Benefits and Challenges of Delivering Synchronisation across Wireless Networks

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Outline

- Background Research
  - Benefits of Synch Time for IP Multimedia / MMOG apps
- Research Plan 2007-2011
  - Wireless challenges for IP MM
  - Time Synch for Cross Layer Optimisation
  - Delivering Time Synch across wireless networks
- Conclusions

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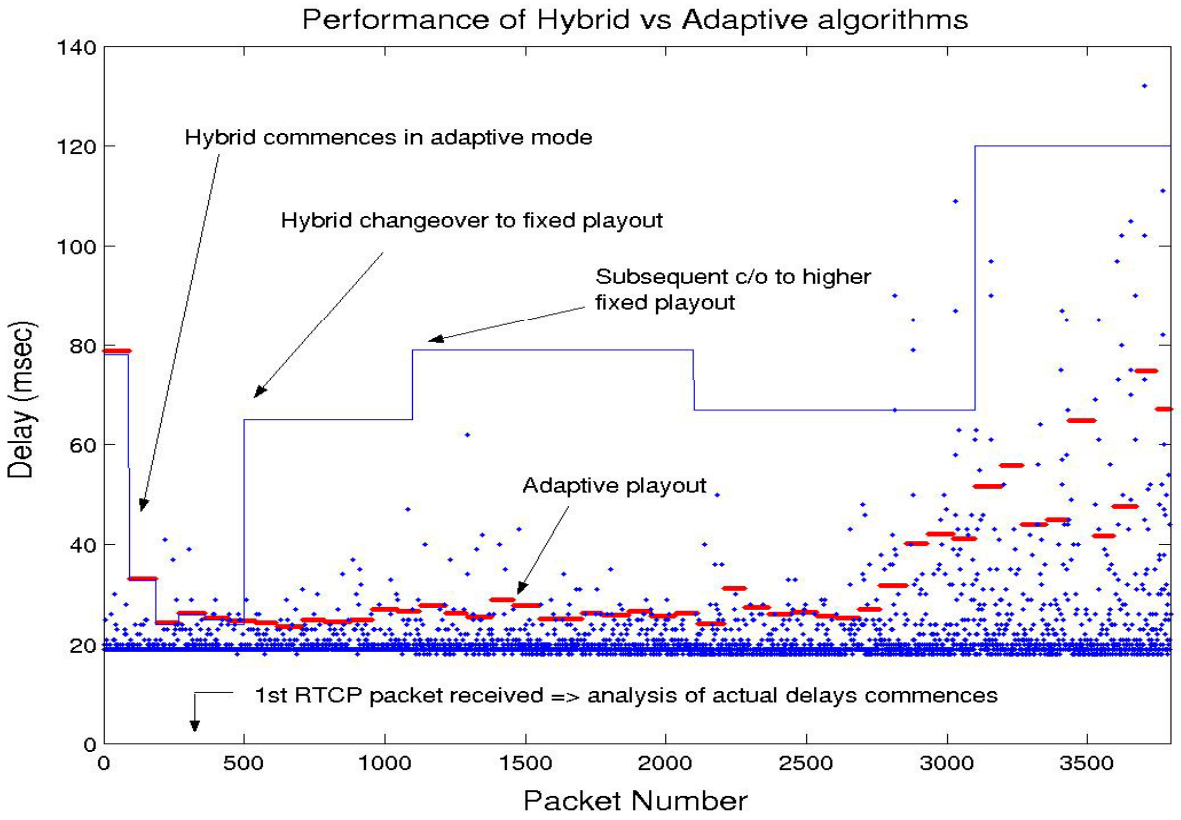
Time Synch for VoIP



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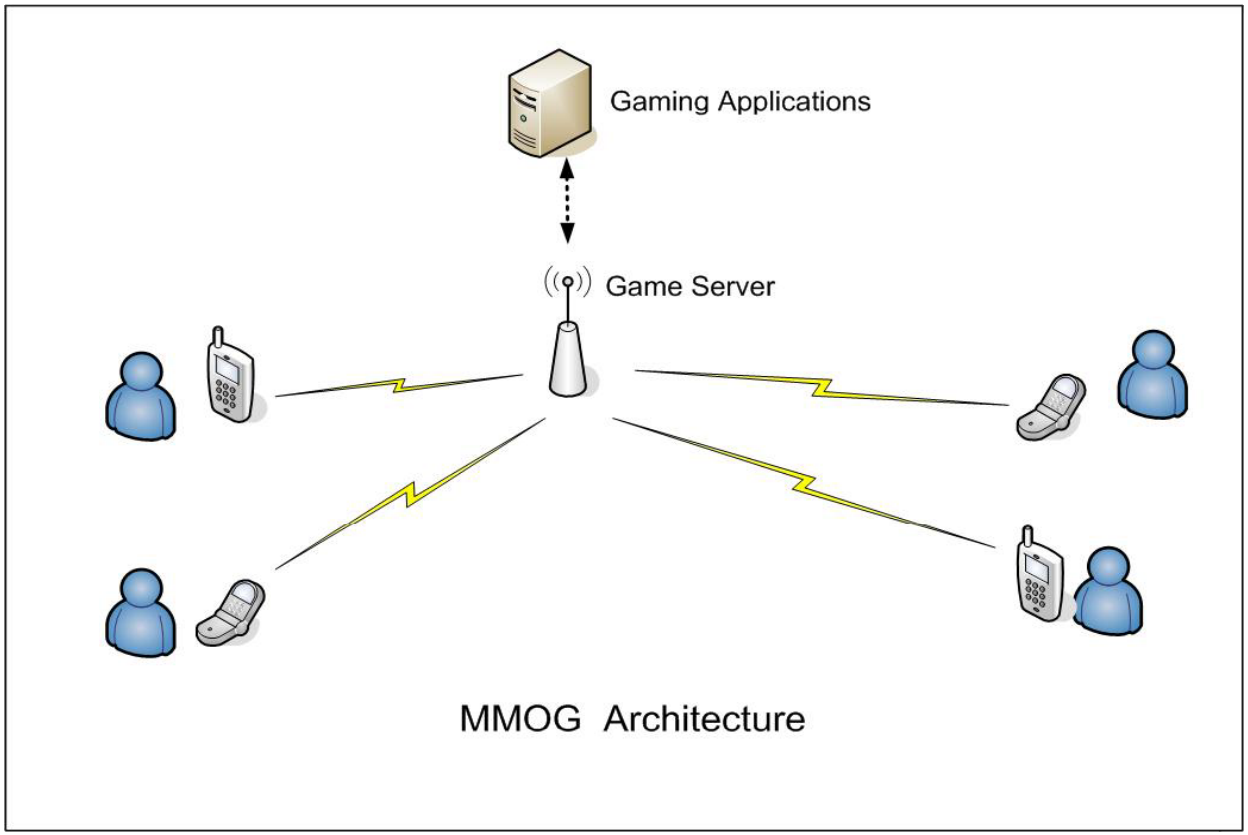
Time Synch for MMOG



