Part VII
Multimedia Programming Abstractions

- Motivation
- Media Modelling Abstractions

MM Programming Environments

framework selection:

- what programming techniques, methodologies, abstractions, etc. are needed
- what basic “services” are provided
- which media and standards are supported

Why Object-Oriented Multimedia Programming?

- encapsulation
- no software legacy (new area)
- need for extensibility (specialization can accommodate new hardware, media formats, standards, compression techniques, etc.)
- need for cross-platform development (abstract interfaces reduce platform dependence)

Framework Development

- identify and define *abstractions* that cover metaphors and mechanisms found in audio and video production
- separate generic parts of a solution and structure them as *collaborating objects*
- provide a general *architecture* of how objects cooperate in a well-defined way (framework)
- *implement classes* that are necessary for the specific purpose and the specific hw platform

Abstractions

- time-object
- timed streams / media elements (“samples”)
- interpretation
- derivation
- composition (often called “synchronization”)
- media processing elements (MPEs, “components”)
- configuration
- quality of service (QoS)

Time-Object

- umbrella for media processing elements and time-related media
- should be system supported yet user extensible and distribution proof
- should support high-level semantics
- should support QoS and synchronization

Time-Object Definitions

- *continuous time value*

  A continuous time value is a measurement of time using some agreed upon units.

- *discrete time coordinate system* $(DTCS)$

  A DTCS, D, is a mapping from discrete time values to continuous time.

  $D_f : i \rightarrow (1/f)i$, where *f* is called the *frequency* of the time system.

  Examples: D_{30} (video), D_{25} (video), D_{24} (film), and D_{44100} (CD audio).

Timed Streams

- streams and stream interfaces are widely used abstractions proposed in different contexts: communications protocols, operating system support and application design
- communication channel with real-time guarantees and continuous transmission of media elements (samples) without application intervention
- should be multicast and cover both asynchronous and isochronous transmission

Timed Streams

media type and media element

definition *media type*:

A *media type* specifies the encoding of data for some medium. Examples of media types include encodings for audio, video and image data.

definition *media element*:

A *media element* is an autonomous unit of data encoded by some media type. Each element has a *size* (length in bytes) and a *descriptor*, which identifies the media-specific and representation-specific parameters.

Timed Streams

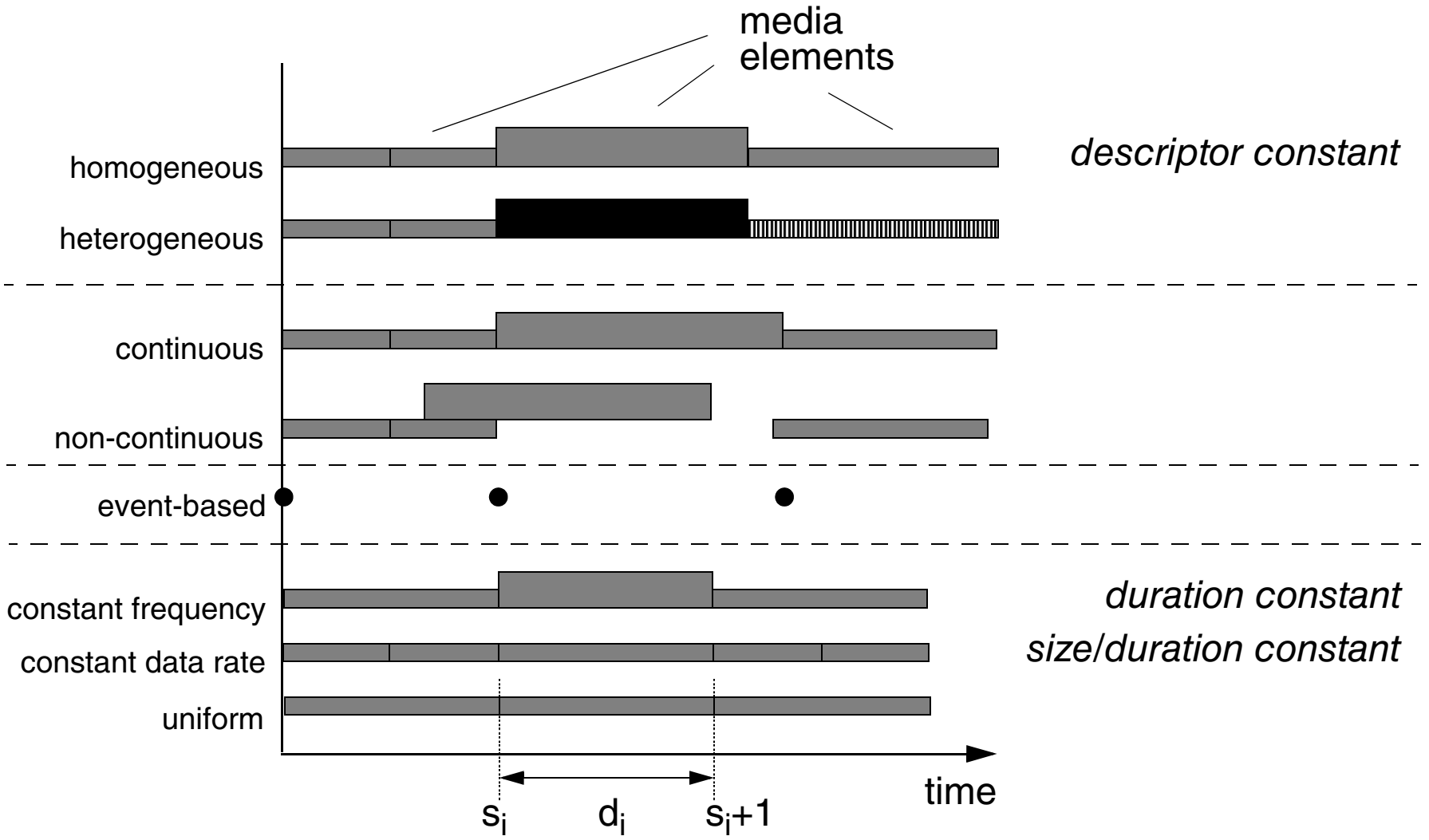
definition *timed stream* (*media object*):

A *timed stream* is a finite sequence of tuples of the form: $<e_i, s_i, d_i>$, $i=1, \ldots n$. Each media sequence is based on a media type *M* and a discrete time coordinate system *D.*

definition *timed-stream type*:

A *timed-stream type* is a tuple $T= <M, D, R>$ where *M* is a media type, *D* a discrete time coordinate system type and *R* is a set of rules that can be considered as integrity constraints for media sequences over *M* and *D*.

Timed Streams - Examples



Timed Streams - Properties

- homogeneity: element descriptors are constant
- continuity: $s_{i+1} = s_i + d_i$, for $i = 1, \ldots n\text{-}1$
- frequency: $d_i = \text{constant}$, for $i = 1, \ldots n\text{-}1$
- data rate: element size/duration = constant
- uniformity: element size and duration are constant

The Dual Nature of Time-Based Media

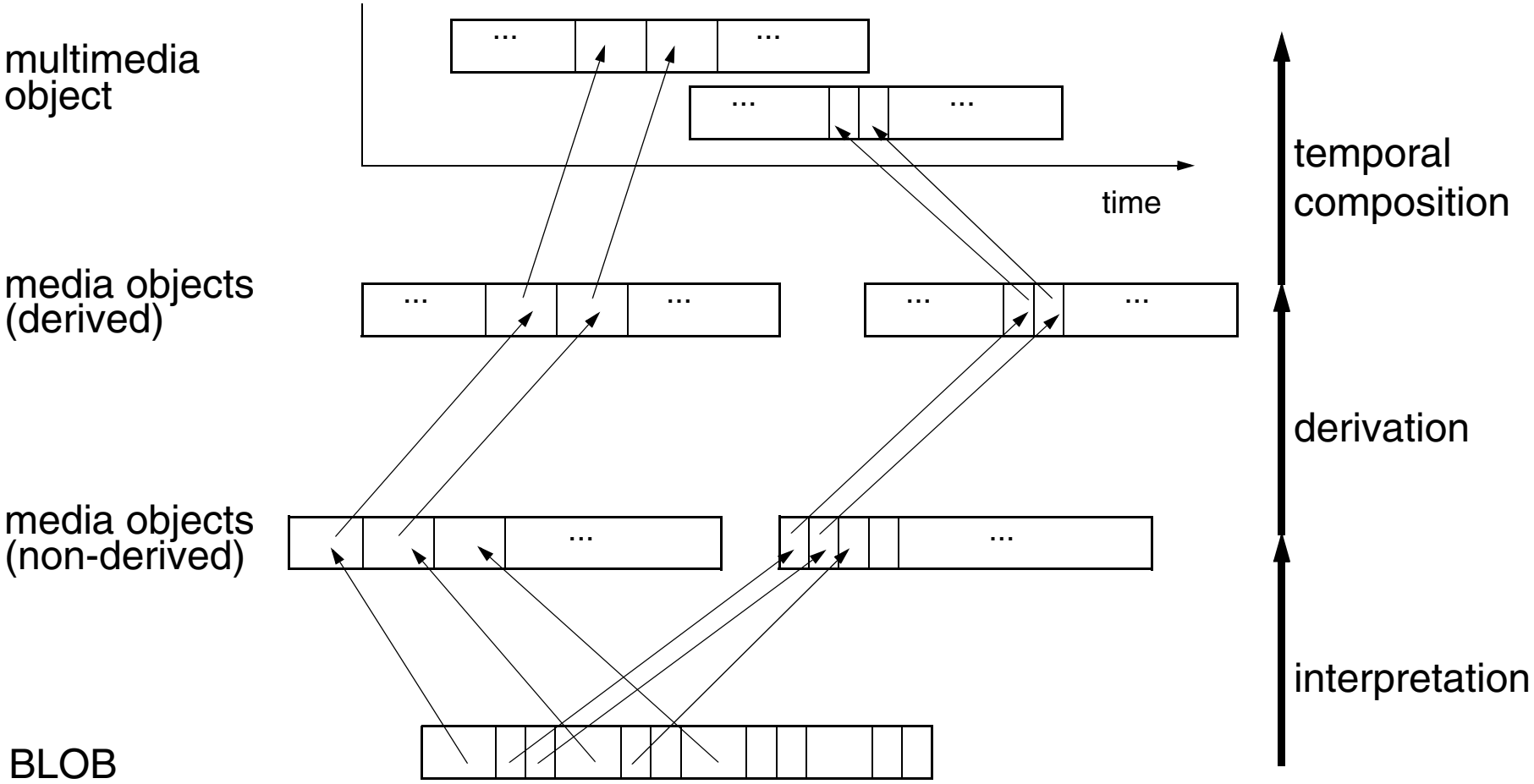
Time-based media can be viewed as:

- *pools,* for media-independent operations, e.g. copying
- *streams,* for media-dependent operations, e.g. editing

Necessary for stream “view”:

- timing information for *inter*- and *intra*-stream synchronization
- structuring information of timed streams

Interpretation—Derivation—Composition



Interpretation

Definition: interpretation

An interpretation of a stream (BLOB) *S*, is a mapping from *S* to a set of media elements.

complicating factors

- heterogeneity
  - variable-sized elements
  - several encoding methods, parameters
- out-of-order elements
- interleaving and padding
- non-destructive editing and scalability

