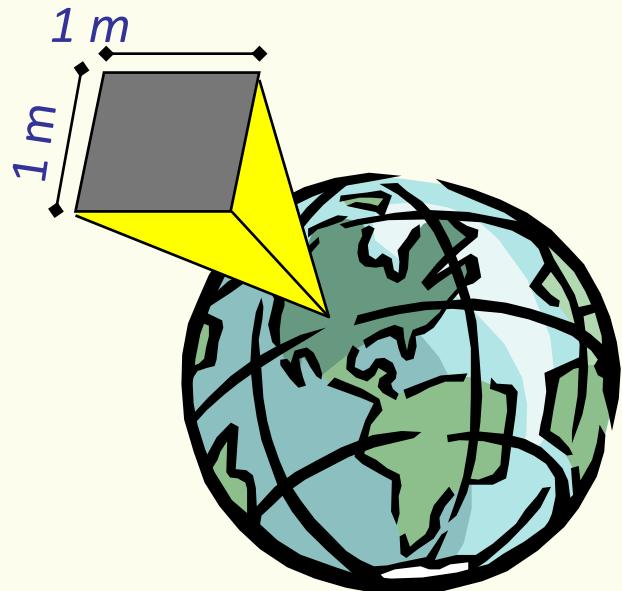


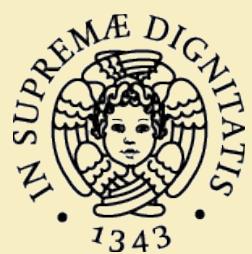
IPv6

Addressing

Motivation for IPv6

- IPv6 address space
 - $2^{128} = 340.282.366.920.938.463.463.374.607.431.768.211.456$
 - 340 trillion trillion trillion (i.e. $\sim 340 \times 10^{36}$)
- About 6.65×10^{23} addresses per square meter on earth (including waters)

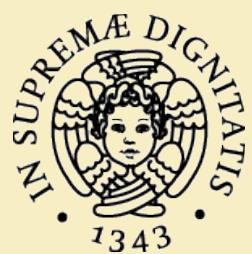




Address categories

- **Unicast**
 - A **unicast** address uniquely identifies an interface of an IPv6 node. A packet sent to a unicast address is delivered to the interface identified by that address
- **Multicast** ↳ ~~SMI address quale è la sorgente del messaggio~~
~~comportamento fatto~~
 - A **multicast** address identifies a group of IPv6 interfaces. A packet sent to a multicast address is processed by all members of the multicast group
- **Anycast** Broadcast è il scenaario → verso un solo indirizzo
saranno quelli solo i ricevitori
 - An **anycast** address is assigned to multiple interfaces (usually on multiple nodes). A packet sent to an anycast address is delivered to only one of these interfaces (usually the nearest one)

↳ ma posso scegliere anche
un altro modo



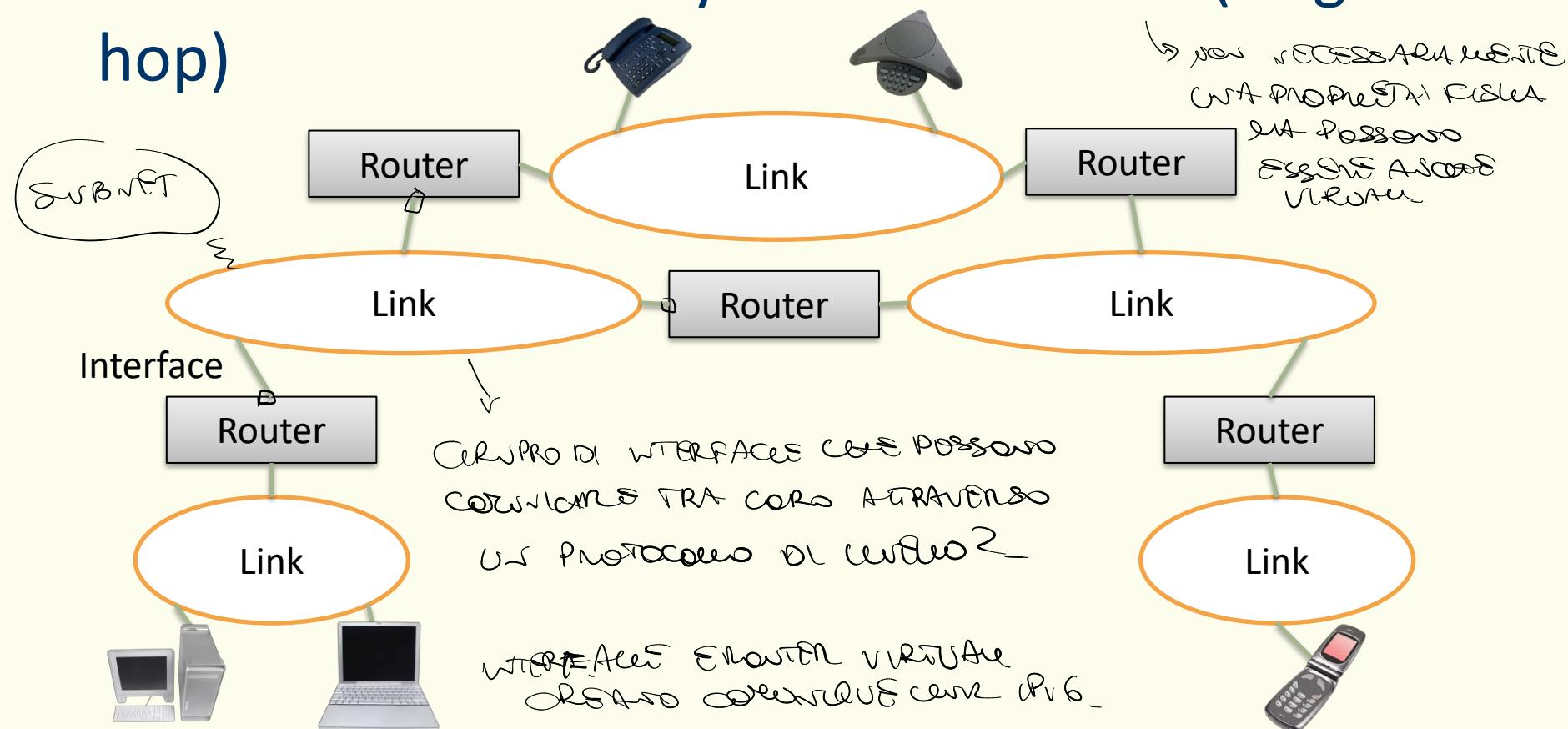
General rules

- An IPv6 address is assigned to an interface
 - At least one unicast address per interface of a node
 - A single interface can be assigned multiple IPv6 addresses of any type
- IPv6 addresses have a scope (encoded as part of the address)
 - The scope is a topological span within which the address may be used as a unique identifier
 - Global and non-global (e.g., link-local) scopes

