End-to-end management of audiovisual and multimedia content and services - the NLB experience

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Abstract

The National Library Board of Singapore (NLB) manages the National Library, the National Archives of Singapore (NAS) and the Public Libraries in Singapore. It holds a comprehensive collection of valuable Singapore content, including over 4,200 oral history interview recordings, 17,000 music tracks/scores/lyrics and 136,000 audiovisual and sound recordings.

The Sound and Moving Image Laboratory (SMIL) of NAS conserves, digitises and preserves audiovisual recordings for NLB. SMIL recently embarked on a major technology refresh. The capacity for off-air recording of public service broadcasts (such as news, current affairs and documentaries) has been significantly increased. It is also able to capture these recordings in HD, a critical new capability as Singapore will be going full HD by 2016. An automated file-based quality control (QC) system has also been implemented to meet compliance to formats and content quality.
requirements. A media asset management (MAM) system manages the workflow and other tasks such as transcoding and reproduction.

NLB has rolled out several innovative services for its audiovisual and multimedia collections. MusicSG is a digital archive set up to digitise, archive and provide access to all forms of published Singapore musical works. It assembles a collection of music composed or published by Singaporeans, music produced or published in Singapore, and music related to Singapore.

The Oral History Centre of NAS has been collecting stories, and building up Singapore’s treasure trove of memories. The Centre has been aggressively making available, where permission allows, the full interviews online at Archives Online, pushing out close to 600 hours every month since March 2014. It has also leveraged on advancement in voice-to-text and text mining technologies to greatly enhance the search and discover experience of the users.

The Audio-Visual Archives of NAS is also working to make full recordings available on Archives Online, starting with English and Mandarin TV and radio news. Full clips are available onsite while partial clips are available online.

A common media streaming system delivers the audio-visual content for these online services. The streaming system is platform-agnostic, multi-format and device-aware. It also comes with security options to provide the necessary protection of the multi-media content.

To support the entire life-cycle of the wide ranging audiovisual and multimedia content within NLB, a comprehensive, agile and cost-effective information technology (IT) architecture has been put in place. This architecture enables NLB to continue to innovate in the management and delivery of the rich and unique Singapore content to the users anytime, anywhere on any device.

**Keywords:** National Library Board of Singapore, Automated Audiovisual Quality Control, Media Asset Management, Media Streaming, Multimedia Life-cycle Management

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1. **ABOUT NLB**

The National Library Board of Singapore (NLB) manages the National Library, the National Archives and the Public Libraries in Singapore.

NLB promotes reading, learning and information literacy by providing a trusted, accessible and globally-connected library and information service through the National Library and a comprehensive network of Public Libraries. By forging strategic partnerships to cultivate knowledge sharing, the libraries also encourage appreciation and awareness of Singapore’s history through their wide range of programmes and collection on Singapore and regional content. The National Archives of Singapore (NAS) oversees the collection, preservation and management of public and private archival records, including government files, private memoirs, maps, photographs, oral history interviews and audio-visual materials.

Audio-visual materials (including the music, oral history interview recordings and broadcast recordings) make up a critical and highly valuable part of the NLB collection, especially as they often capture the emotions of the people that are not available from the other content.
2. END-TO-END MANAGEMENT OF AUDIOVISUAL MATERIALS

The end-to-end management of audiovisual materials poses significant challenges to libraries and archives. The risk of media obsolescence, particularly for the analogue formats and media, provides the impetus for urgent migration and digitization. At the same time, the broadcast industry has been progressively moving to provide higher definition content to wow the viewers. Off-air recording facilities need to keep pace to capture the content at the highest possible quality.

With the influx of digitized and born-digital audiovisual content, quality control can become a bottleneck. Fortunately, tools are now available for automated quality control of audiovisual content. The storage requirements for such content are tremendous. An hour of video in the Digital Moving-Picture Exchange¹ (DPX) preservation format can be well above 1TB. While disk storage cost will continue to fall, it is still cost-prohibitive to place all content on disk storage. A hierarchical storage strategy is required.

