Presenters

6/27/02

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SEQUIN

SErvice QUality across Independently managed Networks

Cambridge, 27 June 2002


Presenters

- Mauro Campanella - GARR
- Rudolf Roth - FOKUS
- Roberto Sabatino - DANTE
- Nicolas Simar - DANTE
- Szymon Trocha - PSNC

Participants

- DANTE
- DFN
- GARR
- GRNET
- PSNC
- RENATER
- SWITCH
- UKERNA

Agenda

- Recommendations from 1st year review
- Work Programme Nov 01 - Apr 02
- WP4 - Dissemination
- WP5 - H.323 testing
- WP6 - procedures, user trials, QoS monitoring
- WP4 - Implementation
- relationship with GEANT, Internet-2, Industry
- PM issues, achievements, future work

Recommendations from 1st year review

- Update D3.1 - done April 2002
- Resubmit D4.1 - done April 2002
- Relationship with GEANT - discussed today
- Standardisation - in progress in co-operation with Internet-2
- Improve Project web site - done

Work Programme Nov 01- Apr 02

- Ongoing Dissemination (WP4)
- Completion of WP5, proof of Concept testing
  - trials with H.323 users
- Testing in a User environment (WP6)
- Specification of monitoring infratsructure (WP6)

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Workshop Objectives

- Dissemination of the SEQUIN Approach towards IP QoS
- Feedback from the research community on GÉANT Premium IP service
- Installation of Co-operations with partner projects for beta-testing

SEQUIN Workshop Facts & Figures

- Agenda
  - Presentation of SEQUIN
  - 7 Interested Partner Projects
  - Panel Discussion
- 35 participants from research and industry; operators, equipment vendors, IST projects representatives, IP QoS researchers

SEQUIN Presentation

- Introduction to the Project
- Premium IP Service Architecture and Implementation
- QoS Monitoring Infrastructure
- First Testing Results

SEQUIN Partner Projects

- MOICANE - Multiple Organisation Interconnection for Collaborative Advanced Network Experiments
- AQUILA -Adaptive Resource Control for QoS Using an IP-based Layered Architecture
- LONG -Laboratories Over Next Generation Networks
- DepAuDE - Dependability for embedded Automation systems in Dynamic Environments with intra-site & inter-site distribution aspects
- DataGrid - Research and Technological Development for an International Data Grid
- ATRIUM - A Testbed of Terabit IP Routers running MPLS over DWDM
- LION - Layers Interworking in Optical Networks

4 Projects selected for beta testing group

Panel Assessing SEQUIN Approach

- Operator and Vendor View on the SEQUIN Approach
  - Heanet, Siemens, DataGrid, Telia, Cisco, Juniper
- Issues raised
  - organisation of service provisioning
  - NRENs support
  - service verification & QoS measurement
  - expression of high demand for early availability to research community

Workshop Outcomes

- Positive response from participants
- Successful establishment of project co-operations
- Premium IP is enabling technology for European Network Research
- Essential Infrastructure for wide-scale experimentation
- Seminal new activities:
  European QoS Monitoring Infrastructure

List of Presentations

- *SLA definition for the provision of an EF-based service* 16th International Workshop on Communications Quality & Reliability
- *Tutorial on QoS* , JRES 2001, Lyon, 11 December 2001
- *QoS across Europe - First Experiences from the Project SEQUIN* DFN-symposium, 19 November 2001
- *Sequin and Premium IP* presentation at SWITCH national technical conference, Zurich 15 November 2001
- *GÉANT Premium IP Overview* . Presentation to the Virtual Internet2 Member Meeting, QoS working group,
- *The SEQUIN Project and GEANT Network* - 2nd International Workshop on Quality of future Internet Services QofIS 2001, Coimbra
- *Premium IP Service* GÉANT Access Port Managers (APM) Meeting, Paris, France, 21 September 2001.
- *QoS and IP Premium Service Specification Implementation* TERENA Networking Conference 2001, Antalya, Turkey, 14-17 May 2001.

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Calibration tests

- Measurement tools evaluation
  - For IP-Premium monitoring
- PSNC - SWITCH low speed tests
  - Two NREN ATM networks (in Berne and Poznan) connected via TEN-155
  - To evaluate Cisco7500 diffserv mechanisms for Premium
  - Core ATM network behaves as a DiffServ network model
  - Guarantees on bandwidth and packet loss could be achieved
  - Guarantees on delay and IPDV require complex configuration and fine tuning

Real users tests (1)

- Testing on production networks
- Multi-domain environment
  - 5 high and lower speed national networks
- Different transmission technologies
  - ATM, POS, Ethernet, Gigabit Ethernet

Real users tests (2)

- Testing on a variety of networking equipment
  - Cisco
  - Juniper
- Interconnected via the new GÉANT backbone

