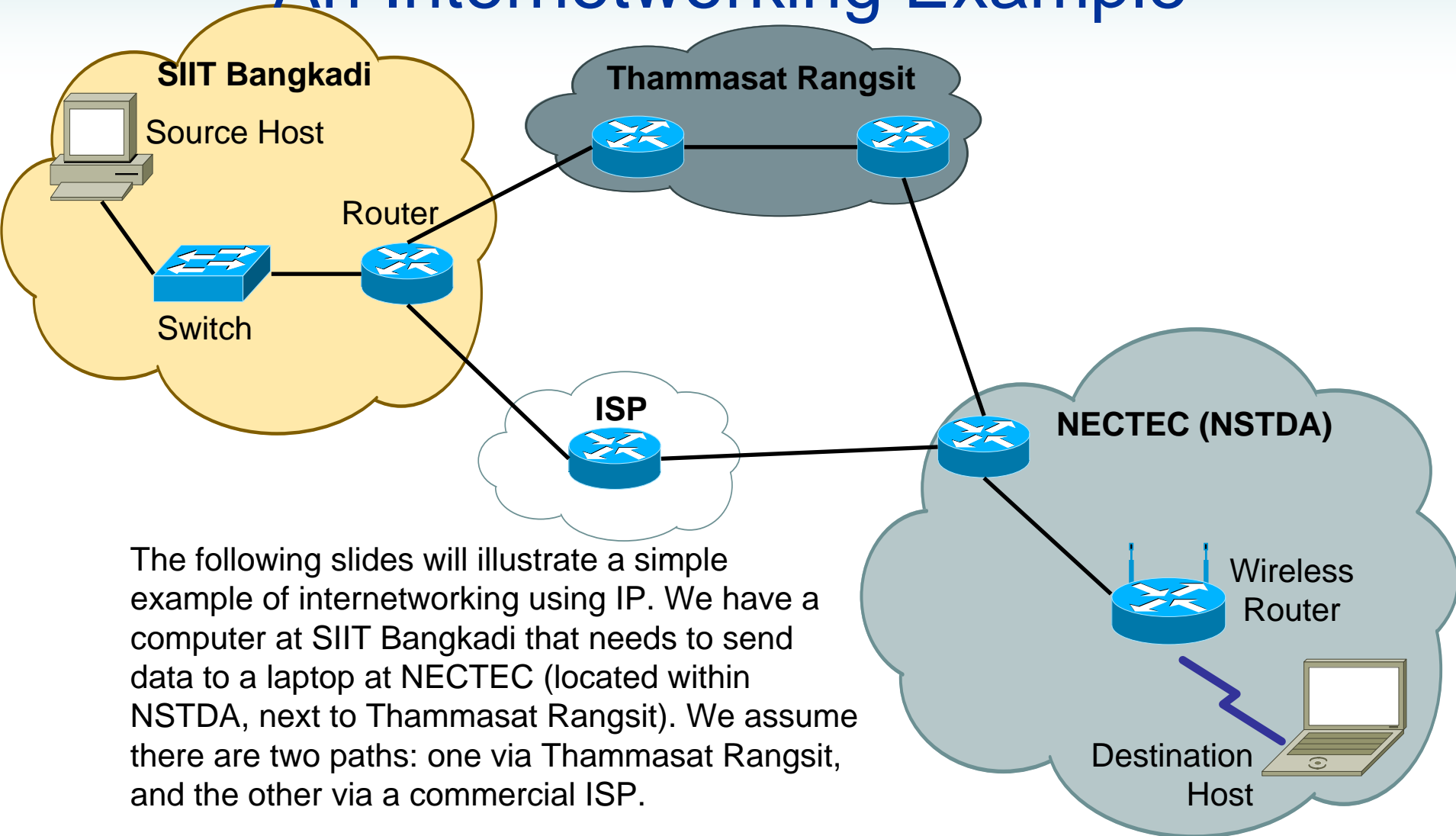


Case Study: SIIT Internetworking

Dr Steve Gordon
ICT, SIIT

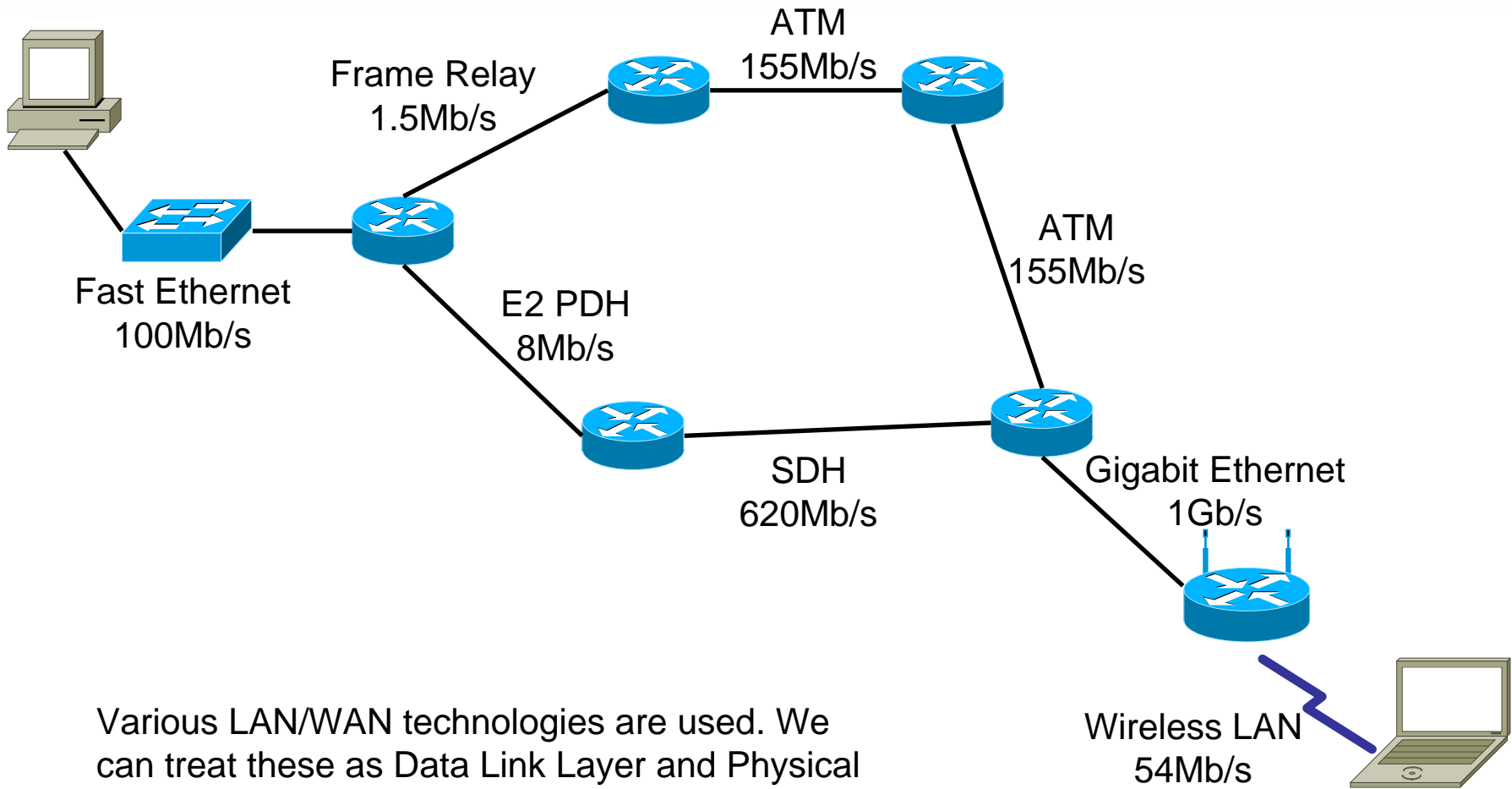
An Internetworking Example



The following slides will illustrate a simple example of internetworking using IP. We have a computer at SIIT Bangkadi that needs to send data to a laptop at NECTEC (located within NSTDA, next to Thammasat Rangsit). We assume there are two paths: one via Thammasat Rangsit, and the other via a commercial ISP.



