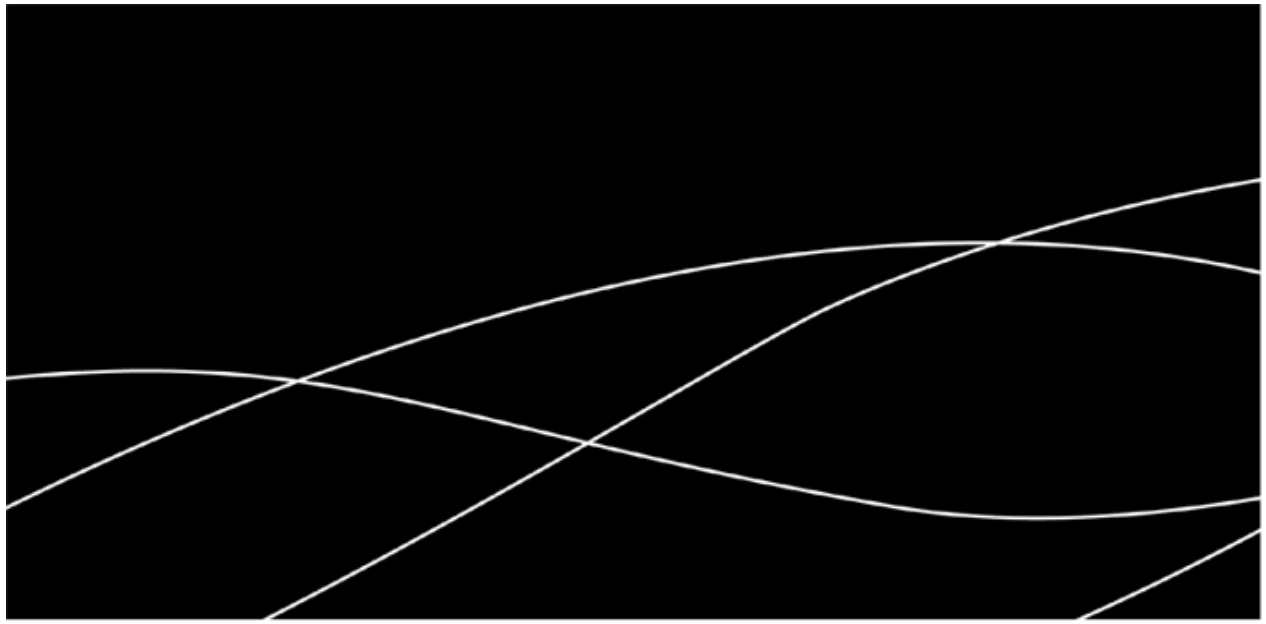
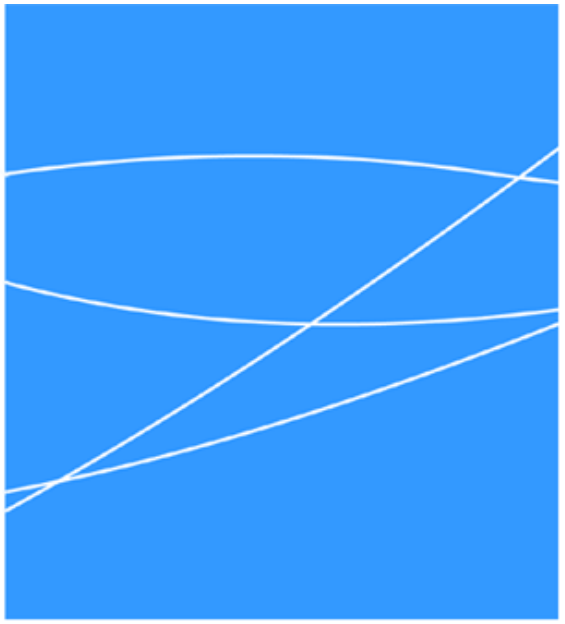
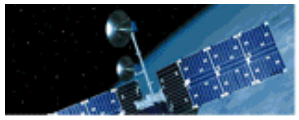
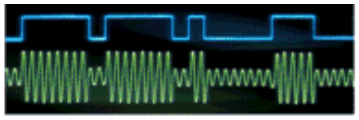








Timing Requirements In IPTV Solutions

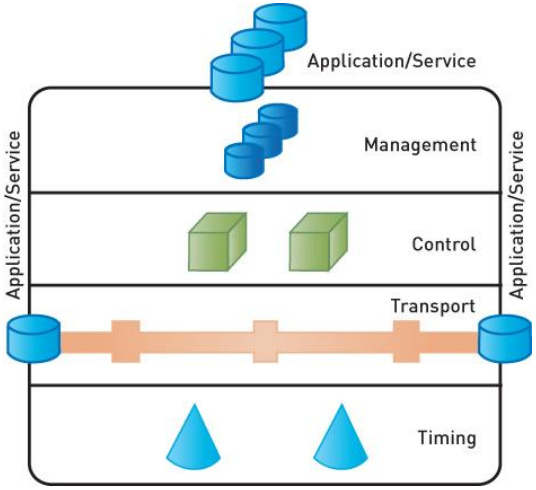
Vandana Upadhyay
Senior Director, Business Development
Symmetricom