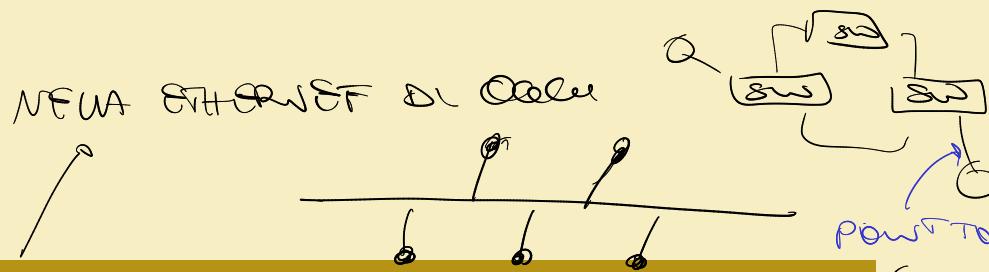
do scarti sono presenti nelle specifiche di Ipv6

IPv6 links

- Identified by a set of interfaces which can communicate directly with each other (single hop)



IPv6 links



GRAN ARANCIONE ETHERNET ORA UN QUADRICOLORE A SEZIO CERVO (ANNO CELESTE)

- **Typical assumptions about a link (e.g., Ethernet or point-to-point)**

- Stable (over time)
- Single link-layer broadcast domain
- Transitive (if $A \rightarrow B$ and $B \rightarrow C$, then $A \rightarrow C$)

Implications

- 1 Network prefixes can be used to determine if an interface is attached to a given link

- 2 Duplicate address detection can be simply addressed

→ NON POSSONO ALCUNI ALTRI QUESTA CEA!
IN CITTADINI PER RISPARMIO SONO SUPERI

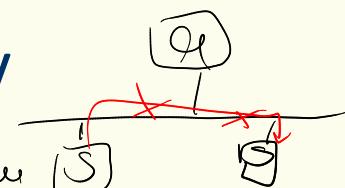
Own SWITCH + A UNA FORWARDING TABLE COMPLETA

(ARP) CON NUOVI MAMMI

NON HA BIGLIETTI OLTRE
OGLI SANT'ELIA E PALLINO CON
I MASTRI



ALCUNE FUNZIONI NELL'
IPV6 SONO ESSENTE
DISPONIBILI ALCUNI NO -



QUANDO HO UNA RETE A DISTENSIONE ELEVATA OSEI
CONNETTI ANCHE ALLE SURFACES DIVERSE
(CLOUDLESS, WIRELESS AREA NETWORK)

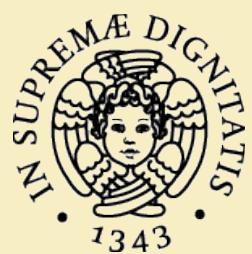
NON POSSO ARRIVEDARE AD UN REACHABLE ADDRESS
DI DUE VERSO DI UN WORKER IN PLEATO.

