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QoS Measurements IPv6/IPv4

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TF-NGN QoS Monitoring

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Activities on Monitoring

- Traffic Analysis (MIRA Project)
- QoS Parameters Measurement (NetMeter)
- Results from LONG project
- Passive QoS Monitoring

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MIRA Objectives

- Develop a flow-based traffic analysis and classification tool which reports enough information in order to:

1) Gather knowledge about the usage the users do with the network resources.
2) Apply an usage-based billing scheme for cost-sharing in academic networks.
3) Detect irregular network usage (auditing).

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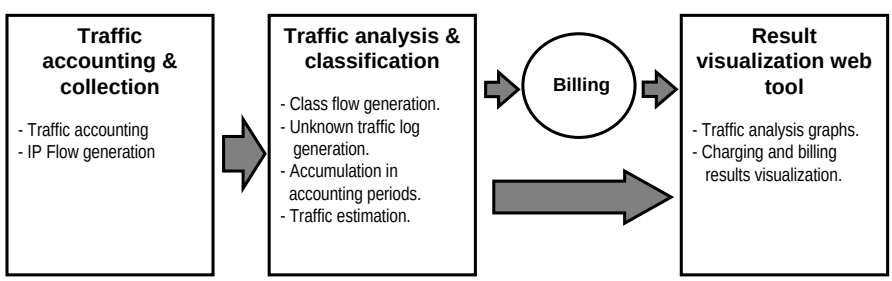
System overview



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Accounting & Collection Platform

- Requirements:
  - Low cost resources.
  - Generate enough information to reach the project objectives.
  - Aggregate captured traffic in IP flow records.
  - Compatible with our network technology (ATM 155 Mbps).
- Difficulties:
  - High-speed networks.
  - High volume information to analyse and store.
- Accounting tools:
  - Intrusive (ex. Cisco NetFlow).
  - Non intrusive (ex. CoralReef).

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Traffic Analysis & Classification

- Difficulties:
  - High volume information is generated by the accounting platform.
  - IP Flow real-time processing.
  - Permanent storage of the network usage information.
  - IP Flows contains too detailed information for billing.
  - Normally, billing periods are longer than the time interval associated with IP Flows.
- Solution: IP Flow transformation.
  - 2 independent processes:
    - Flow transformation process.
    - Accumulation in accounting periods process.

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Flow transformation process (I)

- Objectives:
  - IP flow volume reduction.
  - Translate IP flow information to appropriated parameters for traffic analysis and billing.
- Translation + Accumulation:
  - IP addresses → Entity & Destination groups.
  - Protocol & ports → Application groups.
  - Unidirectional flows → Bi-directional flows.
- Results:
  - IP flows to traffic class flows transformation.
  - Drastic reduction of data storage.
  - Maintains the necessary information for billing.

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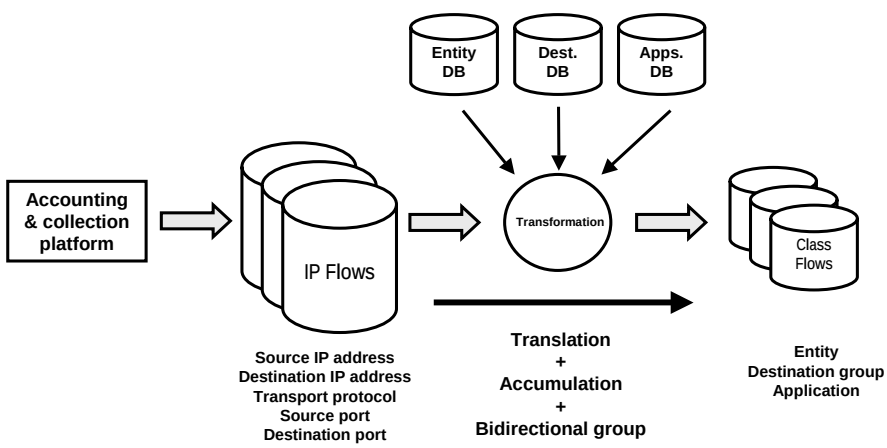
Flow transformation process (II)



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Flow transformation example

Source IP address	Dest. IP address	Protocol	Source port	Dest. port	Packets	Bytes
130.206.1.2	147.83.130.7	6	80	1526	18	24569
138.100.4.2	147.83.130.130	6	80	57917	41	20916
12.216.228.108	161.116.70.61	6	2062	6347	8	725
163.117.136.192	147.83.41.11	6	2130	80	5	571
...	...	...	...	...	...	...

Source IP address	Dest. IP address	Protocol	Source Port	Dest. port	Packets	Bytes
147.83.130.130	138.100.4.2	6	57917	80	24	1332
147.83.130.7	130.206.1.2	6	1526	80	14	988
147.83.41.11	163.117.136.192	6	80	2130	4	335
161.116.70.61	12.216.228.108	6	6347	2062	9	1068
...	...	...	...	...	...	...

