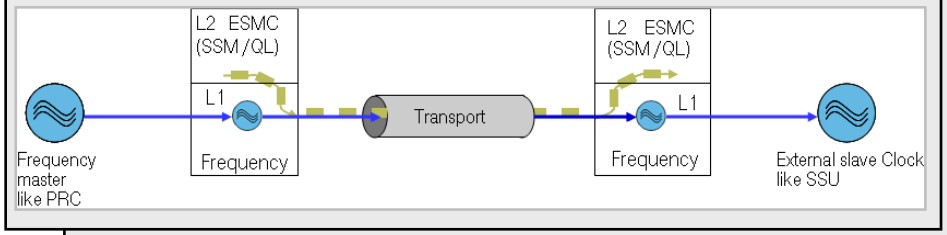
Deutsche Telekom @ ITSF2011: Ethernet Physical Layer Synchronization - A Success Story

Helmut Imlau, 1.11.2011

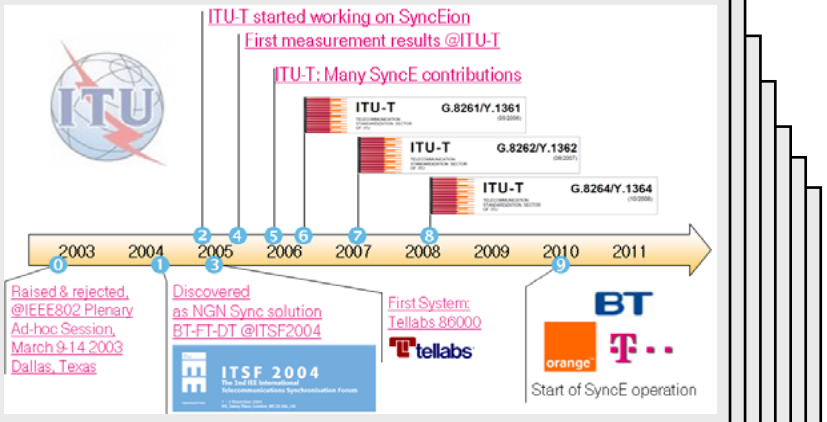
Life's for Sharing

Ethernet Physical Layer Synchronization - A Success Story.
Agenda.

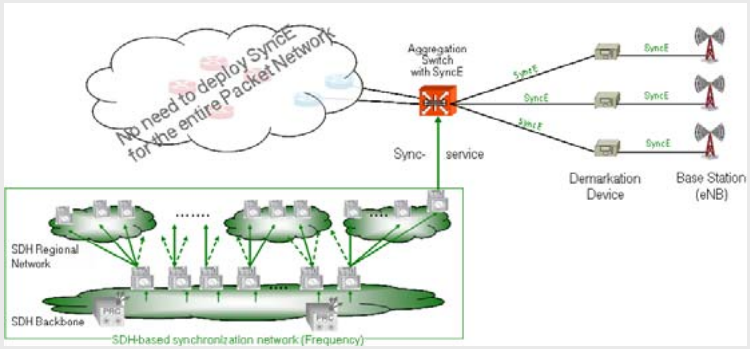
1. Why SyncE?



2. SyncE History: Time bar 2003-now



3. SyncE Application Examples



Mobile backhauling

MSAN synchronization

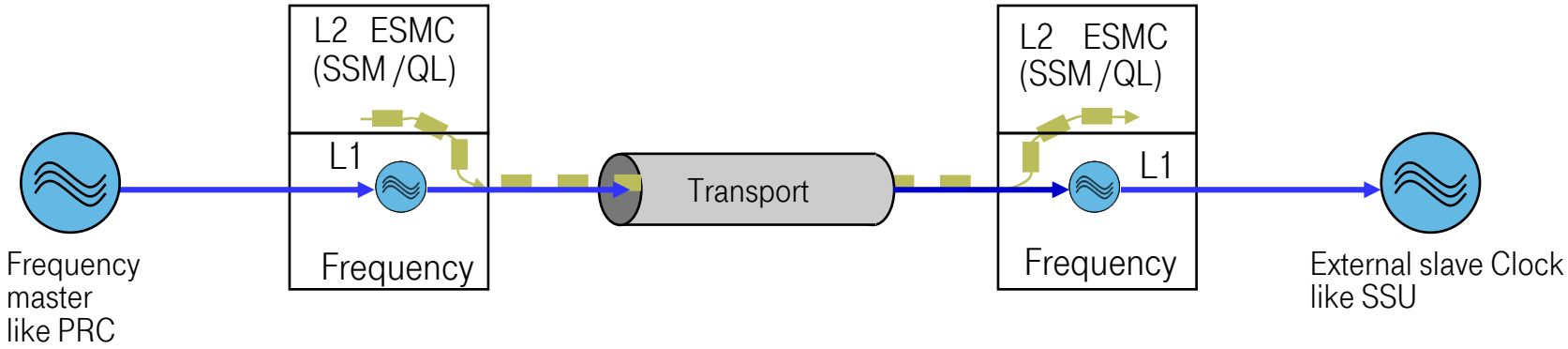
Synchronization network migration

ITU-T Time/phase profile for IEEE1588-2008

CERN White Rabbit project

Ethernet Physical Layer Synchronization - A Success Story
Why SyncE?

- Basis: Existing system with physical layer transport from A to B.
- Need to transfer frequency from A to B, e. g. to supply a SSU from a PRC.
- Solution: At A, physical layer frequency is derived from external source.
  At B, external slave clock is driven by physical layer frequency
  .... as known from E1 and SDH synchronization and used for many years.



ESMC = Ethernet Synchronization Messaging Channel
PRC = Primary Reference Clock
QL = Quality Level

SSM = Synchronization Status Message
SSU = Synchronization Supply Unit

Ethernet Physical Layer Synchronization - A Success Story
Why SyncE?

Interoperability:

- 100% inter-operability with existing E1/SDH based synchronization.

CAPEX saving:

- Inter-operability allows step-by-step migration into SyncE due to traffic growth over a long period. No need for system / module exchange due to synchronization only.
- Existing PRCs and SSUs can still be used.
- Measurement equipment for synchronization interfaces is already available.