The access of the audiovisual content also poses new challenges due to the proliferation of mobile devices. Moreover, online and on-site access needs to be supported due to copyright requirements.

This paper shares NLB’s experience in the end-to-end management of its growing audiovisual content for access and preservation.

3. SOUND AND MOVING IMAGE LABORATORY

The Sound and Moving Image Laboratory (SMIL) of NAS conserves, digitises and preserves audiovisual recordings for NLB. Older media such as audio and film reels and analogue video tapes that are in NLB’s holdings are cleaned and digitised. Systems are built to ingest new formats, including those in High Definition (HD). The constant need to migrate digital files into newer formats is systematically done to ensure that nothing is lost to technological obsolescence.

Over the last two years, SMIL has refreshed and put in place a state-of-the-art audiovisual infrastructure.

3.1 Full HD support

Singapore’s broadcast industry will go full HD in 2016. With the SMIL audiovisual infrastructure refresh, NAS can now handle HD content, right from the off-air recording, to the preservation of such content. The capacity for off-air recording has also been significantly improved, enabling NAS to capture more channels concurrently.

The new high speed fibre channel infrastructure also caters for 8mm, 16mm and 35mm film preservation in 2K digital file format, providing roughly ten times the quality of previous standard definition (SD) format.

¹ http://www.digitalpreservation.gov/formats/fdd/fdd000178.shtml
3.2 File-based quality control software for audiovisual materials

With the increase in content acquisition through accelerated digitisation and off-air recordings, the issue of quality controls to ensure that only good quality content are preserved and made available becomes more critical. SMIL’s manpower is very lean. Baton\(^2\) from Interra Systems, a file-based quality control (QC) software for audiovisual materials has been implemented. Many format and audiovisual quality checks can now be performed automatically. Detail reports of the QC are generated and kept as records alongside the audiovisual materials (Figure 1).

![Figure 1: Example of file-based audiovisual quality control report](http://www.interrasystems.com/file-based-qc.php)

3.3 End-to-end workflow management

Dalet\(^3\), a media asset management (MAM) solution ties all the pieces together. It manages the end-to-end workflow from acquisition and ingest, to QC and managing the preservation copies in LTO tapes. Since it is currently too costly to store all the audiovisual content on disk storage, the preservation copies are stored in LTO tapes.

The MAM also support other activities at SMIL, including format transcoding, content editing and reproduction.

The MAM manages the integration with the indexing module (where the staff describes the audiovisual records), the content management services (for the delivery of the audiovisual content) and the digital preservation system.

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\(^2\) http://www.interrasystems.com/file-based-qc.php

\(^3\) http://www.dalet.com/
3.4 Handling of re-production requests

The number of requests for the use of NAS materials for re-production has more than doubled in 2014 over 2013, and the trend is set to continue going forward. The handling of re-production requests for audiovisual materials is particularly complicated. The first issue relates to rights as there can be different rights for different segments of the same clip. Moreover, the requests are typically for specific segments of the clips, and NAS would need to ‘cut’ and ‘join’ these segments from the original clips. Finally, the request may need to be fulfilled in specific formats.

The MAM provides a user-friendly environment for authorised NAS staff to handle all these tasks easily and efficiently.

4. MAKING AUDIOVISUAL CONTENT ACCESSIBLE

Videos now form the bulk of the Internet traffic. According to the recent Cisco Visual Networking Index: Forecast and Methodology, 2014-2019 report, ‘globally, consumer Internet video traffic will be 80 percent of all consumer Internet traffic in 2019, up from 64 percent in 2014’. The improvement in the broadband speed has enabled content providers to move towards delivering higher resolution content.

The on-the-go lifestyle has fueled the proliferation of mobile devices. This adds to the complexity when delivering audiovisual content to the users.

In the following sections, we describe several innovative NLB audiovisual digital archives.

