# MaRTE OS: Practical view

Daniel Sangorrín

Miguel Tellería

This talk is sponsored by the FRESCOR european FP6 project. More information available at http://www.frescor.org

# Where can I get it?

**MaRTE OS website: http://marte.unican.es**

- news RSS2.0 feed
- documentation
- downloads
- finished projects
- on-going work
- forum

# The documentation

**MaRTE OS User's Guide**

**README, INSTALL**

**Tutorials**

- Boot process
- Misc utilities
- QEMU

**Papers and presentations**

**Other sources:**

- FRESCOR deliverables
- Degree projects reports
- Forum

# Installation, compilation, debugging

**Requirements:**

- Host Computer: GNU/Linux with compilation environment and AdaCore GNAT compiler
- Target Computer (only x86):
  - Ethernet card for remote loading (optional)
  - Serial port for remote debugging (optional)

**MaRTE OS scripts:**

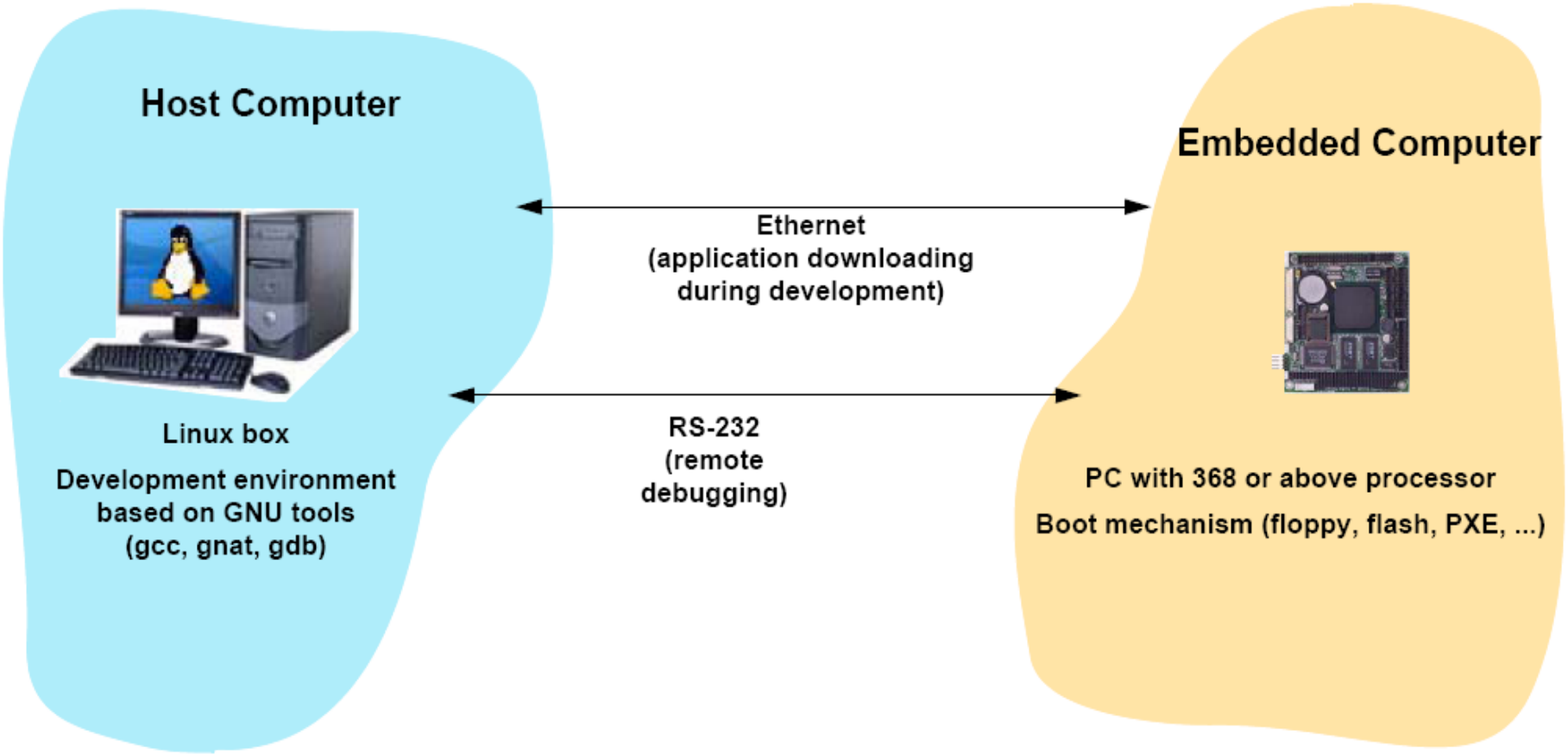
- minstall, mkrtsmarteuc, mkmarte

**Application scripts:**

- mgnatmake, mgcc, mg++

**Debugging (gdb, linux_arch, qemu, serial port)**

# Development environment



# Example 1: hello world

**mgnatmake -g hello_world.adb**

```
with Text_IO;
procedure Hello_World is
begin
   Text_IO.New_Line;
   Text_IO.Put_Line ("Hello FOSDEM");
   Text_IO.Put ("I'm an Ada program running on MaRTE OS.");
   Text_IO.New_Line (2);
end Hello_World;
```

