Relative Timing Agreement In Small PTP Networks

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Agenda

- **Absolute vs Relative Time**
- **Example use cases**
- **Experimental set up**
- **Results**
- **Summary**

Absolute vs Relative Time

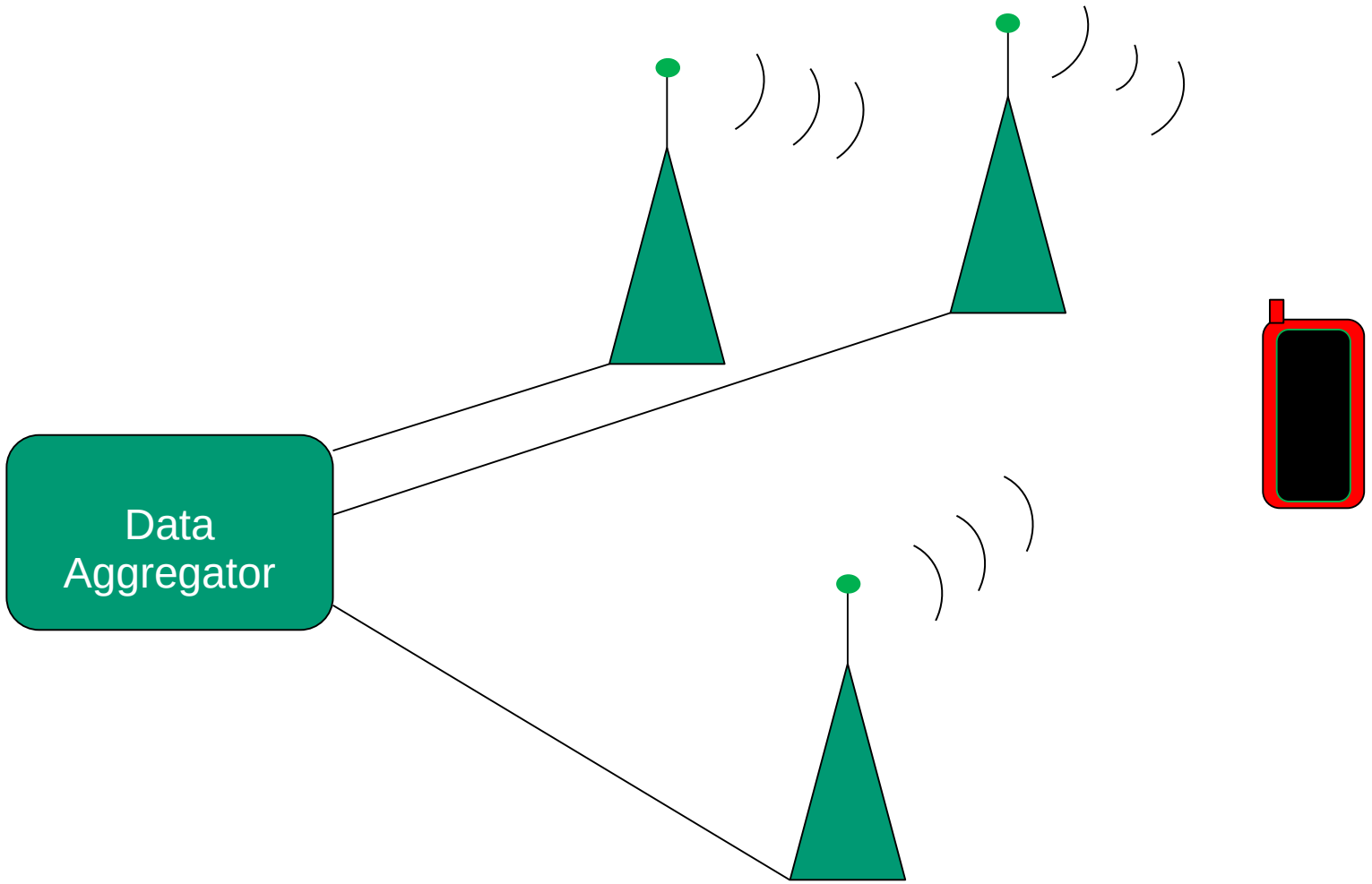
Absolute Time

- **Traceable to international standards**
- **For example, UTC**
- **Advantages**
  - **Often required for regulatory requirements**
  - **Timing agreement among clocks easier to specify when tied to standards**
  - **Scales globally**

