G.823 and G.824

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Agenda

- **What is G.823 and G.824?**
- **Jitter and Wander**
- **G.823 wander limits**
- **G.824 wander limits**
- **G.823/824 and Synchronization in Packet Network**
- **G.8261 wander limits**
- **Summary**

What is G.823 and G.824?

- **ITU-T Recommendation G.823**
  - **Title: “The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy”**
  - **It specifies the maximum network limits of jitter and wander**
  - **It specifies the minimum equipment tolerance to jitter and wander**

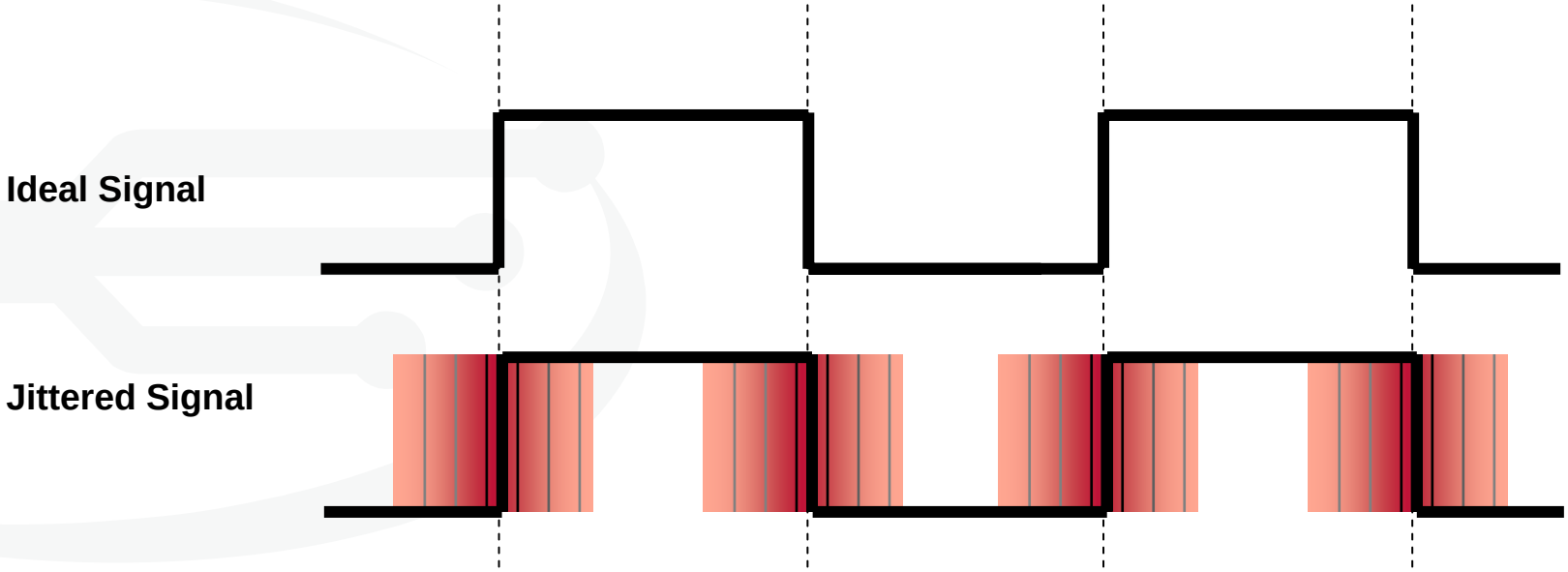
- **ITU-T Recommendation G.824**
  - **Title: “The control of jitter and wander within digital networks which are based on the 1544 kbit/s hierarchy”**
  - **It specifies the maximum network limits of jitter and wander**
  - **It specifies the minimum equipment tolerance to jitter and wander**

Jitter and Wander in the Network

- **Jitter and Wander in the network**
  - **Can affect digital signals**
    - **By generating bit errors, slips and other abnormalities**
  - **Can affect analogue signals**
    - **By generating phase modulation of the transmitted signal**
- **Synchronization is important**
  - **Avoids overflow or underflow of slip buffers, bit errors and other adverse effects**
  - **ITU-T Recommendation G.822 provides criteria for controlled slip rate**
- **High frequency noise (jitter) can be filtered out, but low frequency noise (wander) is difficult to filter**

What is Jitter?

- **ITU-T Recommendation G.810 defines jitter**
  - **“ (timing) jitter: The short-term variations of the significant instants of a timing signal from their ideal positions in time (where short-term implies that these variations are of frequency greater than or equal to 10 Hz).”**



