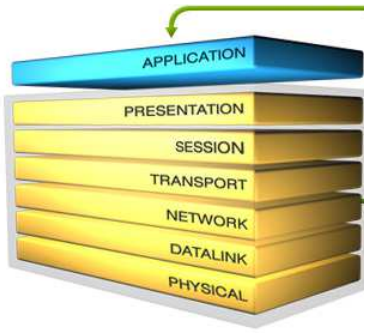
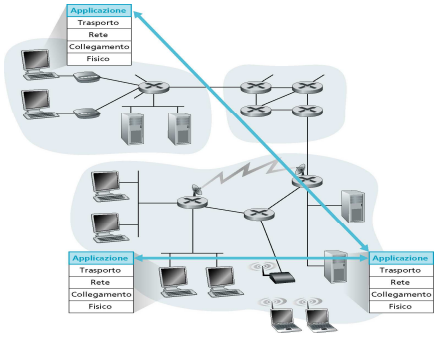
Le Applicazioni

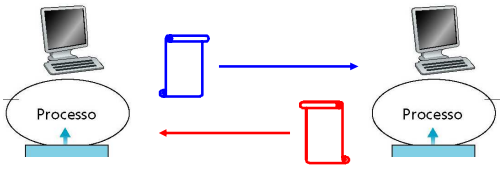


Comunicazioni tra Processi



Le applicazioni richiedono dalla rete un canale bidirezionale affidabile per scambiarsi messaggi.

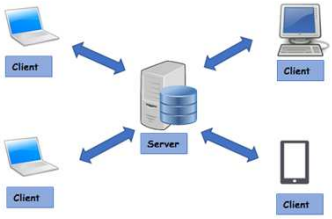
Comunicazioni tra Processi



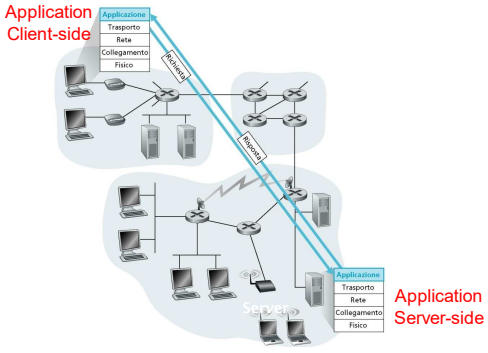
In un sistema distribuito, due processi remoti possono procedere in parallelo solo se riescono a **sincronizzarsi** tra loro.

Lo scambio di messaggi consente la sincronizzazione.

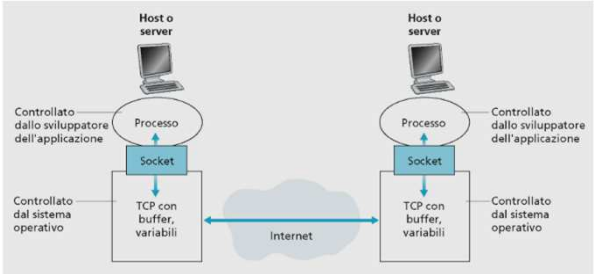
Modello Client – Server



Modello Client - Server



Indirizzamento nelle comunicazioni tra Processi



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)

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

Requisiti delle applicazioni

- Fault Tolerance
- Throughput
- Time Constrain
- Security

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

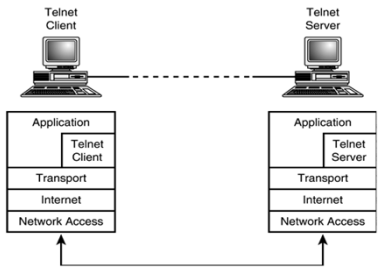
Sicurezza ????

