Q & A for Florence review performance

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Synopsis: *This document contains the questions and answers of the perfomance at the workshop at the 5th Premium IP Meeting and review in Florence, Italy at November 21, 2002. Included are also the slides used for the introduction, as topic background , the expert presentations and the summary.*

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History :	Version	Date	Reason to change
	a	*25/11/02*	*First version*

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1 Questions & Answers

Q = ISP [Natalia Miettinen (ELI)]

A = Manufacturer (AQUILA) [Anne Thomas (TUD)]

Introduction and summary: Gerald Eichler (DTA)

1.1 ACT 1: How to manage the game?

The Quality of Service Management Tool (QMTool)

Q1: As an ISP I am very interested in offering QoS to my customers. I have already heard that the AQUILA architecture can provide QoS. There are many different platforms around in the market, that promise QoS, but they are difficult to administrate.

How do you do this in AQUILA ?

To administrate the architecture we have developed a tool called QM Tool. With this tool you will be able to manage your network, and for example your customers. Yannis is going to show you this feature right now.

Demo QM Tool (Yannis)

1.2 ACT 2: How to access the game?

The End-user Application Toolkit (EAT)

Q2: How can my customer access the AQUILA system?

It depends on the kind of application your customer is using:

- If it is an application, that rely on special signalling protocols like H.323 or SIP., the QoS is requested directly by several protocol gateways,

- If the application is a New QoS-aware applications, it can directly access the End-User Application Toolkit API,
- If it is a Legacy application, the end-user requests personally for QoS via a QoS portal and with the help of Application Profiles.

Q3: Please give me more info about the portal

The portal is an interface between the application, the end-user and the QoS enabled network

It enables the

- Registration in the network,
- The selection of QoS levels,
- The mapping of the selection into an AQUILA QoS request.

Q4: I do not know the detailed QoS requirements of my legacy application

That is not a problem. The EAT provides a set of predefined Application Profiles for the most popular applications.

Q5: What's basically in the profiles?

In the profile you can find information concerning the application like Technical parameters for traffic description and QoS requirements, and user level descriptions of QoS.

Q6: Do I need a special profile for each of my applications?

Yes. AQUILA supports the creation of new profiles.

Q7: If I have a new application, how do I create a new profile?

If you find an existing profile for a similar application you can take it and adjust it, or if not you have to analyse your application and create the profile from scratch.

Q8: How does the portal look like?

Martin prepared a demonstration where you will see two different scenarios for a video download:

- The first one without QoS support.
- And the second one with QoS support and via the portal

Demo video download (Martin)

1.3 ACT 3: How to prove the game?

The Distributed Measurement Architecture (DMA)

Q9: Why is the quality much better now? Are there additional resources in the network now?

No. The network stayed untouched.

Felix will give some more precise information on that.

Felix

For demonstration, we started a background load generator before, which stressed the network with very nasty UDP traffic. Before setting up the reservation, the video application and the background traffic shared the same traffic class.

The overall load was much too high for the network and several packets have been dropped. TCP and UDP react very different on packet loss.

TCP-based video-stream is reducing its sending rate, UDP does not.

The reservation differentiates the traffic, i.e. the video transfer rate increases.

The background best effort traffic gets increased packet loss and lower throughput.

Q10: This means that my premium customers get good quality on demand, but remaining resources can always be used by the other customers, can't they?

Yes, you are right. The remaining resources can always be used, in this way you optimise your network utilisation.

Q11: How can the provider verify, that the premium customer gets the agreed service quality?

The simplest way is to wait until your customer is complaining.

Better to be pro-active and react before your customer notices bad quality the network has to be monitored during the operation.

Q12: How can the network be monitored?

We have two kinds of network monitoring:

- Sending probing packets throughout the network ("active network probing")
- Consulting the routers in the network about their current status. ("router monitoring")

There is a difference between the two probing methods:

- Active network probing produces additional traffic that is treated like premium end-user traffic,
- Whereas router monitoring is passive and does not produce any traffic.

Q13: In the case of active network probing what is the measurement overhead ?

The additional load is below 1% of the overall traffic, depending on link capacity and probing density.

Q14: And what is the router monitoring good for?

With this functionality you can gather statistical data from the routers.

This is useful, to see where possible bottlenecks are in your network.

If you observe too high packet loss (for example with active network probing), you can query the routers along the path and see, where the packet loss occurred.

So you can enhance exactly the bottleneck link.

Q15: Can I somehow test my service before I sell it to my customers?

Yes of course. Therefore you need an application-like load generator, which emulates the end-user behaviour.

This is also an integral part of the AQUILA distributed measurement architecture. It automatically invokes a reservation and starts producing network load following different load models for specific applications.

Q16: How are these approaches realised? Which tools are used?

We have developed our own tools because there is no tool fulfilling our requirements that are

- Measurement accuracy,
- Flexibility and
- Integration into one user interface.
-

Q17: Which additional hardware is necessary?

To run the probing tool you need

- A Measurement Agent available for Linux Operating System,
- And we recommend using GPS Equipment for clock synchronisation.

1.4 ACT 4: How to control the game?

The Admission Control (AC)

Q18: The standard routers that are now available on the market already support many QoS mechanisms; some of the manufacturers claim that their equipment is already "DiffServ" capable. Can I provide QoS in my network only by using these mechanisms?

No, it's not enough. It is true, that most routers support QoS mechanisms, which differentiate the way that packets are handled within the router, but it is not enough to provide "real" QoS guarantees.

First of all, in order to offer QoS, you definitely must avoid congestion in your network. Thus for each traffic class, you need a mechanism limiting the traffic to the level, which does not cause congestion.

This mechanism is implemented in AQUILA and it is called Admission Control.

Q19: What is the benefit of Admission Control?

Effectiveness of bandwidth utilisation by application of Joint AC scheme.

Q20: How is bandwidth managed by Joint AC?

Marek will give you a small presentation.

Marek

1.5 ACT 5: How to scale the game?

The Performance & Scalability of the AQUILA System

Q21: Can you show how the elements of the systems are interacting?

Of course, Martin will show you the interaction between the elements with the example of the QoS video download that we viewed before.

Demo trace tracker (Martin)

Q22: OK, let's move to the system engineering aspects: I'd like to know how many users the system can support, which is the needed equipment and what is the performance of the system for example in terms of reservation setup times.