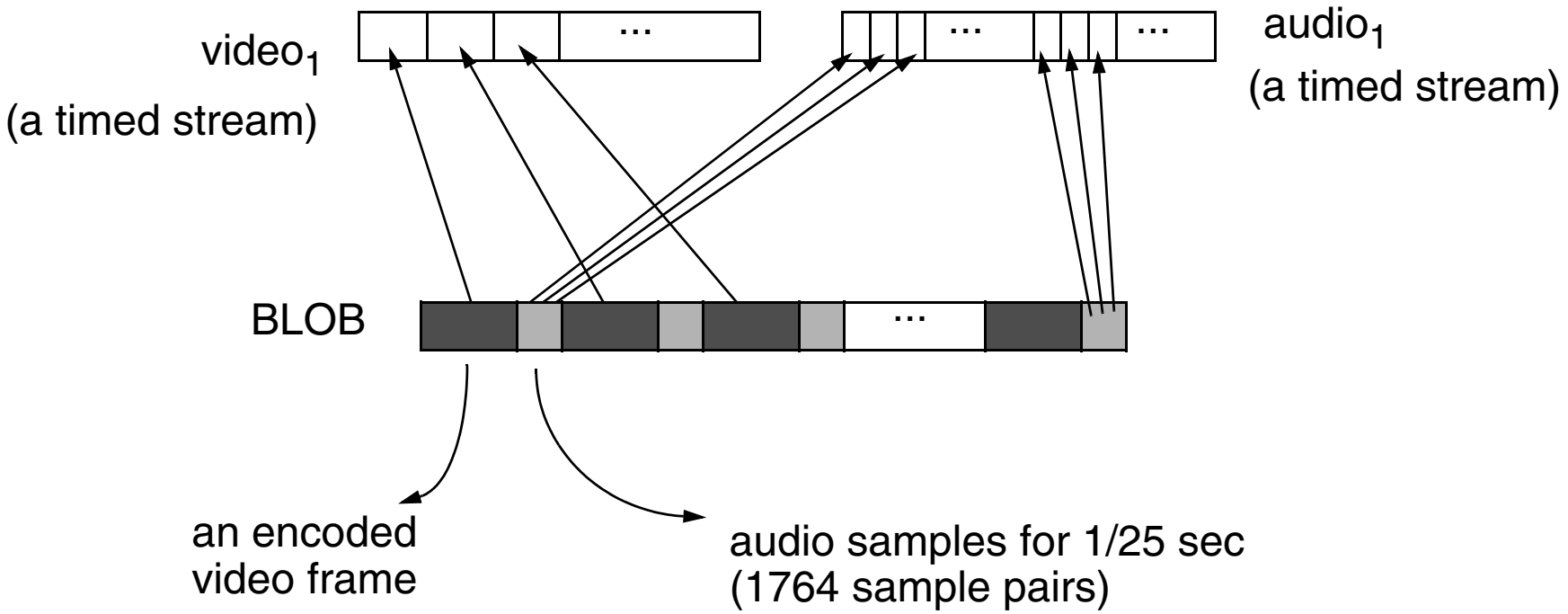
Interpretation

Reasons for Interpretation:

- structural information must not be separated from data
- permits sophisticated queries
- presenting time-based data requires timing information

Interpretation

Example 1



Interpretation

interpretation descriptor example

$video_1$ descriptor = {
category = homogeneous,
constant frequency
quality factor= “VHS quality”
duration = 10 minutes
frame rate = 25
frame width = 640
frame height = 480
frame depth = 24
color model = RGB
encoding = YUV 8:2:2, JPEG }

$audio_1$ descriptor = {
category = homogeneous,
uniform
quality factor = “CD quality”
duration = 10 minutes
sample rate = 44100
sample size =16
number of channels = 2
encoding = PCM }

Interpretation

mapping from element number to BLOB placement

- tables for example 1
  - $video_1$(elementNumber, elementSize, blobPlacement)
  - $audio_1$(elementNumber, blobPlacement)
- table for a heterogeneous video stream
  - $video_1$(elementNumber, startTime, duration, elementDescriptor, elementSize, blobPlacement)

Derivation

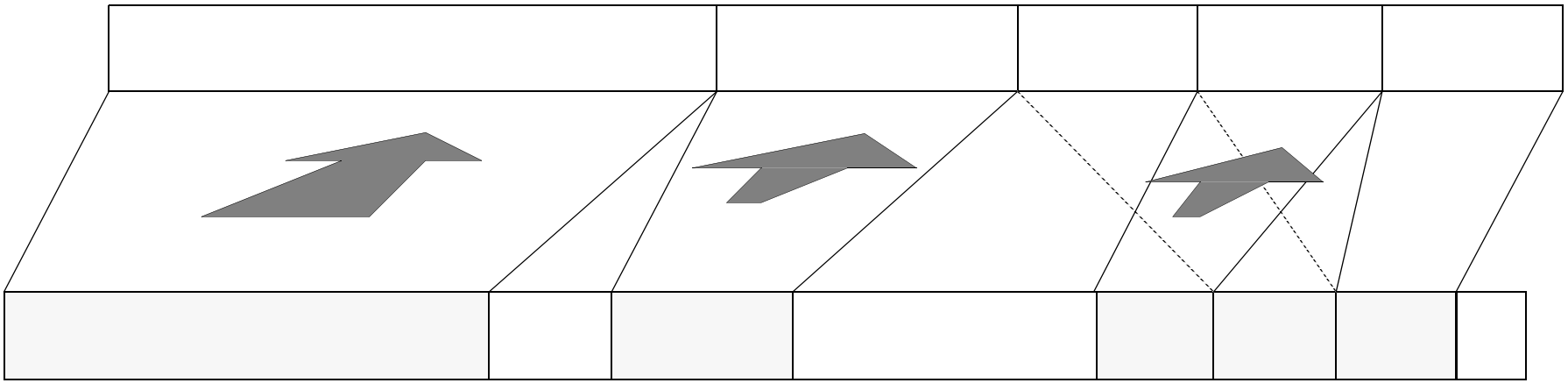
definition: derivation, derived object, derivation object

- The *derivation* (D) of a media object o_1 from a set of media objects O is a mapping of the form $D(O, P_D) \rightarrow o_1$, where P_D is the set of parameters specific to D.
- o_1 is called the *derived object*.
- *derivation object*:
  - references to the media objects
  - and parameter values used.

Derivation

translation *concatenation* *extraction* *conversion ...*

derived value *Lake of Geneva (Video)*



footage Lake of Geneva (Video)

Derivation

Advantages introduced by derivation:

- reduces storage and networking costs.
- allows modification operations to be performed more efficiently.
- provides data independence.

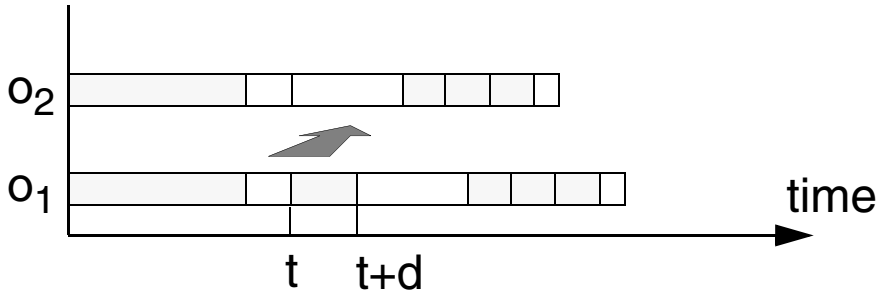
Derivation

examples of derivations

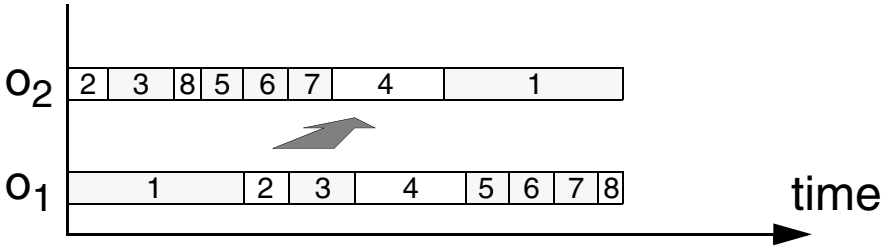
Derivation Name	Argument Type(s)	Result Type	Category
FilterVideo	Video	Video	change of content
FilterImage	Image	Image	change of content
FadeClip	TimeBasedMedia	TimeBasedMedia	change of content
ExtractClip	TimeBasedMedia	TimeBasedMedia	change of timing
CutClip	TimeBasedMedia	TimeBasedMedia	change of timing
InsertClip	TimeBasedMedia	TimeBasedMedia	compound
SynthesizeVideo	Animation	Video	change of type
Synthe-sizeCDAudio	MIDI	CDAudio	change of type

Elementary Derivation - Examples

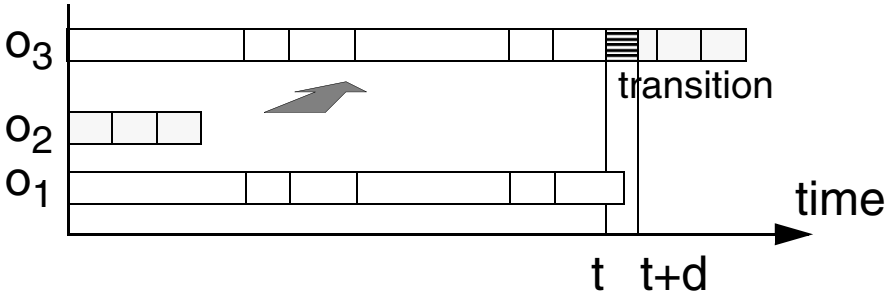
CutClip(o_1, t, d) $\rightarrow$ o_2



PermuteSamples(o_1, f) $\rightarrow$ o_2

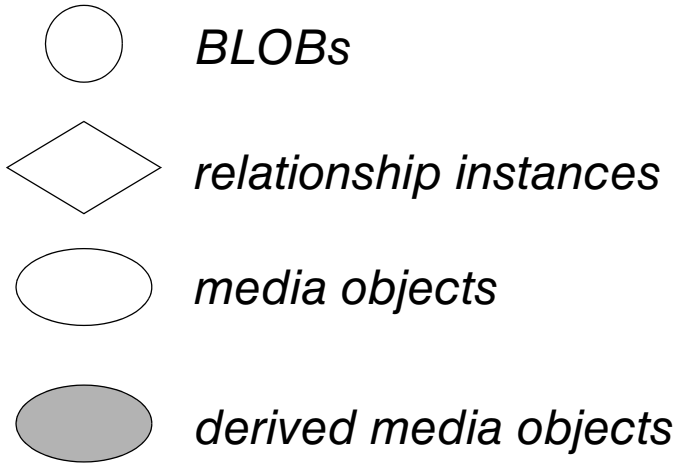


Transition(o_1, o_2, t, d, f) $\rightarrow$ o_3



Derivation - Data Diagram

Graphical Representation of:

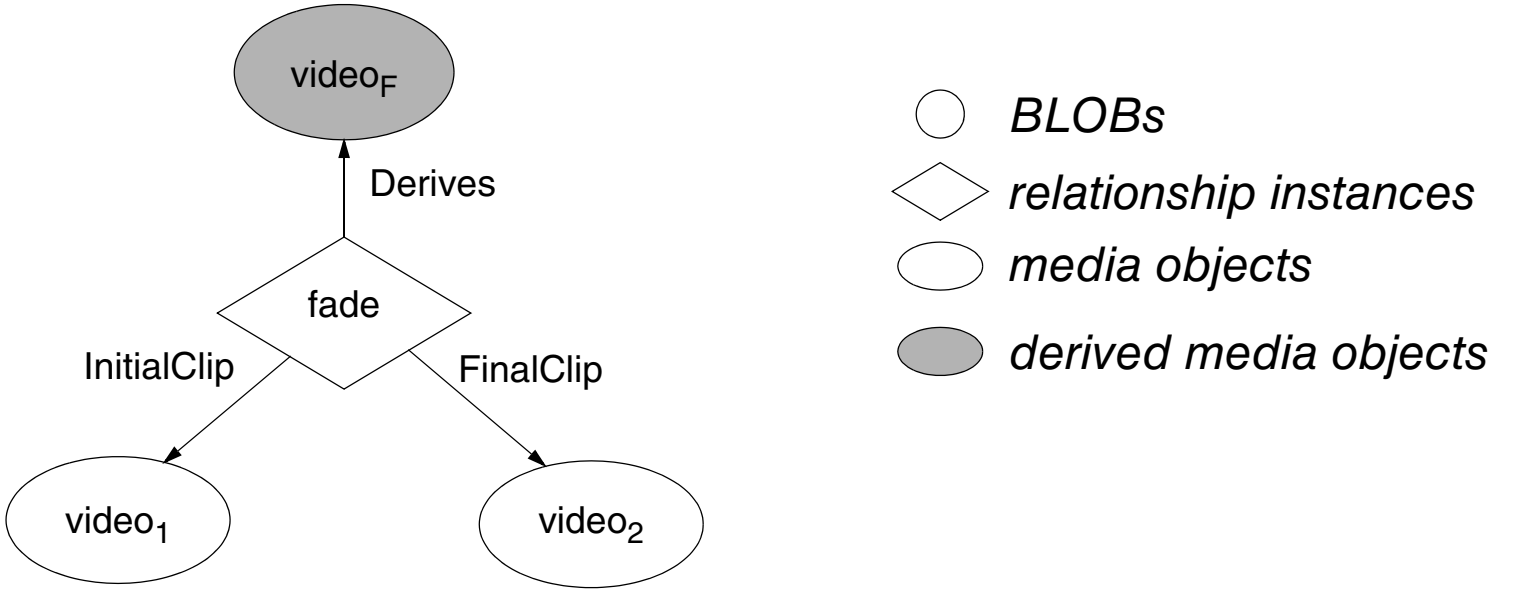


Purpose:

- visualization of interpretation and derivation
- optimization of graphs according to derivation properties

Derivation

data diagram example



fade = new FadeClip(initialClip: video$_1$, startInInitialClip: 1:00,
finalClip: video$_2$, startInFinalClip: 0:0, duration: 0:10)

video$_F$ = fade.Derive()

Composition

- spatiotemporal arrangement of presentation
- currently mainly an authoring issue
- should be intuitive, entity conserving, distribution proof
- should be suited for translation into a playout schedule
- should be suited for unlimited and unknown durations with flexible degree of synchrony.

