

Personalized Radio: Using an Integrated Management System to Uniquely Personalize Radio Content

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Abstract—The personalization of curated radio content has long been a holy grail for the radio broadcast industry. A service that combines both a high quality curated listening experience with the ability for the user to personalize the delivery of content based on their explicitly expressed preferences results in a win-win for the user, and significantly improves the overall listening experience over either individual capability. However, accomplishing these concurrent objectives is not easy and demands an integrated end-to-end content delivery management system. In this paper the challenges and benefits associated with providing ‘personalized radio’ and an integrated management infrastructure that will accomplish these objectives are described. The paper includes a perspective on early user feedback on curated personalized radio.

Index Terms—personalized radio, recommendation system, curated radio, content automation.

I. INTRODUCTION

Radio has been a staple entertainment distribution format since the earliest days. Furthermore, radio has continually transformed over the years. Initially improvements were focused on the studio, working from live delivery to prerecorded delivery, supporting the introduction of clean crossfades through automation, hosted introductions, and carefully curated content¹ by specialist Audio Programmers. These changes ran concurrently with improvements in radio distribution technologies. However, throughout this evolution the essence of radio broadcast remained unchanged – delivering the same audio to many listeners concurrently. The Internet, with its ability to deliver different audio content to each listener enabled new models, including automatically generated Personalized Song Streaming based on estimated user interest and feedback. This paper provides insights into the next stage on this journey, providing a combination of IP streaming services with personalization of *curated* broadcast quality content. Unlike the streaming of songs based on automatically inferred preferences, this latest development requires an end-to-end systems management approach, starting from content creation and annotation through its distribution, interaction with end user preferences, and recommendation.

Once complete, as indicated in Figure 1 the *end user* is able to personalize a channel’s *curated audio content*, based on

¹ Curated content in this context refers to a manual process by which content is augmented with metadata that describes the content in a number of distinct dimensions.

audio programmer characterizations of the channel. This offers the best possible audio experience - a professionally curated radio playlist shaped by listener personalization. The end user experience for a particular channel will be based on a combination of both end user specified preferences and inferred interests.



Figure 1. User Personalized Radio

In Personalized Radio each personalized channel has associated with it a limited set of ‘sliders’ that permit the user to express their preferences along distinct audio axis (e.g. tempo, variety, sound for a ‘Best of Rock’ channel). Figure 1 illustrates the sliders displayed on a mobile application. The function and label of controls (sliders) and the range of adjustment will vary from channel to channel. Each personalized channel has an established default which will conform closely to the base channel experience. Customization will therefore reflect a departure from the existing channel.

Examples for curated slider settings defined for channels (i.e. settings that cannot and cannot be inferred from automated audio analysis of the music) from one service provider are –

Hits Tunes
Popularity: Hit Bound – Top Hits
Style: Pop & Rock – Pop & Rhythm
Teen Pop: Less Teen Pop – More Teen Pop

The Best of Rock
Tempo: Chillin’ – Groovin’

Variety: Lost Hits – Top Hits
Sound: Disco/Soul – Rock

The remainder of the paper is organized as follows. Section II provides a brief review of radio content delivery up to and including curated personalized content delivery. Section III describes the necessary architectural elements required to support curated personalized content delivery. Section IV describes a controlled study as to how the service is perceived. The paper is concluded in Section V.

II. PERSONALIZED CONTENT DELIVERY

The progression from delivering audio content over the airways to personalized content delivery has been an evolution.

A. Traditional Radio Broadcast

Audio broadcast content delivery has a long history. Early content delivery over the airways started in a commercial sense with the radio news program in the 1920s by station 8MK in Detroit, Michigan and has since been stable of modern life providing music, news and comedy to millions of listeners.

B. The Internet and Streaming Music Services

Recent models for audio streaming rely on the delivery of content over the Internet. These models have a fundamentally different flavor from true broadcast in that they are really delivering content over direct communications between the content service provider and the end user. In such a system it is typical that content is placed in a content delivery network (CDN), e.g. Akamai, to permit caching the content across hundreds (or thousands) of servers before delivery to individual users. There are a range of IP radio broadcasters that fall into this category e.g. iHeartRadio, Live-Radio.net and Live365, these providers permit users to easily access any one of thousands of IP based streaming radio channels. These channels cater to almost every taste, but for a particular channel they deliver the same content to all listeners.

