SEQUIN: Results on QoS

Afrodite Sevasti
Greek Research and Technology Network (GRNET)
and
Research Academic Computer Technology Institute (CTI), Greece

Project info

SEQUIN - SErvice QUality across Independently managed Networks (IST-1999-20841)

Duration 18 months (Nov 2000...Apr 2002)

Partners: **DANTE, DFN, GARR, GRNET, PSNC, RENATER, SWITCH, UKERNA**

Project Web site: http://www.dante.net/sequin

Overview

SEQUIN has defined and implemented an end-to-end approach to Quality of Service (QoS), operating across multiple management domains based on IP protocol and independent of link layer technology

The project has specified the implementation architecture for the Premium IP service, which aims at offering the equivalent of an end-to-end virtual leased line service at the IP layer across multiple domains.

The architecture is targeted at the G ANT (The pan-European Gigabit Research Network) and is applicable to each connected National Research and Education Network (NREN) across Europe and local DiffServ domains

QoS parameters

From users requirements and technical considerations :

- One-way delay (OWD)
- IP packet delay variation (IPDV)
- Available bandwidth
- One-way packet loss (OWPL)

The set is common to IETF and ITU-T

Naming and definitions are chosen to be comply to RFC 2330 (Framework for IP Performance metrics) and follow the ongoing IPPM IETF working group work.

QoS user requirements
(from user s questionnaire)

QoS service	One-way-delay	ipdv	packet loss	bandwidth
Best effort	wide	wide	medium	wide
Very good (*Premium IP*)	medium	very small	very small	according to SLA
Prioritised Bandwidth (*IP+*)	medium	medium	medium	according to SLA
Guaranteed bandwidth	medium	medium	very small	single value

	One-way-delay	IPDV	Packet loss	bandwidth
Best effort	Unspecified	Unspecified	< 5%	Unspecified
Premium IP	distance delay + 50 ms	< 25 ms	negligible	according to SLA
IP+	distance delay +100 ms	<25-50 ms	< 2%	according to SLA

Premium IP

- Differentiated Services - RFC2475 and EF PHB
- Overprovisioning
- Limited percentage of link capacity devoted to Premium IP (to 5%)
- Static provisioning-minimal number of actions per node
- IETF IPPM QoS parameters measurement framework
- Modular approach
- A model that can be implemented in short time using available tools
- Based on IP, for various transport protocols
- A chain of Premium IP compatible PDBs

The tasks for each node

always

- admission control and classification

- marking — Selected locations

- policing — Selected locations

- scheduling — always

- shaping — NO Done by source

- congestion control — not needed

- QoS rules propagation — Selected locations

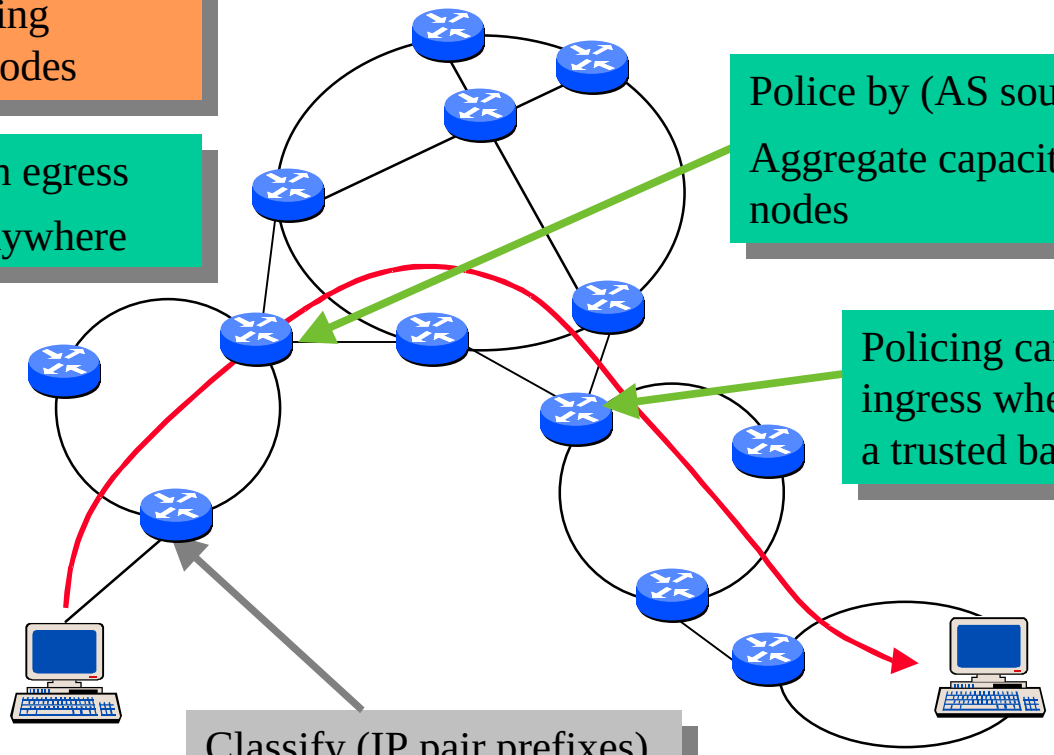
- monitoring and accounting — Selected locations