ENTITY	DEST. GROUP	APPLICATION	PKTS IN	BYTES IN	PKTS OUT	BYTES OUT
UPC	REDIRIS	WWW	64	46056	42	2655
UB	USA	GNUTELLA	8	725	9	1068
...	...	...	...	...	...	...

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Unknown traffic logs usefulness

- Are useful to detect:
  - New entities.
  - New applications.
  - New transport protocols.
  - Irregular or strange usage of the network.
  - Attacks in the monitored network.
  - Bad network entity configurations.
  - etc.
- In general:
  - Permit to know the usage of the network in more detailed way.

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Billing matrix

- Sets a price per volume unit for each traffic class.
- Billing matrix parameters:
  - Entity
  - Destination group
  - Application group
  - Traffic direction
  - Volume
- Permits to differentiate more possible academic applications from less academic ones.
  - ex. Application + Destination combination.
- Many matrix combinations to assign:
  - Default matrix *vs.* specific entity matrix.

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Billing matrix example

	DEST-1 In	*DEST-1 Out*	*DEST-2 In*	*DEST-2 Out*	*...*	*DEST-m In*	*DEST-m Out*
APP-1	1	1	0.5	0.5	...	1	1
APP-2	2	2	1	1	...	2	2
APP-3	2	2.5	1	1.25	...	2	2.5
...	...	...	...	...	...	...	...
APP-n	1	1	0.5	0.5	...	1	1

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Detailed Billing

App Group	Dest. Group	Bytes in	Bytes out	Cost in	Cost out
GAMES	ESPANIX	1.269.434.119	877.998.477	2,54	1,76
	GEANT	358.291.986	1.300.861.516	0,72	2,60
	REDIRIS	33.568.927	105.057.228	0,03	0,11
	USA	509.005.847	1.408.315.378	1,02	2,82
	MCAST	0	0	0,00	0,00
P2P	ESPANIX	7.357.368.841	6.752.278.660	14,71	16,88
	GEANT	1.271.258.523	6.563.840.850	2,54	16,41
	REDIRIS	866.960.752	4.843.256.185	0,87	6,05
	USA	3.231.367.666	6.854.660.388	6,46	17,14
	MCAST	0	0	0,00	0,00
WWW	ESPANIX	11.735.443.286	17.589.200.561	11,74	17,59
	GEANT	5.462.445.756	6.172.086.375	5,46	6,17
	REDIRIS	4.229.836.612	1.062.591.315	2,11	0,53
	USA	31.129.467.647	22.361.413.450	31,13	22,36
	MCAST	0	0	0,00	0,00
...	...	...	...	...	...
TOTAL		116.061.901.833	172.735.794.350	124,86	204,88
		288.797.696.183		329,75 €	

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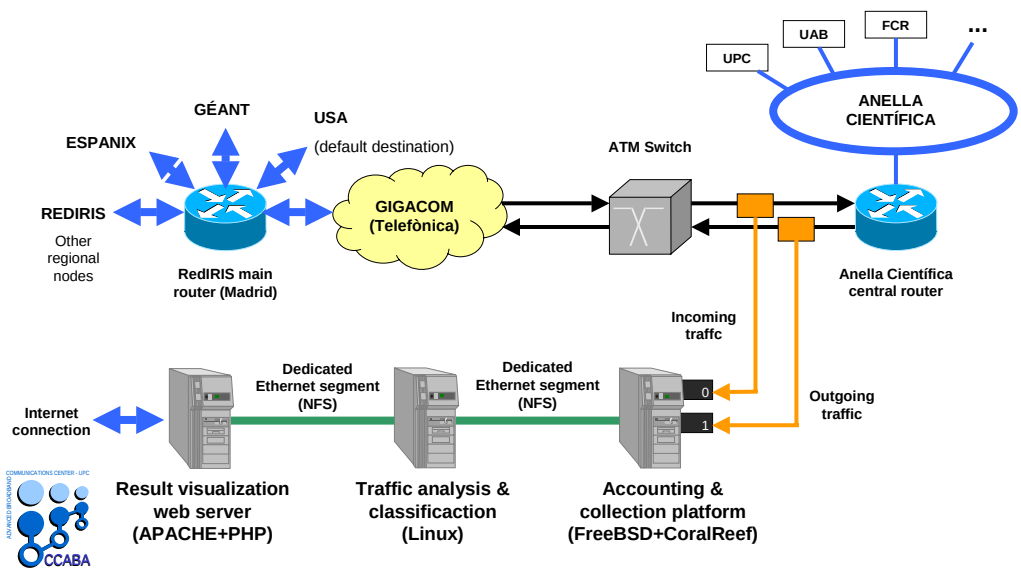
Traffic Analysis on the *Anella Científica*



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Classification parameters (I)

- Entities connected to the Anella Científica determine the studied entities:
  - Anella Científica Entities
  - Unknown Entity (UKNWN) + Multicast Entity (MCAST)
- RedIRIS national and international links determine the selected destination groups:
  - RedIRIS
  - ESPANIX
  - GÉANT
  - USA (default destination)
  - MULTICAST
- Network administrator has to decide the application groups.