C. The introduction of Personal Recommenders and Social Media

Personalized content delivery using a recommendation engine provides a differentiated value proposition. In this model, song play lists are constructed based on individual users' taste preferences by a software 'recommendation engine'. [1,2] Songs (audio content) are automatically analyzed and annotated with metadata tags based on characteristics extracted from the content (e.g. tempo, song type, lyrics, etc.). Users provide initial direction to the recommendation engine as to which songs they wish to listen to, and provide feedback on the songs that have been recommended (e.g. like / dislike). The feedback provided by the user influences subsequent playlists. This feedback capability leverages the advantages of the Internet as a bidirectional communications media in a manner that RF broadcast cannot. An example of this category is Pandora.

This model can be enhanced by the introduction of metadata scraping from a variety of social media sites based on listening favorites, (e.g the extraction of users 'followers' from Twitter allows a user's interests to be inferred). This collective

information, the tagged annotation of audio clips, the users expressed interests, and their user defined preferences provides a conduit for the recommendation engine to select music based on users implicitly and explicitly stated interests. However, while the recommendations increase the dominance of user preferences, they do so at the expense of the expert audio curation, which is not typically accessible to the recommender.

D. Delivery of Curated Personalized Radio – Radio and Users Merge

To combine automated audio ingestion/recommendation, and radio broadcast audio curated content, it is necessary to introduce an end-to-end systems approach for the management of the audio content. In essence, it is necessary for the audio metadata elements associated with content curation of the broadcast service to make their way to the recommendation systems, and to permit the user to modify the *curation centric* selection of content via user adjustable controls. This requires a fundamentally new approach to delivery of tagged metadata to the recommendation systems, and the construction of audio programming curation rules for these tagged elements. The user experience for this is as depicted in Figure 1, and is accomplished using the systems approach as described in Section III and depicted in Figure 2.

III. A SYSTEMS VIEW TO ADDING THE RADIO EXPERIENCE TO PERSONALIZED

The delivery of curated personalized radio is best appreciated by considering Figure 2 which shows the functional elements that comprise the integrated Personalized Curated Content delivery management system.

A. Delivering Personalized Demands Integrated Systems Management

The primary functional actors and roles are provided in Figure 2. These are the Service Provider, the Distributer, the Recommender, the Client Device and of course the User. More fully, these roles are:

The *Service Provider* is the public service of personalization. The Service Provider defines and delivers the services, makes available the original content, owns the relationship with the client, and manages billing and reporting for the services.

The *Distributer* is responsible for the distribution of audio content and metadata to the clients. It is the repository for client personalization data, and for initiating the interaction with the recommender to obtain recommendations.

The *Recommender* is responsible for providing a short list of recommendations based on channel content, channel specification and user preferences.

The *Client Device* is the mobile device and/or browser application that provides the continuous delivery of audio content and metadata. Delivery is supported using an Application that will access both Distributer and Client Device

API's. Popular mobile platforms are iPhone and Android, popular browsers are IE, Firefox, Safari and Chrome. End Users are consumers of a sequence of audio clips. Audio is provided by the distributor based on recommendations provided by the recommender. End Users have associated personalization data and manipulate slider settings.

