



Il routing in Internet Autonomous System

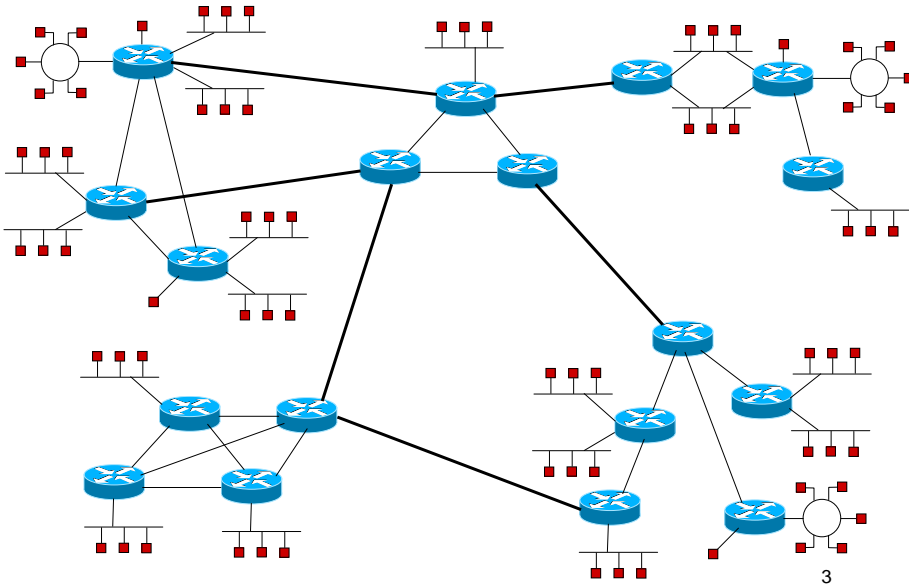
A.A. 2005/2006

Walter Cerroni

Routing gerarchico in Internet

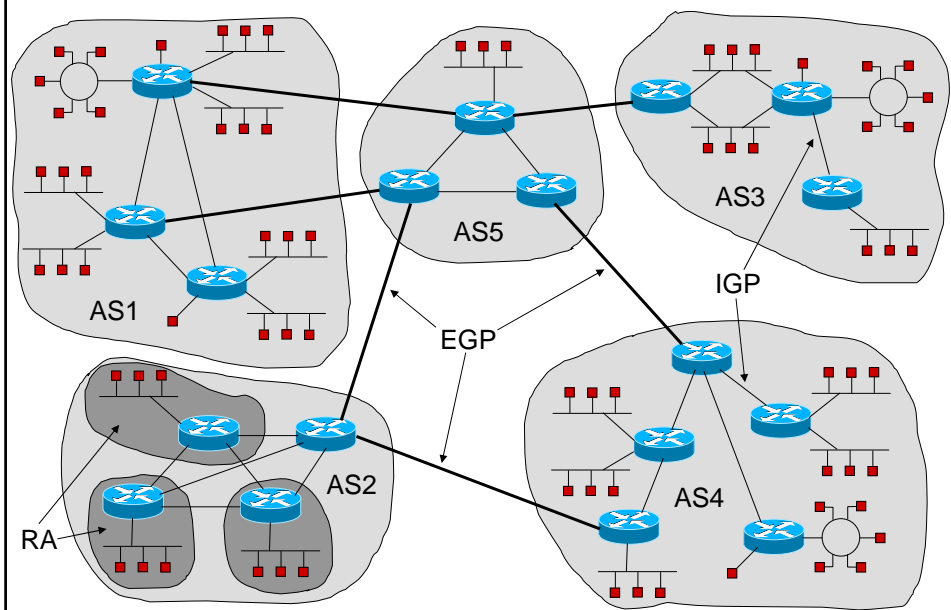
- In Internet si usa il routing gerarchico e le aree di routing sono chiamate **Autonomous System** (AS)
 - un AS può essere ulteriormente suddiviso in porzioni dette **Routing Area** (RA) interconnesse da un **backbone** (dorsale)
 - ogni network IP è tutta contenuta in un AS o in una RA
 - tradizionalmente secondo la classe, oggi secondo il CIDR
 - gli AS decidono autonomamente i protocolli e le politiche di routing che intendono adottare al loro interno
 - i vari enti di gestione si devono accordare su quali protocolli utilizzare per il dialogo tra i router che interconnettono AS diversi
- I protocolli di routing all'interno di un AS sono detti **Interior Gateway Protocol** (IGP)
- I protocolli di routing fra AS sono detti **Exterior Gateway Protocol** (EGP)