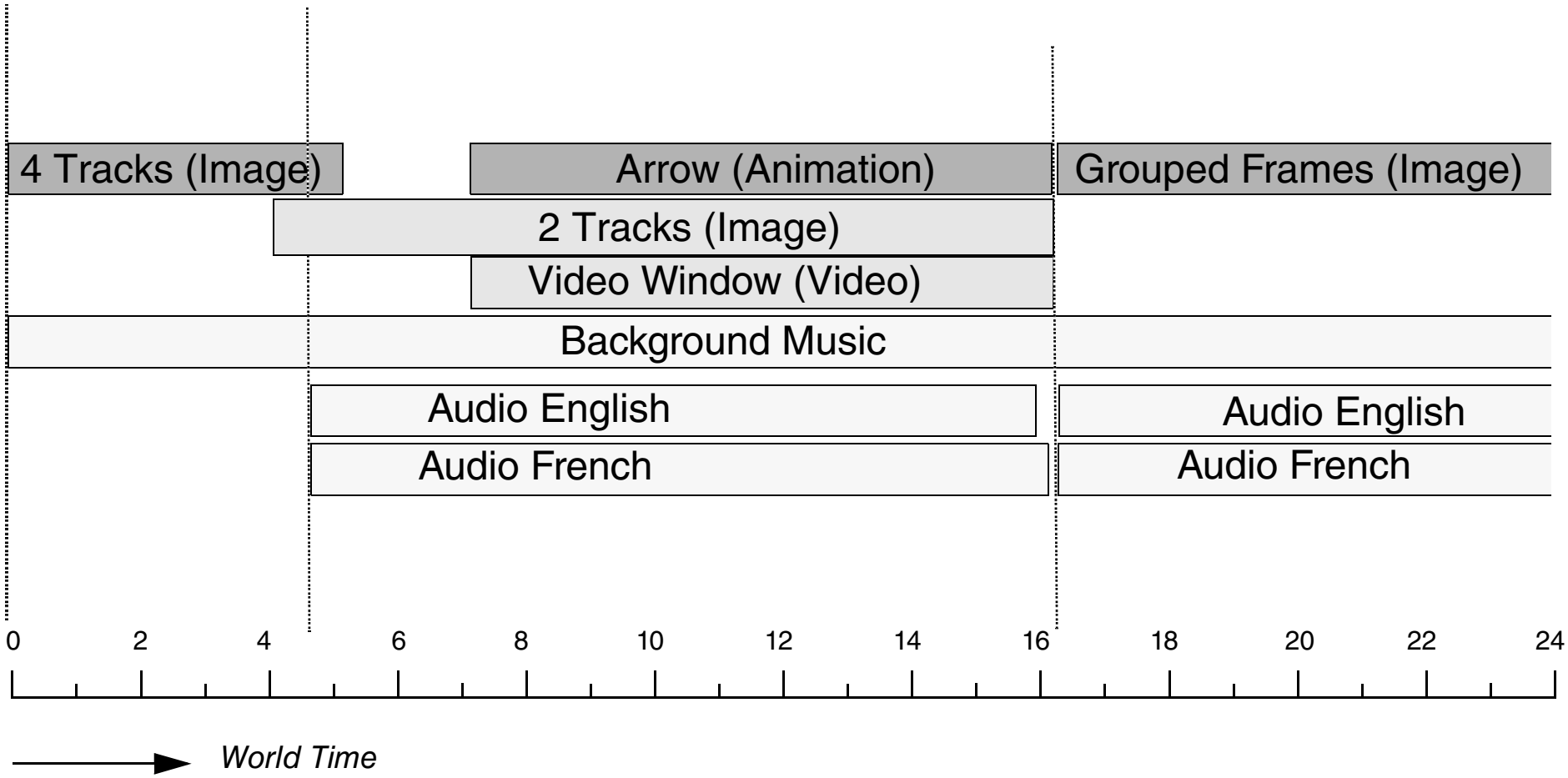
Composition

definition: composition

Composition is the specification of temporal and/or spatial relationships between a group of media objects.

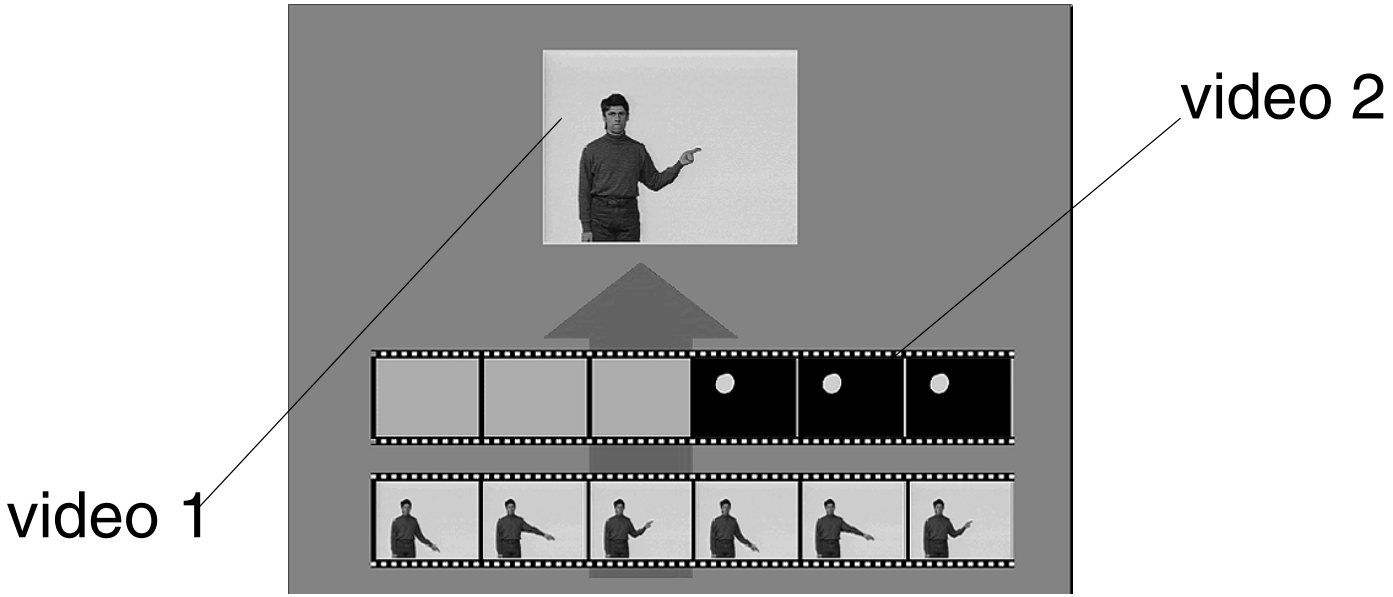
The result of composition is called a *multimedia object*, the original elements are called its *components*.

Temporal Composition - Timeline Diagram



Spatial Composition

- specification of layout for visual data types
  - presentation region (window)
  - clipping and composition operations
- spatial transformations (scaling etc.)



Example Composition

m = new Multimedia

c_1 = new TemporalComp(component: $audio_1$, start: 0:0, stop: 2:10)

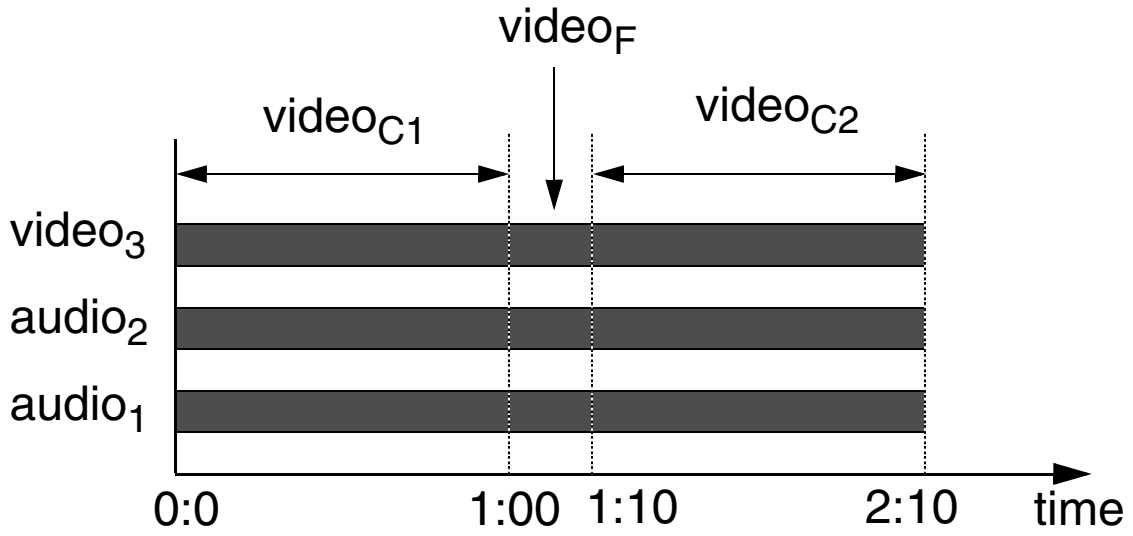
c_2 = new TemporalComp(component: $audio_2$, start: 0:0, stop: 2:10)

c_3 = new TemporalComp(component: $video_3$, start: 0:0, stop: 2:10)

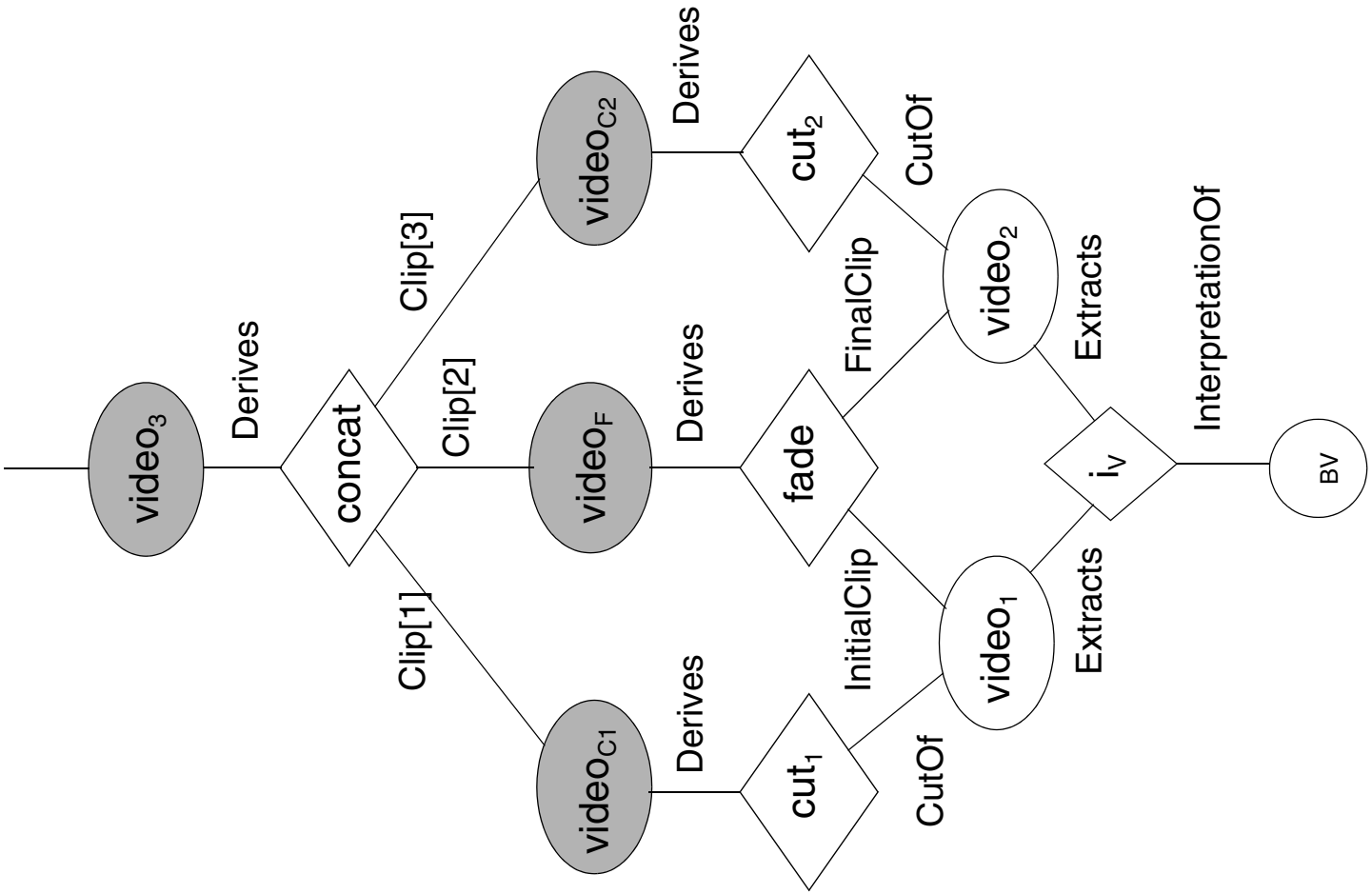
m.Add(composite: c_1)

m.Add(composite: c_2)

m.Add(composite: c_3)