QUESTO RISCEDE' NON VEDENDO (E ASSUNZIONE)
CHE ABBIA IL PROTO

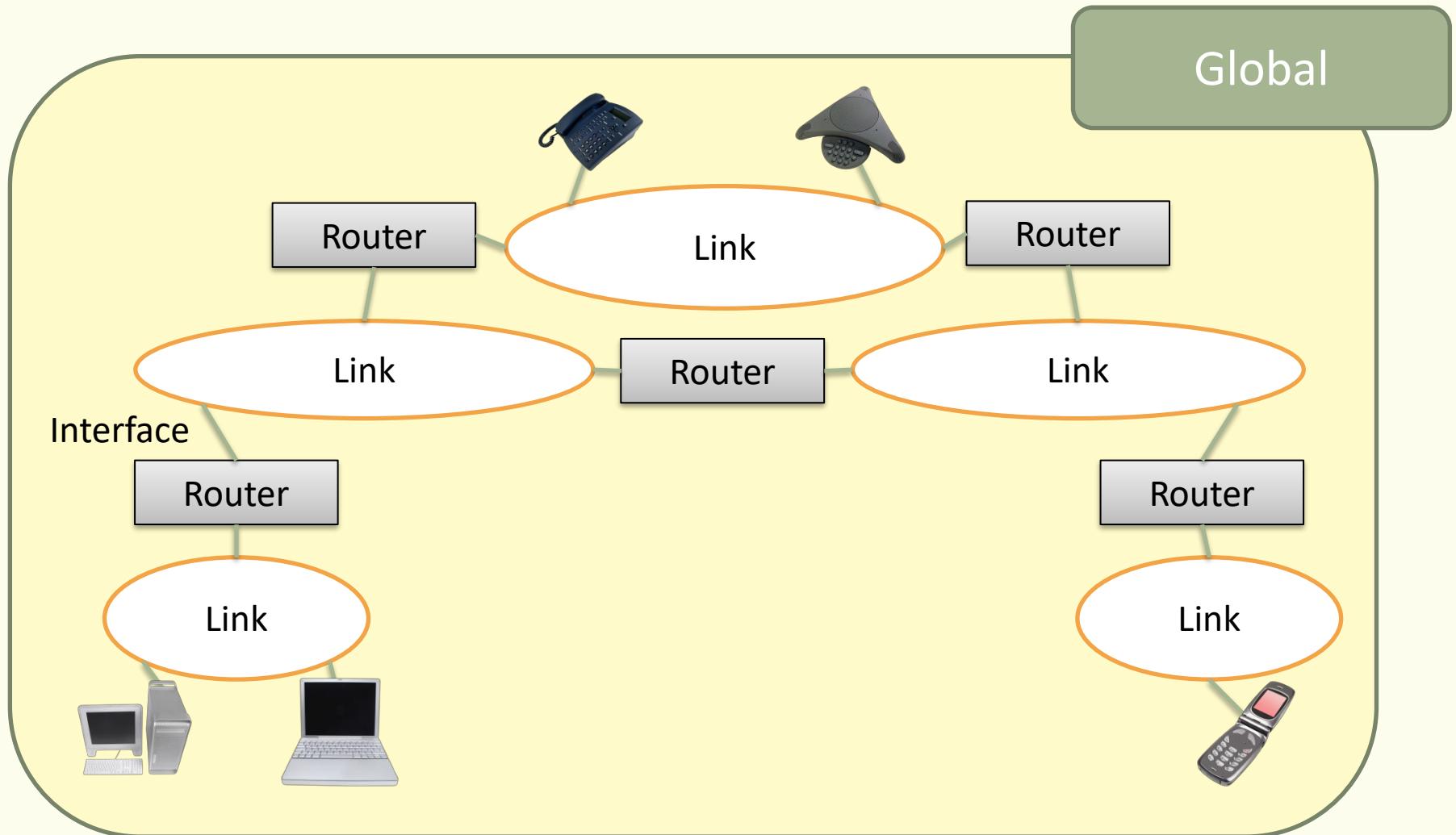
ALLORA A SARANNO ALTRI SISTEMI CORRE PON
ESSE PROVARE REACHABLE ADDRESS IN UN
ALTRIO A DECINE DI METRI DI DISTANZA (PER QUANDO
SI RICEVONO SOLO DUE RISPOSTE NELLA RETE
SOTTO).

ACCIDENTALMENTE, QUANDO VEDONO E ASSUNZIONE,
SCARICAMENTE VEDONO UN ALTRO ADDRESS UN
DISTRIBUITO ARP (ADDRESS resolution process)
CHIEDENDO DI TRASMETTERE GLI WS1 E WS2.

SE NON OTTENGONO RISPOSTA VEDI DNS CHE
NESSUN ALTRIO E POSSIBILE.