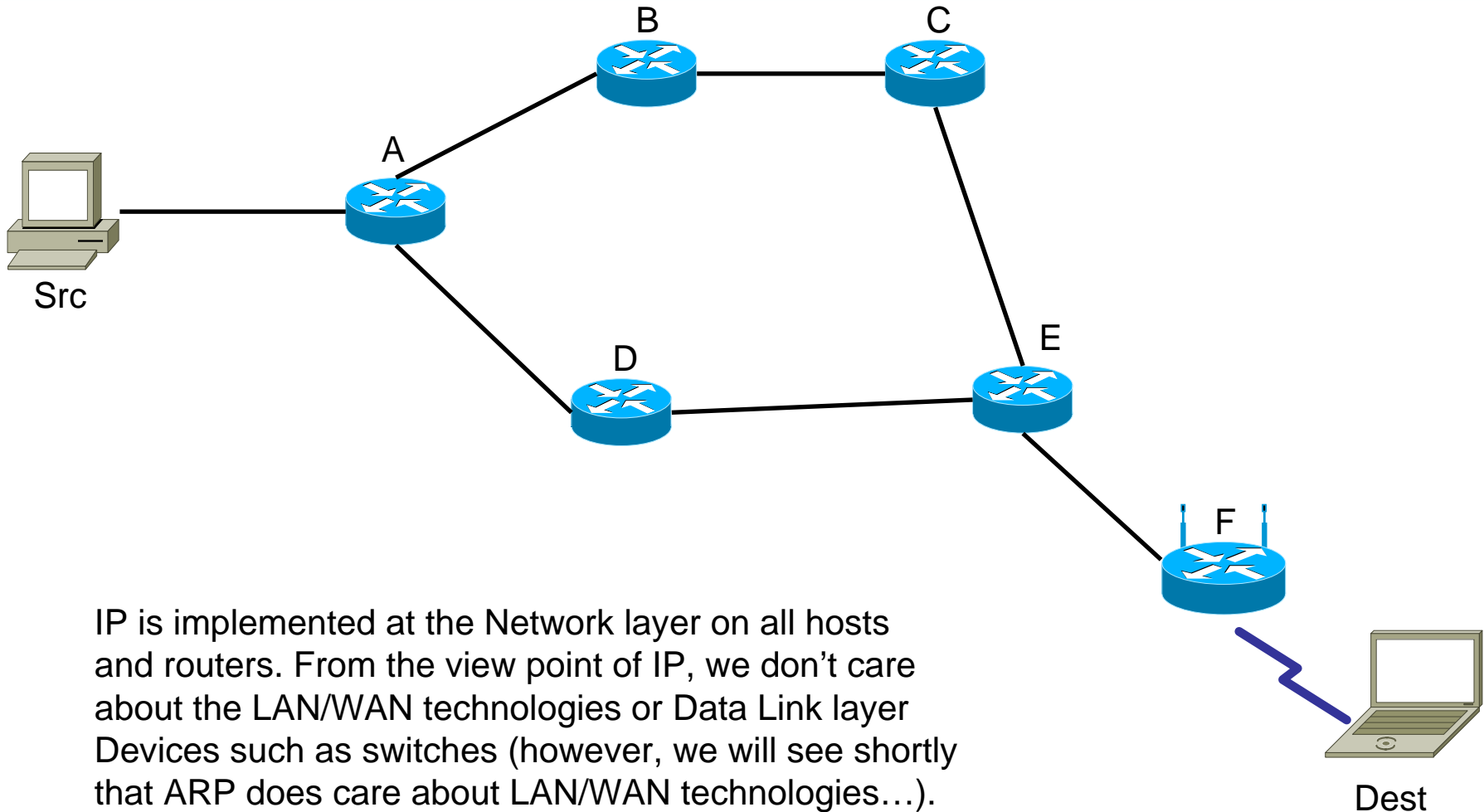
LAN/WAN Technologies



Various LAN/WAN technologies are used. We can treat these as Data Link Layer and Physical Layer technologies.



Internetworking with IP

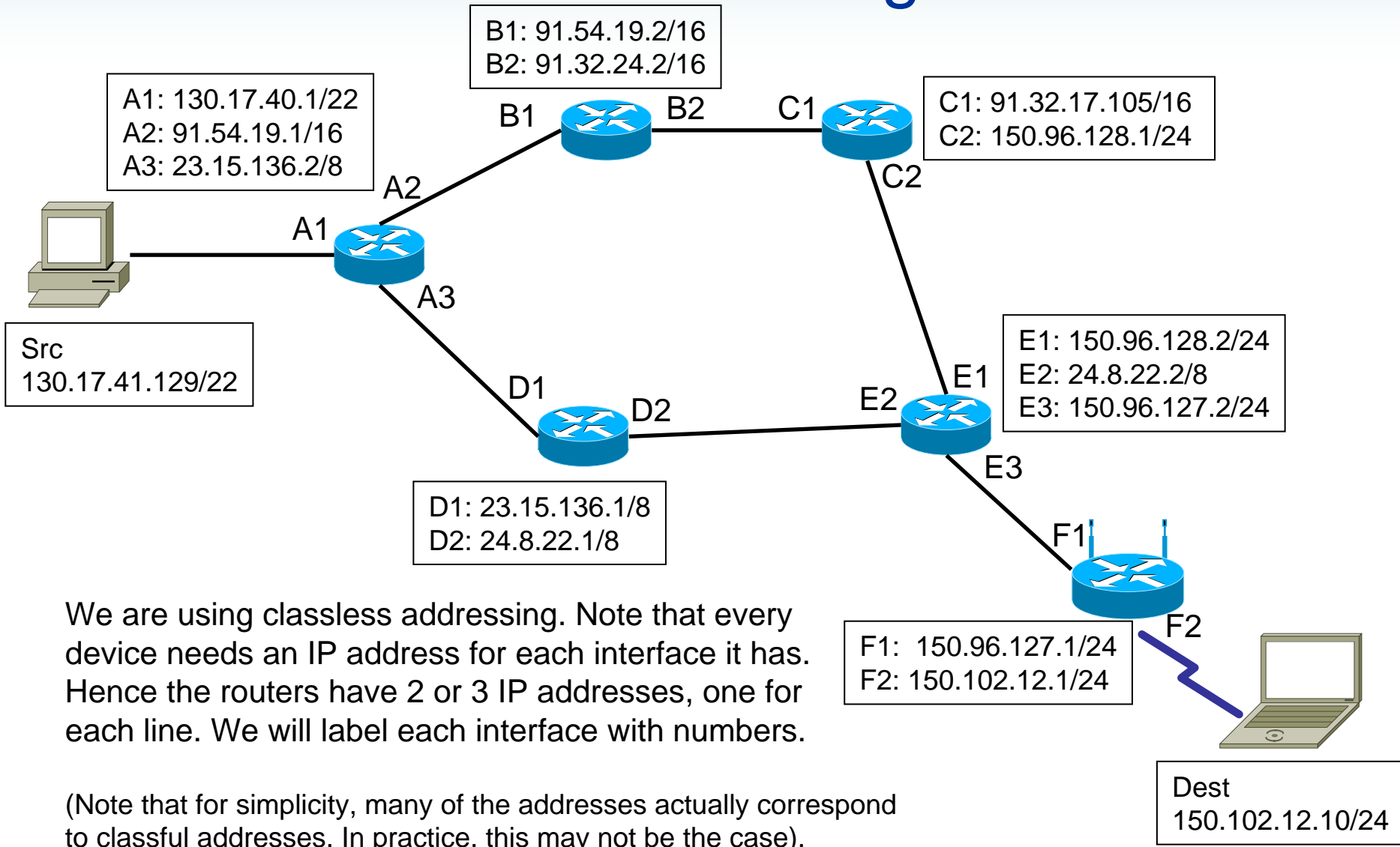


IP is implemented at the Network layer on all hosts and routers. From the view point of IP, we don't care about the LAN/WAN technologies or Data Link layer Devices such as switches (however, we will see shortly that ARP does care about LAN/WAN technologies...).

