An Autonomic Simulation Platform for Studying and Optimizing Addressing Issues in NGN

Sandoche BALAKRICHENAN

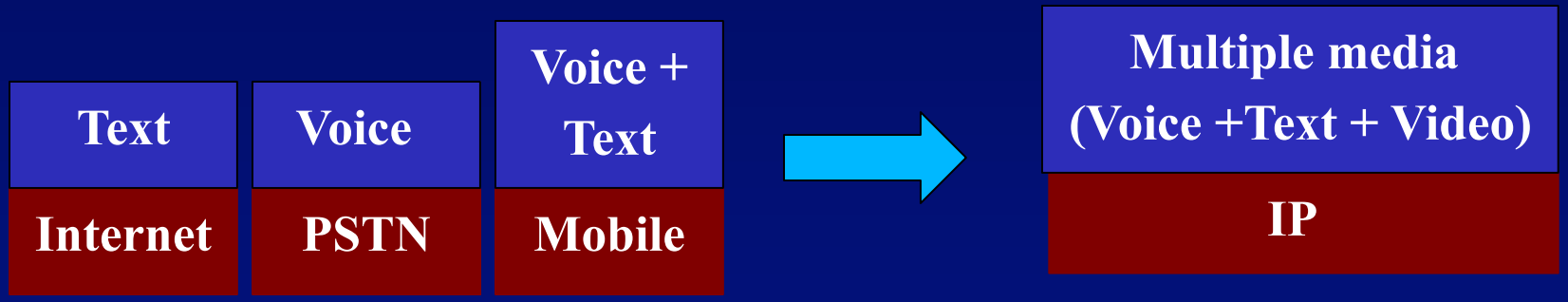
CNRS/SAMOVAR Lab, France

sandoche.balakrichenan@it-sudparis.eu

Structure

- Motivation
- Background
- Measurements & Modeling
- Simulator
- Optimization
- Autonomous

NGN



Issues : Heterogeneity + QoS

Heterogeneity

+33 667600456

www-rst.int-evry.fr/~balakric

Im:sandoche@yahoo.fr

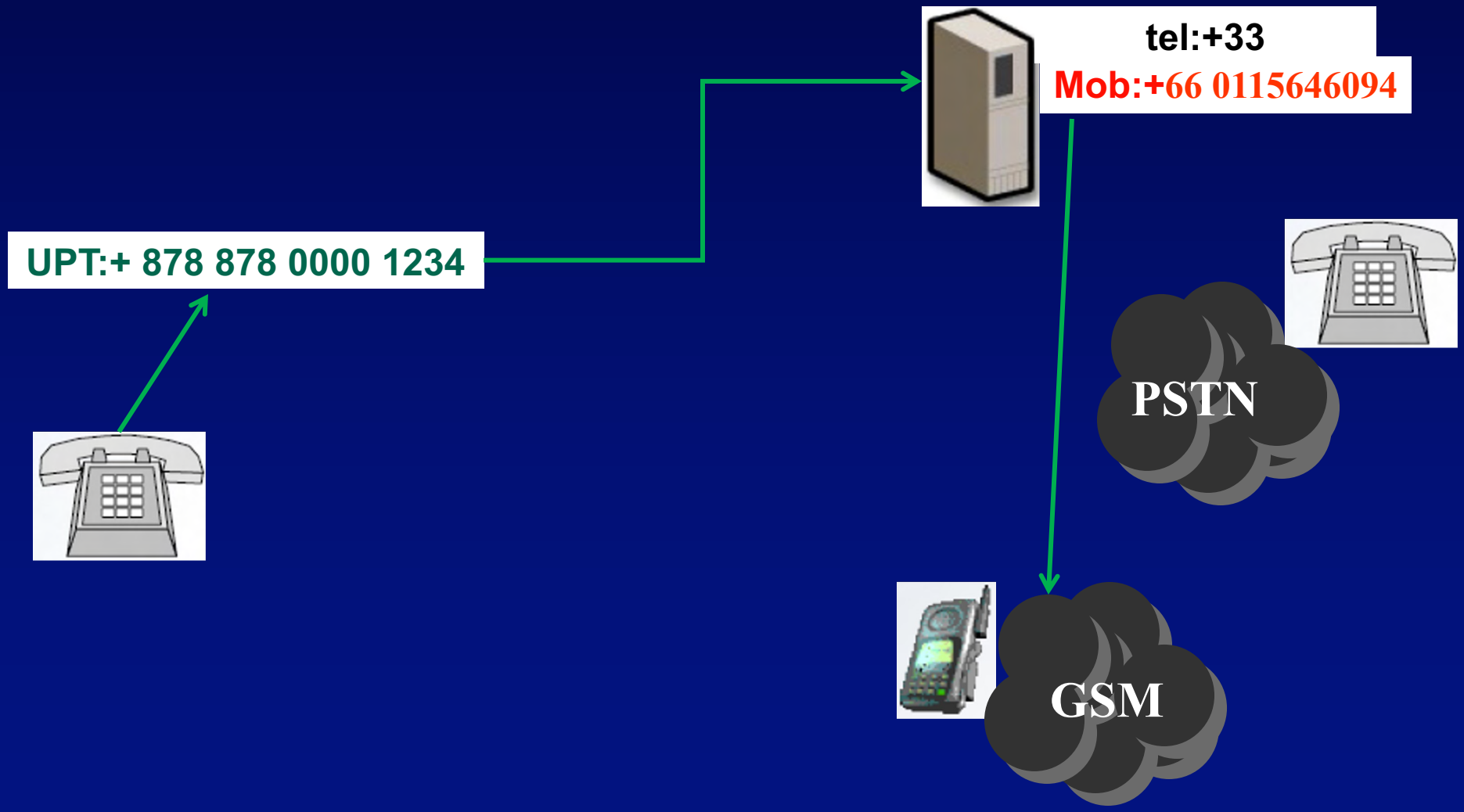
+33 160760456

Email:sandoche.balakrichenan@it-sudparis.eu

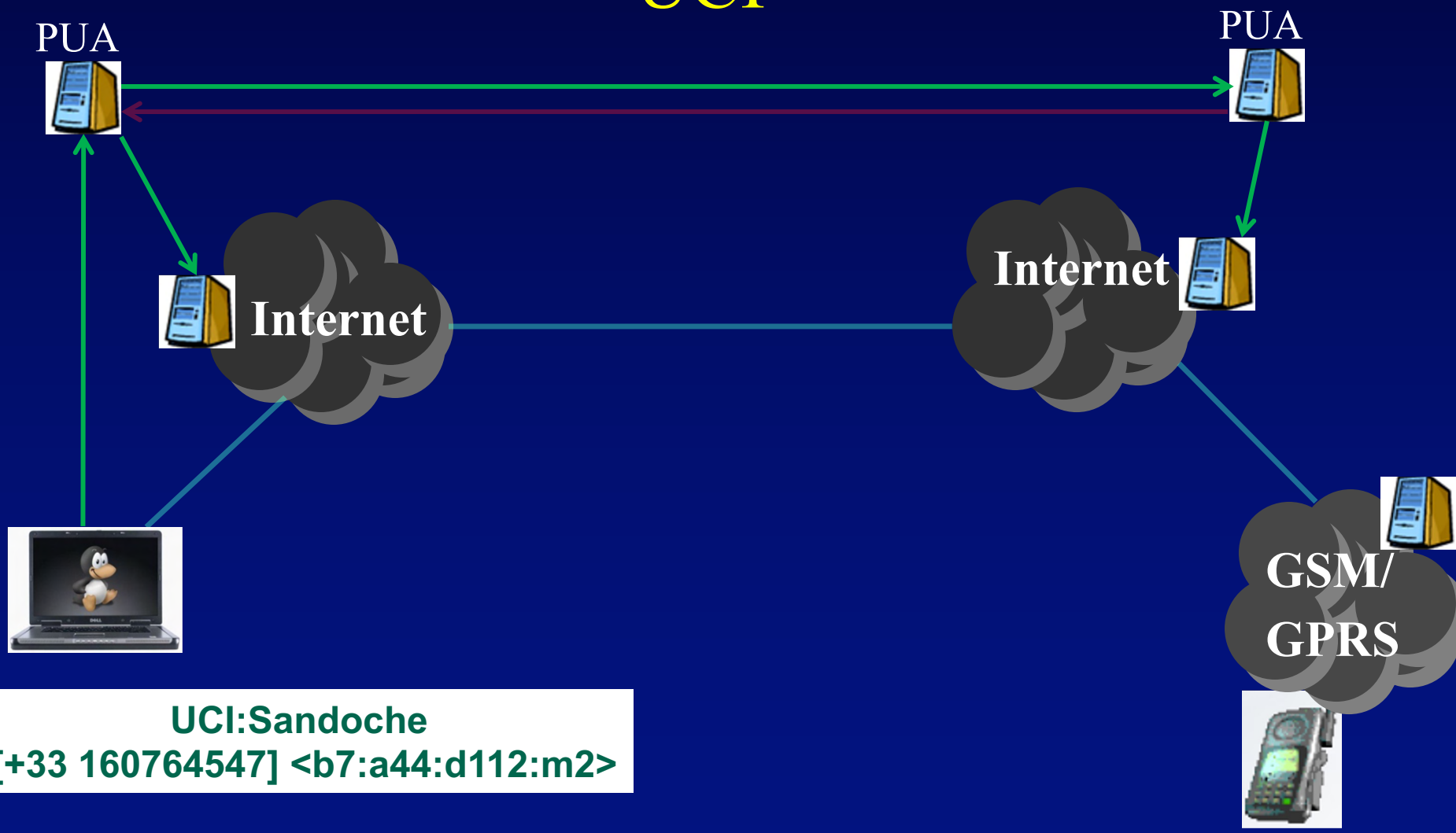
+33 160764547

Sip:sandoche@sip.fr

UPT



UCI


PUA
PUA
Internet
Internet
GSM/
GPRS
UCI:Sandoche
[+33 160764547] <b7:a44:d112:m2>

ENUM

original phone # : (+33)6-41-00-00-01

keep digits only : 33641000001

reverse : 100000014633

add dots : 1.0.0.0.0.0.1.4.6.3.3

FQDN (add suffix) : 1.0.0.0.0.0.1.4.6.3.3.e164.arpa.

DNS Server

SIP + E2U sip:sandoche@sip.fr

Internet

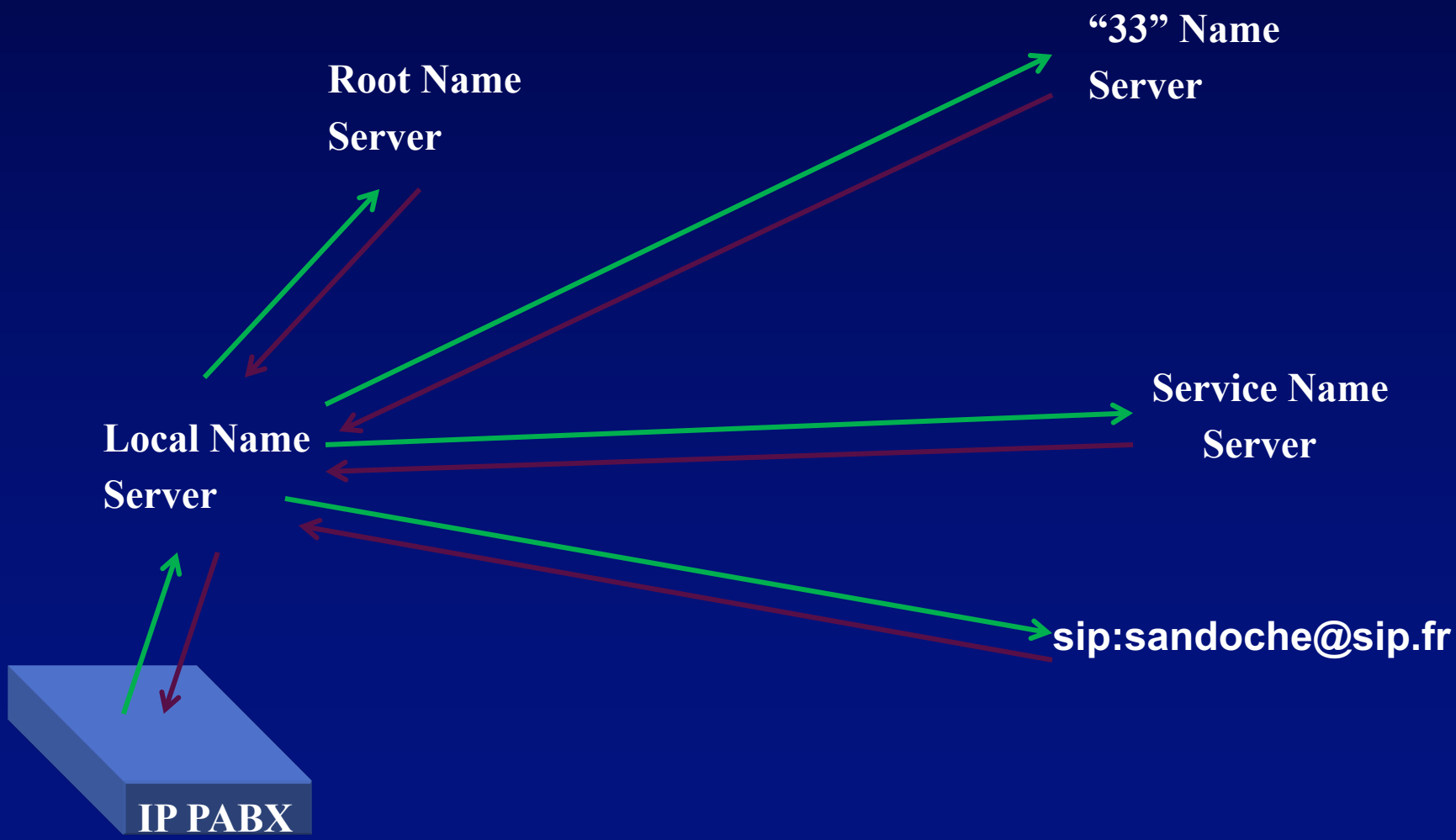
1.0.0.0.0.0.4.6.1.3.3.e164.arpa.

