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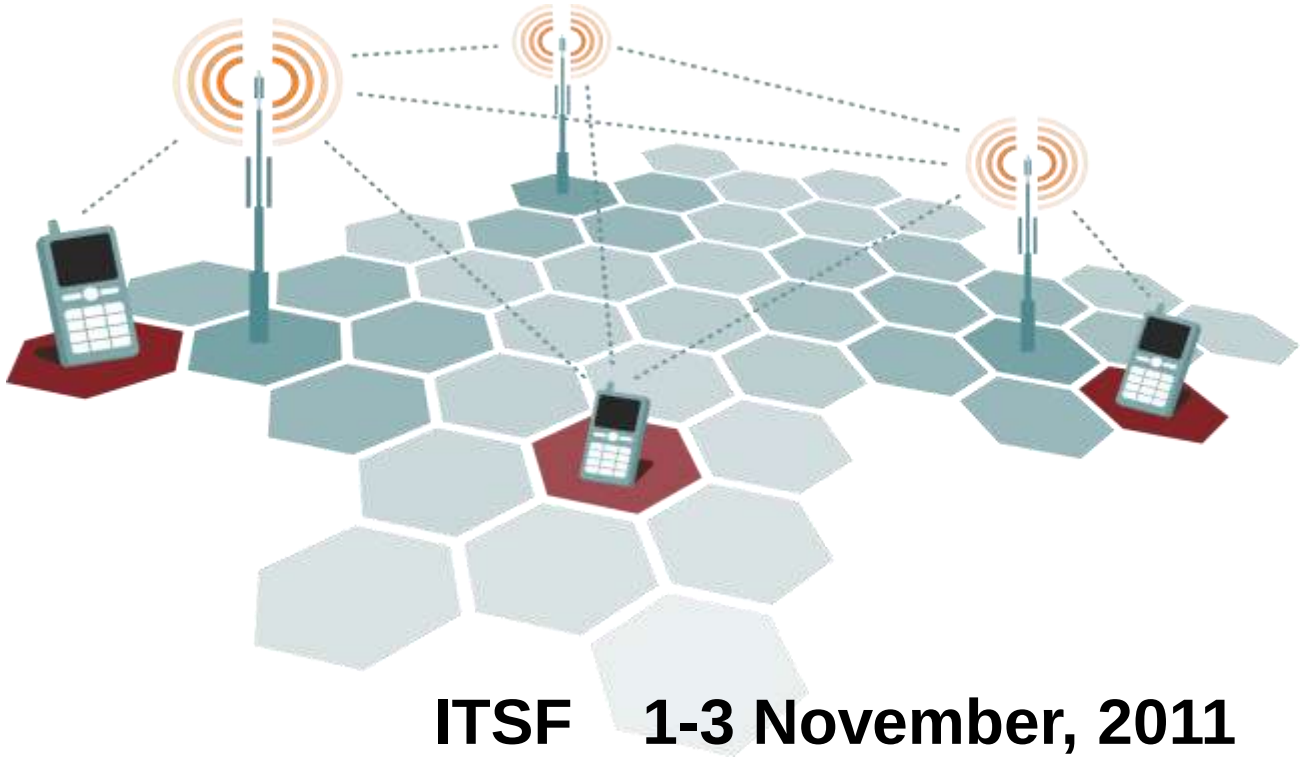

ITSF 1-3 November, 2011

Status of ITU SG15 synchronization standards

Presenter: Jean-Loup Ferrant ITU-T SG15 Q13 rapporteur
sponsored by Calnex Solutions Ltd

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Synchronization activity in ITU SG15

Q2 **Optical systems for fibre access networks**

Q4 **“DSL”**

Q9 **Transport equipment and network protection/ restoration (responsible for G.781, synchronization layer)**

Q13 **Network synchronization and time distribution performance**

Q15 **Test and measurement techniques and instrumentation (responsible for the jitter and wander test equipments)**

1-Status of synchronization standards in ITU

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	TDM	OTN	SyncE	packets Frequency	packets time
Definitions	•G.810			•G.8260	
Architecture	•G.803	G.8251	•G.8261	•G.8265	•G.8275
Performance	•G.823/4 •G.825	G.8251	•G.8261	•G.8261.1	•G.8271
Functional model	•G.781 •G.783	G.8251	•G.8264 •G.781	•G.8261	•G.8271
Profile				•G.8265.1	•G.8275.1
Clock specification	•G.811 •G.812/3	G.8251	•G.8262	•G.8263	•G.8272 •G.8273.n
Simulations					G.Sup
Test equipment	•O.171 •O.172	O.173	•O.174		

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1-Overview of available and future recommendations for packet networks

2-Recent Consents in 2010 and february 2011

- 2.1 Definitions G.8260
- 2.2 Frequency transport-SyncE G.8262, G.8264
- 2.3 Frequency transport G.8261, G.8265, G.8265.1
- 2.4 OTN G.8251

3-Expected consents in December 2011

- 3.1 G.8260- Metric appendix
- 3.2 G.8261.1 Network limits
- 3.3 G.8263 packet clock for frequency distribution over packets
- 3.4 G.8271 Requirements for transport of time over packet networks
- 3.5 G.8251 corrigendum OTN
- 3.6 G.8264 Amd2 SyncE

4-Q13 current work

- 4.1-Use of time protocols over PSN for phase and time distribution
- 4.2-Relationship with other SG15 questions

