

# Synchronisation & Skew Issues within IP-based Multimedia Terminals

Dr. Hugh Melvin,  
Dept. of Information Technology, National University of  
Ireland, Galway

(email: [hugh.melvin@nuigalway.ie](mailto:hugh.melvin@nuigalway.ie))

Dr. Liam Murphy  
School of Computer Science and Informatics, University  
College Dublin

**Performance Engineering Laboratory**  
[www.perfenglab.com](http://www.perfenglab.com)



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# Outline

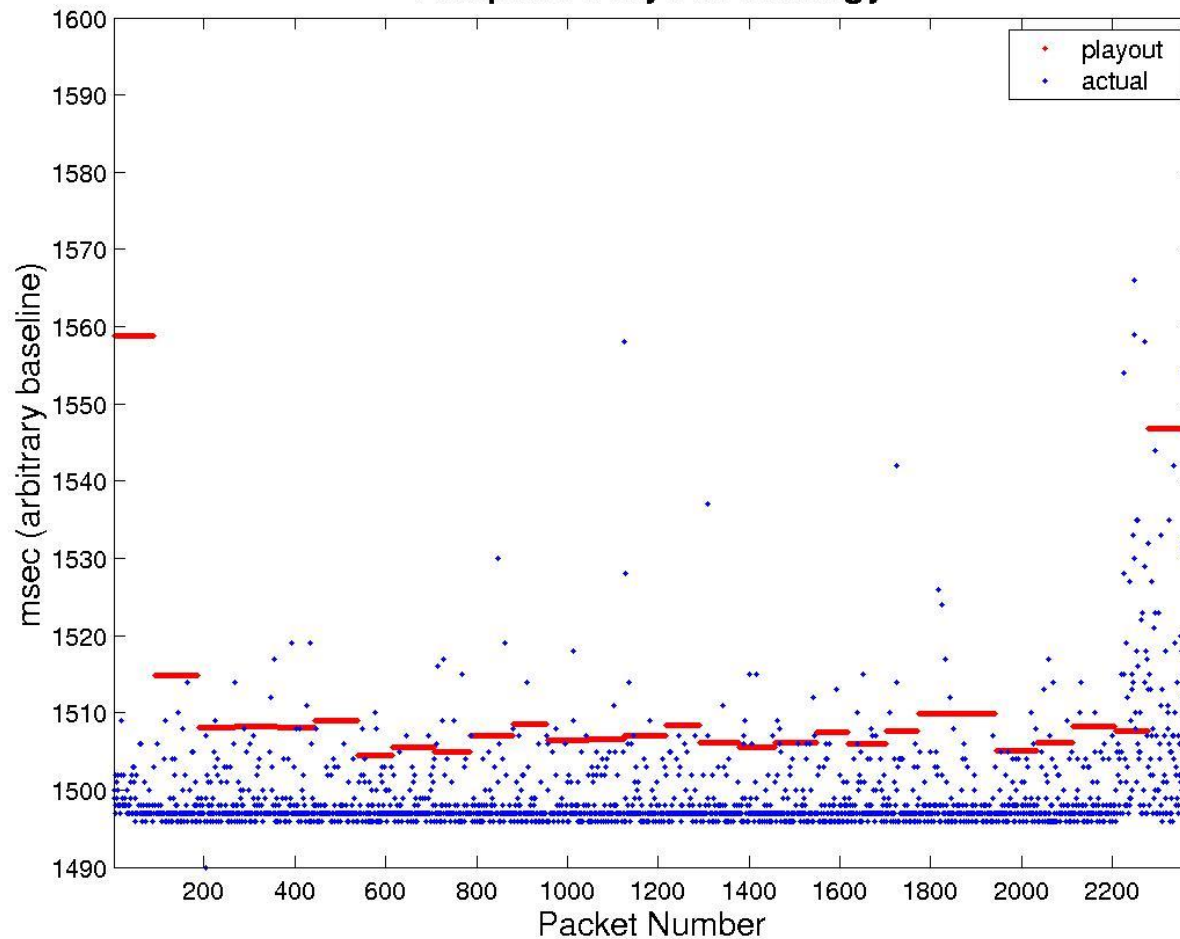
- Background Research
- Synchronised Time
  - Benefits for VoIP
  - NTP Performance
- Impact of Skew
  - VoIP Terminals and Gateways
  - Mixers
  - Wireless Environment
- Solutions
  - Integrated NTP/RTCP approach