Internet = rete di reti

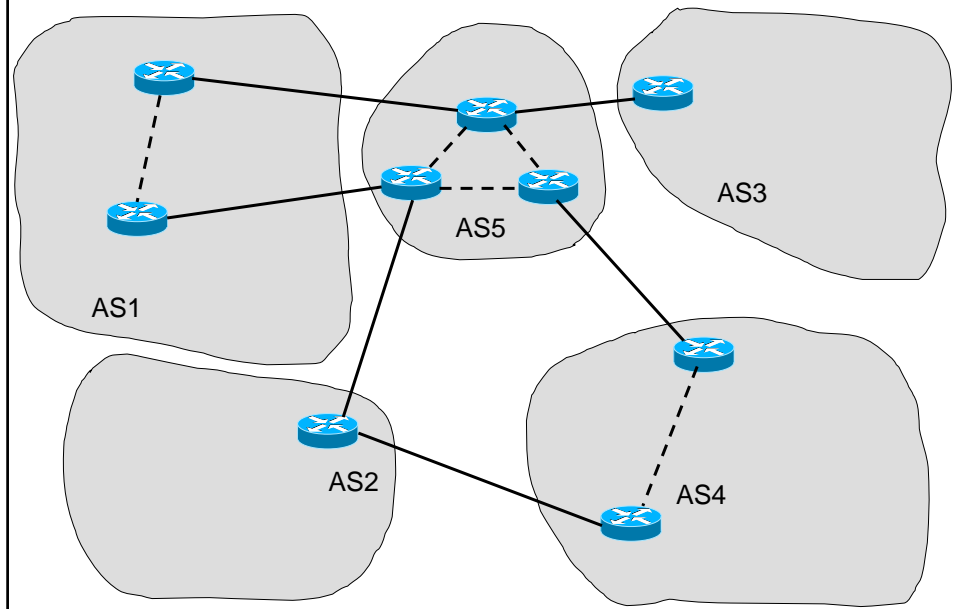


3

Internet = insieme di AS interconnessi



Grafo della rete a livello EGP



Ma cos'è un Autonomous System?

- Originariamente definito come un insieme di router gestiti da un'unica amministrazione (enti, aziende, università,...)
- Nuova definizione (1996 – RFC 1930)
 - un AS è un gruppo connesso di una o più reti IP (classless) gestite da uno o più operatori ma con **identiche** e **ben definite** politiche di routing
 - **politica di routing di un AS**: modalità con cui si prendono decisioni di routing nel resto della rete Internet sulla base delle informazioni provenienti dall'AS (attraverso un EGP)
 - Esempio:
 - Università di Bologna → 137.204.0.0/16
 - Politecnico di Torino → 130.192.0.0/16
 - entrambi comunicano con il resto del mondo tramite il GARR e le sue scelte di peering (**stesse politiche di routing**)
 - non c'è bisogno di avere un AS per ogni ateneo
 - il GARR (e tutte le reti connesse ad esso) costituiscono un unico AS (AS137)

Internet Routing Registries (IRRs)