5 List of ITU-T SG15 recommendations for synchronization

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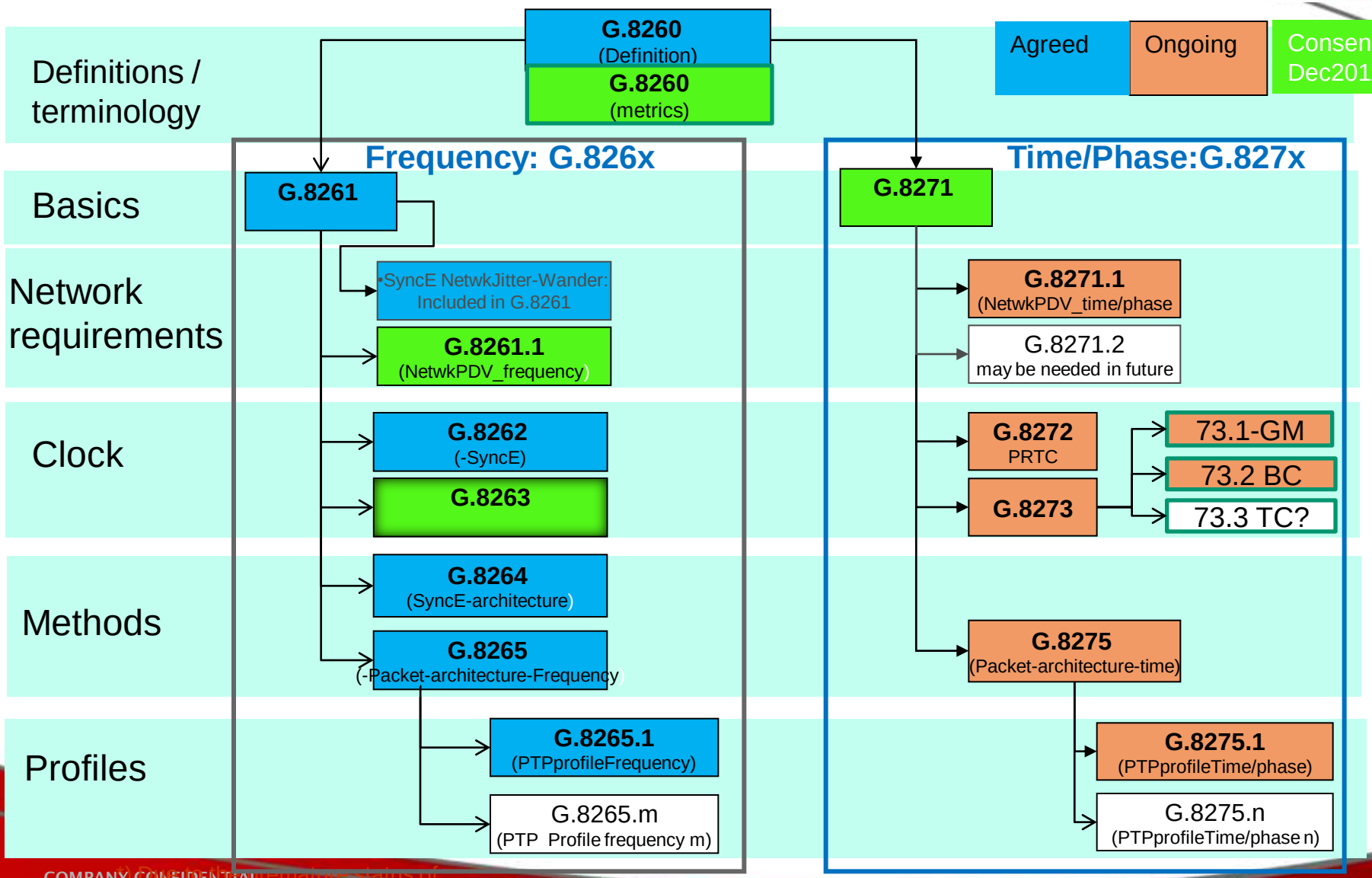
1-Overview of recommendations



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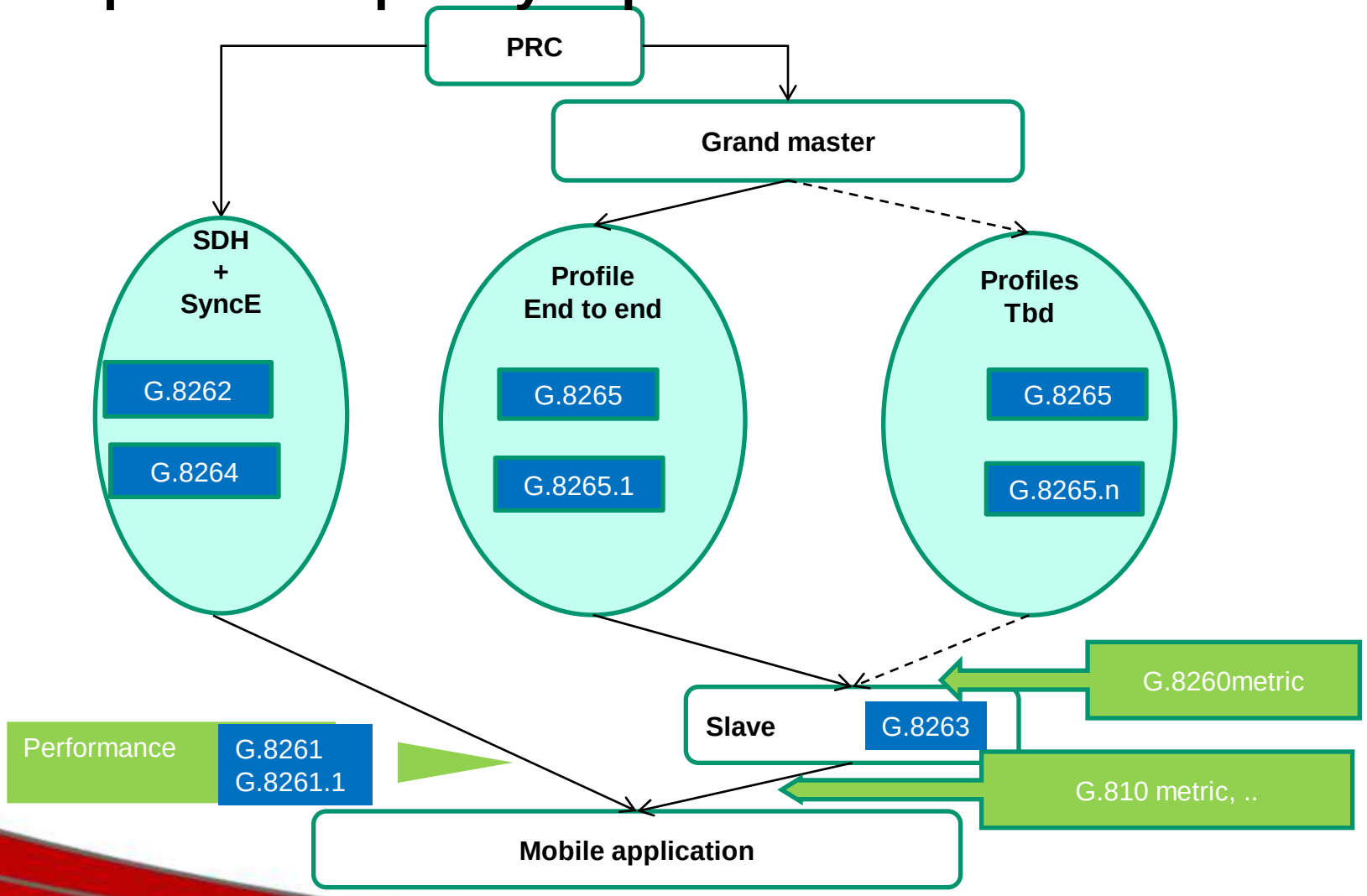
Transport of frequency in packet networks