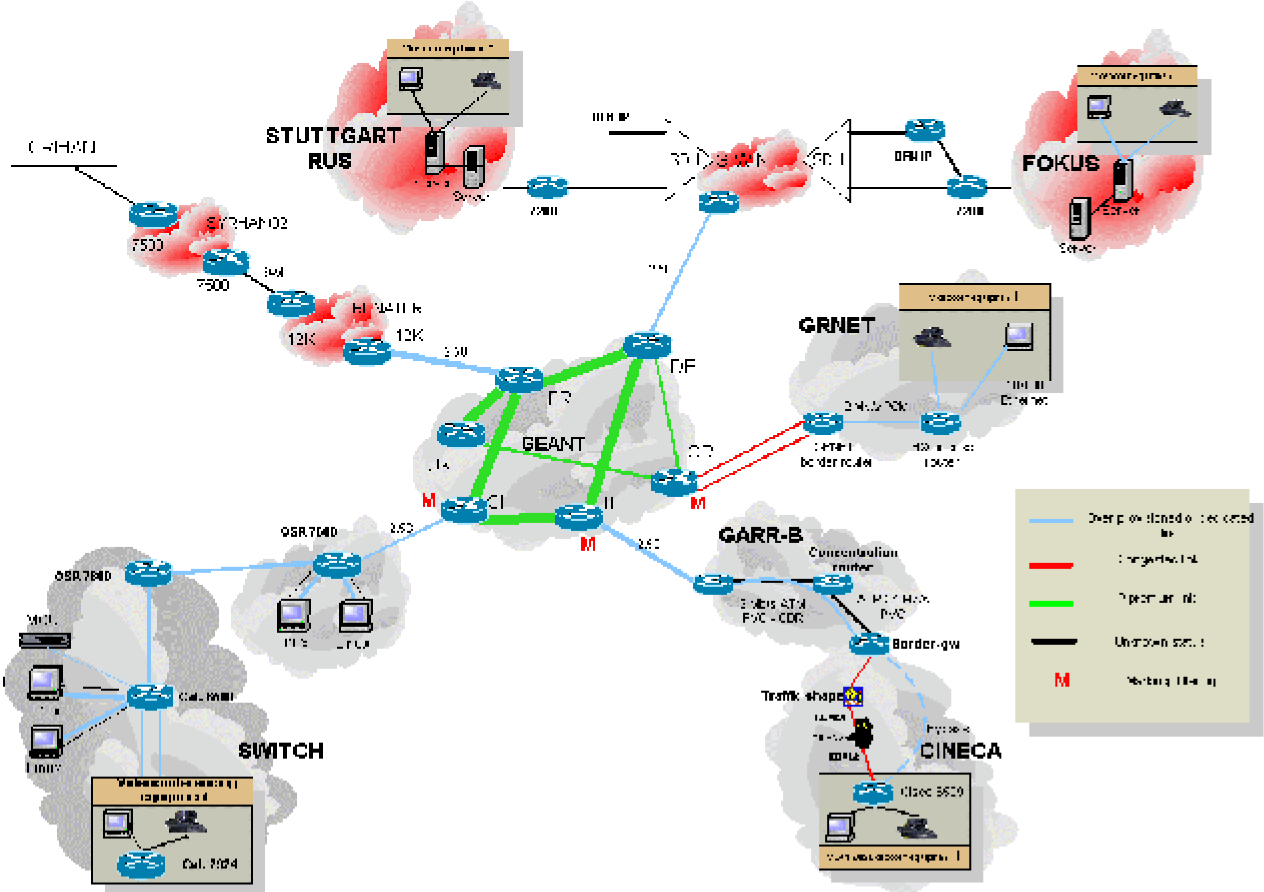
H.323 users

- H.323 users from TF-STREAM Task Force
- Audio/video streaming and conferencing
- Present in most of the countries
- Have good knowledge of the QoS requirements
- Have demand for bandwidth and QoS

H.323 test participants

- DFN
- GARR
- GRNET
- RENATER
- SWITCH

H.323 tests topology



H.323 test scenario (1)

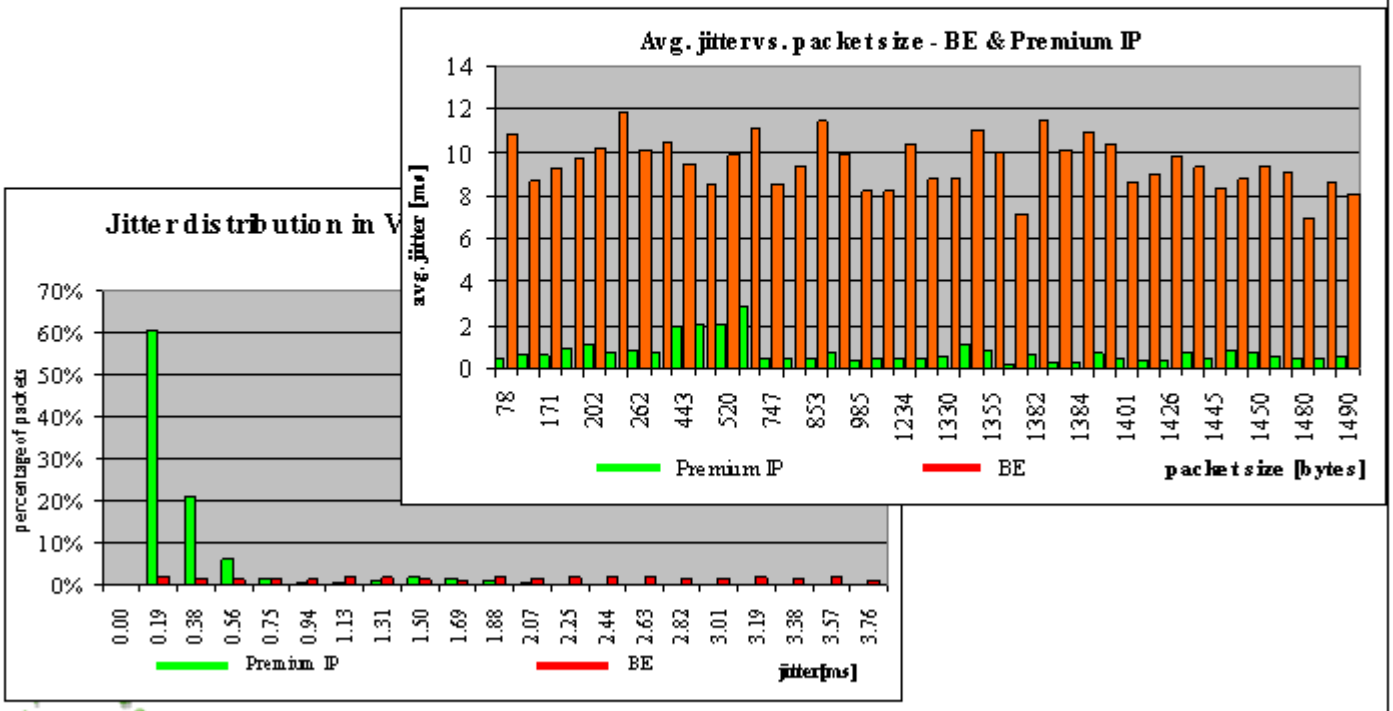
- Baseline measurements
  - done between FOCUS and IND
  - analysing of an H.323 stream
    - H.323 stream captured
    - Distribution of the packet length and the interarrival time
    - H.323 traffic pattern created for RUDE/CRUDE tools

