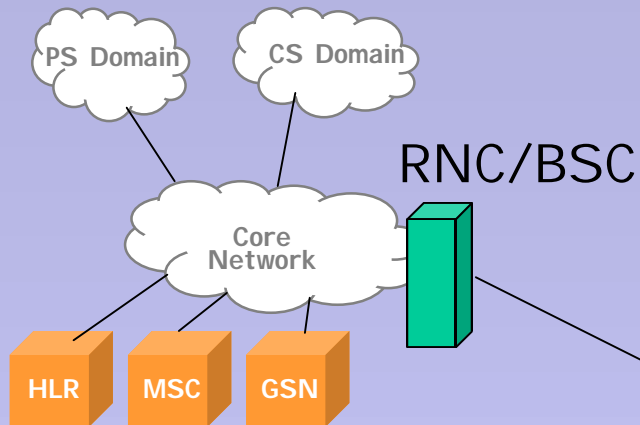


EFM Device Time Reference Protocol Proposal

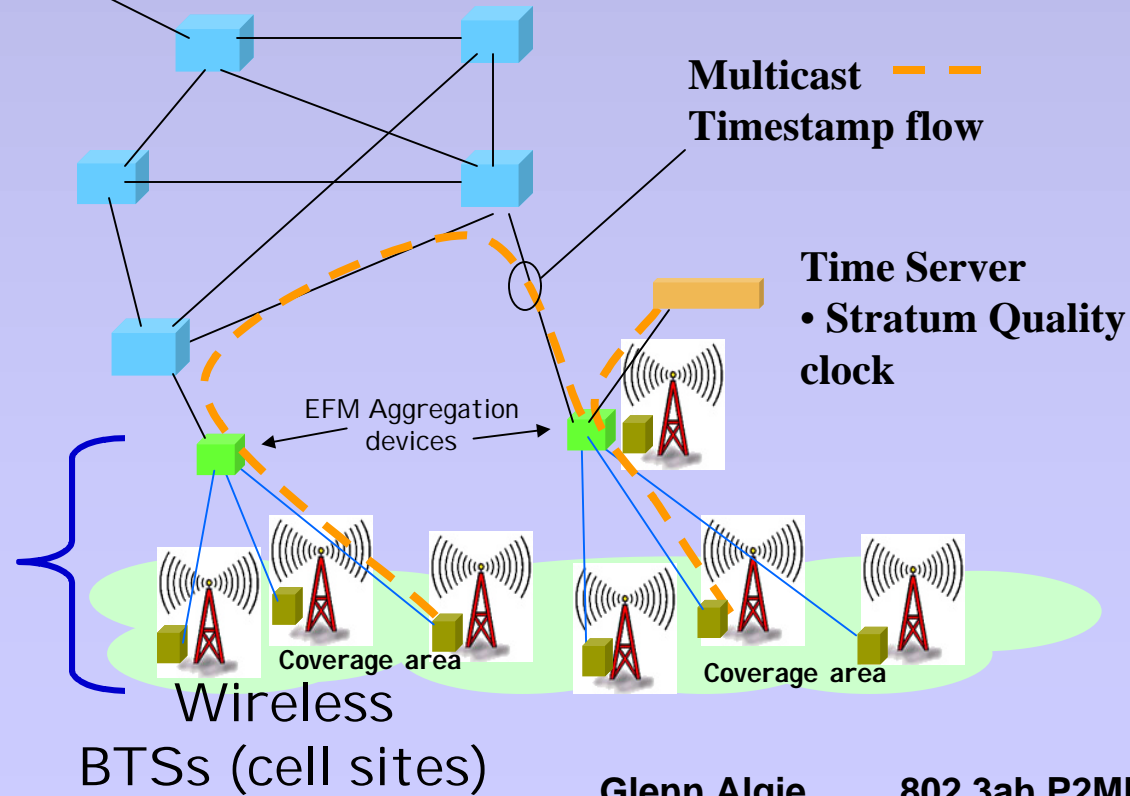
- ❑ Reuse of IEEE 802.3ah MPCP proposed MAC control signals
- ❑ P2P and P2MP EFM architecture common use
- ❑ Copper or Optical fiber PHY flexibility
- ❑ EFM connected outstation has application/services that needs
 - a) Frequency lock to a Metro timing source point.
 - b) Phase lock among outstations to a Metro timing source point.
 - c) Do this at Layer 2 ethernet, optical and non optical first mile value.
- ❑ Frequency lock can be achieved by timestamped flow or by PHY lock
- ❑ Phase lock achieved by ranging: which is also a sequence of timestamp signals between source and dest device clocks.
- ❑ EPON: OLT will track Phase lock for ONU, ONU could track phase lock alternatively where Phase sensitive user side facing service/applications on EPON outstation may reside.
- ❑ Use Case:
Cellular BTS backhaul via EFM connections on copper and fiber

