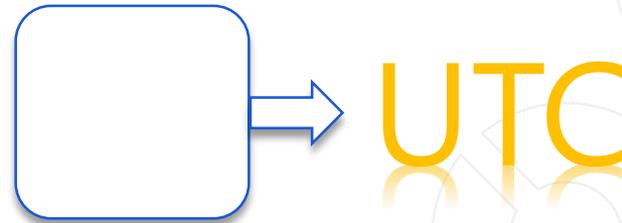


Improving Time Accuracy at the Network Edge



Motivation & Background

New technologies require **high time accuracy**

- eICIC, TDD, 5G, small-cell ...

Synchronization **over network is challenging...**

- Legacy networks
- Diversity of standards
- Multi-vendor / operator networks

High accuracy; **GNSS based solution;** low in network

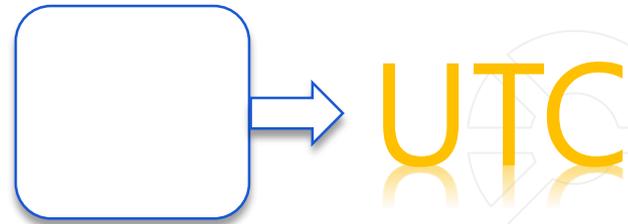
- Accuracy
- Verification
- Results

IOT PRTC - Solution overview

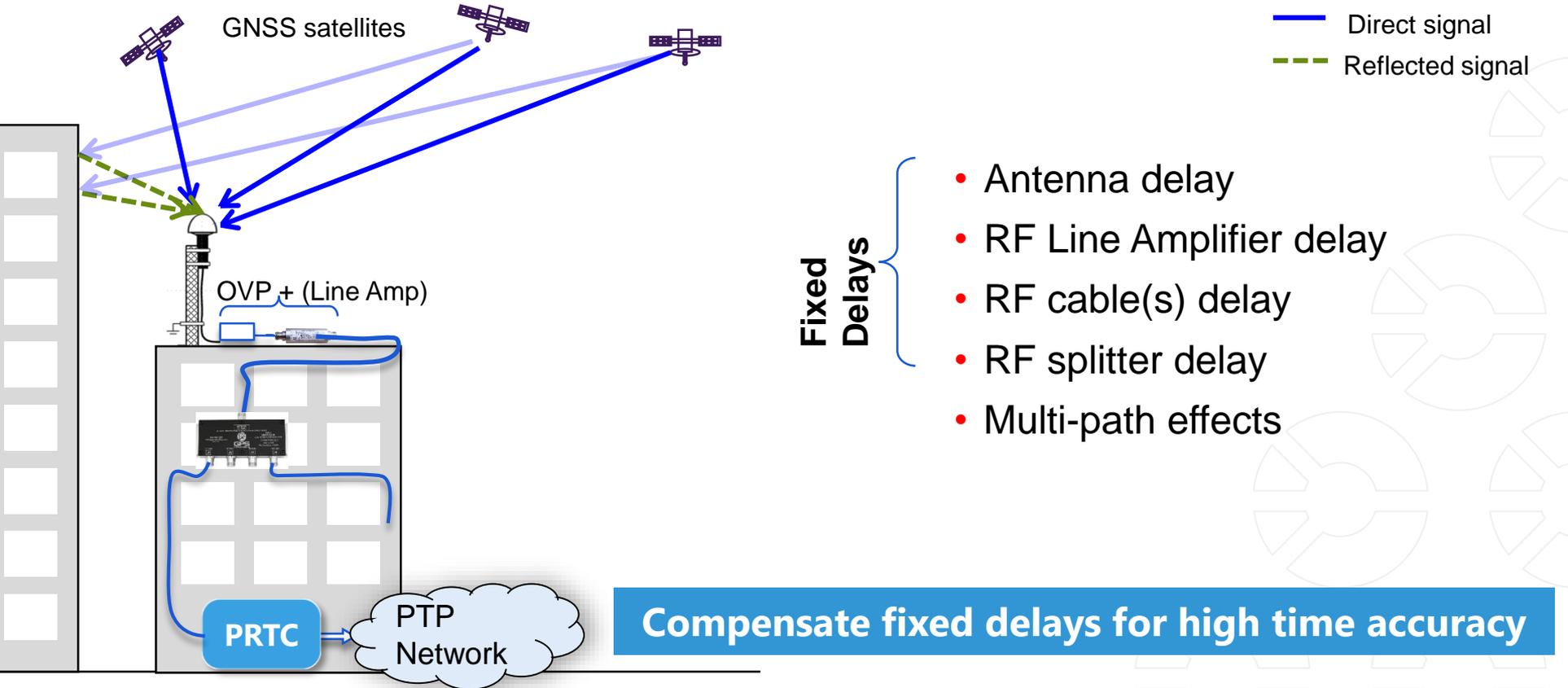
High accuracy; **GNSS based solution;** low in network

