
# Master Thesis Talk

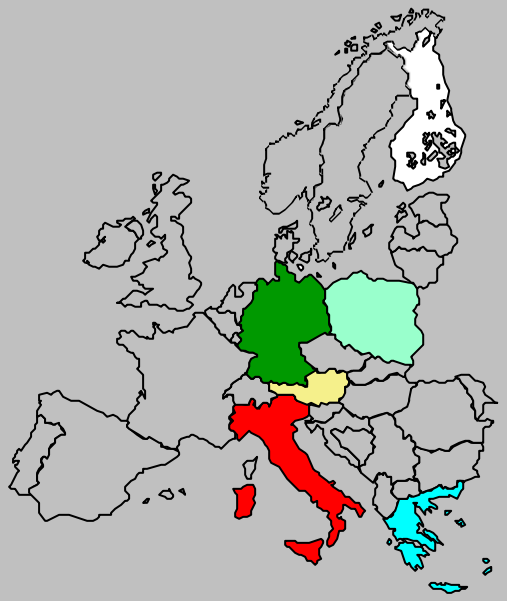
"Extension of a DiffServ enabled IP core network for delivering QoS to xDSL access"

By : Sandeep Misra

Guide : Prof. Hußmann

# AQUILA (IST-1999-10077)

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



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


# Outline

- **Motivation & AQUILA**
- **Resource Reservation Protocols**
- **Implementation Scenarios**
- **Analysis & Design**
- **Implementation**
- **Tests**
- **Summary**
- **Discussion**

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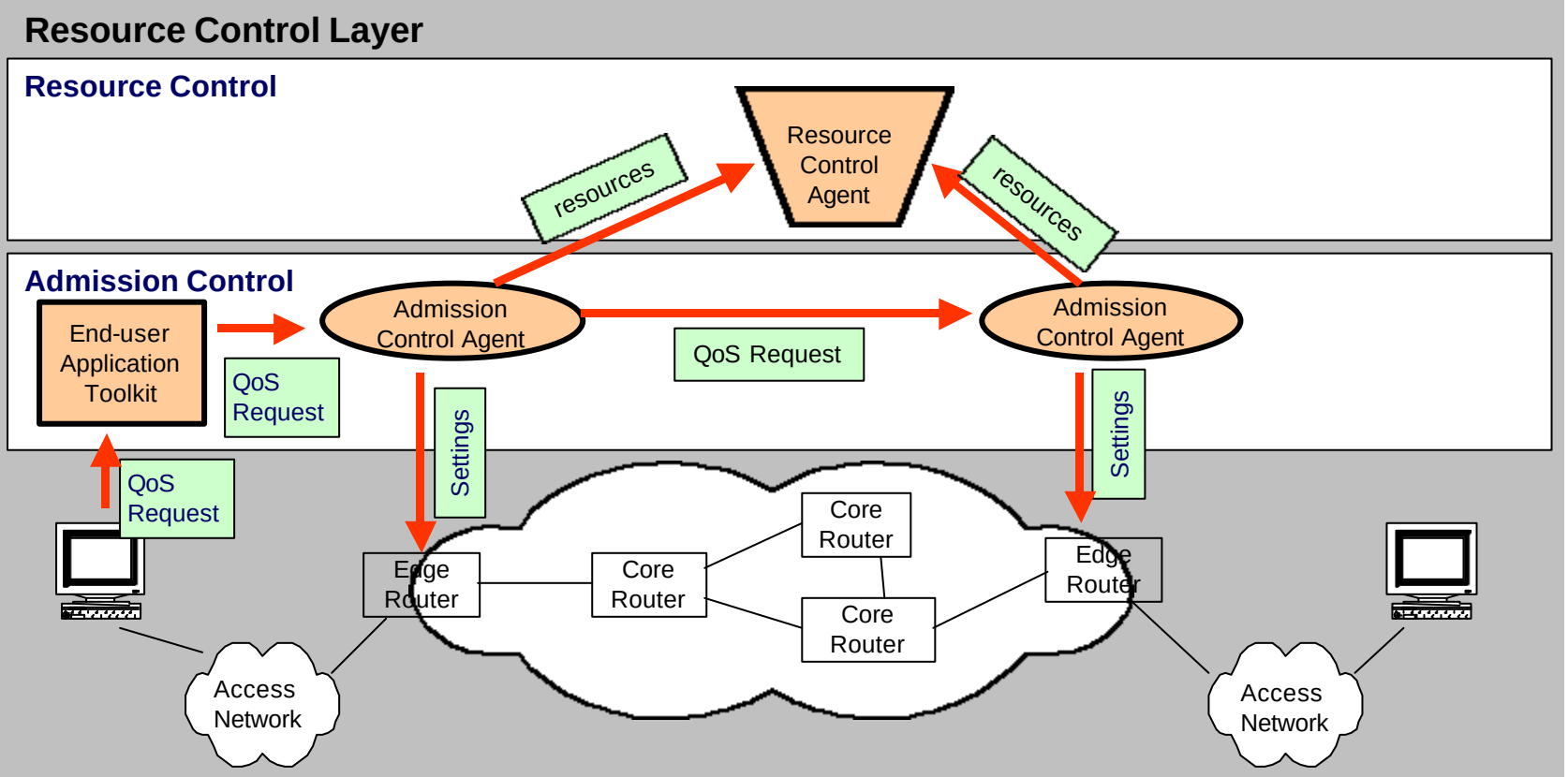
# Quality of Service

- Current traffic flow - Best effort
- Requirements :
  1. Traffic Classification
  2. Real Time Traffic Support
  3. IP Convergence Support
- User is paying for the service
- Need for QoS

# AQUILA : Introduction

- Based on the DiffServ network concept
- Introduces Traffic Classes
- Introduces Admission Control
- Introduces Resource Control
- Only for Core Network
- Is Scalable

# AQUILA Architecture

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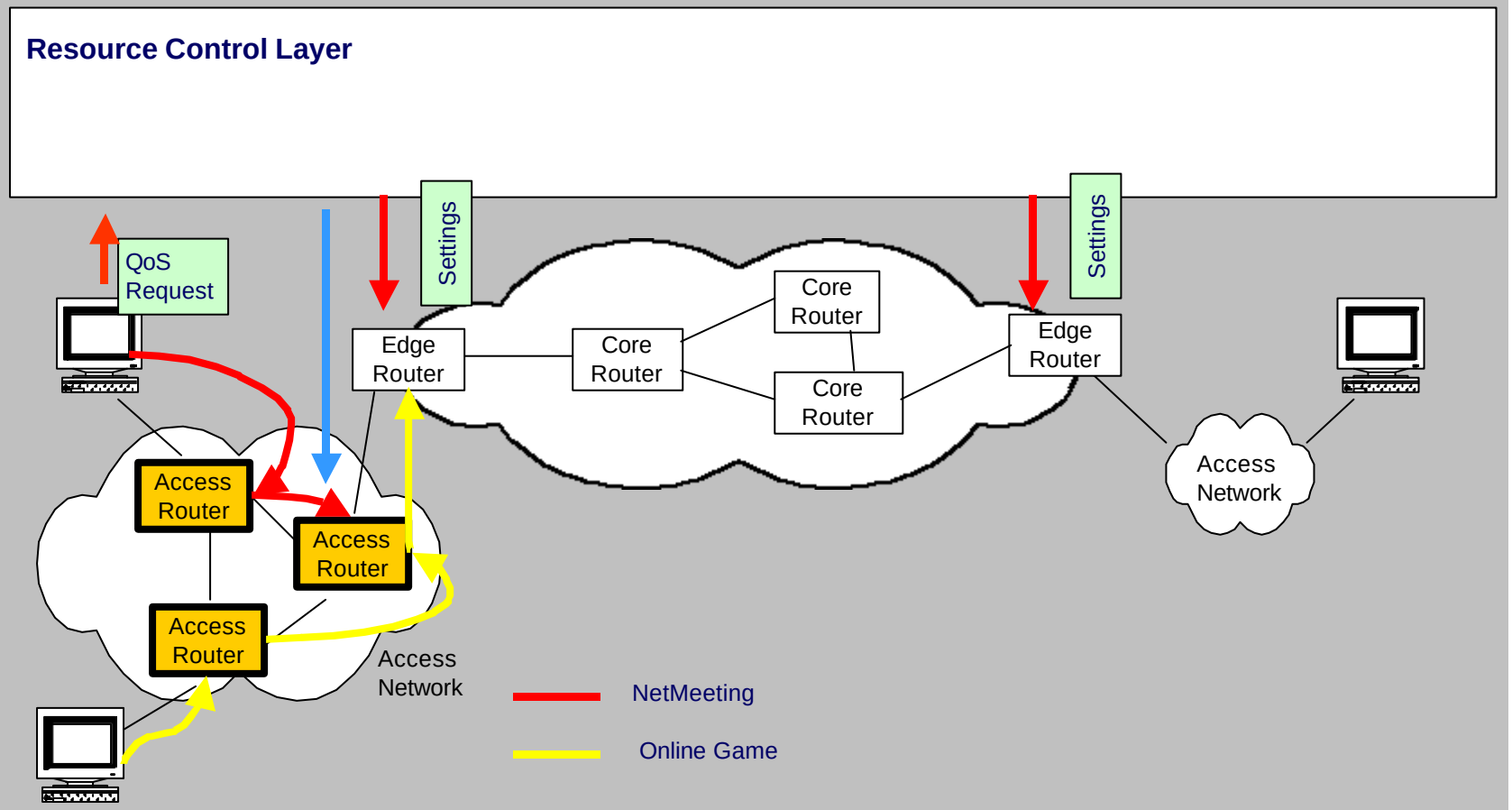
# AQUILA on Access n/w ?

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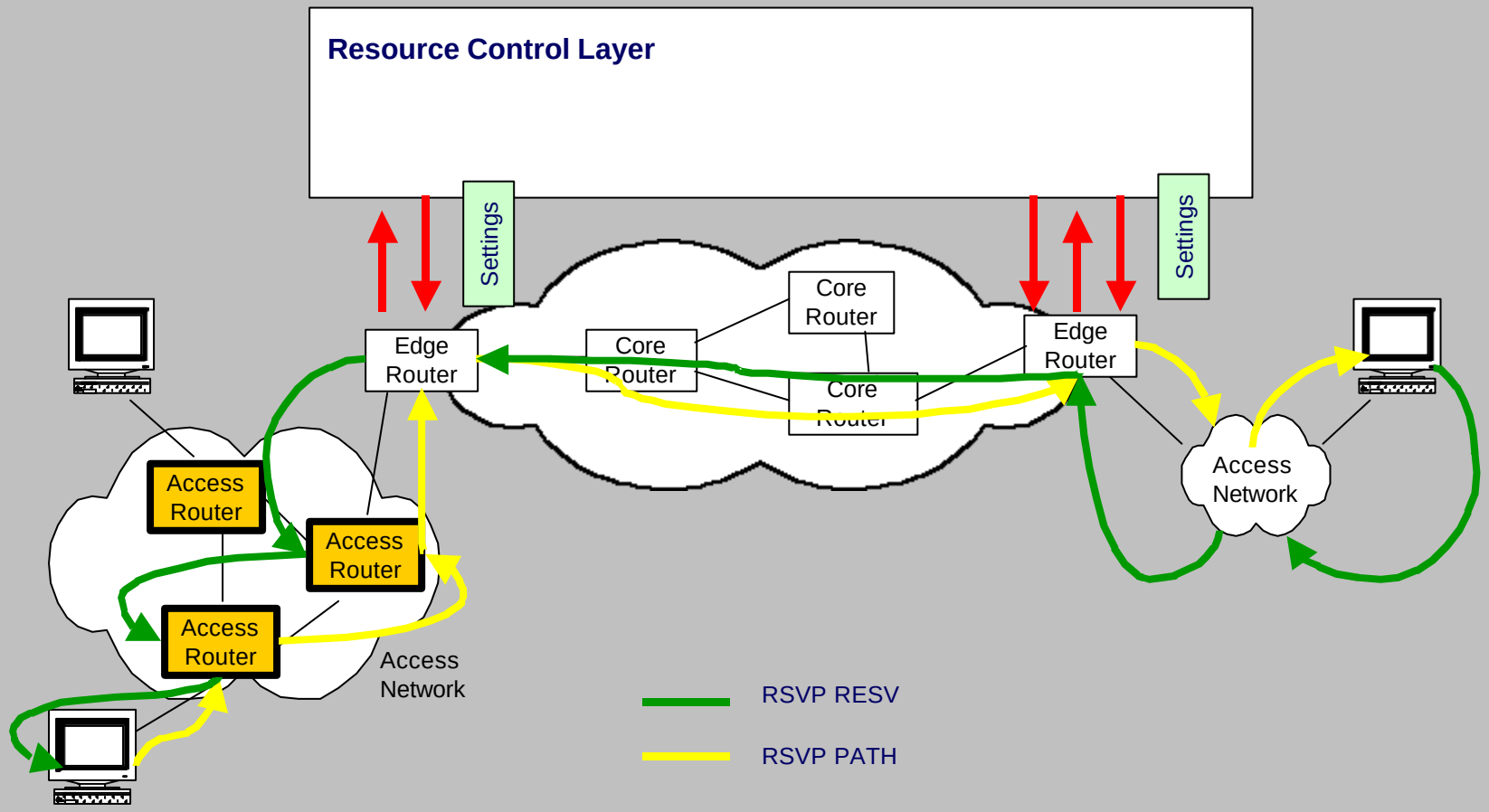
# Protocol Requirements