Servizi forniti da IP

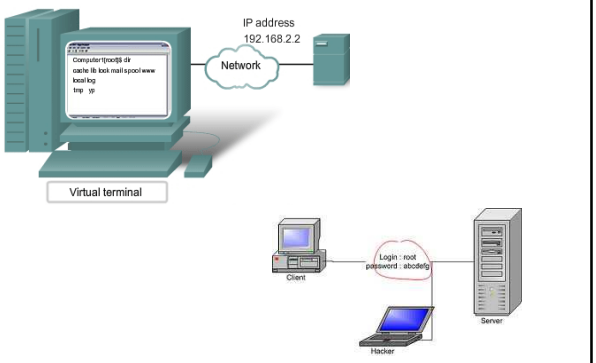
UDP vs TCP

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

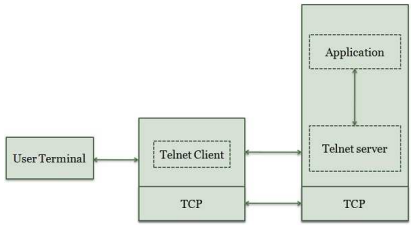
Telnet



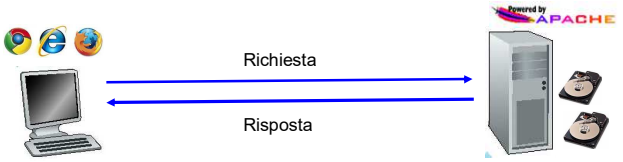
Telnet



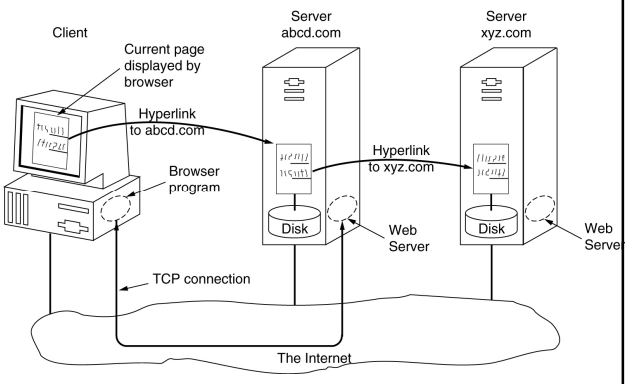
Telnet



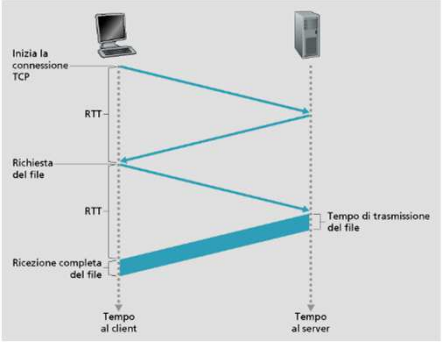
HTTP



HTTP



HTTP



HTTP utilizza TCP per assicurare la correttezza nella trasmissione

HTTP

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

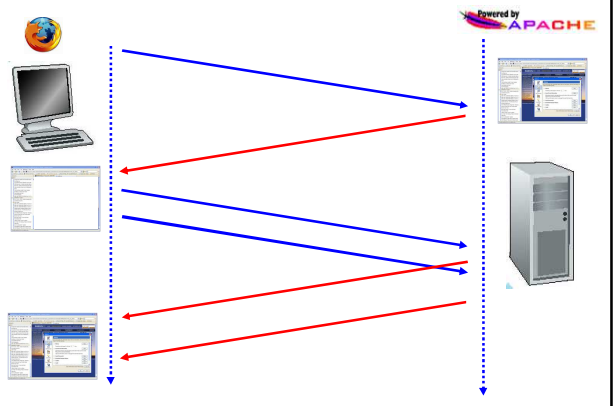
Gli oggetti successivi possono essere spediti sia in parallelo che sequenzialmente (http 1.0) .