# Example 2: concurrency

**Basic test of the Ceiling Locking protocol in protected objects:**

- **A high priority task (T_High) displays periodically a message and suspends.**
- **A low priority task (T_Low) is active all the time and periodically executes a protected operation.**
- **T_High's messages stop while T_Low executes the protected operation since the PO's ceiling is above T_High's priority.**

# Example 3: Hardware management

frescor

## Parallel port

- Handle Interrupt + Access to data register

```
MHI.Associate (PP_IRQ, PP_IRQ_Handler'Unrestricted_Access);
Outb_P (PP_CONTROL_REG, PP_IRQ_ENABLE);
MHI.Unlock (PP_IRQ);
loop
   PHI.Wait (Intr, Handler);
   Outb_P (PP_DATA_REG, 2#00_001_001#); delay (0.5);
   Outb_P (PP_DATA_REG, 2#00_010_010#); delay (0.5);
end loop;
```

# Example 4: RT-EP

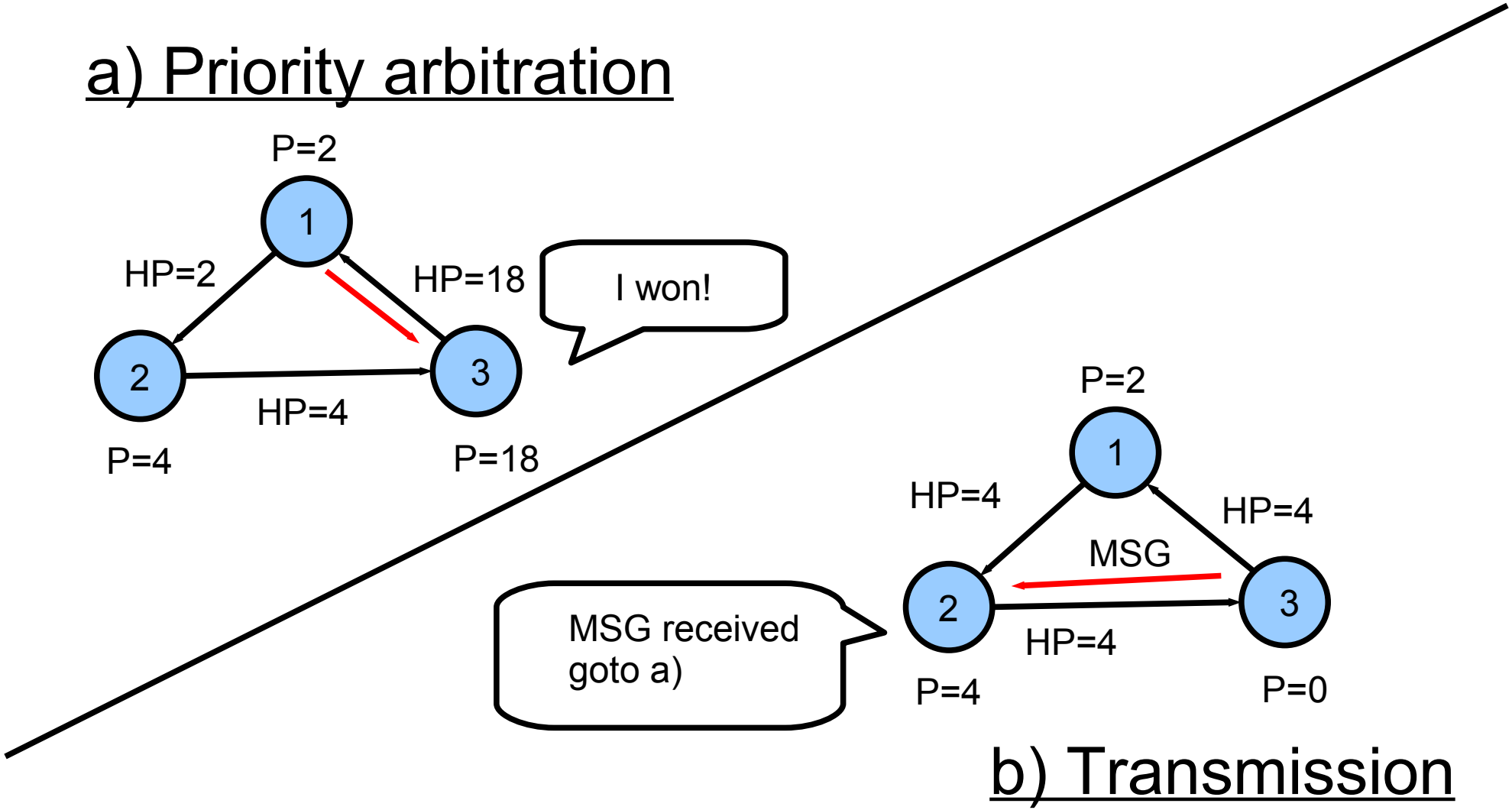
**A Real Time Communication Protocol over Standard Ethernet**