sip:sandoche@sip.fr

PST
N

+ 33 64100001

ENUM



1.0.0.0.0.0.4.6.1.3.3.e164.arpa. ⟷ sandoche@sip.fr

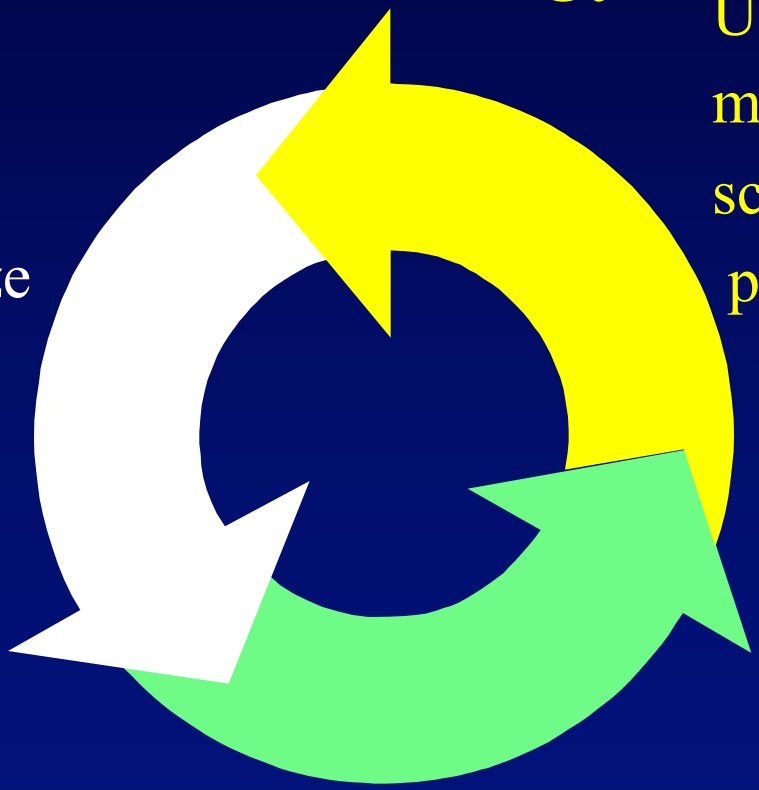
QoS

- Response Time
  - Call set up <= 200ms
- Availability
  - ~99%
- Updates
- Scalability

Goal: A Platform to Study the QoS in NGN Addressing

Methodology

Use the simulation model to study different scenarios and come with promising solutions



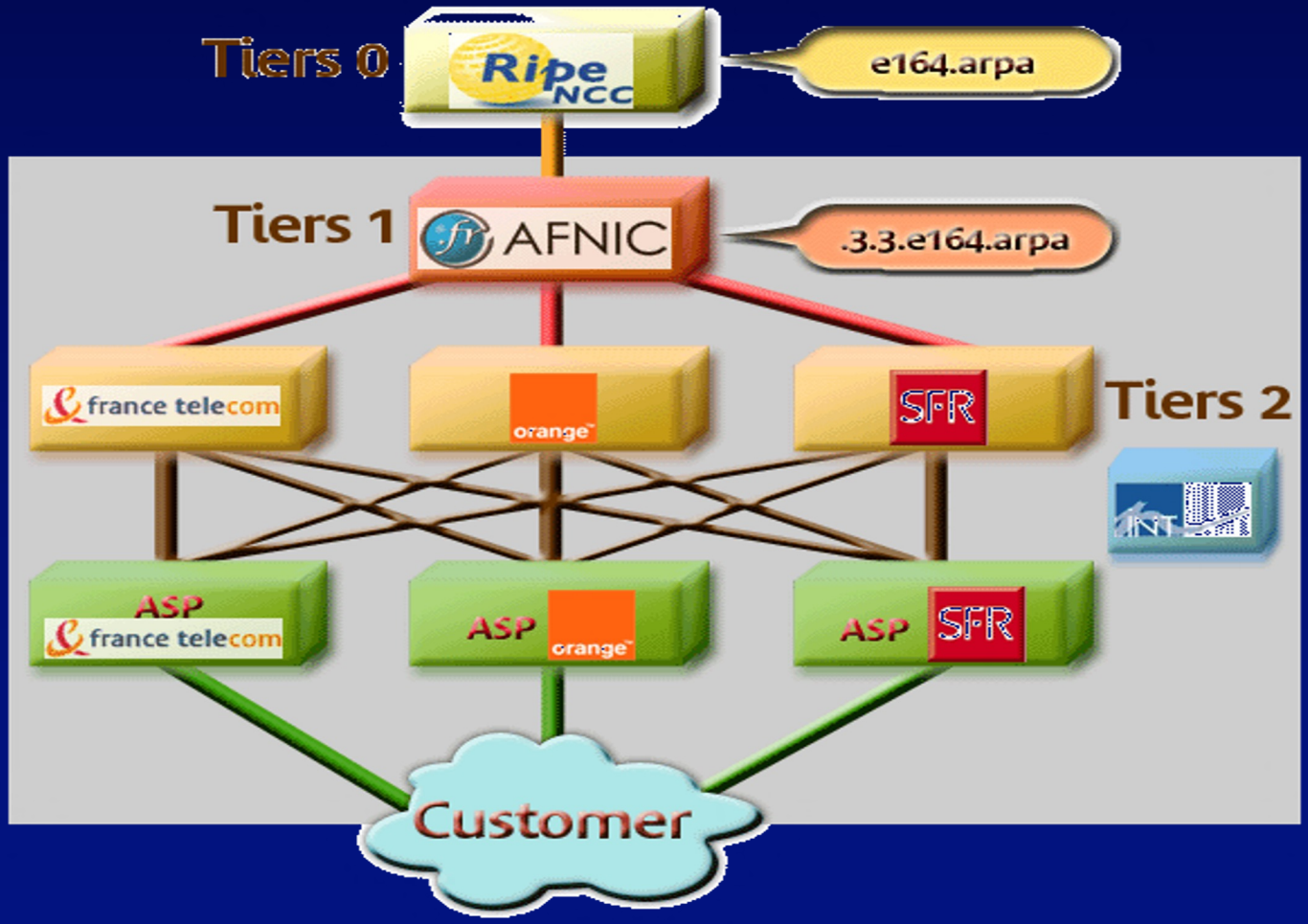
Make empirical measurements, analyze the results and build models

Design build and validate the simulation model with the empirical model

Goal: Use the promising solutions in real implementations

Measurements & Modeling

French ENUM Architecture



Throughput Measurements

ENUM Query throughput is a major concern

[…]
8.5.5.4.6.7.1.6.6.3.3.e164.arpa. NAPTR
[…]

Tier_1

Tier_2 Block

Tier_2 Number

Tier-1	Tier-2 Block	Tier-2 Number
Dell PowerEdge 1750	Sun Fire V210	DS10
2*28 GHz/2Gb	2*1 GHz/2Gb	600 MHz/2Gb
10 Gb	2*36 Gb	36 Gb
Linux FC 1	Solaris 3.0	Tru64 UNIX 5.1
BIND 9.2.3	BIND 9.2.3	BIND 9.2.3
~ 19,000 Qps	~ 13,000 Qps	~ 8,000 Qps