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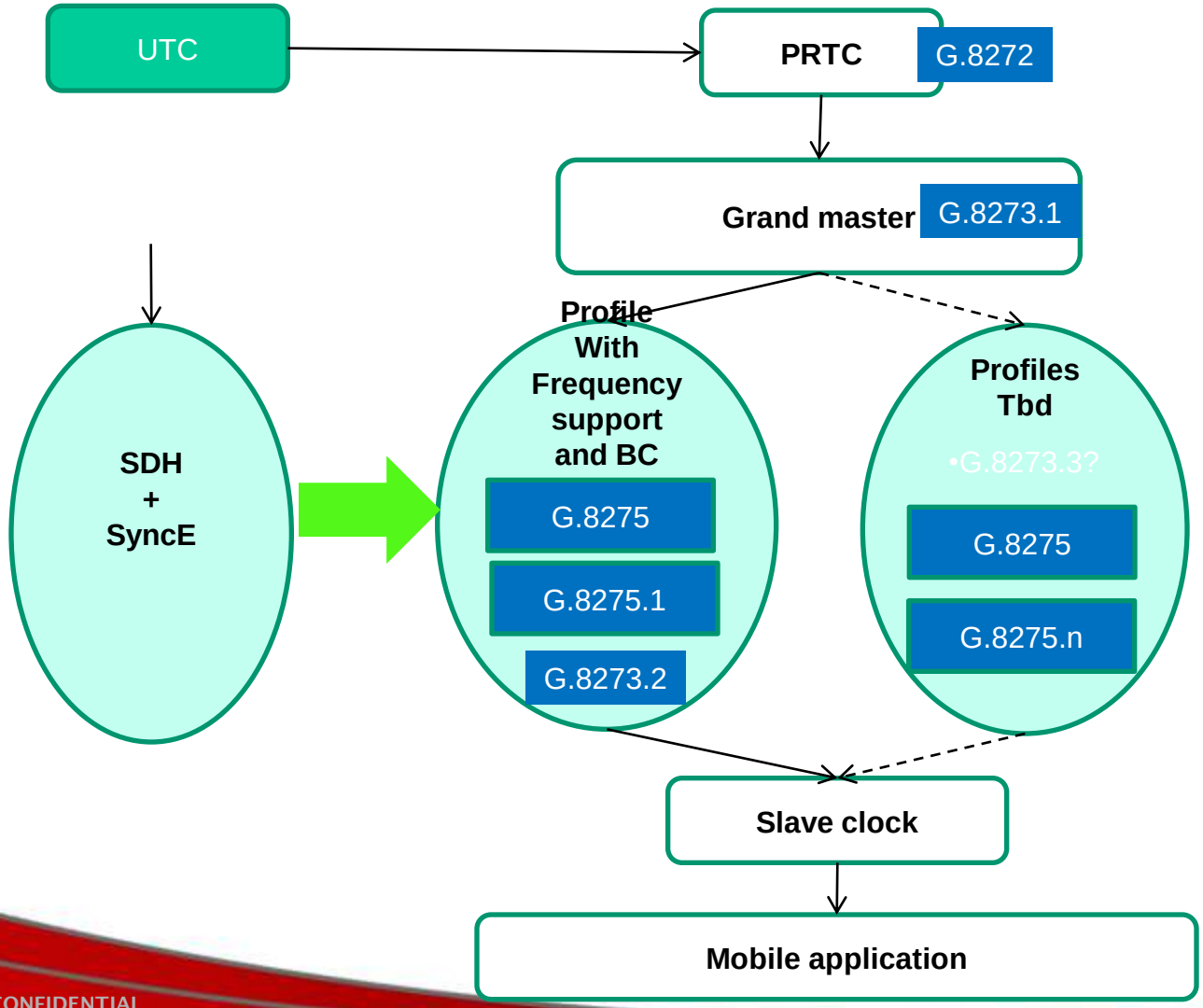
Transport of time in packet networks



2- Recent consents

documents consented in June 2010 and Feb2011 plenary

G.8260 new recommendation (06/2010) on definitions

Frequency transport-SyncE

- ***G.8261 Amd1 (06/2010)***
- ***G.8262 new version (06/2010)***
- ***G.8264 Amd1 (06/2010)***

