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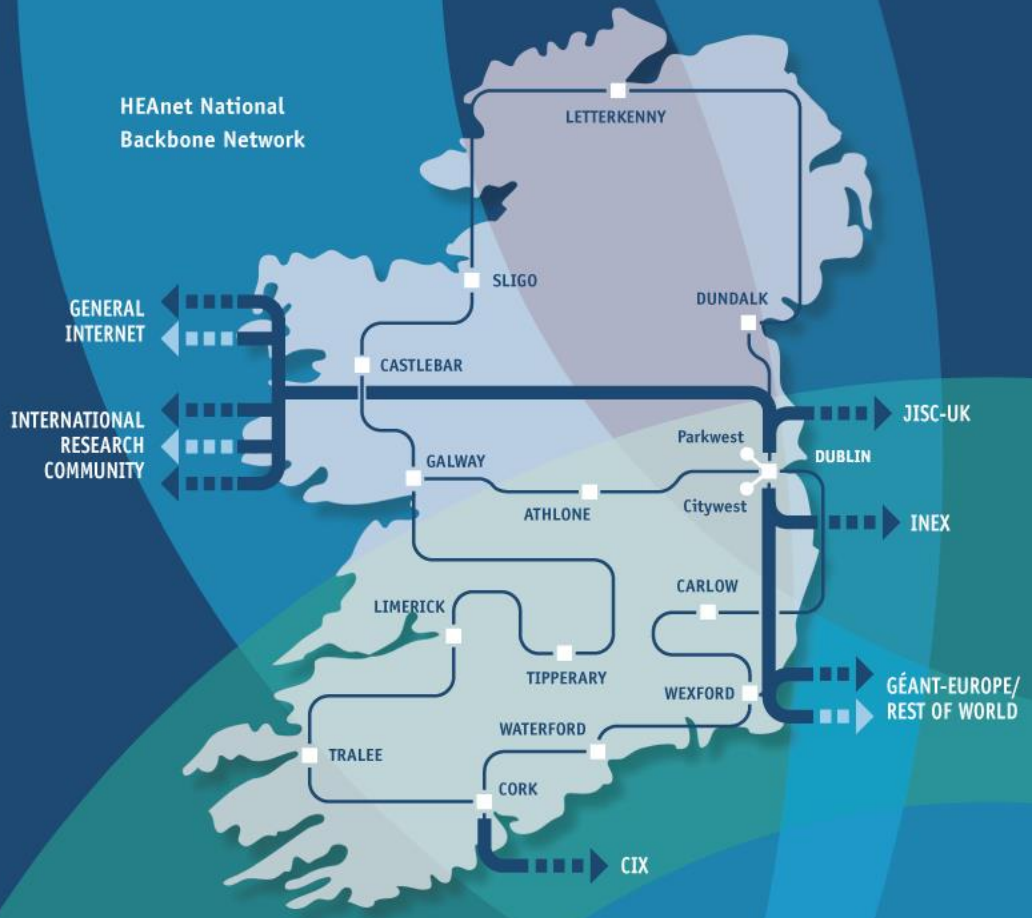
HEAnet T&F Status Next Steps



Eoin Kenny & Dónal Cunningham

Informal Working Group on Time & Frequency

- Academic
  - Atlantic Technological University (Letterkenny)
  - Queen's University Belfast
  - Maynooth University
  - Trinity College Dublin
  - SFI Connect (Open Ireland Optical lab and Open RAN 5G)
- Industry
  - Timing Solutions
  - Data Edge
  - National Standard Authority of Ireland (NSAI)
  - Irish Neutral Exchange - INEX
  - National Physical Laboratory - NPL
- NREN
  - HEAnet
  - Jisc

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HEAnet Time & Frequency Services Today

- Today HEAnet provides NTP services to our clients
  - Very important service for HEAnet and our clients
  - Milli second accurate
  - Used for servers and routers
  - Good enough for log correlation etc

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New(ish) T&F technologies

- Precision Time Protocol (PTP) – 1,000 times more accurate than NTP with the right network support.
- White Rabbit – 1,000 times more accurate than PTP
- ePRTC (Enhanced Primary Reference Time Clock)
- ELSTAB(Electronically stabilized T&F) – active compensation of fibre delay fluctuations

Time and Frequency assets

- HEAnet NTP servers support PTP
- HEAnet routers support(some hardware dependencies) PTP(Some profiles), SyncE, TOD, 1PPS, 10Mhz in/out
- NSAI - Caesium standard traceable to BIPM is on the HEAnet network
- Our clients have R&D labs with T&F equipment
- Industry partners have know-how and testing equipment
- Open Ireland testbed and Open-RAN 5G
- Access to fibre networks HEAnet, Jisc and GÉANT

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Possible T&F uses cases

- PTP service to provide frequency and phase synchronisation for 5G test labs.
- Timing for LTE/5G indoor small cells – Private 5G on campus networks.
- Electricity Grid, requires accurate reliable timing – Smart Grid(Frequency)
- Interferometry for radio telescopes (LOFAR2).
- National Timing Grid (Near real time monitoring & alerting)
- Direct traceability to UTC through UTC(NSAI) & UTC(NPL)
- Enhanced Primary Reference Time Clock (ePRTC)
- In-band Network Telemetry – Time synchronisation – P4 hardware
- Perfsonar – improve timing sensitivity – add PTP support.

