

Time Synchronisation at Application Level: Potential Benefits, Challenges and Solutions

Dr. Hugh Melvin,
Padraig O Flaithearta
Jonathan Shannon
Lourdes Beloqui Yuste

Discipline of Information Technology, National
University of Ireland Galway

(email: hugh.melvin@nuigalway.ie)

Performance Engineering Laboratory
<http://pel.it.nuigalway.ie>

Overview : Research Progress

- Project 1
 - Dynamic optimisation of wireless 802.11e EDCA for VoIP
 - Padraig O Flaithearta
- Project 2
 - Inter-media synchronisation for IPTV
 - Lourdes Beloqui Yuste
- Project 3
 - Wireless synchronisation challenges & solutions
 - Jonathan Shannon

Story so far

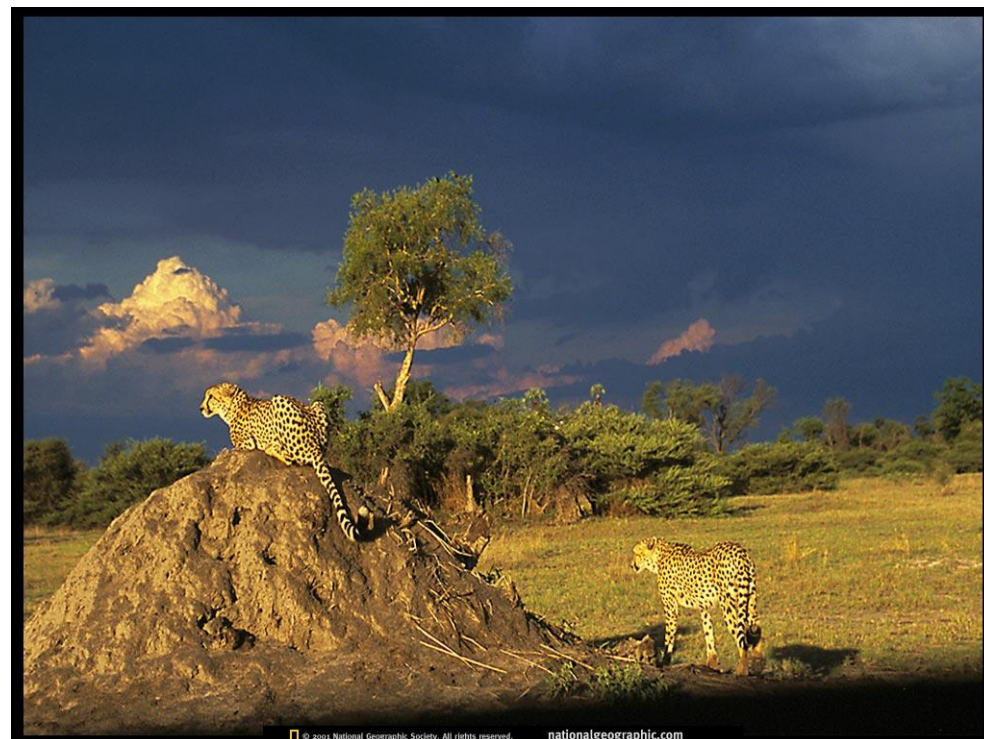
3 days
40 presentations
1000 slides
100,000 Business Cards
1200 Years of Roman History
Not enough sleep
Too much food ..and drink

