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INTRODUCTION

The recent explosion in the use of media-rich applications has resulted in an appreciation for the value of multimedia content, and a realization of the challenges in managing that content. Web and e-commerce applications found in diverse areas such as medical, financial, retail sales, real estate, government, education, and Web publishing, need effective, efficient, and reliable management of multimedia content.

Managing multimedia content for such applications presents unique issues. Large, relatively unstructured media objects come in a wide variety of complex formats, and need to be associated with the appropriate application information. Loading large volumes of multimedia content into a management system requires: associating the correct metadata; indexing the content for search and retrieval; and, efficiently delivering the multimedia content.

Oracle Multimedia (formerly Oracle interMedia) enables Oracle Database 11g to manage multimedia content (image, audio, and video) in an integrated fashion with other enterprise information. It extends Oracle Database 11g’s reliability, availability, and data management to multimedia content in media-rich applications. As an integral part of Oracle Database, Oracle Multimedia data benefits from all Oracle Database 11g capabilities, including its speed, efficiency, scalability, security, and power. Businesses benefit from the ability to easily locate media content for reuse and repurposing, and from the fact that the traditional business information and media content are kept in synchronization.

Applications can easily add multiple image, audio, and video columns, or mixed columns containing any of these types as objects, to existing and new relational tables.

Oracle Multimedia enables open, standard SQL access using native image, audio, and video data type services. It includes services to facilitate integration with popular Web servers and authoring tools. Applications can access Oracle Multimedia using relational, object, or SQL Multi Media (ISO standard) interfaces. Database applications written in Java, C++, or traditional 3GLs can use Oracle Multimedia through modern class library interfaces, or PL/SQL and Oracle Call Interface (often referred to as OCI).

Oracle Multimedia offers two ways for bulk loading multimedia content into the database. SQL*Loader is an Oracle utility that loads multimedia data from external multimedia files into a table of a database containing Oracle Multimedia object type columns. PL/SQL or Java procedures load multimedia data from BLOB, file system, and URL media data sources into Oracle Multimedia object type columns.
Oracle Multimedia extracts format metadata (information about the media) and associates it with the multimedia content in the media objects. Application metadata can be extracted anytime and returned to the application as an XML object. Downloading or delivery of all multimedia content in batch is supported, as is streaming of certain audio and video formats via popular streaming servers.

Oracle Multimedia provides considerable flexibility in the storage of the actual media. While Oracle Multimedia makes it possible for metadata and media to be stored together within the Oracle Database 11g tablespace, it also provides for storage of the media outside the database making it possible to integrate archival storage. This results in considerable storage flexibility, though with considerable tradeoffs in security and manageability. The media can be easily imported and exported between Oracle databases and these sources. These media storage alternatives include the following:

- Binary large objects, or BLOBs, stored within the database
- File-based large objects, or BFILEs, stored in local operating system-specific file systems
- URLs containing image, audio, and video data stored on any HTTP server, such as the Oracle Application Server
- Specialized media storage servers

Application developers benefit from Oracle Multimedia support within Oracle Application Server Portal and Oracle Multimedia integration with Oracle JDeveloper, a key component of Oracle Internet Developer Suite (iDS), the application development environment for Oracle Java.

**PRODUCT OVERVIEW**

**Multimedia Object Types**

Oracle Multimedia uses object data types, similar to Java or C++ classes, to describe image, audio, and video data. These object data types are called ORDImage, ORDAudio, and ORDVideo, respectively. Oracle Multimedia also includes an object data type known as ORDDoc. This multimedia column type can contain any mixture of image, audio, and video objects, thus increasing the flexibility of its multimedia management capability.

An instance of these object data types consists of attributes, including format metadata and the multimedia content, and methods. Multimedia content is the actual image, audio, or video data. Metadata is format information about the multimedia content, including information such as object length, compression or format, and mimetype. Methods are procedures that can be performed on the object such as import, export, or getMetadata, and processCopy to compress or convert image format.
Applications use Oracle Multimedia by adding one or more multimedia columns (ORDImage, ORDAudio, ORDVideo, or ORDDoc) to existing tables, or by creating new tables with multimedia columns in them (see Figure 1). Any number of these columns can be added to a table, and in the simplest form, this represents the integrated management of relational and multimedia data.