# Background Research

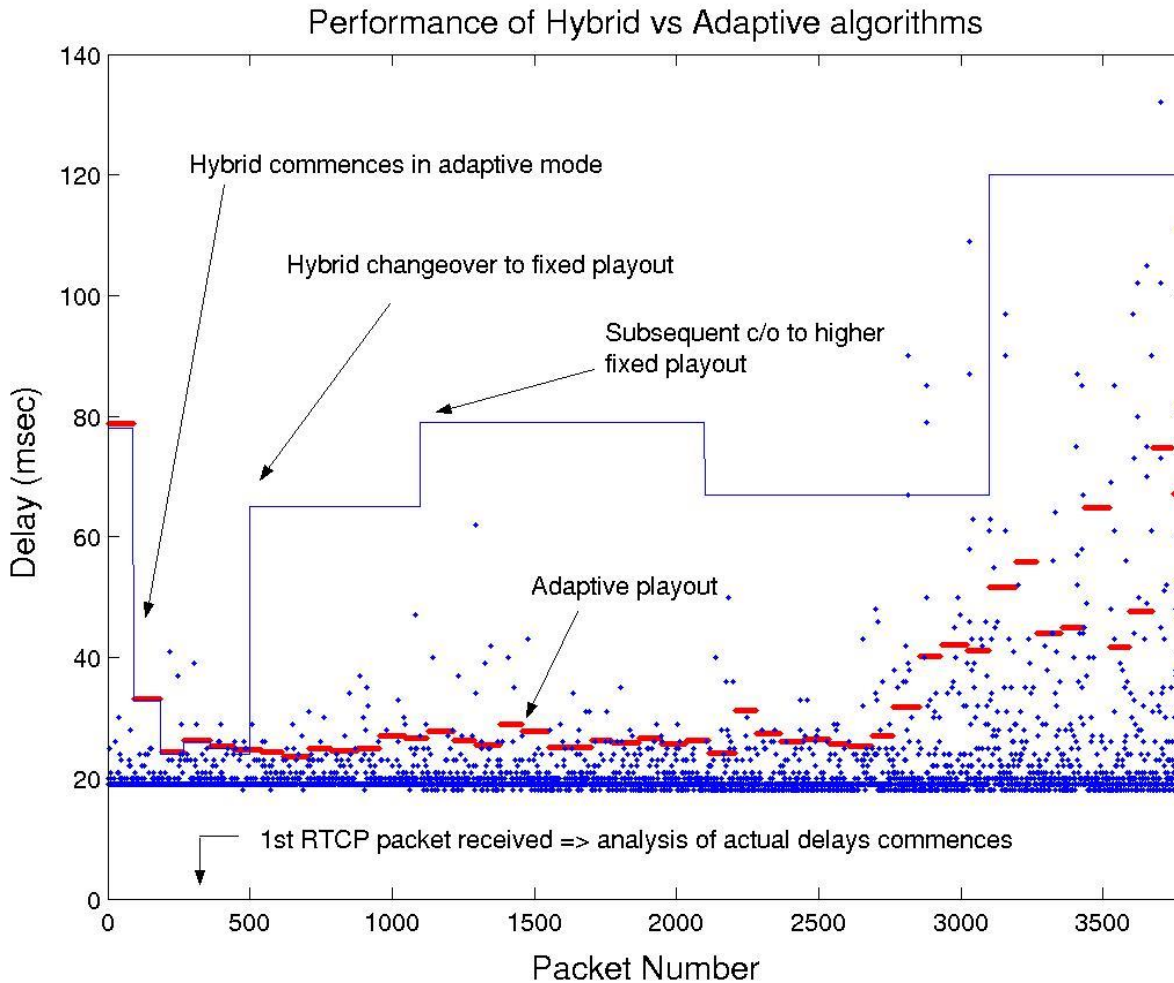
- VoIP : Adaptive Jitter Buffer Algorithms
  - RTP useful for intra-stream synchronisation
  - RTCP SR useful for inter-stream synch for different streams eg lip-synch *from same host*
  - Conventional VoIP: NO knowledge of M2E delay
- Hybrid Algorithm
  - Based on synchronised time across different 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
  - Delay info facilitated by RTCP SR packets