Relative Time

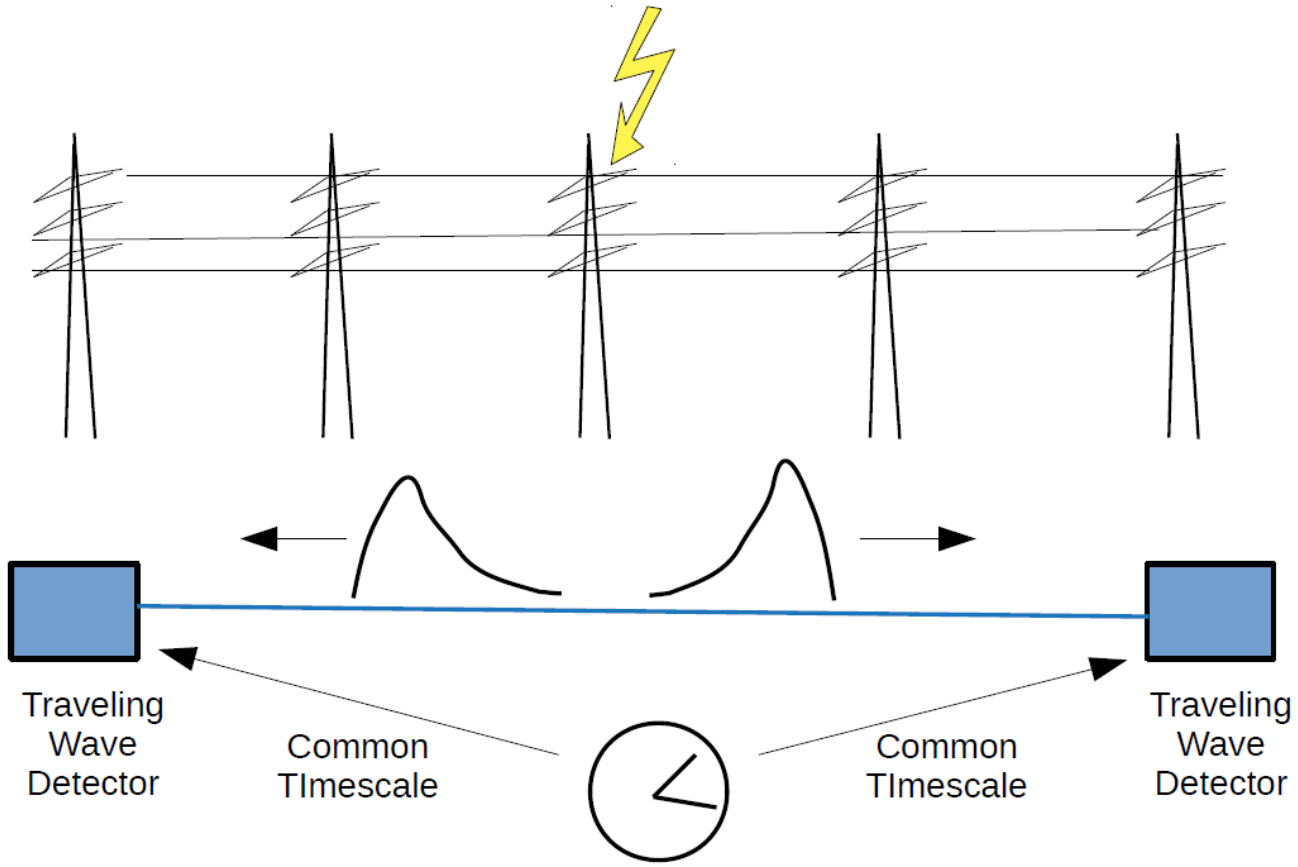
- **Timing agreement among some group of clocks**
- **Advantages**
  - **Better relative timing performance than absolute timing performance can often be acheived for small networks**

5G radio head clusters



Timing agreement
desired among
5 G radio heads for
carrier aggregation
MIMO, 65ns -265 ns.

