Computer Labs: Communication Protocols

2º MIEIC

Pedro F. Souto (pfs@fe.up.pt)

December 16, 2014

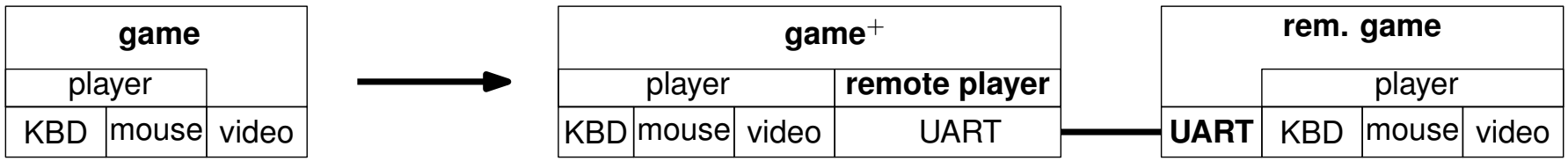
Problem

Assumption So, you are happy with the single-player game you have developed and want to implement a multiplayer version, using the serial port

Problem How to go about this?

Solution There are several approaches, but the simplest one is probably to use a centralized solution where:

- All the game's logic is implemented on the first computer
- The second computer just:
  - Gets the input from the 2nd player and forwards it, via the serial port, to the first computer
  - Receives the "frames", via the serial port, and displays them on the screen



First computer

- Implements the game's logic;
  - Like in the single player version
- Interfaces with the 1st player;
  - Like in the single player version
- Communicates with the second computer to:
  - Receive the input from the 2nd player
  - Send the "frames" to display to the 2nd player

  For uniformization purposes, you can hide this behind the abstraction of a **remote player**

Second computer

- Only interfaces with the 2nd player:
  - To get the input from the keyboard and the mouse
    - And send it to the first computer
  - To display the frames
    - That it receives from the first computer

Getting the Input from the Remote Player

Assumption The game uses both the keyboard and the mouse as input

Problem How to send that input to the main computer?

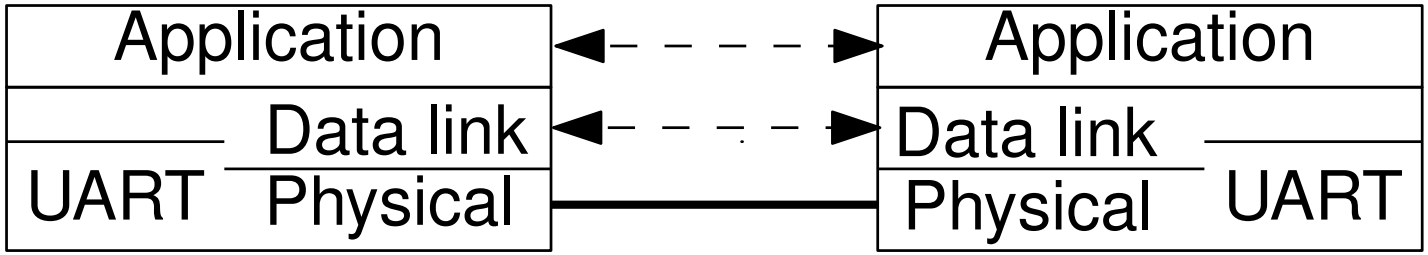
Solution Use the serial port to send

- Scan codes
- Mouse packets

Problem The serial port allows to send only characters

Solution Define multi-character messages

- **Scan code messages** with the scan codes
- **Mouse messages** with the mouse packets
  - I.e. build an application protocol on top of the communications protocol provided by the UART



Messages

Issue 1 How to distinguish between the two types of messages?

Solution Use a **message header** with a control field specifying the type of message. E.g., the first character of each message, indicates the type of message:

`'K'`	*KBD scan code*
`'M'`	*Mouse packet*

Although a bit would be enough, it is not a good idea:

- Inflexible: what if you want to add another message?
- Hard to debug.