November 15, 2006

Driver of Timing

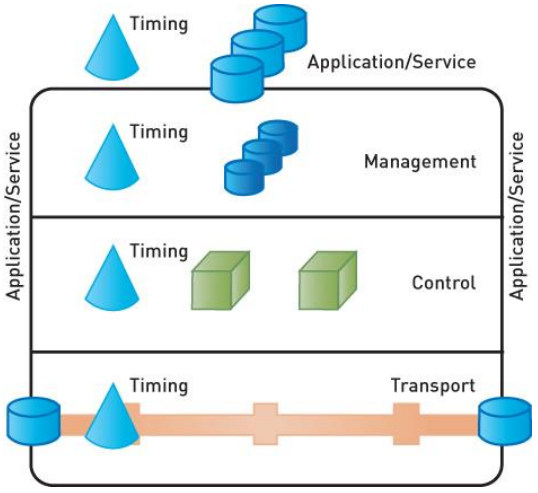
Past

- Frequency
  - Transmission Alignment
  - Real-time services – voice, fax



Future

- Frequency
  - For Certain Types of Transport Alignment
  - Controlling Element Clocks For Real-time Applications & Services in Packet Networks
    - Circuit Emulation and Mobile Call Hand-off
- Time
  - Ways to Measure Packet Performance
  - Billing & Management Application
  - Synchronize Different Aspects of an End-to-end Application/Service Delivery



IPTV – what is it (and is not)

- Internet Protocol Television(IPTV) is an end-to-end delivery of live broadcast and/or stored video signals to users over a broadband connection using Internet Protocols in a managed services network with user interactive features

- What it is not
  - Peer to peer video/image sharing
  - IP streaming over the internet
  - Digital/Packet/IP video – Transport of video over IP/Ethernet Backbone
  - DTV

IPTV Deployment Is Complex

- IPTV Service Is Not the Same As Delivery of Video in Cable/satellite Broadcast Model
- Transport Network Changes
- Service/Application Delivery Changes
- Last Mile & Home Distribution

Carrier Challenge : Ensuring end-to-end QOS
Customer Satisfaction

MPEG Timing Model Requirements
ISO/IEC13818-1/ITUT H.222

Symmetricom

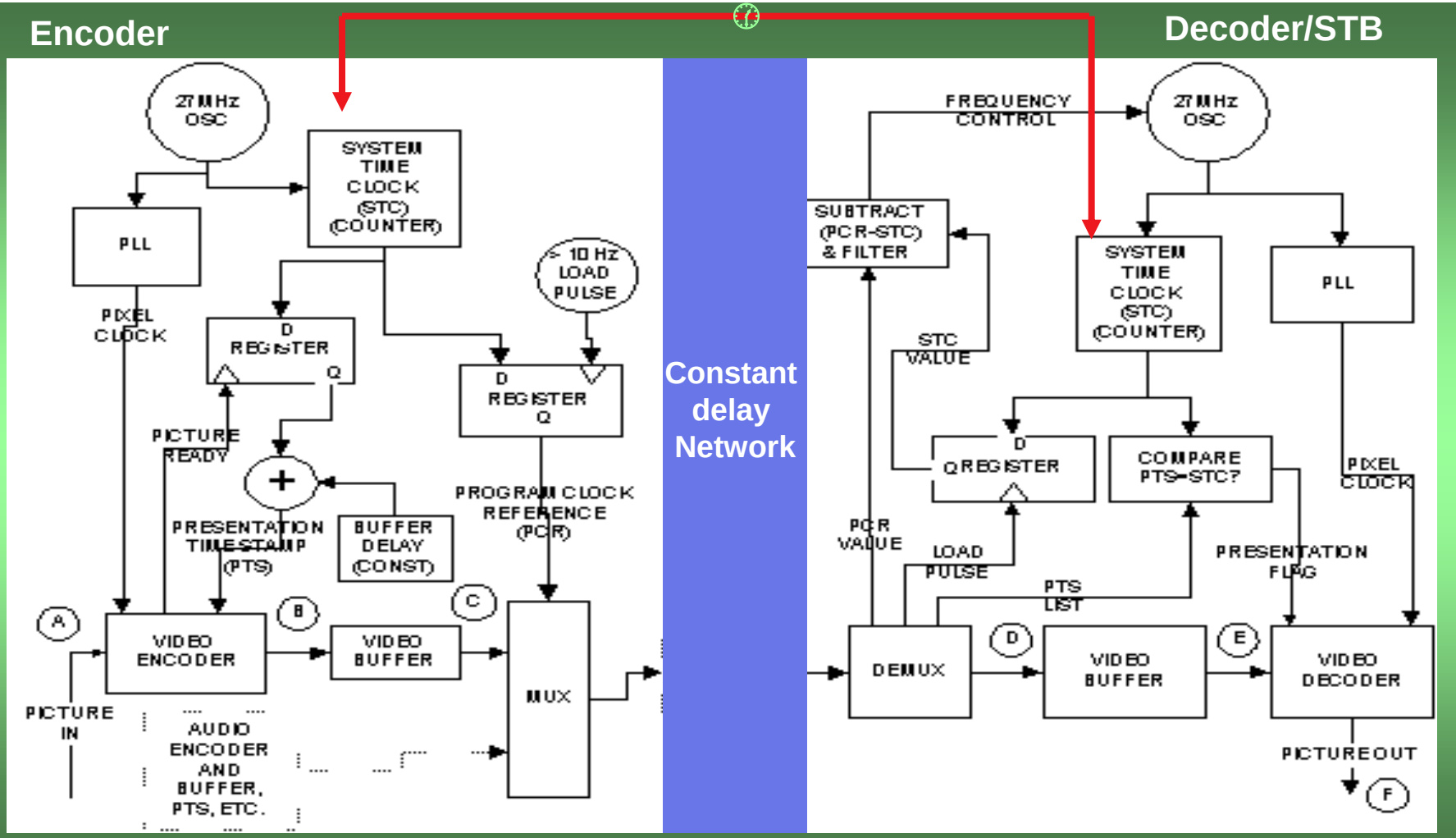
- Encoder and decoder clocks must be synchronized per specifications standardized

