WOCC 2005 Special Session on **Interactive Multimedia**

An Overview of Technologies for E-Learning Application

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Why *e*-Learning (Remote/Distance Education, Distance Learning, Web-based Learning)?

➢ Reasons for e-Learning:

▪ **For individuals that use e-Learning:**

- Cost saving: time, travel
- Flexible schedule, self-driven, and self-paced, on-demand

▪ **For universities that provide distance education:**

- Can attract more students
- To enable students to access their classes anytime, anywhere, even for on-campus students
- USC: 90+ courses available in every fall and spring semester, 25+ courses for summer. MS degrees in various majors
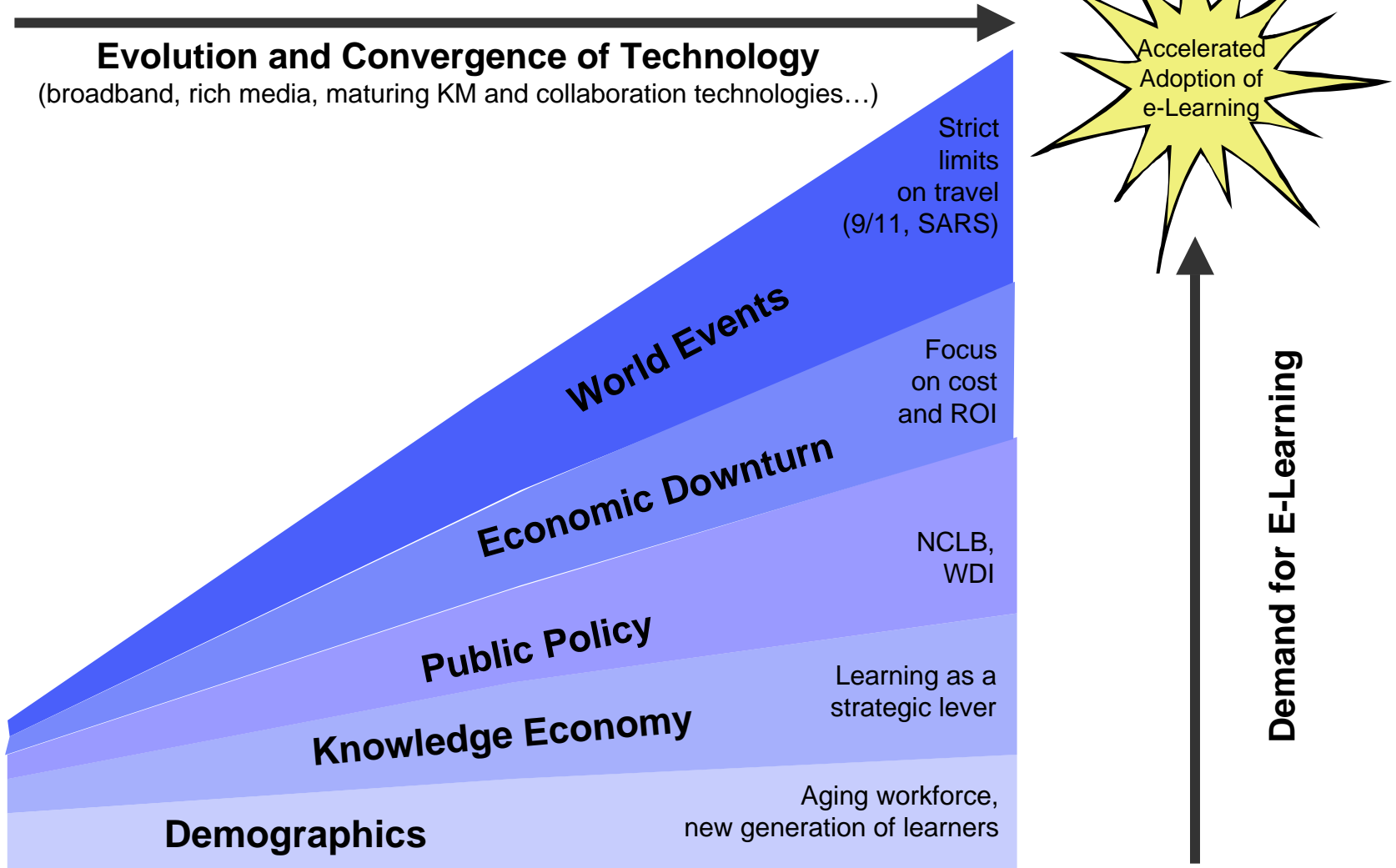
▪ **For industrial organization:**

- Knowledge sharing (*e*-seminars, tutorials)
- Employee skill training
- Customer/partner/supplier education on company products or services
- According to an international data corporation's report, the corporate e-Learning market will grow to 24 billion

A confluence of trends and events have created increased demand for e-learning across all industries….