Local Performance Measurements

Resolver

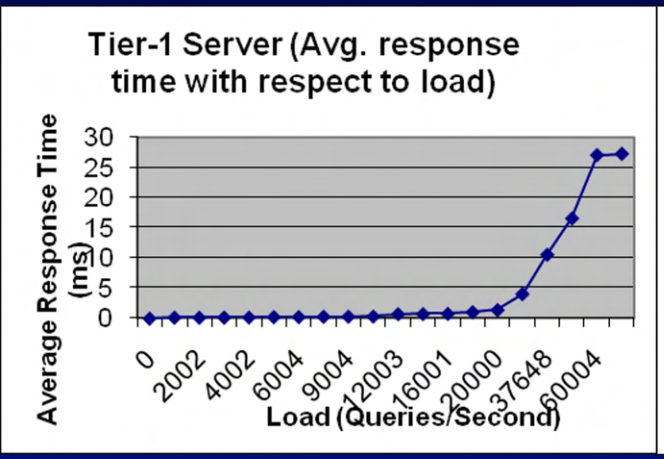
Cache Server

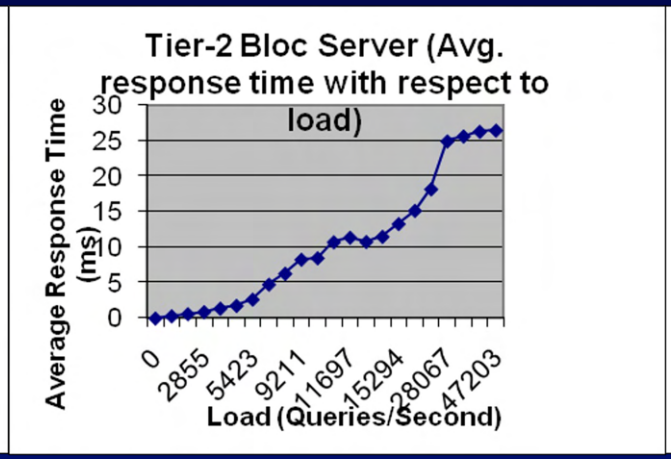
Tier_1

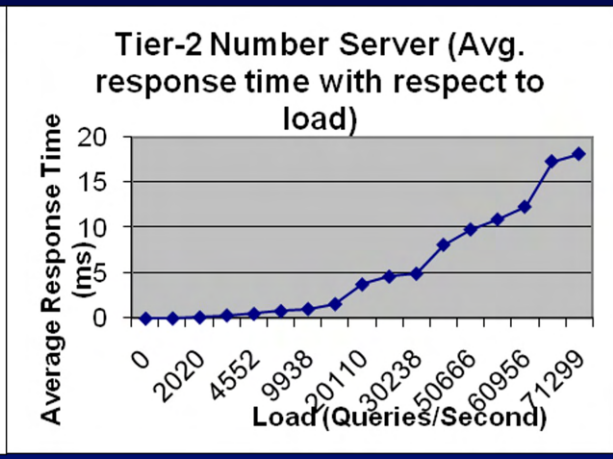
Tier_2 Block

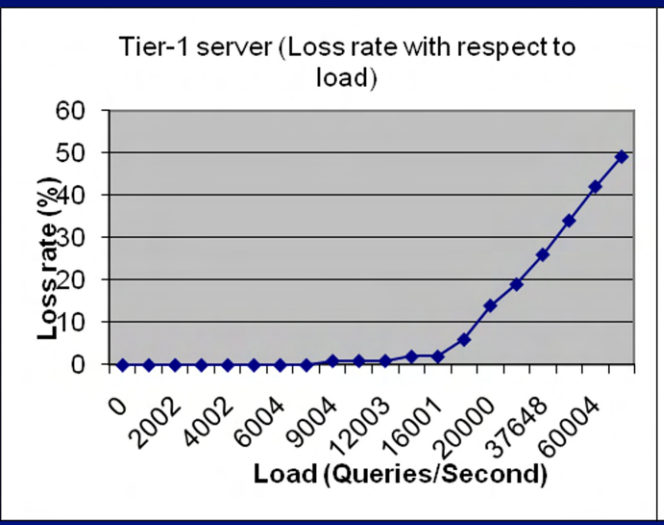
Tier_2 Number

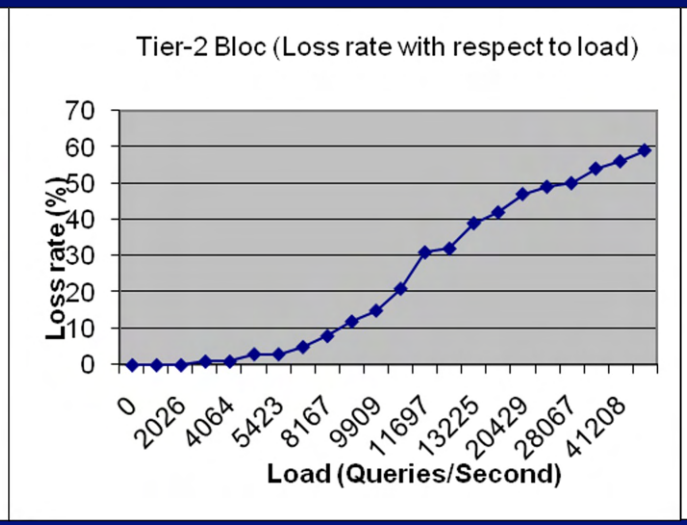
Local Performance - Results

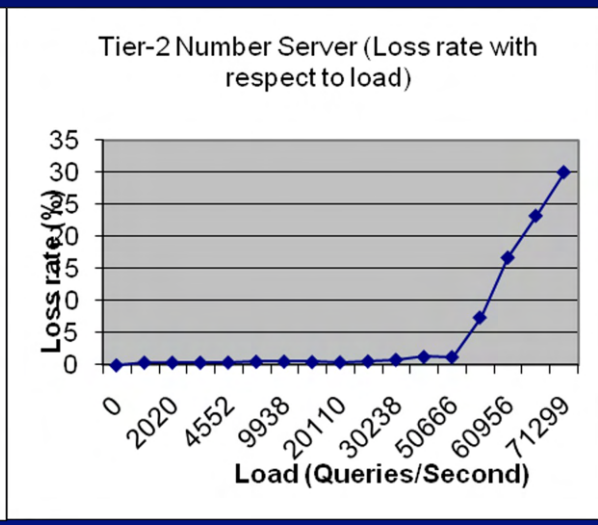




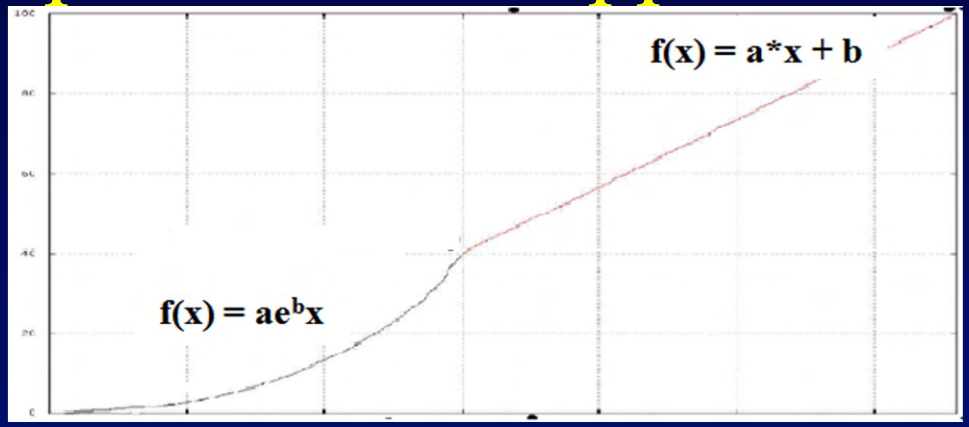


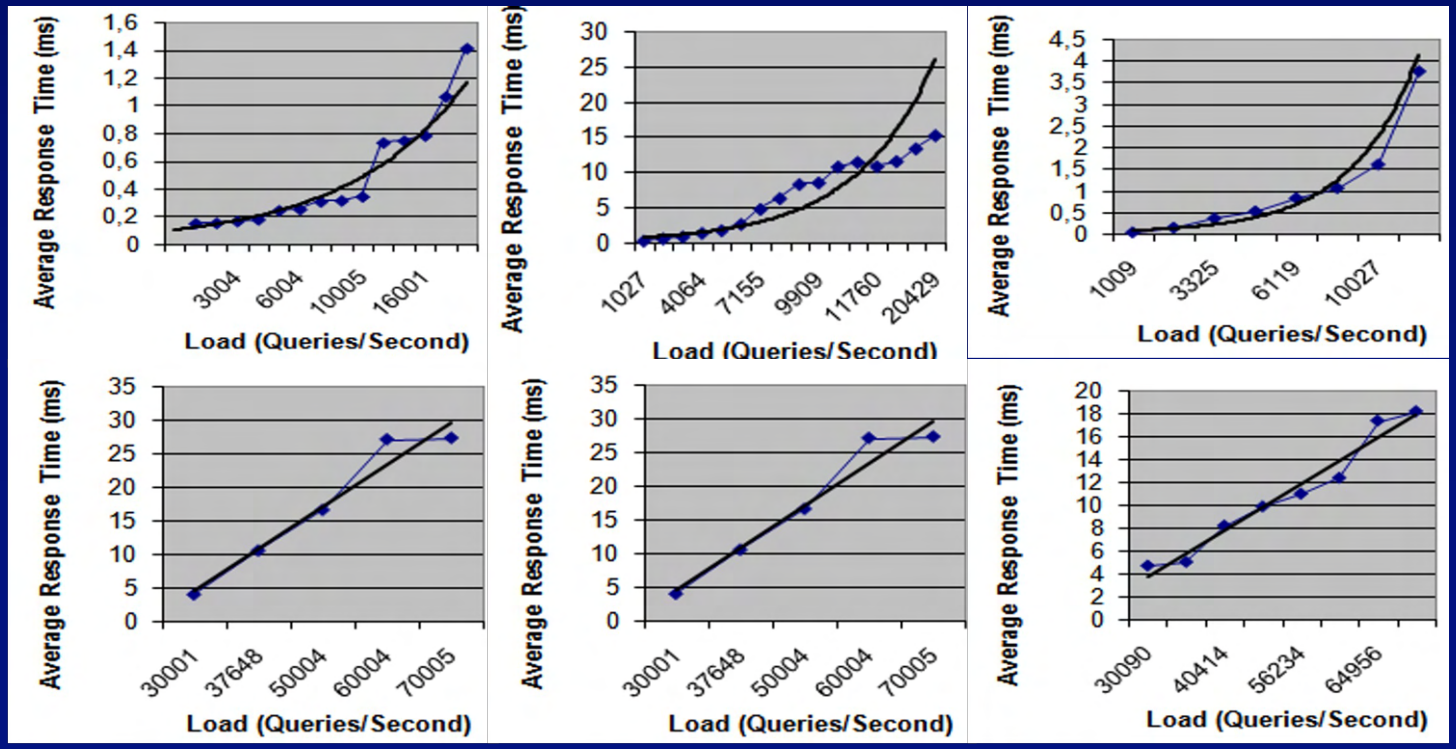




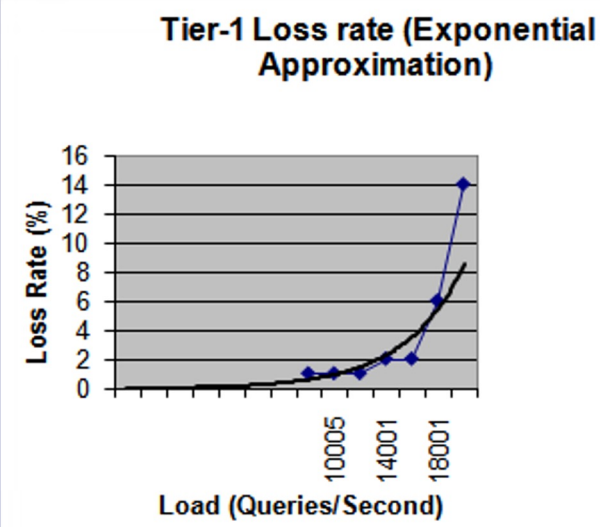


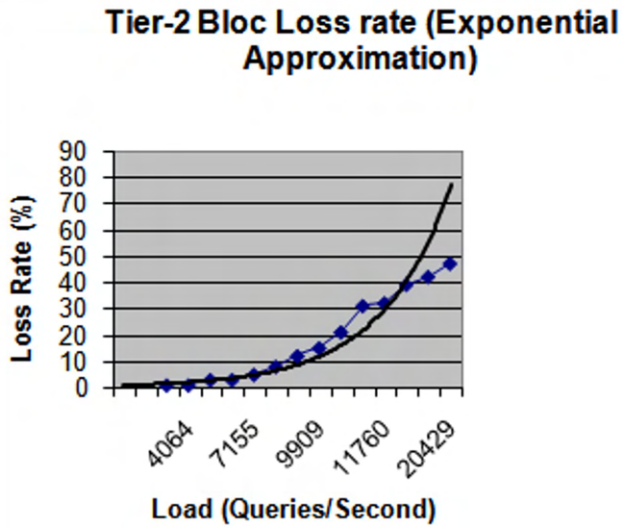
Response Time Approximation

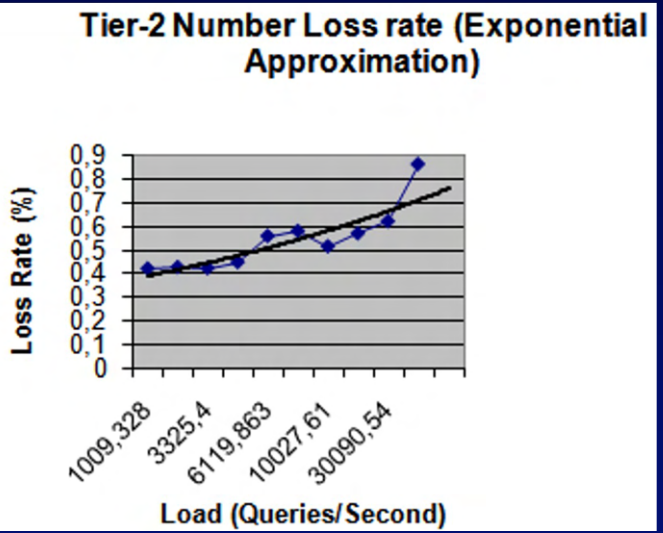


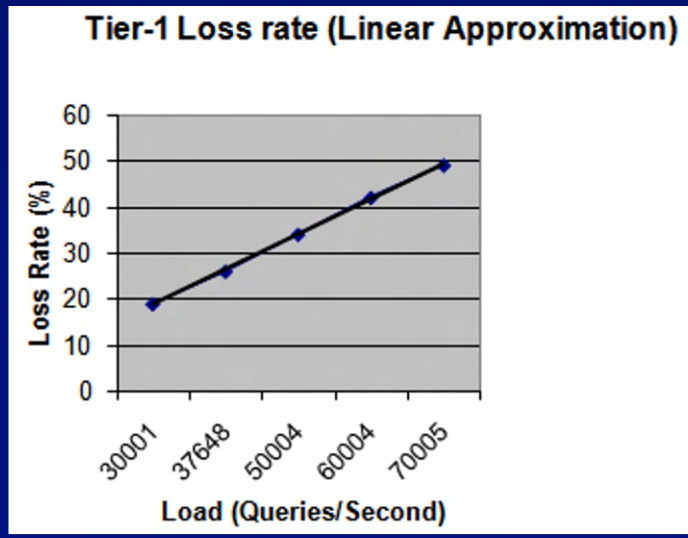


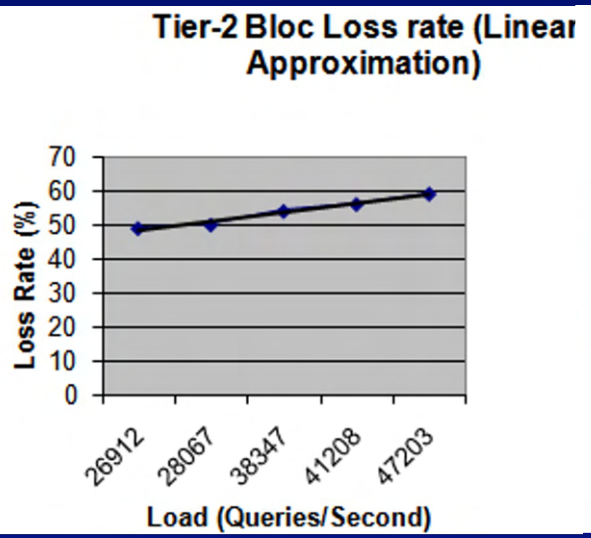