IOT PRTC requirements

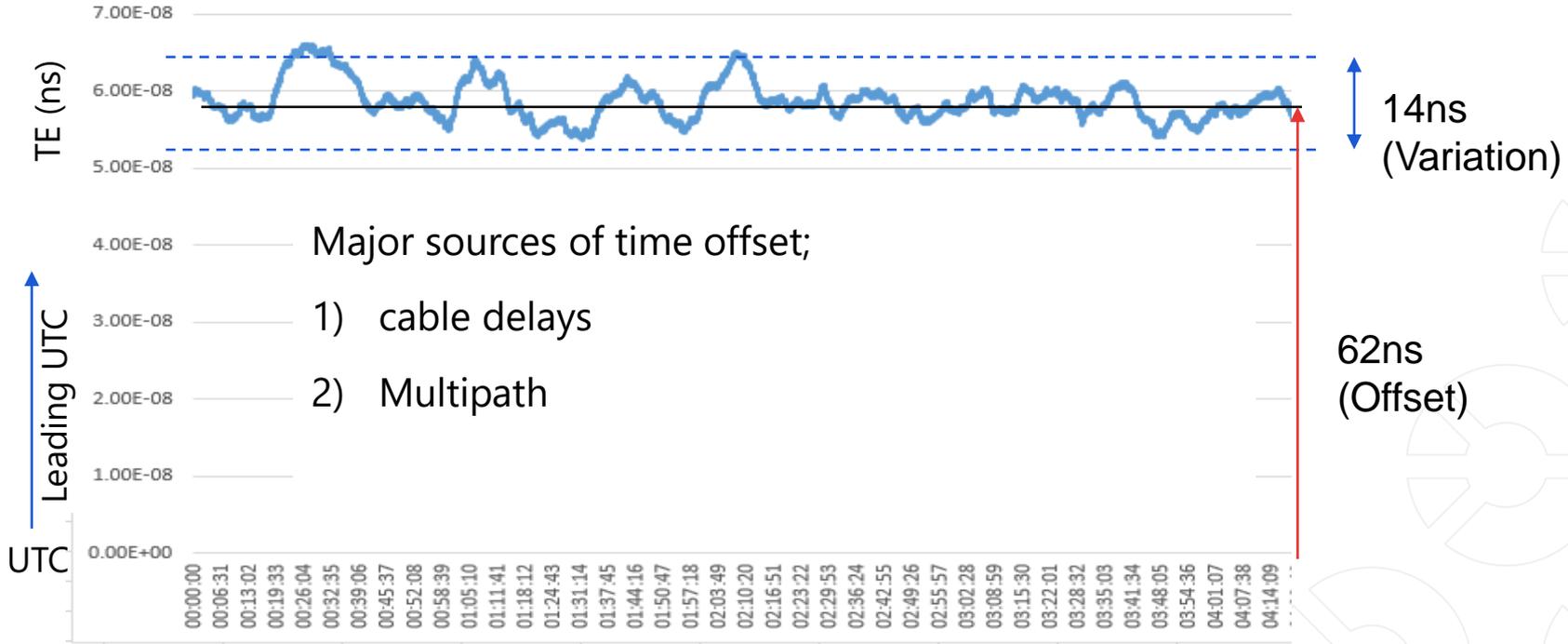
- Simple installation
- Indoor or Outdoor
- No calibration / compensation
- “UTC out-of-the-box”
- Protection via network