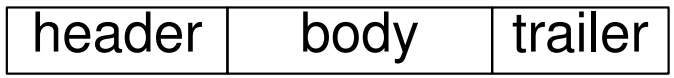
Issue 2 Scan codes do not have fixed length

Solution After receiving a byte, we always know whether this is the last one. Other solutions are:

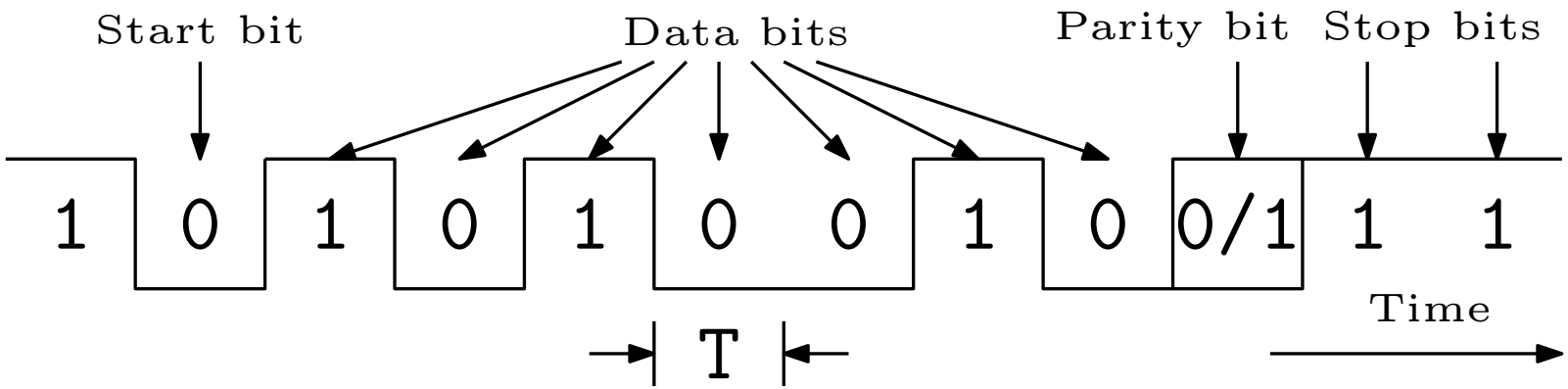
1. Include the length of the message in the message header
2. Add some special bit-sequence/char in the **message trailer**
   - It **must not** occur in either the message head or the **message body**

Message Structure

- Independently of the layer, the general message structure is:



- This is true even at the data link layer:



Communication Errors

Problem What if some characters of a message are lost?

Solution

Just drop message this may make sense, if message loss is not that frequent

Use acknowledgments and retransmit

- Similar to the protocol used between the KBC and the keyboard (**ACK(0xFA), NACK/RESEND(0xFE), ERROR (0xFC)**)
- When to send the acknowledgment?

- In any case, need to detect the loss of a character (the UART usually does it for us)
  - But, what if the problem is with the remote process?
- May need to know also when no more chars of the damaged message will be received
  - This is a synchronization issue

Synchronization Issues

Problem Communication errors or the initial asynchrony between the communicating processes may lead to synchronization issues

Solution Similar to that used by Synaptics in the touchpad: any error reported leads to retransmission of the entire message.

- Use of special bit-patterns that do not occur in the **body** of a message helps resynchronization.
- Unfortunately, this is not the case with the bytes of a mouse packet
  - In the case of scan codes, some byte values may not be used

Question How can we ensure synchronization, without the limitations of the mouse interface?

More Synchronization Issues

Assumption You may have some game logic on both processes, and both of them need to keep the program state synchronized

Problem How do both processes synchronize initially

Solution Two approaches

Asymmetric One of the processes takes a passive stance and the other a proactive stance

- The former waits that the latter gets in touch with it
- What if the passive process is not up when the proactive tries to contact it?

Symmetric Either process can take a proactive stance

- When a process starts up it behaves proactively, but if the other process is not up it switches to passive behavior.
- This has also a few problems:
  - What if the other process is up, but the message is lost?
  - What if the two processes wake ut at the same time?

Sending the Output to the Remote Player

Problem Cannot send the entire frame buffer over the serial port

- The serial port has a very limited bandwidth

Solution 1 **"Compress"** the frame buffer data

- Video encoding algorithms actually apply compression algorithms, but
- We mean some "ad-hoc" compression. E.g.
  - Send the new state of sprites whose state changes from one frame to the next

Solution 2 Use **state-machine replication**. The idea is:

- Each processes keeps the entire game state
- Each process generates the frames to be presented locally
- Each process processes the inputs from both
  - the local player
  - the remote player

  in the same order:

This may not be trivial