- Related to PCR:
  - Frequency offset : ≤ 30ppm
  - Frequency drift rate : ≤ 2.8 ppb/s
  - Time-stamp accuracy : better than 500ns
    - Decoder tolerance is typically 50μs

- Related to PAL (color sub-carrier)
  - Frequency offset : ≤ 2.3ppm
  - Frequency drift rate : ≤ 23 ppb/s PAL

◀MPEG Timing Model assumes constant delay network (e.g. ATM)

MPEG Timing Model for encoder and decoder(STB) synchronization

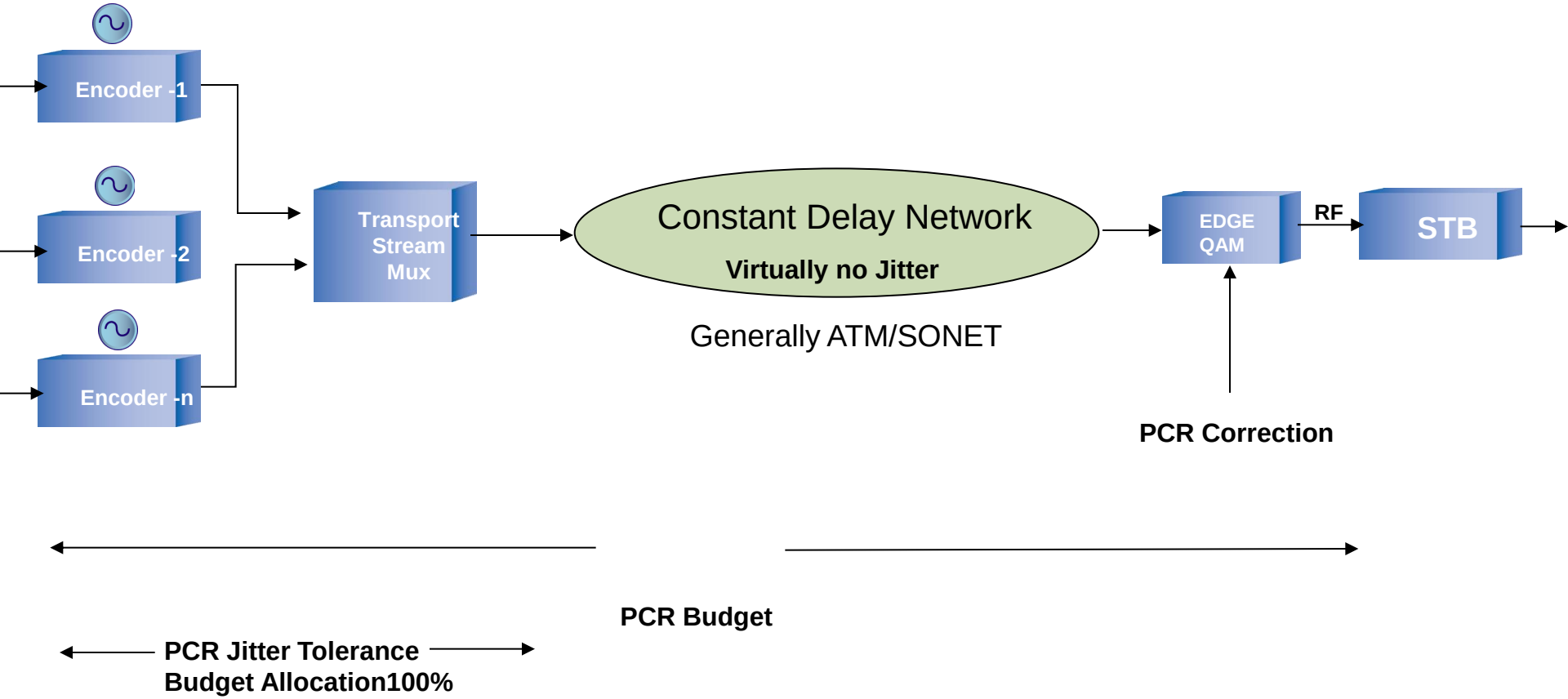


STC: System Time Clock PCR: Program Clock Reference

PCR – a time stamp generated by encoder STC, inserted into a transport stream packet. Used to synchronize decoder STC with encoder STC

PCRs extracted before the receiver buffer to synchronize decoder STC

PCR Integrity in Traditional Video Network



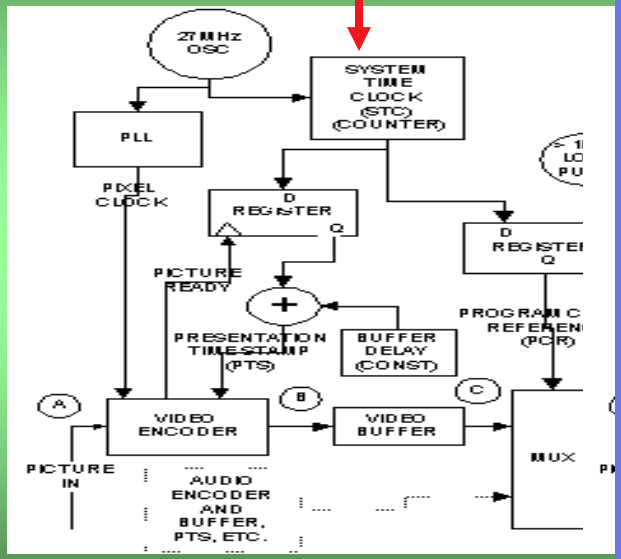
- Even in a constant delay network, some jitter is introduced which is handled through buffering at STB
- In addition, PCR correction and reinsertion is applied at the edge before the RF segment, particularly where backbone transport is IP