Premium IP specification

Classification and high priority scheduling (DSCP) on all nodes

Do not police on egress

Do not shape anywhere



Police by (AS source, destination)

Aggregate capacity on all border nodes

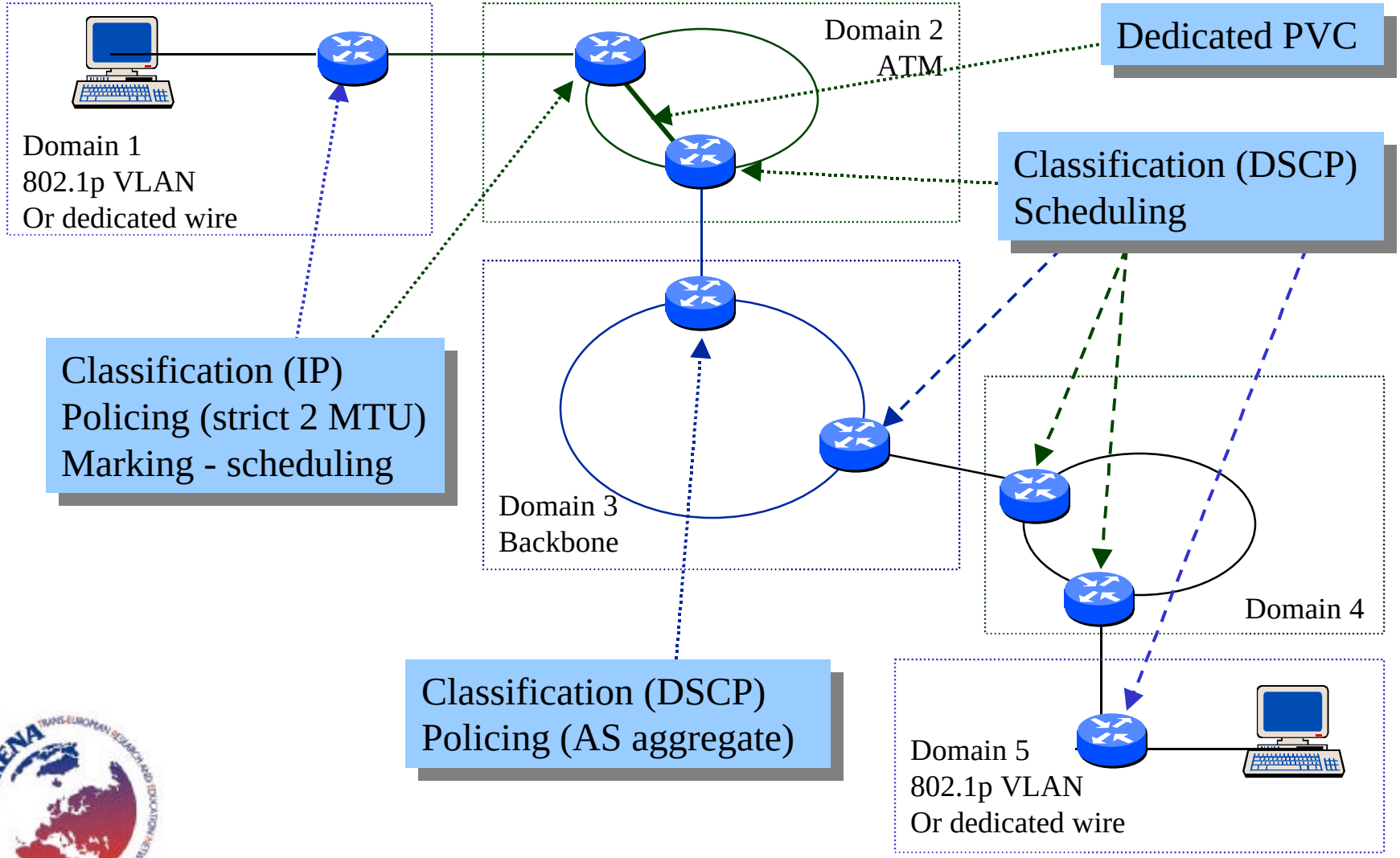
Policing can be avoided at ingress when receiving from a trusted backbone