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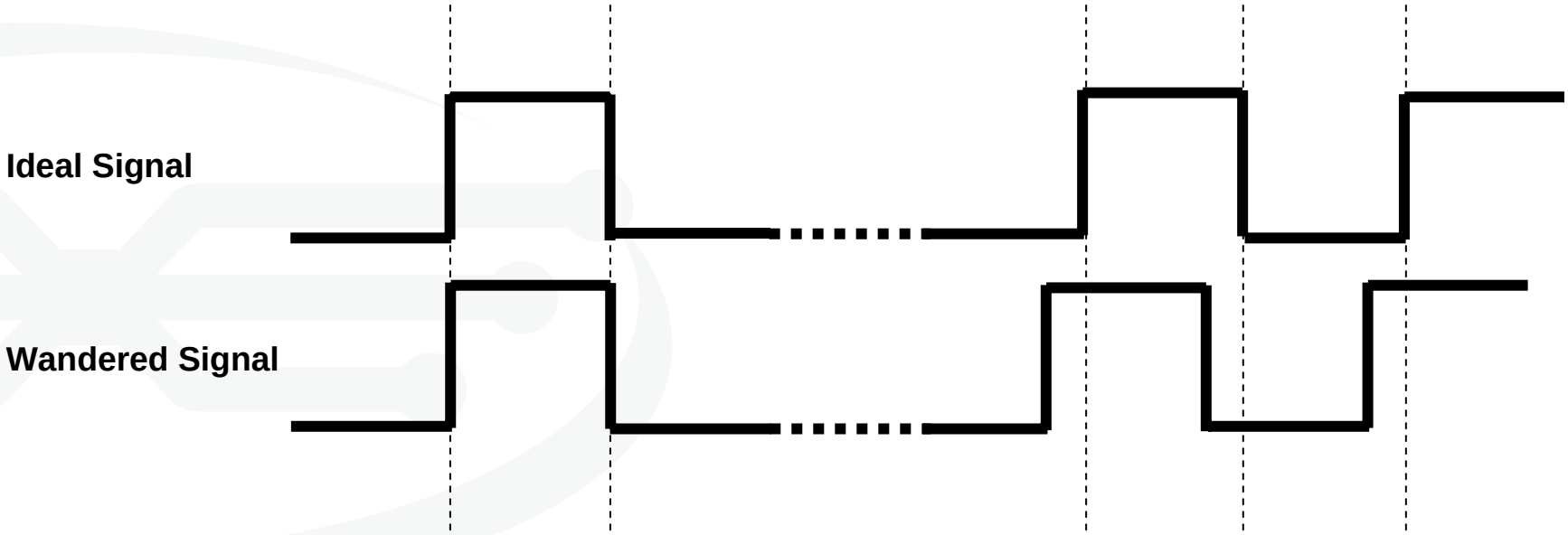
What is Wander?

- **ITU-T Recommendation G.810 defines wander**
  - **“wander: The long-term variations of the significant instants of a digital signal from their ideal position in time (where long-term implies that these variations are of frequency less than 10 Hz).”**



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Wander

- **Wander can affect slip buffers**
  - **Can cause overflow/underflow of buffers**
  - **The slip rate (Fslip) can be expressed as**