Cellular Device Time Reference (DTR)



Wireless
Operator Devices

- Alternate source points for DTR
- Frequency lock, vs Freq + Phase Lock DTR
- Alternate clock stratum sources
- Table stakes for enabling EFM connections to timing sensitive device applications/services



EFM solutions

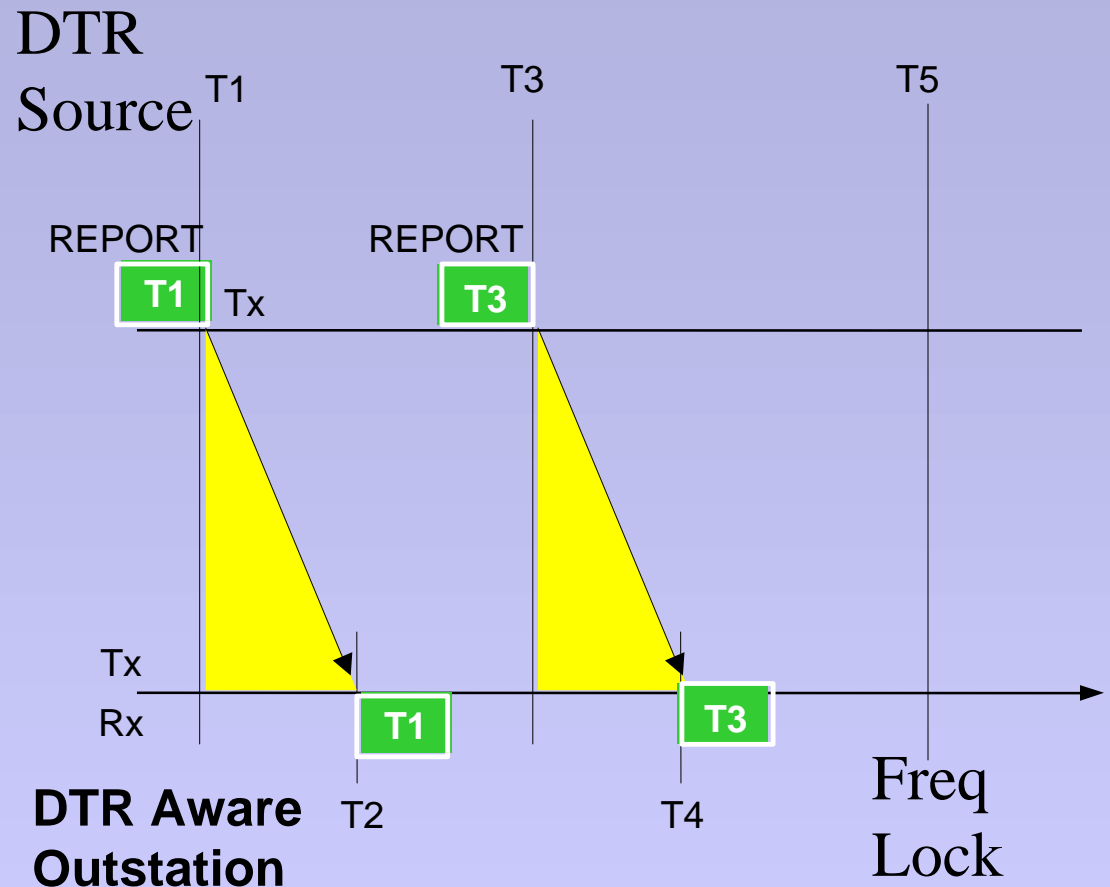
- Fiber (p2p, p2mp)
- Copper (n*DSL or SDM)