Classify (IP pair prefixes)

Police - Strict, Capacity

Mark

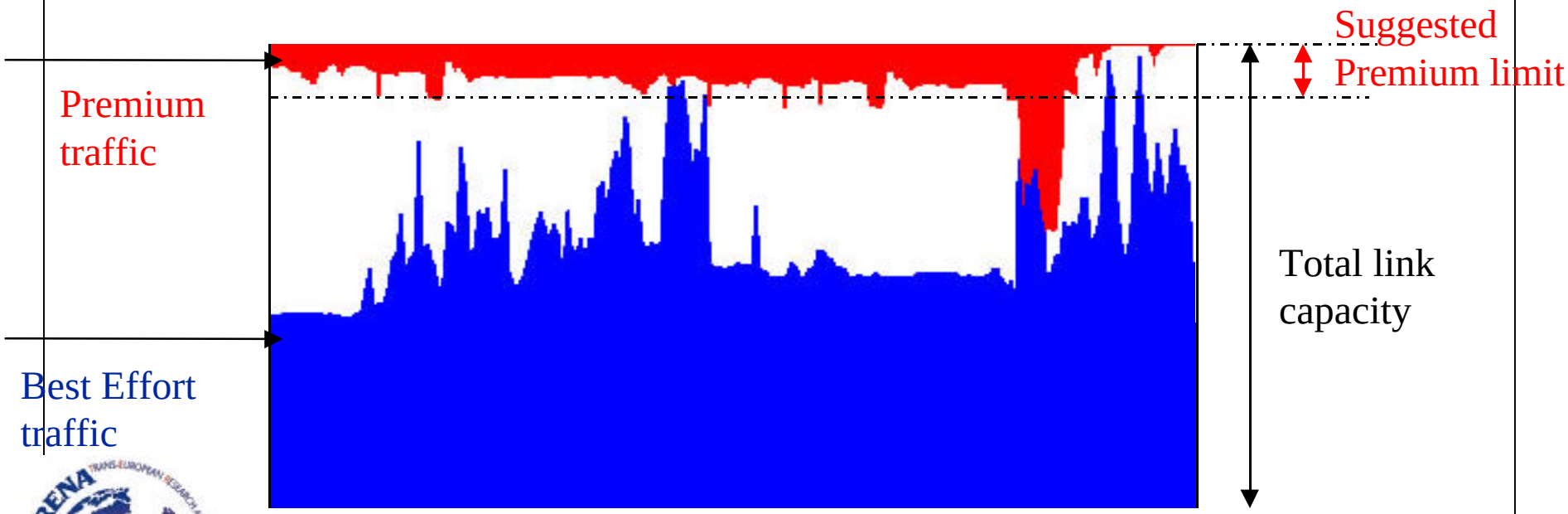
Example (one direction)



Premium IP vs. Best Effort

Use the highest priority queueing mechanism (PQ or WRR).

Limit total Premium capacity when assigning service to users at about 5% of each core link.



Proof of Concept

Initial implementation of the testing methodology by implementing a Proof of Concept testbed involving user groups

Goals:

- access to a controlled environment composed of a variety of hardware and underlying technology
- functionality verification of each component required to implement Premium IP

The set of tests performed included:

- laboratory tests for basic router functionality
- wide area tests for network calibration (understand the performance users can expect & the interaction between different network technologies)
- tests involving users to verify the QoS provisioning processes

