Smart grid Synchronisation: Wireless Challenges & Solutions

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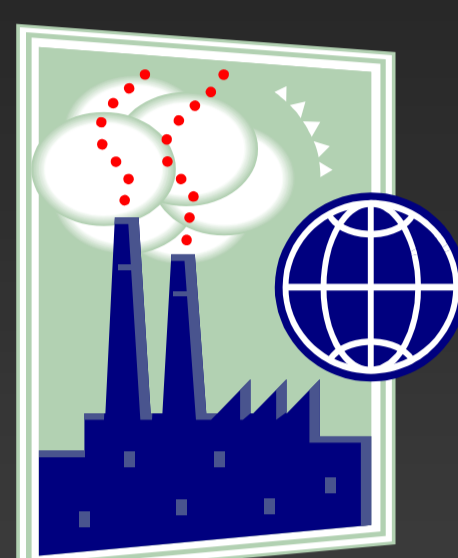
ESB Networks

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Smart Grid

The smart grid project aims to revolutionise the current grid infrastructure in order to reduce inefficient energy consumption, to facilitate the move towards renewable energy, and to better utilise the grid's capacity so as to accommodate growing electricity demand.

Technologies incorporated within the core of the grid will include high-temperature, low-sag (HTLS) conductors for efficient electricity transmission, storage units to house generated surplus energy and advanced PMU-based power flow monitoring for real-time grid activity monitoring.

Technologies such as smartmetering will allow for real-time monitoring of power usage and permit accurate analysis of daily demand and allow for construction of an efficient energy plan based on real-time pricing. Smartmetering together with smartbuildings will allow for automation of a premises systems so as to meet energy plans.

The success of the evolving smart grid project will depend hugely on ICT (Information and Communication Technologies) technologies to revolutionise the traditional power grid and will place various demands on current synchronisation techniques.

Utilisation of wireless communication systems within the smart grid infrastructure seems inevitable, thus, if the project is to reach its full potential then some of the shortfalls of current synchronisation techniques over wireless must be remedied.

Synchronisation

The motivation for sync can be attributed to the imperfections in current computer system clocks which typically utilise inexpensive quartz crystals as their frequency standard.

Local Clock   Local Time / Real Time   Perfect Clock
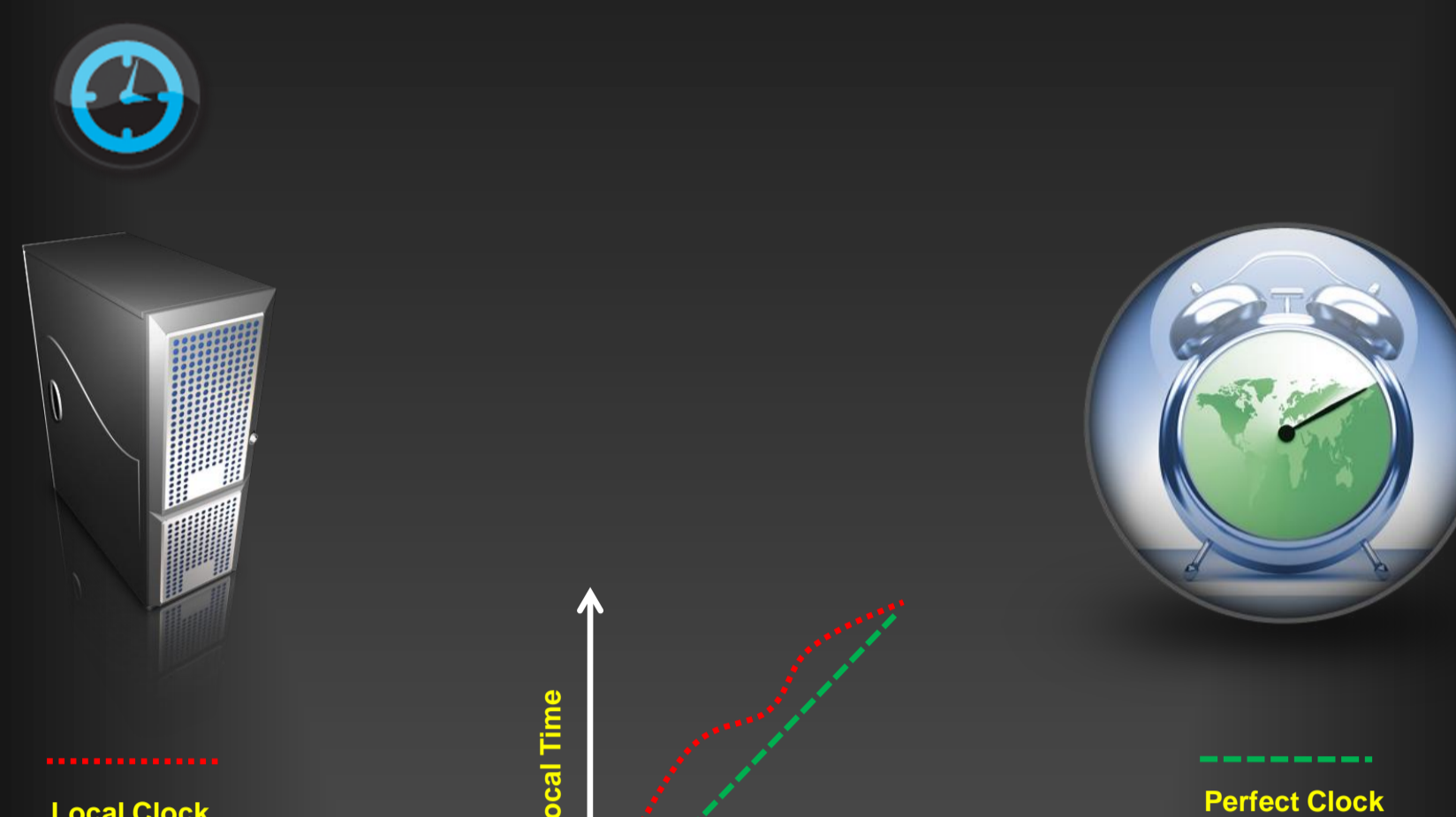
A synchronisation technology such as GPS provides an effective solution for synchronising distributed computer systems, however, it can prove a costly solution in many scenarios with the added disadvantage of receivers requiring line of site communication.

