customized
 - All tasks including OS run in supervisor mode
 - Possible corruption of internal OS structures
- **QNX Neutrino**
 - Microkernel Based
 - Minimal services used by a team of cooperating processes, which in turn provide the higher-level OS functionality.
 - Every driver, application, protocol stack, and file system runs outside the microkernel, in the safety of memory-protected user space
 - Clear delineation between the operating system and the application
 - Completely isolates the user applications from the OS.

Scheduling

- **eCos**
 - Multilevel Queue Scheduler (0 to 31)
 - Multi thread execution
 - Bitmap Scheduler (0 to 31)
 - Single thread execution
- **VxWorks / QNX Neutrino**
 - Fully Preemptive Priority-based Scheduler(256)
 - First-In-First-Out (FIFO) and/or Round Robin.
- **QNX Neutrino**
 - Sporadic Scheduling
 - Allows application threads with sporadic CPU utilization requirements to allocate execution budgets for themselves.

Intertask/interprocess communications

- eCos
 - Synchronization
 - Mutex lock, Counting Semaphores, Flags, Spinlocks
 - InterTask Communication
 - Mailboxes.
- VxWorks
 - Synchronization
 - Semaphores(binary, counting, and mutual-exclusion)
 - InterTask Communication
 - Message queues(Priority or FIFO)
- QNX Neutrino
 - Synchronization
 - Mutex lock.
 - InterTask Communication
 - Message passing forms a virtual "software bus"

RTOS Selection

- Based on Paper from Canadian Space Agency
- 48 Different RTOS Evaluated
- Selection Criteria(elimination)
 - Platform and/or Kernel Footprint
 - (For Workstations, DSP, MicroControllers)
 - Lack of Hard Real Time Capability
 - Limited Process Support & OS Dependencies

Eliminated Candiates

RTOS Name	Vendor	Reason for elimination
BeOS™	Be inc.	Platform and/or size kernel footprint
Blue Cat™	LinuxWorks	Lack of determinism and/or limited real-time capabilities
Chorus OS™	Sun Microsystems	Platform and/or size of kernel footprint
Embedix Real-Time™	Lineo	Platform and/or size of kernel footprint
EPOC™	Symbian	Platform and/or size of kernel footprint
eRTOS™	JK Microsystems	Only one supported processor
ETS™	Phar Lap (VenturCom)	Other OS dependency
EYRX™	Eyring Corp	Only one supported processor
GEOS™	Geoworks	Other OS dependency
Inferno™	Lucent Tech (Vita Nuova)	Platform and/or size of kernel footprint
InTime™	Ten Asys	Other OS dependency
Jbed™	Esmertec	Other OS dependency
NetBSD™		Lack of determinism and/or limited real-time capabilities
On Core OS™	On Core Systems	Other OS dependency
On Time RTOS-32™	On Time Software	Other OS dependency
PDOS™	Eyring	Limited processor support
PSOS™	VxWorks, previously Integrated Systems	Still available but being phased out
QNX 4™	QNX	Other product from same vendor better choice
Real-Time Architect / SSX5™	LiveDevices Ltd	Platform and/or size of kernel footprint
RT Linux™	FMSLabs	Other OS dependency
RTX™	VenturCom	Other OS dependency
RTXC™	Lineo, previously Embedded Power Corp	No longer available
Run HyperPanel OS™	HyperPanel	Other OS dependency
Thread X™	Green Hills Software	Other product from same vendor better choice
TronTask™	US software	Other product from same vendor better choice
Uclinux™	Lineo	Lack of determinism and/or limited real-time capabilities
VelOSity™	Green Hills Software	No longer available
Virtuoso™	Wind River (previously Eonic Systems)	Platform and/or size of kernel footprint

Remaining Candiates

RTOS Name	Vendor
AMX™	Kadak
C Executive™	JMI Software Systems
CMX™	CMX Systems
Cortex™	Artesys
Delta OS™	CoreTek Systems
E COS™	Cygnus Solutions (Red Hat)
Emb OS™	Segger Microcontroller Systeme GmbH
Integrity™	Green Hills Software
Lynx OS™	Lynx Real time systems
Nucleus Plus™	Accelerated Technology Incorporated
OS-g™	Microware system corp
OSE™	OSE (Enea)
Precise/MQX™	Precise Software
QNX/Neutrino™	QNX
RTEMS™	On-Line Applications Research Corporation
SuperTask™	US software
TTPos™	TTTech
UC/OS-II™	Micrium, Inc
VRTX™	Mentor Graphics
Vx Works™	Wind River systems

Evaluation Criteria & Associated Weights

Category Name	W	Criterion	W	W x W _i
Kernel	13 %	Architecture	35 %	5 %
		Multi-process support	15 %	2 %
		Multi-processor support	25 %	3 %
Scheduling	20 %	Fault tolerance	25 %	3 %
		Algorithm	40 %	8 %
		Priority assignment mechanism	20 %	4 %
Process/Thread/Task model	12 %	Time to release task, independent from list length*	40 %	8 %
		Number of priority levels	26 %	3.12 %
		Priority inversion protection	18 %	2.16 %
		Task States	10 %	1.2 %
		Max number of tasks	18 %	2.16 %
		Task switching latency	18 %	2.16 %
Memory	10 %	Dynamic priority changing	10 %	1.2 %
		Min and max RAM space per task	20 %	2 %
		Min and max ROM space	20 %	2 %
		Max addressable memory space per task	20 %	2 %
		Memory protection support	20 %	2 %
		Dynamic allocation support	10 %	1 %
		Virtual memory support	8 %	0.08 %
Interrupt and Exception Handling	8 %	Memory compaction	2 %	0.2 %
		Preemptable ISRs	30 %	2.4 %
		Worst case interrupt handling time	30 %	2.4 %
		ISR model or levels	20 %	1.6 %
Application Programming Interface	7 %	Modifiability of interrupt vector table	20 %	1.6 %
		Library compliance	4 %	0.28 %
		Precise absolute clock	10 %	0.7 %
		External clock support	10 %	0.7 %
		Synchronization and exclusion primitives	18 %	1.26 %
		Communication and message passing	18 %	1.26 %
		Network protocols	10 %	0.7 %
		Certifications	10 %	0.7 %
		I/O support	10 %	0.7 %
		File systems	10 %	0.7 %
Development Information	15 %	Development methodology	20 %	3 %
		RTOS supplied as source or object code	15 %	2.25 %
		Supported compiler	20 %	3 %
		Supported processors	30 %	4.5 %
Commercial Information	15 %	Supported development languages	15 %	2.25 %
		Cost	30 %	4.5 %
		Royalty fees	10 %	1.5 %
		Years on market (i.e. product maturity)	20 %	3 %
		Used in time critical applications	20 %	3 %
		Support type and cost	20 %	3 %

Evaluation Results

QNX/Neutrino™	1st
OS-9™	
Precise/MQX™	2nd
OSE™	
Delta OS™	3rd
RTEMS™	
Lynx OS™	
Integrity™	
VxWorks™	
Nucleus Plus™	4th
VRTX™	
ITPos™	
C Executive™	
Emb OS™	
CMX™	5th
ECOS™	
uC/OS-II™	
SuperTask™	6th
AMX™	
Cortex™	