H.323 users tests

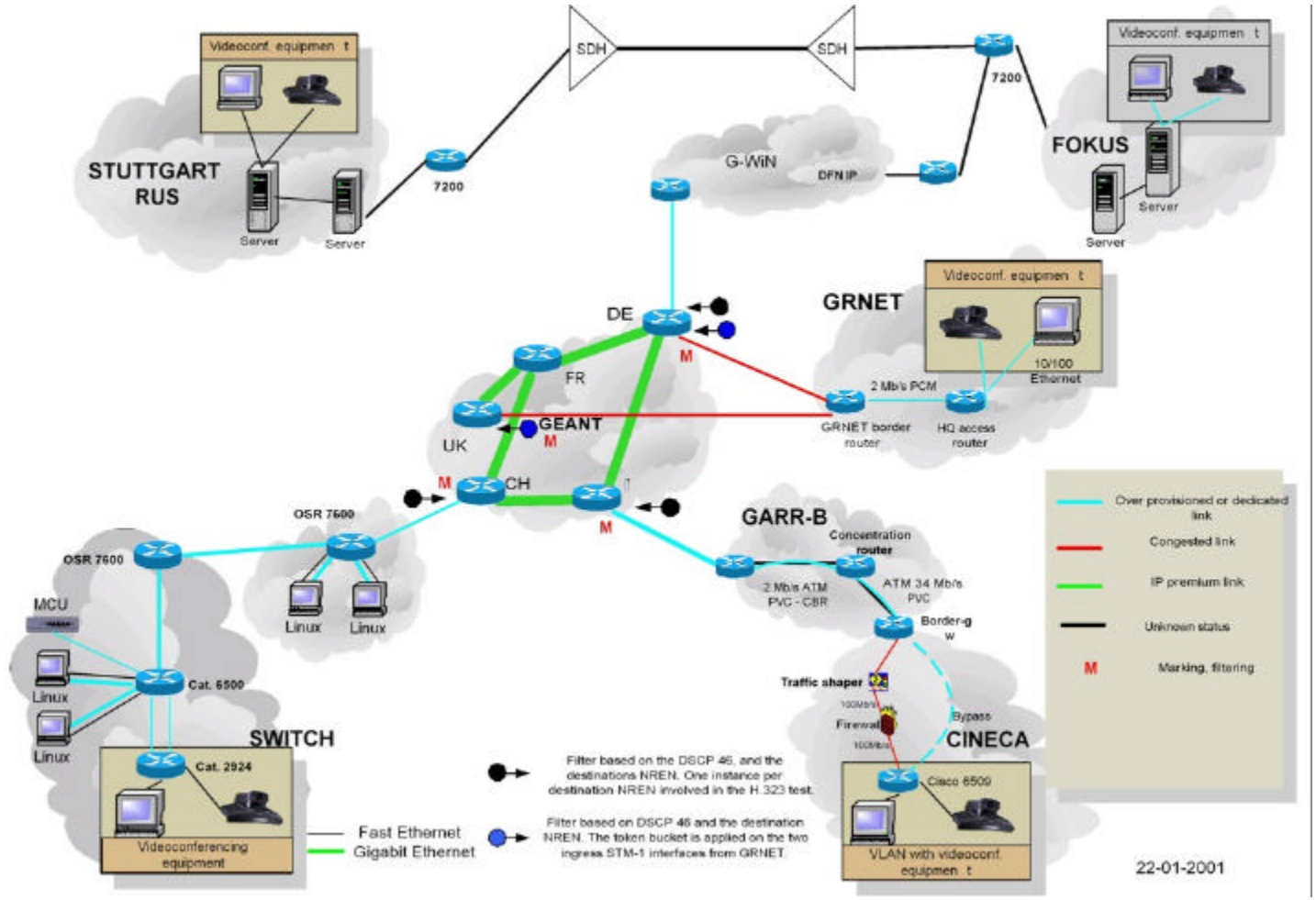
H.323 users from TF-STREAM Task Force

- TF-STREAM, http://www.terena.info/task-forces/tf-stream/

Tests

- Core network (G ANT): 10Gbit/s & 2.5 Gbit/s POS and Juniper routers.
- 4 high (2.5 Gbit/s POS) and lower (2x155Mbit/s ATM access) speed national networks connecting six testing locations
- Traffic tests with measurement tools with/without Premium IP enabled
- Objective and subjective quality assessments of H.323 videoconferencing

H.323 tests topology



Test scenarios

End-to-end setup, between each pair of the participants

Videoconference initiated usersassessment of audio and video quality

ICMP Ping tool was used to measure end-to-end RTT

The videoconference session was terminated

Use of RUDE/CRUDE tool with traffic pattern imitating videoconference stream in both directions for recording jitter and packet loss