... and

Afternoon session
Last day



**"You're not allowed to use
the sprinkler system to keep
your audience awake."**

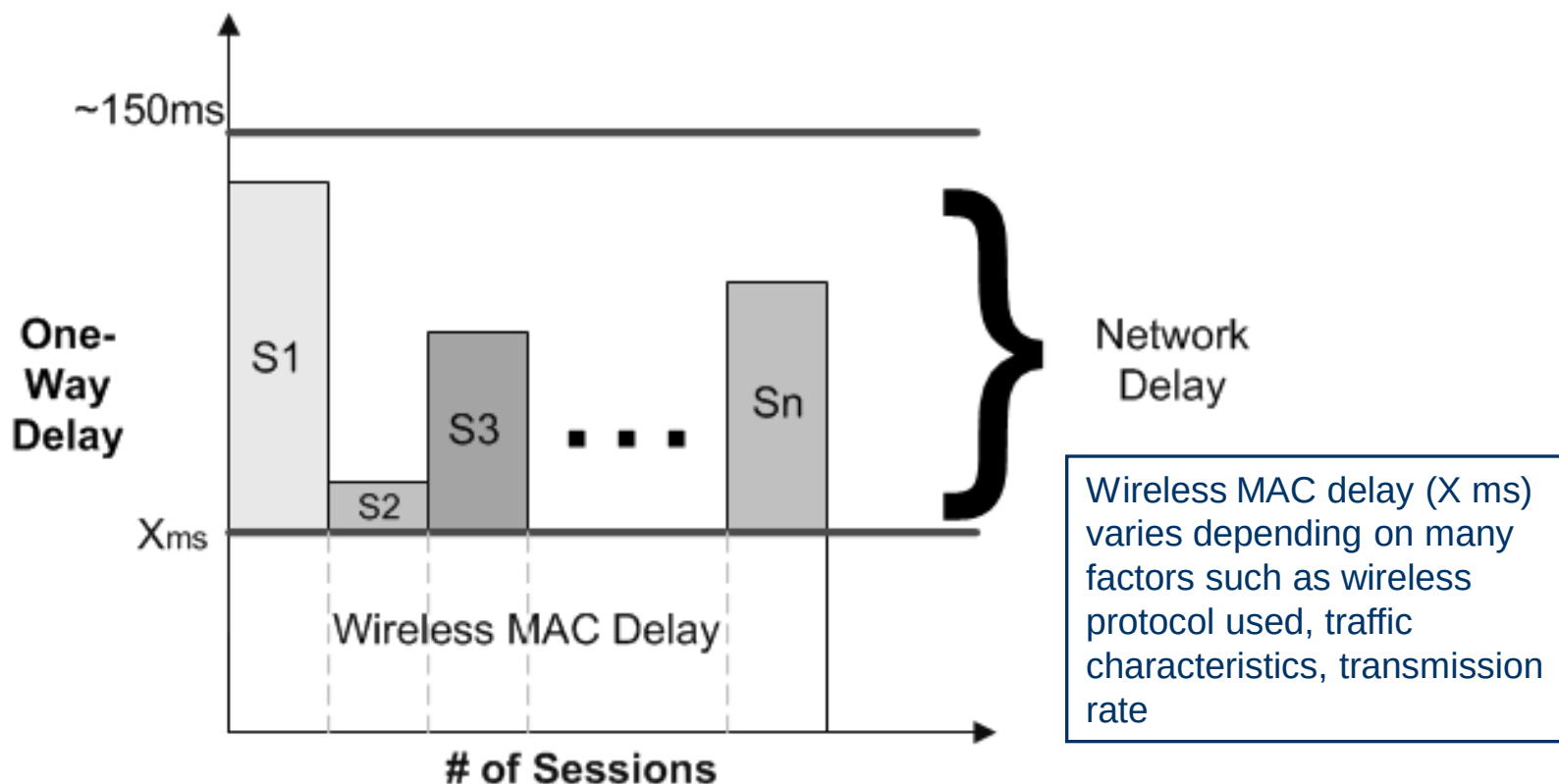


Project 1: VoIP over 802.11e EDCA

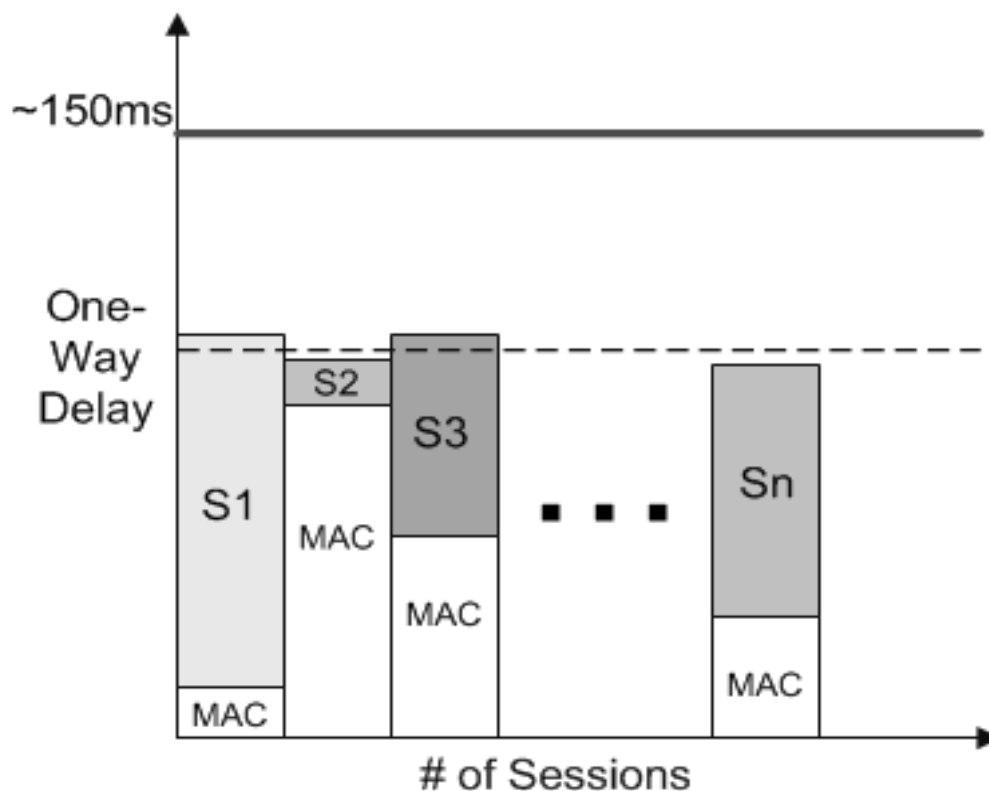
- 802.11e
 - IEEE standard for QoS sensitive data
 - Includes contention based (EDCA) channel access
 - Priority based
- NS2 Network Simulator
 - Discrete Event Open Source simulator
 - Extendable
 - Developed in C++, OTcl
 - Supports many networking protocols over Wired & Wireless networks
 - Including TCP, UDP, 802.11(e)
 - Widely used in Networking Research

```
0026bb0b55a2:~ hugh$ ping www.nuigalway.ie
PING vertualweb.nuigalway.ie (140.203.201.74): 56 data bytes
64 bytes from 140.203.201.74: icmp_seq=0 ttl=56 time=65.900 ms
64 bytes from 140.203.201.74: icmp_seq=1 ttl=56 time=160.759 ms
64 bytes from 140.203.201.74: icmp_seq=2 ttl=56 time=121.220 ms
64 bytes from 140.203.201.74: icmp_seq=3 ttl=56 time=66.146 ms
64 bytes from 140.203.201.74: icmp_seq=4 ttl=56 time=57.934 ms
64 bytes from 140.203.201.74: icmp_seq=5 ttl=56 time=81.739 ms
64 bytes from 140.203.201.74: icmp_seq=6 ttl=56 time=202.166 ms
64 bytes from 140.203.201.74: icmp_seq=7 ttl=56 time=83.097 ms
64 bytes from 140.203.201.74: icmp_seq=8 ttl=56 time=83.159 ms
64 bytes from 140.203.201.74: icmp_seq=9 ttl=56 time=69.542 ms
64 bytes from 140.203.201.74: icmp_seq=10 ttl=56 time=73.532 ms
64 bytes from 140.203.201.74: icmp_seq=11 ttl=56 time=179.785 ms
64 bytes from 140.203.201.74: icmp_seq=12 ttl=56 time=62.455 ms
64 bytes from 140.203.201.74: icmp_seq=13 ttl=56 time=204.550 ms
64 bytes from 140.203.201.74: icmp_seq=14 ttl=56 time=101.341 ms
64 bytes from 140.203.201.74: icmp_seq=15 ttl=56 time=71.130 ms
64 bytes from 140.203.201.74: icmp_seq=16 ttl=56 time=266.069 ms
64 bytes from 140.203.201.74: icmp_seq=17 ttl=56 time=289.524 ms
64 bytes from 140.203.201.74: icmp_seq=18 ttl=56 time=515.910 ms
64 bytes from 140.203.201.74: icmp_seq=19 ttl=56 time=345.792 ms
^C
--- vertualweb.nuigalway.ie ping statistics ---
20 packets transmitted, 20 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 57.934/155.087/515.910/117.671 ms
0026bb0b55a2:~ hugh$
```

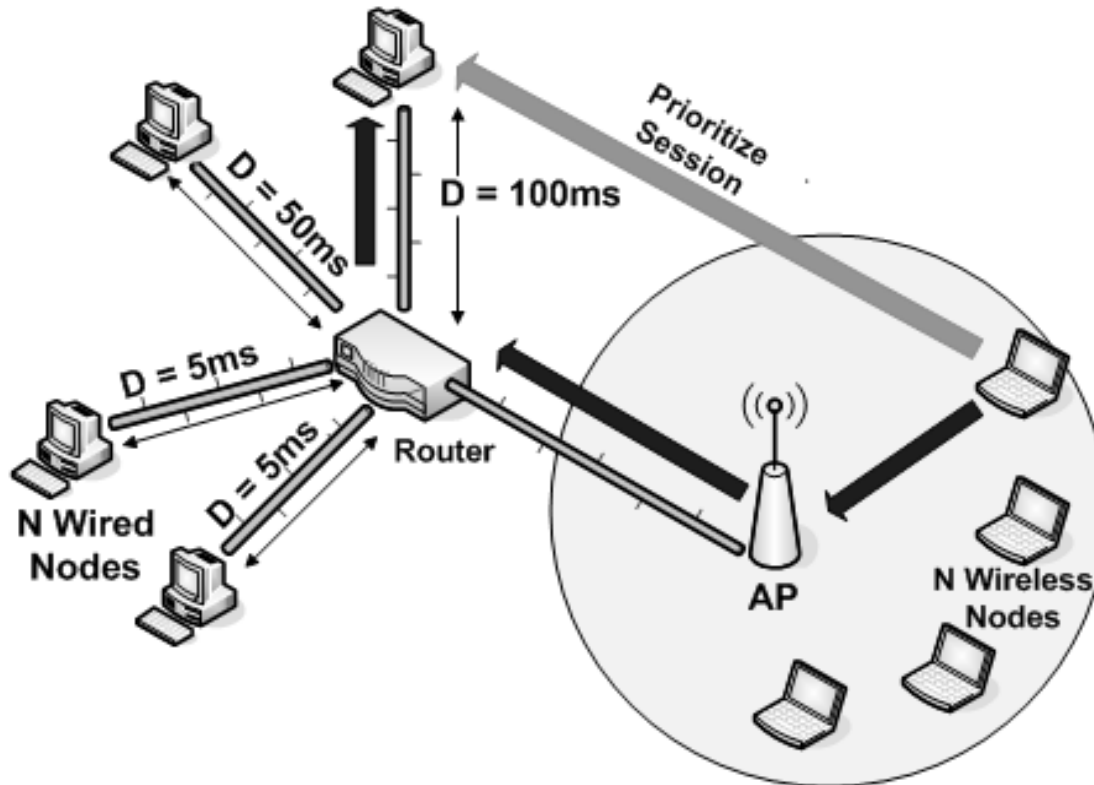
Problem – Default End-to-End Delay



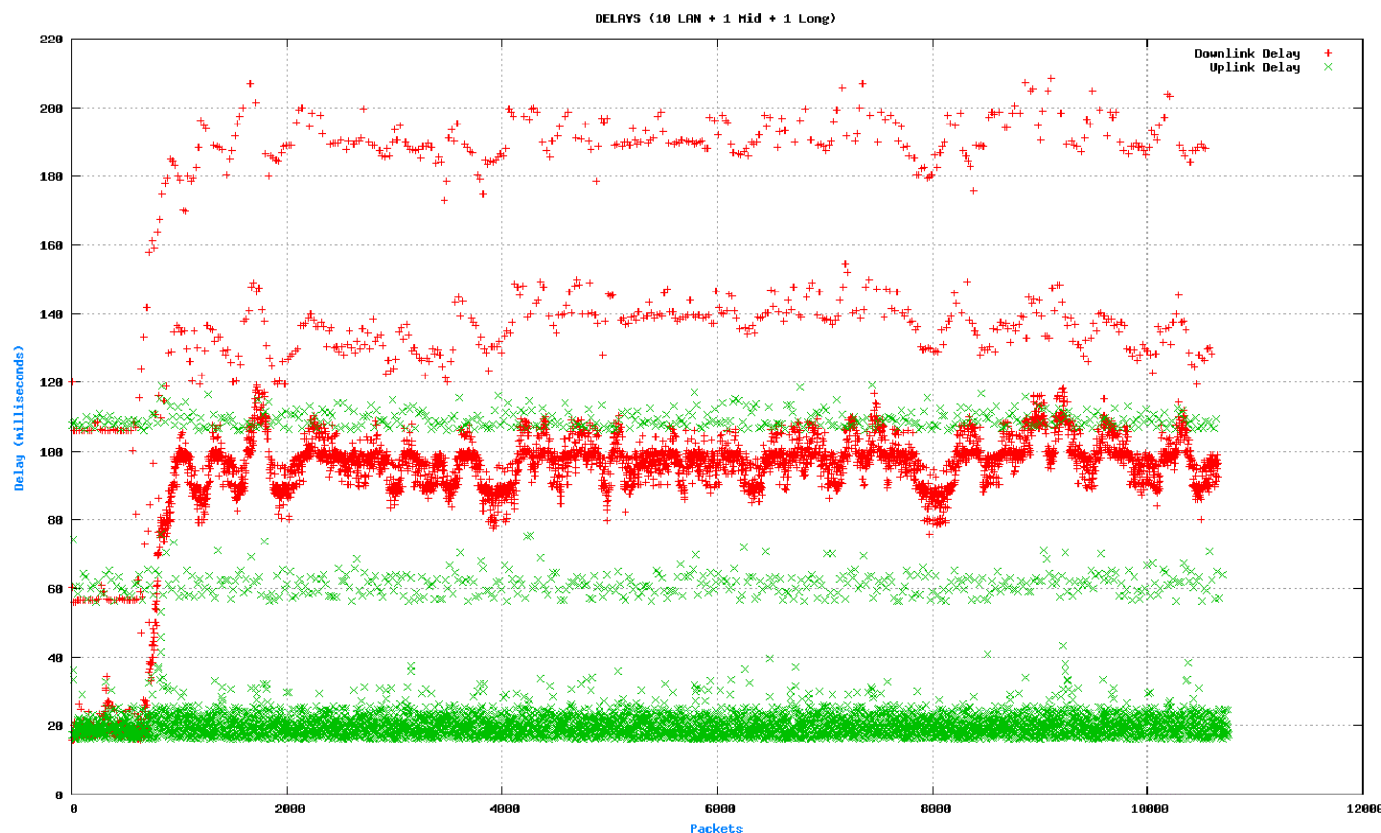
Solution – Tune MAC param's (802.11e)



