ATSC Data Broadcasting

A View of T3S13 Activities and Standards

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Credits

- Participants in ATSC T3S13

- Participants in ATSC IS-DIWG

S13 Ballot

- Second Ballot
  - First ballot passed

- 46 T3 members eligible to vote
- Q1: 16 Yes, 3 No, 2 Abstain
- Q2: 17 Yes, 0 No, 4 Abstain

- 9 Companies provided comments

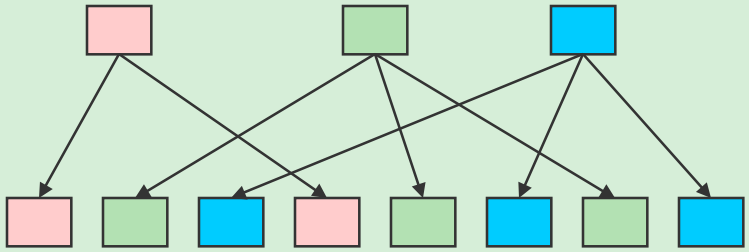
Agenda

- Standards & ATSC
- MPEG
- Data Broadcast & T3S13
  - Encapsulations
  - Discovery & Binding
  - Buffer models
- Implementation
- Conclusion

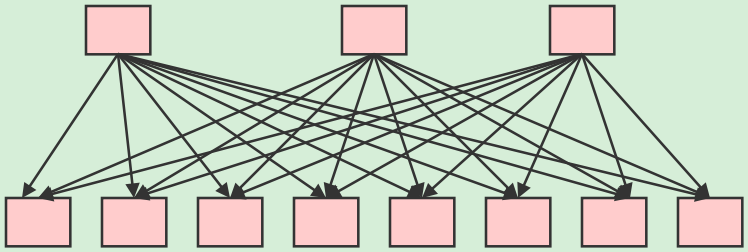
"The most wonderful thing about standards is that there are so many to choose from" - unknown

Why Standards?

Proprietary



Standards Based



Standards ⟷ Interoperabilit

“Standards”

DVB

ATSC

DSM-CC

ARIB

MPEG-(1,2,4,7)

W3C

TV Anytime / Anywhere

Java

DAVIC

ATVEF

OpenCable

DTG

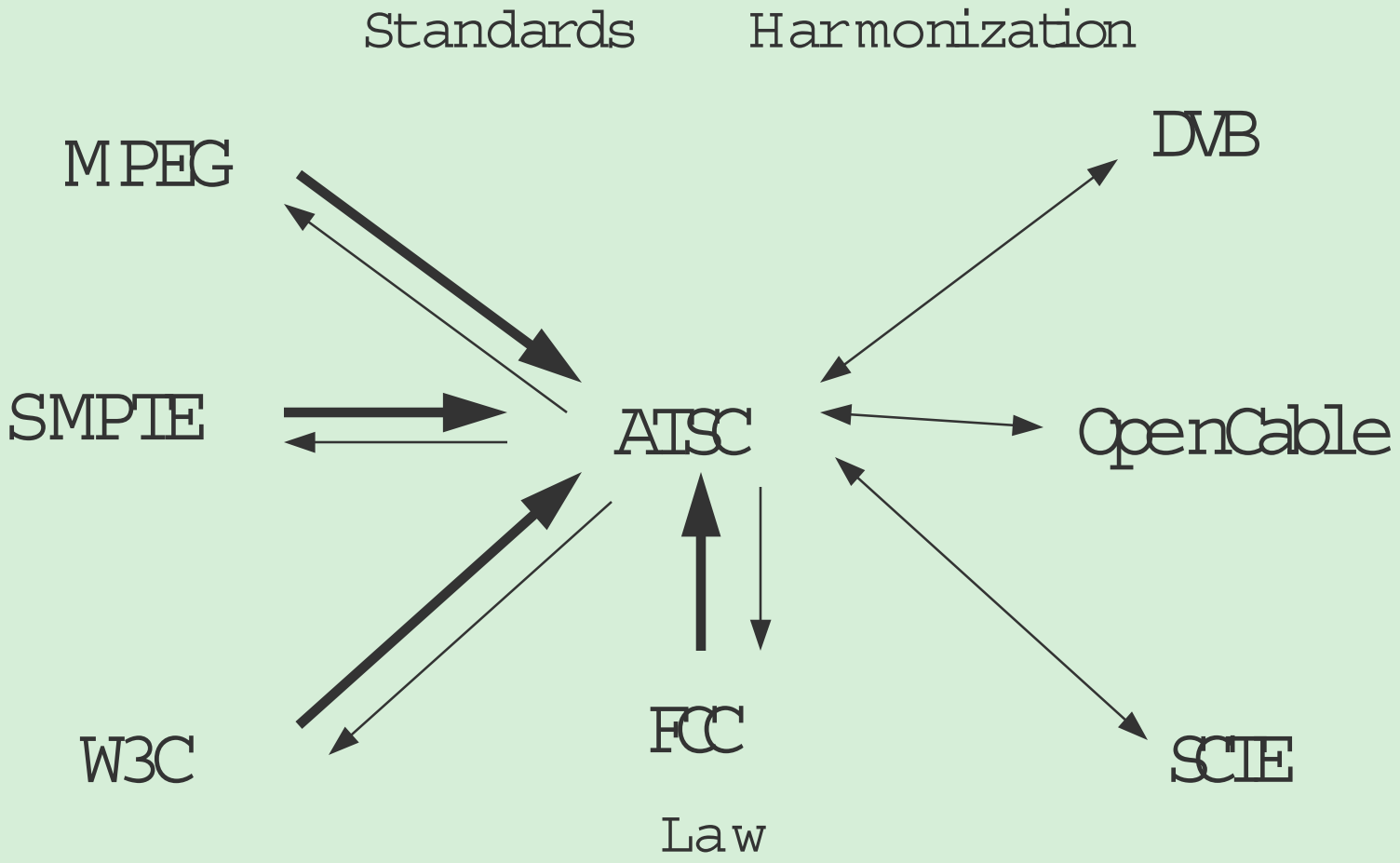
MHEG

SCTE

SMPTE

…

ATSC Interactions



GENERAL PICTURE

* Television Programs
  * A/V
  * PSIP/System Info
* Associated data such as
  - Enhancements
  - e-Commerce

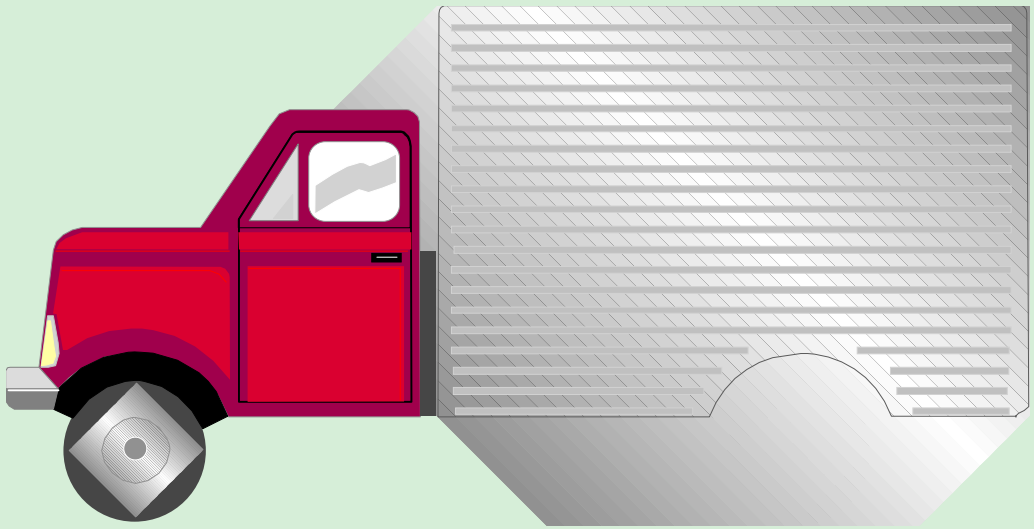
Stand-alone Data Services
* Subscription Services
  - Magazines, Music
  - Targeted info services
* Streaming Data

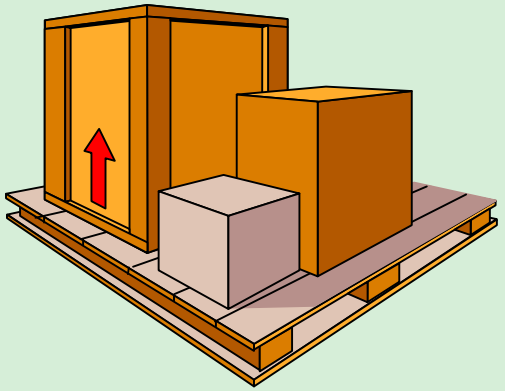
Opportunistic data services
* Business data services
* IP router in the sky
* Targeted info services