Encoder/STB synchronization in IP networks

Symmetricom

Encoder

Decoder/STB

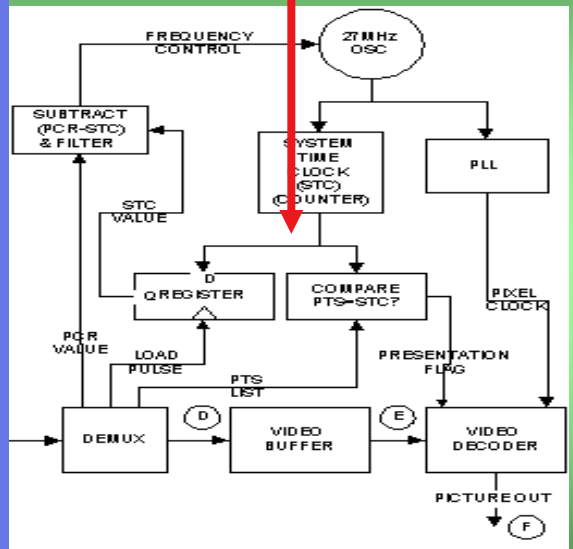


Not a constant delay network

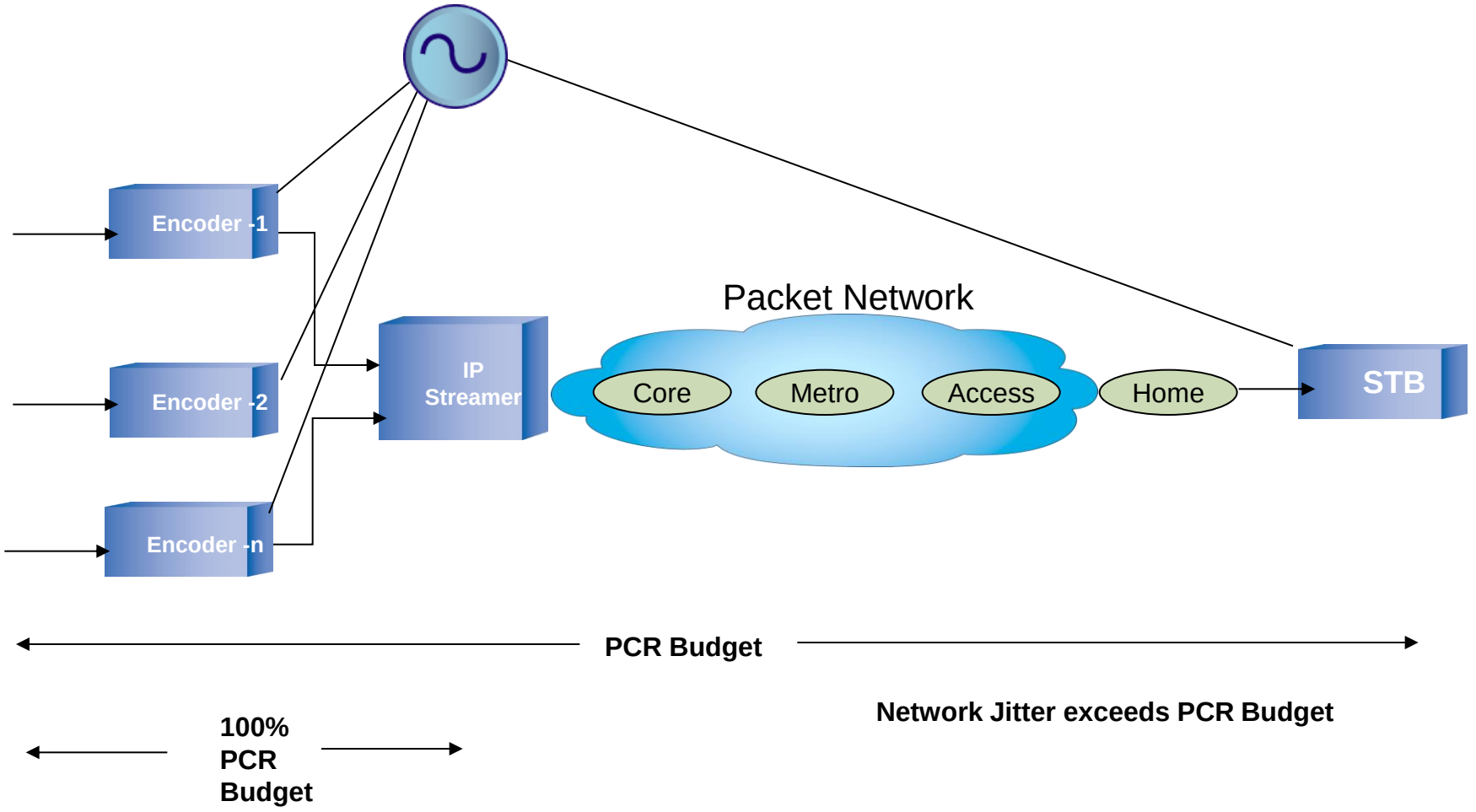
Network jitter adds to PCR
Jitter from other sources

Even brief intervals of high jitter impact QOS

Buffering, FEC not adequate



Mechanism to maintain PCR Integrity in end-to-end IP Delivery



- Ensure all encoder clocks are synchronized
- Provide network time reference at both ends (ISO/IEC 138181-1)
- Currently proprietary implementations, standards being defined e.g. ATIS