- Ada95 and C Interface
- Sporadic servers, Distributed Mutexes , Reliable Multicast
- Bandwith reservation
- Polyorb CORBA and DSA (also Rt-CCM Thales)

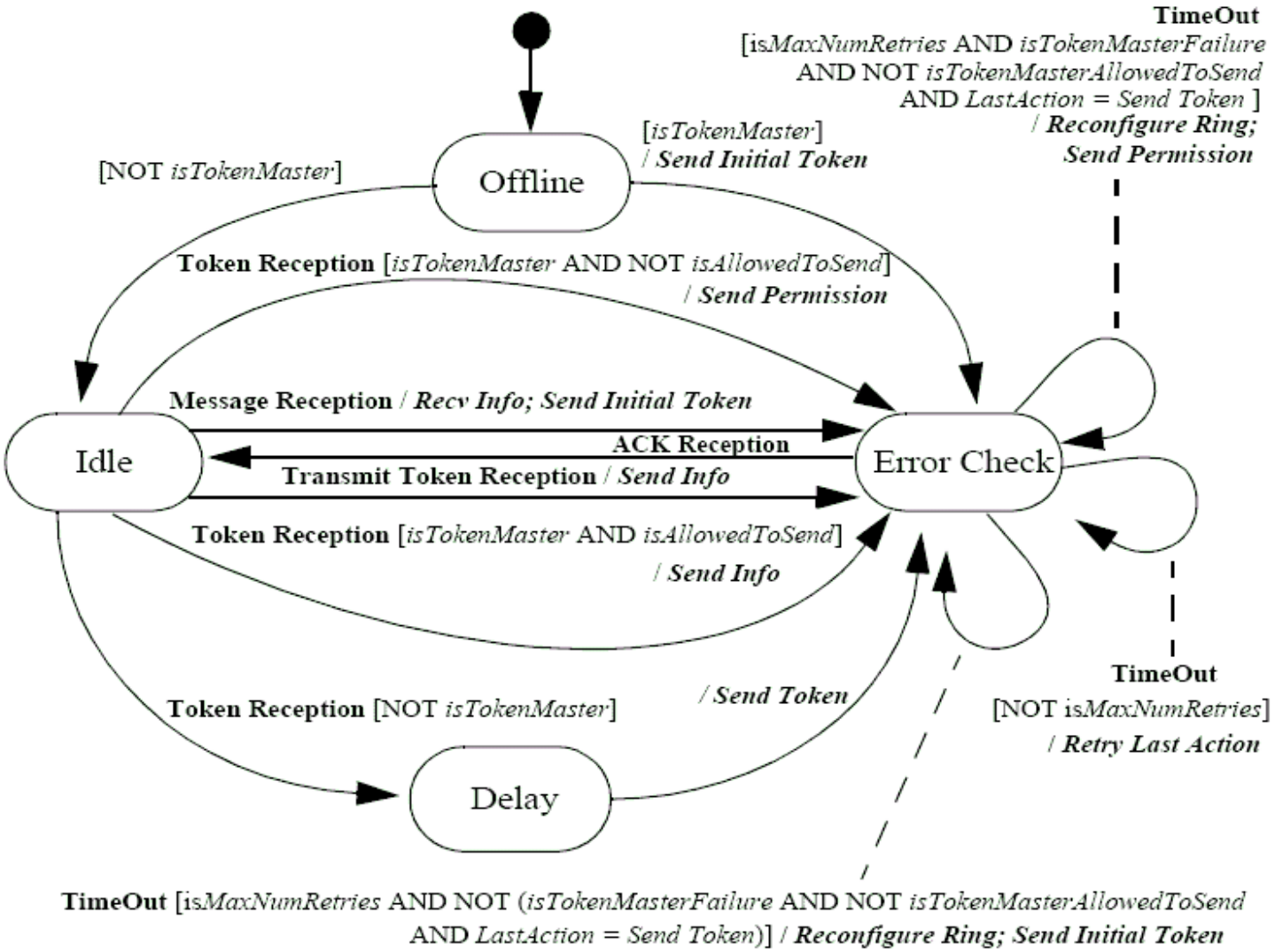
**Some features of Ada that are used in RT-EP implementation:**

- Tasking, Protected Objects, Synchronous Task control
- Package hierarchy
- Exceptions
- Generics
- C Interfaces, FLORIST (Posix Ada bindings)