# Adaptive Jitter Buffering

Adaptive Playout Strategy



# Hybrid Alg.: Synchronised Time



# NTP

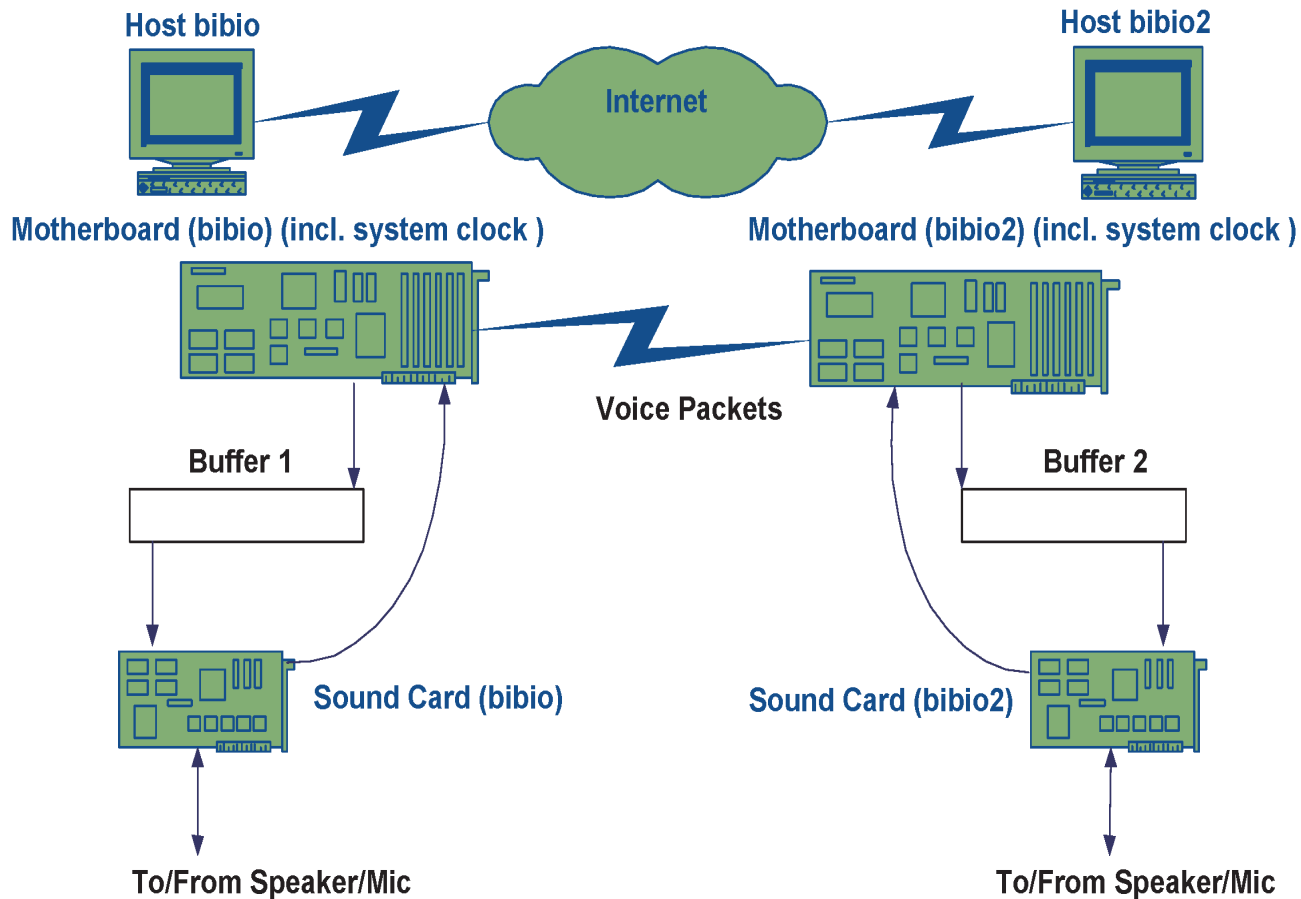
- Achievable performance
  - 1 msec on LAN
  - 1-10 msec on WAN
- Key to performance: Local primary source backed up by multiple redundant peers across diverse paths
- OS dependency issues
- Increased availability of NTP servers and always-on Internet make synchronised time feasible in home environment
- NUI,G Stratum 1 *ntp-galway.hea.net*