- Guarantees QOS
- Implementation should exist
- Should be widely supported
- Scalability, not a problem
- Suitable for Access networks
- Low Bandwidth
- Fast Signaling

# Comparison : Properties

| | RSVP | YESSIR | Boomerang |
|---|---|---|---|
| **Initiator** | Receiver | Sender | Sender |
| **Flow Setup** | Two Messages | One Message | One Message |
| **Setup at router** | Fast | Faster | Faster |
| **Refresh** | Fast | Faster | Faster |
| **Bandwidth** | Low | Lower | Lower |
| **Implementation** | Yes | Yes | Yes |
| **Scalable** | No | Yes | Yes |
| **Support** | Wide | No | No |

# Implementation Scenario : RSVP Encapsulation

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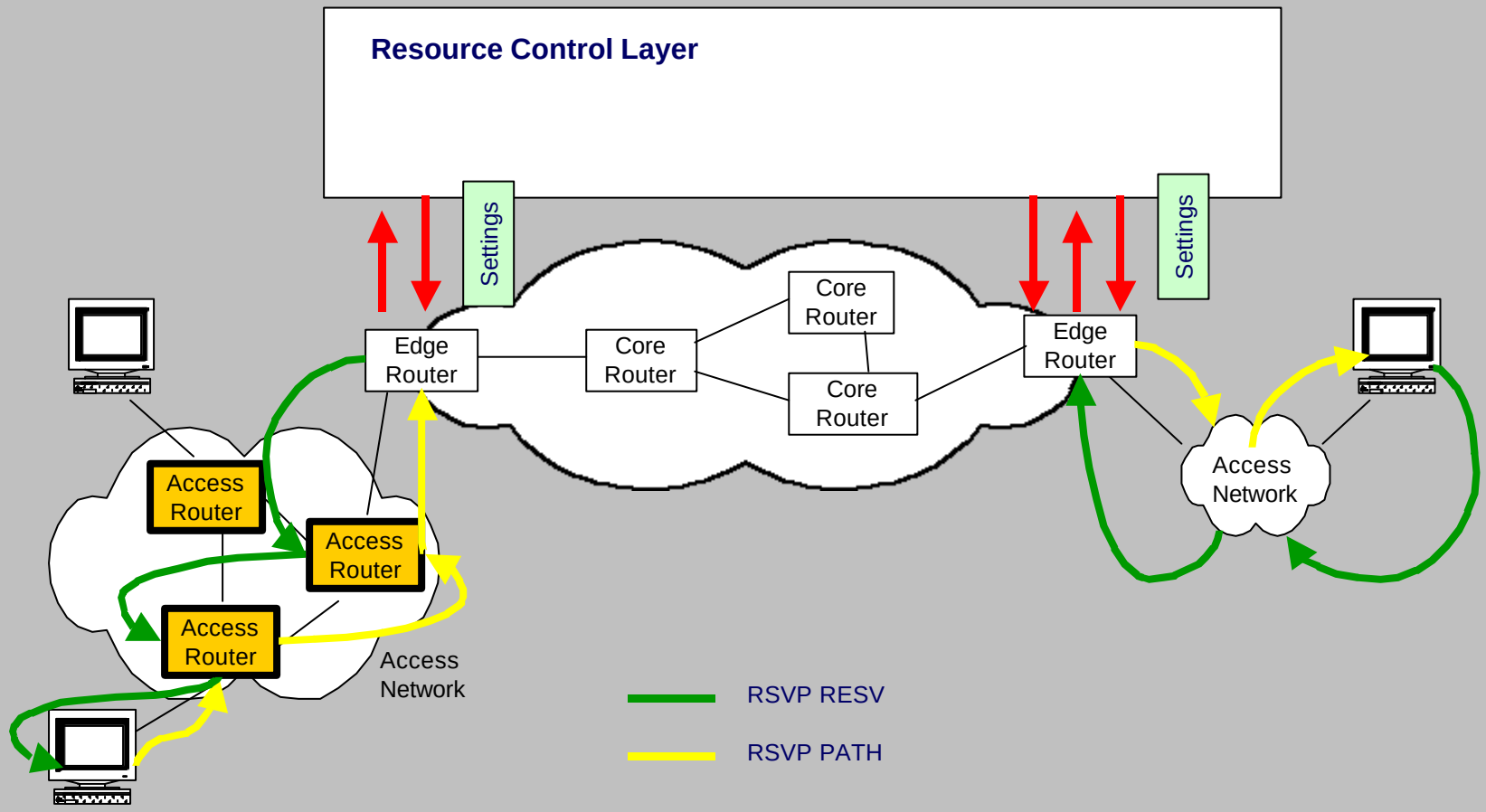
# Implementation Scenario : RSVP Termination

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# Conclusion Analysis (1)

- **xDSL**
- **RSVP**
- **Scenarios**
- **Influencing Factors : NAT**

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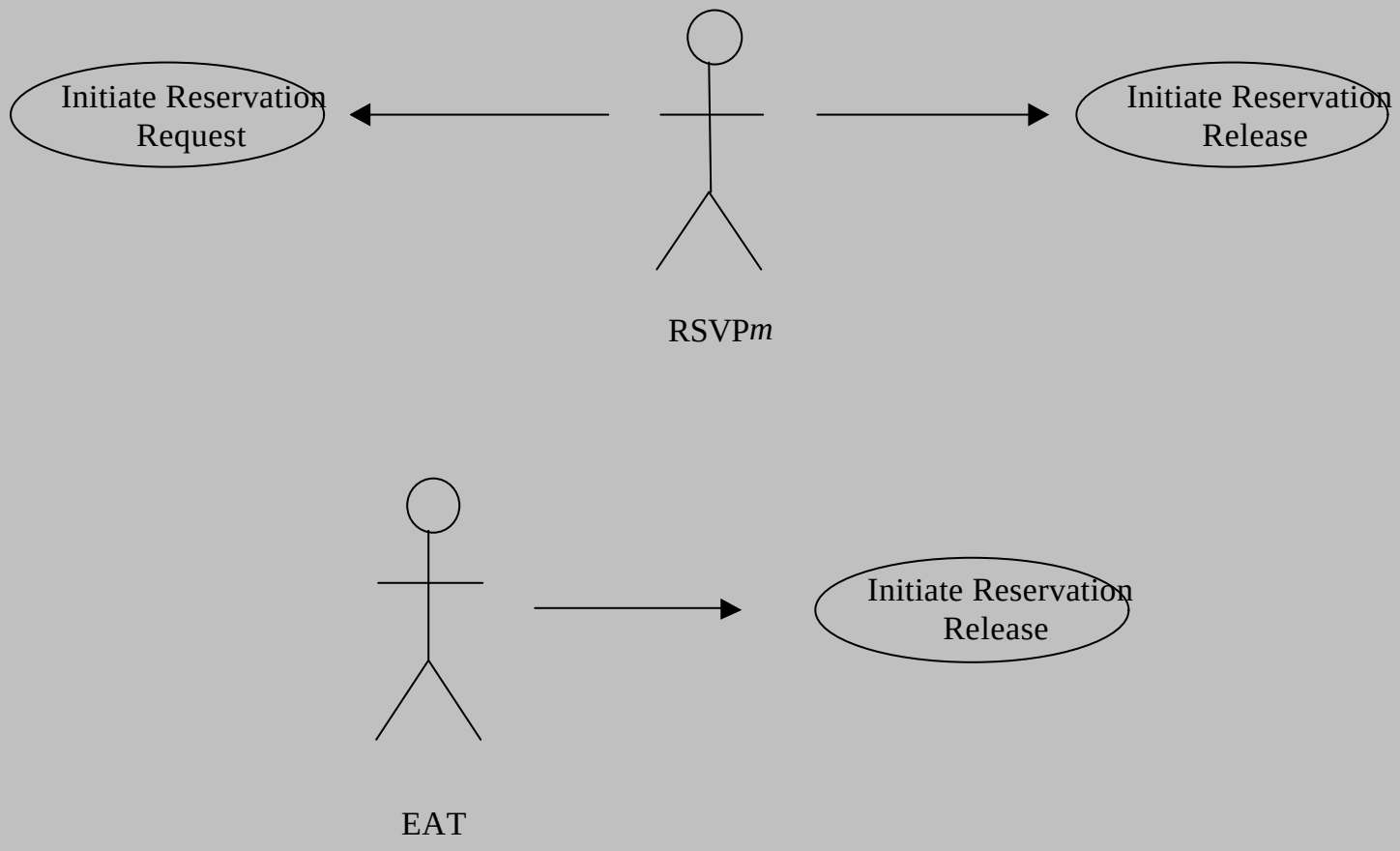
# Analysis (2)

- Changes to RSVP
- Installation of a xDSL router
- Implementation of AQUILA Extension for Access - AEA