Frequency transport- 1588 profile

- ***G.8265 new recommendation (06/2010)***
- ***G.8265.1 new recommendation (06/2010) and Amd1 (02/2011)***

OTN

- ***G.8251 new version (06/2010) and Amd1 (02/2011)***

2.1 G.8260 (June2010) Definitions and metrics for the transport of frequency, phase and time

Equivalent to G.810 for TDM

2.2 Frequency transport- SyncE

G.8262 (june 2010) new version replacing the 2007 one

- **Specification of jitter tolerance and output Jitter at syncE interface for 1G and 10 G**
- **List of Ethernet interfaces applicable to Synchronous Ethernet**

G.8264 Amd1

The main evolution is the operation of SyncE in a multi-operator context

- **Transport of frequency through an intermediate operator**
- **Delivery of frequency by an intermediate operator**

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2.3 Frequency transport

G.8261

Evolution of Fig VI.14 defining test case 17 related to routing changes by failures in the network

Telecom profile for the transport of frequency only

- **G.8265 (June 2010)**

  G.8265 defines high level requirements and the general architecture for frequency transport

- **G.8265.1 (June 2010)**

  Defines the parameters of PTP choosen for the profile

A specific presentation addresses IEEE1588 profiles

2.4-OTN

G.8251 (06/2010) and Amd1(02/2011)

- **New specifications were added to follow evolution of G.709**
- **Introduction of Ethernet in the ODUk clocks**
- **1G Ethernet tributary desynchronizer bandwidth set to 100Hz**
- **Appendix VII introduces a new reference chain, validated by new simulations**

3- Expected consents in december 2011

3.1 G.8260- Metric appendix
3.2 G.8261.1 Network limits
3.3 G.8263 packet clock for frequency distribution over packets
3.4 G.8271 Requirements for transport of time over packet networks
3.5 G.8251 corr1 (OTN)
3.6 G.8264 Amd2 (SyncE)

3.1 G.8260 Metric appendix

2 main classes of PDV metrics were agreed

- **Class A for specification of PDV network limits**
- **Class B for studying network characteristics**

Packet selection

- **2 types: preprocessed and integrated**
- **Methods: minimum, percentile band and cluster**

- **Metric classification**

	Pre-processing	integrated
With pre-filtering	Class A	
Without pre-filtering	Class B	ClassB

3.1-G.8260 Metric appendix (2)

PDV metrics estimating the performance of packet slave clock

- **Metric without pre-filtering, to determine characteristics of packet network in terms of PDV behaviour**

  xTDEV series, x=Min, Percentile, Band and Cluster

- **Metric with pre-filtering, for use to specify network limits**

  MATIE and MAFE

PDV metrics studying minimum floor delay packet population

3.2 G.8261.1

G.8261 specifies HRMs and network PDV limits at reference points

2HRMs have been agreed, HRM1 & HRM2

HRM1 (hypothetic Reference Model) agreed with 10 packet nodes

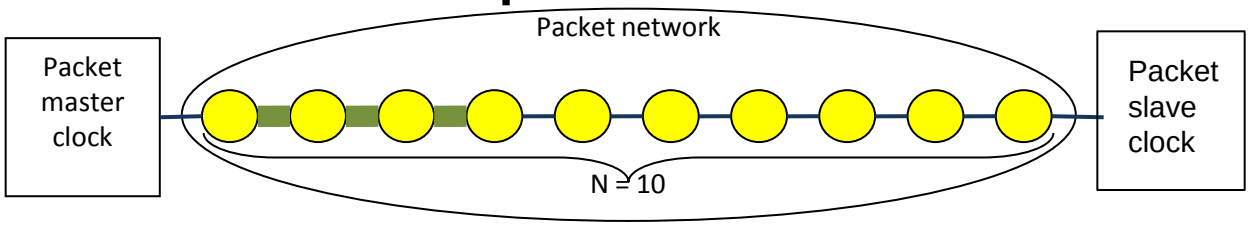

Fig1/G.8261.1

3.2-G.8261 (2)

HRM2 with packet nodes & specific access technologies

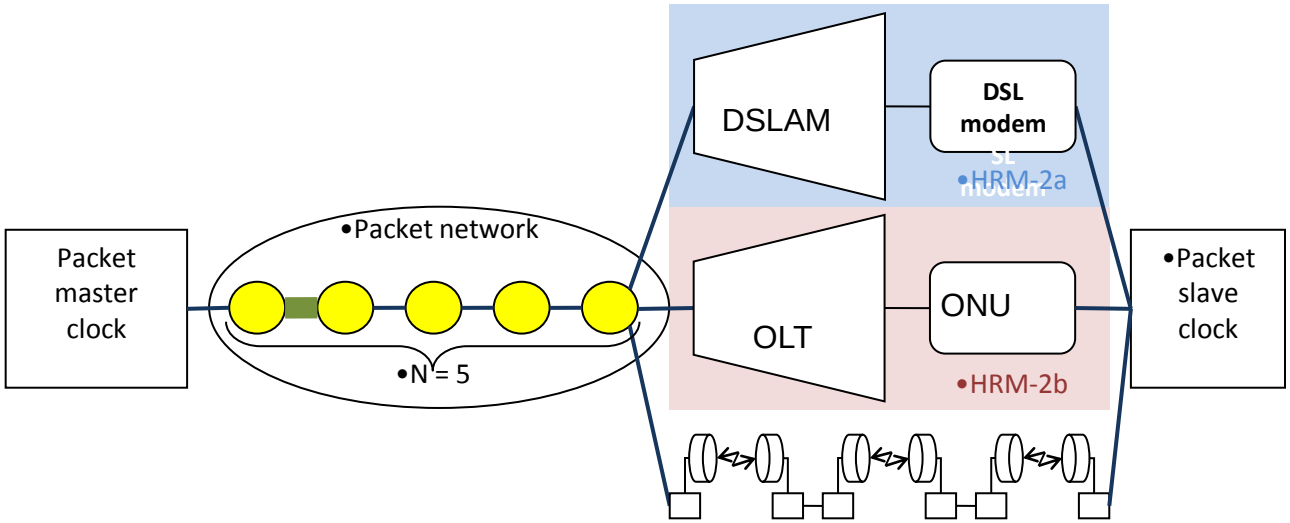

Fig2/G.8261.1

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3.2-G.8261 (3)