A, B, C, D, E, F = routers



IP Addressing

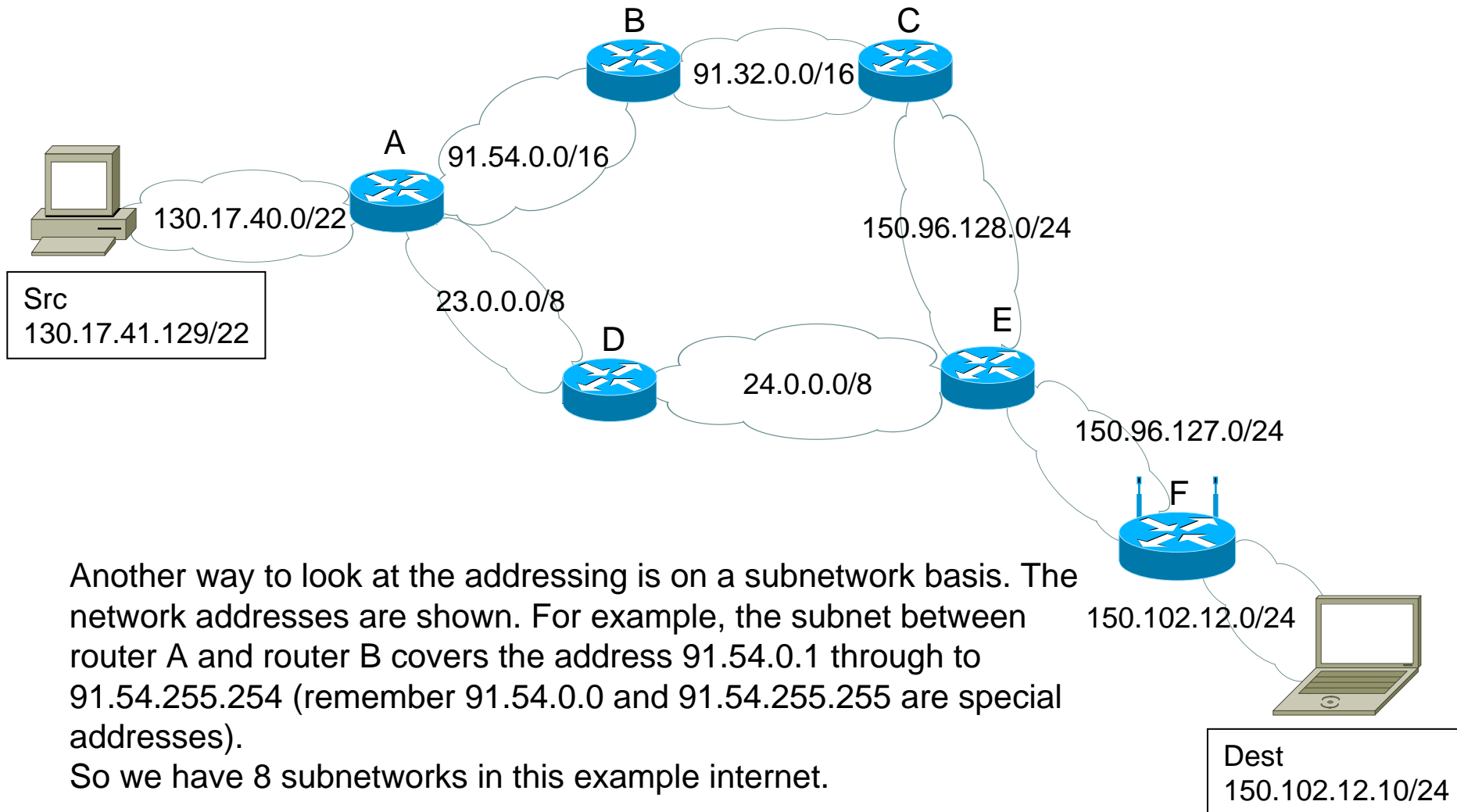


We are using classless addressing. Note that every device needs an IP address for each interface it has. Hence the routers have 2 or 3 IP addresses, one for each line. We will label each interface with numbers.

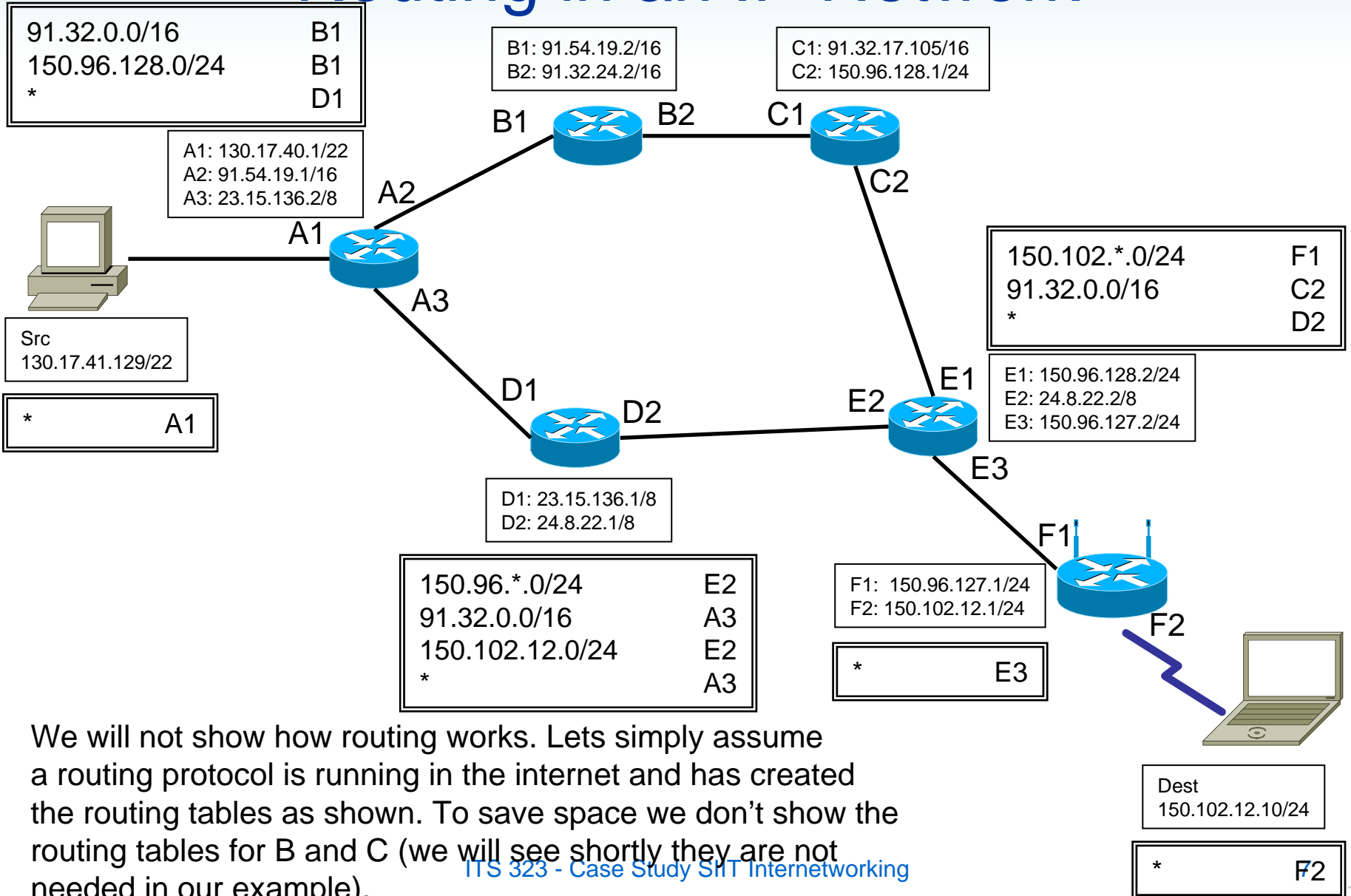
(Note that for simplicity, many of the addresses actually correspond to classful addresses. In practice, this may not be the case).



Another View of the Network



Routing in an IP Network



We will not show how routing works. Lets simply assume a routing protocol is running in the internet and has created the routing tables as shown. To save space we don't show the routing tables for B and C (we will see shortly they are not needed in our example).