5. MUSICSG

MusicSG is a digital archive set up to digitise, archive and provide access to all forms of published Singapore musical works. It assembles a collection of music composed or published by Singaporeans, music produced or published in Singapore, and music related to Singapore. By bringing together a suite of content on Singapore music, MusicSG aims to raise the awareness of Singapore music and provide resources for research and discovery. With over 8,000 tracks, this is also part of the nation-wide initiative to preserve the Singapore heritage.

Figure 2 shows the landing page of MusicSG. MusicSG collects and provides the following digital contents on Singapore music:

- Music recordings
- Album insets
- Lyrics
- Scores
- Articles on topics related to Singapore music
- Biographies

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Majority of the tracks are available for full playback at the NLB libraries due to the copyrighted nature of these content. A 30 seconds playback preview, and the rest of the content (such as insets, lyrics, scores, infographics and interviews) are available online (Figure 3).

Figure 2: MusicSG landing page

Figure 3: Example of online MusicSG content
To cater to the mobile lifestyle of Singapore users, the MusicSG service adopts the responsive web design\textsuperscript{6} approach. It provides an optimal user experience to the users regardless of the device they use to access the service (Figure 4). The music tracks and interviews can also be streamed seamlessly on these devices. More on this in Section 6.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{mobile-friendly-musicsg-service.png}
\caption{Mobile friendly MusicSG service}
\end{figure}

\section{6. ORAL HISTORY INTERVIEWS}

The Oral History Centre of NAS has been collecting stories, and building up Singapore’s treasure trove of memories, with over 4,000 interviews from politicians to street hawkers, medical professionals to prisoners-of-war, artists to entrepreneurs. The Centre has been aggressively making available, where permission allows, the full interviews online at Archives Online\textsuperscript{7} (see Figure 5), pushing out close to 600 hours every month since March 2014.

\subsection{6.1 Automated voice-to-text technologies to enhance search and discovery}

On 27 January 2015, a major refresh of the Oral History Interviews segment of the Archives Online was rolled out. An innovative feature introduced was the ability for the users to ‘jump-to-listen’ exactly at the segments that they are interested in. Automated voice-to-text technology was used to augment the manual transcripts with time-stamps at word level to make ‘jump-to-listen’ possible.

\begin{itemize}
\item \textsuperscript{6} http://alistapart.com/article/responsive-web-design
\item \textsuperscript{7} http://www.nas.gov.sg/archivesonline/oral_history_interviews/
\end{itemize}
The oral history interviews can go into many hours, and they are generally organised into reels of either 30 minutes or 60 minutes. It is therefore time-consuming for the users to locate the exact portion of the audio without the ‘jump-to-hear’ feature. Due to the nature of oral history interviews, the accuracy of the current state-of-the-art automated voice-to-text technology is still not ready to produce a highly accurate transcript that can replace the manual transcripts. The team devised an algorithm that takes the time-stamps created by the voice-to-text technology to enrich the manual transcripts.

Users can now search into the transcripts, jump directly and listen to the segment (Figure 6).

Figure 6: Time markers (highlighted) showing where the word ‘Palmer’ can be found in the recording.
6.2 Contextual discovery of related content via text analytics

Another key innovation introduced is contextual discovery, where related contents are pushed to the users (see highlighted area in Figure 7).

![Figure 7: Contextual discovery of related content via text analytics](image)

It has been well-recognised that the use of appropriate recommendations will greatly increase the usage of the resources. For example, the ‘Customers who bought this item also bought’ recommendations contributed significantly to amazon.com’s revenue.

Text analytics technologies have been used to automatically identify these high quality recommendations of related content. Text analytics is akin to sieving through the text information available for all the materials to identify related resources. The software used in NLB for the text analytics is Apache Mahout running on top of a Hadoop cluster. The users can now easily find all relevant resources, regardless of the collections or formats (Lim & Chinnasamy, 2013).

