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Indirizzamento nelle comunicazioni tra Processi

PORT NUMBERS

Le porte sono suddivise in 3 gruppi:

Well Known Ports: (0 – 1023) Sono le porte dei servizi di sistema

Registered Ports: (1024 – 49151) Sono assegnate da [Internet Corporation for Assigned Names and Numbers](#) per qualche uso specifico

Dynamic and/or Private Ports: (49152 – 65535)

Ref: di Calciolotti 7

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Ports

20/tcp

FTP - data

21/tcp

FTP - control

22/tcp

SSH - Secure login

23/tcp

Telnet

25/tcp

SMTP

53/tcp

DNS

53/udp

DNS

67/udp

BOOTP (Server) e DHCP (Server)

68/udp

BOOTP (Client) e DHCP (Client)

69/udp

TFTP

70/tcp

Gopher

80/tcp

HTTP

88/tcp

Kerberos Authenticating agent

110/tcp

POP3

123/udp

NTP

143/tcp

IMAP4

161/udp

SNMP (Agent)

162/udp

SNMP (Manager)

443/tcp

HTTPS

465/tcp

SMTP su SSL

993/tcp

IMAP4 su SSL

995/tcp

POP3 su SSL

Ref: di Calciolotti 8

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Requisiti delle applicazioni

- Fault Tolerance
- Throughput
- Time Constrain
- Security

Ref: di Calciolotti 9

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Requisiti delle applicazioni

Application	Data Loss	Throughput	Time-Sensitive
File transfer/download	No loss	Elastic	No
E-mail	No loss	Elastic	No
Web documents	No loss	Elastic (few kbps)	No
Internet telephony/ Video conferencing	Loss-tolerant	Audio: few kbps–1Mbps Video: 10 kbps–5 Mbps	Yes: 100s of msec
Streaming stored audio/video	Loss-tolerant	Same as above	Yes: few seconds
Interactive games	Loss-tolerant	Few kbps–10 kbps	Yes: 100s of msec
Instant messaging	No loss	Elastic	Yes and no

Sicurezza ????

Ref: di Calciolotti 10

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Servizi forniti da IP

UDP vs TCP

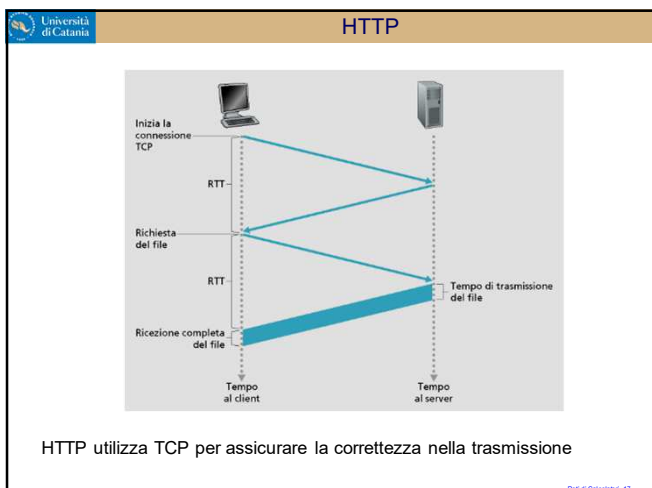
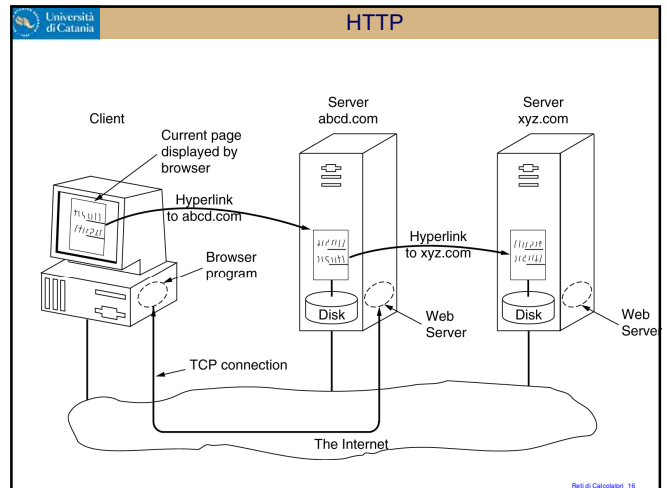
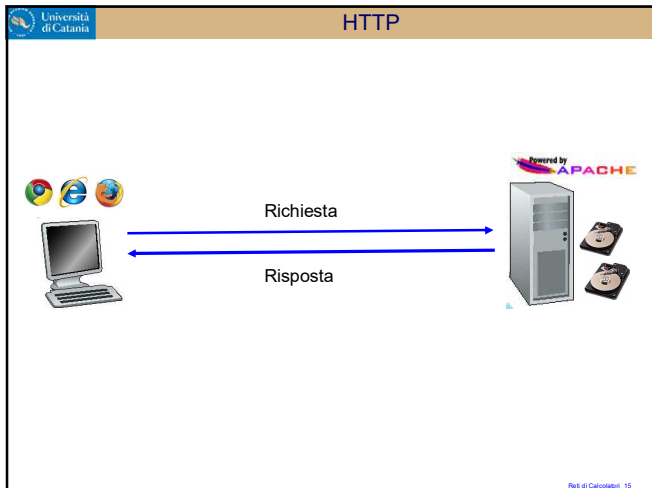
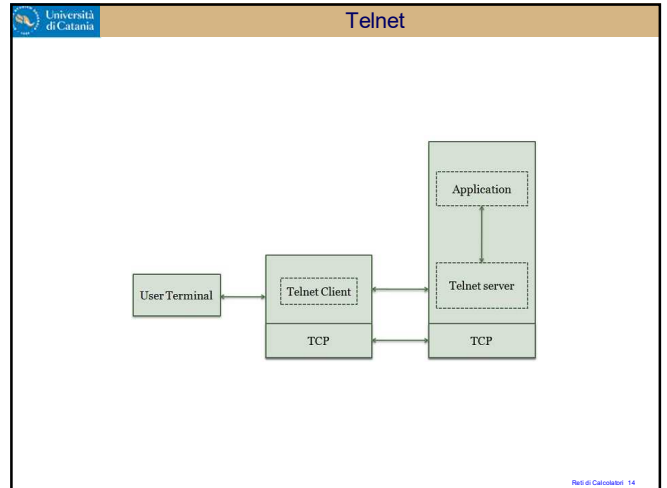
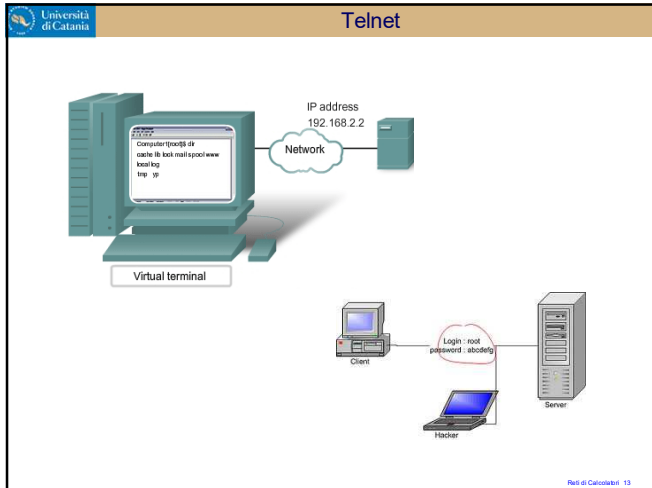
Application	Application-Layer Protocol	Underlying Transport Protocol
Electronic mail	SMTP [RFC 5321]	TCP
Remote terminal access	Telnet [RFC 854]	TCP
Web	HTTP [RFC 2616]	TCP
File transfer	FTP [RFC 959]	TCP
Streaming multimedia	HTTP (e.g., YouTube)	TCP
Internet telephony	SIP [RFC 3261], RTP [RFC 3550], or proprietary (e.g., Skype)	UDP or TCP

