Implementation of IPv6's TOS over ATM Network

Presented by

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Agenda

Introduction

- What is IPv6?
  - The IPv6 Frame Format
  - The Type Of Service (TOS) Field in IPv6 Frame
  - IPv6’s TOS vs. ATM’s Service Category
- Goals of our project
Implementation Details
  – Opnet ATM Standard Node Model that Was Used and Modified
  – Flow Chart of our Design
  – Network Configuration
  – Collected Results/Statistics
Agenda (cont.)

- Discussion
  - Difficulties Encountered
  - Alternative Approach
  - Future Work
  - What We Have Learned

- Questions and Answers

- References
Introduction:
What is IPv6?

- IPv6 addresses many limitations that IPv4 has:
  - limited number of addresses (128 bytes vs. 32 bytes)
  - poor security (not addressed by IPv4 at all)
  - undefined service types (much better defined in IPv6).
Our project emphasizes the application of Type of Services (TOS) field in IPv6 frame which is used to differentiate the priority of the packets.
Introduction: Type Of Service

- TOS 0-7: congestion controlled traffic (e.g. TCP)
- TOS 8-15: non-congestion controlled traffic (e.g. UDP)
### Introduction: IPv6’s TOS vs. ATM’s Service Category

<table>
<thead>
<tr>
<th>TOS</th>
<th>Description:</th>
<th>Suggested ATM Service Category:</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>uncharacterized traffic</td>
<td>UBR/ABR</td>
</tr>
<tr>
<td>1</td>
<td>&quot;filler&quot; traffic (e.g., netnews)</td>
<td>UBR/ABR</td>
</tr>
<tr>
<td>2</td>
<td>unattended data transfer (e.g., email)</td>
<td>UBR/ABR</td>
</tr>
<tr>
<td>3</td>
<td>(reserved)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>attended bulk transfer (e.g., FTP, NFS)</td>
<td>UBR/ABR</td>
</tr>
<tr>
<td>5</td>
<td>(reserved)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>interactive traffic (e.g., telnet, X)</td>
<td>UBR/ABR</td>
</tr>
<tr>
<td>7</td>
<td>internet control traffic (e.g., routing protocols, SNMP)</td>
<td>UBR/ABR</td>
</tr>
<tr>
<td>8</td>
<td>The lowest Priority value (e.g., high-fidelity video traffic)</td>
<td>NRT-VBR</td>
</tr>
<tr>
<td>9</td>
<td>...</td>
<td>NRT-VBR</td>
</tr>
<tr>
<td>10</td>
<td>...</td>
<td>NRT-VBR/RT-VBR</td>
</tr>
<tr>
<td>11</td>
<td>...</td>
<td>RT-VBR</td>
</tr>
<tr>
<td>12</td>
<td>...</td>
<td>RT-VBR</td>
</tr>
<tr>
<td>13</td>
<td>...</td>
<td>RT-VBR/CBR</td>
</tr>
<tr>
<td>14</td>
<td>...</td>
<td>CBR</td>
</tr>
</tbody>
</table>
| 15  | The highest value (15) (e.g., low-fidelity audio traffic). | CBR }}
Introduction: Goals of Our Project

- Develop a general traffic client node with "smart" packet switching mechanism by merging IPv6 and the Asynchronous Transfer Mode (ATM) as the protocol for the QoS enabled Internet.

- By examining the "Type Of Service" field in the IPv6 packets, different TOS packets are routed onto the appropriate SVC which has matching QoS parameters.
Implementation Details: Opnet ATM Standard Node Model

- Project based on Opnet ATM standard model:
  - atm_uni Src,
  - atm_uni_dest.
  - atm4_crossconnect

- Model a raw packet generator and receiver running over ATM.

- Enhance model by making raw packet generator to generate IPv6 formatted packet, transmit packets via different SVC based on their TOS, etc...
User selects mapping of the TOS to ATM's Class of Service

IPv6 Source sets up number of required SVC(s) dynamically

IPv6 packets with different TOS (uniformly distributed) are generated

TOS field of each IPv6 packet is examined and routed to the pre-specified SVC

"IPv6-over-ATM switch" services the ATM cells according to the relative weight of the SVCs the user selected.

"IPv6 Dest" collects packet end-to-end statistics
Implementation Details: IPv6 Source
Implementation Details:
IPv6 Source
Implementation Details: IPv6-over-ATM Switch
Implementation Details: IPv6-over-ATM Switch
Implementation Details: Destination
Implementation Details: Network Configuration
Implementation Details: Collected Results/Statistics

IPv6 TOS Mapping:

<table>
<thead>
<tr>
<th>TOS:</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>SVC:</td>
<td>UBR</td>
<td>UBR</td>
<td>UBR</td>
<td>N/A</td>
</tr>
<tr>
<td>TOS:</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>SVC:</td>
<td>UBR</td>
<td>N/A</td>
<td>UBR</td>
<td>UBR</td>
</tr>
<tr>
<td>TOS:</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>SVC:</td>
<td>RT-VBR</td>
<td>RT-VBR</td>
<td>RT-VBR</td>
<td>RT-VBR</td>
</tr>
<tr>
<td>TOS:</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>SVC:</td>
<td>CBR</td>
<td>CBR</td>
<td>CBR</td>
<td>CBR</td>
</tr>
</tbody>
</table>

Total Packets Sent on Each SVC:
- CBR: 6364
- NRT-VBR: 0
- RT-VBR: 6810
- UBR: 10326
- Total: 24000

Total Packets Sent for Each TOS:
- TOS = 0: 1747
- TOS = 1: 1631
- TOS = 2: 1796
- TOS = 3: 0
- TOS = 4: 1300
- TOS = 5: 0
- TOS = 6: 1723
- TOS = 7: 1669
- TOS = 8: 1624
- TOS = 9: 1732
- TOS = 10: 1705
- TOS = 11: 1751
- TOS = 12: 1786
- TOS = 13: 1582
- TOS = 14: 1701
- TOS = 15: 1705
- Total: 24000
Implementation Details: Collected Results/Statistics
Discussion

- Difficulties Encountered
- Alternative Approach
- Future Work
- What We Have Learned
Discussion: Difficulties Encountered

- Standard ATM client model only establishes one class of service SVC. In our model, we have to dynamically create SVC connections as per user’s selection.

- Add user configurable attribute to the client node to allow user to select mapping of TOS to ATM class of services.
Discussion: Alternative Approach

- Use Opnet ATM standard model IPv4 over ATM as our baseline instead of raw packet generator over ATM which we employed in our project.

- Pros: Transport and Network layer (TCP/IPv4) already implemented, need only to incorporate IPv6 packet formats.

- Cons: Much more complicated model for beginners to Opnet to enhance compared with raw packet generator over ATM model.
Discussion: Future Work

- Allow user to configure the QoS and traffic contract of the SVC (e.g. SCR, peak to peak cell delay variations).
Discussion: What We Have Learned…

- Opnet Simulation Tool

- Mapping of IPv6 TOS to ATM class of services.

- Realize an upgrade of IP in which IP/ATM maybe able to provide service guarantees that IP alone cannot.
References

[1] IP Next Generation Overview
[6] Opnet ATM Model Description
Q & A