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

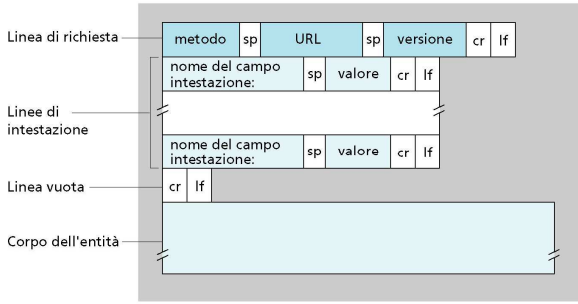
HTTP/1.1 usa connessioni TCP permanenti.

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

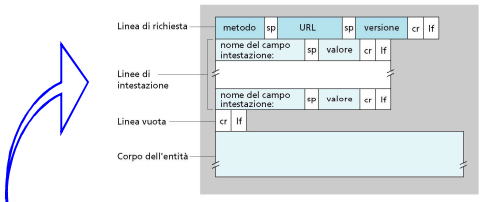
HTTP



Richiesta HTTP

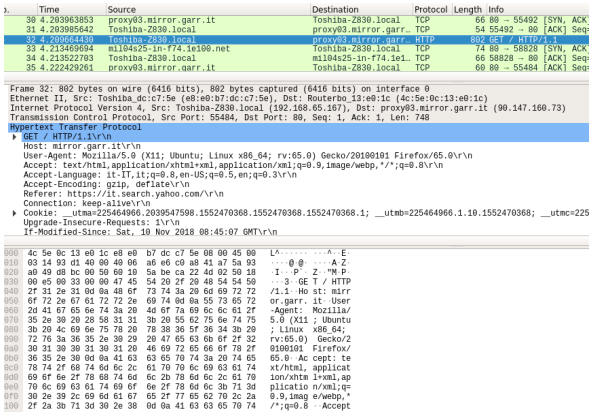


Richiesta HTTP

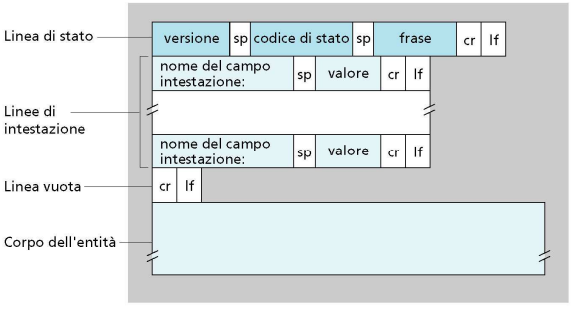



```
GET /home/home.html HTTP/1.1
Host: www.dmi.unict.it
Connection: close
User-agent: Mozilla/5.0
Accept-language: it
...
```

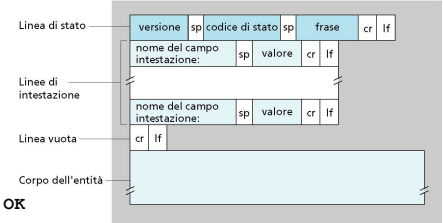

Richiesta HTTP



Risposta HTTP

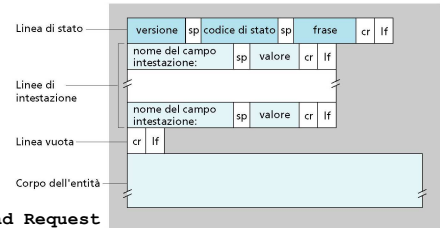


Risposta HTTP




```
HTTP/1.1 200 OK
Connection: close
Date: Thu, 02 Sep 2010 12:00:00 GMT
Server: Apache/2.2.3 (Unix)
Last-Modified: Mon, 19 Jun 2008 15:23:00 GMT
Content-Length: 2653
Content-Type: text/html
```