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Benefits of Time Synch

- Delay sensitive IP Multimedia
  - Precise delay Information
  - Improved QoS (ITU-T E-Model analysis)
- MMOG
  - Levels the playing pitch for all participants
- Synch Time **determined and used** at OSI Application Layer

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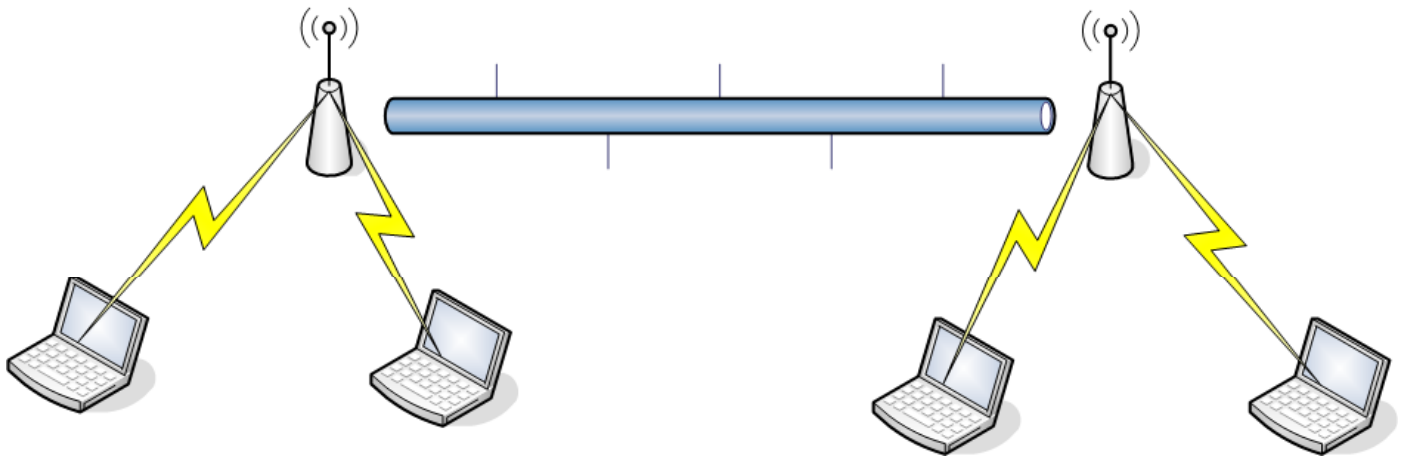
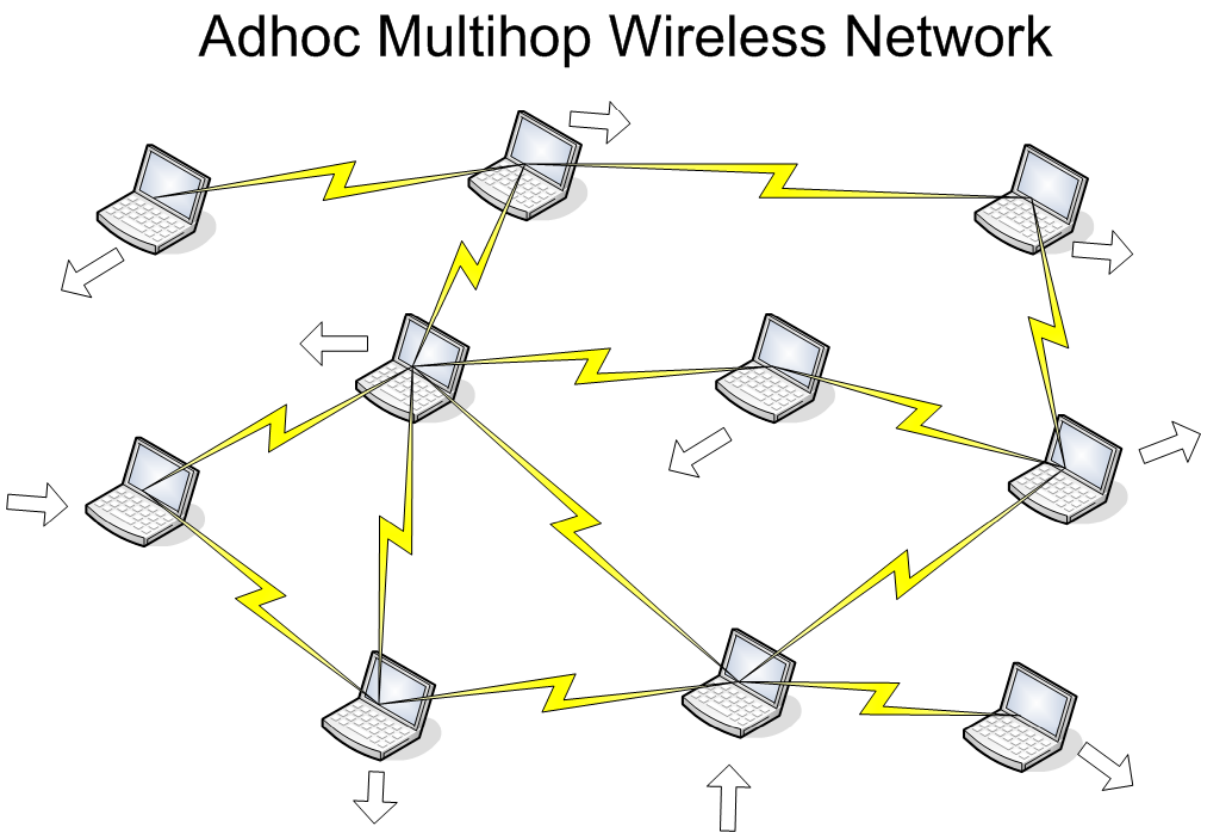
Wireless challenges

- Huge growth in wireless networks
  - 802.11 a➔z
  - Sensor networks…802.15 .. Zigbee
  - Bluetooth
- Ad-hoc multihop networks
  - Dynamic, infrastructureless
- Mesh multihop networks
  - Mesh of routers and clients
- Challenges of delivering QoS for IP MM
  - Contention at MAC layer

Wireless challenges



Greater Wireless challenges !