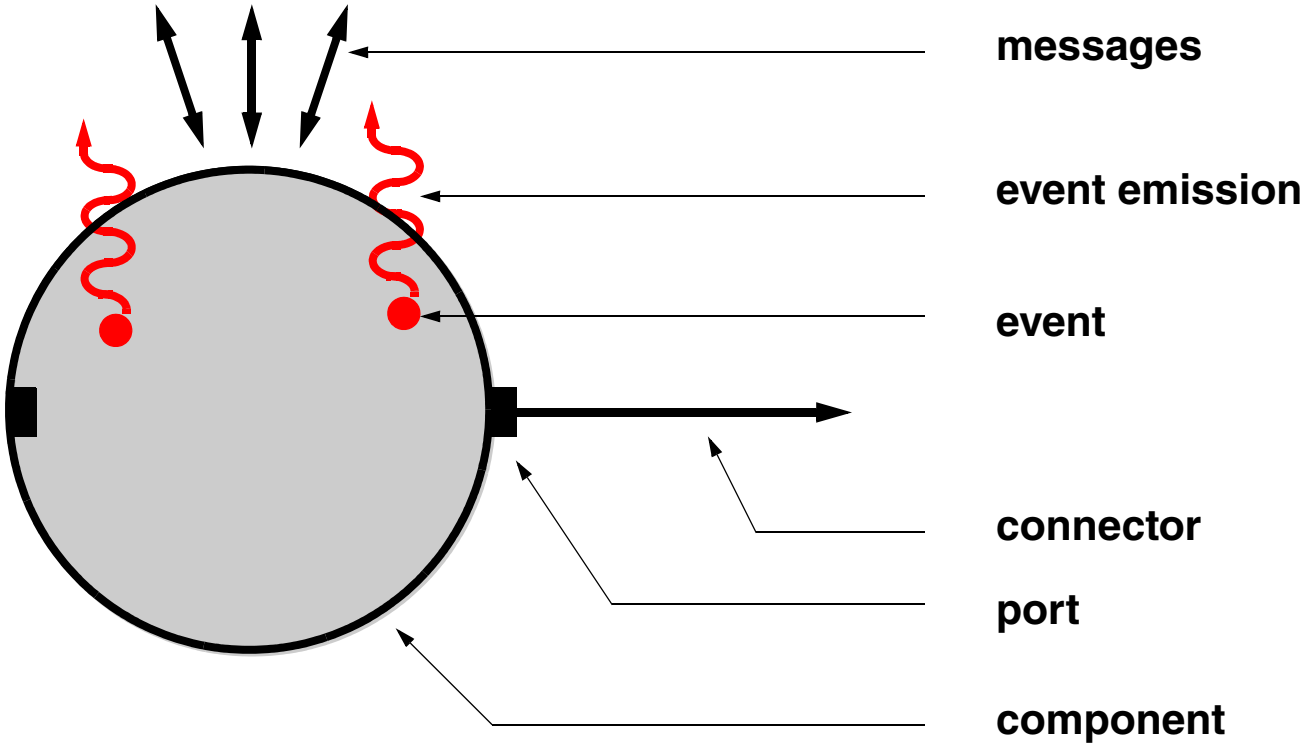
Derivation/Composition Diagram



Components (MPEs)

- produce | consume | transform ***timed media streams***
- streams enter and leave through ***ports***
- connected ports must be ***plug compatible***
- three interfaces:
  - synchronous
  - asynchronous
  - isochronous

Component Interfaces



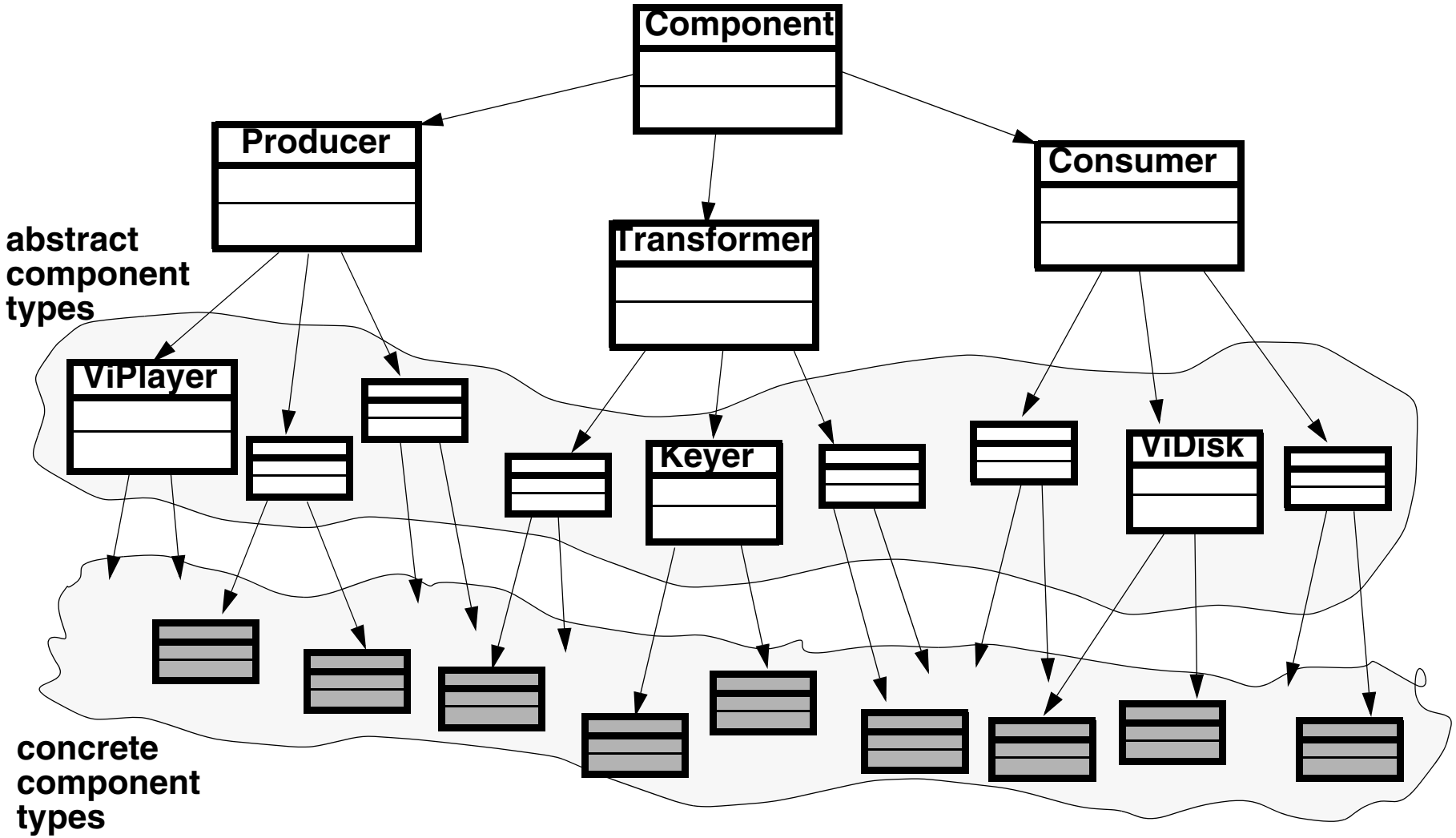
Components - Examples

❑ a video camera	produces video
❑ a video codec	transforms video
❑ a 3D renderer	consumes geometry, produces video
❑ a MIDI keyboard	produces MIDI
❑ an audio recorder	consumes audio
❑ a dataglove	produces tracking data

Component Classes—Port Connection

- Two ports can be connected provided:
  - one is an output port and the other an input port
  - the two ports are *plug compatible*
  - adding the connection does not exceed the *fan-limit* on either port

Component Classes



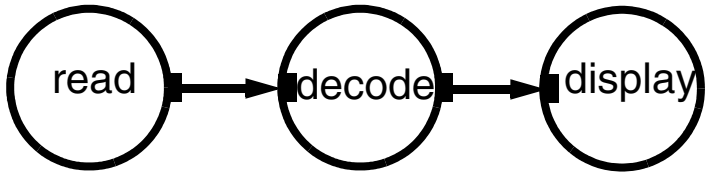
Application Example: A Virtual Studio

media object	input ports	output ports	implementation
3DRenderObj	TrackSeq VideoSeq VideoSeq (mask)	VideoSeq (back-ground) VideoSeq (key)	server on SGI Onyx
TrackObj		TrackSeq	server on SGI Onyx
KeyerObj	VideoSeq (foreground) VideoSeq (background) VideoSeq (key)	VideoSeq (mix) VideoSeq (key)	server on any SGI
VideoPlayerObj		VideoSeq	server on any SGI
CompObj	VideoSeq	MPEGSeq	server on any SGI
DecompObj	MPEGSeq	VideoSeq	server on any SGI

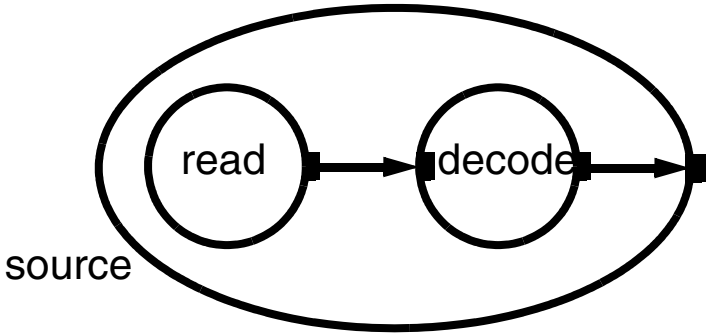
Configuration

- composition of components (MPEs), streams and media into an application
- should support dynamically changing configurations with arbitrary numbers of components
- should support distribution, authoring and programming