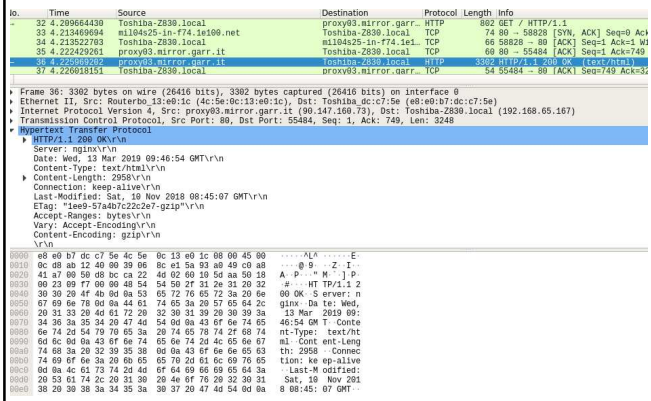
Risposta HTTP




```
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.
```


Risposta HTTP



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

Codici di errore HTTP

Information Codes
- 100 Continue

Success Codes
- 200 OK
- 203 Non-Authoritative Information
- 204 No Content

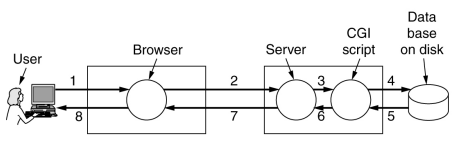
Redirection Codes
- 305 Use Proxy

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

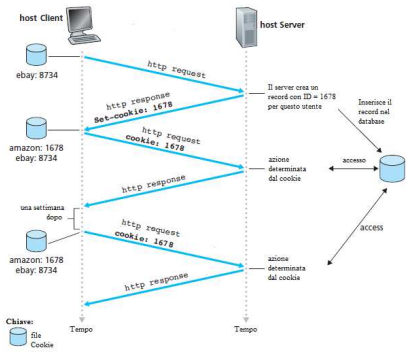
HTTP codes

DHTML

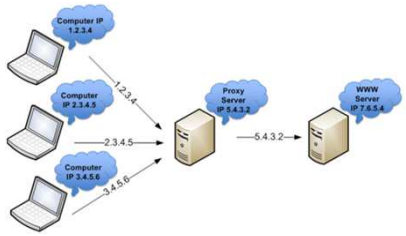


1. User fills in form
2. Form sent back
3. Handed to CGI
4. CGI queries DB
5. Record found
6. CGI builds page
7. Page returned
8. Page displayed