Hence, the use of a synchronisation protocol such as the Network Time Protocol (NTP) or he Precision Time Protocol (PTP) provide a more practical solution.

T1   T2
SLAVE   MASTER
T4   T3
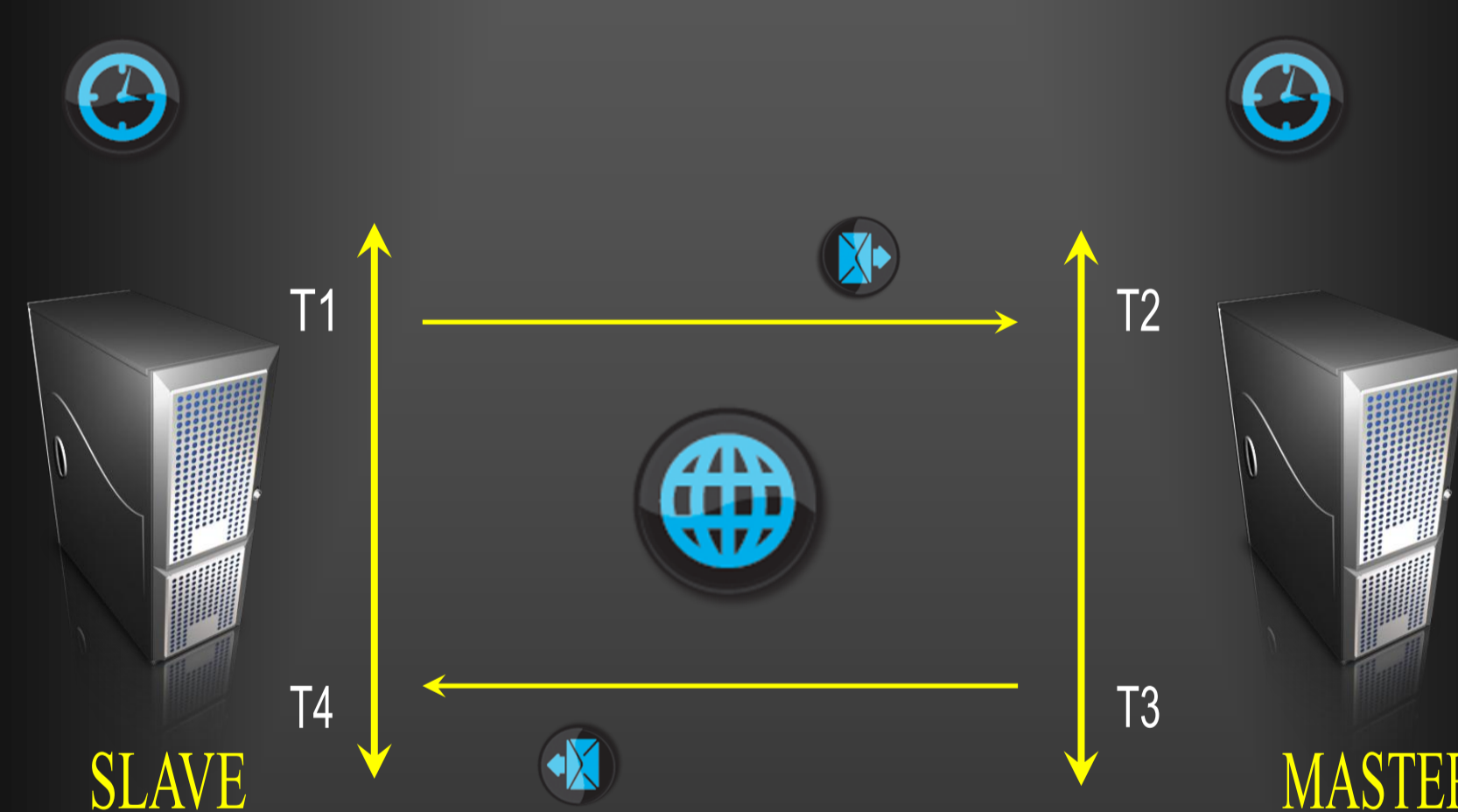
$$Offset = (T2+T3-T1-T4)/2$$