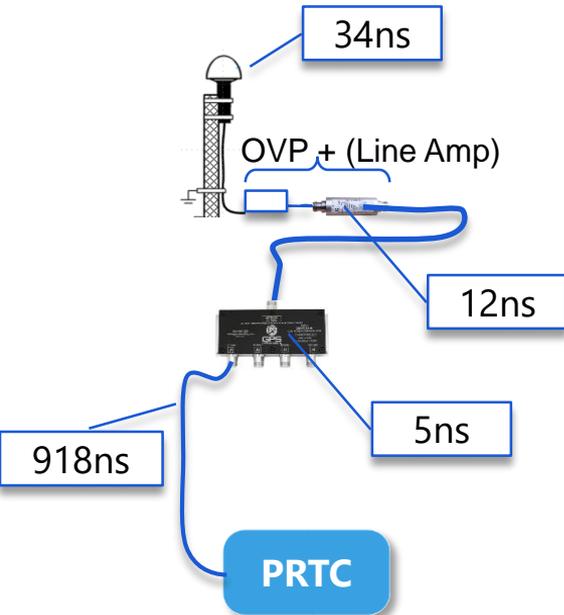
PRTC time error with traditional "system"



Time Variation + offset (or ACDC)



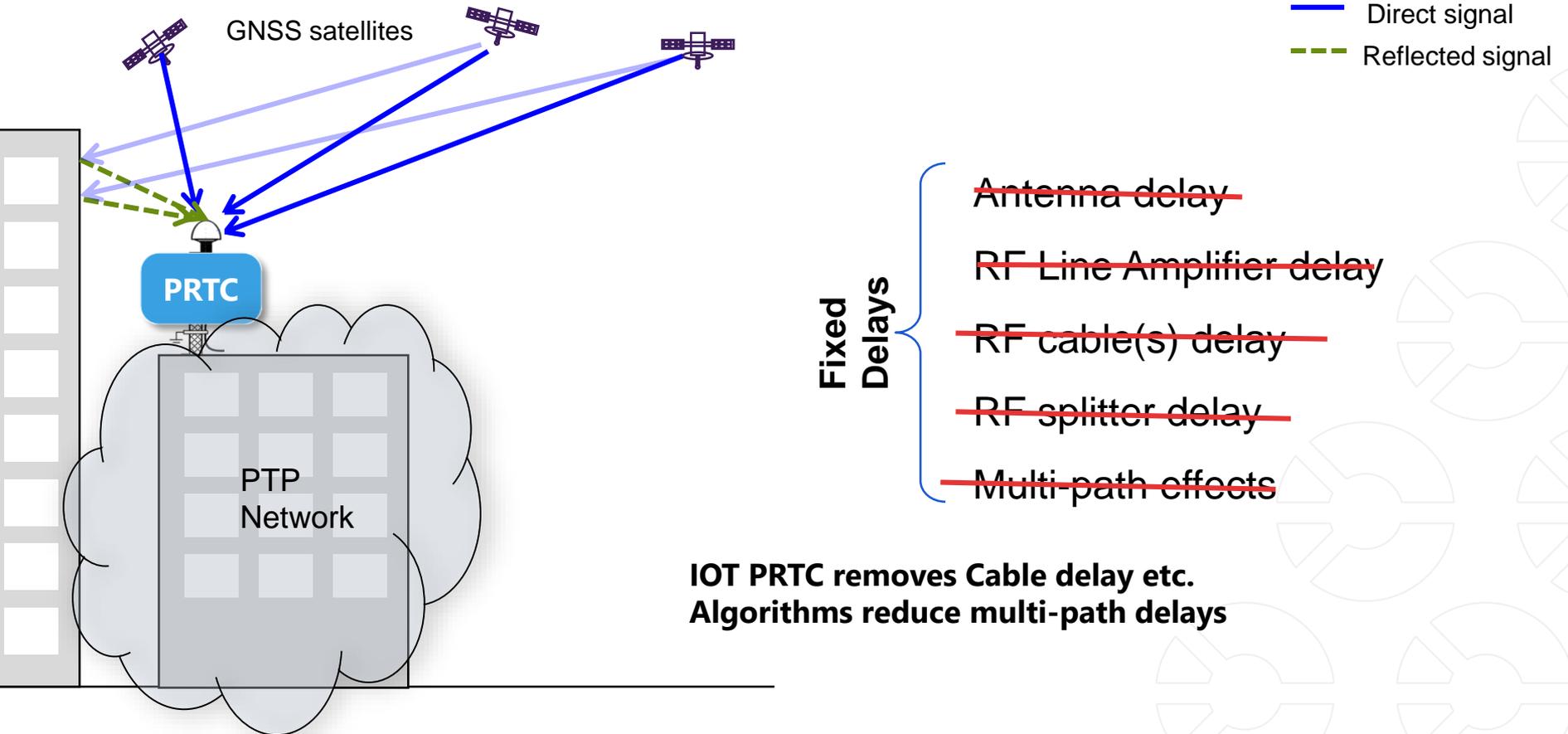
PRTC accuracy = sum of many "system" parts