Configuration - Example

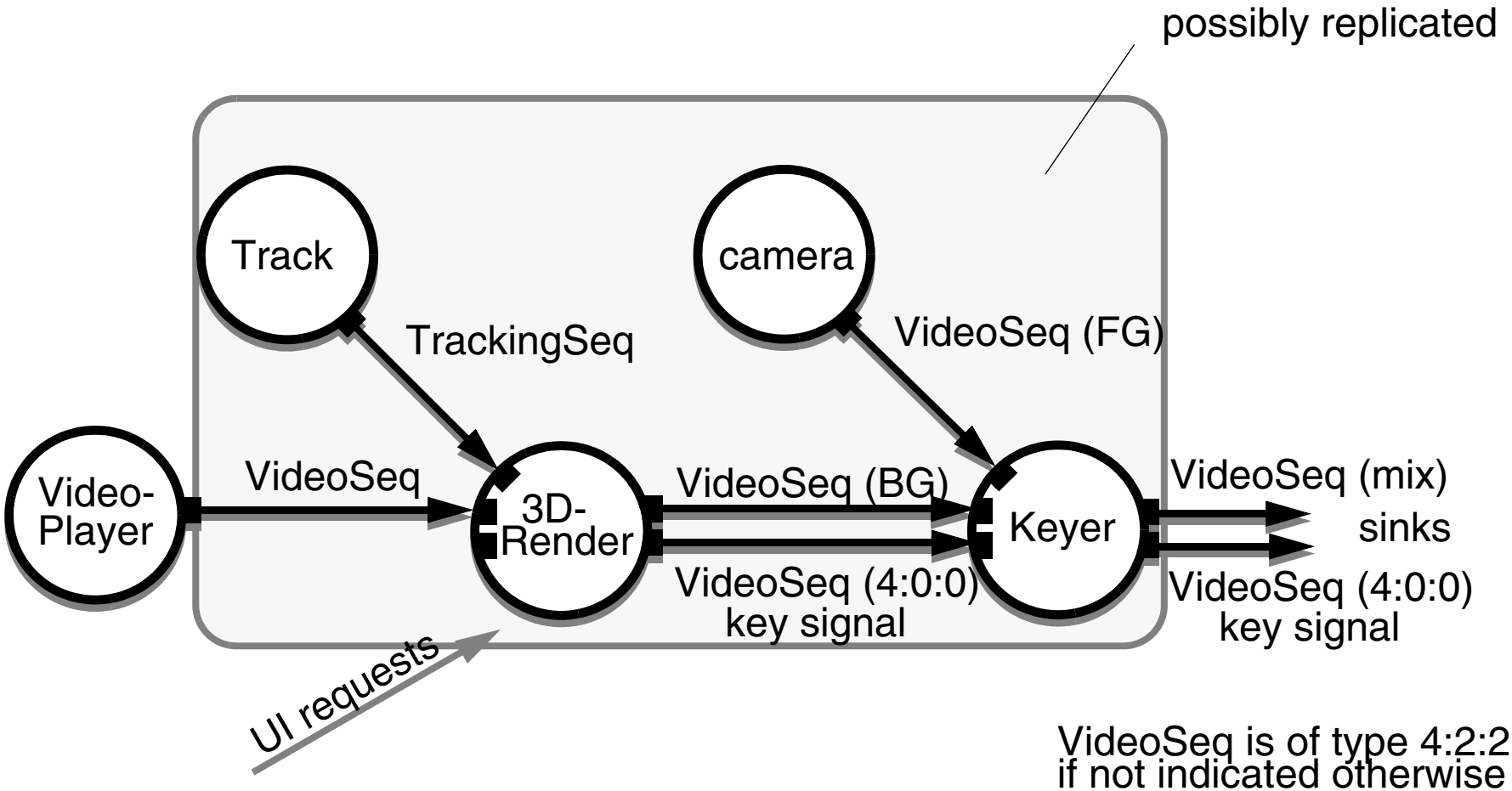


simple components



composite component

Virtual Studio Configuration



Quality of Service (QoS)

- term used to represent the application requirements for a given resource
- “fuzzy” or statistical description of parameters of service delivery
- reflects tolerance in human perception
- enables resource management and trade-offs between conflicting goals
- on the user level, it should be intuitive and controllable
- on all levels, it should be compatible, negotiable and accessible for system-wide optimization

QoS

- typical QoS parameters: minimum and maximum resolution, allowed error rate, acceptable jitter and delay bounds
- some application require hard or deterministic guarantees of service; strong guarantees can be given as long as certain factors as load, buffer space and schedule can be monitored and controlled.
- other applications will need only statistical guarantee of some range of performance (probability)

MPEG-21—MM Framework

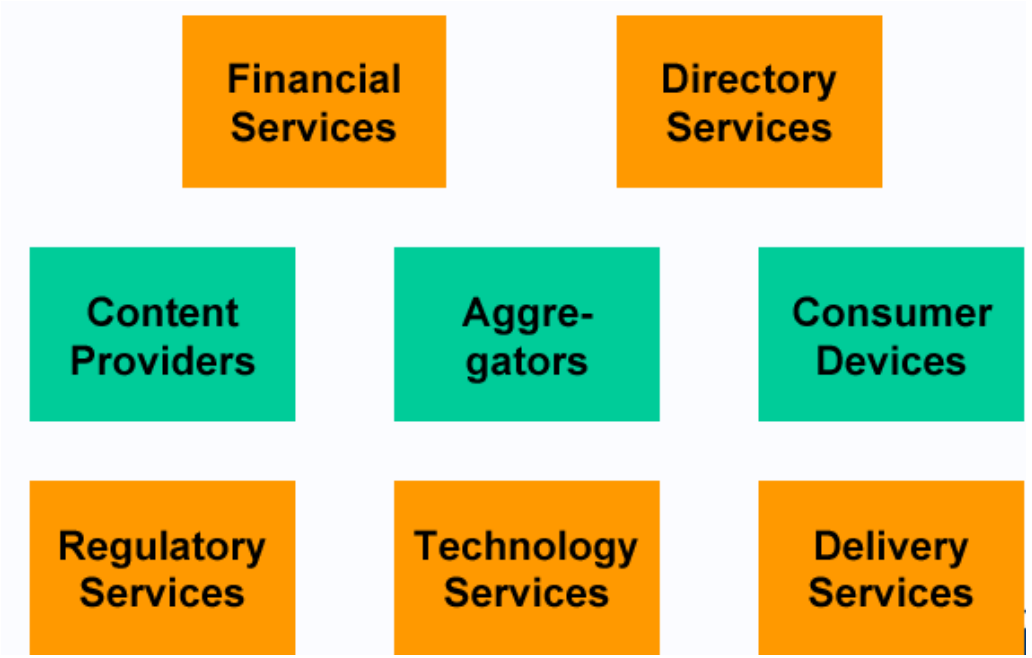
Outline

- Multimedia Framework Context
- MPEG-21 Vision and Goals

Multimedia Framework Context

- Ubiquity of international communication networks such as the Internet challenges traditional business models
  - Shift from physical to electronic commerce
  - Rights management complexities
- Increasingly complex consumption infrastructure
  - Deployment of coexisting heterogeneous networks
  - Wide range of powerful and flexible terminals
- Standards can provide a common infrastructure for trading digital assets

Components of MM Framework



Multiple Flows and Transactions

- Between any two points there are flows of:
  - Information about content
  - Authentication between peer entities
  - Content
  - Content usage rights
  - Technology usage rights
  - Delivery usage rights
  - Money

Current Practice

- Today's media contain implicit or explicit rules
  - A book can be read and resold
  - A CD may be played, but may not be copied
  - A video cassette is for private consumption, can be rented but may not be copied
  - A public broadcast can be watched because licence fee has been paid
  - A commercial broadcast can be watched because one undertakes to watch commercials
  - A pay TV broadcast can be watched because one has paid a monthly subscription

Future practice ?

- The Multimedia Framework gives unlimited flexibility:
  - One can buy an MPEG-21 Digital Item and:
    - Copy it to a portable device once only
    - Rent it for 24 hours
    - Rent it for 10 playbacks
    - Distribute it to 10 friends and get a copy for free
    - Access it for free at a low quality, and for a fee at high quality
    - ...

There is thus a need to:

- Understand the components within an architecture for e-commerce
- Identify their functions
- Identify the processes they are required to support
- Standardize interfaces
- Achieve interoperability and integration

MPEG-21 Vision Statement

- *To enable transparent and augmented use of multimedia resources across a wide range of networks and devices*
- *An examination of the elements, which either exist or are under development, to build an infrastructure for the delivery and consumption of multimedia content*
- MPEG-21 objectives are:
  - To understand how the elements fit together
  - To identify new standards which are required if gaps in the infrastructure exist
  - To accomplish the integration of different standards

Use Cases

- Joe is planning an anniversary party for his parents. Instead of hiring a DJ, he will create his own "dance CD" using the music kiosk at the local S-Mart store. Though he knows some of the songs by name, in other cases he knows only the performer; a few he knows only by a fragment of a lyric. At the kiosk, he identifies the music using a combination of search criteria; he can hear the selected songs using headphones at the kiosk as it streams from many different commercial music sites found during the search. Once he has selected all the music, he saves the "project" and tells the kiosk to burn the necessary CD(s), providing his credit card to pay for services and usage rights.

Use Cases

- A User, "Sally," will be constructing the advertisement for a User (a magazine) using photos from one of several photography Users (brokers) offering photos "on-line". Sally does an outline of the advertisement using desktop publishing software available from potentially someone who may or may not be a User of MPEG-21 (perhaps an application service provider). Next, she searches and finds several suitable photos from three different commercial Users (photo brokers). She downloads a watermarked image of each to add to her photo light box application, creates the advertising mock-up, and saves it and photo light box in a protected session. Next she sends a pointer to the session to other Users (her manager and their client). After the final photo is selected, it is automatically purchased for use in the publication, the layout is completed, the final advertisement is stored in the project; and another User (the magazine's production department) picks up the ad from the project when producing the final layout for the magazine.

MPEG-21 Specifications

- MPEG-21 is based on 2 essential concepts:
  - Digital Item (DI) ["what"] and
  - Users ["who"]

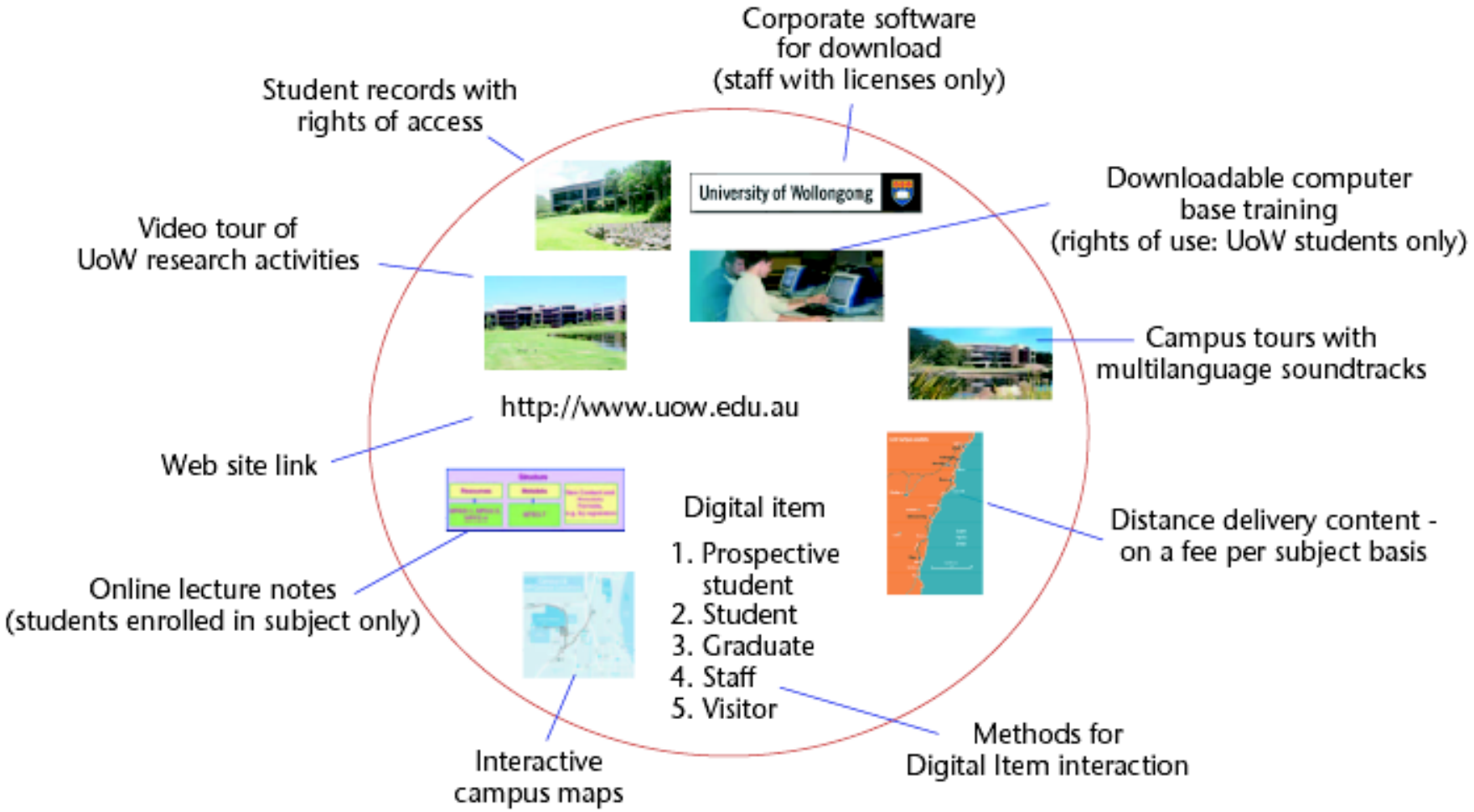
MPEG-21 Digital Item

- A Digital Item is a structured digital object with a standard representation, identification and metadata within the MPEG-21 framework.
- This entity is also the fundamental unit of distribution and transaction within this framework.

