Information and Communications University

Timestamp jitter consideration for 802.11n

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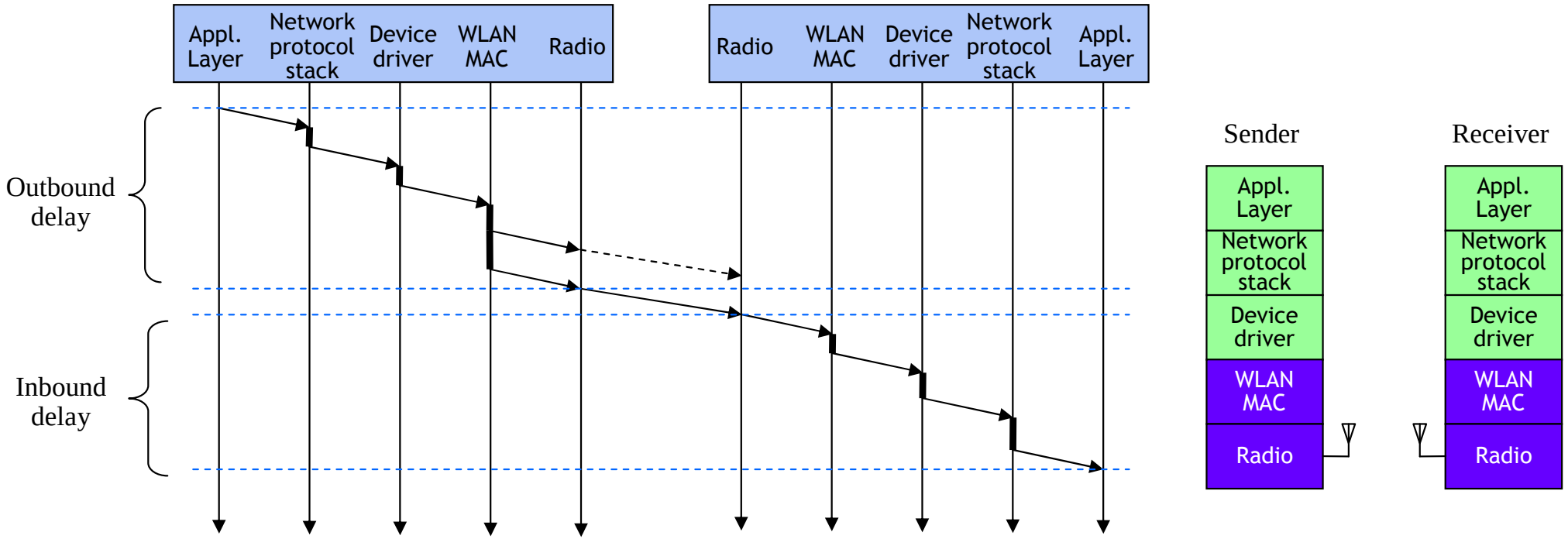
Introduction

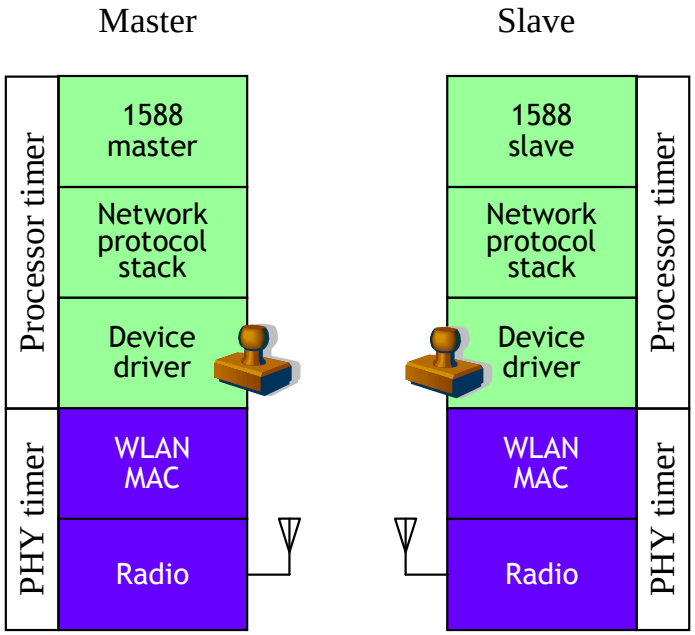
- Packet time synchronization on 802.11
  - IEEE 1588 message – Typically implemented as an application.
  - Time stamp is not generally available from 802.11



