E-BLOCKS™

Modern digital communications

For a live demo preload: Internet Explorer
Windows Explorer
Ethereal

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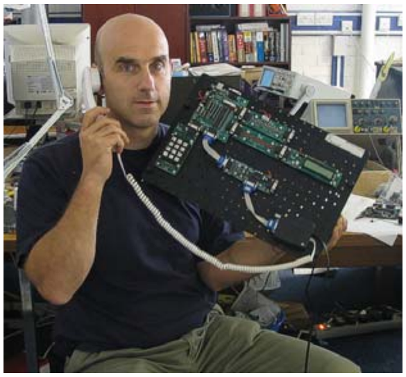
About this presentation



- This presentation was developed by John Dobson – Managing Director of Matrix Multimedia Limited.
- PowerPoint versions of this presentation are available on request.
- Notes on the presentation are included with each slide down here:

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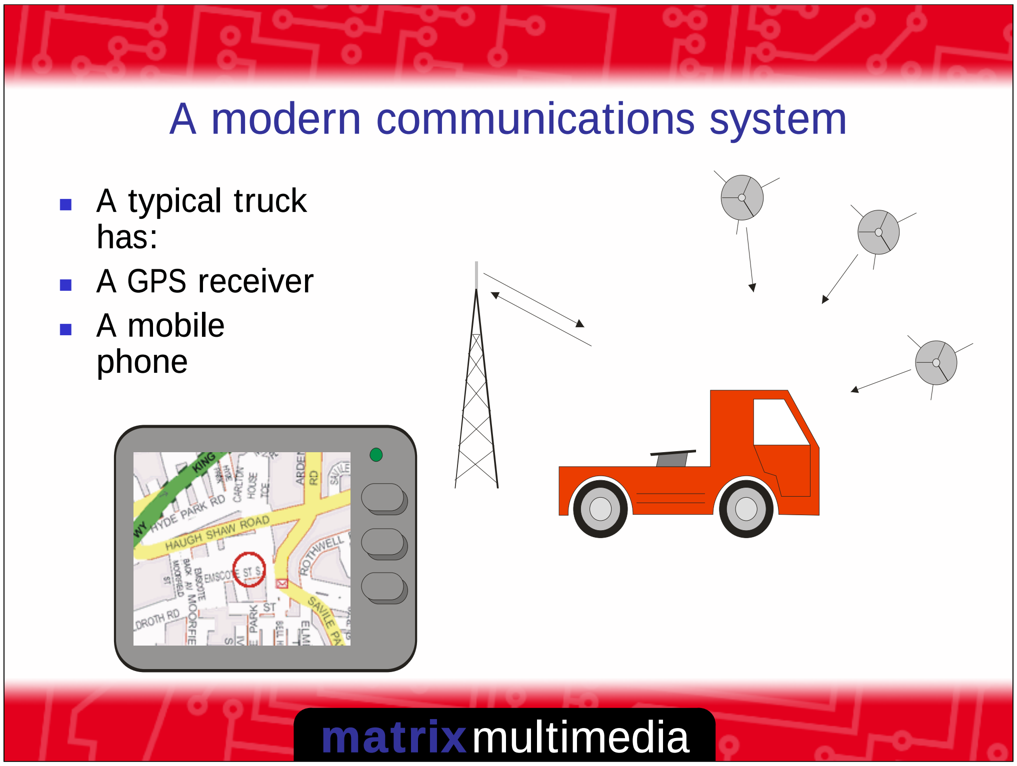
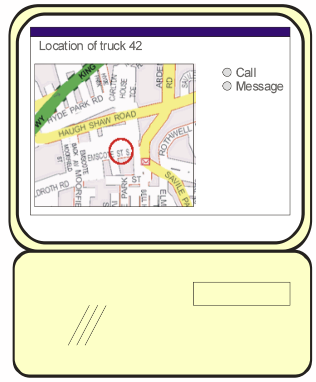
On each slide you will see notes in this position – this is my commentary.



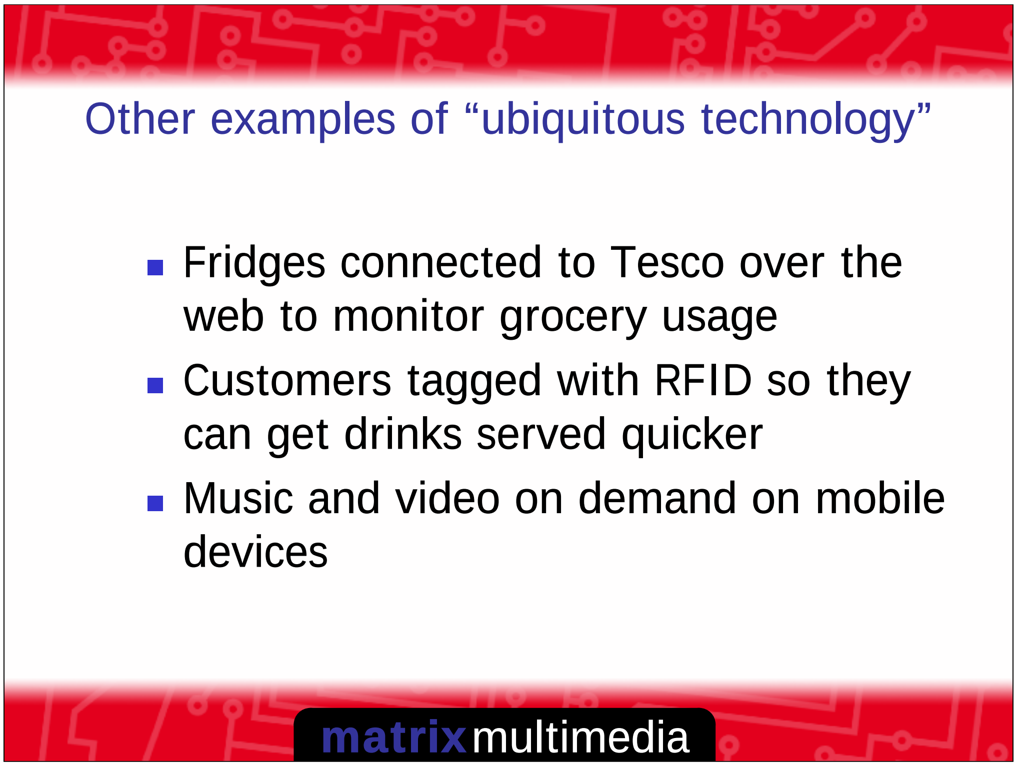
Consider a modern communications system like a GPS receiver and a mobile phone in a truck.