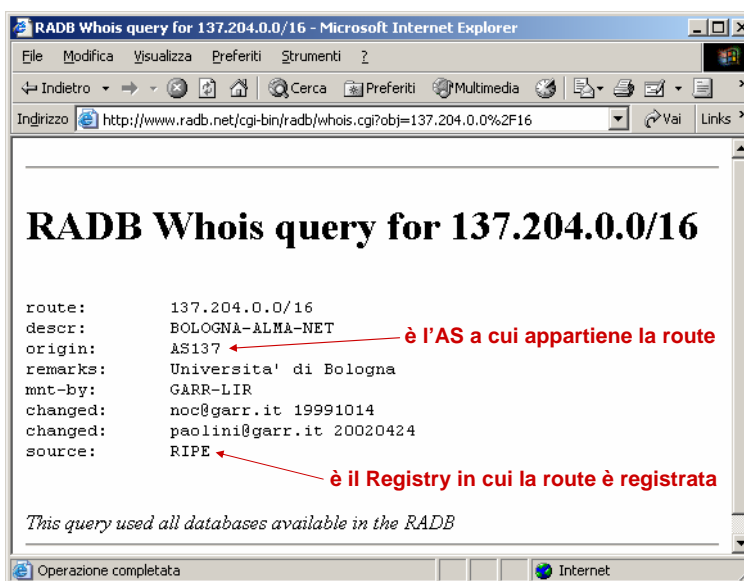
- Sono database contenenti le politiche di routing degli AS allocati dai diversi Regional Internet Registry e da altre organizzazioni nazionali e internazionali
- Possono essere interrogati tramite il client "whois"
 - da shell linux: **whois -h whois.radb.net <QUERY>**
 - da client web: **http://www.radb.net**



- Alcuni esempi di query:
 - **a.b.c.d/m** per avere informazioni su una route
 - **ASxxx** per avere informazioni su un AS
 - **!gASxxx** per conoscere tutte le reti IP in un AS

7

whois 137.204.0.0/16



8

whois 137.204.0.0/16

Se si interroga il RIPE NCC (Registry europeo) si hanno maggiori informazioni sull'allocazione degli indirizzi

<http://www.ripe.net/db/whois/whois.html>

```
inetnum: 137.204.0.0 - 137.204.255.255
netname: BOLOGNA-ALMA-NET
descr:  Universita' di Bologna
country: IT
admin-c: SS3049-RIPE
tech-c:  CM2056-RIPE
rev-srv: almadns.unibo.it
rev-srv: dectcp.cineca.it
rev-srv: dns.nis.garr.it
rev-srv: spoletta.da.unibo.it
rev-srv: cine88.cineca.it
status: ASSIGNED PI
remarks: To notify abuse mailto: cert@garr.it
remarks: Multiple-Lan
mnt-by:  GARR-LIR
changed: heppe@almadns.unibo.it 19950925
changed: dbmaster@nis.garr.it 19951006
changed: A.Bonito@cnuce.cnr.it 19970805
changed: ripe-dbm@ripe.net 20030116
changed: gallio@garr.it 20030507
source:  RIPE
```

Indica che la rete IP in questione è assegnata all'ente in maniera indipendente dall'operatore che gli offre connettività

(opposto a "PA")

9

whois 130.192.0.0/16

```
route: 130.192.0.0/16
descr: TORINO-IT-LAN
origin: AS137
remarks: Politecnico di Torino
mnt-by: GARR-LIR
changed: Franca.Fiumana@cnaf.infn.it 19990310
changed: paolini@garr.it 20020424
source: RIPE
```

stesso AS di 137.204.0.0/16

This query used all databases available in the RADB

10

whois AS137

```
Results for Whois Query:  
whois -h whois.radb.net 'as137'  
  
Number of objects found: 1  
  
aut-num: AS137  
as-name: ASGARR  
descr: GARR Italian academic and research network  
import: from AS20965 action pref=100; accept ANY  
import: from AS1299 action pref=100; accept ANY  
import: from AS3549 action pref=100; accept ANY  
import: from AS6762 action pref=100; accept ANY  
mp-import: afi ipv4.multicast from AS20965 action pref=100; accept ANY  
mp-import: afi ipv6.unicast from AS20965 action pref=100; accept ANY  
mp-import: afi ipv6.multicast from AS20965 action pref=100; accept ANY  
export: to AS20965 announce AS-GARRTOGEANT  
export: to AS1299 announce AS-GARR  
export: to AS3549 announce AS-GARR  
export: to AS6762 announce AS-GARR  
mp-export: afi ipv4.multicast to AS20965 announce AS-GARRTOGEANT
```