Traveling Wave Fault Monitoring



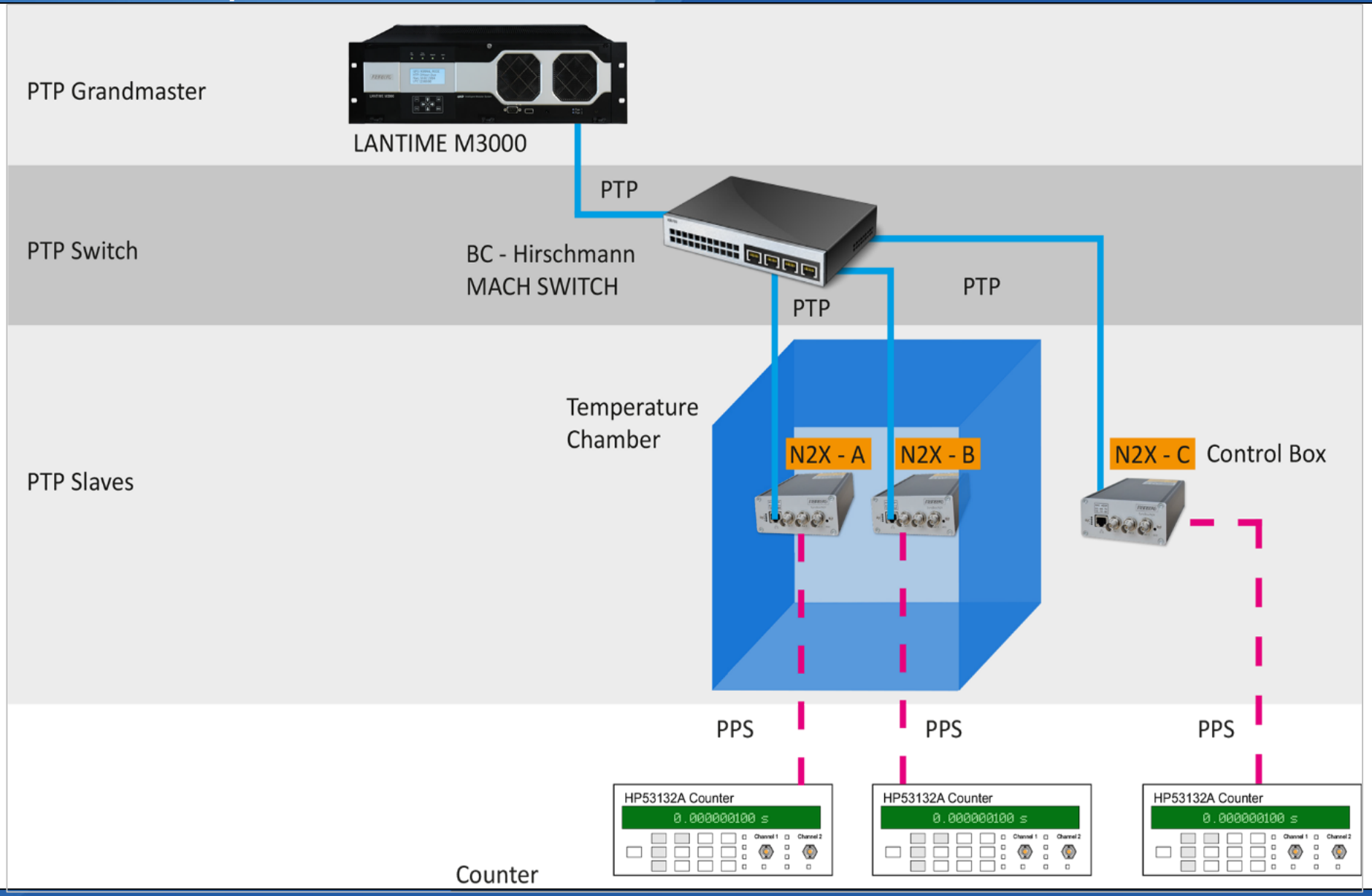
- 100 ns accuracy ~ 30 m location error
- Repair crews can spend less time finding the damaged equipment