Ref: di Calciolotti 11

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Telnet

Ref: di Calciolotti 12



HTTP

Se la pagina HTML contiene riferimenti ad altri oggetti, questi vengono richiesti in seguito sempre attraverso HTTP.

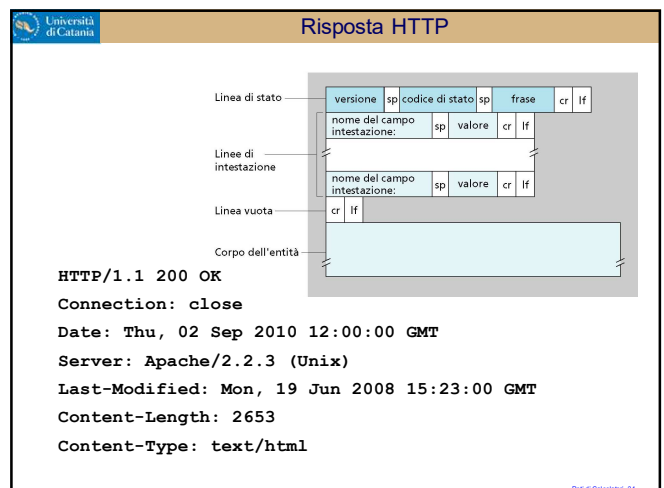
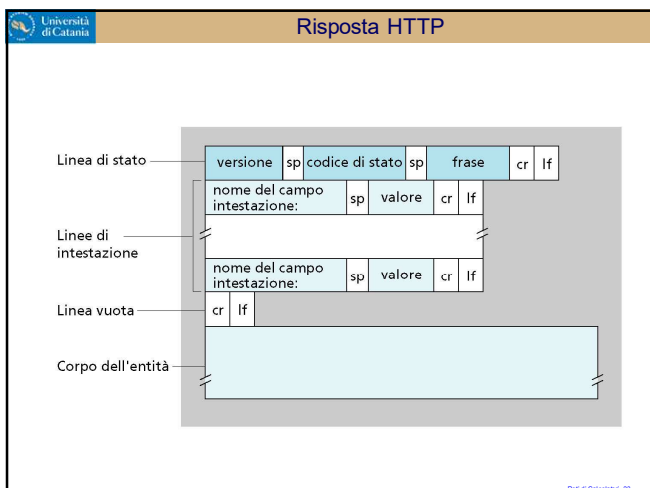
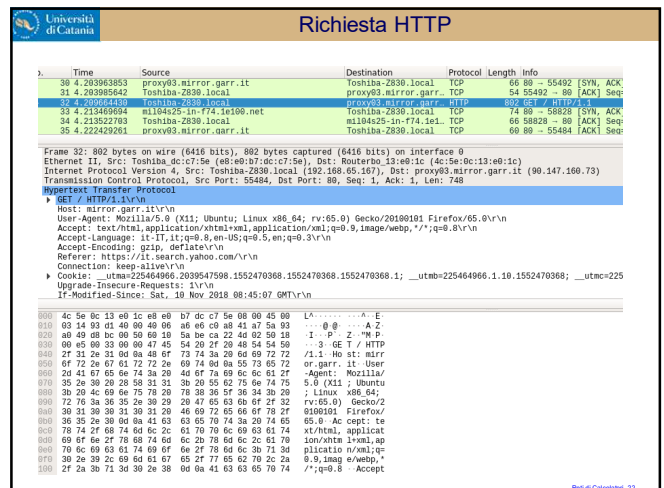
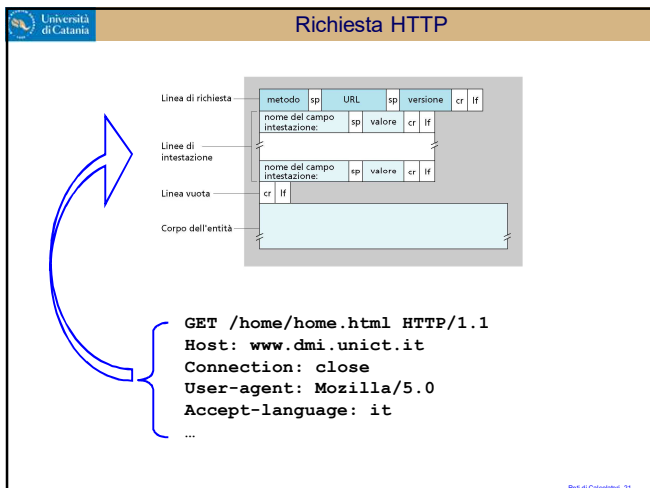
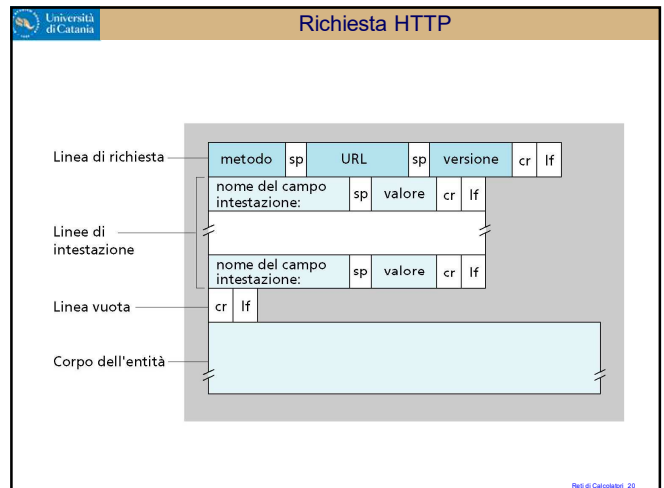
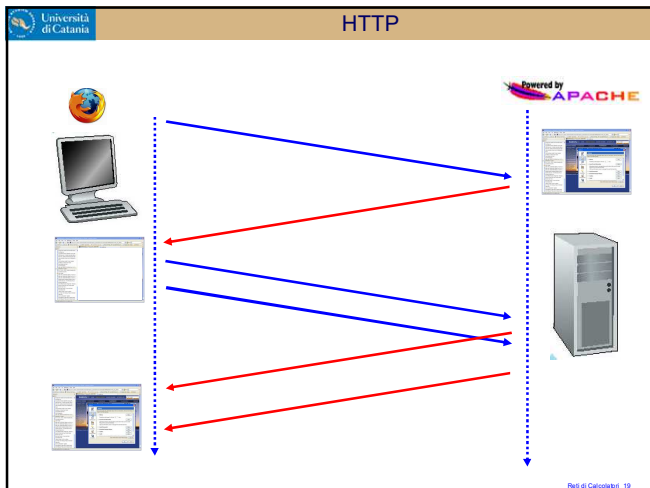
Gli oggetti successivi possono essere spediti sia in parallelo che sequenzialmente (http 1.0).

