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

Helmut Imlau, 1.11.2011
Ethernet Physical Layer Synchronization - A Success Story.

Agenda.

1. Why SyncE?

2. SyncE History: Time bar 2003-now

3. SyncE Application Examples

- ITU-T Time/phase profile for IEEE1588-2008
- CERN White Rabbit project
- Synchronization network migration
- MSAN synchronization
- Mobile backhauling
- SyncE Operation

- First System: Relays, 1999
- BT
- T Mobile
- ITU-T
- ITU-T
- ITU-T
- ITU-T
- ITU-T
- ITU-T
- ITU-T
- ITU-T
- ITU-T
- ITU-T
- ITU-T
- ITU-T
- ITU-T
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
SSM = Synchronization Status Message
SSU = Synchronization Supply Unit
QL = Quality Level
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.

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

- 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.

ITU-T started working on SyncE triggered by UK contribution
First measurement results @ITU-T given by FT contribution
Many SyncE contributions @ITU-T by several companies

2003 2004 2005 2006 2007 2008 2009 2010 2011

0 1 2 3 4 5 6 7 8 9

Raised & rejected, Antti Pietilainen (Nokia) @IEEE802 Plenary Ad-hoc Session, March 9-14 2003 Dallas, Texas
Discovered as NGN Sync solution BT-FT-DT @ITSF2004
First System: As option hidden deep in the manual Tellabs 8600
BT-FT-DT announced start SyncE operation
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
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
May 2005

- ITU-T SG15Q13 started work on SyncE officially

One of the very first SyncE contributions
Provided as UK contribution
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 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
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)
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
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.
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
Ethernet Physical Layer Synchronization - A Success Story.
SyncE Application: 5 - White Rabbit @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
Ethernet Physical Layer Synchronization - A Success Story.

Thank you for your attention!

Helmut Imlau  
Deutsche Telekom Network Produktion GmbH  
Fixed Mobile Engineering Deutschland  
Neuenstrasse 76-80  
28195 Bremen  
Germany

phone: +49 421 300 7410  
fax: +49 421 300 7409  
mailto: helmut.imlau@telekom.de
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