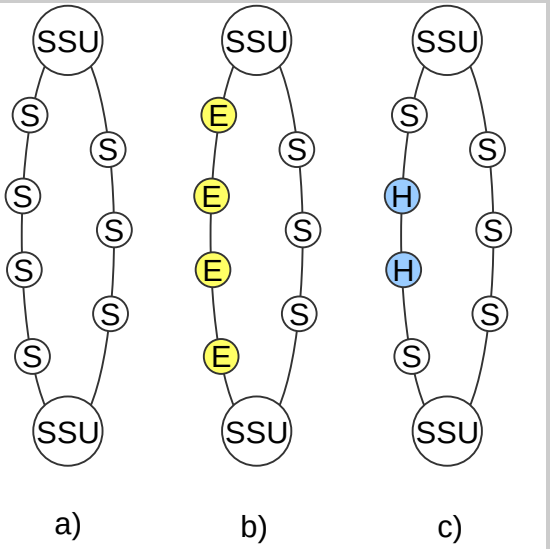


Figure 1 from WD17, DT Contribution for ITU-T SG15Q13 Meeting Ottawa 06-2006

Included in G.8261

OPEX saving:

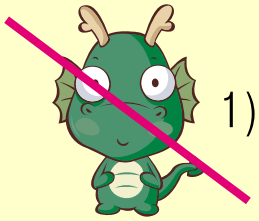
- Operational stuff is trained for measurements as well as failure scenarios.
- Same well-known synchronization interfaces (2048 kHz).

S = SDH based, E = Ethernet based, H = Hybrid synchronization link

Ethernet Physical Layer Synchronization - A Success Story
Why SyncE?

- Weather proof, guaranteed, 100% engineered solution,
  works on both sunny days and rainy days.

- No chance for PDV dragon:
  Packet Delay Variation (PDV) does not play any role



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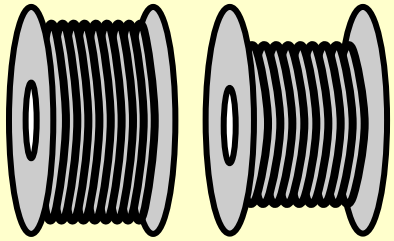
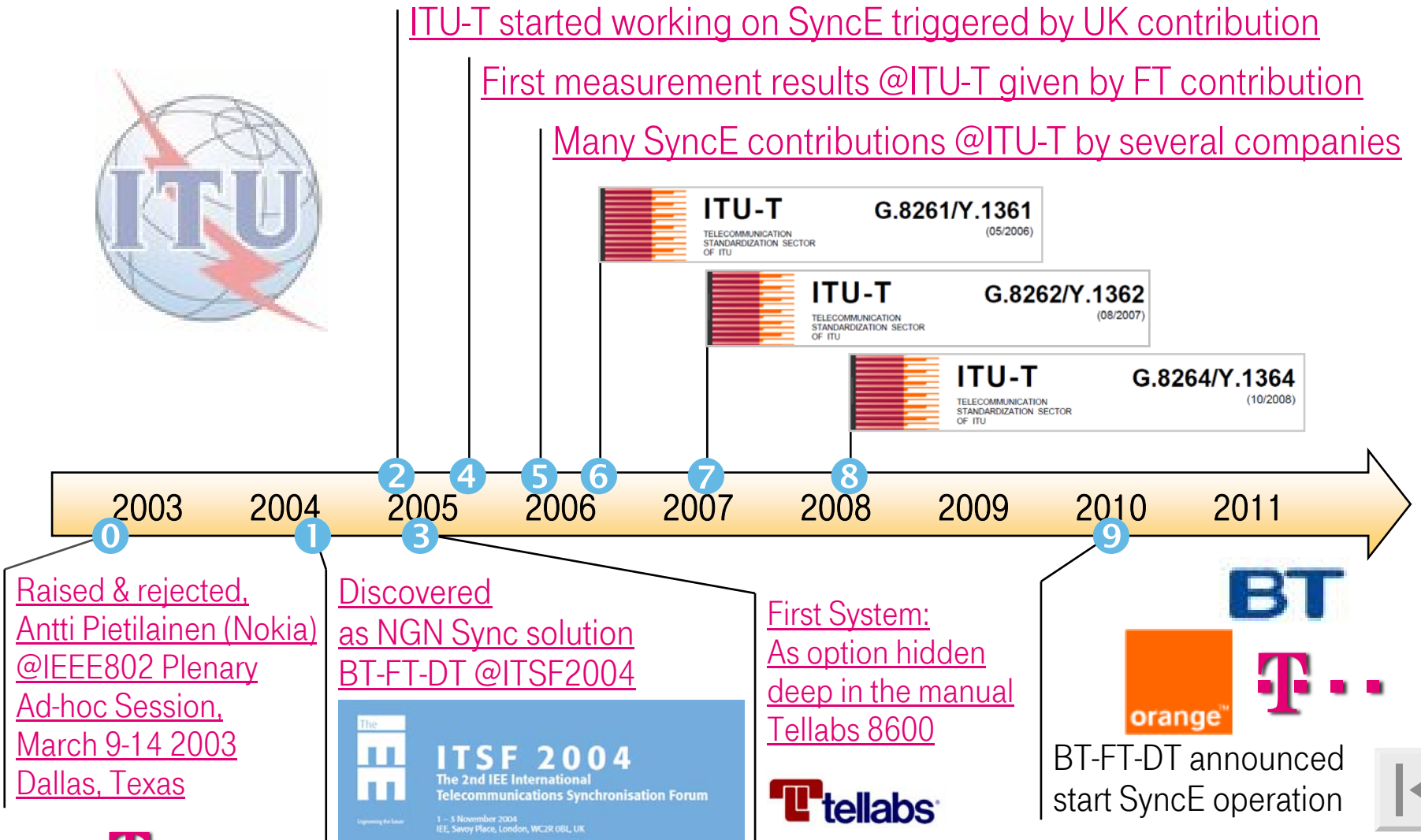


- No issues with link asymmetry
  due to different cable length, PHY issues
  or DCF (Dispersion Compensated Fiber).

1) See Kenneth Hann: Painless Migration to Packet Clocks (ITSF2010)

Ethernet Physical Layer Synchronization - A Success Story.
SyncE History - 1 - Time bar.