NETPERF throughput test was used to assess the bandwidth available for Premium IP service

Test results I

IP Premium	FROM				
Audio	SWITCH	FOKUS	RUS	GRNET	CINECA
SWITCH	x	3(MCU)	4-5	6	6
FOKUS	3.6	x	6	3	6
RUS	3.6	6	x	6	6
GRNET	5.4	3(MCU)	5	x	6
CINECA	6	6	5	6	x

IP Premium	FROM				
Video	SWITCH	FOKUS	RUS	GRNET	CINECA
SWITCH	x	6(MCU)	5	6	6
FOKUS	4.8	x	6	5	6
RUS	4.8	6	x	4	6
GRNET	5.4	5(MCU)	5	x	5
CINECA	5.4	6	5	5	x

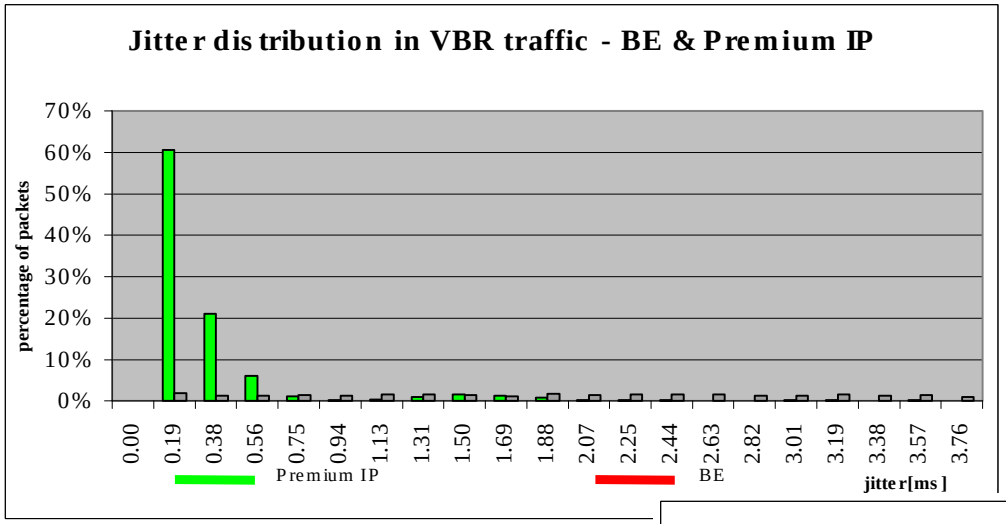
Test results II

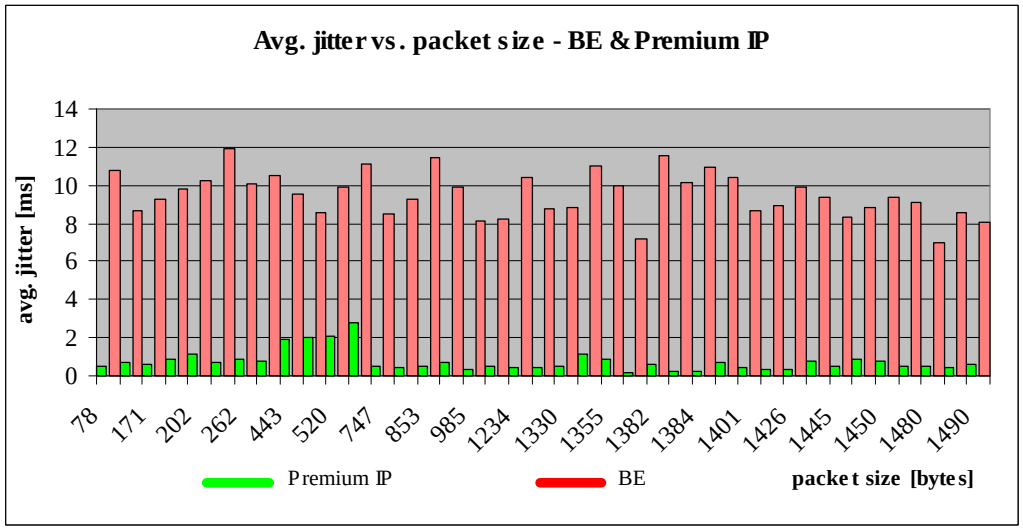
IP Premium	FROM				
Bandwidth [10^3 bit/s]	SWITCH	FOKUS	RUS	GRNET	CINECA
SWITCH	x	3307.87	1909.83	870.00	1816.73
FOKUS	1910.00	x	8725.30	910.00	1825.09
RUS	1910.00	8895.45	x	830.00	1835.18
GRNET	1910.00	853.41*	1909.02	x	1839.94
CINECA	1751.46	1944.39	1844.84	910.00	x