![Multimedia Objects in Relational Table Columns](image)

**Figure 1: Multimedia Objects in Relational Table Columns**

**Multimedia Objects Storage Model**

The Oracle Multimedia objects (ORDAudio, ORDImage, ORDVideo, and ORDDoc) have a common multimedia storage model. The multimedia component of these objects can be stored in the database, as a BLOB under transaction control. The multimedia component can also be stored outside the database, without transaction control. In this case, a pointer, under transaction control, is stored in the database, while the multimedia component is stored in an external BFILE (operating system flat file), at an HTTP server-based URL, on a specialized media server, or at a user-defined source on other servers. Multimedia content stored outside the database can provide a convenient mechanism for managing existing, or legacy multimedia repositories that reside as flat files. This data can be conveniently imported and exported between BLOBs and the external BFILE source at any time.

Object metadata and methods are always stored in the database under transaction control. Whether multimedia content is stored inside or outside the database, Oracle Multimedia manages metadata for all supported multimedia object types, and extracts that format metadata for each type. This metadata includes the following:

- Data storage information including the source type, location, and name
- Data update time and format
- MIME media type
- Image height and width, and image content length, format, and compression type
- Audio encoding type, number of channels, sampling rate, sample size, compression type, play time (duration), and description
- Video frame widths and heights, frame resolution and rate, play time (duration), number of frames, compression type, number of colors, bit rate, and description
Relational Interface

Applications that already store multimedia content in BLOBs, rather than in Oracle Multimedia objects types, can still benefit from the features of Oracle Multimedia through its relational interface. Most of the Oracle Multimedia services are still available to the applications and can be applied to the multimedia content stored in BLOBs.

SQL MM Interface

Oracle Database 11g supports the ISO/IEC 13249-5:2001 SQL/MM Part 5: Still Image Standard. The standard defines object relational types for images and image characteristics. Each object type includes attributes, methods, and associated SQL functions and procedures. While this interface offers only a subset of Oracle Multimedia’s capabilities, using it ensures portability to other vendors who support the standard.

Image Object Type

Oracle Multimedia image services support two-dimensional, static, digital images stored as binary representations of real-world objects or scenes, in most popular file formats and compression schemes. Image file formats provide a convenient means for an application to store an image in a flat file. By publishing the internal layout of such a file, it is possible to use it as an interchange medium between different applications.

A digital image consists of attributes that describe the characteristics of the image, and the image data itself (the digitized bits). The image data (pixels) can have varying depths (bits per pixel) depending on how the image was captured, and can be organized in various ways. The minimum attributes of an image include the following:

- Size (height in scan lines and width in pixels)
- Number of bits per pixel in each of the colors sampled
- Compression type
- Content format

The content format consists of the following:

- Monochrome or bit depth
- Sample model (Band Interleaved by Plane, Band Interleaved by Line, Band Sequential)
- Color model (Lookup Table, Direct), color space (GRAY, RGB)
- Special attributes such as alpha channel or transparency color

Image Formats and Compression Schemes

Oracle Multimedia supports most popular desktop publishing image file formats, including: TIFF, JPEG, JPEG 2000, BMP, TARGA, EXIF, PCX, PICT, GIF,
CALS, SUN RASTER, FPIX, PNMF, PNGF, PPMF, PGMF, PBMF, WBMP, and RPIX. In addition, Oracle Multimedia supports DICOM medical images (DICM).

Developers can easily store images created by applications without becoming experts in image file formats. Oracle Multimedia does not require applications to convert files to and from an internal format for storage and retrieval, ensuring that performance is not degraded.

Oracle Multimedia also extracts key image properties (multimedia metadata), and makes those properties available in the image or document object’s data attributes, thus relieving application developers of the burden of learning subtle format variations. Oracle Multimedia can extract certain metadata formats as XML documents from popular image file formats. Oracle Multimedia can also write or embed metadata into popular image file formats. Metadata is provided as a schema-based XML document. Oracle Multimedia processes the XML document and writes the metadata into the image.

Because there are so many different image formats and many applications support only a subset of them, Oracle Multimedia provides conversion between formats (transcoding), on demand. For example, Oracle Multimedia can convert images from other formats into WBMP, preparing them for use in mobile applications.

RPIX is the uncompressed Oracle Multimedia raw pixel format that makes it easy to access individual pixels for image processing. In addition, the RPIX format can be used as a gateway to import certain proprietary and foreign image formats into Oracle Multimedia. A proprietary or foreign image format can be easily converted to the documented RPIX format by using methods to pass the image format attributes to Oracle Multimedia. Once these attributes have been passed, Oracle Multimedia can process the image, storing, retrieving, and applying image manipulation and conversion methods as needed.

