2da Clase 15/3/2024

75.43 Introducción a los Sistemas Distribuidos
95.60 Redes y Aplicaciones Distribuidas
TA048 Redes

Tema: Capa de Aplicación

Capítulo 2 completo de *Computer Networking : A Top-Down Approach. James Kurose and Keith Ross. Publisher: Pearson Edition: 7th, 2016.*

Dr. Ing. J. Ignacio Alvarez-Hamelin

<u>Teórica (viernes 19-22)</u>

Dr. Ing. J. Ignacio Alvarez-Hamelin

<u>Práctica 1 (martes 19-22)</u>

JTP: Lic. Juan Ignacio López Pecora
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<u>Práctica 2 (jueves 19-22)</u>

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Ay.: Mag. Javier Scodelaro

- Dinámica de las clases
- Condiciones de aprobación y regularidad
- Código de conducta
- Reglamento de la materia (disponible en el campus)
- Herramientas: software libre, por ejemplo:
  - ⋆ **Wireshark** https://www.wireshark.org
  - ⋆ línea de comando *UNIX:* ping, traceroute, dig, ifconfig, netstat
- *Comunicación**: Campus** + **slack** + **e-mails***
- Bibliografía:
  - ❖ **Computer Networking : A Top-Down Approach. James Kurose and Keith Ross. Publisher: Pearson Edition: 7th, 2016.**
  - ❖ **RFCs (Request For Comments)**
  - ❖ **trabajos científicos**