AS da cui accettare le route

AS verso cui annunciare le route

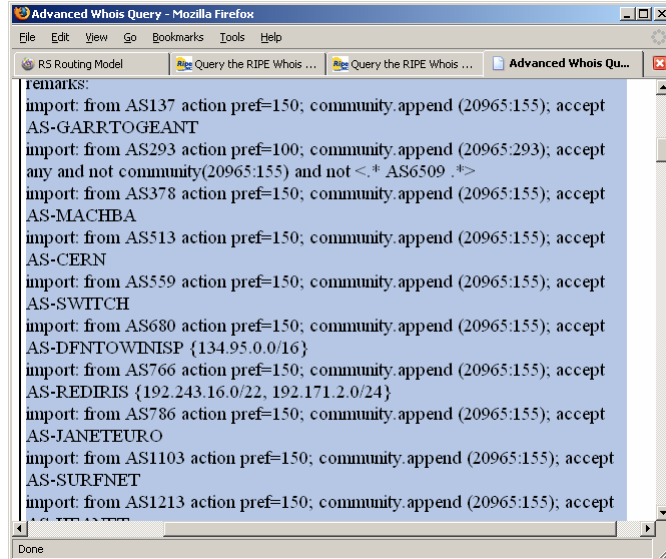
11

whois AS20965

```
Results for Whois Query:  
whois -h whois.radb.net 'as20965'  
  
Number of objects found: 2  
  
aut-num: AS20965  
as-name: GEANT  
descr: The GEANT IP Service  
remarks:  
remarks: There are extra ASes prefixes advertised by some NRENs. We have:  
remarks: 1) AS9199 (Moldova) is behind RoEduNet  
remarks: 2) AS7500 (DNS root name-server) is behind RENATER  
remarks: 3) RedIRIS is advertising a NASA and an ESA prefix  
remarks:  
remarks: GEANT peers with some non-European NRENs. We have:  
remarks: 1) AS11537 is Abilene (US)  
remarks: 2) AS6509:AS-CANET4 is Canarie (Canada) and may be  
remarks: found at: whois -h dooka.canet4.net 'AS6509:AS-CANET4'  
remarks: 3) AS293 is the DOE network (US)  
remarks: 4) AS2018 is the South African NREN (TENET)
```

12

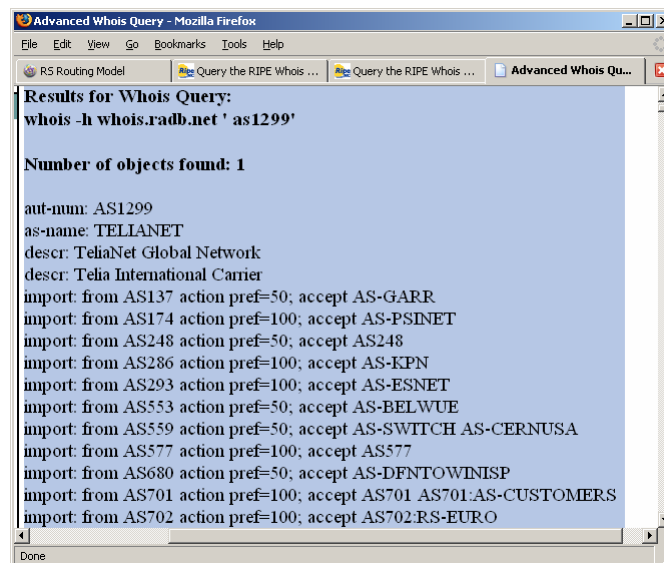
whois AS20965



```
remarks:
import: from AS137 action pref=150; community.append (20965:155); accept
AS-GARRTOGEANT
import: from AS293 action pref=100; community.append (20965:293); accept
any and not community(20965:155) and not <.* AS6509 .*>
import: from AS378 action pref=150; community.append (20965:155); accept
AS-MACHBA
import: from AS513 action pref=150; community.append (20965:155); accept
AS-CERN
import: from AS559 action pref=150; community.append (20965:155); accept
AS-SWITCH
import: from AS680 action pref=150; community.append (20965:155); accept
AS-DFNTOWINISP {134.95.0.0/16}
import: from AS766 action pref=150; community.append (20965:155); accept
AS-REDIRIS {192.243.16.0/22, 192.171.2.0/24}
import: from AS786 action pref=150; community.append (20965:155); accept
AS-JANETEURO
import: from AS1103 action pref=150; community.append (20965:155); accept
AS-SURFNET
import: from AS1213 action pref=150; community.append (20965:155); accept
```