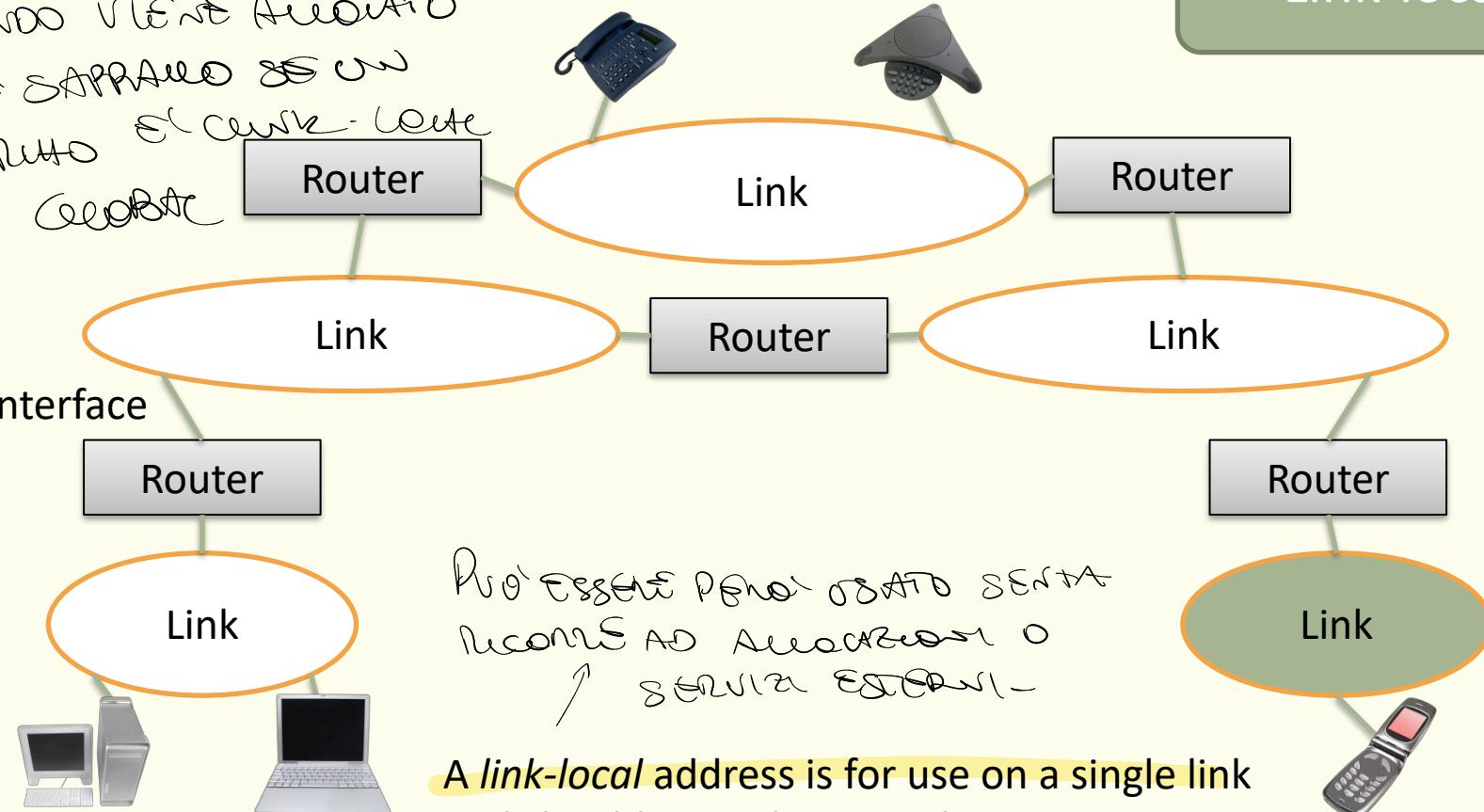
Address scope



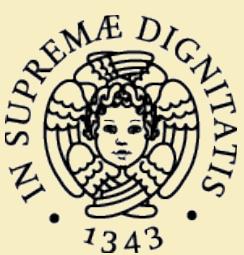


Address scope

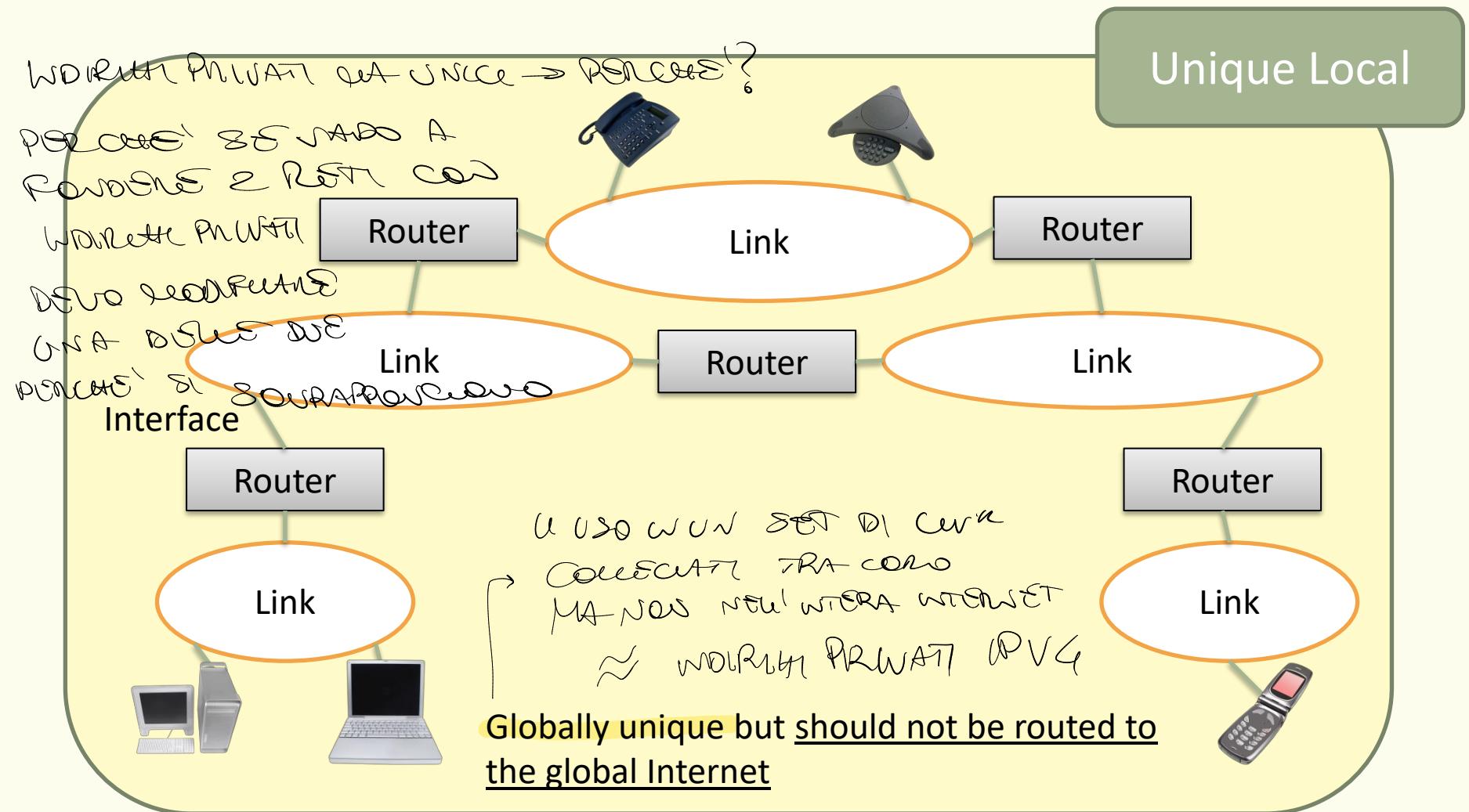
QUANDO VIENE AVVOLTO
COSÌ APPARE SÌ UN
MONDO DI CERCA-LENTE
O GEOPIC



A **link-local** address is for use on a single link
and should never be routed



Address scope

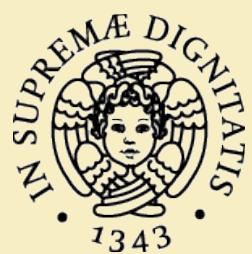




Address notation

- Format: **x:x:x:x:x:x:x:x**
 - x is a 16-bit block represented with four hex digits
- Abbreviation rules
 - Leading zeros can be skipped
 - 09C0 = 9C0
 - 0000 = 0
 - 2031:0000:130F:0000:0000:09C0:876A:130B =
2031:0:130F:0:0:9C0:876A:130B
 - Consecutive zeros can be replaced by ‘::’
 - 2031:0:130F:0000:0000:9C0:876A:130B =
2031:0:130F::9C0:876A:130B
 - This rule can be applied **only once!**

Posso avere diverse diverse
caso rappresentando lo
stesso up

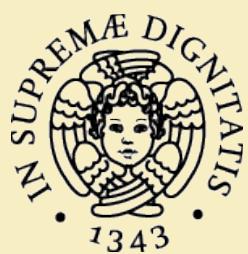


Address notation

- FF01:0000:0000:0000:0000:0000:0001 →
FF01:0:0:0:0:0:1 → **FF01::1**
- E3D7:0000:0000:0000:51F4:00C8:C0A8:6420 →
E3D7::51F4:C8:C0A8:6420
- 3FFE:0501:0008:0000:0260:97FF:FE40:EFAB →
3FFE:501:8:0:260:97FF:FE40:EFAB →
3FFE:501:8::260:97FF:FE40:EFAB
- 0:0:0:0:0:0:0 → :: (unspecified address)
- 0:0:0:0:0:0:1 → ::1 (loopback address)