MPEG-21 User

- Any entity that interacts in the MPEG-21 environment or makes use of a Digital Item
- Users include individuals, organisations, corporations, communities, consortia, governments, other standards bodies, etc
- Roles including creators, consumers, rights holders, content providers, distributors, etc
- Each User will assume specific rights and responsibilities according to their interaction with other users

Example


Corporate software
for download
(staff with licenses only)
Student records with
rights of access
University of Wollongong
Downloadable computer
base training
(rights of use: UoW students only)
Video tour of
UoW research activities
Campus tours with
multilanguage soundtracks
http://www.uow.edu.au
Web site link
Digital item
1. Prospective
student
2. Student
3. Graduate
4. Staff
5. Visitor
Distance delivery content -
on a fee per subject basis
Online lecture notes
(students enrolled in subject only)
Interactive
campus maps
Methods for
Digital Item interaction

Parts of the Standard

1. *Vision, technologies, and strategy*: describes the multimedia framework and its architectural elements with the functional requirements for their specification
2. *Digital Item Declaration (DID):* uniform and flexible abstraction and interoperable schema for declaring Digital Items
3. *Digital Item Identification (DII):* defines the framework for identifying any entity
4. *Intellectual property management and protection (IPMP)*
5. *Rights Expression Language (REL)*: machine-readable language that can declare rights and permissions using the terms as defined in the Rights Data Dictionary.
6. *Rights Data Dictionary (RDD)*: dictionary of key terms

Parts of the Standard

7. *Digital Item Adaptation (DIA)*: defines description tools for usage environment and content format features that might influence the transparent access to the multimedia content
8. *Reference software*: includes software that implements the tools specified in the other MPEG-21 parts.
9. *File format*: defines a file format for storing and distributing Digital Items.
10. *Digital Item Processing (DIP)*: defines mechanisms for standardized and interoperable processing of the information in Digital Items.

Parts of the Standard

11. *Evaluation methods for persistent association technologies*: documents best practices in evaluating persistent association technologies using a common methodology (rather than standardizing the technologies themselves). These technologies link information that identifies and describes content directly to the content itself.
12. *Test bed for MPEG-21 resource delivery*: provides a software-based test bed for delivering scalable media and testing/ evaluating scalable media delivery in streaming environments.
13. *Scalable Video Coding* (Subdivision to be approved)
14. *Conformance Testing* (Subdivision to be approved)

Part VIII
Digital and Interactive Television

- Overview of Digital TV
- Set-top Architecture
- DVB and MHP

Overview of Digital TV

- digital technology for transmitting/receiving broadcast TV
- replaces analog signals
- requires less bandwidth - digital dividend
- unlike transition to color, new TV or special set-top box required for DTV.

Main Issues

- first new major innovation in nearly 60 years of television
- Digital is superior to analog:
  - flexibility—turns TV into Computer/TV
  - versatility—HD or multiple signals, data
  - efficiency—Less power to transmit
  - quality—no noise/ghosting, perfect signal ???
  - wide screen—motion picture like experience
  - audio—5 channel surround sound, DTS

Costs to TV Broadcasters

- transmission - two signals for transition periode
- new DTV transmitters, antennas.
- local production in Digital or HDTV
- new aspect ratio 16:9 compared to 4:3

Transition North America

- United States
- Dec. 1996 adopts ATSC standard
- FCC Mandate:
  - 1344 Stations delivering in digital (Dec. 2004)
  - Fully integrated HDTV sets by 2007
  - Analog shutoff - December 31, 2006 or when 85 percent of U.S. TV households have the capability to receive Digital TV signals (whichever is later)

The FCC Mandate

- The FCC enforcing a phased introduction of digital tuners into all US TV´s above 13" in size by 2007
- enables "Free-To-Air" Digital TV reception
- enables Digital-Cable-Ready TVs in a phased schedule matching the FCC Mandate

Timeline for Switchover

- **2007**: Andorra, Finland, Sweden, Switzerland
- **2009**: Denmark, Germany, Isle of Man, Norway, United States
- **2010**: Belgium, Croatia, Estonia, Guernsey, Jersey, Latvia, Luxembourg, San Marino, Slovenia, Spain
- **2011**: Austria, Canada, France, Israel, Malta, Monaco, Turkey
- **2012**: Czech Republic, Gibraltar, Ireland, Italy, Japan, Lithuania, Saudi Arabia, Qatar, Oman, UAE, Jordan, Egypt, Bahrain, Iraq, Kuwait, Lebanon, Syria, Yemen, Portugal, Serbia, Slovakia, South Korea, Taiwan, United Kingdom
- **2013**: Australia, Azerbaijan, Bulgaria, Hungary, Iceland, Kenya, Macedonia, Mauritius, Moldova, Namibia, New Zealand, Poland, South Africa, Zimbabwe

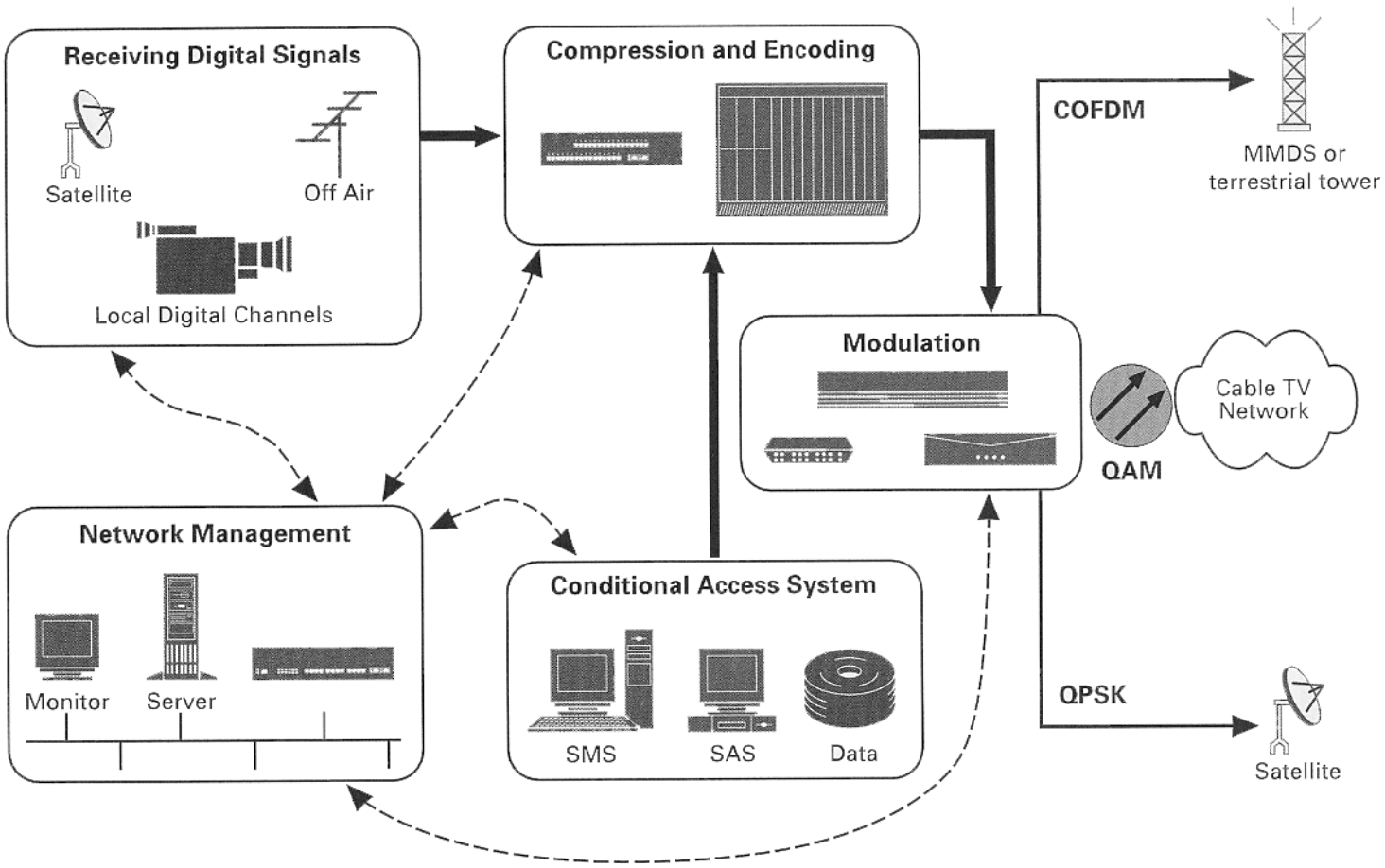
Standard Bodies and Agreements

- European Telecommunications Standards Institute (ETSI)—open forum uniting more than 600 members worldwide; representing administrations, service providers, manufacturers and end-users
- Digital Video Broadcasting (DVB)—inaugurated in 1993; more than 200 members worldwide; including electronic manufacturers, network operators, broadcasters, sw companies and regulatory bodies
- Advanced Television Systems Committee (ATSC)—digital broadcasting and HDTV standards; > 130 members

Standard Bodies and Agreements

- Digital Audio Visual Council (DAVIC)
- European Cable Communications Association (ECCA)—gathering European cable operators with more than 40 million subscribers
  - Eurobox—following DVB standards
  - Euromodem
  - Cable telephony
- Federal Communications Commission (FCC)

Building Blocks of Digital TV



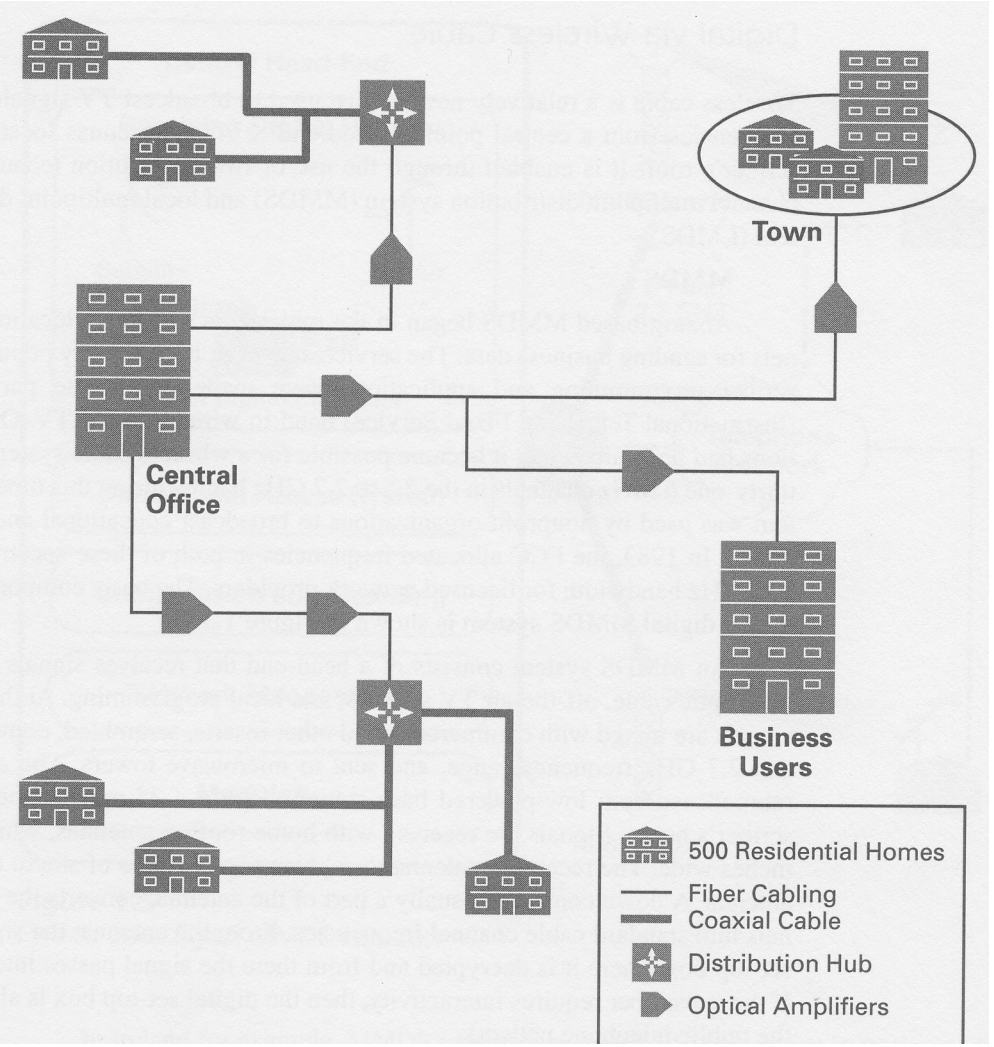
Building Blocks of Digital TV

- compression and encoding
- modulation
  - Quadrature Amplitude Modulation (QAM)—transfer rates up to 40 Mbits/sec, cable companies
  - Quadrature Phase Shift Keying (QPSK)—satellite environment; 10 Mbits/sec
  - Coded Orthogonal Frequency Division Multiplexing (COFDM)—multiple signal carriers, operates well in heavily built-up areas