Benefits and features:

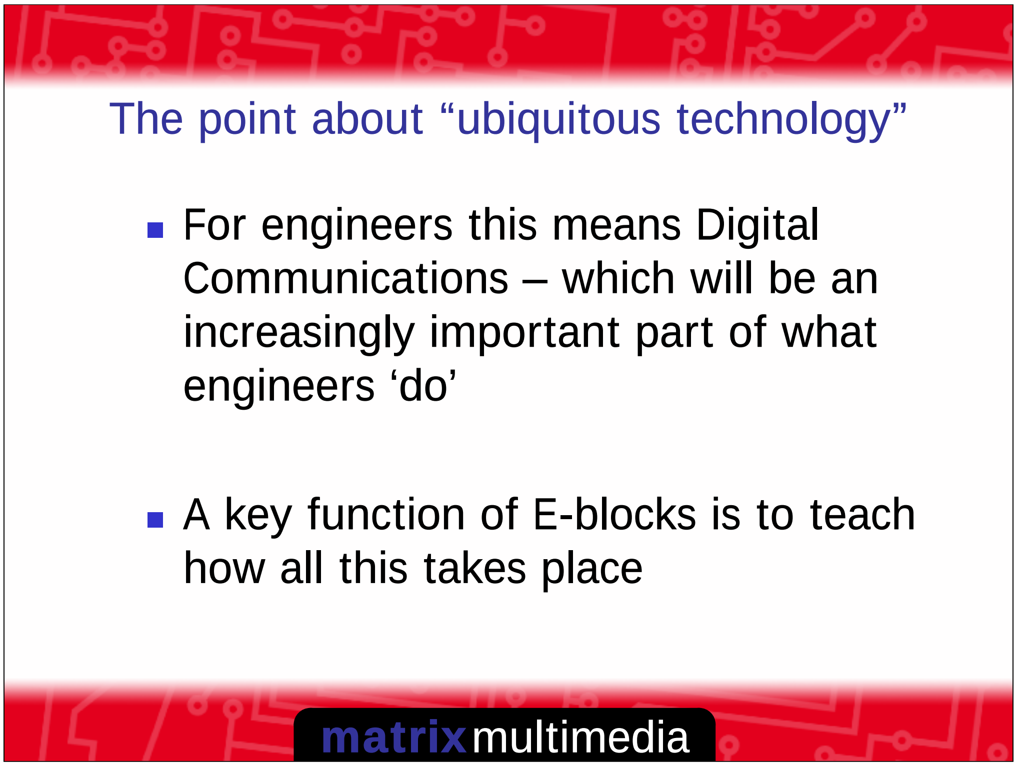
- Hands free mobile phone using Bluetooth
  - Contact with drivers/base
  - Up to date delivery /collection instructions
- GPS system
  - Navigation aids
  - Driver and delivery monitoring
  - Security and theft deterrent
- Together this means:
  - Improved operations monitoring – efficiency etc.
  - New services to customers



These new systems have many benefits and features – for both the operator and the driver.



There are lots of other examples of communications systems. Often this is termed ‘ubiquitous technology’ as communications is now in every part of our lives. Some examples listed here: Supermarkets are considering using RFID tags on all of our food with a reader on the fridge. The fridge would know when we run out of a particular consumable – like milk- and would be able to deliver more to us automatically. In a bar in Amsterdam regular customers have an RFID tag fitted into their necks: when they enter the bar the barman knows their name, and their favourite drink, so that the customer gets fast personal service, and the bar maximises revenue – and drinking time. There are also lots of other examples of modern communications like music and video on demand.



For us as technologists all this communication means the subject of Digital Communications. This is becoming an increasingly important part of what engineers do: and it it not really just limited to electronics engineers: as the sophistication grows, this also applies to Computer Scientists too.

A key function of E-blocks is to allow ubiquitous systems to be developed and to allow students to learn about it.

Part 2 – the E-blocks internet module

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E-blocks internet board

- I^2C interface
- 3.3V or 5V operation
- 10/100 Ethernet function with DLC and MAC support
- TCP, IP, UDP, ICMP and ARP protocol support
- 4 simultaneous channels
- Full software stack

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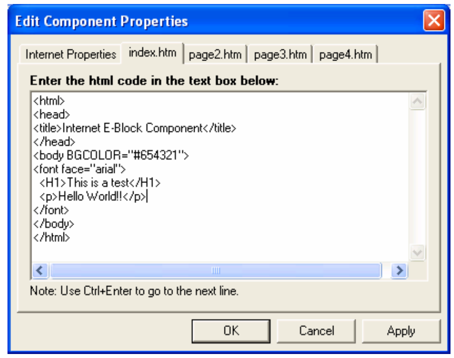
The internet module has the features listed here.

E-blocks software benefits – rapid development

- Easy embedded web page publishing using Flowcode
- Easy embedded email using Flowcode
- Extremely rapid development of



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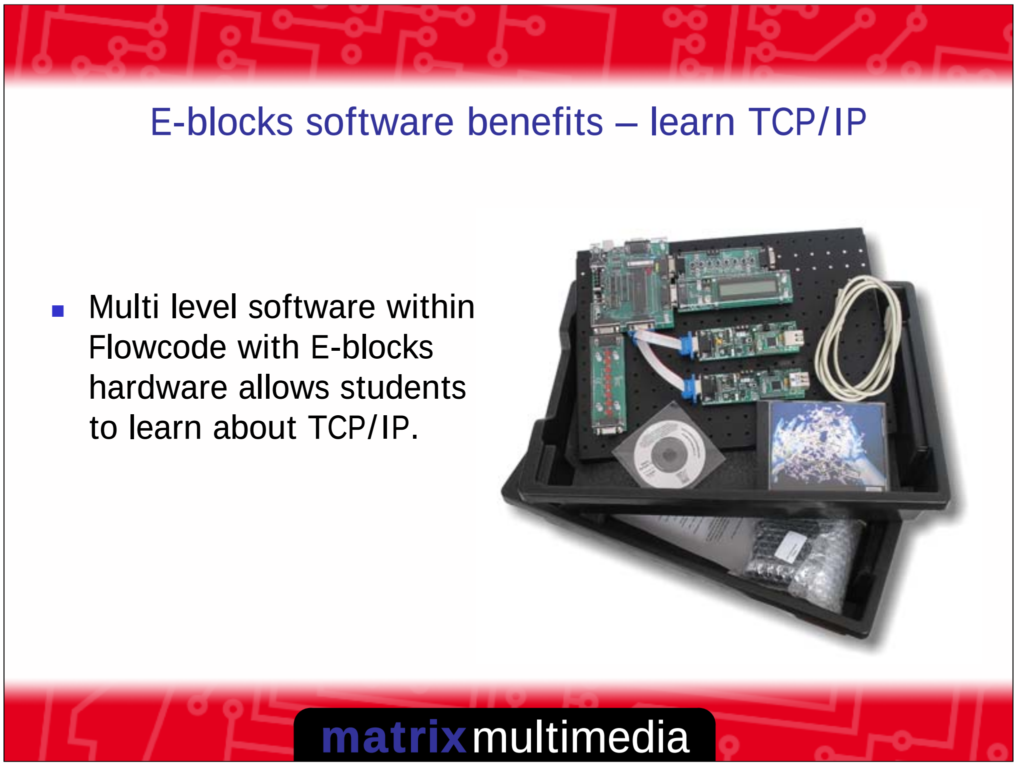
A key benefit of the internet board is that it allows rapid development of embedded systems. Using Flowcode it is possible to design up to 4 HTML pages, paste the HTML into the Flowcode internet component, and the pages will be served when the appropriate http address is accessed. Getting all this up and running takes only minutes.



The second benefit is that the layered software in Flowcode allows students to learn all about TCP/IP communications and the OSI model. The layered software also allows a massive variety of communications tasks to be set up including full email. We are now going to see how this works in more detail.