Loss Rate Approximation

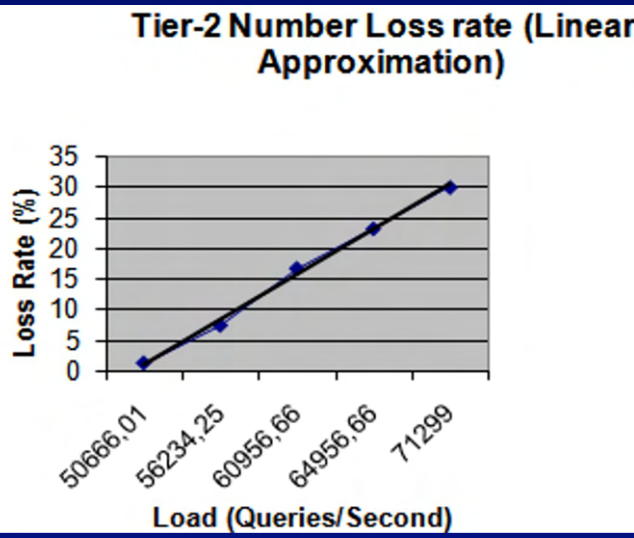




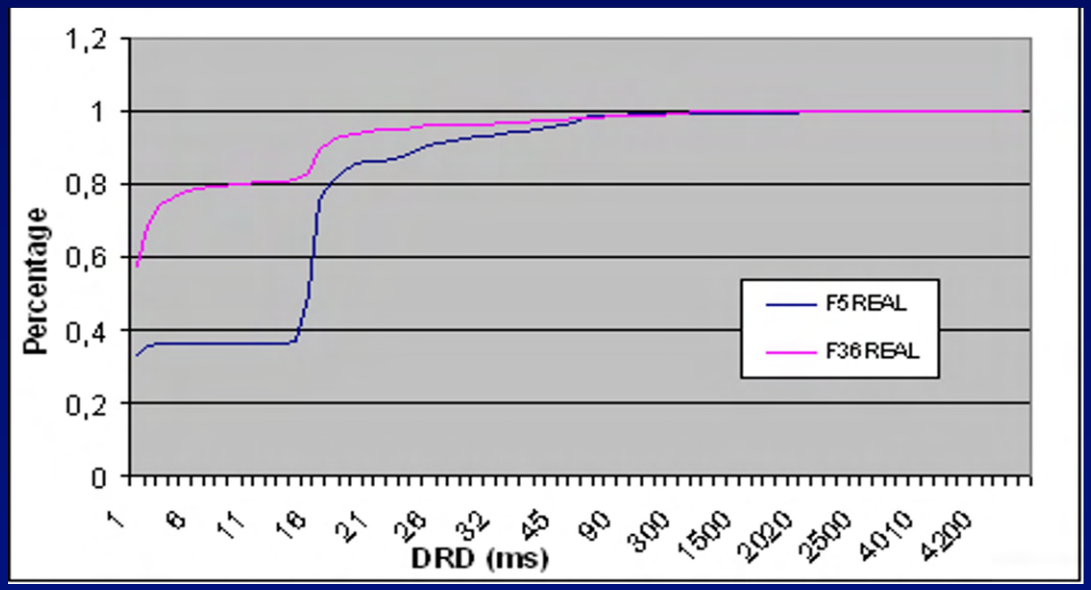








Global Performance - Results



IP Link Measurements

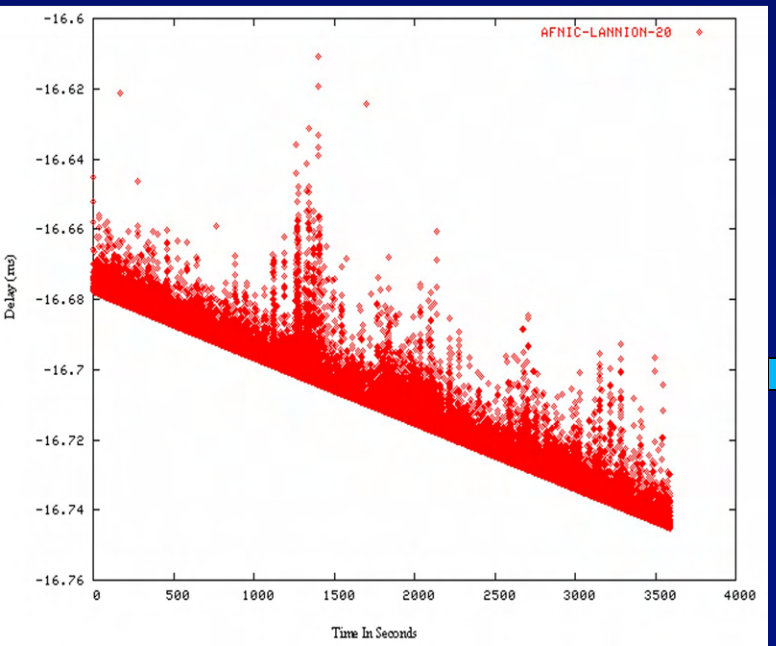
Sender → Receiver

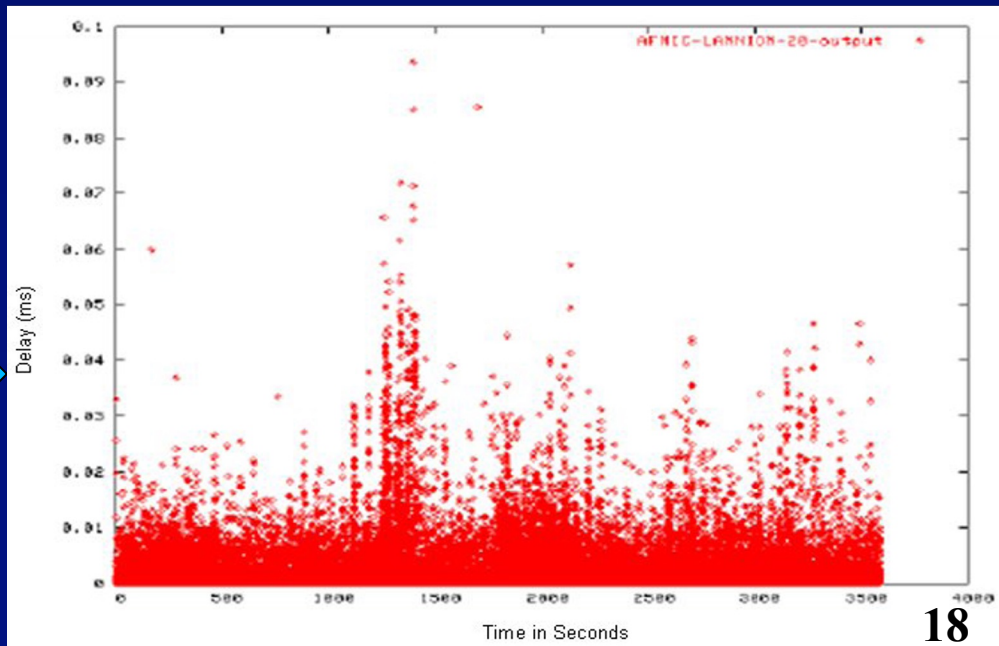
61	1094728989.13132
62	1094728989.15886

Tr – Ts = OWD

Tr – Ts > timeout = Loss

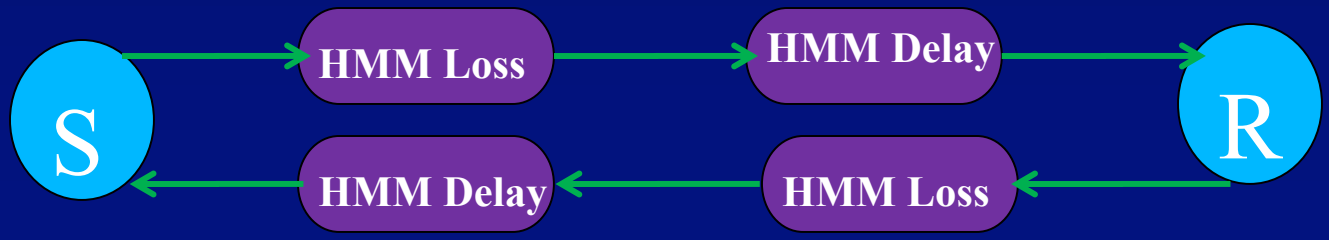
[Zhang et al. and Moon et al]





IP Link Modeling

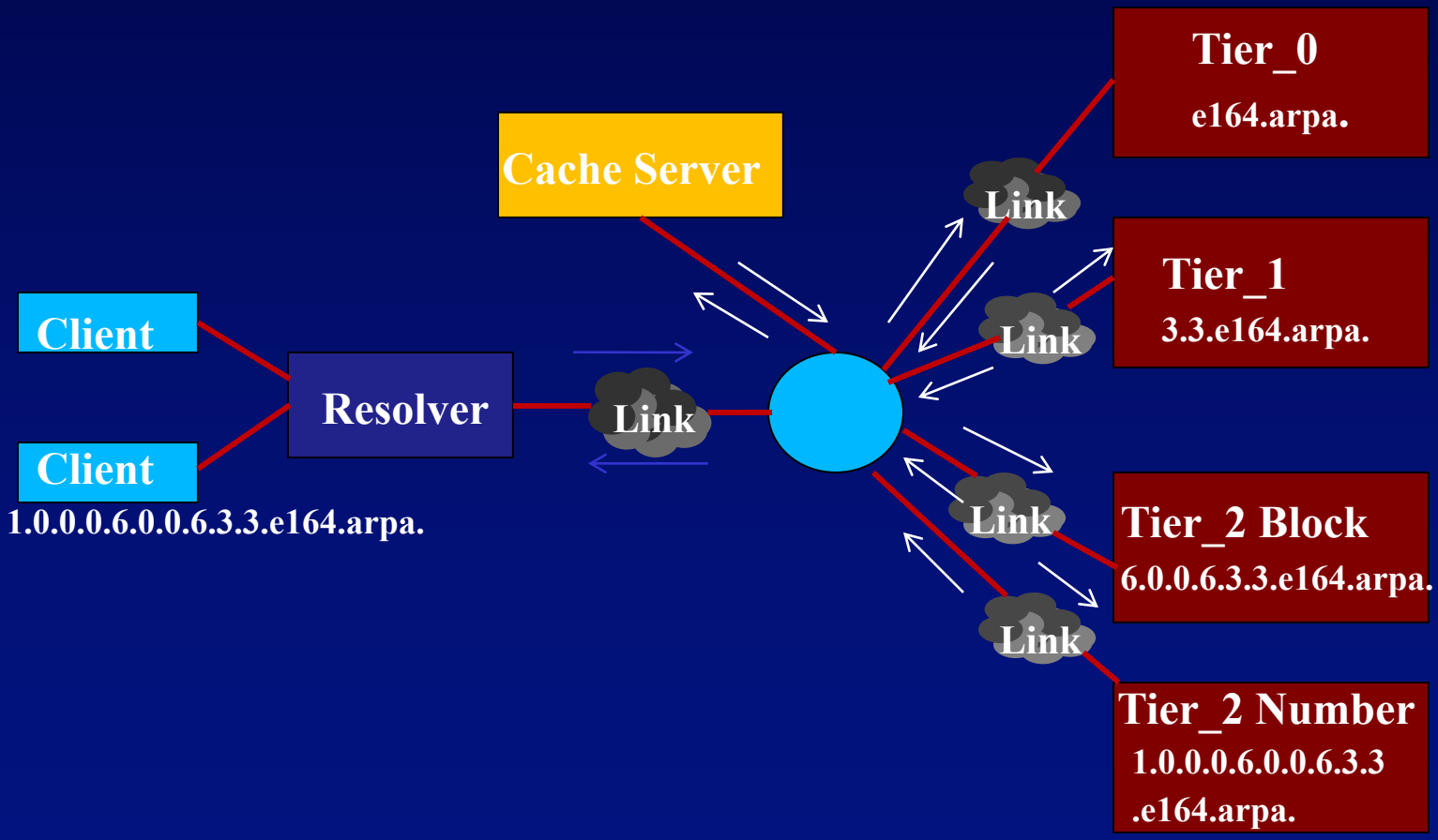
- Characteristics to be reflected
  - Asymmetric
  - Loss & Delay does not occur at the same place
    - Loss occurs only when there is a bottleneck
    - Delay is distributed hop by hop basis
    - Loss & delay are not correlated