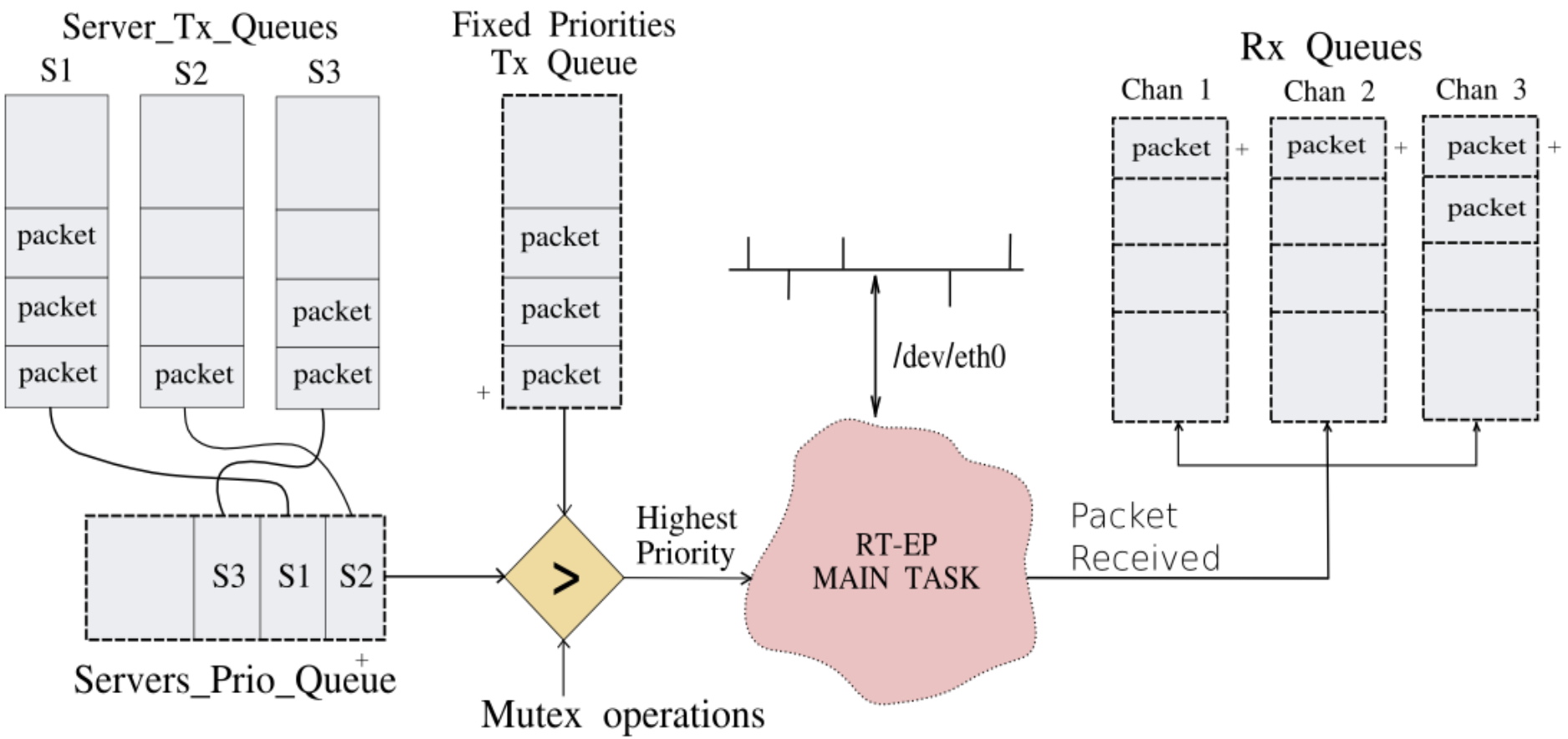
# Example 4: RT-EP



# Example 4: RT-EP



# Example 4: RT-EP



# Example 4: RT-EP

(Untitled) - Wireshark

File Edit View Go Capture Analyze Statistics Help

Filter: rtep | Expression... | Clear | Apply

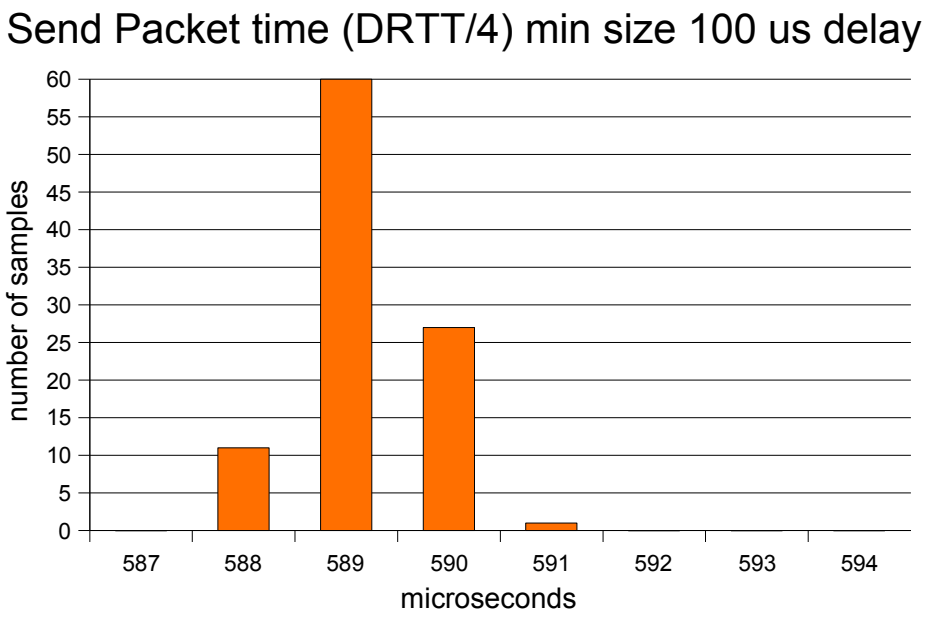
| No. | Time | Source | Destination | Protocol | Info |
|---|---|---|---|---|---|
| 3597 | 9.469688 | 00:30:64:04:ea:ab | ff:ff:ff:ff:ff:ff | rtep | RTEP_INIT_REQUEST Dest: 2 |
| 3598 | 9.469770 | 00:30:64:05:74:73 | ff:ff:ff:ff:ff:ff | rtep | RTEP_INIT_ACK Dest: 1 |
| 3599 | 9.469896 | 00:30:64:04:ea:ab | ff:ff:ff:ff:ff:ff | rtep | RTEP_REGULAR_TOKEN Dest: 2 No Multicast Message |
| 3600 | 9.470031 | 00:30:64:05:74:73 | ff:ff:ff:ff:ff:ff | rtep | RTEP_REGULAR_TOKEN Dest: 1 No Multicast Message |
| 3601 | 9.470147 | 00:30:64:04:ea:ab | ff:ff:ff:ff:ff:ff | rtep | RTEP_REGULAR_TOKEN Dest: 2 No Multicast Message |
| 3602 | 9.470252 | 00:30:64:05:74:73 | ff:ff:ff:ff:ff:ff | rtep | RTEP_REGULAR_TOKEN Dest: 1 No Multicast Message |
| 3603 | 9.470352 | 00:30:64:04:ea:ab | ff:ff:ff:ff:ff:ff | rtep | RTEP_TRANSMIT_TOKEN Dest: 2 |
| 3604 | 9.470728 | 00:30:64:05:74:73 | ff:ff:ff:ff:ff:ff | rtep | RTEP_INFO_PACKET Dest: 1 |