Part 3 – Learning digital comms

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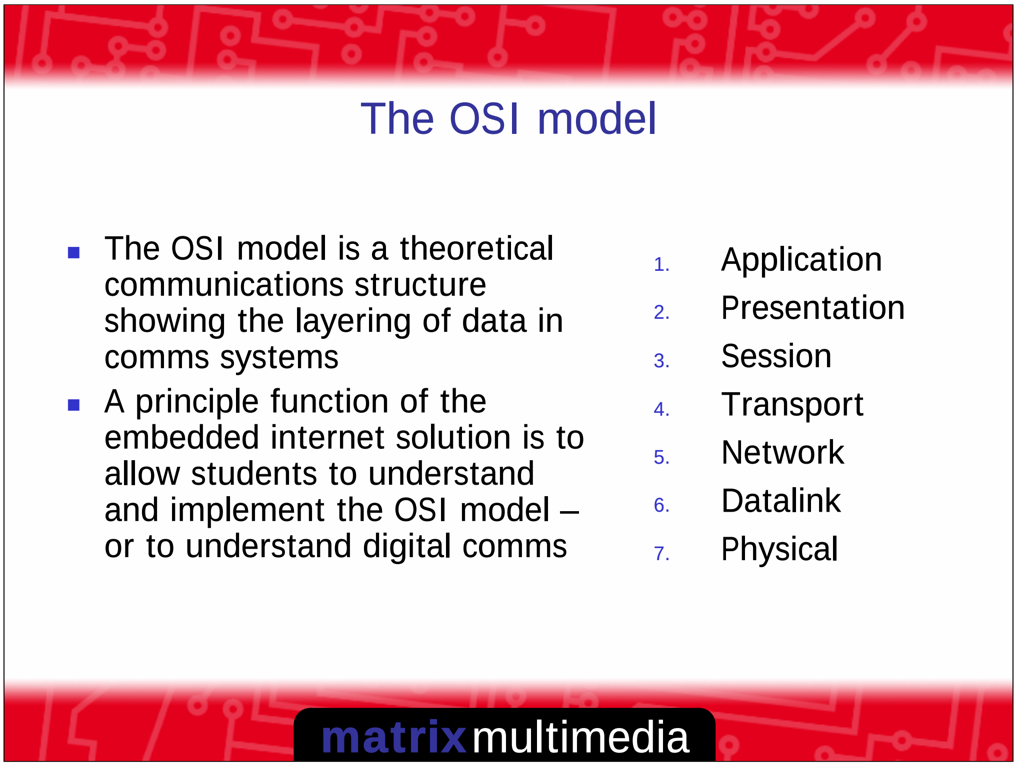
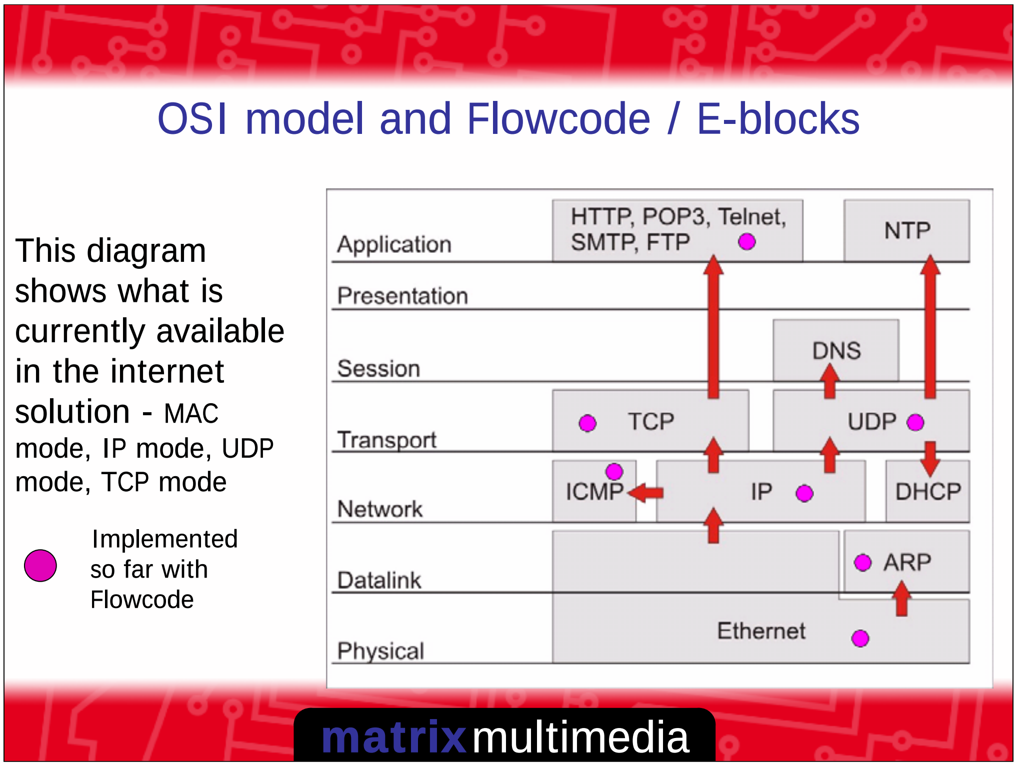


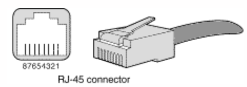
The OSi model is a theoretical model that demonstrates the information layering process in digital communications systems. At the lowest level we have the types of wires used, the voltage levels etc. The 0's and 1's of the physical layer are grouped into packets with error correction in the Datalink layer and further information is added into the packets at each subsequent layer- including application specific data at the top layer.



This diagram shows some of the communication protocols within the OSI model which have been implemented within Flowcode. Flowcode has 4 families of macros which allow access at 4 seperate layers: MAC, IP, UDP, and TCP. Now we are going to look in a little more detail at how this works.

Ethernet physical layer

- 100 ohm
- RJ45 connector
- 8 wires in 4 twisted pairs
- Differential voltages



Pin #	Signal Name	Function
1	BI_DA+	Bi-directional pair +A
2	BI_DA-	Bi-directional pair -A
3	BI_DB+	Bi-directional pair +B
4	BI_DC+	Bi-directional pair +C
5	BI_DC-	Bi-directional pair -C
6	BI_DB-	Bi-directional pair -B
7	BI_DD+	Bi-directional pair +D
8	BI_DD-	Bi-directional pair -D