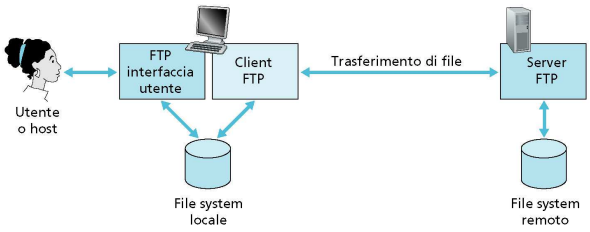
Cookie



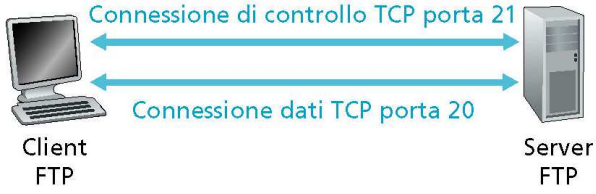
Proxy server



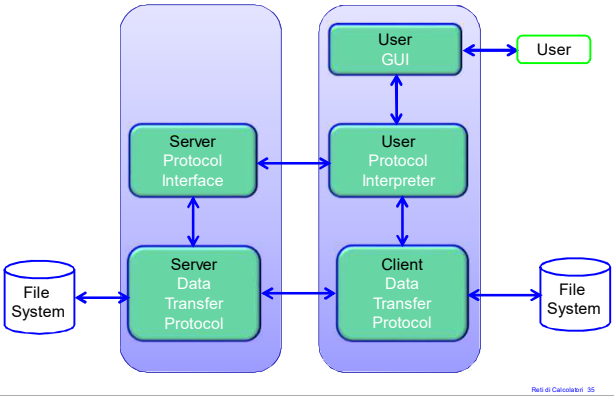
FTP



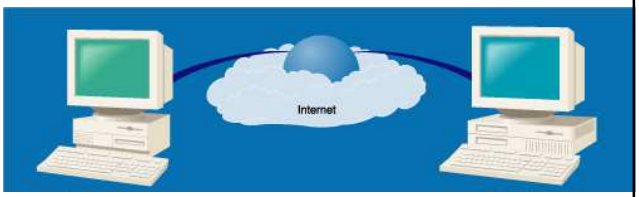
FTP



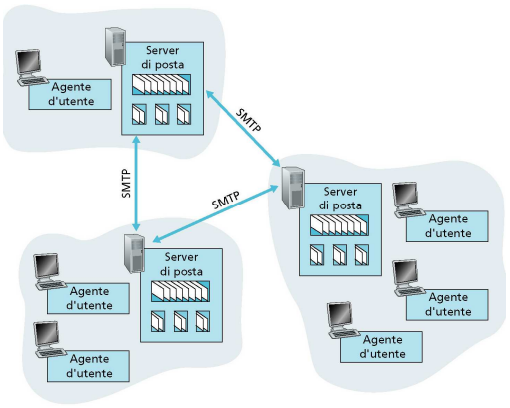
FTP



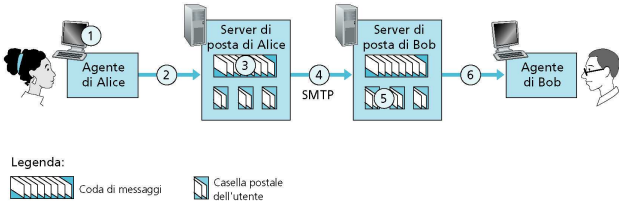
SMTP



SMTP



SMTP



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
```


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
```

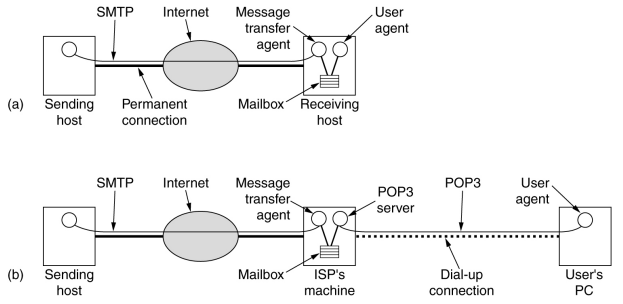

SMTP

```
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
```


SMTP

```
                S: 220 xyz.com SMTP service ready
C: HELO abcd.com
                S: 250 xyz.com says hello to abcd.com
C: MAIL FROM: <elinor@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: elinor@abcd.com
C: To: carolyn@xyz.com
C: MIME-Version: 1.0
C: Message-Id: <07047609 41.AA00747@abcd.com>
C: Content-Type: multipart/alternative; boundary=qwertyuiopasdfghjklzxcvbnm
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: --qwertyuiopasdfghjklzxcvbnm
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: --qwertyuiopasdfghjklzxcvbnm
C: Content-Type: message/external-body;
C:      access-type="anon-ftp";
C:      site="bicycle.abcd.com";
C:      directory="pub";
C:      name="birthday.snd"
C:
C: content-type: audio/basic
C: content-transfer-encoding: base64
C: --qwertyuiopasdfghjklzxcvbnm
C: .
                S: 250 message accepted
C: QUIT
                S: 221 xyz.com closing connection
```

