Quality of Service provisioning in WiMAX Networks: Chances and Challenges

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Outline

- QoS in 802.16
- QoS in IP
- QoS failure
- QoS chances

QoS in 802.16

QoS in 802.16: basics

- Connection oriented
  - QoS per connection
  - all services are applied to connections
  - managed by mapping connections to "service flows"
  - bandwidth requested via signaling

- Three management connections per direction, per station
  - basic connection: short, time-critical MAC / RLC messages
  - primary management connection: longer, delay-tolerant messages authentication, connection setup
  - secondary management connection: e.g. DHCP, SNMP

- Transport connections
  - unidirectional; different parameters per direction

QoS in 802.16: services

- Uplink scheduling types
  - Unsolicited Grant Service (UGS)
    - for real-time flows, periodic fixed size packets
    - e.g. VoIP or ATM CBR
  - Real-Time Polling Service (rtPS)
    - for real-time service flows, periodic variable size data packets
    - e.g. MPEG
  - Non-Real-Time Polling Service (nrtPS)
    - for non real-time service flows with regular variable size bursts
    - e.g. FTP or ATM GFR
  - Best Effort (BE)
    - for best effort traffic
    - e.g. UDP or ATM UBR
- Specified via QoS parameters
  - max. sustained traffic rate / traffic burst, min. reserved traffic rate
  - vendor specific parameters

QoS in 802.16 and ATM

- Convergence sublayers map connections to upper technology
  - thus, also QoS!
  - two sublayers defined: ATM and "packet" (Ethernet, VLAN, IP, ..)

- Services designed for ATM compatibility

CBR (Constant Bit Rate)	emulates a leased line
RT-VBR (Real-time Variable Bit Rate)	for rt-streams w/ varying bandwidth such as MPEG
NRT-VBR (Non-real-time Variable Bit Rate)	similar to RT-VBR, but more jitter is tolerated
UBR (Unspecified Bit Rate)	cheap, too: no promises - best used by IP
ABR (Available Bit Rate)	cheap service - you do what you are told, get what is available and achieve a small cell loss ratio
GFR (Guaranteed Frame Rate)	minimum rate guarantee + benefit from dynamically available additional bandwidth

QoS in IP

Why IP QoS?

- Interview with Van Jacobson, EE Times *http://www.eetimes.com/*
  "TCP/IP pioneer's past is prologue", 03/07/2005

