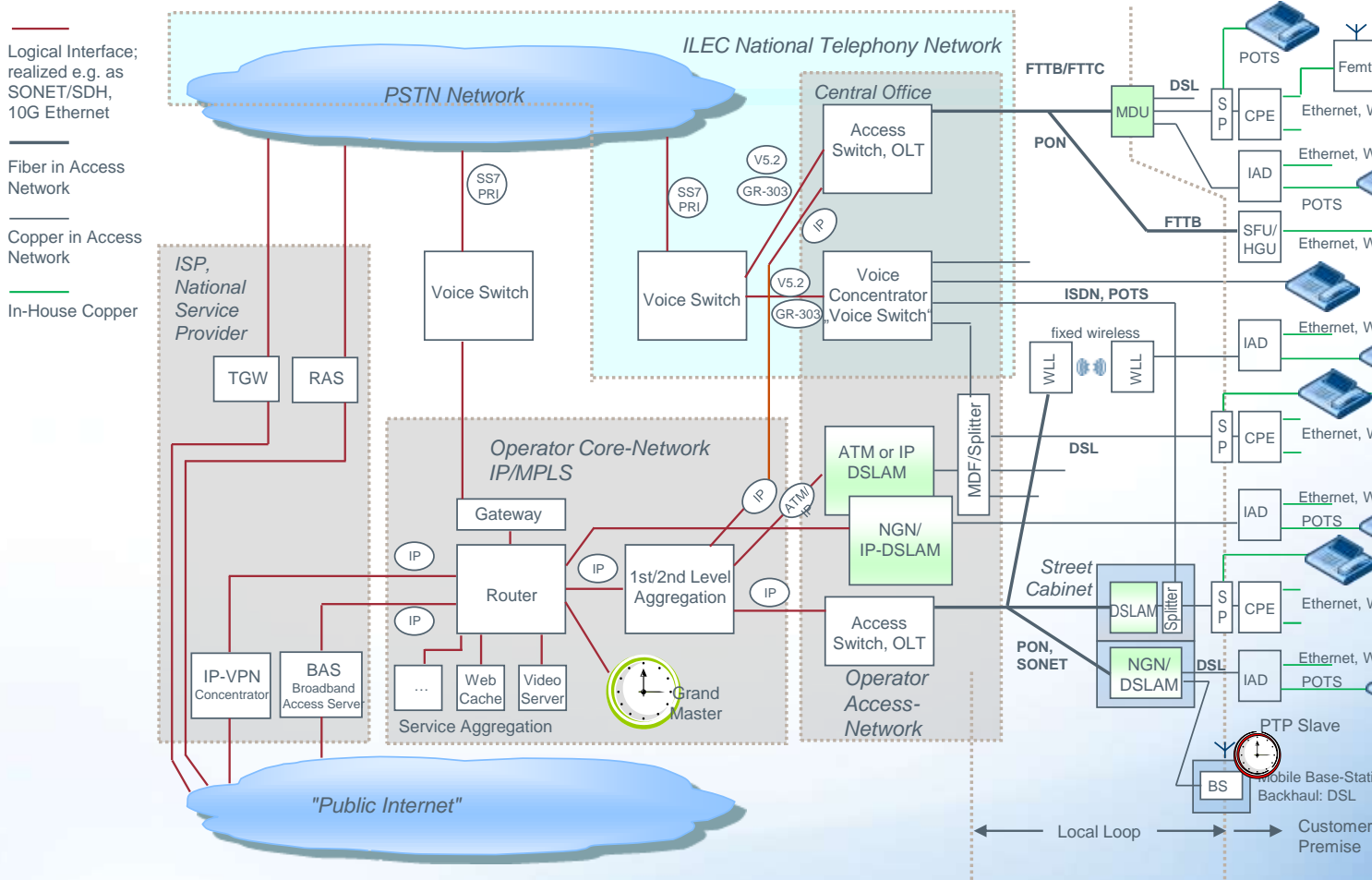




Network Timing Reference for Frequency Synchronization in xDSL based Access Networks

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Frequency & Time Distribution in xDSL End-to-End Network



History and Future of Clock Synchronization over DSL

As of today...

- Γ ADSL, VDSL for data services, residential customers
 - no requirements for frequency & time synchronization
- Γ SHDSL mostly for business (symmetrical) data-services
 - Rather limited use for frequency synchronization
- Γ Backhaul of Base-Stations over copper addressed with T1/E1
 - high precision frequency & clock distribution through TDM frame with native baud-rate (2.048MHz, 1.536MHz)

Future:

- Γ Mobile evolution demands frequency synchronization till the edge of the access network
 - Pico/Femto-Cell architectures for mobile networks, operated customer's premise
 - Bandwidth demand, exceeding T1/E1 capacity
 - Backhaul of 3G/4G Base-Stations partially through (bonded-) D

xDSL Technology Overview

	SHDSL	ADSL2+	VDSL2
Γ DS data rate	5.7 Mbps	28Mbps	100 Mbps
Γ US data rate	5.7 Mbps	1~3 Mbps	100 Mbps
Γ Typ. loop length	24 kft	12...20 kft	6...10 k
Γ Layer 2 Transp.	PTM, ATM, TDM	ATM, PTM	PTM, (ATM)
Γ Typ. Deployment	Ex	Ex, Cab	Ex, Cab, B
Γ Max. Signal BW	1.4 MHz	2.2 MHz	30 MHz
Γ Modulation	PAM 16/32	DMT 512 /32 carriers	DMT 4096/4096 c
Γ Transmit Power	14.5 dBm	20.5 dBm	14.5, 20.5
Γ Frequency Sync	NTR sync	NTR inband, sync	NTR inband, s

Time and Clock Synchronisation for DSL - Overview

	Legacy DSL NTR	Future (Proposed) Time-of-Day Transmission Convergence Layer for DSL
Reference	G.991.2 (SHDSL) G.992.1 (ADSL) G.992.3, G.992.5 (ADSL2, ADSL2+) G.993.2 (VDSL2)	ITU-T Contribution 10MB-054R1 (and others) for VDSL2
Maturity	available/mature	basic idea; principle based on IEEE1588
Frequency Sync	Yes	Yes
Phase Sync	---	Yes
Abs. Time Sync	---	Yes
Working Principle	NTR ib-bits (indicator bits), exchanged every superframe ($\leq 20\text{ms}$)	1588 PTP-style exchange of 4 timestamp time events coupled to DSL-loop time

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