HTTP/1.0 chiude le sessioni TCP dopo il trasferimento di un singolo oggetto.

HTTP/1.1 usa connessioni TCP permanenti.

HTTP/2 usa la compressione delle intestazioni, consente invii «push» e download paralleli (RFC7540)

Reti di Calcolatori 18



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Risposta HTTP

Linea di stato

Linee di intestazione

Linea vuota

Corpo dell'entità

versione

sp

codice di stato

sp

frase

cr

If

nome del campo

sp

valore

cr

If

nome del campo

sp

valore

cr

If

cr

If

HTTP/1.1 400 Bad Request

Date: Tue, 11 Nov 2003 13:28:52 GMT

Server: Apache/1.3.26 (Unix) Debian GNU/Linux PHP/4.1.2

Connection: close

Content-Type: text/html; charset=iso-8859-1

Connessione all'host perduta.

Ref: Calabroli 25

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Risposta HTTP

Time

Source

Destination

Protocol

Length

Info

32 4.209654430

Toshiba-2838.local

proxy83.mirror.garr.it

HTTP

602

GET / HTTP/1.1

33 4.213409694

m104a25-in-774.1e109.net

Toshiba-2838.local

TCP

74

80 - 58828 [SYN, ACK] Seq=0 Ack=

34 4.213522783

Toshiba-2838.local

m104a25-in-774.1e109.net

TCP

66

58828 - 80 [ACK] Seq=1 Ack=1 Mi

35 4.222429261

proxy83.mirror.garr.it

Toshiba-2838.local

TCP

69

80 - 55484 [ACK] Seq=1 Ack=748

36 4.225559292

proxy83.mirror.garr.it

Toshiba-2838.local

HTTP

3392

HTTP/1.1 400 OK [text/html]

37 4.226035151

Toshiba-2838.local

proxy83.mirror.garr.it

TCP

54

55484 - 80 [ACK] Seq=169 Ack=55

Frame 36: 3392 bytes on wire (26416 bits), 3392 bytes captured (26416 bits) on interface 0

Ethernet II, Src: Routerbo,13:e8:1c (4c:5a:0c:13:e8:1c), Dst: Toshiba-de:c7:5e (e8-e8-b7-de:c7:5e)

Internet Protocol Version 4, Src: proxy83.mirror.garr.it (90.147.160.73), Dst: Toshiba-2838.local (192.168.65.187)

Transmission Control Protocol, Src Port: 80, Dst Port: 55484, Seq: 1, Ack: 749, Len: 3248

Hypertext Transfer Protocol

HTTP/1.1 200 OK\r\n

Server: nginx\r\n

Date: Wed, 13 Mar 2019 09:46:54 GMT\r\n

Content-Type: text/html\r\n

Content-Length: 2958\r\n

Connection: keep-alive\r\n

Last-Modified: Sat, 18 Nov 2018 08:45:07 GMT\r\n

ETag: "1ee9-57ab7c22c2e7-gzip"\r\n

Accept-Ranges: bytes\r\n

Vary: Accept-Encoding\r\n

Content-Encoding: gzip\r\n

\r\n

0000 e8 e0 b7 dc c7 5e 4c 5e 0c 13 e0 1c 88 00 45 00

0001 0c 09 ab 12 00 00 39 06 0c e1 5a 93 a8 49 c0 a8

0002 41 a7 00 50 08 bc ca 22 46 02 60 10 5d aa 50 18

0003 00 23 09 f7 00 00 48 54 54 50 2f 31 26 31 20 32

0004 30 30 28 ef 4a 0d 8a 53 65 72 76 05 72 3a 20 6e

0005 67 69 6e 78 0d 8a 44 61 74 65 3a 20 57 65 64 2c

0006 20 33 20 ad 61 72 28 32 30 31 39 20 39 3a

0007 34 30 3a 35 34 20 47 40 54 0a 9a 43 6f 6e 74 65

0008 6e 74 2d 54 79 78 65 3a 20 74 65 78 74 2f 68 74

0009 6d 6c 8d 8a 43 6f 6e 74 65 6e 74 2d 4c 05 6e 67

000a 74 68 3a 20 32 39 35 38 0d 0a 43 6f 6e 65 63

000b 74 69 6f 6e 6d 20 60 65 65 70 2d 61 6f 69 76 65

000c 6d 8a 4c 61 73 74 20 40 6f 64 69 66 69 65 64 3a

000d 20 53 61 74 2c 20 31 38 20 46 6f 76 29 32 30 31

000e 38 20 38 3a 34 35 3a 30 37 20 47 46 54 8d 8a

Ref: Calabroli 26

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Metodi HTTP

Method	Description
GET	Request to read a Web page
HEAD	Request to read a Web page's header
PUT	Request to store a Web page
POST	Append to a named resource (e.g., a Web page)
DELETE	Remove the Web page
TRACE	Echo the incoming request
CONNECT	Reserved for future use
OPTIONS	Query certain options