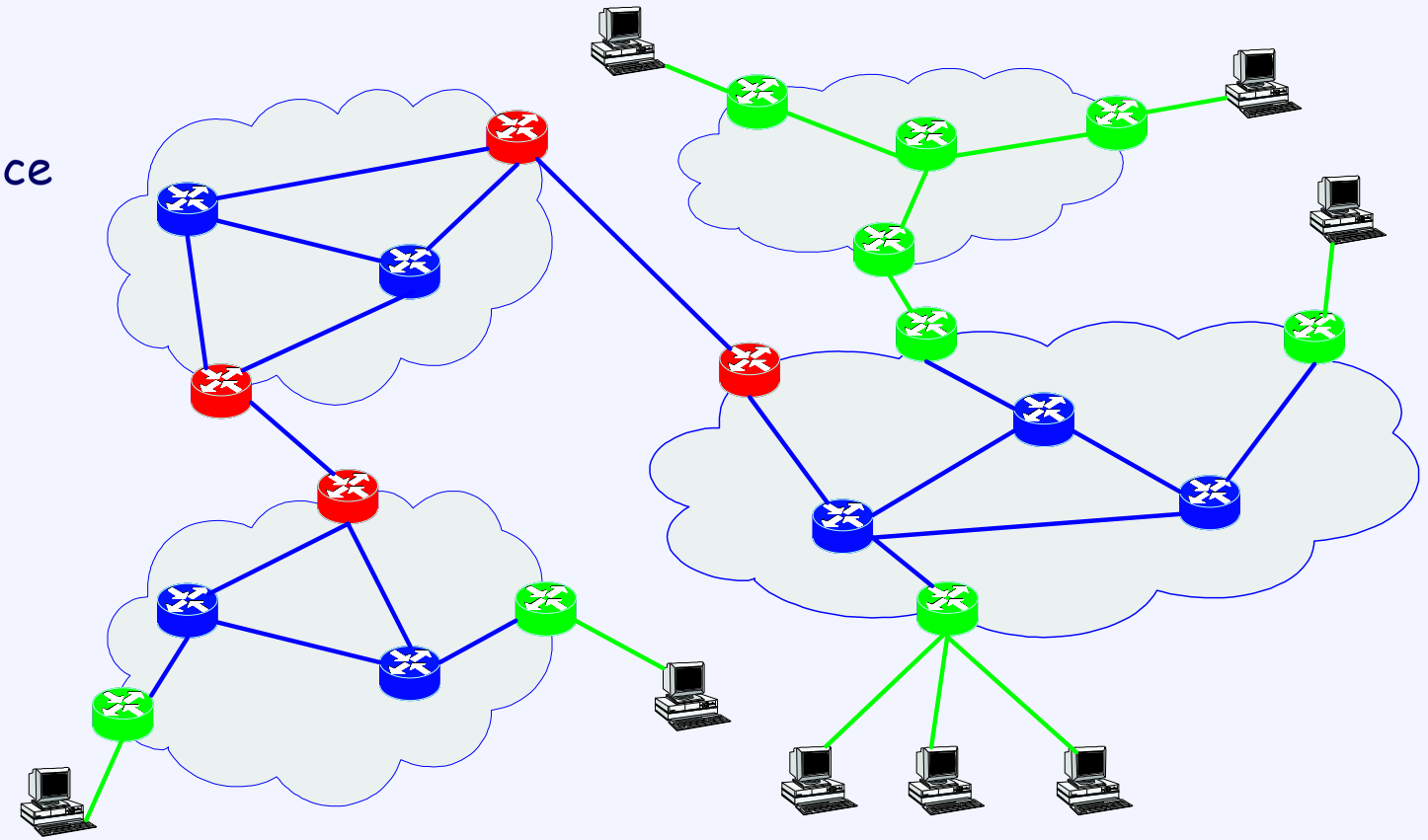
  "From my point of view, ATM was a link-layer technology, and IP of course could run on top of a link layer, but the circuit-oriented developers had interpreted the link layer as the network. The wires are not the network."

- "ATM to the Desktop" failed - so, do it with IP

	Best-Effort	IntServ/RSVP	DiffServ
QoS-Guarantees	none	flow-based	aggregated
Configuration	none	dynamic end2end	static edge2edge
Scalability	100%	limited	more

IP QoS evolvement

- IntServ failed
  - probably scalability
- DiffServ failed
  - probably service granularity
- So what about IntServ over DiffServ?