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Classification parameters (II)

- Application groups:
  - The most reduced possible number of application groups.
  - Enough detailed groups for traffic analysis and auditing tasks.
  - Similar application groups:
    - WWW: HTTP, HTTPS, SQUID, etc.
    - MAIL: POP, IMAP, SMTP, etc.
    - P2P: GNUTELLA, IMESH, EDONKEY, etc.
    - GAMES: QUAKE, UNREAL, etc.
    - Etc.
  - Special applications:
    - Unknown TCP/UDP application (A_UKNWN)
    - Non TCP/UDP (NO_TCPUDP)
    - Unknown transport protocol (T_UKNWN).

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“Complex” bill matrix (II)

	ESPANIX In	ESPANIX Out	GÉANT In	GÉANT Out	REDIRIS In	REDIRIS out	USA In	USA Out	MCAST in	MCAST out
A_UKNWN	1.5	1.5	0.75	0.75	0.5	0.5	1.25	1.25	1	1
DNS	0.75	0.75	0.37	0.37	0.25	0.25	0.62	0.62	0.5	0.5
FTP	1.5	1.5	0.75	0.75	0.5	0.5	1.25	1.25	1	1
GAMES	4.5	4.5	2.25	2.25	1.5	1.5	3.75	3.75	3	3
IRC	3	3	1.5	1.5	1	1	2.5	2.5	2	2
MAIL	0.75	0.75	0.37	0.37	0.25	0.25	0.62	0.62	0.5	0.5
MULTIMEDIA	3	3	1.5	1.5	1	1	2.5	2.5	2	2
NETFS	1.12	1.12	0.56	0.56	0.37	0.37	0.94	0.94	0.75	0.75
NETWORK	0.75	0.75	0.37	0.37	0.25	0.25	0.62	0.62	0.5	0.5
NEWS	1.5	1.5	0.75	0.75	0.5	0.5	1.25	1.25	1	1
NO_TCPUDP	1.5	1.5	0.75	0.75	0.5	0.5	1.25	1.25	1	1
OTHERS	1.5	1.5	0.75	0.75	0.5	0.5	1.25	1.25	1	1
P2P	4.5	7.5	2.25	3.75	1.5	2.5	3.75	6.25	3	5
TELNET	1.12	1.12	0.56	0.56	0.37	0.37	0.94	0.94	0.75	0.75
T_UKNWN	1.5	1.5	0.75	0.75	0.5	0.5	1.25	1.25	1	1
UNIX	1.12	1.12	0.56	0.56	0.37	0.37	0.94	0.94	0.75	0.75
WWW	1.5	1.12	0.75	0.56	0.5	0.37	1.25	0.94	1	0.75

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QoS Measurements for Diffserv Experiences

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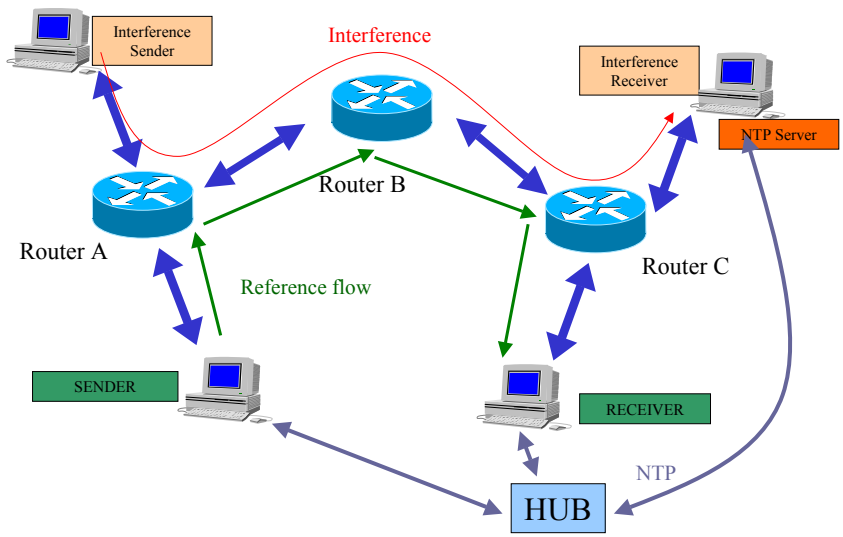
Quality of Service over IPv6