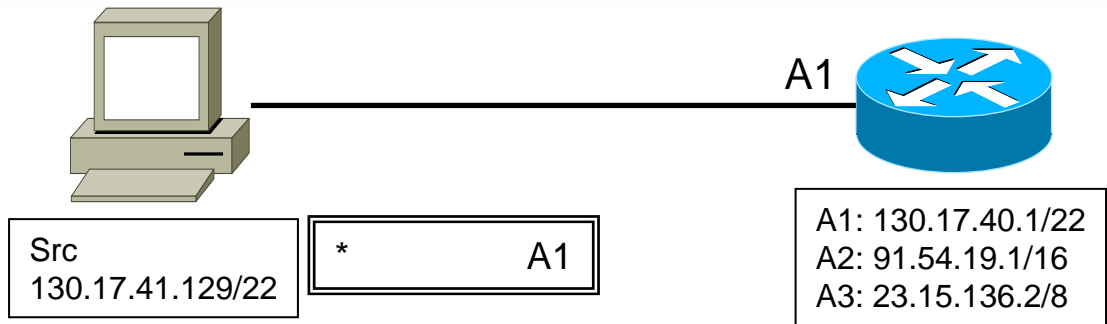
Routing in an IP Network

- How to read the routing tables?
 - When a node receives a datagram it looks at the destination IP address and performs these checks (in order):
 1. Is the datagram destined to this host?
 - Yes: send the datagram to the Transport layer
 - No: continue
 2. Is the datagram destined to a host on a network I am directly connected to?
 - Yes: send to that host using the LAN technology (e.g. Ethernet)
 - No: continue
 3. Look at the routing table, line by line (starting from the top, going down in order):
 - Does the destination address match the network address on the left of the table?
 - » Yes: send the datagram to the interface given on the right of the table
 - » No: repeat for next line in routing table
 - If none of the lines match, then send an error message to the source
 - Note that pattern matching is used
 - » * means any value: so 130.17.42.7 matches 130.17.*.0/24 since 130.17.42.7/24 has a network address of 130.17.42.0 (in this case, * = 42)

(Note: in the Internet the method for looking up routing tables is slightly different!)

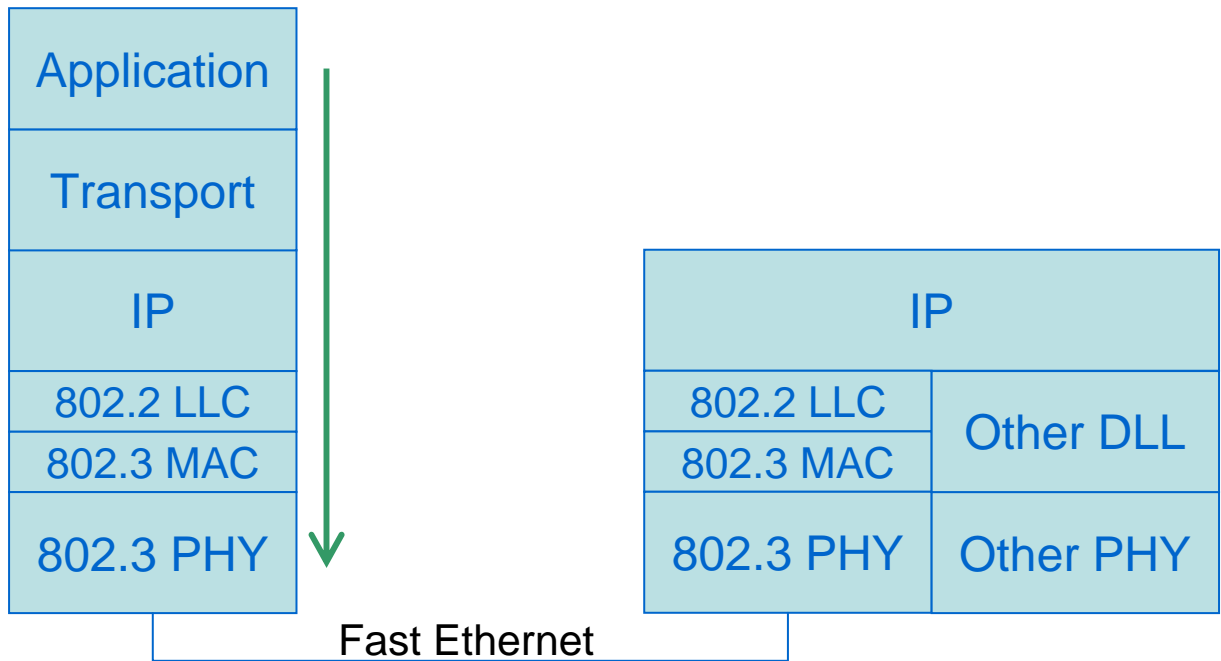


Sending the Datagram from Source

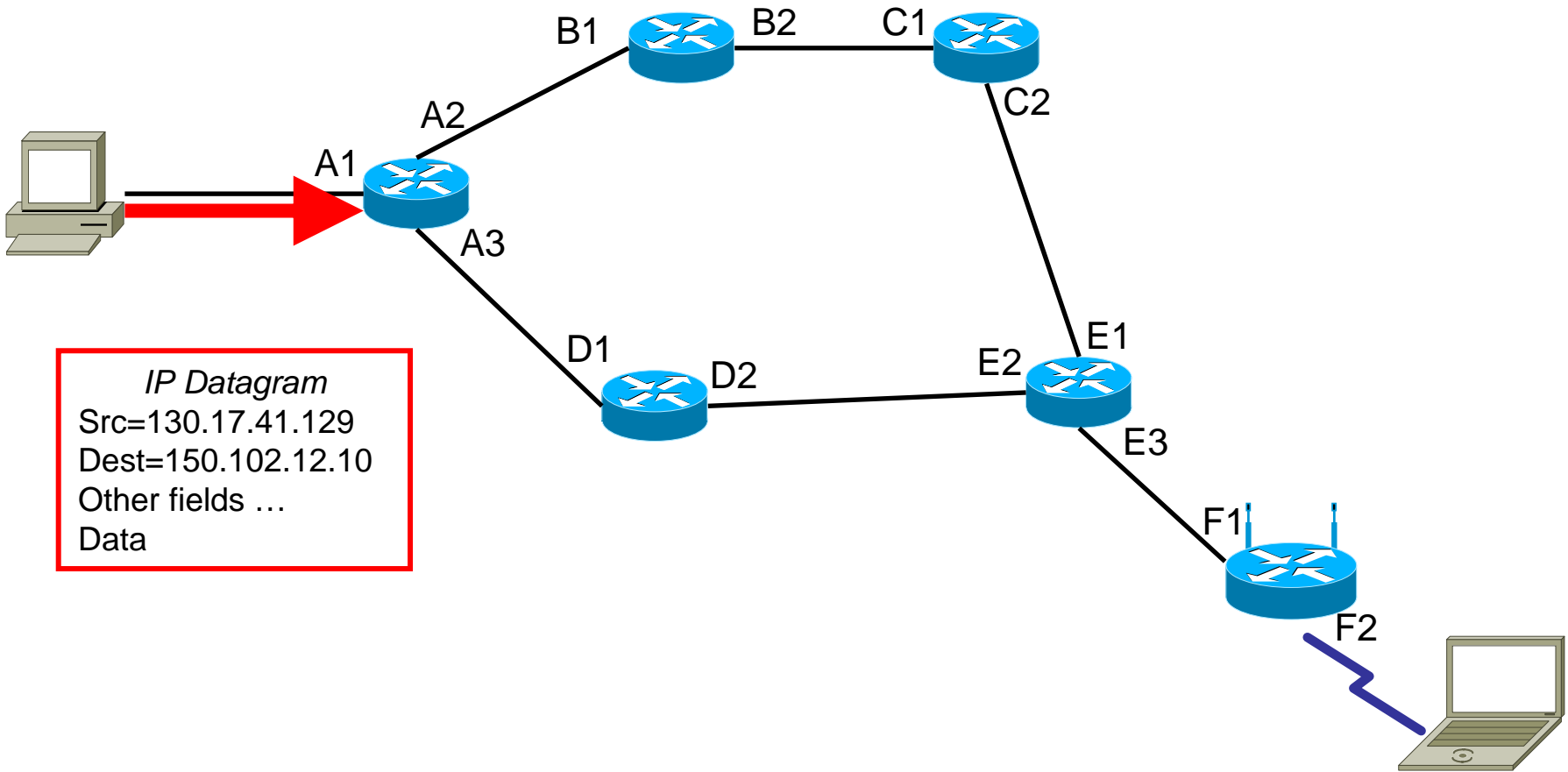


IP at the source creates a datagram, by adding the IP header to the transport layer data. The IP header includes:
Source address: 130.17.41.129
Dest. address: 150.102.12.10

IP performs the checks (previous slide) and determines it must send the datagram to A1, that is, the router it is connected to. The datagram is sent using Fast Ethernet (IEEE 802.3).