H.323 test scenario (2)

- Objective and subjective quality assessments
- Initiate video conference between users
- Observe the video performance
  - with/without QoS features enabled
- Report the user-visible performance
- Traffic tests with measurement tools
  - between all test participants
  - with and without IP Premium enabled
  - jitter, packet loss, bandwidth recording

Traffic measurements

- Jitter distribution RUS->GRNET



Subjective tests results

- Perceived audio quality for video transmission using Premium IP service

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 summary (1)

- Validation of the operational model on production network
- Confirmation of the usability of accepted Premium IP service model
  - preservation of necessary traffic parameters
- Verification of the correct coexistence of the two types of IP traffic: IP Premium and normal BE IP traffic

Test results (2)

- Experience in the service provisioning for real users
- Operational procedures for requesting service (users)
- Operational procedures for implementing service in a multi-domain environment (NRENs, GÉANT)

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Provisioning Challenges

- Intrinsically Multi-Domain
  - GÉANT, NRENs, Regional NWs, Campus-NWs,..
- Heterogeneous technologies
  - Legacy ATM, LAN environment, IOS Releases, ..
- *Bleeding Edge* Technology
  - No off-the-shelf solution
  - No (semi)-automatised support
  - Staff Education & Training

SEQUIN Approach

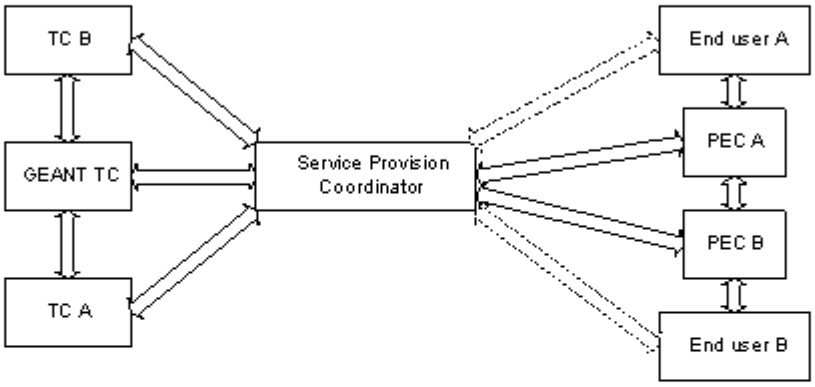
- Build on experience with MBS service
- MBS Provisioning Model as starting point
- Modifications as we go along

Principles & Components

- Parties & actor roles
- Tasks and Responsibilities
- Phases of provisioning procedure

- Structured Communication Flow
  - Communication Hierarchy
  - Recursive Tree for dissemination and concentration

Parties and Roles



- Service Provisioning Coordinator = Single Point of Contact
- Technical Coordinators (TC) for GÉANT, NREN, Campus
- Performance Evaluation Coordinators

Information Co-ordination

- SPC Tasks
  - Information Collection for Service Request
  - Dissemination of Recommendation & Guidelines
- User Group Questionaire
  - Contact Info, Service Timeframe, Topology, Requested Capacity, IP Addressing, ..
- SEQUIN Technical Website
  - Configuration examples, FAQs, How-To's

SEQUIN Provisioning Model SoA

- Proposal of a Premium IP Provisioning Model derived from MBS service
- Open Communication Model
  - Strict responsibilities for tasks
  - Open communication policy
    mailing-list: user group, SPC, TCs, PECs, SEQUIN experts
- Currently On-Trial Phase in on-going user group experiments:
  AQUILA, MOICANE, LONG

Project supported

- AQUILA (IST 1999-10077)
  - Enhanced architecture for QoS in Internet
  - PL (Warsaw) - AT (Vienna), 2.5 Mb/s
  - activated on 15 April 2002