Reference points and Network limits for frequency transport

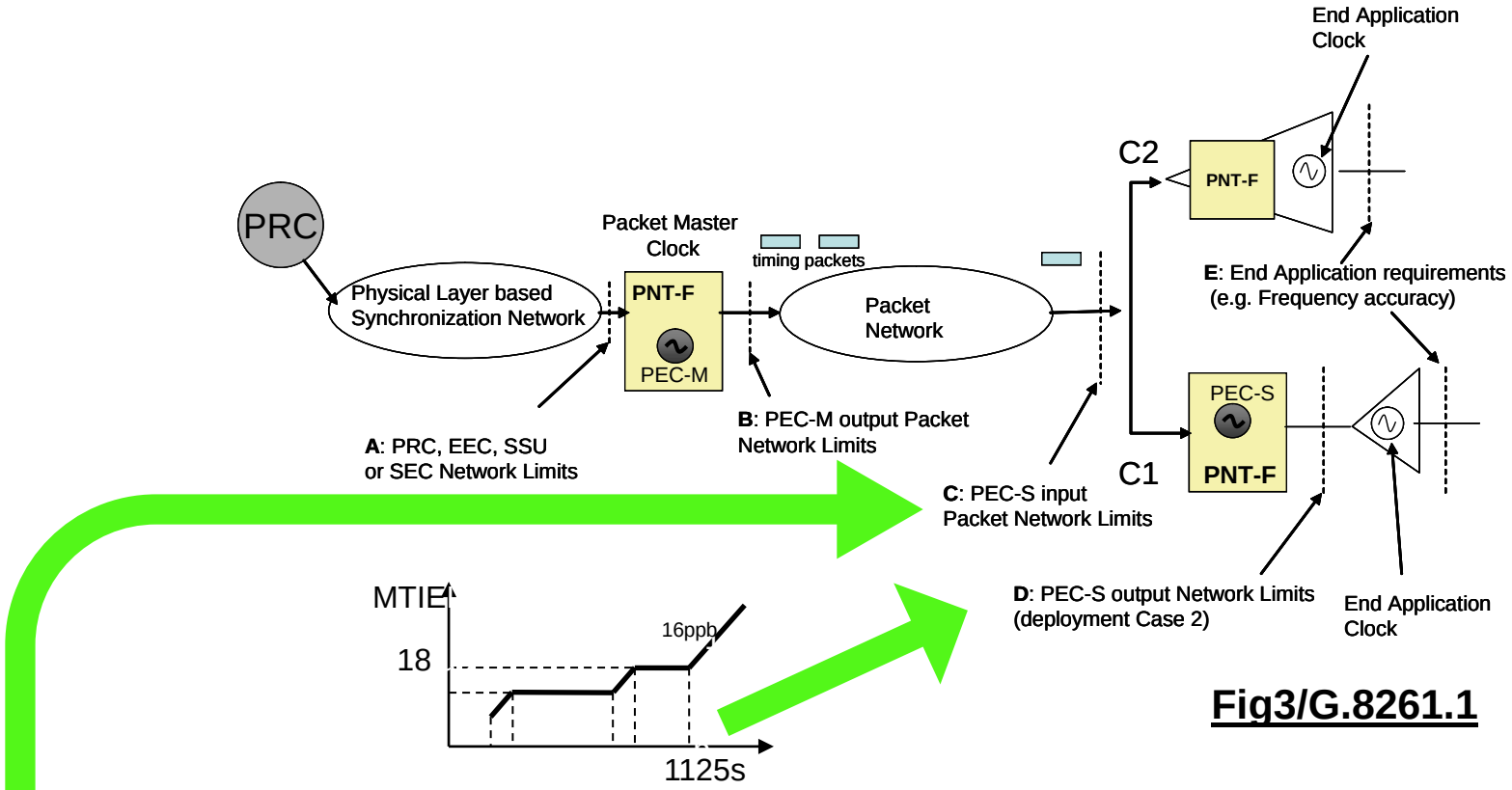


Fig3/G.8261.1

For any window interval of 200 seconds (jumping window), at least 1% of timing packets with a minimum of 2 timing packets must be observed within a fixed cluster, located at the observed floor delay, and having a range of 150 µs.

3.3 G.8263

G.8263 outlines minimum requirements for the timing functions of the Packet Slave Clocks as defined in G.8265.

It supports frequency synchronization distribution when using packet based methods.

It focuses on mobile applications, and in particular on the delivery of frequency synchronization for end applications such as mobile base stations.

It applies to both HRMs of G.8261.1 and both packet slave clocks presented in fig 3/G.8261.1

3.3-G.8263 (2)

- **Frequency accuracy**
  4.6ppm
- **Noise generation**

- **PDV noise tolerance**
  Limits defined in G.8261.1
- **Holdover**.
  not needed for mobile application

