SYNCHRONIZATION IN PACKET SWITCHING NETWORKS

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ABSTRACT

Network providers are faced with significant challenges in delivering backhaul solutions. Given that solutions based on Time Division Multiplexing (TDM), is not providing improved efficiency at a reasonable cost. Thus the need for new backhaul solutions is becoming significant. With the full-IP evolution, all the mobile networks are migrated to full-IP, thus capabilities inherent to traditional TDM needs to be developed in these IP networks. Real-time applications have relatively tight timing requirements concerning delay and delay variations. Therefore, need efficient timing solution for those real-time applications.

Synchronization is important aspect in networks and it is more critical in mobile networks. Loss of synchronization in mobile networks leads to call drops, mobile broadband data speed degrades and packet losses. Network equipment should be synchronized in frequency, time and time of day. To achieve the packet network based synchronization new strategies should be adopted. Else, traditional synchronization techniques is to be continued to synchronize networks.

Specialized synchronization networks can deliver better and accurate performances, but that is with a higher cost. There are new technologies introduced to the industry for synchronization. Before migrating in to new technologies, analyzing these techniques against the service delivery requirement is a prerequisite. There is information available and accessible for the operators, in the areas related to developments of technical standardization proceedings, but there is clear lack of resources and information for practical implementations.

There are gaps to be addressed while migration mobile networks into packet switching networks. Migration from circuit switching network to packet switching networks will break the synchronization chain. Most importantly, delivering the synchronization across the borders is required to interwork communication systems. Packet networks are asynchronous in nature therefore integrating time aware applications with packet network require correct timing at the interfaces to provide acceptable performance. Hence, special consideration and design is required in All-IP networks.

Cost plays a major role in the adaptation of modern technologies to existing telecommunication networks. Hence backhauling need to be a highly cost effective. At present, the IP networks have proven to be the most cost effective and thus migrating mobile network to a full-IP based network with synchronization capability provides additional cost benefit for the network operators.

In this research, technical standards and available synchronization methods are extensively evaluated. Moreover, network requirements, possibilities and limitations are also extensively analyzed. Logical behaviors are compared and analyzed for standardized synchronization techniques. Based on these analyses, implementation guidelines have been developed.

The guidelines have been prepared within the overall technical framework published by ITU-T standards and it is hoped that they will be helpful for the mobile operators who wish to migrate from existing network to future proof capacity agile packet switching network.

Keywords: Packet Networks, Synchronization, Synchronous Ethernet, IEEE 1588v2.

DEDICATION

I would like to dedicate this dissertation to my wife Priya, our parents, to my brothers and to my sisters. Without their continued support I could not have completed this.

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LIST OF ABBREVIATIONS

Abbreviation	Description
ACR	Adaptive Clock Recovery
ANSI	American National Standards Institute
BC	Boundary Clock
BSC	Base Station Controller
BTS	Base Transceiver Station
CBR	Constant Bit Rate
CCR	Combination Clock Recovery
CES	Circuit Emulation Services
CESoP	Circuit Emulation Services over Packet
CoS	Class of Service
CSR	Cell Site Router
DCR	Differential Clock Recovery
DNS	Domain Name Service
DSCP	DiffServ Code Point
EEC	Ethernet Equipment Clock
EM	Edge Masters
ETSI	European Telecommunications Standards Institute
EVC	Ethernet Virtual Circuit
FLL	Frequency Locked Loop
FTP	File Transfer Protocol
GM	Grand Master
GMGW	GSM Media Gateways
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HTTP	Hyper Text Transfer Protocol
IETF	Internet Engineering Task Force
IMAP	Internet Message Access Protocol
IP	Internet Protocol
IPTV	Internet Protocol Television

ITU-T	International Telecommunication Union
IWF	Inter Work Function
LSP	Label Switch Path
ME	Metro Ethernet
MEF	Metro Ethernet Forum
MPLS	Multi Protocol Label Switching
MTIE	Mean Time Interval Error
NTP	Network Timing Protocol
OC	Ordinary Clock
PDV	Packet Delay Variation
PHB	Per Hop Behavior
PLL	Phase Locked Loop
PNT	Packet Network Timing
PRC	Primary Reference Clocks
PSN	Packet Switching Network
QL	Quality Level
QoS	Quality of Service
RNC	Radio Network Controller
SDH	Synchronous Digital Hierarchy
SIGTRAN	Signaling Transport
SIP	Session Initiation Protocol
SMTP	Simple Mail Transfer Protocol
SONET	Synchronous Optical Network
SSM	Synchronization Status Messages
SSU	Synchronization Supply Units
SyncE	Synchronous Ethernet
TDM	Time Division Multiplexing
ToS	Type of Service
UDP	User Datagram Protocol
UI	Unit Interval
VLAN	Virtual Local Area Network

VLL	Virtual Leased Line
VOD	Video on Demand