Broadcast Multiplex

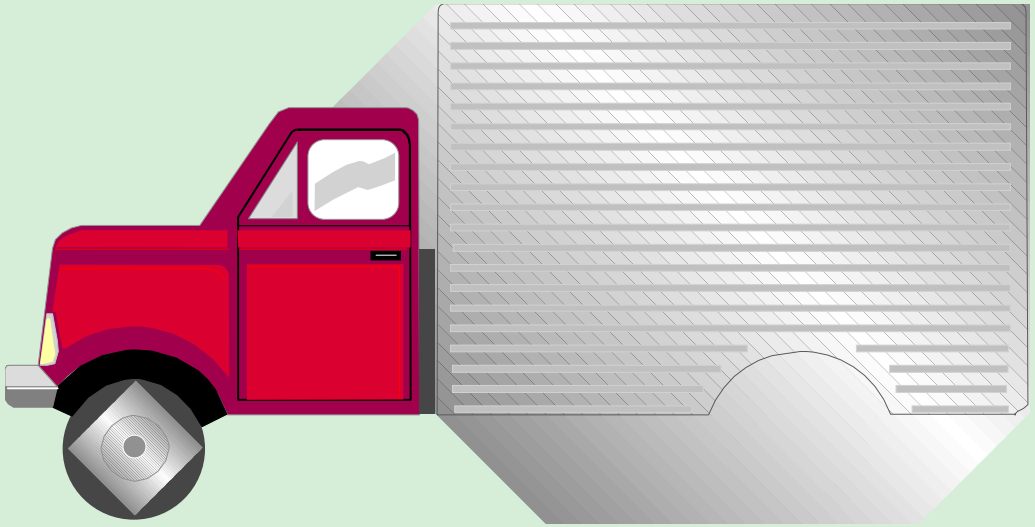
MPEG Transport Stream

Data Broadcast





MPEG-2 Systems



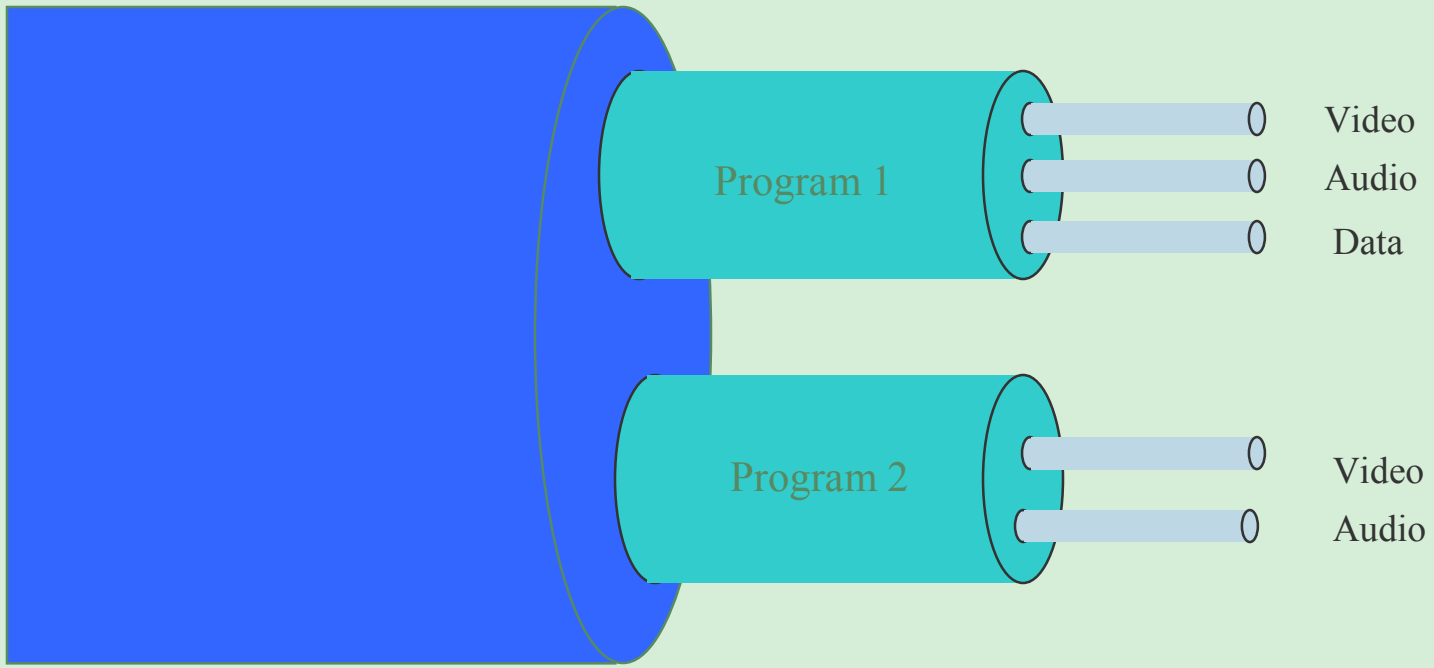
What is MPEG-2

An ISO standard - 13818

consisting of the following parts:

- Part 1 - Systems
- Part 2 - Video
- Part 3 - Audio
- Part 4 - Compliance testing
- Part 5 - Simulation software
- Part 6 - Digital storage media command and control (DSMCC)
- Part 7 - Non-backwards compatible audio
- Part 8 - 10 bit video extension
- Part 9 - Real-time interface