IEEE802.11 communication delay and system architecture

Typical timing performance of 802.11n APs

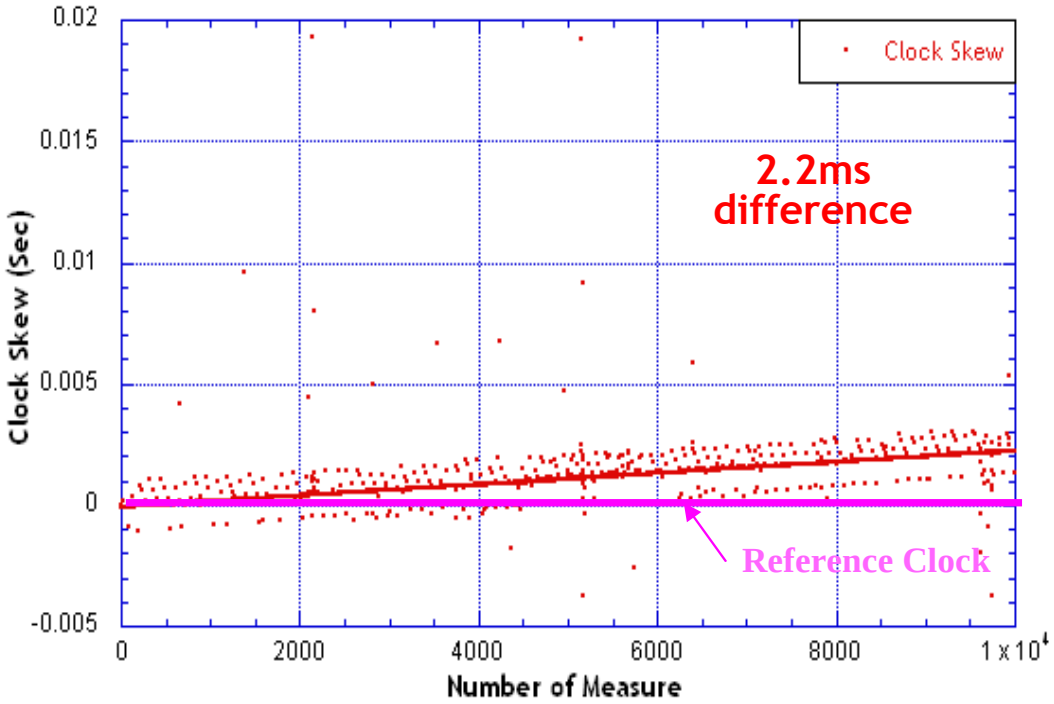
- 802.11 specification
  - PHY clock accuracy : 0.01% (100 ppm)
  - The same as a typical CPU processor clock accuracy.
- Experimental timing characterization of 802.11n APs
  - Two commercial APs are used.
  - IEEE 1588 4-messaging scheme is implemented on modified dd-wrt.
  - One AP is set as a master of IEEE1588.
  - Offset and delay are measured to find the offset between the processor timer – PDV (packet delay variation) measurement
  - TCP level bandwidth : ~80 Mbps
  - PHY data rate : 300 Mbps