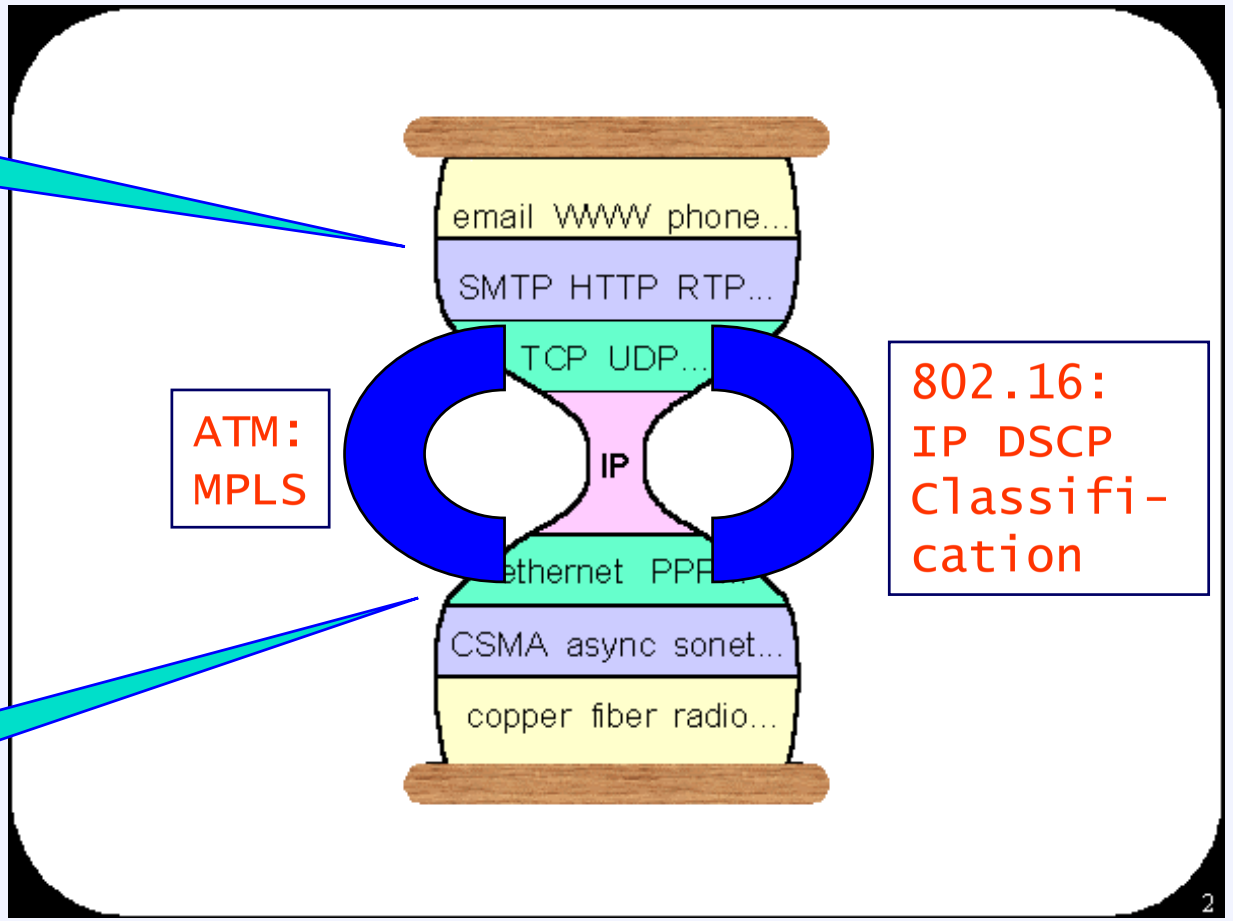


Technology is not the problem!

Everything Over IP

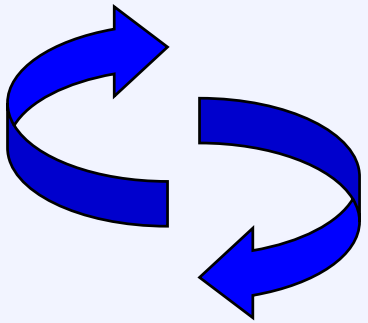
No assumptions
⇒ no guarantees!

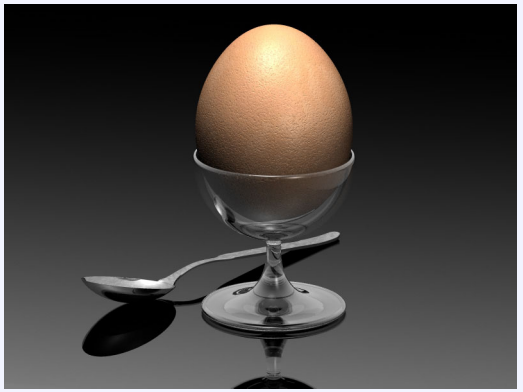
IP Over Everything



The failure of end-to-end Internet QoS

QoS as an end user service





ISP:

- wants to max. revenue
- Install QoS alone: -$
- Provide QoS: ++$
  ...**iff** applications use it!

App developer:

- wants to max. revenue
- Implement QoS support: -$
- Support QoS: ++$
  ...**iff** ISPs provide it!

- Resembles prisoner's dilemma
- Can be solved with coordination (e.g. flow of $$$)
- How to coordinate apps + all ISPs along the path?

Other reasons

- Business model:
  what exactly does "DiffServ EF service" mean to customers?
- Overprovisioning sometimes cheaper
  $ (manpower for administration) > $ (capacity)
- Lack of charging and billing solution
- Lack of global coordination
  Internet QoS = true, global end-to-end QoS
- Internet heterogeneity – what if link layers cannot support QoS?