| 3605 | 9.470871 | 00:30:64:04:ea:ab | ff:ff:ff:ff:ff:ff | rtep | RTEP_REGULAR_TOKEN Dest: 2 No Multicast Message |
| 3606 | 9.471080 | 00:30:64:05:74:73 | ff:ff:ff:ff:ff:ff | rtep | RTEP_REGULAR_TOKEN Dest: 1 No Multicast Message |
| 3607 | 9.471088 | 00:30:64:04:ea:ab | ff:ff:ff:ff:ff:ff | rtep | RTEP_TRANSMIT_TOKEN Dest: 2 |
| 3608 | 9.471426 | 00:30:64:05:74:73 | ff:ff:ff:ff:ff:ff | rtep | RTEP_INFO_PACKET Dest: 1 |
| 3609 | 9.471559 | 00:30:64:04:ea:ab | ff:ff:ff:ff:ff:ff | rtep | RTEP_REGULAR_TOKEN Dest: 2 No Multicast Message |
| 3610 | 9.471658 | 00:30:64:05:74:73 | ff:ff:ff:ff:ff:ff | rtep | RTEP_REGULAR_TOKEN Dest: 1 No Multicast Message |
| 3611 | 9.472032 | 00:30:64:04:ea:ab | ff:ff:ff:ff:ff:ff | rtep | RTEP_INFO_PACKET Dest: 2 |
| 3612 | 9.472174 | 00:30:64:05:74:73 | ff:ff:ff:ff:ff:ff | rtep | RTEP_REGULAR_TOKEN Dest: 1 No Multicast Message |
| 3613 | 9.472278 | 00:30:64:04:ea:ab | ff:ff:ff:ff:ff:ff | rtep | RTEP_REGULAR_TOKEN Dest: 2 No Multicast Message |
| 3614 | 9.472377 | 00:30:64:05:74:73 | ff:ff:ff:ff:ff:ff | rtep | RTEP_TRANSMIT_TOKEN Dest: 1 |
| 3615 | 9.472730 | 00:30:64:04:ea:ab | ff:ff:ff:ff:ff:ff | rtep | RTEP_INFO_PACKET Dest: 2 |