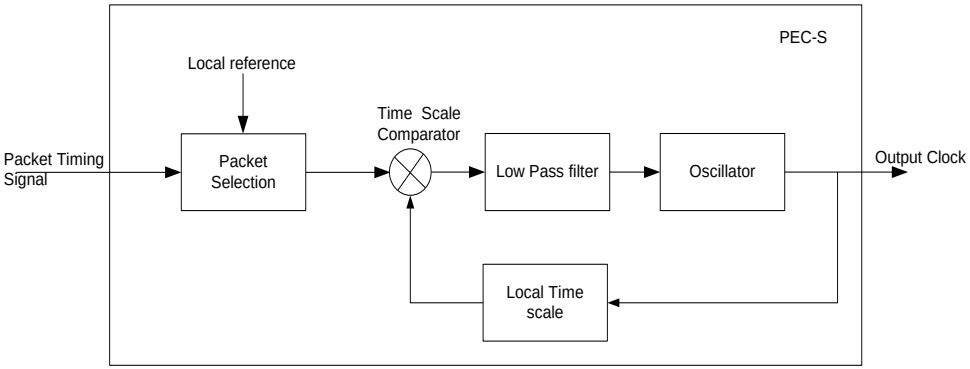


Fig A1/G.8263 Functional model

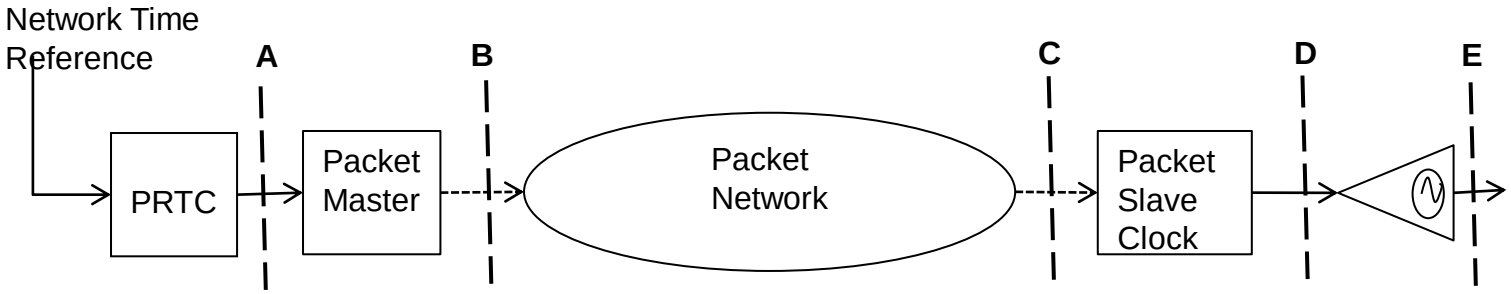
- **Phase response to packet timing interruptions**

3.4 G.8271 (network requirements)

It defines time and phase synchronization aspects in packet networks and the suitable methods to distribute the reference timing used to recover phase and time synchronization according to the required quality.

The main body deals with:

- **-Need for phase and time**
- **-phase and time synchronization methods**
- **-Network reference model**



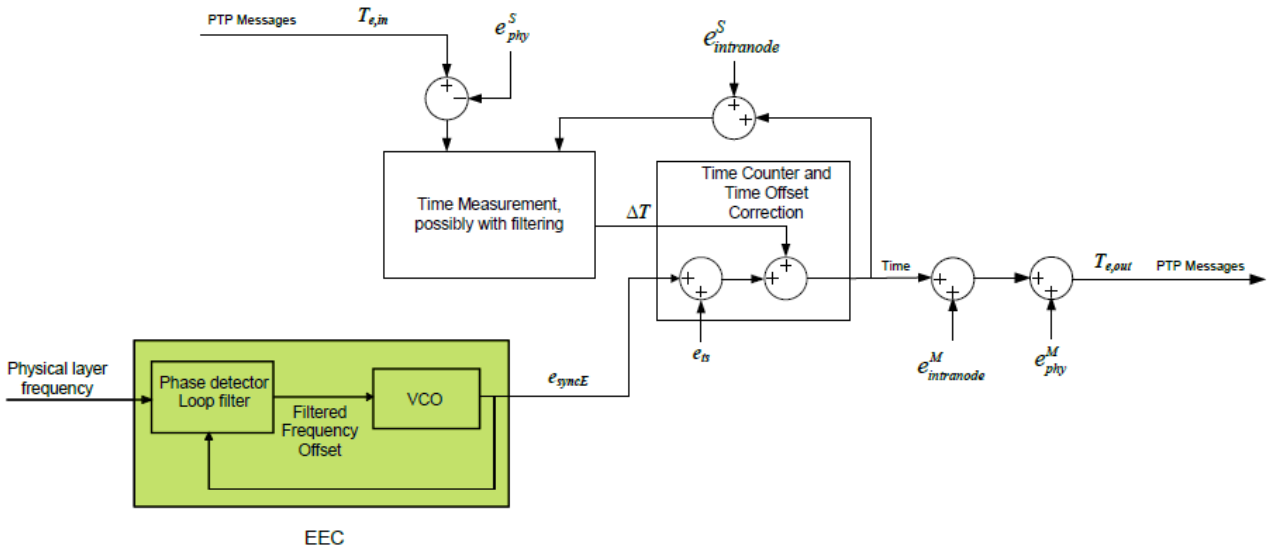
- A: PRTC limit
- B :Packet Master network limit
- C :Packet Slave clock input network limit
- D: Packet Slave output Network Limits
- E: End application requirements

Appendix I Time and phase Noise sources

asymmetry, timestamping granularity, oscillator noise,etc…

Appendix II 2 Clock models for Noise Accumulation simulations

- Time transported by PTP with SyncE assistance



FigII-1 Telecom Boundary Clock Model for simulating the transport of time using PTP with SyncE assistance