IPTV Service Requirements

- Interactivity/On Demand Is New
  - Fast channel change response times
  - New service paradigm – interactive/on demand/customized/targeted/ personalized
- Service delivery infrastructure is highly distributed
  - A single service request involves multiple geographically dispersed servers All need to have consistent time
    - DRM/ Billing/Authentication/Content Server/Ad Server
- Subscriber Authentication and Billing Transaction Handling
  - Lack of consistent time across all systems could cause service disruption e.g.
    - DRM license expires while program in progress
  - BSS/OSS integration
    - Millions of transactions/day
- Network Security and Content Protection is a Must
  - Secure and authenticated time required

Geographically Distributed Service Delivery

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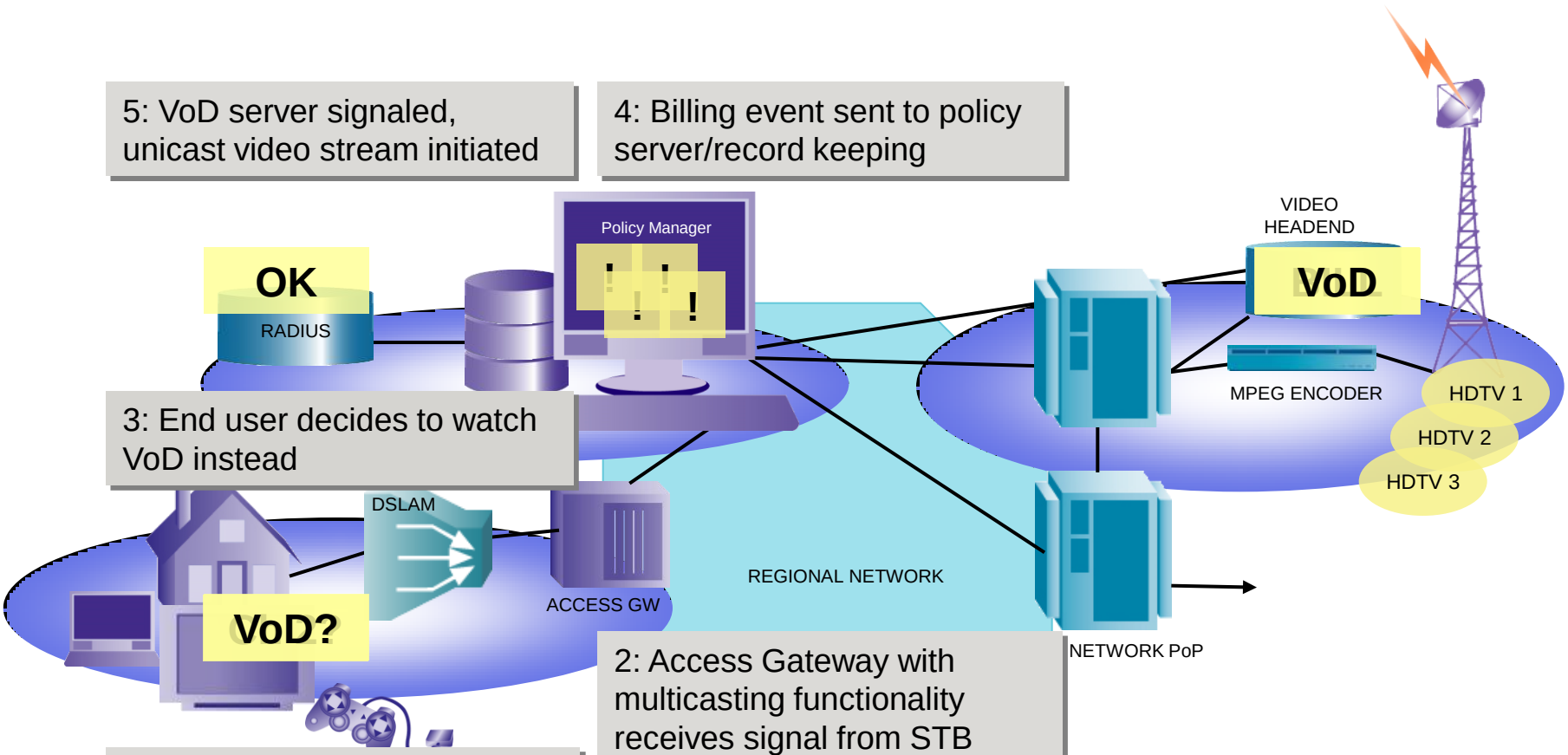
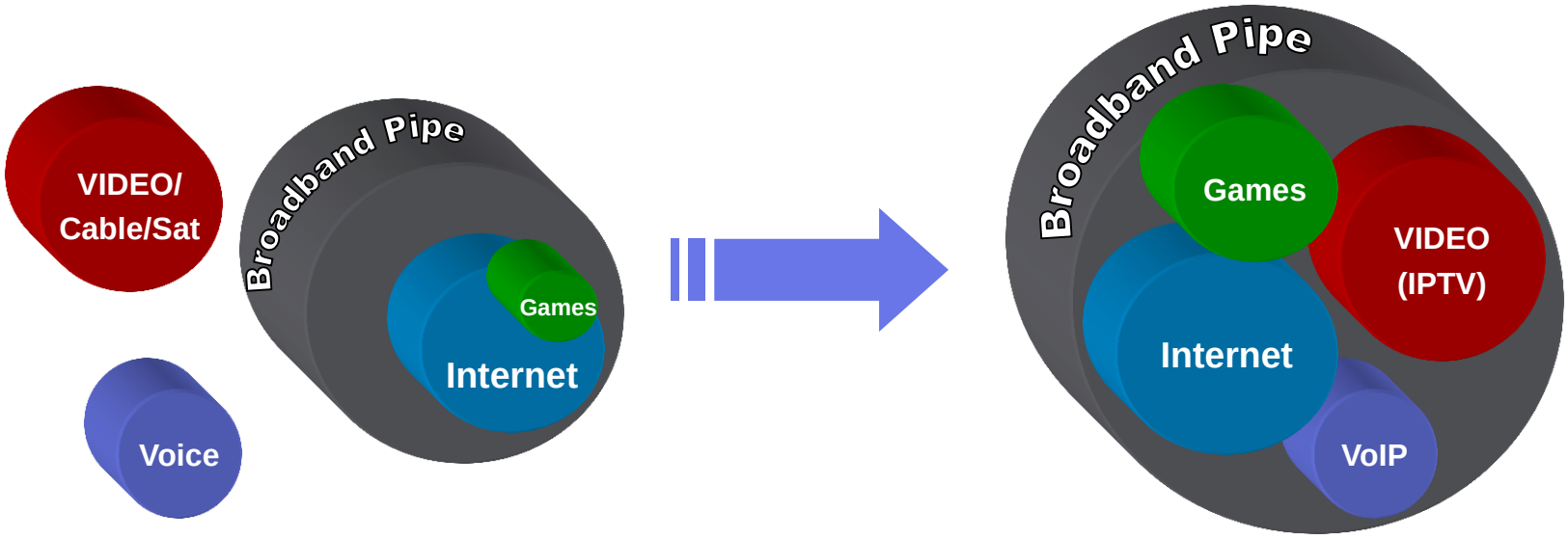


