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Time and Timing Issues within the Wireless Application Home Environment

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Outline

- Background Research
- Time & Timing within IP Multimedia Applications
  - Voice & Video over IP
  - Streaming
  - Gaming
- Challenges of Wireless Ubiquity
  - VoIP / Wireless speaker scenario
  - Delivering NTP over wireless
- Conclusions
VoIP : Adaptive Jitter Buffer Algorithms
- Jitter buffer absorbs packet arrival jitter
- Adaptive buffer tracks network
  - Implemented via silence period adjustment
    - QoS impact unknown
  - No Time Synch between endpoints
  - No knowledge of actual M2E delay
    - Adjustments often unnecessary in context of acceptable M2E delay
Adaptive Jitter Buffering

Adaptive Playout Strategy

http://perfenglab.com
Hybrid Playout Algorithm

- **Hybrid Algorithm**
  - Based on synchronised time across different hosts
  - Minimise late loss at expense of increased delay
  - ITU-T E-Model
    - Net gain in user-satisfaction R-factor
  - Added (unquantified) benefit of reduced silence period distortion
  - Synchronised time provided by NTP
  - Precise delay info facilitated by RTCP SR packets
Hybrid Alg.: Synchronised Time

Performance of Hybrid vs Adaptive algorithms

- Hybrid commences in adaptive mode
- Hybrid changeover to fixed playout
- Subsequent c/o to higher fixed playout
- Adaptive playout

1st RTCP packet received => analysis of actual delays commences
RTP & RTCP

- RTP useful for intra-stream synchronisation (reconstruction)
- RTCP SR useful for inter-stream synch for different streams eg lip-synch *from same host*
  - *Synch Time across hosts not reqd*
- **What if we want to synch different media streams *from different hosts*?**
  - *Require Synchronised Time *across* hosts*
Detectability and Acceptability Thresholds for lip synch

ETSI STQ

Subjective evaluation results (Diffgrade)

Delay time (ms)

-200 -180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100

A A' B B' C C'

Undetectability plateau

Detectability threshold

Acceptability threshold

Sound delay wrt vision

Sound advanced wrt vision

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Lip Synch via RTCP SR

ADC_audio → RTP_audio → RTCP_audio → RTCP_video → RTP_video

ADC_video
Benefits of Synchronised Time

- **VoIP / Video over IP**
  - Precise Delay Information
  - Improved QoS (E-Model analysis)

- **Gaming**
  - MMOG market growth
  - Equalisation of delays
  - *Levels the playing pitch for all participants*
Synch Time for MMOG
Synchronised Timing

- NTP synchronises *system* clocks
- *Media* clocks are often separate subsystem
- Multiplicity of clocks introduces complexity
- Skew in VoIP Terminals / Gateways
  - Increasing delay ➔ QoS issue
  - Buffer overflow/underfill ➔ Pkt loss/discontinuity ➔ QoS issue
- Similar problems for Gaming
  - Delay & Packet Loss
- Streaming
  - Pkt loss rather than delay key issue
Timing ‘Skew’ for IP Multimedia

IP-IP Session

Buffer Overflow ➔ High Delay + Pkt loss

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Skew Solutions in wired world

- Various skew detection and compensation mechanisms
  - Low level buffer monitoring to determine skew
- Patented NTP/RTCP approach
  - Based on Synchronised time
    - Independent benefits
Wireless Ubiquity

- Rapid growth in both Home & Office wireless LANs
  - IEEE 802.11 a/b/g/e
- Demand for similar IP Multimedia applications over wireless networks
  - Voice and Video over IP
  - Streaming
  - Gaming
Wireless Challenges

- Most wired LAN networks are Fast/Gigabit Switched Ethernet
  - Little/No contention & Overprovisioned (so far)
  - Reasonably deterministic
  - Switches can be QoS enabled (often not reqd)
  - WAN provides challenges

- Wireless (802.11) LAN
  - A return to contention based LAN networks
    - CSMA CA
  - Relatively low bandwidth
  - Significant delay & jitter at DLL
    - QoS challenges
Wireless Challenges

- Increased delay jitter due to
  - Contention level & Signal degradation/interference

- Additional problems for
  - VoIP.. buffer/delay management
  - Gaming.. buffer/delay management
  - Streaming
    - Buffer management
    - Stream Alignment for multiple parallel streams
    - Wireless Speakers
Wireless Streaming

Synchronisation of Media Streams

802.11 Wireless Communication Links

Media Server

Speaker A

User

Speaker B
Wireless Streaming

- Playout from speakers A & B needs to be very tightly synchronised
- Impact of delay difference (Haas Effect)
  - $\Delta T < 30 \text{ msec}$
    - Sensory inhibition
      - Only hear the 1$^{\text{st}}$
      - Brain processes $\Delta T$ to determine sound source
  - $\Delta T > 30 \text{ msec}$
    - Two distinct sounds heard .. Echo
    - Both undesirable!
Cause of $\Delta T$

- Delays to speaker A and B may be very different due to 802.11 characteristics
- Skew between media clocks A & B will cause cumulative misalignment over time
  - 100 ppm = 60 msec over 10 minutes
Wireless Challenges

- Have outlined benefits of synchronised time to **wired** applications such as VoIP/gaming/streaming
- Benefits in **wireless** environment are even greater due to significantly greater delay jitter / non determinism
  - Wireless streaming to > 1 media sink has extra requirement for synchronisation
NTP in Wireless Environment

- Presents greater challenges
  - NTP operation is based on symmetric networks
  - Wireless networks can be very asymmetric
    - 802.11 ‘Reliability’ will lead to NTP offset errors
    - Server & Path diversity in NTP design
      - Helps identify/eliminate servers on asymm links
      - 802.11 provides common weak link
  - What about ‘new’ 802.11 e
    - QoS over 802.11
Wireless QoS via 802.11e

- **Default Best Effort ping**
  - 13 packets transmitted, 13 packets received, 0% packet loss round-trip min/avg/max/stddev = 2.485/16.492/31.758/11.551 ms

- **QoS Enabled ping**
  - 12 packets transmitted, 12 received, 0% packet loss, time rtt min/avg/max/mdev = 2.458/3.705/6.478/1.119 ms

- Much lower delay and jitter..but
- What happens when QoS channel is abused?
Conclusion

- Strong awareness of benefits of synch timing
- Less awareness of benefits of synch time
- Does the user currently care?
  - Wired IP world:
    - QoS seen as acceptable?
      - Other more pressing problems in network and terminals
  - Wireless IP world
    - Benefits of synch time more significant
    - Wireless speaker: very noticeable impact
    - May raise awareness of benefits?