In order to answer this question we have to clarify the context: we can consider either the AQUILA prototype, that means the system that we have built and that is here for demonstration, or the AQUILA concept which is the network architecture.

We will start to talk about the prototype because we've built it. We have to take into account that there are some limitations that can be overcome, so the "performance" of the AQUILA implementation can be much better!

I will also give you some possible steps from the prototype to a more powerful system.

Anyway even with the prototype or, with a system with few enhancements, we can find some interesting use cases.

Q23: So, tell me about the prototype: can you give me a use case and discuss its performances?

An example for a use case is the Internet access in small/medium companies via an ISP

Stefano will explain this in more details.

Stefano: expert presentation

- The company has a Customer Edge router. A server with the ACA Admission Control Agent can be deployed in the company LAN or in the ISP network
- We can have for example 20 potential users in the company; they will experience a setup delay of around 1 sec for their reservations.
- We need one server with the RCA in the ISP, and it can handle several of these ACAs.

Q24: But are you only dealing with business clients access, what about residential customers for example using ADSL, can they communicate with QoS ?

In this case we consider the Admission Control Agent in the ISP network close to the access router. Similarly, this ACA may serve a number of connected user in the order of 100.

And I'm still talking about the prototype equipment.

Q25: So, how can you evaluate if the user of the system will receive good performance (i.e. setup time)?

We used our prototype to run some measurements, than we considered a model to derive further considerations.

Q26: How much can you improve the performance of the prototype moving to a real product?

We identified that the bottleneck of the prototype is in the communication to the routers via Telnet and Command Line interface.

Moving from the prototype to a real product we can improve the design of the AQUILA components (in particular the ACA) to overcome this bottleneck.

If available, we could use equipment that provide a different approach to control the router instead of Telnet and Command Line Interface

We estimate that we can have a capacity improvement of a large factor (5 to 10) while re-using most of the prototype components, and this is due to the fact that the bottleneck of the system is not related to the communication in the Resource Control Layer between the AQUILA elements.

Q27: Ok, just to fix the ideas, can you just provide a kind of summary with a scenario ?

Yes, an AQUILA network based on the prototype could look like this:

- 1 RCA
- 100 ACA :
    - 50 for business users, each one collecting traffic from 20 customers with access links at 10 Mb/s and 15 users in each customer network
    - 50 for residential users, each one collecting traffic from 200 connected users

- This means in total: 20000 active users

The services we have considered are video-communications, PMM for video and file download & Mediazine, PMC for on-line games

If we go beyond the prototype… for example you can think of supporting 5 times the users with the same control plane equipment.

1.6 ACT 6: How to extend the game?

The Inter-Domain Extensions (BGRP Enhancements)

Q28: How about the inter-domain aspect of QoS. Can the AQUILA architecture "communicate" with the rest of the world?

Yes, it can. It provides the necessary means to facilitate the interaction with other domains.

Q29: How does the AQUILA network interact with the other domains?

An enhanced version of the BGRP resource reservation protocol. This protocol follows the concept of the aggregation of the reservations into sink trees and is based on the BGP routing protocol

The BGRP protocol operates between BGP-enabled border routers of an Autonomous System.

The BGP routing protocol enables the creation of sink-trees while domains trace their route towards a particular Autonomous System.

Consequently, reservations are aggregated along the sink-trees created by the BGP protocol.

Q30: How do I know which network service the other domains provide I should use?

All the domains that are willing to support end-to-end QoS using the AQUILA inter-domain approach, should support a set of standardized services, which are implemented by all domains, the Globally Well Known Services.

Each domain can map the GWKS to its own network services taking into account the requirements of each service.

Q31: How can I be sure that the other domains will have the resources I need for a specific service?

You can check the SLAs that are established between the neighbouring domains.

The SLAs are based on the set of globally well known services.

In other words, there is a SLA-based admission control at border routers.

Q32: Do the other domains have to implement the AQUILA architecture for their intra-domain resource control?

No! It is not necessary to use the AQUILA architecture; in fact they can use any intra-domain resource control mechanism. They can even just use over-provisioning for their core network.

However, the domain should be able to support the GWKS

1.7 ACT 7: How to win the game?

The User-Trial and Market Expectations

Q33: in your prototype development, did you do some trials with real users ?

Yes, we did tests with a SIP client, which you can evaluate in the next demonstration.

First using a loaded network and without QoS, afterwards with AQUILA QoS.

Please note, that in this case it's not the application requesting QoS, but the SIP proxy!

Demo of Best Effort SIP (Martin)

Q34: is the quality always this awful?

Using AQUILA you'll hear the difference.

Demo of QoS SIP (Martin)

Q35: After all this: do you think, there are promising business cases for both of us?

Yes, because MoIP (Multimedia over IP) will be an important business case in the near future. But QoS support is necessary to add value to existing services and to offer commercial real-time scenarios to our customers:

- AQUILA offers high-level adaptivity to special QoS requirements of different applications.
- *AQUILA is composed of self-contained items, which can be sold individually, but I'd recommend to*
- AQUILA is based on existing standards and works on top of your existing hardware.
- AQUILA brings together QoS guarantees AND high network utilization.

2 Introductory slides, background slides, expert presentations and summary

AQUILA (IST-1999-10077)

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

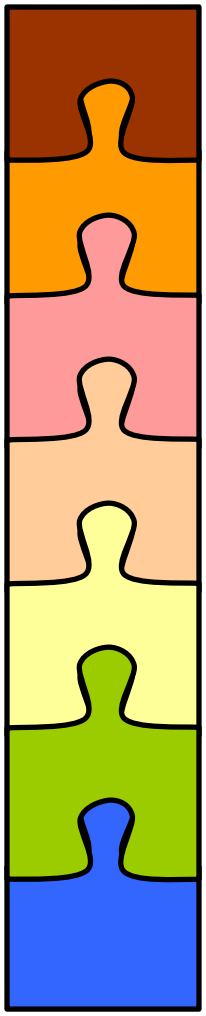
Project Review No. 5
Premium IP Cluster Workshop