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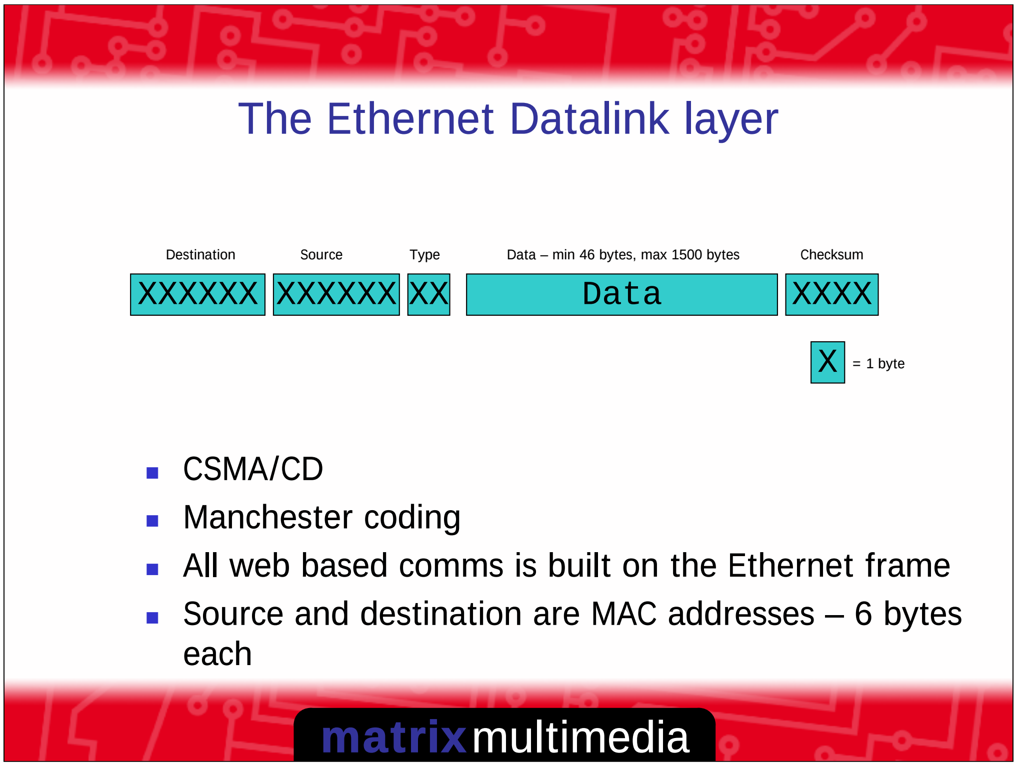
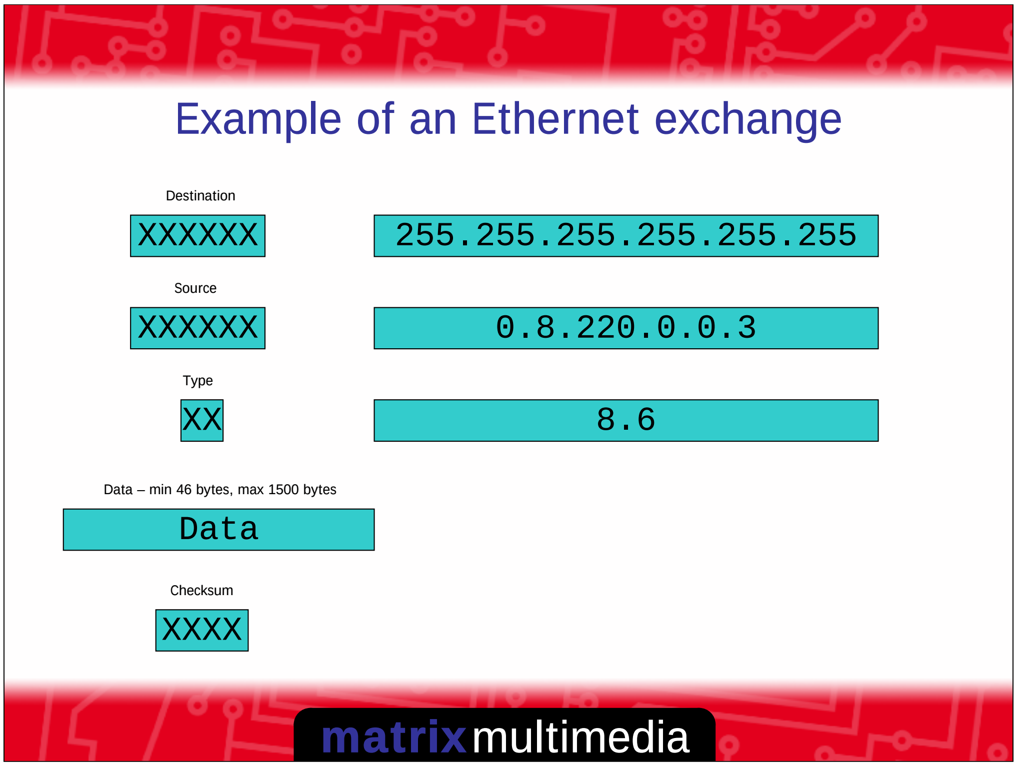
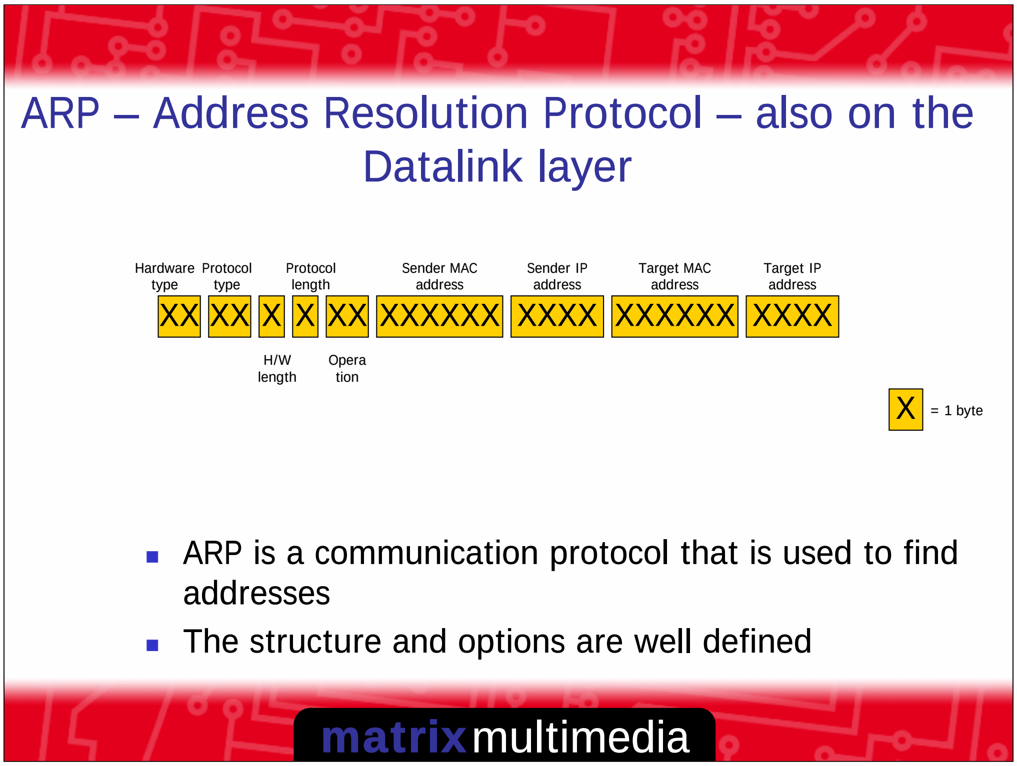
Just so you get your bearings: here is a summary of what is typically specified at the Physical layer. I can’t remember what voltage is used. Does anyone in the audience remember?



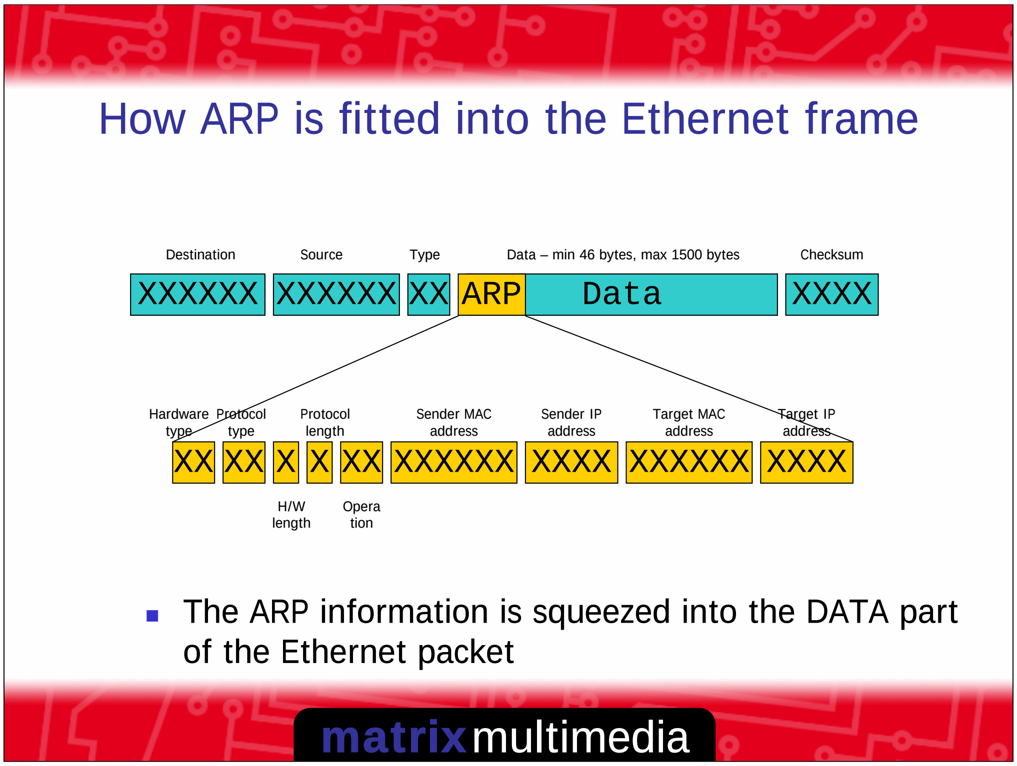
In the Datalink layer we can see the fundamental MAC packet structure.