SMTP



SMTP

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

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

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
```

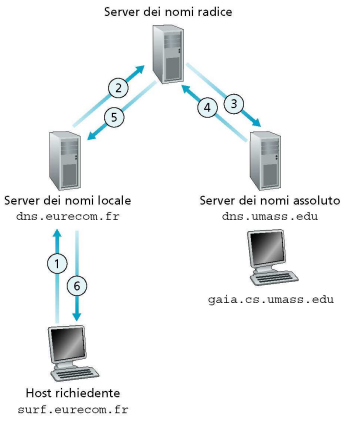

POP e IMAP

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

DNS

151.97.240.18	www.dmi.unict.it
151.97.240.4	www.unict.it
151.97.6.236	www.ing.unict.it
151.97.252.132	galileo.dmi.unict.it

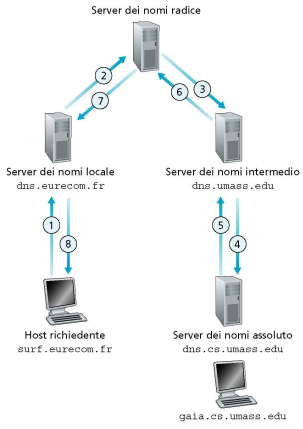
DNS



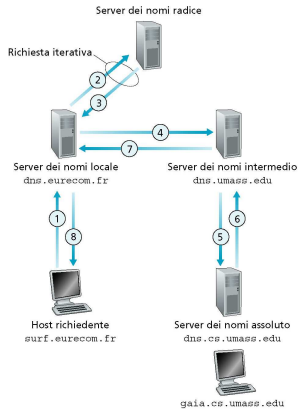
DNS

DNS root servers (13)

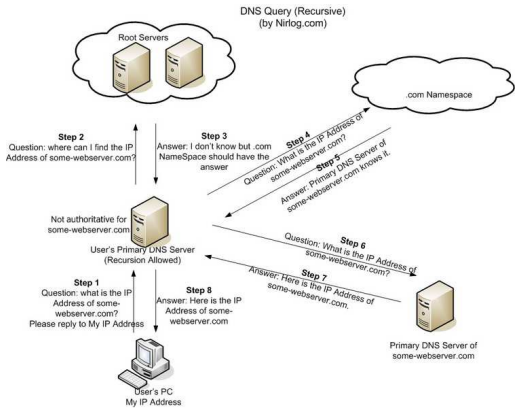
DNS



DNS



DNS



DNS

Identificazione	Etichette	12 byte
Numero di domande	Numero RR di risposta	
Numero di RR assoluti	Numero di RR aggiuntivi	
Domande (numero di domande variabile)		Nomi, tipi di campi per una richiesta
Risposte (numero variabile di record di risorse)		RR in risposta a una richiesta
Assoluti (numero variabile di record di risorse)		Record di server assoluti
Informazioni aggiuntive (numero variabile di record di risorse)		Informazioni aggiuntive "utili" che possono essere usate

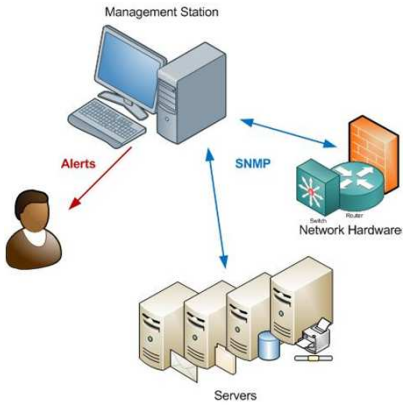
Record DNS

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.
l.google.com.        7217 IN    NS      g.l.google.com.
l.google.com.        7217 IN    NS      a.l.google.com.
l.google.com.        7217 IN    NS      b.l.google.com.
l.google.com.        7217 IN    NS      c.l.google.com.
l.google.com.        7217 IN    NS      d.l.google.com.
```


Network management



SNMP

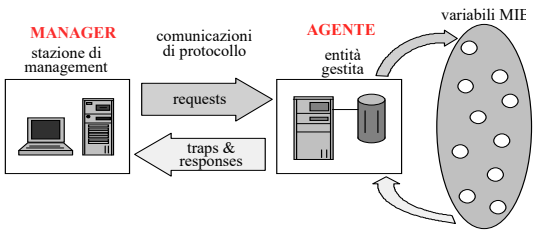
SNMP **S**imple **N**etwork **M**anagement **P**rotocol