Florence, Italy
November 21-22, 2002

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

AQUILA - a performance in seven acts

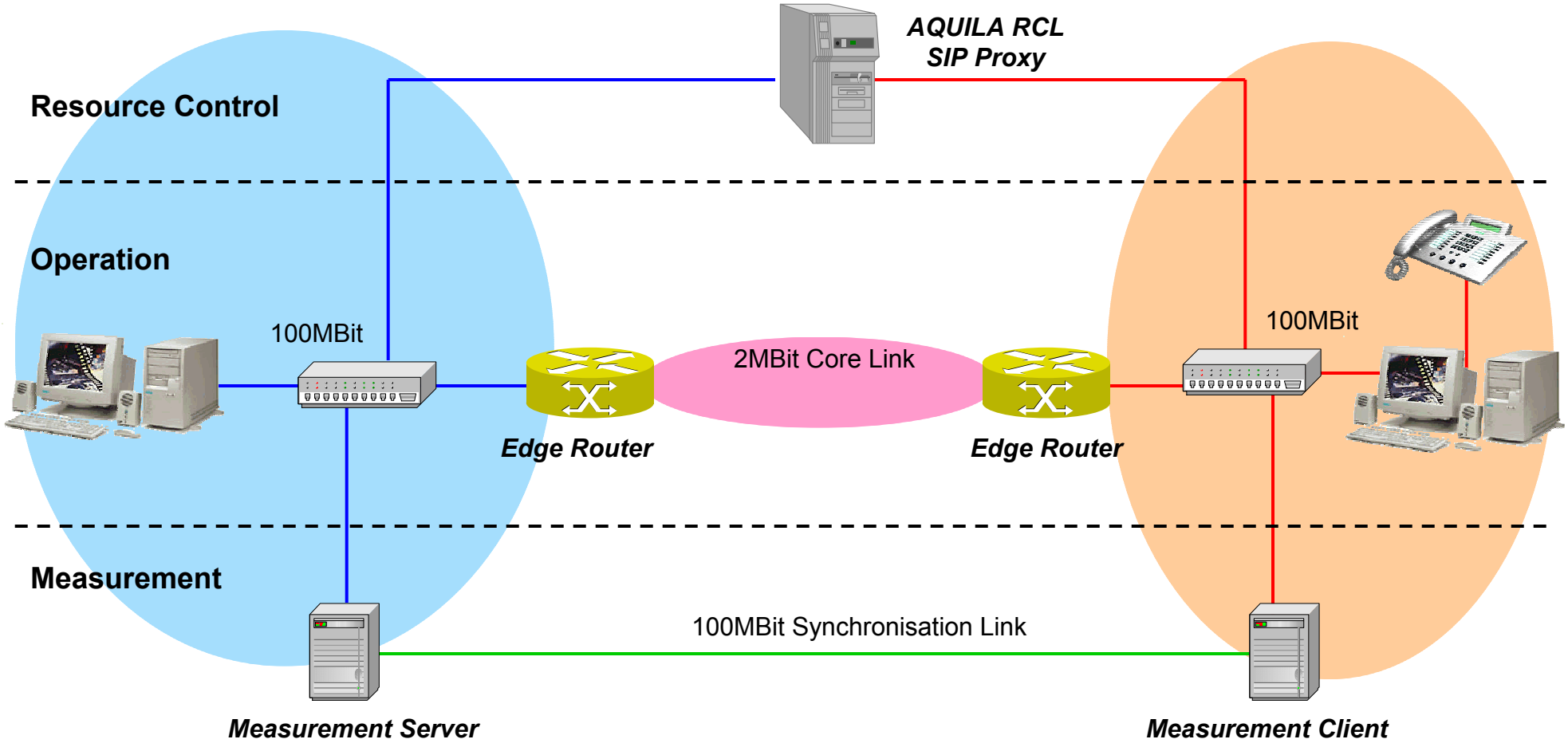
- **ACT 1: How to manage the game?**
  - The Quality of Service Management Tool (QMTool)
- **ACT 2: How to access the game?**
  - The End-user Application Toolkit (EAT)
- **ACT 3: How to prove the game?**
  - The Distributed Measurement Architecture (DMA)
- **ACT 4: How to control the game?**
  - The Admission Control (AC)
- **ACT 5: How to scale the game?**
  - The Performance & Scalability of the AQUILA System
- **ACT 6: How to extend the game?**
  - The Inter-Domain Extensions (BGRP Enhancements)
- **ACT 7: How to win the game?**
  - The User-Trial and Market Expectations