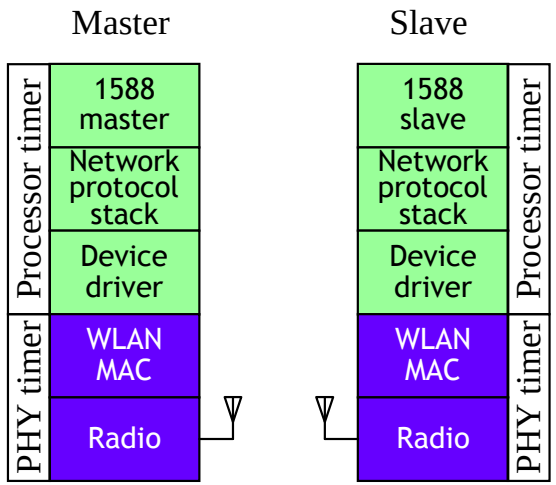


System model

Typical timing performance of 802.11n APs

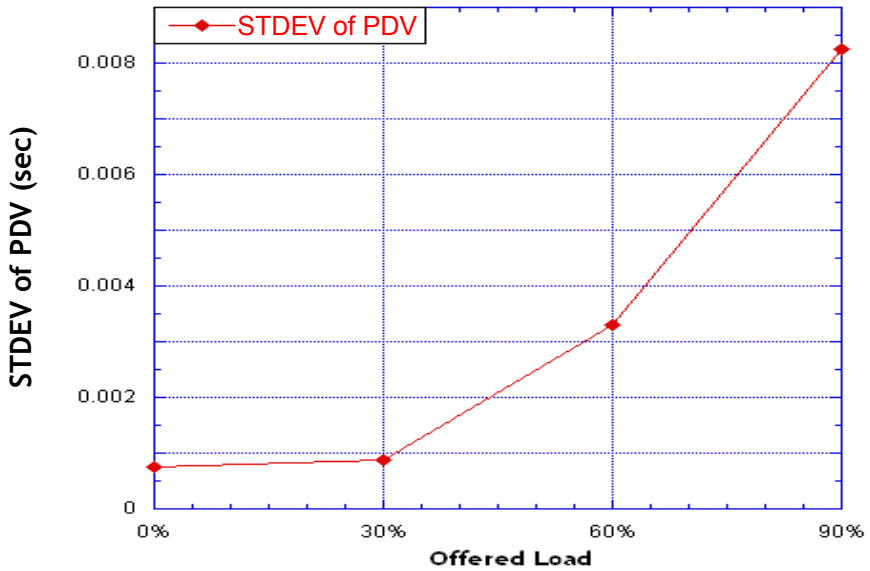
- Clock and timer skew by PDV is measured at every 0.2 second.
  - No background traffic
  - 2.2ms skew measured over 30 minutes (1800 second) – 1.2 ppm
- It requires timer synchronization for distributed AV application.