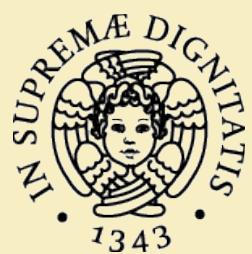
W IPv6 Använda
WORLDS OF R&B
Services
Address on link
CL INTERFACES
Nod ut Address
One WPI Reto IPv6

W IPv6 Använda via Boxes 18



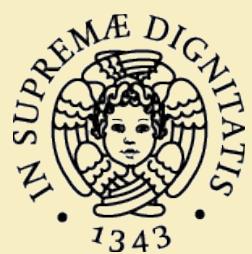
Prefix notation

- Similar to IPv4 with CIDR
 - [IPv6 address]/[prefix length]
- Identifies a set of addresses (e.g., belonging to the same subnet)
- Examples
 - 2E78:DA53:1200::/40
 - 2001:DB8:0:56::/64



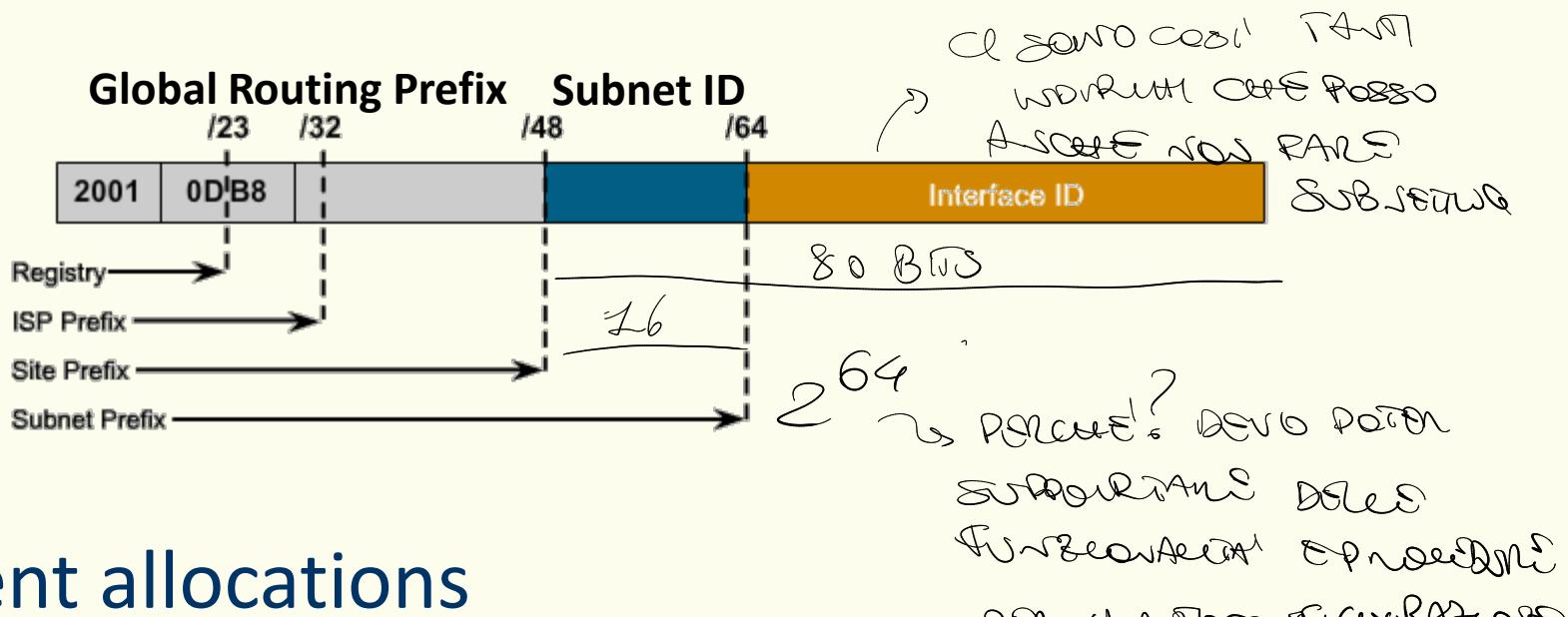
Prefix allocation

Allocation	Prefix binary	Prefix hex	Fraction of address space
Unassigned	0000 0000	::/8	1/256
Reserved	0000 001		1/128
Global unicast	001	2000::/3	1/8 <i>second word has part cons 001 & 1 word of second part</i>
Link-local unicast	1111 1110 10	FE80::/10	1/1024 <i>new dev 0 company prefix na 1 bit! FE80 E1 UN cerv local unicast!</i>
Reserved (formerly Site-local unicast)	1111 1110 11	FEC0::/10* <i>* deprecated</i>	1/1024 <i>new dev 0 company prefix na 1 bit! FEC0 NO 1110 11 local unicast!</i>
Unique-local	1111 110	FC00::/7	
Private administration	1111 1101	FD00::/8	<i>FEC0 NO 1111 1101</i>
Multicast	1111 1111	FF00::/8	1/256 <i>new MCAST AND 1 port!</i>