MPEG-2 Systems

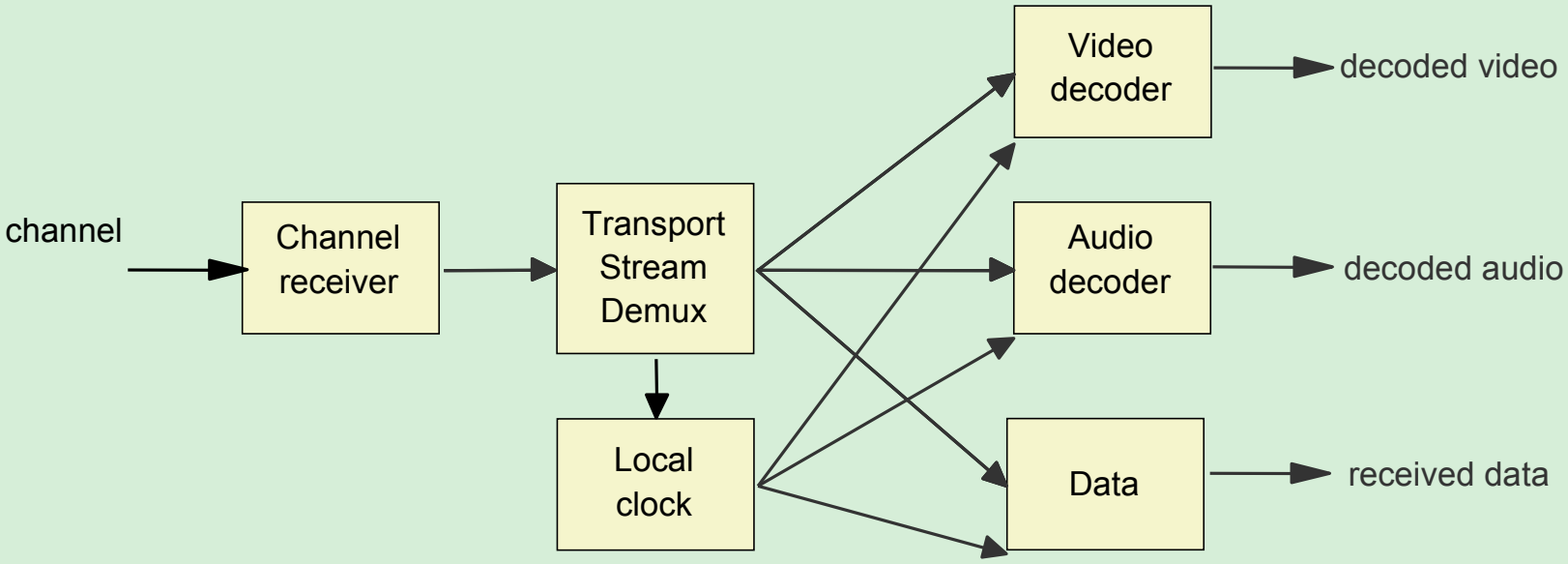


MPEG-2 Transport Multiplex

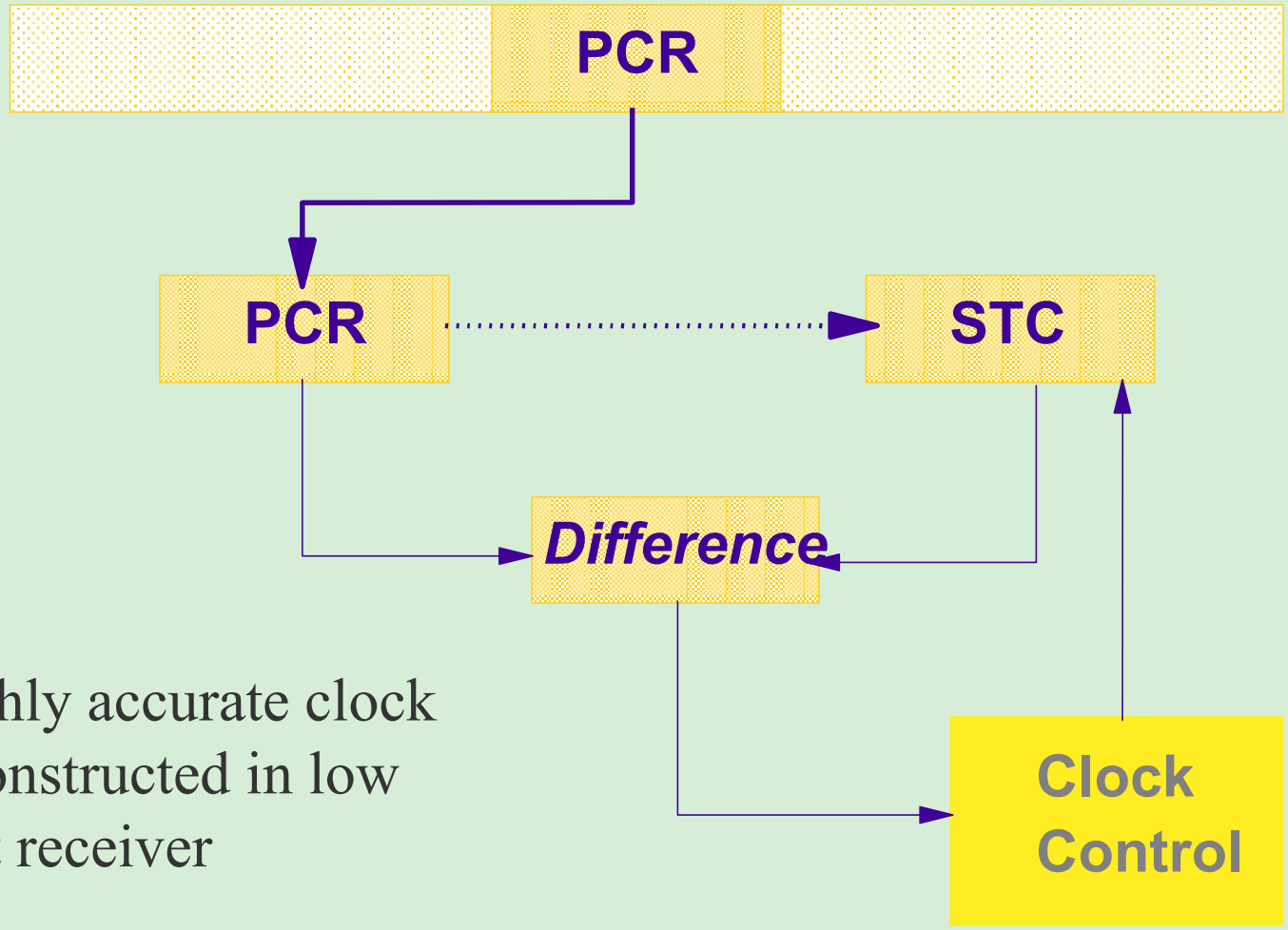
MPEG-2 Systems

Fixed sized packets

- 188 bytes
- byte aligned
- composed of header and payload



MPEG-2 Clock Recovery



Highly accurate clock reconstructed in low cost receiver

DTV Standard types

- Video Coding
- Audio Coding
- Transport
- Broadcast

Required for DTV

- Data Broadcast
- Interactivity
- Software Environment

Additional for ITV

ATSC Groups Looking at Data

- ATSC T3-S13
  - Data Broadcasting
- ATSC T3-S16
  - Interactive Services
- ATSC T3-S17
  - DTV Applications Software Environment
- ATSC IS-DIWG (I and II)
  - Data Implementation Working Group

Data Touches Everything!

- All types of equipment are affected
  - Authoring/editing platforms
  - File servers
  - Tape machines
  - MPEG-2 encoders/decoders/multiplexors
  - Receivers

ATSC T3S13 MANDATE

Define how data associated with a television program is carried, scheduled and announced.

Define how data not associated with a program is carried, scheduled and announced.

Build a foundation for new services (e.g. interactive services).

Define transport mechanisms to support a wide variety of data services:

- **Asynchronous/Synchronous/Synchronized data**
- **Multiprotocol data**
- **Fixed bandwidth data**
- **Opportunistic data.**

DTV = VIDEO + AUDIO + DATA

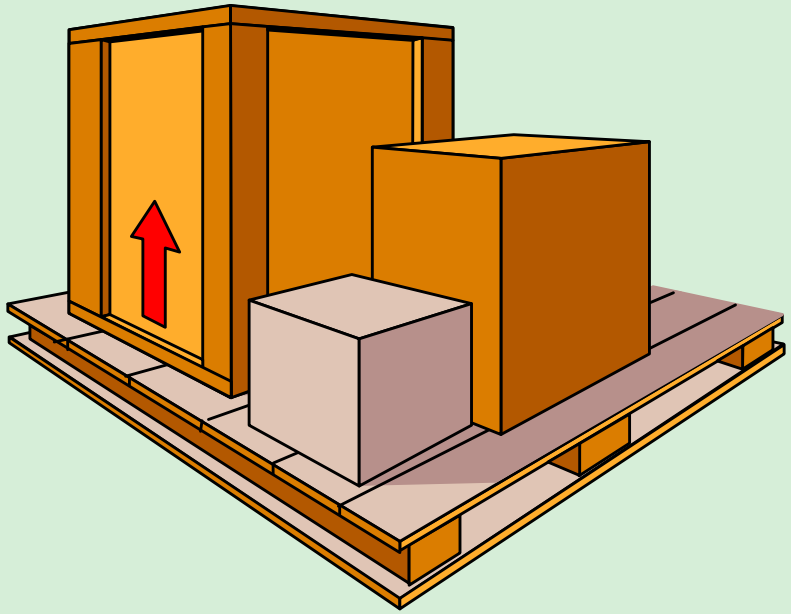
MPEG-2 Transport Streams carrying multiplexed:

- **Service Information (ATSC PSIP + MPEG-2 SI)**
- **Audio, video and *data elementary streams***

ATSC T3S13 BENEFITS

- **Richer presentation model for advertisers/content producers**
  - **Media object delivery**
  - **(HTML, JAVA applets, Rich Graphics)**
- **New incremental capabilities based on data**
- **Support for widespread existing data protocols**
- **Basic data services**
  - **File download**
  - **Integration with Web content**

Encapsulations

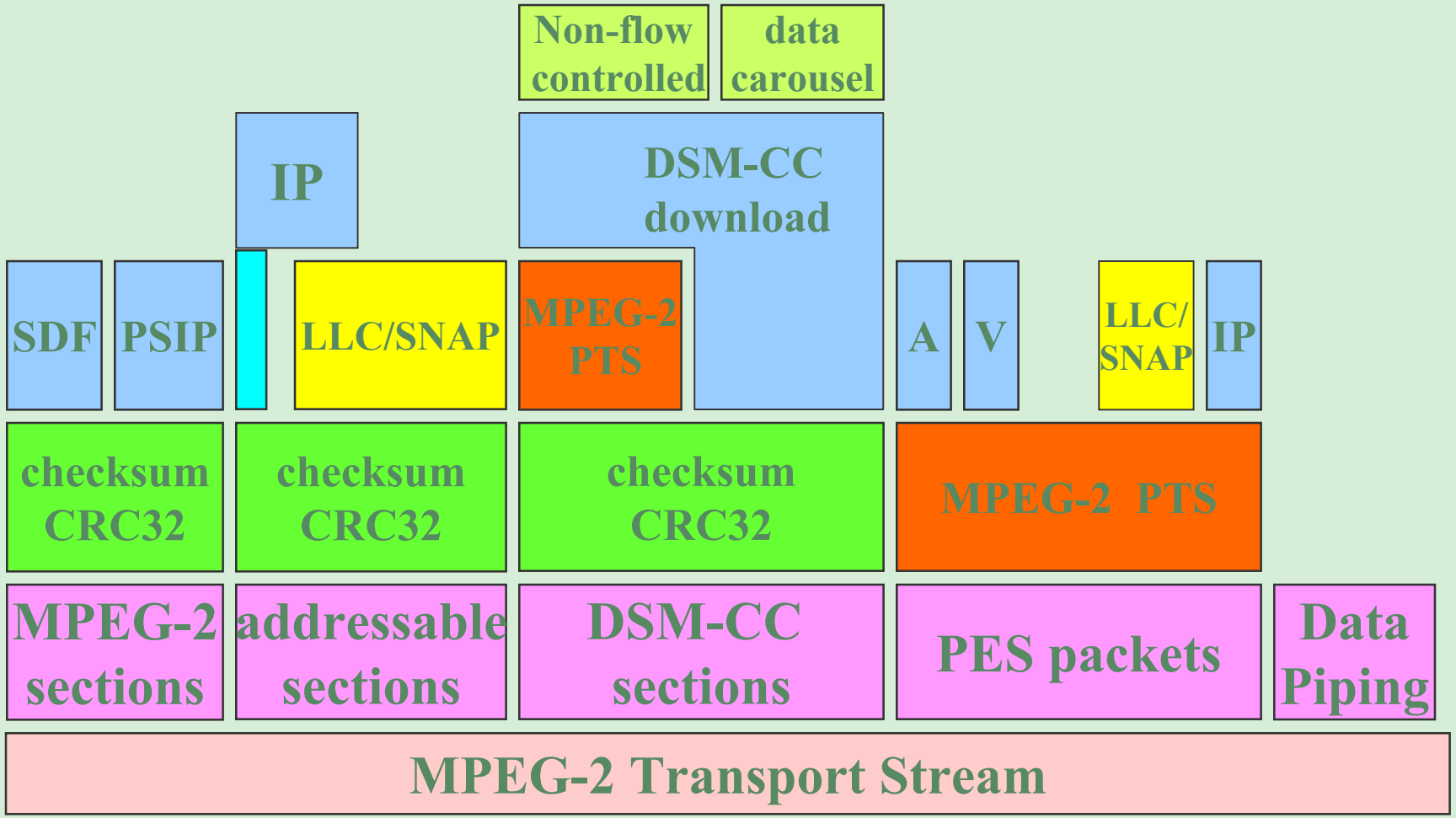


Data Taxonomy

- Protocol encapsulation
  - Standard
  - Proprietary
- Data types
  - Asynchronous vs. synchronous vs. synchronized
  - Streaming vs. non-streaming
  - Blobs, IP, Other wrappers

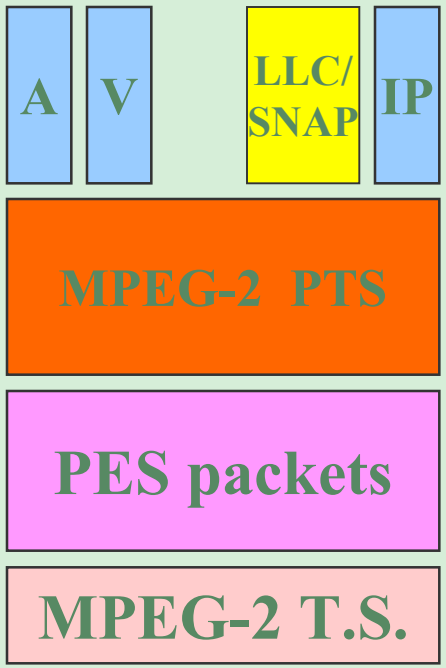
LAYERS AND PROTOCOLS

PACKETIZATION, SYNCHRONIZATION, PROTECTION LAYERS



PES Packets

- Carry A/V data
- Carry data synchronized with A/V
- Carries data synchronized with other PES streams
- Carries synchronous data