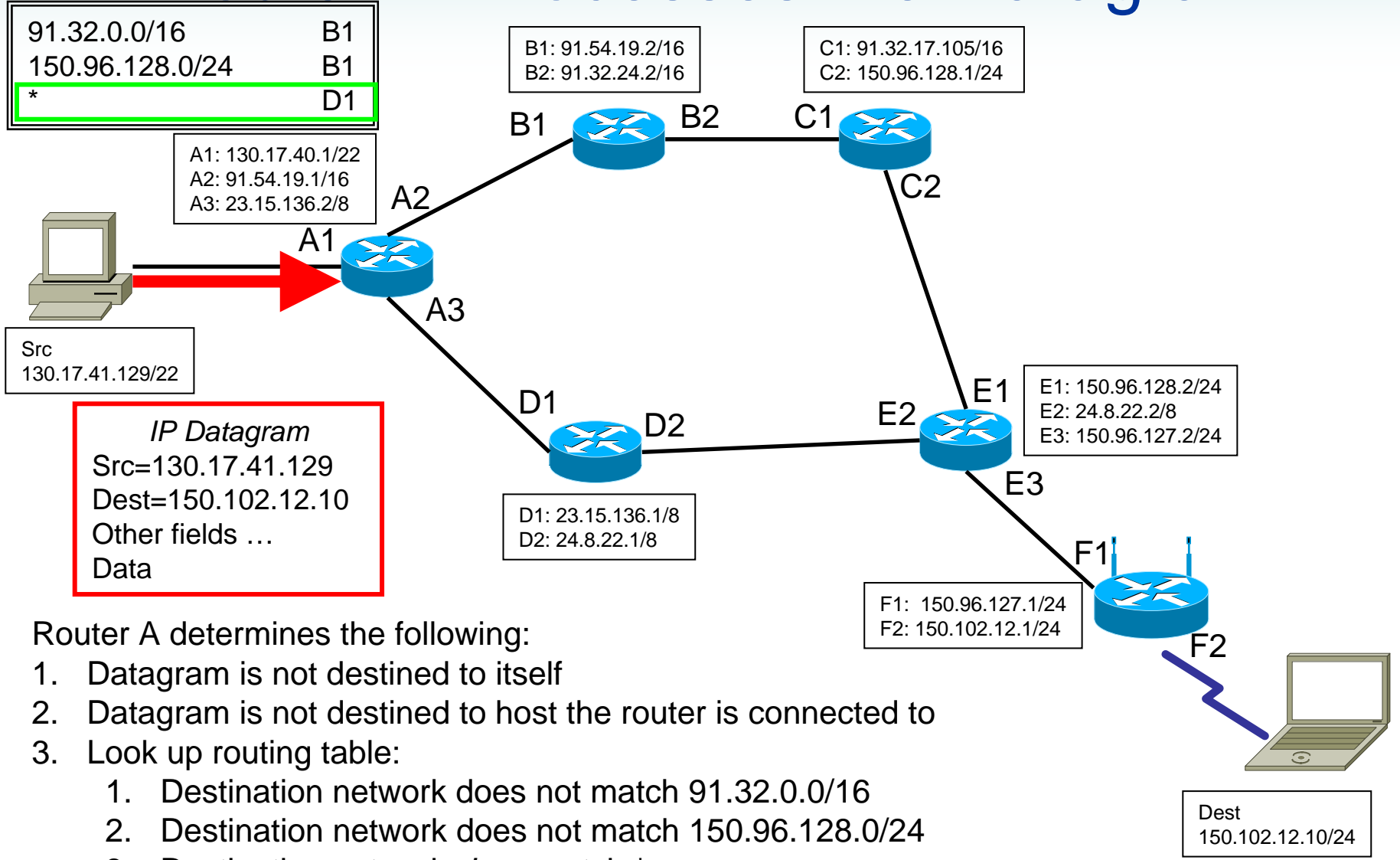
Source to Router A



IP Datagram
Src=130.17.41.129
Dest=150.102.12.10
Other fields ...
Data



Router A Processes the Datagram



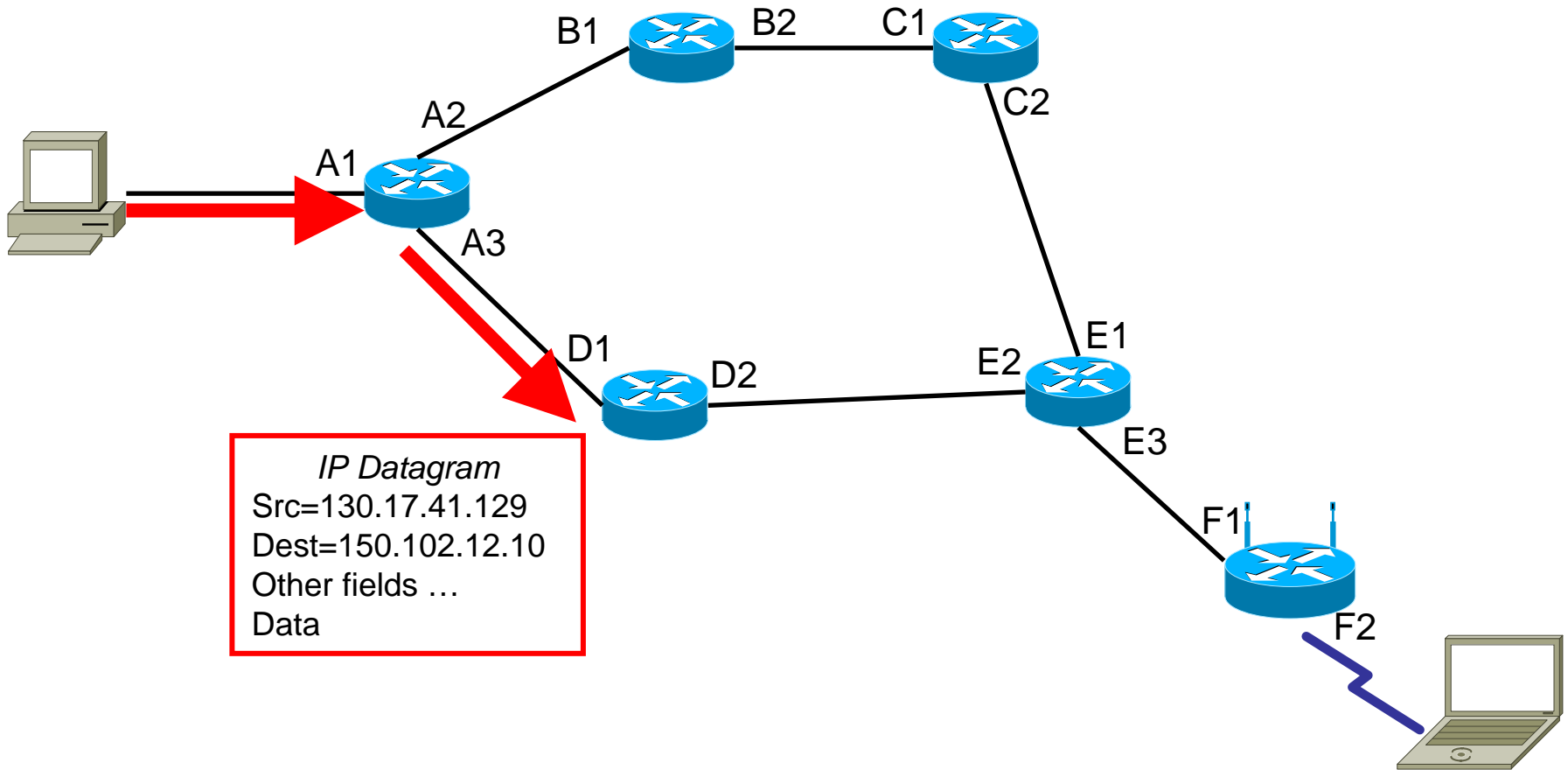
Router A determines the following:

1. Datagram is not destined to itself
2. Datagram is not destined to host the router is connected to
3. Look up routing table:
 1. Destination network does not match 91.32.0.0/16
 2. Destination network does not match 150.96.128.0/24
 3. Destination network *does* match *