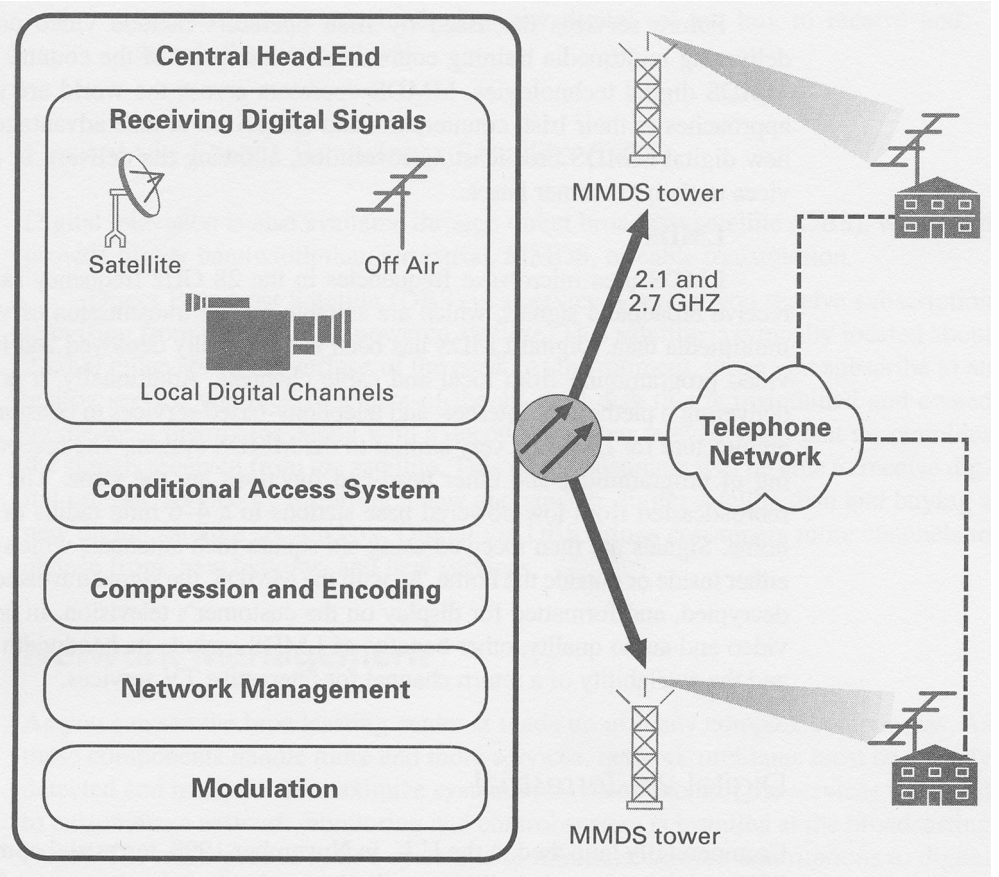
Building Blocks of Digital TV

- conditional access system
- network transmission technologies
  - digital via hybrid fiber-coax (HFC)
  - digital via wireless cable
    - multichannel multipoint distribution system (MMDS)
    - local multipoint distribution system (LMDS)
  - digital via terrestrial (DTT)
  - digital via direct broadcast satellite (DBS)
- network management

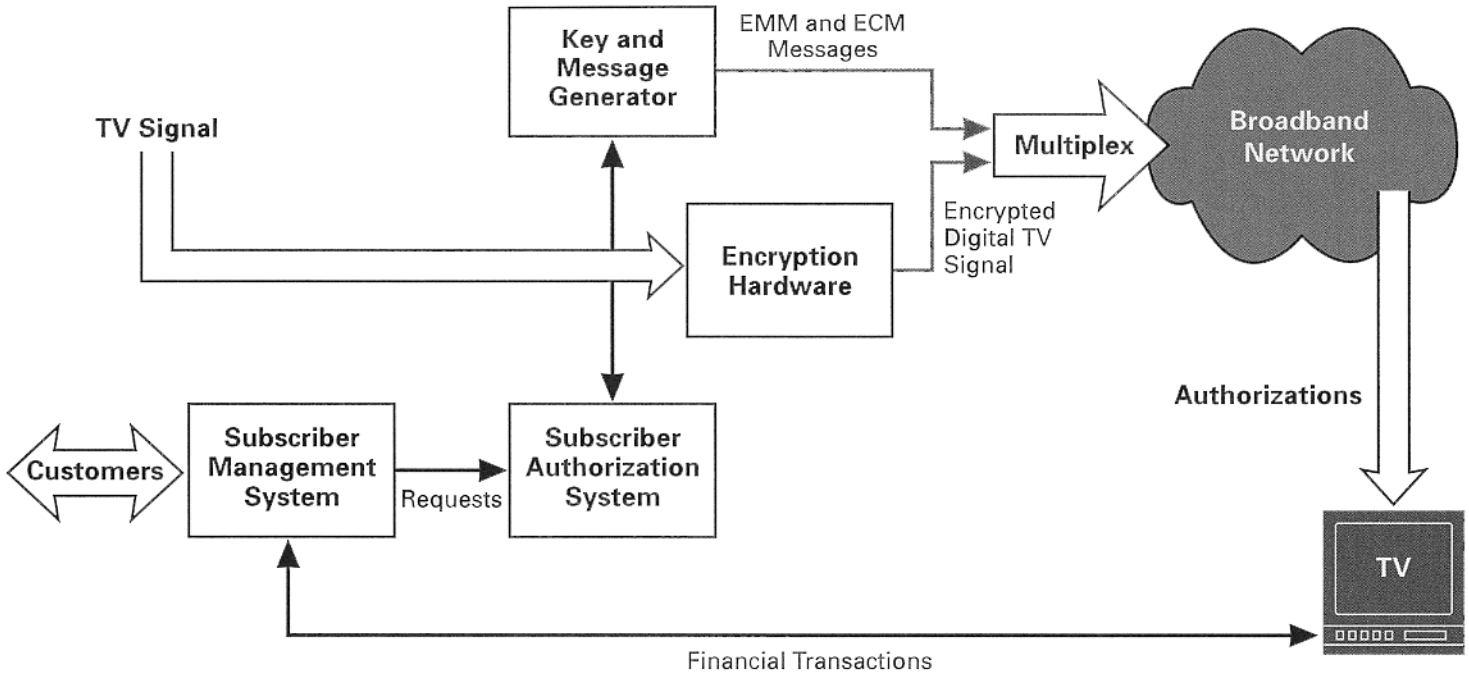
Hybrid Fiber-Coax (HFC)



MMDS


Central Head-End
Receiving Digital Signals
Satellite
Off Air
Local Digital Channels
Conditional Access System
Compression and Encoding
Network Management
Modulation
MMDS tower
2.1 and
2.7 GHZ
Telephone
Network
MMDS tower

Conditional Access System



DVB

- DVB consortium has developed a set of standards for MPEG-2 based digital TV
- platform currently adopted in most of Europe, Asia and Australia.
- enables the play–out of different profiles for HDTV or standard definition television (SDTV)
- frame rates of 30 Hz or 25 Hz.
- for PAL or SECAM; MPEG-2 main profile at main level (MP@ML).

Digital Dividend

- Digital dividend (DD) arises from the switchover to digital TV
- Most of the dividend will be used to provide additional TV programming channels
- The 790–862MHz sub-band (‘800MHz band’) is proposed for use by other services:
  - main use expected to be for next-generation mobile broadband technologies
  - protection from high-power TV transmissions in neighbouring countries
  - emergency services

DD in Österreich

- Studie: http://www.rtr.at/de/komp/DigitaleDividende/DigitaleDividende_Studie.pdf
- Fahrplan Juli 2010 festgelegt
- Versteigerung Ende 2013
- Frequenzbereich zwischen 790 und 862 Megahertz
- Funkmikrofone nützen "Frequenzlücke" zw. 821 und 832 MHz

DVB

- At consumer–side the consumer multimedia home–network (CMHN) interconnects multimedia equipment in a home setting.
- The consumer accesses the services with a Multimedia Home Platform (MHP) compliant settop-box, a standard part of the CMHN.
- MHP is an extension of the DVB digital TV standards for consumer set-top-boxes.
- It basically defines a Java API for value–added services.

DVB

- For value–added applications implementing non-local interactivity, DVB interactive services, a feedback channel is available for two–way information exchange.
- The feedback channel is provided by the ISP through various wired and wireless networks.
- IP–based protocols are typically used in the feedback channel.

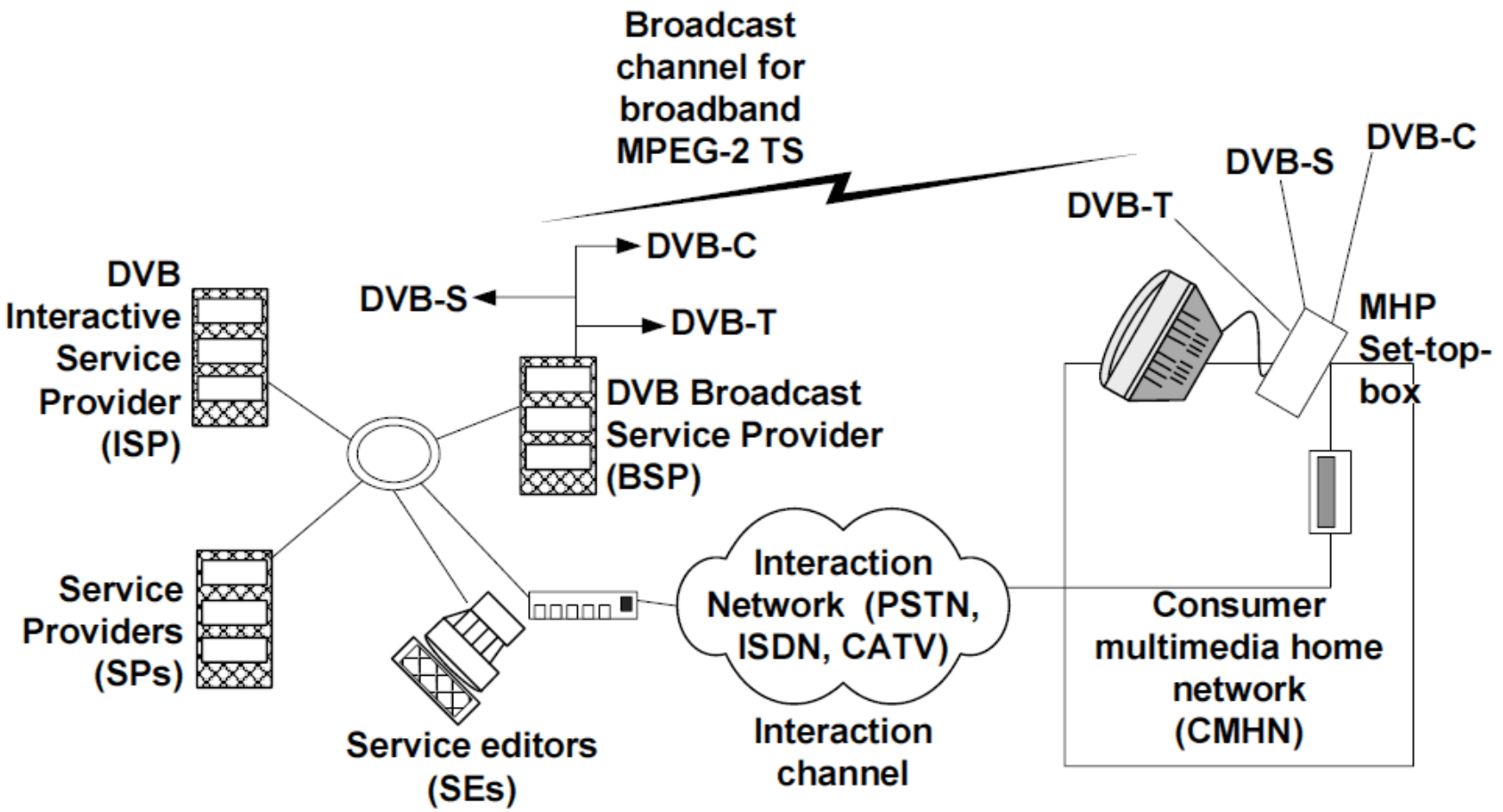
System Reference Architecture

- relies on the following key standards:
  - MPEG-2 transport streams (TS) transmission technology standards
  - DVB-SI service information standards
  - DVB data broadcasting standards based on MPEG-2 and the digital storage media command and control (DSM-CC) protocol
  - DVB interactive service standards including DVB feedback channel standards

DVB Transmission Standards

- transmission of MPEG-2 TS in three physical broadcast media:
  - satellite (DVB-S, QPSK (Quadrature Phase–Shift Keying) modulation)
  - cable (DVBC, QAM (Quadrature Amplitude Modulation))
  - terrestrial (DVB-T, COFDM (Coded Orthogonal Frequency Division Multiplexing)).
- standards share common technical elements enabling a high integration level for TV broadcasting and receiver equipment.