Ethernet Physical Layer Synchronization - A Success Story.
SyncE History - 2003

Raised & rejected,
Antti Pietilainen @IEEE802 plenary
ad-hoc session March 9-14 2003
Dallas, Texas

Frequency Transfer in Packet Networks with 802.3 PHYs*

Welcome to "exchange of ideas" session, Tuesday 7-8 PM in Constellation 11 (same room as P2MP track), Agenda:

- Short introduction
- Preliminary survey of interest among equipment vendors and others
- Discussion of suitable standardization body – ITU-T SG13/SG15, IETF, IEEE802

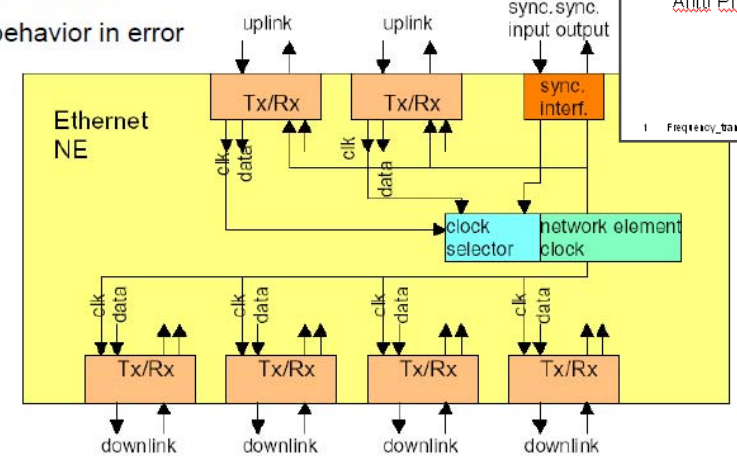
*Need originates from desire to use packet transport employing 802.3 PHYs in fixed portion of cellular networks. However, others PHYs may come into question.

Antti Pietiläinen (antti.pietilainen@nokia.com, cellular phone +358-50-4836660)

1 Frequency_transfer_invitation.ppt API 9.3.2003

Protection in clock distribution

- Clock quality indication
- Clock input selection
- Fall-back behavior in error situation



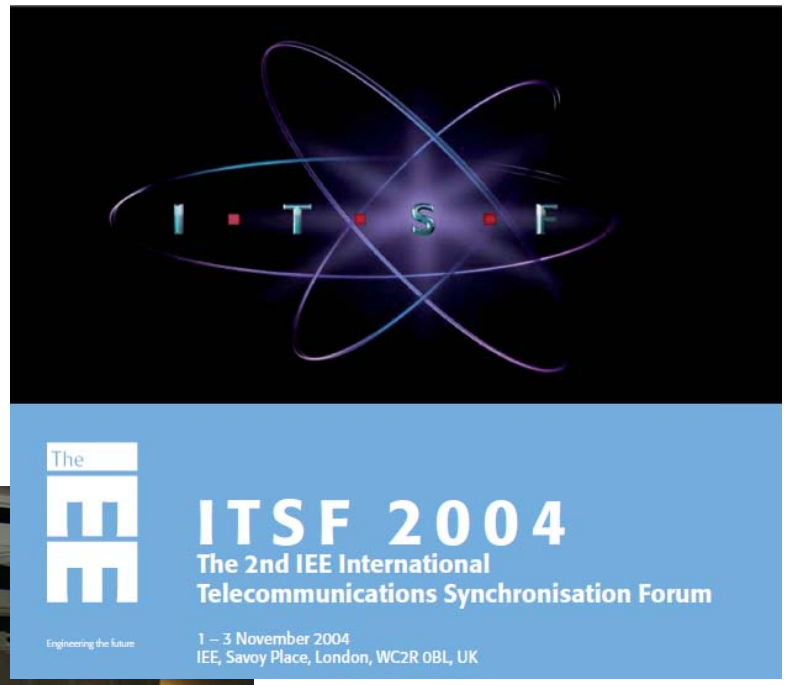
4 Frequency_transfer_presentation.ppt API 11.3.2003

First block diagram showing clock extraction from Ethernet ports, steering a network element clock function

Ethernet Physical Layer Synchronization - A Success Story.
SyncE History - 2004

November 2004

- Discussion at ITSF2004 with operators BT, FT, DT, TA, Orange, Vodafone
- Idea was born, to use Ethernet Physical Layer Synchronization for packet based Next Generation Network