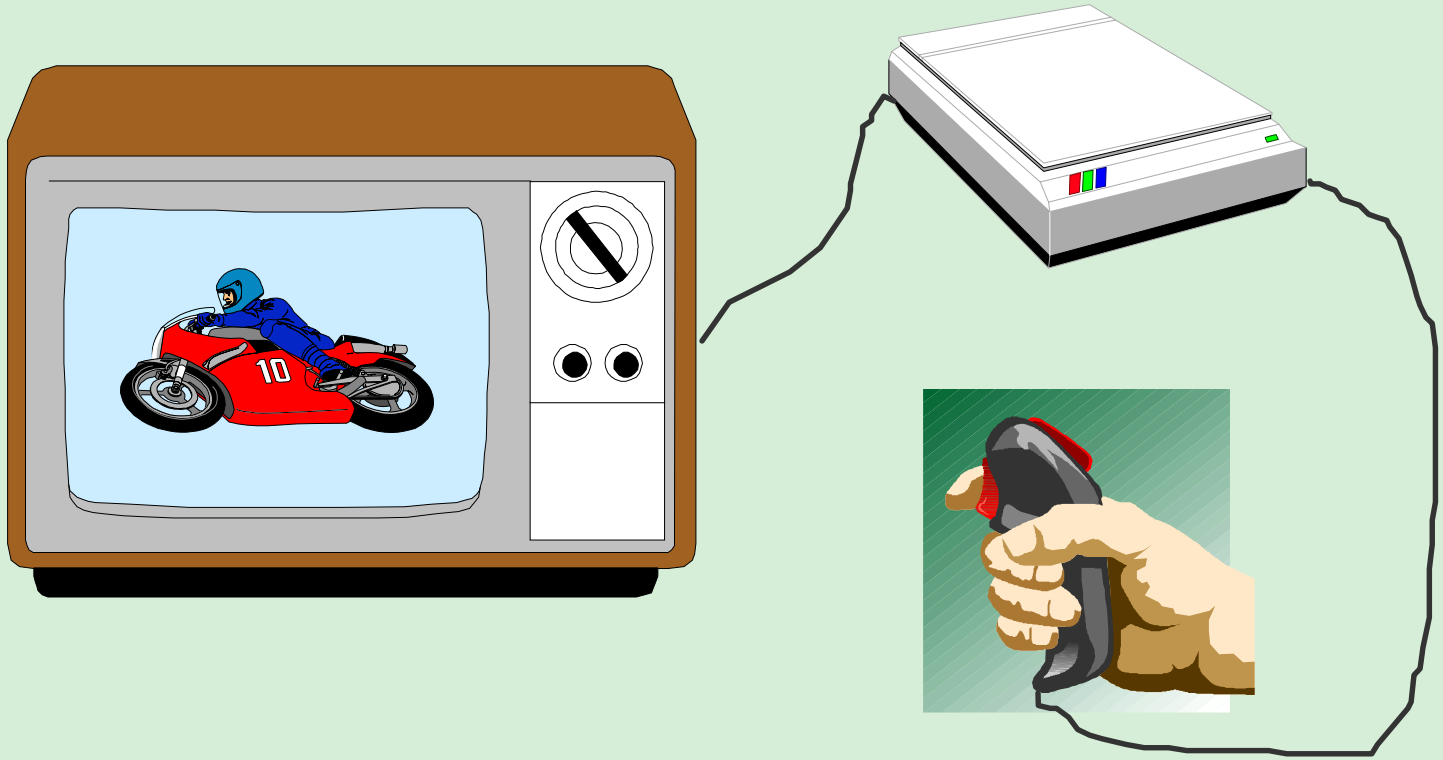


PES PACKETS

- **Synchronous data streaming harmonized with SCTE DVS132**
- **Synchronized data streaming**
- **Each type has a defined header**
- **Headers are not the same for Synchronous and Synchronized data elementary streams**

EXAMPLE OF SYNCHRONOUS DATA SERVICES

- **Video Games based on 2D/3D graphics and image rendering**
- **Infomercial based on animated computer graphics**



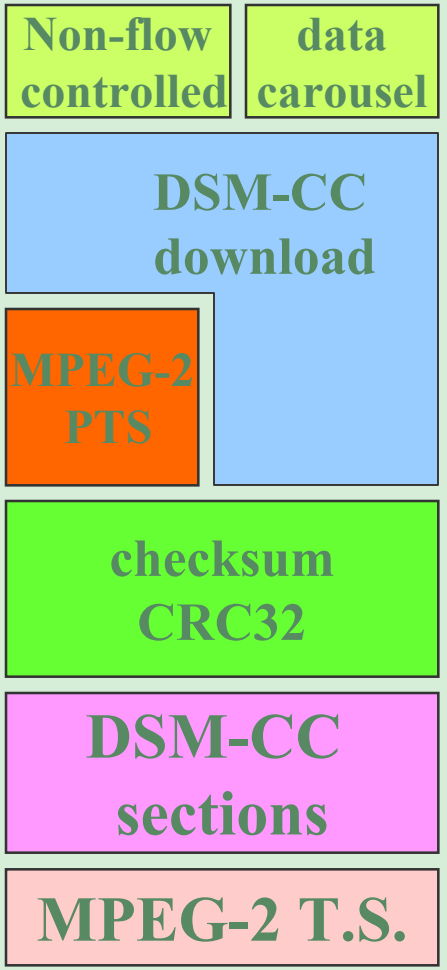
DSM-CC SECTIONS

- **Carousel scenario = periodic re-transmission of data module (for increased accessibility)**

- **Non-flow controlled scenario = one time download of a data module**

- **Two layer download protocol to allow logical grouping of modules as well as large number of data objects**

- **The synchronized download protocol offers capability to transmit non-streaming, error-protected, synchronized data**



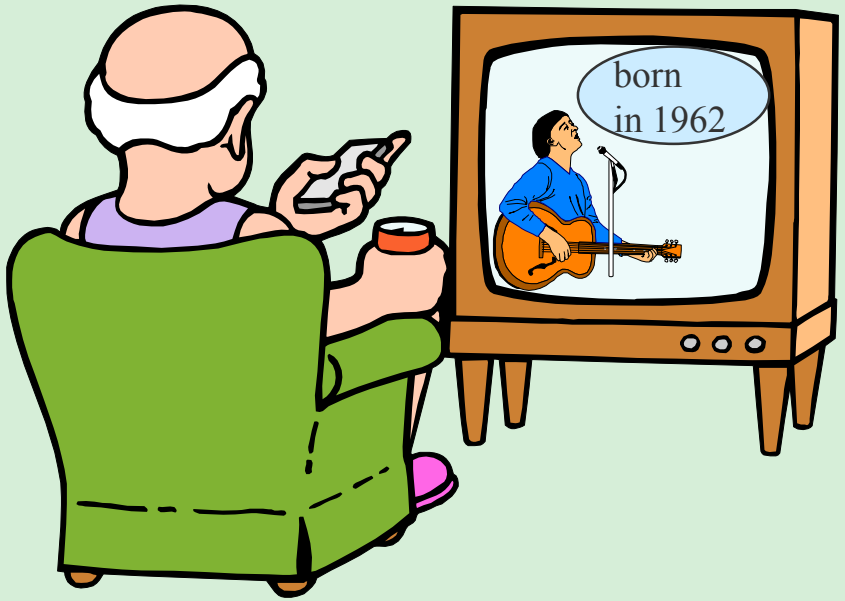
EXAMPLES OF ASYNCHRONOUS DATA SERVICES

- **Stock tickers**
- **sports statistics**
- **weather reports**
- **music downloads,...**

EXAMPLES OF NON-STREAMING SYNCHRONIZED SERVICES

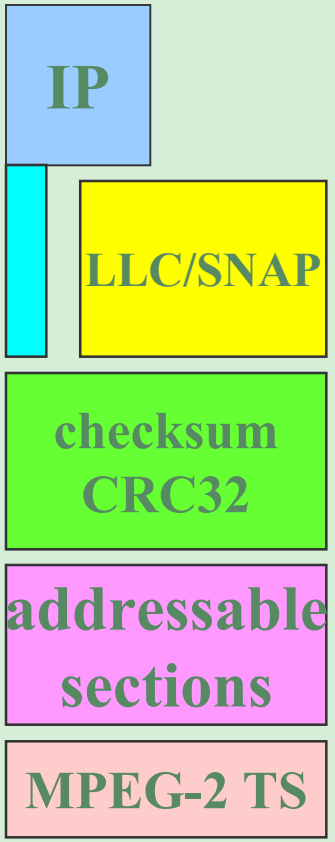
Just-in-Time transmission of data synchronized with video and/or audio

- **Pop-up videos**
- **Hot-spots, URL links in commercials and documentaries**
- **Evening games**
- **Triggers**



ADDRESSABLE SECTIONS

- **For tunneling of Internet Protocol**
- **Include a 6-byte MAC address**
- **Default mapping is 28-bit IP multicast address to 23-bit Ethernet MAC multicast address**
- **Agree with Amendment 1 to DSM-CC**
- **checksum protection only for backward compatibility with MPEG section parsers**