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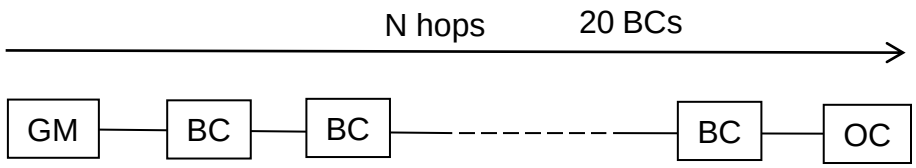
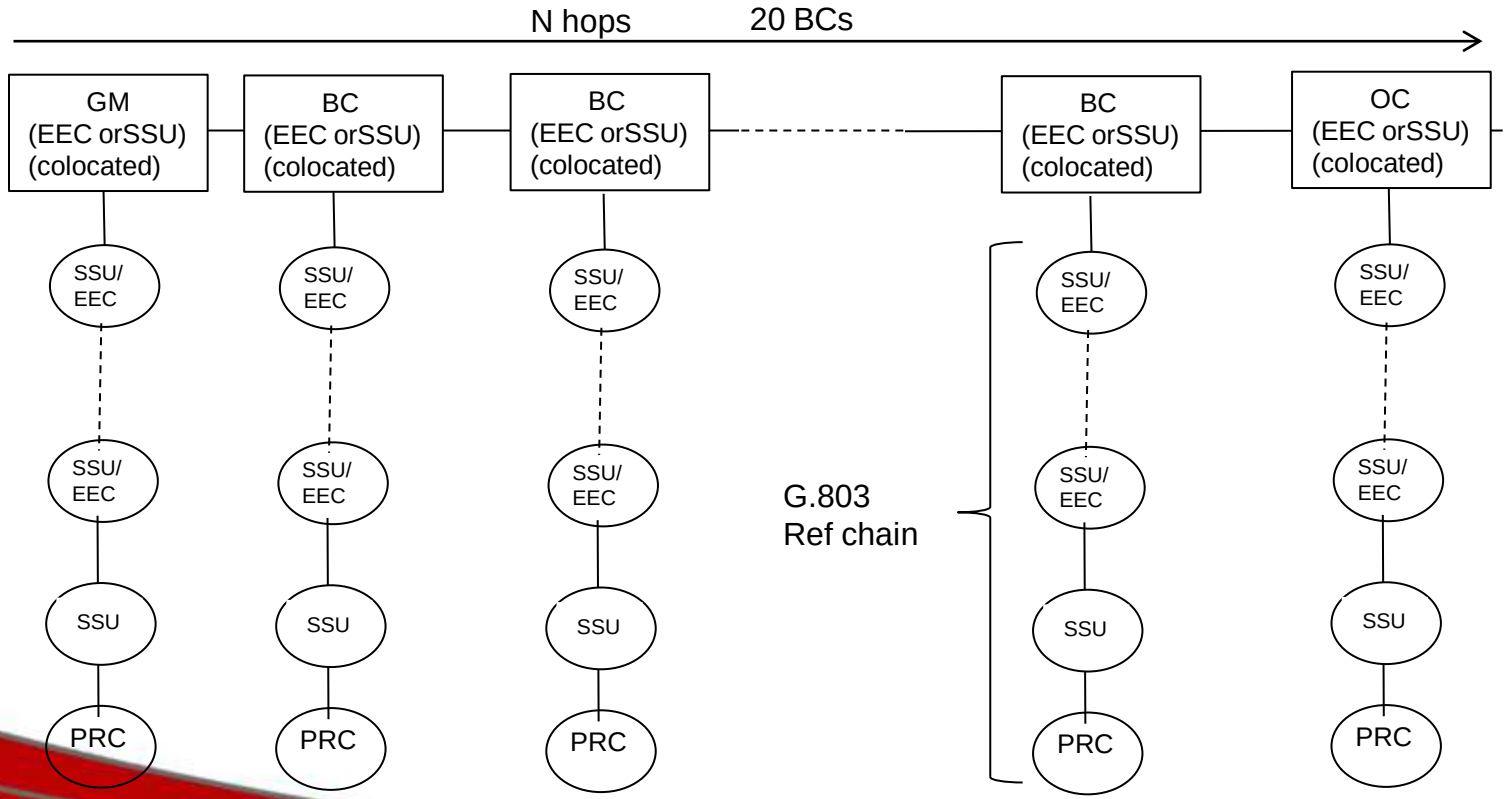
Appendix III 2 HRMs used to derive network limits



HRM without frequency support



HRM with frequency support

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Appendix IV Time and Phase synchronization interfaces

The 1 PPS time/phase interface is using a point-to-point V.11 interface as specified in ITU-T V.11 with an additional requirement on the rise/fall times of the 1 PPS signal.

3.5-G.8264 Amd2

Some new text will include guidance for the IEEE LAG case (link aggregation)
Question: one ESMC per link?
Issue: SSM on parallel links
Proposal: consider G.781 section 5.13.2 case

3.6-G.8251 Corr1

- **removal of a typo in a formula used in simulations**
- **it had been verified that the typo had no effect on simulations**

•4 Current work in Q13

Use of time protocols over PSN for phase and time distribution

4.1-G.8272 defines the Primary Reference Time Clock

4.2-G.8273 defines clocks for GM, BC, etc

4.3-1588 profile

- **G.8275 defines the network architecture**
- **G.8275.1 defines the protocol based on PTP**

4.4-G.Sup xx

4.5- relation with other SG15 questions

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4.1-G.8272

This recommendation will define the PRTC

- **Progress were done on the definition of the clock giving reference to the time: several parameters are under discussion**
- **MTIE and TDEV mask**
- **1pps time offset limit**
- **Need for different type of PRTC, depending on temperature range**

Expected consent dates: September 2012

4.2-G.8273

G.8273.1-Specification of the clock performance of a grand master

G.8273.2-Specification of the clock performance of a boundary clock
A boundary clock model was agreed
Work is ongoing on

- **accuracy**
- **Noise generation**
- **Holdover**
- **Etc**

These specifications are needed in addition to IEEE 1588 specification to specify a boundary clock for use in telecom networks as IEEE 1588 specifies « only » a protocol.