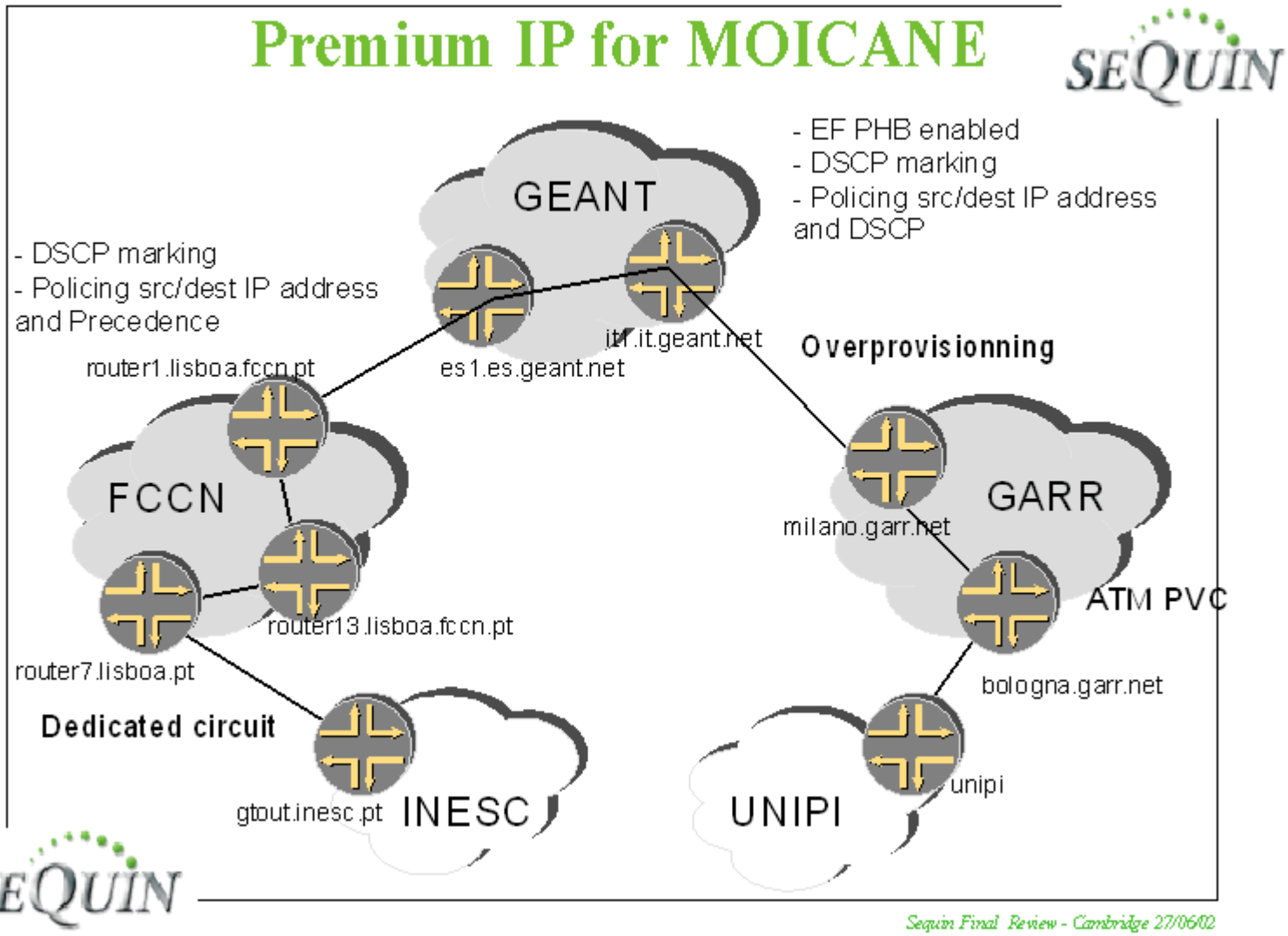
Project supported

- MOICANE (IST 2000-26137)

  - QoS support in access technologies

  - UNIPI (Pisa) - INESC (Lisbon), 1.5Mbps,
  - Pisa-Libon activated the 15th of Mai

  - UNIPI - (Pisa) - UPB (Bucharest), 2Mbps
  - target activation end June


Premium IP for MOICANE
SEQUIN
- EF PHB enabled
- DSCP marking
- Policing src/dest IP address and DSCP
GEANT
- DSCP marking
- Policing src/dest IP address and Precedence
router1.lisboa.fccn.pt
es1.es.geant.net
it1.it.geant.net
Overprovisionning
FCCN
GARR
milano.garr.net
ATM PVC
router13.lisboa.fccn.pt
router7.lisboa.pt
bologna.garr.net
Dedicated circuit
unipi
gtout.inesc.pt
INESC
UNIPI
SEQUIN
Sequin Final Review - Cambridge 27/06/02

Next Supported projects

- LONG (IST-1999-20393)
  - IPv6 project
  - Seven connection between seven sites in Spain and Portugal, 2Mbps each.
  - Premium IP will be supported in GÉANT and in FCCN, but not in redIRIS for the time being due to setting up of new network.

Provisioning

- A person, from the project, has to coordinate the provisioning activities between various networks.
- A provisioning procedure has been defined in order to provide indication about the tasks.

Provisioning

- A questionnaire has been written as an additional help. It contains
  - contact information for each network
  - Site IP prefixes involved, capacity requested
  - Start and end dates
  - Description on how the service will be provisioned in the various domain.