7. AUDIO-VISUAL ARCHIVES

The Audio-Visual Archives (AVA) Department of NAS creates, collects, documents, preserves and disseminates audiovisual recordings of national and historical significance. These recordings serve as valuable research resources on Singapore. Some of the key highlights include:

- Audio recordings of Legislative Assembly (1956-1965) and its successor Parliament (post-1965)
- Berita Singapura news magazine films in four official languages and Chinese dialects documenting the economic and social-cultural developments of Singapore in the 1960s
- Educational television programmes produced from 1967 to 1983 for schools on language teaching, science, mathematics, literature, geography and civics
- Public service broadcast programmes that promote social values, racial harmony, as well as celebrate our culture and heritage
- Home movies donated by private individuals on early Singapore in the 1940s to 1970s
- Audio recordings from Rediffusion, Singapore's first commercial and first cable-transmitted radio station
- Music albums of local artistes from 1960s to 2009

AVA is also working to make full recordings available on Archives Online\(^8\), starting with English and Mandarin TV and radio news. In accordance with the current access rights, the viewing of the full clips is restricted to onsite while the partial clips are available online. At the time of this writing, the full clips of over 10,000 audiovisual records have been made available at the Archives Reading Room\(^9\). Efforts are also on-going to work with the content owners to significantly extend the access to these audiovisual records.

### 8. COMMON MEDIA STREAMING SYSTEM

Singapore has one of the highest mobile penetration rate in the world of around 150\(\%\)\(^{10}\). With the proliferation of mobile devices, it is critical that the audiovisual content can be streamed seamlessly on all devices. Different devices have different supports for audio-visual content. For example, Flash-based playback players will not work on iOS. Recently Android drops the support for Flash too. Moreover, the users have also come to expect a modern and seamless experience similar to YouTube and Spotify.

NLB has put in place a common media streaming system to deliver the audiovisual content for these digital services. The robust and scalable streaming system is platform-agnostic, multi-format and device-aware. It also comes with security options to provide the necessary protection of the multi-media content.

Figure 8 shows the streaming of oral history interviews on various devices.

The media streaming platform handles both onsite and off-site streaming. This is an important feature to meet copyright requirements. Moreover, the platform has been designed to leverage on Content Distribution Network (CDN) to cater for the event of an anticipated high access.

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\(^9\) [http://www.nas.gov.sg/nas/ArchivesReadingRoom/AboutArchivesReadingRoom.aspx](http://www.nas.gov.sg/nas/ArchivesReadingRoom/AboutArchivesReadingRoom.aspx)
At the inception of the media streaming platform, both cloud-based streaming and locally hosted streaming options were carefully considered. On top of the need to provide high assurance on the protection of the copyrighted content, it was also found that the cloud-based options available would incur significant more storage cost given the ‘low-access, high storage’ nature of digital archives.

The locally hosted robust and scalable media streaming platform is a component of the Service Enablement Architecture that NLB has established to enable many of its digital services. The common media streaming platform simplifies the delivery of audiovisual content based on established integration workflow and standards. This shortens the time needed to introduce new services. There are also less teething technical issues since the platform has been thoroughly tested. The sharing of the common streaming platform resulted in a lower total cost of ownership.

9. CONCLUSION

Libraries and archives are confronted with two key challenges managing their growing audiovisual collections for preservation and access. On one hand, there is an urgent need to digitise the valuable and at times irreplaceable content residing on at-risk analogue media. At the same time, new audiovisual content are created more rapidly and at much higher resolution. There is therefore also an urgent need for libraries and archives to keep pace with these developments on born-digital audiovisual content.

To support the entire life-cycle of the wide ranging audiovisual and multimedia content within NLB, a comprehensive, agile and cost-effective audiovisual and information technology (IT) architecture has been put in place. This architecture enables NLB to continue to innovate in the management and delivery of the rich and unique Singapore content to the users anytime, anywhere on any device.
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