Slack

Canal: #2024-1c

Aplicación

HTTP(S)
SMTP
FTP
SSH
CDNs
DNS
VPN
DHCP
LDAP

Transporte

SSL
TCP
UDP
QUIC

Red

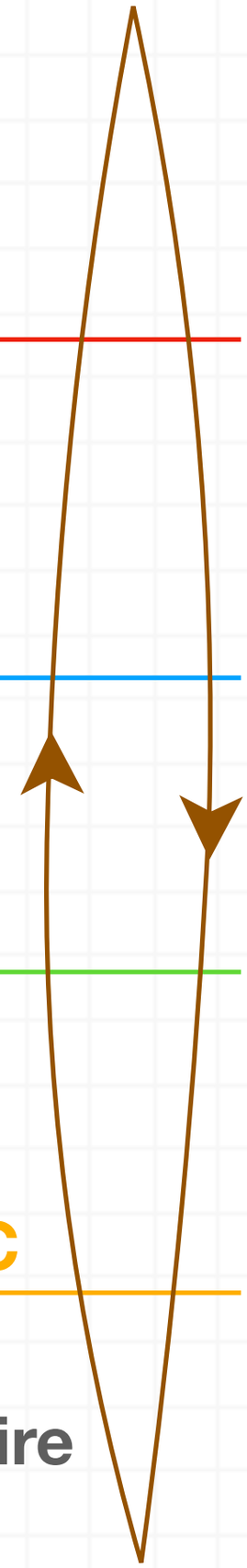
ICMP
IP

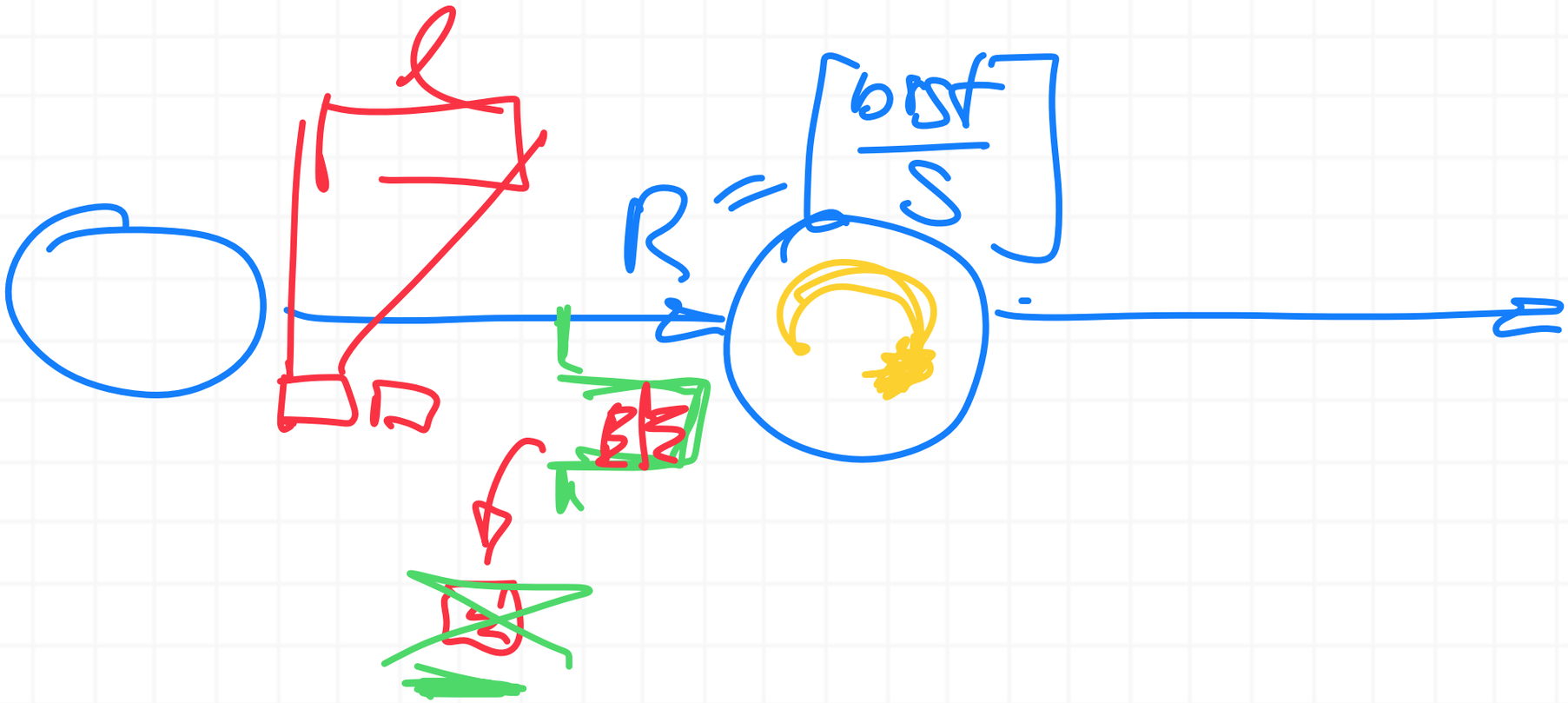
Enlace

Ethernet
Wi-Fi
Bluetooth
cablemodem
ADSL
NFC

Física

coaxial
aire
fibra óptica
UTP





T?

$$l = a.b \ [bits]$$

$$t_{insersión} = \frac{l\,[bits]}{R\left[\frac{bits}{s}\right]} = [s] \qquad t_{transmisión} = \frac{D\,[m]}{\frac{l}{3} \in \left[\frac{m}{s}\right]}$$

$$t_{Buffer} = \frac{k.l}{\uparrow} \qquad t_{procesamiento}$$

$$T = \sum_{}^{i} t_{insersión} + \sum_{}^{i} t_{transmisión} + \sum_{}^{u} t_{Buffer} + \sum_{}^{j} t_{proc.}$$

Las Aplicaciones son la razón de existir de Internet

Arquitecturas:

- Cliente-Servidor [datacenters]
- P2P

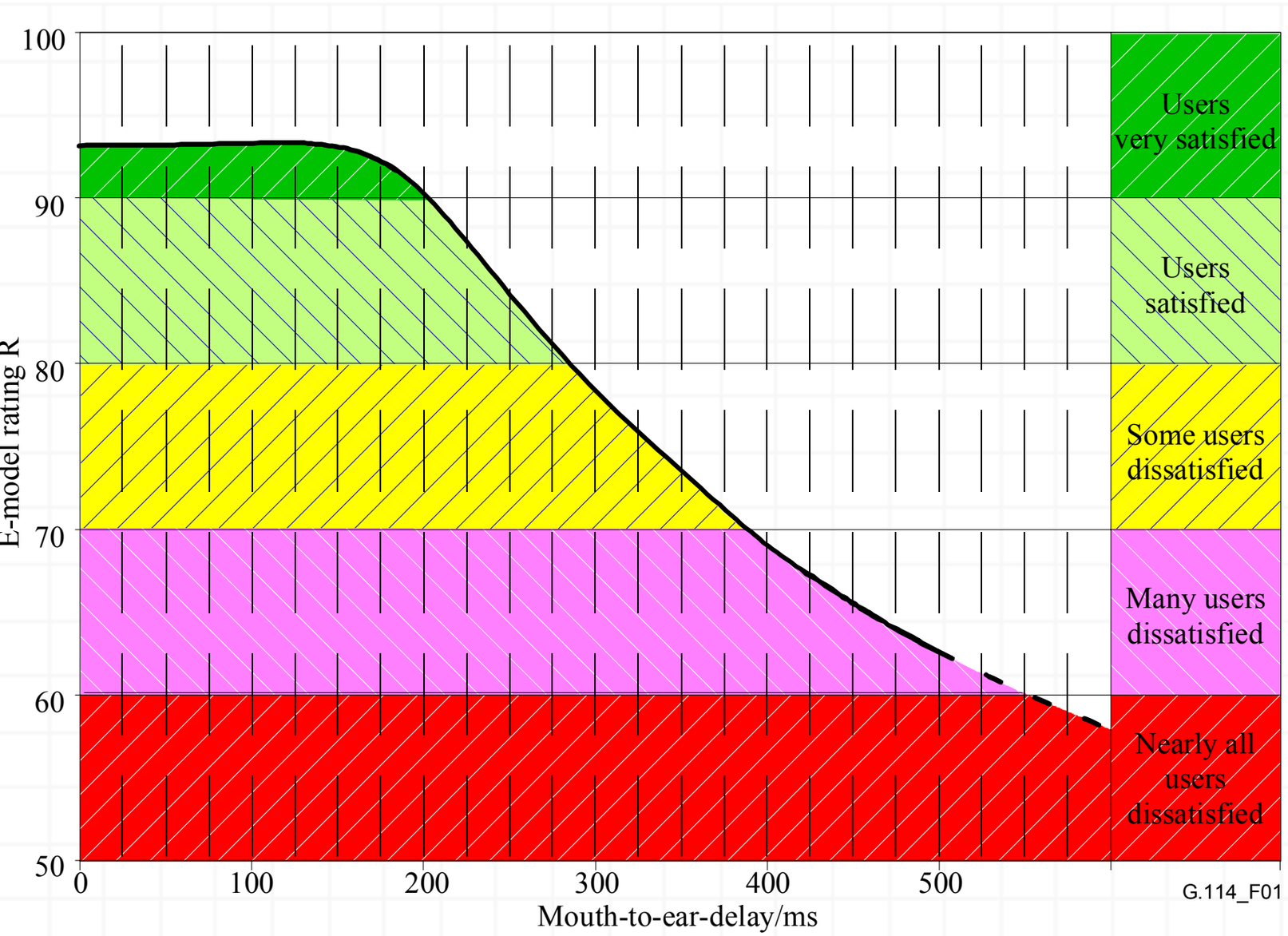
Comunicación entre procesos [mensajes, *socket()*, capa de transporte]

Características que ofrece el transporte:

- Transmisión confiable
- Caudal
- Sincronización
- Seguridad
- Con/sin pérdidas
- Conectado vs. desconectadas