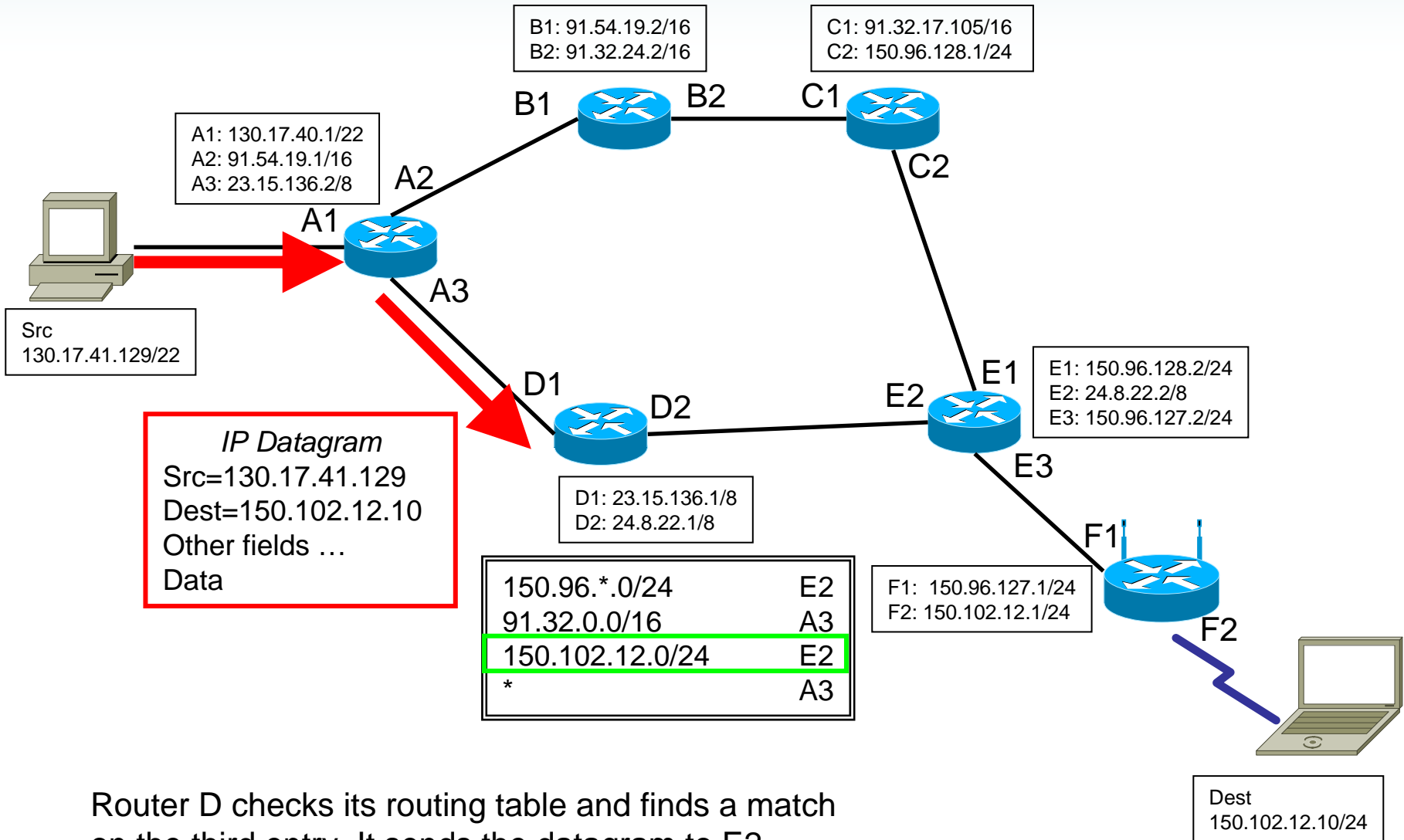
Hence, router A sends the datagram to D1