Ref: Calabroli 27

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Codici di errore HTTP

Information Codes

100 Continue

Success Codes

200 OK

203 Non-Authoritative Information

204 No Content

Redirection Codes

305 Use Proxy

Client Error Codes

400 Bad Request

403 Forbidden

404 Not Found

405 Method Not Allowed

Server Error Codes

500 Internal Server Error

505 HTTP Version not supported

Ref: Calabroli 28

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HTTP codes

Informational Status Codes

100 – Continue (The server is ready to accept more request data)

101 – Switching Protocols (The server has agreed to switch to the protocol indicated by the Upgrade header in the request)

102 – Processing (Reserved for future use)

Client Request Successful

200 – OK (The request has succeeded)

201 – Created (The request has been fulfilled and a new resource has been created)

202 – Accepted (The request has been accepted for processing, but the response may be returned at a later date)

203 – Non-Authoritative Information (The response is from a proxy or a cache or a temporary copy)

204 – No Content (The request has succeeded, but the response body is empty)

205 – Reset Content (The request has succeeded, and the user agent is asked to reset the form)

206 – Partial Content (The request has succeeded, and the user agent is asked to display a range of the resource)

Request Redirected

300 – Multiple Choices (The request has succeeded, but the user agent is asked to choose from multiple resources)

301 – Moved Permanently (The request has succeeded, and the user agent is asked to use the new URI for future requests)

302 – Moved Temporarily (The request has succeeded, but the user agent is asked to use the new URI for this request only)

303 – See Other (The request has succeeded, and the user agent is asked to use the new URI to retrieve the resource)

304 – Not Modified (The request has succeeded, and the user agent is asked to use the cached copy of the resource)

305 – Use Proxy (The request has succeeded, and the user agent is asked to use the proxy for future requests)

Client Request Incomplete

400 – Bad Request (The request could not be understood)

401 – Unauthorized (The request requires authentication)

402 – Payment Required (Reserved for future use)

403 – Forbidden (The request is forbidden)

404 – Not Found (The requested resource does not exist)

405 – Method Not Allowed (The requested method is not allowed)

406 – Not Acceptable (The requested media type is not acceptable)

407 – Proxy Authentication Required (The proxy requires authentication)

408 – Request Timeout (The request has timed out)

409 – Conflict (The request conflicts with the current state of the resource)

410 – Gone (The requested resource is no longer available)

411 – Length Required (The request must specify a length)

412 – Precondition Failed (The precondition is not satisfied)

413 – Request Entity Too Large (The request entity is too large)

414 – Request URI Too Long (The request URI is too long)

415 – Unsupported Media Type (The requested media type is not supported)

416 – Expected Range Not Satisfiable (The requested range is not satisfiable)

417 – Expectation Failed (The expectation is not met)

Server Errors

500 – Internal Server Error (The server has an error)

501 – Not Implemented (The server does not support the requested feature)

502 – Bad Gateway (The server received an invalid response from the upstream server)

503 – Service Unavailable (The server is overloaded or under maintenance)

504 – Gateway Timeout (The gateway timed out)

505 – HTTP Version Not Supported (The server does not support the requested HTTP version)

Unused status codes

306 – Switch Proxy (Reserved for future use)