[Bugnazet]

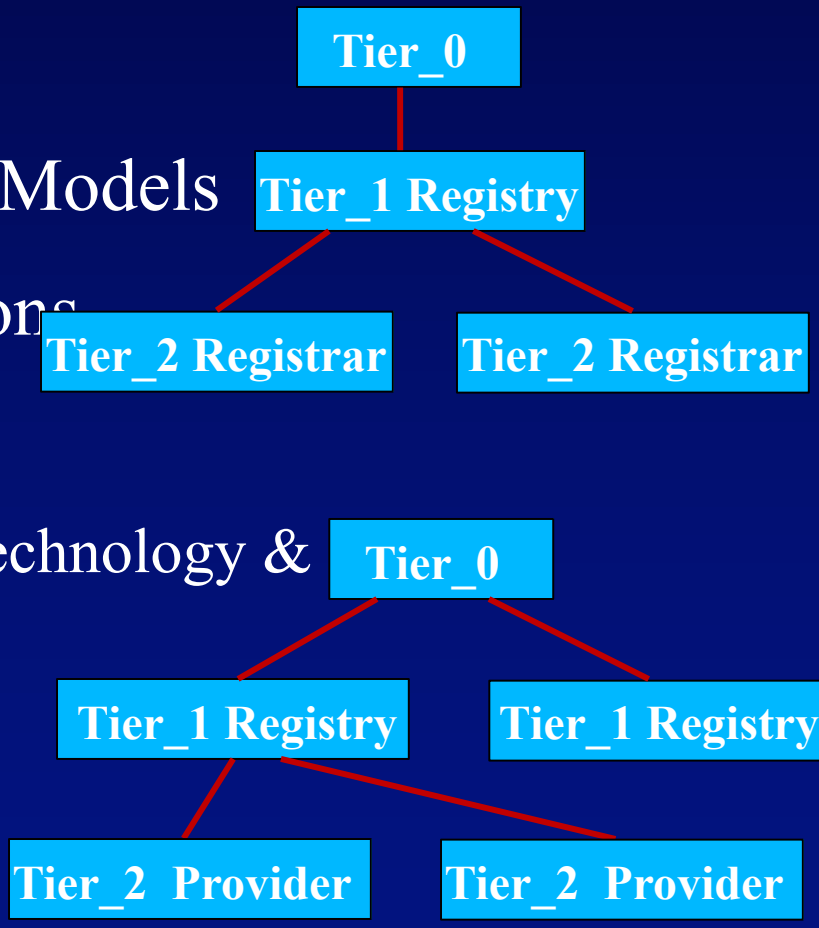
Simulator

Simulation Model



Autonomous Simulation Model

- Different types of ENUM
- Different ENUM delegation Models
- Number of ENUM applications
- Autonomicity
  - NGN Addressing – different technology &
    - Study optimal delegation model
    - Find the optimal metric
    - Add the required resources

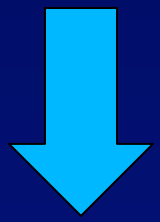


Design Considerations

- NS-2
- Configuration files
- Packet processing

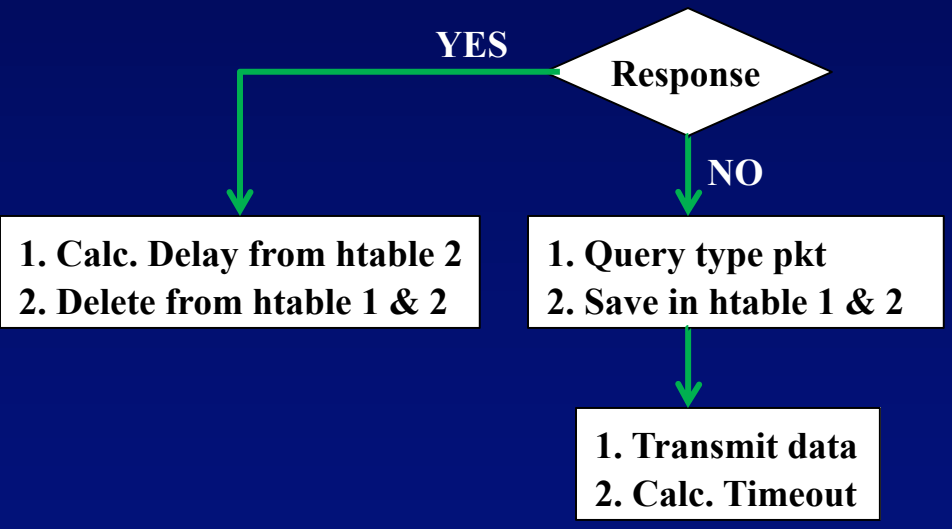
ENUM Client

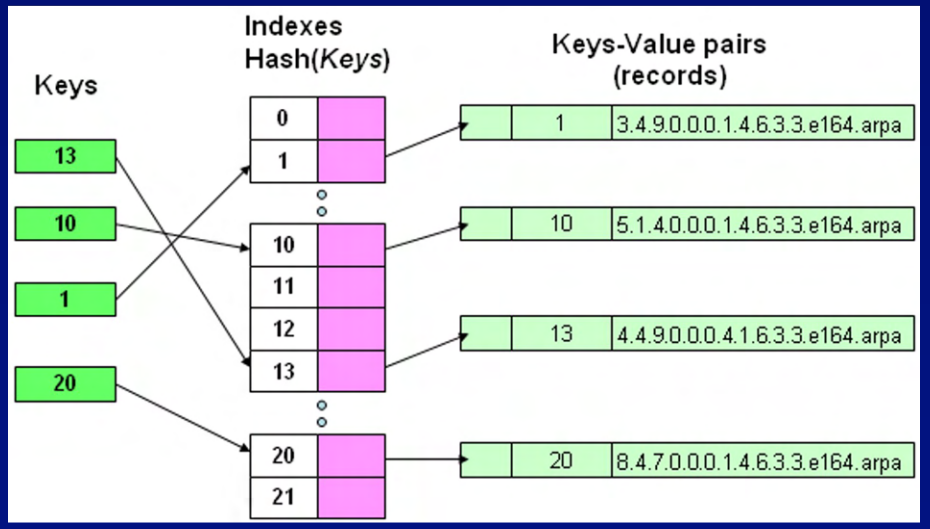
33641000000	**5000**	**500**
33641001000	1000	100



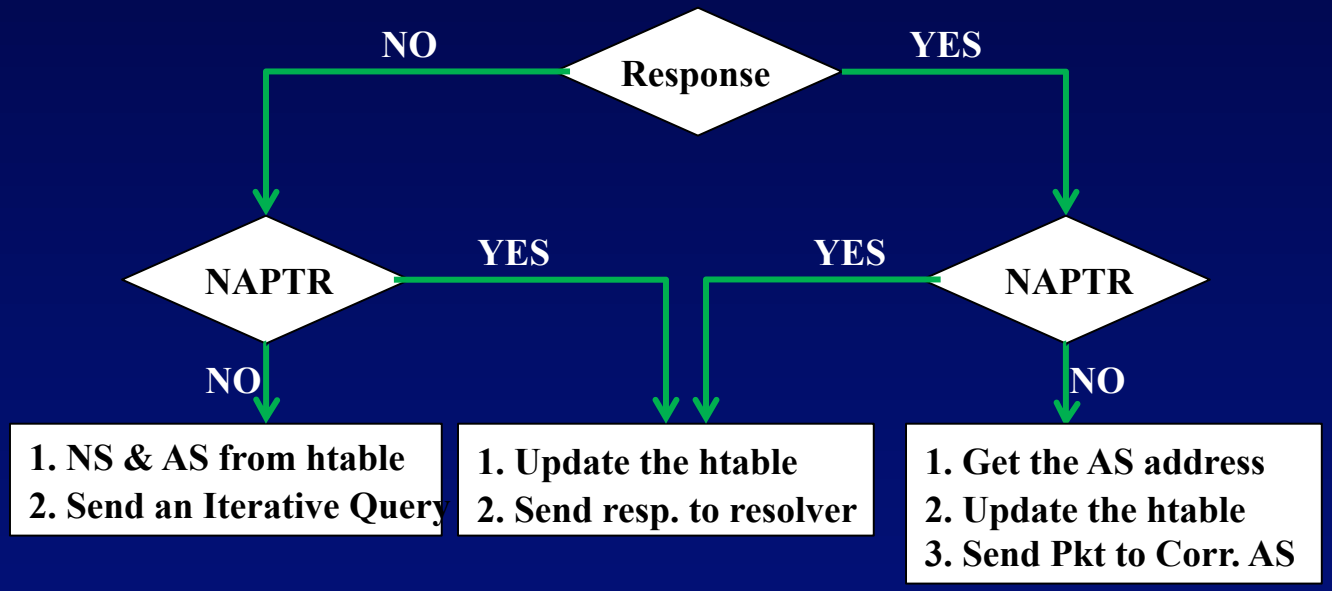
1.0.0.0.6.0.0.6.3.3.e164.arpa.

Resolver


YES
Response
NO
1. Calc. Delay from htable 2
2. Delete from htable 1 & 2
1. Query type pkt
2. Save in htable 1 & 2
1. Transmit data
2. Calc. Timeout

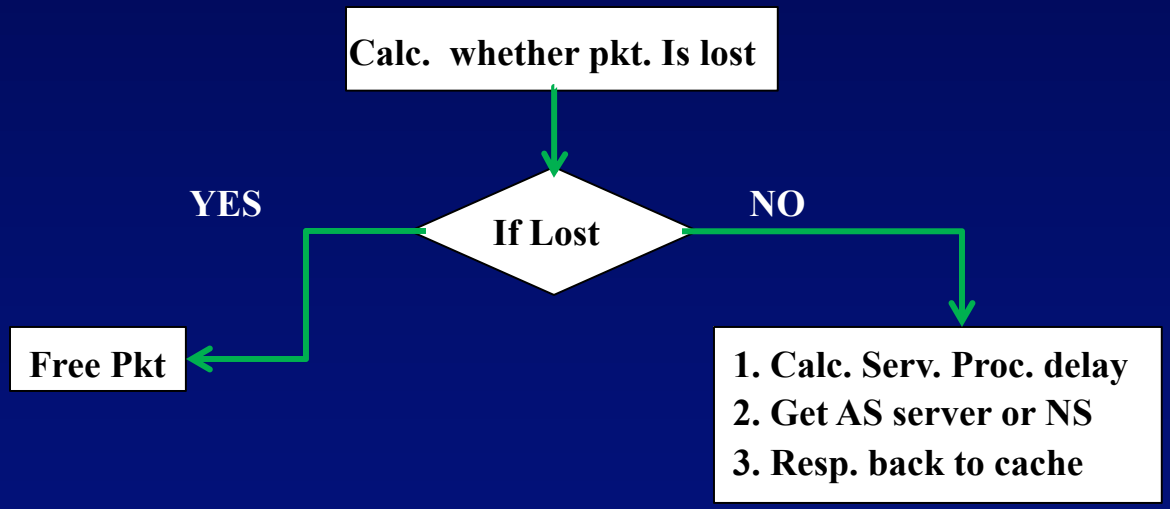

Keys
Indexes
Hash(Keys)
Keys-Value pairs
(records)
13
10
1
20
0
1
10
11
12
13
20
21
1
3.4.9.0.0.0.1.4.6.3.3.e164.arpa
10
5.1.4.0.0.0.1.4.6.3.3.e164.arpa
13
4.4.9.0.0.0.4.1.6.3.3.e164.arpa
20
8.4.7.0.0.0.1.4.6.3.3.e164.arpa