Configuration

- Configuration examples are provided for various platforms as well as explanations on how the service should be implemented. (see technical website)
  - The sites will evolve according to the experience encountered and the question asked (FAQs).
  - Target audience: network operator.
- Tagging configuration verification: “CoS” traceroute.
  - End-users and network operator.

Future Improvement

- Having central information repository for the contact information and a topology diagram of the equipment along the path.
- Creation of a tool for monitoring the OWD, IPDV, OWL and to check the available bandwidth.
  - Target: end-users and network operator

Conclusion

- A cook book and a provisioning procedure are provided to the network operators.
- A monitoring procedure has been written, but its final version will depend of the monitoring infrastructure.
- Monitoring is still missing:
  - more practical experiences are needed on how the service behaves
  - trouble-shooting and debugging still too complex and time consuming

Monitoring

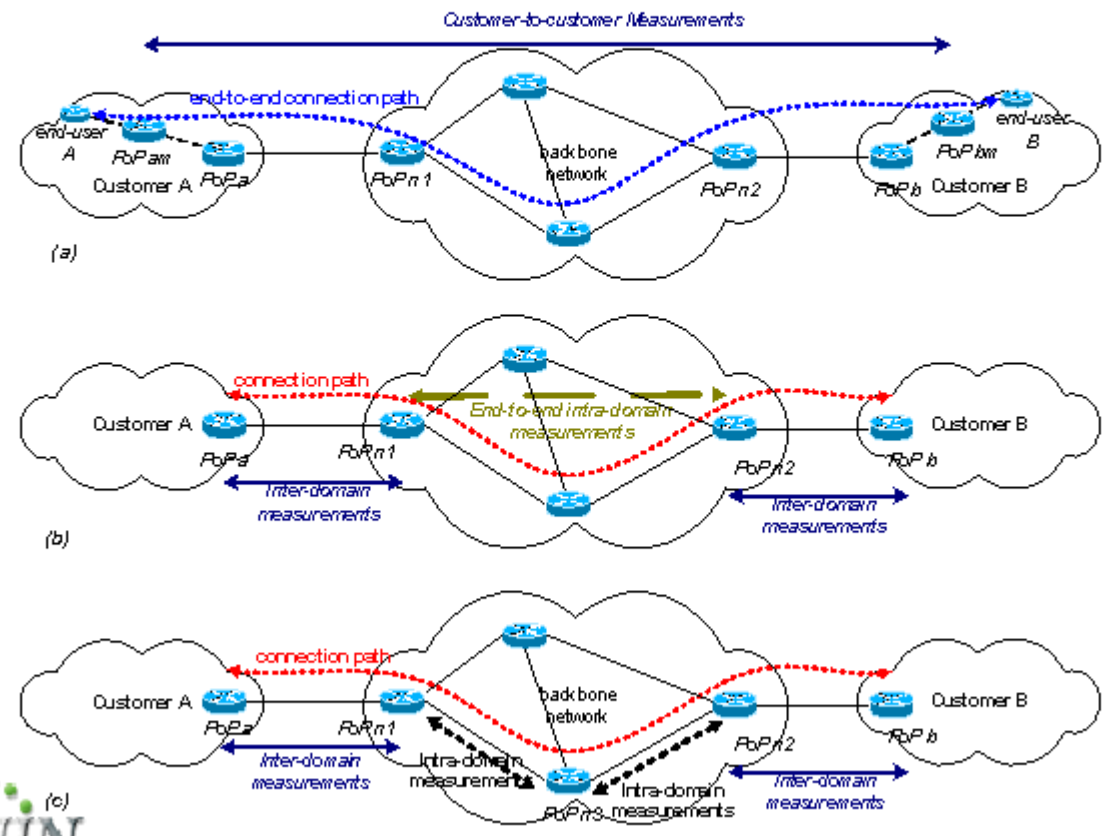
- Check the service health.
- Verification of the network behaviour conformance to the SLA/SLS metrics.
- Operational monitoring (fault detection, alarms, etc)
- Network planning.

- The network and the end-to-end path Premium IP monitoring is one of the requests of the user groups attending the SEQUIN workshop.

Premium IP parameters

- Premium IP has four main QoS metrics:
  - one-way delay
  - one-way IP packet delay variation (IPDV)
  - losses
  - bandwidth
- The QoS metrics are guaranteed on end-to-end basis.
- Monitoring needed a end-to-end as well as on the inter- and intra-domain.

Premium IP parameters



Active/passive Measurement

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- *Active*
- injects measurement traffic
- RUDE/CRUDE, RIPE TTM, Surveyor, chariot, etc
- suitable for loss, one-way delay, IPDV

- *Passive*
- observes traffic, packet capturing and timestamping
- netflow, counters on routers, optical splitters
- suitable for capacity utilisation and layer 3 packet loss

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Monitoring tools

- Self Made Tools (SMT) vs commercial ones.
- Tools requirements
  - Instantaneous monitoring matrix and history.
  - Alarm generation to the NOC/PERT.
  - Amount of traffic generated proportional to the monitored capacity (for active tools).
  - Tool's security.
  - Data analyses.
  - Path used (for active tools).
  - Flat database (several months).
  - Accuracy.