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Cross Layer Design/Optimisation

- OSI 5/7 layer model for Communication
  - Each layer performs specific function(s) independently
  - Well defined interface between layers
  - Works (reasonably) well in wired world
- Wireless world ➔Emerging cross layer paradigm
  - Based on understanding of interactions among layers
  - Greater exchange of information to improve overall network performance
  - Particular relevance for ad-hoc/mesh networks

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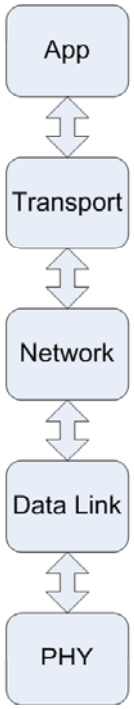
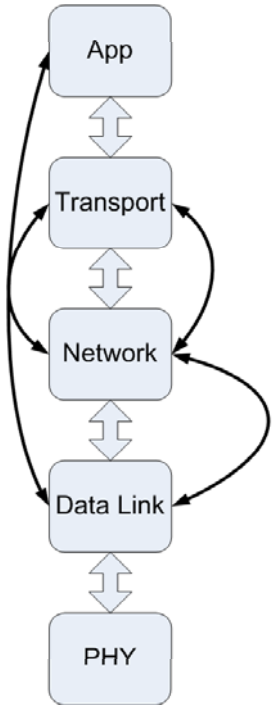
Cross Layer Design/Optimisation

OSI 5 Layer Model



Cross Layer Design



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Cross Layer Design/Optimisation

- Examples for adhoc/mesh networks
  - SNR at PHY layer will influence topology and thus route selection at NL
  - Channel management at DL will affect interference levels which influences topology/routing at NL
  - Power levels at PHY will influence topology and MAC scheduling at DL
  - Window management/congestion control at TL will impact on contention levels at MAC, and influenced by SNR rates at PHY layer.

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802.11e

- Initial focus on infrastructure mode
- Classify traffic by Access Category (AC)
  - Voice, Video, Best Effort, Background
- AC QoS impl via parameters at MAC layer
  - AIFSN
    - Arbitrary interframe space number
  - CW_{min} and CW_{max}
    - Contention window
  - TXOP
    - Transmission opportunity
- Cross layer potential

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Enhanced 802.11 e QoS via Synch Time

- NTP/RTCP SR provides precise incoming delays
- RTCP RR provide periodic RTD
  - Can determine outgoing delay
- Differing **baseline** delays across sessions within AC?
  - Precise 2 way M2E delay info
    - ➔Tune MAC parameters dynamically in realtime
  - Can differentiate between similar AC sessions
  - ***Using applic layer info at MAC layer (cross layer)***
- Ad-hoc/mesh network scenario more complicated

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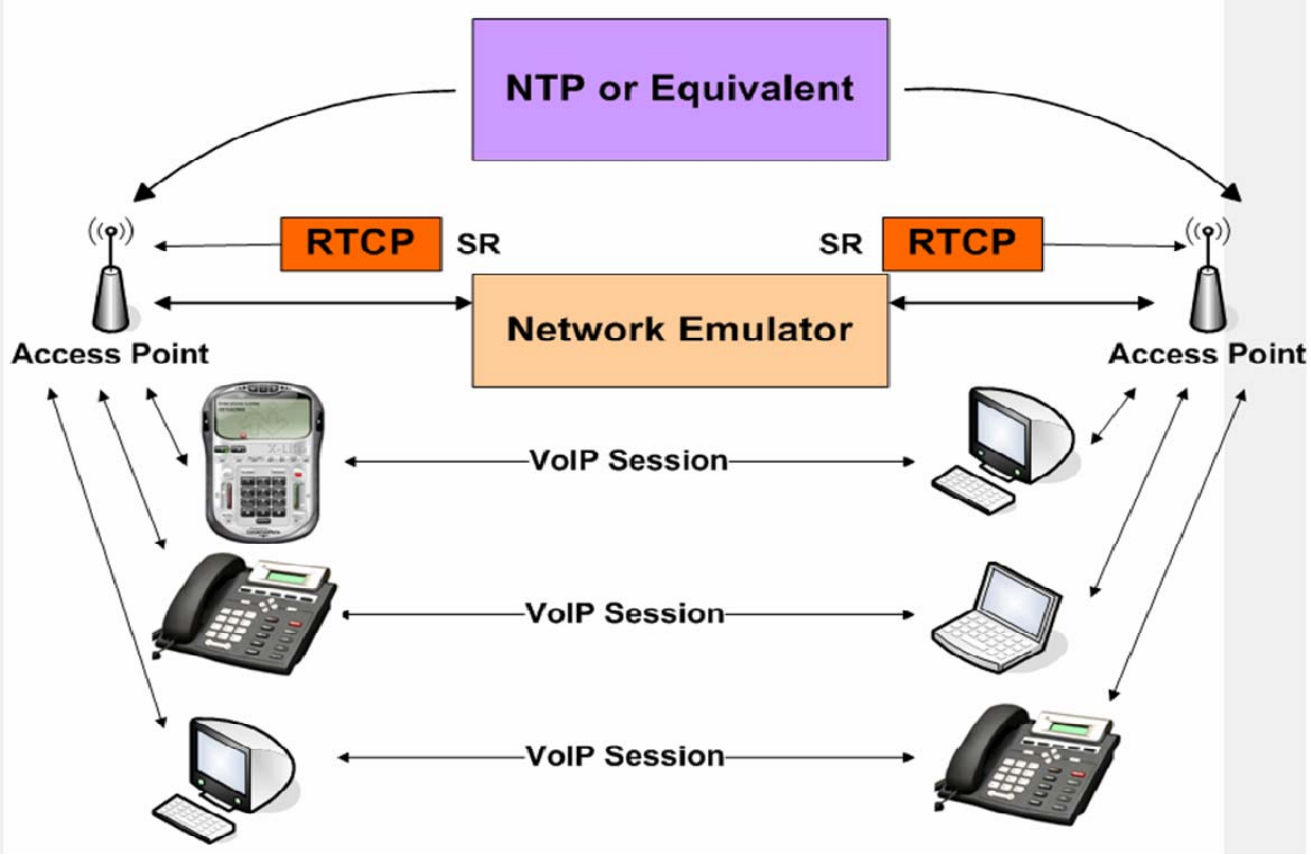
Cross Layer Testbed