**Actors of the System**

- RSVP*m*
- EAT

# Use Case Diagram

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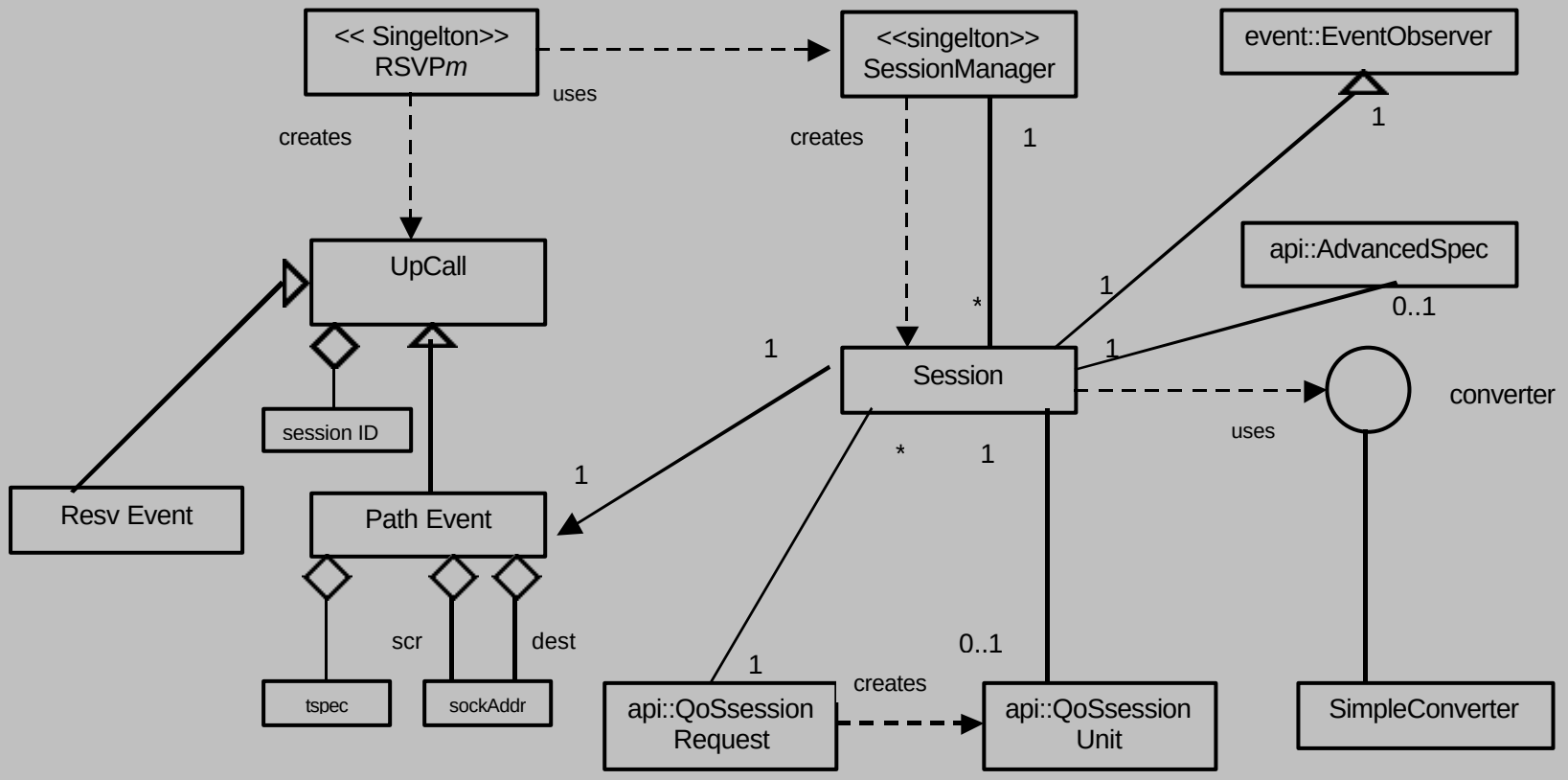
# Design - Class Diagram of AEA

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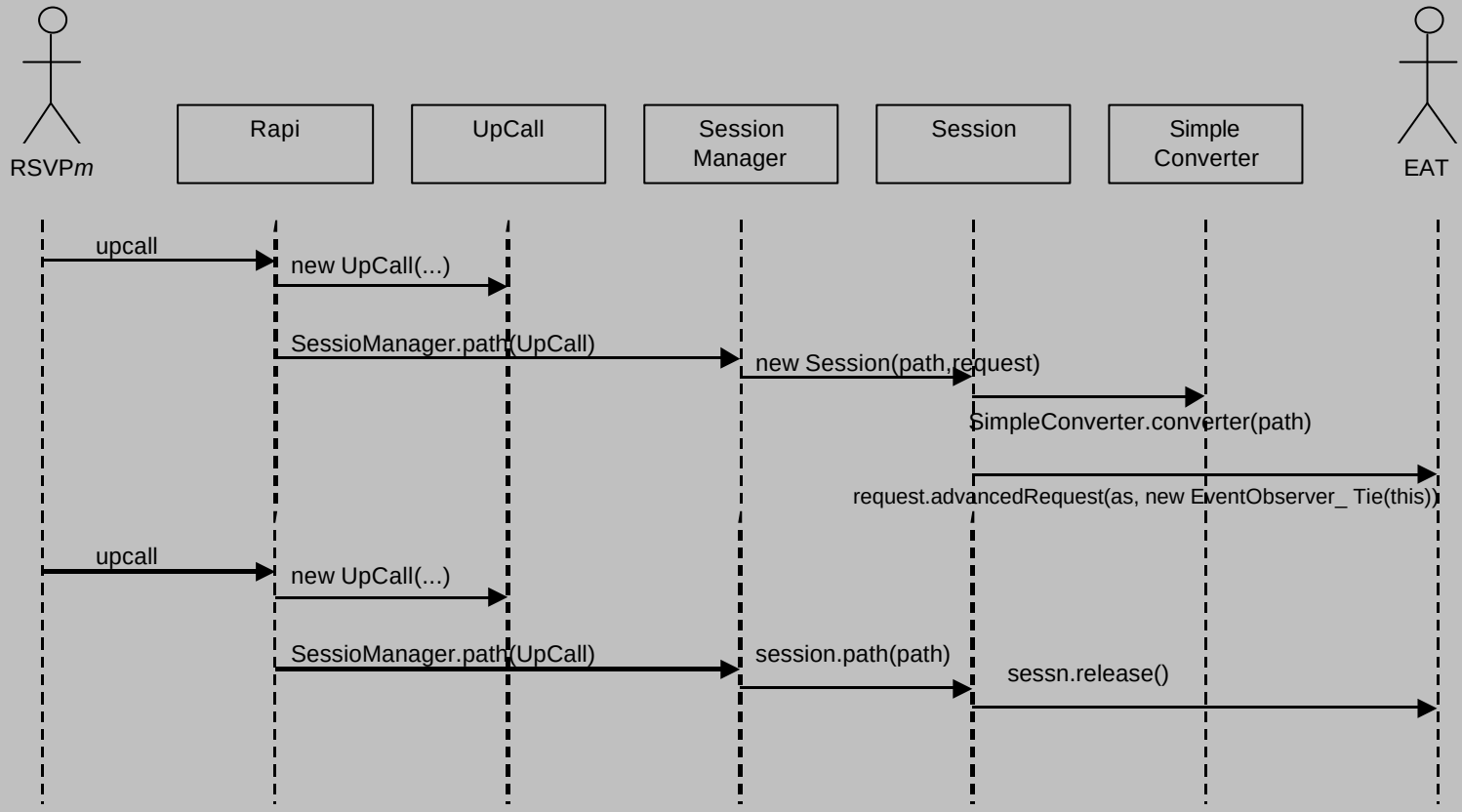
# Sequence Diagram

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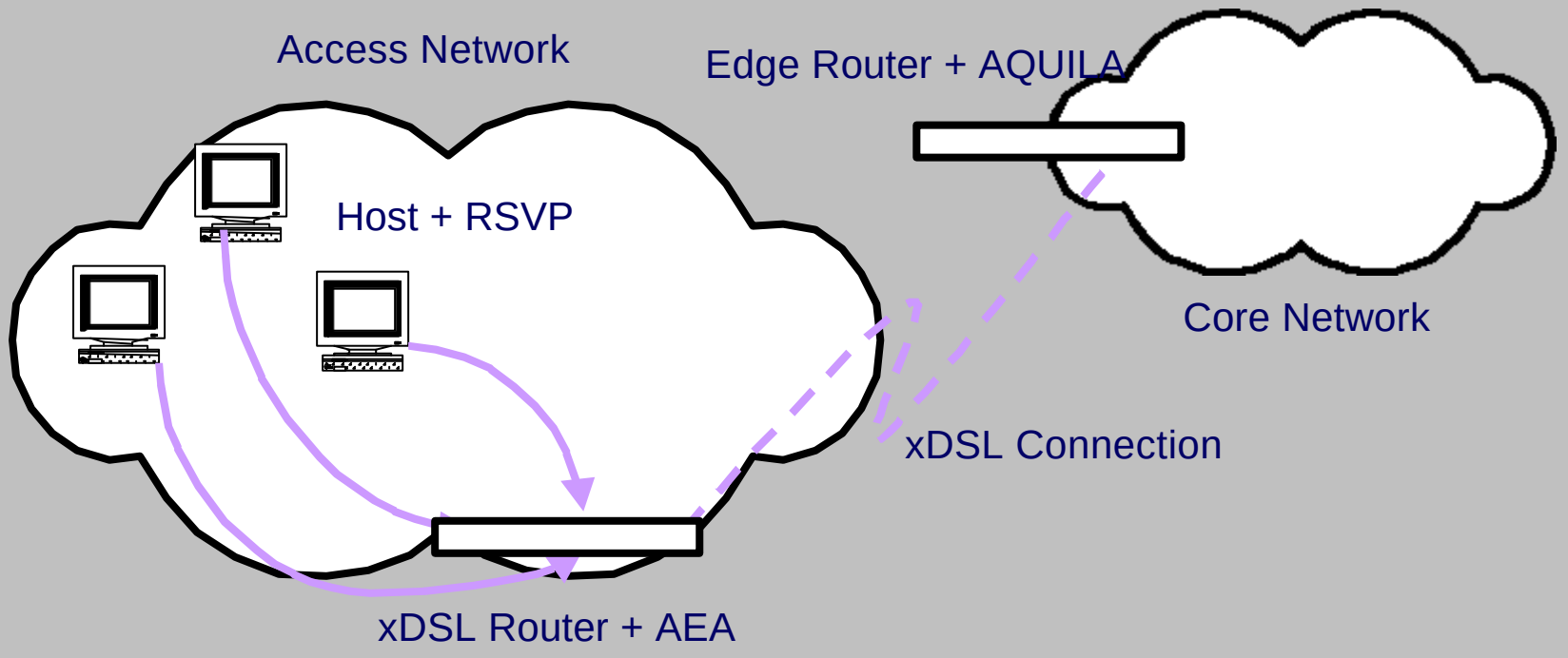
# Implementation Scenario