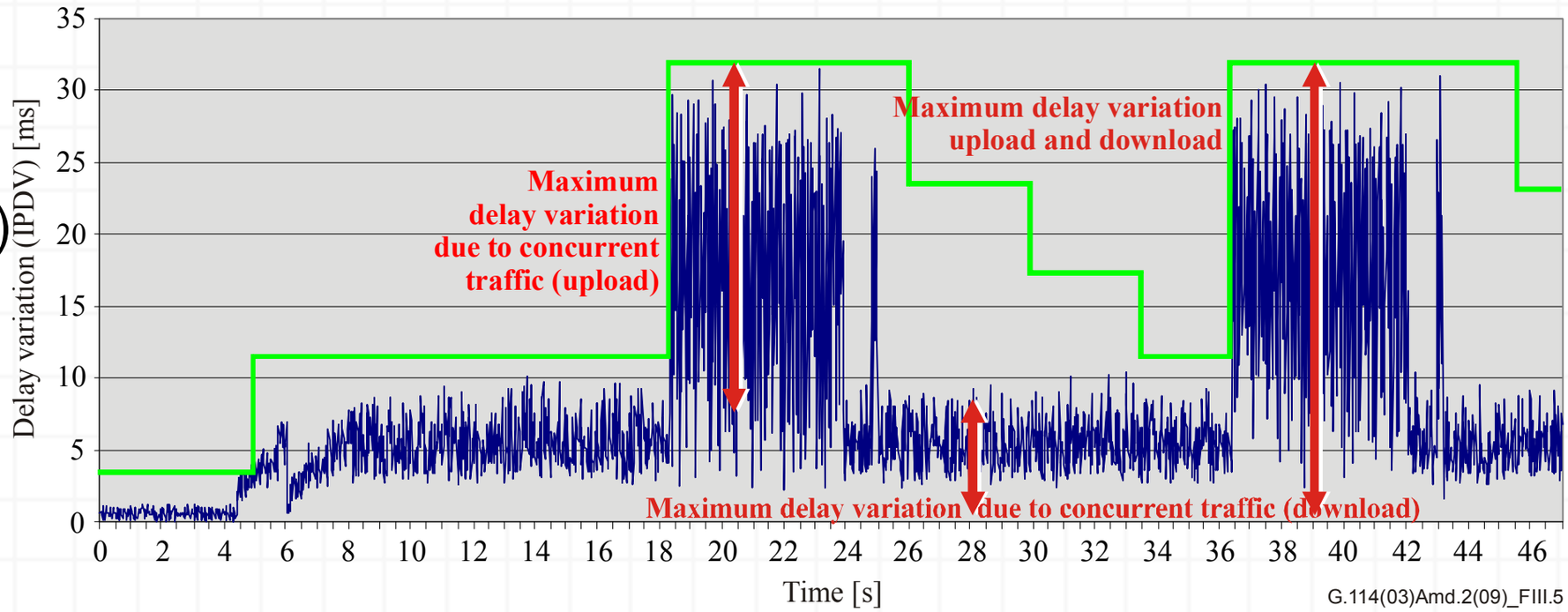
Paréntesis: Organismos Normalizadores

- IETF (Internet Engineer Task Force)
- ITU (International Telecommunication Union)
- W3C (World Wide Web Consortium)



Ejemplo: voz sobre IP (VoIP), en ITU-T Rec. G.114 (05/2003)

Ejemplo de jitter (variabilidad de la demora) en Rec. ITU-T G.114 (2003)/Amd.2 (11/2009)



Protocolo HTTP (HyperText Transfert Protocol)

- Aplicación Cliente-Servidor
- Permite transmitir texto formateado, imágenes, multimedia, etc.
- Conexiones: No-persistentes (1 conexión por elemento) vs. Persistentes (varios elementos por conexión)
- *Web Caching*

```
ihameli@aleph ~ % telnet 157.92.49.38 80
Trying 157.92.49.38...
Connected to www.fi.uba.ar.
Escape character is '^]'.
GET / HTTP/1.1
Host: www.fi.uba.ar
Connection: close
User-agent: Mozilla/5.0
Accept-language: en

HTTP/1.1 200 OK
Date: Tue, 14 Sep 2021 16:27:42 GMT
Server: Apache
X-Content-Type-Options: nosniff
Etag: "1631626276-0"
Content-Language: es
X-Frame-Options: SAMEORIGIN
X-UA-Compatible: IE=edge,chrome=1
Cache-Control: public, max-age=900
Last-Modified: Tue, 14 Sep 2021 13:31:16 GMT
Expires: Sun, 19 Nov 1978 05:00:00 GMT
Vary: Cookie,Accept-Encoding
Connection: close
Transfer-Encoding: chunked
Content-Type: text/html; charset=utf-8

24a0e
<!DOCTYPE html>
```