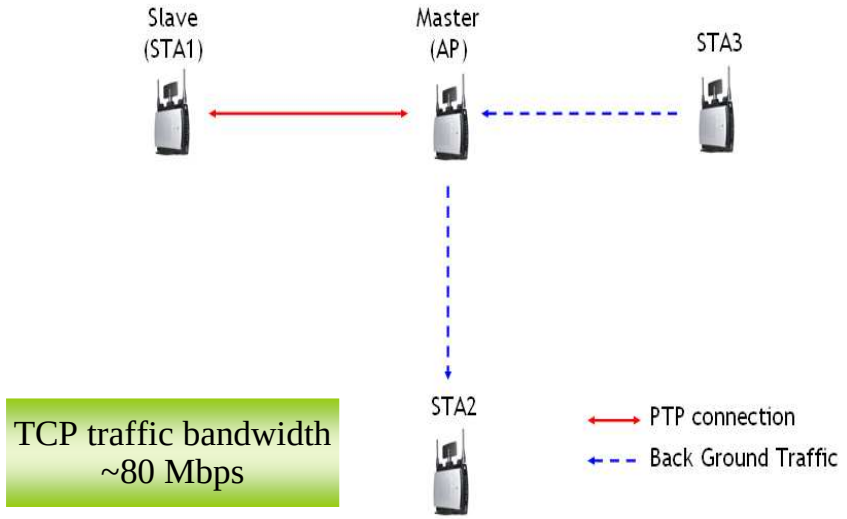


Typical timing performance of 802.11n APs

- PDV characteristics with traffic
  - Standard deviation of PDV measurements by IEEE 1588 at different offered load.
  - At every measurement, the offset is used to adjust slave timer.
  - Time stamp is attained at processor drivers.
  - Offered load is applied in the network and varied for 0,30,60, and 90%.
- StDev of PDV can be as large as 8.5 msec due to time stamping outside the MAC !!!



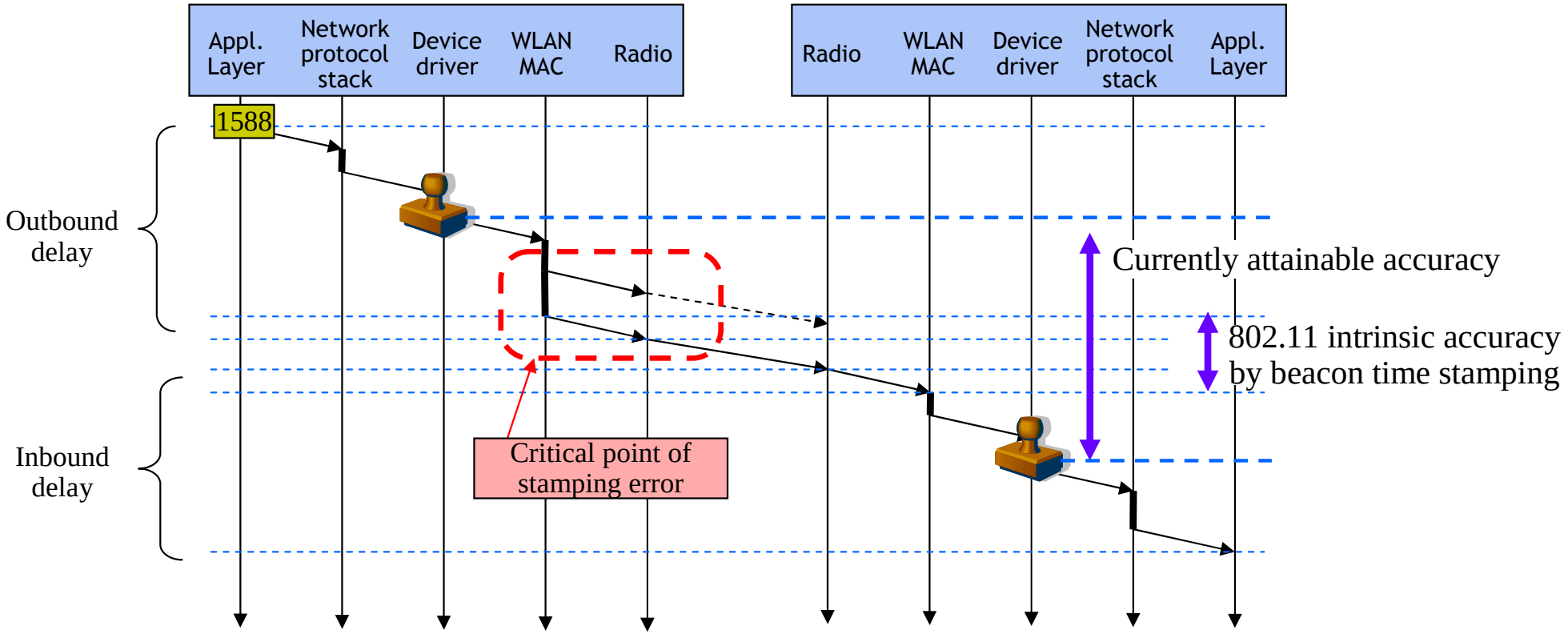
STDEV of Offset at Different Offered Load in Characterization Mode