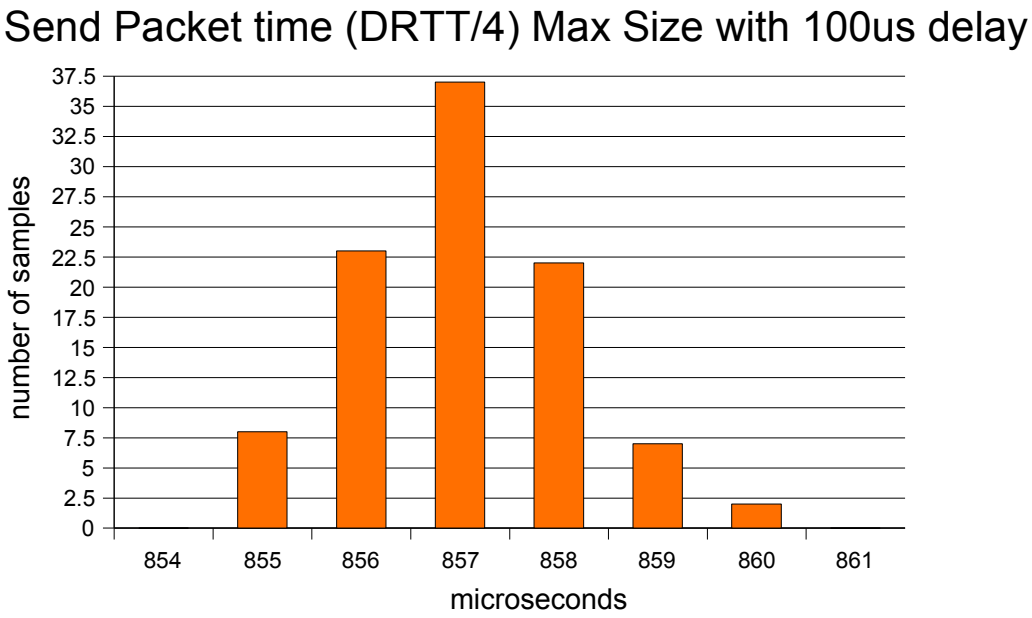
```
Real-Time Ethernet Protocol
    Dest_Station: 0x0200
    Type: TX_GRANT_TOKEN (0x50)
    Prio: 0x09
    Packet Number: 0x0900
    Master_ID: 0x0100
```

```
0000  ff ff ff ff ff ff 00 30  64 04 ea ab a0 00 02 00   .......0 d.......
0010  50 09 09 00 01 00 02 00  00 00 00 00 00 00 00 00   P....... ........
0020  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ........ ........
0030  00 00 00 00 00 00 00 00  00 00 00 00               ........ ....
```

File: "/tmp/etherXXXXrQUl5k" 6223 KB 00:00:16 | Packets: 47765 Displayed: 44159 Marked: 0 Dropped: 925

# Example 4: RT-EP




| *DRTT RT-EP* | *Min Size Packets* | *Max Size packets* |
|---|---|---|
| **max** | 2360,48 us | 3436.05 us |
| **average** | 2354,85 us | 3426.15 us |
| **min** | 2348,88 us | 3416.19 us |

# List of Drivers, Protocols, ...

**Communication protocols and middlewares**

- PolyORB (DSA and CORBA) and GLADE ported to MaRTE OS x86 bare machine using RT-EP
- RT-WMP Real-Time Wireless protocol (UNIZAR)
- RT-EP protocol with a Bandwith reservation layer, distributed mutexes, broadcast services
- FRESCAN network protocol for CAN bus with bandwith reservation and sporadic servers
- DTM, the Distributed Transaction Manager of FRESCOR
- MyCCM, implements the OMG CCM (THALES)

# List of Drivers, Protocols, ...

**Drivers**

- CAN bus
- Wireless ralink rt61
- SVGA, BTTV, Soundblaster 16
- Mouse, Keyboard, Joystick
- Ethernet drivers (intel eepro100, rtl8139, SiS900)
- Serial port driver
- I2C protocol, compass CMPS03 driver
- IDE disk driver (CompactFlash and HD) and FAT 16 filesystem
- Advantech Data adquisition and Digital IO cards drivers (PCM3718 and others)

# List of Drivers, Protocols, ...

- laser-sick-lms200
- GPS Novatel ProPak driver
- P2OS driver (compass, sonar, odometer, motors)
- Yenta Cardbus