EAT : End User Application Toolkit

AEA : AQUILA Extension for Access n/w

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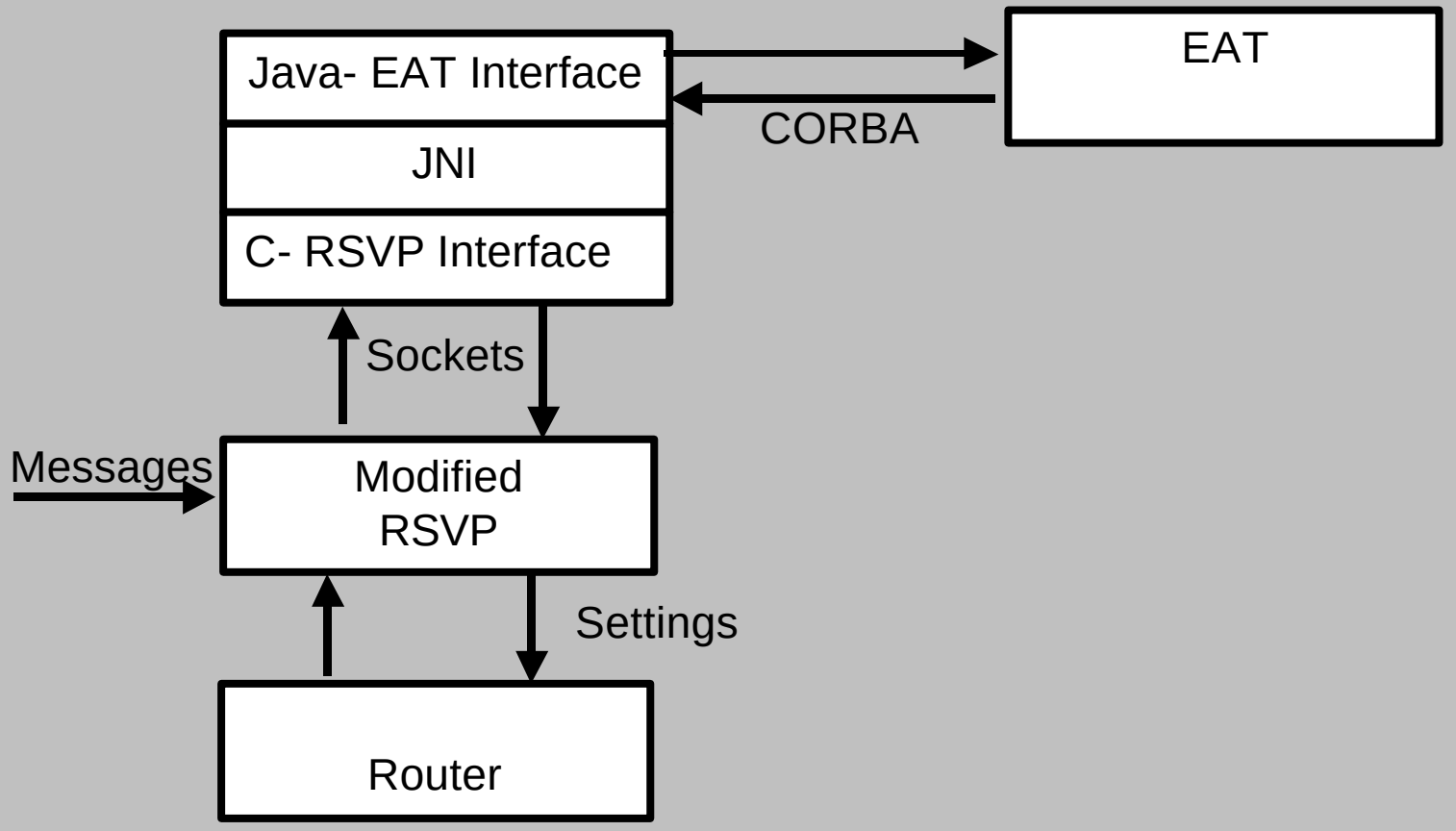
# AEA Architecture

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# Simple Converter

| | UDP Protocol ID = 6 | | TCP Protocol ID = 17 |
|---|---|---|---|
| | Tspec_b > 2 * Tspec_M | Tspec_b <= 2 * Tspec_M | |
| PCBR | | ✔ | |
| PVBR | ✔ | | |
| PMM | | | ✔ |

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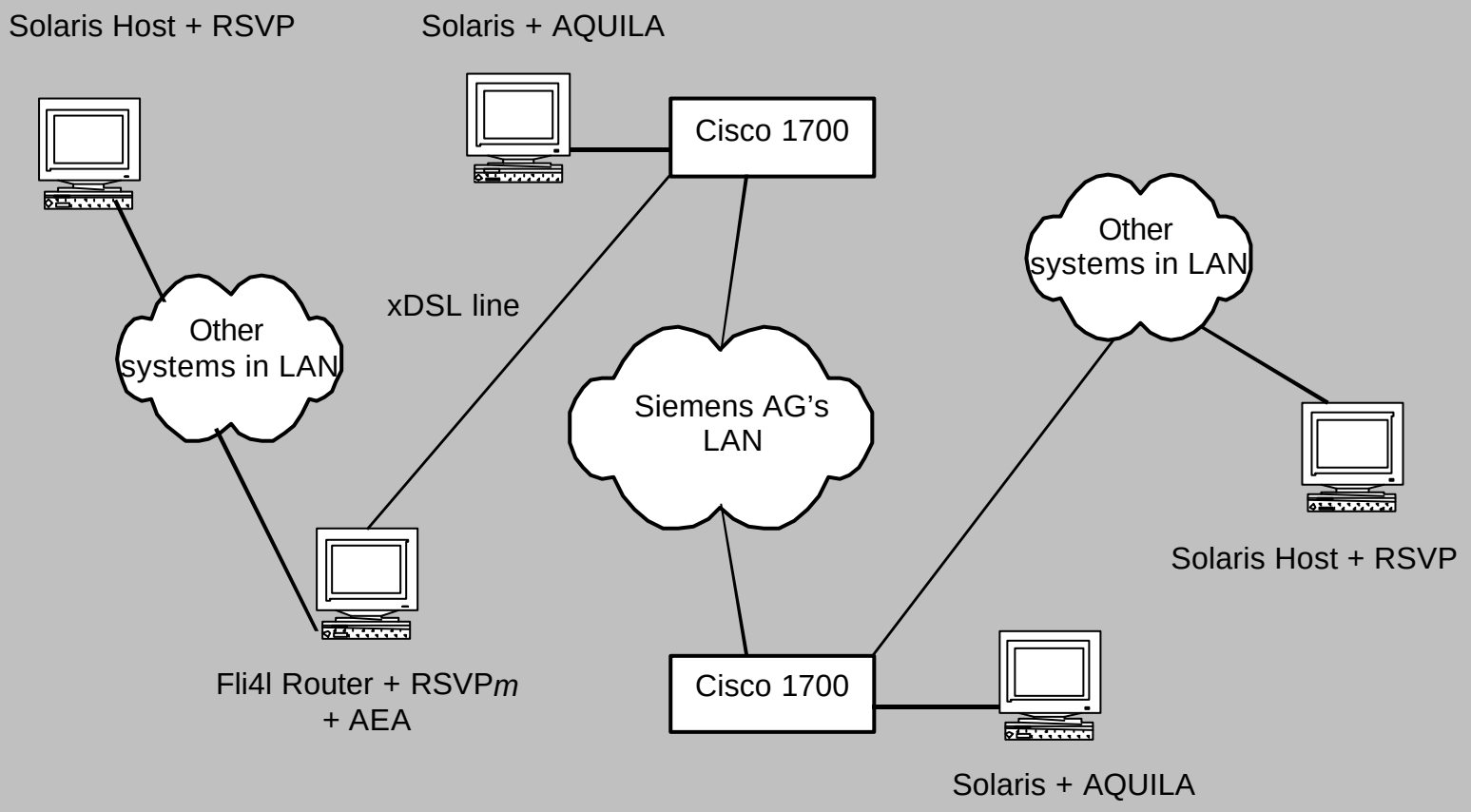
# Test-Bed

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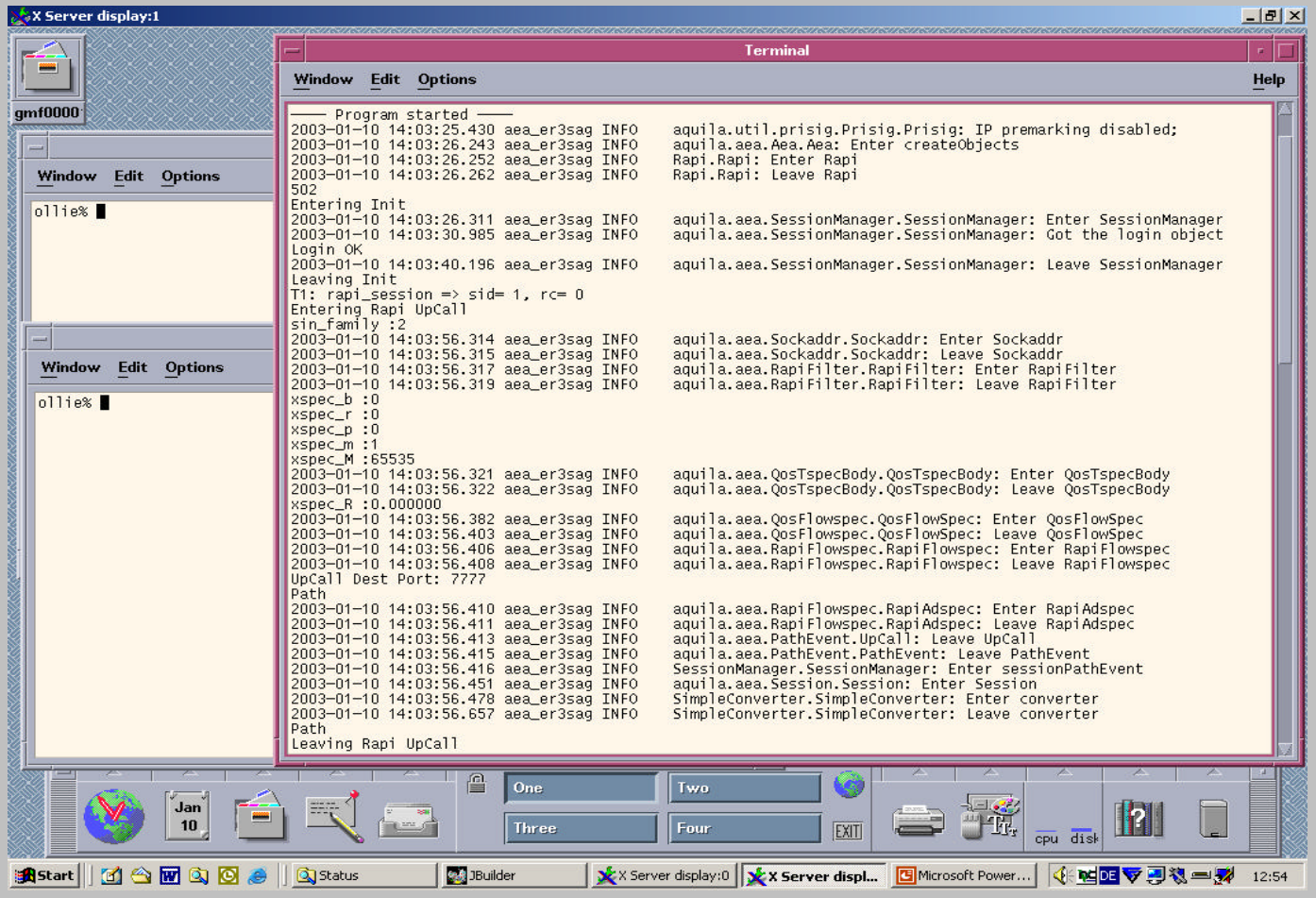
# Running AEA On Router




```
——— Program started ———
2003-01-10 14:03:25.430 aea_er3sag INFO    aquila.util.prisig.Prisig.Prisig: IP premarking disabled;
2003-01-10 14:03:26.243 aea_er3sag INFO    aquila.aea.Aea.Aea: Enter createObjects
2003-01-10 14:03:26.252 aea_er3sag INFO    Rapi.Rapi: Enter Rapi
2003-01-10 14:03:26.262 aea_er3sag INFO    Rapi.Rapi: Leave Rapi
502
Entering Init
2003-01-10 14:03:26.311 aea_er3sag INFO    aquila.aea.SessionManager.SessionManager: Enter SessionManager
2003-01-10 14:03:30.985 aea_er3sag INFO    aquila.aea.SessionManager.SessionManager: Got the login object
Login OK
2003-01-10 14:03:40.196 aea_er3sag INFO    aquila.aea.SessionManager.SessionManager: Leave SessionManager
Leaving Init
T1: rapi_session => sid= 1, rc= 0
Entering Rapi UpCall
sin_family :2
2003-01-10 14:03:56.314 aea_er3sag INFO    aquila.aea.Sockaddr.Sockaddr: Enter Sockaddr
2003-01-10 14:03:56.315 aea_er3sag INFO    aquila.aea.Sockaddr.Sockaddr: Leave Sockaddr
2003-01-10 14:03:56.317 aea_er3sag INFO    aquila.aea.RapiFilter.RapiFilter: Enter RapiFilter
2003-01-10 14:03:56.319 aea_er3sag INFO    aquila.aea.RapiFilter.RapiFilter: Leave RapiFilter
xspec_b :0
xspec_r :0
xspec_p :0
xspec_m :1
xspec_M :65535
2003-01-10 14:03:56.321 aea_er3sag INFO    aquila.aea.QosTspecBody.QosTspecBody: Enter QosTspecBody
2003-01-10 14:03:56.322 aea_er3sag INFO    aquila.aea.QosTspecBody.QosTspecBody: Leave QosTspecBody
xspec_R :0.000000
2003-01-10 14:03:56.382 aea_er3sag INFO    aquila.aea.QosFlowspec.QosFlowSpec: Enter QosFlowSpec
2003-01-10 14:03:56.403 aea_er3sag INFO    aquila.aea.QosFlowspec.QosFlowSpec: Leave QosFlowSpec
2003-01-10 14:03:56.406 aea_er3sag INFO    aquila.aea.RapiFlowspec.RapiFlowspec: Enter RapiFlowspec
2003-01-10 14:03:56.408 aea_er3sag INFO    aquila.aea.RapiFlowspec.RapiFlowspec: Leave RapiFlowspec
UpCall Dest Port: 7777
Path
2003-01-10 14:03:56.410 aea_er3sag INFO    aquila.aea.RapiFlowspec.RapiAdspec: Enter RapiAdspec
2003-01-10 14:03:56.411 aea_er3sag INFO    aquila.aea.RapiFlowspec.RapiAdspec: Leave RapiAdspec
2003-01-10 14:03:56.413 aea_er3sag INFO    aquila.aea.PathEvent.UpCall: Leave UpCall
2003-01-10 14:03:56.415 aea_er3sag INFO    aquila.aea.PathEvent.PathEvent: Leave PathEvent
2003-01-10 14:03:56.416 aea_er3sag INFO    SessionManager.SessionManager: Enter sessionPathEvent
2003-01-10 14:03:56.451 aea_er3sag INFO    aquila.aea.Session.Session: Enter Session
2003-01-10 14:03:56.478 aea_er3sag INFO    SimpleConverter.SimpleConverter: Enter converter
2003-01-10 14:03:56.657 aea_er3sag INFO    SimpleConverter.SimpleConverter: Leave converter
Path
Leaving Rapi UpCall
```