IP Premium	FROM														
RTT[ms]	SWITCH			FOKUS			RUS			GRNET			CINECA		
	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
SWITCH				37.00	37.00	41.00	50.68	51.31	55.43	112.22	114.29	124.14	17.04	19.91	19.97
FOKUS	30.0	38.00	60.00				14.66	17.30	414.66	109.67	110.49	167.59	17.80	20.50	40.00
RUS	50.0	50.00	61.00	10.00	13.00	480.00				186.94	229.82	313.69	29.95	39.62	49.96
GRNET	110.0	114.00	190.00	117.00	119.00	141.00	186.90	230.20	254.80				119.80	120.04	127.82
CINECA	25.1	27.67	48.41	27.00	30.00	82.00	39.93	42.01	81.85	119.82	120.05	127.82			

IP Premium	FROM				
Loss[%]	SWITCH	FOKUS	RUS	GRNET	CINECA
SWITCH	x	0.00	0.00	0.02	0.00
FOKUS	0.00	x	0.00	0.01	0.00
RUS	0.00	0.00	x	0.02	0.00
GRNET	0.00	0.00	0.00	x	0.00
CINECA	0.00	3.07	2.70	0.25	x

Test results III





Testing with IST projects

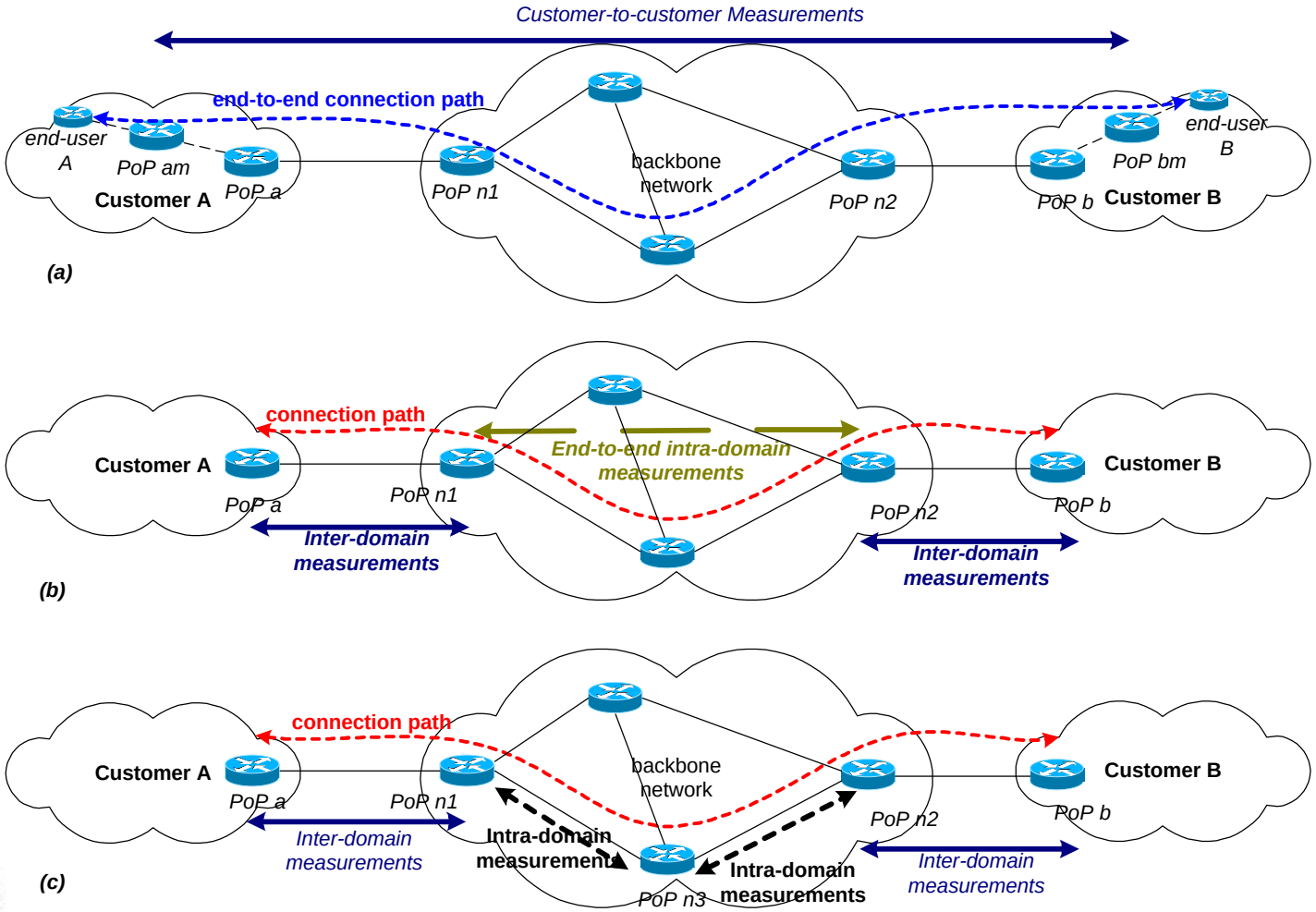
AQUILA (IST 1999-10077)