Global unicast address

- The *global routing prefix* identifies the address range allocated to a site

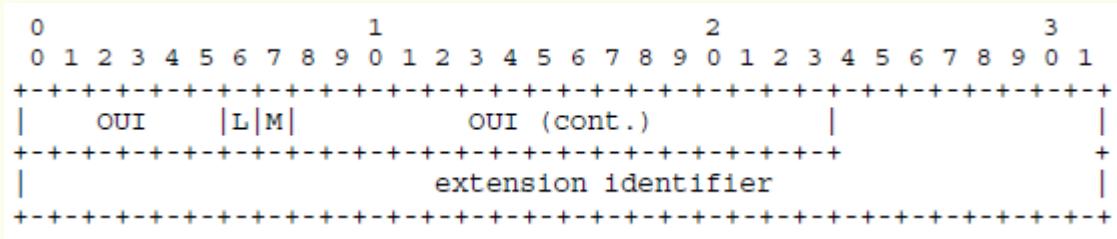


- Current allocations

– <http://www.iana.org/assignments/ipv6-unicast-address-assignments>

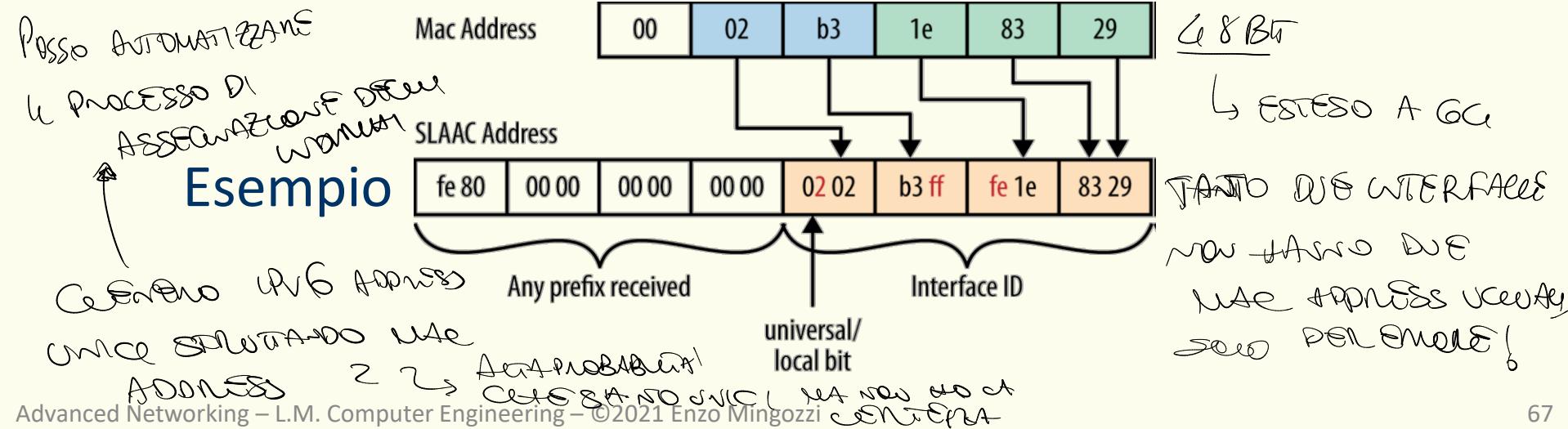


Interface ID



- Interface ID: should follow the IEEE EUI-64 format
 - <http://standards.ieee.org/regauth/oui/tutorials/EUI64.html>

MAC ADDRESS





Cell WORKER NOVA SEDIS ASSESSORIA IN
AUTOS READE, ENVIOS USANDO IDENTIFICACAO
EQUIVALENTE POSSO SERVIR USAR DHCP O
CONFIRMAR RETRANSMISSIONE

Interface ID

Sólo se usa como INTERFACE ID la interface address

- **Privacy issue**
 - Sólo se usa como interface address
 - Pode registrar-se à máquina IPF

- Internet access could be traced even across networks, because the identifier is unique to the interface

- Stable vs. *temporary transient* [RFC 4941] addresses

→ COM QUAE FREQUENTIA? REPORTAR?

- Assigned using a random number that changes in regular intervals

DAI PUNTO DI VISTA DELLE PERFORMANCE?

- Stable privacy addresses [RFC 7217]

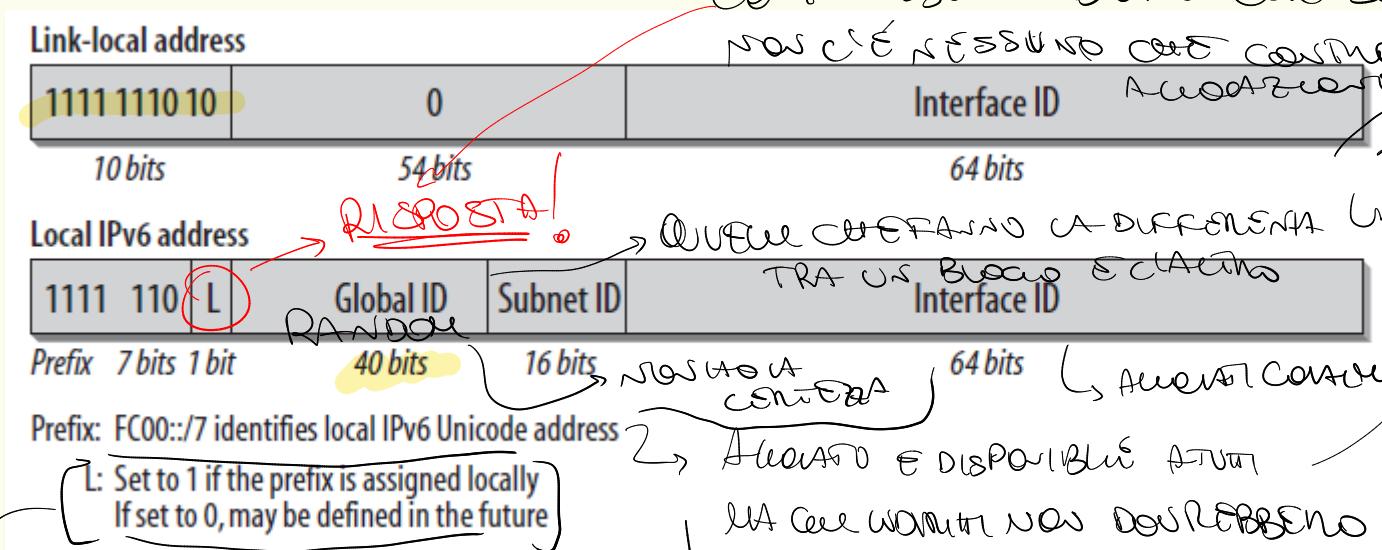
- not based on any hardware identifier
- stable within a subnet, but change when the host moves from one network to another

→ DEVE SER VENDICATO CUSTODIZZARE ID WORKER ABAIXO

Link-local and local addresses



- Link-local addresses are assigned by default through auto-configuration
 - The Global ID of local IPv6 addresses is generated randomly





2=1 VUEL PNT COT U CEBAR ID D' SNAD GENERATO CONVENSITE
TOS E' UNCO SNO SE SIANO NEITO SO RUMAT!