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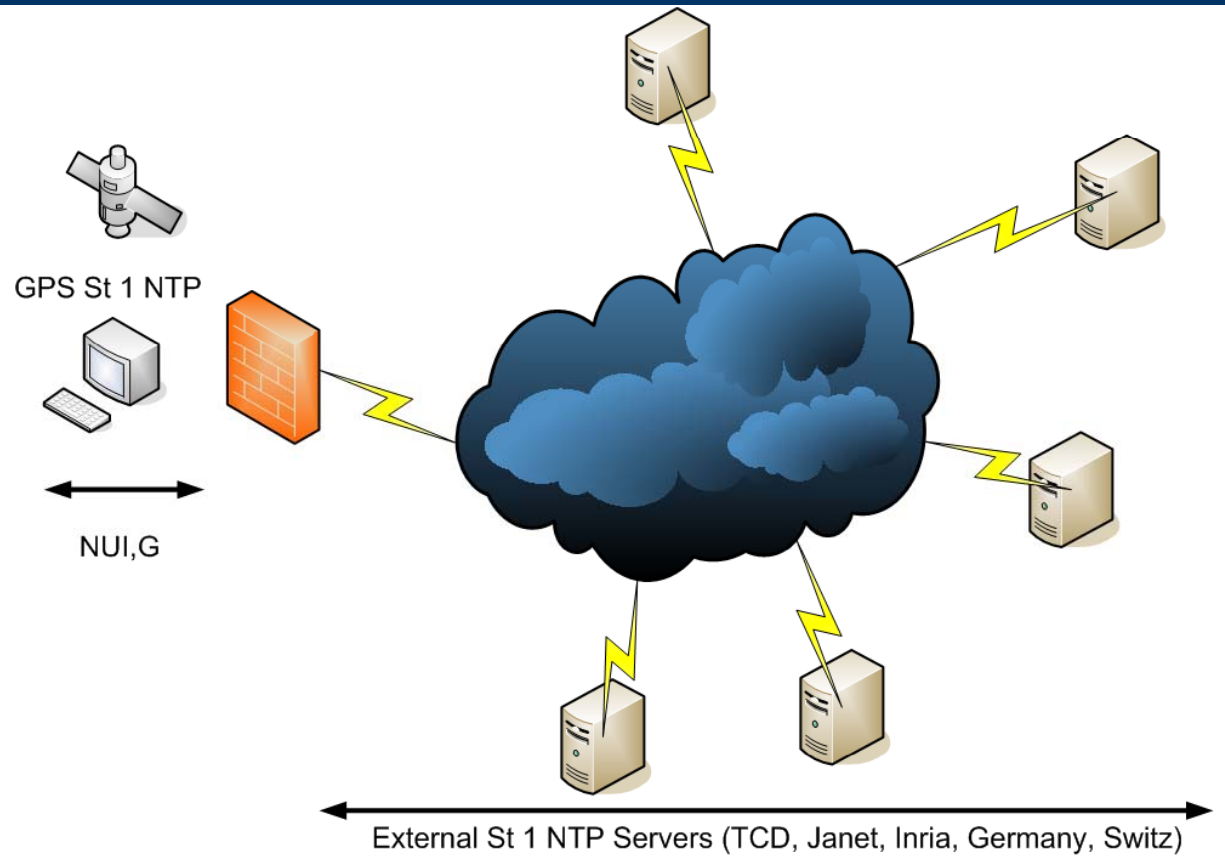
Time Synch in Wireless Environment

- Presents significant challenges for synch protocols
  - Both infrastructure and ad-hoc/mesh
- Wireless networks can be very asymmetric
- Server & Path diversity in NTP design
  - Helps identify/eliminate servers on asymm links
  - Wireless hop may provide common weak link
  - QoS features of 802.11e will assist to some extent

NUI,G NTP Configuration



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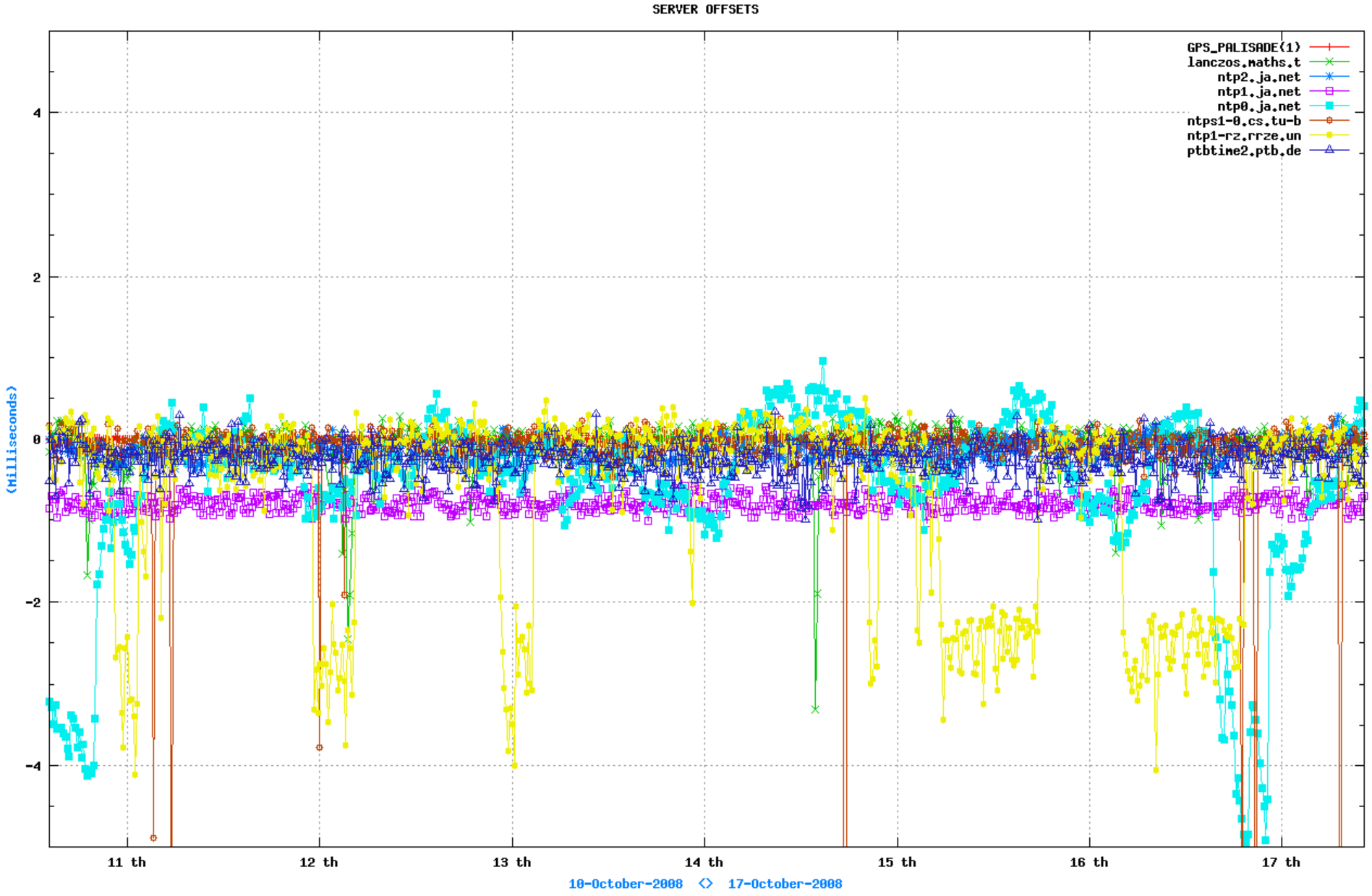