Oracle Multimedia can read and write image data at a variety of bit depths, including monochrome (1 bit), 2, 4, 8, 12, 16, 24, 32, and 48 bits.

Because storage space required for digital images can be large, compression schemes are available to squeeze an image into fewer bytes. Lossless compression schemes squeeze an image so that when it is decompressed, the resulting image is bit-for-bit identical with the original. Lossy compression schemes do not result in an identical image, but the changes may be imperceptible to the human eye.

Oracle Multimedia shields application developers from the complexities of compression technology by allowing them to simply request that images be compressed or decompressed, on demand.

In addition to metadata parsing, format conversion, and compression, Oracle Multimedia provides a set of server-based manipulation functions, including scaling and cropping, useful in preparing image data for general purpose viewing, or input to another process. With these basic functions, preparation of preview or thumbnail image is straightforward. Somewhat more sophisticated image functions offered by Oracle Multimedia include: arbitrary rotation, flip, mirror, gamma correction, contrast enhancement, requantization, and alpha channel. More specialized or sophisticated image processing is left to the middle tier application developer.
Oracle Multimedia DICOM was introduced in Oracle Database 10.2. Oracle Database 11g adds the following Oracle Multimedia DICOM features:

ORDDicom object type
DICOM format support
DICOM metadata extraction
DICOM image processing
DICOM object conformance validation
Making DICOM objects anonymous
Creating DICOM objects
Run-time, updateable DICOM data model

Audio and Video Object Types
Oracle Multimedia audio and video services provide the foundation for digital, audio and video data in Oracle databases. Digitized audio/video consists of the data (digitized bits) and the attributes that describe and characterize the data. The minimum collection of attributes includes the following:

• Source type, location, and name
• Description
• File format
• MIME media type
• Encoding type
• Number of audio channels
• Sample/frame rate and sample/frame size
• Frame resolution and total number of frames
• Number of colors
• Bit rate
• Compression type
• Duration

These data attributes describe or characterize the data as it was recorded or produced by the digital recording device.

Audio Formats
Oracle Multimedia manages industry-standard audio data stored in AIFF, AIFF-C, AUFF, WAV, MPEGI, MPEGII, MPEG IV, 3GP, RealNetworks Real Audio and Microsoft ASF audio formats. It extracts format metadata information on demand from these formats, and stores it as attributes of the Oracle Multimedia audio object (ORDAudio) or document object (ORDDoc). The audio data can be stored either
locally in Oracle Database 11g, or referenced from external sources, described previously under Multimedia Objects Storage Model.

**Video Formats**

Oracle Multimedia manages industry-standard video data stored in QuickTime, AVI, MPEGI, MPEGII, MPEGIV, RealNetworks Real Video, and Microsoft ASF video formats. It enables applications to store metadata information as attributes of the Oracle Multimedia video object (ORDVideo) or document object (ORDDoc). Again, the video data can be stored either locally in Oracle Database 11g, or referenced from external sources.

Where support is defined by the preceding interchange format standards, Oracle Multimedia recognizes compression schemes, including ADPCM and MULAW for audio and AVI Indeo for video.

**Audio and Video Formats**

Oracle Multimedia effectively operates with streaming servers, such as the RealNetworks or Microsoft streaming server, to deliver select formats of audio and video, in streaming mode. An application creates a media presentation with URLs that direct the streaming server to use an Oracle plug-in to retrieve the media data. The URLs contain additional query parameters that the plug-in uses to select the correct media from the database.

If a streaming server is unavailable, Oracle Multimedia can deliver the multimedia information directly to the client in download and play mode. The entire audio or video clip is sent to the application, which then launches the appropriate player.

**Multimedia Content Upload**

Oracle Multimedia provides two ways to bulk load multimedia content into Oracle databases. SQL*Loader loads large quantities of multimedia content very efficiently, using direct path access.

PL/SQL or Java procedures are often used as an alternative to SQL*Loader. An advantage of using PL/SQL or Java scripts to load data is that methods can be called as data is loaded, so that properties can be extracted or thumbnail images can be generated.

**Multimedia Content Storage**

BLOBs, BFILEs, and URLs represent pointers to multimedia storage (see Figure 2). BLOBs are used to store multimedia within the database, under transactional control, optimizing space and providing efficient access. When multimedia data is stored in BLOBs, it is guaranteed to be kept synchronized with other related business data. In addition, it is secured and managed with the same tools as the rest of your database.