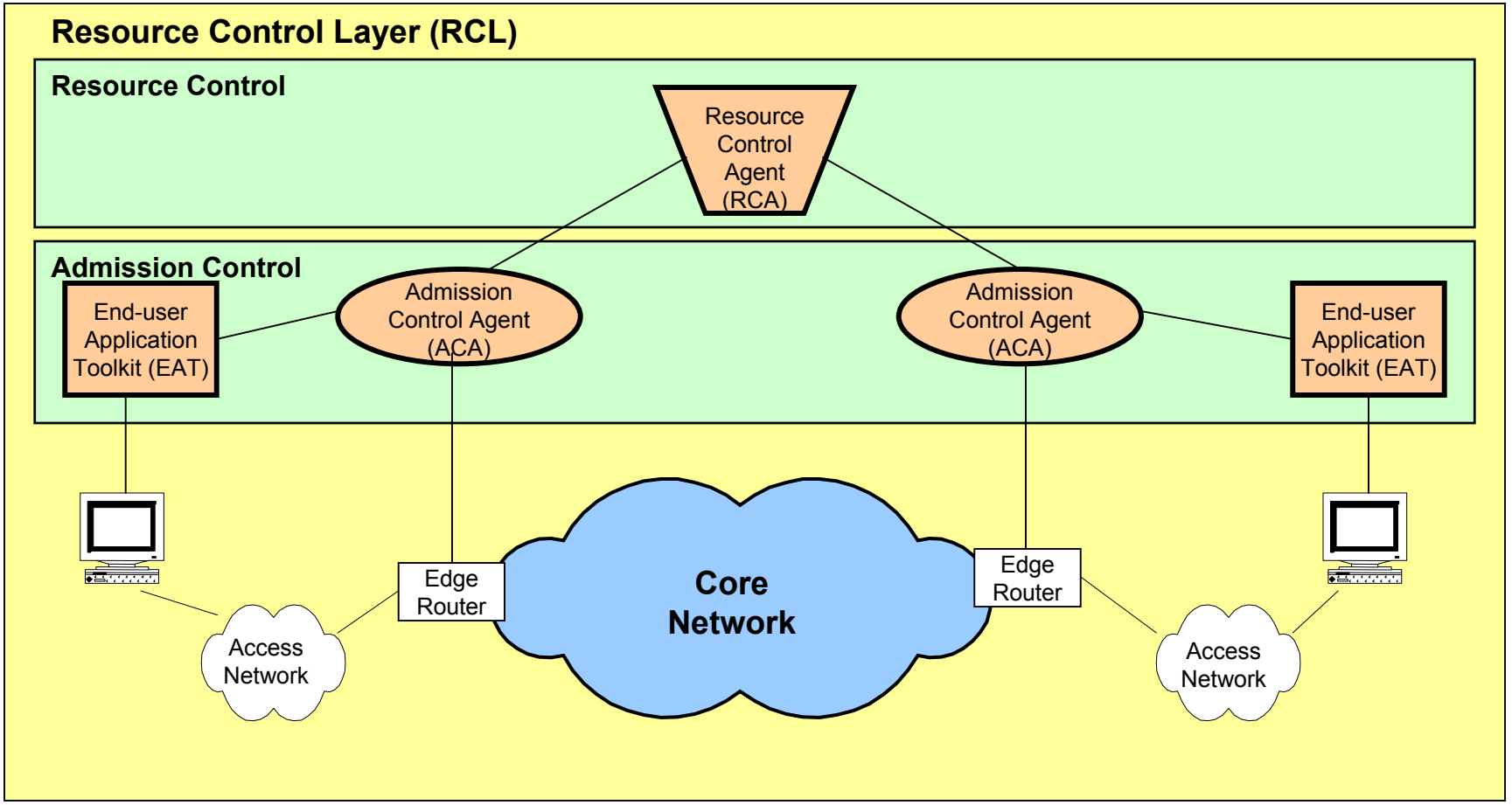
AQUILA - the actors on stage

- **The AQUILA *USER*: representing ISP's & operator's view**
  - Natalia Miettinen (ELISA Communications)
- **The AQUILA *MANUFACTURER*: selling the system**
  - Anne Thomas (TU Dresden)
- **The AQUILA *SPECIALIST*: running the demonstration system**
  - Yannis Karadimas (Q-Systems), Martin Winter (Siemens), Felix Strohmeier (Salzburg Research)
- **The AQUILA *EXPERTs*: giving detailed explanations**
  - Marek Dabrowski (Warsaw Technical University), Stefano Salsano (CoRiTeL)
- **The *moderator*: introducing & summarising the game**
  - Gerald Eichler (T-Systems Nova)
- **The AQUILA *PROTOTYPE*: providing the demonstration**
  - some routers, PCs & cables by various vendors

Demonstration network prototype



Resource Control Layer



ACT 1: How to manage the game?

The Quality of Service Management Tool (QMTool)

ACT 2: How to access the game?

The End-User Application Toolkit (EAT)

ACT 3: How to prove the game?

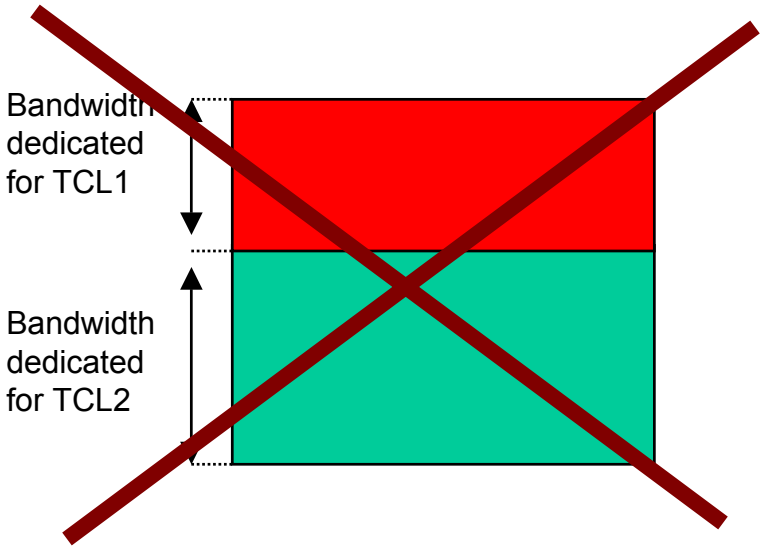
The Distributed Measurement Architecture (DMA)

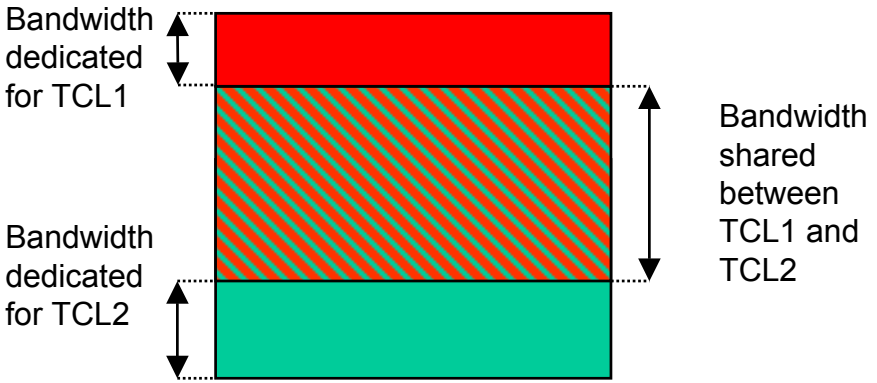
ACT 4: How to control the game?

The Admission Control (AC)

How to provide QoS?

- **How is bandwidth managed by Joint AC?**
  - By dynamic bandwidth sharing between TCLs
    - Especially effective approach when the „traffic peaks" in different TCLs do not overlap
  - By allowing for administrative bandwidth reservation for given TCL





Exemplary bandwidth partitioning between TCL1 and TCL2

How to provide QoS?

- **When can the new flow be admitted?**
  - If after admitting new flow the QoS of running flows (including the new one) is satisfied
- **What do we need for making decision?**
  - QoS requirements of new flow (Packet Delay, Packet Loss Ratio, Throughput, etc.)
  - Traffic profile of new flow
    - From declarations
  - Traffic load of running flows
    - From declarations (Declaration Based Admission Control - DBAC)
    - From measurements (Measurement Based Admission Control - MBAC)
  - Efficient AC algorithms for TCLs (adequate for different QoS objectives and traffic profiles)

How to provide QoS?