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Possible HEAnet T&F Services

- Resolution
  - PTP – unicast and/or multicast via the HEAnet network to labs, end users
  - ToD,1PPS/10Mhz frequency signal direct from HEAnet routers
  - White Rabbit with DWDM links
  - Dedicate wavelengths for distributing T&F
- Compliance
  - Guarantee reference to UTC(NSAI) or UTC(NPL)
- Resilience
  - Connection to a HEAnet/NSAI ePRTC network
  - Participation in a National/European Timing Grid
- Europe
  - Participate in a future GÉANT Pan European T&F service
  - Participate in a UK & Ireland T&F service
  - Participate in a European Timing Grid

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Which PTP profile?

- Microchip TP4100 PTP Profiles
  - telecom-2008 - Pre ITU-T Telecom profile for frequency and phase/time synchronization, unicast over UDP/IP
  - itu-g8265-1 - ITU-T Telecom profile for frequency synchronization
  - itu-g8275-1 - ITU-T Telecom profile for phase/time synchronization with full timing support from the network
  - itu-g8275-2 - ITU-T Telecom profile for phase/time synchronization with partial timing support from the network
  - default - IEEE 1588-2008 Annex J, multicast over UDP/IP
  - ethernet-default - IEEE 1588-2008 Annex F, multicast over 802.3/Ethernet

WAN Interesting PTP Profiles

- ITU-G8275.1 Requires SynchE and PTP
  - “Full Timing Support”
  - All hardware (Routers/Transponders) on the path must be configured for SynchE
  - All routers must be configured as boundary clocks
- ITU-G8275.2
  - “Partial Timing Support”
  - Can operate over existing networks with or without intermediate router support

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HEAnet Current implementation of PTP

TP4100 – #3 on the network:

- Two providing ITU-G8275.2 Unicast IPv4
- One providing Default Profile – Multicast IPv4 - 224.0.1.129
- No use of transparent clocks due to MPLS
- Routers configured as Boundary Clocks
- Phase, Frequency and time distribution
- Enabling on routers on a use case basis

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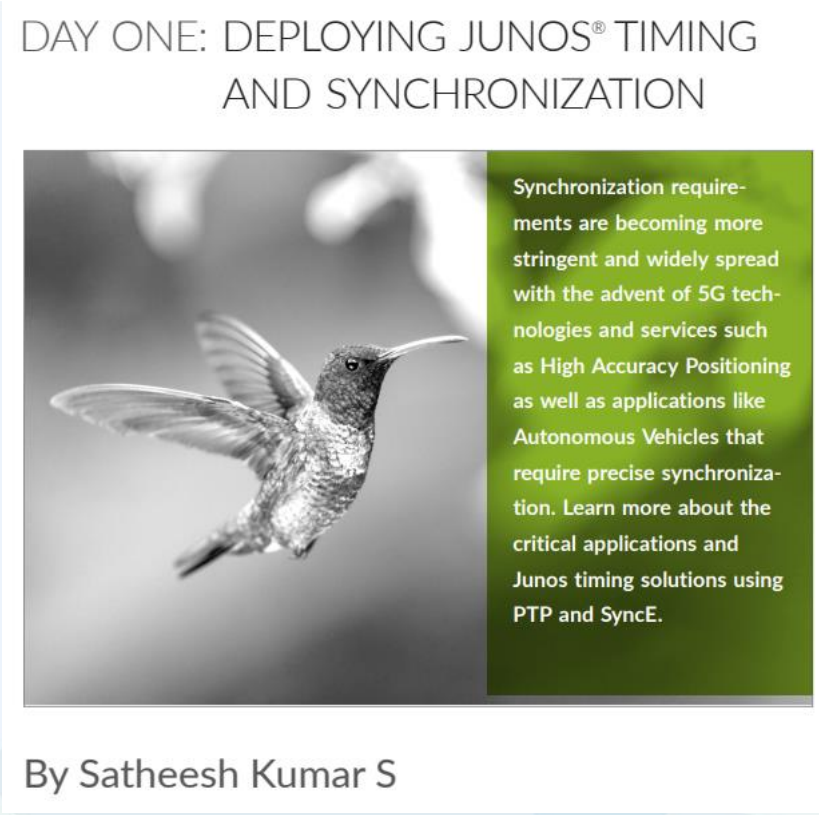
TP4100 Issues encountered

- TP4100 v2.3.6 – NTP box hangs once exceeds about 20K pps.
  - TP4100 needed v2.3.6 for dual stack IPv4/IPv6!
  - Currently running v2.2.3 with separate IPv4 and IPv6 physical interfaces
- TP4100 v2.3.8 – PTP bug in 1588-2019 PTP implementation, which is incorrectly implemented. Add “ptp_minor_version 0” to linuxptp 4.2 config file as a work around.
- PTP Max Clients : 16 – not currently an issue, just be aware

Juniper Routers Support

- Juniper routers support…
  - ToD,1PPS/10Mhz frequency in/out
  - SyncE
  - Phase synch – needed for 5G
  - Loads of gotchas!
    - the supported timing features may vary from platform to platform!
  - Juniper Day One guide.