Cache Server

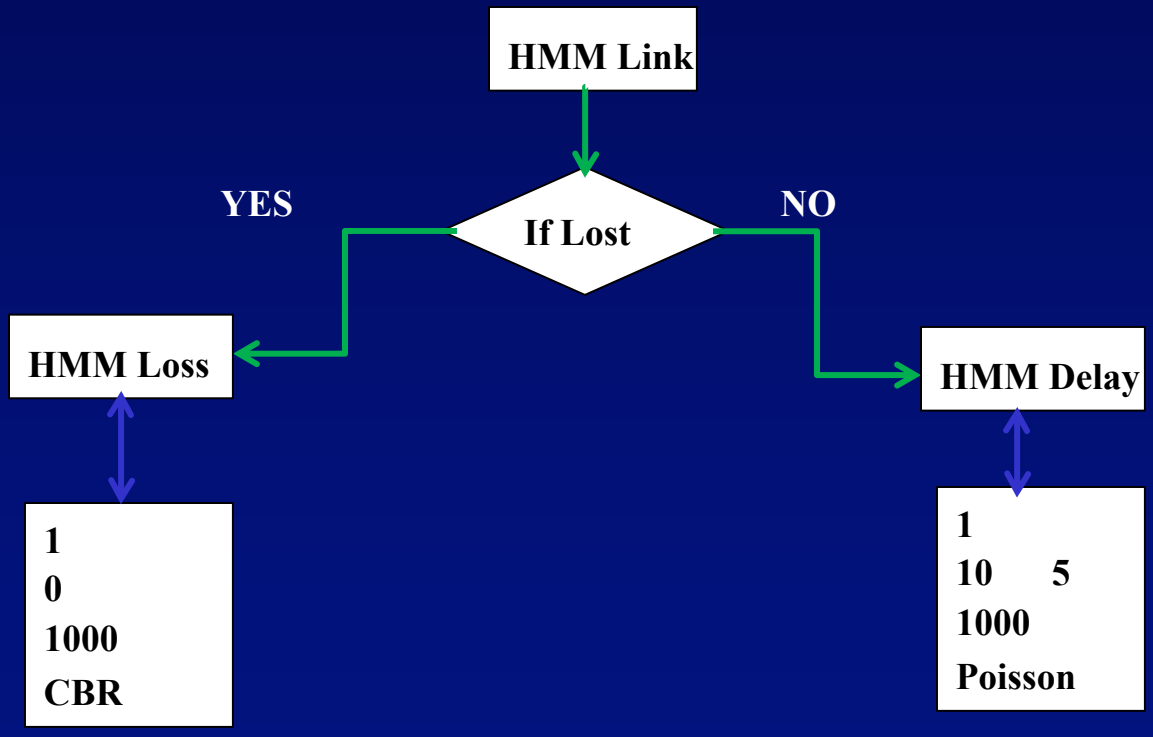


ID	RR Type	Dname	
NS	TTL	Key	Value
AS	TTL	Key	Value
NAPTR	TTL	Key	Value

Authoritative Server

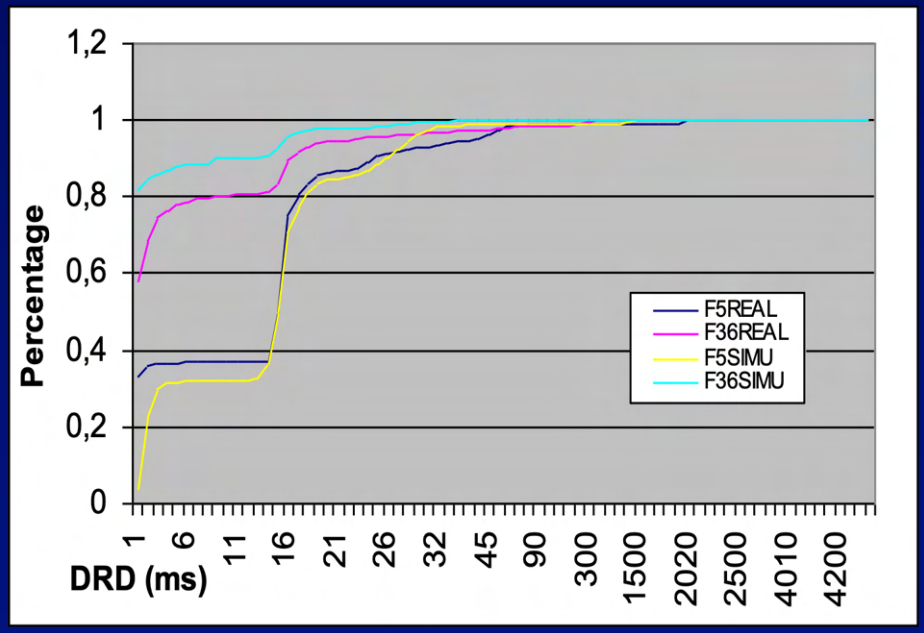


IP Link


HMM Link
If Lost
YES
NO
HMM Loss
HMM Delay
1
0
1000
CBR
1
10 5
1000
Poisson

Validation

- Logic of the simulation program
- Relationship Validity
- Output Validity
- Confidence Interval

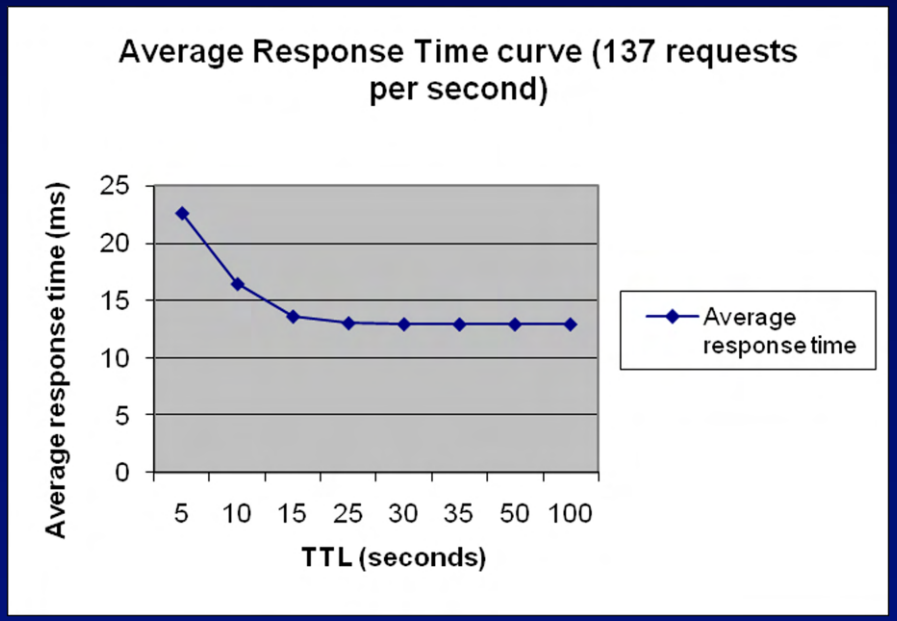


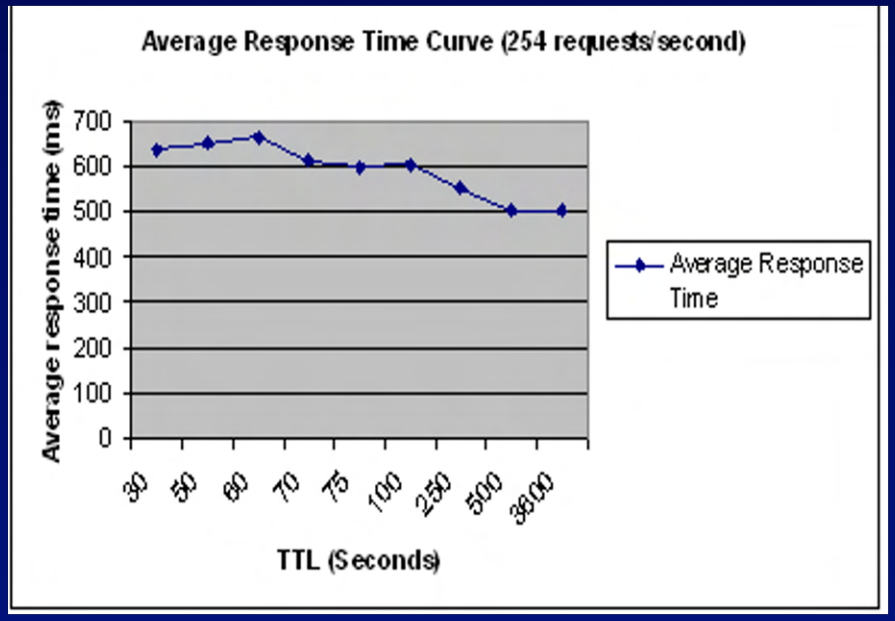
Optimization

Optimization Approaches

- DNS
  - Effective use of Caching
    - TTL is mostly set in days
- ENUM
  - Caching is not effective
    - Faster updates
    - ENUM NAPTR's are too big

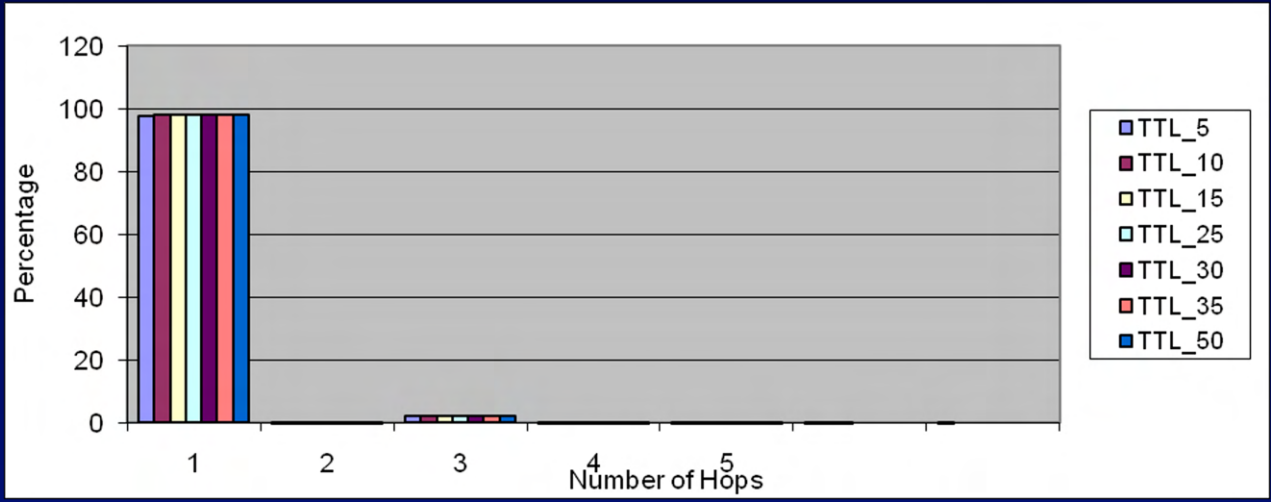
TTL





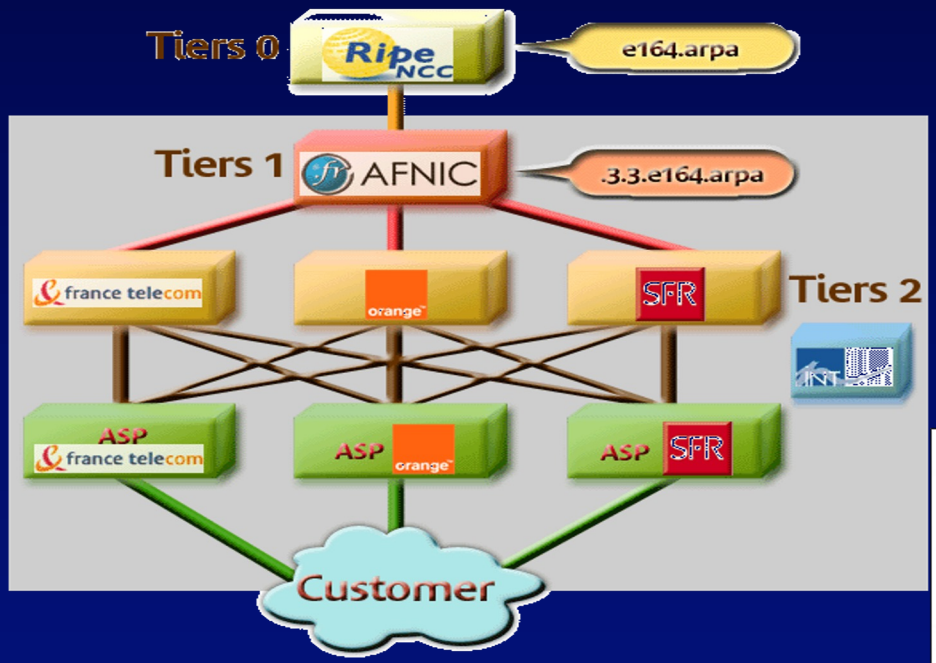
Response time α 1/TTL up to a certain threshhold « K »