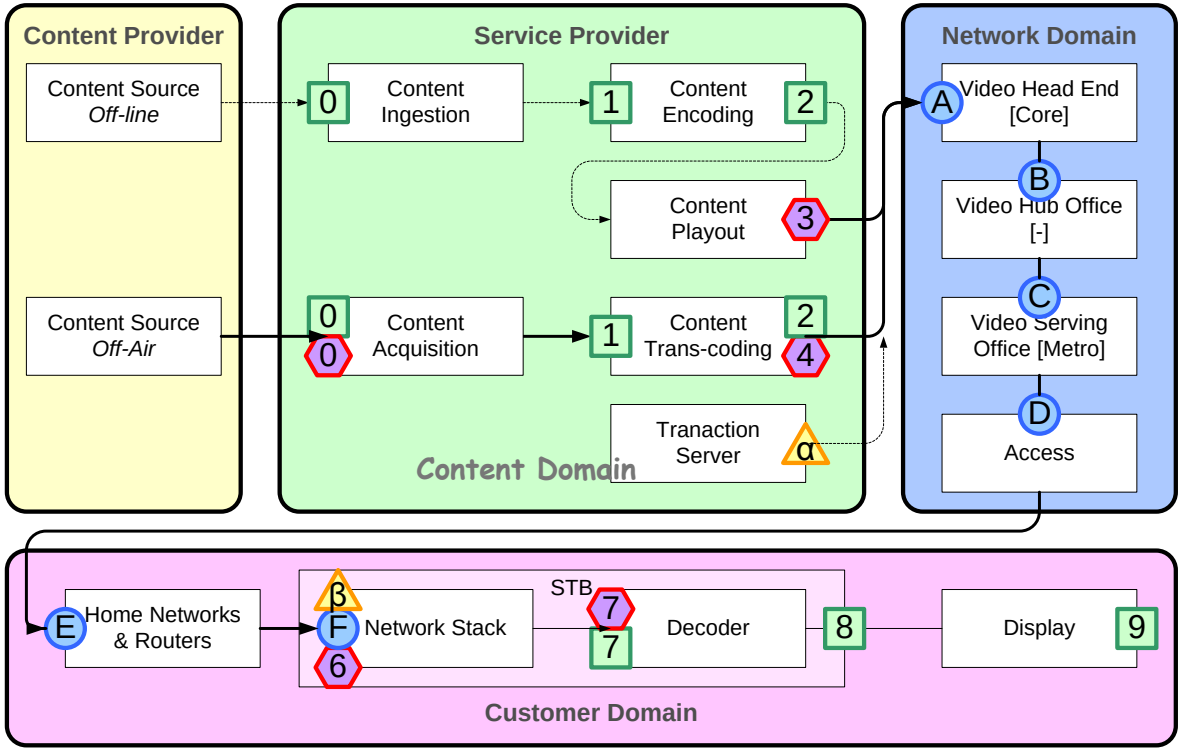
Last Mile Complexity



- Ensuring QoS in the Last Mile a challenge
  - Video delivery is on a shared pipe with other services
  - Last mile prone to physical layer impairments
  - Contention within the home network