13

whois AS1299



```
Results for Whois Query:
whois -h whois.radb.net 'as1299'

Number of objects found: 1

aut-num: AS1299
as-name: TELLANET
descr: TeliaNet Global Network
descr: Telia International Carrier
import: from AS137 action pref=50; accept AS-GARR
import: from AS174 action pref=100; accept AS-PSINET
import: from AS248 action pref=50; accept AS248
import: from AS286 action pref=100; accept AS-KPN
import: from AS293 action pref=100; accept AS-ESNET
import: from AS553 action pref=50; accept AS-BELWUE
import: from AS559 action pref=50; accept AS-SWITCH AS-CERNUSA
import: from AS577 action pref=100; accept AS577
import: from AS680 action pref=50; accept AS-DFNTOWINISP
import: from AS701 action pref=100; accept AS701 AS701-AS-CUSTOMERS
import: from AS702 action pref=100; accept AS702:RS-EURO
```

14

whois AS3549

```
Advanced Whois Query - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
RS Routing Model Query the RIPE Whois ... Advanced Whois Query Advanced Whois Qu...

Results for Whois Query:
whois -h whois.radb.net ' as3549'

Number of objects found: 2

aut-num: AS3549
as-name: GBLX
descr: Global Crossing, Ltd.
S 50th St
Phoenix, AZ 85034
800.414.5028 ncc@gblx.net
admin-c: MH20357
tech-c: MH20357
import: from AS297
action pref=10;
accept AS297 AND NOT {0.0.0.0/0}
import: from AS1849
action pref=10;
accept AS1849 AND NOT {0.0.0.0/0}

Find: any Find Next Find Previous Highlight all Match case
Done
```

15

whois AS6762

```
Advanced Whois Query - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
RS Routing Model Query the RIPE Whois ... Advanced Whois Query Advanced Whois Qu...

Results for Whois Query:
whois -h whois.radb.net ' as6762'

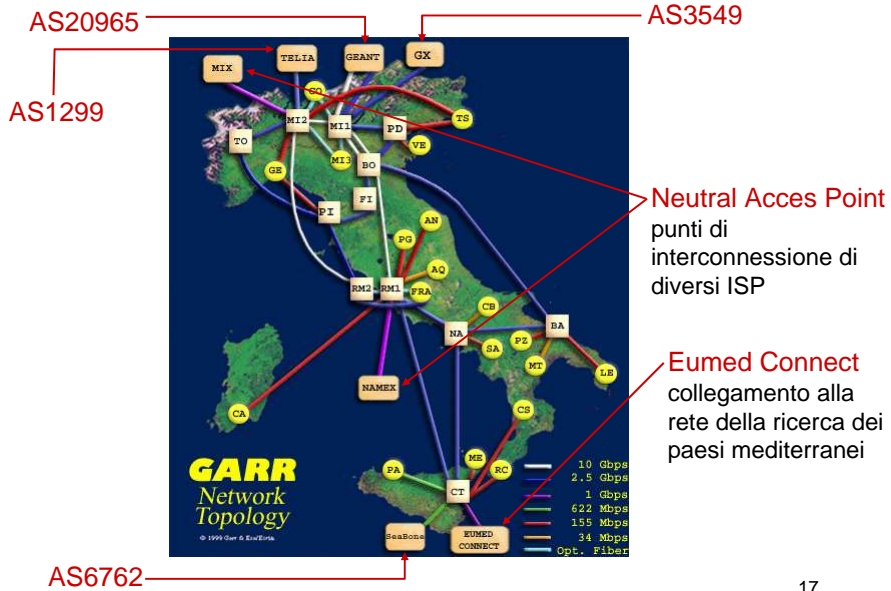
Number of objects found: 1

aut-num: AS6762
as-name: SEABONE-NET
descr: Telecom Italia Sparkle
descr: International Internet Backbone
remarks: =====Customers:
import: from AS137 action pref=50; accept AS-GARR
import: from AS1241 action pref=50; accept AS-FORTHNET
import: from AS2609 action pref=50; accept AS2609
import: from AS3269 action pref=50; accept AS3269 AS6664
AS-IBSCUST
import: from AS3302 action pref=50; accept AS3302
import: from AS3329 action pref=50; accept AS-HOLTR
import: from AS5391 action pref=50; accept AS-HRHINET

Find: any Find Next Find Previous Highlight all Match case
Done
```