416 – Expected range not satisfiable

506 – Redirection failed

Ref: Calabroli 29

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DHTML

User

Browser

Server

CGI script

Data base on disk

1

2

3

4

5

6

7

8

1. User fills in form

2. Form sent back

3. Handed to CGI

4. CGI queries DB

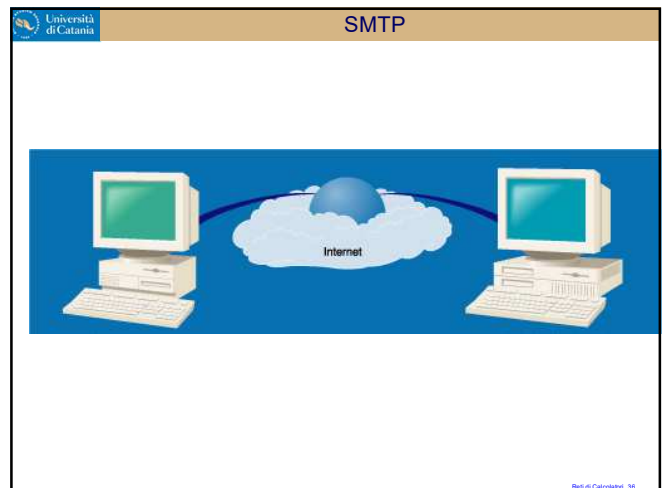
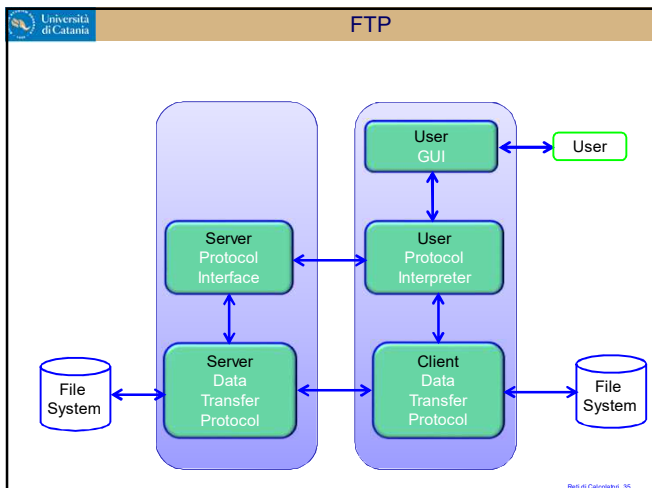
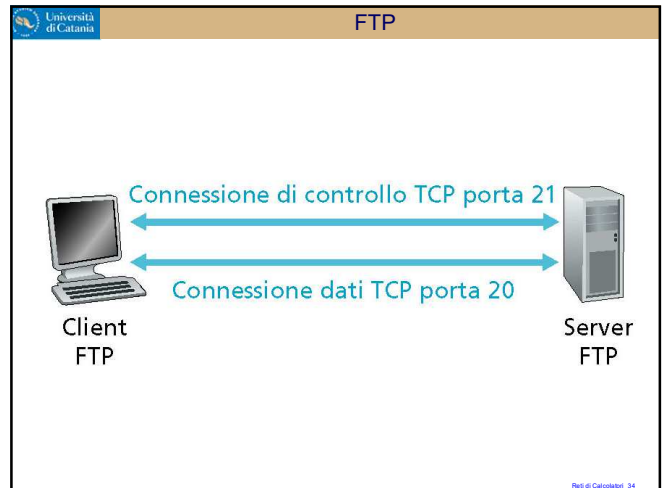
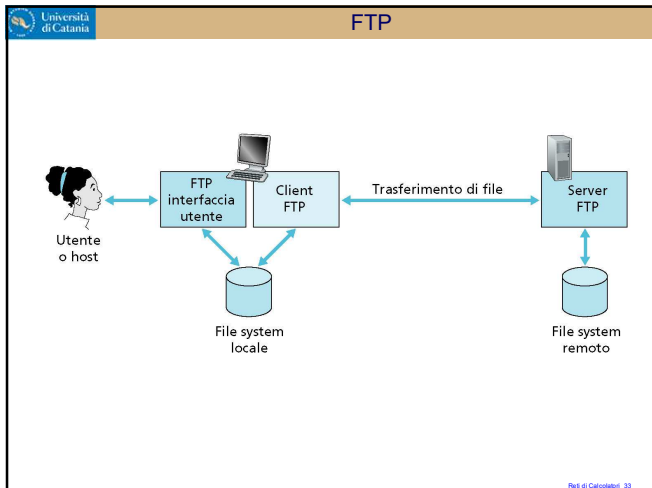
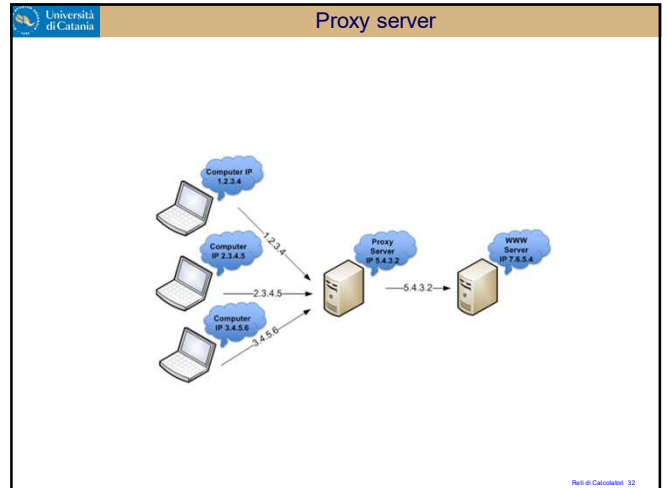
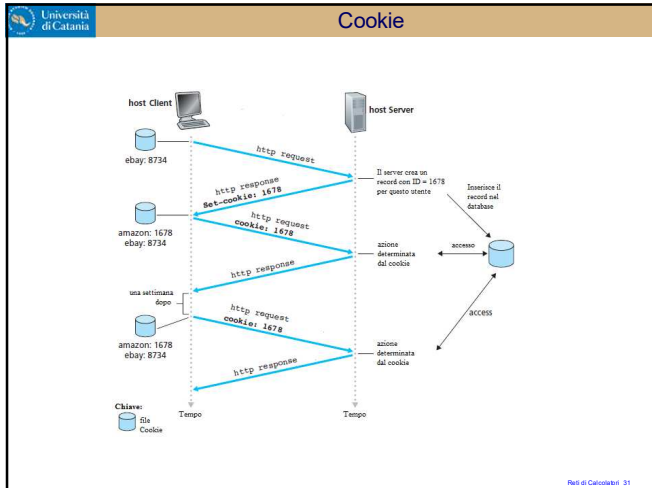
5. Record found

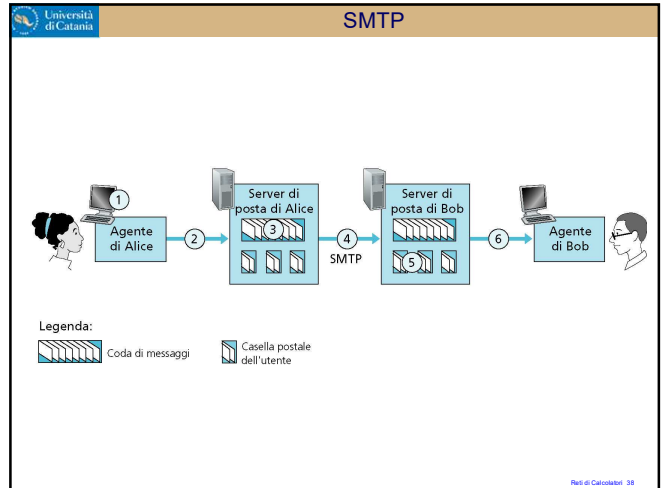
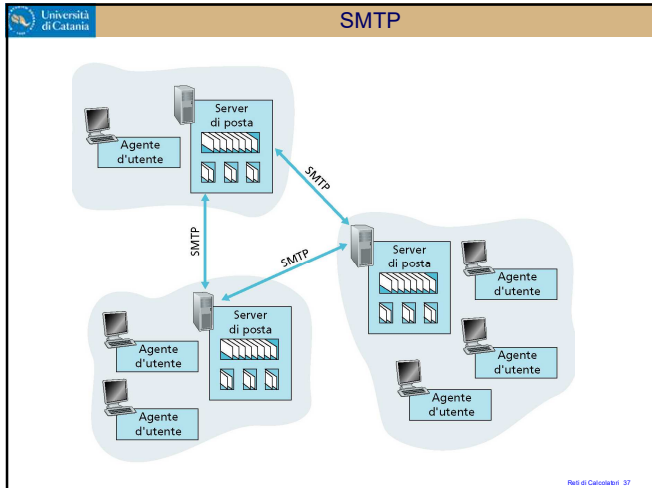
6. CGI builds page