The Thermal Challenge

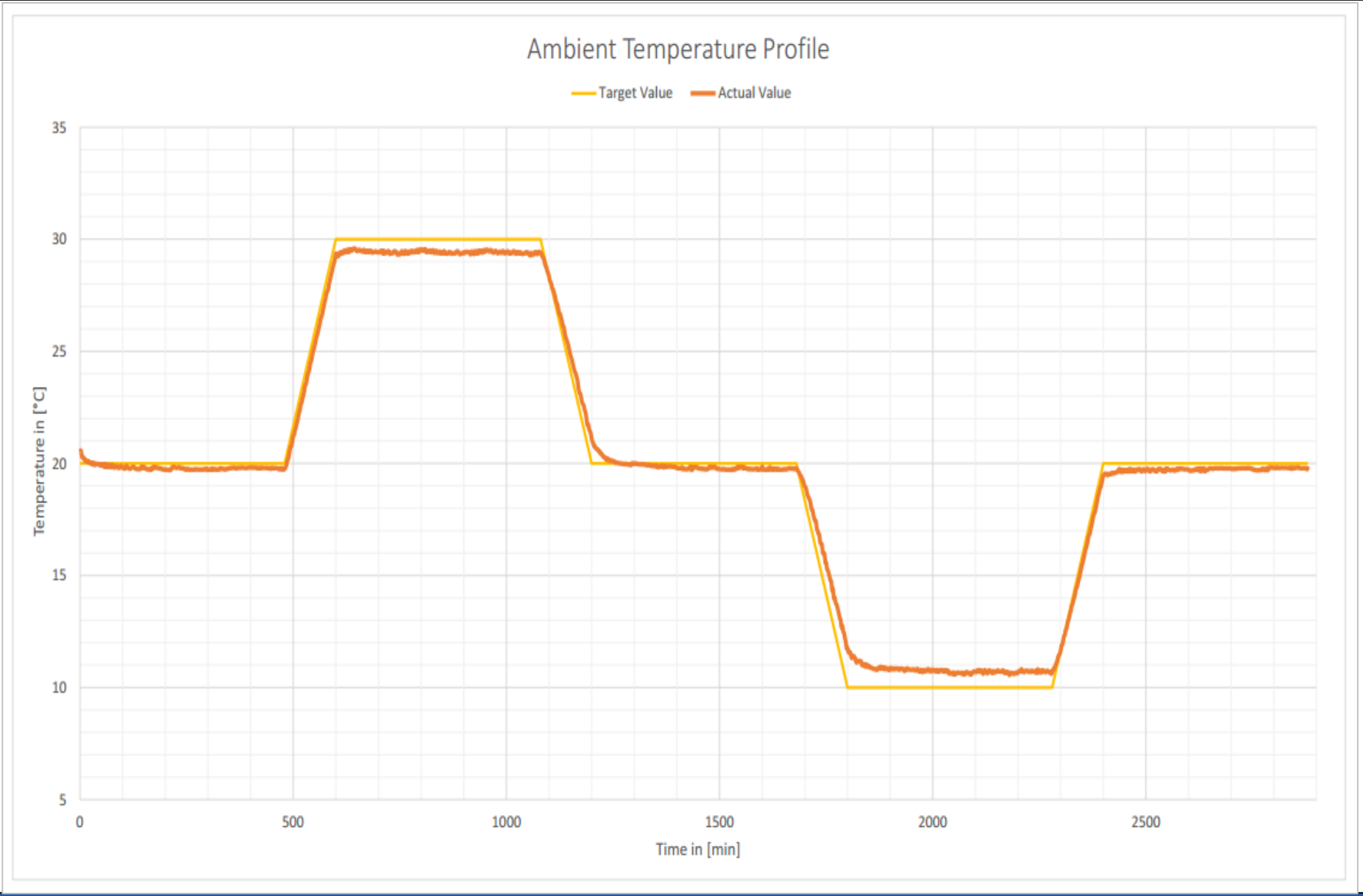
- **A group of initially synchronized clocks will exhibit disagreement during temperature gradiets due to the effect on the local oscillators**
- **Even if when the same model of oscillators are used in the clocks**
- **Especially a problem for outdoor or poorly temperature controlled environments**