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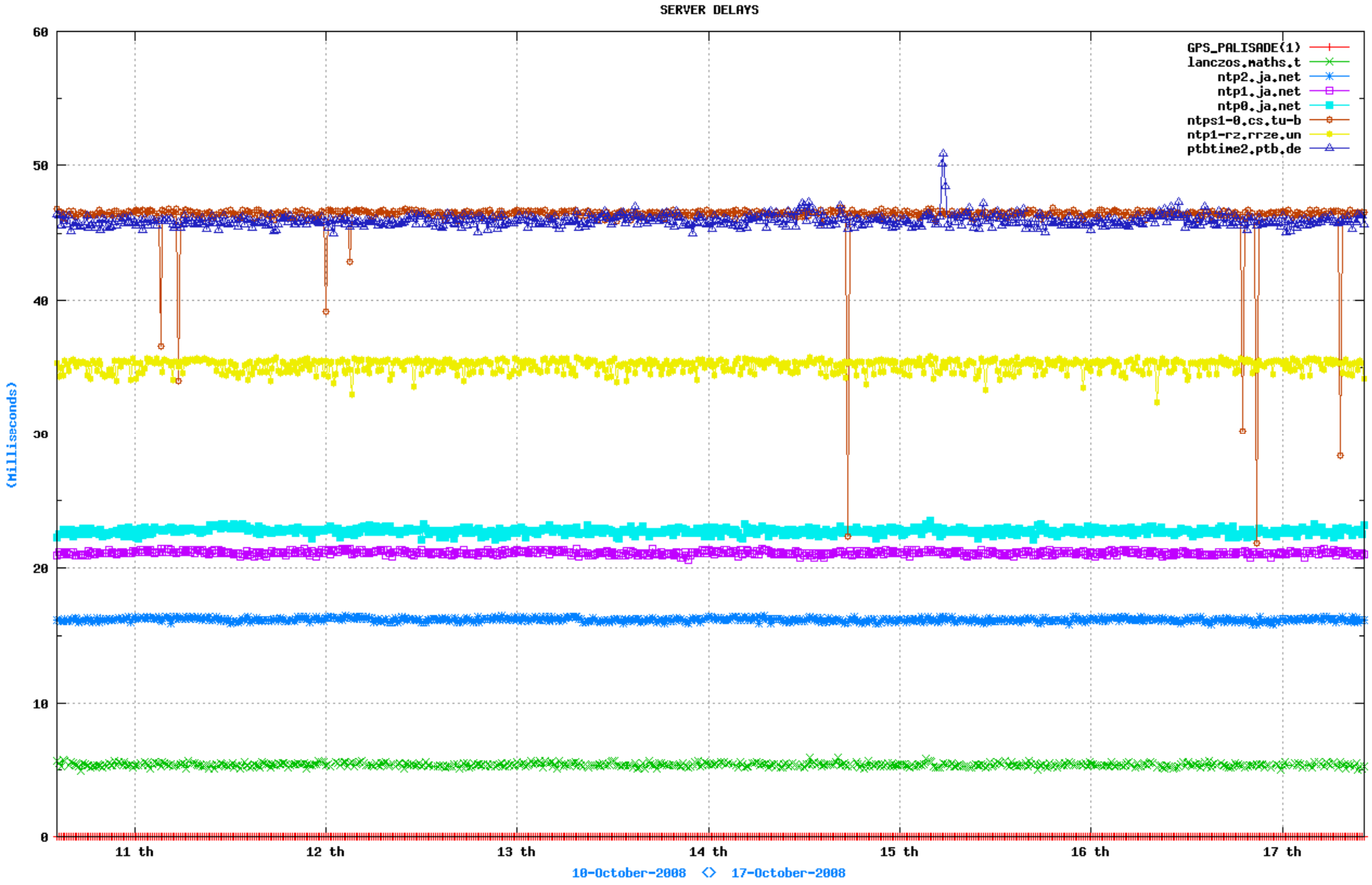
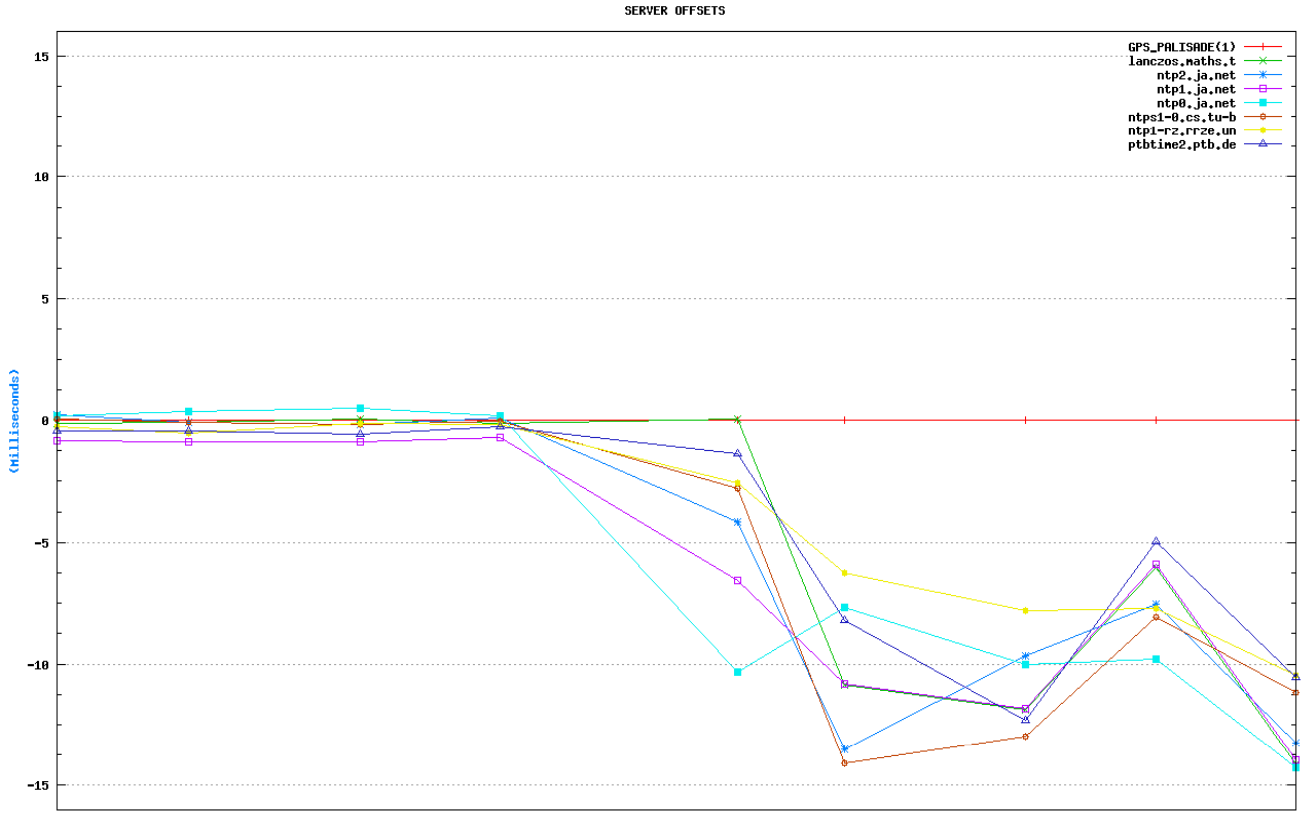
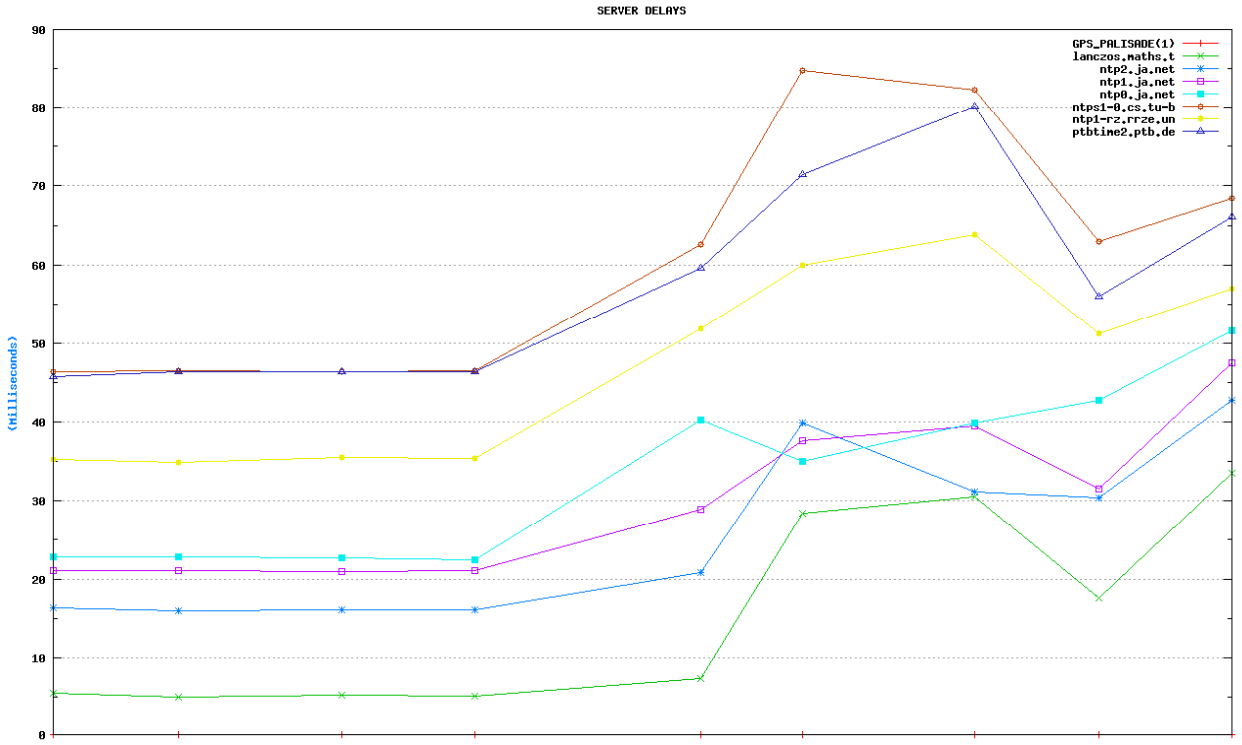