Anycast address

RFC 4193

- An **anycast** address is assigned to multiple interfaces (usually on multiple nodes). A packet sent to an anycast address is delivered to only one of these interfaces (usually the nearest one)
- Designed to provide redundancy and load-balancing when the same service is provided by multiple hosts/routers
 - Multiple HTTP or DNS servers
 - Multiple routers of the same ISP
- Implemented by the routing functionality
- The sender has no control over which interface the packet will be delivered

→ Nos Dero
AssensioNS
Aequo

ANYCAST:

COSA POSSIAMO FARLE CON I PRECEDENTI ANYCAST:

- 1) LOAD-BALANCING \rightarrow REPLICAS
- 2) REDUNDANCY \rightarrow MULTIPLE INSTANCES

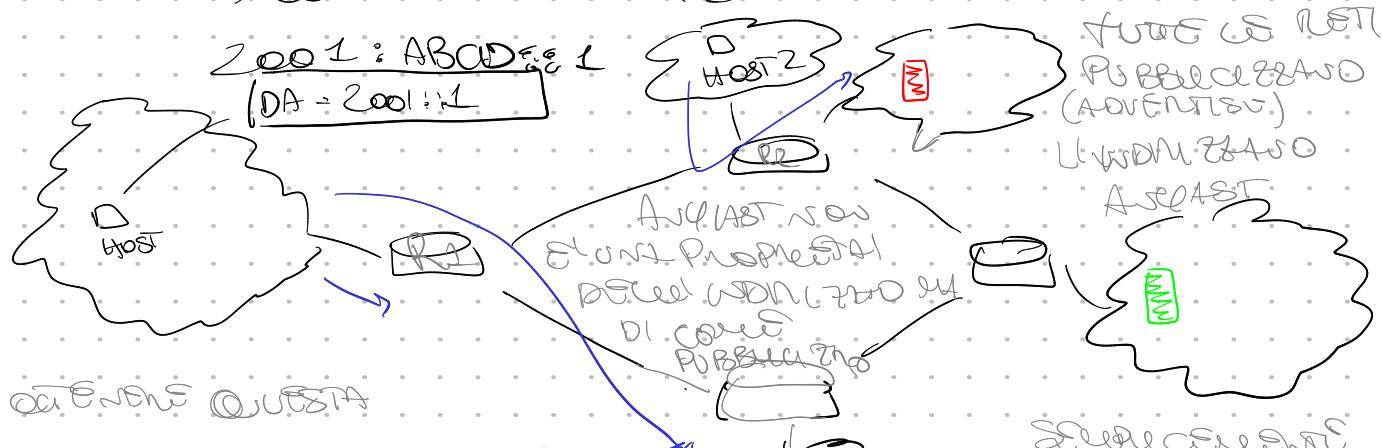
Voglio ACCEDERE AD UN SERVIZIO, MA NON SO CHE IPNESSA C'È E CO FORNISCE

- 1) HTTP: CON LO STESSO SITO ON HA LOCATIONS Sono VIRTUALMENTE - GLOBALE.
- 2) DNS: SERVIZIO CERCA RISULTATO DEL NOME (PER OGNI REQUEST) AL ROOT SERVER, NE RICEVE UNO, MA NON È IL CORRETTO QUALE (PER RICEVERE... HANNO STERZO)

CHE FUNZIONA ANYCAST?

UN FAUTO DICE CHE INDOOTTO SVA ANYCAST O NO MA E' INUTILE
SCEGLIERE UNO DI QUESTI

UN INDOOTTO PUÒ ESSERE ANYCAST O NOCAST IN
BASE AL DNS

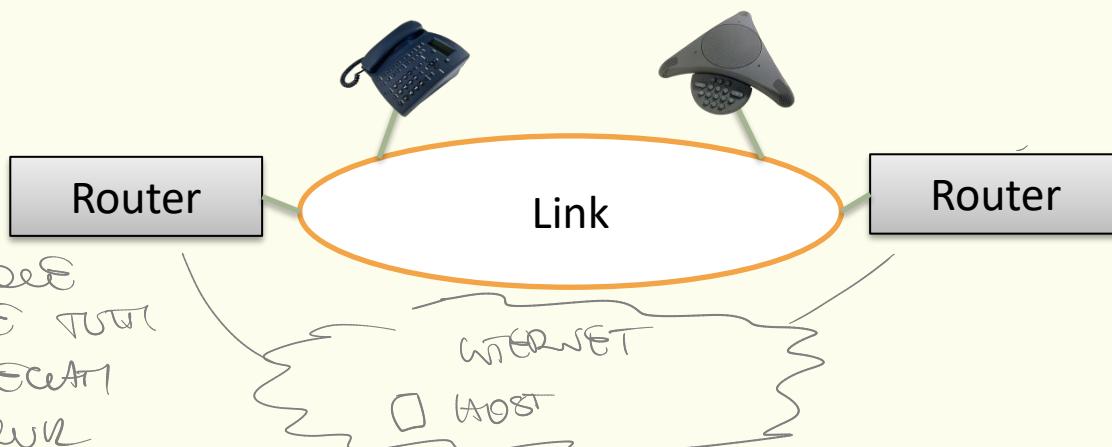
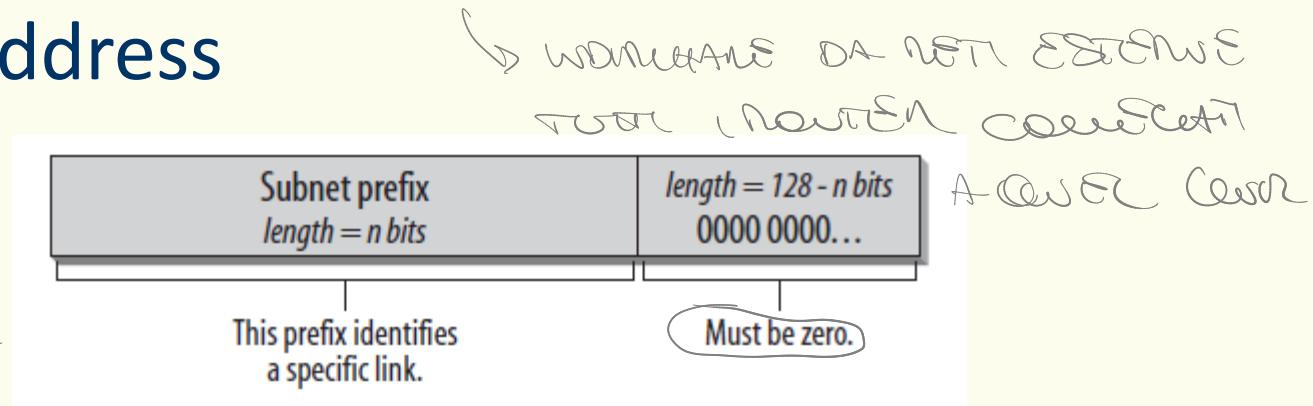