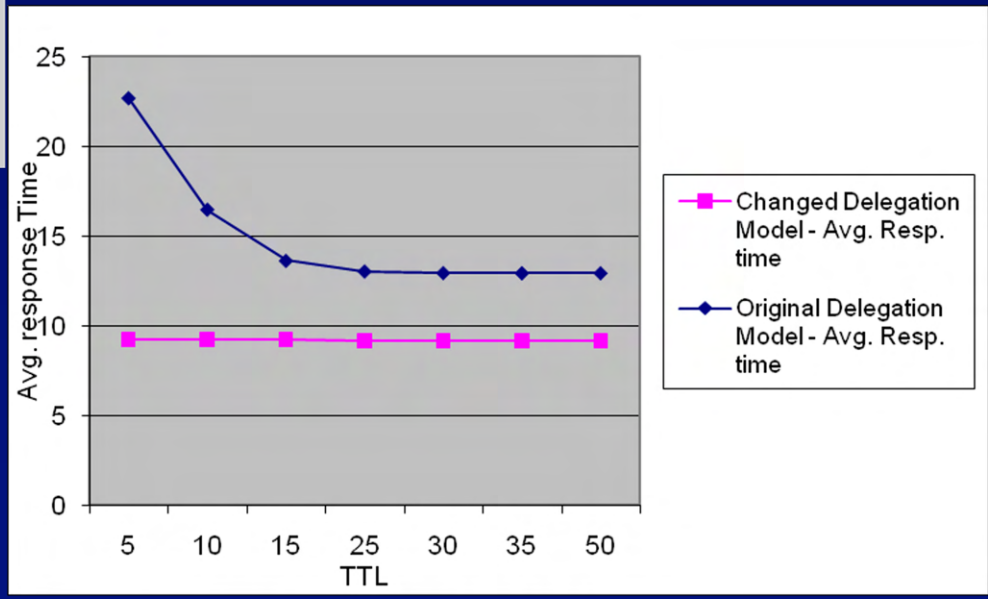
Hop Count (1)



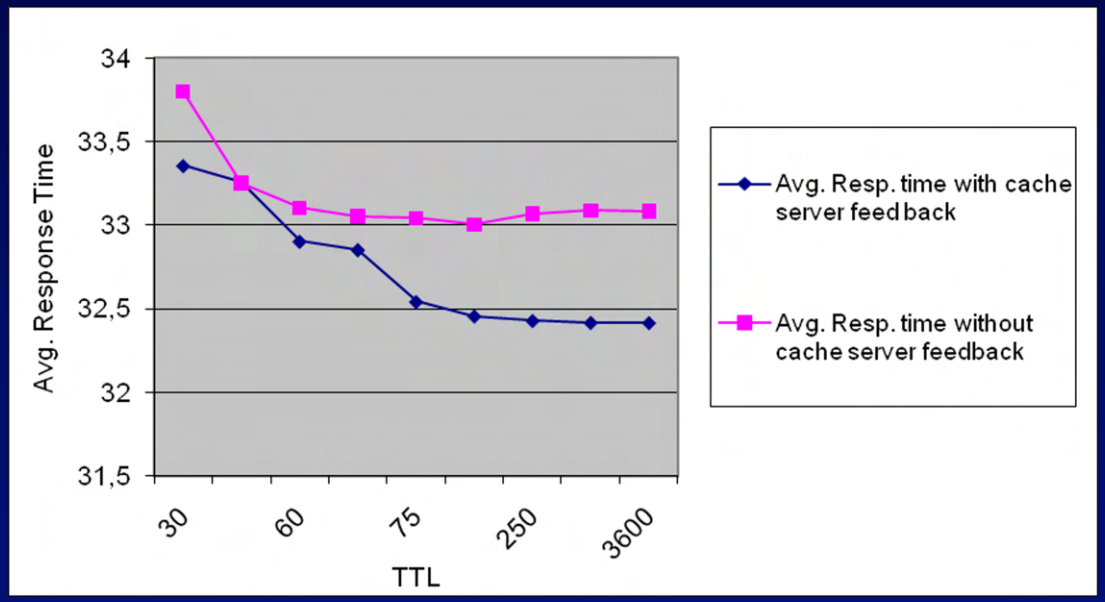
Hop	5	10	15	25	30	50
1	484479	483831	484410	484600	484694	483808
2	50	53	9	10	12	20
3	10892	10836	10842	10946	10801	10943
4	166	103	55	43	40	39
5	52	30	23	13	11	8
6	30	1	2			
7	1					

Hop Count (2)


Tiers 0
Ripe NCC
e164.arpa
Tiers 1
AFNIC
.3.3.e164.arpa
france telecom
orange
SFR
Tiers 2
INT
ASP
france telecom
ASP
orange
ASP
SFR
Customer


Avg. response Time
25
20
15
10
5
0
5
10
15
25
30
35
50
TTL
Changed Delegation Model - Avg. Resp. time
Original Delegation Model - Avg. Resp. time

Link Aware Transport



$n(2), $n(3)

Resolver

Transport
Network
Link
Physical

ack

Cache Server

Transport
Network
Link
Physical

Autonomous

Testing for Autonomicity

- Architecture

Zone "." in {
type hint;
File "db.cache";
}

1
10 5
1000
Poisson

named.conf
db.ROOT-SERVERS
db.e164.arpa.
db.prd.fr.

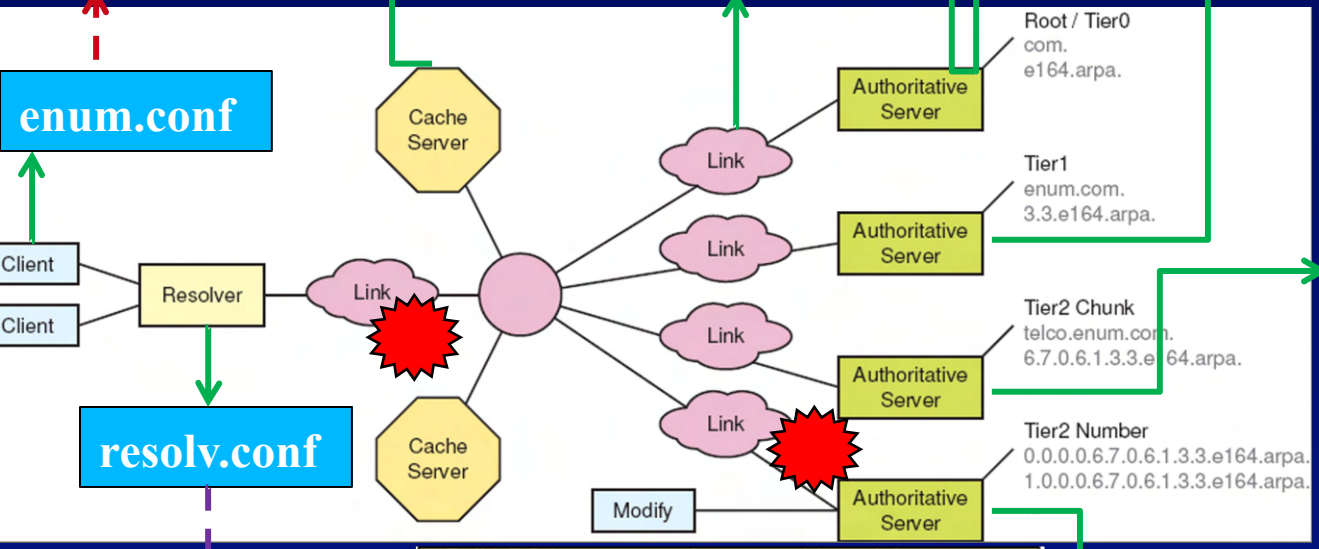
@ IN SOA ns1.numerobis.prd.fr.
admin. ns1.numerobis.prd.fr.(
1;
10800;
3600;
604800;
86400;)
@ IN NS ns1.numerobis.prd.fr.
@ 0.0.1.4.6 IN NS bloc.sfr.numerobis.prd.fr.

named.conf
db.cache

hmm.conf

336 41000000 5000
500

enum.conf



named.conf
db.3.3.e164.arpa.
db.numerobis.prd.fr.

named.conf
db.0.0.1.4.6.3.3.e164.arpa.
db.sfr.numerobis.prd.fr.

resolv.conf

$n(6)
$n(7)

@ IN SOA numero.sfr.numerobis.prd.fr.
admin. numero.sfr.numerobis.prd.fr.(
1;
28800;
27200;
604800;
3600;)
@ IN NS numero.sfr.numerobis.prd.fr.
@ IN NAPTR 2 60

named.conf
db.0.0.0.0.0.0.1.4.6.3.3.e164.arpa.
.....
db.3.4.9.9.1.0.0.4.6.3.3.e164.arpa.

Conclusion

- Identification of one of the key issues in NGN
- Need for an autonomous simulation platform
- Measurements and Modelling
- Build and validate the simulator
- Optimization scenarios
  - Cross Layer
  - Adaptive TTL
  - Architecture modification

- Autonomicity is difficult
- Autonomicity is possible

Future Directions

- Emulation
- Usage of Security extensions, ddos
- Extending Autonomcity

Contributions

- Numerobis, mCampus & mediatvcom
- Eight International Conferences
  - *(Published in the ACM SIGMETRICS Performance Evaluation Review archive Volume 35 , Issue 3 December 2007* &
  - *Published in the NASA Scientific and Technical Aerospace Reports, Volume 44, Issue 24, December 5, 2006)*
- Annals of Telecommunication - Journal
- Credit Incitatif on Interplanetary Internet (GET – 2006) accepted
- Simulation Platform (~ 1500 lines of code)

Questions ?