BFILES are used to store multimedia data in the local file system. A pointer to a local directory and file is stored in the database, but the multimedia content is stored in the file system. In this case, the multimedia content is not synchronized with other business data. It must be secured and managed separately from your database.
URLs are used to point to multimedia data stored in web servers or user-defined sources. As with BFILEs, the multimedia data is not synchronized, secured, or managed with the rest of your business data.

**Figure 2: Storage Alternatives**

**Multimedia Content Access**

Traditional queries on associated relational data are the primary means of locating multimedia content. Once located, Oracle Multimedia content can be accessed using SQL or PL/SQL through ORDImage, ORDAudio, ORDVideo, and ORDDoc object types.

Where available, the traditional relational information can be supplemented by application metadata carried by the multimedia content, and parsed by Oracle Multimedia. Relational queries are the primary means of locating the multimedia content, but now it is the application metadata that serves as the means of location.

Multimedia recognizes application metadata in JPEG, TIFF and GIF images. Within these images, Multimedia recognizes three payload formats including: IPTC (or IIM), EXIF, (in JPEG and TIFF only) and XMP. IIM4 is a standard used extensively in the newsgathering and press industries. The Exchangeable Image File Format, EXIF, is the standard for image file storage for digital still cameras. The Extensible Metadata Platform, XMP, is a standard format developed by Adobe for the creation, processing, and interchange of metadata in a variety of applications.

Metadata extracted from images is represented as a collection of XML documents returned in XMLType objects. Each document corresponds to one of the embedded metadata types. Each returned document conforms to an XML schema that is registered with the database. Once this metadata has been extracted from the image, it can be stored in an Oracle Database, indexed, searched, and made available to applications using the standard mechanisms of XML DB or Oracle Text.
Support for Web Application Development

Oracle Multimedia combined with Oracle and partner application development tools, deliver a powerful, enterprise-level Web application development and deployment platform.

Internet Integration

Using Oracle Multimedia support for Web technologies, one can easily integrate multimedia data into Web and Java applications. One can also store, retrieve, and manage rich media content in a database. Oracle Multimedia provides a Servlets and JSP Java API that facilitates the upload and retrieval of multimedia data stored in a database using the Oracle Multimedia OrdAudio, OrdDoc, OrdImage, and OrdVideo object types.

Oracle Multimedia Servlets and JSP Java API uses Oracle Multimedia Java API to access data stored in the Oracle Multimedia object types. However, Oracle Multimedia Servlets and JSP Java API can also be used to handle upload and retrieval of data using BLOBs directly.

Integration with Oracle Application Server Portal

Oracle Application Server Portal is used to create useful and appealing enterprise portals. A key feature of the Oracle Application Server Portal is used to create useful and appealing enterprise portals. A key feature of the Oracle Application Server Portal framework are portlets, which provide a convenient way to access any type of data, including rich content such as images, audio, and video. Oracle Application Server Portal has components that give the developer a declarative way to create objects that capture, act upon, and display data from an Oracle table or view. These Oracle Application Server Portal components can be connected together to create Web applications that can be applied directly to enterprise databases. And, as Oracle Multimedia objects are stored in Oracle tables, they can be included in the types of data available to Oracle Application Server Portal components.

Integration with Oracle Application Server Development Framework Business Components

For rapid development of media-rich Web applications, Oracle offers developers a Java integrated development environment (IDE), Oracle JDeveloper that maximizes developer productivity. Oracle JDeveloper enables developers to build multi-tier, component-based Internet applications in Java that use Oracle Multimedia features to create visually attractive applications. Oracle Application Development Framework Business Components (ADF Business Components) is the component of JDeveloper that provides a set of intelligent software building blocks to manage common facilities.

An Oracle Multimedia/ADF Business Components integration package includes media-specific domain classes and a set of utilities. The domain classes are wrappers of the classes of Oracle Multimedia Java API, and inherit all the underlying multimedia retrieval, upload, and manipulation methods. The domain classes support the ADF Business Components APIs and provide built-in integrated multimedia capabilities, while the utility classes support the retrieval, rendering, and uploading of multimedia content. Together, they provide a fully featured, integrated application.
development environment that enables a developer to create a wide variety of media-rich applications.

**Java Classes for Servlets and JSP or Multimedia Tag Library**

Deciding whether to use Oracle Multimedia Java Classes for servlets and JSP or Multimedia Tag Library depends on the type of application you want to develop as well as your level of experience with Java programming.