DTR Model

- ❑ A quality stratum clock exists at a sourcing point in Metro
- ❑ A layer 2 ethernet switched path exists from source timing point to EFM outstation
- ❑ A MPCP adapted Report message with timestamp only is multicasted from a Metro L2 ethernet connected source point.
- ❑ Report signal: A 0.5-50 kbps timestamped Ethernet flow (1 to 100 packet per second rate) arrives at Outstation that has a frequency or frequency and phase clock sensitive service.
- ❑ Outstations set their local clock to reflect the timing Source point clock within certain frequency bounds (50ppm to 50ppb)
- ❑ A Unicasted Report signal can optionally be used from/to outstations to/from the timing source in order to achieve timestamp based Phase lock condition, via ranging sequence
- ❑ Report signal's multicast destination address can be link constrained or optionally can be a non link constrained address, following the rules similar to a Garp control aware vs unaware switch/bridge. Use IEEE OUI 01-80-C2-xx-yy-zz range.
- ❑ Both the unicasted and non link constrained multicast can be 802.1p tagged for optimal jitter management of the control flow.

Device Time Reference –Frequency lock

1. DTR source periodically sends Report as a multicasted control packet .
2. DTR aware Outstation receives the multicast report signal and regularly adjusts for frequency alignment.
3. This can occur over a optical or copper based first mile hop.
4. If intermediate non control aware switch/bridge devices exist between source and outstation then propose a non link constrained control multicast address be used and optionally 802.1p tagged.



Why not NTP?

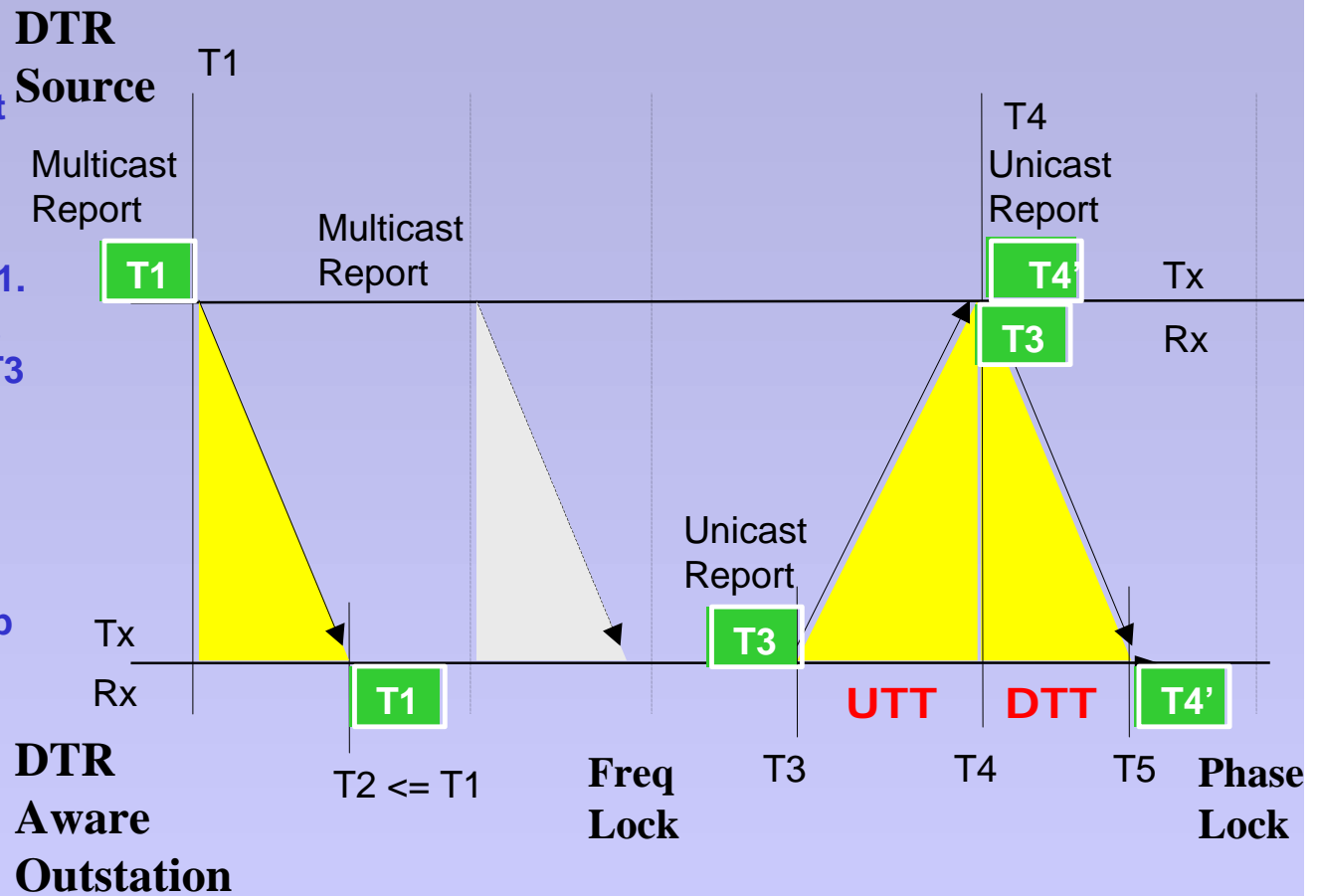
- ❑ NTP delivers clock above layer 3 IP, typically at a Stratum 3 level of stability.
- ❑ IP routing can change paths based on delay and throughput and congestion metrics dynamically.
- ❑ NTP can be interworked at a IWF timing service point in the Metro and mapped into L2 ethernet timestamp flows
- ❑ Outstations clocked by NTP today experience longer time to lock performance and limited performance under drift conditions.
- ❑ NTP was not designed for 50 parts per billion frequency lock nor a 3 microsecond Phase lock capability.
- ❑ NTP recently has been proposed as a more precision clock signal for the Enterprise LAN but does require much HW specialized handling.
 - These techniques can be reused for a L2 timestamp recovery as well
- ❑ Layer 2 based timing distribution in EFM is less complex and fits well into a L2 carrier managed ethernet service