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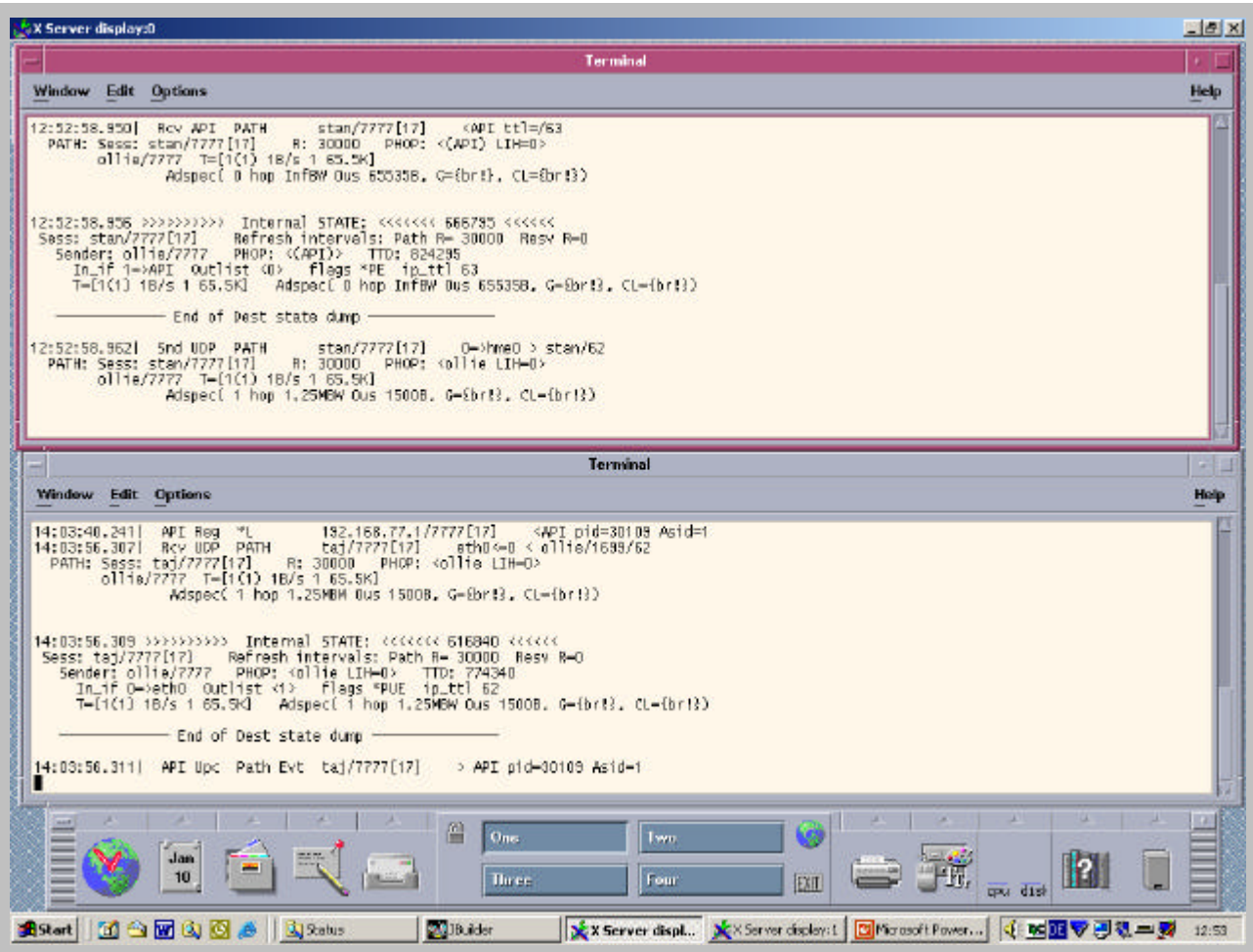
# RSVP on Host