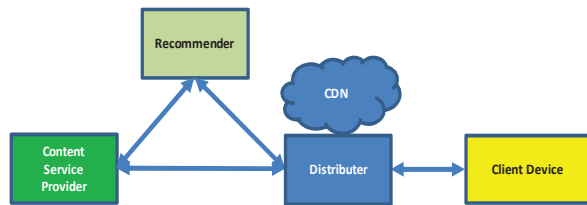


Figure 2. Personalization System Architecture

The interaction sequence for delivery of content to the End User is depicted in Figure 3. Overall, the service operates in steady state by the Client Device requesting a short playlist of clips (e.g. 2 or 3) to play, and providing real-time feedback as to content consumption. The interaction sequence between the key actors is illustrated in Figure 3, steps 1-7. The playlist as provided by the recommender takes into account several different playlist aspects:

- The default channel characterization based on an expert programmer's specification of the channel.
- The end user's slider preferences that indicate a particular preference on a preference axis as made available by the expert programmer.
- The end user's expressly indicated musical preferences, drawing on any previously indicated preferences for particular artists, genres, songs, social media likes (with user consent) etc.
- The end user's indirectly indicated musical preferences, drawing on their previously played songs, etc.
- End user actions, e.g. the skipping the song, replaying the song, etc.

As an audio clip nears completion, the recommender provides an update to the short play list reflecting the end user's ongoing interest in the channel and taking into account any actions they may have made.

Concurrent with the playback of content, the channel itself will be augmented with new musical content. This content appears asynchronously from end user musical playback, but must be carefully managed to ensure that only content that has been fully curated is recommended for play. This sequence is illustrated in Figure 3 steps A-D.

A key element to the creation of the curated content is the annotation of clips in such a way as to provide a pleasurable listening experience that conforms to the end user's expectations. Details on the annotation of the content, and the manner in which playlists are constructed by playlist scheduling systems is beyond the scope of this paper, however details on tagging in general are available in [1,2].

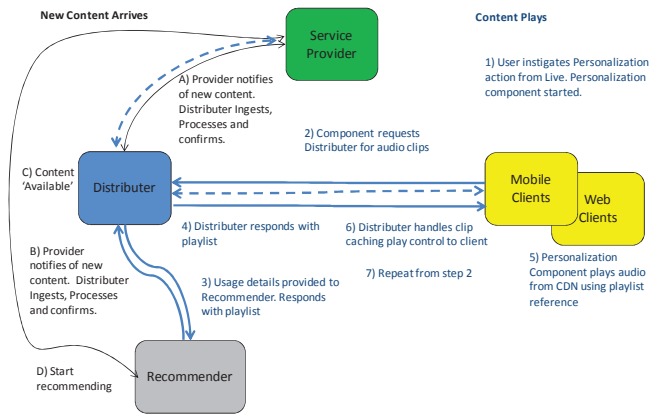


Figure 3. Content Delivery and Updates

A few pertinent points are made:

- Creating a channel that is pleasing to a wide audience and conforms to their expectations is an art not a science. The audio programmers who create and maintain these channels are expert at what they do.
- Channels are frequently defined by annotating clips using very esoteric curation elements (e.g. 'best in breed', 'thought provoking', '70s/jazz fusion' etc.) and rules that select clips based on these annotations. This cannot be easily extracted by audio analysis.
- Channel personalization (i.e. a specification of a set of sliders that an end user can adjust to 'personalize' the channel), like channel specification, is an art and not a science. The audio programmers who create and maintain personalized channels have to think not only about a satisfactory listening experience for the channel defaults, but how best to 'characterize' the personalization of a channel. The elements associated with personalization of a rock channel are very different from the elements of personalization of a comedy channel.

The interaction between the channel specification, the track specification and recommender are illustrated by Figure 4 which imagines a channel called 'The Best of Rock'. The left portion of figure 4 provides a view into characterization of a set of clips (i.e. songs and other audio elements) that form a catalog. Each song is described by a set of tags that are generated both by curation and by automated audio analysis. In figure 4 Song 1 has four custom tags, *category*, *tempo*, *sound*, and *region*. In a fully populated service there might be 20 or more custom tags annotated by curation, and another 20 or more acoustically derived by audio analysis. The right portion of figure 4 provides a view into the characterization of the channel. The channel specification includes a set of rules that dictate the audio experience for the channel, without consideration to personalization. This set is called the *default channel rule set*. In addition, as described earlier, the channel is permitted to be 'personalized' in accordance with programmable sliders. In figure 4 the channel can be

personalized with sliders for the tempo (from Chillin' to Groovin'), the variety (from Lost Hits to Top Hits), and the sound (from Disco/Soul to Rock). Each slider position leverages a set of rules that can be dynamically loaded/unloaded by the recommendation engine based on the slider position. These augment the default rule set. For each slider, the effect in question (e.g. tempo) is established using rules against the custom tags that are available to each of the clips. Again, looking at Figure 4, the tempo slider effect can be accomplished directly by creating rules leveraging the tempo tag associated with each clip, e.g., "if the slider is set to Chillin' increase the proportion of clips that have a tempo < 100". It is possible that some sliders may use several custom tags to represent the effect that is being sought.