Evolution and Convergence of Technology
(broadband, rich media, maturing KM and collaboration technologies…)

Accelerated Adoption of e-Learning

Strict limits on travel (9/11, SARS)

World Events

Focus on cost and ROI

Economic Downturn

NCLB, WDI

Public Policy

Learning as a strategic lever

Knowledge Economy

Aging workforce, new generation of learners

Demographics

Demand for E-Learning

e-Learning Trend …

➢ Over the next 3 years, companies will make significant investments in e-learning

By 2005, except for web infrastructure, e-mail and search engines, e-learning will be the mostly used corporate application on the web (0.7 probability) (**source: Gartner**)

An E-Learning System
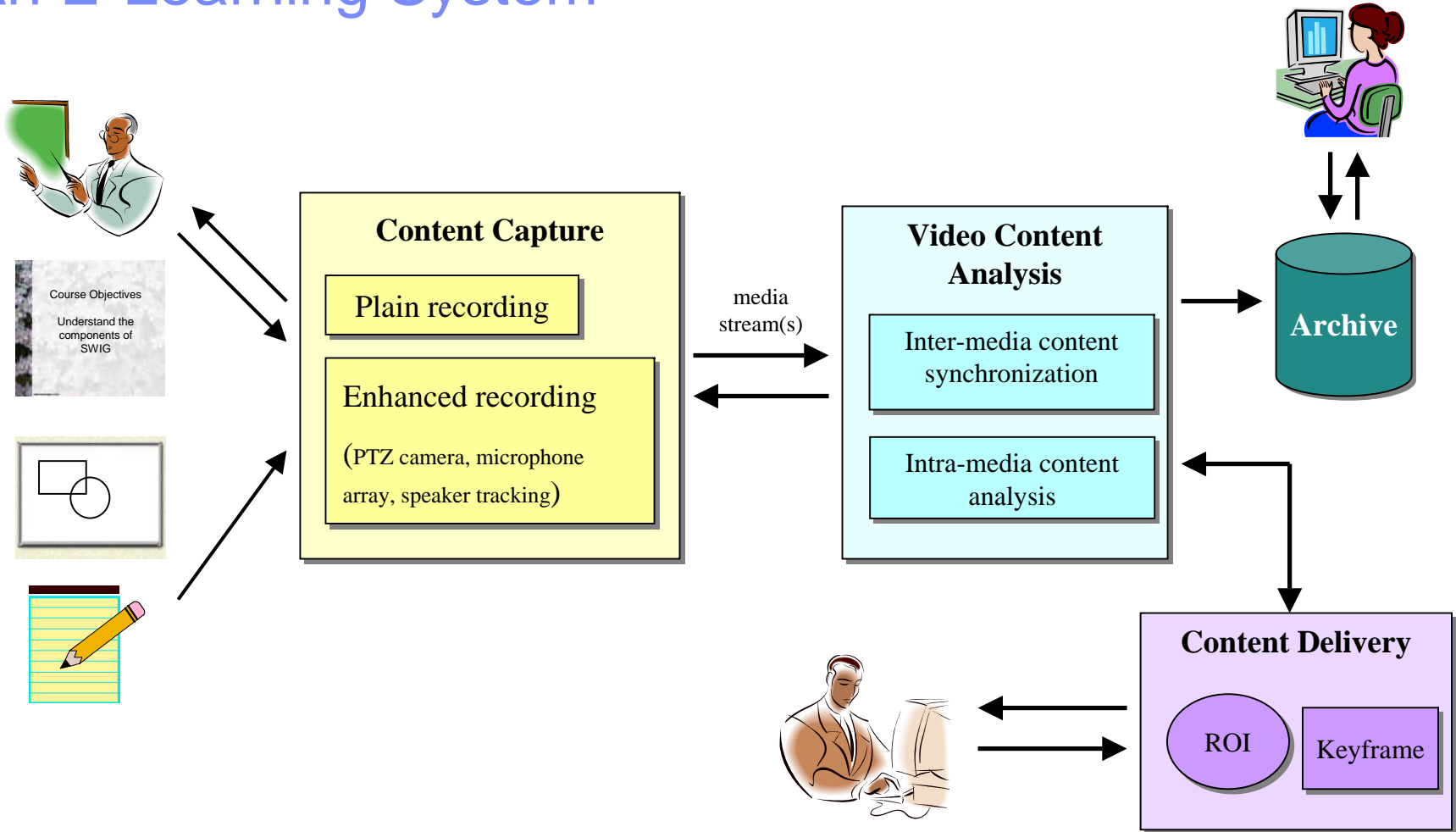
Outline

➢ Content Capture

➢ Content Analysis, Indexing and Retrieval

➢ Content Delivery

➢ E-learning Standards

E-learning Content Capture

➢ **Plain recording**

- Seen in not well-equipped rooms; usually with one camera, mainly focusing on the instructor; no special attention paid to capture audio

➢ **Enhanced recording**

- Multiple cameras or PTZ (Pan-Tilt-Zoom) cameras

- Panoramic video capture

- Multiple content sources (instructor, slides, whiteboard, notes)

- Microphone arrays

- Speaker tracking enabled

- (Semi)-automatic video directing

Panoramic Video Capture With PTZ/Multi- Cameras
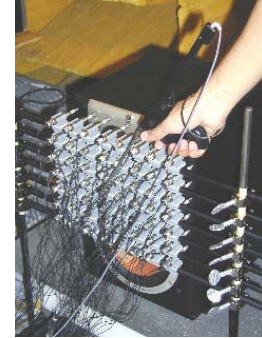

MSR   FX Palo Alto   Ricoh

➢ PTZ cameras could be controlled automatically