Problem – Simulation Setup



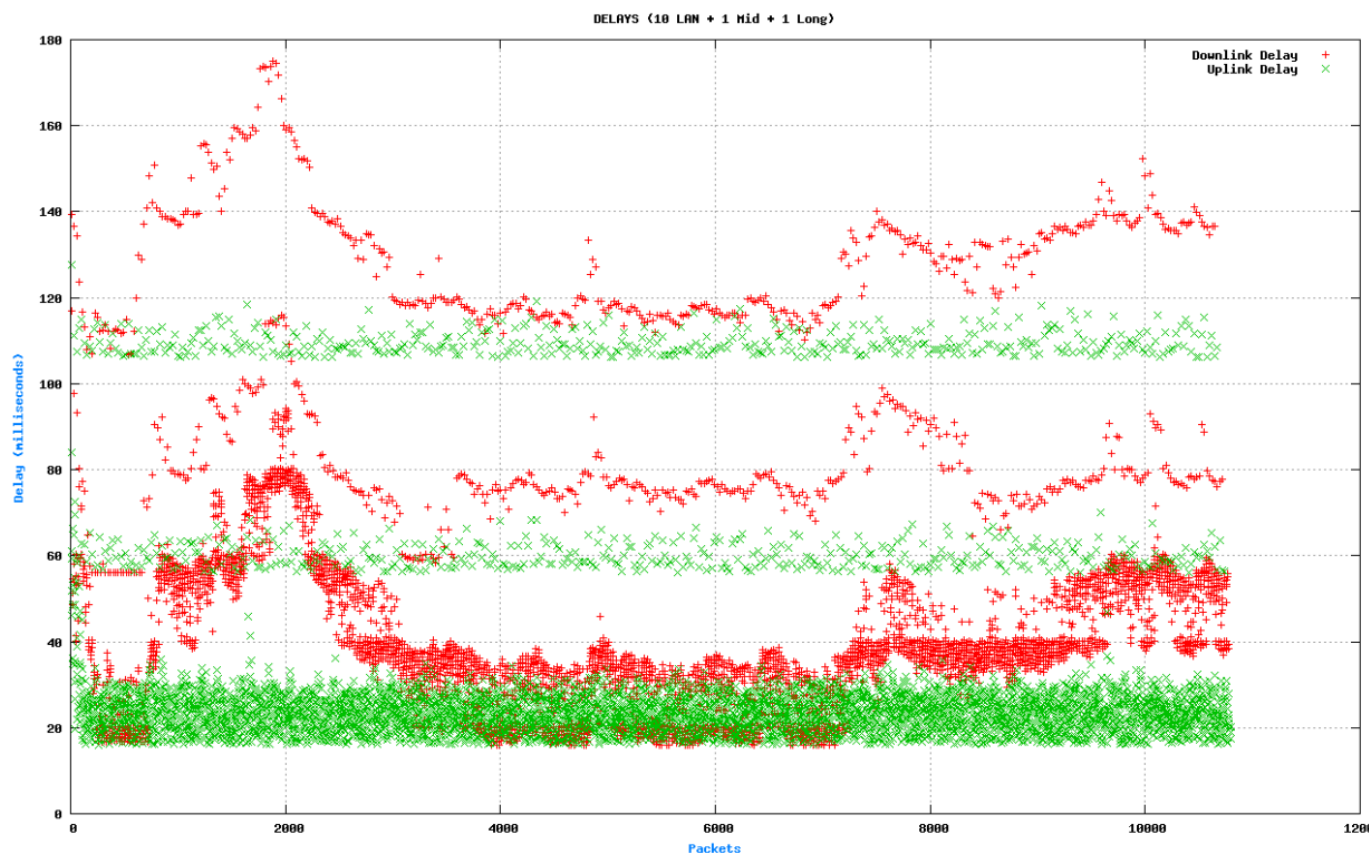
Scenario 1 – Default End-to-End Delay



Voice only
scenario-

All Sessions
have equal
priority

Scenario 2- Prioritisation of Uplink Traffic



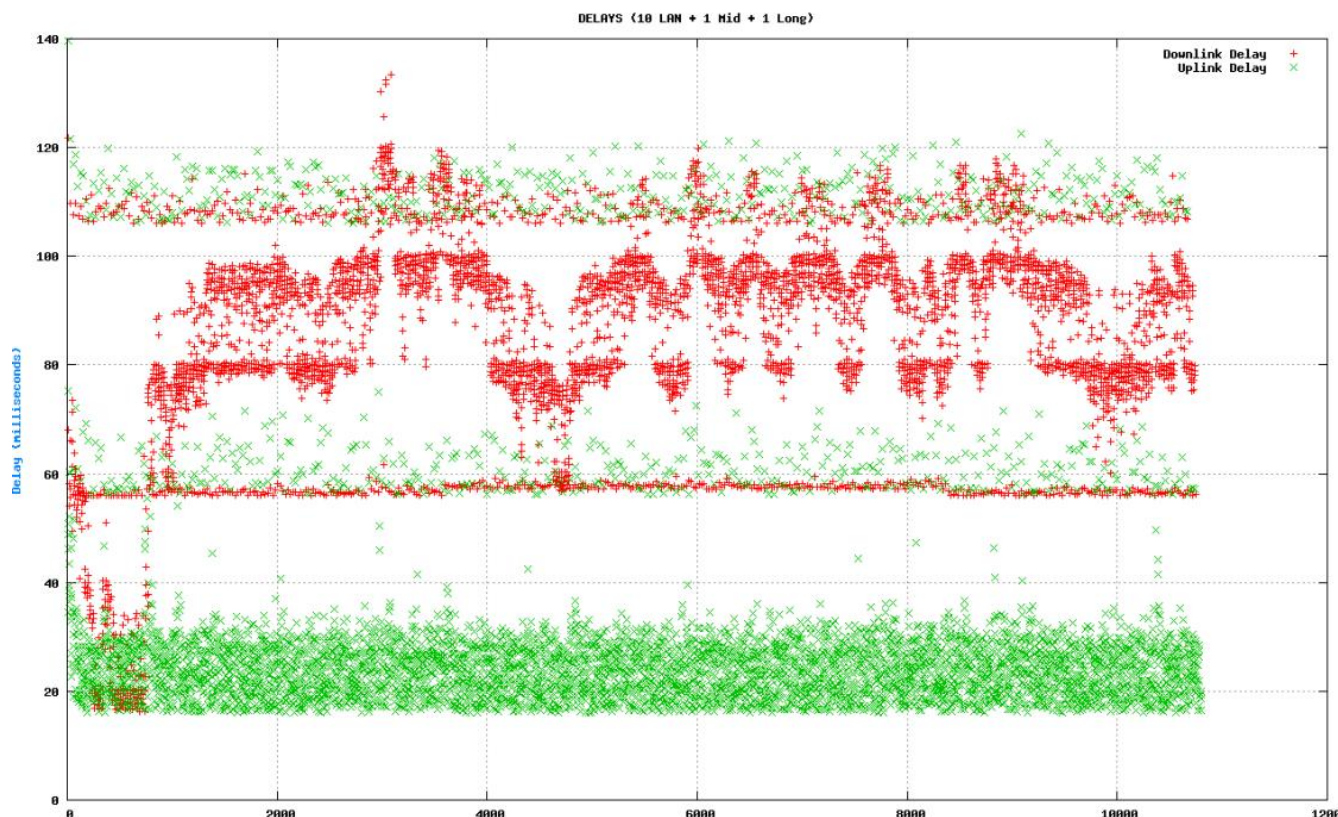
Voice only
scenario-

Uplink traffic
given
priority

Role of Access Point (AP)...

- In Scenario 2, only Uplink traffic receives priority
 - Parameter tuning takes place at end terminal
 - Shows an improvement on Scenario 1 (on downlink)
- Scenario 3 prioritises both uplink and downlink traffic
 - Improvement on scenario 2, (particularly on prioritised traffic)
 - In the real world this requires a virtual queue on the AP....