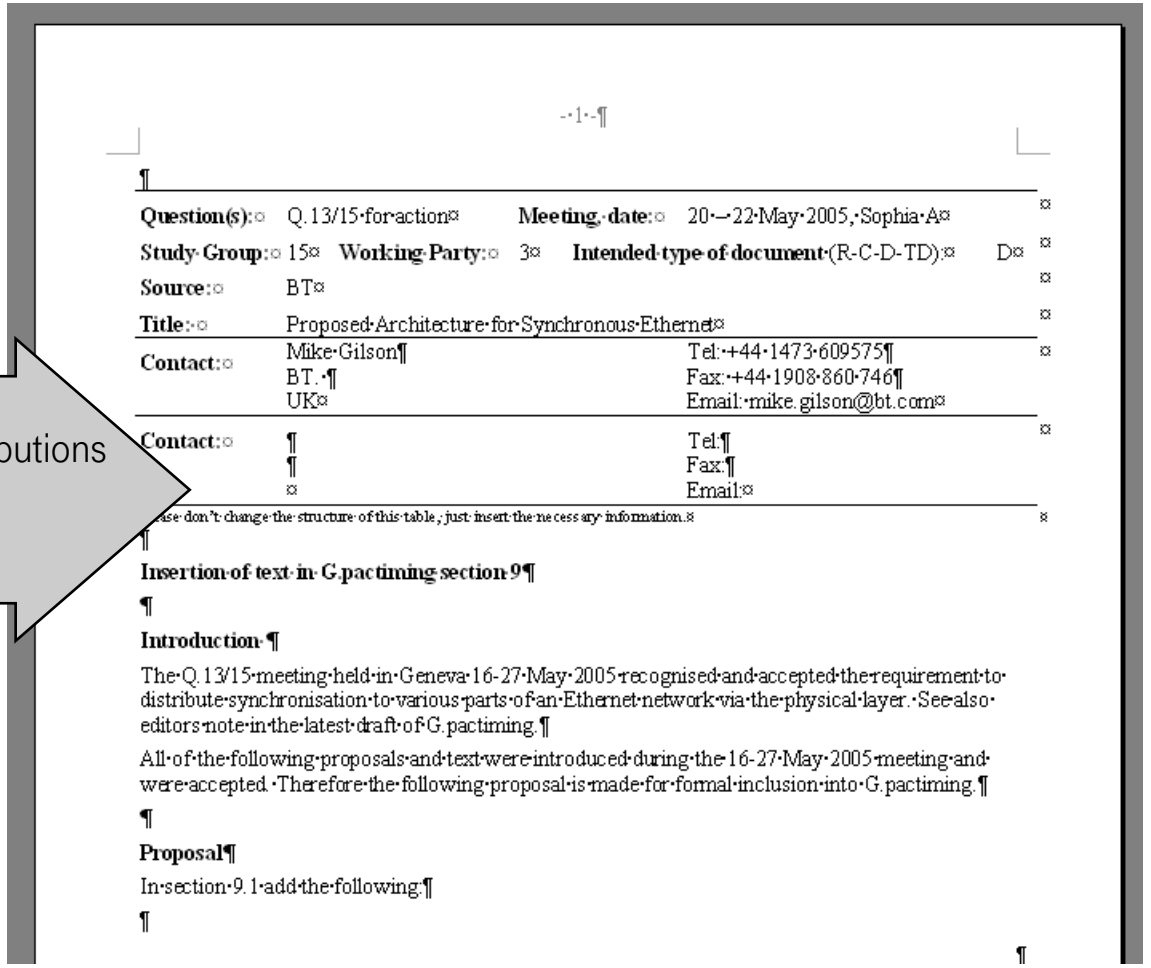


Ethernet Physical Layer Synchronization - A Success Story.
SyncE History - 2005

May 2005

- ITU-T SG15Q13 started work on SyncE officially

One of the very first SyncE contributions
Provided as UK contribution



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Question(s):	Q.13/15·for·action	**Meeting·date:**	20·–·22·May·2005,·Sophia·A
Study·Group:	15	**Working·Party:**	3
Intended·type·of·document	(R-C-D-TD):	D	
Source:	BT		
Title:	Proposed·Architecture·for·Synchronous·Ethernet		
Contact:	Mike·Gilson¶ BT.·¶ UK	Tel:·+44·1473·609575¶ Fax:·+44·1908·860·746¶ Email:·mike.gilson@bt.com	
Contact:	¶ ¶ 	Tel:¶ Fax:¶ Email:	

ase·don't·change·the·structure·of·this·table;·just·insert·the·necessary·information.

¶

Insertion·of·text·in·G.pactiming·section·9¶

¶

Introduction·¶

The·Q.13/15·meeting·held·in·Geneva·16-27·May·2005·recognised·and·accepted·the·requirement·to·distribute·synchronisation·to·various·parts·of·an·Ethernet·network·via·the·physical·layer.·See·also·editors·note·in·the·latest·draft·of·G.pactiming.¶

All·of·the·following·proposals·and·text·were·introduced·during·the·16-27·May·2005·meeting·and·were·accepted.·Therefore·the·following·proposal·is·made·for·formal·inclusion·into·G.pactiming.¶

¶

Proposal¶

In·section·9.1·add·the·following:¶

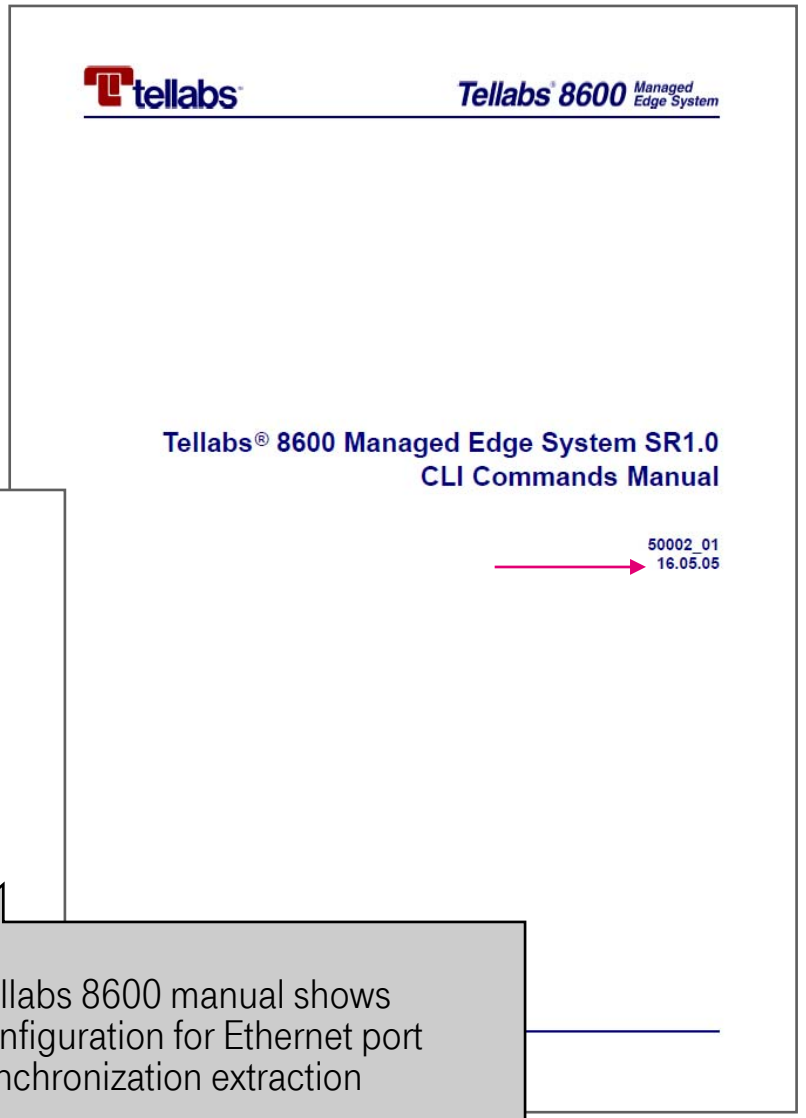
¶

¶

Ethernet Physical Layer Synchronization - A Success Story.
SyncE History - 2005

May 2005

- First System with SyncE ready:
  Tellabs 8600.
  As option hidden deep in the manual.


tellabs

Tellabs® 8600 Managed Edge System

Tellabs® 8600 Managed Edge System SR1.0
CLI Commands Manual

50002_01
16.05.05

node-timing clock-source

Command Description

Adds new clock into fallback list.

Use the **no** option to cancel the command and return to default values.