  ▪ Microphone arrays
  ▪ Speaker tracking
➢ Enable (semi)-automatic video directing
  ▪ Applying pre-defined video production rules: camera positioning, audience tracking, speaker tracking, shot transition
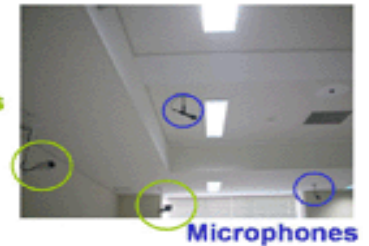
Controlling PTZ Camera

➤ **Using microphone arrays**

- ▪ To locate sound source: instructor, audience

- ▪ To direct the PTZ camera

➤ **Tracking speakers**

- ▪ Use visual cues to locate speaker
  - • Motion, face, gesture

- ▪ Use light-weight hardware devices
  - • Wearable ultrasonic beacons


CARMUL system, Kyoto University

Presentation Slide Capture

➢ Presentation slide: A major content source

➢ Two ways to capture slide content

- Embed in the same video stream with other content sources

- Output as a separate media stream

  - Pre-obtain slides from the presenter
  - Install a plug-in in the presenter's machine
  - Screen-capture software
  - Dedicate a camera to capture slides and store them into a separate stream

Personal Notes/Handwriting Capture

➢ **Excellent access points to lecture recordings**

➢ **Two ways to capture notes or handwritings**

▪ **Separate media stream**

• NotePals, StuPad: compose notes on PDAs and upload to servers separately

▪ **Record notes with slides together**

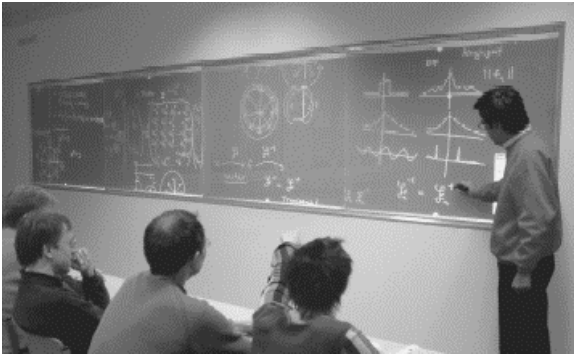• NoteLook, ZenPad, LecternII: compose notes on slides using tablet PC
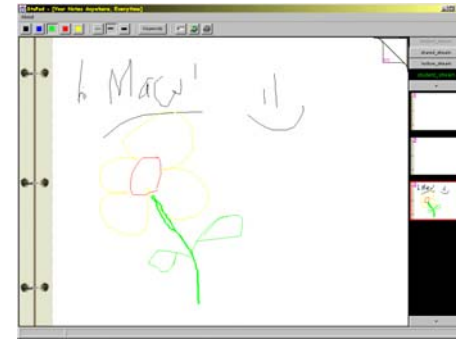
StuPad, George Tech