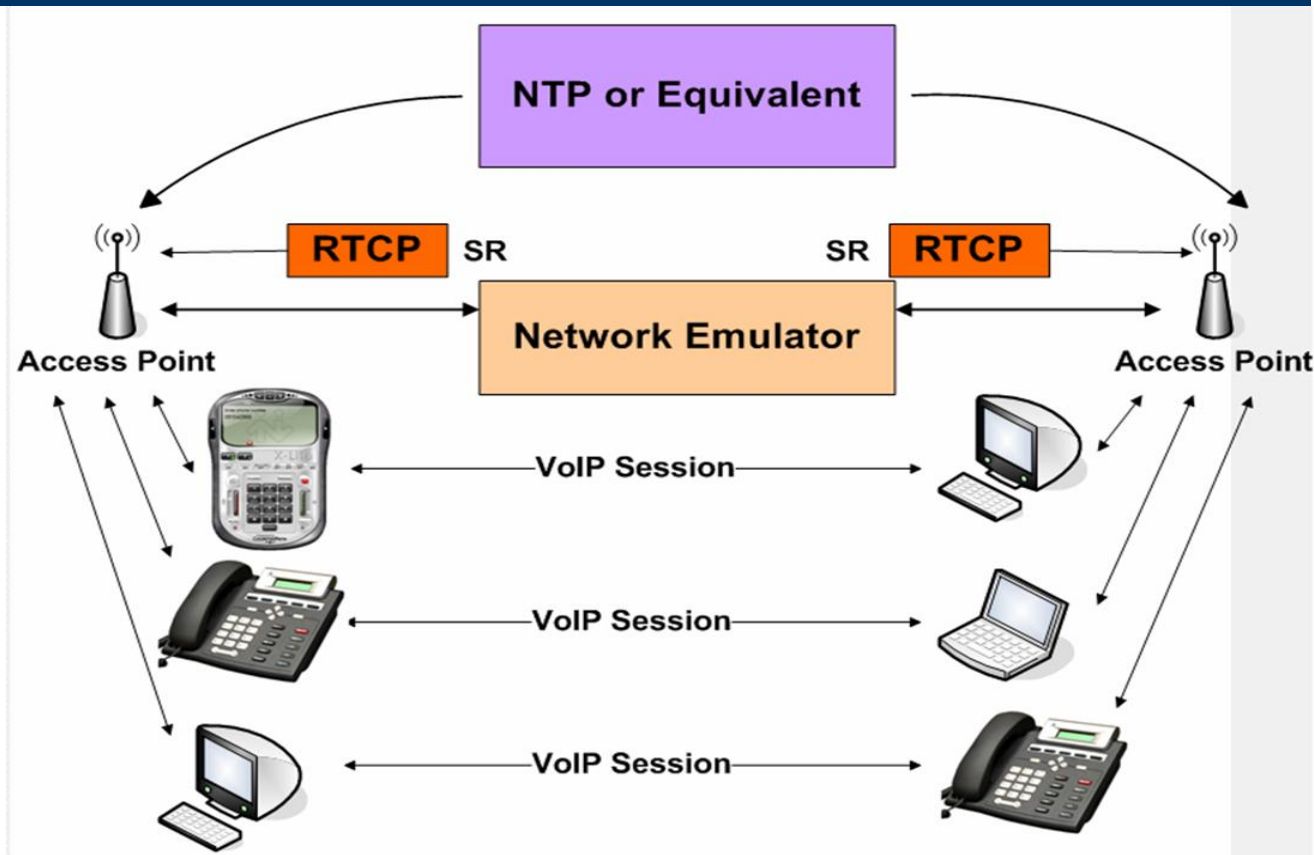
Scenario 3 - Prioritisation of Up + Down-link traffic



Packet delay values “equalised”, as low priority packets wait longer to transmit.

(Downlink [Red] due to congestion at AP)

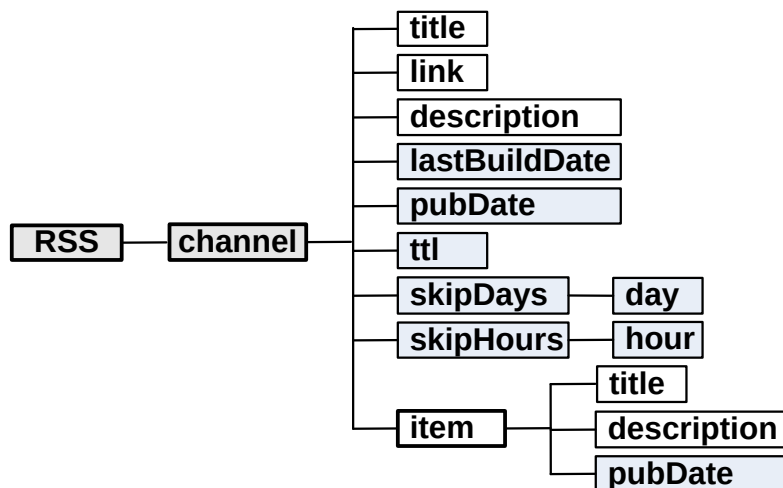
Wireless Testbed



Project 2: Inter-media synch for IPTV

- IPTV USP v Satellite
 - Interactivity
 - User customisation
- Enhanced Services through Synchronised Time
 - TV/RSS
 - TV/TV
 - TV/Audio