Back Ground Traffic Applied BSS Experiment Set Up

Attainable packet timing accuracy

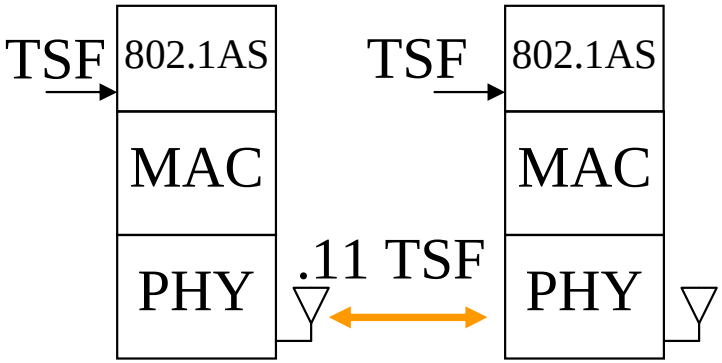
- Time stamp accuracy
  - No time stamp provides from MAC.
  - Process level time stamp can have accuracy of only msec.



IEEE802.11 communication delay and system architecture

802.11 TSF timer accuracy

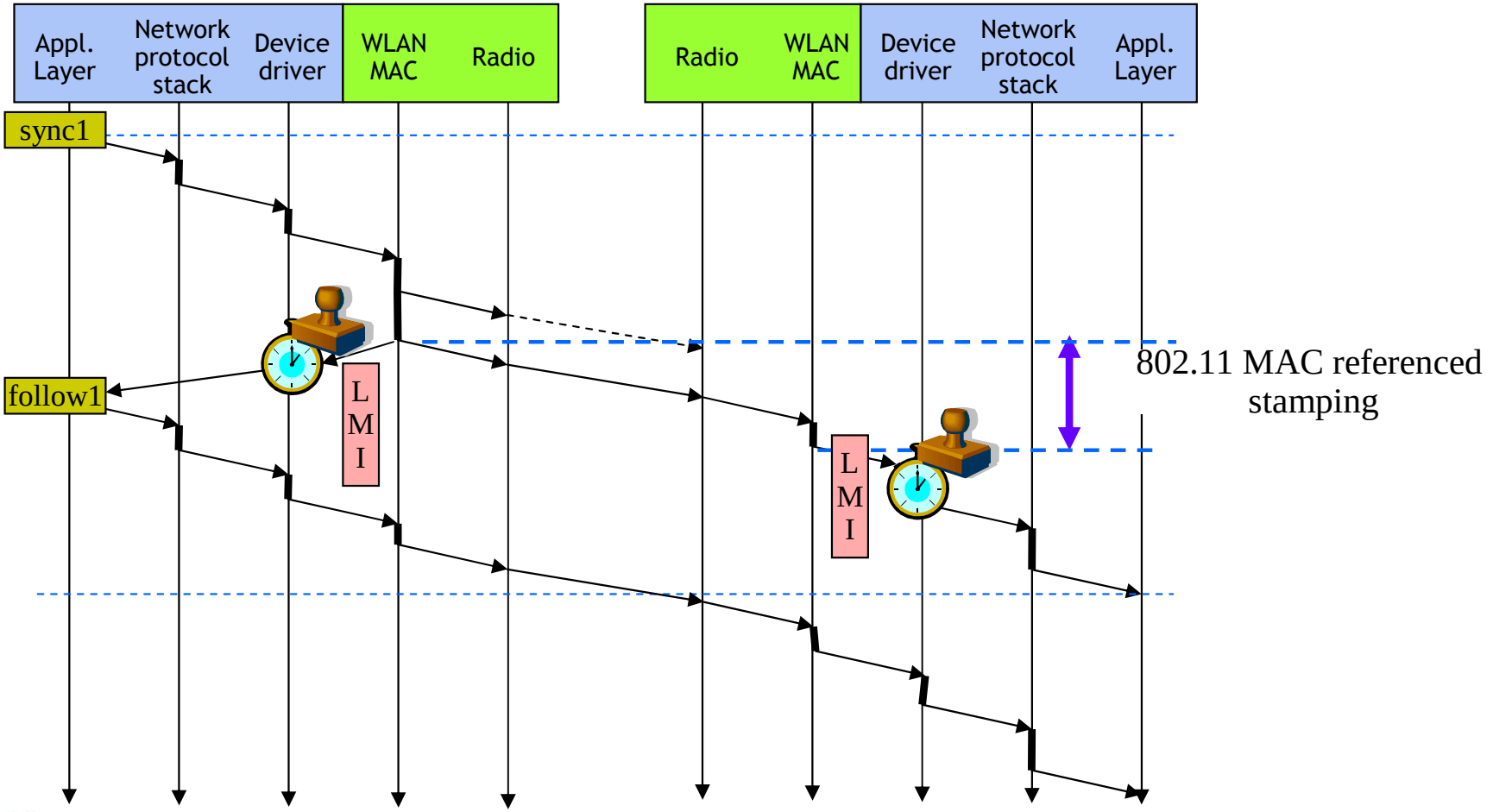
- The accuracy of the TSF timer shall be no worse than ±0.01%, 100ppm
  - Based on 802.11TM -2007 11.1.2.4 TSF timer accuracy
  - ±100 usec over a second
- A STA sending a Beacon frame shall set the value of the Beacon frame's timestamp so that it equals the value of the STA's TSF timer at the time that the data symbol containing the first bit of the timestamp is transmitted to the PHY plus the transmitting STA's delays through its local PHY from the MAC-PHY interface to its interface with the WM
  - Based on 802.11TM -2007 11.1.2