802.16 QoS chances

Bad ideas for 802.16 QoS

- Support for end-to-end QoS across the Internet
  - Never happened, and probably never will
- ATM-like services to the end user
  - "ATM to the desktop" failed
- 802.16 QoS as replacement for IP QoS
  - QoS must be preserved at all layers
- Complicated QoS configurations
  - Simple ones suffice to support IP traffic
  - In theory, 1 bit differentiation is enough!
  - QoS configuration errors / software bugs are often reasons for failure

What can 802.16 QoS do for you?

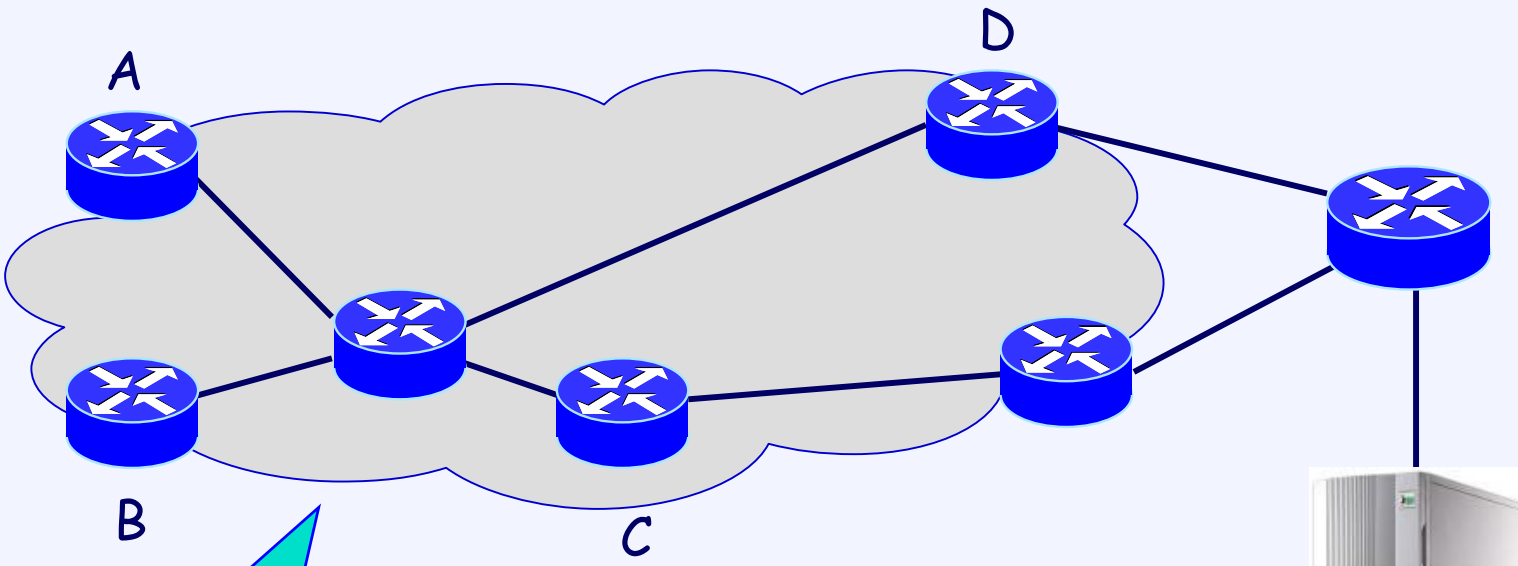
- Nowadays, IntServ, DiffServ, MPLS are traffic management tools
  - e.g. protect TCP traffic from UDP
  - reasonable when overprovisioning is not a solution (i.e. it is more expensive or impossible)
- IP QoS does not work with incompatible link layers
- Classifier in 802.16: assign IP packets to "service flows"
  - can use destination address, source address, protocol, DSCP
  - DSCP QoS association: "glue" between 802.16 QoS and IP QoS
    - enables DiffServ
- ATM convergence sublayer: assign cells to "service flows"
  - glue between { IP - MPLS - ATM VC } and 802.16
    - enables MPLS

Example usage scenario

Customers

Aggregate: DiffServ + 802.16 classification

Fine-grain: ample provisioning or bandwidth broker / IntServ/RSVP, traffic shaping, congestion control…



One ISP network:

"We-do-WiMAX corp."

"We-do-WiMAX" 's own video server

Thank you!

References

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Hourglass picture:
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