These protocols however tend to degrade when operated over a wireless network infrastructure. The medium access times within wireless networks can be quite significant due to contention between multiple stations. This leads to incorrect time estimates.

Contribution

To mitigate the effects of wireless contention delays on time synchronisation, the medium access delays of a time message at the sender and, more importantly, the receiver in the wireless network must be determined or estimated
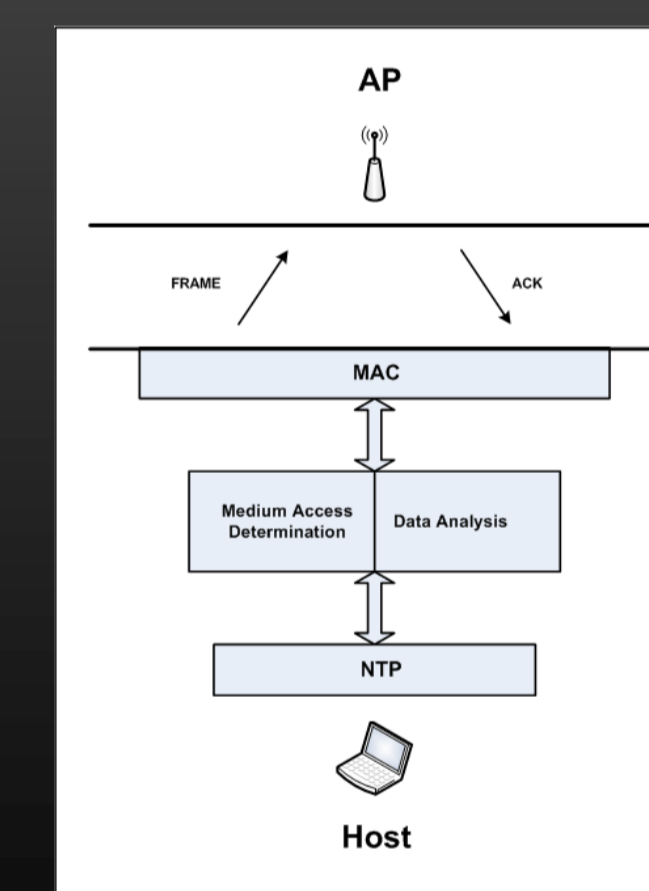
Medium access delays could be determined by examining the transmission and reception times of specific wireless frames. For instance, 802.11 ACK & Probe frames could provide a means to resolve these access delays.