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PTP Profiles & Juniper

- G.8275.1 is supported on the MXs but requires sycnE and PTP on all network devices. All hardware not supported eg MPC4.
- G.8275.2 unicast and does not require intermediate boxes to do PTP but is only supported on certain line cards and some ACX boxes.
- Juniper “enterprise PTP”, which is only supported in the QFX and uses multicast IP - 224.0.1.129.
- Juniper default on MX Profile type: IEEE-2008, can enable unicast negotiation and works with TP4100 G.8275.2
- Juniper G.8275.1.enh adds phase/time to G.8275.1
- Juniper G.8275.2.enh partial network support, phase/time/TOD.

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TP4100

- timeserver1-cwt> show timing-service status eth6
- +----------+----------+
- | Port | Service, Index | Label, Clock Instance |
- |------|----------|----------|
- | eth6 | ptp-master itu-g8275-2, 2 | time-output-unicast-L3, Clk-Inst-0 |+----------+----------+
- Link Status : Up
- Bridge Port : exp6
- Access Port : exp2
- Port State : Master
- Service Packets Per Second : 64
- Number of Clients : 1
- Announce Contents :
- Domain : 44
- Steps Removed : 0

Port Identity : 00:b0:ae:ff:fe:06:f0:9c, Port:6
Clock Class : 6
Clock Accuracy : within 100 ns
Offset Scaled Log Variance : 0x4e5d
Timescale : PTP
Time Source : GPS
Time Traceable : true
Frequency Traceable : true
Current UTC Offset Valid : true
Current UTC Offset : 37
Leap 61 : false
Leap 59 : false

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Juniper ACX7024

- ekenny@acx7024-1> show configuration protocols ptp
- clock-mode boundary;
- profile-type g.8275.2.enh;
- domain 44;
- unicast-negotiation;
- slave {
- interface et-0/0/23.0 {
- unicast-mode {
- transport ipv4;
- clock-source 193.1.8.102 local-ip-address 193.1.249.56;
- } }}
- master {
- interface et-0/0/18.10 {
- unicast-mode {
- transport ipv4;
- clock-client 193.1.200.185/32 local-ip-address 193.1.200.184;
- } }}

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- heanet@acx7024-1> show ptp clock
- Clock Details:
- Slot Number : 0 (CB)
- Default Data:
- Two-step Clock : FALSE Clock Identity : 88:28:fb:ff:fe:1c:bb:5d
- Total Ports on Device : 128 Clock Class : 248
- Clock Accuracy : 254 Log Variance : 65535
- Clock Priority1 : 128 Clock Priority2: 128
- UTC Offset : 37 Leap59 : FALSE
- Leap61 : FALSE Time Traceable : FALSE
- Frequency Traceable : FALSE Time Source : 160
- Delay Req Sending Time: 0 Steps Removed : 1
- Slave-only : FALSE
- Parent Data:
- Parent Id : 00:b0:ae:ff:fe:06:f0:9c
- GMC Id : 00:b0:ae:ff:fe:06:f0:9c GMC Class : 6 (Tx: 6)
- GMC Accuracy : 33 (Tx: 33) GMC Variance : 20061 (Tx: 20061)
- GMC Priority1 : 128 GMC Priority2 : 128 (Tx: 128)
- Global Data:
- UTC Offset : 37 Leap-59 : FALSE
- Leap-61 : FALSE Time traceable : TRUE
- Freq Traceable : TRUE Time Scale : TRUE
- Time source : 32 Path Trace count : 0
- heanet@acx7024-1>

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Phase lock

- heanet@acx7024-1> show ptp lock-status detail
- Lock Status:

- Lock State : 5 (PHASE ALIGNED)
- Phase offset : 0.000000205 sec
- State since : 2024-01-30 23:35:14 GMT (11:10:11 ago)

- Selected Master Details:
- Upstream Master address : 193.1.8.102
- Slave interface : et-0/0/23.0
- Clock reference state : Clock locked
- 1pps reference state : Clock qualified

- heanet@acx7024-1>

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Open Questions…

- How accurate is PTP (Phase, Frequency, TOD) on your routers?
- How can you provide an SLA(guarantees within x nanoseconds of your national metrology service) to your users?
- Suspect G.8275.1 will be more accurate than G.8275.2 but by how much?
- Is G.8275.2 good enough for most user cases?
- Are there design guides available for implementing PTP on WANs?
- How do you monitor PTP on your routers?
- Is there potential interest in a GÉANT incubator proposal?

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Thank you

Any questions?

Visit www.heanet.ie to learn more