16

GARR – Rete italiana delle università e della ricerca



17

whois !gAS137

```

Advanced Whois Query - Mozilla Firefox
File Edit View go Bookmarks Tools Help
RS Routing Model Query the RIPE Whois ... Advanced Whois Query Advanced Whois Qu...

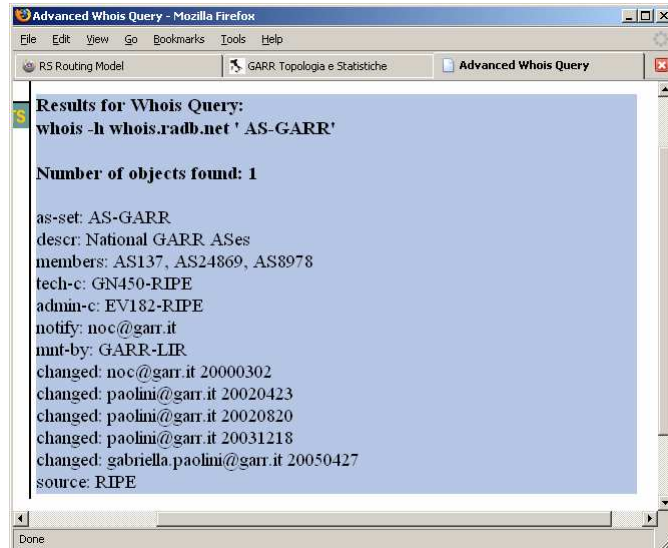
Results for Whois Query:
whois -h whois.radb.net '!gAS137'

Number of objects found: 1

A1372
192.84.152.0/22 147.162.0.0/15 192.106.246.0/23 192.150.194.0/23
192.135.34.0/24 192.135.8.0/21 192.135.31.0/24 192.135.16.0/20 192.167.0.0/16
141.108.0.0/16 151.100.0.0/16 130.251.0.0/16 192.148.193.0/24 192.84.144.0/21
192.135.35.0/24 192.150.196.0/24 193.43.141.0/24 192.84.128.0/20
192.195.110.0/24 192.106.234.0/24 193.206.0.0/16 130.192.0.0/16
193.43.134.0/24 159.149.0.0/16 141.250.0.0/16 192.107.56.0/21 131.175.0.0/16
155.253.0.0/16 150.217.0.0/16 160.80.0.0/16 160.78.0.0/16 192.135.37.0/24
192.84.127.0/24 192.41.218.0/24 155.185.0.0/16 140.164.0.0/16 157.138.0.0/16
160.97.0.0/16 140.105.0.0/16 193.43.109.0/24 147.122.0.0/16 151.97.0.0/16
158.110.0.0/16 192.160.156.0/24 192.146.242.0/24 130.186.0.0/19
149.132.0.0/16 193.43.97.0/24 130.136.0.0/16 137.204.0.0/16 150.178.0.0/16
150.145.0.0/16 193.43.117.0/24 193.43.18.0/23 150.146.0.0/16 149.139.0.0/16
192.156.213.0/24 157.27.0.0/16 192.107.96.0/22 143.225.0.0/16 156.14.0.0/16
192.55.101.0/24 192.132.34.0/24 192.133.28.0/24 192.135.165.0/24
193.43.142.0/24 192.84.156.0/24 192.135.36.0/24 192.107.51.0/24
192.107.100.0/24 192.107.52.0/22 192.135.32.0/23 192.107.64.0/19
193.43.101.0/24 131.114.0.0/16 192.65.131.0/24 194.119.192.0/19 146.48.0.0/16
193.204.0.0/15 193.43.65.0/24 156.148.0.0/16 193.42.139.0/24 193.43.16.0/24
193.43.144.0/24 131.154.0.0/16 212.189.128.0/17 131.154.97.0/24
192.106.252.0/24
C
Done
    
```