→ New requirements for synchronization emerging

IPTV QoS Measurement



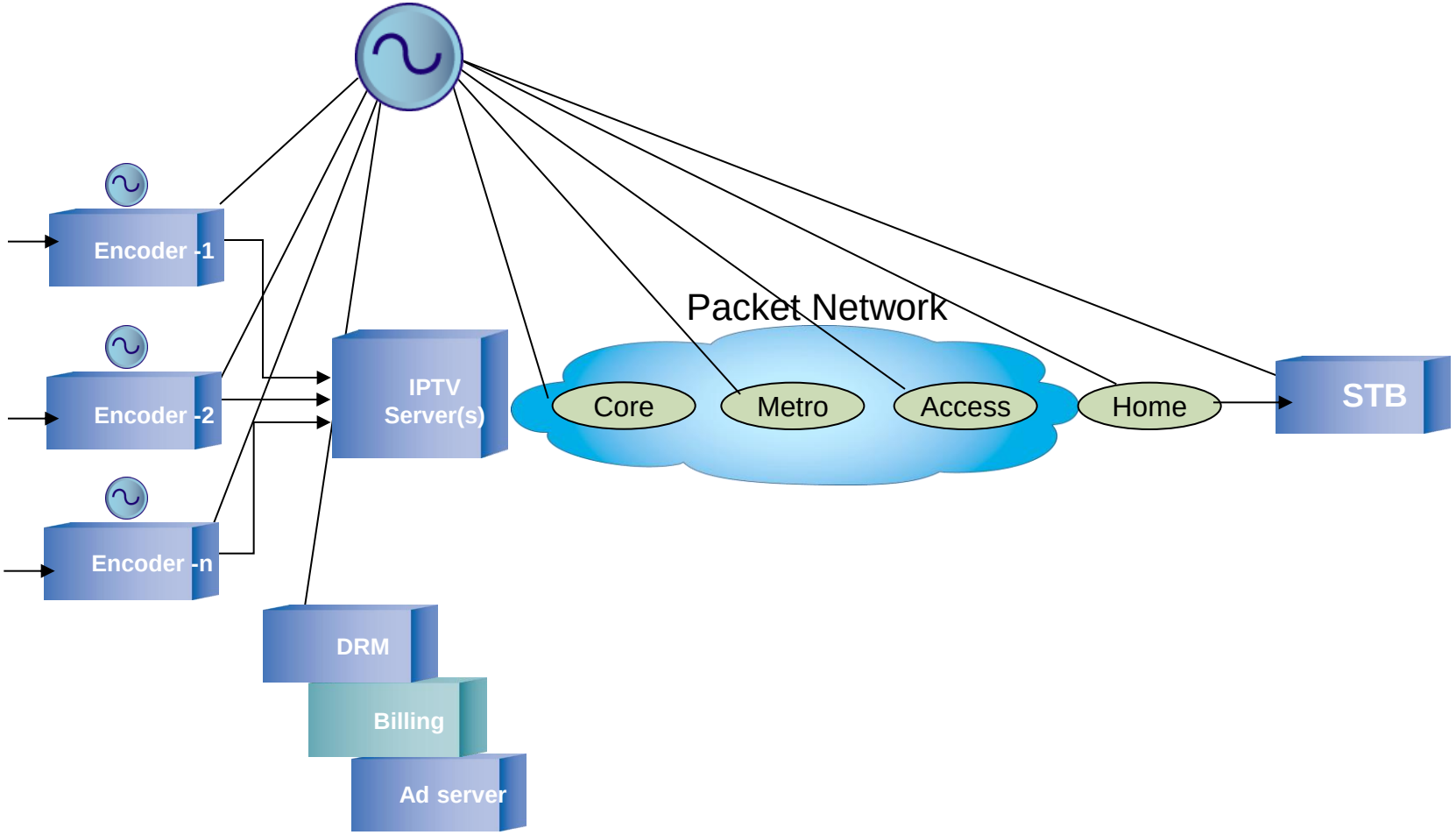
ATIS IPTV QoS Measurement Model

(Original Contribution by Simon Jones/Bob Bissell, British Telecom)

- Ⓐ Video Headend Office(Core)
- Ⓑ Video Hub Office
- Ⓒ Video Serving Office(Metro)
- Ⓓ Access Network
- Ⓔ Residential Gateway
- Ⓕ STB

- ▶ Measurements
  - IP/Transport Layer
    - Well known e.g. packet loss, packet delay, jitter
  - Media/Service Layer
    - being defined in standards bodies – IETF, ITU, ATIS
  - IPTV is an asymmetric service
    - One way delay measurements
- ▶ Measurement points
  - Many points between headend and the end device
  - Measurement points require precise time reference
  - Key Metrics
    - Packet Loss
    - Packet delay
    - PCR Jitter
    - Channel Change Delay
    - DRM Key Arrival

Timing in IPTV Delivery



- All elements in IPTV delivery system need to be synchronized
- Synchronization granularity varies
- However, synchronization implementation must support high transaction volumes and availability

Timing In IPTV Deployment

	Timing Parameter	Timing Distribution Protocol	Purpose	Where
Transport	- Frequency	- BITS Signals - Packet Based Protocols	Network Synchronization	- C.O. - Access Network – PON, DSLAM, etc.
Management	- Time of Day - Time Stamps	- NTP - NTP	- Service Management - DRM, Program Guide - QoS Measurement	- Video Headend - Video Serving Office - CO
Application	- Time Stamps - Time of day	- NTP - NTP	- Video encoding - Ad insertion	- Video Headend - Video Serving Office / CO - STB / Res. Gateway

IPTV Timing Solution

- Timing implementation depends on
  - Middleware implementation and features
  - STB Specifics
  - Network architecture
- Standards
  - Effort underway – ATIS IIF, ITU FG IPTV

Engineered solution for each Implementation

IPTV Timing Solution Key Requirements

Symmetricom

Scalability
▪ Network
▪ Capacity
▪ Peak Conditions

Availability
▪ Accuracy and Precision
▪ Implementation Architecture

IPTV
Timing and Synchronization
Solution

Reliability
▪ System Uptime
▪ Failover recovery

Security
▪ Secure Time
▪ Trusted Time

IPTV Standards Efforts

- ITU FG IPTV
- ATIS IPTV Interoperability Forum(IIF)
  - Primary standards development organization
  - Service Provider Focus
- IEEE/IETF

