

# Prolegomena to any Future Metaphysics of Computer Networking

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# Outline

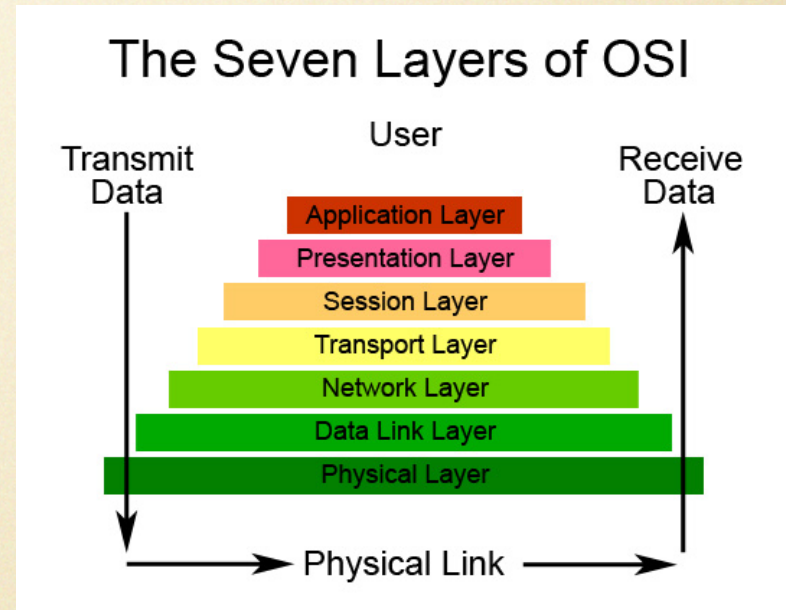
- Dedication
- OSI model of computer networks
- What happens when a web page is requested?
- Bunge's metaphysics and some (metaphysical) questions about computer networks
- Brief summary

# Dedication

- Mario Bunge
- ~90 years of life, with ~50 years of metaphysics of science and technology
- Paper arises out of noticing that both the OSI model of computer networks and his metaphysics involve a hierarchy of levels
- Paper is an application of the latter to metaphysically investigate the former