Router A to Router D



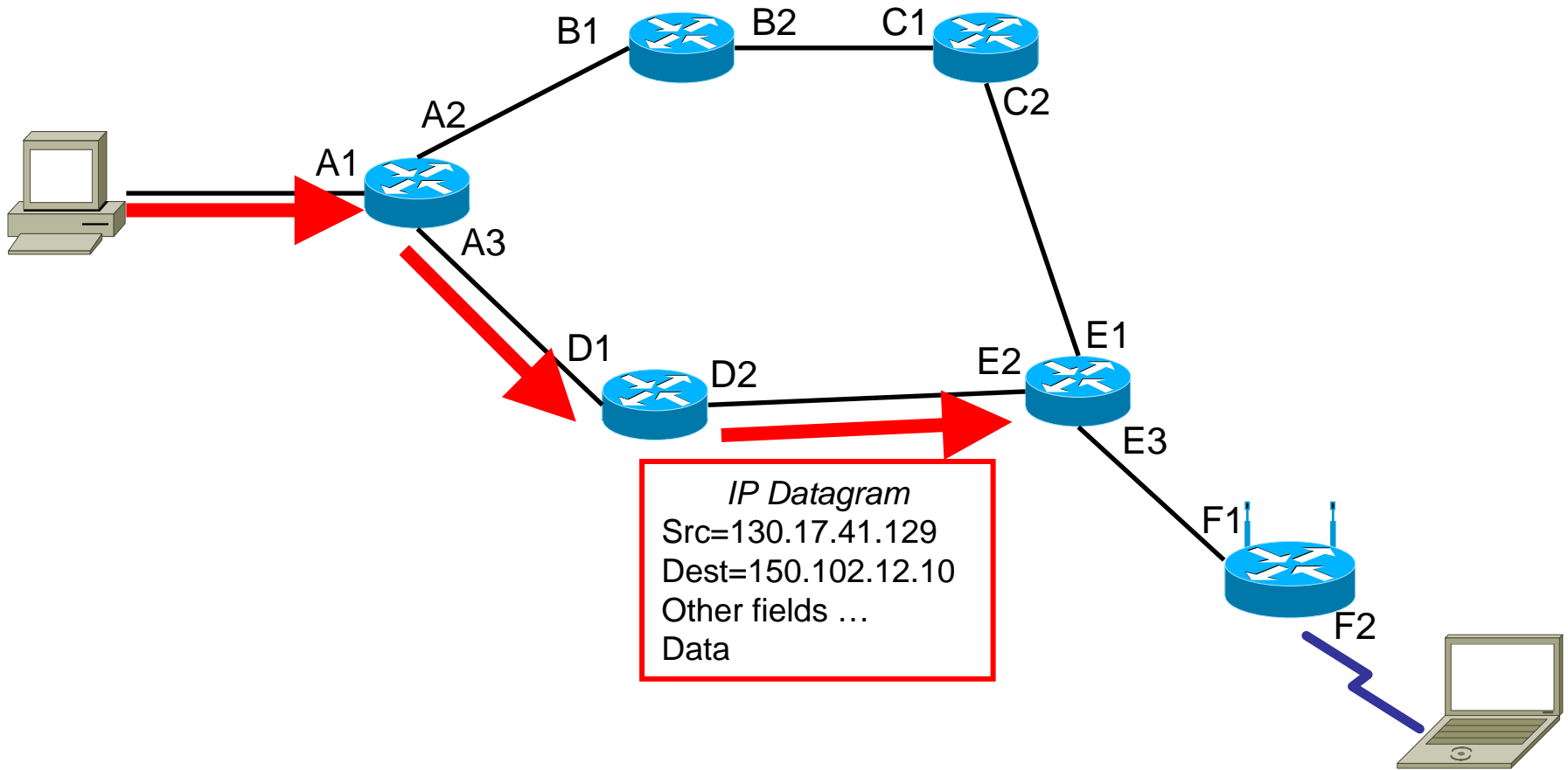
Router D Processes the Datagram



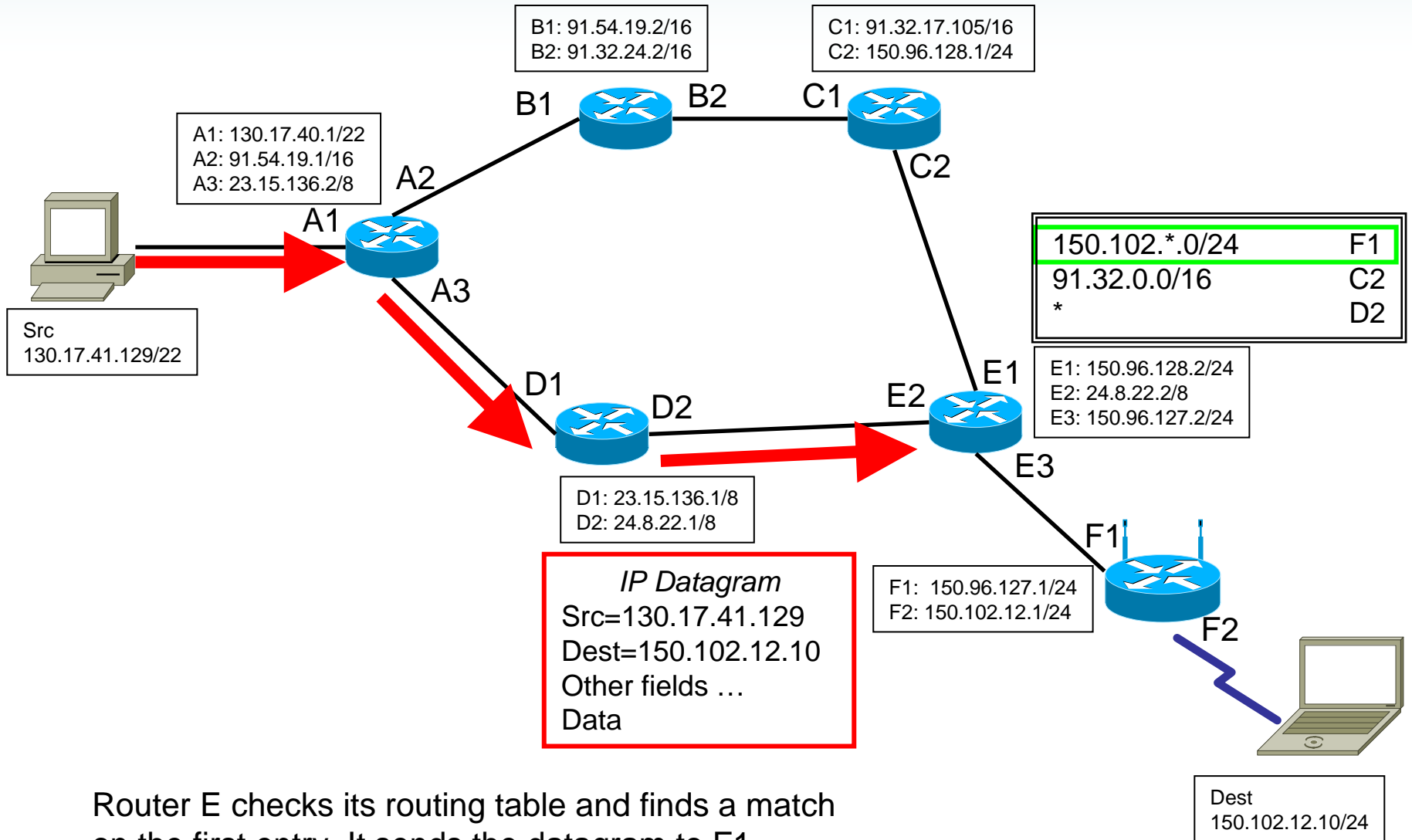
Router D checks its routing table and finds a match on the third entry. It sends the datagram to E2.