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QoS over IPv6

- Measurement of main parameters (delay, jitter ... vs. sending rate) for reference flow. All IPv4 vs. All IPv6 scenarios.
- Focus on Diffserv (Expedited Forwarding)
- Scheduling schemes
  - FIFO
  - Priority queueing (PQ)
  - Weighted Fair Queueing (WFQ)
  - Others
- Background load
  - 50%
  - 100%
- Queue sizes
- Transmit queue sizes
- Working on GPS synchronization

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NetMeter

- TCL/TK interface that allows remote control of test machines, compiling the results and flexibly drawing graphics.
- MGENv4 & v6
- Netperfv4 & v6
- Graphics:
  - One-way delay
  - IPDV
  - Throughput
  - Packet Losses
  - One-way delay distribution
  - IPDV distribution

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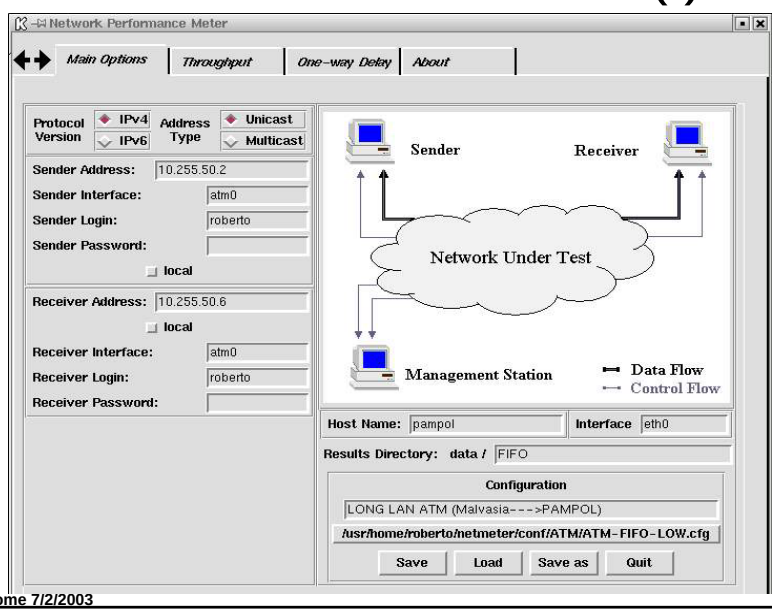
NetMeter Screenshots (I)



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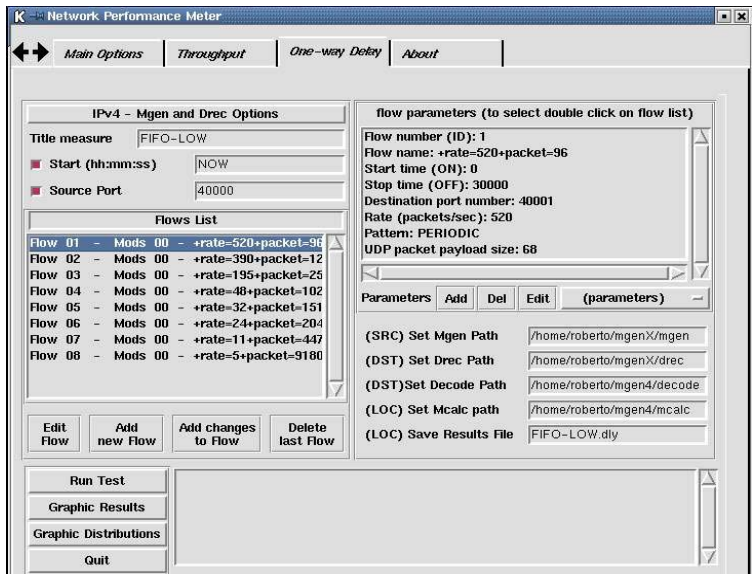
NetMeter Screenshots (II)