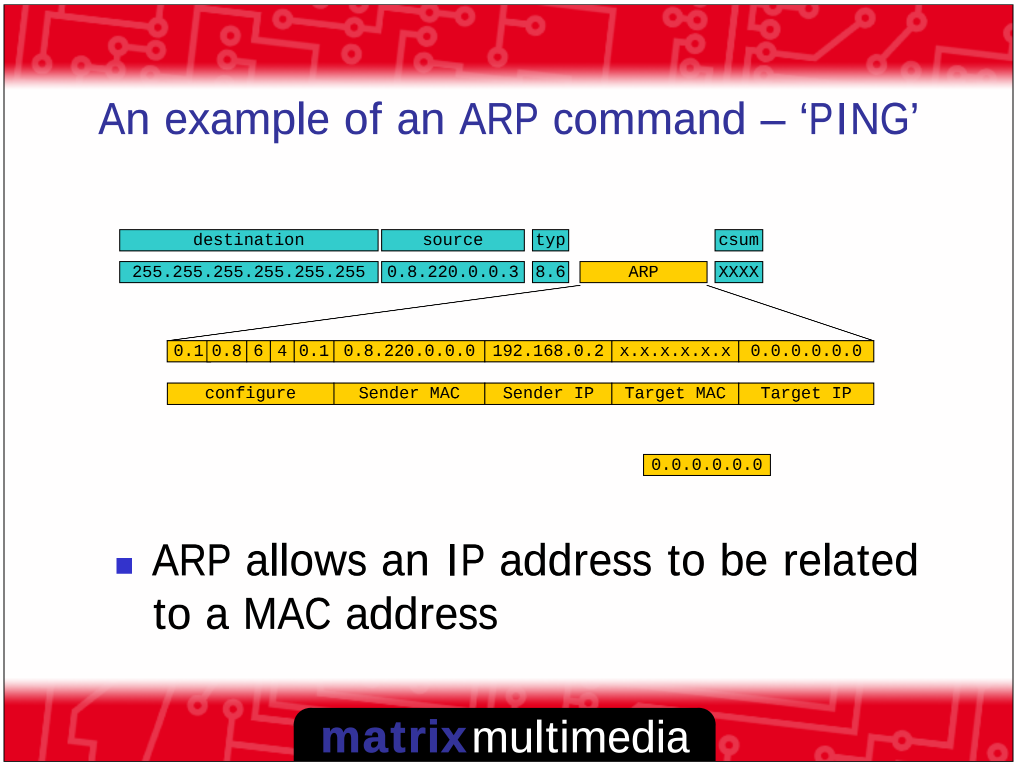
Looking in more detail at the Datalink layer: The Ethernet protocol is part of datalink and already we see the collection of numbers separated by full stops which is familiar to anyone who has set up an internet connection.



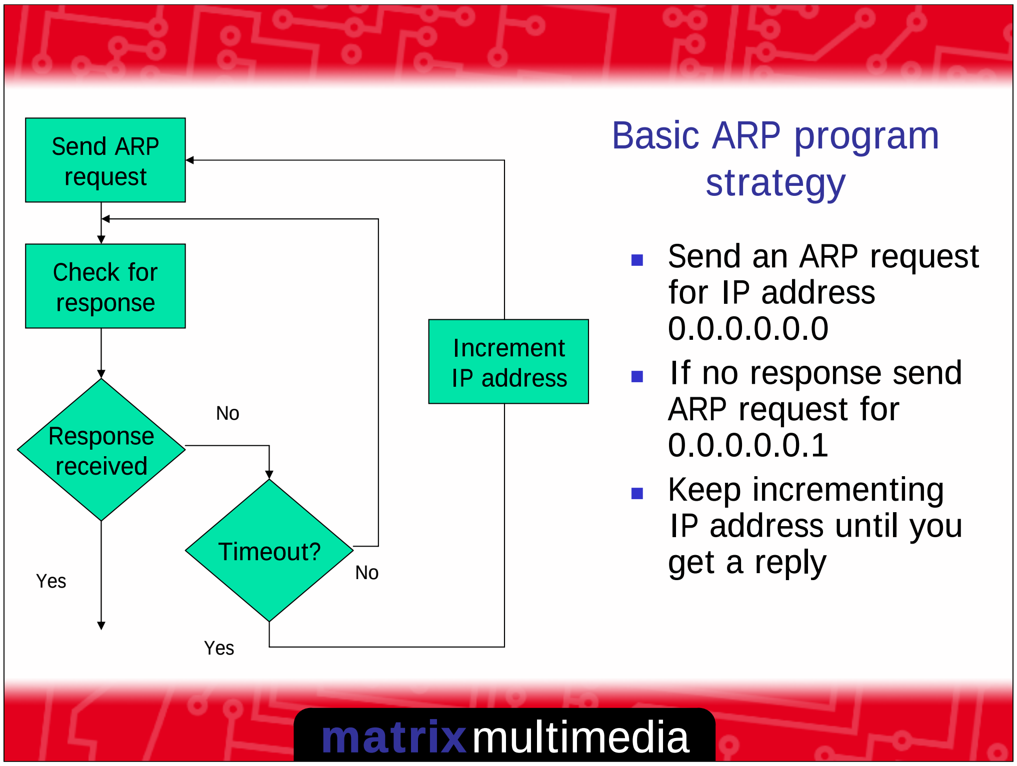
Address Resolution Protocol – or ARP – is also in the Datalink layer. It has a slightly different packet structure and this is built on the MAC layer as you will see on the next slide.