RSS 2.0 time related tags

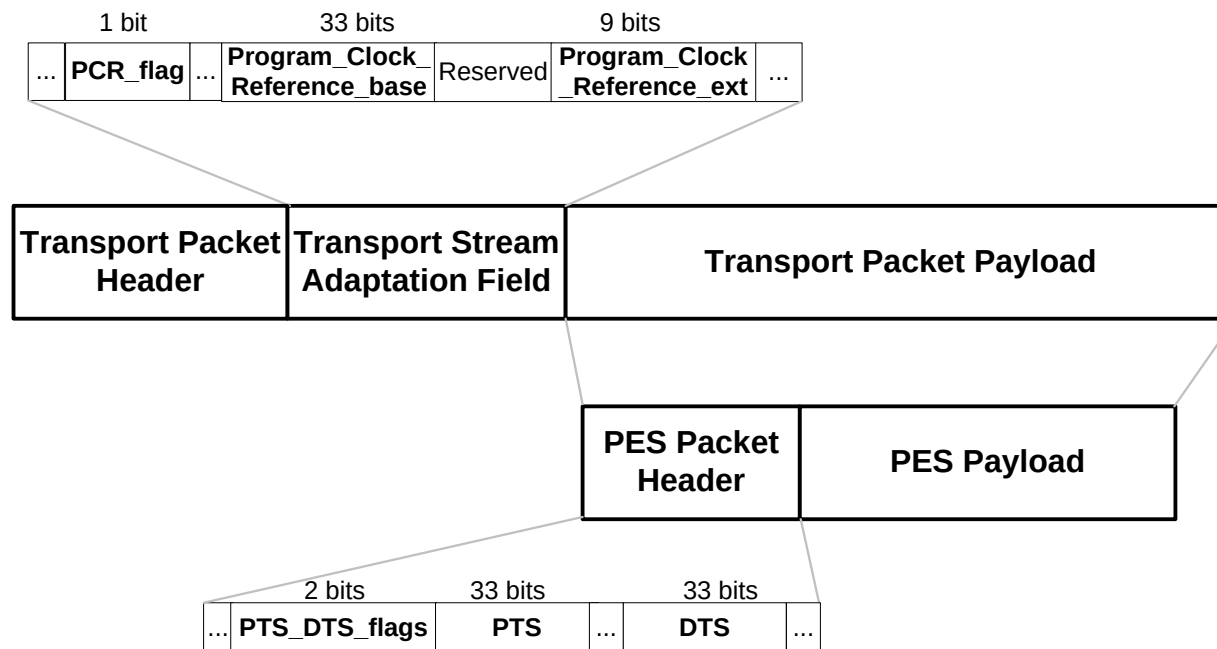


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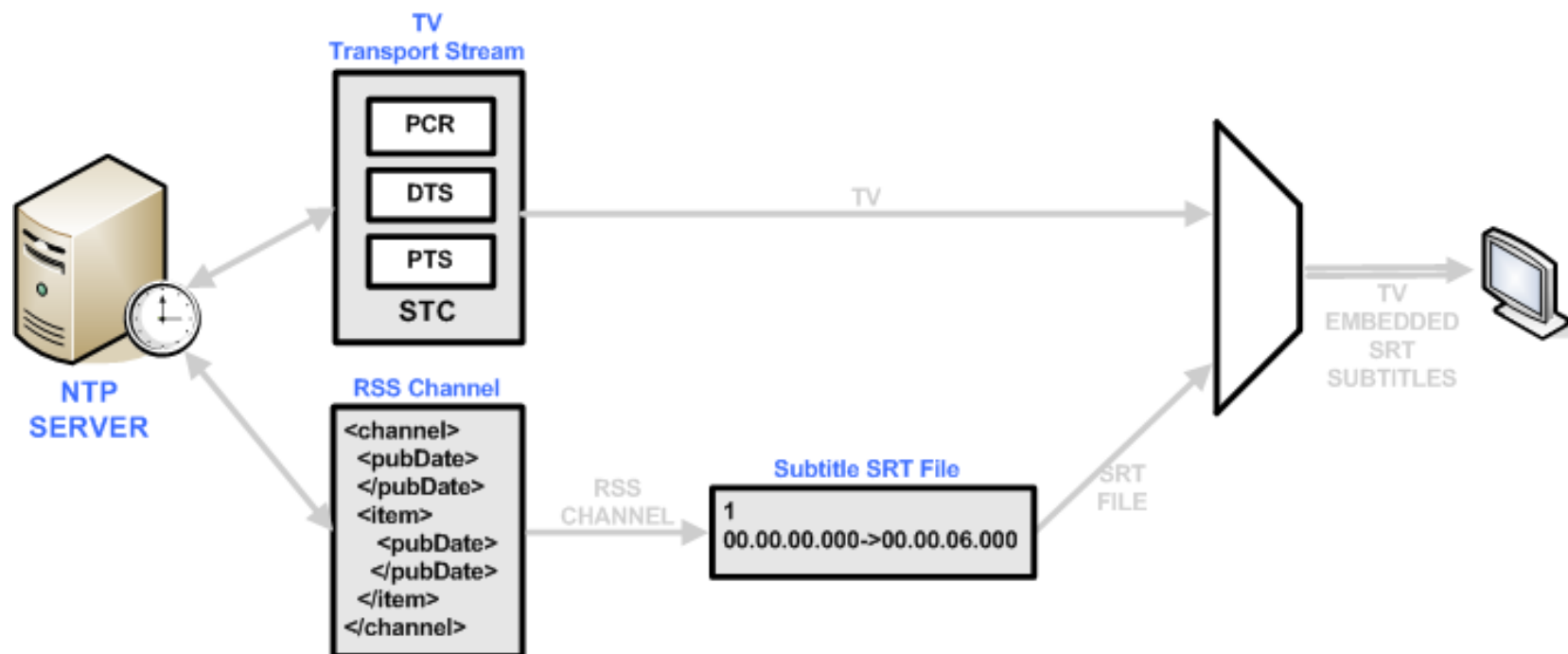
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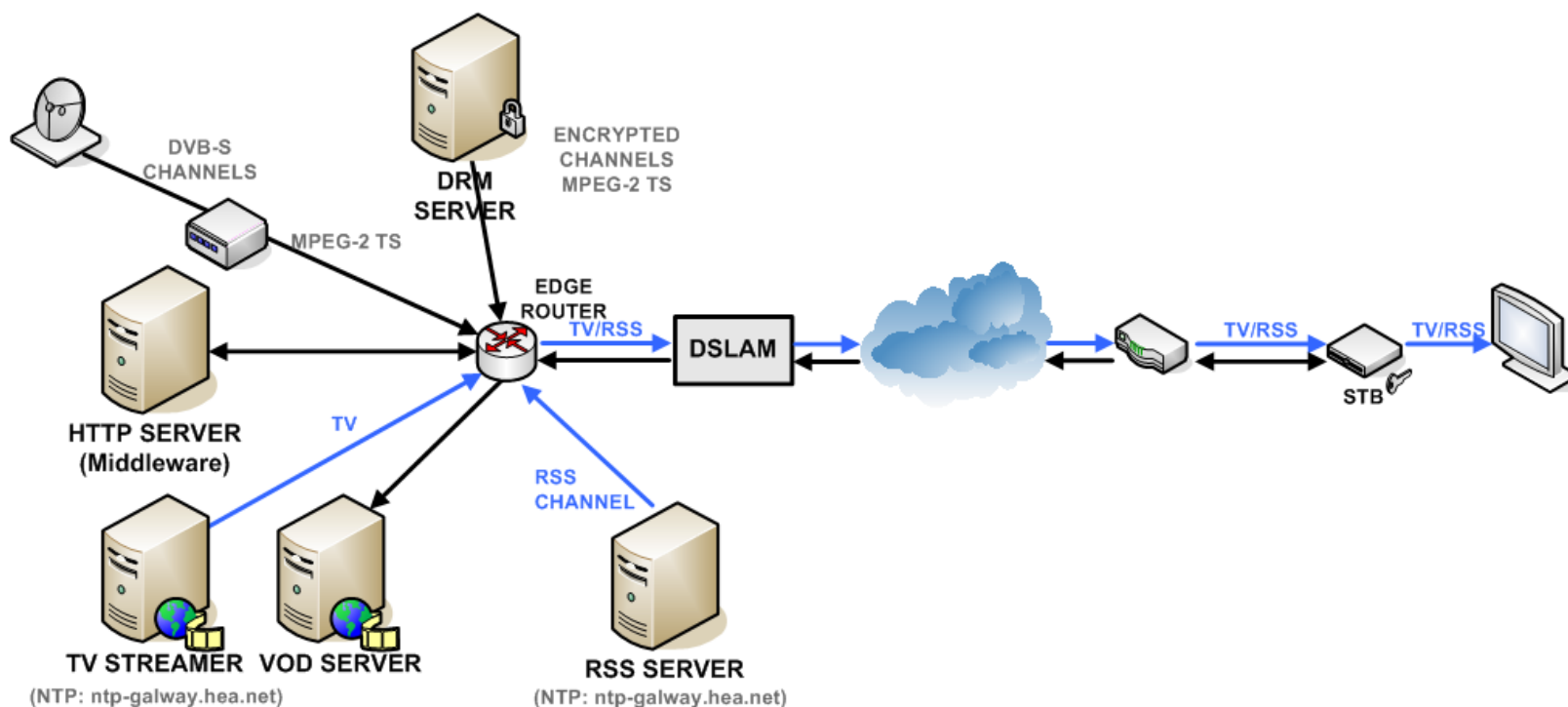
MPEG-2 Transport Stream (ISO/IEC 13818-1)