- **What are the advantages and drawbacks of MBAC and DBAC?**

DBAC

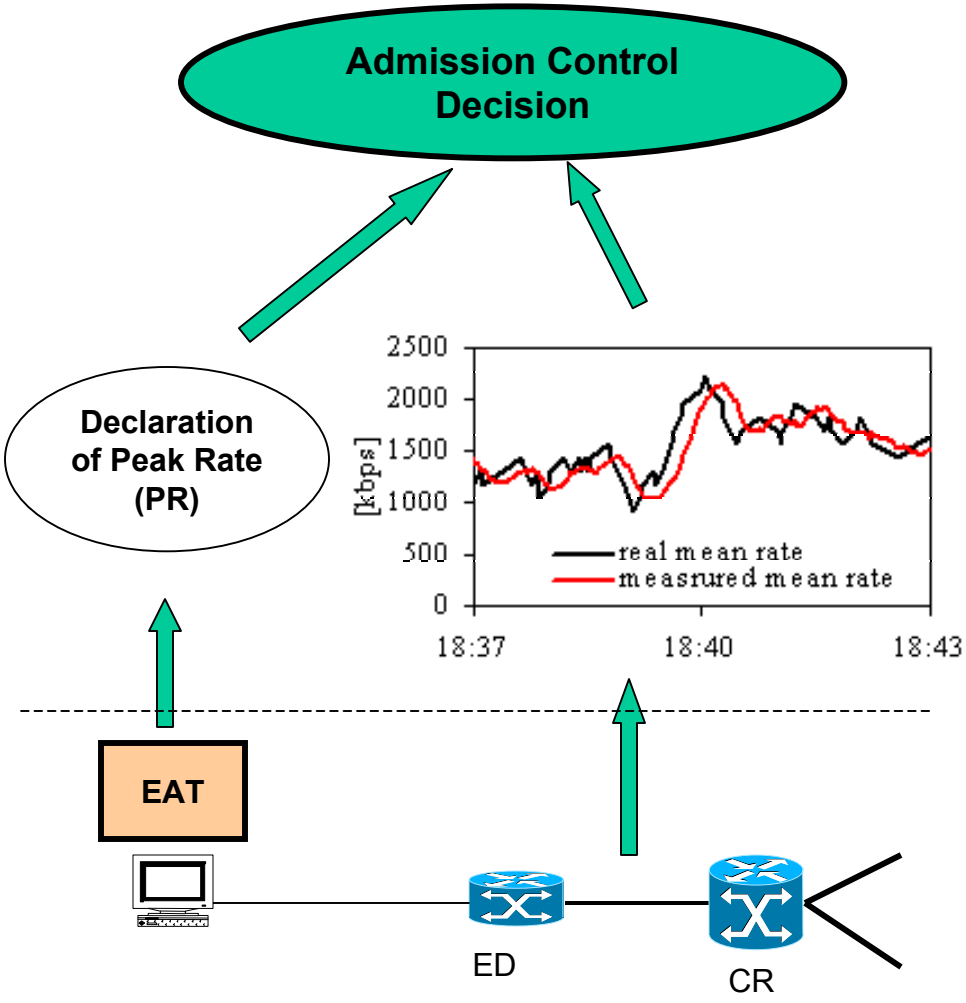
- Advantages:
  - » No additional measurements
  - » Well recognised methods (e.g. implemented in ATM networks)
  - » Strict QoS guarantees
- Drawbacks:
  - » Preventive (low bandwidth utilisation) in most cases
  - » Difficulties in precise traffic declarations in most cases

MBAC

- Advantages:
  - » Simplification of traffic declarations (e.g. only peak rate is required)
  - » Potential higher bandwidth utilisation
- Drawbacks:
  - » Additional measurements are needed
  - » Decision may be affected by the measurement errors
  - » Less effective than DBAC when submitted traffic is exactly as declared

How to provide QoS?

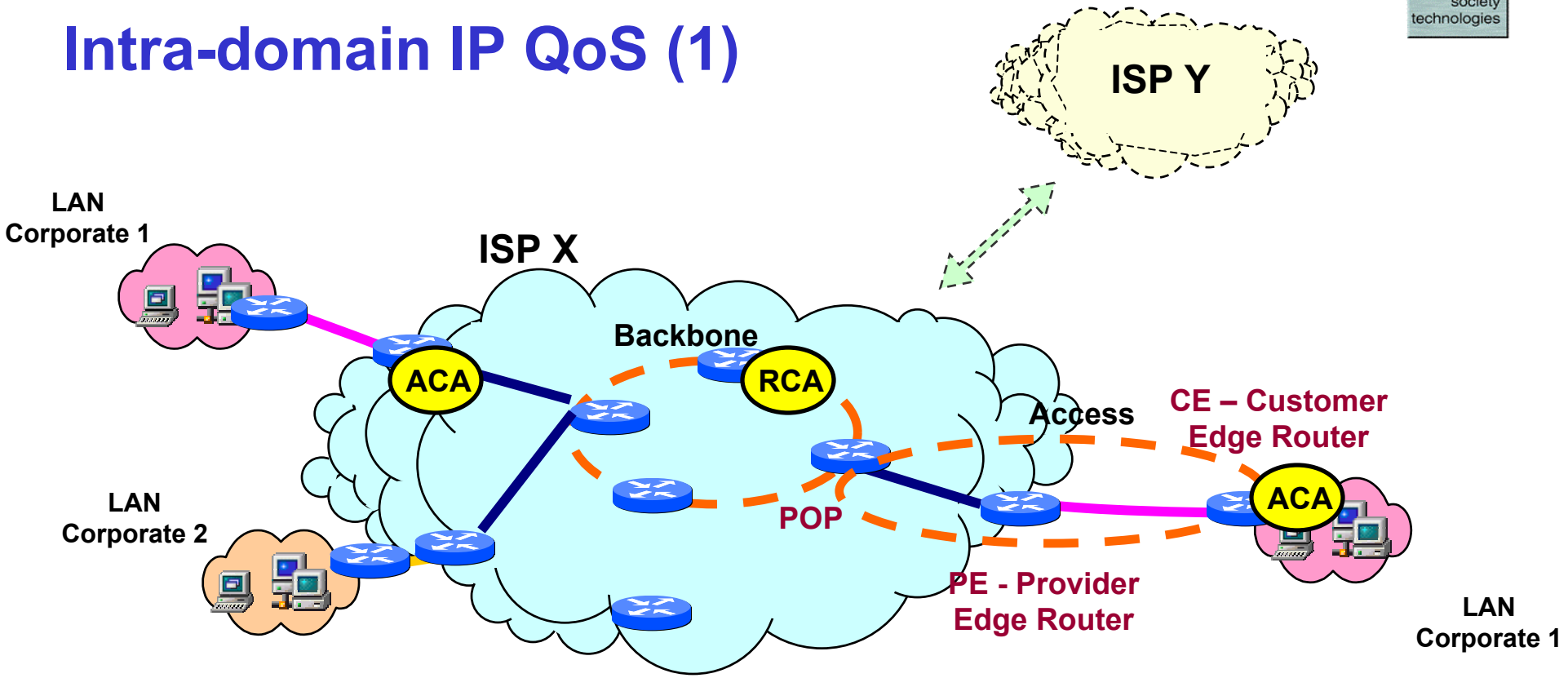
- **How is MBAC implemented in AQUILA?**
  - Only for TCL1 and 2 (streaming flows)
  - Special measurement module is implemented as part of the ACA agent
    - The measurements of mean rate of aggregated traffic stream are performed by polling the router in predefined fixed intervals
  - Hoeffding bound formula is used for assessment of sufficient link capacity for guaranteeing given packet loss ratio
    - Takes into account the results of the measurements as well as the values of PRs declared by the users