SMTs vs commercial tools

	Advantages	Disadvantages
SMTs	- 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

- 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)

Foggy areas

- Amount of traffic needed to monitor a flow aggregate (amount/extra load).
- The monitoring tools accuracy has an impact on the SLA (depending of its accuracy).
- Accurate one-way delay measurements require to synchronise the source and the destination nodes
  - NTP, accuracy around several ms
  - GPS, accuracy less than 1ms

Issues

- Difficult to have tools allowing to monitor OWD, IPDW and OWL.
- GPS antenna installation can be very expensive in some carrier hotel (zero mile rule). Less of an issue if you own/rent the building.
- Good balance between cost, usability and installation easiness needed for broad deployment.

CoS traceroute

- **Modified version of traceroute developed by SEQUIN to help the discovery of the DSCP changes along the path. It allows to verify if the DSCP values are the expected ones.**

```
[root]# ./traceroute -t 184 193.171.2.1
traceroute to 193.171.2.1 (193.171.2.1), 30 hops max, 40 byte packets
 1  css7-ATM4-0-0-101-dmsk.man.poznan.pl (150.254.160.62)  1 ms  1 ms  1
ms
 2  150.254.163.118 (150.254.163.118)  2 ms  2 ms  2 ms
 3  z-pozmanu-oc3.poznan-gw.pol34.pl (212.191.127.49)  2 ms  2 ms  2 ms
 4  pol-34.pl1.pl.geant.net (62.40.103.109)  2 ms  2 ms  2 ms
 5  pl.cz1.cz.geant.net (62.40.96.45)  22 ms (TOS=0!)  22 ms  22 ms
 6  cz.de1.de.geant.net (62.40.96.38)  30 ms  30 ms  30 ms
 7  de1-1.de2.de.geant.net (62.40.96.130)  30 ms  30 ms  31 ms
 8  de.at1.at.geant.net (62.40.96.5)  43 ms  43 ms  43 ms
 9  aconet-gw.at1.at.geant.net (62.40.103.2)  43 ms  43 ms  43 ms
10  193.171.2.1 (193.171.2.1)  45 ms *  45 ms
```

Conclusion

- The SMTs seems to be the best solution for a monitoring infrastructure -flexibility- (tool should be developed and provided with documentation to the domains).

- The QoS monitoring is a pre-requisite for an operational Premium IP service.

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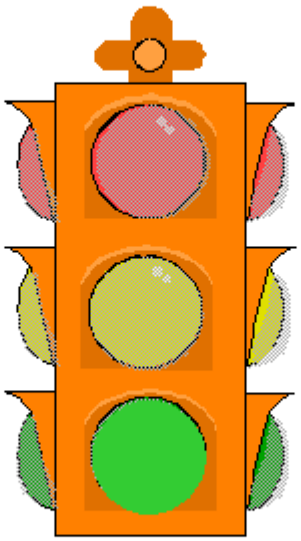

Yes

Green light to QoS service(s) ?

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- Premium IP Service has proven to be implementable and it offers a better service than Best Effort, when needed.
- No technical problem or flaw in the Architecture discovered
- Premium IP can peacefully coexist with other QoS services based on Diffserv (e.g. LBE/Scavenger)
- It does not interact with BE except when congestion is present, not it modifies the network behaviour when configured (if the requirements are met, e.g. “good” hardware)
- Multidomain is feasible, provided Sequin extension to the basic Diffserv architecture are implemented (inter-domain PHB behaviour, e2e SLA/SLS)