Key Provisions in ATIS IIF Standard Publications

- **ATIS is Association of Telecom Industry Solutions.**
  - North American Telecom Standards Body. Represents North America in ITU
  - Appointed lead standards body by GSC
  - ITU FG IPTV following ATIS IIF

- **Requirements**
  - Common stable frequency reference traceable to national frequency standards required for delivering content from different sources
  - Stable time reference required for service aspects such as DRM, billing, ad insertion
  - The IPTV security solution to provide mechanisms to support secure accurate time on the IPTV Receiving Device
  - QoS Metrics Measurement e.g. one way delay

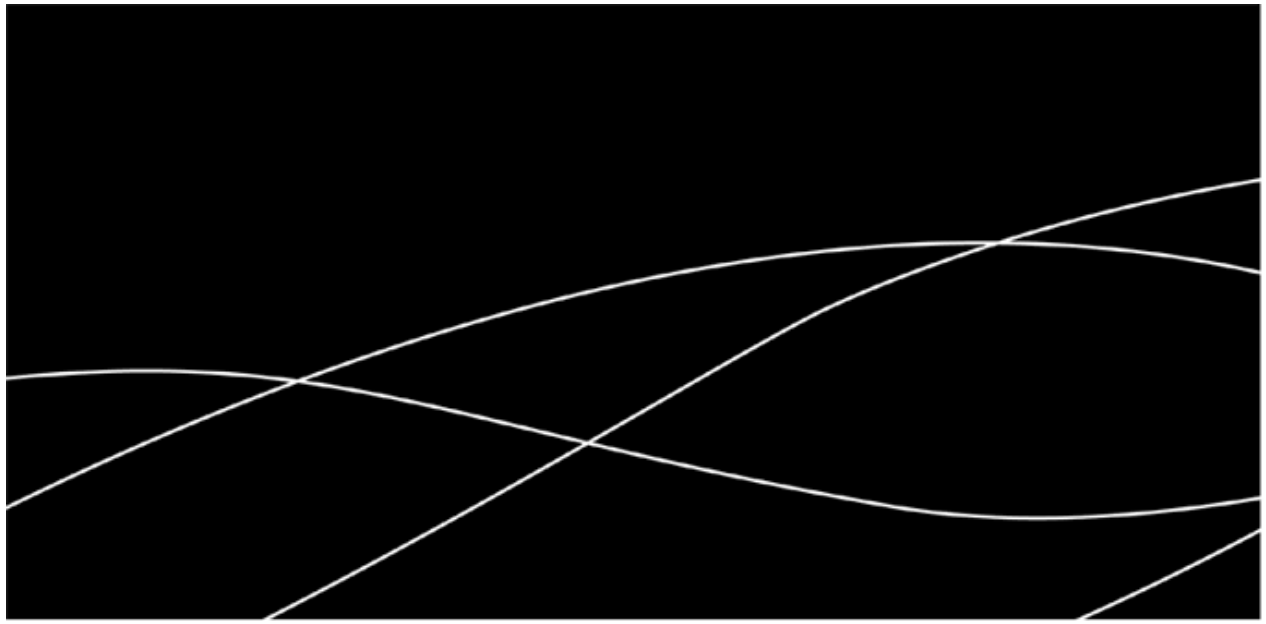
- **Implementation**
  - Time and frequency reference needs to be provided to the IPTV Terminal and the headend
  - Non service affecting provisioning of Time and frequency distribution, particularly in the last mile

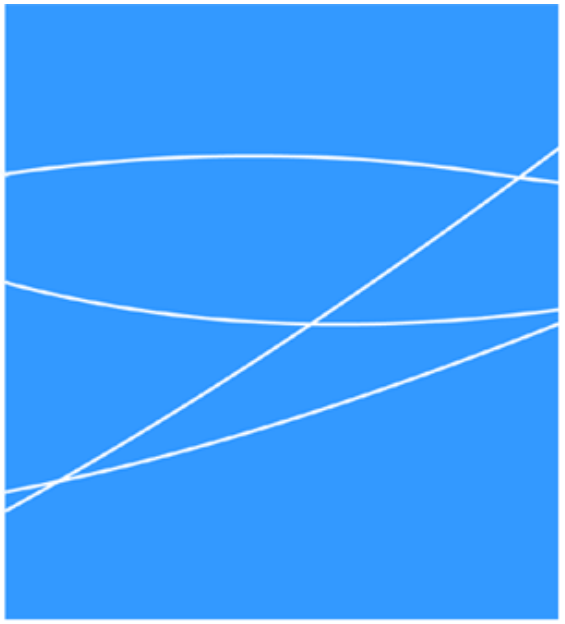
- **Areas of Further Work**
  - Ensuring MPEG Timing Model in high jitter environment
  - Accuracy and precision specifications for various functions

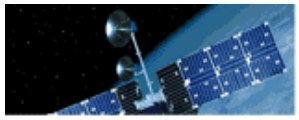
References : ATIS 0800002, ATIS 0800001, ATIS IIF WT-004

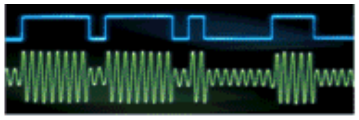
Symmetricom Leadership in IPTV Timing and Synchronization Requirements

- Developing Fundamental Technology to address requirements
- Testing at Symmetricom NGN Lab and with operators/ vendors
- Development of recommended practices in collaboration with IPTV infrastructure and middleware vendors
- Standards
  - ATIS IPTV Interoperability Forum
    - Co-chair, Quality of Service Metrics Task Force
    - Working with the industry(service providers and vendors) to define Timing and Synchronization standards for IPTV









Thank You

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