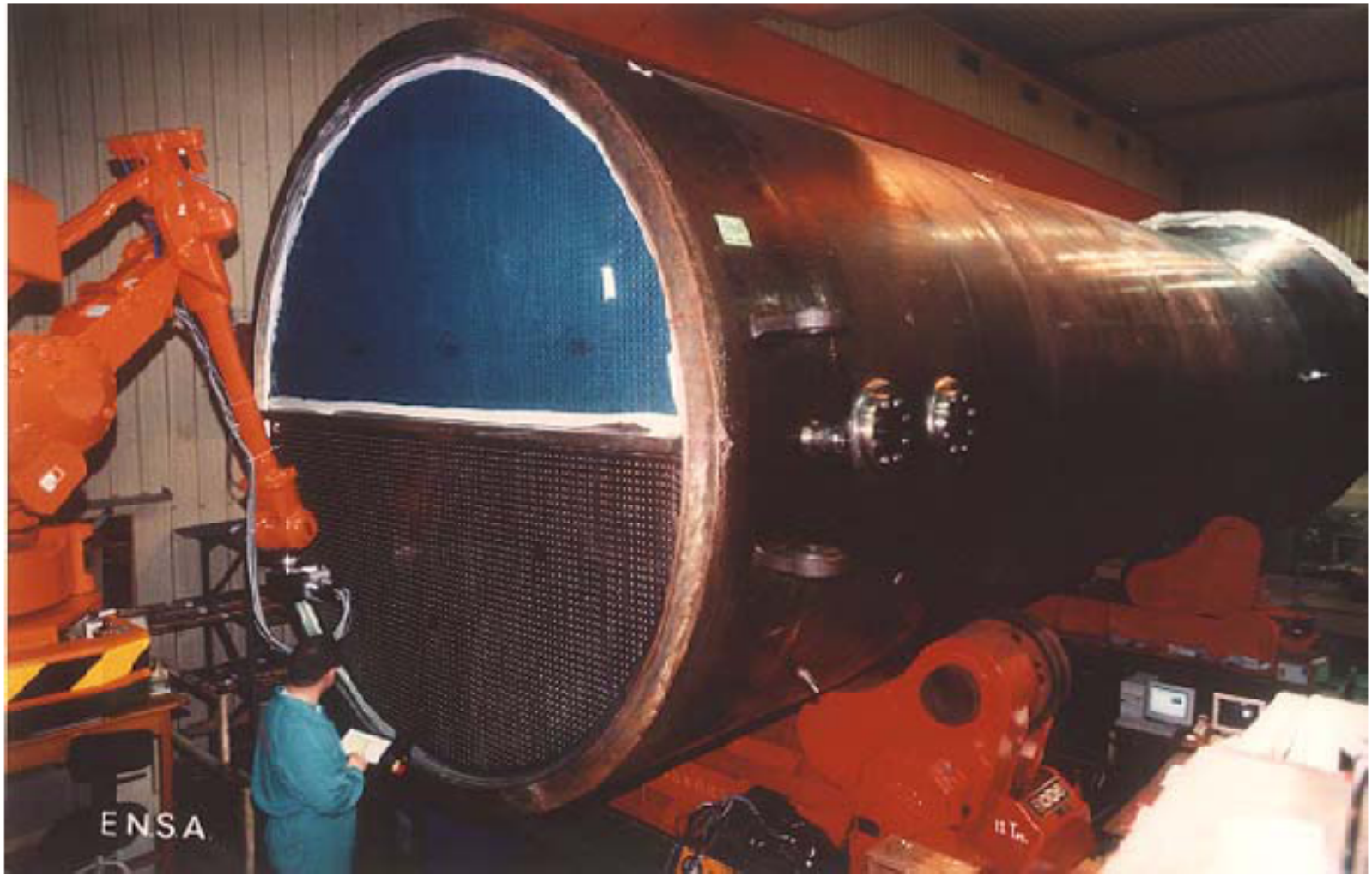
**Other features:**

- MaRTE OS utilities: memory buffer driver, console switcher, logger, oscilloscope, time measurements
- MaRTE-spy
- C++ language support
- TLSF Dynamic Memory Allocator