Router D to Router E



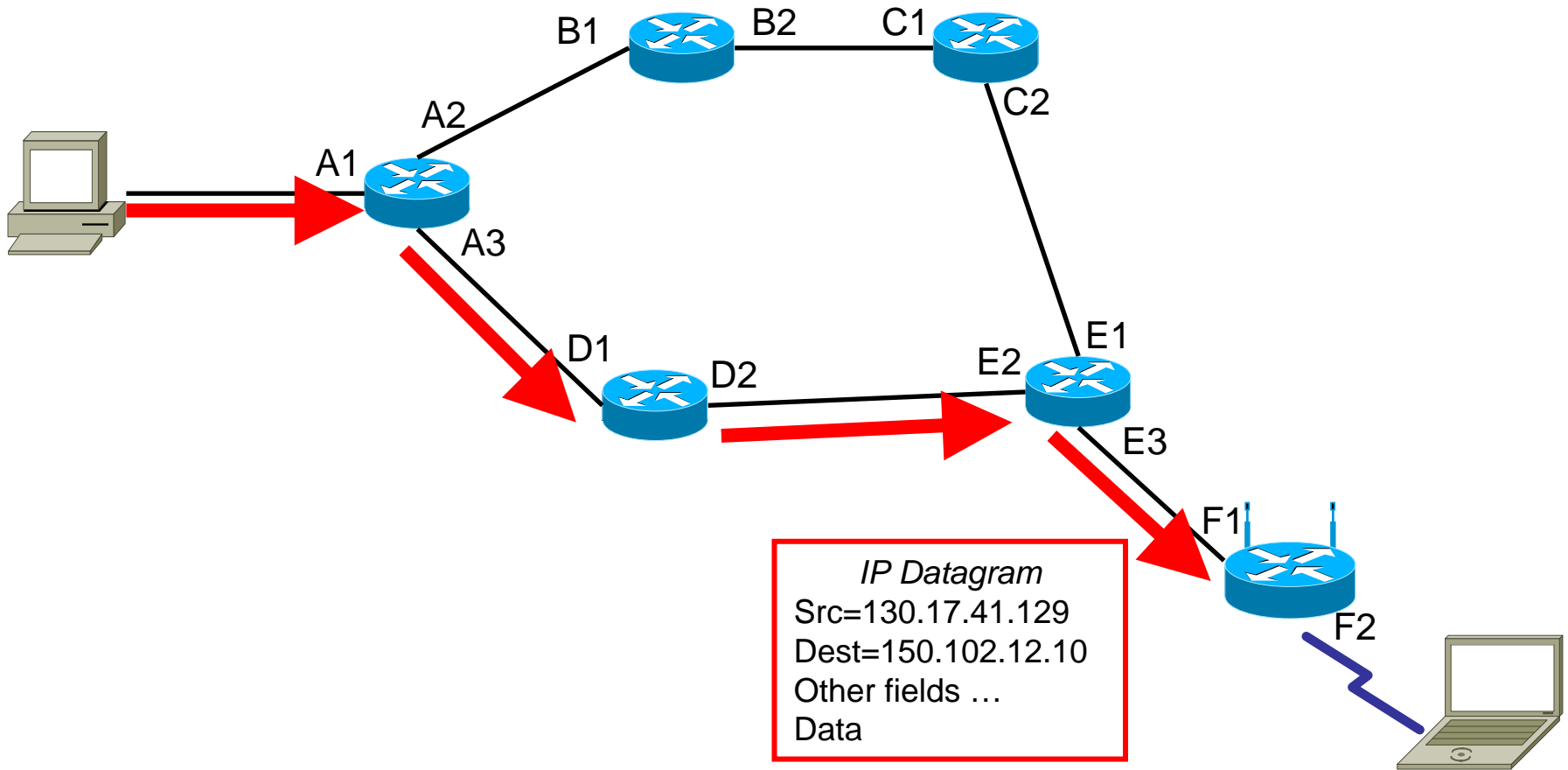
Router E Processes the Datagram



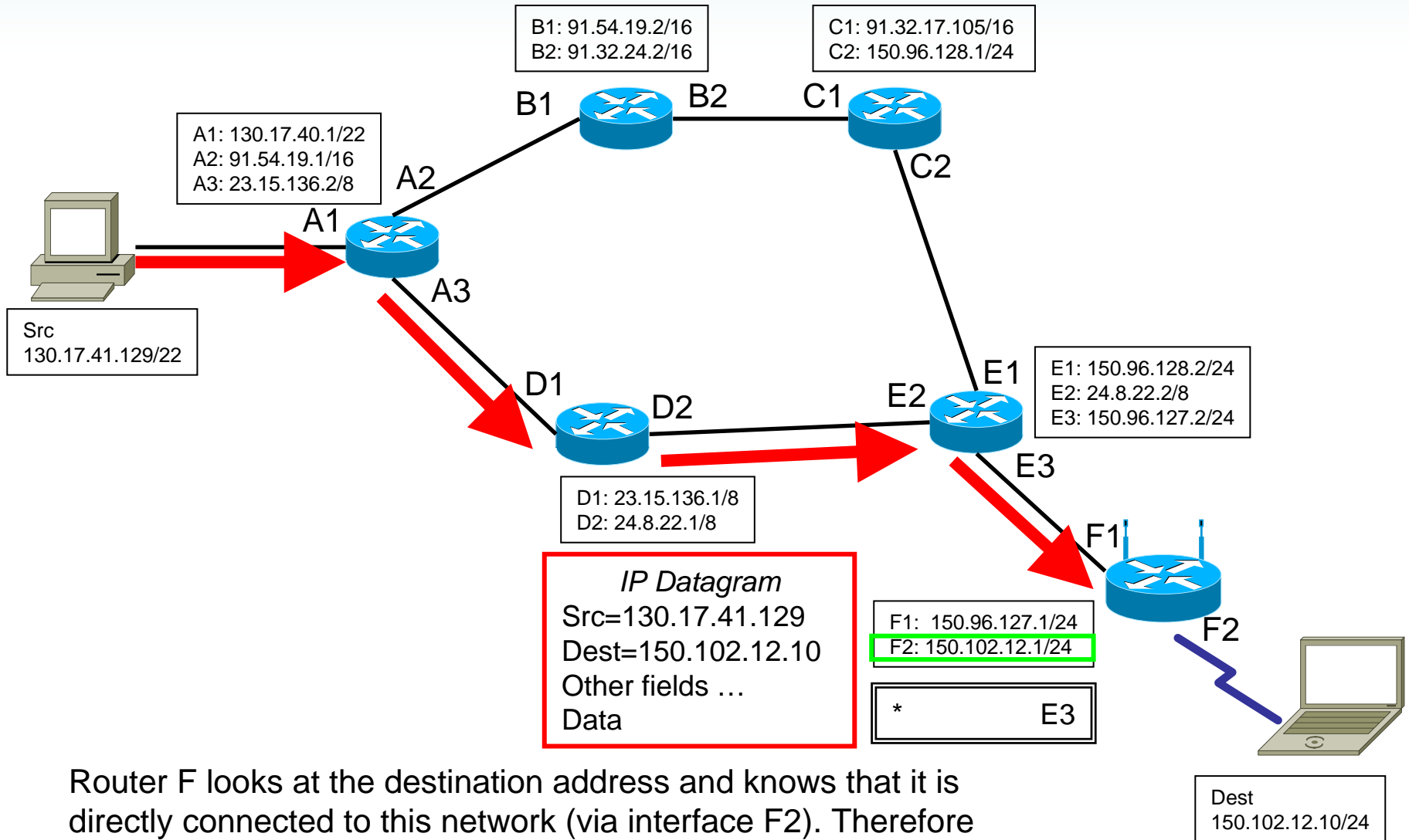
Router E checks its routing table and finds a match on the first entry. It sends the datagram to F1.



Router E to Router F



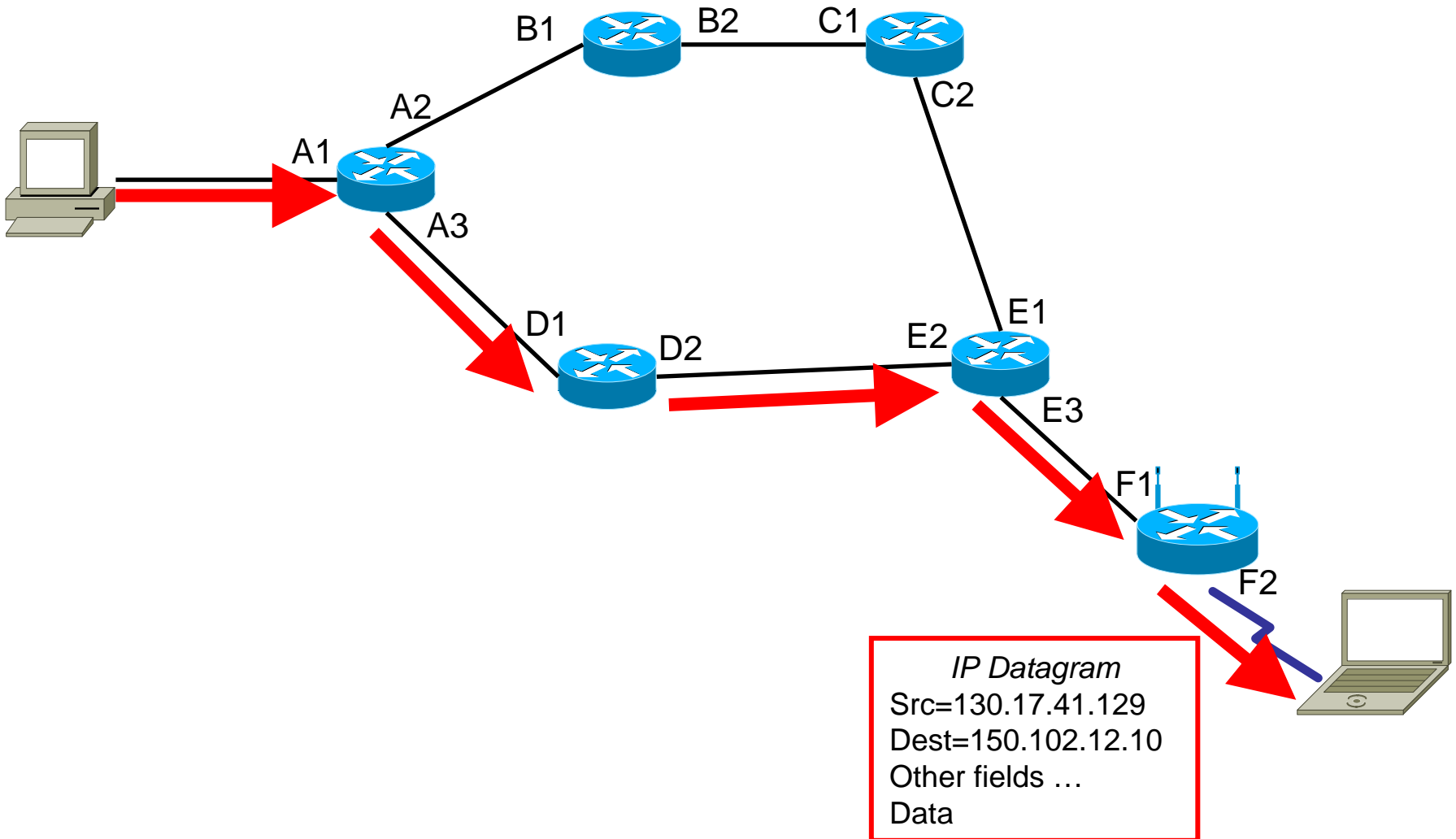
Router F Processes the Datagram



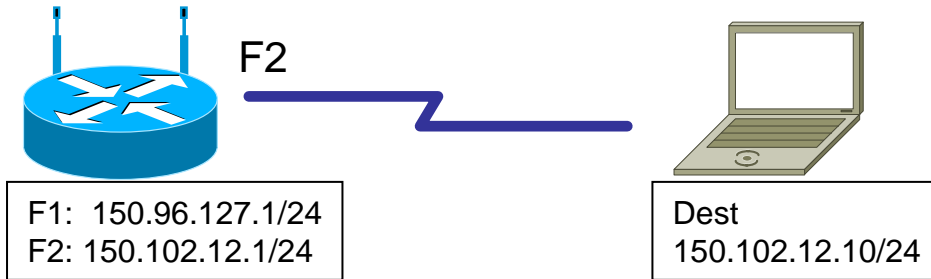
Router F looks at the destination address and knows that it is directly connected to this network (via interface F2). Therefore router F does not look in its routing table. Instead it sends the datagram to the destination (via the wireless LAN).



Router F to Destination



Destination Receives the Datagram



IP	
802.2 LLC	802.2 LLC
GbE MAC	802.11 MAC
GbE PHY	802.11 PHY

Application
Transport
IP
802.2 LLC
802.11 MAC
802.11 PHY



IP at the destination receives the datagram and recognises that it is the final destination. Hence IP removes the header and sends the data to the Transport layer.

Wireless LAN



Summary of IP Internetworking

- IP networking layer includes two main functions:
 - Routing: routing protocols are running on the routers/hosts to create the routing tables
 - As the network changes (new routers added, links fail, load increases) the routing protocols adjust the routing tables accordingly
 - In practice, routing tables can be quite complex
 - 1000's of entries; the main routers in today's Internet contain more than 100,000 entries
 - But still this is manageable because routers only record “how to get to a network”, not to a particular host (if entries for every host were used, then routing tables would have 100's of millions of entries – far too large!)
 - Forwarding: when data is to be sent, the process is known as forwarding (our example showed the detailed steps of forwarding)
 - IP datagram contains the IP address of the source host and destination host
 - Each router looks at the destination and (using the routing tables) determines where to forward the datagram in order to reach the destination
- Although routing protocols can be quite complex, forwarding is relatively simple (and fast, cheap)
- Implementing IP in every host/router allows virtually any computer (using different LAN/WAN technologies) to communicate, that is, the Internet today