- Enhanced architecture for QoS in Internet
- PL (Warsaw) - AT (Vienna), 2.5 Mb/s
- activated on 15 April 2002

MOICANE (IST 2000-26137)

- QoS support in access technologies
- IT, GR, PT, RO
- target time April/May 2002

Monitoring


Customer-to-customer Measurements
end-to-end connection path
end-user A
PoP am
PoP a
Customer A
backbone network
PoP n1
PoP n2
PoP b
PoP bm
end-user B
Customer B
(a)
connection path
Customer A
PoP a
PoP n1
End-to-end intra-domain measurements
PoP n2
PoP b
Customer B
Inter-domain measurements
Inter-domain measurements
(b)
connection path
Customer A
PoP a
PoP n1
backbone network
PoP n2
PoP b
Customer B
Inter-domain measurements
Intra-domain measurements
PoP n3
Intra-domain measurements
Inter-domain measurements
(c)

QoS monitoring infrastructure

	Advantages	Disadvantages
SMTs (Software Management Tools)	- Open architecture - Distributed system - Ease in manipulation of data - Low implementation cost - Easily expanded to end-users	- Cumbersome deployment - Security vulnerabilities
Commercial Products	- Ready for service product - Accurate measurements	- Close architecture - Scaling - centralised architecture - High installation cost

Monitoring scope, measurements methods and synchronisation

SMTs solution monitoring scenario (based on public domain SW with enhancements for data collection, analysis and presentation)

RIPE TTM test-boxes monitoring scenario (suggested for better accuracy)

SLAs

SLAs/SLSs are the essential mechanisms for agreeing, configuring, delivering, guaranteeing and evaluating the obtained QoS

SLA definition between two peers is the structural unit for the establishment of end-to-end services

There are always two SLAs, one for each direction. The contracted values might be different.

SLA definition

- Definition of SLAs between GEANT and NRENs
  - Administrative/legal part
  - SLS part: defining the set of parameters (SLS template) and their values, such as a Traffic Conditioning Specification (TCS)
- Matrix for NREN-to-NREN traffic IP Premium