7. Page returned

8. Page displayed

Ref: Calabroli 30





SMTP

```

S: 220 BBN-UNIX.ARPA Simple Mail Transfer Service Ready
C: HELO USC-ISIF.ARPA
S: 250 Hello BBN-UNIX.ARPA, pleased to meet you
C: MAIL FROM:<Smith@USC-ISIF.ARPA>
S: 250 OK
C: RCPT TO:<Jones@BBN-UNIX.ARPA>
S: 250 OK
C: RCPT TO:<Green@BBN-UNIX.ARPA>
S: 550 No such user here
C: RCPT TO:<Brown@BBN-UNIX.ARPA>
S: 250 OK
  
```

Ref: di Calabrese 39

SMTP

```

C: DATA
S: 354 Start mail input; end with <CRLF>.<CRLF>
C: Blah blah blah...
C: ...etc. etc. etc.
C: .
S: 250 OK
C: QUIT
S: 221 BBN-UNIX.ARPA Service closing transmission
channel
  
```

Ref: di Calabrese 40

SMTP

```

S: 220 USC-ISIF.ARPA Simple Mail Transfer Service Ready
C: HELO LBL-UNIX.ARPA
S: 250 USC-ISIF.ARPA
C: MAIL FROM:<mo@LBL-UNIX.ARPA>
S: 250 OK
C: RCPT TO:<fred@USC-ISIF.ARPA>
S: 251 User not local; will forward to <Jones@USC-
ISI.ARPA>
C: DATA
S: 354 Start mail input; end with <CRLF>.<CRLF>
C: Blah blah blah...
C: ...etc. etc. etc.
C: .
S: 250 OK
C: QUIT
S: 221 USC-ISIF.ARPA Service closing transmission
channel
  
```

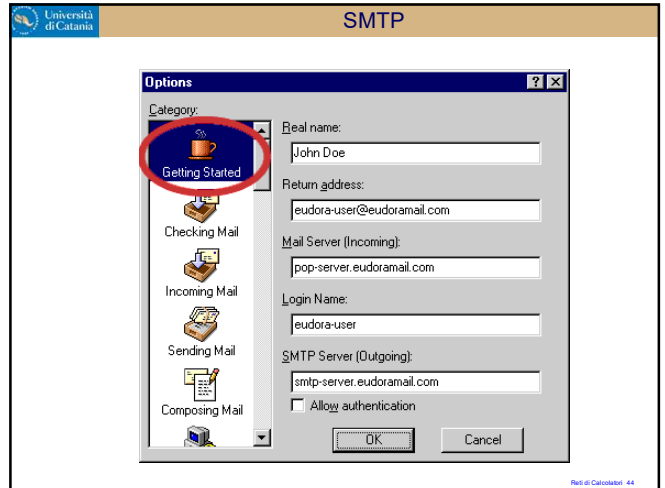
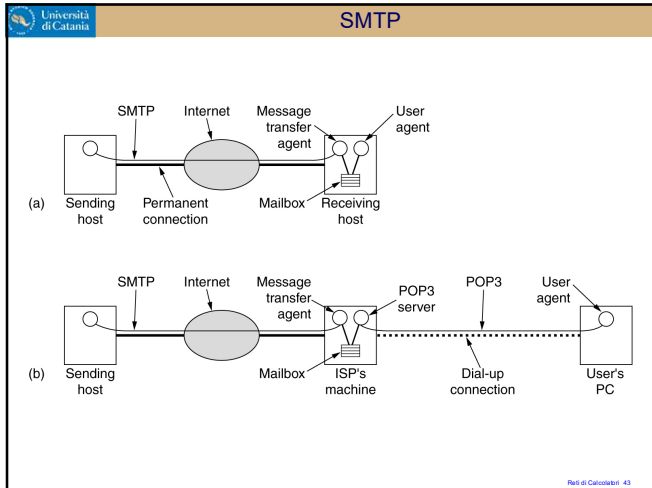
Ref: di Calabrese 41

SMTP

```

S: 220 xyz.com SMTP service ready
C: HELO abcd.com
S: 250 xyz.com says hello to abcd.com
C: MAIL FROM:<elino@abcd.com>
S: 250 sender ok
C: RCPT TO:<carolyn@xyz.com>
S: 250 recipient ok
C: DATA
S: 354 Send mail; end with "." on a line by itself
C: From: elino@abcd.com
C: To: carolyn@xyz.com
C: MIME-Version: 1.0
C: Message-Id: <0704760941.AA00747@abcd.com>
C: Content-Type: multipart/alternative; boundary=qwertyuopasdgjhkizxcvbnm
C: Subject: Earth orbits sun integral number of times
C:
C: This is the preamble. The user agent ignores it. Have a nice day.
C:
C: --qwertyuopasdgjhkizxcvbnm
C: Content-Type: text/enriched
C:
C: Happy birthday to you
C: Happy birthday to you
C: Happy birthday dear <bold>Carolyn </bold>
C: Happy birthday to you
C:
C: --qwertyuopasdgjhkizxcvbnm
C: Content-Type: message/external-body;
  access-type="anon-ftp";
  site="bicycle.abcd.com";
  directory="pub";
  name="birthday.snd"
C:
C: content-type: audio/basic
C: content-transfer-encoding: base64
C: --qwertyuopasdgjhkizxcvbnm
C:
C: S: 250 message accepted
C: QUIT
S: 221 xyz.com closing connection
  
```

Ref: di Calabrese 42



SMTP

Header	Meaning
To:	E-mail address(es) of primary recipient(s)
Cc:	E-mail address(es) of secondary recipient(s)
Bcc:	E-mail address(es) for blind carbon copies
From:	Person or people who created the message
Sender:	E-mail address of the actual sender
Received:	Line added by each transfer agent along the route
Return-Path:	Can be used to identify a path back to the sender

Ref: di Calabrese 45

SMTP

Header	Meaning
Date:	The date and time the message was sent
Reply-To:	E-mail address to which replies should be sent
Message-Id:	Unique number for referencing this message later
In-Reply-To:	Message-Id of the message to which this is a reply
References:	Other relevant Message-Ids
Keywords:	User-chosen keywords
Subject:	Short summary of the message for the one-line display