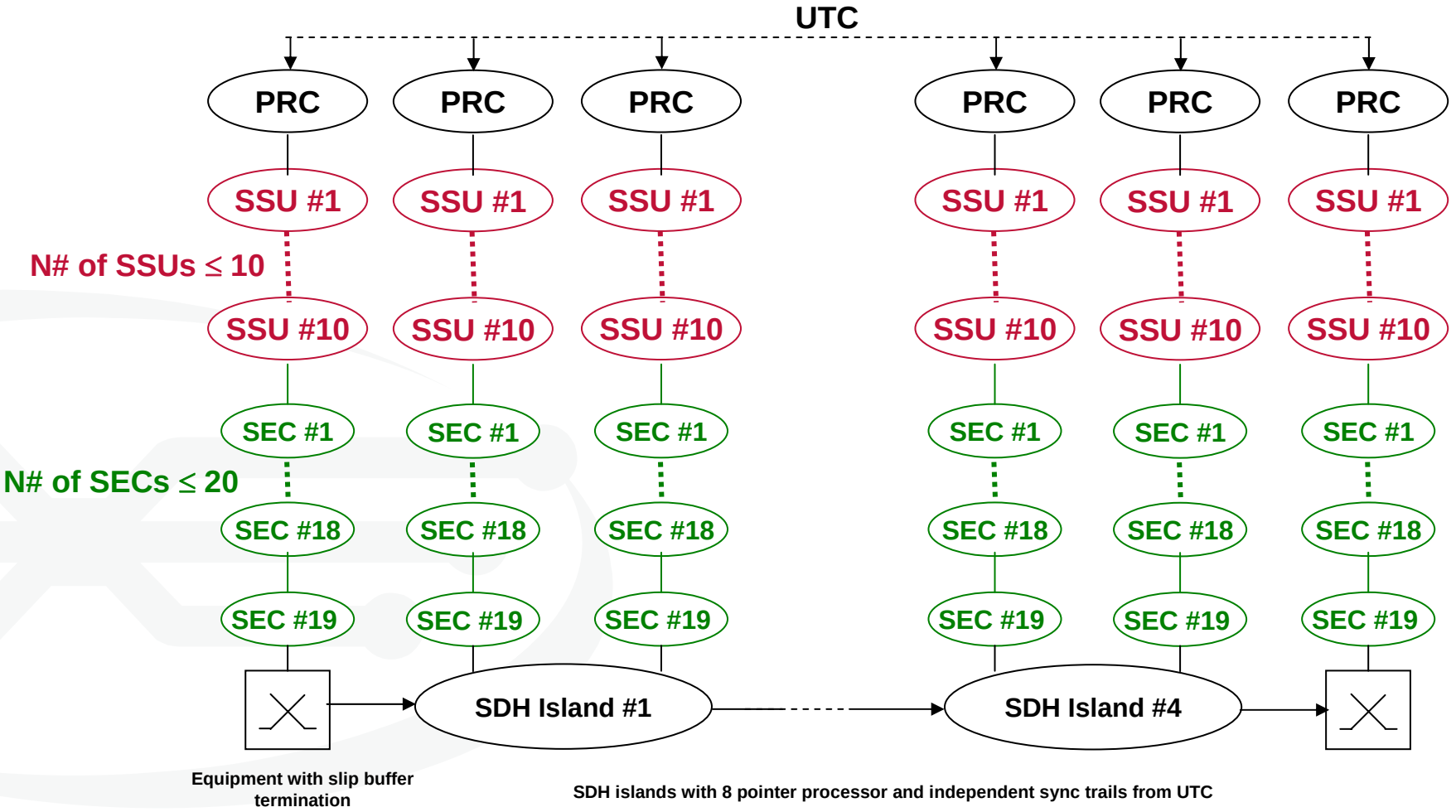
    $$Fslip = 86400 * f_{offset} / N$$

    N is the number of bits repeated or lost in one slip

    86,400 is the number of second in one day
  - **Control of wander is very important to avoid slips**
  - **ITU-T G.822 specifies the controlled slip rate**

    Slip performance better than 0.3per day (98.9% of the time)
- **Wander can be caused by**
  - **Temperature variations in cable**
  - **Asynchronous mapping**
  - **Clock noise and transients**

G.823 Clock Wander Accumulation Model



Total n# of SECs ≤ 60

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Wander Budget

Wander effects	Wander Allocation
Diurnal wander due to environmental effects	1μs
Mapping wander due to asynchronous 2048kbit/s mapping	2μs
Wander caused by clock noise and transients	15μs
Total	**18μs**