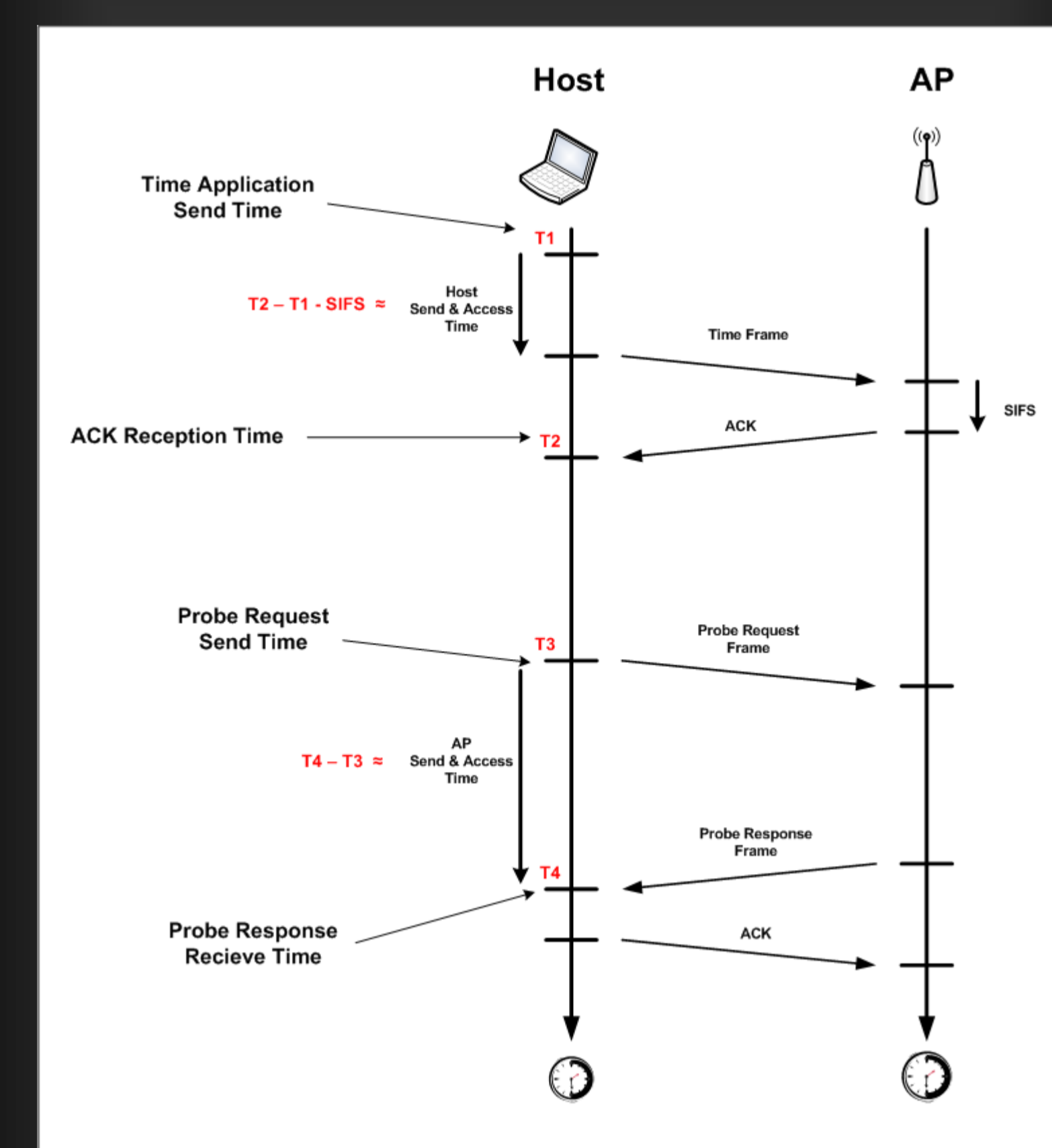
Medium Access Determination

Accuracy could also be improved by analysing network data. Analysis of past data could help to identify network trends and make predictions about the future state of the network. This information could prove to be valuable in improving a protocol's performance

Ultimately the resulting contribution will be a module that can be linked to some synchronisation protocol and used to mitigate the effects of wireless contention using one or both of the above techniques.

Module

Acknowledgements