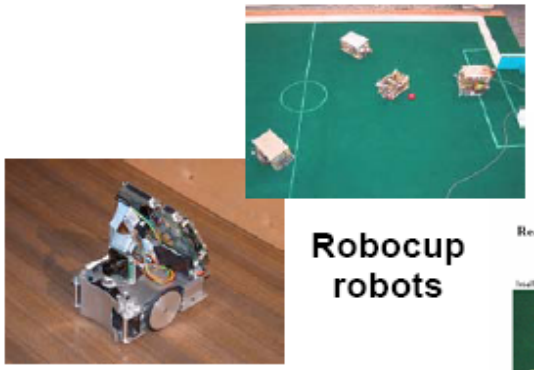
# Apps: Robot Controllers

# Apps: CASEVA

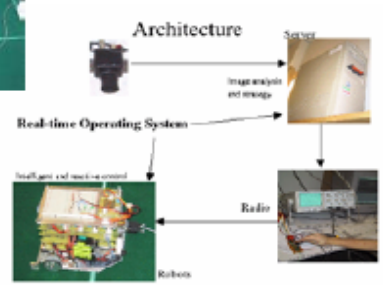
# Apps: AUSILGE

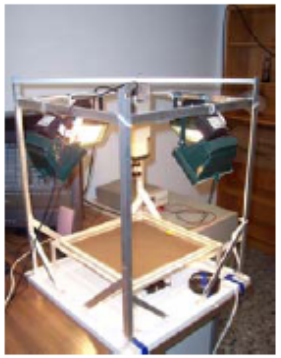


# Apps: other projects



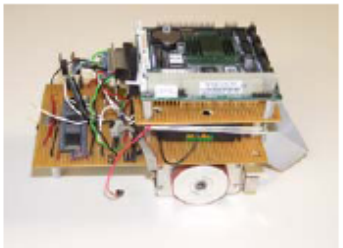
Robocup robots



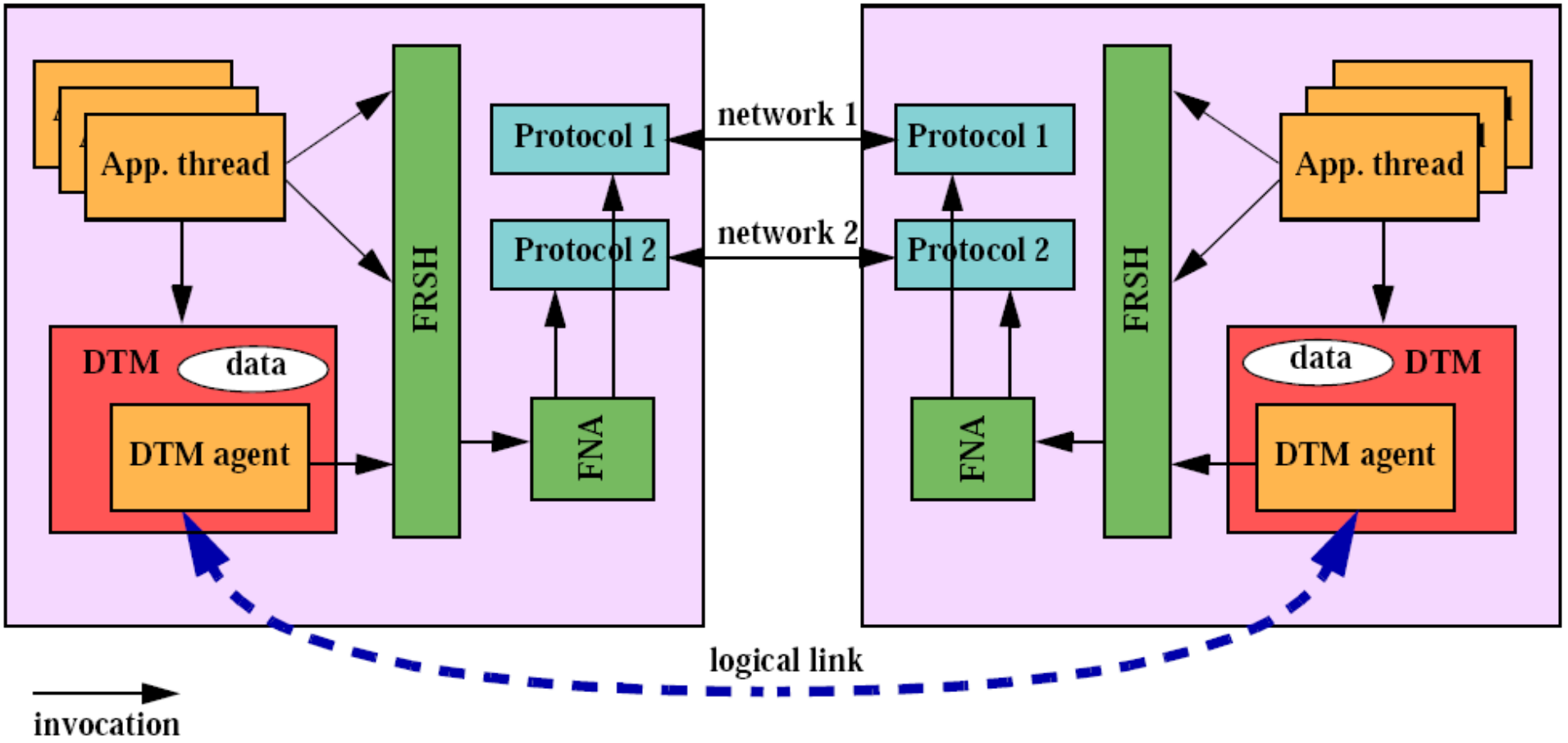
Platform video control

Satellite antenna for high-speed train



Mobile robot

# On-Going: FRESCOR



# Thanks for your attention

```
protected body Questions is
   entry Ask_Question(Gift : out Gift_Type) is
   begin
      Gift := Live_USB_With_MaRTE_OS_And_FRESCOR;
      Put_Line ("Thanks :)");
   end Ask;
end Questions;
```