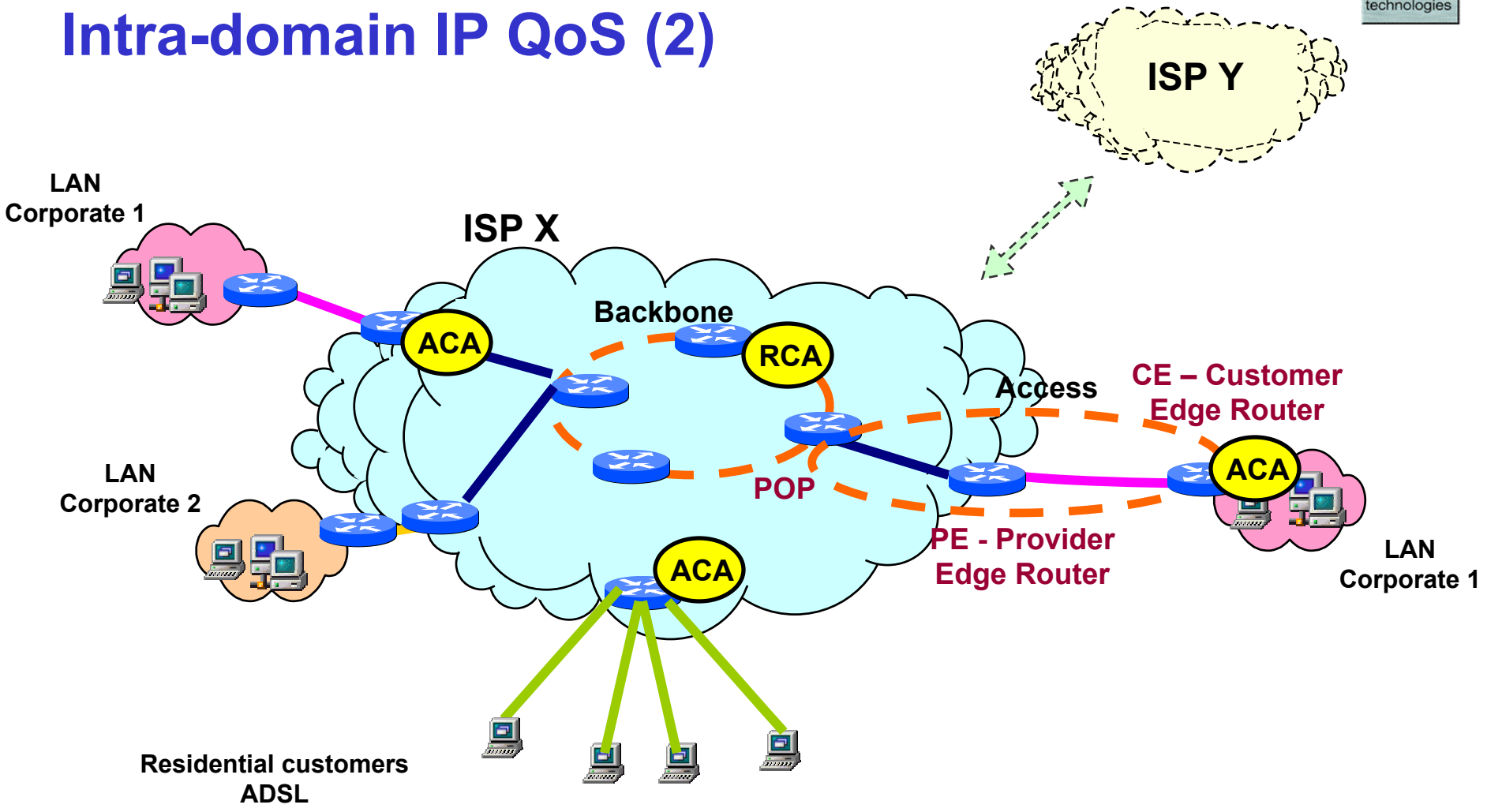
ACT 5: How to scale the game?