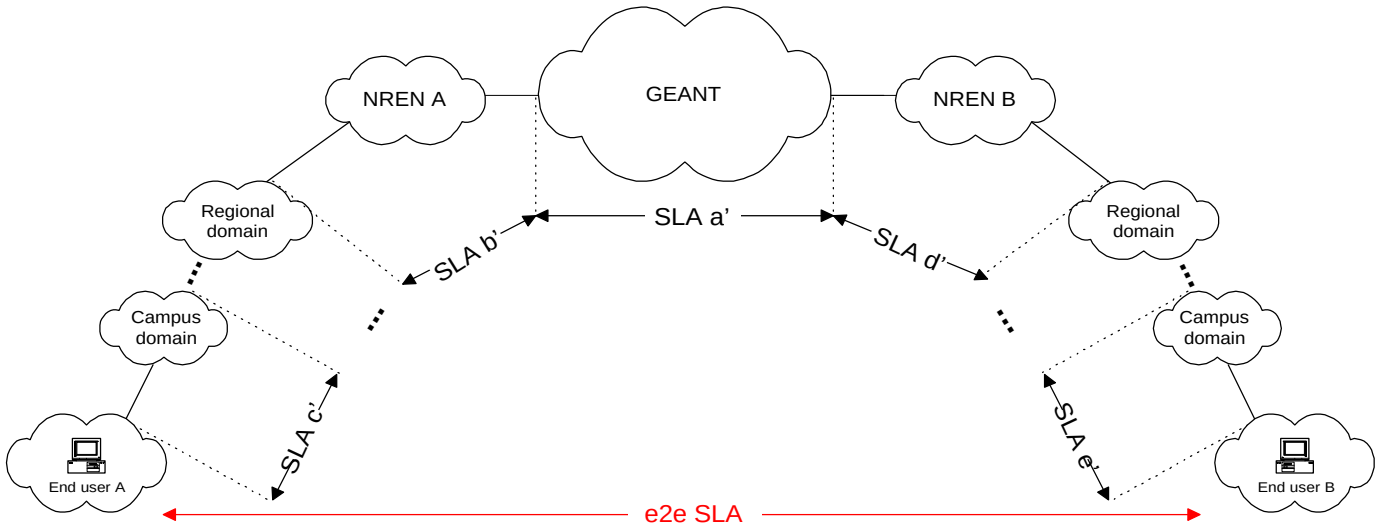
Proposed SLS template

- Scope
- Flow description
- Performance guarantees
  - OWD, IPDV,OWPL, MTU, Available bandwidth
- Traffic Envelope and Traffic Conformance
  - Conformance to a shape and a limit of throughput/capacity
  - Conformance algorithm = the (b,r) token bucket
  - Conformance parameters = (b, r)
    - b = f(number of router interfaces on the same router that are part of the service, distance from the source)
    - r = 1.5*avail_bw
- Excess treatment, service schedule, reliability

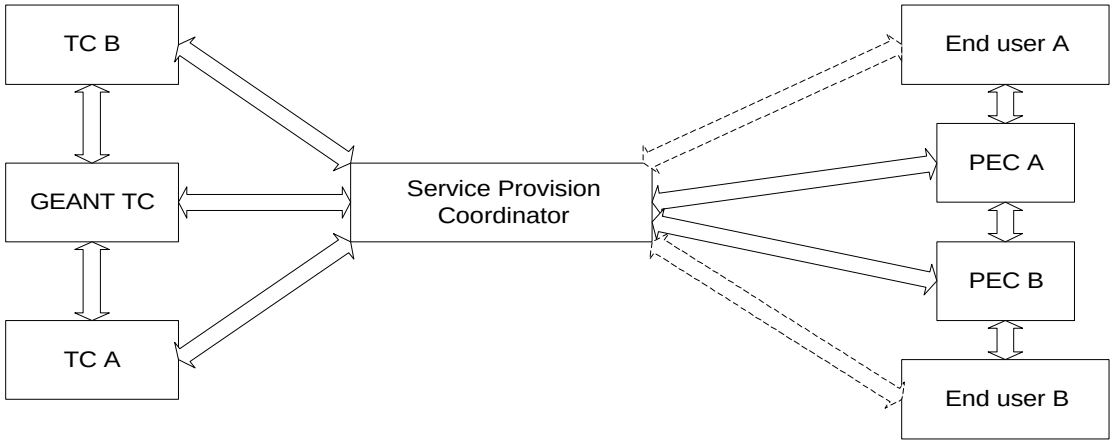
e2e SLAs

Collection of the e2e chain SLAs

After the establishment of the e2e SLA, end-users must also be provided with SMTs to verify the quality and quantity of throughput provided by the service



Service provisioning



SUGGESTED: Centralized model of service provisioning

Parameters and configuration for Premium IP are not yet state-of-art.

A more collaborative approach is initially needed

- Detailed collaboration and exchange of information between all parties, at times in a somewhat un-coordinated fashion

Conclusions

SEQUIN has shown *HOW* to deploy Premium IP

NRENs are invited to implement it

The service provisioning model needs to be further elaborated

Support sought for development of monitoring tools, which is fundamental for the provisioning of the service

Premium IP as a replacement of ATM-based MBS

Thank you