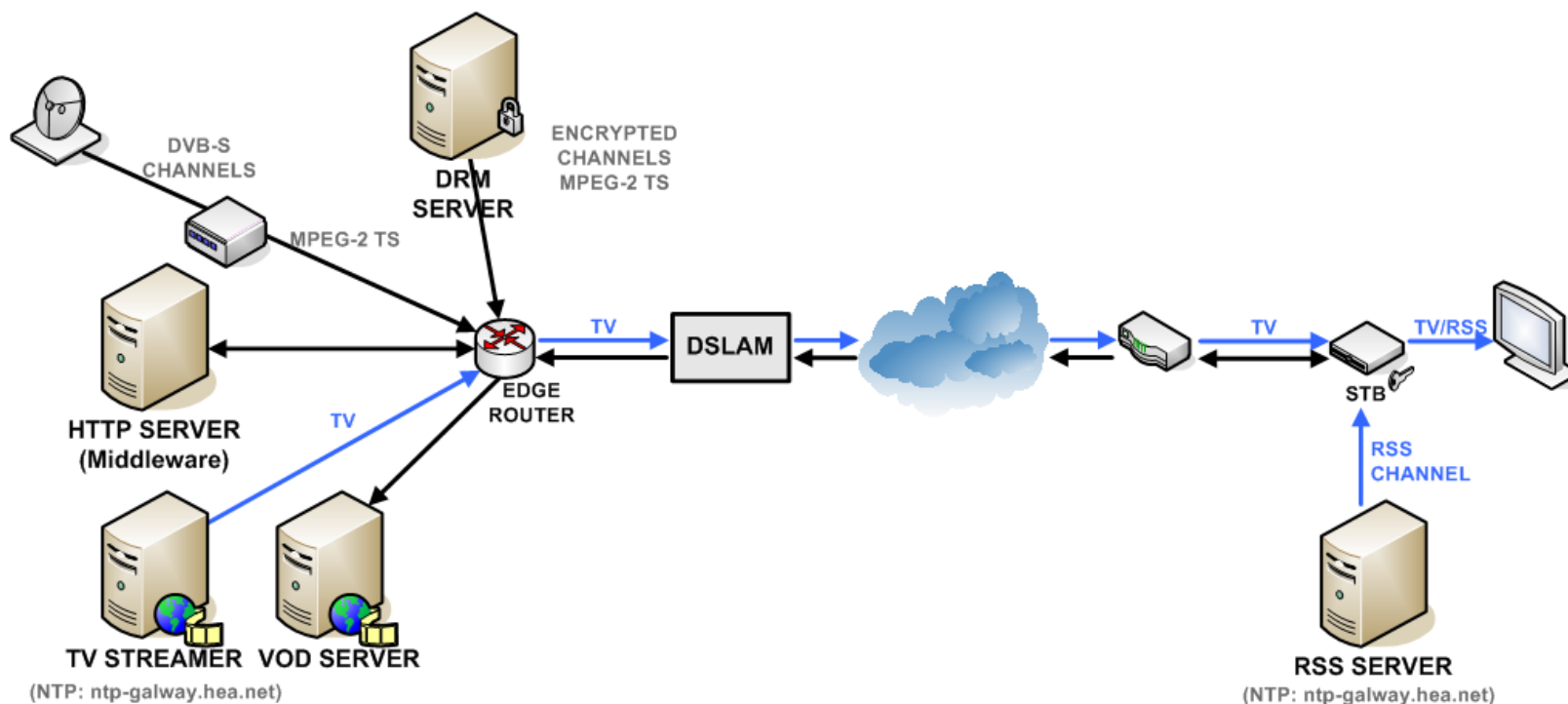
High Level Design Diagram



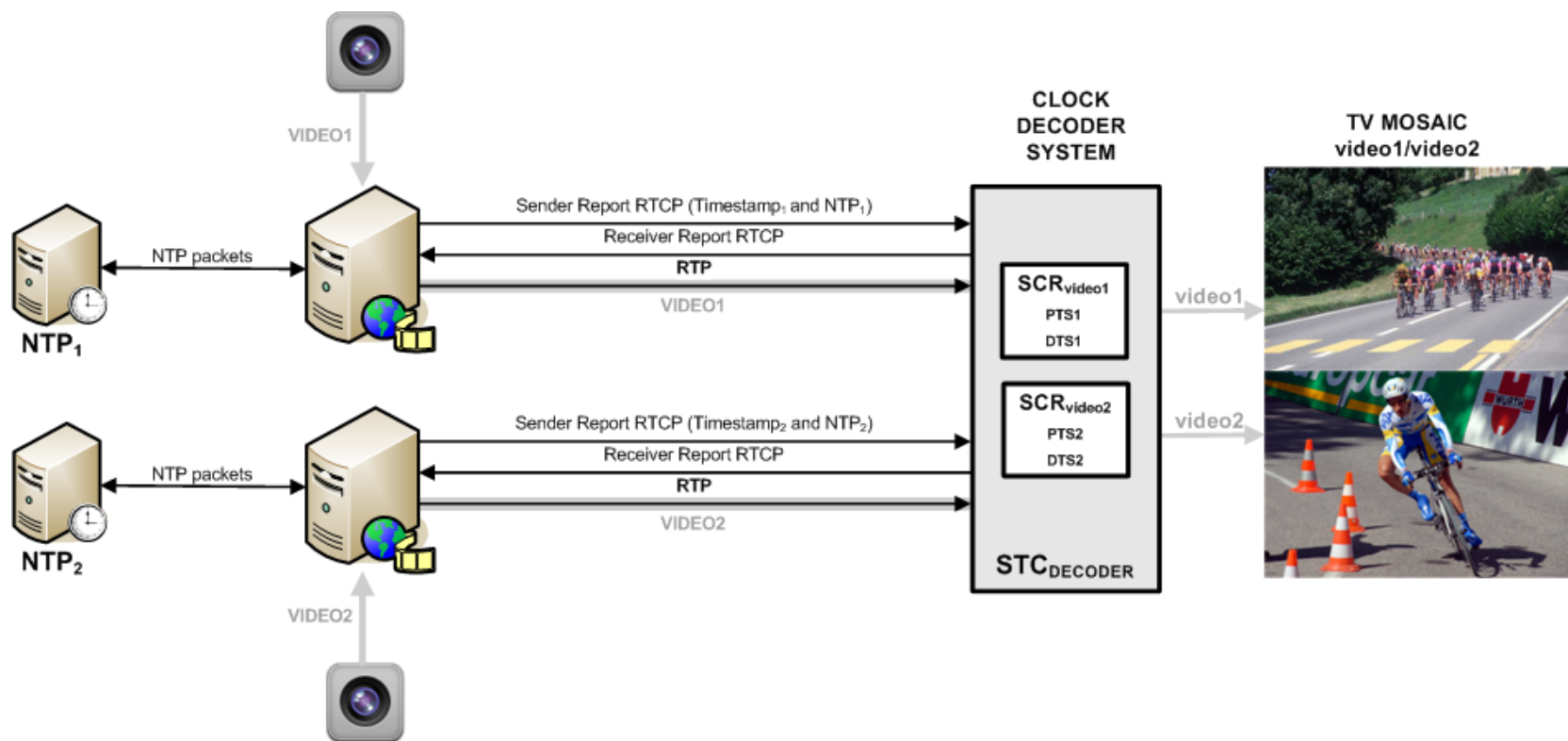
TV/RSS Server-side Synchronisation



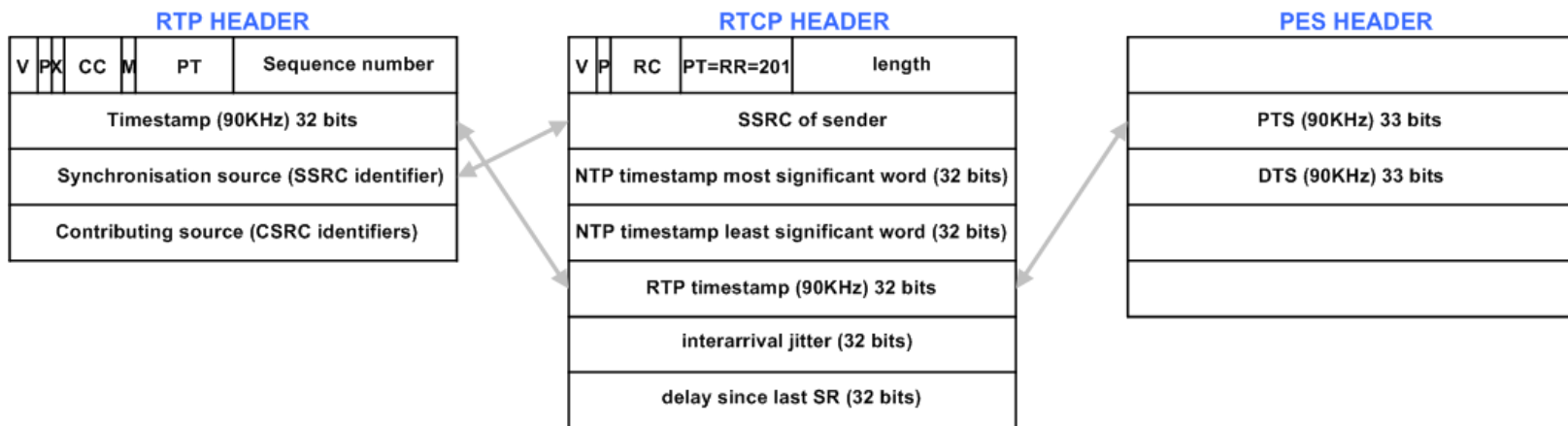
TV/RSS Client-side synchronisation



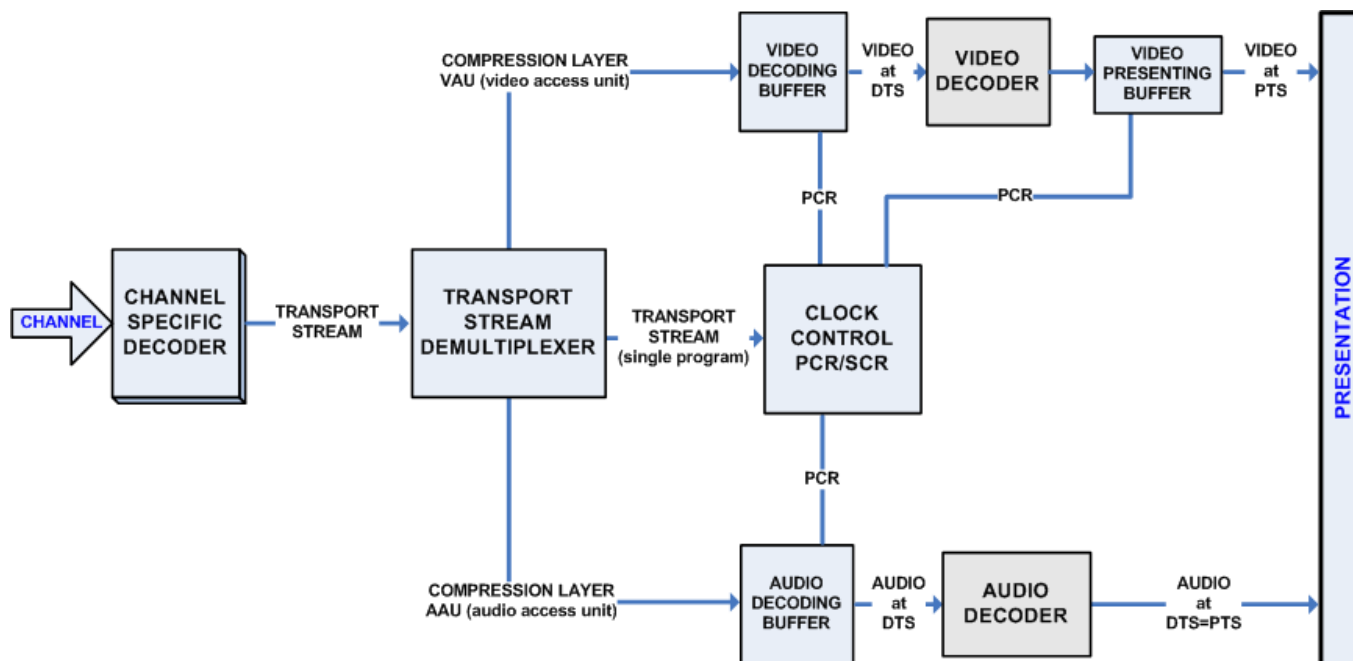
TV/TV Synchronisation



Protocol Support



MPEG-2 General Clock System

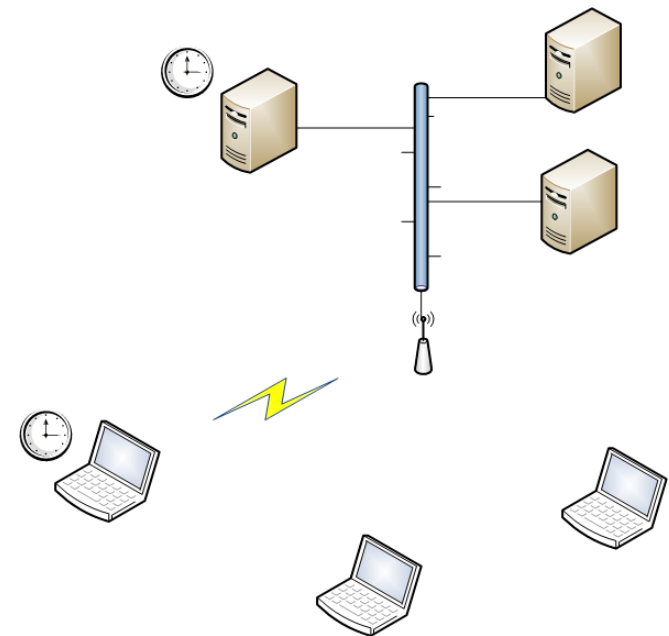


Project 3: Wireless synch challenges & solutions

- PTP/NTP
 - Asymmetric network challenge
- Particular Issue for wireless networks
 - Medium access non-determinism
- Case Studies
 - Wireless 802.11
 - ns2 simulations
 - Sensor Networks 802.15.4