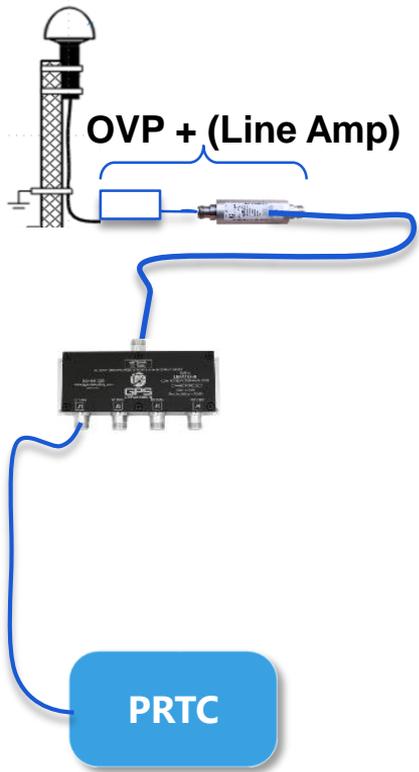
| | Typical Delay (type) | Exact delay (unit) |
|----------------|----------------------|--------------------|
| Antenna | 30ns | 34ns |
| Line Amplifier | 10ns | 12ns |
| Cables | 210m (840ns) | 215m (887ns) |
| Splitter | 15ns | 5ns |
| Total | 895ns | 938ns |

Accurate compensation of RF delays is difficult

Sources of time error with IOT PRTC



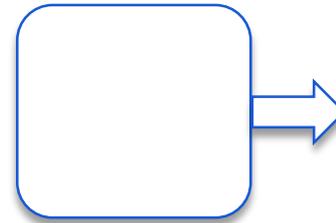
Evolution of PRTC to IOT PRTC



Outdoors



Indoors



UTC

IOT PRTC = Ease of installation + Low cost

- Integrated GNSS antenna with PTP grand master
- Standard Ethernet/IP connectivity
- Installation - Indoor or simple outdoor locations
- No delay compensation required
- Copper or Fibre connection (reach + lightning immunity)



Outdoor



Indoor



Mounting Options for urban canyons

Location choice



Indoor - Window



Outdoor - Pole / Wall / Roof

Indoor Small Cell Sync Requirements

- GM with integrated GNSS antenna
 - optional external antenna
- PTP capacity for building (~64)
- Cost effective and compact design
- Window installation
- Ethernet cabling:
 - Copper/POE
 - Fibre
- Multiple protection options:
 - Sync-E
 - PTP
 - APTS
- Supports multiple profiles