- Total communication delay of 802.11
  - Delay D = D_{MAC} + D_{PHY} + Air + D_{PHY} + D_{MAC}
  - DMAC can dynamically vary due to
    - Medium congestion (Collision detection and avoidance)
    - Random Backoff Retransmission

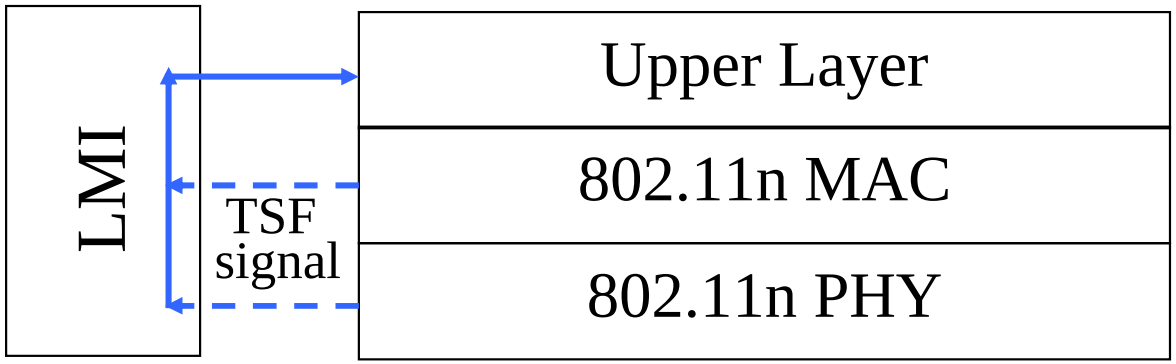
Proposed 802.11 stamping requirement

- Improve time stamp accuracy
  - MAC generates TSF signal (eg. processor interrupt)
  - Processor timers are used for system and network timing.



Conclusions

- Need to timestamp at 802.11n MAC or PHY Layer
- Need not to change legacy architecture
- Need a timestamp deliverer from MAC or PHY to upper layer
- Need a signal triggered when packets are received or sent at PHY



LMI : Local Management Interface