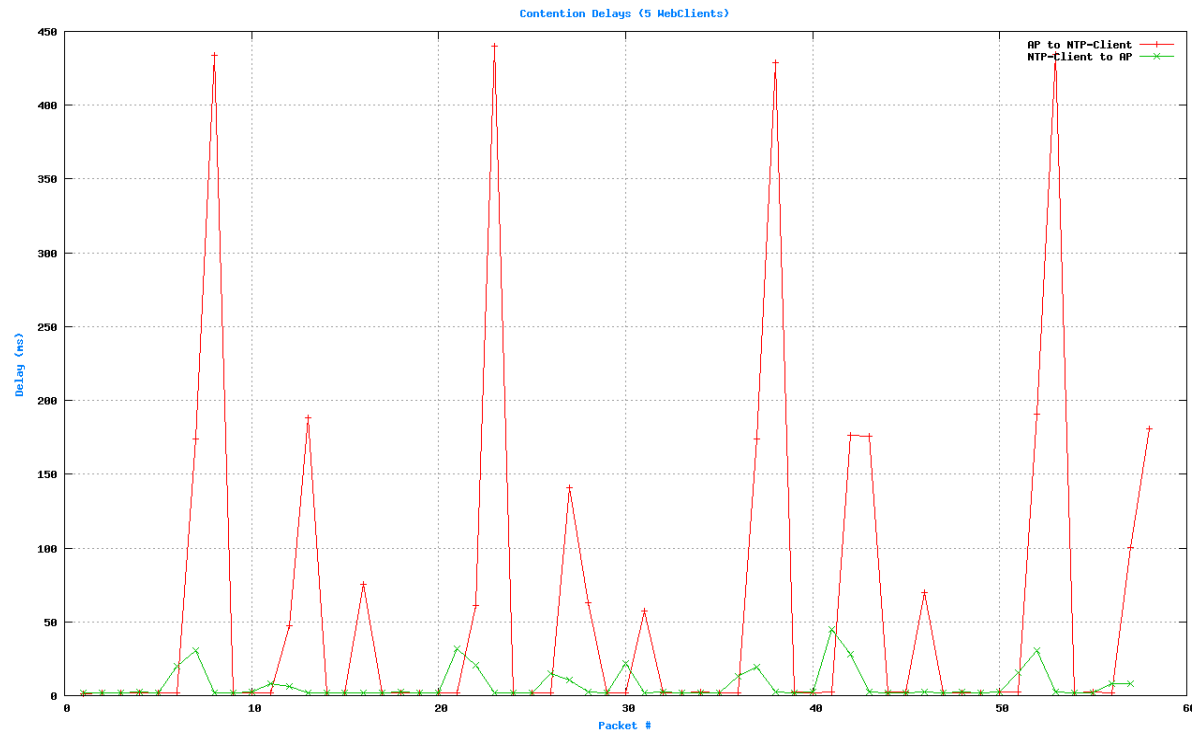
Simulation of 802.11

- Simulated transport of NTP packets over 802.11
 - 60 minute simulations – NTP request every minute
 - Simultaneous web-clients
 - WebPages – 312KB – Average webpage size



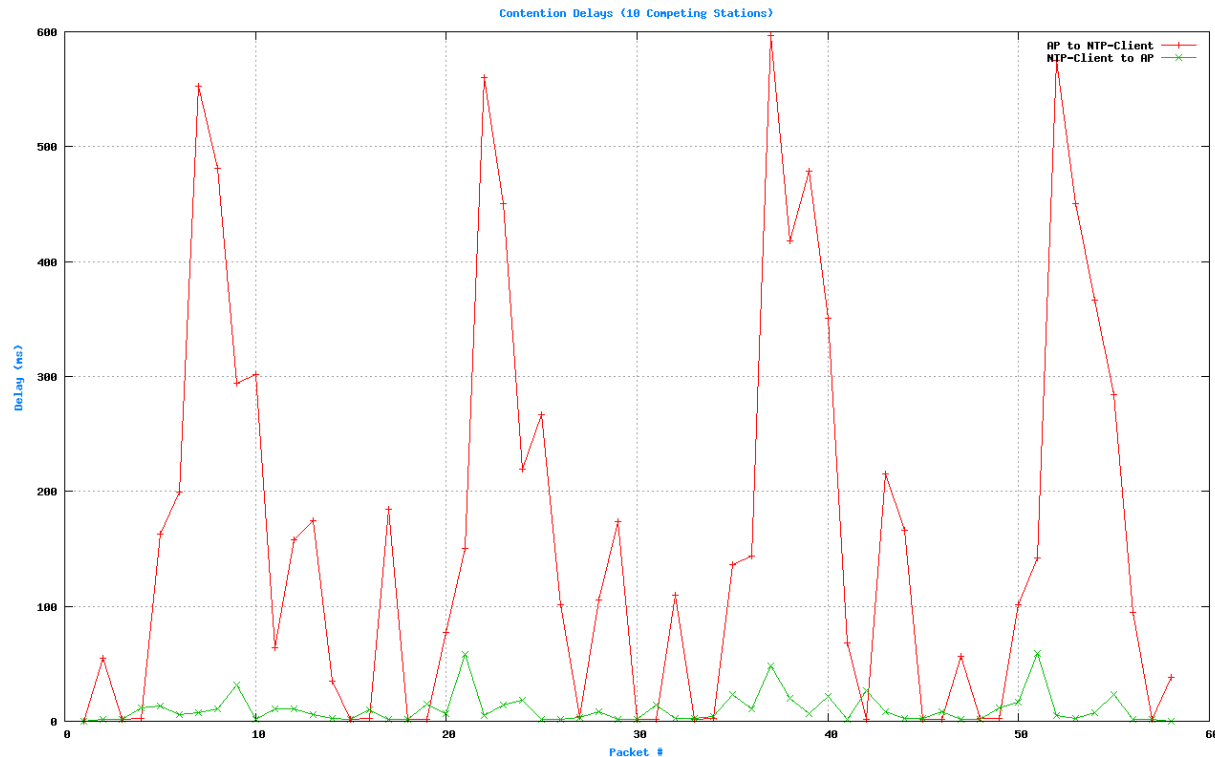
Simulation of 802.11 : 5 web clients

- 5 Competing Web-clients → asymmetrical delay of ~ 400 ms



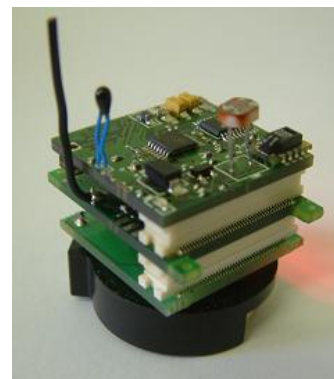
Simulation of 802.11 : 10 web clients

- 10 Competing Web-clients → asymmetrical delay of ~ 500 ms

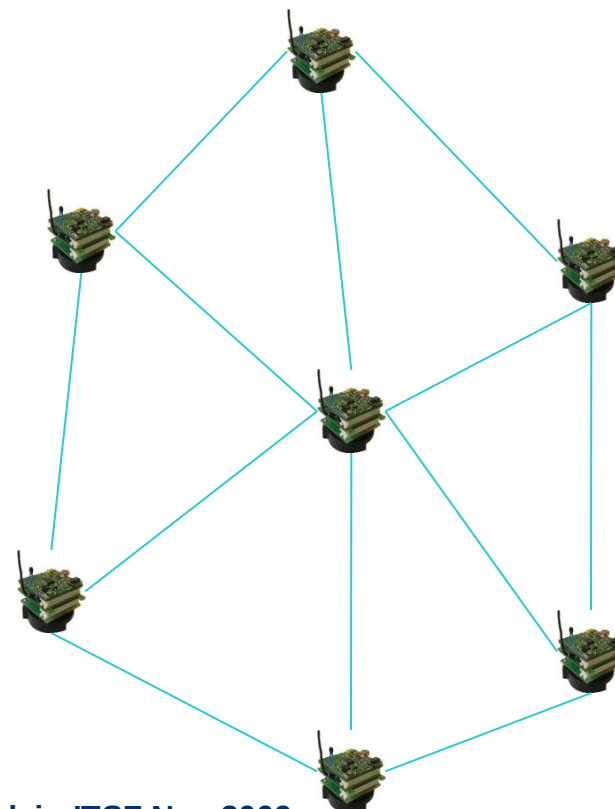
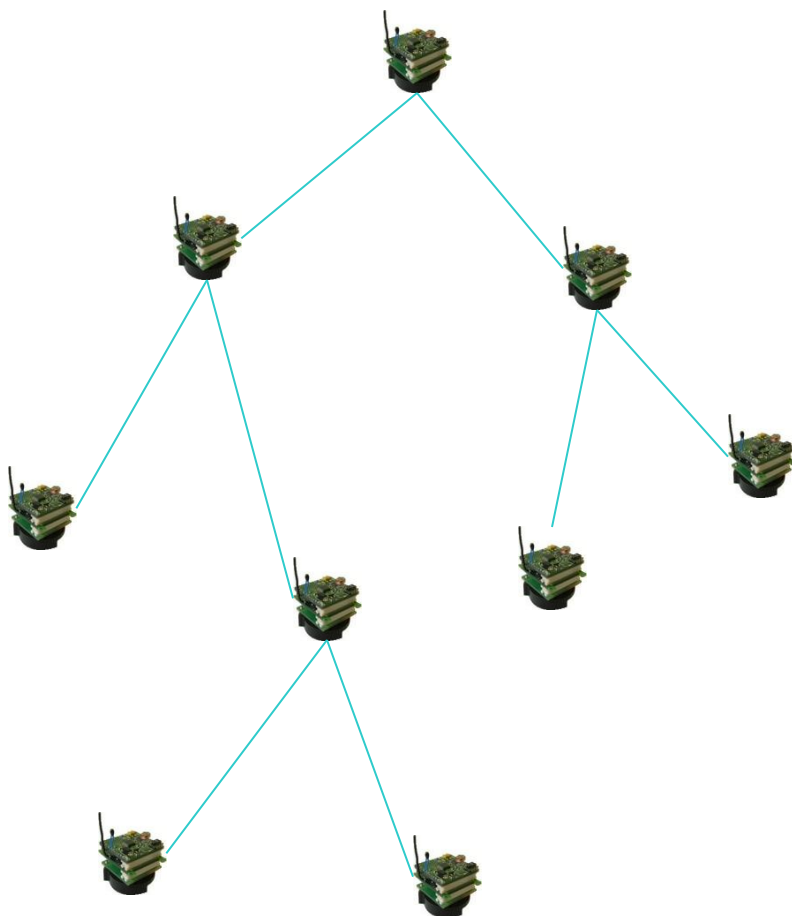