Wi-Fi: en0 (host 157.92.49.38)

Apply a display filter ... <⌘/>

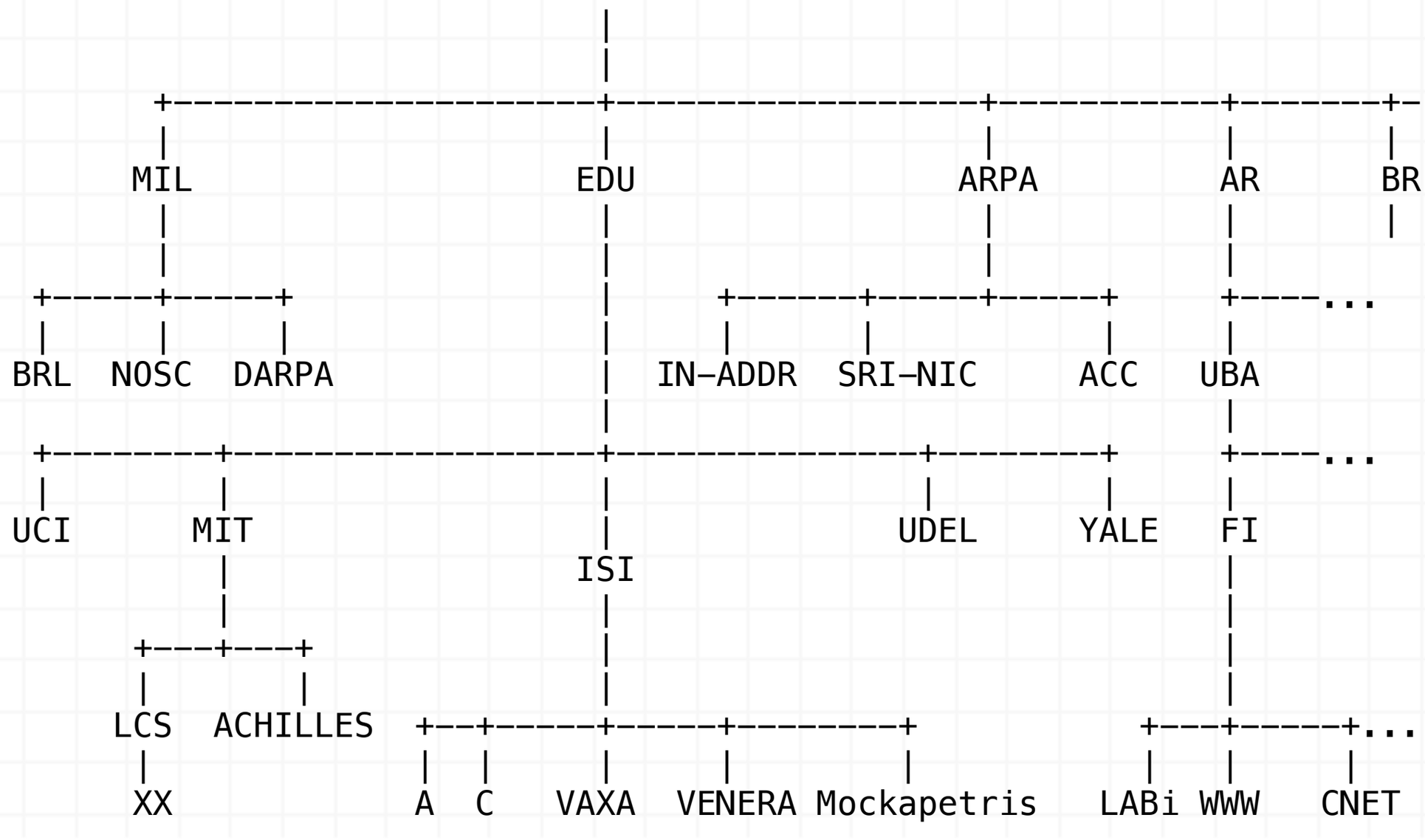
No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.0.7	157.92.49.38	TCP	78	63595 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=313275…
2	0.019424	157.92.49.38	192.168.0.7	TCP	74	80 → 63595 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1460 SACK_PE…
3	0.019555	192.168.0.7	157.92.49.38	TCP	66	63595 → 80 [ACK] Seq=1 Ack=1 Win=131712 Len=0 TSval=3132756109 TSe…
4	5.225987	192.168.0.7	157.92.49.38	TCP	82	[TCP segment of a reassembled PDU]
5	5.246400	157.92.49.38	192.168.0.7	TCP	66	80 → 63595 [ACK] Seq=1 Ack=17 Win=29056 Len=0 TSval=1989624540 TSe…
6	5.246522	192.168.0.7	157.92.49.38	TCP	131	[TCP segment of a reassembled PDU]
7	5.262516	157.92.49.38	192.168.0.7	TCP	66	80 → 63595 [ACK] Seq=1 Ack=82 Win=29056 Len=0 TSval=1989624544 TSe…
8	6.039389	192.168.0.7	157.92.49.38	TCP	87	[TCP segment of a reassembled PDU]
9	6.056451	157.92.49.38	192.168.0.7	TCP	66	80 → 63595 [ACK] Seq=1 Ack=103 Win=29056 Len=0 TSval=1989624743 TS…
10	11.0383…	192.168.0.7	157.92.49.38	HTTP	68	GET / HTTP/1.1
