The Bandwidth Exchange

Vassilis Prevelakis

Computer Science Department
Drexel University

Concepts

• Why reserve bandwidth?
  – Grid computing.
  – Video, music on demand.
  – Multimedia applications.
  – Bandwidth is perishable.

• If its such a good idea, why aren’t we using it already?
  – No commercialization model for the Internet.
  – No architecture for accounting and charging.
  – So far, applications did not require lots of bandwidth (e.g. VoIP)
Motivation

• Assuming that the various links are owned by different organizations, how can the customer construct a path from source to destination?
• Airline analogy

Bandwidth Exchange

• The bandwidth exchange is an on-line site where
  – network providers place quotes for their available bandwidth
  – customers browse for offers for bandwidth
• Futures Market
  – advance bookings
• Spot Market
  – used to allocate bandwidth that has not been previously reserved.
• Requirements
  – transparency (to ensure fairness).
  – assurances (to both buyer and seller).
Example of Spot Market Operation
The BAND-X Clearing House acts as a repository of all the offers for bandwidth issued by the various ISPs.

Customer finalizes the path selection by downloading the offer credentials.
The customer issues a reservation request by sending the offer credentials collected from the BAND-X Clearing House along with a credit-worthiness credential issued by his or her credit institution.

- Each time the path crosses ISP boundaries, additional negotiations have to be carried out, to ensure that the next-hop ISP can be paid for passage.
Band-X Architecture (5)

- The path has now been established and normal communication over the purchased path can proceed.

Band-X Architecture (6)

- Operation of the Futures Market
  - In the spot market, offers have immediate effect.
  - In the Futures market, offers take effect in the future.
    - thus ISP must be informed in advance.
  - Carry out “notional” negotiation (same as spot market).
  - Reservation Credential(s) sent to the user.
  - When bandwidth is required (within the reserved period), user initiated reservation process.
    - in this case only the reservation credentials need be sent.
Implementation (1)

- Trust Management Framework
  - credentials contain public keys of **authorizer**, **licensee**, and **conditions**
  - Credential signed by the **authorizer**

```plaintext
Keynote-Version: 2
Local-Constants: ALICE KEY = "rsa-base64:MCgCIQGB0f8..."
                CG KEY = "rsa-base64:MIGJAo..."
Authorizer: CG KEY
Licensees: ALICE KEY
Conditions: app domain == "Band-X" && currency == "USD"
            && amount < 5.01 && date < "20040324" -> "true";
Signature: "sig-rsa-shal-base64:QU6SZtG9R3IXXAU9vRDBgu..."
```

Implementation (2)

- Trust Management Framework
  - Each entity trusts itself.
    - basic policy allows other entities to be trusted (conditionally)
    - additional credentials allow this trust to be extended (conditionally).
  - For a request to be granted it must be consistent with existing policy.
    - otherwise the request must supply credentials to extend the policy.
    - if not, the request will be denied.
  - Keynote library allows credentials to be verified and integrated into the policy automatically.
Problems

- Overbooking
  - ISPs do not know in advance how many offers will be exercised

- Loss of Quality
  - What happens if a link fails or if a provider fails to deliver on their promises

- Revocation
  - What if one or more actors change their minds?

Conclusions

- Model accommodates both “instant” purchases of bandwidth and advanced purchases
  - ISPs can plan ahead their resource allocation strategies
  - ISPs can get better prices for unused capacity rather that letting it go at Best-Effort prices.

- The entire protocol is efficient requiring only a few exchanges between a buyer and various sellers to effect a reservation.

- An existing reservation protocol (RSVP) is used for the reservation aspect of a BAND-X transaction.
  - BAND-X system can be deployed with minimum disruption.
Conclusions

• Credit Institution(s) link buyers and sellers
  – transactions can take place between buyer and seller without previous business relationship.
  – Allows bandwidth market to work freely with the buyer being able to select the seller offering the best value for money.
  – Model suitable to wireless environments (e.g., a WiFi network in an airport) where mobile users cannot be expected to establish business relationships with the ISPs they use.

• Keynote-based micro-payment framework makes entire system efficient and scalable.

Conclusions

• The BAND-X model allows the presence of multiple entities for each role (i.e., we can have multiple Credit Institutions, Clearing Houses, buyers and sellers) operating within a single market. This increases the competition and overall reliability of the entire system.