Sensor Networks

- Miniature computing devices –
 - e.g. 2.5 cm cubed, 4GHz, 128kb RAM
 - Low power consumption
- Collect physical data and distribute wirelessly
- Use 802.15.4 (physical & MAC)
- Wide application scope
 - Energy & Environmental Informatics
 - Most applications require global time
 - Time synchronisation important

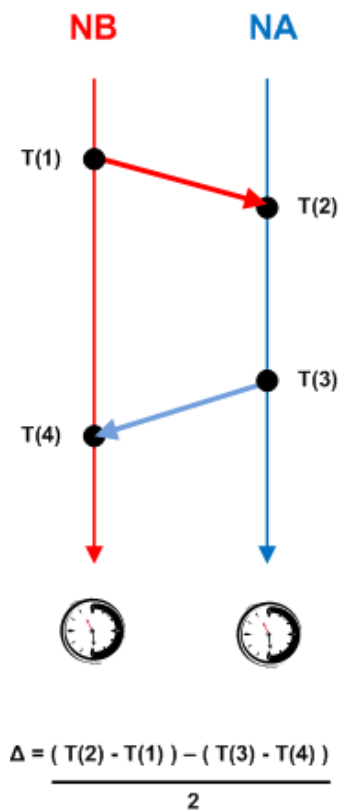
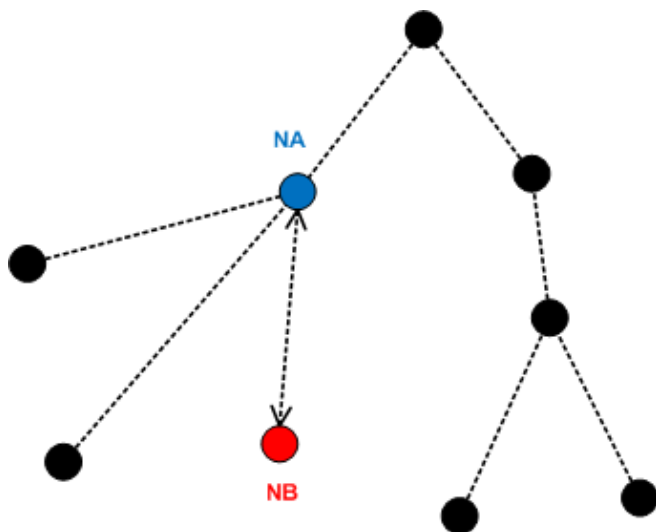


Sensor Networks Architecture



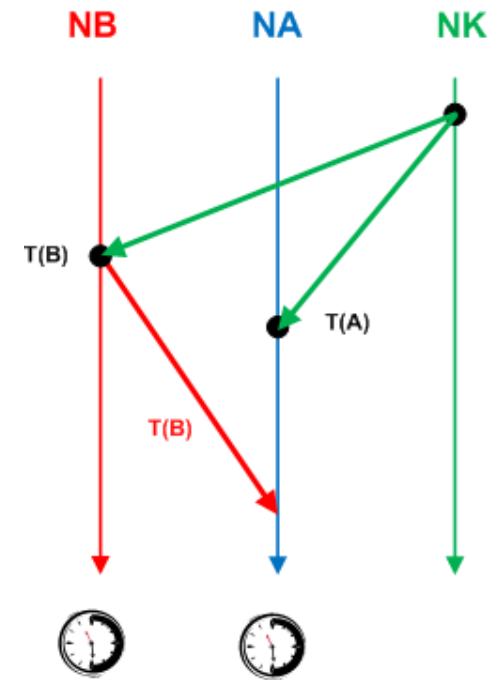
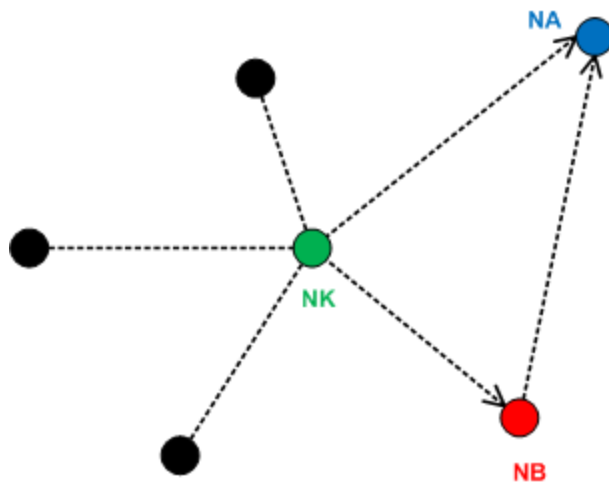
Sensor Synchronisation

- 2 main approaches –
 - **1. Round-Trip Synchronisation –**
 - e.g. TPSN (Timing-sync Protocol for Sensor Networks)



Sensor Synchronisation

– 2. Reference Broadcast Synchronisation



$$\Delta = T(B) - T(A)$$

Contact Details

- EDCA Parameter Optimisation for VoIP

- p.oflaithearta1@nuigalway.ie

*Údarás na Gaeltachta*

- IPTV Synchronisation

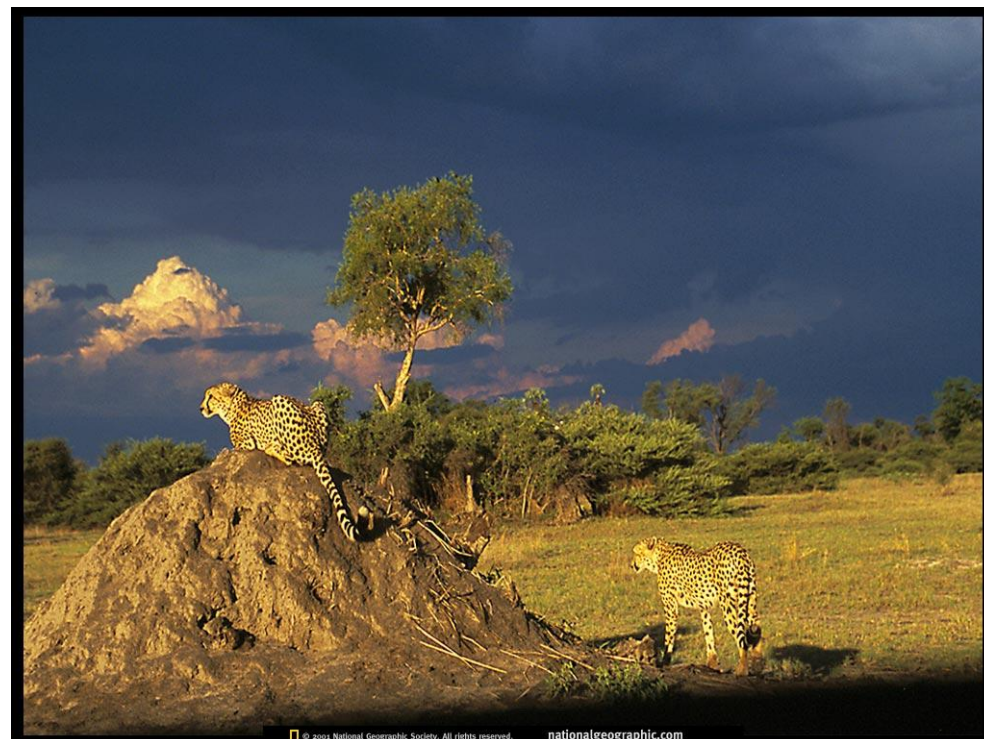
- l.beloquiuste@nuigalway.ie

- Wireless Synchronisation

- shannon.jonathan@gmail.com



- See <http://pel.it.nuigalway.ie>





Jonathan Shannon
j.shannon1@nuiigalway.ie

NTP Server

Discipline of Information Technology

NUI Galway

Dr. Hugh Melvin
hugh.melvin@nuiigalway.ie



NUI Galway
OÉ Gaillimh

This map of the world presents a visualisation of the client base of the Network Time Protocol (NTP) server (ntp-galway.heanet.net) located in the Discipline of Information Technology NUI Galway.

The Network Time Protocol is a protocol designed to synchronise the clocks of computer systems connected via variable latency, dynamic networks.

As of 2009 the number of individual clients requesting time from the NTP server stands at just under 25,000 while the number of requests handled by the server per hour is roughly 62,000.