# Media Clock Skew

- NTP synchronises *system* clocks
- *Media* clocks are often separate subsystem
- Multiplicity of clocks introduces complexity
- Briefly examine range of scenarios
  - VoIP → Gateway
  - Media Mixer
  - Wireless Environment

# VoIP: System & Media Clocks

## System vs Audio Card Clock Issues



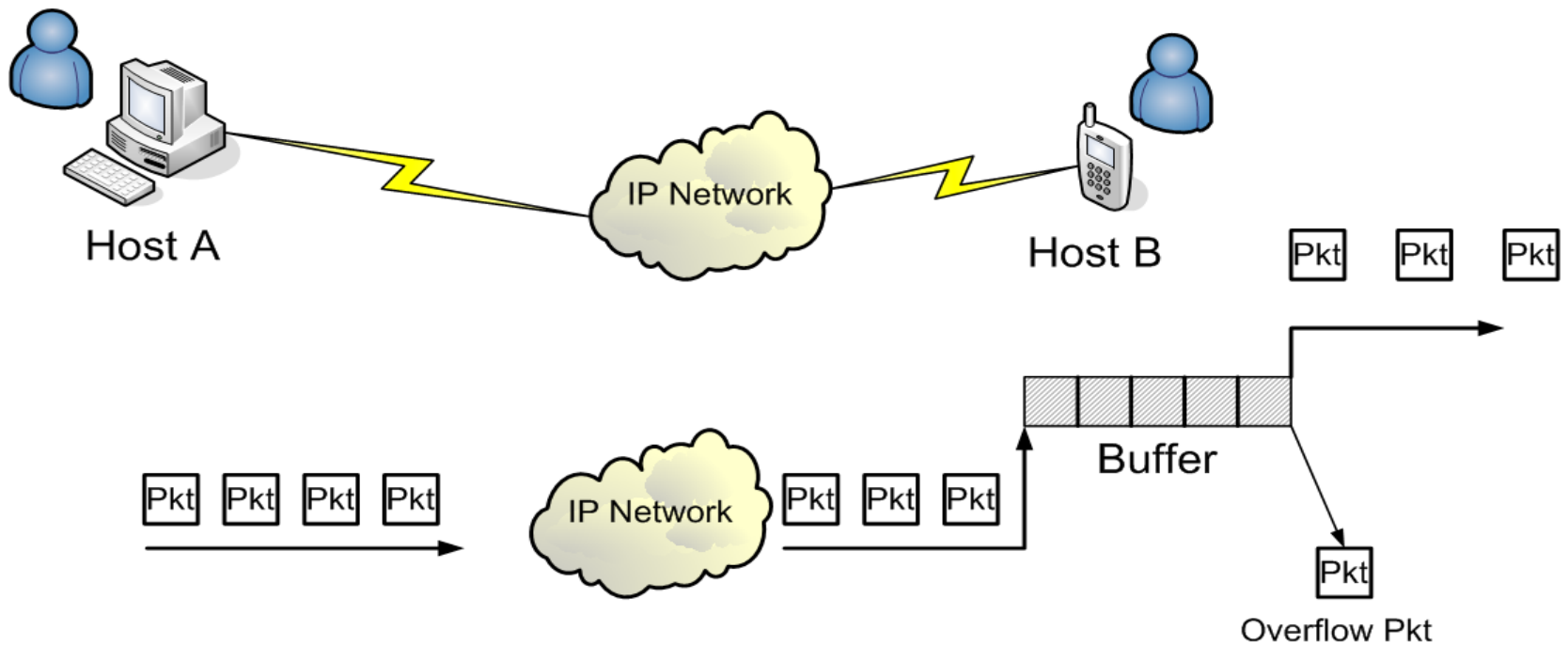


# Scenario 1

- VoIP
  - Media clock skew
    - High delay – Buffer overflow
    - Buffer underfill - Discontinuity
    - VAD minimises these problems
      - VAD introduces its own quality issues
    - Skew compensation required
  - IP-PSTN Gateway
    - Multiple concurrent sessions
      - Scalability problem