ntp-galway.hea.net disturbance



ntp-galway.hea.net disturbance



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NTP Performance Issues

- Common link asymmetry == SPOF
- Relatively easy to detect in this case
  - Offset change ~ 0.5 x (Delay increase)
  - Offset negative ➔ incoming delay asymm
    - Firewall issue
- Develop NTP robustness rules to detect/correct such disturbances
- What about wireless networks?

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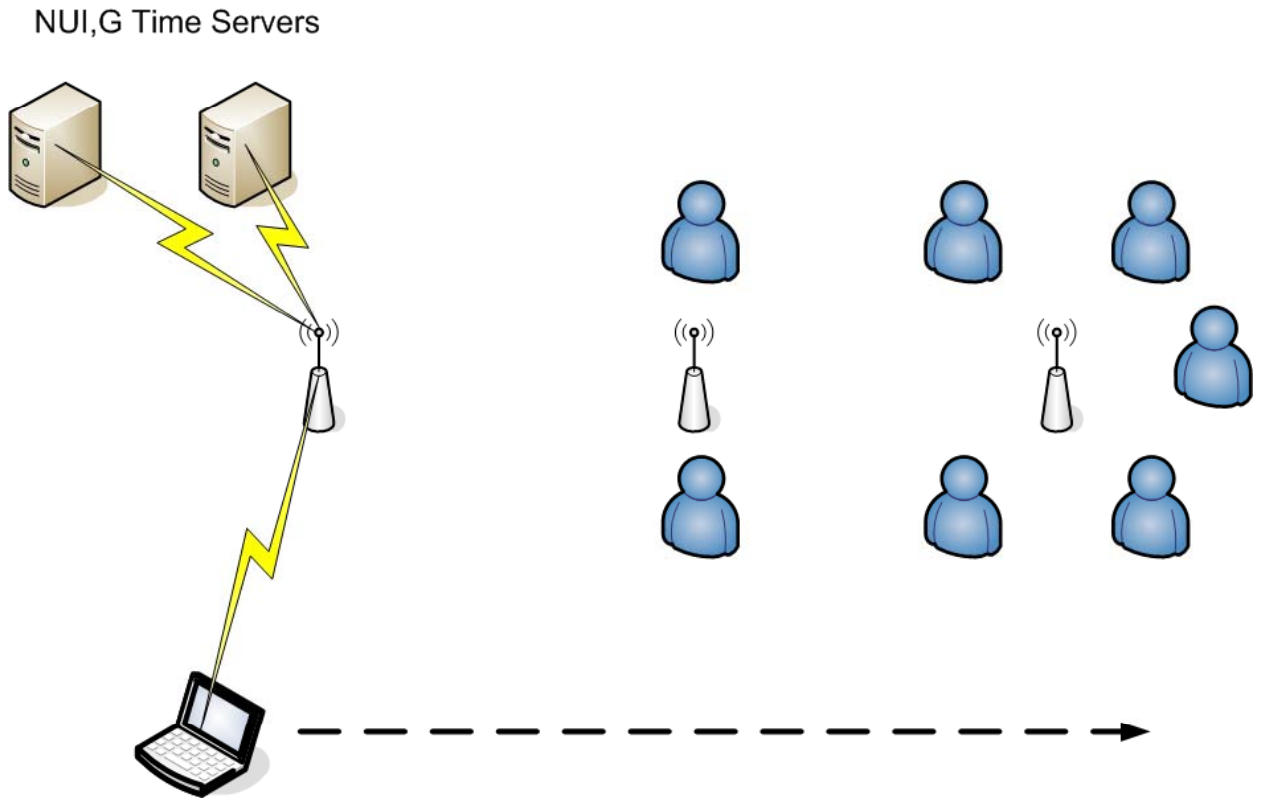
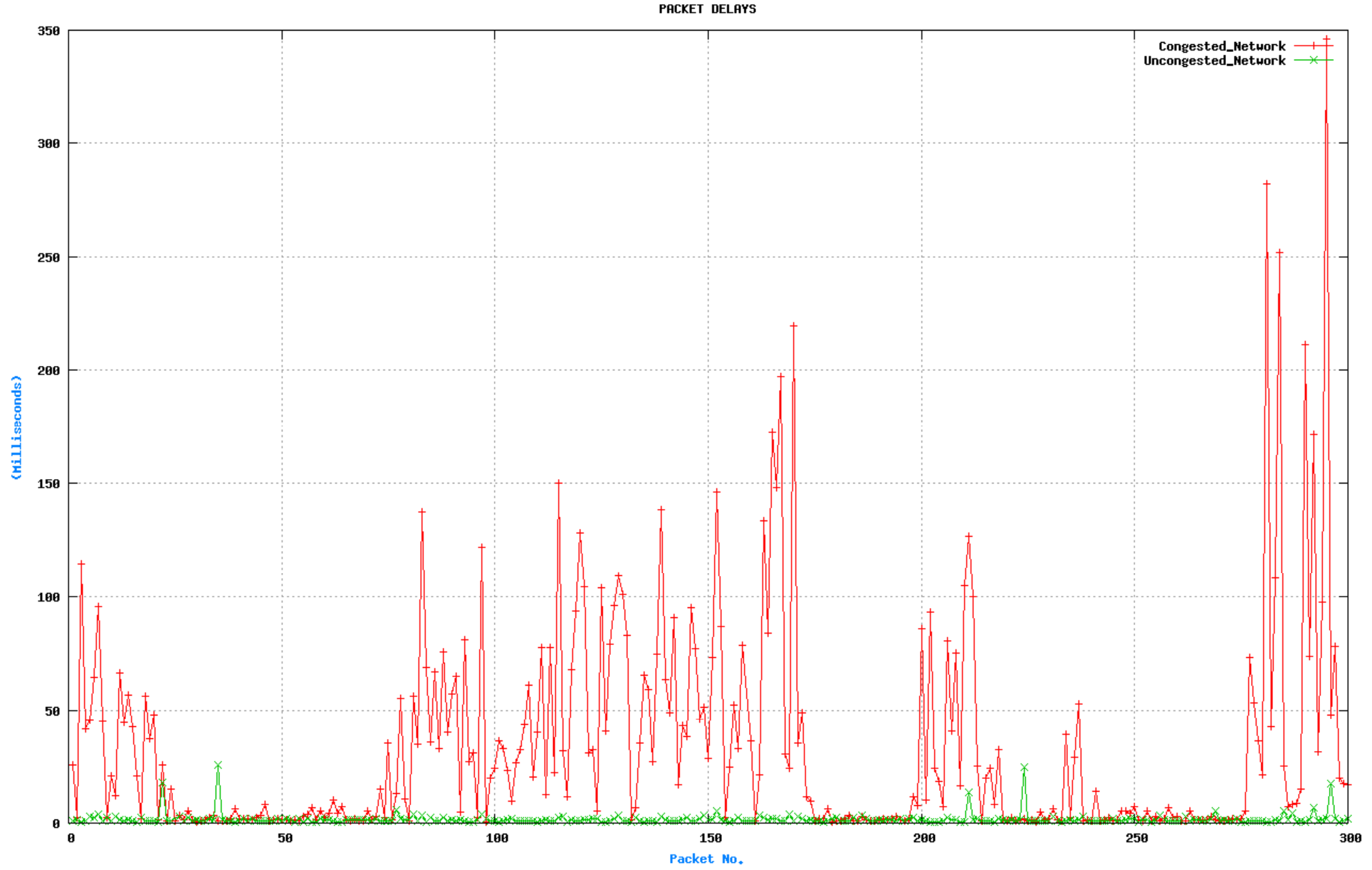
Wireless NTP Test Configuration




PACKET DELAYS
Congested_Network
Uncongested_Network
(milliseconds)
Packet No.
0
50
100
150
200
250
300
350

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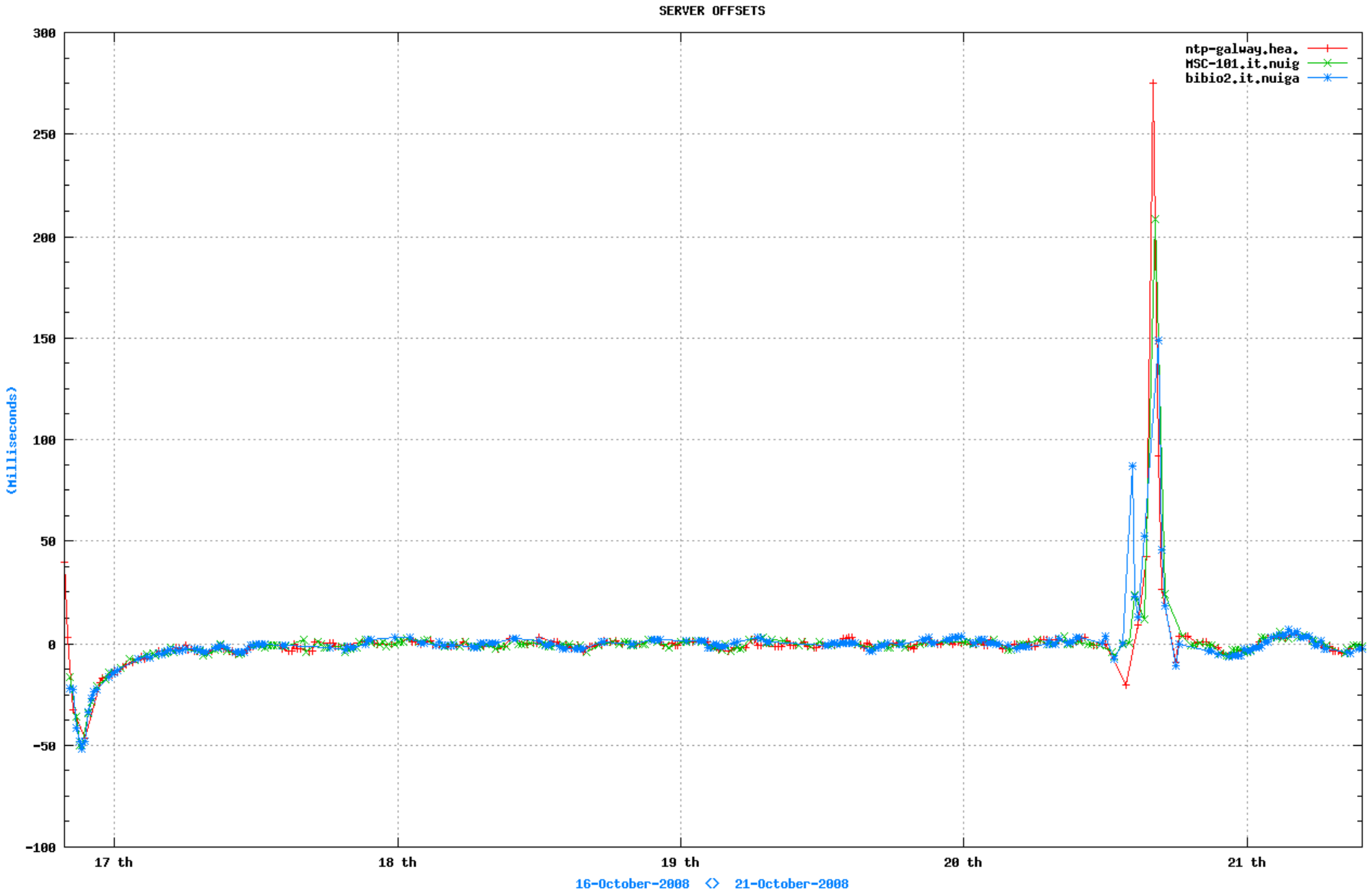

