End-to-End, Multiple-Domain Bandwidth Management

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Abstract

We present a distributed framework for monitoring and operating an end-to-end, multiple domain Managed Bandwidth Service (MBS). The work presented is motivated by the need to monitor and control the ATM MBS service of the Greek University Network (GUNet) that relies on scheduling ATM PVCs spanning over three or more cascaded ATM networks (a backbone and at least two end-point ATM networks). The service allows the user to request guaranteed QoS connections (currently only CBR is examined) between any two end-points for a given time interval. The management layer implements an end-to-end look-ahead scheduling and reservation algorithm in a distributed fashion, where all associated network domains must participate. We present the management requirements and outline the proposed distributed architecture that uses domain managers for realizing cooperative path discovery, end-to-end resource reservation and PVC establishment for concurrent end-users. Two implementation approaches are outlined: based on JAVA/IIOP and JMX/SOAP.
The main operational characteristics of an end-to-end Bandwidth Assignment solution are:

1. Bandwidth delegation service through a wide variety of different vendor, different constituency networks (based on ATM).
2. An end-to-end bandwidth booking service, fully accessible to the user through a registration and authentication process. The whole cross-boundary operation should be transparent.
Management Requirements

Management Information needed

• The best and alternative ways end-to-end
• The best and alternative ways within each network on the path
• The resources already allocated at each network, their availability and scheduling - Provide alternative routes and/or schedules when the required resources are not available.

Distributed Architecture (vs. a centralized "monolithic" one)

Any bandwidth control scheme will have to be accepted by multiple different organizations to access their resources. This raises issues on security, trust and disclosure. An organization may prefer to keep private its internal architecture and usage statistics (needed to be known during bandwidth delegation). A distributed system, with "interfacing" units, under the control of each network offers the solution to this.

The connection points and general network architecture may change or even expand quite rapidly both internally and in the interconnection level following peering agreements and practical needs. A centralized system should have to keep a great amount of difficult to update information and would not be able to scale easily.

The various ATM networks most certainly will be implemented by many different vendors, requiring different access methods and code, added flexibly to the administration system.

Complex management processes to be hidden form the end user

He should be presented with the final approval for his request or a number of alternatives.

Widely accepted user authentication and approval

Additionally to insure that the users will not abuse usage privileges
User initiates a request to his local Management Entity

1. User initiates a request to his local Management Entity

The ME keeps a general map of all the interconnected networks and contacts the MEs at each one of them along the way

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The initiating ME presents to the user the final resource availability message or other possible proposals. Upon his decision sends final reservation messages to each local ME

3. The initiating ME presents to the user the final resource availability message or other possible proposals. Upon his decision sends final reservation messages to each local ME

3.1 Each ME plans the optimal way within its constituency and checks a local DB for the bandwidth availability on the requested date. Upon unavailability of a path, alternative paths are considered. Extra ATM-switch hops will not have a big effect on the final network delay on a high speed ATM backbone

3.2 If the resources are available a message is sent to the initiating ME

3.3 If not, a number of alternative schedules and/or bandwidth proposals are made to the initiating ME

4. Each ME makes a DB entry and on the right time creates the required VP/VC connections to service the user

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End User

Management Entity

ATM Access Network

ATM Switch

LAN

Management Entity

ATM Access Network

ATM Switch

LAN

Network Service

Backbone ATM Network

Management Entity

ATM Switch

Local DB

End User

Management Entity

End User

Management Entity
Java / IIOP-based Pilot

Distributed Manager

- Java Servlets / JSPs
- JDBC
- Mgmt Repository
- RMI

Management Entity (Java Application)

- HTTP
- SNMP

ATM Access Network

- ATM Switch

ATM Backbone Network

- ATM Switch

Distributed Manager

- IIOP

ATM Access Network

- ATM Switch

MBS Service

- Users

Administrator