Adaptive Resource Control for QoS
Using an IP-based Layered Architecture

Information Society Technologies
for
Broadband Europe
October 9 - 11, 2002

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http://www.ist-aquila.org/
Outline

- Network Services
- AQUILA Architecture
- Inter-domain QoS
- AQUILA and GÉANT
- Outlook
Consortium

Siemens, Germany

NTUA, Greece

arvato systems, Germany

Elisa Communications, Finland

Dresden Univ. of Technology, Germany

CoRiTeL, Italy

Salzburg Research, Austria

Q-Systems, Greece

T-Systems Nova, Germany

Telekom Austria, Austria

Polish Telecom, Poland

Warsaw Univ. of Technology, Poland
Main Objectives

- Investigate dynamic end-to-end QoS Provisioning in IP Networks
- Implement Prototypes of a QoS Architecture for a Carrier Grade DiffServ Core Network
- Support a wide Range of Applications by providing a QoS Toolkit / API
- Continuously analyse Customer Requirements, Market Situations and Technological Trends and develop Business Models
- Contribute to Standardisation Bodies like IETF, ITU, ETSI, etc.
Traffic Classes

Customer

The network operator offers the Network Services to the customer

Network Services

Network Services are mapped into traffic classes

Network operator

Traffic Classes

DSCP, scheduling and queuing algorithms (e.g. WFQ, RED), router configuration, admission control rules
Traffic Classes

Five Traffic Classes have been specified

<table>
<thead>
<tr>
<th>Network service</th>
<th>Premium CBR</th>
<th>Premium VBR</th>
<th>Premium MultiMedia</th>
<th>Premium Mission Critical</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic class</td>
<td>TCL 1</td>
<td>TCL 2</td>
<td>TCL 3</td>
<td>TCL 4</td>
<td>TCL STD</td>
</tr>
</tbody>
</table>

... as well as the related Traffic Control Mechanisms in the Routers
Why different **Network Services**?
An application-oriented perspective…

- **PCBR**
  - Real-time
  - Voice

- **PVBR**
  - Real-time
  - Video

- **PMM**
  - Non-real-time
  - FTP, bulk data tr.
  - Elastic stream

- **PMC**
  - Non-real-time
  - Transactional data

- **Best Effort**
  - No QoS assurances

Applications
Why different **Network Services**?  
A traffic-oriented perspective...

- **TCP flows**
  - greedy
  - non-greedy

- **UDP flows**
  - NO stat-gain, small pckt
  - stat-gain, large pckt

- **PCBR**
  - NO QoS assurances

- **PVBR**
  - NO QoS assurances

- **PMM**
  - With QoS assurances

- **PMC**
  - With QoS assurances

- **Best Effort**
Architecture

Resource Control Layer

Resource Control

Admission Control

End-user Application Toolkit

QoS Request

QoS Request

Consideration of Network Load

Monitoring Probing Results

Admission Control Agent

QoS Request

Resource Control Agent

resources

Setting

Access Network

Core Router

Core Router

Core Router

Edge Router

Edge Router
Resource Pools

- **Resource Limits**
  - Limit amount of QoS traffic from each edge router

- **Group neighboured Routers**
  - Limit amount of QoS traffic from each group

- **Dynamic Distribution**
  - Dynamically shift resources within group

- **Hierarchical Structure**
  - “Groups of groups”
End-user Application Toolkit Objectives

- Enable Access to QoS to non QoS aware Legacy Applications
- Support QoS aware Applications (RSVP, DiffServ) / Support various QoS Request Methods
- Provide a Methodology and a Programming Interface to support the Construction of new QoS aware Applications
- Provide an End-user friendly QoS Access
Lessons Learnt from 1st Trial

- **Verification of AQUILA QoS architecture**
- **Network services**
  - fulfil assumptions
    - Delay, packet loss <= specification
  - do not mix streaming and elastic traffic in one service
    - else UDP will degrade TCP
    - UDP will not reach QoS
  - Fair bandwidth sharing for TCP flows
- **Resource and admission control**
  - General mechanisms work
- **Router**
  - WFQ noticeably degrades performance of Cisco routers
Inter-domain Resource Control

Aggregated with other reservations to the same destination domain

Domain may use other QoS mechanisms than AQUILA
2nd Trial Features

- **Evaluation of Measurement Based Admission Control (MBAC)**
  - Feedback for improved network utilisation

- **Real user involvement in Warsaw, Vienna and Salzburg**
  - Subjective and objective tests

- **Inter-domain QoS provisioning**
  - Near-to-reality, scalability, BGRP

- **Complex Internet Service (CIS)**
  - Mediazine, SIGMA, HotStreams
QoS applications used in the 2\textsuperscript{nd} trial

- **NetMeeting**
- **SIGMA (Sip-based IntelliGent Multimedia Application)**
- **Mediazine**
  - IP based Internet / TV application
  - Different multimedia broadband services:
    - video / audio on demand
    - games
    - news
    - email
    - chat
    - e-commerce
Mediazine Screen Shots
Trials of inter-domain AQUILA architecture

- Trials are performed to evaluate the benefits of the AQUILA inter-domain architecture
  - Testing environment should be as close as possible to the real conditions
  - In order to achieve this, the testbeds located in Polish Telecom (Warsaw) and in Telecom Austria (Vienna) were inter-connected via the GÉANT network
AQUILA connects with SEQUIN / GÉANT

- Four AQUILA traffic classes would be mapped into Premium IP
- DiffServ Code Points (DSCP) would be changed
- AQUILA traffic between Warsaw and Vienna must not be interfered during this trial
- In the future, Globally Well-Known Services (GWKS) may help
Trials of efficiency of inter-domain network services

- Artificial traffic flows, emulating the traffic generated by applications, are submitted to the network.

  - QoS metrics (i.e. delay, jitter, packet loss, etc) are measured by using the measurement tools.

- Thanks to GÉANT Premium IP service, the interconnection link is transparent from the point of view of achieved QoS.
Trials with real users

- **Demonstration of benefits of QoS to the „real” users**
  - Users are located in Vienna and in Warsaw
  - Applications used for the trial
    - Voice over IP - SIP user agent
    - Videoconference – NetMeeting
    - Complex Internet Service - Mediazine
  - QoS perceived by the users is evaluated in terms of MOS (mean opinion square) scale
Experiences with GÉANT

- Establishment within shortest time from initial request (04/2002)
- SEQUIN / GÉANT network engineers very helpful
- Network fulfills the AQUILA requirements
  - Positively prooven using applications like ftp, telnet, AQUILA QMTool, …
- AQUILA started it’s 2\textsuperscript{nd} trial using the NREN/GÉANT infrastructure
  - Test scenarios for inter-domain QoS provisioning
  - Evaluation of MBAC
  - Real user involvement in Warsaw, Vienna and Salzburg
Outlook

- **Enhancement of Standardization Activities**
  - Inter-domain QoS signalling: the BGRP+ architecture
    - draft-salsano-bgrpp-arch-00.txt (May 14, 2002)
      » requirements and scalability of inter-domain resource reservation
    - draft-nikolouzou-bgrpp-sim-00.txt (July 26, 2002)
      » mechanisms for inter-domain resource management and simulation results
  - Standardized GWKS
  - Standardization of DiffServ usage (like port numbers e.g.)

- **Further availability of pan-European (and international) Research Network infrastructure**
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Thank you for your attention!

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