Command Mode

Configuration

Command Syntax

8620:
[no] node-timing clock-source { ge *if-module-as-nbr/if-as-nbr-8620* **| so** *if-module-as-nbr/if-as-nbr-8620* **| sci } priority** *priority*

8660:
[no] node-timing clock-source { ge *slot-as-nbr/if-module-as-nbr/if-as-nbr* **| so** *slot-as-nbr/if-module-as-nbr/if-as-nbr* **| sci** *sci-slot-as-nbr* **} priority** *priority*

if-as-nbr — Interface number

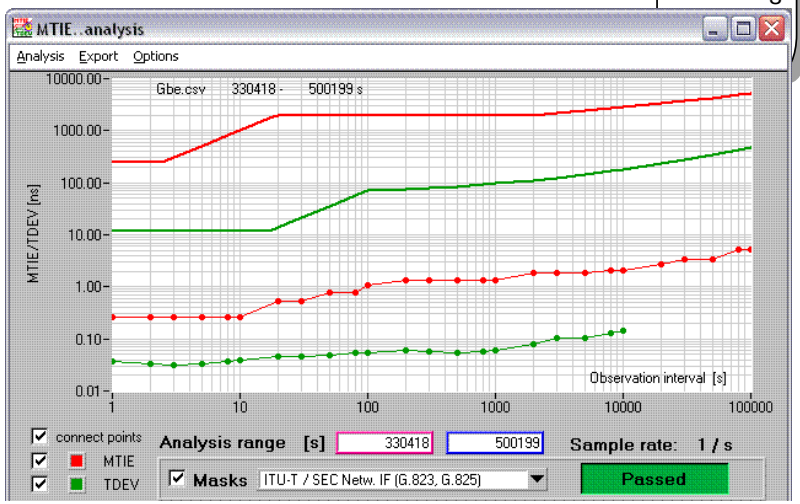
Range:
IFM-2GE-OPT: 0 .. 1
IFM-8STM1-POS: 0 .. 7
IFM-8STM16-POS: 0

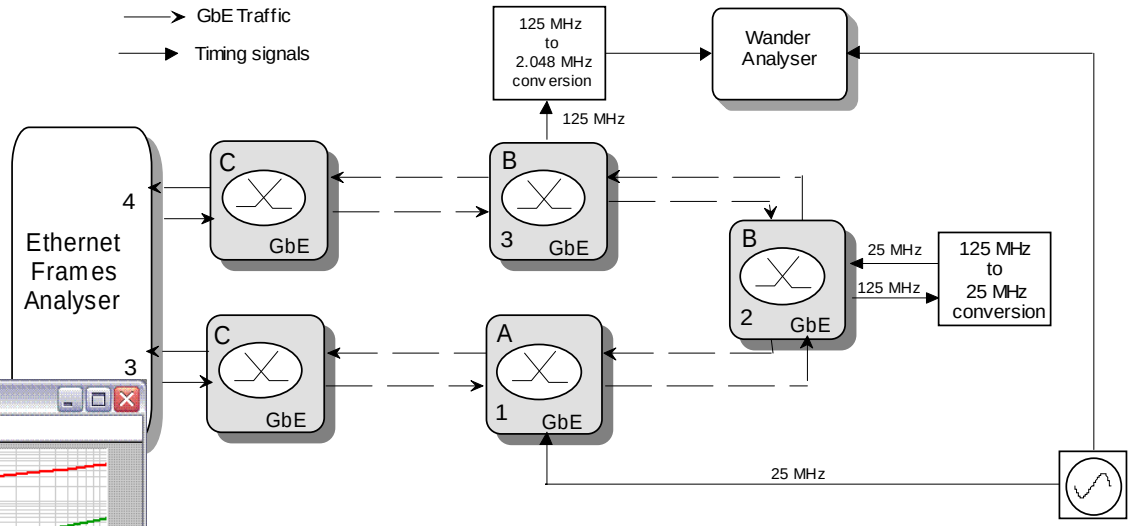
Tellabs 8600 manual shows configuration for Ethernet port synchronization extraction

Ethernet Physical Layer Synchronization - A Success Story.
SyncE History - 2005

November 2005

- ITU-T SG15Q13 WD23 (FT) First SyncE research results published.





- Legathy Ethernet switches where modified
- ITU-T G.823 SEC synchronization mask was fulfilled
- Load & PDV independency was shown.

Ethernet Physical Layer Synchronization - A Success Story.
SyncE History - 2006

2006:

- ITU-T work on SyncE increases a lot with many contributions
- DT SyncE contribution requires inter-op with existing SDH / E1 synchronization networks
- SyncE idea was included in first specification (G.8261, 8.1.1. “Synchronous Ethernet Networks”) at high level
- BT and DT decided on SyncE as part of NGN strategy
- DT: Several bilateral meetings with major vendors on SyncE introduction

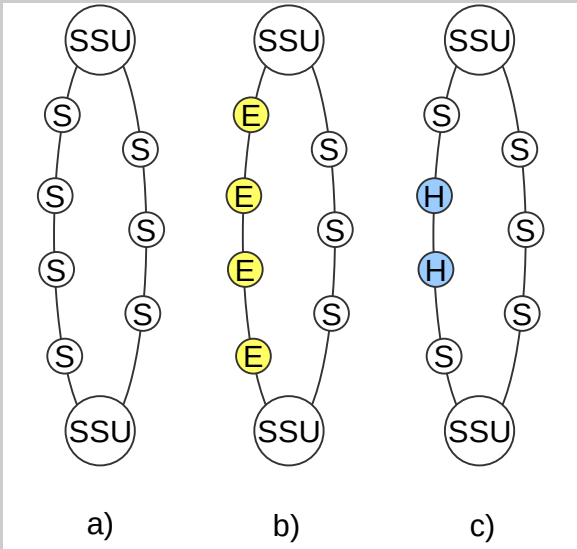
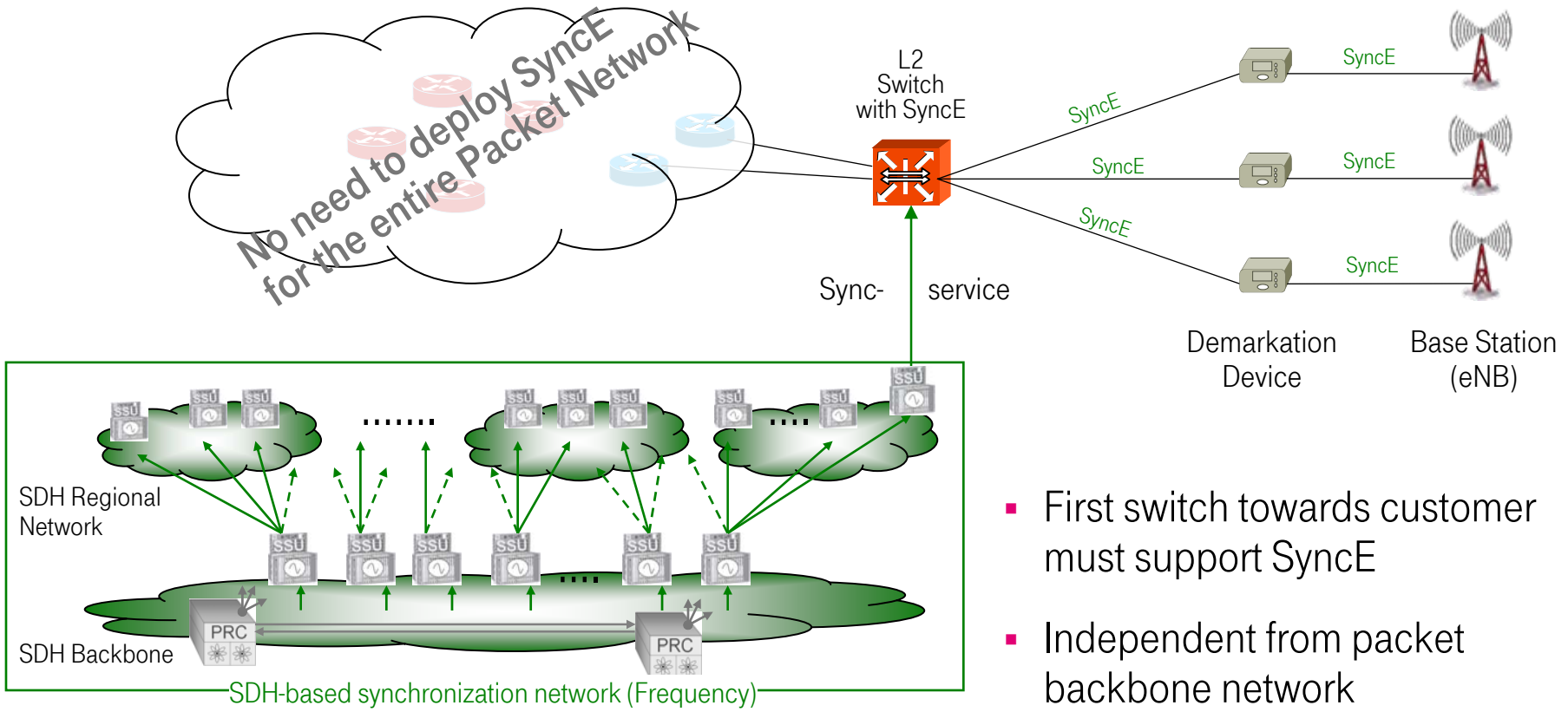