11	11.0718…	157.92.49.38	192.168.0.7	TCP	66	80 → 63595 [ACK] Seq=1 Ack=105 Win=29056 Len=0 TSval=1989625993 TS…
12	11.0718…	157.92.49.38	192.168.0.7	TCP	1514	[TCP segment of a reassembled PDU]
13	11.0719…	192.168.0.7	157.92.49.38	TCP	66	63595 → 80 [ACK] Seq=105 Ack=1449 Win=130304 Len=0 TSval=313276713…
14	11.0721…	157.92.49.38	192.168.0.7	TCP	1514	[TCP Previous segment not captured] [TCP segment of a reassembled …
15	11.0722…	192.168.0.7	157.92.49.38	TCP	78	[TCP Window Update] 63595 → 80 [ACK] Seq=105 Ack=1449 Win=130624 L…

```
Frame 10: 68 bytes on wire (544 bits), 68 bytes captured (544 bits) on interface 0
Ethernet II, Src: 8c:85:90:0e:5e:fe (8c:85:90:0e:5e:fe), Dst: a8:6a:bb:cb:f1:d4 (a8:6a:bb:cb:f1:d4)
Internet Protocol Version 4, Src: 192.168.0.7, Dst: 157.92.49.38
Transmission Control Protocol, Src Port: 63595 (63595), Dst Port: 80 (80), Seq: 103, Ack: 1, Len: 2
[4 Reassembled TCP Segments (104 bytes): #4(16), #6(65), #8(21), #10(2)]
Hypertext Transfer Protocol
  GET / HTTP/1.1\r\n
  Host: www.fi.uba.ar\r\n
  Connection: close\r\n
  User-agent: Mozilla/5.0\r\n
  Accept-language: en\r\n
  \r\n
  [Full request URI: http://www.fi.uba.ar/]
  [HTTP request 1/1]
```