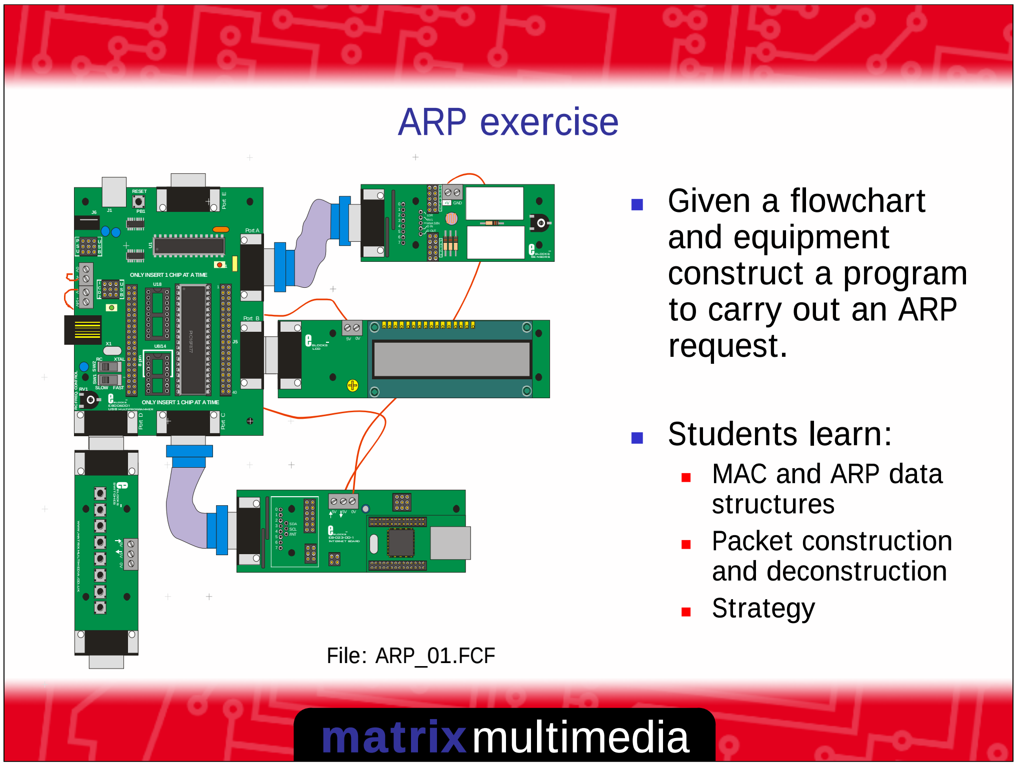
ARP simply take up 28 bytes of the Data section of the MAC layer to insert other relevant information about the ARP. ARP is used by computers to determine an IP address from a known MAC address.



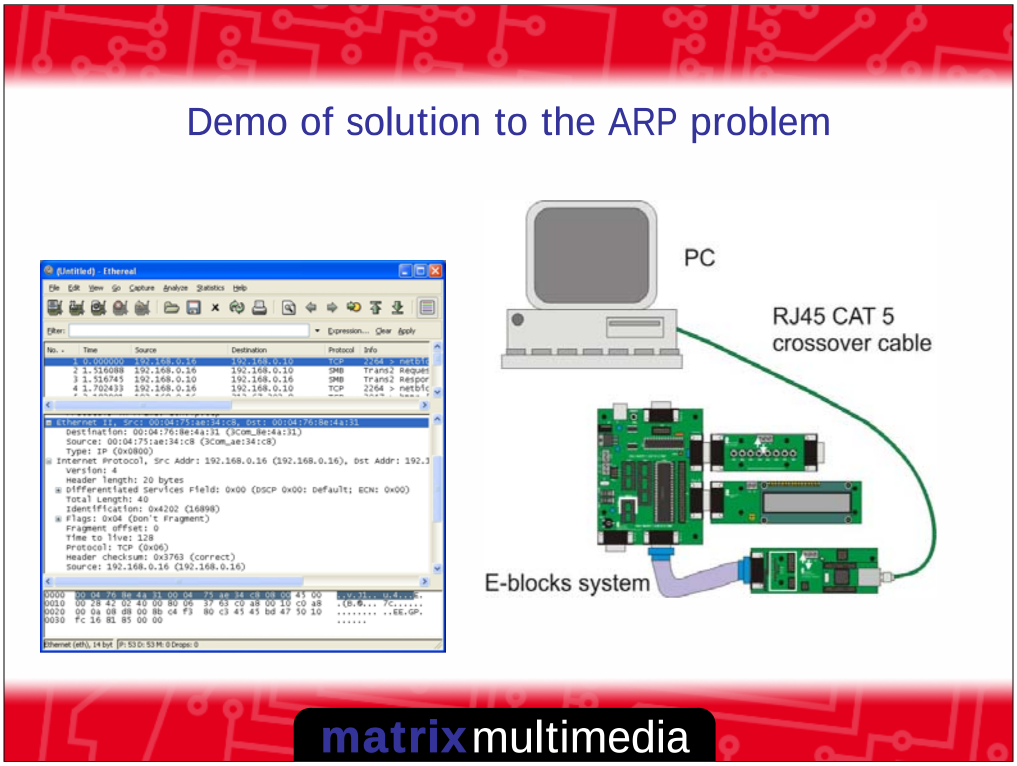
Here you can see some details of a typical ARP command. There are come configuration bytes which set up the type of ARP command, then the MAC and IP addresses of the computer issuing the ARP. We are trying to find the MAC address so we don’t care what the next 6 data bytes are. Then we have the target IP address which is all 0’s. When a computer with IP address 0.0.0.0.0.0 receives this command it will issue a similar packed of data which will contain its MAC address. This type of ARP request allows a network manager to gather information about the MAC addresses of a computer with a particular IP address. Computers can also use this protocol to find MAC addresses so that data can be sent on the network.



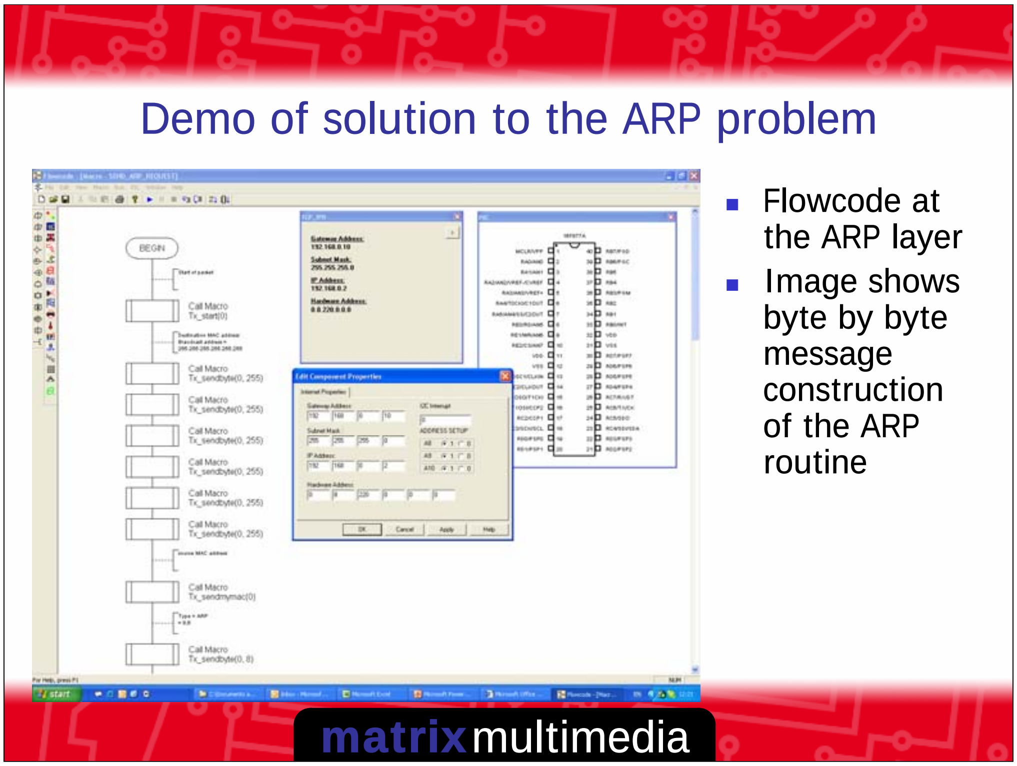
You can easily issue an ARP command if the IP address is known. However it is also possible to develop a small program to find any computers on a network and to log their IP and Mac addresses. This is a typical activity that a PC network manager might want to carry out and, as an exercise, it is a good way of building students' understanding. Here you can see a flow chart that sends an ARP request to address 0.0.0.0.0., waits for a reply, and if none is given increases the IP address until a reply is received. This is one of the examples we set students with the internet solution: it tests their understanding of the ARP protocol, packet structure, and ARP strategy.