SEQUIN

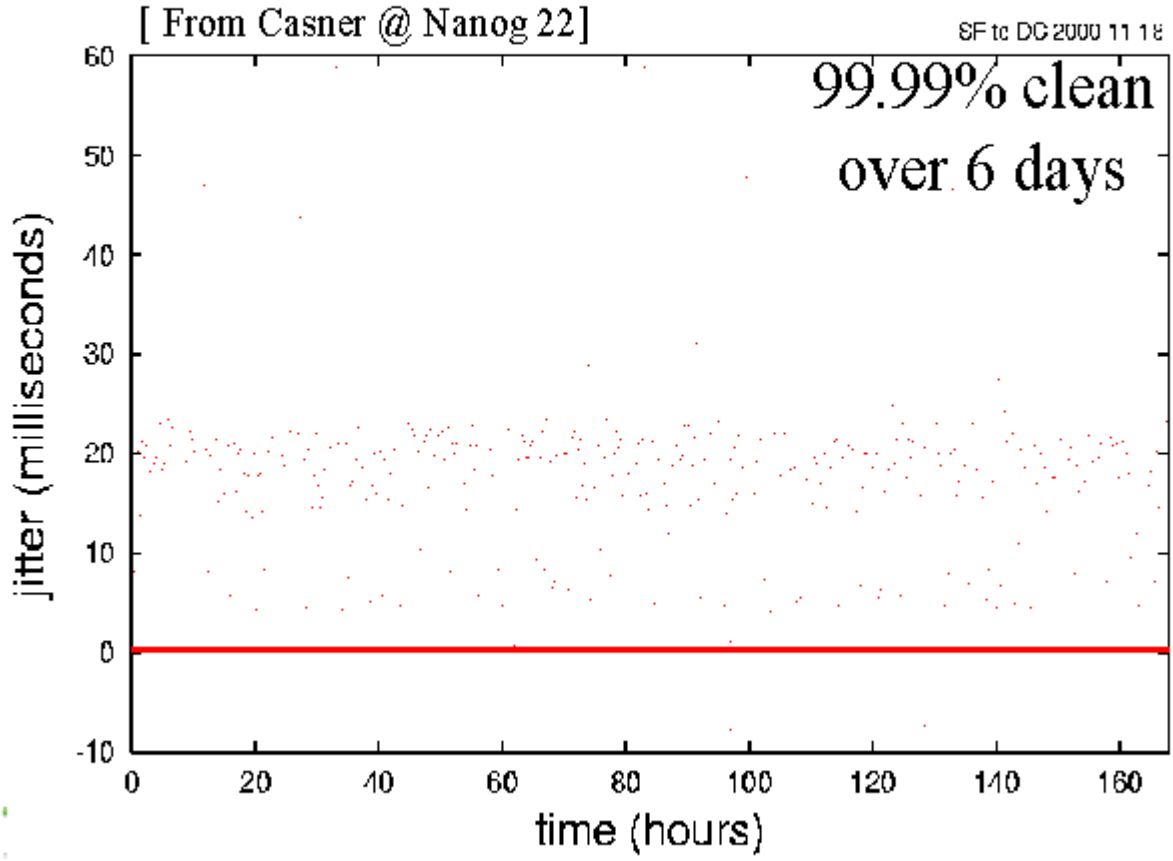
Overprovisioning

Two possible definitions:
- istantaneous link load never greater than 30%
- no packet losses (weaker)

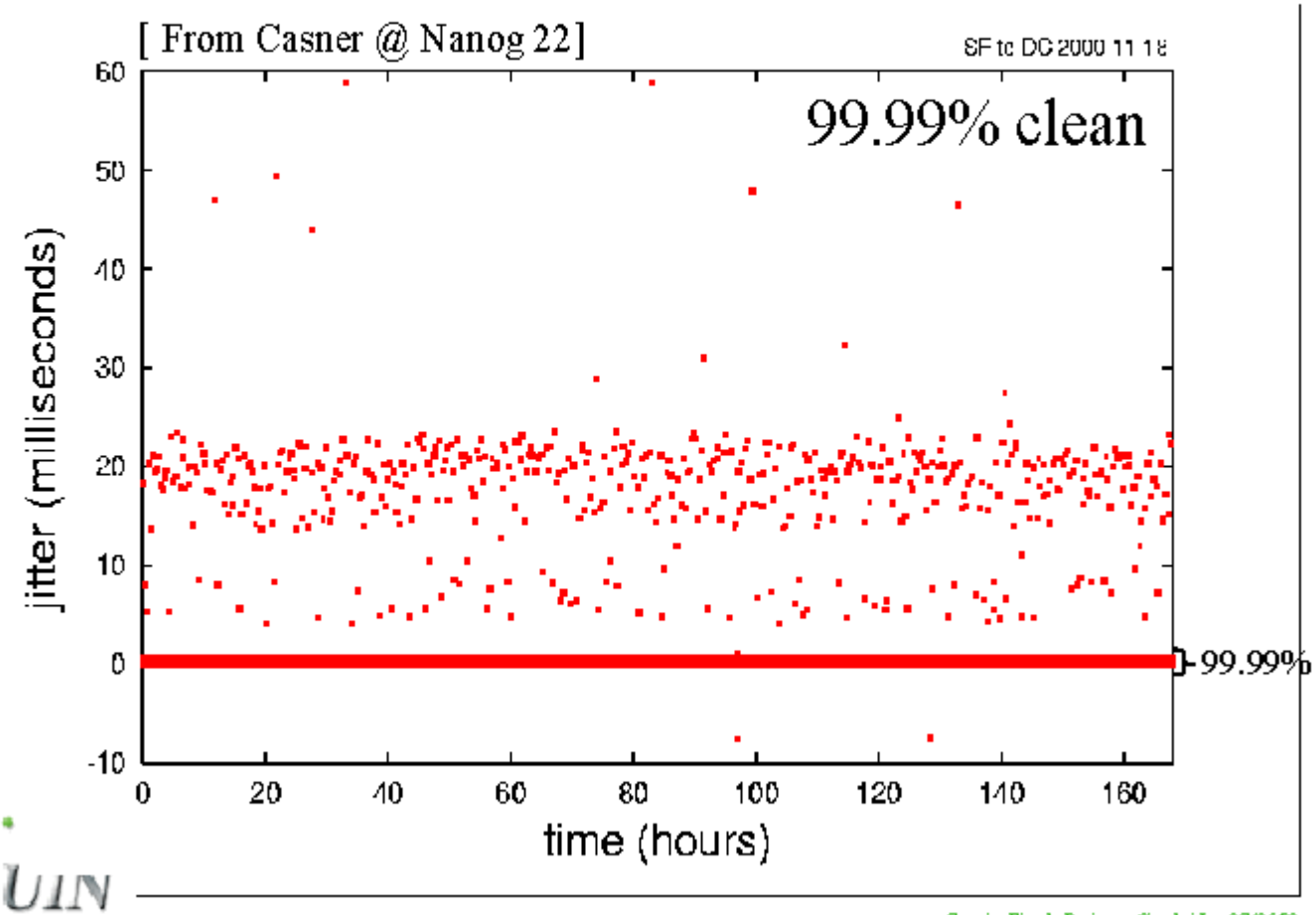
It works for 99.99 % of the cases, but capacity is far from being overprovisioned all over Europe (yet).
Even many LANs do not have enough capacity.

Why it's not perfect though ?

Tier 1 US backbone



Tier 1 US backbone (continued)



Overprovisioning (continued)

The 0.01 % of delay variation values which are not null are due to :

- routing problems;
- routing timers set-up;
- ARP cache timeouts;
- ...