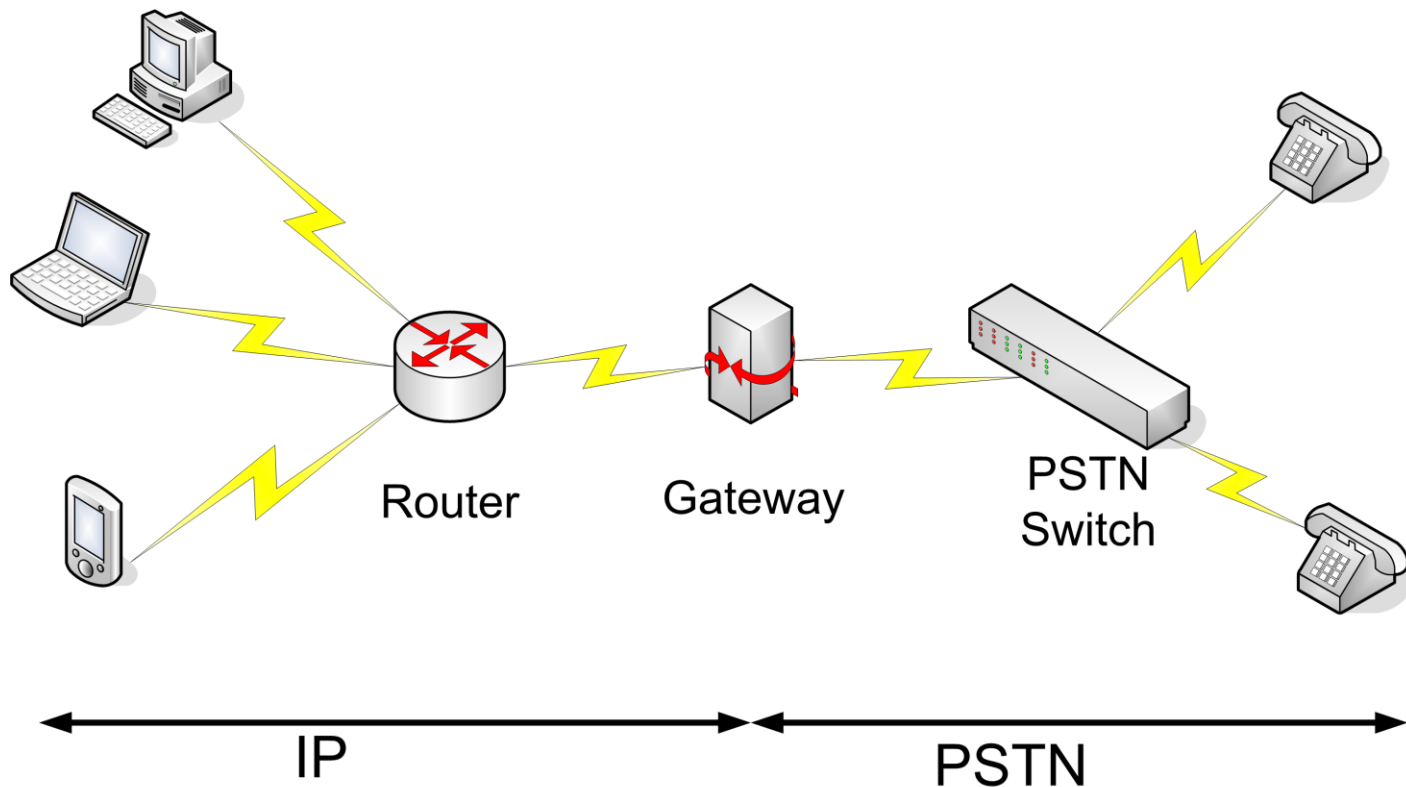
# Media Clock Skew : All IP

## IP-IP Session



# Media Clock Skew : Gateway

## IP-PSTN

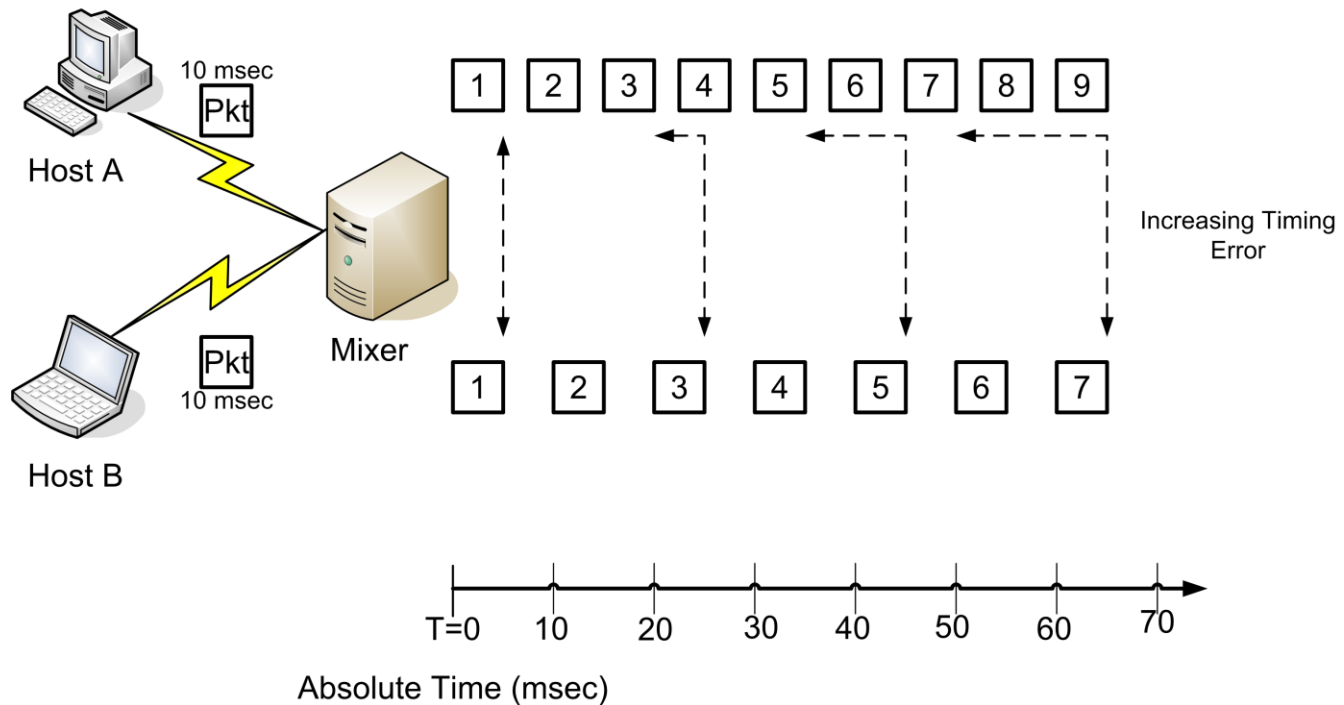


## Scenario 2

- Media Mixer
  - Mixing based on RTP timestamps
    - Skew will lead to cumulative misalignment error
    - Skew compensation required
  - What level of alignment is required?
    - Initial stream alignment may also be required
    - Synchronisation between contributing stream sources will facilitate initial alignment