Figure 1 from WD17, DT Contribution
for ITU-T SG15Q13 Meeting Ottawa 06-2006

Ethernet Physical Layer Synchronization - A Success Story.
SyncE Application: 1 - Mobile backhauling



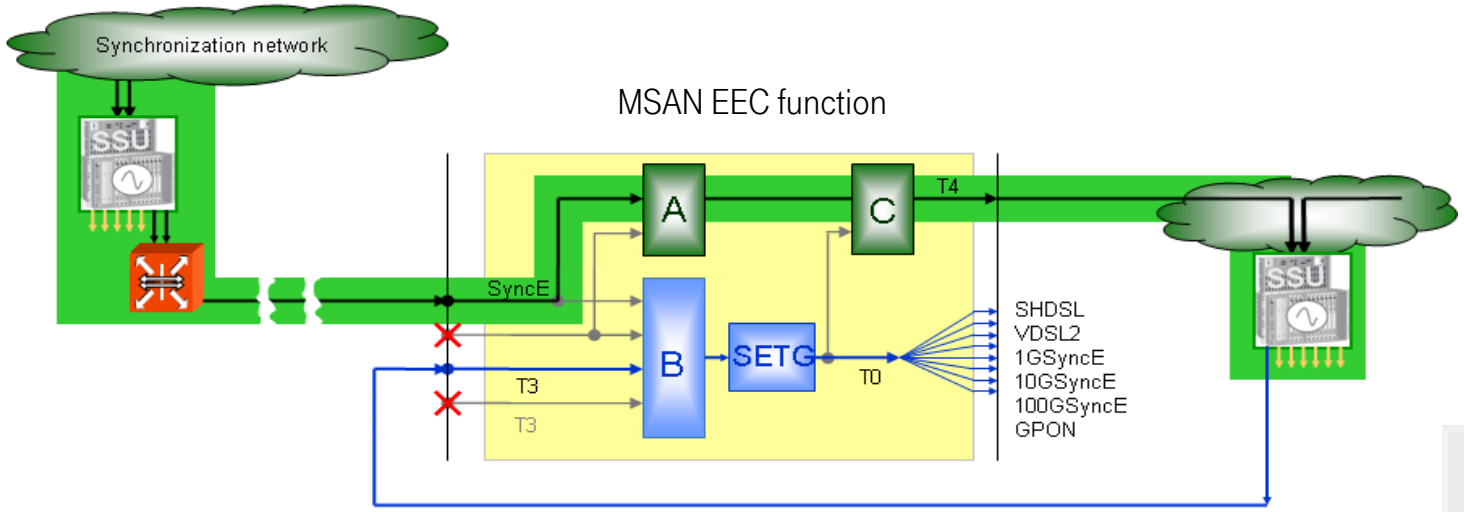
- First switch towards customer must support SyncE
- Independent from packet backbone network

- Frequency synchronization network used (SDH or later OTN based)

Ethernet Physical Layer Synchronization - A Success Story.
SyncE Application: 2 - MSAN synchronization