- **In our experiments we considered temperature ramps of 10C over 1 hour**

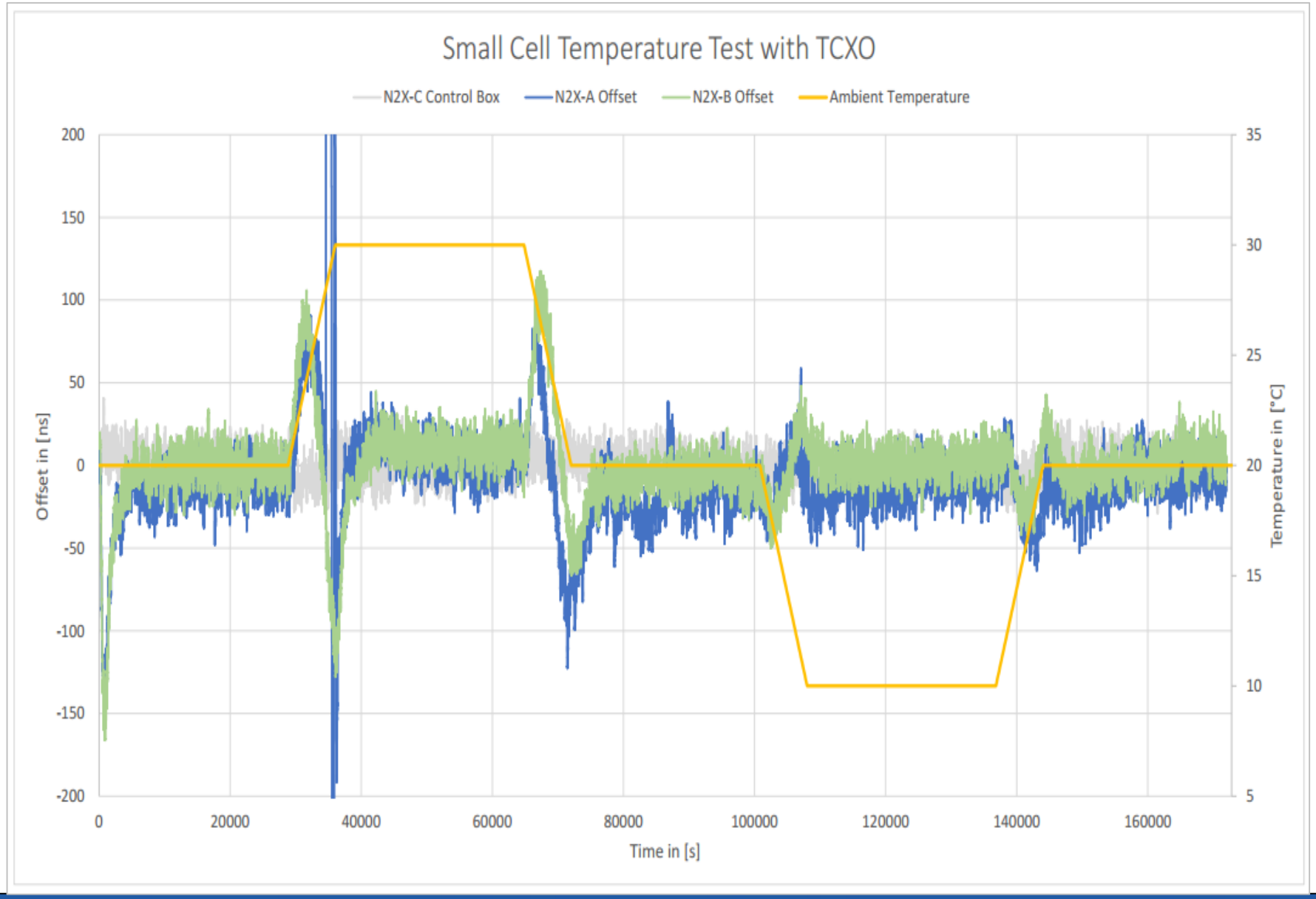
Experimental set-up



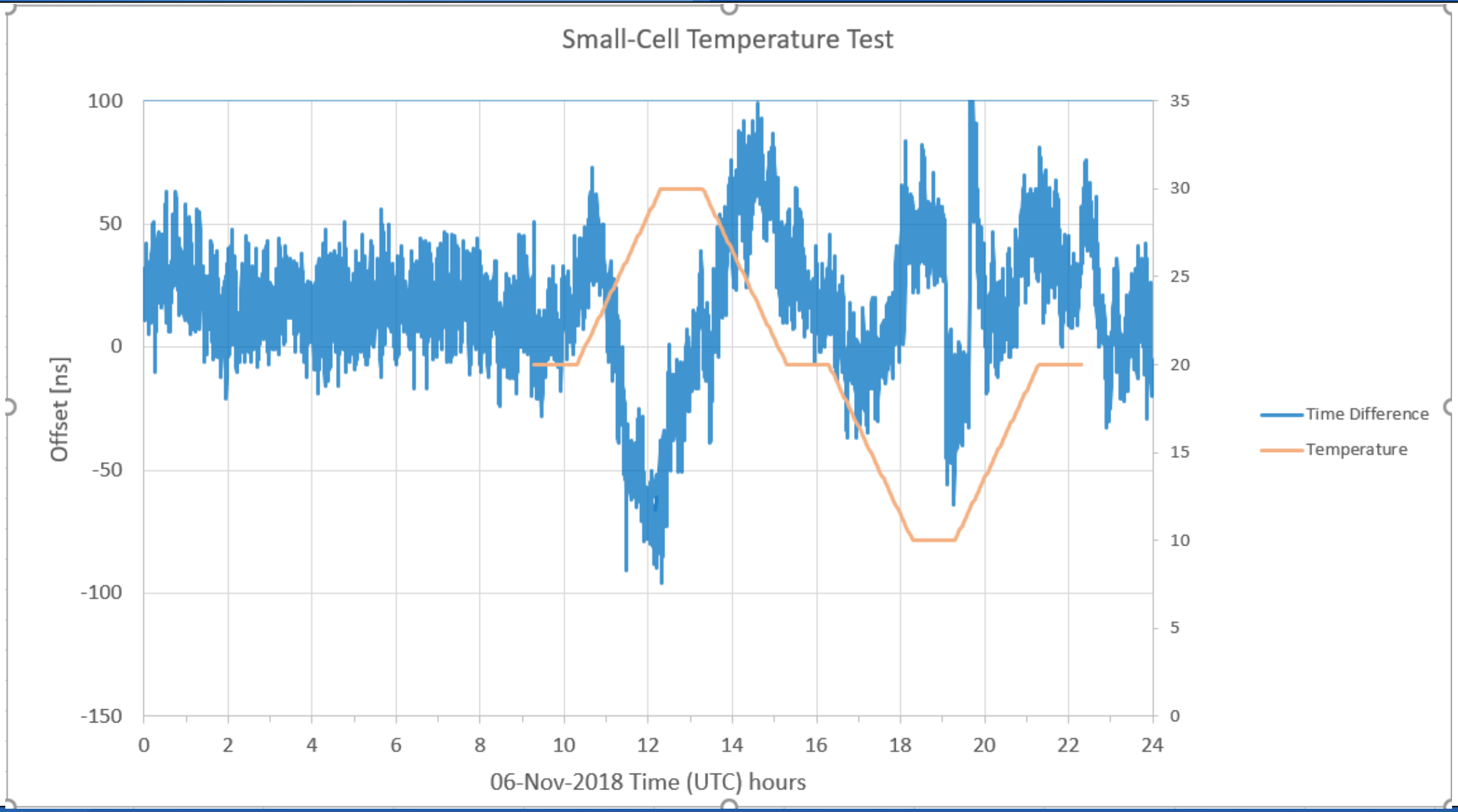
Temperature Profile



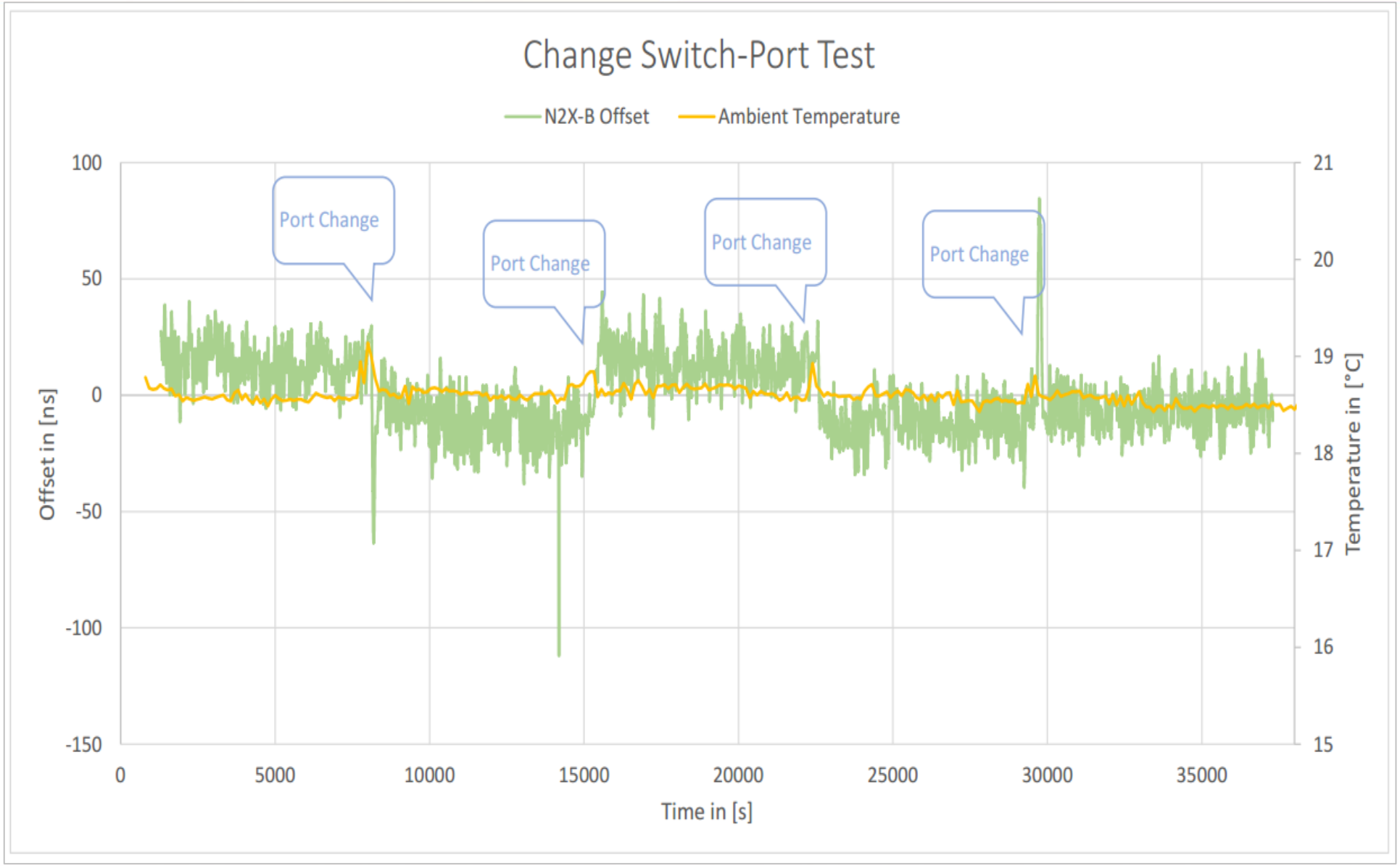
Temperature transients



Temperature transients



Boundary Clock Port Variation



Summary

- **Applications with tight timing requirements may reley on relative timing**
- **Temperature changes can cause significant errors among clocks in outdoor or poorly temperture controlled envirnoments**
- **Results for TCXOs**
- **Results for OCXOs**
- **Disagreement among Boundary Clock Ports Not expected to be a factor for applications with error budgets on the order of 100 ns**

Thank you for your attention

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