# Media Clock Skew : Mixer

## Mixer Timing Error due to Audio Clock Skew

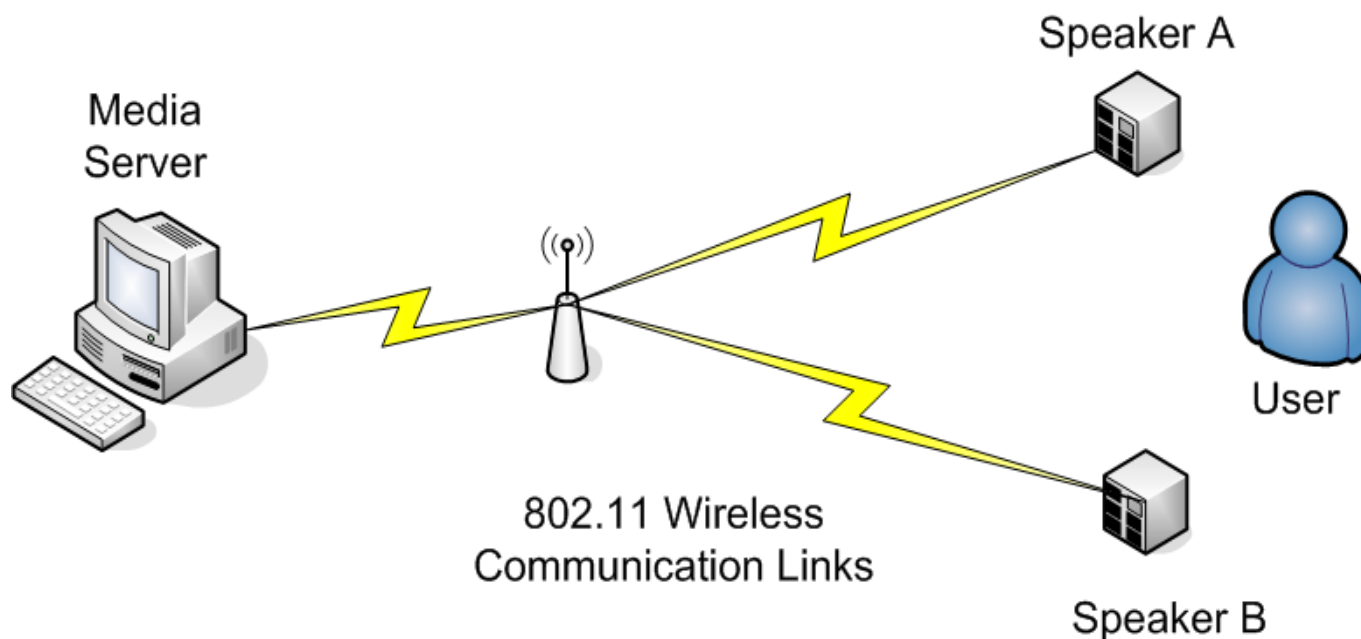


## Scenario 3

- Rapid growth in wireless LAN
  - Separate streaming channels to each speaker
  - MAC layer non deterministic
  - ➔
  - Different delay to each speaker
  - Media clock skew will lead to further misalignment (Haas effect)
    - Synchronisation between speakers required
    - Skew compensation required

# Wireless Environment

## Synchronisation of Media Streams



# Synchronisation & Skew

- Synch between terminals can improve QoS
  - VoIP: Precise per packet delay info .. Informed jitter buffering
  - Mixer/Wireless environment: Initial alignment of media streams
- Media clock skew compensation can also improve QoS
  - VoIP: Better buffer management
  - Mixers/Wireless environment : Maintain alignment of media streams
- Such problems swamped by more pressing quality problems?
  - IP network non determinism
  - Network delay and packet loss
  - Poor application s/w, OS support
  - Other Hardware issues



# Significance of these Issues?

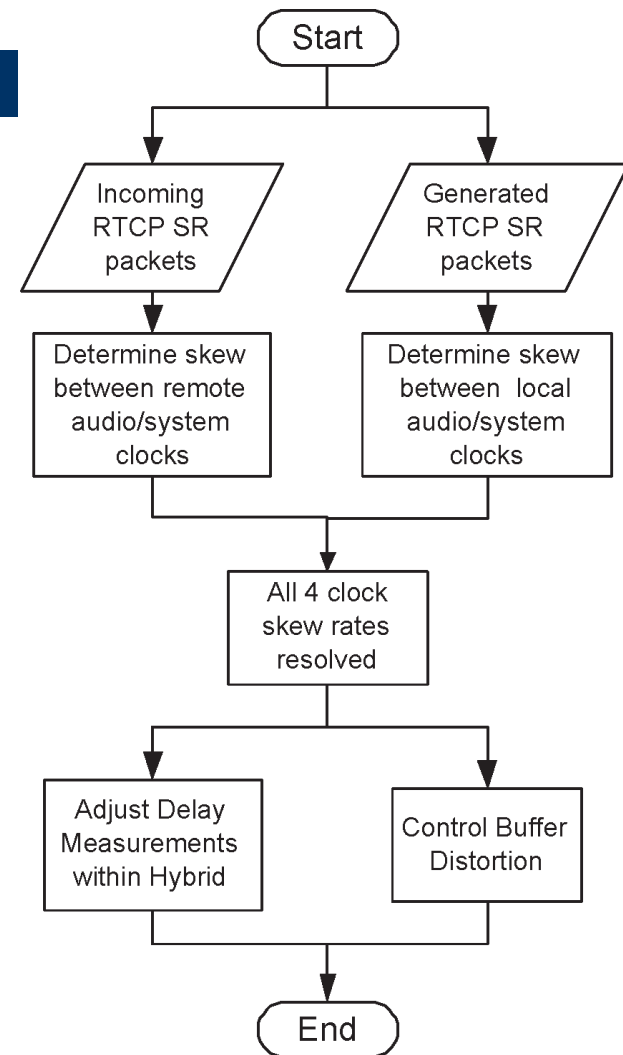
- Does the user currently care about QoS loss caused by synchronisation/skew issues?
- Obviously we care!
- ETSI STQ Draft document on this topic
- Synchronisation
  - Definite benefits in context of underlying network non-determinism
- Media clock skew
  - Perhaps more subtle quality benefits
  - Various skew strategies being deployed