NoteLook, FX Palo Alto

Whiteboard/Blackboard Content Capture

➢ **Two solutions**
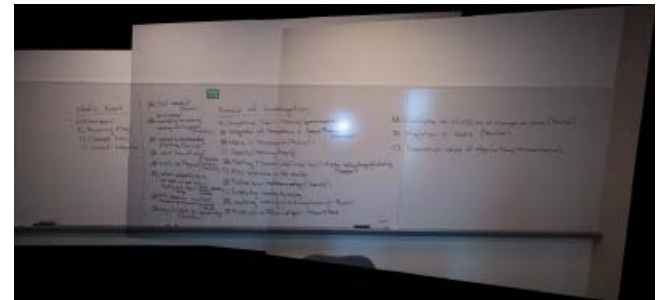
  ▪ **Commercial electronic whiteboards**

    • Automatically record time-stamped pen coordinates

E-Chalk, Freie Univ. Berlin

  ▪ **Image mosaics**

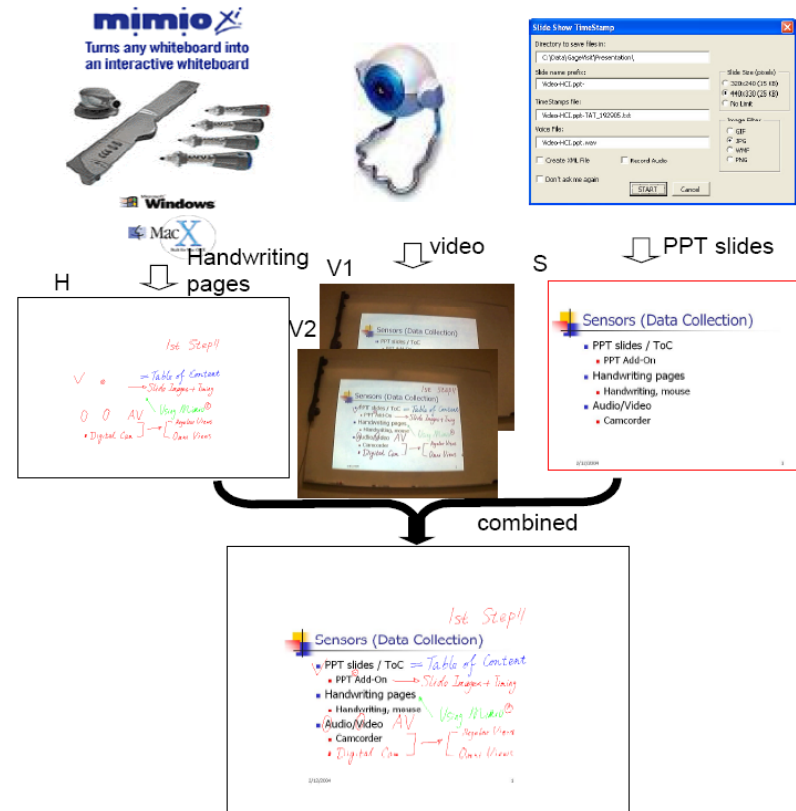   • Capture whiteboard with a PT camera and stitch frames to obtain high-resolution image

MSR

Outline

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- ➢ Content Delivery
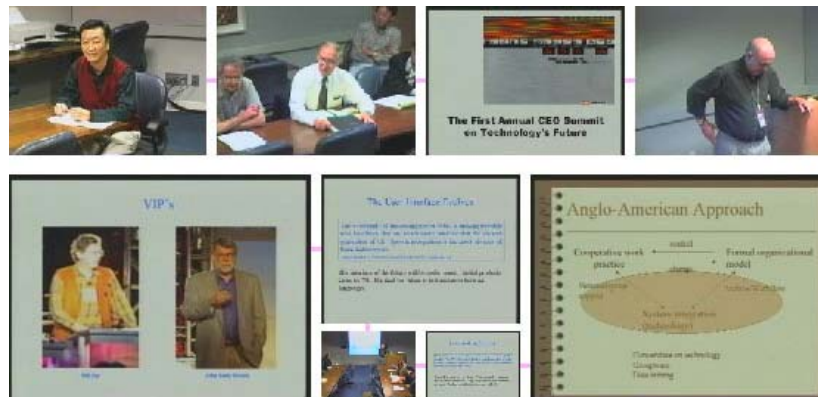- ➢ E-learning Standards