G.823 Wander Limits – Traffic Interface

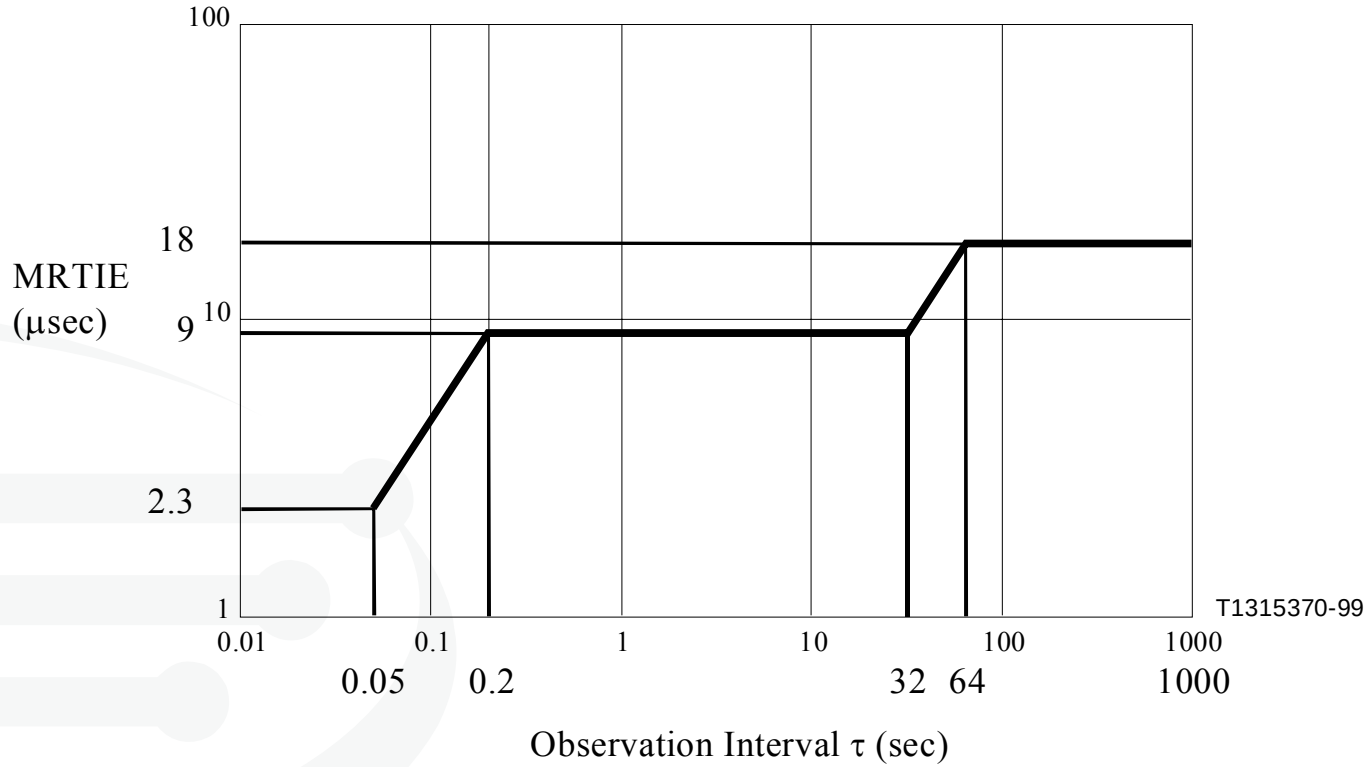


Figure 1/G.823 – 2048 kbit/s interface output wander limit

G.823 Wander Limits – PRC Interface

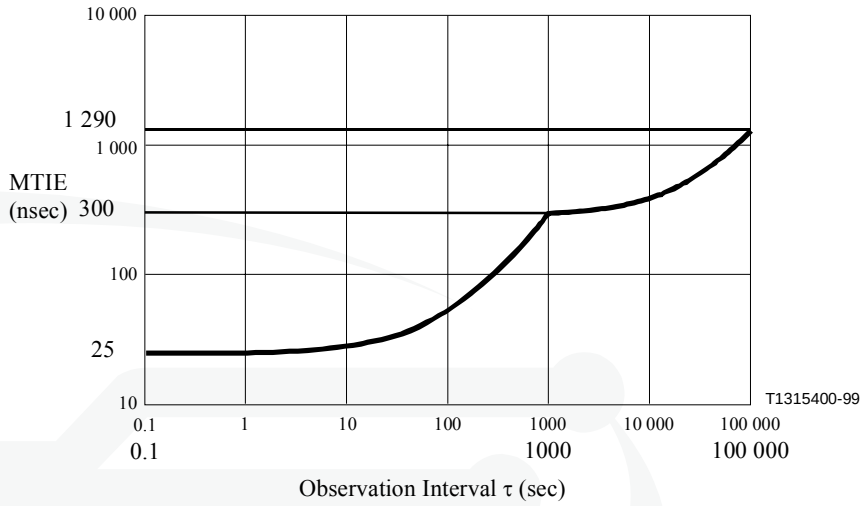


Figure 4/G.823 – Network limit for wander (MTIE) at PRC interfaces

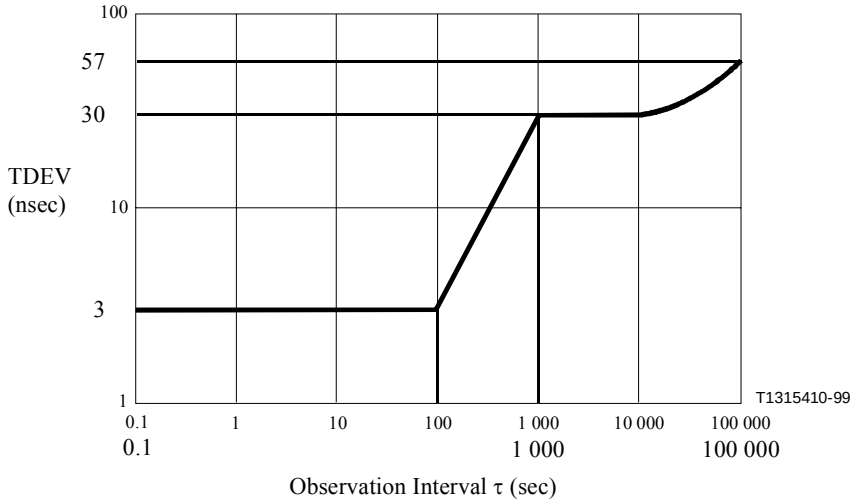


Figure 5/G.823 – Network limit for wander (TDEV) at PRC interfaces

G.823 Wander Limits – Synchronization Interface

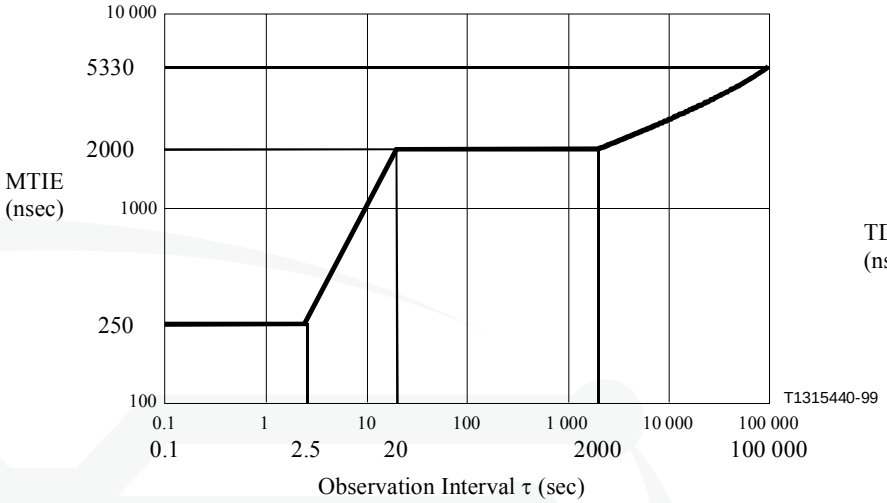


Figure 8/G.823 – Network limit for wander (MTIE) at SEC interfaces

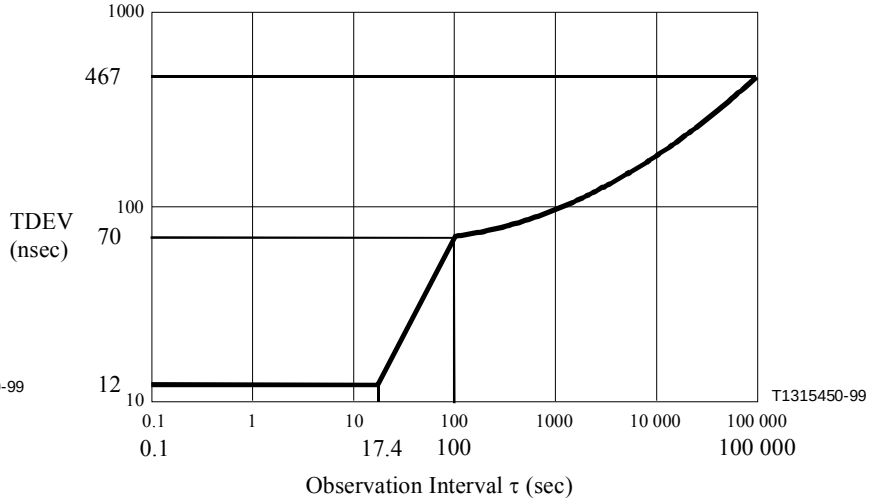
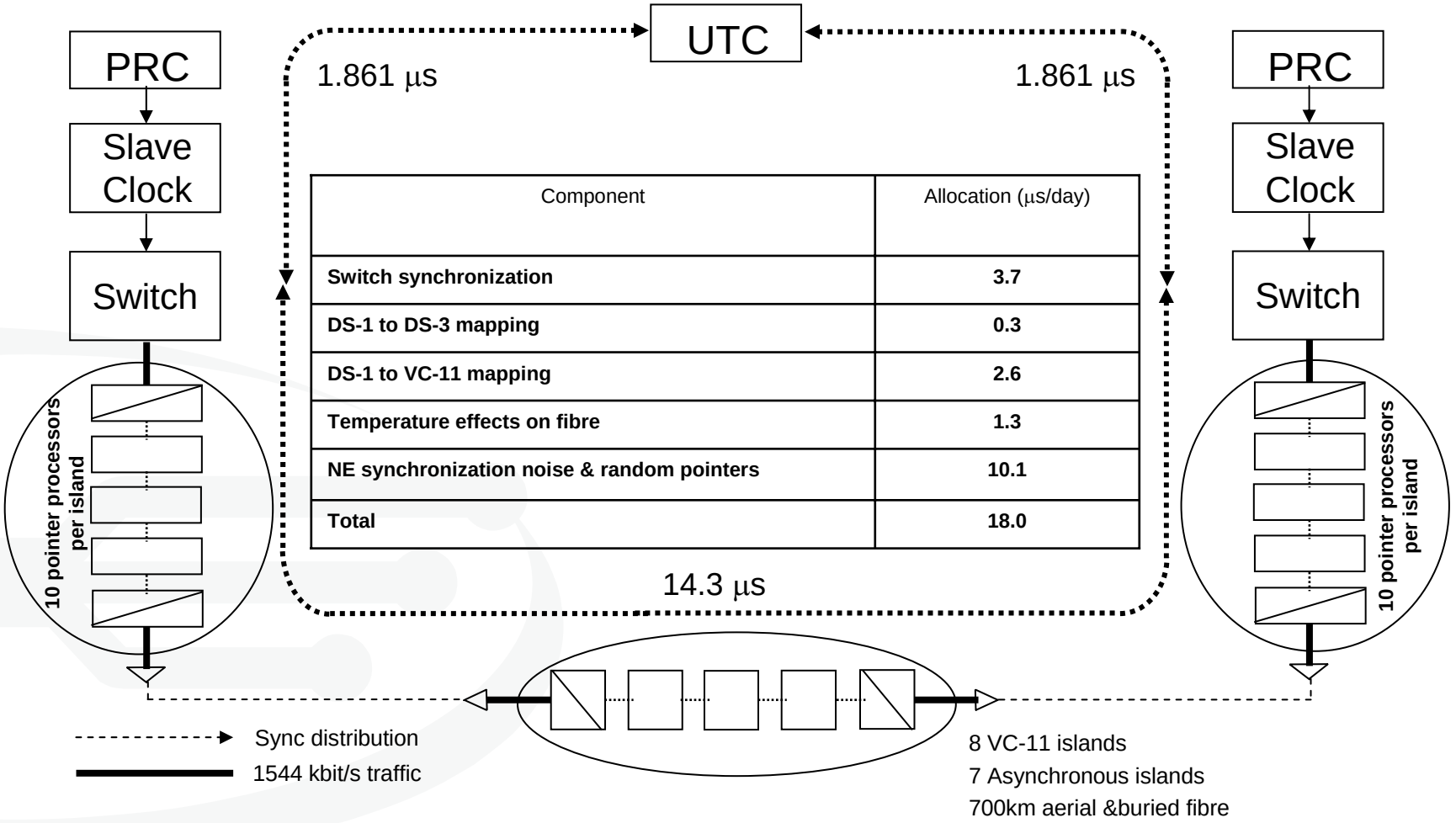


Figure 9/G.823 – Network limit for wander (TDEV) at SEC interfaces

G.824 Wander Accumulation Model



Component	Allocation (µs/day)
Switch synchronization	**3.7**
DS-1 to DS-3 mapping	**0.3**
DS-1 to VC-11 mapping	**2.6**
Temperature effects on fibre	**1.3**
NE synchronization noise & random pointers	**10.1**
Total	**18.0**

Figure A.1/G.824 – SDH VC-11 island wander reference model and wander budget

G.824 Wander Limits – Traffic Interface

Observation interval (τ) in seconds	MTIE in µs
$\tau \leq 900$	8.4
$900 < \tau \leq 86\,400$	18.0

Table 2/G.824 Synchronous network interface for 1544 kbit/s rate

"At the network interface, the wander of a 1544 kbit/s network signal shall not exceed an MTIE (τ) of 28 UI (18 µs) for τ = 24 hours; nor shall it exceed an MTIE (τ) of 13 UI (8.4 µs) for τ = 15 minutes (see Table 2)."