wireshark_pcapng_en0_20210914132733_vgGJGn — Packets: 218 · Displayed: 218 (100.0%) · Dropped: 0 (0.0%) — Profile: Default

DNS (Domain Name System)

- Relación: **NOMBRE ⟺ @IP**
- Base de datos ***jerárquica*** y ***distribuida*** (punto de falla, múltiples consultas, administración distribuida)
- Otros servicios:
    - Host aliasing
    - Mail server aliasing
    - Load Distribution
- Ejemplo de TLDs (Top Level Domains):



Root servers en el mundo:

https://www.google.com/maps/d/viewer?mid=1LcHEpzl-7RzziWzDa4h3BxJcbEo&hl=en&usp=sharing

Tipos de consultas:

- Autorizadas o no
- Recursivas o iterativas
- Tipo:
    - A : nombre @IP
    - NS : Servidor DNS
    - CNAME: es el nombre canónico del host (puede tener muchos)
    - MX : Mail exchanger
    - SOA : *start of a zone of authority*
    - PTR : Pointer to Record

```
ihameli@aleph ~ % dig www.fi.uba.ar

; <<>> DiG 9.10.6 <<>> www.fi.uba.ar
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id:
15468
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0,
ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 512
;; QUESTION SECTION:
;www.fi.uba.ar.         INA

;; ANSWER SECTION:
www.fi.uba.ar.    3525 INA 157.92.49.38

;; Query time: 37 msec
;; SERVER: 8.8.8.8#53(8.8.8.8)
;; WHEN: Tue Sep 14 13:26:23 -03 2021
;; MSG SIZE  rcvd: 58
```

```
ihameli@aleph ~ % dig +trace  www.fi.uba.ar

; <<>> DiG 9.10.6 <<>> +trace www.fi.uba.ar
;; global options: +cmd
.       4351  IN NS m.root-servers.net.
.       4351  IN NS b.root-servers.net.
.       4351  IN NS c.root-servers.net.
```

Wi-Fi: en0 (port 53)

Apply a display filter ... <⌘/>

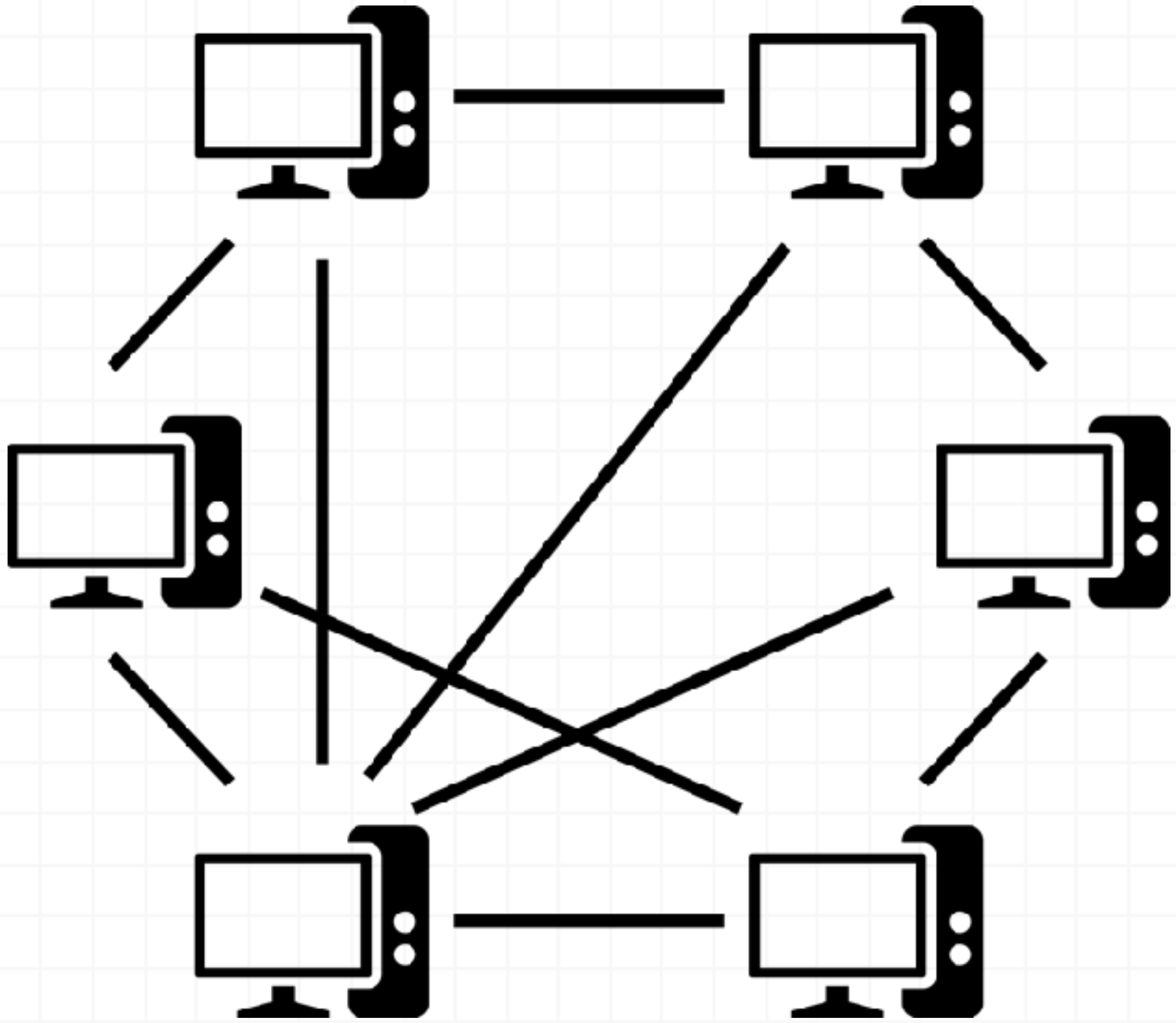
Expression...