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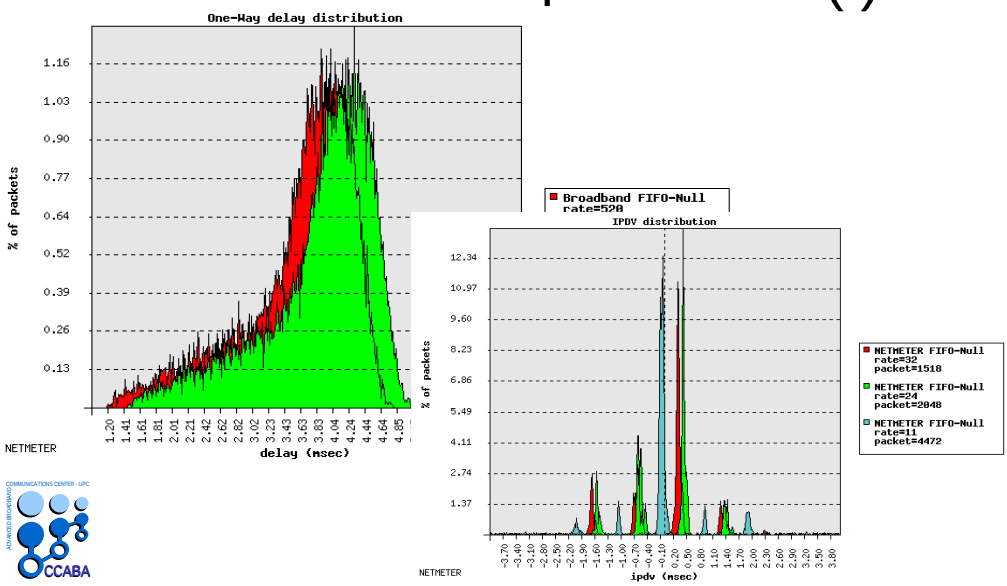
NetMeter: Sample results (I)



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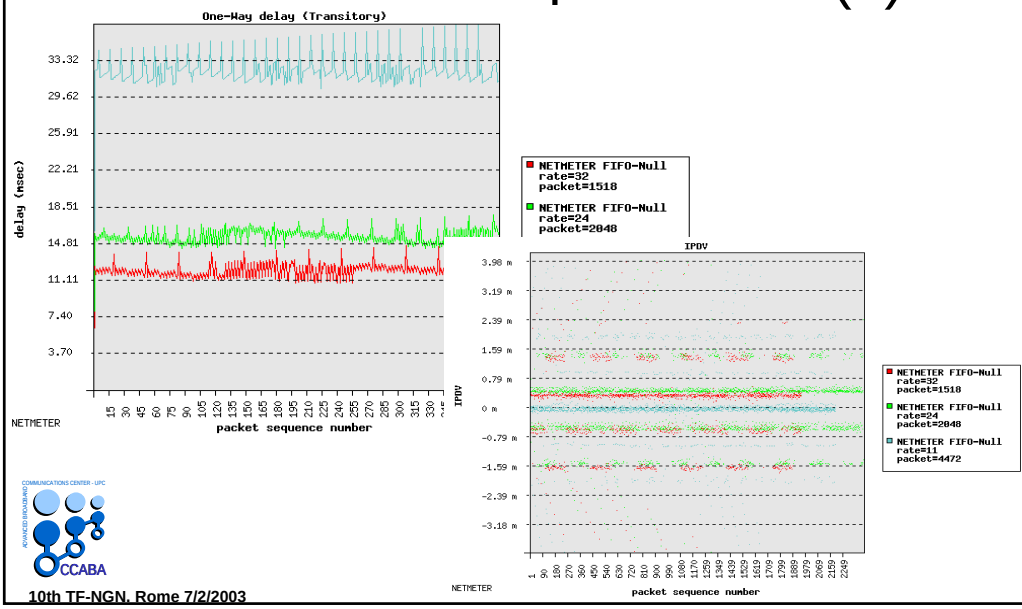
Netmeter: Sample results (II)



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DiffServ Experiments

- NetMeter: graphical GUI developed for easing tests
- Netperf/MGEN shows similar results as Agilent BSTS, specially for small packets
- Diffserv EF tests with CISCO and Linux/iproute2 on IPv6
- EF improves delay figures compared to best-effort mode