It's mostly instability/misbehaviour of the software layer on routers/switches.

Overprovisioning (continued)

Premium IP can benefit and positively interact with overprovisioned networks (or links) although the overprovisioning is not a way to realise an EF PHB.

Through overprovisioning a network can offer an enviroment where EF traffic may maintain its quality (a *supportive network*), although the network can not be defined Premium IP *compliant*.

What we have learnt

Implementing Premium IP can be decoupled in three main action fields:

technological, operational and managemental.

Technological

- the architecture devised works
- different implementation techniques of the EF PHB exist and can interoperate
- the Sequin "extensions" to the Differv model work
  - inter-domain PHB behaviour as EF PHB
  - end to end SLA/SLS
- worldwide DSCP (EF PHB) values would be easier

What we have learnt (cont.)

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Operational

- a structure composed by individuals with clear responsibilities in each participating domain is a must.

Managemental

The collaboration between all parties involved is fundamental to:

- share the knowledge (which has to be stored and made available)
- speed up the setting up and debugging phase

All parties (up to eight) must be coordinated and available at the same time.

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What we have learnt (cont.)

The monitoring infrastructure is fundamental for management and operation, from the beginning, to set-up the service. Simple tools are enough to start, but not all pieces are available now.

The service can be implemented end to end and the "last mile" is fundamental. User's knowledge of the application requirement, ability to configure Premium IP in his premise are a key challenge and appropiate support must be available.

What we have learnt (cont.)

A migration path to the service is devised.

A NREN can start a (QoS sub) domain which is
indifferent: NREN preserves Premium IP DSCP value but applies BE treatment)
then migrates to
supportive: NREN preserves Premium IP DSCP value and offers environment where in general Premium IP characteristics hold, (eg. by overprovisioning)
finally becomes
compliant: NREN offers a realisation of Premium IP that is compliant with the specification

Anything still missing ?

Fine tuning of technical parameters (e.g. token bucket depth for scalability)

Policing by AS capability (requested to Juniper, it will be available in few months, no hardware replacement)

GPS extension to monitoring system. Needed for completeness and greater accuracy.

Risk analysis

Human resources

- needed mostly at users' sites and in NREN NOCs
- expert capable of understanding both application AND network behaviour and debug (not a Sequin issue per se, but fundamental). Creation of a team ?

Hardware capabilities at user's premise.

- network nodes to perform the required classification, policing, marking and queuing functions
- host /application capable of producing a flow compliant to the agreed QoS parameters

Creation of a widespread monitoring infrastructure

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GEANT

- GEANT Premium IP Work Item:
  - define
  - if possible, implement, with a Pilot phase
- co-operation
  - definition (with tf-ngn, GEANT APMs)
  - SEQUIN has provided user cases for Pilot Premium
  - GEANT has provided network infrastructure
  - SEQUIN smaller group and better suited to carry out complex task

Internet-2, standard bodies

- I2 has suspended development of Premium and shifted focus to scavenger
  - bad timing, different scenario in USA
- I2 recognises relevance and importance of Premium IP in Europe.
- Joint decision to move from local DSCPs to global DSCPs - to push through IETF standards

Industry

- Routers (Juniper, Cisco)
  - Juniper committed to add functionality within 9 months
- test equipment (Spirent, Agilent)
- ISPs (Colt, Telia)

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Use of Manpower

	WP 1	WP 2	WP 3	WP 4	WP 5	WP 6	Total MM	Budgeted MM
DANTE	2.24	1.14	1.87	2.07	3.3	0.91	11.53	12
DFN		1.75	2.62	2.47	2.83	0.44	10.11	12
GARR		4.6	4.14	4.55	2.03	1.22	16.54	24
GRNET		4.14	0.47	3.32	3.17	5.05	16.15	12
PSNC			1	2	2.86	1.5	7.36	7.4
RENATER		2.23			0.37		2.6	12.2
SWITCH	0.04	0.54	2.92	1.73	4.06	0.25	9.54	12
UKERNA		0.22	0.07	0.71	0.09		1.09	11.8
TOTAL	2.28	14.6	13.1	16.9	18.71	9.37	74.92	103.4
BUDGET	4	9	10	24	22	34.4	103.4	

Man Power

- UKERNA has not been able to recruit
- RENATER has not been able to replace pre-existing staff allocated to SEQUIN
- PSNC and GRNET have provided man power prior to officially joining the project, which has partly compensated UK and FR

Work-package efforts

- WP2 over-utilised, but some of the work done could be part of WP6 (SLA, monitoring) and WP4 (implementation)
- WP4 under-utilised mainly because of resources from UK and FR and effort allocated to WP2
- WP5 under-utilised because of issues with national testbeds
- WP6 under-utilised because of timing with other projects and effort allocated to WP2

Achievements

- Premium IP definition and implementation architecture, including SLA and monitoring
- Real user test cases on production networks
- Significant user group interest, relevance and willingness to co-operate and use the service

Achievements

- Support from industry (routers, testers)
- Real interest from ISPs (Telia, Colt)
- Instruction from NRENPC to deploy SEQUIN's definition of Premium IP on GEANT

Future work(within GEANT)

- Deployment on GEANT, including monitoring infrastructure
- access to more user groups
- fine tune provisioning, troubleshooting processes

Future work(within GEANT)

- Pursue dissemination of knowledge to NOC staff
  - dedicated tutorials at international and national events
- ipv6