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

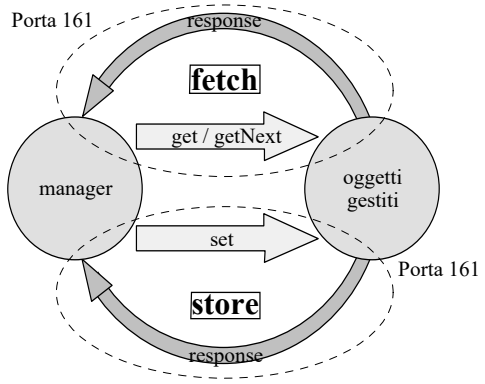
SNMP

SNMP
Si basa su un manager e alcuni agent che controllano variabili che rappresentano gli oggetti da monitorare/controllare

Il manager esegue operazioni di *get* e *set*
Gli agent attendono le richieste ma possono anche inviare *trap*

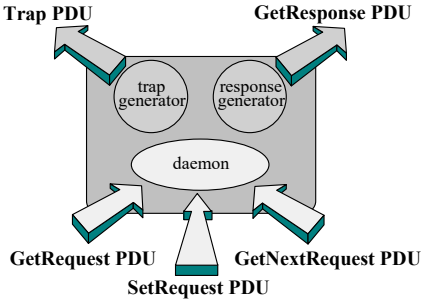


SNMP



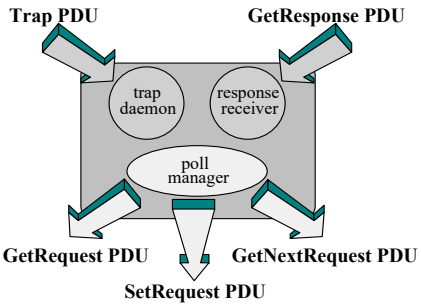
Agent SNMP

Struttura di un agent SNMP

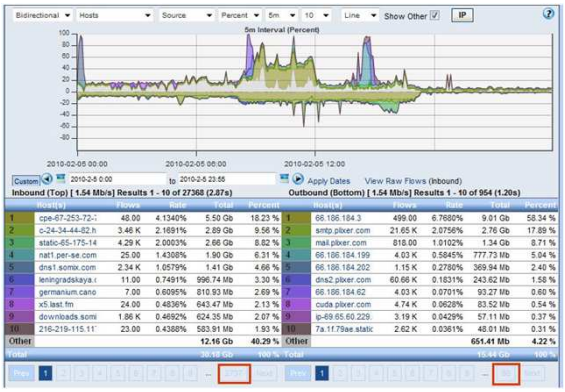


Manager SNMP

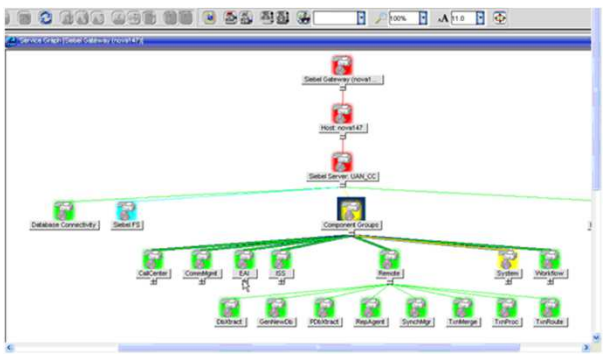
Struttura di un **manager SNMP**



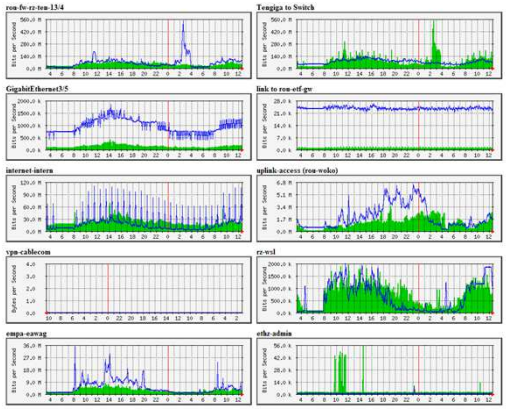
SNMP



SNMP



MRTG



SNMP

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