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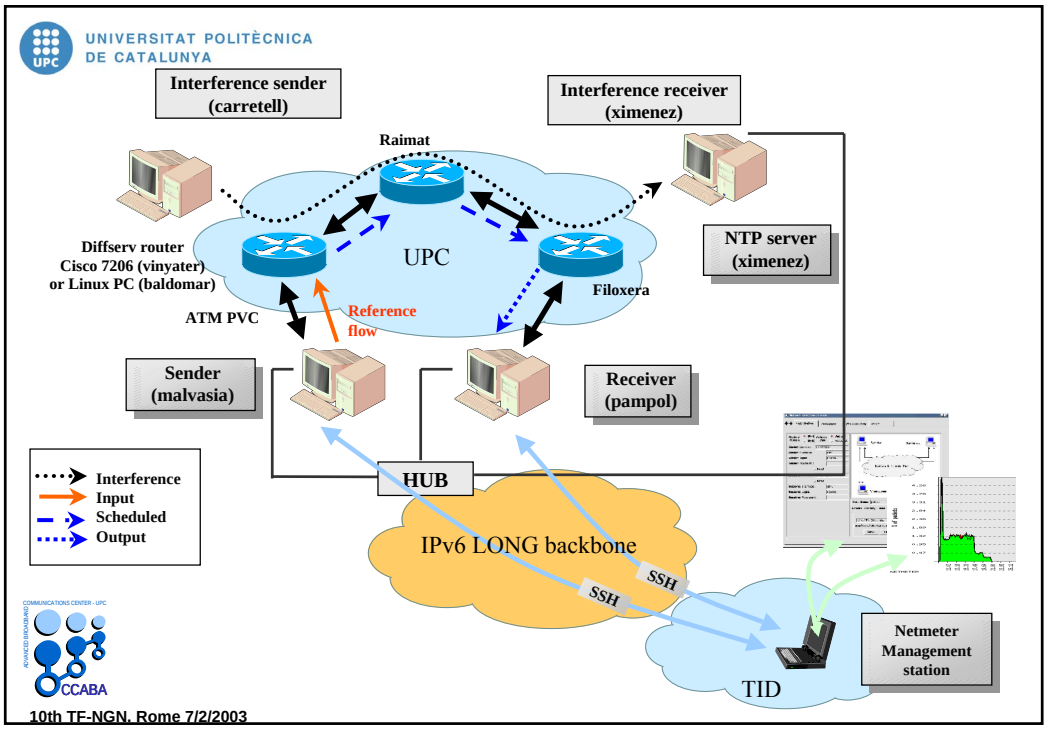
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Interference sender (carretell)
Interference receiver (ximenez)
Raimat
Diffserv router Cisco 7206 (vinyater) or Linux PC (baldomar)
UPC
NTP server (ximenez)
Filoxera
ATM PVC
Reference flow
Sender (malvasia)
Receiver (pampol)
Interference
Input
Scheduled
Output
HUB
IPv6 LONG backbone
SSH
SSH
Netmeter Management station
TID
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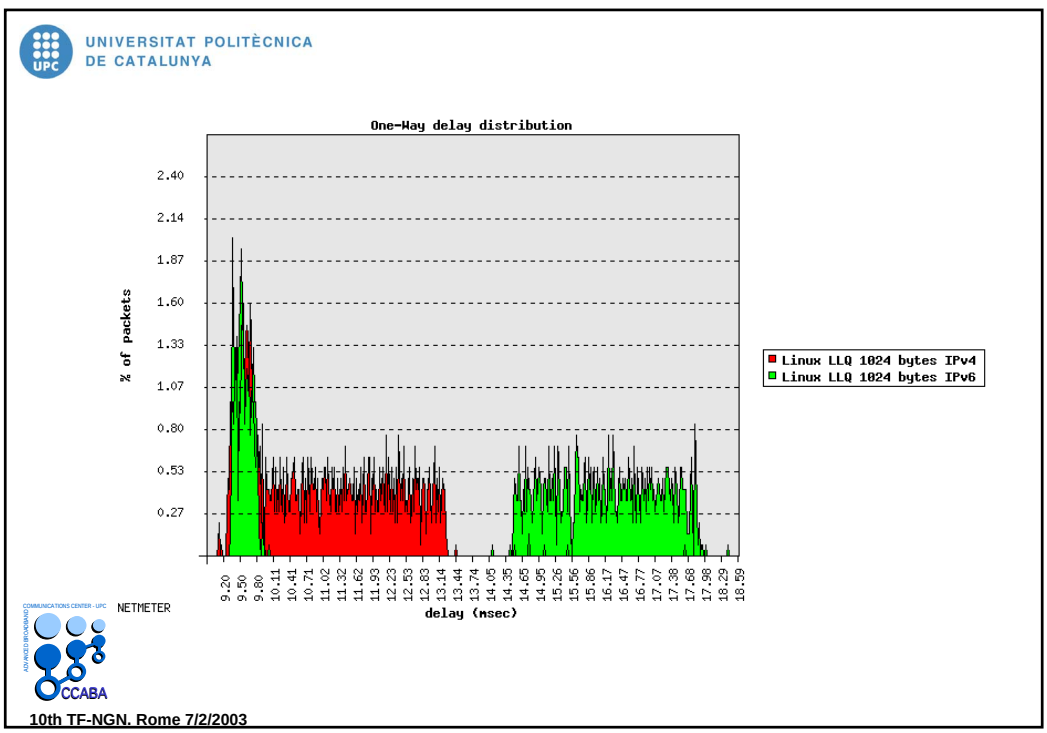
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One-Way delay distribution
% of packets
2.40
2.14
1.87
1.60
1.33
1.07
0.80
0.53
0.27
9.20
9.50
9.80
10.11
10.41
10.71
11.02
11.32
11.62
11.93
12.23
12.53
12.83
13.14
13.44
13.74
14.05
14.35
14.65
14.95
15.26
15.56
15.86
16.17
16.47
16.77
17.07
17.38
17.68
17.98
18.29
18.59
delay (msec)
Linux LLQ 1024 bytes IPv4
Linux LLQ 1024 bytes IPv6
NETMETER
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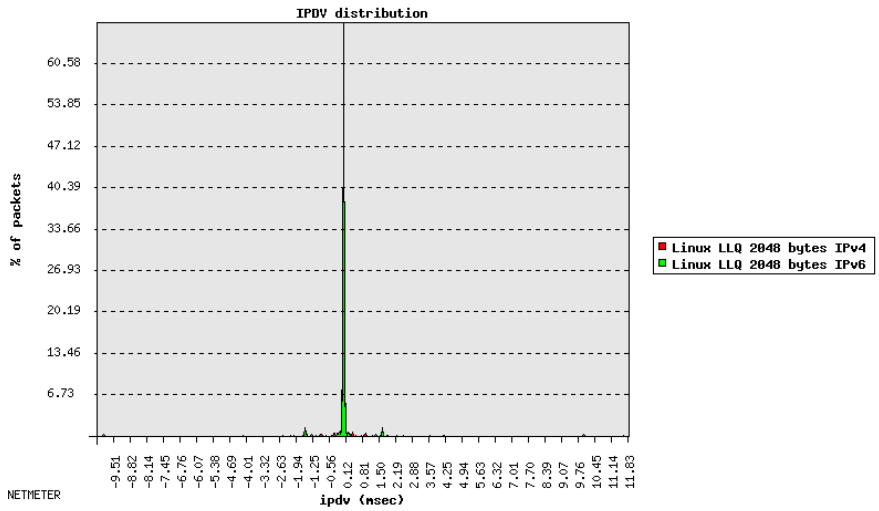