Learning Content Analysis

➢ **Goal**: to facilitate convenient content access, browsing and retrieval

➢ Two types of analysis

  ▪ Inter-media Content Synchronization

    • Link the slide/whiteboard source with the video stream

      – E.g. Identify the point in video stream where a particular slide is presented

    • Link notes/handwritings with the video or slide

    • Synchronize audio with video

  ▪ Intra-media Content Analysis

The City University of NY

Intra-media Content Analysis

- Activity detection and recognition
  - Gesture (hand raise)
  - Discussion (Q&A, classroom discussion)
- Speaker identification
  - Face, voice
- Video content identification
  - Speaker, audience, slide, whiteboard, web-page, notepad
- Narrative structure extraction and content indexing
- Video summarization

FX Palo Alto

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Learning Content Delivery

➢ Many e-learning systems support *on-demand* and *real-time* streaming of lectures with synchronized voice, video, slides, etc.

➢ Some systems support *real-time* and *interactive* sharing of slides and whiteboards

   ▪ *Virtual auditorium*: supports dialog-based distance learning and real-time monitoring

   ▪ *Virtual classroom*: to simulate a real classroom for remote students using interactive Q&A, real-time audio and video

Virtual Auditorium, Stanford University
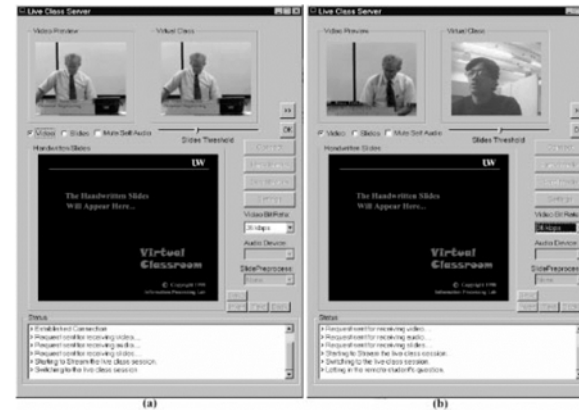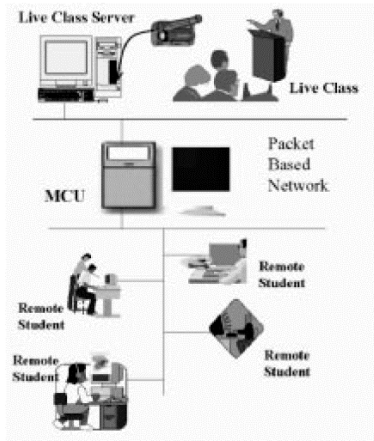
Virtual Classroom, University of Washington

Mobile Learning

- Mobile learning is becoming popular …
- Mobile transmission of e-learning data is challenging
  - Rich media content with limited bandwidth

- **Solution**: *content-aware mobile transmission*
  - Transmit salient content regions (ROI)
  - Transmit optimal (compressed) keyframes with adaptive feedback control
  - Transmit video summary

University of South Carolina

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e-Learning Standards

➤ The Department of Defense (DoD) established **Advanced Distributed Learning** (ADL) initiative in 1997

- **Purpose**: To ensure access to high-quality education and training materials that can be tailored to individual learner needs and made available whenever and wherever they are required

- Developing strategy for using learning and information technologies to modernize education and training on the Web, and to promote cooperation between government, academia and business to develop e-learning standards

➤ A **Sharable Content Object Reference Model** (SCORM) was defined by ADL to enable the interoperability, accessibility, durability and reusability of Web-based learning content

SCORM: Sharable Content Object Reference Model

➢ **SCORM is built on many e-Learning standardization efforts**

- ■ IMS Global Learning Consortium

- ■ The Aviation Industry Computer-based training committee (AICC)

- ■ The IEEE Learning Technology Standards Committee (LTSC) – **Learning Objects Metadata** (LOM) specification

- ■ The Alliance of Remote Instructional Authoring & Distribution Networks for Europe (ARIADNE)