EXAMPLES OF ADDRESSABLE SECTION

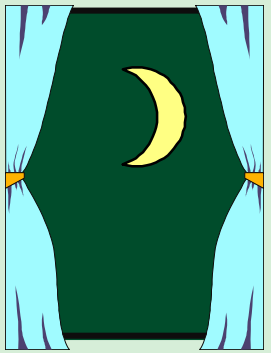
-BASED SERVICES

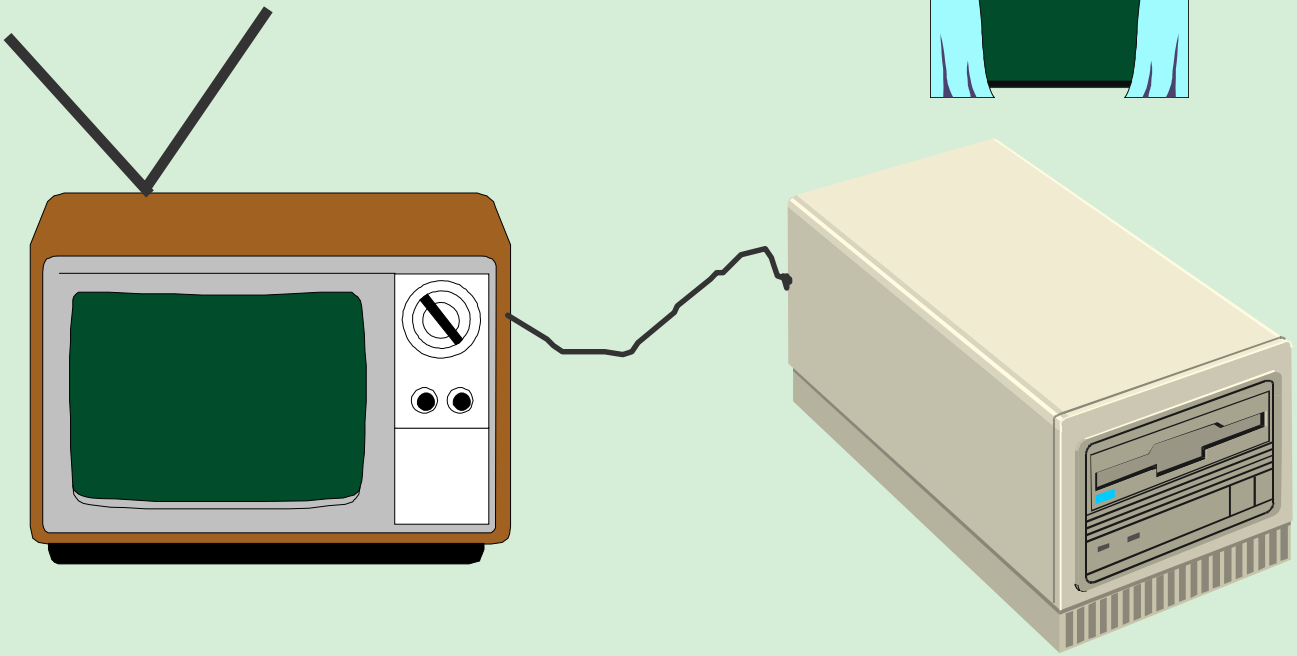
Personalized services:

- **Download of software at night**
- **Subscription to newspaper service**

Scalable services:

- **platform-dependent downloads**





Proprietary

- Data Piping
- No guarantee of interoperability

MPEG-2 TS

Discovery & Binding

- **ANNOUNCEMENT : PSIP + DET**

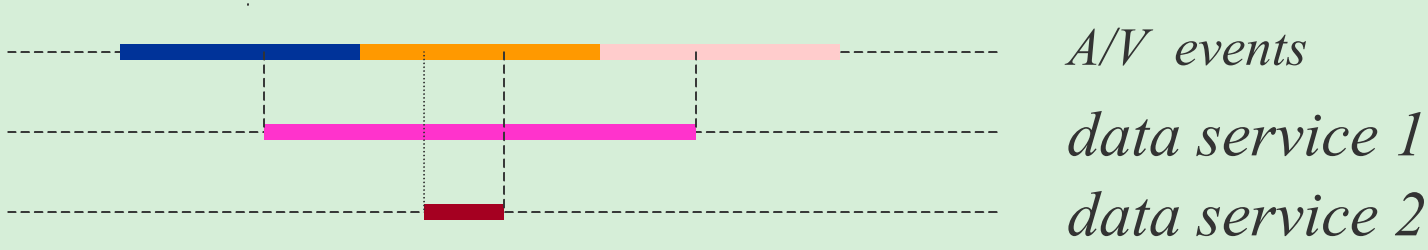
- **DISCOVERY**
- **BINDING**

} **SDF**

ANNOUNCEMENT (SCHEDULE)

Data Services associated with an A/V event:

- **value of service_type is 0x02 or 0x03**
- **Use either**
  - **> PSIP EIT(s) for a data services sharing same schedule and same title as A/V event OR**
  - **> DET(s) for a data service having a separate schedule or title**



Data Services NOT associated with an A/V event:

- **value of service_type is 0x04**
- **Use DET(s)**

ANNOUNCEMENT (SCHEDULE)

In the descriptor loop of every A/V/D or D event:

A Data Broadcast Descriptor is present.

service_profile

service_level

Fields may be used by data receiver to determine whether it can proceed with acquisition of data service or not

A PID Count Descriptor is optionally present:

total # of PIDs

minimum # of PIDs

Fields may be used by data receiver to determine whether it can acquire full or "minimal" data service

ANNOUNCEMENT (SCHEDULE)

- **Only <u>one</u> data service per virtual channel**
- **Possibly <u>multiple</u> data services in a single MPEG-2 Transport Stream**
  (in this case SDF must be on distinct PIDs)

DISCOVERY AND BINDING: SERVICE DESCRIPTION FRAMEWORK

SDF:
Describes a data service as an aggregation of applications (discovery)

Provides information for associating an application with broadcast or remote data components (binding)

Is designed based on MPEG-2 DSM-CC mechanisms (Association Tag descriptor, Tap structure).

SERVICE DISCOVERY

Main element is the Data Service Table identifying the applications making up a data service

The transmission of a Data Service Table is mandatory for any ATSC Data Service

Data Service Table follows MPEG-2 System section format

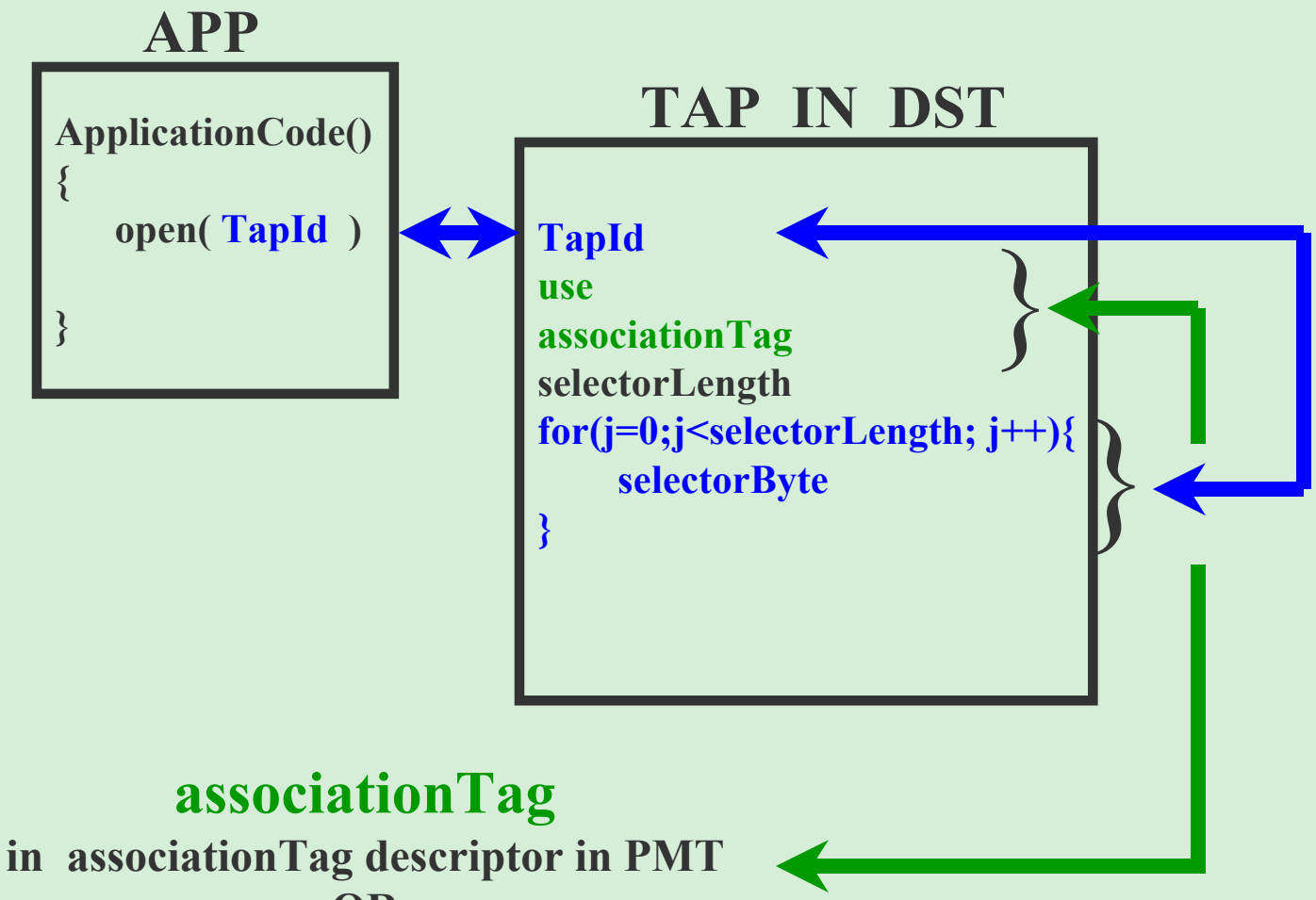
DATA SERVICE TABLE

```
dataServiceTable(){
      for (applications count) {
            compatibility descriptor
            application identifier
            for (tapsCount){
                  protocol_ encapsulation
                  Tap()
            }  // end  tapsCount
            application parameters
            descriptors
            application private information
       } // end applications count
       service private information
}
```