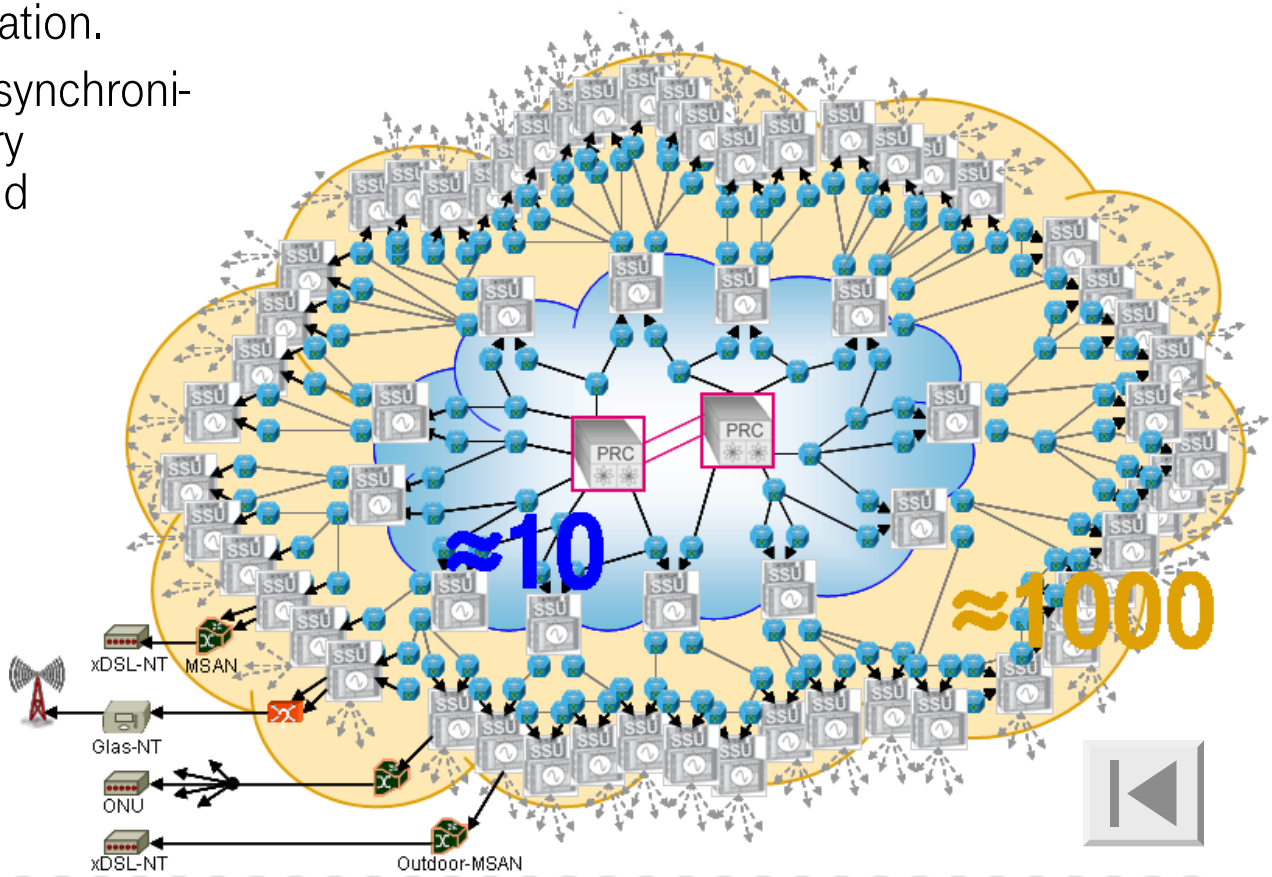
Remote location synchronization:

- Synchronization path from synchronization network via SyncE to MSAN selector A & C to supply local SSU
- Customer interfaces @ MSAN are synchronized from local SSU via T3 and selector B



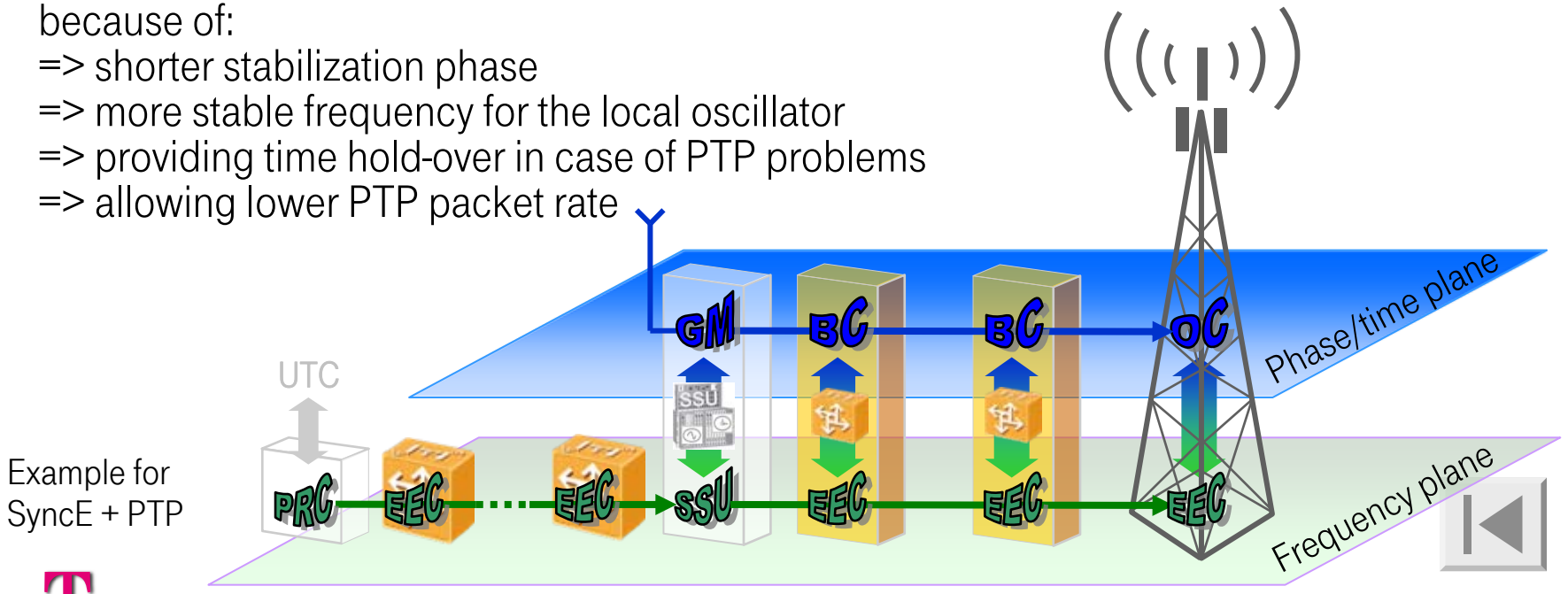
Ethernet Physical Layer Synchronization - A Success Story.
SyncE Application: 3 - Synchronization Network Migration

- New Packet and/or OTN based transport technology do not need their own synchronization (no TDM/SDH any more), but must serve synchronization.
- Currently used frequency synchronization components Primary Reference Clock (PRC) and Synchronization Supply Units (SSUs) are fit for future.
- New frequency carrying links are needed.
- Solution: SyncE over OTN
- New NGN synchronization architecture follows simpler NGN transport architecture.