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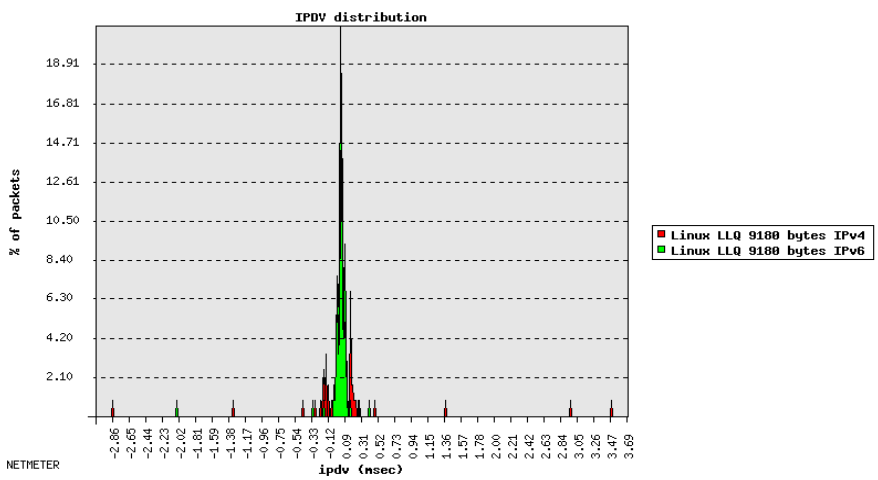

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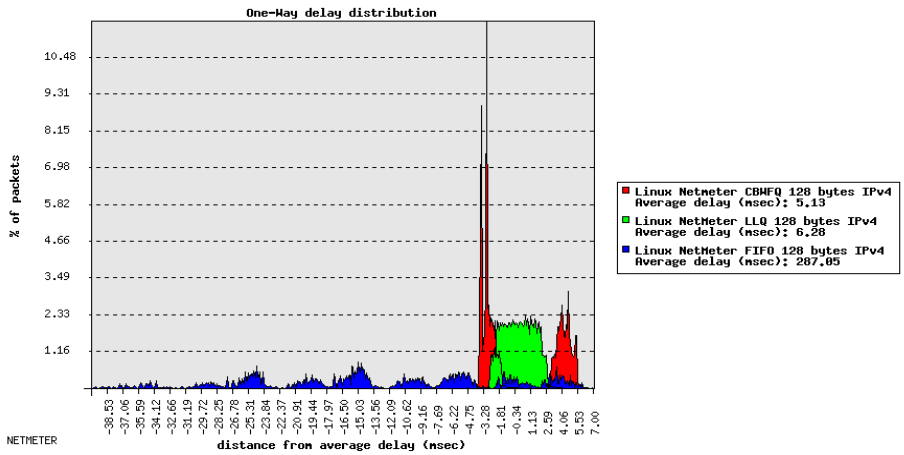