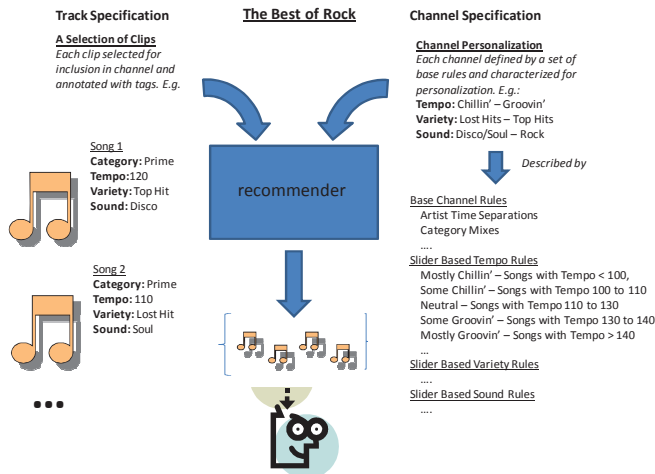


Figure 4. Recommendation and Channel Rulesets.

IV. USER PERCEPTIONS OF PERSONALIZED RADIO

As part of the user experience design, and also during quality assurance prior to service launch, the authors commissioned a user perception review of personalized curated content. The trial was conducted by a selected set of existing satellite radio subscribers. The sample pool was small, but sufficient for statistically significant responses to be obtained.

1) Research Protocol

Users were directed through access to the new service in a systematic fashion by the following research protocol.

a) Introduction to Music Listening Preferences

Provide a background survey questionnaire, e.g. what role does the streaming music and talk play in your professional or personal activities?

b) Walk Through Current Experience

Walk the participants thru and answer any questions participants have about the current experience.

c) Introduce the Service

As we introduce the feature, we probe with many questions about Personalization. What do you expect this feature will do? When might you use it? What channels would you use it on?

d) Ecosystem Integration

Have each listener pick which device they want to explore first. Have them explore its functionality. Have them think out loud. Have them articulate what feels different/similar across all the devices? Have them show us what they mean.

e) User's Cognitive Model for Personalized Service

Finally the test team shifted the roles, acting as if we had never heard of the new feature, we had the listeners explain to us what this new feature was. This allowed us to gain insight into how they interpreted and understood the personalization feature.

2) Results

Although not the focus of this paper, the results of the personalization service were overwhelmingly positive.

a) Personalization Feedback

"Love the Feature." Overall, it sounds like listeners were almost always enthusiastic about using this feature if it were available. "If I could still get the content I was looking for, I would probably always listen to the customized version."

b) Audio Feedback

"Sounds Great!" Overall, participants enjoyed a continuous audio listening experience that provides no dead air, provides direct feedback and changes songs immediately in response to slider movements. Each station-specific DJ works with the personalization audio programmers keep the notion of "Radio" alive.

I. CONCLUSIONS

Since its inception, radio has gone through a process of continual transformation, working from live delivery to curated content, from Broadcast to Satellite, Internet, and Personalized Song Streaming. This paper provides insights into the next stage on this journey, providing a combination of IP streaming services with personalization of carefully curated content. Unlike the simple streaming of songs based on automatically inferred preferences, this latest development requires an end-to-end systems management approach, starting from content creation and annotation through its distribution, interaction with the end user preferences, and recommendation. An end-to-end systems approach is not easily accomplished but provides flexible content delivery options. Overall, the initial feedback from this service has been overwhelmingly positive.

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