The Performance & Scalability of the AQUILA System

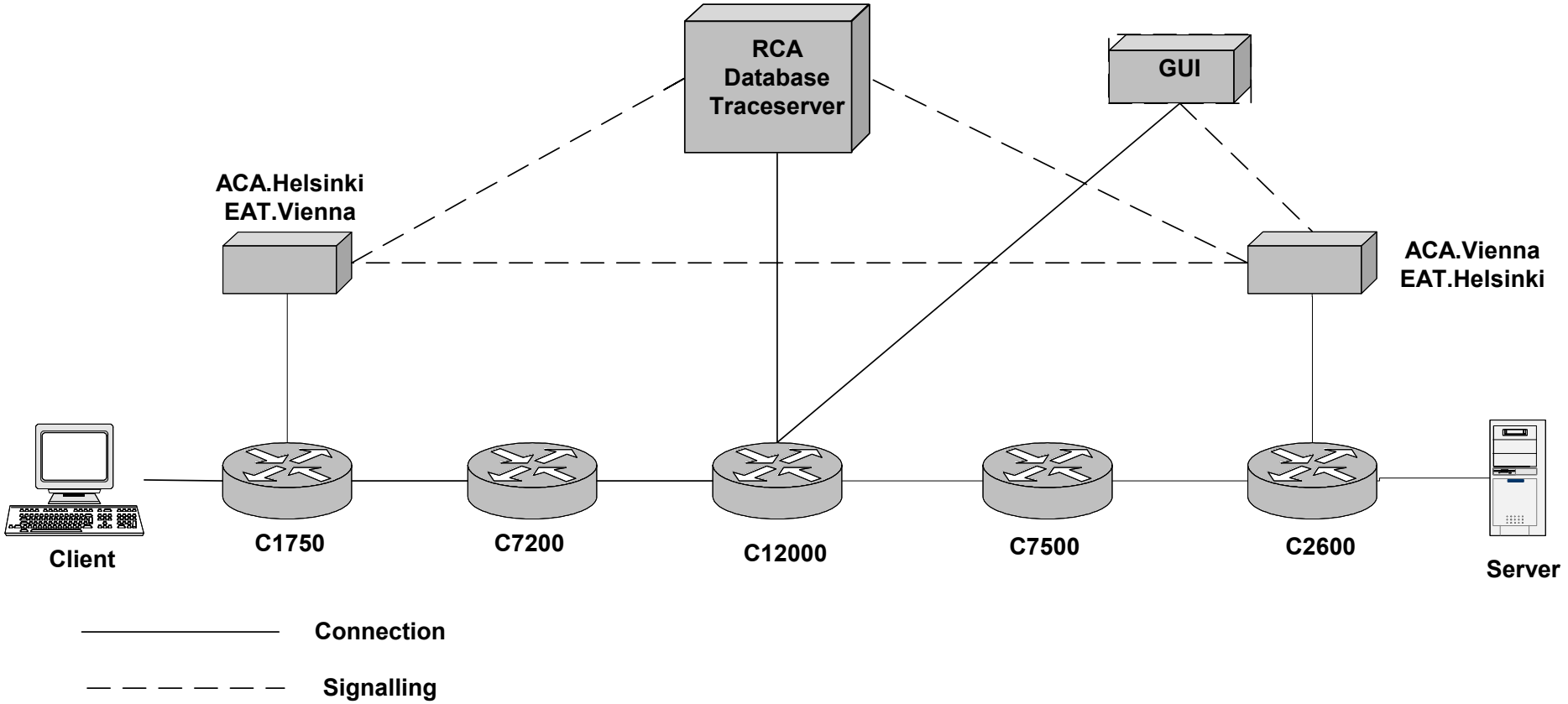
Intra-domain IP QoS (1)



Intra-domain IP QoS (2)



Intra-Domain Test Environment



Processing delays for reservations with DBAC

	Setup Delay [s]		Release Delay [s]	
	Delay	Deviation	Delay	Deviation
TCL 1 Reservation	0,90	0,026	0,46	0,065
TCL 2 Reservation	1,12	0,114	0,66	0,088
TCL 3 Reservation	0,97	0,071	0,50	0,011
TCL 4 Reservation	1,04	0,065	0,72	0,060

Router and resource pool contribution to total processing delay

	Request Delay [s]			Release Delay [s]		
	Total	Router	RP	Total	Router	RP
Initial	4,508	1,188	0,199	0,676	0,464	0
Subsequent	1,102	0,754	0	0,665	0,435	0

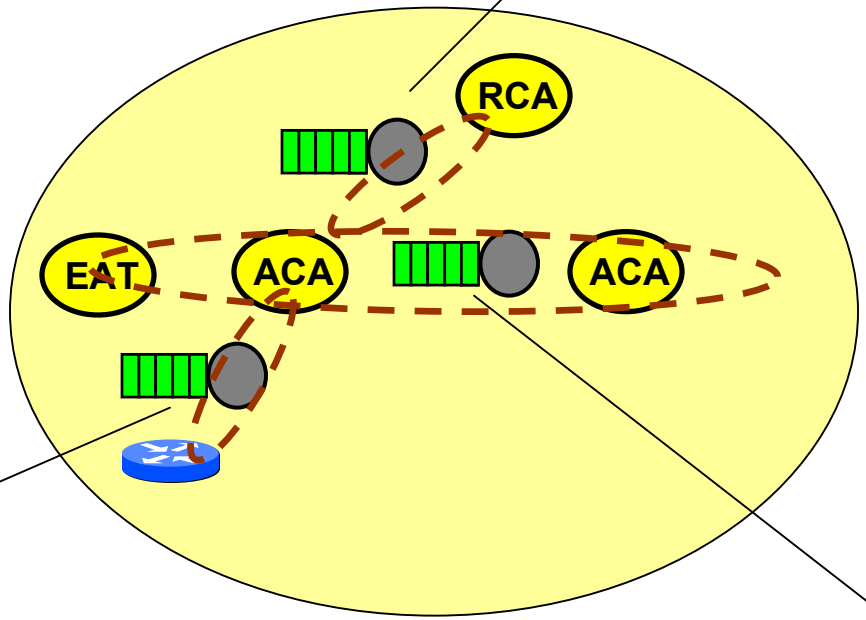
Building a model

- **From the measured values we derived a simple model separating the following processing (delay) components for the setup:**
  - BGP Route lookup (telnet to the router) 350 ms
  - Flow configuration (telnet to the router) 700 ms
  - Other RCL processing and communications (with logging) 350 ms
  - Resource pool interaction 100 ms
- **and for the release:**
  - Flow configuration (telnet to the router) 400 ms
  - Other RCL processing and communications (with logging) 200 ms

  - Other measures show that with no logging, the “Other TCL proc. and comm.” becomes 200 ms for setup and 120 ms for release

Rough model

RCL communication and processing:
ACA-RCA (resource pools)



Telnet to the router

RCL communication and processing:
ACA, ACA-ACA, EAT-ACA

Demand model

- **We have to relate user plane requirements and control plane requirements**
- **Assumptions on user activity**

"Heavy" user

• Video communications	0.5	req./hour	30 min	500 kb/s
• PMM flows (e.g. video-downl.)	3	req./hour	20 min	500 kb/s
• PMC flows (e.g. on-line games)	3	req./hour	20 min	5 kb/s

9 flow setup/hour/user — 630 kb/s on average (!!!)