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```
---- Program started ----
2002-12-23 19:03:48.177 aea_er3sag INFO   aquila.util.prisig.Prisig.Prisig: IP premarking disabled;
2002-12-23 19:03:55.048 aea_er3sag INFO   aquila.aea.Aea.Aea: Enter createObjects
2002-12-23 19:03:55.056 aea_er3sag INFO   Rapi.Rapi: Enter Rapi
2002-12-23 19:03:55.067 aea_er3sag INFO   Rapi.Rapi: Leave Rapi
502
Entering Init
2002-12-23 19:03:55.124 aea_er3sag INFO   aquila.aea.SessionManager.SessionManager: Enter SessionManager
2002-12-23 19:04:00.084 aea_er3sag INFO   aquila.aea.SessionManager.SessionManager: Got the login object
Login OK
2002-12-23 19:05:35.299 aea_er3sag INFO   aquila.aea.SessionManager.SessionManager: Leave SessionManager
Leaving Init
T1: rapi_session => sid= 1, rc= 0
Entering Rapi UpCall
2002-12-23 19:06:15.982 aea_er3sag INFO   aquila.aea.Sockaddr.Sockaddr: Enter Sockaddr
2002-12-23 19:06:15.984 aea_er3sag INFO   aquila.aea.Sockaddr.Sockaddr: Leave Sockaddr
2002-12-23 19:06:15.986 aea_er3sag INFO   aquila.aea.RapiFilter.RapiFilter: Enter RapiFilter
2002-12-23 19:06:15.988 aea_er3sag INFO   aquila.aea.RapiFilter.RapiFilter: Leave RapiFilter
2002-12-23 19:06:15.990 aea_er3sag INFO   aquila.aea.QosTspecBody.QosTspecBody: Enter QosTspecBody
2002-12-23 19:06:15.991 aea_er3sag INFO   aquila.aea.QosTspecBody.QosTspecBody: Leave QosTspecBody
2002-12-23 19:06:16.056 aea_er3sag INFO   aquila.aea.QosFlowspec.QosFlowSpec: Enter QosFlowSpec
2002-12-23 19:06:16.078 aea_er3sag INFO   aquila.aea.QosFlowspec.QosFlowSpec: Leave QosFlowSpec
UpCall Dest Port: 7777
2002-12-23 19:06:16.082 aea_er3sag INFO   aquila.aea.RapiFlowspec.RapiFlowspec: Enter RapiFlowspec
2002-12-23 19:06:16.083 aea_er3sag INFO   aquila.aea.RapiFlowspec.RapiFlowspec: Leave RapiFlowspec
UpCall Dest Port: 7777
Path
2002-12-23 19:06:16.085 aea_er3sag INFO   aquila.aea.RapiFlowspec.RapiAdspec: Enter RapiAdspec
2002-12-23 19:06:16.087 aea_er3sag INFO   aquila.aea.RapiFlowspec.RapiAdspec: Leave RapiAdspec
2002-12-23 19:06:16.089 aea_er3sag INFO   aquila.aea.PathEvent.UpCall: Leave UpCall
2002-12-23 19:06:16.090 aea_er3sag INFO   aquila.aea.PathEvent.PathEvent: Leave PathEvent
2002-12-23 19:06:16.092 aea_er3sag INFO   SessionManager.SessionManager: Enter sessionPathEvent
2002-12-23 19:06:16.128 aea_er3sag INFO   aquila.aea.Session.Session: Enter Session
2002-12-23 19:06:16.181 aea_er3sag INFO   SimpleConverter.SimpleConverter: Enter converter
2002-12-23 19:06:16.356 aea_er3sag INFO   SimpleConverter.SimpleConverter: Leave converter
Path
Leaving Rapi UpCall
```

# Summary

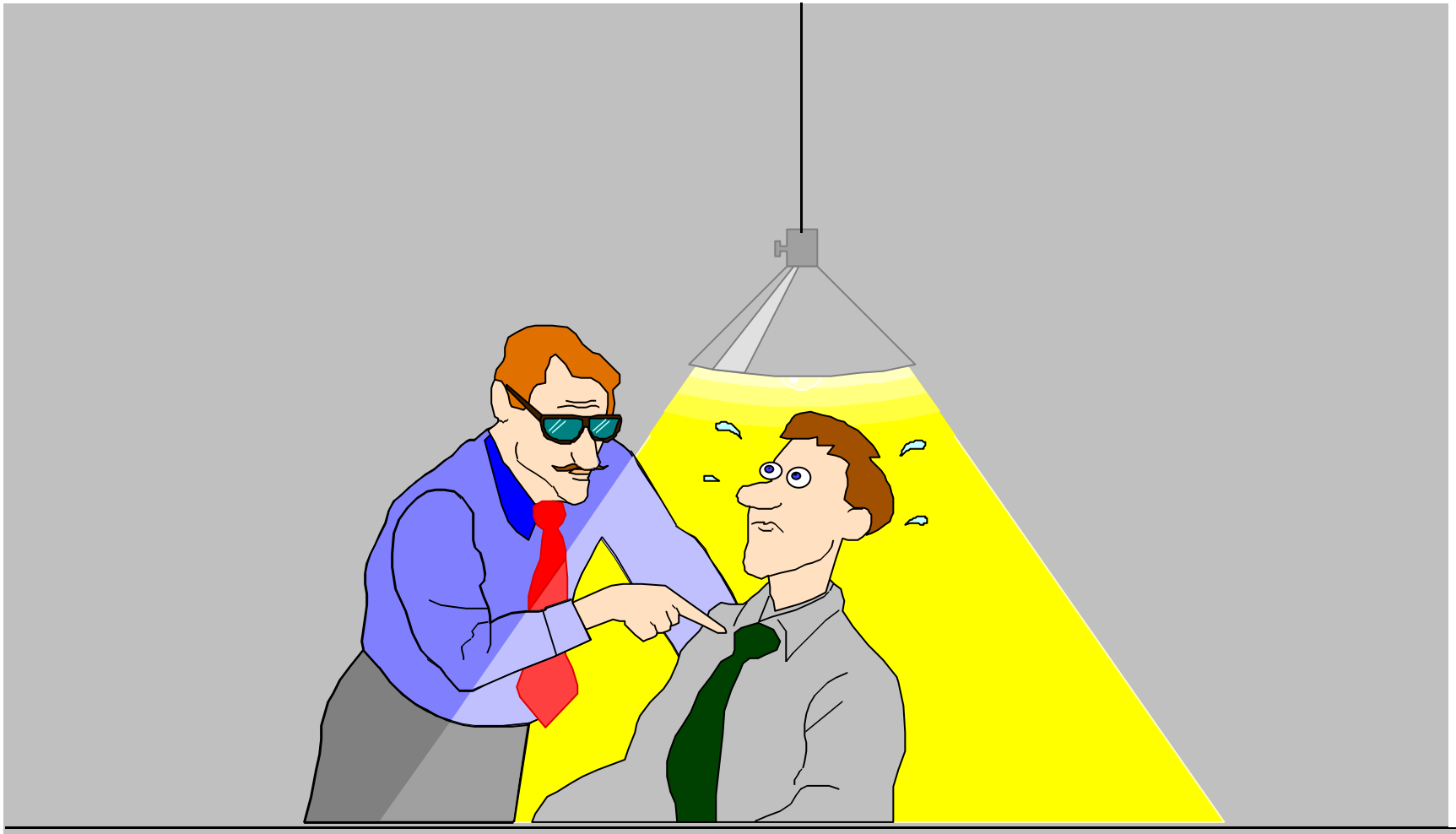
**Achievements**

- **Very complicated problem in limited time solved**
- **RSVP Proxy proposed and first one to implement**
- **Presented in NSIS working group**
- **Work reviewed by various researchers**

**Open Points**

- **Debug the existing problems**
- **Extend to egress side**

# Questions & Discussion



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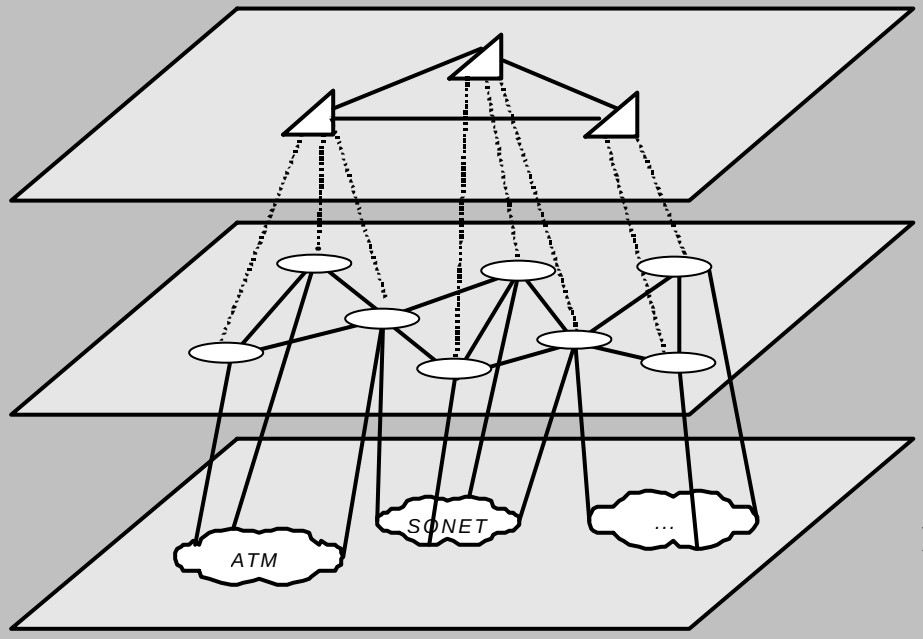
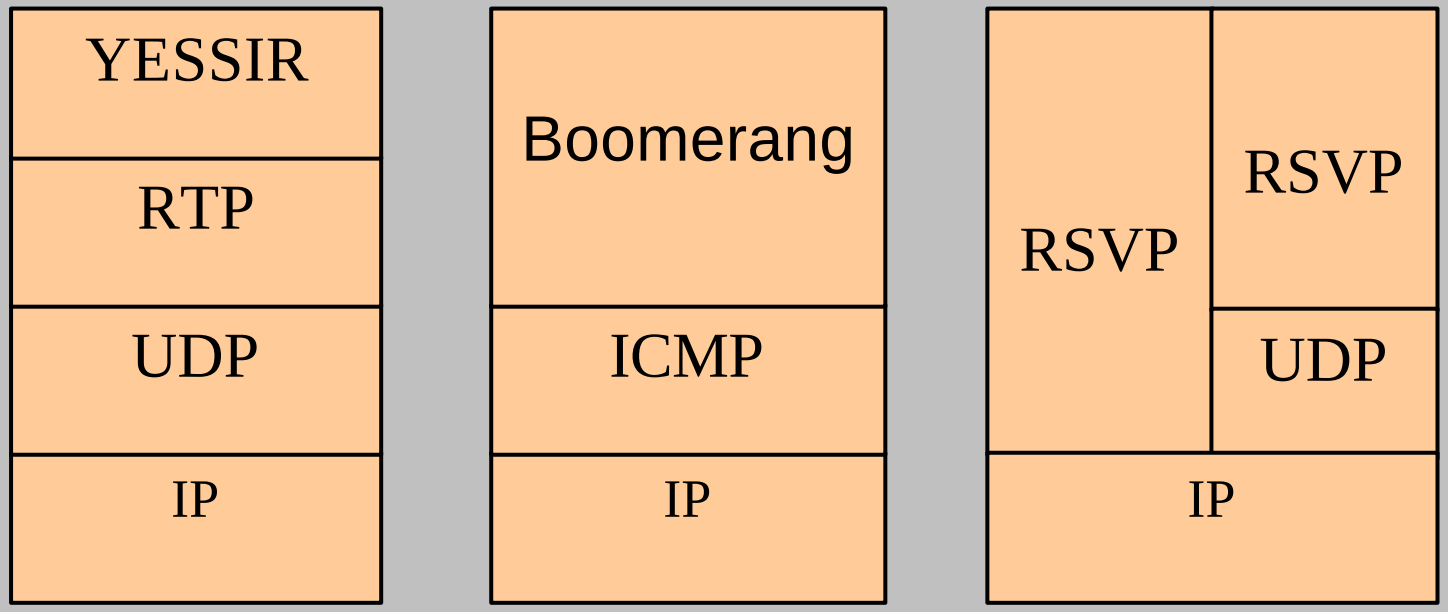
# AQUILA over Diffserv




Backup Slides

# Comparison : Headers




YESSIR Header

Boomerang Header

RSVP Header

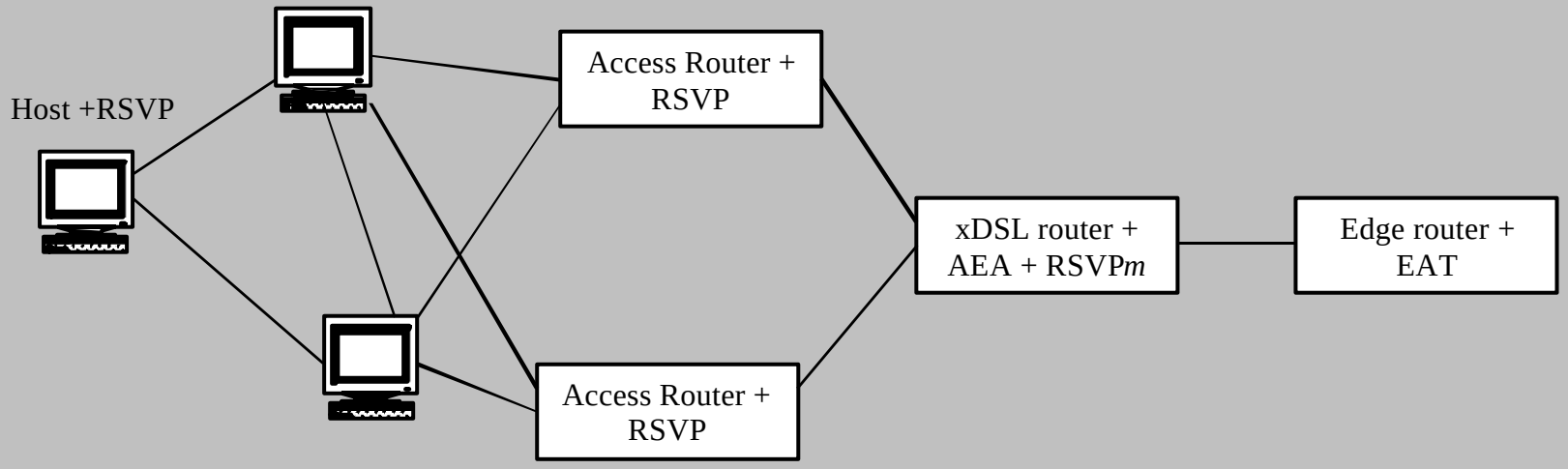
Backup Slides

# RSVP Support on Routers

| Cisco | IBM | Intel |
|---|---|---|
| Cisco 12000 Series | IBM Nways 2210 | Intel Express 9200 |
| Cisco 7600 Series | IBM Nways 2216 | Intel Express 9300 |
| Cisco 3700 Series | IBM Nways 8210 | Intel Express 95xx |
| Cisco 2600 Series | | Intel Express 8210 |
| Cisco 1700 Series | | Intel Express 8220 |

Backup Slides

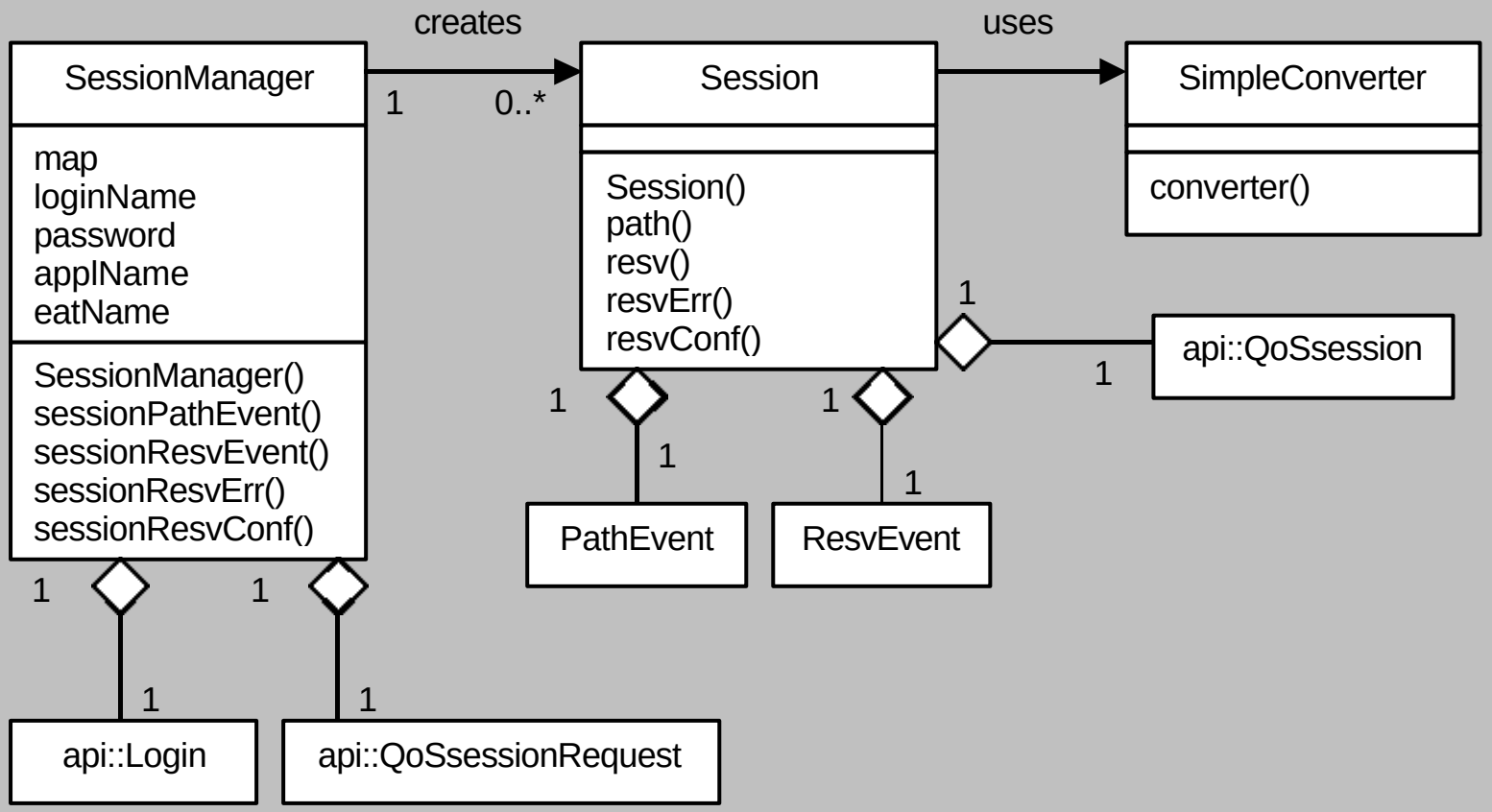
# Access Network




Backup Slides

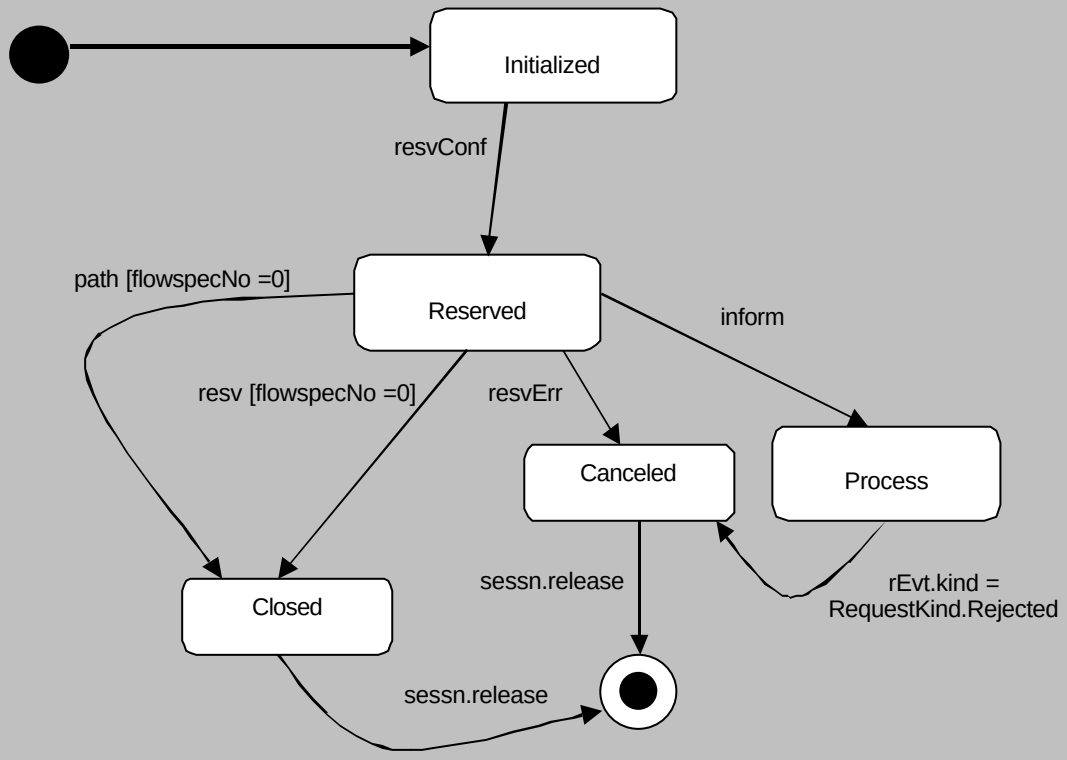
- Slide I
- Slide II
- Slide III
- **Slide IV**
- Slide V
- Slide VI
- Slide VII
- Slide VIII
- Slide IX
- Slide X
- Slide XI
- Slide XII
- Slide XIII
- Slide XIV

# Class Diagram – *SessionManager*, *Session* and *SimpleConverter*




Backup Slides

# State Transition Diagram of *Session*




Backup Slides

# Running RSVP*m* on Router