MPEG-2 packetization, synchronization, protection layers + protocol

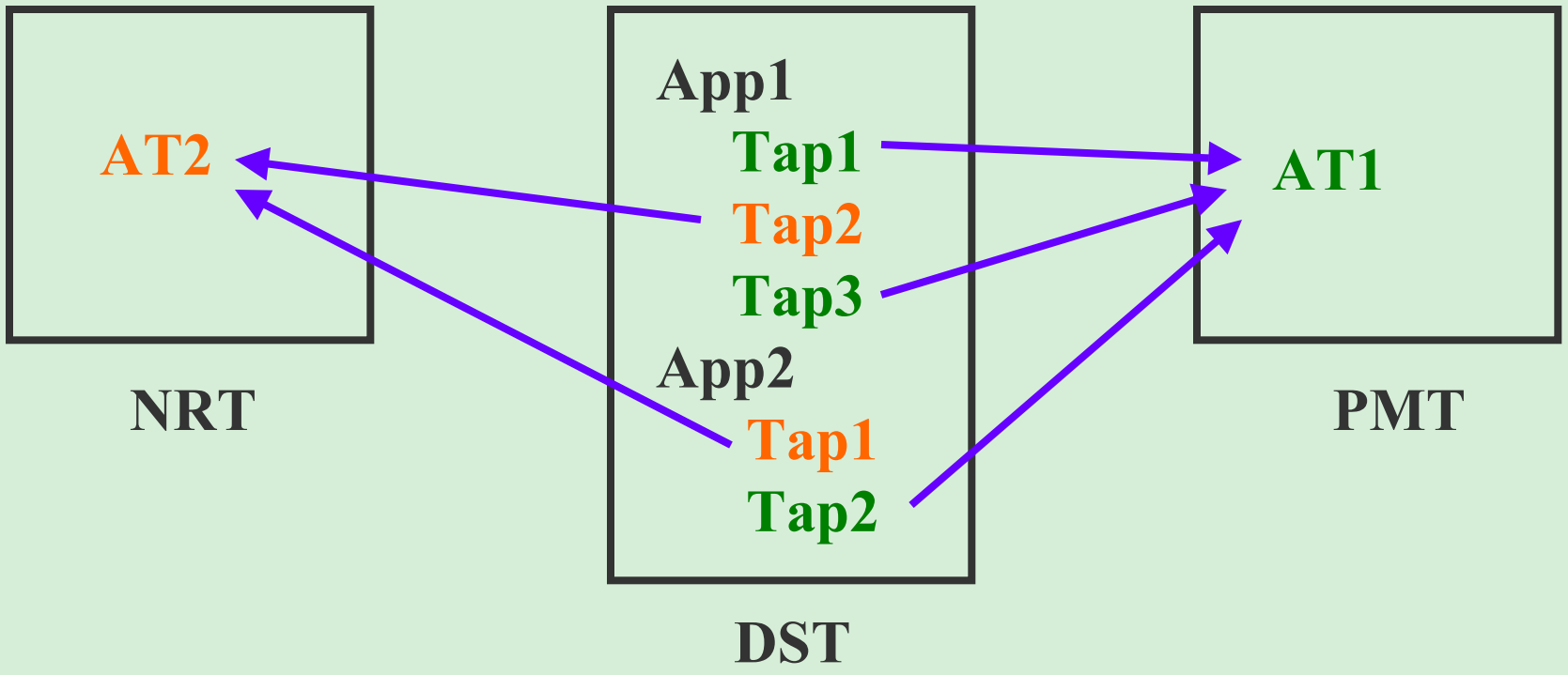
"pointer" to data element

BINDING TO A COMMUNICATION CHANNEL



SERVICE BINDING

Multiple Taps of one or several applications can reference the same Network Resource !!!



SERVICE BINDING

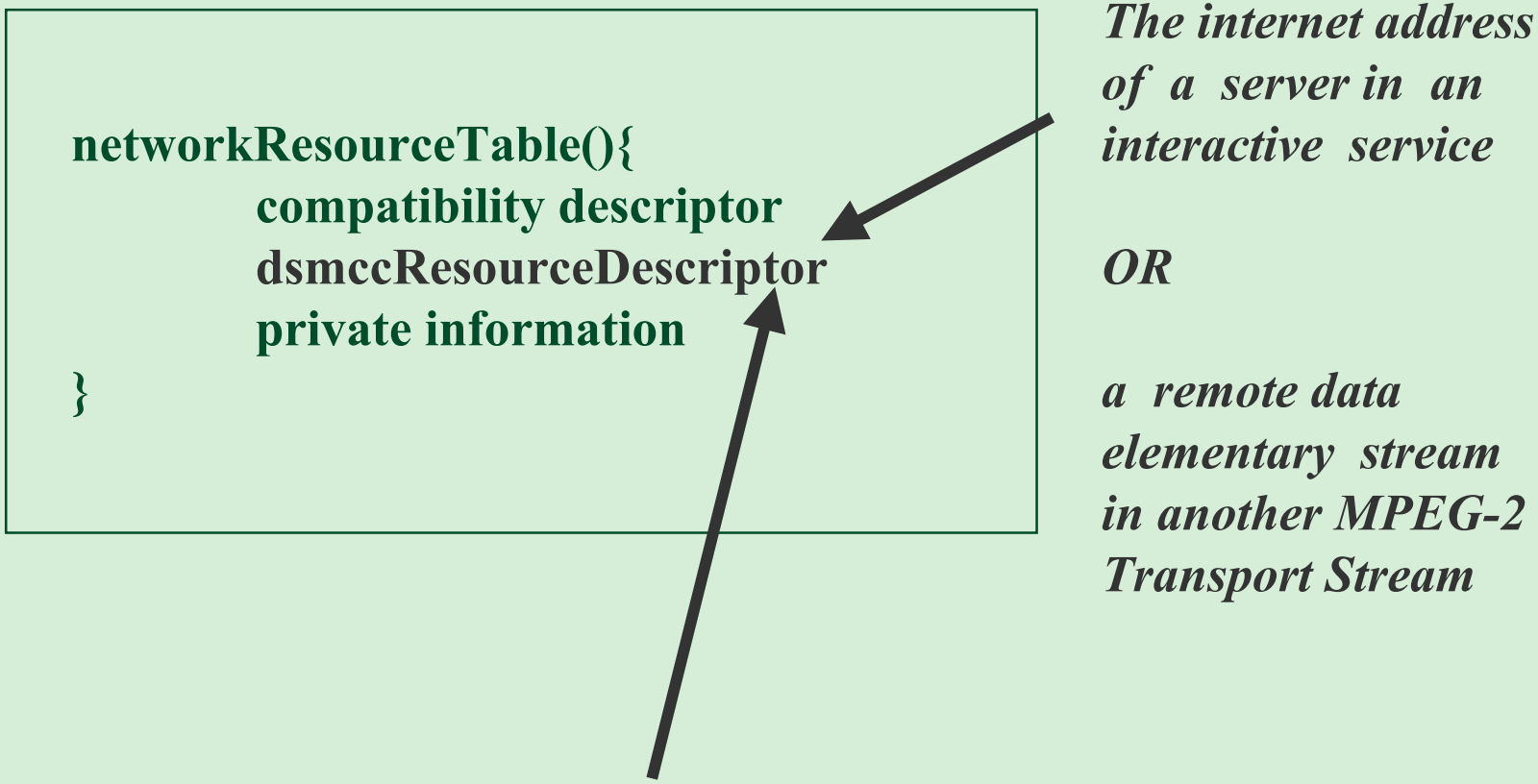
Main elements are the Network Resources Table and the Association Tag descriptor(s) in the PMT

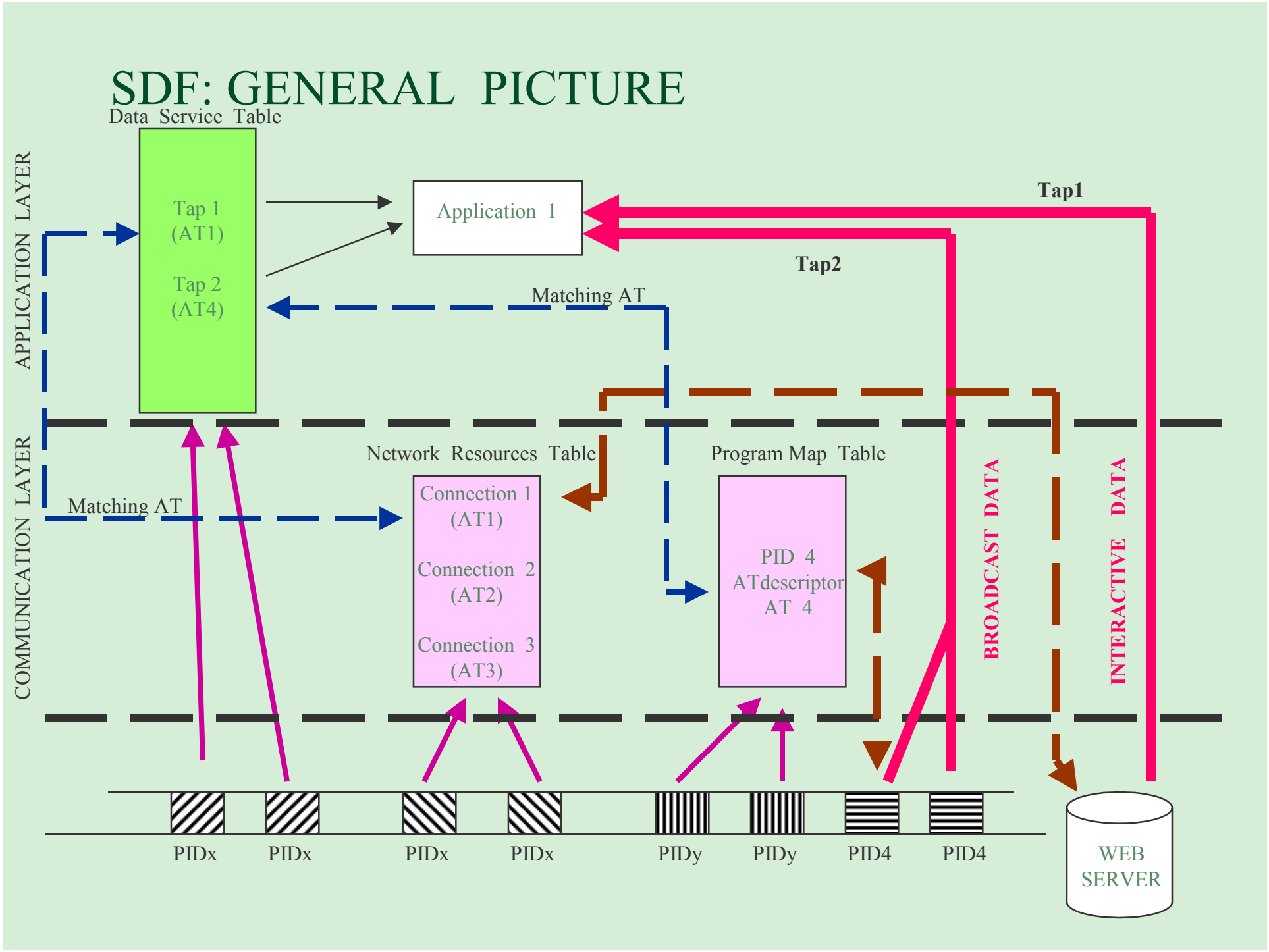
The Network Resources Table announces any external communication channels used by a data service.