G.824 Wander Limits – PRC Interface

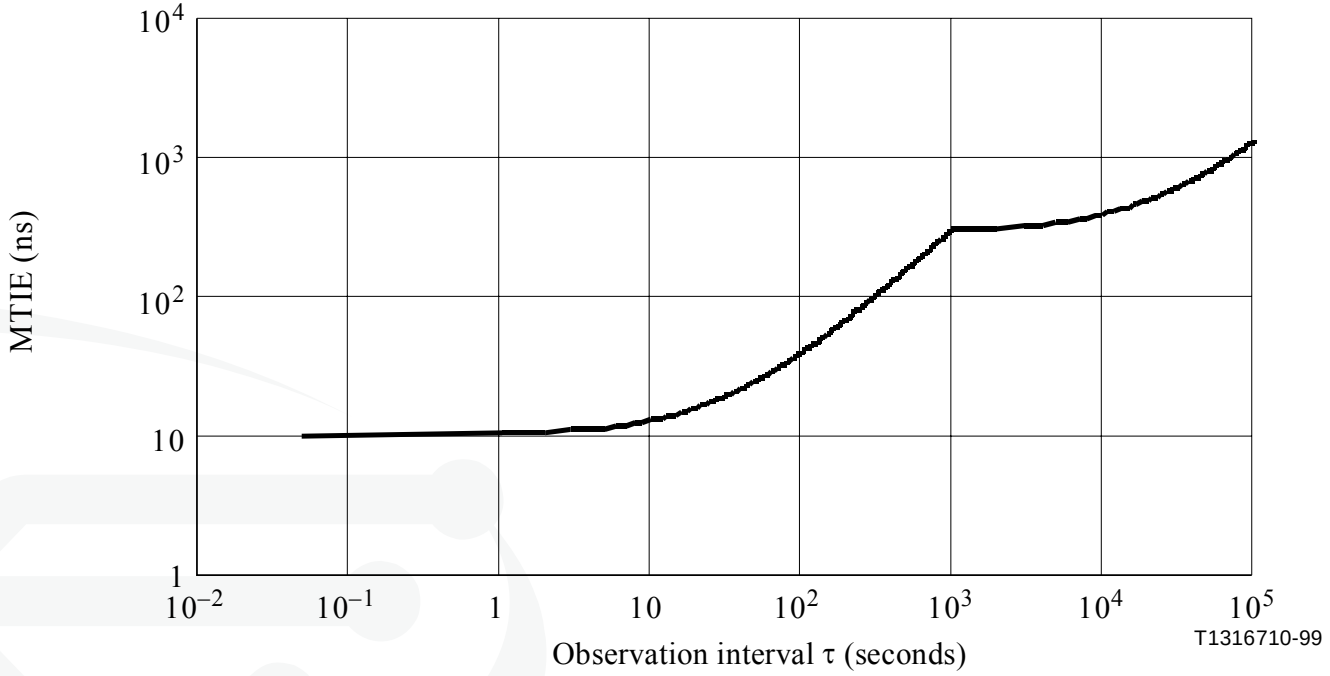


Figure 2/G.824 – MTIE limit at the output of a Primary Reference Clock

G.824 Wander Limits – Synchronization Interface

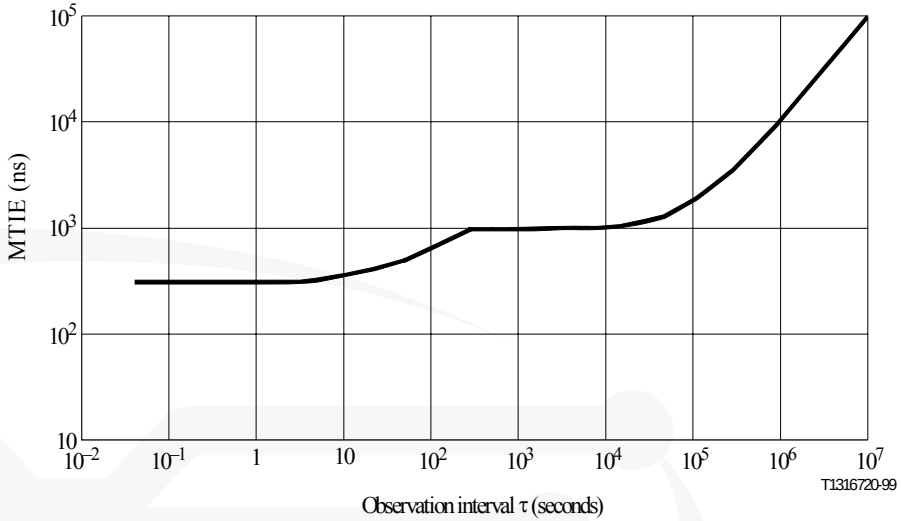


