PART III: ATM

Traffic and Congestion Control

Traffic and Congestion Control in ATM Networks (1)

- Objective: effectively control congestion.
- Difficulties:
  - Limited number of overhead bits available for control over flow of user cells.
  - Majority of traffic is not amenable to flow control (voice, video)
  - Feedback is slow due to reduced cell transmission time compared to propagation delays across the network.
  - Wide range of applications:
    - Very different traffic traffic patterns
    - Very different services required (delay-sensitive for voice/video, loss-sensitive for data)

Traffic and Congestion Control in ATM Networks (2)

- Basic ATM Traffic control functions:
  - 1. Connection admission control (CAC)
    - At call set-up phase
    - Call accepted if sufficient resources are available
    - Traffic contract negotiated and agreed upon between user and network.
      - Limit on traffic volume (traffic descriptors)
      - Requested QOS (cell transfer delay, delay jitter, cell loss ratio)
      - Tolerance to accommodate cell delay variation

Traffic and Congestion Control in ATM Networks (3)

- 2. Usage/network parameter control (UPC, NPC)
  - UPC performed at UNI
  - NPC performed at NNI
  - Set of actions taken by network to control traffic on an ATM connection (Police Function) to enforce compliance with negotiated traffic contract.

Traffic and Congestion Control in ATM Networks (4)

- Definitions
  - Traffic Parameters:
    - A traffic parameter is a specification of a particular traffic aspect.
    - Quantitative aspect
      - Peak cell rate
      - Mean cell rate
      - Average burst duration
    - Qualitative aspect (telephone, video phone)
  - ATM Traffic Descriptor:
    - Generic list of traffic parameters used to capture the traffic characteristics of an ATM connection. (e.g. peak cell rate)
  - Source Traffic Descriptor:
    - Set of traffic parameters belonging to the ATM traffic descriptor used during the connection set-up phase

GCRA

Generic Cell Rate Algorithm

- Unambiguous discrimination between conforming and non-conforming cells (referred to as *Parameterized Conformance-Testing Algorithm*.)
- Standardized.
  - ITU-T Recommendation I.371
- Two equivalent versions:
  - Virtual Scheduling (VS)
  - Continuous-state Leaky Bucket (LB)

Traffic Contract Specification

- Traffic Contract Specification
  - 1. Connection traffic descriptor
    - Declared by user at connection set-up by means of signaling
    - Mandatory parameters: peak cell rate and cell delay variation
    - Optionally: sustainable cell rate burst tolerance.
  - 2. Requested Quality of Service Class
    - Required cell loss ratio
    - Cell transfer delay
    - Cell delay variation

UPC and NPC Actions

- UPC and NPC Actions
  - a) Cell passing.
  - b) Cell tagging. (operates on cells with CLP = 0, overwriting the CLP bit to 1)
  - c) Cell discarding.

Available Bit Rate
Bearer Capability (1)

- CBR
- VBR

} Bandwidth resource Allocation process. (CAC)

- Many data communication applications follow a different model.
  - They may modulate their information rate as a function of network loading status

⇨ ABR: Available bit rate service.

- User adapts its traffic to the changing ATM layer transfer characteristics as indicated by feedback control information received from the network.

⇨ Lower cell loss ratio

⇨ No control for cell delay & cell delay variation.

ABR Bearer Capability (2)

- ABR Traffic Control Mechanism
  - Rate Based control (as opposed to credit based approach with buffer allocation).
  - Closed loop traffic control mechanism
  - Source End System (SES) adjust rate based on feedback control information received from the network.
- Tutorial paper at:

http://www.atmforum.com/atmforum/library/53bytes/backissues/others/53bytes-1095-2.html

ABR Bearer Capability (3)

- SES injects Resource Management (RM) cells into information cell stream on a regular basis, in order to probe the network.
  - RM cells have CLP = 0, PTI = 110
- RM cells are returned by Destination End System (DES) to SES
  - a bit called DIR in the RM information field differentiates between forward and backward directions

ABR Bearer Capability (4)

- In the absence of backward RM cells, SES should continuously decrease its sending rate.
- SES may only increase its rate when given an explicit authorization by a backward RM cell.
- Upon receipt of backward RM cells with negative indication SES should further decrease its rate.

ABR Bearer Capability (5)

- Binary Feedback Information
  - For reasons of compatibility with existing ATM switching equipment that provide EFCI (explicit forward congestion notification) marking of cells.
    - SES sends cells with EFCI = 0
    - Switching nodes may set EFCI = 1
    - DES keeps track of congestion state
    - DES sends info in backward RM cell flow (one bit in RM cell is for congestion indication (CI))
  - May do same as above using RM cells (but not both EFCI & RM)

ABR Bearer Capability (6)

- Explicit Rate Feedback Information
  - Explicit rate field in the RM cells (ER field) 2 byte long.
  - Intermediate switching nodes may explicitly mark the desired SES cell sending rate.
  - SES initially writes the cell rate it would like to send.
  - ER field is subsequently modified by congested switches (and DES)
  - No switching node could ever increase ER.