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.0.7	8.8.8.8	DNS	70	Standard query 0x3e0c NS <Root> OPT
2	0.018767	8.8.8.8	192.168.0.7	DNS	567	Standard query response 0x3e0c NS <Root> NS m.root-servers.net NS b.root-servers.net…
3	0.022615	192.168.0.7	8.8.8.8	DNS	78	Standard query 0xe439 A m.root-servers.net
4	0.022773	192.168.0.7	8.8.8.8	DNS	78	Standard query 0xd04c AAAA m.root-servers.net

```
Domain Name System (query)
  [Response In: 2]
  Transaction ID: 0x3e0c
  Flags: 0x0020 Standard query
    0... .... .... .... = Response: Message is a query
    .000 0... .... .... = Opcode: Standard query (0)
    .... ..0. .... .... = Truncated: Message is not truncated
    .... ...0 .... .... = Recursion desired: Don't do query recursively
    .... .... .0.. .... = Z: reserved (0)
    .... .... ..1. .... = AD bit: Set
    .... .... ...0 .... = Non-authenticated data: Unacceptable
  Questions: 1
  Answer RRs: 0
  Authority RRs: 0
  Additional RRs: 1
  Queries
    <Root>: type NS, class IN
      Name: <Root>
      [Name Length: 0]
      [Label Count: 0]
      Type: NS (authoritative Name Server) (2)
      Class: IN (0x0001)
  Additional records
    <Root>: type OPT
      Name: <Root>
      Type: OPT (41)
      UDP payload size: 4096
      Higher bits in extended RCODE: 0x00
      EDNS0 version: 0
    Z: 0x8000
      1... .... .... .... = DO bit: Accepts DNSSEC security RRs
      .000 0000 0000 0000 = Reserved: 0x0000
      Data length: 0
```

wireshark_pcapng_en0_20210914134307_xEujdO Packets: 172 · Displayed: 172 (100.0%) Profile: Default

Arquitectura P2P (peer to peer)



The 360 Degree, CC BY-SA 4.0, via Wikimedia Commons

Para hacer (no es obligatorio): usar el comando “`dig`" con las opciones iterativa, autorizada y verborrágica capturando por la pantalla de la terminal y también mediante "`Wireshark`". Subirlo al Campus un informe en formato PDF.

Resumen:

Capa de Aplicación:

- necesidades
- interfases
- modelos de comunicaciones

HTTP: *(realizar captura con Wireshark)*

- arquitectura
- métodos
- proxy + caching

DNS: *(realizar captura con Wireshark)*

- arquitectura
- TLS
- propiedades

Consideraciones de las arquitecturas P2P

Próxima clase 22/4/2024: Capítulo 3, hasta *3.4 Principles of Reliable Data Transfer* inclusive.