Figure 3/G.824 – MTIE limit for 1544 kbit/s reference signals

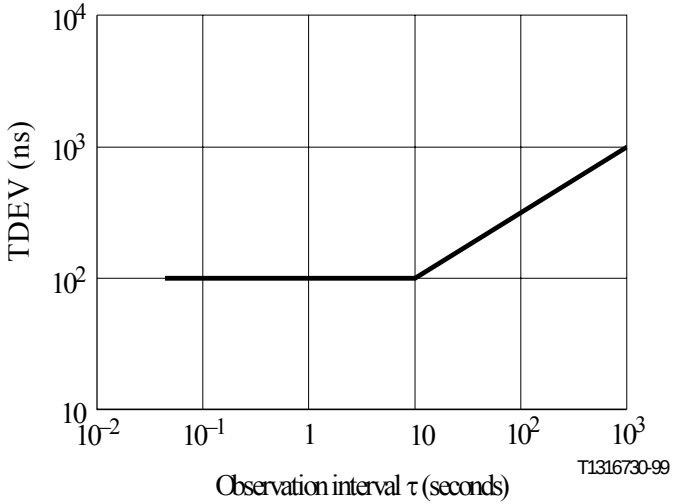


Figure 4/G.824 – TDEV limit for 1544 kbit/s reference signals

G.823/824 and Synchronization in Packet Network

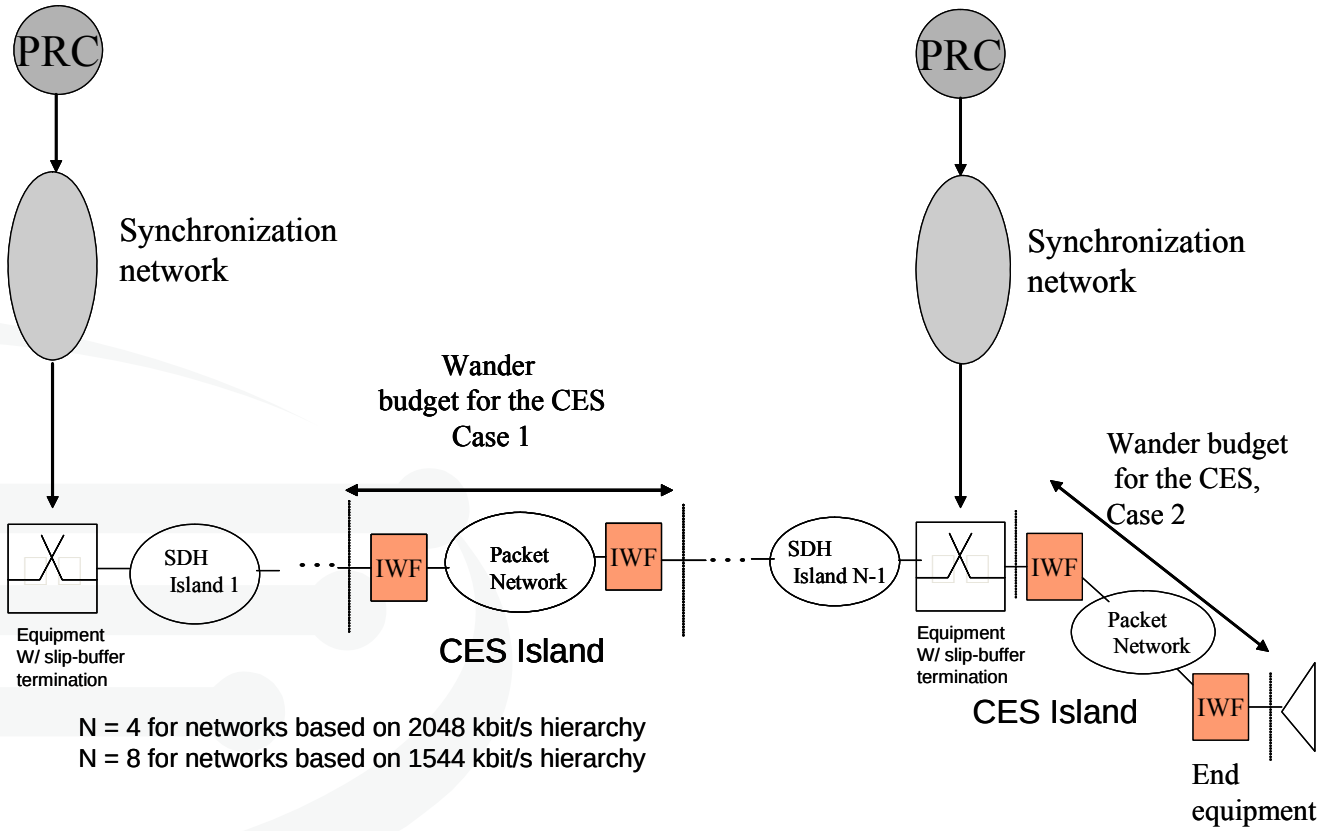
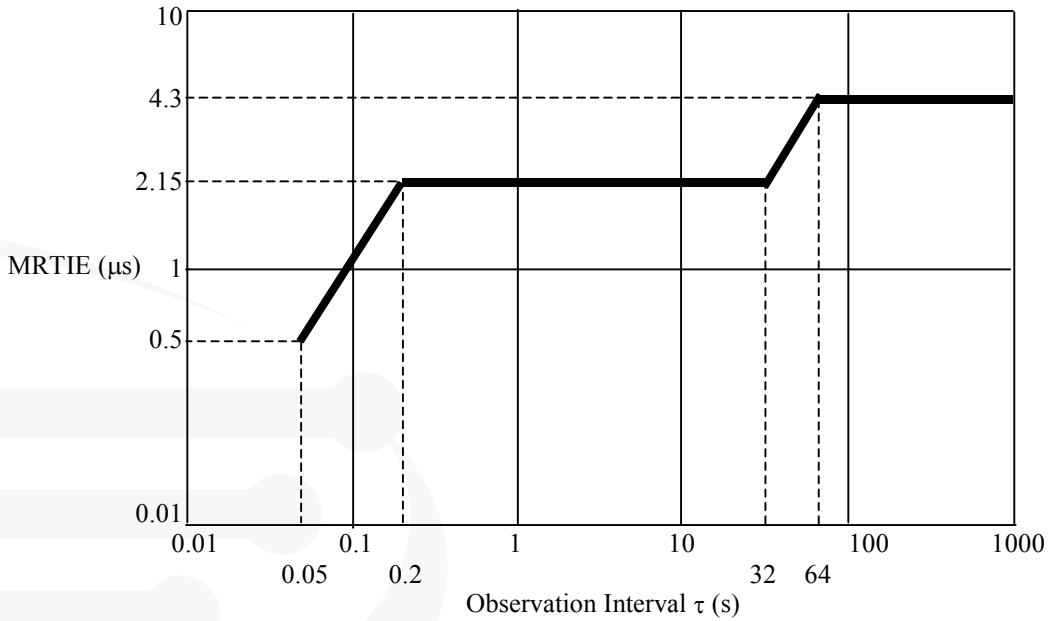