```
T1> 19:05:47.344|  API Reg  *L       192.168.77.1/7777[17]    <API pid=7331 Asid=1
19:06:15.976|  Rcv UDP  PATH      taj/7777[17]    eth0<=0 < ollie/1699/62
 PATH: Sess: taj/7777[17]    R: 30000   PHOP: <ollie LIH=0>
      ollie/7777  T=[1(1) 1B/s 1 65.5K]
            Adspec( 1 hop 1.25MBW 0us 1500B, G={br!}, CL={br!})


19:06:15.978 >>>>>>>>>>  Internal STATE: <<<<<<< 2103281 <<<<<<
 Sess: taj/7777[17]    Refresh intervals: Path R= 30000  Resv R=0
  Sender: ollie/7777   PHOP: <ollie LIH=0>   TTD: 2260781
    In_if 0=>eth0  Outlist <1>   flags *PUE  ip_ttl 62
    T=[1(1) 1B/s 1 65.5K]   Adspec( 1 hop 1.25MBW 0us 1500B, G={br!}, CL={br!})

  ------------ End of Dest state dump ----------

19:06:15.980|  API Upc  Path Evt  taj/7777[17]    > API pid=7331 Asid=1

19:06:45.990|  Rcv UDP  PATH      taj/7777[17]    eth0<=0 < ollie/1699/62
 PATH: Sess: taj/7777[17]    R: 30000   PHOP: <ollie LIH=0>
      ollie/7777  T=[1(1) 1B/s 1 65.5K]
            Adspec( 1 hop 1.25MBW 0us 1500B, G={br!}, CL={br!})

19:06:48.013|  Rcv UDP  PATH-TEAR taj/7777[17]    eth0<=0 < ollie/1699/62
 PTEAR: Sess: taj/7777[17]    PHOP: <ollie LIH=0>
      ollie/7777  [ ]

19:06:48.015|  API Upc  Path Evt  taj/7777[17]    > API pid=7331 Asid=1
```

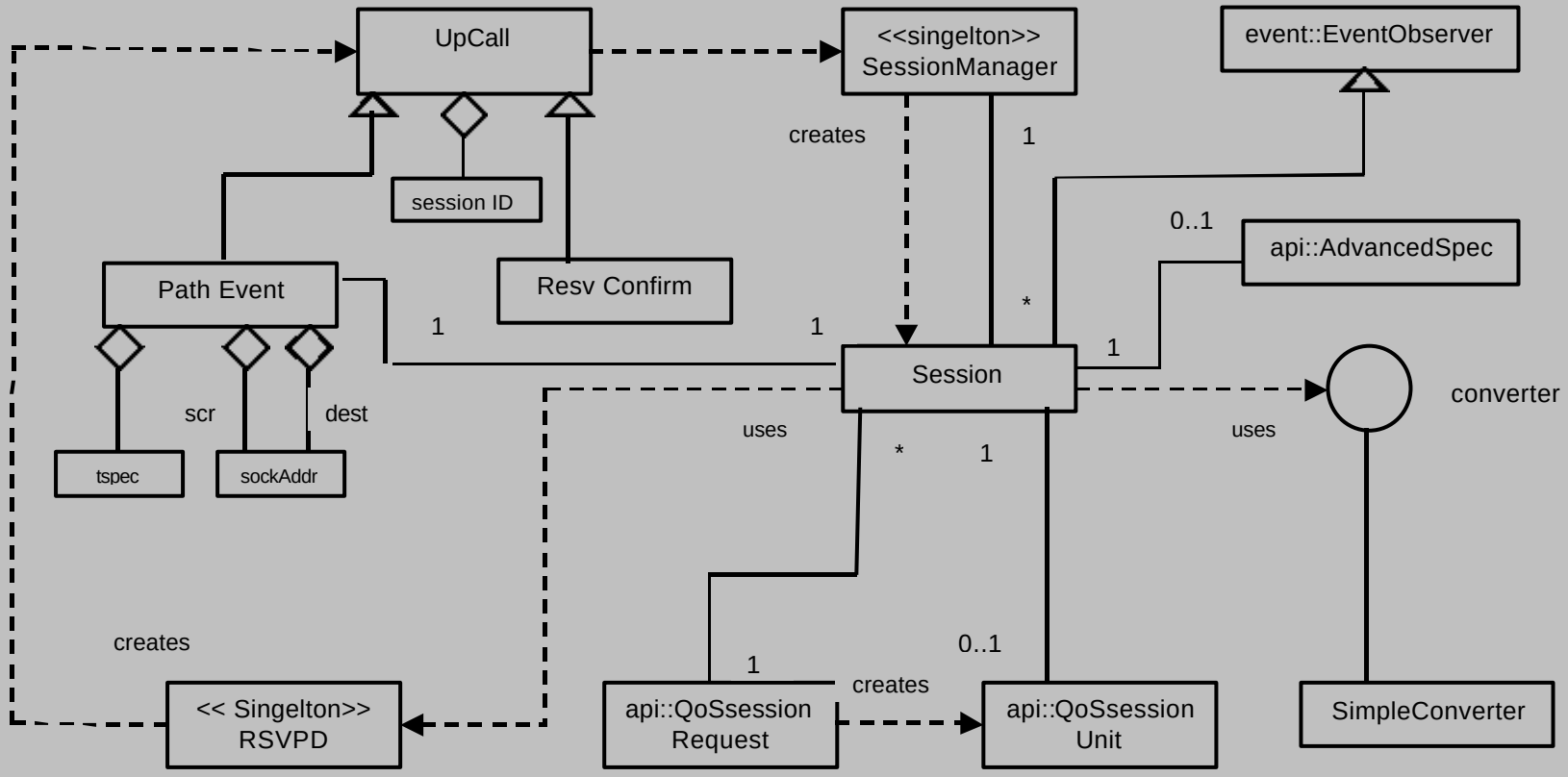
## Backup Slides

# RSVP Running on Host

```
T1> dest udp taj/7777
T1: rapi_session => sid= 1, fd= 17
T1> 17:59:37.935| API Reg  *L       stan/7777[17]   <API pid=25671 Asid=1
sender 7777 [t 1 1 1 1]
rapi_sender() OK
T1> 17:59:54.007| API Reg  *L       stan/7777[17]   <API pid=25671 Asid=1
  Register sender: (*)  T=[1(1) 1B/s 1 65.5K]
17:59:54.011| Rcv API  PATH     stan/7777[17]   <API ttl=/63
 PATH: Sess: stan/7777[17]   R: 30000   PHOP: <(API) LIH=0>
      ollie/7777  T=[1(1) 1B/s 1 65.5K]
            Adspec( 0 hop InfBW 0us 65535B, G={br!}, CL={br!})



close
T1: rapi_release(): sid= 1, fd= 17
T1> 18:00:26.048| API Cls          stan/7777[17]   <API pid=25671 Asid=1
18:00:26.049| Rcv API  PATH-TEAR stan/7777[17]   <API ttl=/63
 PTEAR: Sess: stan/7777[17]   R: 30000   PHOP: <(API) LIH=0>
      ollie/7777  T=[1(1) 1B/s 1 65.5K]
            Adspec( 0 hop InfBW 0us 65535B, G={br!}, CL={br!})