18

whois AS-GARR



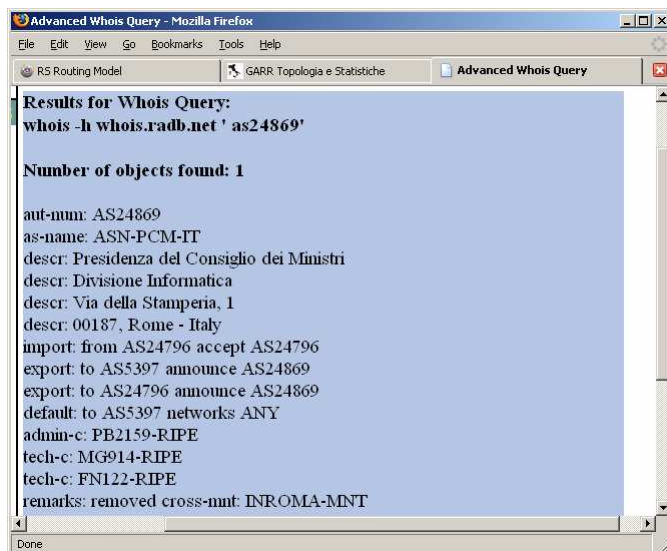
```
Results for Whois Query:
whois -h whois.radb.net ' AS-GARR'

Number of objects found: 1

as-set: AS-GARR
descr: National GARR ASes
members: AS137, AS24869, AS8978
tech-c: GN450-RIPE
admin-c: EV182-RIPE
notify: noc@garr.it
mnt-by: GARR-LIR
changed: noc@garr.it 20000302
changed: paolini@garr.it 20020423
changed: paolini@garr.it 20020820
changed: paolini@garr.it 20031218
changed: gabriella.paolini@garr.it 20050427
source: RIPE
```

19

whois AS24869



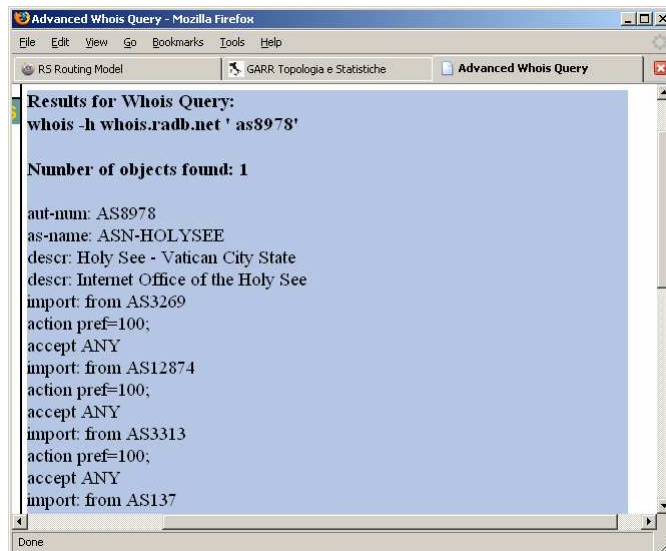
```
Results for Whois Query:
whois -h whois.radb.net ' as24869'

Number of objects found: 1

aut-num: AS24869
as-name: ASN-PCM-IT
descr: Presidenza del Consiglio dei Ministri
descr: Divisione Informatica
descr: Via della Stamperia, 1
descr: 00187, Rome - Italy
import: from AS24796 accept AS24796
export: to AS5397 announce AS24869
export: to AS24796 announce AS24869
default: to AS5397 networks ANY
admin-c: PB2159-RIPE
tech-c: MG914-RIPE
tech-c: FN122-RIPE
remarks: removed cross-mnt: INROMA-MNT
```

20

whois AS8978



```
Advanced Whois Query - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
RS Routing Model GARR Topologia e Statistiche Advanced Whois Query

Results for Whois Query:
whois -h whois.radb.net ' as8978'

Number of objects found: 1

aut-num: AS8978
as-name: ASN-HOLYSEE
descr: Holy See - Vatican City State
descr: Internet Office of the Holy See
import: from AS3269
action pref=100;
accept ANY
import: from AS12874
action pref=100;
accept ANY
import: from AS3313
action pref=100;
accept ANY
import: from AS137
```

21

Protocolli di routing per Internet

- Interior Gateway Protocol
 - **RIP**: **R**outing **I**nformation **P**rotocol
 - **OSPF**: **O**pen **S**hortest **P**ath **F**irst
- Exterior Gateway Protocol
 - **EGP**: **E**xterior **G**ateway **P**rotocol
 - **BGP**: **B**order **G**ateway **P**rotocol

22