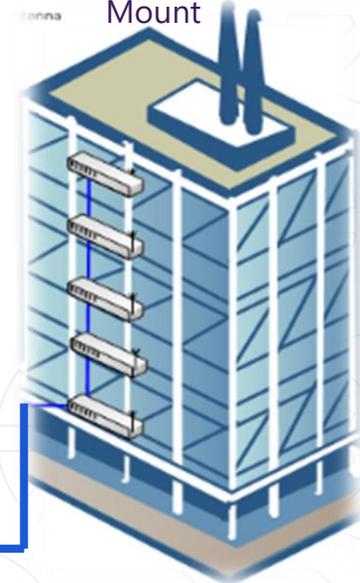
Outdoor Small Cell Sync Requirement

- Features as Indoor plus...
- Options to be installed on:
 - external walls,
 - Pole / lamp post,
 - roof
- Rugged device
 - -40C to +65C
 - IP66 waterproof

Pole Mount

Street
Cabinet
Top

External
Wall
Mount



GNSS/PRTC/PTP GM

Measurement Results

From VTT Finnish Timekeeper



Antenna/GM testing locations at VTT

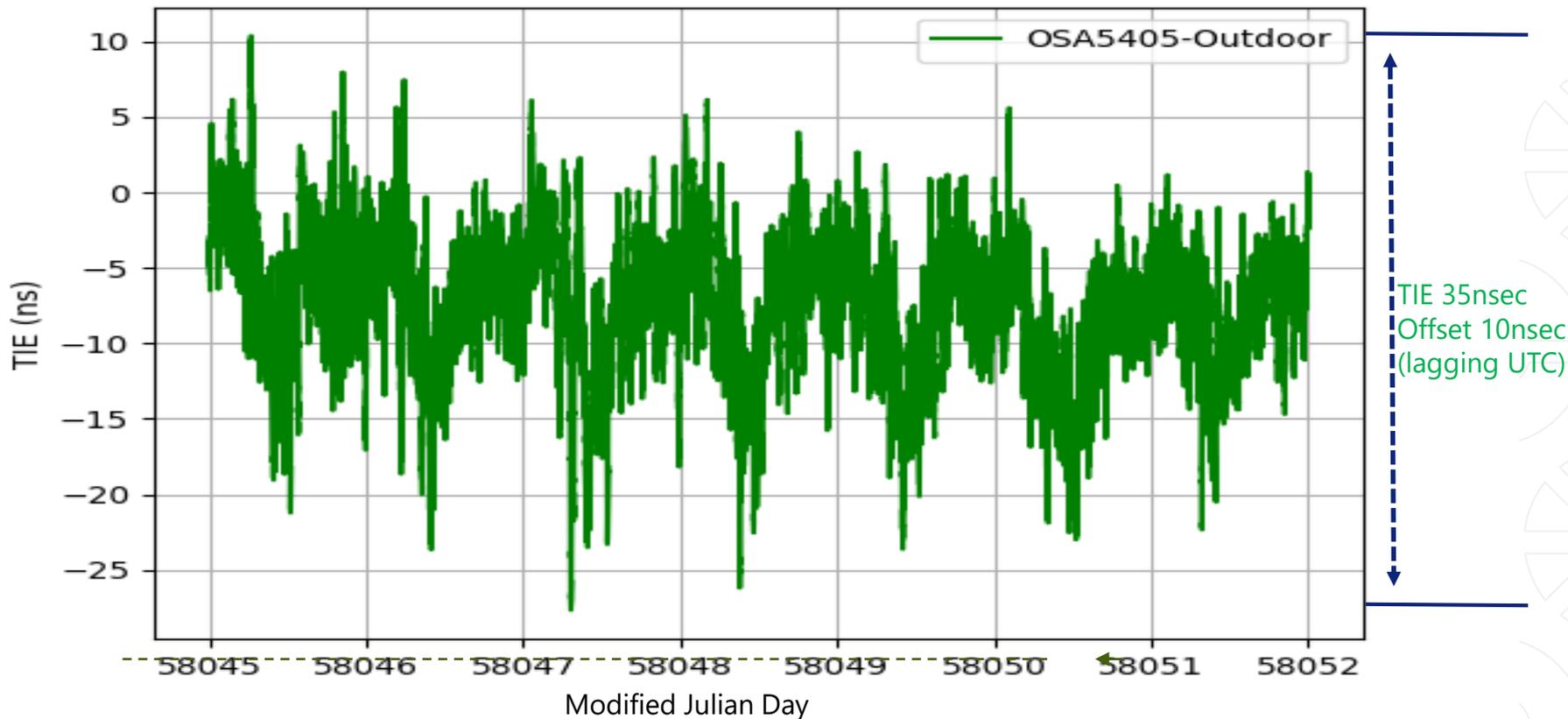
#1 Indoor (glass bricks); #2 Outdoor (wall)