# OSI model of computer networks

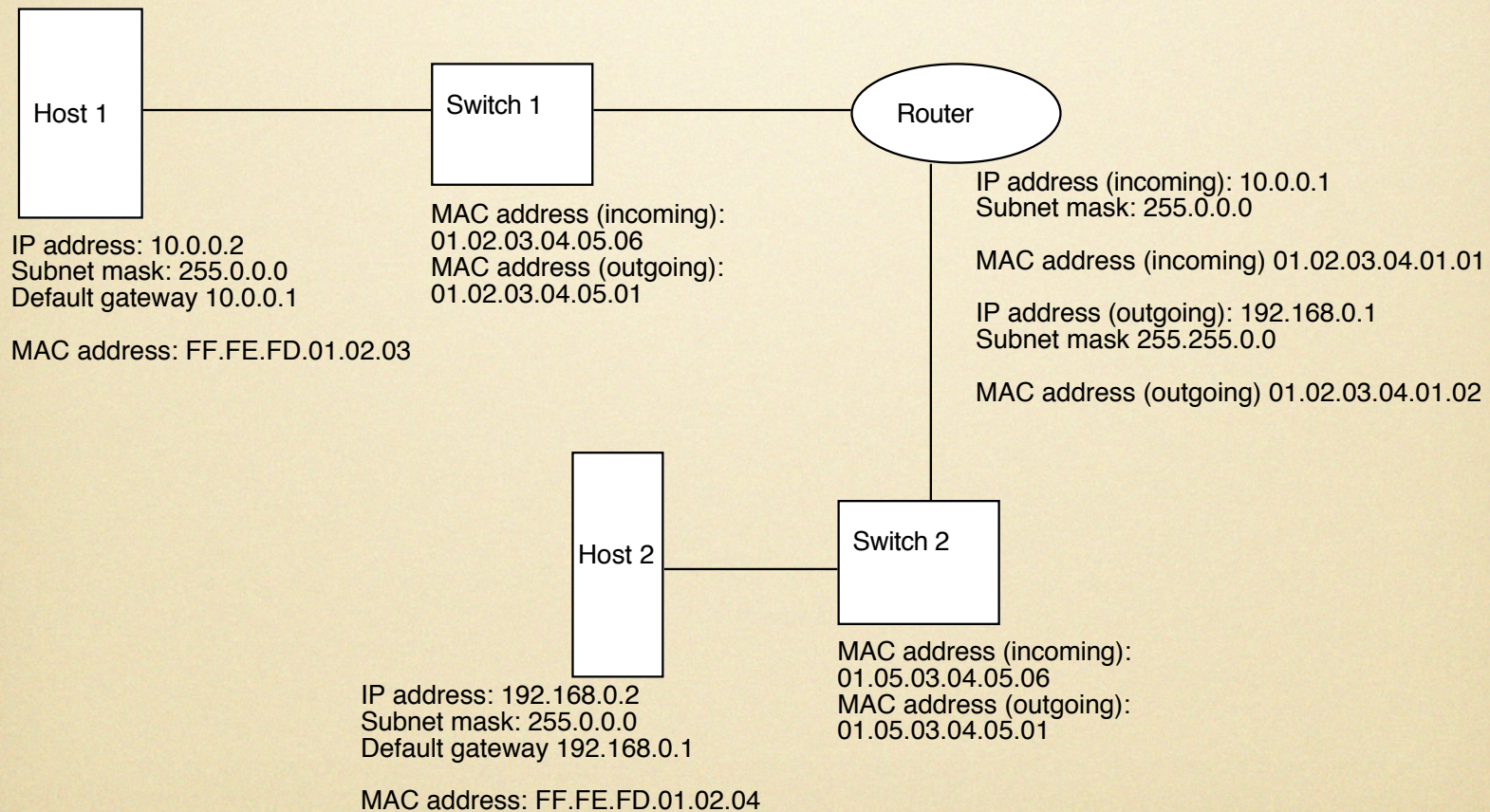
- 7 layer hierarchy
- “Top” of the screen is the “top” of the hierarchy, layer closest to user
- Network wrappers (e.g. some encryption) at layer 6
- “Operator” at layer 5



# OSI model of computer networks (cont'd)

- Simplification: ignoring 5, 6 in what follows
- Layer 4 - in “Internet style” TCP here
  - Handles ordering and “manageable pieces”
  - No addressing yet
- Layer 3 - IP
  - Path selection, “logical” addressing
- Layer 2 - physical addressing, flow control
- Layer 1 - electrical, etc. specifications

# Transmission over Internet



Note: “outgoing” and “incoming” from perspective of Host 1

# Transmission over Internet

- Previous / handout simplest case
- Goal in this section is to examine what happens at a rough and ready level what happens when a computer user tells a web browser to get <http://192.168.0.2/page.html>
- Some initial simplifications to state

# Transmission over Internet

- All connections are “category 5” (Cat5) Ethernet
- Switches and routers are each just that
- Hosts have only one network interface port
- Entire network is TCP/IP v4
- Routing and IP addresses are static
- IP addresses bound to one interface only
- DNS is not involved

# Transmission over Internet

- Enter URI in web browser, get:

```
GET /page.html HTTP/1.1 [CRLF]
Host: 192.168.0.2 [CRLF]
Connection: close [CRLF]
User-Agent: Safari [CRLF]
Accept-Encoding: gzip [CRLF]
Accept-Charset: ISO-8859-1, UTF-8; q=0.7, *; q=0.7 [CRLF]
Cache-Control: no [CRLF]
Accept-Language: de, en; q=0.7, en-us; q=0.3 [CRLF]
Referer: http://10.0.0.2/ [CRLF]
```

[CRLF]

- (Skip layer 5,6)

# Transmission over Internet

- Layer four *segment* the data and add meta data:  
20 bytes of header (TCP)
  - Source and destination ports
  - Sequence number
  - Checksum
  - etc.