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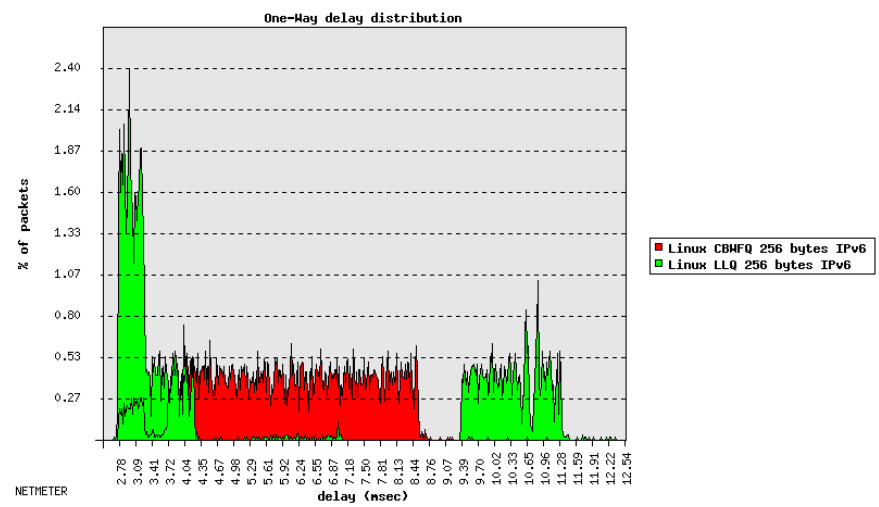

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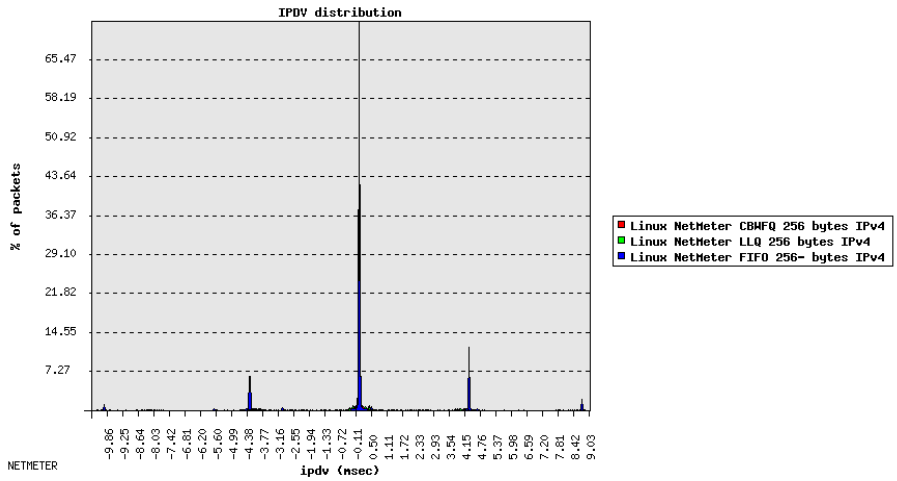

NETMETER

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LLQ Comparison for IPv6 / IPv4

Maximum Delay (ms)		
Packet Size (bytes)	**LLQ-IPv4**	**LLQ-IPv6**
96	36,29	16,42
256	30,23	14,98
1024	77,61	21,71
2048	36,39	36,49
9180	89,31	87,27

Miniumum Delay (ms)		
Packet Size (bytes)	**LLQ-IPv4**	**LLQ-IPv6**
96	1,22	1,31
256	2,49	2,56
1024	9,06	9,16
2048	17,93	18,01
9180	79,2	79,31

Average Delay (ms)		
Packet Size (bytes)	**LLQ-IPv4**	**LLQ-IPv6**
96	5,33	5,41
256	5,99	6,09
1024	13,5	13,63
2048	23,35	23,38
9180	83,21	82,12

Delay Variation (ms)		
Packet Size (bytes)	**LLQ-IPv4**	**LLQ-IPv6**
96	35,06	15,1
256	27,74	12,4
1024	68,55	12,54
2048	18,45	18,47
9180	10,11	7,96

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Passive QoS parameters monitoring

- Passive capture of traffic at both ends
  - Optical splitters
  - Copy traffic option (some routers/switches)
  - First phase: regular network adaptors (FE, ATM, GE)
  - Second phase (planned): DAG cards
- Filter IP flow/s and analyse it/them
  - Packet loss, OWD, IPDV, throughput, Packet reordering, OWD distribution, IPDV distribution

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Future Work

- Traffic Analysis (MIRA)
  - IPv6 support
  - GE capture platform
  - Distributed capture platforms (RedIRIS mesh)
- NetMeter
  - Synchronisation using GPS for owd
  - Include new version of *mgen*
  - Verify routes during measurement period
  - Adapt for mobile scenarios (DS and IPv6 TM)
- Passive QoS parameters monitoring
  - Validate the measurements
  - DAG cards

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