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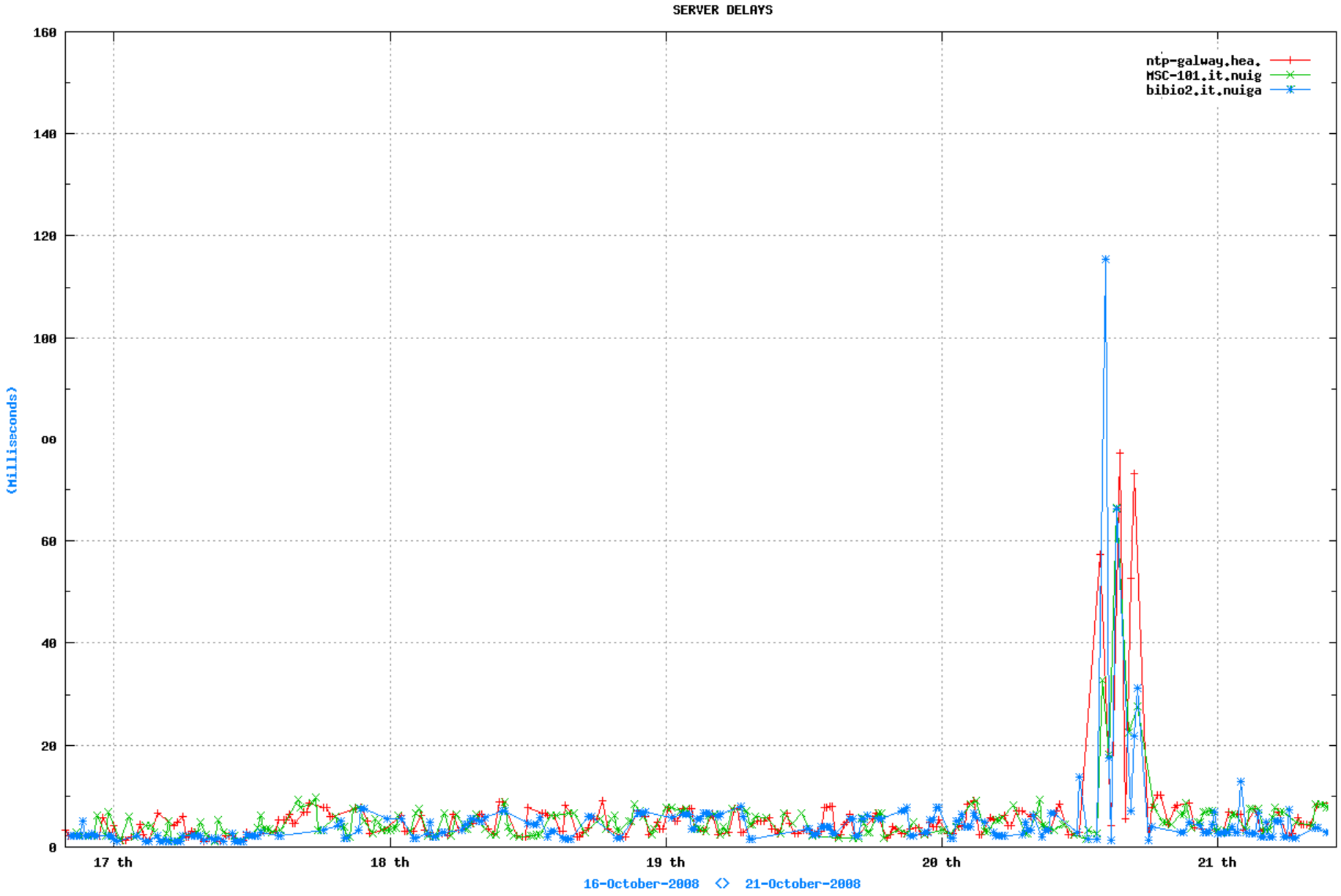
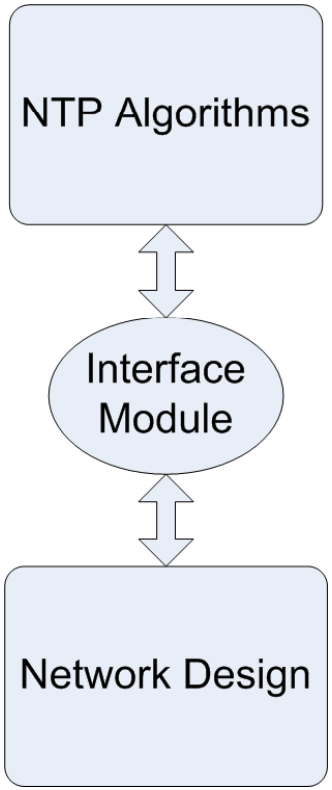


Research Objective

- Determine extent of NTP (and IEEE 1588) performance issues across a range of wireless networks
  - Infrastructure & ad-hoc
- Develop where possible a generalised approach to improve performance



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Conclusion

- Significant QoS challenges over wireless networks
- Synch time can assist
- Cross layer optimisation is key factor
- Delivering synch time over wireless networks is further challenge

Paddy Kavanagh (1904-1967)

- *The Green Fool*

"Its not six till the sun shines
on the second of them
blue plates "