Figure 1/G.8261 - Network Models for traffic and clock wander accumulation, Deployment Case 1 and Case2

ITU-T G.8261 Wander Limit



Graph based on Table 1/G.8261, Deployment Case 1: 2048 kbit/s interface output wander limit

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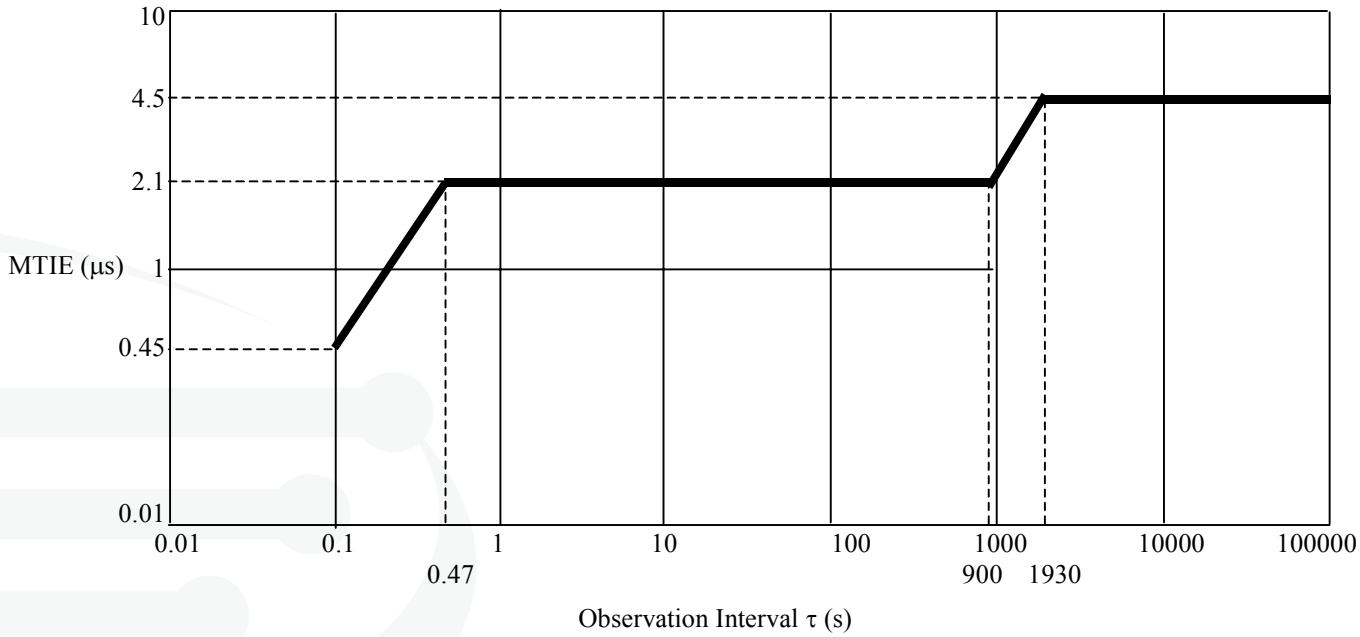
ITU-T G.8261 Wander Limit



Graph based on Table 2/G.8261/Y.1361 – Deployment Case 1: Wander limit for 1544 kbit/s interface

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Summary

- **ITU-T G.823 and ITU-T G.824 are very important Recommendations for synchronization**
- **These specifications still need to be met to allow legacy equipment in the network to interoperate in a Packet Switched Network**
- **ITU-T G.8261 was the first Recommendation to address synchronization in Packet Switched Network**
  - **G.823 and G.824 Recommendations were important input to it**
- **Study Group 15, Question 13 are working on a series of Recommendations for transporting synchronization over Packet Switched Network**

Thank you!

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