DTR Phase lock RTT Compensation

- ❑ Phase Delay compensation is performed at DTR aware outstation (as opposed to OLT for EPON suggested case)
- ❑ Periodic “Report” control signal multicasted from Metro L2 ethernet Device timing reference source allows DTR aware outstation to achieve Frequency lock condition
- ❑ Unicasted type “report” control signals for ranging sequence of events.
- ❑ Unicast Report signal from DTR aware outstation to DTR source then unicast Report signal from DTR source back to DTR aware outstation.
- ❑ Phase difference from a DTR source can be calculated at each DTR aware outstation once DTR aware outstation achieves a sufficient Frequency lock condition.
- ❑ Jitter boundary determines where a DTR source can occur. For DTR Frequency Lock Nortel simulation recommends 2.5 msec or less.

DTR Phase Lock Ranging - RTT Measurement

1. DTR Source sends Report at absolute T1.
2. DTR aware Outstation receives REPORT at T2, and resets local clock to show T1.
3. DTR aware outstation sends uncasted REPORT at time T3 showing timestamp T3 and correlation index.
4. DTR Source receives uncasted REPORT at absolute time T4 and overwrites report timestamp to T4'.
5. DTR aware outstation receives uncasted report at T5, calculates the DTT Phase shift time.
6. May validate DTT with a couple of unicast reports.
7. DTR aware outstation enters timing Phase Lock condition. Local time is now absolute DTR source time.



DTR impacts/needs

- ❑ **MPCP Report message adaptation required (via TLV?):**
 - Make the queue stats back pressure information optional (since is EPON outstation specific)
 - DTR uses optional correlation id if using it in a ranging sequence with unicasted header to achieve a Phase Lock condition
- ❑ **Allow MPCP signals to use unicast destination address**
- ❑ **Allow MPCP signals to use a “non link constrained” multicast group id.**
 - Perhaps go for new ethertype to avoid backward compatibility with MAC control deployed hardware/software limitations
 - Use similar sink vs forwarding philosophy as Garp aware vs non Garp aware bridges.
 - In fact, can we get a unused multicast address from the same range set aside for Garp?
 - 01-80-C2-00-00-2201-80-C2-00-00-2F (GMRP 20, GVRP 21)
 - Proposal then to IEEE 802.1 is to rename this space for use as non link constrained control protocols, of which Garp can use and other control protocols such as DTR timestamping flows.
- ❑ **Can't call these MPCP signals any more? Call them EFM MAC control signals? Has link constrained option and non link constrained option**
- ❑ **Applies to optical and non optical EFM alternatives!**