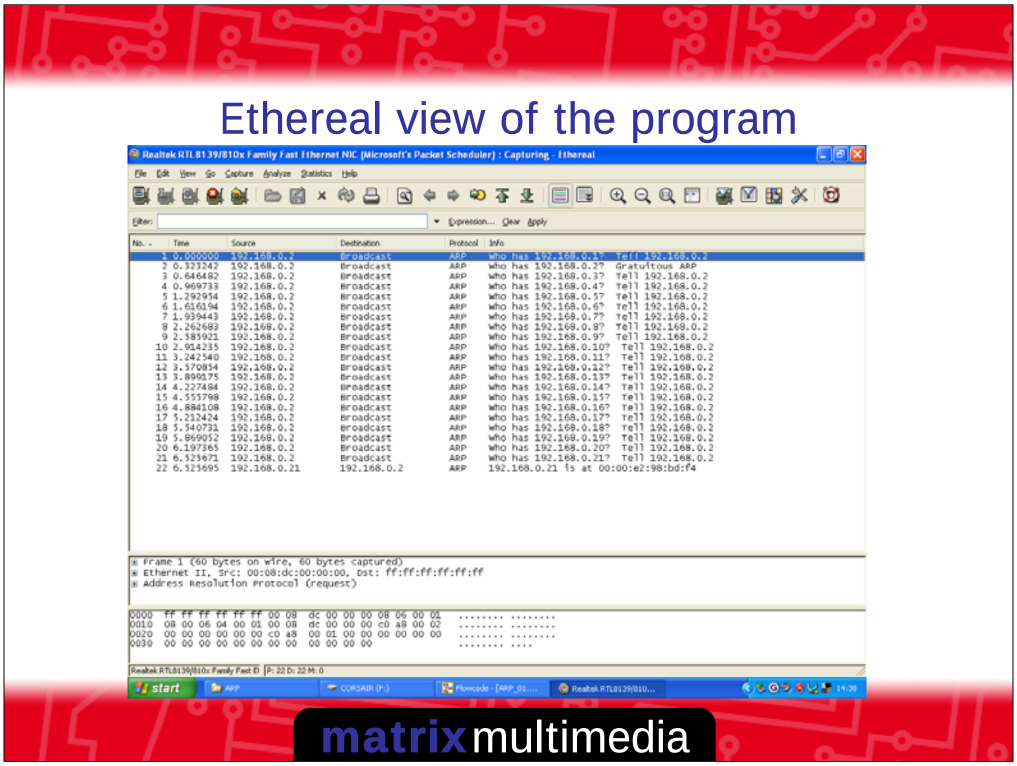
This is the layout of the equipment in the internet solution – there is a Multiprogrammer with a 16F877 PICmicro, a sensor board on port A, a LCD board on port B, the Internet board sites on port C, and a switch board on port D.



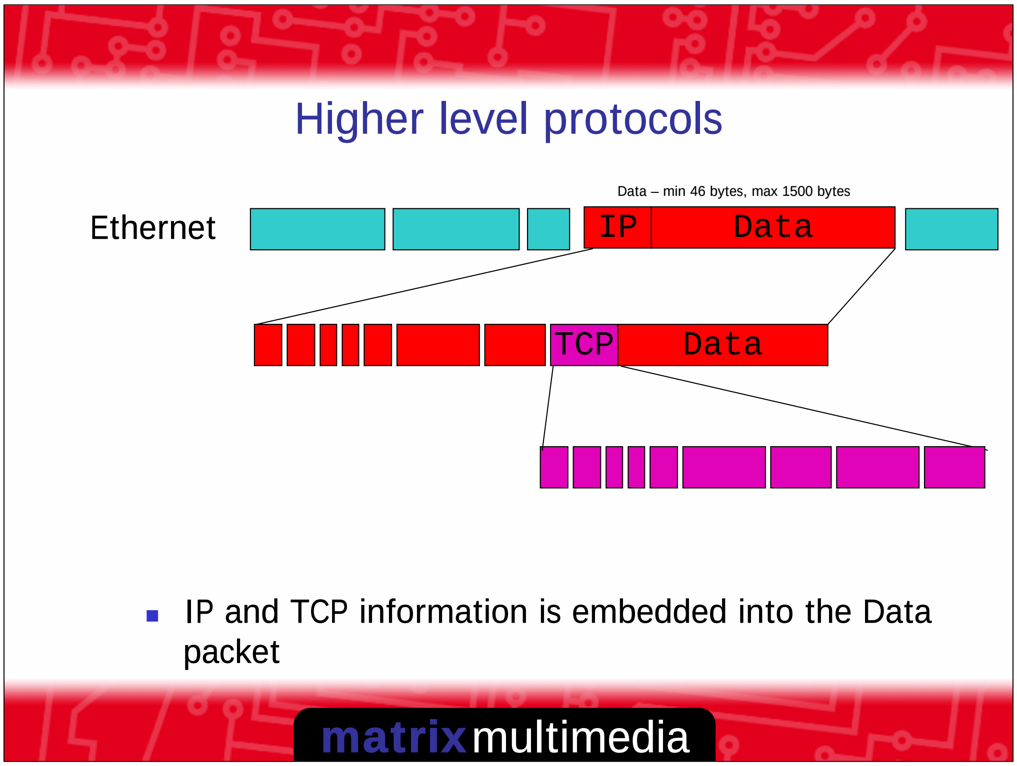
We use a RJ45 crossover cable to communicate back to the PC. When using the internet solution it is possible to go into the local area network, but to start with we recommend that students just use a PC and the internet board so that the integrity of the local area network is preserved. We use a utility called ‘Ethereal’ on the PC to show the traffic on the network. Ethereal allows you to see the source and destination addresses of communications on the network – and a utility like this is essential for all communications work.



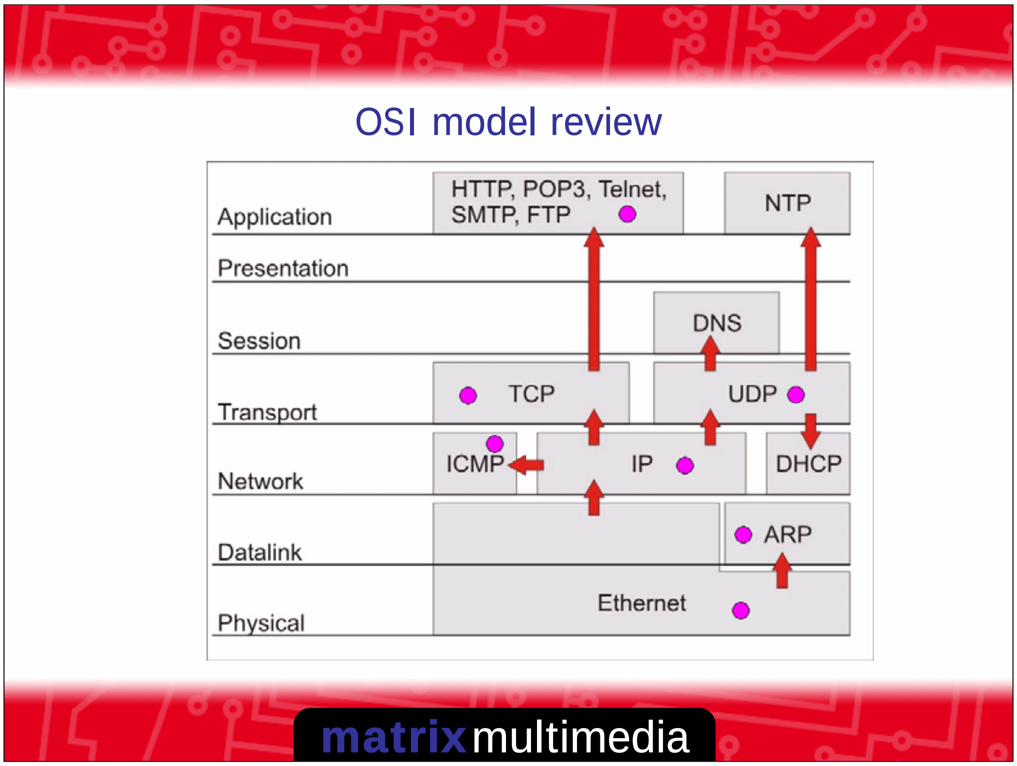
This is a screen image of part of the Flowcode solution to the ARP exercise. You can see here that at this layer Flowcode forces students to construct the MAC/ARP packet one byte at a time, but that some macros like Tx_sendmyMAC do send the internet module MAC address automatically. (Note that the collection of six ‘255’ (hex FF) bytes is used to send the APR command to all users on the network.)