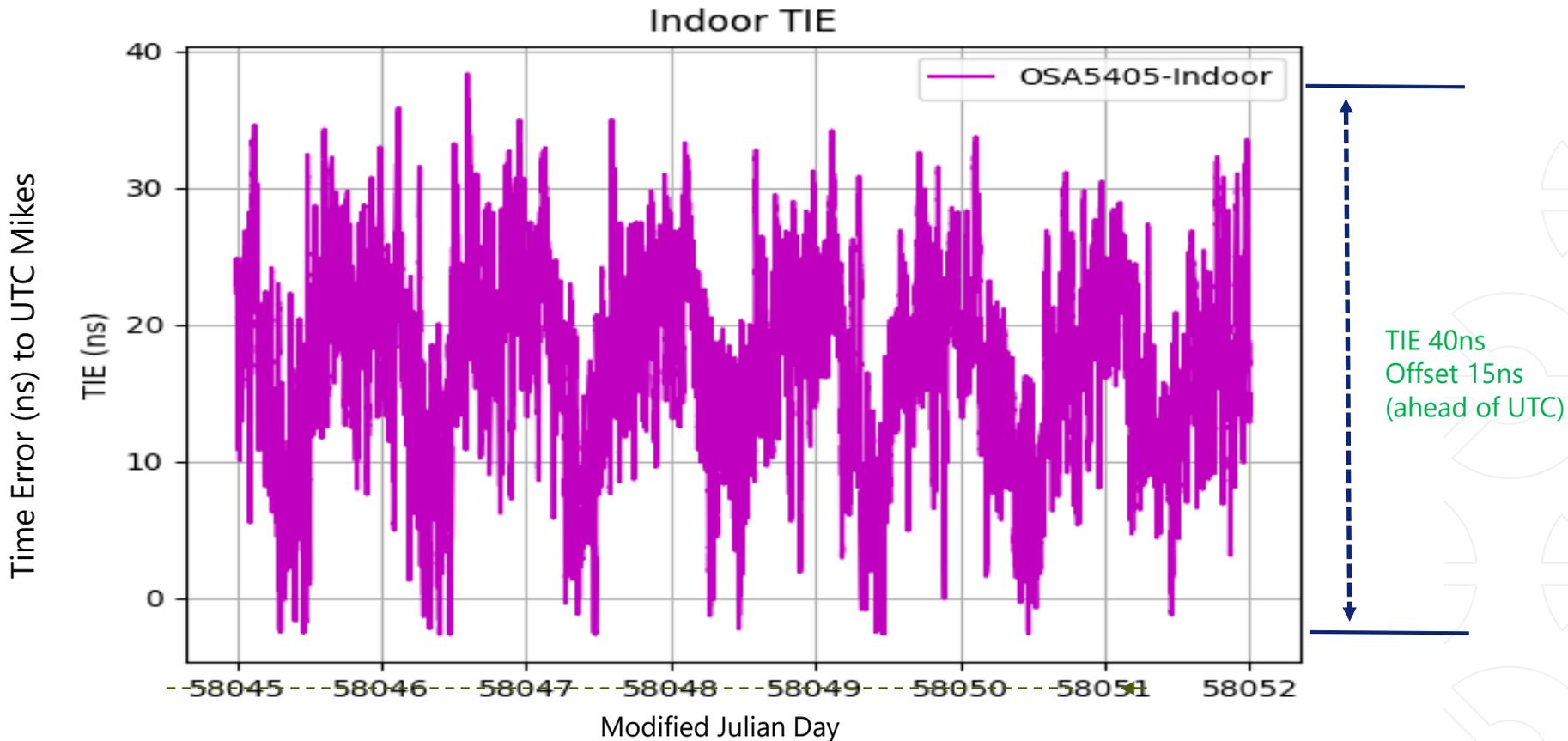
VTT Test results (~1 week) 5405 Outdoor

Outdoor TIE

Time Error (ns) to UTC Mikes

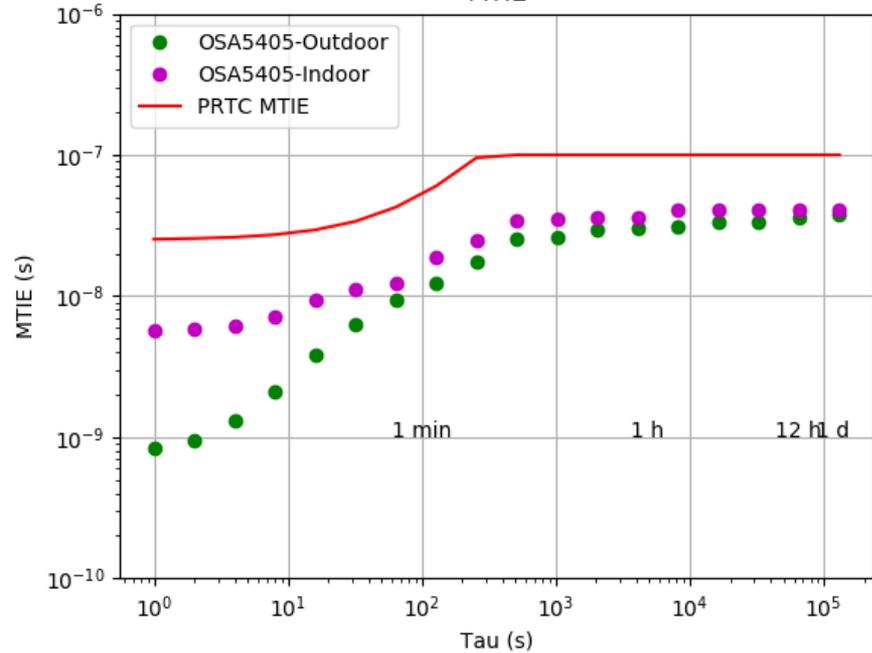


VTT Test results (~1 week) 5405 Indoor

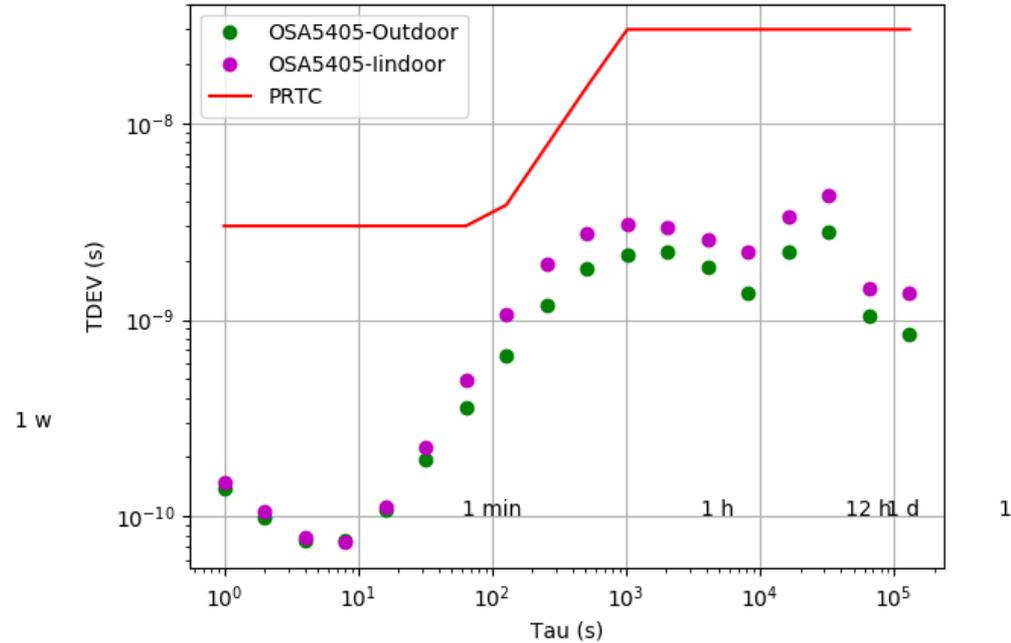


VTT Test results – MTIE / TDEV

MTIE

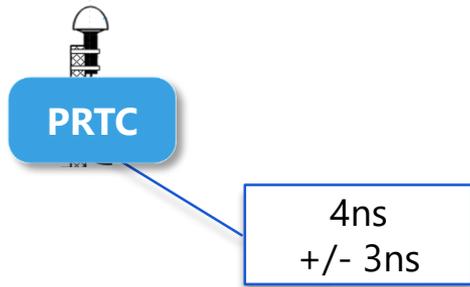


TDEV



IOT PRTC – suitable for ultra high accuracy

(Per-unit compensation is possible)



| | Typical (type) | Exact (unit) |
|-----------------|----------------|--------------|
| Time offset | 0ns | 4ns |
| Time variation* | +/-3ns | +/-3ns |