Java servlets and JSP pages offer flexibility by enabling you to customize the application output. This customization requires a moderate level of skill with the Java programming language, and with servlet and JSP technology. Thus, servlets and JSP pages are best suited for complex applications developed by reasonably experienced Java programmers.

The tags provided by Multimedia Tag Library offer speed and ease of use, allowing you to write simple Java applications requiring little or no customization. JSP tags are appropriate for less experienced Java programmers who want to develop common applications quickly, using limited Java code.

**Integration with Application Express**

Oracle Multimedia can be used with Oracle Application Express. Oracle Application Express (Oracle APEX), formerly called HTML DB, is a rapid web development tool for Oracle database. A user with limited programming experience can develop and deploy professional applications that are fast and secure, using only a web browser.

**Application Development Environments**

Oracle Multimedia is accessible to applications through both relational and object interfaces. Database applications written in Java, C++, or traditional 3GLs can interface to Oracle Multimedia through modern class library interfaces, or PL/SQL and OCI. These applications can easily add image, audio, video, and document columns to store objects in existing and new relational tables. Applications can use Oracle Multimedia to query and retrieve multimedia data in the same manner as any other relational data.

In addition, applications with a JMF player can access and play audio/video from Oracle Multimedia. Oracle Designer can generate C++ classes that enable C++ applications running on the client or the application server to call Oracle Multimedia methods.

**ORACLE MULTIMEDIA ARCHITECTURE**

The Oracle Multimedia architecture is best explained against a typical three tier architecture: database tier – Oracle Database; application server tier – Oracle Application Server; and client tier – thin and thick clients.

**Database Tier**

In the database tier, through the use of Oracle Multimedia, Oracle Database holds rich content in tables along with traditional data. Through a database-embedded Java Virtual Machine, a server-side media parser is supported as well as an image processor. The media parser has object-oriented and relational interfaces, supports
format and application metadata parsing. The image processor includes Sun’s Java Advanced Imaging (JAI) and provides image processing for operations such as producing thumbnail image and converting image formats.

Using Oracle Multimedia methods, import and export operations between the database and operating system files (external file storage) are possible. Oracle Multimedia also supports special delivery types of servers, such as streaming content from a database. Using the Oracle Multimedia Plug-ins for RealNetworks or Windows Media Services, the Helix Universal Server, or Windows Media Streaming Server can stream multimedia data to a client directly out of the database using Real-Time Streaming Protocol (RTSP).

**Application Server Tier**

In the middle tier, Oracle Application Server provides access to Oracle Multimedia through Oracle Multimedia Java classes, which enable Java applications on any tier (client, application server, or database) to access, manipulate, and modify audio, image, and video data stored in a database.

In addition, Oracle Multimedia Servlets and JSP Java API facilitate the upload and retrieval of multimedia data stored in a database using the Oracle Multimedia OrdAudio, OrdDoc, OrdImage, and OrdVideo object types. Oracle Multimedia Servlets and JSP Java API can access data stored in the Oracle Multimedia objects or BLOBs or BFILEs directly.

Developers can also use Oracle JDeveloper and Oracle Multimedia to build media-rich Java applications quickly and easily using the Oracle Multimedia/ADF Business Components integration package. Oracle Multimedia rich content can also be easily and transparently incorporated into Oracle Application Server Portal, which can then be published as portlets.

SQL Developers familiar with the database can develop Web applications that use Oracle Application Server exclusively, and Oracle Database using the PL/SQL development environment.

**Client Tier**

In the client tier, the ability to perform local processing is supported through Oracle Multimedia Java classes, Sun’s Java Advanced Imaging (JAI), and Sun’s Java Media Framework (JMF). JAI and JMF provide a set of APIs for media processing on the client, and Oracle Multimedia Java classes supply direct access to all media types from the client.
Figure 3: Oracle Multimedia Architecture

SUMMARY

Oracle Multimedia is a single, integrated feature that extends the database by storing, managing, and retrieving image, audio, and video data, and by supporting Web technologies for multimedia data. With Oracle Multimedia, multimedia content can be managed as easily as traditional relational data. Oracle Multimedia lets multimedia content benefit from advanced database technology services.

With Oracle Multimedia, the security, administrative controls, performance, scalability, and open access provided by Oracle Database 11g for professionally managed enterprise information systems is available to multimedia content stored in corporate Web sites and media-rich application.