Possiamo dire che i protocolli
che fanno questo sono
Protocolli di Routing.

Studieremo
questi protocolli
in un altro momento.
Per ora possiamo vedere
il meccanismo.

Anycast address

- The *subnet-router anycast address* is a required anycast address



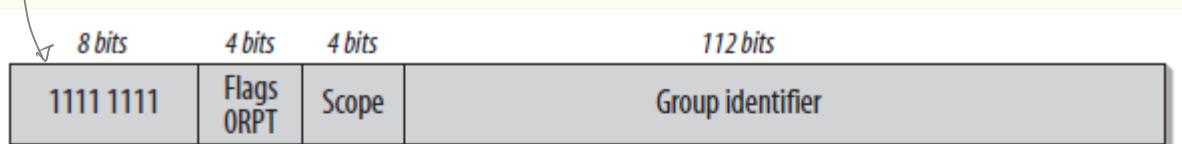


Multicast addresses

- When a packet is sent to a multicast address, all members of the multicast group process the packet

- A node can belong to more than one multicast group

MULTICAST group



Flags: high-order flag reserved, set to zero

R-flag: R=0 Rendezvous point not embedded
R=1 Rendezvous point embedded

[RFC 3956]

new
discuss!

P-flag: P=0 Multicast address without prefix information
P=1 Multicast address based on network prefix

[RFC 3306]

see notes

T-flag: T=0 Well known multicast address
T=1 Temporary multicast address

[RFC 4291]

Dobbiamo sapere quali sono le cose
che un host può fare!
Scegliere di ricevere → possibile
ma non è vero

STESSESCOPE ORGANIZZAZIONA → POSSIBILE

OFFICIALE!

SCOPE

Value	Description
1	Interface-local scope
2	Link-local scope
E	Global scope
...	... MULTICAST now ... FINE DA MULTICAST

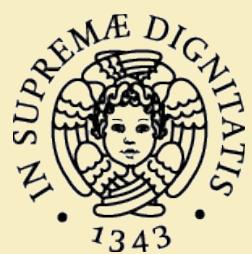
4 PROBLEMI

1) ACCIDENT

BIG CROWN

MULTICAST

ALIEN USO, VIRTUALIZZA
zeta =
A RETE IN DATA CENTER



Multicast addresses

- Well-known link-local scope multicast

addresses

USATO
PER VEDERE SE QUALESCO

JUTI
Cell
SETTI
~ 001
CET
HANNO
UGNE
6 CEN

STA USANDO IL MEDESIMO NUMERO, SOSTITUITO DI ARP
PER EFFICIENTE CHE NELLA BROADCAST

RISERVATO

BROADCAST SU

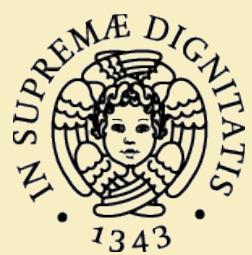
UN CERVO

Address	GROUP ID	Description
FF02:0:0:0:0:0:1		All-nodes address → ANY INTERFACE AFFECTED
FF02:0:0:0:0:0:2		All-routers address → TO THIS CERVO
FF02:0:0:0:0:0:5		OSPFIGP → TUTTI I RUTTORI DI QUESTO CERVO
FF02:0:0:0:0:0:9	Network Protocols	RIP routers
FF02:0:0:0:0:0:A	Protocols	EIGRP routers
FF02:0:0:0:0:0:B	Mobile agents	Mobile agents → QUESTA CERVO COLLEGATA CON IL CERVO BROADCAST
FF02:0:0:0:0:0:1:2	All DHCP agents	All DHCP agents → QUESTA CERVO È UN CERVO BROADCAST
FF02:0:0:0:0:0:1:4	(QUASI) CERVA	DTCP Announcement → QUESTA CERVO È UN CERVO BROADCAST
FF02:0:0:0:0:1:FFXX:XXXX	Solicited-node address	Solicited-node address → QUESTA CERVO È UN CERVO BROADCAST

QUESTO CERVO È UN BROADCAST CERVO, MA QUESTO CERVO È UN CERVO

ESSERE INCONTRATO A RICERCA

Se A CERVO 2 USO IL BROADCAST ETHERNET, MA QUESTO CERVO, DUE TRAMONTE IN ETHERNET



References

- RFC 4291, “IPv6 Addressing Architecture,” 2006