# Transmission over Internet

- Layer three (IP):
  - Logical addresses (192.168.0.2, 10.0.0.2)
  - Encapsulation into a *packet*
  - Destination examined to determine route
  - “Sent” to layer two

# Transmission over Internet

- Layer two:
  - MAC (“physical”) addressing
  - Packet has metadata prepended and appended to form frame
  - Destination can be broadcast (if the switch is “unknown”) or its address
  - (As if) frame is converted to a signal and put on cable in appropriate physical fashion
  - Now cable engineer problem, then physics

# Transmission over Internet

- Frame arrives at switch
- Switching table or broadcast determines where to go (still layer 2)
- Arrive at router
- Packet *routing* based on layer 3 info (table)
- Finds route and then down to layer 2 for new frame
- Eventually gets passed back up to application layer with application (Apache, IIS)

# Transmission over Internet

- Warning: I have simplified a lot and breezed through repetitive steps
- Slides (if you are reading these and not listening) omit deliberately some of these
- Paper (or any textbook on networking) will have details
- Goal was to make the metaphysics (next) make some sort of sense



# Bunge's Metaphysics

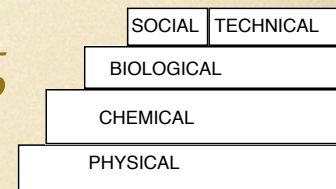
- Bunge's metaphysics here: volumes 3,4 of *Treatise* (1977, 1979) and *Emergence and Convergence* (2003)
- Goal: examine 3 areas where Bungeian metaphysics and the OSI model create interesting philosophical puzzles
- Common theme: is the OSI hierarchy one of emergence?

# Bunge's Metaphysics

- First area of puzzlement: **emergent properties**
- We are to look at theories for possible candidates (epistemic factor)
- But: no theories of networks - instead rules and guidelines and isolated statements of physics and engineering

# Bunge's Metaphysics

- Second area of puzzlement: where in the levels of reality do networking objects belong



- Centers around Bunge's theory of things
- “\*\*\* Signoff: Tyburn (Quit: It's only a stream of electrons. I know where I can get more. )”
- Quote illustrates the idea that a networking object could simply be a physical object
- But could be technical level too

# Bunge's Metaphysics

- But: hierarchy one of composition and emergence of properties
- But it seems that Internet would function for a while with no humans around
- Hence emergence
- Network objects composed out of bit sequences?

# Bunge's Metaphysics

- Possible view, but then frames are more complex objects than packets, since we talk as if the former has the latter as proper part
- So it looks like lower level networking items emerge out of the higher level ones
- Requires several assumptions

# Bunge's Metaphysics

- Paradoxical conclusion of the last slide needs several premisses
- Introduce some stipulations (handout 2)
- 3 states of a concrete system: 0, 1 and  $\epsilon$ .
- Bit string: semigroup on the sequence of states and an association operator (unspecified)
- Stream: temporal association
- Register: spatial association

# Bunge's Metaphysics

- The network objects (packets, frames) are thus bit strings that we can feign exist at once
- Note that these states are characterized functionally: they are (apparently) multiply realizable
- We thus do not have any idea from their composition where they belong in the hierarchy from this notion of composition

# Bunge's Metaphysics

- Returning to the hierarchy of emergence
- Looks like that the hierarchy not quite inverted, rather as  $1 < 7 < 6 < 5 < 4 < 3 < 2$ , where  $x < y$  means “y is composed of xs”)
- But what are things at lowest level? As said we don't know
- Could they be events not things? Open problem (cf. Douglas, Simons)

# Bunge's Metaphysics

- Final area of puzzlement: additional two Bunge-premisses to generate paradoxical conclusion about the OSI model and emergence
- Scientific realism
- Relational (?) persistence conditions for networking objects : really no frame on the cable ever in some cases at all

# Bunge's Metaphysics

- No persistence through time strictu sensu for Bunge
- But it seems that there is not even partial in the case of a first register bound string, then serially transmitted (as all are to some degree) one. Similar for change in media (electronic <-> fibre optic, etc.)
- Essentiality of origin? (Kripke) Not discussed by Bunge anywhere

# Summary

- We have met three families of related issues with Bunge-style views on the OSI model for computer networking
- Some of these point to interesting areas of incompleteness in his work
- Some are simply puzzles