Ref: di Calabrese 46

POP

```

S: +OK POP3 server ready
C: USER carolyn
S: +OK
C: PASS vegetables
S: +OK login successful
C: LIST
S: 1 2505
S: 2 14302
S: 3 8122
S: .
C: RETR 1
S: (sends message 1)
C: DELE 1
C: RETR 2
S: (sends message 2)
C: DELE 2
C: RETR 3
S: (sends message 3)
C: DELE 3
C: QUIT
S: +OK POP3 server disconnecting
  
```

Ref: di Calabrese 47

POP e IMAP

Feature	POP3	IMAP
Where is protocol defined?	RFC 1939	RFC 2060
Which TCP port is used?	110	143
Where is e-mail stored?	User's PC	Server
Where is e-mail read?	Off-line	On-line
Connect time required?	Little	Much
Use of server resources?	Minimal	Extensive
Multiple mailboxes?	No	Yes
Who backs up mailboxes?	User	ISP
Good for mobile users?	No	Yes
User control over downloading?	Little	Great
Partial message downloads?	No	Yes
Are disk quotas a problem?	No	Could be in time
Simple to implement?	Yes	No
Widespread support?	Yes	Growing

Ref: di Calabrese 48

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DNS

151.97.240.18
151.97.240.4
151.97.6.236
151.97.252.132

www.dmi.unict.it
www.unict.it
www.ing.unict.it
galileo.dmi.unict.it

Ref: di Calabrese 49

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DNS

Server dei nomi radicale

2

5

Server dei nomi locale
dns.eurecom.fr

1

6

Host richiedente
surf.eurecom.fr

Server dei nomi assoluto
dns.umass.edu

4

3

gaia.cs.umass.edu

Ref: di Calabrese 50

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DNS

a. NSI Herndon, VA
c. PSInet Herndon, VA
d. U Maryland College Park, MD
g. DISA Vienna, VA
h. ARL Aberdeen, MD
e. NASA Mt View, CA
f. Internet Software C. Palo
b. USC-ISI Marina del Rey, CA
I. ICANN Marina del Rey, CA

i. NORDUnet Stockholm
k. RIPE London
m. WIDE Tokyo

DNS root servers (13)

Ref: di Calabrese 51

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DNS

Server dei nomi radicale

2

7

Server dei nomi locale
dns.eurecom.fr

1

8

Host richiedente
surf.eurecom.fr

Server dei nomi intermedio
dns.ce.umass.edu

6

3

Server dei nomi assoluto
dns.ce.umass.edu

5

4

gaia.cs.umass.edu

Ref: di Calabrese 52

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DNS

Server dei nomi radicale

2

3

Richiesta iterativa

Server dei nomi locale
dns.eurecom.fr

1

8

Host richiedente
surf.eurecom.fr

Server dei nomi intermedio
dns.ce.umass.edu

4

7

Server dei nomi assoluto
dns.ce.umass.edu

5

6

gaia.cs.umass.edu

Ref: di Calabrese 53

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DNS

Root Servers

Step 2

Question: where can I find the IP Address of some-webserver.com?

Not authoritative for some-webserver.com

Step 1

Question: what is the IP Address of some-webserver.com?

User's Primary DNS Server (Recursion Allowed)

Step 8

Answer: Here is the IP Address of some-webserver.com

User's PC

My IP Address

Primary DNS Server of some-webserver.com

Step 7

Answer: Here is the IP Address of some-webserver.com

Step 6

Question: What is the IP Address of some-webserver.com?

Step 5

Answer: Primary DNS Server of some-webserver.com knows it.

Step 4

Question: What is the IP Address of some-webserver.com?

Step 3

Answer: I don't know but .com NameSpace should have the answer

Step 2

Question: where can I find the IP Address of some-webserver.com?

Ref: di Calabrese 54

DNS	
Identificazione	Etichette
Numero di domande	Numero RR di risposta
Numero di RR assoluti	Numero di RR aggiuntivi
Domande (numero di domande variabile)	
Risposte (numero variabile di record di risorse)	
Assoluti (numero variabile di record di risorse)	
Informazioni aggiuntive (numero variabile di record di risorse)	

12 byte

Nomi, tipi di campi per una richiesta

RR in risposta a una richiesta

Record di server assoluti

Informazioni aggiuntive "utili" che possono essere usate

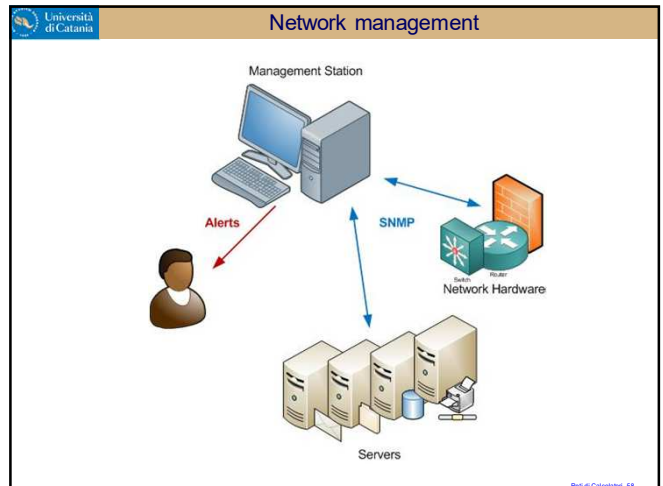
Record DNS	
A	corrispondenza tra un nome ed un indirizzo IPv4
AAAA	corrispondenza tra un nome ed un indirizzo IPv6
CNAME	alias dell'host
PTR	risoluzione inversa (IP -> nome)
MX	(Mail eXchange) server e-mail per il dominio
SRV	server per un dato servizio
NS	(Name Server) server DNS autoritativo
SOA	(Start of Authority) gestione delle zone DNS.
TXT	Testo