"Average" user

2,5 flow setup/hour/user — 230 kb/s on average (!)

Rough performance analysis

- **"Bottleneck" analysis**
  - We set the target bottleneck utilization to 0,4
    (the bottleneck in the prototype is the Telnet communication ACA-Router)
  - Number of "Heavy" users / ACA-router : ~140
    corresponding user plane bandwidth: 89 Mb/s
  - Number of "Average" users / ACA-router : ~ 400
    corresponding user plane bandwidth: 91 Mb/s

Rough performance analysis

- One ACA can serve many customer edge routers if the access links are in the order of 2 Mb/s
- Only for big access links (155 Mb/s) is it worth putting the ACA in the customer network

"Heavy" user				"Average" user		
Access link speed (Mb/s)	Number of users/ Access link	ER/ACA		Access link speed (Mb/s)	Number of users/ Access link	ER/ACA
2	1,27	111,7		2	3,47	114,6
10	6,35	22,3		10	17,33	22,9
34	21,59	6,6		34	58,92	6,7
150	95,24	1,5		150	259,93	1,5

Rough performance analysis

RCA capability / dimensioning

- Assumpions:

  - signaling reduction due to the resource pools
    "damping factor" 10

  - RCA-ACA target utilization 0.4

- The number of ACAs that can be supported by a single RCA is ~ 140

Rough performance analysis

- **Bandwidth usage for RCL signaling**
  - Flow setup signaling amount: ~ 40000 byte
  - Average signaling rate per ACA: 88 kb/s
  - This must be compared with QoS user plane bandwidth:
    88 kb/s vs. 90 Mb/s -> 0.1% of QoS bandwidth
  - => Bandwidth usage for RCL signaling is negligible

ACT 5: How to scale the game?

The Performance & Scalability of the AQUILA System

Feasible scenario with AQUILA prototype

- **Services: video communications, PMM (e.g. video download), PMC (on-line games)**

- **1 RCA**
- **100 ACAs**
  - business customers: 50 ACAs x 20 customer ER x 10 users (10 Mb/s links)
  - residential customers: 50 ACAs x 200 connected users
- **Total: 20000 active users**

ACT 6: How to extend the game?

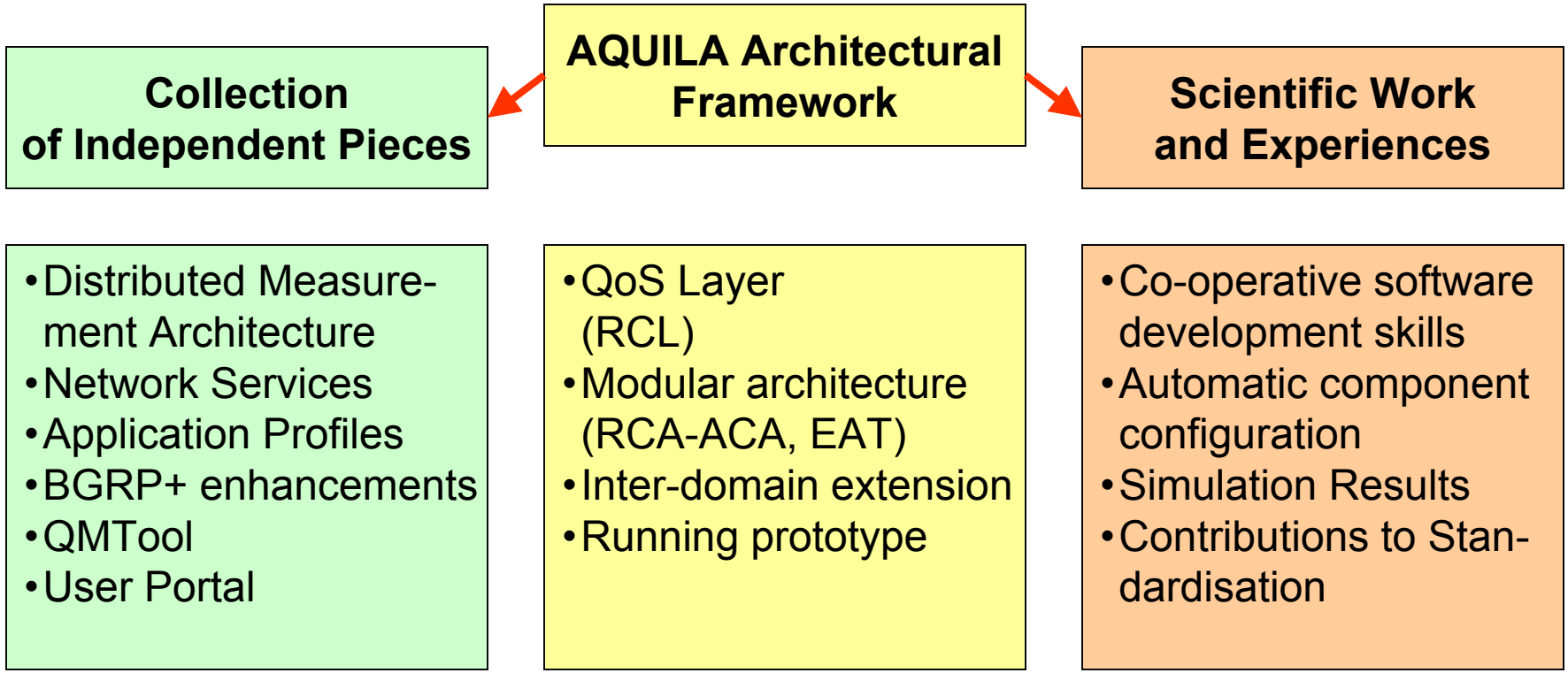
The Inter-Domain Extensions (BGRP Enhancements)

ACT 7: How to win the game?

The User-Trial and Market Expectations

Result & Product Summary

- **What is the overall re-usable outcome of AQUILA?**



Exploitation & Dissemination Summary

- **Who is the target audience of AQUILA, having what advantages?**

End-User	ISP	Operator
• Adaptive QoS portal • Complex Internet appli-cations (Mediazine) • Real-time support (SIP)	• User management • New optimised proxies • Adequate configuration	• Network management & optimised utilisation • QoS enabled network with guarantees • Proof of QoS • Globally Well-known Services (GWKS)
• Customer Profiles	• Application Profiles	• Network Services

AQUILA (IST-1999-10077)

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

Thank you for your attention !

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