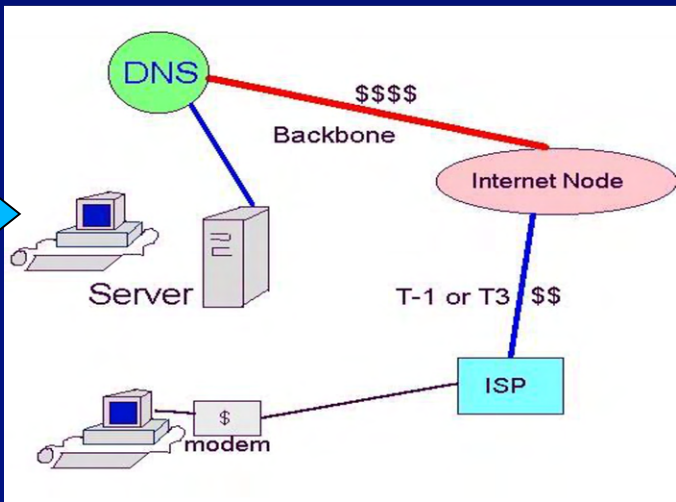
Model

- At QPS, DNS server can be characterized with few metrics.
- Mathematical function to describe evolution over load.
- Model characterizes the whole behavior of a local DNS server.
- Can be used in simulations to derive global DNS Performance from local ones

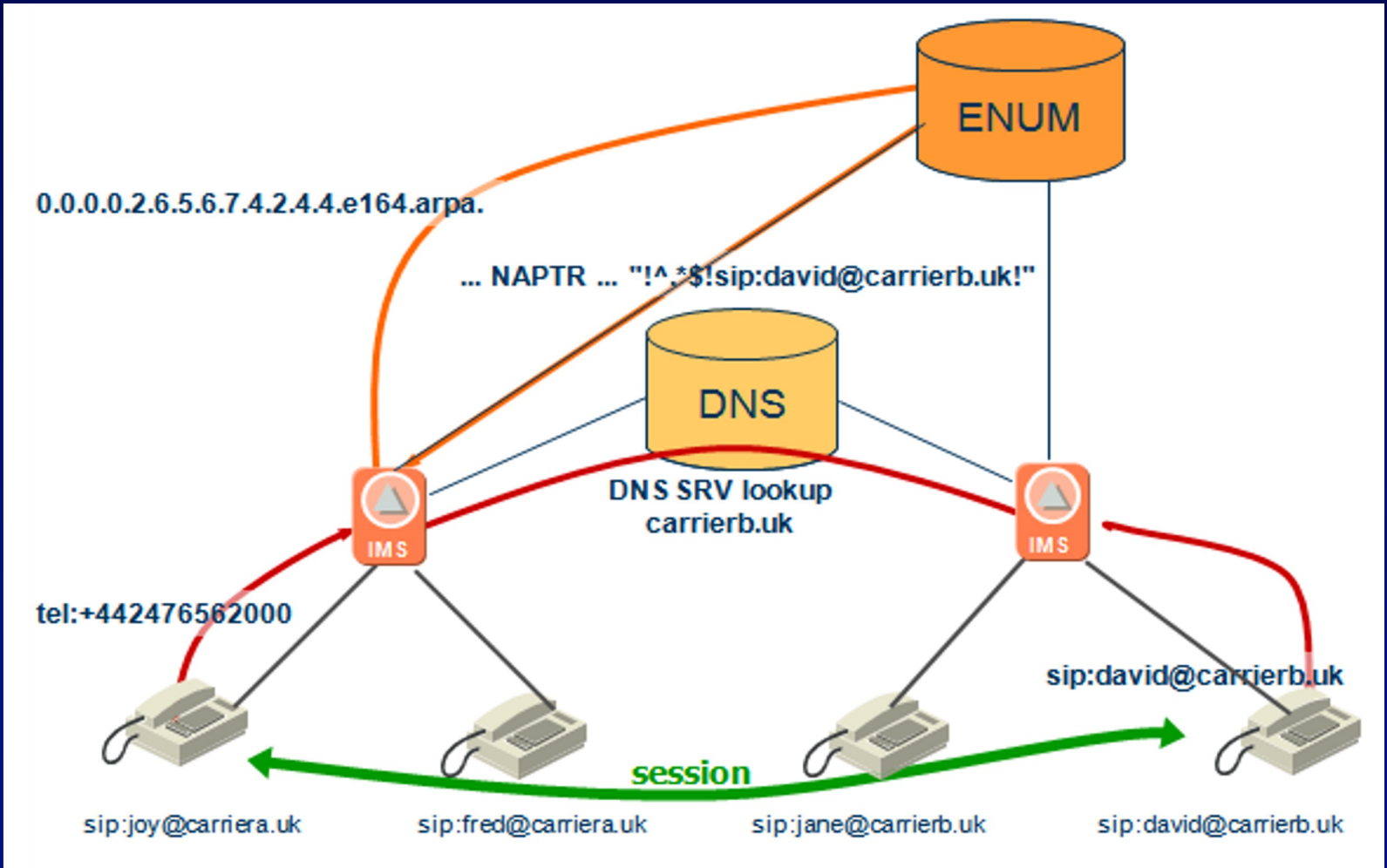
ENUM

- E.164 identifiers
- URI'S
  - mail to : sandoche.balakrichenan@int-evry.fr
  - http://www-rst.int-evry.fr/~balakric
  - sip: sandoche@sipphone.fr

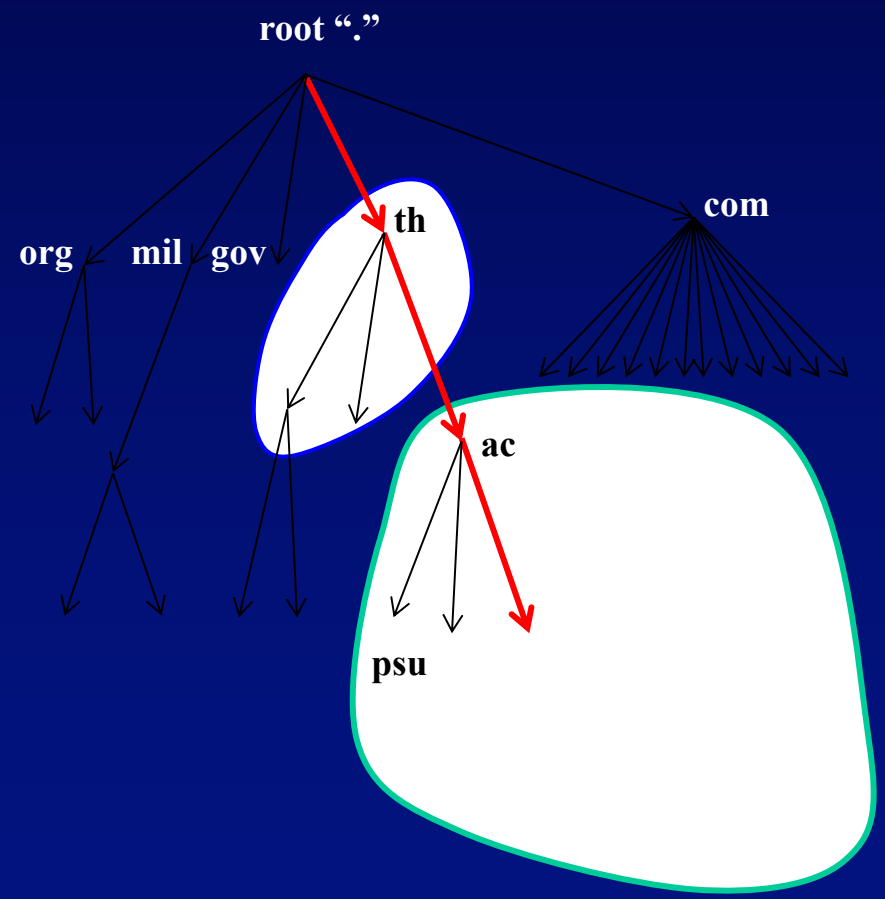
ENUM



Call Establishment Using ENUM in IMS



Tree



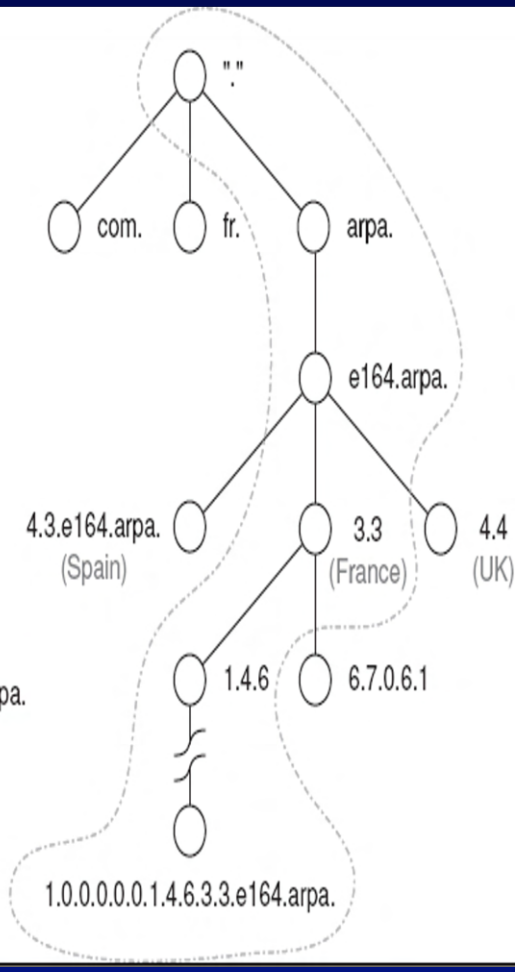
original phone # : (+33)6-41-00-00-01

keep digits only : 33641000001

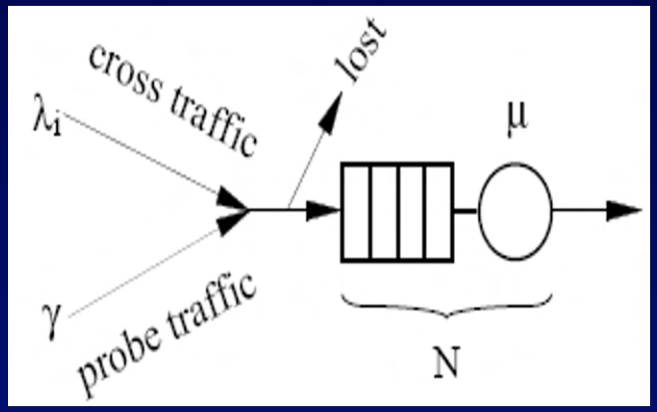
reverse : 100000014633

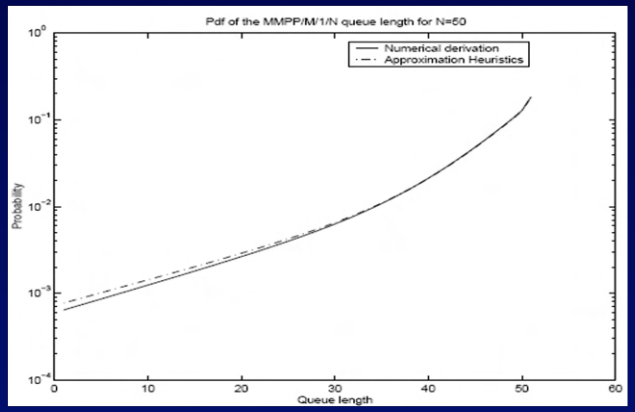
add dots : 1.0.0.0.0.0.1.4.6.3.3

FQDN (add suffix) : 1.0.0.0.0.0.1.4.6.3.3.e164.arpa.



Model Validation



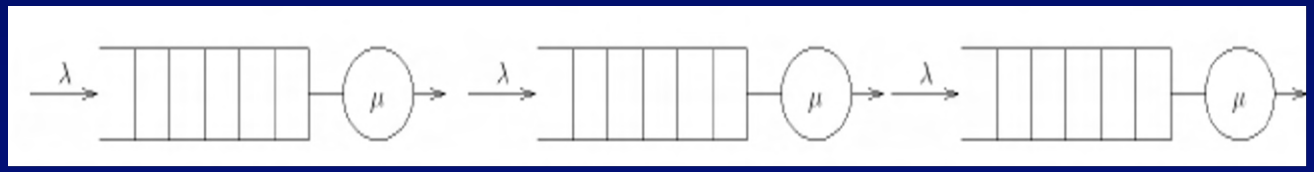


$$\rho = \begin{pmatrix} 20 & 1.2594 & 1.07 \end{pmatrix}$$

$$\Gamma = \begin{pmatrix} 0.937 & 0.0623 & 0.0006 \\ 0.0026 & 0.9973 & 0.0002 \\ 0.0000 & 0.0004 & 0.9996 \end{pmatrix}$$

$$p = \begin{pmatrix} 0.94 & 0.204 & 0.07 \end{pmatrix}$$

$$\Gamma = \begin{pmatrix} 0.9431 & 0.0568 & 0.0000 \\ 0.0022 & 0.9976 & 0.0002 \\ 0.0000 & 0.0008 & 0.9992 \end{pmatrix}$$



Number of Stat	Max. Likelihood	AIC	BIC
1	3.989153	7.978318	7.978374
2	5.801725	11.603471	11.603584
3	5.966903	11.933840	11.934008
4	5.967350	11.934745	11.934969
5	5.978269	11.956594	11.956875

0.944233 0.055767 0.000000
0.078995 0.871870 0.049136
0.000000 0.289698 0.710302

0.019920 0.211656
0.111144 0.405952
0.046572 0.619134