The transmission of a Network Resources Table is optional for any ATSC Data Service

Network Resources Table follows MPEG-2 section format

NETWORK RESOURCES TABLE




SDF: GENERAL PICTURE
Data Service Table
APPLICATION LAYER
COMMUNICATION LAYER
Tap 1
(AT1)
Tap 2
(AT4)
Application 1
Tap1
Tap2
Matching AT
Matching AT
Network Resources Table
Program Map Table
Connection 1
(AT1)
Connection 2
(AT2)
Connection 3
(AT3)
PID 4
ATdescriptor
AT 4
BROADCAST DATA
INTERACTIVE DATA
PIDx
PIDx
PIDx
PIDx
PIDy
PIDy
PID4
PID4
WEB
SERVER

SDF ADVANTAGES

- **promotes responsible usage of bandwidth**
- **flexibility to determine how frequently it is transmitted (impact on accessibility)**
- **designed for broadcast and interactive services**
- **based on basic MPEG section parsing.**
- **direct access to association tags so they can be managed easily in emission station**
- **uses new resource descriptors for broadcast and interactive services (amendment 2 to DSM-CC)**

TRANSPORT SYSTEM TARGET DATA RECEIVER MODEL

DATA SERVICE PROFILES

Purpose is:

- **To represent maximum bandwidth allocated to a data service.**
- **Multiple services can be bundled together into the same profile**
- **A data service may use less than the transmission bandwidth allowed by the profile**

DATA SERVICE PROFILES

G1	**Guaranteed bandwidth up to 384 kpbs**
G2	**Guaranteed bandwidth up to 3.84 Mbps**
G3	**Guaranteed bandwidth up to 19.39 Mbps**
A1	**Opportunistic up to 19.39 Mbps**

(NTSC VBI-based Data Services: **180 kbits/sec** max)

OPPORTUNISTIC DATA SERVICES

Opportunistic data service = A data service for which no transmission bandwidth has been provisioned in the emission station. Data packets are inserted into the multiplex upon request from multiplexer (see IS DIWG)

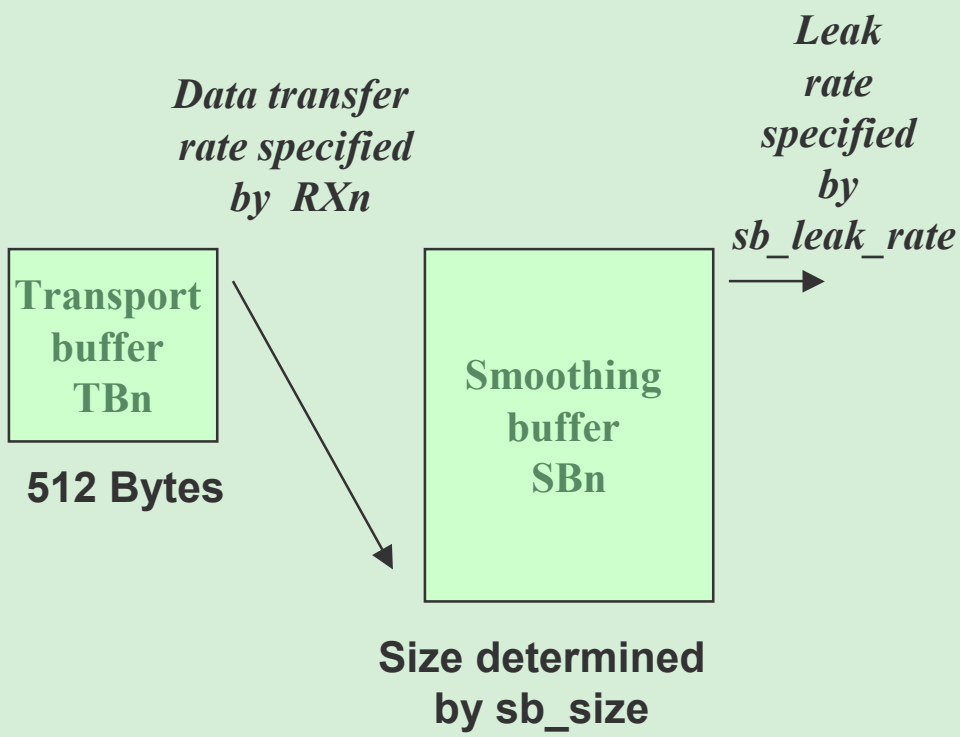
Opportunistic data services make use of instantaneous bandwidth available in a transport stream. Profile to be used in connection with VBR video encoders .

T-STD BUFFER MODEL

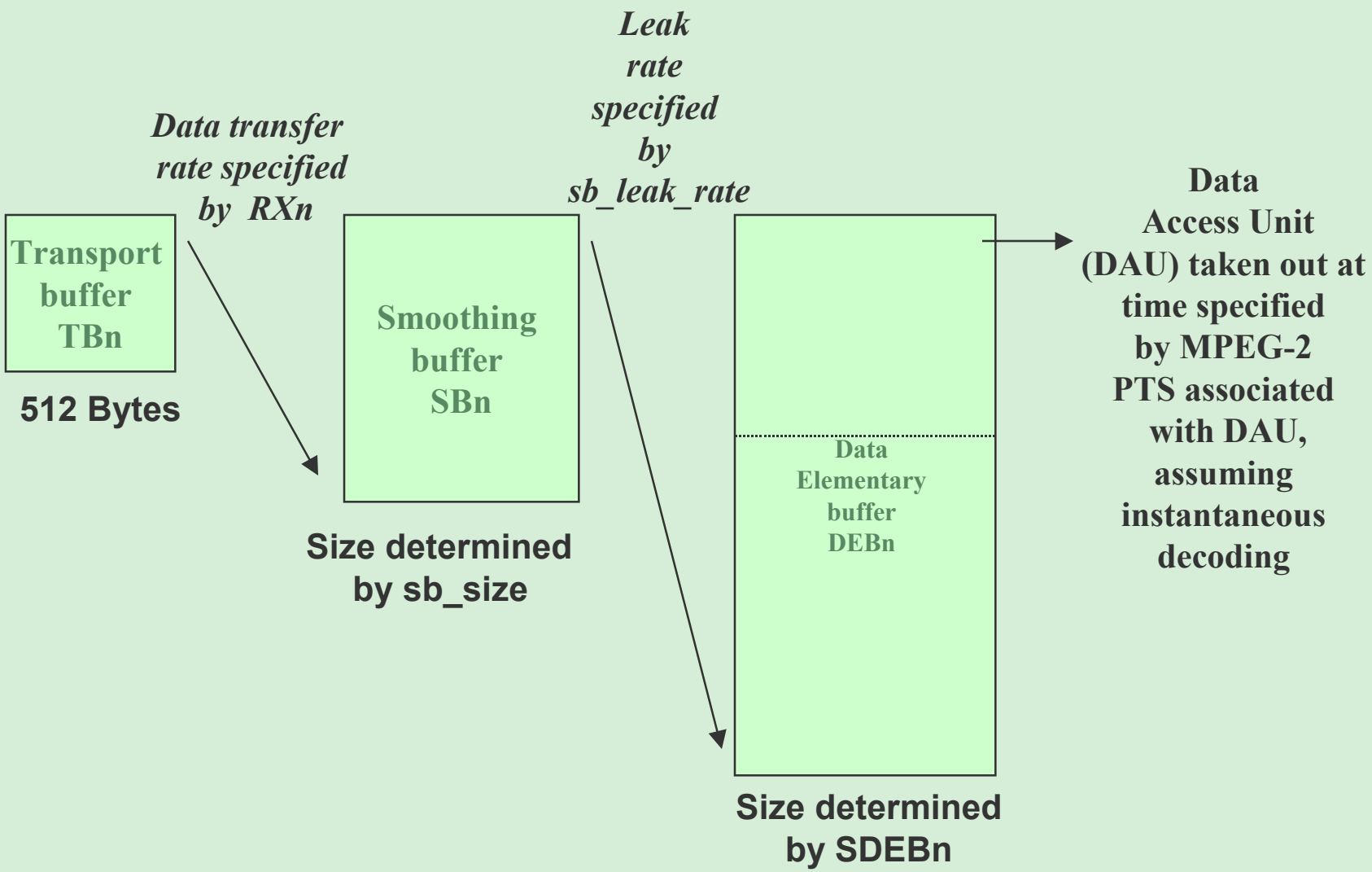
The T-STD buffer model embodies the *timely and controlled delivery* of data. Its purpose:

- **To provide multiplexers with tool to implement synchronization of data with video or audio in a reliable manner.**
- **To define bounds on size of data to be acquired by data receivers**
- **To define bounds on throughput required in data receivers.**

T-STD BUFFER MODEL FOR ASYNCHRONOUS SERVICES



T-STD FOR SYNCHRONIZED SERVICES



DATA SERVICE LEVELS

Purpose to provide reference points for memory and throughput requirements in data receivers

DEBn buffer is split uniformly among all data elementary streams so applications of a same service can be run concurrently in a data receiver

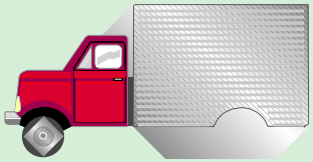
Nominal Data Access Unit (DAU) size is 40040 bytes
= 19.2 Mbits/sec * 1001 / (8 * 60 * 1000)

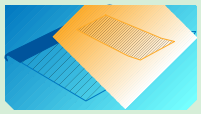
DAUs must at least 5.561111 msec apart (172.8 Mbits/sec throughput for level 1 services)

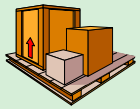
DATA SERVICE LEVELS

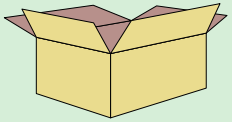
1	DEBSn = 120120 bytes
4	DEBSn = 480480 bytes
16	DEBSn = 1921920 bytes
64	DEBSn = 7687680 bytes

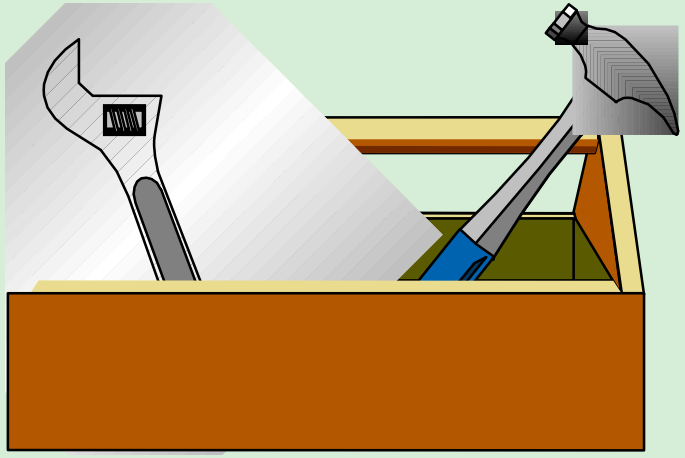
Implementation











Implementation

- Standards provide firm basis for system
  - BUT, may(shall?/do?) not work exactly as written
- Real world implementation
  - Interoperability
  - Physical realities
- Thus: Recommended Practices needed

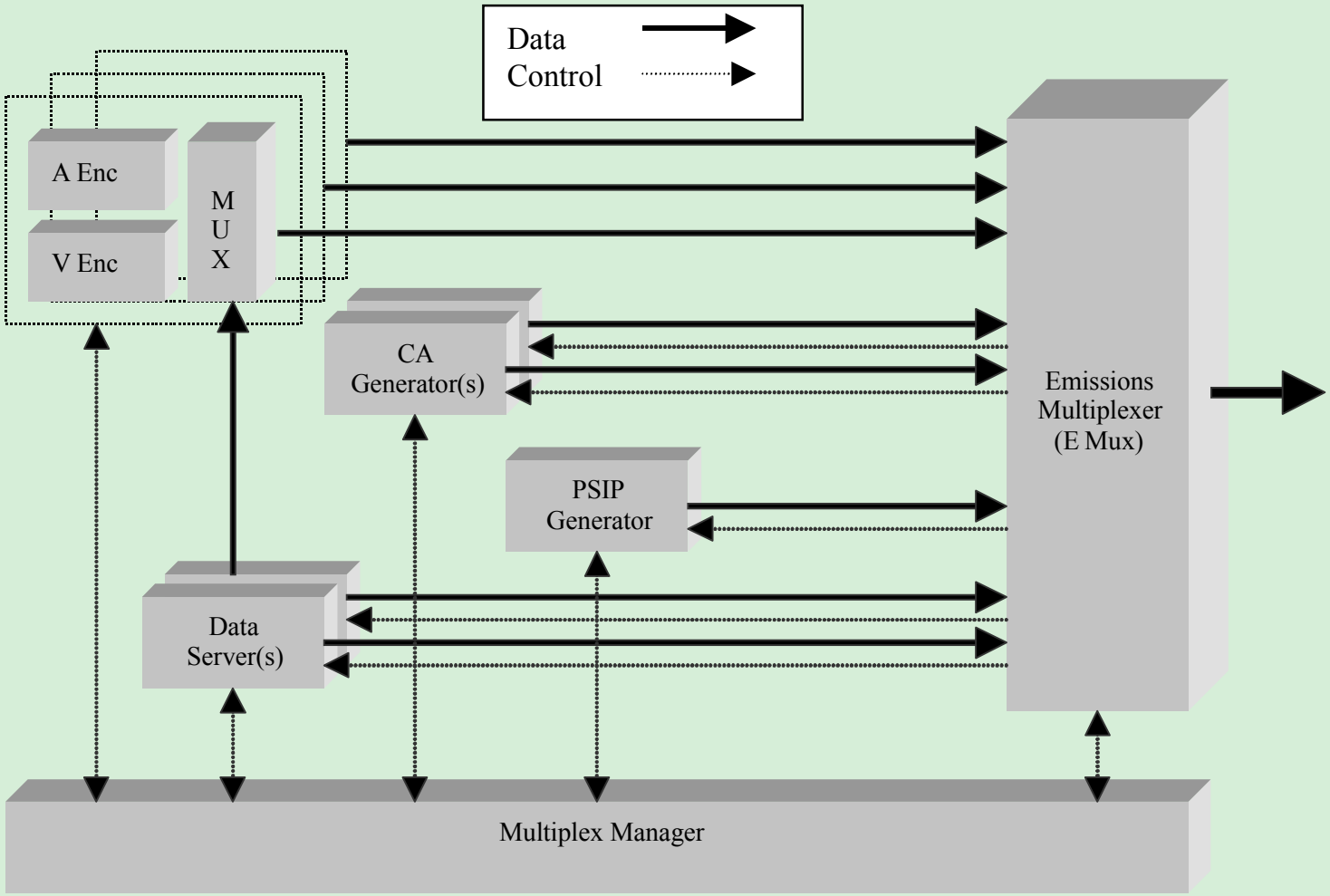
IS-DIWG I

- Implementation of data broadcast in an ATSC emission station
  - Recommendations
  - Interoperability
  - How to make it work
  - Focus tightly scoped to emission station
- IS “findings” document (IS-151) posted on ATSC web site

Scope

- Data Broadcast for ATSC emission station
- Connection of data source(s) to emission multiplex
  - Physical
  - Protocol(s)
  - Control
  - Synchronization
- Broadened scope for
  - Sources that “look, act & feel” like data
  - Beyond emission station for synchronization

Environment



IS-DIWG I

- Opportunistic data connection between data server and emissions multiplexer
  - SMPTE 325M, RP203, RP206
- End-end synchronized data requirements
  - MPEG-2 domain time stamping
  - Baseband domain time stamping
  - Authoring, storage, transport requirements

Synchronization

- Synchronizing data with other streams is desirable
- While MPEG-2 systems provides the tools for synchronized data, the general implementation problem is not solved.
- Core problem: Data is unbounded in complexity, Receivers are unbounded in stupidity

Synchronization Types

- Loose - within a few seconds
  - Scheduling / Traffic System
- Tight - frame/field accurate presentation
  - Requires special considerations

- Synch to A/V or other data stream
  - Need common MPEG timebase

Examples of Tight Synch

- “Buy Me” Icons that appear exactly at the 1st frame of an ad
- Moving hotspots that follow characters around the screen

Issues in Tight Synchronization

- Standardized Encapsulations
- Workable Implementation Guidelines
- Buffer Management
- Bandwidth Management
- Authoring Tools

General Solution

- Need common set of recommended practices (interoperability)
- Need authoring tools that are synchronized data aware
- Need data awareness through entire food chain
- Need agreement amongst players to do it right

IS-DIWG II (*...the revenge!*)

- Solve problems discovered in DIWG-I
  - End-end data walk-through exercises
  - Authoring parameters
  - Transport of synchronized A/V/D in studio
  - Conversion of synchronized A/V/D between baseband, MPEG-2, and back again
  - Discovery of data services at receiver

IS-DIWG II

- Wider scope
  - Complete data essence food-chain
  - Authoring/production through distribution through emission
  - Must look at entire picture to solve the problem

Plenty of Work to Do!

- Work spaces overlap ATSC and SMPTE
- Ideal to minimize redundant efforts
- Cooperation has worked well in the past
  - DIWG-I opportunistic data flow control
- Identify groups in ATSC, SMPTE that have specific expertise in areas that involve data broadcasting

CONCLUSION

- **ATSC Data Broadcast Service specification is the result of more than 3 years of successful collaboration between CE, PC and head-end equipment manufacturers.**

- **It has been recorded as DVS 161 by SCTE**

- **The specification opens up new business opportunities (opportunistic data, data service devices, IEEE 1394, personalization,...)**

- **The specification will help accelerate deployment of DTV services.**