DVB Architecture



DVB Architecture Components

- DVB broadcast service provider (BSP)
- DVB interactive service provider (ISP)
- service providers (SPs)
- service editors (SEs)
- broadcast channel
- feedback channel
- consumer multimedia home network (CMHN)

Set-top Hardware Architecture

evolution

- 1st generation of set-tops—receiving and unscrambling analog transmissions and displaying results
- 2nd generation—basic MPEG decoding, low-cost CPU, 1 Mbyte of memory, low speed return channel
- advanced set-tops—fully interactive, including high-speed data interfaces, extra memory, a powerful CPU, high-speed return channel, ability to process mm content

Main Features of Set-tops

- decoding the incoming digital signal
- verfying access rights and security levels
- displaying cinema-quality pictures on TV set
- outputing digital surround sound, and
- processing and rendering internet and interactive services

Set-top Architecture 1

Archicture is very similar to a standard desktop multimedia computer, it is divided into following categories—

- system board—
- tuners—mostly digital and analog input signals. divided into—
  - Broadcast In-Band—isolates a physical channel from a multiplex of channels and convert to baseband
  - Out-of-Band Tuner—provides subscribers with a medley of interactive services
  - Return Path Tuner—send data back to the interactive services provider

Set-top Architecture 2

- demodulator— converts modulated signal to a digital bitsteam
- modulator—converts a digital bitsteam to a modulated signal
- demultiplexer—splits mpeg2-stream into separate streams video, audio and data of interactive services
- decrypter—prevents unauthorized users from viewing programms
- decoders—data decompression
- CPU and memory
- modems— standard telephone, cable modems. Provide sending requests to web server, uploading files, sending emails

Set-top Architecture 3

- High-speed interfaces—real time communication with DVD-players, Camcorders, CD players...
  USB (12Mbps), Firewire (IEEE 1394, 400 Mbps)...
- smart card readers—authorizes subscriber access to various digital television services
- wireless keyboard—enables subscribers to access internet and interactive TV services through their television

Set-top Operating Systems

Similar to a desktop, set-top box needs an operating system.

Requirements and restrictions—

- very robust and relieable
- only limited hardware resources
- capability to concurrently process a number of tasks ranging from processing incoming mpeg digital streams to validating security messages
- needs to embrace open computer and internet standards whereever possible

Set-top Operating Systems 2

- set-top OS are typically built in layers
  - kernel layer
  - loader
  - drivers
  - APIs
- there is no standard set-top OS; consumer electronics companies promote their own solutions

Set-top Middleware

- Middleware equates to the application, presentation and session layers of the Open Systems Interconnect (OSI) seven-layer model
- is used to isolate set-top application programs from the details of the underlying hardware and network components.
  - Virtual Machines
  - Multimedia Home Platform
  - products: OpenTV, PowerTV, WebTV, MediaHighway, PlanetWeb, ...

MHP

- enabling the reception and presentation of applications in an open framework.
- applications from service providers will be interoperable with different MHP implementations
- applications, networks and MHP terminals can be made available by independent providers
- defines a Java–based API for value–added services in DVB
- relies on the DVB digital TV system reference model with standardized broadcast and feedback channels.

MHP History

1996	Start of the EU-project "Unitel - Universal Settop-Box-Project" aim: developing a common platform for accessing a wide range of digital multimedia services
1997	Activities has been tranferred to the DVB project. Two working groups were set up ❑ DVB-MHP—defines requirements for enhanced TV, interactive TV, internet access in a dual broadcasting/internet environment ❑ DVB-TAM—concentrating on the definition of a common API specification
2000	Specification of MHP has been declared to a *offizielles Norm* by the ETSI *(European Telecommunications Standards Institute)*
2001	German TV operators have agreed on MHP

Multimedia Home Platform

- MHP is a open standard based on Java SW
- MHP standardizes the interface between software of the box (middleware) und TV-application
- MHP isn't subject to any licence
- MHP set-top boxes enable the reception and presentation of applications in a vendor, author, and broadcaster neutral framework
- Applications from various providers will be interoperable with different MHP implementations in a horizontal market
- MHP works on low- to high-end products

MHP

- MHP consists of user terminal (set-top box, PC, associated peripherials) a standard middleware,a suite of APIs that are capable of supporting a range of services
- MHP is based on Internet and web standards and so offers compatibility and convergence between TV and the Internet

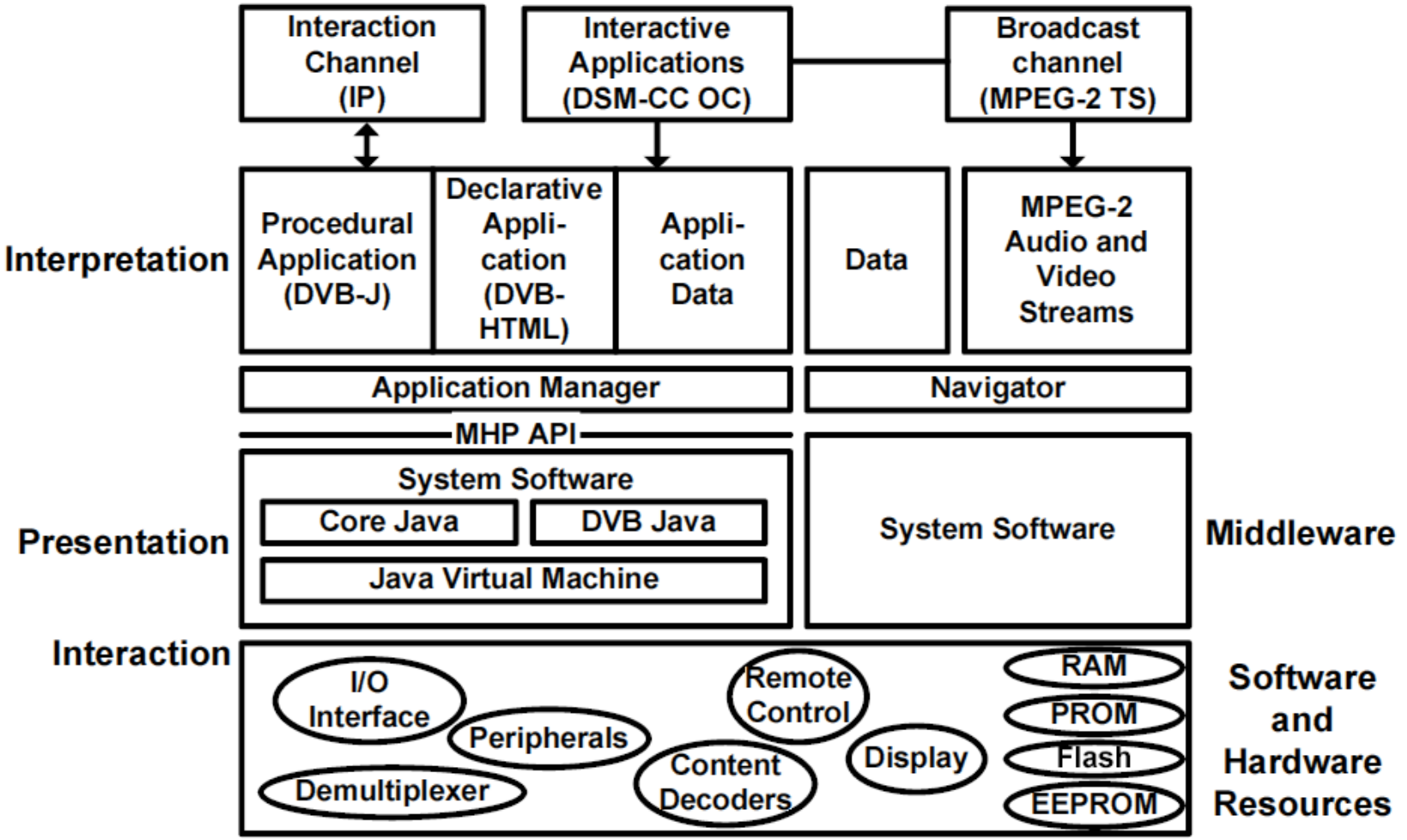
MHP for the Audience

MHP provides three new services for the audience

- Enhanced Broadcasting—provides e.g. enhanced teletext based on html; delivers much more information in a professional layout

- Interactive Broadcasting—allows interactivities like televoting (set-top box with a backchannel is required)
- Internet service — full connection between home TV-equipment and internet (www, email-service.....)

MHP Compliant Receiver Architecture



Categories of Digital Set-tops

Digital set-top boxes can be classified into three categories

- Broadcast TV—only capable of receiving data contained within the mpeg2 stream
- Enhanced TV—additional a return channel: provides VOD, e-commerce, internet browsing
- Advanced services—resemblance to a MM-desktop; high speed return channel: access of internet and interactive services at very high speeds.....

Set-top Internet Applications

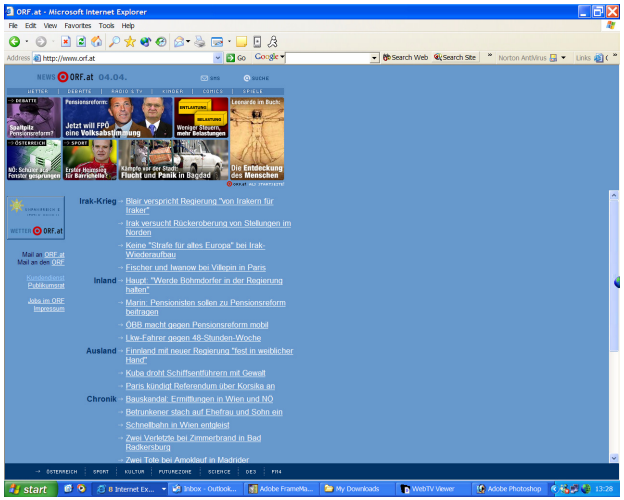
- Set-top application are—browsing, email service, online chat, webcasting
- Four major components associated with an end-to-end TV browsing application—
  - browser —displays content on TV screen
  - Web server—to listen for and respond to requests
  - proxy server—improve performance and optimize for a television environment
  - high speed physical connection to the internet

Browsing—Comparison TV/PC

Web on TV

WebTV-viewer: downloadable at *http://developer.webtv.net/*

Web on PC



Set-top Applications

- Broadcasters' Dilemma
  - Infrastructure in-place to reach most homes—3 Billion TVs worldwide
  - Extensive Investments in Programming Assets—TV, Film, CDs, ...
- BUT:
  - TV is not part of the Internet
  - Interactivity wins over passivity
  - Losing audience to the Internet
  - Advertising

Smart TV - Hybrid TV - HbbTV

- high speed internet access
- multi-user network games
- t-commerce applications
- streaming video and audio
- broadcasting rich multimedia content
- security !