Record DNS

```

;; QUESTION SECTION:
www.google.it.      IN      A
;; ANSWER SECTION:
www.google.it.      190592 IN      CNAME   www.google.com.
www.google.com.     431593 IN      CNAME   www.l.google.com.
www.l.google.com.   111      IN      A       74.125.39.147
www.l.google.com.   111      IN      A       74.125.39.99
www.l.google.com.   111      IN      A       74.125.39.103
www.l.google.com.   111      IN      A       74.125.39.104
;; AUTHORITY SECTION:
l.google.com.        7217 IN      NS      e.l.google.com.
l.google.com.        7217 IN      NS      f.l.google.com.
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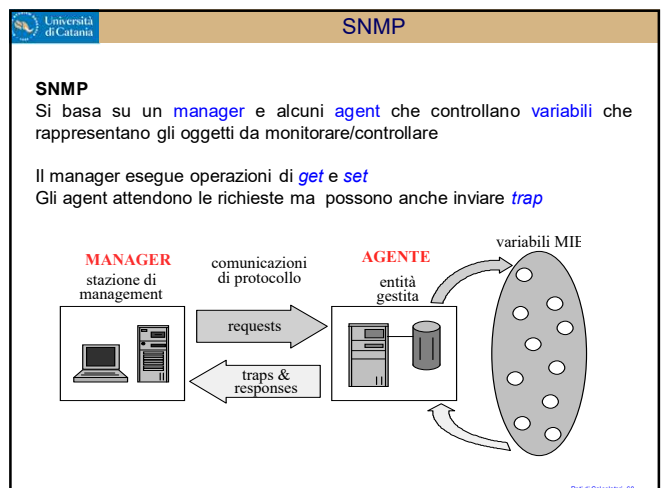


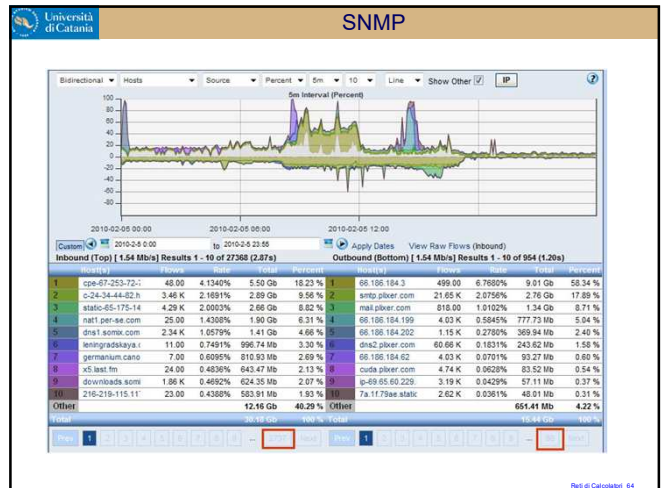
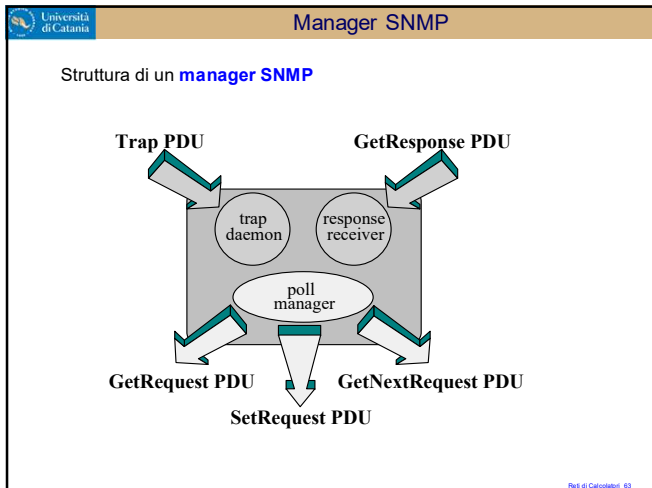
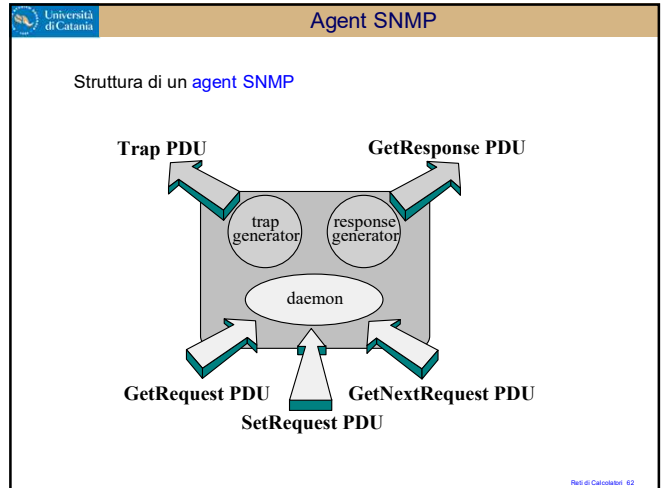
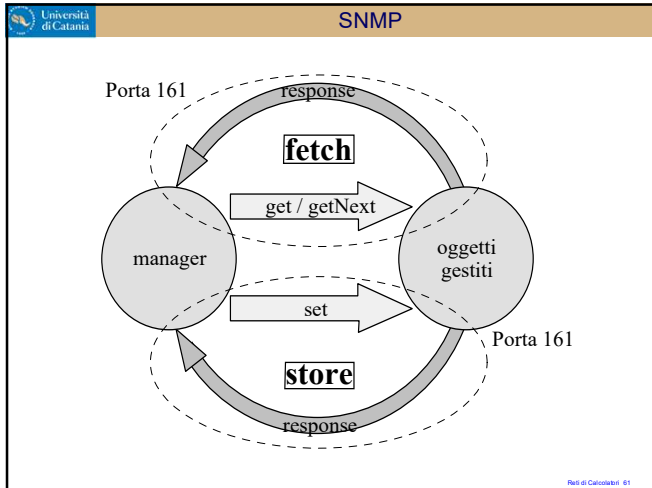
SNMP

SNMP Simple Network Management Protocol

SNMP è stato oggetto di vari aggiornamenti e reingegnerizzazioni

- per tenere conto di esigenze di sicurezza
- per tenere conto di modelli di gestione flessibili
- per tenere conto di sistemi legacy esistenti
- ...
- e per potere gestire non solo apparati, ma entità di qualunque tipo





SNMPv1

Estrema semplicità e Limitata espressività
Solo aree di **configuration** management (**fault**)
Limitata previsione dei trap (azioni iniziate dall'oggetto)

SNMPv2

Superamento del C/S con gerarchia di manager agent

SNMPv3

Introduzione della sicurezza **S-SNMP**
si trattano i problemi di integrità delle informazioni (anche stream),
masquerading, privacy (prevenire disclosure)
non si trattano denial of service e analisi del traffico