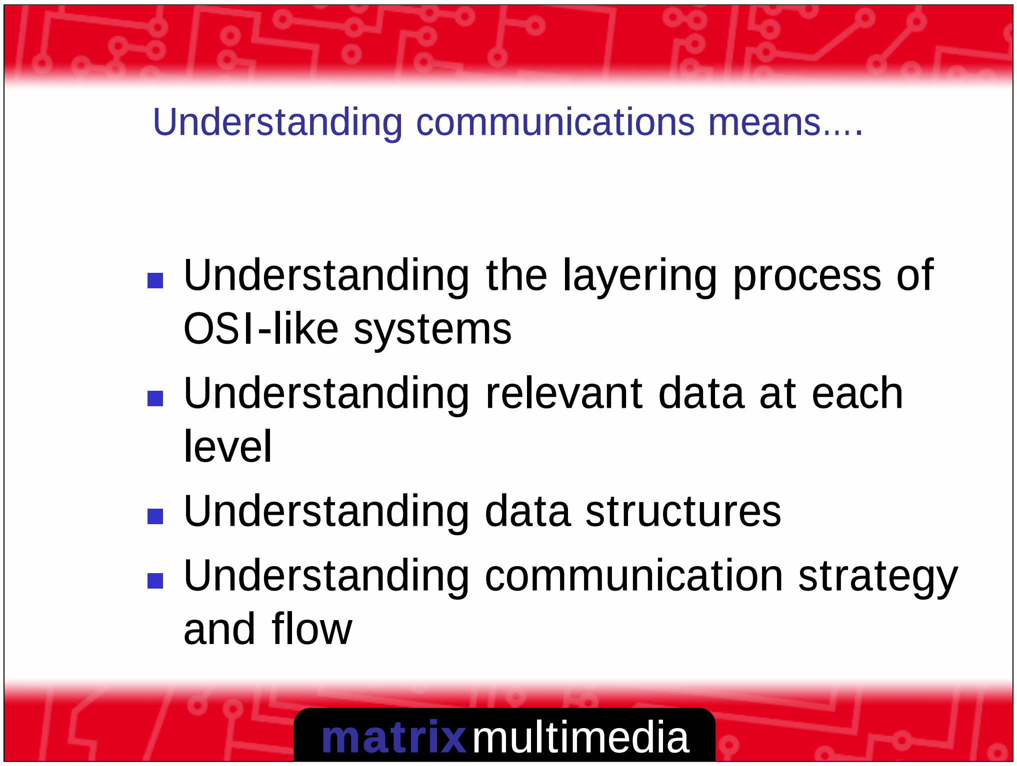
Here you can see the screen image from the results of the program as monitored by Ethereal. You can see that the Flowcode program increases the IP address until address 0.0.0.0.0.21 is reached – the address of the PC. At that point the PC recognises that the ping is targeted at it and replies with the relevant MAC address – in this case 00:00:e2:98:bd:f4. Note that the Flowcode program also displays this on the LCD display.



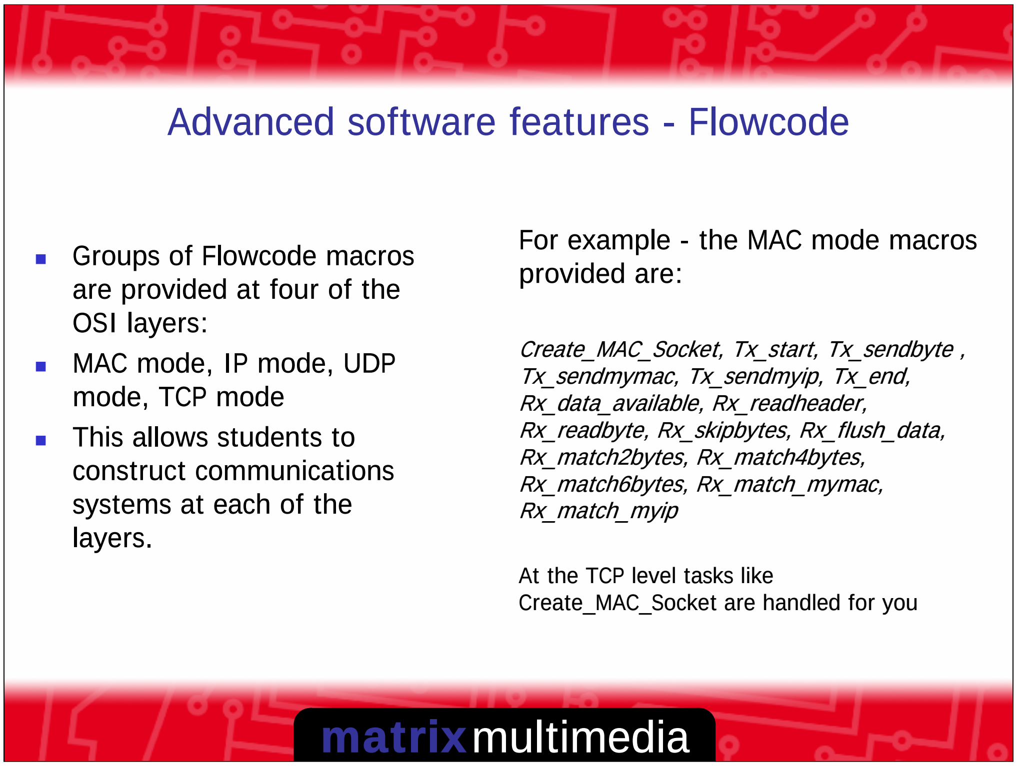
At higher layers in the OSI model the data packet is nibbled away by additional data at each layer. So IP data is embedded in the MAC data frame, and TCP data is embedded in the IP data frame.



At these higher layers Flowcode takes care of many of the byte by byte datastructure compilation – only requiring that students manually construct the relevant data at each layer. This enables students to understand the relevant data at each layer.



When we examine what ‘understanding digital communications’ means it breaks down into the areas here.



Flowcode and the internet solution are designed to provide a flexible learning platform that allows students data structures, communication flow in a digital system, and programming strategy. The families of macros at the MAC, IP, TCP, and UDP layers are a key, and unique, feature here. Flowcode allows students to build on their understanding at each level before they progress onto the next.

Our solution

- The solution contains two miniature Ethernet modules
- Includes Flowcode and a set of Macros for investigating OSI protocols and for setting up web pages
- Includes a comprehensive set of teacher's notes (80 pages)

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The internet solution includes all the hardware and software required as well as a comprehensive teacher's manual which explains how to use the equipment and gives sample exercises and solutions.