Expected consent dates: September 2012

4.3-Telecom profile for the transport of phase & time

- **G.8275**

  G.8265 will defines high level requirements and the general architecture for phase & time transport

- **G.8275.1**

  Defines the parameters of PTP choosen for the profile

A specific presentation addresses IEEE1588 profiles

4.4-G.Supp xx

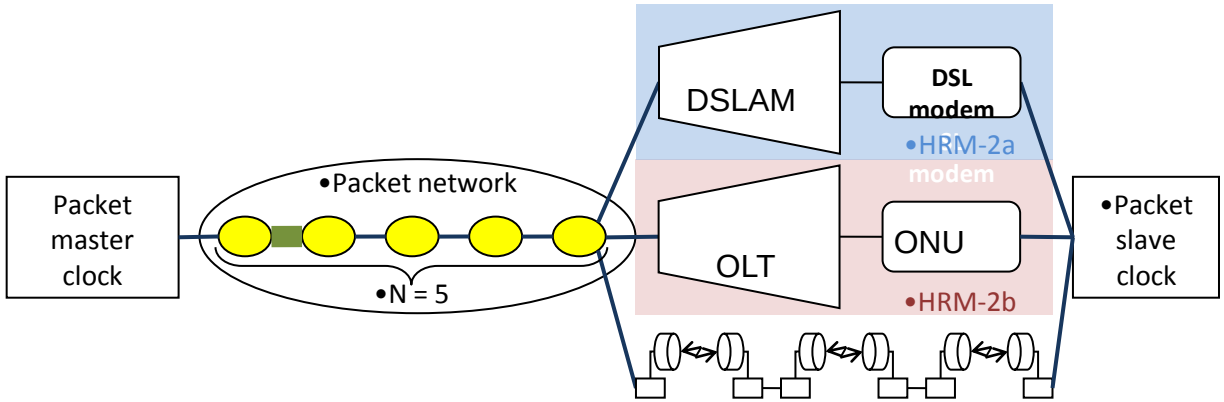
This supplement will contain the simulation results done using HRMs and clock models

Simulations are currently on progress according 2 different mathematical methods, pseudo continuous systems and discrete time model.
Good news, current results done with both methods are similar.

Preliminary conclusions:
- random noise accumulated on a chain of 20 nodes will not exceed 100/150 ns
-Assymetry will be the dominant parameter in the noise budget

4.5-Relationship with other SG15 questions

Q13 uses to meet with Q2 and Q4 during SG15 plenary meetings



Q2 and Q4 have their own system solution to transport timing through GPON and DSLsystems, we look together how to interwork with Q13 solution

Q15 is responsible for specifying test equipments . Q15 & Q13 worked together once Q13 has finished specifying SyncE

5-List of ITU-T main recommendations related to synchronization

- **G.803 (2000),** ***Architecture of transport networks based on the synchronous digital hierarchy (SDH)***
- **G.810 (1996),** ***Definitions and terminology for synchronization networks***
- **G.811 (1997),** ***Timing requirements of primary reference clocks***
- **G.812 (2004),** ***Timing requirements of slave clocks suitable for use as node clocks in synchronization networks***
- **G.813 (2003),** ***Timing requirements of SDH equipment slave clocks (SEC)***
- **G.822 (1988),** ***Controlled slip rate objectives on an international digital connection***
- ***G.823 (2000), The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy***
- ***G.824 (2000), The control of jitter and wander within digital networks which are based on the 1544 kbit/s hierarchy***
- ***G.825 (2000), The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH)***
- ***G.781 (1999), Synchronization layer functions***

Recommendations for timing over packet networks

- *G.8260 (2010) Definitions and terminology for synchronization in packet networks*

Recommendations for Synchronous Ethernet

- *G.781 (2009), Synchronization layer functions*
- *G.8261 (2008), Timing and Synchronization aspects in Packet Networks*
  - *G.8261 Amd1 (2010)*
- *G.8262 (2010), Timing characteristics of synchronous Ethernet Equipment slave clock (EEC)*
- *G.8264 (2008), Distribution of timing through packet networks*
  - *G.8264 Amd1 (2010)*
  - *G.8264 Amd2 (Dec 2011?)*

Recommendations for OTN

- *G.8251 (2010) The control of jitter and wander within the optical transport network (OTN)*
  - *G.8251 Amd1 (2011)*
  - *G.8251 Corr2 (Dec 2011?)*

Recommendations for the telecom profile for frequency only

- *G.8261 (2008), Timing and Synchronization aspects in Packet Networks*
- *G.8265 (2010) Architecture and requirements for packet based frequency delivery*
- *G.8265.1 (2010) ITU-T profile for frequency distribution without timing support from the network (provisional title)*
- *G.8265.1 Amd1 (2011)*

Recommendation on Jitter and wander tests equipments

- *O.171 (1997) Timing jitter and wander measuring equipment for digital systems which are based on the plesiochronous digital hierarchy (PDH)*
- *O.172 (2005) Jitter and wander measuring equipment for digital systems which are based on the synchronous digital hierarchy (SDH)*
- *O.173 (2007) Jitter measuring equipment for digital systems which are based on the Optical Transport N...*
- *O.174 (2009) Jitter and wander measuring equipment for digital system based on synchronous Ethernet network*

- **expected consent in December 2011**
  - *G.8261.1 Packet Delay Variation Network Limits applicable to Packet Based Methods (Frequency Synchronization)*
  - *G.8260 Definitions and terminology for synchronization in packet networks with addition of Appendix I on metrics*
  - *G.8263Timing characreisctics of packet based equipment clocks (PEC)and packet based service clocks (PSC)*
  - *G.8271 Network requirements for transport of time/phase*
- **Future recommendations (provisional titles)**
  - *G.8272 Specification of Primary Reference Time Clock (PRTC)*
  - *G.8273 Specification of clocks for the transport of time/phase*
    - *G.8273.1 Telecom Grand Master*
    - *G.8273.2 Telecom boundary clock*
    - *G.8273.3 Telecom transparent clock (to be confirmed)*
  - *G.8275 Packet network architecture for the transport of time/phase*
  - *G.8275.1 Telecom profile for the transport of time/phase*

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