18:00:26.055| Snd UDP  PATH-TEAR stan/7777[17]   0=>hme0 > stan/62
 PTEAR: Sess: stan/7777[17]   PHOP: <ollie LIH=0>
      ollie/7777  [ ]
```

Backup Slides

# Class Diagram




## Backup Slides

# xDSL : Overview

- **HDSL : High-bit rate Digital Subscriber Line**

  **Symmetric**

  **Up to 2 Mbps**

- **SDSL : Symmetric Digital Subscriber Line**

  **Symmetric**

  **Up to 3 Mbps**

- **ADSL : Asymmetric Digital Subscriber Line**

  **Asymmetric**

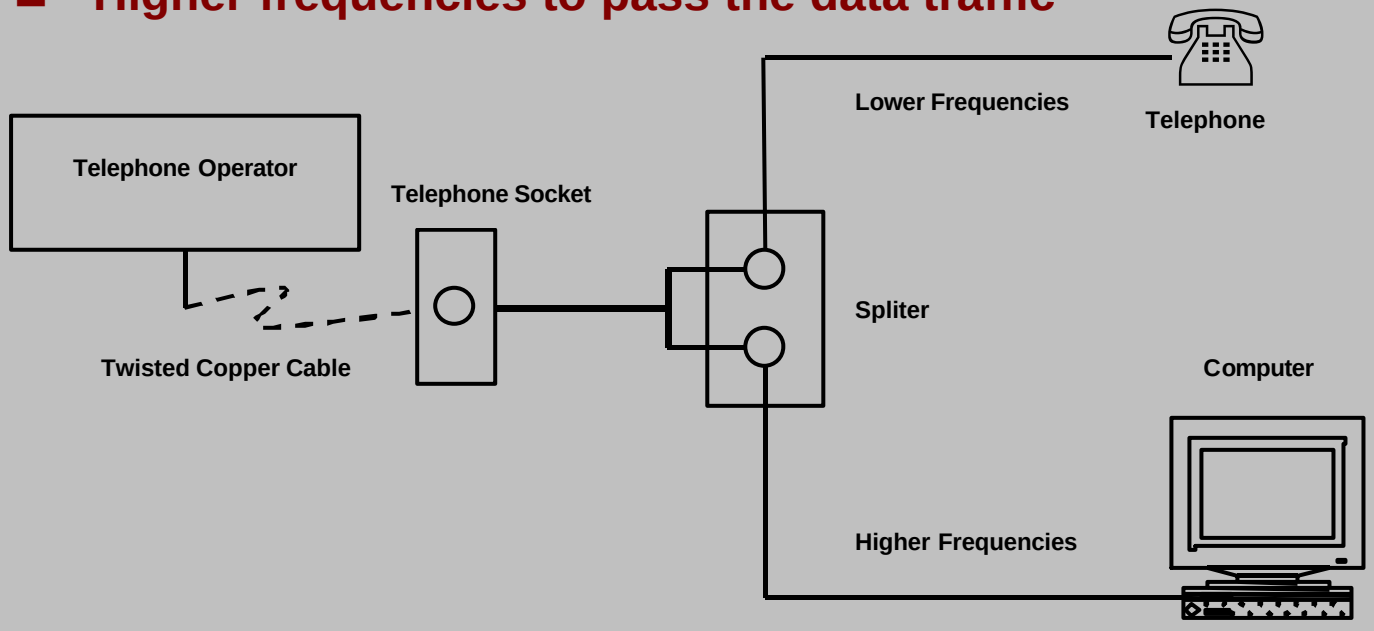
  **Downstream : up to 9 Mbps**

  **Upstream : 128 kbps upstream**

Backup Slides

# ADSL : Technology

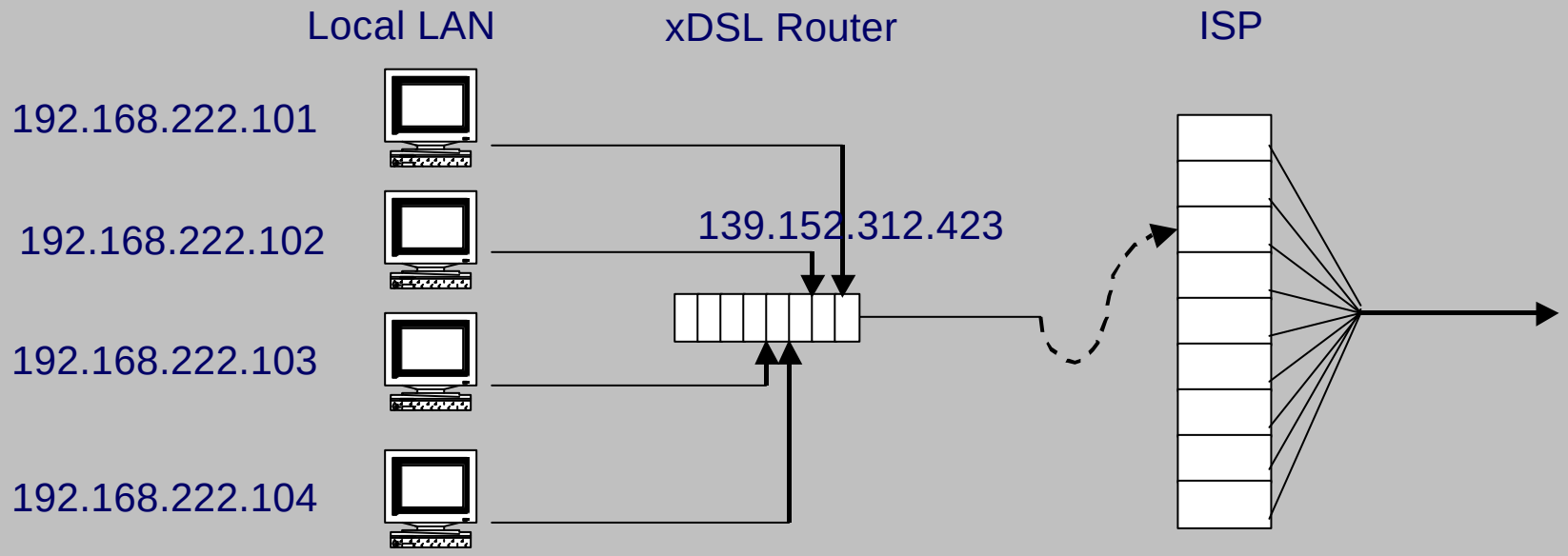
- Simultaneous voice and data use of a single copper connection
- Voice call, Fax etc use the normal 0-4kHZ
- Higher frequencies to pass the data traffic




Backup Slides

# NAT : Network Address Translation

- NAT translates local IP header address to unique IP
- Does not look for IP address in payload
- Plug in, in NAT for RSVP



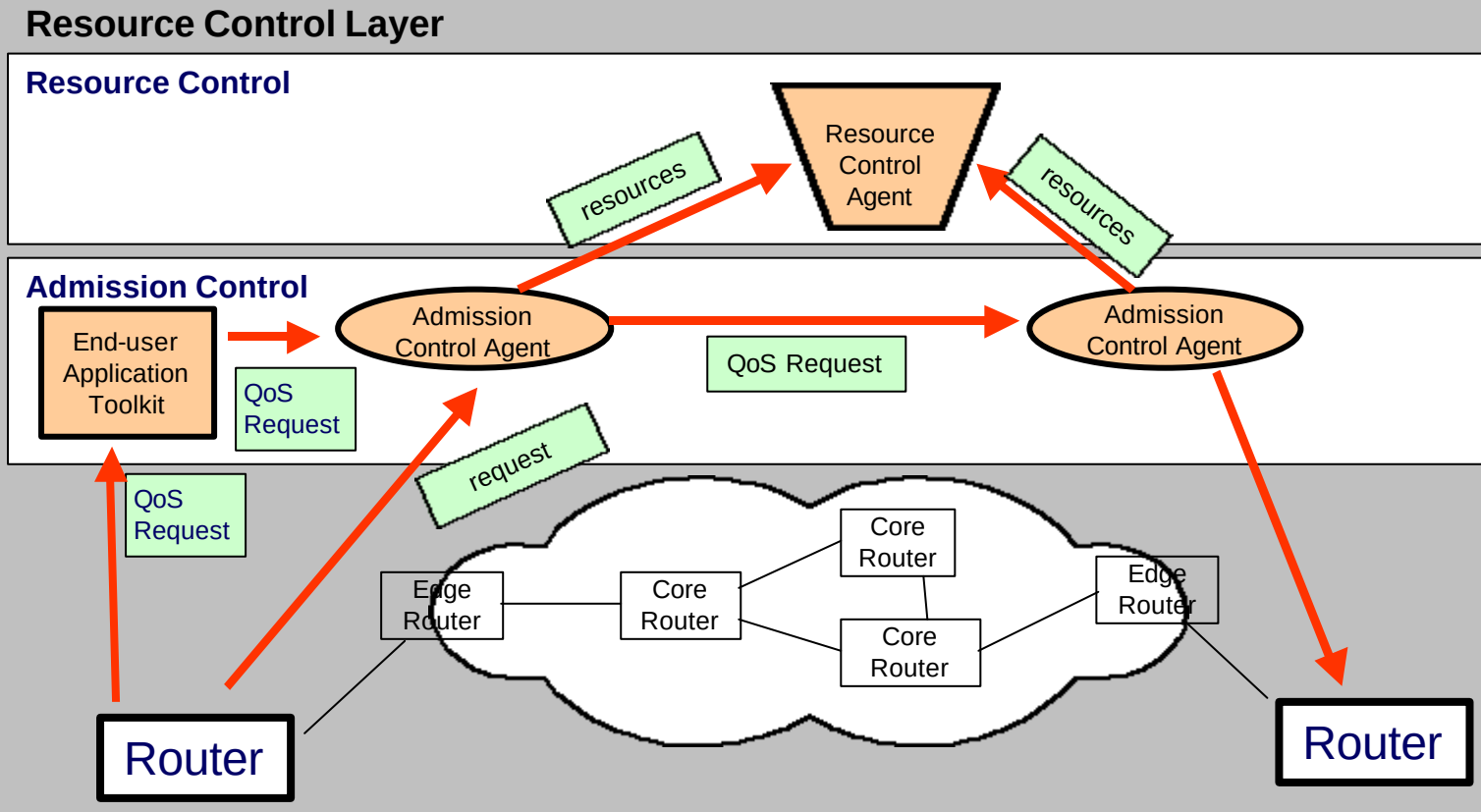

Backup Slides

# Reservation Protocols

- RSVP – Resource Reservation Protocol
- SRP – Scalable Resource Reservation Protocol
- FIRST – Flow Initiation and Reservation Tree
- DRP – Dynamic Sender Initiated Reservation Protocol
- Boomerang – A simple protocol for Resource Reservation
- YESSIR – Yet another Sender Session Internet Reservation

Backup Slides

# Ingress & Egress Communication

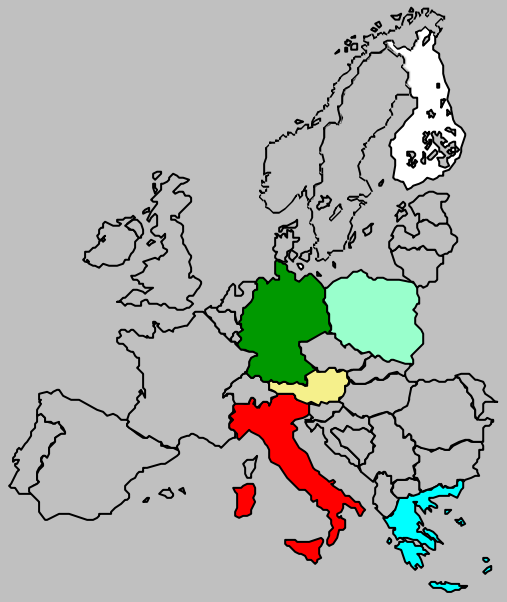



Backup Slides

AQUILA

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/