➢ **SCORM LOM overview**

- ■ Nine learning object metadata categories from IEEE LOM specification

  - • General, Lifecycle, Meta-metadata, Technical, Educational, Rights, Relation, Annotation, and Classification

- ■ IMS's XML binding specification for metadata representation

- ■ Describe three content model components

  - • **Asset**, **Sharable Content Object** (SCO), **Content Aggregation**

IMS Content Packaging

➢ **IMS content packaging:** to provide a standardized way to exchange digital learning resources between different systems or tools
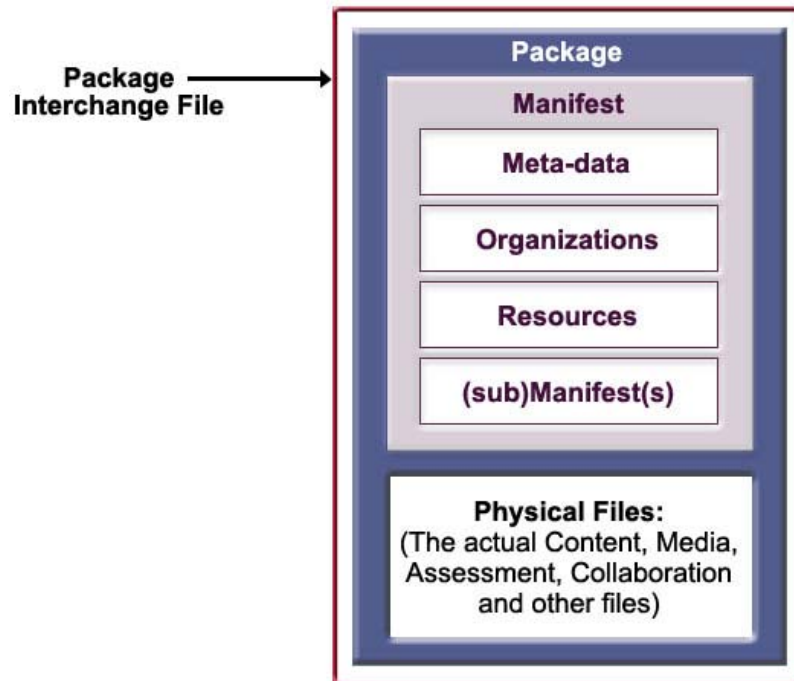
-Single hierarchical organization

- One resource entry for each asset

- Physical files include a Content file and a Metadata file for each asset and any supporting files

SCORM and MPEG

SCORM LOM $\longleftrightarrow$ MPEG-7

IMS Content Packaging $\longleftrightarrow$ MPEG-21
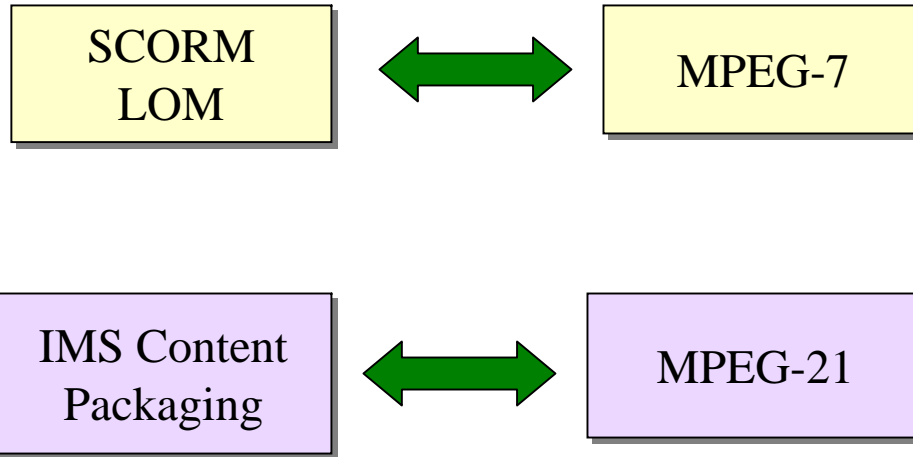
Future Research Directions in *e*-Learning

➢ Convenient and effective e-learning content authoring (e-classroom setup, automatic/smart learning video acquisition, creation, synchronization and editing)

➢ Integrating multiple media modalities (such as visual/face/gesture/gaze, audio/speech, text/handwriting, motion) to better understand the learning content

➢ e-Learning applications: content summarization, browsing and retrieval

➢ Learning content sequencing

➢ Collaborative e-learning