* Depends on installation location and GNSS constallations used



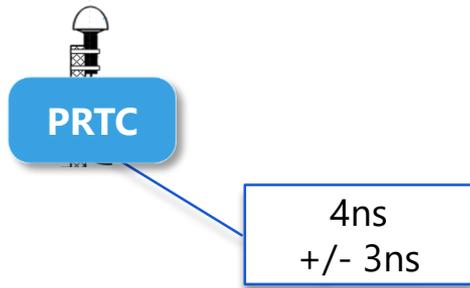
Extremely low fixed time offset

Time offset stable across e.g. link flaps

“Precise UTC out-of-box”

IOT PRTC – suitable for ultra high accuracy

(Per-unit compensation is possible)



| | Typical (type) | Exact (unit) |
|-----------------|----------------|--------------|
| Time offset | 0ns | 4ns |
| Time variation* | +/-3ns | +/-3ns |

* Depends on installation location and GNSS constallations used



Extremely low fixed time offset

Time offset stable across link flaps; resets; etc.

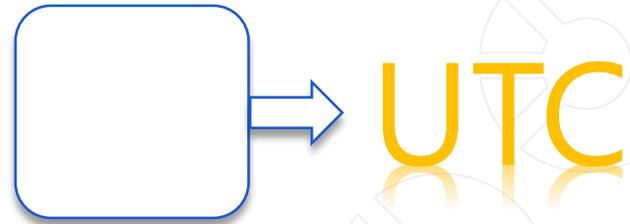
“Precise UTC out-of-box”

Conclusions - IOT PRTC

Easier-to-install and lower-cost solution

PRTC accuracy Indoors and in deep Urban Canyons
(multi-Path delay reduction)

Also platform for high accuracy





Selecting the right wave improves packet clock performance

Thank You



Telecom!
Can't you
behave like an
Ordinary clock!



Sorry Telecom!
This PDV would cause
you too much wander.



Most kind Telecom, but
Ordinary clocks don't
surf PDV.





Thank you



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