# NUI,G / UCD Skew Detection

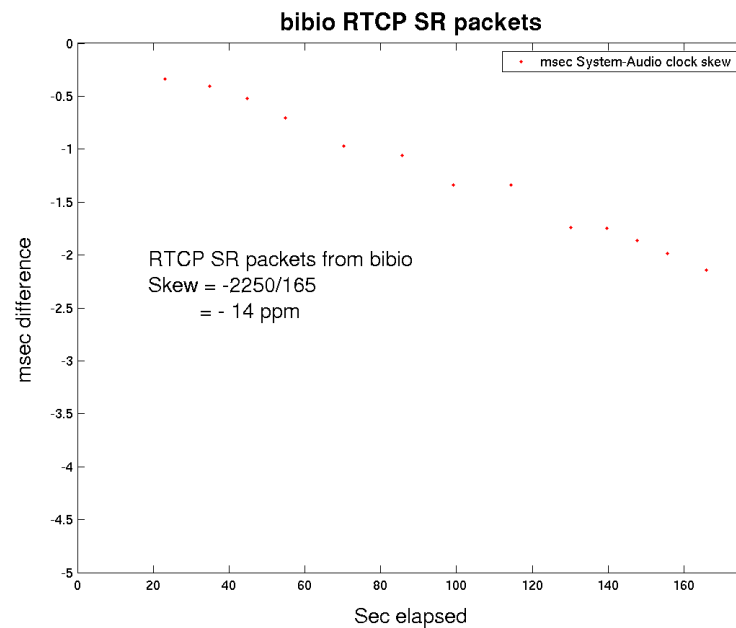
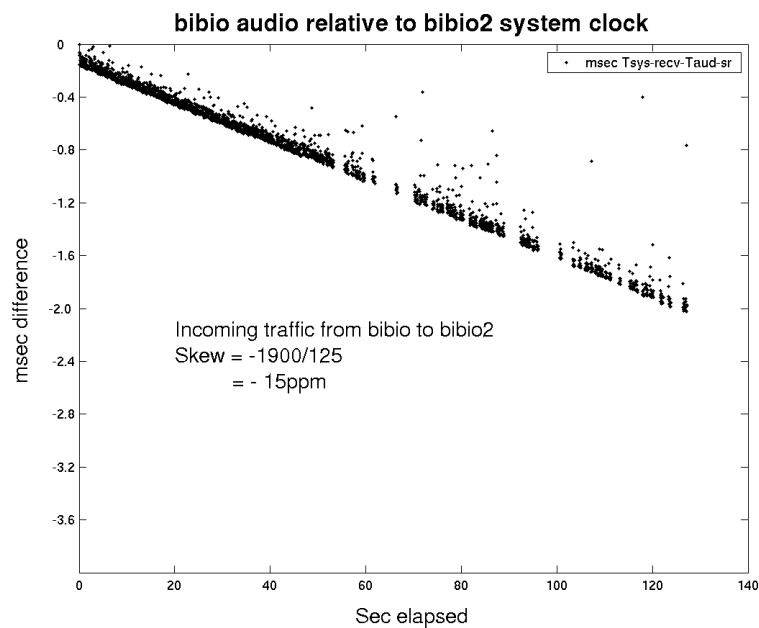
- Based on synchronised time
  - Independent Benefits
- Integrates existing protocols
  - NTP + RTCP
- Low complexity
  - Operates at protocol level
- Quickly determines extent of skew
  - Obvious reqd for VoIP
- Not impacted by network jitter
- Tested in Linux environment

# How does it work ?

- RTCP SR packets contain mapping between RTP media clock and system clock
- Are sent periodically by each sender.. every few seconds
- Incoming RTCP SR
  - Can determine remote skew
- Outgoing RTCP SR
  - Can determine own skew
- All 4 clocks resolved



# Solution



# Conclusion

- Challenge for IP Based Multimedia
  - Network QoS
    - Significant research
  - Terminal QoS
    - Complexity in hardware/software mix
    - Time synchronisation & Skew compensation
      - Two distinct issues
      - Both can deliver benefits
    - Q is whether user will notice/care/pay?