Ethernet Physical Layer Synchronization - A Success Story.
SyncE Application: 4 - Planned ITU-T IEEE1588-2008 phase/time profile

- Several LTE-Advanced options as well as TDD need phase/time synchronization *)
- ITU-T chosen method is Precision Time Protocol (PTP) acc. to IEEE1588-2008 with Telecommunication Application Profile for phase/time acc. to ITU-T G.8274.1
- First ITU-T profile for phase/time is based on SyncE
- Using SyncE in parallel improves phase/time synchronization because of:
  => shorter stabilization phase
  => more stable frequency for the local oscillator
  => providing time hold-over in case of PTP problems
  => allowing lower PTP packet rate



LTE = Long Term Evolution, TDD = Time division Duplex

*) see DT @ WSTS2011: .....

Ethernet Physical Layer Synchronization - A Success Story.
SyncE Application: 5 - White Rabbit @CERN

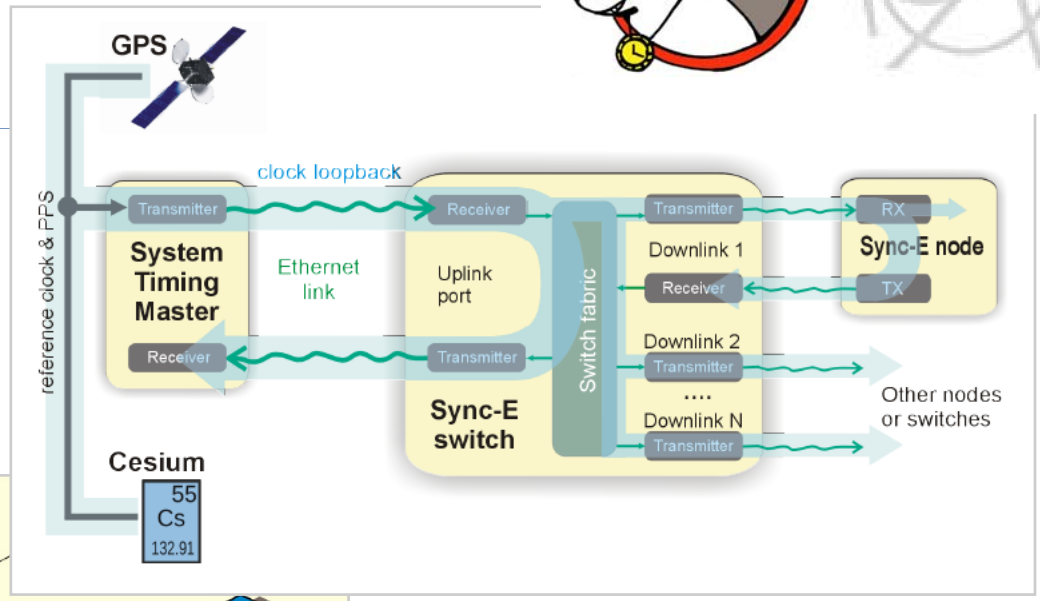
CERN

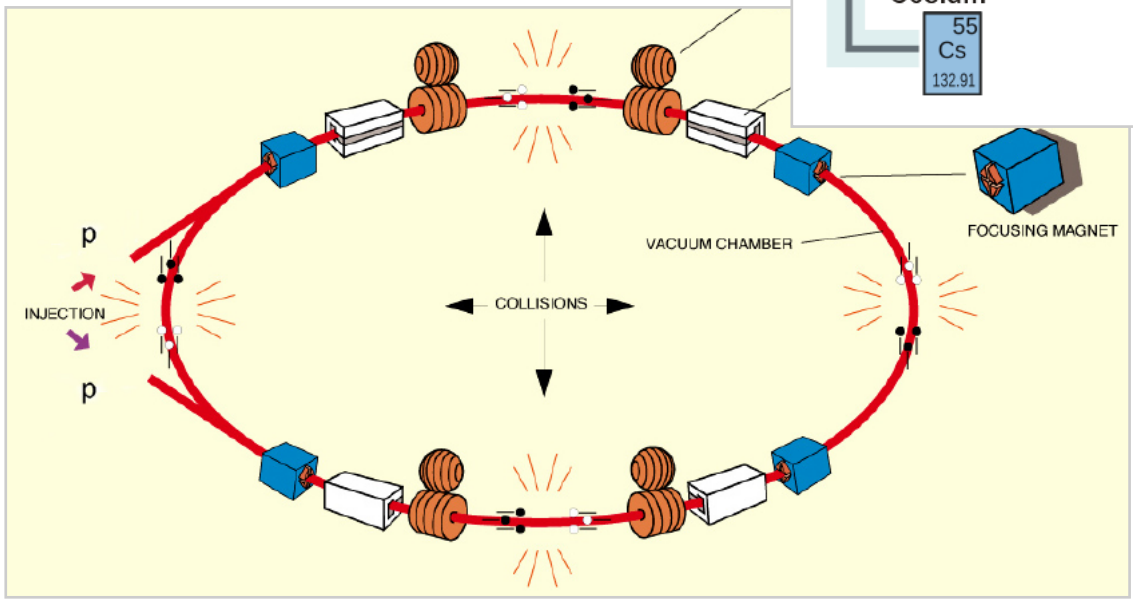
Why:

- Large Hadron Collider (LHC) Time Synchronization: Collisions must be at detector location

How:

- SyncE + PTP + DDDS





Source: Javier Serrano:
Synchronization systems in Particle Accelerators
Presentation at ISPCS 2011 Munich

Link:
http://www.ohwr.org/projects/white-rabbit/activity

CERN = Conseil Européen pour la Recherche Nucléaire, engl.: European Organization for Nuclear Research, DDDS - Distributed Direct Digital Synthesis

Thank you for your attention!

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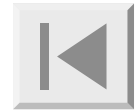

Ethernet Physical Layer Synchronization - A Success Story.

Abbreviations

- BC Boundary Clock
- CERN Conseil Européen pour la Recherche Nucléaire, Engl.: European Organization for Nuclear Research
- DDDS Distributed Direct Digital Synthesis
- EEC Ethernet Equipment Clock
- eNB enhanced NodeB (LTE Base station)
- ESMC Ethernet Synchronization Messaging Channel
- GM Grandmaster
- GPON Gigabit Passive Optical Network
- LHC Large Hadron Collider
- LTE Long Term Evolution
- MSAN Multi-Service Access Node
- NGN Next Generation Network
- OC Ordinary Clock
- OTN Optical Transport Network
- PDV Packet Delay Variation
- PRC Primary Reference Clock
- PTP Precision Time Protocol
- QL Quality Level
- SDH Synchronous Digital Hierarchy
- SEC Synchronous (SDH) Equipment Clock
- SSM Synchronization Status Message
- SSU Synchronization Supply Unit
- SyncE Ethernet Physical Layer Synchronization
- TDD Time Division Duplex